

Object Oriented Design and Programming

5th Tutorial

Territorial Goldfish

The following description of a two dimensional world populated with goldfish will serve as the basis for our tutorial. You are asked to:

1. part: produce a UML class diagram,
2. part: declare the appropriate classes (i.e. header files),
3. part: write the appropriate main program,
4. part: complete function bodies for member functions declared in 2.

All goldfish have a position. The position is described as a point in the plane in terms of a floating point value for the x-axis and a floating point value for the y-axis.

Furthermore, all goldfish have a territory. Territories are rectangles. They are described by the rectangle spanned between the southwest point and the northeast point. A newly born goldfish at position (x,y) is originally given a territory consisting of the rectangle defined by the two points $(x-1, y-1)$, $(x+1, y+1)$.

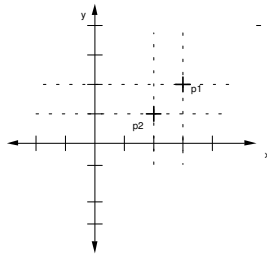
Also, goldfish have a size, measured in floating point numbers. Any newly created goldfish has an initial size of 2.3 cm.

Goldfish may attack other goldfish. When a goldfish is attacked by another goldfish, if the attacking goldfish is inside the territory of the one being attacked, then the attacking goldfish retreats. Otherwise, if the attacking goldfish is more than 1 cm longer than the goldfish being attacked, then the attacked goldfish will retreat, and the attacking goldfish will triumph. If their size difference is less than 1 cm, then the attacked goldfish will give birth to five new goldfish at the positions (x,y) , $(x-4, y-4)$, $(x+4,y-4)$, $(x-4,y+4)$ and $(x+4,y+4)$, where (x,y) is the position of the attacked goldfish .

When a goldfish retreats, then its size decreases by 0.2cm, it moves backwards, and it shrinks its territory.

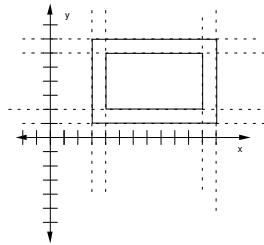
When a goldfish triumphs, its size increases by 0.3cm, and its territory expands.

A goldfish at position (x,y) moves backwards by moving to position $(x-1, y-1)$.



EXAMPLE: point p1 moves backwards to point p2.

When a territory expands, provided it does not exceed the GTB described later on, then the south-west point moves backwards, whereas the north-east point moves forwards (i.e. the values of the x- and y- co-ordinates increase by 1). For a territory to shrink, provided its area does not fall under 1.2, the southwest point moves forwards, and the northeast point moves backwards.



EXAMPLE: extending/shrinking territory

The area of a territory is not allowed to exceed the GTB, i.e. Goldfish Territorial Bound. This is $60/(\text{number of live goldfish})$. Also, no territory is allowed to have an area less than 1.2.

Write a main program, which describes the following situation:

- There are three goldfish: Peter at position $(5,6)$ with a size of 6.3cm, Paul at position $(2,2)$ with a size of 2.4 cm, and John at position $(5,6)$ with a size of 4.3cm.
- Peter attacks Paul.
- Paul attacks John.
- A new goldfish, under the name of Matthew, appears at position $(6,10)$.

Note: Of course, the above is not a realistic set up. For example, goldfish may attack each other from any distance, and any number of goldfish may be occupying the same position. These considerations were left out of the description on purpose, in order to obtain a small exercise that allows us to practice the corresponding C++ features.

Note: The sample answer takes 4 pages, and is longer than a typical exam question. The purpose of the exercise is to think about “larger” programs.