COMPARISON OF SOFTWARE FUNCTIONAL SIZE MEASUREMENT METHODS

Anandi Hira
University of Southern California

Outline

1. **Size Metrics Evaluated**
2. Technical background information
3. Regression Analysis Results
4. Introduction to Causal Analysis
5. Causal Analysis Results
6. Conclusions

Software Size Metrics Being Evaluated

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

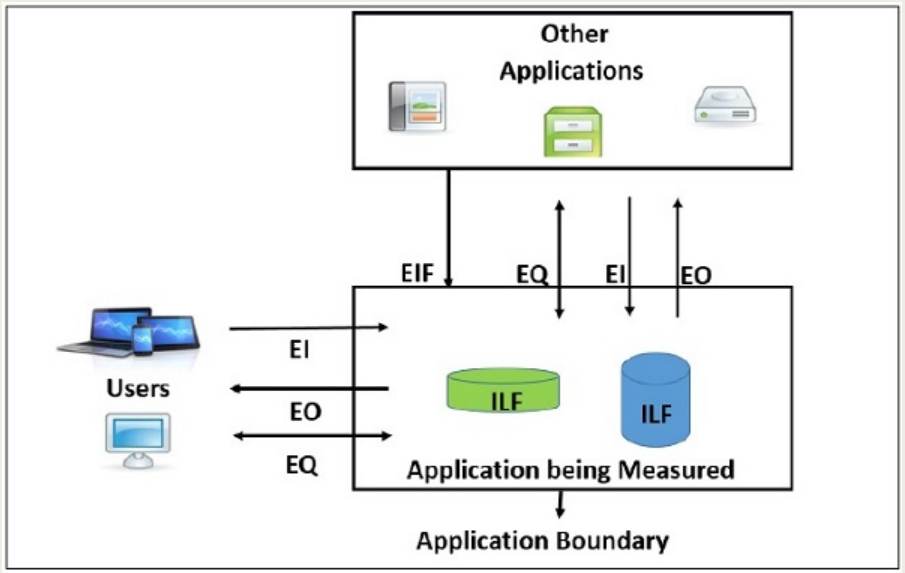
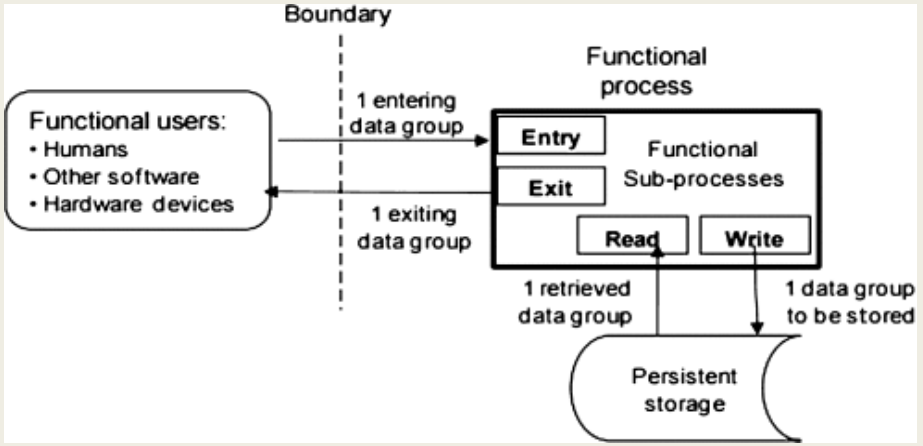


Figure 1: Application Boundary, Data Functions, Transaction Functions

COSMIC



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

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

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

Prediction Accuracy Statistics

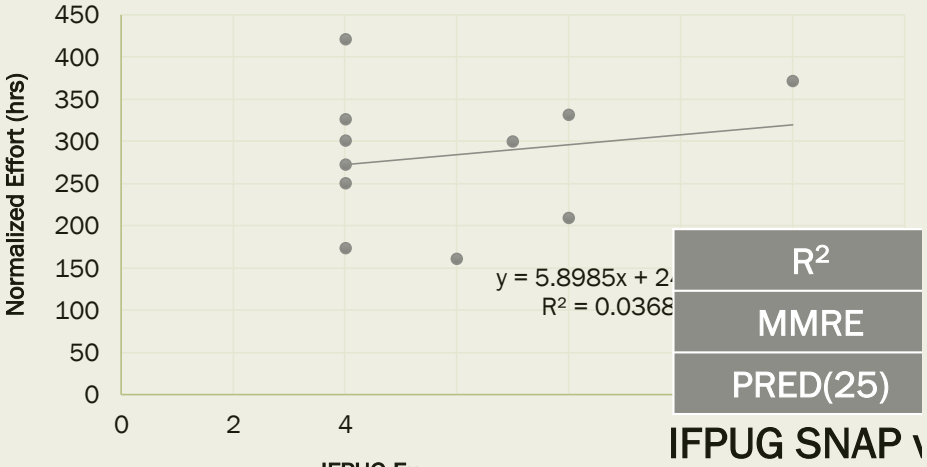
- **R^2**: how closely the regression curve fits the data points
- **MMRE**: Mean Magnitude of Relative Error
- **PRED(25)**: Percentage of estimates within 25% of actuals

Ideally want:

- $R^2 \geq 0.8$
- MMRE $\leq 25\%$
- PRED(25) $\geq 75\%$

RESULTS: ADDING NEW FUNCTIONALITY

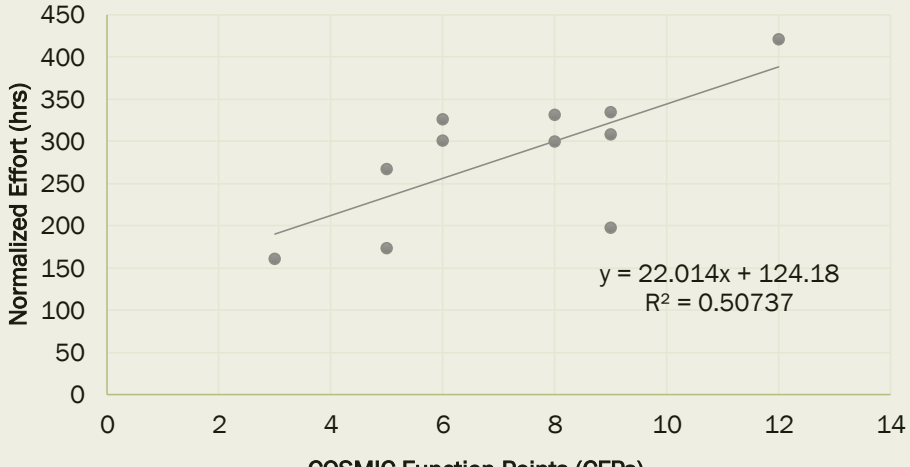
IFPUG FPs vs Effort



R^2	
MMRE	
PRED(25)	

