



The Science of Activity-Predictive Cyber-Physical Systems (APCPS)

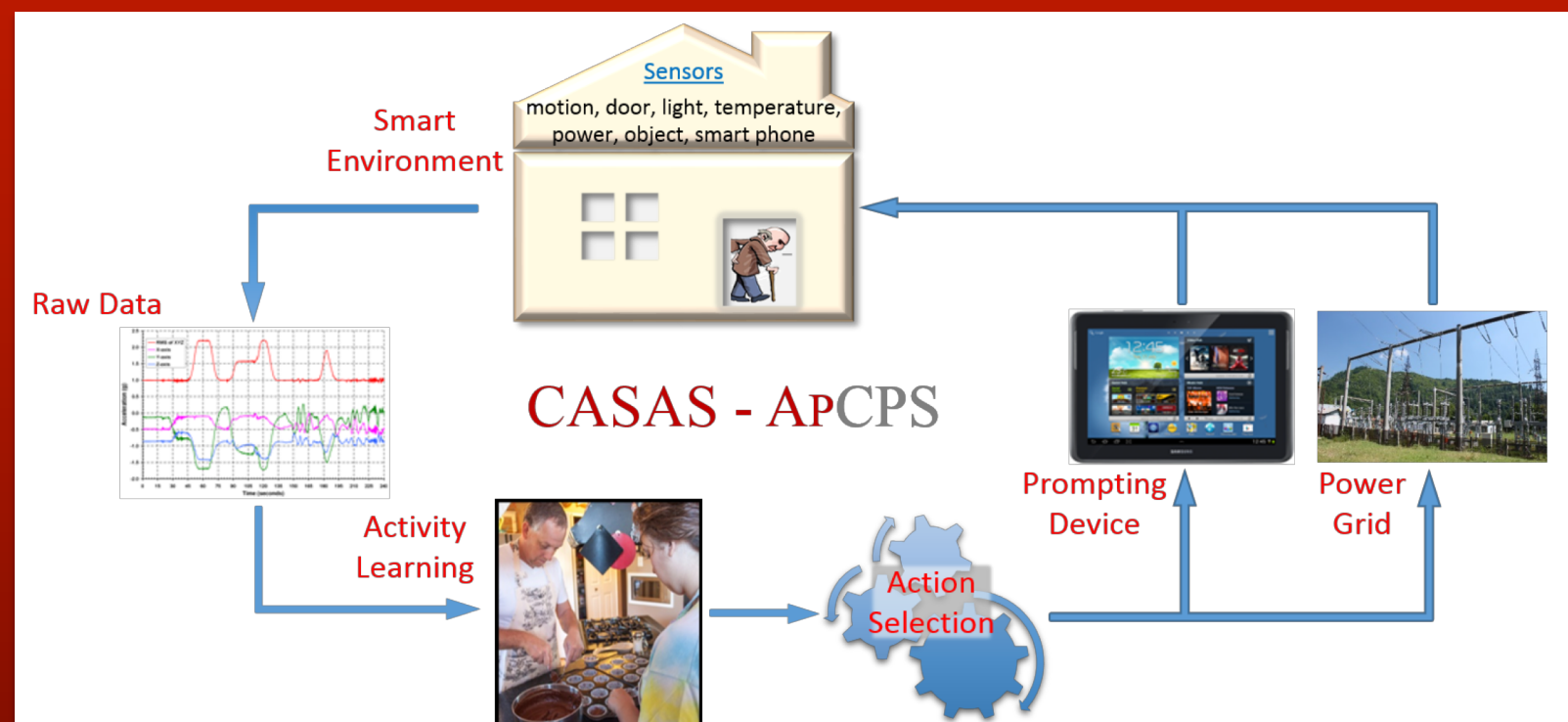
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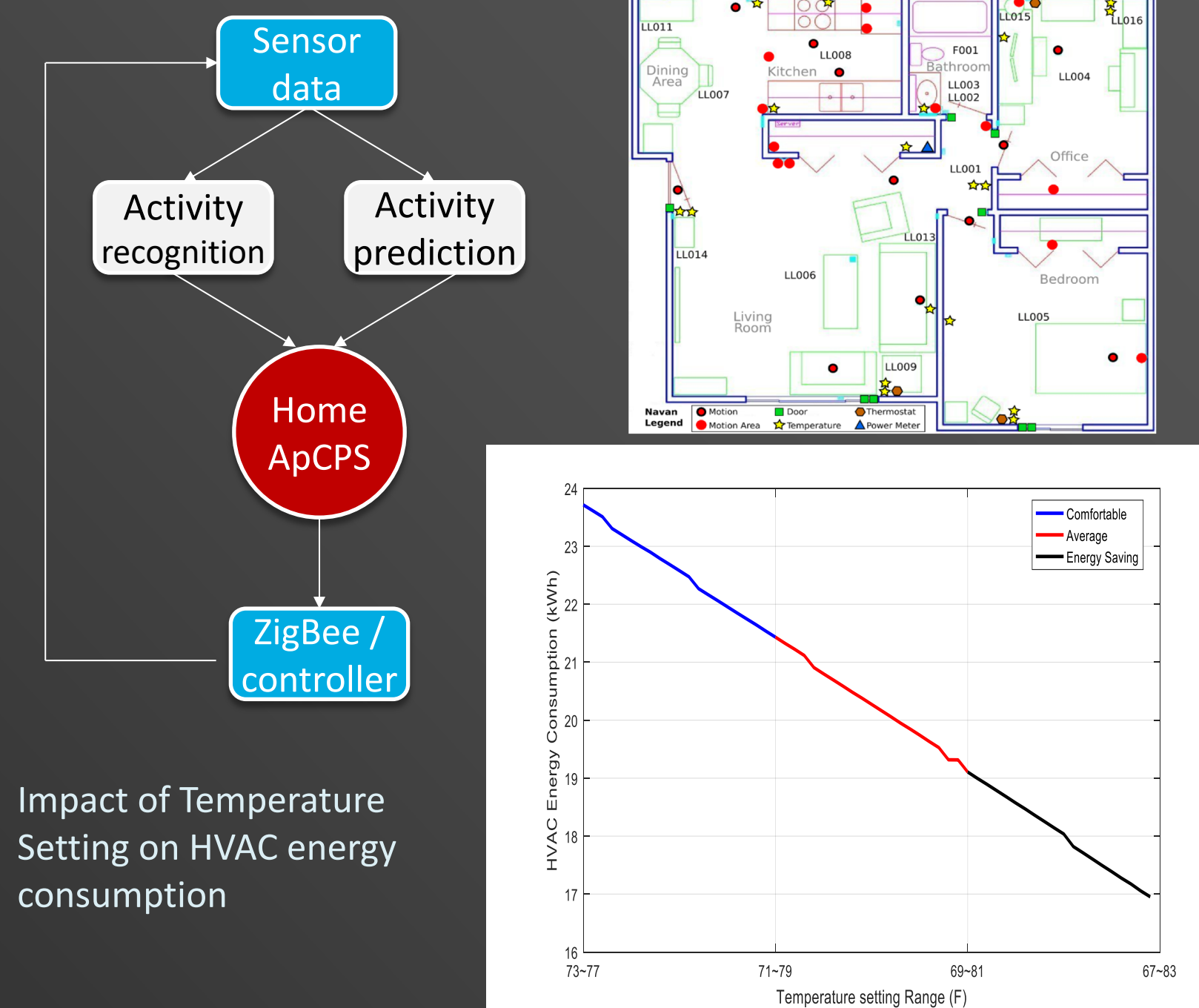
Washington State University, <http://casas.wsu.edu>



