Ques: (1)

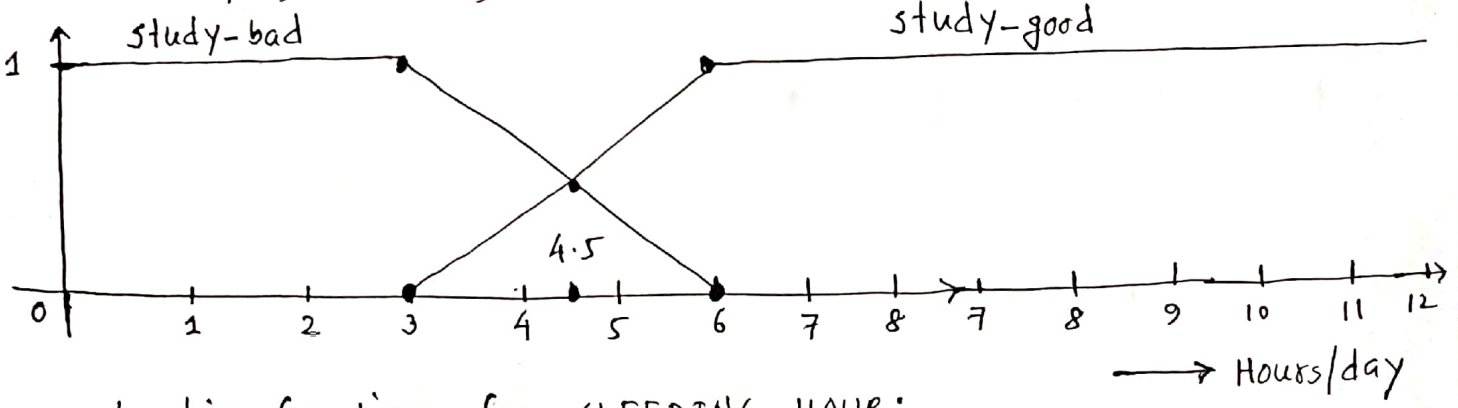
Membership function (fuzzification) for STUDY_HOUR {study-bad, study-good}, SLEEPING_HOUR {Under_sleep, Well_sleep, Over_sleep} and STUDENT {good, bad}, and fuzzy rules are given below. Find the obtained mark of a student who studies 4.5 hours and sleeps 7.5 hours in a day using the centroid defuzzification method.

Fuzzy rules:

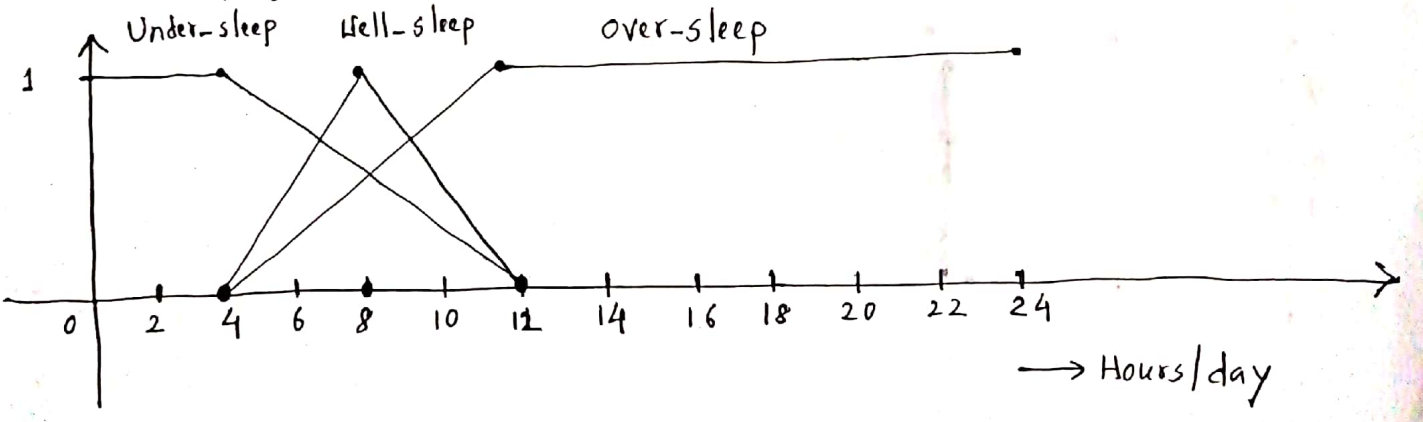
If a student studies and sleeps well, he will be good student

If a student studies bad, and sleeps bad or over, he will be bad student.

