Advances on cognitive automation
at LGI2P / Ecole des Mines d'Alès

Doctoral research snapshot 2011-2012

June 2012
Research report RR12/Lab/002
Foreword

This research report is the accompanying document of the 2012 PhD seminar of the LGI2P lab (Alès School of Mines). This annual day-long meeting gathers presentations of the latest research results of LGI2P PhD students.

The 2012 edition of the seminar will take place on June 14th. All PhD students will present the works they led during the past academic year. All presentations will be followed by extensive time for questions from the audience.

The aggregation of abstracts of these works constitute the present research report and give a precise snapshot of the research on cognitive automation led in the lab this year.

I would like to thank all lab members, among which the PhD students and their supervisors, for their professionalism and enthusiasm in helping me prepare this seminar. I would also like to thank all the researchers that will come and listen to the presentations and ask questions, thus contributing to the preparation of our students’ thesis defense.

I wish you all a dense and fruitful seminar, an inspiring reading and hope to see you all again for next year’s 2013 edition!

Christelle Urtado
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Some contributions for the deployment of Systems Engineering processes in industry considering interoperability
Title

Improving Usability in Human Computer Interfaces: an investigation into cognitive fatigue and its influence on the performance of hybrid brain computer interfaces.

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Partners

Research Group in Biomedical Engineering Dept. of Electronic Engineering - National University of Ireland Maynooth (NUIM), Ireland.

This research group bears focuses on the development of innovative technological tools for health especially neurehabilitation. The group has pioneered the use of diffuse optical tomography for brain computer interfacing and has recently demonstrated the first hybrid BCI based on a fusion of near infrared spectroscopy and electroencephalography. Four PhD theses in the area of optical interfacing have emerged from this lab since 2004.

Propulsys (Propulsion & System) team in Movement to Health (M2H) lab - Montpellier 1 University (UM1), France.

This research group initially studied neurophysiological dynamics and their cerebral correlates during various fatigue-inducing motor tasks. In particular this group has developed expertise in the measurement of cerebral activation by the means of functional Near Infrared Spectroscopy (fNIRS) techniques. In the past two years, this group has also developed interest and expertise in the cerebral correlates of the cognitive tasks.

Introduction

BCIs require attention

Brain-Computer Interfaces (BCIs) allow the user to voluntary "control" his brain activity in order to control a technological device. One of the characteristics of the BCIs is that their use needs the attentional resources of the user. This is the case for all BCI including motor imagery based systems, cognitive association-based devices and exogenous stimuli solutions such as using the Steady-State Visual Evoked Potentials (SSVEPs).

Attention is characterized by a "Time-On-Task" effect

It has long been known through neuropsychological studies that during activities requiring sustained attentional focus over long periods, there is a marked and progressive deterioration in a person's capacity to successfully focus their attention. This decrease is experimentally evaluated through the
measurement of reaction times (RTs) (e.g., Lim et al., 2010) which demonstrate marked increases as a subject’s capacity to sustain attention diminishes. This change appears to be associated with a modification of the activation of several cerebral structures (Grinband et al., 2011). This phenomenon is described in the literature as “time-on-task” (TOT) effect. For example, during task of vigilance of 60 minutes, Paus et al. (1997) found that TOT induced a decrease of the regional cerebral blood flow (rCBF) over some subcortical (the thalamus, the substancia innominata, the putamen) and cortical (the ventrolateral, dorsolateral and orbito frontal cortex and parietal cortex) structures with a concomitant increase of reaction times (RTs).

**TOT effect must be reduced during the use of a BCI**
For at least two reasons, the TOT effect must be reduced during the use of a BCI. Firstly, the progressive decrease of the attentional capacities should finally induce an exhaustion state, concretely expressed by the inability of the user to use the interface. This claim is further reinforced if we take into consideration the clinical symptoms of the patients who potentially use such technologies, which are commonly characterized by an important cognitive fatigability (Baï et al., 2010). Secondly, BCIs aim to translate the cerebral activation into commands. Thus, if the cerebral activation is progressively modified because of the TOT effect, the classification performance will likely change. Faced with this problem, researchers have proposed solutions such as developing BCIs requiring minimal training, and thus, less mental load (Baï et al., 2010). Such devices rely on the targeting of natural cognitive tasks for which the brain is well adapted.

**A new type of BCI to enhance classification accuracy: the simultaneous hBCI**

<table>
<thead>
<tr>
<th></th>
<th>ERD</th>
<th>SSVEP</th>
<th>Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean accuracy (%)</td>
<td>69.4</td>
<td>82.8</td>
<td>84.5</td>
</tr>
<tr>
<td>Standard deviation (%)</td>
<td>8.6</td>
<td>12.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Number of illiterates</td>
<td>11</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Recently, new types of BCIs, named hybrid BCIs (hBCIs), have been proposed as a potential advance in the field. These have been designed to achieve better classification than a simple BCI (Pfurtscheller et al., 2010). One type of hBCI is named simultaneous hBCI and consists of a simultaneous process of two tasks by the user. The research team of Gräz, lead by Pfürtscheller is the world leader in the development of such technologies. Allison et al. (2010; see also, Brunner et al., 2010) belong to this group and have developed a hBCI based on simultaneous detection and classification of event related desynchronization (ERD) following mental imagery and steady-state visual evoked potentials (SSVEP) subsequent to the focusing of attention to an oscillating light. The authors tested the accuracy of the classification and the number of illiteracy (subjects whose classification accuracy was below 70%): mental imagery only (ERD), focusing of attention to an oscillating light only (SSVEP), or combining the two tasks simultaneously. Their results are presented in the Table 1 above. Briefly, the conclusion of this study is that the classification accuracy was higher in the hybrid condition, although this effect did not reach statistical significance.

**Incompatibility of simultaneous hBCI and TOT**
However, because each of the tasks used in the simultaneous hBCI requires attention, such dual task paradigms involved divided attention. Intuitively, it seems inevitable that the mental load when simultaneously performing two tasks requiring attention is higher than when performing only one task requiring attention (Nebel et al., 2005). As theoretically described by Eysenck and Keane (1991), during a task involving divided attention, the attentional resources needed to perform the divided attention task cannot be considered as being the sum of the attentional resources required to perform each of the two tasks separately. Indeed, according to Eysenck and Keane, the simultaneous performing of two tasks requires in addition, the control and the coordination of these tasks.

**Questions**

Considering this higher mental "cost" (or load) of a task requiring divided attention, the paradigms proposed in the simultaneous hBCI of the Pfürtscheller research team is not compatible with a reduced attentional requirement.

Therefore, our questions are the following:

- Does the task requiring divided attention generate an early acute cognitive fatigue state (*i.e.*, measured through the increase of the RTs)?
- If so, is it linked to an early modification of the cerebral activation?
- Finally, does it generate an early decrease of the classification accuracy?

We hypothesize that the divided attention task, generating a higher mental load, will produce an early acute cognitive fatigue, notably manifested through an early modification of the cerebral activation and thus an early decrease of the classification accuracy.

**Proposed protocol**

**Session test 1:** Mental arithmetic only

...  

PASAT  
PASAT  
PASAT  
PASAT  
PASAT  

RTs  
RTs  
RTs  
RTs  

2 minutes
**Executive summary - Gérard Derosière**

Time

PASAT: Paced Auditory Serial Addition Test (mental arithmetic task).

\[ \text{RTs} \]
\[ \text{RTs} \]
\[ \text{RTs} \]
\[ \text{RTs} \]

...  

SSVEP
SSVEP
SSVEP
SSVEP

**Session 2:** Steady State Visual Evoked Potential (SSVEP) only

Time

SSVEP + PASAT
SSVEP + PASAT

\[ \text{RTs} \]
\[ \text{RTs} \]
\[ \text{RTs} \]
\[ \text{RTs} \]

SSVEP + PASAT
SSVEP + PASAT

...

**Session 3:** hybrid condition
Afterwards, the TOT effect will be appreciated through the increase of the RTs. Concurrently, the cerebral activation will be measured by the mean of the fNIRS and the electroencephalography (EEG). This will allow us to observe the dynamic evolution of the cortical activation. We will test the evolution of the classification accuracy throughout the protocol in the different sessions. Finally, the classification accuracy will be tested in a multimodal manner (combining EEG/fNIRS). This multimodality has been found, especially by researchers of the Maynooth team, to be more accurate concerning the classification in a non-fatiguing situation. We will test if this fusion can reduce the decrease of the classification accuracy when acute cognitive fatigue state occurs.

Indeed, one expected solution to delay the decrease of the classification accuracy with TOT will finally be to combine the modalities of measurement of the cerebral activation. This will bring new knowledge to the researchers of the field about the technological challenges that represent the development of the BCIs.
EVALUATION IN SYSTEM ENGINEERING: APPLICATION TO
MECHATRONIC DESIGN

Mambaye LÔ

Abstract: Evaluation is present at any phase of the life cycle of a product and each time engineering choices must be made or justified. We focus on evaluation for multidisciplinary design. In order to contribute to supporting the evaluation process, we propose: a meta-model of data needed to evaluate product design within the Systems Engineering framework, the fundamental concepts for evaluation, and some multicriteria analysis tools. Relevant to the MBSE approach, the proposed meta-model should facilitate the communication within a multidisciplinary design team as it highlights the concepts and relations that must be handled and shared by the designers. It could be a basis for the development of a computer assisted evaluation tool for designing interdisciplinary systems such as mechatronics ones. Some concepts and relationships of the proposed meta-model are illustrated in the mechatronic context of designing a module for a power-assisted wheelchair.