From Context-Aware to Activity-Aware



ApCPS Home Automation



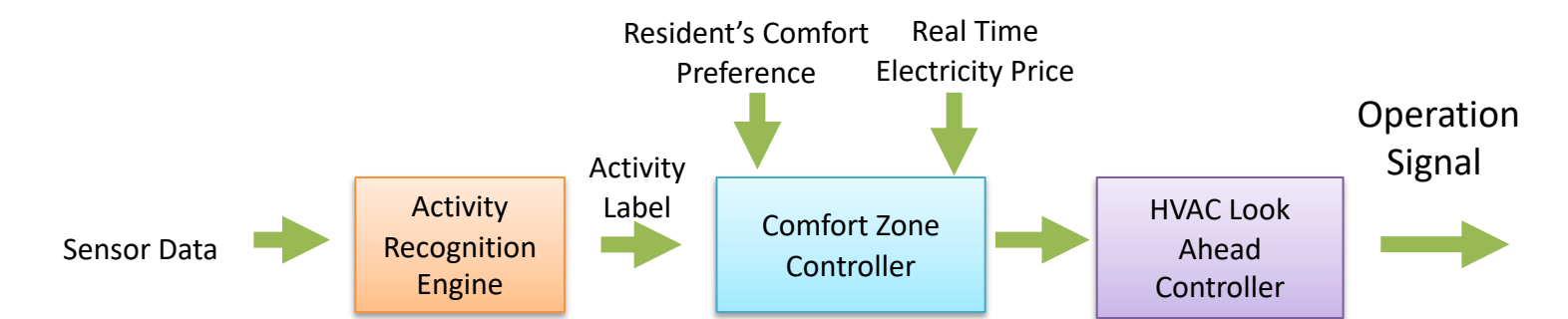
Impact of Temperature Setting on HVAC energy consumption

Wider temperature setting → less comfortable but save more energy.