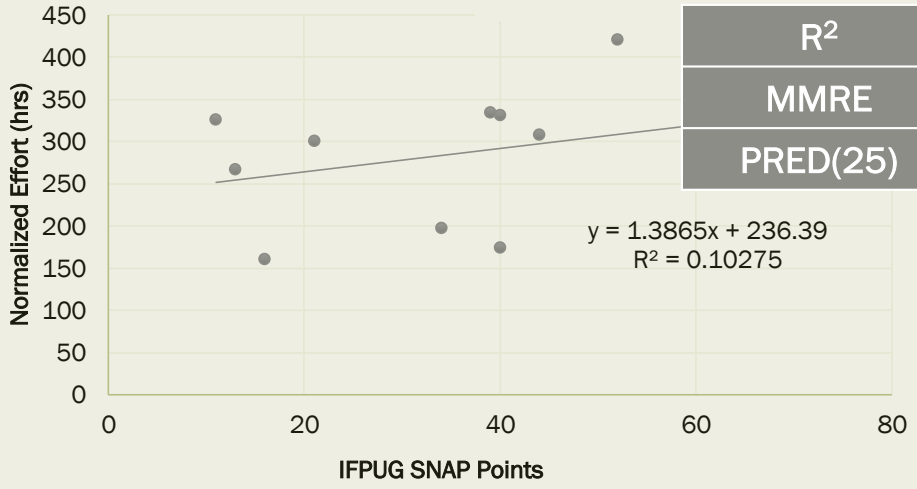
IFPUG Fu

COSMIC FPs vs Effort



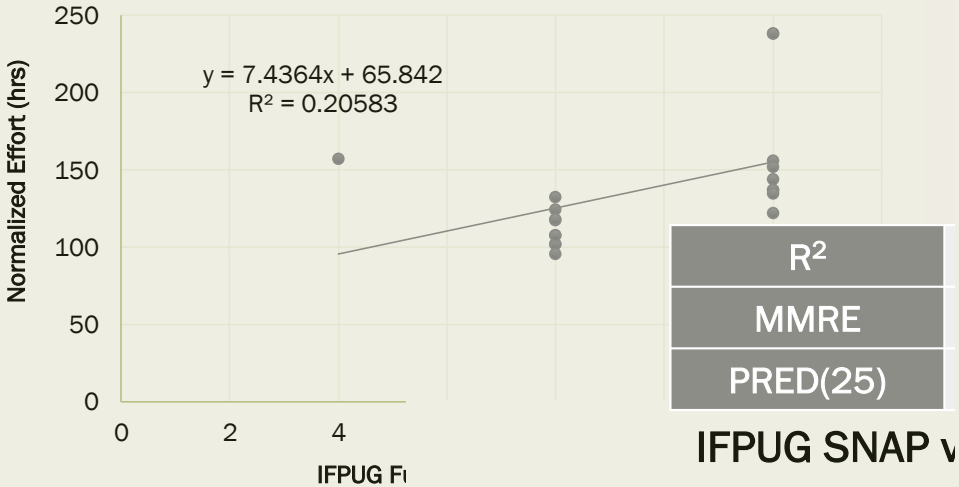
IFPUG SNAP

R^2	0.5074
MMRE	21.3438
PRED(25)	72.7273



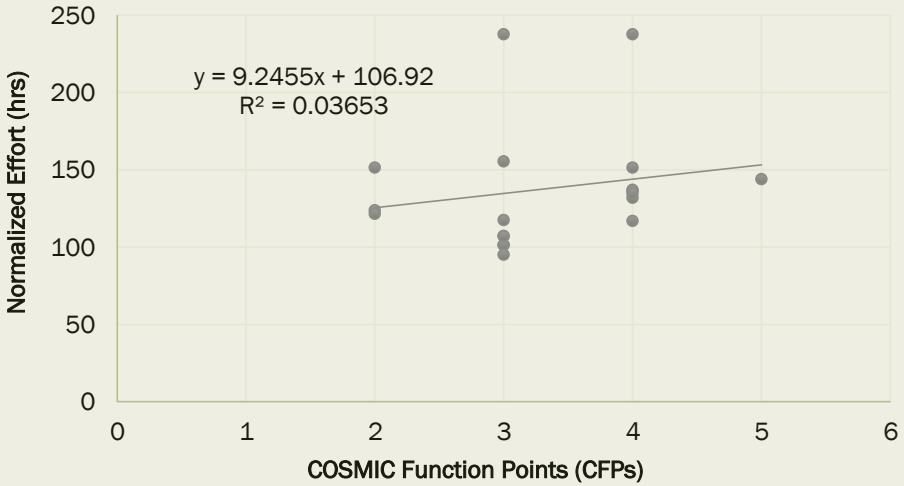
RESULTS: MODIFYING EXISTING FUNCTIONALITY

IFPUG FPs vs Effort



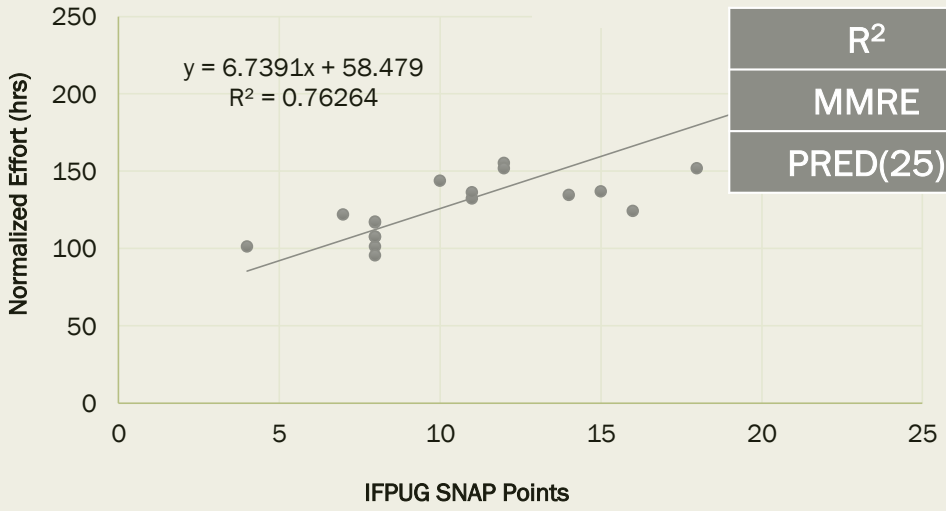
R^2	
MMRE	
PRED(25)	

COSMIC FPs vs Effort



R^2	0.0365
MMRE	18.2658
PRED(25)	63.1579

IFPUG SNAP v



RESULTS: ADDING NEW FUNCTIONALITY

Combine IFPUG and COSMIC Function Points with IFPUG SNA

$$\text{Normalized Effort (hrs)} = 222.94 + (3.93 \times FP) + (1.09 \times SNAP)$$

R^2	0.092
MMRE	26.126
PRED(25)	63.636

$$\text{Normalized Effort (hrs)} = 124.97 - (1.07 \times CFP) + (26.9 \times SNAP)$$

R^2	0.543
MMRE	16.311
PRED(25)	90.909

RESULTS: MODIFYING EXISTING FUNCTIONALITY

Combine IFPUG and COSMIC Function Points with IFPUG SNAP

$$\text{Normalized Effort (hrs)} = 51.462 + (6.518 \times SNAP) + (1.022 \times FP)$$

