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Preface

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Challenges to researchers, corporate CIOs and even to all levels of ICT industry professional are numerous. We have had to survive years of restrictions in ICT investments and university budgets, we have had to realize shortcuts of our budgets, human resources and upgrading our infrastructure. Maybe these years are over, but the Canaan will never be back, for sure! The reasons are of twofold: first, the rapid development of the ICT technology seems to be too fast for industrial and governmental decision makers, second, we suffer of lack of number and appropriate portfolio of ICT human resources. Statistics say about a million jobs will be opened in some years caused by clouding technology only in the EU – and what about Big Data, online analytics, mobile applications, BYOD and other main trends, not to mention security issues. The EU higher education system delivers only approximately 100,000 professionals: no wonder why big international ICT companies establish their own training and certificating systems, indoor education, eLearning courses and others. In between, thousands of new applications knock on the door and managers face to make a hard decision: pour more budget to develop the corporate information asset, the ICT architecture, the suspicious ICT labor – or make a turn and finance marketing, better production management, logistics or any other business functions?

These are the challenges to face on these OGIK/ISBIS Conferences. Respondents have been invited to contribute and we have had dozens of submissions. The Program Committee has made a selection, a double blind review process has been executed and now we have a bit diversified, but really "GIKOF-conform" programme: business-oriented, industrial and educational applications and research results. Speakers are coming from universities, ICT companies, public sector and enduser environments. Special welcome goes to those PhD student who will be here with their first results and – hope – are ready for the first critical voices. And special thanks go for those, who established this organization years ago and contributed to editing our Journals, organizing the seminars and conferences on Business Information System.

The JvN CS SEFBIS SIG (Scientific and Educational Forum on Business Information Systems Special Interest Group) Community) as a Task Force Group of the John von Neumann Computer Society of Hungary was established one and a half decade ago in 2002. It has been working on building goodwill and respect for this area of research and education since then. We give floor to professionals to build relationships, to work on joint programs, distribute results, to learn from each other on development, educational and training areas. During these years we have been organizing forums, workshops, conferences and unique in Hungary! we published professional Journals (GIKOF Journal in Hungarian, SEFBIS Journal in English) using also the best papers of our Conference.

In recent years we have worked on establishing new BSc and MSc level diploma-programs on Business Information Systems – today appr. 1,200 freshmen start their studies on this area every year. The graduates who can build bridges (we do hope) between ICT engineers, program-developers, business professionals and company leadership are employed widespread both at large international companies and at SMEs. We are aware of performing the higher education program in the field of ICT is not easy, but we feel proud that students, faculty members and researchers of this education and of the lone Hungarian PhD Doctoral School on BIS is supported by the GIKOF/SEFBIS SIG, mainly through our Conferences and the Journals we publish.

Our mission is to show up and demonstrate: ICT is not equal to software, to simple architecture-investment or supporting operations. Success and acceptance of ICT is based on high quality applications, serving end-users, responding to information demands of decision makers at all levels of business operations. What we investigate, where we do our research, as we see information systems working – these are topics like ICT project management, system design and development, business process reengineering, handling investment problems, calculating ROI, defining information management, supporting knowledge management, building HR policies and practice in ICT, leadership, and many other problems to deal with.

The scope of research we cover encompasses contributions of lasting value to any area of BIS. To be accepted, a paper must be judged to be truly outstanding in its field. The Editorial Board and also the readers of our Journals are interested not only in work in research and developing business applications at boundaries of sub disciplines of BIS and the boundaries between computer science and other fields but also in educating IT professionals..

The Journal seeks original papers of the highest quality, which will be accessible to a broad audience. Papers should be written in a way that a no specialist can understand the main ideas! Authors submitting papers for peer-review to SEFBIS Journal publications make a number of representations. In particular, authors should hold the copyright on all contents of the submitted article, or request permission from the copyright holder. Submissions to SEFBIS Journal is done electronically through sending a request in email to the Editor in Chief (raffai@sze.hu) by sending an abstract that will be checked as a synopsis of the paper with defining the topic of it. Remember, you, the author, know best which area and sub-areas are covered by your paper; in addition to clarifying the area where your paper belongs, classification often helps in quickly identifying suitable reviewers for your paper.

Thank for a hard work of SEFBIS Board after a long process of applying the EBSCO has accepted the SEFBIS Journal as an indexed professional publication, so its volumes are already uploaded to and accessible in the EBSCO Database. The present volume of the SEFBIS Journal covers three main areas of BIS, namely

- research papers about methodologies and techniques that can be useful in developing BIS applications,
- business solutions, analysis utilizing the most up-to-date ICT results and
- analysis, solutions and results of Higher Education in the field of BIS.

Let this current issue be a good issue of the papers!
By wishing you a useful reading of that volume, we hope that our Readers will be the future authors of our Journal!

Máriaff aRia
Editor in Chief

Péter Dobay
PC co-chair; Chair of GIKOF

The electronic version of the Journals are downloadable from: http://raffa6.wix.com/sefbis#!journals/lt5ez

Practical Aspects of a Simulation Software for Multi-Agent Models

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ABSTRACT

Computer simulations of multi-agent systems are capable of handling such agent-based (formalised, modelled human society) research topics which are far too complex to be solvable analytically. In these cases simulations can suggest new directions as well as a decision on the validity of the researcher's hypothesis. As models are not just abstract and approximate but also very specific views of reality, an agent-based simulation technically depends very much on the model being used. When our interest turned to such kind of a research problem, we decided to create a simulation software for our specific needs. As a case study, this paper does not focus on this specific research problem, hypothesis, results and conclusion; instead, it summarises the experiences we gained during the development of the simulation software, and shows the decision points we faced, by describing our choices. *The author gratefully acknowledges the support of the MTA-BCE "Lendület" Strategic Interactions Research Group (LP-2012-52) at an earlier stage of this research.*

Introduction

Traditional research uses either inductive or deductive approaches. But those methods fail when the studied phenomenon consists of elements which cannot be generalized [1, 2]: i) despite knowing the element, the system as a whole cannot be described inductively; ii) even though the behaviour of the system is known, ascertainment on the elements cannot be derived. These elements are usually called agents. According to Bonabeau [3], this is the case when "agents are complex, nonlinear, discontinuous", or when agents' position in space is important, and the "population is heterogeneous", or "agents exhibit complex behaviour, including learning and adaption". That is why Axelrod [4] considers Agent-Based Modelling as "a third way of science". Solutions offered by this third way, as well as techniques and criticism are well summarised in the work of Kovács & Takács [5]. Requirements are also formulated, the fulfilment of which is necessary to withstand the criticism. As an introduction to agent-based social simulations [6] is also worth mentioning.

The paper is organised into three closely related parts. The first part focuses on aspects of creating a model suitable for agent-based simulation, finding the ways of representing those characteristics of the real agents we want our model to consider. Our choices are also presented. This part leaves lots of questions open – the qualitative formulation of the components of the model is the easier step, but this approach declares many parameters whose values are not known. Thus, the second part offers a method to handle this case and explore the multidimensional parameter space in an iterative process. At the end, before the conclusion, some technical aspects of the simulation software implementation are discussed.

Modeling

At the beginning we have a hypothesis which we would like to investigate. One way of investigation is to run simulations and examine the outputs. The reason why we want to implement a simulation is that we want to know what happens if a given model is excited with random data. Random, because the model inputs are assumed to originate from a sto-

chastic data generator process (DGP) which always outputs random data of some kind. In lucky cases, we are fully familiar with the properties of the DGP; we know its distribution, which is time invariant. Otherwise, we shall take assumptions on these inputs. Either way, we have to generate random numbers with a given distribution to excite our model.

But the real aim by performing simulations is not that we want to know what happens if a given model is excited with given inputs. We perform simulations because we try to figure out what would happen in a defined situation with real agents. Real agents, who can be human members of society, corporate members of the market, or species of a fauna etc., depending on our research problem [7, p. 93].

The model, then, is not an input for the simulation, it is only a tool we use, maybe an intermediate output. Therefore, there are two main aspects of building the model: the first, which was mentioned earlier, is that it should represent those characteristics of the agents we want to take into consideration. The second aspect is that it should realise this representation in a way that it can be translated into data structures and operations on them, because that is what a computer can handle. It is also important that computers have finite resources, so the data structures should be as small as possible, and the operations as simple as possible.

According to the above, in what follows we shall enumerate the decisions taken during building our model, deriving them from the agents' characteristics which we wanted to represent.

In multi-agent models it is essential that there are multiple agents: the interaction between them is very important. This is why an agent-based approach is chosen for a specific problem: the researcher wants to know how agents influence each other by interactions. As an obvious solution, Game Theory has been chosen to model agent interactions because of its many advantages. Argumentation is given by Russel&Norvig [8, p. 122]: “It is this abstraction that makes game playing an appealing target of AI research. The state of a game is easy to represent, and agents are usually restricted to a fairly small number of well-defined actions. That makes game playing an idealization of worlds in which hostile agents act so as to diminish one's well-being.” (Game-theoretic foundations on multi-agent systems can be found in [9]) Games have been studied widely; there are well-known games available for almost all abstracted situations which can occur in real agent interactions. Thus, our model inherits the toolset of game theory. Even though we only use a small subset of that, it is still a great help that we can refer to things on their common, accepted names. And it is also possible in some cases to compare the results to analytic solutions: for example to check whether in a stabilized simulation the most frequently played outcome is a Nash-equilibrium or not. Furthermore, the usage of payoff matrices is also ideal from the implementation point of view; a game can be represented by a payoff matrix, which is a convenient structure for the simulation. Playing a game means that players make their decisions. Since the payoff matrix tells how much points/money the players gain, the agents are influenced by each other’s decisions. From computational perspective, it is a simple task to read the elements of the matrix indexed by the players’ decisions, and update the players’ record accordingly.

When we are talking about multi-agent models the number of agents is definitely higher than two. If this is the case, how do they interact? How many of them can interact at the same time? The answer to this second question gives the dimensions of the payoff matrix. If the answer is more than two, this would, on one hand, mean a poorer performance due to exponentially increasing memory usage and computational time in function of the concurrent players; on the other hand, it would make it very difficult to fill the payoff matrices. In most cases, modelling multilateral interactions as a sequence of bilateral interactions is a good approximation. (A method for transforming multilateral bargaining to a sequence of bilateral negotiations was developed by Suh&Wen [10]. Yeung, Poon and Wu also construct an algorithm for multilateral coalition formation which uses only bilateral interactions. [11]) Here an expedient simplification is made: interactions are modelled on a two-party basis.

In the previous section, we assumed that agents are capable of making decisions, i.e. choosing an action from among the possibilities when playing a game. This capability implies that agents have a strategy. So it must be decided how to model agents' strategies. A strategy, by definition, orders actions to every possible situation. So an appropriate rule shall select an action from the list of possible ones, in case of any possible list. Simple rules, however, which give a single action as outcome in all situations, are hard to interpret. Therefore, we rather decided to define partial rules, let us call them heuristics, which are easier to interpret. (As an example consider the rule: "Do not take a strictly dominated action!", which we call a heuristic. This naming mostly regards the meaning of "rule of thumb" from the list of meanings collected in [8, p. 94]) Heuristics, however, cannot tell the result in all cases, sometimes they leave multiple options alive, so they cannot be strategies. To solve this problem, we defined strategies as lexicographical lists of heuristics. If a heuristic rule leaves more than one course of action open, then the next heuristic shall be applied to this subset of actions, until only one is left. So heuristics act like filters on the set of the possible actions of an agent in a game. There is a special heuristic, which is neutral and always gives a singleton as output. This is the Random heuristic, which means choosing an action randomly with equal distribution. Random heuristic is important in our case, because it shall be put to the end of each strategy to ensure that in the case when all former heuristics let through more than one action, Random chooses a single one in the end. This is needed to fulfil the original definition of strategy by our specialised interpretation.

Another special case may occur when using the strategies defined above. This is when heuristics filter out all actions. We found two options in handling this case. Option 1 is to abandon these interactions. This could be interpreted for example as two parties meeting to negotiate, but failing to make a deal in the end. Option 2 is to roll back the effect of the last applied heuristic and apply Random instead. The latter sounds the more technical approach, but it has the advantage that the chances to play are not reduced when the neighbours have often inconclusive strategies.

We developed a simple method for filling the payoff matrices in those frequent cases when only qualitative information is available about the games. Properties of a game are determined by the relation of the payoffs, so modelling an interaction in our case means setting up inequalities between the elements of the payoff matrix. Consider, for example, a half payoff matrix (half refers to that only the payoffs for one player are shown):

$$P_{row} = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}$$

which is the half payoff matrix[1] of a 2-player Prisoners' Dilemma if the following stands for its elements $p_{21}<p_{11}<p_{22}<p_{12}$. considering the first action for both players as *Defection* and the second as *Cooperation*.

Although there are infinite number of solutions to these inequality sets, one shall be chosen somehow. It is also important to balance the payoff matrix of different games. It may be possible in some modelling situations that a specific game is more momentous than the others, so it should yield more points to the players. But in lack of further information it is preferable that games are accorded the same weight. To achieve this, we complemented the inequality set with an equation to fix the expected value of the payoffs. To be able to calculate the expected value of payoffs, one needs to know the probability distribution of the outcomes. We defined the expected value of payoffs as the expected value of payoffs when both players play according to the Random heuristic. This definition is identical to assigning equal probability to every outcome. In the example, by having a target payoff of m=25, the following equation is added:

$$0.25*p_{11}+0.25*p_{12}+0.25*p_{21}+0.25*p_{22}=m$$

But the payoff values still can be chosen arbitrarily, and the games can be pretty much different as regards risk, meaning the variance of the payoffs. Again, if this difference is not intended, the risk (variance) shall be normalised too.

[1] Since the Prisoners' Dilemma is a symmetric game, the payoffs are examined regarding only one player, as the payoffs of the other player are the same

This criterion may not be fulfilled, but the best approximation should be used. In our example, let's have a target relative standard deviation of 1, so try to minimise f(x) that is equal to (RelStdDec-1)[2].

$$\text{RelStdDev}=\frac{\sqrt{\frac{(m-p_{11})^2+(m-p_{12})^2+(m-p_{21})^2+(m-p_{22})^2}{4}}}{m}$$

Technically, this is a nonlinear optimisation problem. We used the *fmincon* [12] function of Matlab to find a desirable local optimum. To do so, one has to formulate the above in matrix form. *Fmincon* expects the following inputs:

$$\min_x f(x) \text{ such that } \begin{cases} c(x)\leq 0 \\ ceq(x)=0 \\ A\cdot x\leq b \\ Aeq\cdot x=beq \\ lb\leq x\leq ub \end{cases} \text{, where}$$

x, b, beq, lb and ub are vectors, A and Aeq are matrices,, c(x) and ceq(x) are functions that return vectors, and f(x) is a function that returns a scalar. f(x), c(x), and ceq(x) can be nonlinear functions. Our exemplar inputs in the above form:

$$x=\begin{bmatrix} p_{11} \\ p_{12} \\ p_{21} \\ p_{22} \end{bmatrix}$$

Constraints are linear, so c(x) = 0 and ceq(x) = 0. The expected value crtiterium:

$$Aeq=[1 \quad 1 \quad 1 \quad 1], \quad beq=100$$

Payoffs are expected in [0..100]:

$$lb=\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, \quad ub=\begin{bmatrix} 100 \\ 100 \\ 100 \\ 100 \end{bmatrix}$$

Game specific criteria (inequalities) in matrix form:

$$A=-\begin{bmatrix} 1 & 0 & -1 & 0 \\ -1 & 0 & 0 & 1 \\ 0 & 1 & 0 & -1 \end{bmatrix}, \; b=\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

For starting point let's have $x_0=\begin{bmatrix} 20 \\ 50 \\ 0 \\ 30 \end{bmatrix}$, which is a possible solution. The result of *fmincon* is: $x=\begin{bmatrix} 5 \\ 65 \\ 2 \\ 28 \end{bmatrix}$

This means the payoff matrix[2] of our Prisoners' Dilemma is:

	D	C
D	(5;5)	(65;2)
C	(2;65)	(28;28)

We would also want our Prisoners' Dilemma to fulfil the criterion according to which the welfare level is higher in case of mutual cooperation. This means: $2*p_{22}\geq p_{12}+p_{21}$. If we augment our optimization problem with this constraint we get:

$$A=-\begin{bmatrix} 1 & 0 & -1 & 0 \\ -1 & 0 & 0 & 1 \\ 0 & 1 & 0 & -1 \\ 0 & -1 & -1 & 2 \end{bmatrix}, \; b=\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad x=\begin{bmatrix} 2 \\ 61 \\ 1 \\ 37 \end{bmatrix}$$

Regarding the desirable expected value, there are two main possibilities to consider. It shall be decided whether agents refusing to play shall be penalized or not. (This makes sense when games can be abandoned according to the formerly discussed option.) If penalties are preferred, a positive expected value shall be chosen in combination with an inflation factor which is applied to the agents' asset in every iteration. If such penalties are not needed, zero can be chosen as expected value. (Our software supports both approaches.)

In the previous section, we defined how the agents interact. Now we shall define when they interact. There are five main methods in the literature handling the selection of agents for interaction [7, p. 93]. The simplest is the "Soup" model, where agents are selected randomly: they do not have any spatial relation.

[2] *C* refers to Cooperation, *D* refers to Defection

The cellular automata was first created by von Neumann; in the model each cell has four neighbours (or less, if not all possible positions are occupied by a cell). The third type is the Euclidean Space (usually 2D). This can be extended with real geographical data, which models constitute to the fourth type. The last model group is that which uses a network topology. Agent interactions take place between random agents in a "Soup" model and according to fix connections in a model with network topology. In the other three types of models interactions take place when the distance between two agents is sufficiently low.

Since geographic data and network topology is known only in case of some specific research topics, we did not choose them for our framework. Cellular automata are special cases of the Euclidean Space model: when coordinates are integers and neighbour distance is 1. The "Soup" model can also be simulated by an Euclidean Space model if the agents' possible moving range per iteration is as big as the whole map. Considering the before-mentioned arguments, we chose the most universal model type, the Euclidean Space.

In our model the agents are put onto a section of a two-dimensional plane, and they are allowed to walk randomly. The section cannot be too large (infinite), because then the stationary agent density would be zero, which is undesirable. In order to avoid the distorting effect of the boundaries, we connected the opposite borders of the section in a way that if an agent steps out on the right it steps in on the left etc. The same method was chosen in the original Sugarscape model [13]. This simple two-dimensional model makes it easy to visualize the simulation.

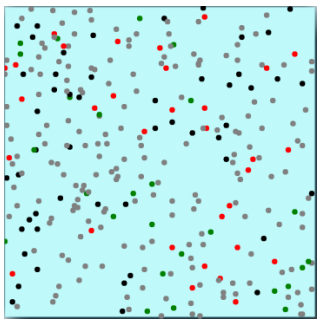

Figure 2-1: Agents on the simulation plane

The Figure 2-1 was cropped from the window of our simulation software to illustrate the visualization of agents. The colouring of the agents is based on the first heuristic rule in their strategies. It is a question, whether it is a good approximation to mark the strategies depending only on their first heuristic rule. The answer depends on the heuristics themselves. In our software, we monitor the agents' decisions and count the number of heuristic rules which are used in the decision. In our case we found that in most of the cases the first heuristic is responsible for the decision. In the cases, when heuristic rules next in line are also used, they can only choose from the subset of actions which were selected by the first rule, so the effect of the first rule is still determining in these cases. Thus, grouping strategies based on their first heuristic can be an acceptable approximation, hence it can handle the problem caused by the large number of possible strategies (n! possible strategies by n heuristic rule). Figure 2-2 cropped from the window of our simulation software shows a typical distribution of the applied heuristic rules per decision.

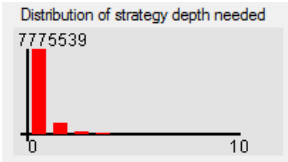

Figure 2-2: Applied heuristic rules per decision

If agents are sufficiently close to each other, they play a game. If the simulation contains multiple games, then a specific one is selected. The selection can be performed based on equal or unequal distribution when differing weights are assigned to the games.

In order to observe the performance of the strategies, the achievements of the agents can be analysed. However, there exists a more realistic way to pick out the best strategies: if learning or any other kind of evolutionary mechanism is introduced to the model, the best strategies will survive.

We implemented the following learning method: the agents at specific times select one of their neighbours and learn from them. The neighbour definition is simply based on distance between agents. We implemented two algorithms for se-

lecting one among the neighbours. Obviously, the selection shall prefer better-performing agents, so the simplest solution is to select the "richest" neighbour, a.k.a. the one which has the most points. A somewhat less determinate solution is to select from among the neighbours randomly based on a distribution which assigns higher probabilities to agents with more points, but assigns positive probability to all neighbours. Boltzmann-distribution is known within the field of genetic and evolutionary algorithms [14], and it owns the properties just discussed: this distribution still prefers the rich agents, but it introduces some noise (through its "temperature" parameter) into the decision.

As we will discuss it in detail in the second section, the simulation results are good for analysis if the simulation is ergodic: the stationary results do not depend on the starting situation. in order to make this possible, we introduced mutation to the model. At a certain point, a subset of agents change their strategy randomly. This is important because learning can only prefer non-extinct strategies. If a good strategy dies out at the beginning in a situation which is far from the equilibrium, learning cannot bring it back, but mutation can. Thus, by a correctly tuned mutation rate the strategy which gets widespread must perform well steadily, while one which becomes rare must perform badly steadily.

To allow grouping in the model, a comfort property can be introduced. If an agent is satisfied with its last few incomes, it feels comforted, and its willingness to move is reduced. In implementation the amplitude of random walk is determined by the moving average of the payoffs the agent got (inverse ratio).

Parameter Space

In the first section, we discussed several modelling possibilities to represent agent properties. However, most of these methods have parameters which are not easy to calibrate. Depending on these parameters, the simulation can be run in an infinite number of ways.

Researchers run simulations with the aim to draw conclusions, therefore, it is the simulations which enable ascertainment that is good. The minimal technical criteria for this are stationarity and ergodicity. If the series, output by the simulation, reaches an equilibrium and becomes stationary it means that simulation can be stopped, as the actual values are expected not to change significantly by running the simulation further. This, however, does not necessarily mean that the results are characteristic for that parameter set; it is still possible that running the simulation several times with the same settings will bring significantly different results. In order to have a constant result, it is also required that the process be ergodic.

Since setting the parameters analytically is not possible, the parameter space should be explored to find relevant subspaces. The dimension of the parameter space equals to the number of parameters. To travel through the parameter space, simulations should be run in random points. These points should be selected practically as samples of a Sobol-sequence [15].

Sobol-sequences or $LP\tau$ sequences are low-discrepancy quasi-random sequences. Low discrepancy sequences are less random than pseudorandom sequences, but they are "more equally" distributed. This property makes them attractive for such applications where random numbers are used to sample the system we want to know better. For example, this is the case with Monte-Carlo integrations, where Sobol-sequences are also willingly applied to accelerate convergence [16]. Sobol sequences can be easily generated with the help of MatLab [17]. If this tool is not available, GNU-licensed libraries can be downloaded and integrated into the project like [18] or [19].

To check stationarity and ergodicity, the tests published by Grazzini [20] have been implemented. These tests are based on the Wald-Wolfowitz Runs Test [21]. The stationarity test is quite simple to implement; it assumes that a stationary process with i.i.d. errors produces samples above and below its stationary value randomly. The test checks this randomness by observing the number of runs: sequences which are continuously above or under the mean. Grazzini suggests dividing the time series into windows and calculating the interesting moments of both of the subseries and the whole series. Then one has to perform the Runs Test on these

moments. If the null-hypothesis of randomness cannot be rejected, it means that the interesting moments of the series do not change in time save the noise. The ergodicity test discussed by Grazzini can only be used on stationary processes; however, this is not a problem in our case, since we are interested in both stationary and ergodic processes, so the latter test is run only if the first test identifies the process as stationary.

Despite the stationarity test, which can be performed on a single, adequately long simulation datum, the ergodicity test needs several runs of the simulation. Therefore, as Grazzini also notes, this test cannot be used on real data, since, in case of real data, there is always only a single run. But it is useful in case of artificial data, where producing alternative runs is only a matter of computational time. Grazzini used the Wald-Wolfowitz test to decide whether two sample series are the product of the same data generator process. He created the first series by dividing a long simulation into windows of equal duration and calculated the required moment of the windows. To create the second series, he ran the simulation several times (as many times as the number of the windows) for a length of a window and calculated the required moment for each simulation.

As Grazzini also underlines, the test is likely to falsely reject ergodicity in case of the shorter runs. So it is advisable in case of the runs which should produce the second sample series for the ergodicity test that they are not run for the window duration, rather a setup time plus the windows length. The setup time shall be sufficient for the process to reach its equilibrium and become stationary.

If, with the help of the above tests, an interesting point of the parameter space is identified, it is advisable to drill in and run Sobol-sequence based simulations narrowed to the surroundings of the found point to investigate its region. Increasing resolution and narrowing the currently investigated subspace is an iterative process, but helps to understand the effect that the parameters have on the results. Although Grazzini addresses his article to agent-based models, it has not been implemented to any major frameworks yet.

Technical Considerations

Before the concluding part of this paper, we shall discuss some technical questions regarding the implementation of the simulation and reference some other works which address these questions.

Galán et al. analyse agent-based modelling from the software development perspective [22]. They suggest a role-based development methodology to minimize the errors in every level of the creation of a simulation.

As Galán et al. set up general development methodologies, the relating IEEE standards committee, FIPA publishes standards on several aspects of agent-based modelling [23]. One of their aims is to make it possible that agents are distributed in a network of computers which may run the simulation on different platforms. The computers can be different, running different simulation framework implementations on different operating systems, but as long as the standardised simulation description is distributed to them, they can contribute to the simulation cluster. An introduction to the FIPA standards is given by the FIPA vice president, Stefan Poslad [24]. Compliance to standards always requires extra effort, but even partial adaption can be useful (architectural concepts etc.). If the built framework is general and is planned to be used in several situations, FIPA-compliance is worth considering.

There are plenty of simulation frameworks available for usage. Their list is continuously growing, however, there are some main frameworks which have a place on every list, like Repast and MASON. Swarm was also at the top but it is less favoured nowadays. The frameworks may differ in several aspects, like programming language, platform dependence, FIPA-compliance, user interface (if any), etc.; a comprehensive comparison is presented by Allan [25] or Nikolai&Madey [26] or North et al. [27]. For an up-to-date lists of frameworks one might consult maintained web pages, like Prof. Leigh Tesfatsion's home page [28].

When one would like to exploit the multicore architecture of modern processors, one should run a multithreaded application. Multithreading support is not common among the available frameworks, MASON has a variant: D-MASON which supports parallel execution [29]. We created a multithreaded implementation which brings up a problem related to the pseudorandom numbers used. In a single threaded application the simulation is repeatable easily provided that the simulation is started with the same seed value. This, however, is not true for multithreaded applications, since the threads are only synchronized at the points where data created by another thread are needed (these points shall be minimized for efficient code), between these points the running order of the threads is undetermined, it is up to the operating system. The before-mentioned facts mean that, running the simulation twice with the same random seed, it is likely that the result will be different. This happens because the threads run in a possibly different order so they ask for random numbers in a different order too. Which means that they get different numbers compared to the previous run (they get each others' random number).

Considering the topic of stationarity and ergodicity discussed in the second section, the impossibility of rerunning exactly the same simulation is not a crucial problem. It is still necessary to rerun the simulation with the same parameters and with different seeds to perform the ergodicity test, but rerunning it with identical seed is not needed.

Agent-based research is an iterative process while the simulation is continuously tuned and the results are processed by the researchers. Thus, the way, the results can be perceived, is important: one should put stress on the visualisation capabilities of the framework. Design guidelines collected by Kornhauser et al. can be used as reference [30].

As a last technical note, it should be mentioned that since simulation implementations always have routines which run a lot of times, it is highly advisable to perform some profiling on the code to identify the parts which consume the most runtime. A code part can consume much runtime due to two reasons: either it is called many times or it consumes much runtime itself even if called only once. In either case, supposing the call count is justifiable, the individual runtime shall be reduced to achieve better performance. In our case, since we created our framework in C#, it should be considered to implement these code parts as C++ functions, or try to implement them using basic language elements. Convenient services available in the .NET framework are often resource consuming, it is worth using them generally and advisable to avoid them in critical code parts identified by profiling. The techniques might be different on every platform, but it is true generally that most frequently called code parts need to be simple and fast.

Conclusion

Agent-based modelling, thanks to the increasing computational performance available, is becoming a substantive tool of researches in many disciplines. If multiagent simulation is selected as a research method, it is worth checking the readily available frameworks. Either one of them is suitable or one needs to create one's own custom implementation, this paper may help in the forthcoming questions regarding the creation of the model, and may give directions in realisation of the simulation.

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Supporting the Hungarian Demographic Pre-calculations with Microsimulation Methods

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ABSTRACT

In the last few years, and probably in the next decade, the sustainability of the pension system will be one of Hungary's most important economical and social problems. The questions regarding this problem can only be answered by the pre-calculation of the different demographic processes. Microsimulation methods have many preferable features compared to the more commonly used cohort-component methodologies. This paper summarizes the implementation of a microsimulation system that is only based on birth and mortality rates at the moment. To forecast mortality rates the Lee-Carter model and its modifications are applied, while birth rates are fixed at the latest available values. The goal of the paper is to compare the different models through their effects on the results of the microsimulation system.

Introduction

Hungary, just like many other developed countries [1] has to face the problems of an aging society. The increasing life expectancies together with the decreasing birth rates continuously worsen the ratio of active workers and pensioners. This results in a significant burden for the pension system, since its expenses are covered by the currently working population. Fortunately the course of the demographic processes is slow enough for the government to take action, but the clear understanding of these processes is crucial to make the right decisions.