Consumption reduce 0.625kWh → temperature setting is 1 F wider.

Home Automation

Look-Ahead HVAC Controller

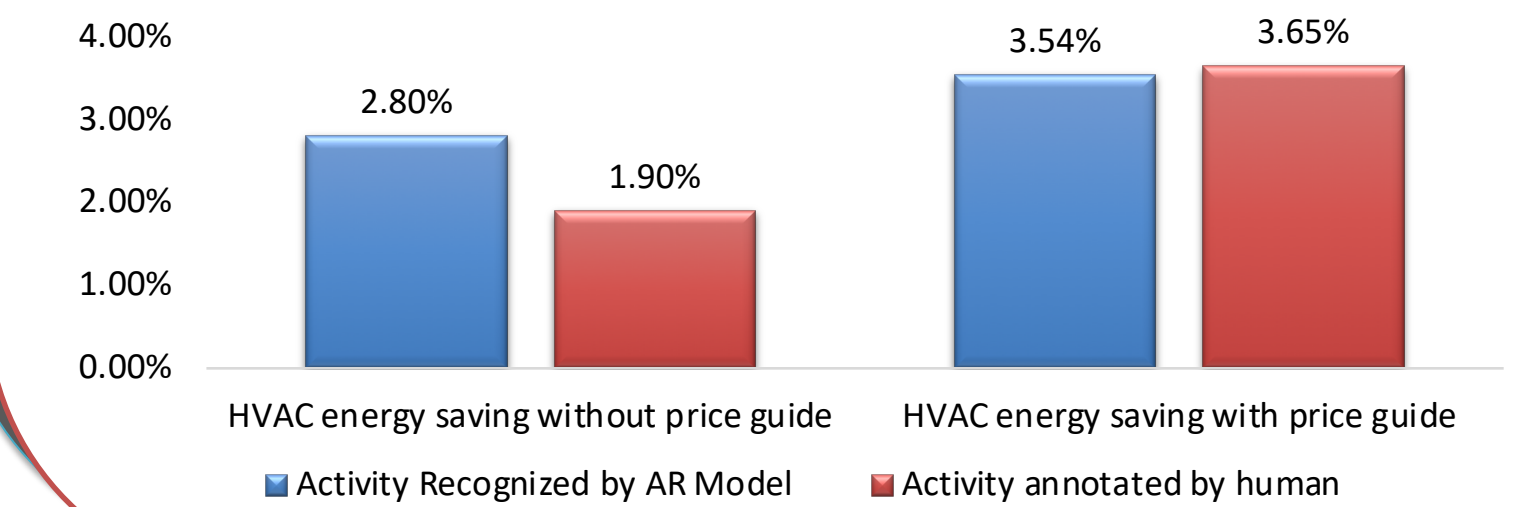


The AR engine takes activity sensor data as input and generate activity label for each time stamp.

The comfort zone controller takes the residents preference and real time electricity price as input and generate comfort zone temperature limits for each time interval.

The HVAC look ahead controller takes comfort setting and predicted air temperature as input and generate the HVAC control signals.

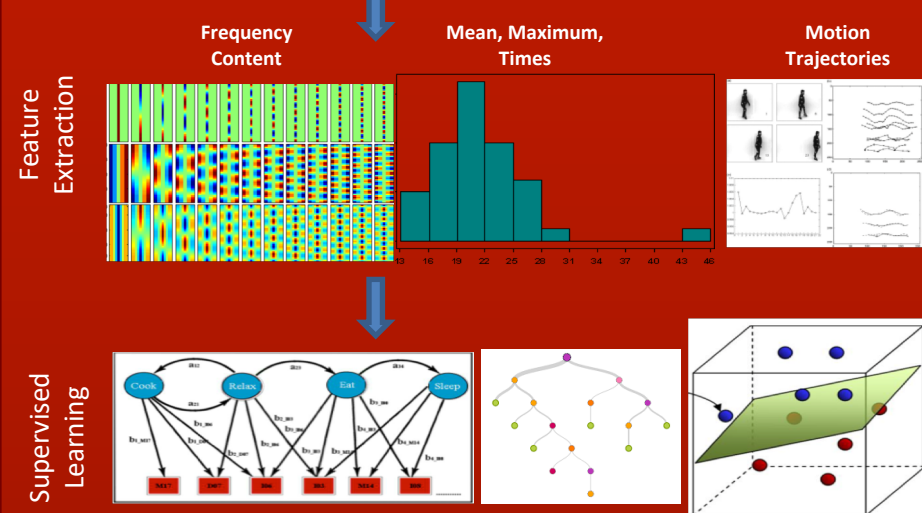
Impact of AR accuracy on the performance of HVAC controller