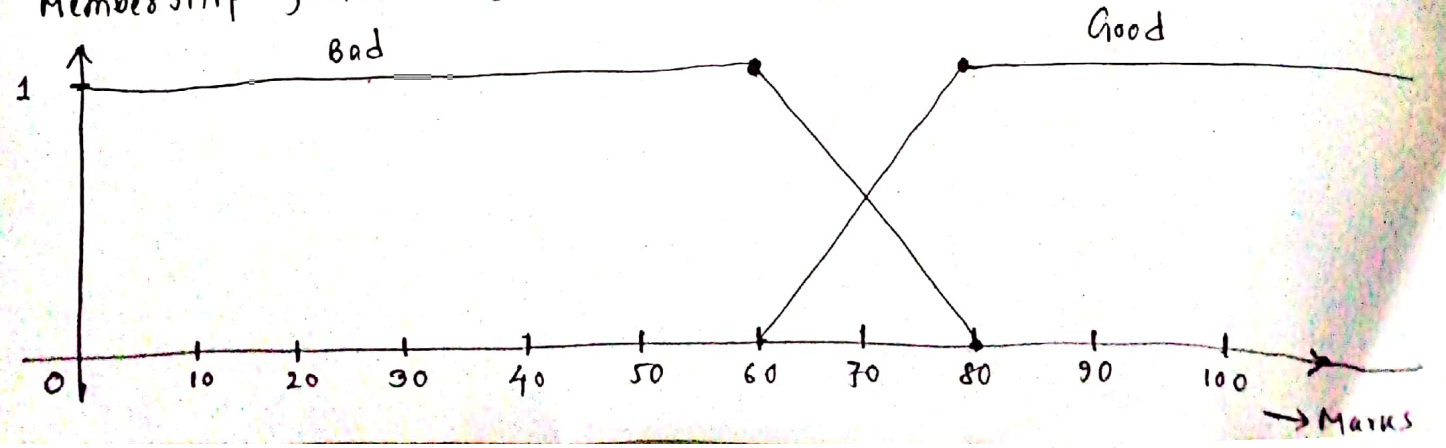
Membership function for STUDY_HOUR:



Membership function for SLEEPING_HOUR:



Membership function for a STUDENT:



Ans: (2)

step 1: Fuzzification or Membership function construction

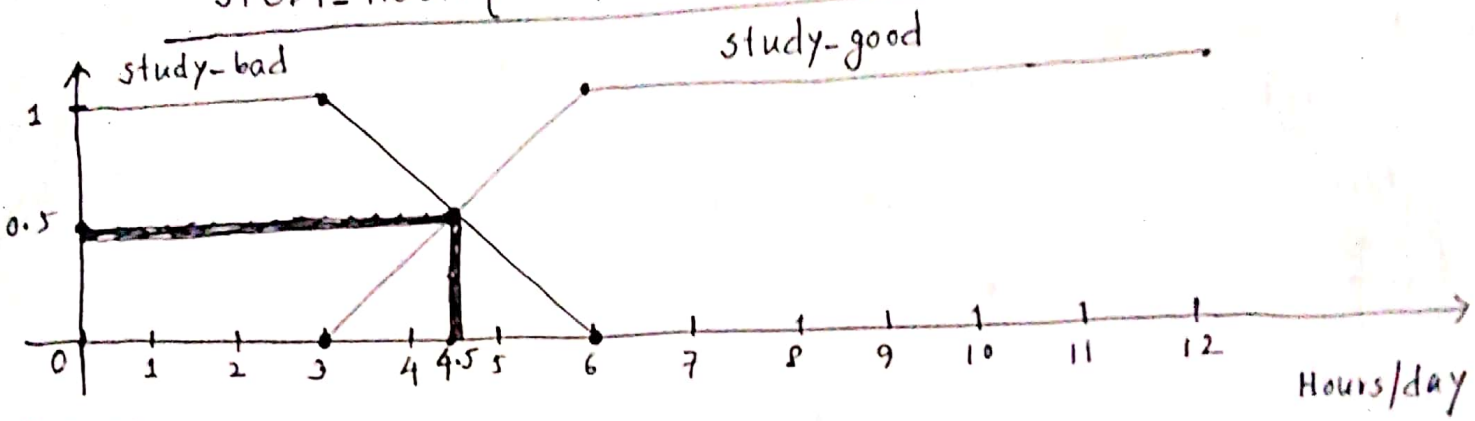
Draw figure 1 from Question

Draw figure 2 from Question

Draw figure 3 from Question

~~degree apply inference end~~

STUDY_HOUR {study-bad, study-good} :

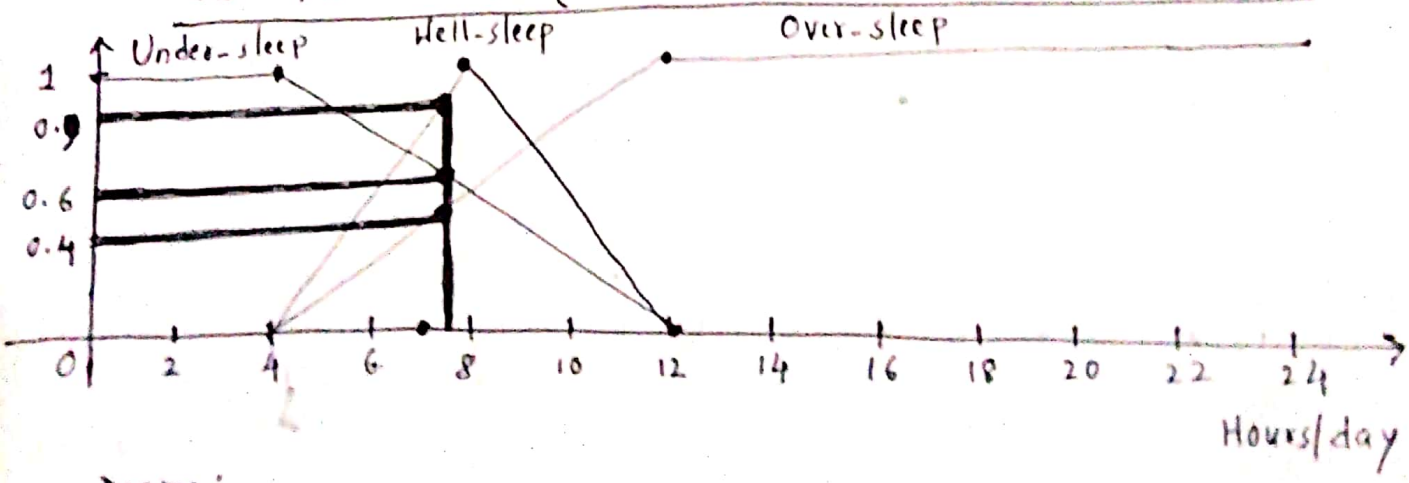


Degree:

study-bad = 0.5

study-good = 0.5

SLEEPING_HOUR {Under-sleep, Well-sleep, Over-sleep} :



