Decision Trees & CBC Intro – Lecture Overview

- Problem Representation using a Decision Tree
- ID3 algorithm
- The problem of overfitting
- Research on affective computing, natural HCI, and ambient intelligence
- Facial expressions and Emotions

➢ Overview of the CBC

➢ Group forming

CBC - Goal

- Hands-on experience in implementing and testing basic machine learning techniques

- Work with other team members

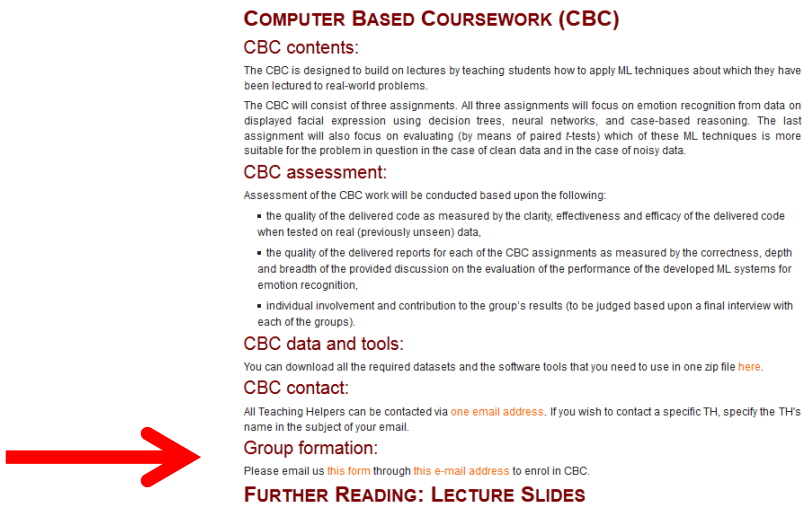
➢ CBC = Computer-Based Coursework

Group Forming

- Students will be divided in groups of 4
- Simply fill in the **excel form** with the following information (for each group member):

  - First Name, Last Name, Student login, Email, Course, CID

- You can find the excel form on http://ibug.doc.ic.ac.uk/courses, http://ibug.doc.ic.ac.uk/media/uploads/documents/ml-cbc-groupform.xls



COMPUTER BASED COURSEWORK (CBC)

CBC contents:

The CBC is designed to build on lectures by teaching students how to apply ML techniques about which they have been lectured to real-world problems.

The CBC will consist of three assignments. All three assignments will focus on emotion recognition from data on displayed facial expression using decision trees, neural networks, and case-based reasoning. The last assignment will also focus on evaluating (by means of paired *t*-tests) which of these ML techniques is more suitable for the problem in question in the case of clean data and in the case of noisy data.

CBC assessment:

Assessment of the CBC work will be conducted based upon the following:

- the quality of the delivered code as measured by the clarity, effectiveness and efficacy of the delivered code when tested on real (previously unseen) data,
- the quality of the delivered reports for each of the CBC assignments as measured by the correctness, depth and breadth of the provided discussion on the evaluation of the performance of the developed ML systems for emotion recognition,
- individual involvement and contribution to the group's results (to be judged based upon a final interview with each of the groups).

CBC data and tools:

You can download all the required datasets and the software tools that you need to use in one zip file here.

CBC contact:

All Teaching Helpers can be contacted via one email address. If you wish to contact a specific TH, specify the TH's name in the subject of your email.

Group formation:

Please email us this form through this e-mail address to enrol in CBC.

FURTHER READING: LECTURE SLIDES

Group Forming

- This year groups will consist of students that belong to the **same** class.
  - Groups with MSc students only
  - Groups with M.Eng and/or B. Eng students only

- The reason for this is that the 2nd assignment will be different depending on the class you follow.

