Digital Transformation, Data Science, AI, Machine Learning

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What is Digital Transformation?

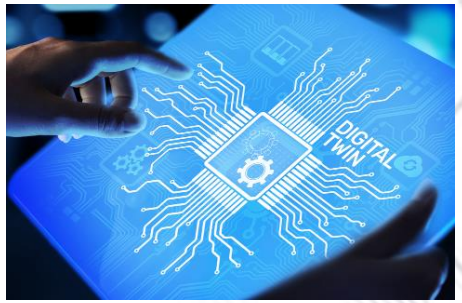
Digital Transformation has already changed our world…

Employing digital technologies (e.g., AI, mobile, cloud, data) to **change a process, product, or capability so dramatically** (e.g., real-time, intelligent, personalized, anywhere, anytime) that it's **unrecognizable compared to its traditional form**

TRADITIONAL → **DIGITIZED** → **TRANSFORMED**

… & technology discovery and convergence is accelerating change!

- Cloud Computing
- Mobile Access
- Automation and Robotics
- Big Data / Data Mining / Analytics
- Artificial Intelligence / Machine Learning
- Model-Based Systems Engineering
- Agile Software Development / DevOps / DevSecOps
- Internet of Things / Sensors
- Digitized Manufacturing (e.g., 3-D Printing)
- Augmented Reality / Virtual Reality
- Multidisciplinary Modeling and Simulation
- High Performance Computing
- Collaboration Platforms
- Social Media / Crowdsourcing
- Virtual Meetings
- **And more…**



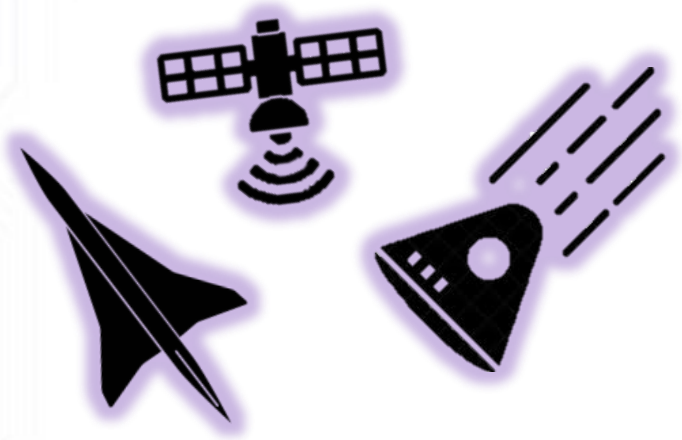
Home & Work: Common Denominators

Similar challenges at both home and at work:

- More demands
- More complex & complicated
- More interactions
- Faster paced
- More frequent changes
- More budget pressures

The same kinds of **digital solutions** that are helping us navigate modern life at home will also **transform our work world**

WHY: Enterprise DT Goals

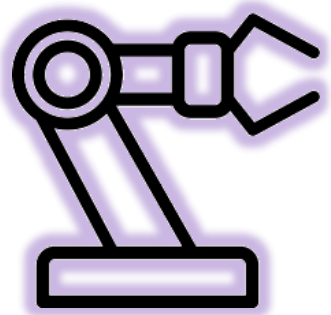


Transform NASA's Work

Deliver increasingly **complex missions** leveraging increasingly **complicated partnerships**, on **shorter timelines** to achieve **bolder outcomes** that **inspire** the world

Transform NASA's Workforce

Create a seamless, integrated, and inclusive **employee experience** that **energizes** our people by feeling **connected** to the NASA enterprise, continuously **grow,** and take **pride** in rapidly delivering **high-value work**

