Mansoura University
Faculty of Computers and Information
Department of Computer Science
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Software Cost Estimation

Grade : 4 (SWE)

Week : 2

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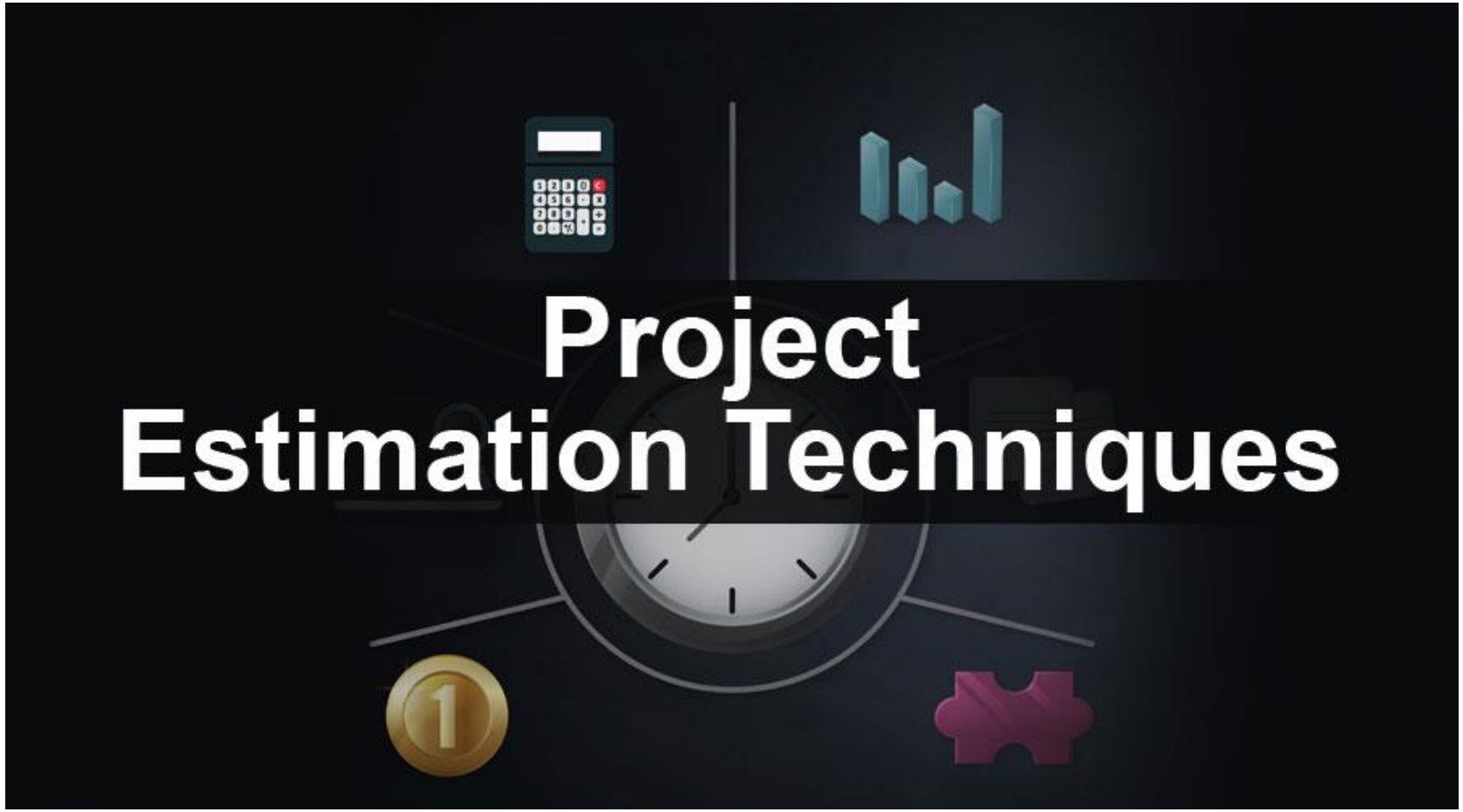
Software Cost Estimation

Agenda

- Estimation techniques
- COCOMO cost modeling

Estimation techniques



Estimation techniques

- **Organizations need to make software effort and cost estimates.**

There are two types of technique that can be used to do this:

