Comparing IFPUG and COSMIC Measurements for Software Maintenance

Annual Research Review 2017

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Outline

- Intro
  - Motivation
  - Dataset
- Metrics
  - IFPUG
  - COSMIC
  - Normalized Effort
- Analyses Results
  - IFPUG
  - COSMIC
- Ending
  - Validity
  - Conclusions

Motivation

- Cost Models – SLOC for size input
- SLOC difficult to estimate
  - Especially maintenance
- Several size measures based on functionality
  - IFPUG FPs and SNAP
  - COSMIC FPs
- Which one is best?

Current Guidance

Software Estimation Best Practices, Tools & Techniques: A Complete Guide for Software Project Estimators

- Organization's standard
- Manager's/client's suggestion
- Most familiar
- Most popular

Journal Article by Sheetz, Henderson, and Wallace

- Automation
- Calculation Ease
- Objectivity
- Data Availability
- Context Independence
- Lifecycle Applicability
- Standardization
- Sensitivity
- Intuitiveness
- Understandability
- Validity

SLOC and FP Comparison

Criteria	SLOC	FPs
Automation	✔ ✔	✗ ✗
Calculation Ease	✔	✗
Objectivity	✔ ✔	✗
Data Availability	✔	✗
Context Independence	✗ ✗	✔ ✔
Lifecycle Applicability	✗	✔ ✔
Standardization	✗	✔ ✔
Sensitivity	✗	✗
Intuitiveness	✔	✗
Understandability	✔	✗
Validity	✔	✔ ✔

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 Functions
  - New language parsers
  - New features, such as GUI
- Modify Functions
  - Cyclomatic complexity support (modify existing language parsers with mathematical operation and algorithms)

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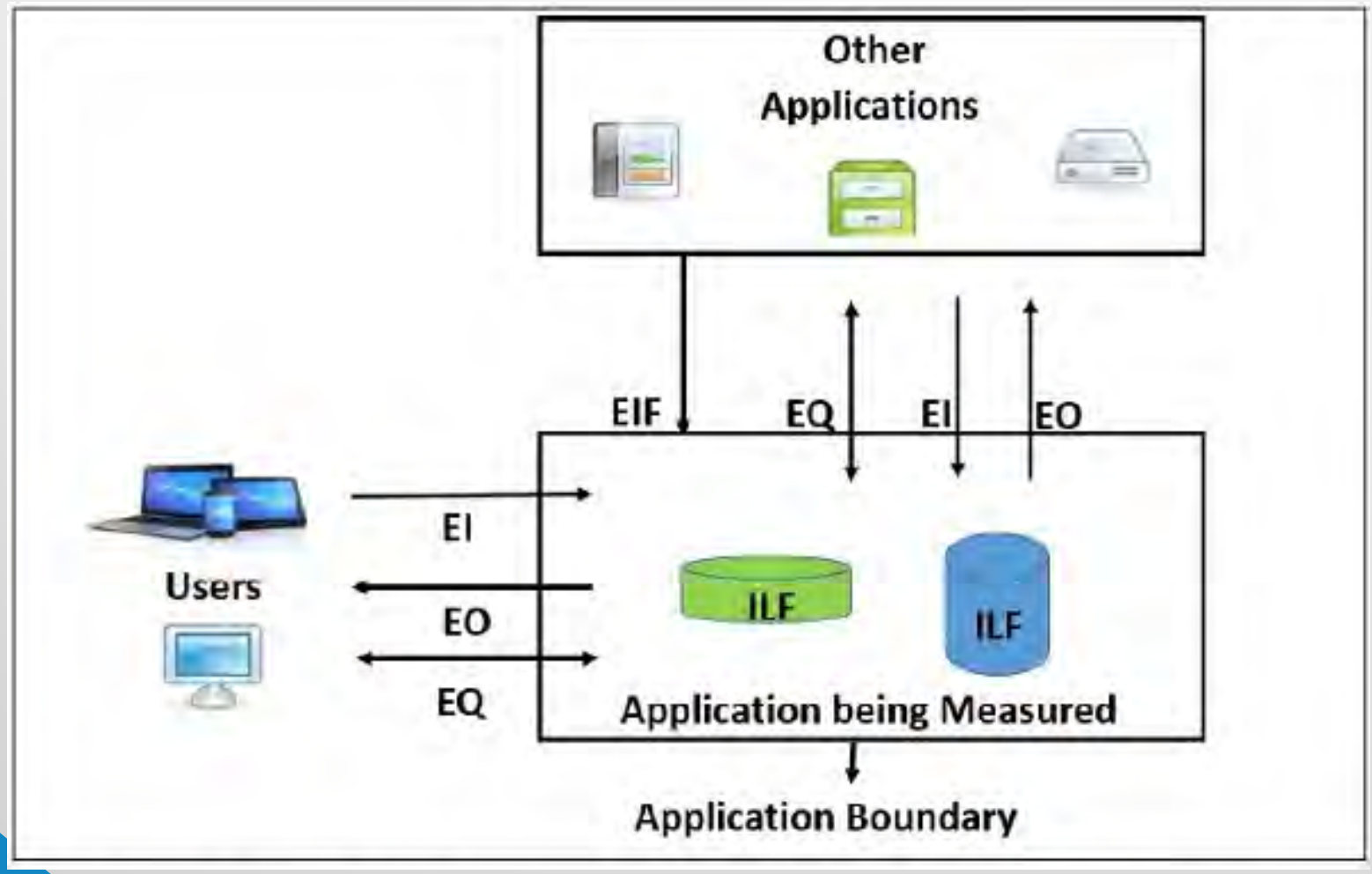
IFPUG Software Model



