2008
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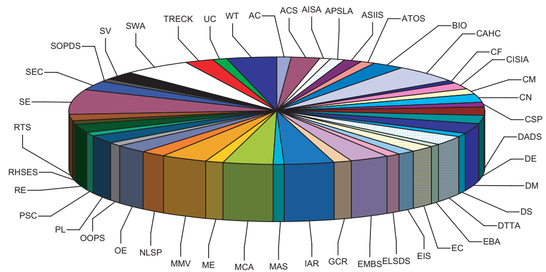

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Fortaleza, Ceará, Brazil
March 16-20, 2008

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The 23rd Annual ACM Symposium on Applied Computing

Fortaleza, Ceará, Brazil
March 16-20, 2008

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Message from the Symposium Chairs

Welcome to the 23rd Annual ACM Symposium on Applied Computing (SAC 2008). This international event is dedicated to computer scientists, engineers, and practitioners seeking innovative ideas in various areas of computer applications. This year, the conference is hosted by the University of Fortaleza and the Federal University of Ceará, Brazil. The organizing committee is grateful to your participation in this exciting international gathering.

The ACM Special Interest Group on Applied Computing is dedicated to further the interests of computing professionals engaged in the design and development of new computing applications, interdisciplinary applications areas, and applied research. The conference provides a forum for discussion and exchange of new ideas addressing computational algorithms and complex applications. This goal is reflected in the wide spectrum of application areas and tutorials designed to provide a variety of discussion topics during this event.

SAC 2008 offers Technical, Posters, and Tutorials programs. We thank the Program Chairs, Ronaldo Menezes from Florida Institute of Technology and Mirko Viroli from Università di Bologna for their tireless effort in coordinating these programs represented by 45 technical tracks and over 1300 paper submissions. Individual technical tracks are professionally organized by dedicated Track Chairs and Co-Chairs. Each track maintains a program committee and a group of highly qualified reviewers. We thank the Track Chairs, Co-Chairs, and participating reviewers for their commitment to the success of SAC 2008. The Posters Program, organized by Mathew Palakal from Indiana University Purdue University, offers invited posters representing the conference tracks. We thank Mathew for his effort and dedication to the success of this program. The Tutorial Program offers six high-quality and timely tutorials, selected from more than 23 tutorial submissions. We thank the Tutorials Committee, lead by Maria Andréia Rodrigues, from the University of Fortaleza, for the hard work in putting together this year's successful program. We also thank our invited keynote speakers for sharing their knowledge and experience, the authors and presenters for sharing their work with us, and all attendees for joining us in Fortaleza, Brazil.

The local organizing committee has always been the key to the success of the conference. This year, the local committee is lead by Nabor Mendonça, from the University of Fortaleza and Javam Machado from the Federal University of Ceara. We thank them for their outstanding leadership. We thank Lorie Liebrock, from New Mexico Institute of Mining and Technology, for her tremendous effort putting together the conference proceedings. We also thank the Publicity Committee lead by Rossana Maria Andrade from Federal University of Ceara, Jiman Hong from Soongsil University, and Sung Shin from South Dakota State University. Finally, we extend our thanks and gratitude to Angelo Brayner, from University of Fortaleza, for hosting the conference and coordinating the local support.

Again, we welcome you to SAC 2008 in the beautiful costal city of Fortaleza. We hope you enjoy your stay in Fortaleza and leave this event enriched with new ideas and friends. Next year, we invite you to participate in SAC 2009 to be held in Honolulu, Hawaii, USA, March 15 to 19, 2009. The conference will be hosted by the University of Hawaii at Manoa and Chaminade University of Honolulu. We hope to see there!

Hisham M. Haddad and Roger L. Wainwright
SAC 2008 Conference Chairs

Message from the Program Chairs

Ronaldo Menezes
Florida Institute of Technology, USA

Mirko Viroli
Alma Mater Studiorum – Università di Bologna, Italy

Welcome to the 23nd Symposium on Applied Computing (SAC 2008). Over the past 22 years, SAC has been an international forum for researchers and practitioners to present their findings and research results in the areas of computer applications and technology. The SAC 2008 Technical Program offers a wide range of tracks covering major areas of computer applications. Highly qualified referees with strong expertise and special interest in their respective research areas carefully reviewed the submitted papers. As part of the Technical Program, this year the Tutorial Program offers several tutorials that were carefully selected from numerous proposals. Many thanks to Maria Andréia Formico Rodrigues from the University of Fortaleza for chairing the Tutorial Program. Also, this is the fifth year that SAC incorporates poster papers into the Technical Program. The inclusion of posters would not be possible without the work of our Posters Chair Mathew Palakal from Indiana University Purdue University.