To answer the questions emerging in terms of the pension system we must predict the number of pensioners and the number of workers in a given year. In a long time forecasting it is necessary to understand how these numbers change with time. We have to find out how many people die how many are born and what are the estimates of life expectancies at a given age.

The pre-calculation methods

In the international practice the demographic pre-calculations are done using the cohort-component method. Hungarian demographers are usually following this concept [2, 3]. This method divides the population into different groups by some selected properties. The basic properties are age and gender, but models can include educational attainment, marital status or employment as well. The individual groups are described by the number of their members. The data to create these groups is available at the Hungarian Central Statistical Office (HCSO). To predict future values the cohort-component method iterates these groups yearly: at every iteration step the group values are modified according to the transition probability matrixes that are put together based on the estimates of demographic experts. For example one percent of the 24 year old single male group who survive and marry will become a member of the 25 year old married male group. The main benefit of this method is that it does not require any kind of programming knowledge or high computing capacity. Once the transition probability matrixes are available, the method can be implemented in a simple spreadsheet.

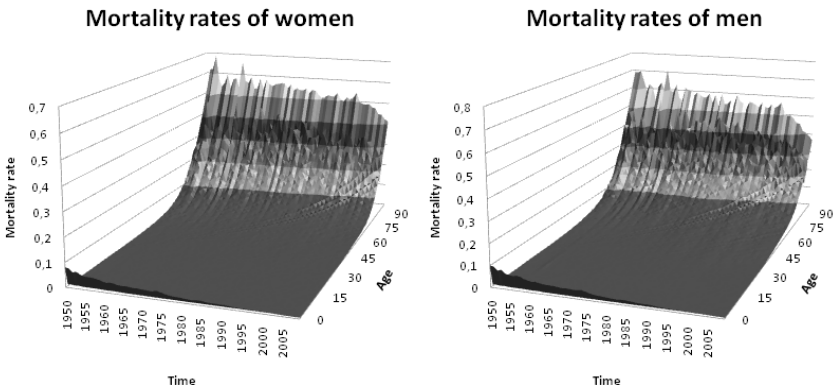
Microsimulation is another approach to pre- calculate the demographic processes. This method follows the life cycle of every single entity individually instead of grouping them together. Iteration steps are performed on the entity level, and the different properties of the entities are modified at every step according to the statistical probabilities, rules or algorithms based on empirical data. In case of the Hungarian data this means a simulation of about ten million entities, and during iteration steps a relatively complex algorithm has to be executed for each entity. This task requires significant computing capacity and advanced programming knowledge. In the HCSO microsimulation solutions were already in use for impact assessment tasks at the end of the 1980s [4], but due to the implementation challenges the methods were not widely popular.

Although the more prevalent cohort-component method has some advantages compared to microsimulation, many problems arise if we want to increase the dimensions of the examined properties. With a few added properties the transition probability matrices become not feasible. The particular probabilities become extremely small, and impossible to estimate. However this problem does not arise when using microsimulation methods. When using entity level computations, the probabilities do not have to be fully recalculated even when new properties are introduced to the system. Thus microsimulation solutions are also easily expendable and these expansions are necessary since the age alone is not sufficient to describe the productivity of an individual [5]. They also result in a kind of estimated dataset for the iterated years that otherwise could only be acquired by new data collections.

Initial Data

For the above reasons we chose to use a microsimulation solution to pre-calculate the Hungarian demographic processes. Our main goal is to create a microsimulation system that is capable of forecasting the Hungarian demographic processes with as few presumptions as possible. We chose to use models that work based on purely historical data and do not require any kind of estimation. We compare these models through mathematical and statistical methods. The demographic assumptions are only present to facilitate the understanding of our results. The main goal of the current paper is to support the development of a more complex system and to analyze the effect of the various mortality forecasts on the output of our microsimulation system, while other time varying properties such as birth rates are set to constant values.

We only implemented the birth and death statistics and left out all other properties. Initial data is extracted from the results of the Mikrocenzus in 2004. The age specific birth and mortality rates change from year to year, so these have to be forecasted to be used in the iteration steps. The mortality, the childbirths and the relationships are equally important pillars of the demographic forecasts [6], but for the first implementation of our system we chose to focus on mortality rates only. We set the age specific birth rates to the 2013 values and the proportion of newborn boys is set to 51.4% [7, 8]. The mortality rates are pre-calculated through different methods from the available data between 1950 and 2009.



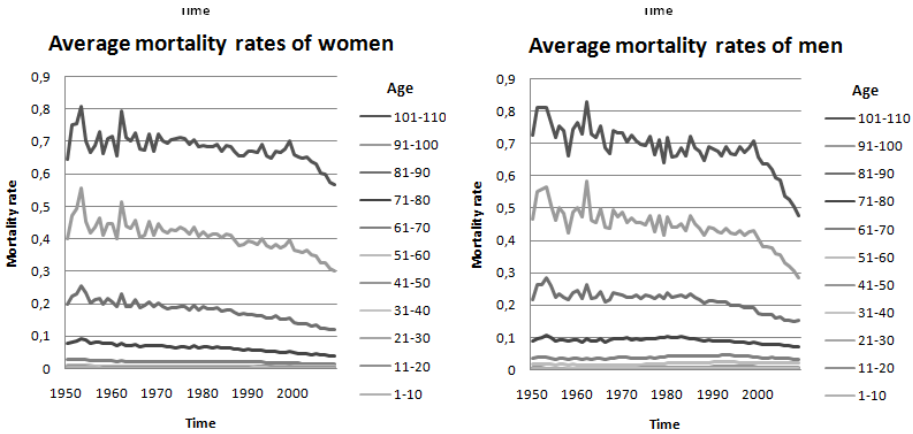


Figure 3-1. Hungarian mortality rates between 1950 and 2009

The initial mortality rates are shown on Figure 1. The difference between the rates of women and men is obvious - especially during the given time-span in Hungary - so there is no reason not to handle them separately. The diagram of the women is much smoother, while the mortality rates of men were influenced more by the historical events. For example there is a small bump at the year of the '56 revolution on the men's side which is absent on the other. The graphs show a decreasing, linear trend in the mortality rates, but this trend is broken at year 1990, the year of regime change is Hungary. The break can be seen at both sexes although it is more obvious on the graph of the men.

Forecasting Mortality Rates

There are many possible approaches to forecast mortality rates, but the literature uses the Lee-Carter model [9] or one of its modifications [10, 11] almost exclusively. Hungarian demographers successfully applied these models many times in the past [12, 13]. For this reason we also decided on using Lee-Carter models to forecast the mortality rates for our simulation.

Lee-Carter Model

The main idea behind the model is that we take the matrix of the age specific mortality rates for the given years, and we decompose it into time varying and time invariant vectors. In this way only a vector has to be forecasted through statistical methods, and then the final matrix can be reassembled. The mortality matrix is described by the following equation:

$$\ln\left(m_{x,t}\right)=\alpha_x+\beta_x k_t+\varepsilon_{x,t} \tag{1}$$

where $m_{x,t}$ is the mortality rate for age x and year t. α_x and β_x are age specific constants and k_t is the time varying parameter. $\varepsilon_{x,t}$ is the error with mean 0. The model can be fit by the use of the least squares method:

$$\min_{\alpha,\beta,k}\sum_{x,t}\left(\ln\left(m_{x,t}\right)-\alpha_x-\beta_x k_t\right)^2 \tag{2}$$

In practice this is done by setting α_x equal to the average of the x-th row of matrix m, then β_x and k_t can be calculated from the single value decomposition (SVD) of the matrix $\ln(m_{x,t})-\alpha_x$. This would yield an infinite number of solutions for β_x and k_t, so we employed the constraints used by the original author:

$$\sum_x \beta_x^2=1 \text{ and } \sum_t k_t^2=0 \tag{3}$$

Taking these constraints into account the β_x and k_t parameters can be calculated in the following way:

$$\beta_x=\frac{U_1(x)}{\sum_x U_1(x)} \tag{4}$$

$$k_t=S_1V_1(t)\sum_x U_1(x) \tag{5}$$

where U, S and V are the results of the SVD, and U_1, S_1 and V_1 denotes their first term.

In the next step the k_t values are rectified according to the following equation:

$$\sum_x d_{x,t} = \sum_x E_{x,t} e^{\alpha_x + \beta_x k_t} \quad (6)$$

Where the results of the former calculations are used for α_x and β_x, and k_t is the only variable. $d_{x,t}$ is the number of deaths at age x in year t and $E_{x,t}$ is the exposure-to-risk at age x in year t. This way the number of deaths will be equal for the observed and modelled values in every year. Without this step the younger ages would get the same weights as the older ones even though they have a much lower influence on the actual number of deaths.

The resulting k_t values are fairly linear for the examined periods (See Figure 3-2). The diagrams show the forecasts of the k_t values with an ARIMA (0,1,0) and its 95% confidence interval (thick lines). According to [9-13] it is assumed that random walks based on this model leads to the best results. Figure 3-2 shows four different setups for forecasting k_t for the 2010-2059 periods with a random walk (narrow line). Each subplot is based on the same random seed. Subplot A shows the k_t values based on the mortality rates of years 1950-2009, while subplot B is based on the years 1990-2009. We examined both of these cases since the regime change at 1990 had a great influence on the mortality rates and caused a break in the trend. The values forecasted by the random walk change much more vigorously than the initial values. For this reason we also examined a smoothed version of the forecasts. We chose to use a Savitzky-Golay filter to reduce the spikes of the graph while keeping the form of the envelope. The respective results can be seen on the C and D subplots.

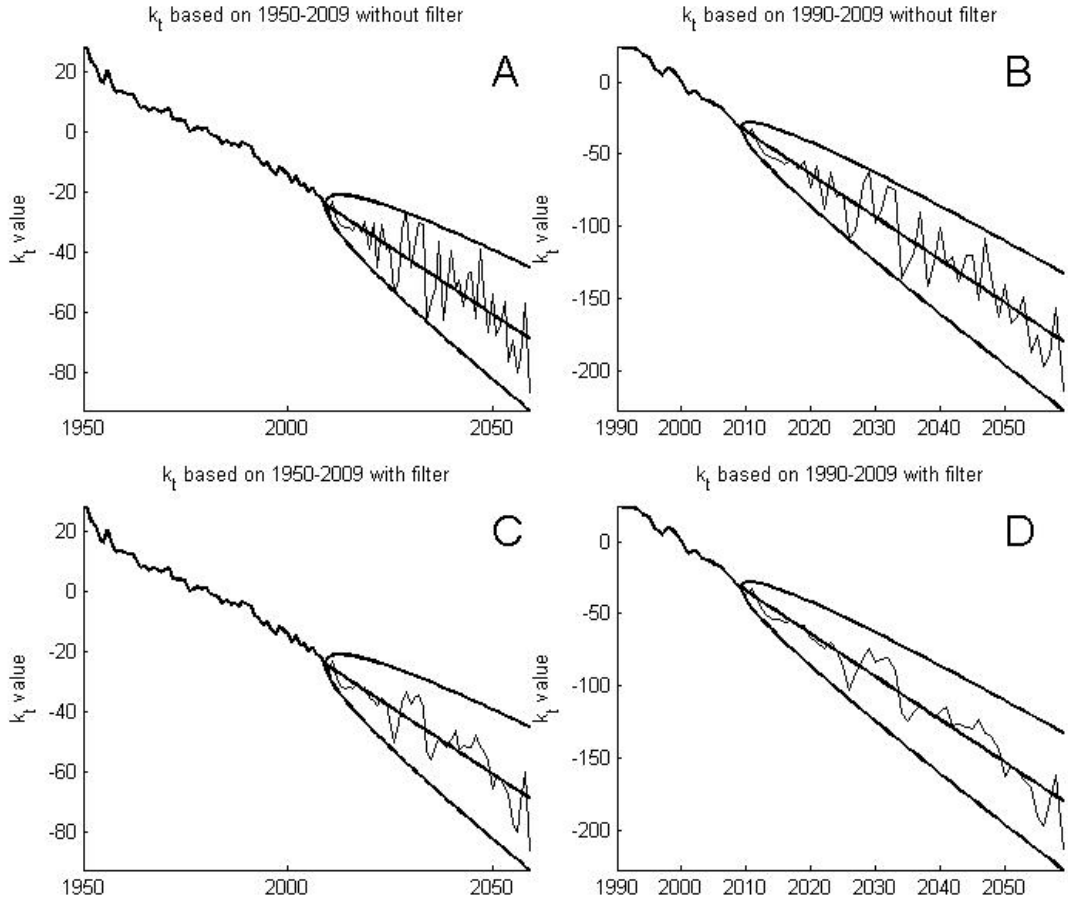


Figure 3-2. Different forecasts of the Lee-Carter models time varying parameter

Once the k_t values are forecasted, the estimated mortality rates can be easily calculated with the help of the α, β and k vectors from the original equation.

The correction step of the k_t value (6) is the only step in the Lee-Carter model, where we take advantage of the fact that we are forecasting the mortality rates, and not just a simple time varying vector. Our model uses the actual death rates (denoted by q) for the simulation instead of the mortality rates. The difference is that death rates are simply the ratio of deaths to overall population at a certain age, while mortality rates adjusted with exposure-to-risk. Because of the correction step we cannot simply forecast the death rates. The following two equations are the most commonly used recalculation methods for the death rates:

$$q_{x,t} = \frac{m_{x,t}}{1+\frac{1}{2}m_{x,t}} \tag{7}$$

$$q_{x,t} = 1-e^{-m_{x,t}} \tag{8}$$

where $q_{x,t}$ is the death rate of the people at age x in year t. We chose to implement the second version (8) since it fit our observed data better.

Lee-Carter Modifications

The Lee-Carter model has many flaws; even the original author suggested several modifications [10]. There are some really simple options like disaggregation by sex, which we already discussed. He also mentioned the possibility of using dummy variables to filter out special events like the Spanish flu in 1918 or the revolution in 1956 in our case. The exclusion of the Spanish flu did not yield significant change in the results and since the revolution had a much lower relative death count we chose to not filter it out from our model.

There are some more complex modifications like geographic disaggregation, including the reasons of death in the model or taking into consideration that lagging countries have a much faster increase in life expectancy than leading countries, but this effect is diminishing as they catch up. These complex versions require extra initial data that we do not have access to at the time of this research. The modifications suggested by Wilmoth [11] do not require additional data, and they only change the estimation process of the α, β and k vectors. The first suggestion is to include the number of deaths at given age as a weight to the model, to get a better estimation of the death rates at higher ages:

$$\min_{\alpha,\beta,k}\sum_{x,t} d_{x,t}\left(\ln\left(m_{x,t}\right)-\alpha_x-\beta_x k_t\right)^2 \tag{9}$$

The equation can be solved by computing the respective partial derivatives. This results in the following:

$$\alpha_x = \frac{\sum_t d_{x,t}\left(\ln\left(m_{x,t}\right)-\beta_x k_t\right)}{\sum_t d_{x,t}} \tag{10}$$

$$\beta_x = \frac{\sum_t d_{x,t}k_t\left(\ln\left(m_{x,t}\right)-\alpha_x\right)}{\sum_t d_{x,t}k_t^2} \tag{11}$$

$$k_t = \frac{\sum_x d_{x,t}\beta_x\left(\ln\left(m_{x,t}\right)-\alpha_x\right)}{\sum_x d_{x,t}\beta_x^2} \tag{12}$$

With these three equations the parameters can be iteratively recalculated until the iteration yields little to no improvement. The α_x, β_x and k_t values on the right sides of the equations are the values from the previous iteration. At each step the most recent parameters are used on the right hand side and the initial parameter can be set to the results of the original least squares method.

Another approach is to use the maximum likelihood method to find the parameters. The number of deaths can be approximated with Poisson distribution with the parameter $\lambda_{x,t} = m_{x,t}E_{x,t}$ [11]:

$$L\left(d_{x,t},\lambda_{x,t}\right) = \frac{\lambda_{x,t}^{d_{x,t}}e^{\lambda_{x,t}}}{d_{x,t}!} \tag{13}$$

$$l\left(d_{x,t},\lambda_{x,t}\right) = d_{x,t}\ln\left(\lambda_{x,t}\right)-\lambda_{x,t}-\ln\left(d_{x,t}!\right) \tag{14}$$

where L is the likelihood- and l is the loglikelihood function. Assuming that the observations are independent, we can sum over age and time to acquire the full loglikelihood function from equation (14):

$$\sum_{x,t} d_{x,t}\ln\left(\lambda_{x,t}\right)-\lambda_{x,t}-\ln\left(d_{x,t}!\right) \tag{15}$$

This has to be maximized to obtain the parameters α_x, β_x and k_t. The third part of the equation is independent of the estimated parameters, so after the substitution of $\lambda_{x,t}$ into (15) only the following equation has to be solved:

$$\max_{\alpha,\beta,k} \sum_{x,t} d_{x,t} \ln\left(E_{x,t} e^{\alpha_{x,t}+\beta_x k_t}\right) - E_{x,t} e^{\alpha_{x,t}+\beta_x k_t} \qquad (16)$$

Simulation

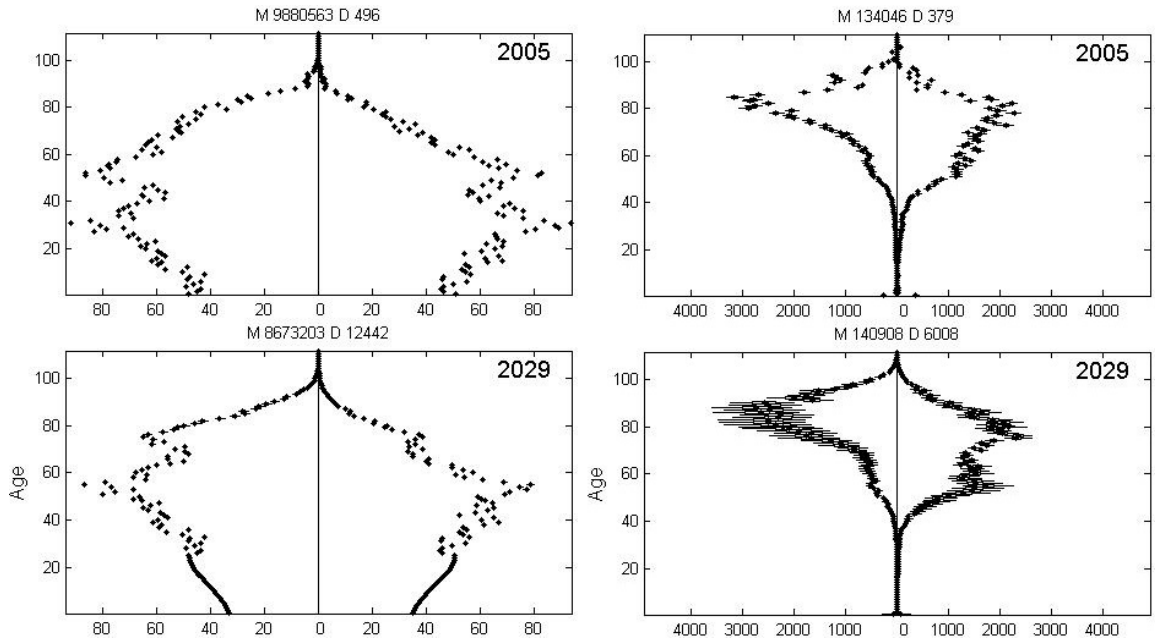
We used three different model types: the original least square method (OLS), the weighted least squares method of Wilmoth (WLS) and the maximum likelihood method (MLM). All of these were applied to initial data between 1950-2009 and 1990-2009, and every model was tested with and without the Savitzky-Golay filter. The combination of these resulted in a total of 12 different forecast models. Since the Lee-Carter based models use random walk to determine the forecasted values we ran each model with 500 different random seeds.

The microsimulation system was written in C# using the Microsoft .Net Framework based on former researches [14].We pre-calculated 50 years of demographic processes. Our initial data was from 2004, but we had mortality rates till 2009, so we used the actual values for the first five years and the forecasted ones for the 2009-2054 period. We used parallel computing techniques on Windows 8 operation system on a quad-core Intel Core i5-2500 3.3GHz processor. This way a single simulation finished processing in about 90 seconds, so the overall runtime of the simulations was approximately 150 hours.

The output of every simulation was the population, the number of deaths and the number of births for both genders grouped by age and forecast year. We evaluated the results and created our diagrams with the help of MATLAB scripts.

Results

We examined the development of the age trees for models discussed above. Figure 3-3 shows the results of the unfiltered OLS model based on data from 1950-2009. On every subplot the left side shows the females and the right shows the males. The left column consists of age trees while the right column displays the numbers of deaths at a certain age. Every data point is a candlestick pattern, even though on the age trees the relative deviation is so small that they look like normal points. The subplot titles show the mean and deviation of the total population and total number of deaths respectively.



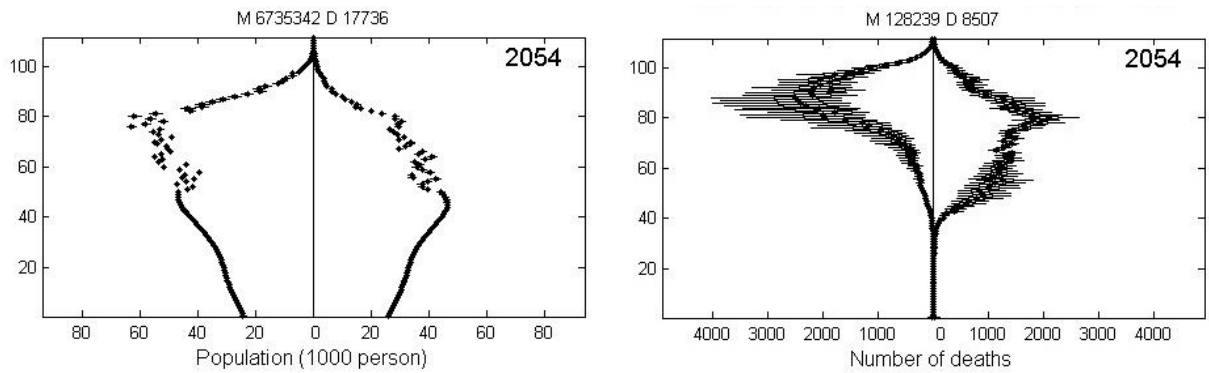


Figure 3-3. Development of age trees (left) and numbers of deaths (right) during unfiltered OLS simulation based on 1950-2009 data. Summarized means (M) and deviations (D) are shown in the title of the plots.

On the left subplot of 2005 the two big spikes on the age tree are caused by the so called Ratkó-children and Ratkó-grandchildren. Ratkó Anna was the Hungarian Minister of Welfare from 1949 to 1953 and the Minister of Health from 1953 to 1956. During this period her strict actions, including the ban of abortion, caused a huge increase in the number of newborns. The second spike is caused by the children of the Ratkó-children, who got significant support from the government at around 1975. On the other hand the Ratkó-grandchildren did not have such strong influence, and they are less willing to bear a child. This is the reason for the absence of a third spike.

The problem of the pension system can be clearly seen on the subplot of the year 2029. If current trends follow, then at the time when the Ratkó-grandchildren retire they will outnumber the working population. The relative gap might decrease till 2054, but the population will be drastically reduced.

It is clear that some external events, like political influence, disasters or migration, can have a great effect on the development of the demographic processes. In our case, the political influence had the most impact. A forecasting method should take the likely future events into account by including the results of political science for example [15]. Unfortunately the inclusion of any kind of estimates might ruin the main concept of our system. We try to forecast demographic processes through mathematical and statistical methods. On the other hand, the effects of these external events appear in the historical data. The current version of our system only concentrates on mortality rates, but future implementations will include other important aspects like birth rates. A purely mathematical system will never be able to forecast unexpected external events, but the inclusion of more properties will hopefully converge towards more realistic scenarios.

The diagrams of the left column show that the means of the number of deaths do decrease through the years, though the relative deviations become much higher. These figures also justify our decision to forecast the male and female mortality rates separately. The difference between the sides is clearly visible. Between the age of 45 and 75 the number of deaths of women is only one third of that of the men. The women who outlived the males still die at a greater age and this can be seen on the big spikes above age 80.

At the bottom of the diagrams the numbers of newborn deaths stand out compared to older children for obvious reasons. In demographic pre- calculations the calculation of newborn deaths is always questionable. It is not clear, from what point we should count them. For example in many cases the deaths before the first few days is not included in the statistics. We did not have information about what kind of deaths were included in the 0 year olds mortality rates, so we decided to include them without modifications. This way at the end of every simulation the number of newborn deaths was close to zero, but this seems like an overly optimistic forecast.

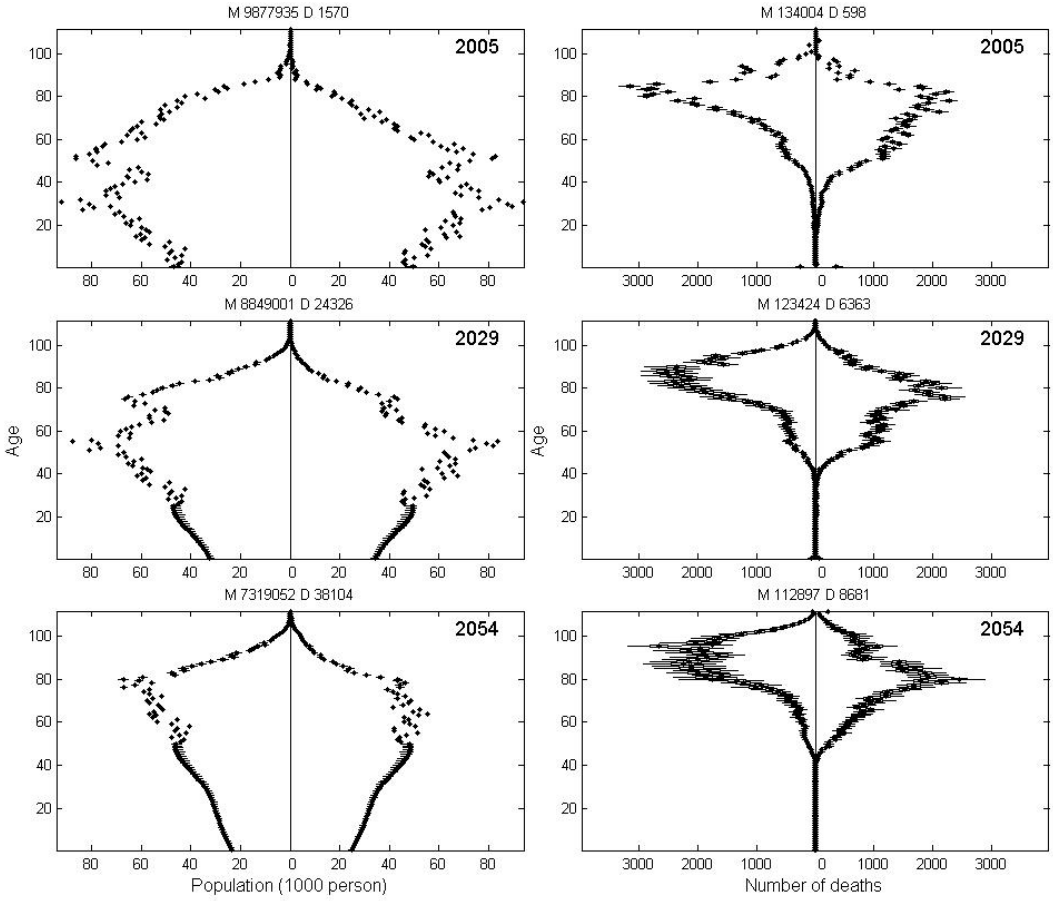


Figure 3-4. Development of age trees (left) and numbers of deaths (right) during filtered OLS simulation based on 1990-2009 data. Summarized means (M) and deviations (D) are shown in the title of the plots.

The number of deaths and the mortality rates are decreasing and the population still decreases rapidly. The example model on Figure 3-3 might be the most pessimistic, but without significant increase in the birth rates all simulations show similar results.

The OLS simulation based on mortality rates after the regime change resulted in the highest population at the end of the simulation (

Figure 3-4). Compared to Figure 3-3 the women side of the left column barely changed except for the increase in deviations caused by the smaller base period. On the other hand the side of the men varies significantly from the former figures, especially in the upper half. The reason for this is that the events before the regime change had a much bigger, negative influence on the mortality rates of men, than on the rates of women. In the above model this resulted in higher male life expectancies and higher male population, but the overall size of the population did not change much. This is caused by the lack of relationships between the entities in our system. Without relationships the male society has no influence on the number of newborns and this way the growth of the male population only increases the overall population in a linear way. This only worsens the problems of the pension system. The relative increase in the population is concentrated on the ages above 50, so on people who are not too far from retirement.

The above statements are supported by the diagrams in the right column as well. The initial conditions are the same as in Figure 3-3, but as the simulation progresses, the male death counts start to "behave" just like female death counts. At the end of the simulation the shape of the two sides starts to look more similar, unlike before where the female part had a main spike, while the male part was practically flat above the age of 50.