Degree:

Under-sleep = 0.6

Well-sleep = 0.9

Over-sleep = 0.4

: Apply inference or fuzzy rules

Rule 1:

If a student studies and sleeps well, he will be good student

Rule 2:

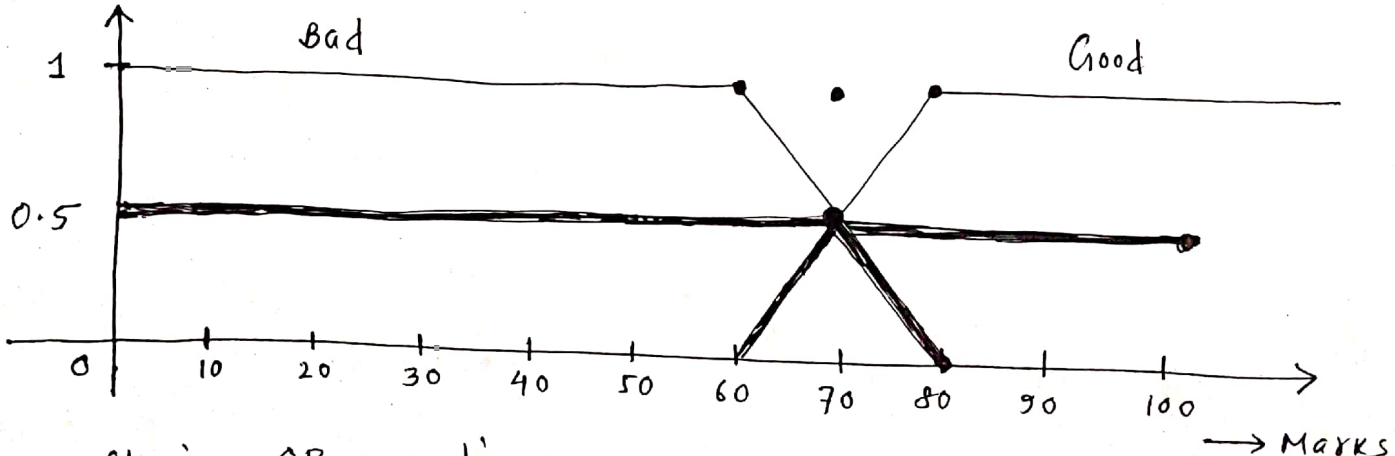
If a student studies bad, and sleeps bad or over, he will be bad student

According to rule 1:

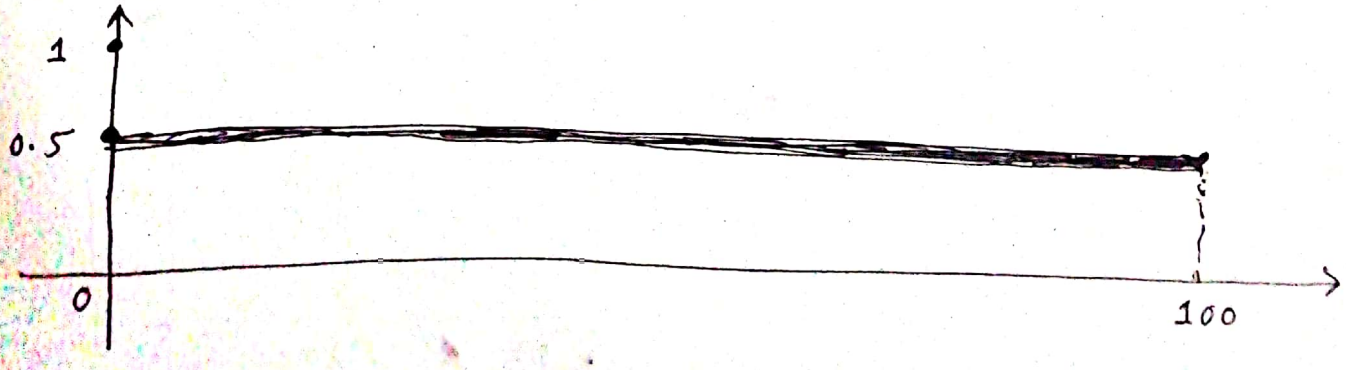
$$\text{study-good} \wedge \text{Well-sleep} = 0.5 \wedge 0.9 = \min(0.5, 0.9)$$
$$= 0.5 \text{ (good)}$$

According to rule 2:

$$\text{study-bad} \wedge (\text{Under\_sleep} \vee \text{Over\_sleep})$$
$$= 0.5 \wedge (0.6 \vee 0.4)$$
$$= 0.5 \wedge 0.6$$
$$= \min(0.5, 0.6) = 0.5 \text{ (bad)}$$