Group Forming

- Email the **excel form** by noon **Wednesday January 24th** machinelearningtas@gmail.com

- You will be assigned a TH who will email you informing you about your group number and confirming the members of your group by the end of the week

Group Forming

- 4 members per group, this is a hard limit!
  - In other words, groups of 5, 6, 7, etc are not allowed!!
- If you cannot form a team with 4 members then just email us the above information and we will assign you to a team.
  - Case 1 member: We will add you to a group of 2-3 members
  - Case 2 members: 1-2 more members will be added to your group
  - Case 3 members: 1 member may be added to your group
- We sometimes allow groups of 3 (depends on the number of students who take the course) but generally you should expect that a 4^{th} member will be added by us.
- Once the groups are formed you cannot change groups

External Students

- Follow instructions provided by the department

Tutorial Helpers

- ***A Tutorial Helper (TH) will be assigned to each group***

  - ***Eftychia Fotiadou***
  - ***Markos Georgopoulos***
  - ***Konstantinos Vougioukas***
  - ***Kritapat Songsri-In***
  - ***Yujiang Wang***
  - ***Pingchuan Ma***
  - ***Bingnan Luo***
  - ***Mengjiao Wang***
  - ***Jie Pu***
  - ***Jiankang Deng***
  - ***Yiming Lin***

http://ibug.doc.ic.ac.uk/people

•If you have any questions about courseworks, marking etc you can ask:

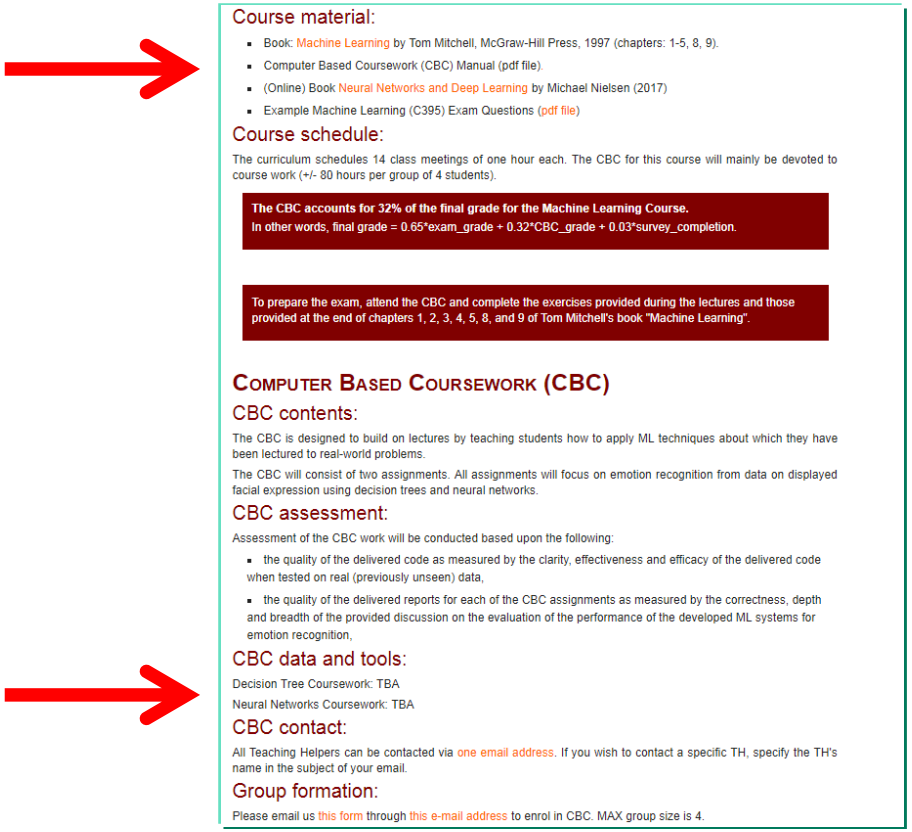
Linh

Markos

•In the labs you can ask questions to any TH

Communication

- Via the website: http://ibug.doc.ic.ac.uk/courses/machine-learning-course-395/
  - CBC Manual (Section Course Material)
  - Provided files, datasets (Section Data and Tools)
  - Tutorials



