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The aim and scope of the Journal of Information Technology and Applications (JITA) is:

- to provide international dissemination of contributions in field of Information Technology,
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JITA provides a medium for exchanging research results and achievements accomplished by the scientific community from academia and industry.

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Contents

Dear Reader,

Welcome to first issue, volume 1, of Journal of Information Technology and Application (JITA)!

The Journal of Information Technology and Application publishes peer-reviewed original articles dealing with some aspects of Information Technology, including theory and practice, original papers that contribute to the methodology of IT research as well as good examples of practical applications.

Submissions may include full-length research articles, short presentations, the analysis, reports on IT studies, and case studies of new and innovative solutions of practical application.

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We accept that writing a paper for scientific journal is not an easy task because of the rigour demanded, what we ourselves have experienced.

To a large extent, we had the help and support of our publisher, PanEuropean University APEIRON (Banja Luka, Republic of Srpska, Bosnia and Herzegovina), as it was crucial for the publication of this issue.

We will endeavor to ensure the reputation and quality of journal with each issue.

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Applications of Smartphones for Ubiquitous Health Monitoring and Wellbeing Management

Mladen Milošević, Michael T. Shrove, Emil Jovanov

Electrical and Computer Engineering Department
University of Alabama in Huntsville
Huntsville, AL 35899, U.S.A.

Contribution of state of art
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Abstract: Advances in smartphone technology and data communications facilitate the use of ubiquitous health monitoring and mobile health application as a solution of choice for the overwhelming problems of the healthcare system. In addition to easier management and seamless access to historical records, ubiquitous technology has the potential to motivate users to take an active role and manage their own conditions.

In this paper we present capabilities of the current generation of smartphones and possible applications for ubiquitous health monitoring and wellness management. We describe the architecture and organization of ubiquitous health monitoring systems, Body Sensor Networks, and integration of wearable and environmental sensors. We also describe mainstream mobile health related applications in today's mobile marketplaces such as Apple App Store and Google Android Marketplace. Finally, we present the development of UAHealth - our integrated mobile health monitoring system for wellness management, designed to monitor physical activity, weight, and heart activity.

Keywords: Smartphone, Body Sensor Networks, Health, Wellbeing.

Introduction

Information and communications technologies are transforming our social interactions, our lifestyles, and our workplaces. One of the most promising applications of information technology is healthcare and wellness management. Healthcare is moving from reactive response to acute conditions to proactive approach, characterized by early detection of conditions, prevention, and long-term healthcare management. Current trend places emphasis on the management of wellness and acknowledges the role of home, family, and community as significant contributors to individual health and wellbeing. This is particularly important in developed countries with a significant aging population, where information technology can significantly improve management of chronic conditions and improve quality of life. Demographic trends indicate two significant phenomena: an aging population due to increased life expectancy and a baby boomer peak. Life expectancy has significantly increased from 49 years in 1901 to 77.9 years in 2007. According to the U.S. Census Bureau, the number of elderly individuals over age 65 is expected to double from 35 million to nearly 70 million by 2025, which is when the youngest baby boomers retire. This trend is global, so the worldwide population over age 65 is expected to more than double from 357 million in 1990 to 761 million in 2025. These statistics underscore the need for more scalable and affordable health care solutions. To counter these trends, the Medical Technology Policy Committee of the IEEE USA believes: "Appropriate adoption of existing and emerging technology can improve the efficiency and quality of health care delivery, restrain cost increases and, perhaps most importantly,

improve the quality of life for our aging population" [13].

With advantages in technology and data communications, ubiquitous healthcare systems such as mobile health applications are becoming the quickest solution to the overwhelming problem of the healthcare system issues [19][5][6]. In addition to easier management and seamless access to historical records, ubiquitous technology has the potential to motivate users to take an active role and manage their own conditions. This is particularly important for the management of chronic conditions.

Electronic medical records allow personalization of services and collection of large database of records. Personalized systems will take advantage of data mining, decision support software systems, and context aware systems to facilitate diagnosis, treatment, and care based on an individual's genetic makeup and lifestyle[19][26].

In this paper we present capabilities of the current generation of smartphones and possible applications for ubiquitous health monitoring and wellness management. We describe architecture and organization of ubiquitous health monitoring systems, typical applications, and the development of our iPhone application *UAHealth* for health monitoring and management.

UBIQUITOUS HEALTH MONITORING

Wearable health monitoring systems integrated into a ubiquitous mobile health system (mHealth), emerged as a technology of choice for ambulatory monitoring [27][28]. This approach facilitates continuous monitoring as a part of a diagnostic procedure, optimal maintenance of a chronic condition, or computer assisted rehabilitation. Traditionally, personal medical monitoring systems, such as Holter monitors, have been used only to collect data for off-line processing. Ubiquitous

FIGURE 1. SYSTEM ARCHITECTURE OF THE UBIQUITOUS HEALTH MONITORING SYSTEM

connectivity allows real-time processing and communication; it also facilitates warnings, computer assisted rehabilitation, and continuous health monitoring.

Important limitations for wider acceptance of the existing systems for continuous monitoring are the following: a) unwieldy wires between sensors and a processing unit, b) lack of system integration of individual sensors, c) interference on shared wireless communication channels, and d) nonexistent support for massive data collection and knowledge discovery. Wireless Body Area Networks of intelligent sensors [19] provide a solution for unobtrusive continuous ambulatory monitoring. Typical system architecture of the ubiquitous health monitoring system is presented in Figure 1. A set of on or in-body sensors monitor a person's physical activity and physiological signals. Sensors are controlled and communicate with the personal server that integrates information from individual sensors and communicate with *mHealth* system [18][20]. *mHealth* is defined as "mobile computing, medical sensor, and communications technologies for health-care" and has the potential to revolutionize health care by allowing inexpensive, non-invasive, continuous ambulatory health monitoring with near real-time updates of electronic medical records via the Internet.

mHealth systems can be used for diverse, unobtrusive monitoring:

- postoperative monitoring of patients;
- monitoring of patients with chronic diseases;
- social networking of relatives and peers for monitoring of elderly;
- lifestyle and general well-being monitoring (e.g., to deal with obesity);
- wellness and exercise monitoring;
- monitoring vitals and status of soldiers and firefighters;
- emergency medical care and mass casualty events;
- computer-assisted rehabilitation and therapy; and
- development of new emergency services with prolonged monitoring.

Body Sensor Networks

Technological advances in low-power integrated circuits, wireless communications, energy scavenging and storage have enabled the design of Body Area Networks (BANs), also known as Body Sensor Networks. Body area networks integrate low-cost, lightweight, intelligent sensors and networking platforms. BANs connect nodes attached to the body surface, implanted into body, or dispersed in clothing. The nodes have sensors for vital sign monitoring (through ECG, SpO2, blood pressure and similar sensors) and motion monitoring (through accelerometers, gyroscopes and similar sensors).

Emergence of the new generation of wearable sensors is particularly evident in cardiac monitoring. Several systems are commercially available, such as iRhythm [17], Corventis [8], Cardionet [7], and Toumaz [28]. Highly integrated systems, such as Sensium by Toumaz, provide both physiological monitoring and activity monitoring on a single, low-power small patch [31]. Wearable systems may integrate several sensors embedded in clothes [6][21] or using smart textiles [9] [23][32]. Capacitive sensing and smart clothes promise an increased level of user's convenience and comfort. Wireless communication within Body Area Network (BAN) or Body Sensor Network (BSN) significantly improves user's convenience and allows integration of implanted sensors, such as pacemakers and future generations of blood glucose monitors. Wireless communication standards commonly used in BANs are Bluetooth (IEEE 802.15.1), Zigbee (IEEE 802.15.4 with additional specification of network, security, and application layers on top of the official standard), and ANT. All standards are working on 2.4 GHz (although some Zigbee versions are working on 915 MHz and 868 MHz) with the typical data rate of 1-3 Mbit/s for Bluetooth, 250 Kbit/s for Zigbee, and 1Mbit/s for ANT. There are also other alternative technologies for wireless communication in BAN, such as custom wireless radios, the medical implant communication service (MICS), and ultra wideband (UWB).

Environmental Sensors and Context Awareness

Context represents any information that can be used to describe the state of a person, place, or physical object. Context awareness represents the system's

ability to detect a user's state. Context-awareness in BAN describes the ability of a system to sense user's state and the environment, and modify its behavior based on this information [22].

Traditionally, the knowledge of the context of the user is acquired through self-reporting. This method is both time consuming and unreliable, especially for the elderly. Current technology provides context awareness, such as GPS location, light, noise level, position, activity, proximity, social interaction, and connectivity. Context recognition can be formulated as a general pattern recognition process which consists of data acquisition, feature extraction, model construction and inference, and performance evaluation [32].

Due to great diversity of context aware environments, the range of physiological conditions, and the dynamic nature of BSNs themselves, there are many challenges for context-aware sensing. The common issues are overcoming sensor noise, node failure, integration of multi-sensory data, providing long continuous usage, smooth context recognition, and selecting relevant data in BSN [22].

SMARTPHONES

First generations of ubiquitous systems used wearable computers that were worn on the body or integrated into clothes. However, the need for ubiquitous connectivity and integration of multiple devices on a single platform created the need for smartphones as a single universal platform. Mass market created a push for ever increasing performance of smartphones, where recent smartphones use high performance embedded processors. As an example, Motorola Atrix 4G uses the following:

- 1GHz dual core Nvidia's Tegra 2 processor
- Display 4.0-in. (960 x 540)
- Sensors: Acc, GPS, Proximity, and ambient light sensors
- WiFi 802.11 a,b,g, and n.

Smartphone market exceeded 100 million units in Q4 2010. Typical contemporary smartphones and operating systems are presented in Fig. 2 and Table 1.

In today's ever-increasing use of mobile phones and mobile applications, users expect to have their favorite desktop applications on smartphones. In addition, a number of new applications are taking advantage of the specific features and sensors on smartphones. Smartphone manufacturers introduced a major shift in the application distribution by creating application stores. Apple introduced the concept as the App Store in July 2008. Many applications offered free light versions with limited functionality, and reasonably priced fully functional versions. In September 2009, the App Store had over 2 billion downloads, with more than 100,000 applications available [19]. In January 2011, the App Store had over 10 billion downloads, with more than 300,000 applications available.

FIGURE 2. CONTEMPORARY SMARTPHONES AND OPERATING SYSTEMS, FROM LEFT TO RIGHT: HTC EVO 4G (ANDROID), IPHONE 4 (IOS), BLACKBERRY TORCH (RIM OS), NOKIA C6 (SYMBIAN), AND HTC 7 TROPHY (WINDOWS PHONE 7).

Table 1. Smartphone Operating Systems and Languages [19]

OS	Symbian	RIM BlackBerry	Apple iPhone	Windows Mobile	Google Android	Palm webOS
Language	C++	Java	Objective-C	C#	Java	Javascript

Current statistics of applications in the App store are the following [3]:

- Total Active Apps (currently available for download): 362,306
- Total Apps Seen in US App Store: 439,458
- Number of Active Publishers in the US App Store: 75,358
- Current Average App Price: $4.15
- Current Average Game Price: $1.06
- Current Average Overall Price: $2.46

The revolution introduced by the Apple App Store was quickly followed by others. For example, Google opened Android Market in October 2008. In December 2009, there were over 20,000 applications available, and by the end of 2010 the Android market had over 200,000 applications available and over 2.5 billion downloads.

However, applications that once had to run on full size desktop computers now can run on mobile devices with similar performance. This makes for a challenging task for developers. Not only do yesterday's apps have to run on a smartphones but also have to fit on a smaller screen and run on fewer resources and limited power budget. That is why it is critical that smartphone developers carefully plan application design, not only program organization but also the user interfaces. Most of the smartphone operating system developers, such as Apple, Google, and Microsoft deliver guideline documents to help with the design of the application [4][14][25]. All of these guidelines have three things in common:

- keep the application responsive,
- keep the application consistent with the platform, and
- design for the platform.

If these guidelines are not followed, especially in medical applications, the user experiences problems and frustrations when using the application. As a result, the user may either stop using the application or cause vitals to increase because of the frustrating experience, which defeats the purpose of the application. If doctors can not determine or read vitals because the user stops using the application, they can not treat the patient or may even miss an event that might have been important to the patient's diagnosis. Moreover, the people that need to be monitored are often elderly patients, not familiar with modern technologies. This means that medical smartphone applications have to be intuitive enough for elderly patients to increase compliance and everyday use.

Smartphones are designed to be used anytime, anywhere. Wide area connectivity using a cell phone network provides opportunities for immediate upload of health-critical information and events to medical provider or specialized service. In addition, location capabilities implemented through integrated GPS or cell phone network localization can provide information about the current location of the person in need. As an example, the system can detect epileptic attack and send that information together with the location of the user to the monitoring center.

Another important function of health monitoring systems is prolonged monitoring. Available memory allows smartphones to store physiological data for days and months at the time, even in the case of limited Internet connectivity. Once connection is reestablished, all locally stored data may be uploaded to the medical server.

Smartphone Applications for Health Monitoring

With the recent explosion of smartphone application marketplaces and the increase in smartphone performance, a number of health monitoring and wellness applications also increased. As an example, in a six month time span from February to August 2010 the number of health related applications between Google Android Marketplace and the Apple App Store increased for more than 3,600 newly cre-

ated applications [11]. At this moment there are over 8,600 health related applications only on Apple App Store [3].

All of these applications can be divided into three main categories:

- Medical Reference
- Hospital Workflow Management
- Health and Wellness Management

Medical reference applications help medical professionals and other users in finding information related to a broad spectrum of medical topics, such as anesthesiology, cardiology, and dermatology. Typical example of a medical reference application is *Netter's Atlas of Human Anatomy* on the Android platform. This application provides detailed information and graphical illustrations of the human anatomy [16].

Hospital workflow management applications assist medical professionals in their everyday activities. Medical professionals can remotely access patients' historical health records, their current vitals, or use it for pharmaceutical calculations. Airstrip Technologies has developed a hospital workflow management iPhone application, *AirStrip Patient Monitoring*, for real time and historical access of patients' physiological data [1].

Most of health related smartphone applications are dedicated to health and wellness management. Such applications include prenatal & infant care, cardio fitness, diet, medication adherence, women's health, strength training, stress, smoking cessation, sleep, mental health, and chronic disease management. Applications as *Wellness diary* are designed to support users in learning about their behavior, and both making and maintaining behavior changes. [24]

FIGURE 3. SYSTEM ARCHITECTURE OF THE UAHEALTH

Applications for physiological monitoring can use internal sensors in smartphone like camera, accelerometer, GPS, or they can use external sensors like chest belts, footpods, or similar sensors. The majority of physiological monitoring applications provide support for heart monitoring. A typical example of a health monitoring application that uses the iPhone's internal sensors for physiological monitoring is *Heart fitness*. This application uses iPhone camera and iPhone's built-in flash light to process reflection from user's fingertip in order to detect heart beats. During measurement the instantaneous heart rate is monitored in beats per minute (BPM) and the physiological photoplethysmographic (PPG) signal is also displayed [15].

Increasing number of sensors is available as low-cost off-the-shelf sensors, and some applications provide support for integration of measurements from a variety of sensors. The DigiFit iPhone suite of applications uses external sensors for physiological and activity monitoring via the ANT+ wireless standard. They provide applications for heart and physical activity, but users are limited to only one physiological signal monitoring at a time [10].

mUAHealth – Personalized Health and Wellness iPhone Application

UAHealth is an integrated mobile health monitoring system designed to monitor physical activity, weight, and heart activity. Most of the existing applications on the market monitor only a single parameter where our system can monitor multiple signals at a time. System architecture of the UAHealth is presented in Figure 3.

The mobile *UAHealth* application (*mUAHealth*) is developed for iPhone. The application communicates with a set of sensors in a wireless body area network (WBAN) to collect information about physical activity and physiological signals. Our WBAN uses low power ANT+ wireless standard with commercially available off-the-shelf sensors, such as Garmin [12] and Suunto [29] chest belts. Since ANT+ is not supported on iPhone, we use Wahoo Fisica Key ANT+ transceiver adapter for iPhone [30]. Collected data is uploaded to the personal health record on a server. Personal medical records on the server can be accessed by the user, medical professionals, or other individuals approved by the user.

mUAHealth was designed to have an intuitive user interface, navigation, and seamless integration of sensors. The user interface was designed keeping in mind the iOS Human Interface Guidelines [4]. When developing *mUAHealth* we tried to automate the most frequently used functions to improve user experience. The system has to provide simple and intuitive presentation of the common parameters in two different formats: smartphone interface for user and remote desktop interface used by a physician. Typical screenshots of *mUAHealth* for heart rate monitoring, heart rate trend and weight are presented in Figures 4, 5, and 6.

Figure 4. mUAHealth – Heart rate monitoring

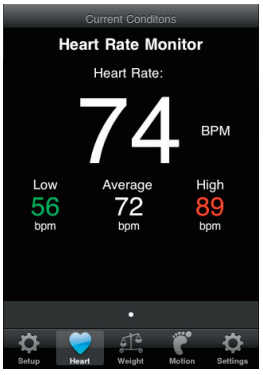
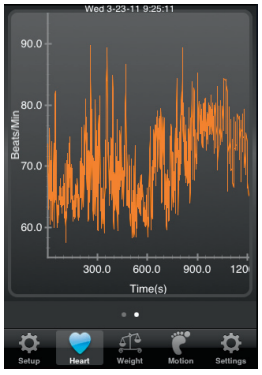


Figure 5. mUAHealth – Heart rate plot



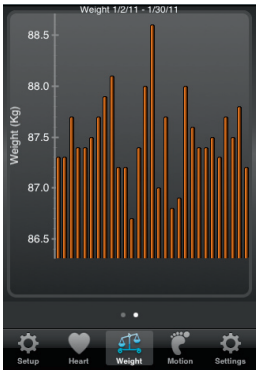


Figure 6. mUAHealth – Weight plot

Ubiquitous monitoring systems have to adapt to intermittent communication. Therefore *mUAHealth* is designed to work both online and offline. Users do not always exercise or perform daily activities near an Internet connection. Consequently, *mUAHealth* monitors Internet connectivity to determine when to submit health related information to the remote

medical server. That is why it is essential for smartphone medical applications to have a local and remote database.

Discussion and Conclusion

Smartphones integrate processing and communication capabilities of the recent generation of workstations into a small and wearable form, creating a revolution in the number of fields and applications. The most promising applications of smartphones are health monitoring and wellness management.

Continuous monitoring and real-time, customized feedback on health and behavior will increasingly rely on remote and networked sensors and actuators, mobile platforms, novel interactive displays, and advances in computing and networking infrastructure. Data collected by sensors at point of care or labs needs to be anonymized and aggregated for community-wide health awareness and maintenance. Such data, especially collected over populations, can lead to inferences about best practices and cost savings in providing health services.

In this paper we present the capabilities of smartphone technology for ubiquitous health monitoring, typical applications, and development of our new ubiquitous health monitoring system *UAHealth* that integrates most common functions for ubiquitous health monitoring and wellness management. This is a very promising field with exponentially increasing number of sensors and opportunities in the marketplace that has the potential to significantly change healthcare system and make it more efficient.

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A MULTIMODAL APPROACH TO DESIGN OF AIRCRAFT COCKPIT DISPLAYS

Mlađan Jovanović[1], Dušan Starčević[2], Mirko Petrović[3]

Faculty of Organizational Sciences, University of Belgrade

[1]mladjan@rcub.bg.ac.rs

[2]starcev@fon.bg.ac.rs

[3]mirkop@fon.bg.ac.rs

Contribution of state of art

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Abstract: In this paper, we present an approach to design of command tables in aircraft cockpits. To date, there is no common standard for designing this kind of command tables. Command tables impose high load on human visual senses for displaying flight information such as altitude, attitude, vertical speed, airspeed, heading and engine power. Heavy visual workload and physical conditions significantly influence cognitive processes of an operator in an aircraft cockpit. Proposed solution formalizes the design process describing instruments in terms of estimated effects they produce on flight operators. In this way, we can predict effects and constraints of particular type of flight instrument and avoid unexpected effects early in the design process.

Keywords: Aircraft cockpit, multimodal user interfaces, aircraft instrument, formal description of cockpit display.

INTRODUCTION

Today's modern aircraft operators rely on vast amount of data that has to be presented in real-time. The meaning of this data is difficult to asses in its raw format. Therefore, we need sophisticated methods to interpret and present data to the user in a suitable format [8]. There is also a need for a data visualization platform that can distribute flight data to a variety of animated graphical displays for easy interpretation by the aircraft operator. Large amounts of airflow velocity data presented in real-time cause numerous effects on human sensory and perceptual apparatus. In situations where the operator must react in a limited period of time and avoid hazardous situations, it is very important to present flight data in a form that can be easily interpreted and processed having in mind user's abilities and preferences. This paper addresses the problem of adapting immense amount of visualization data to the operator in an aircraft cockpit based on the ideas from the multimodal human-computer interaction [11] [12].

This paper is structured as follows. In next section, an overview of the research field and some existing solutions is given. Then, we discuss basic concepts of multimodal systems from the point of our interests. After that, we describe the proposed approach, where we present formal description technique based on the existing metamodel of multimodal human-computer interaction. In Section 4, we demonstrate our solution giving the case study example of Unmanned Aerial Vehicle's (UAV) visual instrument that we have developed. Finally, we give short discussion and conclusions.

BACKGROUND

In our approach, we are reusing ideas from multimodal user interfaces, and applying them in the designing of aircraft cockpit displays. In this section, we give an overview of these two fields, emphasizing their similarities.

