

# **CS-417 INTRODUCTION TO ROBOTICS AND INTELLIGENT SYSTEMS**

## **Midterm Review**

# Overview

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- History
- Sensors
- Actuators
- Locomotion
- Mapping
  - Topological
  - Metric
  - Feature Based
  - Occupancy Grid
- Computer Vision
- Coverage
- Path-Planning
  - Visibility Graph
  - Bug (0, 1, 2, Tangent)
  - C-Space
  - Probabilistic Roadmaps
  - Potential Fields
  - RRT
  - Generalized Voronoi Graph (GVG)
- Multi-Robot Systems
- Control Theory

# Sensors

- **Proprioceptive Sensors**

(monitor state of vehicle-propagate)

- IMU (accels & gyros)
- Wheel encoders
- Doppler radar ...
  - **Noise**



- **Exteroceptive Sensors**

(monitor environment-update)

- Cameras (single, stereo, omni, FLIR ...)
- Laser scanner
- MW radar
- Sonar
- Tactile...
  - **Uncertainty**



# Sensors

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- Tactile
- Close-range proximity
- Angular position
- Infrared
- **Sonar**
- Laser (various types)
- RADAR
- Compasses, Gyroscopes, Accelerometers - IMU
- Force
- GPS
- Vision



# Actuators

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- Hydraulic Actuators
- Pneumatic Actuators
- Air Muscle
- Shape Memory Alloy Actuators
- Electric Actuators
- Stepper Motors



# Locomotion

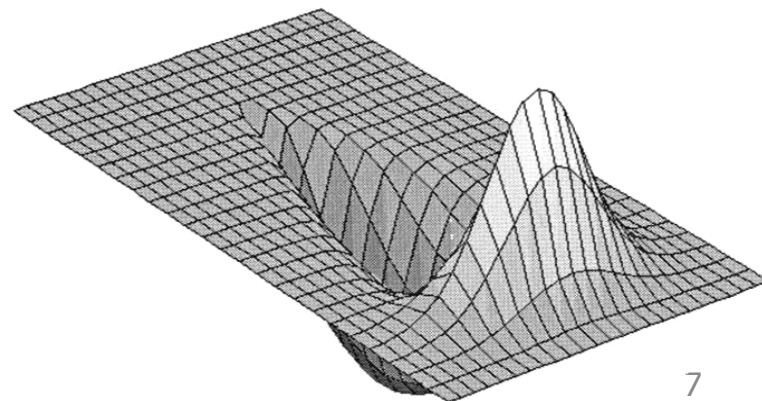
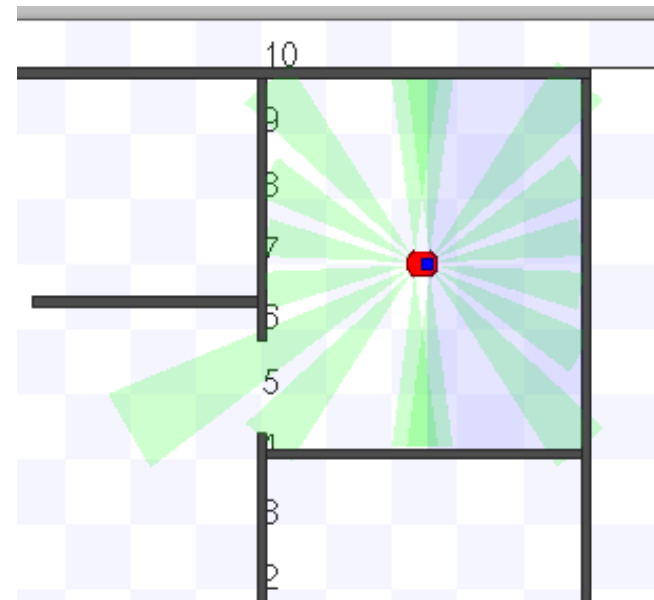
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- Differential drive
- Synchronous drive
- Ackerman drive
- Legged Locomotion
  - Quadrupeds
  - Hexapod
  - Biped



# Mapping

- Occupancy Grids
- Sonar model



# Path Planning

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## World

- Indoor/Outdoor
- 2D/2.5D/3D
- Static/Dynamic
- Known/Unknown
- Abstract (web)

## Robot

- Mobile
  - Indoor/Outdoor
  - Walking/Flying/Swimming
- Manipulator
- Humanoid
- Abstract

