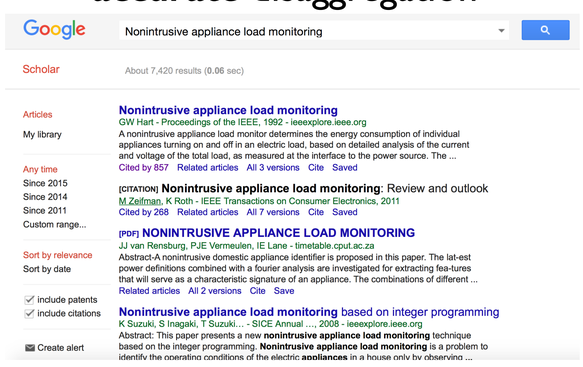
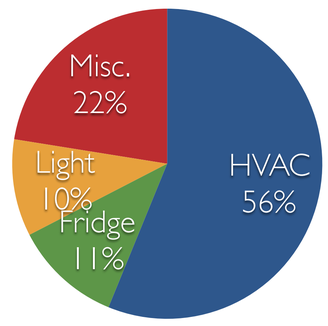
If You Measure It, Can You Improve It? Exploring The Value of Energy Disaggregation

Nipun Batra, Amarjeet Singh, Kamin Whitehouse
IIIT Delhi, University of Virginia

Dozens of new NILM techniques proposed for more **accurate** disaggregation



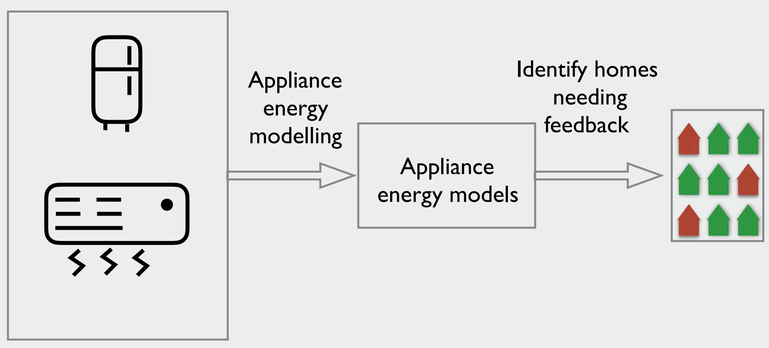
Accuracy **traditionally** measured on metrics such as error in energy (difference between predicted and actual pie)



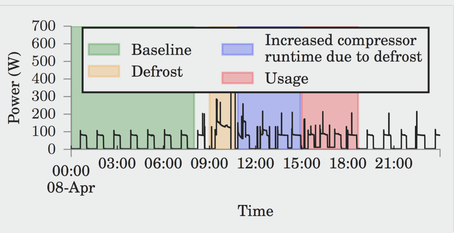
Do these techniques **actually** save energy?
Does **higher accuracy** imply **higher savings**?

Can disaggregated traces be used to provide actionable feedback?

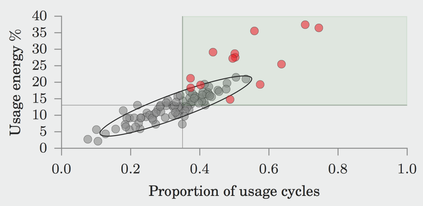
Overview



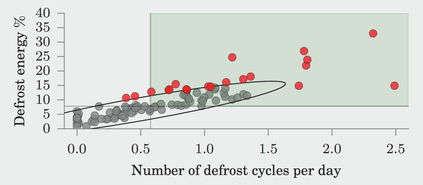
Model of fridge energy



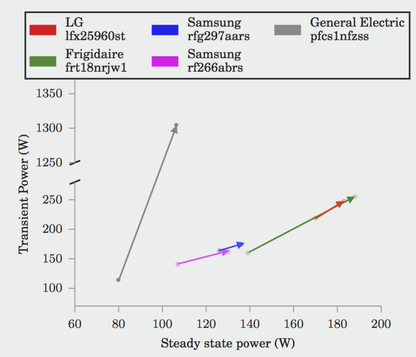
Actionable feedback on fridge



13 out of 95 homes can be given feedback
for excessive fridge usage saving upto 23% energy



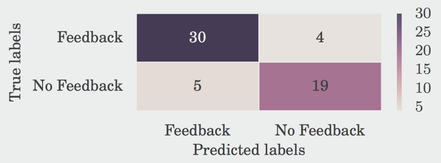
17 out of 95 homes can be given feedback
for excessive defrost saving upto 25% energy



Identical fridges with the same model and age can have differences of 10% or more in steady state power levels. Feedback about failing or misconfigured fridges can save up to 26% energy.

