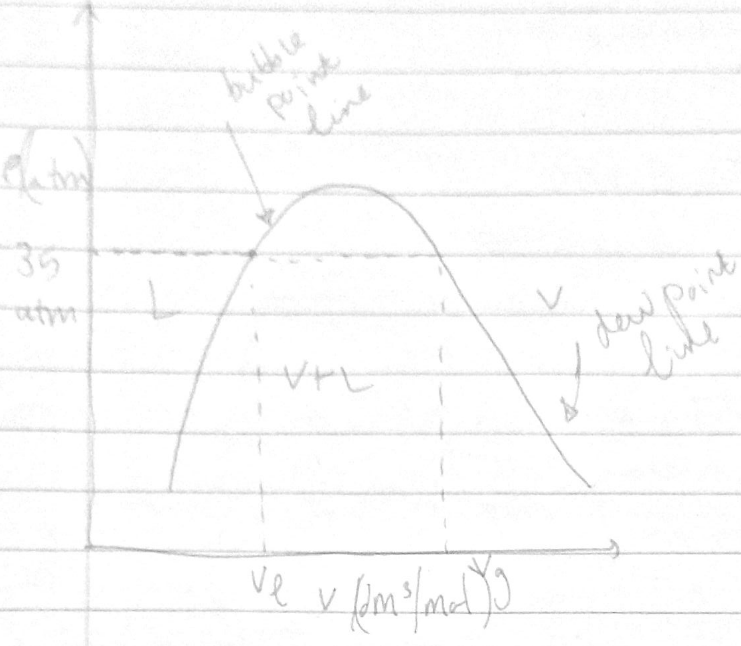

(Shape may be expressed in a P-T diagram instead?)

↑ ignore (from CET coursework)

5 month period

	cost	max prod
Int prod →	£10k/unit,	2000 units
Ext prod →	£15k/unit,	600 units

Inventory = £2k/unit · month

Initial Stock = 300 units, after 5 months wants to still have inventory of 300 units

Order book:

Month nº	NO. units
1	1200
2	2100
3	2400
4	3000
5	4000

How many hex. should be produced (and where) each month in order to meet demands and minimise costs?

1 = int prod   2 = ext prod

$C_M = 10\,000\, x_1 + 15000\, x_2$

$x_1 \leq 2000 \qquad x_2 \leq 600$

$C_S = 2000\, x_1$

Wrong approach:

Need a month - by - month strategy (similar to prev.)

init = 300

$\underbrace{x_1 \; x_2 \; x_3 \; x_4 \; x_5}_{\text{no. produced internally ea. Month}} \quad \underbrace{x_6 \; x_7 \; x_8 \; x_9 \; x_{10}}_{\text{n° prod. ext. ea. Mon.}} \quad \underbrace{x_{11} \; x_{12} \; x_{13} \; x_{14} \; x_{15}, x_{16}}_{\text{no. stored ea. Month}}$

$$C = 10e^3\left(\cancel{2a}\sum_{n=1}^{5} x_n\right) + 15e^3\left(\sum_{n=6}^{10} x_n\right) + 2e^3\left(\sum_{n=11}^{16} x_n\right)$$

Obj. functions normally

$C = x_1 + 2x_2$ or Something

$$\begin{array}{l} \text{Internal prod c} \\ \text{ext prod c} \\ \text{Storage c} \end{array} \left\{ \begin{array}{l} C_1 = 10\,(x_1 + x_2 + x_3 + x_4 + x_5) \\ C_2 = \cancel{20}\,15\,(x_6 + x_7 + x_8 + x_9 + x_{10}) \\ C_3 = 2\,(x_{12} + \ldots\; x_{16}) \end{array} \right.$$

We actually want to satisfy 3 objective functions all at once

$$\begin{array}{ccccc} x_{1/6/11\ldots} & x_2 & x_3 & x_4 & x_5 \end{array}$$

$$\begin{bmatrix} 10 & 10 & 10 & 10 & 10 \\ 15 & 15 & 15 & 15 & 15 \\ 2 & 2 & 2 & 2 & 2 \end{bmatrix} = c$$

