MATH 5620 CLASS PROJECT SUGGESTIONS
NUMERICAL ANALYSIS II

1. Project guidelines

- It is possible to do projects in pairs. If you plan to do so, please let me know before you choose your project so that we can adjust the workload accordingly.
- Two persons (or groups) can do the same project
- A short talk (10-20min) where you will present your results to the class will be part of your project grade (20% talk, 80% write up). The time for your talk is flexible, just let me know well in advance if you will need more time.
- Please do **keep me informed on the progress** of your project.
- Please do let me know by email when you have chosen a project.

2. Tentative Schedule

- Choose a project by the Spring break (Mon 03/23 at the very latest)
- Project reports due on the last day of classes (Wed 04/29)
- Project presentations on the last week of classes (04/27–04/29).

3. Suggested class projects

This project list will be updated regularly, and is not an exclusive list. If you are interested in a particular application, we can figure out a numerical analysis project based on it. Don't be thrown off by the name of the method, some of them

1. Static linear elasticity problem on a rectangular domain using finite elements.
2. A multigrid method for 1D elliptic equation.
3. An $h-$adaptive finite element method for 1D elliptic equation.
4. The Lax-Wendroff discretization scheme.
5. A Total Variation Diminishing (TVD) or an Essentially Non-Oscillatory (ENO) method for equations with shocks.
6. Model propagation of fire using the Eikonal equation (can be combined with previous project if working in a pair)
7. Use the Perron-Frobenius theorem to rank teams in your favorite sport (or any other ranking problem). This is the mathematical basis of Google's PageRank algorithm [2, 1].
8. An example where the Runge-Kutta-Felberg method fails [4].
9. A simple mesh generator: [3]
10. Simulated annealing or the simplex method or some optimization method not seen in class.

Let me know if you have problems accessing any of the papers cited or if you want more references.

4. Report and talk

What I expect is that you identify the problem (why is the method used?), tell me how the method deals with the problem and show a (simple) implementation of the method. For example you could apply Lax-Wendroff to the 1D advection equation. You have to convince me in your report that you have understood the method. For the talk you would present the method to the class and show some numerical results

References

[1] Kurt Bryan and Tanya Leise. The $\$25,000,000,000$ eigenvector: the linear algebra behind Google. *SIAM Rev.*, 48(3):569–581 (electronic), 2006.

[2] James P. Keener. The Perron-Frobenius theorem and the ranking of football teams. *SIAM Rev.*, 35(1):80–93, 1993.

[3] Per-Olof Persson and Gilbert Strang. A simple mesh generator in Matlab. *SIAM Rev.*, 46(2):329–345 (electronic), 2004.

[4] Joseph D. Skufca. Analysis still matters: a surprising instance of failure of Runge-Kutta-Felberg ODE solvers. *SIAM Rev.*, 46(4):729–737 (electronic), 2004.