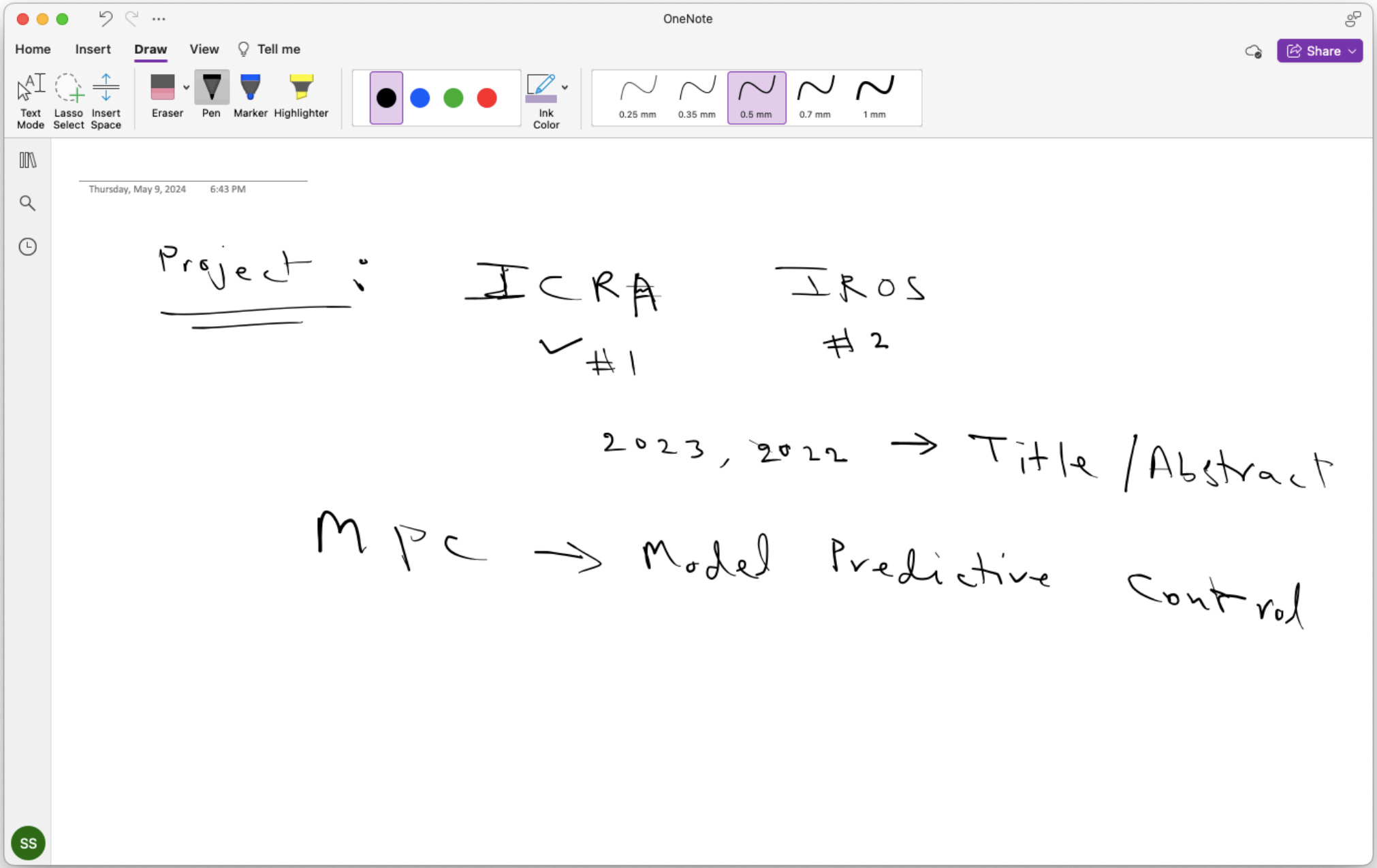
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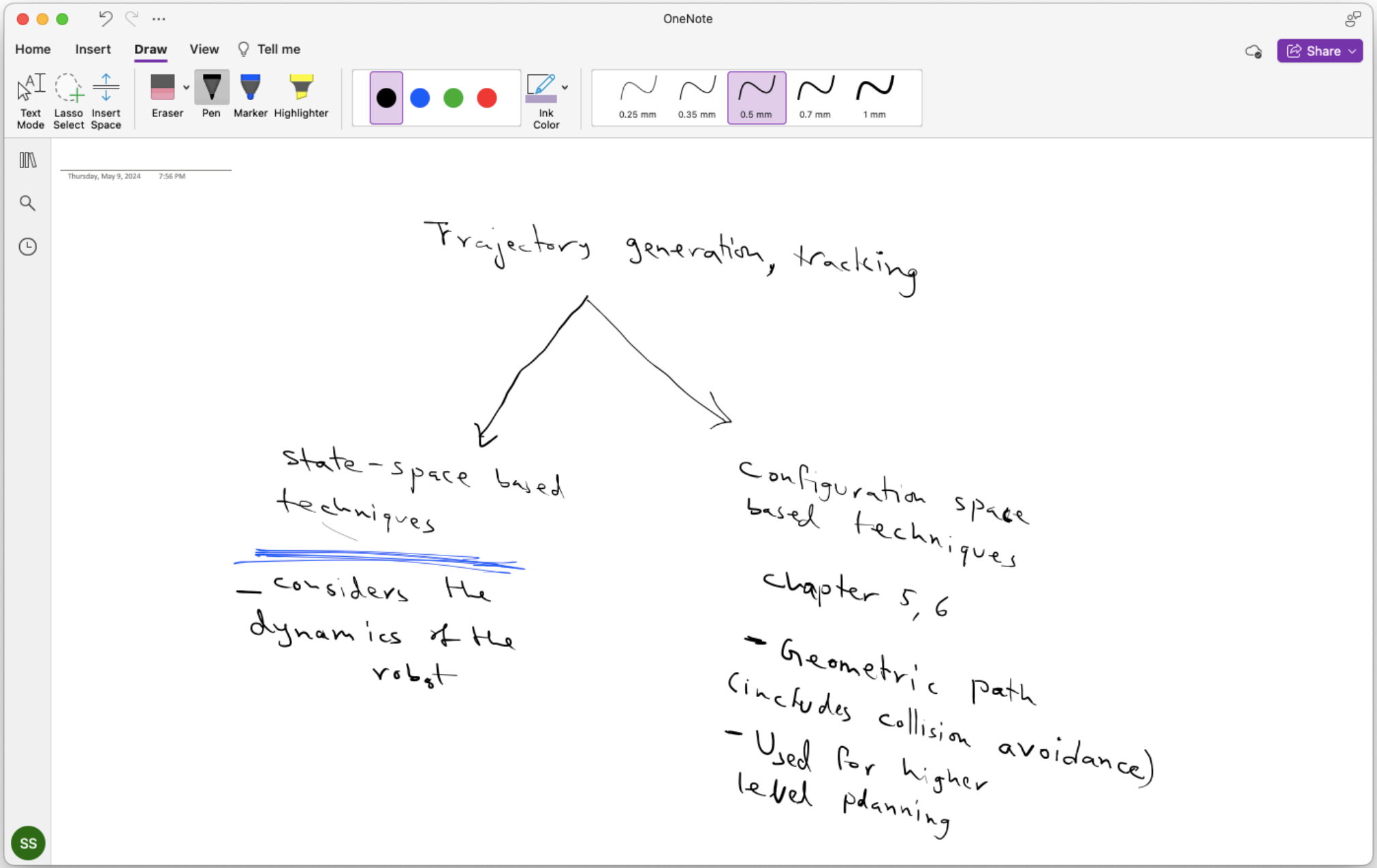
Project :
ICRA
#1
IROS
#2
2023, 2022 → Title / Abstract
MPC → Model Predictive Control
SS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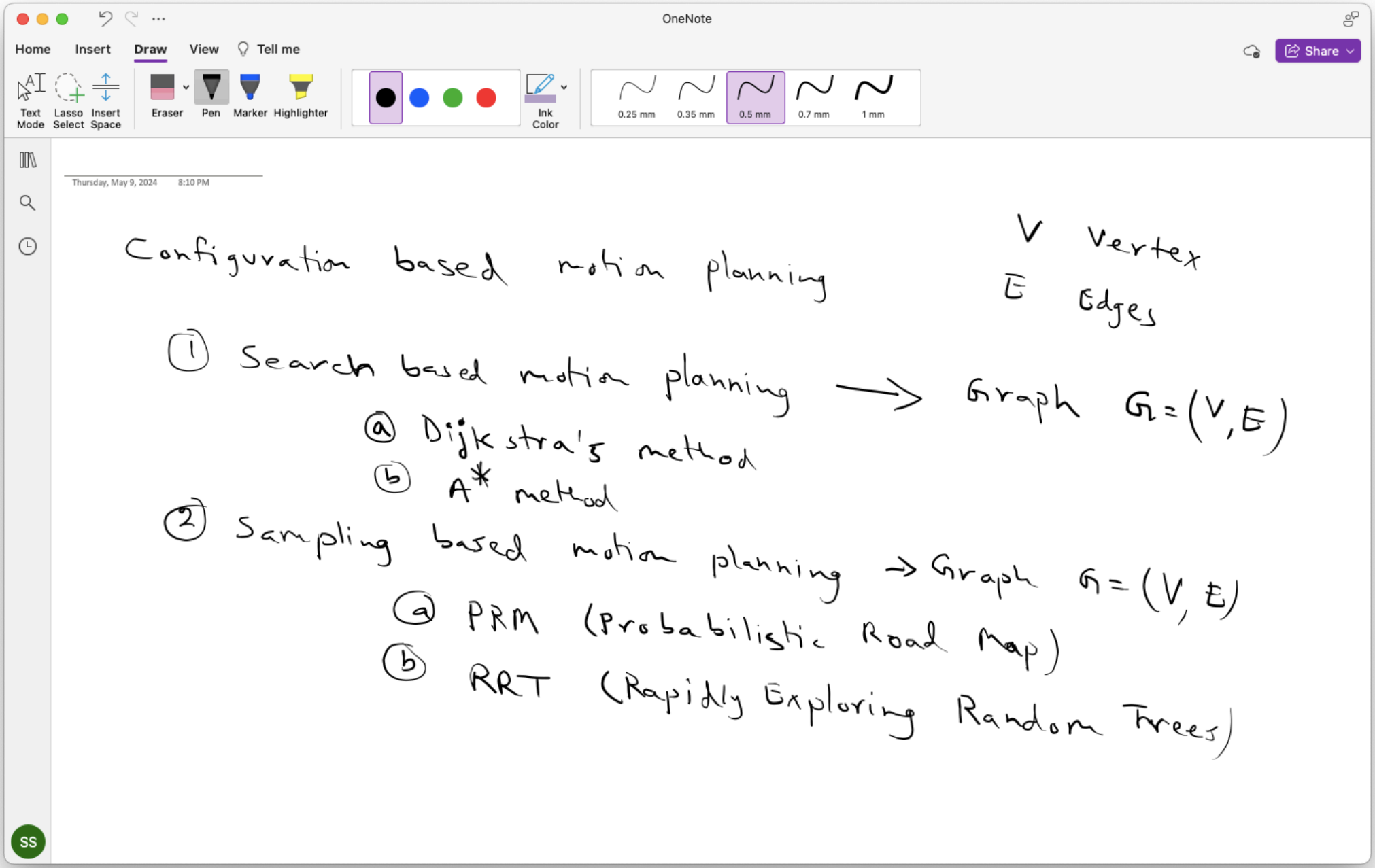
Thursday, May 9, 2024 7:56 PM
Trajectory generation, tracking
State-space based techniques
- considers the dynamics of the robot
Configuration space based techniques
Chapter 5, 6
- Geometric path (includes collision avoidance)
- Used for higher level planning
SS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Configuration based motion planning
V Vertex
E Edges
1 Search based motion planning → Graph G = (V, E)
a Dijkstra's method
b A* method
2 Sampling based motion planning → Graph G = (V, E)
a PRM (Probabilistic Road Map)
b RRT (Rapidly Exploring Random Trees)
SS

