Teaching and Learning

Henning Flaecher (Bristol)
Student trajectory

Year 1
- Taught modules
- Computational skills
- Autumn and spring meeting, transferable skills training, external partner engagement

Year 2
- Taught modules
- Computational skills
- Autumn and spring meeting, transferable skills training, external partner engagement

Year 3
- External placement
- Research project

Year 4
- Thesis writing
Taught modules

Main principles:

• Modules delivered at the 5 partner universities
• Register once you have obtained your university email addresses
• Accessible via recorded lectures, online material
• Meet the lecturer in person at CDT events and/or via video call

• No exams at the end (you are no longer undergrads!)
• Assessment via coursework and participation
• Monitored by lecturer and CDT management team
• Part of probation, progression after 6/12 months
Year 1: modules

• Semester 1
  • Machine Learning - Bristol
  • Data Analysis - Cardiff

• Semester 1+2
  • Information Visualisation - Bangor
  • Reading and Writing Development Group - Aberystwyth

• Semester 2
  • Big Data and Data Mining - Swansea

• Research theme specific modules, in the students’ home university
Module: Machine learning (semester 1)


• Dr Carl Henrik Ek
  Computer Science
  Bristol University
  carlhenrik.ek@bristol.ac.uk

• Assessment: coursework assessment throughout module, submitted via Blackboard/email

• Course content public at [http://carlhenrik.com/COMS30007/](http://carlhenrik.com/COMS30007/)

• Lectures on Mon 12pm – 1pm and Tue 5pm – 6pm from 30th Sep – 17th Dec
Module: Machine learning (semester 1)

Machine Learning is concerned with three things,
1. formulate assumptions and beliefs mathematically
2. incorporate beliefs with data to support or disprove our belief
3. generate new knowledge by providing an updated belief

Course structure:
Part 1 Introduction and recap of probability theory
Part 2 Modelling
Part 3 Inference

• The aim of the unit is to provide you with a solid understanding of what allows us to learn from data so that you can read papers, understand new models and build your own. Importantly this unit will not provide you with a toolbox or a bag-of-tricks.
Module: Machine learning (semester 1)

Introduction: Weeks 1-2
• The first two weeks will provide a recap of the language of machine learning, probabilities. We will provide a semantic to probabilities to clarify the "misunderstanding" that probabilities are simply "frequencies of events" and provide a much richer interpretation.

Topics Probabilities, Distributions, Gaussian Identities, Conjugacy

Modelling: Weeks 3-6
• We will focus on building models, we will build more and more advanced models with the aim of communicating that the principle of machine learning is exactly the same. We will also introduce how we can look at computation as statistical inference.

Topics Linear Regression, Dual Linear Regression, Gaussian Processes, Unsupervised Learning, Stochastic Processes Dirichlet Processes, Topic Models, Bayesian Optimisation, Neural Networks, Reinforcement Learning

Inference: Weeks 7-12
• Integration is essential operation in machine learning and sadly its often very hard to do and we have to resort to approximate integration. We will look at both stochastic and deterministic approximations to integration.

Topics Laplace Approximation, Sampling, Variational Inference, Derivation of Variational Inference
Module: Data analysis (semester 1)

- [https://data.cardiff.ac.uk/legacy/grails/module/PXT125.html](https://data.cardiff.ac.uk/legacy/grails/module/PXT125.html)

- Prof Haley Gomez  Physics and Astronomy  Cardiff University  GomezH@cardiff.ac.uk

- 2 assessed question sheets and 1 mini project (Jupyter notebooks), weekly exercises
Module: Data analysis (semester 1)

• **The basics:** Displaying and interpreting data. Data mining, causes of uncertainty. Linear error propagation.

• **Introduction to Bayesian Foundations:** What is probability, distributions, hypothesis testing (t-tests, Mann Whitney, Kilmogorov-Smirnov test), confidence intervals; Bayes theory, priors.

• **Parameter Estimation and sampling:** Relationships between quantities, correlation; minimizing and maximizing functions, global and local minima, least squares, maximum likelihood, singular-value decomposition, Principle component analysis.

• **Sampling:** Bias, Monte Carlo sampling, pseudo random distributions, MCMC method, bootstrapping and Jack-knife samples, multivariate analysis techniques.

