Software Release Decisions –
Advanced Models and Optimization
Methods

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Agenda
• Overview release decisions
• What-to-release
• What-to-release under complex feature
dependency constraints
• When-to-release
• Re-planning
• Summary and outlook
Release planning (RP) – What it is?

- Which features should be offered in the next release(s)?
- How to implement the next release (scheduling and staffing)?
- When is the best time for a product release?
- How to adjust to change for a given release?
  - When to re-plan? How often?
  - Which features should be replaced by new ones?
- How to plan for product lines?
- How to balance between quality and functionality?
Release planning - Why it is difficult?

- Information is
  - Uncertain
  - Inconsistent
  - Incomplete
  - Fuzzy

- Decision space
  - Large size
  - High complexity
  - Dynamically changing

- Multiple objectives
  - Usability
  - Value
  - Time-to-market
  - Frequency of use
  - Risk

- Hard and soft constraints on
  - Time
  - Effort
  - Quality
  - Resources

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The diversification principle

A single solution to a cognitive complex problem is less likely to reflect the actual problem when compared to a portfolio of qualified solutions being structurally diversified.

Diversified release plans
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Release planning by Constraint Programming (CP)


Application of Constrain Programming:

MiniZinc: Syntax to define decision variables, input variables, and constraints using various logical and arithmetic operators such as

- \and (logical AND) \lor (logical OR)
- \rightarrow (logical implication)
- = (equality) ≠ (inequality)
- + (addition) * (multiplication).
CP versus EVOLVE II: Efficiency

<table>
<thead>
<tr>
<th>Tasks for 7 experimental subjects</th>
<th>CP (average)</th>
<th>EVOLVE II (average)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adding a feature to feature repository</td>
<td>186</td>
<td>134</td>
<td>Seconds</td>
</tr>
<tr>
<td>Editing features</td>
<td>154</td>
<td>61</td>
<td>Seconds</td>
</tr>
<tr>
<td>Defining a dependency between features</td>
<td>135</td>
<td>102</td>
<td>Seconds</td>
</tr>
<tr>
<td>Defining available resources</td>
<td>147</td>
<td>73</td>
<td>Seconds</td>
</tr>
<tr>
<td>Editing available resources</td>
<td>197</td>
<td>61</td>
<td>Seconds</td>
</tr>
<tr>
<td>Inputting stakeholder votes</td>
<td>154</td>
<td>98</td>
<td>Seconds</td>
</tr>
<tr>
<td>Defining stakeholder importance</td>
<td>161</td>
<td>65</td>
<td>Seconds</td>
</tr>
<tr>
<td>Generating a solution</td>
<td>147</td>
<td>95</td>
<td>Seconds</td>
</tr>
<tr>
<td>Number of errors or failed commands</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Frequency of help or documentation use</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>


CP versus EVOLVE II: Effectiveness

96 randomized projects. Defined by varying paramters N = {30, 150}, M = {1, 5}, K = {1, 5}, S = {N/25, N/10}, H = {N/10}, L = {N/50, N/10}, T = {0.2, 1.0, 3.0}.
Hybrid approach

Phase 1 (EVOLVE II)
If solution $x^*$ gained from EVOLVE II is feasible and there are no added value components in the objective function
then STOP else goto Phase 2

Phase 2 (CP versus Hybrid RP)
CP
2.1 Transformation of the problem using MiniZinc
2.2 Solution of the transformed problem using Gecode
Hybrid RP
2.1 Transformation of the problem using MiniZinc
2.2 Solution of the transformed problem using Gecode
2.3 Initiating solution process with $x^*$

Empirical evaluation: Data sets

(1) Artificial data sets

Worst-performing project from the artificial dataset
- 150 features,
- 7 resources,
- 5 releases,
- 21 precedence constraints,
- 3 coupling constraints

Progressively addition of 0, 5, 10, 15, 20, 25, 30, 35, up to 40 non-EVOLVE II constraints.