- **Experience-based techniques: The estimate of future effort requirements is based on the manager's experience of past projects and the application domain.**
- **Algorithmic cost modeling: In this approach, a formulaic approach is used to compute the project effort based on estimates of product attributes, such as size, and process characteristics, such as experience of staff involved.**

Algorithmic Cost Modeling

- It uses a **mathematical formula** to predict **project costs** based on estimates of the project size, the type of software being developed, and other team, process, and product factors.
- Algorithmic cost models are developed by analyzing the costs and attributes of completed projects, then finding the **closest-fit formula** to the actual costs incurred.
- Most algorithmic models for estimating effort in a software project are based on a **simple formula**:

$$Effort = A \times Size^{B} \times M$$

A: a **constant factor**, which depends on local organizational practices and the type of software that is developed.
Size: an **assessment of the code size** of the software or a functionality estimate expressed in function or application points.

B: represents the **complexity** of the software and usually lies between **1** and **1.5.**
M: is a **factor that takes into account process**, product and development attributes

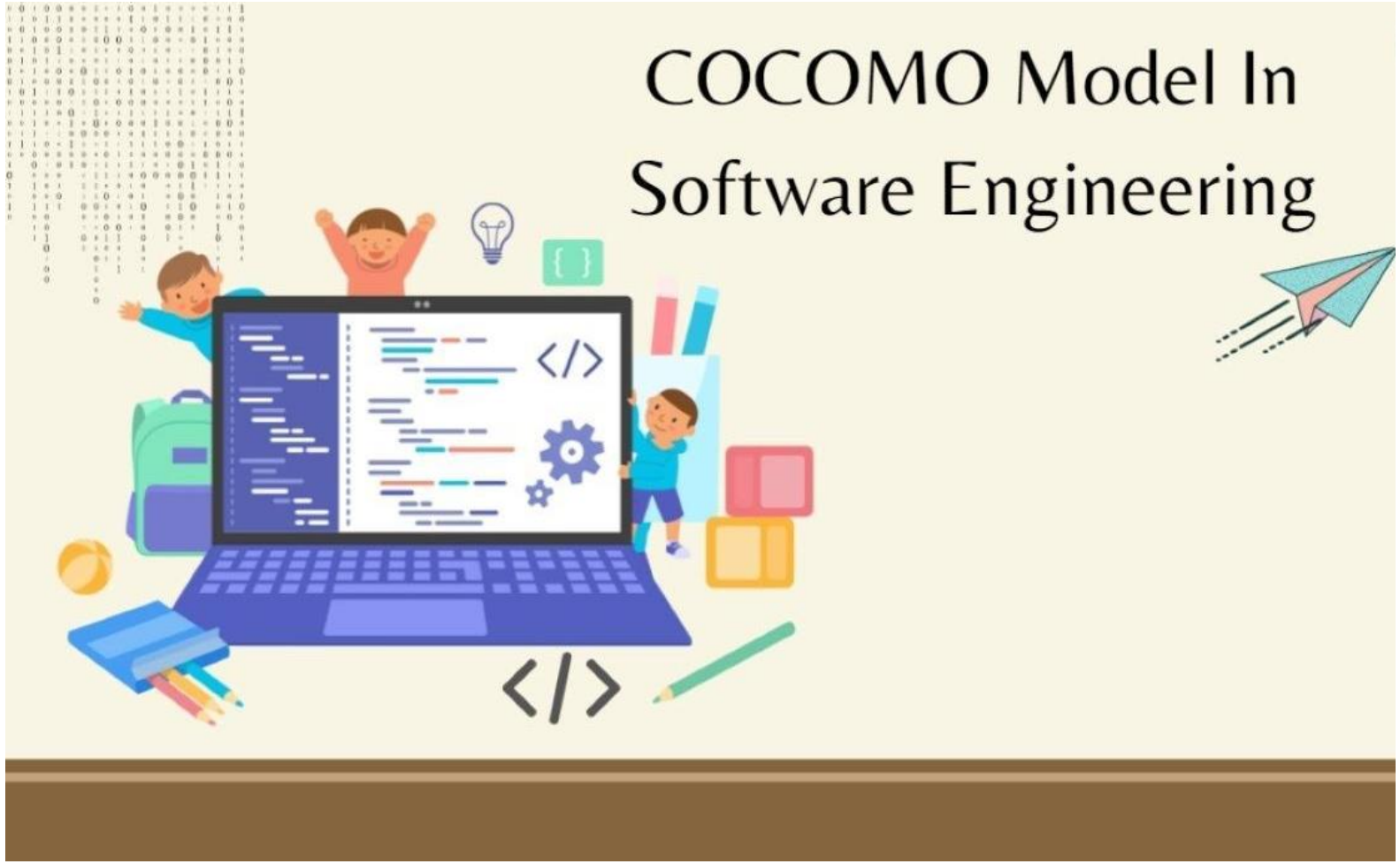
Problems of Algorithmic Cost Modeling

- **All algorithmic cost models suffer from two key problems:**

➢ It is practically **impossible to estimate Size accurately** at an early stage in a project, when only the specification is available.

➢ The estimates of the complexity and process factors contributing to **B and M are subjective.**

Constructive cost modeling (COCOMO)



Constructive cost modeling (COCOMO)

- **An empirical model based on project experience.**
- **Well-documented, 'independent' model which is not tied to a specific software vendor**
- **COCOMO 2 takes into account different approaches to software development, reuse, etc.**

COCOMO 2 models

- **COCOMO 2 incorporates a range of sub-models that produce increasingly detailed software estimates.**
- **The sub-models in COCOMO 2 are:**

Application composition model.

Early design model

Reuse model

Post-architecture model

Early Design Model

