# Intro To Artificial Intelligence Maze Solver - Project Report

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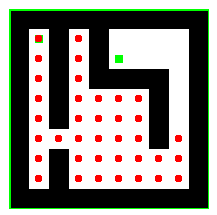


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# Tools & environment

* Python 3.7
* PyCharm version 11.0 (IDE)
* Libraries used:
* HeapDict: we used HeapDict to implement a data structure that combines minimum heap and a hash table
* Heapq: we used heapq to implement priority queue

# Overview

In this project we develop an independent agent that can solve a given maze using various search algorithms - both informed and uninformed while using heuristics we developed.  
  
The goal of the agent is to solve the maze with the cheapest path possible.  
The maze is represented by NxN matrix of costs (all costs are 1+), starting point coordinates and goal point coordinates. The agent can move to all 8 adjacency direction.  
  
Working and developing this project required research and deep understanding of the algorithms, programming it required a lot of code optimizations and complexity optimizations. One of our major challenges was to come up with the right kind of heuristic.

We offer 5 different search algorithms: Bi-Astar, AStar, ID-Astar, UCS, IDS to that the agent can solve the maze with while using 2 kinds of consistent heuristic.

The results are presented as \_\_

# Program code architecture

* Main:

Annotations*:*

* *Folder*
* *Class  
  function*
* Entities:
* Maze
* Node
* Algorithms:
* UCS
* IDS
* Astar
* IDASTAR
* BiAstar
* Data Structures:
* HeapDict
* Priority Queue
* Heuristics:
* Heuristics
  + Moves Counter
  + Diagonal
* Utilities:
* Utilities
  + Read file
  + Write files (TODO)
  + Calculate run statistics.
* Scripts:
* Maze generator

# Documentation

*General flow* of solving a maze is like so – We open a problem file via utility function, analyze it and generate the entities and variables that are passed into the solving algorithm. After executing, the algorithm passes the statistics to another utility function that prints the results.

Entities:

* **Maze** – keeps the data about the maze and functions that relate to the maze.  
  holds the mazes matrix, starting node, goal node and size
* **Node** – keeps the data of a specific node (cell) in the maze. This entity plays a significant role in this program. Each node holds its coordinates, cost, heuristic value, depth, and father node which is used to backtrack when reaching a solution to generate the solution path.

Data Structures:

In order for our code to run fast, we had to invest in choosing the right data structures.  
In this project we used minimum heaps, hash tables and HeapDict which is a data structure that combines a minimum heap and a hash table. This enabled us to search a node with O(1) and reduce its value with a cost of O(log(n)). Using this dramatically changed the run time of the algorithms.

* **Hash Table** – we used python’s unsorted dictionary as hash table.
* **Minimum Heap** (Priority Queue) – implemented a priority Queue Wrapper
* **HeapDict** (Hash Table + Minimum Heap) – implemented a wrapper for this module

Algorithms:

* **UCS** – we implemented this algorithm in a classic way, maintaining a frontier priority queue and explored hash table, always expanding the node which has the current cheapest path. This is done until reaching the goal.