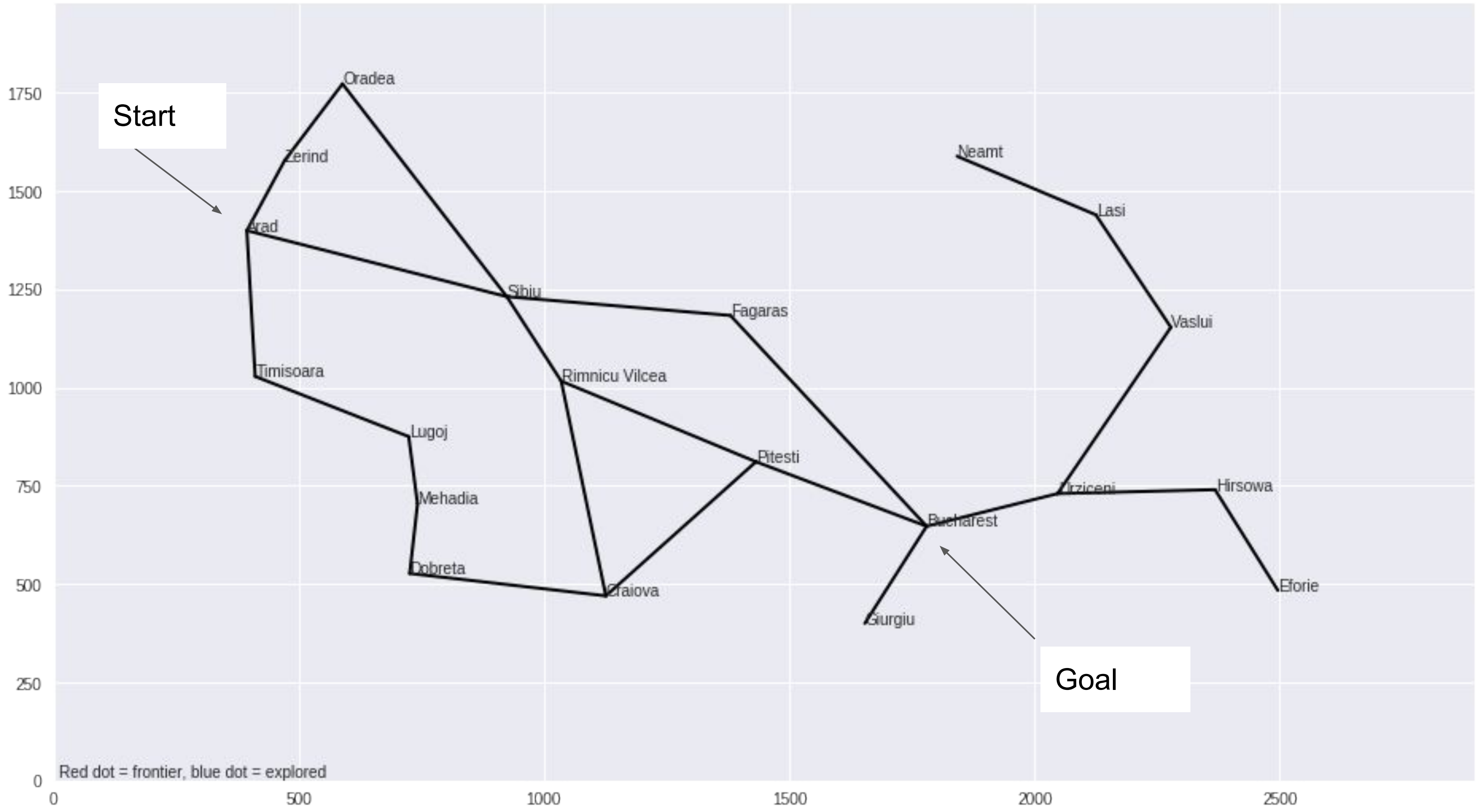
A*

And uniform cost search

First Uniform Cost search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Giurgiu
Bucharest
Urziceni
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Vaslui
Red dot = frontier, blue dot = explored
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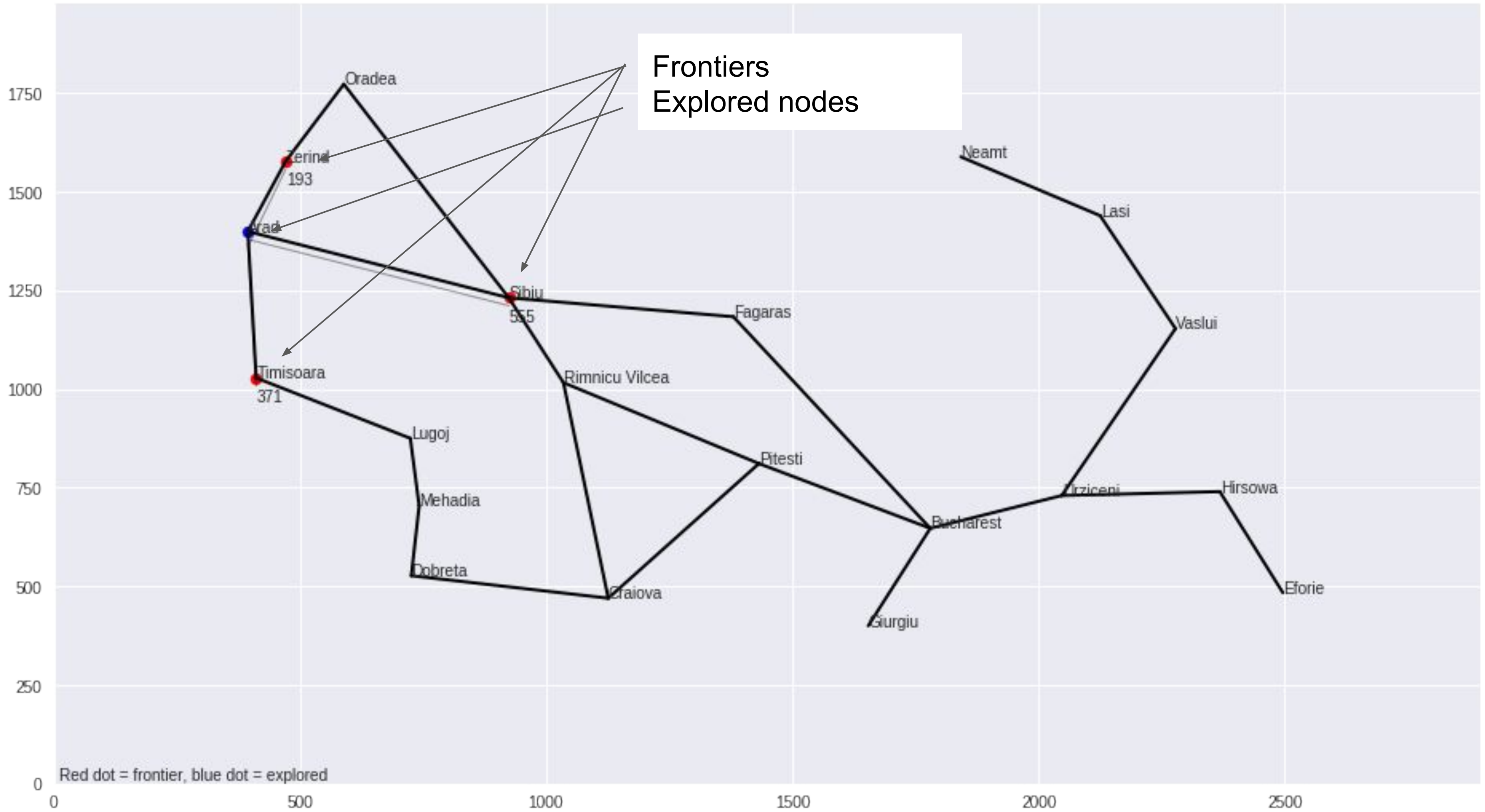
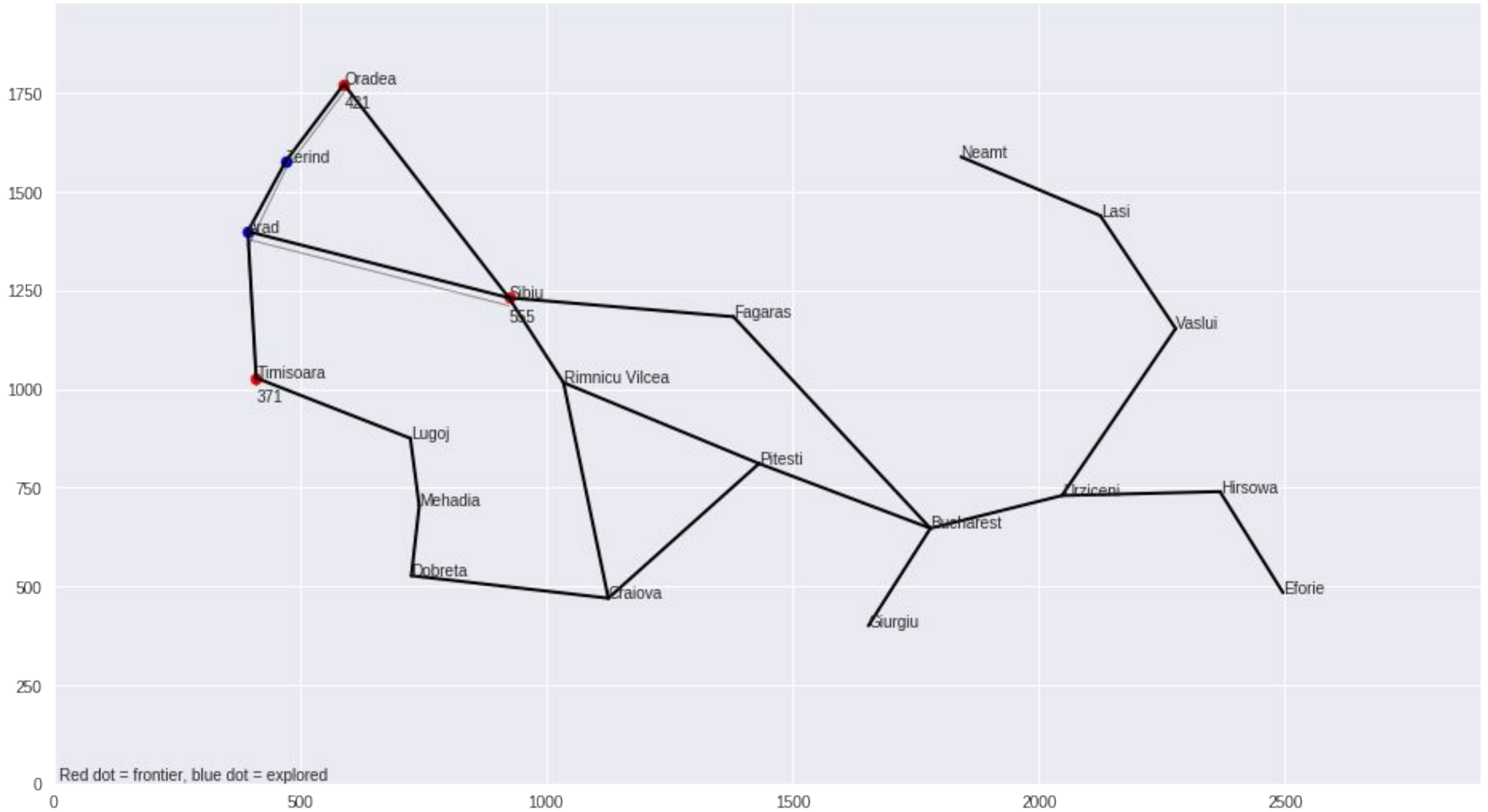
Start

