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The University of Sheffield-EPSRC Winter School 2008

Mathematics for Data Modelling

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Some Admin First

- Fire safety – continuously ringing bell
- Leave immediately by nearest fire exit and wait by St George's Church
- Coffee breaks/lunch
- Access to PCs/web and PC lab sessions
- Poster session
- Thursday dinner
- Accommodation ok?
- Any questions about the week?
- Questionnaires
- Payment/registration

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Aim

To provide researchers with an overview of data modelling.

Why mathematics?

- Core to data modelling algorithms

But, we will also cover how to model data well.

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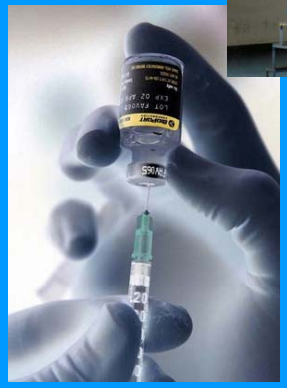
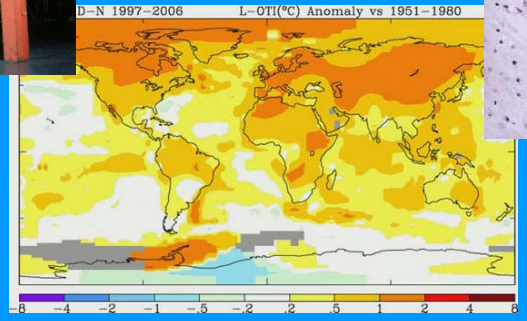
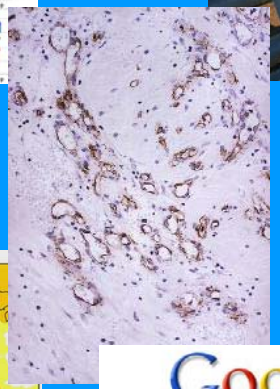
Why data modelling?







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Why data modelling?

Increasingly important to success of many practical applications:

- Engineering
- Ecology
- Chemistry/chemical engineering
- Financial services
- Crime prevention
- Internet search
- Systems biology
- Medical diagnosis…

Engineers with experience in data modelling are in high demand!

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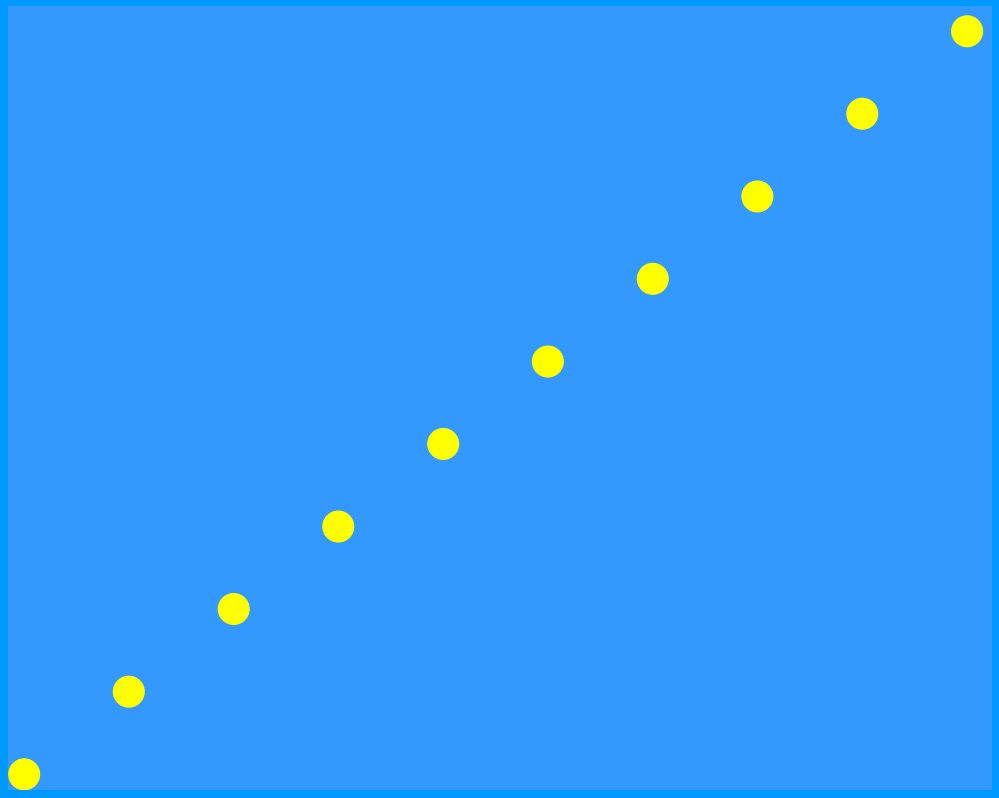
So what is data modelling?

