Combining Risk and Distance for INDOPACOM

8 May 2025

How far is it from my house to the store?

It depends on how you measure distance…

If you ask Google / Mapquest / Waze you will get an answer that is reflected in terms of distance

Risk is reflected into Delays, which is then added in to distance.

If you ask a probabilist / statistician, you will get an answer that is reflected in terms of Probability of failure / success.

Risk is reflected into the chance that you will accomplish the mission

Our approach and contribution is:

1

Combine the computation for risk and the computation for distance into a single, unified framework

2

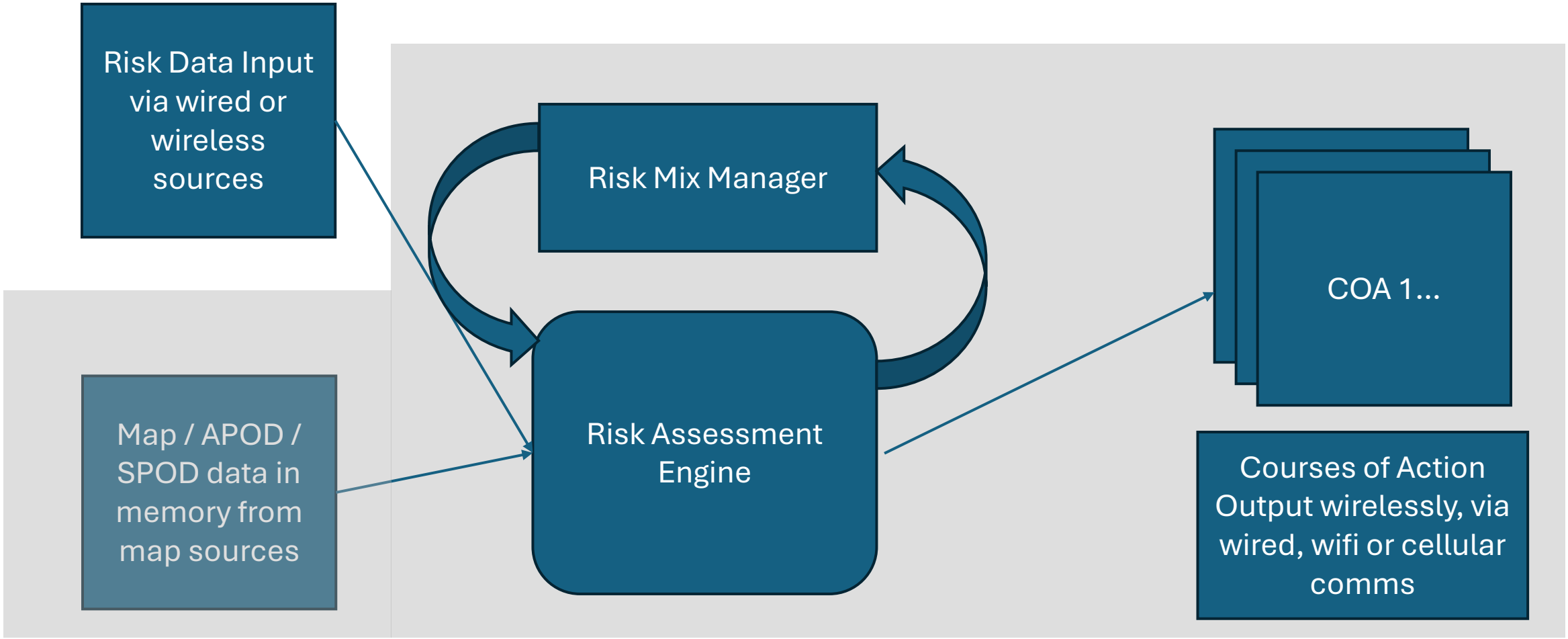
Do so in a way that runs fast on existing networks and protocols

3

Do so in a way that can be implemented in a small computer.

