MGB 206: Decision Making and Management Science

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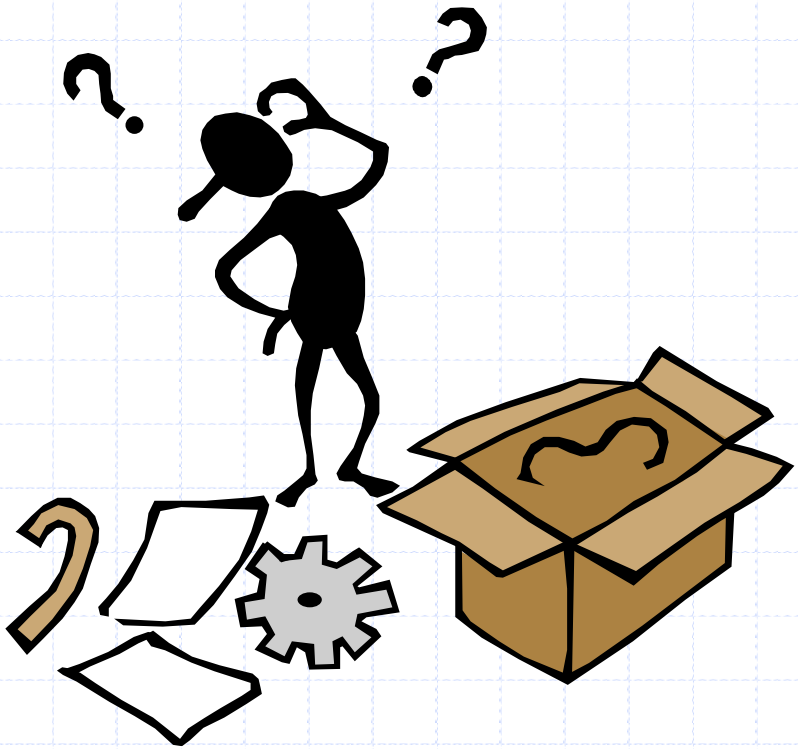
Lesson Plan: Session 5

1. Session 4 reprise
2. Dual values
3. Integer programs

What We Discussed Last Time



Homework Review

- HW#3: Key
- HW#4: Key

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LP Sensitivity Analysis

- If we change input data, how does the solution change?
- Solver provides this answer "for free"!
  - Constraint – shadow price
  - Variable – reduced cost

Constraint Shadow Price

Change in optimal objective value if constraint limit is increased by 1 unit

- One shadow price per constraint
- Unit of shadow price is unit of objective divided by unit of constraint
- Often nice obvious economic signal
- Bounds within which shadow price applies also available

- See 4 boats production planning LP

Variable Reduced Cost

Change in optimal objective value if variable bound is increased by 1 unit

- One reduced cost per variable
- Only makes sense for 'inactive' variables
- Economic interpretation not so obvious
  - Change in associated objective coefficient required to 'activate' that variable

Summary: LP Sensitivity Analysis

- Available "free" with solve
  - Dual values (shadow prices, reduced costs)
  - Limits within which dual values apply
- If proposed changes touch multiple inputs, then it's best to resolve LP
  - Often much faster than *ab initio* solve
- Widely used, but usually not in its direct sense

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Exercise: Extending Boats LP

1. What if we have multiple objectives?
2. What if demand is limited?
3. What if we need to analyze multiple time periods in one model?
4. What if we need to upgrade manufacturing?

Multiple Objectives

- Corporate edict: use up all the engines
- Is that the best you can do?
- Ok, wait! Maybe that wasn't such a great idea! Use up all the engines but make at least $456k!

Limit Production by Demand

- Demand
  - Large sailboat 160
  - Motorboat 130
  - Small sailboat 170
  - Sailboard 150
- What does this do to our profit?

Plan For Two Seasons

- Demand split over next two seasons

Demand	S1	S2
Large sailboat	80	80
Motorboat	65	65
Small sailboat	85	85
Sailboard	45	105

- Additional sailcloth can be ordered for S2 at $50 /unit

Evaluating A Costly Upgrade

- Producing large sailboats requires an upgrade of existing production facilities
  - Cost: $14,000
- How to model such a bump in cost?

Integer Programs

- An LP in which some of the variables cannot take on fractional values
  - A mix of continuous and integer variables, is called Mixed-Integer Programming (or, MIP)
- Integer variables typically model
  - On/off type decisions (binary, i.e., 0/1)
  - Logical conditions
  - True whole numbers (integer)

Integer Programs (2)

- Simple to implement in Risk Solver
- *Warning*: Will increase solution time
  - Adding integrality to an LP may make it unsolvable!
  - That's because MIPs are solved using a more complex algorithm: Branch and bound
- *Warning*: Dual values carry no meaning

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