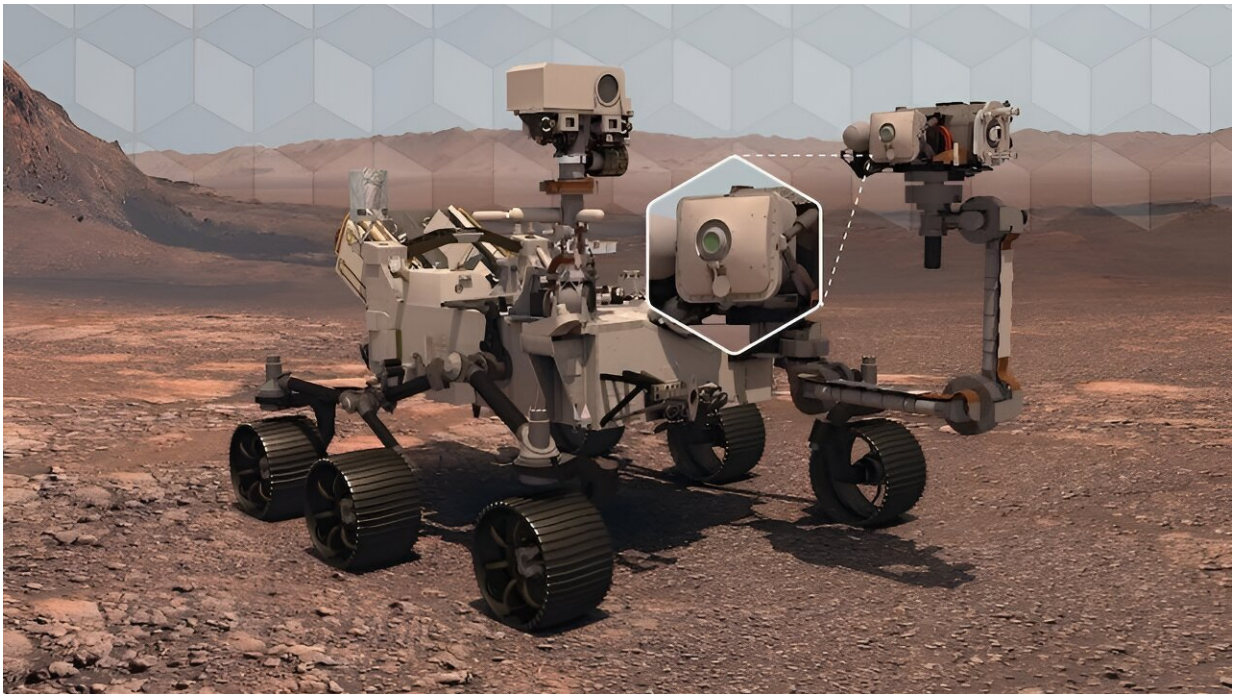


Algorithm used on Mars rover helps scientists on Earth see data in a new way

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Credit: NASA

A new algorithm tested on NASA's Perseverance Rover on Mars may lead to better forecasting of hurricanes, wildfires, and other extreme weather events that impact millions globally.

Georgia Tech Ph.D. student Austin P. Wright is first author of a paper that introduces Nested Fusion. The [new algorithm](#) improves scientists'

ability to search for past signs of life on the Martian surface.

This innovation supports NASA's Mars 2020 mission. In addition, scientists from other fields working with large, overlapping datasets can use Nested Fusion's methods for their studies.

Wright presented Nested Fusion at the [2024 International Conference on Knowledge Discovery and Data Mining](#) (KDD 2024) where it was a runner-up for the best paper award. The work is [published](#) in the journal *Proceedings of the 30th ACM SIGKDD Conference on Knowledge Discovery and Data Mining*.

"Nested Fusion is really useful for researchers in many different domains, not just NASA scientists," said Wright. "The method visualizes complex datasets that can be difficult to get an overall view of during the initial exploratory stages of analysis."

Nested Fusion combines datasets with different resolutions to produce a single, high-resolution visual distribution. Using this method, NASA scientists can more easily analyze multiple datasets from various sources at the same time. This can lead to faster studies of Mars' surface composition to find clues of previous life.

The algorithm demonstrates how data science impacts traditional scientific fields like chemistry, biology, and geology.

Even further, Wright is developing Nested Fusion applications to model shifting climate patterns, plant and animal life, and other concepts in the [earth sciences](#). The same method can combine overlapping datasets from satellite imagery, biomarkers, and climate data.