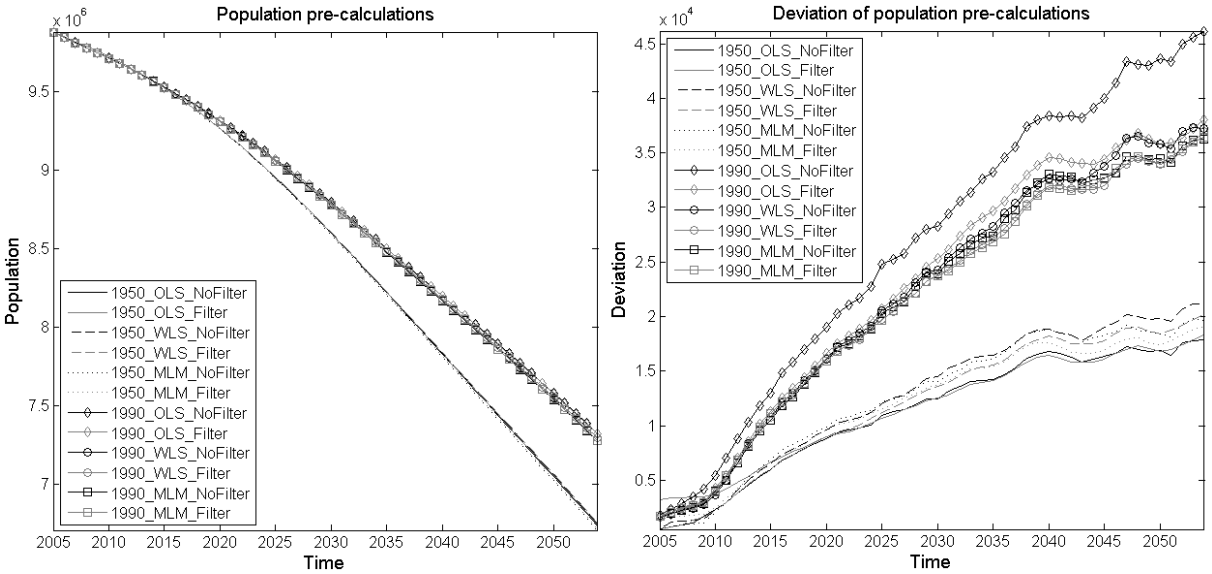


Figure 3-5. Mean (left) and deviation (right) of the development of the population for every model type.

Figure 3-5 shows the population changes of the different models. The left panel shows the average of the 500 simulations, while the right side shows the respective deviations. On the left side practically only two lines can be seen. The only difference is caused by the different initial values of the Lee-Carter models. The different model types and the filtering did not influence the average results. The data based on the years after the regime change shows significantly higher population numbers. This can be explained by the improved living conditions after 1990. The deviations on the other hand show a much more diverse picture. As expected, the Lee-Carter models based on fewer years increase and the filters decrease the deviation. Interestingly the two OLS models resulted in the two extremes.

The reason for the lower average population in the 1950-2009 based results is the much lower life expectancy (see Figure 3-6). The years before 1990 featured much worse living conditions and the victims of the terror just worsened the statistics. This had a much bigger effect on the male population, their life expectancies are relatively lower, and fluctuate much more, as seen on the figure. There is usually a difference between the male and female life expectancies, but this difference is roughly constant, just like in the case of the results based on 1990-2009 data. This might suggest that the models based on data after the regime changes are more appropriate for our simulations.

The use of filters had really low impact on the outcome of the simulations. Of course the filtering reduced the deviation of the results, but the average values barely changed. The estimations of the male life expectancies based on the 1950-2009 periods were the only ones noticeably influenced by the filters. The otherwise oscillating graphs smoothened, but the means of the life expectancies remained the same.

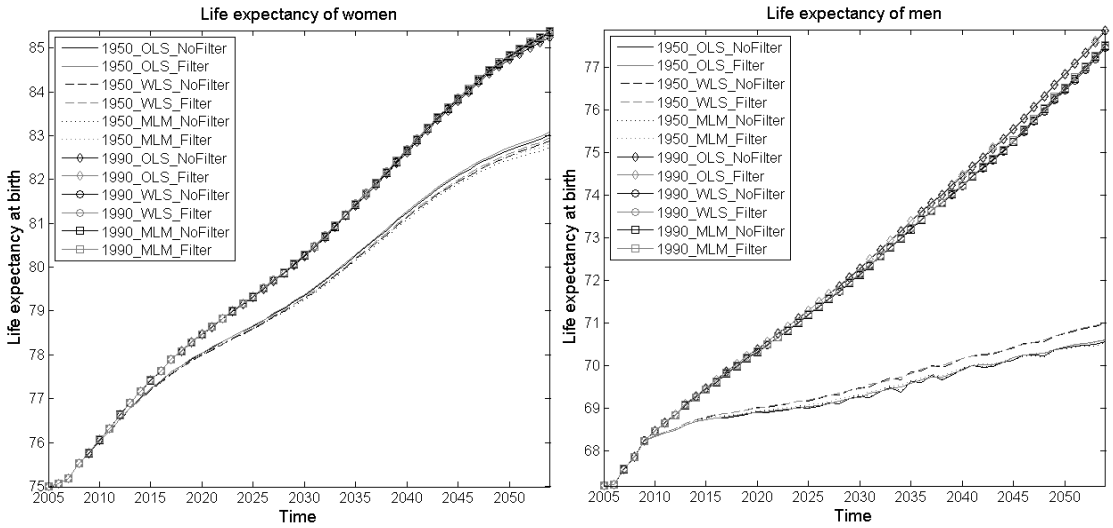


Figure 3-6. Life expectancies of women (left) and men (right) for every model type.

Conclusion

The main distinguishing factor between the different models is clearly the selection of the base data. The events before the regime change distort the mortality rates of men. This results in pre-calculations that greatly differ from the international trends, especially in the terms of life expectancies. This might suggest that the Lee-Carter models are not appropriate for pre-calculating the Hungarian demographic processes. Using weights for the years of the base data in a way that former years get lower weights might be a solution for this problem.

The models with the base data from 1990-2009 showed a significant increase in the male population, but had very little effect on the female population, thus the number of newborns remained relatively unchanged as well. This brought to light the necessity of including the family relationships in our simulation system. Otherwise the changes in the male population will have infinitesimal effect on the simulated society.

Since the Ratkó-grandchildren are less likely to have children than their parents or grandparents. The missing third spike on the age tree caused by this is an important phenomenon. The model based on the years 1990-2009 lacks the information about the former, higher number of newborns thus it might underestimate the decreasing birth rates of the current years. This probably has a relatively smaller impact on our model, but might have a significant influence on the results after the implementation of the time varying birth rates. For this reason, even if the models based on the narrower sample seem to have performed better, their results have to be verified in future works.

Overall the simulations based on the data after the regime change did deliver results of the same order of magnitude as traditional cohort-component forecasts. Further comparison is not necessary since the goal of our microsimulation system was only to compare the Lee-Carter models. After the promising results our future goal is to expand our system and implement forecasted birth rates, family relationships and educational attainments and finally compare it against other solutions.

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Existing Link Analysis Techniques for Graphical Data: A Scholarly Analysis of Literature

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Abstract

The aim of this study is to analyze the Link analysis techniques, which mine graphical data, and their features, taxonomies, processes and limitations. This paper evaluates the link analysis techniques with respect to different parameters, such as mining technique, working, input parameters, complexity, and relevancy. The method which is adopted to conduct this review consisted of exhaustive search for relevant literature via electronic resources – IEEE Xplore, ACM Digital Library, Springer and Google– using search strings obtained from the subject of discussion. The findings explained that existing link analysis techniques need more improvements as many applications rely on these techniques like space communication, fraud detection, social networks and search engines. The contribution of this study is to critically examine the current link analysis techniques. This paper surveyed most popularly used techniques of link analysis and its combination with traditional data mining techniques. Moreover, it surveys, applications of link analysis like social network analysis, Internet search, space communication, crime prevention and fraud detection. Besides, the paper has discussed and critically evaluated the features and limitations of different link analysis algorithms.

Introduction

Link analysis deals with mining useful and appropriate information from linked structures such as graphs. Link analysis is not a single technique rather it is a group of techniques, which operates on graphical data including nodes and links.

The demand of link analysis and associated challenges are increasing rapidly as information in databases is extensively growing. This information is in the form of plain texts, structured documents, transcribed conversations, images and videos. Currently, link analysis techniques are used in multitude of practical scenarios, especially in the domain of computer networks. Many data sets are linked collection of objects today. They represent heterogeneous or homogeneous networks. WWW (World Wide Web) is an example of a homogeneous network because all nodes are web URLs, while a network of bibliographic citation and links is a heterogeneous network as nodes can be books, papers and articles, etc. [1]. Hence, link analysis is an exciting and rapidly expanding area of data mining.

Traditional data mining techniques for information retrieval on the web were inadequate and did not perform well. Various new link analysis techniques have been developed in the last decade to overcome this problem. Link analysis covers a diverse set of activities, which encapsulates useful information for these networks. There are various link analysis tasks: Link-based object Ranking (LOR), Link-based object classification (LOC), Group detection, Link prediction. Whereas, PageRank (PR), HITS, Weighted PageRank (WPR), SimRank are most popular approaches of LOR. We discussed all these in detail in our literature review section.

This paper describes strength and drawbacks of link analysis techniques regarding different areas such as social networks, space communications, web mining and crime prevention. The findings of this study will help researchers and practitioners to propose new link analysis techniques with the aim of addressing the drawbacks of existing techniques.

Rest of paper is structured as follows: Research method is defined in the next section. After, we described the taxonomies of link analysis algorithms and highlighted the previous work in the field of link analysis. The subsequent section presents a critical evaluation of link analysis algorithms. Finally, last section describes the conclusion and future work. References are delineated in the end.

The research method we adopted in this paper was proposed by [2], known as review protocol.

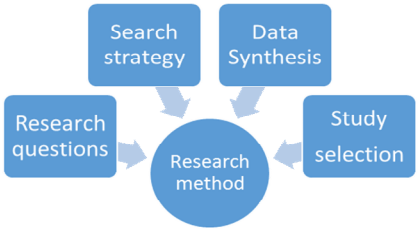

Figure 4-1. Phases of the review protocol

Research Questions

The aim of this survey was to survey was to understand the empirical proof regarding link analysis techniques, and find new areas for more research in order to escalate the performance of existing techniques. To accomplish this purpose three-research questions being the basis for our research were codified:

- what are taxonomies of existing link analysis techniques?
- what are the various applications of existing link analysis techniques?
- what are the features and limitations of existing link analysis techniques?

Search Strategy

We have used search terms, search processes and literature resources for search strategy to accomplish our survey. To build the search terms, we used these steps:

- derivation of dominant terms of the research questions
- recognition of synonyms and substitute spellings for major terms; and
- recognition of keywords in papers.

The resulting search terms were (task or method or approach or technique) and ("link analysis techniques") or ("tasks of link analysis") or ("taxonomies of link analysis") or ("link mining") or ("algorithms of link analysis") and ("link analysis limitations").

Literature resources

We have used various electronic resources to extract data used in this research, including IEEE Explore, Springer, ACM Digital Library and Google. We used research papers from various international journals, book chapters, International workshops and International conference proceedings.

At first stage, we selected 90 papers from different electronic resources mentioned above. After filtering and removing duplication, 40 papers were selected for this survey paper, which were adequate of giving answers to our research questions. Three additional papers were selected as secondary references. Hence, 43 papers were finalized.

Our review contains an exhaustive search of all relevant sources regarding a specific topic. However, the search processes used in this study consisted of the two steps showed in Figure 4-2.

- *Step 1:* Comprehensive search was launched in the electronic database sources and 40 relevant papers were selected.
- *Step 2:* The reference lists of all relevant papers were examined to identify extra relevant papers and then, we found 3 additional papers. We grouped them to previously selected papers

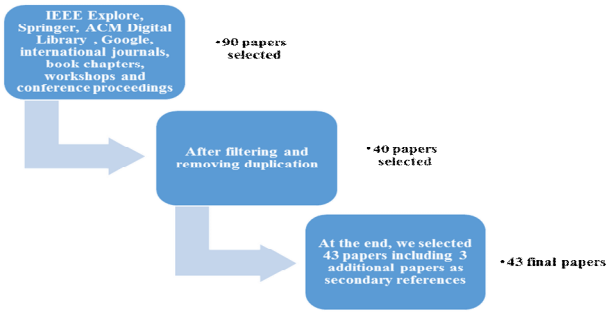

Figure 4-2. Search and selection process

At first stage, 90 prospective papers were collected. After, we used titles of these research papers to analyze and assemble related papers. This process was important for removing duplication and irrelevant papers. Hence, 40 relevant papers were selected. Thereafter, we analyzed references of all selected papers to recognize substantial papers as some might have been ignored at the first stage of the search process. This process enabled us to identify 15 additional papers. Hence, total 43 papers were finalized, which were enough capable to answer the research questions.

Data synthesis

The purpose of data fusion is to encapsulate evidence from the selected papers to answer the research questions. The 43 selected studies examined additionally to determine the detailed contents of each paper.

Literature Review

In this section, firstly, we have described the most common tasks and approaches of link analysis. Secondly, we discussed and analyzed different link analysis techniques used in different fields.

Tasks in Link Analysis (RQ1)

Link Analysis encompasses multiple distinct tasks [1]. These tasks can be grouped into a small set of overall categories. Figure 4-3 shows hierarchy of these link analysis tasks. We have discussed some of these categories below.

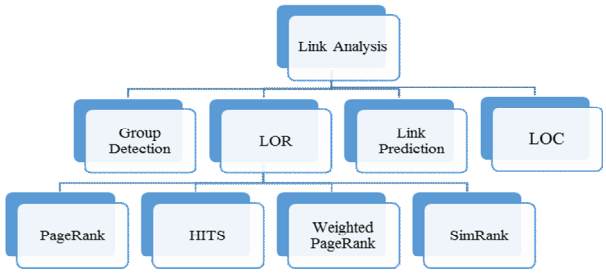

Figure 4-3. Link Analysis Tasks

Link-based Object Classification

It is the most known and straightforward upgrading of a link analysis task. Link-based object classification predicts the object's category based upon its attributes and links to other objects. An example of link-based object classification is webpage classification. Link-based object classification can predict the category of paper in the bibliographic domain, based on its citations. A very simple example that describes LOC is to classify those nodes, which are tightly connected and weakly connected. LOC classify these nodes on the basis of their degree i.e., total number of links incident on them [1].

Link-based Object Ranking (LOR)

Link-based object ranking (LOR) ranks objects in a graph based on several factors e.g., their strength and importance in graph structure. The goal is to assign a relative quantitative assessment with all nodes in a network. Web page ranking is one of the most well-known LOR tasks. We can say that LOR is a more fine-grained version of LOC [1]. In social network analysis, Link-based object ranking is primary task. The research in LOR mainly target graphs which have single link type and single object type [3]. HITS , PageRank, Weighted PageRank (WPR) and SimRank algorithms are the most popular algorithms of LOR [1].

PageRank Algorithm

The PageRank algorithm distinguishes between low quality and high quality web pages, and it is used by Google search engine. Page Rank assigns a score value to each web page or document independent of a specific query [4]. PageRank assigns a numerical score weighting 1-10 to any single web page or a website. PageRank is represented by PR, which shows firmness and importance of a website. Search engines like Google calculates the PR by analyzing different backlinks pointing to a specific website [5]. The modified equation of PageRank is demonstrated in Equation-1 [6]:

$$PR(x) = (1-d) + d\sum_{y \in H(x)} \frac{PR(y)}{N_y} \qquad (1)$$

Where PR (x) is the score of page x, PR(y) is the score of page y. u shows a web page while H(x) (set of pages) points to x and N_y shows total outgoing links of page y. d is a dampening factor (1 –d) is the page rank distribution from pages which are associated non-directly. The value of d mostly set to be 0.85

Weighted PageRank

Weighted PageRank (WPR) algorithm is an extension of the original PageRank algorithm proposed by Xing and Ghorbani [7]. It assigns a larger score to the extra important pages instead of dividing the rank of a page evenly between its outgoing linked pages. The importance is assigned according to weight values to both incoming and outgoing links and are represented as $W^{in}(y,z)$ $W^{in}(y,z)$ and $W^{iout}(y,z)$ which are shown in equations 2 and 3 [7, 8].

$$W^{in}(y,z) = \frac{I_z}{\sum_{p \in R(y)} I_p} \qquad (2)$$

where I_p and I_z are the number of incoming links of page p and page z respectively. R (y) shows the reference page list of page y.

$$W^{in}(y,z) = \frac{O_z}{\sum_{p \in R(y)} O_p} \qquad (3)$$

O_z and O_p shows outgoing links of page z and p respectively.

HITS Algorithm

Another PageRank algorithm is HITS. The Hyper-link-Induced Topic Search algorithm was proposed by Kleinberg in 1999 [4]. It identifies hub and authority nodes in a network. Hubs are those web pages which link to many authoritative pages while authorities are web pages which are linked by many hubs. Each web page in assigned authority and hub scores. The HITS algorithm calculated two different metrics for each node: hubness and authority. Figure 4-4 illustrates links in hubs and authority.

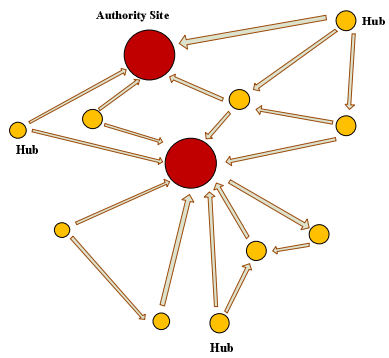

Figure 4-4. Hubs and Authorities

The Google PageRank and the Kleinberg HITS algorithms are eigenvector methods for identifying "influential" or "authoritative" articles, given citation information or hyperlink. For a group of web pages, the HITS algorithm first creates the n-by-n adja-

cency matrix A. If page i links to page j, then its (i,j)-element is 1, and 0 otherwise. HITS iterates the following equations [9]:

$$a_i^{(t+1)} = \sum_{j:j\to i} h_j^{(t)} \quad (4)$$

$$h_i^{(t+1)} = \sum_{j:i\to j} a_j^{(t+1)} \quad (5)$$

where "i→j"" means page i links to page j.

SimRank

Qiao, T. Li, H. Li, and Zhu [10] proposed a new page rank approach based on a similarity measure named "SimRank", to score web pages. The authors presented this algorithm to calculate the similarity of pages. Moreover, they divided a web database into many web social networks (WSNs) using this algorithm. Furthermore, they improved the traditional PageRank algorithm and designed an effective web crawler to download the data from webpages. SimRank defines that two objects are related to similar objects then they are similar [11]. Suppose, the similarity between two objects u and v is s (u, v) Є [0,1]. If u = v then s (u, v) is '1'. Otherwise, the basic equation for SimRank is shown in Equation.6 [11]:

$$\frac{D}{|I(u)|\,|I(v)|}\sum_{i=1}^{|I(u)|}\sum_{j=1}^{|I(v)|} s(I_i(u), I_j(v)) \quad (6)$$

If u ≠ v where D is a constant between 0 and 1, if u or v does not have any in-neighbors, then is (u, v) = 0. The summation in above equation becomes 0 when I (u) = Ø or I(v) = Ø.

Link Prediction

Link prediction methods in link analysis are set of methods, which can be used to search new connections and link. The Link prediction method is used to identify new friends and connections in a friendship network specifically in social networks. There are many types of the link prediction method e.g., link existence problem, predicting edge weights over time, link removal problem. Link prediction can be performed in many ways like in relational data e.g. Relation Markov Networks (RMN) . Chakraborty et al. [1] and Markov Logic Networks [3] has presented a survey of predictors based on various graph proximity measures [3].

Group Detection

One of the major interesting concerns in link analysis and link discovery is identical objects or individuals presented by distinct ids. This is known as deduplication, alias detection object consolidation and record linkage.

The purpose of group detection is to make cluster of the nodes into groups, which share common characteristics. Many techniques have been presented in many communities to address this problem. Many approaches of group detection are based on stochastic block modeling from social network analysis [3].

Applications of Link analysis (RQ2)

In this section, we explained the use of link analysis in various fields. After going through many research papers regarding link analysis, we came to know that link analysis is widely used in areas of social networks and web mining. However, there are many other emerging applications where researchers are implementing link analysis techniques. We discussed these fields as follow:

Social Network Analysis

In the last decade, social media has become essential and ubiquitous for social networking and content sharing. Social network sites such as Facebook, Twitter, LinkedIn and Google+ are becoming popular day by day in all age groups. There has been prior work on social media data analysis using different data mining techniques, but the most popular technique is link mining or link analysis.

Link prediction predicts new connections in social network analysis based on previous observed links. The previous work in this field is based on an approach, which deals with the problem by making timely analysis in the network rather to consider its evolution over time. According to researcher's analysis, time-aware information can bring sounder results of link prediction considering both supervised and unsupervised learning. Moreover, when this time-aware information combined with the traditional link prediction approached the results improved in some networks. However, the proposed

approach shows some limitations, as few networks were use in experiments and their domains. Hence, this approach can explore in other social networks for achieving more salutary link prediction results.

The link analysis techniques (used in various applications like WWW, social networks and Bioinformatics) perform well on the patterns of connections among features in the graph directly instead of statistical approached like clustering in feature space. The authors obtained better results on the Caltech-10 examples. Moreover, they obtained efficient results for the TUD/ETHZ dataset. However, this approach should use in other visual tasks. There is a need for more feature level interaction, such as manipulating a group of images having various classes and instances.

Link prediction and link structure tasks have been examined by Dawei Yin, Liangjie Hong and Brian D. Davison within the microblogging network Twitter [12]. Author proposed a novel structure-based link prediction technique and compared it with other link prediction methods from the microblogging network Twitter. Moreover, he compared his approach with a popular method 'matrix factorization'. Noticeable results were obtained by experimenting on both dynamic and static real world data sets. Author only discussed one microblogging network Twitter. He performed experiments on data taken from Twitter and he ignored all other hybrid networks. His method of link prediction should implement on other microblogging networks like Google Buzz as well.

Fraud Detection, Crime Prevention

Link analysis is a hot research topic in fraud detection, law enforcement, anti-terrorism and other security areas. Fraud rings and crime rings are a kind of social networks as well. Detection of these rings can do easily by analyzing links between entities.

Ahmed proposed a new algorithm Association Rules to Detect Fragment Attack (ARDFA) for IDS to detect fragment attacks[13]. Intrusion detection system (IDS) is uses as a key element to limit attacks in network security. However, some fragmentation techniques like evasion and insertion can produce attacks, which are not recognized by IDS. The proposed approach used data mining techniques of link analysis for detection of fragment attacks. The ARDFA made two major contributions. The first is the Enhanced Host Control (EHC) and the second is Enhanced IDS Control (EIDSC). The EHC can identify fragment attacks based on log data using link analysis techniques of data mining. Moreover, it provides circumstances of attack production.

Link Analysis

Link analysis is important for any satellite communications system to observe the quality of the link. The researchers proposed a link analysis tool for deep space communication [14]. This tool was developed by "The Aerospace Corporation". It analyzes data and coverage throughput for communication links between a spacecraft and Deep Space Network (DSN). The tool describes data throughput and link margin during the trajectory of a spacecraft over time observed by the DSN.

A DPLAT (Dynamic Proximity Link Analysis Tool) proposed by researchers in this paper[15]. This tool was developed by "The Aerospace Corporation". The tool returns the data throughput from ground assets of MARS to orbiting communication satellites for proximity links. The tool computes the total data throughput grounded on the data rate computations.

Search Engines and Web Mining

The link analysis techniques have played an integral role in the current generation of web search engines such as Google, Ask, Yahoo, and Microsoft's search engine Bing. Sachan and Ichise described a supervised learning method for creating link predictors with the help of the structural attributes of underlying network along with semantic attributes of the nodes such as the title and abstract information [16].

Retrieving documents on the World Wide Web (WWW) is furnished by two types of tools: classified directories (catalogues) and search engines. Maintenance of the catalogues is done by automatic classification of documents. Monika Henzinger described two successful link analysis algorithms; Query-dependent Connectivity-Based Ranking and Query-Independent Connectivity-Based Ranking [4]. In the latter each page is assigned a score without a user query. At the time of the query, this assigned score was used without or with some criteria to rank all pages or documents matching the query.

The drawback of this approach was that it could not distinguish between high and low quality pages, as all links are equally important. Brin and Page proposed the PageRank algorithm as a remedy for this drawback. Mishra, Jaiswal, and Ambhaikar proposed a new approach Topic sensitive weighted page rank for ranking of webpages based on weighted PageRank and Topic-sensitive PageRank [7]. The proposed algorithm computes an importance score for each web page. Linked-based ranking algorithms such as Weighted PageRank, PageRank are commonly used for web mining. As compared to these existing algorithms, the proposed algorithm shows more relevancies of the web pages on a given topic.

Attractiveness of Tourist Destination

Web link analysis is used in many subjects, which shows a reference for research on tourism. With the speedy development in network technology and growing rationality of tourists, the services and information catered by tourist attraction play a vital role in the decision making process of tourists. Hence, link analysis techniques are useful for research in tourism field.

Critical evaluation (RQ3)

This section critically reviews all described link analysis algorithms. Firstly, we compared all link- based object ranking algorithms in Table 4-1. [17] [18] [5] [19] [8] [20]. Secondly, comparison of link prediction and group detection is illustrated in Table 4-1.

Analysis and Discussion

Table 4-1. shows the comparison of four different link-based object-ranking techniques according to different parameters. The followings are the parameters used: Mining Technique, Working, Input parameters, Complexity, Limitations, Advantages, Quality of results, Relevancy, Search Engine / Applications, and Query dependency. Mining technique is defined as each algorithm uses which technique to mine the data and links. Working is defined as how the algorithm assigns the rank to the web pages. Input parameters are incoming or outgoing links of each node; some algorithms use inlinks to compute the rank value and some use both inlinks and outlinks. Complexity shows how much running time each algorithm takes while mining the links and assigning the ranks. Limitations explain the deficiency and drawbacks of the algorithms. Quality of results shows which algorithm has better results than the other one.

The PageRank algorithm uses web structure mining and inlinks to assign ranks to the web pages, it consumes less time, and it is easy to use because it assigns rank score on indexing time rather than the query time. The disadvantage of PageRank algorithm is that it considers older pages because a new page will not have as much links unless the new page is part of any already existing website. Moreover, PageRank has low relevancy.

Weighted page rank returns high quality of pages rather than a simple PageRank algorithm. It divides the rank value of a page on the base of outlink pages according to the significance of that page. It assigns a larger score to pages that are more important. It has low relevancy and is mostly used in research models. SimRank is another link analysis algorithm, which has high relevancy; it also uses web structure mining in link analysis. This algorithm is based on structural and textual context, which shows similarity scores among nodes. It also uses back links and forward links to compute the rank value.

❖ Link Analisys Techniques

Table 4-1. Comparative Analysis of Link Analysis Rank Algorithms

Algorithms→ Criteria↓	**PageRank (PR)**	**Weighted PageRank (WPR)**	**SimRank**	**HITS**
Mining Technique	Web structure mining (WSM)	Web structure mining (WSM)	Web structure mining (WSM)	Web Content mining (WCM) and Web structure mining (WSM)
Working	Rank the pages at indexing time of the pages	The weight of the web page is computed based on both input and outgoing links. Importance of page is decided on the basis of weight	It is based on structural context which shows similarity scores among nodes	Calculates scores of hub and authority of n highly related pages
Input parameters	Backlinks	Forward links, Backlinks	Forward links, Backlinks	Forward Links, Content and backlinks
Complexity	O(log n)	<O(log n)	$O(kd^2 n^{2)}$	<O(log n)
Limitations	Results get at the indexing time and not at the time of query, Spider Traps, Dead Ends, Dangling Links	Relevancy is ignored	It does not consider the strength and nature of links, it can only apply to static graphs	Topic drift and efficiency problem
Advantages	Rank is computed on the basis of the page's importance, Anti-spam capability	It assigns a larger score to more important pages	Flexible and provides good similarity scores	It uses the hyperlinks so it gives better results. It considers the Content of the page also
Quality of results	Medium	Higher than PR	Better than PR	Less than PR
Relevancy	Low	Low	More	More
Search Engine/ Applications	Google	Research model	Web spam detection, link prediction and collaborative tagging analysis	IBM's search engine Clever
Query dep.	Query Independent	Query Independent	NA	Query dependent

Table 4-2. Comparative Analysis of Link Prediction and Group Detection [3] [16]

Criteria	**Link Prediction**	**Group Detection**
Working	Prediction of links among different edges or nodes	Cluster the edges of a graph having common characteristics
Technique Used	Graph proximity measures, Logistic regression model	Stochastic block modelling approach, K-mean clustering
Description	A set of methods used to search new connections and links between nodes depending upon the existing links	The purpose of group detection is to combine the number of nodes who share the common characteristics
Limitation	Sparsity of networks, Statistical modeling is low due to the low preceding problem of links	Scalability is restricted, Execution becomes in traceable for large networks

HITS use both Web structure mining (WSM) and Web Content mining (WCM) in link mining. It assigns rank of the page on the base of authorities and hubs, it uses three input parameters, which are inlinks, outlinks and content of the page. The quality of its results is less than the Page Rank algorithm. HITS algorithm is not as much popular as PageRank, due to the lack of features like efficiency, feasibility, less time complexity etc. This algorithm is used in IBM's search engine Clever.After going through exhaustive analysis of link analysis algorithms for ranking of web pages against the different parameters, it is concluded that these techniques have some limitations regarding time complexity, relevancy, and accuracy of results. By combining these algorithms together, we can get better results

Analysis and Discussion

Link prediction is a technique of link analysis, which is used to predict the links among different people on social media networks. Many different methods are used to identify the links among the nodes. For example, Graph Proximity measures, Logistic regression model, etc. Link prediction contains set of methods used to search new links depending upon the existing links. Limitations of link prediction technique are that due to the sparsity of most attractive links it is hard to predict the links between nodes. The preceding probability of links is very low that is why it is difficult to design the statistical models.

