Data-Driven Schedule Assessment: An Integrated Approach for Space Systems Command Programs

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Introduction

About us

The SSC/FMC cost research team has developed many different schedule estimating methods and approaches over the years.

Attributes

Focus
Time to launch for space systems

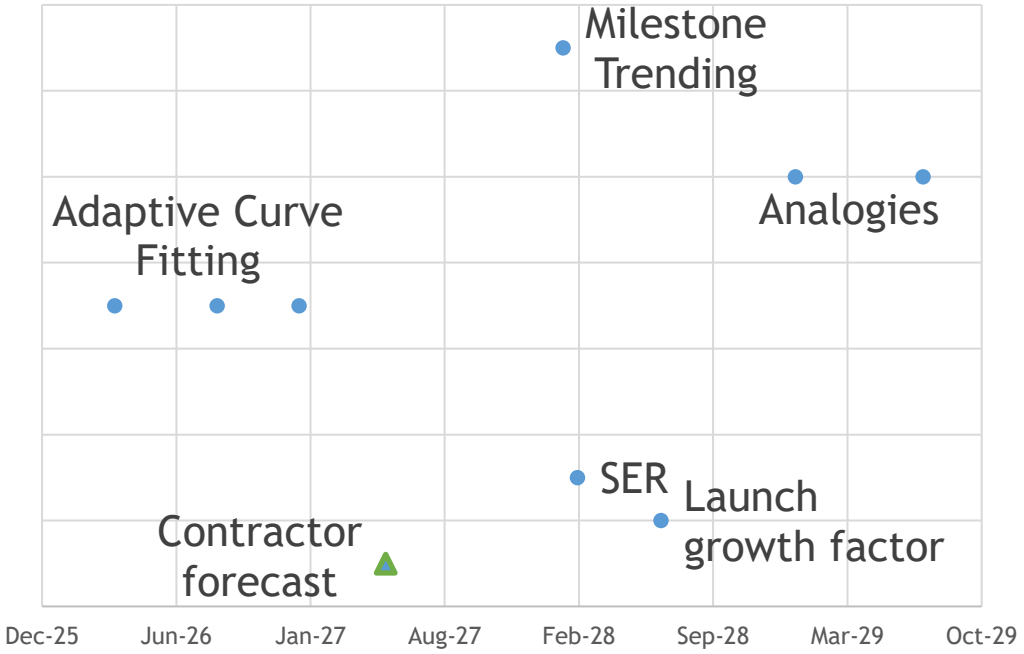
Simple
Fast to apply

Quantity
More than a few

For consideration

- Any single parametric method is not equivalent to a SRA / JCL; *they can be run in-between these longer / more in-depth analyses*
- Multiple different independent methods utilized together can be informative

Preview



Multiple Estimating Methods is Better than 1

- Parametric
- Algorithmic
- Schedule Slip
- Integration
- Enablers
- Summary

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Parametric Methods

Types of parametric methods	**Schedule Estimating Relationships using Technical Parameters as the Independent Variables**	**Schedule Estimating Relationships using Cost as the Independent Variables**	**Growth Factor (from baseline)**
Variable(s)	• Space Vehicle Weight • # of payloads • Design life • # mission types	• Bus (NR + T1) • IA&T (NR + T1) • SV (NR + T1)	# months from ATP to Launch (baseline)
Equation Form	Development: a * ((**SV_WGT** * **NUM_PL**) ^b) * (**DL** ^ c) * (**MT** ^ d) Production: a * **SV_WGT** ^ b * **MT** ^ c	a * (T1+NR)^b a + b * (T1+NR)	a*(months from ATP to launch)

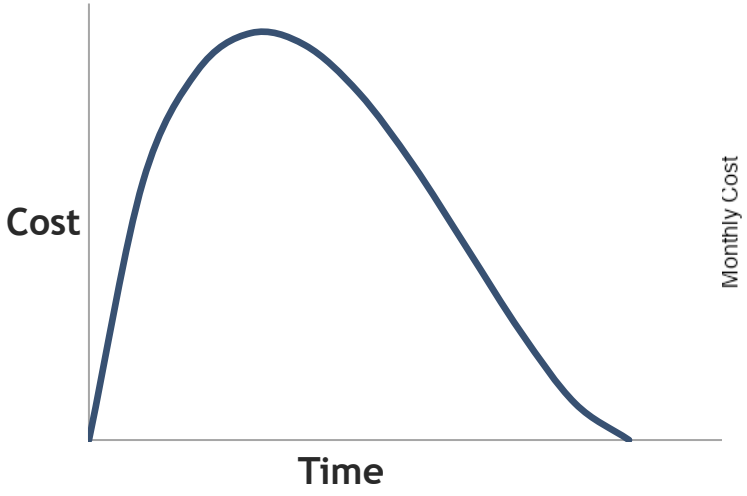
- Statistics well behaved across methods; should be repeatable for others.
- Model Development contracts separate from Production.
- Acquisition Agency modeling differences exist.