• **Time-frequency analysis and Image/Signal Processing:** Fourier techniques including convolution, deconvolution, filtering techniques, wavelets, Floquet modes, modulation.
Module: Information visualization (semester 1+2)

• [https://www.bangor.ac.uk/computer-science-and-electronic-engineering/postgraduate-modules/ICE-4121](https://www.bangor.ac.uk/computer-science-and-electronic-engineering/postgraduate-modules/ICE-4121)

• Prof Jonathan Roberts  
  Computer Science  
  Bangor University  
  [j.c.roberts@bangor.ac.uk](mailto:j.c.roberts@bangor.ac.uk)

• 2 Assignments in 2\textsuperscript{nd} semester
  1. Design an information visualisation (on a choice of data) using the Five Design-Sheets method
  2. Implementation of your creative idea (in Processing)
Module: Information visualization (sem 1+2)

- The **history** and future of Information Visualization; the challenges of Information Visualization; tasks; user, perception, data types.
- Looking at **data**. Data capture and problems of capturing data. Selection/abstraction of data (aggregation, sampling; binning; cropping); Big data challenges.
- Understand current **visualisation techniques**, including traditional plots (bar, line, scatter etc.), parallel coordinate plots, treemaps, re-orderable matrix; scatter plot matrix.
- **Perception** and interpretation; understanding how humans perceive information. Encoding of value; Encoding of relation; Models: Bertin, Mackinlay (Quantitative, Ordinal, and Categorical), Semiotics.
- **Design of visualisations**, dashboards, and considering alternative solutions and critical analysis of these visualisations.
- **Interaction and exploration**, looking at focus + context and distortion technique; multiple views and composite interaction; brushing; animation.
Module: Reading and Writing Development (semester 1+2)

- https://www.aber.ac.uk/en/modules/deptfuture/PGM2610/AB0/

- Prof Reyer Zwiggelaar  Computer Science  Aberystwyth University  rrz@aber.ac.uk

- delivered to all students simultaneously, using video conferencing; run over both terms; schedule will be determined by you and the lecturer

- Assessment: attendance, draft literature review, reflective essay
Module: Reading and Writing Development (sem 1+2)

• Aim is to develop the research skills of the students, with an emphasis on the critical analysis of the literature

• Identify and discuss subject specific literature
• Communicate with non-experts
• Defend points from the literature, which they might not support
• Reflect on aspects in the literature
• Critically evaluate the literature
• To write up literature review aspects
Step I
Step II

PDM2610 2018/2019 Group 2 – Schedule

Each session has three papers, as suggested by the relevant person (e.g. Alex’s Own Research). In the first instance discussed by the other two people associated with the paper (e.g. Daniel & Jason), and subsequently by the proposer (e.g. Alex) and then open to the group.

05/02/2019
- Alex’s Own Research Area – Daniel & Jason
- Daniel’s Overlapping Paper – Matthew & Alex

08/02/2019
- Jason’s Public Engagement – Alex & Matthew
- Matthew’s Something Different – Jason & Daniel

15/02/2019
- Daniel’s Own Research Area – Alex & Jason
- Jason’s Overlapping Paper – Daniel & Alex
- Matthew’s Public Engagement – Alex & Jason

19/02/2019
- Alex’s Something Different – Jason & Matthew
- Jason’s Own Research Area – Matthew & Daniel
- Matthew’s Overlapping Paper – Daniel & Alex

01/03/2019
- Alex’s Public Engagement – Matthew & Daniel
- Daniel’s Something Different – Jason & Matthew
- Matthew’s Own Research Area – Jason & Daniel

07/03/2019
- Alex’s Overlapping Paper – Daniel & Jason
- Daniel’s Public Engagement – Matthew & Alex
- Jason’s Something Different – Alex & Matthew

Overflow and/or Reflection/Assessment
Step III

THE DEAD STILL AMONG US: VICTORIAN SECULAR RELICS, HAIR JEWELRY, AND DEATH CULTURE

By Deborah L. Edwards

[Abstract and main text discuss the Victorians' fascination with death and post-mortem memorabilia, including hair jewelry and other relics.]

REFERENCES AND NOTES

[Entries for references and notes follow, providing detailed citations and sources related to the Victorian death cult and its cultural significance.]

Auschwitz: Museum Interpretation and Darker Tourism

[Discussion on the interpretation of the Auschwitz memorial as a site of darker tourism and its implications for understanding historical trauma and memory.]

Introduction

Auschwitz-Brzezinka, also known as Auschwitz-Birkenau, is a former Nazi death camp located in Poland. It served as the central command of the Auschwitz concentration camp complex during World War II. The site is now a museum dedicated to preserving the memory of the Holocaust and the victims of Nazi persecution.

Symbolic power

The symbolic power of Auschwitz-Birkenau lies in its role as a site of memory and commemoration. The museum and memorial aim to educate visitors about the Holocaust and its consequences, fostering a sense of responsibility and preventing the recurrence of such atrocities.

Tourism and darker tourism

Tourism to Auschwitz-Birkenau has been controversial, with some criticizing its commercialization and the commodification of suffering. The concept of "darker tourism" suggests a darker projection on the site, focusing on the dark aspects of history and the human condition.

