$$OF = \{(x_1, x_2, \dots, x_m); (t_1, t_2, \dots, t_m)\}$$

We assume $x_K \geq 0 \quad \forall \quad K \in \{1, \dots, m\}$

$$D = \frac{x_1(1+i(0,t_1))^{-t_1} \cdot t_1 + x_2(1+i(0,t_2))^{-t_2} t_2 + \dots + x_m(1+i(0,t_m))^{-t_m} t_m}{x_1(1+i(0,t_1))^{-t_1} + x_2(1+i(0,t_2))^{-t_2} + \dots + x_m(1+i(0,t_m))^{-t_m}}$$

EX32: Consider the following cash flow

$$OF1 = \{(1,1,1,100); (1,2,3,4)\}$$

and the following term structure of spot interest rates

$$i(0,1) = 0.07,\ i(0,2) = 0.075,\ i(0,3) = 0.065,\ i(0,4) = 0.08.$$

$$V_1 = x_1(1+i(0,t_1))^{-t_1} =$$

$$= 1(1+0.07)^{-1}$$

ecc...

$$\underbrace{\begin{bmatrix} 1 \\ 2 \end{bmatrix}}_{V1} + \underbrace{\begin{bmatrix} 3 \\ 1 \end{bmatrix}}_{V2} = \begin{bmatrix} 1+3 \\ 2+1 \end{bmatrix} = \begin{bmatrix} 4 \\ 3 \end{bmatrix}$$

multiplication by a scalar (i.e., a number)

$$2 \begin{bmatrix} 1 \\ 2 \end{bmatrix} = \begin{bmatrix} 2 \cdot 1 \\ 2 \cdot 2 \end{bmatrix} = \underbrace{\begin{bmatrix} 2 \\ 4 \end{bmatrix}}_{V3}$$

$V5 = [-1, 1, 3, 4, 6]$

"house"

-1	1	3	4	6
1	2	3	4	5

"civic number"

index

In position 1 there is -1

-1	~~1~~	3	4	6
1	2	3	4	5

~~-1~~	3	4	~~6~~
1	2	3	4

3	4
1	2

$V5 = [\,2 \quad 3 \quad \boxed{3 \mid 4} \quad -1\,]$

$V5 = [\,2 \quad 3 \quad 3 \quad 4 \quad -1\,]$

$$\underbrace{[\,2 \quad 3 \quad 3 \quad 4 \quad -1\,]}_{1 \times 5 \text{ vector}} - \underbrace{1}_{1 \times 1 \text{ vector}}$$

From a mathematical point of view this operation is not possible because the two "vectors" are not compatible.

casting

$$[\,2 \quad 3 \quad 3 \quad 4 \quad -1\,] - [\,1 \quad 1 \quad 1 \quad 1 \quad 1\,]$$

But in Matlab, is operation is possible and it means to subtract 1 to each element of the array.

When all the . t of an array undergo the same operation, we alk about ELEMENT-WISE OPERATIO .

$V_5 = [\,1 \quad 2 \quad 2 \quad 3 \quad -2\,]$

Suppose we want to compute the square of each element and save the result into a new array, say V6

$$V6 = [\,1^2 \quad 2^2 \quad 2^2 \quad 3^2 \quad (-2)^2\,] = [\,1 \quad 4 \quad 4 \quad 9 \quad 4\,]$$

$$V6 = V5 .\hat{} \, 2$$

↑ element - wise operation

$$y = x^2$$ parabola

$$f(x) = x^2$$

$$f(-2) = (-2)^2 = 4$$

$$f([-1, 0, -2]) = [(-1)^2, 0^2, (-2)^2] =$$

$$= [1, 0, 4]$$