Machine Learning: Assignment 3

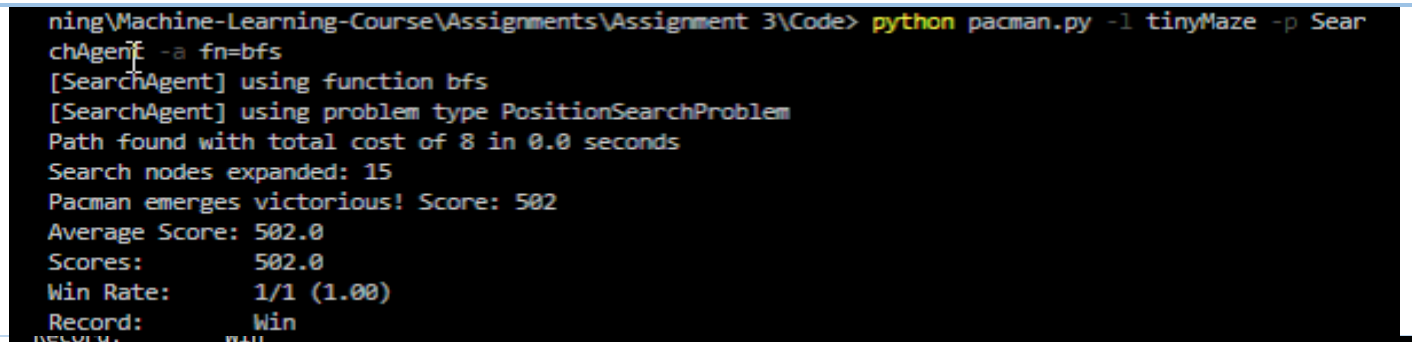
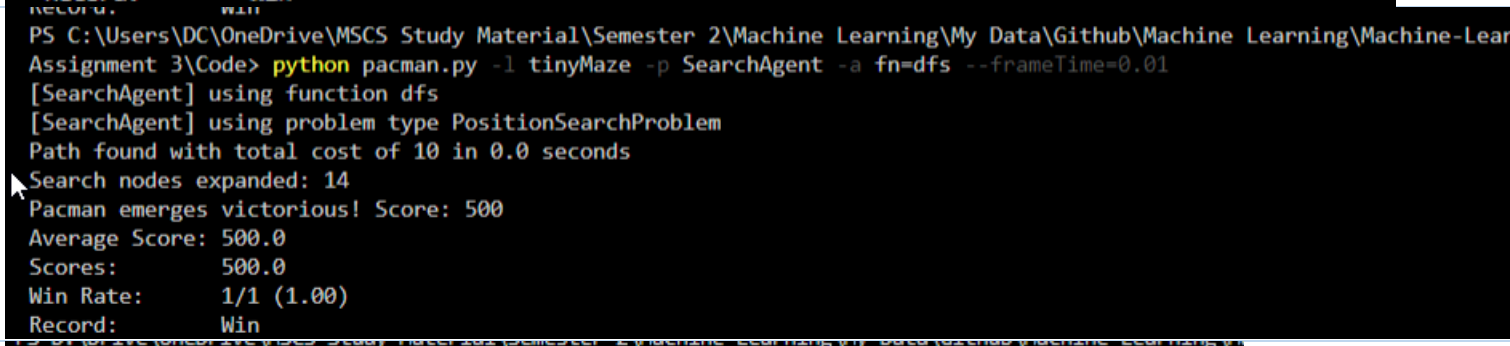
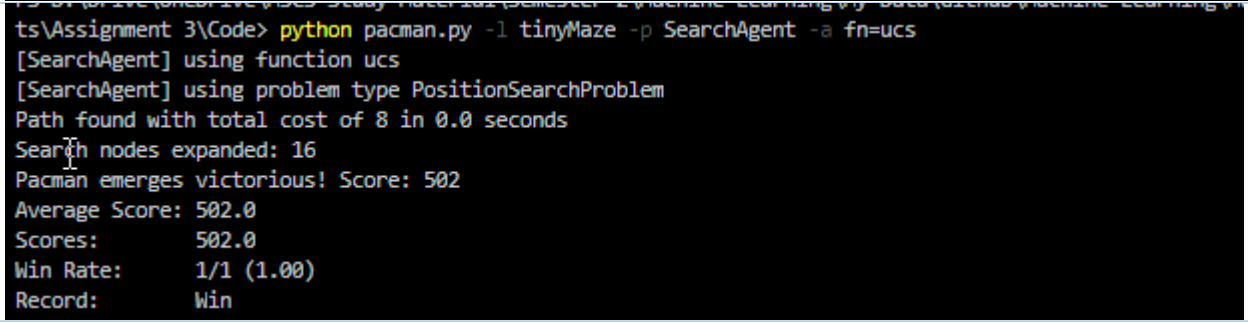
Submitted to:

