Maze Project

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Introduction

We all have seen and solved a simple maze like this before. For most, solving this maze this is very basic and intuitively, we analyze the different paths until we get the correct one. However, imagine you have to solve a maze 1000 times larger than this. Could you do it by hand? Sure, but it will take a long time, and you probably need a systematic approach to solve it. The objective of this project is define and test a systematic approach to solve this maze, in such a way that a robot/computer could find the path by using simply using this solving method.

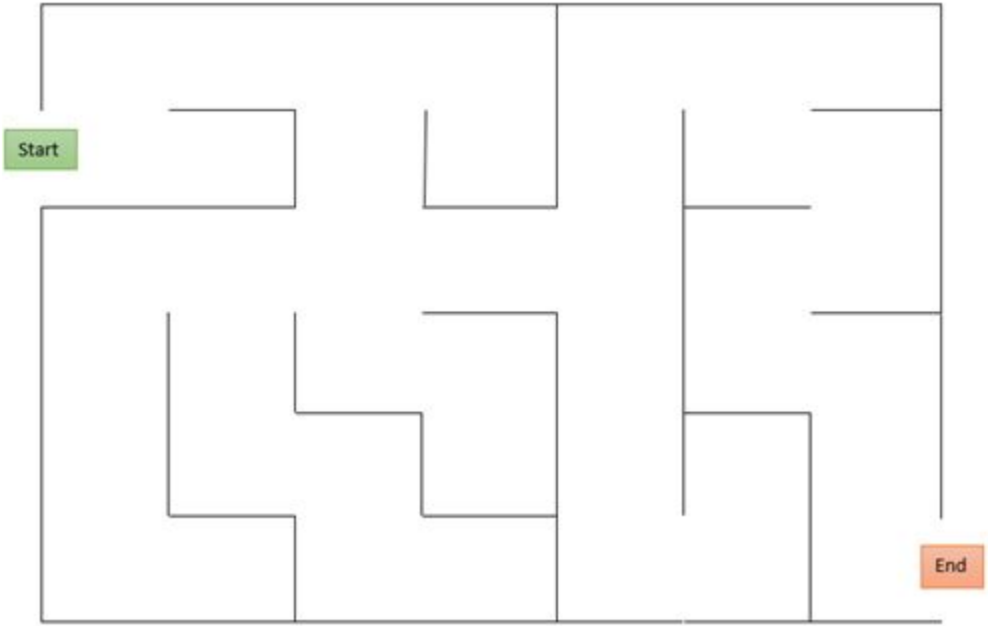

Figure 1. Basic Maze

Understanding a maze

Objective:

Find the path from **START** to **END**.

Components:

- Decision Nodes (Green)
- Path Nodes (White)
- End Nodes (Orange)
- Steps of the path (Blue lines)

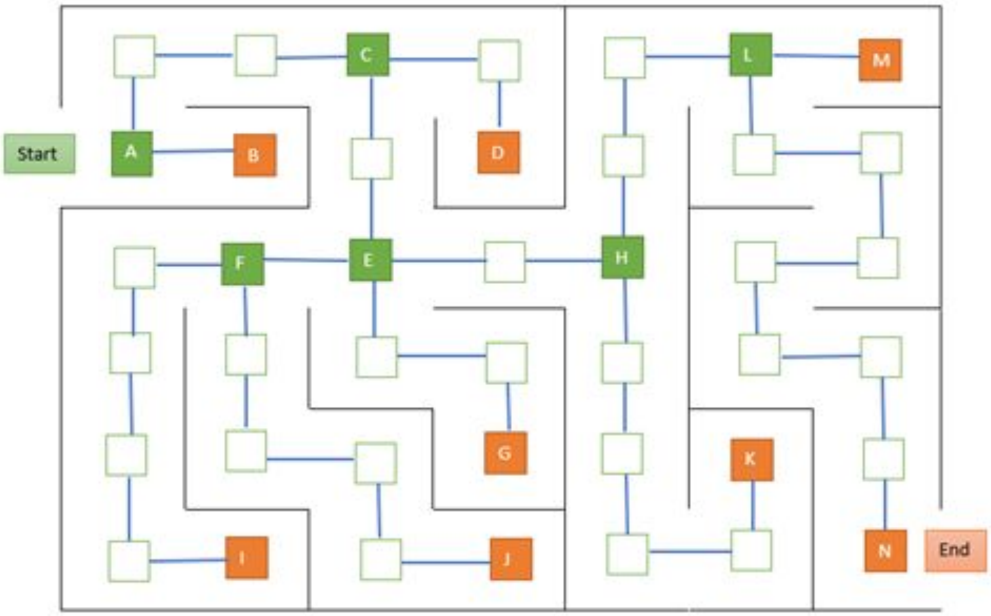

Figure 2. Maze components

Solving Method

We will follow a path until we reach either a **GREEN** or **ORANGE** node.