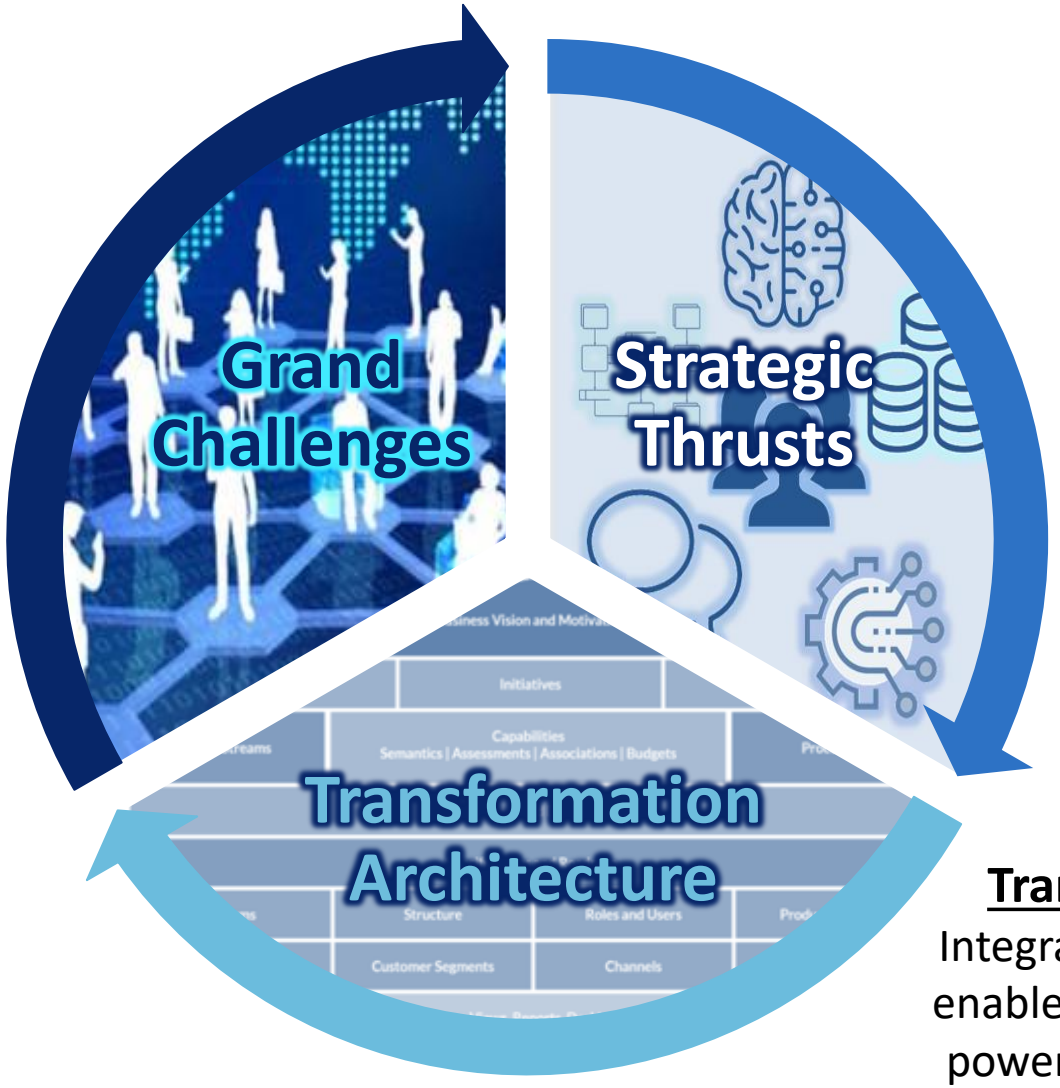


Transform NASA's Workplace

Optimize a 21st Century **cyber-physical work environment** that powers **flexible, adaptable, efficient, and effective** employee / partner **teaming**.

WHAT: Enterprise DT Essential Elements

Grand Challenges
"Real world" transformation pathfinders that serve as a lightning rod to catalyze enterprise DT adoption and integration and deliver tangible end-to-end outcomes, using integrated digital enablers

