Software Development with Regards to Simulations: Are Interaction Features Needed for a Better Description of Actual Reality?

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Abstract: This paper is centered on the optimal description of an actual reality for better support needed processes based on simulations. Data processing was, is and will be at the center of interest of all firms, organizations and individuals. The reasons are natural. There is an enormous amount of information, and orientation is very difficult with regards to data volume, variety and velocity. The selection of the correct way for optimal computational processing has a number of forms via preferences by actual conditions and IT user preferences. The better solutions are designed with support in cooperation with the global environment. The new approaches and ideas are often linked to innovations based on inspiration from swarm intelligence, trust in an agile method, or graphic support within the simulation. All such approaches help in software development and optimal implementation through settings and configuration, but many IT users have doubts about their real benefits in practice. They have problems with complexity, orientation, offered services, or timelines of obtained results and analyses. Based on this reality, there is a question about a better method for simulation design for optimal software development with regards to actual reality. These simulations are successfully used in software specification through needed objects. Standard objects are used for the description of the adopted resolution based on object features such as Name, Size, and Capacity. For actual reality description, there are other features needed with links on current context. Inspiration of this idea is based on pheromones from swarm intelligence like a point of interaction. These additional object features are oriented on practical preferences such as standard professional matter, cooperation, presentation, management, analytical matter, creativity, multicultural needs, services, and contact with the customer. Practical preferences then define the total priority of an object in a simulation. The benefit of the total priority of an object is a better relation to actual reality, and an optimal description of existing needs by preferences in a dynamic society. This approach offers a better way of software development like operating and database systems, or BI (Business Intelligence) and CRM (Customer Relationship Management) products.

Key-Words: Global changes, object features, software development, swarm intelligence

1 Introduction

Today's modern global society brings a number of challenges for the application of information technology to solve current problems. Urgent problems are high unemployment, low economic growth, the unequal approach of overall societal growth, or lack of environmental protection. Basic global problems are defined together with their solution. [1, 4] Globalization contributes to intense visibility of existing problems. Stresses and imbalances are created and they cause confusion and vulnerability. This reality brings crisis of complexity. [39, 42] We must remember that globalization is a spontaneous uncontrolled process of increasingly intensive integration of the world into a single economic system. Communication and information play a key role with effective cooperation within a collaborative environment. [7] The continuous flow of information leads to acceleration of social processes as well as transformation of the time and space. [32]

Communication and information has an important influence on society in this situation. Emphasis is placed on speed and quality. Positive aids for solving existing problems are information technology and education. [34] The aim is to inspire and develop a proactive approach to life via various types of available software [24] and simulators. [8]

Proposals for solving global problems are also listed in the Global Marshall Plan:

- Reverse loss of environmental resources,

- Substantial improvement in education,
- Creation of productive employment opportunities,
- Ensuring access to modern technologies. [33]

Information and data are different terms. Data is a sequence of characters, numbers and symbols. Information is created on the basis of represented and available data. [14, 15] The necessary knowledge and skills are derived from data. Data are often stored in database systems. Information has required characteristics like order, context and entropy with statistical probability. [47] Entropy (disorder) is the amount of information needed to describe a given state, and a degree of uncertainty is removed. Generally, for a system with a finite number of possible states $S \in \{s_1, s_2, \dots, s_n\}$, $n \leq \infty$, and probability distribution $P(s_i)$, an information entropy is defined as the mean value:

$$H(S) = -\sum_{i=1}^{n} P(s_i) \log_2 P(s_i) \text{ [44]} \qquad (1)$$

The natural logarithm is often replaced with a binary logarithm and then basic information is measured in bits. If entropy decreases, overall information increases and vice versa. Entropy is a measure of prior ignorance by Shannon; therefore, it characterizes the content that could be passed in the message.