At a **GREEN** node, we can make a decision to which path to take.

At an **ORANGE** node, we have reached the end of a path. If it is not the *exit*, we will go back to the previous **GREEN** node and chose a different path.

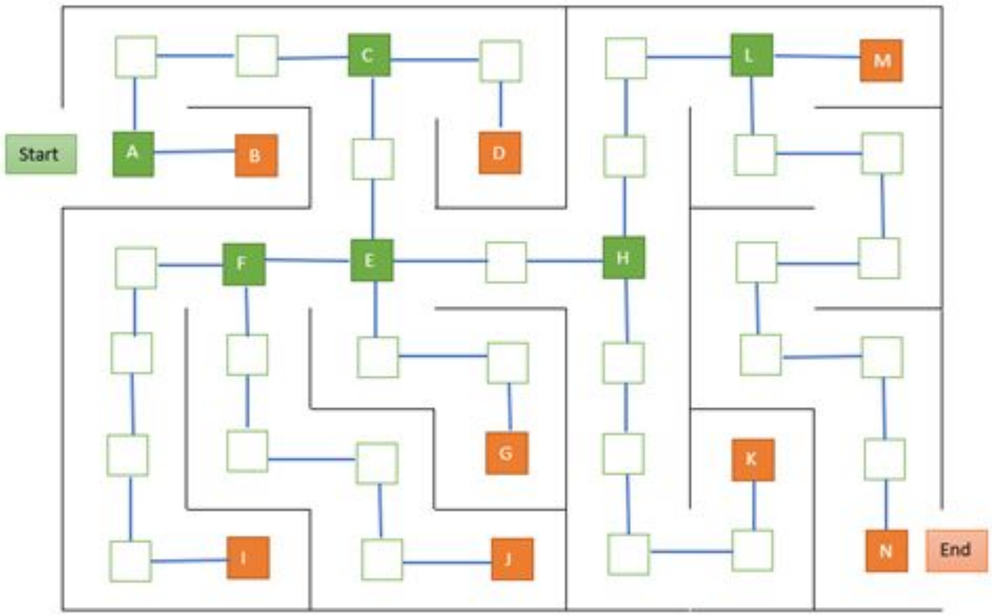

Figure 2. Maze Components

Analyzing the results (Dijkstra’s Algorithm)

We want to record all the paths that we can take.

- At any point we reach a decision node (green) we will have multiple paths.
- At any point we reach a end node (orange) , that particular path will end.

For example, in *Figure 2*:

We start and immediately reach node A

From node A we make the decision to go Up (towards C) or right (towards B).

If we go to B, that path ends, but it we go to C, now we have two new paths open up.

This is represented used a decision tree as show in *Diagram 1*.

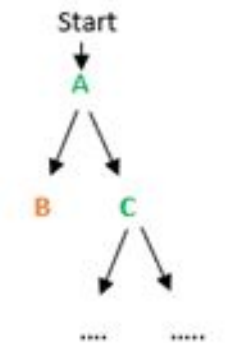

Diagram 1.
Decision Tree Analysis

Complete Solution

Each path will also keep track of the steps taken and the distance as shown in *Diagram 2*.

In *Diagram 2* we can see that the exit is in node N, and that we can reach the exit by going down the far right of the decision tree.

We can get the total distance by adding all the values of the steps taken (A -> C -> E->H->L), for a total of 18 steps.

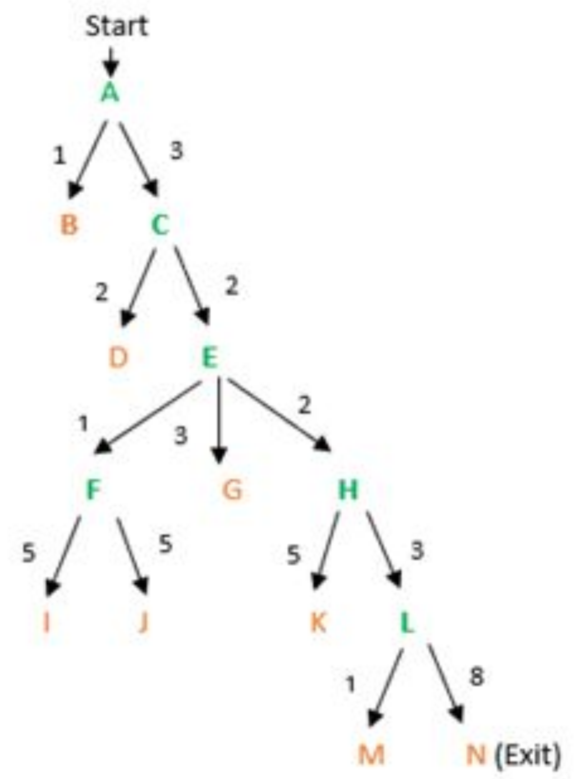

Diagram 2
Decision Tree Solution

Graphic Solution and Verification

From *Diagram 2* we concludes that the distance of the path to the exit was 18. In this case we easily use *Figure 3* to verify the results, by counting the number of yellow steps taken.