Group detection is an object-centric task. The purpose of group detection is to make cluster of the nodes into groups, which share common characteristics. Many techniques have been presented in many communities to address this problem. After going through the analysis of link prediction and group detection in link analysis against different parameters, it is concluded that these techniques have some limitations regarding sparsity of data and networks. Effective group detection techniques can be combined together to detect the groups and find the future links between the nodes.

Conclusion and Future Work

Link analysis is an emerging and promising area in data mining field, which concentrates on searching patterns and rules in datasets by explicitly and exploiting creating the links between the objects. First, we described many link analysis tasks like link-based object classification (LOC), link-based object ranking (LOR), PageRank, HITS, SimRank, Weighted PageRank, group detection and link prediction. Secondly, we explained the use of link analysis in different fields such as social networks, fraud detection, web mining, E-learning environment and space communication. However, there are many more fields where link analysis techniques apply. Moreover, there are many new link analysis emerging techniques, because many researchers are working in this field.

In future, we have to improve link analysis techniques because many of applications rely on these techniques like space communication, fraud detection, social networks and search engines. We can combine traditional data mining techniques to link analysis and get better results.

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IT Challenges of a Production System

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ABSTRACT

The purpose of the applied IT solutions during the operation of factories is to support the manufacturing workflow and the strategic decision making of company managers. We reviewed the industrial techniques in nowadays and the newest trends ("Industrial Internet", "Industrie 4.0") which are based on the idea of "Internet of things". In our research, several aspects of furniture production were analyzed: (1) the IT solutions, which can help the manufacturing processes, (2) the required image and video analyzing processes, (3) how to reduce the number of waste products by monitoring and analyzing. By replacing a currently used, outdated system, the developed system makes the production more efficient. The analyzing of the image or video is a difficult task, because of the inhomogeneous color of timber board.

Introduction

The role of industrial innovation is one of the most important process in manufacturing. Since production is the most valuable process in a company environment, it is necessary to optimize production processes and create new production technologies utilizing the continuously evolving IT developments. Different production fields need special technology and each company has its own special production processes. In a furniture production company, working with timber board (or wooden material) requires another processes than in metal industry, because the wood and metal must be handled in different ways. Therefore, the production system can be very individual and complex. However, companies must use some kind of production support systems starting with the office applications ending with the integrated production systems. Data are created during production process and are handled by production systems. Based on these data, analyses can be performed and as a result, feedback can be returned to the production itself to optimize the entire process. The production system can be integrated into an ERP[3] system but self- developed solutions and processes must be connected to the ERP in most cases due to the unique nature of the production. Unfortunately, production system cannot always be integrated into ERP.

Experts present new and flexible production system on the market. The origin of production problem goes back in the early of the mid of 20th century. The Toyota was the first one which established the basic characteristics of the first production system named TPS[4]. The Bosch, FESTO and other companies used and further developed TPS. TPS was extended with JIT[5], TQC[6], Jidoka[7], and other production support solutions. Experts always try to implement these solutions in poka-yoke way, i.e., in fail-safing way. But it is not possible in all cases, since all kind of operator mistakes cannot be handled with IT [1].

[3] Enterprise Resource Planning
[4] Toyota Production System
[5] Just In Time
[6] Total Quality Control
[7] English: Autonomation - automation with human intelligence

Industrial Solutions Nowadays

There are ideas from 1950s in the industry which became standards later. The engineers added these standards to the production processes in several ways in the factories. In this section, these standards and their backgrounds are summarized.

Lean management

This management philosophy was developed by Toyota Company in Japan. The approach recommends three things:

- thinking long-term,
- focusing on quality and
- the smoothness of a process's flow.

The Lean idea's goal is to reduce the costs, which are not necessarily connected to the people or machines. The management has to find those parts of the production progress which are valuable. They want to know if they are doing the right things want to take as little risk as possible. The Lean attitude is about challenging problems, continuously improving and continuously striving for perfection. This is a competition with the company's rivals since there are same problems on the same markets and that company will be the market leader, which solves the problems better. There is a Japanese quote, which describes the Lean philosophy in the best way: *"if we are not a little better next week than we are this week, we will sooner or later be out of business"* [2]. The Lean companies are looking for perfection; they do not settle with just being the best for now.

The Lean attitude's goal is handling visions that are overwhelming. This procedure can be described in four simple steps:

- Define the company's vision even if it feels impossible to reach;
- Define where the company is now;
- Define what the next reachable goal in the right direction;
- Iteratively make improvements until the goal is reached.

Steps (2) to (4) should be repeated forever, as long as the vision is still valid. If it is not, the company's management will need to go back and find a way of redefining it. The following ideas and tools are parts of Lean management.

Kaizen

This is the most important method, which supports the applying of the Lean management. Kaizen guarantees the sustainable development and growth in the life of company. It helps to discover and reduce the waste through the process's development. It improves the results and outcomes of production. With the Kaizen[8] idea, the company can reach a higher level of quality. Kaizen means an improvement by the company's workers. They give recommendations, which connect to the production process, and the causes and effects of problems are solved. Kaizen is a way that contains three simple steps:

- We identify the processes, which are not valuable or necessary and we terminate those;
- We minimalize the time and the resources for those processes, which are not valuable, but necessary;
- Finally, we have to optimize or change the rest of the work and resources.

Kaizen is not a method, but a philosophy. It determines how the workers (including the management) have to work. The forms of Kaizen can fit to a person, a team or an area of the company. In case of the last one, the management of the company nominates a team, which works a process's development. This development contains some typical tasks:

- defining area or theme,
- configuring a team,
- defining goals, indicators, milestones,
- collecting data,
- measuring the area, taking pictures, "track&trace",
- configuring the concept and the recommendation of the development,
- applying new methods, executing the changes,
- measuring the efficiency, making feedback,
- final presentation and documentation,
- standardization and training.

To reach the shortest lead time and the highest efficiency, we have to apply the Kaizen approach in the whole supply chain management [3].

[8] English: the optimizing of the supply chain management is good

The following approaches complete the Kaizen method and Lean philosophy, therefore these will be summarized shortly.

5S method

The Seiri-Seiton-Seiso-Seiketsu-Shitsuke method[9] [4] creates the basics of the other Kaizen actions. The 5S defines a system at the worker-level that improves the company's culture. This system mostly supports the order's maintenance. The well-structured company can reach circa 20% outcomes growth. The goal is to create and maintain the efficient, safe workplace. It can be applied operative-level areas of the factory, where the workers are working.

TPM[10] system

The TPM is a complex and integrated system that consists of management elements which support to increase the outcomes of production. This goal can be achieved by decreasing the costs of the equipment (e.g., downtime, waste, input materials and energy costs). The basics of TPM:

- developing the maintenance service,
- motivation and training,
- measuring the source of waste and its elimination (OEE[11]) and
- making safe the workplace.

SMED[12]

This instruction is one of the Lean management's goals. This is a quick method for changing tools. We have to decrease the switching time between different products' manufacturing as short as possible. Therefore, (1) we can avoid the waste, (2) the unnecessary resources can be reduced, and (3) the production progress can be balanced as well. With years of work the engineers managed to achieve the standardization of the hand-tools and equipment.

Kanban[13] and Scrum

The Kanban and Scrum are process tools (in this view: *tool* = anything that solves a problem, *process*

[9] English: Sort, Set, Shine, Standardize, Sustain
[10] Total Productive Maintenance/Manufacturing/Management
[11] Overall Equipment Effectiveness
[12] Single Minute Exchange of Die (Quick Changeover)
[13] English: Signal Board or Signal Card

= how the factory works). These help the company to work more effectively by, to a certain extent, telling the management what to do. These tools provide certain constraints and guidelines. Scrum defines for the company to have time limited iterations and cross-functional teams. Kanban defines for the company to use visible cards and limit the size of its production queues. These process tools are changing the company's culture and the operators' personal attitude to their work [5].

As a summary, these industrial approaches need measurements and data, but these data are not available or not exist every time. However, data are necessary for making precise analyses, which give good decision suggestions.

In this paper, a new approach of the USA and Germany's industrial companies is introduced called "Industrial Internet" or "Industrie 4.0". Then we describe our self-developed monitoring system in the production field of a company. This system contains a camera, which is working as a real-time sensor. Since the built-in analyzing software of the camera is outdated, we have started to implement our solution in which several new methods for analyzing images and videos are applied. Finally, our results are summarized.

The Future of the Industry

A memorable citation from Bill Gates tells that *"A fundamental new rule for business is that the Internet changes everything."* (1999). But not necessarily in the industry... In these days, we are using our smartphones or tablets for nearly everything (e.g., surfing on internet, listening a music, contacting people, reading the news etc.). There are smart homes and smart energy usage, monitoring systems for failure sensing in transportation and so on. But in the manufacturing, the PLC[14] computers are the same as in 1985. The Internet didn't change everything, the "Internet thinking" is a key to smart manufacturing, smart connected products and smart production data. This approach is leading the next industrial and economic revolution. Several multinational companies (General Electric, Cisco, Gartner, McKinsey) prognosticate hundreds billion dollar gain, because they will create new products and services (new markets). They will be more efficient, and this will drive down costs (reduced maintenance costs with predictive maintenance, reduced waste with precision monitoring to control machines). It will be helped by many technological developments (e.g., interoperability, big data, cloud computing, virtualization, decentralization, real-time capability, service orientation, modularity etc.).

To support these processes, an institute named Industrial Internet Consortium was established in the USA. It was launched in March 2014 by five founding members, AT&T, CISCO, General Electric, IBM and Intel. The mission of the consortium is *"To accelerate growth of the Industrial Internet by coordinating ecosystem initiatives to connect and integrate objects with people, processes and data using common architectures, interoperability and open standards that lead to transformational business outcomes."* [6]. They are creating different environment for testing their techniques and technologies. A sample of their test environment can be seen in Figure 5-1.

In Germany, the governmental project "Industrie 4.0" started in 2011. The goals of the government are the same as the goal of the similar organization in the USA. The German engineers are reaching of their goals by experiences with Internet of Things, intelligent machines, big data and analytics. For example, the experts of General Electric have created a complete framework and solution which supports the decision making progress. This platform contains 8 levels of analytics:

- Standard reports
- Ad hoc reports
- Query drilldown (or OLAP: OnLine Analytical Processing)
- Alerts
- Statistical analysis
- Forecasting
- Predictive modeling
- Optimization

[14] Programmable Logic Controller

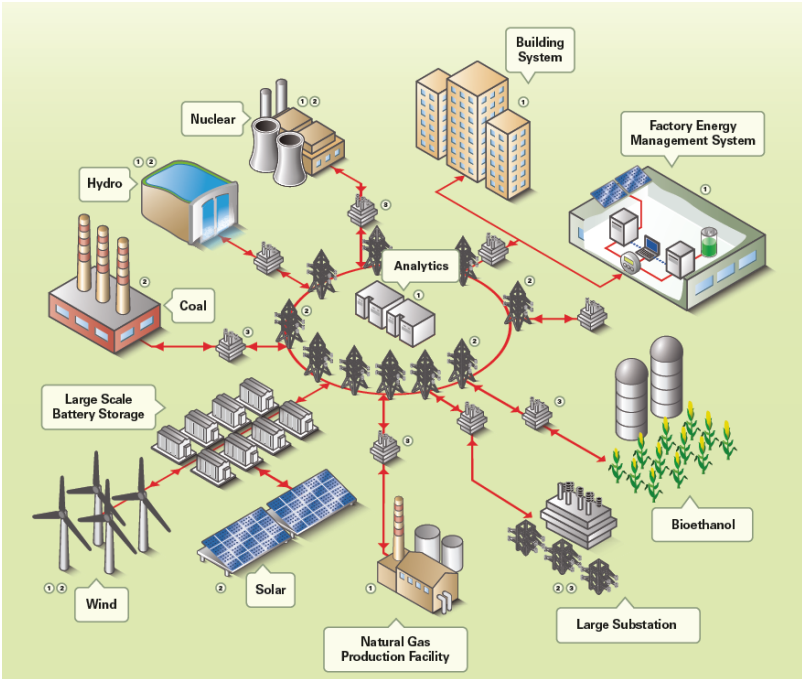

Figure 5-1. Industrial Internet Consortium's testbed: communication and control [1]

These levels answer questions of varying difficulty (e.g., "What happened when?", "Why it happened then?", "What and when will it happen?", "Why it will happen? What to do?"). The time progression is one of the most important variables in the industry. The more difficult questions can be answered, the easier the system will be to automate. Finally, the production system can be completely automatized (without human inputs).

Currently, there is no project or institute for supporting this high stage in the industry in Hungary. Typically, the IT section is not a part of the supply chain management by the national companies, therefore, the necessary and important developments are missing. There are only basic, minimal developments in the industry. But the IT support is essential in the working of a factory since if the IT section does not work correctly, every manufacturing system could stop.

Based on the experiments of Industrial Internet (Industrie 4.0) techniques and technologies, our team has started a development by a company. In this paper, we focus in this development and the related results.

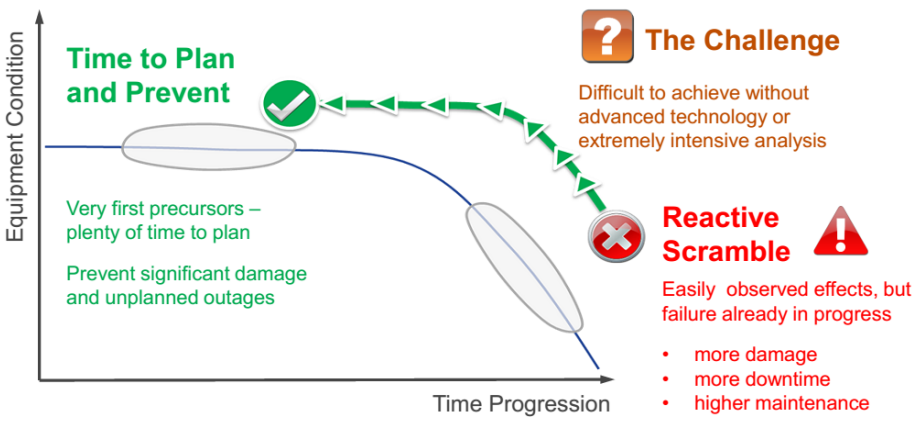

Figure 5-2. When are we able to prevent the failure? [7]

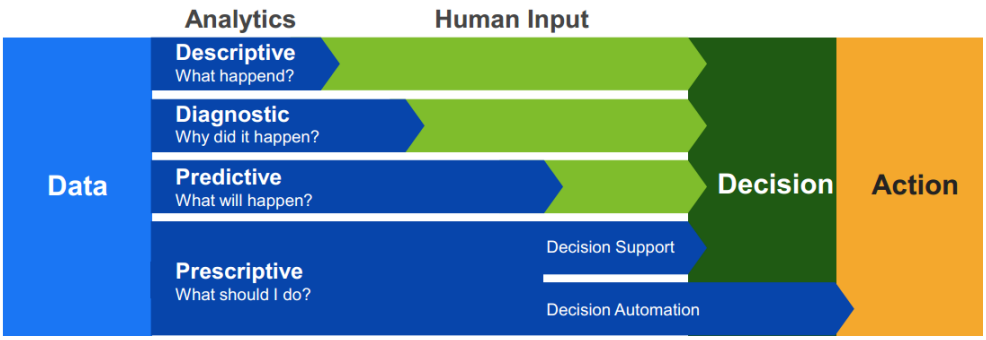

Figure 5-3. The Analytics Continuum (Source: Extend Your Portfolio of Analytics Capabilities, Gartner, 2013)

The Production Progress

For implementing a system which is based on the "Industrial Internet thinking", we have to use sensors, different supporting systems, electronic devices and their connections. We had to complete several tasks for the configuration of the "smart system":

- Automatic collecting the production data;
- Connecting database and ERP systems;
- Keeping the process error free;
- Analyzing the production data.

We have chosen a furniture production company to illustrate the IT challenges of a smart production system. Before the implementation of the system, the company's manufacturing processes were analyzed. Our first objective was to reduce the ratio of waste products. Stocks are received from several suppliers during the provisioning. These stocks include wood materials. At the reception, a sampling procedure is done to assess the quality of the shipment (whether sampled material is straight for example). If a certain percent is deemed adequate, the shipment is accepted. In the next process, the received shipment is sorted by size.

In the chosen company, the first production step is the alignment of the timber board. Then a camera determines wooden material color, which is a really important property for the production line. The wooden material color has a lower and upper limits and the color is sufficient, when the measured color value is between the limits. However, if a measured value is under the first limit, then the wooden material having dark color must be handled another ways in later production phases as timber boards with the proper value to achieve the proper quality. Similarly, a wooden material with light color value (upper measured value as second limit), can also be signed for the later work. Since the production company use several wood species and each specie has its own limits and the color can depend on plane machine performance, the problem is getting more complex. But defining the color remains critical and the wrong decisions led to high refuse material rate.

To reduce refuse rate, a monitoring and controlling system was developed. The supported process is the following. First, an operator pulls down a barcode. The barcode identifies two kind of information:

- The wooden material shipment and
- One of the wood species (e.g., beech, birch, oak).

Due to the wooden material shipment information, the measurement can be connected to the given vendor. In the second process phase, the wooden material is planed by a plane machine, then the timber colour is determined by a camera in real time. The most waste products are created at this step. The automatic qualification is somewhat outdated, manual qualification can never be perfect as people make errors. Near the *vendor identifier*, *one of the wood species*, and the *timber board colour*, the following metadata is attached: shift identifier, date, time and colour result etc.

The third step is data uploading into the company database, while the current measurement values is presented on the client computer screen. The presentation is an information to the operator, who can react immediately if wrong values appear. The production support system is connected to three printers. The last step is to label the timber boards according to the color value, so dark, ok and light sign can be printed on timber boards. The process is repeated with a new wooden material. The whole measurement is summarized in Figure 5-4. where the steps of the production progress are as follows:

- An operator pulls down the barcode of shipment
- The timber boards are planed by a plane machine
- The timber board color is determined by a camera
- The computer defines a color result
- The timber board goes by an illuminating barrier
- Printers print the color result on the timber board
- After the shipment data is uploaded into database

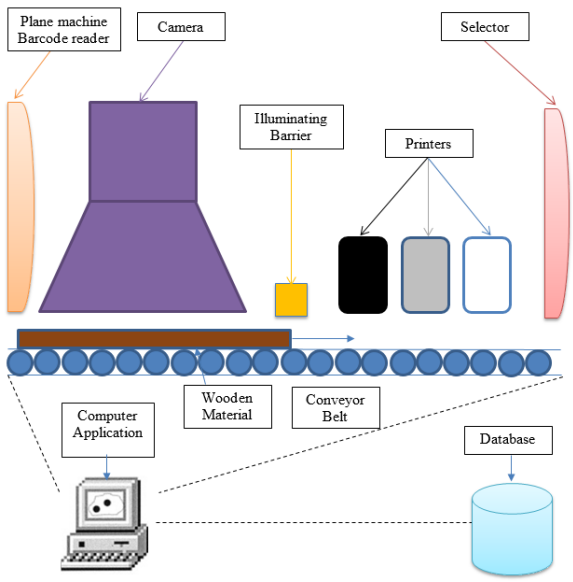

Figure 5-4. Environment of the production progress

The system provides an administration desktop as well where an administrator can change the production machine identifier and database IP address. Since the company has several plain machine and the internal informatics infrastructure can be changed, the production support system can be applied in these situations without new IT development. The company can order several new wooden material, therefore new wood specie can also be added with its limits to the system. The production environments change always, so current limit values can also be changed with administrator privileges.

Monitoring HW-Components

Image and video processing is a solution used in several industrial areas:

- Security camera systems;
- Medical image processing;
- Mapping of agricultural operations, etc.

Industrial image and video processing systems are able to monitor quantity and quality levels of manufactured products. Our system analyzes the color of timber board after the alignment. This task has to be done 24/7 in 3 shifts continuously. The system has to work without errors, otherwise the manufacturing process will stop causing extra cost. A few of the many advantages of our image and video processing system are the following:

- The burden of monotonous task on human operators can be reduced;
- Accidental errors can be avoided;
- Objective measurement instead of a subjective one
- Data collection can be automated.
- As a consequence, current and real-time statistics can be observed during the whole operation.

The multiple components of the system are camera, camera lenses, mounting frame, lighting, computer, data collection software. The factory's environmenttal conditions can affect the measurement process, which has to be protected from these environmental factors. One of the most difficult tasks is to protect the system from dust. Any kind of analyzing algorithm will be employed, environmental factors will play a key role, which can ruin the algorithmically calculated results of the system. Lighting has to be kept at a fixed level and external light sources have to be closed out. Camera has to be also mounted in a fixed position, shaking cannot be tolerated to achieve consistent results. Lens selection is crucial, and the camera resolution is also important. These parameters are affected by the distance from the subject and the viewport, and by the industrial standard used to connect the camera and the lenses.

The lighting largely affects image processing, the main types are:

- Direction: from the bottom or from the top;
- Light rays can be parallel or diffuse;
- Angle of incidence can be big or small, because of this the viewport can light or dark.

To achieve the best result, the parameters in previous settings can be combined. The light source has to operate according to CIE standards, the most widely used one is D65 (~6504K), which equals to daylight. As wood material is opaque, we use a light source on the top. Viewport will be bright, because many of the rays from the light will go to the camera. So the image will be darker at places, where the light direction is distorted by a surface error (scratches, contamination.) It is advisable to set rays from light source to be parallel. Diffuse light can enter the cracks on wood reducing the effectiveness of error detection.

The Software Solution

In the view of information technology, the production support system must communicate with a lot of individual solutions. The vendor identifier and wood specie come from MOVEX ERP. The database management system is Firebird. The camera communicates with the client machine through serial port. Another serial port is used for the connection with the illuminating barrier, which starts the printer phase. The printing is performed with LPT (Linear Print Terminal) ports. The system operation is illustrated in Figure 5-5. The system was operated over the last 4 years in the company and it was used to rank the vendor performance. The good the wooden material color, i.e., color value is between limits, the good the vendor is. Having ranking, the company reduced the refuse material rate by selecting good vendors and shipments are addressed to them. The research is continued in two directions:

- a camera system can be integrated into our self-developed solution;
- further and more complex analysis can be done.

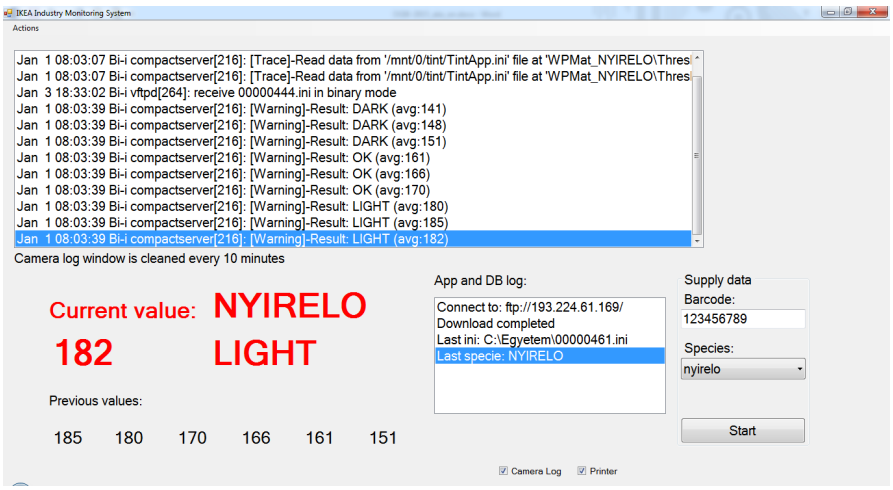

Figure 5-5. Screen of the monitoring application (Note: The production support system was developed in Microsoft .NET framework and programmed in C# language.) [8]

The production progress is handled by the monitoring system which solves general IT problems. However, we would like to select a specific problem's solution and introduce it. There were at least three industrial printers that we have to control at the same time, but we have only one LPT port in the controlling computer. For the solution, we were cooperating with electricians. The LPT port has eight data pin and the first three ones were linked with the printers. By sending a signal on the correct data pin, the correct printer started to print on the timber board. In this way, we are able control maximum eight different printers.

In this type of works, 80% of time and money reserved for the project will be spent on data collec-

tion, and not on the analysis or decision making. The full Return Of Investment (ROI) is rather questionable by the chosen company.As we mentioned, furniture industry deems waste product by color. As our future objective is the video analyzation, we have to assess the image analyzing solutions. There exist industrial solutions for image processing e.g., National Instruments: LabVIEW, Cognex Solutions [9]. These systems operate as a black box since they have closed source and they are difficult to fine tune. Our aim is to provide an open source system, which can work efficiently in an industrial environment. One of the standards of "Industrial Internet" is the using of open source technologies.

The core of the image processing system is the OpenCV (Open Source Computer Vision Library). This is an open source application for analyzing image and video, which contains more than 2500 optimized algorithmic solutions for real-time or post processing. The main purpose of the application is to reduce the burden of CPU intensive processes. Our image processing solution uses the features of this class library. Our main goal is to provide efficient industrial solutions using the algorithms of the open source OpenCV library [10].

In our goals, we would like to segment the timber board from the environment. This process called segmentation can be made with using brightness, color and textural properties. Edge detection can be helpful during this analysis. Edge detection can be also used to detect future errors on the timber board. These errors are followed by morphological operations, which means the preparation of the image for the shape detection process. By using these steps, it is easier to identify the shape which makes the process more precise. The identification of the shapes can be divided in two parts:

- Emphasizing the substance properties;
- Decision making.

During the emphasizing, we declare parameters, which can be used to identify shapes. Such parameters are circumference, area, shape/form, biggest/ smallest diameter etc. During the decision making process, clustering processes can be applied. After the shape identification, other parameters can be detected and determined (e. g., color). The timber board's color is inhomogeneous, therefore the analysis is more complex challenge.

Conclusion

In this paper, we introduced international tendencies which shape the future of the industry. We reviewed the industrial techniques in nowadays and the newest trends ("Industrial Internet", "Industrie 4.0") which are based on the idea of "Internet of things". A Lot of data come from machine's sensors, therefore the analysis gets more precise and the production progress gets more efficient. A production system was introduced with our monitoring solution.

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From ERP Trainings to Business: a New Approach of Simulations in Economics

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ABSTRACT

Enterprise Resource Planning (ERP) is one of the most interdisciplinary entity in business informatics programs but understanding of ERPs and their properties can be difficult in the classroom. With classic linear exercises, e.g., create a sales order, invoice booking, manage the warehouse stock etc., students learn only sub-processes, but they less understand the entire processes and their relationships. Therefore, we developed a system to simulate the whole economics processes, where the sub-process connects to each other. The VALISE system has been created for education and research purposes.

Introduction and literature overview

ERP requires interdisciplinary mentality since the different sub-processes connect to each other (e.g., sales order processing, purchase and production processes, human resource management, economics laws). Understanding of the relationships can be difficult during first ERP courses. To ease the learning process, many theoretical and educational elements were developed. Our solution is VALISE, a simulator based on Supply Chain Management (SCM) with gamification technique. In this way, we can take advantage of these technologies and methodologies in a compact system.

The SCM starts from extraction of the raw materials and ends with delivery of the finished product to the end-user; and includes a variety of services related to the product (e.g., storage, waste management, recycling). With SCM, a competitive advantage can be achieved. It supports the profit growth, the reduction of warehouse costs and the shortened lead times.

The consumers on the market "*pull*" the goods and information for their needs; and the suppliers "*push*" their products towards the consumers. There are two basic types of supply chains: (1) push-based model and (2) pull-based model. In the push-based model (built-to-stock), the production is based on the forecast and the products are delivered to the end-users (consumers) [1]. The Internet and web-based solutions use this model. In the pull-based model (built-to-order), production is based on the customer purchases. The difference between push and pull-based model can be easily recognized by comparing Figure 6-1 and Figure 6-2.

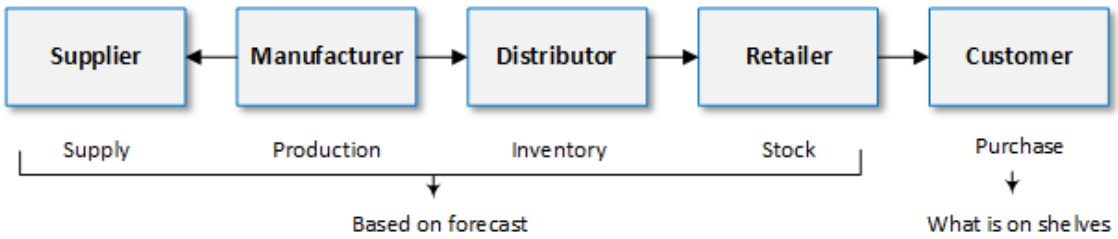

Figure 6-1. Push-based model

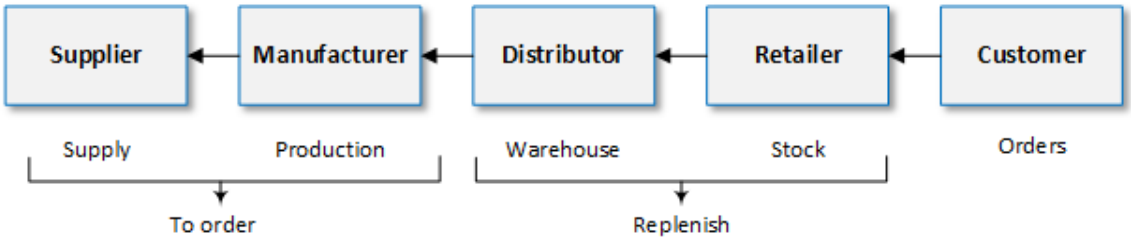

Figure 6-2. Pull-based model

VALISE is a simulator. In general, simulation is used to demonstrate various processes, examine different scenarios for an event, check the difference between the expected and actual behavior of a physical or computer modelled system. The first step in simulator design is the mapping of the processes and elements, which we want to use in our model. However, the most important phase is validation. After the design and implementation phases, we have to test our system. We run the simulation program with such parameter values and settings which enables us to check our results with other methods We validated the system with an example of axe production. The entire validation process is introduced in the Chapter of Simulation mode of Valise. Because we passed the validation test, VALISE is ready for simulations of complex supply chain processes. Simulations are used in different scientific fields, e.g., meteorology, energy systems, astronomy and life sciences, and they are good bases to simulate various business events.

