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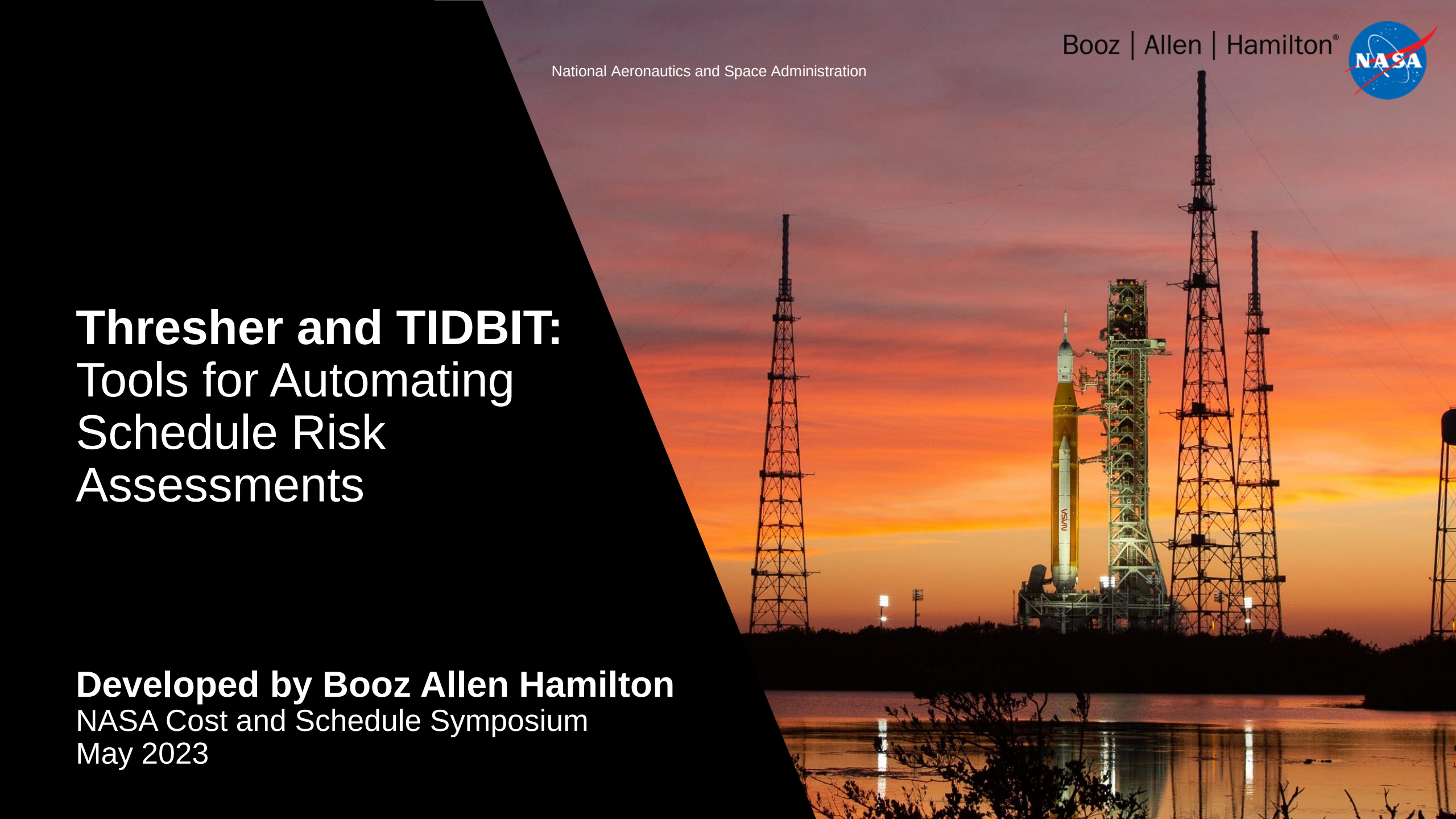

Thresher and TIDBIT: Tools for Automating Schedule Risk Assessments

Developed by Booz Allen Hamilton

NASA Cost and Schedule Symposium
May 2023

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Automation tools for Schedule Risk Assessments

Goals

This brief will cover uses for both Thresher and TIDBIT, automation tools used for NASA Artemis-related Schedule Risk Assessments.