Course material:

- Book: Machine Learning by Tom Mitchell, McGraw-Hill Press, 1997 (chapters: 1-5, 8, 9).
- Computer Based Coursework (CBC) Manual (pdf file).
- (Online) Book Neural Networks and Deep Learning by Michael Nielsen (2017)
- Example Machine Learning (C395) Exam Questions (pdf file)

Course schedule:

The curriculum schedules 14 class meetings of one hour each. The CBC for this course will mainly be devoted to course work (+/- 80 hours per group of 4 students).

The CBC accounts for 32% of the final grade for the Machine Learning Course.
In other words, final grade = 0.65*exam_grade + 0.32*CBC_grade + 0.03*survey_completion.

To prepare the exam, attend the CBC and complete the exercises provided during the lectures and those provided at the end of chapters 1, 2, 3, 4, 5, 8, and 9 of Tom Mitchell's book "Machine Learning".

COMPUTER BASED COURSEWORK (CBC)

CBC contents:

The CBC is designed to build on lectures by teaching students how to apply ML techniques about which they have been lectured to real-world problems.

The CBC will consist of two assignments. All assignments will focus on emotion recognition from data on displayed facial expression using decision trees and neural networks.

CBC assessment:

Assessment of the CBC work will be conducted based upon the following:

- the quality of the delivered code as measured by the clarity, effectiveness and efficacy of the delivered code when tested on real (previously unseen) data,
- the quality of the delivered reports for each of the CBC assignments as measured by the correctness, depth and breadth of the provided discussion on the evaluation of the performance of the developed ML systems for emotion recognition,

CBC data and tools:

Decision Tree Coursework: TBA

Neural Networks Coursework: TBA

CBC contact:

All Teaching Helpers can be contacted via one email address. If you wish to contact a specific TH, specify the TH's name in the subject of your email.

Group formation:

Please email us this form through this e-mail address to enrol in CBC. MAX group size is 4.

Communication

- Piazza

- Via email: machinelearningtas@gmail.com

ALWAYS put your group number in the subject line

CBC – Organisation

- Each group must hand in a report of ~4-5 pages (excluding figures) per assignment, including discussion on implementation and answers to questions posed in the manual.
- ONE report per group
- Each group must hand in the code they implemented for each assignment.
- Hand in the code and the reports via CATE.

CBC – Assignment hand in

- Hand in via CATE
  - One group leader per group who submits the report/code and invites the other group members.
  - Each and every group member individually has to confirm that s(he) is part of that particular group, for each and every assignment submission (under the pre-determined group leader) before each assignment submission deadline.

Late Submissions

- Up to 24h: Mark is capped to pass (50/40 for MSc/UG students)
- >24h: Mark = 0.
- It's OK if one member confirms late that he/she belongs to the group.
- If the leader is late then the above penalties apply!!

