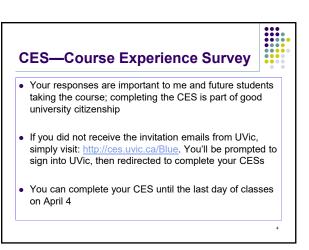


Quiz 3: Course Experience	Wed, Mar 23	In class	2% of course
Deliverable C3	Thu, Mar 24	C3 feedback on S3a&S3b	10% of project
Easter break	Fri-Mon, Mar 25-28	Fri, Mar 25 no class	
Deliverable S4	Tue, Mar 29	S4 project demo (in ELL 167)	10% of project
Deliverable S4 SENG 321	Wed, Mar 30 & Fri, Apr 1	S4 project demo (in MAC D288)	10% of project
Deliverable C4 Calendar	Fri, Apr 1	C4 feedback on S4 (in MAC D288)	5% of project
Last Day of Classes	Fri, Apr 1		
Final Exam	Sat, Apr 16	19:00-22:00 ECS 125	35%

Announcements Wed, March 23 Tue, March 29 Quiz 3 In Elliot 167 3:30-6:00 pm • Fri, March 25 +++++++ Good Friday Wed/Fri, March 29/30, No class In class and Tue lab demos Teaching evaluations No labs on Thu Until April 4 3 presentations per hour 15 mins per presentation Final Exam Sat, April 16 **Evaluation form**



Quiz 3—Course Experience

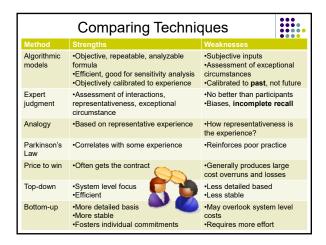
- Describe in detail how selected requirements engineering topics discussed in this course topics could be beneficial for your career as an engineer or scientist. Note you are expected to answer this question even if you are aiming for a different career path than engineer or scientist.
- 2. What are selected requirements engineering learning outcomes and skills acquired in this course that you should consider including in your resume when applying for a job as an engineer or scientist. Note you are expected to answer this question even if you are aiming for a different career path than engineer or scientist.

Project Cost and Effort Estimation Techniques



- Seven traditional techniques for software cost estimation
 - 1. Algorithmic cost modeling
 - 2. Expert judgment
 - 3. Estimation by analogy
 - 4. Parkinson's law
 - Pricing to win
 - 6. Top-down estimation
 - Bottom-up estimation
- Some of these techniques are pathological (i.e., have problems built-in)!
 - → Use more than one method

6



Combining Techniques

- Motivation
 - Each technique has advantages and disadvantages
- For large projects, several techniques should be used in parallel and results continuously compared.
 - If the results predict radically different costs ...
 - ... more information should be sought ... and costing pro
- Process should continue until estimates converge
- Traditional cost models assume the existence of a firm set of requirements and a well-developed specification
 - Costing carried out with a solid SRS as a basis
 - Sometimes requirements and/or specification are changed to make sure that fixed costs are not exceeded

Algorithmic Models



- · Not necessarily the most accurate
- Mathematical formula used to predict costs
- · Based on estimates of
 - Project size
 - Number of programmers
 - · Other process and product factors

Algorithmic Models



- Have exponential component
 - costs do not normally increase linearly with project size.
- As software size increases, extra costs incurred
 - communication overhead of larger teams
 - more complex configuration management
 - more difficult system integration

Highly Recommended Reading Traditional Software Metrics ftp://ftp.sei.cmu.edu/pub/education/cm12.pdf

Algorithmic Models



- General form of equation: E = a + b KLOC^o
 - a = constant factor; local organizational practices, type of software
 - b = multiplier includes process, product, and development attributes
 - KLOC: measure of software size (lines of code)
 - c usually between 0.9 and 1.5
- Halstead [1977]: E = a + 0.7 KLOC1.50
- Boehm [1981]: $E = a + 2.4 \cdot KLOC^{1.05}$ TRW
- Walston-Felix [1977]: *E* = *a* + 5.2 *KLOC*^{0.91} IBM
- RADC [1977]: $E = a + 4.86 \cdot KLOC^{0.976}$ Rome Air Develop. Center
- Doty [1984]: *E* = *a* + 5.28 *KLOC*^{1.047} Doty Associates
- JPL [1981]: E = a + 2.43 KLOC^{0.962} Jet Propulsion Lab

Analysis of Algorithmic Models



- All models suffer from same basic difficulties
- Difficult to estimate size at an early project stage
 - Usually only specification available at this time
 - Function point and object point estimates are easier to produce than code size ... may also be inaccurate
- Estimates of b and c are highly subjective
 - Depend on background and experience and vary from
 - · One person to another
 - One model to another
 - One company to another
 - One domain to another

Estimating Size

- Most commonly used metric: lines of source code (LOC)
 - . Measure of finished system ... but of course, we don't have the system yet
- Size estimation therefore involves estimation by
 - Analogy with other projects
 - Estimation by ranking sizes of system components, using known reference components to estimate size; measure previously developed system to estimate the model parameters a, b, c
 - Application of engineering judgement
- Code size estimates uncertain because of dependencies
 - Hardware choices
 - Software choices
 - Commercial DBMS choices
 - Middleware choices

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Functions Points A better measure than KLOC



- Related to functionality of software rather than size
- Function points computed by counting the following characteristics
 - External inputs and outputs
- User interactions
- External interfaces
- · Files or databases used by system
- Each characteristics is individually assessed for complexity
- Each characteristics is given weight for complexity
 - 3 for simple external inputs
 - 15 for complex internal files