Block Diagram

Shading indicates on Device

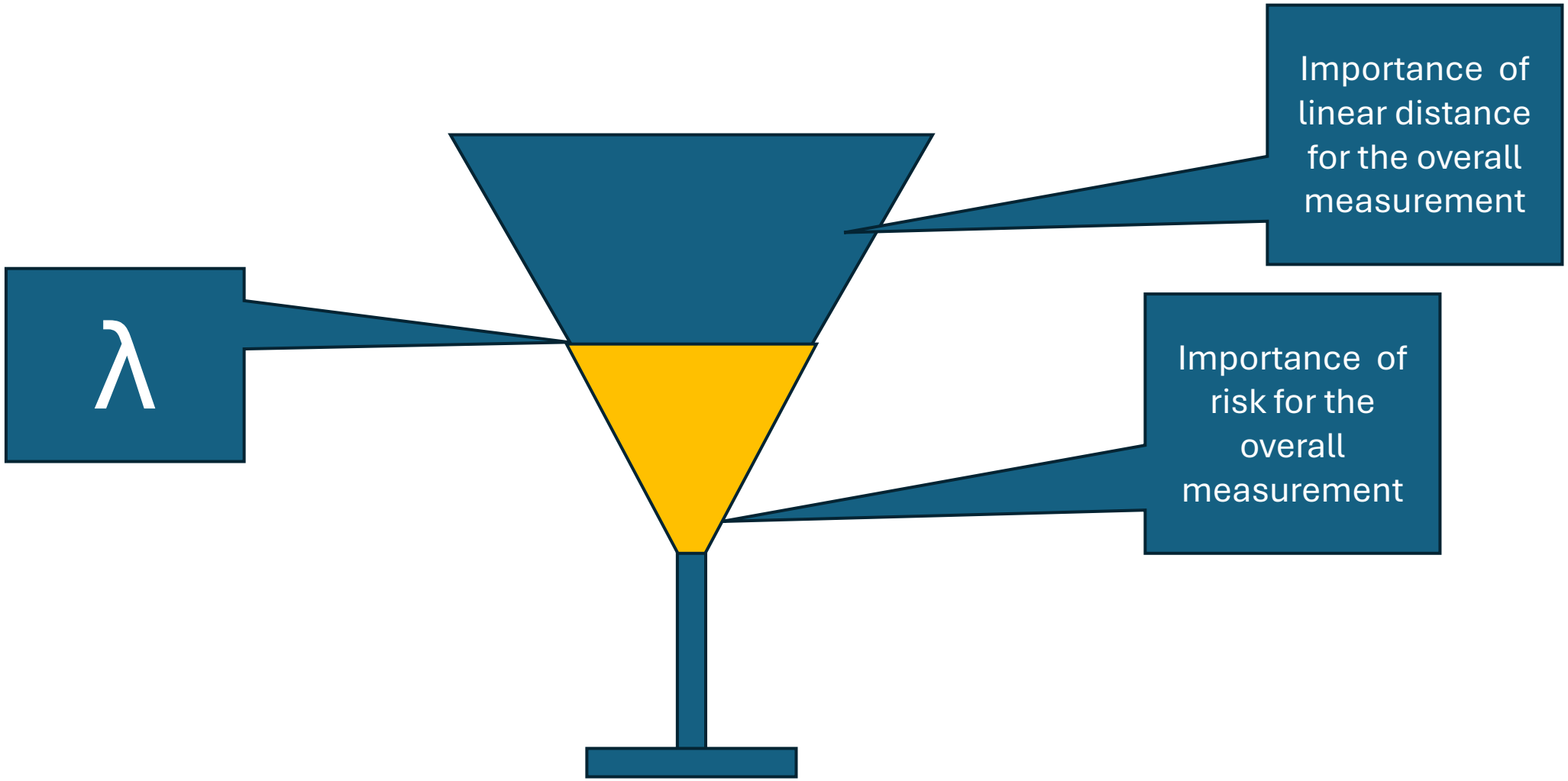


The equation (Technical Stuff)

$$RD = \lambda LD + (\lambda - 1)\kappa \ln(1 - P_{surv})$$

- In words:
  - The Risk Distance is mixture of the Linear Distance and the Risk Distance, which is measured by taking the logarithm of the probability of loss:
  - No risk -> Zero Distance
  - Certain Death -> Infinitely far away

