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

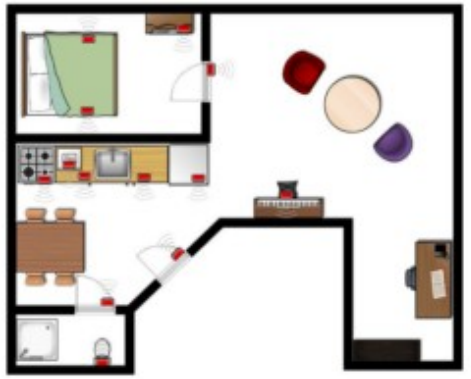
Problem definition

- Infer occupant activities using sensors home deployed sensors

Evaluation

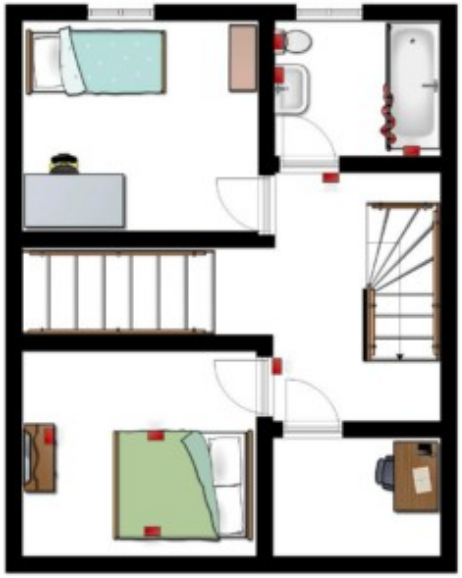
- 2 apartments
  1 home
- Each single occupant
- Duration
  14 – 25 days

(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

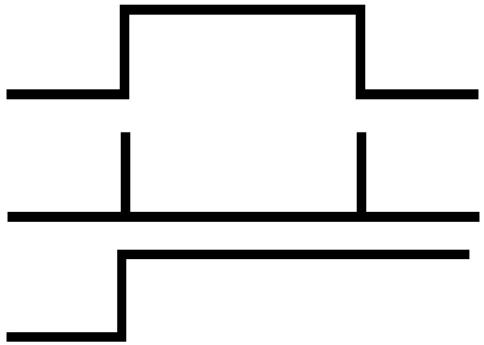
- Tapia, Emmanuel Munguia, Stephen S. Intille, and Kent Larson. *Activity recognition in the home using simple and ubiquitous sensors*. Springer Berlin Heidelberg, 2004.