SAC 2008 would not be possible without contributions from members of the scientific community. As anyone can imagine, many people have dedicated tremendous time and effort over the period of 10 months to bring you an excellent program. The success of SAC 2008 relies on the effort and hard work of many volunteers. On behalf of the SAC 2008 Organizing Committee, we would like to take this opportunity to thank all of those who made this year's technical program a reality, including speakers, referees, track chairs, session chairs, presenters, and attendees. We would specially like to thank the local arrangement committee lead by Angelo Brayner from the University of Fortaleza.

SAC's open call for Track Proposals resulted in the submission of 50 track proposals. These proposals were carefully evaluated by the conference Program Committee. Some proposals were rejected on the grounds of either not being appropriate for the areas that SAC covers traditionally or being of rather narrow and specialized nature. Eventually, 45 tracks were established, which then went on to produce their own call for papers. In response to these calls, 1307 papers were submitted from more than 60 countries. After a reviewing process where each paper was evaluated by a minimum of three reviewers, 384 papers were strongly recommended for acceptance as full papers and inclusion in the Conference Proceedings. This gives SAC 2008 an acceptance rate of 29.3% across all tracks. These numbers make SAC 2008 the most successful and the most competitive SAC to date. This year we also introduced the concept of themes where tracks are organized on 6 main areas. The themes were used in the preparation of the schedule of presentations aiming at minimizing the overlap of presentations in related fields.

We hope you will enjoy the meeting and have the opportunity to exchange your ideas and make new friends. We also hope you will enjoy your stay in Fortaleza, Brazil and take pleasure from the many entertainments and activities that the city and Fortaleza has to offer. We encourage you and your colleagues to submit your research findings to next year's technical program when the conference will be move back to the USA, more specifically to Hawaii. Thank you for being part of SAC 2008, and we hope to see you in Hawaii for SAC 2009.

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Formal Definition of Measures for UML Statechart Diagrams Using OCL

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ABSTRACT

The informal definition of a measure in natural language is ambiguous, so it must be accompanied by a precise and formal definition, for avoiding misunderstanding and misinterpretation. In this paper we show the formal definition of measures for UML statechart diagrams using OCL, upon the UML statechart metamodel. The use of a formal definition upon a metamodel (where the main concepts and relationships are modelled) assure that measures capture the concepts they intend for and could facilitate the implementation of measures extraction tools.

Categories and Subject Descriptors

D.2.8 [**Software Engineering**]: Metrics – *Product metrics.*

General Terms

Statechart Diagrams, Measurement, Metamodeling, UML.

Keywords

Measures, UML, OCL, Statechart Diagrams, Understandability, Structural Properties, Formal Definition, Metamodeling.

1. INTRODUCTION

The quality of UML models should be evaluated through quality indicators or measures [7]. However, when measures are defined in an unclear or imprecise way many difficulties may arise. The lack of precision of what is captured by a measure may produce that the persons who build the measure extraction tool make their own decision during implementation. In this way, they can arrive at incorrect values of the measure. This situation arise when measures are not repeatable (the same result would not be produced each time a measure is repeatedly applied to a same artifact by a different person). Consequently, when measures are not repeatable, quality evaluators of models can take incorrect and undesirable decisions of the external quality attributes of their models. We believe that the understandability of what is captured by the measure should be defined not only in natural language but also in formal language, because how well a measure is understood will influence the way the measure is implemented and used.

Software measures can be defined through query operations using the Object Constraint Language (OCL) [4] upon a particular metamodel of the measured software artifact. The usage of the meta modeling approach for defining model-specific measures have been previously introduced for defining class diagram measures [1] and OCL measures [6] upon the UML metamodel. The contribution of this paper is the formal definition of Statechart Diagram (SD) measures using a meta-modeling approach. Even though many proposals of SD measures exist (see [3]), none of them has formally defined the measures using this formal approach.

A thoroughly definition of a set of measures for structural properties of UML SD is presented in [3] based on the hypothesis that structural properties of an UML SD (the software artifacts measured) have an impact on the cognitive complexity of modelers (subjects), and high cognitive complexity leads the UML SD to exhibit undesirable external qualities, such as less understandability or a reduced maintainability [2]. These measures are supposed to be good indicators of the understandability of such diagrams. This fact was empirically validated in [3].