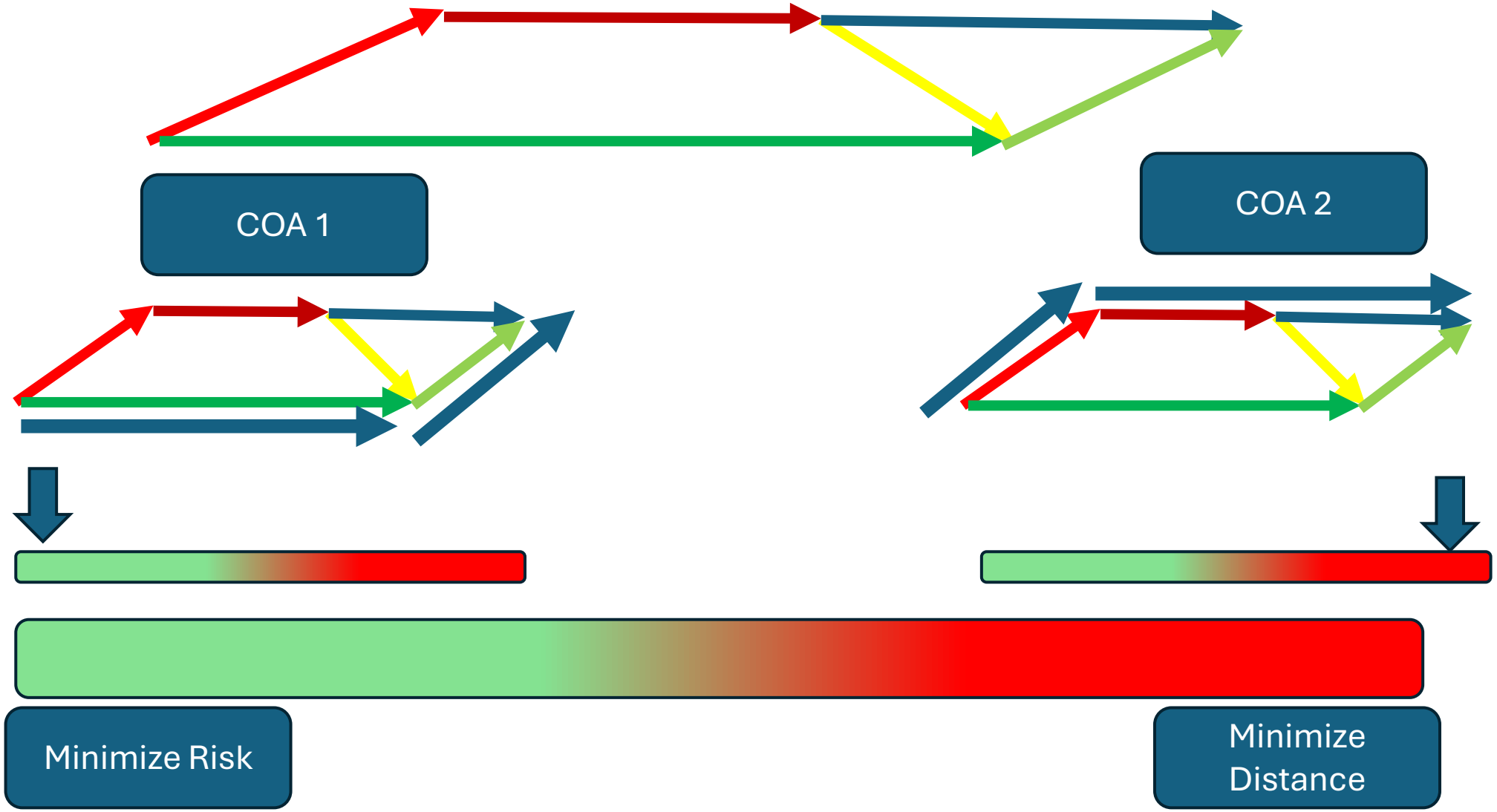
Making a ‘risk martini’



More technical stuff

- Each choice of lambda yields a “unique” solution. Each solution will either:
  - Adjust the current plan for a different overall risk distance (different score for the same Course of Action (read: Plan)
  - Result in a similar risk distance with a fundamentally different course of action
- Big Idea: Adjusting lambda will yield different Courses of action, accounting for both risk and distance. We will settle from an uncountable set of possible actions to a small number, like 5
- Because all of the work is done in the objective function, we can use classical, fast-solving algorithms (like Djikstra) to iterate and brute force solutions should need be.

