COMPARISON OF SOFTWARE FUNCTIONAL SIZE MEASUREMENT METHODS

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Outline

1. Size Metrics Evaluated
2. Technical background information
3. Regression Analysis Results
4. Introduction to Causal Analysis
5. Causal Analysis Results
6. Conclusions
1. IFPUG Function Points (FPs)
   - *IFPUG* = *International Function Points User Group*
2. IFPUG SNAP Points (SNAP)
   - *SNAP* = *Software Non-functional Assessment Process*
3. COSMIC Function Points (CFPs)
   - *COSMIC* = *Common Size Measurement International Consortium*
2 Prominent Functional Size Methods

IFPUG

COSMIC

Figure 1: Application Boundary, Data Functions, Transaction Functions
Outline

1. Why cost and size estimation is needed
2. Background information
3. Regression Analysis Results
4. Introduction to Causal Analysis
5. Causal Analysis Results
6. Conclusions
Dataset: Unified Code Count (UCC)

Project Description
- Maintained at USC
- Code metrics tool (logical SLOC, cyclomatic complexity)
- Implemented in C++
- 45 to 1425 logical SLOC
- 2010 to 2014
- Modularized architecture
- 4-month time-boxed increments

Project Types
- Add New Functionality
  - New language parsers
  - New features, such as GUI
- Modify Existing Functionality
  - Cyclomatic complexity support (modify existing language parsers with mathematical operation and algorithms)
Normalized Effort

Normalized Effort (hours) = \frac{\text{Total Effort (hours)}}{(\prod EF_i)}

- Where EF = Effort Factors
- Remove effects of effort factors from effort
- More objective way to evaluate effect of size on effort
Prediction Accuracy Statistics

- $R^2$: how closely the regression curve fits the data points
- **MMRE**: Mean Magnitude of Relative Error
- **PRED(25)**: Percentage of estimates within 25% of actuals

Ideally want:
- $R^2 \geq 0.8$
- MMRE $\leq 25$
- PRED(25) $\geq 75$

RESULTS: ADDING NEW FUNCTIONALITY
RESULTS: MODIFYING EXISTING FUNCTIONALITY
RESULTS: ADDING NEW FUNCTIONALITY

Combine IFPUG and COSMIC Function Points with IFPUG SNAP
Normalized Effort (hrs) = 
222.94 + (3.93 \times FP) 
+ (1.09 \times SNAP)

<table>
<thead>
<tr>
<th>R²</th>
<th>0.092</th>
</tr>
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<tbody>
<tr>
<td>MMRE</td>
<td>26.126</td>
</tr>
<tr>
<td>PRED(25)</td>
<td>63.636</td>
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</tbody>
</table>

Normalized Effort (hrs) = 
124.97 – (1.07 \times CFP) 
+ (26.9 \times SNAP)

<table>
<thead>
<tr>
<th>R²</th>
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<tr>
<td>MMRE</td>
<td>16.311</td>
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<td>PRED(25)</td>
<td>90.909</td>
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RESULTS: MODIFYING EXISTING FUNCTIONALITY

Combine IFPUG and COSMIC Function Points with IFPUG SNAP
Normalized Effort (hrs) = 51.462 + (6.518 × SNAP) + (1.022 × FP)  

<table>
<thead>
<tr>
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<tr>
<td>MMRE</td>
<td>11.159</td>
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<td>PRED(25)</td>
<td>94.737</td>
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</tbody>
</table>

Normalized Effort (hrs) = 53.287 + (6.689 × SNAP) + (1.742 × CFP)  

<table>
<thead>
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<th>R²</th>
<th>0.764</th>
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<tbody>
<tr>
<td>MMRE</td>
<td>11.279</td>
</tr>
<tr>
<td>PRED(25)</td>
<td>94.737</td>
</tr>
</tbody>
</table>
Outline

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Causal Inference

Causal Learning/Inference

- Causal Discovery
- Causal Estimation

Algorithms and Domain Knowledge on Data

Algorithms to quantify causal influence
Past Causal-Type Analyses

**Dr. Boehm COCOMO® 81**
- In-depth behavioral analyses for effort factors

**Cuoto et al**
- Granger’s causality test for software defect predictability
  - *Doesn’t get to heart of causality*

**Evidence-Based SE**
- Experiments
- Cause precede effect
- Cause covaries with effect
- Alternative explanations are implausible

**Hu et al**
- Bayesian networks with causality constraints for software risk factors
PC Search

- Named after Peter Spirtes and Clark Glymour
- First scalable discovery algorithm

\[ X_1 \rightarrow X_2 \quad \text{Change in } X_1 \text{ causes change in } X_2 \]

\[ X_1 \rightarrow X_2 \quad \text{Insufficient data to select orientation} \]

\[ X_1 \leftrightarrow X_2 \quad \text{May be common confounder of both variables, missing from dataset} \]
Tetrad
RESULTS: ALL DATA POINTS
IFPUG Function Points (FPs)
COSMIC Function Points (CFPs)

Normalized Effort (hours)

COSMIC Function Points (CFPs)
RESULTS: ADD FUNCTIONALITY
IFPUG Function Points (FPs)
IFPUG SNAP Points

The graph displays a scatter plot with IFPUG SNAP Points on the x-axis and Normalized Effort (hours) on the y-axis. The data points are represented by green diamonds. The graph also includes labeled boxes for ACAP, PCAP, SNAP, CPLX, and DOCU, connected by a blue line labeled TotalEffort.
COSMIC Function Points (CFPs)
RESULTS: MODIFY FUNCTIONALITY
IFPUG SNAP Points

Normalized Effort (hours) vs. IFPUG SNAP Points

Diagram showing a scatter plot with points representing different effort and SNAP points. The diagram includes labels for TotalEffort, SNAP, ACAP, and CPLX.
COSMIC Function Points (CFPs)
Conclusions

1. Effort Estimation Effectiveness
2. Causal Analysis
Conclusions

Effort Estimation Effectiveness

■ Adding New Functionality
  – COSMIC FPs more effective.
  – Requires either grouping projects by complexity/change type, or metric to account for complexity as complement.

■ Modifying Existing Functionality
  – IFPUG SNAP Points more effective.
  – Carries weight when combined with IFPUG FPs or COSMIC FPs.

Causal Analysis

■ Adding New Functionality
  – Need more data points

■ Modifying Existing Functionality
  – SNAP has causal effect on Effort

■ All Data Points
  – COSMIC FPs has causal effect on Effort
  – SNAP has causal effect on Effort