Lecture 6-1: Topological Path Planning

***Introduction to AI Robotics* (Ch. 9)**

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Objectives:

- Define the differences between natural and artificial landmarks and give one example of each
- Given a description of an indoor office environment and a set of behaviors, build a relational graph representation labeling the distinct places and local control strategies using gateways
- Describe in one or two sentences: gateway, image signature, visual homing, viewframe, and orientation region
- Given a figure showing landmarks, create a topological map showing landmarks, landmark pair boundaries, and orientation regions

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Navigation is one of the most challenging mobile robot competencies. It refers to the way a robot finds a way in the environment but it is rooted in uncertainty because of sensor and odometry error.

Successful navigation requires

- _____
- _____
- _____
- _____

There are two types of navigation: _____ and _____

There are 4 questions required for navigation:

1. Where am I? (_____)
2. What's the best way to get there? (_____)
3. Where have I been? (_____)
4. Where am I? (_____)

Typically, for successful navigation the robot will have local and global behaviors and rules and these may not necessarily be delineated by reactive and deliberative layers of the hybrid control architecture. For example, map making may require local and global behaviors/rules.

The worlds' representation is the robot's _____.

Spatial memory supports 4 basic functions:

1. _____ - what to look for?
2. _____ - where can the robot fit?
3. _____ - what is the best way through the space?
4. _____ - what does the place look like?

There are also two forms of spatial memory:

1. _____ (qualitative) – expresses space in terms of connections between landmarks (egocentric)
2. _____(quantitative) – expresses space in terms of approximate scale to estimate distances (bird's eye view)

There are also two types of route representations:

1. Relational – the robot connects the dots in a graph representation
2. Associative – couples sensing with localization, reflexive behaviors

Topological navigation depends upon route representation where a ***landmark*** is a perceptually distinctive feature of interest on an object or locale of interest (i.e. red door, McDonalds).

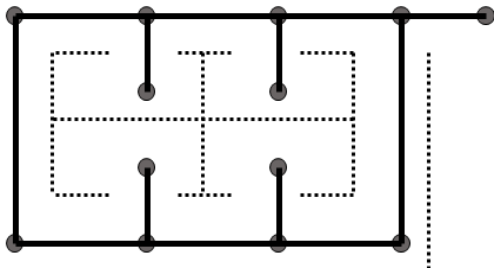
A _____ is an opportunity for the robot to change overall direction of navigation (i.e. intersection of 2 hallways)

Landmarks can be

- _____ - added to an object so support recognition (i.e. interstate highway exits)

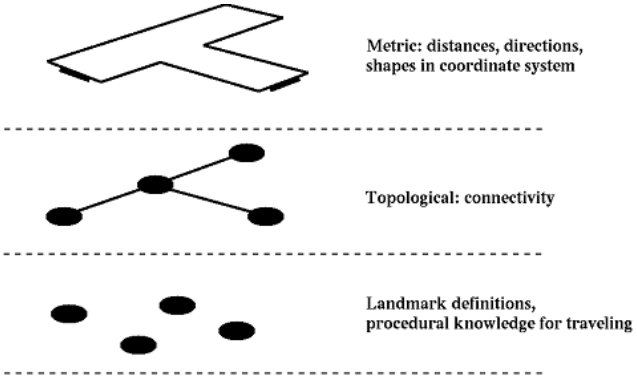
- _____ - configuration of existing features for recognition (i.e. McDonald's golden arches)

Landmarks should be readily recognizable, support the task dependent activity and perceivable from different viewpoints.

A ***relational graph*** has nodes which represent landmarks, gateways and goal locations. The edges represent a navigable path.	

A ***distinctive place*** is a landmark that the robot could detect from a nearby region called a ***neighborhood*** (i.e. corner of a room)

There are three levels of spatial hierarchy based upon cognitive science. The higher layers represent increasing intelligence.



The advantages of topological navigation are that:

- Eliminates or corrects navigational errors
- Possible to build a reasonable metric map
- Supports the discovery of new landmarks

The disadvantages of topological navigation are that:

- Landmarks are not always distinguishable
- Good distinctive places are hard to perceive
- A landmark must be unique

_____ are less popular than relational methods and involve creating a behavior which converts sensor observations into a direction to go to reach a particular landmark. Two examples of using association methods are:

- _____ - the use of an image signature to direct the robot to a specific location.
- _____ - qualitative navigation is a means of localizing the robot to a particular orientation region defined by landmark pair boundaries.