Uncertainty Quantification IV
Mini-project

Submission deadline via Gradescope:
5pm 20th Jan 2025 (i.e. Monday of Week 12)

Weighting: (20% of total mark)

Mini-Project Description and Tasks:

This project is a chance for you to show off what you have learned so far on the UQ course, especially the skills you have developed throughout the 4 computer practicals. We would like you to demonstrate these skills on a physical model of your choice, from a website given below, that contains a list of interesting, real worlds models used for testing various UQ techniques. While the mini-project is open ended, several steps/suggestions are given below to help you get started and to ensure you cover the core techniques. Any questions, do not hesitate to ask.

Tasks:

1. **Find an interesting model**: go to the website,

https://www.sfu.ca/~ssurjano/index.html

If you click on the "EMULATION/PREDICTION" tab on the left it will bring up a list of models. Have a look through a few and see if there is anything you like (the “Physical Models” might be a good list to choose from, but there are many others of interest). Each model should be implemented in R so once you have chosen a model, copy its R code and try to run the model in RStudio.

2. Explore the model: evaluate the model for different values of the input parameters and plot any results you think are interesting e.g. try changing one input at a time with all other inputs set to their midrange values. Try to understand what the inputs are doing and which are important, both from the model description and from your initial investigations.

3. Prepare for emulation: each model will have inputs that are defined over a physical range. Define new transformed input parameters that are scaled to the [0,1] range and use these as input to the emulator in the next steps.

4. Demonstrate 1D emulation: choose one of the input parameters to be free and fix the other inputs at constant values. Attempt to demonstrate emulation of the model over this 1D input space.

5. Demonstrate 2D emulation: choose two of the input parameters to be free and fix the other inputs at constant values. Attempt to demonstrate emulation of the model over this 2D input space, being careful with design considerations.

6. Demonstrate further UQ techniques: Try out some more techniques that you have learnt in this course. E.g. you could create some observed data (along with observation errors and model discrepancy) and attempt to perform multi-wave History Matching. Or you could attempt to perform Optimisation. Or you could consider more careful designs within either HM or Optimisation. Or you could attempt to emulate using more that 2 input dimensions. Or perform more careful assessment of emulator parameters. Simple BL emulators will be sufficient for this project, but you could include global basis functions if you wish.

Details of Report Structure: Length: 6-10 pages (an additional appendix for less important plots is optional and not included in the above page count, but shouldn’t be too long). A very brief

Introduction and brief Conclusion should be included. It is expected that the main content of the mini-project will be heavily based on plots, but do write enough to introduce the model, explain what you are doing at each stage, and to give some interpretation/insight into what the plots are showing (e.g. is the emulator behaving well, is the HM or optimisation achieving its goal etc.). Bullet points instead of prose are fine for the text, Introduction and Conclusion.

Marking Criteria: the most important criteria are: clarity and interest of results presented (i.e. interesting plots), clear insight demonstrated (either via text discussion or careful choice of plots or both), development of a careful UQ analysis (starting with the basics, then extending logically to more complex techniques, with each aspect carefully dealt with), and finally meaningful conclusions reached.

Contact Hours for Project Support: feel free to email at any point if you need support. My office hours will be available too: 10am Wed, week 10 and 10am Wed, week 11 (i.e. first week of Epiphany term).