With gamification, the teaching curriculum could be made more enjoyable [2]. Using gameplay elements can improve the users experience and commitment. Primarily, it is used in the online world, but the original concept does not exclude any possibilities for use it offline. Gamification techniques support the human desire for the competition and the self-expression. It mainly focuses on inspiration and uses bonus system to reward the best performance.

Different solutions have been appeared in the past few years. Stack Overflow is a website, where programmers can ask the community about their problems. The members can answer or give them a solution for their problems. If the answer is good, they can get upvotes from the users and after sufficient upvote, members can get badges. Based on the acquired badges, the answers of the given member can be more believable. Duolingo is a free language-learning platform, which helps to learn foreign languages and keeps fresh the user's language skills. Users can complete different topics, practice and translate articles and also can see each other's experience and level.

Several methodologies introduce models and methods to achieve Gamification goals [3, 4]. Having followed these methodologies, specific systems were born. Evaluation model are developped by Erdős and Kallós for effectiveness of Gamification Add-On techniques [5]. Bicycle and jeans factory management Gamification solution is available on the Internet [6]. Schubert and Williams introduced ERP Challenge to create and manage own kitchen with building kitchen furniture and other elements related to a kitchen environment [7].

There are many types of management systems that helps to ease handling of business processes, such as production management systems, supply chain management systems, marketing management systems and ERP systems. The common in these systems is that each focuses on only one particular area, except ERP systems.

ERP includes comprehensive functionality, e.g., warehouse management, human resource management, accounting, production management, etc. Technology knowledge is also important in the field of ERPs. There are many ERP solutions on the market with different architecture and implementation [8, 9]. Although ERPs can handle complex company processes in one integrated system; the learning and teaching process of ERPs is still difficult.

VALISE Concept

Using and further developing some existing model and technology patterns from state-of-art literature, VALISE has been invented. It is a virtual economic environment that creates events, which have to be handled in an ERP environment. This way the users (typically students) can learn the using of an ERP system in a virtual economy world. But VALISE is not only for education purpose, it also can be used for running simulations and examining economic processes.

Abstract Model

The logic of VALISE is based on SCM. According to supply chain properties, our model in VALISE contains three kind of entity: (1) Extraction Company [Level 1], (2) Inner Nodes [Level 2] and (3) Customers [Level 3]. The Inner Nodes are different companies, such as production company, import or export company, wholesaler and retailer. Since different supply chains exist, the Inner Node supports the supply chain diversity, i.e., if we would like to create a supply chain with only extraction (production) customer approach, then the import and export companies are not created. If we would like to create more complex supply chain, then Inner Nodes can be import, export, wholesaler and retailer companies or any other type of companies. The VALISE model is summarized in Figure 6-3.

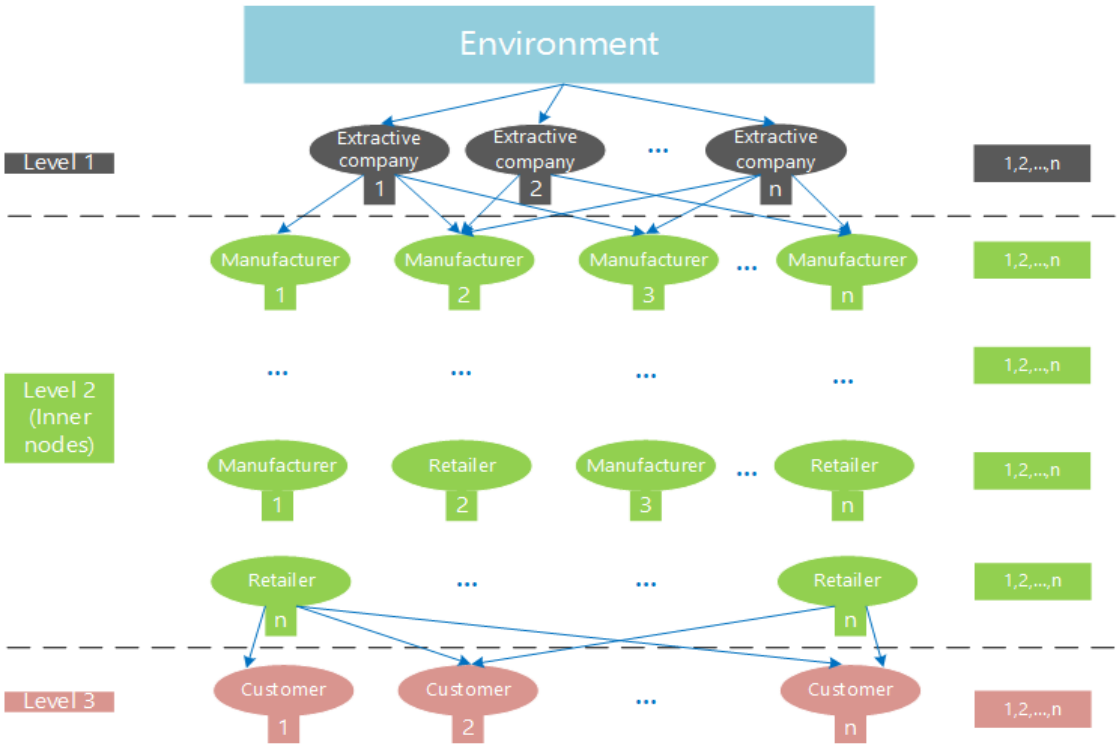

Figure 6-3. The VALISE model

VALISE has two different operational modes: (1) educational mode and (2) simulation mode. If we choose the educational mode, the system loads the supply chain network, the simulation process starts and the web page is ready to use. In this mode, the supply chain network is pre-defined. If we choose the simulation mode, a setup panel appears. On this panel, we can set the structure of the Inner Nodes, the distribution (normal, exponential or Poisson) and add more Inner Nodes as a new layer (e.g.,

import, export, wholesaler or retailer). In this mode, the supply chain network is not pre-defined, i.e., any kinds of supply chain can be created. After click the start button, the simulation will start. In this case, simulation is performed without any human's, i.e., students', interaction.

Architecture

In educational mode, VALISE has three layers: (1) Simulation Core, (2) Database and (3) Client. The Simulation Core creates the given supply chain entity parametrized by administrator and it is also responsible for the connection and communication between Database and Client layers. The system is written in .NET framework and programmed in C# language. MSSQL database management system runs in the background and the Client is implemented in ASP.NET.

The Client allows the interactions between the students and VALISE in runtime. The Core generates events and these events are stored in the Database. The users can see their orders on the responsive web page and they must react to them. Based on their reaction, the Database is updated. The Core notices the changes, reacts to them and generates another events as well. The whole process is illustrated in Figure 6-4.

We chose the responsive ASP.NET web page for the client layer with reason. Using this technology, the users can check their company on any devices which has a browser. This way, they can check the web page in the classroom on a lab computer, on their own notebook or on tablet or mobile. In a later phase, this can be supported with mobile applications written for specific platform (Android, iOS, Windows Phone).

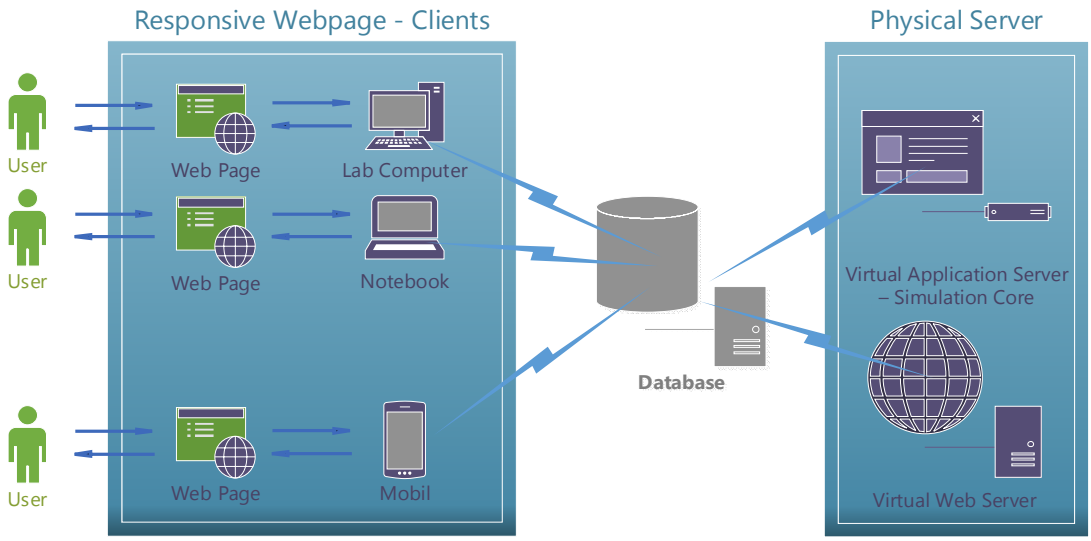

Figure 6-4. The VALISE architecture

Educational Mode of VALISE

In the educational mode, we parameterize the simulated world and start the simulation. Groups of students create virtual companies where they have to manage their orders on the web page (accept or reject the orders) and have to handle the accepted orders in their ERP system. The Core generates orders for the members of the supply chains and manage the rejected orders.

An order has several parameters including product name, quantity, deadline, etc. The life of an order begins at the generation. The Core chooses a random company, who produce the given product, and sends the order. The owners of the company (students) can see their orders on the website. They have to use their acquired knowledge and their existing information to make decisions about the orders. They have to check the warehouse content, already accepted orders and deadlines.

If the raw materials are not enough, but the deadline is far, then they can create orders for the supplier companies to get enough resources for production, while the students must always control the deadlines. If they believe that the order cannot be fulfilled, they can reject it.

In the IT point of view, the process is as follows. The Core generates the order and write in the Database. The web page is notified about the changes and displays the new orders. The users can see their orders and the order's details. They can decide about the orders and take the necessary steps. After the decision, the record of the order will be updated in the Database depending on the decision. If it is accepted, then everything is done, but if it is rejected, the Core decide about to drop the order or resend to another company. This actually looks like a coin toss, the chance of order dropping is *50* percent, just like order resending. The summary of the process is shown in Figure 6-5.

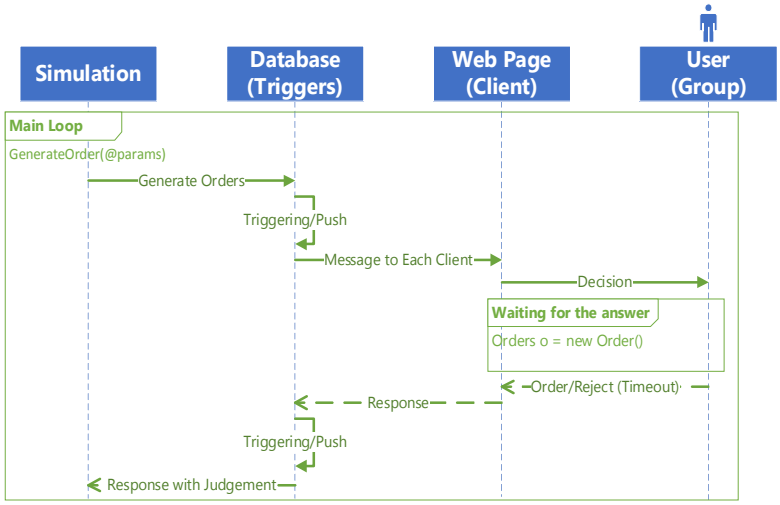

Figure 6-5. Life of an order

After implementing the first version of VALISE, we tested it in one of our courses. Students created groups where each groups represented a company. They managed their company through VALISE by using the website to manage their orders. However, if an order is accepted, it has to be handled in an ERP system such as create the order entry, check warehouse and production capacities, organize purchase orders, etc. We teach Microsoft Dynamics NAV ERP system, however, VALISE is independent of ERP. Students can use any kinds of ERP. The structures of the Inner Nodes are specified. They are shown in Figure 6-6. It has two types:

- three-level-seven-node structure and
- two-level-three-node structure. It is important to note, that each Node has the same number of participants.

Every company needs two materials for its product. These structures and restrictions are responsible to provide the fair competitive situation for each participant.

Figure 6-6. The structures of the Inner Nodes

After the lessons, they had to complete a survey about VALISE system, especially about the website. The survey contains questions about usability, difficulty, manageability and the task's lucidity. They had to answer for the questions in a one to five scale or answer with their own words. The size of the class was 23 people, including boys and girls of different years.

The average of their responses were between 3.22 and 4.48 points. The best result was the manageability, but the worst was the graphic quality. They formulated also various remarks, such as we need graphic improvements or have to be more information on the website about the companies. Based on their responses, improving web interface is adviced. To secure the fair company competition environment and prevent any monopole situation, orders can be generated not just by virtual companies, but by the Simulation Core as well. Using automatic order generation and system's virtual company creation capability, VALISE can simulate any kinds of supply chain. Simulations can be used to study supply chain in different aspects. We can answer questions related to economics such as when the chain is stable, what count of companies is optimal at each level or when monopole situations can be evolved. In scientific point of view, VALISE can be used for economics research purposes.

Simulation Mode of VALISE

In the simulation mode, the processes are automatized to simulate the world without human interactions. The Core generates orders and the entities automatically decide about them, depending on their information (warehouse content, accepted orders, deadlines, etc.). Orders to their suppliers are generated if necessary. The different decisions are based on the pre-defined conditions.

In this mode, we need extended structures. Therefore, there are not only two structures pattern as we can see in Figure 6-6, but any kinds of supply chain network can be created. The companies do not have the same number of suppliers and various number of manufacturers produce the same product (e.g., there is two tire factory and four frame factory). This way we can simulate any kinds of supply chain. The generation of orders occur in discrete intervals called day. During a simulated day, three processes are executed in each node. The first process is to deliver the products to the Customer or customer company (Inner Node). Related to that, finished products indicates the companies process, i.e., the wares are shipped to the customer company's warehouse and they are ready for consuming. The second process is the production. The manufacturers make their products, according to their production speed. The production speed is the capacity of the given company. The production speed is a constant value and shows how many products will be produced in a day. The speed is predefined in the initial phase of the simulation, however, it will not change during the simulation. If the given day is the last day of the given production, the next day is the day of shipping of the given products. For example, if we have an order for *100* bicycles, and the production needs three days, then by end of the third day, the production of bicycles is complete, and in the next day, bicycles will be shipped.

The customer company can consume the products on the day of delivery. In the case, the entire time is *production time + 1*. The customer company can start its own production and that company can complete its own order in time. At the end, we reach the end of the supply chain, i.e., the last customer is a Customer Node. Then, it is assumed that Customer consume the products, and the order is completed finally. From the view of simulation, the order leaves the supply chain, i.e., the chain of orders is over. The third process is the order generation. From the view of supply chain, third process is the demand chain (pull-based model). This kind of orders can be created only the Customer Nodes.

The order generation phase contains five sub-processes:

- *Number of orders*. Each Customer Node generates random number of orders. The number of orders is from *0* to *x* where *x* is a predefined integer. Between *0* and *x*, the generated integer follows the uniform distribution.
- *Product*. In the case of a given order, simulator core chooses one from the final products. One order contains only one product. The choice follows the uniform distribution. Because of the uniform distribution, all kinds of product are chosen with the same probability. With this, we can avoid choosing that always one or small set of products are ordered.

- *Targets*. Based on the chosen product, there are potential companies, which produce it. From this set, one is chosen according to uniform distribution. Uniform distribution supports the equality of the companies' competition.
- *Quantity*. This sub-process generates the number of products in the case of a given order. There are three distributions: (1) normal, (2) exponential, and (3) Poisson. Type of the distribution can be set in the simulation mode's setup panel. The chosen distribution cannot be changed during the simulation.
- *Deadline*. For the given order, a deadline is generated with the same distribution as in the case of *Quantity*.

All orders are dedicated to one of the companies, however, not all companies get orders because of the order's randomization. All three process start all over again in the next day. From the view of decision making, i.e., reject or accept the order, the sequence of the processes is not important. The sequence is shipping, production, order generation. If the shipping is at time *t*, then the customer company can calculate with the incoming product also at time *t*. We assume Just in Time (JIT) shipping. The accepted orders at time *t* do not effect on the production at time *t*. For example, if the sequence is order generation, production, shipping, the decision (reject or accept) would be the same as the current sequence, i.e., shipping, production, order generation. For the first validations, a supply chain was created based on axe manufacturing as it is illustrated in Figure 6-7. The example is a simple one since the validation can be checked easily. The example characteristics are as follows:

- There are two companies in each node. It means, there are two Iron Extractors, two Wood Extractors, two Axe Manufacturers. The simulation focuses on Axe Manufacturer Node, i.e., the two axe manufacturer companies.
- There are two customers in the Customer Node.
- There is one product, which is axe.
- There are two raw materials, metal and timber. To produce an axe, one piece of metal and one piece of timber are needed.
- Two simulations were executed. During the first, axe manufacturer *company01* has *2* production speed, the *company02* has *3*. During the second, they have *4* and *5* individually.

The extractor companies create their products from the environment and sell them to the axe manufacturers. They create their product and sell them to customers. They are rivals in this environment, except the customers. This way we can avoid from non-competition situations. The simulator was used as a year had passed, a day was *1* second. In the first simulations, the length of the days was *30* seconds. It was necessary, because this way we can validate this simple example in runtime. We are able to check the orders' flow, warehouse content, deadline. All semantic functions can be verified by human validation. During the simulation, all of the interactions of the nodes can be checked continuously and therefore the system can be fine-tuned, i.e. filter incorrect functions.

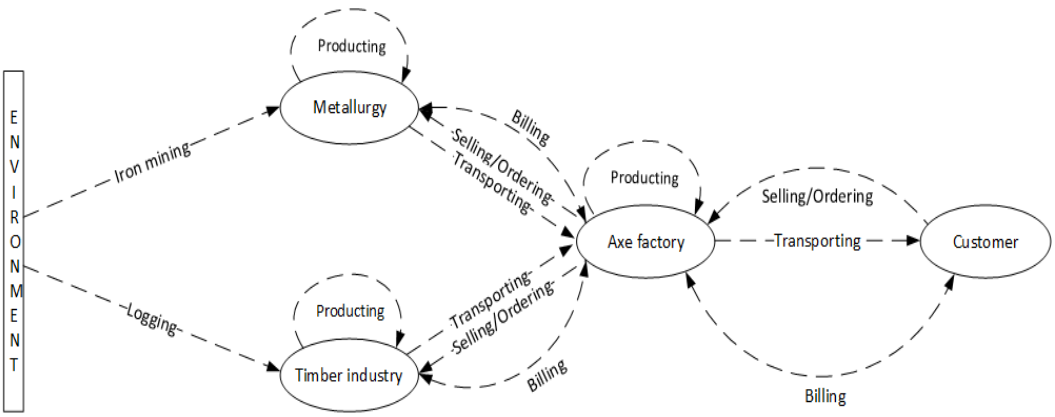

Figure 6-7. Axe factory model

The example does not calculate with the following parameters:

- Refuse material (both for raw and final products)
- Shipping time (we assume JIT).
- Time of machine setting.
- Time of material moving.

	Orders → ←Simulation Companies ↓	Received	Accepted	Rejected	Stored
#1	Company 01	190	203	26	74
	Company 02	175	147	46	73
	Lost order	15			
#2	Company 01	178	178	0	0
	Company 02	187	187	0	0
	Lost order	0			

Table 6-1. The results of the simulations

Malfunctions of machines. The results of the simulations are shown in Table 6-1. The main difference between the two simulations was the production speed of the companies. In the first simulation, the two companies had *2* and *3* production speed (product/day) and the same initial warehouse content. They accepted and rejected orders, but they have also stored orders, which will be completed. There are also lost orders, which are dropped from the supply chains. In the second simulation, the two companies had *4* and *5* production speed and the same initial warehouse content. There was not any rejection since every order was accepted for the first time. The results of the two simulations shows, that a little change in the initial parameters can change the entire result.

Conclusion

Nowadays, all companies use some kind of ERP solution. The everyday actions are heavily supported by them in different enterprise territory: (1) collect data and data storage, (2) support each business process, (3) create and maintain the connection between departments. Moreover, a good ERP does not just contain IT solutions, but economics, strategy, human resources with knowledge management, and even legal environment must be the part of a holistic ERP. This scientific field is strongly interdisciplinary.

VALISE was developed to solve the interdisciplinary challenges. VALISE has two purposes: (1) educational purpose and (2) simulation purpose. First, we used VALISE to support students' understanding of business processes and the connection of these processes. After the planning phase, the proper architecture was proposed. We started using VALISE in the ERP course. Based on students' feedback, web page reorganization is advised.

Other VALISE mode is used to execute SCM simulations. The first simulation has two purposes: (1) validation, and (2) simulations. The validation was introduced with simple example. The other result was that SCMs can be very sensitive for parameter values, e.g., production speed. VALISE is ready for further, more complex simulations to answer more difficult questions related to economics' problem.

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Does Service Elimination Make Customers Less Satisfied?

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ABSTRACT

This research aims to analyze service elimination with a special focus on customer satisfaction. Service elimination has been rather a neglected field among marketing researchers so far with only a few studies describing the characteristic of the service elimination process within firms. The study is focusing on the customer side and includes a scenario based experiment. The main result of the experiment is that economic cost has stronger effect on customer reactions than psychological cost in case of service elimination.

Introduction

Service elimination decision is mainly related to the need of managing demand and leading the customers out of the service that is about to be dropped [9]. Service elimination has strategic importance too: *"product elimination can generate outcome benefits for the organization in four areas: simplification/concentration of management and sales effort; improved product portfolio performance; customer management related; improved physical and financial resource management"*

Service elimination is highly relevant in the telecommunication industry, due to the short life-cycles of services, though not yet used as a context for studying service elimination. To our knowledge service elimination studies are focusing on financial services ([3],[5],[4]). Service elimination may have many potential outputs affecting satisfaction, loyalty for example. In our study we propose to incorporate customer satisfaction as a potential output of service elimination which has practical relevance in telecommunications as well. Based on the Hungarian telecommunications market, the trend is clear: voice subscriptions are strongly declining [2] with basically constant market shares by the three operators (T-Mobile, Telenor, Vodafone).

These trends show the difficulty of acquiring new clients, which is possible only if operators convince clients to change their current operator. Therefore, it is important to examine consumer preferences as accurately as possible. The other important remark in this context is that operators should no longer focus on individual clients, but rather on High Value Customers (HVC) in the business segment, who have numerous SIM cards.

So our conclusion is that even in an oligopolistic market, as in Hungary, because of the declining voice trends, operators have to create new types of portfolios, in which the role of SE will be key: eliminating services enables the redesign of the whole service portfolio.

Literature review

Service elimination

The focus of the paper is service elimination (SE), which was studied only by a small group of researchers ([3],[5],[4]), although the topic has also relevant managerial implications that will be highlighted later in the paper.

The importance of the topic of SE can be underlined from two main aspects:

- There are gaps in academic research in many subfields: our literature review clearly shows the possible research directions, such as customer perspective studies and other sectors than financial services;

- There is a need from companies as well to build a proper SE strategy, as they are currently managed on an ad-hoc basis.

A review article [6] provides an overview of the whole field and can be used to position our research objectives. The authors list all the areas ever studied within SE based on two perspectives: firm and customer perspective. There are three phases of the SE process itself:

- the pre-elimination phase deals with the causes;
- the PEDM (product elimination decision-making) process determines the attributes of the elimination process and
- the post-elimination phase focuses on the result of the SE.

One important implication of the literature review is that the first two groups are basically covered, what remains relatively unstudied is the post-elimination phase. Second is the customer side, which is rather neglected. His later studies in the financial sector [11], [3] applied similar methodology, exploring formalization in financial institutions' product line pruning decisions, and maintaining a link between service elimination decision-making and structural characteristics of organizational decision-making. Service elimination decision and implementation is also key in the work of Avlonitis [7].

Satisfaction

Our study combines SE with customer satisfaction, which is a frequent tool to determine the success of the SE process. Aksoy et al. measure the relationship between overall satisfaction and loyalty intensions of mobile telecommunications customers in Australia, Brazil, Canada, China, France, Spain, UK, and USA, and they use moderating effects for the culture dimension [1]. They found that satisfaction is an important predictor of recommendation/ repurchase, in other words, it could influence the NPS as well what we implemented in our research.

Gustafsson et al. used scales for measuring satisfaction that we incorporated in our research [8]. They investigate the relationship between customer satisfaction on commitment and customer retention. They define customer satisfaction as the driver of customer retention.

Homburg defined two main categories we used regarding product elimination: psychological and economic cost [10]. As our research has references to Homburg's terminology, we decided to use scales of Gusftaffson to measure it, as Homburg has not defined clear categories within these main types. So based on the satisfaction literature, SE can be viewed as a situational factor that modifies customer satisfaction and engagement.

Research Questions, Methodology

The aim of the research is to analyze the service elimination strategies in the context of the telecommunication industry, because it was not studied before and it is ideal to understand the special characteristics of services during elimination.

Method: Experimental Design

The research focuses on the following research question: What is the relationship between perceived costs of service elimination and customer satisfaction?

The first research question is investigated with the use of an experimental design. The manipulation of the independent variables is based on scenarios.

The independent variables are perceived economic cost and perceived psychological cost as proposed by Homburg [10]. The dependent variable is satisfaction. We use economic and psychological cost to measure the effect of SE on customer satisfaction. The following hypotheses are proposed:

- H1: Psychological cost decreases satisfaction
- H2: Economic cost decreases satisfaction
- H3: There will be an interaction effect for psychological and economic costs

Results of the Study

Based on the literature review we prepared a 2x2 between subject experiment based on scenarios, (N=163); with independent variables of economic and psychological cost [10] .Economic cost is incorporated into the scenarios as the cost of the service package for the customer, which is defined as a Dummy variable that takes the value of one if the cost of the offered service package is high

(worse offer), and zero if the cost is low (better offer). As Homburg did not specify the exact measure of psychological cost, we defined it as whether the SE is expected for the customer, which means that the role of notice will be emphasized here: if the customer gets a prior notice about the SE, we expect psychological costs to be lower, and their effect to be marginal.

Our aim with the experiment design based on scenarios was to determine the relationship between SE and economic and psychological cost. To measure the effects between SE and the dependent variable, we used the valid measures for satisfaction. *Dependent variable:* satisfaction

Short description of scenarios:

- Better service package after elimination; customer receives letter and call notification before the elimination (no economic with no psychological cost).
- Worse service package after elimination; customer receives letter and call notification before the elimination (economic cost with no psychological cost).
- Better service package after elimination; customer does not receive call notification before the elimination (no economic cost with psychological cost).
- Worse service package after elimination; customer does not receive call notification before the elimination (economic cost with psychological cost).

General Linear Model (GLM) was used to assess the effect of economic and psychological cost on satisfaction. The results of the differences in means according to the four scenarios are summarized in Table 7-1 (significant means are in bold; Cronbach alpha's of satisfaction and loyalty variables are all above 0,8):

- *Psychological cost (0: no cost; 1: there is a cost):* Satisfaction is higher when no psychological cost is present. So H1 is supported.
- *Economic cost (0: better service package; 1: worse service package):* In case of the economic cost we see that satisfaction behaves as expected based on our hypotheses: economic cost decreases satisfaction. So H2 is supported.

Interaction between economic and psychological cost: When worse service package if offered, satisfaction is higher in case of no psychological cost, as expected. This means that more customers would be more satisfied, if they receive a worse service package offer, but they are receiving a prior notice compared to not receiving one. The interactions between the better service package and psychological cost are also meeting our expectations: customers are more satisfied with a better service package if they receive a prior notice compared to not receiving one. So H3 is supported.

Table 7-1. Mean values of dependent variable in the groups based on independent variables

Independent variables: costs		Dependent variable: Satisfaction
Economic		F=145,562***
	Yes (worse)	1,97
	No (better)	4,04
Psychological		F=7,706 sig. 0,006
	Yes	2,71
	No	3,14
Economic	Psycho-cost	F=6,991 sig. 0,009
Yes (worse)	Yes	1,95
	No	1,98
No (better)	Yes	3,58
	No	4,51

The contradictory results are clearly shown also on the plots of satisfaction: satisfaction is higher in case of a better service package offer, where psychological cost decreases satisfaction (Figure 7-1).

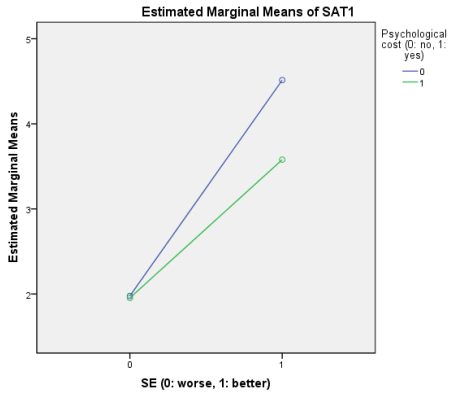

Figure 7-1. The relationship between satisfaction and economic cost (SE) in connection with psychological cost

Limitations and Future Research

The limitation of the current study is that we did not perform the manipulation checks, which should be added before the larger scale experiment to see whether the scenarios measure the same as we intended on different samples.

