Agenda

- Practice Exam to help you prepare for Tuesday
- Questions

Practice Exam: Problem 1

- Autopower Europe trying to ship motors from the ports to the plants.
- What are the basic variables in this optimal solution?
- Sensitivity Report

Basic Variables

- How many should there be?
  - Answer: 6
  - Why: There are 7 constraints (3 ports, 4 plants), but one is redundant
- What must the 6 basic variables be?
  - The 6 with positive values
  - Careful, sometimes basic variables have value 0, but they always have Reduced Cost of 0. That's how reduced cost is defined.

Question 2

- Is this the only optimal solution?
- Sensitivity Report

Unique Optimum?

- No.
- How do we know: The reduced cost of Amsterdam to Leipzig is zero. We can move flow onto this edge without increasing the objective.
- Careful, if some of the basic variables had been zero, we may not have been able to move any flow onto this edge.

Question 3:

- One carrier would like to win business between Antwerp and Tilburg. At what price per unit would Autopower be willing to use this route?
- Sensitivity Report

Reduced Cost

- Current Cost per unit is $110
- Reduced Cost is $118
- Each unit we send costs $110 but decreases the objective value by $118.
- The carrier would have to pay us $8 for each unit we sent on this edge before it would be attractive!

Question 4

- If we could shift a small amount of production from one plant to another, all else being equal, what plant would it be best to move production from and what plant should we move the production to?
- Sensitivity Report

Shadow Price

- Move it from the plant with the highest shadow price and to the plant with the lowest shadow price.
- So, from Leipzig to Liege.
- The net effect should be to reduce the objective by 120 - 41 = $79 for each unit we move.

Modeling

- Demands for Autopower's products outstrip its available supply of motors. In fact, demand in Liege has risen to 300. We estimate the cost of backordering (failing to meet current demand) at each plant to be:

Plant	Cost per motor backordered
Leipzig	$50
Liege	$70
Nancy	$30
Tilburg	$100

Backordering

Autopower Transportation Model

Unit Cost

From/To	Leipzig	Nancy	Liege	Tilburg
Amsterdam	$ 120.0	$ 130.0	$ 41.0	$ 59.5
Antwerp	$ 61.0	$ 40.0	$ 100.0	$ 110.0
The Hague	$ 102.5	$ 90.0	$ 122.0	$ 42.0
Backorder	$ 50.0	$ 30.0	$ 70.0	$ 100.0

Shipments

From/To	Leipzig	Nancy	Liege	Tilburg	Total	Available
Amsterdam	-	-	300	200	500	500
Antwerp	-	700	-	-	700	700
The Hague	300	200	-	300	800	800
Backorder	100	-	-	-	100	100
Total	400	900	300	500	-	
Required	400	900	300	500		

Total Cost

From/To	Leipzig	Nancy	Liege	Tilburg	Total
Amsterdam	$ -	$ -	$ 12,300	$ 11,900	$ 24,200
Antwerp	$ -	$ 28,000	$ -	$ -	$ 28,000
The Hague	$ 30,750	$ 18,000	$ -	$ 12,600	$ 61,350
	$ 5,000	$ -	$ -	$ -	$ 5,000
Total	$ 35,750	$ 46,000	$ 12,300	$ 24,500	$ 113,550

AMPL Model

- set PORT;
- set PLANT;
- param supply {PORT};
- param demand {PLANT};
- param cost {PORT, PLANT};
- param BackOrderCost{PLANT};

Model Cont'd

```
var Trans {PORT, PLANT} >= 0;
var BackOrder{PLANT} >= 0;
minimize Total_Cost:
   sum{f in PORT, t in PLANT} cost[f,t]*Trans[f,t] +
   sum{t in PLANT} BackOrderCost[t]*BackOrder[t];
s.t. Supply {p in PORT}:
   sum{t in PLANT} Trans[p, t] <= supply[p];
s.t. MaxBackOrder:
      sum{t in PLANT} BackOrder[t]
<= sum{t in PLANT}demand[t] - sum{p in PORT} supply[p];
s.t. Demand {t in PLANT}:
   sum{p in PORT} Trans[p,t] + BackOrder[t] >= demand[t];
```

Modeling Time

- Suppose the Singapore Electric Generator Company must send its completed generators to Australia for testing before they can be sold. This process takes an entire month so that, for example, generators made in January are not available for sale until February. Extend the Singapore Electric Generator Model accommodate this delay.

