Exercise 4

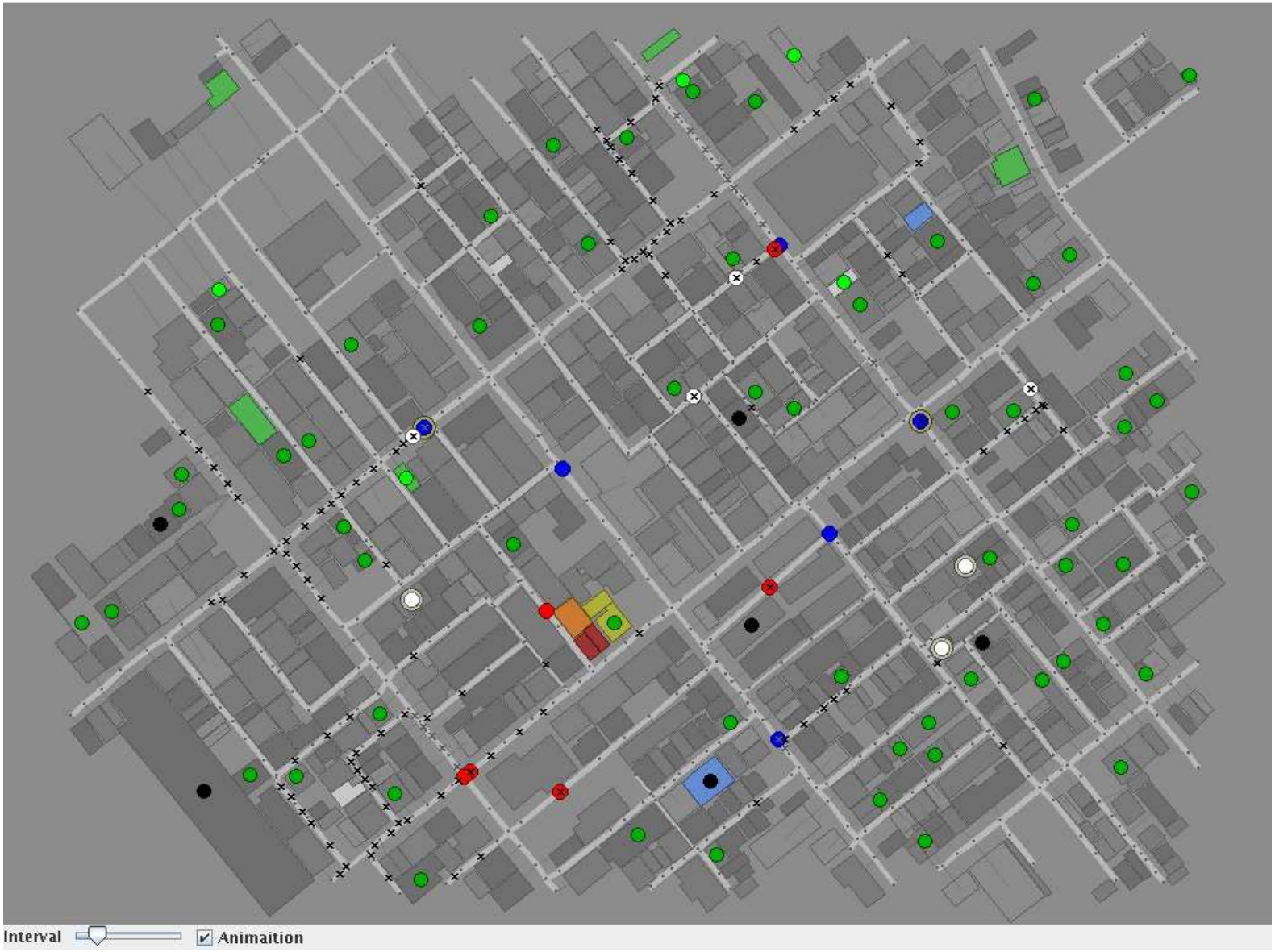
Path planning in RCRSS

- General: Find path or costs from position A to B
- Basic: A is always agent‘s position
- Agent‘s code usually needs general solution for evaluation of different targets
- Cost query might be called a lot, path usually only once
- → Need efficient calculation: cost A to B

Example: Ambulance agents

- Civilians are buried: Takes B/N rounds to unbury with N ambulance teams
- Civilians are hurt: Will die, if not after X rounds at refuge
- Ex: civilian: B = 30 will probably die after 15 rounds, 3 ambulance teams
- Can you save him?
- Or better save two other civilians?

