CUQI Summer Internship Opportunity 2024

Uncertainty Quantification Benchmarking in CUQIpy

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Are you interested in:

- Doing a project within inverse problems, uncertainty quantification and sampling algorithms.
- Using and contributing to an open-source software project.
- Gaining experience of working in a highly collaborative scientific software team.
- Learning software development tools and practices such as version control with git and GitHub.
- Obtaining mentoring and guidance on all of the above from researchers at DTU Compute.

Then apply to our 2024 CUQI Summer Internship

The CUQI project (https://sites.dtu.dk/cuqi) at the Technical University of Denmark (https://www.dtu.dk/english) is developing the Python package CUQIpy, Computational Uncertainty Quantification for Inverse problems in python. The package aims at providing powerful and accessible modeling and computational tools for UQ for inverse problems (https://cuqi-dtu.github.io/CUQIpy/).

The goal is to allow researchers to easily quantify uncertainties in solutions to inverse problems. For example, in an X-ray CT scan we can usually get decent-looking cross-section images of a patient, but it is less clear how much in fact we can trust these pictures. Something that looks like a cancer or other feature may in fact just be an unreal artifact resulting from the measurement noise, modeling errors or the computational method.

CUQIpy provides a Bayesian inversion framework for a variety of inverse problems including sampling methods to explore posterior distributions. Sampling is a computationally demanding task and different sampling algorithms exist. To ensure reliable and fast sampling it is important to understand and compare performance of sampling algorithms on known test problems (“benchmarks”).

The goal of this summer intern project is to implement benchmark problems and carry out benchmarking studies of sampling algorithms in CUQIpy. This may involve one or more of the following directions:

- Implementing benchmarks in CUQIpy based on small-scale test problems from the literature.
- Systematic performance comparisons of CUQIpy sampling algorithms on benchmark problems.
- Experimenting with accelerated samplers employing gradient or Hessian derivative information.
- Exploring problems relying on third-party software such as C or C++ libraries.
- Other directions may possibly be identified based on the intern interests and background.

Qualifications

- Currently enrolled in a Master's degree program.
- Previous experience with numerical methods and programming in Python.
- Fluency in both spoken and written English.

Setup

- Starting date: August 1, 2024.
- Duration: 1–3 months (preferably 2 or 3) full time.
- Unpaid, but travel expenses to Denmark, travel insurance and reasonable accommodation expenses near DTU will be covered.

References

- Riis et al., *CUQIpy: I. Computational uncertainty quantification for inverse problems in Python*, Inverse Problems, 40, 045009, https://doi.org/10.1088/1361-6420/ad22e7.
- Alghamdi et al., *CUQIpy: II. Computational uncertainty quantification for PDE-based inverse problems in Python*, Inverse Problems, 40, 045010, https://doi.org/10.1088/1361-6420/ad22e8.

Contact

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