MATH 3401 (Ng/Spring 2009)
Handout 1
January 21, 2009.

Big Picture of Operations Research

1 Operations Research a.k.a. (OR)

Branch of mathematical sciences that approaches large-scale problems in design and planning via mathematical modeling or simulation.

2 Branches of OR

- Deterministic* - where input data are known (mathematical programming models).
- Non-deterministic† - where data have uncertainties (probabilistic or stochastic models).

3 Phases of (deterministic) OR

- Formulation of the problem.
- Identify and construct an appropriate mathematical model.
- Finding a solution to the aforementioned model.
- Analyze the solutions obtained.
- See if model can be embellished based on the solutions.
- Implementing techniques and solutions.

4 Mathematical modeling and programming

Branch of OR that is concerned with the optimum allocation of limited resources among competitive activities under a set of constraints. In other words, to maximize or minimize an objective function in the presence of functional constraints.

Types of mathematical programming include, but not limited to, the following:

- Linear programming a.k.a. (LP).

  (Mathematical programming models whose objective functions are linear, whose constraints are linear inequalities or equalities, and whose variables take continuous values.)

- Non-linear programming (NLP).

  (Embellishment of (LP) where the functions and constraints need not be linear.)

*covered in Math 3401
†covered in Math 2501 or 3502

- Integer programming (IP).

  (Mathematical programming models whose variables can only take discrete values).

- Dynamic programming (DP).

  (Mathematical programming models that decompose complex optimization problems into a sequence and simpler problems, and solving the latter in a recursive manner.)

Now, for an elaboration of (LP), which is the main foundation of Math 3401.

5 Formulating and constructing an (LP) model

(Refer to Handout 2 or Assignment 1 for examples.)

- Recommended steps:
  - define decision variables.
  - find and set up the objective function.
  - find and set up the constraints.
  - (usually) add non-negativity constraints, unless otherwise specified.
- Issues of objective function:
  - constants can be dropped; it will only differ in the *optimal value*, NOT any *optimal solution*.
  - maximizing a function is equivalent to minimizing the negative of that function. Again, the only difference is the sign of the optimal value.
- Concise way of formating an (LP):
  - right hand side of constraints can always be made up of constants.
  - subscripts (on variables or on constraints enumeration) can be used to reduce writing.