GrowingLeaf: Supporting Requirements Evolution over Time

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Problem

• Assumptions of early-phase requirements modeling:
  ➡ all model elements have a value
  ➡ model values are constant

• In reality intentions and relationships in the environments are not constant.
Example Questions

1. Is it possible to satisfy Goal-A and partially satisfy Goal-B? and how?

2. How does completing Task-A and Task-B but not Task-C affect the top level goals?

3. How do changes in Actor-A’s dependums affect the Actor-A’s root-level goals over time?

4. Which possible scenarios always satisfy Goal-A even if Goal-B becomes denied in the future?

5. Does the satisfaction order of Goal-C and Goal-D matter?
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Use Qualitative Evaluation Labels with Forward Analysis and Backward Analysis
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Provide tooling to:

- enrich goal models intentions with dynamically changing evaluation
- analyze the impacts of dynamically changing intentions on decision making
Why another modeling tool?

• Why another modeling tool?
Why another modeling tool?
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Why another modeling tool?
Why another modeling tool?
Why another modeling tool?

• Surveyed previous tools
  • Extend their iStar meta-model
  • Add icons/labels on top of intentions

• Web-based tool
  • Framework vs. self-built
  • Multi-view vs. multi-tab
Introducing GrowingLeaf
Introducing GrowingLeaf
Introducing GrowingLeaf
Outline

• Modeling Problem and Tool Justification

• Tool Introduction

• Dynamic Intentions and Analysis

• Tool Functionality

• Discussion and Validation

• Status and Future Work
Modeling Dynamic Intentions
Modeling Dynamic Intentions

- City
  - Update Truck Route
  - Upgrade Trucks
  - Use Current Dump
    - Manage City Waste
      - Comply with Standards
    - Build Large Dump
      - Purchase Land
    - Build Small Dump
  - Use New Dump
  - Reduce Operating Costs
  - Space in Dump
  - Process Green Waste
  - Help Build Green Centre
    - GW Education Program
  - Have Workers Union Contract

- Citizen
  - Quality of Waste Separation
    - Environmental Concern
    - Willingness to Separate Waste
    - Enjoy City
  - Positive City Image

Relationships:
- Depends
- Helps
- Hurts
- Makes
- Or
- And
Modeling Dynamic Intentions

Stochastic (R)

Patterns:

T ✓  ⋯  ⋯  ⋯  ✓  ⋯  ⋯  ⋯  ✓
F ✗  ⋯  ⋯  ⋯  ✗  ⋯  ⋯  ⋯  ✗

Examples:

Environmental Concern
Modeling Dynamic Intentions

Elementary Functions

Stochastic (R):

Increase (I):

Decrease (D):

Constant (C):

or
Modeling Dynamic Intentions

Denied-Satisfied (DS)

Patterns:

Examples:

Build Small Dump
Build Large Dump
Build Green Centre
Denied-Satisfied (DS)

Patterns:

Examples:

- Build Small Dump
- Build Large Dump
- Build Green Centre
Modeling Dynamic Intentions

Monotonic Negative (MN)

Patterns:

Examples:

Space in Dump
# Common Compound Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denied-Satisfied (DS)</td>
<td>the satisfaction evaluation remains <em>Denied</em> until $t_i$ and then remains <em>Satisfied</em></td>
</tr>
<tr>
<td>Monotonic Negative (MN)</td>
<td>changes in satisfaction evaluation become “less true” to a $maxValue$ at $t_i$ and then remains constant at $constantValue$</td>
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### Common Compound Functions

<table>
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<th>Function Type</th>
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<tr>
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<td>the satisfaction evaluation remains <em>Satisfied</em> until ( t_i ) and then remains <em>Denied</em></td>
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<tr>
<td>Stochastic-Constant (RC)</td>
<td>changes in satisfaction evaluation are stochastic or random until ( t_i ) and then remains constant at ( constantValue )</td>
</tr>
<tr>
<td>Constant-Stochastic (CR)</td>
<td>the satisfaction evaluation remains constant at ( constantValue ) until ( t_i ) and then changes in evaluation are stochastic or random</td>
</tr>
<tr>
<td>Monotonic Positive (MP)</td>
<td>changes in satisfaction evaluation become “more true” to a ( maxValue ) at ( t_i ) and then remains constant at ( constantValue )</td>
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<td>Monotonic Negative (MN)</td>
<td>changes in satisfaction evaluation become “less true” to a ( maxValue ) at ( t_i ) and then remains constant at ( constantValue )</td>
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Modeling Dynamic Intentions

User Defined (UD)

Repeating Function

GW Education Program

Have Workers Union Contract
(Strategy 1: Leaf Simulation) create a random path given initial states in the model

(Strategy 2: CSP Analysis) create a path given desired properties of the intermediate state (with optional properties over the initial or final state)

(Strategy 3: CSP History) create a path which is different than the previously seen path over the same constraints
Outline

• Modeling Problem and Tool Justification
• Tool Introduction
• Dynamic Intentions and Analysis
• **Tool Functionality**
• Discussion and Validation
• Status and Future Work
GrowingLeaf - Modeling Demo Summary

- Drag and drop interface
- Naming and adding elements
- Loading, saving, exporting, and zooming models
- Resizing label fonts
- Changing initial satisfaction values
- Changing dynamic function types
- Creating User Defined functions
GrowingLeaf - Analysis Demo Summary

• How to run analysis
• Adjust simulation length
• Types of analysis
• Scrolling through analysis results
Improving Analysis with Constraints

• Undesirable results due to EB ordering

• Add constraints over EB order
  • Adding model links is inappropriate
  • Test relationship before updating the model

• Used on rare occasions
• Adding constraints between EBs
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Architecture

Client Side (Front-end)
- Chrome Browser
  - JointJS
  - Javascript
- Tool Page Request
  - Analysis (CGI in Python)

Server Side (Back-end)
- Application Server
  - Java
- File System Data Storage
Design Decisions

• Browser versions and updates

• JointJS data model and constrains
Usability

- Two rounds user testing
- Found issues with
  - resizing
  - ‘enter’ key
  - ‘backspace’/‘delete’ key
  - selecting analysis techniques
- Further user studies are ongoing
- Built several models and examples
Examples and Case Studies

- City transportation planning
- Network maintenance
- Software supply chains
- Technical debt
- Compliance
- Sustainability

Further case studies are ongoing….
Ongoing Validation

- Evaluate usability / effectiveness with controlled experiment
- Prototype study at this week at iStar and RE
- Please Participate!!

http://www.cs.toronto.edu/~amgrubb/restudy.htm
Where do I get the tool?

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www.cs.toronto.edu/~amgrubb/leaf-ui/Tool.html
Where do I get the tool?

Use Google Chrome
Where do I get the tool?

http://www.cs.toronto.edu/~amgrubb/growing-leaf

Join the development team.
Future Work

- Update tool to use iStar 2.0 Language Guide
- External industrial case study
- Improve server connection (security)
- Multiple users to simultaneously edit
- Development for other browsers
Questions?
GrowingLeaf: Supporting Requirements Evolution over Time

GrowingLeaf
http://www.cs.toronto.edu/~amgrubb/growing-leaf

Tool Study at RE’16:
http://www.cs.toronto.edu/~amgrubb/restudy.htm

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