RRT MP

ECE/CS498

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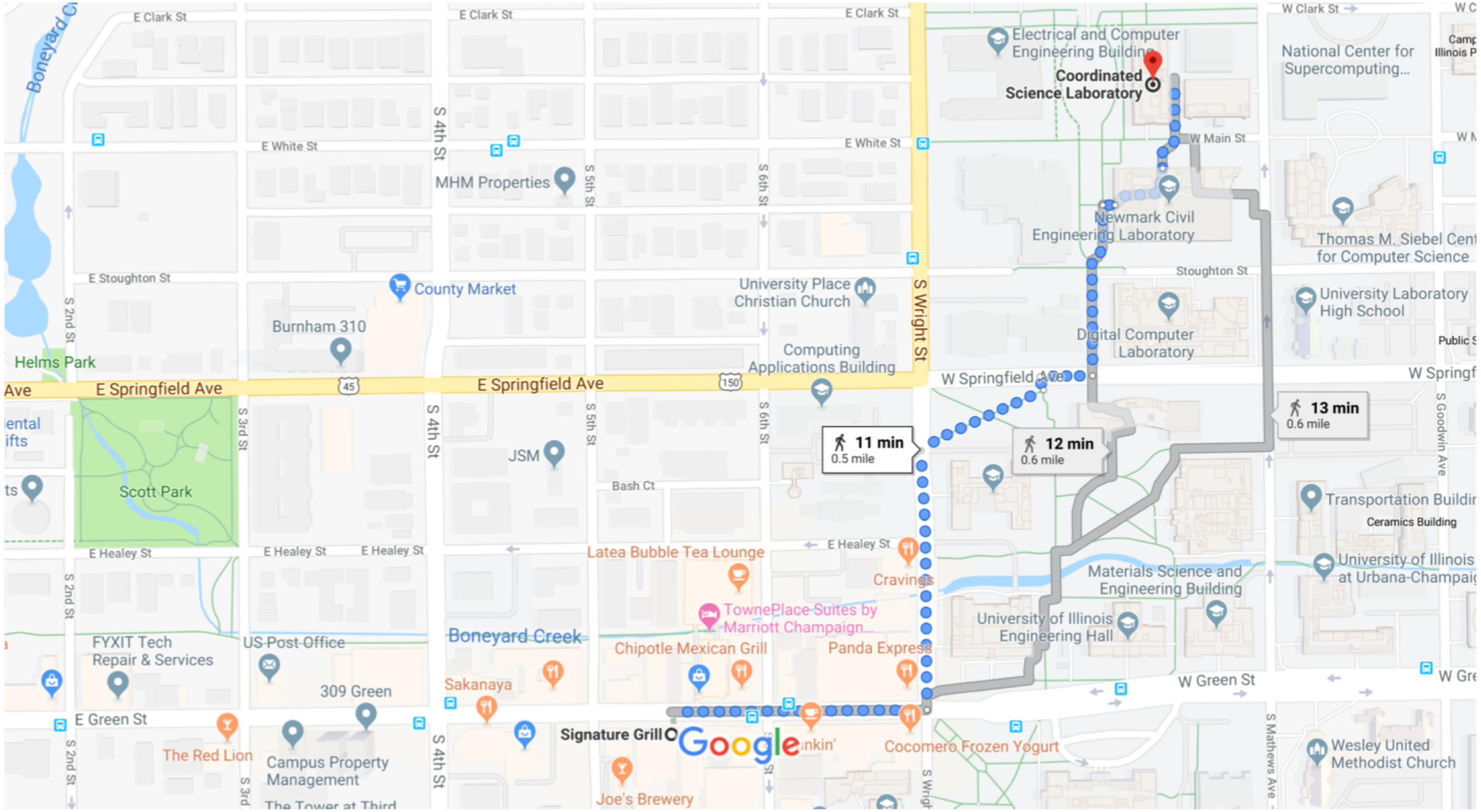
8th April, 2019

Outline

- Introduction
- Rapidly-Exploring Random Tree
- Controller Design
- Putting it all together

What is Planning?

Google Maps Signature Grill to Coordinated Science Laboratory Walk 0.5 mile, 11 min



Map data ©2019 Google 200 ft

Motion Planning

Given initial state x_{init} and a goal X_G, what is the path or sequence of control inputs that will lead us from start to goal?

