Project: Concurrency and Parallelism

Final Report

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**Project goal:**

Build a distributed client-server system, with multithreaded dynamically allocated clients, in order to handle the clustering algorithm described in "AntClass: discovery of clusters in numeric data by a hybridization of an ant colony with the Kmeans algorithm". [1]

**Project description**

The software system consists of 3 main parts, Server, Client, and a shared library project being referenced by the Server and Client projects.

The communication between the Server and Client applications is based on standard Java RMI API.

All the heavy-computations are done on client side, and the update functions are invoked to change the states of the original objects on the server side.

Client

Server

Shared library of classes

Figure 1. Graphical representation of the project Client-Server architecture.

**Clustering algorithm implementation**

We have implemented the board structure according to the

Board architecture:

Board

Cell

Cell Entity

Empty Cell Entity

Ant Cell Entity

Heap Cell Entity

Heap Objects of different types

Figure 2. Graphical representation of the Board structure.

As can be seen on the figure 2, we have board object which consists of m\*m cells objects, where m – board size in rows and columns.

Each Cell contains a CellEntity object. A CellEntity object can be:

1. Ant
2. Heap
3. EmptyCell

A Heap consists of HeapObjects. The type of these HeapObjects is predefined.

Graphical representation of a Board.



Figure 3. Graphical representation of an empty cell, an Ant in the cell, a Heap, containing three heap objects of two different types.

Properties of the board objects:

Empty Cell:

* Can be replaced with a Heap, when Ant drops a HeapObject
* Can be replaced with an Ant, when an Ant moves onto the Cell

Heap:

* Can be modified by an Ant:
  + If there was one HeapObject in the Heap:
    - Ant takes the object – heap is destroyed
    - Ant is carrying a HeapObject – put a HeapObject in the cell – Heap grows
  + If there were 2 and more HeapObjects in the heap:
    - Ant takes the HeapObject – Heap shrinks
    - Ant puts the HeapObject – Heap grows

Ant:

Ant objects have several methods:

1. Move – Randomly assigned movement of an Ant, on x, y or both axis’s of the board, but only to empty cells.
2. Look Around - Ant explores 8 cells around it in the following order: cell 1 = in front of an ant, cell 2 = to the left, cell 3 = to the right, etc. The location of the first heap found around an ant is returned as a result.
3. Process pick up algorithm – If there was found a heap near the ant and an ant is not carrying any objects, pick up algorithm is called to take one of the objects of a heap. Before taking an object ant locks the whole board to avoid inconsistency by checking if the heap still exists on the same location and prevent other ants from taking an object from the same heap.
4. Process drop algorithm – If there was found a heap and ant is carrying an object – it locks the board to avoid clashes with other ants, drops an object on the heap and continues to move randomly.

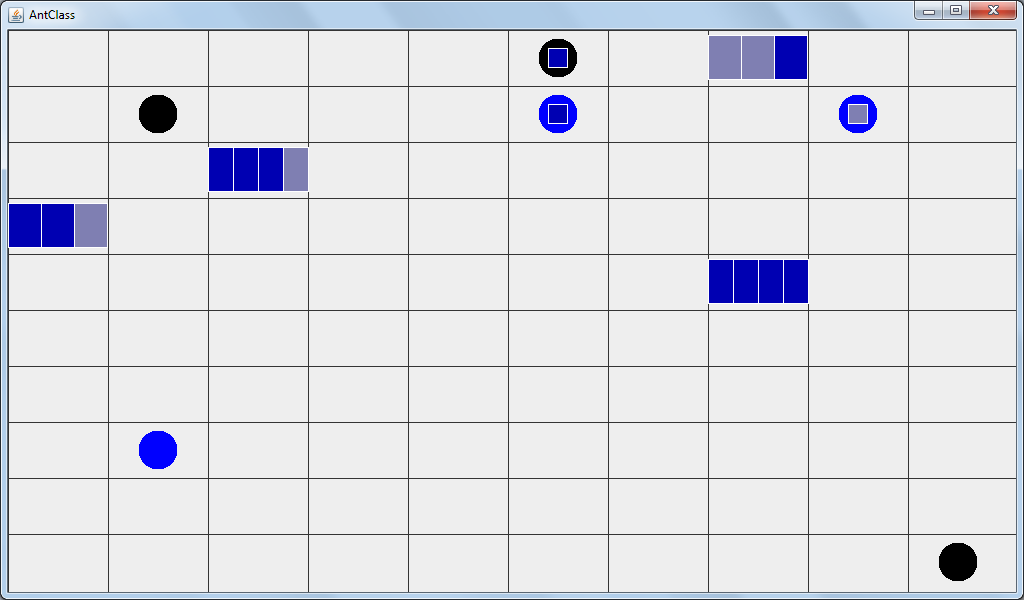


Figure 4. Full board view during runtime. Black ants belong to a client 1, blue ants belong to a client 2. Ants with a rectangle on top are considered to carry the heap object of a type indicated by the color of rectangle.