Additional Insights

- SERs can be tailored based on analogous programs
- Cost is as an independent variable
  - Con: estimate based on an estimate
  - Pro: explicitly address schedule growth as a function of cost growth
- Growth factor insensitive to mission type

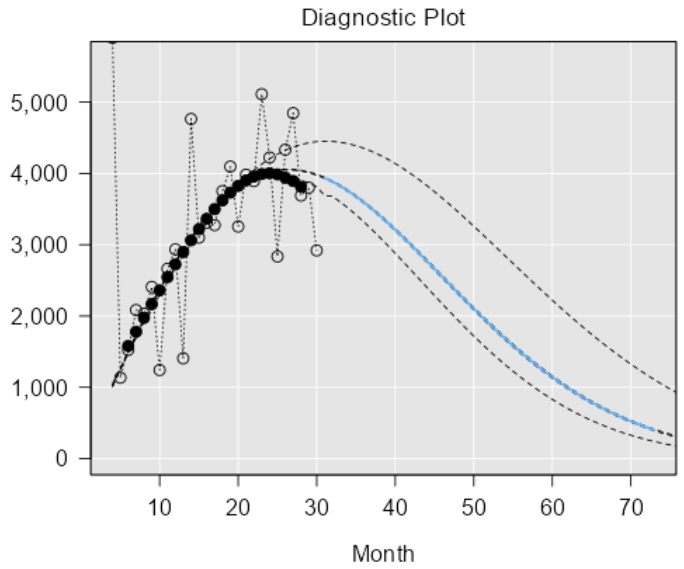
Adaptive Curve Fitting Forecasting Algorithm

The Concept

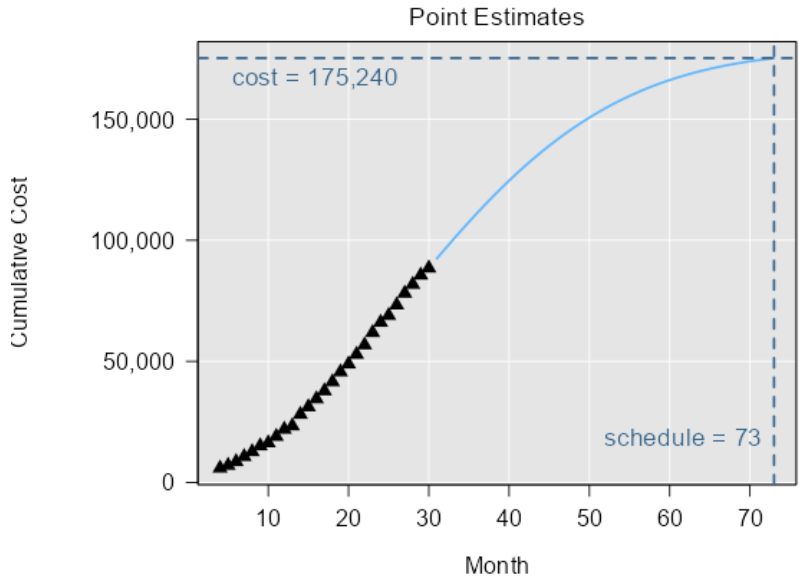


ACF can be applied to programs that follow a known distribution function

An Example: 30 months of ACWP -> 73 mo. duration



ACF fits curves to the smoothed trend of the monthly expenditures.

