①

x_{ij}: en prodotto $i \in \{A,B,C,D\}$ in $j \in \{1,2,3\}$

y_{ij}: 1 se $x_{ij} > 0$, 0 else

z_j: acquisto esterno in $j \in \{1,2,3\}$

w_j: 1 se D accesa in j e $j-1$, $j \in \{2,3\}$

$$\min\ 2.5(x_{A1}+x_{A2}+x_{A3}) + 3.0(x_{B1}+x_{B2}+x_{B3}) + 3.1(x_{C1}+x_{C2}+x_{C3}) + 2.8(x_{D1}+x_{D2}+x_{D3}) + 20(y_{A1}+y_{A2}+y_{A3}) + 25(y_{B1}+y_{B2}+y_{B3}) + 10(y_{C1}+y_{C2}+y_{C3}) + 15(y_{D1}+y_{D2}+y_{D3}) + 10(w_2+w_3) + 1.4(z_1+z_2+z_3)$$

s.t. $x_{A2} \geq x_{B2} + 5$

CAPACITÀ (attive y):
$15\,y_{Aj} \leq x_{Aj} \leq 40\,y_{Aj}$, $\forall j \in \{1,2,3\}$
$10\,y_{Bj} \leq x_{Bj} \leq 50\,y_{Bj}$, $\forall j \in \{1,2,3\}$
$10\,y_{Cj} \leq x_{Cj} \leq 40\,y_{Cj}$, $\forall j \in \{1,2,3\}$
$15\,y_{Dj} \leq x_{Dj} \leq 60\,y_{Dj}$, $\forall j \in \{1,2,3\}$

logiche attive w:
$y_{C3} \leq y_{A3} + y_{B3}$
$w_2 \leq y_{D1}$ $w_2 \leq y_{D2}$
$w_3 \leq y_{D2}$ $w_3 \leq y_{D3}$

DOMANDA: $x_{A1}+x_{B1}+x_{C1}+x_{D1}+z_1 \geq 60$; $x_{A2}+x_{B2}+x_{C2}+x_{D2}+z_2 \geq 30$; $x_{A3}+x_{B3}+x_{C3}+x_{D3}+z_3 \geq 30$

dom: $x_{ij} \in \mathbb{R}_+$, $y_{ij} \in \{0,1\}$, $z_j \in \mathbb{R}_+$, $w_j \in \{0,1\}$

②

$\min -x_1 - 2x_2 - 5\hat{x}_3$

s.t. $x_1 + x_2 + 2\hat{x}_3 + x_4 = 1$
$2x_1 + x_2 - \hat{x}_3 + x_5 = 2$
$-x_1 - x_2 + 2\hat{x}_3 + x_6 = 4$
$x_i \geq 0$

	x_1	x_2	$\hat{x}_3$	x_4	x_5	x_6	z	b	
	-1	-2	-5	0	0	0	-1	0	
x_4	(1)	1	2	1	0	0	0	1	
x_5	2	1	-1	0	1	0	0	2	
x_6	-1	-1	2	0	0	1	0	4	
	0	-1	-3	1	0	0	-1	1	$+R_1$
x_1	1	(1)	2	1	0	0	0	1	$=R_1$
x_5	0	-1	-5	-2	1	0	0	0	$-2R_1$
x_6	0	0	4	1	0	1	0	5	$+R_1$
	1	0	-1	2	0	0	-1	2	$+R_1$
x_2	1	1	(2)	1	0	0	0	1	$=R_1$
x_5	1	0	-3	-1	1	0	0	1	$+R_1$
x_6	0	0	4	1	0	1	0	5	$=R_3$
	3/2	1/2	0	5/2	0	0	-1	5/2	$+R_1'$
x_3	1/2	1/2	1	1/2	0	0	0	1/2	$R_1/2$
x_5	3/2	3/2	0	1/2	0	0	0	5/2	$+3R_1'$
x_6	-2	-2	0	-1	0	1	0	3	$-2R_1$

$z_{max} = -z_{MIN} = -(-5/2) = 5/2$ — — —

b) — duale PrCa, 5/2

③

i	A	B	C	D	E	F	G	Agg
0	(0,∞)	+∞,A	+∞,A	+∞,A	+∞,A	+∞,A	+∞,A	A
1	0,A	1,A	(3,A)	5,A	+∞,A	+∞,A	+∞,A	BCD
2	0,A	1,A	2,B	5,A	8,D	7,D	(4,C)	CEF
3	0,A	1,A	2,B	5,A	(5,F)	3,C	8,F	EFG
4	0,A	1,A	2,B	5,A	4,F	3,C	(6,E)	EG

c) A - C - F - E - G d) NO! ($E \cap F \neq \emptyset$)

(NOTA: NO DIJKSTRA! (MAX HOP!))

