Hidden Markov Models for indirect classification of occupant behaviour

Even for similar residential buildings, a huge variability in the energy consumption can be observed. This variability is mainly due to the different behaviours of the occupants and this impacts the thermal (temperature setting, window opening, etc.) as well as the electrical (appliances, TV, computer, etc.) consumption.

It is very seldom to find direct observations of occupant presence and behaviour in residential buildings. However, given the increasing use of smart metering, the opportunity and potential for indirect observation and classification of occupants’ behaviour is possible. This paper focuses on the use of Hidden Markov Models (HMMs) to create methods for indirect observations and characterisation of occupant behaviour.

By applying homogeneous HMMs on the electricity consumption of fourteen apartments, three states describing the data were found suitable. The most likely sequence of states was determined (global decoding). From reconstruction of the states, dependencies like ambient air temperature were investigated. Combined with an occupant survey, this was used to classify/interpret the states as (1) absent or asleep, (2) home, medium consumption and (3) home, high consumption. From the global decoding, the average probability profiles with respect to time of day were investigated, and four distinct patterns of occupant behaviour were observed. Based on the initial results of the homogeneous HMMs and with the observed dependencies, time dependent HMMs (inhomogeneous HMMs) were developed, which improved forecasting. For both the homogeneous and inhomogeneous HMMs, indications of common parameters were observed, which suggests further development of the HMMs as population models.