



# 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
  - $x = \text{number of yards of newsprint}$
  - $y = \text{number of yards of wrapping paper}$



# 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

$$\text{Minimize} \quad d_1^+$$

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





# 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

$$\text{Minimize} \quad d_2^-$$

$$\text{Subject to} \quad 0.2x + 0.25y + d_2^- - d_2^+ = 300$$



# 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

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

- Written as a linear program

$$\text{Minimize} \quad 4d_3^- + 5d_4^-$$

$$\begin{aligned} \text{Subject to} \quad & x + d_3^- - d_3^+ = 500 \\ & y + d_4^- - d_4^+ = 400 \end{aligned}$$



# 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  $d_5^-$

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

- 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

Center Stage

Group IV  
Download Sheet 4

Group I  
Download Sheet 1

Group III  
Download Sheet 3

Group II  
Download Sheet 2





# Ex: Oregon Atlantic Company



- Same set of constraints for all groups

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

- 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)

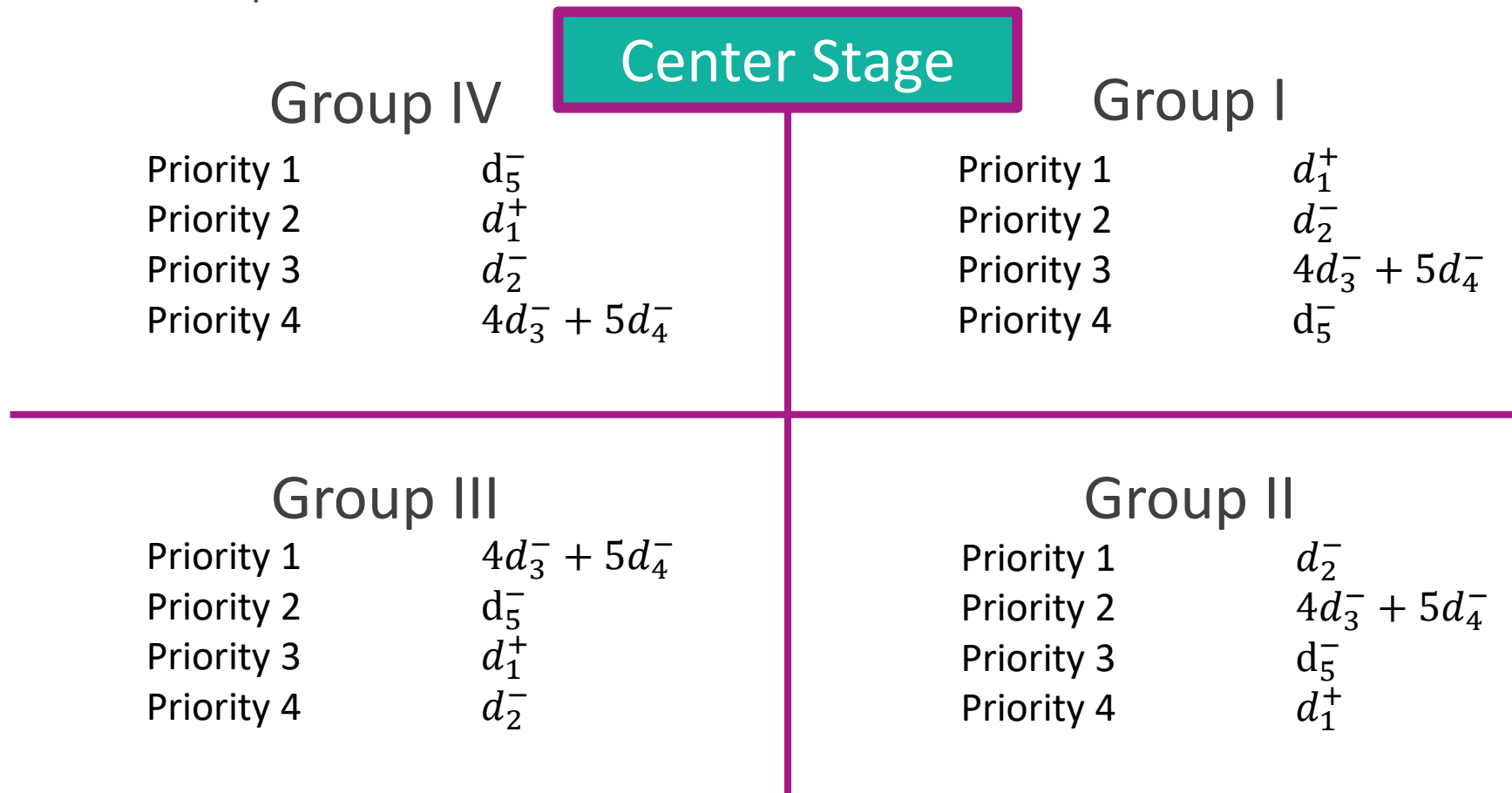
# Ex: Oregon Atlantic Company

- Different groups are different branches of the same company
  - Group 1 doesn't prioritize labor and cares most about minimizing cost and increasing the desired 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

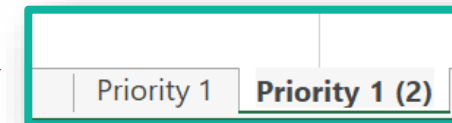
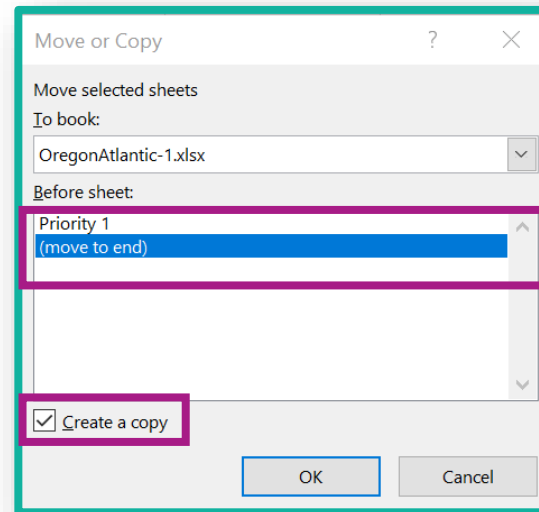
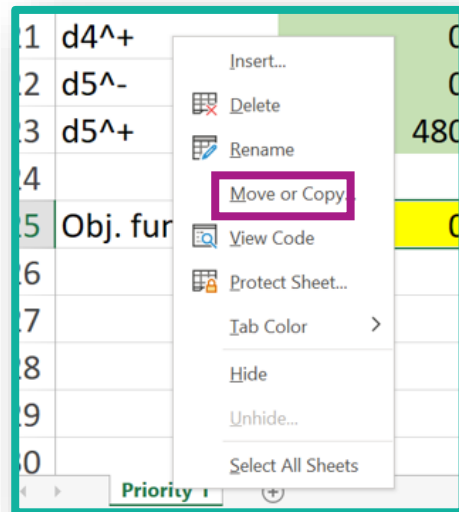
- Division of priorities



# Goal Programming in Excel



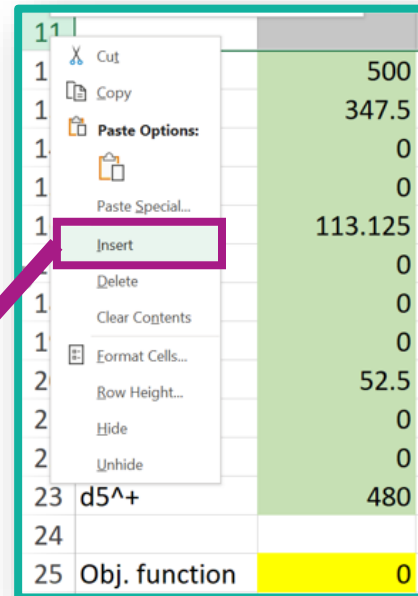
- Instructions for solving goal programming problem in Excel
  - Top priority objective has been optimized (see tab **Priority 1**)
  - Almost all groups have different initial solutions ( Group I and IV **identical**)
  - Copy sheet **Priority 1** and rename **Priority 2** (right click on tab)



# 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 <sup>-</sup>	d1 <sup>+</sup>	d2 <sup>-</sup>	d2 <sup>+</sup>	d3 <sup>-</sup>	d3 <sup>+</sup>	d4 <sup>-</sup>	d4 <sup>+</sup>	d5 <sup>-</sup>	d5 <sup>+</sup>	Used	Constraint	Value
4															
5	<b>Constraints:</b>														
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 under	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		Center Stage	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