Possible Issues:

- Obstacle avoidance
- Nonholonomic systems
- Computationally intensive
  - Nonconvex optimization
  - Large number of samples required in real-time

Two approaches: optimization-based & sampling-based techniques

Rapidly exploring Random Tree (RRT)

Build tree by generating next states through the dynamics by randomly selecting inputs

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Generate_RRT($x_{init}, K, \Delta t$)

$\mathcal{T}$.init(x_{init})

for k = 1 to K

x_{rand} ← RANDOM_STATE()

x_{near} ← NEAREST_NEIGHBOR($x_{rand}, \mathcal{T}$)

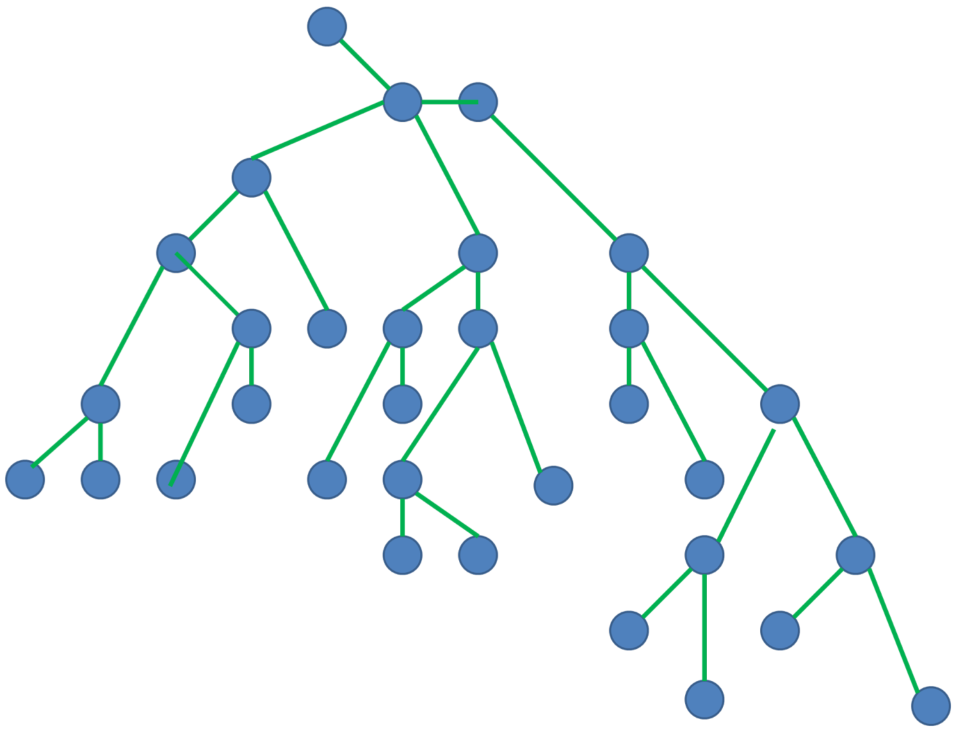
u ← SELECT_INPUT(x_{rand}, x_{near})

x_{new} ← NEW_STATE($x_{near}, u, \Delta t$)

$\mathcal{T}$.add_vertex(x_{new})

$\mathcal{T}$.add_edge(x_{near}, x_{new}, u)

Return $\mathcal{T}$



Rapidly exploring Random Tree (RRT)

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  x_{rand} ← RANDOM_STATE()

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  u ← SELECT_INPUT(x_{rand}, x_{near}) How???

  x_{new} ← NEW_STATE($x_{near}, u, \Delta t$)