Keywords: MBSE (Model-based Systems Engineering), multidisciplinary design, Systems engineering, Evaluation process, multicriteria, System analysis, Mechatronics.

I. Introduction

1. Context: multidisciplinarity and mechatronics

Engineering of processes and products have deeply changed during these last decades, showing heavy progressive integration of mechanics with digital electronics and information processing. This integration is made between the components (hardware) and is controlled by a "software" part of the systems.

Mechatronics is an approach needing the synergic integration of mechanics, electronics, computing and information technology during the design and the manufacturing of a product in order to improve/optimize its functionality [NF E 01-010]. Such integration can be functional or physical and involves members of a multi-disciplinary team who generally share neither the same methods, nor tools, nor scientific culture and must cooperate to reach a common goal of satisfaction of the final customer. In such a context, with temporal and financial constraints, how is it possible to ensure that design choices (architecture) are the good ones?

The contribution of our work is on the evaluation of multidisciplinary systems (NASA 2007; Quirante, Ledoux, and Sebastian; Gausemeier and Moehringer; E11-632 1999), in order to help to obtain a product definition coherent with its stakeholders requirements. We here propose a methodological approach for supporting the design of multidisciplinary systems (specifically mechatronic ones), including a way to reach efficiently a compromise between experts that may have different and often contradictory points of views.

We issue three assumptions for that:

- The use of Systems Engineering (SE) framework. SE is a structuring framework for system design (E11-632 1999), (ISO 2008), and allow to structure specification and design activities of a given system in each situation of its lifecycle.
- MBSE (Model-Based Systems Engineering) are used as modeling support: MBSE is a formalized application of modeling support system requirements, design, analysis, verification activities and validation phases starting from the conceptual design of system and continuing to through the other phases lifecycle of the system to do.

- Evaluation process is determinant for the decision making process between engineering choices. In the context of SE, to evaluate means to provide useful elements and arguments for helping decision making, along the technical processes of SE, in order to make the good choice (Faisandier 2005).

II. Propositions et contributions

For answering to our problematic, and regarding our hypothesis, we have based our work on the following main ideas:

- A conceptual methodological and tooled contribution:

A globalized and unified vision of evaluation (Bahil 2003) and multidisciplinary product architecture analysis is a necessary condition to multidisciplinary design. Such a view of the analysis allow to agree on activities to be undertaken on alternatives to evaluate, on concerned data, and on links between these activities and the SE activities (Cf Figure 1).

Thus, we early established a meta-model, in UML 2.0 (OMG 2011) formalism, of the necessary data for evaluation, and their interactions.

![Figure 1 Meta-model – Evaluation and Analysis concepts added](image)

By visualizing this meta-model, we can easily see the « analysis extension » (evaluation process activities), with its constitution, interactions with the technical SE (Needs analysis and definition...
Technical requirements definition, functional architecture definition, Embodiment and detailed design):

a) The comparative studies interact with the SE processes by evaluating alternatives whenever it is necessary. The product is described by its behavioral model and is scored regarding the level of satisfaction of the system’s performance requirements issued by the stakeholders. The evaluation process is enriched by a data base of previous evaluations and provides reports of the current evaluation. This contributes on the traceability aspect of evaluation. Such tools are useful for the evaluators, deciders, and specialized design engineers.

b) Technical indicators precise evaluation criteria, and so the analysis objective (NASA 2007):
   - A decision model makes a decomposition of MOEs (Measure Of Effectiveness: global objective for a given configuration of the system), which are composed of MOPs (Measure Of Performance: intermediate level sub objectives), which are composed of TPMs (Technical Performance Measurement: local objectives, where performance can be directly observed).

c) The design consideration can be quantified. The observable design parameter (DDPs: Design Dependant Parameter) specialize those design consideration, and can be quantified by TPMs, which integrate the target value of an observation and its current value.

Each instance of the set of DDPs constitutes an alternative solution, which can be improved by modifying some design variables values.

d) The relationship between decision and behavioral model drives puts in evidence the relation between the design space and its impact on the system’s performance. One vision of this relationship is proposed by (Imoussaten 2011), Cf. Figure 2:

![Figure 2 Potential action influences on complex systems performances from (Imoussaten 2011)](image)

Here, the authors focused on the link between potential actions (strategies) and performance of a studied system. Analogically, the values of the design variables may be the potential actions (constituting alternative solutions), and their impacts on observable variables (DDPs) could be estimated (computed, or simulated). A system of preferences allows to measure the performances of the alternatives, and to rank them. By this vision, we can see how important is the fact that the combination of decision model and behavioral model allow to identify the constraints between the alternatives, and their influence on the system performance.

Once evaluations have been executed and alternative solutions ranked, sensitivity analysis have to be made. This help to observe the impact of modifications of criteria weights, and alternatives scores on
the ranking. If the ranking is not sensitive to those modifications, the ranking is called robust (otherwise, not). Sensitivity analyses allow determining the most critical criterion and alternatives in the ranking robustness point of view.

- Application case:

We have applied our work to a mechatronic example: power-assisted wheelchair. This wheelchair is supposed to provide real improvement of the mobility, and a transparent usage (same than manual one) for roundsman job. By this example we show how evaluation process can support the design and help on choosing between alternatives. Our first application was the choice of “electrical assistance principle” for the wheelchair.

Identified alternative solutions are (C.f. Figure 3): pushing wheels, tyre roller, tractor, and motor wheel. Mobility has been identified as a high level goal of the system. As we can see it in the meta-model, the criteria of Mobility have been expressed from its corresponding technical requirement (TR). It is a “many-to-one” relation because one TR can involve many criteria and one criterion is linked to one TR. Then the considered criterion is precised by technical indicators. Here, with the mobility, we are in a high level’s goal of the system which correspond to MOE indicator. Indeed, Mobility is not directly measurable on the system: it has to be decomposed by other indicators. By decomposing until a sufficient (and direct) level of measurability, we aggregate then all the local measurements in order to obtain a higher level measurements. Thus Mobility MOE has been decomposed by many MOPs: maneuverability, adaptation to environment, autonomy, and transportability. These MOPs often correspond to the same level of decomposition of the considered TR by other sub-TRs. Let us take the maneuverability MOP (C.f. Figure 4) as an example. This one has been decomposed by some local measurements (TPMs): climbing, braking, turning, passing obstacles, and speed. The identified alternatives can now be evaluated regarding the criteria precised by TPMs. We have used AHP (Analytical Hierarchy Process)(Saaty 1980) for multicriteria calculus, and obtained a ranking for all MOP, and aggregated them.

![Connecting Examples of Wheelchair](image)

*Figure 3 Candidate solutions for electrical assistance principle – Electrical wheelchair*
III. Conclusion

Our work aims at providing tools and organizing the evaluation of multidisciplinary systems, during design. With a globalized and coherent process, we hope to automate as well as possible, some activities of the evaluation process. By this way, all the actors of the system have the same view of evaluation, and can better understand each other. This work includes the traceability monitoring of evaluation. As basis, we are working on mechatronic systems. The next step of our work is to implement with more details the evaluation methods in the design, and apply traceability method guidance.

IV. References

http://www.sie.arizona.edu/syseng/slides/DAR.ppt.  
Abstract. Semantic measures based on semantic graph are largely used by numerous communities to study semantically characterized entities (documents, genes, diseases). Despite the large number of measures proposed, their formal definitions are not made using a common framework thus hampering their understanding. Moreover, difficulties are encountered in distinguishing best suited measures according to a particular context of use. Our studies focus on proposing (i) an abstract framework to analyze and express these measures, (ii) an open sourced library dedicated to their computation, analysis and comparison, (iii) analysis of measure behaviors according to biomedical context of use.

Keywords: Semantic measures, semantic graph, ontology.

1 Context

Ontologies enable explicit expression of a shared conceptual specification which can be used to model domain specific knowledge. From taxonomies to ontologies, numerous fields, especially Biology, have largely adopted structured conceptual representations. All these representations can be mapped or reduced into a semantic graph in which nodes represent semantic elements such as concepts and edges express direct semantic relationships established between these semantic elements e.g. 'subClassOf', 'regulate'. This semantic graph can then be used to characterize entities (genes, disease, documents) through a subset of semantic elements capturing their nature according to the scope of the domain expressed by the semantic graph. As an example, the Gene Ontology (GO) models our current understanding of Molecular Functions (MF), Biological Processes (BP) and Cellular Components (CC) involved in a cell [1]. Thanks to bio-curators around the world, the GO is used to annotate genes and their products (e.g. proteins) through MF, BP and CC aspects. Numerous studies exploit these annotations to analyze genes through their semantic projection in conceptual specifications. This can be useful to characterize clusters of semantically related genes which can be used to infer knowledge helping us to capture more of the tremendous complexity of living beings.

Many treatments relying on a semantic graph related data model require a semantic measure (SM) i.e. a function enabling similarity, relatedness or distance assessment between the semantically characterized entities. Due to the particular interest of numerous fields in SMs, extensive interdisciplinary literature is
dedicated to their study. However, a lot of measures being ad-hoc, the semantic measure landscape is not unified through a common abstract model, which would enable characterization of both SM properties and SM relationships. Not only will such a model enhance our understanding of SMs, it will also pave the way to algorithm optimization, which is increasingly demanded in order to face the Big (Semantic) Data avalanche. Moreover, most of the time, SM related contributions are dedicated to new SM definitions only evaluated considering a non-representative subset of state of the art SM improvements. Indeed, no code library or software currently available enables large scale computation of such a subset of SMs. Furthermore, benchmark construction and difficult to reproduce as benchmarks are almost never communicated, which heavily hampers comparative studies. Therefore, despite the large efforts made by researchers to design improved measures, only few comparative studies are available to distinguish best suited SMs. On another note, it has been underlined that SM performances depend on the context of use. In fact, semantic graph expressivity (size, depth), annotation repartitions and expected goals can heavily impact measure performances. Thus, in regard to GO, depending on the taxon studied, the semantic knowledge considered and the treatment relying on the SM, selecting the best-suited measure is today a challenging task requiring detailed analysis of the state of the art.

In this context, our work is dedicated to SM characterization and comparison aiming to answer the previously mentioned limitations. Although our commitment was to stay, as often as possible, domain independent considering technical SM aspects, we are mainly focusing on biomedical related semantic graphs for all context dependent evaluations. In this report, we first succinctly describe the essence of the abstract model we propose to express graph based SMs. We then present the Semantic Measure Framework developed to facilitate SM related studies.

2 Contributions

2.1 Abstract Framework

Extending the 1977 Tversky abstract model [7] and other studies working on relationships between measures [6, 2], we have defined a model to express and characterize graph based SMs. Although this model is general and can be used to express SMs in order to compare both pairs of concepts and pairs of entities (groups of concepts), we only present here the model considering pairs of concepts. In short, we define measures considering the strategies used to represent a concept in the graph (e.g. induced graph, ancestors) and the operators defined to evaluate a pair of concept representations (e.g. commonality, difference). Such operators can be used to express operational taxonomic units (OTUs), classically used in binary similarity measures and distances [3]. In table 1 we present various existing SM expressions based on a similar abstract measure. All SMs presented in table 1 can be studied according to the abstract expression measure as $\rho$ function requires to monotonously decrease from the leaves to the root of
the graph in order to be compliant with the taxonomical knowledge expression. Thus, such a model can be useful to (i) establish relationships between existing measures, (ii) demonstrate properties on a group of measures rather than on a particular measure, (iii) characterize best suited approaches to represent concepts and define operators according to performances (algorithmic complexity), (iv) express new SMs.

\[
\rho \left| A^+(c) \right| \quad \psi \left| A^+(a) \cap A^+(b) \right| \quad \theta(c) \quad \sum_{t \in A^+(a)} \theta(t) \\
2 \frac{2 \psi \left| A^+(a) \cap A^+(b) \right|}{\rho_a + \rho_b} \quad 2 \psi \left( LCA, \text{root} \right) \quad 2 \psi \left( LCA, \text{root} \right) \quad 2 \psi \left( MICA \right)
\]

Table 1. Example of pairwise semantic measure expressions. \( \rho \) a function evaluating the information contained in a particular concept representation \( \tilde{c} \). \( \psi \) a function evaluating the information shared by a pair of concept representations \( \tilde{a}, \tilde{b} \), which define a way to assess commonality between two concepts. \( A^+(c) \) the set of inclusive ancestors of a concept \( c \). \( \theta(c) \) a function evaluating the information content of \( c \), \( MICA \), the Most Informative Common Ancestor of a pair of concepts. \( LCA \), the Least Common Ancestor of a pair of concepts i.e. the common ancestor with the maximal depth. \( sp(a, b) \) the shortest path between two concepts.

### 2.2 Semantic Measure Framework

Only few SMs are today implemented in free open source software and no library provides functionalities to compare various SMs according to a particular context of use. This is limiting because users cannot take advantage of state of the art improvements, also making method comparisons difficult. To fill this gap we developed a highly tunable Semantic Measure Framework (SMF) providing:

- a benchmark builder which can be used to generate context specific benchmarks.
- an easy way to compute over hundreds of SM configurations according to a particular context of use.
- a benchmark result evaluator to analyze results and distinguish best suited measures according to the defined context of use.

The proposed SMF is open sourced (Cecill license). However, in order to facilitate SM selection and comparison, a Mediawiki dedicated to the SMF and SM state of the art proposes benchmark datasets and evaluations for numerous contexts of use. This is helpful for end-users in order to select the best suited
measure and for SM designers to evaluate their measure according to numerous contexts of use. All proposed results are strictly reproducible using free open source software and associated datasets can be downloaded through our FTP server. Both benchmarks and corresponding evaluations will be updated to take into account SMF, semantic graph and annotations versioning.

3 Conclusion

The proposed abstract model provides a new perspective of the graph based SM landscape. Such an abstract model can be used to better understand, express and optimize SMs. What’s more, because empirical analyses are still required to distinguish best suited measures in a particular context of use, we propose the Semantic Measure Framework. The SMF is a piece of open source software facilitating computation, comparison, evaluation and design of SMs. We also propose a web platform dedicated to SMs. Among other things, this platform will maintain various SM evaluations and reproducible benchmarks useful for selecting best suited measures and for evaluating new SMs. This work will lead towards large scale biomedical analyses and studies based on SMs.

References

RIDER* project: Research for IT Driven EneRgy efficiency based on a multidimensional comfort control

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1 Introduction

Total building energy consumption accounts for about 40\% of total energy demand and more than one half is used for space conditioning: heating, cooling, and ventilation [1]. In the EU, about 57\% of total energy consumption is used for space heating, 25\% for domestic hot water, and 11\% for electricity [2]. Many projects have been started in order to save energy. Recent studies have investigated efficient building control in order to find strategies that provide a comfortable environment from thermal, and indoor-air quality points of views, and minimize energy consumption at the same time [3]. Nevertheless, these optimization systems are strongly dependent on the energy management framework and cannot be applied for other systems \textit{i.e.,} one building optimization routines are directly implemented on its control system and cannot be reused for further energy management. Additionally, these optimization routines are not supposed to be interpreted by human operators since they are integrated in regulation loops which made them necessarily dependent on the SCADA system (supervisory control and data acquisition). In order to satisfy the weak energy system dependency, control rules must be high level supervision rules which can be suggested to the energy manager. The RIDER DSS aims to provide qualitative recommendations and suggest the most relevant target values to be provided to the energy control system. It ensures the weak dependency of the DSS w.r.t. the energy system and its control, and control rules interpretability.

Users may be more or less tolerant to the temperature setpoint variations and thus not equally satisfied. It can be explained by the more or less tolerant user’s requirements are but also by other parameters than temperature that contribute to the thermal comfort. This illustrates that thermal comfort (and not only temperature) should be the variable to be controlled by the RIDER DSS in order to ensure building occupants’ satisfaction. However, the notion of comfort is subjective and multidimensional. Subjectivity entails that comfort cannot be modeled in a deterministic way. Comfort is multidimensional because many variables can be considered in its definition: temperature but also hygrometry, radiant temperature and air velocity. These remarks explain why providing efficient energy management for optimal comfort may be con-

\footnote{\textit{FUI RIDER project: \url{http://rider-project.com/}}
sidered as a multicriteria decision-making process in uncertain environment, and must be modeled as such [4]. Section 2 describes statistical and preferential approaches to model thermal comfort and explains why it is interesting to use the MAUT preference framework for energy control issues. Section 3 illustrates how these control issues can be easily solved thanks to the new thermal comfort preference model.

2 Optimization and comfort

The Predicted Mean Vote PMV [5] is the most used statistical thermal comfort index. It defines the mean thermal sensation vote on a standard 7 level scale from a group of approximately 1300 persons. It is written as a function of 4 thermal environmental variables: air temperature $T_a$, air humidity $H_y$, air velocity $V_a$, and mean radiant temperature $T_r$, and 2 human parameters: metabolic rate $M_e$ and cloth index $C_i$. The $PPD$ (Predicted Percentage Dissatisfied) index is based on the PMV one and indicates the percentage of thermal dissatisfied persons. Both PMV and PPD indexes have been used since 1995 by the NF EN ISO 7730 standard to describe ergonomics of thermal environments [6]. Such a thermal comfort representation verifies the RIDER DSS weak dependency constraint from one hand, and captures the inherent subjectivity and uncertainty related to thermal sensation from the other hand. The statistical based thermal comfort modeling is the result of a sample-ballot which makes it reusable for various application contexts. Whereas comfort is intuitively related to a preference model, the formalism [5] [6] is far away from any classical preference modeling framework. In particular, interactions among comfort attributes are considered as if they were physical ones which is not the case [7]. The $PPD$ model is not interpretable for energy manager and its non linearity does not facilitate optimization and control problems solving. Comfort is a degree of satisfaction that summarizes various aspects of thermal sensation and it should explicitly be modeled as such. This paper explains why comfort should be associated to a MAUT preferential model. In our approach, comfort appears as an aggregated utility function that makes thermal sensation model more tractable and interpretable for control purposes.

