6 of 29

Optimization

- Set of techniques to find the maximum or minimum soluon for a problem
- **Goal Seek:** alter one variable to determine which value achieves a specific objecv e (e.g., product price)
- **Solver (unconstrained):** alter mulple v ariables to determine which combinaon r esults in a maximum or minimum result
- **Solver (constrained):** solve objecv e by altering mulple variables, subject to constraints

13 of 29

Examples

- Find the demand for a product that results in a breakeven point.
- Find the product price that maximizes profit.
- Determine the opmal mix of pr oducts to be produced to maximize profit (subject to raw material and labor constraints).
- Schedule a workforce to minimize number of workers that sll c overs all shifts.
- Determine product distribuon plan fr om warehouses that sas fies demand and minimizes transportaon c osts.
- Select best projects in capital budgeng tha t opmiz e NPV (subject to budget constraints).

17 of 29

History

- 1827—Joseph Fourier proposed inial op miz aon techniques.
- 1939—Kantorovich developed more modern approaches during WWII to opmiz e military planning (won Nobel Prize).
- 1947—Dantzig developed the simplex method, which is used in most soluons of linear pr oblems today.

21 of 29

Terminology

- **Objective (objective function):** the variable that you are trying to opmiz e
  - E.g., maximize profit, minimize travel me
- **Constraints:** condions tha t limit the search for a soluon
  - E.g., labor, raw material, inventory

Techniques

1. Linear programming assumes that the goal is linear and the changing variables are connuous.
2. Nonlinear programming assumes that the goal is nonlinear and the changing variables are connuous.
3. Integer programming assumes the changing variable must be a whole number.

All of these are automated within Excel.

View All View Keyframes

Goal Seek

- Excel technique that searches for values of a variable that will result in a precise outcome
- Only allows one variable to be changed
- Measures the effect of these changes on the objecv e unl the g oal is achieved

4 of 8

Sample Problem

How many products must be sold to reach the breakeven point (profit = zero) for that product?

6 of 8

Sample Problem

How many products must be sold to reach the breakeven point (profit = zero) for that product?

- Goal Seek allows you to set profit at zero.
- Vary demand unl g oal is reached.

8 of 8

View All View Keyframes

Unconstrained Optimization with Solver

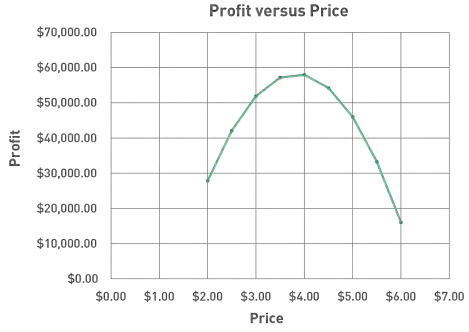
- Opmiz aon ma ximizes or minimizes objecv e.
- Unconstrained opmiz aon has no limits on the possibilies of the v ariables.
- Relies on linear, nonlinear, or integer programming techniques to find the soluon, depending on the pr oblem.
- Sample problem: Find the price of a product that maximizes profit, recognizing that as price increases, demand will decrease.

6 of 14

Demand and Profit

7 of 14

Demand and Profit



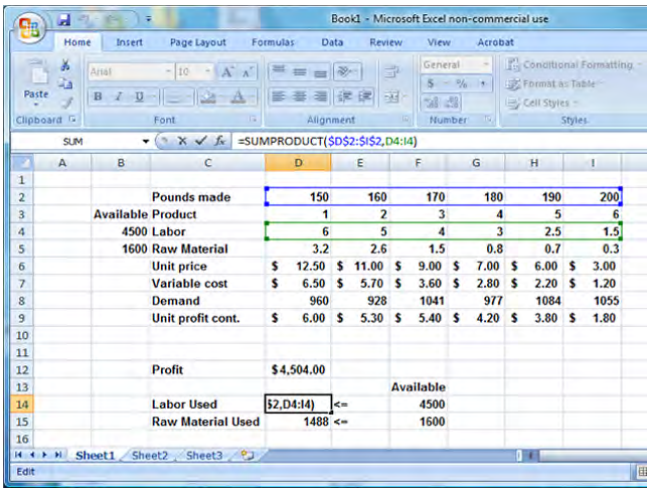
9 of 14

View All View Keyframes

Optimization and Useful Solvers

- Opmiz ation often requires seng up c omplex equaons, which r equires you to mulply mulple r ows of data.
- SUMPRODUCT takes the product of two separate rows/columns, mulplies them t ogether, and calculates the sum.