HVAC energy data
Weather data
→ Non-linear HVAC model → HVAC setpoint →

Actionable feedback on HVAC

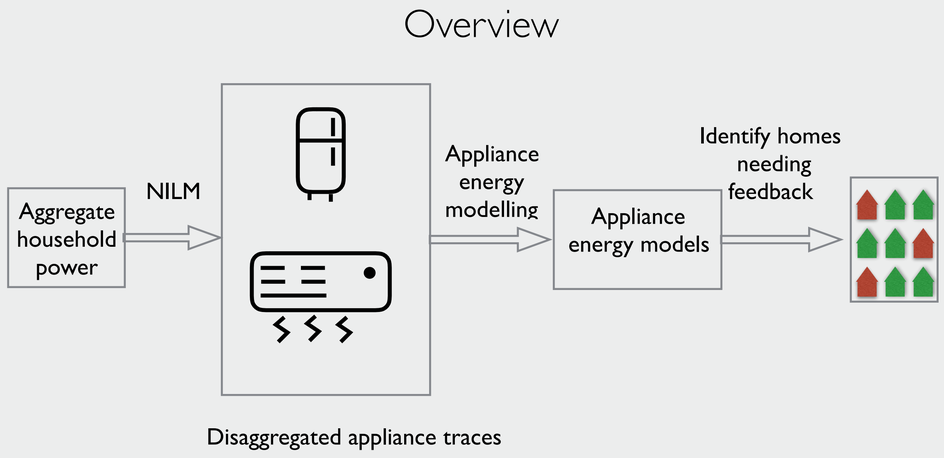


Our method correctly identifies 84.4% of the homes as either having or not having a setpoint schedule, based on submetered HVAC data.

Appliance level data does enable **actionable** energy saving feedback

Do NILM approaches give traces with sufficient fidelity to support such feedback?

Overview

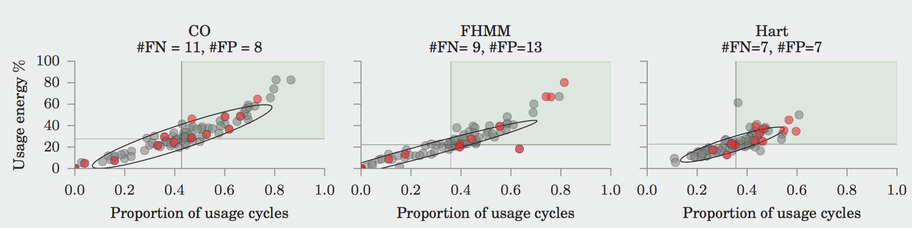


Benchmark NILM algorithms on our data set give accuracy comparable to state-of-the-art

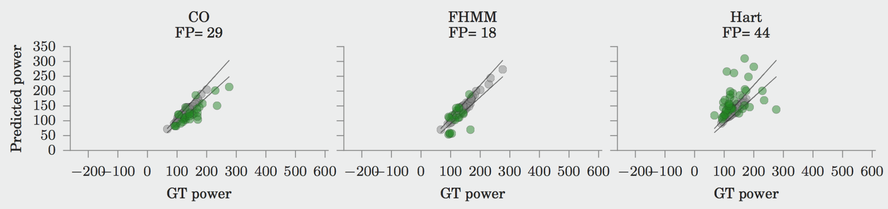
Authors	Year	Dataset	#Homes	Algorithm	Fridge			HVAC		
					RMSE (W)	Error Energy %	F-score	RMSE (W)	Error Energy%	F-score
Kolter [15]	2012	REDD	6	Additive FHMM	-	62.5 $^{\Delta}$	-	-	-	-
Parson [18]	2012	REDD	6	Difference HMM	83	55	-	-	-	-
Parson [19]	2014	Colden$^{\Psi}$	117	Bayesian HMM		45				
Batra [5]	2014	iAWE	1	FHMM	-	50	**0.8**	-	30	**0.9**
Current work		Data port	240	CO*	85	**19**	0.65	**600**	**15**	0.87
Current work		Data port	240	FHMM*	95	20	0.63	650	18	0.89
Current work		Data port	240	Hart	**82**	21	0.72	890	23	0.76

Feedback based on traces generated using NILM

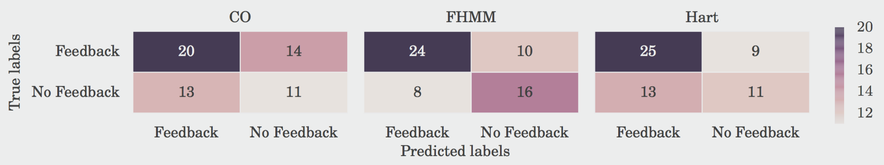
Poor accuracy in identifying homes which can be given feedback based on usage energy



NILM estimates are not accurate enough to reliably detect malfunctioning fridges based on power draw



Classification of homes into those with setback schedules decreases from 84% with submetered power traces to 53%, 69%, and 62% respectively with power traces produced by the three NILM algorithms



Feedback accuracy can be **low** despite **good disaggregation accuracy**
Time to **revisit metrics** by which we **measure progress**?