Lecture 18

Produced by Dr. Worldwide

Welcome to the 305

Ex: Oregon Atlantic Company

- Oregon Atlantic Company produces two paper products
  - Newsprint
  - Wrapping paper

- Labor
  - Need 5 minutes per yard of newsprint
  - Need 8 minutes per yard of wrapping paper
  - Company has 4,800 minutes per week

- Profit
  - Make $0.20 for a yard of newsprint
  - Make $0.25 for a yard of wrapping paper

- Demand
  - 500 yards of newsprint per week
  - 400 yards of wrapping paper per week

Ex: Oregon Atlantic Company

- List of weekly goals
  - Limit overtime to 480 minutes
  - Achieve profit of $300
  - Fulfill the demand for the products in order of magnitude of their profits
  - Avoid underutilization of production capacity

- Q: Can the Oregon Atlantic Company achieve all their weekly goals?

- Primary decision variables
  - $x = number\ of\ yards\ of\ newsprint$
  - $y = number\ of\ yards\ of\ wrapping\ paper$

Ex: Oregon Atlantic Company

- Goal 1: Limit overtime to 480 minutes
  - Amount of labor needed in minutes to produce x yards of newsprint and y yards of wrapping paper

    $5x + 8y$

  - Company has 4,800 minutes, but they are okay with 480 extra

    $5x + 8y \leq 4800 + 480 = 5280$

  - Written as a linear program

    Minimize $\quad d_1^+$

    Subject to $\quad 5x + 8y + d_1^- - d_1^+ = 5280$

Ex: Oregon Atlantic Company

- Goal 2: Achieve profit of $300 each week
  - Profit from producing x yards of newsprint and y yards of wrapping paper

    $0.2x + 0.25y$

  - We would like to maintain weekly profit above $300

    $0.2x + 0.25y \geq 300$

  - Written as a linear program

    Minimize d_2^-

    Subject to $0.2x + 0.25y + d_2^- - d_2^+ = 300$

Ex: Oregon Atlantic Company

- Goal 3: Fulfill the demand for newsprint and wrapping paper
  - Based on weekly demands, we want

$$x \geq 500$$
$$y \geq 400$$

  - We want to prioritize fulfilling demands according to their profit

$$\frac{Profit\ of\ newsprint}{Profit\ of\ wrapping\ paper} = \frac{0.2}{0.25} = \frac{20}{25} = \frac{4}{5}$$

  - Written as a linear program

Minimize $\quad 4d_3^- + 5d_4^-$

Subject to $\quad x + d_3^- - d_3^+ = 500$
$\qquad\qquad\quad y + d_4^- - d_4^+ = 400$

Ex: Oregon Atlantic Company

- Goal 4: Avoid the underutilization of production capacity
  - Remember that company has 4,800 minutes of normal production
  - We would like to use all this production

    $5x + 8y \geq 4800$

  - Written as a linear program

    Minimize $\quad d_5^-$

    Subject to $\quad 5x + 8y + d_5^- - d_5^+ = 4800$

- Class activity
  - Split up class into 4 groups
  - Give each group different ordering of goals according to priority
  - Each group solves goal programming model
  - Compare and discuss the results from the 4 groups

Ex: Oregon Atlantic Company

- Division of class

Group IV: Last Initial U-Z Download Sheet 4	Group I: Last Initial A-G Download Sheet 1
Group III: Last Initial O-T Download Sheet 3	Group II: Last Initial H-N Download Sheet 2

Ex: Oregon Atlantic Company

- Same set of constraints for all groups

$$5x + 8y + d_1^- - d_1^+ = 5280$$
$$0.2x + 0.25y + d_2^- - d_2^+ = 300$$
$$x + d_3^- - d_3^+ = 500$$
$$y + d_4^- - d_4^+ = 400$$
$$5x + 8y + d_5^- - d_5^+ = 4800$$
$$x, y, d_i^-, d_i^+ \geq 0$$

- Recall the objectives for minimization
  - d_1^+ (Limit Overtime)
  - d_2^- (Achieve Profit)
  - $4d_3^- + 5d_4^-$ (Fulfill Demand)
  - d_5^- (Avoid Underutilization of Labor)

Ex: Oregon Atlantic Company

- Different groups are different branches of the same company
  - Group 1 is okay with employees working overtime to ensure that they achieve their profit
  - Group 2 cares most about profit and fulfilling demand and least about the utilization of labor
  - Group 3 cares most about fulfilling the demands of their customers and least about reaching the desired profit
  - Group 4 cares most about making sure their employees reach the desired regular production capacity and the ideal overtime scenario

