Beyond RIFT: Improved Metrics to Manage Cost and Schedule

The Story of Localized Analysis and Conditional Metrics

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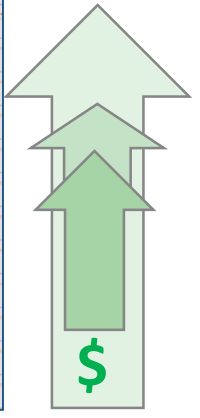
Introduction

- As cost and schedule disciplines merge, the metrics used in the analysis may not
  - The same metrics and statistics are often used in both analysis
  - Cost models and schedule models have fundamental differences
  - It is vital to understand how these differences influence the common metrics used in both fields and modify the analysis where needed to account for the fundamental differences
- This presentation introduces an enhanced method for analyzing data: "Local Analysis"
  - Local Analysis is a variety of methods to analyze a **subset** of the iterations results from any schedule uncertainty model

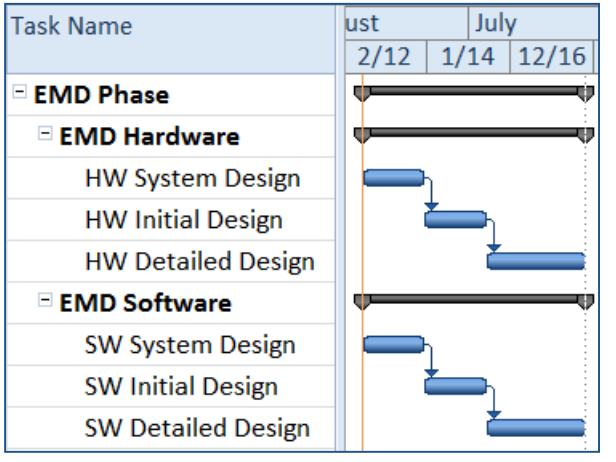
Discrepancies - Introduced

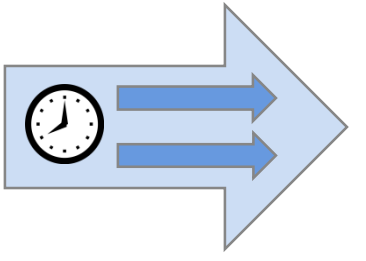
- In cost models, everything sums, so that everything is proportional to the whole
  - Cost element X is $10 and total cost is $100, definitively say element X is 10% of the total cost
- Schedules do not share that proportional behavior found in cost models
  - Schedule element Y is 10 days and total duration is 100 days, you need to know more before you can say anything definitively about element Y

1	* Cost Estimate	
2	**System Total Cost**	**$ 100**
3	EMD	$ 100
4	Air Vehicle	$ 50
5	Development	$ 25
6	Prototypes	$ 25
7	SW	$ 10
8	SE	$ 10
9	PM	$ 10
10	ST&E	$ 5
11	Training	$ 5
12	Data	$ 5
13	PSE	$ 5



Money sums



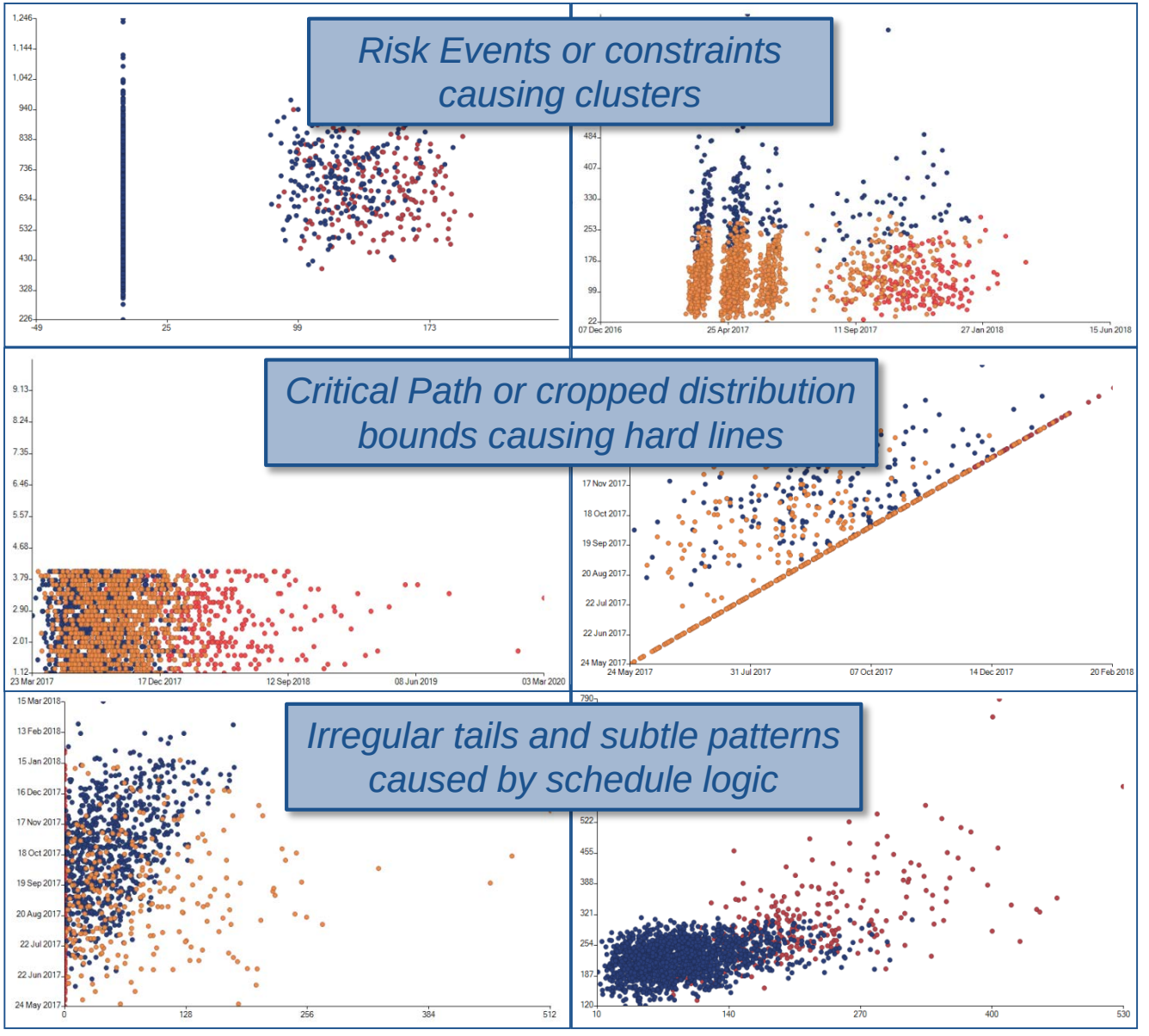


Time does not sum

Discrepancies - Causes

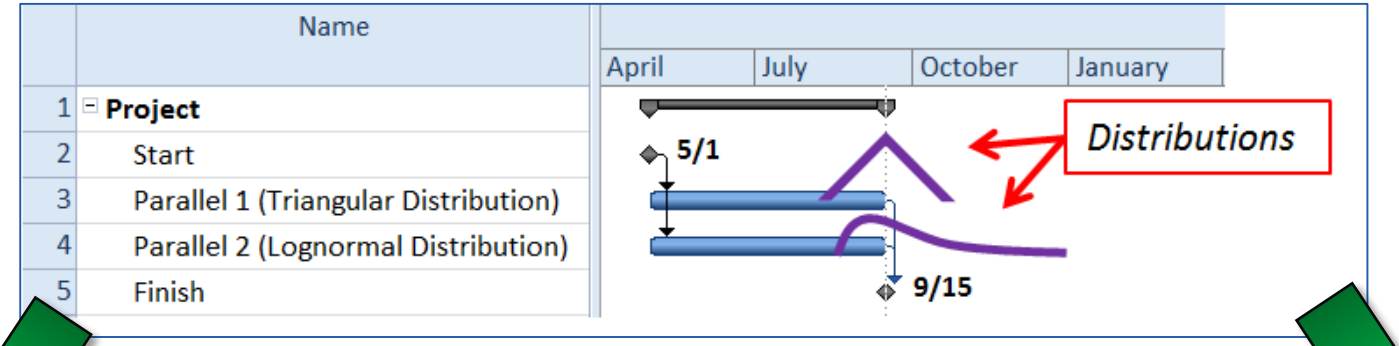
- Schedules structure and logic create near-limitless relationships between elements and the total when running an uncertainty simulation
  - Constraints that override or interrupt natural movement
  - Network dependencies that illogically attempt to mimic reality
  - Lead/Lag that might result in unneeded margin or contingency
  - Risk events (serial and parallel) cause ripple effects
- Even the most basic schedule contains relationships that require careful scrutiny for a full understanding of the model

Discrepancies - Examples

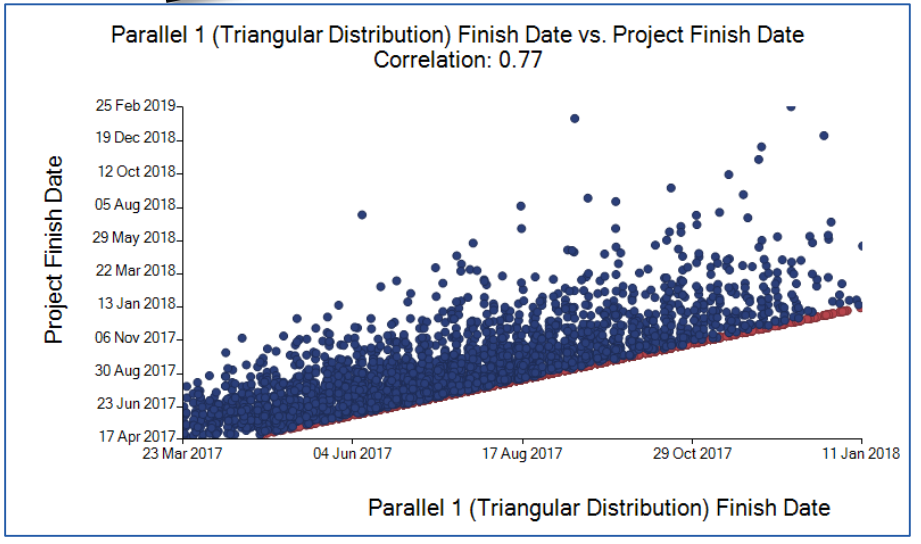


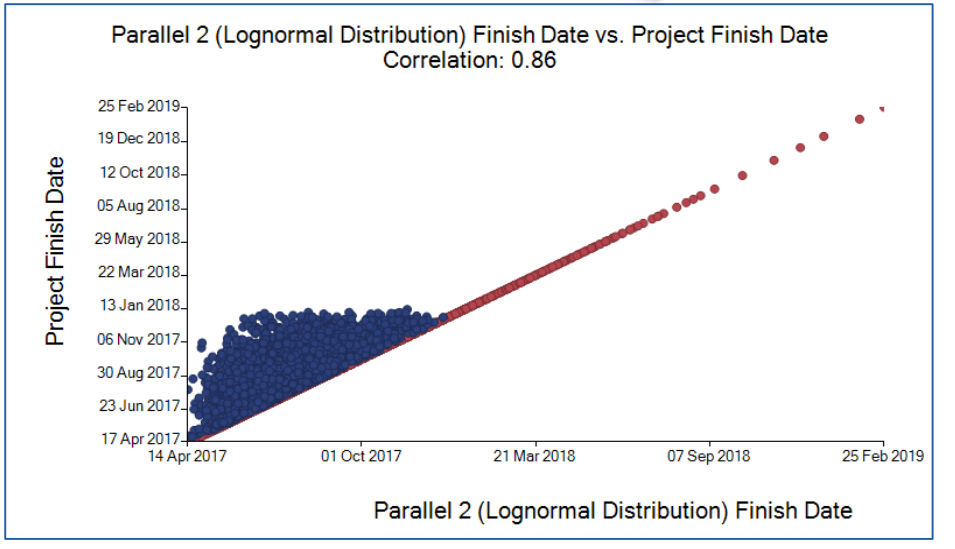
How Easily Schedules Differ from Cost

- Two parallel tasks whose criticality, CV, correlation to Project, and average finish dates are about equal



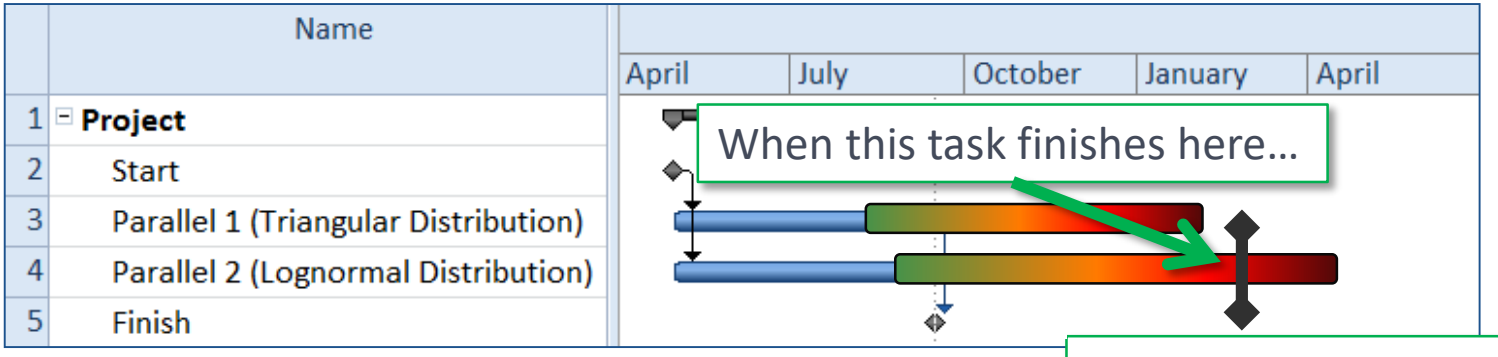
… and yet something is very different between the two