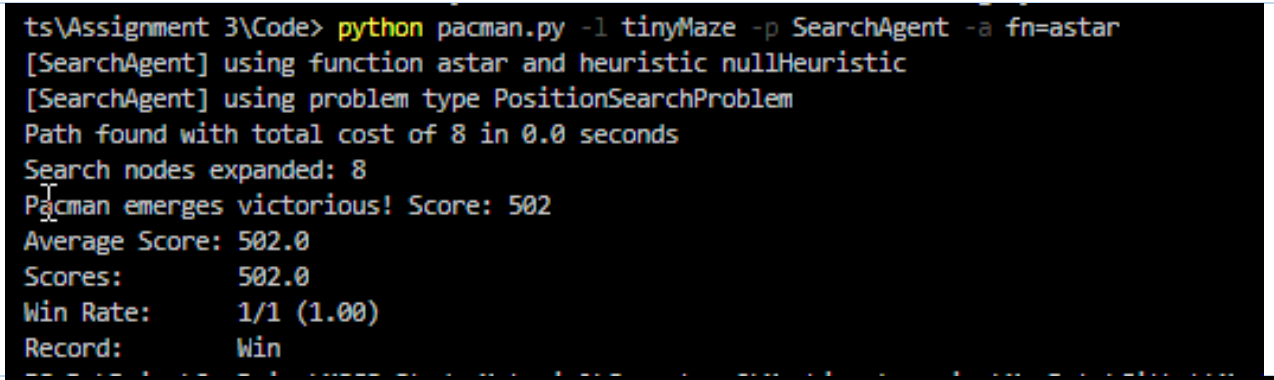
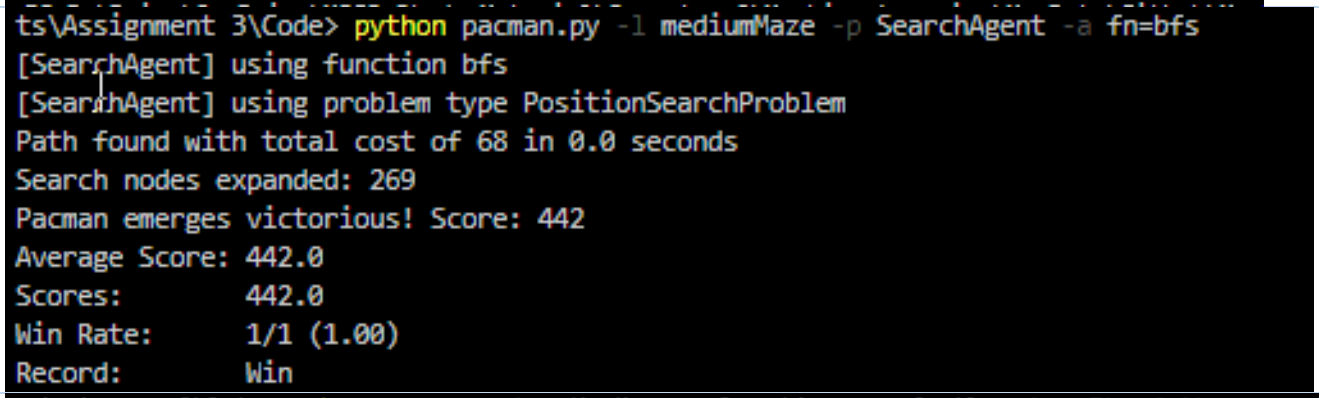
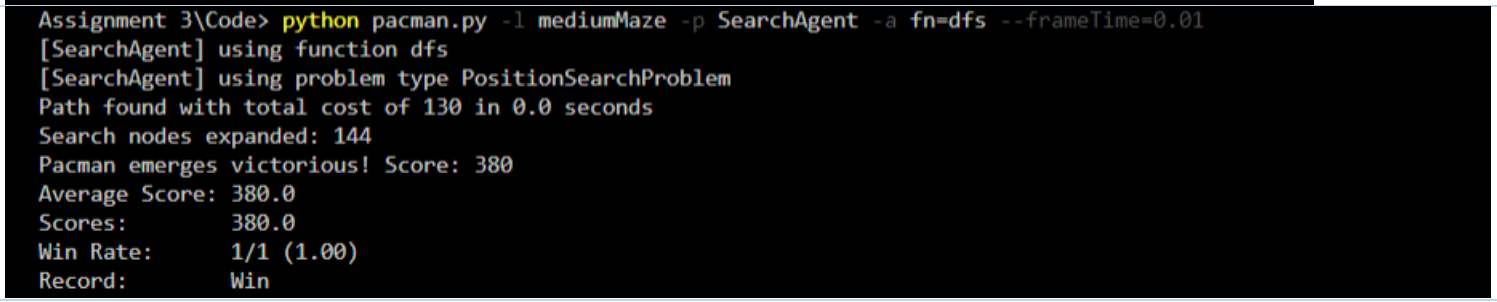
Dr. Awais Hassan