The MAUT [8] is based upon the utility theory which is a systematic approach to quantify individual preferences. Utility theory consists in interpreting any measurement as a satisfaction degree in $[0,1]$ where 0 is related to the worst alternative and 1 to the best one. Measurements are thus made commensurate and interpretable. In this way, a utility $u_i(x_i)$ is attached to each measurement $x_i$. Then, the MAUT aims at providing the synthesis utility $U$ that brings an answer to the comparison problem of two described situations by means of their elementary utility expressions. When comfort can be written under the decomposable preferential model $g(u_{i_1}(T_a), ..., u_{i_K}(M_e))$ of Krantz et al. [9], it makes thermal sensation more interpretable w.r.t attributes variations. In fact, the coexistence of some antagonist behavioral rules makes difficult for the energy manager to directly envisage attribute changes in order to control the energy system, whereas comonotony of $100 - PPD$ and $u_{i_{10}}$ holds everywhere in $H_y$ domain which offers a more relevant control system for thermal comfort attributes.
Moreover, in the real thermal comfort perception, there is no physical correlation between attributes. These last should rather be considered as preferential interactions related to criteria associated to attributes [10]. Fuzzy integrals provide adequate models to capture such interactions. It is then obvious that a preferential model of thermal comfort would be more appropriate for semantic reasons.

In order to build a reusable preferential model, elementary utility functions identification should be based on statistical techniques developed in [5] [6] instead of interviewing techniques as usual. As the PPD index is a standard thermal comfort statistical model and its results have been acknowledged since long, we propose to take advantage of this in order to identify our reusable thermal comfort preferential model. Labreuche has proposed an original approach to compute both the utilities and the aggregated overall utility function $U(x_1, \ldots, x_n)$ when $U$ is a Choquet integral without any commensurateness assumption [11]. It is important to highlight that using a Choquet integral facilitates optimization problem solving thanks to its linearity by simplex.

3 Control problems based on the piecewise Choquet integral

The comfort model is now built in the control of the energy system of a building floor. Let us suppose that the control variables are ambient temperature and airflow of all the offices at this floor. In RIDER DSS, comfort appears as an overall performance of the control problem. RIDER DSS supports the energy manager to manage significantly different temperature setpoints in each office in order to warranty the comfort levels and minimize as well the energy cost. Then, in order to satisfy both requirements: cost and comfort, RIDER DSS aims to compute adequate setpoints to be provided to the energy control system. In this paper, we consider that RIDER DSS manages only the energy system performances (utilities related to measurements) without worrying about the way these performances are achieved. RIDER DSS aims to prove that reasoning using an aggregated comfort objective function already provides substantial savings. Then, tractable optimization issues such as: control, adaptation and anticipation can be considered by RIDER DSS. Because thermal comfort has been approximated with Choquet integrals, this optimization problem can be locally linearized and, so, becomes an easily tractable problem [12]. Furthermore, the gain between comfort degree and temperature or air velocity variations is locally a constant computed with these attributes related utilities and the Choquet integral parameters in the simplex search space. This gain value makes the improvement interpretable for control purposes. Finally, domains of validity of the Choquet integral based approximations provide the necessary bounds to reason with a constant gain.

4 Conclusion

This work focuses on proposing generic optimization techniques for energy management systems based on a thermal comfort preference model. It explains why and how associating comfort to a MAUT preference model for energy management issues. The introduced thermal comfort model can be easily generalized for different building
occupants and simplifies the energy control issues. In fact, thanks to the MAUT, the interpretation of attributes influences on the thermal sensation in term of utility functions makes the multidimensional comfort control process more tractable. The introduction of MAUT techniques in energy control completely shifts the energy control paradigm. For example, the aggregated model for comfort allows designing new lower temperature setpoints that could not be envisaged even in advanced multivariable control techniques. Indeed, relationships between attributes are preferential interactions and not physical influences: each attribute can be controlled independently but any change of an attribute entails a variation of its local utility that may have consequences on the comfort overall utility. RIDER aims to prove that reasoning using an aggregated comfort objective function provides substantial savings. Within the MAUT, it can reasonably be imagined that temperature setpoints of a building could be decreased from one to two degrees. It represents a substantial economic gain that is probably much more significant than any optimization of the energy manager control system. Furthermore, the control recommendations resulting from this model are obviously transferable to any energy facilities.

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User centered and ontology-based information retrieval system

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Abstract. The main task of an information retrieval system (IRS) is to select information (whose unit is called document) which is likely to meet user needs, expressed as queries. To do so, indexing resources, allowing their representation as expressive as possible, plays a key role. Historically, IRSs are classified into two categories depending whether they use keywords (words, noun phrase) or concepts from domain ontology for indexing. In this paper, we first present an ontology based information retrieval system (OBIRS) using semantic similarities and aggregation operators to assess documents relevance with respect to (w.r.t.) a user query. We add a relevance feedback stage to OBIRS in order to implicate the user within the relevance calculus process and we also exploit the Synopsis approach [1] to build ontology lexical component allowing, hence, fine grained explanation of document relevance by providing passage highlights.

Keywords: information retrieval, ontology, relevance feedback, ontology and lexical resources interfacing techniques.

1 Introduction to Information Retrieval

The main task of an information retrieval system (IRS) is to select information, which is likely to meet user needs, expressed as queries. Three processes are usually implemented in IRSs to fulfill this task: i) an indexing process, which aims to provide a representation as compact and expressive as possible of resources (textual, multimedia documents) and queries; ii) a matching process for selecting relevant resources w.r.t. to a query; iii) a query reformulation process that typically occurs between the two previous points. An IRS may thus be seen as a function that maps a user query \( Q_u \) (from a query set \( H_q \)) to a set \( D_{rs} \) of documents selected among the collection \( D \) of all indexed documents (also called corpus) and ranked according to a retrieval status value (RSV). Depending on indexing methods, IRSs are historically classified in two categories: keyword-based IRSs, also called syntactic search systems, and conceptual IRSs, known as semantic search systems.
2 Conceptual vs. keyword-based IRSs

Keyword-based IRSs represent documents and queries as a bag of weighted words or multiword (phrase). A keyword-based IRS relevance process may rely on an exact match, an approximate match, or a string distance between words within documents and query indexing. Unfortunately, they suffer from the so-called synonymy problem (e.g. carcinoma instead of tumor) as well as from the polysemous problem (e.g. cancer as astrological sign or as illness) due to language ambiguity. All of these issues account for the lack of precision of keyword-based information retrieval systems, which is a well known problem.

To overcome these limitations, conceptual resources have been used to represent document contents based on their meaning rather than on their words. These conceptual resources may be arranged from less formal ones (thesaurus with strong lexical compounds: WordNet or UMLS) to more formal ones (e.g. Gene Ontology), and from general to domain specific. Conceptual IRSs are based on the assumption that document contents are better described by conceptual abstractions of real word entities than by lexical relationships that may be found within it or dictionaries. In these systems, ontology based concepts are used as pivot language for indexing documents and expressing queries. Such conceptual description of the world may also be used as a semantic guideline while visualizing documents or data. Besides, ontologies provide conceptual space in which metrics (semantic similarities or distances) can be deployed to implement the relevance calculus process in IRSs.

3 OBIRS, a multi-level score aggregation and ontology based information retrieval system

We have developed, through OBIRS\(^1\) [2], a domain ontology based information retrieval system that models relevance as a multi-level aggregation process. OBIRS uses domain ontology as pivot language for expressing queries as bag of weighted concepts and for estimating document relevancies based on semantic similarities and aggregation operators. Given \(Q\), a bag of weighted concept query and \(d \in D\) a document, the relevance score computation between them is considered as an aggregation model and consists of three stages.

The first stage allows computing the semantic similarity of any concepts of the ontology \(O\). Let \(\pi\) be such a semantic similarity measure. Several semantic proximity measures may be used here, that can be based on calculation of the shortest path, on the use of the information content (IC) or on set based measures. In order to favor user interactions, concept proximities must be intuitive (so that the end-user can easily interpret them) and fast enough to compute (to ensure that the IRS remains efficient even in case of large ontologies). By default, OBIRS relies on Lin’s proximity:

\[
\pi(c_s, c_j) = \frac{2 \cdot IC(MICA(c_s, c_j))}{IC(c_s) + IC(c_j)}
\]

\(^1\) http://www.ontoolkit.mines-ales.fr/ObirsClient/
Then the adequacy between $c_i \in Q$ and $d_j \left( \text{sim} \left(c_i, C\left(d_j\right)\right) \right)$ is assessed using aggregation of the elementary concept similarities as follows:
\[
\text{sim} \left(c_i, C\left(d_j\right)\right) = \text{agreg}_{c_i \in C\left(d_j\right)} \left(\pi \left(c_i, c_j\right)\right)
\]
(2)

With $C\left(d_j\right)$ the set of concepts indexing the document $d_j$. Many aggregation strategy (max, min, ...) is possible depending on the search expectation.