Agenda

- Intro & Overview
- Thresher
- TIDBIT
- Questions & Discussion

Overview of Automation Tools

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Why develop Thresher and TIDBIT?

- We identified steps in our Schedule Risk Assessment process that could be automated to save time.

Benefits of Automation

- Using automation tools, scheduling practices are accomplished faster and with fewer user errors.
- Consistency will be applied over multiple SRA Iterations.

What are Thresher and TIDBIT built on?

- Python, JavaScript, Microsoft VBA, HTML

Challenges

- Finding compatibility with software on NASA Machines.

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Artemis Schedule Risk Assessment

Analysis Schedules at the tip of your fingers

- Using Thresher we created a skeleton analysis schedule to build an Artemis SRA out from. Thresher determined the critical and near critical path items to include in our analysis schedule.
  - -Thresher saves large amounts of time to develop an analysis schedule:
    - -**Manual method: ~2 hours**
    - -**Thresher: ~5 minutes**
- With TIDBIT (Triangular Distribution Back In Tool) our given best case, most likely, and worst-case dates could be turned into duration uncertainties.
  - -**This was mostly done by hand with an excel formula. Total Time: 1 Week**
  - -**Done by the automation script, Total Time: 2 Days**

*Result times calculated per schedule package received from each program

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SRAs with Automation Advantages

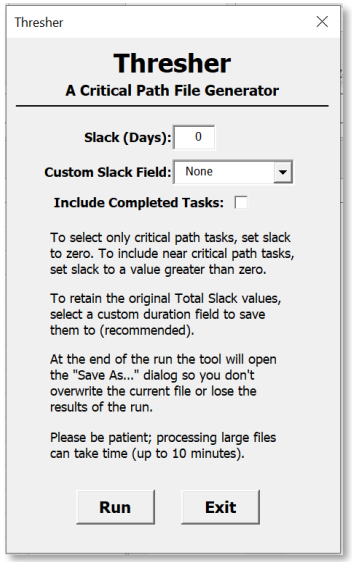
- Time

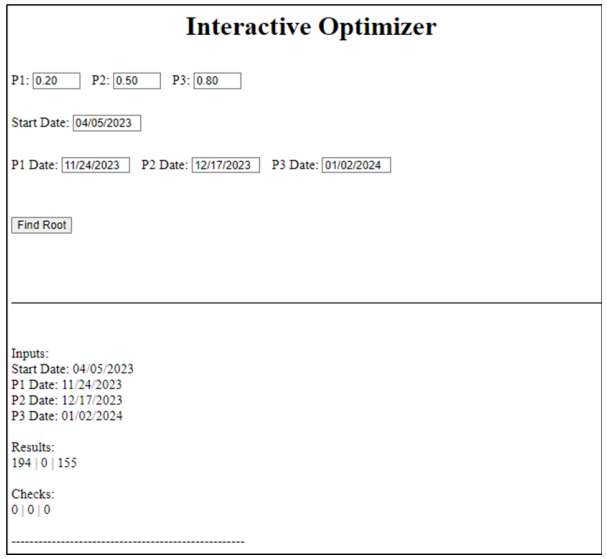
The advantage of building Schedule Risk Assessments with Automation scripts is the time it will save. This could allow for faster iterations with more relevant data.

SRAs without Automation tools, the SRA process takes longer making the data used as a baseline to be out of date by the time the results are parsed and presented.

- Accuracy

Automation tools have the capacity to replicate calculations every time they are run. This cuts down on user error.