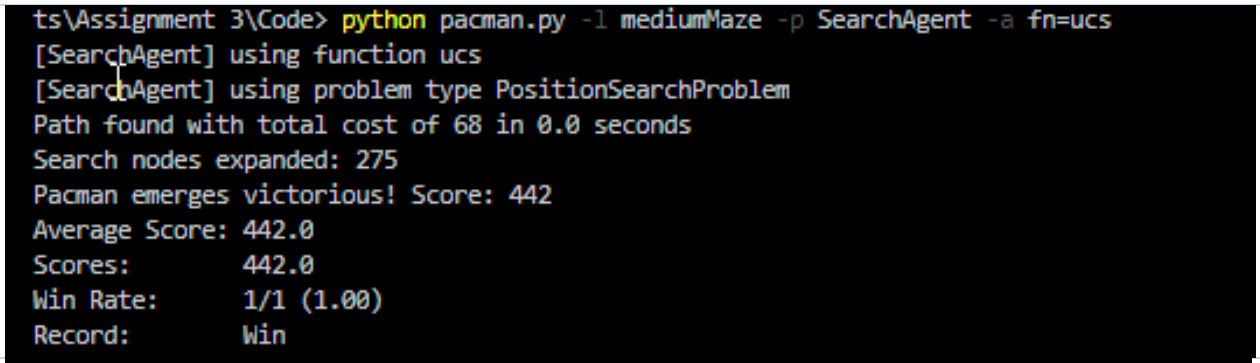
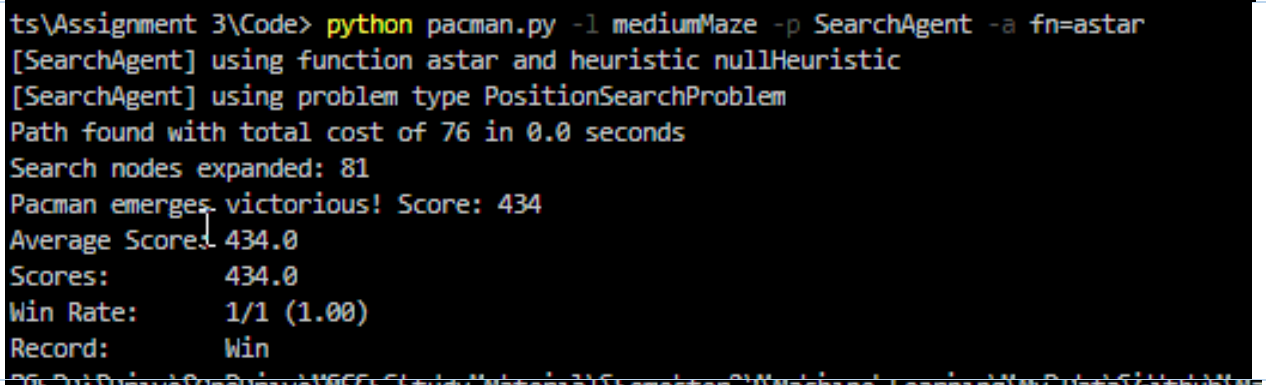
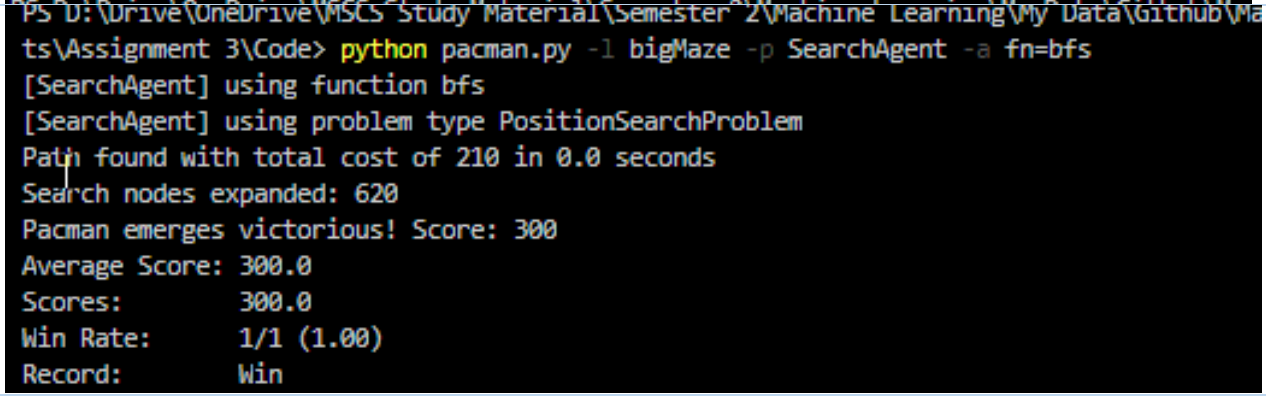
Submitted by:

