第一次作业（搜索问题）

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本次作业需独立完成，不允许任何形式的抄袭行为，如被发现会有相应惩罚。在上方修改你的姓名学号，说明你同意本规定。

问题 0：引入（30 分）

1. 最短路径问题（12 分）

a. 回答问题（2 分）

TODO

b. 证明（2 分）

TODO

c. 证明（4 分）

TODO

d. 回答问题（2 分）

TODO

e. 证明（2 分）

TODO

2.A* 算法，判断对错并说明原因（10 分）

a TODO

b TODO

c TODO

d TODO

e TODO

3. 网格城市（8 分）

a. 回答问题（8 分）

TODO

问题 1：查找最短路径（12 分）

a. 代码实现 ShortestPathProblem 部分（8 分）

```python
class ShortestPathProblem(SearchProblem):
    """The illustration and __init___ part is ommited here."""

    def startState(self) -> State:
        # BEGIN_YOUR_CODE (our solution is 1 line of code, but don't worry if you
            deviate from this)
        return State(location=self.startLocation, memory=None)
        # END_YOUR_CODE

    def isEnd(self, state: State) -> bool:
        # BEGIN_YOUR_CODE (our solution is 1 line of code, but don't worry if you
            deviate from this)
        return self.endTag in self.cityMap.tags[state.location]
        # END_YOUR_CODE

    def successorsAndCosts(self, state: State) -> List[Tuple[str, State, float]]:
        # BEGIN_YOUR_CODE (our solution is 7 lines of code, but don't worry if you
            deviate from this)
        successors = []
        for neighbor, cost in self.cityMap.distances[state.location].items():
            new_state = State(location=neighbor, memory=None)
            successors.append((neighbor, new_state, cost))
        return successors
        # END_YOUR_CODE
```

b. 路线可视化（4 分）

1. 比较有趣的路线

```
startLocation = "8763079035"
endTag = "label=6107399985"
```

图 1: 比较有趣的路线

这条路线从校园的西北角穿到东南角，经过的地点比较多。

2. 比较短而无聊的路线

```
startLocation = "8763079035"
endTag = "entrance=yes"
```

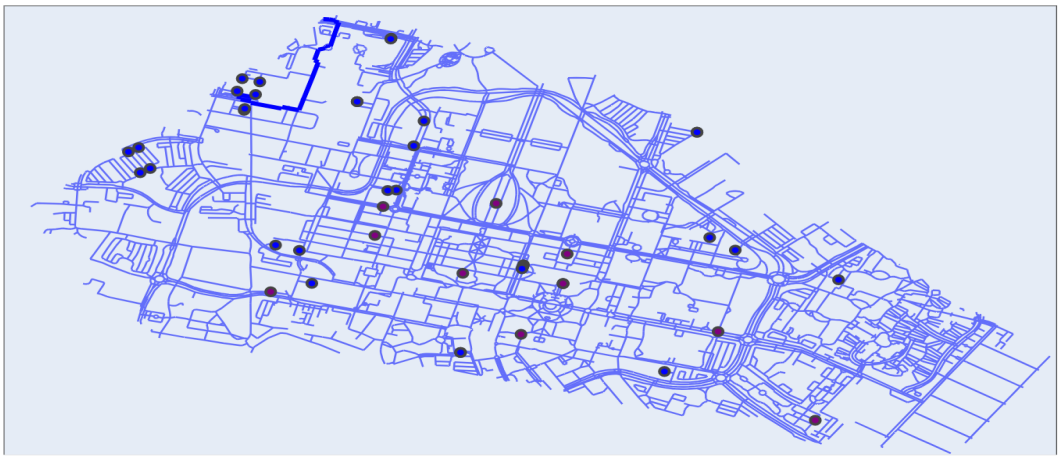

图 2: 比较短而无聊的路线

这条路线从校园西北角通到有入口的地方，比较短，但确实符合要求，如果我希望去更远处的入口，应该换一个更特别的标签来建模。

问题 2：查找带无序途径点的最短路径（20 分）

a. 代码实现 WaypointsShortestPathProblem 部分（12 分）

```
class WaypointsShortestPathProblem(SearchProblem):
```

```
    """The illustration and __init___ part is ommited here."""

    def startState(self) -> State:
        # BEGIN_YOUR_CODE (our solution is 1 line of code, but don't worry if you
            deviate from this)
        return State(location=self.startLocation, memory=frozenset())
        # END_YOUR_CODE

    def isEnd(self, state: State) -> bool:
        # BEGIN_YOUR_CODE (our solution is 5 lines of code, but don't worry if you
            deviate from this)
        return self.endTag in self.cityMap.tags[state.location] and all(tag in state.
            memory for tag in self.waypointTags)
        # END_YOUR_CODE

    def successorsAndCosts(self, state: State) -> List[Tuple[str, State, float]]:
        # BEGIN_YOUR_CODE (our solution is 17 lines of code, but don't worry if you
            deviate from this)
        successors = []
        for nextLocation, distance in self.cityMap.distances[state.location].items():
            memory = set(state.memory)
            for tag in self.cityMap.tags[state.location]:
                if tag in self.waypointTags:
                    memory.add(tag)

            new_state = State(location=nextLocation, memory=frozenset(memory))
            successors.append((nextLocation,new_state,distance))
        return successors
        # END_YOUR_CODE
```

b. 回答问题（4 分）

$n2^k$,k 个标签的集合有

c. 可视化（4 分）

```
startLocation = "8763079035"
endTag = "label=6107399985"
```

图 3: 1b 中第一条路线

```
waypointTags = ["crossing=uncontrolled", "bicycle=yes", "foot=yes", "kerb=lowered", "
    traffic_sign=stop"]
```