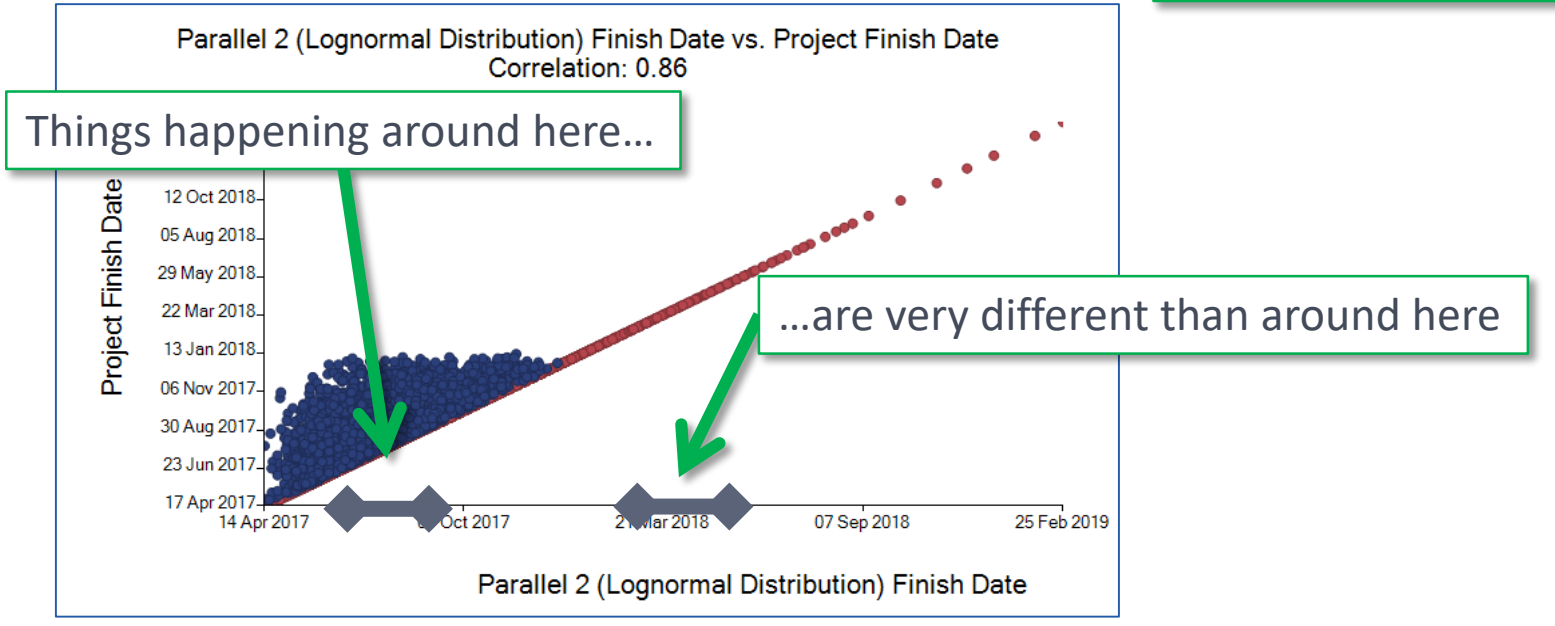




The Answers We Seek

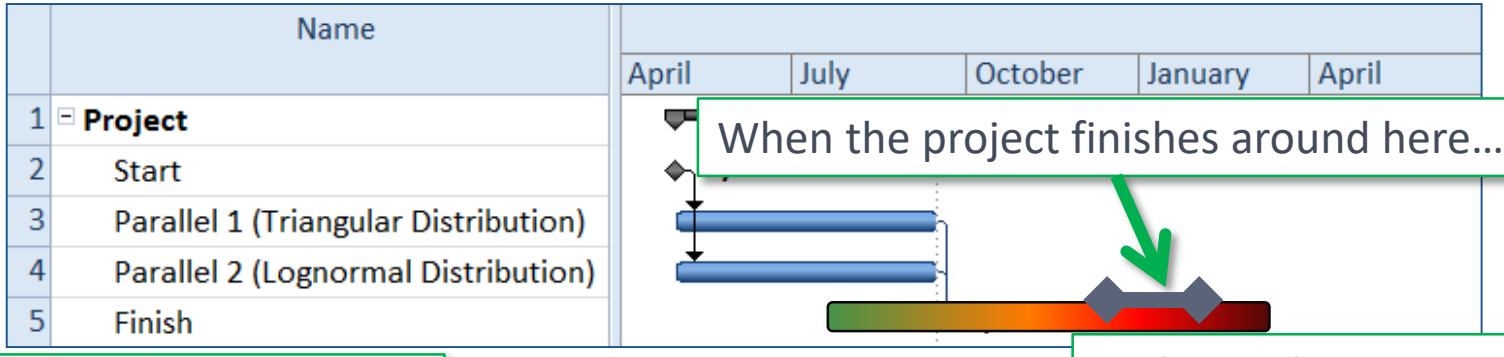
- What happens given certain conditions on tasks?
  - Measurements of *all* possible outcomes creates metrics too generalized

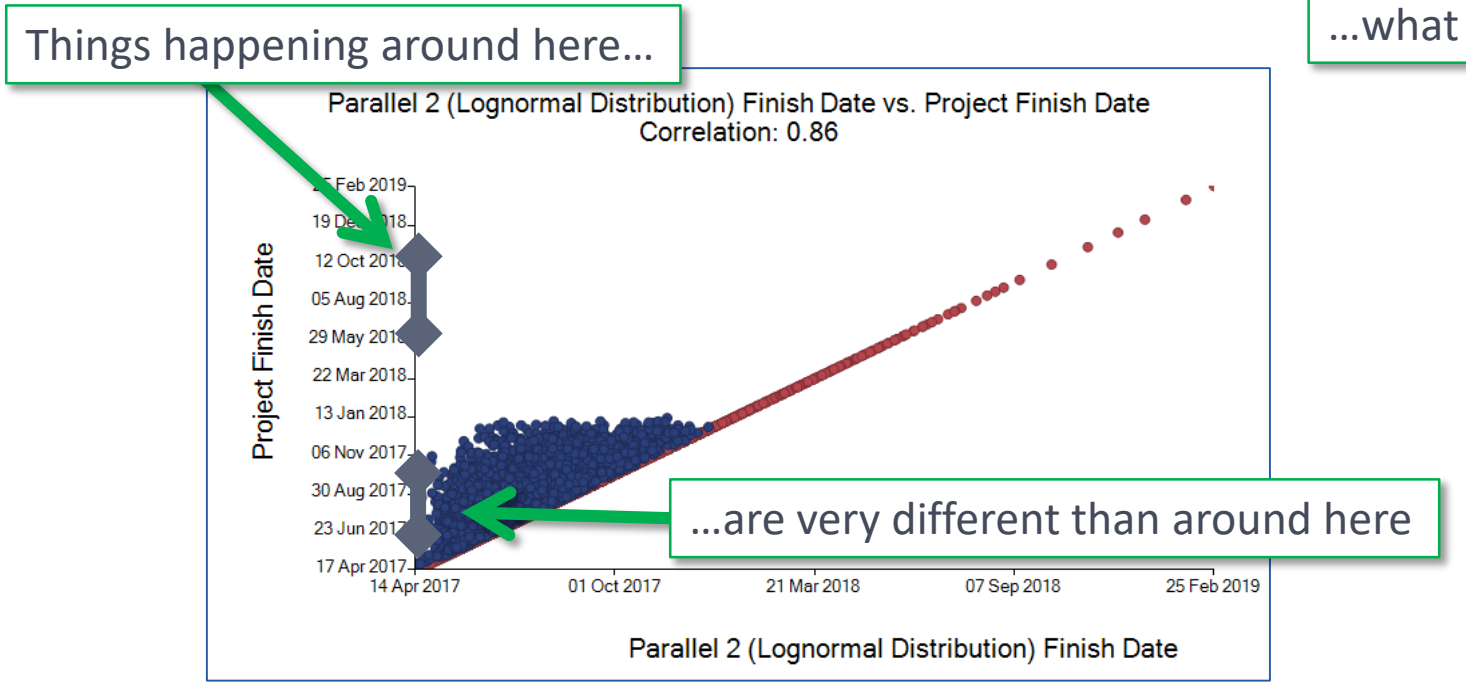




The Answers We Seek

- What happens given certain conditions on the Project?
  - Measurements of *all* possible outcomes creates metrics too generalized





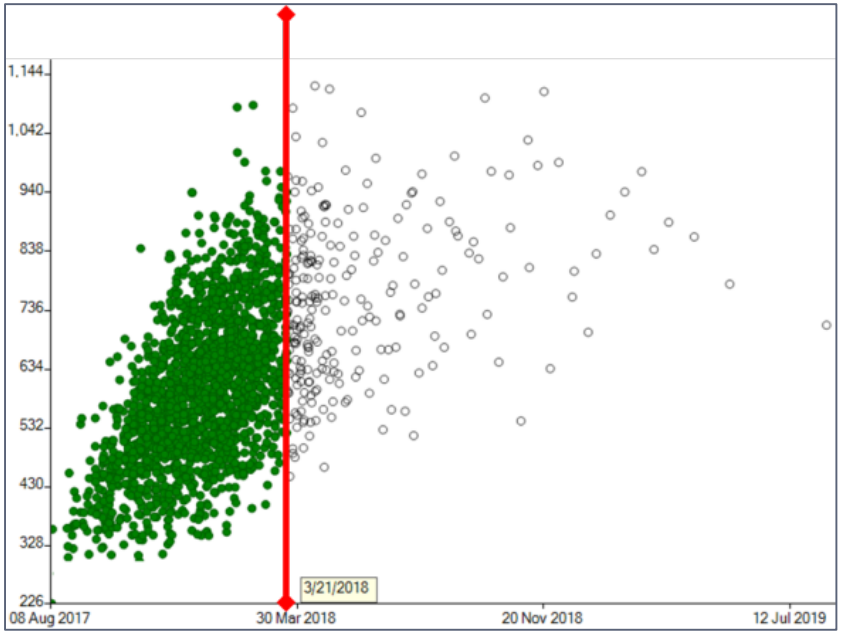
Local Analysis

Local Analysis - Introduction

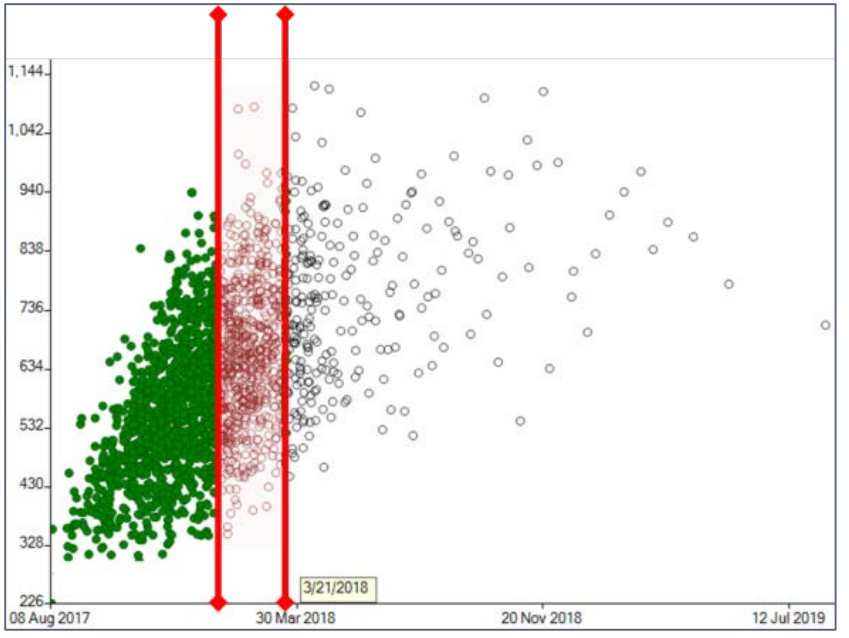
- Concept: Generate metrics based on only a subset of all iteration results
  - A metric derived given a specific condition is met
  - When a calculation is based upon a certain condition being met, the result is a "conditional metric"
- This presentation reveals the insight that Local Analysis provides by demonstrating powerful examples of conditional metrics
- Local analysis also provides vital insight when dealing with clustered data (iteration results that are split into distinct "groups")
  - Cluster analysis is discussed in backup slides and the paper's appendix
  - A new algorithm is also presented to detect and analyze clusters

Local Analysis - Introduction

- Two informal definitions:
- **Cut**: a single value that separates data into two distinct groups
- **Slice**: a subset of data forming a region within the scatter