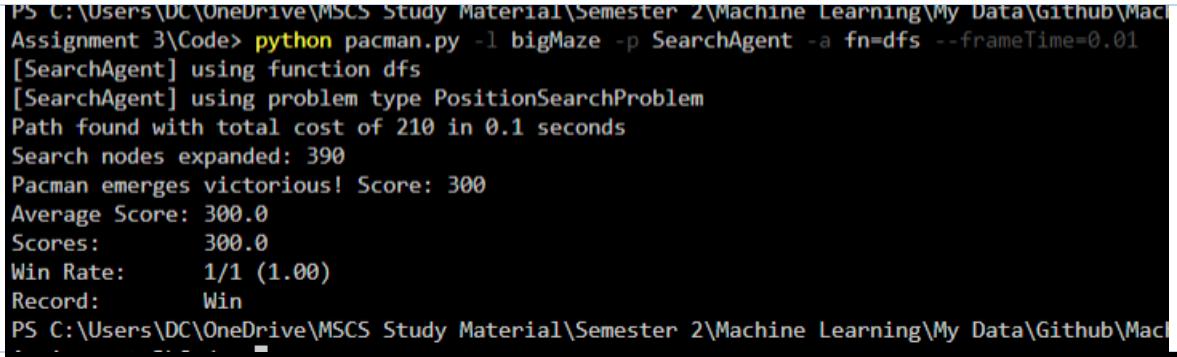
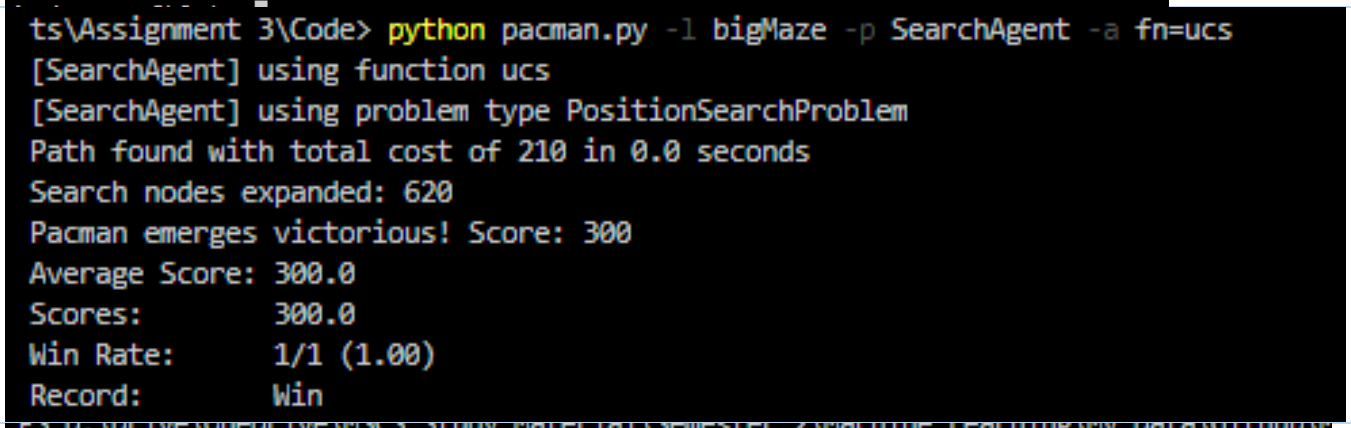
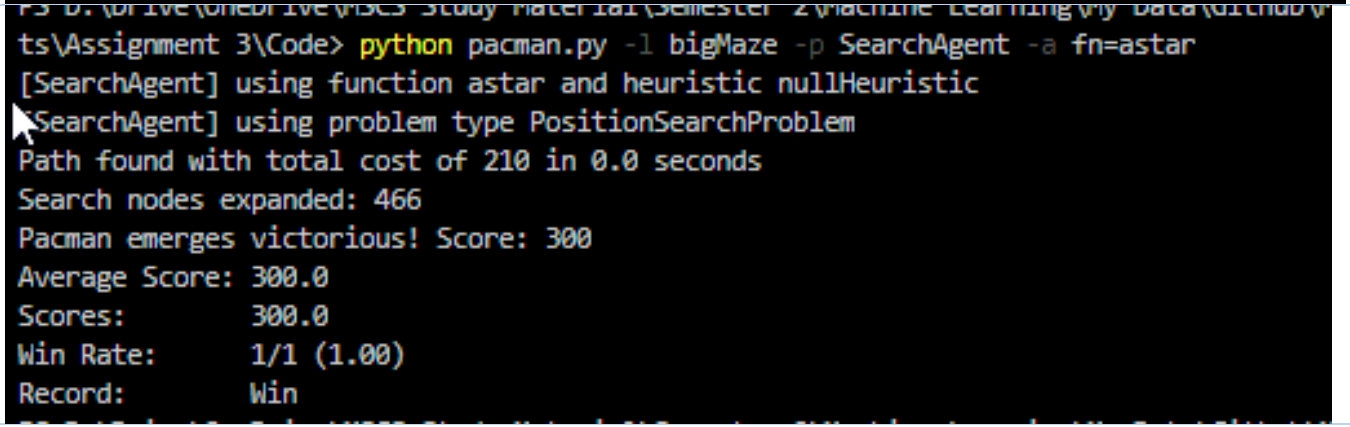
Komal Shehzadi (2020-MSCS-590)

Assignment 3 Data Analysis

Maze Name	Search Function	Nodes Expanded	Cost	
Tiny Maze	BFS	15	8	
Tiny Maze	DFS	14	10	
Tiny Maze	UCS	16	8	

Tiny Maze	AStarSearch	8	8	
Medium Maze	BFS	269	68	
Medium Maze	DFS	144	130	

Medium Maze	UCS	275	68	
Medium Maze	AStarSearch	81	76	
Big Maze	BFS	620	210	

Big Maze	DFS	390	210	
Big Maze	UCS	620	210	
Big Maze	AStarSearch	466	210	

Challenge 1:

DFS graph algorithm:

```
def isExistInQ(self, item):
    for p in self.list:
        if(item == p):
            return True
    return False

def depthFirstSearch(problem):
    """
    Search the deepest nodes in the search tree first.

    Your search algorithm needs to return a list of actions that reaches the
    goal. Make sure to implement a graph search algorithm.

    To get started, you might want to try some of these simple commands to
    understand the search problem that is being passed in:

    print("Start:", problem.getStartState())
    print("Is the start a goal?", problem.isGoalState(problem.getStartState()))
```

```
    print("Start's successors:", problem.getSuccessors(problem.getStartState()))
    """
    currentState = problem.getStartState()
    F = util.Stack()
    E = []
    a = []
    paths= {}
    F.push(currentState)
    paths[currentState] = []
    while not F.isEmpty():
        currentState = F.pop()
        path = paths[currentState]
        E.append(currentState)
        if problem.isGoalState(currentState):
            return path
        else:
            successors = problem.getSuccessors(currentState)
            #successors.reverse()
            for child in  successors:
                if (child[0] not in E) and (not isExistInQ(F, child[0])):
```

```
                    F.push(child[0])
                    a.append(child[1])
                    paths[child[0]] = path + a
                    a = []
    return []
```

Challenge 2:

MediumMaze:

- Adding in same order as provided by getSuccessors function.

