$$\min \; -10x_1 - 12x_2 - 12x_3$$
$$x_1 + 2x_2 + 2x_3 \le Y_1$$
$$2x_1 + x_2 + 2x_3 \le Y_2$$
$$2x_1 + 2x_2 + x_3 \le Y_3$$
$$x_i \geq 0$$

$\Rightarrow$ $-10(2) - 12(0) - 12(0) - (-20)$

$20 - 20 = 0$ ✓

$2 \le 2$

$4 \le 5$

$4 \le 4$

$$\min \; -10x_1 - 12x_2 - 12x_3 - z = 0$$
$$x_1 + 2x_2 + 2x_3 + s_1 = 2$$
$$2x_1 + x_2 + 2x_3 + s_2 = 5$$
$$2x_1 + x_2 + 2x_3 + s_3 = 4$$
$$x_i, s_i \geq 0$$

$M_5 = 2 \; ; \; Y_1 = \frac{2}{2} + 1 = 2$

$M_6 = \left[\frac{7}{2}\right] + 2 \; ; \; Y_2 = 5$

$3.5 = 3 + 2$

$M_7 = 1 + 3 = 4 = Y_3$

I TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	−10	−12	−12	0	0	0	−1	0
s_1	1	2	2	1	0	0	0	2
s_2	2	1	2	0	1	0	0	5
s_3	2	1	2	0	0	1	0	4

$R_0' : R_0 + 10R_1 : 0 \quad 8 \quad 8 \quad 10 \quad 0 \quad 0 \quad -1 \quad 20$

$R_2' : R_2 - 2R_1 : 0 \quad -3 \quad -2 \quad -2 \quad 1 \quad 0 \quad 0 \quad 1$

$R_3' = R_3 - 2R_1 = 0 \quad -3 \quad -2 \quad -2 \quad 0 \quad 1 \quad 0 \quad 0$

II TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	8	8	10	0	0	−1	20
x_1	1	2	2	1	0	0	0	2
s_2	0	−3	−2	−2	1	0	0	1
s_3	0	−3	−2	−2	0	1	0	0

$X = (2, 0, 0, 0, 1, 0) \qquad z_{MIN} = -20$

soluzione verificata e corretta

22/01

FORMULAZIONE DEL DUALE

$$\max \; 5u_1 + 2u_2 - u_3 \quad \Big] \text{ termini noti primale}$$

$$\left.\begin{array}{l} -3u_1 - 2u_2 \le 2 \\ -3u_1 + 2u_2 + 2u_3 \ge -1 \\ u_1 - u_3 = 1 \\ u_1 - 3u_2 \le 0 \end{array}\right\} \text{segno opposto al segno delle variabili nel primale}$$

$$\left.\begin{array}{l} u_1 \ge 0 \\ u_2 \le 0 \end{array}\right\} \text{il segno viene stabilito dai segni dei vincoli nel primale}$$

u_3 libera

$$\begin{aligned} \max \; & 5x_1 + 4x_2 + 4x_3 \\ & -4x_1 + 5x_2 - x_3 \le y_1 \\ & 2x_1 + 2x_2 - x_3 \le y_2 \\ & 3x_2 + 4x_3 \le y_3 \\ & x_i \ge 0 \end{aligned}$$

$$y_1 = \left(\frac{2}{5}\right) + 1 = 1$$

$$y_2 = \left(\frac{7}{5}\right) + 1 = 2$$

$$y_3 = \frac{3}{7} = 1$$

$$\begin{aligned} \min \; & -5x_1 - 4x_2 - 4x_3 - z = 0 \\ & -4x_1 + 5x_2 - x_3 + s_1 = 1 \\ & 2x_1 + 2x_2 - x_3 + s_2 = 2 \\ & 3x_2 + 4x_3 + s_3 = 1 \\ & x_i, s_i \ge 0 \end{aligned}$$

$x_1 = 9/8$

$x_3 = 1/4$

$s_1 = 23/4$

I TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	-5	-4	-4	0	0	0	-1	0
s_1	-4	5	-1	1	0	0	0	1
x_1	2	2	-1	0	1	0	0	2
s_3	0	3	4	0	0	1	0	1

R_0': $-5 + 2k = 0$; $k = \frac{5}{2}$; $R_0' = R_0 + \frac{5}{2} R_2 =$ 0 1 -13/2 0 5/2 0 -1 5

R_1': $-4 + 2k = 0$; $k = 2$; $R_1' = R_1 + 2R_2 =$ 0 9 -3 1 2 0 0 5

$R_2' = \frac{1}{2} R_2 =$ 1 1 -1/2 0 1/2 0 0 1

II TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	1	$-13/2$	0	$5/2$	0	-1	5
s_1	0	9	-3	1	2	0	0	5
x_1	1	1	$-1/2$	0	$1/2$	0	0	1
x_3	0	3	4	0	0	1	0	1