Objective functions

not here

$$\begin{bmatrix} 10 \\ 10 \\ \vdots \\ 10 \\ 15 \\ \vdots \\ 15 \\ 2 \\ \vdots \\ 2 \end{bmatrix}$$

actually

A matrix → constraint matrix B → constraint

weight of variable (var)

$\underbrace{2x_1}_{\text{num Produced}} + 3x_2 \geq \underbrace{10}_{\text{actual constraint}}$

~~2000 [1 1 1 1 1]~~

$x_1 \leq 2000 \quad x_2 \leq 2000 \ldots$

$x_6 \leq 600 \quad x_7 \leq 600 \ldots$

Simple constraints

~~We must have~~ units now...

In 1st month Start w/ 300 units, Must Produce 1200 units. x_1 & x_6 must satisfy inequality

$300 + x_1 + x_6 - 1200 \geq x_{11}$

$x_1 + x_6 - x_{11} \geq 900$

$\boxed{-x_1 - x_6 + x_{11} \leq -900}$

$$\begin{array}{l|ccccccccccccccc} & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 \\ \text{1st line in A:} & -1 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{array}$$

$b\, 1^{st}_L = -900$

Stored from m1 → init prod m2 → ext prod m2 → order req m

$\cancel{x_{12}}\ x_{11} + x_2 + x_7 - 2100 \geq x_{12}$

$x_{11} + x_2 + x_7 - x_{12} \geq 2100$

$-x_{11} - x_2 - x_7 + x_{12} \leq -2100$

$x_{13} = x_{12} + x_3 + x_8 - 2400$

$x_{12} + x_3 + x_8 - 2400 \geq x_{13}$

$x_{12} + x_3 + x_8 - x_{13} \geq 2400$

$-x_{12} - x_3 - x_8 + x_{13} \leq -2400$

$x_{14} = x_{13} + x_4 + x_9 - 3000$

$-x_{13} - x_4 - x_9 + x_{14} \leq -3000$

$300 \leq x_{15}$

$\cancel{x_{15}} = x_{14} + x_5 + x_{10} - \overset{4000}{\cancel{24}} \leq \cancel{300}$

$-x_{14} - x_5 - x_{10} + \cancel{x_{15}} \leq -4300$

A must contain simple constraints & these.

comp:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ -1 & 1 & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & -1 & 1 \end{bmatrix} = \cancel{\text{eye}(4)\ \text{zeros}}$$

horzcat(vertcat(eye(4), zeros(4,1)), zeros(1,5)))

Cvar

$$\begin{bmatrix} -900 \\ -2100 \\ -2400 \\ -3000 \\ -4300 \end{bmatrix}$$

alt =

```
for i=1:m-1
  C1(k+1, k)=1;
end
```

comp =
eye(m) - C1

simp constr $\longrightarrow$ [eye (10)   zeros (10, 5)]

$$\begin{array}{ccc} & & \text{SVar} \\ \begin{matrix} 1\,0\,0\,0\,0\,0\,0\,0\,0\,0 \\ 0\,1\,0\,0 \cdots \rightarrow \\ 0\,0\,1\,0 \cdots \rightarrow \\ \vdots \end{matrix} & \begin{matrix} 0\,0\,0\,0\,0 \\ 0\,0 \\ 0 \\ 0 \\ 0 \\ \downarrow \end{matrix} & \begin{bmatrix} 2000 \\ 2000 \\ 2000 \\ 2000 \\ 2000 \\ 600 \\ 600 \\ 600 \\ 600 \\ 600 \end{bmatrix} \end{array}$$

i.e.

$x_1 \leq 2000$ $x_6 \leq 600$

$x_2 \leq 2000$ ...

$x_3 \leq 2000$

...

Constr $\longrightarrow$

$$\begin{bmatrix} I(10) & \text{zeros}(10,5) \\ \begin{bmatrix} -I(5) & -I(5) \end{bmatrix} & \text{horzcat(vertcat(eye(4), zeros(4,1)), zeros(1,5))} \end{bmatrix}$$

$$\text{Var} = \begin{bmatrix} \text{SVar} \\ \text{CVar} \end{bmatrix}$$

[x, fval] = linprog(f, constr, ConstrVar, [], [], lb)

$$lb = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$