Engineering Tripos Part IB, 2P8: Information Engineering, 2018-19

Lecturers

Professor R Cipolla, Dr R Turner, Dr G Vinnicombe

Timing and Structure

Easter Term: Weeks 1-4 - 14 lectures + 2 examples classes, 4 lectures/week

Aims

The aims of the course are to:

- Provide a unified view of information engineering showing how signal processing, control, machine learning and machine intelligence relate to one another.
- Use example applications drawn from autonomous driving to provide concrete examples of important concepts and subareas of information engineering including computer vision, machine learning and reinforcement learning.
- Introduce computer vision including algorithms for 3D reconstruction, registration and object detection and recognition.
- Introduce basic concepts in inference, learning and optimisation including maximum-likelihood estimation, Bayes’ rule and gradient descent.
- Introduce basic algorithms for planning and the general area of sequential decision making / reinforcement learning.

Objectives

As specific objectives, by the end of the course students should be able to:

- Provide example applications of machine perception, machine learning, and autonomous decision making systems.
- Understand the mathematical basis for perspective projection, feature detection, neural networks and parameter estimation, basic planning and reinforcement learning.
- Implement methods to solve simple computer vision and machine learning problems including image-matching, classification, and sequential decision making.

Content

A: Autonomous Driving: Machine Perception, Learning and Action Systems (1L)

- Description of autonomous driving hardware (the car, sensors, and actuators)
- Motivate the need for machine perception (computer vision), learning and action systems
- Important sub-problems in the data processing pipeline: object detection, sensor fusion, intention prediction, forecasting, planning and action

B: Machine Perception: Introduction to Computer Vision (6L) (R. Cipolla)

- An introduction to computer vision: reconstruction, registration and recognition
- Perspective projection
- Convolution with gaussians and derivatives of gaussians to provide bandpass filters.
Edge detection using directional filters.
Scale-space and image pyramids for feature detection
The SIFT feature descriptor for matching image features.
Examples paper and class

C: Machine Learning: Introduction to Deep Learning (5L) (R. Turner)

- Training a simple classifier: logistic regression and gradient descent
- Neural networks: Multi-layer perceptrons and back propagation
- Neural networks: convolutional neural networks
- Demonstrations of state-of-the-art object and face recognition, semantic segmentation and pose estimation systems
- Examples paper and class

D: Autonomous Decision Making: Planning and Reinforcement Learning (4L) (G. Vinnicombe and A. Kendall)

- Introduction to planning and reinforcement learning
- Applications of planning and reinforcement learning
- Demonstration of perception and planning algorithms running on an autonomous car
- Examples paper

Booklists

Please see the [Booklist for Part IB Courses][2] for references for this module.

Examination Guidelines

Please refer to [Form & conduct of the examinations][3].

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Links

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