Midterm 02

Due date Monday October 29th of 2012 at 1pm.

Discuss relevant equations, describe you solution, show results. All Matlab code/scripts must be present in the carbon copy as well, put them near relevant parts of the text (avoid appendixes). The text part of your report should not exceed 10 pages.

Bio hazard spread problem (100 points total)

We will model a quite simple 2D model of a virus spread.

Imagine that aliens are invading the Earth. Your team's job is to organize the most productive resistance (i.e. the one which generates the most counter alien equipment for a given number of days). You spread your team members randomly and uniformly across the available area (with only 1 person per cell).

The aliens do not care about the Geneva convention and actively use bio weapons. On the zero day (and only this day), aliens were able to infect 200 people (or all of your group if its size is less then 200 people) at random places with a virus. Luckily it happens only once. However every day aliens bomb the planet with bio bombs, which results in 0.006 probability to get infected with the same virus in that day for every human. The virus has following properties

- the probability to transfer the virus to the next cell neighbor in all 4 directions is the same and equal to 0.15 per day
- probability of dying from this virus is .05 per turn/day
- there is no cure for this virus
- virus can not jump to an empty (unpopulated) cell

Due to lack of timing for a better simulation, we have to make a reasonably simple model of the virus spread and the production of counter-alien equipment.

Imagine that you are in charge of the square territory of 100x100 cells. Each cell might have a human living or be empty. At the beginning of each day all alive members generate 1 unit of the counter-alien equipment per capita (it does not matter if a person is ill or healthy). Then they talk to the next cell neighbors to exchange the news and updated blueprints (radio is jammed by aliens) in the four directions (north, south, west and east). Notice that each neighbor speaks with another twice, for example north one goes to south and then south one goes the north to speak again. If one of the neighbors has the alien's virus it has a probability to transfer to the other one according to the virus specification. Then this virus may kill infected people. If a person dies in a certain cell that cell is treated as empty from the next day forward. After this the aliens bomb again trying to infect more people.

Task 1 (40 points):

Program a probabilistic model of the virus spread on the given territory for a given population. Write a function which calculates how many equipment units will be produced for 1200 days of resistance.

Book keeping: Keep population statistic in the 2D array called 'AreaMap' with the size of the area dimensions. Assign 1 to the empty cell, 2 to the healthy human, 3 to the ill/infected human. I would suggest to have a current population map and another map reflecting a new situation with newly infected people and so on, since a human who was not infected at the beginning of the current day cannot infect another one due to an incubation period.

It is convenient to look at the area map from time to time during debugging to see how the virus has spread. Use the following code to output the image of the area.

```
% assignees black to the empty cell,
% green to the healthy human, and red to the ill person
population_colormap=[ 0,0,0; 0,1,0; 1,0,0];
image(AreaMap), colormap(population_colormap); % outputs the map image
```

Task 2 (20 points):

How many people will you take under your command? Using the function optimization algorithm (golden search or matlab built in), find the optimal resistance group size. Run you algorithm several time to estimate error bars on this number.

Task 3 (20 points): Make a movie of your group map evolution for the optimal group size during the first 200 days. At the begining of every **2nd** day execute the following

```
population_colormap=[ 0,0,0; 0,1,0; 1,0,0];
image(AreaMap), colormap(population_colormap); % outputs the map image
% frame_counter must start from 1
map_evolution_movie(frame_counter)=getframe;
frame_counter=frame_counter+1;
% this movie can be played with the 'movie' command
% i.e. movie(map_evolution_movie);
```

Save this movie at the very end of the simulation of the virus spread.

```
save('movie_file.mat', 'map_evolution_movie');
```

Attach this movie file 'movie_file.mat' to your electronic submission.

You can check the validity of the movie with the following commands

```
load('movie_file.mat');
movie(map_evolution_movie);
```

Task 4 (10 points):

Plot accumulated production vs number of days since the virus introduction for the optimal group size. Make sure that you have the interesting transient behavior in zoomed in version.

Task 5 (10 points):

Plot accumulated number of people killed by virus vs day number for the optimal group size. Make sure that you have the interesting transient behavior in zoomed in version.