Mansoura University
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Software Cost Estimation

Grade : 4 (SWE)

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Software Cost Estimation

Agenda

- Estimating size.
- Estimating Effort.
- Estimating Schedule.

Estimating size

- **Unadjusted Function Point & Adjusted Function Point.**
- **Range of the Size Estimate.**
- **Dutch Method to calculate the number of function points.**

Unadjusted Function Point

- **To calculate Unadjusted Function Point :**

  Unadjusted Function Point = External Inputs + External Outputs + External Queries + Internal Logical Files + External Interface Files.

- **To calculate One of each program characteristic :**

  External Inputs:

  - **Low Complexity : Number of External Inputs * weight**
  - **Medium Complexity : Number of External Inputs * weight**
  - **High Complexity : Number of External Inputs * weight**

Unadjusted Function Point

- **To calculate One of each program characteristic :**

External Outputs:

- **Low Complexity :** Number of External Outputs * weight
- **Medium Complexity :** Number of External Outputs * weight
- **High Complexity :** Number of External Outputs * weight

External Queries:

- **Low Complexity :** Number of External Queries * weight
- **Medium Complexity :** Number of External Queries * weight
- **High Complexity :** Number of External Queries * weight

Unadjusted Function Point

- **To calculate One of each program characteristic :**

Internal Logical Files :

- **Low Complexity :** Number of Internal Logical Files * weight
- **Medium Complexity :** Number of Internal Logical Files * weight
- **High Complexity :** Number of Internal Logical Files * weight

External Interface Files:

- **Low Complexity :** Number of External Interface Files* weight
- **Medium Complexity :** Number of External Interface Files* weight
- **High Complexity :** Number of External Interface Files* weight

Adjusted Function Point

- **To calculate Adjusted Function Point :**

Adjusted Function Point =

Unadjusted Function Point * Influence Multiplier

Example 1

Calculate the total unadjusted function point and the Adjusted function points in the following case:

	Function Points		
Program Characteristic	**Low Complexity**	**Medium Complexity**	**High Complexity**
External Inputs	6 × 3 = 18	2 × 4 = 8	3 × 6 = 18
External Outputs	7 × 4 = 28	7 × 5 = 35	0 × 7 = 0
External Queries	0 × 3 = 0	2 × 4 = 8	4 × 6 = 24
Internal Logical Files	0 × 7 = 0	2 × 10 = 20	3 × 15 = 45
External Interface Files	2 × 5 = 10	0 × 7 = 0	7 × 10 = 70
Unadjusted Function Point total			**284**
Influence multiplier			**1.0**
Adjusted Function Point total			**284**

Example of computing the number of function points

Range of the Size Estimate

- **To calculate Range of the Size Estimate :**
  - **The minimum number of LOC = Adjusted Function Point * Minimum Range per Function Point.**
  - **The Maximum number of LOC = Adjusted Function Point * Maximum Range per Function Point.**
  - **The Nominal number of LOC = Adjusted Function Point * Expected Value Range per Function Point.**

Example 2

If you have 284-function-point program were to be implemented in Java, and SQL, calculate the range of the size estimate and the nominal value in both cases given that for Java: you would take the range of 40 to 80 LOC per function point and the expected value of 55 LOC per function point, and for SQL you would take the range of 7 to 15 LOC per function point with most common value of 13 LOC.

What is the solution ???

Solution

Solution :

For Java:

The minimum number of LOC = 284 x 40 = 11360 ≈ 11000 LOC

The maximum number of LOC = 284 x 80 = 22720 ≈ 23000 LOC

The nominal number of LOC = 284 x 55 = 15620 ≈ 16000 LOC

For SQL:

The minimum number of LOC = 284 x 7 = 1988 ≈ 2000 LOC

The maximum number of LOC = 284 x 15 = 4260 ≈ 4000 LOC

The nominal number of LOC = 284 x 13 = 3692 ≈ 4000 LOC

Dutch Method

- To calculate the number of function points :

$$\text{IndicativeFunctionPointCount} = (35 \times \text{InternalLogicalFiles}) + (15 \times \text{ExternalInterfaceFiles})$$

Example 3

If you have 7 ILF and 5 EIF, use the Dutch Method to calculate the number of function points.

What is the solution ???

Solution :

IndicativeFunctionPointCount =

(35 * InternalLogicalFiles) + (15 * ExternalInterfaceFiles)

FunctionPointCount = (35 * 7) + (15 * 5) = 245 + 75 = 320 function point.

Estimating Effort

- **Productivity& Cost of one LOC.**
- **Informal Comparison.**
- **International Software Benchmarking Standards Group (ISBSG) Method.**

Productivity & Cost of one LOC

- **To calculate Productivity:**

  Productivity = LOC / Effort

- **To calculate Cost of one LOC:**

  Cost of one LOC = total cost / LOC

Example 1

If the LOC = 83000, Effort = 9 staff years, total cost = 1400000 $, calculate the Productivity and the cost of one LOC.

