1) Motivation
• Every house in the UK will have a smart meter by 2019
• Disaggregated, appliance-by-appliance information enables consumers to manage their electricity consumption effectively
• Reducing energy consumption is a good idea for multiple reasons

2) Aim
• Build a disaggregation web service
• The only required input should be the smart meter signal
• Infer which appliances are active & energy used by each appliance

The following figure gives a feel for the task at hand:

3) The challenge
• An unresolved challenge in the literature is to model multi-state appliances like washing machines, tumble dryers, dish washers etc.

- The following figure shows five runs of the same washing machine. Note that
- the washing machine has multiple states and
- the transition between states varies from run to run

4) Our proposed solution
• Model the internal components of each appliance
• Hence build faithful, expressive models of appliances
• Our approach consists of 2 conceptual steps:

Step 1: Parameterised models of appliance components
• All appliances are constructed from a set of components such as motors, heaters, compressors and plasma screens, for example:

- Components will be modelled using simple mathematical formulae capturing the physical behaviour of the component
- For example, a tumble drier’s components would be specified like this:

Step 2: Probabilistic graphical models of appliances
• The probability of observing a component state change will be represented by a graphical model
• The steps to produce a tumble drier model are outlined below:

a) Record the power consumption signature of a tumble drier

b) Decompose the signature into a timeline where each row represents the state of a single component:

c) Use several signatures to build a probabilistic graphical model representing all possible state transitions

5) Next steps
• Implement the appliance modelling framework described above
• Experiment with training appliance models by hand from aggregate data
• Build an algorithm to automatically train appliance models from aggregate data
• Build an algorithm to automatically disaggregate smart meter data using the models