Goal



Frontiers

Explored nodes



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Vaslui
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Bucharest
Eforie
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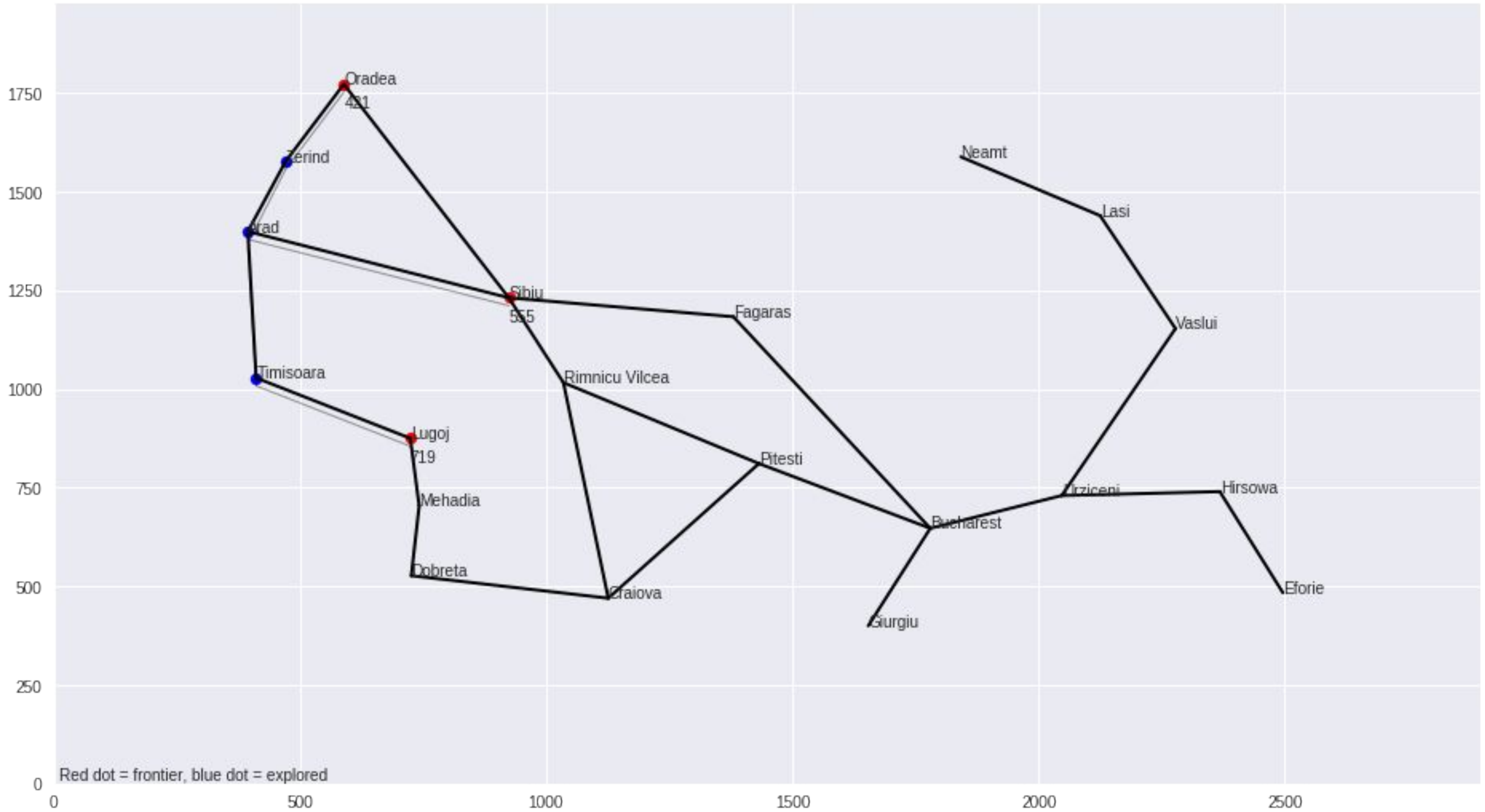
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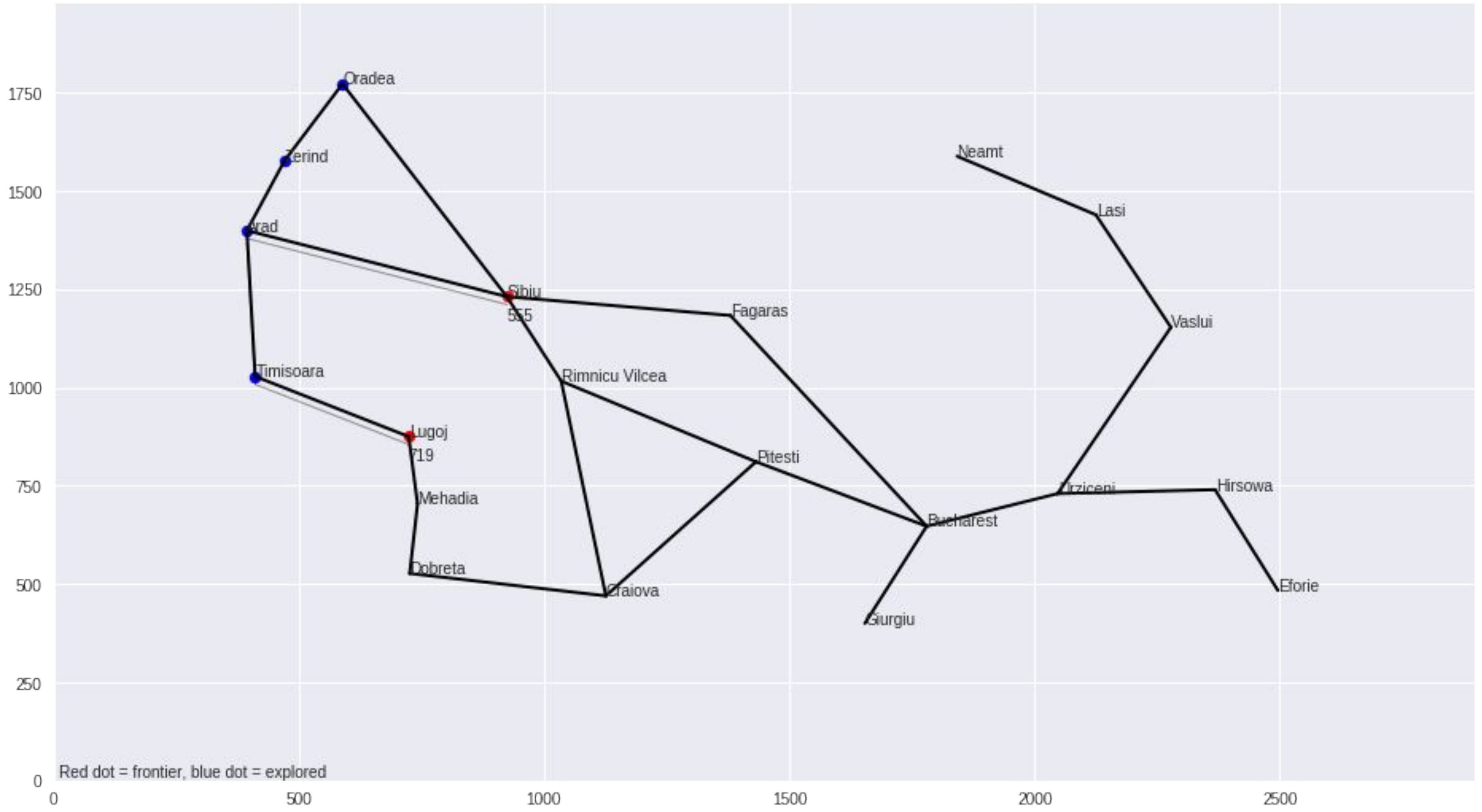
