

# Activity Recognition in a home

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# Activity Recognition

- Recognizing human activities e.g. home occupancy, sleeping, cooking, bathing



**Nest**



**Ulo**



**Belkin Smart Switch**

# Problem definition

- Infer occupant activities using sensors home deployed sensors



z z z



# Evaluation

- 2 apartments  
1 home
- Each single  
occupant
- Duration  
14 – 25 days



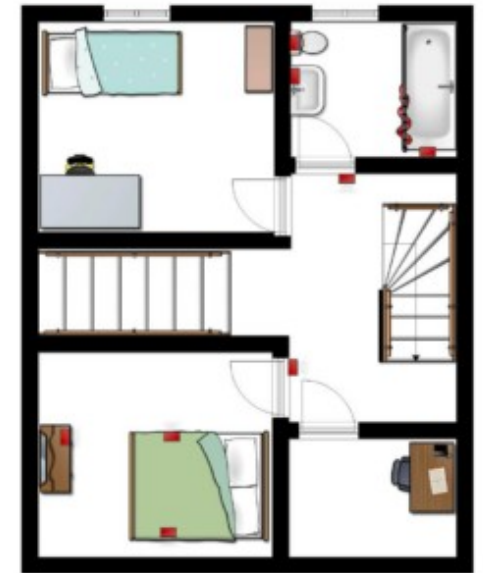
(a) House A



(b) House B



(c) House C, First floor



(d) House C, Second floor

# Dataset

- Binary sensor data:
  - Reed switches : doors or cupboards open or closed
  - Pressure mats : lying on bed or couch
  - Passive infrared: Detect motion in specific area
  - Float sensors: toilet being flushed
- Labels:
  - Handwritten diary
  - Bluetooth diary

# Related work

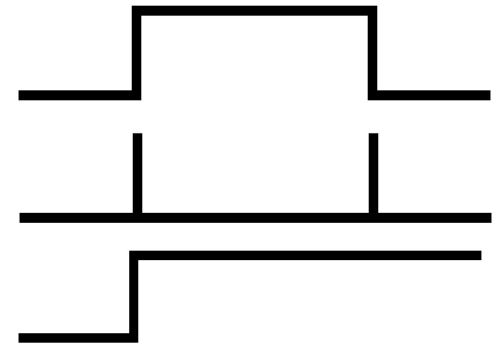
- Van Kasteren, T. L. M., Gwenn Englebienne, and Ben JA Kröse. "Human activity recognition from wireless sensor network data: Benchmark and software." *Activity recognition in pervasive intelligent environments*. Atlantis Press, 2011. 165-186
- Tapia, Emmanuel Munguia, Stephen S. Intille, and Kent Larson. *Activity recognition in the home using simple and ubiquitous sensors*. Springer Berlin Heidelberg, 2004.

# Methods

- Naïve Bayes
- SVM
- HMM
  - Generative probabilistic model
- CRF
  - Discriminative probabilistic model
- Structured SVM
  - Allows training of a classifier for general structured output labels

