Basic network flow problems

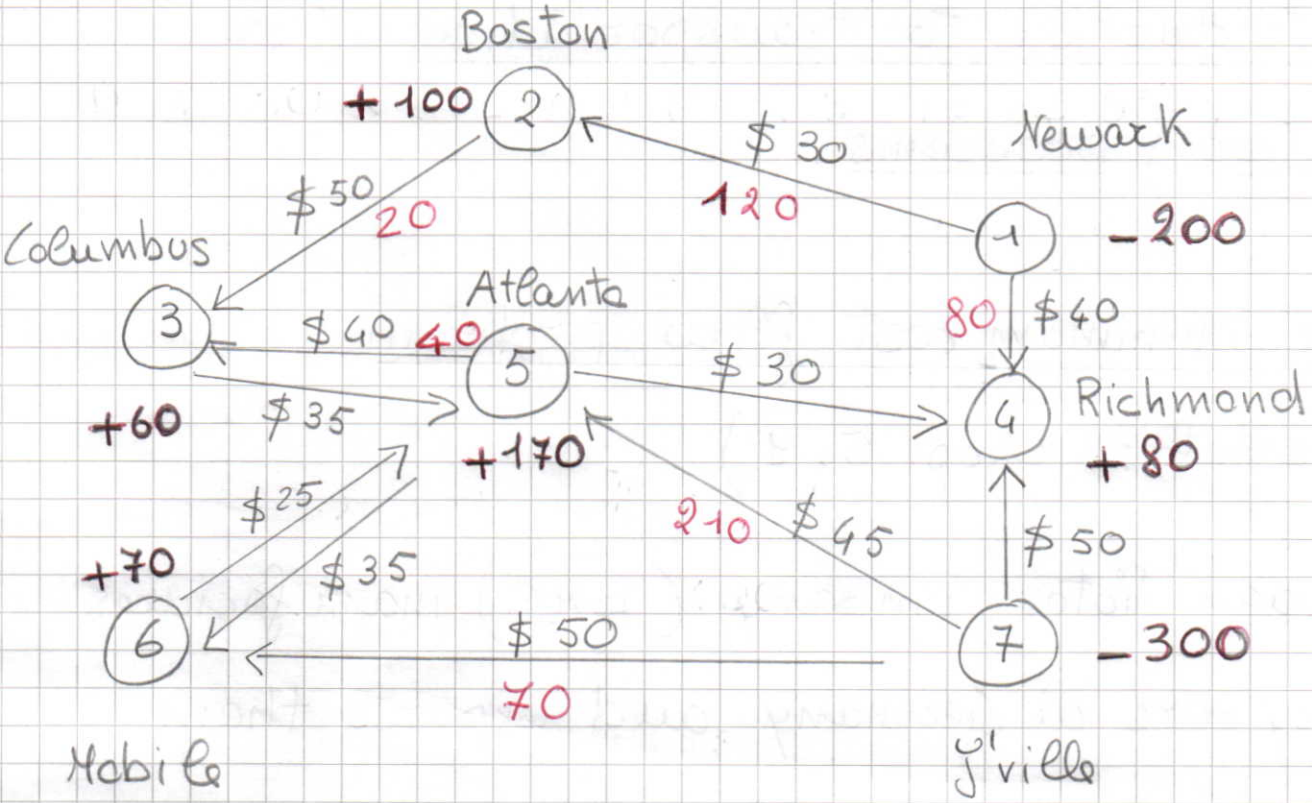
- Introduction to transportation (or routing) problems

The minimum cost flow problem

(Ragsdale: Chap. 5.1)

- Bavarian Motor Company (BMC) manufactures luxury cars in Germany and exports them in the U.S.; currently:
  - 200 cars available at the port in Newark
  - 300 " " " " Jacksonville
- From there, the cars are transported (by rail or truck) to six distributors having a specific requirement of cars (see the figure)

Logistics network of (BME):



In the network:

- Newark and J'ville : <u>supply nodes</u> (<u>origins</u>)

  negative numbers (e.g. -200) represent their supply

- Boston, Columbus ... : <u>demand nodes</u> (<u>destinations</u>)

  positive numbers (e.g. +100) represent their <u>demand</u>

- there can be <u>transshipment nodes</u> (with 0 value) <not in the figure>

The problem: determine how to transport (flowing) cars along the arcs of the network to satisfy the demands at a minimum cost

Decision variables:

x_{ij}: number of cars shipped (or flowing) from i to j along (i,j), $\forall (i,j)$

So: 11 flow variables

Flow conservation constraints:

e.g. node 1 (Newark), which is a supply node:

$$x_{12} + x_{14} \leq 200 \quad \text{i.e.}$$

$$-x_{12} - x_{14} \geq -200$$

e.g. node 2 (Boston), which is a demand node:

$$x_{12} - x_{23} = 100$$

x_{12}: entering flow; x_{23}: leaving flow