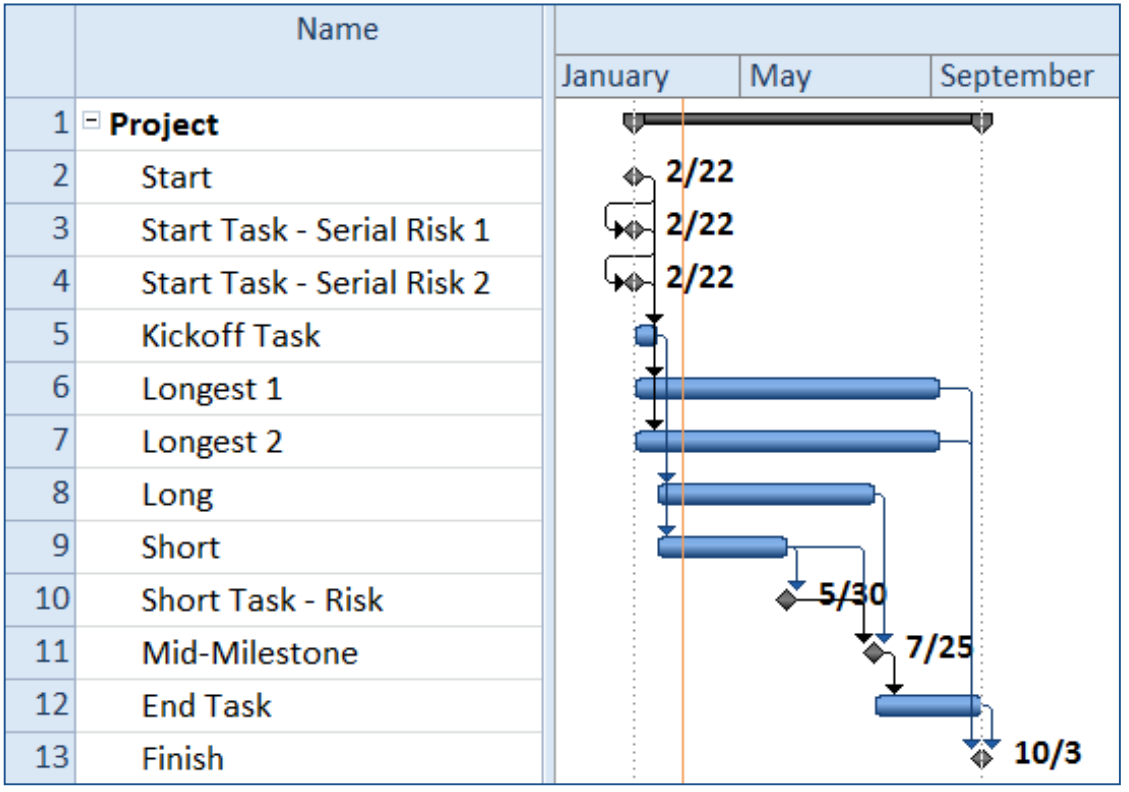
Cut



Slice

Simple Sample Schedule

- A small schedule used to demonstrate examples
  - Lognormal, triangular and uniform distributions, some correlation
  - Unremarkable CVs, no constraints, three risk events, all FS relationships



Local Analysis is necessary even in the most inconspicuous schedules

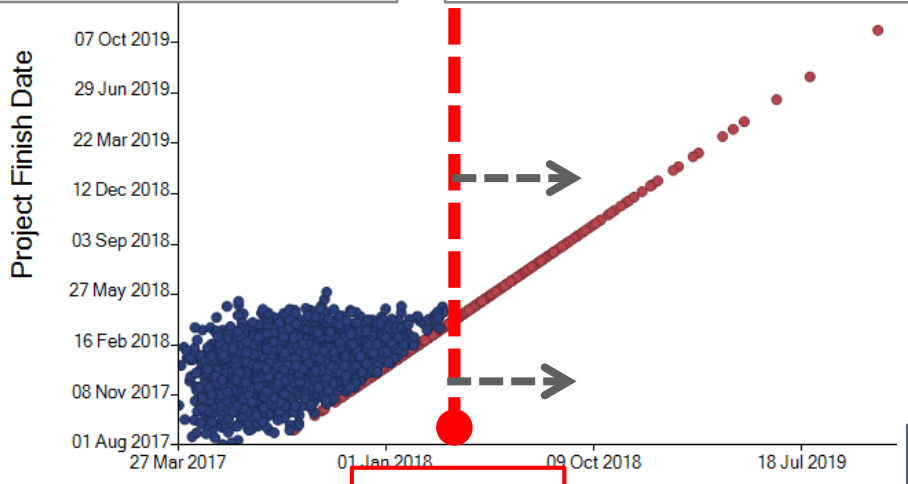
Examples of Criticality Local Analysis – with cut

Data View

- How often is my task on the critical path if it *finishes* after 01Jan2018
  - Calculate criticality index using only the iterations after a specified date to find out how critical the task becomes if it slips out

*Overall Criticality: **0.16***

*Criticality past January 2018: **0.71***



Use "Critical" row results corresponding only to "Finish Date" results greater than Jan 2018

Iteration Results

Finish Dates	9/28/2017	10/26/2017	9/11/2017	5/9/2018	10/6/2017	1/14/2019	6/13/2017	8/23/2017	10/27/2017	...
Critical	0	0	0	1	0	1	0	0	1	

Examples of Criticality Local Analysis – with cuts

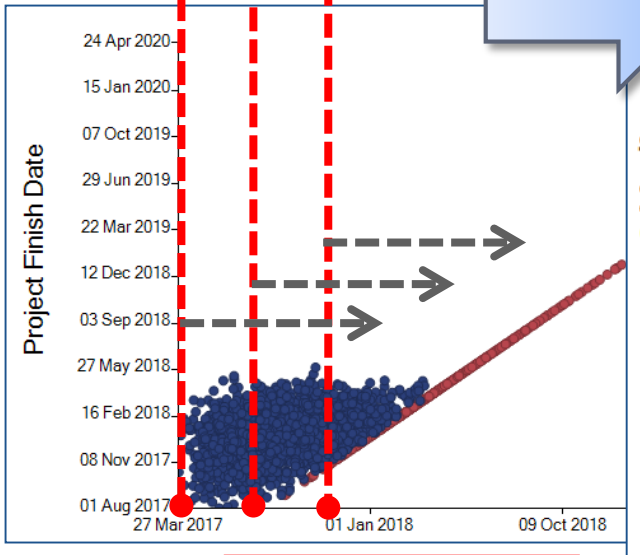
Chart View

- How does the criticality change over the duration of the task?
  - Multiple cuts allow for charting the behavior of a metric over time

*Criticality past **Mean**: **0.39***

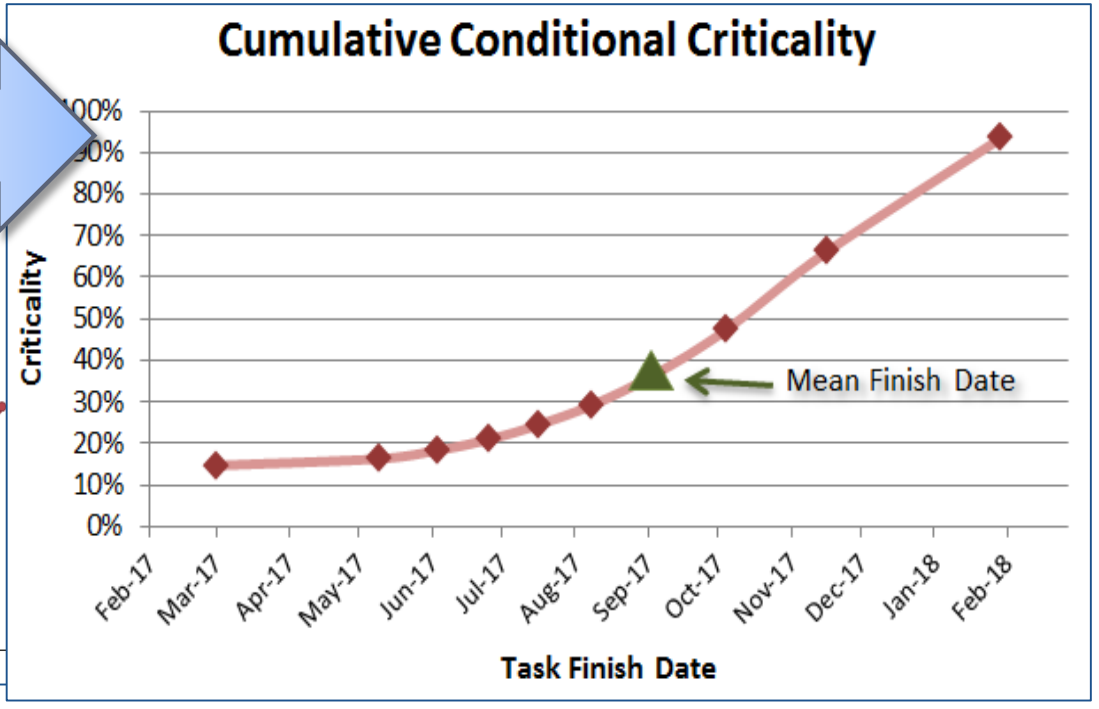
*Criticality past **Plan**: **0.33***

*Overall Criticality: **0.16***



Multiple Cuts

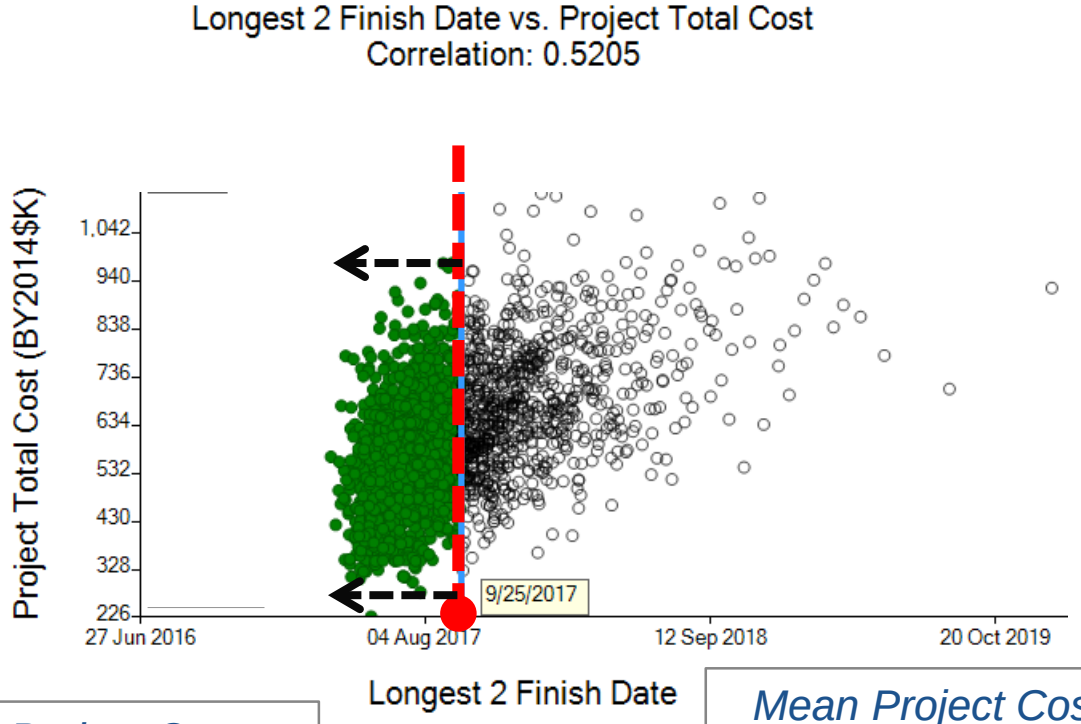
Conditional criticality plotted as cumulative values over time



Examples of Cost Local Analysis – with cut

Data View

- What is the Project's **average cost** if "Longest 2", the most correlated task to Project, finishes *before* the task's mean finish date (25Sep2017)