$R_0' = -\frac{13}{2} + 4k = 0 \;;\; k = \frac{13}{2} \cdot \frac{1}{4} \;;\; k = \frac{13}{8}$

$R_0' = R_0 + \frac{13}{8} R_3 = 0 \quad \frac{39}{8} \quad 0 \quad 0 \quad 5/2 \quad 13/8 \quad -1 \quad 53/8$

$R_1' = -3 + 4k = 0 \;;\; k = \frac{3}{4} \;;\; R_1' = R_1 + \frac{3}{4} R_3 = 0 \quad 45/4 \quad 0 \quad 1 \quad 2 \quad 3/4 \quad 0 \quad 23/4$

$R_2' = -\frac{1}{2} + 4k = 0 \;;\; k = \frac{1}{8} \;;\; R_2' = R_2 + \frac{1}{8} R_3 = 1 \quad 11/8 \quad 0 \quad 0 \quad 1/2 \quad 1/8 \quad 0 \quad 9/8$

$R_3' = \frac{1}{4} R_3 = 0 \quad 3/4 \quad 1 \quad 0 \quad 0 \quad 1/4 \quad 0 \quad 1/4$

III TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	$39/8$	0	0	$5/2$	$13/8$	-1	$53/8$
s_1	0	$45/4$	0	1	2	$3/4$	0	$23/4$
x_1	1	$11/8$	0	0	$1/2$	$1/8$	0	$9/8$
x_3	0	$3/4$	1	0	0	$1/4$	0	$1/4$

$X = \left(9/8,\ 0,\ 1/4,\ 23/4,\ 0,\ 0\right) \qquad z_{MIN} = -\frac{53}{8}$

Quesito 4 16/02/2022

$$\begin{aligned} \text{Max} \quad & 100x_1 + 40x_2 \\ & 6x_1 + 4x_2 \leq 160 \\ & 3x_1 + 2x_2 \leq 200 \\ & x_1, x_2 \geq 0 \end{aligned}$$

$Y_1 = M_4/3 + 4 = 6$

$Y_2 = M_5/3 + 3 = 3$

$Y_3 = M_6/3 + 2 = 4$

$Y_4 = M_7/3 + 1 = 2$

Quesito 4 4/04/21

$$\max\ 5x_1 + 10x_2$$
$$4x_1 + 2x_2 \leq 40$$
$$x_1 \leq 3$$
$$x_2 \leq 2$$
$$x_1, x_2 \geq 0$$

19/02/2021

$$\max\ 3x_1 + 2x_2 - 5x_3$$
$$4x_1 - 2x_2 + 2x_3 \leq 4 \quad \Rightarrow \quad \cancel{4} \cdot \frac{1}{\cancel{2}} \quad 2 \leq 4 \checkmark$$
$$-2x_1 + x_2 - x_3 \geq -1 \qquad -1 \geq -1 \checkmark$$
$$x_i \geq 0$$

la soluzione proposta e' ammissibile

Verificare che la soluzione $[x_1, x_2, x_3] = [1/2, 0, 0]$ sia ottima

$$\min\ 4\mu_1 - \mu_2$$
$$4\mu_1 - 2\mu_2 \geq 3 \quad \Rightarrow \quad 4 \cdot 0 - \cancel{2}\left(-\frac{3}{\cancel{2}}\right) \geq 3 \ ; \checkmark$$
$$-2\mu_1 + \mu_2 \geq 2 \qquad -2 \cdot 0 + \left(-\frac{3}{2}\right) \geq 2 \quad X$$
$$2\mu_1 - \mu_2 \geq -5$$
$$\mu_1 \geq 0$$
$$\mu_2 \leq 0$$

Condizione di ortogonalita'

$$\mu^T (Ax - b) = 0$$

$$x (c^T - \mu^T A) = 0$$

$$\mu_1 (\underbrace{Ax}_{\text{vincolo primale}} - b) = (4x_1 - 2x_2 + 2x_3 - 4)$$

sostituisco la soluzione proposta

$$2\cancel{4} \cdot \frac{1}{\cancel{2}} - 2(0) + 2(0) - 4 = -2$$

μ_1 e' uguale a 0

$$\mu_2 (Ax - b) = (-2x_1 + x_2 - x_3 + 1)$$
$$-\cancel{2}^{1} \cdot \frac{1}{\cancel{2}} + 0 - 0 + 1$$