Different things to different people.

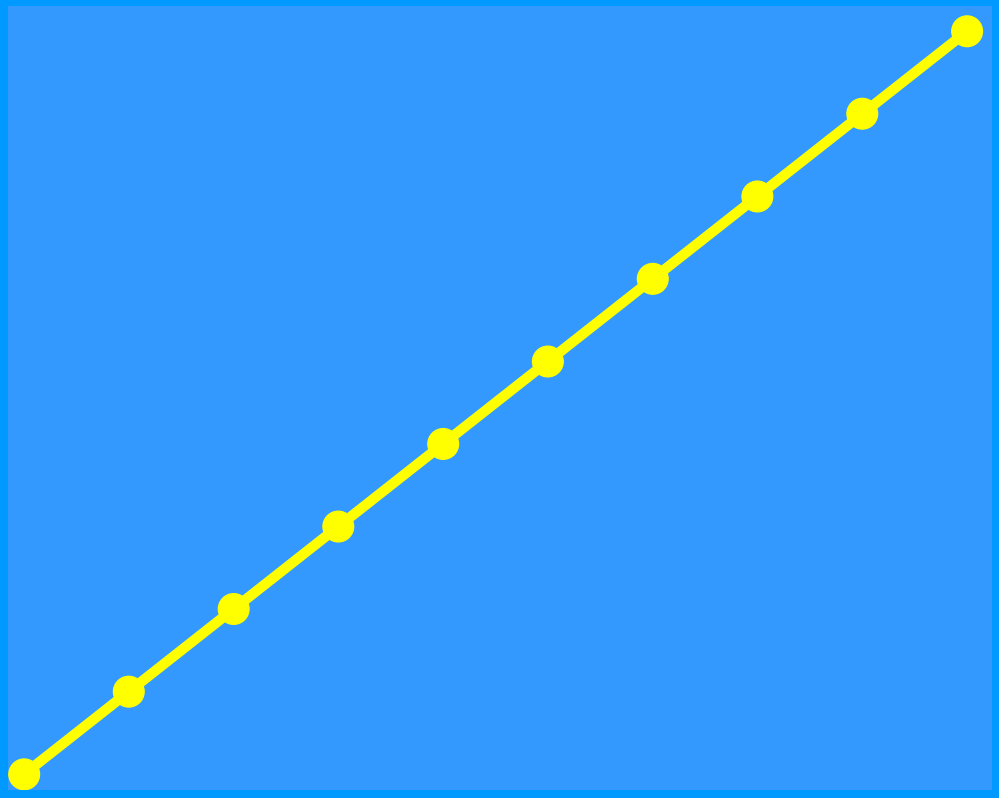
- Structuring and organising data.
- Physical models of data.
- Models to predict unseen data.

For this course consider some examples…

Example 1



Example 1



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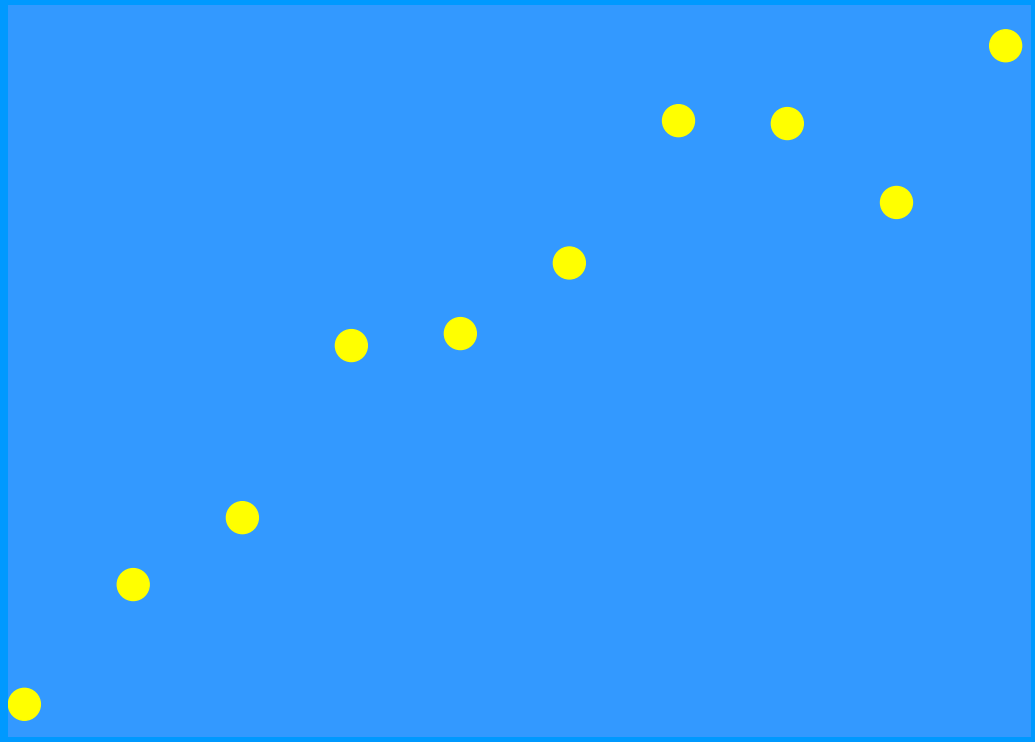

