

Estimation and Classification

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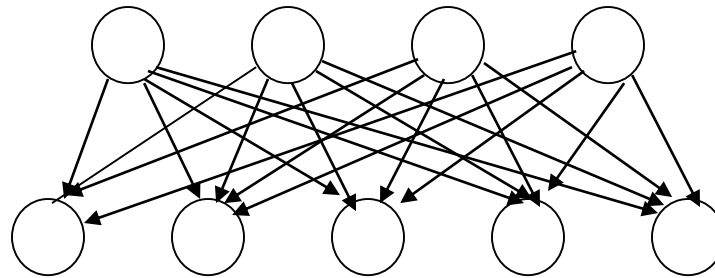
Summary

- What problems are addressed ?
- Topics
- Grading
- Bibliography

Medical Diagnosis

Diseases

Symptoms



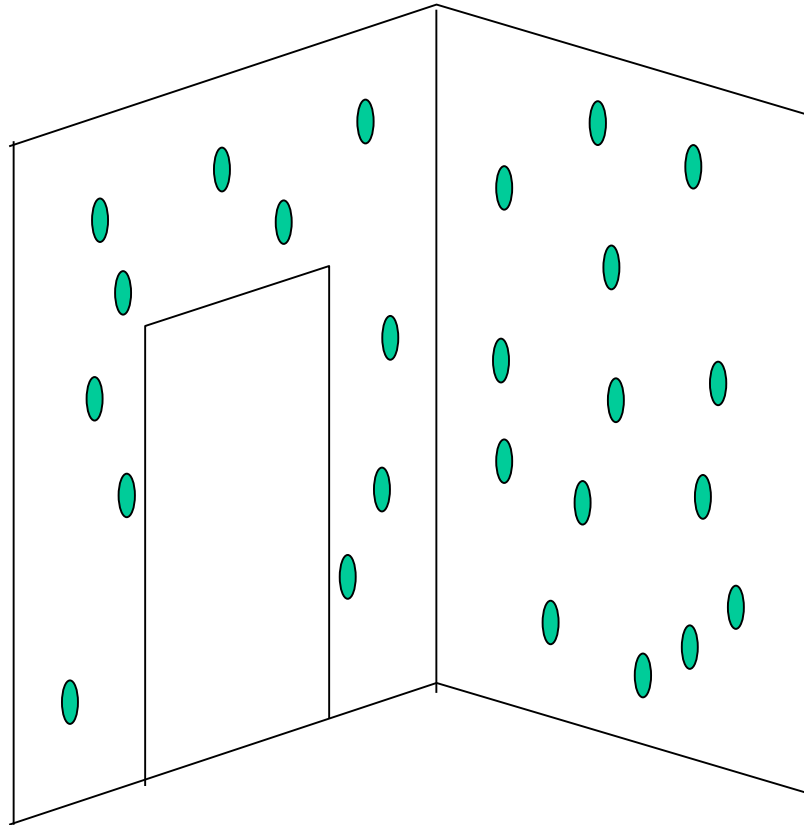
What is the relationship between causes and symptoms ?

Learning

How to infer the cause from some symptoms ?