μ_2 e' ok per i valori di x

$$x_1 (c^T - \underbrace{\mu^T A}_{\text{vincolo duale}}) = x_1 (4\mu_1 - 2\mu_2 - 3)$$

$$x_2 (c^T - \mu^T A) = x_2 (-2\mu_1 + \mu_2 - 2) = \text{e' ok per } x_2 = 0$$

$x_3 (c^T - \mu^T A) = x_3 (2\mu_1 - \mu_2 + 5) =$ e' ok per $x_3 = 0$

$$\begin{cases} \mu_1 = 0 \\ 4\mu_1 - 2\mu_2 = 3 \end{cases} ; \quad \begin{cases} \mu_1 = 0 \\ -2\mu_2 = 3 \end{cases} ; \quad \begin{cases} \mu_1 = 0 \\ \mu_2 = -\frac{3}{2} \end{cases}$$

Verifichiamo che la soluzione μ_1, μ_2 sia ammissibile per il duale

Non e' ammissibile, quindi la soluzione $[x_1, x_2, x_3] = [1/2, 0, 0]$ non e' ottima

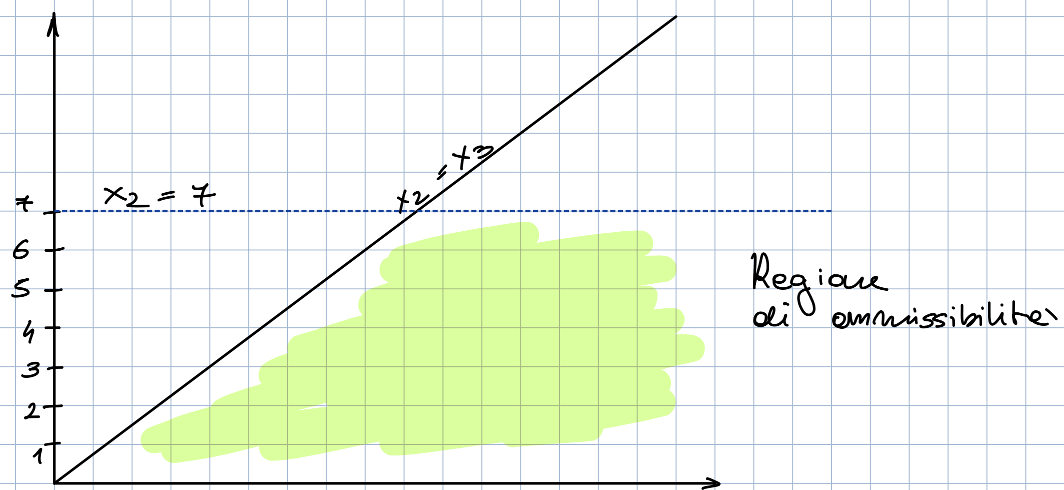
16/04/2020

Disegnare la regione di ammissibilita'

$x_2 - x_3 \leq 0$

$x_2 \leq M_3$ $\quad\quad M_3 = 7$ vi matricola

$$\boxed{\begin{array}{l} x_2 = y \\ x_3 = x \end{array}}$$



3/09/2020

$$\max\ 24x_1 + 17x_2 + 12x_3 + 6x_4$$
$$10x_1 + 8x_2 + 6x_3 + 5x_4 \le 15$$
$$x_i \geq 0 \quad x_i \in \mathbb{Z}$$

$$\min\ -24x_1 - 17x_2 - 12x_3 - 6x_4 - z$$
$$10x_1 + 8x_2 + 6x_3 + 5x_4 + s_1 \le 15$$
$$x_i \geq 0,\ s_1 \geq 0$$

I TABLEAU

	x_1	x_2	x_3	x_4	s_1	z	b
	-24	-17	-12	-6	0	-1	0
s_1	10	8	6	5	1	0	15

Esce s_1 entra x_1

$R_0' = -24 + 10n = 0$; $n = \frac{\cancel{24}}{\cancel{10}}\ \frac{12}{5}$

$R_0' = R_0 + \frac{12}{5}R_1 = 0 \quad 11/5 \quad 12/5 \quad 6 \quad 12/5 \quad -1 \quad 36$

$R_1' = \frac{1}{10}R_1 = 1 \quad 4/5 \quad 3/5 \quad 1/2 \quad 1/10 \quad 0 \quad 3/2$

II TABLEAU

	x_1	x_2	x_3	x_4	s_1	z	b
	0	$11/5$	$12/5$	6	$12/5$	-1	36
x_1	1	$4/5$	$3/5$	$1/2$	$1/10$	0	$3/2$

$$x = (x_1, x_2, x_3, x_4, s_1) = (1.5, 0, 0, 0, 0)$$

$z_{MAX} = -z_{MIN}$

$z_{MAX} = -(-36)$

$z = 36$

$\boxed{\begin{array}{l} z = 36 \\ x = 1.5 \end{array}}$

$x \le 1$ $\qquad\qquad$ $x \geq 2$

$\min -24x_1 - 17x_2 - 12x_3 - 6x_4 - z$ $\qquad$ N.A.