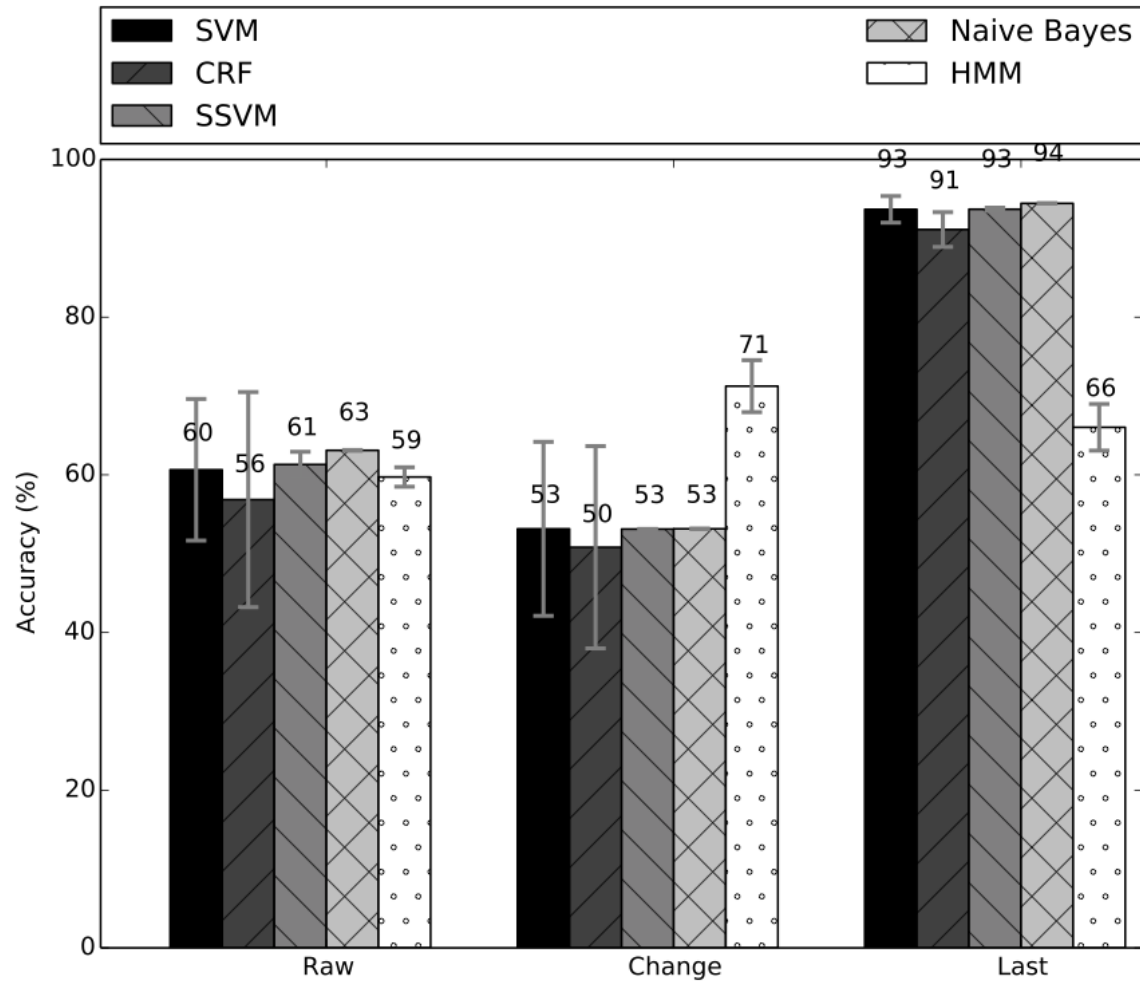
# Evaluation Design

- Feature representations
  - Raw
  - Change
  - Last
- 5 fold – cross validation
- Divide the dataset into smaller subsequences of ~2 hours