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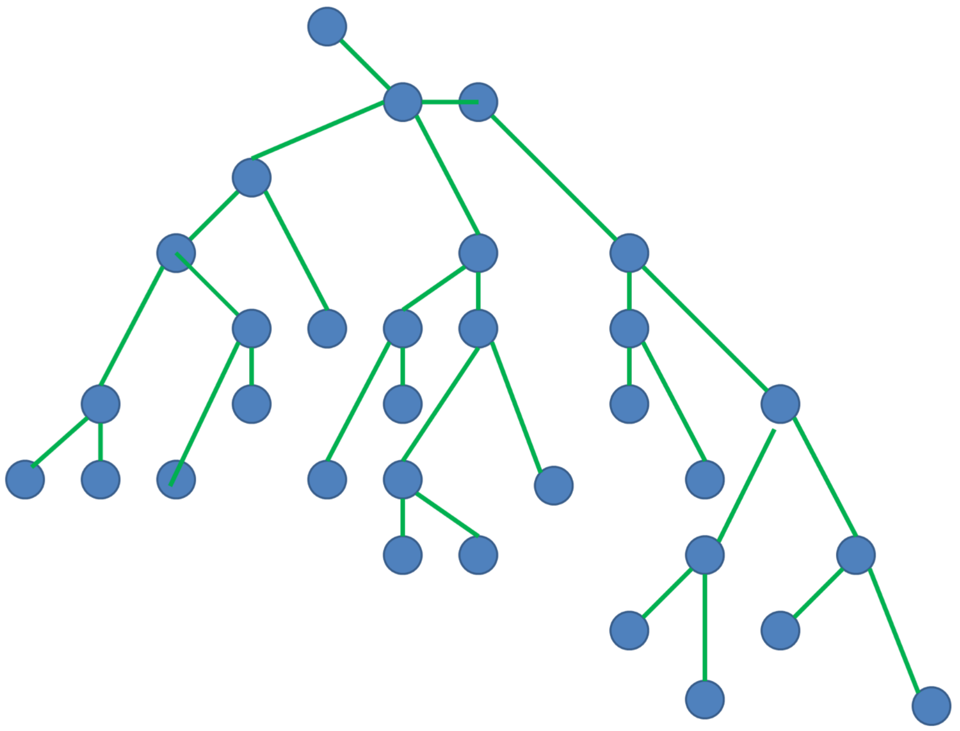
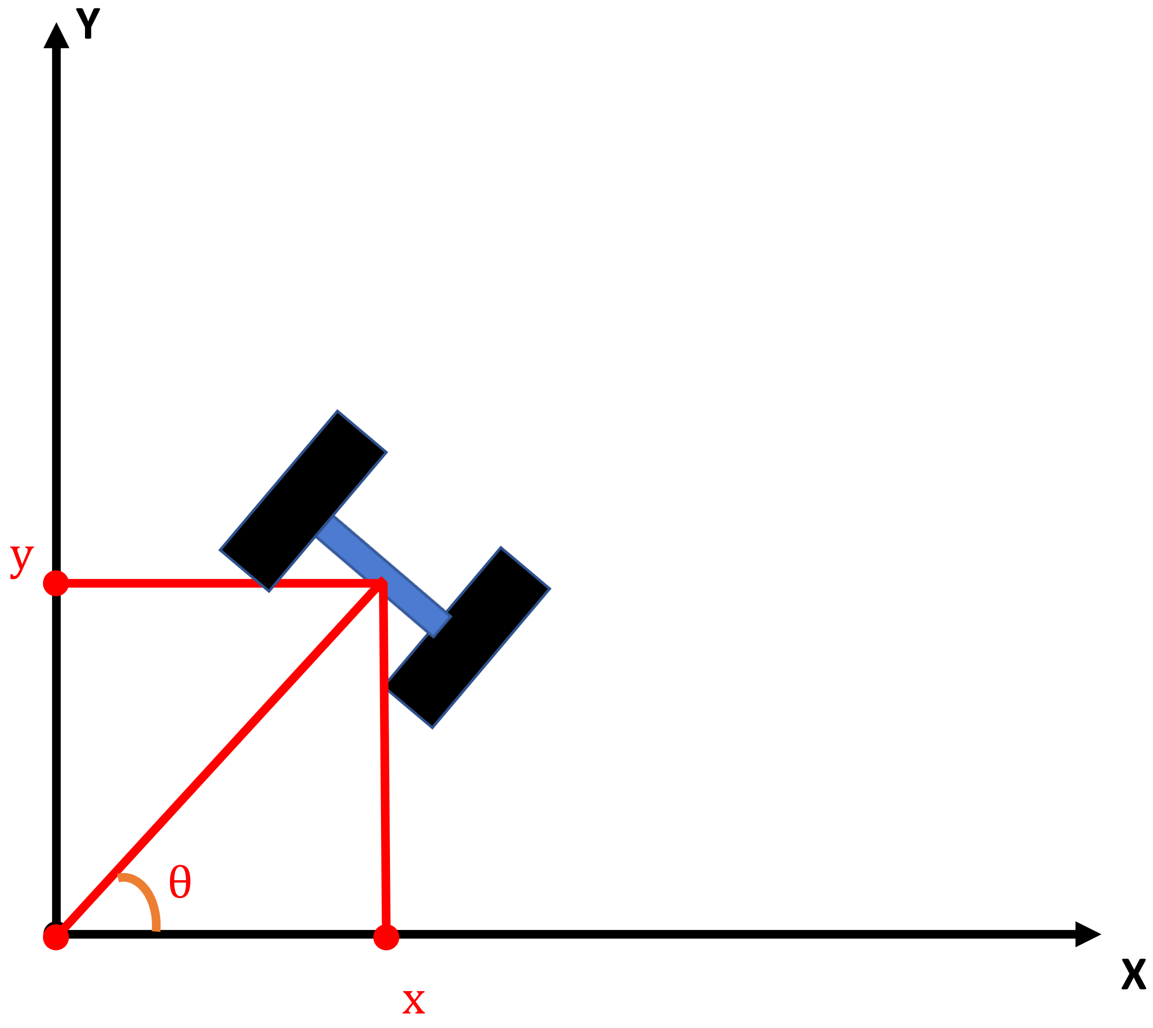


