TASK-1 : BEST CHOICE FOR MICROPHONE EDM(D).

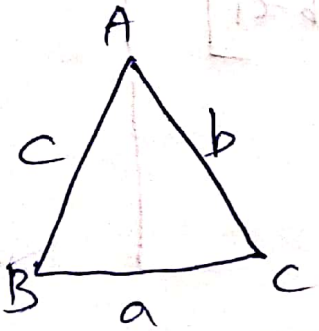
→ Echo sorting takes $h(t)$s (RIRs) & microphone EDM(D) as inputs.

→ We have $h(t)$s, but not D.

→ But D can be approximately obtained by using triangle inequalities.

→ Let us consider two cases where we have different underestimates & over estimates, & by applying different relations between them, we get few approximate Ds.

case ①:- Let's consider a ∆gle.



∆gle inequalities:-

$a-b < c$, etc.

$a+b > c$, etc.

i) orig_edm

$$\begin{bmatrix} 0 & c^2 & b^2 \\ c^2 & 0 & a^2 \\ b^2 & a^2 & 0 \end{bmatrix}$$

ii) Under_estimate

$$\begin{bmatrix} 0 & (a-b)^2 & (a-c)^2 \\ (a-b)^2 & 0 & (b-c)^2 \\ (a-c)^2 & (b-c)^2 & 0 \end{bmatrix}$$

iii) Over-estimate_1

$$\begin{bmatrix} 0 & (a+b)^2 & (a+c)^2 \\ (a+b)^2 & 0 & (b+c)^2 \\ (a+c)^2 & (b+c)^2 & 0 \end{bmatrix}$$

iv) GP_edm_1

$$\begin{bmatrix} 0 & |(a+b)(a-b)| & |(a+c)(a-c)| \\ |(a+b)(a-b)| & 0 & |(b+c)(b-c)| \\ |(a+c)(a-c)| & |(b+c)(b-c)| & 0 \end{bmatrix}$$

v) AP_edm_1

$$\begin{bmatrix} 0 & \frac{1}{2}[|a+b|+|a-b|] & \frac{1}{2}[|a+c|+|a-c|] \\ \frac{1}{2}[|a+b|+|a-b|] & 0 & \frac{1}{2}[|b+c|+|b-c|] \\ \frac{1}{2}[|a+c|+|a-c|] & \frac{1}{2}[|b+c|+|b-c|] & 0 \end{bmatrix}$$

vi) Hp_edm_1

$$\begin{bmatrix} 0 & [GP^2/AP](1,2) & [GP^2/AP](1,3) \\ [GP^2/AP](1,2) & 0 & [\frac{GP^2}{AP}](2,3) \\ [GP^2/AP](1,3) & [\frac{GP^2}{AP}](2,3) & 0 \end{bmatrix}$$

Note:

i) orig_edm:- formed when all 3 sides are given.

ii) Under-estimate:- formed when only 2 sides are given & based on inequality $\underbrace{a-b}_{\text{given}} < \underbrace{C}_{\text{unknown.}}$

iii) over-estimate:- formed when only 2 sides are given & based on Inequality $\underbrace{a+b}_{\text{given}} > \underbrace{C}_{\text{unknown.}}$

iv) Gp-edm:- formed when only 2 sides are given & based on geometric progression blw x underestimate & corresponding over-estimate EDM elements.

$$G.P = [|(a+b)(a-b)|]^{1/2}$$

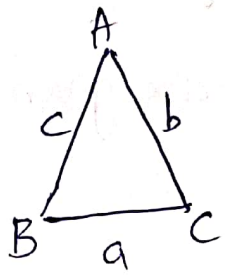
v) Ap_edm:- formed when only 2 sides are given & based on Arithmetic progression between underestimate & corresponding overestimate EDM elements.

$$A.P = \frac{[|a+b| + |a-b|]}{2}$$

vi) Hp_edm:- formed when only 2 sides are given & based on Harmonic progression between corresponding underestimate & overestimate EDM elements.

$$\frac{2}{H.P} = \frac{1}{x_1} + \frac{1}{x_2} \Rightarrow H.P = \frac{2x_1x_2}{x_1+x_2} \Rightarrow H.P = \frac{(G.P)^2}{A.P}$$

Case ②:- Lets consider the Δgle



Δgle Inequalities:

$a-b<c$

$a+b>c$

→ For this case, we use this inequality of Δgle, where $a \geq b \geq c$.

$$1 < \frac{a+c}{b} < 3$$

$$\Downarrow$$

$$b < a+c < 3b$$

$$\Downarrow$$

$$a-b < c < 3b-a$$

Using Δgle Inequality (as $b-a$ is -ve & is anyhow less than c).