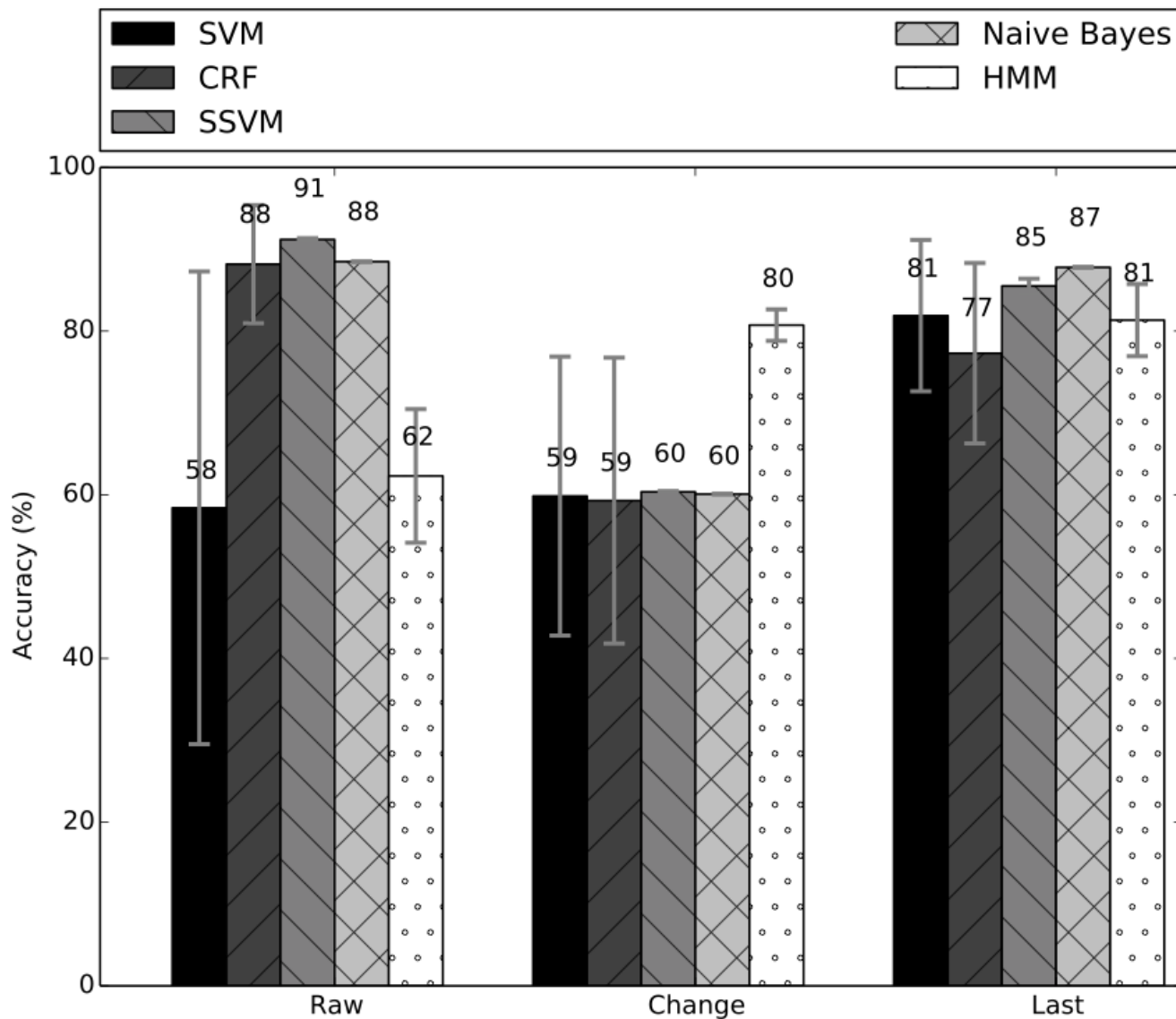
# Comparison: House A



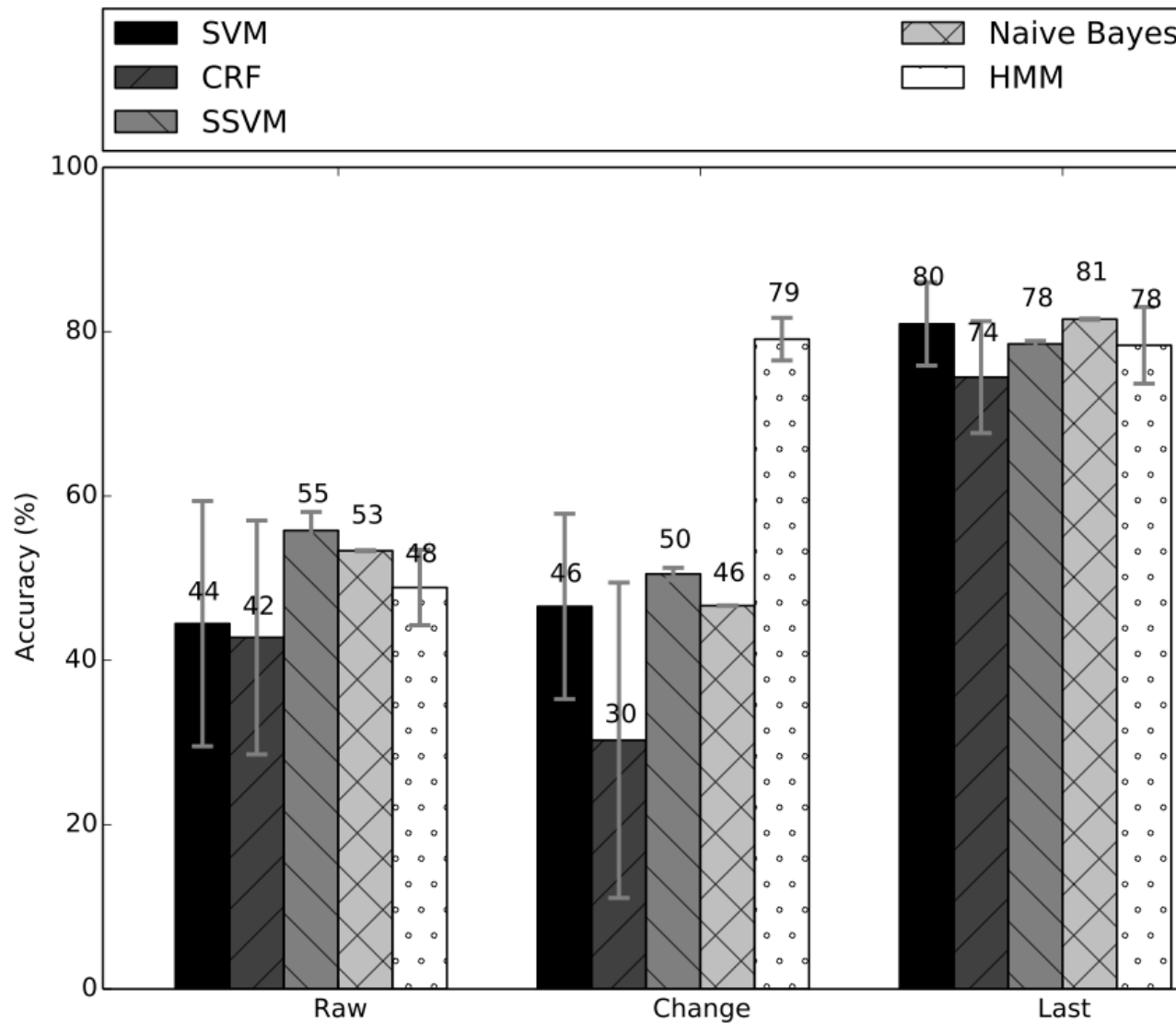
# House A Metrics

		Precision	Recall	F-Measure	Accuracy
Model	Feature				
HMM	Change	36.9	35.2	31.8	$72.0 \pm 3.3$
	Raw	30.8	13.8	12.9	$58.0 \pm 1.2$
	Last	21.8	19.3	15.2	$66.6 \pm 3.0$
SVM	Change	34.7	11.4	9.5	$53.1 \pm 11.0$
	Raw	33.2	17.0	17.4	$60.6 \pm 9.0$
	Last	26.7	27.9	27.3	$93.7 \pm 1.7$
SSVM	Change	13.9	10.3	7.5	$53.1 \pm 0.0$
	Raw	23.0	15.2	15.3	$61.3 \pm 1.6$
	Last	30.3	29.2	28.9	$93.7 \pm 0.2$
CRF	Change	3.1	10.0	4.8	$31.3 \pm 0.0$
	Raw	17.9	15.7	14.9	$62.1 \pm 0.0$
	Last	19.4	19.3	14.5	$65.9 \pm 0.0$
HMM	Change	36.9	35.2	31.8	$72.0 \pm 3.3$
	Raw	30.8	13.8	12.9	$58.0 \pm 1.2$
	Last	21.8	19.3	15.2	$66.6 \pm 3.0$
NB	Change	38.1	11.6	9.9	$53.1 \pm 0.0$
	Raw	52.7	17.3	17.0	$63.0 \pm 0.0$
	Last	28.3	28.2	27.7	$94.5 \pm 0.0$

# Comparison: House B



# Comparison: House C



# Summary

- Naive Bayes consistently outperforms other methods
- Structured SVM also performs well in sensors based activity recognition.