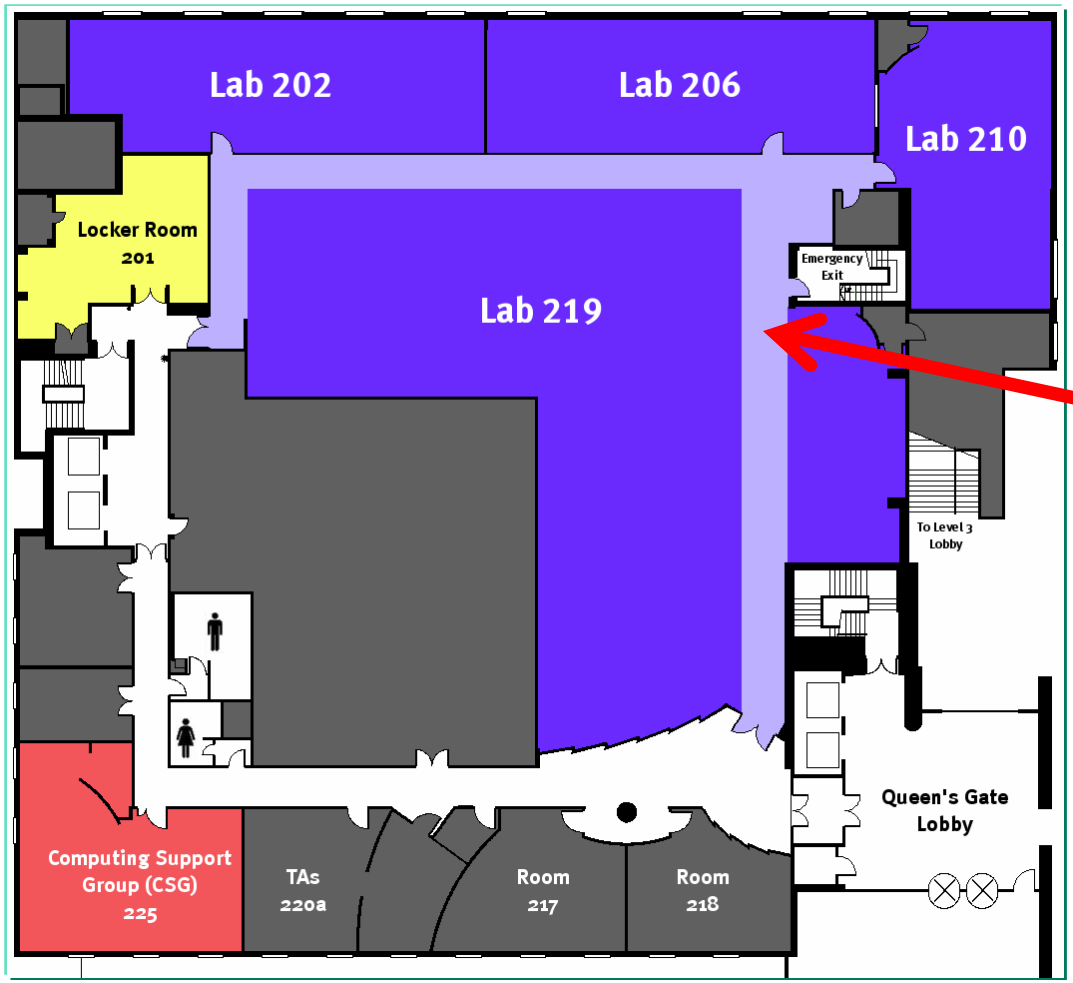
CBC – Report + Code marking

- The THs will mark your report and provide feedback
- The THs will test the implemented algorithms using a separate test set (not available to the students).
- We will inform you about the performance of your algorithm on our test set.
- We just want to check that your code runs and your classifier has been properly trained, i.e., it can generalise to unknown data

Lab Schedule

Assisted Labs (THs present to answer questions), starting on January 25th

- Every Thursday 11:00-13:00, labs 202, 206, 219
- Every Thursday 16:00 – 18:00, labs 202, 206, 219



THs will be here

Deadlines

- Assignment 1: February 12th (Monday) – noon
- Assignment 2: March 5th (Monday) – noon
- Assignment 3: March 9th (Friday) – noon

CBC – Grading

- Every group member is expected to have sufficient contribution to the implementation of every assignment.

- Plagiarism is not allowed!
  Involved groups will be instantly eliminated.