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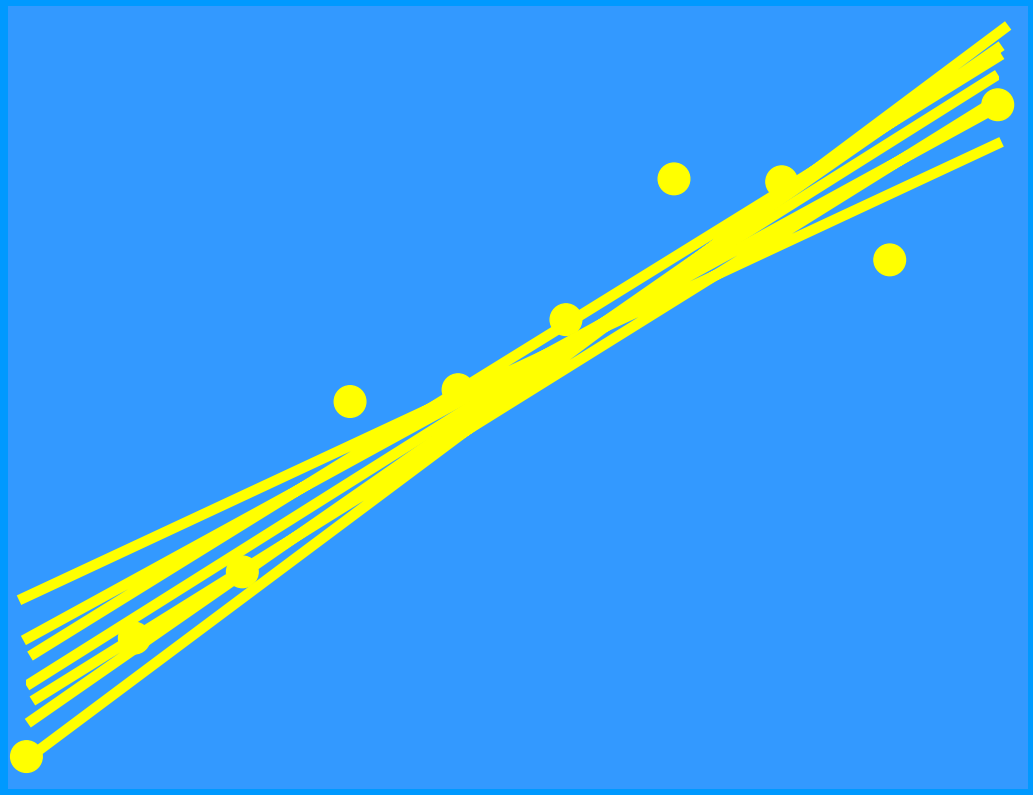

