Problem 1:

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Given membership functions :-

i) fast speed → $\mu_F(v)$

ii) very fast speed → $\mu_F(v - v_0)$, $v_0 > 0$

iii) "presumably fast speed' → $\mu_F^2(v)$

a). Very fast speed:

$\mu_F(v - v_0)$ is appropriate as speeds beyond 'v_0' would be considered higher speeds compared to F, whereas speeds upto v_0 will not be considered 'very fast speeds'.

Considering element $v = 90$ rev/s from V and $v_0 = 50$ rev/s :-

$\mu_F(v) = \mu_F(90) = 0.1$

$\mu_{F'}(v - v_0) = \mu_F(90 - 50) = \mu_F(40) = 0.8$

Hence, 90 rev/s has higher membership value in "very fast speed" compared to "fast speed".

Presumably fast speed:

$\mu_F^2(v)$ is not appropriate for this representation as it results in contraction.

For example, $v = 20$ rev/s,

$\mu_F(20) = 0.3$

then, $\mu_F^2(20) = 0.09$, this does not represent "presumably fast speed" correctly.

b) $F = \left\{ \frac{0.1}{10}, \frac{0.3}{20}, \frac{0.6}{30}, \frac{0.8}{40}, \frac{1.0}{50}, \frac{0.7}{60}, \frac{0.5}{70}, \frac{0.3}{80}, \frac{0.1}{90} \right\}$

Universe $V = \{0, 10, 20, \ldots 190, 200\}$ rev/s

$V_0 = 50$ rev/s

Very fast speed $\mu_F(v - v_0)$:-

By using extension principle, we deduct 50 rev/s from elements of universe.

For $v = 0$, $\mu_F(0-50) = \mu_F(-50) = 0$

For $v = 10$, $\mu_F(10-50) = \mu_F(-40) = 0$

For $v = 20$, $\mu_F(20-50) = \mu_F(-30) = 0$

For $v = 30$, $\mu_F(30-50) = \mu_F(-20) = 0$

For $v = 40$, $\mu_F(40-50) = \mu_F(-10) = 0$

For $v = 50$, $\mu_F(50-50) = \mu_F(0) = 0$

For $v = 60$, $\mu_F(60-50) = \mu_F(10) = 0.1$

For $V = 70$, $\mu_F(70-50) = \mu_F(20) = 0.3$

For $V = 80$, $\mu_F(80-50) = \mu_F(30) = \underline{0.6}$

For $v = 90$, $\mu_F(90-50) = \mu_F(40) = 0.8$

For $V = 100$, $\mu_F(100-50) = \mu_F(50) = 1.0$

for $v = 110$, $\mu_F(110-50) = \mu_F(60) = 0.7$

for $v = 120$, $\mu_F(120-50) = \mu_F(70) = 0.5$

for $v = 130$, $\mu_F(130-50) = \mu_F(80) = 0.3$

for $v = 140$, $\mu_F(140-50) = \mu_F(90) = 0.1$

for $v = 150$, $\mu_F(150-50) = \mu_F(100) = 0$

for $v = 160$, $\mu_F(160-50) = \mu_F(110) = 0$

for $v = 170$, $\mu_F(170-50) = \mu_F(120) = 0$

for $v = 180$, $\mu_F(180-50) = \mu_F(130) = 0$

for $v = 190$, $\mu_F(190-50) = \mu_F(140) = 0$

for $v = 200$, $\mu_F(200-50) = \mu_F(150) = 0$

Thus,

$$\mu_F(v - v_0) = \left\{ \frac{0.1}{60}, \frac{0.3}{70}, \frac{0.6}{80}, \frac{0.8}{90}, \frac{1.0}{100}, \frac{0.7}{110}, \frac{0.8}{120}, \frac{0.3}{130}, \frac{0.1}{140} \right\}$$

Presumably fast speed $\mu_F^2(v)$:-

To calculate $\mu_F^2(v)$, we can square the degree of membership for every element from universe V.

Elements for low speed will have membership values closer to 0.

