Activity Recognition using integrated sensors

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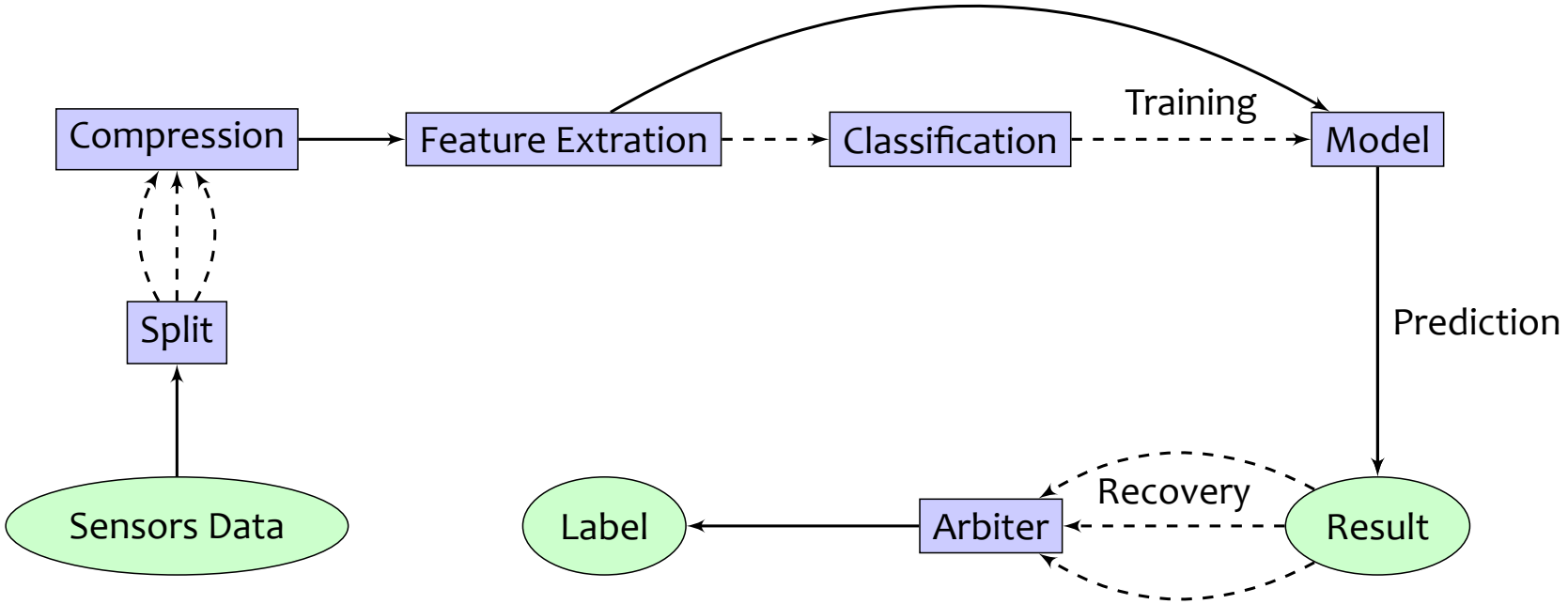
Big Picture


Compression
Feature Extration
Classification
Training
Model
Split
Prediction
Sensors Data
Label
Arbiter
Recovery
Result

