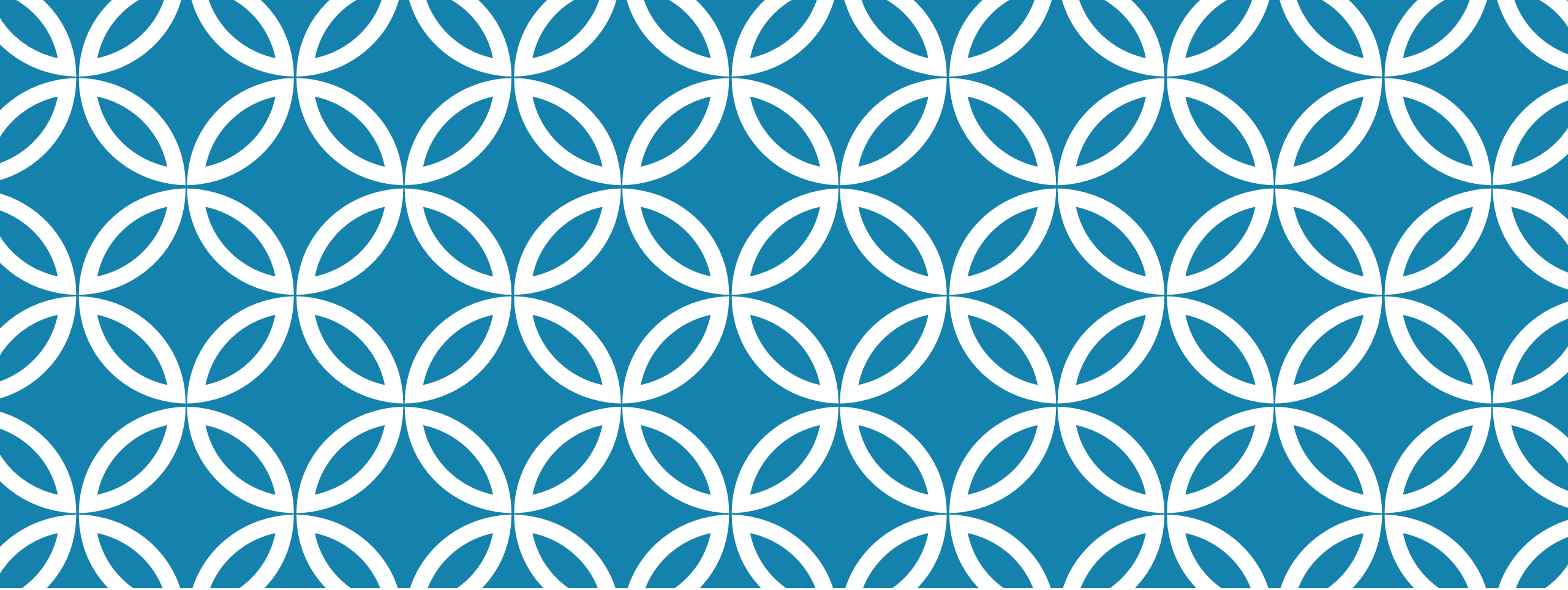

HUMAN SWARM SEARCH STRATEGIES

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THE PROBLEM

Given a rectangular block with R rows and C columns to be searched by N drones, find the optimal coordination of these drones to search the block in the least amount of time and also making sure that not too many squares are burned before searching.

Terminology: One block with R rows and C columns has RC squares.

Some squares in the block could be likely to burn down faster, depending on the location of the fire.

One or more of the initial N drones may drop out of the search midway for whatever reason (they have been reassigned or they drop down to engage with a civilian group, etc.). In that case, the other drones need to recalibrate to search the area in the most optimal way.

CUSTOM SEARCH OPTIONS

It is difficult to build one system that works for all values of R, C and N. So it is useful to come up with some custom searches like say, (i) using 2 drones to search a 3x3 block or (ii) using 3 drones to search a 5x4 block.

The SP could then suggest these custom searches to the operator and the operator can use them when necessary.

STATE SPACE

We need information about each of the RC squares in the block. The status information of each square in the block can be represented by one of the following 5 status variables.

-1 → Burned

0 → Searched

1, 2, 3 → Not searched and represents the amount of time left before the square is burned. Call this ‘burn time’

STATE SPACE

Additionally, we also want to know how many drones are actively searching out of the initial N drones. For each drone we maintain a status variable

0 → Inactive, not searching

1 → Active, searching

This will also make sure that we don't call out actions to inactive drones.

STATE SPACE

There are (5^RC * 2^N) states in this system.

If we use Function Approximation, we can bring it down to RC+N (not necessarily binary) features.

ACTION SPACE

We need to be able to call out actions to N drones simultaneously

We could ask each drone to do one of the following five actions: Move Up, Down, Left, Right, Stay.

That gives us a total of 5^N actions.

ACTION SPACE

Reducing the action space is a challenge.

We could move only one of the drones every turn, but that is extremely inefficient.

We could come up with an individual searching policy for each drone, independent of the others, and try to simulate the performance of the other searching drones but that simulation could be extremely inaccurate. But we could attempt such a simulation.

REWARDS

-1 for every action we play

-100 if a square is burned down before we search it