Today's Do-Now (1.23.15)
In your 1-sub. Notebook with date

1. Have Day 2 HW out with HW Cal.
2. Find the solution set to the system of linear inequalities:

$y > -x + 4$ $\qquad\qquad$ $y > x - 2$

Math3 – Unit 1 Day 3 PPT #1

Linear Programming

A Method for Determining Maximums and Minimums

History

- George Dantzig developed its foundational concepts between 1947-1949.
- During WWII he worked on proposed schedules of training, logistics supply, and deployment.

See Chelst, Kenneth and Edwards, Tom in bibliography

- He was the first to express the criterion for selecting a good or best plan as an explicit mathematical *function*, now called an *objective function*.

- Developed the simplex algorithm that finds the *optimal solution* for a set of linear inequalities.

First Problem Dantzig Solved

- A minimum cost diet problem that involved nine equations (nutrition requirements) with seventy-seven *decision variables*.
- It took 120 man days using hand-operated desk calculators.
  - Now a personal computer could solve it in less than one second.

For Example: Nabisco

http://www.bizrate.com/buy/products__cat_id--16030900,keyword--Nabisco,start--12.html

Key Operations for the NABISCO Biscuit Division:

- Baking
  - Raw materials are fed into an oven on a conveyor belt
- Secondary operations
  - Sorting, packaging, and labeling

Scheduling Biscuit Production is Difficult:

- The ovens can't be used to bake all products
- Efficiency of ovens varies
- Production must be planned to keep the manufacturing and transportation costs as low as possible.

Questions To Be Answered With Mathematical Model

- Where should each product be produced?
- How much of each product should be assigned to each oven?
- As new products are developed where should new plants be developed?

Problem

- Study of the differences between “dump” pack vs. “slug” pack.
  - Dump – cookies are loose
  - Slug – Crackers are stacked in columns and wrapped separately.

- Model was used to plan the equipment changeover for different locations to convert to “slug” packaging.

Realistic Problems To Be Solved at Nabisco in 1983...

- Could involve:
  - 150 products
  - 218 facilities
  - 10 plants
  - 127 customer zones

- A problem this size would use:
  - Over 44,000 *decision variables*
  - Almost 20,000 *constraints*

- These problems were routinely solved in 1983 on an IBM computer in under 60 seconds!

Foe Example: Agricultural Production in Chang Qing, China

The Problem to Solve:

- County officials used linear programming to aid farmers in their choices of crops.
- They wished to increase profit while protecting the environment
- Problem had over 3000 variables and 100 constraints

Wheat

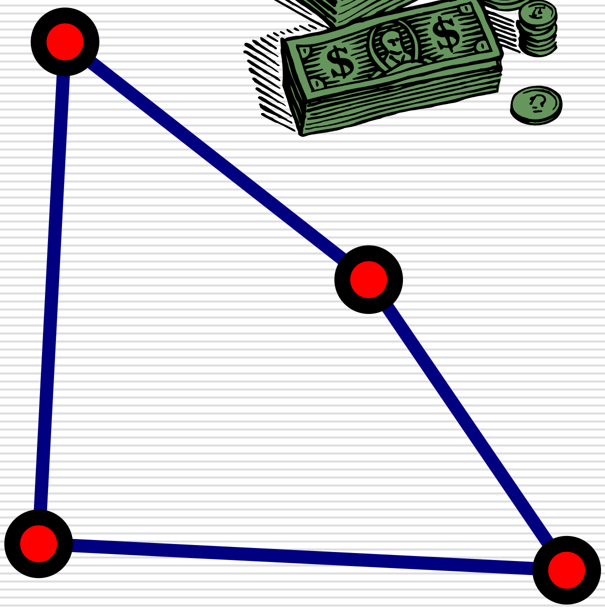
Rice

Nongmuyu ye bu waishi si and Zhongguo nongxue hui, ed., *Zhongguo nongye,* (Beijing: Nongye chuban she, 1983), p.100.

