IPNN LECTURE COURSES 2007/08: FIRST SEMESTER

MATHEMATICS

COMPULSORY COURSE: Neural Networks (7CCM451a)
A Annibale, Fri 14:00–16:00 (423)
This introductory course covers the basics of neural information processing. Subjects include: biological neurons and model neurons, layered neural networks, linear separability, multi-layer networks, the perceptron, learning in layered networks, dynamics of learning in large perceptrons, recurrent neural networks, interaction symmetry, dynamics of symmetric and non-symmetric attractor networks.

Applied Probability & Stochastics (7CCMFM01)
A Lökka, Mon 17:00–19:00 (K6.29/11F) (tutorials tba by lecturer)
Probability spaces, random variables, distributions, independence, product spaces. Expectation and conditional expectation. Moments, generating functions, characteristic functions. Random processes, filtrations and stopping times. Martingales, Brownian motion and the Poisson process. Elements of Ito integration.
Note: This course requires a strong background in rigorous mathematics.

Linear Systems with Control Theory (6CCM356a)
D Lavis, Mon 10:00–12:00 (GFSB1) & Tue 9:00–10:00 (K1.56)
Topics covered include first order linear systems of ordinary differential equations; autonomous systems, phase portraits, stability; non-linear systems, linearisation; Laplace transforms, the transfer function, Routh-Hurwitz criterion for stability, and more advanced transfer function methods. In control theory, the course covers: the rank criterion for controllability, linear feedback and optimal control, including Euler-Lagrange methods and introduction to Hamiltonians; the Hamilton-Pontryagin method, bounded control functions, Pontryagin's principle; bang-bang control; switching curves.

Distribution Theory (7CCMFM05)
M Pistorius, Fri 17:00–19:00 (K6.29/11F) (tutorials tba by lecturer)
The course covers important concepts and techniques in probability theory and statistics, based on examples mainly drawn from mathematical finance. Content includes: distribution functions, moments, moment generating functions. Common families of discrete and continuous distributions. Conditional distributions, (in)dependence, correlation, elements of copula theory. Generation of random variables and simulation. Elements of estimation. Applications to mathematical finance.
Note: somewhat more application-oriented than CMFM01 but still requires background in pure/rigorous mathematics.

ENGINEERING

Fundamentals of Digital Signal Processing (7CEEM345)
Z Cvetkovic, Mon 14:00–16:00 (K4U.13) & Thu 15:00–17:00 (K6.29/11F)
This course aims to introduce the fundamentals of digital signal processing, including the basics of analog-to-digital and digital-to-analog conversion, digital filters, digital spectral analysis and digital multirate signal processing. Lectures are reinforced with MATLAB-based computer assignments.

MATHEMATICS (LSE)

Computational Learning Theory and Neural Networks (MA401)
T Batu, Thu 11:00–13:00 (E168), tutorial Fri 16:00-17:00 (A247); check at LSE for start date
Neural networks and other learning systems. Boolean functions. A framework for supervised learning. Probabilistic modelling of learning. Dimension and the sample complexity of learning. Computational complexity of learning. The complexity of neural network learning. shall concentrate on the 'probably approximately correct' (pac) model

Algorithms and Computation - part 1 (M407)
B von Stengel, Tue 14:00–16:00 (H102), tutorials: different groups with different times, check with lecturer
An introduction to algorithms, data structures and computation. Syllabus includes: Programming in Java. Data structures; including stacks, linked lists and tables. Sorting and searching. Running times; order of functions, graph algorithms. Basics of numerical computing, including rounding errors and error propagation.
Note: course runs for two semesters, but with lectures only every other week. Hence credit is as for any other one-semester course.

IPNN LECTURE COURSES 2007/08: SECOND SEMESTER

MATHEMATICS

COMPULSORY COURSE: Advanced Neural Networks (7CCMNN15)
P Sollich, Wed 10:00–12:00 (429)
Unsupervised learning processes: self-organising maps (SOM) and (soft and hard) vector quantisation (SVQ & VQ). Radial basis functions, committee machines and function approximation. Bayesian analysis of learning in layered networks, regularisation and generalisation, evidence-based model selection. Learning via Gaussian Processes, Support Vector Machines (SVM).

Statistical Mechanics of Neural Networks (7CCMNN13)
I Pérez-Castillo, Mon 10:00–12:00 (521)
This course covers applications of advanced tools from equilibrium and non-equilibrium statistical mechanics (mainly from the field of disordered magnetic systems) to analyse and quantify operation and learning in neural networks. The course concentrates on analytic solutions obtained by replica theory and the theory of stochastic processes, in the context of the operation of recurrent attractor neural networks and the dynamics of learning in layered networks.