What is the solution ???

Productivity = LOC / Effort = 83000 / 9 = 9200 LOC/Staff year
Cost of one LOC = total cost / LOC = 1400000 / 83000 = 17 $

Informal Comparison

- **Project is being too Small if it is less than 1/3 the size of the low end of your range.**
- **Project is being too Large if it is more than 3 times the top end of your range.**
- **Low estimate of effort = lowest end size / highest productivity.**
- **Highest estimate of effort = Highest end size / lowest productivity.**

Example 2

Informal comparison:

Suppose you're estimating the effort for a new business system, and you've estimated the size of the new software to be 65,000 to 100,000 lines of Java code, with a most likely size of 80,000 lines of code. Use the table to estimate the effort for this project.

Project	Size (LOC)	Schedule (Calendar Months)	Effort (Staff Months)	Productivity (LOC/Staff Month)	Comments
Project A	33,842	8.2	21	1,612	
Project B	97,614	12.5	99	986	
Project C	7,444	4.7	2	3,722	Not used—too small for comparison
Project D	54,322	11.3	40	1,358	
Project E	340,343	24.0	533	639	Not used—too large for comparison

Example of past project productivities for use as the basis of an effort estimate

What is the solution ???

Solution

Solution :

- **Project C is too small to use for comparison purposes because it is less than 1/3 the size of the low end of your range.**
- **Project E is too large because it is more than 3 times the top end of your range.**
- **Thus your relevant historical productivity range is 986 LOC per staff month (Project B) to 1,612 LOC per staff month (Project A).**
- **Low estimate of effort = lowest end size / highest productivity**

  Low estimate of effort = 65000 / 1612 = 40 staff months
- **Highest estimate of effort = Highest end size / lowest productivity**

  Highest estimate of effort = 100000 / 986 = 101 staff months

ISBSG Method

- **The Desktop equation:**

$$StaffMonths = 0.157 * FunctionPoints^{0.591} * MaximumTeamSize^{0.810}$$

- **The Third Generation Language equation:**

$$StaffMonths = 0.425 * FunctionPoints^{0.488} * MaximumTeamSize^{0.697}$$

Example 3

ISBSG Method:

Suppose you are creating an effort estimate for a desktop business application of 1450 function points in Java and you have a maximum team size of 7 people.

Calculate the effort for this application.

What is the solution ???

We can consider the application as either a Desktop or a Third generation language application:

The Desktop equation:

$$\text{StaffMonths} = 0.157 * \text{FunctionPoints}^{0.591} * \text{MaximumTeamSize}^{0.810}$$

$$\text{StaffMonths} = 0.157 * 1450^{0.591} * 7^{0.810} = 56$$

The Third Generation Language equation:

$$\text{StaffMonths} = 0.425 * \text{FunctionPoints}^{0.488} * \text{MaximumTeamSize}^{0.697}$$

$$\text{StaffMonths} = 0.425 * 1450^{0.488} * 7^{0.697} = 58$$

Estimating Schedule

- **ScheduleInMonths.**
- **Computing Schedule by Using Informal Comparisons to Past Projects.**
- **First-Order Estimation Practice.**
- **Average team size.**

Estimating Schedule

- **ScheduleInMonths.**

$$\text{ScheduleInMonths} = K * \text{StaffMonths}^{1/3}$$

- **Computing Schedule by Using Informal Comparisons to Past Projects.**

$$\text{EstimatedSchedule} = \text{PastSchedule} * (\text{EstimatedEffort} / \text{Past Effort})^{1/3}$$

Calculate EstimatedSchedule in Low , Nominal and High Estimation in each project.

Then Calculate the average of EstimatedSchedule.

Example 1

Suppose you've estimated that you will need 80 staff months to build your project. Calculate the schedule range from The Basic Schedule Equation.

(The Basic Schedule Equation: $ScheduleInMonths = K \times StaffMonths^{1/3}$ Where K is a constant ranges from 2 to 4)

What is the solution ???

$ScheduleInMonths = K \times StaffMonths^{1/3}$

For K = 2: $ScheduleInMonths = 2 * 80^{1/3} = 8.6$ months

For K = 4: $ScheduleInMonths = 4 * 80^{1/3} = 17.2$ months

The nominal schedule will be = $3 * 80^{1/3} = 12.9$ months

Example 2

Suppose you have an effort estimate of 65 to 100 staff months, with a most likely estimate of 80 staff months. Derive the estimated schedules from past projects shown in the table, then calculate the expected average schedule and its range.

