UNDERSTANDING APPLIANCE POWER CONSUMPTION WITHOUT SENSORS

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Objectives

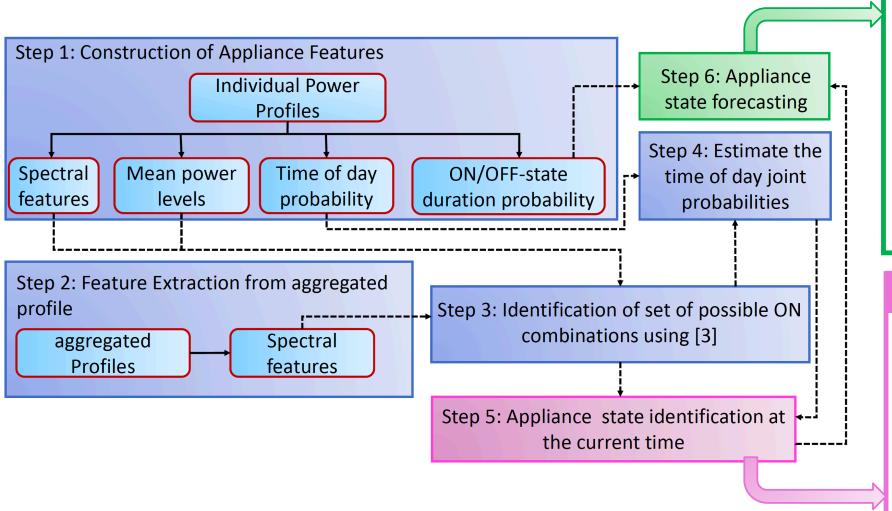
- To develop a residential appliance state identification method without individual sensors, and with:
  - ✓ *high identification accuracy*
  - ✓ *low computational time*
- To forecast future power consumption of individual appliances, which can be used for dynamic demand-side management.
- This is called *non-intrusive load monitoring* (**NILM**).

Impact

- In 2016, residential and commercial buildings used **20%** of the total delivered **energy consumed** worldwide [1].
- A meta-study has shown when occupants **understand** how appliances consume energy they can **reduce** consumption by **14%** [2].
- That is a **reduction** of about **0.6 trillion kWh** of electricity consumed per year.
- Savings will increase per year to **1 trillion kWh** by 2050.

Innovativeness of the Research

- Proposed efficient method for estimating time-of-day joint state probabilities for a set of appliances.
- Joint probabilities used to more accurately identify appliance states and improve convergence speed of the algorithm.
- Appliance state identification used to forecast future power consumption.



References

[1] J. Conti *et al.*, "International Energy Outlook 2016," tech. rep., U.S. Energy Information Administration (EIA), 2016.

[2] K.Ehrhardt-Martinez, K.A.Donnelly,S.Laitneretal.,"Advanced metering initiatives and residential feedback programs: a meta-review for household electricity-saving opportunities." American Council for an Energy-Efficient Economy Washington, DC, 2010.

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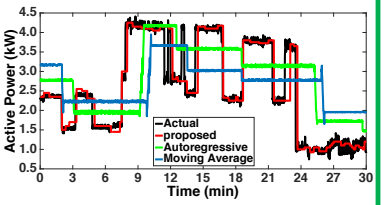
Results – Forecasting

Results for REDD [4] dataset:

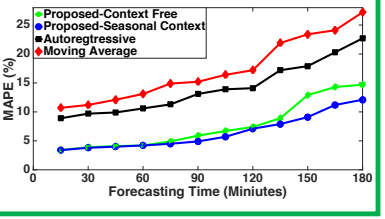
House	Proposed method *MAPE* (%)	AR method *MAPE* (%)	MA method *MAPE* (%)
1	2.8	6.1	6.3
2	2.6	6.4	6.7
3	4.9	8.9	8.8
4	6.8	10.5	11.4
5	8.1	10.8	11.9
6	8.3	12.4	13.7

MAPE – mean absolute percentage error
AR – autoregressive, MA – moving average



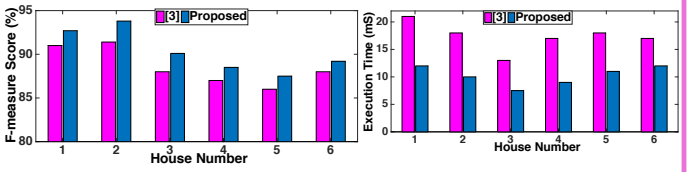
Results for AMPds2 [5] data set:

Season	Forecast accuracy in terms of MAPE (%)			
	Proposed method		Benchmarks	
	Context-free	Seasonal context	AR	MA
Winter	4.2	3.9	9.7	10.9
Spring	3.9	3.8	9.2	11.2
Summer	4.1	4.0	11.4	11.8
Fall	4.4	4.1	13.5	15.6



Results – Appliance State Identification

Results for REDD [4] dataset:



Results for AMPds2 [5] data set: