

This question took me around 30min - 1 hour to finish

$$\begin{array}{lll} \mathbf{q}_1 = [1, 2, 3] & \mathbf{k}_1 = [1, 1, 1] & \mathbf{v}_1 = [2, 0, 1] \\ \mathbf{q}_2 = [2, 3, 2] & \mathbf{k}_2 = [0, 0, 0] & \mathbf{v}_2 = [3, 0, 0] \\ \mathbf{q}_3 = [5, 6, 7] & \mathbf{k}_3 = [2, 2, 0] & \mathbf{v}_3 = [1, 2, 2] \end{array}$$

Step 1: Calculate a values

$$a_{11} = q_1 \cdot k_1 = [1, 2, 3] \cdot [1, 1, 1] = 1+2+3 = 6$$

$$a_{12} = q_1 \cdot k_2 = [1, 2, 3] \cdot [0, 0, 0] = 0$$

$$a_{13} = q_1 \cdot k_3 = [1, 2, 3] \cdot [2, 2, 0] = 2+4+0 = 6$$

Step 2: Divide by $\sqrt{|k_1|} = 2$

$$a_{11} / 2 = 3$$

$$a_{12} / 2 = 0$$

$$a_{13} / 2 = 3$$

Step 3: Normalize by dividing by sum

$$\sum_{k=1}^3 a_{1k} = 3+0+3 = 6$$

$$a_{11}/6 = 1$$

$$a_{12}/6 = 0$$

$$a_{13}/6 = 1$$

Step 4: Weighted sum

$$z_1 = a_{11} \cdot v_1 + a_{12} \cdot v_2 + a_{13} \cdot v_3 = 1 \cdot v_1 + 0 \cdot v_2 + 1 \cdot v_3 = [2, 0, 1] + [0, 0, 0] + [1, 2, 2] = [3, 2, 3]$$