Acknowledgements

Acknowledgments are due to [names or institutions] for their contributions to the research and writing of this article.
Module: Big data and data mining (semester 2)

• [https://intranet.swan.ac.uk/catalogue/default.asp?type=moddetail&dept=any&mod=CSCM35&ayr=19%2f20&psl=TB2&detailOnly=false](https://intranet.swan.ac.uk/catalogue/default.asp?type=moddetail&dept=any&mod=CSCM35&ayr=19%2f20&psl=TB2&detailOnly=false)

• Dr Jingjing Deng  Computer Science  Swansea University  
j.deng@swansea.ac.uk

• Assessment: 4 coursework assessments
Module: Big data and data mining (semester 2)

- This module introduces students to the fundamental topics of data mining, including data pre-processing techniques, applied probability and statistics, data mining algorithms (incl. associate rule, classification, clustering, outlier detection and probabilistic graphical model), and big data frameworks.

- Course Overview and Python Programming for Data Science
- Frequent Pattern, Association, Correlations
- Naïve Bayes Classifier, Quantitative Evaluation
- Decision Tree, Random Forest, AdaBoost
- Maximum Likelihood Estimation, Expectation Maximisation
- Clustering, DBSCAN, High Dimensional Data Analysis
- Text Data Analysis, Word2Vec, Skip-Through, CBOW
- Time-Series Data Analysis, Regression, Hidden Markov Model
- Scalability and Efficiency Big Data Analysis

Scientific libraries, e.g. NumPy, SciPy, Scikit-Learn, Matplotlib, Tensorflow, Hadoop, Spark.
Research-specific modules

In addition, you should take research–specific modules at your university, relevant for your research topic, e.g.

• Machine Learning for Intelligent Systems (Aberystwyth)
• Virtual Environments & Human Perception (Bangor)
• Statistics for Particle Physicists (Bristol)
• Gravitational Waves (Cardiff)
• Machine Learning in Healthcare (Swansea)

This is arranged in discussion with your supervisor, local PGR coordinator
Taught modules

Recap:

• No exams, but coursework and assessments
• Registration with other universities overseen by CDT management, once you have your university email addresses
• Take advantage of what is on offer!

Any questions?
Transferable Skills Training

Delivered throughout the programme, via inter/intra cohort meetings

- Communication, critical thinking, unconscious-bias, EDI, impact
- Workshops via the Alan Turing Institute (later years)
- Leadership, grant writing, public engagement
- Management and financial planning skills
- Thesis writing, employability, careers

- Training/workshops led by industrial partners
Delivery

• Two-day residential meetings to meet lecturer, work on open problems, exchange experiences

• Software Carpentry sessions (computing skills)

• Cohort-building activities/transferable skills during autumn and spring meetings, mentoring via experienced CDT students

Schedule to be planned shortly, with your input
Annual meetings

Two meetings per year for all students, external partners, supervisors

• All cohorts and external partners invited, networking and feedback
• Autumn meeting:
  • welcome to new cohort
  • Pairing of students with external partners
  • Mentoring, feedback, transferable skills, …
• Spring meeting: annual conference
  • Science! oral and poster presentations, best poster prize
  • EDI, RI, industrial research presentations by external speakers
  • Mentoring, feedback, transferable skills, …
• Stakeholder board and External Board meetings
Responsible innovation/equality, diversity & inclusivity

Best practice and pro-active actions

Reyer Zwiggelaar (Aberystwyth)
Responsible Innovation – Induction Event

- Responsible research in the global context – societal responsibilities, plagiarism, falsification, collaboration
- Issues of integrity – individual and institutional responsibilities
- Data management – sharing data, open access, medical data
- Research ethics – human participants, animals, health
- AI and ML specific aspects – bias, transparency
- Case studies
Responsible Innovation – Subsequently

• Reflect on which RI issues may arise
• Two-page report
  • Written in the spring
  • Part of the end-of-year progression
• Explicit example of RI in the context of AI
  • At spring meeting
• Peer learning/reflection in later years

Input from external partners on RI in non-academic environments welcome, for example via presentations at annual meetings
Industrial and external placements
Industrial Placements

• Indicative 6 month placement in industry, public sector or commerce around the end of the 2\textsuperscript{nd} or during the 3\textsuperscript{rd} year
  • Work on an AI/ML/AC project, e.g.,
    • Novel ML models applied to industrial data
    • Applications of multi-agent systems for decision making
    • Data analysis and large-scale calculations
  • Relevant to the company and not necessarily part of the Ph.D. project
  • Benefit to the student: applying gained knowledge in industrial contexts
  • Benefit to the company: availability of unique skills to solve a problem relevant to them

• Shorter placements in 1\textsuperscript{st}/2\textsuperscript{nd} year (1 month)
How is the CDT related to industrial applications?

Research areas of the CDT:

• Machine learning applications to advanced fundamental science contexts: relevant for industrial applications in which speed, volume, variability etc. are challenging

• Medical applications: immediate relevance in related industrial contexts

• Novel algorithms and methods: give the possibility to transform and disrupt ways of operating with data
Wrap-up

• Questions, questions, questions?