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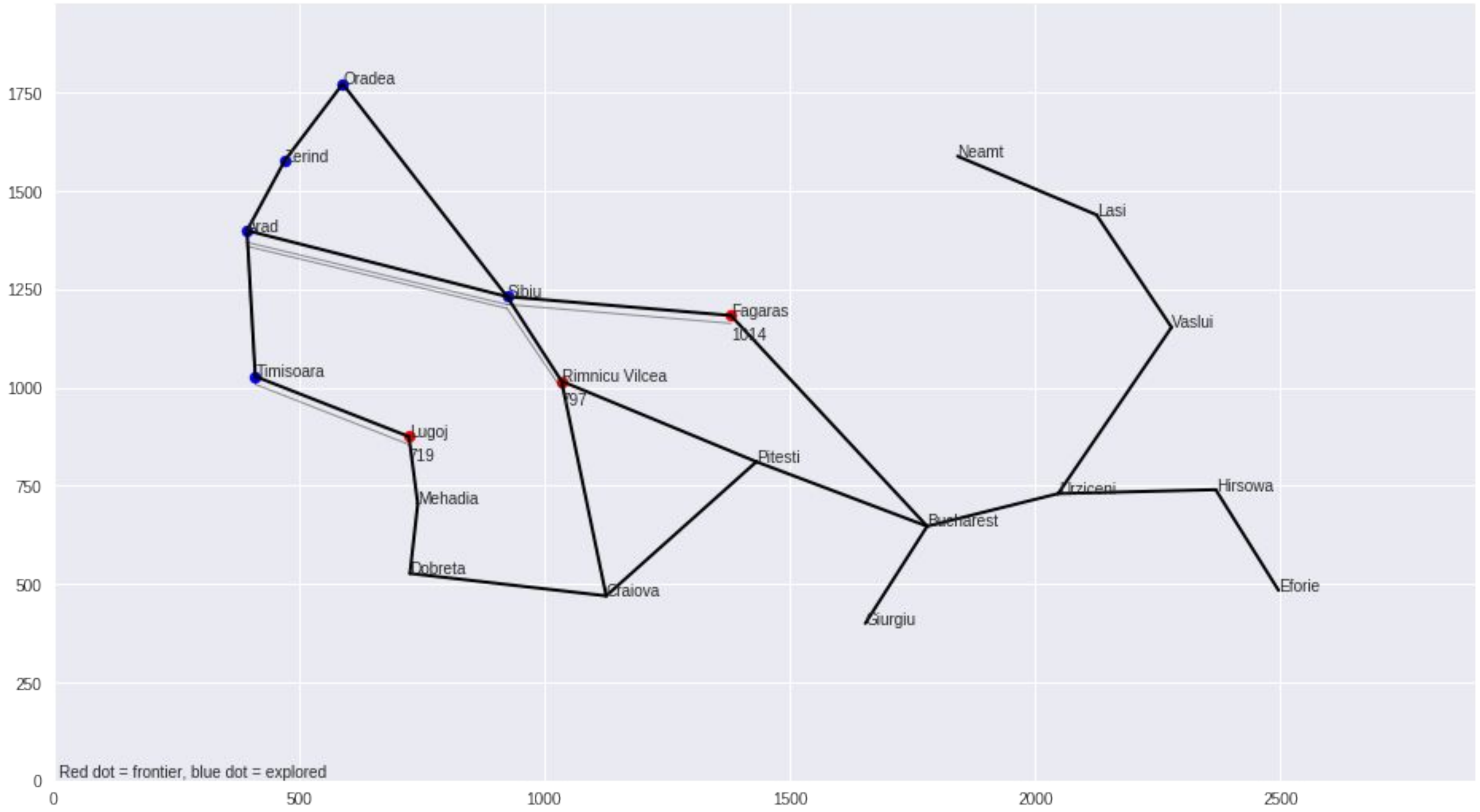
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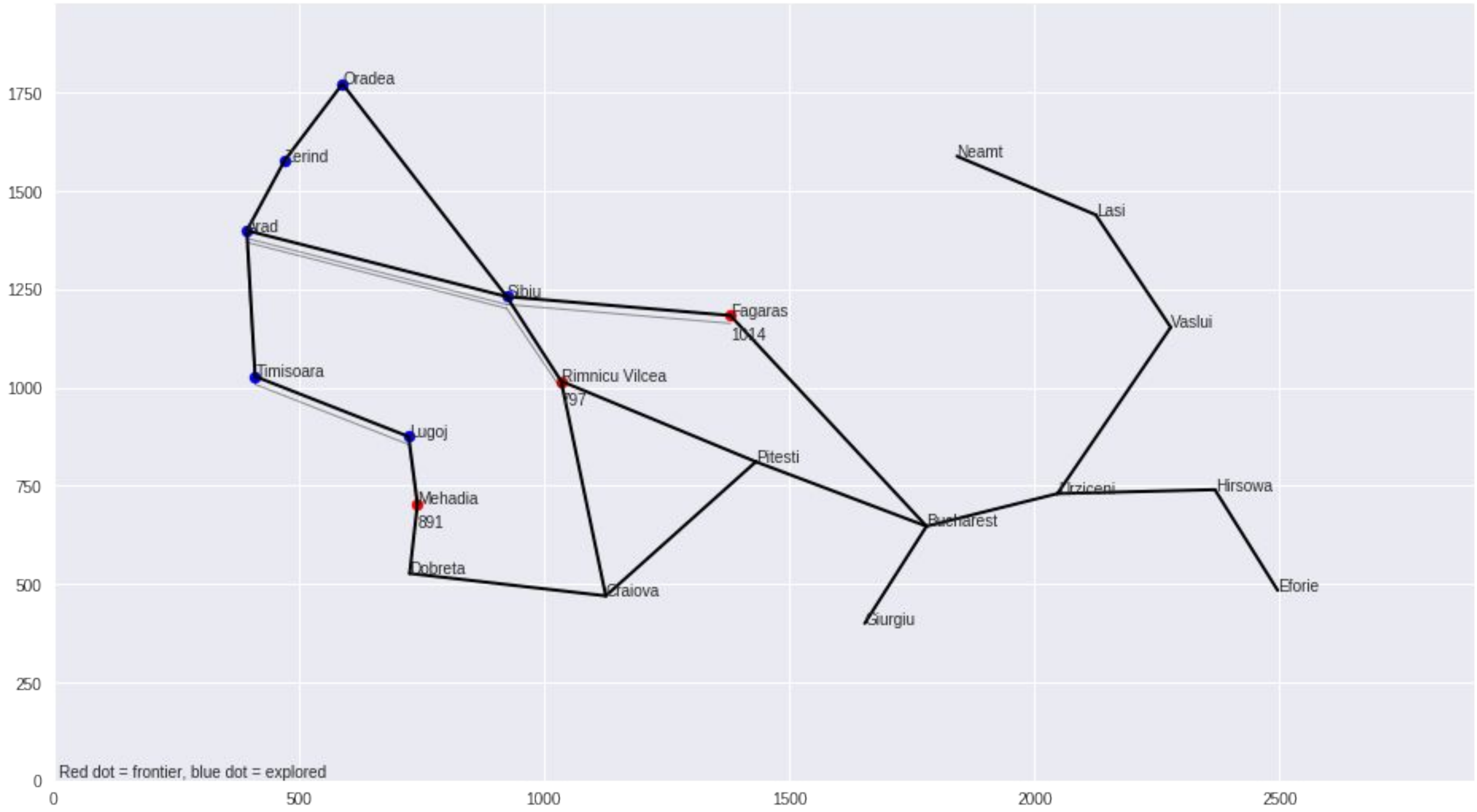
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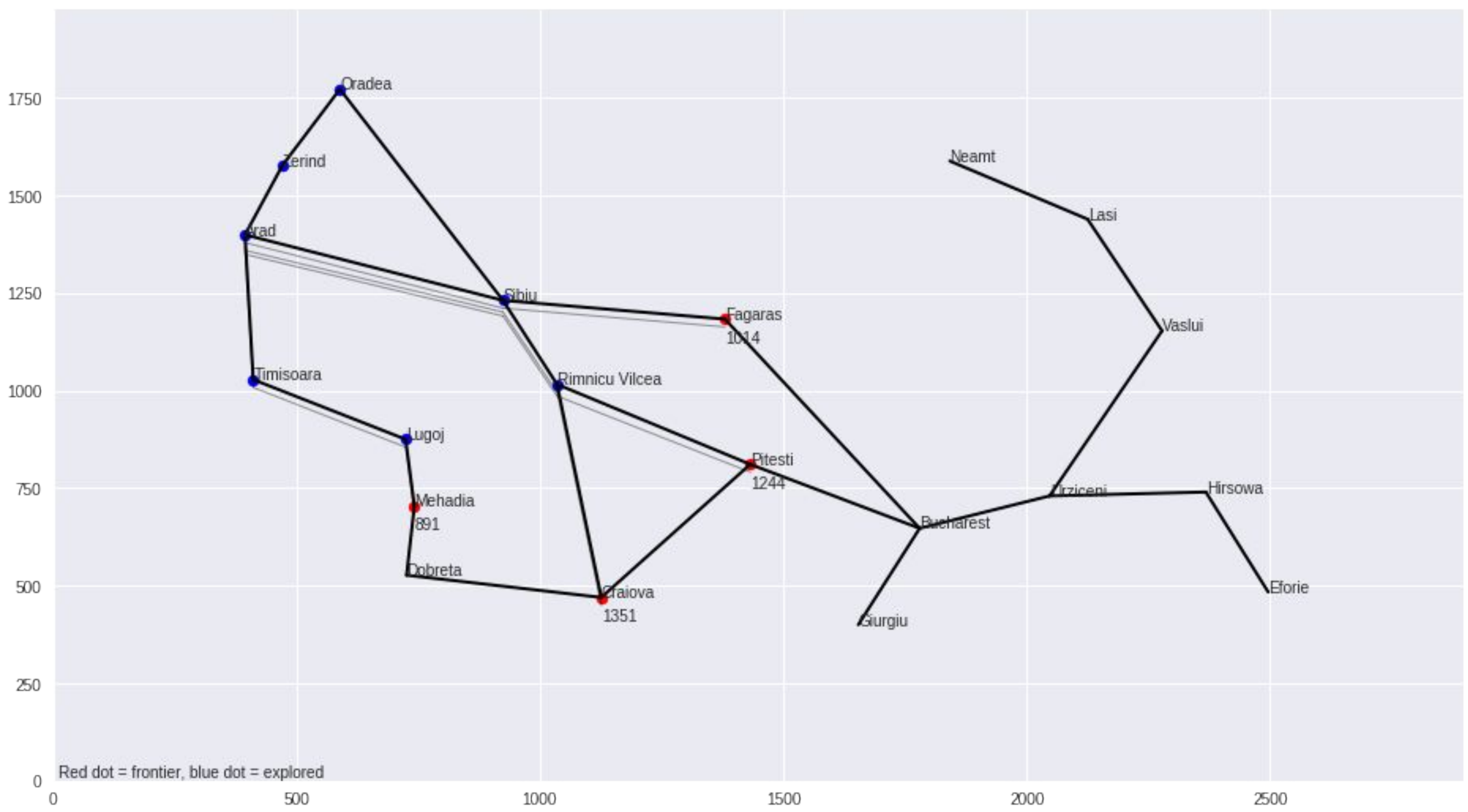
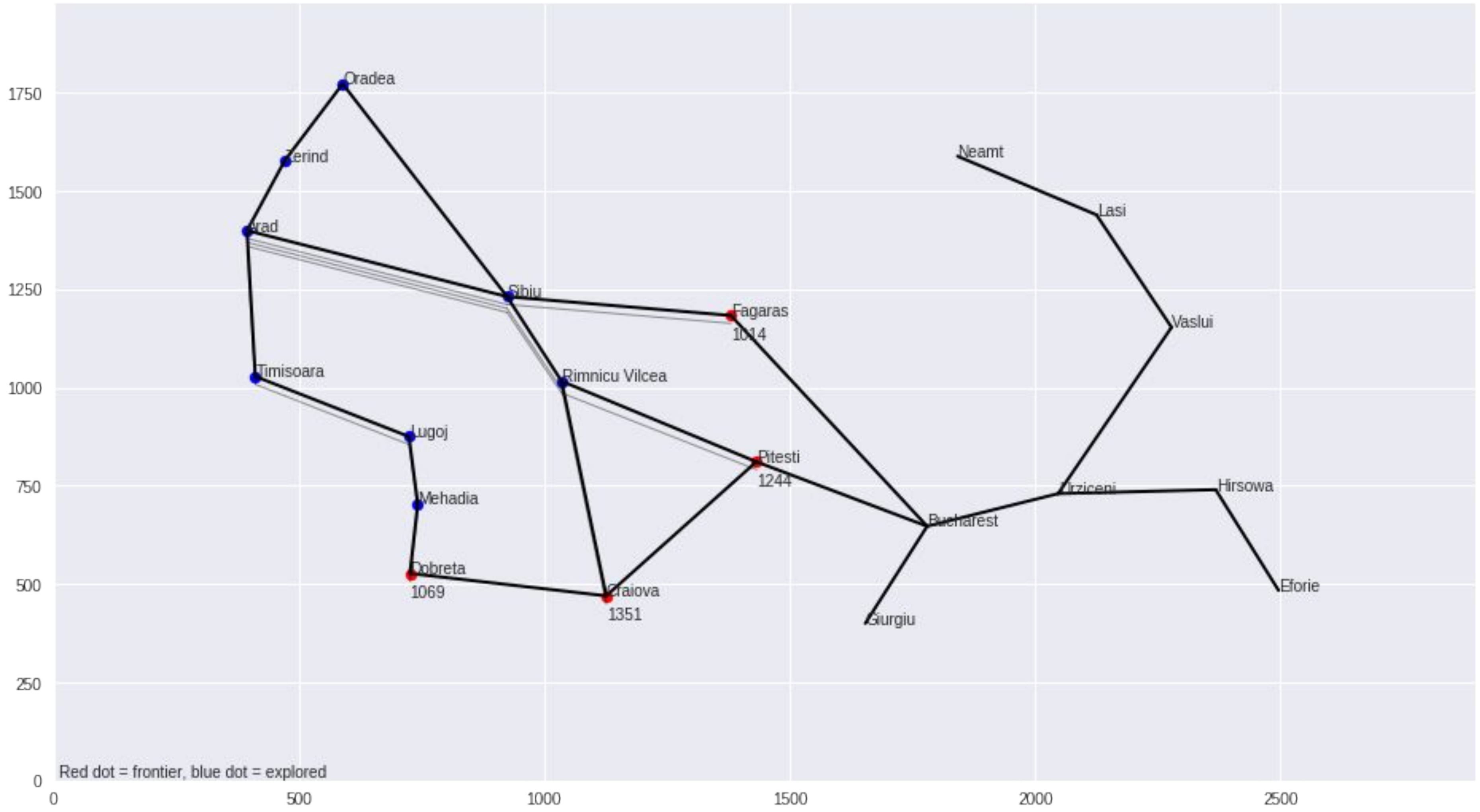
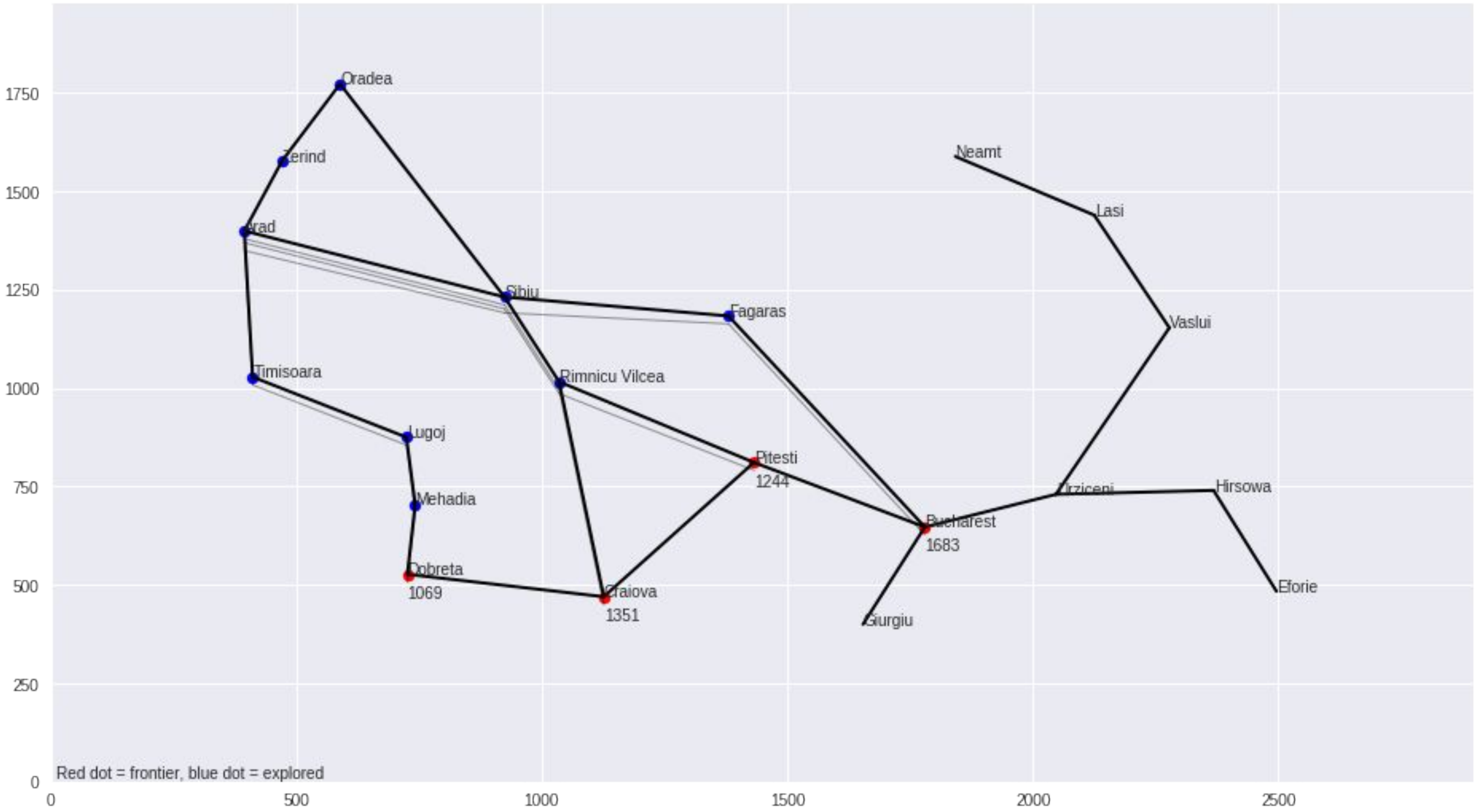