Network Risk – Executive Version

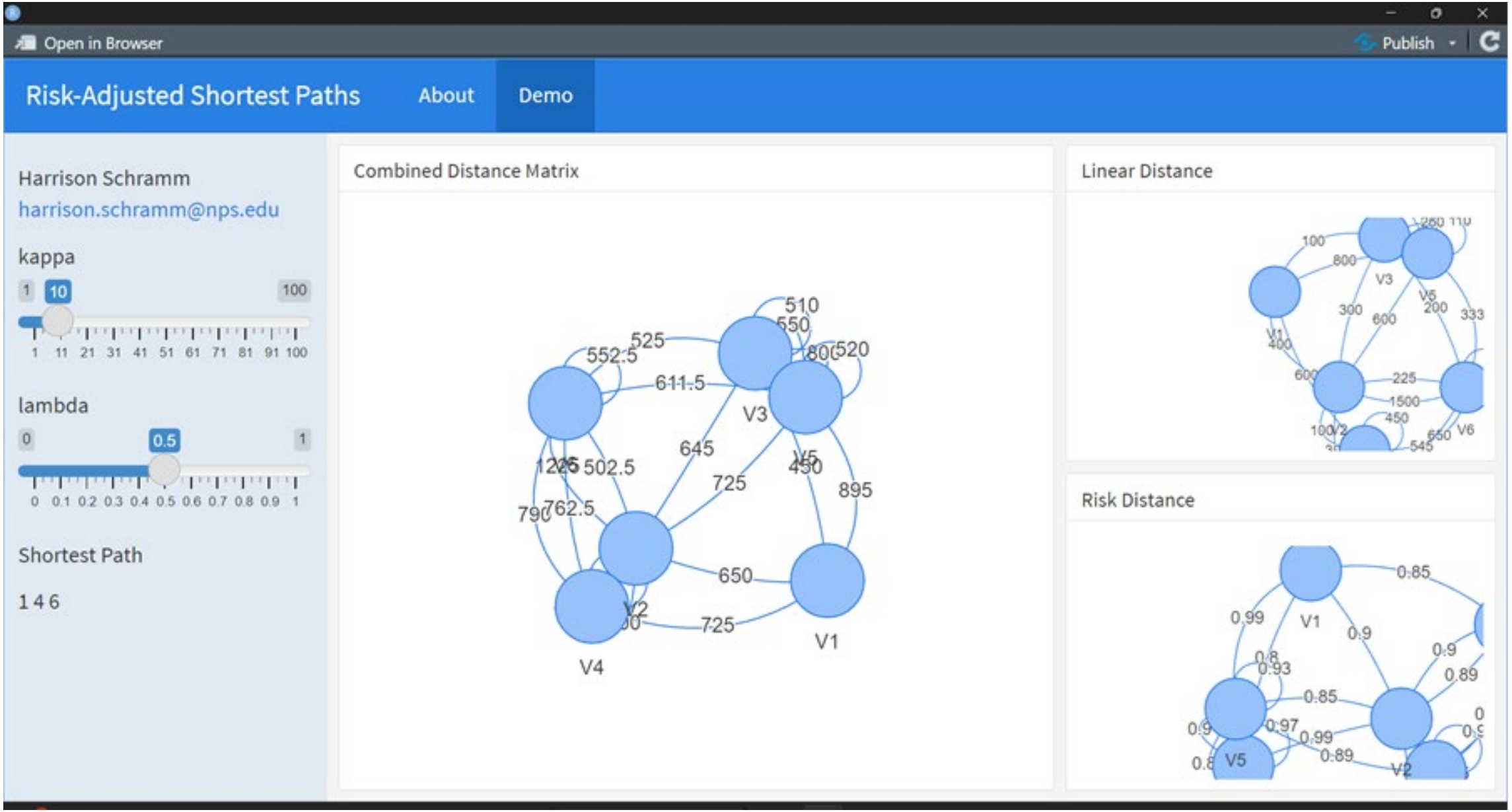


A note on Kappa