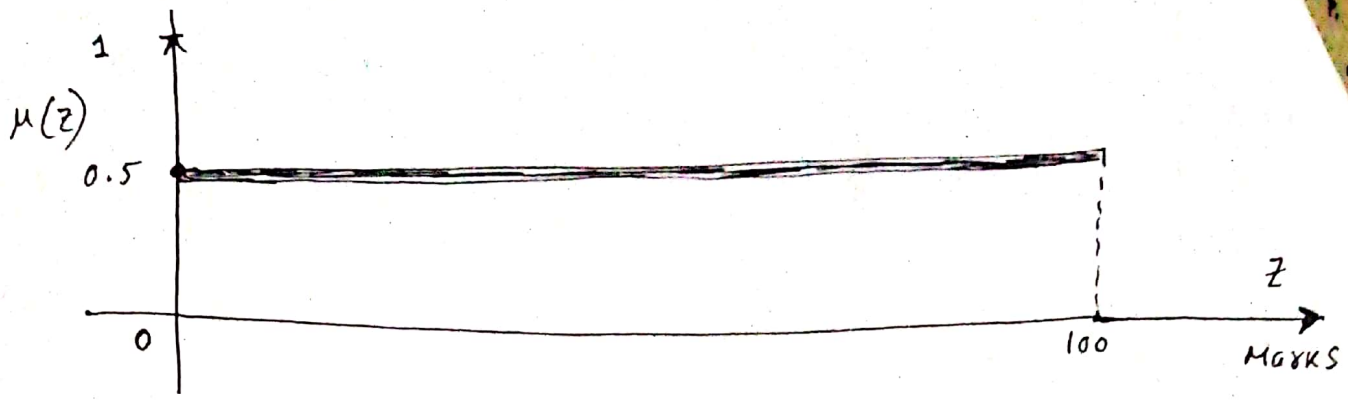


Aftering OR operation:



step3: Defuzzification Technique

Apply centroid defuzzification Technique



Obtained marks = $0.5 * 100 = 50$

line is parallel to z axis
$y = b$
$\Rightarrow \mu(z) = 0.5$

OR

$$\text{Obtained marks} = \frac{\int_0^{100} z\,\mu(z)\,dz}{\int_0^{100} \mu(z)\,dz}$$

$$= \frac{\int_0^{100} z \cdot 0.5\,dz}{\int_0^{100} 0.5\,dz} = \frac{N}{D}$$

N = Numerator $= \int_0^{100} 0.5\,z\,dz$

$= 0.5 \int_0^{100} z\,dz$ $\quad \left[\int x^n dx = \frac{x^{n+1}}{n+1}\right]$

$= 0.5 \left[\frac{z^2}{2}\right]_0^{100}$

$= 0.5 \left[\frac{100^2}{2} - \frac{0^2}{2}\right]$ $\quad \left[\int 1\,dx = x\right]$

$= 0.5 * 5000 = 2500$

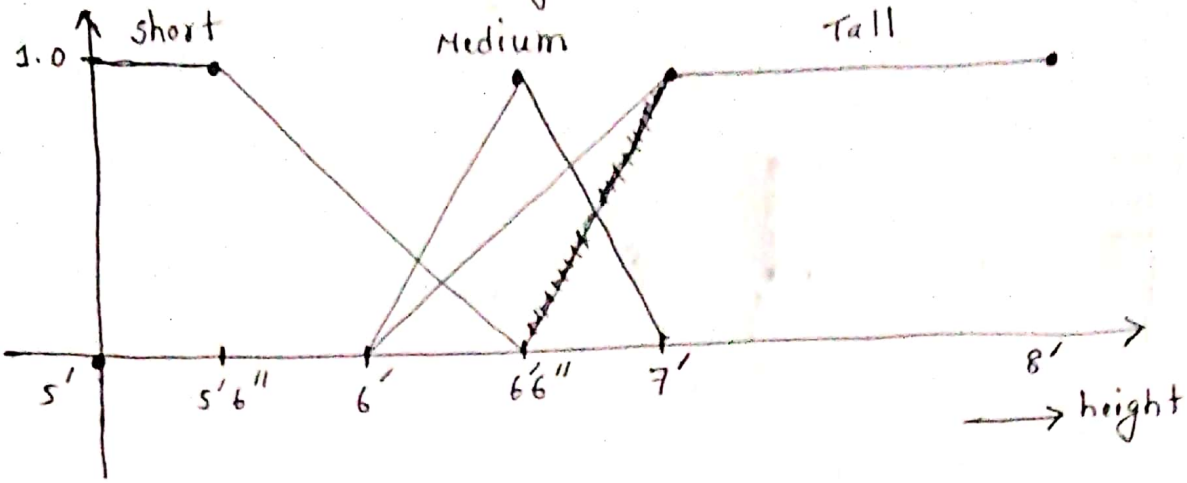
D = Denominator $= \int_0^{100} 0.5\,dz = 0.5 \int_0^{100} dz = 0.5 \left[z\right]_0^{100}$

