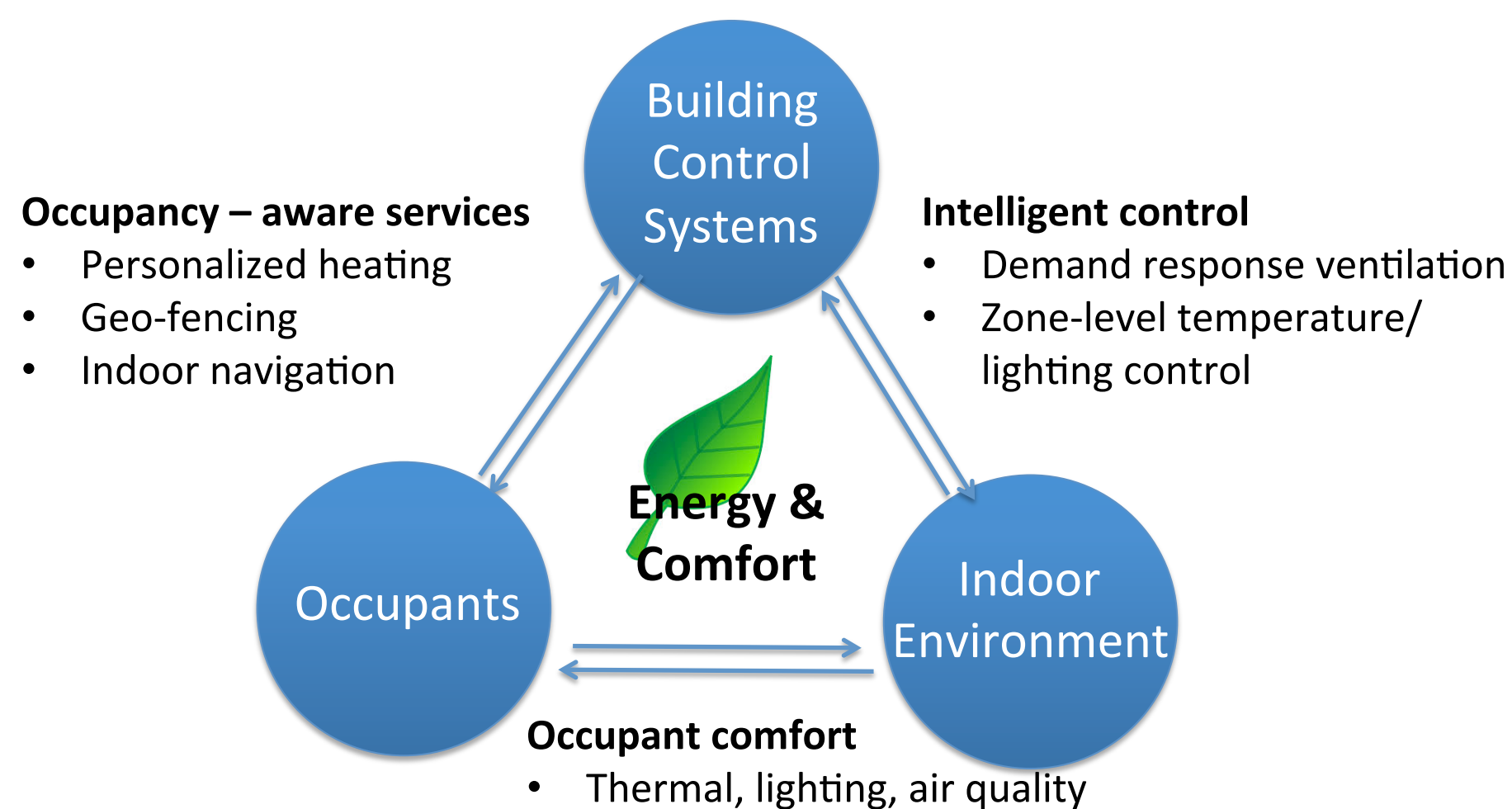


Environmental Sensing by Wearable Device for Indoor Activity and Location Estimation