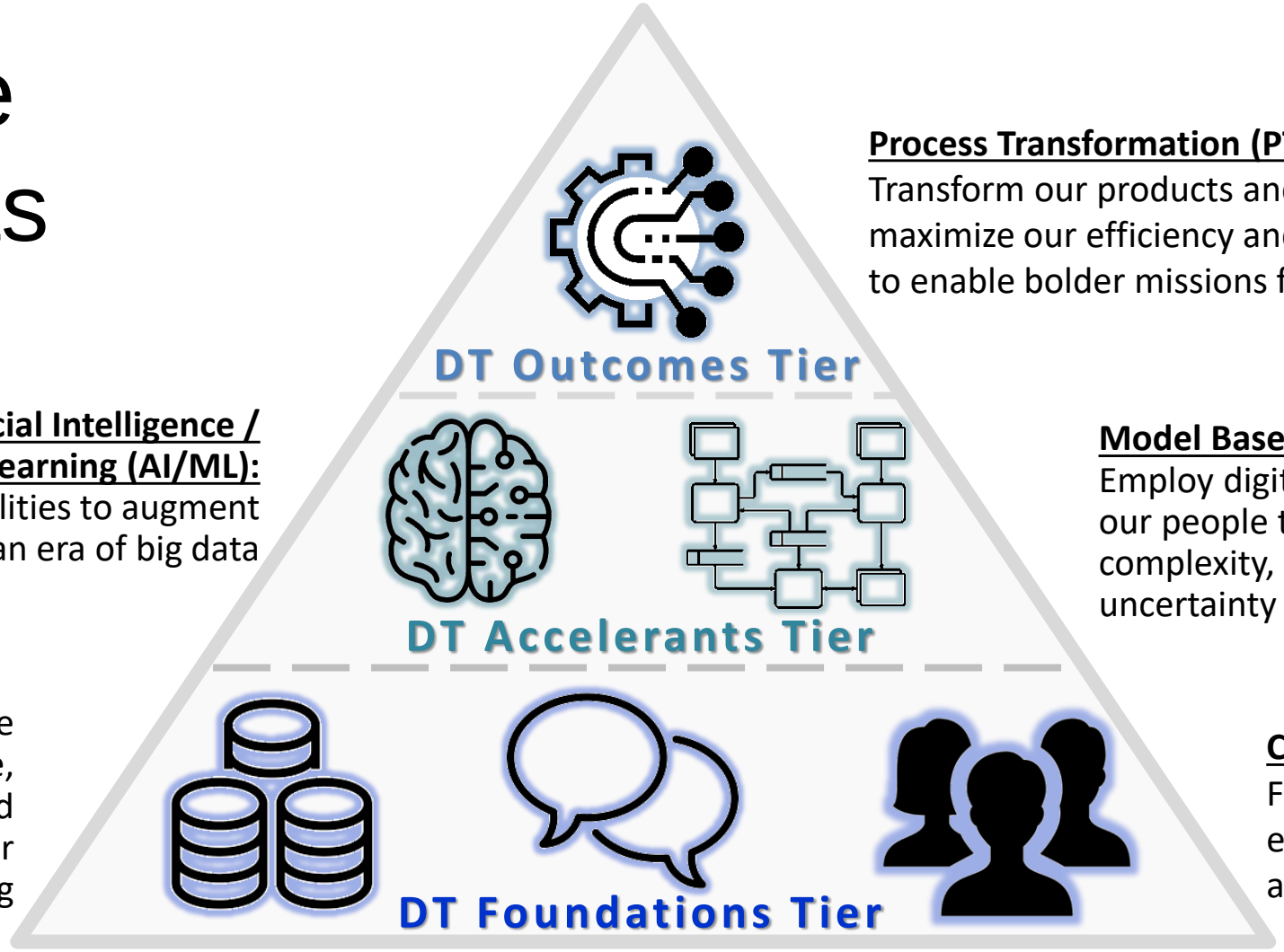


Strategic Thrusts
Catalysts for transformation → key shared enterprise-level digital enablers that orgs can use to accelerate transformation outcomes

Transformation Architecture
Integration plan for how those digital enablers can/should work together to power our future transformed NASA

WHAT: Enterprise DT Thrusts

WORK



Process Transformation (PTx):
Transform our products and processes to maximize our efficiency and effectiveness to enable bolder missions faster

Artificial Intelligence / Machine Learning (AI/ML):
Harness machine capabilities to augment human intelligence in an era of big data

Model Based Everything (MBx):
Employ digital models to enable our people to address increasing complexity, scope, speed, uncertainty & changes

Data: Ensure the data we need is Findable, Accessible, Interoperable, and Reusable (FAIR) to power data-driven decision making

Culture & Workforce:
Foster digital savvy, enterprise connection, and growth mindsets

WORKPLACE

Collaboration:

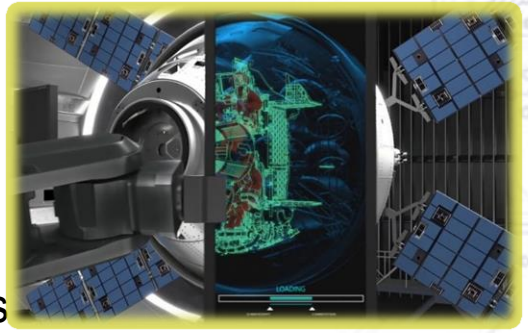
Enable agile teaming via seamless, secure internal and external collaboration