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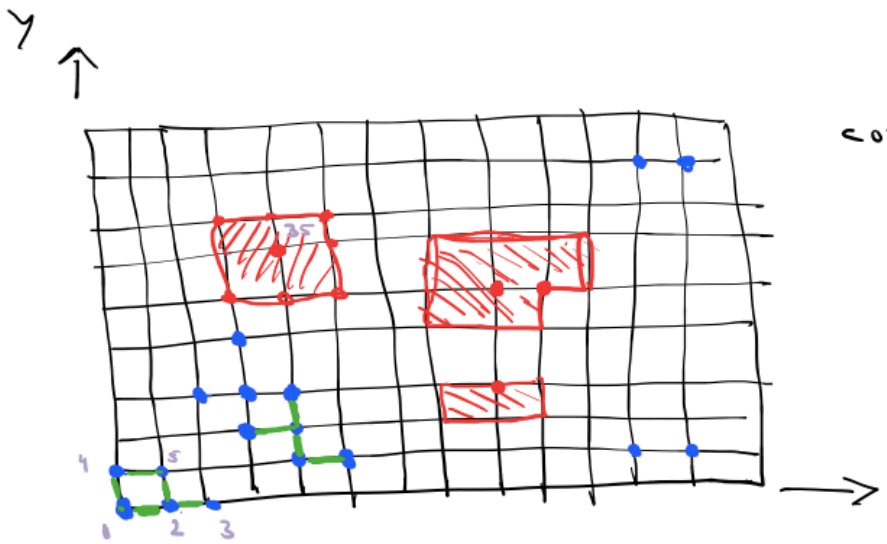
Chapter 5 Search based methods