Problem Background

Over the last few decades, the continuous global growth of air traffic has led to increasing problems with respect to airspace capacity and delays [17]. This situation has initiated the research for new operational concepts and aircraft systems that aim for more independent aircraft systems in order to probe the human factors of pilots when operating in aircraft cockpit. Key aspects of this research include modeling interaction in complex time-critical environments like aircraft cockpit and providing timely context-sensitive information in real time without overloading or distracting the human operator [5]. In aircrafts, human-machine interaction is the key issue in providing situational awareness and maintaining safety. The operator functions as an observer who monitors display's information from the flight computer, pays attention to the environment and concentrates on communication tasks. To facilitate the amount of work and tasks he or she has to accomplish, the aircraft becomes more and more computerized. However, the displays in the cockpit of an aircraft can be quite complex and have to function in a harsh visual environment that may strongly affect the quality of the displayed information. Numerous reports and studies clarify specific fields of research such as situation awareness [4], tactile sensation [10], color patterns [3] and so forth. Major drawback of existing solutions is a lack of operational feedback regarding human performances connected with audio, visual and haptic cues in highly interactive environments such as aircraft cockpit.

If we consider interfaces developed in the field of highly interactive (also called post-WIMP) applications, the dynamicity of interaction objects in terms of existence, reactivity and interrelations appears as a new characteristic [6]. These interfaces may include new interactors such as graphical representations of aircrafts at any time during the use of application. Even though this kind of problem is, by programming languages, handled easily, it is hard to master it in terms of models. This is why classical formal description techniques have to be improved in order to be able to describe highly interactive environment in a complete and unambiguous way. The reason for deployment of formal description techniques lies in the fact that they are means for modeling all components of an interactive system (presentation, dialogue and functional module). Besides, they are usually applied to early phases of development process and clarify their limits when it comes to evaluation.

Multimodal Human-Computer Interaction

Multimodal systems represent a research-level paradigm shift from conventional WIMP interfaces toward providing users with greater expressive power, naturalness, flexibility and portability [13]. Multimodal research focuses on human perceptual channels [16]. User communicates with the system through set of communication channels which use different modalities, such as visual display, audio, and tactile feedback, to engage human perceptual, cognitive, and communication skills in understanding what is being presented. Multimodal systems integrate various modalities simultaneously, sequentially or independently, and they are defined by multimodal integration patterns [14].

Various systems offering multimodal interaction techniques have been provided since the early work Bolt in early 80's [1]. Although some real systems have been presented, development process of multimodal interactive systems remains difficult task usually carried out by an ad hoc process.

Previous study on multimodal interaction [8] has shown that multimodal interaction presents several advantages:

Multimodality increases the overall efficiency of interaction. Task-critical errors decrease during multimodal interaction. This advantage justifies the use of multimodal techniques in highly interactive environments (for instance aircraft cockpit).

Flexibility of a multimodal interface can accommodate a wide range of users, tasks and environments-including users who are temporarily or permanently handicapped and usage in adverse surroundings (aircraft cockpit, for example).

Users have a strong preference to interact multimodally. This preference is most pronounced in spa-

tial domain systems when describing spatial information about location, number, orientation or shape of an object.

Multimodality provides greater naturalness and flexibility of interaction that facilitates learning process. This can be very useful for the flight simulator training.

We find multimodal interaction techniques very useful for designing user interfaces in an aircraft cockpit from the point of quantity (they can increase the bandwidth between user and system) and quality (extracting and adapting content according to user abilities and preferences).

For all these reasons, multimodal human-computer interaction appears to be very useful in the field of interactive systems. It permits enhancing human-computer interaction in these systems, but formal description technique is needed to describe entire multimodal interactive system in a way that can be incorporated in current software development practices.

PROPOSED SOLUTION

In this section, we describe how we model aircraft cockpit displays as a multimodal interface. We begin with an overview of the vocabulary of modeling primitives. Then we define basic steps for describing aircraft displays as complex modalities, and describe how these models can be used in evaluating human performances. In the following section, we give a concrete example of a formal description of a visual instrument as a complex modality.

Metamodel of Sensory, Motor, Perceptual and Cognitive Effects

The engineering of multimodal systems introduces additional complexity to the development of interactive software systems, which is rarely addressed by current software development methodologies. For example, the UML Unified Software Development Process [7] devotes only a short paragraph to the design of the user interface. For describing multimodal interfaces we use set of modeling primitives defined by the semantic metamodel of multimodal interaction which has been previously developed [11].

The main concept of the metamodel is a HCI modality, which is described as a form of interaction designed to engage some of human capabilities, e.g. to produce some effects on users. A HCI modality can be simple or complex. A complex modality integrates other modalities to create simultaneous

TABLE 1. CLASSIFICATION OF SENSORY, PERCEPTUAL, MOTOR AND COGNITIVE CONCEPTS

Classification	Concepts
Sensory	Stimulus: light, sound, vibration
	Sensory excitation
	Sensory processing: color, sharpness, peripheral vision
Perceptual	Pattern recognition
	Grouping: similarity, proximity, or voice color or timber
	Highlighting : color, polarity, or intensity
	3D cue such as stereo vision or interaural time difference
	Illusion
Motor	Movement: translation or rotation
	Force: pressure or twisting
	Hand or head movement
	Degree of freedom
Cognitive	Short- or long-term memory and memory processes such as remembering forgeting
	Attention: focus and context
	Reasoning: deductive, inductive, and abductive
	Problem solving: Gestalt, problem space, and analogical mapping
	Analogy
	Skill acquisition: skill level, proceduralization, and generalization
	Linguistics: speech, listening, reading, and writing

use of them, while a simple modality represents a primitive form of interaction. Simple HCI modality can be input or output, using the computer as a reference point. Input and output modalities are not symmetric with human input and output modalities because they represent a computer viewpoint, where it is computer code, not neural circuity that controls interaction with users. Each modality engages some of human capabilities, e.g. it produces some effects on the user. Effects are classified in four main categories: sensory, perceptual, motor, and cognitive (Table 1).

Sensory effects describe processing stimuli performed by human sensory apparatus. Perceptual effects are more complex effects that human perceptual systems get by analyzing data received from sensors. Motor effects describe human mechanical action, such as head movement or pressure. Cognitive effects describe effects that take place at a higher level of human information processing, such as memory processes, attention, and curiosity. Furthermore, effects are often interconnected. For example, all perceptual effects are a consequence of sensory effects. These relations among effects are important because in this way a designer can see what side effects will be caused by his intention to use some effects.

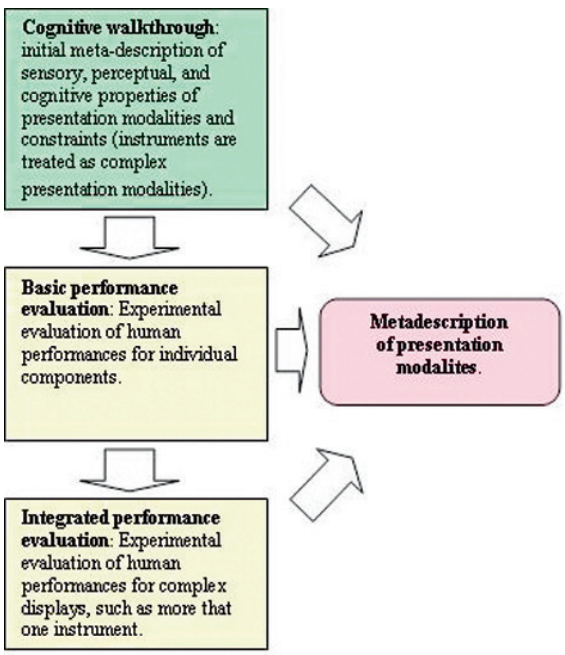
Proposed Approach

Our approach is inspired by the model-driven development, where software development's primary focus and products are models rather than computer programs. In this way, it is possible to use concepts that are much less bound to underlying implementation technology and are much closer to the problem domain [15].

In the design of the instrument table, we have classified instrument types by analogy with modalities as basic or complex. Basic instrument tracks simple parameter values and changes and engages a specific human sense. According to the type of human sensory system it excites, basic instrument can be visual, audio or haptic. Each basic instrument consists of an instrument scale, instrument pointer, instrument zone, and scale marker. Complex instrument integrates other instruments combining information aimed at specific human sensory apparatus into complex and uniform excitation event.

Each individual instrument engages some human capabilities. Communication channel established between the human and system is parameterized by effects produced on the user. By classifying instruments into categories, we can have an insight into specific effects produced by them, which enables predicting effects conducted in complex instruments where various types of signals interfere and integrate. Next step is connecting estimated effects with cockpit environment characteristics and operator abilities that increase or decrease them. In this way, we can treat each instrument as a presentation modality having some inherit sensory, perceptual or cognitive qualities. Thus, a concrete instance of some instrument will add or change some qualities according to user abilities and preferences, for example, by choosing color scheme or shape pattern that can introduce some analogy. Upon these instrument descriptions, experimental evaluation of human performances for individual and complex components is done in order to conclude the metadescription of the presentation modalities as shown in Figure 1. Given the metadescriptions of the presentation mo-

Fig. 1. Proposed design process.



dalities, each instrument is considered as an instance of defined metamodels.

Mapping between instruments and effects can serve several purposes. It provides context where we could perceive many relations that are not always obvious. Predicting effects that an instrument causes on humans and connecting these effects with descriptions of limiting environment characteristics gives an opportunity to avoid some undesired situations which can occur (for example, increasing visual workload during instrument scan). Finally, information channels between users (pilot/operator) and device (the aircraft) are described in a uniform and an unambiguous way.

DESIGN CASE STUDY: A VISUAL INSTRUMENT

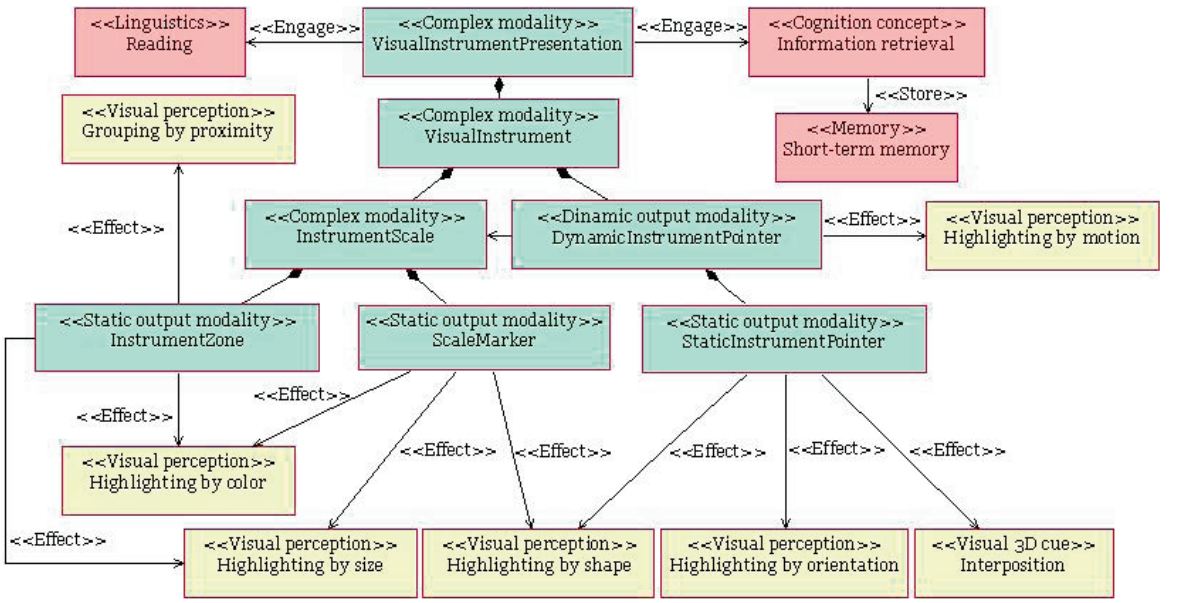
We have applied our approach in designing virtual cockpit for close-range Unmanned Aerial Vehicles (UAV). Requirements for human-computer interface developed are as stated [9]:

- Ergonomic Goal. In order to minimize physical fatigue, the system has to form and fit a human body and to give comfortable environment (temperature and lighting).
- Cognitive Goal. In order to decrease cognitive fatigue, the system should use analog versus digital displays. Placement and font of text and appropriate symbol shapes and colors should minimize scan time.
- Response Goal. This concerns minimizing UAV response time and is achieved by underlying implementation technology.

To realize these three goals we have applied proposed approach. Figure 2 is a UML class diagram, created with defined UML extensions [11], describing the effects of a visual instrument as a complex presentation modality. These effects are used as a basis for achieving our ergonomic, cognitive and response goals. An instrument's basic presentation modality is an instrument pointer that presents the current value of tracked parameter. A *DynamicInstrumentPointer* is modeled as a dynamic output modality animating presentation of the *StaticInstrumentPointer*. Instrument pointers introduce several perceptual effects: it is recognizable by its shape; orientation denotes its current position; and interposition highlights pointer from instrument scale ticks. By smoothly animating positions of the pointer, a *DynamicInstrumentPointer* gives a notion of motion. An *InstrumentScale* defines global extent in which parameter value can change. Scale is presented to the user as a set of *ScaleMarkers* described as static output modalities. Scale markers add perceptual effects of highlighting by shape, size and color. To distinguish between normal and critical extents of parameter values, an *InstrumentScale*

CORRECT SPELLING DYNAMIC

FIG. 2. VISUAL INSTRUMENT DEPICTED IN TERMS OF EFFECTS



consists of several *InstrumentZones*, also described as static presentation modalities. Each zone defines local extent in which parameter's value varies. Zones distinguish themselves by introducing perceptual effects of highlighting by color and shape, and grouping proximate of visual indicator for parameter values. A *VisualInstrument* presents complex modality integrating *InstrumentScales* and *DynamicInstrumentPointers*. A set of visual instruments represents multimodality *VisualInstrumentPresentation* which engages human cognitive functions of reading and information retrieval.

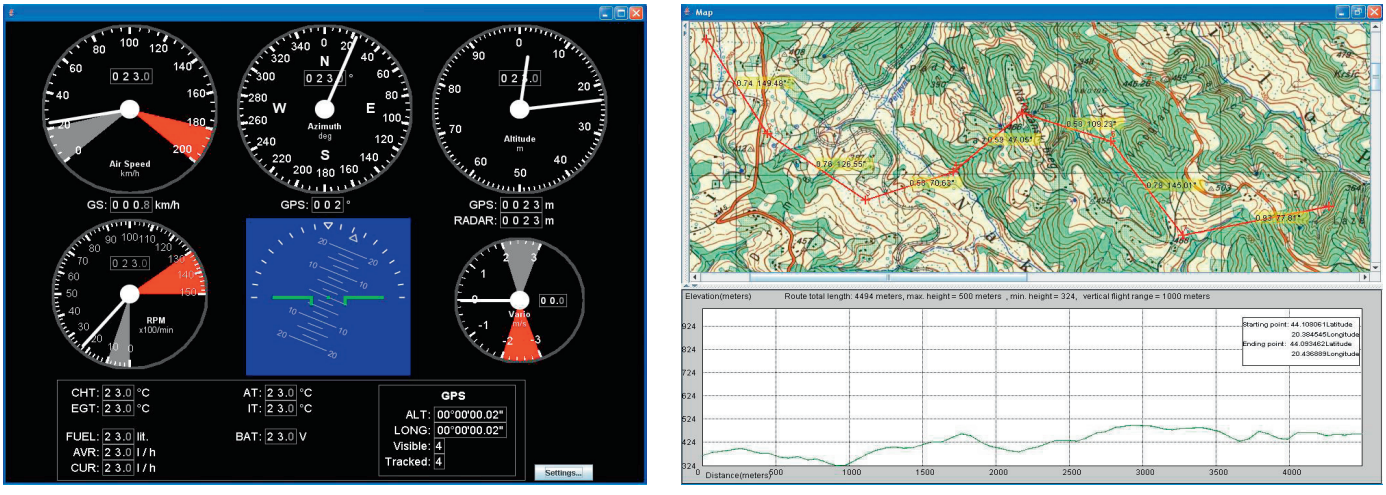
Figure 3 shows instrument table developed upon given metadescriptions. These metadescriptions are most useful in cognitive walkthrough phase, as we have noticed that most of the designers and programmers are not aware of the huge number of parameters that presentation effects introduce by every part of user interface. Presented display operates in a way that represents an operator's intuitive understanding. Controls that have different functions are distinguishable from one another in order to clearly assess flight status data. Instruments and controls with related functions are grouped together in a logical arrangement, which helps reduce instrument scan time and lowers operator's workload.

Discussion

The presented work can serve several purposes. First, we demonstrated the ability to predict effects that certain type of instrument produces on humans. Proposed instrument classification connected with the metamodel of multimodal communication gives us predictive and explanatory approach for describing complex effect notions in an aircraft cockpit and connecting them with user and device profiles. Describing a cockpit in a common language, we facilitate more effective user interfaces. Designing displays and information flow at a higher level of abstraction enables predicting undesirable effects that can appear early in the design and reduces information overload. What is more important it reduces interdisciplinary gap among designers and allows integration of results from various fields of research. For example, multimodal research techniques introduce results that have been used as a basis for a measurement and enhancement of situational awareness [2]. Metadescriptions of instruments as presentation modalities with some sensory, perceptual and cognitive qualities permit experimental evaluation of human performances for complex displays from which users can clearly benefit. Evaluation results allow seeing if concrete aircraft display suits user's abilities and preferences.

Proposed approach describes all effects introduced by the instrument table. However, for more detailed analysis, it is useful to include a notion of a visual scan, which is currently partially addressed by our approach. Visual scan considers a sequence of monitoring tasks associated with flight status. Scan characteristics (where to look, how frequently

Fig. 3. Instrument table as instance of complex modality (A), and the window showing aircraft mission route (B).



(A) (B)

and how long) are currently determined by the complexity of the information provided by devices and level of operator's expertise. Operator/pilot forms a mental model as a comprehensive understanding of a system and its dynamics. However, mental models are refined with experience, so less experienced operator can employ random scan that is not sensitive to the changing needs for information from one moment to the next. Experienced pilots often feel uncomfortable when transitioning to a new aircraft because of a conflict between their mental model and arrangement of instruments in this new aircraft cockpit. Describing cockpit at higher level of abstraction facilitates transfer of operational skills between various systems and avoids negative learning transfer.

The efficiency of usage of our method depends very much on the efficiency of supporting tools. In our current approach, we are relying on the existing UML modeling tools, and their integration mechanisms. The advantage is that the designers who are familiar with UML can do the design in their natural environments. Additional advantage is that the UML tools, such as Rational Rose, enable integration of custom code connecting the tool with other systems. However, the problem with UML tools is lack of rigorousness in modeling, which requires discipline at the side of the designer. Tools that can support analysis of the designed models are a subject of our future work.

In order to take into account the type of aircraft, the level of aircraft operator training, environment, our method allows definition of different models of users and interfaces, at different levels of abstraction. Models can be organized hierarchically and grouped according to different aspects. Models can be reused, which reduces the effort. According to our experience, the creation of the initial model is the most time consuming effort.

In the end, we would like to add that one of the advantages is the increased awareness of the designers and programmers about the human factors involved in the design of interfaces.

CONCLUSION

The presented work describes an approach to modeling aircraft cockpit devices in terms of multimodal interfaces using the UML notation [11]. This work could help cockpit designers in analyzing the information presentation to humans and avoiding overload as well as streamlining information acquisition. Each instrument consists of one or more modalities (depending on its complexity) and causes one or more effects on the user/operator. In essence, the instrument is a container for one or more information channels between operator/pilot and the device (the aircraft). If we describe the whole cockpit in terms of modalities, we get a unified way of analyzing the inputs and outputs and the resulting effects on the operator (and the device). This can be used as a basis for analyzing cognitive load as well as studying the expressiveness the inputs provide in controlling the aircraft.

We have illustrated our approach on the example of unmanned aircraft vehicle, but it is applicable for manned aircrafts as well. Presented work is a part of ongoing project and is developed as an experimental prototype. In our future work, we plan to integrate our solution into existing CASE tools and work on implementation of tools for designing aircraft cockpits based on multimodal technique presented as a proof of feasibility of the approach.

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THE USAGE OF INFORMATION TECHNOLOGY IN THE IMPLEMENTATION OF THE BOLOGNA PRINCIPLE OF THE STUDENT MOBILITY

Gordana Radić
Paneuropean University APEIRON
gordana.r@apeiron-uni.eu

Contribution of state of art
UDC **37:331.55(4)**

Summary: In this paper, student mobility is observed as one of the steps in realization of the Digital Agenda of the European Union. Student mobility, as one of the main principles of the Bologna process, is the means of effectiveness increase and quality of the educational system in European Higher Education Area, EHEA, because it enables better exchange and flow of knowledge and ideas, as well as the adoption of good practices. Management Identity (IdM) system of the Higher Educational institution is a system which supports student mobility by using personal information when accessing data. The basic identity document in this system is a student smart card with the owner's fingerprint. This biometrical data insures high level of data and identity protection. This paper proposes informational system which, in itself, contains standards for student mobility support as one of the modules of the IdM system of the Higher Educational institution.

