Homework 5 : Problem Solving

① Decision variables

x_i : the number of ice cream type i $\begin{cases} 1 : \text{vanilla} \\ 2 : \text{strawberry} \end{cases}$

so, x_1 : the number of vanilla ice cream

x_2 : the number of strawberry ice cream

② Objective

Max : $\underset{c_1}{2}X_1 + \underset{c_2}{3}X_2$

③ Constrains

<fresh milk>	$\underset{a_{11}}{0.5}X_1 + \underset{a_{12}}{0.2}X_2$	$\leq$	$\underset{b_1}{10}$	(1)
<the number of dolls>	$\underset{a_{21}}{1}X_1 + \underset{a_{22}}{1}X_2$	$\leq$	$\underset{b_2}{30}$	(2)
	x_1, x_2	$\geq$	0	

▶ Change to variables

<Max>	$c_1X_1 + c_2X_2$		
<basic ingredients>	$a_{11}X_1 + a_{12}X_2$	$\leq$	b_1
<fancy ingredients>	$a_{21}X_1 + a_{22}X_2$	$\leq$	b_2
	x_i	$\geq$	0 , $\forall_i$

▶ Convert in matrix

$$\mathbb{X}_{2\times1} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$\mathbb{C}_{1\times2} = \begin{bmatrix} c_1 & c_2 \end{bmatrix}$$

$$\mathbb{A} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$$

$$\mathbb{B} = \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$$

▶ Summarize

Max : $\mathbb{C}$

Constraints : $\mathbb{A}_{2\times2}\,\mathbb{X}_{2\times1} \leq \mathbb{B}_{2\times1}$

④ Plot linear graph from constraints in python program as follows:

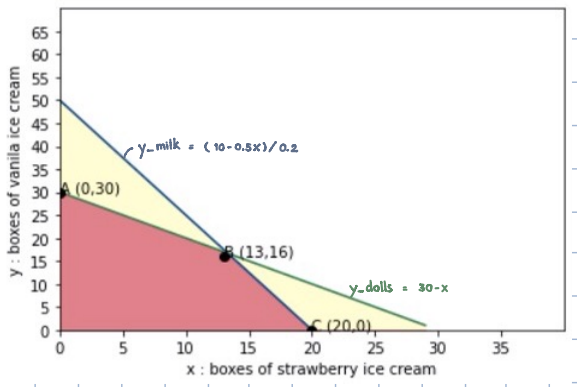
```
In [38]: x = np.array(range(30))

         # Constraints (use x,y instead x1,x2 for linear programming)
         ## <max> : 2x + 3y
         ## <basic ingredients> : 0.5*x + 0.2*y <= 10
         ## <fancy ingredients> : x + y <= 30

         # Create linear graph in formula y = ax + c
         ## <fresh milk> : y_milk = (10 - (0.5*x))/0.2
         ## <the number of dolls> : y_dolls = 30 - x

         y_milk = (10 - (0.5*x))/0.2
         y_dolls = 30 - x
         y_min = np.minimum(y_milk, y_dolls)
```

▶ Create linear graph by using import mathplotlib.pyplot as plt and we will get the graph below.



▶ From the previous constraints, the states that can be a maximize profits are A, B and C so we calculate profits of each state to find the most maximize profits as follows :

```
At point A : the maximize profits =  90 $
At point B : the maximize profits =  74 $
At point C : the maximize profits =  40 $

Therefore, the maximize profits is 90 $.
box of vanila ice cream = 0 #
box of strawberry ice cream = 30 #
```

⑤ Conclusion

We can make 30 boxes of strawberry ice cream and we will get the maximum profits 90 $ perday in condition having daily 10 liters of fresh milk and the number of dolls is 30 dolls per day. #