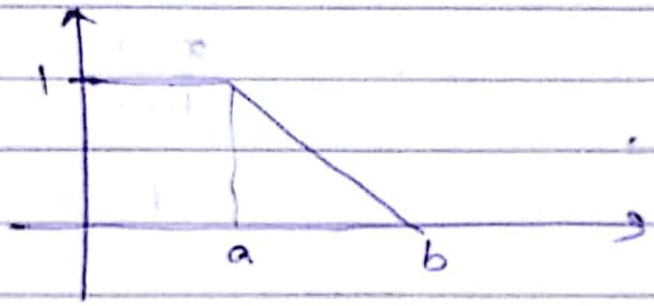
shapes used to represent graphical form of membership function.

The rules that describe fuzziness graphically are also fuzzy.

But standard shapes of the membership functions are maintained over the years.

L - function

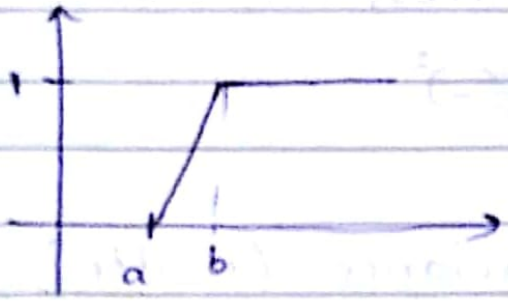


$$f(x) = 1 \quad x \leq a$$

$$= \frac{b-x}{b-a} \quad a < x \leq b$$

$$= 0 \quad x > b.$$

T - function

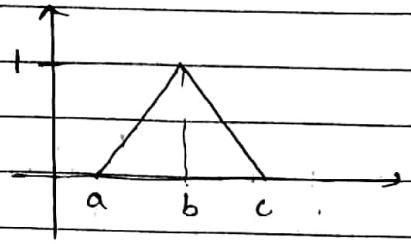


$$f(x) = 0 \quad x \leq a$$

$$= \frac{x-a}{b-a} \quad a < x \leq b$$

$$= 1 \quad x > b$$

3) Triangular function –



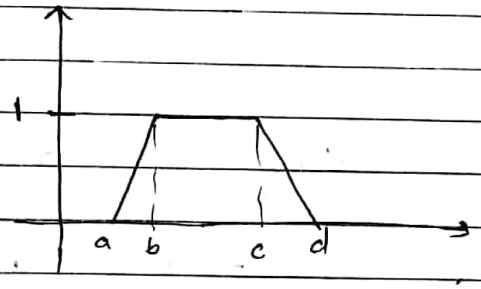
$f(x) = 0 \quad x \le a$

$= \frac{x-a}{b-a} \quad a < x \le b$

$= \frac{c-x}{c-b} \quad b < x \le c$

$= 0 \quad x > c$

4) Trapezoidal function



$f(x) = 0 \quad x \le a$

$= \frac{x-a}{b-a} \quad a < x \le b$

$= 1 \quad b < x \le c$

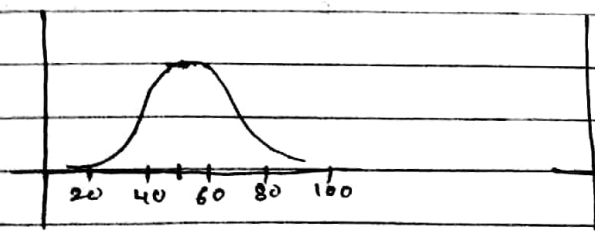
$= \frac{d-x}{d-c} \quad c < x \le$

$= 0 \quad x > d$

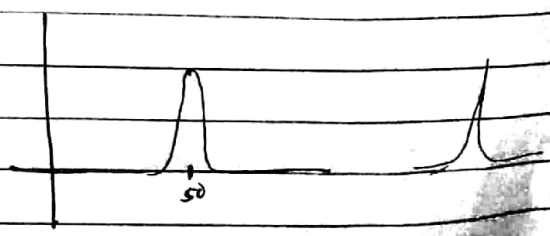
5) Gaussian membership function

$$\mu(x, c, \sigma) = e^{-\frac{1}{2}\left(\frac{x-c}{\sigma}\right)^2}$$

$c \rightarrow$ mean (centre), σ – variance (width)

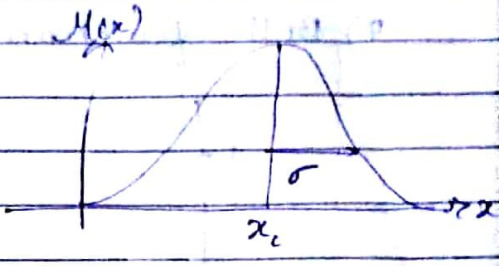


$c = 50$
$\sigma = 20$



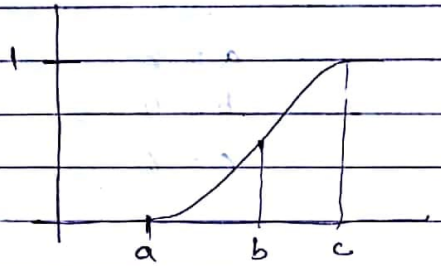
$c = 50$
$\sigma = 5$

5) `x = 0:0.1:10`
`y = gaussmf(x, [2,5]);`
`plot(x,y)`
`xlabel('gaussmf, P=[2,5]')`



6) S-function.