IFPUG Function Points – 1/2

Type of Component	Complexity of Components Multiplier Factor			
	Low	Average	High	**Total**
External Inputs	3	4	6	
External Outputs	4	5	7	
External Inquiries	3	4	6	
Internal Logical Files	7	10	15	
External Interface Files	5	7	10	
Total Number of Unadjusted Function Points				

IFPUG Function Points – 2/2

General System Characteristics

- Data Communications
- Distributed Data Processing
- Performance
- Heavily used Configuration
- Transaction Rate
- Online Data Entry
- End-user Efficiency
- Online Update
- Complex Processing

General System Characteristics Cntd.

- Installation Ease
- Operational Ease
- Multiple Sites
- Facilitate Change

Equations

$$VAF = 0.65 + \frac{(\sum C_i)}{100}$$

$$EFP = [\,(\,ADD + CHGA\,) \times VAFA\,] + (\,DEL \times VAFB\,)$$

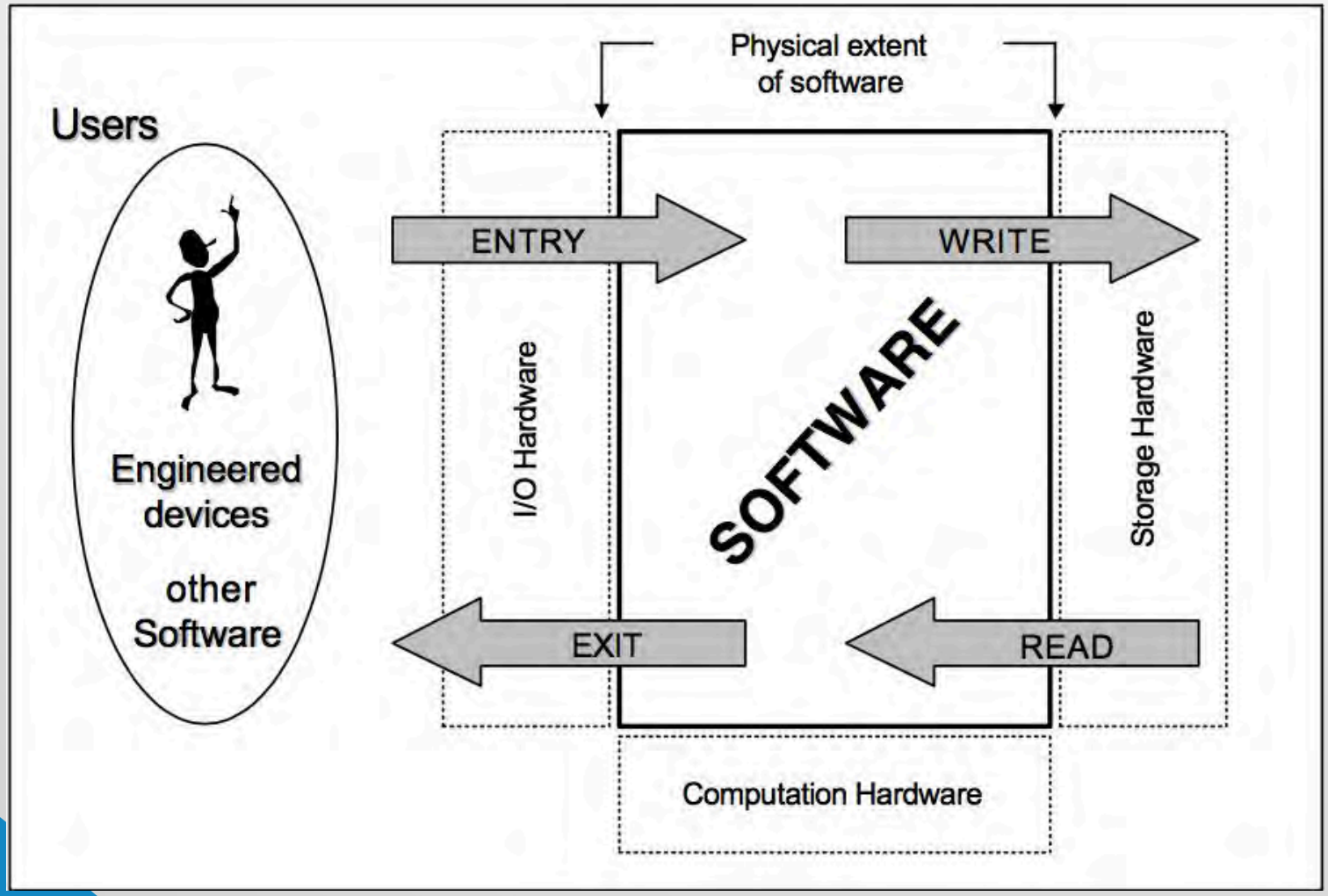
IFPUG SNAP Points

Subcategory	Complexity of Components Multiplier Factor			
	Low	Average	High	**Total**
Data Entry Validation	2	3	4	
Logical Operations	4	6	10	
Mathematical Operations	3	4	7	
Data Formatting	2	3	5	
Internal Data Movements	4	6	10	
User Interface	2	3	4	
Total Non-Functional Requirements Size				

Enhancement Project SNAP Points

$ESP = ADD + CHG - DEL$

COSMIC Software Model



COSMIC Function Points

Functional Processes	Data Groups			Transactions				Totals
	DG 1	.....	DG n	Entry	Exit	Read	Write	
FP 1								
FP 2								
FP 3								
....								
FP n								
Software Totals								

Normalized Effort

COCOMO model:

$$\text{Effort (PM)} = 2.94 \times Size^{1.0997} \times \prod_{i=1}^{17} EM_i$$

$$\text{PM} = 152 \text{ hours}$$

$$\text{Normalized Effort (hours)} = \frac{\text{Total Effort (hours)}}{\left(\prod EM_i\right)}$$

