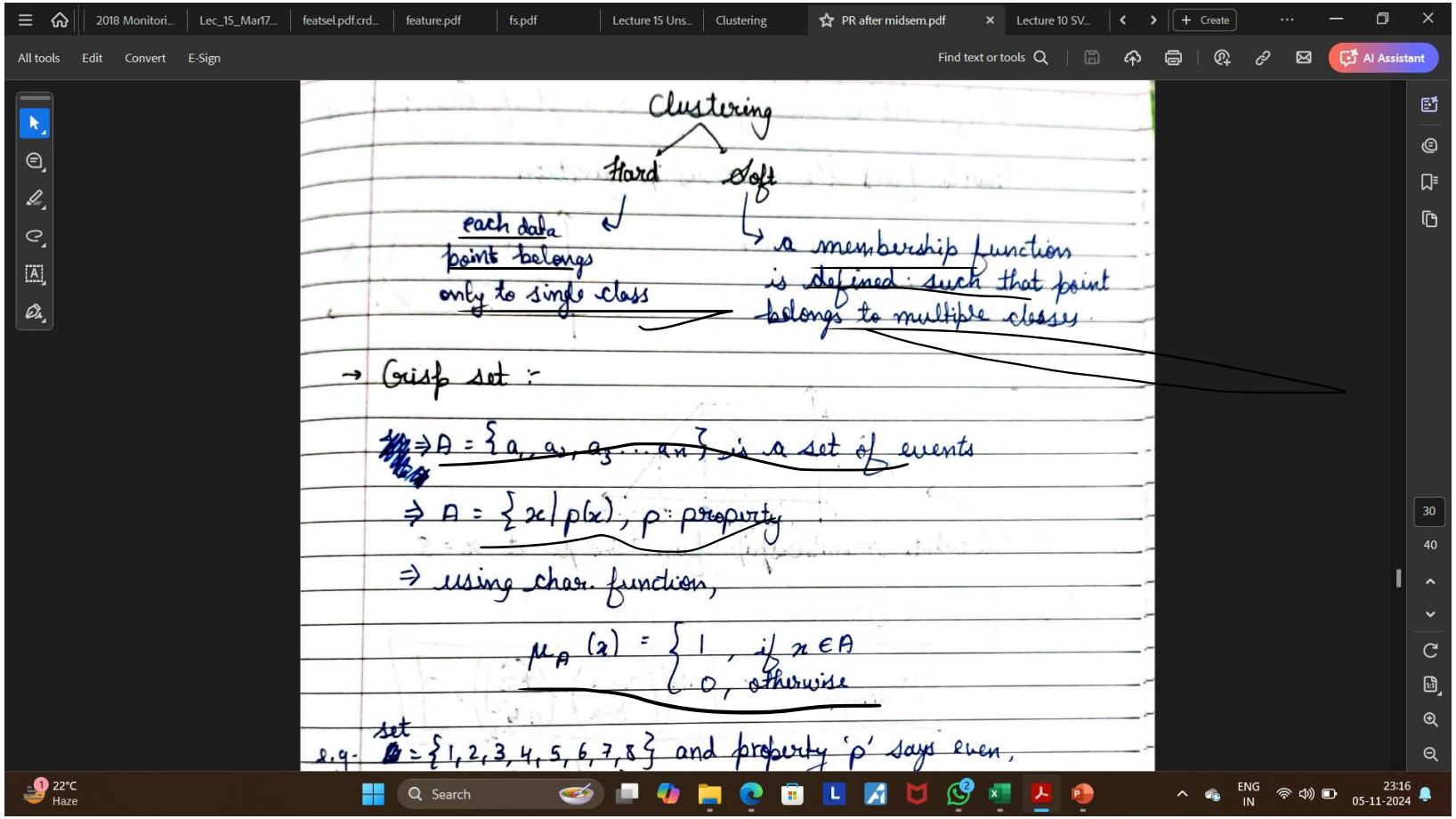
Fuzzy clustering



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$$\mu_A(x) = \begin{cases} 1, & \text{if } x \in A \\ 0, & \text{otherwise} \end{cases}$$

e.g. set = $\{1,2,3,4,5,6,7,8\}$ and property 'p' says even, then $A = \{2,4,6,8\}$

→ Fuzzy set : boundary is not crisp.