$10x_1 + 8x_2 + 6x_3 + 5x_4 \le 15$

$x_1 + s_2 \le 1$

$x_i \geq 0$

I TABLEAU

	x_1	x_2	x_3	x_4	s_1	s_2	z	b
	0	11/5	12/5	6	12/5	0	-1	36
x_1	1	4/5	3/5	1/2	1/10	0	0	3/2
s_2	1	0	0	0	0	1	0	1

$R_2' = R_2 - R_1 = 0 \quad -4/5 \quad -3/5 \quad -1/2 \quad -1/10 \quad 1 \quad 0 \quad -1/2$

II TABLEAU

	x_1	x_2	x_3	x_4	s_1	s_2	z	b
	0	11/5	12/5	6	12/5	0	-1	36
x_1	1	4/5	3/5	1/2	1/10	0	0	1
x_2	0	-4/5	-3/5	-1/2	-1/10	1	0	-1/2

DUALE

Non continuo perché ora consegue il testo e' per PLI B che non abbiamo fatto

Quesito 2

$$\max \; 5x_1 + x_2 + 3x_3$$
$$5x_1 - 4x_2 + 3x_3 \leq H_7$$
$$-5x_1 + 5x_2 + 3x_3 \leq H_6$$
$$x_1 + 5x_2 - 4x_3 \geq -H_5$$
$$x_i \geq 0$$

$$\min \; -5x_1 - x_2 - 3x_3 - z = 0$$
$$5x_1 - 4x_2 + 3x_3 + s_1 = 3$$
$$-5x_1 + 5x_2 + 3x_3 + s_2 = 7$$
$$-x_1 - 5x_2 + 4x_3 + s_3 = 2$$
$$x_i, s_i \geq 0$$

I TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	-5	-1	-3	0	0	0	-1	0
s_1	5	-4	3	1	0	0	0	3
s_2	-5	5	3	0	1	0	0	7
s_3	-1	-5	4	0	0	1	0	2

entre esce

$R_0' = R_0 + R_1 = 0 \quad -5 \quad 0 \quad 1 \quad 0 \quad 0 \quad -1 \quad 3$

$R_1' = \frac{1}{5} R_1 = 1 \quad -4/5 \quad 3/5 \quad 1/5 \quad 0 \quad 0 \quad 0 \quad 3/5$

$R_2' = R_2 + R_1 = 0 \quad 1 \quad 6 \quad 1 \quad 1 \quad 0 \quad 0 \quad 10$

$R_3' = -1 + 5k = 0;\ k = \frac{1}{5};\ R_3 = R_3 + \frac{1}{5} R_1 = 0 \quad -29/5 \quad 23/5 \quad 1/5 \quad 0 \quad 1 \quad 0 \quad 13/5$

II TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	-5	0	1	0	0	-1	3
x_1	1	-4/5	3/5	1/5	0	0	0	3/5
s_2	0	1	6	1	1	0	0	10
s_3	0	-29/5	23/5	1/5	0	1	0	13/5

entre esce

$R_0' = R_0 + 5R_2 = 0 \quad 0 \quad 30 \quad 6 \quad 5 \quad 0 \quad -1 \quad 53$

$R_1' = -\frac{4}{5} + k = 0;\ k = \frac{4}{5};\ R_1' = R_1 + \frac{4}{5} R_2 = 1 \quad 0 \quad 27/5 \quad 1 \quad 4/5 \quad 0 \quad 0 \quad 43/5$

$R_3' = -\frac{29}{5} + k = 0;\ k = \frac{29}{5};\ R_3' = R_3 + \frac{29}{5} R_2 = 0 \quad 0 \quad 197/5 \quad 6 \quad 29/5 \quad 1 \quad 0 \quad 303/5 \ \surd$

III TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	0	30	6	5	0	-1	53
x_1	1	0	27/5	1	4/5	0	0	43/5
x_2	0	1	6	1	1	0	0	10
s_3	0	0	197/5	6	29/5	1	0	303/5

$$X = (x_1, x_2, x_3, s_1, s_2, s_3) = (43/5, 10, 0, 0, 0, 303/5)$$

$$Z_{MAX} = -Z_{MIN} \qquad z = -(-53) = 53$$

La soluzione e' verificata per tanto e' corretta

5/02/2024

$$\max\ 6x_1 + 4x_2 + 8x_3$$
$$5x_1 + 6x_2 + 5x_3 \geq 5$$
$$4x_1 + 6x_2 + 6x_3 \leq 2$$
$$5x_1 + 4x_2 + 8x_3 \leq 4$$

$$\min\ -6x_1 - 4x_2 - 8x_3 - z$$
$$5x_1 + 6x_2 + 5x_3 - s_1 = 5$$
$$4x_1 + 6x_2 + 6x_3 + s_2 = 2$$
$$5x_1 + 4x_2 + 8x_3 + s_3 = 4$$

I TABLEAU

x_1	x_2	x_3	s_1	s_2	s_3	z	b
-6	-4	-8	0	0	0	-1	0
5	6	5	-1	0	0	0	5
4	6	6	0	1	0	0	2
5	4	8	0	0	1	0	4

IL PROBLEMA E' NON AMMISSIBILE

Es. 7

$$\max\ 3x_1 + 2x_2 - 5x_3$$
$$4x_1 - 2x_2 + 2x_3 \leq 4$$
$$-2x_1 - 2x_2 - x_3 \leq 1$$
$$x_i \geq 0$$

$$\min\ -3x_1 - 2x_2 + 5x_3 - z = 0$$
$$4x_1 - 2x_2 + 2x_3 + s_1 = 4$$
$$-2x_1 - 2x_2 - x_3 + s_2 = 1$$
$$x_i \geq 0,\quad s_i \geq 0$$

I TABLEAU

	x_1	x_2	x_3	s_1	s_2	z	b
	-3	-2	5	0	0	-1	0
s_1	4	-2	2	1	0	0	4
s_2	-2	-2	-1	0	1	0	1

ILLIMITATO

Es. 7

max $3x_1 + 5x_2$
$x_1 \leq 4$
$2x_2 \leq 12$
$3x_1 + 2x_2 \leq 18$
$x_i \geq 0$

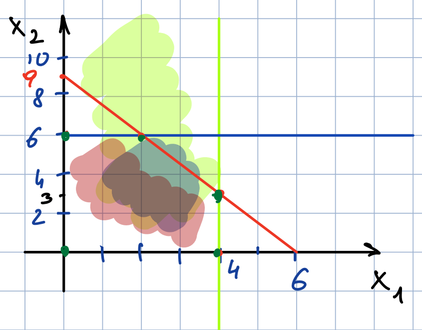
min $-3x_1 - 5x_2 - z = 0$
$x_1 + s_1 = 4$
$2x_2 + s_2 = 12$
$3x_1 + 2x_2 + s_3 = 18$
$x_i \geq 0$, $s_i \geq 0$

RAPPRESENTAZIONE GEOMETRICA

Considero $x_1 = x$, $x_2 = y$

$x = 4$
$y = \frac{\cancel{12}}{\cancel{2}}\ 6$

$3x + 2y = 18$; $2y = 18$; $y = 9$
$x = 0$; $3x = 18$; $x = 6$
$y = 0$



max $3x_1 + 5x_2$
$x_1 = 0$ $x_2 = 0$ } sostituisco alla funzione obiettivo $= 0$
$x_1 = 0$ $x_2 = 6$ $= 30$
$x_1 = 2$ $x_2 = 6$ $= 36$
$x_1 = 4$ $x_2 = 3$ $= 27$
$x_1 = 4$ $x_2 = 0$ $= 12$

Determino la regione di ammissibilità

I TABLEAU

	x_1	x_2	s_1	s_2	s_3	z	b
	-3	-5	0	0	0	-1	0
s_1	1	0	1	0	0	0	4
s_2	0	2	0	1	0	0	12
s_3	3	2	0	0	1	0	18

$R_0' = R_0 + 5/2\, R_2 = -3 \quad 0 \quad 0 \quad 5/2 \quad 0 \quad -1 \quad 30$

$R_2' = 1/2\, R_2 = 0 \quad 1 \quad 0 \quad 1/2 \quad 0 \quad 0 \quad 6$

$R_3' = R_3 - R_2 = 3 \quad 0 \quad 0 \quad -1 \quad 1 \quad 0 \quad 6$

II TABLEAU

	x_1	x_2	s_1	s_2	s_3	z	b
	-3	0	0	5/2	0	-1	30
s_1	1	0	1	0	0	0	4
x_2	0	1	0	1/2	0	0	6
s_3	3	0	0	-1	1	0	6