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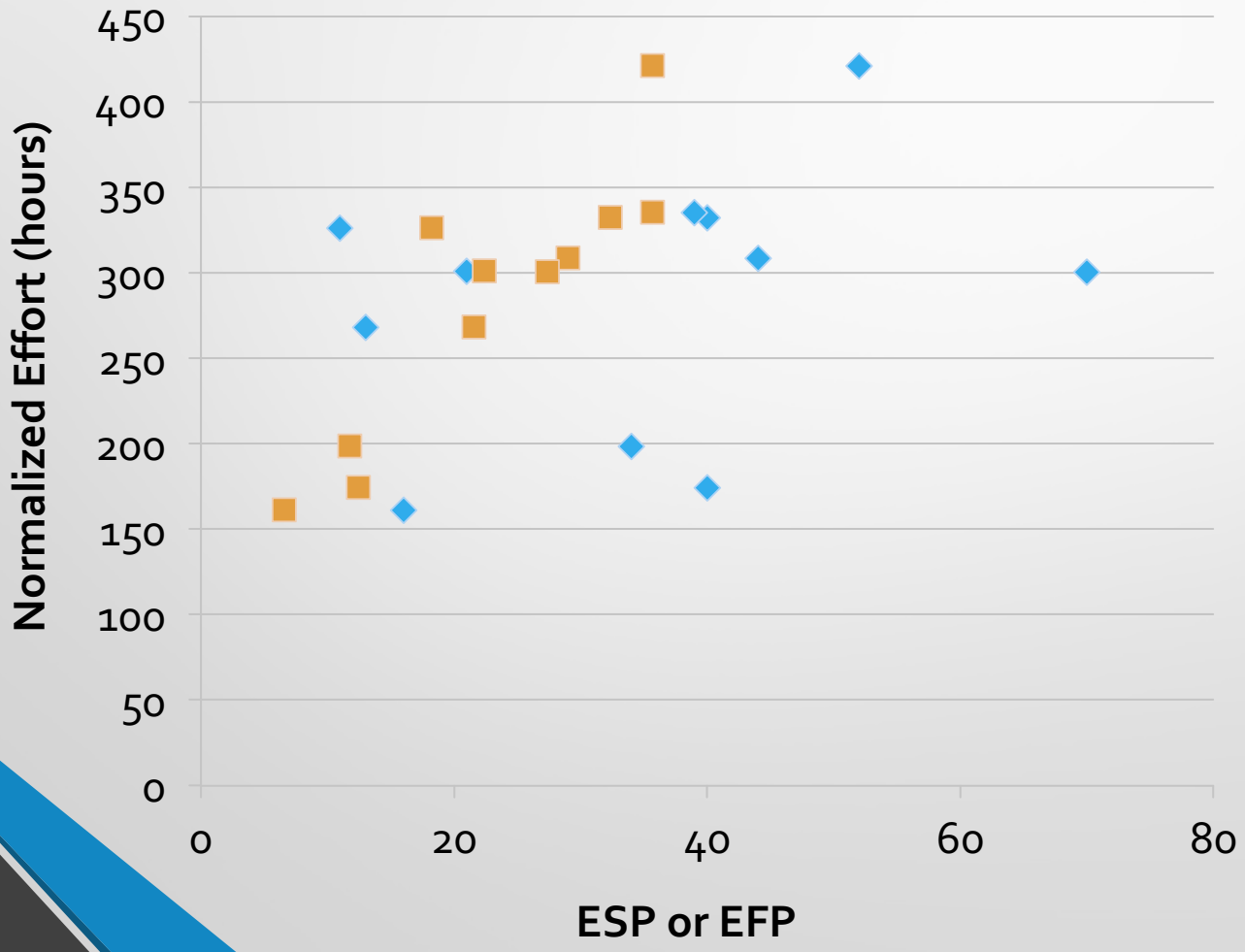
Results: IFPUG FPs and SNAP

Adding New Functions

Adding New Functions

Normalized Effort (hrs) = 133.702 + (7.855 x EFP) – (0.877 x ESP)