Membership Function

⇒ Fuzzy sets : sets with imprecise or vague boundaries

↳ It is a potential tool for handling imprecision and uncertainties

DOMS

crisp set

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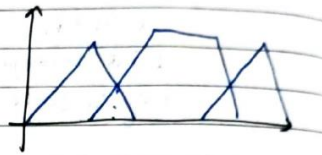
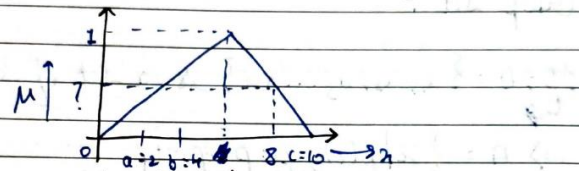
(crisp set)

Fuzzy set is more general concept of classical set.

How to find the membership function

e.g. fuzzy set will have overlapping areas





Q Calculate membership function μ at x = 8

Ans General formula

$$\mu_{triangle} = \max\left[\min\left(\frac{x-a}{b-a}, \frac{c-x}{c-b}\right), 0\right]$$

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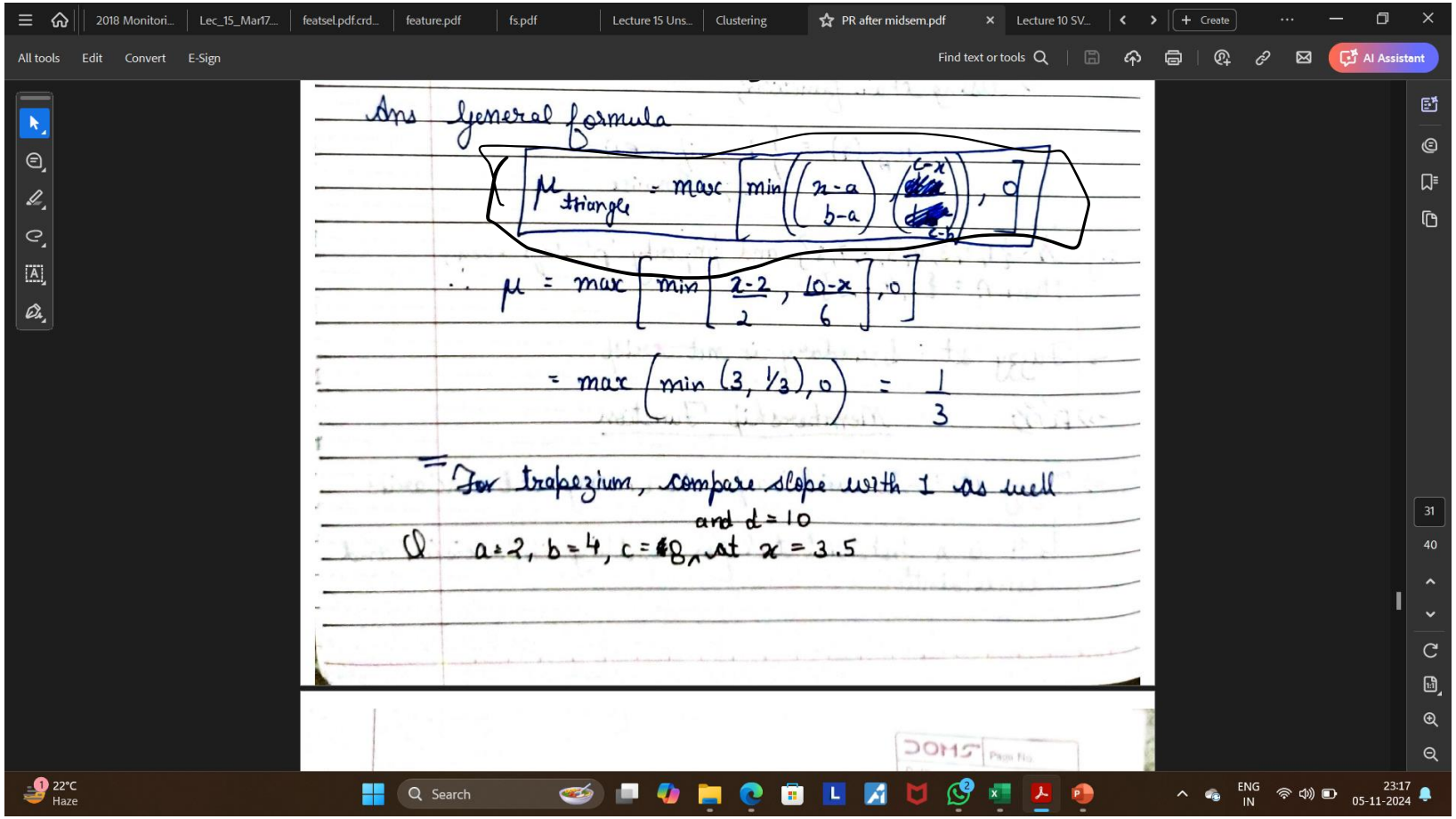
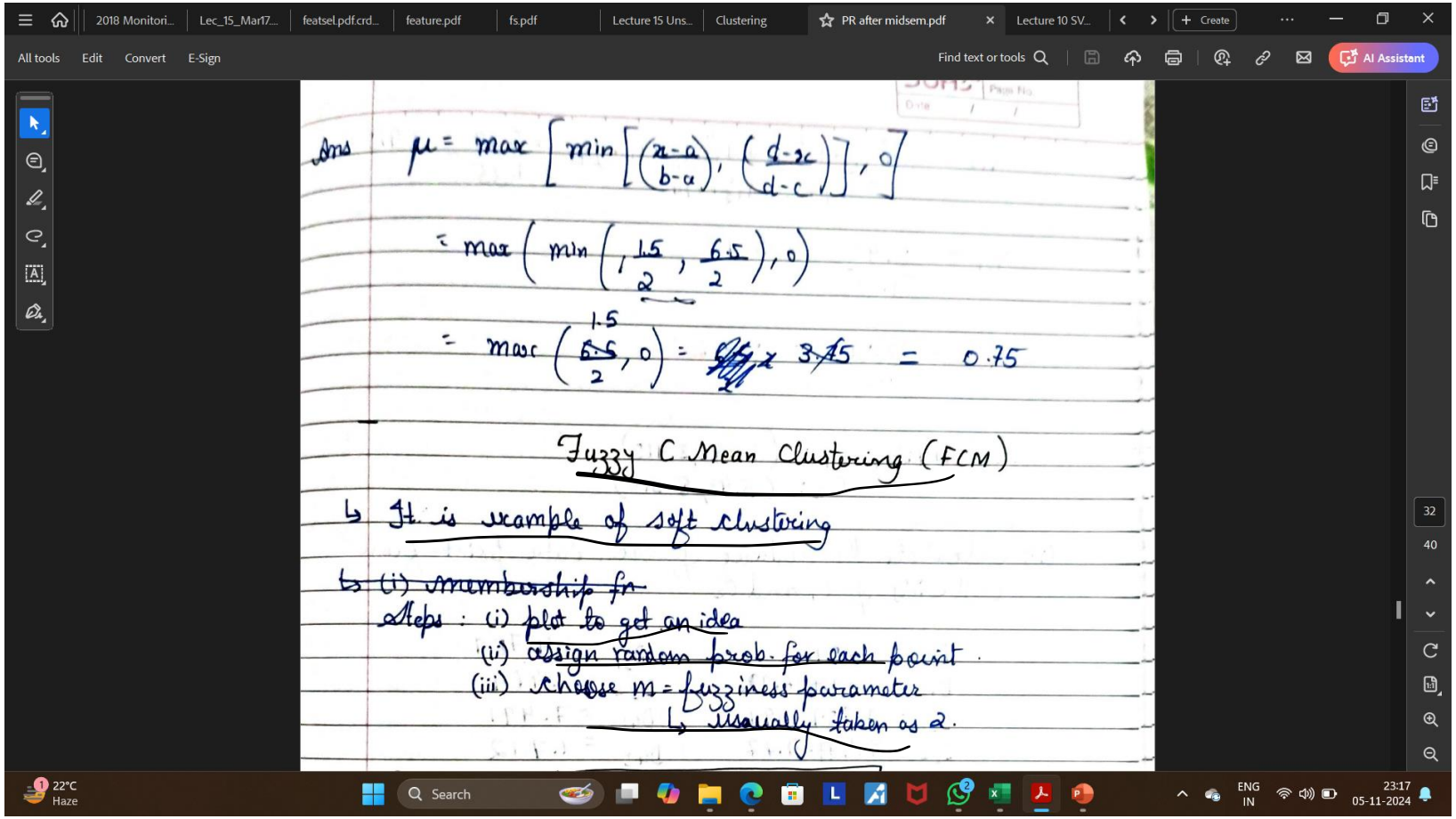
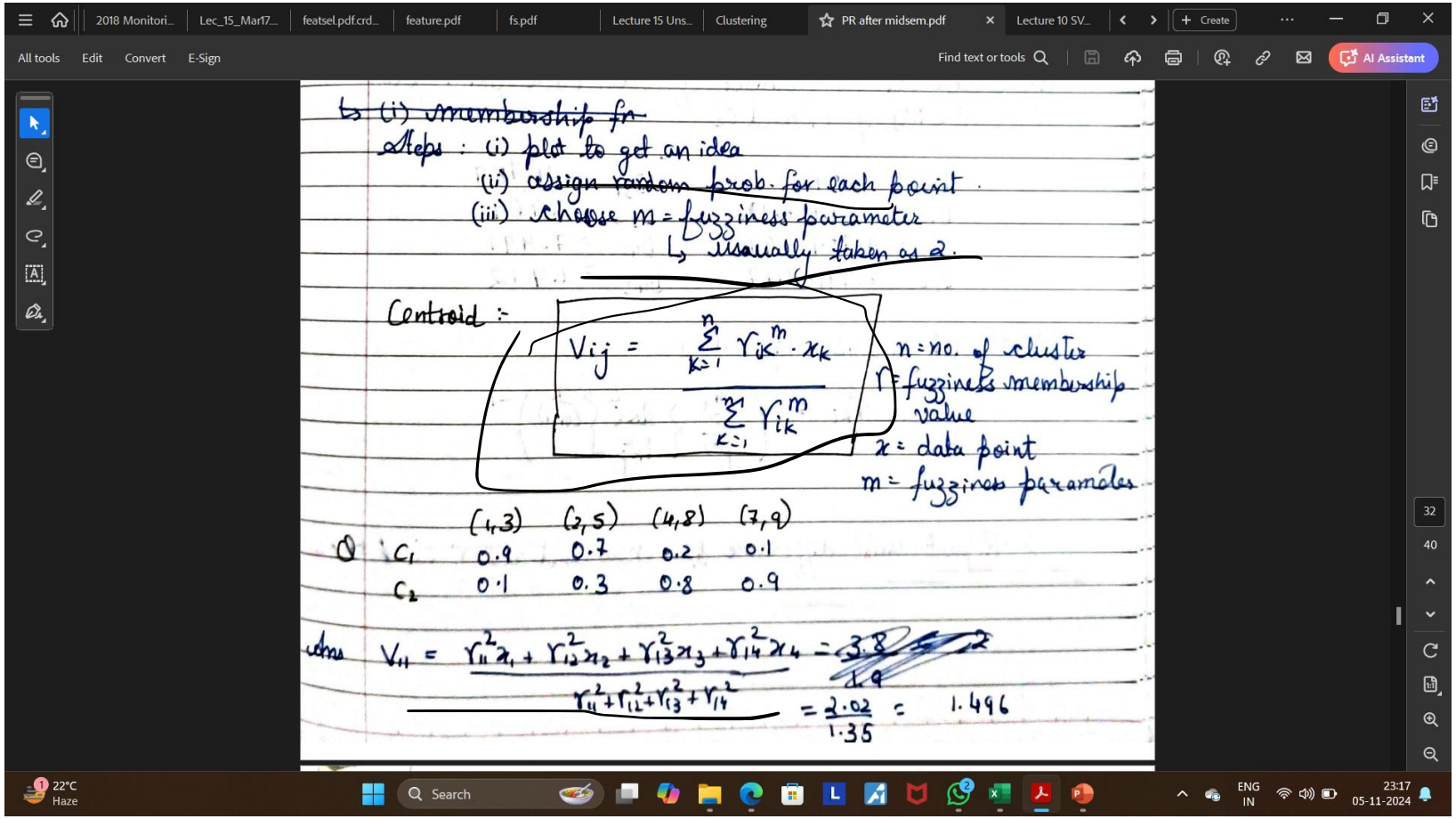

