Software Engineering

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model
  - Software cost estimation model
  - 3 categories of projects
    - Organic
      - Relatively small, simple software projects
      - Small teams with good application experience
      - Similar to previously developed projects
      - Relatively small and require little innovation
    - Semidetached
      - Intermediate software projects
      - Teams with mixed experience
      - Mix of rigid and less rigid requirements
    - Embedded
      - Software projects that must be developed within set of tight hardware, software and operational constraints

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model

P. Characteristics Development Mode	Size	Innovation	Deadline	Development Environment	KLOC
Organic	Small	Little	Not tight	Stable	2-50
Semidetached	Medium	Medium	Medium	Medium	51-300
Embedded	Large	Greater	Tight	Complex hardware	>300

- 3 stages
  - Basic
  - Intermediate
  - Detail

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model
- Basic COCOMO model

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

$$\text{Time} = 2.5 (\text{Effort})^{b} \text{ months}$$

$$\text{People} = \frac{\text{Effort}}{\text{Time}} [\text{count}]$$

Project Category	a_1	a_2	b
Organic	2.4	1.05	0.38
Semidetached	3.0	1.12	0.35
Embedded	3.6	1.20	0.32

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model
- Consider an **embedded** project with **700KLOC**. Calculate the **effort**, development **time**, average **staff** size, **productivity** to develop the product.

Sol:

$$\text{Effort} = a_1(\text{KLOC})^{a_2}\text{pm}$$
$$= 3.6(700)^{1.2}\text{pm}$$
$$= 3.6(700)^{1.2}\text{pm}$$
$$= 9341.58\ \text{pm}$$

$$\text{Time} = 2.5(\text{Effort})^{b}\ \text{months}$$
$$= 2.5(9341.58)^{0.32}\ \text{months}$$
$$= 46.61\ \text{months}$$

$$\text{Average staff size} = \frac{\text{Effort}}{\text{Time}}\ \text{persons}$$
$$= \frac{9341.58}{46.61}\ \text{persons}$$
$$= 200.42\ \text{persons}$$

$$\text{Productivity} = \frac{\text{KLOC}}{\text{Effort}}$$
$$= \frac{700}{9341.58} = 0.0749\ \text{KLOC/PM}$$

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model
- Intermediate COCOMO model
  - Basic: LOC, constraints
  - In reality?
  - Cost drivers (15) for estimation

Cost Drivers	Ratings/Values				
Product Attributes	Very Low	Low	Nominal	High	Very High
Required Software Reliability	0.75	0.88	1.00	1.15	1.40
Size of Application Database		0.94	1.00	1.08	1.16
Complexity of The Product	0.70	0.85	1.00	1.15	1.30

Cost Drivers	Ratings/Values				
Hardware Attributes	Very Low	Low	Nominal	High	Very High
Runtime Performance Constraints			1.00	1.11	1.30
Memory Constraints			1.00	1.06	1.21
Volatility of the virtual machine environment		0.87	1.00	1.15	1.30
Required turnabout time		0.94	1.00	1.07	1.15

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model
- Intermediate COCOMO model

Cost Drivers	Ratings/Values				
Personnel attributes	Very Low	Low	Nominal	High	Very High
Analysis Capability	1.46	1.19	1.00	0.86	0.71
Application experience	1.29	1.13	1.00	0.91	0.82
Software engineer capability	1.42	1.17	1.00	0.86	0.70
Virtual machine experience	1.21	1.10	1.00	0.90	
Programming language experience	1.14	1.07	1.00	0.95	

Cost Drivers	Ratings/Values				
Project Attributes	Very Low	Low	Nominal	High	Very High
Application of software engineering methods	1.24	1.10	1.00	0.91	0.82
Use of software tools	1.24	1.10	1.00	0.91	0.83
Required development schedule	1.23	1.08	1.00	1.04	1.10

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model
- Intermediate COCOMO model

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

EAF: Error Adjustment Factor

$$\text{Time} = 2.5 (\text{Effort})^{b} \text{ months}$$

$$\text{People} = \frac{\text{Effort}}{\text{Time}} [\text{count}]$$

Project Category	a_1	a_2	b
Organic	3.2	1.05	0.38
Semidetached	3.0	1.12	0.35
Embedded	2.8	1.20	0.32

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model
- Consider a project with the estimation of **250KLOC**. Although the size of the application **database** is **nominal** it has **high memory constraints**. The technical team has developers who have **high application experience** but **very low experience in programming**. The **required development schedule** for the project is **low**. Calculate the **effort**, development **time** and average **staff** size required to develop the product.

Sol:

$$\text{Effort} = a_1(\text{KLOC})^{a_2} \times \text{EAF pm}$$
$$= 3(250)^{1.12} \times (1 \times 1.06 \times 0.91 \times 1.14 \times 1.08)\,\text{pm}$$
$$= 1727.79\,\text{pm}$$

$$\text{Time} = 2.5(\text{Effort})^{b}\ \text{months}$$
$$= 2.5(1727.79)^{0.35}\ \text{months}$$
$$= 33.97\,\text{months}$$

$$\text{Average staff size} = \frac{\text{Effort}}{\text{Time}}\ \text{persons}$$
$$= \frac{1727.79}{33.97}\ \text{persons}$$
$$= 50.86\,\text{persons}$$

Software Project Planning

- The COCOMO (COnstructive COst MOdel) model
- Detail COCOMO model
  - All characteristics of intermediate
  - Divided into different modules
  - Apply COCOMO in each modules
  - Sum all efforts