2D grid → Graph $G=(V,E)$

configuration space

C_{free} (free space)

C_{obs} (obstacle red color)

- blue → (x,y) coordinate → Vertex (V)

green line connects the blue dots → Edges (E)

If a node $q \in C_{free}$ add to graph

If a node $q \in C_{obs}$ then discard

SS

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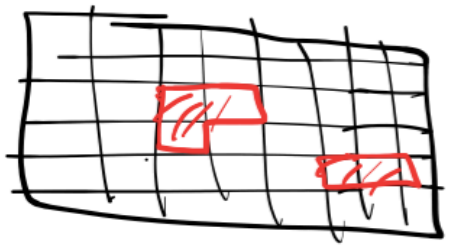
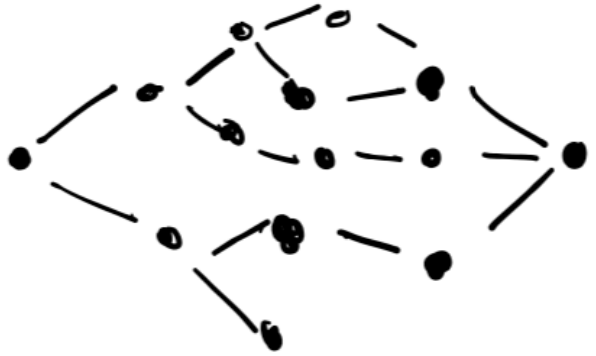


