11. COCOMO Model

CSE333: Software Engineering

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Discussion Agenda

- **Boehm's Definition of Software Project Types**
- **COCOMO**
- **Basic COCOMO**
- **Estimation of development effort**
- **Estimation of development time**
- **Example practicing**

Boehm's Definition of Software Project Types

- Boehm postulated that any software development project can be classified into one of the following three categories based on the development complexity
  - Organic
  - Semidetached
  - Embedded.

Boehm's Definition

- Boehm's [1981] definition of organic, semidetached, and embedded systems are elaborated below.
  - **Organic:** A development project can be considered of organic type, if the project deals with developing a well understood application program, the size of the development team is reasonably small, and the team members are experienced in developing similar types of projects.
  - **Semidetached:** A development project can be considered of semidetached type, if the development consists of a mixture of experienced and inexperienced staff. Team members may have limited experience on related systems but may be unfamiliar with some aspects of the system being developed.
  - **Embedded:** A development project is considered to be of embedded type, if the software being developed is strongly coupled to complex hardware, or if the stringent regulations on the operational procedures exist.

COCOMO

- COCOMO (Constructive Cost Estimation Model) was proposed by Boehm [1981].
- According to Boehm, software cost estimation should be done through three stages
  - Basic COCOMO
  - Intermediate COCOMO
  - Complete COCOMO.

Basic COCOMO

- The basic COCOMO model gives an approximate estimate of the project parameters. The basic COCOMO estimation model is given by the following expressions:

$$\text{Effort} = a_1 \times (\text{KLOC})^{a_2} \text{ PM}$$

$$\text{Tdev} = b_1 \times (\text{Effort})^{b_2} \text{ Months}$$

- Here
  - **KLOC** is the estimated size of the software product expressed in Kilo Lines of Code,
  - a_1, a_2, b_1, b_2 are constants for each category of software products,
  - **Tdev** is the estimated time to develop the software, expressed in months,
  - Effort is the total effort required to develop the software product, expressed in person months (PMs).

Estimation of Development Effort

- For the three classes of software products, the formulas for estimating the effort based on the code size are shown below:

Organic : $\mathbf{Effort} = 2.4(KLOC)^{1.05}$ PM

Semi-detached : $\mathbf{Effort} = 3.0(KLOC)^{1.12}$ PM

Embedded : $\mathbf{Effort} = 3.6(KLOC)^{1.20}$ PM

Estimation of Development Time

- For the three classes of software products, the formulas for estimating the development time based on the effort are given below:

Organic : $\mathbf{Tdev = 2.5(Effort)^{0.38}\ Months}$

Semi-detached : $\mathbf{Tdev = 2.5(Effort)^{0.35}\ Months}$

Embedded : $\mathbf{Tdev = 2.5(Effort)^{0.32}\ Months}$

Example

- Q. Assume that the size of an organic type software product has been estimated to be 32,000 lines of source code. Assume that the average salary of software engineers be Rs. 15,000/- per month. Determine the effort required to develop the software product and the nominal development time.

- **Answer:** From the basic COCOMO estimation formula for organic software:
  - Effort = 2.4 x $(32)^{1.05}$ = 91 PM
  - Nominal development time = 2.5 x $(91)^{0.38}$ = 14 months
  - Cost required to develop the product = 14 x 15,000 = 210,000/=

References

1. **Software Engineering A practitioner's Approach** by Roger S. Pressman, 7th edition, McGraw Hill, 2010.

2. **COCOMO Model:** https://www.educba.com/cocomo-model/

3. **Software Engineering COCOMO Model:** https://www.geeksforgeeks.org/software-engineering-cocomo-model/