## Map

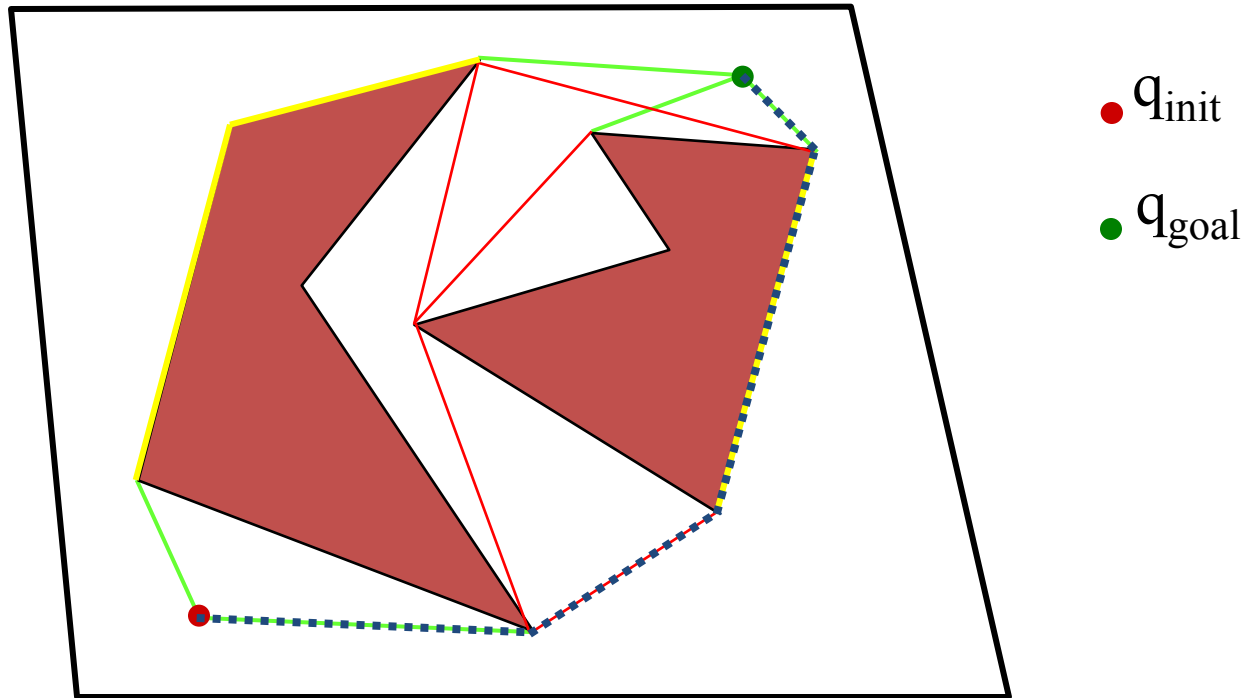
- Topological
- Metric
- Feature Based
- 1D,2D,2.5D,3D