Finally, the relevance score of a document w.r.t a query is assessed using the family of aggregation operators proposed by Yager. Each query concept is considered as a criterion to be satisfied and corpus documents as alternatives. The assessment of such alternatives with regard to the criteria is given by:
\[
RSV\left(Q, d_j\right) = \left( \frac{\sum_{c_i} p_i \cdot \text{agreg}_c \left(c_i, C\left(d_j\right)\right)}{|Q|} \right)^{\frac{1}{\gamma}}, q \in \mathbb{R}, \sum_{c_i} p_i = 1
\]
(3)

4 OBIRS-feedback, a relevance feedback strategy

The interaction between a user and a search engine often begins with the submission of his/her information need through a query. Since user queries are often short and ambiguous, search engines implement a reformulation stage in order to better take into account user needs. After the submission of a query $Q_{init}$, the search engine returns a list of documents $D_{res} \subseteq D$ as results. Among them, let $D_{see} \subseteq D_{res}$ be the set of documents that the user has seen and $D_{u} \subseteq D_{see}$ be the set of documents that interest him. Our relevance feedback strategy follows the Rocchio schema and is based on the intuition that the user wants documents similar to those in $D_{u}$ (called positive documents) and different to those in $D_{see} \setminus D_{u}$ (called negative documents). Our aim is therefore to construct a new query $Q_{max}$ which favors positive documents and penalizes negative ones. This tradeoff will be asserted using an objective function which associates to a real value score each query. A reformulated query $Q_{max} \in P\left(C\right)$ is a bag of concepts query that maximizes an objective function $(\text{ind} : P\left(C\right) \times P\left(D\right) \times P\left(D\right) \rightarrow \mathbb{R})$:
\[
Q_{max} = \arg \max_{Q} \left( \text{ind} \left(Q, D, D_{res}\right) \right)
\]

Let introduce a general family of such objective function:
\[
\text{ind} \left(Q, D, D_{res}\right) = \alpha RSV\left(Q, Q_{res}\right) + \beta \text{agreg}_d \left(RSV\left(Q, d_j\right)\right) - \gamma \text{agreg}'_d \left(RSV\left(Q, d_j\right)\right)
\]
with $\alpha, \beta, \gamma \in [0, 1]$ and $\text{agreg}$ and $\text{agreg}'$ being two, possibly different, aggregation functions from the Yager family operators (Eq.4). The number of concept combinations to be tested (i.e. the number of reformulated query candidates) is exponential. Considering all concepts of the ontology $O$, there are $2^{|O|}$ possible queries and testing all of them is not realistic within real applications. We therefore propose a heuristic in order to find an approximate solution in reasonable time. See [3] for further details about this heuristic.
5 How ontology based information retrieval systems may benefit from lexical text analysis

Information retrieval is about finding the most relevant documents (precision) w.r.t. a user query and preferably all the relevant ones (recall) whereas information extraction techniques extract from the text what the documents mean. Also, full conceptual documents indexing are hard to obtain within realistic collection due to concept extraction tools limitations. So two kinds of document indexing (keywords and concepts based) are available and relative to two different levels of description (document level and text level). We designed and defined an hybrid IRS, named CoLexIR, in order to benefit from these two kinds of documents description in order to allow users to find relevant information (through conceptual based IRS) but also to be able to understand why a document is found and to what extend it is related to his/her query (through relevant passages). Ontologies have to be supplemented with lexical resources so as to be able to indentify document passages that are related to query concepts. This task is known as ontology and lexical resources interfacing techniques. Indeed, most domain ontology construction methods do not hold lexical information from which its concepts are taken and this issue is known as the missing link issue. CoLexIR ([4]) define ontology and lexical resources interfacing technique using the Synopsis approach developed in [1]. Our strategy builds from the documents found in the World Wide Web a lexicon for each concept in the used domain ontology. Those lexicons are used to segment documents within the collection in order to highlight their passages that deal with a particular concept.

This work has been done together with Benjamin Duthil and is already accepted for publication as a chapter in the book: "New Trends of Research in Ontologies and Lexical Resources" edited by Springer.


Incremental construction of architectural specification supported by behavioral verification

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Abstract. Our goal is to study the incremental construction of architectural specifications. Techniques and tools will be provided to detect errors in the specification and design phases. This work distinguishes two kinds of component: primitive components and composite components. Components are described using UML, and their formal semantics are given by transforming a subset of UML into LTS. The verification techniques are based on existing comparison relations to ensure that each step preserves dynamic properties of previous steps. Verifying architectures is accomplished by checking the freedom of dead-locks and the substitutability of components.

Keywords: UML, LTS, state machine, activity, composite structure, incremental development, software architecture, dead-locks, substitutability.

1 Introduction

The construction of critical reactive software architectures, in which errors could have serious consequences on human life, environments or significant assets, is challenging. When constructing such architectures, one focus on behavioral analysis in order to detect communication problems such as dead-locks between components. Hence, two aspects are considered: construction processes of architectures and evaluation techniques.

First, to support the construction of architectures, we believe that using an incremental approach \cite{3,10} is suitable. The incremental construction operations of architecture that we consider are the following: i) addition operation (adding a component or a connection into the architecture); ii) removal operation (removing a component or a connection from the architecture); iii) substitution operation (substituting a component by a new one); iv) split operation (split a component into sub-components); v) merge operation (several components are merged into a component). At this stage, the addition and substitution operations are focused.

Second, to support the evaluation techniques, we have to deal with two problems:

i. Define the semantics of architectures by transforming UML architectures into formal languages. We have chosen LTSs (Labeled Transition Systems) for the semantics of UML architectures and components.
ii. Compare models in order to verify that a model preserves the necessary properties of the previous version by using pre-orders and equivalences. Conformance relations (conf, red, ext, conf-restr, cred, cext) [2], [8], [11], testing pre-orders (≤_may, ≤_must, ≤_eq), and bi-simulations (=, ≈) have been considered and implemented in previous works. However, conformance relations and testing pre-orders do not preserve the substitution property in hiding contexts, while bi-simulations relations are claimed to be too strong. In complex system design, hiding and parallel composition are the most important contexts and have to be considered carefully. So we need to find appropriate relations to be used correctly in hiding and parallel composition contexts.

2 Methods for architecture analysis

2.1 Architecture modeling

Two kinds of components are distinguished: primitive components, and composite components. A primitive component may specify its behavior by itself, while a composite component contains the internal architecture so that its behavior is deduced from its sub-components’ behaviors. In this work, architectures mean composite components.

Our work focuses on defining reusable pieces of models, which means that pieces are independent and well-encapsulated. So, we use the notion of port, which is means to ensure the encapsulation property. Ports may be behavioral or non-behavioral. Ports of primitive components are all behavioral ports. Requests received are directly forwarded from a provided port to the classifier behavior of the owning component. Requests received from ports are indicated by Triggers of State Machines. In order to represent demands, which are sent to required ports from the classifier behavior, we use Invocation Actions of Activities. From our point of view, the combination of State Machines and Activity is necessary for the encapsulation of primitive components.

Architectures are modeled by assemblies of components using UML Composite Structures. Ports of architectures are non-behavioral ports, as they act like a routing device to forward the messages to or from the sub-components. At this moment, we restrict to binary connections between ports.

2.2 Semantics of architectures

The semantics of primitive components is determined by transforming a subset of State Machines and Activity into LTSs [10][11].

We define the semantics of architecture by transforming UML Composite Structures into EXP.OPEN [7] specification by a set of rules. Then LTSs are generated by using facilities of the CADP toolkit [5]. In case the system contains many components, the obtained LTS can be very complex. We have proposed the methods to compare the LTSs of architectures based on their minimizations [10].
2.3 Verification of architectures

Once the semantics of architectures is determined, the following verification activities can be done: a) verifying the absence of dead-locks in architectures; b) verifying the conformance between architectures using comparison relations.

Dead-lock analysis.

We have proposed a compatibility relation [4][6][12], which can be used to guarantee the absence of dead-locks in architectures, between two LTSs. Because it is always possible to consider the context of a component as a set of components, which can be modeled by a unique LTS, the compatibility between a component and its context can be verified. However, this relation is not strong enough to guarantee the conformance between two architectures.

In case a new component C is added into the system, the compatibility between C and its environment E (the components that C is connected to) needs to be verified. A possible solution is to benefit the advantages of the substitution relations (to be discussed in the next part) by replacing E by the new composite EC created from E and C. As a result, the verification of the substitutability between E and EC guarantees the absence of dead-locks and the conformance between the two versions of architecture.

Concerning b), to compare two architectures, there are two ways [10]:

i. Global analysis: the behaviors of the whole architecture are computed, and then analyzed using the conformance relations we have implemented. This method can be used to evaluate all incremental operations. But a problem appears when the system becomes complex so that having the LTS of the whole architecture is space expensive. The second way could solve this limitation.

ii. Differential analysis: only the behaviors of the modified parts between two architectures are considered. For example: a component is substituted by a new one (or a group of components); or a group of components is substituted by a component. This leads to the problem of component substitutability.

Component substitutability.

The relations which satisfy the substitutability properties in any context are congruence relations. Congruence relations defined over the conformance relation are cext and cred [8]. However, these relations fail to be congruent in hiding contexts creating divergences [8][9], (i.e. an infinite sequence of internal actions) which means cext and cred are not appropriate in the context of components assembly.

