Final Project Flash Talk

San Francisco 69ers

Problem Statement

Infectious cell and White Blood cell interaction in the blood stream can be modeled by a multiagent system

Infectious cells pose a threat to the host; White Blood cells try to cleanse to host of infection

Observation of this interaction can identify which factors influence the survival of the host the most; can also identify successful strategies in search and destroy scenarios

Environment Set-Up

There will be a bounded region representing a section of bloodstream

The environment will contain infectious cells, white blood cells, red bloods cells and nutrients (nutrients will be static matter - like agar)

The simulation will end when either: 1) no infectious cells exist anymore or 2) the infectious cell mass reaches a critical mass detrimental to the host

If a white blood cell touches an infectious cell, the infectious cell dies. Infectious cells will reproduce at a given interval

The mechanics of the environment can be see at agar.io

Environment Set-Up

There would be several environmental parameters that would determine the success of the infectious cells. The initial count of both the infectious cells and white blood cells would be set at the beginning. Cell size and speed could also be configurable. The last configurable properties would be the minimum reproduction size of the infectious cells and the critical mass needed to become harmful.

Nutrients and red blood cells will be randomly spawned at defined intervals.

Agent Design - Infectious Cells

These would focus on surviving White Blood Cell attacks. When eating nutrients they will grow in size. When they hit a certain mass, they will mitotically reproduce into two infectious cells.

These cells will have a detection radius - if cells come within this radius the infectious cell will 'know' it's there. When Infectious cells detect a White Blood cell or region boundary they will move in the opposite direction to avoid death.

The motivation of these cells is to stay alive as long as possible as reproduce rapidly. The cells accomplish their goal when the combined infectious cell mass reaches a critical level (predefined for the region).

Agent Design - White Blood Cells

These agents would focus on attacking infectious cells and removing all infection from the host. These cells would also have a detection radius, like the infectious cells, that allows white blood cells to ‘see’ infectious cells.

The white blood cells would not only be able to detect infectious cells, but also other white blood cells. By detecting nearby white blood cells, they can move as a group to corner or pincer infectious cells.

White blood cells would be the largest and slowest type of cell. Alone, a white blood cell wouldn't be able to make contact with the infectious cells so they must work together to defeat the infection.

Agent Design - Red Blood Cells

These dumb agents would move randomly within the environment. They wouldn’t react to any surrounding cells and merely consume the food it passes by.

Infectious cells would specifically target these cells as an easy food source, but the red blood cells will not go after other cells. These cells would be medium in both size and speed, moving in random directions. Each random wandering cell wouldn't interact or respond to other random wandering cells near it.

Desired Emergent Behavior

The desired emergent behavior would be that the white blood cells are able to communicate and coordinate with each other to destroy all the infectious cells. The white blood cells must do this as fast as possible to limit the infectious cells from repopulating via mitosis.

Hypotheses

Hypothesis 1: A low white blood cell count is more beneficial to infectious cells than a high infectious cell count. White blood cells can be more controlling and can have more power over the outcome.

Hypothesis 2: The white blood cells will be more efficient when they are closer in size to the size of the infectious cells. If the white blood cells are too much lower than the infectious cells, then the infectious cells easily elude the white blood cells.

Hypothesis 3: Infectious cell success would be maximized when spacing is kept between themselves, to prevent white blood cells from forming a singular large group around them.

Experimental Design

Control: All local strategies. White blood cells will only pursue the nearest infectious cell and infectious cells will avoid the nearest white blood cell.

Each cell type will have a cooperative strategy. The white blood cell strategy is to trap infectious cells between walls and other white blood cells. The infectious cell strategy is to spread out in order to avoid the entrapment of the white blood cells. By staying away from other white infectious cells, the survival of infectious cells as a whole will be prolonged since white blood cells won't be able to rapidly destroy infectious cells before they reproduce.

Experimental Design

The three experimental groups (other than the control) will be one group where just infectious cells use cooperative strategies, one where white blood cells use cooperative strategies, and once where both cell types use cooperative strategies. We will measure the efficiency of the system by how quickly it takes either the white blood cells to 'cure' the host or the infectious cells to harm the host.

Within each of those trials we will vary the count of each type of cell as well as varying other environmental variables, such as infectious cell reproduction rate and relative cell size (ranging from white blood cells being marginally larger than infectious cells to several times their size).

Questions?

Thanks for listening.