Information and data have close links to knowledge. [17, 18, 29] Knowledge has an important influence on the information and global society. Knowledge enables to carry out necessary activities from various fields with an optimal overview and acceptable speed. Optimal knowledge supports for example:

- IT development for optimal implementation,
- Offer products for target customers,
- Selection of services with defined parameters,
- Application methodology and methods for problem solution.

2 Software for Innovations

Users in firms and organizations use IT products for the support of realized activities. These users select from commercial or open-source products. The boundary between such products is not clear, because many commercial products are offered for testing and education purposes as open-source. On the other hand, open-source products offer editions in commercial versions. The benefit is that both offer plenty of examples and teaching materials on websites with the aim to support user communities. Users of IT products must specifically recognize implemented technologies; therefore, they must have the following suitable knowledge about information technology:

- Importance of basic components forming information systems,
- Process of design and implementation of IT products,
- Ways of monitoring, maintaining, adapting and detecting unpredictable situations,
- Simulation for active monitoring and analyzing the actual reality based on the object-oriented approach,
- Potential use of information technology for management. [30]

Information technologies bring good inspiration for effective solutions to existing problems and tasks. Users and individuals everyday run a number of application and tools. These IT products also support sustainable development through innovation. Information technologies create an optimal background for various innovations like social innovations. These innovations build new tools, ideas, and methods of working that improve or address needs in society.

These approaches bring more efficiency, and realized changes are new ideas or modifications of existing practices. Social innovation is spread in the form of ideas, values, software or tools. Resources are diverse in many places. The stimulus can be based on scientific research, business opportunities, or new technologies. [46] A positive example of such an innovation is the SmogAlarm application [45] from Eagle Software. Interested persons may find appropriate support innovation on the Internet. [16] Various areas of interest are:

- Mobile technologies and their influence on urban areas

Mobile technology enables access to resources, news, information, knowledge, and commerce. Mobile technologies create new barriers, concerns and a new kind of illiteracy. [23]

- Competitions

Work is oriented on a business strategy, product design, and profit on the basis of judging feedback. [12]

- Culture of innovation

Considerations are linked with the environment and innovators in a firm or organization. It is necessary to find footholds, to move ideas through bureaucracy and hierarchies, and to implement them into existing realities. [22]

Innovation is suitable when it is living and mixes, blends, challenges and inspires impact in various fields, cultures, firms, organizations and individuals.

In this situation, connection is important. Of course, information technology also helps in this area. Users can share a selected topic and interest for better implementation in practice. The benefit is the occasion for questions and answers. The Internet and specialized websites offer an optimal space for discussion, searching for help and people across continents, knowledge sharing [35] and, of course, simulation is also one of the active methods for a pragmatic solution with verification based on the automated analysis of system properties. [3]

3 Problem Formulation and Hypothesis

New software implementation usually needs correct analysis of the actual reality. Such an analysis is default based on a simulation that brings the ability to design an innovative solution. One suitable way is monitoring actual trends, adopted solutions from competitors, and IT user preferences. A standard simulation is created by objects with needed relations and features. For example, Petri Nets (PN) use places, transitions, and oriented edges. The following relation describes the existing relationships well:

$$PN = (P, T, F, W), \quad (2)$$

where P and T represent places and transitions, F is dedicated to relations in the net, and W assigns a specified weight to edges. [31] For a new design, objects as places and transitions are important in forming a composition. There is a natural assumption that all objects are not suitable, and such objects must be removed from the design of a new simulation. On the other hand, a designed simulation also needs new objects for effective innovation with links to preferences and needs. The question is about the number of such objects and their features. Based on this hypothesis H_1, there is an optimal design of the innovative simulation (InSi) with an exactly defined number of objects:

$$H_1: InSi = \{O_1, \ldots, O_n\}, \quad (3)$$

where O_i for i-1, …, n represents the needed objects (paces and transitions) for the best fit solution.