Courtesyof:
:http://www.chamberlain.net.au/~ken/china/pict
ures/photo11.html

- Using the model led to 12% increase in crop profits and a 54% increase in animal husbandry profits.
- It improved the region’s ecology and diversified the economy.

Terminology

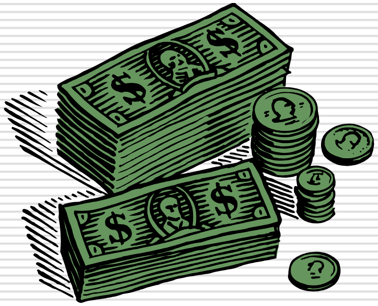


Variables

- Represent the quantities that a manager can change

Objective Function

- The *equation* that represents the goal of either maximizing profit or minimizing cost

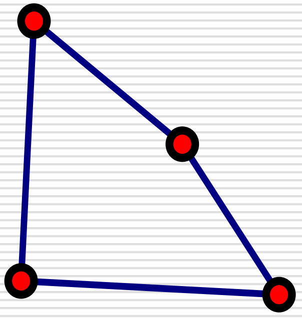


Constraints

- Limitations created by scarce resources (time, equipment, etc.)
- Expressed algebraically by *inequalities*

Feasible Region

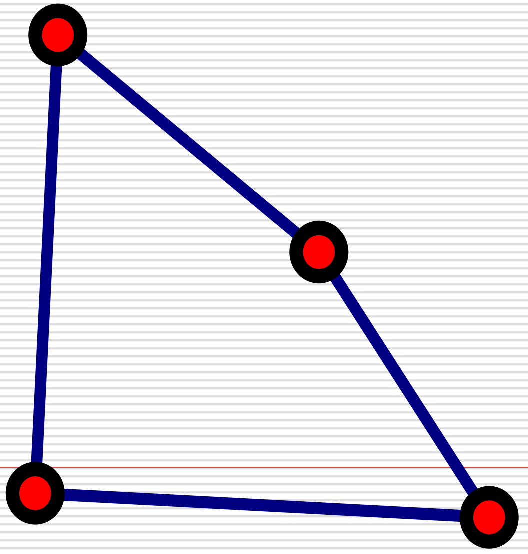
- Area containing all the points that satisfy the constraints (System solutions)



- All possible solutions to the problem lie in the feasible region, on the boundary, at the vertices.

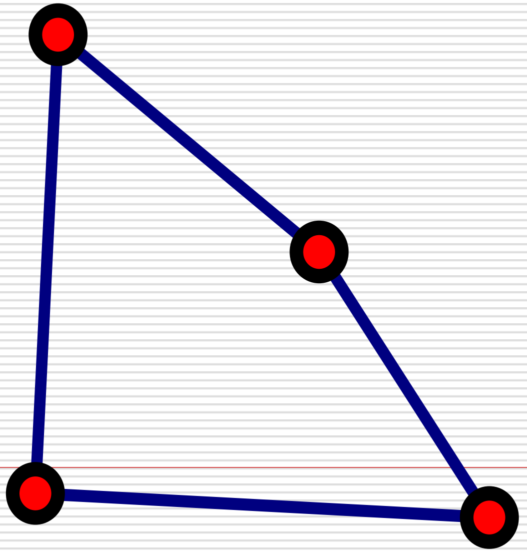
Vertices

- The optimal solution (the MAX/min) will **always** be at a vertex of the feasible region.