$= 0.5 [100 - 0] = 50$

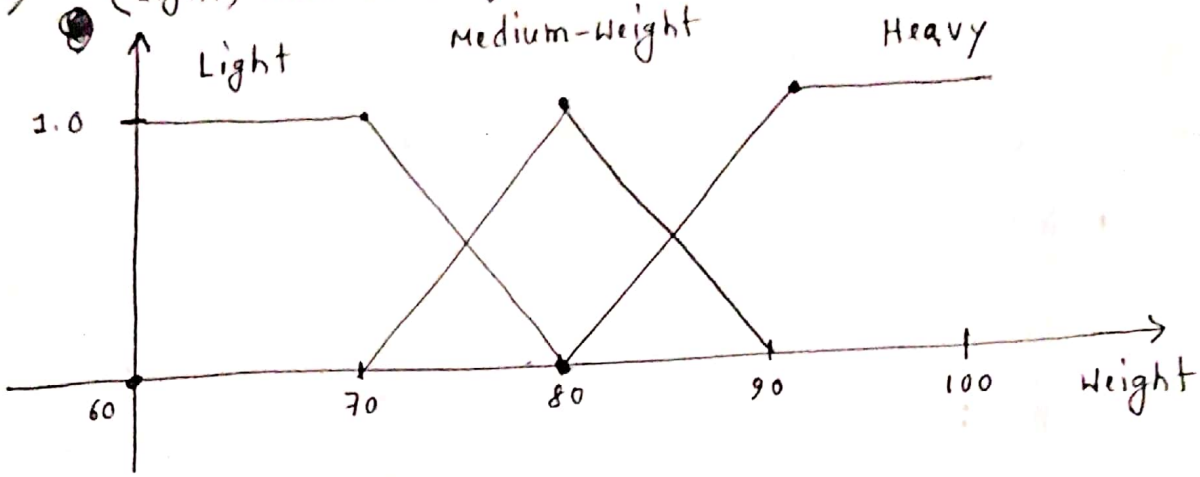
obtained marks $= N/D = 2500/50 = 50$

Given Membership function for

a) short, medium-height, tall



b) (Light, Medium-Weight, Heavy)



ii) Inference Rule or Fuzzy rules:

If height is short then weight is light [Rule 1]

If height is medium then weight is medium [Rule 2]

If height is tall then weight is heavy [Rule 3]

If John's height is 6'1", Estimate John's weight.

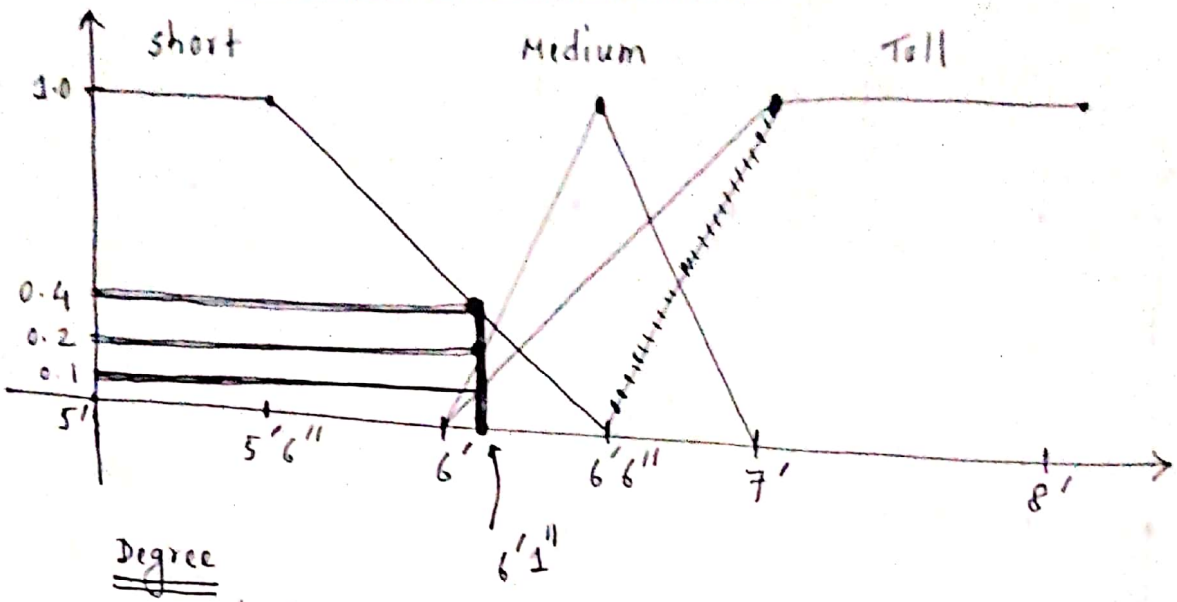
Use mean of maximum method for defuzzification.

Ans: step1: Fuzzification or Membership function construction

Draw figure 1 from Question

Draw figure 2 from Question

HEIGHT (short, medium-height, tall):