R^2	0.762
MMRE	11.159
PRED(25)	94.737

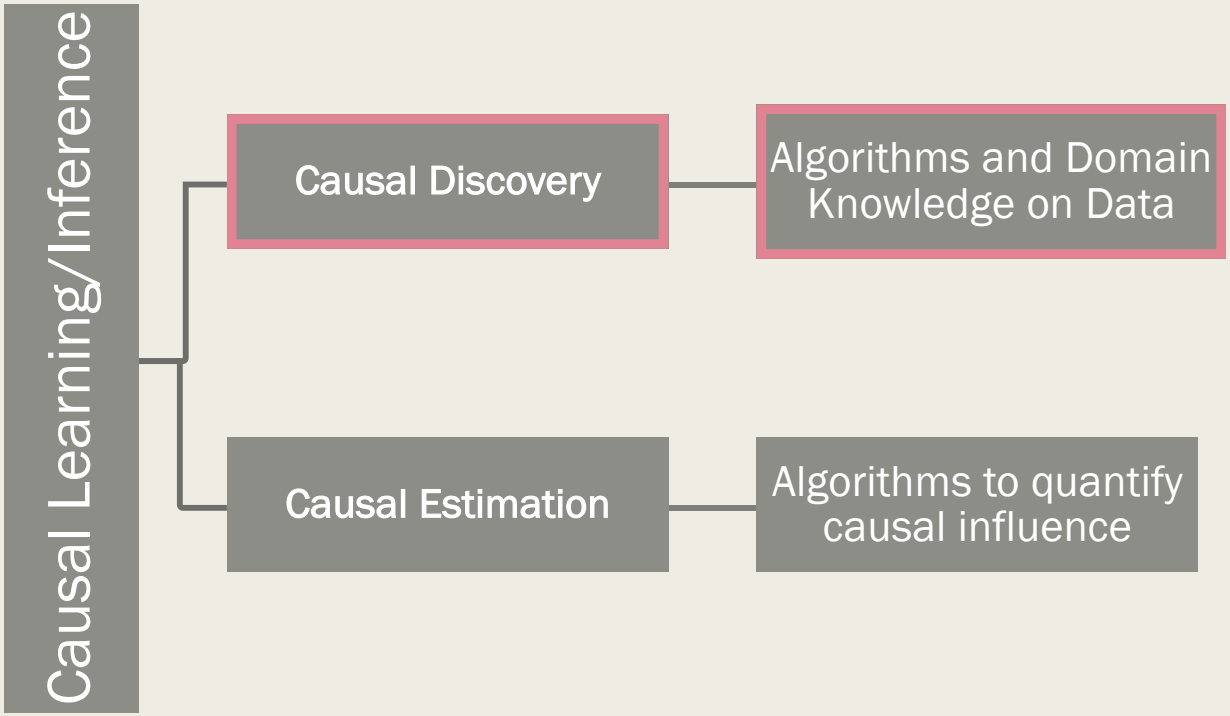
$$\text{Normalized Effort (hrs)} = 53.287 + (6.689 \times SNAP) + (1.742 \times CFP)$$

R^2	0.764
MMRE	11.279
PRED(25)	94.737

Outline

1. Why cost and size estimation is needed
2. Technical background information
3. Regression Analysis Results
4. **Introduction to Causal Analysis**
5. Causal Analysis Results
6. Conclusions

Causal Inference



Past Causal-Type Analyses

Dr. Boehm COCOMO® 81

- In-depth behavioral analyses for effort factors

Evidence-Based SE

- Experiments
- Cause precede effect
- Cause covaries with effect
- Alternative explanations are implausible

Cuoto et al

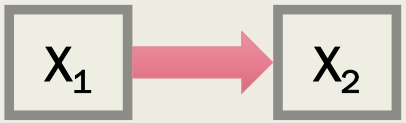
- Granger's causality test for software defect predictability
  - *Doesn't get to heart of causality*

