$$x_1 \leq 4$$

$$1 \cdot x_1 + \cancel{0 \cdot x_2} \leq 4$$

$$2 x_2 \leq 12$$

2 $\underline{\text{ORE}}$ x_2 LOTTI

LOTTO

$$3 x_1 + 2 x_2 \leq 18$$

$$c = \begin{pmatrix} 3000 \\ 5000 \end{pmatrix}$$

$$x = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

$$c^T x =$$

$$3000\,x_1 + 5000\,x_2$$

$$\sum_{j=1}^{n} P_j\, x_j$$

$$2x_1 + 1.5x_2 + 3x_3$$

$$\leq 10000$$

$$x_1 + 2x_2 + x_3$$

$$\leq 5000$$

$$x_1, x_2, x_3$$

$$y_1, y_2, y_3$$

$$\left[6x_1 + 4x_2 + 7x_3\right]$$

$$-200y_1 - 150y_2 - 100y_3$$

$$3x_1 + 2x_2 + 6x_3 \leq 150$$

$$3x_1 \cdot y_1 +$$
$$2x_2 \cdot y_2 +$$
$$6x_3 \cdot y_3 \leq 150$$

$$y_1 = 0 \Rightarrow x_1 = 0$$

$$y_1 = 1 \Rightarrow x_1 \geq 0$$

$$x_1 = 10 \quad y_1 = 0$$

$$0 \leq x_1 \leq 40$$

$$0 \leq \boxed{x_1 \leq y_1 \cdot 40}$$

$$40y_1 - x_1 \geq 0$$

x_1 = num. utilitarie

x_2 = n. berline

x_3 = n. station-wagon

$$x_1 \begin{cases} = 0 & (y_1 = 0) \\ \geq 1000 & (y_1 = 1) \end{cases}$$

$$\boxed{\begin{aligned} \max \quad & 2000\, x_1 + \\ & 3000\, x_2 + \\ & 4000\, x_3 \end{aligned}}$$

$$y_1, y_2, y_3 \in \{0, 1\}$$

$$\begin{cases} y_1 = 0 \Rightarrow x_1 = 0 \\ y_1 = 1 \Rightarrow x_1 \geq 1000 \end{cases}$$

$$\boxed{x_1 \geq 1000\, y_1}$$

$y_1 = 0$ $\qquad$ $y_1 = 1$

$x_1 \geq 0$ $\qquad$ $x_1 \geq 1000$

$$\boxed{x_1 \le \overset{M}{2000}\, y_1}$$

$y_1 = 0$ $\qquad$ $y_1 = 1$

$x_1 \le 0$ $\qquad$ $x_1 \le 2000$

$x_1 = 0$

$$\min \sum_{i=1}^{6} c_i x_i + \sum_{i=1}^{6} 0.015 \cdot c_i \cdot \left(\frac{y_i + y_{i+1}}{2} \right)$$

$$2000 \le x_1 \le 4000$$

$$1750 \le x_2 \le 3500$$

$$\dots$$

$$y_1 = 2750$$

$$y_1 + x_1 - 1000 = y_2$$

$$y_2 + x_2 - 4500 = y_3$$

$$y_i \geq 1500$$

$$\forall i = 1, \dots, 7$$

$$y_i \leq 6000$$

$$\forall i = 1, \dots, 7$$

---

quantità (euro) investita nella comp. 1

$x_1, x_2, \dots, x_6$

$$\max \quad \frac{8.65}{100} x_1 + \frac{9.50}{100} x_2 + \dots$$

$$x_1 + \dots + x_6 = 750000$$

$$x_i \leq 0.25 \cdot 750000$$

$$\forall i = 1, \dots, 6$$

$$x_1 + x_2 + x_4 + x_6 \geq 0.5 \cdot 750000$$

$$x_2 + x_3 + x_5 \leq 0.35 \cdot 750000$$

$$x_i \geq 0$$

<u>Parametri</u> n compagnie

B budget

r_i = rendimento comp. i
$i = 1, \dots, n$

S_i = anni alla scadenza dell'obb. i

R_i = rating comp. i

SC = max <u>percent.</u> possiamo inv. in una singola comp.

LT = percent. minima investita in totale obb lungo termine

t = <u>numero anni</u> minimo di un'obbl.

a lungo termine

RB = percent. $\frac{\text{max}}{\text{totale invest.}}$ in comp. con rating basso

$\underline{b}$ = rating minimo delle compagnie con rating basso

Variabili

x_i = investimento nella compagnia i

$x_i \geq 0$

$\boxed{SC = 25}$

obiettivo

$$\max \sum_{i=1}^{n} r_i x_i$$

$SC = 0.25$

vincoli

$$\sum_{i=1}^{n} x_i = B$$

$$x_i \leq \frac{SC}{100} \cdot B \qquad \forall i = 1, \dots, n$$

$$\sum_{\substack{i=1 \\ \text{t.c.} \\ \boxed{s_i \geq t}}}^{n} x_i \geq \frac{LT}{100} \cdot B$$

$$\sum_{\substack{i=1 \\ \text{t.c.} \\ R_i \geq b}}^{n} x_i \leq \frac{RB}{100} \cdot B$$

$$\max \sum_{i=1}^{n} z_i x_i$$

$$\sum_{i=1}^{n} c_i x_i \leq B$$

$$x_i \in \{0, 1\}$$

$$i = 1, \dots, n$$

$$\min \; x_{A1} + x_{B1} + x_{C1} + x_{D1}$$

$$1.018\, x_{A1} = x_{A2}$$

(fine 1° mese)

$$1.035\, x_{B1} + 1.018\, x_{A2}$$

$$= x_{A3} + x_{B3} + 250$$

(fine 2° mese)

- - -

20 variabili

$$x_i \in \{0, 1\}$$

$$x_i = \begin{cases} 1 & \text{se costruisco magazzino in } i \\ 0 & \text{altrimenti} \end{cases}$$

$i = 1, \dots, 20$

$$y_{ij} = \begin{cases} 1 & \text{se cliente } j \text{ è rifornito da mag. costruito} \end{cases}$$

in i

0 altr.

