Aim: Estimate cost of the project using COCOMO (Constructive Cost Model) / COCOMO II approach for the system

Link to perform this experiment:- http://vlabs.iitkgp.ac.in/se/

Objectives

After completing this experiment, you will be able to:

- Categorize projects using COCOMO, and estimate effort and development time required for a project

Project Estimation Techniques

A software project is not just about writing a few hundred lines of source code to achieve a particular objective. The scope of a software project is comparatively quite large, and such a project could take several years to complete. However, the phrase "quite large" could only give some (possibly vague) qualitative information. As in any other science and engineering discipline, one would be interested to measure how complex a project is. One of the major activities of the project planning phase, therefore, is to estimate various project parameters in order to take proper decisions. Some important project parameters that are estimated include:

- Project size: What would be the size of the code written say, in number of lines, files, modules?
- Cost: How much would it cost to develop a software? A software may be just pieces of code, but one has to pay to the managers, developers, and other project personnel.
- Duration: How long would it be before the software is delivered to the clients?
- Effort: How much effort from the team members would be required to create the software?

In this experiment we will focus on two methods for estimating project metrics: COCOMO and Halstead's method.

COCOMO

COCOMO (Constructive Cost Model) was proposed by Boehm. According to him, there could be three categories of software projects: organic, semidetached, and embedded. The classification is done considering the characteristics of the software, the development team and environment. These product classes typically correspond to application, utility and system programs, respectively. Data processing programs could be considered as application programs. Compilers, linkers, are examples of utility programs. Operating systems, real-time system programs are examples of system programs. One could easily apprehend that it would take much more time and effort to develop an OS than an attendance management system.

The concept of organic, semidetached, and embedded systems are described below.

Organic: A development project is said to be of organic type, if

- The project deals with developing a well understood application
- The development team is small
- The team members have prior experience in working with similar types of projects

Semidetached: A development project can be categorized as semidetached type, if

- The team consists of some experienced as well as inexperienced staff
- Team members may have some experience on the type of system to be developed

Embedded: Embedded type of development project are those, which

- Aims to develop a software strongly related to machine hardware
- Team size is usually large

Boehm suggested that estimation of project parameters should be done through three stages: Basic COCOMO, Intermediate COCOMO, and Complete COCOMO.

Basic COCOMO Model

The basic COCOMO model helps to obtain a rough estimate of the project parameters. It estimates effort and time required for development in the following way:

Effort = a * (KDSI)b PM

Tdev = 2.5 * (Effort)c Months

where

- KDSI is the estimated size of the software expressed in Kilo Delivered Source Instructions
- a, b, c are constants determined by the category of software project
- Effort denotes the total effort required for the software development, expressed in person months (PMs)
- Tdev denotes the estimated time required to develop the software (expressed in months)

The value of the constants a, b, c are given below:

Software Project	*a*	*b*	*c*
Organic	2.4	1.05	0.38
Semi-detached	3.0	1.12	0.35
Embedded	3.6	1.20	0.32

Intermediate COCOMO Model

The basic COCOMO model considers that effort and development time depends only on the size of the software. However, in real life there are many other project parameters that influence the development process. The intermediate COCOMO take those other factors into consideration by defining a set of 15 cost drivers (multipliers) as shown in the table below [i]. Thus, any project that makes use of modern programming practices would have lower estimates in terms of effort and cost. Each of the 15 such attributes can be rated on a six-point scale ranging from "very low" to "extra high" in their relative order of importance. Each attribute has an effort multiplier fixed as per the rating. The product of effort multipliers of all the 15 attributes gives the Effort Adjustment Factor (EAF).

Complete COCOMO Model

Both the basic and intermediate COCOMO models consider a software to be a single homogeneous entity -- an assumption, which is rarely true. In fact, many real life applications are made up of several smaller sub-systems. (One might not even develop all the sub-systems -- just use the available services). The complete COCOMO model takes these factors into account to provide a far more accurate estimate of project metrics.

To illustrate this, consider a very popular distributed application: the ticket booking system of the Indian Railways. There are computerized ticket counters in most of the railway stations of our country. Tickets can be booked / cancelled from any such counter. Reservations for future tickets, cancellation of reserved tickets could also be performed. On a high level, the ticket booking system has three main components:

- Database
- Graphical User Interface (GUI)
- Networking facilities

Among these, development of the GUI is considered as an organic project type; the database module could be considered as a semi-detached software. The networking module can be considered as an embedded software. To obtain a realistic cost, one should estimate the costs for each component separately, and then add it up.