Keywords: Identity management, student mobility, smart card, biometrics

INTRODUCTION

Our society is, nowadays, also called informational society, in order to emphasize the rising influence of Informational-communicational Technologies (ICT). It refers to society in which cheap information and ICT are widely used, or society of knowledge, in order to emphasize the fact that the largest profit is obtained by investing in non-material, human and social capital, and that the essential factors of society development are knowledge and creativity.

World Summit on the Information Society – WSIS [7] which was held in Geneva in October 2003 provided us with a definition in which it is stated that Information society is society where everyone can create, access, utilize and share information and knowledge, enabling individuals, communities and peoples to achieve their full potential in promoting their sustainable development and improving their quality of life.

Informational society offers great possibilities: new workplaces, new tools for education and training, easier access to public services, more active participation of people with special needs and more effective collaboration between regions.

In a developed Information society, creation, distribution and information manipulation become a significant economic and cultural activity.

The second chapter of this paper examines Digital Agenda as one of the leading initiatives of the EUROPE 2020 and the reform of the Bologna process of the higher education, which promotes student mobility.

The third chapter examines multidisciplinary system of the IdM, and the fourth chapter is dedicated to the biometrics and smart card as the carrier of the identity. The proposal for the informational system for the student mobility sup-

port based on the smart card is given in the fifth chapter.

Digital Agenda And Bologna Proccess

Digital agenda

Digital agenda [1] represents one of the seven leading initiative strategies of the EUROPA 2020, which goal is to provide sustainable economic and social gain of the unique digital market based on fast and ultra-fast internet and interoperable applications by 2020. It defines the key roles of ICT, if Europe wants to succeed in its ambitions for the year 2020. The goal of the Digital agenda is to make the way for maximization of social and economic ICT potentials, and to make Europe a provider of smart, sustainable and inclusive growth on a global level. Internet is the most significant potential for the execution of the tasks, education, communication and freedom of speech.

European Digital agenda relies on seven standards which have international dimension, namely the making of the unique digital market, the improving of the interoperability of the ICT products and services, inciting trust and internet safety, significantly faster internet access, inciting research and development investment, the improvement of digital literacy, skills and the usage of the ICT in solving crucial social challenges (health care, education, climatic changes,…).

Europe has to insure that the new IT equipment, new applications, data repository and services communicate without limit. Digital agenda defines procedures and standards which are improved, and sets interoperability as a key to success. Internet is a good example of the interoperability because many units and applications work together anywhere in the world. Over 50% of Europeans use internet daily, but 30% of them have never used it at all. It is necessary to improve digital skills of individuals, and Digital agenda takes into account this kind of digital division.

Bologna process

Bologna process [6] is the process of the European Higher Education reform which goal is to promote student and professor mobility by establishing the European area of Higher Education by the year 2010. This process is named after Bologna Declaration from June 1999, which was signed by Ministers in charge of Higher Education from 29 European countries, and its official name is the European Higher Education Area – EHEA. This process is characterized as a national-international process and is conducted by national Ministries of education, universities, professors and students which/who present their work to the Council of Europe and European Commission.

Mobility, as the principle of the Bologna process, refers to students, teachers, graduates and researchers. Student mobility refers to the period of studies outside Home University, and return back after successful studies at another university in home country or abroad. Mobility can be horizontal, meaning that a student spends certain amount of time at another educational institution whether in his/her home country or abroad, and vertical, when a student finishes his/her complete studies in another country.

Mobility, which is referred to in the Bologna process of Higher Education reform, is not the only goal of the reform. The principle of mobility can be fulfilled if other set principles are fulfilled too, namely if the system of ECTS credits is established, system of quality is insured, study cycles and qualification validation are obtained. All these principles are mutually connected and conditioned by each other.

Mobility is the means of enlargement of effectiveness and the quality of educational system among the European Union members and other European countries, because it enables better exchange and flow of knowledge and ideas, as well as the adoption of good practices.

In the process of making the European area of Higher Education, it is concluded that the unique evaluation of a student's load is necessary, which would be used for defining student's necessary work

in order to successfully overcome a subject, a year, or a whole study program. This measure was introduced at the beginning of the Bologna process in order to accomplish student mobility, and was called the European Credit Transfer System. As the process of the reform was developing, it was concluded that the student's load could be measured by this kind of measure. Through the ECTS system, the institution of the higher education insures autonomy, is more transparent, it can change and adjust its programs and has a simple approach to the international programs. Credit Transfer System is an important instrument of mobility improvement within the Bologna process.

Transparency criteria and procedure of profiling student's value expressed in ECTS credits is gained by insuring additional information about curriculum and its relevancy to the academic level of qualification.

IDENTITY MANAGEMENT

Identity Management (IdM) represents a system which insures the managing of adjustable access to the IT surrounding for every user, which is mostly determined by business function and security requirements. This system improves work processes and mutual use of information, one identity per person. If this system is used and maintained properly, it does not allow unauthorized access. It is necessary to set all authorizations in concordance with the present law regulations, and special attention should be paid to the user's privacy policy, the establishing of central data base for internet maintenance, the managing of access rights of every user and inciting strict policy of the managing of this data.

The consolidation of access control is the most important thing in a successful IdM strategy. The control most often exists on the level of software application. The attempt of the access control for every application represents a problem from the aspect of system's vulnerability and weak spots because of the inability to test them properly. However, a centralized access to the Identity Management allows automation and speeding up of the process. Besides needed technologies, it is necessary to establish required policies which will enable proper use of user's account. A consistent monitoring of resource access can be the only way of detecting improper use.

Typical IdM system of organization includes: repository of personal data which is used by the system in order to define user's identity; set of tools for adding, up-date and deletion of data; system which regulates user's access and system of control and report.

A simple definition of the Identity Management is that it is an informational system or set of technologies which are used for identity management support. It is important to emphasize that every identity has its life cycle which consists of:

- *Account provisioning* – establishing of identity which gives the user an appropriate level of resource access
- *Account maintenance* – insures update on identity information
- *Account de*-provisioning – refers to the deactivation of user's account when the user leaves IdM system

Identity Management automatic solution helps with the consolidation and centralization of the IdM module including it into the IT system.

Identity Management system consists of four modules.

The first module is the establishing of identity by link on the person's name or object and reestablishing of identity, e.g. by link on a new or added name or subject's or object's number.

The second module is the identity description which is done by an arbitrary assignment of one or more attributes which are used for a certain subject or object as an identity, or re-description of the identity (e.g. changing one or more attributes of subject or object identity).

The third module represents activity flow, in which it is necessary to record and/or insure access to the identity activity protocol and optionally analyze the sample of identity behavior.

The fourth module deals with the destruction of identity if the user leaves organization, or identity management system.

The introduction of the biometrical data into the identity management system raises the level of identity data security.

A great number of European universities have their IdM systems. It is necessary to determine data standards which determine subject's identity and unique identity for the EHEA. This data should be accepted by the EUA (European University Association) and thus setting the basis for the managing of student's smart card with the goal of student mobility support.

Biometric and Smart Card

From the beginning of civilization, the identification of a human body was crucial in the creation of human society [5]. Hence, the identification of the person is an integral part of infrastructure which supports financial business, care for human health, distance learning, communication, judiciary, border services and many other areas.

As society becomes more electronically connected and represents a large global community, it is necessary to enable a reliable identification of a distant person by method of automatic identification. Representatives of such kind of surrogate identification are passwords, which are mostly used as an electronic access control, and cards mostly used in bank and administration applications. Cards and passwords can be used by other persons besides those to whom they are assigned by which unique person identification is not insured.

Biometrics which refers to the automatic person identification, based on its distinctive anatomic and behavior characteristics can become an essential component of the effective person identification. Biometric components of an effective solution in person identification cannot be mutually used by several persons, cannot be shared or lost. Essentially, they represent physical identity of the person. Biometrics represents automatic methods of the person identification based on physical characteristics or behavior. It represents a simple relationship human – machine, insuring three basic functionalities: positive identification, wide range identification and authentication.

Biometrics is regarded as an essential technology in defining secure identification system because it insures the highest level of privacy in identity verification.

Wide rage system of identification and system of triage cannot be implemented without the support of various biometrical methods.

In order to make a complex biometrical system, three basic requirements must be fulfilled: accuracy, data base capacity and utilization.

Any reliable system of the person identification must include biometrical components. Biometrics has an important role in applications used for sample recognition [2]. Precondition for biometrical recognition is to create data base with samples, which will serve as a comparative tool, and finally for recognition.

It is necessary to emphasize that the biometrical characteristic of a person, besides its advantages, has some disadvantages too. It is difficult to predict a biometrical data without any disadvantages, which would be perfect in any given conditions. If we take a fingerprint [4] [3], into account, then these disadvantages are related to the cases when fingers are, for example somehow tainted or when the skin is damaged. In cases of sample damage, it is necessary to up-date biometrical identification of the person, and this is done in the repository of biometrical data.

Smart card is a card of standard dimensions with an integrated chip, and integral circuits, which can process information. A great amount of information can be uploaded onto the smart card. This card is accepted as one of the safest and most familiar form of electronic identification. The identification security is increased by adding biometrical data onto the smart card [5].

EHEA AND STUDENT MOBILITY

As mentioned before, mobility is the means of enlargement of effectiveness and the quality of educational system among European Union members and other European countries, because it enables better exchange and flow of knowledge and ideas, as well as adoption of good practices.

The idea of necessity of international cooperation and mobility within and outside of the system of higher education came from Europe itself. The establishment of student and teacher mobility in the Bologna process had the biggest support among European countries. For accomplishing this goal, EU has promoted programs such as Socrates/Erasmus/Phare, which supported the efforts of contracting parties of the Bologna Declaration to establish conditions for the accomplishment of mobility. Mobility of highly educated people has often been regarded as a "Brain drain" from underdeveloped countries or countries which are members of the EU. This emigration of educated people to Europe and developed countries was not parallel with the influx of highly educated people to the underdeveloped countries. Mobility existed, but was directed one-way.

European programs for student exchange have insured international cooperation between different universities.

The most common problems that students encounter when they want to study outside their Home Universities are the recognition and verification of exams with which they proceed to study in another country. The verification is usually characterized as being international or widely institutional. We can differentiate two kinds of verification; one is the verification for academic and professional purposes, and the other is the verification of a program which refers to the verification of a specific study program of one higher education institution by another. This mutual verification is conducted by colleague professors and its goal is to enable the continuation of studies at another institution or to vindicate a student from a repeated study of a certain subject or material which does not differ significantly from one institution to another. In terms of institutions, the verification refers to the verification of agencies which are considered responsible and trustworthy, and which guarantee prescribed quality.

Academic verification represents the recognition of studies, qualifications or national or international university degree. It is necessary for forming an academic career at another educational institution or for professional needs and competition at the work market.

National ENIC/NARIC centre is the reporting centre of academic student mobility for students with national and international qualifications.

In the context of the EHEA, we can differentiate between three basic levels of verification:

- The recognition and verification of qualifications, including previous studies and professional experience for the purpose of acceptance or re-acceptance to higher education
- The recognition and verification of short study periods connected to the student mobility, wherein ECTS credits are used as the basic instrument of verification
- The recognition and verification of fully completed academic degrees, wherein a Diploma Supplement, which will be discussed later, is used as the basic instrument of verification

ECTS system is based on three basic elements, namely information about the study programs and achievements, agreement between partner institutions and the usage of ECTS credits. These three elements are effective if the three crucial documents are set, namely

- informational package
- study agreement
- transcript of records

The goal of the **Informational package** is to objectively present, to the students and their mentors, the study program of the educational institution, the assessment of the student's load, the module of examination, which is, assumingly, sufficient for the proper choice of the study program in inter-university exchange.

Study agreement is signed by a student, Home Institution and the institution which is the host after achieving mutual agreement prior to student's return to his/her studies. By signing this agreement, student accepts studies abroad as an integral part of his/her studies according to the coordinated part of the study program of the Host Institution and this agreement has to be accepted by all three parties, namely a student, Home Institution and Host Institution [5]. Home institution guarantees to the student that it will fully verify all completed courses stated in the agreement. By the agreement, the Host Institution confirms that the study program is acceptable and that it is not in collision with its study regulation. There is a possibility of a change in the agreed study program for justifiable reasons about which all three parties have to make statements.

Transcript of records is a document which is issued in order to demonstrate student's load in overcoming certain study program and achieved success prior to student's transfer to another studies and after his/her return from another university. This document is important for the verification of achieved ECTS credits for the student exchange, namely mobility support.

The fourth document which supports student mobility is the **Diploma Supplement** (DS), and it is submitted with a certain degree providing more detailed insight into the content, system and study regulations, especially concerning achieved results of an individual to whom this document is issued. The goal of the DS introduction is to improve transparency and facilitate academic and professional verification and the assessment of the achieved qualification in the last study program. Information, which is part of the DS, enables various academic institutions, in the country and abroad, to independently assess acquired skills and knowledge of a graduate. DS contributes to the affirmation of the higher educational institution itself on the international level and the verification of various universities. The content of the Diploma Supplement is acquired through the process of the implementation and creation of EHEA. This document is complementary to the degree issued to the individual, and it contains short biographical data of a student providing more detailed insight into the content, system and study regulations, especially concerning achieved results of the individual to whom this document is issued. DS is an official document, attached to the main degree and written in at least two languages, national and international, and is issued by the higher educational institution. This attached document enables the comparison of the degrees and qualifications acquired by them in various systems of the higher education, which enables their easier verification abroad.

University Information System - The Recommendation of the Information System For Student Mobility Based on the Smart Card

Student mobility supported by the smart card

As already mentioned, the most common problems that students encounter when they want to study outside their Home Universities are the recognition and verification of exams with which they proceed to study in another country. Student who wishes to continue his/her studies at another higher educational institution by module of exchange, has to fill in the application in which he/she states at which higher educational institution he/she wants to study and which study program he/she has chosen. Documents which student "carries" with him are: Study agreement, Transcript of records, DS optionally, and Informational package. These documents are uploaded onto the student smart card which is issued by the Home higher educational institution.

Figure 1. The block diagram of the study agreement

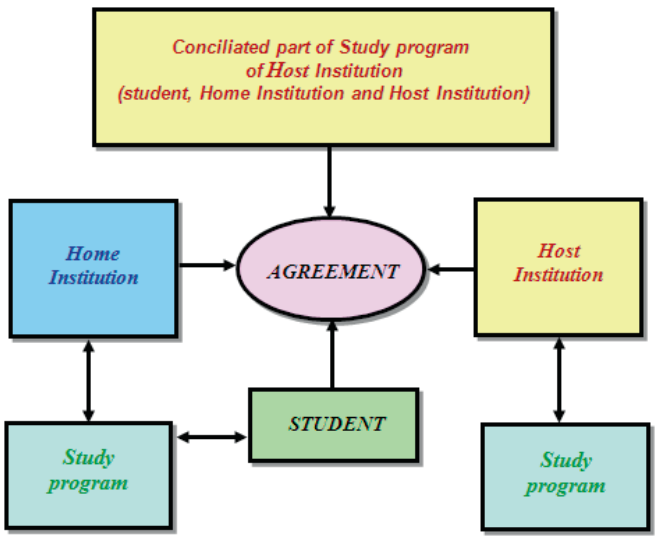


Figure 1 shows the block diagram of the study agreement [5]. By signing study agreement, student accepts studies abroad as an integral part of his/her studies according to the coordinated part of the study program of the Host Institution and this agreement has to be accepted by all three parties, namely a student, Home Institution and Host Institution [5].

Student smart card is designed in a way to protect data which contains. The biometrical data of the card's owner insure the highest level of protection. In this case, I recommend a fingerprint as an identification data which raises the level of protection of the smart card system and represents very reliable solution from the aspect of privacy. All data concerning the card's owner is uploaded onto the card's computer chip. The computer chip requires a smart card reader, thus enabling a successful communication with a computer platform.

Each university has its own system of IdM which contains all necessary data which has to be uploaded onto the smart card. Data which is necessary for the student mobility support is uploaded onto the smart card. University IdM system must have a biometrical system.

Module of the system of personal identity verification

Which data is necessary for the student mobility support?

Following data is necessary: student personal data and fingerprint, student's home institution data, student's host (abroad) institution data, and regulated subjects which student has to pass at host institution.

Personal data:
- First and last name
- Date of birth
- Permanent address
- National Unique ID

Fingerprint:
- Right hand thumb
- Right hand index finger

Study Agreement:
- Student data
- Home institution basic data
- Home institution study program
- Host institution basic data
- Host institution study program
- Regulated (coordinated) part of the study program, accepted by Home institution, Host Institution and student
- Time period of the Agreement Validity

Transcript of Records of the smart card owner:
- Date of the exam
- Subject name
- Letter and numerical grade
- Allocated number of ECTS credits

In order to accomplish this kind of concept of the horizontal mobility support, each Higher Educational Institution, besides standard ICT equipment and applications, needs to have:

a. Smart card read/write device
b. Fingerprint read/write device, as a part of the biometrical IS and
c. Standard application to support process of the smart card content for the identification of the card's bearer, incorporated into the IdMS of the institution.

In order for a biometrical data to be a unique student identification data, it is necessary for a biometrical system, together with an accompanying hardware support, to be a subsystem of the IdMS. It is important to emphasize that the identity biometrical data, by means of biometrical informational system, which operates as a subsystem of the IdMS, is loaded into the data base, and together with the personal data on the smart card represents a unique ID of the card owner (carrier).

Figure 2 shows a simplified block diagram of the biometrical IS which collects and verifies biometrical data in the sensor module and in the module for input and verification of the fingerprint characteristics. Then, it loads the data into the data base. The module for pairing of the loaded data and the data from the data base provides information about verified or declined identification.

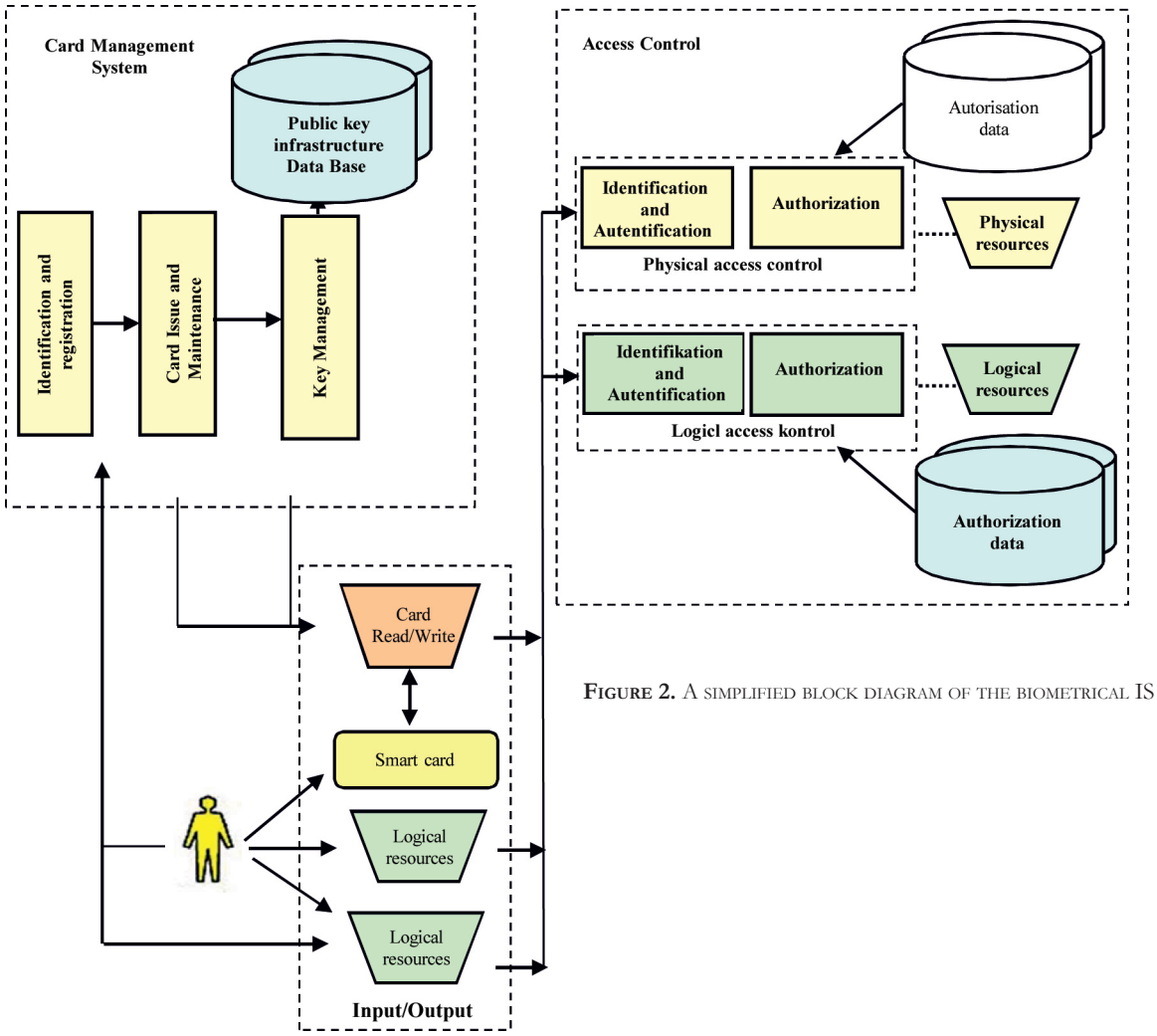
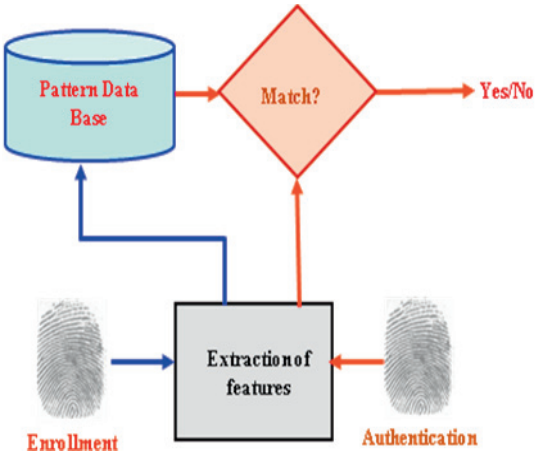


Figure 2. A simplified block diagram of the biometrical IS

Figure 3 shows the model of the personal identity verification [5].

