

Software Metrics and Estimation

Ali Dogru

Contents

- Metrics
- Size and Function Oriented Software Metrics
- Reconciling different approaches
- Empirical Estimation
- Metrics for Quality
- Make/buy decision

Ali Dogru METU

35

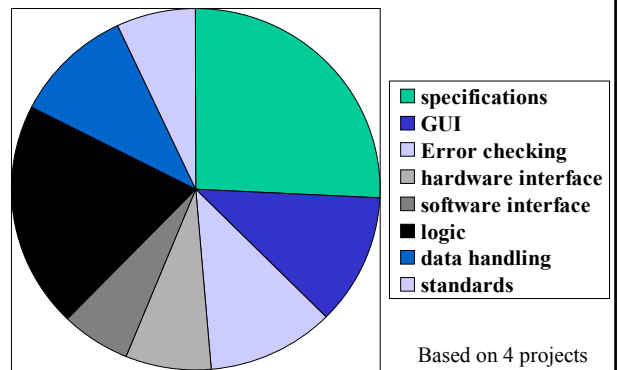
Metrics and Measurement

- Measure: Quantitative indication of an attribute of a product or a process
- Metric: Degree to which a process or a component possesses an attribute
- Indicator: A (combination of) metrics that provide insight to process or product.

Ali Dogru METU

36

Origin of Errors



Ali Dogru METU

37

LOC Based Estimation

Function	Estimated LOC
User Interface	2300
Database management	3350
3D Geometry	6800
Peripheral Control	2100
Estimated LOC:	14550

- Productivity: LOC/pm
- Labor cost: \$/pm

Ali Dogru METU

38

Function Points

- $FP = \text{countTotal} \times [0.65 + 0.01 \times \sum F_i]$

parameter	count	simple	Average	complex	
#user inputs	m	3	4	6	Count total =
#user outputs	n	4	5	7	
#user inquiries	...	3	4	6	
# files		7	10	15	
#external interfaces		5	7	10	

Ali Dogru METU

39

Complexity Adjustment Values F_i

- 1 Reliable backup and recovery grade all from 0 to 5
- 2 Data communications
- 3 Distributed processing
- 4 Critical performance
- 5 Heavily utilized operational environment
- 6 On-line data entry
- 7 Input transactions over multiple screens (on-line)
- 8 Master file updates on-line
- 9 Complex input/output/file/inquiries
- 10 Complex internal processing
- 11 Reusable code design
- 12 Conversion and installation included in design
- 13 Multiple installations for different organizations
- 14 Design for facilitating change and ease of use

Ali Dođru METU

40

Extensions to Function Points

- Feature Points: Number of algorithms is added to the information domain parameters
- 3D Function Points: Data, function, and control dimensions are included in the information domain parameters:
 - data: same as in Function Points
 - function: number of transformations
 - control: number of states

Ali Dođru METU

41

GUI to Function Points

GUI Feature	FP Category	DETs *	F.Points	Java LOC
Msg Box	Outp - low	1..19	4	212
Dlg simple	Inp - low	1..15	3	159
Dlg avr	inp - avr	16+	4	212
Dlg cplx	inp - hgh	16 + Tabs	6	318
windw smpl	Outp - low	1..19	4	212
windw avr	outp - hgh	20 + Tabs	7	371
windw cplx	O -H, I-H	16+Ti 20+To	13	689
Rprt smple	O-L	1..19	4	212
Rprt avr	O-A	20+	5	265
Rprt cplx	O-H	20 + Tabs	7	371
datafile avr	File-L	1..50	7	371
datafile cplx	File-H	51+Links	15	795
xtrnal smpl	xtrn-L	1..50	5	265
xtrnal avr	(X-A + F-A)/2	51+	9	477
xtrnal cplx	(X-H + F-H)/2	51+	13	689

* Data Element Types

FP to LOC transformation

Programming Language	FP/LOC
Assembly	320
C	128
COBOL	105
FORTRAN	105
Pascal	90
Ada	70
Object Oriented	30
4th Generation	20

Ali Dođru METU

43

Empirical Estimation Models

- Effort = A + B (size)^C
- 5.2 (KLOC)^{0.91} Walston-Felix
- 5.5 + 0.73 (KLOC)^{1.16} Bailey-Basili
- 3.2 (KLOC)^{1.05} Boehm: simple
- 5.288 (KLOC)^{1.047} Doty for KLOC>9
- -13.39 + 0.045 FP Albrecht - Gaffney
- 60.62 + 7.728 10⁻⁸ FP³ Kemerer
- 585.7 + 15.12 FP Matson, Barnett, Mellichamp

Ali Dođru METU

44

COCOMO

- Constructive Costing Model(s):
 - 1 Basic: Effort and time, as a function of size
 - 2 Intermediate: Like Basic, also a set of cost drivers for subjective assessments of product, hardware, personnel and project attributes
 - 3 Advanced: Like Intermediate, also dynamic (each phase like analysis, design... considered)
- Project types for COCOMO:
 - organic
 - semi-detached
 - embedded

Ali Dođru METU

45

COCOMO Equations

- Basic
 - Effort = $a_b \text{ KLOC}^{b_b}$
 - Time = $c_b \text{ Effort}^{d_b}$
- Intermediate
 - Effort = $a_i \text{ KLOC}^{b_i} \times \text{EAF}$

project	a_b	b_b	c_b	d_b	b_i	b_i
organic	2.4	1.05	2.5	0.38	3.2	1.05
semi-detached	3.0	1.12	2.5	0.35	3.0	1.12
embedded	3.6	1.20	2.5	0.32	2.8	1.20

Ali Dođru METU

46

Putnam's Software Equation

- $E = [\text{LOC} \times B^{0.333} / P]^3 \times (1/t^4)$
- E: effort (person months)
- t: duration in years
- B: special skills factor (0.16 ... 0.39) for (5 KLOC ... > 70 KLOC)
- P: productivity factor
 - 2000: real-time embedded software
 - 10000: telecomm and systems software
 - 28000: business systems applications

Ali Dođru METU

47

Metrics for Quality

- Correctness: defects per KLOC
- Maintainability: Mean-Time-To-Change
- Reliability: Mean-Time-Between-Failure
- Integrity: Ability to withstand attacks =
 - $\Sigma [1 - \text{threat} \times (1 - \text{security})]$
-
-

Ali Dođru METU

48