- **Estimates can be made after the requirements have been agreed.**
- **Based on a standard formula for algorithmic models.**

$$PM = A \times Size^{B} \times M$$

Where:

- **M** depends on 7 Factors
- **A = 2.49** in initial calibration, (proposed value based on large dataset).
- **Size in KSLOC**, which is the number of thousands of lines of source code.
- **B varies from 1.1 to 1.24** depending on novelty of the project, development flexibility, risk management approaches and the process maturity.

Post-Architecture Model

- **It is used when you have an initial architectural design for the system. It uses the same formula as the early design model but with 17 rather than 7 associated multipliers for M**

$$PM = A \times Size^{B} \times M$$

Where:

The exponent term B depends on 5 scale factors ,these factors are rated on a Six-point scale from 1 to 5, where 1 means "extra high" and 5 means "very low". :

- **Precedentedness** - new project -----→(4)
- **Development flexibility** - no client involvement - Very high -----→(1)
- **Architecture/risk resolution** - No risk analysis - V. Low ------→(5)
- **Team cohesion -** new team - nominal -----→(3)
- **Process maturity -** some control - nominal -----→(3)

Post-Architecture Model

$$PM = A \times Size^{B} \times M$$

To calculate B :

$$\text{The exponent } B = [(\sum \text{ scale factors}) / 100] + 1.01$$

To calculate M:

M = RELY * CPLX * STOR * TOOL * SCED .

Reliability **(RELY),** complexity **(CPLX),** storage **(STOR),** tools **(TOOL),** and schedule **(SCED)** are the key cost drivers in the project. All of the other cost drivers have a nominal value of 1, so they do not affect the effort computation.

Example 1

If the scale factors affecting the exponent B in the effort equation are given as Precedentedness = 2, development flexibility = 4, risk resolution = 4, team cohesion = 4, process maturity = 3. If B is given by the equation [B = (sum of scale factors/100) + 1.01], **calculate B**

What is the solution ???

Solution

Solution :

The exponent B = [(∑ scale factors) / 100] + 1.01

The exponent B = [(2 + 4 + 4 +4 + 3)/100] + 1.01 = 1.18

Example 2

In the following project duration equation B = 1.17, PM = 50:
TDEV = 3 * PM ^(0.33+0.2 * (B-1.01)), **Calculate the project duration.**

What is the solution ???