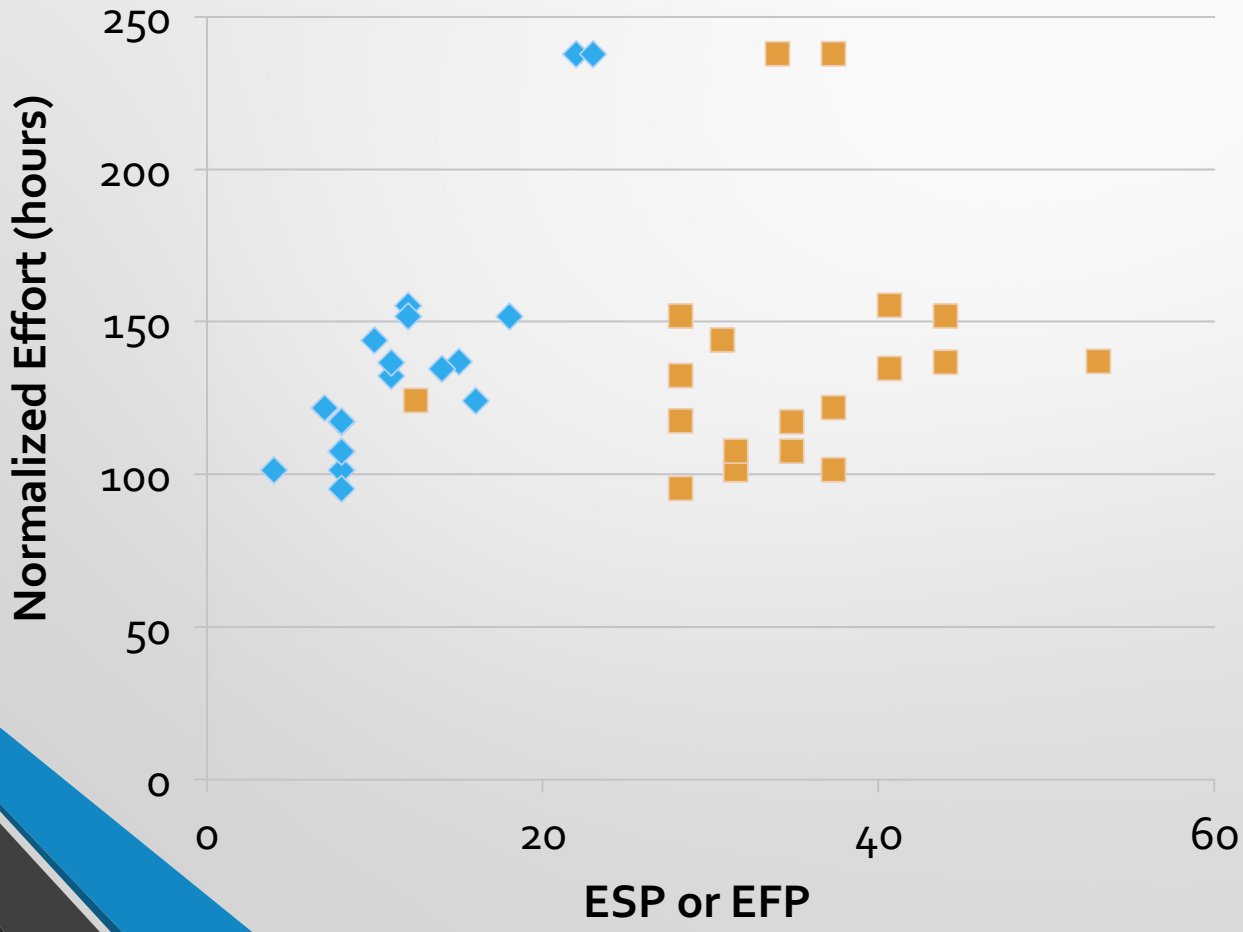
R^2	0.831
p-value	0.001
PRED (20)	100
PRED (25)	100
PRED (30)	100

Results: IFPUG FPs and SNAP

Modifying Existing Functions

Modifying Existing Functions

Normalized Effort (hrs) = 48.701 + (0.305 x EFP) + (6.673 x ESP)