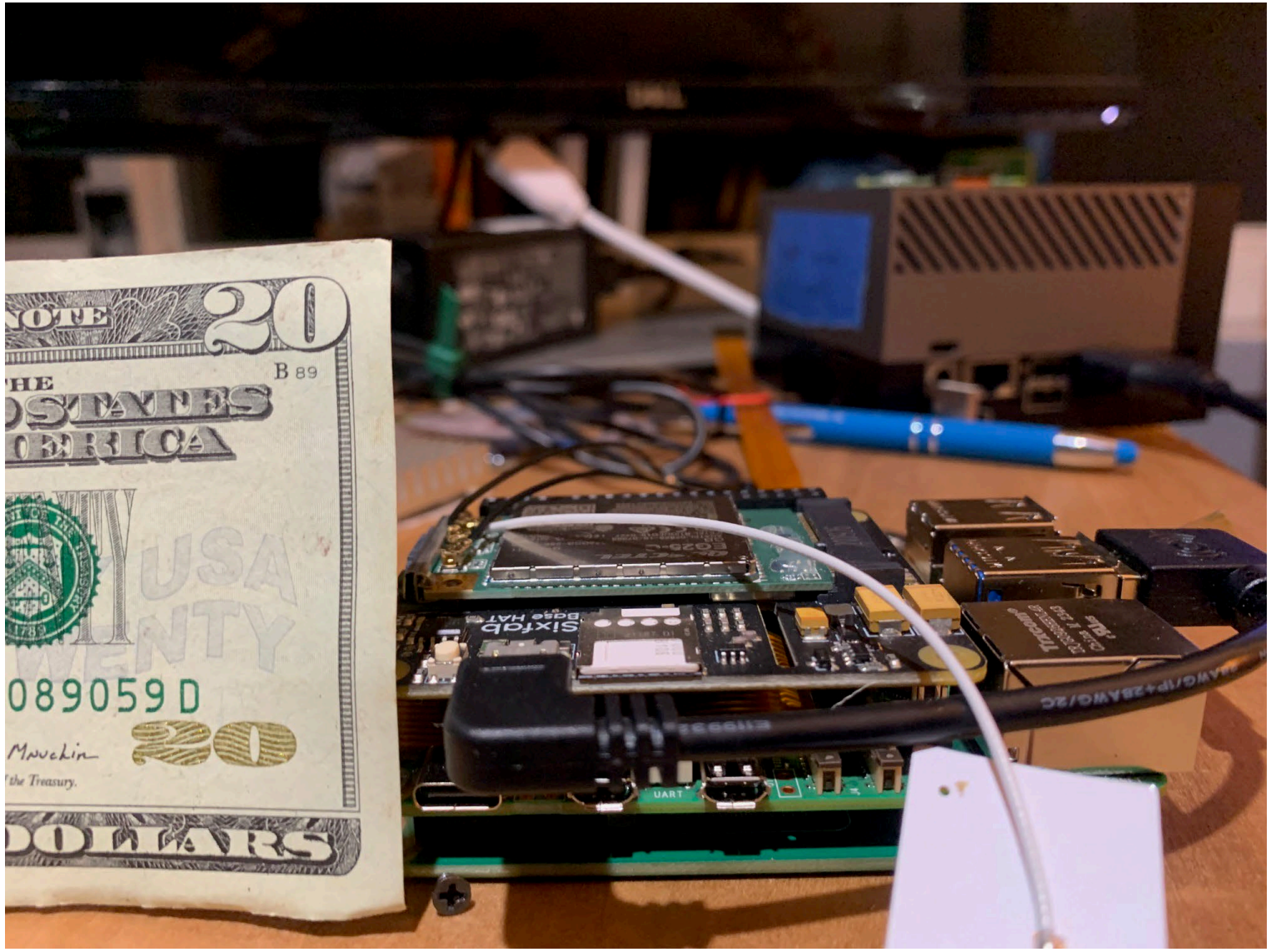
This is informed by a series of ‘would you rather’ questions:

