18-697
Human Activity Recognition via Mobile Sensors

Classification Models

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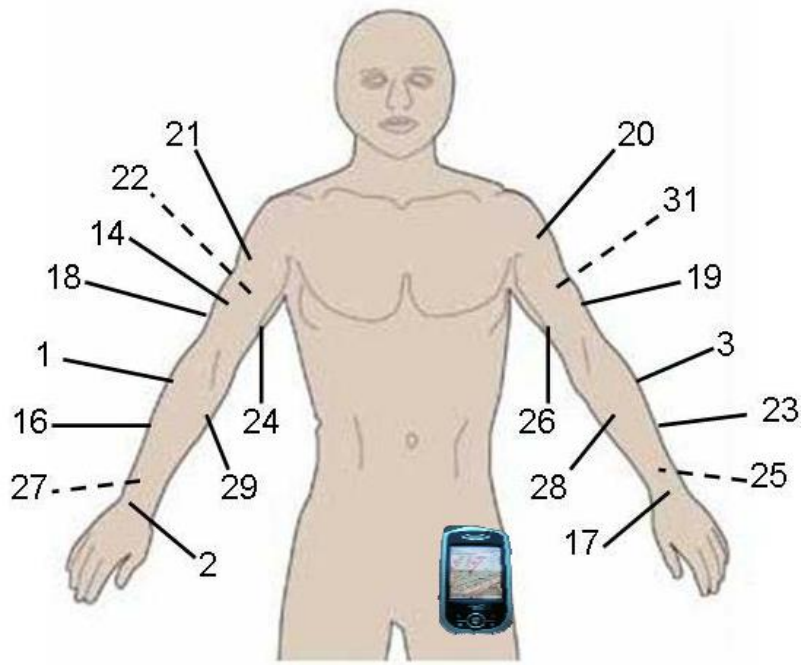
December 2nd , 2014

Idea

- Human activity recognition
- Baseline classification
- Look at activity specific improvement
  - After feature selection
  - For percentage amounts of original data

Dataset: Skoda Mini Checkpoint

- Time series data recorded by 10 sensors on each arm separately
- Accelerometers: 3 measures per sensors (x,y,z)
- 11 activities including one null-activity
- About 700,000 measurements from all sensors



Resulting data sets:

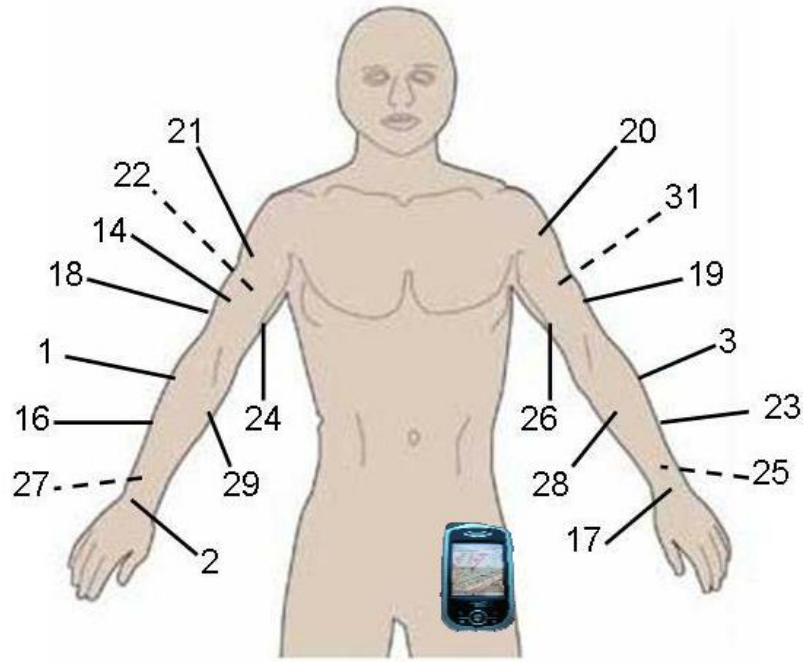
- Left arm
- Right arm
- Combined

Pre-processing: Sliding window

- Raw data from sensors
- 64 meas./window, 50% overflow

- Feature extraction
  - Mean
  - Std. Dev.