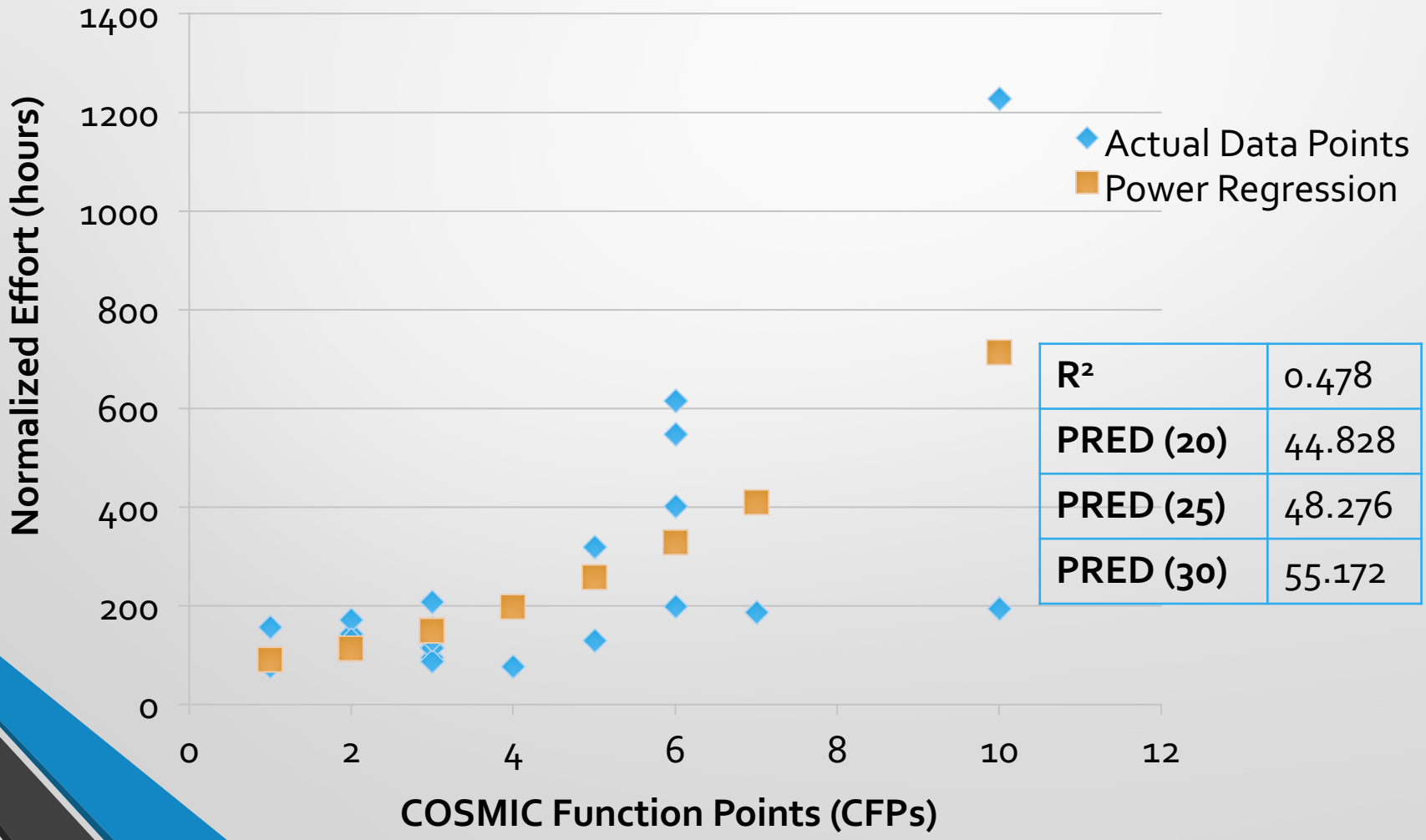


R^2	0.767
p-value	0.0001
PRED (20)	84.211
PRED (25)	94.737
PRED (30)	100

Results: COSMIC FPs

COSMIC FPs

Normalized Effort (hrs) = 81.354 + 9.097 x CFPs$^{1.842}$



R²	0.478
PRED (20)	44.828
PRED (25)	48.276
PRED (30)	55.172

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Validity Considerations

Internal

- Reported effort may not be accurate
  - Forget to update timesheets
  - Show high productivity
  - Show excessive hours

Mitigation

- Members evaluated on ability to meet deadlines, adapt to problems, communicate clearly

External

- Segregation between adding functions and modifying functions
  - Test and verify on other datasets
- Linear relationship does not account for diseconomies of scale
  - Analyze on datasets with larger projects for scalable results
- Results might not be repeatable in full-time employee situations

Conclusions

- IFPUG
  - Function Points: Effective for inputs and outputs with minimal algorithms
  - SNAP: Effective for algorithms and mathematical operations
  - FPs + SNAP: Effective (2 separate models)
- COSMIC
  - Does not size data manipulation – algorithms, mathematical operations