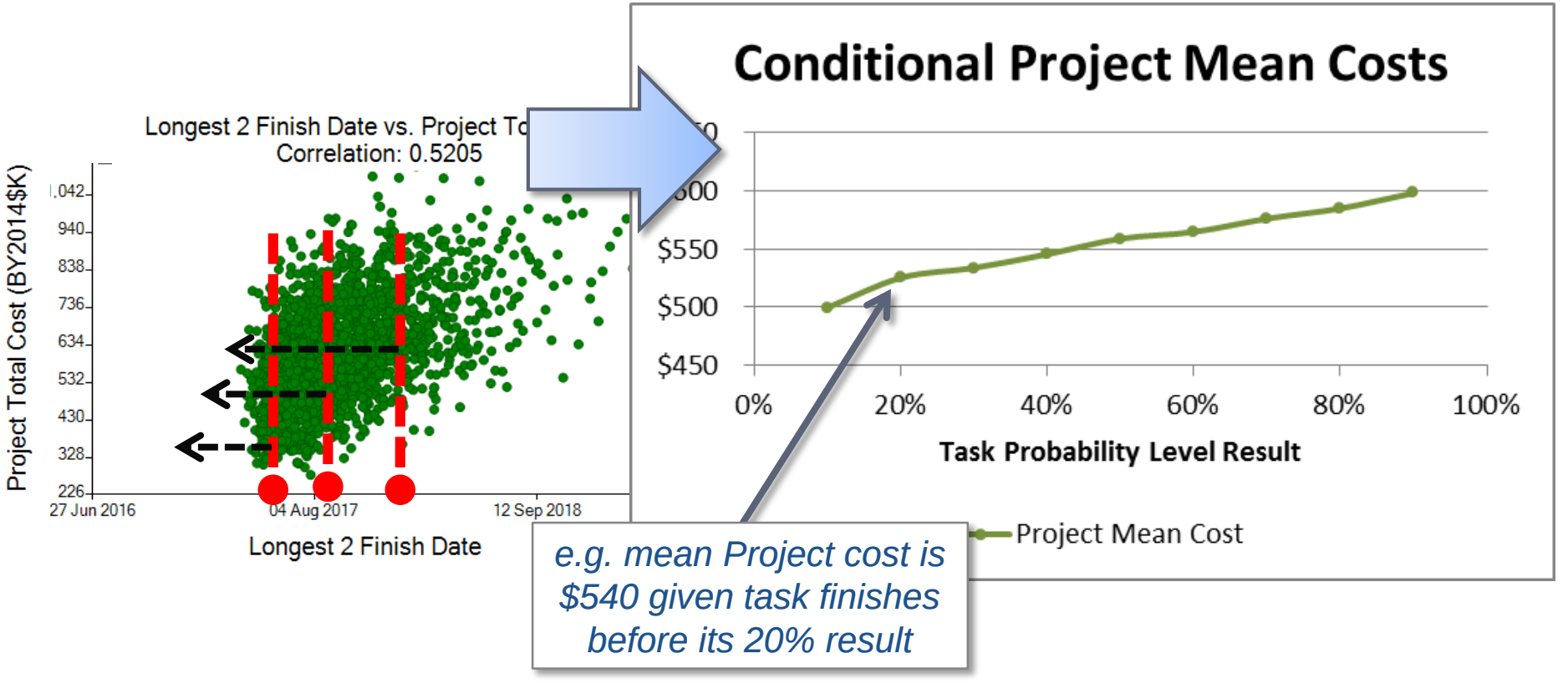
Total Mean Project Cost: ***$615***

Mean Project Cost if "Longest 2" finishes before September 2017: ***$565***

Examples of Cost Local Analysis – with cuts

Chart View

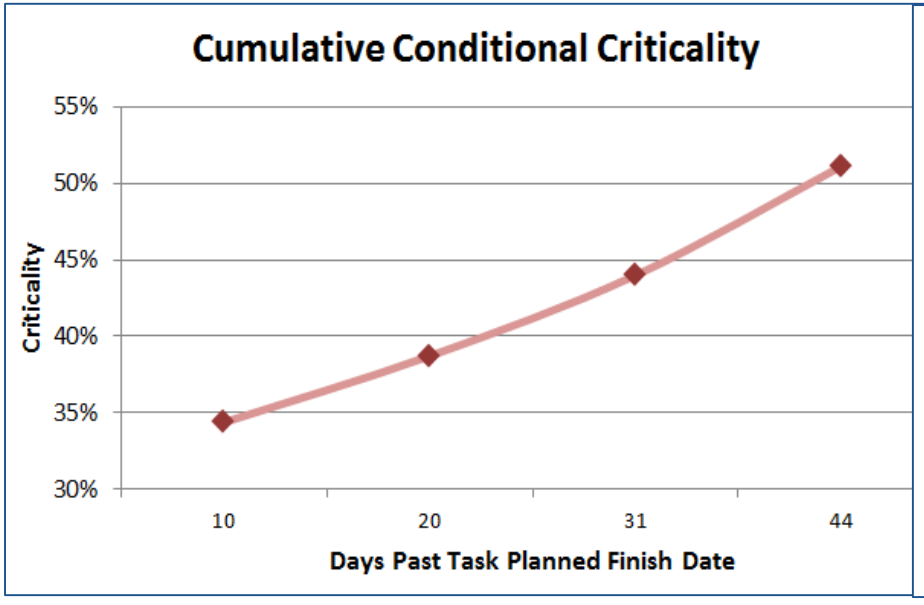
- How does the Project **average cost** behave as my task finishes later and later?
  - Other examples could have different x-axis (such as delta from the planned finish or probability task finishes *after)*

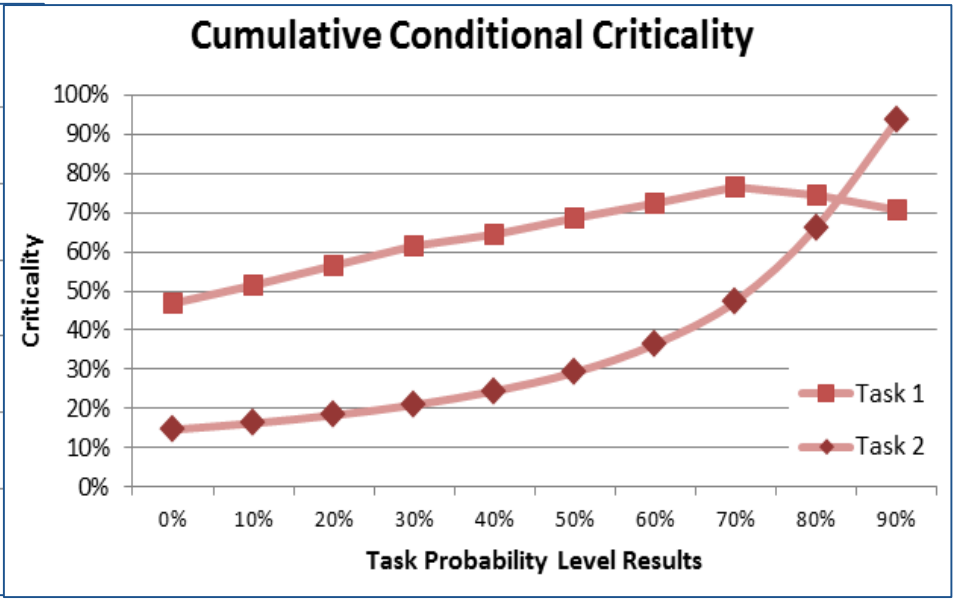


Criticality Line Chart Variations

Chart View

- Cumulative Conditional Criticality Line Chart but with two simple variations to the axis
  - Plot the delta from the planned finish along x-axis
  - Plot the probability result along x-axis (facilitates comparisons)

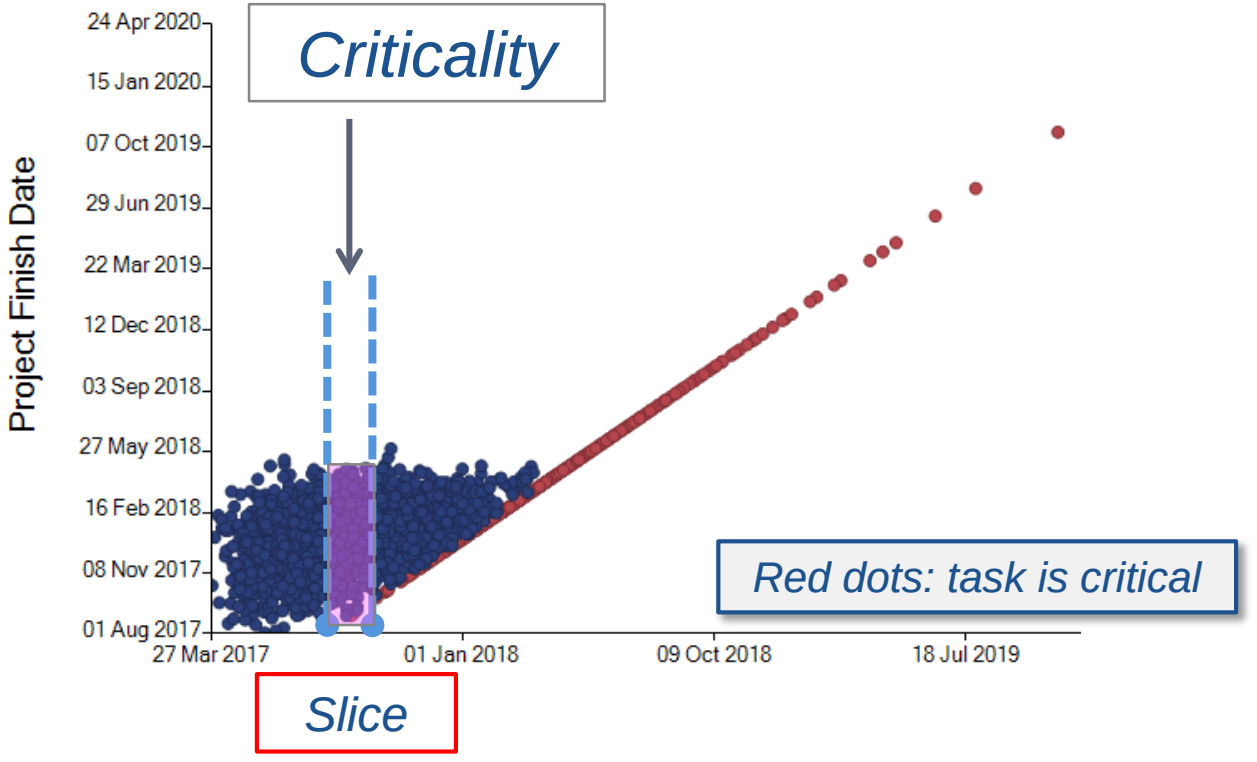




Examples of Criticality Local Analysis – with slice

Data View

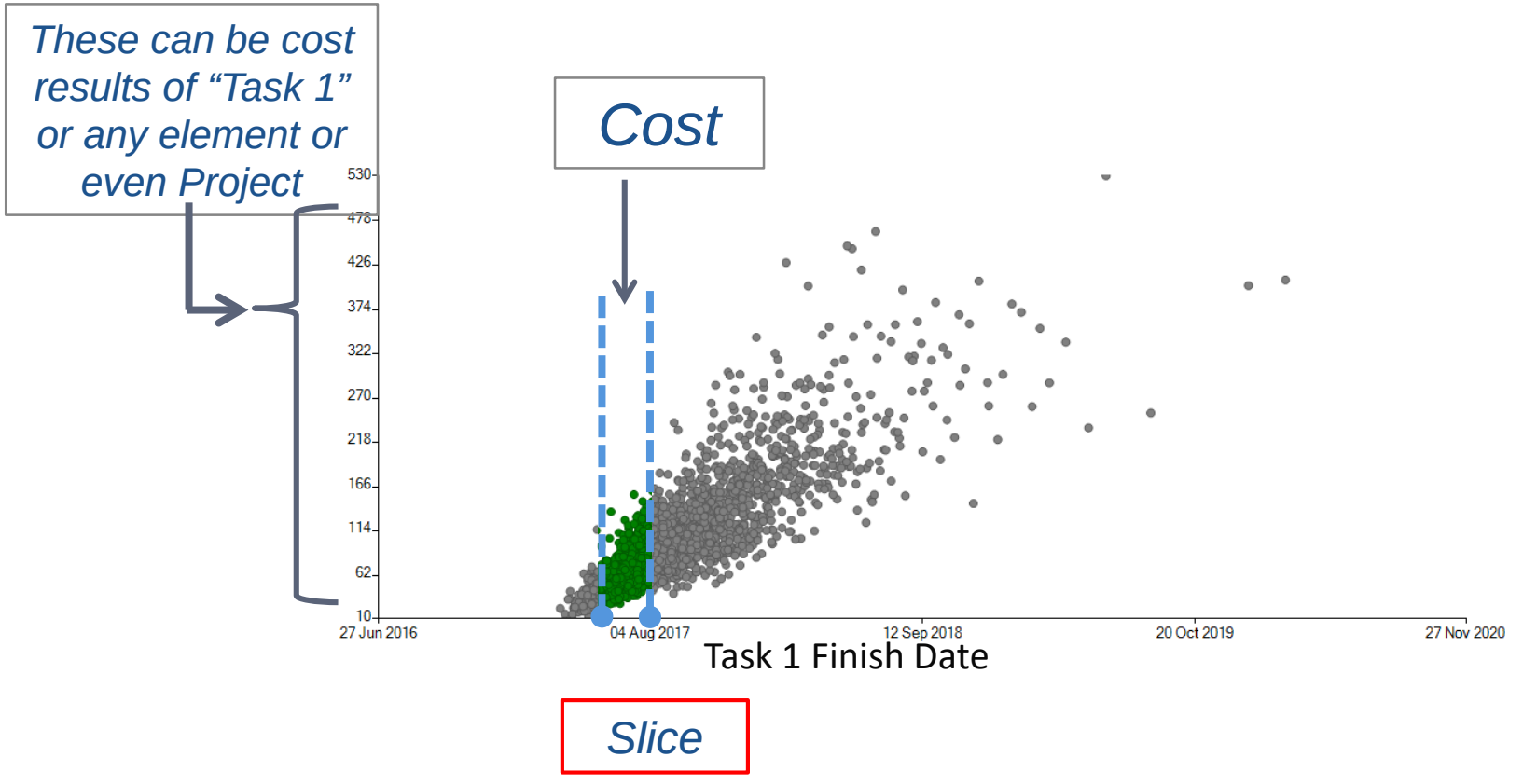
- What is the probability my task lands on the critical path if it achieves its mean duration?
  - Calculate criticality index using only the iterations when task is at (or near) its mean finish date



Examples of Criticality Local Analysis – with slice

Data View

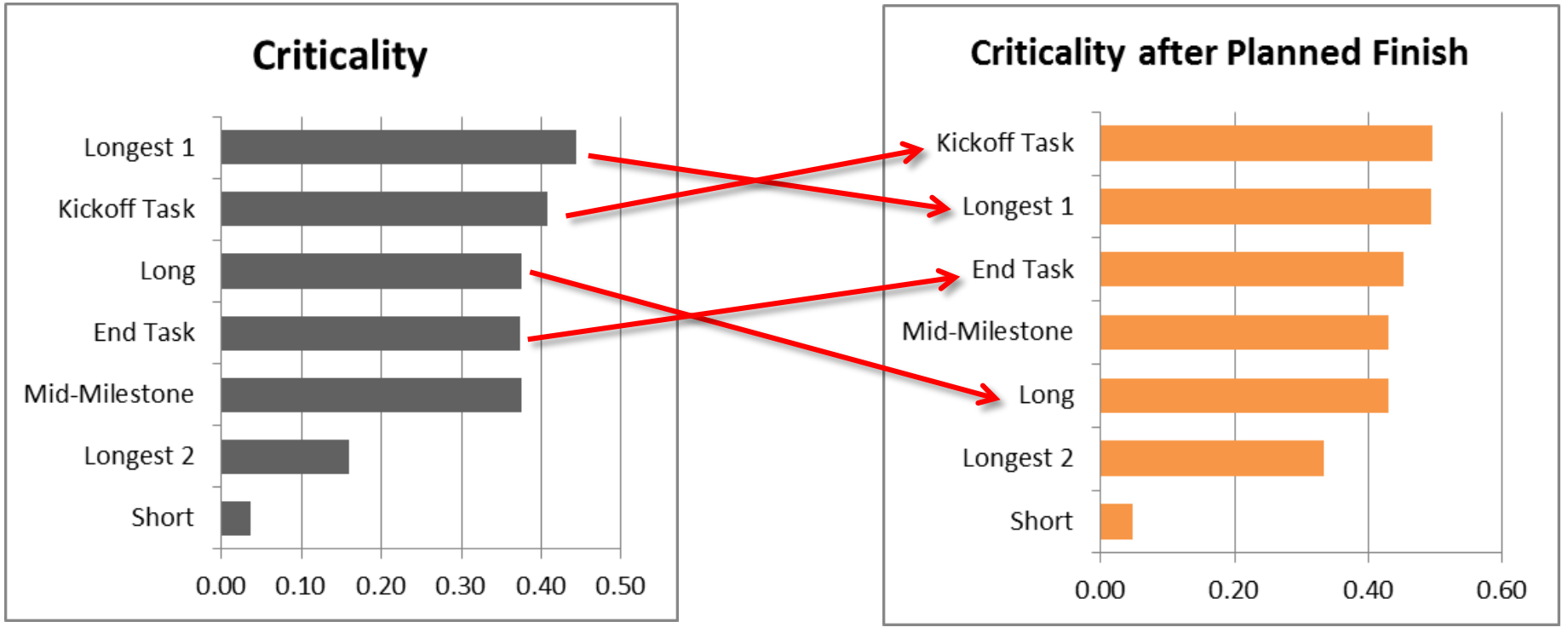
- What is the **average cost** of my task if it achieves its mean finish date?
  - Calculate mean cost (of the task or project or any element) using only the iterations when task is at (or near) its mean finish date



