

# CS450 Homework one: Quantities with errors

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1. Part1:

$$\sum_{i=1}^n \tilde{x}_i \tilde{y}_i = \sum_{i=1}^n x_i y_i (1 + \delta)^2 = \sum_{i=1}^n x_i y_i (1 + 2\delta + \delta^2) \quad (1)$$

2. Part2: There are  $n$   $\otimes$  and  $n - 1$   $\oplus$ . The expression equals to :

$$x_1 y_1 (1 + \delta)^n + x_2 y_2 (1 + \delta)^n + x_3 y_3 (1 + \delta)^{n-1} \cdot + x_n y_n (1 + \delta)^2 \quad (2)$$

3. Part3: There are  $n$  fma applied. The fma expression equals to:

$$x_1 y_1 (1 + \delta)^n + x_2 y_2 (1 + \delta)^{n-1} + x_3 y_3 (1 + \delta)^{n-2} \cdot + x_n y_n (1 + \delta) \quad (3)$$

As we can see, if we just consider input error (part1), then the total value would comparatively have small errors. As for double rounding errors(part2), we have larger total errors than fuse multiply-accumulate (fma, part3).