Conts Vs Discrete (Types of Optimization)

There are three types of problems, depending on the variables (the x_s):

1) Discrete optimization problems:

$x_{ij} \in \mathbb{Z}$, integers, (or, sometimes called, integer programming problem

Papadimitriou and Steiglitz's book is the one we choose to follow (later) for addressing some of the issues involved. (also, simplex method)

2) Continuous Optimization problems:

Your textbook appears to be the best here:

$x_{ij} \in \mathbb{R}$

3) Mixed Integer Programming problems:

"Some" $x_{ij} \in \mathbb{Z}$ and the rest satisfy: $x_{ij} \in \mathbb{R}$

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Constrained and Unconstrained Optimization

From $f(x)$ in $\min_{x \in \mathbb{R}^n} f(x)$, we have:
linear, nonlinear, or convex problems
(to be discussed next).

Then, depending on the number of variables, we have large or small problems.

For small (to medium) unconstrained problems, I strongly reccomend the classic textbook (Newton-based):
Dennis & Schnabel, "Numerical Methods for Unconstrained Optimization and Nonlinear Equations," SIAM classics in Applied Mathematics. (freely available software)

For large optimization problems, I strongly recommend:
R. Fletcher, "Practical Methods of Optimization", 2nd ed, Wiley
written by a pioneer in the area, whose algorithms, we will use.

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Smoothness of the function

We have smooth & non-smooth methods here (see REDUCE?, free online books on this, see refs).

Unconstrained problems

Constraints enter by penalization terms ...

Constrained Optimization

Explicit restrictions on the variables:

$$0 \leq x_i \leq 100, \text{ etc}$$

(do not confuse with integer constraints)

Global and Local Optimization

Convex programming

- All local solutions are also global.
- Linear programming problems also belong to convex programming.

Our book focuses on local problems, but we will also want to generalize our discussion to global optimization problems from Dennis & Schnabel (and others?).

Stochastic and Deterministic Optimization

Suppose that the models are not known, but we only have estimates. Then the problem itself is stochastic.

... not covered here, but could look at algorithms which generate deterministic subproblems ...

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Optimization Algorithms

- **Robustness**: perform well on a wide-range of problems, for reasonable choices of the initial variables.
- **Efficiency**: should not require too-much time or storage.
- **Accuracy**: precision of the solution, w/out being overly sensitive to rounding errors.

... often conflicting. So, we must report them together.