

# A\* Path Planning Algorithm

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November 30, 2022

# Introduction

## Introduction

Motion Planning  
Path Planning  
Graph-Based Methods

## A\* Algorithm

What is A\* algorithm  
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How it works  
Drawbacks

## References

- Motion Planning.
- Path Planning.
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# Motion Planning

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**Definition:** Finding a trajectory (path) that connects a start pose to a goal a pose in an environment.

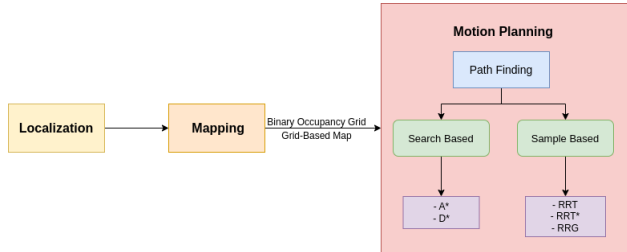


Figure: Hierarchical diagram

# Path Planning

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- It is a subset of motion planning.
- It is responsible for generating a sequence of robot pose states, to reach a "*goal state*" from a "*start state*".
- The path is defined regardless of the motion (**pose derivatives**: velocity, acceleration, rotation rate, etc.)

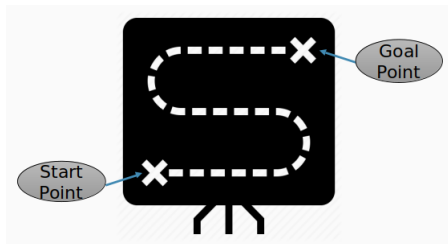


Figure: Path planning

# Graph-Based Methods

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### Definition:

Discretizing the environment and converting it to discrete nodes, to find the shortest distance to a goal given the cost of each node.

### Classification:

- I Search-based algorithms
  - A\*
- II Sample-based algorithms
  - RRT
  - RRT\*

# A\* Algorithm

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# What is A\* algorithm

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- It is an informed search algorithm that is based upon *Uniform Cost Search* (UCS) and *Greedy Search*.
- It builds a tree by adding nodes in an ordered pattern.
  - **Graph:** fully interconnected nodes.
  - **Tree:** each node has a single parent.

# History

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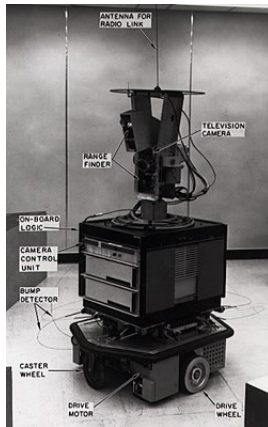


Figure: Shakey robot 1968



# How it works

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### Node Prioritizing Based on Cost Function:

$$\min \quad F = G + H$$

- $G \longrightarrow$  actual cost of the node ( $n$ ) (node w.r.t start)
- $H \longrightarrow$  estimated cost (heuristic) of the node, distance from node ( $n$ ) to goal (node w.r.t goal)

# Pseudo-code

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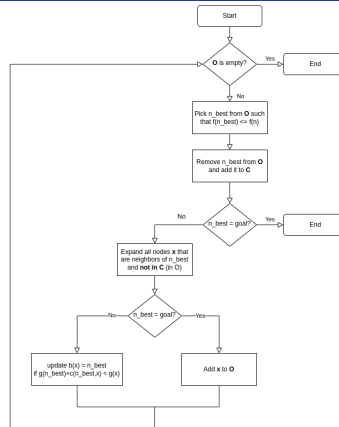


Figure: A\* flow chart

# Drawbacks

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- 1 It becomes computationally expensive, as the dimension of state space increases.
- 2 Fails to deal with multi-jointed manipulators.
- 3 Fails in large low-dimensional state space.

**Solution:** using sample-based algorithms.

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## References



**Brian Douglas**

Path Planning with A\* and RRT

<https://www.youtube.com/watch?v=QR3U1dgc5RE>.



**Cyrril Stachniss**

Robot Motion Planning using A\*

<https://www.youtube.com/watch?v=HR1TNa8Lp7w>.



Thanks!

