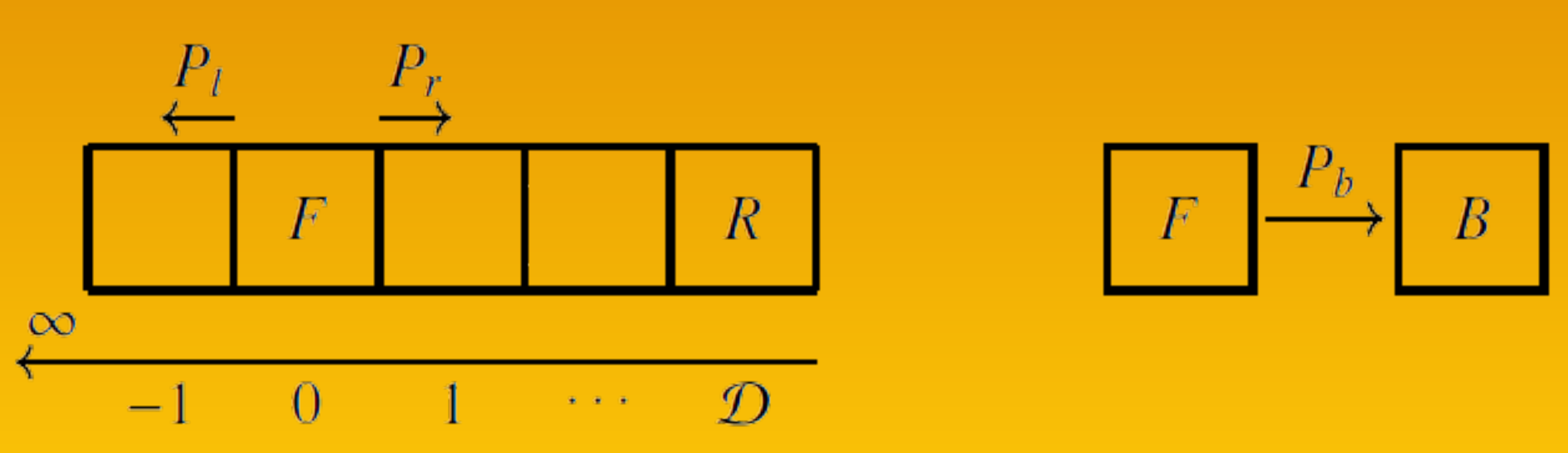
Optimizing Wildfire Evacuations: A Real Options Perspective

Daniel Guerrero; Supervisors Matt Davison and Douglas Woolford

Objective

We aim to model the decision-making process for evacuating an urban area when a wildfire approaches a location. In this scenario, a decision-maker must choose between evacuating immediately or waiting.

How did we model the fire?



Fire can spread to the right with probability P_r, to the left with probability P_l, and can change from burning to burnt with probability P_b.

How did we model the decision cost?

$$C(d) = \begin{cases} \min\left[E(d),\ \frac{F\cdot P_r\cdot(1+P_l)}{1+2\cdot P_l\cdot P_r}\right] & \text{if d = 1} \\ \min\left[E(d),\ \frac{F\cdot P_r\cdot(1+P_l)}{1+2\cdot P_l\cdot P_r} C(d-1)\right] & \text{if d > 1} \end{cases}$$

Where:
- d is the distance from the fire to the location.
- F is the damage cost of the fire.

When should we evacuate according to the model?

Fire Cost	Evacuation Distance	Probability
5	4	0.9
	3	0.7
	2	0.5
	1	0.2
10	6	0.9
	5	0.8
	4	0.8
	3	0.7
	2	0.5
	1	0.1
50	6	0.9
	5	0.8
	4	0.8
	3	0.7
	2	0.5
	1	0.1

As we increase the fire cost and probability, the evacuation distance increases.

