National Grid - Familiarity Zone Indicator

Background

The electricity industry is changing at an ever increasing pace. The demands placed on the electricity infrastructure are changing in their very nature and are quite different today compared to recent history.

The following questions are key during real time operations:

- Has this situation been seen before? If so then what did we do then?
- Do we have a comfortable margin? Are we operating close to a limit?
- Do we need more power plants in reserve?
- Can we trim back our margins to save money and still maintain system security?

These questions are all part of the job of real time operations in the Electricity National Control Centre. The question for this proposal is, "**Can a computer make an objective evaluation to support decision making here?"**

It is with this in mind that the idea of the *familiarity zone indicator* has been proposed. The familiarity zone indicator would be a software algorithm that would provide an evaluation of the current situation in the context of all the historical data available. The implicit assumption here is that if a situation has occurred many times in the past then it would be regarded as familiar and thus easier to manage. If a situation has never occurred or rarely occurred then it would be regarded as unfamiliar and thus more difficult to manage.

Questions to consider in this research.

1. "What is familiarity?" from the point of view of running an electricity system. We need to define a methodology for objectively assessing the level of familiarity in a particular electricity system state.
2. What parameters and quantities need to be measured to effectively assess the level of familiarity? There is a rich source of data available online of generation output measurements that could be used as a starting point for this research. This data is available on the Gridwatch website. http://www.gridwatch.templar.co.uk/
3. What kind of network patterns would be considered similar to each other and how different do they need to be before they can be considered different?
4. Can a computer algorithm should decide for itself on what is familiar or unfamiliar? Or would it be a better approach to provide a set of expert opinions for historical dates and times that were considered unfamiliar? This would require some consideration on the characterisation of familiar or unfamiliar times and system states.

Initial steps to consider.

The data quality available is not perfect. Bad data may fool an algorithm into indicating that the system is in uncharted territory when in fact it is just a data spike or metering drop out. Algorithms that are robust to bad data or algorithms that can clean data of errors would be valuable here.

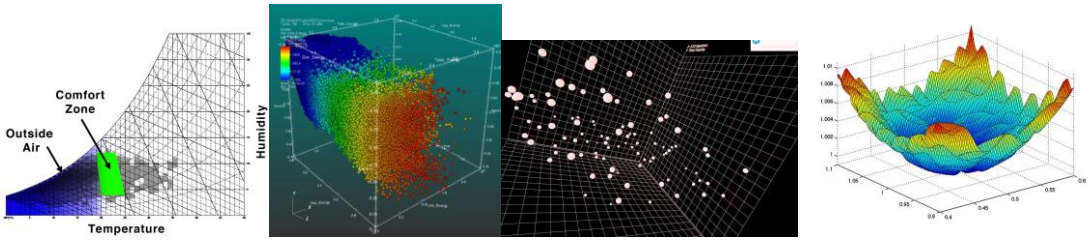
For classifying different system states as similar or different from each other could use techniques such as k-means clustering or Kohonnen Self Organising maps. There may

be other techniques that would be more appropriate. It is part of this effort to identify other techniques that could be used.

https://en.wikipedia.org/wiki/K-means_clustering
https://en.wikipedia.org/wiki/Self-organizing_map

Visualisation of the result

It would be good to be able to map out the familiarity zone in some way and display this on a screen. This would allow a path to be plotted of recent activity. This could be extended into the future with forecast data to indicate if unfamiliar times are likely in the near future. A few example plots are shown here to stimulate thought on this.



Further Steps beyond the end of this project.

National Grid is replacing the existing Balancing Mechanism system with a global best practice 'Electricity Balancing System' (EBS) for balancing the real-time electricity supply and demand. The new system is due to be implemented in 2016.

This computer system will automate a lot of the actions required to instruct generation to increase or decrease output. This is an important aspect of maintaining adequate levels of margin to guard against plant loss, demand forecast error and renewable generation error.

Computers lack the intuition of a human control engineer. A human control engineer would be able to gather a large amount of information in many different formats and form an opinion as to whether the system is being operated well or has been placed in an unfamiliar position. A computer lacks this kind of intuitive judgement.

It is thought that this project could be an early step in trying to provide the EBS system with a way of evaluating whether the electricity system is being operated close to the edge of danger or being wrapped in cotton wool. Armed with this intuition the computer could be able to instruct margins accordingly.