General structure of the project: To be changed

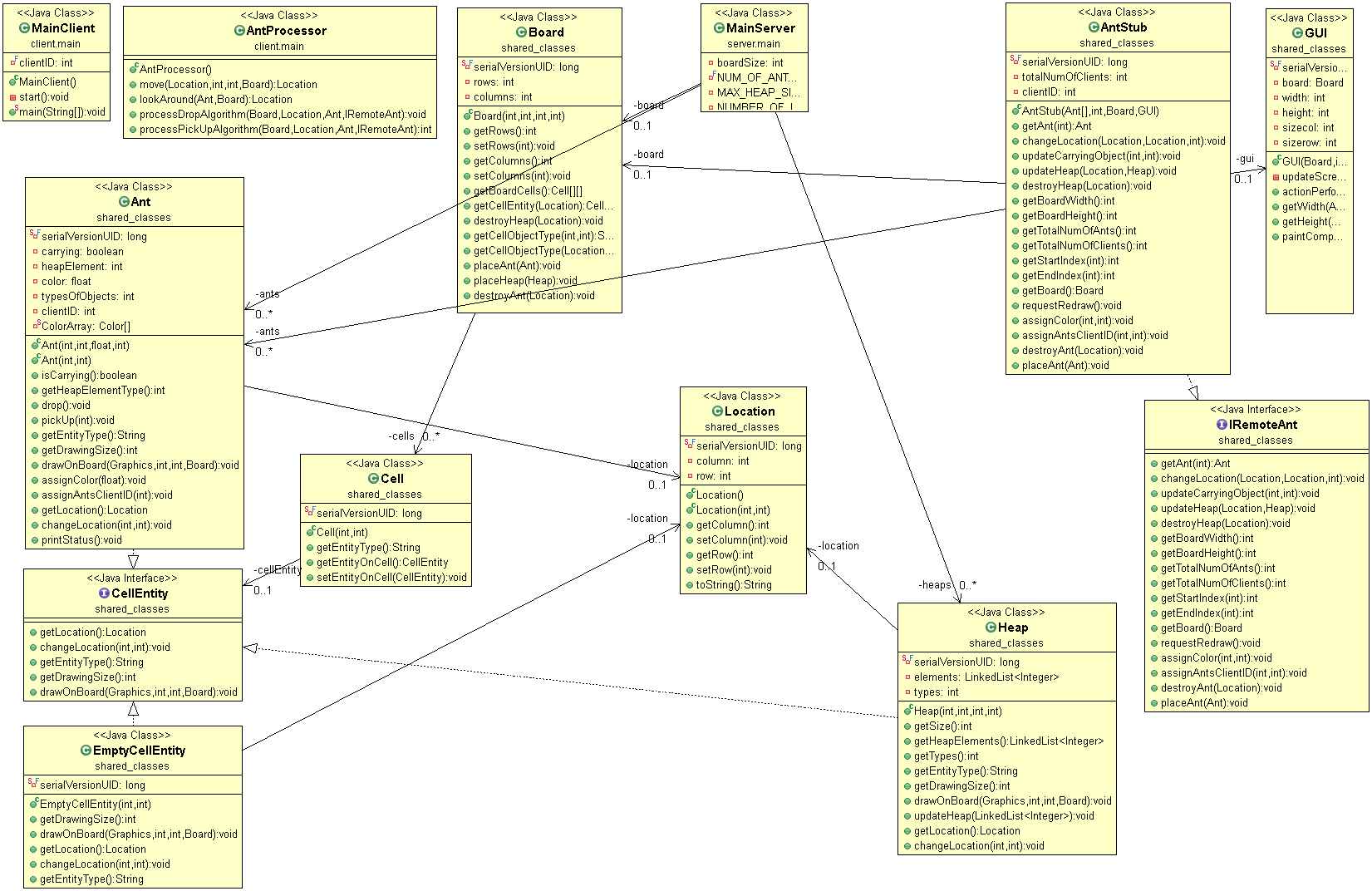


Figure 4. Class diagram of a project.

References:

[1] "AntClass: discovery of clusters in numeric data by a hybridization of an ant colony with the Kmeans algorithm" by N. Monmarche, M. Slimane, G. Venturini; January 1999, Laboratiore d'Informatique, Ecole d'Ingenieurs en Informatique pour l'Industrie (E3i), Universite de Tours, France