We are interested in the fairness assumption, in which divergences are not always considered as catastrophic (as in [9]). Fairness assumptions mean that the system is not allowed to continuously favor some choices at the expense of others. Fairness is important in reactive systems. We have found that the should-testing pre-order [1], which is congruent in parallel composition and hiding context, is an answer to a long stated problem: the greatest congruence stronger than conf. It exactly corresponds to
what we are looking for and in addition, its decidability is represented in [13]. We have studied and implemented this relation, which has the complexity of $O(nm^{3n+5m})$.

3 Conclusion

We have considered the usage of UML State Machines and Activity for describing primitive components, and UML Composite Structures for describing architectures. Then a set of rules has been proposed to transform UML architectures and components into formal semantics. We have added to our tool, IDCM [10] (Incremental Development of Conforming Model): i) the transformation of component’s behaviors (described by State Machine and Activity) into LTS; ii) the transformation of UML Composite Structures into EXP.OPEN. Finally, the dead-lock detection and substitutability problems have been considered. The should-testing pre-order [13], which is suitable for the context of component substitutability, has been implemented.

For future works, we would like to: i) study problems of asynchronous communication between components, which often are used in web services applications; ii) formalize a framework for incremental construction of architectures;

References

A proposed tool and process to design domain specific modeling languages

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Abstract. Domain Specific Modeling Languages (DSML) design is based on metamodels which follow the entity-association paradigm. Entities figure the concepts of the domain, associations hold cardinalities, and the elements belonging to that abstract graph are decorated with labels, in order to express the semantics of the domain. So that these metamodels can be manipulated, they are actually represented by concrete draws that also are graphs. A third graph of correspondence between elements of the metamodel and those of the concrete graph is difficult to maintain manually through several design iterations. We propose a methodology and a language to formalize their coevolution.

Keywords: dsml, mda, metamodel, concrete syntax, coevolution

1 Introduction

In the field of Systems Engineering (SE), we focus on functional and organic architecture design languages enhanced by the leverage of Design Patterns. Such systems are very diverse; software-intensive systems are a special case, our study covers the design of systems of any kind, including technology-less ones (purely organizational for example) up to embedded systems composed of mechanical, electronic, pneumatic, hydraulic... organs and also human agents. The systems under study are considered in their environment at the interface with other systems (context, contributing systems). The point of view is transverse to technical fields, as an architect we need to express and refine functional and organic models. The latter will finally be implemented by technical engineers.

After proposing a metamodel that integrates design patterns (Pfister et al, 2012), in the SE processes, based on eFFBBD and PBD views (Long, 2002), we are faced with a methodological and technical lock. Indeed, the design of the concrete syntax part of a DSML, including the synthesis of a graphical editor, refers to a collection of non-formal practices looking like recipes.

So we completed existing tools which are parts of Eclipse EMF-GMF (Budinsky et al., 2003) by a toolbox federating many well-known MDA (Soley et al. 2000) con-
cepts. We also propose a seamless process that structures the metamodel and its concrete syntax graph as a grammar able to ensure the co-evolution of both aspects by an approach based on metadata.

2 Context, State of the Art

A DSML (Domain Specific Modeling Language) is an alternative to general purpose modeling languages (UML, SysML, for example) for describing model views. Indeed, the generic languages provide a limited number of views with, on the other hand, a lack of precise semantics. When the model cannot be represented using generic views, modelers use languages specifically tailored to their problems, which promotes their concepts at the level of first-class entities. Such concepts can be broken down according to the following points of view (not limited):

- Behavioral points of view
  - state, statechart, belief, opinion, influence, goal, scheduling, skill, competence, interoperability, trigger, event, action, time
- Functional points of view
  - task, action, function, input, output, flow, item, process, duration
- Qualitative, non-functional points of view
  - pattern, ilities, cost, time
- Operational points of view
  - scenario, need, requirement, function, activity, process, service, server, client, agent, actor, discovery, negotiation, contract, perception, execution
- Organizational points of view
  - agent, role, scope, architecture, environment, resource, skill
- Protocol points of view
  - message, synchronous, asynchronous, emitter, receiver, acknowledgment, acceptance, rejection, request, response, exception, iteration, information
- Structural points of view
  - class, item, component, type, namespace, concept, relation, association, attribute, reference, taxonomy, ontology
- Semantic points of view
  - denotation, state, execution

Many toolboxes support the design of such specific languages, and are integrated in modeling platforms such as Microsoft DSL Tools, Eclipse EMF-GMF (Budinsky et al., 2003), XMF Mosaic (Clark et al., 2004) or GME (Ledeczi et al., 2001). These environments are able to generate graphic editors from which we can create instances of metamodels. The generation of these editors takes at the input the metamodel on one hand, and manual parameters given by the modeling expert on the other hand. The degree of automation of the generation process remains a challenge.
3 Contribution

In practice, designers are focusing on the DSML metamodel that defines the language. This phase is generally well controlled by practitioners, but is often separated from the design of graphical concrete syntax. The workflow described in Figure 1, shows how to process temporally in parallel and with the same interest, the two aspects of the modeling process. Indeed, an impossibility or difficulty of graphically instantiating a concept coming from the metamodel could denote some conceptual errors, or the transgression of topographical rule. Graphical concrete syntax generation becomes a step in the metamodel verification process.

Figure 1: DSML Definition activity

The proposed process organizes the design process of the DSML by maintaining consistency in its abstract syntax and concrete syntax graphs. The relationship between the abstract and concrete syntax graph is a third graph of correspondences between the elements of both graphs. This correspondence graph is noted on the abstract syntax graph by annotating the latter with a very simple language, like a layer that would provide additional information to a map, by transparency.

In addition, the process prescribes to avoid large and monolithic metamodels, but rather to involve many small and loosely coupled ones, which may contribute to a library of reusable metamodels, foreshadowing the concept of reusable pattern. These fragments are located in an area called Megamodel (Bézivin, 2004).

The modeling framework named Diagraph including the described process, the annotation language, and the megamodel manager contributes to the Eclipse platform (Budinsky et al., 2003) as a plugin, in a non-intrusive way, on the top of legacy tools. The resulting landscape is described in Figure 2.

Elements in pink form the context of the Diagraph environment, around its core element which is represented by the workflow named “DSML Process” on the one
hand and by the layer named “Generic Graphical Concrete Syntax Layer” associated to a transformation noted “to” in front of “GmfTools”, on the other. The layer on the top named “Domain Specific Metamodel”, figures the metamodels under work.

4 Conclusions and further work

We unlocked a methodological and technical bolt with the described environment that provides an annotation language upon metamodels conforming to the Ecore metametamodel, in order to automatically generate a graphical editor for a specific graphical modeling language (DSML).
The benefits gained are:

- The modeling language unification as a grammar in a sole artifact (the annotated metamodel)
- The incremental nature of a concrete syntax definition (the whole set is not questioned, just modify the annotations on impacted entities)
- An immediate validation of metamodels. (instantaneous generation of an instance editor)
- A formal model of the abstract to concrete transformation, which can be used for automating refactoring operations (syntactic sugar providing)
- The modeler’s productivity enhancement

Finally, the management of a metamodel and model repository as a megamodel is a natural consequence of this initiative.

Federated metamodels stored in the repository foreshadow the notion of re-usable patterns, it is still necessary to validate, by implementation, a final module formalizing the concepts of parameterizable models, and the related generic transformations mechanisms.

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Mobile Execution of Scenarized Services
in Pervasive Environments

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1 Introduction

Pervasive environments [8] contain multiple devices shared by multiple users. Users have access to device functionalities through services. However, simple access to services is not sufficient to meet users’ needs. Users need to compose the services they find in their surroundings to play coarser-grained scenarios. Based on this observation, we proposed the SaS (Scenario as Service) system for users to define, control and share scenarios [3]. SaS proposes a step-by-step execution mechanism for scenarios which enables to manage their execution life-cycle and to adapt them to users actions and environment changes.

However, in pervasive systems, mobility is only regarded as service disappearance handling [4]. Indeed, it is not possible to compose services (i.e. define a scenario) that are not currently or simultaneously available. In addition, service recovery, when handled, does not take into account service combinations [5] (services that depend on other ones or appear several times in a composition).

In this paper, we present how SaS manages a representation of its execution context (device or service presence, device location, device ownership) and enable users to enrich the context with their own preferences (such as defining device or service categories). Context representation is persistent. Users can therefore define scenarios executable on multiple locations. Moreover, we anticipate service disappearance and propose some recovery strategies by analyzing the roles of services in scenarios.

2 Context Representation

According to Coutaz et al. in [2], a context should be viewed not simply as a complex state but as a process that takes into account spontaneous interactions between users, services and resources. This implies being continuously aware of the context and enabling users to represent it as they wish.

2.1 Automatic Service Organization.

SaS automatically discover services and registers in a directory service declarations defined with SaS-SDL (service declaration language). Once registered, SaS classifies services depending on their providing device and service name. SaS groups services
from the same device, services with the same name and operations with the same name. This enables users to have a structured, browsable overview of available services. For example, if two services have the same name, SaS only displays one to users and joins all operations. The user will not see the two different services, and when he/she chooses an operation, SaS will select the appropriate service.