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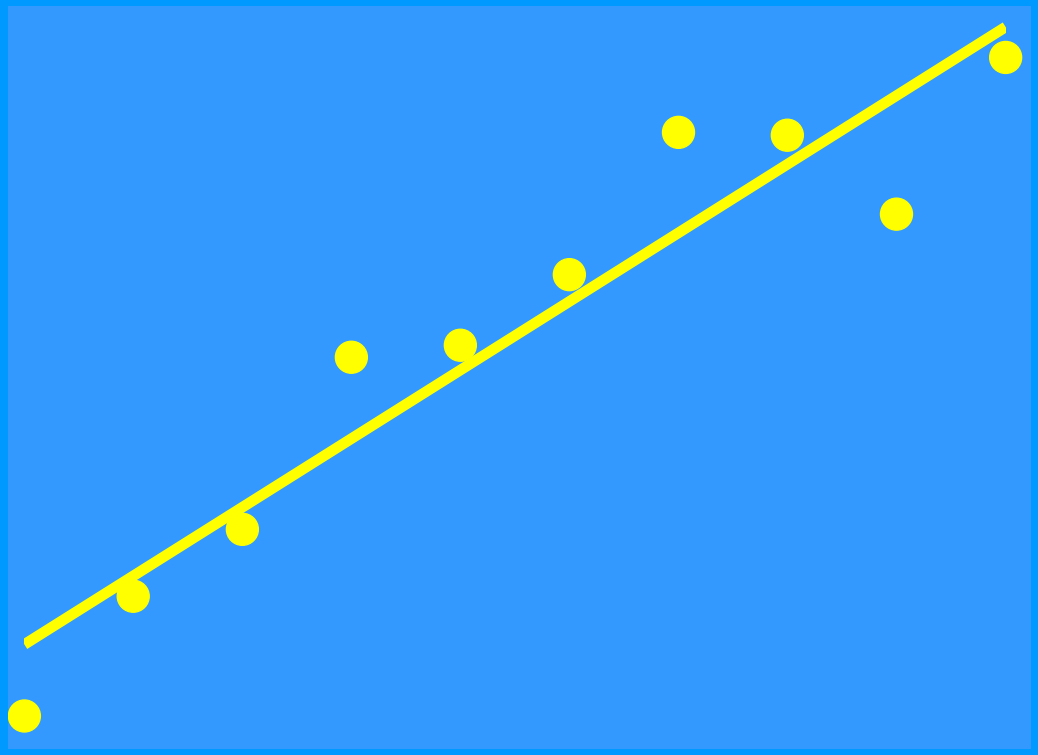

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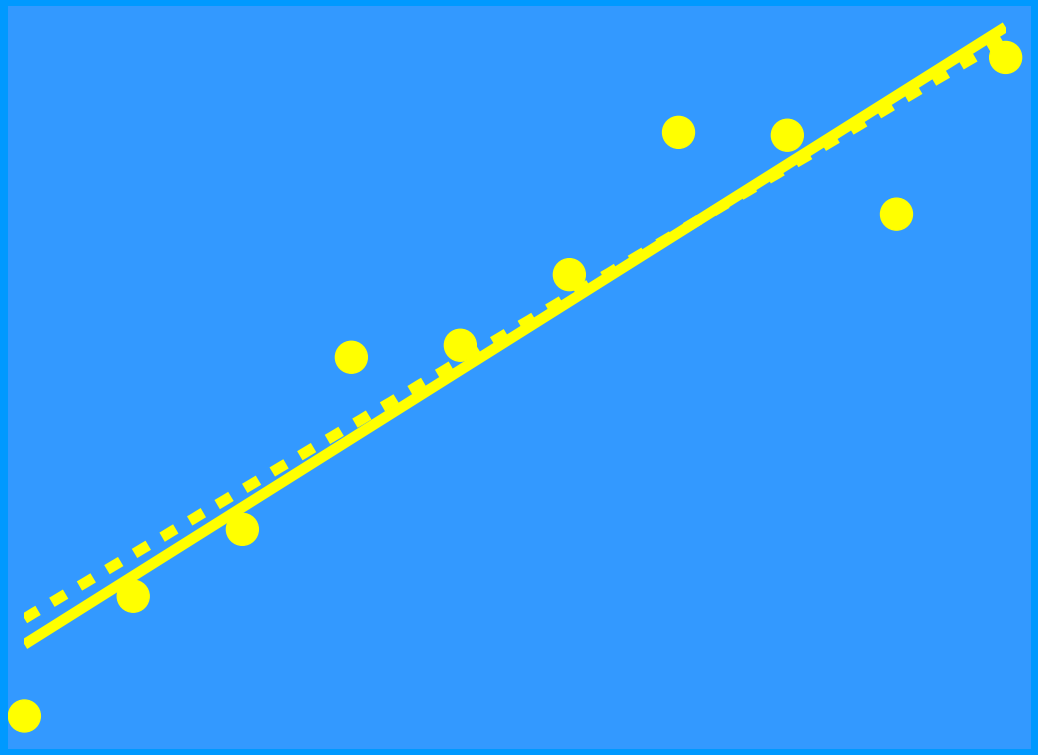

