Good Website overviewing Astar
www.redblobgames.com/pathfinding/a-star/introduction.html

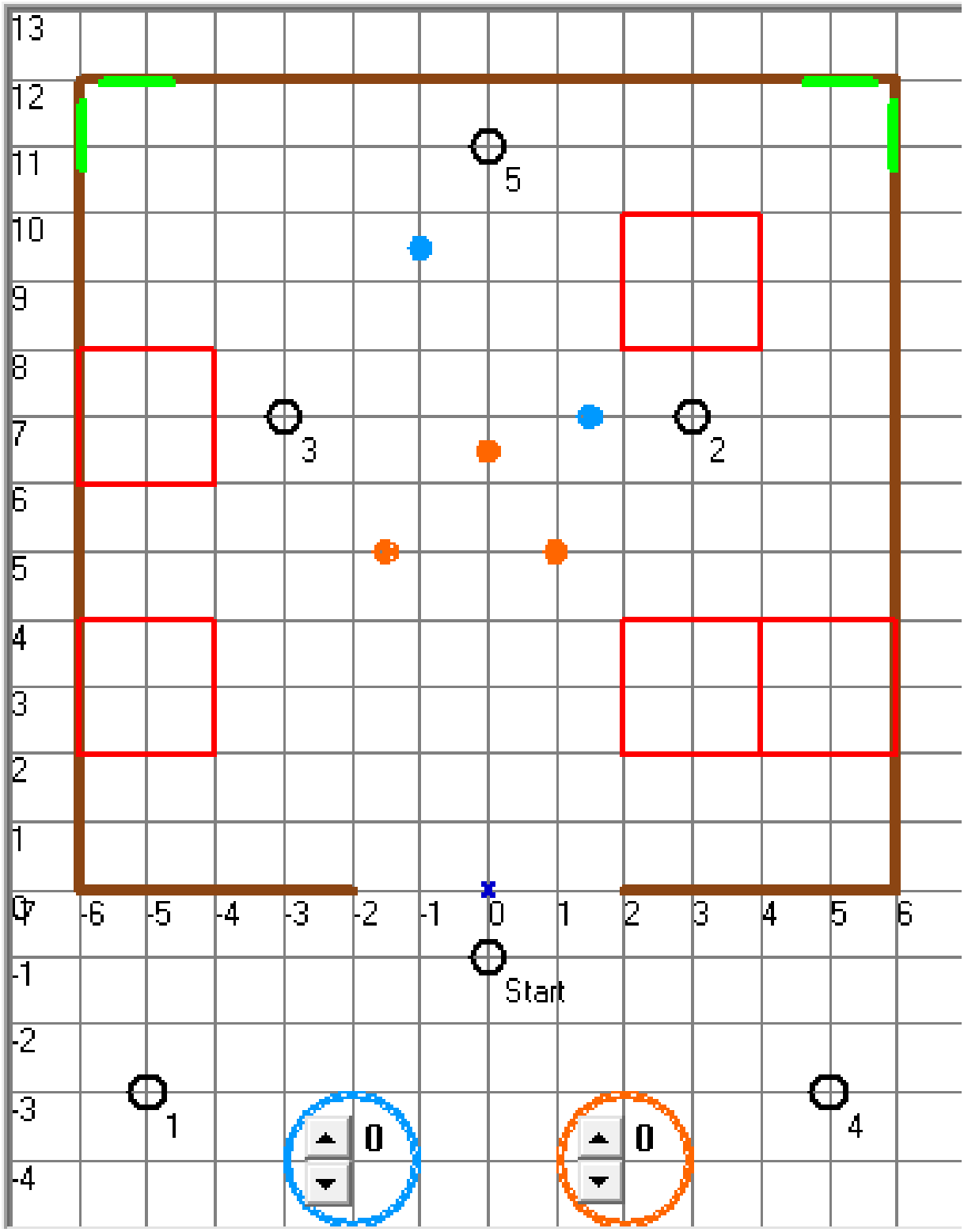
Good Website about Priority Queues
http://pages.cs.wisc.edu/~vernon/cs367/notes/11.PRIORITY-Q.html

Astar Algorithm Pseudocode

```
// A*
Function A*(start,goal)

// Initialize the closed list, the set of nodes already evaluated
Closedset = the empty set
//Initialize the open list, the set of tentative nodes to be evaluated
//initially containing the start node
Start g score = 0
Start f score = g score plus h "Manhattan distance from start to goal"
Openset = {start}
came_from = empty  // The map of the navigated nodes

while the open list is not empty
    Find the node with the least f on the open list, call it "q"
    Pop q off the open list
    Generate q's 4 neighbors
    For each neighbor
        If neighbor is the goal, stop the search
        neighbor.g = q.g + distance between neighbor and q
        // h distance is the "Manhattan" distance on a square grid
        neighbor.h = distance from goal to neighbor
        neighbor.f = neighbor.g + neighbor.h

        If a node with the same position as neighbor is in the OPEN list \
            which has a lower f than neighbor, skip adding this neighbor

        if a node with the same position as neighbor is in the CLOSED list \
            which has a lower f than neighbor, skip adding this neighbor

        otherwise, add the node to the open list
        and came_from[neighbor] = q //set neighbor's parent equal to q
    end
    push q on the closed list
end
```