Ming Jin

Joint work with Han Zou, Kevin Weekly, Ruoxi Jia, Alexandre M. Bayen, and Costas J. Spanos

Motivation



Use case: intelligent watch w/ temperature, humidity, light sensors

- Usage 1:** inform HVAC of the user's metabolic rate and location zone
- Usage 2:** establish an activity and location profile for occupants to improve energy efficiency and space utility

Experiments

Location: CREST office in Cory Hall at UC Berkeley
Two graduate students perform daily activities

- Sit in the cubicle / lab
- Walk/run indoor / outdoor
- Take an elevator, climb stairs

stairs	elevator	walk out.	walk ind.
44	25	41	37
run ind.	sit lab	sit cub	rest
52	176	169	26

★unit: minutes

Platform: Temperature, light, humidity, acceleration

Sensor Fusion for Activity Recognition

Implement classification algorithms with acceleration, environments data and a fusion of both groups:

- Environmental data: 97.42% with random forest
- Result is best when acceleration data is also added

	Acceleration	Environment	Acc.+Environ.
Naïve Bayes	.5309	.8706	.9459
Bayes Net	.5396	.9372	.9843
Logistic Reg.	.5194	.8995	.9728
MLP	.5099	.8512	.9379
J48 Tree	.5403	.9599	.9854
Random Tree	.5033	.9616	.9850
Rand. Forest	.5033	.9742	.9913

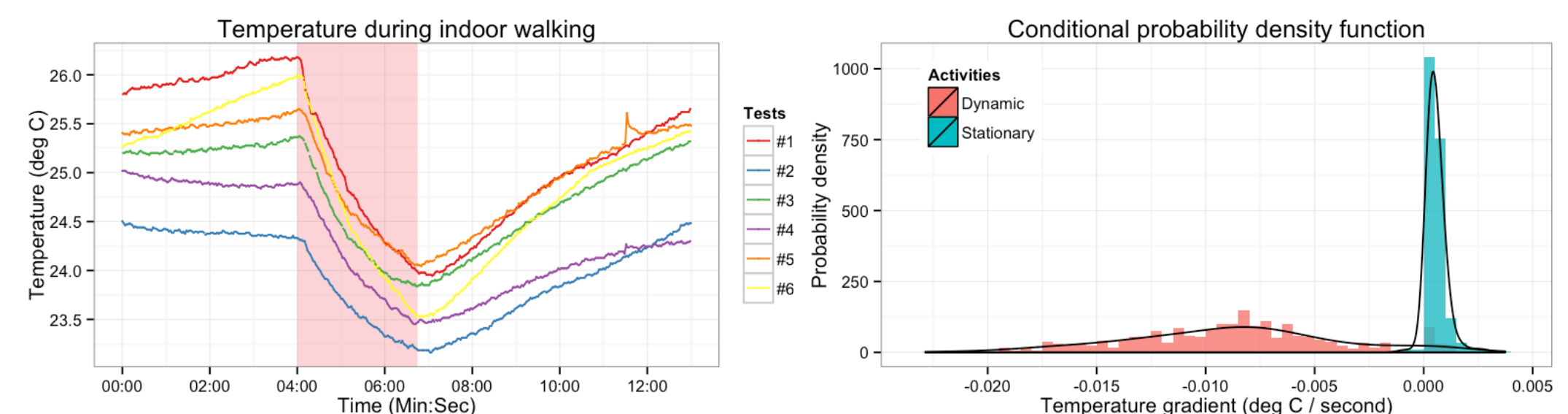
Conclusion and Future Work:

- ✓ Indoor activity and location can be estimated with wearable device for environmental sensing.
- How to adapt to different user behaviors and situations? Active sampling? Transfer learning?
- Online activity and location estimation through particle filter.