Red dot = frontier, blue dot = explored



Red dot = frontier, blue dot = explored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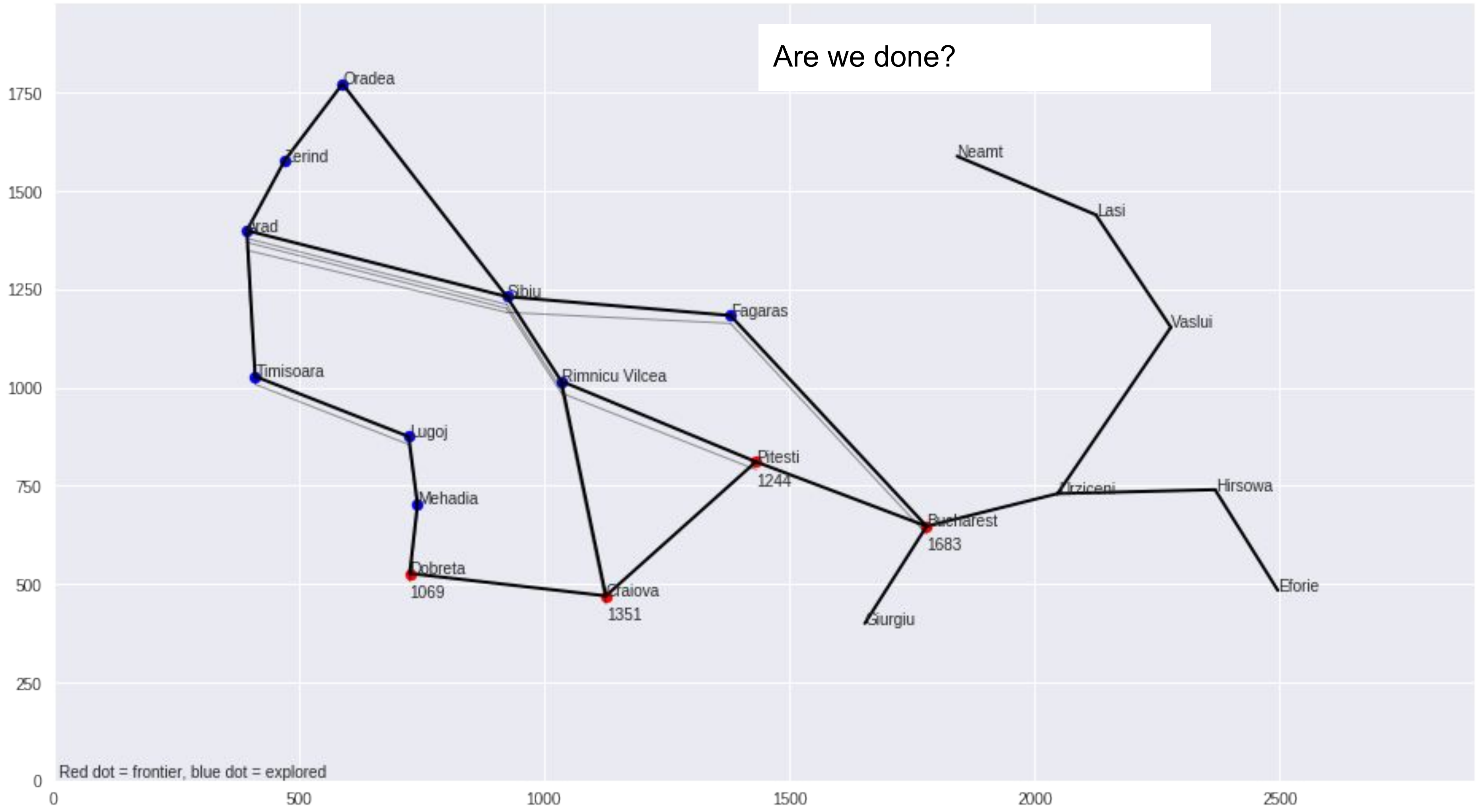
Are we done?