Degree

short = 0.4

Medium = 0.2

Tall = 0.1

step2: Apply inference or fuzzy rules

Rule 1: —

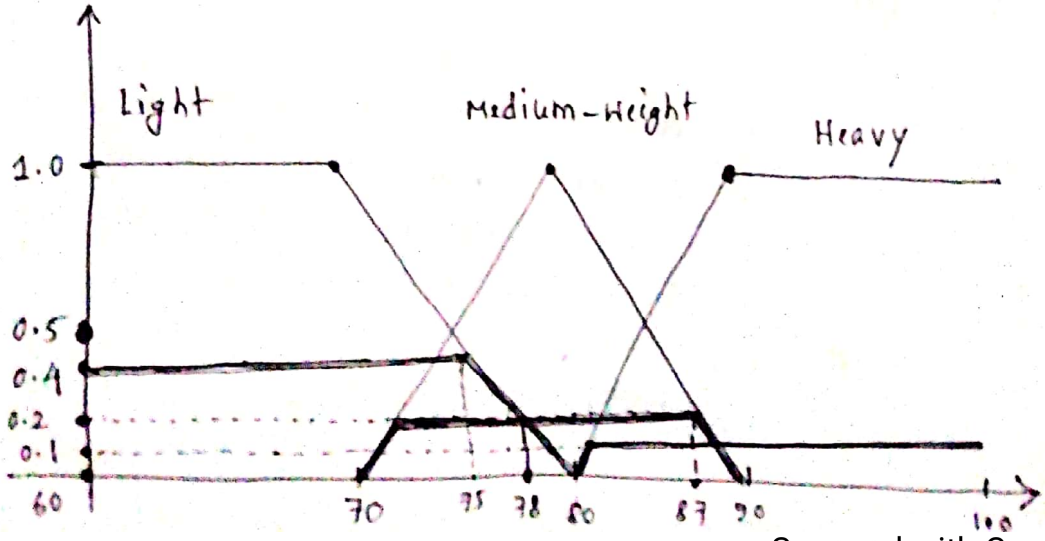
Rule 2: —

Rule 3: —

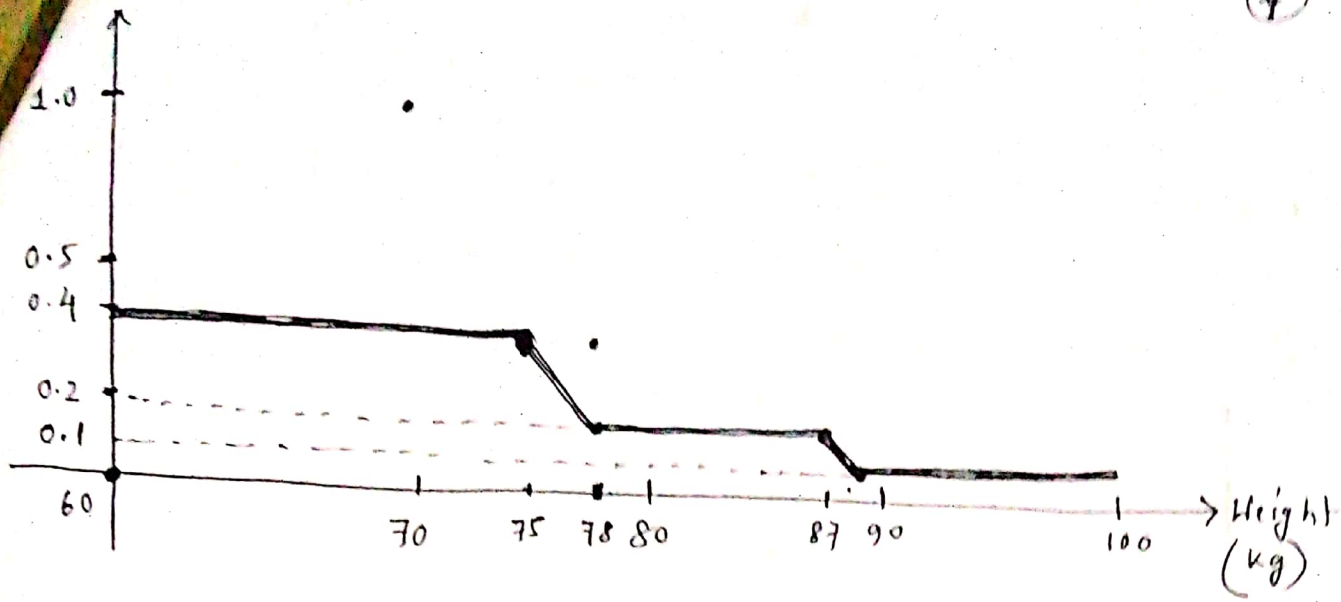
According to Rule 1: short = 0.4 (light)

According to Rule 2: Medium = 0.2 (Medium)

According to Rule 3: Tall = 0.1 (Tall)



OR operation:



Step3: Defuzzification Technique

Apply Mean of Maximum ~~OR~~ defuzzification technique

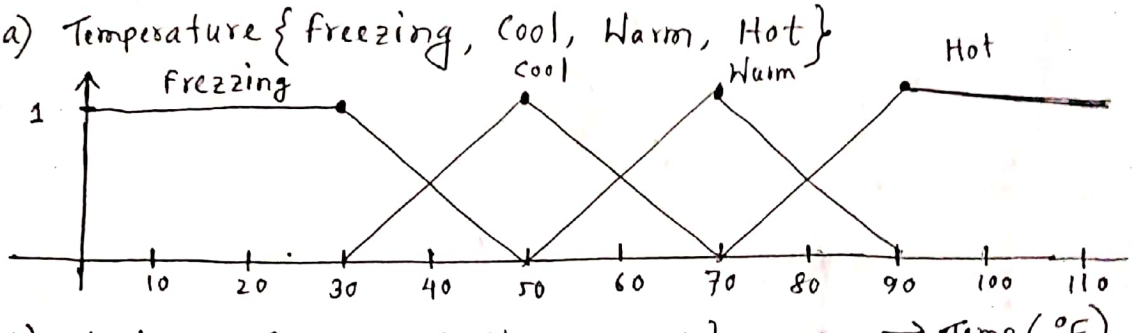
$$\text{John's weight} = \frac{60+75}{2}$$

