COCOMO II.1999

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Outline

- COCOMO II Overview
- COCOMO II.1999
- COCOMO II Suite of Models
  - COTS Integration (COCOTS)
  - Quality: Delivered Defect Density (COQUALMO)
  - Stage Distributions (COSSEMO)
  - Rapid Application Development Schedule (CORADMO)
  - Productivity Improvement (COPROMO)
  - Tool Effects
  - UML-Based Sizing
- October 1998 Workshop Results
COCOMO II Overview

- Extended Modeling Approach
  - Effort ~ (Environment) \* (Size) Process
  - Schedule ~ (Effort) Process

- Tailorable Family of Models
  - Keyed to information available and development approach

COCOMO II Family

<table>
<thead>
<tr>
<th>Model</th>
<th># Drivers</th>
<th>Sizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications Composition</td>
<td>2 0</td>
<td>Object Points</td>
</tr>
<tr>
<td>Early Design</td>
<td>7 5</td>
<td>Function Points or SLOC</td>
</tr>
<tr>
<td>Post-Architecture</td>
<td>17 5</td>
<td>Function Points or SLOC</td>
</tr>
<tr>
<td>COCOMO II</td>
<td>15 1</td>
<td>SLOC (FP Extensions)</td>
</tr>
</tbody>
</table>
COCOMO II.1999

- Significantly more accurate
  - Bayesian calibration
- More USC COCOMO II.1999 tool features
  - Early Design estimates
  - Spreadsheet import-export
  - Full calibration capability
- Commercial implementations
  - COSTAR complete; others underway
  - Commercial 1999 tutorial series: Don Reifer
- Book draft nearing completion
- Improved Web page

USC-CSE Modeling Methodology

1. Prepare Existing Code
2. Perform Behavioral Analysis
3. Identify Relative Significance
4. Perform Expert Judgment/Defect Assessment
5. Gather Project Data
6. Determine BayesPosterior
7. A-Posteriors Updating
8. Gather more data and refine model
COCOMO II Calibration Approaches

Data

Application Experience (AEXP)

Calibration: COCOMO II.1997 Vs. .1999

<table>
<thead>
<tr>
<th></th>
<th>1981</th>
<th>1997</th>
<th>1999</th>
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<tbody>
<tr>
<td>Project Data Points</td>
<td>63</td>
<td>83</td>
<td>161</td>
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<tr>
<td>Calibration</td>
<td>10% Data, Bayesian</td>
<td>90% Experts</td>
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<tr>
<td>PRED (.30) Values</td>
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<tr>
<td>Effort</td>
<td>81%</td>
<td>52%</td>
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<td>- by Org'n</td>
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<tr>
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<tr>
<td>- by Org'n</td>
<td>62%</td>
<td>81%</td>
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COCOMO II Book

- Publication date now late-1999
  - Full draft by May 1
- Will use current calibration values as COCOMO II.1999
- Providing USC COCOMO II.1999.0 as beta-1 version of CD version for book
- Have added Early Design model for CD version

Process Maturity (PMAT) Effects

- Effort reduction per maturity level, 100 KDSI project
  - Normalized for effects of other variables
- Clark Ph.D. dissertation (112 projects)
  - Research model: 12-23% per level
  - COCOMO II subsets: 9-29% per level
- COCOMO II.1999 (161 projects)
  - 4-11% per level
- PMAT positive contribution is statistically significant
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Status of Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Literature</th>
<th>Behavior</th>
<th>Signif. Variances</th>
<th>Prof</th>
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<td>Defects in</td>
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COCOMO vs. COCOTS Cost Sources

1) COTS Amortization
2) COTS Tailoring
3) COTS/Application Glue Code Development and (System) Test
4) Increased Application Effort due to COTS Volatility

Integrated COQUALMO

Software Size estimate
Software product, process, computer and personnel attributes
Defect removal capability levels

Defect Introduction Model
Defect Density per unit of size
Number of residual defects
Software development effort, cost and schedule estimate

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COCOMO II RAD Extension
(CORADMO)

COCOMO II Baseline
(cost drivers, except SCED)

Language, Level, experience, ...

COCOMO II

Stage
Distributions

Baseline
effort,
schedule

Effort,
schedule
by stage

CORADMO

RAD effort,
schedule
by stage

COPROMO (Productivity) Model

- Uses COCOMO II model and extensions as assessment framework
  - Well-calibrated to 161 projects for effort, schedule
  - Subset of 106 1990's projects for current-practice baseline
  - Extensions for Rapid Application Development formulated
- Determines impact of technology investments on model parameter settings
- Uses these in models to assess impact of technology investments on cost and schedule
  - Effort used as a proxy for cost
No Comparison of the Same Kind of Tools
No Clear Definition of Tools
No Considerations of Interactions with Other Factors

COCOMO II Tool Refinement

COCOMO II Tool Rating Scale

New Tool Rating Scale

• Basis of Tool Rating Scale
  - Activity Support
    • Specification, Analysis, Design, Programming, Test, CM, QA, Management, etc.
  - Tool maturity and support
  - Degree of Tool Integration
    • Process, syntactic, semantic
UML-Based Sizing

- In early exploration stages
- Exploring hierarchical approach

Number of properties of use cases

Number of properties of intermediate views
  - classes, objects, components, sequence/collaboration diagrams, state transition diagrams

Number of properties of source code statements

UML Sizing Challenges

- UML-view usage conventions
- View overlaps and double counting
- Size vs. complexity measures
- Counting attributes and relationships
- Data collection
Round #2 Result

1. COCOMO II
2. COSSEMO
3. CORADMO
4. COCOTS
5. COQUALMO
6. COPROMO
7. UML-Based Sizing
8. Tool Ratings and Effects
9. Incremental Development
10. Detailed COCOMO (Phased Distribution)