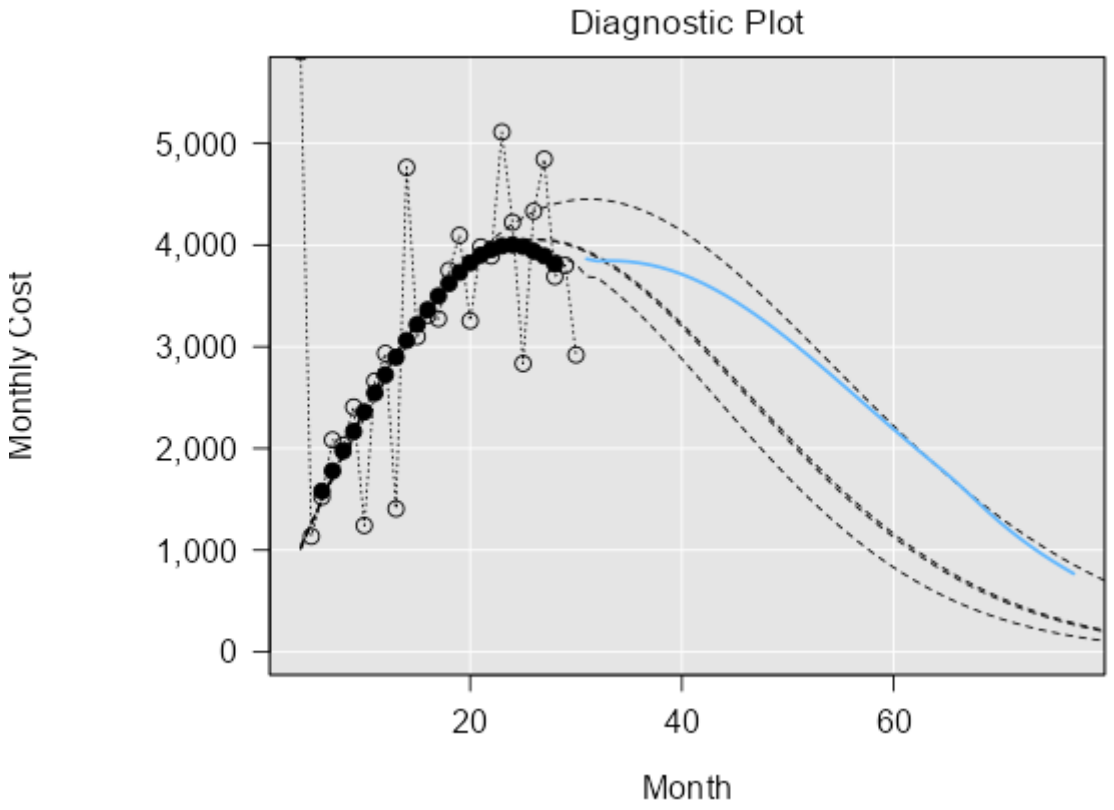


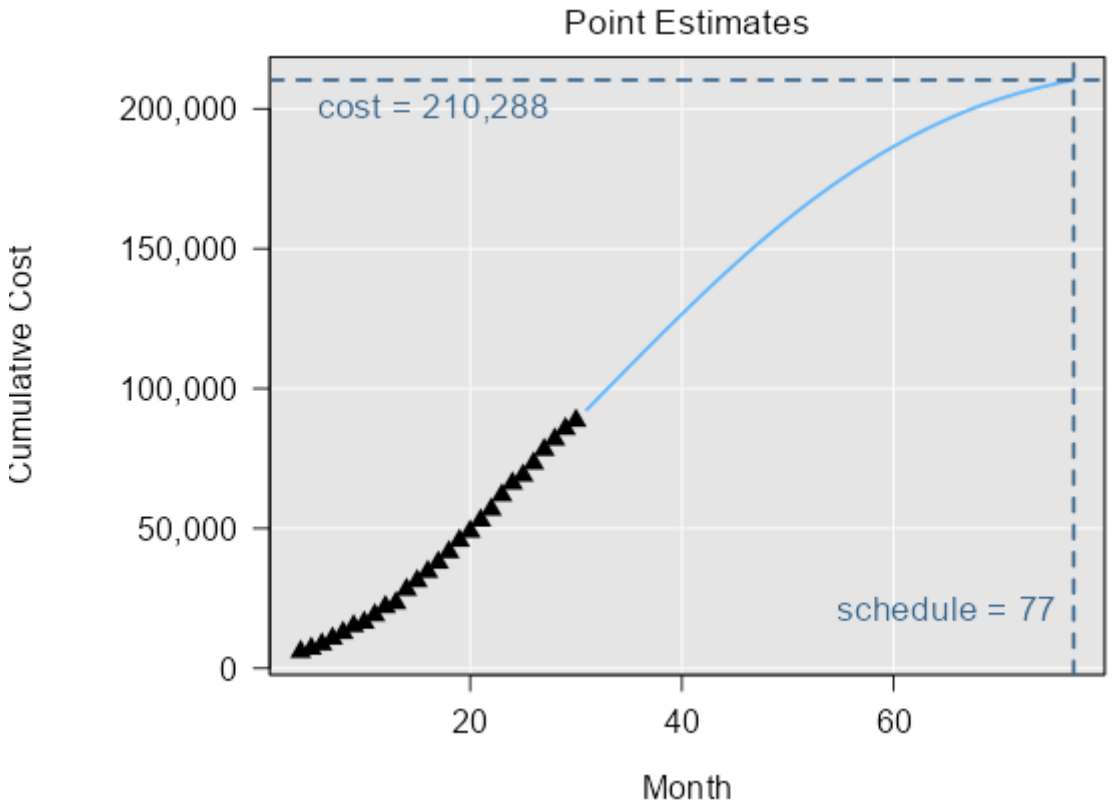
This data can be represented as a cumulative plot. Using historical data, one can compute the % spent at which 1st launch typically occurs to derive the duration.