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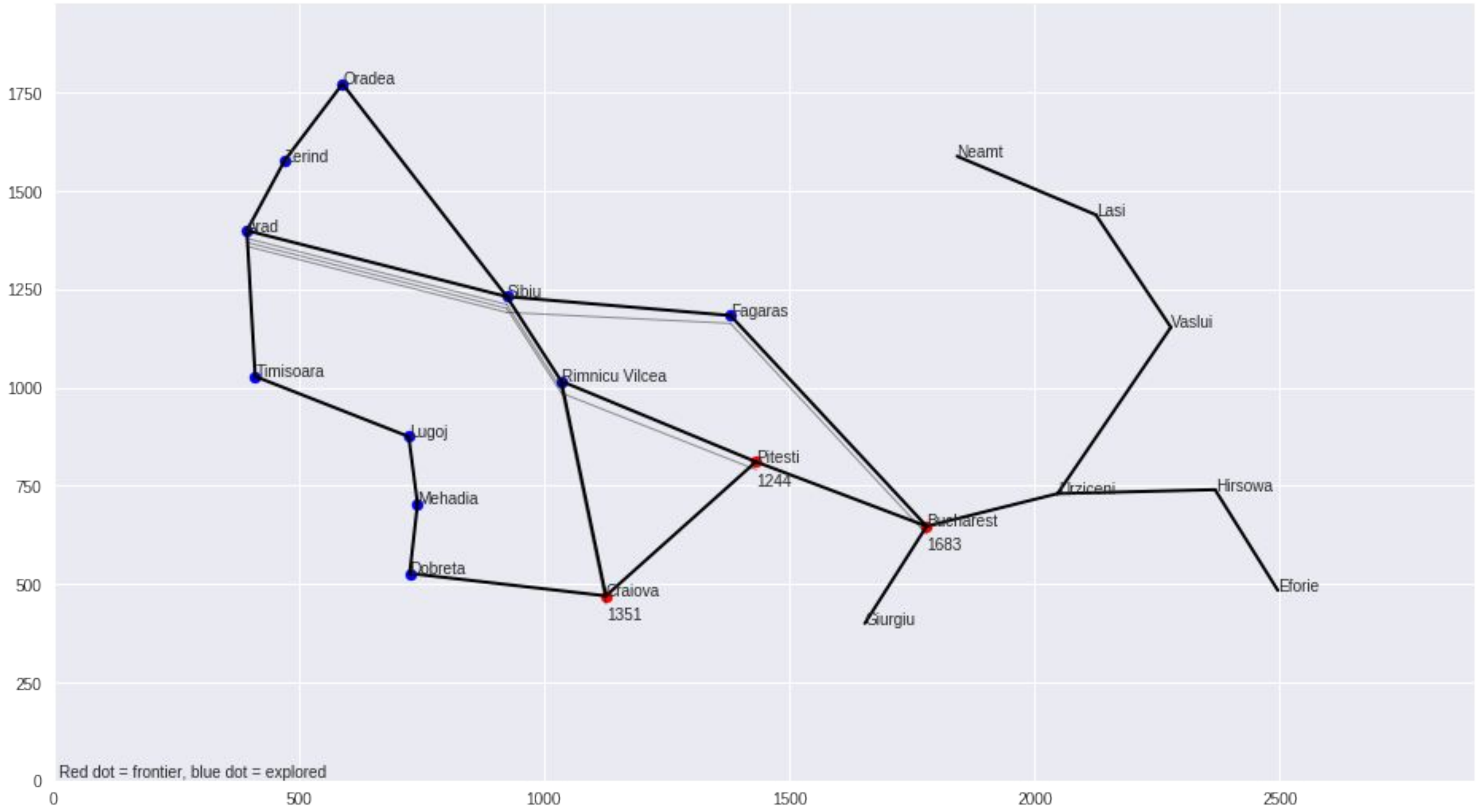
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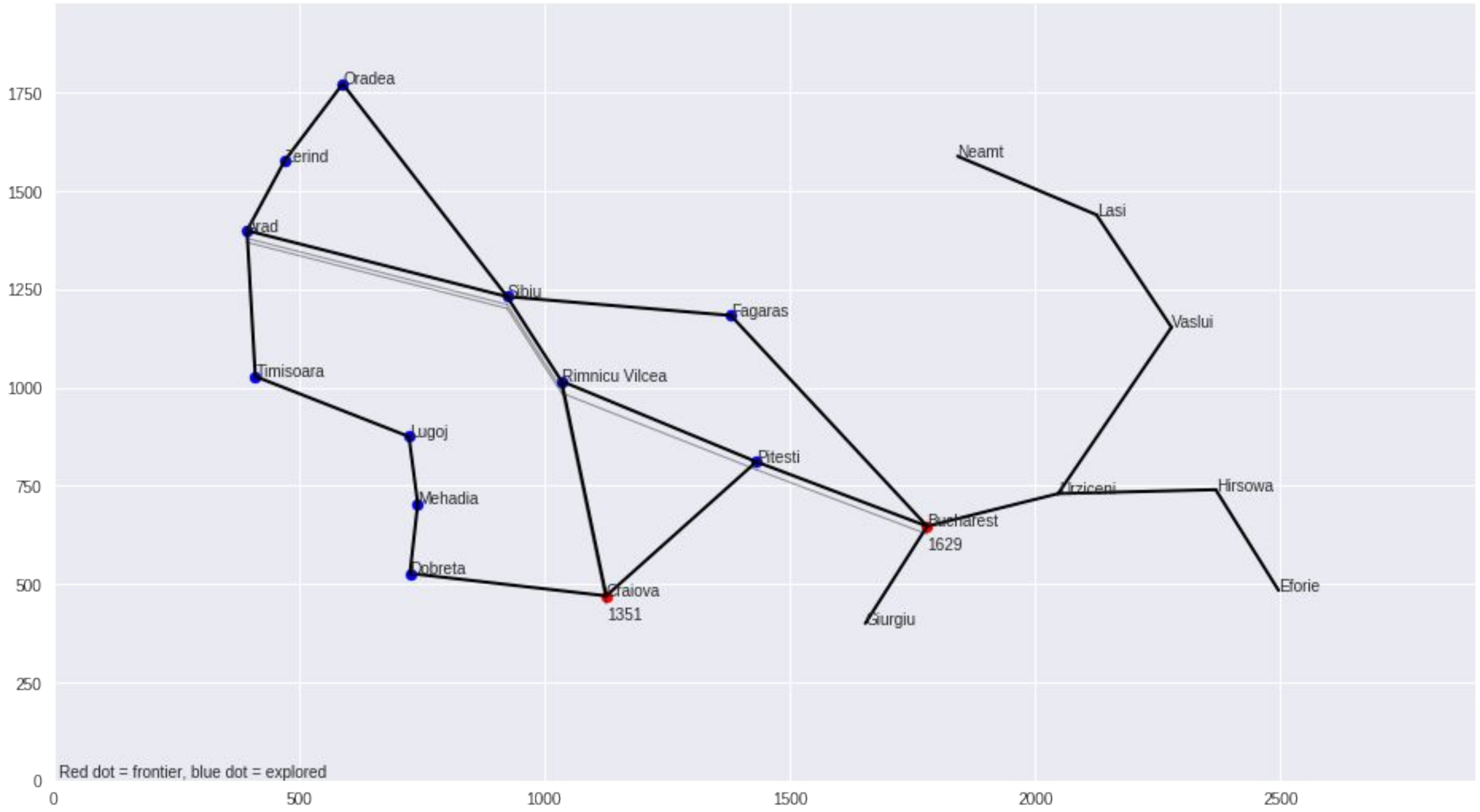
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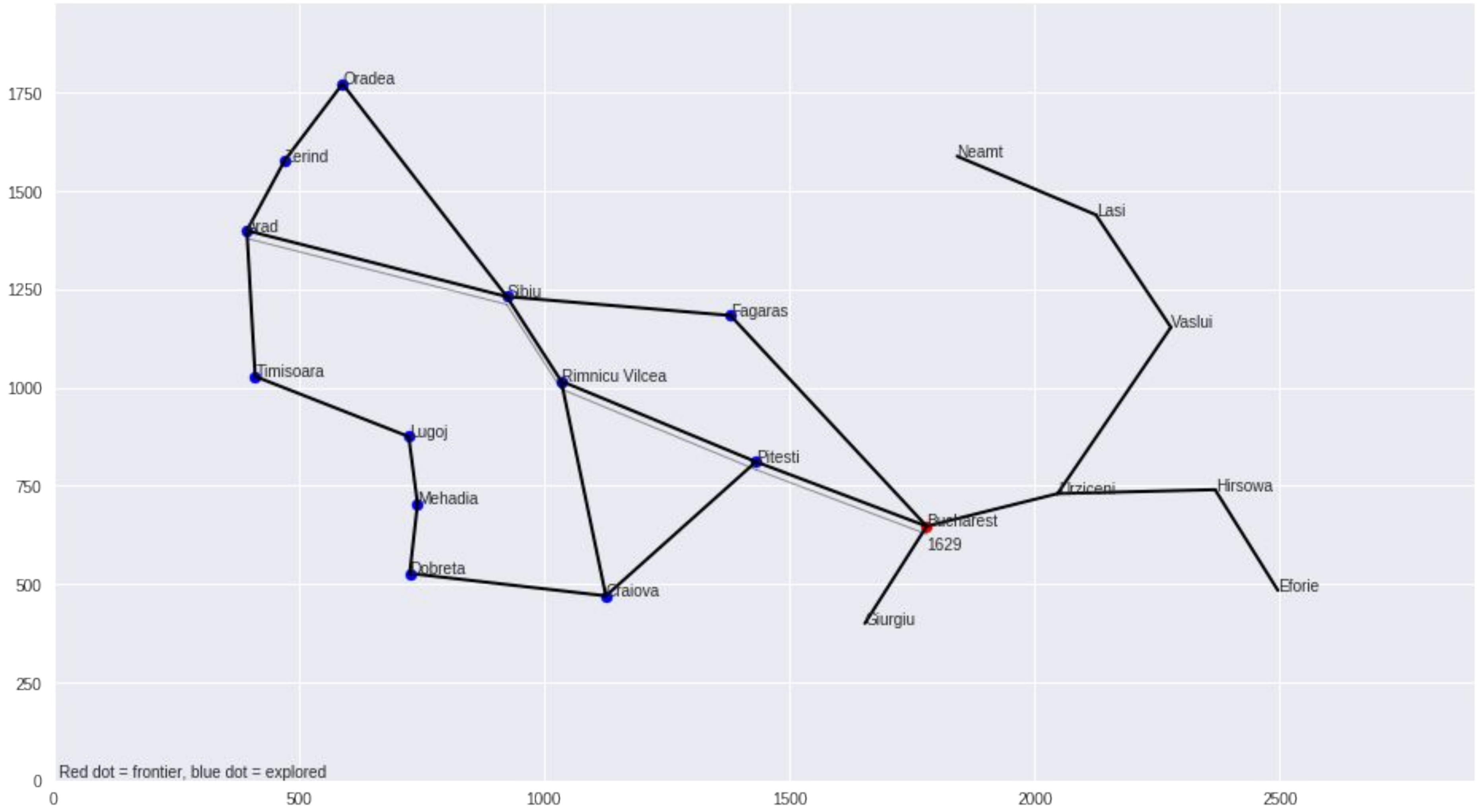
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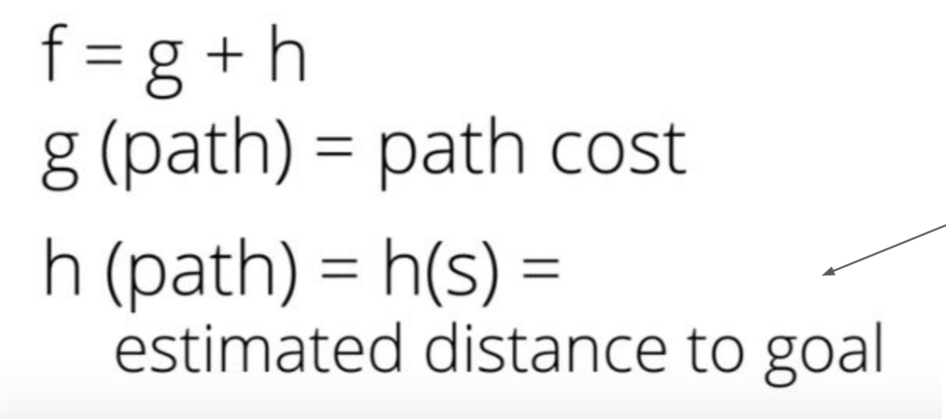
Steps

```
frontiers = [start]
explored  = []
if start == goal: return path
while frontiers not empty
    frontier = frontiers with lowest cost
    if frontier == goal: return path to frontier
    remove frontier from frontiers and add location to explored path
    for node connected to frontier there isn't explored
        new cost = frontier cost + cost for going to node
        add node with new cost and previous nodes to frontier if not in list,
                                                            replace it if it is in list and new path i cheaper
```