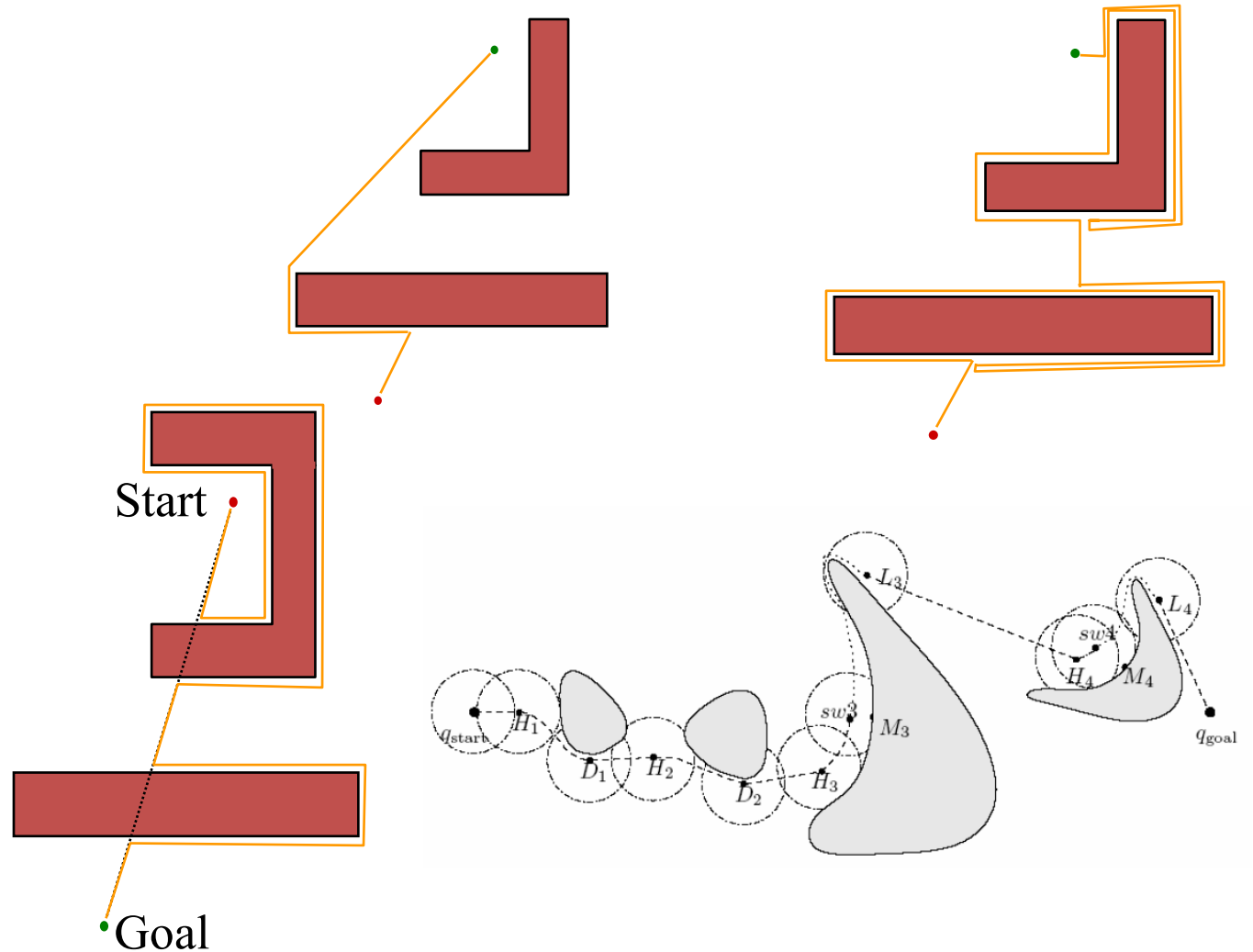
# Path Planning

- Visibility Graph



# Bugs

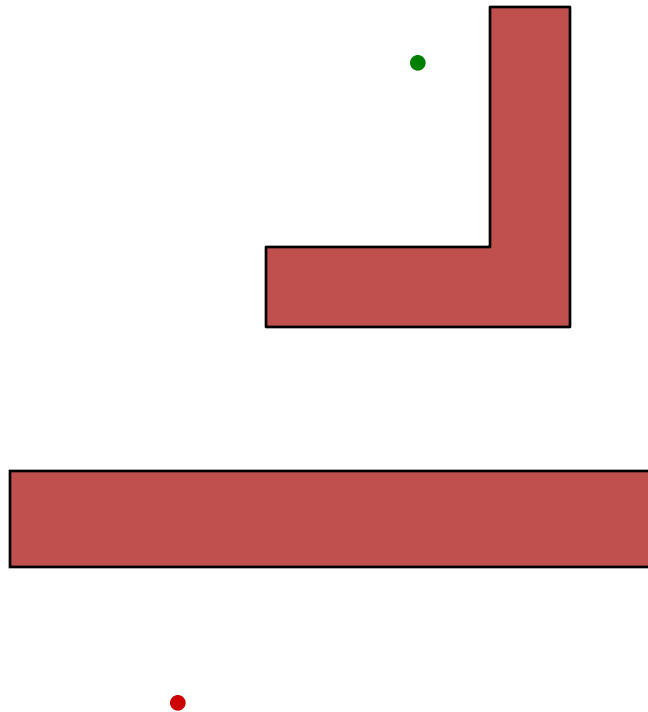
- Bug0
- Bug1
- Bug2
- Tangent Bug



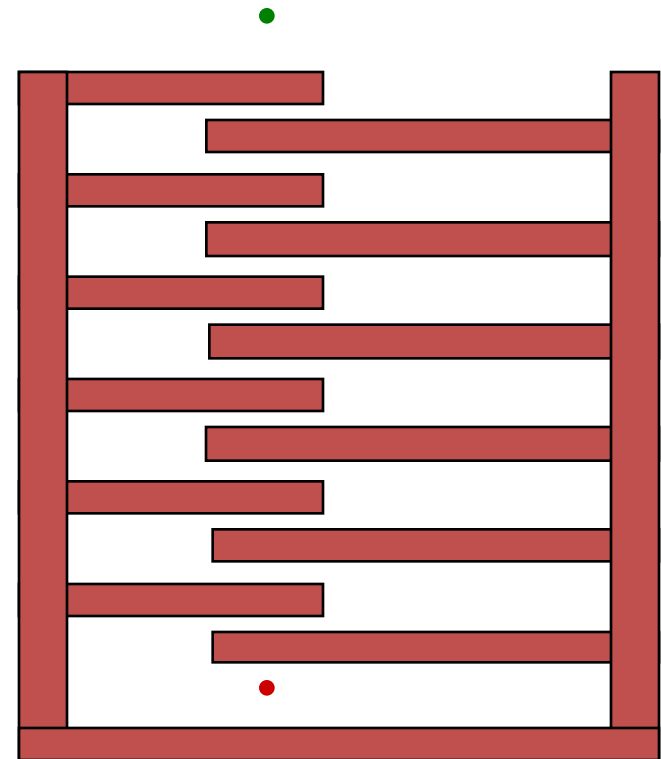
# Head-to-Head Comparison

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- Bug 2 beats Bug 1

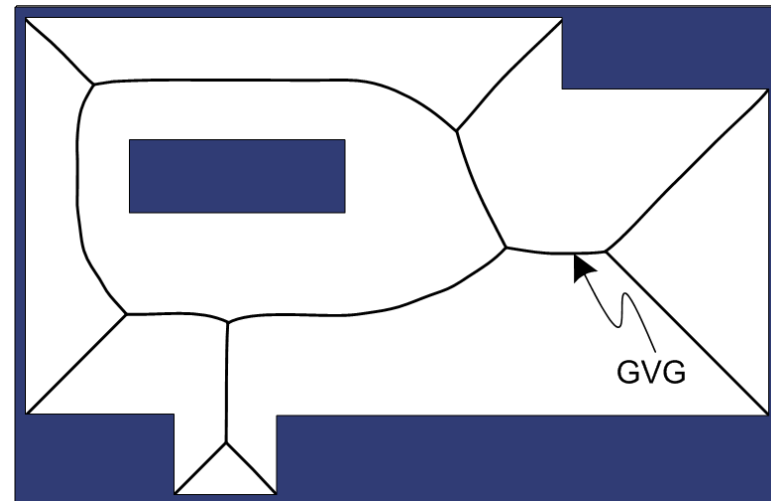
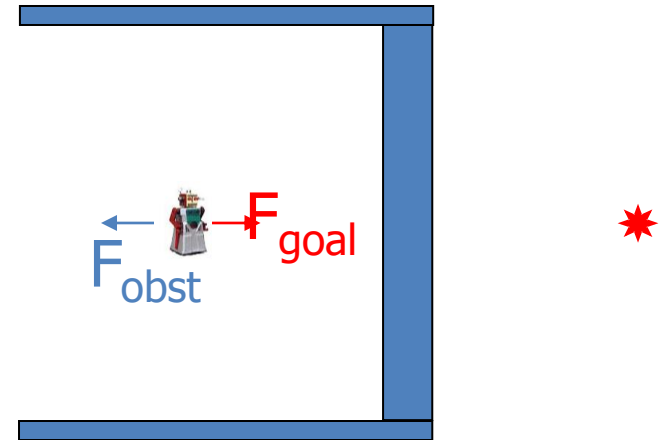


- Bug 1 beats Bug 2



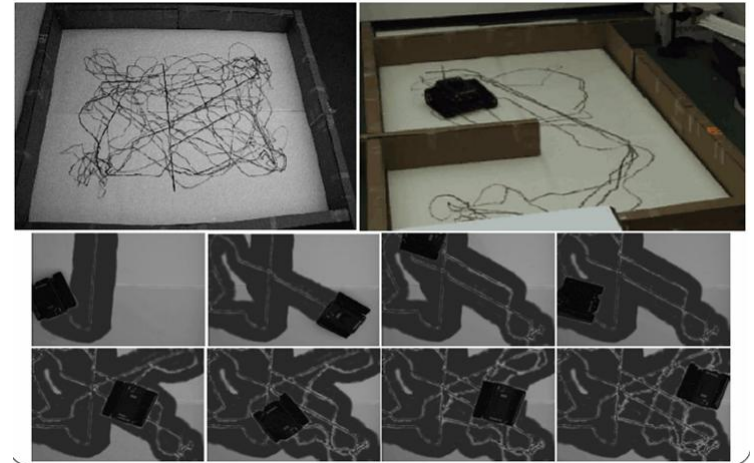
# Path Planning

- Potential Field Path Planning
- Generalized Voronoi Graph
- Wavefront Planner
- Configuration Space
- Probabilistic Roadmaps
- Rapidly Exploring Random Trees (RRT)



# Coverage

- Complete?
- Deterministic?
- Optimality
- Applications
- Boustrophedon
- Multi-Robot Coverage



# Computer Vision

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- Camera Geometry (Perspective Transformation)
- Ill Posed Problem
- Correspondence Problem
- Gaussian Blur
- Fiducial Markers
- Stereo Vision
- Optical Flow



# Multi-Robot Systems

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- Coverage
  - Communication capabilities
- Auctions
- Marsupial Robotics
- Formations
- Cooperative Localization
- Cooperative Mapping and Exploration



# Control Theory

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- Control the robot to perform the required actions
- Follow a trajectory