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Adaptive Curve Fitting (cont.)

Another Example: IF (20% EAC growth) -> THEN (duration increases from 73 to 77 mo)



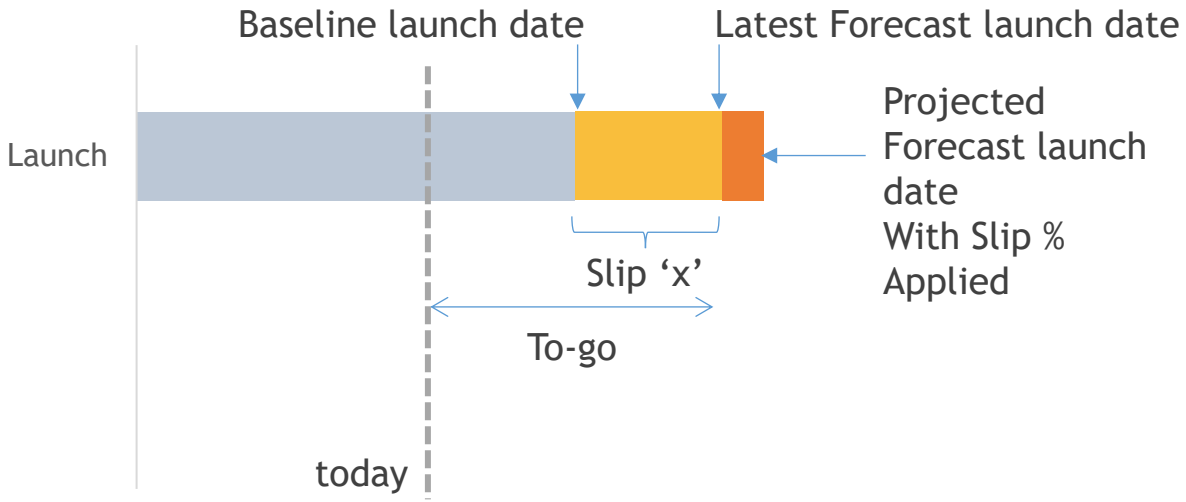


ACF enables what if scenarios. Fix 1 parameter (e.g. cost) to evaluate impact on the others (e.g. schedule).

