University of Toronto
Department of Computer Science
CSC 270 - Fall 1994

Assignment 2: Desert Warfare

Due: in tutorial, November 7

Saddam Hussein is on the move again, and you have been recruited to provide him with military advice. In order to do so, you will simulate expected war-time conditions and provide him with an analysis.

The War Scenario[1]

Given a base which currently holds $n_F > 0$ units of food, $n_S > 0$ SCUD missiles, and n_A anti-aircraft missiles, each day, the soldiers on this base consume 3 units of food and fire $\lceil 0.1 n_S \rceil$ SCUDs at enemy positions. At the start of the war, each base begins operations with 150 units of food, 100 SCUD missiles, and 200 anti-aircraft missiles.

If the food supply is depleted for three days or less, and then replenished, the base may continue operations. However, if the food supply remains empty beyond this time, then all of the soldiers die from starvation or dehydration and the base is considered eliminated.

On any given day, enemy forces attack each of the surviving bases with probability, $P(A)$ given by

$$P(A) = \begin{cases} 5/\text{surviving bases}, & \text{if surviving bases} \geq 10 \\ 0.5, & \text{otherwise.} \end{cases}$$

In order to repel each enemy attack, the base must fire a number of anti-aircraft missiles, drawn from a Normal distribution with $\mu = 20$ and $\sigma^2 = 5$. If the base is unable to repel the attack due to an insufficient supply of anti-aircraft missiles, then the base is destroyed.

Starting exactly seven days after commencement of hostilities, supply trucks are dispatched to the surviving bases in turn, at a uniform rate of one truck per day. In addition, for each truck, there is an associated maintenance delay of

$$\text{delay} = \begin{cases} 50/\text{trucks remaining}, & \text{if trucks remaining} > 10 \\ 5, & \text{otherwise.} \end{cases}$$

In order to reduce susceptibility to attack, trucks travel only at night. All bases are within one night's travel of the main supply depot. Note that since supply trucks must leave at nightfall,

[1] The scenario depicted in this assignment is not intended to serve as an accurate depiction of battle conditions in the Persian Gulf. Actual conditions may differ in practice. Furthermore, this assignment does not reflect an advocacy of military decisions based on simplistic simulations on the part of the instructor nor of the University of Toronto.

any fractional part of a day must be treated as a full 24 hours in the schedule. Hint: use the *ceil* of the scheduled departure date.

Saddam begins the war with a fleet of 100 supply trucks. Each truck carries with it 100 units of food, 50 SCUD missiles, and 50 anti-aircraft missiles, which are transferred to the destination base immediately upon arrival.

Reconnaissance flights will indicate which bases are still surviving, so supply trucks will not be sent to bases which have already been destroyed. However, a base could be destroyed while a truck is en route to it, in which case the delivery is aborted. There are no secondary delivery destinations. In addition, trucks are also attacked by enemy forces, and on each outing, are destroyed with a 10% probability. For simplicity, we assume that trucks are only attacked while en route to a base.

What Saddam wants

Through your simulations, you are to recommend to Saddam the number of bases, B_0, with which he should begin the war, so that he will retain a military capability[2] for as long as possible.

Of course, you should also be concerned about minimizing casualties to Saddam's forces, and hence, must analyze the effect of different values of B_0 on the progress of the war.

In addition, to your report, program listing, output, and analysis, Saddam will be especially interested in the following statistics:

- the number of SCUD missiles fired at enemy targets
- the number of bases lost as a result of starvation or dehydration
- the number of bases destroyed by enemy fire
- the number of aborted supply deliveries
- the number of trucks destroyed by enemy fire

You may choose to use a time-driven or an event-driven simulation, but in either case, you must justify your decision. You may have to make some independent decisions regarding the order in which events occur. For example, should a base die of starvation before launching its SCUD missiles for the day? Finally, make sure that you try multiple runs of your program for each starting condition, and use different random number seeds for each of these runs.

[2] For simplicity, we assume that Saddam retains a military capability so long as at least one base remains in operation and is armed with SCUD missiles.