Ref: Jin, Ming, et al. "Environmental Sensing by Wearable Device for Indoor Activity and Location Estimation." IECON'14

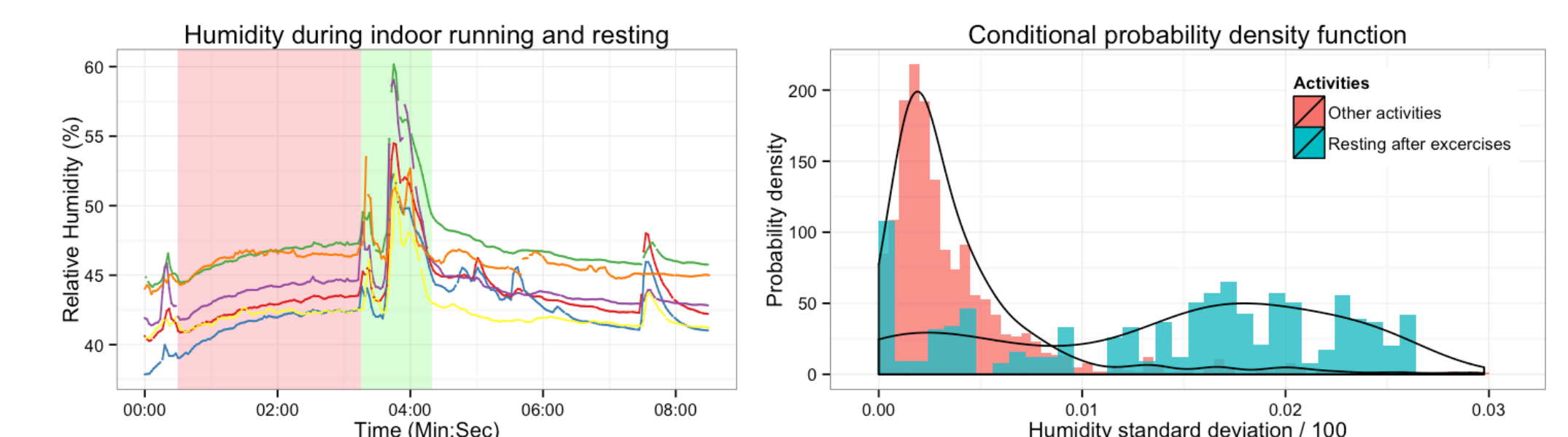
Results and Discussion

Hypothesis I: When the user starts to move, then the temperature reading will drop as is reflected by the negative gradients and the larger standard deviation.



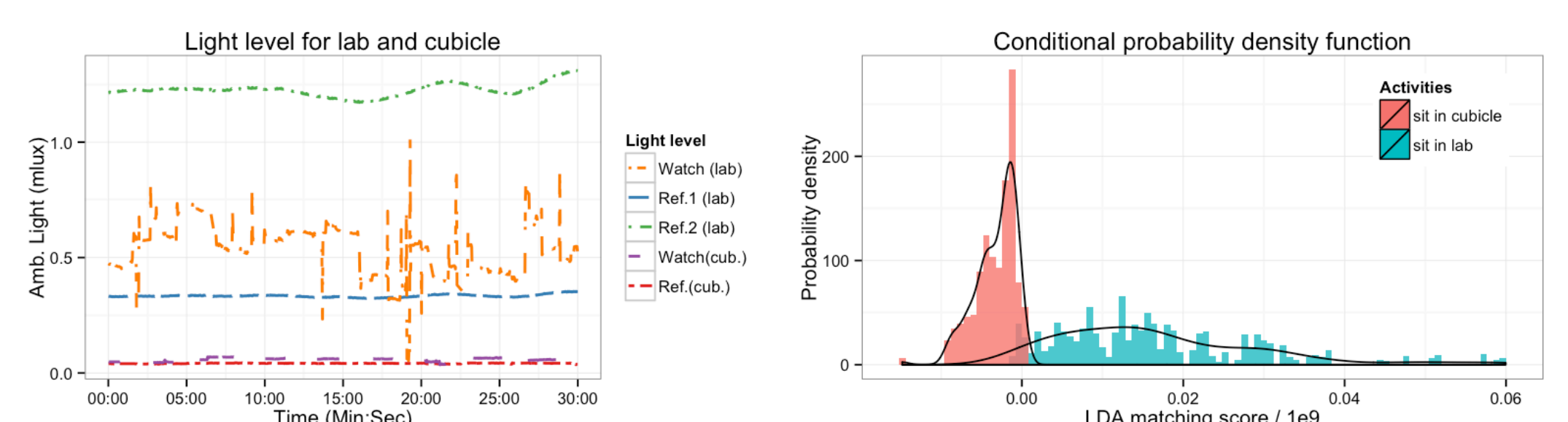
- ❖ Temperature decreases during movement: heat dissipation by increased air flow.
- ❖ Large and negative temperature gradients is indication of dynamics.