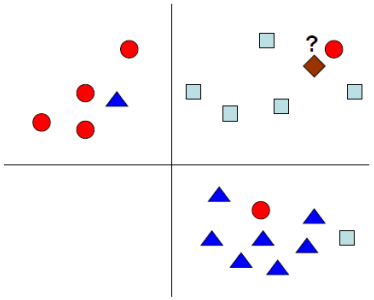
- Randomization
- Partitioning



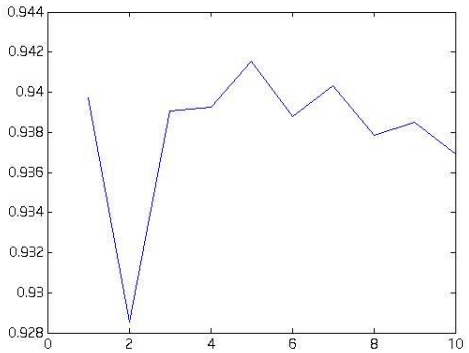
Baseline classifier

K Nearest Neighbors: Deterministic Association

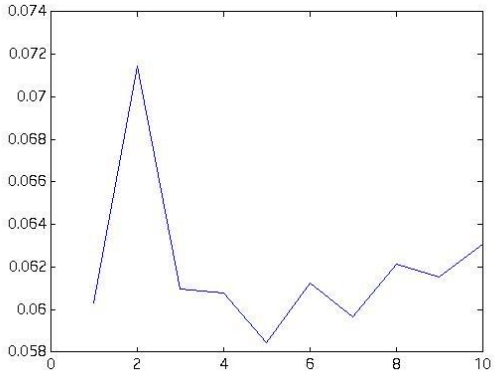
- ✓ Determine k with 10-fold Cross-Validation error and performance analysis
- ✓ Evaluate per-activity performance with confusion matrices



Example: Determining number of neighbors for *combined* dataset



Performance



MSE for predictions

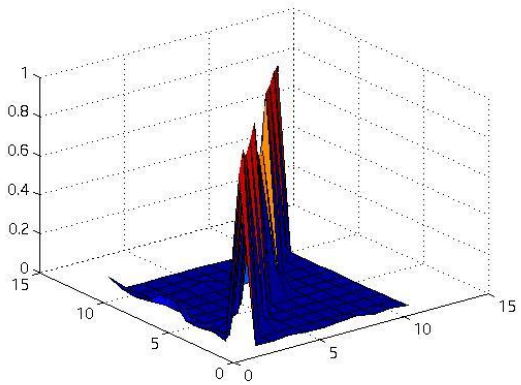
Per-activity performance by baseline

Example: Right-arm dataset performance

	32	48	49	50	51	52	53	54	55	56	57
32	0.89583	0.01003	0.00887	0.01582	0.00617	0.00733	0.01235	0.02083	0.00231	0.01350	0.00694
48	0.02229	0.97771	0	0	0	0	0	0	0	0	0
49	0.04170	0.00348	0.90009	0.04952	0.00087	0.00087	0.00087	0.00261	0	0	0
50	0.03285	0	0.05018	0.91150	0.00456	0	0	0.00091	0	0	0
51	0.03388	0	0.00125	0.00376	0.95483	0	0.00125	0.00251	0.00251	0	0
52	0.10581	0.00415	0	0	0	0.73651	0.15353	0	0	0	0
53	0.10965	0	0	0	0	0.18421	0.70614	0	0	0	0
54	0.04615	0	0.00118	0	0.00118	0	0	0.94911	0.00237	0	0
55	0.03652	0.00107	0.00107	0.00322	0.02470	0	0	0.00430	0.92911	0	0
56	0.04718	0	0	0.00093	0.00093	0.00093	0	0.00185	0	0.94820	0
57	0.07680	0	0	0	0	0	0	0	0	0	0.92320

