COCOMO

The Constructive Cost Model (COCOMO) is an algorithmic software cost estimation model developed by Barry Boehm. The model uses a basic regression formula, with parameters that are derived from historical project data and current project characteristics.

COCOMO was first published in 1981 Barry W. Boehm's Book *Software engineering economics*[^1] as a model for estimating effort, cost, and schedule for software projects. It drew on a study of 63 projects at TRW Aerospace where Barry Boehm was Director of Software Research and Technology in 1981. The study examined projects ranging in size from 2,000 to 100,000 lines of code, and programming languages ranging from assembly to PL/I. These projects were based on the waterfall model of software development which was the prevalent software development process in 1981.

References to this model typically call it COCOMO 81. In 1997 COCOMO II was developed and finally published in 2000 in the book *Software Cost Estimation with COCOMO II*.[^2] COCOMO II is the successor of COCOMO 81 and is better suited for estimating modern software development projects. It provides more support for modern software development processes and an updated project database. The need for the new model came as software development technology moved from mainframe and overnight batch processing to desktop development, code reusability and the use of off-the-shelf software components. This article refers to COCOMO 81.

COCOMO consists of a hierarchy of three increasingly detailed and accurate forms. The first level, *Basic COCOMO* is good for quick, early, rough order of magnitude estimates of software costs, but its accuracy is limited due to its lack of factors to account for difference in project attributes (*Cost Drivers*). *Intermediate COCOMO* takes these Cost Drivers into account and *Detailed COCOMO* additionally accounts for the influence of individual project phases.

Basic COCOMO

Basic COCOMO computes software development effort (and cost) as a function of program size. Program size is expressed in estimated thousands of lines of code (KLOC)

COCOMO applies to three classes of software projects:

- Organic projects - "small" teams with "good" experience working with "less than rigid" requirements
- Semi-detached projects - "medium" teams with mixed experience working with a mix of rigid and less than rigid requirements
- Embedded projects - developed within a set of "tight" constraints (hardware, software, operational, ......)

The basic COCOMO equations take the form

\[
\text{Effort Applied} = a \cdot (\text{KLOC})^b \quad \text{[man-months]}
\]

\[
\text{Development Time} = c \cdot (\text{Effort Applied})^d \quad \text{[months]}
\]

\[
\text{People required} = \frac{\text{Effort Applied}}{\text{Development Time}} \quad \text{[count]}
\]

The coefficients \(a\), \(b\), \(c\), and \(d\) are given in the following table.
Basic COCOMO is good for quick estimate of software costs. However it does not account for differences in hardware constraints, personnel quality and experience, use of modern tools and techniques, and so on.

**Intermediate COCOMOs**

Intermediate COCOMO computes software development effort as function of program size and a set of "cost drivers" that include subjective assessment of product, hardware, personnel and project attributes. This extension considers a set of four "cost drivers", each with a number of subsidiary attributes:

- **Product attributes**
  - Required software reliability
  - Size of application database
  - Complexity of the product
- **Hardware attributes**
  - Run-time performance constraints
  - Memory constraints
  - Volatility of the virtual machine environment
  - Required turnabout time
- **Personnel attributes**
  - Analyst capability
  - Software engineering capability
  - Applications experience
  - Virtual machine experience
  - Programming language experience
- **Project attributes**
  - Use of software tools
  - Application of software engineering methods
  - Required development schedule

Each of the 15 attributes receives a rating on a six-point scale that ranges from "very low" to "extra high" (in importance or value). An effort multiplier from the table below applies to the rating. The product of all effort multipliers results in an *effort adjustment factor (EAF)*. Typical values for EAF range from 0.9 to 1.4.

<table>
<thead>
<tr>
<th>Software project</th>
<th>(a_b)</th>
<th>(b_b)</th>
<th>(c_b)</th>
<th>(d_b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>2.4</td>
<td>1.05</td>
<td>2.5</td>
<td>0.38</td>
</tr>
<tr>
<td>Semi-detached</td>
<td>3.0</td>
<td>1.12</td>
<td>2.5</td>
<td>0.35</td>
</tr>
<tr>
<td>Embedded</td>
<td>3.6</td>
<td>1.20</td>
<td>2.5</td>
<td>0.32</td>
</tr>
</tbody>
</table>
The Intermediate Cocomo formula now takes the form:

\[ E = a_i (KLoC)^{b_i} \cdot EAF \]

where \( E \) is the effort applied in person-months, \( KLoC \) is the estimated number of thousands of delivered lines of code for the project, and \( EAF \) is the factor calculated above. The coefficient \( a_i \) and the exponent \( b_i \) are given in the next table.

<table>
<thead>
<tr>
<th>Software project</th>
<th>( a_i )</th>
<th>( b_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>3.2</td>
<td>1.05</td>
</tr>
<tr>
<td>Semi-detached</td>
<td>3.0</td>
<td>1.12</td>
</tr>
<tr>
<td>Embedded</td>
<td>2.8</td>
<td>1.20</td>
</tr>
</tbody>
</table>

The Development time \( D \) calculation uses \( E \) in the same way as in the Basic COCOMO.
Detailed COCOMO

Detailed COCOMO - incorporates all characteristics of the intermediate version with an assessment of the cost driver's impact on each step (analysis, design, etc.) of the software engineering process. The detailed model uses different efforts multipliers for each cost driver attribute these Phase Sensitive effort multipliers are each to determine the amount of effort required to complete each phase.

Projects using COCOMO

five phases of detailed cocomo are:- -plan and requirement. -system design. -detailed design. -module cod and test. -integration and test.
  • Ohloh

References


Further reading


External links

• COCOMO II website (http://sunset.usc.edu/csse/research/COCOMOII/cocomo_main.html)
• COCOMO II online calculator (http://www.cms4site.ru/utility.php?utility=cocomoi1)
• NASA basic COCOMO online calculator (http://cost.jsc.nasa.gov/COCOMO.html)
• COCOMO 81 Calculator (http://sunset.usc.edu/research/COCOMOII/cocomo81_pgn/cocomo81.html)
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