Observation

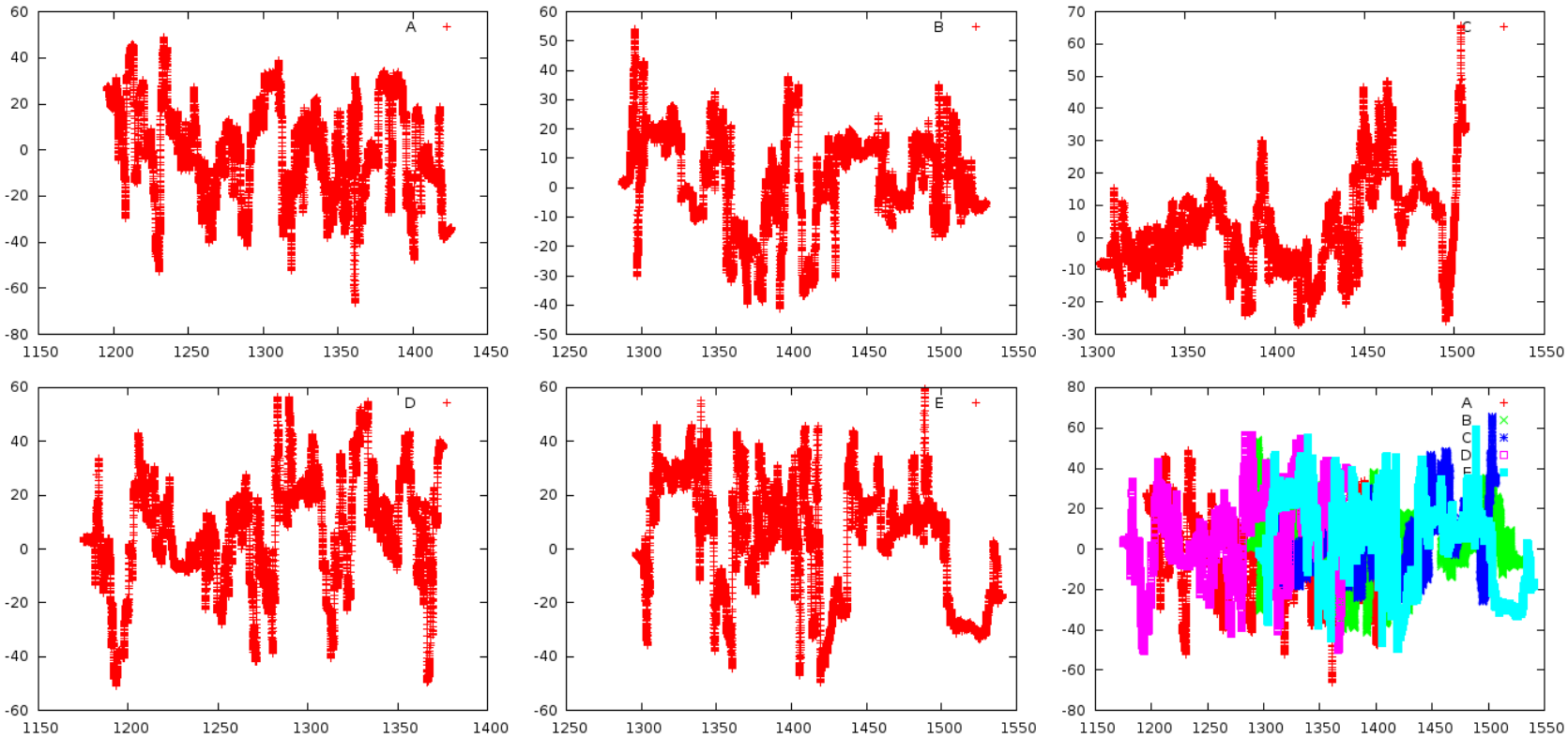


Figure : Discrete time-series data of the same activity in different data set

Split

Procedure

- Splitting raw data by Label
- Remapping Label to $\{-1, 1\}$

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Multi-Class Classification $\Rightarrow$ Two-Class Classification

