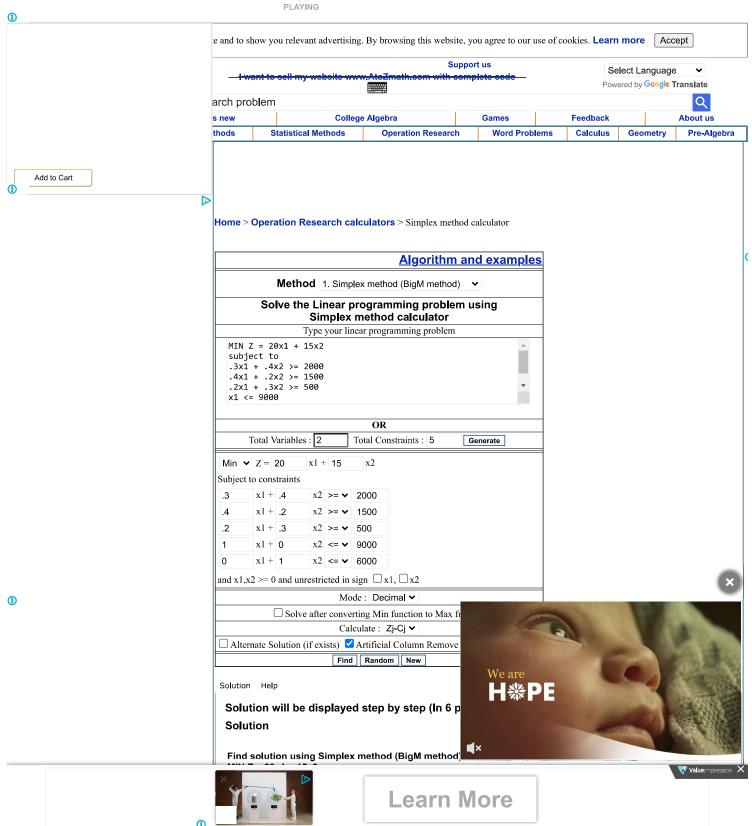


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x2 <= 6000 and x1,x2 >= 0

Solution:

Problem is

 $Min Z = 20 x_1 + 15 x_2$

subject to

 $0.3 x_1 + 0.4 x_2 \ge 2000$

 $0.4\,x_1 \ + \ 0.2\,x_2 \geq 1500$

 $0.2 x_1 + 0.3 x_2 \ge 500$ ≤ 9000

 $x_2 \le 6000$

and $x_1, x_2 \ge 0$;

The problem is converted to canonical form by adding slack, surplus and artificial variables as appropriate

- 1. As the constraint-1 is of type ' \geq ' we should subtract surplus variable S_1 and add artificial variable A_1
- 2. As the constraint-2 is of type \ge we should subtract surplus variable S_2 and add artificial variable A_2
- 3. As the constraint-3 is of type ' \geq ' we should subtract surplus variable S_3 and add artificial variable A_3
- 4. As the constraint-4 is of type ' \leq ' we should add slack variable S_4
- 5. As the constraint-5 is of type ' \leq ' we should add slack variable S_5

After introducing slack, surplus, artificial variables

$$\operatorname{Min} Z = 20x_1 + 15x_2 + 0S_1 + 0S_2 + 0S_3 + 0S_4 + 0S_5 + MA_1 + MA_2 + MA_3$$

subject to

subject to
$$0.3 \, x_1 \, + \, 0.4 \, x_2 \, - \, S_1 \qquad \qquad + \, A_1 \qquad \qquad = 2000$$

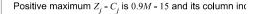
$$0.3 x_1 + 0.4 x_2 - S_1$$
 + A_1 = 2000
 $0.4 x_1 + 0.2 x_2$ - S_2 + A_2 = 1500
 $0.2 x_1 + 0.3 x_2$ - S_3 + A_3 = 500
 $x_1 + x_2 + x_3 + x_4 + x_5 + x$

$$x_1$$
 + x_2 = 9000
+ x_2 + x_3 = 6000

and
$$x_1, x_2, S_1, S_2, S_3, S_4, S_5, A_1, A_2, A_3 \ge 0$$

Iteration-1		C_{j}	20	15	0	0	0	0	0	M	M	M	
В	C_B	X _B	<i>x</i> ₁	x ₂	<i>S</i> ₁	S ₂	<i>S</i> ₃	S ₄	S ₅	A_1	A_2	A_3	MinRatio $\frac{X_B}{x_2}$
A_1	M	2000	0.3	0.4	-1	0	0	0	0	1	0	0	$\frac{2000}{0.4} = 5000$
A_2	M	1500	0.4	0.2	0	-1	0	0	0	0	1	0	$\frac{1500}{0.2} = 7500$
A_3	M	500	0.2	(0.3)	0	0	-1	0	0	0	0	1	$\frac{500}{0.3} = 1666.6667 \to$
S_4	0	9000	1	0	0	0	0	1	0	0	0	0	
S_5	0	6000	0	1	0	0	0	0	1	0	0	0	$\frac{6000}{1} = 6000$
Z = 4000M		Z_j	0.9M	0.9M	-M	_M	_M	0	0	М	М	М	
		Z_j - C_j	0.9M - 20	0.9 <i>M</i> - 15 ↑									

= 2000



Minimum ratio is 1666.6667 and its row index is 3. So, the

∴ The pivot element is 0.3.