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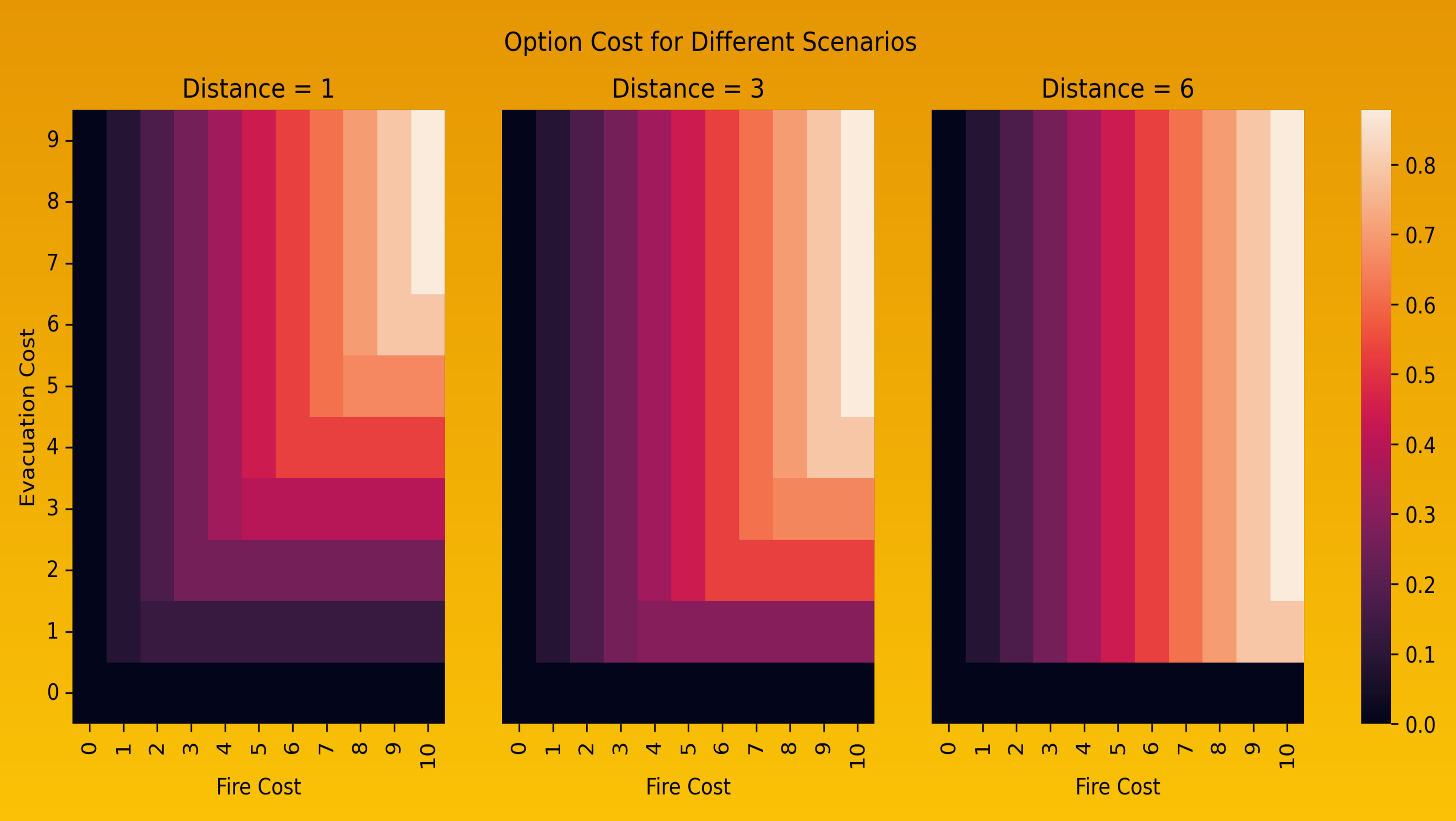
How the decision change when we change the costs?



The evacuation decision is highly dependent on the catastrophe and evacuation costs. In the above figure, we can see the cost combinations where we should evacuate and wait.

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Conclusions and Future Work

- This yielded results that shed light on the primary factors influencing evacuation decisions during wildfires.
- For a more realistic model, transitioning to a 2D grid becomes imperative, as it can simulate real-world scenarios more accurately. But the calculation could become highly complex
- We could work in an intermediate step exploring a hybrid approach where fires have a limited number of pathways, resembling a network, through which they can reach roads or towns.

References

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