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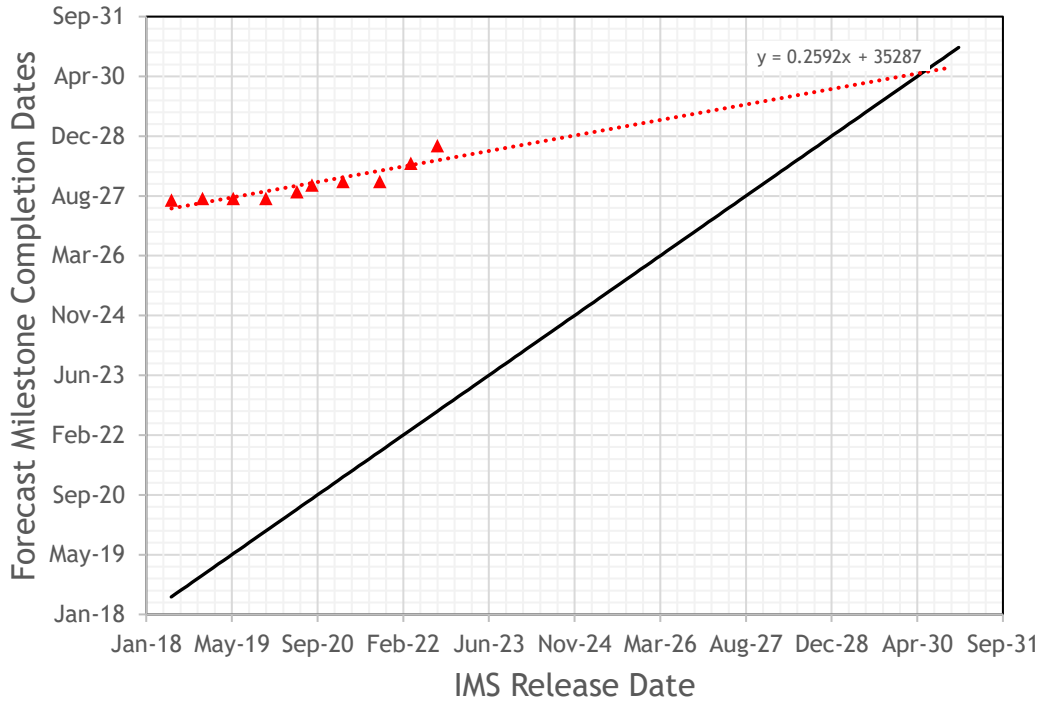
Schedule Slip Methods