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

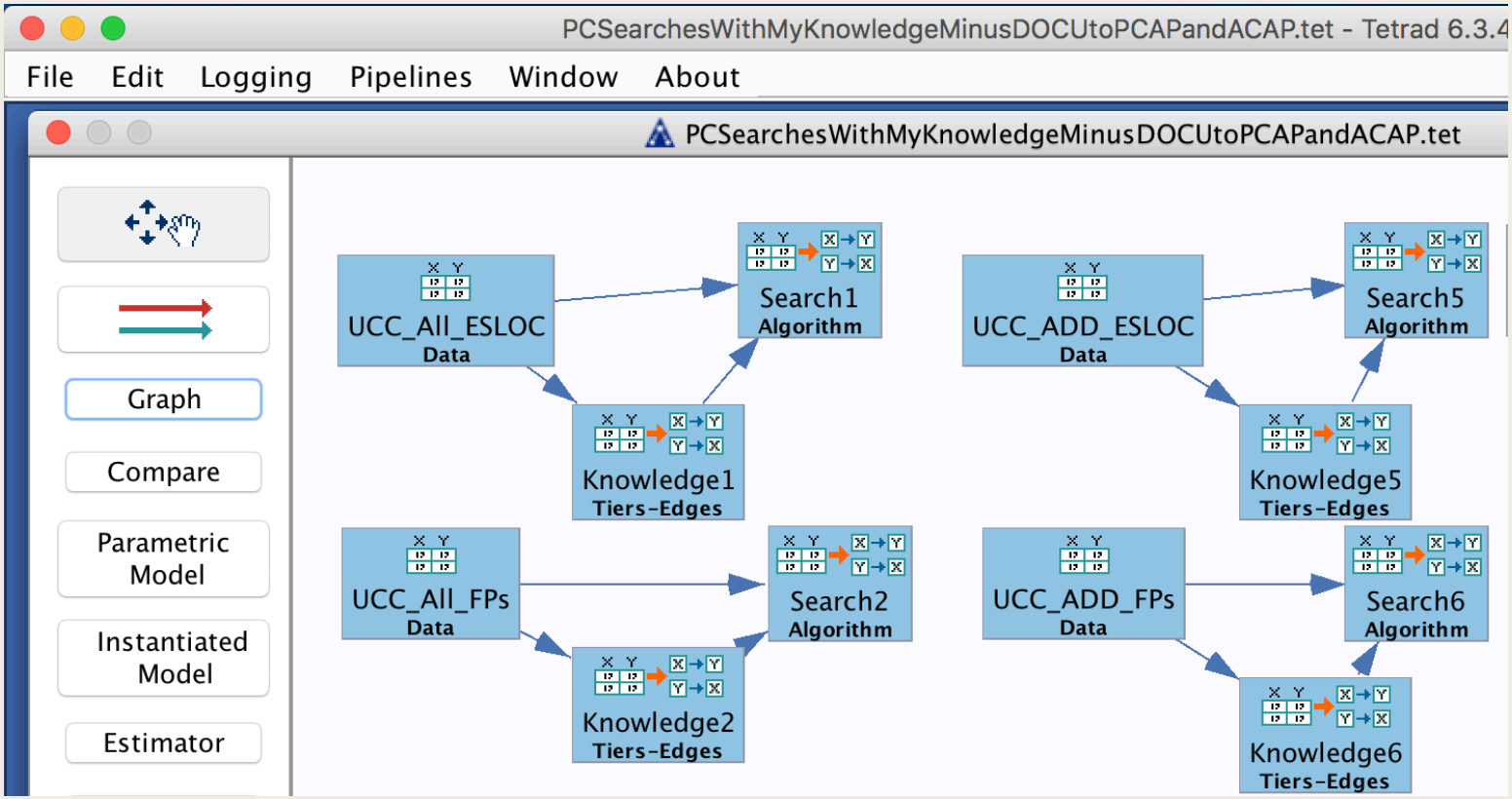


Change in X_1 causes change in X_2

Insufficient data to select orientation

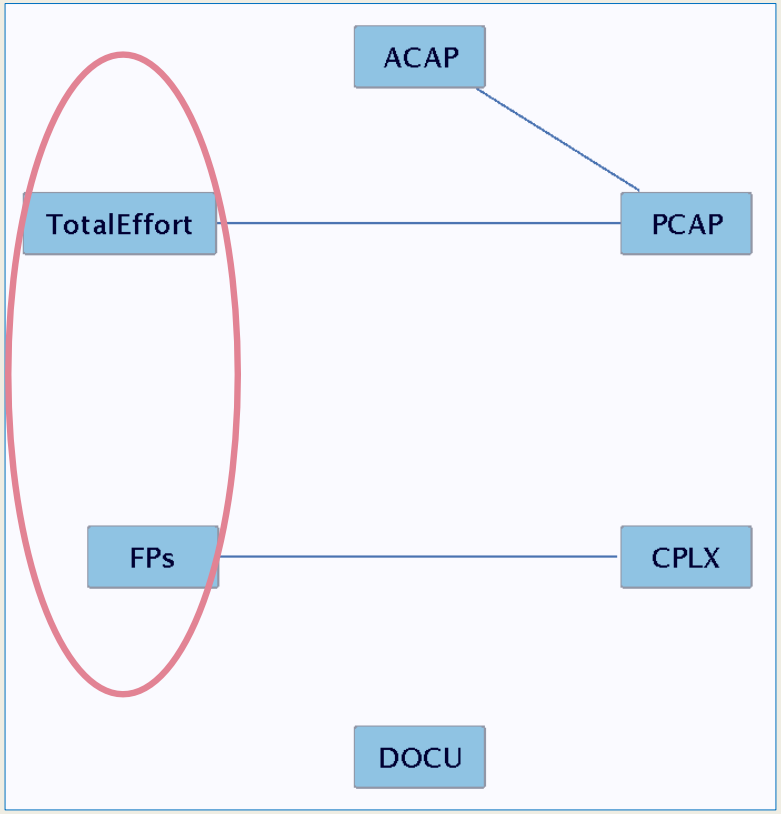
May be common confounder of both variables, missing from dataset

Tetrad

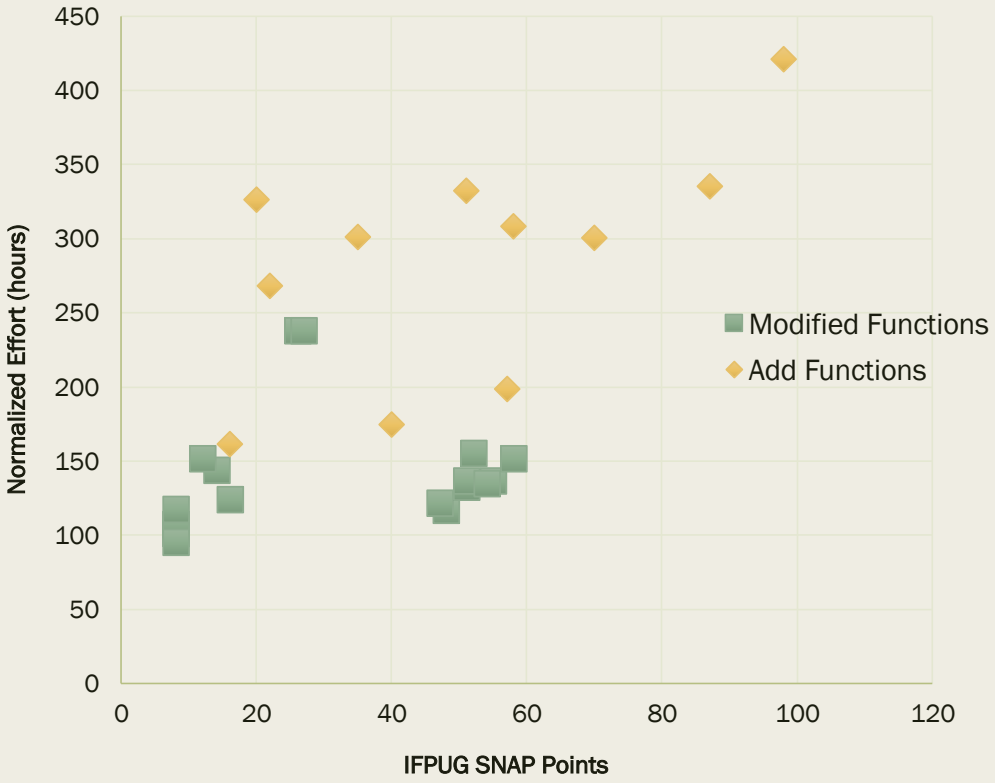

PCSearchesWithMyKnowledgeMinusDOCUtoPCAPandACAP.tet - Tetrad 6.3.4
File
Edit
Logging
Pipelines
Window
About
PCSearchesWithMyKnowledgeMinusDOCUtoPCAPandACAP.tet
Graph
Compare
Parametric Model
Instantiated Model
Estimator
UCC_All_ESLOC
Data
Search1
Algorithm
Knowledge1
Tiers-Edges
UCC_All_FPs
Data
Search2
Algorithm
Knowledge2
Tiers-Edges
UCC_ADD_ESLOC
Data
Search5
Algorithm
Knowledge5
Tiers-Edges
UCC_ADD_FPs
Data
Search6
Algorithm
Knowledge6
Tiers-Edges

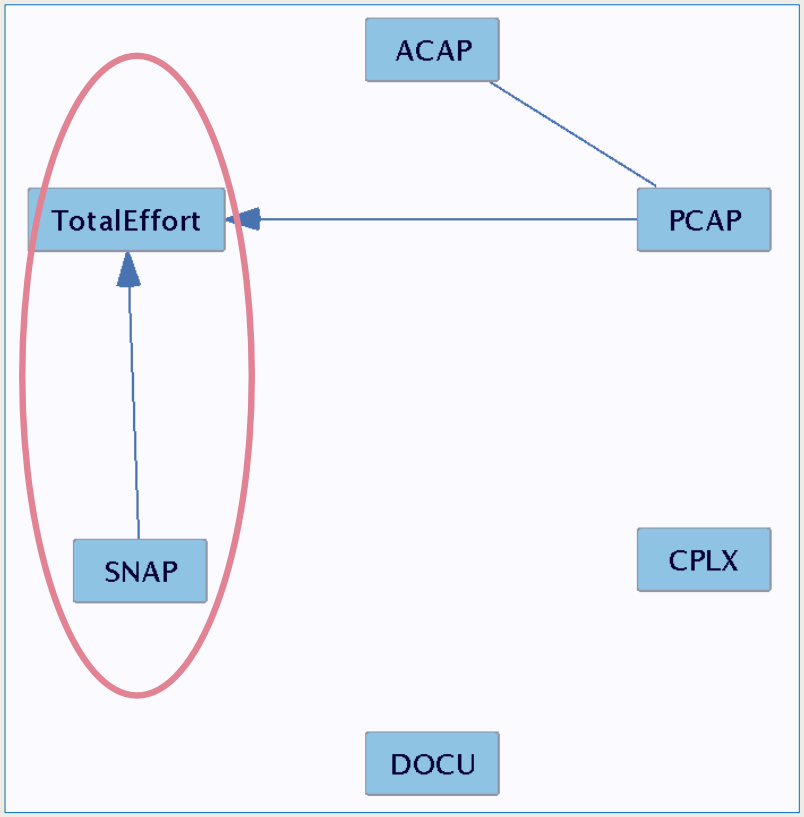
RESULTS: ALL DATA POINTS

IFPUG Function Points (FPs)