In general, there are further questions about the suitable maximum or minimum of such a number of required objects for an optimal solution in IT products. The usefulness of objects is defined via links to the actual reality. Some information also brings assigned properties [40] such as Name, Size, Capacity, Initial Tokens, Current Tokens, or Tokens Count (for places), and Initial Delay, Range Delay, Current Delay, or Tokens Fired (for transitions).

Such properties have no links to diversity in reality, on perception of necessity, or customer preferences via specified visions and missions. The spectrum is broad for other relations to dynamic changes in society:

- Standard professional matter, [49]
- Cooperation, [10]
- Presentation, [11]
- Management, [20]
- Analytical matter, [36]
- Creativity, [26]
- Multicultural needs, [21]
- Services, [9]
- Contact with customer. [37]

For effective implementation of such variables, other features (properties) are needed that will be defined for individual objects. These properties define an actual link to dynamic changes and society preferences via a number in the form of total priority; therefore, the second hypothesis H_2 assumes that the object is described with assigned properties in form of the point of interaction as the number:

$$H_2: Object = (Properties, PointOfInteraction) \quad (4)$$

The defined hypothesis would help with search for the best solution for optimal software development, because the diversity of access to software development is visible. It is natural because every IT user has an individual approach to a given topic. There are diversity in preferences and think maps for understanding a selected topic based on different software development in contexts. [13] The well implemented ideas are focused on extended elements of objects [25] and swarm intelligence from nature.

4 Benefits of Simulation

A good starting point is to compare existing experiences and implemented solutions. Effective design of the innovation helps to define mind maps. The solution is to plan in workable units. If it is necessary to solve a problem, then the solution is to draw a mind map. Mind maps help with the contribution of creativity, because they support imagination, association, and ability to combination. The creation procedure is defined in several steps:

- Definition of the topic,
- Topic is further divided into sub-topics,
- Topic and sub-topics are connected,
- Descriptions are expressed in simple words,
- Labels, symbols, images and colors are useful,
- Associations have freedom. [6]

These things are objects with links to the real world. Fields of science, technology, and management introduce the examined things to abstractions that ignore some attributes of these things. Other attributes are analyzed and designers can investigate relations between them via simulation. Simulation is a research technique. The essence is replacing the examined system by the simulator. This simulator serves for the experiment in order to obtain information about the originally examined system. [28]

Follows lines are focused on security layer in IT products and needed number of implemented objects. The selected product is Jaspersoft Suite that brings solution from BI area. BI products are centered on analysis stored data from various sources. The aim such analysis is to search secret relation with vision to be prepared for unexpected events. Complexity makes troubles for users in this sphere. [48] The question is about needed objects for effective security. Security is focused on [27]:

- User and role management - user account properties (name, email, password), and assignment of roles to users. Assigned permissions allow access on a folder or source.
- System administrator - super-user that exists at the root level. This user installs needed modules, configures server settings, creates, and modifies users, roles, and repository objects.
- Repository permissions - permission setting for users and roles on folders and sources in the repository. Implemented sources have defined ID, name, and description. Focus is oriented on data sources with links on queries and input controls.
- Data level security - row and column level permissions to data access. These permissions are defined via domains.
- Audit and monitoring - logging key indicators in specified levels as SQL query executer, Ad Hoc data policy logging, or General controller.

A model for security layer is shown in Figure 1. The validity of the defined model is verified by starting the given simulation. A route cycle is built from the P1 place via specified transitions and places. The specified model creates places as circles and transitions as rectangles based on Petri Nets. [2]