2.2 Persistent Service and Platform Representation.

The system has to be adaptive according to environment changes. For instance, service directories dynamically maintains lists of the current available services. However, to manage their context (e.g. locations or users) users must be provided with persistent context information. SaS therefore enables users to keep record of some surrounding services and platforms in persistent directories. A persistent service (resp. a platform) declaration thus stays accessible even if the service (resp. the platform) is not available anymore in the environment. By this means, scenarios can be defined using services that temporarily miss (thanks to the service directory). Platform directory can also be used to collectively share scenarios (which is equivalent to providing group access rights).

As defined in [1], two characteristics of pervasive systems are the social environment (e.g. presence of other users) and the evolving environment (e.g. users encounter different locations). To better represent their environment, SaS enables users to group services and platforms into named categories. These categories are like keywords because a service (resp. a platform) can be included into several distinct categories. Examples of categories are locations (e.g. all services available at home) or users (e.g. all platforms owned by kids). Categorization also eases directory browsing, and diminishes the amount of information presented to users. Listing 1.1 represents the grammar of SaS-SDL used for context representation and Listings 1.2 and 1.3 illustrate how this part of SaS-SDL can be used.

```
<sas_platform> ::= platform <platform_id> <platform_dir> <service_dir>

<platform_dir> ::= platform_directory { {<platform_cat>}, } 
<platform_cat> ::= category <cat_name> <platform_list>
<platform_list> ::= { platform <platform_id>, user <username> }

<service_dir> ::= service_directory { {<service_cat>}, } 
<service_cat> ::= category <cat_name> <service_list>
<service_list> ::= { <service> }
```

Listing 1.1. Context representation with SaS-SDL

```
platform_directory { 
category myPlatforms 
    platform Nakio3310, user John 
    platform IBN, user John 

category family 
    platform makintosh, user Janis 
    platform Soni, user James 
}
```

Listing 1.2. Platform directory

```
service_directory { 
category home 
    service Clock_Bedroom Clock 
        operation getTime() : Time; 
        operation setTime(Time) : void; 
    service TV_Living TV 
        operation on() : void; 
        operation off() : void; 
        operation selectChannel(int) : void; 
}
```

Listing 1.3. Service directory
3 Scenario Recovery Strategies

Because of mobility and the use of wireless networks, some services may be sporadically (un)available. The system has to handle these interruptions, even more when the disappearing service is involved in a running scenario.

Our idea is to support different strategies to maintain scenario execution on the top of our step-by-step scenario execution mechanism. The strategies we chose are based on the work of Mikic-Rakic and Medvidovic [6] who classified the most commonly used techniques to support disconnected operations. There are two sorts of strategies: anticipation strategies and repair strategies.

3.1 Fault Anticipation.

SaS proposes some strategies to anticipate the loss of a service.

– *Caching*. It consists in storing locally some data locally that have been already retrieved. Because of the size of the cache, this strategy is adapted to services that provide few information (for example a thermometer). It is useful for a service that is called many times. In SaS, if a service is present several times in the scenario, its result (if it is pertinent) is cached at the first service invocation.

– *Hoarding*. This strategy anticipates the disconnection and prefetches the data needed to execute a scenario step. When service is present few times it is useful to use this strategy on it. In SaS, when a pre-condition cannot be satisfied because of the absence of one or several services, the available services that are also used in the pre-condition are hoarded to anticipate reconnection.

– *Replication*. When possible, a local copy of the service is done. In this strategy the copy should be synchronized at every change of the original. This is specially adapted for a scenario registered as a service. This is why, when the invoked service is a scenario (SaS recognizes scenarios from simple services), SaS tries to replicate it. SaS gets if possible its description file to redeploy it if it becomes unavailable. If the scenario description is updated, SaS tries to get the new version.

– *Queuing*. This is not a fixing solution but enables to not abort a scenario when no other solutions can be immediately applied. The idea is to retain the invocations of a missing service until it is available again. Of course this strategy is only effective when service result is not needed immediately. In SaS, steps that cannot be executed immediately are queued until their respective pre-conditions become satisfied.

3.2 Repair strategies.

Step execution may fail for various reasons. Depending on the detected error, SaS applies different recovery strategies.

– *Unreachable service*. The service is present but an error occurs when it is invoked. It may be due to wrong parameters, etc. If the error persists after several attempts, SaS tries to invoke another service instance that could replace it.
– *Disappearing service*. The service disappears during execution step. SaS tries to find the same service or an equivalent.

– *Unresponsive service*. The service is available but do not answer. SaS has a service timeout. If a service do not answer after a moment SaS tries to re-invoke the service instance. After three tentatives, this service instance is black-listed, it will not be anymore invoked for this scenario and marked as unreachable in the service directory. Owner of the SaS platform can remove the service from the blacklist whenever he/she wants.

– *Interrupted scenario*. The scenario could be interrupted by a user. Alternatively, scenario timeout can be reached and scenario is thus aborted. Same situation as if the scenario is aborted by an user or if the scenario timeout is reached.

## 4 Conclusion

Managing applications in pervasive environments is a great new challenge in software engineering. As devices functionalities can be seen in term of services, Service-Oriented Computing is a suitable paradigm to design software for pervasive environments. Service composition responds to user needs. However, mobility and sporadic service disappearance in pervasive environments must be specifically considered.

SaS provides means to organize users’ evolving contexts. Users can thus register services for future use and define scenario with services not currently or simultaneously available. Moreover, some recovery strategies (anticipation and repair strategies) are applied to scenarios taking account of the roles of the services that compose them.

In perspectives, we plan to define generic type of devices (e.g. light). Discovered devices will be thus attached to a type of devices. This could be done through semantics (depending on device or service name), or with a transcription from service declaration model such as UPnP [7] which contains a list of predefined home devices. Such capacity enables to significantly improve the service selection at scenario run-time.

## References

Opinion Extraction Applied to Criteria

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Abstract. The success of Information technologies and associated services (e.g., blogs, forums,\ldots) eases the way to express massive opinion on various topics. Recently new techniques known as opinion mining have emerged. One of their main goals is to automatically extract a global trend from expressed opinions. While it is easy to get this overall assessment, a more detailed analysis will highlight that the opinions are expressed on more specific topics: one will acclaim a movie for its soundtrack and another will criticize it for its scenario. Opinion mining approaches have little explored this multicriteria aspect. In this paper we propose an automatic extraction of text segments related to a set of criteria. The opinion expressed in each text segment is then automatically extracted. From a small set of opinion keywords, our approach automatically builds a training set of texts from the web. A lexicon reflecting the polarity of words is then extracted from this training corpus. This lexicon is then used to compute the polarity of extracted text segments. Experiments show the efficiency of our approach.

1 Introduction

Web technologies development have made numerous textual records available. The rapid increase of this mass of information requires efficient support system to ease the search of relevant information. Numerous tools are already designed in this way. For instance exhibiting customers opinion on a specific product, searching or automatically indexing documents are contemporary concerns. In particular, numerous tools have been developed for moviegoers to know the global trends of opinions on movies. However aggregated information found on the web does not always reflect the semantic richness provided by the critics.

We propose an approach to answer the problem of opinion identification on selected criteria. A first step consists in extracting text segments related to one criterion ([1]). In a second step the polarity of each segment relatively to the criterion is identified. This process is iterated for each selected criterion. The way opinions are expressed may be quite different from one document to another and are often specific to the thematic the document deals with. Thus the vocabulary which is used depends on this thematics ([2]). This vocabulary is then automatically learned for the thematic prior to any text or opinion extraction.
Learning the vocabulary is usually performed using supervised method (e.g., Mindserver Categorization, Thunderstone, ...). This require annotated training sets to extract the vocabulary of opinion specific to a given topic. However, in the web context, creating annotated corpus for each criterion is very expensive and even discouraging.

Indeed, considering the diversity of documents (e.g., blogs, forums, journalistic dispatches), numerous topics of interest (films, news, hi-tech ...), the language levels used may vary significantly from one medium to another. This considerably increases the number of significant words to learn before being able to get meaningful results. Moreover, the mass of data to process makes the manual task of annotation difficult and even impossible. All these facts highlight the interest of being able to automatically build training corpus with minimal human intervention.

Based on statistical methods, our approach builds a lexicon of opinion descriptors for the selected thematic. This lexicon is then used to automatically extract polarity of the document for each of the criteria.

2 Description of the Opinion Mining process

In this section we present the three main phases of the opinion mining process. The first one consists in the automatic acquisition of the corpus of texts from web document and is presented in section 2.1. The second one explains how learning opinion words is done leading to the creation of the lexicon of opinion descriptors. This process is described in 2.2. Finally, the third step consisting in the opinion extraction is presented in 2.3.

2.1 Acquiring the training corpus automatically

The main objective is to automatically acquire a set of texts of opinions to form the training corpus. This corpus is needed to learn and classify descriptors denoting a positive or negative opinion. Opinion descriptors are specific to the thematic in which they are used ([2]) and their interpretation may drastically change from one thematic or context to another. For example, let us consider the two following sentences: "The picture quality of this camera is high" and "The ceilings of the building are high". The first one is related to the thematic of movies while the second focuses on architecture. The adjective high expresses a positive opinion in the first sentence and is neutral in the second one. This highlights the unavoidable construction of an opinion training corpus that is related to the thematic of interest.