$i = 1, \dots, 20$

$j = 1, \dots, 100$

$$\min \sum_{i=1}^{20} c_i x_i + \sum_{i=1}^{20} \sum_{j=1}^{100} t_{ij} y_{ij}$$

$$\boxed{x_i = 0 \Rightarrow y_{ij} = 0 \quad \forall j = 1, \dots, 100}$$

$$x_i = 1 \Rightarrow y_{ij} = ?$$

$$x_i \geq y_{ij} \qquad \forall i = 1, \dots, 20$$

$\forall j = 1, \dots, 100$

$$\sum_{i=1}^{20} y_{ij} = 1 \qquad \forall j = 1, \dots, 100$$

$$y_{1j} + y_{2j} + \dots + y_{20j} = 1$$

$$x_{ij} = y_j$$

$$\boxed{y_j = 0 \Rightarrow x_{ij} = 0 \quad \forall i}$$

$$\boxed{y_j = 1} \Rightarrow x_{ij} \begin{cases} 0 \\ 1 \end{cases}$$

$$\boxed{x_{ij} = 0 \underset{\text{NO}}{\Rightarrow} y_j = 0}$$

$$x_j \in \{0, 1\}$$

$$x_j = \begin{cases} 1 & \text{se deposito } j \text{ rifornisce almeno un centro di dist.} \\ 0 & \text{alt.} \end{cases}$$

$$y_{ij} = \begin{cases} 1 & \text{se centro } i \text{ sarà rifornito dal dep. } j \\ 0 & \text{alt.} \end{cases}$$

$$\min \sum_{j=1}^{n} f_j x_j + \sum_{i=1}^{m} \sum_{j=1}^{n} c_j \text{ di } y_{ij}$$

$$\sum_{j=1}^{n} y_{ij} = 1, \quad \forall\, i = 1, \dots, m$$

$$y_{ij} \le x_j \qquad \forall\, i, j$$

$$\sum_{i=1}^{m} d_i\, y_{ij} \le U_j$$

$$\forall\, j = 1, \dots, n$$

$$x_{ij} = \begin{cases} 1 \text{ se operaio } i \text{ svolge attività } j \\ 0 \text{ alt.} \end{cases}$$

$$\max \sum_{i=1}^{8} \sum_{j=1}^{10} x_{ij} M_{ij}$$

$$\sum_{j=1} x_{ij} M_{ij} \leq 1 \quad \forall i = 1, \dots, 8$$

$$\sum_{i=1}^{8} x_{ij} M_{ij} \leq 1, \forall j = 1, \dots, 10$$

$$M_{ij} = \begin{cases} 1 & \text{se operaio } i \text{ sa svolgere att. } j \\ 0 & \text{alt.} \end{cases}$$

(parametro)

x_1 = num. auto spedite da 1

x_7 = " " 7

y_2 = num. auto arrivano a 2

y_3 = " 3

⋮

y_6 = " 6

$x_{1,2}$ $x_{7,2}$

$x_{1,3}$ $x_{7,3}$

$x_{1,4}$ $\vdots$

$\vdots$

$x_{1,6}$ $x_{7,6}$

$\underline{(i,j) \in A}$

x_{ij} = numero auto spedite da i a j

x_{12}
x_{14}
x_{23}
x_{35}

$c_{ij} \quad \forall (i,j) \in A$

$$\min \sum_{(i,j) \in A} c_{ij} x_{ij}$$

$$-(x_{12} + x_{14}) \overset{=}{\geq} -200 \quad (\text{nodo } 1)$$

$$\boxed{\rightarrow x_{12} + x_{14} \leq 200} \quad (\text{nodo } 1)$$

$$x_{12} - x_{23} \underset{=}{\geq} 100 \quad (\text{nodo } 2)$$

$$(x_{23} + x_{53}) - x_{35} \underset{=}{\geq} 60 \quad (\text{nodo } 3)$$

$$x_{14} + x_{54} + x_{74} \underset{=}{\geq} 80 \quad (\text{nodo } 4)$$

$$x_{ij} = \begin{cases} 1 & \text{se scegliamo percorrere arco } (i,j) \\ 0 & \text{alt.} \end{cases}$$

$$\forall (i,j) \in A$$

flusso ent. in 1 − f. uscente da 1 = −1

$$\rightarrow \quad x_{12} + x_{13} = 1 \quad (\text{nodo } 1)$$

$$x_{12} - (x_{24} + x_{23}) = 0 \quad (\text{nodo } 2)$$

$$x_{24} + x_{23} - x_{12} = 0 \quad (\text{nodo } 2)$$

f. ent. in 11 − f. uscente da 11 = +1

$$x_{9,11} + x_{10,11} = 1 \quad (\text{nodo } 11)$$

MyScript Notes