Decode Exoplanet Atmospheres Using AI: Ariel Data Challenge 2024 Awaits.

2nd Aug 2024

The study of extrasolar planets and ultimately the search for habitable worlds beyond our solar system is one of the most exciting frontiers in modern science, but a major obstacle stands in the way of unlocking the secrets of exoplanet atmospheres.

The Ariel Data Challenge 2024 is calling all data scientists, astronomers, and AI enthusiasts to help tackle one of astronomy's most complex and important data analysis problems—extracting faint exoplanetary signals from noisy space telescope observations.

The NeurIPS 2024, a world-renowned machine learning conference, will feature an exciting competition based on the Ariel Space Mission. This contest offers participants a unique chance to contribute to cutting-edge research in the fascinating field of exoplanet atmospheres. With a substantial prize pool of $50,000 USD at stake, the competition aims to attract top talent and innovative solutions.

Dr. Kai Hou (Gordon) Yip, Ariel Data Challenge Lead, UCL said:

“We are excited to see the innovative solutions that the global data science community can bring to this formidable task.”

This groundbreaking challenge has been made possible through a collaborative effort led by UCL Centre for Space Exochemistry Data, bringing together an impressive international team of academic partners including Centre National D'études Spatiales, Cardiff University, Sapienza Università di Roma, and Institut Astrophysique de Paris. The competition is generously sponsored by Centre National d'Etudes Spatiales, in collaboration with Kaggle Competitions Research Program. It also benefits from the support of a consortium of leading space agencies and institutions, including the UK Space Agency, European Space Agency, STFC RAL Space, and STFC DiRAC HPC Facility.

Dr Caroline Harper, Head of Space Science, UK Space Agency said:

“By supporting this challenge, we aim to find new ways of using AI and Machine Learning to develop our understanding of the universe.

Exoplanets are likely to be more numerous in our galaxy than the stars themselves and the techniques developed through this prestigious competition could help open new windows for us to learn about the composition of their atmospheres, and even their weather.

The UK Space Agency’s investment in cutting-edge space science research is essential for supporting innovative missions like this, that can benefit people, businesses, and communities across the globe. We can’t wait to see the results.”

Dr Theresa Rank-Lueftinger, Project Scientist for the ESA Ariel Mission, ESA said:

"Every noisy signal from our space telescopes could hide the key to understanding remote atmospheres. Our job is to unlock that potential with innovative machine learning approaches. It will be amazing to see what the AI community comes up with!"

Ms Pascale Danto, Project Scientist In charge of the French contribution to Ariel Mission, CNES (Centre National d’Etudes Spatiales) said:

“Astrophysics space missions are now producing huge amount of data and AI is becoming essential to process all the information and take giant steps in understanding our universe”

Understanding the atmospheres of exoplanets

The discovery of exoplanets has transformed our cosmic perspective, challenging conventional notions about the nature of the Solar System, the Earth's uniqueness and the potential for life elsewhere.

As of today, we are aware of over 5,600 exoplanets. However, detecting these worlds is only the initial step; we must also comprehend and characterise their nature by studying their atmospheres.

The European Space Agency’s Ariel Space Mission will be launched in 2029 and will complete one of the largest ever surveys of these planets by observing the atmospheres of around one fifth of the known exoplanets.

Paul Eccleston, Ariel Mission Consortium Manager, RAL Space, said:

“It’s an exciting time for Ariel and for RAL Space involvement, where we’re due to start building the payload structural model in the coming months. It’s also a busy time for other parts of the consortium, including those that are pre-empting data challenges we might face after launch. The Ariel Data Challenge will be incredibly useful for us in this respect, but it’s also a great opportunity for participants to get involved and contribute to a very exciting mission. Good luck to those taking part!”

However, observing these atmospheres and deriving their properties is a formidable challenge. These atmospheric signals only account for a minute fraction of the starlight received from the planetary systems, and are regularly corrupted by instrument noise.

Prof. Ingo Waldmann, Professor of Astrophysics, UCL (University College London) and Ariel Data Challenge co-lead said:

“Modern astrophysics poses big-data problems that can best, and sometimes only, be solved using modern AI techniques. This problem in particular lends itself to fresh approaches, and I am very excited to see what new solutions the AI community will come up with. ”

The Ariel Data Challenge

The Ariel Data Challenge 2024 focuses on overcoming these noise sources, such as "jitter noise" caused by spacecraft vibrations. This noise, along with other disturbances, complicates the analysis of spectroscopic data used to study exoplanet atmospheres.