The next phase of our research is to refine the model based on the experiment questionnaire's results, and use a larger sample to test the relationship between SE and satisfaction.

Conclusions

Our research including experiment design based on scenarios aims to analyze whether SE has a negative effect on customer satisfaction. We used experiment design to determine this: customers are more satisfied, when they receive a better offer and there is no psychological cost; all our hypotheses are supported.

The research investigates the effects of service elimination on customer satisfaction, with an experimental design study based on scenarios. We incorporated two scenarios into our research: economic and psychological costs. Based on Homburg's dimensions (Homburg, 2010), we refined the meaning of psychological cost in case of our study carried out in a telecommunication context: economic cost means that the service package is better/worse as the current one (which is to be eliminated), and psychological cost refers to the fact of prior notice received by the customer before the elimination.

This paper introduces the results of our research: 2x2 between subjects experiment based on scenarios. We found that both economic and psychological costs individually decrease customer satisfaction, but interactions of the scenarios behaved differently. In case of a worse service package, psychological cost makes customers more satisfied, which did not confirm our hypothesis. However in case of a better service package and no psychological cost present, customer satisfaction is higher, according to our a priori expectations.

The next phase is going to be a 3x3 between subjects experiment based on scenarios, adding the compensation variable to our current research, as based on the literature compensation has an effect on customer complaints and so, it is to be expected to correlate with customer satisfaction as well. In the case of a forced migration during service elimination we expect compensation to make customers more satisfied.

The limitation of the current study is that we applied a convenience sampling and did not perform the manipulation checks that we plan to do in the next phase.

So our conclusion is that SE in itself does not make customers less satisfied, it depends on the quality of the new offer and the SE process handled by the company.

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Context-aware Self-Assessment Path Generation for Personalised Education

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ABSTRACT

Self-assessment is a critical building block to manage personal education. Where requirements are changing over time and where education is self-moderated, as within the higher education or on the job market, students and workers need the ability to track the already owned knowledge while detecting related knowledge areas where they can improve. With its ontology-driven approach, the STUDIO system for educational self-assessment, assess the knowledge of students in context of their desired education, based on a domain ontology. This paper will show, on the example of STUDIO, a new, innovative way of how the structure and the connections between knowledge areas of a domain ontology can be used to identify knowledge profiles of the students in an adaptive assessment process. The new process will transform the multi-dimensional network of the domain ontology into assessment paths, which are then assessed depending on the performance of the student. The administering of questions will change on the fly, based on the transformed testing paths, adapting the assessment to the performance of the student. The final results will be discussed on a prototypic realisation of the process, with a preliminary analysis of a practical field test.

Introduction

Structured education is still frequently packed into static built curricula with one main path created to master the content. To enrich this main road of education and to cope with individual learning situations, learners have to identify the gap between their own knowledge and the expectations of the specific curriculum. As students progress within the different fields of higher education, they are steadily encountering situations where they have to evaluate their existing knowledge and reason on ways to expand their knowledge to become a life-long learner and a future worker. Further learners tend to misjudge their personal skills, with their self-prediction being often substantive and systematically flawed [1]. A systematic and objective solution for self-assessment could help here to support self-prediction of personal proficiency and to prevent a wrong or biased self-evaluation.

Self-assessment provides feedback to the students about their personal performance in relation to the target of education, which can be deepened by repeated learning and self-assessment. This feedback cycle is usually integrated into other technology enhanced learning solutions in the frame of a learning management system (LMS) also known as virtual learning environment (VLE), which combine educational services with channels of feedback [2]. Or the feedback could be mined, even from high volume, high throughput educational systems like MOOCS [3]. Seidel, Perencevitch and

Klett, summarizes here the requirements and distances between the tutor and the learner in technology enhanced environments of learning [4]. Indeed one of the best connections between learners and educators is direct tutoring, as shown by Bloom for classic tutoring [5] and Fletcher for computer aided systems [6]. Further, as Jonassen shows in his thesis about constructivism, knowledge to assess for any scope of learning, is interrelated and associated with past experiences [7]. In technology enhanced assessment and especially in self-assessment, with its stronger correlation to personal education, the educated knowledge has to be seen in the environment of past experiences and related knowledge to improve situations of learning.

Even though an LMS is a strong computerized frame for learners, tutors and education interaction, the direct nature of interaction in this triple is often weak or missing. A system of "short ways" in technology enhanced education is promoted in this paper. The approach presented in this paper, makes use of a compact system, combining a fast creation, compilation and re-compilation of learning topics and materials for assessment, with an adaptive system for self-assessment, assessing knowledge in context of related education.

The STUDIO suit for educational self-assessment enables to model areas of education as substantial sources for assessment. It supports to close the gap between potentially flawed self-prediction and proficiency, offering an objective online knowledge-test based on the experience of a tutor and adapting to the knowledge of the learner. Following a natural learning process, the software embeds the knowledge to asses into a network of contextual knowledge, which acts as a source and structure to adapt the assessment to the learner's responses. The result is a system frame which facilitates a more direct and contextualized learning and highlights a better concept for self-assessment. STUDIO is developed at the Corvinno Technology Transfer Center and goes back to the conceptual work of Vas [8] and is consecutively developed in a close cooperation with the Corvinus University of Budapest and applied in national and European funded research projects

In the following section 2, the paper will give an overview of the existing STUDIO system for educational self-assessment and elaborate the internal structure to store knowledge for a contextualized assessment. Then in section 3 a new concept of assessment paths, developed by the author, is presented, which makes use of the structure of the domain ontology to provide an assessment path based testing. Section 5 gives an outlook on how the presented approach and the available interfaces can motivate more results for educational data mining applications. Finally, in section 6 limitations of the current approach are discussed in the light of recent developments in the field of technology enhanced education and the wider adoption of Massive Open Online Courses (MOOCS).

STUDIO-Based Self-Assessment

The existing STUDIO solution, which will be used to integrate the presented new approach of a path based assessment, models education is an expert-driven knowledge structure. The knowledge structure describes the knowledge to be assessed on as a domain related network of knowledge. It divides possible curriculum into sub-areas and defines what knowledge items to know to master the domain and enriches the structure by attaching a meaning to the relation between knowledge areas. This way it provides also a description of the learning context and collects the requirements to master specific parts of the education in a structured way. Knowledge tests for learners are created from the model by exploiting the benefits of this complex knowledge structure. A major advantage of this approach to modelling is that the fusion of assessment and knowledge structure provides the learner guidance over the course of self-assessment and learning, based on the structure. This way the learner does to not only answer questions from the knowledge areas but explores the given educational field in its entire context.

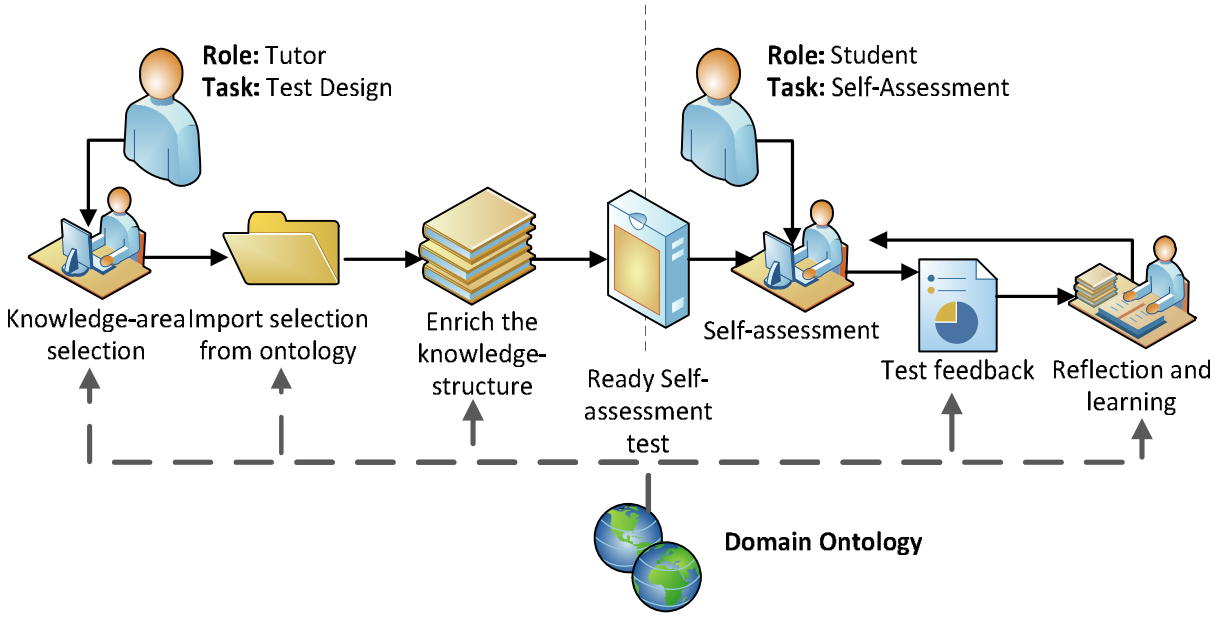

Figure 8-1: Test definition, re-use and self-assessment as a cycle over one integrated process

The assessment-system itself is divided into three phases of learning, supported by modules within the system. The first phase is the self-assessment, which is discussed in section 0 and has the target to capture the current state of the learners' knowledge by using the main assessment-module. The second phase is the reflection on the assessment, where the learners explore the test feedback through a visualization of the answered knowledge areas within the knowledge structure. In the third phase the learners gain access to learning materials, which they use to intensify their knowledge and to complete the current learning cycle. Based on the test feedback, different learning materials, fitting their assessed knowledge, are presented to the learner, improving the direct relation between learners and their target education.

This combined approach creates a unique self-assessment experience, where the connection between the tutor-experience-based assessment-test and the learner-knowledge-based self- assessment and educational-exploration is captured in short iteration cycles. The modeled knowledge context is used to create a trade-off between the time to test and time to learn and adapts the assessment depending on the test performance of the learner. A cycle of repeated assessment and learning is one major factor for a better personal learning performance, as collected by Roediger in [9]. The combined creation and self-assessment cycle is shown in Figure 8-1.

Instead of the classic approach of creating a static test to help the learners to assess their knowledge, the tutor will use STUDIO to create a flexible and adaptive test. As shown in Figure 8-1, (1) the tutor selects the relevant knowledge areas for the target education in STUDIO and imports the knowledge elements from the overall domain ontology. The imported concepts are fused to a knowledge structure, called a Concept-Group (CG) (2) Based on the bigger frame of the ontology the system will then additionally select knowledge areas needed to connect and complete the manually selected concepts and completes the concept group. The result of this step resembles then a model of the educational target for the assessment. From an internal repository of questions and learning materials, described in section 0, the system finally imports the related questions and learning materials and converts the extracted structure into a full assessment test. (3) The tutor can then explore the created structure and enrich it with more questions or extended learning material.

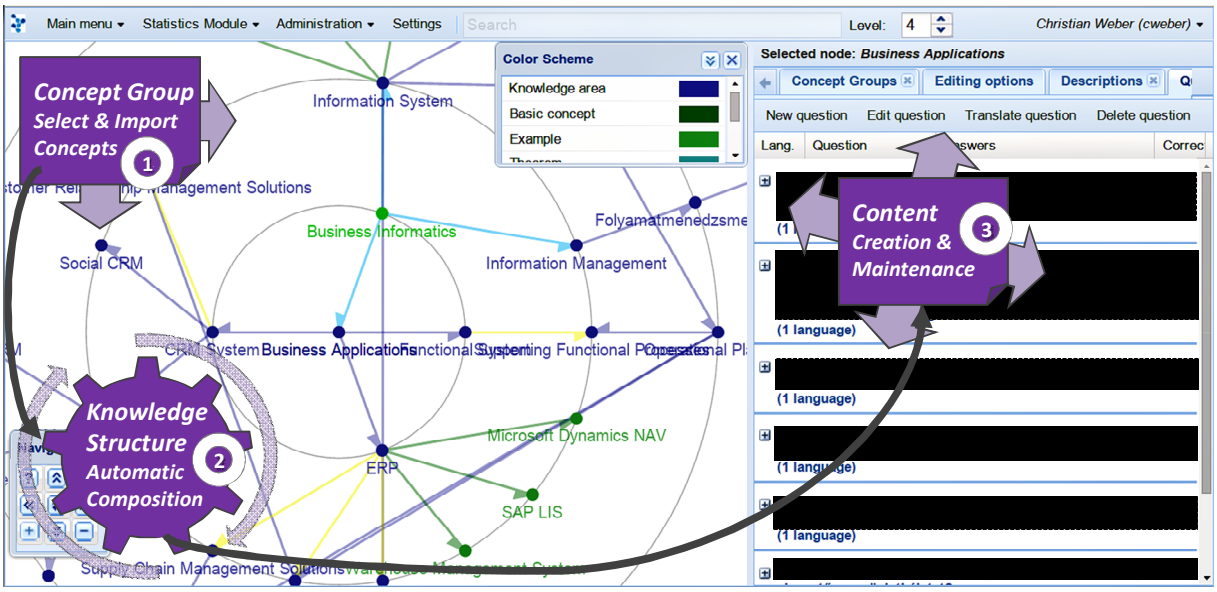

Figure 8-2: The main ontology maintenance and administration interface, showing a part of the domain ontology.

The resulting model of the test is then ready to be offered as a self-assessment test to the learner. As the questions are triggered based on the knowledge structure, the learner explores with the test the target educational field. To decide which question is triggered, based on the performance of the learner and the position within the knowledge structure, different intelligent assessment strategies are used. The rules and concepts of this strategies are discussed in section 0 and 0.

The Educational Domain Ontology

The educational domain ontology were developed by Vas and explained in more detail in [8]. The term domain ontology is common in the field of ontologies [10], [11] and underlines here the storage of education in domains of knowledge.

On a high level an ontology defines a hierarchical structure, together with allowed relations and abstract concept entities as classes with the target to describe formally a domain of the real world. This definition is then used to model residuals within the frame. Within STUDIO the domain ontology formalizes the knowledge and the relations between knowledge in the domain of education. The classes are instantiated as members of the special concepts, detailing the class information and connecting to other instances within the frame of the ontology definition. In this regards the class definition is acting as a universal blueprint to model educational fields. E.g. the general concept of a knowledge area is instantiated to single concepts within fields of education like the “knowledge areas” “process management”, “process” or “gardening” but also to specialisations as the “knowledge example” “tulip gardening” or the “theorem” “Pythagorean theorem”. Figure 8-3 shows the classes of the educational ontology that enable to detail knowledge elements of the given domain. Connections among classes define the relations between concepts and model dependencies between different aspects of the knowledge.

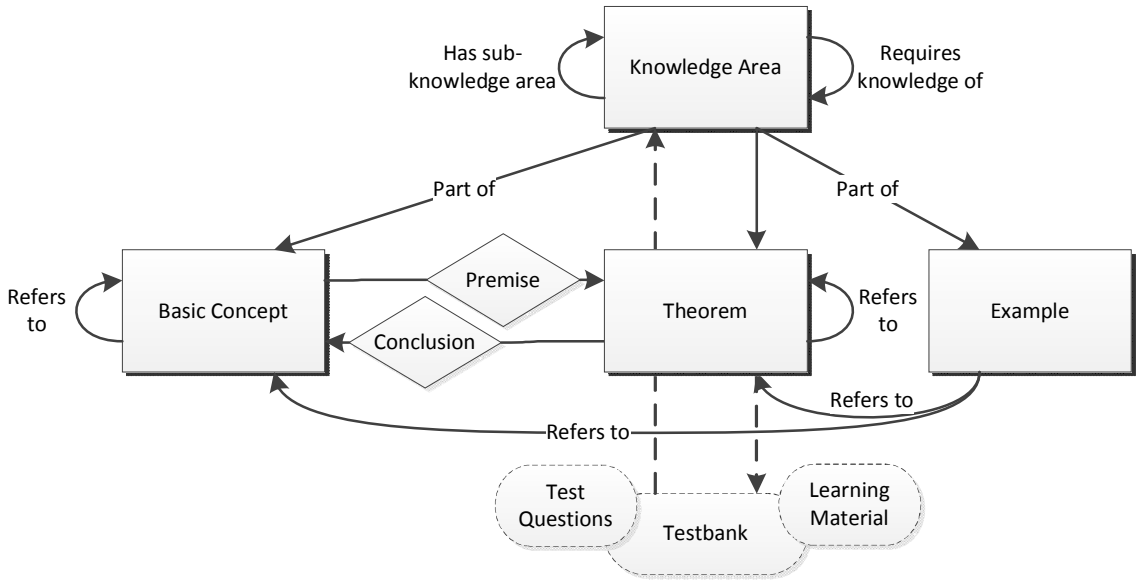

Figure 8-3: The model of the educational domain ontology.

Among these classes, 'Knowledge Area' is the super-class and the core-concept of the ontology. The ontology defines different qualities for relations between knowledge areas. Knowledge areas are set as sub-knowledge areas of other knowledge areas with a "has_sub-knowledge_area" relation. They are required for another knowledge area with the "requires_knowledge_of" relation. "Requires knowledge_of" defines that a node is required to complete the knowledge of a parent knowledge area. Each knowledge area may have multiple connected knowledge areas, as a requirements or sub-areas. This concept of a required dependency in education gives the option to assess perquisites of learning within the assessment, which is analogue to the fundamental idea of perquisites in knowledge spaces, as developed by Falmagne [12].

In education, knowledge is split into sub-aspects of learning to process the education in steps. Fitting to this, concept knowledge areas are detailed and extended by a sub-layer of specialized knowledge elements, to support educational and testing requirements more efficiently. By splitting the assessed knowledge into sub-concepts, the coherence and correlation of self-assessment questions could be expressed more efficiently also providing potentials for a more detailed educational feedback.

Within sub-areas of education, theorems express in a condensed and structured way the fundamental insights. They capture and explain the basic concepts of knowledge areas and set them in relation for learning using examples. Resulting, multiple theorems could be "part_of" a knowledge area. Each theorem could define multiple "Basic Concepts" as a "premise" or "conclusion", which structures how the aspects of the knowledge areas are related. Examples are enhancing these aspects and "refer_to" the theorems and basic concepts as a "part_of" one or more knowledge areas.

Questions and Learning Materials

As a fully integrated self-assessment environment, STUDIO stores the assessment- questions and learning materials together with the knowledge-elements of the domain ontology. The goal of the self-assessment is to continuously improve the personal knowledge within target areas of education. Here an integral part is to provide detailed feedback on the performance after each phase of testing. To do so, for each extracted knowledge area, the system is able to directly access the available questions and learning material simultaneously for each ontology element and its relations.

This aspect of STUDIO is captured as a test bank and realizes a repository of learning and testing materials, directly connected to the domain ontology. All learning materials are organized into sections, including different formats as structured text with mixed media like pictures and videos, and are based on a wiki-engine to maintain the content, including external links.

Creating and Maintaining Tests

Within STUDIO, the creation and maintenance of the domain ontology is a continuous task of ontology engineering. As the maintainer of the ontology the ontology engineer, also called the ontologist, is responsible for creating, using and evaluating the ontology [13]. Within the range of tasks, maintaining the structure and content has the highest priority, in favour of a more reduced set of formalized constraints. As such, within STUDIO, the task of creation and maintenance is a guided process. The system defines a specialized administration workflow which splits into a basic set of three consecutive task areas, in line with access rights, unified as user roles and a concept level context. The details are visualized in Figure 8-1 and described in Table 8-1

Table 8-1. The tasks, roles and concept levels involved in the ontology maintenance.

Task	Role	Concept level	Description
Ontology-engineering	Ontologist	Ontology (instances only)	Creation and linking of instances of knowledge-elements into the overall domain ontology.
Test definition	Ontologist/ Tutor	Concept Groups	For each new assessment test, relevant knowledge areas are selected and grouped into specialized containers called Concept Groups (CG). The concept groups are organized further into trees of concept groups depending on the target of assessment. The resulting tree is equivalent to a sub-ontology. Concept groups are organized internally, based on the overall domain ontology and include all relations between knowledge elements which are also defined within the domain ontology.
Question and learning material creation	Tutor	Knowledge Elements	Questions and learning materials are directly linked to single knowledge areas and could be created and extended by the tutor on demand. Based on the designed concept group tree (test frame), existing questions and materials are imported, from the repositories. More questions and learning materials are defined by the tutor, completing the assessment frame to meet the need of the target education. Every extension of questions and learning material is then also available for future assessment tests.

Independent of on the domain ontology or within connected material, the central structure of classes and relations is fixed and is acting as a blueprint for all new knowledge element instances. A view on the administration interface of the system is given in Figure 8-2. The left area pictures circular visualizetion of an excerpt of the ontology, while the right area pictures the question listing and editing interface. Each tab gives access to additional views for editing, including the learning material management and interfaces to modify node relations and node descriptions.

Adaptive Self-Assessment

The creation of a self-assessment test starts with the interaction between the tutor and the system. To create a self-assessment test in the frame of STUDIO, the tutor has to select the relevant knowledge elements, which STUDIO will then automatically connect to a knowledge structure based on the imported relations. The resulting tree of knowledge elements is equivalent to a sub-ontology of the main domain ontology. The specifics of this first part of the process are detailed in more depth in [14].

As seen in section 0, for each part of the concept group the system will import further knowledge elements from the domain ontology to complete the blueprint for the test. Within this step STUDIO will filter all knowledge areas and relations from the domain ontology which are needed to connect knowledge areas defined in the concept groups.

After the extraction, the structure is cached as a graph. By definition the top element of the concept group will be set as the start-element. This start-element then acts as an orientation point from which the assessment algorithm will start and from where the imported knowledge structure is interpreted for the assessment. To assess the learner's knowledge, the test will then move through the knowledge structure while online administering the questions connected to knowledge areas and knowledge elements. For this stage of testing the existing, top-down based test algorithm makes use of two assumptions, gathered in Table 8-2:

Table 8-2: Necessary assumptions for traversing the knowledge structure for assessment.

Assumption	Description
Ordering	All knowledge areas are connected with "part_of" and "requires_knowledge_of" relations. So, every path, starting with a start-element, will develop from general concepts to detailed concepts (given that the concept groups in the test definition are also selected and ordered to lead from general to more detailed groups).
Knowledge-dependency	If a test-taker fails on more general concepts he or she will potentially fail on more detailed concepts. When a high number of detailed concepts are already failed, then the parent knowledge will not be sufficiently covered and resulting be derived as failed, too.

The Basis of Assessment

A loaded assessment-test frame defines a sub-ontology of the complete domain ontology, starting with the start-element of the highest defined concept group. To now load the knowledge structure for the self-assessment, the system follows in a cycle three basic steps:

- Each type of relation between two knowledge-elements defines a direction for the connection. Assuming the system now loads all relations, starting with the start-element and ending on a knowledge-element, this creates a two level structure where the start-node is a parent-element and all related, loaded elements are child-elements.
- The loading now takes each child-element and assumes it as a start-element and repeat the loading process of knowledge-elements.
- When no knowledge-elements for a parent-element could be loaded, this sub-process stops. When all sub-processes have stopped, the knowledge structure is loaded.

Out of the directed one-directional nature of the defined relations, this loading-process essentially creates a directed tree as the knowledge structure. An example visualization of a one level depth tree is shown in Figure 8-4.

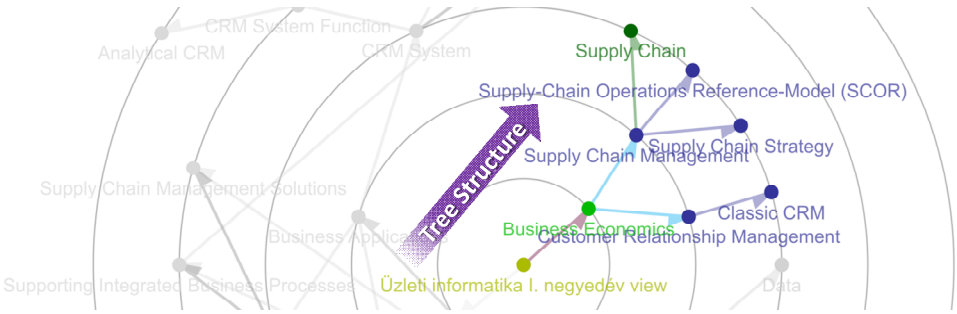

Figure 8-4: Excerpt from the CG sub-ontology visualization, showing the desired tree structure.

Based on the first assumption, defined in the previous Table 8-2, the deeper a knowledge-element is within the tree, the more detailed is the concept of the element, creating a hierarchy going from general concepts to specialized concepts while moving down the tree structure. E.g. within an example from the business economics, as shown in Figure 8-4, the tree starts with the general concept of "business economics" and grows into the outer areas into more detailed concepts as "supply chain strategy" to then capture the highly granular basic concept of "supply chain". Based on the tree shaped knowledge structure, the assessment then follows these steps to assess the knowledge, based on the questions connected to each knowledge-element:

- Starting from the start-element, the test algorithm will activate the child knowledge-areas of the start element. E.g. starting from "business economics" in Figure 8-4, it activates "supply chain management" and "classic CRM".
- The algorithm now selects the first child-knowledge area and draws a random question, connected to the knowledge-element. Following the example e.g. it will draw a question from "supply chain management".
- If the learner fails the question, the algorithm will mark the element as failed and select the next knowledge area from the same level, e.g. here "classic CRM". If the learner's answer is correct, the system will activate the child elements of the current node and trigger the process for each child-element. So the system would explore now deeper the child element "supply chain strategy".

Following this testing algorithm in a cycle, the system dives down the knowledge structure and triggers questions depending on the learner's answers and depending on the modeled structure of the relevant education. In this regards the STUDIO system adapts the test on the fly to the performance of the learner, providing an adaptive solution for the self-assessment. As the learner continues to use the self assessment to evaluate the personal knowledge, he or she will be able to dive down further into the knowledge structure and explore more detailed areas of the target education.

The logic of the existing and well used way of assessment within STUDIO follows the idea of a constructivistic approach to learning. The learning theory of constructivism promotes a top-down vision on the field of learning where new knowledge is build up in connection to previous experiences. Learners will first learn through interacting with general concepts, which divide the field into an overall composition. These general concepts are then de-composed into detailed concepts which further specify the general concepts. Following this rational, the top-down algorithm for assessment motivates the early interaction of the learner with the general concepts of a specific domain. This goal correlates with characteristic of the implemented strict stop criteria which further reinforces the focused engagement of the learner with more general concepts, as the existing algorithm for assessment will stop following a branch of the knowledge structure if the learner fails on frequently on first more general and then more detailed knowledge elements. This correlates with desired behaviour in other fields of assessment, as computerized adaptive testing (CAT) [15], [16], it regulates the exploration of the knowledge structure. But this comes at the cost of less often tested detailed concepts while not having fully mastered the general concepts of a knowledge-area. While the implemented top-down approach on assessment has a clear rational, the testing of detailed concepts first, in a bottom-up manner may provide further insights into learning, which will be the starting point for the path-based assessment, which is the implementation of an alternative bottom-up approach.

A Path-Based Self-Assessment

One major benefit of the domain ontology supported self-assessment is the potential to use the knowledge structure to see the single answers to questions in the context of the "bigger" knowledge structure of the ontology. If the system stops in an early stage of the assessment, it may prevent an early picture of the already known concepts and can discourage learners to retry the test after gaining more insights. A new bottom-up-based approach to assessment may help to differently explore the knowledge structure and collect different informa-

tion about the existing knowledge of the learner and the coherencies of the area. One could imagine several cases in which it may have sense and reason to continue to ask questions for related knowledge areas, even after a sequence of wrong answers. E.g. a learner may not have the overall knowledge of an educational area as business economics but may already know prequisite knowledge areas as “supply chain” as sub-areas to the current test. Or a part of the test questions for higher level knowledge-elements may be biased and require a higher redundancy in testing. In both cases an exploration of knowledge-elements deeper in the knowledge structure may shed light on further improvement potentials of a learner.

A solution to explore deeper the knowledge of the learner comes in the form of assessment paths. Within the existing, basic assessment algorithm, the evaluation of the progress is based on the second assumption for testing that continuously failing on higher level general concepts forecasts failure on lower level (detailed) concepts. To prevent an insufficient exploration of the knowledge structure within the assessment, this currently implemented top-down strategy will be replaced by a bottom-up thesis and a more relaxed evaluation criterion, summarized in
Table 8-3. Based on the new assumptions the system will essentially collect knowledge elements which are directly or indirectly connected to the start-element and assess them from the details to the general concepts of the domain.

Table 8-3: Revised assumptions for a path based assessment.

Assumption	Description
Extended Ordering	All knowledge areas are connected with “part_of” and “requires_knowledge_of” relations. Resulting, every path, starting with a start-element, will develop on average from general concepts to detailed concepts. To sufficiently explore the knowledge structure, within each set of knowledge-elements, reachable through a path of connected relations, the test will first select knowledge-elements which are part of the longest path of intermediate knowledge-elements.
Path/Knowledge evaluation assumption	If a test-taker fails on more general concepts he or she could potentially still succeed on more detailed concepts. Compromising, each knowledge-area or element is relevant for the main test goal, if there is a path of knowledge-elements to the start-element, which includes only knowledge-elements which are marked as passed.

With this changed assumption about the structure and their evaluation, a new concept is introduced: assessment paths. An assessment path is a set of connected knowledge-elements which connects finally with one knowledge-element to the start- element. With this new focus the tree shaped knowledge structure extracted for the assessment, could be seen as a set of possible paths from knowledge-elements to the start-element. These paths are routes through the knowledge structure and how far a learner succeeds on a path marks the personal knowledge of a learner, while the set of succeeded paths marks knowledge-areas in which the learner excels. Beside the feedback on the reached depth within the structure, the new assessment offers a broader data basement to group the assessed knowledge, based on the set of finished and unfinished paths.