Controller Design?

- How to move a robot from point **A** to point **B**
- We need a model first

$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} V_R \cos(\theta) \\ V_R \sin(\theta) \\ \delta \end{bmatrix}$$

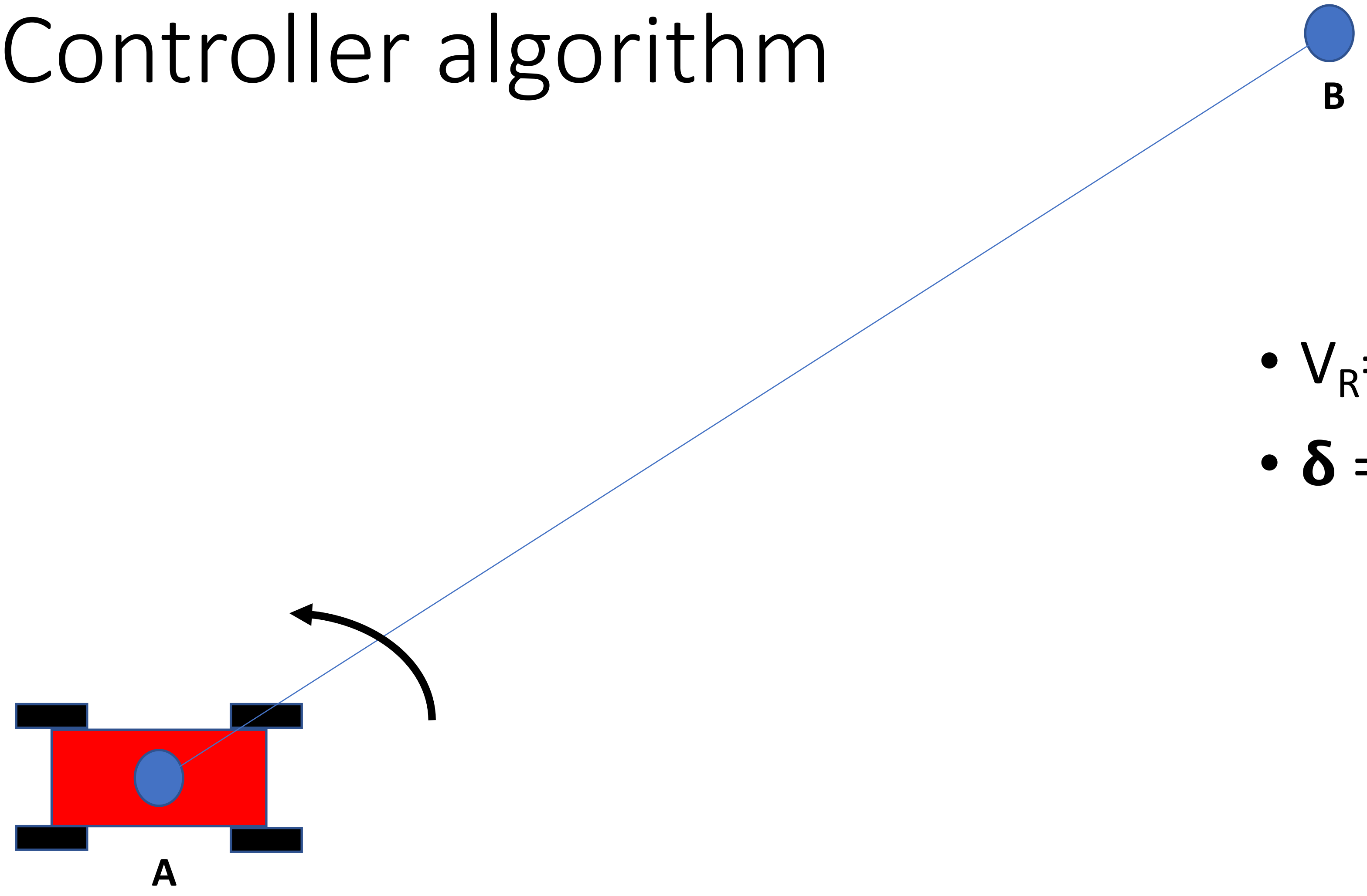