Activity Learning

2016-06-15 03:38:34.621729 Bedroom ON
 2016-06-15 03:38:37.316330 Bedroom ON
 2016-06-15 03:38:41.294208 Bedroom OFF
 2016-06-15 03:38:41.374899 Bedroom OFF
 2016-06-15 03:38:41.459318 Bedroom ON
 2016-06-15 03:38:44.482092 Bedroom ON
 2016-06-15 03:38:45.133517 Bedroom OFF
 2016-06-15 03:38:17.814393 Bathroom ON
 2016-06-15 03:38:22.584179 Bathroom OFF
 2016-06-15 03:38:23.203947 Bathroom ON
 2016-06-15 03:38:23.271939 Bathroom OFF

$\Lambda \rightarrow X$



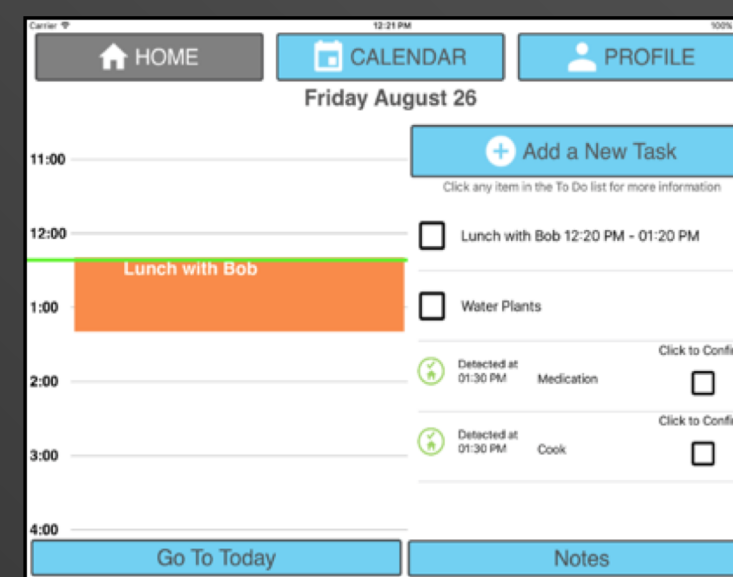
- **Activity Recognition:**
 - 98% accuracy
 - n=30 homes
 - 3-fold cv
 - 11 activities
- 85% accuracy leave-one-home-out
- 84% EMA validation

$X \rightarrow A$

Bed-Toilet-Transition

- **Activity Prediction:**
 - 98% accuracy
 - n=30 homes
 - 11 activities
 - lag = 12
 - r=.9873

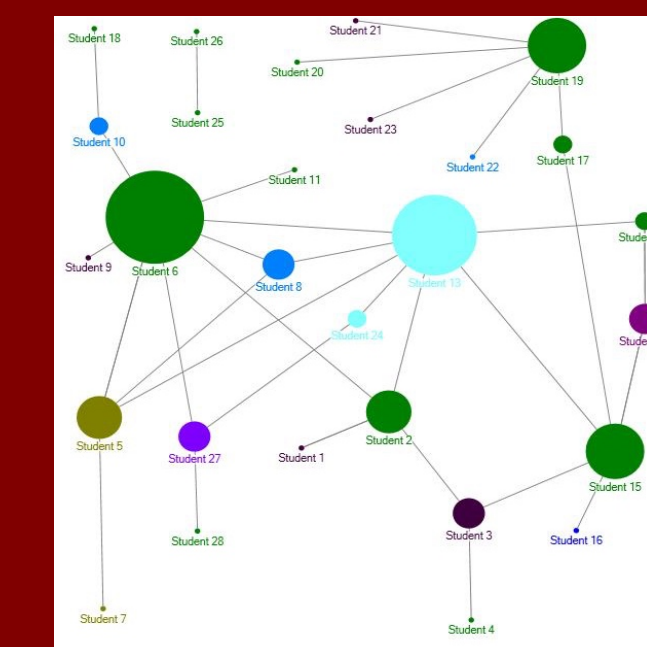
ApCPS Digital Memory Notebook



Cognitive prosthesis for individuals with memory impairment

Automated task checklist / task prompting

Broader Impacts



Multi-disciplinary training



Shared resources



K-12 museum exhibit