Advantages of COCOMO

COCOMO is a simple model, and should help one to understand the concept of project metrics estimation.

Drawbacks of COCOMO

COCOMO uses KDSI, which is not a proper measure of a program's size. Indeed, estimating the size of a software is a difficult task, and any slight miscalculation could cause a large deviation in subsequent project estimates. Moreover, COCOMO was proposed in 1981 keeping the waterfall model of project life cycle in mind [2]. It fails to address other popular approaches like prototype, incremental, spiral, agile models. Moreover, in present day a software project may not necessarily consist of coding of every bit of functionality. Rather, existing software components are often used and glued together towards the development of a new software. COCOMO is not suitable in such cases.

Simulation

Using Basic COCOMO model to estimate project parameters

Use the simulator on the right hand side to understand how project type and size affects the different parameters estimated.

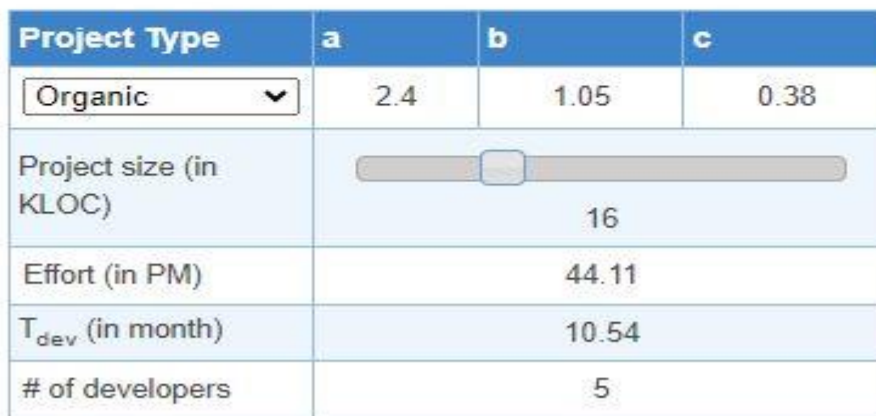
Quick glance at the formulae:

Effort: a * (Size)b person-month

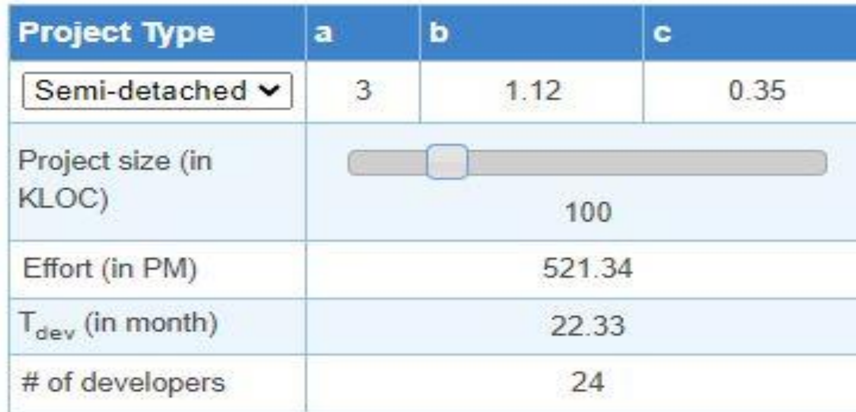
Time for development: 2.5 * (Effort)c month

Drag the slider to change the project size. Note: select the nearest discrete value corresponding to the actual size.

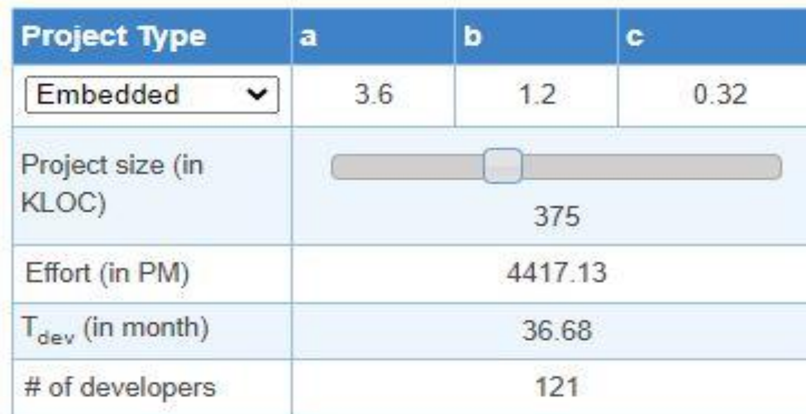
Simulation Output: -



Project Type	a	b	c
Organic	2.4	1.05	0.38
Project size (in KLOC)	16		
Effort (in PM)	44.11		
T_{dev} (in month)	10.54		
# of developers	5		