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Counting Functions Points



- · Count function points
 - Multiply each raw count by estimated weight, then sum all values
- Next multiply with project complexity factors
- Degree of distributed processing, amount of code reuse, performance
- Function point analysis can be combined with LOC estimation techniques
 - Function points used to estimate final code size
- Uses historical data
 - AVC: average number of lines of code required to implement one function point
 - Code Size = AVC * Number of function points
- Advantage
- Easier to estimate points than LOC early in the development process
- Can be reaadily done with a completed SRS

COnstructive COst MOdel (COCOMO) Barry Boehm



- COCOMO is an algorithmic Software Cost Estimation Model
- The model uses a basic regression formula, with parameters that are derived from historical project data and current project characteristics

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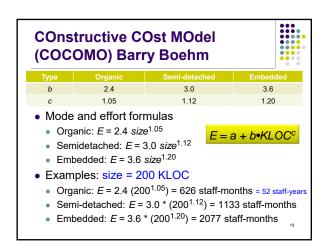
COnstructive COst MOdel (COCOMO) Barry Boehm

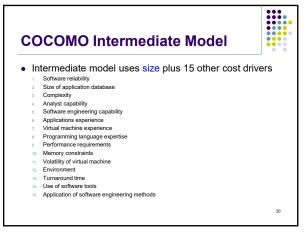


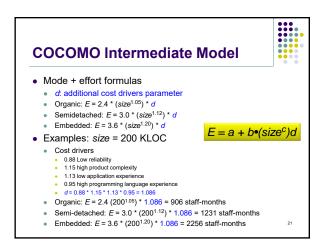
- One of first empirically-based models for effort and cost estimation
 - Considers wide variety of factors
 - Provides values for b, c and project size (KLOC or proxy) of effort equation
- Projects fall into three categories
 - Organic: small team, known environment
 - Semidetached: intermediate category—mix of experience, may be large project but not excessively so
 - Embedded: inflexible and constraining environment

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COnstructive COst MOdel (COCOMO) Barry Boehm Project Type Size Innovation Deadline / Constraints Organic Small Little Not tight Stable Embedded Large Greater Tight Complex hardware Custom interfaces Semi-detached Medium Medium Medium Medium

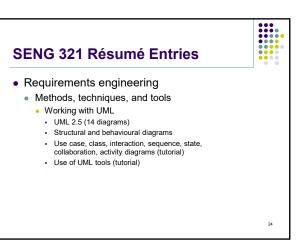






Summary—Project Cost and Effort Estimation Techniques • Variety of cost estimation methods algorithmic estimation models based on real data and experience (e.g., IBM, TRW, JPL) • Challenge: how to translate experience to local situation • Some success with well-specified problems/domains • Depend on solid requirements at estimation time • For many situations this is impossible • Algorithmic models are from late Seventies & early Eighties • Today we have very powerful programming environments and reuse strategies and generate a lot of code—UI, middleware, libraries • Recommendation • Combine techniques; one technique alone never suffices

SENG 321 Résumé Entries Requirements engineering Requirements process Elicitation, Analysis, Specification, Validation Methods, techniques, and tools Use case modeling techniques Domain analysis and modeling Review techniques Walkthroughs Valukthroughs Inspection and validation Inspection meetings Inspection checklists CRUD (Create, Read, Update, Delete) Matrix



SENG 321 Résumé Entries



- Software life cycle models
 - Waterfall and Spiral models
- Requirements analyst
 - Interface between customers and developers
 - · Requirements specification documentation skills
 - IEEE Std 830-1998 Requirements Standard and Specification Template
 - Documentation skills
 - Visio (tutorial)
 - Proiect (tutorial)
- Project Cost and Effort Estimation Techniques
 - COCOMO model (Barry Boehm)

SENG 321 Résumé Entries



- · Codes of Ethics
 - APEGBC
 - ACM Software Engineering
- · Communication and management skills
 - Presentation skills
 - Teamwork
 - Organization skills
 - Leadership skills
 - Management skills
 - Project management skills
 - Time management skills

Final Exam SENG 321 Format and Materials



- Format

 - · Closed books, closed notes, no gadgets
 - The same format as the midterm
 - Mostly essay style questions
- Slides
- 600+ slides posted on the course website
- Midterm
 - Similar format and questions
 - A couple of questions from midterm (e.g., major phases)

Final Review



- Use case modeling techniques
 - Use case scenarios
 - Process for identifying use cases
 - Use case template
 - Use case diagrams
 - Context diagrams Use case mistakes and limitations
- Review techniques
 - Walkthroughs
 - (Formal) inspection and validation
 - Inspection meetings
 - Inspection checklists
- CRUD (Create, Read, Update, Delete) Matrix
 - Develop a CRUD matrix for a well-known scenario
 - For example, bank checking account

Final Review



- Codes of Ethics

 - ACM Software Engineering
- UML overview
 - Structural and behavioural diagrams
 - · History of UML
 - What do you know about UML and its history?
- Explain the uses of the 14 diagrams in UML 2.0
- Project cost and effort estimation techniques
 - Techniques
- Parameters
- · Algorithmic models
- Comparison of techniques
- COCOMO model (Barry Boehm)
- Contrast different project cost and effort estimation techniques

Course Discussion



- · What caught your eye in this course?
- What have you learned in this course?
- How does this course prepare you for your work in industry?
- How was your group experience?
- · What would you do differently?
- · Was this course a character-building experience for you?
- · What surprised you in this course?
- · What did you learn about yourself?
- What did you learn about your team players?