	Historical Data	
Project	Past Schedule (Calendar Months)	Past Effort (Staff Months)
Project A	8.2	21
Project B	12.5	99
Project D	11.3	40

What is the solution ???

Solution

Solution :

Computing Schedule by Using Informal Comparisons to Past Projects

EstimatedSchedule = PastSchedule * (EstimatedEffort / Past Effort) $^{1/3}$

For project A:

EstimatedSchedule = PastSchedule * (EstimatedEffort / Past Effort) $^{1/3}$

Low Estimate: EstimatedSchedule = 8.2 * (65 / 21) $^{1/3}$ = 12 months

Nominal Estimate: EstimatedSchedule = 8.2 * (80/ 21) $^{1/3}$ = 12.8 months

High Estimate: EstimatedSchedule = 8.2 * (100/ 21) $^{1/3}$ = 13.8 months

For project B:

Low Estimate: EstimatedSchedule = 12.5 * (65/ 99) $^{1/3}$ = 10.8 months

Nominal Estimate: EstimatedSchedule = 12.5 * (80/ 99) $^{1/3}$ = 11.6 months

High Estimate: EstimatedSchedule = 12.5 * (100/ 99) $^{1/3}$ = 12.5 months

Solution

Solution :

For project D:

Low Estimate: EstimatedSchedule = 11.3 * $(65/40)^{1/3}$ = 13.2

Nominal Estimate: EstimatedSchedule = 11.3 * $(80/40)^{1/3}$ = 14.2

High Estimate: EstimatedSchedule = 11.3 * $(100/40)^{1/3}$ = 15.3

The expected nominal schedule is the average of the nominal values:

Expected Nominal Estimate = (12.8 + 11.6 + 14.2) / 3 = 12.9 months

Expected Low Estimate = (12 + 10.8 + 13.2) / 3 = 12 months

Expected High Estimate = (13.8 + 12.5 + 15.3) / 3 = 13.9 months

	Historical Data		Estimates		
Project	Past Schedule (Calendar Months)	Past Effort (Staff Months)	Low Estimate (65 Staff Months)	Nominal Estimate (80 Staff Months)	High Estimate (100 Staff Months)
Project A	8.2	21	12.0	12.8	13.8
Project B	12.5	99	10.8	11.6	12.5
Project D	11.3	40	13.2	14.2	15.3

Example of schedules estimates computed using informal comparison to past projects

Estimating Schedule

- **First-Order Estimation Practice.**

EstimatedSchedule = (Total number of function points)^{k}
Where k is given as shown in the table.

k is given as shown in the table from Better, Average and Worse according to kind of software .

Kind of software	Better	Average	Worse
Object-oriented software	0.33	0.36	0.39
Client-server software	0.34	0.37	0.40
Business systems, internal intranet systems	0.36	0.39	0.42
Shrink-wrapped, scientific systems, engineering systems, public internet systems	0.37	0.40	0.43
Embedded systems, telecommunications, device drivers, systems software	0.38	0.41	0.44

Exponents of the computed schedules from function points

Example 3

First-Order Estimation Practice

Kind of software	Better	Average	Worse
Object-oriented software	0.33	0.36	0.39
Client-server software	0.34	0.37	0.40
Business systems, internal intranet systems	0.36	0.39	0.42
Shrink-wrapped, scientific systems, engineering systems, public internet systems	0.37	0.40	0.43
Embedded systems, telecommunications, device drivers, systems software	0.38	0.41	0.44

Exponents of the computed schedules from function points

EstimatedSchedule = (Total number of function points)^{k}
Where k is given as shown in the table.

(a) If you estimate your project's total number of function points to be 1450, and you're working in a business-systems organization with average productivity, compute the estimated schedule.

What is the solution ???

Solution

Solution :

EstimatedSchedule for average productivity = (Total number of function points)$^{0.39}$

EstimatedSchedule = $(1450)^{0.39}$=17 months.

(b) If you are working in a best-in-class business-systems organization:

EstimatedSchedule for average productivity = (Total number of function points)$^{0.36}$

EstimatedSchedule for best-in-class = $(1450)^{0.36}$=14 months.

Solution

Solution :

(c) If you're developing an object-oriented business system, compute the range of the estimated schedule:

EstimatedSchedule for best productivity in-class = $(1450)^{0.33}$ = 11 months.

EstimatedSchedule for worst productivity in-class = $(1450)^{0.39}$ = 17 months.

The schedule range will be from 11 to 17 months.

Estimating Schedule

- To calculate the average team size :

Average team size = Effort estimate / Schedule estimate

Example 4

Calculate the average team size if you've estimated a 12-month schedule for a project of 80 staff months.

What is the solution ???

Solution :

Average team size = Effort estimate / Schedule estimate

Average team size = 80 / 12 = 6.67

Which means that the team size will be 6 to 7 team members

Any Question ?

Next ….