Code:

```
def isExistInQ(self, item):
    for p in self.list:
        if(item == p):
            return True
    return False


def depthFirstSearch(problem):
    """
    Search the deepest nodes in the search tree first.
```

```
    Your search algorithm needs to return a list of actions that reaches the
    goal. Make sure to implement a graph search algorithm.

    To get started, you might want to try some of these simple commands to
    understand the search problem that is being passed in:

    print("Start:", problem.getStartState())
    print("Is the start a goal?", problem.isGoalState(problem.getStartState()))
    print("Start's successors:", problem.getSuccessors(problem.getStartState()))
    """
    currentState = problem.getStartState()
    F = util.Stack()
    E = []
    a = []
    paths= {}
    F.push(currentState)
    paths[currentState] = []
    while not F.isEmpty():
        currentState = F.pop()
        path = paths[currentState]
```

```
        E.append(currentState)
        if problem.isGoalState(currentState):
            return path
        else:
            successors = problem.getSuccessors(currentState)
            for child in  successors:
                if (child[0] not in E) and (not isExistInQ(F, child[0])):
                    F.push(child[0])
                    a.append(child[1])
                    paths[child[0]] = path + a
                    a = []
    return []
```

Results:

```
Assignment 3\Code> python pacman.py -l mediumMaze -p SearchAgent -a fn=dfs --frameTime=0.01
[SearchAgent] using function dfs
[SearchAgent] using problem type PositionSearchProblem
Path found with total cost of 130 in 0.0 seconds
Search nodes expanded: 144
Pacman emerges victorious! Score: 380
Average Score: 380.0
Scores:        380.0
Win Rate:      1/1 (1.00)
Record:        Win
```

- Adding in reverse order.

Code:

```
def isExistInQ(self, item):
    for p in self.list:
        if(item == p):
            return True
    return False


def depthFirstSearch(problem):
    """
    Search the deepest nodes in the search tree first.

    Your search algorithm needs to return a list of actions that reaches the
    goal. Make sure to implement a graph search algorithm.

    To get started, you might want to try some of these simple commands to
    understand the search problem that is being passed in:

    print("Start:", problem.getStartState())
    print("Is the start a goal?", problem.isGoalState(problem.getStartState()))
    print("Start's successors:", problem.getSuccessors(problem.getStartState()))
    """
```

```
    currentState = problem.getStartState()
    F = util.Stack()
    E = []
    a = []
    paths= {}
    F.push(currentState)
    paths[currentState] = []
    while not F.isEmpty():
        currentState = F.pop()
        path = paths[currentState]
        E.append(currentState)
        if problem.isGoalState(currentState):
            return path
        else:
            successors = problem.getSuccessors(currentState)
            successors.reverse()
            for child in  successors:
                if (child[0] not in E) and (not isExistInQ(F, child[0])):
                    F.push(child[0])
                    a.append(child[1])
```

```
                    paths[child[0]] = path + a
                    a = []
    return []
```

Results:

```
Record:       Win
PS C:\Users\DC\OneDrive\MSCS Study Material\Semester 2\Machine Learning\My Data\Github\Machine Learning\Machine-Learning-Course\Assignments\
Assignment 3\Code> python pacman.py -l mediumMaze -p SearchAgent -a fn=dfs --frameTime=0.01
[SearchAgent] using function dfs
[SearchAgent] using problem type PositionSearchProblem
Path found with total cost of 244 in 0.0 seconds
Search nodes expanded: 264
Pacman emerges victorious! Score: 266
Average Score: 266.0
Scores:        266.0
Win Rate:      1/1 (1.00)
Record:        Win
PS C:\Users\DC\OneDrive\MSCS Study Material\Semester 2\Machine Learning\My Data\Github\Machine Learning\Machine-Learning-Course\Assignments\
```

Challenge 03:

Depth First Search(DFS):

```
def isExistInQ(self, item):
    for p in self.list:
        if(item == p):
            return True
    return False


def depthFirstSearch(problem):
    """
```

```
    Search the deepest nodes in the search tree first.

    Your search algorithm needs to return a list of actions that reaches the
    goal. Make sure to implement a graph search algorithm.

    To get started, you might want to try some of these simple commands to
    understand the search problem that is being passed in:

    print("Start:", problem.getStartState())
    print("Is the start a goal?", problem.isGoalState(problem.getStartState()))
    print("Start's successors:", problem.getSuccessors(problem.getStartState()))
    """
    currentState = problem.getStartState()
    F = util.Stack()
    E = []
    a = []
    paths= {}
    F.push(currentState)
    paths[currentState] = []
    while not F.isEmpty():
```