Examples of Local Analysis Driver Charts

Chart View

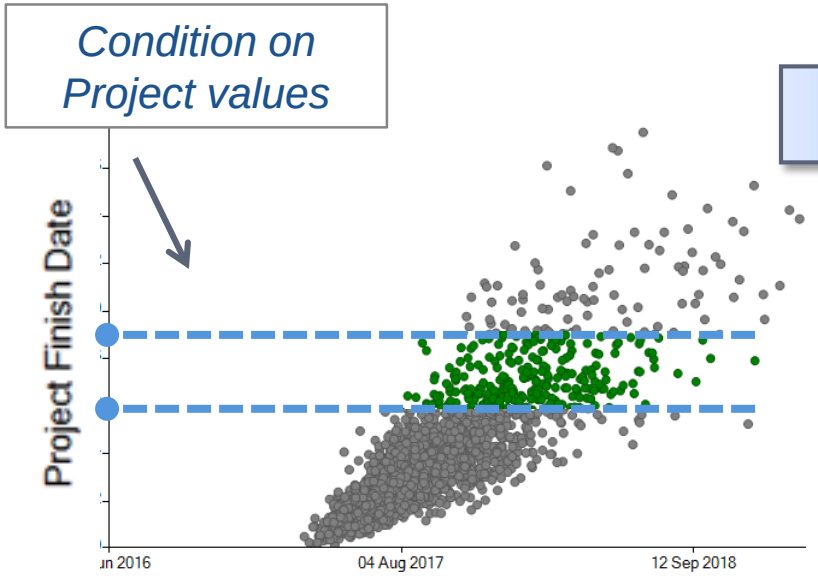
- What tasks are most likely on the critical path once they slip past their plan finish date?
  - Rank based upon the conditional criticality (criticality index of task if it slips past given finish date)

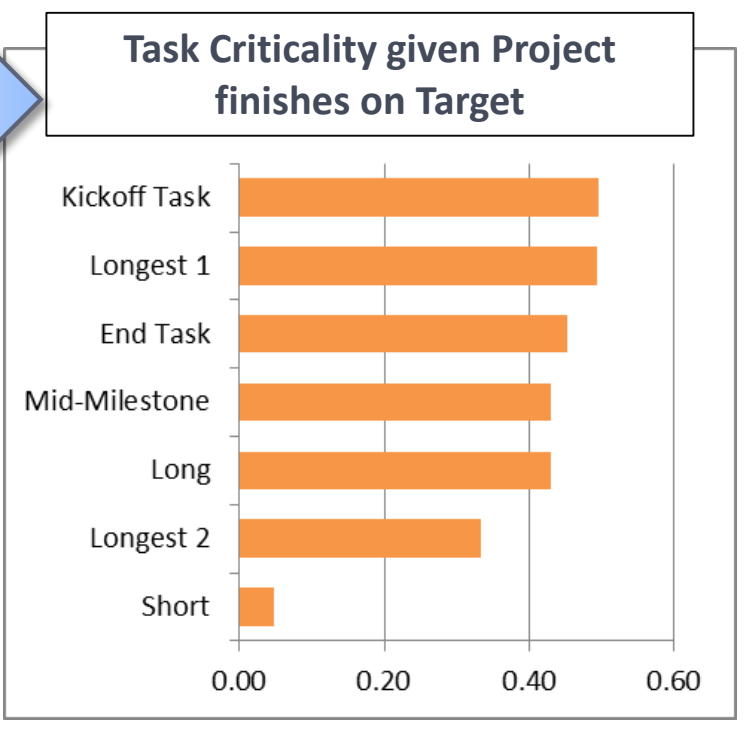


Examples of Local Analysis Driver Charts - Conditioning on the Project Results

Chart View

- Conditioning on the Project instead of on the task
  - What is the probability my entire schedule finishes before my Project target date, given my tasks all achieve their mean duration?
  - What is the criticality of all my tasks given my Project finishes on a given date?

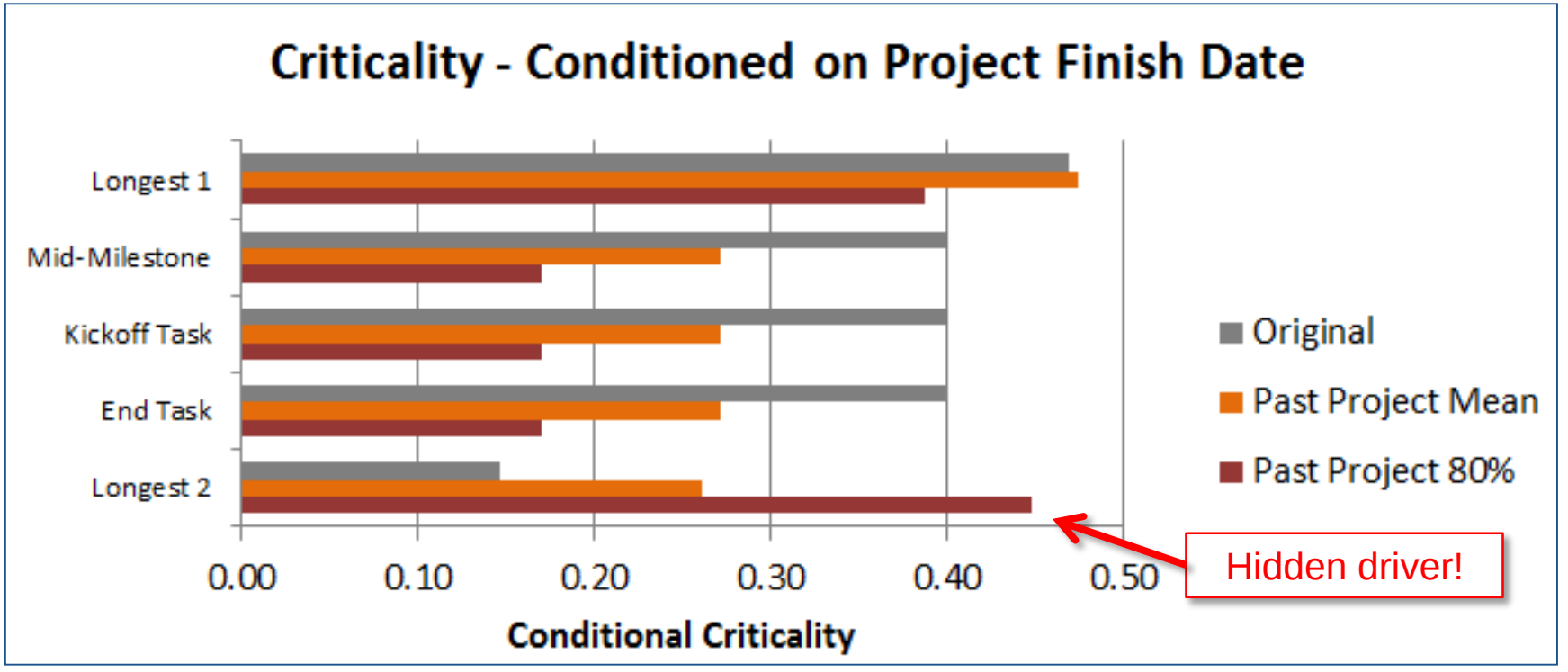




Examples of Local Analysis Driver Charts - Conditioning on the Project Results

Chart View

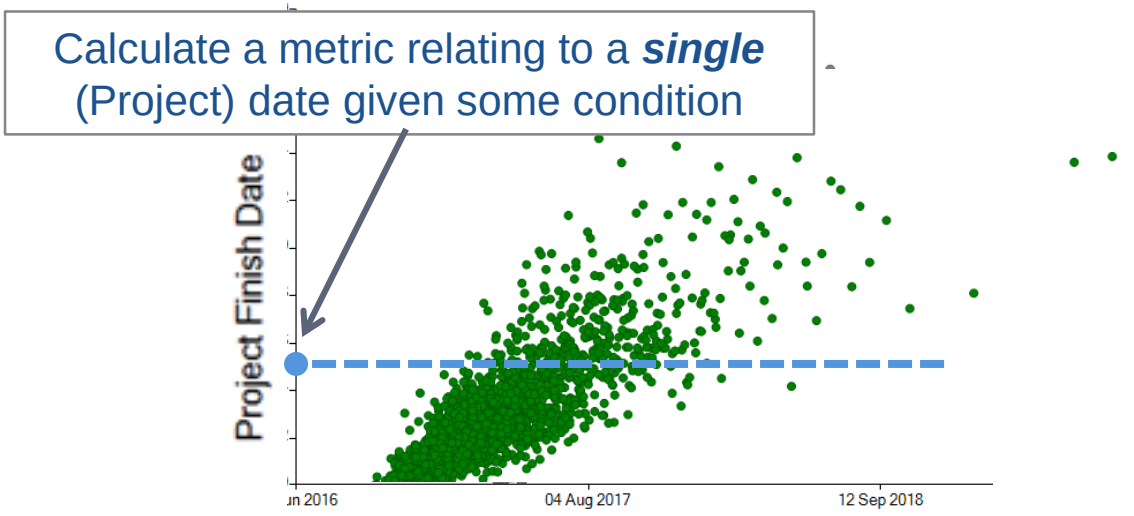
- What is the criticality of each task given Project finishes after given dates?
  - Interesting to notice in this example, the highest critical path driver drastically changes if the Project finishes after the 80% result



Target Analysis

Target Analysis - Introduction

- Measure the relationship a task has to a ***specific*** target date (e.g. Project finish date target)
  - As opposed to measuring the relationship a task has to all possible Project finish dates
- This provides insight into how elements in the model influence *a single date*

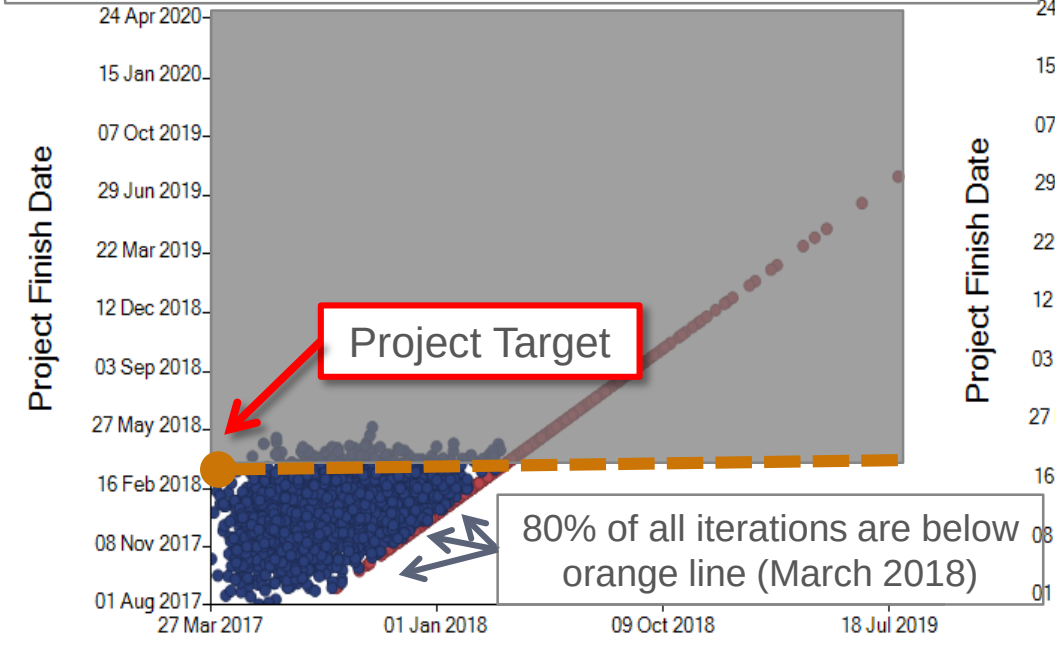


Examples of Target Analysis – Given a date, calculate its probability

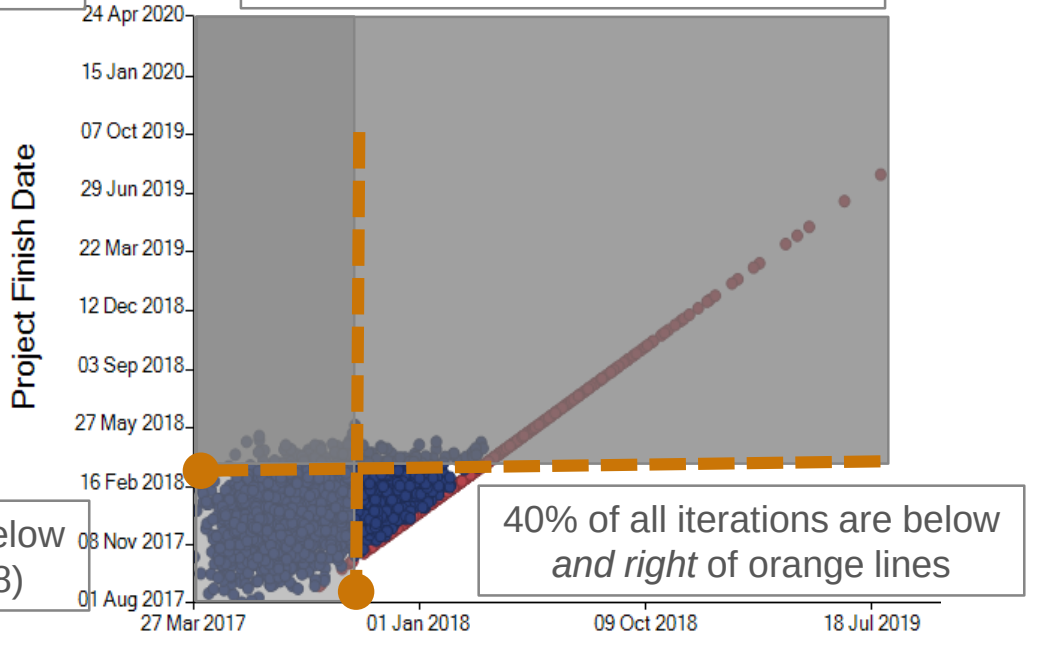
Data View

- What is the probability of hitting my Project target date if my task slips past date X?
  - Calculate the probability of the target date using only the iterations ***after*** a specified date

