Towards a Unified Framework for Contextual Variability in Requirements

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Talk outline

- Research question
- Discussion of related work
- Weaving Context with Requirements
  - Holistic product family model:
    - Context, Goals, Features, and Problem Frames integration.
  - Insightful reasoning on requirements model:
    - Example on insightful detection of conflicts.
- Future work
Research Question

• Variability is that in human choices & intentions before that in system features
• Context influences variability at the intentional level first/as well.
• Reasoning about the mutual influence between the system and context requires clear problem structure.

Capturing variability at different abstraction levels and reasoning on the mutual influence between requirements and context.

[this is the ultimate goal, this paper is just a position one ]
Part 1: Related Work
Context models

- **Context is** [Finkelstein 01]:
  - the reification of the environment which is whatever provides a surrounding in which the system operates
- Several context models have been proposed, e.g.
  - Ontology-based [Yau 06][Wang 04] Object-based [Henricksen 04]
- The relation between context & its use is missing
  - Why is context needed? What context is relevant?
- Context awareness is mainly focused on the software domain (architecture, HCI..), not on the problem domain.
Goal models (Tropos [Bresciani 04] [Yu 95])

- Represents variability at the intentional level.
- But... (i) in which context a requirement is needed, (ii) an alternative is adoptable, (iii) a quality measure is well satisfied?
Contextual Goal Model \cite{Ali08a, Ali08b}: Variation Points

Context is linked to a set of variation points:

1. **OR- Decomposition.**
2. **Delegation**
3. **AND- Decomposition.**
4. **Contribution**
5. **Means-End**
6. **Root-Goal Activation**
Contextual Goal Model [Ali09a. Ali09b]: Context Analysis

- Constructs to analyze high level contexts and discover what alternative set of facts to verify and what data is needed for this verification.
Context with Features

Feature Diagram of Car Infotainment System [Hartmann, SPLC08]

- For a **systematic** contextualization of feature model, we need to explicitly **relate features to context**. [Hartmann SPLC 08]
- Higher level of abstraction that **justifies features**, probably Goals [Yu 08], is still needed as an earlier starting point.
Monitoring and Switching Problems in Context [Salifu et al, RE07]

- Monitoring/Switching problems for self-healing of a given requirement [Salifu07]
- Refinement: how to relate context of a problem to its subproblem? Composition: how to reason about the context in composed frames?
Part 2: The Integrated Framework
Integrating GM-FM-PF & Context: Why

- **Traceability of goals at the system level**
- **Justifying features by stakeholder intentions and relating them to quality measures**
- **Variability rationale at the intentional level and quality measures for assessment of variants**
- **Variability rationale at the system characteristics level**
- **Clear problem structure that allows for more detailed analysis of the system level variability**

- **Context influences what products to derive**
- **Context is observed and actuated by the machine**

- **Context influences the adoptability of goal satisfaction alternatives, and their qualities.**

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Context is observed and actuated by the machine

- **Context influences what products to derive**
- **Clear problem structure that allows for more detailed analysis of the system level variability**

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**Feature Models**

**Problem Frames (PF)**

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**Goal Models**

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**Clear problem structure that allows for more detailed analysis of the goal level variability**

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Integration Benefits: an example

- Insightful detection of conflicts manifested on context
PF contribution

- PF facilitates the detection of conflict on the use of resources through the explicit modeling of the physical elements in the machine context.
  - Both machines “Caregiver Notifier” and “Relative Notifier” require exclusive possessing of the landline.
- We probably still need additional constructs to PF specific for each reasoning we need to do.
FM contribution

- Knowing that a conflict happens, FM gives the other alternatives the system has and if they are applicable in all/some contexts when the conflict occurs:
  - Relative can be notified through SMS always
  - Caregiver can be notified through the public speaker if it is not late at night (context)
GM contribution

• Knowing the goal behind each feature is essential for better resolution
  ▫ notifying caregiver for reaching the goal “save patient from anxiety attack” will be given the priority on notifying relative for reaching the goal “relative is informed about the social meeting”.

• Goal models give also alternatives at the intentional level conditioned by context:
As a result

- Our work is for Holistic Software Product Line Engineering, that takes into account Goals, System Features, and Problem Structure together with Context.
- From the example we have shown: a more insightful discovery and resolution of conflicts on context resources can be obtained from the integrated model.
Future work

• Evaluation on complex case studies
• Merging between context and security requirements variability as well.
• Formal framework and reasoning mechanism.
• .....
Thank you!

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References (1)

References (2)