A*



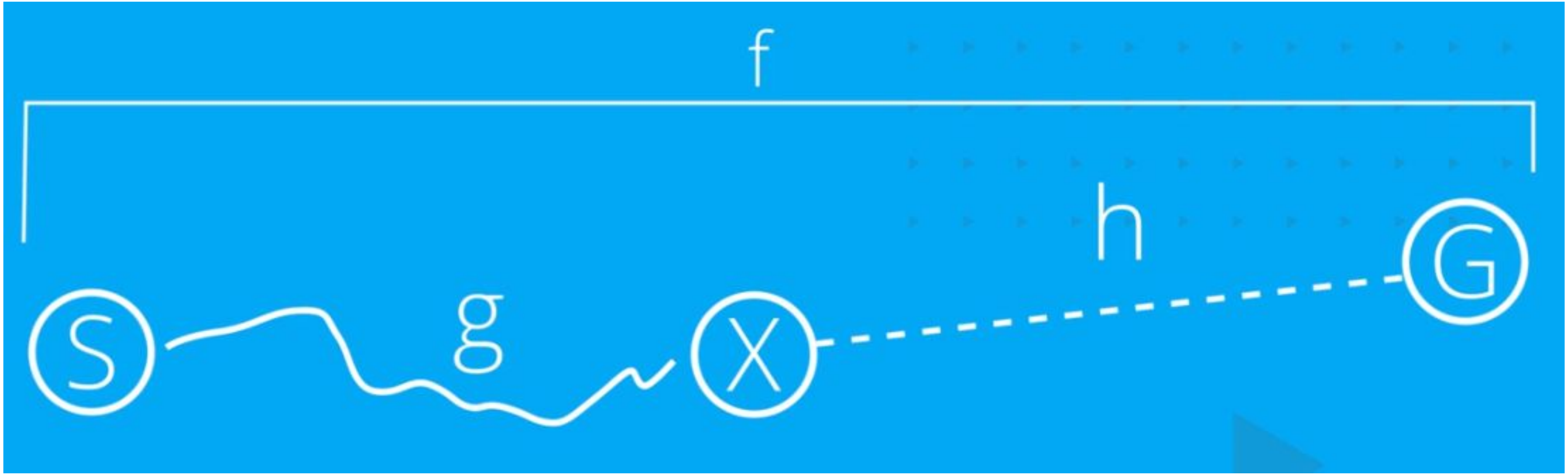
$f = g + h$

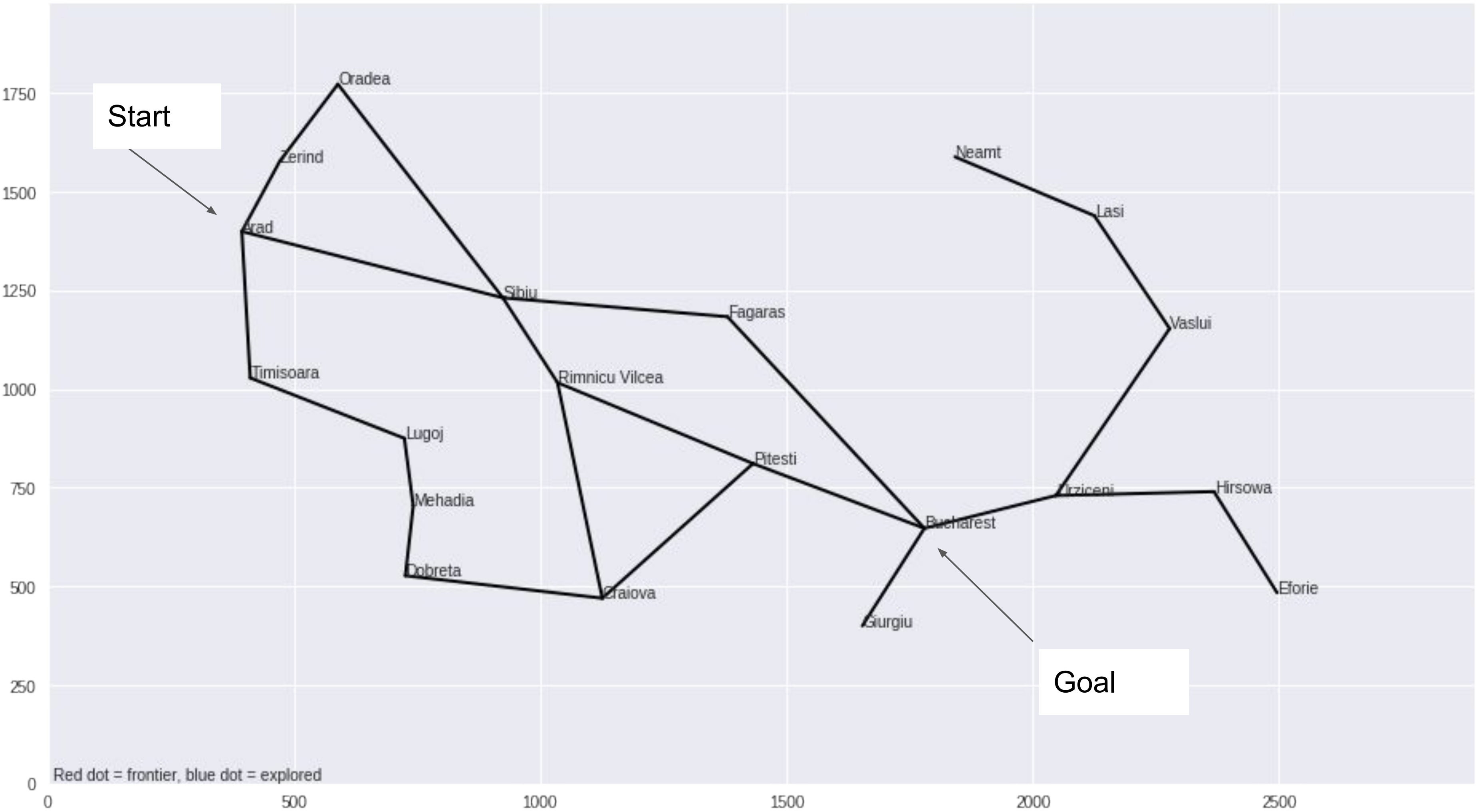
g (path) = path cost

h (path) = $h(s)$ =

estimated distance to goal

h(s) has to be underestimated to ensure the shortest path is found

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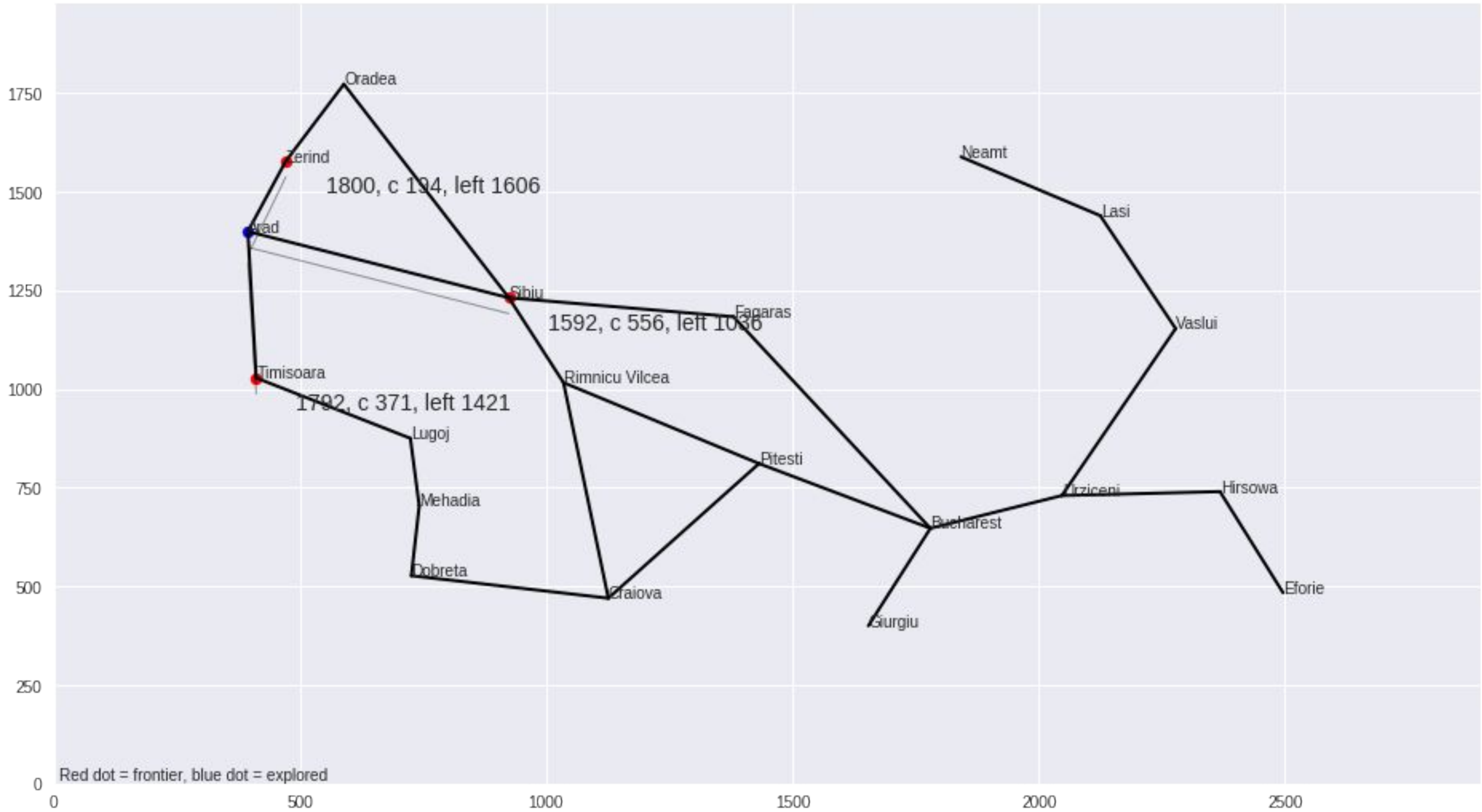
Goal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Rimnicu Vilcea
1792, c 371, left 1421
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Dobreta
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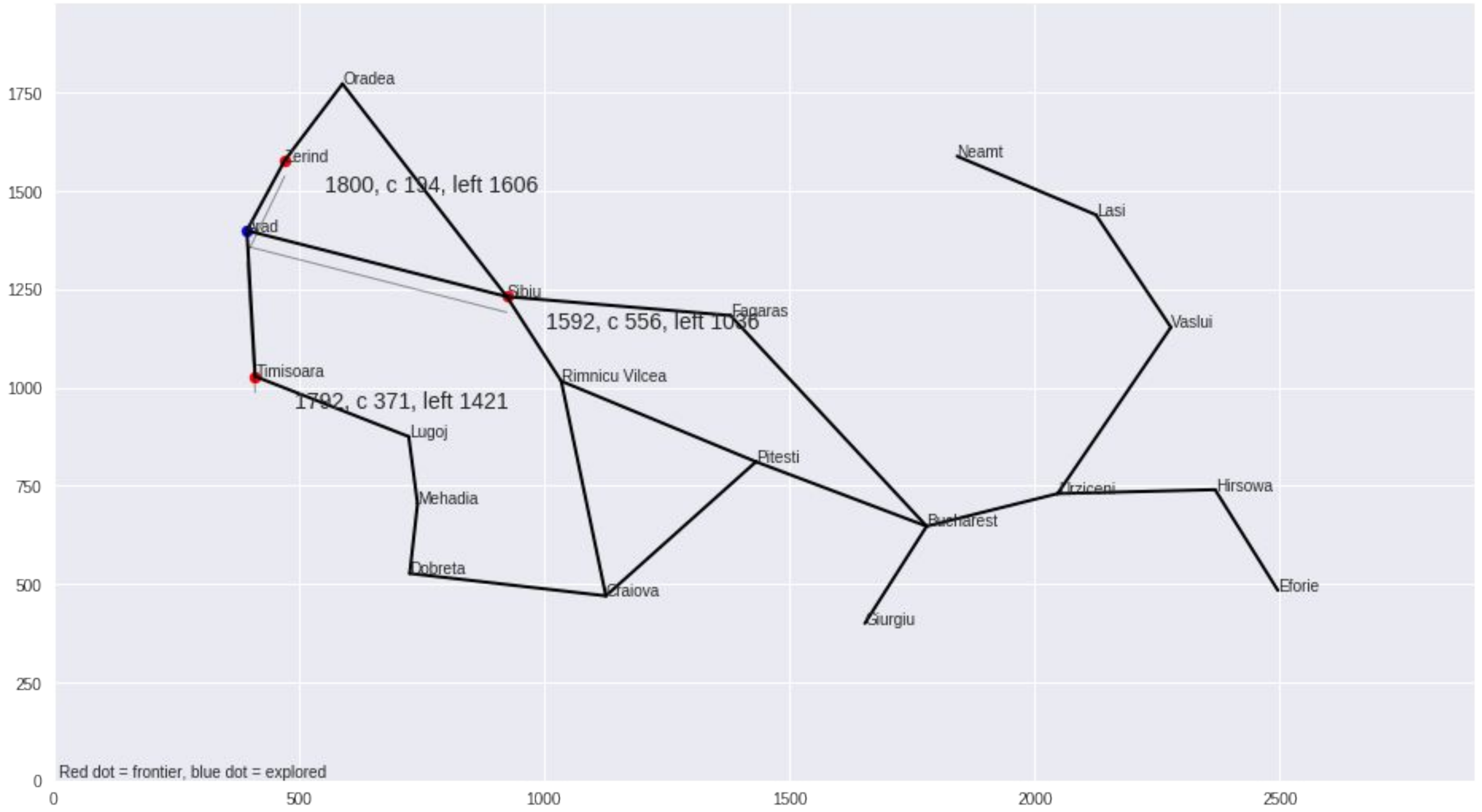