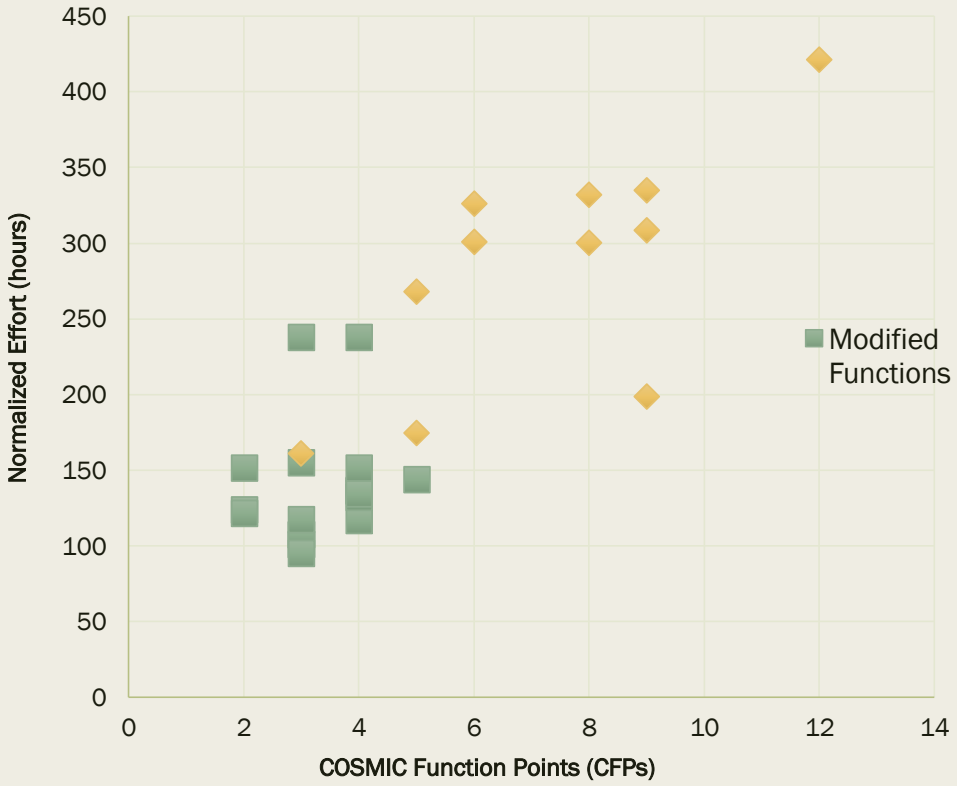


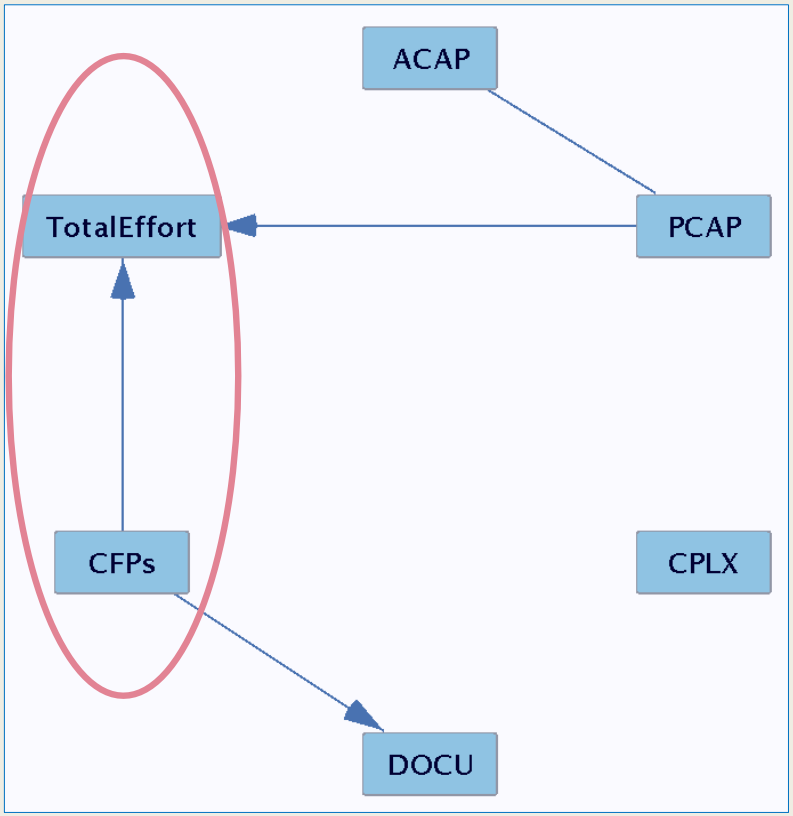
IFPUG SNAP Points





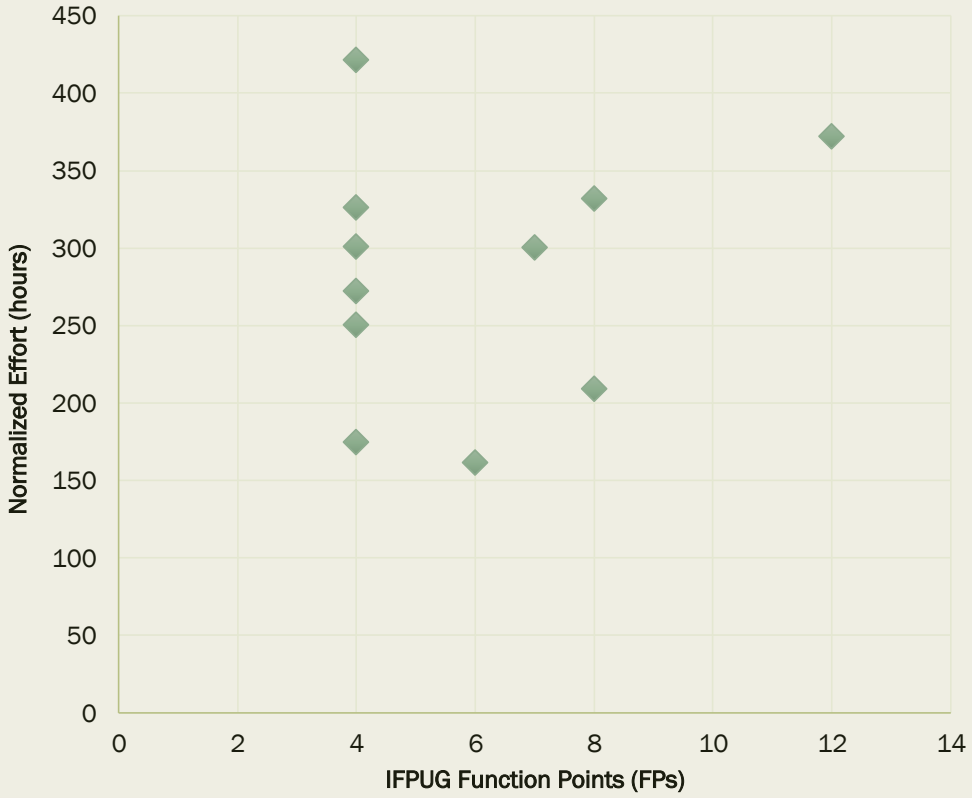
COSMIC Function Points (CFPs)

