Stanford University, Dept of Management Science and Engineering

# MS&E 318 (CME 338) Large-Scale Numerical Optimization

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Homework 1, Due Wednesday April 6

`http://www.stanford.edu/class/msande318/homework.html`

The aim here is to become familiar with the broad range of optimization software now available. Most packages are licensed, but there are open source solvers in some categories, notably those provided by COIN-OR, and NEOS is freely accessible.

There are two main solution methods for continuous optimization. *Active-set methods* tend to need many "cheap" iterations (because certain sparse-matrix factorizations can be updated). They can be restarted easily if the problem is modified. *Interior methods* (also called *interior-point methods*) need relatively few iterations involving more expensive linear algebra. So far, there is little progress toward warm-starting them.

1. Review the GAMS website: `http://www.gams.com`.
   (a) Try to find all the solvers that can solve LP problems. (This may include nonlinear solvers.)
   (b) Find the solvers that can handle general NLP problems (with nonlinear objective and/or nonlinear constraints).
   (c) Find a solver that can solve LP and QP problems but not general NLPs.
   (d) Find as many solvers as you can that solve general NLP problems using an *interior method*.

2. Review the NEOS Server for Optimization: `http://www-neos.mcs.anl.gov`. In particular, study the FAQ page.
   (a) In the context of LP and NLP, what does "Programming" really mean?
   (b) For an LP model, is it easy or hard to determine if a feasible solution exists (compared to finding an optimal solution)?

3. Experiment with the NEOS Case Study for the Diet Problem: `http://www.neos-guide.org/CaseStudies/dietpy/WebForms/`
   (a) Try "CLICK HERE for the demo!". Select 8 of your *very favorite* foods. Record them in your homework answer, and click "Solve". Did NEOS return a feasible solution? If not, which constraints could not be satisfied?
   (b) Select some additional "healthy" foods one by one, clicking on "Solve" each time until a feasible solution is returned. Record your results. (This isn't easy if you're allergic to dairy products!)

4. Look at the AMPL code for the NEOS Diet Problem. It is already quite concise, but there are some extraneous spaces. Codes like AMPL, MATLAB, LaTeX, ... are easier to read if we take care to format them tidily. Some people might think `f_min` and `f_max` are good names, but `fmin` and `fmax` are simpler and seem good enough. It also helps to align things where possible.

   Make a copy of the AMPL code and reformat it in the way that you feel is most tidy and readable. Print your version using `verbatim` format.