"Users have extended Nested Fusion and similar algorithms toward earth science contexts, which we have received very [positive feedback](#)," said

Wright, who studies [machine learning](#) (ML) at Georgia Tech.

"Cross-correlational analysis takes a long time to do and is not done in the initial stages of research when patterns appear and form new hypotheses. Nested Fusion enables people to discover these patterns much earlier."

Nested Fusion: A Method for Learning High Resolution Latent Structure of Multi-Scale Measurement Data on Mars

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Nested Fusion advances exploratory analysis of multi-layer multi-scale measurement data. It learns latent structure at **high resolution** to produce distributions of phenomena at a **greater fidelity** and **scientific impact** than previous approaches.

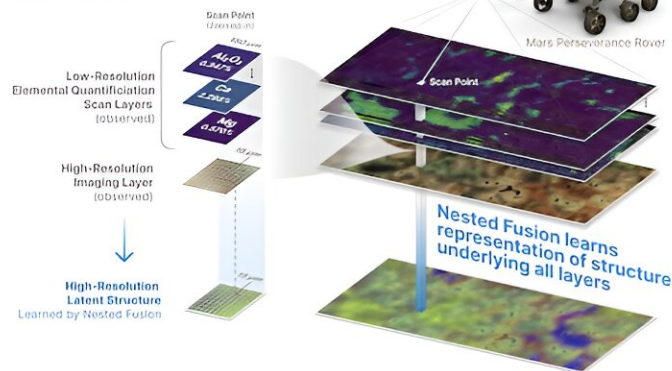


Figure 1: Our method, Nested Fusion, radically accelerates the exploratory analysis of nested measurement datasets by learning the latent structure at high resolution to produce distributions of phenomena at a greater fidelity and scientific impactfulness than previous approaches. In the figure the DOURBES target location is shown, out of over a hundred locations on Mars scanned by the Perseverance Rover at the time of writing.

Credit: *Proceedings of the 30th ACM SIGKDD Conference on Knowledge Discovery and Data Mining* (2024). DOI: 10.1145/3637528.3671596

Wright is the data science and ML lead for [PIXLISE](#), the software that NASA JPL scientists use to study data from the Mars Perseverance Rover.

Perseverance uses its Planetary Instrument for X-ray Lithochemistry (PIXL) to collect data on mineral composition of Mars' surface. PIXL's two main tools that accomplish this are its X-ray Fluorescence (XRF) Spectrometer and Multi-Context Camera (MCC).

When PIXL scans a target area, it creates two co-aligned datasets from the components. XRF collects a sample's fine-scale elemental composition. MCC produces images of a sample to gather visual and physical details like size and shape.

A single XRF spectrum corresponds to approximately 100 MCC imaging pixels for every scan point. Each tool's unique resolution makes mapping between overlapping data layers challenging. However, Wright and his collaborators designed Nested Fusion to overcome this hurdle.

In addition to progressing data science, Nested Fusion improves NASA scientists' workflow. Using the method, a single scientist can form an initial estimate of a sample's mineral composition in a matter of hours. Before Nested Fusion, the same task required days of collaboration between teams of experts on each different instrument.

"I think one of the biggest lessons I have taken from this work is that it is valuable to always ground my ML and data science problems in actual, concrete use cases of our collaborators," Wright said.

"I learn from collaborators what parts of data analysis are important to them and the challenges they face. By understanding these issues, we can discover new ways of formalizing and framing problems in data science."

Nested Fusion won runner-up for the best paper in the applied [data science](#) track. Hundreds of other papers were presented at the conference's research track, workshops, and tutorials.

Wright's mentors, Scott Davidoff and Polo Chau, co-authored the Nested Fusion paper. Davidoff is a principal research scientist at the NASA Jet Propulsion Laboratory. Chau is a professor at the Georgia Tech School of Computational Science and Engineering (CSE).

"I was extremely happy that this work was recognized with the best paper runner-up award," Wright said. "This kind of applied work can sometimes be hard to find the right academic home, so finding communities that appreciate this work is very encouraging."

More information: Austin P. Wright et al, Nested Fusion: A Method for Learning High Resolution Latent Structure of Multi-Scale Measurement Data on Mars, *Proceedings of the 30th ACM SIGKDD Conference on Knowledge Discovery and Data Mining* (2024). [DOI: 10.1145/3637528.3671596](https://doi.org/10.1145/3637528.3671596)

Provided by Georgia Institute of Technology

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