$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} V_R \cos(\theta) \\ V_R \sin(\theta) \\ \delta \end{bmatrix}$$

- V_R : speed of the car
- **δ** : steering of the car

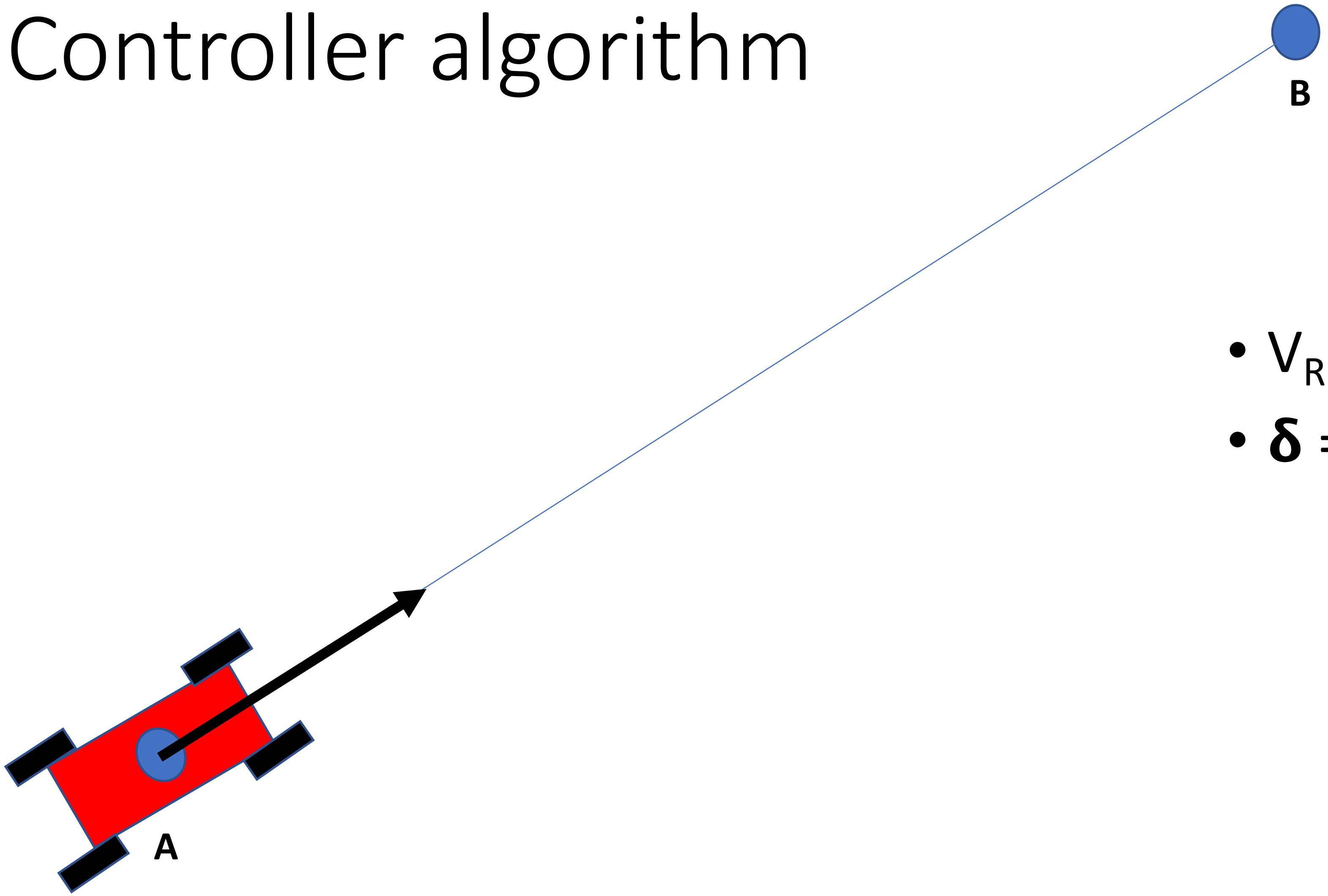
How to figure out this V_R and **δ**?