We could say that this kind of system implementation is conducted in three steps.

Figure 3. The model of the personal identity verification



The **first** step is to regulate standard, on the EUA level, which will support this kind of system.

The **second** step is the implementation of these IdM systems at Higher Educational Institutions which are willing to support this kind of concept of the horizontal student mobility.

The **third** step would be the networking of these Higher Educational Institutions, as a part of the strategy of the Digital Agenda, Europe 2020.

Conclusion

This paper emphasizes the importance of student and teacher mobility concept as one of the binding components of the unique European Higher Education Area, which is insured by previous implementation of ECTS credits, European Credit Transfer

System, and standardized cycles of academic education lasting eight years in total. Within the mobility concept, the relationship between documents which support mobility concept is emphasized. These documents are: Agreement, Transcript of Records, Informational Package and Diploma Supplement.

A recommended integral informational system of the higher educational institution especially represents the possibility of the implementation of new technological solutions, smart card, which makes use of biometrical data in realization of the system of the student mobility concept, as well as of distance learning.

This kind of system would be a starting point of a full scale system of the student, graduate, teacher and scientist mobility support within the EHEA and ERA (European Research Area). It is also necessary that the European University Association (EUA) defines standards for the smart card content, which will support student mobility, data and the form in which it is used. The development and implementation of this kind of system is based upon regulated standards of European University Association (EUA), which would support the mobility of students, graduates, researchers and scientists.

The important document which supports graduate mobility is the Diploma Supplement (DS), which insures transparency, facilitates academic and professional recognition and the assessment of achieved qualifications within the last study program. Data, which is part of the DS, enables various academic institutions to independently assess graduates' acquired skills and knowledge. It is important to emphasize that the DS contributes to the affirmation of the High Educational Institution itself, on the international level and to the evaluation of various universities. Job market has to recognize regulated qualifications of graduates.

The networking of the High Educational Institutions with an implemented and recommended IdMS, will support the strategy of the Digital Agenda, Europe 2020.

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Model for Managing Software Development Projects by Fixing Some of the Six Project Management Constraints

[1]Boris Todorović, [2]Miroslav Matić

[1]*Information technology project manager, Republic of Srpska Securities Commission, Banja Luka*

Email: boris.todorovic@gmail.com

[2]*CEO, East Code d.o.o., Banja Luka, Email: eastcode@blic.net*

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Abstract: This study is focused on the software development process, viewed from perspective of information technology project manager. Main goal of this research is to identify challenges in managing such projects and provide a model for delivering software solutions that satisfies client's expectations. Project management theory describes six constraints or variables in every project, which project managers can use to better control the project and its outputs. Fixing some of the six project management constraints (scope, cost, time, risks, resources or quality) will allow project manager to focus on most important project aspects, rather than being drawn between all of the variables.This paper is aimed at information technology project managers and portfolio managers, as it describes the practical application of this model on a software development project. Findings of this research support the theory that, by applying good project management practice and focusing on project/business-critical requirements, will enable project managers to complete projects successfully and within tolerance limits. Results show that by identifying key business constraints, project managers can create good balance of six constraints and focus on the most important ones, while allowing other constraints to move between limits imposed by clients and stakeholders.

Keywords: software development, project management, PMBOK, six project constraints, fixed project constraints, risk management, quality management, project scope management

Introduction

Information technology project management and software development processes have been around for several decades, but have begun maturing only at the brink of 21st century. Since the early 90's, when majority of software-based corporations started expanding rapidly, until today, whole process of software development and project management has been constantly challenged. The *Chaos Report study* [17] suggests that most information technology projects even today do indeed fail, or are heavily challenged – notproducing quality software, not conforming to business scope and cost requirements and even going over budget. Costs of software development have steadily been brought to a more acceptable level by adopting modern software development methodologies such as Unified Process and eXtreme Programming, which provided a new set of tools, methods and techniques for project managers and team members.

On the side of the project management, most influential framework today is *Project Management Body of Knowledge* or **PMBOK** [12], which proposes set of six constraints or variables, which are used to evaluate project success. By controlling projects scope, cost, time, quality, resources and risks using this framework, project managers can indeed efficiently manage projects. However, in the real world situations, it is not entirely possible to control all of these constraints.

Main hypothesis of this paper is that it is more effective and realistic to fix some, but not all of the constraints. In other words, project manager must set most important aspects of the project with the client and stakeholders. Top priority constraints must be fixed, while others will be monitored to be within acceptable limits.

INFORMATION TECHNOLOGY PROJECT MANAGEMENT IN THEORY

Software development is not just an activity in which specific software is written in a programming language, but a whole *set of processes and activities*, with clearly defined structure and rules. In theory [14] [2], software development process consists of several phases: user requirements definition, system analysis, system design, implementation (programming), software testing (quality control) and installation in production environment. Schwalbe (2006, p. 46) suggest that these phases are not sufficient in the perspective of project manager, so two additional phases are added to software development lifecycle: project initiation and project planning. These two phases are actually starting points for any software development project, as they are not initiated by the project team but by senior management, board of directors, technical directors or prospective clients. The software development lifecycle can be then illustrated as follows:

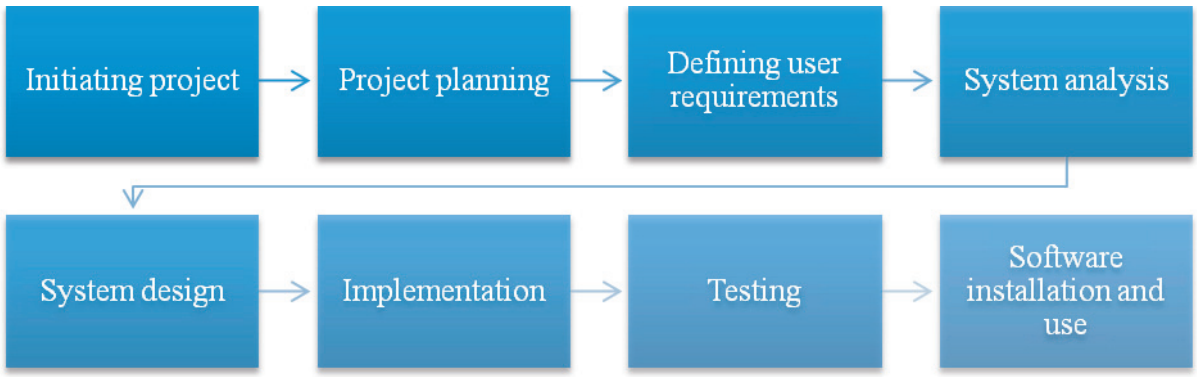
Some of the modern software development methodologies, such as widely accepted IBM's Unified Process, propose a mix of software development and project management processes by including such disciplines as project change management, general project management and environment management. However, a clear separation must be made between software development methodology, which has to do with controlling the software building process itself; and project management methodology, which in essence provides a set of tools, methods and techniques for managing project, financial assets, human resources, time, communication, etc. Goals of project management include not only creating software and proving highest level of quality possible (which is primary goal of software development process), but creating software within budget, timeframe, with acceptable level of risk and available human resources (Nicholas & Steyn, 2008, p. 4).

Project Management Body of Knowledge (PMBOK)

Project management body of knowledge is a project management methodology written by one of the largest international project management professional organizations, The Project Management Institute. First edition of "*A Guide to Project Management Body of Knowledge*" was published in 1987 and the latest edition in 2010. Since 1987, it has become number one standard in project management worldwide [1]. The standard itself comprises of five process groups [12].

1. Project initiation
2. Project planning

DIAGRAM 1–MIXED SOFTWARE DEVELOPMENT PROJECT LIFECYCLE(SATZINGER, JACKSON, & BURD, 2004, P. 64)



3. Project execution
4. Project monitoring and controlling
5. Project closing

Each of the process groups deals with the specific timeframe of the project. Project initiation process group deals with portfolio management, or precisely speaking, a process of initiating new project using proven and reliable methods [16]. Project planning is all about analyzing project requirements and allocating resources and time in order to complete project successfully and within budget. Project execution deals with the time in project when majority of work is being done, and is focused on maintaining team, leveraging resource usage and optimizing the process in order to satisfy limitations and client's expectations. Project monitoring and controlling is about monitoring team's progress and controlling any unwanted situations by constantly applying good practice and leadership skills of a project manager. Finally, project closing deals with the final phase of the project, when team is delivering the product and writing closure reports, evaluating team work in lessons learned report and generally getting acceptance by a client.

On the other side, PMBOK describes the *nineknowledge areas*, or project manager's key competencies: [12]

1. Project integration management
2. Project scope management
3. Project time management
4. Project cost management
5. Project quality management
6. Project human resources management
7. Project communication management
8. Project risk management
9. Project procurement management

These nine knowledge areas are the primary focus of the standard, as they provide a necessary set of techniques, tools and methods for project managers to follow. For example, project time management describes usage of critical path analysis, PERT technique, Gantt and network diagrams, in order to create preliminary and final project time frameworks. PMBOK also suggests best practices for applying these techniques, tools and methods, as well as workflows in projects with clearly identified input and outputs (list of project documentation).

Some of the knowledge areas are not directly linked with the project requirements, such as project communication management, integration management and procurement management. Each of them is dealing with intra-project issues. However, six others reflect the real project requirements set by the client.

Project constraints (project management triangle)

Most projects have defined certain financial or schedule limits, such as what is the definite project budget or what is the due date of system being fully operational. These are not imposed by the development team, but by management, clients or stakeholders. Project manager must work with these non-technical project requirements and a framework for managing them is actually contained within PMBOK. PMBOK proposes concept of using a *project management triangle*, or managing and evaluating project success through three variables, or constraints: **time**, **cost** and **scope** (as illustrated in the diagram below).

Diagram 2 - Three variables of project management triangle(Project Management Institute, 2000)

Time constraint presents *schedule*, or allocated time for project team needed for successful completion of project. Cost constraint is a *budget*, or financial assets allocated for human resources, hardware, software, or other incurring costs such as consulting

services and goods.Finally, scope constraint represents *realized project goals*, or in the information technology terms, functionality of the finalized software. In order for project to be kept on track and within limits, project manager must continually evaluate these three constraints and delegate project team activities accordingly.

The three constraints are in fact interconnected, as Schwalbe [15] and Haugan [4] notes. Increasing the scope of the project has direct impact on time and costs, as more work will be done, and more work means spending more money on resources. Fixing all of the constraints is impossible, but fixing one or two is them is possible. For example, fixing scope and time will mean that project will be done on schedule with all functionality, but project manager may manipulate with cost variable, by having various software development contractors join the project in order to actually meet previous two constraints. Fixing the third constraint is, therefore, very hard, in theory considered impossible [5].

The outcome of this triple-constraint model is software quality. That is, if project satisfied acceptable limits of three constraints, the produced software has got enough level of quality. This statement, however, was disputed in modern project management and software development theory by Haugan [4] and Hamilton et al [3], among others. A project could, in fact, satisfy the acceptable limits of the three constraints, but the quality may be unacceptable for the client. This is why there was a need for change of triple-constraint model.

Evolution of project constraint management in PMBOK 2010 (six project constraints)

Triple constraint model was changed in PMBOK's 4thedition [12] in order to better cover all possible variables that are affecting success of projects. First of all, quality was removed from being a goal of the project, to being a constraint. Secondly, project risks and (human) resources are added, forming a final **six-constraint model**. The main goal of the model is project itself – *the successful completion of a project*, as illustrated on the diagram below:

DIAGRAM 3 - SIX CONSTRAINTS OF PROJECT MANAGEMENT (PROJECT MANAGEMENT INSTITUTE, 2010)

When arguing that quality is a constraint, not a goal [10], suggests the quality itself can projected. In other words, project team and client can agree on what level of quality software will have. Project manager can than make tradeoffs based on the agreement and can balance between quality, risks, costs or any other constraint. Finally, all six variables illustrate real world scenario, where project manager has to find a balance between different requirements. They indeed provide an excellent overview of all potential issues of a project.

RESEARCH METHODOLOGY

This research proposes a new model of managing software development projects by utilizing existing best practice in the field of project management. The six-constraint model, described in PMBOK [12] was modified by the author in order to achieve greater level of project control. Since all projects have certain, specific requirements, a project manager can agree with the client on their importance. For example, if it is a critical for a project to be released on the specific date and with all the functionality completed, project manager can fix those constraints (time and scope), while leaving others negotiable. This model uses method of **fixing certain constraints** in order to prioritize tasks and project success factors.

While agreement with client can be made on priorities, project manager must also set *control limits for rest of the six constraints*. If this is not set, costs, for

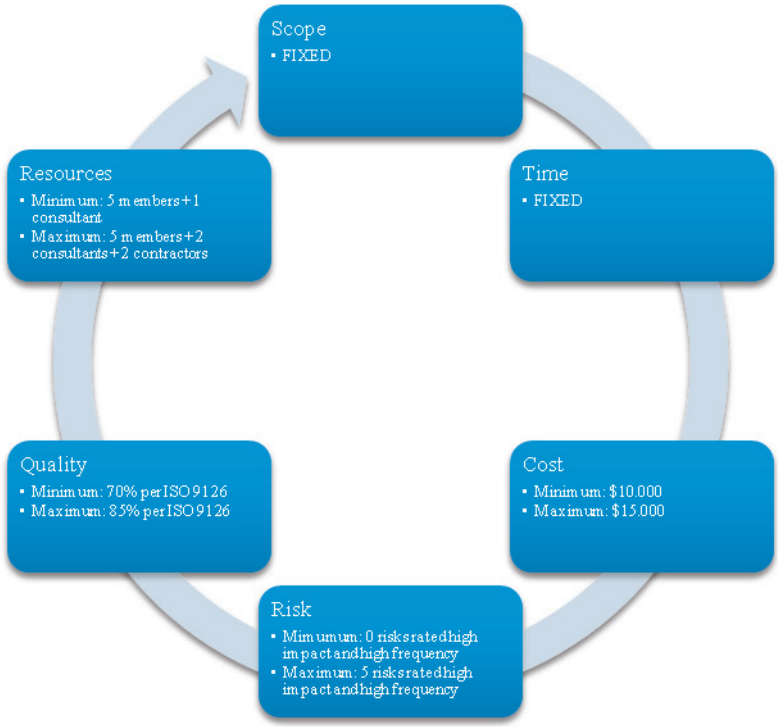
example, could skyrocket, eventually spending all of the financial resources on getting the work done on time and within scope. This would pose a great risk for the project, and although time and scope constraints would be satisfied, other constraints would get out of control.Diagram below illustrates usage of such model, with clearly defined constraints that are fixed for the project and with defined maximum and minimum control limits for others.

Since this paper seeks adequate model for project constraints management, adequate research subject was chosen. Experimental research in this paper was conducted at a software development company in Bosnia and Herzegovina. Research will, therefore, be conducted on one software development project, in order to confirm research hypothesis.The software development project chosen for the purpose of research was the creation of *centralized, Web based information system*. System featured following requirements:

- Web-based application with centralized storage mechanisms based on relational database management systems (SQL-like)
- multiuser environment with authentication and encryption capabilities
- adequate security mechanisms
- efficient and effective data entry interfaces and report creation
- document management system integrated with Microsoft Office SharePoint technologies

The requirements regarding the usage of this software were not well formed at the beginning of the project, so the **project scope was not defined entirely**. However, the company was given **fixed amounts of financial assets** and was given a **very strict timeframe** in which software had to be fully operational. This was an excellent opportunity to test real word situation in which three out of six constraints were fixed.

Diagram 4–Example of model in which two out of six constraints are fixed (source: author)



While company could easily shift focus from time and costs to scope, risks, resources or quality, this model was used to in fact control the most important aspects of the project. This research will set goals and limits for each of constraints and evaluate them after completion of the project. After the evaluation, we will present projected and real values for each constraint and will inspect how the project

manager succeeded in applying the model and controlling the project's success.

In order to hide sensitive financial data, project costs will be enumerated using *relative weights*. For example value 1.0 will indicate initial costs, while value 1.5 will indicate 50% greater costs relative to initial project costs. Project time constraint will be measured using *total working hours* (w/hrs.), which is the only true measurement of time it took to produce working software solution. Project scope will be measured by number of *use cases implemented* (uc/i) by project team in the final software build. Resource usage will be measured by indicating *number of persons* were active during project lifecycle, but making a clear difference between their roles (e.g. project manager, team member, contractor or consultants). Level of quality will be evaluated using ISO 9126 standard its "quality in use metrics", then summarizing the result using weighted averages for the entire software in order to provide single *quantitative software quality level* [6]. Risk constraint will be measured by extracting *number of major risks* with combined value (possibility of occurrence * impact) information from risk register, a part of risk management documentation.

ANALYSIS OF RESEARCH RESULTS

Presentation of research results

The following table represents comparison between planned and actual values for all six constraints, measured during experimental research on a chosen software development project:

Measured results for the project were compared to initially planned values, in order to create a **performance index** for each characteristic. *Green-colored performance index result* indicates a positive result, meaning that planned value was completely met. *Yellow-colored performance index result* indicates a satisfying result, where actual values did not meet the plan, but are within minimum and maximum control limits. *Red-colored performance index result* indicated result that was on the limit, or out of minimum and maximum control limits.

Discussion and analysis

Using the suggested model, project manager was able to fix two of six constraints and to control them throughout the lifecycle of the project. As presented in research results, *cost* performance index was at 100%, meaning that there was no cost overrun. *Time* constraint's performance index was at 103%, just slightly over the planned value, but within the control limit. Although this was a case of project team working behind original schedule, we can conclude that this constraint was very much within control limits and almost entirely met. Real-world situations, such as changing business environments don't always allow for complete satisfaction of all plans. Since costs were fixed, *resources* were also limited, so performance index for this constraint was also 100%. Finally, all of the fixed constraints have been successfully managed using the model, which results in their nearly perfect performance index, which was the primary goal of this research.

Since the project was managed in a way to satisfy budget and schedule, other constraints did not achieve planned values. *Scope* constraint had performance index of 89%, meaning that project team did not produce all of the software modules by the end

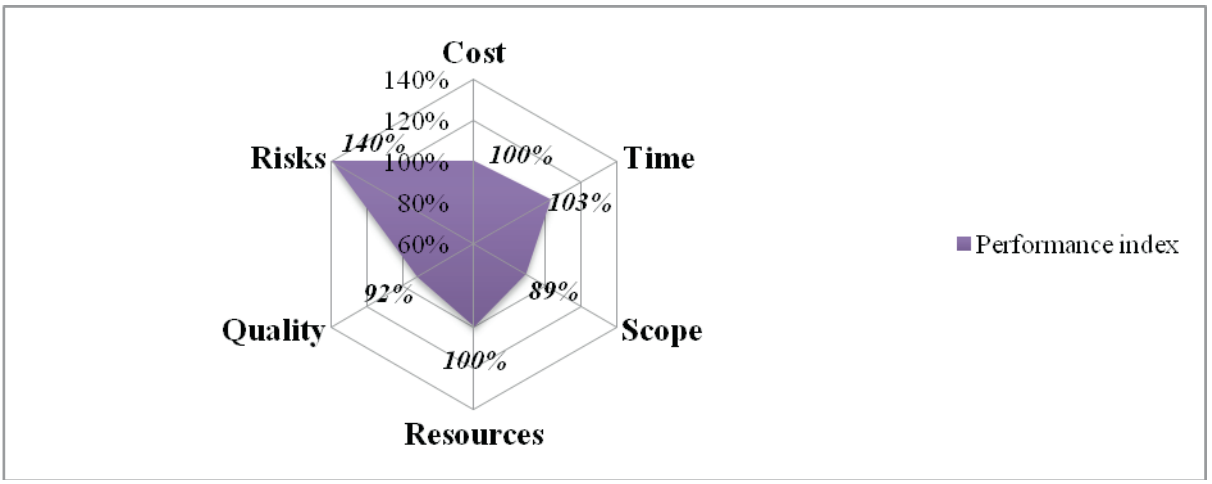
TABLE 1 - COMPARISON OF PROJECTED AND ACTUAL VALUES FOR SIX CONSTRAINTS (SOURCE: AUTHOR)

	Planned values	Minimum control limits	Maximum control limits	Actual values	Performance index
Cost	1.0	1.0	1.1	1.0	100%
Time	2.900 w/hrs.	2.900 w/hrs.	3.100 w/hrs.	2.980 w/hrs.	103%
Scope	123 uc/i	102 uc/i	123 uc/i	110 uc/i	89%
Resources	1 project manager (PM), 3 project team members (PTMs), 2 contractors (CTRs)	1 PM, 2 PTMs	1 PMs, 3 PTMs, 4 CTRs	1 PM, 3 PTMs, 2 CTRs	100%
Quality	90% by ISO 9126	80%	95%	83.45%	92%
Risks	10 major risks	5 m/r	14 m/r	14m/r	140%

of the project. However, performance index was within control limits. Same thing happened with *quality* and *risk* constraints, whose performance indices were at 92% and 140% respectively. Quality was within control limits, as well as risks.

