

Благодарю Артём Витальевич 8 в списке

$$3(8+5) \bmod 44 + 1 = 40$$

$$A = \begin{pmatrix} 1 & 0 & -2 & 3 & 0 \\ 0 & 1 & 0 & -1 & 0 \\ 2 & 0 & 1 & 0 & -2 \end{pmatrix} \quad b = \begin{pmatrix} -8 \\ 2 \\ 1 \end{pmatrix} \quad c = \begin{pmatrix} 2 \\ 1 \\ -3 \\ 1 \end{pmatrix} \quad d^* = \begin{pmatrix} -2 \\ -1 \\ 0 \\ 2 \\ 0 \end{pmatrix} \quad d^* = \begin{pmatrix} 3 \\ 4 \\ 6 \\ 4 \\ 5 \end{pmatrix}$$

$$2x_1 + x_2 + x_3 - 3x_4 + x_5 \rightarrow \max$$

$$\begin{cases} x_1 - 2x_3 + 3x_4 = -8 \\ x_2 - x_4 = 2 \\ 2x_1 + x_3 - 2x_5 = 1 \end{cases}$$

$$\begin{aligned} -2 &\leq x_1 \leq 3 \\ -1 &\leq x_2 \leq 4 \\ 0 &\leq x_3 \leq 6 \\ -2 &\leq x_4 \leq 4 \\ 0 &\leq x_5 \leq 5 \end{aligned}$$

$$x = (-2, -1, 0, -2, 0)$$

$$W = \begin{bmatrix} -8 \\ 2 \\ 1 \end{bmatrix} - \begin{bmatrix} 1 & 0 & -2 & 3 & 0 \\ 0 & 1 & 0 & -1 & 0 \\ 2 & 0 & 1 & 0 & -2 \end{bmatrix} \begin{bmatrix} -2 \\ -1 \\ 0 \\ -2 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 5 \end{bmatrix}$$

$$\begin{cases} x_1 - 2x_3 + 3x_4 + x_6 = -8 \\ x_2 - x_4 + x_7 = 2 \\ 2x_1 + x_3 - 2x_5 + x_8 = 1 \end{cases}$$

$$\begin{aligned} 0 &\leq x_6 \leq 0 \\ 0 &\leq x_7 \leq 1 \\ 0 &\leq x_8 \leq 5 \end{aligned}$$

$$-x_6 - x_7 - x_8 \rightarrow \max$$

$$M_6 = \{6, 7, 8\}$$

$$x = (-2, -1, 0, -2, 0, 0, 1, 5)$$

I итерация

$$1) \begin{bmatrix} 1 & 0 & 0 & -1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & -1 \end{bmatrix} \quad u = \begin{bmatrix} -1 \\ -1 \\ -1 \end{bmatrix}$$

$$2) \Delta_1 = 0 - (1 \ 0 \ 2) \begin{pmatrix} -1 \\ -1 \\ -1 \end{pmatrix} = 0 - (-1 - 2) = 3 > 0 \quad x_1 = d^*$$

Выводение по $j^* = 1$

$$3) l_1 = 1 \quad l_2 = l_3 = l_4 = l_5 = 0$$

$$\begin{array}{c|c} 400 & -1 \\ \hline 010 & 0 \\ 001 & -2 \end{array} \quad \begin{array}{l} l_8 = 1 \\ l_7 = 0 \\ l_8 = -2 \end{array}$$

$$\theta_6 = \frac{0-0}{-1} = 0 \quad \theta_1 = \frac{3+2}{1} = 5$$

$$\theta_7 = \infty$$

$$\theta_8 = \frac{0-5}{-2} = 2.5$$

$$\min \theta = 0 \quad j=6$$

$$Y_6 = \{1, 7, 8\}$$

II шаг

$$1) \begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \\ u_3 \end{bmatrix} = \begin{bmatrix} 0 \\ -1 \\ -1 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 & | & 2 \\ 0 & 1 & 0 & | & -1 \\ 0 & 0 & 1 & | & -1 \end{bmatrix} \Rightarrow u = \begin{bmatrix} 2 \\ -1 \\ -1 \end{bmatrix}$$

$$2) \Delta_2 = 0 - (0 \ 1 \ 0) \begin{pmatrix} 2 \\ -1 \\ -1 \end{pmatrix} = 1 \quad X_2 = d^*$$

Корректировка по $j^*=2$

$$3) l_2 = 1 \quad l_3 = l_4 = l_5 = l_6 = 0$$

$$\begin{bmatrix} 1 & 0 & 0 & | & 0 \\ 0 & 1 & 0 & | & -1 \\ 2 & 0 & 1 & | & 0 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & 0 \\ 0 & 1 & 0 & | & -1 \\ 0 & 0 & 1 & | & 0 \end{bmatrix} \Rightarrow \begin{array}{l} l_1 = 0 \\ l_7 = -1 \\ l_8 = 0 \end{array}$$

$$4) l_7 = -1 \Rightarrow \theta_7 = \frac{0-1}{-1} = 1 \quad \theta_1 = \theta_8 = \infty \quad \theta_2 = \frac{4+1}{1} = 5$$

$$\min \theta = 1 \quad j=7$$

$$5) Y_7 = \{1, 2, 8\}$$

$$\bar{X} = (-2, -1, 0, -2, 0, 0, 1, 5) + 1 \cdot \begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} = (-2, 0, 0, -2, 0, 0, 0, 5)$$

