When to use which operation

Questions to ponder:

Q1. Have we seen the difference between +, × and min/max before? Where have we seen it?

Hint: Think of notions of α-fairness

Q2. What does DRF teach us about aggregation functions? Does CEEI (section 5.2) remind you of something? Does this motivate you to study game theory?

Q3. What does the harmonic of throughputs represent? Alternately, you can think of the speed of a moving object.

Q4. Think about the following claims:

$$\text{Average}(x_1, \ldots, x_N) = \underset{\bar{x}}{\operatorname{argmin}} \sum_{i=1}^{N} (x_i - \bar{x})^2$$

$$\text{Median}(x_1, \ldots, x_N) = \underset{\bar{x}}{\operatorname{argmin}} \sum_{i=1}^{N} |x_i - \bar{x}|$$

Q5. Think of [redacted] in the decades of wasted cores paper. Could you have predicted in advance that using averages is a bad idea? I believe that one should be suspicious of any use of averages

Q6. What type of aggregation (percentile or arithmetic/geometric/harmonic mean) would you use for the following?

- mean growth rate of something that grows exponentially: stock price, covid, # transistors in a chip etc.
- The % speedup due to a compiler optimization
- Incoming network traffic across multiple ports in a switch
- End-to-end latency for serving requests

Q7. The L_k norm is defined as

$$L_k(x_1, \ldots, x_n) = \sqrt[k]{\sum_{i=1}^{n} |x_i|^k}$$

- Many physical quantities such as velocity and acceleration use $k=2$. What does this have to do spherical symmetry?
- What do $k = 0, 1, 2$, and ∞ represent?
- If you were to draw a unit ball for all vectors $\vec{x} \in \mathbb{R}^n$, how do they look for $k=1$ vs $k=2$?
  Whose volume is bigger for large n? What does this mean for high dimensional vector databases?
  How about adversarial robustification for neural networks

Q8. Learn the central limit theorem and what it implies about the number of samples needed to determine an average of a random variable.
Note: The L_2 norm becomes important here

Q9. Learn about compressed sensing if possible