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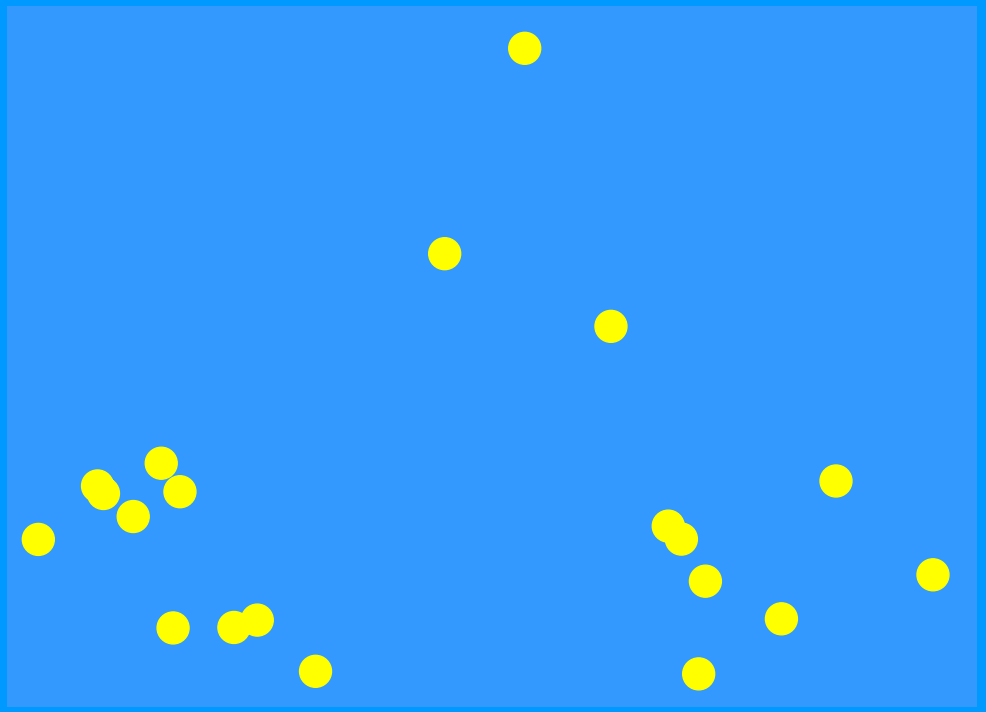
Example 2



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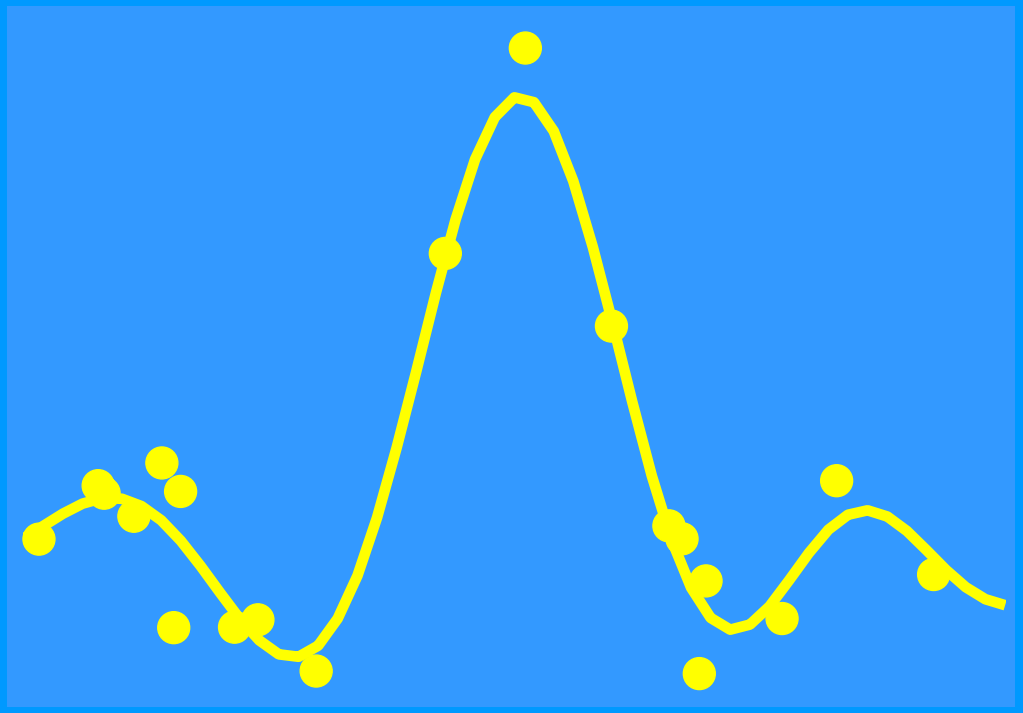

