Autonomous Coin Sorting Robot Arm

Authors:
Rory Charlton
Mitch Fullelove
Kianoosh Soltani Naveh
Joshua Song
Tyson Zastrow

Supervisors:
Dr Surya Singh
Dr Hanna Kurniawati

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

https://youtu.be/z4qVI7Ybxac

Overview

- Task: sort coins on a moving turntable into bins
- Solution: difficult to pick coins up, so slide them off

Image

Image processing

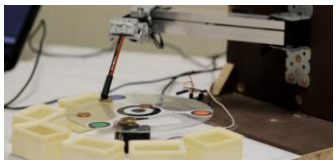
Layout of coins, turntable speed

Motion planning

Trajectory

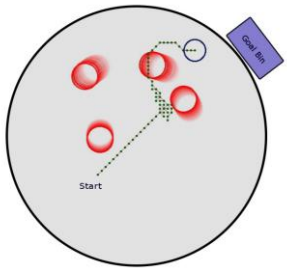
Inverse kinematics (simple trigonometry)

Joint angles



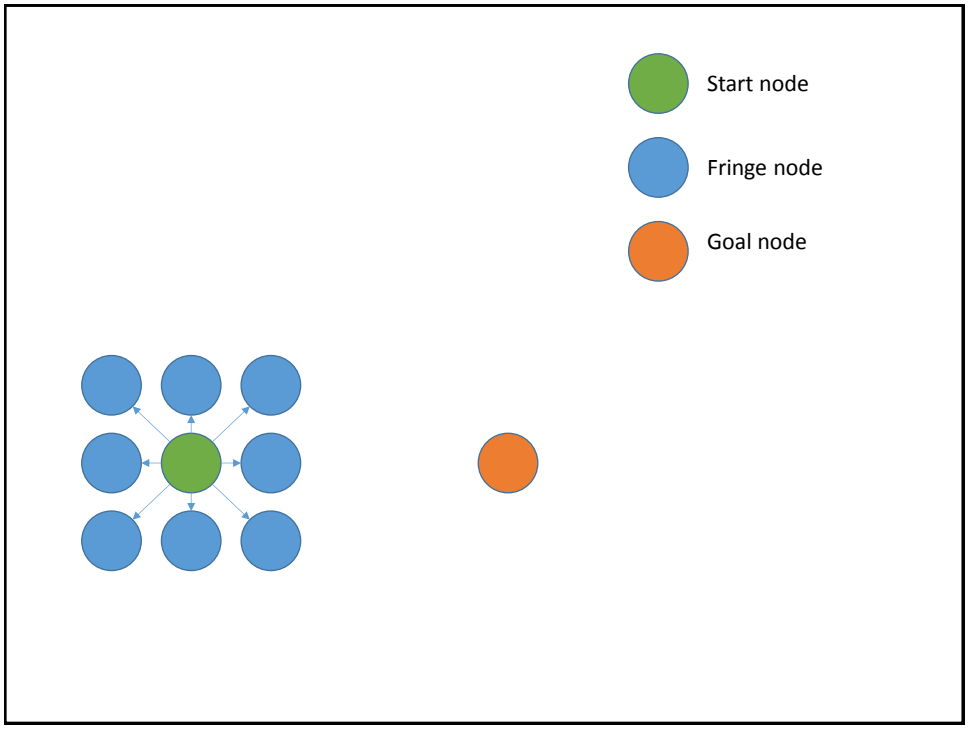
Motion planning problem

- Given a coin and its goal bin, what path can be taken
- Reference frame fixed on table → other coins are moving obstacles
- We planned in a 3 dimensional state space: x, y, time (alternative is to plan in configuration space: joint angle 1, joint angle 2, time)