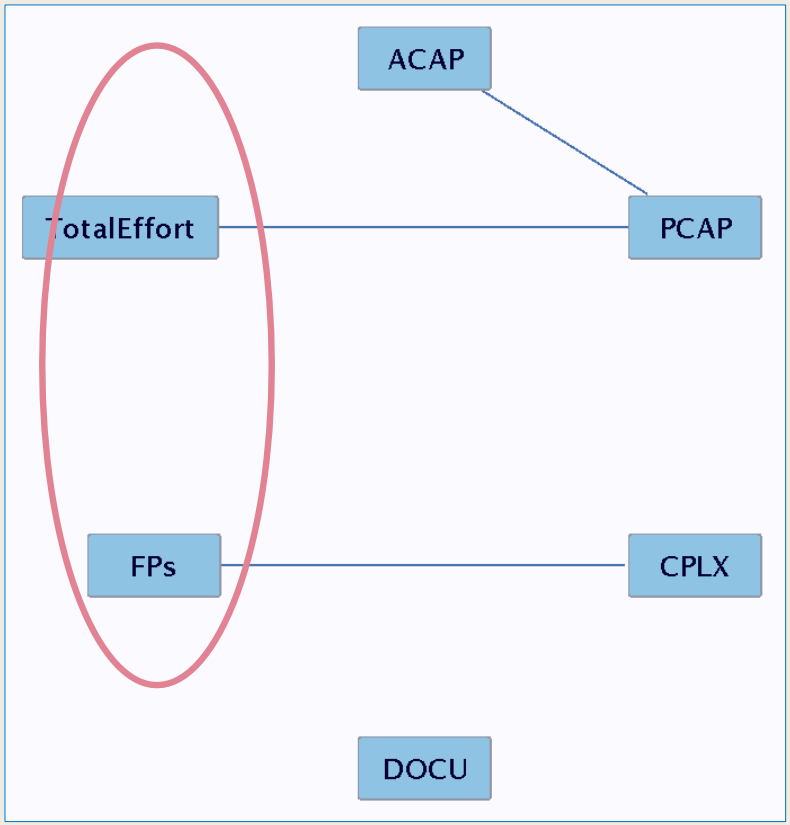




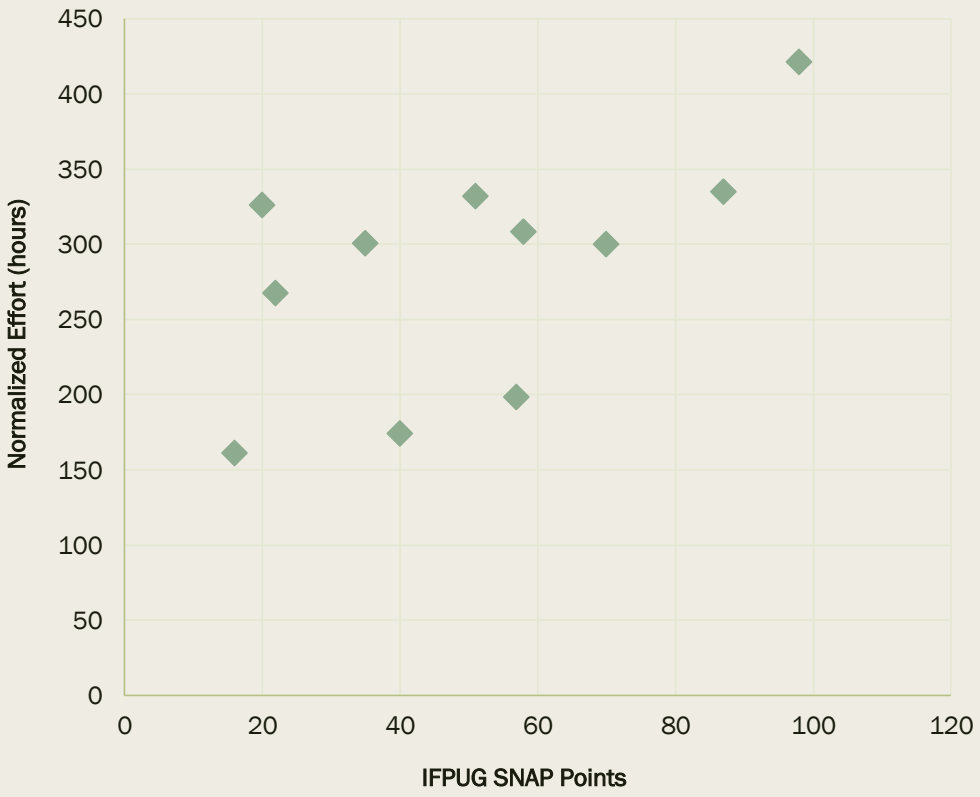
RESULTS: ADD FUNCTIONALITY

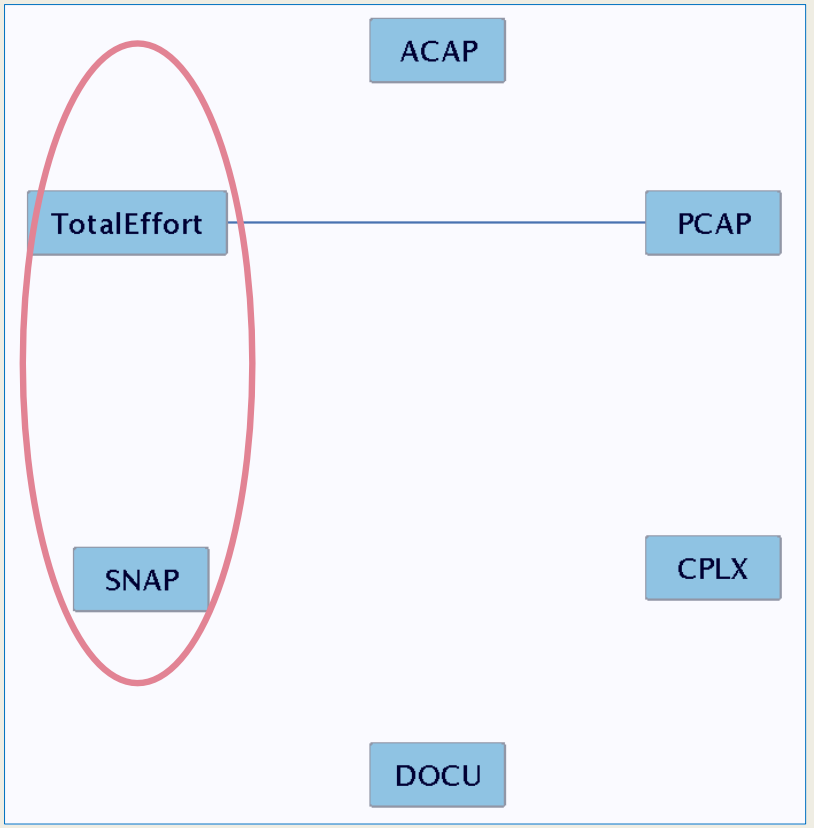
IFPUG Function Points (FPs)