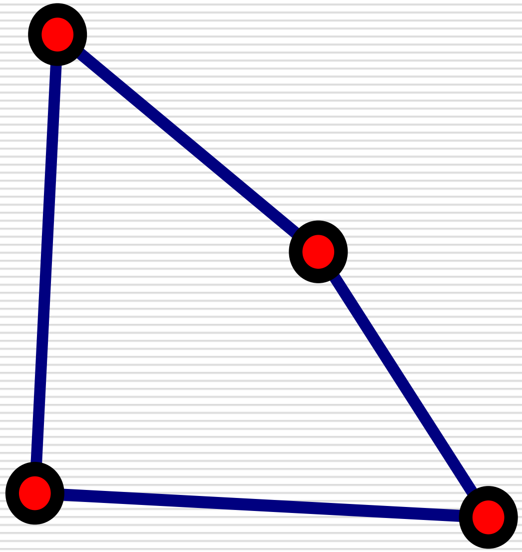
STEP 1

- Read the problem
- Choose the variables



STEP 2

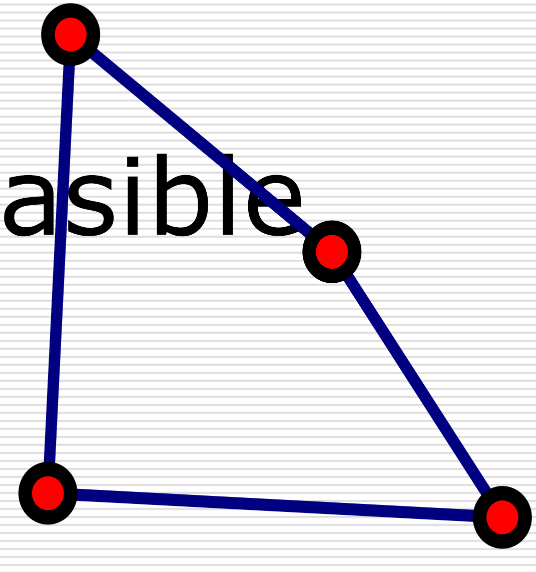
- Write the constraints (inequalities)
- Write the Objective Function



STEP 3

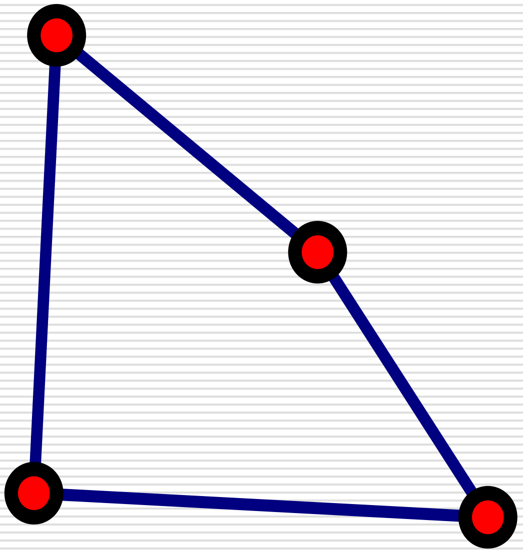
- Graph the constraints (inequalities)

- Shade the Feasible Region



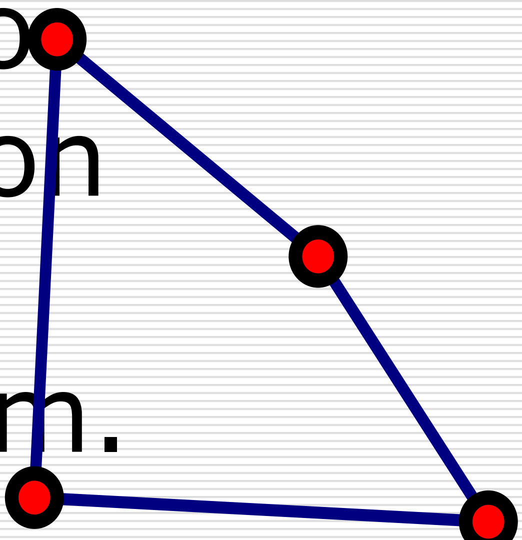
STEP 4

- Find the vertices - the intersections of each two lines graphed



STEP 5

- Substitute each vertex ordered pair into the Objective Function to determine the solution to the Linear Programming problem.



Example 1

- Open the next PPT!