3 of 12



4 of 12

Example

- Labor used = SUMPRODUCT (D2:I2, D4:I4)
- Mulplies D2*D4, E2*E4, … , then adds sums t ogether

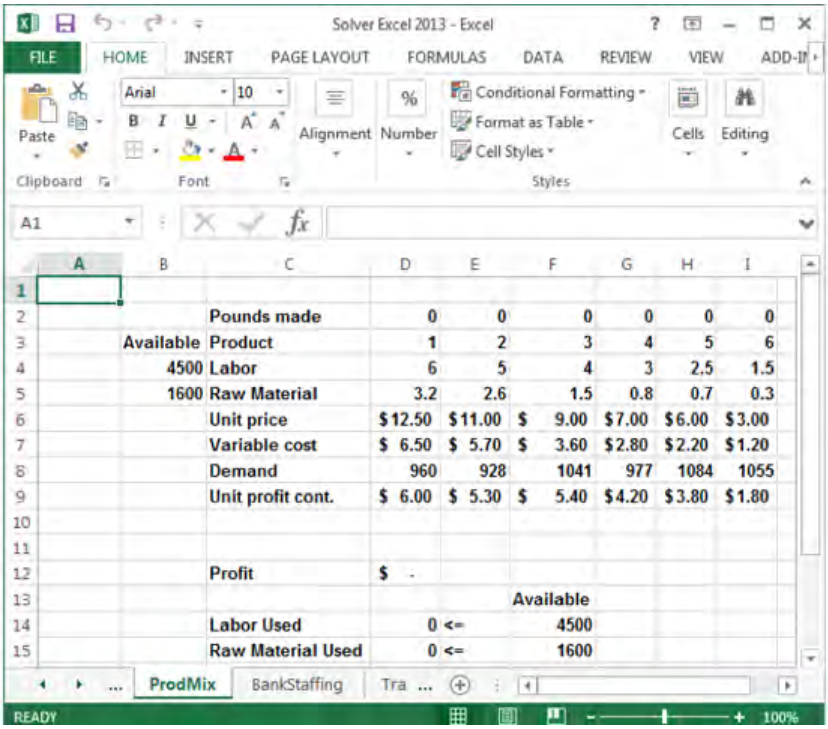
12 of 12

View All View Keyframes

Product Mix

- Company generates a variety of products.
  - Each product generates profit.
  - Each product requires raw material and labor.
- **Product mix** determines how much of each product to manufacture subject to constraints of raw material and labor.

5 of 9



		Pounds made	0	0	0	0	0	0
	Available	Product	1	2	3	4	5	6
	4500	Labor	6	5	4	3	2.5	1.5
	1600	Raw Material	3.2	2.6	1.5	0.8	0.7	0.3
		Unit price	$12.50	$11.00	$ 9.00	$7.00	$6.00	$3.00
		Variable cost	$ 6.50	$ 5.70	$ 3.60	$2.80	$2.20	$1.20
		Demand	960	928	1041	977	1084	1055
		Unit profit cont.	$ 6.00	$ 5.30	$ 5.40	$4.20	$3.80	$1.80
		Profit	$ -					
					Available			
		Labor Used	0	<=	4500			
		Raw Material Used	0	<=	1600			

6 of 9

View All View Keyframes

Workforce Scheduling

- Problems are common where shift work requires minimal but different levels of staffing.
- Must determine how many staff are needed by shift rotation to cover all staffing needs.
- Overall goal is to minimize worker expense.

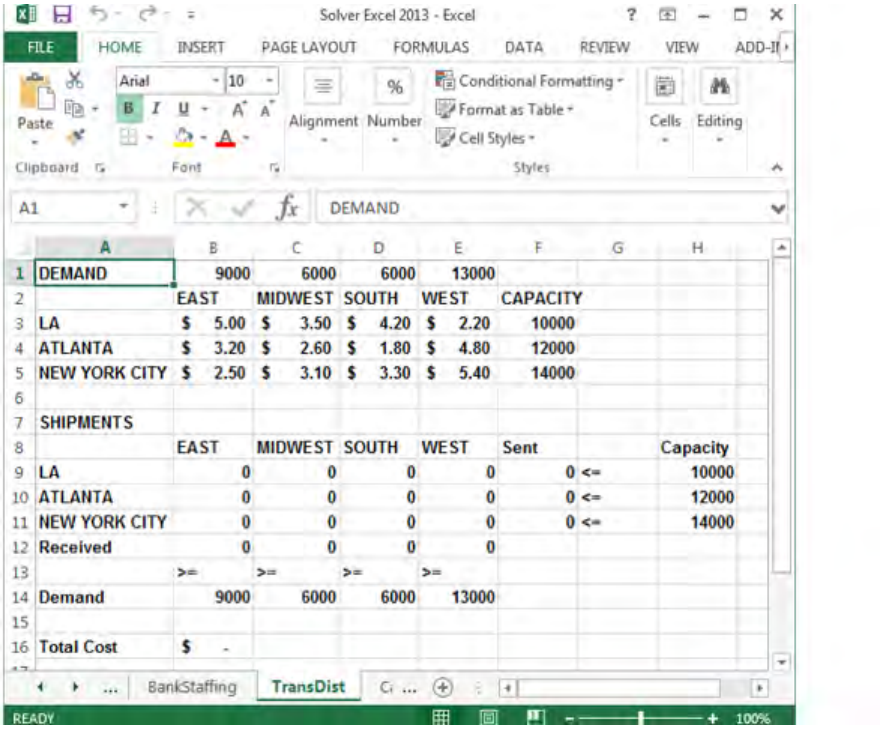
7 of 17

View All View Keyframes

Transportation and Distribution

- Corporations try to find the cheapest way to transport products from warehouses to customers.
- The challenge is that warehouses and customers are located all over the country.
- The goal is to satisfy demand with the lowest transportation cost.