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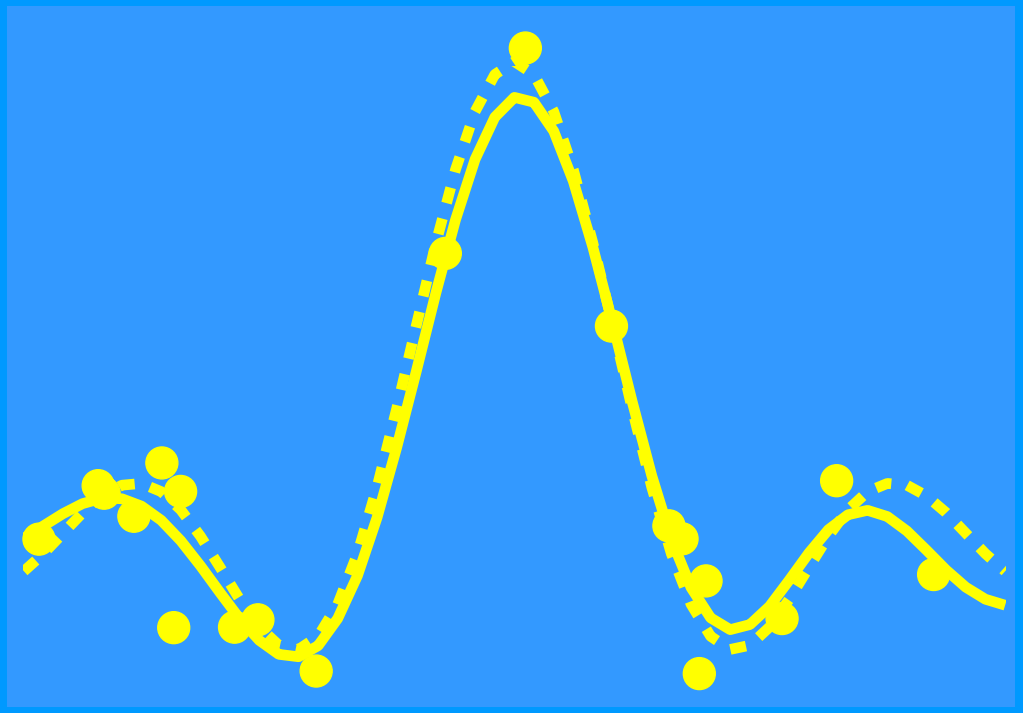

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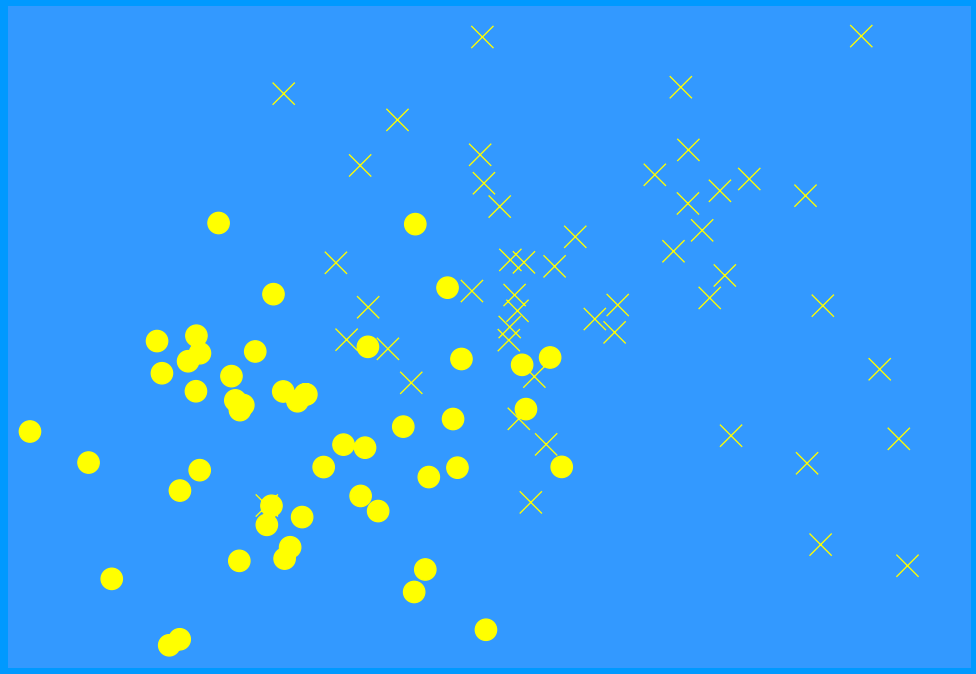
Example 3