WORKFORCE

WHERE: Enterprise DT Early Wins (selected)

Process Transformation

- **Process Transformation Playbook** – guidelines to make PTx easy and repeatable for all NASA orgs; test on initial use cases including Robotic Process Automation



AI/ML:

- **High priority (learning) use cases –** Natural Language Processing for Requirements Analysis, Inverse Design of Materials, Extreme Weather Forecasting

Model Based Everything (MBx):

- **Orion MBSE Digital Twin Pilot –** Test common models and standards Agency-wide for MBSE w/Orion

Data

- **Data-Driven Decision Lens** – Integrate NASA data into central analytics/viz platform to enable holistic, enterprise level executive data driven decision making; less rework; better risk forecast; what-if analysis
- **Agency Data Analytics Platform -** Integrate/scale COTS analytics tools to power data-driven decision making

Collaboration

- **ITAR File Sharing** – ISS w/ESA prototype of 2-way secure sensitive file sharing for rapid external collab
- **Remote Immersive 3D Visualization** – Visualize engineering models via 3D headsets at remote locations

Culture & Workforce

- **SWARM Innovation –** Rapidly develop innovation skills and mechanisms in key early adopter community

NASA AI/ML Strategy – Elevator Pitch

Context:

- NASA is forming a Digital Transformation (DT) Strategy and Roadmap, led by the Office of Chief Technologist and Office of Chief Information Officer. This strategy includes AI/ML as one of six key strategic thrusts.
- NASA has a rich history of applying artificial intelligence (AI) to our hardest problems, such as autonomous behaviors in Mars rovers, deep analysis of space suit data, or image analysis to understand material strength. With the advent of powerful, plentiful, and affordable AI in business and industry, NASA is crafting a strategy to use AI as an accelerant for all NASA missions and business functions.

Strategy: As part of NASA's overall Digital Transformation, NASA's AI strategy includes:

- **Apply:** Solve relevant mission and mission support problems via AI / ML.
- **Teamwork:** Lead and synchronize NASA AI/ML via an open Agency AI / ML community.
- **Reskill:** Expand AI training, education, hiring, and retention across the workforce.
- **Tools:** Assess, recommend, and establish AI / ML platforms for NASA-wide adoption.
- **Data:** AI-enabled! Establish secure, authoritative access to the right data.
- **Outreach:** Make selected data and problems available for public / partner AI / ML work.
- **Adapt:** Leverage industry AI / ML work and adapt it to NASA use rather than reinventing.
- **Scale:** Plan to promote selected AI / ML capabilities from pilot to production operations.

The AI/ML team is from **across** the Agency with over 60 active members; additional contributors are always welcome.

Contact:

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AIML Intersection with Missions and Mission SPT (Examples, not Exhaustive)

Mission-Embedded	Command & Control Autonomy For Moon / Mars Robots	Enable Scaled Air Traffic Control	On-Board Analysis for Science Sensors
	Condition Based Maintenance For Space Habitats	**Autonomous Navigation For UAS/UAM**	**Early Warning of Severe Storms via ML Image Analysis**
Mission Analysis	AI-Assisted Project Management	AI-Enabled Vehicle Design	Horizon Scanning via AI Recommendation Engines
	AIML + Traditional Hybrid Analysis	ML-Enabled Requirements Optimization	AI-Assisted System Engineering
Mission Support	Bot Automation of Repetitive Processes	Condition-Based Maintenance For Facilities	ML IT Security Monitoring
	AI-Enabled HR Processes: Resume Review, More	AI-enabled Lessons Learned Recommendations	ML Assisted Fraud Detection

Above Anvil Cirrus Plumes (AACP) ML Project

Purpose: Identify above anvil cirrus plumes (AACP) in satellite imagery.

Problem: AACPs are typically ~31 minute precursors to severe weather such as hail, high winds, and tornadoes. They also eject water into the stratosphere which acts as a greenhouse gas.