Ex: Oregon Atlantic Company

- Division of priorities

Group IV

Priority 1	d_5^-
Priority 2	d_1^+
Priority 3	d_2^-
Priority 4	$4d_3^- + 5d_4^-$

Group I

Priority 1	d_1^+
Priority 2	d_2^-
Priority 3	$4d_3^- + 5d_4^-$
Priority 4	d_5^-

Group III

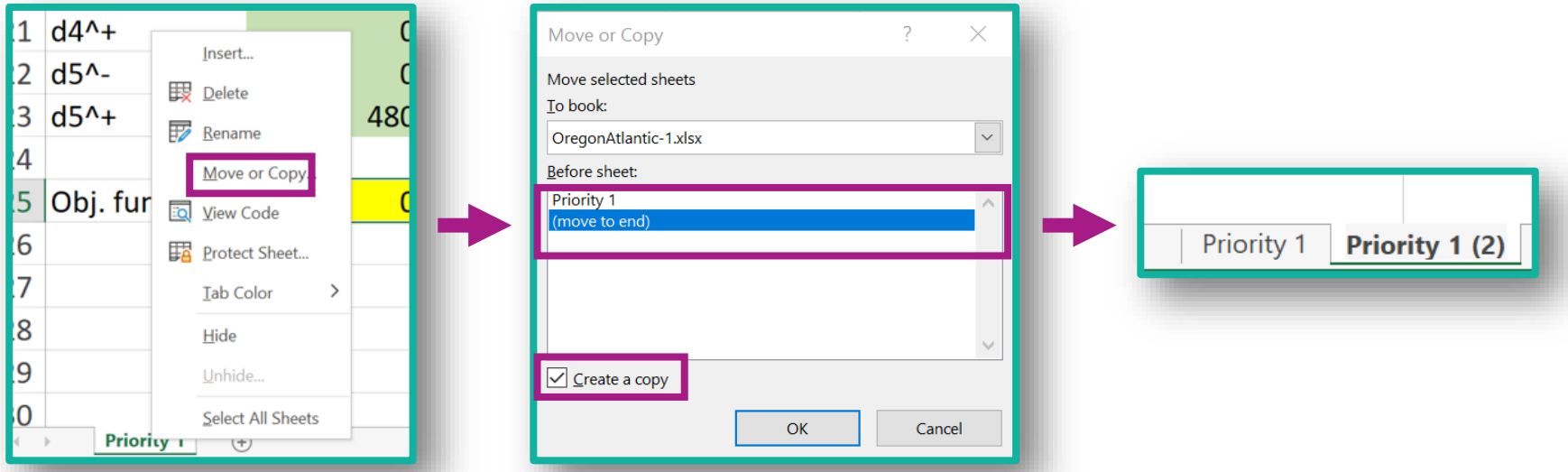
Priority 1	$4d_3^- + 5d_4^-$
Priority 2	d_5^-
Priority 3	d_1^+
Priority 4	d_2^-

Group II

Priority 1	d_2^-
Priority 2	$4d_3^- + 5d_4^-$
Priority 3	d_5^-
Priority 4	d_1^+

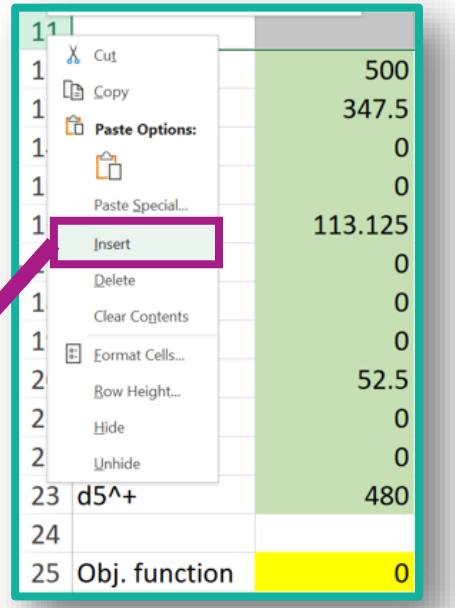
Goal Programming in Excel

- Instructions for solving goal programming problem in Excel
  - Top priority objective has been optimized (see tab Priority 1)
  - Almost all groups have different initial solutions (Group I and IV identical)
  - Copy sheet Priority 1 and rename Priority 2 (right click on tab)



Goal Programming in Excel

- Instructions for solving goal programming problem
  - Create new constraint in tab Priority 2 based on previous results for Priority 1



Set value equal to previous minimization

Formula with MMULT

		x	y	d1^-	d1^+	d2^-	d2^+	d3^-	d3^+	d4^-	d4^+	d5^-	d5^+			
5	***Constraints:***													*Used*	*Constraint*	*Value*
6	Labor overtime		8	1	-1	0	0	0	0	0	0	0	0	5280	=	5280
7	Profit	0.2	0.25	0	0	1	-1	0	0	0	0	0	0	300	=	300
8	Demand x	1	0	0	0	0	0	1	-1	0	0	0	0	500	=	500
9	Demand y	0	1	0	0	0	0	0	0	1	-1	0	0	400	=	400
10	Labor underti	5	8	0	0	0	0	0	0	0	0	1	-1	4800	=	4800
11	Priority 1													#VALUE!	=	0

Ex: Oregon Atlantic Company

- Recall your group's objectives in order of priority

Group IV		Group I	
Priority 1	d_5^-	Priority 1	d_1^+
Priority 2	d_1^+	Priority 2	d_2^-
Priority 3	d_2^-	Priority 3	$4d_3^- + 5d_4^-$
Priority 4	$4d_3^- + 5d_4^-$	Priority 4	d_5^-
Group III		**Group II**	
Priority 1	$4d_3^- + 5d_4^-$	Priority 1	d_2^-
Priority 2	d_5^-	Priority 2	$4d_3^- + 5d_4^-$
Priority 3	d_1^+	Priority 3	d_5^-
Priority 4	d_2^-	Priority 4	d_1^+

- We want to fill in the following table

Decision Variables	x	y	d_1^-	d_1^+	d_2^-	d_2^+	d_3^-	d_3^+	d_4^-	d_4^+	d_5^-	d_5^+
Group I												
Group II												
Group III												
Group IV												

The End

Dale