Semantic-Based Aspect Interaction Detection with Goal Models

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Background: Aspect-oriented Modeling

- Aspects address the problem of one concern crosscutting other concerns in a system or model.
- Aspects can encapsulate concerns even if they are crosscutting.

**Without Aspects**

Concern A  Concern B  Concern C

- Tangling
- Scattering

**With Aspects**

Concern A  Concern B  Concern C

- Aspect 1
- Aspect 2
- Aspect 3

(each aspect contains a composition rule illustrated by the arrows that defines where to add the aspect)

… 3 Crosscutting Concerns (Aspect 1, Aspect 2, Aspect 3)
Motivation

• Aspect Interaction Problem is closely related to the Feature Interaction Problem
  • Multiple aspects may be applicable at a given point in the base model

• Syntactic Interactions can be detected by comparing syntax
  • In the best case, aspects may simply be ordered
    (e.g., an aspect may assume certain modeling elements in the base are introduced by another aspect)

• Semantic Interactions require a context-based interpretation of the meaning of models
  • In the worst case, there may be deep semantic conflicts
    (e.g., inherent trade-offs between two non-functional aspects such as security and performance)
    • Security mechanisms must be enforced $\rightarrow$ performance impact
    • Performance aspect may cache results $\rightarrow$ security implications
Motivation (2)

• Our approach to address semantic interactions
  • Lightweight semantic annotations of aspect models
  • Model the semantic impact of aspects on each other in a goal model called an influence model

• Identify and trade-off semantic aspect interactions with influence model
• Reason about stakeholder needs and aspect interactions with the help of qualitative or quantitative evaluation mechanisms
• Novel research direction
Table of Contents

• Overview of our Approach

• Example: Electronic Voting Machine
  • Reporting Use Case (Base Model)
  • Aspects
  • Composed Model

• Goal-oriented Requirement Language (GRL)

• Goal Model for Electronic Voting Machine

• Conclusion and Future Work
Overview

MATA / AoUCM

Composition

MATA / AoUCM

GRL Goal Model

Evaluation

Strategies

Semantic Markers

Values for initial satisfaction levels

AoUCM … Aspect-oriented Use Case Maps
GRL … Goal-oriented Requirement Language
MATA … Modeling Aspects Using a Transformation Approach
Electronic Voting Machine: Reporting Use Case

Poll Official
- report
- selectReport
- reported

Voting Machine
- presentOptions

Backend Server
- saveResults

Introduction Overview Base Model Aspects Composed Model GRL Goal Model Evaluation Conclusion/Future Work

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Electronic Voting Machine: Authentication Aspect

Aspectual Properties (Behavior & Structure)

Poll Official
- authenticate
- enterCredentials

Voting Machine
- authenticate
- fail
- requires Authentication
- [success]
- end

Pattern for Composition Rule
Electronic Voting Machine: Remote Service Aspect

<<local>> Authentication Server

access Remote [true]

accessed Remote [false]

requires RemoteAccess P

<<remote>> Authentication Server

authenticate

Voting Machine

Authentication Server

authenticate
Electronic Voting Machine: Composed Model

Poll Official
- enter Credentials
- report
- selectReport
- reported

Voting Machine
- fail
- [success]
- presentOptions
- saveResults
- authenticate

Backend Server
- saveResults

Authentication Server
- <<confidential>>
- <<local>>
- Authentication Server

Reporting Use Case:
- Reporting Use Case
- Authentication
- Remote Service
Goal-oriented Requirement Language (GRL)

• GRL is integrated with Use Case Maps (UCM) in the User Requirements Notation (URN)
  • URN is the first and currently only standard which explicitly addresses goals in addition to scenarios in a graphical way in one unified language (International Telecommunication Union, ITU-T Z.150 series)

• GRL is based on i* (concepts / syntax) and the NFR Framework (evaluation mechanism)
  • Ideally suited to capture qualitative relationships (as required by the influence model)
  • Reason about stakeholder needs and aspect interactions with the help of qualitative or quantitative evaluation mechanisms
Electronic Voting Machine: Goal Model

**Goal** (intermediate node for combining semantic markers)

**Softgoal** (for NFR addressed by aspect)

**Contribution** (for impact of semantic marker on its own aspect’s NFR)

**Task** (for semantic markers)

**Decomposition**

**Correlation** (for impact of semantic marker on another aspect’s NFR)

**GRL Contribution Types:**
- 
- 
- 
- 
- 

- Make
- Some Positive
- Help
- Hurt
- Some Negative
- Break
Electronic Voting Machine: Evaluated Goal Model

**Initial Satisfaction Level** (100 for semantic marker in use; indicated by *)
- Remote Service: 100
- Local Server: 100
- Consistency: 75

**Propagated Satisfaction Level** (for each aspect’s NFR)
- Confidentiality: 0
- Authentication: 100
- Caching: 0
- Encryption: 0
- Performance: 25

**Initial Satisfaction Level** (0 for semantic marker not in use; default value)
- Remote Service: 0
- Local Server: 0

GRL Satisfaction Levels:
- Denied
- Weakly Denied
- None
- Weakly Satisfied
- Satisfied
Electronic Voting Machine: Evaluated Goal Model 2

GRL Satisfaction Levels:
- Denied
- Weakly Denied
- None
- Weakly Satisfied
- Satisfied
Conclusion and Future Work

• Presented the first steps towards an approach for semantically detecting interactions between aspect models based on lightweight semantic annotations

• Tool support
  • MATA tool for UML sequence diagrams
  • jUCMNav for AoUCM and GRL
  • not automated at this point: GRL propagation algorithms do not take semantic markers into account → initial satisfaction levels have to be assigned manually

• Empirical studies are needed to compare the benefits versus the additional effort required (one industrial case study exists)

• Use existing, domain-specific, standardized profiles for lightweight semantic annotations