

TUFTS UNIVERSITY DEPARTMENT OF MATHEMATICS  
Final Assignment, with Project Pitch

Math 87, Duchin

Spring 2020

## Part I: Model Blitz

| Method                       | Description  | Examples from class                                   |
|------------------------------|--|---|
| Calculus-style optimization  | Critical pts as potential extrema. Set derivs to zero.   |   |
| Sensitivity analysis         |  | Clean oil spill.                                      |
| Optimization w/ constraints  | Back-substitution or Lagrange multipliers.   | Manufacture 2 products.                               |
| Root finding                 | Newton's method and alternatives   |   |
| Finite differences           | Taylor approximations for derivatives  | Blood testing.  |
| <b>Linear programming</b>    | Linear objective, convex feasible region.<br>Simplex algorithm, dual LP, complem. slackness.<br>Fair division. | Diet problem.<br>Israel/Palestine negotiation.        |
| Integer programming          | Branch-and-bound.  | Mixed integer example.                                |
| Max flow                     | Network and capacities set up LP.  | Soviet rail network.                                  |
| Min cut                      | Dual to max flow.  | Boston T system.                                      |
| Matchings                    | Add source/terminus, use max flow.<br>Stable matchings.  | Alaska district pairings.<br>Medical residency match. |
| Finite state automata        | Nodes and transitions.   | Population growth.                                    |
| <b>Monte Carlo methods</b>   | Randomize and evaluate repeatedly.   | Buffon's needle.<br>Approximate integrals.            |
| <b>Markov chains</b>         | Random walk on graphs.   | Stock market steady state.<br>Autocomplete, PageRank. |
| MCMC optimization            | Metropolis-Hastings.   | Code-breaking.  |
| Poisson processes            | Fix $\lambda = pn$ , simulate.   | Bus arrival predictions.                              |
| Linear least squares         | Minimize residual with normal equations.   | Line fit, curve fit.                                  |
| Principal component analysis | Dimension reduction by fitting line, plane, etc.   | IQ, personality, music.                               |

Your task: choose four methods learned in class and write one paragraph each about a problem you could approach with this method. Be creative!

(The methods you choose for this part should be different from the one(s) featured in your project pitch.)

## Part II: Project Pitch

The aim of the project pitch is to communicate a clear **question**, modeling **approach**, and an appropriate **formulation** of the key aspects of the problem you are studying. Your model should include the gathering of appropriate data. You should discuss how you expect that a **solution** (from the model) will lead you to an **answer** (to the motivating question).

Your proposal should be 2-3 page PDF using a font size of 10 points and one-inch margins on all sides. The pitch should include the following:

- Full statement of the problem to be investigated. This includes any constraints you may have to consider, and your choice of parameters.

- Clear statement of why this problem is interesting to you and others.
- Justification for modeling approach. Discussion of potential interpretations of outputs.
- Brief literature review. (Cite a few references that you used to get a deeper understanding than the introduction in lectures. Don't use only Wikipedia.)
- Concise description of data collection strategy or sourcing and computational methods.
- Clear plans for plausibility checks, sensitivity analysis, and ways of assessing model success.

References can be cited throughout, but should be listed in a separate section at the end.

You should then prepare exactly 2 slides for the final presentation of your pitch. You will have 3 minutes to present it in the block for our final exam slot on **Monday May 4** from 3:30-5:30pm Eastern.

## **Due Dates**

Draft due Thursday April 30 at 8pm

You'll get feedback by Friday May 1

Final pitch and slides due Sunday May 3 at 8pm