Solution

Solution :

TDEV = 3 * PM ^(0.33+0.2 * (B-1.01))

TDEV = 3 * 50 ^(0.33+0.2 * (1.17-1.01))= 12.3636

Example 3

A company takes on a project in a new domain. The client has not defined the process to be used and has not allowed time for risk analysis. The company has a CMM level 2 rating (Capability Maturity Model is a framework for assessing how well organizations manage the development of their staff). **Estimate the scale factors used to calculate the exponent B in the general effort equation and calculate B.**

What is the solution ???

Solution

Solution :

The scale factors can be estimated on **5 point** scale where **5** is **very low** and **1** is **very high** as follows:

The project is in a new domain → **Precedentedness** = **4**

The client has not defined the process to be used → **Development flexibility** = **1**

The client has not allowed time for risk analysis → **Risk resolution** = **5**

The company has a CMM level 2 rating → **Process maturity** = **5** – 2 = **3**

Team Cohesion can be estimated as nominal value = **3**

The exponent B = [(∑ scale factors) / 100] + 1.01

The exponent B = [(4 + 1 + 5 + 3 + 3)/100] + 1.01 = **1.17**

Example 4

A company takes on a project in a domain of its experience. The client defined the process to be used and has allowed time for risk analysis. The company has a CMM level 4 rating (Capability Maturity Model is a framework for assessing how well organizations manage the development of their staff). **Estimate the scale factors used to calculate the exponent B in the general effort equation and calculate B**

What is the solution ???

Solution

Solution :

The scale factors can be estimated on **5 point** scale where **5** is **very low** and **1** is **very high** as follows:

The project is in a domain of experience → **Precedentedness** = **2**

The client has defined the process to be used → **Development flexibility** = **4**

The client has allowed time for risk analysis → Risk resolution = **1**

The company has a CMM level 4 rating → **Process maturity** = **5** – 4 = **1**

Team Cohesion can be estimated as nominal value = **1**

The exponent B = [(∑ scale factors) / 100] + 1.01

The exponent B = [(2 + 4 + 1 + 1 + 1)/100] + 1.01 = **1.1**

Example 5

Given the value of the key cost drivers in a project used to calculate the multiplier **M** in the general cost equation as: Reliability **(RELY)** = 1.4, complexity **(CPLX)** = 1.3, storage **(STOR)** = 1.2, tools **(TOOL)** = 1.15, and schedule **(SCED)** = 1.3. All of the other cost drivers have a nominal value of 1, so they do not affect the effort computation. **Calculate the multiplier M**

Solution :

M = RELY * CPLX * STOR * TOOL * SCED.

M = 1.4 * 1.3 * 1.2 * 1.15 * 1.3 = 3.265 .

Example 6

Given the value of the key cost drivers in a project used to **calculate the multiplier M** in the general cost equation as: Reliability **(RELY)** = 0.8, complexity **(CPLX)** = 0.75, storage **(STOR)** = 1, tools **(TOOL)** = 0.75, and schedule **(SCED)** = 1. All of the other cost drivers have a nominal value of 1, so they do not affect the effort computation.

Solution :

M = RELY * CPLX * STOR * TOOL * SCED.

M = 0.8 * 0.75 * 1 * 0.75 * 1 = 0.45 .

Example 7

A system size (including factors for reuse and requirements volatility) 145000 KLOC, for the **values of exponent B calculated in problem 1, 2**:

a) Calculate the initial **COCOMO** effort estimate without cost drivers (M = 1).

b) Calculate the **COCOMO** effort estimate with cost drivers in problem 3 (M = 3.265).

c) Calculate the **COCOMO** effort estimate with cost drivers in problem 4 (M = 0.45).

Solution

Solution :

a) $PM = 2.49 \times 145^{1.17} \times 1 = 2.49 \times 337.9 = 841.4$

$PM = 2.49 \times 145^{1.1} \times 1 = 2.49 \times 238.51 = 593.9$

b) $PM = 2.49 \times 145^{1.17} \times 3.265 = 2747.15$

$PM = 2.49 \times 145^{1.1} \times 3.265 = 1939.04$

c) $PM = 2.49 \times 145^{1.17} \times 0.45 = 378.63$

$PM = 2.49 \times 145^{1.1} \times 0.45 = 267.25$

Any Question ?

Next ….