- Using different model
- More accuracy

Compress

Procedure

- Combine every α raw data
- Average

Compress

Procedure

- Combine every α raw data
- Average

Smooth

- Eliminate unknown data
- Smooth extreme data
- Reduce scale of raw data

Observation

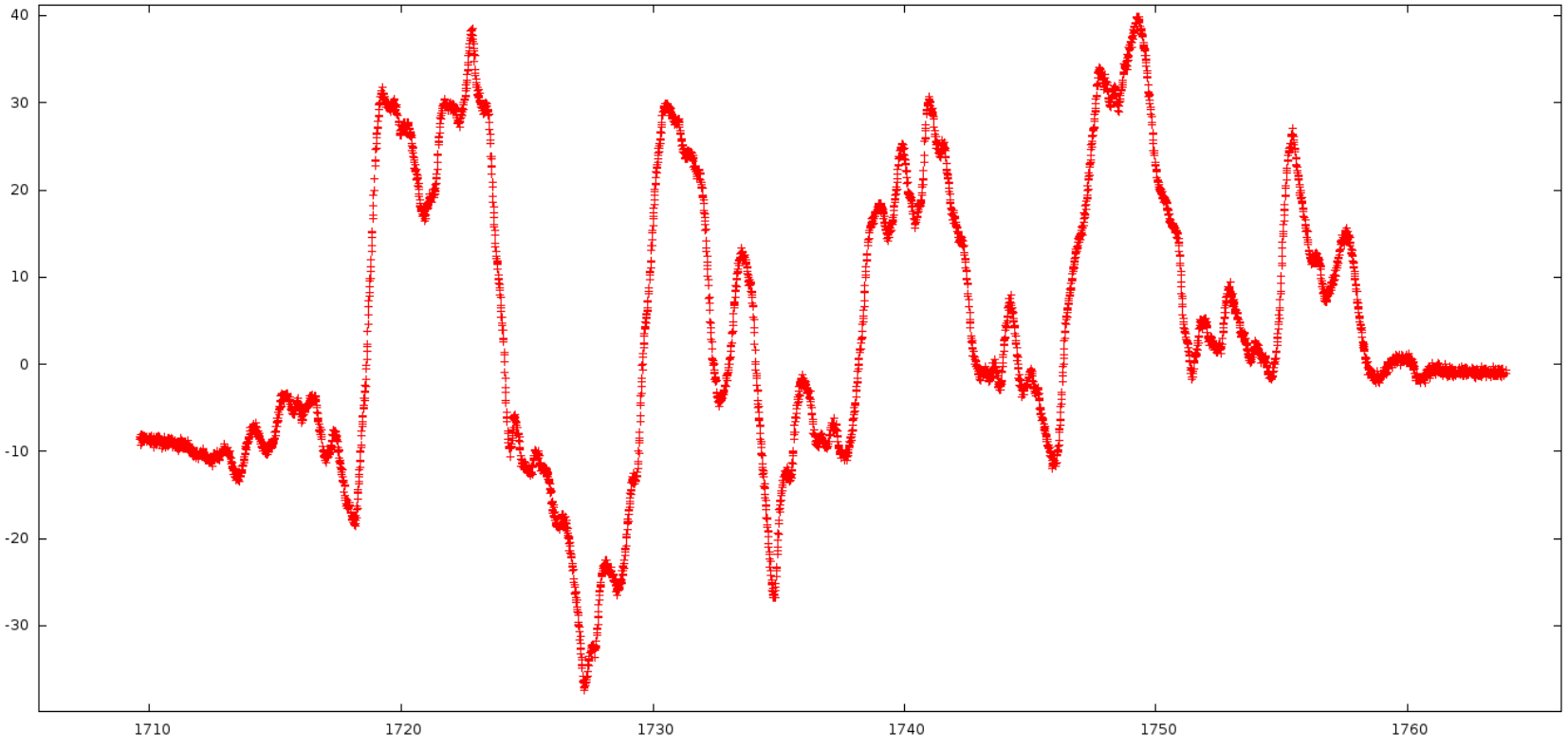

Figure : Discrete time-series data

Time-Series

Continous vs. Discrete

Every β time-based data point $\Rightarrow$ Features

Features

- Average: $\bar{X}$
- Variance: $\frac{1}{n}\sum(X_i - \bar{X})^2$
- $\max X_i - \min X_i$
- $X_1 - X_n$
- $\frac{1}{n}\sum|X_i - \bar{X}|$
- Time between Peaks
- Binned Distribution
- Discrete Wavelet Transform: Haar