Ans General formula
$\mu_{triangle} = \max\left[\min\left(\frac{x-a}{b-a}, \frac{c-x}{c-b}\right), 0\right]$
$\therefore \mu = \max\left[\min\left[\frac{2-2}{2}, \frac{10-x}{6}\right], 0\right]$
$= \max\left(\min\left(3, \frac{1}{3}\right), 0\right) = \frac{1}{3}$
= For trapezium, compare slope with 1 as well
and d = 10
a = 2, b = 4, c = 8, at x = 3.5

Fuzzy C mean clustering (FCM)




(i) membership fn
Steps : (i) plot to get an idea
(ii) assign random prob. for each point
(iii) choose m = fuzziness parameter
↳ usually taken as 2.
Centroid :-
$V_{ij} = \frac{\sum_{k=1}^{n} \gamma_{ik}^{m} \cdot x_k}{\sum_{k=1}^{n} \gamma_{ik}^{m}}$
n = no. of cluster
γ = fuzziness membership value
x = data point
m = fuzziness parameter
(1,3) (2,5) (4,8) (7,9)
C1 0.9 0.7 0.2 0.1
C2 0.1 0.3 0.8 0.9
$V_{11} = \frac{\gamma_{11}^2 x_1 + \gamma_{12}^2 x_2 + \gamma_{13}^2 x_3 + \gamma_{14}^2 x_4}{\gamma_{11}^2 + \gamma_{12}^2 + \gamma_{13}^2 + \gamma_{14}^2} = \frac{2.02}{1.35} = 1.496$

$$v_{12} = \frac{r_{11}^2 y_1 + r_{12}^2 y_2 + r_{13}^2 y_3 + r_{14}^2 y_4}{r_{11}^2 + r_{12}^2 + r_{13}^2 + r_{14}^2} = \frac{5.29}{1.35} = 3.918$$

$$v_{21} = \frac{8.42}{1.55} = 5.43$$

$$v_{22} = \frac{12.89}{1.55} = 8.316$$

∴ Centroids, C_1 : (1.496, 3.918)
C_2 : (5.43, 8.316)

(iv) Calculate the distance of each data point from centroids of C_1 and C_2

$D_{11} = 1.043$ $\quad D_{31} = 4.789$

$D_{12} = 6.92$ $\quad D_{32} = 1.464$

C_2: (5.43, 8.316)

(iv) Calculate the distance of each data point from centroids of C_1 and C_2

$D_{11} = 1.043$ $\quad D_{31} = 4.789$

$D_{12} = ~~6.194~~ \; 6.92$ $\quad D_{32} = 1.464$

$D_{21} = ~~4.789~~ \; 1.194$ $\quad D_{41} = 7.491$

$D_{22} = ~~7.491~~ \; 4.77$ $\quad D_{42} = 1.712$

(v) Update membership values

$$\gamma_{ki} = \left(\sum_{j=1}^{n} \left\{ \frac{d_{ki}^2}{d_{kj}^2} \right\}^{\frac{1}{(m-1)}} \right)^{-1}$$

⇒ Repeat until difference b/w new and old γ is $\leq \pm 0.01$