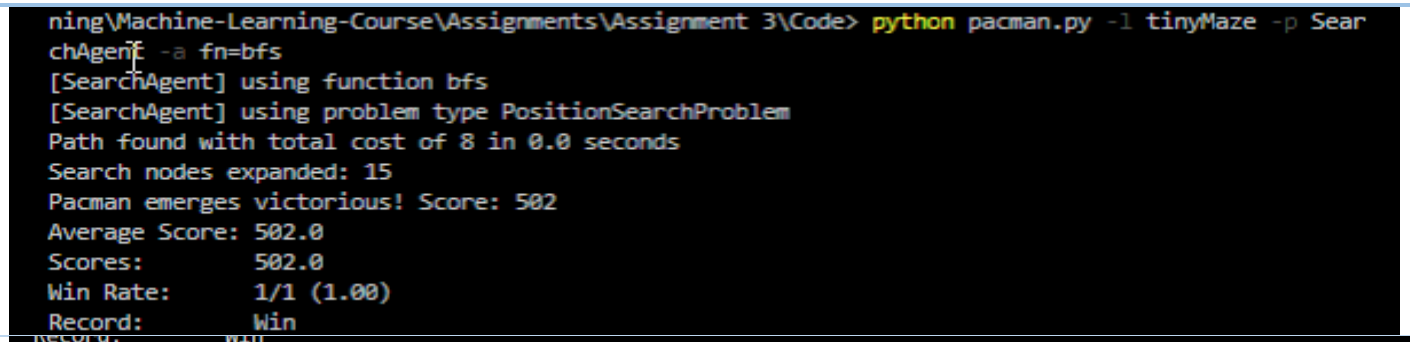
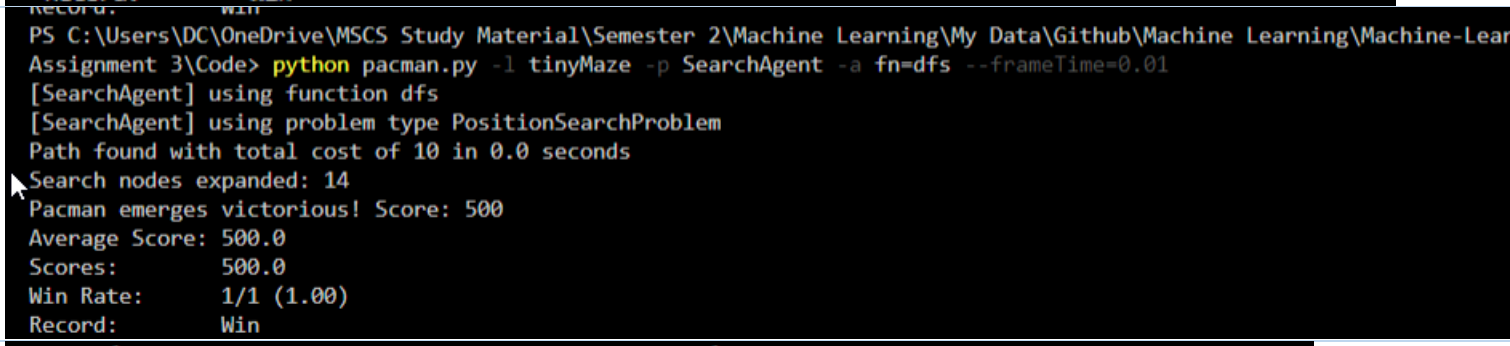
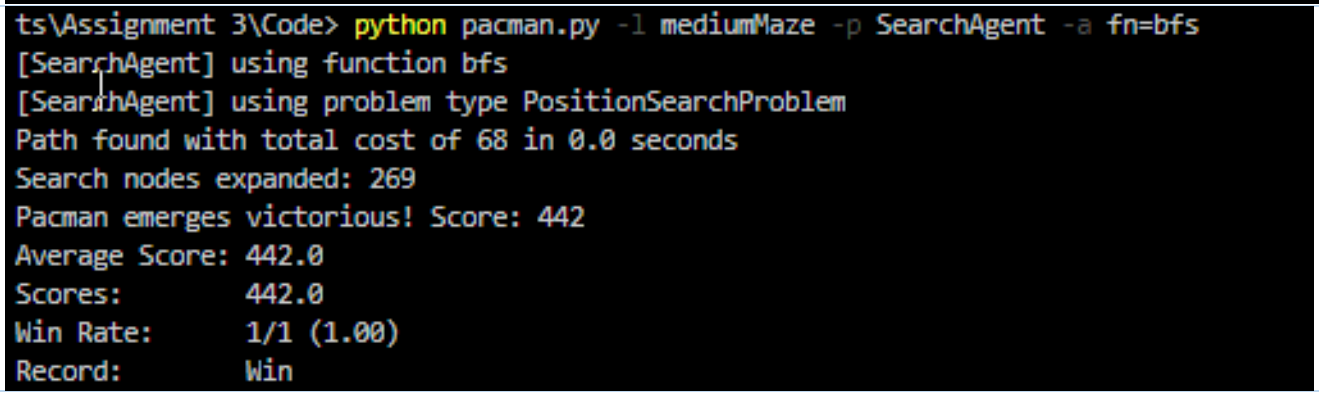
```
        currentState = F.pop()
        path = paths[currentState]
        E.append(currentState)
        if problem.isGoalState(currentState):
            return path
        else:
            successors = problem.getSuccessors(currentState)
            for child in  successors:
                if (child[0] not in E) and (not isExistInQ(F, child[0])):
                    F.push(child[0])
                    a.append(child[1])
                    paths[child[0]] = path + a
                    a = []
    return []
```