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Thresher: A tool for simplifying a schedule to only critical or near-critical tasks

The Challenge

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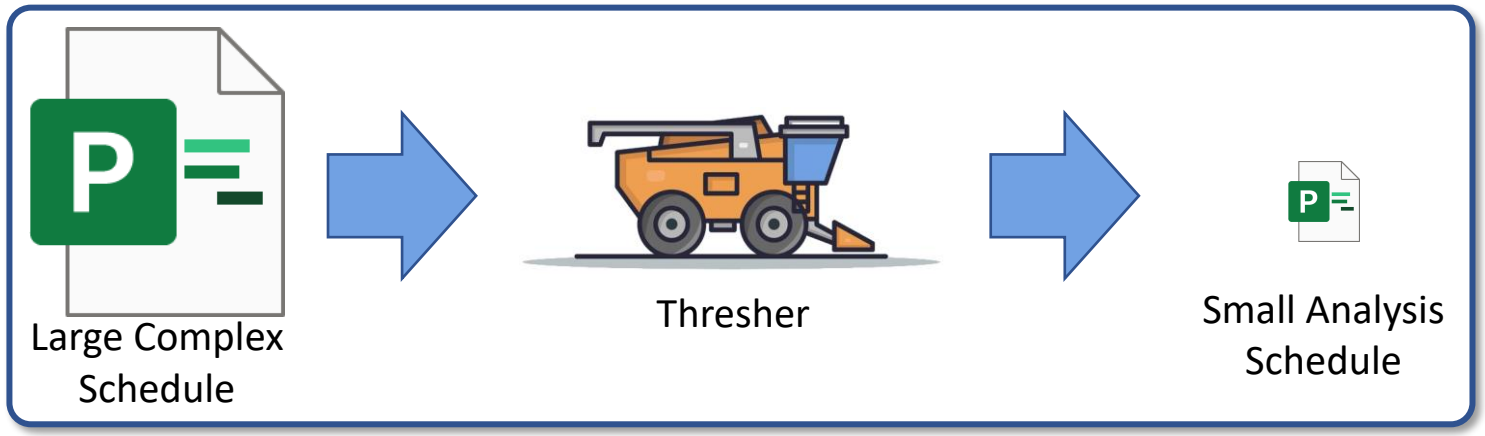
- Large project schedules are often complex, convoluted, have multiple paths and, contain many exceptions or non-standard items.
- Finding and analyzing the critical or near critical path in these large schedules is a challenge; it can be a very unwieldy and time-consuming effort.
- Just as the name suggests, Thresher separates the wheat (critical and/or near critical tasks) from the chaff (the rest of the project schedule) making a smaller schedule file which is much quicker and simpler to analyze.
- Thresher can turn a complex, unwieldy 8-10,000 line schedule into a focused 2-300 line critical path schedule for analysis. This reduction results in dramatic time savings and increases confidence in the results.



Thresher: A Tour

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- Thresher uses VBA to create a small analysis file from a larger project schedule.
- There are three options/fields in Thresher which affect the output:

1) **Slack (Days)**

Changing the Slack value can narrow or widen tasks selected to include critical or near-critical tasks.

Example 1: Changing Slack to 3 would include all tasks with Total Slack of 3 days or less (including negative slack)