$y = smf(x, [a\ b])$.



$$f(x,a,b) = 0 \quad x \le a$$

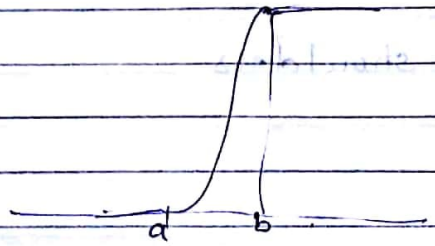
$$= 2\left(\frac{x-a}{b-a}\right)^2 \quad a \le x \le \frac{a+b}{2}$$

$$= 1 - 2\left(\frac{x-b}{c-a}\right)^2 \quad \frac{a+b}{2} \le x \le c$$

$$= 1 \quad x \ge c$$

$$b = \left(\frac{a+c}{2}\right)$$

matlab fn ⟶ smf.



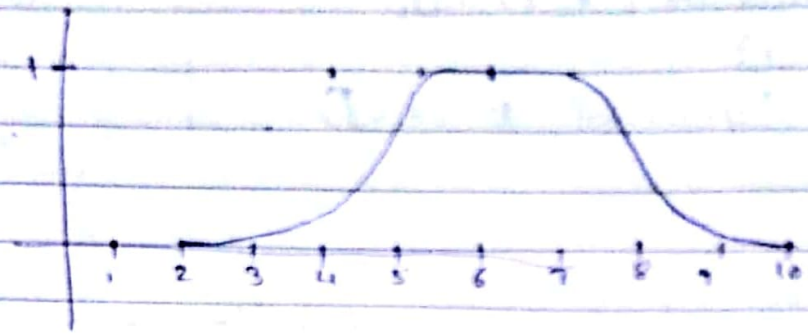
$$0 \quad x \le a$$

$$2\left(\frac{x-a}{b-a}\right)^2 \quad a \le x \le \frac{a+b}{2}$$

$$1 - 2\left(\frac{x-b}{b-a}\right)^2 \quad \frac{a+b}{2} \le x \le b$$

$$1 \quad x \ge b.$$

7) Bell function



$f(x, a, b, c)$

$$= \frac{1}{1 + \left| \frac{x - c}{a} \right|^{2b}}$$

$a = 2$
$b = 4$
$c = 6$

b is usually positive.
c locates the centre of the curve.

fn → gbellmf.

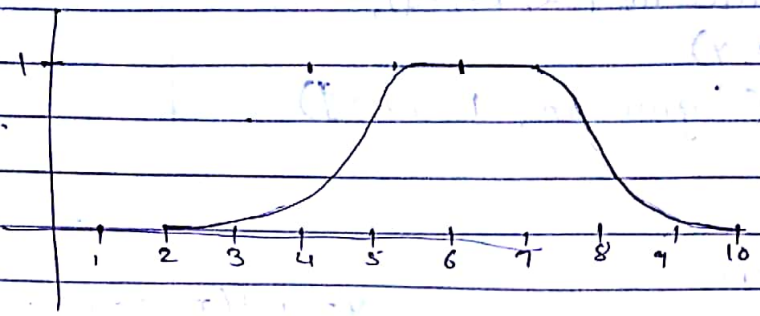
8) Π fn → pimf.

The spline based curved — named Π because of its shape.

a, d → locate feet of the curve.

b, c → locate shoulders

7) Bell function



$$f(x, a, b, c) = \frac{1}{1 + \left| \frac{x - c}{a} \right|^{2b}}$$

$a = 2$
$b = 4$
$c = 6$

b is usually positive.
c dictates the centre of the curve.

fn → 'gbellmf'

8) π fn → pimf.

The spline based curved — named π because of its shape.

a, d → locate feet of the curve.

b, c → locate shoulders.

$f(x, a, b, c, d) =$

$$\begin{cases} 0 & x \le a \\ 2\left(\frac{x-a}{b-a}\right)^2 & a \le x \le \frac{a+b}{2} \\ 1 - 2\left(\frac{x-b}{b-a}\right)^2 & \frac{a+b}{2} \le x < b \\ = 1 & b \le x \le c \\ = 1 - 2\left(\frac{x-c}{d-c}\right)^2 & c \le x \le \frac{c+d}{2} \\ = 2\left(\frac{x-d}{d-c}\right)^2 & \frac{c+d}{2} \le x \le d \\ = 0 & x \ge d. \end{cases}$$