But the use of paths has an additional algorithmic impact. Where previously only single elements had to be loaded from the knowledge structure, now whole paths will be pre-fetched and based on the complexity of the structure a multitude of different paths could be extracted. To lessen this additional resource strain, the new algorithm uses the knowledge about the evaluation. As a path will only be evaluated when no knowledge-element within the path was failed through a wrongly answered question, each failed knowledge-element will essentially “block” one or more assessment paths, crossing this knowledge-element. So while the algorithm explores the knowledge structure it also decreases the set of potential paths which will be assessed for a later evaluation.

Figure 8-5 shows the overall process of the new assessment algorithm. The source for the process is the extraction process as pictured in Figure 8-1, where the tutor-selected groups are acting as filters for the domain ontology. Through this filtering STUDIO extracts a set of knowledge-elements and combines them in alignment with the structure of the complete domain ontology. The resulting sub-ontology then delivers the structure which is used to drive the assessment.

Within the path creation, as pictured in the left part of Figure 8-5, the overall assessment will continuously trigger three steps:

- The step "Build" extracts fitting knowledge-elements from the knowledge structure and combines them to paths.
- "Use", triggers the central assessment which then will assess the path based on the connected questions from the bottom to the top element.
- The step of "Store Results" is a parallel process, storing the success or fail of knowledge elements.

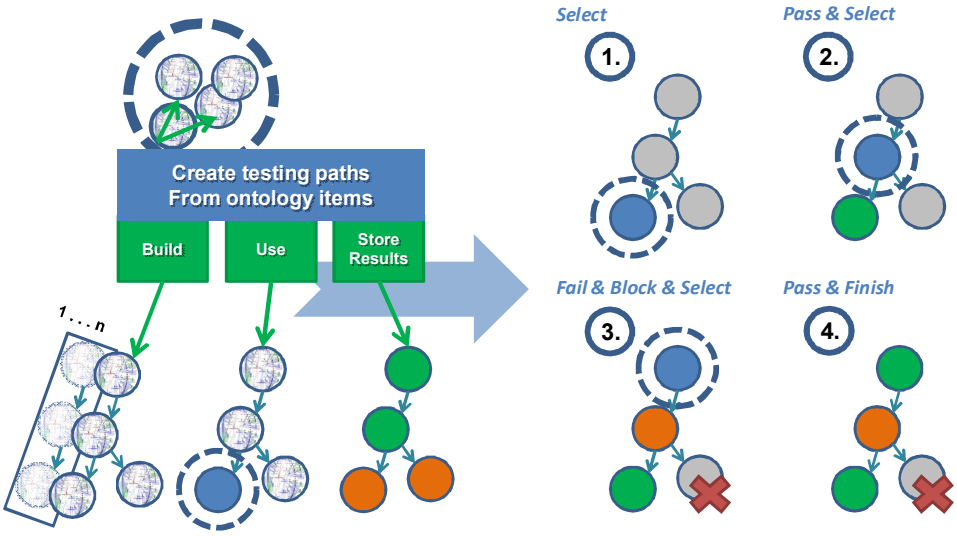

Figure 8-5: Path based assessment process, including an overview of the specific knowledge element exploration.

If any element fails, the knowledge-element will be marked as failed and blocks the current path to the start-element. With this failure, the knowledge-element will block as well every other path including the element from the position below this element and as such minimizes the set of further sub-paths to assess. The system accepts every path of knowledge-elements which reaches the start-element through offered relations. Resulting, a "blocking" / failed knowledge-element essentially splits a path into a "top" part which still could reach the start-element and a bottom part which won't be evaluated for the final result.

The right part of Figure 8-5 pictures the process of the path based bottom-up assessment. The system selects in step (1) the bottom element and assesses it. The user then passes the element (2) and the new algorithm selects the next element of the same path, which is nearer to the start-element. In (3) the user fails the asked element. Now the system marks the element as failed but also marks the still unused other child element as "blocked" as no other path leads to the start-element from the same child.

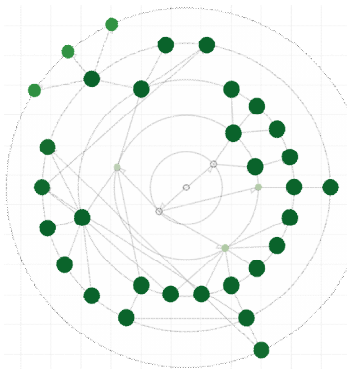

Figure 8-6: Result visualization as educational feedback for the learner.

Then in (4) the start-element is tested and passed. Finally, the system starts the evaluation but for the calculation only the start-element can be taken into account as it is the only element which has a connection to the start-element (it is in this case the start-element itself) and is marked as passedThe Figure 8-6 visualizes an aggregation of all the times an element within the concept group, pictured in Figure 8-2 and Figure 8-4, was visited by learners using the bottom-up algorithm for assessment. The data is based on a study with 200 learners and the size and colour of the visualized nodes are showing a visiting frequency between 10 and 900. To spread the exploration, the next used path for exploration were selected at random. It is visible that the elements are uniformly explored on the bottom levels, while the learners tend to fail on the highest level of knowledge elements. The three innermost elements are sole structural elements and act as entry points and are not counted for the frequency of visits.

Data Mining Opportunities

Data collection is a vital point in any type of technology enhanced learning environment to conclude on the current performance and future potentials of a system. To capture the learner as a part of the environment a range of different methods are evident in research to describe the learner itself and the system as a reflection of the learner (or vice versa), while the specific research field is summarised "user modelling". A user model is a series of features which describe a single user or groups of users in regards to specific aspects of a person. Brusilovsky and Millán [17] gather five different aspects which may share certain user features: the user's knowledge, interests, goals, background, and individual traits.To provide a sufficient data collection for future analysis and data mining activities, the used solution, STUDIO, implements two main streams of data:

- *Qualitative Statistics:* The qualitative statistics capture the core data of the assessment tests in connection to any collected and derived results which have a relevance to the assessment. Examples are here the passed knowledge elements per test and over all elements and over all elements assessed within the specific test. The data is enriched with information as timestamps, the specific question asked and the answer given. All data is stored with unique identifiers for users, assessment sessions and assessment domains.
- *Event-based Data:* The event data captures essentially a general scale of events which have or may have meaning in relation to the learner or the system and are extended continuously. Using event-data it is possible to track a "click-stream" [18] – a stream of action based events which describe how the learners are interacting with the system. The event-stream is a continuous stream of data and captures sequences of interaction with the system. The profit of this part of the collection is the highly scalable granularity of defined events. A limitation is the complexity of analytical approaches, as sequential pattern mining, to uncover the insights hidden within the data stream. Examples for events are: visited learning materials and visited description pages or the changing of choices for answers before the submission.

The main potentials for data collection and analysis are twofold: First, a better tracking of the learner's performance, together with insights into the development of the individual state of knowledge. Second, the opportunity to group people based on their performance and their behaviour on the system. Especially for the later the field of application is broad and promising as learning- and cognitive-styles, to on the fly modify the type of representation of learning materials and questions to better fit the user's needs [19] or stereotypes and other clustering frames which allow to further group learner into clusters of learners to e.g. adopt personalised scaffolding and content preparation [20]. A further excerpt of currently tracked features and variables is given in [21].

Limitations

STUDIO is a blended learning approach and targeted on situations were learners have basic knowledge of the fields of learning. Especially for tests with many different defined knowledge ele-

ments, learners may here miss the sufficient background to decide on the best starting point to explore the offered learning material. In contrast, in fields with high numbers of knowledge elements a knowledgeable learner will be tested extensively as the presented knowledge helps to unlock a high number of concepts. This is especially the case for the extension proposed in this paper as it focuses first on the broad basis of facts to then explore more abstract and general concepts. A test designer has here to balance the completeness of the domain against the time to test and the focus to learn and master the domain. Further there is a strong future potential to analyse the data, gathered from the assessment, to provide a better parameterisation for both the top-down and the bottom-up, path-based assessment. Based on the parameterisation, e.g. a different threshold for the evaluation could change the speed and trend of the exploration of the domain.

As for other technology enhanced systems for guided learning processes, the use of STUDIO has to be planned in terms of the target knowledge and in the frame of an overall instructional design. In the design phase of new fields for assessment and learning, tutors profit from the repository of available knowledge elements and material and can rapidly prototype a new curriculum. Learners profit as questions and materials are shared between different tests and are pre-tested and optimized for learning. Through the clear simplicity of the test and learning cycle the entry steps to master the system before mastering the knowledge are fast taken. Yet for specialized fields as math intense knowledge areas or very visual fields as art, the used approach for testing is limited in the construction and presentation of these specific knowledge elements and may only partially cover the domain of learning.

The solution presented here for learning, and especially the proposed extension, focuses to start on a detailed level of composed knowledge. The knowledge is prepared for testing and learning in a connective way, making active use of the knowledge structure. It is targeted to specifically support learners with initial knowledge to explore the coherences and connections between the single fields and knowledge elements of the study domain. The learner receives a trade-off between a fast exploration of the coherencies within a field and the long term learning and mastering of the field. To learn a domain from a complete ground level other approaches may be more suitable if they offer a different and deeper lower level of basis knowledge and a more directed approach to structured learning. Further, learners have no system integrated opportunity to connect to other learners which can support and improve the learning process through a collaborative component.

Here the rise of new Massive Open Online Courses (MOOCs) provides an integrated and collaborative platform for learning. With its mix of carefully designed phases of online teaching, individual work and online collaboration, they offer a different structured approach of learning. Learners and educators can openly interact and discuss through synchronous and asynchronous online tools and visit and revisit a mix of different resources fitting to their preferred way of learning. When combined with assessment, different MOOCs solutions could additionally offer certification in contrast to the adaptive, non-certifying approach discussed in this paper. While substantially different in their scale and composition still MOOCs and STUDIO share common aspects. Both systems embrace the new idea of a connective learning, as evident in the theory of connectivism [22], [23] and offer a replicable service to an open group of people. In the earlier case, STUDIO even goes one step further as it connects different curriculum through the use of the same repository of granular knowledge elements and materials, which are shared and connected across different domains and goals of learning. This presents a contrast to the common critic on MOOCS as being connective within the lectures but isolated among the courses. In this regards STUDIO may deliver the right potential to overcome the flaw of content isolation in MOOCs by integrating STUDIO into the MOOCs curriculum, hand in hand with a wider strategy of teaching and learning.

Conclusion

The concept of technology enhanced educational assessment using a domain ontology offers a functional and semantically rich extension for learning and education. This paper gives an overview of the involved concepts and implications. Retaking the test in cycles of testing and learning, while adapting the content interaction, enables the learner to improve the personal performance and knowledge over time, as shown in [9]. With the exploratory approach on self-assessment, the system connects learning success with insights and feedback based on the educational model of the target education. This enables the learners to see their development in the frame of the desired education and in line with the expertise of the tutors. The system offers here short cycles of assessment and learning and improves the direct connection between learners, tutors and education.

The new, assessment path-based algorithm for self-assessment helps to better explore the tested education, in line with the performance of the learner. Further, the different coverage of the knowledge structure offers a broader and different source for the use of data mining methodologies, which can be used to gain insights on the performance of the learner and provide feedback about clusters and correlations within knowledge-elements and across learners. This feedback could be the source for an improved adaptation of the self-assessment to the behavior of the learner. The results of this new path-based approach for assessment are currently further tracked and analysed by a study with 200 students, using the system and the new algorithm to prepare themselves for an examination within the higher education.

Acknowledgement

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Gamification in Education

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ABSTRACT

One of the most popular buzzwords of the last few years is gamification, which tries to make the "grey", serious work and tasks more enjoyable. It is often used for marketing purposes, but we can use gamification for particular value-creating activities, such as improving the skills and attitude of the employees, and it is also suitable for knowledge-transfer. In my research I would like to exploit the possibilities of academic education, fostering to improve the judgement of the courses, the students' motivation and participation, and to extend the possibilities of their personal development. The paper contains a summary of a pilot project that was a web-application with an aim of teaching the basics of ITIL. The main project of gamifying a course at Corvinus University of Budapest is also described with the examination of the currently available results. The aim of the project was to improve the motivation of an e-learning based course with applying the principals of gamification such as give the freedom of choice to students, provide them more ways to accomplish the subject and give proper feedback about their performance regularly.

Introduction

The final definition of gamification is yet to be formed [2], however there are some definitions which can describe this conception quite well. Sebastian Deterding defines gamification as the use of game design elements in non-game contexts [1]. Gabe Zichermann specifies the term in such way that it means the specific process of using game thinking and game mechanics to solve problems and engage users [10]. Werbach and Hunter described its meaning similar to Deterding et al. They think that in the course of gamification we use game elements and game design techniques in non-game contexts [9].

Using game-elements is not a new method, they have already been used for different aims, however, the beginning of the consciously usage of gamification can be placed to the 2000s.

Gamification was first used in 2003, when Nick Pelling, a British game-developer suggested to implement game-like interfaces into electronic devices. In the following years the term was used in a slightly misconceived way, and the current meaning of the term was established in 2010. [9]

The supporters of the method of gamifying the orthodox operations and activities expect primarily the improvement of the users' motivation, the increase of the participation rate in the process, and the enhancement of the attendance's commitment. On the other hand, the detractors of gamification submit that these are simply based on collecting points ("pointsification") rather than using essential elements of gaming, and the use of the term is simply and solely a marketing tool, which promises an immersive experience of games, but gives only meaningless point-haunting [3]. Nevertheless - as Scott Nicholson highlights too - they fear that the given external motivation affects the personal urge in a negative way, reducing the internal motivation [5].

An effective game (or game-like application) must be motivating and addictive as well as providing encouragement through the possibilities to reach short-term goals, while it maintains the option for making a mistake or fail, along with retrying as long as the user finally succeeds [6].

To create the proper form of the gamified process, it is not enough to think over the game elements. The forming of the process needs more separate fields which are interesting on their own too. The process reengineer should take into consideration the theories of games, game design issues, data mining methods for processing the huge amount of data, psychological principles in order to affect the users' behaviour and motivation, as well as the creation of the programme needs some knowledge in system and database designing. (Figure 9-1)

Figure 9-1.: Connected fields to Gamification (2014, Own figure)

The aim of my research is to use the university's current systems - and improving them, if necessary - for reforming one or more courses in a specific way, which primarily uses gamification elements in order to improve the motivation of students, increases their participation rate, makes the attainment of the curriculum easier, and in the end a better judgement of the courses.

Game Elements

Game elements used by gamification can be points, goals and aims, badges, user levels, state indicators and progress bars, knowledge map, difficulty levels, virtual currency and story too.

Points: the most basic element of the games. For each activities, achieved goals, completed tasks etc. the user can gain different degrees of points, which represent the amount of time and/or effort the user devoted to the service, and the points show how successful, how "experienced" the player is.

Goals: we can establish various kinds of objectives for the user (e.g.: elaborating a topic, watching 5 videos etc.), that can affect the user as a motivating factor. These goals can be predetermined by the system, but it is advisable to maintain the possibility for the user to set or choose the goals by himself/herself, in this way the freedom of the user is ensured.

Badges: the user can obtain them by accomplishing different topics, achieving goals, completing special tasks etc. These badges can represent the users' gained skills, achieved goals in a succinct way.

User-levels: according to the gained points, reached goals and collected badges the user can reach a higher and higher user-level, which shows his or her proficiency.

Progress indicators: these kinds of indicators can show the states of the user's goal-achieving processes (e.g.: how many point the user needs to collect to the next levelling up), his or her activity (e.g.: how many days the user visited the website in the last 20 days), the fulfillness of the desired skill (how many topics of the skill is completed), and show the overall state of the "gameplay".

Knowledge map: an overview map that contains the topics that can be accomplished, and the interdependence of them. Every item can be a point (circle), and they can be decomposed into other sub-knowledge elements. For each item can belong more than one sub-items, and these sub-items can contain other sub-items, therefore the user can decide by himself/herself which items, which routes in which order he or she would like to take.

Activity points: this kind of point reflects the user's activity, for example the frequency of the visiting the site, using the service, the number of viewed videos, the amount of the collected badges etc.

Difficulty levels: completing a task in a higher difficulty level can give higher honorarium, motivating the user to invest more energy in the completion of the task. For the higher difficulty level, the user can gain more points, have access to more badges that have a higher prestige, and can activate certain knowledge elements in the (knowledge-)map.

Virtual currency: for completing various tasks, achieving objectives, even for one certain step, the user can receive not only (experience) point-like rewards, but he or she can also collect virtual money. With this virtual money, the user can purchase in-game accessories, extras, functions etc., or use it for options with real-life effects (e.g.: purchase a unique, game-specific T-shirt).

Story: a higher level of gamifying, where we can hardly decide if the application is game-like or it is exactly a game-application. The knowledge-transferring and rewarding system is restricted by a fictitious or real story, therefore, the coherence between each tasks and options is stronger. For this reason, the game shows a quite consistent presence to the player. Speaking of the story, it is advisable to take into consideration the field of application, the scope and/or the environment of the potential users, that is to say, if we are planning to implement a gamified system with IT-specialist users, the conception of the story should be based on IT-like circumstances.

Motivation

Motivation is the process, whereby the completion of a well-targeted activity is motivated, managed and has long-term character [7]. The motivational processes include short- and long-term goals, the freedom of choosing and setting these goals, the expectations of the outcomes and activities, self-evaluation, social comparisons and self-efficacy [8].

Goal setting is not just about gaining more point but the willingness to attempt the goals and self-evaluation on attaining the goals [3]. As Scott Nicholson highlights, if we let the users set their own goals, they will have a better connection to the application, therefore it has a more meaningful content for them [5]. Both internal and external outcome expectations provide motivations. For internal motivation, the user should feel pride in their accomplishments. For external motivation, the ability to show that they have beaten the game or passed the certain level is motivating [3].

Social comparisons encourage self-evaluation. Those who compare themselves to other players, can become more motivated and have higher self-efficacy. The players can share with others their points, badges, or the fact that they have just beaten a level. [3]

Gamification Today

The market of gamification is widely spreading, and the term is used mainly for marketing purposes. As Mario Herger highlighted in his presentation, the value of gamification-software market can reach 2500 million dollars (in 2012, it was around $92m) [3]. The conception appears in the field of education and education-like activities, for example in the case of Duolingo, which has great popularity among language education, or Lumosity, that helps to improve a person's mental skills.

The term appears specifically in education, although these kinds of courses need some improvement. Khan Academy gamified its course called Computer Science in 2012, wherein the students could learn two programming languages (JavaScript and Python) in an interactive way. Briana B Morrison and Betsy DiSalvo examined the aforementioned course, and their result was that it was a good idea, however, the Khan Academy did not lay emphasis on meaningful content and giving the users the freedom of choosing the goals. [3]

The researchers of University of Cape Town Department of Computer Science gamified their game-development course. The course owned a fictitious story, and the syllabus followed this through the semester. The story can be accessed through a website with high-quality graphics design. The students can transfer the gained points into specific options which had real-life affects. [6]

Pilot-Project

In 2014 participated in a project at a multinational company, which aim was to develop a web-application that teaches the users the basic of ITIL, in a powerful gamified form.

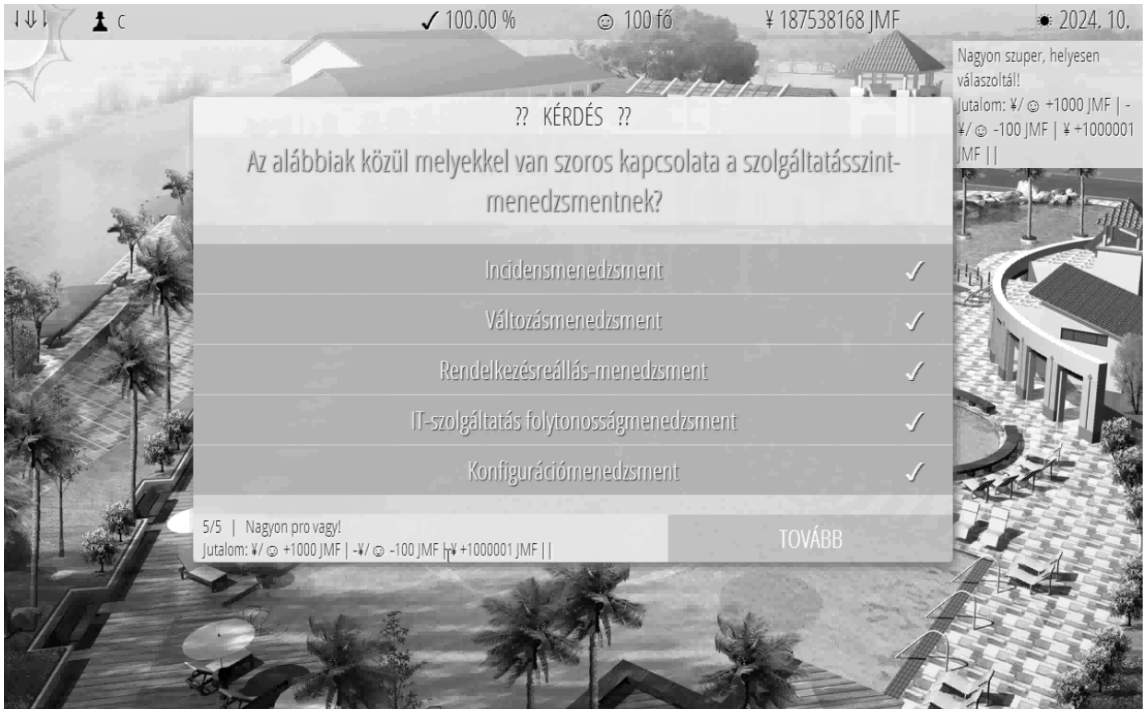

Figure 9-2.: Web-based simulator game application with the topic of ITIL;
The player answered the multiple choice question correctly (2014, Own figure)

The user has to manage a hotel, control services that interact with others (covering the purchasing, shutting down if necessary, restarting, maintaining periodically and improving). In the game, it is possible to implement different knowledge topics, sorting them in a hierarchical way, and they can be activated in the gameplay by several actions (such as new round, opening the description of a service or a function etc.).The players should pay attention to several KPIs through the gameplay, such as the amount of available money, the number of customers and customer-satisfaction.

At the beginning of every round, the KPIs and the services certain attributes modify (e. g. chance of failure), and according to the activated knowledge topics the game can ask the user questions, that can be theoretical or - as a casework - it can be a decision situation of the actual step of the story, and the player should choose the most optimal, the most correct answer. The types of the question can be multiple choice or filling with string. (Figure 9-2)

The goal of the game is to make the hotel more and more successful in a predetermined number of rounds, while the player gains the specific knowledge. The application was created in pure PHP language (without using any framework) at the back-end side. The front-end was created in JavaScript, using the library of jQuery.

The project has been paused temporarily, and I could not take part in the further developing process, therefore I could not participate in the testing and implementing sessions. The project has not been finished yet, thus I cannot report the results in this manner.

Although this application's aim is the gamified educating, these kinds of solutions can be examples of the extreme use of the term. According to the definition of gamification, game elements are used in non-game context, however in this situation we have created a game that contains educational, knowledge-transferring elements.

E-learning Based Education at CUB

Corvinus University of Budapest (CUB)has more e-learning based education systems. Among them, the Moodle has the most functions, and it is widely used at the university. The Moodle is an open source system that can be installed and modified freely, and written in PHP. Some of the activity-like functions which can be activated to a course (based on the inner site of Moodle):

- lesson
- glossary
- database
- wiki
- assignment
- choice
- questionnaire
- quiz
- forum, chat
- attendance
- survey

Many courses use this system, though only for sharing the curriculum and other files. In 2013, the reorganization of courses called 'Informatika', and the formation of it into an e-learning based education have begun. Therefore, knowledge-giving has been transferred into knowledge-gaining which is based on the individual's time-schedule. The learning method is helped by videos and exercises, and a part of the grade depends on self-checking online tests.

The number of students in these courses is around 1200. The final grade is based on "point haunting" which has more than one way, though it has indispensable parts. The students can collect some points from activities that are not connected to the syllabus, for example uploading profile picture or filling out a questionnaire. These shows that the course already can show up some elements of gamification, and one of its main parts that it gives freedom at a certain degree, the user can decide how he or she gains the necessary amount of points.

'Informatika', the Gamified Course

The 'Informatika' (Basics of Information Technology) is a mandatory, one-semester long course for the students of Faculty of Business Administration and of Faculty of Economics. Due to the high number of students (more than 1000 students register for the course every year), the course is held in the form of e-learning since the autumn of 2013. In this way, the students should prepare for the assignments and for the exam using the weekly activated video tutorials. Based on the experiences of the last year, in 2015 the structure of the course has been changed in order to increase the motivation of the students.

In pursuance of the aforementioned principals of gamification we sought to find a solution in which the students have more ways (so they have the *freedom of choice*) to *achieve a goal* (to reach a specific level or points), their performance is evaluated regularly by a summary *feedback* which is generated every few days (thereby displaying their current state of development continuously), and the theme of the feedback can be set by the student (providing them with the *feeling of personalization*). (Schunk et al, 2012)

The curriculum is made up of 4 modules, and the undergraduates should reach a minimum level of each module to complete the study-period of the course. Each module have weekly and minor tests. The required minimum level can be achieved with both types of tests, however, achieving the modules at top level rewards the student with a badge which gives a plus point to the final exam. The student receives feedback continuously which contains their gained points and the evaluation of the levels reached by modules, as well as information about his or her further possibilities.

The theme of the feedback can be selected from six options, some of them are playful and some of them are more casual. The theme-choosing works as an opt-in system, so it is not compulsory to make a decision. For those who do not choose any option, the Regular theme is applied, however they are not counted in the statistics of theme-selectors. [74]

Examination of the Gamified Parts

In the process of the research, the abovementioned Moodle e-learning system, a manually created script – written in the programming language of Visual Basic for Application – and the Microsoft Excel spreadsheet-software were used. Two types of data-set were collected from the Moodle system, the log-data (containing all of the filling-outs of the tests) and the scoreboard. The script was used to create the proper feedback for the students. The inputs were the exported scoreboard and chosen feedback-themes (in spreadsheet-files), and the script generated text-files as outputs. These text-files were uploaded to the Moodle system, so the feedbacks could be displayed for the students.

1271 students participated in the research, 1082 of them were full-time, 189 of them were part-time students of our university. Our data based on the study period of the semester (14 weeks), including 13 weekly tests and 28 minor tests.

The activity of students in the course is examined by the willingness to fill out the weekly tests. Each weekly test can be filled out at most twice, and the better result is counted in the final evaluation. It is important to note that it is not mandatory to fill out the tests, but it helps to earn part of the points that can be gained through the study period of the semester.

As for the willingness to fill out the weekly tests, a huge difference can be realized between the full-time and the part-time students, not only in their number, but in their trends as well (Figure 9-3). Averagely, the 86.28% of full-time students filled out the tests at least once with a relatively even deviation (2.40%). It can be concluded that the system of weekly tests provides a basis for the performance of the full-time students

Among the part-time students, even the first test had lower participation rate with 67.72%, which decreased week by week, by the 8th week it almost halved to 37.51%, however, for the last third of the semester it jumped back to around 60%. This fact leads to a conclusion that in the case of part-time students, the system of weekly tests does not have a considerable activity-keeping factor, therefore, the system in its current state is not suitable for re-

dounding to regular preparing, as well as reaching the maximum level is not a high priority goal for the majority of part-time students.

Averagely six tenths of those students who decided to fill out the tests took the opportunity to use the second chance, and there is no significant difference between the two types of training

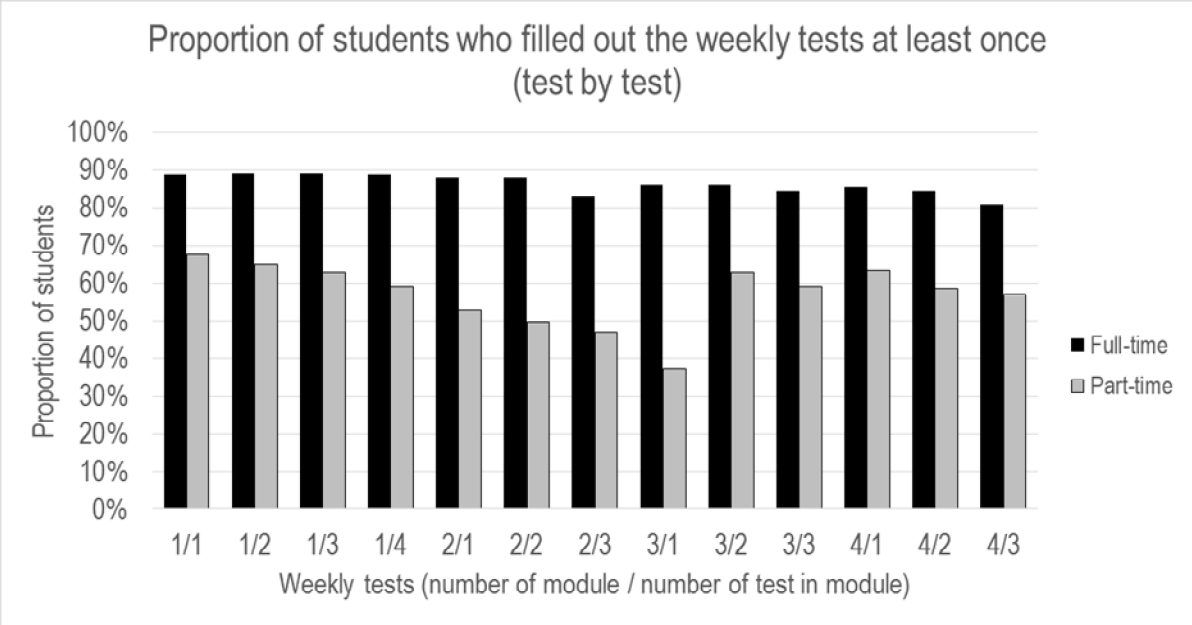

Figure 9-3.: Proportion of students who filled out the weekly tests at least once (test by test) (2015, own figure)

In contrast to weekly tests, the minor tests can be completed unlimited times, but the value of one test is at most only a quarter of the value of a weekly test, though the minimum level of each module can be achieved only by them too. The collected data show that the willingness to complete the minor tests loses to the rate of weekly tests. Among the full-time students (not counting the initial enthusiasm on the first week) the completion rate changed between 40% and 55% in the whole study-period. It can be observed that those students who filled out tests would probably fill them out again (averagely 68.69% of students completed a test again), and there were some students who tried the test at least 30 times (the maximum was 37). In the case of part-time students, the completion rate stood in lower but wider fluctuation rate, between 25% and 45%, and the rate of multiple filling-outs is almost the same, 71.34%. Altogether, the examinations show that despite the fact that minor tests did not reach as many students as the weekly tests, third-half of the students used it with a non-decreasing popularity.