Hypothesis II: When the user starts to move, then the temperature reading will drop as is reflected by the negative gradients and the larger standard deviation.



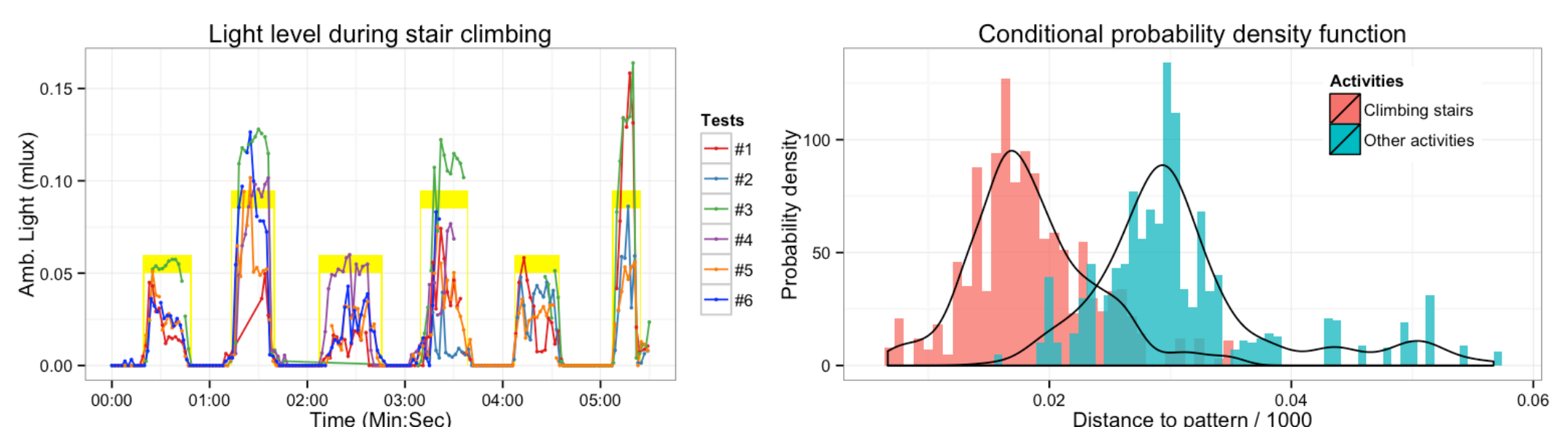
- ❖ Humidity changes drastically after physical activities: near-skin evaporation.
- ❖ Distinguishes from other activities: intelligent HVAC for thermal comfort.

Hypothesis III: When the user sits in a lab/, then the light level will reflect the characteristics of that location as compared to the reference points.



- ❖ Compare the probability of given observations conditioned on different locations.

Hypothesis IV: When the user is climbing the stairs, then the light level will exhibit periodic pattern and reflect the floor he/she has reached.



- ❖ Light level exhibits periodicity during stairs climbing: dimmer in the intermediate landing and brighter in the main floor entrance.
- ❖ The periodicity is also present for acceleration when taking elevators.