*Classic: March 2018 is the **80%** Project Finish Date target (when considering **all task iterations**)*



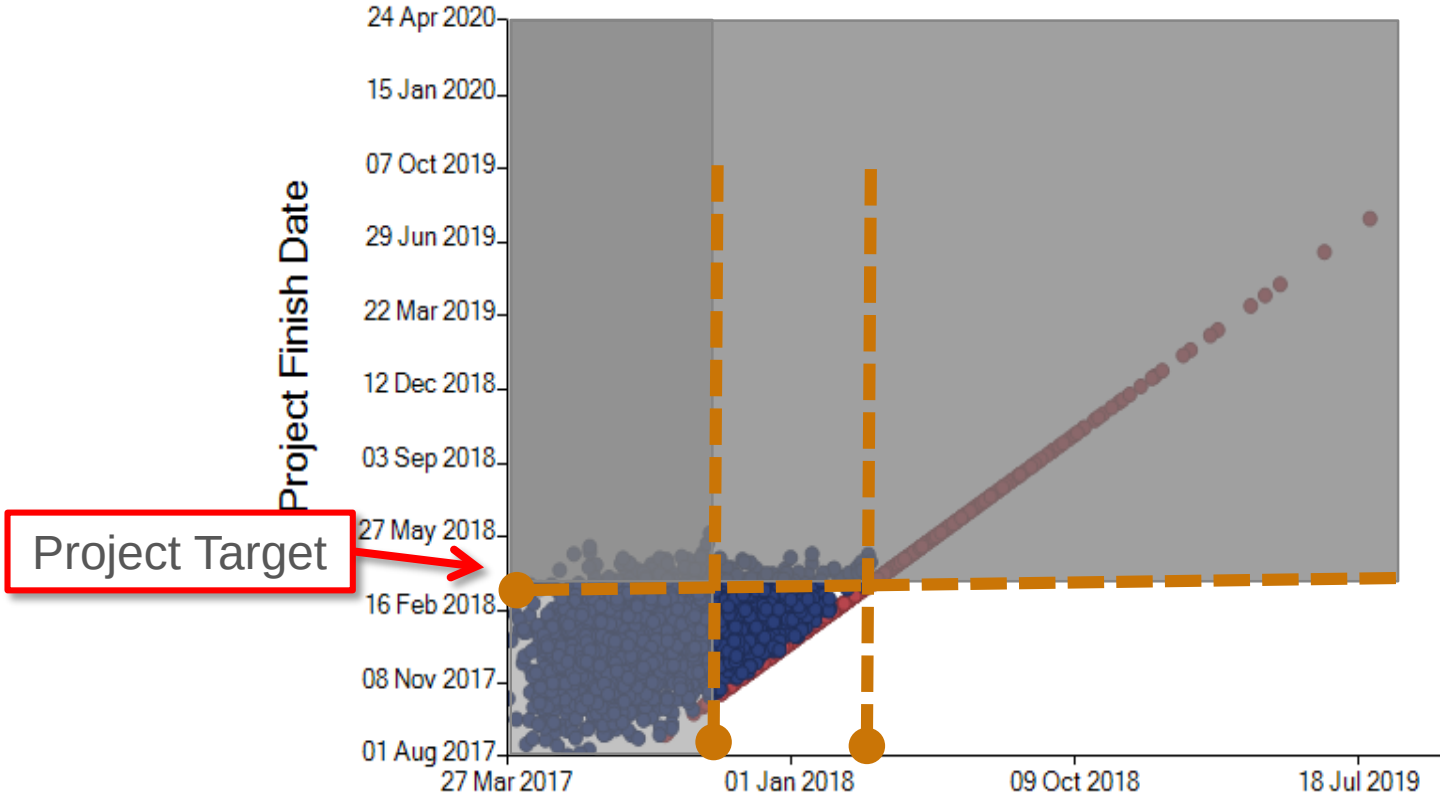
*Target: March 2018 falls to **40%** if task slips past Dec 2017*



Examples of Target Analysis – Given a Project date, calculate its probability

Data View

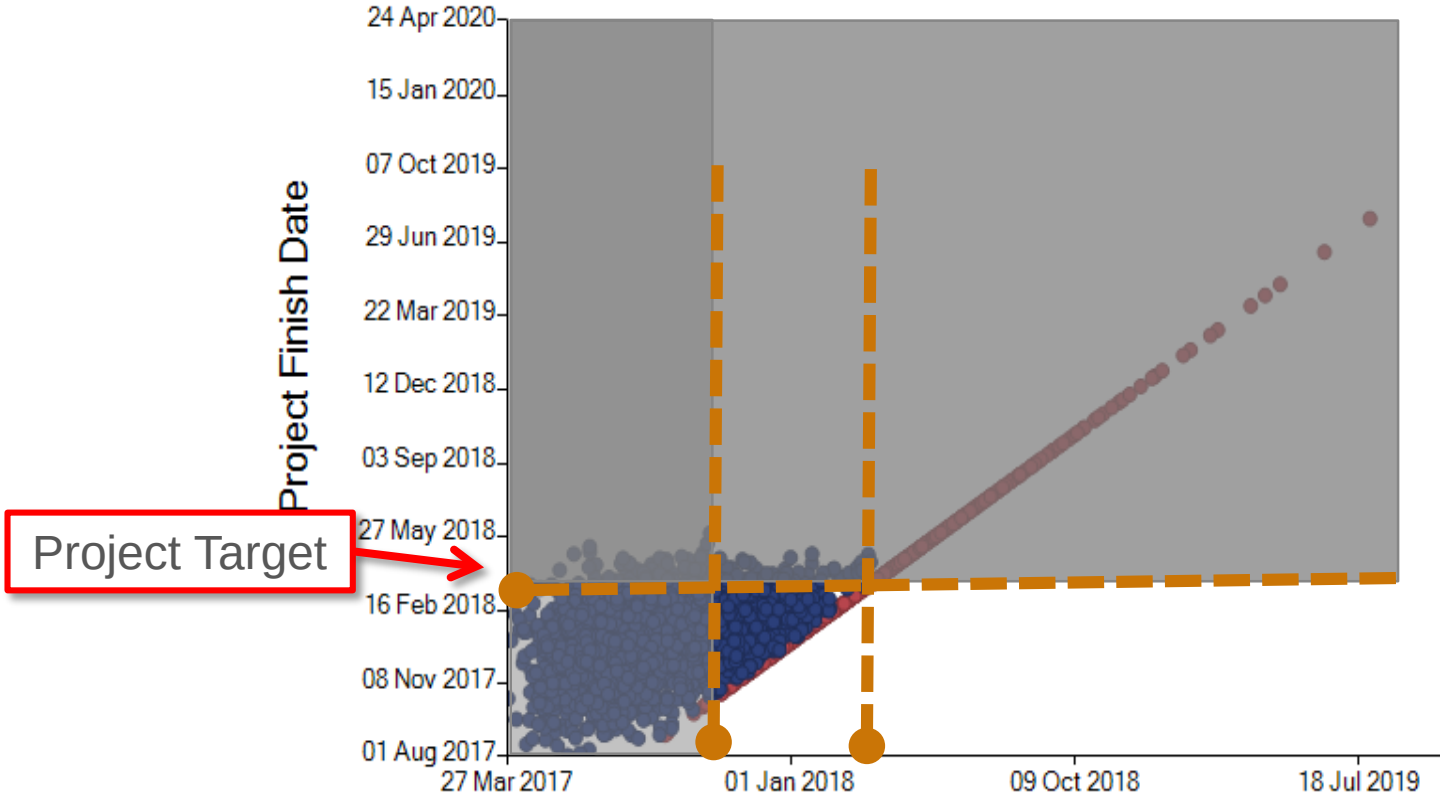
- What is the **probability** of hitting my Project target **date** if my task finishes between date X and Y?
  - Calculate the probability of the target date using only the iterations ***within a specified window.***



Examples of Target Analysis – Given a Project probability, calculate its date

Data View

- What is the target Project **date**, to achieve an **80%** probability of finishing the schedule, given my task finishes between date X and Y?
  - Calculate the date that lands at 80% of only the iterations ***within a specified window***

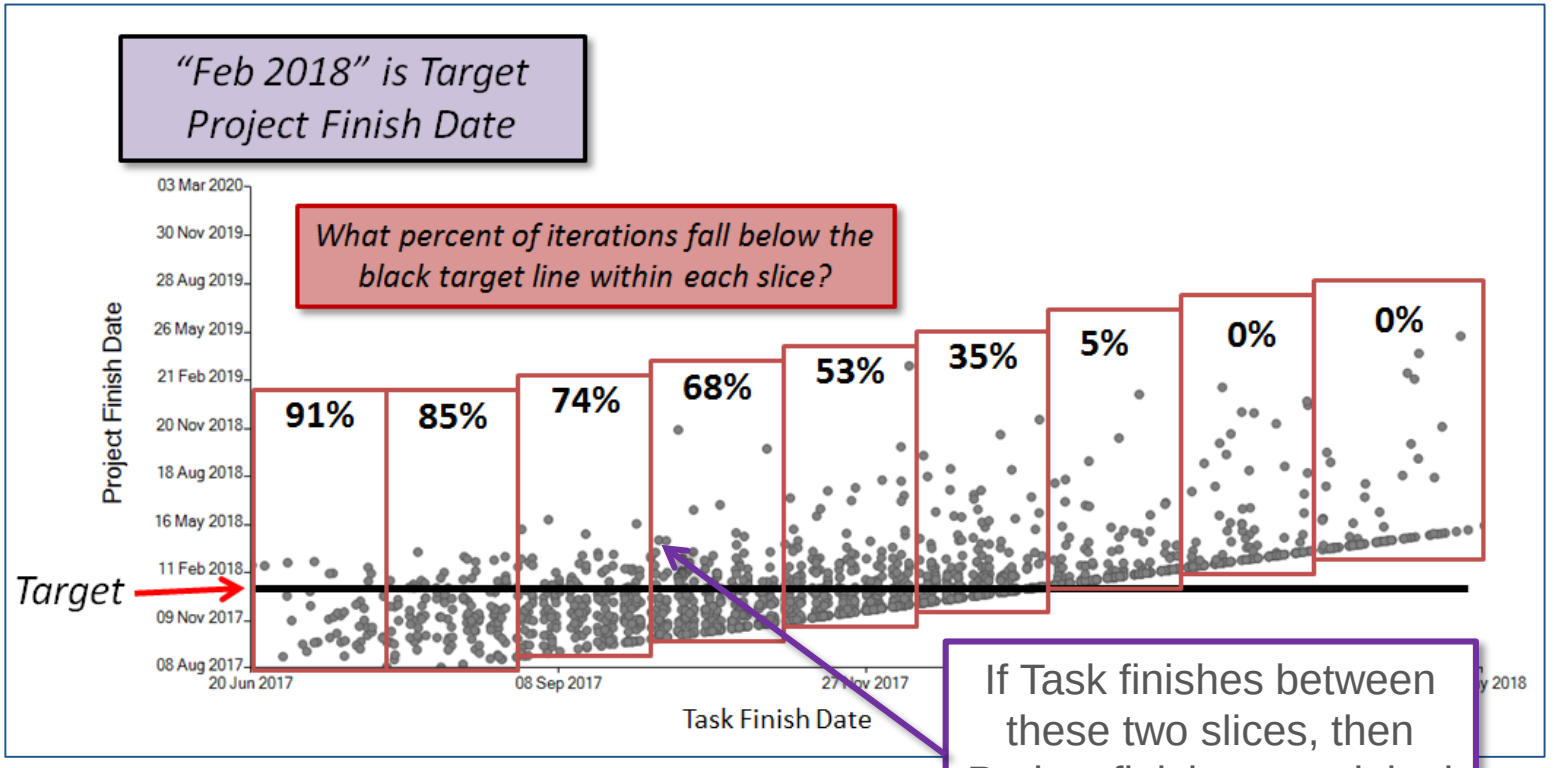


Examples of Target Analysis – Given a Project probability, calculate a Task Date

Data View

What if you don't know Date X and Y?