The connection between the overall results and the number of the tests filled out has been examined as well. The results show that filling both test-types have positive connection with the final points. Between the number of completed weekly tests and the final points, a correlation of 0.59 is realized. Though it is not necessary to use the weekly tests, it is quite advisable to fill them out. Those who had higher number of attempts, achieved better results at the end of the study-period. In the case of minor tests the connection is also positive but a bit weaker, it is 0.39. Despite the fact that the correlation is smaller, the connection between the attempts of minor tests and the final result is still moderate. The group of students who completed one from both of the weekly and minor tests have significant correlation (0.51) with their final scores, but where the students used only one of the types has a correlation with -0.23. These correlations imply that though it is possible to fulfil the minimum requirements with only one type of tests, the students who use both of them have a significantly higher chance to meet the requirements.

Another metrics for measuring the activity of students in the course is the use of feedback-themes. On the last query (last day of the study period) 224 people declared their intentions about the themes, which results an overall 17.62% activity rate in the whole course. The full-time students had higher interest in the themes, 18.58% of them chose a possibility, while the part-time students were less interested in this function, 12.17% of them chose a feedback-theme. (Figure 9-4)

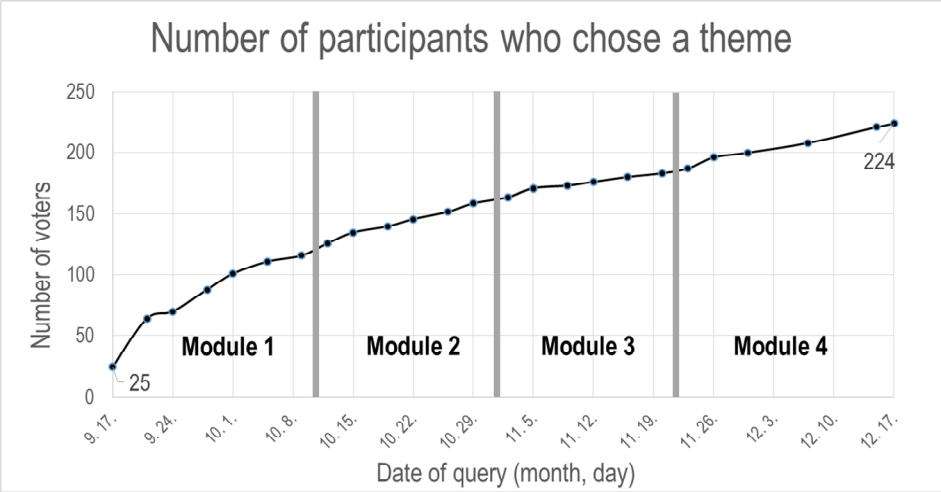

Figure 9-4.: Number of participants who chose a theme (2015, own figure)

The rise of the number of participants shows a slowing trend. After the initial interest, the rise was moderate at the second module, and in the second half of the study-period the average growth per week was about 5%. It should be noted that this function is not an integral part of the course, only a complementary function, therefore the selectors and non-selectors are not discriminated positively or negatively.

An interesting fact can be observed between the full-time and part-time students while examining the popularity of feedback-themes. While the full-time participants chose a fictional character the most frequently, the part-time students preferred a more realistic option, the organization-hierarchy was the most commonly used theme. It is interesting that the most liked theme of one side is one of the less preferred theme to the other side, and vice versa. For example, the 'Dumbledore' theme was the most liked among full-time students, however among part-time students it was only the third. The 'Organization-hierarchy' was chosen the most by part-time students, though it was the least liked (the sixth) theme among full-time participants. Taken together all of the students, the least preferred theme from the six possibilities was the 'Judo', therefore it should be omitted from the list in the future (see Figure 8-3).

Summarizing the project, it can be stated that the research has been successful, it is worth to take additional efforts to apply the principals of gamification on education. After the semester is finished, the final results can be compared with the results of the previous courses, and it can be found out whether the applied system had a better motivation increaser factor than the previously used system.

Conclusion

The first step of the research was to gather the appropriate and detailed scientific literature and to understand as many aspects as possible (what kind of game elements and mechanics should be used, which motivational factors help the most to make the project successful).

The next step was to find a suitable course at Corvinus University of Budapest which is attended by a large amount of students. The structure of the specific course could be formed in a way that the elements of gamification were implemented, while the quality of the subject did not decrease.

After the study-period of the semester finished, the activity of the students could be examined in two ways: the willingness to fill out weekly and minor tests, and the willingness to select a feedback theme from a given list.

Further improvements are going to be applied on the gamification framework, therefore the system will be able to (besides improving the motivation) find out different kinds of study-patterns with the result of which the framework can be used to create more personalized study strategies.

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Scientific and Educational Forum on Business Information Systems
S·E·F·B·I·S

SEFBIS Board's Adopted and Performed Decisions of 2015

Decision No. 1/2015.

The GIKOF SIG Board put together and accepted the Annual Workplan required by the Secretariat of the NJSzT. Decisions made on 17th January, 2015:

- Review and control valid membership of the SEFBIS SIG
- Acceptance of the Annual Report about activities in 2013 by the JvN CS Leadership
- Movie the GIKOF website to the JvN CS server, update the content
- Cooperation with other SIG groups of JvN CS
- Upload the SEFBIS Journal to the database of EBSCO for indexing
- Cooperation with the Organizing Committee of the 13th OGIK Conference in November at DU

Decision No. 2/2015.

The Board had a meeting at the General Assembly meeting of JvN CS and made decisions as follows:

- Conference *date* and *venue*: 8-9. November 2015, Pannon University, Veszprem
- The *Programme Committee*:
  Chair: RAFFAI, Mária (Széchenyi István University); *Co-chairs:* DOBAY, Péter (Pécs University of Sciences) and KOSZTYÁN, Zsolt Tibor (Pannon University)
  Members: BACSÁRDI, László (University of Wes-Hungary); CHROUST, Gerhard (Johannes Kepler University, Austria), CSERNY, László (Dunaújváros College); DOUCEK, Petr (Prague University of Economics, Czeh Republic), ERDŐS, Ferenc (Széchenyi István University); FEHÉR, Péter (Budapest Corvinus University); GÁBOR, András (Budapest Corvinus University); HOMONNAY, Gábor (GIKOF EC); HONFI, Vid (Dunaújváros College); JENEI, Sándor (Pécs University of Sciences); JEREB, László (University of West Hungary); KŐ, Andrea (Budapest Corvinus University); KRUZSLICZ, Ferenc (Pécs University of Sciences); NOSZKAY, Erzsébet (University of Applied Sciences, Budapest); RACSKÓ, Péter (Budapest Corvinus University); TJOA, A Min (Vienna University of Technology, Austria) and UCHIKI, Tetsuya (Saitama University, Japan)
- The *Organizing Committee* of the OGIK'2015 : *Chair:* KOSZTYÁN, Zsolt Tibor (Pannon University); *Members*: DOBAY, Péter, NÉMETH, Anikó and the colleagues of the Pannon University Department of Organization and management
- *Sponsors* of the Conference will be: JvN CS, Pannon University, ESRI Hungary, Foundation Alexander, Guidance Ltd.

Decision No. 3/2015

The SEFBIS SIG meeting was held on 7th of November 2015 at the 12th ISBIS Conference

- The SEFBIS SIG Board expresses gratitude and thanks to organizers, reviewing board members and authors to successful work of the annual OGIK Conference, held at Pannon University, 6-7th of November 2015
- Final papers for publication into the SEFBIS Journal (on English) has to be sent to the Committee by 15th January the latest. The papers, the contact with the authors, the whole reviewing process and the editing, printing works will be managed by Maria Raffai.

Decision No. 4/2015

New Board of SEFBIS has to be elected. The nominations has to be done until 30th of September, the election has to be organized at the end of OGIK conference in Veszprém.

Decision No. 5/2015

The annual Activity Report'2015 and the Workplan '2016 of the SEFBIS SIG has to be circulated in December and –after acceptance– sent to the Secretariat of the JvN CS by 20th December, the latest.

SEFBIS' Action-Plan for 2016

At the end of ISBIS conference the members of SEFBIS (GIKOF) Community elected a new Board. This was require because by the Statutes and Bylaws of JvN CS all the Boards have to be re-elected in every 3 years the past president Peter Dobay arranged a nomination process and managed the election. The meeting was held on 7th November 2016 in Veszprém, where the president reported on the activity having performed by SEFBIS in 2015, and gave proposal for the members of the new Board. By the result of the election process that was managed in secret paper ballot, the new Board members are as follows:

President: Mária RAFFAI
Members: György BÖGEL, András GÁBOR, Vid HONFI, Ferenc KISS, Zsolt KOSZTYÁN, Andrea KŐ, Zoltán VAJNA
Honorary members: Péter DOBAY, Gábor HOMONNAY

On its first meeting held in January 2016 the Board decided to perform the following tasks in 2016:

Description	Estimated termin	Estimated venue	Participants, responsibles
Call for publishing in the GIKOF and SEFBIS Journals Collecting the papers	continuous	NA, virtual	SEFBIS Board
Managing the work of reviewing and editing process of publishing the professional Journal(s).	continuous	NA, virtual	Approximately 12 reviewers
Uploading the new Journals to the international EBSCO Database	continuous	NA, virtual	SEFBIS President
Applying to MTMT and MTA (Acadamy of Sciences, Hungary) Economy Committee for accepting the Journals as indexed ones.	continuous	Meetings, discussions, correspondance	Board
Cooperation both with business and university departments responsible for BIS education	continuous	Personal and virtual comm..	4-5 Board member Resp. SEFBIS pres.
Development and uploading database on experts, professionals in the field of BIS in Hungary	continuous	Gathering information	2-3 Board members + activists, students
Update the GIKOF/SEFBIS website by the new expectations for the content and the design	Continuous, but latest yearend	Design, implementation	SEFBIS President
Discuss, plan and accept both the action and financial plan for 2016	Until 15 January 2016		SEFBIS Board
Active participation at the meeting of the JvN CS professional communities, giving proposals for more effective cooperation.	Februar 2016	Meeting Room of JvN CS	SEFBIS President
Workshop on the topic: ICT in the Nuclear Industry:	May 2016	Paks	~40 participants
OGIK/ISBIS'2016 conference: call for papers, applying for sponsorship, reviewing papers, organizing work	Form April to November 2016	NA, virtual	14 colleagues, SEFBIS Board, IPC, experts
OGIK/ISBIS'2016 Conference	11-12 November 2016	DU	50-60 participants,+ students, 40-45 papers
Evaluation of the yearly activity: results, report to JvN CS Presidency	20 December 2016 latest	NA, virtual	SEFBIS President

Conferences in 2016-2017 Orgenized Worldwide that are Relevant to the SEFBIS Community

Event	Date/Location	Organizers' Contact
WCCE 2017 World Conference on Computers in Education	03–06/07/ 2017 Dublin, IE	michael@ics.ie Tel. +353 (01)6647820
FIP WG 9.4 2017 The International Conference on the Social Implications of Computers in Developing Countries	22–24/05/ 2017 Yogyakarta, ID	fathul.wahid@uii.ac.id Tel. +62 8112510605
WiOpt 15th International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks	15-19/05/ 2017 Paris, FR	marceau.coupechoux@ telecom-paristech.fr
DoCEIS`17 Doctoral Conference on Computing, Electrical and Industrial Systems	03–05/05/ 2017 Caparica (Lisbon)	pmrp@fct.unl.pt Tel. +351 212948545
CONFENIS 2016 International Conference on Research and Practical Issues of Enterprise Information Systems	13–14/12/ 2016 Vienna, AT	amin@ifs.tuwien.ac.at Tel. +43 1 58801 18801
IFIP 8.2 Working Conference Dublin 2016	09–10/12/ 2016 Dublin, IE	donncha.kavanagh @ucd.ie +353-1-7164751
ITDRR-2016 First IFIP Conference on Information Technology in Disaster Risk Reduction	16–18/11/ 2016 Sofia, BG	dgvelev@unwe.bg Tel. +359 878 703 297
NoF`2016 7th International Conference on Network of the Future	16–18/11/ 2016 Búzios, BR	otto@gta.ufrj.br Tel. +552124376396
PoEM 9th IFIP WG 8.1 Working Conference on the Practice of Enterprise Modelling	08–10/11/ 2016 Skövde, SE	anne.persson@his.se Tel. +46 500 44 83 42
ISBIS–OGIK 2016: 13th International Symposium on Business Information Systems	11–12/11/ 2016 Dunaujvaros, Hu	raffa6.wix.com/sefbis#!conferences/c1tsl
EI2N Workshop on Enterprise Interoperability, Integration and Networking	26–27/10/ 2016 Rodos, GR	georg.weichhart@Profactor.at Tel. +43 7252 885 335
ICSOC International Conference on Service Oriented Computing	10–13/10/ 2016 Banff, CA	barbara.pernici@polimi.it Tel. +390223993526
DRW2016 Dewald Roode Information Security Research Workshop (IFIP WG8.11/WG11.13)	07–08/10/ 2016 Albuquerque, US	xinluo@unm.edu Tel. 505-277-8875
PRO-VE 2016: 17th IFIP Working Conference on Virtual Enterprises	03–05/10/ 2016 Porto, PT	asoares@inescporto.pt Tel. +351 222 094 317
WIS 2016The 6th International Conference Well-being in the Information Society	16–18/09/ 2016 Tampere, FI	hongxiu.li@utu.fi Tel. +358503722471
I3E 2016: The 15th IFIP Conference on e-Business, e-Services and e-Society (I3E)	13–15/09/ 2016 Swansea, GB	y.k.dwivedi@swansea.ac.uk Tel. 00441792602340
IFIP WITFOR 2016 IFIP World Information Technology Forum	12–14/09 2016 San José, CR	gabriela.marin@ecci.ucr.ac.cr /putxi@uib.cat

CONFENIS'2016
International Conference on Research and Practical Issues of Enterprise Information Systems

13 – 14. December 2016
Austrian Computer Society (OCG), Vienna, Austria

Confenis'2016 conference provides an international forum for Enterprise Information System (EIS) researchers and practitioners from all over the world to come together, present and discuss their latest research findings and ideas. The conference is specifically aiming at facilitating the exchange of ideas and advances in all aspects and developments of EIS. The organizers of the conference invite EIS-experts who are interested in presenting and disseminating their work at an international forum to submit their contributions. As in the previous years, the proceedings of the conference will be published by Springer.

Topics that are not limited to the following areas:

- EIS Concepts, Cases and Management
- Business Process Management
- EI and Computing, Enterprise Modeling
- Open Source EIS
- Cloud Computing Services
- Big Data Analytics
- Knowledge Management
- Governance and Decision Making in EIS
- Business Value of EIS
- Supply Chain Management Aspects
- Security and Privacy Issues
- Cross-Organizational Collaboration and EIS
- EIS, Internet of Things, Social Media
- EIS Teaching and Education
- Use of Open Data for EIS
- Semantic Web Concepts

Jubilee of CONFENIS Conference Serie

On the occasion of its 10th Anniversary the conference will be held at the Austrian Computer Society (OCG) in downtown Vienna, Austria on 13–14 of December 2016. The conference is supported by the International Federation for Information Processing (IFIP) and jointly organized by the Vienna University of Technology (TU-WIEN) and the Austrian Computer Society (OCG).

Important dates

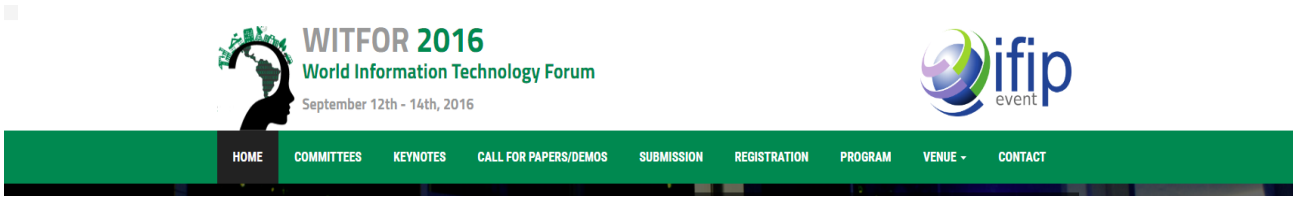
Papers Submission Deadline	15-08-2016 (extended!)
Notification of acceptance	15-09-2016
Camera-ready deadline	30-09-2016
Conference	13–14.December / 2016

Registration Fees

	Before	After	On-site
	01-10- 2016		Reg.
Authors	€ 300	N/A	N/A
Regular (non-authors)*	€ 320	€ 350	€ 350
Students (non-authors)**	€ 150	€ 200	€ 200
Additional Papers (per paper)	€ 150	N/A	N/A

The Registration fee covers admittance to all sessions, lunches and coffee breaks throughout the conference, gala dinner on Tuesday evening, the conference kit and conference proceedings.

More information on Conference Website
http://webcampus.ifs.tuwien.ac.at/confenis2016/fee#overlay-context=user/1



WITFOR 2016
World Information Technology Forum
12-16 September 2016, San José, Costa Rica

About WITFOR 2016

The World Information Technology Forum (WITFOR) was initiated by the International Federation for Information Processing (IFIP) and has been organized by IFIP periodically since 2003 in cooperation with several stakeholders in the host country. So far WITFOR has been held in Lithuania, in 2003; in Botswana, in 2005; in Ethiopia in 2007; in Vietnam in 2009 and in India, in 2012. WITFOR brings together senior policy-makers, academics, NGOs and GOs representatives, ICT experts, and the private ICT sector

WITFOR 2016 intends to bring together members of the ICT community from governments, academia, industry and associations, to discuss recent proposals aimed to reach the sustainable development goals, promoted by the United Nations, to improve global conditions by reducing poverty and hunger; achieving universal education; promoting gender equality; ensuring environmental sustainability; combating diseases and reducing mortality.

The Conference

WITFOR investigates successful ICT strategies in developing countries and examines different initiatives and projects on effective, context sensitive development and use of ICT applications.

It is intended to:

- Help to put ICT-enabled development initiatives on the agenda of different organizations, governmental bodies, groups currently involved in ICT.
- Work with different groups to ensure that senior policy makers and political leaders are aware of the developmental potential of ICT and promote its diffusion and sustainable effective use.
- Assist international organizations and donor agencies to include issues of the spread of ICT and access to information into their loan and funding programs and be more pro-active in using new technologies to reduce existing social tensions and conflicts.
- Encourage scholars, analysts and researchers to put the issue of digital equity higher on their research agendas.
- Encourage industrialized nations, as individuals and groups, to listen to and learn from colleagues around the world about their unique concerns over access to ICT.
- Develop guidelines on these issues and advise governments, to formulate and follow the best strategy for the use of ICT in order to achieve global ICT-equity.

WITFOR 2016 will be held in San José, Costa Rica, in collaboration with the Costa Rican Public Universities, under the overarching theme of ICT for Promoting Human Development and Protecting the Environment.

In particular, WITFOR 2016 intends to bring together members of the ICT community from governments, academia, industry and associations, to discuss recent proposals aimed to reach the sustainable development goals, promoted by the United Nations, in order to improve global conditions by reducing poverty and hunger, achieving universal education, promoting gender equality, ensuring environmental sustainability, combating diseases, and reducing mortality.

The conference goals will be pursued through technical sessions as well as keynote speeches on important topics. The technical sessions will refer to the following main areas:

ICT and cross-cutting development
ICT and climate change
ICT and sustainable energy
ICT and employment
Digital divide
E-government
E-readiness and ICT impact
Smart cities

ICT and human development problems
ICT and poverty
ICT and food security
ICT and health
ICT and education
ICT and gender
ICT and conflict resolution/human rights
ICT and human settlements
ICT role on enhancing human capabilities

ICT and environmental problems
ICT and water, including sanitation
ICT and sustainable production and consumption
ICT and sustainable use of oceans, seas and marine resources
ICT and biodiversity
ICT and the combat of desertification
ICT and prevention/management of natural disasters

ICT and economic development problems
ICT and sustainable economic growth
ICT sector and economic growth
ICT and infrastructure and industrialization
ICT and innovation

We welcome academic contributions as well as practical solutions and examples related to the areas described above. Particularly, we encourage full and short papers using a variety of approaches or perspectives (human, environmental, and economic) to address pressing sustainable problems. Full papers should present completed projects or initiatives and can have 10 to 12 pages (2 additional pages are possible at an additional cost). Short papers can be used to present on-going or proposed projects, and should have 5 to 7 pages (1 additional page is possible at and additional cost). Submissions will go through the normal reviewing process associated with a quality symposium, that is, each paper will be reviewed by at least three Programme Committee Members.

Criteria for acceptance for papers are its originality, relevance, and quality. Accepted papers will appear in the conference proceedings published by Springer-Verlag as a volume of the IFIP Series Advances in Information and Communication Technology (AICT).

To complement the papers to be presented during the technical sessions, we are also looking for demonstrations of pilot/sample projects in different stages (completed, halfway, just started, proposed), case studies, technical recommendations, experiences, policies, initiatives and best practices regarding innovative ICT applications promoting human development and/or protecting the environment, in the same areas proposed for the papers. These presentations do not require an associated paper and will not be published in the proceedings.

Details: http://www.witfor2016.org/index.html

Submission:
http://www.witfor2016.org/submission.html.

ISBIS / OGIK Conference 2016
Nov 11-12, 2016; Dunaújváros
13th Conference on Business Information Systems
Call for Papers

The SEFBIS/GIKOF professional forum organizes its traditional, now already 13th International Conference on 11-12th November, 2016 in Dunaújváros. The ISBIS (International Symposium on Business Information Systems)/OGIK (in Hungarian) Conference gives not only floor to senior and junior researchers and practitioners to present their results, to show experiences or new applications but also it is a great opportunity for face-to-face open discussions among professionals and for establishing joint research work and other cooperation.

The ISBIS/OGIK conference 's motto in 2016 is: **The Information Aspects of the Generation Change**

The International Committee proposed to send papers in the topics below:
- the future generation and the ICT → technological, human and cultural competences
- Internet: Cloud; Internet of Things; the role and effects of the common media
- development new applications, new methods and techniques
- ICT security: technological and business aspects
- new ICT technologies for making innovation and competiveness more effective
- the role of Robots in the 21st century's industries
- teaching ICT professionals: competences, methods, developing curriculums, teaching materials, training both in higher education system, in high schools or inside the companies

Registration
The Organizing Committee manages the registration on-line using Easychair Conference Management System. The topics listed above are suggestions but the papers are not limited to that ones. Sections will be organized as the Program Committee will see the scope and quality of contributions. The best papers selected by the IPC will be published in the EBSCO indexed SEFBIS Journal (ISSN 1788-2265). Contributions (a 2-3 pages, essay-long abstract in English or in Hungarian) has to be uploaded together with the on-line registration or it can be sent via email to Honfi Vid (honfivid@unduna.hu) or Mihalovicsné Kollár Anita (mkollar@uniduna.hu or +36-25-551-669).

Important Dates		**Conference Fees** includes: opening reception, coffee in breaks, lunches, proceedings w. progam and extended abstracts
Abstract	30-09-2016	
Acceptance	15-10-2016	Employees from business: 100,- EUR/30.000 HUF
Extended abstract	30-11-2016	University teachers: 80,- EUR/25.000 HUF
Conference event	11-12 Nov.2016	PhD students, retired colleagues: 50,- EUR/15.000 HUF

In the hope that this conference will also have as great interest as all the others in the previous years, on behalf of International Committee I invite all the professionals who are involved in Business Information Systems let them work either in business, in software development or in education, to participate at ISBIS'2016!

Mária Raffai
Chair of IPC

Report on ISBIS-OGIK 2015
6-7th of November, Veszprém

International Conference of Scientific and Educational Forum on Busines Information Systems

Mária RAFFAI – Péter DOBAY – Zsolt KOSZTYÁN
Chair and vice-chairs of Program Committee

Twelve – this is a dozen. Not a bad serial number for a Conference on a relatively new topic, on research and application experiences in Business Information Systems in Hungary. Our International Conferences on Business Information Systems have been organized by the Special Interest Group of John von Neumann Computer Society, as a Forum on „Business Information Systems" The other main branch in activity of our community is to publish the relevant GIKOF (in Hungarian) and SEFBIS (in English) Journal special editions.

The annual Conferences offer possibilities for academics, researchers, industry professionals to meet and change their expertise, their innovative ideas, solutions and also their problems. Managing business information can be called our mission: but that is not a simple profession, this should be an attitude, a way of thinking about business and ICT parallel.

We do appreciate to sponsors contributing these Conferences – especially to the JvN Computer Society, and in this year to the ESRI Hungary Kft. because without their support the event could not be managed successfully. Also thanks should go to those professionals who have participated in reviewing contribution proposals and have supported authors (many young ones among them) to make their presentations and articles better.

In this years the International Program Committee (IPC) of the conference invited 3 keynote authors and accepted altogether 40 papers. As the conference was running during two days it was really a strict program. All the speakers had to keep the time available for the presentation. Although there remained not so much time after a presentation for the discussion, the participants could change their thoughts during the breaks and evening programs.

The conference was held at Pannon University in Veszprém, where comfortable lecture rooms served the programs. It was a great honor for the IPC that not only the guests from abroad but also the Hungarian speakers hold their presentations in English.

During the Plenary Session that was assigned to *"Living in a Digital World"* the audience could get acquainted with database techniques in health care (István Kósa), with user requirements notation that can be used in business process modeling (Daniel Arnyot) and they could see, how useful is to apply the digital maps in business especially in the field of BI (Attila Oláh).

After the plenary speeches the conference continued in 7 different sessions:

- In the session *"Business Solutions"* we could hear 6 very interesting presentations about different topics, such as datacenter consolidation project (A.Baumann–Gy.Dömse), MDE methodology (A.Medve), virtual reality in decision making (F.Kiss–B.Szabadkai), disruptive innovation (F.Kruzslicz), software vulnerabilities (A.Horvath) and cloudsourcing (R.Marciniak).

- As there were more papers dealt with business solutions we organized more sessions for this field of BIS which was addressed to the *Business-Social and Environmental Problems*. The lectures were running on data mining for rule generation (B.Kovács), kvalitative indicators for competitiveness characterization (M.Hornyák), defining research profile by communication channels (F.Kruzslicz), added value of the IT-services at SMEs (Á.Horváth), the role of IT in solving environmental challenges (E.Kormány), Envirodata, a complex IT-solution for environmental problems (R.Szűcs-Winkler).
- The most interesting session is always that one where the colleagues present their new *research results.* This time the authors were talking about not only technical and methodological solutions but they also presented analysis and experiences about how new results can be used. Most interesting themes: business value of new generation DBMSs (F.Erdős), LEAN solution in IT (Z.Vajna), metamodel based workflow management (I.Kilián), intuitive estimation in measuring work affinity (Zs.Kardkovács–G.Kovács), experiences of developing a simulation software (T.Tibori).
- In the *"Knowledge Management"* session we could hear the experiments of research advisors (A.Balogh–E.Noszkay), and we got acquainted with the associative knowledge management (F.Kiss and M.Török). At the end of the session the audience had so many comments and questions, that finally the session chair had to close the interesting and useful debate.
- In the second block of *"Business Solutions"* session the speakers were dealing with IT solutions, methodologies that can be useful in managing industrial tasks and business problems. Among the presentations there were topics as method for project portfolio planning (Zs.Kosztyán), expert system for managing multiprojects (Cs.Hegedűs-Zs.Kosztyán), IT challenges of production systems (G.Bencsik–A.Ludovátz), scale-free network maintenance (A.Németh), rank computation (J:Abaffy–Sz.Fodor) and multidimentional modeling (Z.Németh).
- The ISBIS conference always has been dealing with the problems of education, subsequently this conference has also got papers in this topic. The colleagues were talking about their experiences in eLearning (G.Baksa-Haskó), about the ERPs in higher education both from application aspect (V.Honfi–Z.Király–A.Kollár– L.Rádai) and from training aspect (L.Bacsárdi–G.Bencsik–P.Kiss). and we also saw how to develop a knowledge database for an application management system (Z.Novák).

Although the participants were very tired of the busy conference program all had great feeling about the togetherness with colleagues who are interested in the same topic of BIS although from different aspects. Everyone felt that these days having spent together were useful, and the discussions gave new ideas that will make everyone's work more effective.

On behalf of the IPC we wish all the colleagues a successful year in the hope that we will meet again at the next conference where we can welcome new colleagues as well!