MATH 408 D100 ASSIGNMENT #1

Due: Friday, September 19th (in class)

Reading

Chapters 1 and 2.

From Chapter 1, please make sure you understand the translation of combinatorial optimization problems into integer programs, especially knapsack, set covering and travelling salesman.

Also, convince yourself that it is straightforward to model most natural constraints using mixed integer programs. LP is already powerful, but doesn't easily capture integer variables. IP gives those and a way to model constraints of the form "A or B", "satisfying k of n constraints" or even "takes a value from a specified discrete set". See the ideas at the end of Section 1.5 (Discrete Alternatives or Disjunctions) as well as problem 1.2.

Problems for Math 408 and Math 708

0. (Not graded.) Download and install the demo version of `AMPL` that is available at `http://www.ampl.com/try-ampl/download-a-demo-version/`. You can use either the command-line or graphical version. Note that demo solvers are included with the download. Work through the McDonald's diet examples described at: `http://www.ampl.com/EXAMPLES/index.html`, so that you are familiar with the software.

1. Take your nine digit student id number and add 10 to each digit to get a sequence of nine numbers $a_1, a_2, \ldots, a_9$ between 10 and 19. Take $b_1, b_2, \ldots, b_9$ to be the first nine digits of π. Your personal knapsack problem is:

$$\text{Maximize } \sum_{i=1}^{9} b_i x_i \quad \text{subject to } \sum_{i=1}^{9} a_i x_i \leq \frac{1}{2} \sum_{i=1}^{9} a_i \quad \text{and } x_i \in \{0,1\} \text{ for } i = 1, \ldots, 9.$$

Solve this integer program using the `AMPL` demo version that with the `Gurobi` solver. Submit a screen shot of the final solution.

2. Chapter 1, problem 1.

3. Chapter 1, problem 4. Note that $B = \{0,1\}$.

4. Chapter 1, problem 7.

5. Consider the problem of colouring the vertices of a graph $G = (V, E)$ using the minimum possible number of colours such that no edge connects vertices of the same colour. Formulate this problem as an integer program. You can assume that you have an a priori upper bound K for the number of colours you will use, perhaps $K = |V|$ or something smaller based on knowledge of the graph.

Additional Problems for Math 708

6. Chapter 1, problem 2. In each case you want constraints involving the given variables, the new variable that you want to model and possibly additional variables that could form part of a larger program. For instance, in part (i) these given variables are x_1 and x_2, the new variable is u.

7. Chapter 1, problem 10.

8. Chapter 1, problem 13. As with problem 1, solve the problem using the demo version of `AMPL`. Submit a screen shot of the solution, as well as the `.mod` and `.dat` files used.