2.2 Learning opinion descriptors

The objective of the second phase consists in identifying the descriptors carrying opinion in collected documents. They are adjectives and specific "expressions". We call "expression" the concatenation of an adjective and all of the adverbs preceding it in the text. For example: "the ridiculously uneducated", "all bad", "very very good", "very nice", "simply not good", "so very good".
In the documents collected in all the corpus, the approach will now search for adjectives and expressions which are correlated with the seed word associated with the document. Both adjectives and expressions which are carrying opinion are merged into the same concept called *descriptor*. The purpose of this learning phase is to enrich the original sets of seed words with opinion descriptors having same polarity. To do that task, we consider the following assumption: the more a descriptor is correlated to a seed word (i.e. it is close to the seed word), the more it is likely to have the same polarity as this seed word. In opposite a "distant" descriptor (far from any seed word) is considered irrelevant to this seed word.

**The learning phase**

The learning phase is based on a discrimination technique *class/anti-class* as explained previously but is done on all corpus from $S_P$ (resp. $S_N$) instead of doing it separately for each seed word $q$. For any descriptor $M$ a frequency $X(M)$ in the class $C_P$ (resp. $C_N$) is computed as follows using windows of size $1$ ($sz = 1$):

$$X(M) = \sum_{g \in P} \sum_{t \in S_g} \sum_{\gamma \in O(g,t)} |O(M,F(\gamma, sz, t))|$$

The frequencies $\overline{X}(M)$ in the anti-classes $AC_P$ (resp. $AC_N$) are computed in a similar way using only descriptors outside all windows.

**2.3 Opinion mining**

Once the lexicon is built, opinion can be automatically extracted from a text or an excerpt of text dealing with thematic $T$. A window is again introduced. But this time, instead of centering the windows on seed words and propagating the polarity of the seed word to the descriptor, we reverse the process: windows are centered on every adjective and their polarity is inferred from the ones of all the descriptors it contains. This is done by computing a score for each window $f$ as follows:

$$WSc(f) = \frac{\sum_{M \in f} (X - \overline{X})^3}{(X + \overline{X})^2}$$

The polarity of a text $t$ is then identified by studying the sign of the score of the text computed as follows:

$$Score(t) = \frac{\sum_{f \in t} WSc(f)}{|\{f \in t\}|}$$

The polarity of the text $t$ is given by the sign of its score: if $Score(t) < 0$ then $t$ is negative and if $Score(t) > 0$ the $t$ is positive.

**3 Validation upon criteria**

The validation consists in evaluating the opinion mining task on chosen criteria excerpts. To do that we have chosen the two concepts *actor* and *scenario*. Once again we use the annotated corpus proposed by [3]. First we extract all the segments of text belonging to any of the two criteria.
actor or scenario. This was done by using Synopsis [1]. We then extract all the opinions of excerpts related to a criterion in a text and aggregate them to assess the global polarity of the text relatively to each criterion. We simply uses an average as aggregation operator. This is done similarly using the lexicon learned with our approach and the one from SenticNet. Results are compared in table 1.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Actor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Our approach</td>
<td>SenticNet</td>
</tr>
<tr>
<td>positive</td>
<td>negative</td>
</tr>
<tr>
<td>FScore</td>
<td>0.92</td>
</tr>
<tr>
<td>precision</td>
<td>0.90</td>
</tr>
<tr>
<td>recall</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Table 1. Text classification results for criteria actor obtained on the corpus [3]

Analysis of the results shows that opinions formulated on those critics highly depend on criteria. We can notice that criterion actor is more in line with the overall opinion expressed in the critics than the scenario one. This is highlighted by the lower score obtained for criterion scenario than for actor. In a multicriteria approach this might correspond to allocate a lower weight to criterion scenario than to actor one and to check the overall score.

4 Conclusion

This paper presents a novel approach to automatically extract opinions from texts. The orientation given to this work was to minimize the human expertise to be provided to obtain relevant results. Furthermore we relate opinion extraction to multicriteria analysis. Following this guideline, our approach automatically builds the training corpus from which it learns the polarity of descriptors and automatically builds its lexicon lately used for opinion extraction. We have also demonstrated that the descriptors may bring different opinions in different contexts and that our criteria based method is able to automatically construct such a context oriented lexicon. Using such a lexicon in proper context significantly enhances the results. This work illustrates the complexity of human mind in the process of extracting the opinion carried by a text or a sentence.

References

Some contributions for the deployment of Systems Engineering processes in industry considering interoperability

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Abstract. Systems Engineering is a tried and tested methodological approach to design and test new products. It acts as a model based engineering approach and promotes for this purpose a set of standardized collaborative processes, modelling languages and frameworks. The systems engineering processes imply many interactions and exchanges between resources. Nevertheless, currently there is no method guiding companies in the deployment of these processes adapted to meet their stakeholders' expectations. Particularly, interoperability abilities and capacities which are required at each level of the company and by each resource remain poorly addressed. This research work aims to support companies in their efforts to deploy Systems Engineering by providing them with an equipped methodological guide. This paper presents some elements of this guide.

Keywords: Systems Engineering, Processes deployment in Industry, Interoperability, Enterprise Modelling.

1 Introduction

Considering the increased competition on markets, companies seek to eliminate the origins of their customers’ lack of satisfaction or of their products’ lack of profitability. This can be achieved by applying the principles of Systems Engineering (SE) which can be defined as a “general methodological approach that includes all the appropriate activities to design, develop and test a system which both provides an economical and competitive solution to the needs of a customer and also satisfies all stakeholders”¹. Among the numerous stakes of Systems Engineering (SE), we can

¹ Definition from the Association Française d'Ingénierie Système, the French chapter of INCOSE (http://www.afis.fr/)
mention: the reduction of development cycles and therefore development costs, the reduction of system complexity and a greater satisfaction of all system stakeholders.

Activities to implement good practices of the SE are formalized with more or less standardized process described in reference documents (e.g.[1],[2],[3] etc.). However, the introduction of SE in an enterprise is not obvious since it requires first answering many questions such as:

- How to know if the company is ready for the application of SE and on which specific topics a specific attention must be paid on?
- Since there is no public methodology that describes how to introduce SE within companies, how to do it pragmatically?
- How to guarantee that the resources that are considered to take part in new processes will be able to work together and with the rest of the organisation.

This research work aims to help companies to introduce the SE in their organizations by providing an equipped methodological guide that not only helps them at each stage of their effort, but also offers ways to promote interoperability (i.e. the "ability of companies and entities within those companies to communicate and interact effectively"[4]) to ensure the success of the deployment. In this context, this paper specifically provides an overview of some elements of the guide.

**2 Overview of some contributions for the deployment of SE processes**

This section provides an overview of the following guide’s elements:

- a maturity model to assess before the deployment if the company is ready for it,
- a detailed deployment process fully modelled in BPMN 2.0,
- an interoperability assessment method dealing with the three barriers of interoperability.

**2.1. A deployment maturity model**

We have developed an innovative easy to use maturity model to assess the readiness of a company and its components to face a deployment of Systems Engineering (SE) processes before any deployment action[5]. This maturity model has been designed by and for industrials with the goal to be an open-ended pragmatic solution to the needs of managers having to introduce SE in their design offices. Its originality is to consider the interoperability of resources constituting the entity assessed in order to maximize the probability of success of the inevitable company’s transformation required by SE application. By the way, it can also be used to have a first idea of the maximal CMMI® level that the entity could reach. Thus, this contribution tested and improved within a helicopter manufacturer, aims to support the promotion and application of SE
within large companies while considering interoperability and respecting Enterprise SE principles.

2.2. A detailed deployment process

In order to guide companies deploying by themselves without external help new SE processes, we provide them with a deployment method based on both top-down and bottom-up approaches [6]. Its fundamental strength is to draw its principles from two research fields both based on systematism which do not overlap but could bring a lot of advantages when used together: Systems Engineering (SE) and Enterprise Modelling (EM). It is fully modelled in a standard process modelling language: BPMN 2.0. Thus, it can be easily automated thanks to a workflow engine.

2.3. An interoperability assessment method

Interoperability is a condition of success for process deployment in companies. It should be assessed all along deployment stages. To that end, we have developed a method to assess interoperability of resources involved or potentially involved in processes [7]. It can be applied on single or couples of resources and is applicable not only once the collaboration has started but also before a collaboration to anticipate future difficulties. This assessment method is useful before and after the pragmatic deployment. From a semantic point of view, this method is based on a meta-model enabling a shared understanding between all people concerned with the interoperability assessment. Its strength is its design made by and for industrials, and thus thought to be easily and directly applicable in industry with the possibility to get easily automated. This method is currently tested within a helicopter manufacturer for the deployment of Systems Engineering processes. The next step in this research work is to automate this method and to couple it with process modelling activities.

3 Conclusion

This paper presents parts of the equipped guide we are currently developing to support the introduction of Systems Engineering within companies. This guide includes not only methodological and conceptual tools useful to describe and organize the deployment, but also a set of coherent and interoperable software tools to facilitate its application. One of the strengths of this guide is that each component of the guide is designed to be directly operational in industry and to improve the interoperability of the company which applies it. Another of its strengths is to progressively support companies in their approach to deploy and adapt System Engineering according to their specific needs and constraints. Thus, it enables maximizing the chances of success for the deployment even if the company is not fully prepared to it.
References


