Renaissance Philanthropy

AI for Math Summer Fellowship – Copilots for Isabelle

Project Details

- **Project Title:** Copilots for Isabelle: Learning Logical Structure for a Better Proving Experience
- **Eligibility Criteria:** Open to undergraduate, master's, or PhD students.
- **Location**: Placements may be hybrid or in-person depending on the project location (Sheffield, London, or Copenhagen). Renaissance Philanthropy will cover travel costs if necessary for fellows who need to relocate temporarily for the placement.
- **Host Organization / Institution:** University of Sheffield, University of Copenhagen, King's College London
- **Project Lead / Mentor:** Fellows will be supervised by members of the Isabelle research community depending on project placement.
    - Sheffield: Andrei Popescu, Kevin Kappelmann
    - Copenhagen: Dmitriy Traytel, Lukas Stevens
    - London: Mohammad Abdulaziz, Maximilian Schäffeler

About the Project. Isabelle is one of the most popular proof assistants which has hosted landmark verification results in both mathematics and computer science. As a team that puts together experienced Isabelle designers, developers and users with AI experts, we will extend the system with intelligent copilots that will take advantage of the substantial amount of highly structured information that is acquired through human interaction. Isabelle will "pay more attention" to data coming from its highly intelligent users and developers and will herself become more intelligent. This will lead to the formulation of new AI problems relevant for theorem proving beyond Isabelle.

About the Host. The fellow would join a group of six researchers at three sites, University of Sheffield, University of Copenhagen, and King's College London, working in close collaboration on the project topics. The fellowship can take place at any of the sites, depending on the fellow's preference; there is also the option of travelling between the sites. The fellow will be integrated in the respective scientific environment at the chosen host institution: the *Foundations of Computing*, *Security of Advanced Systems* and *Natural Language Processing* groups at the University of Sheffield, the *Software, Data, People and Society* section at the University of Copenhagen, and the *Software Systems* and the *Reasoning and Planning* groups at King's College London.

Role and Responsibilities

1. Proof Wrap-Up Copilot for Isabelle (Sheffield)
Develop an LLM-based tool that produces high-quality final proofs from complete or partially structured ("messy") proof drafts. This copilot will help streamline the final stages of proof development and improve usability for Isabelle users.

2. Auto-Documentation for Isabelle/ML (Copenhagen)
Build an AI-based copilot that dynamically generates up-to-date documentation for Isabelle/ML code, taking into account the code's history, structure, and development context.

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3. Tuning LLMs for Computer Science Proofs (London)
Adapt and fine-tune language models for proofs commonly occurring in computer science, such as proofs of program refinement, correctness of graph algorithms, and complexity analysis.

Key Qualifications

- Strong background in computer science, mathematics, or a related field
- Experience with formal verification, theorem proving, or proof assistants
- Familiarity with Isabelle/ML or Isabelle/Scala is a strong plus
- Interest in AI-assisted theorem proving and LLM-based tooling

Deliverables

By the end of the fellowship, the fellow is expected to contribute:

- Produce a working prototype implementation of the planned tool
- Jointly with the project members, produce a technical report with the potential of leading to a publication submitted to a top conference
- Present this work at workshops or conferences

(For all of these duties, the fellow will receive substantial support from the project team. We want all these duties to be career building opportunities for the fellow.)

How to Apply

Submit the following materials through this application link:

- CV / Resume
- Statements of interest and relevant expertise (1–2 paragraphs)
- Optional: links to GitHub, research papers, or prior technical work