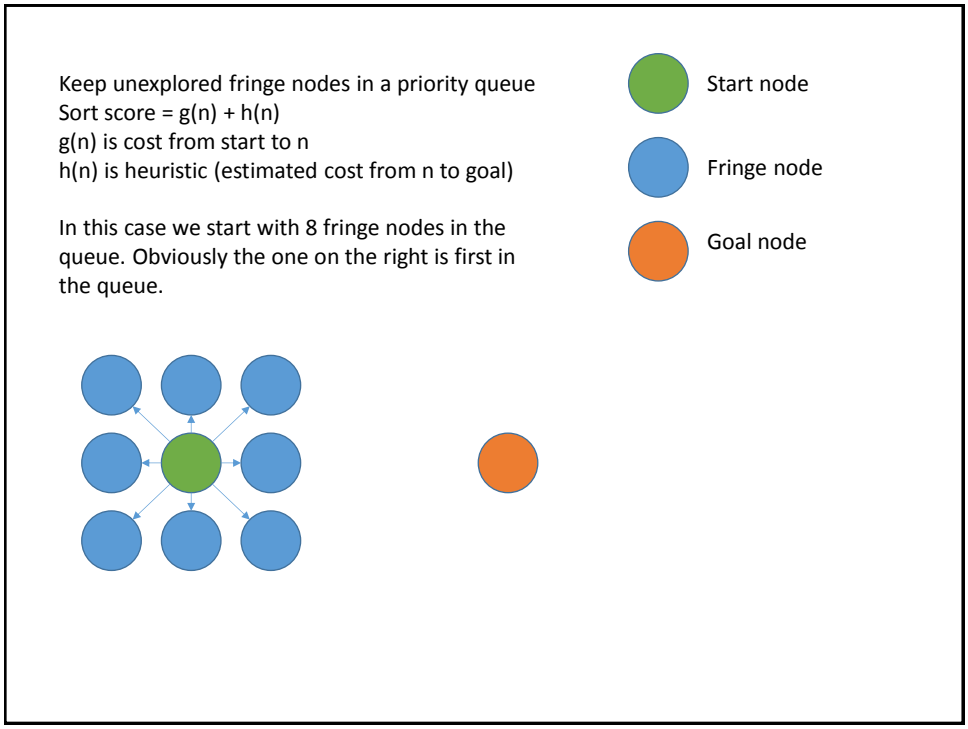
Our simplified A* path finding

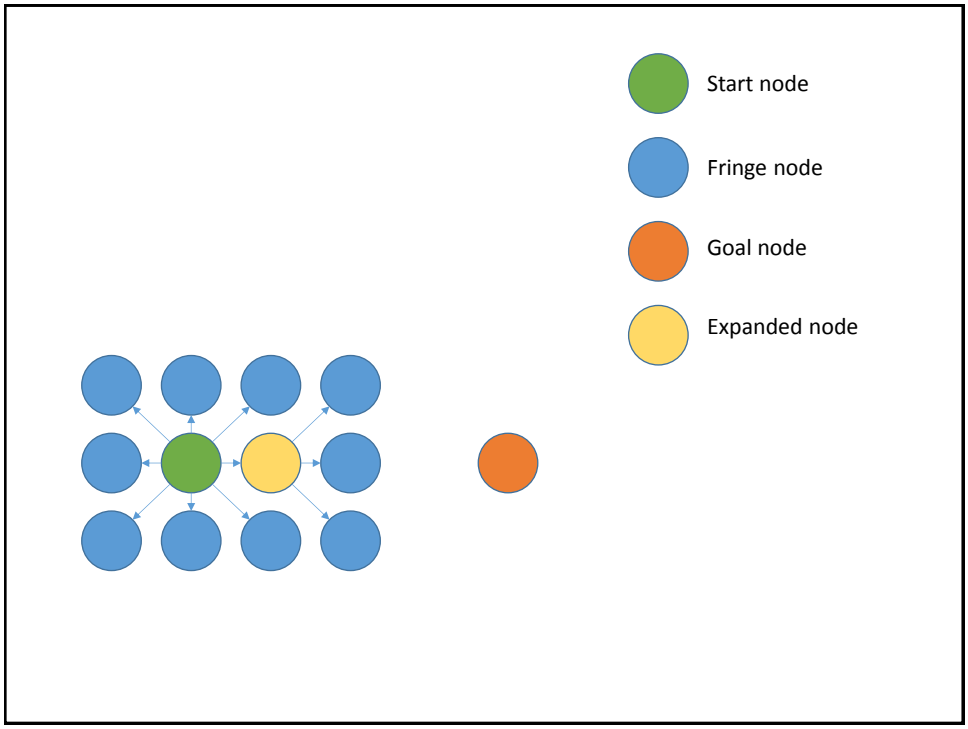
- We slide the coin at a constant speed
- We discretised the state space into a grid (we can get away with this due to sparse obstacles)
- We check for collisions while exploring nodes instead of generating the entire map of valid nodes at the start

