



Jet Propulsion Laboratory

North Carolina State Univers

Data Mining Methods and Cost Estimation Models

Why is it so hard to infuse new ideas?

Jairus Hihn

Jet Propulsion Laboratory, California Institute of Technology

Tim Menzies

North Carolina State University

ACTION15: Actionable Analytics for Software Engineering
Lincoln, Ne.



Introduction

Jet Propulsion Laboratory

North Carolina State Univers

- ❖ In this talk we will describe our experiences and lessons learned from our ten year journey in conducting and infusing data mining methods into the world of cost estimation
 - ❖ 10 years ago with 2CEE we failed to make it to the launch pad
 - ❖ This time we have launched and even have a few early users but will we make it to a stable earth orbit

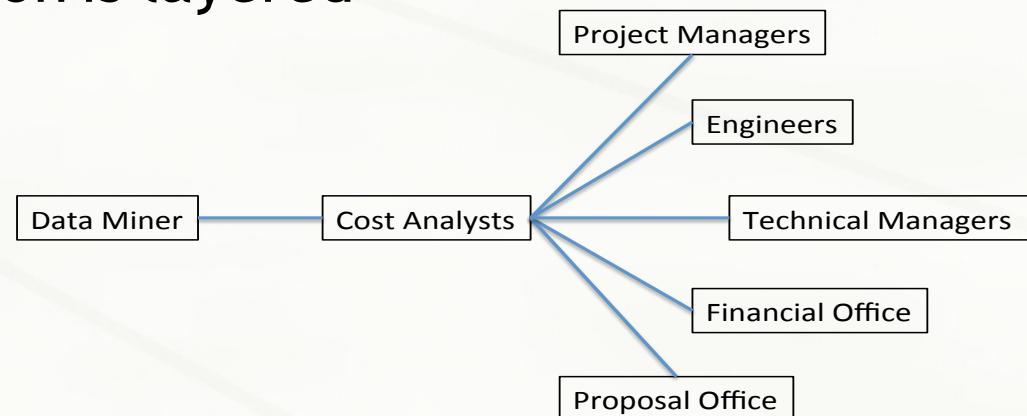


Background

Jet Propulsion Laboratory

North Carolina State Univers

- ❖ Everyone in an organization knows just enough about cost to be dangerous
- ❖ Current cost methods have been in use for over 30 years and even then there is still some resistance to the use of cost models over expert judgment bottom up methods
- ❖ Infusing new ways of doing things is hard and takes time
- ❖ There is minimal to no cross fertilization of ideas between academia and practitioners in industry
- ❖ Stakeholder Communication is layered





A Script Writers Version of the Conversation Between a SME and DME

Jet Propulsion Laboratory

North Carolina State Univers

- ❖ DME: (All excited like he just solved the mysteries of the universe) ~~SME~~ look there a “model” I can unsupervised learning with ~~x~~ show my stakeholders? outperforms all the other ~~methods~~ ~~DME~~ sort of but it changes based on the median MRE. everytime as it depends on
- ❖ SME: But is there a formal technique ~~SME~~ to compare to F-test that tells us one result is ~~sense~~ ~~SME: (Frustrated)~~ What are the actual parameter values in the locally calibrated actuall significantly better than the ~~COCOMO~~ so I can see if they make any sense. ~~DME: But the MREs are great.~~
- ❖ DME: By the way I have a ~~DME: We do not know we just know how~~ brand new method that works even better.
- ❖ SME: ~~We can do~~ Walks away feeling as if they are walking on quicksand wondering why he ever got involved with this DME)
- ❖ DME: That does not matter and is irrelevant because ~~xxx~~ ~~the different types of models perform~~. That's a lower order question. ~~SME: We can do~~