Entering = x_2 , Departing = A_3 , Key Element = 0.3





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 $+ R_2(\text{new}) = R_2(\text{old}) - 0.2R_3(\text{new})$

 $+ R_4(\text{new}) = R_4(\text{old})$

 $+ R_5(\text{new}) = R_5(\text{old}) - R_3(\text{new})$

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Iteration-2		C_{j}	20	15	0	0	0	0	0	М	M	
В	C_B	X_B	<i>x</i> ₁	<i>x</i> ₂	S_1	S ₂	S_3	S_4	S ₅	A_1	A2	$\frac{X_B}{S_3}$
A_1	М	1333.3333	0.0333	0	-1	0	(1.3333)	0	0	1	0	$\frac{1333.3333}{1.3333} = 1000 \to$
A_2	М	1166.6667	0.2667	0	0	-1	0.6667	0	0	0	1	$\frac{1166.6667}{0.6667} = 1750$
<i>x</i> ₂	15	1666.6667	0.6667	1	0	0	-3.3333	0	0	0	0	
S_4	0	9000	1	0	0	0	0	1	0	0	0	
S_5	0	4333.3333	-0.6667	0	0	0	3.3333	0	1	0	0	$\frac{4333.3333}{3.3333} = 1300$
Z = 2500M + 25000		Z_{j}	0.3M + 10	15	-M	-М	2M - 50	0	0	M	М	
		Z_j - C_j	0.3 <i>M</i> - 10	0	-M	-M	2 <i>M</i> - 50 ↑	0	0	0	0	

Positive maximum Z_i - C_i is 2M - 50 and its column index is 5. So, the entering variable is S_3 .

Minimum ratio is 1000 and its row index is 1. So, the leaving basis variable is A_1 .

∴ The pivot element is 1.3333.

Entering = S_3 , Departing = A_1 , Key Element = 1.3333

 $+ R_1(\text{new}) = R_1(\text{old}) \div 1.3333$

 $+ R_2(\text{new}) = R_2(\text{old}) - 0.6667R_1(\text{new})$

 $+ R_3(\text{new}) = R_3(\text{old}) + 3.3333R_1(\text{new})$

 $+ R_4(\text{new}) = R_4(\text{old})$

 $+ R_5(\text{new}) = R_5(\text{old}) - 3.3333R_1(\text{new})$

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Iteration-3		C_j	20	1
В	C_B	X_B	<i>x</i> ₁	x
S_3	0	1000	0.025	(
A_2	М	500	0.25	(
x_2	15	5000	0.75	1



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	Z = 500M + 75000	Z_{j}	0.25M + 11.25	15	0.5M - 37.5	-M	0	0	0	M	
		Z_j - C_j	0.25M - 8.75	0	0.5M - 37.5 ↑	-M	0	0	0	0	

Positive maximum Z_i - C_i is 0.5M - 37.5 and its column index is 3. So, the entering variable is S_1 .

Minimum ratio is 400 and its row index is 5. So, the leaving basis variable is S_5 .

.. The pivot element is 2.5.

 \triangleright

Entering = S_1 , Departing = S_5 , Key Element = 2.5

- $+ R_5(\text{new}) = R_5(\text{old}) \div 2.5$
- $+ R_1(\text{new}) = R_1(\text{old}) + 0.75R_5(\text{new})$
- $+ R_2(\text{new}) = R_2(\text{old}) 0.5R_5(\text{new})$
- $+ R_3(\text{new}) = R_3(\text{old}) + 2.5R_5(\text{new})$
- $+ R_4(\text{new}) = R_4(\text{old})$

Iteration-4		C_j	20	15	0	0	0	0	0	M	
В	C_B	X_B	x_1	x ₂	<i>s</i> ₁	S ₂	<i>S</i> ₃	S ₄	S ₅	A_2	MinRatio $\frac{X_B}{x_1}$
S_3	0	1300	-0.2	0	0	0	1	0	0.3	0	
A_2	M	300	(0.4)	0	0	-1	0	0	-0.2	1	$\frac{300}{0.4} = 750 \rightarrow$
x_2	15	6000	0	1	0	0	0	0	1	0	
S_4	0	9000	1	0	0	0	0	1	0	0	$\frac{9000}{1} = 9000$
S_1	0	400	-0.3	0	1	0	0	0	0.4	0	
Z = 300M + 90000		Z_j	0.4 <i>M</i>	15	0	-M	0	0	-0.2M + 15	М	
		Z_j - C_j	0.4 <i>M</i> - 20 ↑	0	0	-M	0	0	-0.2M + 15	0	

Positive maximum Z_i - C_j is 0.4M - 20 and its column index is 1. So, the entering variable is x_1 .