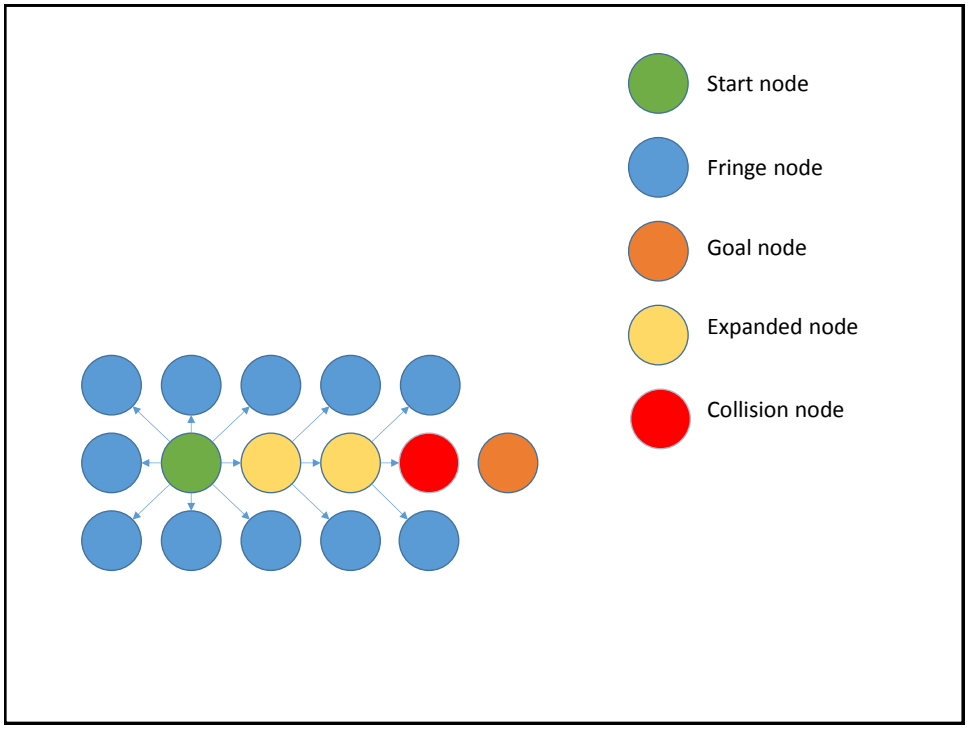


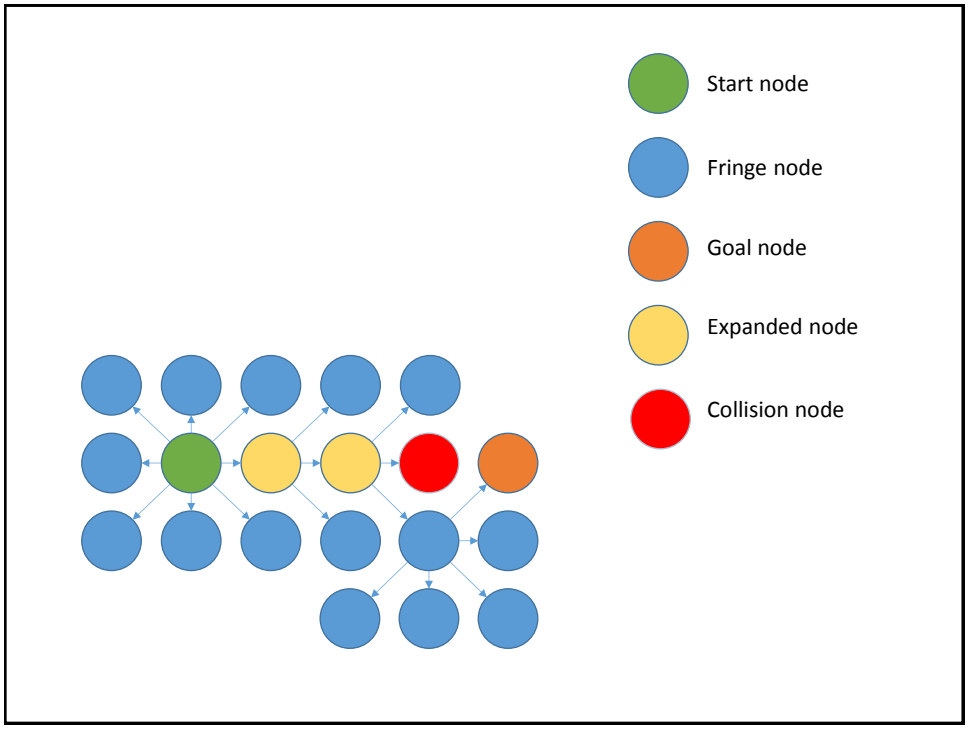
Keep unexplored fringe nodes in a priority queue
Sort score = g(n) + h(n)
g(n) is cost from start to n
h(n) is heuristic (estimated cost from n to goal)