2D Grid



Graph $G = (E, V)$

All nodes $q \in C_{free}$

SS

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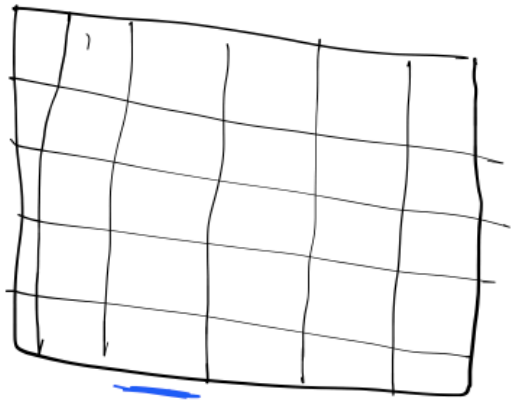
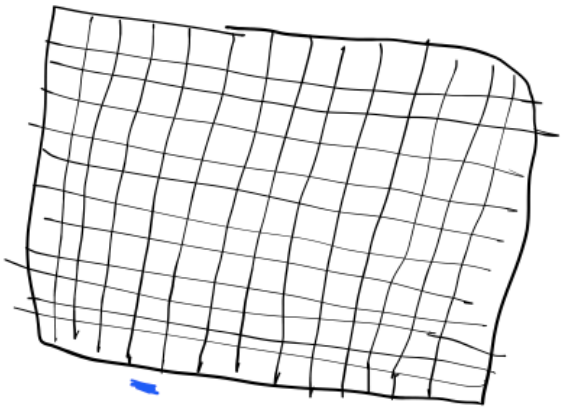


1

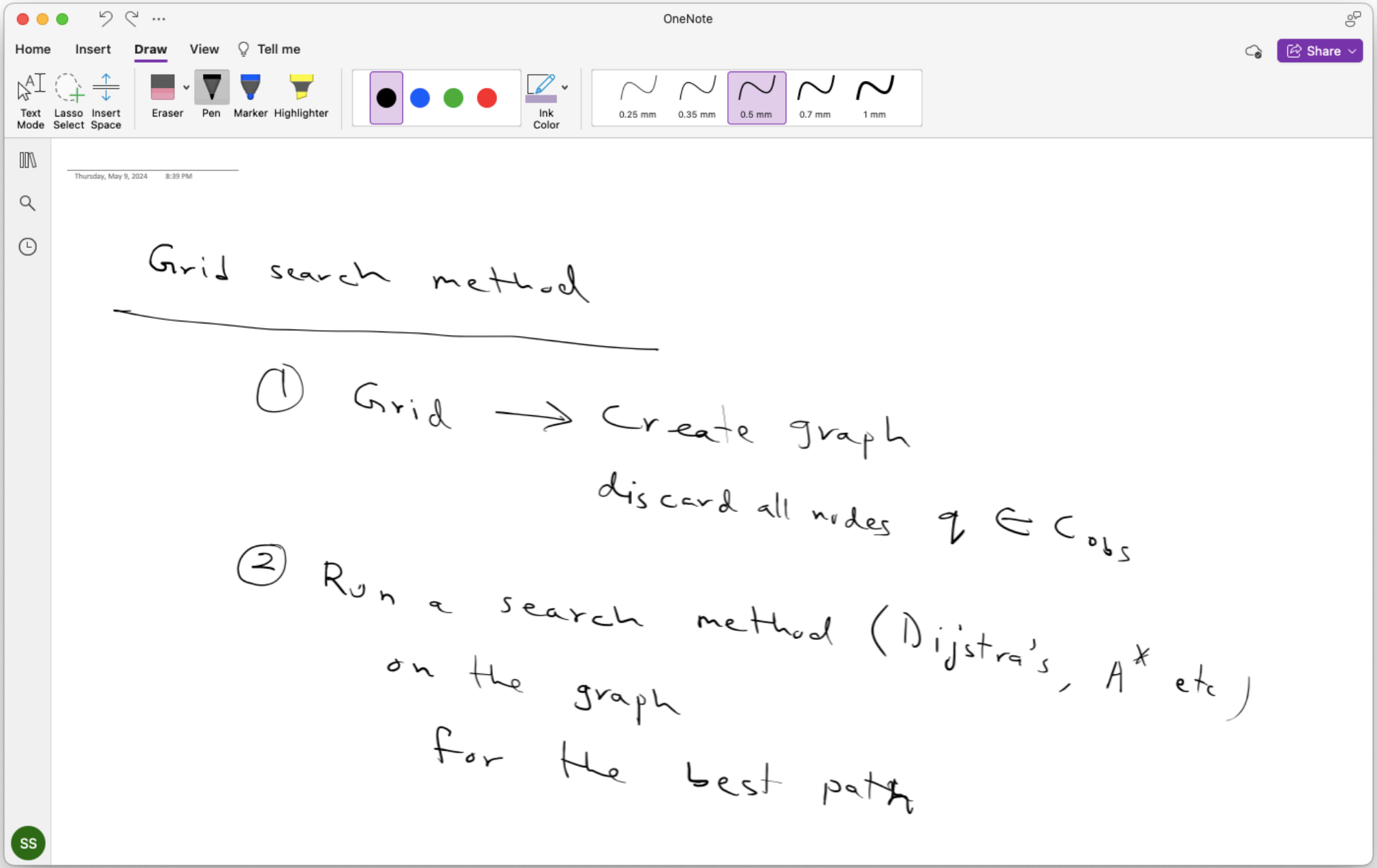
Large discretization → small # of node
→ smaller graph
lower computation
→ less accuracy