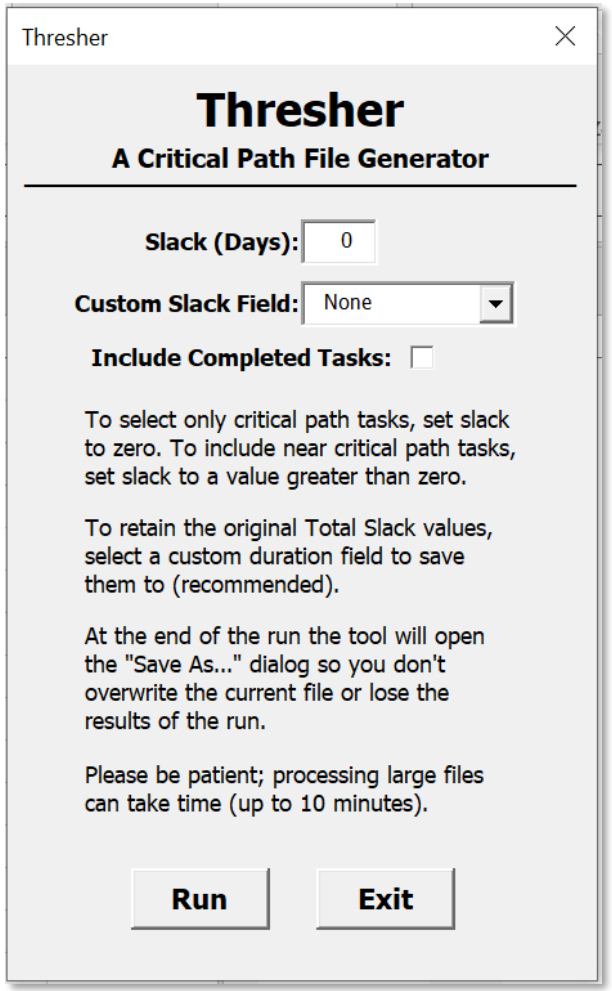
Example 2: Changing Slack to -5 would only include tasks with a Total Slack of -5 days or less (a subset of critical path tasks)

2) Custom Slack Field

The values for Total Slack calculated by MS Project change as tasks are removed from the schedule. To preserve original (and correct) values for the analysis schedule, select a custom Duration field. Thresher will copy the original Total Slack values over to this field and rename it as “Original Total Slack.“

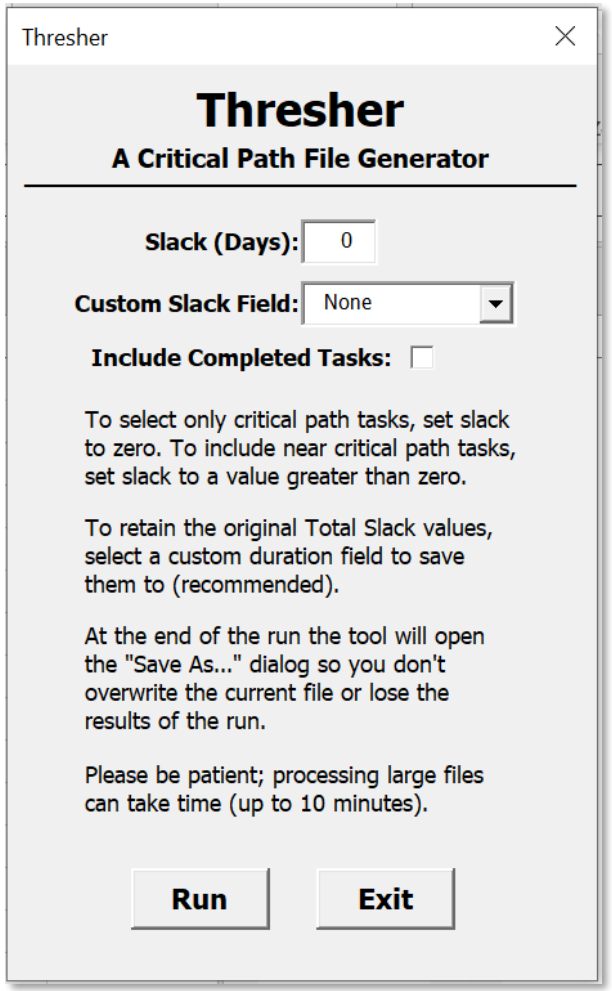
3) Include Completed Tasks

As the name of this checkbox indicates, this allows for the inclusion/exclusion of completed tasks in the analysis file. A completed task in MS Project has a Total Slack of 0d. Early in the life of a project this will not have a big effect as most tasks will not yet be started but as the project matures this can have a significant effect on the analysis file size.