Method 1: Slip Rate



1. Calculate the slip % to date,
2. Apply that slip increase to the to-go portion

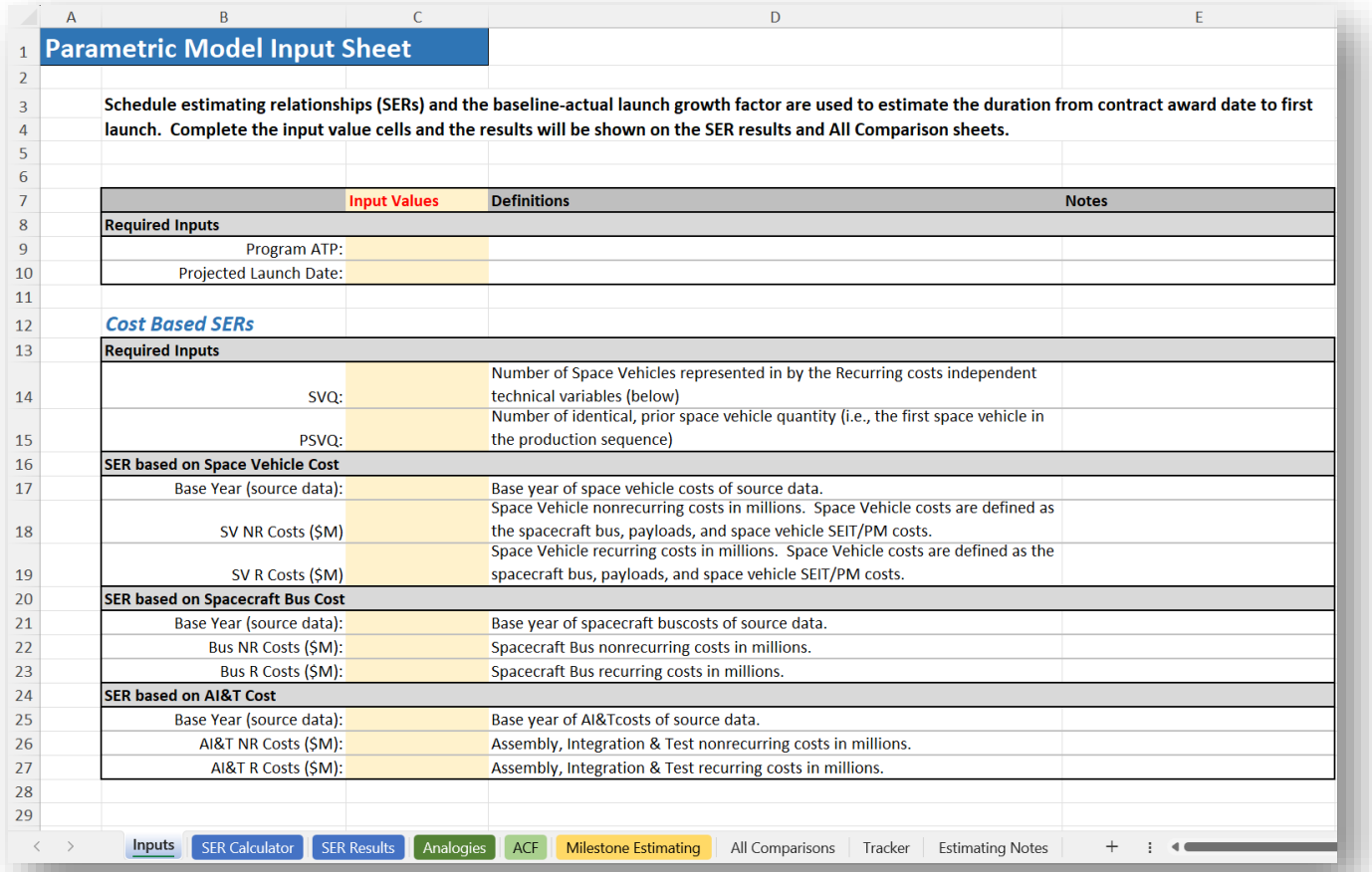
Method 2: Slip Regression



1. Track the ktr's forecast each month
2. Plot regression line through each forecast
3. The point in which the regression line has the same forecast as IMS release date is the forecast

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Integrating/Documenting the Results



Parametric Model Input Sheet

Schedule estimating relationships (SERs) and the baseline-actual launch growth factor are used to estimate the duration from contract award date to first launch. Complete the input value cells and the results will be shown on the SER results and All Comparison sheets.

	Input Values	Definitions	Notes
Required Inputs			
Program ATP:			
Projected Launch Date:			
Cost Based SERs			
Required Inputs			
SVQ:		Number of Space Vehicles represented in by the Recurring costs independent technical variables (below)	
PSVQ:		Number of identical, prior space vehicle quantity (i.e., the first space vehicle in the production sequence)	
SER based on Space Vehicle Cost			
Base Year (source data):		Base year of space vehicle costs of source data.	
SV NR Costs ($M)		Space Vehicle nonrecurring costs in millions. Space Vehicle costs are defined as the spacecraft bus, payloads, and space vehicle SEIT/PM costs.	
SV R Costs ($M)		Space Vehicle recurring costs in millions. Space Vehicle costs are defined as the spacecraft bus, payloads, and space vehicle SEIT/PM costs.	
SER based on Spacecraft Bus Cost			
Base Year (source data):		Base year of spacecraft buscosts of source data.	
Bus NR Costs ($M):		Spacecraft Bus nonrecurring costs in millions.	
Bus R Costs ($M):		Spacecraft Bus recurring costs in millions.	
SER based on AI&T Cost			
Base Year (source data):		Base year of AI&Tcosts of source data.	
AI&T NR Costs ($M):		Assembly, Integration & Test nonrecurring costs in millions.	
AI&T R Costs ($M):		Assembly, Integration & Test recurring costs in millions.	

Inputs | SER Calculator | SER Results | Analogies | ACF | Milestone Estimating | All Comparisons | Tracker | Estimating Notes

- A given assessment can easily have 5-10 independent schedule forecasts
- Developed workbook to calculate parametric methods, document other analysis, auto generate charts…

Next: Enablers

Enabler 1: Strategic Data Collection

About

- Data collection template captures schedule and related meta data
- Data collection stats
  - 734 programs
  - 11.8k meta data entries

Lessoned Learned: Data sourcing needs to be very rigorous

Specificity in data collection is required

Field name	Example
type description	Launch
Value	1/1/2023
Original_name	Launch Date
Date Type (B = Baseline / F = Forecast / A = Actual)	F
Date Accuracy (P = Precise / E = Estimated)	E
Source document	ABC IMS Schedule SV 1 Consolidated Jan 2022.pdf
Date of source	1/31/22
Notes	Day is estimated. Only month and year are known.