2

small discretization (large # nodes)
→ larger graph
much higher computation
→ higher accuracy

SS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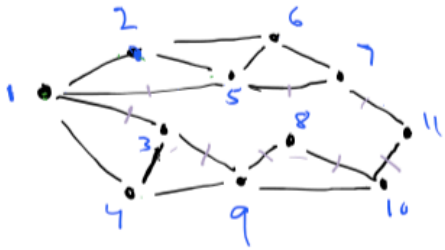
Grid search method
(1) Grid → Create graph
discard all nodes q ∈ C_obs
(2) Run a search method (Dijstra's, A* etc)
on the graph
for the best path
SS

Thursday, May 9, 2024 8:49 PM

Graph search algorithms

Starting node q_I Goal Node q_G

Objective: Find best path from q_I to q_G (minimum cost)



$q_I = 1$

$q_G = 11$

Shortest path

$1 \rightarrow 5 \rightarrow 7 \rightarrow 11$

Methods:

1. Breadth first search
2. Depth first search
3. Best first search (Dijkstra's method)
4. A* search ✓ (Best)

SS

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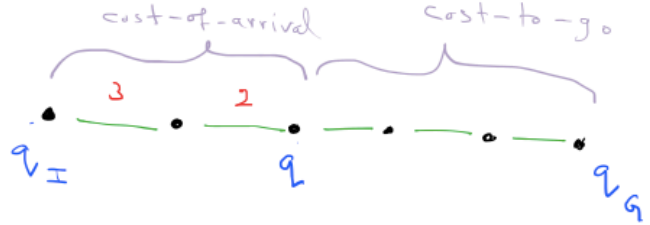
Define costs to go from one node to the next node.

