MGB 206: Decision Making and Management Science

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Lesson Plan: Session 4

1. Recalling Session 3
2. Homework review
3. Intro to optimization

What We Discussed Last Time

Key Simulation Learnings

1. Distributions
   - What are they? How ate they related to histograms? Which one to use when?
2. Convergence
   - How long should this be going on?
3. Flaw of averages

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Homework Review

- *HW 1*: Simpson's Paradox goes away when we use a weighted average
- *HW 2*: Key

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Recall 'Formal Decision-Making'

- Choosing
  - between possible alternatives
  - based on preferences
- Mathematical optimization implies choosing
  - the **best possible** alternative
  - between **all possible** alternatives

Example: Boat Production

- Production planning in a boat yard
  - Two types – sailboats and motorboats
  - Different raw materials, different profits
  - Raw materials are limited
  - Otherwise, production can be unlimited
- We'll set this up as an optimization problem

Optimization Basics

- Key concepts
  - **Variables** – decisions you control
  - **Objective** – goal you wish to maximize or minimize
  - **Constraints** – limits on resources (usually)

Optimization Basics (2)

- There is never one 'best model'
- Standard check-list
  - Create model (with variables, an objective and constraints)
  - Ensure we have the right data
  - Set up model in Analytic platform
    - Excel is ours; many others exist
  - Let "solver" compute best possible
    - RSP is our choice; many others exist

Exercise: Production Planning

- Slightly larger instance of boat production exercise from Session 1
  - Difficult to solve using data tables
- Introduction to formal optimization

Problem Description

- Goal: identify best production plan for the year ahead

Finished product (type of boat)	Profit (/unit)
Large sailboat	$1,200
Motorboat	$1,050
Small sailboat	$930
Sailboard	$750

- Can sell as many as we produce

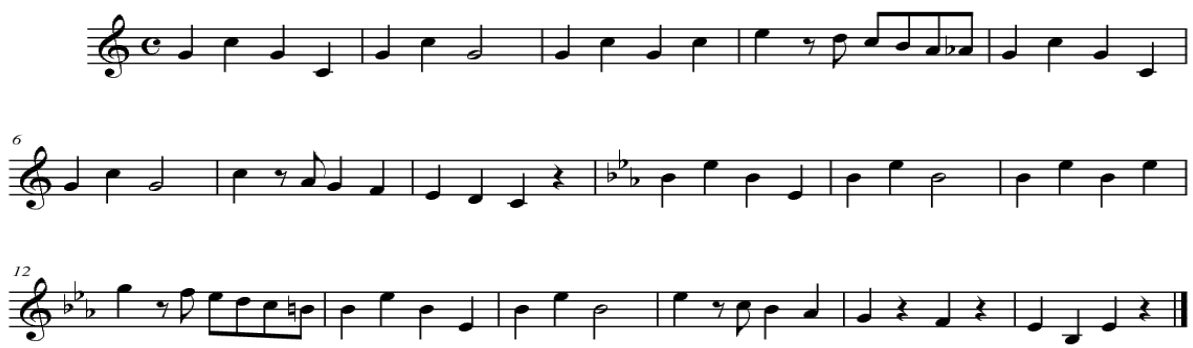
Problem Description (2)

- Raw materials are supply-limited

Material	Inventory	Requirements by finished product			
		Large sailboat	Motorboat	Small sailboat	Sailboard
Sailcloth	700	4	0	3	1
Glass fiber	1,380	8	4	3	2
Epoxy	1,280	3	3	3	2
Aluminum	1,100	4	2	2	2
Engines	120	0	1	0	0

Exercise Steps

1. Write out model on paper
2. Create in Excel
3. Explore “what if” approach
4. Compute using Risk Solver



Key Concepts

- 100% linear formulas make it a Linear Program (LP)
  - Certain Excel operations preserve linearity, others destroy it
- Feasibility, optimality, unboundedness
- Dual values
  - Constraint - shadow price
  - Variable – reduced cost

Linear Programs Are Ubiquitous!

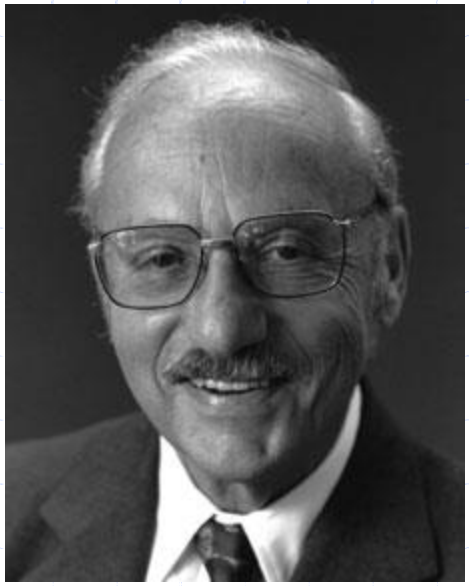
" […] let me relate my recent encounter with a farmer at a conference on commercial LP software systems. The farmer manages cattle and chicken farms. Surprisingly to me, he had his laptop computer at the conference. He related that during the fall harvest season, he travels extensively through agricultural areas and always takes his laptop. Why? Because it contains LP-based diet models for various cattle and chicken feed formulations. *Before accepting an offer from a farm for feed-mix raw materials, he uses the LP software's sensitivity analysis to check, on the spot, whether this offer would reduce his overall feed costs.* Doing this has helped him reduce his costs substantially." *Katta Murthy, U Mich*

Typical Models & Applications

- Planning
  - Network design
  - Budgeting
  - Facilities
  - Product mix
  - Blending
  - Portfolios
  - Pricing/revenue
- Scheduling
  - Machines
  - Personnel
- Real-time operation
  - Networks and flows
    - Transportation
  - Interactive selling
  - Control systems

Historical Note

- Solution due to George Dantzig
  - 'Simplex method' developed in 1947
- Context: Air Force planning
- Developed LP further at RAND, Berkeley, Stanford
  - Extensions to uncertainty
- Passed away in 2005



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