We must note that risks were at the highest level of maximum control limit, which was due to the project team focusing on delivering as much quality as possible. This, in essence, means that management of risks was of tertiary priority (primary priority being fixed cost and time constraints, and second being quality and scope). Also, risks were higher due to usage of relatively new technology - Microsoft SharePoint 2010. Since the development of modules based on this technology was not a priority, risk management process was focused on other project goals and issues, leaving this as a major risk though the end of the project.

Diagram 5 - Graphical representation of performance indexes (source: author)



Conclusion

This research presented the practical, experimental results, which support the main hypothesis: by fixing some of the project management constraints, project managers can more effectively control success and outcomes of projects. Focusing on important aspects of the project, such in this case, satisfaction of budget and schedule, other constraints can be well balanced and kept within minimum and maximum control limits.

Although the model's effectiveness was be measured by comparing projected and actually achieved performance indices, it should be used on day-to-day basis by project manager as a mean of continually controlling project performance.

This paper opens a new research direction in information technology project management by suggesting a new and practical model for controlling project's success. Further research directions for this model include evaluations of different mixes of fixed project management constraints, as well as application of this model to small, medium and large project teams.

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Trends in Educational Games Development

Miroslav Minović, Dušan Starčević

University of Belgrade, Faculty of Organizational Sciences, Jove Ilica 154, 11000 Belgrade, Serbia

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Abstract: In this paper we will give a literature review related to game-based education, in the first place at university, as well as the analysis of existing solutions which should enable this type of eLearning. The main topic of this research will be capacity for applying modern information technologies for developing game-based learning platform. When we chose this topic, we started form the fact that there are no applied game-based eLearning systems at universities. During analysis phase, we found that more research is needed in order to improve application of games in education. In the first place, these studies should cover listed problems: how to design educative games in order to achieve better learning effects; how to develop software tools to automate educative game development process; establish methods and techniques for knowledge and skills assessment utilizing educative games.

Keywords: Game-based learning, eLearning, Games, Motivation for learning

Introduction

With the development of personal computers and their penetration into all sectors of the economy, and also into many aspects of everyday life, it became clear that computers can be used as machines for entertainment. The first computer games appeared in the fifties of the 20th century - since then, their development has proceeded at a vertiginous speed. It was almost impossible to assume that they will become one of the dominant social phenomena, and that, in the last decade of the 20th century, the industry of computer games generates more revenue from the film industry. This game development has enabled them to become more complex, richer in content, more attractive - and also more appealing to customers. Great popularity of computer games has led to the fact that they have become an integral part of modern culture.

The popularity of computer games led to thinking about their application in education. Games became an integral part of modern society. They are the ideal platform for presenting new content and new technology - a lot of people play computer games and accept them as a normal form of entertainment. Research shows that it is not only the youth who plays games - big part of the playing population represents adults [13]. According to the report of the American Association for entertainment software (ESA - Entertainment Software Association) in 2006, the 69 percent of the U.S. population plays video or computer games. The average age of players is 33, and 25 percent are older than 50. Men make up to 62% of the population [9].

Electronic games are a new mass medium, with its characteristics, as compared to the now traditional media such as books, television, film or music. In contrast to all existing media, games have the opportunity to interact, allowing the user to actively participate, not just passively receive information. That is why the last few years we can see more and more use of computer games for education. Educational games are social, card, or computer games that are specifically designed to teach people about a certain subject, expand concepts, reinforce development, understand an historical event or culture, or assist in the development of certain skills.

Games

Game as a concept is not easy to define. There is a field called game theory and is principally engaged in the strategy of playing moves between play-

ers based on mathematical rules. It deals with the choice of optimal moves, and its greatest application is in economics and politics. However, it has almost nothing to do with the development of video games. We can certainly say that what unites all forms of games is fun. It is the main reason for the success of the games. The aim is to exclude us from reality and bring in another reality that is governed by other rules, and other forms of behavior. It is a unique form of real-world simulation that comes as abstraction of the important elements for the functioning of game logic. The human brain must constantly process large amounts of information in the real world, while in the games, the level is much lower because it uses only the information relevant to the game scenario. This leaves to the brain a lot of room to entertain while playing game, and also the possibility to acquire certain knowledge during the play. First of all, the games are looking for a challenge [35]. From the simplest games like Rubik's Cube to the most complex computer 3D simulation the player expects a challenge. In every game there must be obstacles that the player will invest time and effort to overcome and that will give him emotional satisfaction. The player expects to earn the respect of other players with achievement of certain success in the game. Another important factor in games is imagination. It is expected from the game to enable an opportunity to develop imagination, and that through narration player gets involved into the game world. Due to the specifics of educational games, it is reasonable to conclude that it is crucial to find a good balance between fun and some seriousness that educational content carries. With respect to this principle, we can expect the maximum impact of this form of knowledge transfer.

Games became a very important tool for knowledge transfer because of their ability to actively hold the attention of participants and because of the fact that they are creating an impression of fun in learning. In particular, computer games gain the significant role in education. The development of information technology makes it possible to create more interesting games that have more and more power to actively engage the players and introduce them into the story. This leaves ample room for the application of educational games. Also development of the Internet opens up many possibilities of distance education, and inclusion of more physically remote users in the educational game.

E-LEARNING

Changes caused by the development of computer networks and information technology were such that they have an impact on all aspects of society, including education. There was a justified need for the introduction of computers and the Internet in education systems. E-learning (electronic learning) is a comprehensive term, generally used to describe a computer-assisted learning. It often includes other devices such as digital assistants (PDAs), mobile phones, etc. However, all these devices, given the way they work, can be classified as mini-computers. So, E-learning can be defined as computer-assisted learning. Also, e-learning can include materials based on web technology, and hypermedia in general content (multimedia CD-ROMs, web sites, discussion forums, collaborative software, e-mail, blog's, wiki's, educational animation, simulations, games, software for course management, etc.), often a combination of different methods. E-learning is a natural extension of distance education that is present since the 1930s when they created the first correspondence school.

Today, e-learning in higher education tends towards the formation of virtual learning environments (Virtual Learning Environment - VLE), which in conjunction with controlled information system becomes a controlled learning environment (Managed Learning Environment – MLE). This environment is characterized by a consistent user interface that is standardized throughout the educational institution. An increasing number of universities, both traditional and virtual, include as an offer, a specific degree and relevant courses that can be completed online. Some of them require students to be present at the campus, but there are courses that are fully completed online. The advantages of e-learning are flexibility and convenience to users, especially when they have other obligations, then good communication between students, adoption to student's needs, versatility compared to traditional courses, and the presence of multimedia content to facilitate adoption of learning material.

The largest number of authors cited a lack of interaction with mentors as well as physical isolation of students as a shortcoming of e-learning. Many of them even say that this process is not educational in character, speaking from a strictly philosophical point of view. First mentioned disadvantage can be partly removed from the video and audio conference system on the network. As for the isolation of students, it can be compensated by the existence of forums, chat services and other forms of online communication.

Cost-effectiveness of e-learning is the subject of much debate, primarily because of the high initial costs, which can be compensated by the massive offering. Especially development of network software could prove as a costly investment. The development of flexible educational materials may also be time-consuming compared to the production of the classic material. Also, when switching from traditional methods of education on e-learning, significant financial resources must be set aside in the name of training for the use of both hardware and software components of the system. Among the first institutions which founded e-learning, in the mid 90s, are the Western Institute of behavioral science (Western Behavioral Sciences Institute), New York Institute of Technology, System for exchanging information (EIES) Institute of Technology and Organization of New Jersey and Connected Education founded by Paul Levinson. According to the Sloan Consortium, virtually all institutions of higher education, like most private institutions now also offer online classes. In contrast, only about half of the non-profit educational institutions offer this service. Sloan's report says that, according to a survey in academic circles, most students are satisfied with online classes at least as much as they are satisfied with traditional learning methods.

Communication technologies used in e-learning can be divided into synchronous and asynchronous. Synchronous activities are those that require that all participants communicate simultaneously. This type of activity belongs to interactive messaging (chat), and other multimedia content (e.g., whiteboard), and virtual classrooms and meetings. Asynchronous activities can be web logs (Blog's), the contents of which anyone can change and update (wikis) and Internet forums and discussion groups.

To test student's knowledge in the process of e-learning, different methods of computer evaluation are used (Computer-Aided Assessment and e-Assessment). These methods are diverse and range from simple automatic processing questioner to more complicated systems that include recognition of words and short sentences. Systems often include obtaining immediate test results, along with any corrections and instructions, known as feedback. Some systems perform error analysis that the student made thereon and are adapted to test each student individually. However, it is obvious that all of these systems are still in their infancy and have yet to reach their maturity.

Educational Games

The paper focuses on educational computer games. They combine education and entertainment in a concept known as edutainment. This concept usually assumes that users provide lessons in a fun environment recognizable: television, computer games, movies, music, websites, multimedia software and so on.

It is known that computer simulation has long been used to train civilian and military pilots. Modern flight simulation games are so highly developed that they have greatly surpassed the commercial software, especially in the quality of sound, graphics, and the degree of realism in general. In Germany, it is already being worked on a program very similar to computer games that simulates driving a car in the city and on the open roads. The advantage of these flights and car-simulations are that they represent a cheap way to simulate incidents and enhance response by participants. Disadvantage is that in comparison to modern computer games they reminiscent to clumsy attempts at 3D animation of the twentieth century.

There are indications that even a shooting game in first person in some areas can be used as an educational tool. Some armies take them to be cost-effective way to supplement tactical knowledge of military and anti-terrorist units, as well as orientation

and coordination skills. Many social and computer games that are not intended to be strictly educational carry a significant educational aspect. Monopoly teaches us basic principles of market economy, Microsoft's Age of Empires series, Total War games, and Civilization teach political economy, history, military theory, and even sociology and ecology. There are also many games that teach management: Transport Tycoon (management of urban and intercity transport), Railroad Tycoon (managing railway), Rollercoaster Tycoon (managing amusement park), SimCity I-IV (management of the modern city), Football Manager (managing a football club) and many others.

It is significant to mention the educational games for kids. Sales of classic toys have shown a downward trend from year to year and almost all the kids spend more time in front of the screen. Thus, this genre of computer games is becoming extremely important. Children's educational games are educational in the true sense of the word. There are games for all ages, from those that resemble picture books in electronic format, to games like The Sims to help teenagers to cope with and resolve problems in the real world.

OVERVIEW OF THE FIELD APPLICATION OF ELECTRONIC GAMES IN EDUCATION

This section contains an overview of existing research in the field of application of electronic games in education.

The most important classification

This section presents the most important classification of educational games. Classification aims to highlight the main factors that connect games, and to emphasize the critical differences between the groups and members of the group games. Well-designed classification will often suggest the unexplored areas of making games. More importantly, classification reveals the principles that underlie the development of games. However, the classification is the only way to organize a large number of related objects. As the field of games is too young, and the sample is small, it is not easy to find a good criterion for the division. Games that exist today are more product of chance rather than an inevitable result of well-organized forces [11].

By the type of the game

We decided to name the classification given by Chris Crawford, in his book 'The art of computer games' [11], published for the first time back in 1970. It is a classification by the type of the game, and essentially covers the actual games today.

1. Games of skill and action
a. Combat game
b. Maze
c. Sports Games
d. Games blow
e. Racing Games
f. Various other games
2. Strategy Games
a. Adventures
b. D & D (Dungen & Dragons) game
c. War Games
d. Games of Chance
e. Educational and children's games
f. Interpersonal games

Games of skill and action - Represents the largest and most popular group of computer games. Most people link all the games with this category. All arcade games are games of skill and action, also almost all the games for the Atari 2600 belong to this group. Features are playing in real time; the reliance is on graphics and sound effects and using the joystick rather than keyboard. The basic skill required of a player is to coordinate hand and eye movements, and have quick reaction time.

Combat game - Combat games are a direct violent conflict. The player has to shoot and destroy the bad guys controlled by computer. The challenge is that the player is positioned to avoid the attack and the shooting by the enemy. This is a very popular group game, and there are many variations on the theme, the environment in which to play, and the types of weapons used.

Maze -Another subset of games class skills and actions represents the game with a maze. PAC-MAN

is the most successful representative of this group. Primary characteristic is the existence of the maze, the path which the player must pass in order to successfully beat the game.

Sports games - These games are modeled as popular sports. The basic idea is to design games that simulate sports games in the real world. Because players are already familiar with these games in the real world, it is easier for electronic version to find the way to them. For example, there are games based on basketball, football, baseball, American football, tennis, boxing and other sports. Such games usually ignore certain aspects of the real sport in order to be able to be played on computer.

Paddle games - We use this term to describe a game based on the PONG game. PONG is certainly one of the most successful games, with more successful clones and sequels. The basic characteristic of this class of games is to intercept and divert the object that is moving. The original version was made for two players, an electronic version of the game ping-pong, from which comes the name. The version that made the greatest popularity was the one in which a player, who has the task of retrieving the ball, destroys a wall made of bricks.

Racing games - Some video games include classic racing. Most of these games allow players to move at a constant speed, and require players to skillfully avoid obstacles and operate the vehicle. For example, a player in the game of skiing has to avoid trees and rocks, the result is based on the time it takes for a player to finish the race. MATCH RACER is a racing car on the road with obstacles such as oil stains. NIGHT DRIVER is also a race car with a view of the road from the cabin. The problem with this class of the games is that they are not real games for several game-type puzzles, because there is no real interaction between players and enemies. Indeed, it is difficult to identify the enemy in these games.

Strategy games - Strategy games are another large group of computer games. These games favor thinking rather than handling. That does not mean that some of the games from skills and action have no strategic content. The main factor that distinguishes the strategic game of skills and games type of actions is that the game requires motor skills from a player. Strategy games do not require motor skills, while the games of skills and actions do. Playing in real time is very rare in strategy, although in recent years more real-time strategy appears on the market. Strategy games usually require more time for playing than the games of skill and type of action. Strategy games are rare on gaming consoles like the Atari 2600; they occur more frequently in the version for the home computer.

Adventures - This group of games is derived from one of the earliest computer games, which is also called 'Adventure'. In adventure a player moves through the complex world, collects items and tries to overcome every obstacle, until it finally reaches the goal.

D & D - Completely independent way of development was followed by games based on D & D games. The first game of this type was a board game, no computers, dungeons and dragons (Dungeons and Dragons) by Gary Gygax, which included research, cooperation and conflict, and was located in the fairy tale world of castles, dragons and wizards. Group of players led by leaders of the game, the so-called dungeon masters, go in search of treasure. The game is played with very few props. Players are around the table and use the block trading. The leader of the game defines rules of the game and controls the players. He has the authority to rule on all the events during the game. In this way we can create very complex systems without burdening the complex rules. The atmosphere is very relaxed and informal. For these reasons, D & D has become a very popular game, with unlimited number of variations.

War Games - The third subclass is war strategy games, games which are the most complex and most demanding games available to the public. Books with the rules often look like corporate merging contracts, and playing time is often more than three hours.

Games of Chance - Games of chance are played in the past several thousand years, and were expected to be implemented as computer games. They are quite simple to program, so there are many versions of these games. Despite the great deals, these games did

not prove so popular, mainly because they do not take advantage of the computer. These games are simply transferred from one game medium to another.

Educational and children's games - The next category are the educational games. Although all the games are educational in their own way, the games in this group are designed with explicit educational goals. A group of these games is still not so much popular, probably because people in the field of education have not yet addressed enough attention to creating games.

DEVELOPMENT TRENDS

Although the use of games in education recently became a hot topic, games have always been one of the available techniques for education. Education is often the first field for testing new technologies [7], and video games can be considered as a type of technology for education [29].

After several years of intensive research, during which the main focus was to attract attention to the possibility of using games in education, the situation has changed and led to wider interest in this area. Most people still believe that games can attract the attention, be effective and have place in the field of education [45].

What is now needed to do is:

1. research to show why learning based on games is efficient and effective.
2. development of practical suggestions on how games can be integrated into the learning process to maximize the potential of learning.

Unfortunately, we are not well prepared to give adequate instructions for making educational games because most recent research was focused on the propagation of the fact that games can be effective for learning, rather than for explaining why and which factors affect this.

Another problem is that until now, educational games were developed by people from academia, so even if they were good in educational sphere, they were not as good when it comes to games. Therefore, the basic tendencies of development should be a connection between pedagogy and designing games, in order to achieve successful educational games.

We can identify three ways of game development:

1. students make educational games
2. educators and / or game designers make educational games for the education of students
3. integration of commercial games in the classroom

All three approaches have advantages and disadvantages. In the first case, when students are engaged in developing the game, problem is that they are not professionally trained to design games, and the time they have available during the semester is limited. On the other hand, there is a positive effect on the students because they learn while they are making the educational game. In this way it is possible to realize the simple types of games that cover smaller parts of the curriculum.

The problem of the second approach is that if educators work alone, without the game designers they do not have enough professional knowledge, or resources, to make a game that can be compared with commercial games. On the other hand, it can be expected that the commercial companies will not be involved in the business of development of educational games until they can be proven as a profitable market. A third approach is the best from the standpoint of costs and benefits, but there is a problem of selection and integration of existing games into existing school curriculum [45].

Use of the media requires only that the media is integrated into the lecture. The integration of media, on the other hand, requires careful analysis of strengths and weaknesses of the media, and conformity with the strategy of education, methods and expected outcomes.

EDUTAINMENT

Most of the works that attempt to link the play and education are among the edutainment category.

Although the word is formed by merging the two words, education and entertainment (education and entertainment), the term is often used for each game that puts the focus on educational content. Basically it comes to the placement of official educational content (mostly elementary school programs) in an environment that resembles the game. From the point of designing games, these actions derive from educational content, which is later added to the logic of the game. Many authors believe that this is not good approach, and that it has negative consequences on the reputation of educational games [21,26,38,14]. This is because if the game is not well designed, it has no positive effect on motivation and engagement of players, so the effect on learning is not so positive at all [23].

Use of existing commercial games for training

On the other hand there are initiatives to use existing commercial games for educational purposes. Although in these games educational aspect is not taken into account during design, some of them have model and content rich enough to be used for education, if done properly. The two most famous examples of such games are SimCity and Civilization:

In the SimCity game, player has a role of a city mayor, and manages the development of the city. The work presented in [22] describes the experiences with this game, how it can be used for discussion on topics such as social dynamics and development. After the success of SimCity titles, many similar appeared which share the prefix 'Sim', with a focus on economic and practical problems of management in different environments. Such games are SimFarm and SimHealth used as a tool for education, as described in [41].

Civilization is a series of games, realized as simulation games, where players manage the development of entire worlds and infrastructure, military, research and scientific progress, which starts with an empty ground and ends with the developed world civilization [2].

Work of Barab and Squire [40] gives an overview of the experience with students who used the game in history class, and then analyzed and discussed the subject. These examples suggest that successful integration of commercial games in the process of education is possible. The basic advantage of this approach is low cost: the development of entirely new educational games that will be at par with commercial games is too high to be profitable, which makes access to the use of existing games very appealing [5]. On the other hand, there are limitations that may have a negative impact on educational potential. One of the main disadvantages is that these games are still designed for fun, without taking pedagogical and educational factors into account. Although realism and historical accuracy may contribute to the success of the game, every decision in which the party is threatened to be made in favor of fun is at the expense of education. Some of the concepts in these games are too simplistic and can lead to erroneous conclusions, as indicated by the papers presented in this section. Therefore, this approach should always be combined with the supervision of instructors, and frequent discussions.

Educational Games

After a short analysis of the previous two extreme approaches, we can conclude that none of them is optimal. The main factor for success is to achieve a balance between fun and learning in the model of game design [32]. Unfortunately, this is not an easy task. Design of the game is not an exact science, primarily because of the sophisticated nature of fun [23]. However, there are plenty of successful games that have managed to achieve a given goal, and that are presented to the players who are not interested in themes, motivate them to play the game to the end, and learn without being aware of it, simply by playing the game. Examples of these games belong to the wide range of games, from action shooter games to strategic and logic games. Here are some interesting examples: Monkey Wrench Conspiracy – first-person shooter intended to be a learning tool for the design. In the game, the player must construct its own weapons in the console that operates much like a software tool for that task. View given in [32] provides additional analysis of that game and the incredible results it achieved in terms of training as well as in advertising for a given software tool.

Virtual Leader [1] - game with a focus on learning advanced management. The game consists of a number of scenarios, representing different meetings at different levels and different subjects. The player can follow the participants at the meeting, their mood, and the ideas proposed and being discussed. The aim of the player is to present participants' ideas on how to be accepted and that the morale of other participants is not compromised.

Virtual UTM [46] - the player takes the role of the rector of the university, with a mission to lead the entire university, including budget management, staff, quality of teaching, research and other activities.

On the other hand, despite the existence of such successful titles, many other initiatives have not led to successful implementation of educational games. A major problem is the high costs of developing games, and the problem of finding a balance between fun and learning, so the game is fun, interesting and educational at the same time.

Another possible approach would be the modifications of existing commercial games in order to improve their educational value [34]. Although this approach would drastically reduce development costs, the problem of finding a suitable game design for education still remains. If the original game is engine specific, then it is a limiting factor for educational upgrading. On the other hand, when we utilize a generic engine (basically provides only low-level operations), technical requirements for development are high. Although the reduction of costs and technical requirements of educational games is desirable, recommendation is to use engine made specifically for the creation of educational games, which increases their pedagogical value, allowing educators to develop educational games. Such engines should be able to support creation of certain genre of games, which were described using domain-specific language developed for a particular genre. Given that these languages are specific for the domain, they would be easy to use and would allow educators to create and maintain their own educational games.