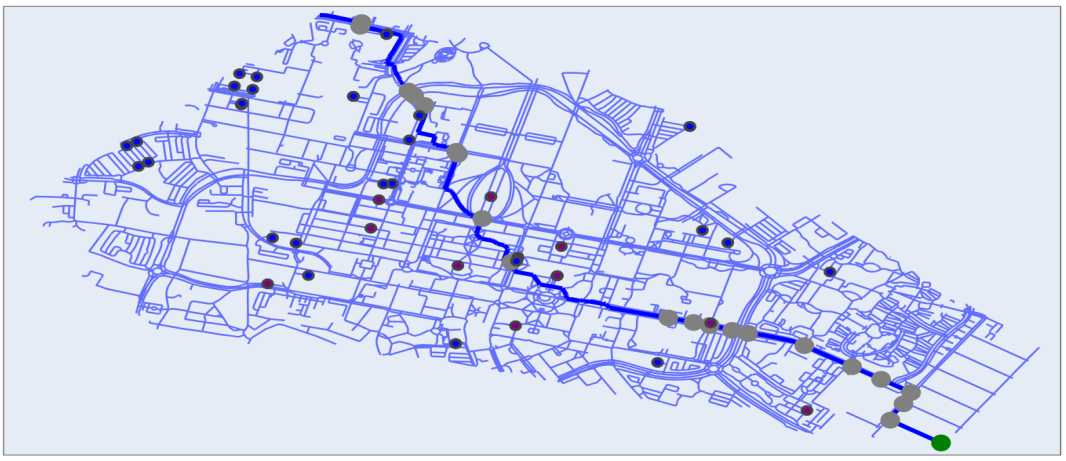

图 4: 1b 中第一条路线加了途径点后的结果

这张图的路径经过了指定的途径点，使得路径比 1b 的更长，但能去到更多地方。

问题 3：使用 A* 算法加快搜索速度（28 分）

a. 代码实现 aStarReduction 的 NewSearchProblem 部分（8 分）

```
def aStarReduction(problem: SearchProblem, heuristic: Heuristic) -> SearchProblem:
    class NewSearchProblem(SearchProblem):
        def startState(self) -> State:
            # BEGIN_YOUR_CODE (our solution is 1 line of code, but don't worry if you
                deviate from this)
            return problem.startState()
            # END_YOUR_CODE
```

```
        def isEnd(self, state: State) -> bool:
            # BEGIN_YOUR_CODE (our solution is 1 line of code, but don't worry if you
                deviate from this)
            return problem.isEnd(state)
            # END_YOUR_CODE

        def successorsAndCosts(self, state: State) -> List[Tuple[str, State, float]]:
            # BEGIN_YOUR_CODE (our solution is 8 lines of code, but don't worry if you
                deviate from this)
            successors = []
            for action, nextState, cost in problem.successorsAndCosts(state):
                newCost = cost + heuristic.evaluate(nextState) - heuristic.evaluate(
                    state)
                successors.append((action, nextState, newCost))
            return successors
            # END_YOUR_CODE

    return NewSearchProblem()
```

b. 代码实现 StraightLineHeuristic 部分（8 分）

```
class StraightLineHeuristic(Heuristic):

    def __init__(self, endTag: str, cityMap: CityMap):
        self.endTag = endTag
        self.cityMap = cityMap
        # Precompute
        # BEGIN_YOUR_CODE (our solution is 5 lines of code, but don't worry if you
            deviate from this)
        self.end_locations = []
        for location, tags in self.cityMap.tags.items():
            if self.endTag in tags:
                self.end_locations.append(location)
        # END_YOUR_CODE

    def evaluate(self, state: State) -> float:
        # BEGIN_YOUR_CODE (our solution is 6 lines of code, but don't worry if you
            deviate from this)
        distances = []
        for end_location in self.end_locations:
            distance = computeDistance(self.cityMap.geoLocations[state.location], self.
                cityMap.geoLocations[end_location])
            distances.append(distance)
        return min(distances) if distances else 0
        # END_YOUR_CODE
```

c. 代码实现 NoWaypointsHeuristic 部分（12 分）

```
class NoWaypointsHeuristic(Heuristic):

    def __init__(self, endTag: str, cityMap: CityMap):
        # Precompute
        # BEGIN_YOUR_CODE (our solution is 25 lines of code, but don't worry if you
            deviate from this)
        self.endTag = endTag
        self.cityMap = cityMap
        self.locations = list(self.cityMap.geoLocations.keys())
        self.end_locations = [location for location, tags in self.cityMap.tags.items()
            if self.endTag in tags]
        self.shortest_paths = {}
        for location1 in self.end_locations:
            problem = ShortestPathProblem(location1, "label=0", cityMap)
            ucs = UniformCostSearch()
            ucs.solve(problem)
            for location2, cost in ucs.pastCosts.items():
                self.shortest_paths[(location2, location1)] = cost
        # END_YOUR_CODE

    def evaluate(self, state: State) -> float:
        # BEGIN_YOUR_CODE (our solution is 1 line of code, but don't worry if you
            deviate from this)
        distances = [self.shortest_paths[(state.location, end_location)] for
            end_location in self.end_locations]
        return min(distances) if distances else 0
        # END_YOUR_CODE
```

反馈（10 分）

- 这次作业花了几天的空闲时间，主要用于看代码和思考 3c。看代码的过程感觉比较困难，可能是因为内容比较多，但看明白后做得就很快了。3c 的想法过于巧妙，很难想到;
- 感觉上课时讲得比较快，不太好消化，课后还要自己学很久，而且自己对相关代码也不够熟练。