APMA2550 NUMERICAL PDES I
FINAL PROJECT

MARK AINSWORTH

As you will have realised by now, the class has developed all of the components needed in order to be able to approximate non-linear reaction diffusion (and other types of) partial differential equations in two (or more) spatial dimensions. The project component of the course gives you the opportunity to put all of these components together and to use them to look at an application of your own choosing.

The literature *abounds* with interesting systems of non-linear reaction diffusion equations that arise in physics, medicine, biology and chemistry, and which exhibit pattern formation when the parameters are in certain regimes. Here are a few names to get you started: Fitzhugh-Nagumo, Schnakenberg, Cahn-Hilliard, Swift-Hohenberg, Kuramoto-Sivashinsky, Lotka-Volterra, Gierer-Meinhardt, Keller-Segel, ...)

(1) Write a code that uses the techniques developed in the homework assignments to solve the two dimensional version of the Brusselator problem. Demonstrate that the code is working by using it to generate the Turing patterns similar to those that were demonstrated in class.

(2) Do some independent reading to identify an application that interests you and produce a code that can simulate the behaviour. In particular, you should:
   (a) Provide a description of the application and the features of the problem that make it interesting.
   (b) Discuss the features unique to your problem that have to be addressed in order to approximate the solutions numerically using your code. Give a description of how you addressed these issues including any modifications to the algorithms and code.
   (c) Identify an appropriate test problem where, ideally, one knows the solution explicitly or at least what to expect. Demonstrate that your code is able to reproduce the correct results for the test problem.
   (d) Once you are confident your code is working, use it to approximate the solution of the problem in a case of more practical interest. Discuss the results that you obtain and relate them to what we expect to find.

Your answers should include any theory needed and include appropriate code snippets that illustrate the key points. As always, undocumented or indiscriminate listings of large sections of code will not attract any marks.

You should write all code yourself. *No credit* will be given for using existing PDE packages, although you may use packages for solving linear systems of equations, plotting results etc.

I will be awarding marks based on the choice of application and the methodology that you use to tackle it. Marks will also be awarded based on the quality of the writing and the presentation of the results. Most projects will be around 10 pages long of typeset script and figures using Latex or similar package.

The deadline for turning in the project is **3.00pm on Wednesday 18th December 2024**. Please re-read the guidelines concerning collaborative work on homework/project on the course syllabus, and also the policy regarding late submissions.

19th November 2024