Hence, we promote the use of known approaches to the development of software engineering for developing software, which will allow easy creation and maintenance of educational games. The first step is to determine the pedagogical features essential for the development of engine and educational games [30].

GAMES AND HUMAN BRAIN

Some authors argue that if the children spend a lot of time playing games while growing up, it changes the structure of their brain. According to Carsten and Beck [8]: "Time spent with the games while growing up led to the fact that their brains are differently connected than brains of people who did not play the games well enough." Similarly, [32] argues that "the vast changes in the development of technologies in the last thirty years, of which video games are an important part, led to a dramatic and discontinuous changes the way people think, learn and process information ... The change is so great that young people today have, according to the intellectual style and preferences, a different brain than their parents and older generation".

GAMES AND TYPES OF INTELLIGENCE

It is known that different people learn in different ways and at different pace. Research shows that learning style is inherited. Some people visualize things when they think about them; others are more oriented to the description of words. While one group of people mostly use logic, others are more likely to rely on intuition. It is known that IQ is distributed according to a bell-shaped distribution, as is also well known that IQ tests do not measure all forms of intelligence. [20] says that in fact there are seven forms of intelligence, as follows:

1. Linguistic
2. Logical-mathematical
3. Bodily-kinetic
4. Spatial
5. Musical
6. Interpersonal
7. Intrapersonal (directed inward, self-motivation)

Different people will be interested in different types of games because of differences in their natural talents. We should not forget that people will not solve puzzles which they perceive as confusing and

are not well known and explained clearly. Greater probability is that they will choose the issues they think are likely to be solved.

People with bodily-kinetic intelligence will gravitate toward sports, while those with linguistic will end up solving a crossword or Scrabble.

The balance between motivation and learning

Aim of game-based learning is to provide an environment that is both fun and which enables the achievement of learning goals. [27,28] have identified four motivational factors in games:

1. Challenge: the structure of the game must be neither too simple nor too complicated
2. Control: A player must have a sense of manageability that may affect the outcome of the game
3. Curiosity: for example, opportunities to explore the world in the game can lead to unexpected outcomes
4. Fantasy: the perception of participation in the imagined world.

The main challenge when designing educational games is the realization of a balance between factors that stimulate the motivation to play in a way that does not harm the learning process. Games or simulations can easily distract players in the way that is counterproductive for learning. For example, games that have a fast logic do not leave time for reflection. Games or simulations that have a very detailed and realistic visualization and audio effects can lead to memory overload of the players. Also, games or simulations with rich worlds, can lead to significant activities of the players, but with very little learning. The solution lies in the careful selection of motivational elements in the game in a way that they support and not interfere with the basic psychological mechanism of learning. Nicole Lazzaro has conducted research looking at people when they play games, based on which he has found four groups of emotions that the players show in their facial expression: hard to have fun, easy entertaining, altered state, and human factors [25].

When we successfully resolve the issue given to us, we stimulate the brain with a dose of satisfaction [23]. If the inflow of new problems slows down, pleasure will disappear and can induce boredom. If the inflow of new problems increases above our capacity, we will not feel the satisfaction, as we will be unable to make progress.

State of flow (Flow)

It represents the time that most of the players are referring to as "being in the zone". One of mostly cited academic definitions is one given as Csikszentmihalyi's concept of 'flow' (flow), where flow - is a condition in which the player enters when experiencing an absolute concentration on the task (physical, mental or both), so he loses sense of time and the outside world [12].

Lazzaro [25] calls this phenomenon 'hard fun' (hard fun).

This condition is not achieved very often, but when it happens it is a great experience. The problem is to precisely match the challenges and the capabilities of the player, which is a very difficult task.

If they had been in this kind of situation, the players usually ascertained "This was really fun." If it was not the case, they would say: "... it was fun" but with less enthusiasm. It does not mean that there is no fun if there is no entry into this condition. So the fun is not a state of flow. The state of flow can also be experienced in many situations that are not fun.

Evaluation and verification of knowledge

Thibault also talks about the need for constructing a framework to test the learning through play, based on cognitive psychology, design, games, machine learning, neurobiology and theories of education. Until a unique methodology comes, which will be widely accepted, we will require the presence of people in the process of testing knowledge. Full automation of the test cannot be expected before that [43].

Currently, the knowledge verification is reduced to the traditional ways of testing and self-checking which is given to the player before and after playing the game. On the other hand, video games have

the potential to change the way of how we perform tests [39]. Utilizing the games as a tool for testing knowledge, necessity to use conventional tests will be reduced, since knowledge verification will be integrated in the course of the game. Lecturer, or the software itself, will be able to determine whether a student understood some of the material or not, based on the behavior of the players. This is the direction in which we should go in the future.

ACCEPTANCE BY THE TEACHER

The differences between the new generation, which Prensky calls the "Digital Native", and the older generation that is called "Digital Immigrant" is the source of many problems for the application of games and new technologies in the classroom in general [33,15].

Most of the experience that today's teachers have with the technology is reduced to word processing, database, presentation software, and possibly work with multimedia and the recording and broadcasting video. Given that teachers in class use technologies which they know how to manage, it becomes clear why the use of games in the classroom is not represented to a greater extent.

GENDER DIFFERENCES

Historically, toys and games were always different for boys and girls. Although boys and girls play together, and often play the same game, the way of enjoying the game is very different. If we analyze the way of playing, we can try to find out how male and female brains are engaged while playing. There is a clear difference in playing style as well as in toys which boys and girls traditionally use. The reason for these differences may be in the way the brain works, and the different roles they play in society. In any case, the observed differences are part of today's culture and should be explored further.

Many popular board games have proven to be neutral in terms of sex. Also, the first electronic games, like Pong, are equally suitable for both genders. [42]. However, girls and boys are usually divided into groups, in order to play different games [44].

Barbie (Barbie) is one of the most popular toys for girls, often the number one choice when it comes to gifts for the holidays [31]. Identification with Barbie is a common phenomenon and Dress up Barbie dolls for different occasions are an important activity during the play [24]. Later, shopping for many women is the sequel to Barbie dolls. Indeed, the shopping centers are initially made keeping in mind the female consumers [37].

One of the most popular and best-selling games, The Sims, is also a rare game that is played more by females [16]. For many females, the relationship between playing The Sims and Barbie is very strong. Creating a character, equipping houses with furniture, paintings and editing situations are the same tasks.

One of the arguments often cited in relation to females and video games is that females are not willing to devote so much time playing. According to a study conducted at high school, girls spend only 6% of their time playing games, while boys spend 38% of their time. [6,36].

In a study conducted by [4], the presented results indicate that the time spent on playing games decreases during the first and second years of secondary school, although boys are still playing an average of 6 hours per week, while for girls playing time falls to 2 hours per week.

While it is clear that there are individual differences, numerous studies confirm that there are differences between the sexes in the context of learning, thinking and playing. [3,17,19,44]. On the other hand, individual differences may be stronger than gender differences [19]. In order to better understand the differences between the sexes, it is necessary to understand how the brain works.

Today, the brain can be seen in greater detail, using magnetic resonance imaging. The brain is influenced by hormones from birth. [17] found differences in how male and female brains collect, process and use information. With more neural fibers, the female brain is connected in a way that helps women detect small changes and differences in the emotions of others. Women have more active frontal part of their

brains and are quicker to master the language, and are considered to have higher verbal ability. Females also interact more with others using the language. Women are better at executing multiple parallel tasks [17].

Men are oriented towards the visual, and their ability to cope in the space proved to be better than for most women. They also proved to be better at abstract thinking. Men better remember the simple information [17]. All this gives men an advantage in playing video games. The boys were able to talk for hours about the skills of characters from video games, details of the game to be compared to each other. Above all, boys are more aggressive than girls and more oriented towards the goal. They are mainly focused on one thing at a time [17].

All these differences come into play when boys and girls play games and learn. So girls prefer to solve problems by concluding, through discussion and reflection. The boys prefer a visually stimulating environment where they can learn. Men also like the competition and race against time [17]. Most boys prefer to learn new material through the method of trial and error. Try, and if they guess the answer they go further, and if not, they try until they hit it. Eventually they will remember the correct answer, in order to progress further through the game. Girls, on the other hand, spend some time analyzing the issues, thinking about them and in consultation with their tutor and colleagues. When they finish with the question, girls know the matter, but progress slower than men through the game. Thus, tests with multiple choice questions are much easier for boys than for girls, due to the different approaches [17]. Boys are more prone to guessing, while girls prefer to know the correct answer before they mark it. One more thing, girls are disrupted by the noise and disturbance from the environment when they learn something new.

To be effective, the game must have elements that are appropriate for both sexes. But this is not an easy task. It is especially difficult to design games for women, since the software is not yet sophisticated enough to match the female brain, which processes data simultaneously and is excellent in communication and thinking.

Games and older

A study conducted by Cramer revealed that the elderly in their sixties or seventies can improve their cognitive function by playing strategic video games, such as nation-building and conquering territory. This is one of the first such studies, which confirmed the positive impact on cognitive abilities, even those that are not used in the game [10]. The author is most interested in whether the training conducted by playing video games can improve cognitive skills used in everyday life. They chose to play "Raising the nation" (Rise of Nations) that allows players to build worlds, food and employing people, maintaining an army and conquering new territories. The results have shown that this type of training improves the ability of participants, as measured by different assays. Compared to the control group, the players have become better and faster in switching from one task to another. Working memory has also significantly improved and it also positively affected reasoning abilities. To a lesser extent, the players have shown better short-term memory and visual memory, as well as identification of objects. Training video game had no effect on the ability of remembering lists of words, numbers, or the ability of giving certain answers. One of the conclusions was that the effect was similar to the effect of drug - more training leads to greater prosperity. The general conclusion is that playing certain video games can certainly help the elderly to maintain cognitive and mental abilities.

Conclusion

There are many open questions on the application of games in education. Van Eck [45] pointed out that research should explain why educational games are effective, and provide practical guidance on how educational games should be successfully implemented with the aim of maximizing the educational potential. In addition to research in the filed of educational games, he pointed out the problem of how to operate different types of games and how that affects learning. For example, simple card games can be good for pattern recognition and connecting concepts, and adventure games, on the other hand, promote access to test hypotheses and solving problems.

Further research, in order to promote the use of games in education, should address the following issues:

1. how to design educational games in order to achieve better learning effect
2. development tools for the automation of the educative game production
3. propose methods and techniques in order to test the knowledge and skills acquired through educational games.

Several research teams have recently made a number of experiments and analyzed the results, in order to test the effectiveness of the usage of games and simulations for learning, but there are no clear and common findings, except one: the need to implement better and more qualitative research.

Hays [18] has found over 270 papers on the application of games in education, but only 48 of them include any empirical data. His conclusion is that "empirical research on the effectiveness of games for education is very fragmented, full of poorly defined terms and methodological flaws. Some games provide an effective solution for certain tasks under certain circumstances, but the results can not be generalized to other games or educational software".

There is still no unimpeachable evidence of the efficiency of games in the classroom, as well as for educational games compared with traditional methods. Eric Klopfer, a professor at MIT says that the question: "Are games educational?" is set too wide. It is clear that some games are educational, while some are not. Investigations are still at an early stage, but some studies are promising and demonstrate the potential benefits of applying games in education.

Another problem that occurs in most of the existing educational games is the lack of thematic portability. The essence of the problem is that the complete knowledge of the whole system and games is intertwined and inextricably linked only to one specific game. Development of new games requires the development of an entirely new system and collection of knowledge related to the new area. Research question is how to enable knowledge portability between games.

From the foregoing, our proposal is to develop a unified framework for development of educational games, which will define the methods, techniques and tools for production of educational games.

Developing such a framework requires a multidisciplinary approach and cooperation between scientific disciplines, such as psychology, computer science, and human-computer interaction.

Single framework for development should resolve most of these problems, and identify systemic approach to educational games, which would reconcile the different roles of the participants in this process. Method development should define the process of development that will include the creation of educational content, design and logic games, as well as the development of software systems, using the experience gained in each of these areas independently, in such a way as to allow the creation of effective educational games.

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EXTRACTION OF INFORMATION IN THE CONTEXT OF BUSINESS INTELIGENCE

Branko Latinović

Pan-European University APEIRON, Banja Luka

General survay

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Summary: business Intelligence in the developed business systems allows better reasoning and decision making. ETL processes represent the most important processes in the system of Business Intelligence. It is about extracting, transforming, and filling a Data Warehouse with data which then transforms into data that is by its nature new and presented in a way that is meaningful and useful in an actual business organization. In conjunction with the methods of Information Extraction, knowledge is significantly expanded and given a completely new image. Intention is the collection of data that is available and processing the same in one place, regardless of whether the data was in a structural form or any other.

Key words: Business Intelligence, Data Warehouse, Information Extraction

INTRODUCTION

Information technologies today, represent a dominant infrastructural way in almost all spheres of social life. With that, collection, safe-keeping, processing and use of data and information, give modern management a whole new character. These activities are creating functional knowledge for the decision making process.

The business is based on data which is transformed into information and knowledge. Business organizations transform information into knowledge, into business solutions in several ways. The process starts with collecting data from various sources and storing it into database, then selection and processing of that data in order to be in a format that fits the data warehouse. Then users are using data from a data warehouse for analysis. The analysis is done by using the analysis tool that searches for patterns and by using intelligent systems that support the interpretation of data [6].

From the existing data sources which can be transactional data sources, OLAP cubes, various ERP and CRM solutions, as well as texts which are located on local PCs , data is extracted, transformed and filled with so called ETL processes into analytically oriented systems or data warehouses. Data warehouse is a system which is with its structure modified to fit analysis and business concept of its users, and it is not that dependent on the platform and base type, in which it will be implemented. After the data base construction, the report system and analytics are built.

Contribution of the information extraction methods to the business intelligence is clear in itself. It is about new information that with these remakes is becoming available and which further contributes to the development of final reports and the eventual making of the decision that should be the result of the whole data processing whether it is the case of structured data or unstructured data. Less clear is the impact that methods of deep data analysis can have on the systems for information extraction. Finding different non-obvious connections between data acquired from textual documents, one can come up with new findings and ideas in regards to what type of information is even useful to search for in the text, and with that, a sum of extracted information which is useful is growing over time.

BUSINESS INTELLIGENCE

Business Intelligence (short BI) is a set of methods and software tools which enables use of data from the

data warehouse (short DW) and its transformation into information needed for the business decision making.

Business intelligence system is such system which saves information and knowledge about competition, buyers, suppliers and processes. It allows business negotiations and reasoned presentation towards buyers and suppliers, quality operational planning, competition behavior tracking, certain market segments' overview, and future events forecast. Besides stated, business intelligence system offers better insight into understanding of existing buyers and knowledge into what stimulates them to behave in a certain way.

Business intelligence started developing intensively when business organizations automated their business processes, i.e. when they implemented different transactional systems, which have very soon proved as generators of large amount of information. From the technical point of view, business intelligence is a process with which raw data is transformed into information. Such information is then analyzed and used in the decision making process within the organization.

Conducting business intelligently means introduction of a business intelligence concept deep into the existing organization's structure. This raises a question: In which way can the business intelligence be successfully integrated into business processes of the organization so that employees could at any point in time use it and give their personal input in the realization of the strategic business goals. Every next point, every next business intelligence implementation project will rely on strategic goals which have been identified in this initial step, and which are documented in the business strategy of the organization.

When organization's strategic goals are in question, it is necessary to have an absolute agreement on their definition, and each one individually, represents the base for a potential business intelligence project. Employees must come to an agreement in regards to priorities related to the strategic goals, so that it is clearly defined which one will be chosen as a base for the initiative in the field of business intelligence.

One of the strategic goals can, for example, be "operational costs reduction". On the basis of this example question can be raised: "how does business intelligence help in the operational costs reduction?"

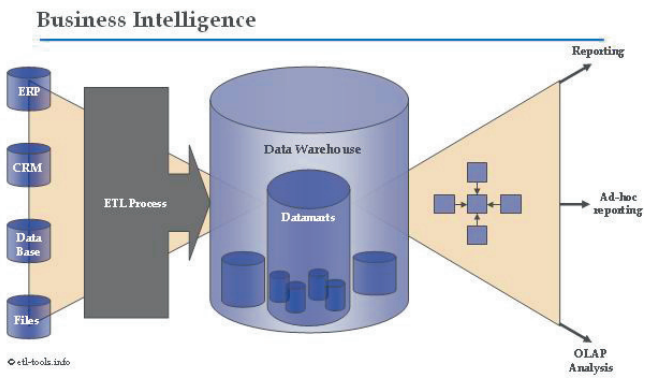
Key is in the identification of the business intelligence service in every process in order to achieve set goals, then in the business intelligence integration into these processes, and at the end, it must be taken into consideration that one business process can be intertwined through more organizational parts of the organization.

Because of that, it is not only important to understand the business process, but also the role of the people involved in that process, as well as applications which they use in each of their activities. Such approach is necessary in order to understand the mechanism of business intelligence integration into business processes.

Some activities in business processes happen automatically and are controlled by software, while others are done manually and are controlled by people, participants in the process [1]. In automated activities business intelligence is integrated directly through some technology, i.e. web service technology. In case the activity is controlled by an individual, some issues must be addressed. Primary issue is the role that each individual has, as well as the application that individual in question is using in the development of a certain activity of the business process.

Also, there are some technical questions as well, for example, is the individual in a remote location and will it access business intelligence through a mobile device? Role identification is equally important so that proper business intelligence form is applied in the context of specific business activity which participant with certain role, is conducting, and at specified time. Business intelligence system architecture, Picture 1.

Picture 1. Business intelligence system architecture



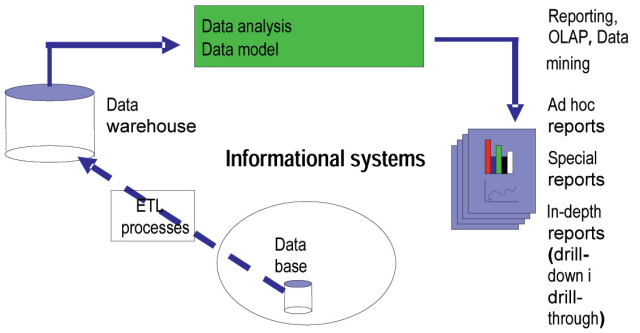
DATA WAREHOUSE

Today, every organization or a company disposes not only with a large amount of information, but also with a large number of data sources, hence the need for the integration of all possible systems. Big step in this regard has been made with the introduction of data warehouse which should put together all data within the company, independent of the type of data or an application, but here all the textual documents are neglected. In order not to, again, come to the separation of the systems due to different types of inputs, there is a need for the integration of information which is available in non-structural or semi-structural text. The goal is to later equally use that information with all other data available in common forms and ways.

As getting the quality information on time is important for gaining the advantage over the competition, the manager must get the same information as fast as possible and in the form which is adjusted to his needs. From that is concluded that from today's companies' informational systems is expected to secure information which content, performance speed and the way it is presented, conforms to immediate needs of the manager in the decision making process. While for the purpose of operational business management, classic data bases are used, based on relational model, and fast, the actual state of the system with certain data, after it is updated, is lost, and for the purpose of making correct business decisions, it is necessary to have insight into business events time line, so such data bases do not represent satisfactory solution.

Due to the above stated phenomena, new ways of information organization in informational system of computer memories are created. Developed is the new generation of computer systems based on the concept of data warehouses. Data warehouse contains information collected from different sources, company's business historical data, as well as data outside of the company, and it is designed in a way that allows data search, on-line analytical processing, reporting and support to the decision making process. Date warehousing process illustrated in Picture 2.

PICTURE 2 DATA WAREHOUSING



Data warehouse is by technical specifications and by content, different from transactional systems based on transaction manipulation. Even though operational base is its assumption, data warehouse, in its design, relies on multidimensional concept. So, the new generation of computer systems now consists of two parts, operational (transactional) and data warehouse (analytical), which achieves separation of the information generating processes (extraction, aggregation, reporting, analysis) which by their nature differ from operational processes.

According to the definition created by Inmon [9], data warehouse represents subject oriented, integrated, time-variant, and non-volatile sum set of data, and it ultimate goal is to help management in the decision making process.

Subject orientation of data means that data is organized around subject, in a way that it gives information about clearly defined subjects within the functional field (i.e. sales, procurement, etc.) instead of about current operations of the company. Opposite to this, operational data bases are organized around business applications, so they are directed towards the current operations (i.e. order processing, deliveries and similar).

Integration means that data is collected into data base, from different sources and it is always stored in the same format, so that it is shown in a consistent manner.

Connection to the time means that all the data in data warehouse is identified in relation to a certain time period, meaning that it has a historical character. As oppose to that, in operational data bases,

stored are only current, and the most recent data. However, from the point of view of business intelligence concept, all-inclusive future events forecast is not possible without the history knowledge of the same or some other events. This means that even though data in the data warehouse reflects past, its orientation is towards the future.

Non-volatility requires form of data that it is stable and once stored in the warehouse, by rule, is unchanged. This allows management or anyone who uses data warehouse to be sure to get the same answer regardless of time or frequency.