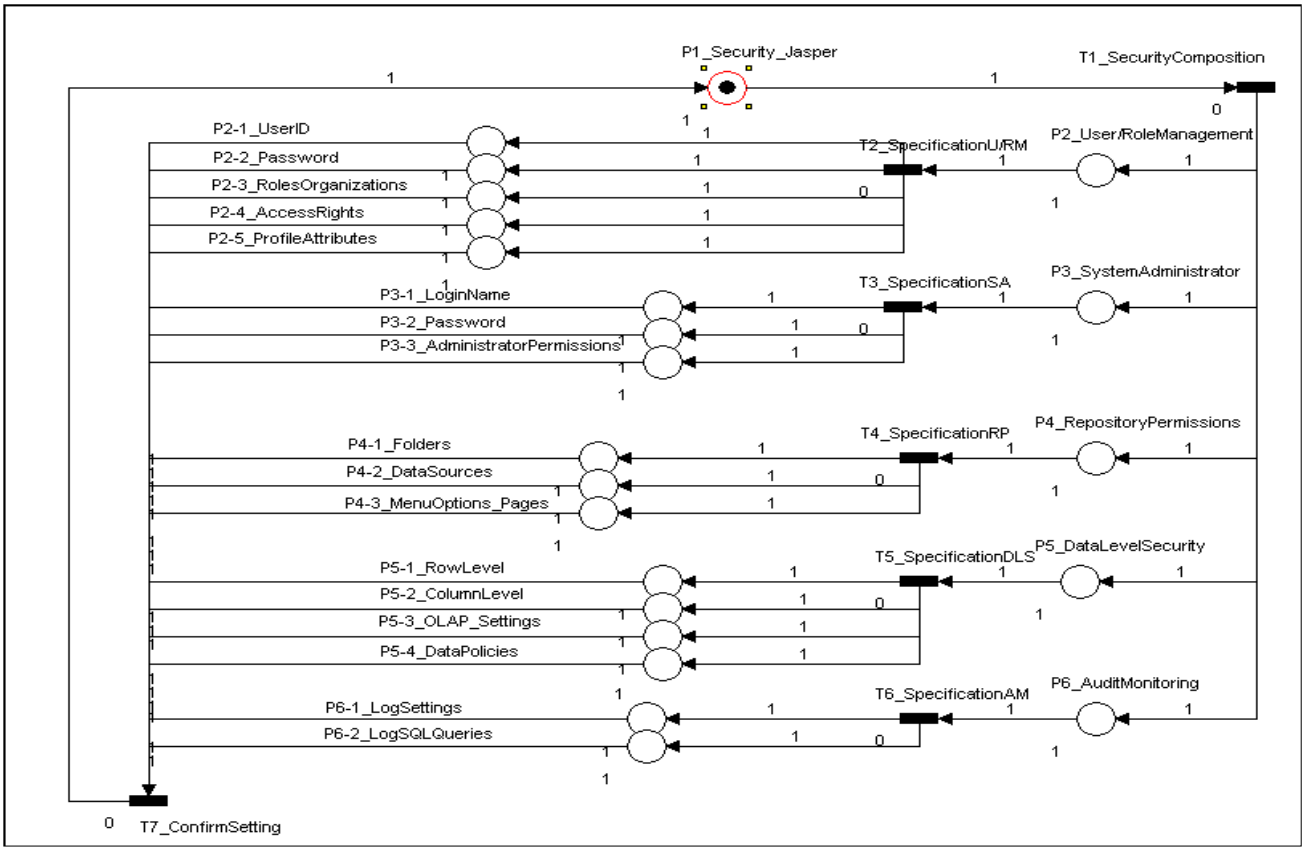

Figure 1: A model describing security layer in a BI product. (own source)

The specified places of the model are:
- P1 – interface of the Jaspersoft Suite.
- P2, P2-1, …, P2-5 – places are dedicated to user and role management (user identification and password, roles, access rights and profile attributes).
- P3, P3-1, …, P3-3 – places are dedicated to a system administrator (login name and password, administrator permissions).
- P4, P4-1, …, P4-3 – places are dedicated to repository permissions (on folders, data sources, and menu options with pages).
- P5, P5-1, …, P5-4 – places are dedicated to data level security (for rows, columns, OLAP and data policies).
- P6, P6-1, P6-2 – places are dedicated to audit and monitoring (log settings and log SQL queries).