$$\Downarrow$$

i) orig-edm:-

$$\begin{bmatrix} 0 & c^2 & b^2 \\ c^2 & 0 & a^2 \\ b^2 & a^2 & 0 \end{bmatrix}$$

ii) Under-estimate

$$\begin{bmatrix} 0 & (a-b)^2 & (a-c)^2 \\ (a-b)^2 & 0 & (b-c)^2 \\ (a-c)^2 & (b-c)^2 & 0 \end{bmatrix}$$

iii) over-estimate_2

$$\begin{bmatrix} 0 & (3b-a)^2 & (3c-a)^2 \\ (3b-a)^2 & 0 & (3c-b)^2 \\ (3c-a)^2 & (3c-b)^2 & 0 \end{bmatrix}$$

iv) GP_edm_2

$$\begin{bmatrix} 0 & |(a-b)(3b-a)| & |(a-c)(3c-a)| \\ |(a-b)(3b-a)| & 0 & |(b-c)(3c-b)| \\ |(a-c)(3c-a)| & |(b-c)(3c-b)| & 0 \end{bmatrix}$$

v) Ap-edm-2:

$$\begin{bmatrix} 0 & \frac{|a-b|+|3b-a|}{2} & \frac{|a-c|+|3c-a|}{2} \\ \frac{|a-b|+|3b-a|}{2} & 0 & \frac{|b-c|+|3c-b|}{2} \\ \frac{|a-c|+|3c-a|}{2} & \frac{|b-c|+|3c-b|}{2} & 0 \end{bmatrix}$$

vi) Hp-edm-2:

$\frac{GP^2}{AP}$ between corresponding elements of under-estimate & over-estimate-2.

Note:

same terminology follows for case 2 also, with overestimate elements being $3b-a$.

OBSERVATIONS ⇓

Examples (a,b,c)	(5,4,3)	(11,10,6)	(9,7,3)	(29,17,13)	(90,56,41)	(43,42,41)
rel_err_under	0.9028	0.8302	0.6990	0.9126	0.8960	0.9989
rel_err_over1	2.8953	2.8989	2.7901	2.6993	2.7314	2.9989
11-over2	1.2897	2.0731	1.7136	0.5659	0.6840	2.7512
11-gp1	0.5803	0.3776	0.5504	0.9962	0.9163	0.9369
11-gp2	0.6975	0.6924	0.9379	0.8505	0.8274	0.9391
11-ap1	1.1837	1.2056	1.3651	1.3931	1.3669	1.0023
11-ap2	0.6732	1.1030	1.0635	0.6834	0.7030	0.8791
11-hp1	0.8232	0.6895	0.5660	0.9180	0.8763	0.9977
11-hp2	0.8372	0.7537	0.9387	0.9110	0.8872	0.9812

→ Rounded ones indicate less rel-error.

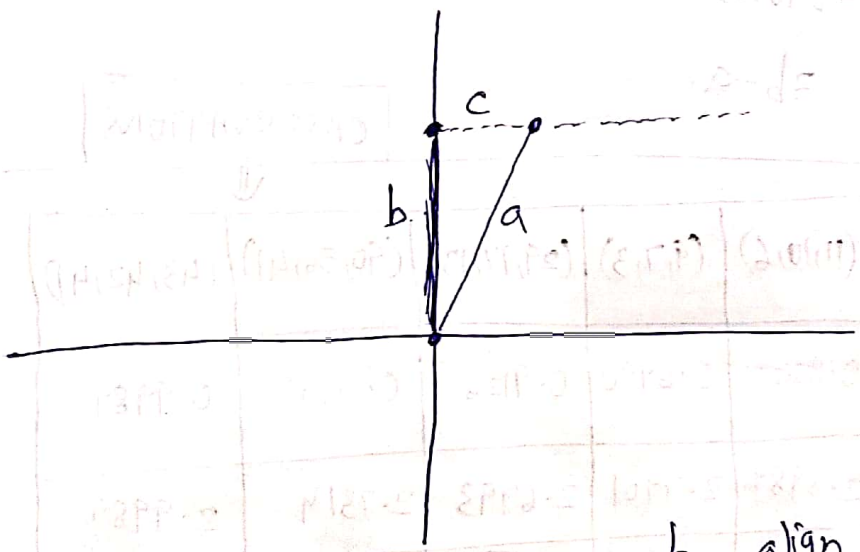
CONCLUSION:

i) Though rel-errors for under, gp1, gp2, hp1, hp2 are good in comparision with others, gp1 has an edge / working well for every case.

ii) So, it is recommended to go with gp1-edm for choice of D (microphone EDM).

INTERPRETATION of GP1:-

→ Consider we have 2 sides a, b. ($a \geq b$).



→ From the above figure, as $a > b$, align b along y-axis & draw a horizontal line at it's end point.

→ Now, taking the length of 'a' as radius & starting point of 'b' as centre, draw an arc on horizontal line drawn.

→ Now, we have hypotneuse & a side of right angled Δgle.

→ Therefore, estimated $c = \sqrt{a^2 - b^2} = \sqrt{(a+b)(a-b)}$, which is gp-1 formula.