④

$\max -u_1 + 3u_3$

s.t. $u_1 + u_2 = 1$ x_1
$3u_1 + 2u_2 + u_3 \geq -2$ x_2
$-u_1 + 2u_3 \leq 1$ x_3
$-u_1 + u_3 = 2$ x_4
$u_1 \leq 0$ $u_2 \geq 0$ u_3 l.b.

Usa Primo Ann!

- (x_1 libera $\Rightarrow 0$ no ccpd) $x_2 = 0 \Rightarrow 0$ //
  $x_3 = 2 \Rightarrow$ $-u_1 + 2u_3 = 2$ ccpd (x_4 libera)
- $u_1(0) = 0 \Rightarrow 0$ // $u_2 \cdot 0 = 0 \Rightarrow 0$ //
  u_3 libera $\Rightarrow 0$ no ccpd

SISTEMA
$$\begin{cases} -u_1 + 2u_3 = 1 & \text{ccpd} \\ u_1 + u_2 = 1 & \text{A.D.} \\ -u_1 + u_3 = 2 & \text{A.D.} \end{cases}$$

$\Rightarrow 0$ $u_3 = +1-2 = -1$, $u_1 = -3$, $u_2 = 4$

$u_1 + u_2 = 1$ ✓ $3u_1 + 2u_2 + u_3 = -2$ ✓

$-u_1 + 2u_3 = 1$ ✓ $-u_1 + u_3 = 2$ ✓ $u_1 \leq 0$ $u_2 \geq 0$ ✓

OTTIMO! $(-u_1 + 3u_3 = 0 = 0$ ✓$)$

⑤

a) $x_B^T = [x_5, x_7, x_2] = [100, 540, 420]$

b) $\Rightarrow x_3 < 0$ c) 54 (x_1, x_7) 42 (x_1, x_2) 12 (x_3, x_5)

d) x_1 x_2 (42), $-22 - 14 \cdot 10 = -162$

e) $x_2 = 0$, $x_7 = 5$ (illimitata!)

⑥

$\max\ 8x_1 + 5x_2 + 5x_4 + 3x_3 + x_5$ (ORDINE)

s.t. $4x_1 + 3x_2 + 5x_4 + 4x_3 + 2x_5 \leq 10$

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

P_0) $-$ 10
$x_1 = 1$ 6
$x_2 = 1$ 3
$x_4 = 3/5$

P_1) $x_4 = 0$ 10
$x_1 = 1$ 6
$x_2 = 1$ 3
$x_3 = 3/4$

P_2) $x_4 = 1$ 5
$x_1 = 1$ 1
$x_2 = 1/3$

$UB = 8+5+\lfloor \frac{3}{5} 5 \rfloor = 16$ $UB = 8+5+\lfloor 3/4\ 3 \rfloor = 15$ $UB = 5+8+\lfloor 1/3\ 5 \rfloor = 14$

$LB = 8+5+1 = 14$, $LB = 8+5+1 = 14$, LB -

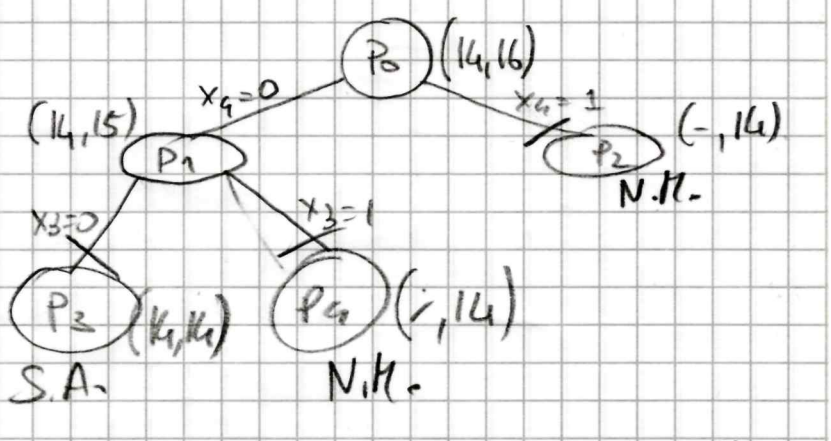
P_3) $x_4 = x_3 = 0$ 10
$x_1 = 1$ 6
$x_2 = 1$ 3
$x_5 = 1$ 1

$UB = LB = 8+5+1 = 14$

P_4) $x_4 = 0$ $x_3 = 1$ 6
$x_1 = 1$ 2
$x_2 = 2/3$

$UB = 3+8+\lfloor 2/3\ 5 \rfloor = 14$

LB = /



OTTIMA $x_1 = x_2 = x_5 = 1$, VALE 14

b) [14, 16]