Model-based Informative Path Planning for Benthic Habitat Mapping

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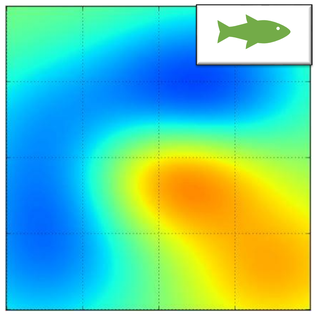
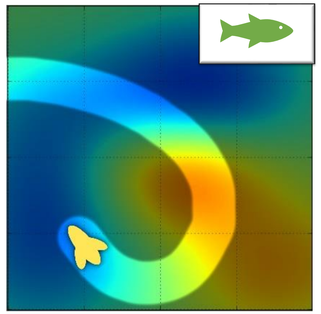
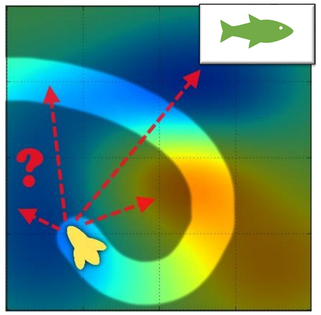
What is Informative Path Planning?



1. We wish to map a continuous variable in a spatial field.

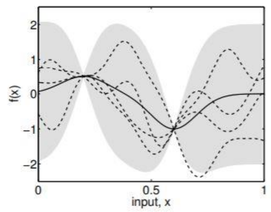


2. Our autonomous agent has only observed part of the field (bright) at a given time.



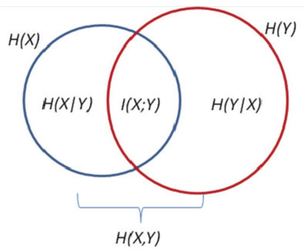
3. The agent must decide where to sample next based on its previous observations.

Incentivizing Information Gain

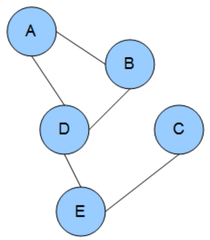


A **Gaussian Process** model (illustrated above) is a kernel-based method commonly used for mean and uncertainty prediction in informative path planning.

Optimal Informative Path Planning seeks to maximize **Information Gain**, which is the amount each new observation informs our model.

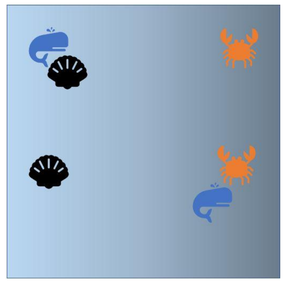


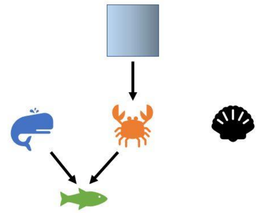
A **Graphical Model** expresses the conditional relationships between jointly distributed variables.



The key contribution of our work is the application of graphical models to improve Informative Path Planning where some partial observations and expert knowledge are available from the start.

Motivating Example

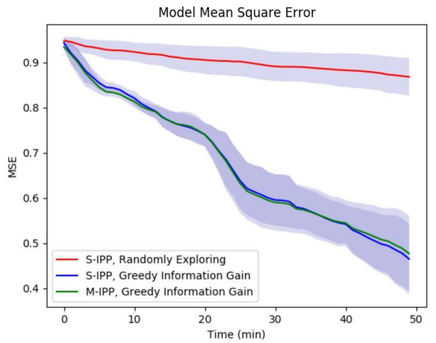




For a previously observed field (left) and expert-provided independence knowledge (right) about species presence (discrete) and sea floor depth (continuous), plan a path to determine the distribution of a new species (fish). We use principles of information gain to actively learn the parameters of the expert model.

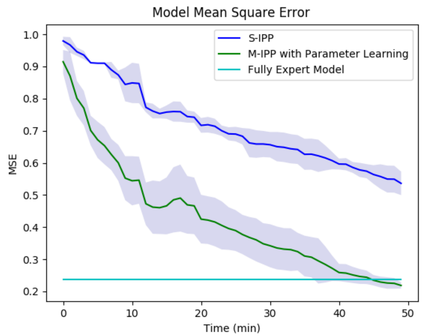
Results

Random Paths vs Informative Paths



We validate a common result from literature that seeking information gain can substantially improve field coverage.

Informative Paths vs Active Model Learning



We present a novel result that seeking information gain **about a graphical dependence model** can substantially improve field prediction.

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