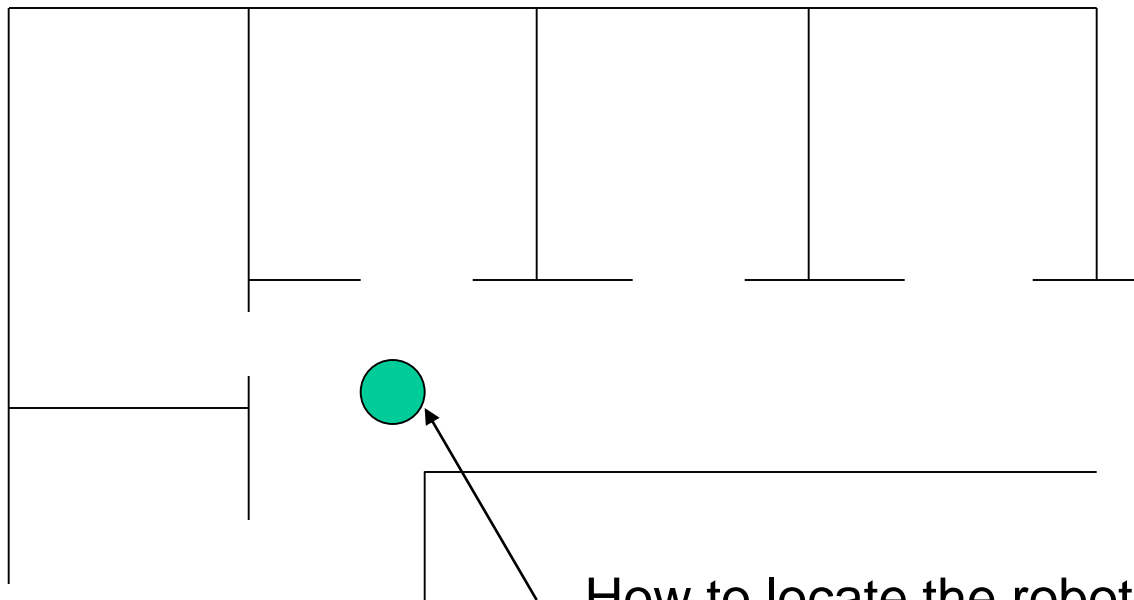
Inference

3D Reconstruction



How to determine the number of planes and their equations ?

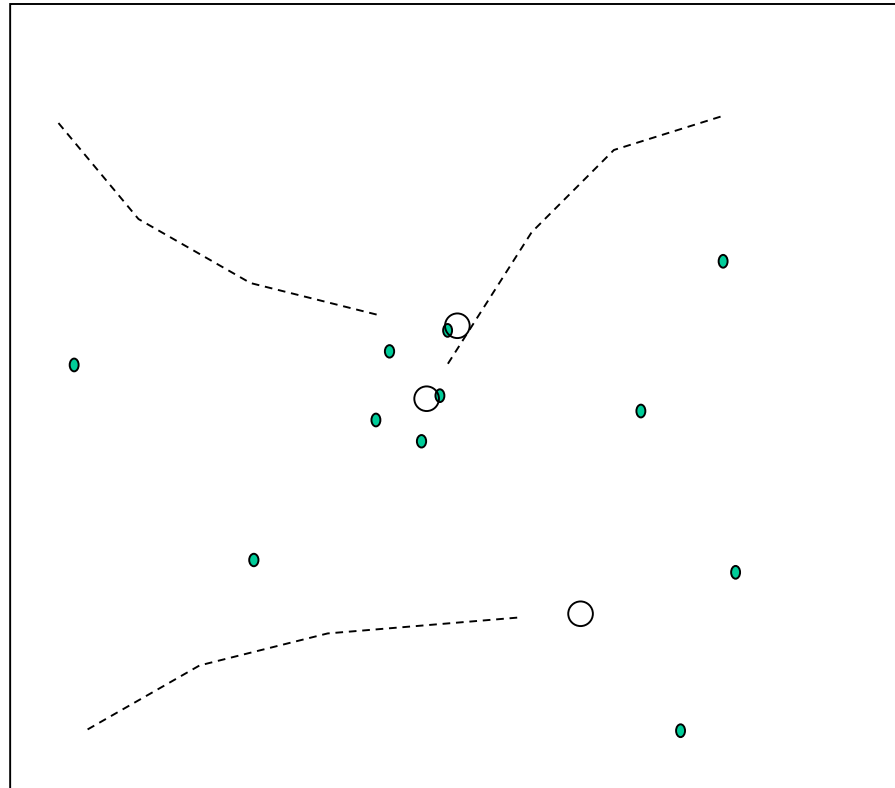
Self Localization



How to locate the robot ?

How to estimate the environment ?

RADAR



Where are the targets located, knowing the radar returns ?

Digital Communication



The source generates discrete symbols which are encoded and sent to the channel. The channel distorts the symbols and corrupts them with noise.