Assignment Grading

Report Content	***Code***	***Report Quality***
75%	***15%***	***10%***

Group_grade = 0.75*report_content + 0.15*code + 0.1*report_quality

- ***Code Mark:*** Depends on the performance on the hidden Test set
  e.g. for Decision Trees = performance on hidden Test set + 15
  (Max Performance in previous years was 85%)

- ***Make sure your code runs. If not you lose 30% of the code mark.***

Assignment Grading

Grade1 ***Grade2***

$$CBC\_grade = 0.4*Grade1 + 0.6*Grade2$$

Machine Learning Grade

CBC Grade

32%

Exam Grade

66.7%

- ***CBC accounts for 30% of the final grade for the Machine Learning Course. In other words, final grade = 0.667*exam_grade + 0.32*CBC_grade + 0.013*questionnaire.***

Questionnaire

- We would like to get some useful feedback about the course from (all) students.
- Feedback on organisation, amount of time spent on the course, etc

There were 4 hours of lab sessions per week. Do you suggest: (please circle)

Keep the same More hours Fewer hours

How many lab sessions did you attend every week? (please circle)

0 1 2 3 4

- Will be uploaded on CATE as an exercise.
- Doesn't replace SOLE. You can still provide anonymous feedback on SOLE.

CBC – Emotion Recognition

Anger Surprise Sadness Disgust Fear Happiness

- Prototypic facial expressions of the **six basic emotions** were introduced by Charles Darwin (1872) and elaborated by Ekman
- These prototypic facial expressions can be described in terms of AUs (e.g., surprise ↔ AU1 + AU2 + AU5 + AU26 / AU27)

Facial Muscle Actions (Action Units - AUs)

CBC – Emotion Recognition

Emotion	AUs	Emotion	AUs
Happy	{12}	Fear	{1,2,4}
	{6,12}		{1,2,4,5,20,
Sadness	{1,4}		25‖26‖27}
	{1,4,11‖15}		{1,2,4,5,25‖26‖27}
	{1,4,15,17}		{1,2,4,5}
	{6,15}		{1,2,5,25‖26‖27}
	{11,17}		{5,20,25‖26‖27}
	{1}		{5,20}
Surprise	{1,2,5,26‖27}		{20}
	{1,2,5}	Anger	{4,5,7,10,22,23,25‖26}
	{1,2,26‖27}		{4,5,7,10,23,25‖26}
	{5,26‖27}		{4,5,7,17,23‖24}
Disgust	{9‖10,17}		{4,5,7,23‖24}
	{9‖10,16,25‖26}		{4,5‖7}
	{9‖10}		{17,24}

V: *AUs* → *basic-emotions*

V': ‹a_1, …, a_{45}› → [1..6]

learning algorithms:

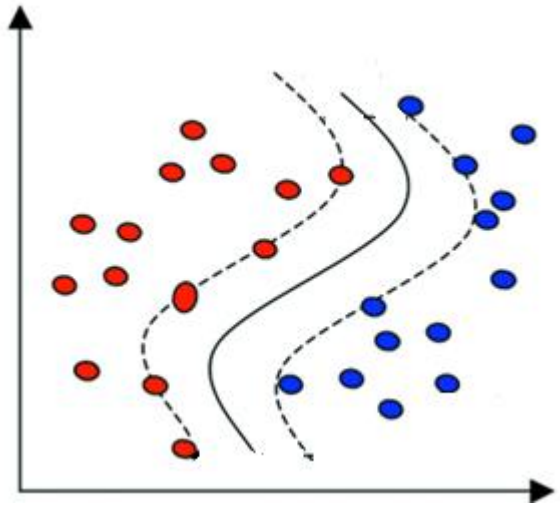
- decision trees (ID3)
- Neural Networks
- Case-based Reasoning

evaluating developed systems:

- t-test

Assignments 1-2 : Overview

- Classification Problem
  - Inputs: *x (AU vectors or Images)*
  - Desired Output: *y (Emotion label)*



- Use *x* and *y* to train your learning algorithms to discriminate between the 6 classes (emotions)