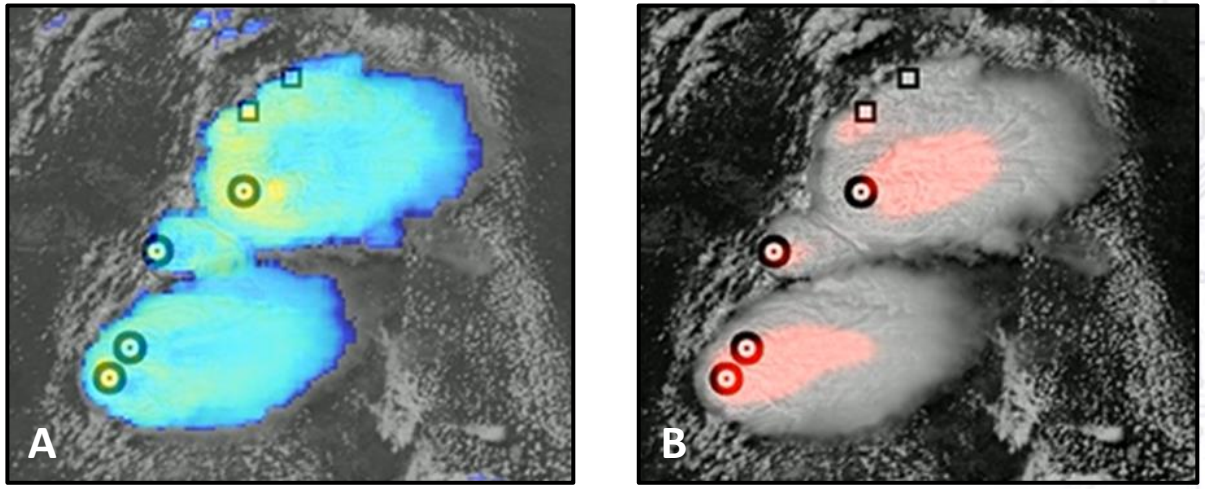
Objective: Identify AACP occurrences in satellite imagery to assist with weather forecasting and long-term climate studies.

Customer/SME: Dr. Kristopher Bedka, Science Directorate

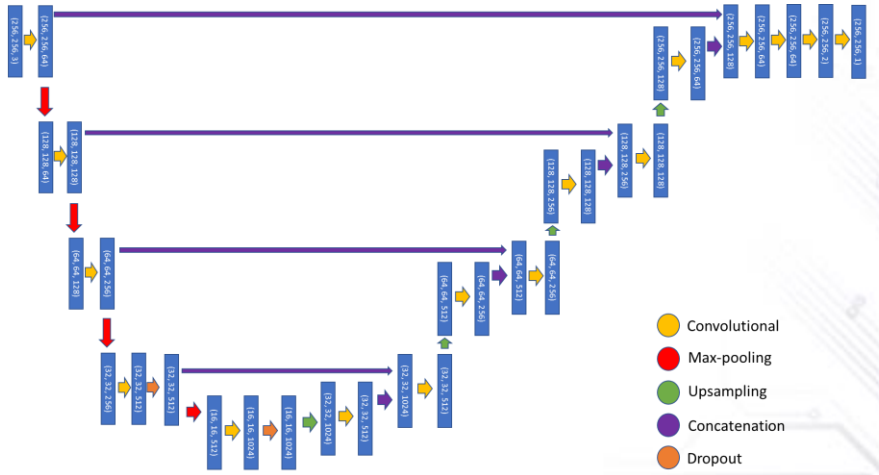
Data Scientist: Charles Liles

Approach: Deep learning U-net's for semantic segmentation of AACPs.

Status: Exploring the use of LSTM layers in a U-net to account for temporal component of satellite imagery.



(A) Model input with infrared GOES 16 imagery "sandwiched" as a colormap on top of visible imagery. (B) Model output with semantic segmentation AACP probability prediction overlain in red over visible imagery. Rectangular markings represent SME-labeled non-AACP storm updrafts while circular markings represent AACP updrafts in both images.



U-Net Architecture

Intelligent Contingency Management

Data Science

Purpose: UAM Mission - Safely fly from point A to point B under all vehicle-allowable weather conditions, in a high-density airspace complex urban environment, including off-nominal situations without direct human intervention, i.e. autonomous

Problem: For an arbitrary set of sensors and actuators, there is no robust, repeatable method of identifying the necessary data needed to train and verify that a vehicle can intelligently address an emergency.