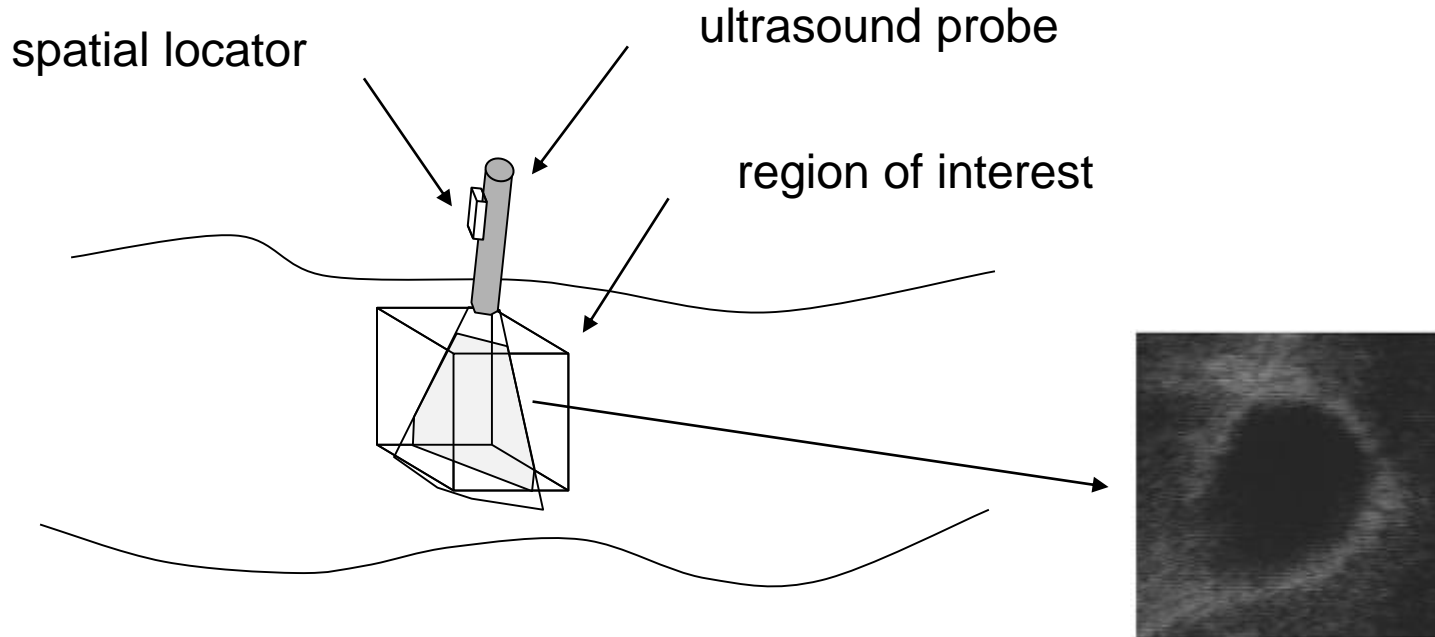
At the receiver, the main problem is: what is the symbol (or symbol sequence) sent by the source to the channel ?

Inference problem !

What is the channel model ?

Learning problem !

3D Ultrasound



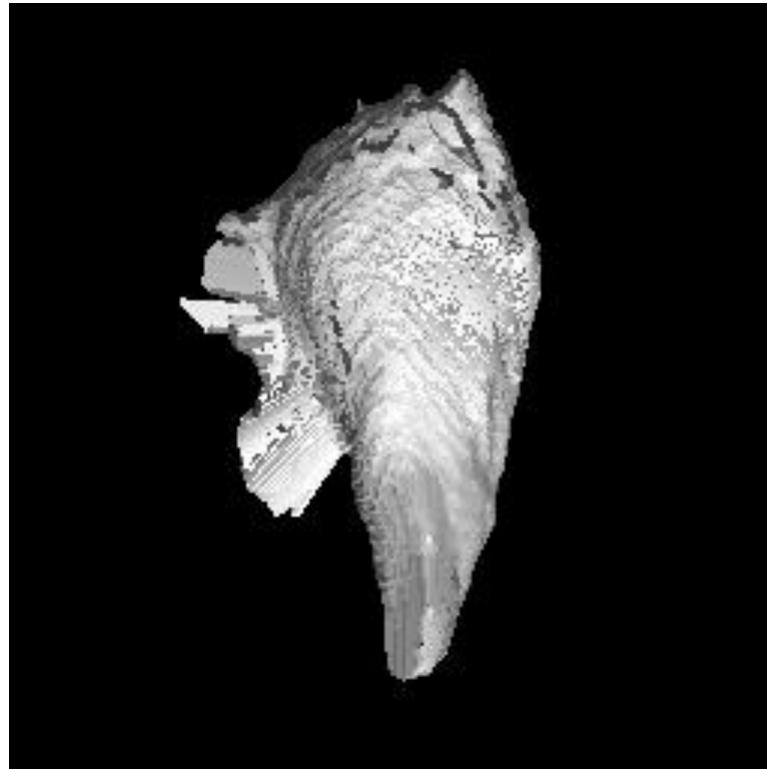
How to estimate the volume the tissue properties in the region of interest ?

Inference problem !

How to compute the acquisition parameters ?