III упражнение

$$1) \begin{bmatrix} 1 & 0 & 2 & | & 0 \\ 0 & 1 & 0 & | & 0 \\ 0 & 0 & 1 & | & -1 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & 2 \\ 0 & 1 & 0 & | & 0 \\ 0 & 0 & 1 & | & -1 \end{bmatrix} \quad u = \begin{bmatrix} 2 \\ 0 \\ -1 \end{bmatrix}$$

$$2) \Delta_3 = 0 - (-2 \ 0 \ 1) \begin{pmatrix} 2 \\ 0 \\ -1 \end{pmatrix} = 0 - (-4 - 1) = 5 > 0 \quad x_3 = 0^*$$

Нормирование по $j^* = 3$

$$3) l_3 = 1 \quad l_4 = l_5 = l_6 = l_7 = 0$$

$$\begin{bmatrix} 1 & 0 & 0 & | & 2 \\ 0 & 1 & 0 & | & 0 \\ 2 & 0 & 1 & | & -1 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & 2 \\ 0 & 1 & 0 & | & 0 \\ 0 & 0 & 1 & | & -5 \end{bmatrix} \Rightarrow \begin{matrix} l_1 = 2 \\ l_2 = 0 \\ l_8 = -5 \end{matrix}$$

$$4) \theta_1 = \frac{3+2}{2} = \frac{5}{2} \quad \theta_3 = \frac{0-0}{1} = 0$$

$$\theta_2 = \infty$$

$$\theta_8 = \frac{0-5}{-5} = 1$$

$$\min \theta = 1 \quad j = 8$$

$$5) J_6 = \{1, 2, 3\}$$

$$x = (-2, 0, 0, -200, 0, 5) + 1 \cdot \begin{pmatrix} 2 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ -5 \end{pmatrix} = (0, 0, 1, -200, 0, 0)$$

IV упражнение

$$1) \begin{bmatrix} 1 & 0 & 2 & | & 0 \\ 0 & 1 & 0 & | & 0 \\ -2 & 0 & 1 & | & 0 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & 0 \\ 0 & 1 & 0 & | & 0 \\ 0 & 0 & 1 & | & 0 \end{bmatrix} \Rightarrow u = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\Delta_4 = \Delta_5 = 0 +$$

$$\Delta_6 = \Delta_7 = \Delta_8 = -1 +$$

Критерий оптимальности выполнен \Rightarrow переходим к II фазе

II фаза

I итерация

$$J_0 = \{1, 2, 3\} \quad x = (0, 0, 1, -2, 0)$$

$$1) \begin{bmatrix} 1 & 0 & 2 & | & 2 \\ 0 & 1 & 0 & | & 1 \\ -2 & 0 & 1 & | & 1 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & 0 \\ 0 & 1 & 0 & | & 1 \\ -2 & 0 & 1 & | & 1 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & 0 \\ 0 & 1 & 0 & | & 1 \\ 0 & 0 & 1 & | & 1 \end{bmatrix} \quad u = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}$$

$$2) \Delta_4 = -3 - (3-1 \cdot 0) \begin{pmatrix} 0 \\ 1 \end{pmatrix} = -2 \Rightarrow x_4 = d^* +$$

$$\Delta_5 = 1 - (0 \cdot 0 - 2) \begin{pmatrix} 0 \\ 1 \end{pmatrix} = 3 \Rightarrow x_5 = d^* -$$

Корректировка по $j=5$

$$3) l_5 = 1 \quad l_4 = 0$$

$$\begin{bmatrix} 1 & 0 & -2 & | & 0 \\ 0 & 1 & 0 & | & 0 \\ 2 & 0 & 1 & | & 2 \end{bmatrix} \sim \begin{bmatrix} 5 & 0 & 0 & | & 4 \\ 0 & 1 & 0 & | & 0 \\ 2 & 0 & 1 & | & 2 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & \frac{4}{5} \\ 0 & 1 & 0 & | & 0 \\ 0 & 0 & 1 & | & \frac{2}{5} \end{bmatrix} \quad \begin{array}{l} l_1 = \frac{4}{5} \\ l_2 = 0 \\ l_3 = \frac{2}{5} \end{array}$$

$$4) \theta_1 = \frac{3-0}{\frac{4}{5}} = \frac{15}{4} \quad \theta_2 = \infty \quad \theta_3 = \frac{6-1}{\frac{2}{5}} = \frac{25}{2} \quad \theta_5 = \frac{5-0}{1} = 5$$