4 of 13



	A	B	C	D	E	F	G	H
1	DEMAND	9000	6000	6000	13000			
2		EAST	MIDWEST	SOUTH	WEST	CAPACITY		
3	LA	$ 5.00	$ 3.50	$ 4.20	$ 2.20	10000		
4	ATLANTA	$ 3.20	$ 2.60	$ 1.80	$ 4.80	12000		
5	NEW YORK CITY	$ 2.50	$ 3.10	$ 3.30	$ 5.40	14000		
6								
7	SHIPMENTS							
8		EAST	MIDWEST	SOUTH	WEST	Sent		Capacity
9	LA	0	0	0	0	0	<=	10000
10	ATLANTA	0	0	0	0	0	<=	12000
11	NEW YORK CITY	0	0	0	0	0	<=	14000
12	Received	0	0	0	0			
13		>=	>=	>=	>=			
14	Demand	9000	6000	6000	13000			
15								
16	Total Cost	$ -						

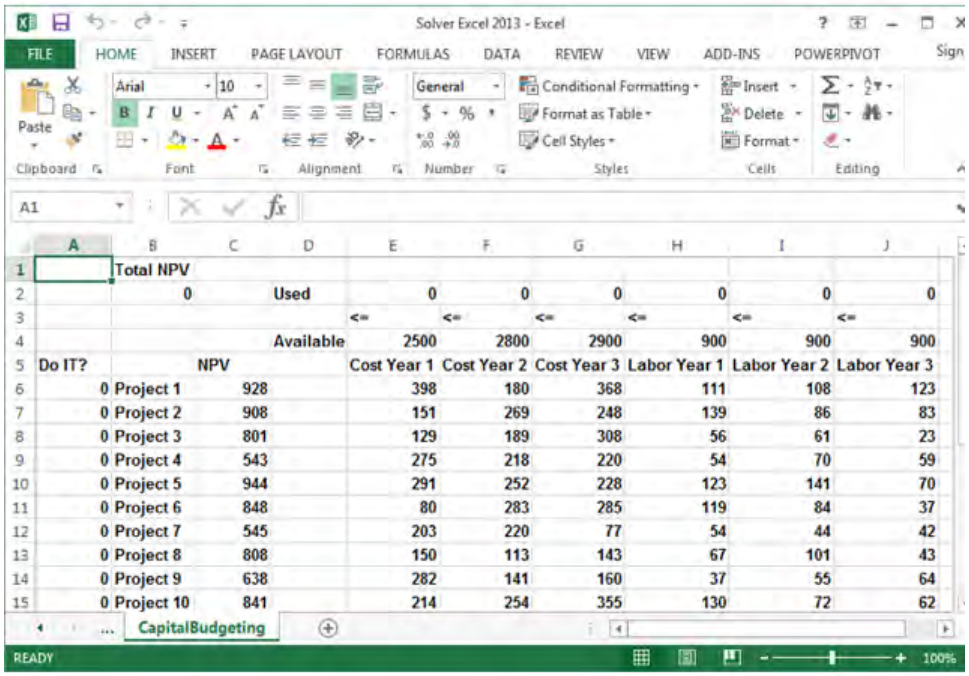
5 of 13

View All View Keyframes

Capital Budgeting

- Organizations have many projects they want to take on yet are constrained by their budget.
- Capital budgeting researches evaluates to determine which projects should be chosen.
- Goal: Maximize NPV subject to investment cost and labor constraints.

4 of 10



	A	B	C	D	E	F	G	H	I	J
1		Total NPV								
2		0		Used	0	0	0	0	0	0
3					<=	<=	<=	<=	<=	<=
4				Available	2500	2800	2900	900	900	900
5	Do IT?		NPV		Cost Year 1	Cost Year 2	Cost Year 3	Labor Year 1	Labor Year 2	Labor Year 3
6	0	Project 1	928		398	180	368	111	108	123
7	0	Project 2	908		151	269	248	139	86	83
8	0	Project 3	801		129	189	308	56	61	23
9	0	Project 4	543		275	218	220	54	70	59
10	0	Project 5	944		291	252	228	123	141	70
11	0	Project 6	848		80	283	285	119	84	37
12	0	Project 7	545		203	220	77	54	44	42
13	0	Project 8	808		150	113	143	67	101	43
14	0	Project 9	638		282	141	160	37	55	64
15	0	Project 10	841		214	254	355	130	72	62

5 of 10