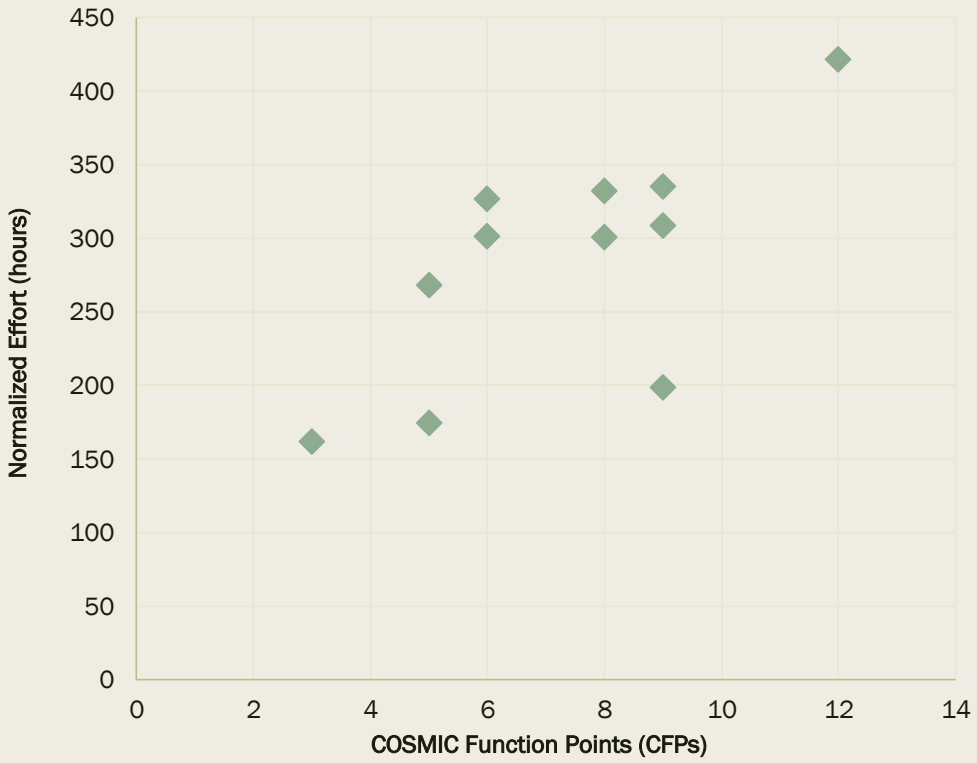


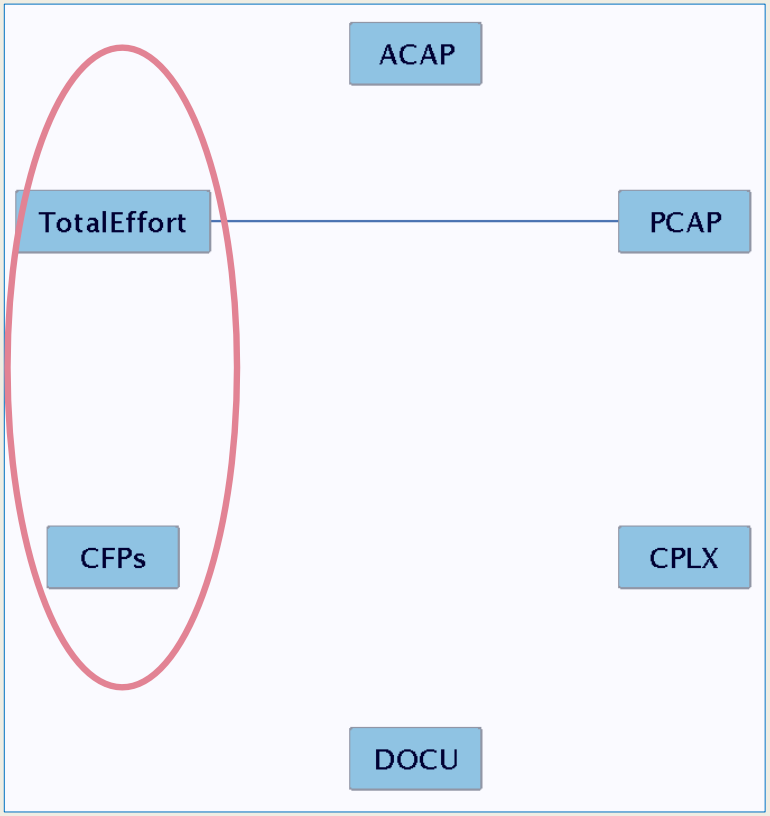
IFPUG SNAP Points





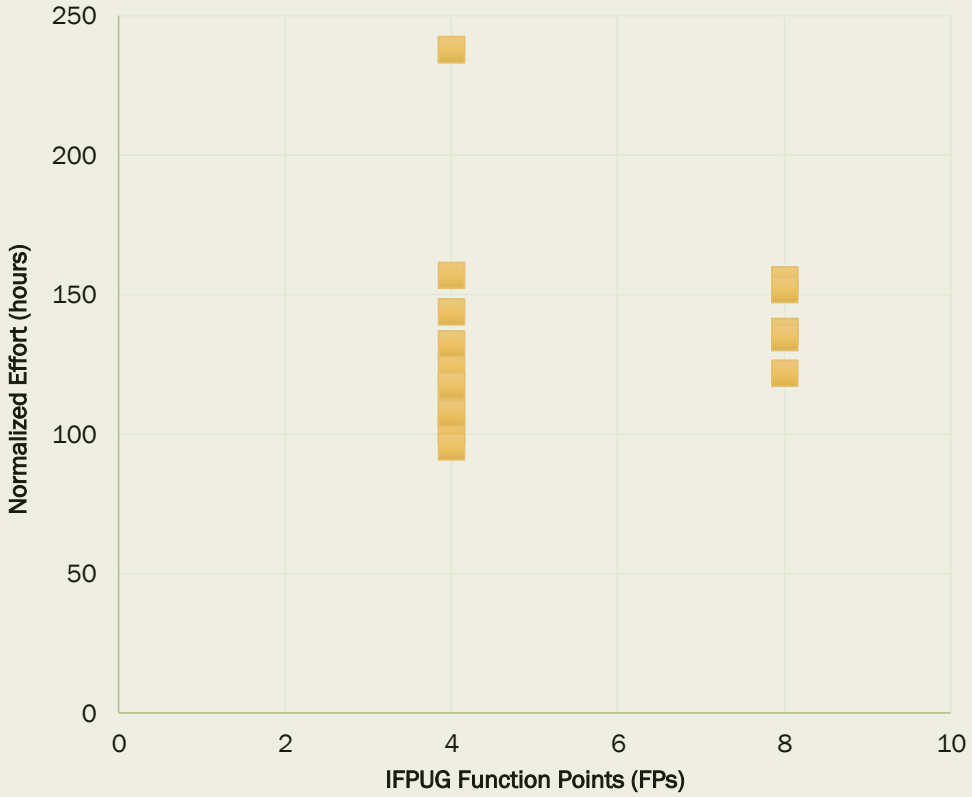
COSMIC Function Points (CFPs)

