COCOMO II

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Outline

- » What is a parametric model?
- How is one used?
- Parametric models need to be calibrated
- Collecting data

Parametric Model

- Mathematical representation of “idealized” real-world relationships
- The mathematical formula has a number of “parameters”
- Mathematical formula to estimate development effort:

$$Effort = A \cdot (Size)^B \cdot C$$

Parametric Model

- Parameters can be:
  - Quantitative such as size, number of defects, months
  - Qualitative such as complexity, required reliability, tool usage, analyst capability
- Models are used for analysis and estimating (forecasting)
- COCOMO II is an example of a parametric model for estimating effort and schedule from size and other factors

COCOMO II

$$PM = A \cdot (KSLOC)^{B} \cdot \prod_{i=1}^{17} EM_i$$

$$B = 1.01 + \sum_{j=1}^{5} SF_j$$

- A is a constant
- KSLOC is thousands of source lines of code
- EM are effort multipliers, parameters that effect effort the same amount regardless of project size
- SF are scale factors, parameters that have large influence on big projects and small influence on small projects

COCOMO II Parameters

- EM Example: Application Experience

Criteria	< 2 months	6 months	1 year	3 years	6 years
Rating	Very Low	Low	Nominal	High	Very High
Value	1.22	1.10	1.00	0.88	0.81

- SF Example: Process Maturity

Criteria	CMM 1 Lower	CMM 1 Upper	CMM 2	CMM 3	CMM 4	CMM5
Rating	Very Low	Low	Nominal	High	Very High	Extra High
Value	0.78	0.62	0.47	0.31	0.16	0.00

Differences between COCOMO 81 and COCOMO II

- Three modes replaced by five Scale Factors (SF)
- Reuse of code is non-linear in COCOMO II
- Requirements Volatility replaced by Breakage (BRAK)
- Added DOCU, RUSE, PVOL, PEXP, LTEX, PCON, SITE
- Removed VIRT, TURN, VEXP, LEXP, MODP

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Analysis

- Analysis
  - Parameter influence

	VL	L	N	H	VH	XH	Influence
RELY	0.82	0.92	1.00	1.10	1.26		1.54
CPLX	0.73	0.87	1.00	1.17	1.34	1.74	2.38
AEXP	1.22	1.10	1.00	0.88	0.81		1.51

  - Sensitivity analysis (change a parameter one increment)
  - Risk identification (compare parameters)

Estimation

- Effort and schedule are estimated for a specific span of phases in the development cycle
  - Which phases?
  - What labor categories are included in the effort?
  - How does software reuse and COTS effect the overall effort
  - What about critical resources, facilities, etc.?

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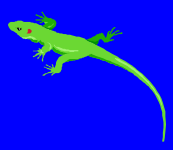
Calibration

- Parametric models are built on data - usually someone else’s
- Best results are obtained if model is calibrated to local development environment.
- Usually, only the model constants are adjusted
  – Reduces the amount of data needed

COCOMO II Calibration

$$PM = A \cdot (KSLOC)^{B} \cdot \prod_{i=1}^{17} EM_i$$

$$B = 1.01 + \sum_{j=1}^{5} SF_j$$



- Calibrate constant A
- Calibrate constant A and fixed exponent

COCOMO II.1997 Accuracy Results

Effort Prediction	Before Stratification By Organization	After Stratification By Organization
PRED(.20)	46%	49%
PRED(.25)	49%	55%
PRED(.30)	52%	64%

- Stratification means model constant, A, was calibrated for each organization

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Data Collection

- Collect all of the model parameters on complete project data (size, application experience, complexity, etc.)
- Collect the project result values for the model output (effort, schedule)
- You calibrate the model inputs to the known project results

Data Collection

- Collection can be done using paper forms
  - Interview project personnel
  - Sift through existing data
- Collection can be done with Software Process Database
  - Project historical estimates
  - Interview project personnel
- Collection can be done with the PSM Insight tool
  - Add model parameters to Insight using customization feature

Summary

- Parametric models offer both analysis and estimation capability; they are worth learning
- Parametric models need to be calibrated to local conditions; collect data
- COCOMO II is in the public domain and is free available at:

`http://sunset.usc.edu/COCOMOII/Cocomo.html`