With support from DiRAC HPC Facility, Mission Scientists have meticulously produced the most accurate representation of Ariel observations to date, based on Ariel's payload design and incorporating representative noise effects from in-flight data obtained by the James Webb Space Telescope.

Professor Mark Wilkinson, DiRAC High Performance Computing facility said:

“The complexity and volume of incoming data from Ariel, combined with the advanced AI techniques used in this challenge will help to drive the ongoing revolution of exo-planetary science. I am delighted that, in 2024, DiRAC has been able to support the Ariel Data

Challenge by providing the computing resources to generate the dataset which the AI community will be tasked with analysing."

Scientists involved in the Ariel mission now seek novel methods to push the boundaries of current data analysis approaches - innovative solutions that can effectively suppress these noise sources and extract vital signals from exoplanet atmospheres.

Dr Lorenzo v. Mugnai, Postdoctoral Researcher, Cardiff University, said:

"As astronomers, we've been dealing with these noise reduction issues for decades. We've used that experience to put together this challenge, and now we're excited to see the fresh ideas and solutions this community will come up with."

Dr Andrea Bocchieri, Postdoctoral Researcher, Sapienza Università di Roma, said:

"The Ariel Data Challenge 2024 sits at the intersection of observation, instrumentation, and interpretation of exoplanet data, where the complexities of each coalesce, and machine learning can really make a difference."

The Ariel Data Challenge calls on the AI community to investigate solutions with potential to facilitate breakthroughs in this field.

Orphée Faucoz, Data Scientist, Centre National D'études Spatiales, said:

"Unleash your inner astronomer, join our data challenge and unravel the hidden signals of the universe. Thanks to AI, we can offer a new perspective on the formation of exoplanets and gain insight into the mysteries of the universe!"

Dr Pierre Drossart, Research scientist, Institut d'astrophysique de Paris, said:

"The Ariel Data Challenges is for the IAP Ariel investigators an opportunity to enter in the field of the AI community, which is expanding rapidly in all science domains. The question of classical vs machine learning approaches in detrending the instrumental data is still highly debated, and investigating both approaches is at the heart of our science involvement in Ariel and other missions in IAP."

Dr Virginie Batista, Research Engineer, Institut d'astrophysique de Paris said:

" The data are multidimensional and affected by complex and high-amplitude noise in comparison to the tiny atmospheric features we try to extract, the task is really challenging. We are eager to discover the ideas that the Ariel Data Challenge 2024 will inspire."

The competition

The competition is open now until late October. Winners will be invited to present their solutions at the prestigious NeurIPS conference, with cash prizes available for the top six solutions.

This competition is made possible through the support of Kaggle Competitions Research Program, the UK Space Agency, European Space Agency, Centre National D'études Spatiales, STFC RAL Space, and STFC DiRAC, with contributions from University College London, Centre National D'études Spatiales, Cardiff University, Sapienza Università di Roma, and Institut Astrophysique de Paris.

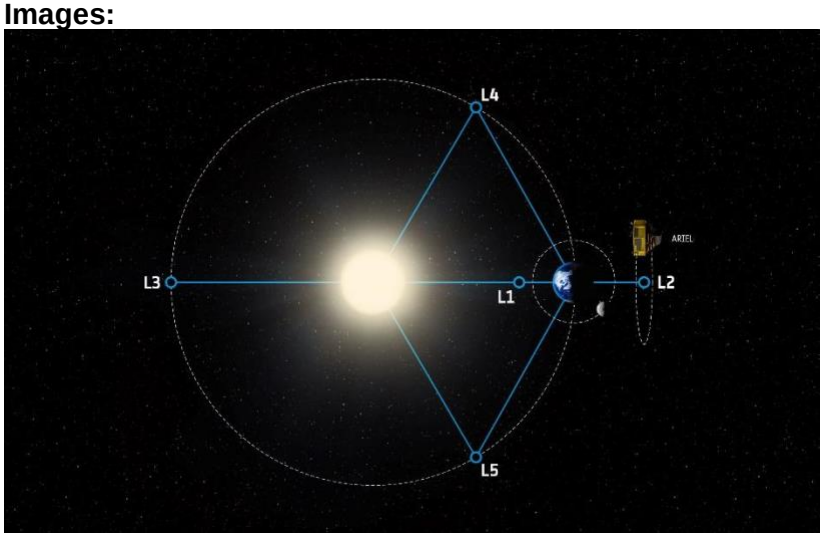
Previous competitions

This will be the fifth instalment of the Ariel Machine Learning Data Challenge, following four very successful competitions in the past five years. The Ariel Data Challenge attracts around 200 participants from across the world every year, including entrants from leading academic institutes and AI companies.