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Enabler 2: Search Don't Map

About

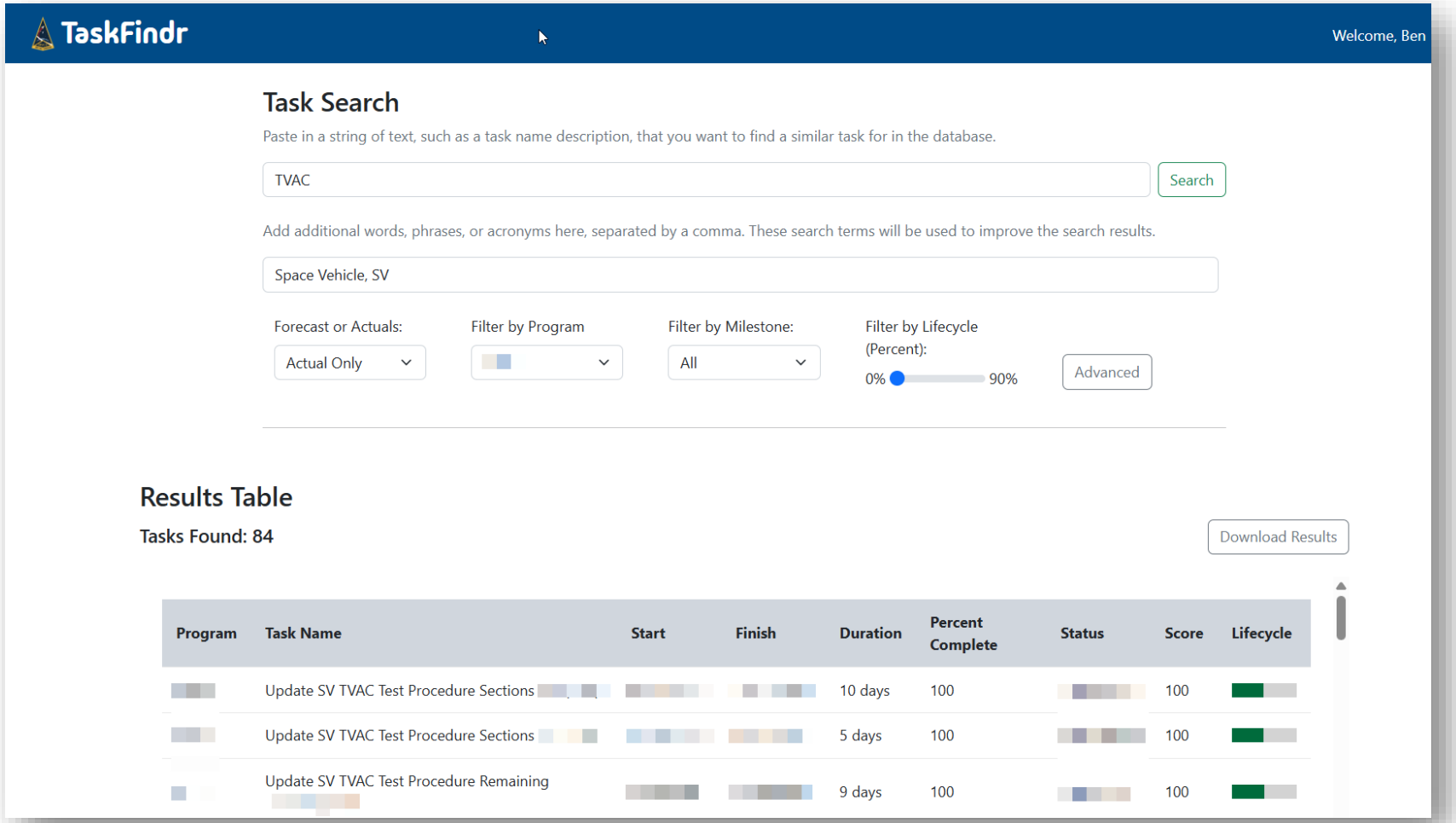
Taskfindr provides rank ordered schedule task name search results

Software Stack

- Python
- Django

NLP Techniques

- String similarity
- Word similarity
- N-Grams



Conclusions

Aggregation of schedule methods: a powerful program office tool

Regular schedule assessment

Facilitates regular discussion between cost and schedule teams

Serves as early warning for program managers

Approach works best when data is readily accessible

- After initial setup, maintenance should be simplified
- Alternate approaches to data acquisition (such as search) may be necessary to quickly gather inputs for the various methods

Acknowledgements & References

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Questions?
Comments?

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- Adaptive Curve Fitting (https://www.iceaaonline.com/ready/wp-content/uploads/2019/06/AM05-Adaptive-Curve-Fitting-Schiavoni.pdf, https://www.iceaaonline.com/ready/wp-content/uploads/2019/06/AM05-Paper-Adaptive-Curve-Fitting-Schiavoni.pdf)