$$\min \theta = \frac{15}{4} \quad j = 1$$

$$J_0 = \{2, 3, 5\}$$

$$X = (3, 0, \frac{5}{2}, -2, \frac{15}{4})$$

II шаг

$$1) \begin{bmatrix} 0 & 1 & 0 & | & 1 \\ -2 & 0 & 1 & | & 1 \\ 0 & 0 & -2 & | & 1 \end{bmatrix} \sim \begin{bmatrix} -2 & 0 & 1 & | & 1 \\ 0 & 1 & 0 & | & 1 \\ 0 & 0 & 1 & | & -\frac{1}{2} \end{bmatrix} \sim \begin{bmatrix} -2 & 0 & 0 & | & \frac{3}{2} \\ 0 & 1 & 0 & | & 1 \\ 0 & 0 & 1 & | & -\frac{1}{2} \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & -\frac{3}{4} \\ 0 & 1 & 0 & | & 1 \\ 0 & 0 & 1 & | & -\frac{1}{2} \end{bmatrix}$$

$$u = \begin{bmatrix} -\frac{3}{4} \\ 1 \\ -\frac{1}{2} \end{bmatrix}$$

$$2) \Delta_1 = 2 - (1 \ 0 \ 2) \begin{pmatrix} -\frac{3}{4} \\ 1 \\ -\frac{1}{2} \end{pmatrix} = 2 - \left[-\frac{3}{4} - 1\right] = 2 + \frac{7}{4} = \frac{15}{4} > 0 \quad X_1 = d^* +$$

$$\Delta_4 = -3 - (3 \ -1 \ 0) \begin{pmatrix} -\frac{3}{4} \\ 1 \\ -\frac{1}{2} \end{pmatrix} = -3 - \left[-\frac{9}{4} - 1\right] = -3 + 1 + \frac{9}{4} = -2 + \frac{9}{4} = -\frac{8}{4} + \frac{9}{4} = \frac{1}{4} > 0 \quad X_4 = d^* -$$

Выбирается по $j^* = 4$

$$3) l_4 = 1 \quad l_1 = 0$$

$$4) \begin{bmatrix} 0 & -2 & 0 & | & 3 \\ 1 & 0 & 0 & | & 1 \\ 0 & 1 & -2 & | & 0 \end{bmatrix} \sim \begin{bmatrix} -1 & 0 & 0 & | & 1 \\ 0 & 1 & 0 & | & \frac{3}{2} \\ 0 & 1 & -2 & | & 0 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & 1 \\ 0 & 1 & 0 & | & \frac{3}{2} \\ 0 & 0 & -2 & | & -\frac{3}{2} \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & | & 1 \\ 0 & 1 & 0 & | & \frac{3}{2} \\ 0 & 0 & 1 & | & \frac{3}{4} \end{bmatrix}$$

$$l_2 = 1 \quad l_3 = \frac{3}{2} \quad l_5 = \frac{3}{4}$$

$$5) \theta_2 = \frac{4-0}{1} = 4 \quad \theta_3 = \frac{6-\frac{5}{2}}{\frac{3}{2}} = \frac{\frac{7}{2}}{\frac{3}{2}} = \frac{7}{3} \quad \theta_5 = \frac{5-\frac{15}{4}}{\frac{3}{4}} = \frac{\frac{5}{4}}{\frac{3}{4}} = \frac{5}{3}$$

$$\min \theta = \frac{5}{3} \quad j^* = 5$$

$$6) J_0 = \{2, 3, 4\}$$

$$X = (3, 0, \frac{5}{2}, -2, \frac{15}{4}) + \frac{5}{3} \begin{pmatrix} 0 \\ 1 \\ \frac{3}{2} \\ 1 \\ \frac{3}{4} \end{pmatrix} = (3, \frac{5}{3}, 5, -\frac{1}{3}, 5)$$

III итерация

$$J_5 = \{2, 3, 4\} \quad x = (3, 5, 5, -\frac{12}{9}, 5)$$

$$1) \begin{bmatrix} 0 & 1 & 0 & 1 \\ -2 & 0 & 1 & 1 \\ 3 & -1 & 0 & -3 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 & -\frac{2}{3} \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & -\frac{1}{3} \end{bmatrix} \quad u = \begin{bmatrix} -\frac{2}{3} \\ 1 \\ -\frac{1}{3} \end{bmatrix}$$

$$2) \Delta_1 = 2 - (1 \ 0 \ 1) \begin{pmatrix} -\frac{2}{3} \\ 1 \\ -\frac{1}{3} \end{pmatrix} = \frac{10}{3} > 0 \quad x_1 = d^* +$$

$$\Delta_5 = 1 - (0 \ 0 \ -1) \begin{pmatrix} -\frac{2}{3} \\ 1 \\ -\frac{1}{3} \end{pmatrix} = \frac{5}{3} > 0 \quad x_5 = d^* +$$

Критерий оптимальности выполнен \Rightarrow
точка $(3, 5, 5, -\frac{12}{9}, 5)$ является оптимальной.