The required transitions for the defined model are:
- T1 – available security services in BI product via menus and commands.
- T2, T3, T4, T5, T6 – transitions for detailed use of the specified security.
- T7 – transition enabling set-up and manipulation with the defined parameters and items via menus and commands, and also return to a standard interface.

The above-created model is a good point for specification default structure of security layer in BI product. It is apparent that security composition (BI_Sec) has been given the following relation:

$$BI\_Sec = (URM, SA, RP, DLS, AM) \quad (5)$$

where URM is dedicated to the user/role management area, SA specifies security for system administration, RP defines a way to restrict access via repository permissions, DLS is oriented on data level security, and AM are standard monitoring events in Jaspersoft Suite. These objects are created by the items for detailed specification via P2-i (for i=1-5), P3-j, P4-j, (for j=1-3), P5-k (for k=1-4), P6-l (for l=1-2):

$$URM = \sum_{i=1}^{5} P_{2-i}\ ,\ SA = \sum_{j=1}^{3} P_{3-j}\ , \quad (6)$$

$$RP = \sum_{j=1}^{3} P_{4-j}\ ,\ DLS = \sum_{k=1}^{4} P_{5-k}\ ,$$

$$AM = \sum_{l=1}^{2} P_{6-l}\ .$$

This simulation is used for easy specification of needed objects (5) with aim to solve the security layer in BI product. The question is about suitability of such a resolution. Perhaps the optimal resolution requests more or less specified objects (places or transitions) with respect to actual needs.

5 Solution Design Based on Inspiration from Nature

Nature offers many inspirations based on evolution. There are interested resolutions for support everyday activities. Such approach is visible for swarm intelligence. Swarm is adaptive via important role of feedbacks. The result is global self-organization.

Swarm is defined as swarm of individuals (ants, birds and fish). [43] Many analysts monitor and describe realized activities of swarms. Auto-organization of a swarm is based on pheromones. [38] The standard aim is to specify optimal route to food, but an individual animal has no knowledge about optimal resolution such situation. What is amazing that swarm defines the correct solution. [5]

For many IT designers, there are similarities and parallelisms between swarm domain and information technology, and available simulations can be designed based on principles from swarm intelligence.

For dynamic evaluation of objects in simulation design, pheromones are required as indicators of the best interest about the given solution. If simulation (S) is created by a given number of objects (O_i, for i=1, …, n), there are preference needed (in the role of pheromones) for every object. Consequently, simulation (S) needs the same number of preferences (PO_i, i=1, …, n) like it has objects (every object has its own preference as total priority of object). These total priorities of objects PO_i define the important objects in the simulation for given theme in the form of a number. This number is defined as the standard or weighted average based on practical preferences PP_{ij} (i=1, …, n; j=1, …, m) that are assigned based on required links and contexts. The optimal selection of the number of suitable practical preferences (m) is now important for every object O_i. The reason is the link to priorities from practice, IT development, and users.

The good starting point is created based on actual trends, professional knowledge and additional skills; therefore, practical preferences are created by standard professional matter (P_1), cooperation (P_2), presentation (P_3), management (P_4), analytical matter (P_5), creativity (P_6), multicultural needs (P_7), services (P_8), and contact with customer (P_9). For example, a question about the importance of a

UserID is very high for IT experts and users in security layer; therefore, the priority for standard professional matter is $P_1 = 1$. Similarly for the cooperation ($P_2 = 1$), presentation ($P_3 = 1$), services ($P_8 = 1$), and contact with customer ($P_9 = 1$). The reason is that UserID must support the needs of unique user identification for cooperation, presentation, services, and contact with customer. Other practical preferences are set to 0. The resulting number (total priority of object) is defined as the standard or weighted average from the assigned priorities. The following relation is defined for a standard average:

$$PO_i = \sum_{j=1}^{m} PP_{ij} \Big/ m \qquad (7)$$

where PO_i defines the total priority of the object O_i (i=1, …, n) based on practical preferences PP_{ij} (for j=1, …, m) with links to priorities in society, IT development, and users. For actual evaluation, a preference monitor is important based on contact with practice and IT experts.

