Birzeit University - Faculty of Engineering and Technology
Electrical & Computer Engineering Department - ENCS4330
Real-Time Applications & Embedded Systems - 2^{nd} semester - 2022/23

Project #3
POSIX threads under Unix/Linux
Due: June 16, 2023

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Ant searching for food simulation

We would like to build a multi-threading application that simulates the behavior of a group of ants once any of them smell the presence of food. Keep in mind that ants behavior might be more complex than the simulation we're building. We intend to keep things simple for now. The simulation can be described as follows:

- A user-defined number of ants are created when the simulation starts (e.g. 100 ants). These ants are randomly located on the screen and walk in random directions and random speeds. Assume the direction of walking can be North (N), South (S), East (E), West (W), North-East (NE), North-West (NW), South-East (SE), South-West (SW). The speed is an integer value belonging to the range $[1 \ldots 10]$.

  When an ant hits the limit of the simulation window, it continues walking with the same speed but with an additional 45° angle, either CW or CCW (random). The behavior continues forever.

- Pieces of food will be placed in random locations every user-defined amount of time. Assume an ant can smell the presence of food if the food is placed anywhere within a user-defined distance from the ant. Once it smells the presence of food, it releases a pheromone which is a chemical substance that triggers a social response in the ants next to it. Assume the following:

  - All ants whose distance with the ant that smelled the food is below a user-defined distance will shift direction and head towards the food. In addition, these ants will release a pheromone that is less powerful but will help in propagating the social response in more ants (the released pheromone amount is indirectly proportional to the distance to the food). However, as these ants get closer to the food source, they will release bigger quantities of pheromone.
  - Ants that smell pheromone but with lesser quantities will change direction by an angle of 5° in the direction of the food position per second. If the pheromone smelled by an ant drops below a user-defined quantity, it continues in the current direction of movement.
  - If an ant gets pheromone smell from 2 different food locations, it will favor the one with the higher smell.

- When ants are gathered on top of the piece of food, they will stop walking and will each eat a small portion of that food until it is all gone. Of course food eating should be monitored so 2 ants do not eat the same food portion. Assume each ant can eat a user-defined portion (in percent) of the food per second.

- The simulation ends when a user-defined amount of time (in minutes) has elapsed.

What you should do

- Implement the above problem on your Linux machines using a multi-threading approach.
- Compile and test your program.
- Check that your program is bug-free. Use the `gdb` debugger in case you are having problems during writing the code (and most probably you will :-). In such a case, compile your code using the `-g` option of the `gcc`.
- In order to avoid hard-coding values in your programs, think of creating a text file that contains all the values that should be user-defined and give the file name as an argument to the main program. That will spare you from having to change your code permanently and re-compile.
- Use graphics elements from opengl library in order to best illustrate the application. Nothing fancy, just simple and elegant elements are enough.
- Be reaslistic in the choices that you make!
- Send the zipped folder that contains your source code and your executable before the deadline. If the deadline is reached and you are still having problems with your code, just send it as is!