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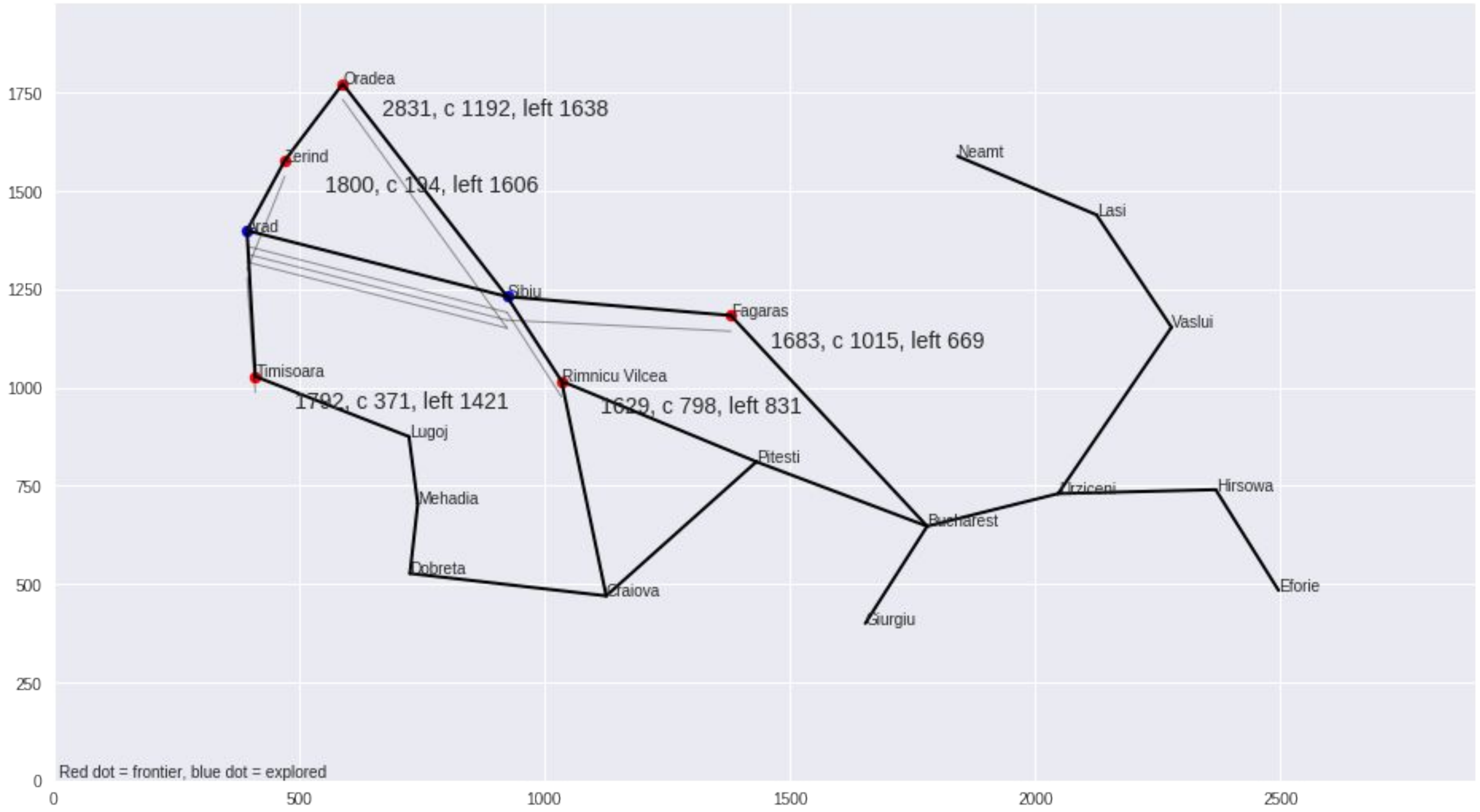
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Arad
Sibiu
Fagaras
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Timisoara
1792, c 371, left 1421
Rimnicu Vilcea
1629, c 798, left 831
Lugoj
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Craiova
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Giurgiu
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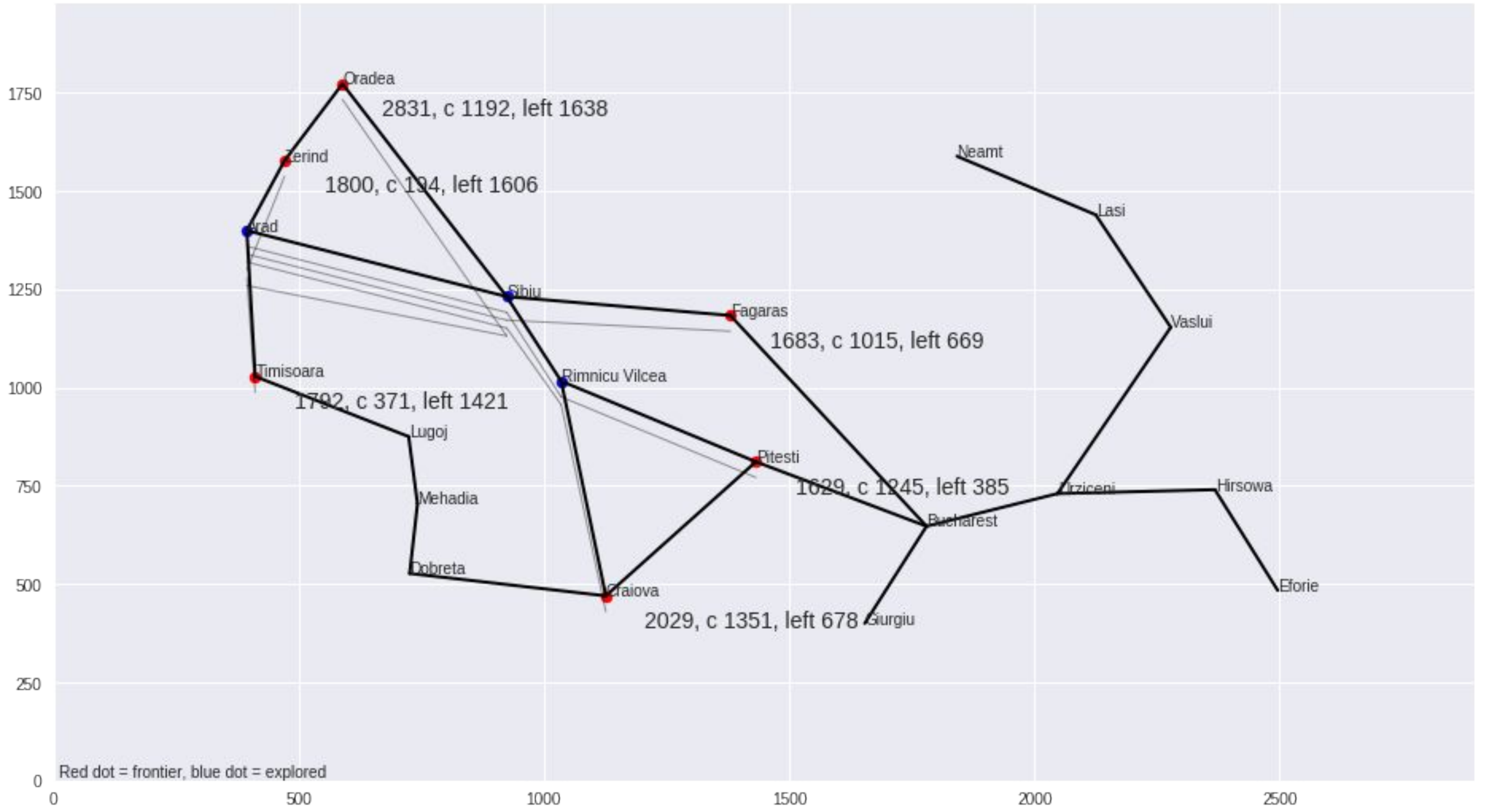
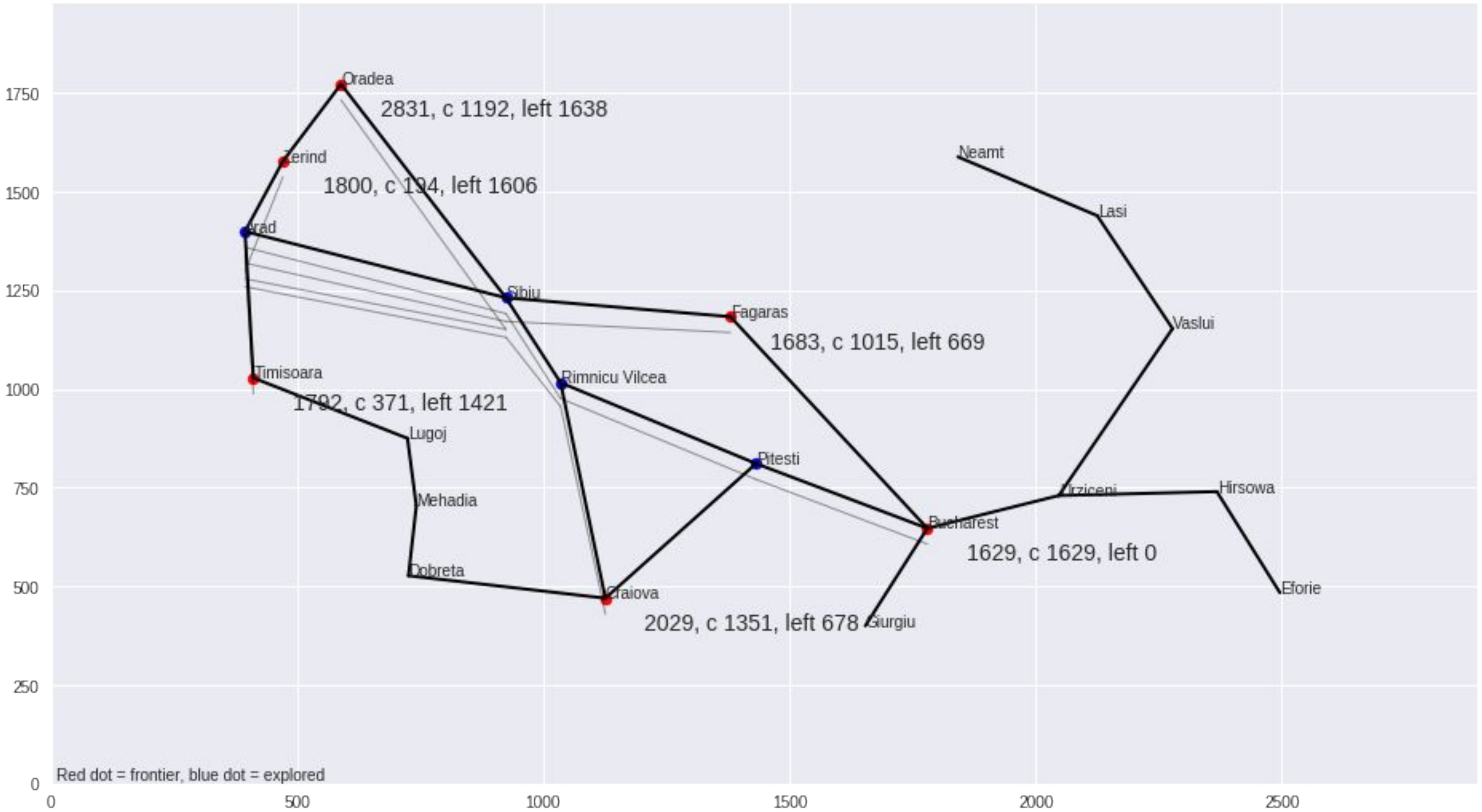