Project Type	a	b	c
Semi-detached	3	1.12	0.35
Project size (in KLOC)	100		
Effort (in PM)	521.34		
T_{dev} (in month)	22.33		
# of developers	24		



Project Type	a	b	c
Embedded	3.6	1.2	0.32
Project size (in KLOC)	375		
Effort (in PM)	4417.13		
T_{dev} (in month)	36.68		
# of developers	121		

Aim: Identifying the Requirements from Problem Statements

Link to perform this experiment: http://vlabs.iitkgp.ac.in/se/

Introduction

- Requirements identification is the first step of any software development project. Until the requirements of a client have been clearly identified, and verified, no other task (design, coding, testing) could begin. Usually business analysts having domain knowledge on the subject matter discuss with clients and decide what features are to be implemented.
- In this experiment we will learn how to identify functional and non-functional requirements from a given problem statement. Functional and non-functional requirements are the primary components of a Software Requirements Specification.

Objectives

After completing this experiment you will be able to:

- Identify ambiguities, inconsistencies and incompleteness from a requirements specification
- Identify and state functional requirements
- Identify and state non-functional requirements

Requirements

- Sommerville defines "requirement" [1] as a specification of what should be implemented. Requirements specify how the target system should behave. It specifies what to do, but not how to do. Requirements engineering refers to the process of understanding what a customer expects from the system to be developed, and to document them in a standard and easily readable and understandable format. This documentation will serve as reference for the subsequent design, implementation and verification of the system.
- It is necessary and important that before we start planning, design and implementation of the software system for our client, we are clear about it's requirements. If we don't have a clear vision of what is to be developed and what all features are expected, there would be serious problems, and customer dissatisfaction as well.

Characteristics of Requirements

Requirements gathered for any new system to be developed should exhibit the following three properties:

Unambiguity: There should not be any ambiguity what a system to be developed should do. For example, consider you are developing a web application for your client. The client requires that enough number of people should be able to access the application simultaneously. What's the "enough number of people"? That could mean 10 to you, but, perhaps, 100 to the client. There's an ambiguity.

Consistency: To illustrate this, consider the automation of a nuclear plant. Suppose one of the clients say that it the radiation level inside the plant exceeds R1, all reactors should be shut down. However, another person from the client side suggests that the threshold radiation level should be R2. Thus, there is an inconsistency between the two end users regarding what they consider as threshold level of radiation.

Completeness: A particular requirement for a system should specify what the system should do and also what it should not. For example, consider a software to be developed for ATM. If a customer enters an amount greater than the maximum permissible withdrawal amount, the ATM should display an error message, and it should not dispense any cash.

Categorization of Requirements

Based on the target audience or subject matter, requirements can be classified into different types, as stated below:

User requirements: They are written in natural language so that both customers can verify their requirements have been correctly identified

System requirements: They are written involving technical terms and/or specifications, and are meant for the development or testing teams

Requirements can be classified into two groups based on what they describe:

Functional requirements (FRs): These describe the functionality of a system -- how a system should react to a particular set of inputs and what should be the corresponding output.

Non-functional requirements (NFRs): They are not directly related what functionalities are expected from the system. However, NFRs could typically define how the system should behave under certain situations. For example, a NFR could say that the system should work with 128MB RAM. Under such condition, a NFR could be more critical than a FR.

Non-functional requirements could be further classified into different types like:

Product requirements: For example, a specification that the web application should use only plain HTML, and no frames

Performance requirements: For example, the system should remain available 24x7

Organizational requirements: The development process should comply to SEI CMM level 4

Functional Requirements

Identifying Functional Requirements

Given a problem statement, the functional requirements could be identified by focusing on the following points:

- Identify the high level functional requirements simply from the conceptual understanding of the problem. For example, a Library Management System, apart from anything else, should be able to issue and return books.
- Identify the cases where an end user gets some meaningful work done by using the system. For example, in a digital library a user might use the "Search Book" functionality to obtain information about the books of his interest.
- If we consider the system as a black box, there would be some inputs to it, and some output in return. This black box defines the functionalities of the system. For example, to search for a book, user gives title of the book as input and get the book details and location as the output.
- Any high level requirement identified could have different sub-requirements. For example, "Issue Book" module could behave differently for different class of users, or for a particular user who has issued the book thrice consecutively.