Objective: Decision making under uncertainty and incomplete information

1. Explore machine learning for intelligent contingency management, with a focus on assessing/projecting vehicle capability and maintaining nominal performance via reinforcement learning
2. Develop vehicle intelligent contingency management system architecture at a functional level and validate against a specific UAM-class vehicle
3. Incorporate (1) and (2) into an evolving toolset for an autonomous vehicle

Customer/SME: Dr. Irene Gregory (ARMD TTT-Autonomous Systems)

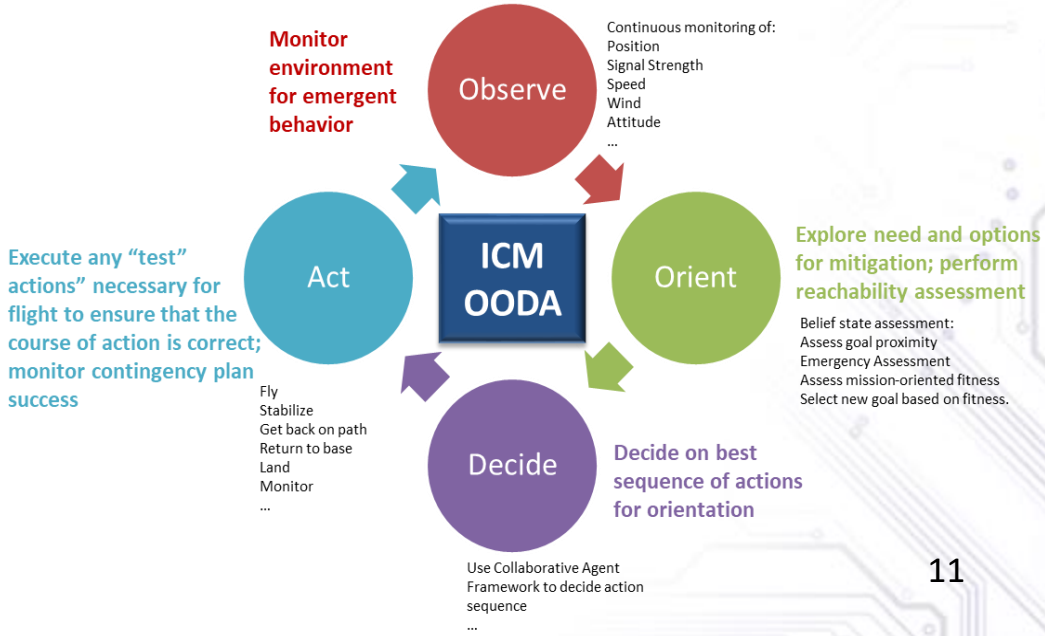
Data Scientist: Dr. Newton Campbell

Approach:

- Develop probabilistic inference techniques to detect changes in vehicle or mission state and contextualize emergencies.
- Develop reinforcement learning and knowledge reasoning techniques to create and assess the performance of contingency plans.

Status:

- Completed Year 1 exploration; Preparing high-quality simulation platform for program experimentation
- Publishing Problem Specification to AIAA Aviation 2020.



Watson Explorer

Text Analytics

Purpose: Provide users with a way to intuitively interface with their textual data.

Problem: NASA has lots of textual data in search of a visualization mechanism.

Objective: Perform cognitive search and content analysis for accessing insight from large amounts of structured and unstructured text. Rapidly identify trends, expert connections, technology gap exploration and connect cross-domain research.