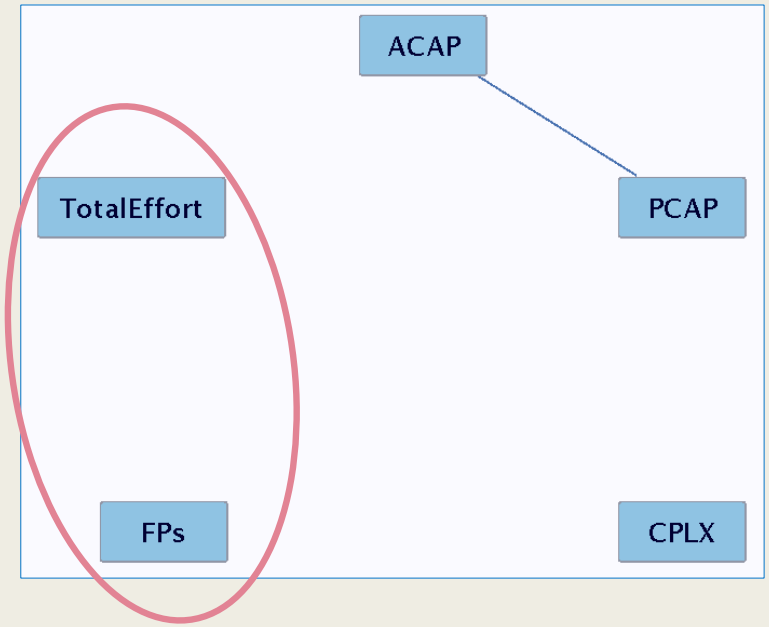




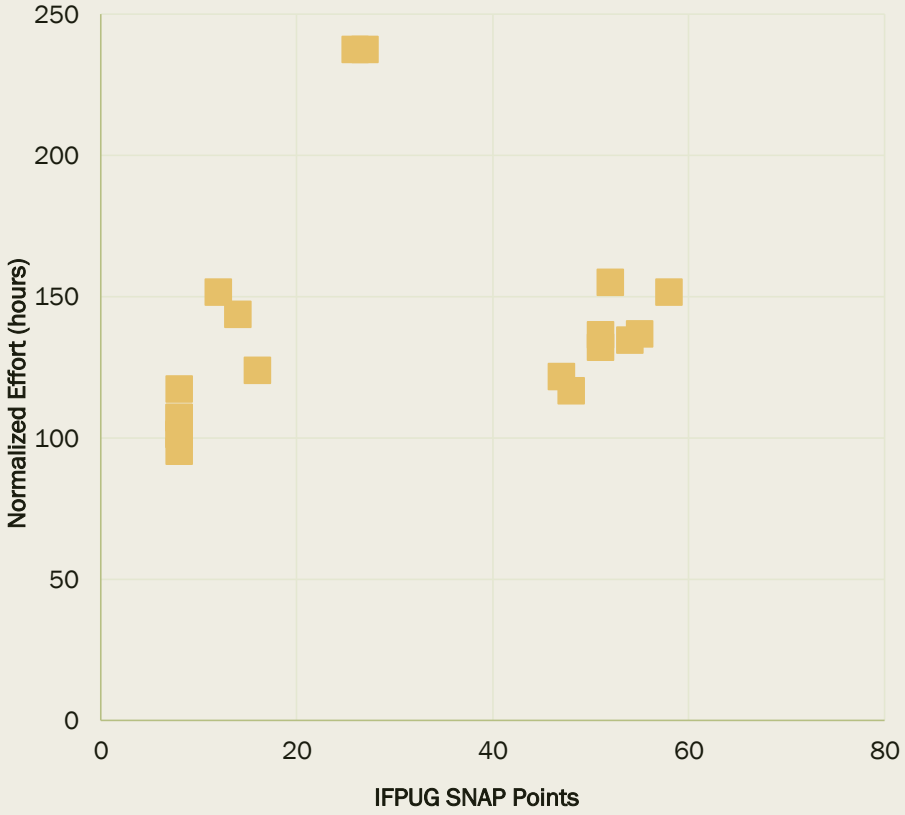
RESULTS: MODIFY FUNCTIONALITY

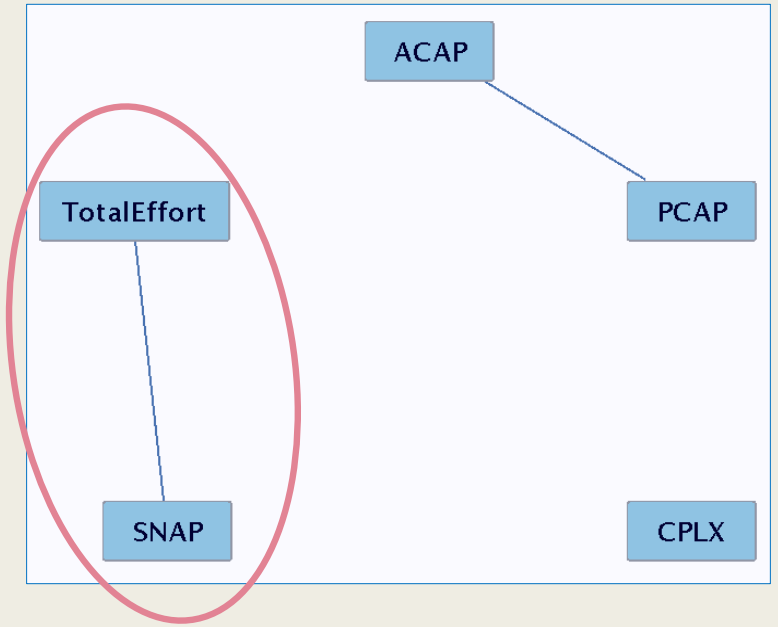
IFPUG Function Points (FPs)



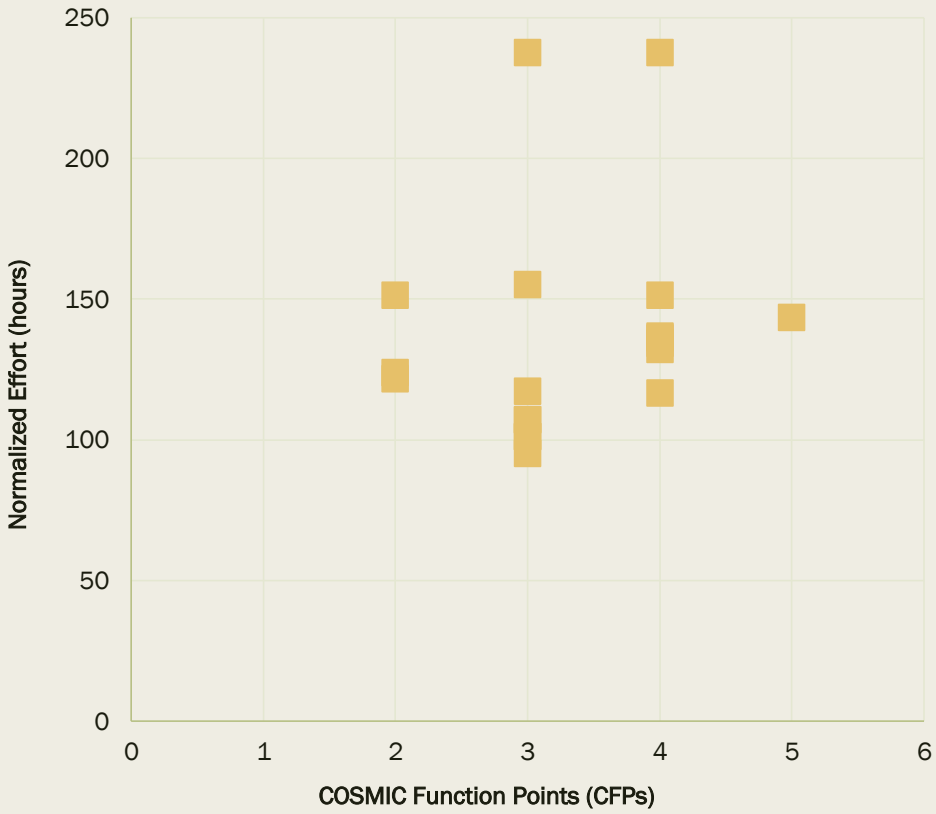


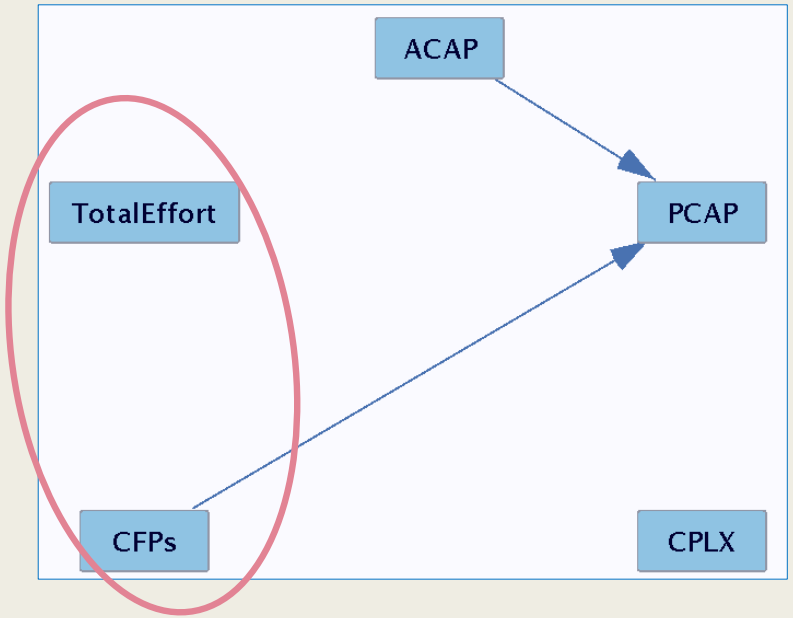
IFPUG SNAP Points





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*