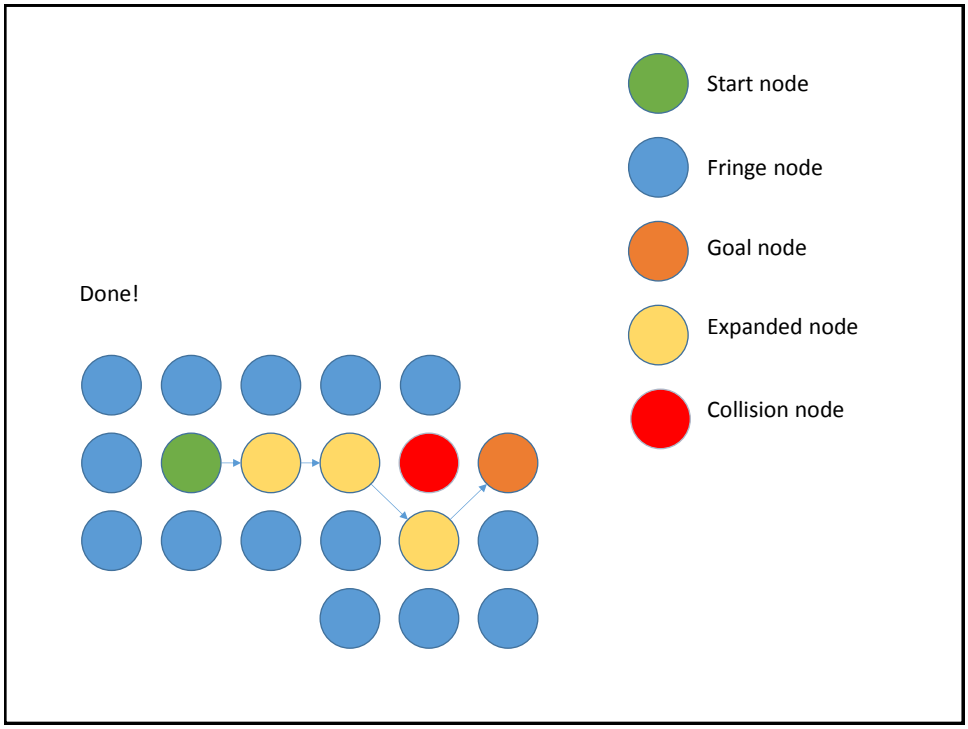
In this case we start with 8 fringe nodes in the queue. Obviously the one on the right is first in the queue.




Start node
Fringe node
Goal node
Expanded node


Start node
Fringe node
Goal node
Expanded node
Collision node


Start node
Fringe node
Goal node
Expanded node
Collision node


Done!
Start node
Fringe node
Goal node
Expanded node
Collision node

If grid discretisation isn't good enough:

Instead of grid, randomly sample a bunch of valid states e.g.

Probabilistic Roadmap (PRM)

Rapidly-exploring Random Tree (RRT)

Deciding on which coin to move first

- We used a greedy approach whereby we plan trajectories for every coin and pick the shortest trajectory.
- Estimate new positions of remaining coins (easy as we know turntable rotation speed and time required for the trajectory taken
- Repeat