The Soul of The (Threshing) Machine

- Thresher reads the Total Slack of each task in a schedule and, if equal to or less than the inputted value, adds the task UID to an array. Thresher also checks for completed tasks and only includes them if the checkbox is checked.
- After creation of the array of critical or near-critical tasks, Thresher looks for relevant summary tasks and adds their UIDs to the array.
- Once the array (tasks + summary tasks) is complete, Thresher deletes all tasks in the schedule that are not included in the array followed by a prompt to “Save As” to not lose the original file.
- After deletion and saving with a new name, the analysis file is ready for use.



Future Improvements?

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- Thresher follows the Unix philosophy of *"building simple, compact, clear, modular, and extensible code that can be easily maintained and repurposed by developers other than its creators. The Unix philosophy favors composability as opposed to monolithic design."* [1]
- Thresher is a modular, lightweight tool that does one task well and does not try to do anything more than create a schedule file of critical/near-critical tasks for analysis.
- **But…** all tools can be improved and we have big plans for Thresher including:
    - Adding more user options such as date range and WBS selectors to develop more focused and smaller analysis files.
    - Refactoring the code base to improve its modularity and speed.
    - Development of a user guide to detail how to use Thresher and provide examples.
    - Improvements to the user interface and experience.

1 "Unix Philosophy." Wikipedia, 28 Jan. 2023, en.wikipedia.org/wiki/Unix_philosophy.

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TIDBIT: Triangular Inverse Distribution Back In Tool

The Challenge

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- Uncertainty and risk distributions provided by organizations are delivered in one of two formats:
  - A duration uncertainty
  - An array of best case, most likely, and worst-case dates
- Encountering the second format is almost guaranteed.
- Effectively modeling with this format can take weeks compared to receiving a duration uncertainty.
- The goal of TIDBIT is to reduce time spent calculating a duration uncertainty when given the array format.

Current Techniques

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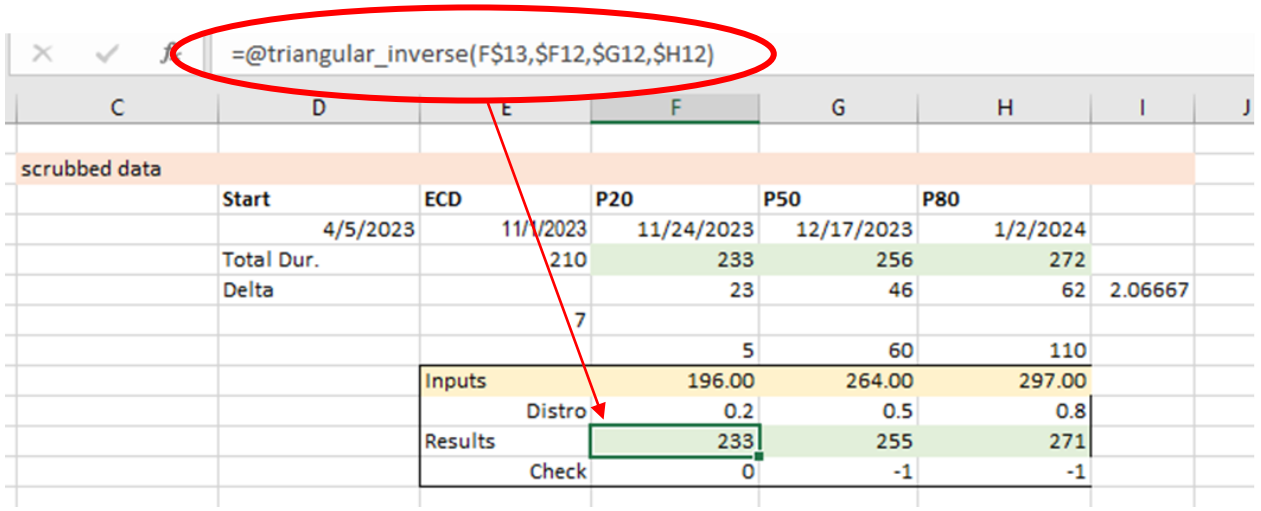
- The current tactic is to back into the duration uncertainty using a triangular distribution formula.
- Once the array of cases are entered by the user, the formula guides checks and inputs through a trial-and-error process.
- Checks are desired to resolve to 0 or with in a ±5-day range to ensure an accurate distribution has been calculated.
- This process can take weeks depending on the number of iterations required for the model.