Methods

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

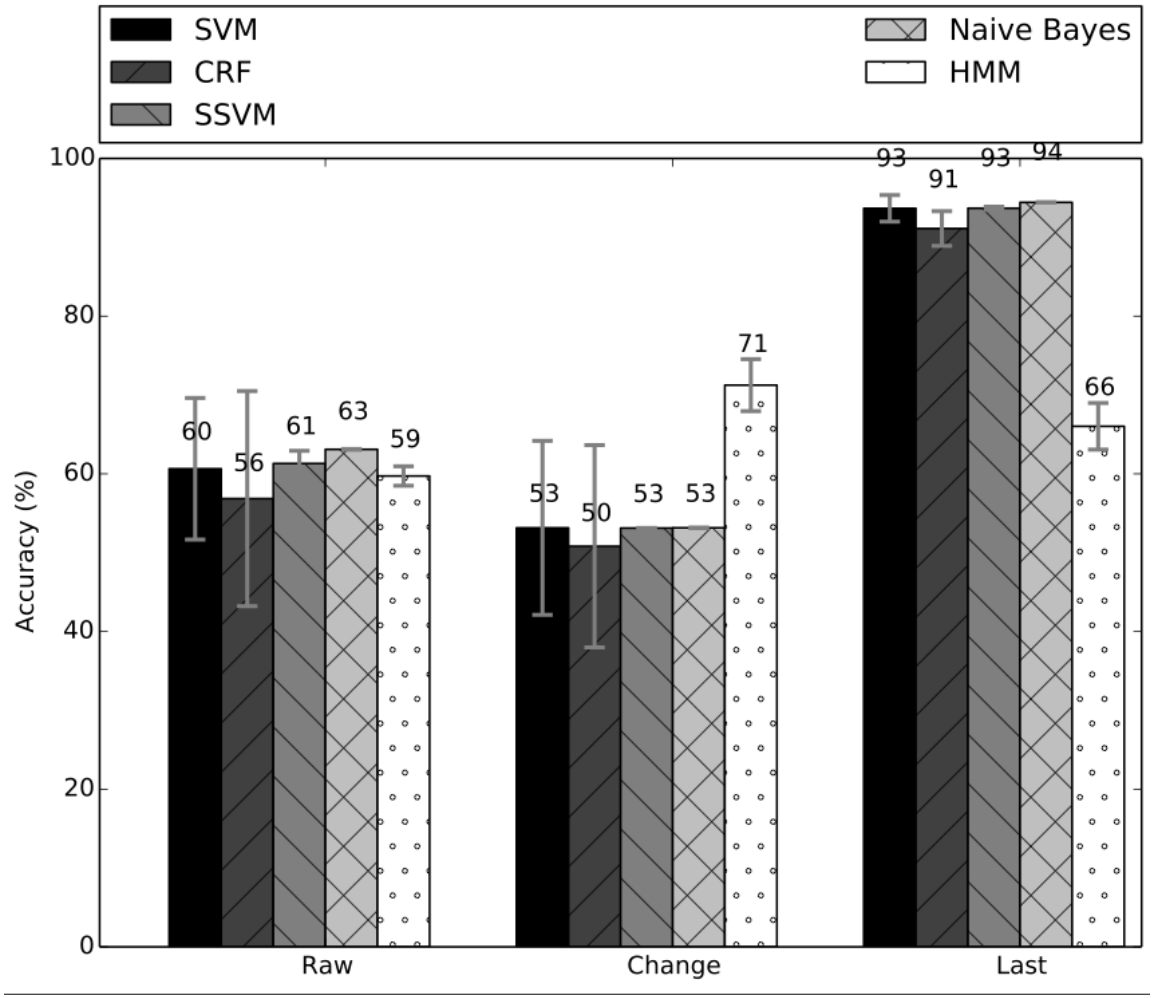
Evaluation Design

- Feature representations
  - Raw
  - Change
  - Last



- 5 fold – cross validation
- Divide the dataset into smaller subsequences of ~2 hours