(2) Real world data sets with added artificial constraints:

<table>
<thead>
<tr>
<th>Project</th>
<th># feat.</th>
<th># res.</th>
<th># releases</th>
<th># dep.</th>
<th># dep. features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>7</td>
<td>3</td>
<td>23</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
<td>5</td>
<td>2</td>
<td>81</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>633</td>
<td>1</td>
<td>5</td>
<td>19</td>
<td>67</td>
</tr>
<tr>
<td>4</td>
<td>914</td>
<td>1</td>
<td>4</td>
<td>85</td>
<td>232</td>
</tr>
</tbody>
</table>
Empirical evaluation: (Non-) Usage step 2.3

(1) Artificial data sets

<table>
<thead>
<tr>
<th># non-RPP constraints</th>
<th>Value (CP)</th>
<th>Value (Hybrid-RP)</th>
<th>Hybrid-RP/CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20961</td>
<td>47843</td>
<td>2.28</td>
</tr>
<tr>
<td>5</td>
<td>21581</td>
<td>47874</td>
<td>2.22</td>
</tr>
<tr>
<td>10</td>
<td>23471</td>
<td>48173</td>
<td>2.05</td>
</tr>
<tr>
<td>15</td>
<td>22230</td>
<td>47477</td>
<td>2.13</td>
</tr>
<tr>
<td>20</td>
<td>22823</td>
<td>47802</td>
<td>2.09</td>
</tr>
<tr>
<td>25</td>
<td>21252</td>
<td>47148</td>
<td>2.21</td>
</tr>
<tr>
<td>30</td>
<td>21313</td>
<td>46533</td>
<td>2.18</td>
</tr>
<tr>
<td>35</td>
<td>22335</td>
<td>46533</td>
<td>2.08</td>
</tr>
<tr>
<td>40</td>
<td>24475</td>
<td>46299</td>
<td>1.97</td>
</tr>
</tbody>
</table>

(2) Real world data set (ratio between values obtained from Hybrid-RP versus CP)

<table>
<thead>
<tr>
<th>Project</th>
<th>after seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1.0132</td>
</tr>
<tr>
<td>3</td>
<td>*</td>
</tr>
<tr>
<td>4</td>
<td>*</td>
</tr>
</tbody>
</table>
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When-to-release problem W2RP\textsuperscript{1)}

• Is defined by a sequence \{RPP\}_i of problems RPP.
• Each individual RPP has a different fixed release date \(RD_i\).
• W2RP means to determine operational release plans with varying feature sets \(F_i\) which represent trade-off solutions among all the variations of possible plans in terms of the three criteria
  – Maximize total release value \(TRV(F_i)\)
  – Maximize total release quality \(TRQ(F_i)\)
  – Minimize \(RD_i\)
• \(CoQ(n) = CoC(n) + CLoC(n)\) for all features \(f(n)\)

\textsuperscript{1)} J. Ho and G. Ruhe, “Releasing sooner or later? - An optimization approach and its case study evaluation,” submitted to RELENG 2013
Re-optimization

Start

RASORP

Feature set F_t and baseline plan for release data (RD)

Feature repository

Specific scenarios for varying release date (RD) and target quality

3.1 Reduce effort spent on testing to maximize value
3.2 Balance testing and implementing to meet deadlines
3.3 Reduce features implemented to maintain quality

Candidate release plans

Global Variation of release date

Determine trade-off solutions

Select final plan

End

Sets of trade-off solutions

Graph showing different sets of trade-off solutions with labels for Good Quality, High, and Very High Q values.
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Dynamic Re-planning\(^1\)

- RQ1: How to perform dynamic re-planning of product releases in consideration of multiple factors?
- RQ2: How to integrate optimized operational and strategic planning into the re-planning process?

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Outlook

• Fundamental directions for improvement related to
  – Algorithms
  – Models
  – Empirical evaluation
• Planning for both functional and non-functional requirements
• New decision problems in the context of product lines
• Broader scope: More holistic planning including requirements elicitation, testing, design, project management

Important Dates

FULL PAPERS
Submission: April 5, 2013
Notification: May 17, 2013
Camera Ready: June 7, 2013

SHORT PAPERS/GRADUATE TRACK PAPERS
Submission: May 3, 2013
Notification: May 27, 2013

Conference Dates: August 24-26, 2013