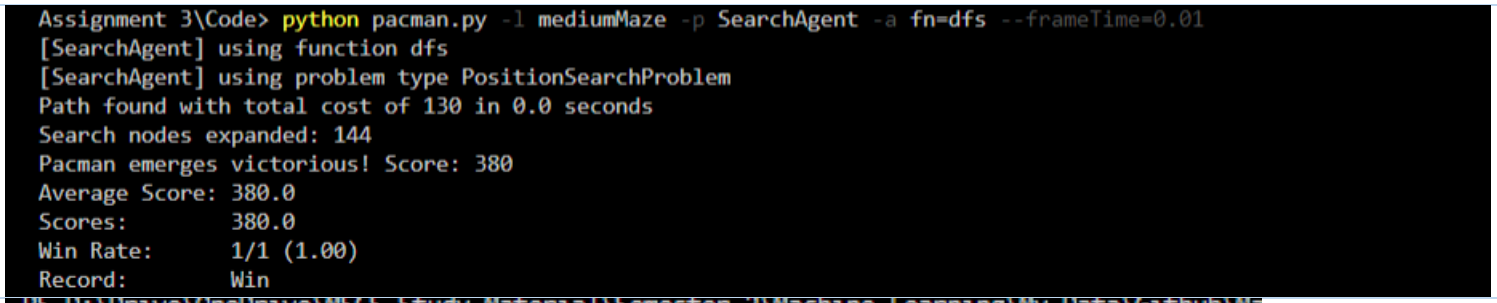
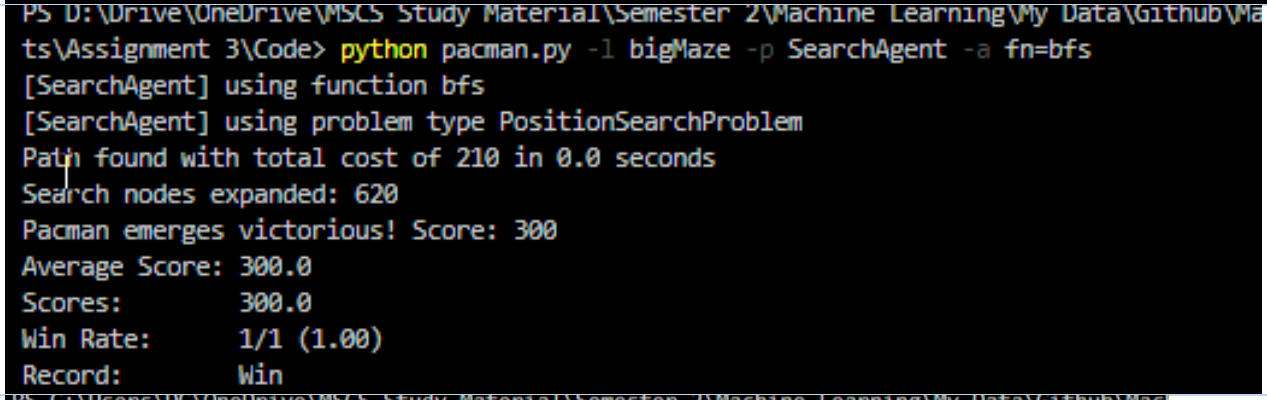
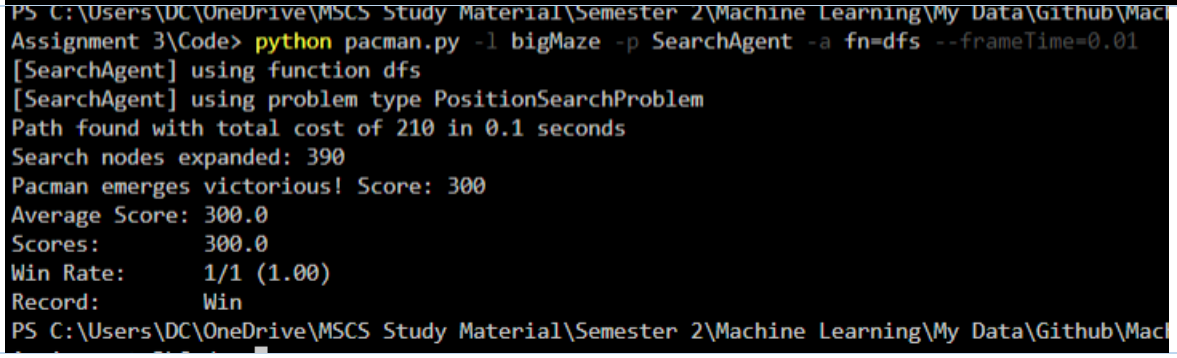
Breadth First Search(BFS):

```
def breadthFirstSearch(problem):
    """Search the shallowest nodes in the search tree first."""
    currentState = problem.getStartState()
    F = util.Queue()
    E = []
```

```
    a = []
    paths= {}
    F.push(currentState)
    paths[currentState] = []
    while not F.isEmpty():
        currentState = F.pop()
        path = paths[currentState]
        E.append(currentState)
        if problem.isGoalState(currentState):
            return path
        else:
            for child in  problem.getSuccessors(currentState):
                if (child[0] not in E) and (not isExistInQ(F, child[0])):
                    F.push(child[0])
                    a.append(child[1])
                    paths[child[0]] = path + a
                    a = []
    return []
```

Comparison Table:

Maze Name	Search Function	Nodes Expanded	Cost	
Tiny Maze	BFS	15	8	
Tiny Maze	DFS	14	10	
Medium Maze	BFS	269	68	

Medium Maze	DFS	144	130	
Big Maze	BFS	620	210	
Big Maze	DFS	390	210	

Challenge 04:

UCS algorithm implemented in code, which finds a solution, which takes minimum cost and maximum score.

```
def isExistInPQ(self, item):
    for p in self.heap:
        if(item == p):
            return True
    return False
def uniformCostSearch(problem):
    """Search the node of least total cost first."""
    currentState = problem.getStartState()
    F = util.PriorityQueue()
    E = []
    a = []
    paths= {}
    F.push(currentState, 0)
    paths[currentState] = []
    while not F.isEmpty():
        currentState = F.pop()
        path = paths[currentState]
        E.append(currentState)
```

```
        if problem.isGoalState(currentState):
            return path
        else:
            for child in  problem.getSuccessors(currentState):
                if (child[0] not in E) and (not isExistInPQ(F, child[0])):
                    F.push(child[0], child[2])
                    a.append(child[1])
                    paths[child[0]] = path + a
                    a = []
                elif isExistInPQ(F, child[0]):
                    F.update(child[0], child[2])


    return []
```

Challenge 05:

Astar heuristic algorithm implemented with absolute distance heuristic.

```
def isExistInPQ(self, item):
    for p in self.heap:
        if(item == p):
```

```
            return True
    return False
def manHattanHeuristic(state, problem=None):
    goalState = problem.goal
    i = abs(state[0][0] - goalState[0]) + abs(state[0][1] - goalState[1])
    p = state[2] + i
    return p;
def aStarSearch(problem, heuristic=nullHeuristic):
    """Search the node that has the lowest combined cost and heuristic first."""
    currentState = problem.getStartState()
    F = util.PriorityQueue()
    E = []
    a = []
    paths= {}
    goalState = problem.goal
    i = abs(currentState[0] - goalState[0]) + abs(currentState[1] - goalState[1])
    F.push(currentState,  i)
    paths[currentState] = []
    while not F.isEmpty():
        currentState = F.pop()
```

```
        path = paths[currentState]
        E.append(currentState)
        if problem.isGoalState(currentState):
            return path
        else:
            for child in  problem.getSuccessors(currentState):
                if (child[0] not in E) and (not isExistInPQ(F, child[0])):
                    # using absolute distance heuristic
                    p = manHattanHeuristic(child, problem);
                    F.push(child[0], p)
                    a.append(child[1])
                    paths[child[0]] = path + a
                    a = []
                elif isExistInPQ(F, child[0]):
                    F.update(child[0], child[2])
    return []
```

Challenge 06:

1. **Fill following table with the information**.

	A* Heuristic	**UCS**
Total Cost	210	210
Nodes Expanded	620	466
Score	300	300

2. **Why Node Expanded is Greater in UCS and Less in A* Heuristic?**
   UCS is only focusing on cost effective path whilst A* algorithm keeps cost and distance both into account by updating the path by absolute distance factor.
3. **Compare other parameters and give reason why they greater/less/equal/.**
   Both algorithms are focusing on cost and score equally that's why they are equal and nodes expanded are lesser for A* algorithm because of distance heuristic we are using in it.

Challenge 07:

Euclidean Code:

```
def EuclideanHeuristic(state, problem=None):
    goalState = problem.goal
    i = math.sqrt((state[0][0] - goalState[0])**2 + (state[0][1] - goalState[1])**2)
    p = state[2] + i
    return p;
def aStarSearch(problem, heuristic=nullHeuristic):
    """Search the node that has the lowest combined cost and heuristic first."""
    currentState = problem.getStartState()
```

```
    F = util.PriorityQueue()
    E = []
    a = []
    paths= {}
    goalState = problem.goal
    #i = abs(currentState[0] - goalState[0]) + abs(currentState[1] - goalState[1])
    i = math.sqrt((currentState[0] - goalState[0])**2 + (currentState[1] - goalState[1])**2)
    F.push(currentState,  i)
    paths[currentState] = []
    while not F.isEmpty():
        currentState = F.pop()
        path = paths[currentState]
        E.append(currentState)
        if problem.isGoalState(currentState):
            return path
        else:
            for child in  problem.getSuccessors(currentState):
                if (child[0] not in E) and (not isExistInPQ(F, child[0])):


                    # using absolute distance heuristic
```

```
                #p = manHattanHeuristic(child, problem);


                # using Euclidean Heuristic
                p = EuclideanHeuristic(child, problem)
                F.push(child[0], p)
                a.append(child[1])
                paths[child[0]] = path + a
                a = []
            elif isExistInPQ(F, child[0]):
                F.update(child[0], child[2])


    return []
```

mediumMaze Results::

```
PS C:\Users\DC\OneDrive\MSCS Study Material\Semester 2\Machine Learning\My Data\Github\Machine Learning\Machine-Learning-Course\Assignments\
Assignment 3\Code> python pacman.py -l mediumMaze -p SearchAgent -a fn=astar --frameTime=0.01
[SearchAgent] using function astar and heuristic nullHeuristic
[SearchAgent] using problem type PositionSearchProblem
Path found with total cost of 152 in 0.0 seconds
Search nodes expanded: 159
Pacman emerges victorious! Score: 358
Average Score: 358.0
Scores:        358.0
Win Rate:      1/1 (1.00)
Record:        Win
PS C:\Users\DC\OneDrive\MSCS Study Material\Semester 2\Machine Learning\My Data\Github\Machine Learning\Machine-Learning-Course\Assignments\
```

Comparison Table

	Euclidean	**Manhattan**	**UCS**
Total Cost	152	76	68
Nodes Expanded	159	81	275
Score	358	434	442

Manhattan distance is better for mediumMaze problem states. Distance heuristc varies their efficiency based on the problem states provides that is why the results are different.