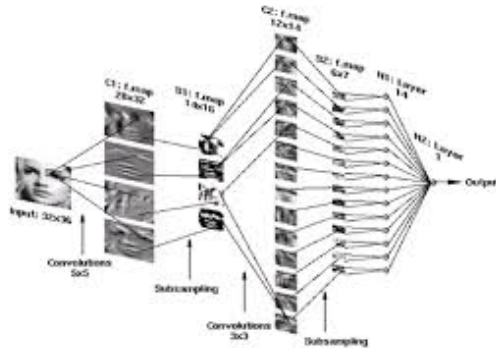


Course Outline



Course Details and Topics

Problem Sheets

- I am going to provide many problem sheets
- One problem sheet will be marked and worth 20% (you will know which one this is)
- The other problem sheets are optional, but some small proportion of the questions will be on the exam
- I will go through the problem sheets, but if you have not attempted the questions you won't learn that much

- Lectures
 - ★ 11:00-11:45 Tuesday, Building 35 room 1005
 - ★ 16:00-16:45 Tuesday, Building 44 room 1041 (L/T A)
 - ★ 15:00-15:45 Thursday, Building 44 room 1041 (L/T A)
- Assessment
 - ★ 80% Exam
 - ★ 20% Problem Sheet

What's in the Course

- This course is going to cover the core principles and mathematics behind machine learning
- It is not going to explicitly teach different machine learning algorithms, although some will be covered
- We are not looking at advanced algorithms but cover the principles
- There are very good implementations available (e.g. scikit-learn)
- Along the way though we will meet (often many times) particular algorithms

- Mathematics is the language of machine learning■
- You can do machine learning without mathematics, but if you want to develop and understand advanced algorithms then you have no choice■
- This course invites you on a journey to crack the code of mathematics for machine learning■
- If this isn't a challenge you want, then this is probably not the course for you■

- Learning Theory
 - ★ Bias-Variance
 - ★ Overfitting, symmetry and regularisation
 - ★ Ensembling, bagging and boosting■
- Mathematics
 - ★ Function Spaces: Kernel Methods and Gaussian Processes
 - ★ Linear Algebra, embeddings, positive definiteness, subspace, determinants■

Topics Continued

- Optimisation
 - ★ Newton/Quasi-Newton Methods: convergence rates
 - ★ SGD, momentum, ADAM■
- Constrained Optimisation
 - ★ KKT conditions
 - ★ Duality Linear/Quadratic Programming
 - ★ SVMs■
- Convexity
 - ★ Convex sets: linear constraints, PD matrices
 - ★ Convex functions
 - ★ SVMs, Lasso
 - ★ Jensen's inequality■

Topics Continued

- Probability
 - ★ Naive Bayes
 - ★ Gaussian Processes
 - ★ Dependencies and Graphical Models
 - ★ Expectations and MCMC■
- Advanced Methods
 - ★ Divergences: KL and Wasserstein
 - ★ VAEs and GANs
 - ★ Entropy and information theory
 - ★ Variational Approximation■