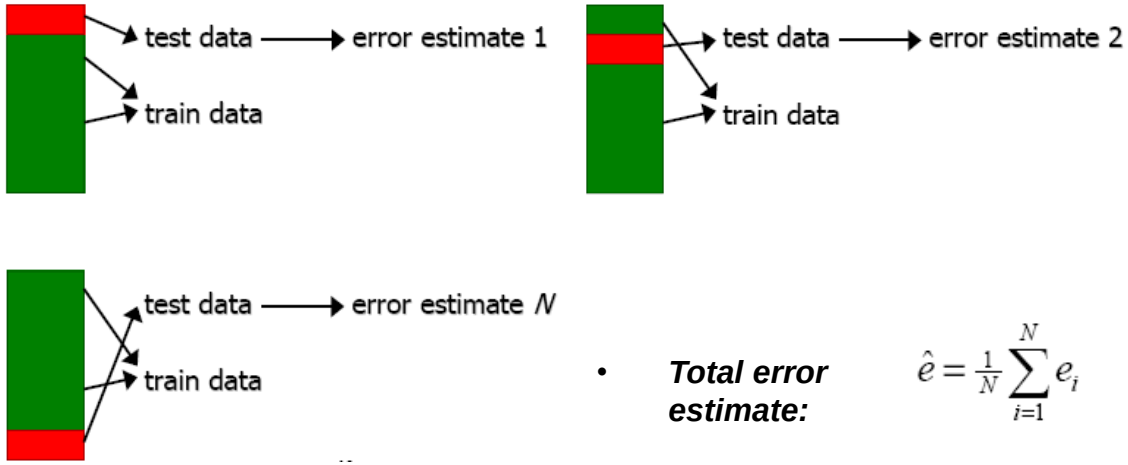
- Evaluate your algorithms using 10-fold cross validation (decision trees) or the holdout method (training/validation/test sets)

- Write a function $y^{pred} = testLearner(T, x)$, which takes your trained learners T and the features *x* and produces a vector of label predictions y^{pred}

Training – Validation – Test Sets

- Training Set: Used to train the classifiers
- Validation Set: Used to optimise the parameters of the classifiers
  - e.g. number of hidden neurons in neural networks
- Test Set: Used to measure the performance of the classifier

N-fold Cross validation



- ***Total error estimate:*** $\hat{e} = \frac{1}{N}\sum_{i=1}^{N} e_i$

- Initial dataset is partitioned in N folds
- Training + **Validation** set: N - 1 folds, Test set: 1 fold
- This process is repeated N times → N error estimates
- Final error: Average of the N error estimates

Assignment 1 : Decision Trees

- Implement and train a decision tree learning algorithm
- Evaluate your trees using 10-fold cross validation
- Write a function $y^{pred} = testTrees(T, x)$, which takes your trained trees T and the features x and produces a vector of label predictions y^{pred}
- You can use Python or Matlab
- Theoretical / Implementation questions

Assignment 2 : Artificial Neural Networks

- Use a Neural Networks to train your networks (UG)
- Write the training functions from scratch (UG/MSc)
- Evaluate your networks on the test set
- Write a function: y^{pred} = testANN(N, x), which takes your trained networks N and produces a vector of label predictions y^{pred} .
- You can use Python or Matlab
- Theoretical / Implementation questions

CBC – Tips

- Work together!!! Divide the work, but you should all know how you have implemented your algorithms, why you took some specific decision, etc...
- Make sure your code runs!!
- **Make sure you use the new version of the manual (updated yesterday!)**
- If you have any complaints (marking, THs etc) contact the course support leader

Group Forming

- Students will be divided in groups of 4 students
- Simply fill in the **excel form** with the following information (for each group member):

  -Student login, email, First Name, Last Name, Course, CID

- You can find the excel form on http://ibug.doc.ic.ac.uk/courses, Section: Group Forming

  http://ibug.doc.ic.ac.uk/media/uploads/documents/ml-cbc-groupform.xls

- Email the **excel form** by noon **Wednesday January 24th** machinelearningtas@gmail.com
- If you cannot form a team with 4 members then just email us the above information and we will assign you to a team.