- cost-of-arrival
- cost-to-go

Node / Vertex



q intermediate nodes

q_I start node, q_G goal node

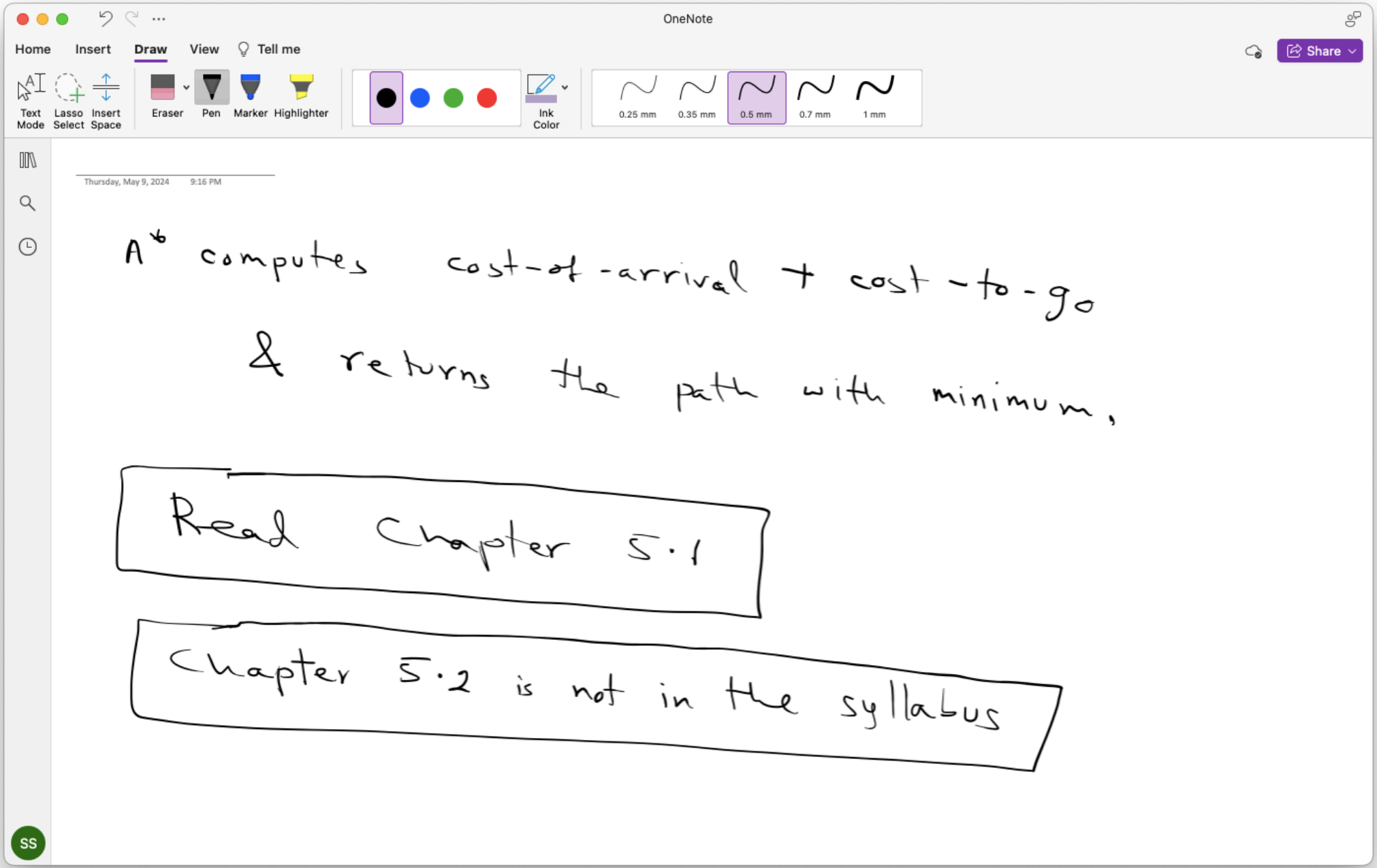
cost-of-arrival

The cost $c(q)$ for a node q is the cost to go from q_I to q

$c(q) = 2+3 = 5$

cost-to-go

The cost $c(q_G)$ for a node q_G is the cost to go from q to q_G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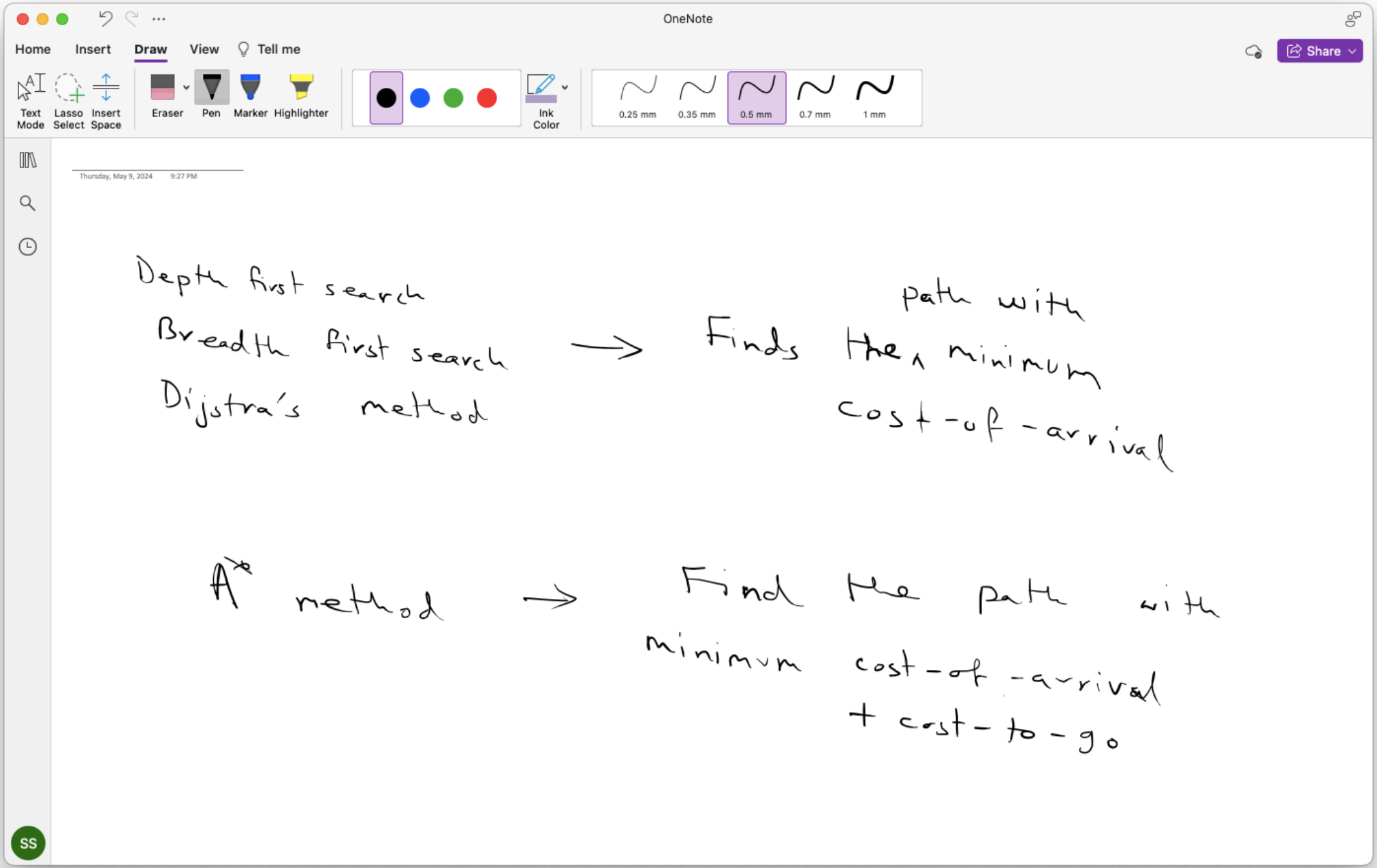
A* computes cost-of-arrival + cost-to-go
& returns the path with minimum,
Read Chapter 5.1
Chapter 5.2 is not in the syllabus
SS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Thursday, May 9, 2024 9:27 PM
Depth first search
Breadth first search
Dijstra's method
Finds the path with minimum cost-of-arrival
A* method
Find the path with minimum cost-of-arrival + cost-to-go
SS

Grid-based search method → computationally heavy

Alternatively, we can try sampling based methods

For example, sample $n = 50$ nodes from the grid
or $n = 100$

Sample from uniform distribution

rand