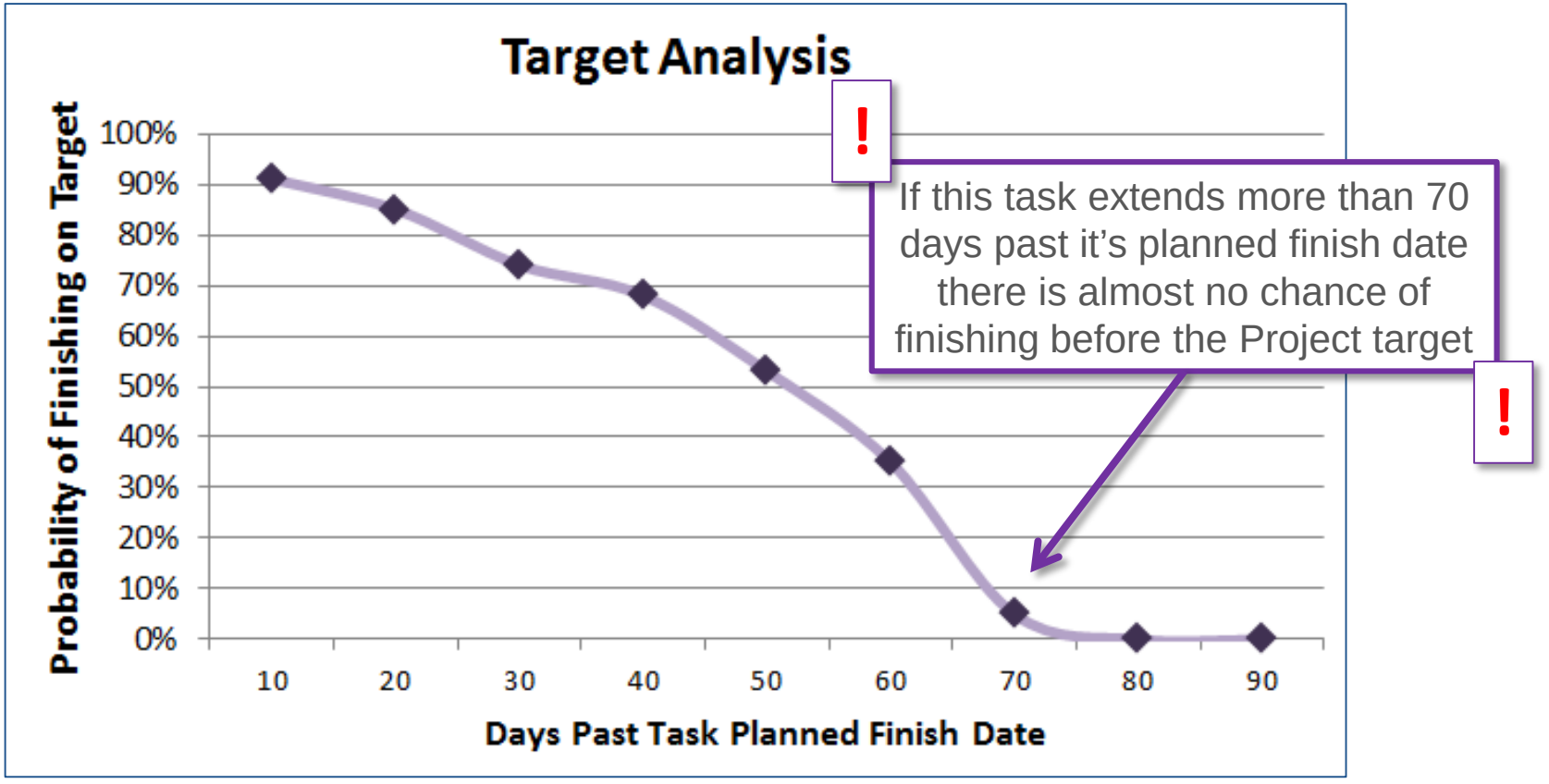
- What date does my task need to finish on in order to keep my target?
  - ***The RIFT date*** (Risk-Informed Finish Threshold)



Examples of Target Analysis – Given a Project probability, calculate a Task Date

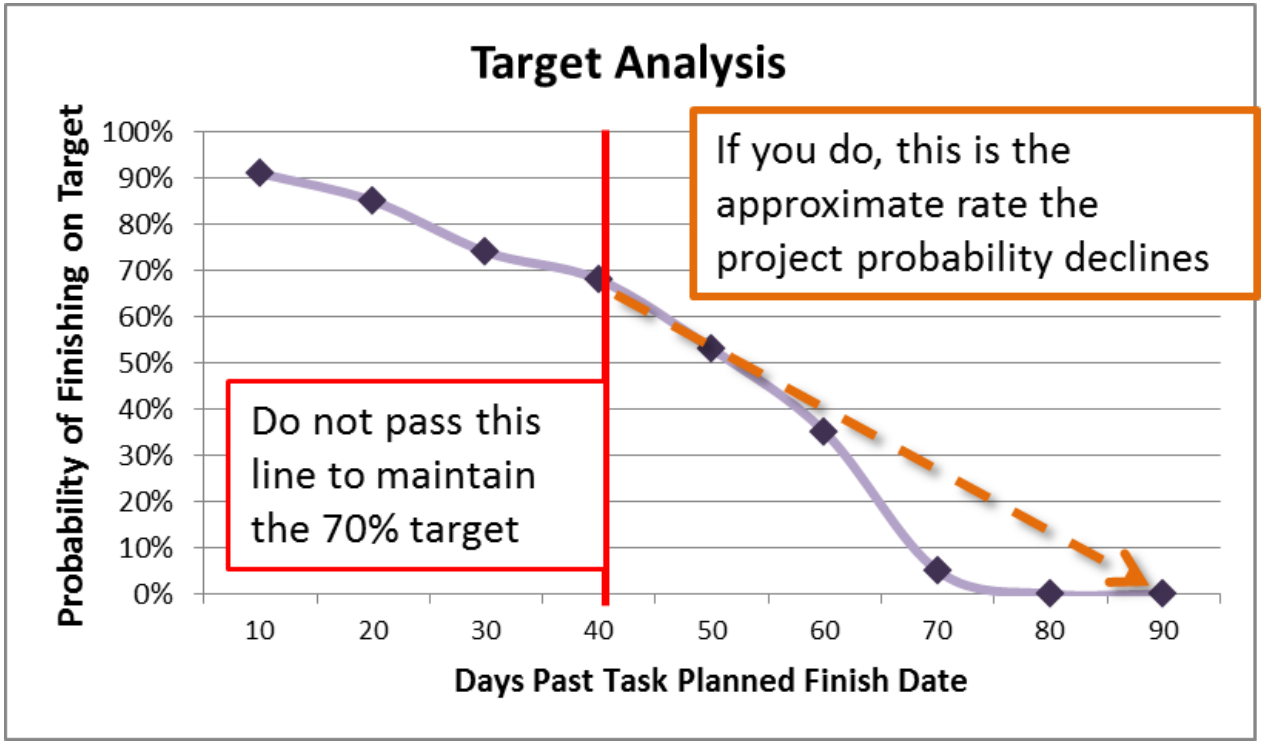
Chart View

- How does the probability of hitting my target change as my task slips?
  - Just as with previous line charts, variations to x-axis are simple



Examples of Target Analysis Charts - Drivers

- What tasks most degrade my chances of hitting my target
  - Rank tasks by: the probability of the target date given each task finishes after planned date
  - Rank tasks by: the probabilities of the target date given each task finishes after planned, mean, 70%, 90% finish date
  - Rank tasks by: the *rate* at which they degrade they target



Sample Tabular Reports

- A sample of various local metrics to improve the context of any standard schedule analysis report

Schedule Report

Project Finish Target at 70%, Budget at $850

	Criticality Metrics				Target Project Finish				Project Mean Cost given task finishes before:		
Task Name	Criticality	Criticality past Plan	Criticality past Mean	*Criticality given Project finishes at 70%*	Probability given task finishes before plan	Probability given task finishes before mean	Do not pass to maintain target %	Rate of decline	Plan	Mean	80%
Task a	60%	70%	75%	65%	90%	85%	1/1/2018	0.2% /mo	$15	$30	$50
Task b	60%	65%	80%	55%	85%	80%	2/1/2017	0.15% /mo	$10	$15	$30
Task c	35%	40%	40%	20%	85%	75%	3/1/2019	n/a	$10	$12	$25

	Cluster Metrics			
Task Name	Cluster?	Gap Center	Criticality before/after	Probability of Target before/after
Task a	no	n/a	n/a	n/a
Task b	no	n/a	n/a	n/a
Task c	yes	2/1/2017	20% / 50%	85% / 40%

If clusters exist in the data, locating where they split and using local analysis based upon this split is vital

Discussed in PowerPoint backup slides and Paper Appendix

The End

Please contact Nick DeTore
with any questions or comments
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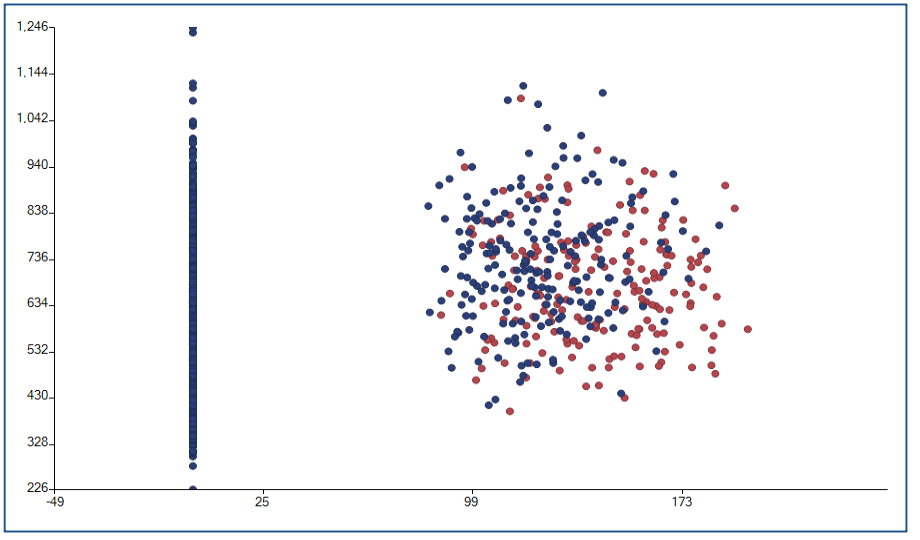
Appendix Topic: Cluster Analysis New Algorithm

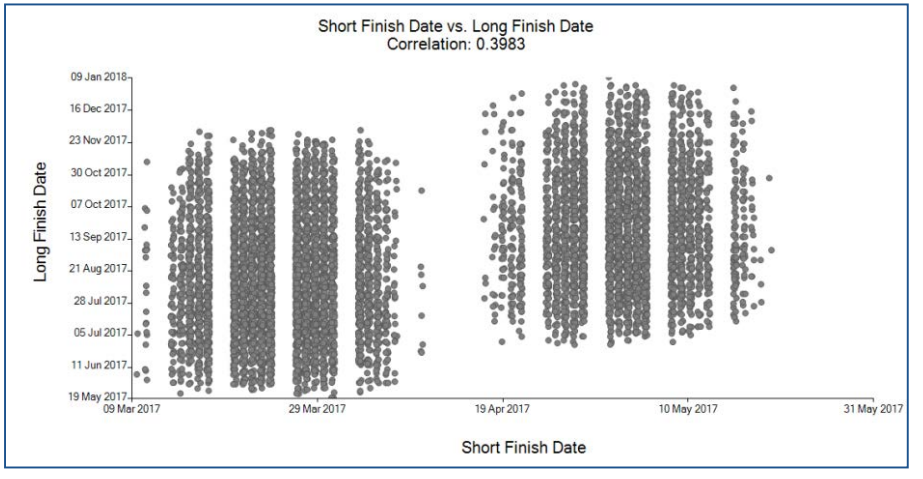
A Common Attribute of Misleading Results: Clusters

- Cluster analysis is an ongoing area of research focused on algorithms that quantify if and how a dataset is clustered (i.e. grouped together into distinct parts)
- A cluster has no strict definition and no simple method for determining if data is clustered and what those clusters are
- Presented here is a new method to flag a task that is likely split into two (or more) distinct clusters

What does a cluster look like?