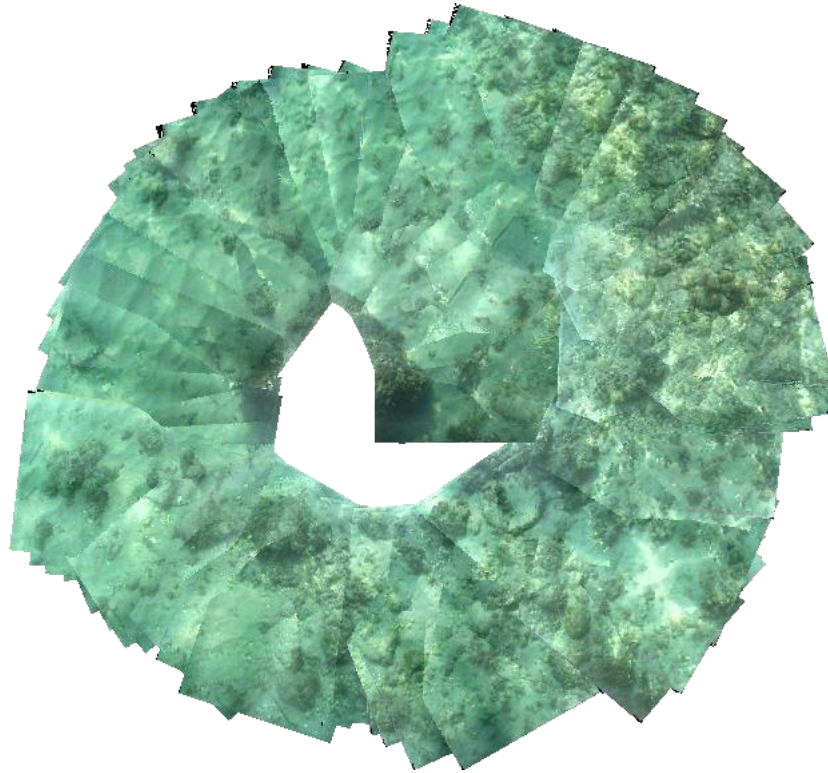
Learning problem !

Results



(Courtesy of João Sanches)

Mosaicing



(Courtesy of José Santos-Victor)

Other Problems

- Speech recognition
- Face and object recognition
- Three dimensional reconstruction of human organs
- Prediction of temporal series
- System identification
- Estimation of probability distributions

Objectives

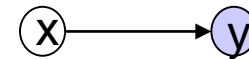
The course addresses the following questions:

- How to compute variables which can not be directly measured by sensors ?
- how to obtain models for observed data (signals, image, video) and use these models in decision problems ?

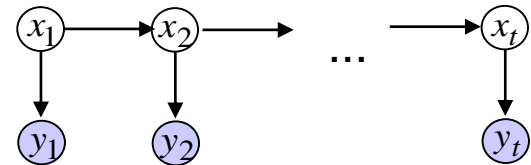
3 Problems

Three problems of increasing complexity will be considered:

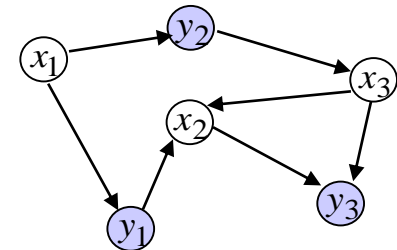
- estimation of **isolated variables**



- estimation of **sequences of variables**



- estimation of **sets of dependent variables**



Inference and learning have to be considered in each case.

Lectures

Probabilities (revisited)

Classic Estimation

Bayesian Inference

Inference with unobserved variables

Pattern Recognition

Discriminant Analysis

Nonlinear and Kalman filtering

Robust and Multiple Model Filtering

Hidden Markov Models

Graphical Models and Bayesian Networks

Applications

Grading

- problem series (and discussion)
- exam

Bibliography

books

- Duda, Hart, Stork, Pattern Classification, Wiley, 2001.
- J. S. Marques, Reconhecimento de Padrões Métodos Estatísticos e Neuronais, IST Press, 1999.
- Y. Bar Shalom, T. Fortmann, Tracking and Data Association, Academic Press
- F. Jensen, Bayesian Networks and Decision graphs, Springer-Verlag, 2001.

papers

- L. Rabiner. A tutorial on hidden Markov models and selected applications in speech recognition, Proceedings of the IEEE, 77(2):257-284, 1989.
- S. Geman and D. Geman. Stochastic relaxation, Gibbs distributions and the Bayesian restoration of images. IEEE Transactions on Pattern Analysis and Machine Intelligence, 6:721-741, 1984.