

Preference Elicitation and AgentSwitch

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The Challenge

How can we help homeowners make the most of differential tariffs for electricity?

Economy 7

Economy 7 is a simple differential tariff with peak and off-peak hours. Homeowners save money by deferring appliance usage until off-peak hours. Deferrable appliances are:

- Dishwasher
- Washing machine
- Tumble dryer

Strategies for Saving Money

A strategy is defined by the number of deferred uses of each deferrable appliance per week. For example, the strategy

$$s = [2_{\text{washingMachine}}, 1_{\text{dishwasher}}, 0_{\text{dryer}}]$$

says to defer two loads of the washing machine and one load of the dishwasher each week. The utility for a strategy is given by:

$$u_{\text{homeowner}} = u_{\text{savings}} + u_{\text{inconvenience}}$$

Estimating Savings

We estimate savings based on previous usage. Using work by Parson et. al. 2012, we obtain a history of deferrable appliance usage. We then simulate every possible strategy on the historical data.

Challenges:

- Historical data is unable to differentiate between different appliances
- For a given previous week, we do not know which appliance uses the homeowner would have chosen to defer

Measuring Inconvenience

An example factor contributing to inconvenience is having to stay up to start the dishwasher. We measure inconvenience by having the homeowner fill in forms such as the following:

How much money would you need to be paid in order to defer the following number of loads of the dishwasher? Lower Bound Upper bound

1	£0.2	£0.4
2	£0.4	£0.5
3	£0.6	£1.1
4	£0.9	£1.3

Recommending a Strategy

Based on the user's input, we use minimax regret (Wang and Boutilier, 2003) to recommend a strategy.

$$\max \text{Regret}(s_1, s_2) = \max u(s_2) - \min u(s_1)$$

$$= [u_{\text{savings}}(s_2) + u_{\text{inconvenience}}^{\max}(s_2)] - [u_{\text{savings}}(s_1) + u_{\text{inconvenience}}^{\min}(s_1)]$$

$$\min \max \text{Regret} = \min_s \max_{s'} \max \text{Regret}(s, s')$$

Example output:

We recommend the strategy of deferring two loads of the washing machine a week. This will save you, in total, between £1.3 and £2 a week, and in the worst case, this recommendation will save you £0.5 less than the optimal. To reduce this error, refine your inconvenience bounds.

Future Work

The key piece of future work will be human experiments. There are also many interesting questions to examine:

- How to use these results to allow agents to decide on which deferrals should actually take place.
- Can we integrate a Bayesian approach to help improve the accuracy of simulations based on historical data?
- For the average person, how useful is Economy 7? Can we make it better?
- How do we generalize this approach to work with a real time pricing system?