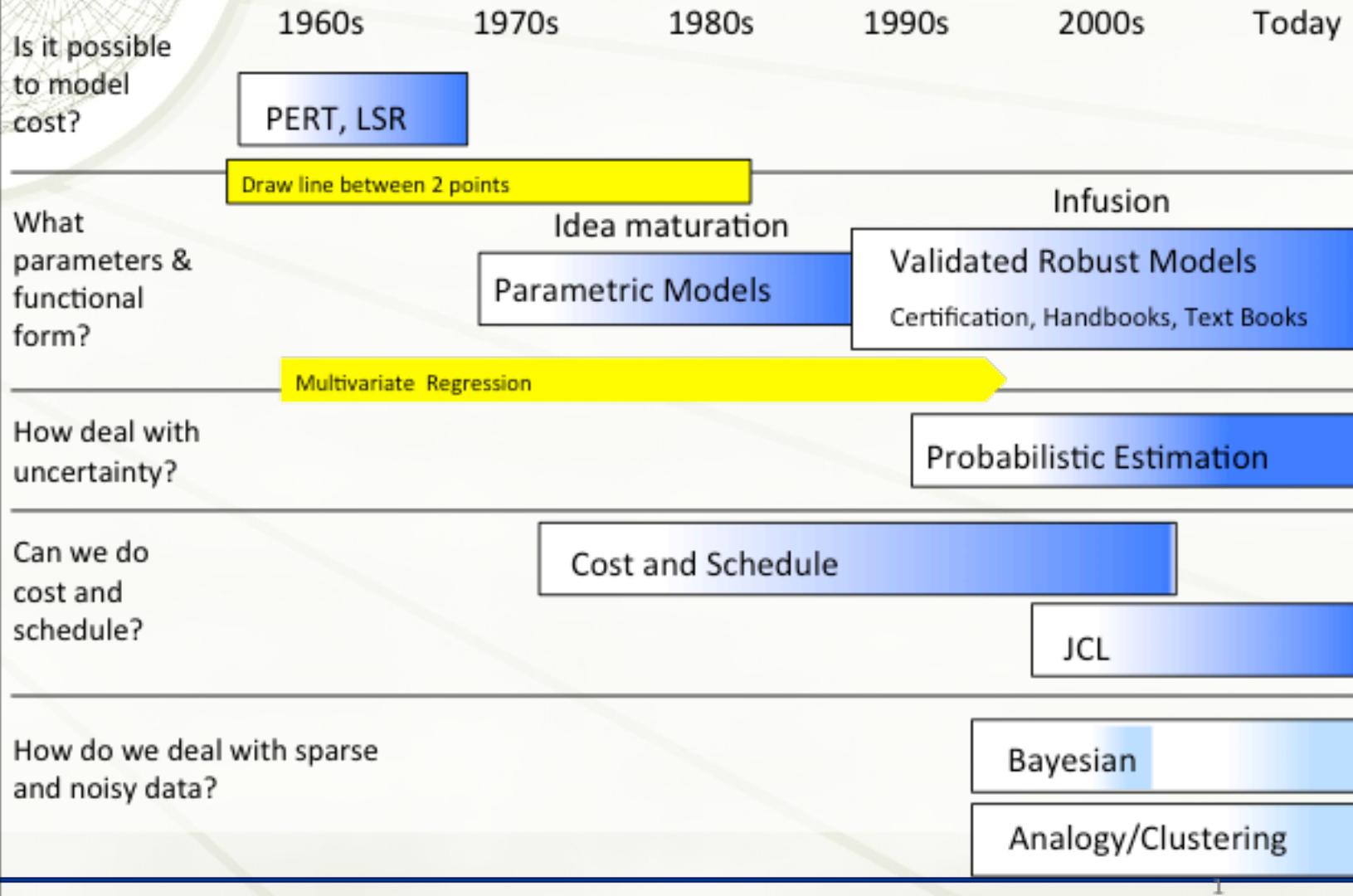


History of Industry Cost Estimation Methods

Jet Propulsion Laboratory

North Carolina State Univers

Evolution of Model Based Estimation Methods





One of the Keys to Success was this time we have a hook

Cost Analysis Division

Jet Propulsion Laboratory

West Virginia University

- ❖ The purpose of the model is to
 - ❖ Supplement current estimation capabilities
 - ❖ *Be effective in the very early lifecycle when our knowledge is fuzzy*
 - ❖ uses high level systems information (Symbolic Data)
 - ❖ *Be usable by Cost Estimators, Software Engineers and Systems Engineers*
- ❖ *Methodology handles*
 - ❖ small sample sizes
 - ❖ noisy and sparse data



Keys to Success - 1

3. Learn to Communicate.

- Unless the target community accepts the idea, they will not use the idea.
- Learn the users vocabulary and patiently teach them the key aspects of your vocabulary
- Constantly communicate to develop a shared language and at least consistent mental models

4. Validation is important

- Validate continuously both at the technical level and with the SMEs.
- Make things visible to the user but do not bury them in overly technical details of the algorithm.
- But be aware that merely having excellent validation results is not enough to guarantee success

1. Engage, engage, and engage again.

- Plan for infusion from day one. New methods require new processes and new ways of thinking, these do not change easily.
- Be patient. It takes time to introduce something fundamentally new. Especially into a large organization or community (e.g. NASA).

2. Users before algorithms.

- Clearly understand the industry users problem they are trying to solve. You must meet a recognized need even if you have to help the user articulate what that need is.



Keys to Success - 2

Jet Propulsion Laboratory

North Carolina State Univers

5. Broad skill set, big toolkit

- Initially prototype and experiment with a variety of techniques and testing them with the users to determine what works best for both the available data, the usage scenarios, and the existing mental models of the stakeholders

6. Visualization

- Humans by nature but especially external users need to be able to visualize results and the key internal data structures. Summary statistics provide no insight and create no belief or trust in the results. This enables aspects of validation and also supports the evolution of new insights and new ways to communicate the results.

7. Be humble and open to unexpected ideas.

- The truth is a blend of what the data says and the experts many years of experience. The perfect answer is rarely the best answer. Sometimes the data is partly wrong.



First Stab Prototype Interface

Jet Propulsion Laboratory

North Carolina State University

STEP 1) Enter data for the NASA project you would like to estimate:

Name: ***Mission name	profilename
Software Size Category:	I
Inheritance:	Very Low to None
Mission Type:	Deep Space
Secondary Element:	Inspector/ Probe
Number of Instruments:	0
Flight Comp. Redundancy:	Single string
Total Deployables:	3

STEP 2) Once you have entered data, press the "Submit Inputs" button.

Prepares to wait ~ 30 seconds for results.

STEP 3) Run Estimate

Effort Estimate: **483.13**

STEP 4) Reset tool before calculating new estimate

Reset Tool

TRAINING-CLUSTER DATA SUMMARY

Effort Values	Equivalent Lines of code (LOC)
Minimum: 47	Minimum: 76.0
Maximum: 1042.0	Maximum: 1000
Median: 451	Median: 125.1

Estimated Software Effort vs. NASA In-Cluster Mission software

Click "Restart" if an error occurs

Restart

TRAINING-CLUSTER NAMES	Name	Software Size Category	Equivalent LOC	Inheritance	Mission Type	Secondary Element	Number of Instruments	Flight Comp. Redundancy	Total Deployables	Actual Effort
	OME	I	340	medium	deep space	none	2	single string	3	1042.0
	OCO	I	126.0	high	earth/orbit	none	1	single string	3	483
	WISE	II	76.0	observatory	none	1	single string	3	47	

9



Next Step

Jet Propulsion Laboratory

North Carolina State Univers

This capability will be released through the NASA ONCE Portal on December 4th for use by NASA and its contractors so we will launch

But ...