$R_0' = R_0 + R_3 = 0 \quad 0 \quad 0 \quad 3/2 \quad 1 \quad -1 \quad 36$

$R_1' = 1+3k = 0 \cdot k = -\frac{1}{3}$; $R_1' = R_1 - \frac{1}{3} R_3 = 0 \quad 0 \quad 1 \quad 1/3 \quad -1/3 \quad 0 \quad 2$

$R_3' = \frac{1}{3} R_3 = 1 \quad 0 \quad 0 \quad -1/3 \quad 1/3 \quad 0 \quad 2$

III TABLEAU

	x_1	x_2	s_1	s_2	s_3	z	b
	0	0	0	3/2	1	-1	36
s_1	0	0	1	1/3	-1/3	0	2
x_2	0	1	0	1/2	0	0	6
x_1	1	0	0	-1/3	-1/3	0	2

$X = (x_1, x_2, s_1, s_2, s_3) = (2, 6, 2, 0, 0)$ $\qquad z_{MAX} = -z_{MIN} = 36$

$$\begin{aligned} \min\ & -x_1 - 3x_2 + x_3 \\ & 2x_1 + x_2 \leq 3 \\ & x_1 + x_2 + 3x_3 \leq 6 \\ & 2x_1 + x_2 + 3x_3 \leq 8 \\ & x_i \geq 0 \end{aligned}$$

$$\begin{aligned} \min\ & -x_1 - 3x_2 + x_3 - z = 0 \\ & 2x_1 + x_2 + s_1 = 3 \\ & x_1 + x_2 + 3x_3 + s_2 = 6 \\ & 2x_1 + x_2 + 3x_3 + s_3 = 8 \\ & x_i, s_i \geq 0 \end{aligned}$$

I TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	-1	-3	1	0	0	0	-1	0
x_1	2	1	0	1	0	0	0	3
s_2	1	1	3	0	1	0	0	6
s_3	2	1	3	0	0	1	0	8

3/2 6/1 8/2

$R_0' = -1 + 2k = 0$; $k = 1/2$; $R_0' = R_0 + \frac{1}{2} R_1 = 0 \quad -5/2 \quad 1 \quad 1/2 \quad 0 \quad 0 \quad -1 \quad 3/2$

$R_1' = \frac{1}{2} R_1 = 1 \quad 1/2 \quad 0 \quad 1/2 \quad 0 \quad 0 \quad 0 \quad 3/2$

$R_2' = 1 + 2k = 0$; $k = -\frac{1}{2}$; $R_2' = R_2 - \frac{1}{2} R_1 = 0 \quad 1/2 \quad 3 \quad -1/2 \quad 1 \quad 0 \quad 0 \quad 9/2$

$R_3' = R_3 - R_1 = 0 \quad 0 \quad 3 \quad -1 \quad 0 \quad 1 \quad 0 \quad 5$

II TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	-5/2	1	1/2	0	0	-1	3/2
x_1	1	1/2	0	1/2	0	0	0	3/2
s_2	0	1/2	3	-1/2	1	0	0	9/2
s_3	0	0	3	-1	0	1	0	5
	esce	entra						

$R_0' = -\frac{5}{2} + \frac{1}{2} k = 0$; $k = \frac{5}{\cancel{2}} \cdot 2$; $R_0' = R_0 + 5R_1 = 5 \quad 0 \quad 1 \quad 3 \quad 0 \quad 0 \quad -1 \quad 9$

$R_1' = 2R_1 = 2 \quad 1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0 \quad 3$

$R_2' = R_2 - R_1 = -1 \quad 0 \quad 3 \quad -1 \quad 1 \quad 0 \quad 0 \quad 3$

$X = (x_1, x_2, x_3, s_1, s_2, s_3) = (0, 3, 0, 0, 3, 5)$ $\quad z = -9$

16/04

$$\max \quad 3x_1 + x_2 - x_3$$
$$-x_1 + x_2 - 3x_3 \le M_7$$
$$-x_1 + 3x_2 - 5x_3 \le M_6$$
$$2x_1 - x_2 + 3x_3 \le M_5$$
$$x_i \geq 0$$

$$\min \quad -3x_1 - x_2 + x_3 - z = 0$$
$$-x_1 + x_2 - 3x_3 + s_1 = 3$$
$$-x_1 + 3x_2 - 5x_3 + s_2 = 7$$
$$2x_1 - x_2 + 3x_2 + s_3 = 2$$
$$x_i \geq 0, \; s_i \geq 0$$

I TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	-3	-1	1	0	0	0	-1	0
s_1	-1	1	-3	1	0	0	0	3
s_2	-1	3	-5	0	1	0	0	7
s_3	2	-1	3	0	0	1	0	2