Time: 54 Score: 93,647112

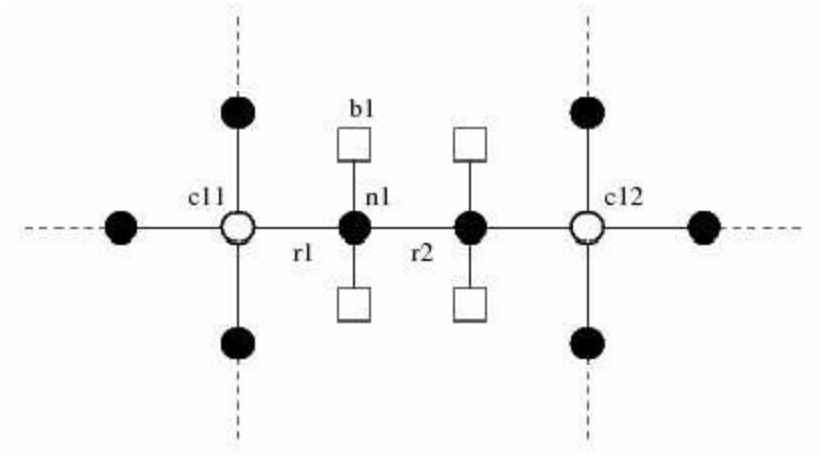


Search space

- Search/path planning: G=(V, E) and c:E→R+
- search algorithm (A*, D*, dijkstra)
- Problem solved?
- What is G, c?
- The search space needs to be defined to solve a real problem

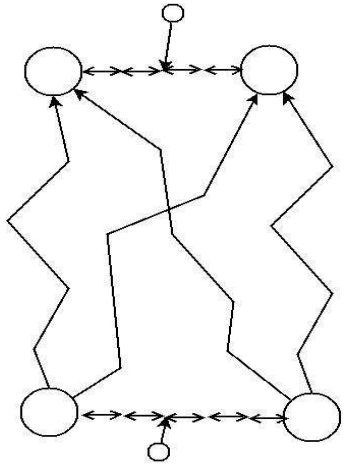
Searching Long-roads

- Long-road nodes are nodes, that connect more than two roads (i.e. a junction)
- Efficient structuring of search space
- Users of path planning do not know about this!



Long-roads details

- Upon a planning query you need to
  - Find the two nearest longroad nodes to start and goal (or one if start/goal is LRN)
  - Get distances to both LRNs
  - Compute minimal path for all four possibilities



Implementation

- Keep the interface at RescueObjects, i.e. the long-roads only exist in the planner
- What you might want to do:
  - Get the long-road/long-road-nodes for a position
  - Get the „real“ roads for a long road
  - Keep the long road planner abstracted, i.e. it should really just deal with the graph
  - Get costs for a long-road

Implementation (2)

- Calculate the longroads once and store the information for the planner
- Look in Memory class for functions how to get objects of a certain type
- Your planner should work on MotionlessObjects
- Look in SampleSearch.java as how to access objects/find neighbors, etc.
- What the simulator finally wants as a path is a list of IDs of your path

Path Planning

- Ideally your planning nodes are designed very similar to those in the lecture
  - Parent pointer
  - Cost
  - Depth
  - Etc.
- Use predefined data structures, e.g. PriorityQueue and Set for OpenList/ClosedList
- When extracting the path: Remember you start at the goal and follow the parent
- Implement at least A*/Dijkstra. More advanced algorithms as D*/D* lite, Real time A* etc. are also fine!

Multi-Query Path planning

- You will use the path planner for task assignment later
- Multiple (cost) queries will be done in the same round
- Store the costs of queries in a NxN matrix, which you can access like (N = #long-road nodes):
  - costMatrix[start][goal]

Modifications

- Change the path planner to use the matrix instead of A* (or similar) for costs (i.e. planning is just matrix lookup), if there is an entry
- The matrix needs to be invalidated after a world update (for now use: every round)
- Use A*/Dijkstra to fill the rows corresponding to the nodes nearest to the agents

Matrix row calculations

- Run A* with no goal (i.e. explore all)
  - Without a heuristics, this is behaving like Dijkstra (SSMG)
- The closed list now contains optimal paths to each node
- Ideally: only calculate, if information is needed

A look at the sample search

```
public static int[] breadthFirstSearch(RescueObject start, RescueObject goal, Memory memory) {
                List open = new LinkedList();
                Map ancestors = new HashMap();
                open.add(start);
                RescueObject next = null;
// SEARCH
                if (next==null) {
                        // No path
                        return null;
                }
                // Walk back from goal to start
                RescueObject current = goal;
                Stack path = new Stack();
                do {
                        path.push(current);
                        current = (RescueObject)ancestors.get(current);
                } while (current!=start && current!=null);
                int[] result = new int[path.size()];
                for (int i=0;i<result.length;++i) {
                        result[i] = ((RescueObject)path.pop()).getID();
                }
                return result;
        }
```

SampleSearch (2)

```
do {
        next = (RescueObject)open.remove(0);
        RescueObject[] neighbours = memory.findNeighbours(next);
        if (neighbours==null) continue;
        for (int i=0;i<neighbours.length;++i) {
                if (neighbours[i]==null) continue;
                if (neighbours[i]==goal) {
                        ancestors.put(neighbours[i],next);
                        next = neighbours[i];
                        break;
                }
                else {
                if (!ancestors.containsKey(neighbours[i]) && !neighbours[i].isBuilding()) {
                        open.add(neighbours[i]);
                        ancestors.put(neighbours[i],next);
                }
                }
}
} while (next != goal && next != null);
```