Controller algorithm



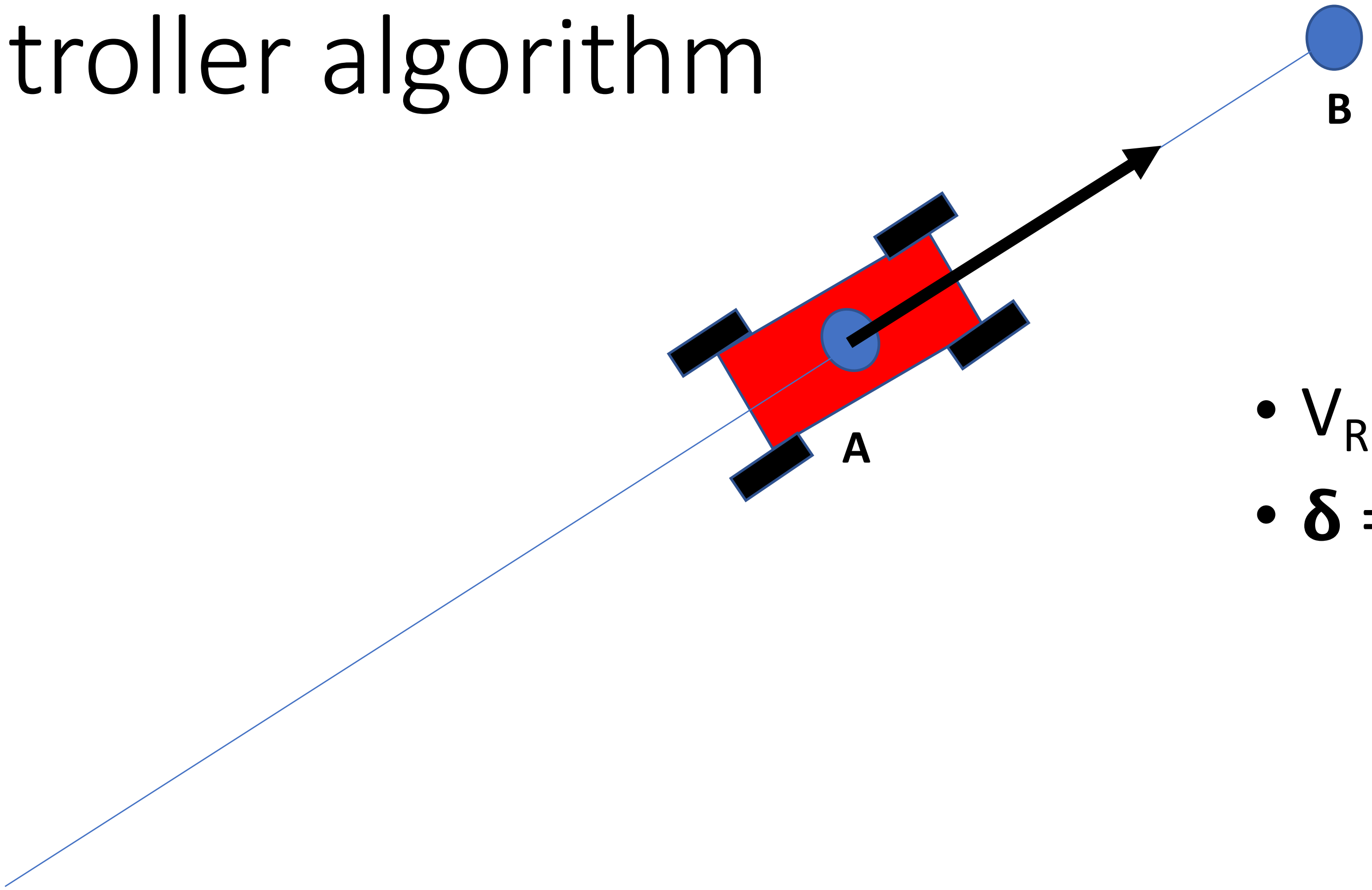
- $V_R = 0$
- $\boldsymbol{\delta} = K(\arctan(\overrightarrow{AB}) - \theta)$