Time between Peaks

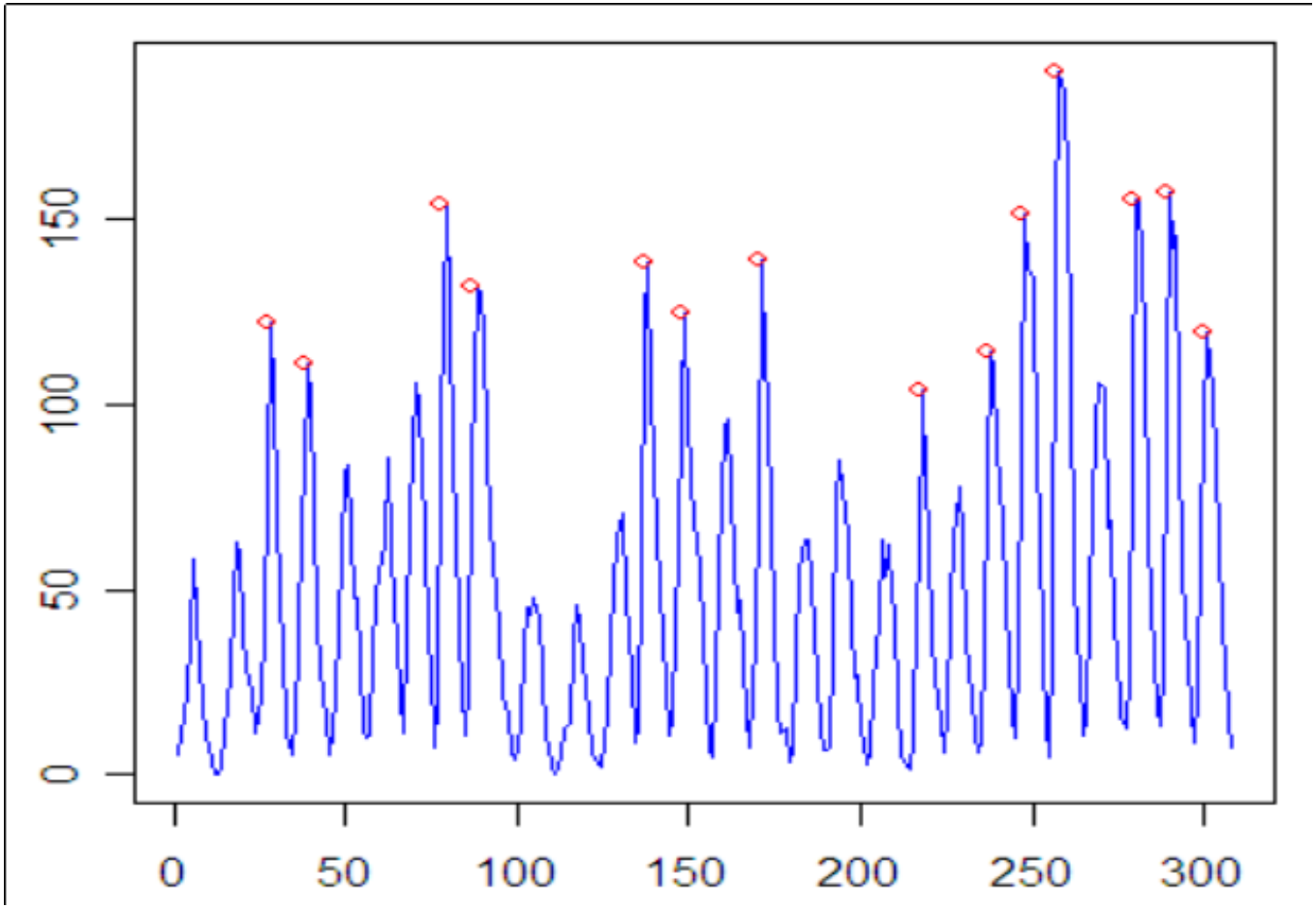

Figure : Peaks Detection

Time between Peaks

Algorithm

Algorithm 1: Peak Detection Algorithm that uses Peak Function F

Input : Time-series of N points: $X = \{x_1, x_2, \cdots, x_N\}$, N
Window size around the peak: K
Threshold: H

Output: Set of peaks detected in X: S

begin
  $S = \emptyset$
  for $i = 1$ **to** N **do**
    $A[i] = F(X, i, K)$
  end
  Compute the mean avg and standard deviati n var of all values in array A
  for $i = 1$ **to** N **do**
    if $A[i] > 0$ **and** $(A[i] - avg) > H \cdot var$ **then**
      $S = S \cup \{x_i\}$
    end
  end
  for *every adjacent pair of peaks* x_i *and* x_j *in* S **do**
    if $|j - i| \leq K$ **then**
      Remove the smaller value of $\{x_i, x_j\}$ from S
    end
  end
end