A ⟶ C = 3

C ⟶ E = 2

E ⟶ H = 2

H ⟶ L = 3

L ⟶ M = 8

A⟶ C ⟶ H ⟶ L ⟶ M = 18

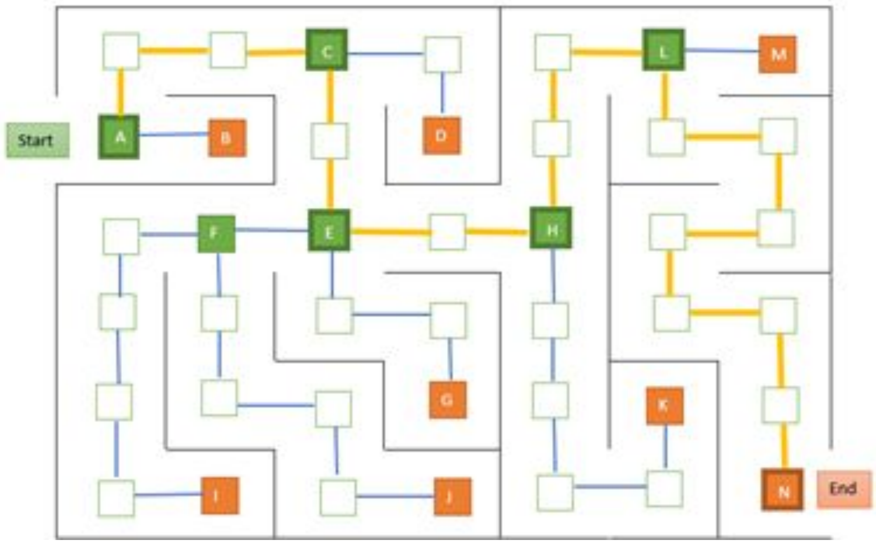

Figure 2. Graphic Solution of the Maze

Real-world application (Path planning)

- A maze is a simple illustrative example
- Maze solving is part of path planning in the field of robotics
- Path Planning is essential in real-world scenarios
- Robot navigation includes this essential elements:
  - Self location
  - Path Planning
  - Map building and interpretation

- Usages of path planning for robotics in the real world:
  - Automated Guided Vehicles (AGV)
  - Autonomous Cars
  - Service Robots (Cleaning Robots))

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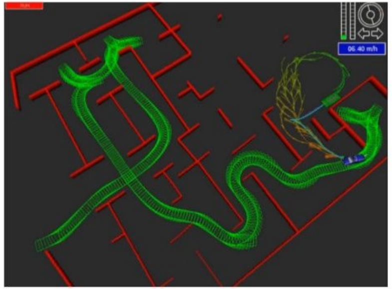
Limitations / Considerations

- Multiple Routes : Chose the optimal path (if many)
    - Using distance as a parameter
- Variable Objects/Obstacles: There need to be a way to detect
    - Retrieve real world data
        - Computer Vision
        - Other sensors
    - Decision making to adjust path trajectory if needed and possible
- Learning: Solving the same maze with optimal efficiency
    - Map building and map learning
    - Artificial Intelligence
- Non-linear objective: We want to go to multiple destinations or cover all the map efficiently
    - Map building
    - Optimization algorithms



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Conclusion

- ❖ A maze is a simple and illustrative problem for path planning in robotics
  - ➢ Path Planning is big and highly relevant field of robotics
- ❖ Dijkstra’s Algorithm can be use to solve a maze by considering all different path
- ❖ Path Planning has multiple application in the real-world
  - ➢ Can be highly complex
  - ➢ Often combined with other tools
  - ➢ Key component of robot navigation

Sources

1 *Excellent Tutorial on A* Robot Path Planning* -Robotshop.com

2 *Automated guided vehicles improve production* - Bill Lydon

3 *Mobile Robot Path, Motion, and Task Planning* - Spyros G.Tzafestas

4 *Path Planning* - ScienceDirect.com

5 *Robot Path Planning: An Object-Oriented Approach* - Morten Strandberg