For $v = 0$, $\mu_F^2(0) = 0.00$

For $v = 10$, $\mu_F^2(10) = 0.01$

For $v = 20$, $\mu_F^2(20) = \cancel{0.36}\ 0.09$

for $v = 30$, $\mu_F^2(v) = 0.36$

for $V = 40$, $\mu_F^2(40) = 0.64$

for $v = 50$, $\mu_F^2(50) = 1.0$

for $V = 60$, $\mu_F^2(60) = 0.49$

for $v = 70$, $\mu_F^2(70) = 0.28$

for $V = 80$, $\mu_F^2(80) = 0.09$

for $v = 90$, $\mu_F^2(90) = 0.01$

for $v = 100$, $\mu_F^2(100) = 0$

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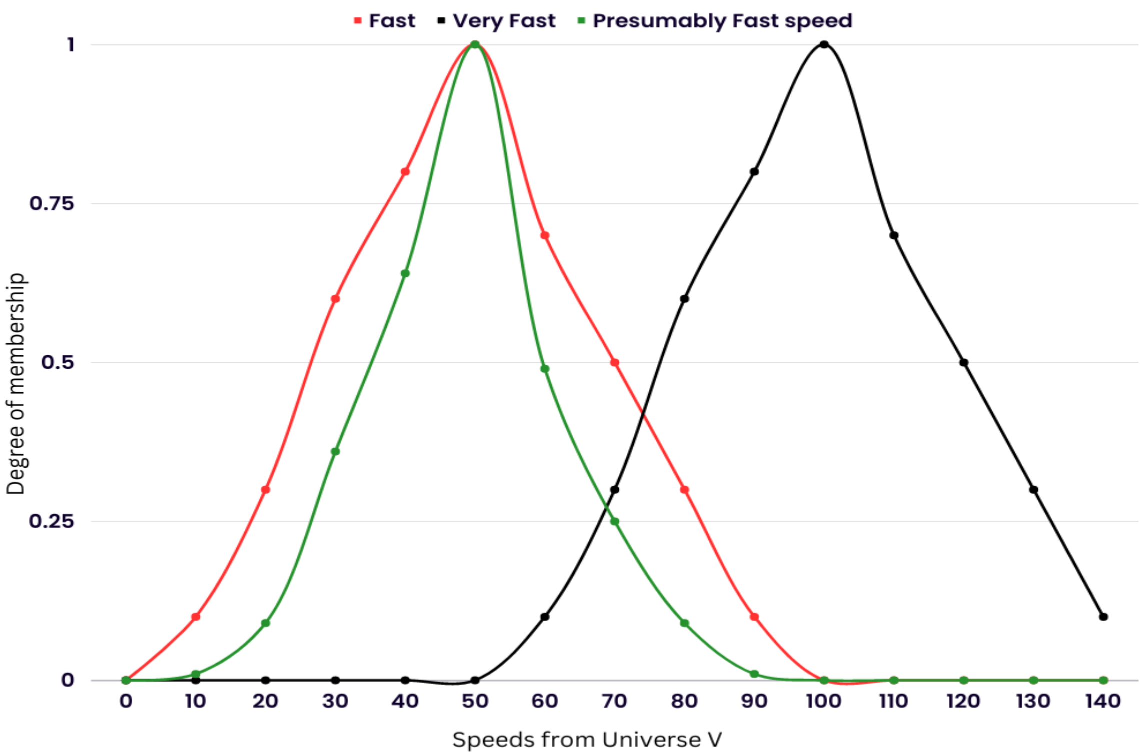
for $v = 190$, $\mu_F^2(190) = 0$

for $v = 200$, $\mu_F^2(200) = 0$

Thus:

$$\mu_F^2(v) = \left\{ \frac{0.01}{10}, \frac{0.09}{20}, \frac{0.36}{30}, \frac{0.64}{40}, \frac{1.0}{50}, \frac{0.49}{60}, \frac{0.28}{70}, \frac{0.09}{80}, \frac{0.01}{90} \right\}$$



From the graph, it is evident that 'very fast speed' membership function appropriately represents the linguistic hedge. However, $\mu_F^2(V)$ does not represent elements to the left of the 'fast speed' graph. It has contracted it instead, which does not appropriately represent the linguistic hedge.