Red dot = frontier, blue dot = explored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Red dot = frontier, blue dot = explored
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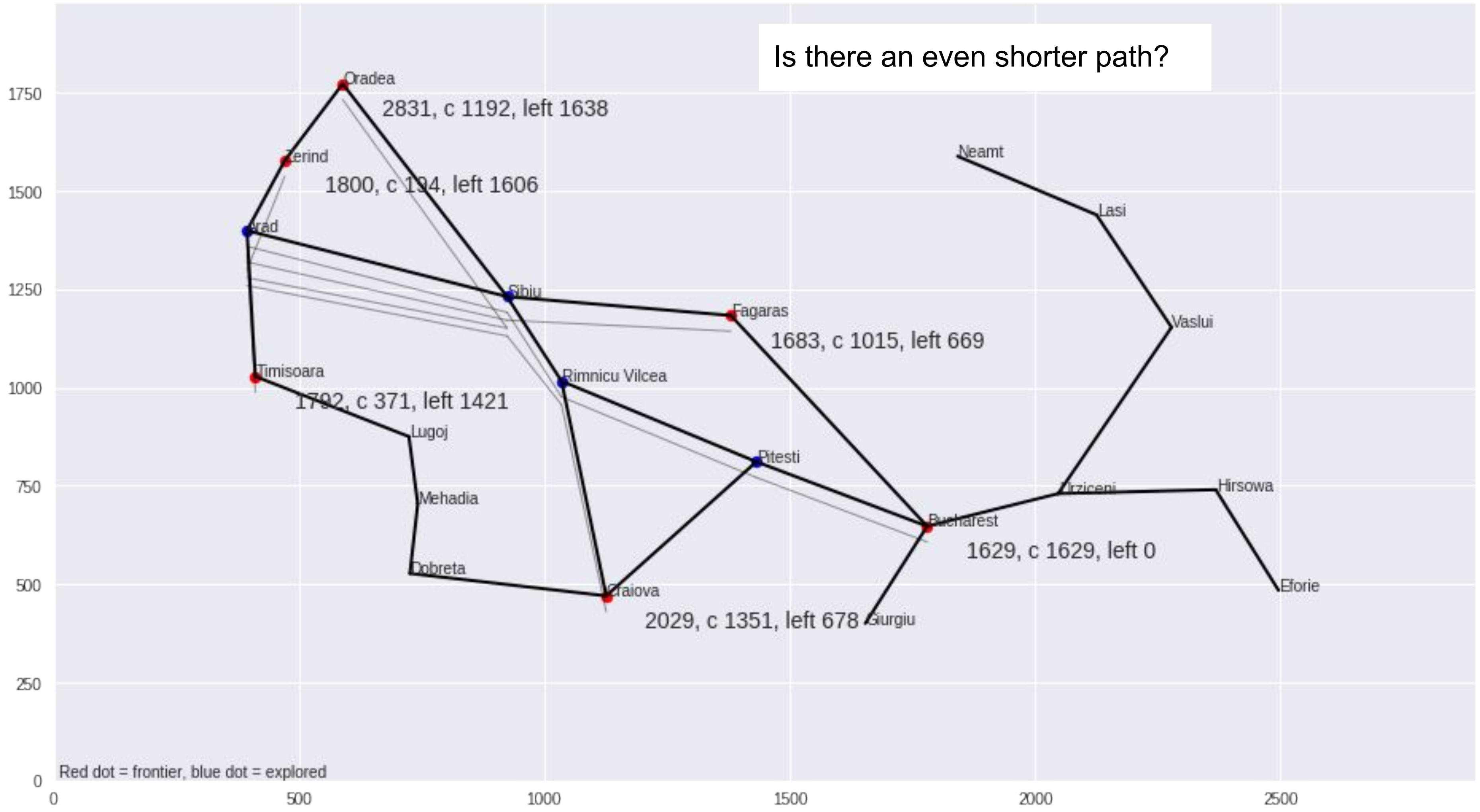
Is there an even shorter path?



Steps

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frontiers = [start]
explored  = []
if start == goal: return path
while frontiers not empty
    frontier = frontiers with lowest F cost
    if frontier == goal: return path to frontier
    remove frontier from frontiers and add location to explored path
    for node connected to frontier there isn't explored
        new G cost = frontier G cost + cost for going to node
        new H cost = h(node)
        new F cost = G + H
        add node with G and F and previous nodes to frontier if not in list,
                                        replace it if it is in list and new paths F cost is cheaper
```

Links

A* with array of ancestors and PQ: https://bit.ly/2YDbL2Q

A* (unoptimized), uniform cost & breadth first: https://github.com/benjaco/search-algorithms