Information Theory in Neural Networks (7CCMNN14)
R Kühn, Mon 15:00–17:00 (429)
The first part covers the basics of Shannon's information theory: definitions and properties, with proofs, of the main tools for quantifying information, such as entropy, relative entropy, mutual information, and Shannon's theorems on the link between entropy and optimal coding. The second part describes applications of information-theoretic concepts to neural information processing, e.g. Boltzmann Machine learning, learning by maximum information preservation, detection of coherent features, learning based on information geometry (natural gradient descent).

Financial Mathematics (7CCMFM05)
I Buckley, Mo 13:00–14:00, Tue 9:00–10:00, and Fri 12:00-13:00 (K2.31/2C) (tutorials tba by lecturer)
An introductory but challenging course on the use of stochastic methods in modern finance. The problem is how to price derivatives and currency options. The most successful model for this is the log-normal or Black-Scholes-Merton model. Mathematical tools used include Ito calculus, martingales, stochastic differential equations and their relation to the heat equation. Relevant terms used in the financial markets will be explained.

ENGINEERING

Communications Theory (7CEEM210)
MR Nakhai, Mon 15:00–17:00 (3B20) & Tue 15:00–17:00 (3B20)
This course introduces the basic concepts behind advanced digital communications systems, including widely used equalisers, multi-carrier transceivers for data transmission channels with moderate/severe Inter-Symbol Interference (ISI).
Note: Background knowledge in Digital Communications or Communications Systems is required; check with the course lecturer.

COMPUTER SCIENCE

Cryptography and Information Security (7CCSMCIS)
L Mouchard, Tue 10:00–13:00 (20CA)
This course introduces both theoretical and practical aspects of cryptography, authentication and information security. Syllabus includes: Basic terminology and concepts, ciphers, public-key ciphers, key establishment protocols, authentication and identification, digital signatures, applications (PGP, Kerberos, firewalls, electronic commerce).

MATHEMATICS (LSE)

Algorithms and Computation - part 2 (M407)
T Batu, Thu 16:00–18:00 (E304), tutorials: different groups with different times, check with lecturer
An introduction to algorithms, data structures and computation. Syllabus includes: Programming in Java. Data structures; including stacks, linked lists and tables. Sorting and searching. Running times; order of functions, graph algorithms. Basics of numerical computing, including rounding errors and error propagation.
Note: course runs for two semesters, but with lectures only every other week. Hence credit is as for any other one-semester course.

Practicalities of course registration

- If you decide to follow any of the intercollegiate courses of the IPNN programme at the London School of Economics, you will need to *register at LSE* in addition to your registration here at King's.
- If you decide to follow the courses given by the Computer Science department, please fill in one of their registration forms for non-computer science students. This should be available from Rebecca Cullen or, failing that, from the Computer Science Departmental Office in 1DA. Then take it to the Senior MSc Tutor for computer science, Prof Costas Illiopoulos.

Advice on choosing courses

- Bear in mind that you must not take a module for which you have previously been examined as part of an undergraduate or postgraduate programme at the University of London. Note also that you need to pass at least six courses at level 7; see the detailed IPNN regulations. Of the IPNN options list only one module is level 6 (Linear Systems with Control Theory).
- Think ahead to what kind of M.Sc. project you may want to do. Many of the theoretical projects supervised in the Mathematics department require some knowledge of the topics and techniques covered in 7CCMNN13 (Statistical Mechanics of Neural Networks), so if you're inclined to do such a project you should consider taking this course.
- Most M.Sc. projects also require programming skills; this applies even to theoretical projects (when numerical solutions of equations have to be obtained, or simulations performed to compare with theory). Such skills are also expected by prospective employers, and equally useful if you want to do further study in Information Processing and Neural Networks. If you don't already have substantial programming experience, you are therefore encouraged to take appropriate (non-examinable) courses. Programming courses are provided e.g. by the Information Systems & Services unit of King's College.

Once your course has started

- Check the programme home page `http://www.mth.kcl.ac.uk/ipnn/` regularly for announcements.
- For courses in other departments, make sure you know where information about courses is displayed (noticeboards, web pages etc) and check regularly.
- Check with lecturers whether they will send information by email, and if so make sure they have your email address. (There will be a general mail alias for all of this year's IPNN students, either `ipnn0708@mth.kcl.ac.uk` or `ipnn0708@kcl.ac.uk`, to be confirmed)
- Check whether solutions to assignments, past exam papers etc are available and where; also make sure you know about revision classes etc.
- And finally: let us know if there are any problems! My email is `ton.coolen@kcl.ac.uk`, office 406, phone ext. 2235; or speak to Rebecca Cullen in the departmental office.