SUCCESSIVE REFINEMENT OF MODELS FOR MODEL-BASED TESTING TO INCREASE SYSTEM TEST EFFECTIVENESS

Presented by Ceren Şahin Gebizli
Outline

• Testing Challenges in Consumer Electronics Domain
• Model-based Testing and System Models
• Overall Approach
• Model Updates and Case Study
• Results & Conclusions
Challenges

- Short time-to-market
- Limited resources
- Large code base
- Large models
- Importance of User Perception
Model-based Testing (MBT)

Effective test case generation;
- Focus on features that are **mostly used**
- Focus on scenarios that are mostly **error-prone**
- Focus on scenarios that reveal **different** failures
System Models used for MBT

*Hierarchical Markov chains defined with the MaTeLo tool* (http://www.all4tec.net)

- **start state**
- **transition probabilities**
- **finish state**
- **states** that can comprise sub-models
Overall Approach

- Update system models based on:
  - Frequency of usage by the end-users
  - Estimated risk of failure based on static analysis
  - Estimated risk of failure based on dynamic analysis
- (Re)generate and execute test cases
System Model Updates

• First assignments of transition probabilities based on number of visits recorded in the usage profile.

\[ \frac{v_i}{\sum_{i=0}^{n-1} v_i} \]

• Next: second & third updates based on estimated risk of error
Update based on Risk of Error

- Risk estimations:
  - Static analysis: Ratio of static code analysis alerts
  - Dynamic analysis: Ratio of memory leaks
- Example: Update of the system model after the probability of error for state $s$ is calculated as 0.2
Industrial Case Study

• Initial model was previously developed by the software test group in the company.

Data Collection and Estimations;
• Usage Profile
• Static Analysis*
• Memory Profile

*Performed with the Klockwork tool (http://www.klocwork.com/)
Model Updates
## Iterations

<table>
<thead>
<tr>
<th>Software Module</th>
<th>Iteration 1</th>
<th>Iteration 2</th>
<th>Iteration 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># of Visits</td>
<td>Calculated Prob.</td>
<td># of Warnings</td>
</tr>
<tr>
<td>Portal</td>
<td>1900</td>
<td>0.146</td>
<td>18</td>
</tr>
<tr>
<td>Youtube</td>
<td>2250</td>
<td>0.173</td>
<td>18</td>
</tr>
<tr>
<td>HBBTV</td>
<td>500</td>
<td>0.038</td>
<td>6</td>
</tr>
<tr>
<td>MBR Video</td>
<td>1750</td>
<td>0.134</td>
<td>2</td>
</tr>
<tr>
<td>MBR Audio</td>
<td>400</td>
<td>0.03</td>
<td>1</td>
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<tr>
<td>MBR Picture</td>
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<td>1</td>
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<tr>
<td>PVR</td>
<td>1000</td>
<td>0.076</td>
<td>3</td>
</tr>
<tr>
<td>Channel List</td>
<td>1750</td>
<td>0.134</td>
<td>3</td>
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<tr>
<td>EPG</td>
<td>2000</td>
<td>0.153</td>
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<td>1250</td>
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<tr>
<td>HDMI-SCART</td>
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<td>1</td>
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</tbody>
</table>
Results

- Reduction in the number of test cases
- Detection of new faults

<table>
<thead>
<tr>
<th>Iteration #</th>
<th># of Test Cases</th>
<th>Test Execution Time (hr)</th>
<th># of Faults Detected</th>
<th># of New Faults Detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>847</td>
<td>4</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>809</td>
<td>4</td>
<td>9</td>
<td>2</td>
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<tr>
<td>2</td>
<td>136</td>
<td>1.5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>117</td>
<td>1.5</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
Conclusions

- Consumer electronics domain
- Context of an industrial case study for MBT of a Smart TV system
- An iterative model refinement approach
- New faults were detected in each iteration
QUESTIONS?

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