A!

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Informative Path Planning

Information to the rescue!!

Dr. Kshitij Tiwari

Dept. of Electrical Engineering and Automation
kshitij.tiwari@aalto.fi

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Overview

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Recap

Ever seen a dog perform graph-search?

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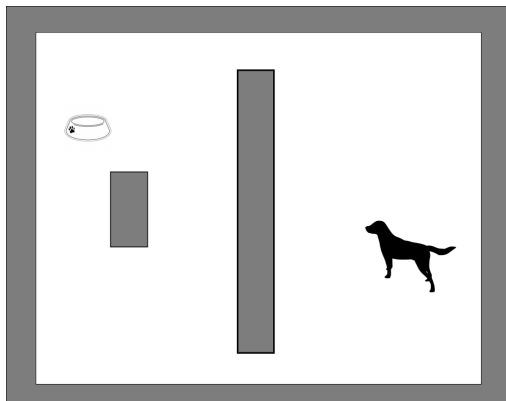
Recap (cont.)

Figure: Dog and the food scenario.

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Recap (cont.)
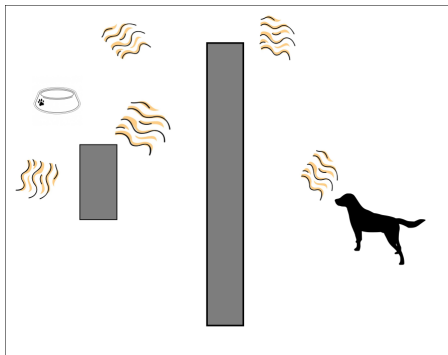
Figure: Food odor attracts the dog.

How to *encode* this behavior?

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Informative Path Planning (IPP)-Information

Information can be of 2 types:

1. **High Value:** high measurements/readings.
   - ▶ *E.g.,* Doggo senses very strong odor of food.
2. **High Variance:** high variance/uncertainty.
   - ▶ *E.g.,* Doggo senses odor but unsure what object it is.

Figure: High Value: My precious (Imagine Gollum's voice).

Figure: High Variance: What the heck??

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Informative Path Planning (IPP)-Information (cont.)

Pop-Quiz (PQ1**)!!**

When to rely on which kind of information?

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Informative Path Planning (IPP)-Path Planning

Planning paths using "information" encompasses:

1. Defining *information*.

2. Defining information *optimization* strategy.

3. Defining *termination* strategy.

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Informative Path Planning (IPP)-Path Planning (cont.)
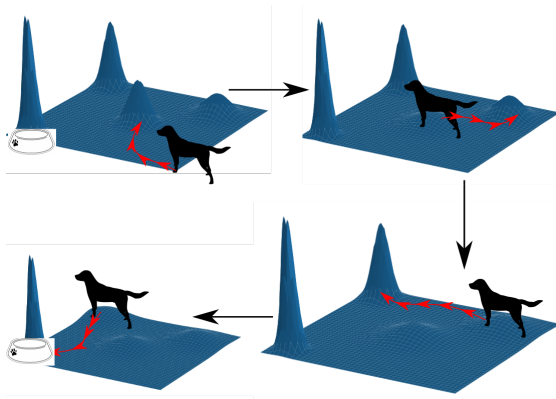
Figure: Doggo following "information".

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Informative Path Planning (IPP)-Path Planning (cont.)

Pop-Quiz (PQ2)!!

What kind of information was the doggo using in this example?

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Informative Path Planning (IPP)-Path Planning (cont.)

$\textbf{\textit{IPP}}(StartNode, AreaLim, TermCond, InfoFunc)$

1: **Input**:
- $StartNode$: node representing start position (root)
- $AreaLim$: limits of the area for acquiring information
- $InfoFunc$: formulation of information
- $TermCond$: termination condition

2: **Output**:
- $Path$: Path to acquire information

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Informative Path Planning (IPP)-Path Planning (cont.)

3: **while not** $TermCond$ **do**
4:      $x \leftarrow$ CurrLoc() $\triangleright$ Get current loc
5:      $x^+ \leftarrow$ GetCandidates(x,AreaLim) $\triangleright$ Find all possible next-loc
6:      $x^* \leftarrow \arg\max_{i \in x^+}$ Info(i) $\triangleright$ Most informative loc
7:      MoveTo(x^*) $\triangleright$ Execute
8: **end while**

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Informative Path Planning (IPP)-Path Planning (cont.)

Pop-Quiz (PQ3)!!

- $1-$ step lookahead is sufficient?
- How about planning full trajectory at once?
- How can we get information about the places that we have not visited yet?
- Is it worth revisiting places that have already been observed?
- How to handle multi-doggo teams?

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Informative Path Planning (IPP)-Challenges

IPP is beset with following challenges:

- ► How to decide **termination** condition?
    - ► Stop when doggo is *tired*?
    - ► Stop when doggo reaches *food*?
    - ► Stop when time is up?
    - ► . . .
- ► Scaling to multiple doggos?
- ► How to prevent interference with other information?
    - ► Doggo distracted by other odors.
- ► What does one call sufficient amount of "information"?
    - ► When do we say doggo knows enough about location of food?

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Summary

- Introduction to Informative-path planning
- Exposure to categories of information
- Worked examples and pseudo-codes.
- Animations as visual props to ease understanding.
- Several pop quizzes for open discussion via *MyCourses*

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Summary (cont.)

Figure: Finally, *doggo* gets to eat the food!!!

Can you try doing this with robots?

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Books

Multi-Robot Exploration For Environmental Monitoring

The Resource Constrained Perspective

Edited by:

Dr. Kshitij Tiwari
Aalto University, Intelligent Robotics Group, Department of Electrical Engg. & Automation,Espoo, 02150, Finland

Prof. Nak Young Chong
Japan Advanced Institute of Sc. & Tech. (JAIST),School of Information Science,,Nomi City, 923-1211, Ishikawa, Japan

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ROS Tutorial

- ▶ ROS stands for *Robot Operating System*
- ▶ Used to program and interface with robots
  - ▶ Can use Python/C++
- ▶ ROS Crash course for absolute beginners using Python

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Thank You!!

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