$R_0' = -3 + 2k = 0 \; ; \; k = \frac{3}{2} \; ; \; R_0' = R_0 + \frac{3}{2} R_3 = 0 \quad -5/2 \quad 11/2 \quad 0 \quad 0 \quad 3/2 \quad -1 \quad 3$

$R_1' = R_1 + \frac{1}{2} R_3 = 0 \quad 1/2 \quad -3/2 \quad 1 \quad 0 \quad 1/2 \quad 0 \quad 4$

$R_2' = R_2 + \frac{1}{2} R_3 = 0 \quad 5/2 \quad -7/2 \quad 0 \quad 1 \quad 1/2 \quad 0 \quad 8$

$R_3' = \frac{1}{2} R_3 = 1 \quad -1/2 \quad 3/2 \quad 0 \quad 0 \quad 1/2 \quad 0 \quad 1$

II TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	$-5/2$	$11/2$	0	0	$3/2$	-1	3
s_1	0	$1/2$	$-3/2$	1	0	$1/2$	0	4
x_2	0	$5/2$	$-7/2$	0	1	$1/2$	0	8
x_1	1	$-1/2$	$3/2$	0	0	$1/2$	0	1

$4 : \frac{1}{2} \; ; \; 4 \cdot 2 = 8 \qquad 8 : \frac{5}{2} \; ; \; \frac{8 \cdot 2}{5} \simeq 3.2$

$R_0' = R_0 + R_2 = 0 \quad 0 \quad 2 \quad 0 \quad 1 \quad 2 \quad -1 \quad 11$

$R_1' = \frac{1}{2} + \frac{5}{2} n = 0 \; ; \; n = -\frac{1}{2} \cdot \frac{2}{5} \; ; \; R_1' = R_1 - \frac{1}{5} R_2 = 0 \quad 0 \quad -4/5 \quad 1 \quad -1/5 \quad 2/5 \quad 0 \quad \frac{12}{5}$

$R_2' = \frac{2}{5} R_2 = 0 \quad 1 \quad -7/5 \quad 0 \quad 2/5 \quad 1/5 \quad 0 \quad \frac{16}{5}$

$R_3' = R_3 + \frac{1}{5} R_2 = 1 \quad 0 \quad 8/5 \quad 0 \quad 1/5 \quad 3/5 \quad 0 \quad \frac{13}{5}$

II TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	0	2	0	1	2	-1	11
s_1	0	0	-4/5	1	-1/5	2/5	0	12/5
x_2	0	1	-7/5	0	2/5	1/5	0	16/5
x_1	1	0	8/5	0	1/5	3/5	0	13/5

$X = (x_1, x_2, x_3, s_1, s_2, s_3) = \left(\frac{13}{5}, \frac{16}{5}, 0, \frac{12}{5}, 0, 0\right)$

$z_{MAX} = -z_{MIN}$

$z_{MAX} = -(-11)$

$z_{MAX} = 11$

max $3x_1 + 5x_2$

$x_1 \leq 4$

$2x_2 \leq 12$

$3x_1 + 2x_2 \leq 18$

$x_i \geq 0$

min $-3x_1 - 5x_2 - z = 0$

$x_1 + s_1 = 4$

$2x_2 + s_2 = 12$

$3x_1 + 2x_2 + s_3 = 18$

$x_i \geq 0, \; s_i \geq 0$

I TABLEAU

	x_1	x_2	s_1	s_2	s_3	z	b
	-3	-5	0	0	0	-1	0
x_1	1	0	1	0	0	0	4
s_2	0	2	0	1	0	0	12
s_3	3	2	0	0	1	0	18

REGOLA DI BLAND
PER EVITARE CHE IL
TABLEAU DEGENERI
SI SCEGLIE SEMPRE LA
VARIABILE CON INDICE MINORE

$R_0' = R_0 + 3R_1 = 3 \quad -5 \quad 3 \quad 0 \quad 0 \quad -1 \quad 12$

$R_3' = R_3 - 3R_1 = 0 \quad 2 \quad -3 \quad 0 \quad 1 \quad 0 \quad 6$

II TABLEAU

	x_1	x_2	s_1	s_2	s_3	z	b
	3	-5	3	0	0	-1	12
x_1	1	0	1	0	0	0	4
s_2	0	2	0	1	0	0	12
s_3	0	2	-3	0	1	0	6

$R_0' : -5 + 2k = 0; \ k = \frac{5}{2}$; $R_0' = R_0 + \frac{5}{2} R_3 = 3 \quad 0 \quad 9/2 \quad 0 \quad 1 \quad -1 \quad 27$