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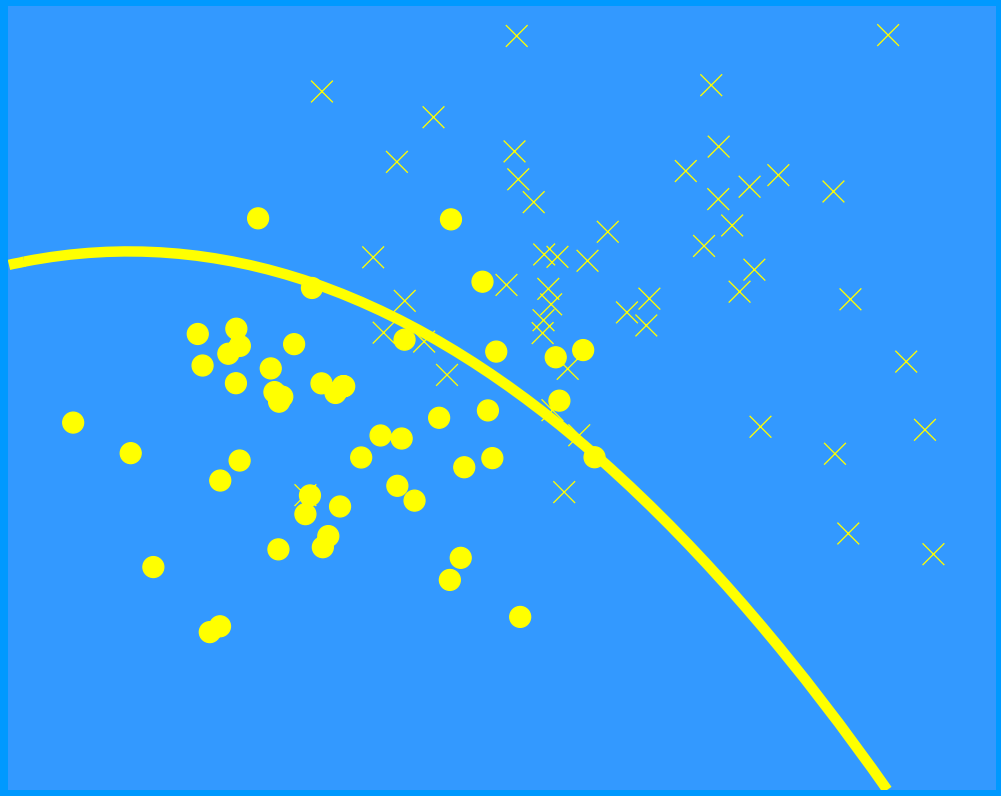
Example 3



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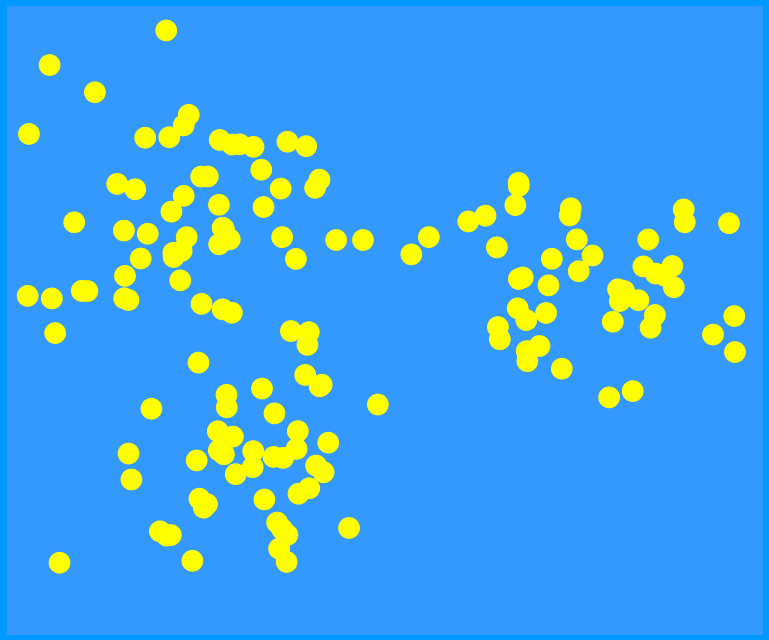
Example 4