scrubbed data

	Start	ECD	P20	P50	P80	
	4/5/2023	11/1/2023	11/24/2023	12/17/2023	1/2/2024	
	Total Dur.	210	233	256	272	
	Delta		23	46	62	2.066667
		7				
			5	60	110	
		Inputs	196.00	264.00	297.00	
		Distro	0.2	0.5	0.8	
		Results	233	255	271	
		Check	0	-1	-1	



TIDBIT in Action

- TIDBIT runs both the triangular distribution formula and error checks significantly faster than previous methods.
- Reducing time required to develop an uncertainty distribution to a single day.
- The tool can be used in two formats:
  - A Jupyter Notebook
  - A stand-alone executable file
- The second format was created so that TIDBIT can be run without requiring the user to configure a local environment or install software dependencies.

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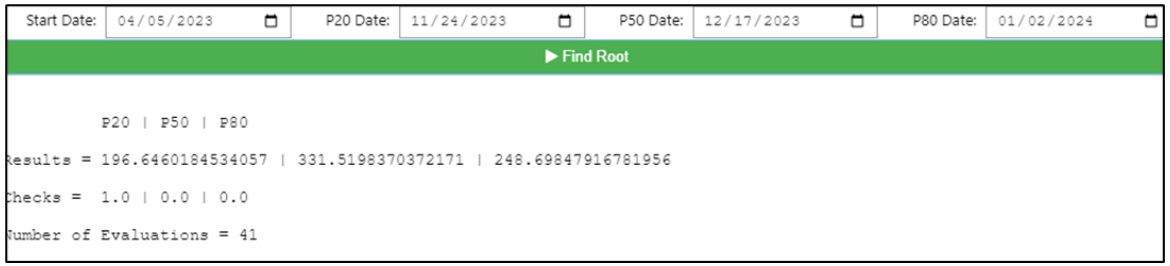
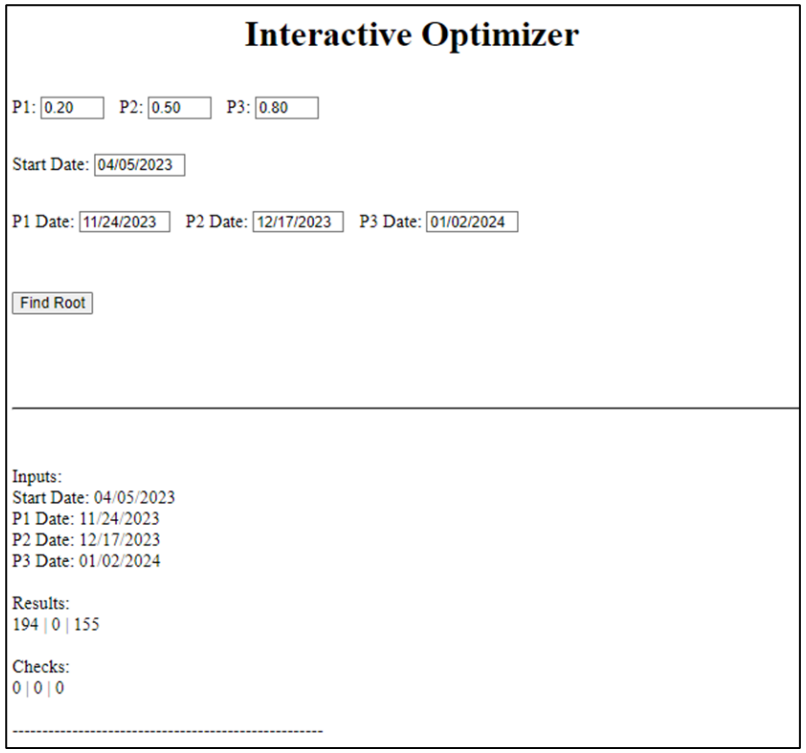