Binned Distribution

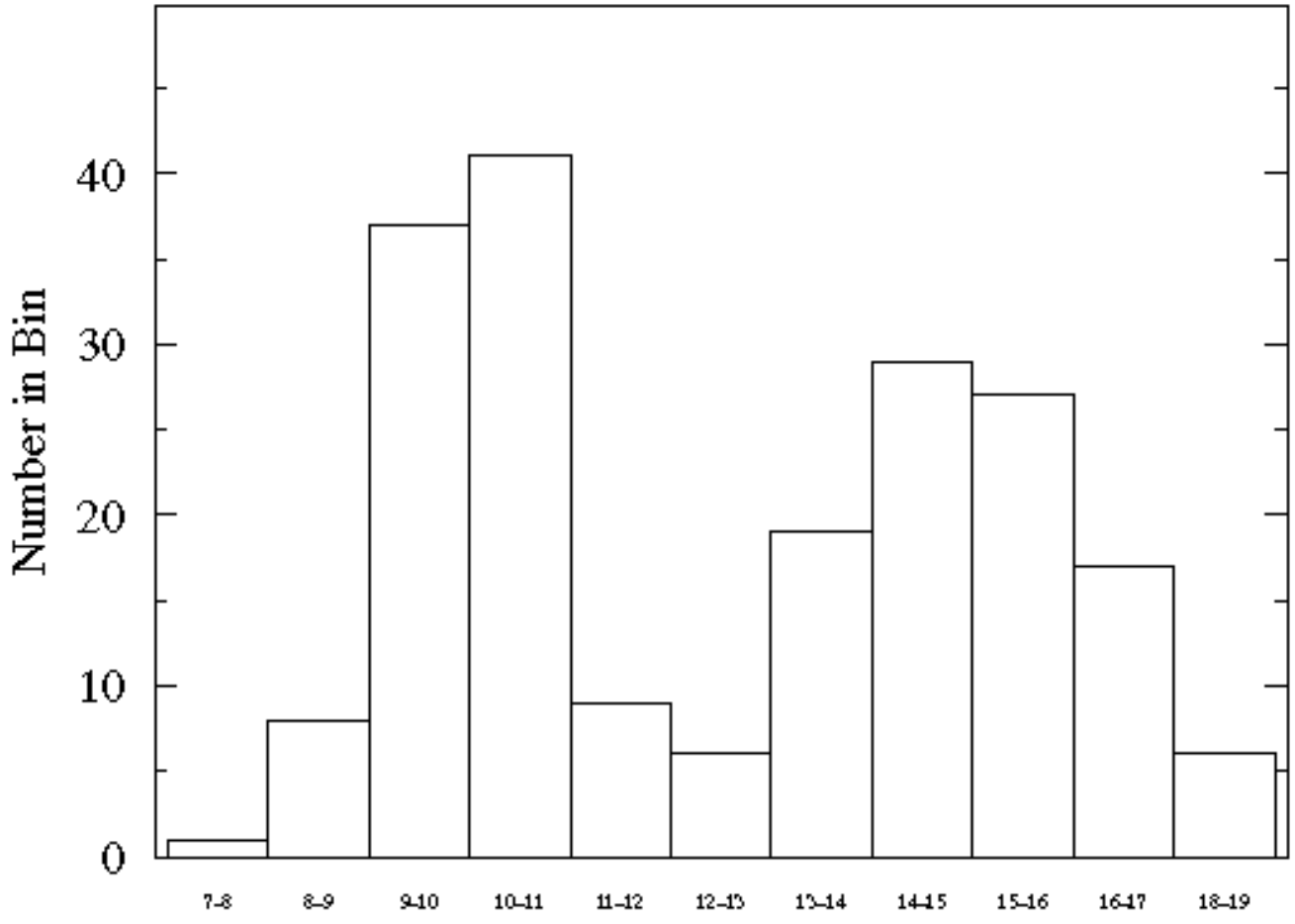

Figure : Binned Distribution

Discrete Wavelet Transform: Haar

Procedure

- 1D Haar Wavelet Transform
- Largest 5 components

Discrete Wavelet Transform: Haar

Procedure

- 1D Haar Wavelet Transform
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Period

Describe the period of the time-series data

Training and Predicting

Support Vector Machine

- RBF Kernel
- Two-Class Classification
- Performance

Training and Predicting

Support Vector Machine

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Recovery

- Expand

Arbiter

Procedure

- Collect the vote from all models
- For each data
  - 1 Positive $\Rightarrow$ Confirmed
  - 0 Positive $\Rightarrow$ Unknown
  - > 1 Positive $\Rightarrow$ Confused
- If "Confused" $\Rightarrow Score_i = F(Model_i, Probability_i, Estimate_i)$

Result

Parameters

Activity	α	β	Training Data	Temperature	Haar	Time between Peaks	Binned Distribution
1	40	20	ABCDE	+	-	+	+
2	50	20	DE	-	+	-	-
3	10	100	BCDE	-	+	-	-
4	50	20	ABCDE	-	-	-	+
5	50	50	BDE	-	-	+	+
6	50	20	ABCDE	-	-	-	+
7	50	20	ABCDE	-	-	-	+
12	50	20	ABDE	+	+	-	-
13	50	50	BDE	-	-	-	$+(\lvert Bins\rvert = 5)$
16	50	20	ABCDE	+	+	-	-
17	50	50	ABCDE	-	+	-	-
24	50	20	ABCDE	+	-	+	+

Result

Activity	1	2	3	4	5	6	7	12	13	16	17	24	Sum	Best	Worst
F_1	0.9938	0.9884	0.9763	0.9451	0.9872	0.9372	0.9690	0.8577	0.8681	0.8819	0.9718	N/A	10.3766	0.9938	0.8577

Thank you!