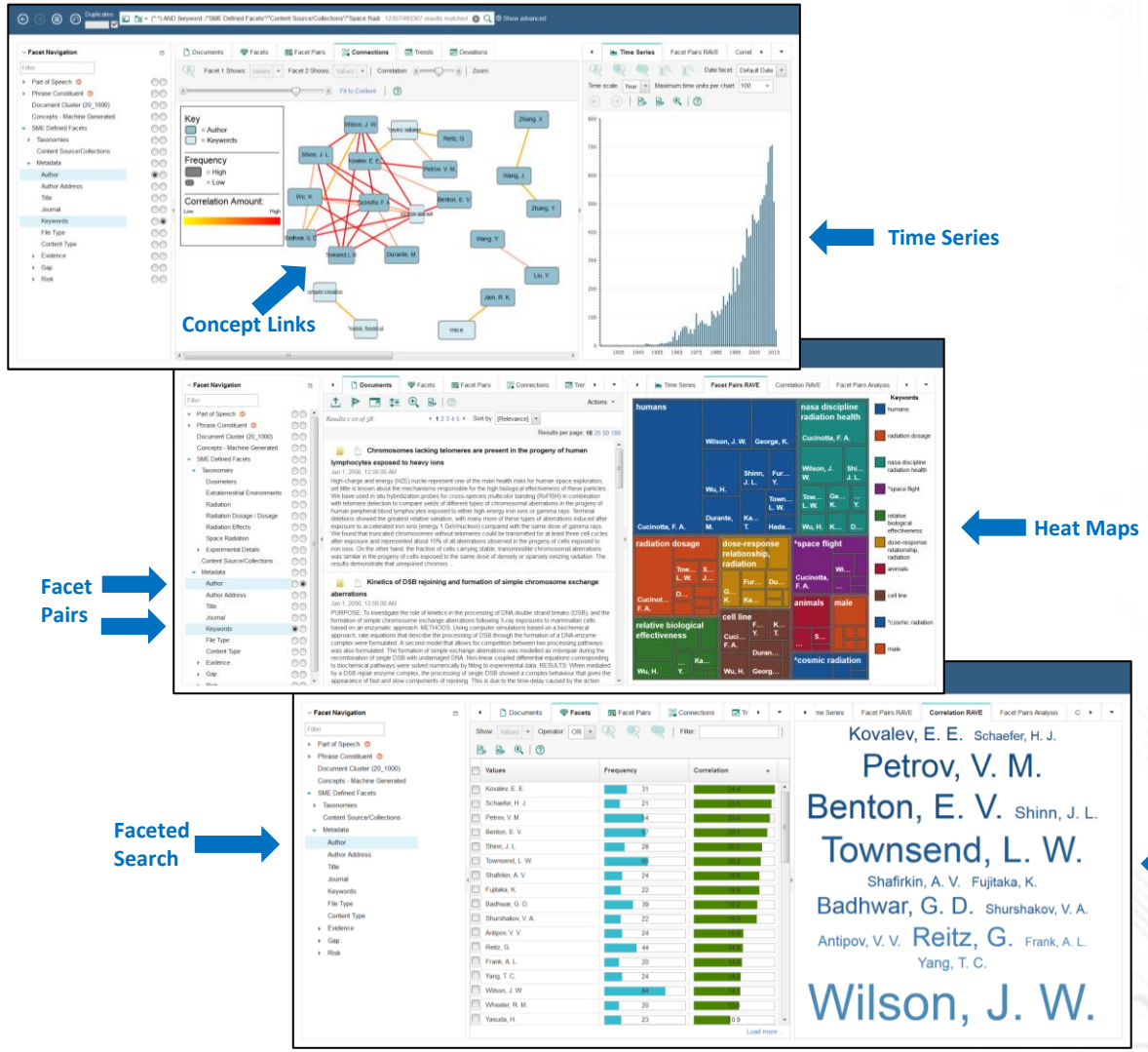
Customer/SME: Bob Beil/Delmar Foster (NESC-Kennedy)

NLP Data Scientist: Ted Sidehamer

Approach: WEX is installed on a dedicated server to take advantage of its computing and visualization capabilities.

Status: Current work focused on FORs: Findings, Observations, Recommendations System attempting to identify previous FORs related to current evaluations. Largest collection - Space Radiation: 600k+ records.

Watson Explorer User Interface



Working with NASA

- Internships: https://intern.nasa.gov/
  - One term at a time: Summer, Fall, Winter/Spring
- Pathways internships - https://www.nasa.gov/careers/pathways
  - At least a year
  - Part time school and internship in parallel
  - Goal – convert to government civilian upon successful completion and HR approval
- Government civilian positions – https://www.usajobs.gov/Search/Results?k=nasa
  - Availability comes and goes; be persistent!
- Contractor positions – see company career / job sites
  - Sometimes faster & higher availability
- Term projects or Capstone projects – willing to work with professors & students
  - National Institute for Aerospace is an easy way to handle the logistics
- Hints:
  - Tailor your resume!
  - Demonstrate strong motivation and passion for NASA

Thank you!

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I’m in LinkedIn too