Both boxes are TIDBIT.
Top: Python interface
Bottom: HTML Interface



Future Improvements?

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- Additions to TIDBIT could include a downloadable excel file of the run back in distributions for reference and iteration history

- Backend: implementing a root solver in JavaScript
  - Currently, HTML/JavaScript uses a password solver algorithm (slow runtime)
  - An ordinary differential equation (ODE) root solver, as is used by the Python solution, is much faster
  - Would need to implement linear algebra functions in JavaScript in addition to the ODE solver (longer development time)
  - Option for different distribution calculations such as logarithmic function for wider range of use

- User experience: implementing a more seamless input experience
  - Currently, user must type or copy/paste entries into separate input boxes
  - This results in many clicks back and forth between Excel and TIDBIT
  - Copying multiple Excel cells and pasting into 1 TIDBIT input box would improve user experience
  - Additionally, a spinning wheel could indicate the program is loading, so there's no confusion as to whether it's running after clicking "Find Root"

Thrasher and TIDBIT- Automating SRAs

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- Developed for the Artemis Enterprise Schedule Risk Analysis
- Used on recent Artemis SRA modeling
- Being perfected for future iterations of an Artemis SRA

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Questions & Discussion

Authors

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Kimberly M. Smith (kimberly.m.smith@nasa.gov; Smith_Kimberly2@bah.com), with 2 degrees in English and working as an adjunct professor, tripped and fell into process improvement and project management after finding work as a Proposal Editor for an 8(a) federal-contractor with the Department of Defense. Thirteen years later, she serves as a program manager and data analyst laboring to show how predictive analysis works as a handy addition to any decision-making toolkit. Ms. Smith has worked with multiple Government Agencies, including at Department of State, Consular Affairs; United States Agency for International Development (USAID), Office of the CIO; Department of the Army; NASA.

Authors

Patrick Schneider (schneider_patrick@bah.com) graduated Cal Poly with a bachelor's degree in aerospace engineering and a minor in computer science. He worked for 3 years at the startup electric aviation company Wright Electric as a project manager and data analyst, proposing and executing contracts with NASA, DoD, and DoE. On those NASA contracts, he built schedules, cost estimates, risk registers, JCL analyses, and automation tools. Patrick joined Booz Allen in 2022 to help automate SRA's and build various other software tools.

Dylan Posner (Posner_Dylan@bah.com) has a bachelor's degree in Business Information Technology from Virginia Tech. Since joining Booz Allen in September of 2021, Dylan has completed two certifications, one as an ICAgile Certified Professional and another as an AWS Certified Cloud Practitioner. Dylan is adept at problem solving and enjoys the challenge of breaking down complex data science problems into simple solutions. He has a broad range of coding experience with a strong background in the concepts of Object Oriented-Programming.

Eric Zander (zander_eric@bah.com) has followed an unexpected career path; much like the critical path of a large and complex project. He started with a Bachelor of Science in biochemistry followed by several years in the Peace Corps (Thailand). After returning to the US, he earned an MBA with a focus on technology management and half a master's degree in urban planning. He has spent nearly 20 years in the consulting field in numerous areas and roles of program/ project management and controls. He has a particular interest in solving challenges and developing tools to make (work) life simpler and easier.

Backup