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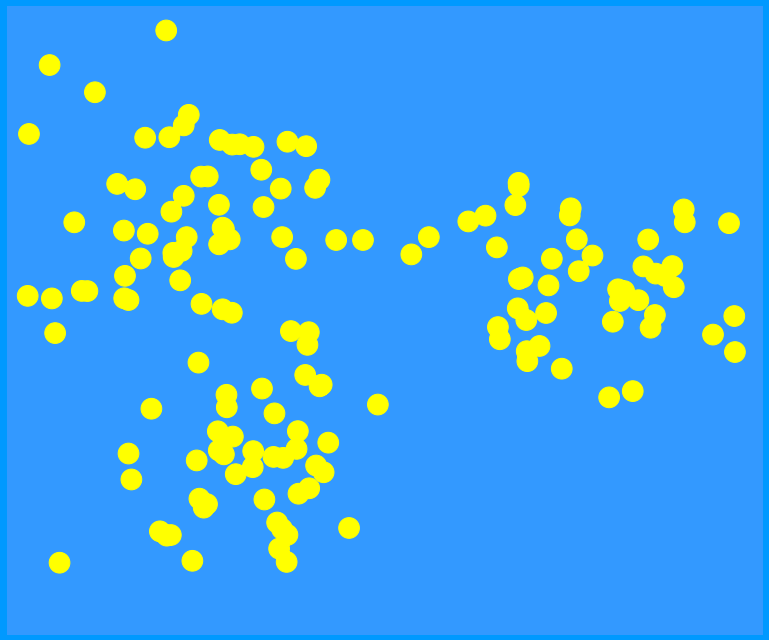
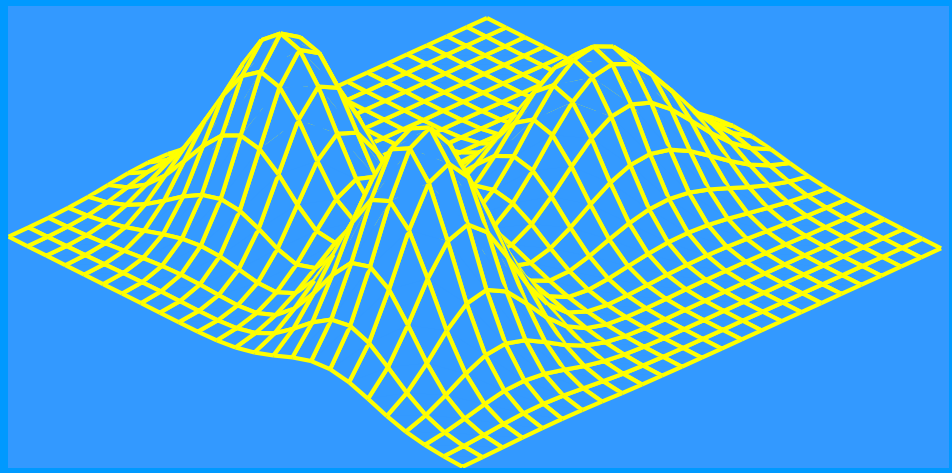
Example 4





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Data modelling problems

- Examples 1,2 – regression/curve fitting.
- Example 3 – classification/pattern recognition.
- Example 4 – density estimation.

This course - where do you put the line?

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Different types of learning

Supervised vs unsupervised

- Do you have target data?
- Learning with/without a teacher

Batch, incremental, sequential, online…

- Are all the data available initially?
- Are the data processed one at a time?

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- Day 1 – introduction, linear models, neural networks, how to model data well
- Day 2 – kernel methods, support vector machines
- Day 3 – unsupervised/semi-supervised
- Day 4 – Bayesian methods
- Day 5 – applications

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Notation

Inputs $\{x_i\}_{i=1}^N$, $x \in R^d$

Input variables $x_i = \left[x_{i,1}, x_{i,2}, \cdots, x_{i,m} \right]^T$

Outputs $\{y_i\}_{i=1}^N$ $y \in R$ regression

$y \in \{0,1\}$ classification

Targets $\left\{ z_i \right\}_{i=1}^N$ Possible values as per y

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Basic problem

Given

$$y = f(x)$$

$$z = y + e$$

where e is noise.

Estimate $\hat{f}$ from $\{x_i, z_i\}_{i=1}^{N}$.

Density estimation requires a more complicated notation – given as required.

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Finally…

- Ask questions.
- The course is for you.
- Use the breaks to network and discuss your work.
- Notes will be available at

http://www.datamodelling.group.shef.ac.uk/winterschool2008/lectures.php

- Videoed as well!