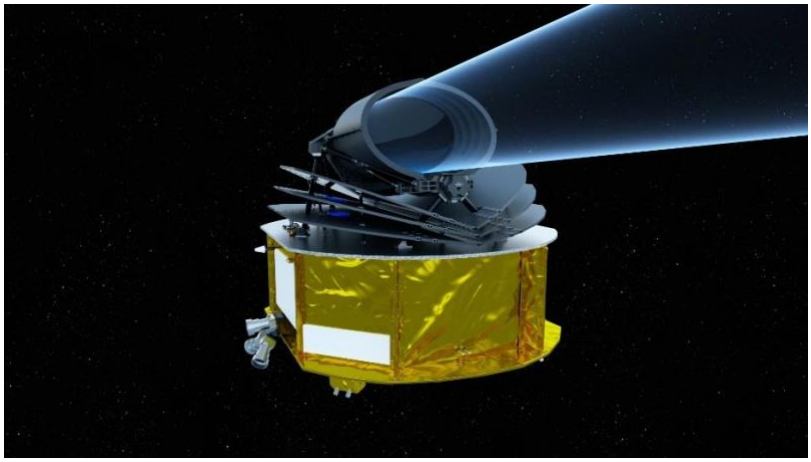
This challenge and its predecessor took a bite-sized aspect of a larger problem to help make exoplanet research more accessible to the machine learning community. The challenge is not designed to definitively solve the data analysis issues faced by the mission outright but provides a forum for discussion, and to encourage future collaborations, and to help the Ariel team to be prepared with the best possible data analysis methods by the time the mission flies.

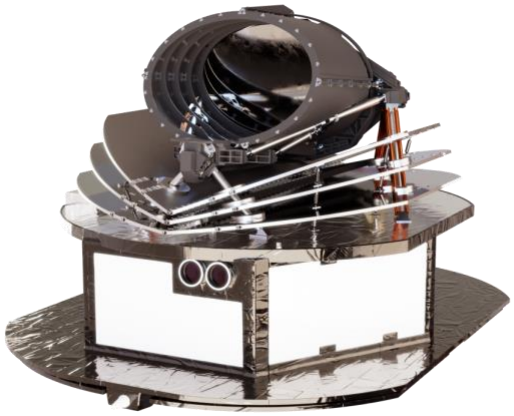
More details about the competition and how to take part can be found on the Ariel Data Challenge website. Follow @ArielTelescope for more updates.

Images:



Ariel will be placed in orbit around the Lagrange Point 2 (L2), a gravitational balance point 1.5 million kilometres beyond the Earth's orbit around the Sun. Image Credit: ESA/STFC RAL Space/UCL/Europlanet-Science Office





Artist’s impression of Ariel. Image Credit: ESA/STFC RAL Space/UCL/UK Space Agency/ ATG Medialab

Ariel Data Challenge 2024 logo.

https://arielspacemission.files.wordpress.com/2020/11/ariel-telescope.jpg
https://www.esa.int/ESA_Multimedia/Images/2018/03/Hot_exoplanet

Videos:
Note: Please get in touch with press contact for mp4 files.

Ariel animations: https://www.youtube.com/playlist?list=PL7nlYuIpjicaxp36LxZwkXOH72Otf-rgY
Welcome to Ariel: https://youtu.be/28afJ_5TTGc

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Notes to editors:

Ariel (Atmospheric Remote-sensing Infrared Exoplanet Large-survey)
Ariel, a mission to answer fundamental questions about how planetary systems form and evolve, is a European Space Agency (ESA) medium-class science mission due for launch in 2029. During a 4-year mission, Ariel will observe up to 1000 planets orbiting distant stars in visible and infrared wavelengths to study how they formed and how they evolve. It is the first mission dedicated to measuring the chemistry and thermal structures of exoplanet atmospheres, enabling planetary science far beyond the boundaries of the Solar System.

The Ariel mission is being by a consortium of more than 50 institutes from 16 ESA member state countries, including the UK, France, Italy, Poland, Belgium, Spain, the Netherlands, Austria, Denmark, Ireland, Czech Republic, Hungary, Portugal, Norway, Sweden, Estonia – plus contributions from the US (NASA), Canada (CSA) and Japan (JAXA).

Twitter: @ArielTelescope | YouTube: Ariel Space Mission | Instagram: arieltelescope | www.arielmission.space | https://www.cosmos.esa.int/web/ariel

Ariel Data Challenge

https://www.ariel-datachallenge.space/