Data warehousing process represents continuous planning process, data collection from different sources, data use, maintenance management and continuous upgrade. Among many steps in this complex continual process, it is important to emphasize the importance of having a vision of what is to be achieved by creation of a data warehouse. One of the roles of warehouses is development and use of data-based knowledge. Primary function of data warehouses is collection of data and creation of logically integrated and subject-oriented information. Warehouses should be modeled in a way that they could easily and quickly be modified to all the changes and requirements in the business environment.

Taking into consideration subject-orientation of the data, when modeling warehouses applied are techniques which support subject orientation and secure enough adaptability in order to, over time, be able to integrate data from additional sources. Data warehouse should be a source of stable data, independent of eventual changes in the business processes. Free from operational processing, data warehouse secures information generation process upgrade, and through techniques of knowledge discovery secures continuous findings of new information.

ETL process is a term for a data transfer process from data transactional systems into data warehouses and unavoidable link to a development of business intelligence system. The name comes from an English words extract, transform and load. ETL process includes:

- (Extract) collection of data from the outside sources,
- (Transform) data adjustment in line with business needs,
- (Load) data upload into data warehouse.

ETL process is very important because it defines the way of data upload into data warehouse. Term ETL can be used for naming the upload process into any data base.

Collection (Extract)

First phase of the ETL process is data collection from different system sources. Each individual system can be using different organization or data format. There are many different data source formats, and most often are used relational data bases or unrelated data bases. After completing data collection, they are in columns which are sometimes called fields. After this, each type of data can be individually processed.

Transformation (Transform)

Transformation phase refers to a series of commands or functions within collected data which secure data upload. Some data sources do not require complex processing of e-data. In some cases any of the below listed processing combinations may be demanded:

- Upload of only specifically chosen data column
- Recalculation of coded value (i.e. system source stores M as a mark for male and F as a mark for a female)
- Securing the new recalculated value
- Pulling the data from multiple sources at the same time
- Sum of more data rows (i.e. joint sales of all regions)

Upload (Load)

In the upload phase data is uploaded into data warehouse. The scope of the process depends on the size of the company or organization. Some data warehouses exchange old data with new, and complex systems may even store data from the past and track its changes.

INFORMATION EXTRACTION

Basically, there are two types of extraction of information, depending on the type of texts that are manipulated. The first relates to the extraction of knowledge and it is possible if the documents themselves contain that knowledge, not just a group of data, which should undergo further processing. The main problem in this approach to information extraction is that the extraction of knowledge is extremely complex because of the language features and demanding methods of processing of the natural language. In addition, most methods can find connections between data that is physically located near one another, but some further cause and effect relationships are much harder to detect. When the extracted information is actually a specific value, we cannot treat it as knowledge, and it is necessary to make another step. This applies to in-depth analysis of extracted data. This process of extraction of information actually serves to convert the text into a structured record of the same information, and shall continue to apply some of the methods of in-depth data analysis or this information is further only treated for the purposes of reporting within the business intelligence [8].

Information extraction types

Extraction types are not strictly determined when it comes to the rules of information extraction from the texts, by information extraction methods. However, there are common types of information extraction which are used in most systems. Those types are based on distinguishing the names, finding of phrases with the same meaning, semantic roles, connections between entities and time periods. All other information is dependent on the specific system and actual textual source of the information [4].

Distinguishing names refers to distinguishing and classification of terms in the text which define some name of the person, organization, place, position, etc. This is the simplest, but also the most reliable information extraction type. When we talk about phrases with the same meaning, then we have synonyms a.k.a. different names for the same person or a thing. In use are also different linguistic elements which reference direct description of an actual object somewhere earlier or later in the text. Good example of such linguistic element are pronouns *he* or *she* which refer to the already mentioned person.

Semantic roles are assigned to different syntactic parts of sentences. They determine some actions or states of participants, and consequences, and can be more or less generalized.

There is also a possibility of detecting the connection or relation between the entities found in previously mentioned methods. Typical examples of such relations would be that such specific person (first entity) works for the specific organization (another entity) and lives in a particular place (the third entity).

Recognizing the time elements takes place in two phases. In the first phase, expressions of time are to be found such as absolute time or a specific date or time, the relative temporal expressions such as, for example, yesterday or tomorrow, the relative terms related to a specific event, periodically repeated, etc. After finding such expressions the timeline can be determined in which certain events occurred.

It should be emphasized that all the information that can be found in the text is independent of the domain of the text, but also could very well describe some event or object. Some events are often also interdependent, so the next step is to connect a series of events into a more complex scenario [5].

Methods

Theory and practice distinguish two basic ways of extracting data such as [3]:

- Knowledge engineering approach or symbolical techniques and
- Automatic trainable systems

With first method it is necessary to have rules, which are mostly created by linguists in cooperation with experts in the field under which system operates. Here, most of the time is spent studying a set of documents and generating and optimizing a set of rules. The problem is that information can be found in different shapes and contexts, which is very hard to predict in advance and take into consideration all the cases with the help of rules. With automatic learning everything is based

on statistics and additional linguistic knowledge is not necessary, which means that they are independent of the language of the input documents. The biggest problem with this method is a need for a large set of input documents, which are used for studying in order to achieve rationality of the system. These methods are much more efficient and there is a significant number of learning methods which can be applied to this type of information extraction [7].

Symbolical techniques

During the knowledge engineering which is still used for information extraction, often are used regular grammar and regular expressions, which do not permit the emergence of elements that are not final. It is clear that this is a partial parsing, where taken are only predetermined parts of the text while others are ignored. Regular grammar can very well show patterns in the text, and when implemented using final automat it is very efficient in parsing text. Final automats are often used during the extraction of information, because many samples in the text have fixed, pre-defined order. For a complete natural language processing final automat is not good enough. For this reason we moved from the merger of several final automats in the network, which can be organized in several ways. In any case, final automats have many limitations, but their main advantage is that they are fairly easy to implement and maintain, as a result of a relatively small set of regular expressions with which they are defined. Moreover, the additional advantage of this approach is the high-speed parsing of the text [2].

Automatic learning

Information extraction is often done with the help of automatic learning methods. Since it is the case of detection and recognition of certain information within large amounts of text, it all actually comes down to recognition of samples, i.e. their classification. Samples are recognized based on a combination of features and their values. In this case those features are text characteristics which can be identified and measured. Automatic learning methods replaced manual creation of rules and knowledge creation based on which, information extraction would be performed. Besides, additional advantage is that those methods are not of deterministic nature, but certain element can be added to a certain class with specific probability. Human being actually functions in the same way, because while reading the text we come to many conclusions based on some uncertain information. That uncertainty is also, later on, during further processing of received information, good to take into consideration. [6, 2]

Conclusion

In order for business intelligence systems to really include all available information and the conclusions that can be drawn from them, it is necessary to introduce additional sources of data. One large and poorly explored set is text data, which capabilities with appropriate treatment are extremely high. In this direction one can start moving by using the method for information extraction, where information is what needs to be found and represents a new assignment for which purpose it is necessary to consolidate knowledge in the field of business intelligence, and the processing of text data. Combining these two methods, business intelligence gets a new dimension.

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MEASURING THE CHARACTERISTICS OF DG CAC ALGORITHM

[1]Goran Đukanović, [2]Milan Šunjevarić, [3]Nataša Gospić

[1]Telekomunikacije RS a.d., Banja Luka, [2]RT-RK Computer Based Systems LLC, Novi Sad,

[3]Faculty of Transport and Traffic Engineering, University of Belgrade

Contribution of state of art

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Abstract: Users today expect email and instant messaging access, surf, video games and other services through mobile broadband access networks. In order to support this increasing data traffic, advanced resource management has to be implemented. As CAC (Call Admission Control) algorithm plays an important role in this resource management, comparing of two proposed call admission control algorithms has been done in this paper. Algorithms are tested in simulation environment, for two different periods of time. They showed expected characteristics in both 1000 and 10000 seconds periods, and newly proposed DG CAC algorithm showed better results than other algorithm, in number of handover requests, and in the way of returning resources to degraded connections.

Keywords: CAC, QoS, UMTS, Wireless.

INTRODUCTION

Most contemporary and future wireless networks support data and voice services. Wireless data traffic is expected to grow significantly in the next period. Cisco forecasts that mobile data traffic will increase 39 times between 2009. i 2014 [2]. 66% of that traffic will be video traffic. Portable devices and smartphone will carry 91% of data traffic. The reason for this is in the nature of device which is easy for use for high quality video.

With the increasing number of requests for mobile multimedia services (audio, video, data transfer), it is expected that the next generation of wireless networks ensures QoS for multimedia services. Those multimedia services are required by many users, and most of them are in constant movement, on the whole territory. In heterogeneous wireless networks, users requires service transparency, distributed service quality and seamless handover. In that sense, user in handover should not experience any significant data loss or latency.

In most cases the best effort that QoS has is enough for simple data transfer service. For advanced multimedia services, which are great resource for consumers, however, the best effort is not sufficient, and better QoS mechanisms have to be implemented in this type of wireless network. Scarce spectrum resources are often the major problem in wireless multimedia networks. Spectrum is always limited, and network responsibility is to efficiently ensure resources on the fair basis to different users. Network controller should ensure that different QoS requests are enabled for each type of service.

For this purpose Call Admission Control algorithms are used, which were active research area in the last two decades, and are still being researched [4, 11, 10, 9, 1]. Many different types of CAC algorithms are developed in the last few years. For the WCDMA network, we receantly proposed a DG CAC algorithm and published it in [4]. DG CAC algorithm is based on the idea of dynamic resources management and dynamic guard margin. Since static reservation schemes often results with not so advanced resource utilization, dynamic adjustment of optimal guard bandwidth is proposed by many authors [11, 10, 9, 1, 6].

In this paper we test this algorithm for different simulated conditions and compare it to last proposed algorithm, in order to examine the behaviour characteristics in congestion environment.

Spectrum is a limited natural resource, and it is a common practice to share it among many users of wireless system.

The rest of the paper is organized as follows. In section II resource utilization and system model for simulation are explained. In section III degradation rate is defined and simulation method is explained. In section IV simulation results are presented, followed by conclusion.

RESOURCE UTILIZATION PLANNING AND SYSTEM MODEL

Planning resources in a fixed network is a relatively simple task, and it is possible to prepare it in advance. Mobility in wireless networks except having the freedom of movement and using services, also brings some unpredicted movements and user groupings. This means new responsibilities for operator, like preserving the service continuity through high handover quality. No service shall stop during the change of a cell.

In order to ensure the quality to the users, and to keep wireless network beyond congestion level, most advanced call admission control algorithms have to be used. This means using different class of services, and using algorithm which will ensure the least number of rejected requests during handover, and which will respect used class of service. In 2G network, situation was quite simple, since controlling of hard capacity is easy, and CAC algorithms always were algorithms considering only voice. Soft capacity in 3G networks requires more advanced resource control algorithms. Rate-adaptive multimedia applications can adapt to different bit rates and to different network conditions, e.g. MPEG-4 [7], and H.263+ [8] can support various bit rates.

In this paper, in order to test A2 algorithm characteristics and degradation properties as well, which was proposed in [4], we have tested it in simulation and compared it with earlier proposed algorithm A1 [3]. In order to test the degradation level released through restitution of required resources, as well as duration of degraded user's statuses in DG CAC algorithm proposed in [4], we conducted extended measures during 10 000 s on the algorithm. In that way we expect to get a better insight in user's status after enough resources are free, and to expose the restitution mechanism to test it in simulated activities.

DEGRADATION RATE AND SIMULATION METHOD

As a measure of user satisfaction, we defined a degradation rate. Degradation rate *DR* is here calculated as follows:

$$DR = \frac{DR_{total}}{N_{active}}, \quad (1)$$

where

DR_{total} is the total number of degradations (of all classes together), where the first level of degradation is calculated as one degradation, and second level of degradation is calculated as two degradations,

N_{active} is the number of active users.

For the simulation environment we developed a system with two overlapping cells, one UMTS and other being WLAN, and users distributed randomly through the cells. In simulated user movements, all the output parameters are measured and acquisitioned in each time step during the whole simulated time.

For the simulation input parameters, following parameters were used:

1) Populations of WLAN and UMTS users (250 WLAN and 1 UMTS in the beginning);
2) Powers of UMTS B-Node and WLAN Access Point (21 dBm, 20 dBm);
3) UMTS B-Node gain and Access Point gain (18 dB, 5dB);
4) Gains of UMTS and WLAN user antennas (0 dBi, 5 dBi);
5) Carrier frequencies for UMTS and WLAN (2100 MHz, 2400 MHz);
6) Handover thresholds for UMTS and WLAN users (-120 dBm, -84 dBm);

7) Moving speeds of UMTS and WLAN users (10 m/s, 2 m/s);
8) x and y positions of B-Node and Access Point (B-Node: x=1885.9 m, y=1885.9 m, AP: x=3836.9 m, y=1885.9 m);
9) Simulation duration (1000 s, and 10000 s);
10) Time step size (5 s).

The simulation software then calculates B-Node radius, and with our given parameters it gives 1642,6 m.

SIMULATION RESULTS

For defined input parameters, simulation gives the results as presented in this section.

FIG. 1 TOTAL NUMBER OF HANDOVER REQUESTS DURING 1000 SECONDS

Fig. 1 shows the total number of handover requests. This number is independent of algorithm type, since it is connected to user's movements in simulated environment. For that reason this number is the same for each algorithm. Figure shows cumulative status, meaning that in each exact time point, the total number of requests until that moment is shown. We can see that the number of requests range from around 60 up to some 150 requests in total.

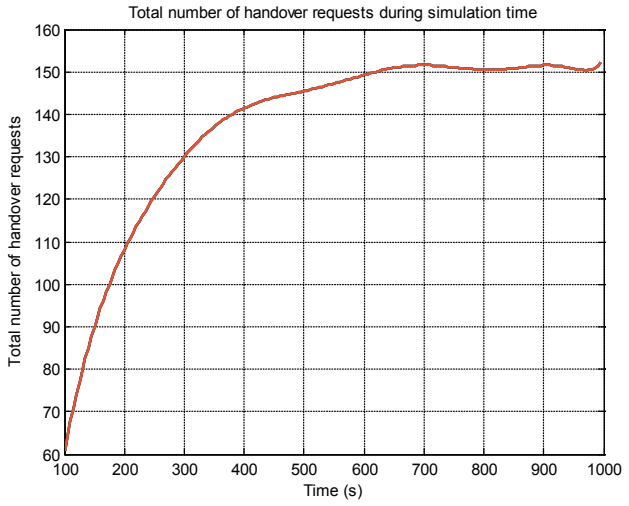


FIG. 2 TOTAL NUMBER OF HANDOVER REQUESTS DURING 10000 SECONDS

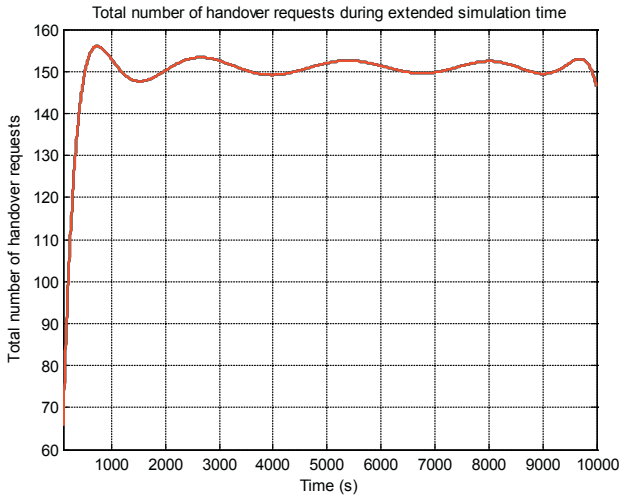
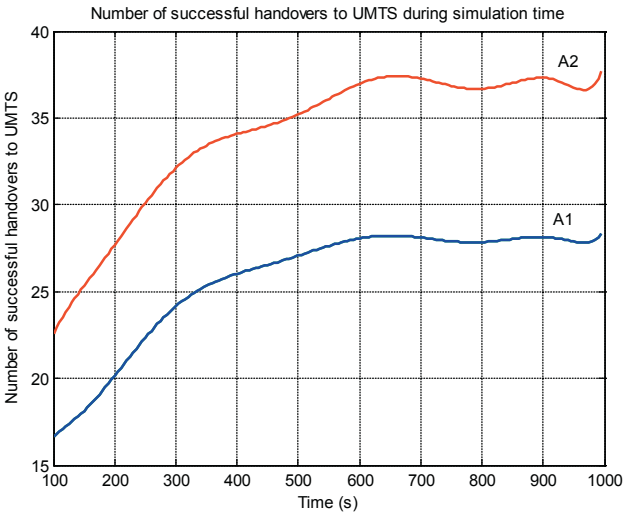


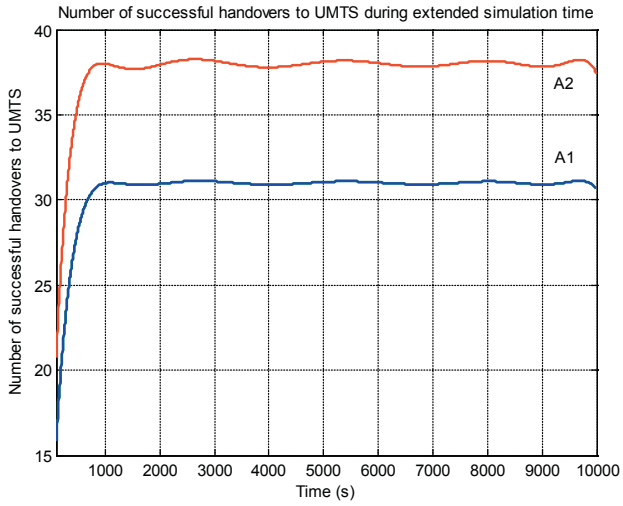
Fig. 2 shows the total number of handover requests during extended simulation time to 10000 seconds. It can be seen that after 1000 seconds the number of handover requests is stabilizing. The reason is that users are more and more leaving the observed cell, and the number of handover requests is decreasing after 1000 seconds.

FIG. 3 NUMBER OF SUCCESSFUL HANDOVERS TO UMTS DURING 1000 SECONDS



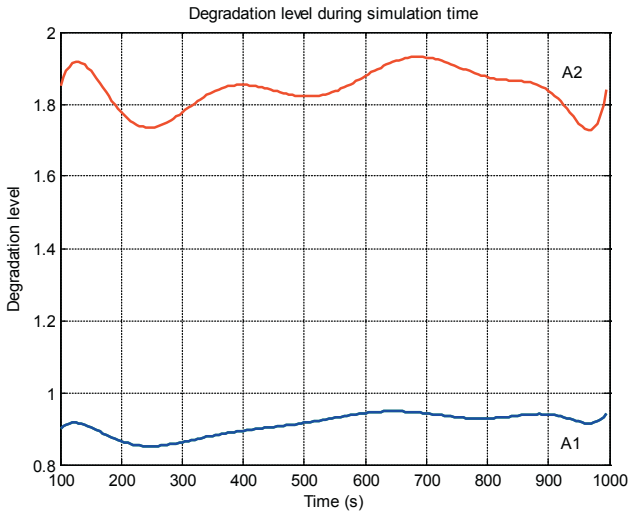
In Fig. 3 the number of successful handovers to UMTS during simulation time is shown. Algorithm A2 accepted more handover requests than algorithm A1 during simulation time. For the reason of testing algorithms' behaviours during longer time, simulation time is extended ten times.

FIG.4 NUMBER OF SUCCESSFUL HANDOVERS TO UMTS DURING 10000 SECONDS



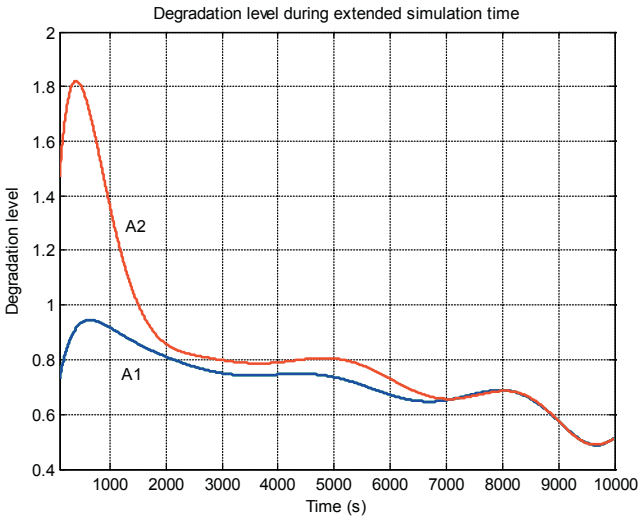
In Fig. 4 the number of successful handovers to UMTS during extended simulation time is shown. Algorithm A2 accepted more handover requests than algorithm A1 during extended simulation time as well.

FIG.5 DEGRADATION LEVEL DURING 1000 SECONDS



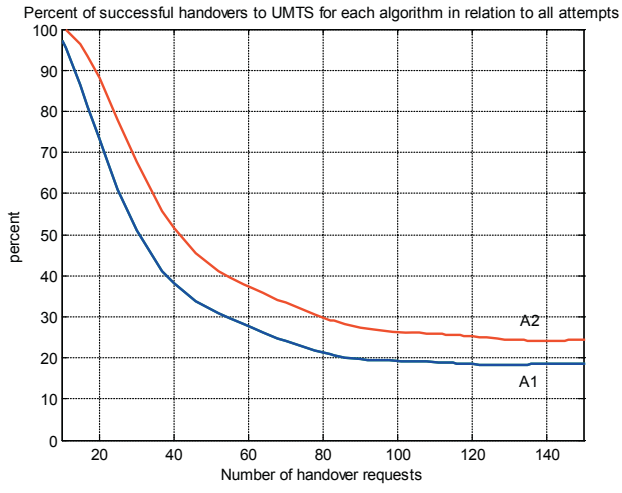
In Fig. 5 degration levels for A2 and A1 algorithms are measured. Algorithm A2 uses more degradation in congestion situation than algorithm A1. This is due to the involved critical bandwidth for incoming requests in A2 algorithms. Measures here represent real degradation rate in every time step, and not a cumulative value.