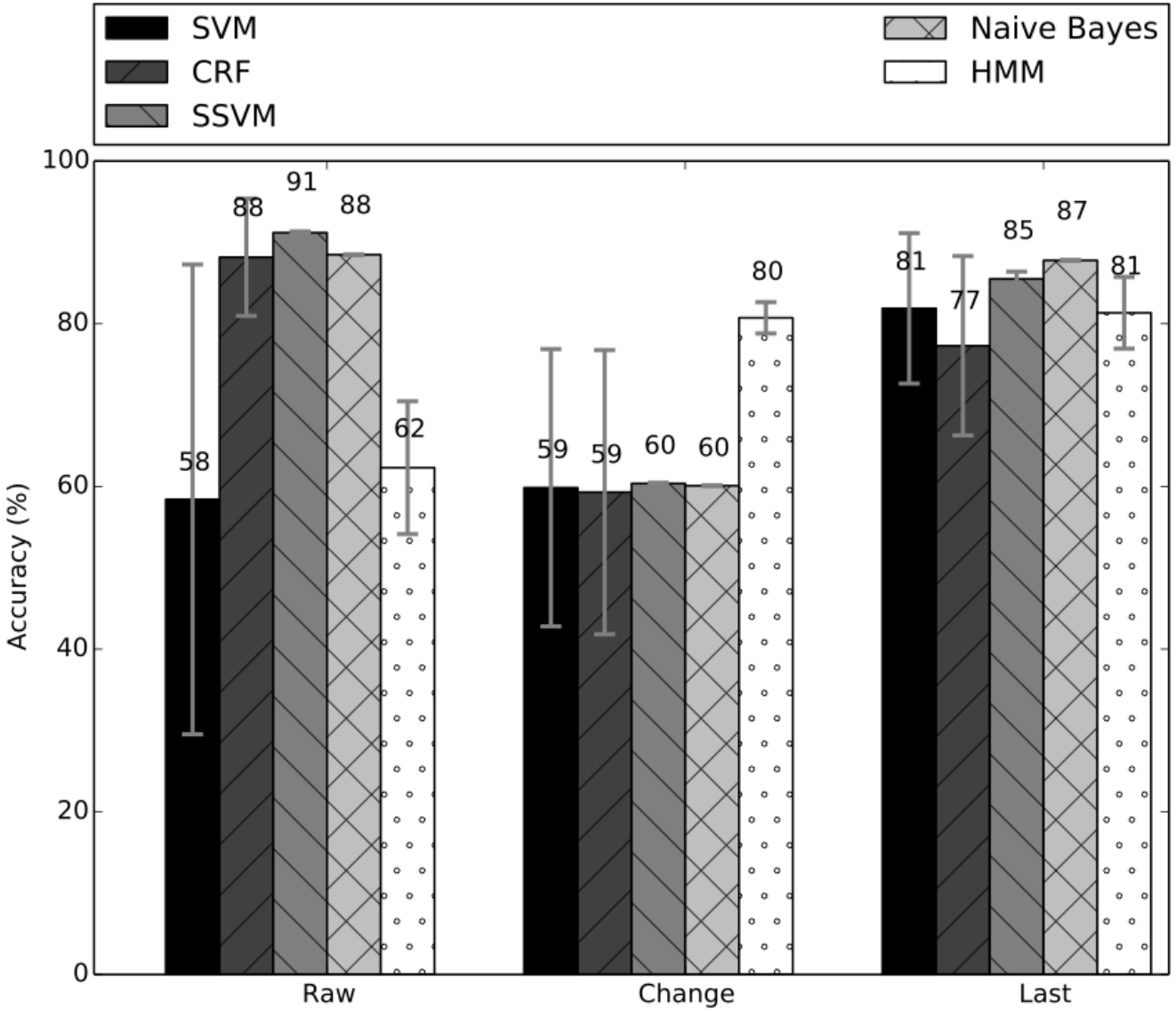
Comparison: House A



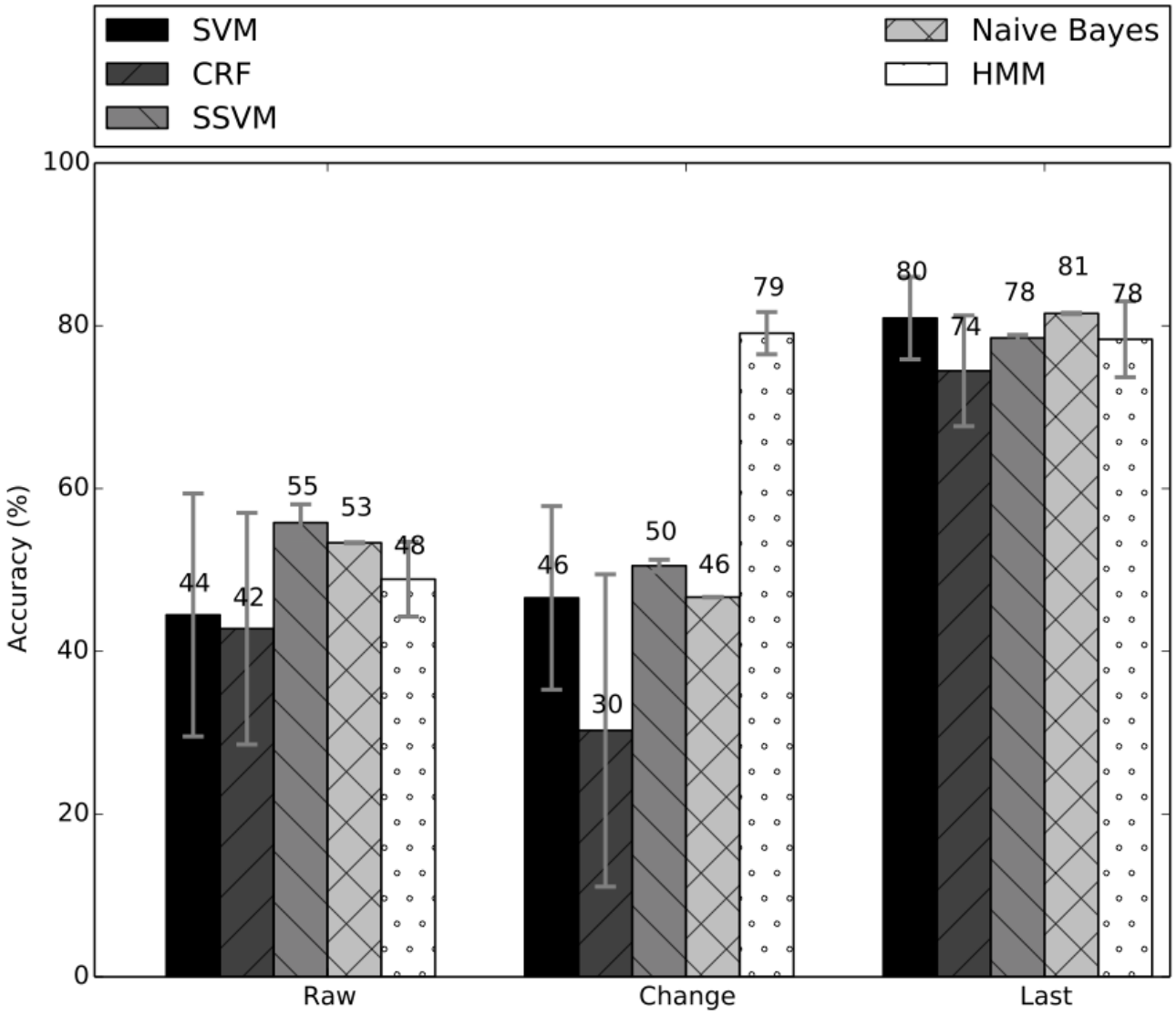
House A Metrics

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