SIE 464-564 Cost Estimation

Mon & Wed 3:00 PM – 4:15 PM
Engineering Building, room 304/Zoom https://arizona.zoom.us/j/81891049723

Ricardo Valerdi
rvalerdi@arizona.edu
Office hours: By appointment

TA: Alexus Hurtado (alexushurtado@email.arizona.edu)
Office hours: 1:30-2:30 PM Mondays and Thursdays or by appointment via
https://arizona.zoom.us/j/9848986636

This course focuses on principles of **cost modeling**, **measurement systems**, and **forecasting** with specific emphasis on parametric models. Approaches from the fields of hardware, software and systems engineering are applied to a variety of contexts (risk assessment, judgment & decision making, performance measurement, process improvement, adoption of new tools in organizations, etc.). Material is divided into five major sections: cost estimation fundamentals, parametric model development and calibration, advanced engineering economics principles, measurement systems, and behavioral economics/forecasting.

Course Description

Each section will include analysis of theoretical principles that have motivated the state of the practice as well as a review of applicable methodologies. Where appropriate, case studies will be used for more detailed exploration of critical issues and examples from Sabermetrics (using baseball data) will be introduced to enhance discussions. Selectively, guest speakers will be invited to share their perspectives on the development, use, and evaluation of cost models and complementary approaches. Students are encouraged to leverage their interests into individual projects that involve developing and validating their own cost model.

Rationale

The objective of this course is to provide future technical leaders the necessary tools and evaluation techniques to reason about the economic impact of their decisions for the technologies and products they develop. This will be done through a combination of technical skills and storytelling.

Technical leadership requires an understanding of: statistics, human decision making, and storytelling. This course assumes a background in some area of technology that can be analyzed from a cost perspective. This course will explore the more challenging – and often overlooked – domain of cost estimation and incorporate methodologies from established engineering disciplines to explore the impact of: continuous process improvement, economies of scale, present value, risk and decision analysis, etc. This will be done in the context of new challenges in complex engineering systems and new approaches introduced by process maturity models, evolutionary development, and systems architecting and engineering.

Learning objectives [measurable outcome]

1. Build awareness of phenomena that influence cost of engineering systems across a variety of contexts [homework]
2. Understand the practical application of cost modeling and its role in government and industry [homework, final project]
3. Use cost models to develop cost estimates [homework, midterm]
4. Learn the financial vocabulary and effective methods for communicating with non-technical audiences [homework, midterm]
5. Employ data-driven decision making to make economic choices between design alternatives [final project]
6. Understand the methods used to develop and validate cost models and associated limitations [homework]
7. Learn storytelling with data techniques [homework, final project]
8. Communicate technical results in clear and concise writing style [final project]
9. Develop an appreciation for the controversial issues in the area of cost estimation [homework]
10. Develop a parametric cost model [final project]

Required Course Texts

Hubbard, D. W., *How to Measure Anything: Finding the Value of Intangibles in Business,* Wiley, 2014. (3rd Edition)
https://ebookcentral.proquest.com/lib/uaz/detail.action?docID=1641073
Knaflic, C., *Storytelling With Data*, Wiley, 2015.
https://ebookcentral.proquest.com/lib/uaz/detail.action?docID=4187267

Additional Resources Provided by Instructor

Boehm. B. W., et al, *Software Cost Estimation with COCOMO II*, Prentice-Hall, 2000.
Valerdi, R., *The Constructive Systems Engineering Cost Model (COSYSMO): Quantifying the Costs of Systems Engineering Effort in Complex Systems*, VDM Verlag, 2008.

Class Topics

1. Intro and course overview
    a. Cost, schedule, performance
    b. Cost vs. price
    c. Total ownership cost
    d. Brooks' Law
2. Cost estimation approaches
    a. Parametric, bottom up, analogy, expert opinion, etc.
    b. NASA's cost estimation process
    c. Mars Rover source code analysis
    d. Online cost model: COCOMO II
3. Sizing and Work Breakdown Structures
    a. How to build a WBS
    b. Software sizing
    c. 10 deadly sins of cost estimation
4. Systems engineering cost modeling
    a. COSYSMO
    b. Data collection and calibration
    c. Bayesian approximation
5. Economic principles
    a. Reuse
    b. Diseconomies of scale
    c. Risk and uncertainty assessment
6. Modeling
    a. Descriptive vs. inferential statistics
    b. Regression analysis
    c. Kaggle project
7. Decision analysis/Storytelling
    a. Heuristics
    b. Optimism
    c. Data visualization
8. Forecasting/ Counterintuitive results
    a. Simpson's Paradox
    b. Prediction markets
    c. Signal to Noise

Basis of grade (SIE 464)

Component	Weight	Notes
Homework	24%	8 assignments @ 3% each
Midterm	30%	Around April
Kaggle project	10%	
Final project	30%	5-6 pages
DMAIC Report	6%	2-3 pages

Basis of grade (SIE 564)

Component	Weight	Notes
Homework	24%	8 assignments @ 3% each
Midterm	30%	Around April
Kaggle project	10%	
Final paper	30%	8-10 pages
DMAIC Report	6%	2-3 pages

Homework assignments
There are eight homework assignments worth a total of 24% of your grade. Assignments must be 2-3 pages in length (single spaced) and must be submitted (via D2L) on the date indicated in the syllabus.

Midterm Exam
An exam will be administered approximately two-thirds through the semester to assess progress on learning objectives. Rather than testing memorization, the focus will be on the application of concepts from the first half of the class. Questions for the midterm will be a combination of questions generated from students and the instructor.

Kaggle Project
Each student will have an opportunity to apply their knowledge from the course on a dataset of housing prices available on Kaggle.
https://www.kaggle.com/c/house-prices-advanced-regression-techniques

Final Project
The final project should be summarized in a report between 5 and 10 pages long (plus or minus 20%; clarity of understanding and evidence of independent thinking are much more important than length) single spaced 12-point font. Projects should be a result of individual effort only. Students are expected to develop their own cost model and are encouraged to select a technical area that interests them. Proposals for final projects, which is a homework assignment, will serve as an opportunity to negotiate the topic and scope of the final paper.