EUROPEAN SPACE AGENCY

Internal Research Fellow (PostDoc) in Physics-Informed (Quantum) Neural Networks in Astrodynamics

Job Req ID: 15012
Closing Date: 12 May 2022
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Vacancy Type: Internal Research Fellow
Date Posted: 14 April 2022

Internal Research Fellowship Opportunity in the Directorate of Operations.

ESA is an equal opportunity employer, committed to achieving diversity within the workforce and creating an inclusive working environment. For this purpose, we welcome applications from all qualified candidates irrespective of gender, sexual orientation, ethnicity, beliefs, age, disability or other characteristics. Applications from women are encouraged.

This post is classified F2.

Location
ESOC, Darmstadt, Germany

Our team and mission
The Research Fellowship will be based in the ESOC Mission Analysis Section, Flight Dynamics Division. The Mission Analysis Section is responsible for the trajectory design of all ESA missions. This task can often be formulated as a complex optimisation problem. Different techniques have been developed in the past specific to the different mission types. A rather novel, but promising approach to this problem is based on so-called Physics-Informed Neural Networks. Instead of explicitly using the natural dynamics and adjusting the thrust parameters to optimise the objective, a neural network is trained to both learn the relevant physical laws and achieve the transfer objective. Very little research has been done on this topic so far. Therefore, it is an exciting opportunity which requires the successful candidate to not only work in a highly independent manner, but also to propose relevant research questions.
You are encouraged to visit the ESA website: https://www.esa.int/

Field(s) of activity/research for the traineeship
You will carry out your research as member of the Mission Analysis Section at ESOC, a team of astrodynamics specialists from backgrounds including aerospace engineering, physics and mathematics. Collaboration on the topic with researchers from external institutions, such as universities, is also possible. After an initial literature study, you will work on the problem of solving different trajectory transfer problems using (classic) Physics-Informed Neural Networks (PINNs). In particular, your research activities will consist in working on the following questions:
- Can low-thrust transfer problems between two given orbits be solved using PINNs?
- How does the performance and fidelity compare with traditional methods to solve the problem?
- Which kinds of neural networks are most suited to the task?

As a result of these initial activities, you will propose further research questions. These may include an application of the technique to more complex transfer problems such as multi-flyby missions. Alternatively, they may involve other areas of application of PINNs within astrodynamics, such as non-linear uncertainty propagation.

Once a basic understanding of classical PINNs for astrodynamics has been reached, another key question will be whether PINNs can be implemented efficiently on a quantum computer using quantum neural networks.

Technical competencies
Knowledge relevant to the field of research
Research/publication record
Ability to conduct research autonomously
Breadth of exposure coming from past and/or current research/activities
Ability to gather and share relevant information
General interest in space and space research

Behavioural competencies
Result Orientation
Operational Efficiency
Fostering Cooperation
Relationship Management
Continuous Improvement
Forward Thinking

Education
You should have recently completed, or be close to completing a PhD in mathematics, physics, engineering, computer science or a similar relevant field. Preference will be given to applications submitted by candidates within five years of receiving their PhD. A PhD with a thesis subject relevant to the description of the tasks outlined above is an asset.

Additional requirements
The following technical skills are required
- Ability and interest in prospective interdisciplinary research
- Ability to work in a team, while being able to work autonomously regarding your own personal research directions
- Solid programming skills in Python are mandatory
- Proven experience in machine learning and familiarity with the relevant Python packages, such as pytorch and tensorflow.
- Knowledge of orbital mechanics
- Previous experience with quantum computing and familiarity with the relevant Python packages, such as qiskit

Moreover, the following skills would be an asset
- Familiarity with quantum machine learning
- Previous experience in astrodynamics and trajectory design
- Previous experience with the Python astrodynamics platform, GODOT

The working languages of the Agency are English and French. A good knowledge of one of these is required. Knowledge of another Member State language would be an asset.

Other information
For behavioural competencies expected from ESA staff in general, please refer to the ESA Competency Framework.

For further information on the Internal Research Fellowship Programme please visit: [Internal Research Fellowship](#)

The Agency may require applicants to undergo selection tests.

In addition to your CV and your motivation letter, please add your proposal of no more than 5 pages outlining your proposed research in the "additional documents" field of the "application information" section.

At the Agency we value diversity and we welcome people with disabilities. Whenever possible, we seek to accommodate individuals with disabilities by providing the necessary support at the workplace. The Human Resources Department can also provide assistance during the recruitment process. If you would like to discuss this further please contact us at contact.human.resources@esa.int.

Please note that applications are only considered from nationals of one of the following States: Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, and the United Kingdom. Nationals from Latvia, Lithuania and Slovenia, as Associate Member States, or Canada as a Cooperating State, can apply as well as those from Bulgaria, Cyprus and Slovakia as European Cooperating States (ECS).

According to the ESA Convention, the recruitment of staff must take into account an adequate distribution of posts among nationals of the ESA Member States*. When short-listing for an interview, priority will first be given to candidates from under-represented or balanced Member States*.([https://esamultimedia.esa.int/docs/careers/NationalityTargets.pdf)](https://esamultimedia.esa.int/docs/careers/NationalityTargets.pdf)

In accordance with the European Space Agency's security procedures and as part of the selection process, successful candidates will be required to undergo basic screening before appointment conducted by an external background screening service.

*Member States, Associate Members or Cooperating States.

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