Performance review through confusion matrix:

- Generally strong classification performance
- Particular struggle with certain activity pairs
- Null activity also difficult
  - Often confused with other activities



label value:

- 32 null class
- 48 write on notepad
- 49 open hood
- 50 close hood
- 51 check gaps on the front door
- 52 open left front door
- 53 close left front door
- 54 close both left door
- 55 check trunk gaps
- 56 open and close trunk
- 57 check steering wheel

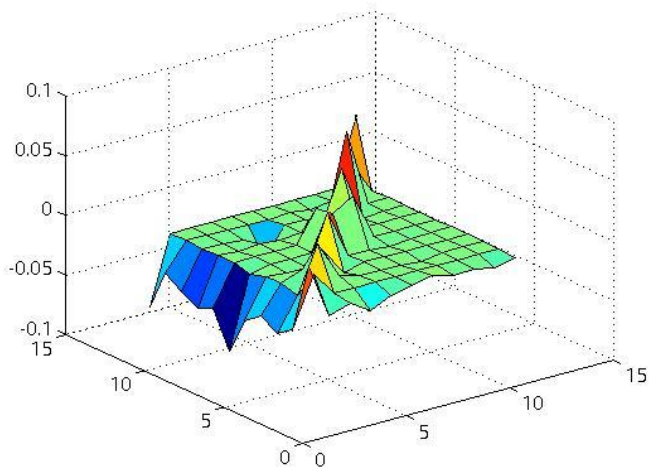
Per activity improvement with Feature Selection data by LDA

Example: Right-arm dataset relative improvement with LDA

	32	48	49	50	51	52	53	54	55	56	57
32	0.03737	-0.00760	-0.00183	-0.01315	-0.00544	-0.00126	0.00223	-0.00213	-0.00134	-0.00573	-0.00111
48	-0.02067	0.02067	0	0	0	0	0	0	0	0	0
49	-0.03025	-0.00348	0.03487	0.00407	-0.00087	-0.00087	-0.00087	-0.00261	0	0	0
50	-0.02186	0.00096	0.00760	0.01878	-0.00456	0	0	-0.00091	0	0	0
51	-0.03253	0	-0.00125	-0.00174	0.04044	0	-0.00125	-0.00251	-0.00116	0	0
52	-0.06323	-0.00415	0	0	0	0.02873	0.03865	0	0	0	0
53	-0.03320	0	0	0	0	0.02664	0.00656	0	0	0	0
54	-0.03986	0	-0.00118	0	-0.00118	0	0	0.04459	-0.00237	0	0
55	-0.03194	-0.00107	-0.00107	-0.00322	-0.02356	0	0	-0.00430	0.06517	0	0
56	-0.02278	0	0	-0.00093	-0.00093	-0.00093	0	-0.00185	0	0.02740	0
57	-0.05700	0	0	0	0	0	0	0	0	0	0.05700

Performance review of improvement:

- Overall improvement
- Positive diagonal:
  - Higher classification power
- Generally less confusion
- Big improvement on null activity classification



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General performance results

Baseline kNN with 10-fold Cross-Validation:

- Left-arm dataset score: 92.001 %
- Right-arm dataset score: 90.78 %
- Combined dataset score: 94.12 %

Improvement with feature selection LDA processed data:

- Left-arm dataset score: 95.35 %
- Right-arm dataset score: 94.46 %

(same algorithms used for all data sets)

Observations and conclusions

- Baseline: Generally strong performance
  - Activities most confused by kNN
    - Open door vs. Close door
    - Null activity highly confused
- Improvements: Feature Selection
  - Particular activities affected by LDA
    - Improved: Close both doors vs. Check trunk gaps
    - Highly improved: Null activity classification and confusion
    - Performance loss: Open hood vs. Close hood
- More possible analysis:
  - Percentage amounts of original data
  - Other algorithms

Thank you for your attention