- Often caused by risk events or constraints



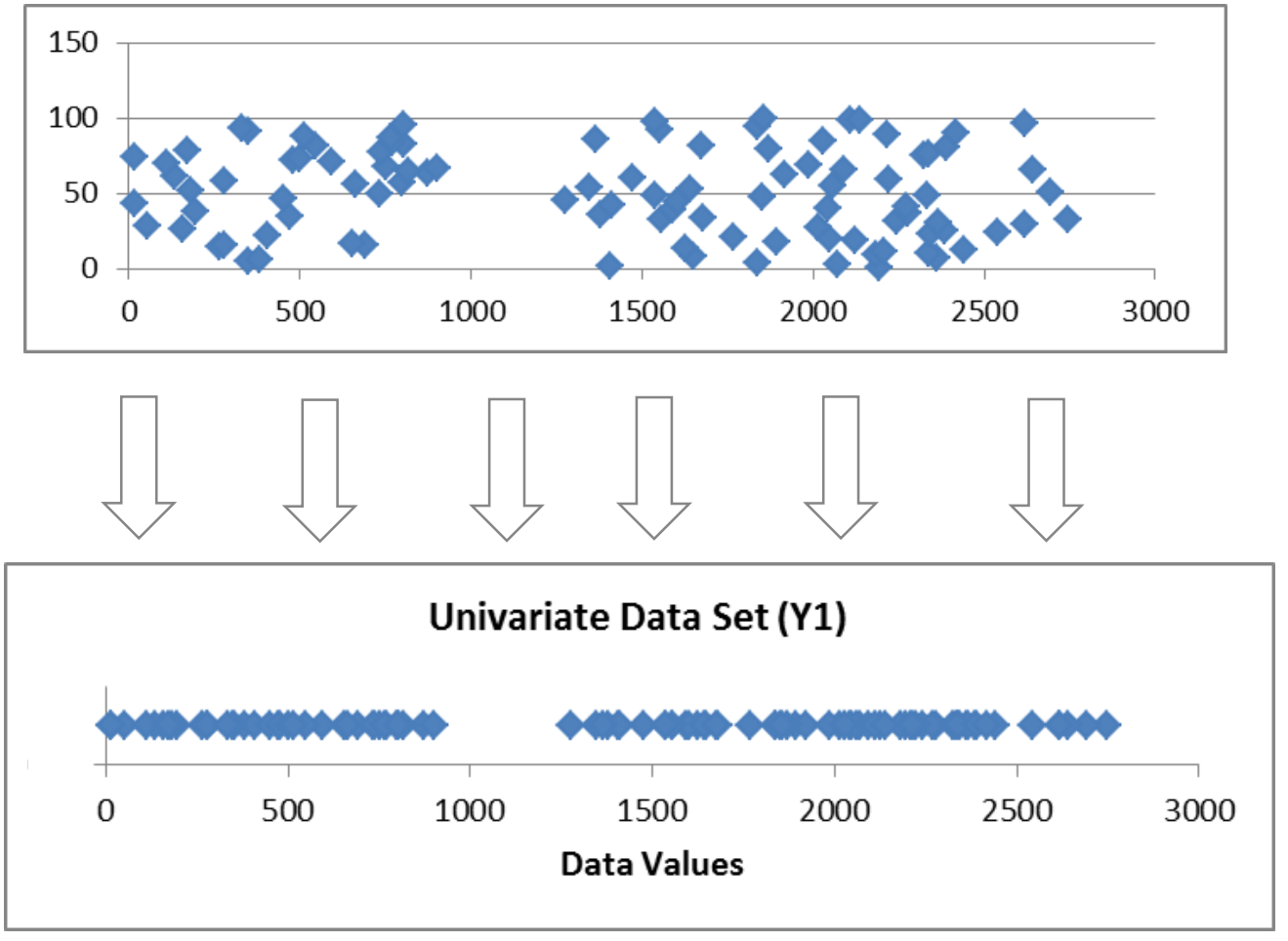


New Algorithm for Cluster Analysis

- Assumptions:
  1. Univariate (1-dimensional) analysis of simulation results
  2. Gap size that defines the space between two clusters is a certain factor of the average space between any two points
- Benefits:
  1. No input needed
  2. A single calculation, not an iterative algorithm
  3. Immediately flags results that need further review
  4. Locates the split, if it exists
  5. Can be modified to search for any number of clusters

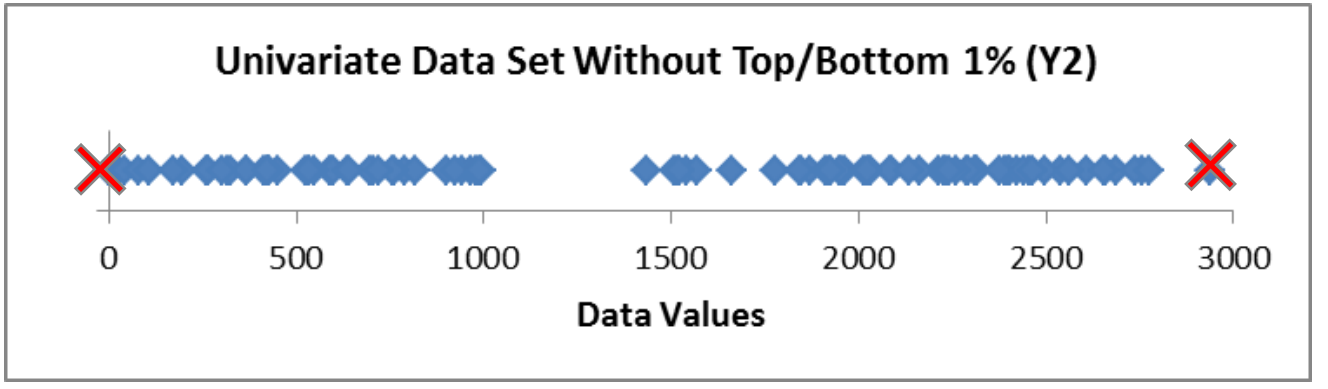
How this new method works

- Step 1: Reorder a single variable smallest to largest

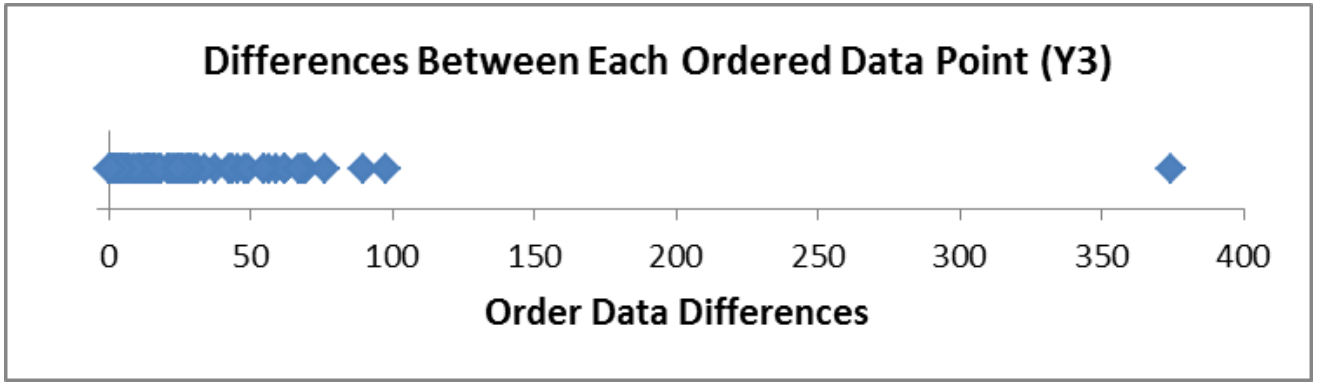


How this new method works

- Step 2: Remove extremes

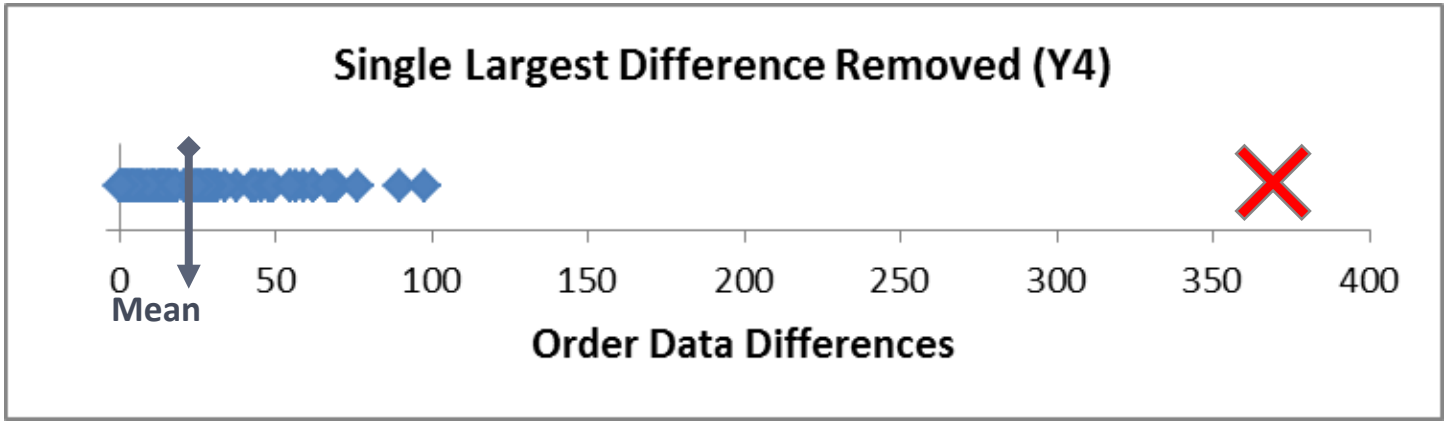


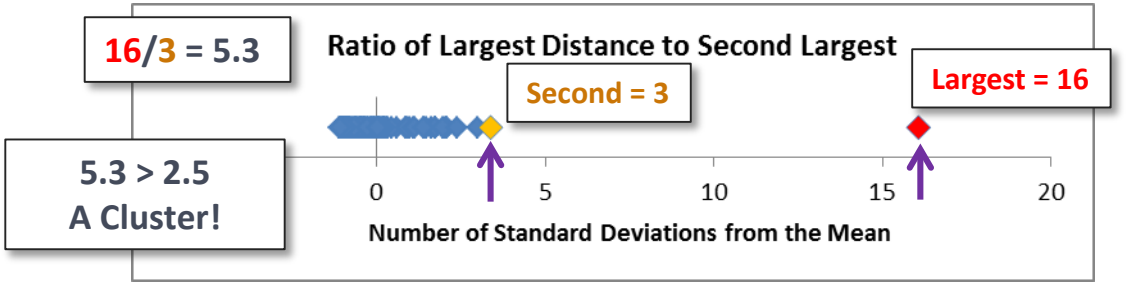
- Step 3: Calculate differences



How this new method works

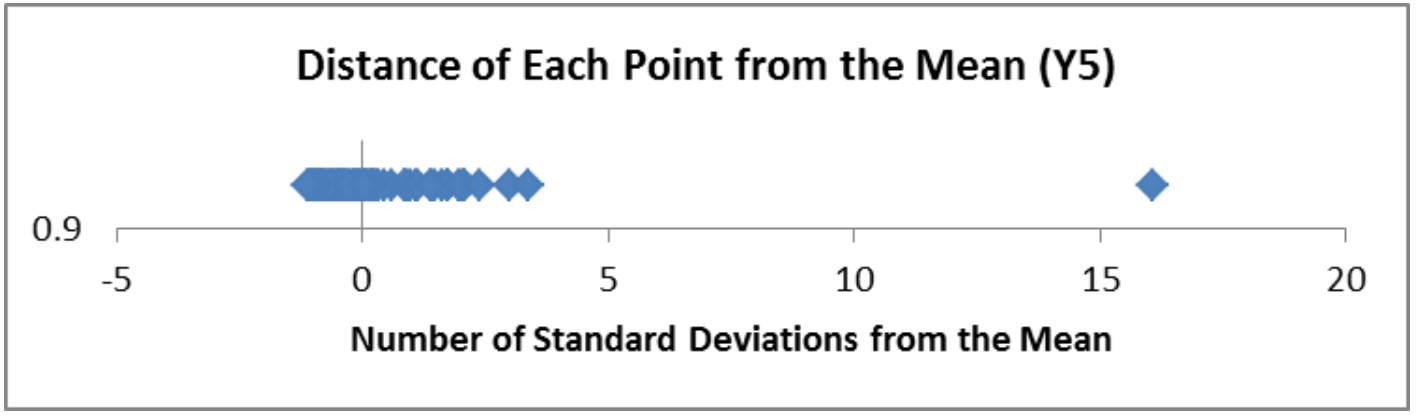
- Step 4: Remove largest





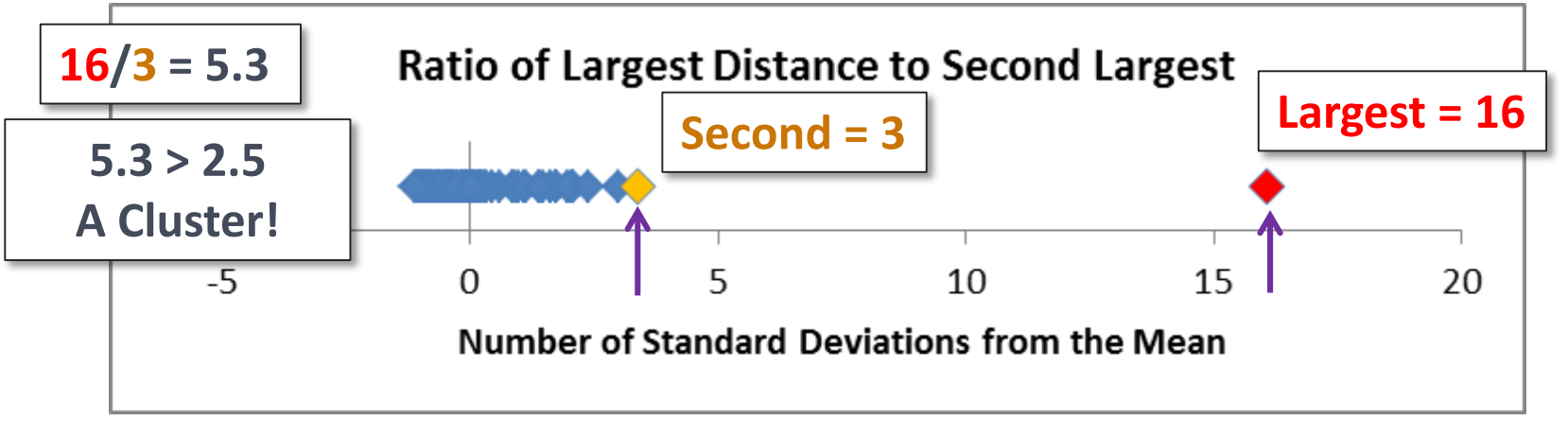
How this new method works

- Step 5: Calculate the number of standard deviations each point lies from the mean



How this new method works

- Step 6: Largest divided by second largest



- If this ratio is "big" then there is a single gap

Clusters and Local Analysis

- Use the split to define the criteria for local analysis