Minimum ratio is 750 and its row index is 2. So, the leaving basis variable is A_2 .

∴ The pivot element is 0.4.

Entering $= x_1$, Departing $= A_2$, Key Element = 0.4

- $+ R_2(\text{new}) = R_2(\text{old}) \div 0.4$
- $+ R_1(\text{new}) = R_1(\text{old}) + 0.2R_2(\text{new})$
- $+ R_3(\text{new}) = R_3(\text{old})$
- $+ R_4(\text{new}) = R_4(\text{old}) R_2(\text{new})$



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	1		20	1.5						
Iteration-5		C_j	20	15	0	0	0	0	0	
В	C_B	X_B	<i>x</i> ₁	x ₂	s_1	S_2	S_3	S ₄	S_5	MinRatio $\frac{X_B}{S_5}$
S_3	0	1450	0	0	0	-0.5	1	0	0.2	$\frac{1450}{0.2} = 7250$
x_1	20	750	1	0	0	-2.5	0	0	-0.5	
x_2	15	6000	0	1	0	0	0	0	1	$\frac{6000}{1} = 6000$
S_4	0	8250	0	0	0	2.5	0	1	0.5	$\frac{8250}{0.5} = 16500$
S_1	0	625	0	0	1	-0.75	0	0	(0.25)	$\frac{625}{0.25} = 2500 \rightarrow$
Z = 105000		Z_j	20	15	0	-50	0	0	5	
		Z_j - C_j	0	0	0	-50	0	0	5 ↑	

Positive maximum Z_j - C_j is 5 and its column index is 7. So, the entering variable is S_5 .

Minimum ratio is 2500 and its row index is 5. So, the leaving basis variable is S_1 .

: The pivot element is 0.25.

Entering = S_5 , Departing = S_1 , Key Element = 0.25

- $+ R_5(\text{new}) = R_5(\text{old}) \div 0.25$
- $+ R_1(\text{new}) = R_1(\text{old}) 0.2R_5(\text{new})$
- $+ R_2(\text{new}) = R_2(\text{old}) + 0.5R_5(\text{new})$
- $+ R_3(\text{new}) = R_3(\text{old}) R_5(\text{new})$
- $+ R_4(\text{new}) = R_4(\text{old}) 0.5R_5(\text{new})$

Iteration-6		C_j	20	15	0	0	0	0	0	
В	C_B	X_B	<i>x</i> ₁	x ₂	<i>S</i> ₁	S ₂	S_3	S ₄	S ₅	
S_3	0	950	0	0	-0.8	0.1	1	0	0	
x_1	20	2000	1	0	2	-4	0	0	0	
<i>x</i> ₂	15	3500	0	1	-4	3	0	0	0	
S_4	0	7000	0	0						
S_5	0	2500	0	0						
Z = 92500		Z_{j}	20	15						
		Z_j - C_j	0	0						

Since all Z_j - $C_j \leq 0$

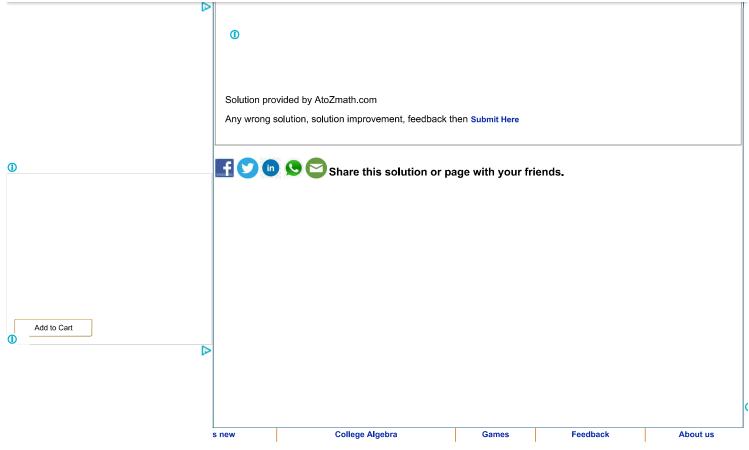
Hence, optimal solution is arrived with value of variable $x_1=2000,\,x_2=3500$



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