$R_2' = R_2 - R_1 = 0 \quad 0 \quad 3 \quad 1 \quad -1 \quad 0 \quad 6$

$R_3' = \frac{1}{2} R_3 = 0 \quad 1 \quad -3/2 \quad 0 \quad \frac{1}{2} \quad 0 \quad 3$

III TABLEAU

	x_1	x_2	s_1	s_2	s_3	z	b
	3	0	9/2	0	1	-1	27
x_1	1	0	1	0	0	0	4
s_2	0	0	3	1	-1	0	3
x_2	0	1	-3/2	0	1/2	0	6

$X = (x_1, x_2, s_1, s_2, s_3) = (4, 3, 0, 6, 0)$ $\qquad z_{MAX} = -z_{MIN}$

$z = 27$

$-3(4) - 5(3) + 27 \qquad -27 + 27 = 0$ ✓

22/01/2021

$\min -2x_1 - x_2 + x_3$

$-3x_1 - 3x_2 + x_3 + x_4 \geq 5$

$-2x_1 + 2x_2 - 3x_4 \leq 2$

$2x_2 - x_3 = 1$

$x_1, x_4 \geq 0$

$x_2 \leq 0$

x_3 libera

se fosse stato di massimo avrei cambiato i segni delle variabili

D:

$\max 5\mu_1 + 2\mu_2 + \mu_3$

$-3\mu_1 - 2\mu_2 \leq -2$

$-3\mu_1 + 2\mu_2 + 2\mu_3 \geq -1$

$\mu_1 - \mu_3 = 1$

$\mu_1 - 3\mu_2 \leq 0$

$x_1, x_4 \geq 0$

$x_2 \leq 0$

x_3 libera

$\max 5x_1 + 4x_2 + 4x_3$

$-4x_1 + 5x_2 - x_3 \leq 1$

$2x_1 + 2x_2 - x_3 \leq 2$

$3x_2 + 4x_3 \leq 2$

$x_i \geq 0$

$\min -5x_1 - 4x_2 - 4x_3 - z = 0$

$-4x_1 + 5x_2 - x_3 + s_1 = 1$

$2x_1 + 2x_2 - x_3 + s_2 = 2$

$3x_2 + 4x_3 + s_3 = 2$

$x_i \geq 0, \; s_i \geq 0$

I TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	-5	-4	-4	0	0	0	-1	0
s_1	-4	5	-1	1	0	0	0	1
s_2	2	2	-1	0	1	0	0	2
s_3	0	3	4	0	0	1	0	2

$R_0' = -5 + 2h = 0;\; h = \frac{5}{2};\; R_0' = R_0 + \frac{5}{2} R_2 = 0 \quad 1 \quad -13/2 \quad 0 \quad 5/2 \quad 0 \quad -1 \quad 5$

$R_1' = -4 + 2h = 0;\; h = \frac{4}{2} = 2;\; R_1' = R_1 + 2R_2 = 0 \quad 9 \quad -3 \quad 1 \quad 2 \quad 0 \quad 0 \quad 5$

$R_2' = \frac{1}{2} R_1 = 1 \quad 1 \quad -1/2 \quad 0 \quad 1/2 \quad 0 \quad 0 \quad 1$

II TABLEAU

	x_1	x_2	x_3	s_1	s_2	s_3	z	b
	0	1	-13/2	0	5/2	0	-1	5
s_1	0	9	-3	1	2	0	0	5
x_1	1	1	-1/2	0	1/2	0	0	1
x_3	0	3	4	0	0	1	0	2

$R_0' = -\frac{13}{2} + 4h = 0 \; ; \; h = \frac{13}{2} \cdot \frac{1}{4} \; ; \; R_0' = R_0 + \frac{13}{8} R_3 = 0 \quad 37/8 \quad 0 \quad 0 \quad 5/2 \quad 13/8 \quad -1$

$R_1' = R_1 + \frac{3}{4} R_3 = 0 \quad 45/4 \quad 0 \quad 1 \quad 2 \quad 3/4 \quad 0 \quad 13/2$

$R_2' = R_2 + \frac{1}{8} R_3 = 1 \quad \frac{11}{8} \quad 0 \quad 0 \quad 1/2 \quad 1/8 \quad 0 \quad 5/4$

$R_3' = \frac{1}{4} R_3' = 0 \quad 3/4 \quad 1 \quad 0 \quad 0 \quad 1/4 \quad 0 \quad 1/2$

$x = (x_1, x_2, x_3, s_1, s_2, s_3) = (5/4, 0, 1/2, 13/2, 0, 0)$

$z_{MAX} = -z_{MIN}$

$z = \frac{33}{4}$