$$= 67.5 \text{ kg}$$

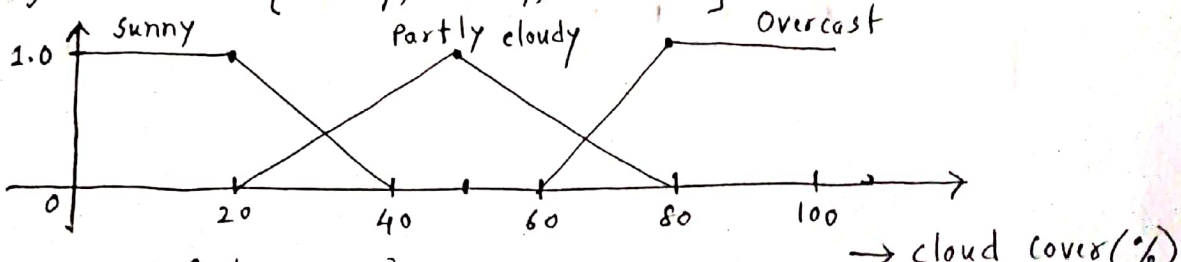
Ques:

i) Membership function for

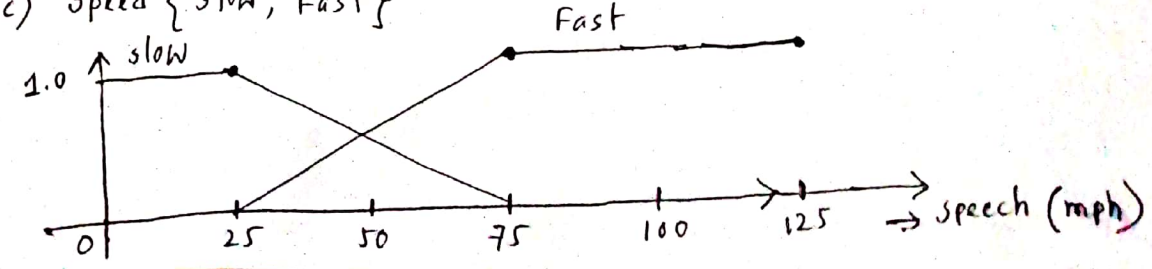
a) Temperature {freezing, cool, warm, Hot}



b) cloud cover {sunny, Partly, Overcast}



c) Speed {slow, Fast}



ii) Fuzzy Rules:

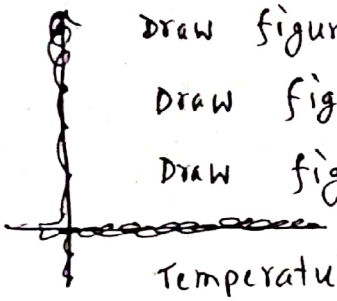
If it is sunny and Warm, drive fast [Rule 1]

If it is cloudy or cool, drive slowly [Rule 2]

How fast will I go if it is 65°F and 25% cloud cover? Use Weighted average defuzzification technique.

Ans:

step1: Fuzzification or Membership Function Construction

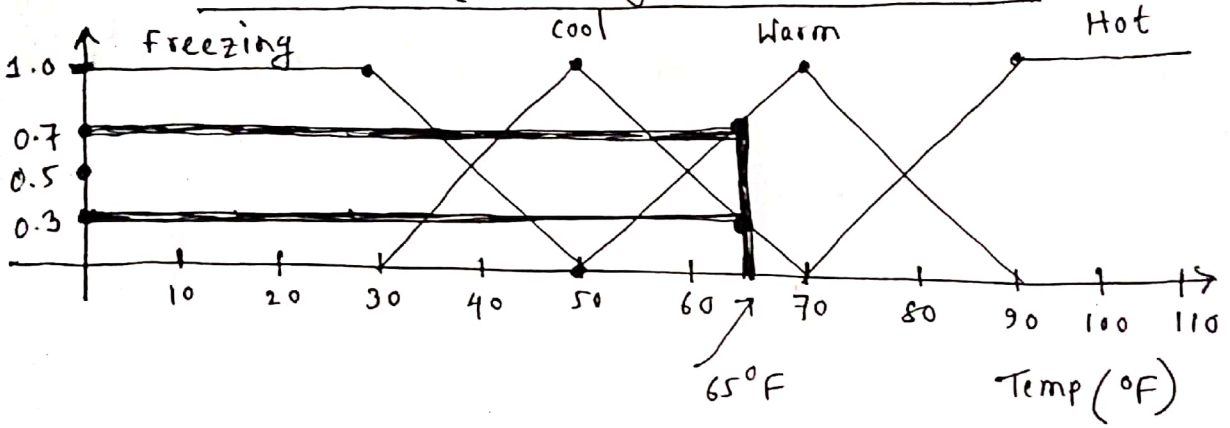


Draw figure 1 from Question

Draw figure 2 from Question

Draw figure 3 from Question

Temperature {Freezing, Cool, Warm, Hot}

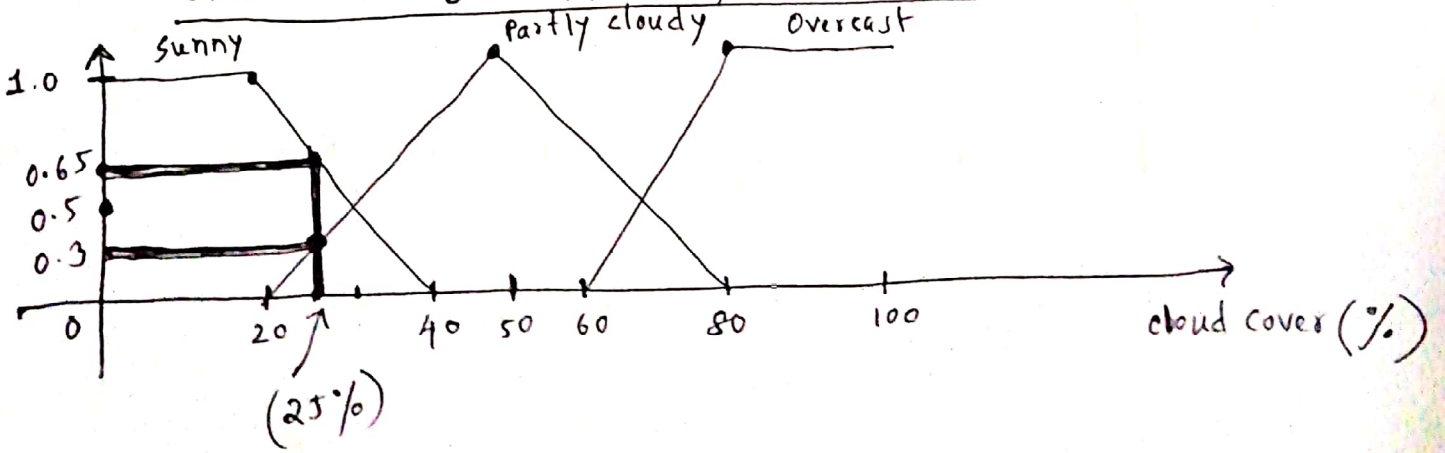


Degree

cool = 0.3

Warm = 0.7

cloud cover {sunny, Partly, Overcast}



Degree

Partly cloudy = 0.3

Sunny = 0.65

Apply Inference or Fuzzy rules

Rule 1 :

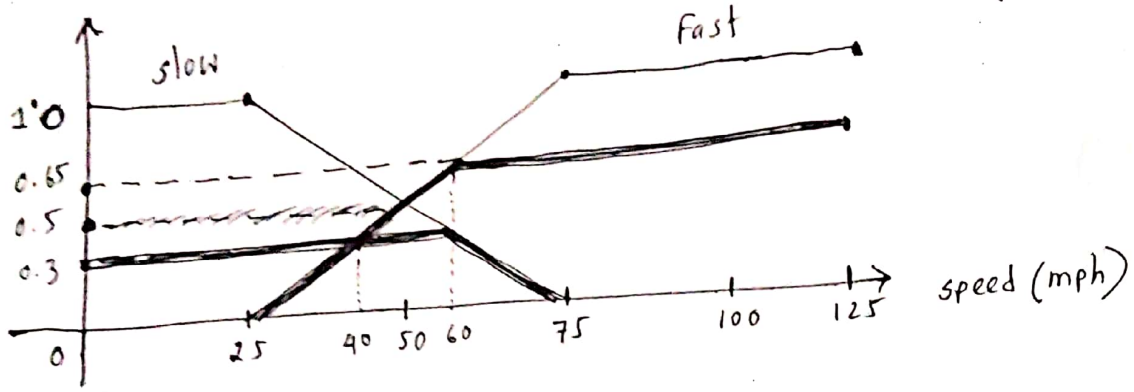
Rule 2 :

According to Rule 1:

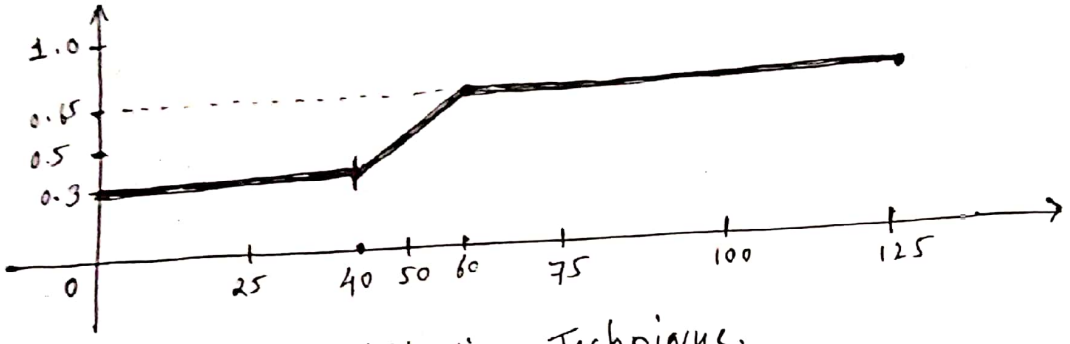
Sunny and Warm = $0.65 \wedge 0.7 = \min(0.65, 0.7) = 0.65$ (Drive Fast)

According to Rule 2:

cloudy or cool = $0.3 \vee 0.3 = \max(0.3, 0.3) = 0.3$ (Drive slow)



After OR operation :



Step 3: Defuzzification Technique

(Apply Heighted Average Defuzzification Technique)

$\mu_1 = 0.3, \quad W_1 = \frac{0+40}{2} = 20$

$\mu_2 = 0.65, \quad W_2 = \frac{60+125}{2} = \frac{185}{2} = 92.5$

$$\text{Obtained Speed} = \frac{\mu_1 W_1 + \mu_2 W_2}{\mu_1 + \mu_2} = \frac{0.3 * 20 + 0.65 * 92.5}{0.3 + 0.65}$$

$$= \frac{6 + 60.125}{0.95} = 69.61 \text{ mph}$$