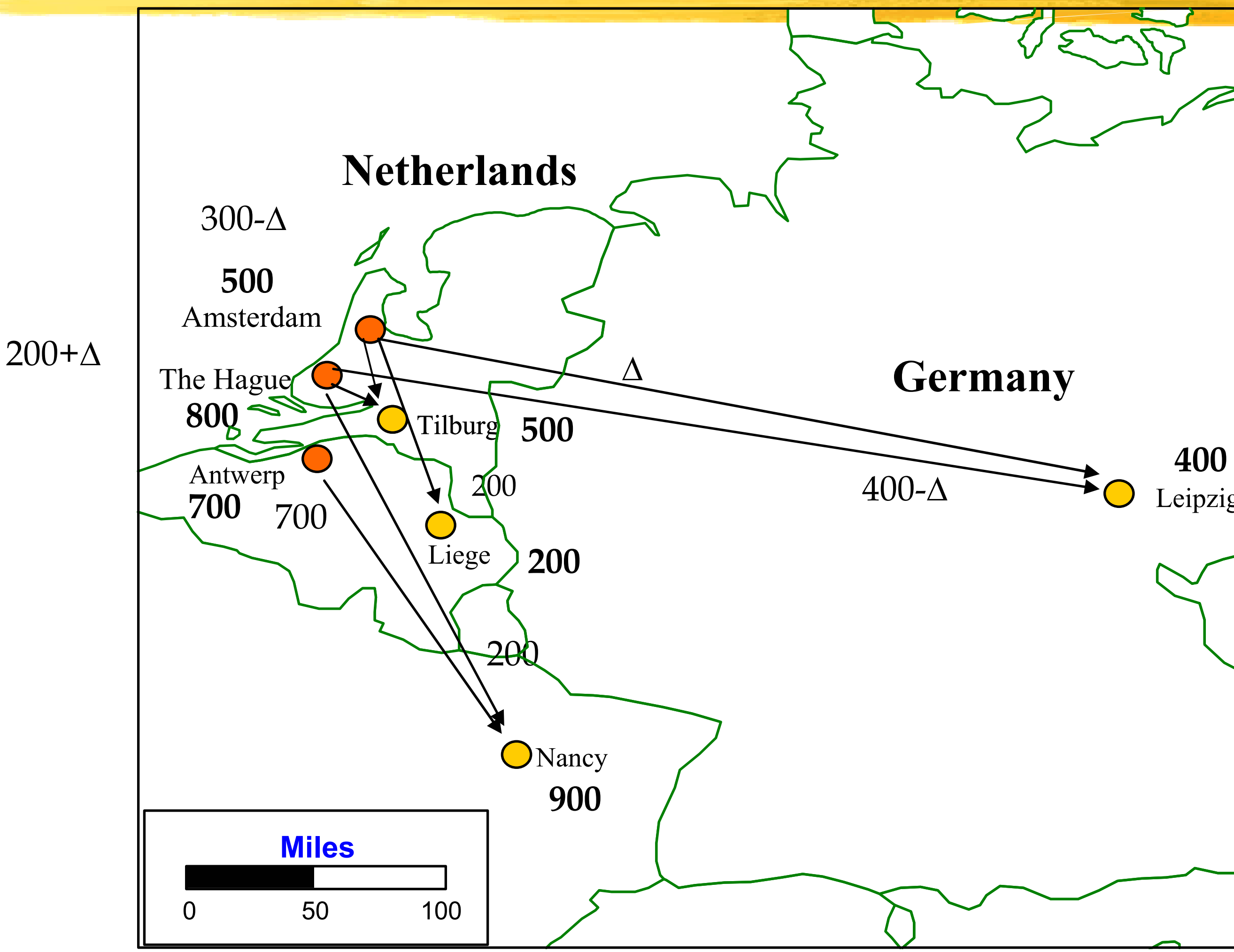
Modeling Time

Singapore Electric Generator Production						
Unit Costs	Dec	Jan	Feb	Mar	Apr.	May
Production	$ 29.00	$ 28.00	$ 27.00	$ 27.80	$ 29.00	
Inventory	$ 0.30	$ 0.30	$ 0.30	$ 0.30	$ 0.30	
Production Qty	50	29	62	38	0	
Production Limits		60	62	64	66	
Beginning Inventory	7	15	7	0	28	
Delivery Reqmts		58	36	34	59	Minimum
Ending Inventory		7	-	28	7	7
Production Cost	$ 1,450.00	$ 812.00	$ 1,674.00	$ 1,056.40	$ -	
Inventory Cost	$ 3.30	$ 3.30	$ 1.05	$ 4.20	$ 5.25	Total
Total Cost	$ 1,453.30	$ 815.30	$ 1,675.05	$ 1,060.60	$ 5.25	$ 5,009.50

Short Answer

- Give an example of an optimal, but not basic solution to a network flow problem.

Optimal, but not basic



Basic Variables

- How many basic variables will there be in a basic feasible solution to a Transportation Problem like Autopower's, but with 4 ports and 5 plants?
- 8
- Why? 9 Constraints, but 1 is redundant.

Exam Structure

- Distribute Word document and Excel Spreadsheets
- Return Word document and Excel spreadsheets, etc.
- Keep time to 2 hrs.

- Ayla and Lincoln in class during class time.