In the next section the UML SD metamodel is briefly introduced. Section 3 provides the formal specification of two measures. Finally, the last section presents some concluding remarks.

2. THE UML SD METAMODEL

The abstract syntax for state machines is expressed graphically in UML SD metamodel [5], which covers all the basic concepts of state machine graphs such as states, transitions, guards, etc. Every state machine has a *top* state, usually a composite state, that contains all the other elements of the entire state machine. The graphical rendering of this top state within an SD is optional.

The *State* hierarchy has a *State* superclass and three subclasses,

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CompositeState, *SimpleState* and *FinalState*. This hierarchy, in fact, is part of the *StateVertex* hierarchy in the SD metamodel, which also includes the *PseudoState*, *SynchState* and *SubState* classes. The composite state may contain any state of the *StateVertex* hierarchy. All the classes, attributes of classes and relationships previously mentioned are part of the UML SD metamodel [5]. Each *State* in an SD may have associated actions, such as entry, exit or a do-activity actions (see the relationships between the *State* and *Actions* classes with the *entry*, *exit* and *doActivity* rolenames in the SD metamodel [5]). Transitions usually connect two states, for example two Simple States, a Simple State with a Final State, etc. These connections are described through two relationships between the *StateVertex* and *Transition* classes, where each of them identifies the *source* and *target StateVertex* which is connected through the transition. So, any transition connects exactly a *source* to a *target* S*tateVertex*. Within an SD, transitions may also be labeled with Guard and Events, modelled through the *Guard* and *Event* classes which are related to the *Transition* class. The set of all transitions within an SD is modeled through a relationship between the *StateMachine* and the *Transition* classes.

3. SPECIFICATION OF SD MEASURES

In this section we will present a general overview of the specification of SD measures using the UML SD metamodel [5]. For illustrating our approach we will show the formal definition of two measures. The specification of the measures relies on three query operations:

1. Alltransitions operation, defined in the *StateMachine* metaclass, obtains the set of transitions in an SD.
2. AllStates operation, defined in the *StateMachine* metaclass, selects the set of all the states within an SD.
3. AllSubStates operation, used by the two previous operations and defined in the *StateVertex* metaclass, obtains the set of all *Subvertex* included in a SD. It is recursively defined.

Their OCL definitions are shown below:

```
context StateMachine::allTransitions::Set(Transition)
body: result =  self.transitions>
            union(self.allSubStates().internaltransitions)
context StateMachine::allStates:Set(State)
body : result = self.top.allSubstates()

context StateVertex::allSubstates::Set(StateVertex)
body: result =if self.oclIsKindOf(CompositeState)
            then self.oclAsType(CompositeState).subvertex->union
            self.oclAsType(CompositeState).subvertex
            -> select (s:StateVertex| s.allSubstates())
            else Set{} endif
```

For obtaining the value of each SD measure (described in [3]) we defined in the *StateMachine* metaclass an operation with the same name as the measure. So, 14 operations were defined, one for each defined measure. Using the *allSubState* operation the value of many SD measures are specified. This operation returns the set of all the states (of different kinds: *Initial*, *Final*, *Simples*, etc.) included in a diagram, even those states which are part of composite states.

For example, selecting from the *allsubstate* operation result, those states of an SD which have associated a *doActivity* action it is possible to obtain the value of the Number of Activity (NA) measure. The quantity of objects selected represents the value of the NA measure.

```
context StateMachine::NA():Integer
body: result = self.top.allSubstates()->select(s | s.oclType(State) and
s.doActivity->notEmpty() )-> size()
```

The Number of Transition (NT) measure is specified through the use of the *alltransitions* operation. The cardinality of the set represents the quantity of transitions within a SD.

```
context StateMachine::NT():Integer
body: result = self.allTransitions() -> size()
```

4. CONCLUSIONS

The main contribution of this paper is the formal definition of measures for UML SD proposed in [3] using OCL upon the UML SD metamodel. A formal definition of the measures is useful to avoid misunderstanding and misinterpretation between the stakeholders within the measurement process. This is one of the main requirements to start any measurement program in software development organizations. Refactoring techniques which improve the design of SD (such as [8]) can take advantage of using the formally defined measures of this paper. Measure value can be computed before and after the refactoring (or model transformation) is applied, to express the quality of the diagram [7] and to evaluate a change. Moreover, the formal definition of measures using OCL can be introduced in MDA compliant tools to extract the measures values for UML models.

5. ACKNOWLEDGMENTS

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