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APPLYING MACHINE LEARNING TECHNIQUES FOR FORECASTING FLEXIBILITY OF VIRTUAL POWER PLANTS

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With the rising share of renewables in the energy mix, there is a need for alternative flexible capacity. The emerging role of the aggregator is important in unleashing new flexibility sources. An aggregator bundles flexibility capabilities of distributed generation and demand response, and offers the collective resources to the wholesale electricity markets. This technical aggregation is referred to as a Virtual Power Plant (VPP). The main aim of this paper is to work towards a model to estimate flexibility characteristics of aggregates of DR (demand response) and DG (distributed generation) in order to better provide ancillary services from those aggregates in existing and future wholesale markets. This knowledge is the missing connection to ensure capabilities of real time response into existing energy markets.

Previous and existing evaluations of available flexibility using small device demand response have typically been done with detailed information of end-user systems. With these large numbers having lower level information both has privacy and computational limitations. We propose a black box approach to investigating the longevity of aggregated response of a virtual power plant using historic bidding and aggregated behaviour with machine learning techniques. The two supervised machine learning techniques are investigated an compared in this paper, multivariate linear regression and single hidden layer artificial neural network (ANN). Both techniques are used to model a relationship between the aggregator portfolio state and requested ramp power to the longevity of the delivered flexibility. Using validated individual household models , a smart controlled aggregated VPP is simulated. A hierarchical market based supply demand matching control mechanism is used to steer the heating devices in the virtual power plant. For both the training a validation set of clusters, a random number, between 200 and 2000, of households is generated with day ahead profile scaled accordingly. Further, a ramp power was assigned at various hours of the day and requested to hold for the remainder of the day. Using only the bidding functions and the requested ramp powers the ramp longevity was estimated for a number of different cluster setups for both the artificial neural network as well as the multi-variant linear regression.

It was found that it is possible to estimate the longevity of flexibility with machine learning. The linear regression algorithm was, on average able to estimate the longevity with a 14.96% error. However, there was a significant improvement with the ANN algorithm achieving, on average, a 5.26% error. This was lowered to 2.36% when learning for the same virtual power plant. With this information it would be possible to offer, accurately, residential VPP flexibility for market operation to safely avoid causing further imbalances and maximizing financial benefit.

Figure 1: DTU Risø Campus

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