The final simulation design is influenced by the valuation of available objects on the basis of the assigned number (total priority of object PO_i) like pheromones in a swarm. The designer defines initial values for practical preferences. The aim is to support interest about actual themes and needed objects and services.

Practical implementation of these ideas can be presented on the above-created simulation for a security layer in a BI product. There are defined objects such as UserID, Password, Roles Organizations, Access Rights, Profile Attributes, Login Name, Administrator Permissions, Folders, Data Sources, Menu Options Pages, Row Level, Column Level, OLAP settings, etc.
For effective evaluation of their meaningfulness, practical preferences are defined in the form of a number (0 defines any influence, 1 defines an assigned influence). All map-specified preferences are shown in the following Table 1:

Table 1: The evaluation of defined places with practical preferences for the specification of total priority

	Practical preferences									
Place name	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	Total priority
User ID	1	1	1	0	0	0	0	1	1	5
Password	1	1	0	1	1	0	1	1	1	7
Roles Organizations	1	1	0	1	1	1	1	1	1	8
Access Rights	1	0	0	1	0	1	1	0	0	4
Profile Attributes	1	0	0	1	0	0	0	0	0	2
Login Name	1	0	1	0	1	0	0	0	1	4
Password	1	1	0	1	1	0	1	1	1	7
Administrator Permissions	1	0	0	1	0	1	1	0	0	4
Folders	0	0	1	1	0	0	0	0	0	2
Data Sources	1	1	1	1	1	1	1	1	1	9
Menu Options Pages	0	0	1	0	0	1	0	1	0	3
Row Level	1	0	1	1	1	0	0	1	0	5
Column Level	1	0	1	1	1	0	0	1	0	5
OLAP Settings	1	0	1	1	1	1	1	1	1	8
Data Policies	1	0	1	1	1	0	1	1	1	7
Log Settings	1	0	1	1	1	0	0	1	0	5
Log SQL Queries	1	0	1	1	1	1	1	1	1	8

Based on such an approach, there are defined object features with links on their perception in optimal software development. The highest number (total priority) specifies an object that is very important for further development of software support; the smallest number (total priority) specifies an object that can be removed from the simulation. Specifically, objects such as Data Sources, OLAP Settings, etc. must be developed with links to modern trends. The objects such as Profile Attributes, Folders, Menu Options Pages, etc. can be removed without doubts about their indispensability.

Further work will focus on the detailed analysis of practical preferences PP_{ij} (i=1, …, n; j=1, …, m) for objects, and suitable implementation in simulation tools via standard settings of necessary properties for the realized designs. The question is regarding the needed number of such practical preferences and methods for their actualization. For a suitable link to practice, it would be appropriate to suggest an ability of global cooperation for better evaluation by analysts and designers. They can change the initial priority from their own experience.

6 Conclusion

Software developers, testers, and users have a number of applications and tools for better implementation of IT products in practice. Unfortunately, practical experiences of IT users are not always positive. The global society has high requirements on information and communication technologies. The current topic is still oriented on optimal information; therefore, there is difficulty in volume, variety, and velocity. Communication and cooperation with links to the actual benefit of implemented IT products is important for optimal software development.

Positive helpers for solving existing problems are effective innovations based on simulations with links on Petri Nets. Simulations create models for better description of a given reality. Another benefit is the ability to compare different solutions with the aim to select the best resolution for practice with the support of common relations.

A good method brings the dynamic evaluation of objects in simulation based on defined preferences like pheromones from swarm intelligence. So there are other properties of the objects in simulation. Important and needed objects have high score. The reason is the fact that some IT users, analyst, or designers prefer diverse context. Such approach supports optimal interest about needed IT support with links on suitable services and knowledge.

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