FIG.6 DEGRADATION LEVEL DURING 10000 SECONDS



In Fig. 6 degradation level for A2 and A1 algorithms is shown. It is clear that algorithm A2 is doing a quick restitution of degraded resources to degraded connections with congestion decrease. Measures here represent real degradation rate in every time step, and not a cumulative value.

FIG.7 PERCENT OF SUCCESSFUL HANDOVERS IN RELATION TO ALL ATTEMPTS



In Fig. 7 the percent of successful handovers to UMTS for each algorithm in relation to all attempts is shown. Measuring during 1000 seconds gives almost identical results as measures during 10 000 seconds, and because of that reason, here is presented only one graph. It can be noted from the graph that algorithm A2 shows always bigger percent of successful handovers for all values of handover requests.

CONCLUSION

In this paper new measures on DG CAC algorithm have been done in order to test algorithm's behavior in extended time and to compare it to our previous algorithm A1. The number of successful handovers to UMTS during extended simulation time remained bigger for algorithm A2. Measures showed more intensive use of degradation force by algorithm A2 in 1000 seconds period. However, in extended measures it showed quick degradation level released through restitution of required resources to earlier degraded connections. The percent of successful handovers to UMTS for each algorithm in relation to all attempts showed better results for A2 algorithm.

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Comparable Evaluation of Contemporary Corpus-Based and Knowledge-Based Semantic Similarity Measures of Short Texts

[1]Bojan Furlan, [2]Vladimir Sivački, [3]Davor Jovanović, [4]Boško Nikolić

[1](bojan.furlan@etf.bg.ac.rs), School of Electrical Engineering, University of Belgrade

[2](vsivacki@gmail.com), School of Electrical Engineering, University of Belgrade

[3](mdmdavor@yahoo.com), School of Electrical Engineering, University of Belgrade

[4](bosko.nikolic@etf.bg.ac.rs), School of Electrical Engineering, University of Belgrade

Case study

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Abstract: This paper presents methods for measuring the semantic similarity of texts, where we evaluated different approaches based on existing similarity measures. On one side word similarity was calculated by processing large text corpuses and on the other, commonsense knowledgebase was used. Given that a large fraction of the information available today, on the Web and elsewhere, consists of short text snippets (e.g. abstracts of scientific documents, image captions or product descriptions), where commonsense knowledge has an important role, in this paper we focus on computing the similarity between two sentences or two short paragraphs by extending existing measures with information from the ConceptNet knowledgebase. On the other hand, an extensive research has been done in the field of corpus-based semantic similarity, so we also evaluated existing solutions by imposing some modifications. Through experiments performed on a paraphrase data set, we demonstrate that some of proposed approaches can improve the semantic similarity measurement of short text.

Keywords: semantic similarity, corpus-based, knowledge-based

Introduction

The use of computers has changed our everyday lives, in a way of accelerated, automated and simplified job execution. Today, the information can be found fastest by using electronic resources, such as web pages. But, the large amount of information can greatly linger the search process. The problem is also in connecting questions in natural language with responses that are presented in electronic form.

This paper presents two methods for measuring the semantic similarity of texts, using corpus-based (CBSS) and knowledge-based (KBSS) measures of similarity. Previous work on this problem has focused mainly on either large documents (e.g. text classification, information retrieval) or individual words (e.g. synonymy tests). Given that a large fraction of the information available today, on Web and elsewhere, consists of short text snippets (e.g. abstracts of scientific documents, imagine captions, product descriptions), in this paper we focus on measuring the semantic similarity of short texts. A short text in typical human dialogue would be a sentence in the range of 10-20 words, bearing in mind that user utterances include other forms that fail to conform to the grammatical rules of sentences. A large number of software applications is based on the use of this kind of communication, for example in automatic processing of text and e-mail messages, natural language interfaces to databases, health care dialogue systems, online customer self-service, real estate sales, phone call routing and intelligent tutoring.

Therefore, this paper analyzes various techniques of short text processing based on existing similarity measures and presents their possible improvements. On one side word similarity was calculated by pro-

cessing large text corpuses and on the other commonsense knowledgebase was used. An extensive research has been done in the field of corpus-based semantic similarity, so we also evaluated existing solutions by imposing some modifications. Also, we focus on computing the similarity between two sentences or two short paragraphs by extending existing measures with information from the ConceptNet knowledgebase. Through experiments performed on a paraphrase data set, we show that by some of those approaches the semantic similarity measurement can be improved.

The rest of this paper is organized as follows: Section 2 considers some relevant features of corpus-based semantic similarity, implementation of discussed algorithms and evaluation of the results; Section 3 describes approach based on the knowledge-based semantic similarity. Section 4 outlines directions for future work.

CORPUS-BASED SEMANTIC SIMILARITY

There is a relatively large number of word-to-word similarity metrics that were previously proposed in literature, ranging from distance-oriented measures computed on semantic networks, to metrics based on models of distributional similarity learned from large text collections. From these, we chose to focus our attention on a corpus-based metrics. Corpus-based measures of word semantic similarity try to identify the degree of similarity between words using information exclusively derived from large corpora [3]. We applied different approach for calculating semantic word similarity that is based on the word-space models.

The general idea behind word-space models is to use distributional statistics to generate high-dimensional vector spaces, in which words are represented by *context vectors* whose relative directions are assumed to indicate semantic similarity. This assumption is motivated by the *distributional hypothesis*, which states that words with similar meanings tend to occur in similar contexts [9].

In the standard word space methodology, the high-dimensional vector space is produced by collecting the data in a co-occurrence matrix F, such that each row F_w represents a unique word w and each column F_c represents a context c, typically a multi-word segment such as a document, or another word. In the former case, where the columns represent documents, we call the matrix a *words-by-documents* matrix, and in the latter case where the columns represent words, we call it a *words-by-words* matrix. LSA [2] is an example of a word space model that uses document-based co-occurrences, and Hyperspace Analogue to Language (HAL, [7]) is an example of a model that uses word-based co-occurrences. COALS (*Correlated Occurrence Analogue to Lexical Semantic*) [4] is a method for deriving, from large text corpora, vectors representing word meanings, such that words with similar meaning have similar vectors and it is inspired by and highly related to the HAL and LSA methodologies. Random Indexing (RI) is word space approach, which presents an efficient, scalable and incremental alternative to standard word space methods [9].

In a corpus, terms co-occurrences is captured by means of a dimensionality reduction operated by singular value decomposition on the term-by-document matrix T representing the corpus. The cells F_{wc} of the co-occurrence matrix record the frequency of co-occurrence of word w and document or word c (Figure 1). The frequency counts are usually normalized and weighted in order to reduce the effects of high frequency words and, in case document-based co-occurrences are used, to compensate for differences in document size. On the Figure 1 we can no-

FIGURE 1 - AN EXAMPLE OF WORDS-BY-DOCUMENTS MATRIX

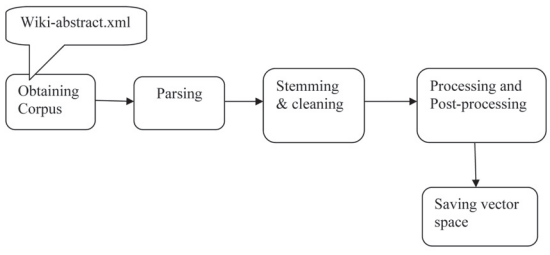
	DOC1	DOC2	DOC3	…	DOCn
W1	3	2	1		0
W2	4	2	1		0
W3	4	4	15		15
…					
Wm	2	2	2		2

tice that W_2 and W_m have very similar row vectors as a consequence of the distributional hypotheses.

CBSS Implementation

Figure 2 represents phases of implementation. The first stage is to obtain a corpus for generation of semantic space. Since Wikipedia abstracts dump (wiki-abstract.xml size of 1.7 GB) is in XML format; it has to be parsed to extract a flat text. The next phase is *stemming* and *cleaning*, which is the part of pre-processing phase. Stemming is a process of singling out a base of a word. For example, words: "fisher, fishing, fished" have the same base word "fish". Also, it is very common that large corpuses contain non-English words; therefore they have to be discarded by cleaning operation. The next phase is processing and post-processing, which is built upon implemented algorithms from SSPACE package. This package is a part of Google airhead open source project [4] and it implements large number of semantic analysis algorithms and provides possibility for developing new ones by using various utility classes (in our case COALS, RI and LSA). At the final stage, constructed semantic space has to be saved. Since it contains large amount of data it is impractical to keep it in a file, so we used database and its indexing functionalities, in order to obtain better performances for retrieving the specific vector for a given word.

Figure 2 – Implementation phases



Finally, for implementation of semantic similarity measure of sentences we applied algorithm explained in [3], by using string similarity and corpus-based word similarity, where for word similarity we used previously built semantic space model.

CBSS Evaluation

For the purpose of evaluation, we used *Microsoft Shared Paraphrase Corpus* (MSPC, [1]). It consists of 5081 pairs of sentences graded with a binary 0 for semantically non-similar and binary 1 for semantically similar. The MSPC itself is divided in two sets: train part (70% of the evaluation corpus) and the test part (other 30%). The train set is used to assess optimal threshold value, where samples with a value above the threshold are classified as similar and below as not similar. The threshold levels were evaluated in a range between 0.4 and 0.8, with a 0.1 increment, and optimal results on train part were found around threshold value of 0.6 with accuracy of 71% as shown at Table 1. Experiments were also carried on test part of the evaluation corpus, and results are shown in Table 2.

Table 1- The results on the train part of the corpus (70%)

Threshold	Accuracy
0.4	67.75%
0.5	69.27%
0.589	71.33%
0.6	71%
0.7	67.72%
0.8	57.4%

Table 2 - The results on the test part of the evaluation corpus (30%)

Threshold	Accuracy
0.4	66.7%
0.5	69.4%
0.589	70.32%
0.6	70.1%
0.7	67.8%
0.8	58%

The evaluation results on the test part were similar to results presented in [3]. However, we used different measure for calculating word similarity and also we processed different text corpus (Wikipedia abstracts dump) that is considerably smaller. Therefore, we assume that processing of larger corpus will increase accuracy of word similarity measure and consequently it will result in overall improvement of algorithm's accuracy. Also, one important algorithm's characteristic is that it showed good re-

sults with proper nouns that represent unique entities (specific names of countries, cities, people etc.), since it combines string similarity measure with semantic word similarity.

KNOWLEDGE-BASED SEMANTIC SIMILARITY

Another approach that we evaluated is based on algorithms that use ConceptNet knowledge base to extract and compare different concepts. ConceptNet is a semantic network that aims at providing common-sense knowledge to computers [5]. Its knowledge base is collected through an open source project called Open Mind Common Sense, where people can freely contribute with new knowledge. It has Python implemented Natural Language Processing (NLP) tools and many built-in tools for extracting valuable information from its knowledge base, such as methods for comparing two concepts, finding concepts that have the highest level of similarity to a given concept, etc. The similarity calculation is done by using Divisi, an implementation of AnalogySpace, which is a way of representing ConceptNet's common-sense knowledge base in a multi-dimensional vector space. MontyLingua [6] is also a Python implemented tool that is used for natural language understanding. Given a sentence, it can extract verb/subject/object tuples, as well as other semantic information.

KBSS IMPLEMENTATION

Our next approach was to combine the features of ConceptNet and MontyLingua to measure the semantic similarity of two text segments. ConceptNet offers a method for measuring similarity between two texts (lists of identified words), without taking into account the importance of a particular concept in the sentence. We tried to improve this method by adding a measure of a weight to each word, so the words with a bigger weight would factor more in the overall evaluation of sentence similarity. Next, we imposed a modification of a text similarity scoring function, defined in [8], where the similarity between the input text segments T_1 and T_2 is determined by using the following scoring function:

As in [8], each word ω from the first sentence T_1 is compared with words from the second sentence T_2, using ConceptNet's similarity function, so we could identify the word in the second sentence that has the highest level of similarity *(maxSim(*ω*,* T_2 *))*. The similarity is then multiplied with the word's weight and the resulting sum is normalized with the total sum of weights for all words from the sentence. The same method is applied to the sentence T_2 and finally the resulting similarity scores are combined using a simple average.

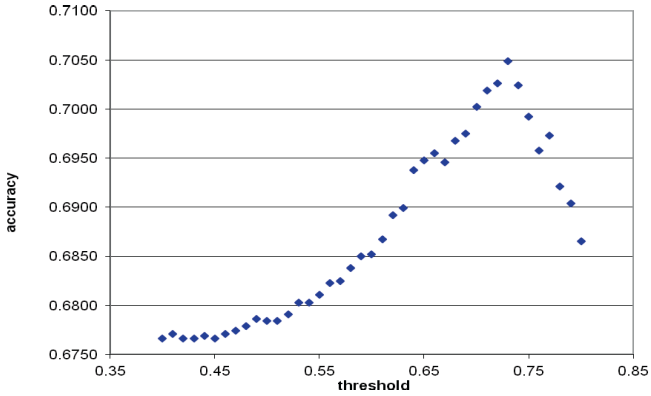
The scoring function originally used is *idf(ω)* instead of *weight(ω),* where *idf(ω)* stands for inverse document frequency, defined as the total number of documents in the corpus divided by the total number of documents that include the word *ω*. In our approach, we replaced inverse document frequency with the word's "weight" that represents its importance in the sentence. Assigning the optimal weight for each word was done by determining its role by extracting verb-subject-object tuples from a sentence with MontyLingua. Each word was then assigned with a weight, including some of the words not recognized by MontyLingua, and the scoring function was evaluated on MSPC corpus.

KBSS EVALUATION

The first step in experiment was to determine an optimal threshold for returned similarity values, where samples with a value above the threshold are classified as similar and below as not similar. The threshold levels were evaluated in a range between 0.4 and 0.8, with a 0.01 increment, and the results on the train part of the corpus (70%) are shown in the following Figure3.

$$sim(T_1,T_2)=\frac{1}{2}\left(\frac{\sum_{\omega\in\{T_1\}}\left(\max Sim(\omega,T_2)*weight(\omega)\right)}{\sum_{\omega\in\{T_1\}}weight(\omega)}+\frac{\sum_{\omega\in\{T_2\}}\left(\max Sim(\omega,T_1)*weight(\omega)\right)}{\sum_{\omega\in\{T_2\}}weight(\omega)}\right)$$

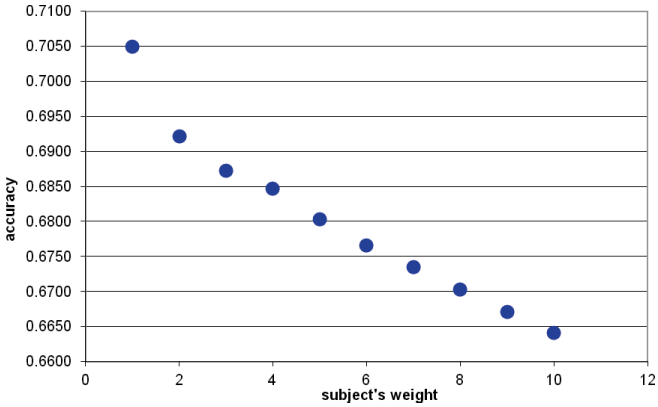
Figure 3 – The results on the train part of the corpus (70%)

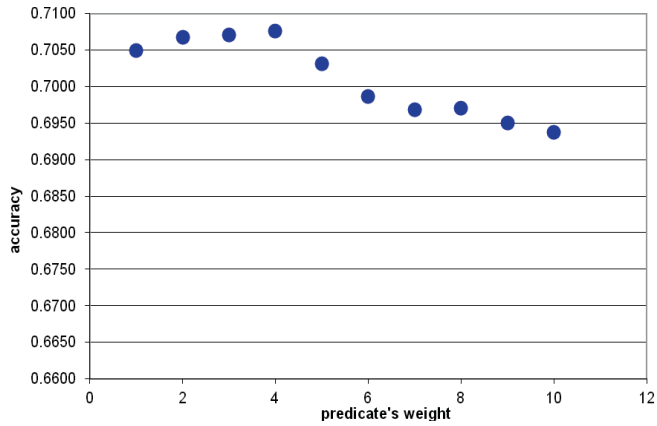


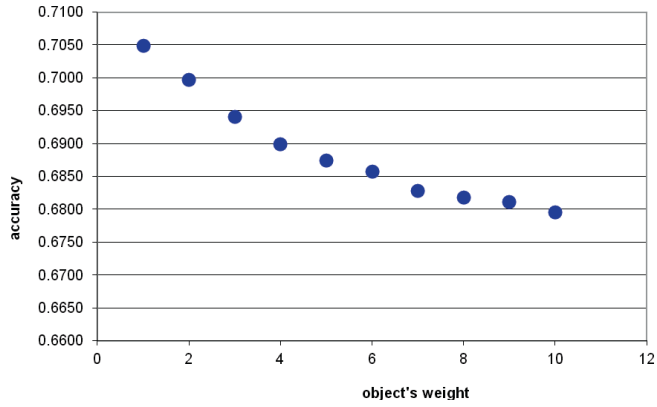
The results were according to expectations, since similar algorithms from literature [3, 8] had optimal threshold values around 0.7. In our case the best results were obtained with a threshold value at 0.73 and the algorithm produced the same results as a human judge in 70.49% of the cases.

Since the threshold evaluation was done by keeping the weight of the words in the sentence at a same level, for the next series of tests, we observed a correlation between the accuracy and the change of relative weight of specific parts of the sentence (predicate, subject and object). First, the weight of the predicate was increased from 1(the same weight as the other words) to 10, while keeping the weight of the other words constant. We repeated the procedure for the subject and object and the results are shown in the following Figure 4.

Figure 4. Correlation between the accuracy and the change of relative weight of specific parts of the sentence (predicate, subject and object)







The evaluation results showed that the measurement accuracy improved with the increase of predicate's weight, when comparing it to the given weight of the subject and object. Further increase of the weight of the subject or object resulted in a constant drop of the algorithm's performance. One of the reasons is that most of the words that appeared in these sentences as subjects or objects are proper nouns representing unique entities (specific names of countries, cities, people etc.). Since concepts can be transformed into vectors in AnalogySpace only if they are represented by four or more features in the database, such concepts were not taken into account when comparing sentence similarity. AnalogySpace as such works better with common nouns simply because it has more information to work with, which is important when generalizing and comparing concepts.

Since any increase of subject's or object's weight, while keeping the weight of the verb at an optimal level of 4, produced worse results, the conclusion was that the algorithm gave the best results with a threshold level of 0.73 and with the weights of verb,

subject and object at 4:1:1 respectively. Using these parameters, the results of the evaluation on the test part (other 30% of the MSPC), are presented in Table 3.

TABLE 3- THE RESULTS ON THE TRAIN PART OF THE CORPUS (OTHER 30% OF THE MSPC)

Number of pairs of sentences tested:	1725
Number of pairs where the algorithm reported an error:	38
Number of pairs where the algorithm gave the same result as the human judge:	1177
Relative accuracy rate (without unrecognized pairs):	1177/1687 = 0.6977 = 69.77%
Absolute accuracy rate:	1177/1725 = 0.6823 = 68.23%

Also, we evaluated ConceptNet's built-in algorithm for calculating semantic similarity of short text against the same corpus and its accuracy rate was 5% lower than the modified algorithm we previously presented.

CONCLUSION

We evaluated corpus-based measure, where we used different measure for calculating word similarity. We gained similar results, but with the considerably smaller processed corpus. Furthermore, since this algorithm, besides semantic word similarity measure, employs string similarity, it showed good results with proper nouns that represent unique entities and this was one of the main weaknesses of knowledge-based measure.

Given that a large fraction of the information available today, on the Web and elsewhere, consists of short text snippets (e.g. abstracts of scientific documents, image captions or product descriptions), where commonsense knowledge has an important role, we experimented on computing the similarity between two sentences or two short paragraphs by extending existing measures with information from the ConceptNet knowledgebase. The evaluation results showed that the measurement accuracy improved with the increase of predicate's weight, when comparing it to the given weight of the subject and object. Further increase of the weight of the subject or object resulted in a constant drop of the algorithm's performance. One of the main reasons is that most of the words that appeared in these sentences as subjects or objects are proper nouns representing unique entities (specific names of countries, cities, people etc.).

Therefore, the idea for further work is to extend the semantic text similarity measure that uses corpus-based word similarity and string similarity, by adding a measure of weight to each word, so the words with a bigger weight (importance) would factor more in the overall evaluation of sentence similarity.

Finally, it is also worth mentioning that the results were compared with those given by two human judges comparing the semantic similarity of the sentences. In some instances, they could not decide the similarity themselves, so a third judge was used to break the tie. This was interesting since the purpose of these and similar evaluations, of implementing and modifying algorithms for measuring the semantic similarity of two sentences, was an attempt to make the algorithms compare sentences the same way a human does when it still seems to be unclear how it is actually done. Thus, the main challenge is how to determine the best measure while a precise definition of that measure still remains unknown.

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