Assignment 4 - Transportation problem and Network Model

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Part 1 - Transportation problem

Loading the necessary libraries

```
setwd("C:/Users/Fabrizio/Desktop/MyBlackBoard/MIS 64018 - Quant. Management Modeling/Module 7
-  Network Models/Assignment 4")
library(lpSolveAPI)
```

Introduction

Heart Start produces automated external defibrillators (AEDs) in each of two different plants (A and B)The AEDs are sold through three wholesalers. How many AEDs should be produced in each plant, and how should they be distributed to each of the three wholesaler warehouses so as to minimize the combined cost of production and shipping?

Solve the LP Model

In this assignment, we chose to write the problem formulation in the lp format, a text file created specifically for this problem, that includes all the information.

```
x <- read.lp("Heart_Start.lp")
x
```

```
## Model name:
##              Pa    Pb   Xa1   Xa2   Xa3   Xb1   Xb2   Xb3
## Minimize    600   625    22    14    30    16    20    24
## R1            0     0     1     0     0     1     0     0  >=  80
## R2            0     0     0     1     0     0     1     0  >=  60
## R3            0     0     0     0     1     0     0     1  >=  70
## R4           -1     0     1     1     1     0     0     0  <=   0
## R5            0    -1     0     0     0     1     1     1  <=   0
## Kind        Std   Std   Std   Std   Std   Std   Std   Std
## Type       Real  Real  Real  Real  Real  Real  Real  Real
## Upper       100   120   Inf   Inf   Inf   Inf   Inf   Inf
## Lower         0     0     0     0     0     0     0     0
```

Now that the file has been read by R, we can solve it.

```
solve(x)
```

```
## [1] 0
```

Here, zero means that R found an optimal solution.

```
get.objective(x)
```

```
## [1] 132790
```

```
get.variables(x)
```

```
## [1] 100 110  40  60   0  40   0  70
```

From the results we know that the optimal solution is reach with a minimum total cost of $132,790. The total production from Plant A and B is, respectively, 100 and 110. Moreover, 40 AEDs are produced in Plant A and shipped to Warehouse 2, 60 are produced in plant A and shipped warehouse 2, 40 are produced in plant B and shipped to warehouse 1, and finally 70 are produced in plant B and shipped to warehouse 3.

```
get.constraints(x)
```

```
## [1] 80 60 70  0  0
```

These are the RHS values for our 5 constraints.

Part 2 - Network Model

Since there is a difference between total supply (276TBD) and total demand(274TBD), we will introduce a dummy variable, Refinery 6 (R6), that will demand 2TBD.

Objective Function (minimization problem):

Z = 1.52 Xw1pa + 1.60 Xw1pb + 1.40 Xw1pc + 1.70 Xw2pa + 1.63 Xw2pb + 1.55 Xw2pc + 1.45 Xw3pa + 1.57 Xw3pb + 1.30 Xw3pc + 5.15 Xpar1 + 5.69 Xpar2 + 6.13 Xpar3 + 5.63 Xpar4 + 5.80 Xpar5 + 5.12 Xpbr1 + 5.47 Xpbr2 + 6.05 Xpbr3 + 6.12 Xpbr4 + 5.71 Xpbr5 + 5.32Xpcr1 + 6.16 Xpcr2 + 6.25 Xpcr3 + 6.17 Xpcr4 + 5.87 Xpcr5

Constraints:

Supply/Capacity Constraints:

Xw1pa + Xw1pb + Xw1pc = 93 Xw2pa + Xw2pb + Xw2pc = 88 Xw3pa + Xw3pb + Xw3pc = 95

Demand/Requirement Constraints:

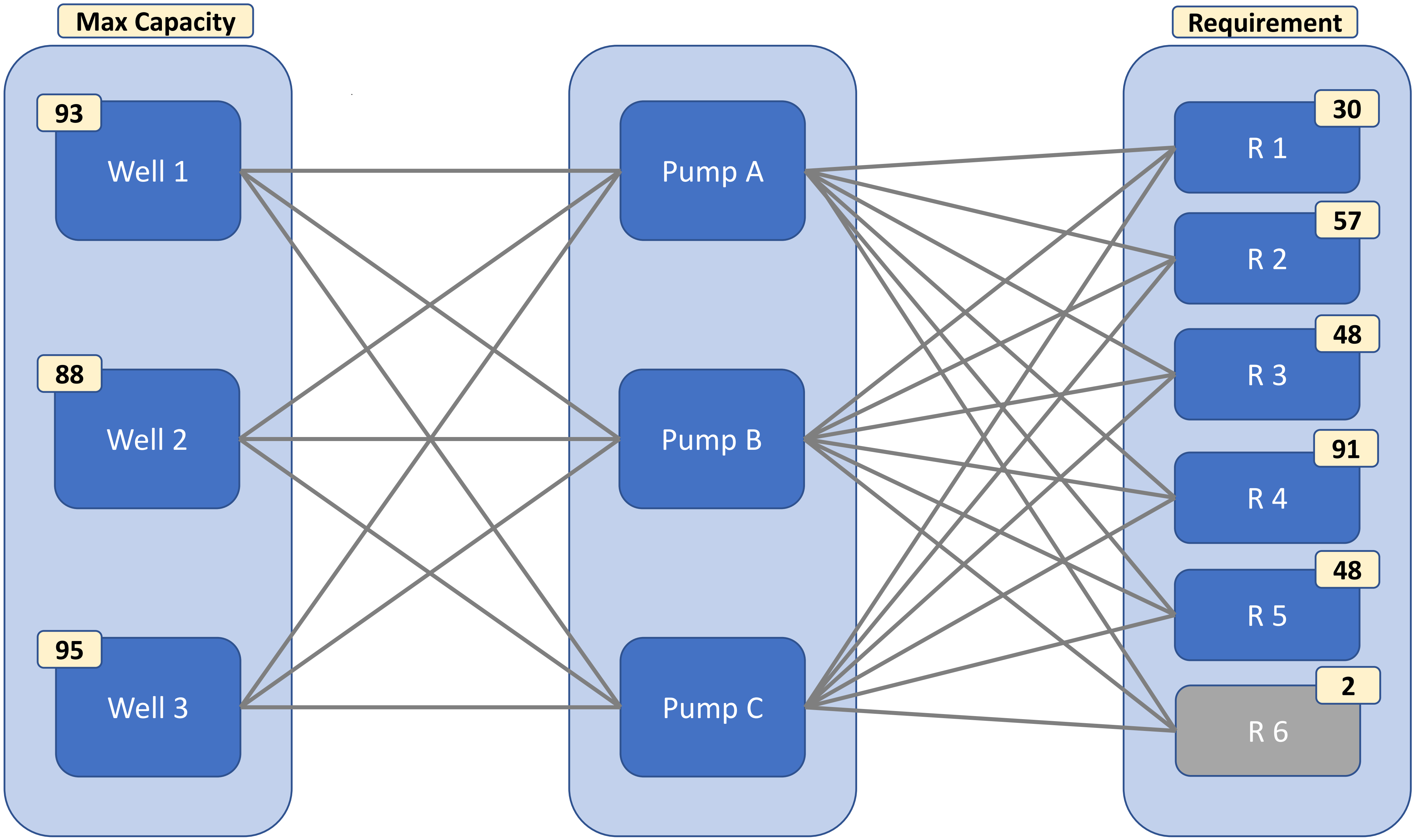
Xpar1 + Xpbr1 + Xpcr1 = 30 Xpar2 + Xpbr2 + Xpcr2 = 57 Xpar3 + Xpbr3 + Xpcr3 = 48 Xpar4 + Xpbr4 + Xpcr4 = 91 Xpar5 + Xpbr5 + Xpcr5 = 48 Xpar6 + Xpbr6 + Xpcr6 = 2

Constraints from pumps to the refineries:

Xw1pa + Xw2pa + Xw3pa + Xpar1 + Xpar2 + Xpar3 + Xpar4 + Xpar5 + Xpar6 = 0 Xw1pb + Xw2pb + Xw3pb + Xpbr1 + Xpbr2 + Xpbr3 + Xpbr4 + Xpbr5 + Xpbr6 = 0 Xw1pc + Xw2pc + Xw3pc + Xpcr1 + Xpcr2 + Xpcr3 + Xpcr4 + Xpcr5 + Xpcr6 = 0

Non-negativity constraints:

Xij >= 0 (i = w1,w2,w3 ; j = pa,pb,pc) Xjk >= 0 (j = pa,pb,pc ; k = r1,r2,r3,r4,r5,r6)


Max Capacity
Requirement
93
Well 1
88
Well 2
95
Well 3
Pump A
Pump B
Pump C
30
R 1
57
R 2
48
R 3
91
R 4
48
R 5
2
R 6

$$\min \mathrm{Z} = \sum_i^n \sum_j^n c_{ij} * x_{ij}$$
subject to $\sum_j^n x_{ij} - \sum_j^n x_{ji} = b_i$

min $\mathrm{Z} = 1.52x_{W1Pa} + 1.6x_{W1Pb} + 1.4x_{W1Pc} + \cdots + 1.3_{W3Pc} + 5.15_{PaR1} + \cdots + 5.87_{PcR5}$

subject to

$x_{W1Pi} + x_{W2Pi} + x_{W3Pi} + x_{PiR1} + x_{PiR2} + x_{PiR3} + x_{PiR4} + x_{PiR5} = 0$ (for i = a, b, c)

$x_{W1Pa} + x_{W1Pb} + x_{W1Pc} = 93$ (max capacity W1)

$x_{W2Pa} + x_{W2Pb} + x_{W2Pc} = 88$ (max capacity W2)

$x_{W3Pa} + x_{W3Pb} + x_{W3Pc} = 95$ (max capacity W3)

$x_{PaR1} + x_{PbR1} + x_{PcR1} = 30$ (requirement R1)

$x_{PaR2} + x_{PbR2} + x_{PcR2} = 57$ (requirement R2)

$x_{PaR3} + x_{PbR3} + x_{PcR3} = 48$ (requirement R3)

$x_{PaR4} + x_{PbR4} + x_{PcR4} = 91$ (requirement R4)

$x_{PaR5} + x_{PbR5} + x_{PcR5} = 48$ (requirement R5)

$x_{PaR6} + x_{PbR6} + x_{PcR6} = 2$ (requirement R6)