Controller algorithm



- V_R= Constant
- $\boldsymbol{\delta}$ = 0.0

Controller algorithm



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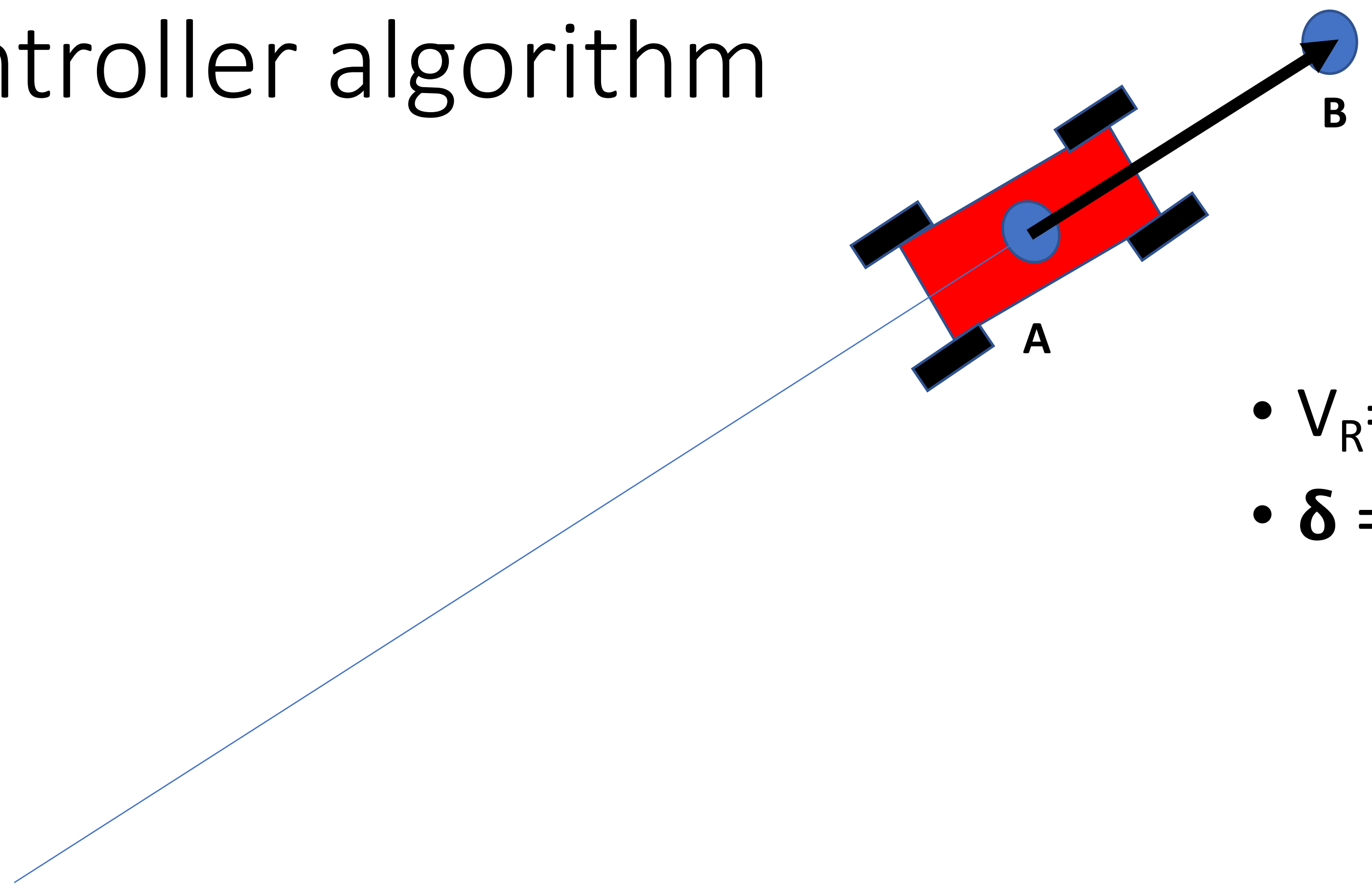

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This MP