//After Astar has run call reconstruct_path passing it the final goal point to combine the total path (but in reverse order from finish to start.

```
function reconstruct_path(came_from,current) // first current is goal
    while current in came_from:
        total_path.append(current)
        current = came_from[current] // assign current to the parent
    return total_path
```


13
12
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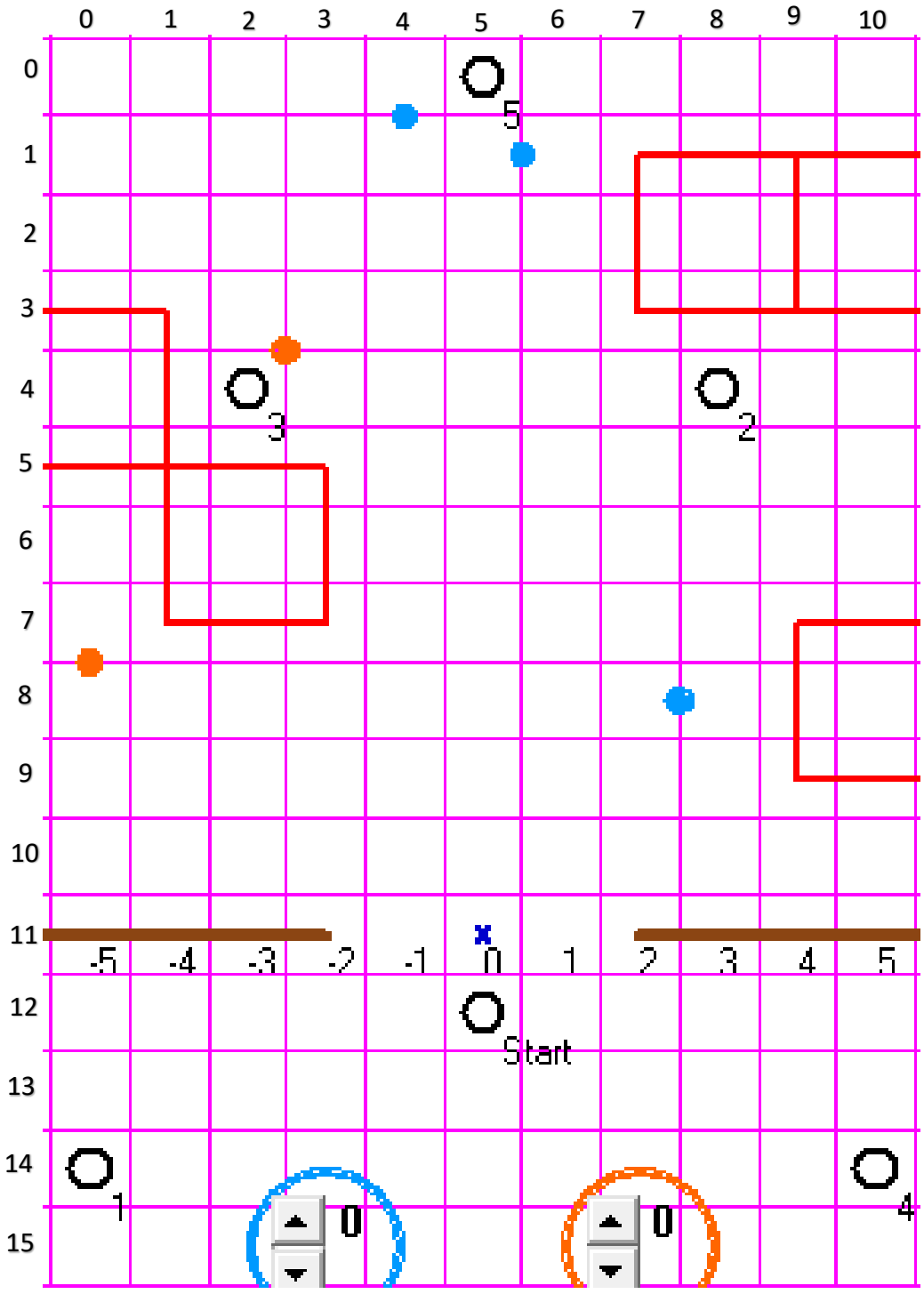
0 1 2 3 4 5 6 7 8 9 10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
5
3
2
1
4
Start
-5 -4 -3 -2 -1 0 1 2 3 4 5
0
0