Would you rather accept 1% risk or drive 10 extra miles…

Sample output – Sandboxed Application



Prototype System



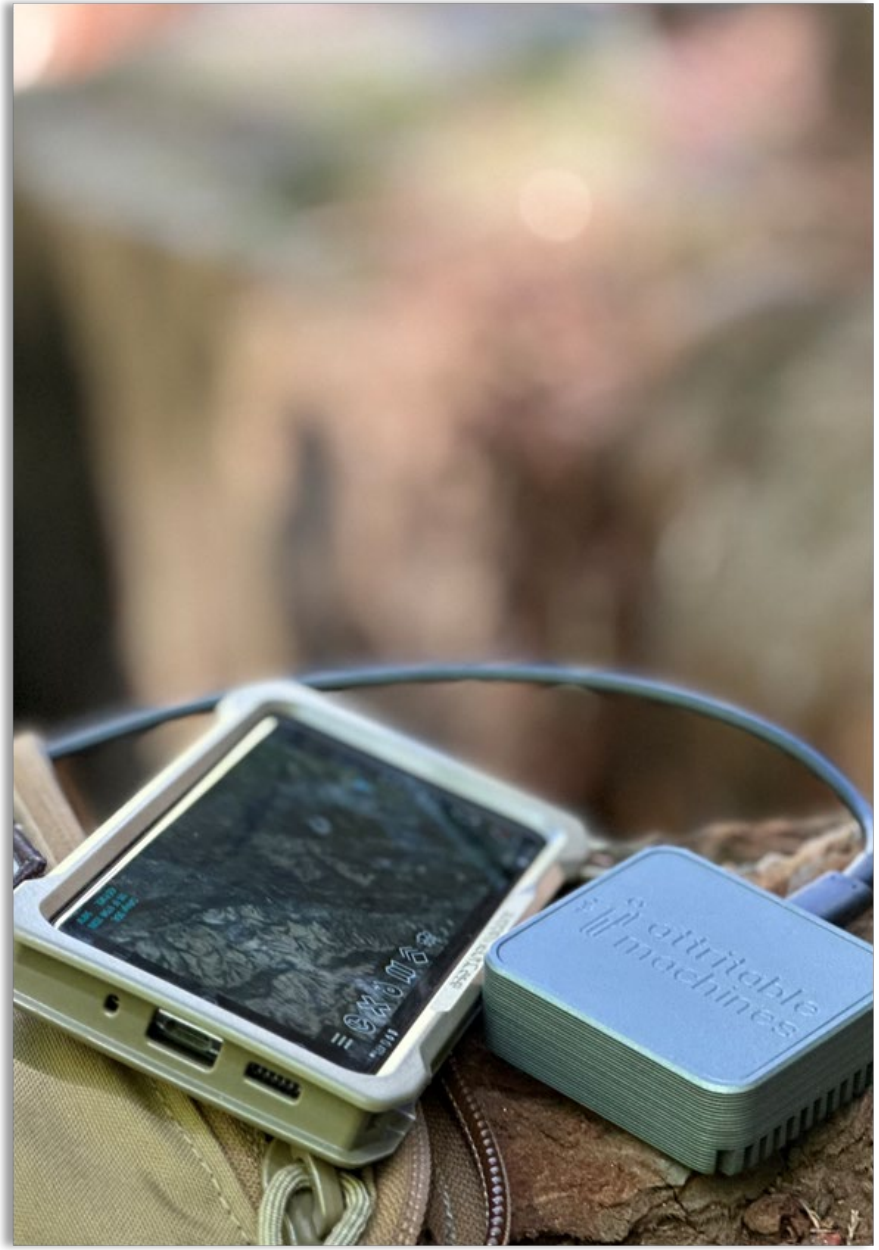
Coral Edge TPU rated at 4TOPS* (Bottom layer) mated to Raspberry Pi 5 8GB computer (Middle layer) with input/output options using a Sixfab Cellular Modem. Total system weight < 8 oz, power consumption < 4 watts.

20$ bill for size comparison only!

*Trillion Operations per second

Next Steps / other interest

- I’m interested to the point of fascination with small computers and AI.
- A colleague and I have developed a purpose-build, small large language model (LLM) that runs completely independently of networks.



Discussion

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