CS 435 - Homework 5

Deadline

Due by 11:59 pm on Thursday, March 27, 2014

How to submit

Submit your files for this homework using `~st10/435submit` on nrs-labs, with a homework number of `5`

Purpose

To become more familiar with top-down effort estimation models, especially COCOMO 81 and COCOMO II.

Important notes

- Note that some of your submissions for this assignment may be posted to the course Moodle site.
- Create a file named `435hw5.txt` or `435hw5.pdf` (your choice) that starts with your name. Then give the problem number and your answer(s) for each of the following problems.

Problem 1

[course text, p. 71] "Watson and Felix [81] analyzed the data of more than 60 projects done at IBM Federal Systems Division, ranging from 4000 lines to 467,000 lines of delivered source code, and found that

- if the `SIZE` estimate is in thousands of lines of delivered source code (KLOC),
- the total effort, `EFFORT`, in person-months (PM) can be given by the equation

  $\texttt{EFFORT = 5.2 * (SIZE)}^{.91}$

Consider, then, a 4000 line project.That's 4 KLOC. This formula estimates such a project would take:

$\texttt{EFFORT = 5.2 * (4)}^{.91}\texttt{ \textasciitilde= 5.2 * 3.531 \textasciitilde= 18.36 person-months}$

Based on this rough formula, how does the predicted effort grow as the estimated project size grows? To get a rough idea, compute the estimated effort for projects of size:

- `8 KLOC`
- `16 KLOC`
- `40 KLOC`
- `400 KLOC`

For each project size above, give at least:

- the project size in KLOC,
- the resulting formula for that size, and
- the resulting estimated number of person-months for that size, to at least 2 fractional places.

Problem 2

Now consider COCOMO as described in the Jalote course text (which is, more specifically, COCOMO 81).

- You first get the initial estimate (nominal estimate) using the formula:

  $E_i = 3.9 * (SIZE)^{.91}$

  ...where, again, SIZE is given in KLOC and the resulting E_i is given in person-months (PM).

- Then you modify this estimate based on **cost driver attributes**:
  - you qualitatively rate a collection of cost driver attributes attributes -- in COCOMO 81, a set of 15 different attributes -- as "Very Low", "Low", "Nominal", "High", and "Very High".
  - then you consult a chart of effort multipliers (such as Table 4.1 on p. 72 in Section 4.1.1 of the Jalote course text) for each cost driver attribute based on the rating you gave it,
  - and multiply your initial estimate by the obtained 15 effort multipliers to get the final effort estimate.
  - (the Jalote course text notes that the product of the 15 effort multipliers can be called the **effort adjustment factor** (EAF),

    and then the final effort estimate, called the adjusted effort estimate E, can be described as the result of multiplying the initial effort estimate E_i by the EAF.)

So, consider, again, a 4000 line project.That's 4 KLOC. Based on COCOMO 81 as described above, the initial effort estimate E_i would be:

$E_i = 3.9 * (4)^{.91}$ ~= 3.9 * 3.531 ~= 13.77 person-months

Now, the 15 different cost drivers are estimated for this particular project. When you look at Table 4.1 on p. 72 of Section 4.1.1, you'll see that a cost driver with a rating of "Nominal" has an effort multiplier of 1.0.

For this example, assume that it is decided that all of the cost drivers are rated as "Nominal" (thus with an effort multiplier of 1.0) except for:

- CPLX, product complexity, rated as "High", which the table gives an effort multiplier of 1.15
- PCAP, programmer capability, rated as "Low", which the table gives an effort multiplier of 1.17
- AEXP, application experience (a personnel attribute), rated as "Low", which the table gives an effort multiplier of 1.13

So, the effort adjustment factor EAF is:

```
EAF = 1.15 * 1.17 * 1.13 ~=  1.52
```

And so the adjusted effort estimate E would be:

```
E = Ei * EAF ~= 13.77 * 1.52 ~= 20.93 person-months
```

In this case, then, considering the cost factors increased the effort estimate by more than 7 person-months for an estimated 4 KLOC project.

2 part a

Consider a project whose size is estimated as 8 KLOC, for which all of the cost factors are rated as "Nominal" except for:

LEXP, programming language experience, rated as "Very Low",

RELY, required reliability, rated as "High"

DATA, database size, rated as "Low"

TOOL, use of software tools, rated as "Low"

Based on COCOMO 81 as described above and on Table 4.1 on p. 72 in Section 4.1.1, compute and give E_i, EAF, and the adjusted effort estimate E for this project.

2 part b

Now consider a project whose size is estimated as 16 KLOC, for which all of the cost drivers are rated as "Nominal" except for PCAP, programmer capability.

Let's consider how much the effort estimate can vary based on the rating for PCAP, programmer capability. Again based on COCOMO 81 as described above and on Table 4.1 on p. 72 in Section 4.1.1:

- Give the E_i, EAF, and the adjusted effort estimate E for this project if PCAP, programmer capability, is rated as "Very Low".
- Then, give the E_i, EAF, and the adjusted effort estimate E for this project if PCAP, programmer capability, is rated as "Very High".

2 part c

(The following is adapted from the Self-Assessment Exercise 3 on p. 93 of the Jalote course text.)

Suppose an organization plans to use COCOMO 81 for effort estimation, but it considers all of the cost drivers to be rated as "Nominal" except for:

- product complexity
- programmer capability
- development schedule

Consider Table 4.1 on p. 72 in Section 4.1.1, containing the effort multipliers for different cost drivers.

- In the "best" case, by how much could the initial effort estimate E_i be changed by these three cost drivers?
- In the "worst" case, by how much could the initial effort estimate E_i be changed by these three cost drivers?

Problem 3

USC's Center for Systems and Software Engineering has some very interesting pages involving the original version of COCOMO, now called COCOMO 81, and its major extension COCOMO II. Besides brief descriptions of each at:

- http://csse.usc.edu/csse/research/COCOMOII/cocomo81.htm
- http://csse.usc.edu/csse/research/COCOMOII/cocomo_main.html

...this site also includes web-based estimation tools for each of these, at:

- http://sunset.usc.edu/research/COCOMOII/cocomo81_pgm/cocomo81.html
  - (although this tool no longer appears to be operational -- but you can still see its form)
- http://diana.nps.edu/~madachy/tools/COCOMOII.php
  - (but this one DOES appear to still be operational, and has cool features such as a staffing profile graph that estimates how many people will be needed each month during the course of the project!)

and much more.

3 part a

Consider the brief description of COCOMO II at:

- http://csse.usc.edu/csse/research/COCOMOII/cocomo_main.html

This suggests that COCOMO II can be used for more than just project effort estimation. Give at least 3 other "major decision situations" that it suggests COCOMO II might be used for.

3 part b

Consider again the brief description of COCOMO II at:

- http://csse.usc.edu/csse/research/COCOMOII/cocomo_main.html

It describes a number of software development techniques that changed dramatically between 1981, when the original COCOMO 81 model was first published, and the mid 1990s, when the model was reinvented, resulting in COCOMO II. Give at least two of the software development changes that it lists as having occurred between 1981 and the mid 1990s.

3 part c

Play around/experiment with the web-based tool for COCOMO II at:

- http://diana.nps.edu/~madachy/tools/COCOMOII.php

Describe at least two interesting and/or surprising things that you found (related to COCOMO II and either effort estimation or software project planning) in your experiments/playing with this.

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