Context-aware Wireless Networks: Exploiting Mobility

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Context Matters

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Thurs 10th 2014

Daily Today

Op!

Girl kills elderly woman!

Shoes still missing

Lorem ipsum dolor sit amet, consect
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Fri 11th 2014

Daily Day After

Op!

Fancy dress shop robber

He's in there somewhere

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dolore magna aliqua. Ut enim ad
quis nostrud exercitation ullamco
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Scenarios

Scenarios

Current Scanning Frequencies

802.11

- Active scans every 15-60 seconds[1]
  - Per saved network (max 16 for Android)

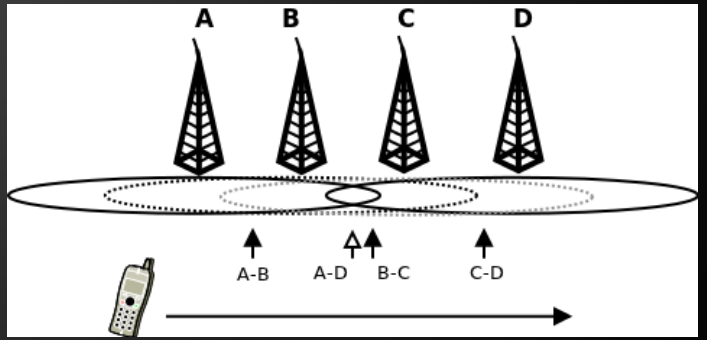
LTE

- Scans once every ~5mins

Wasted energy if in previous scenarios

Future

- Adaptive scanning interval
- Opportunistic active scans
  - Only probe a subset of saved networks
  - ‘Seen together’ APs
- Predictive handover
  - Historical handovers used



Mobility

Location

Possible Contexts

Social Interaction

Usage

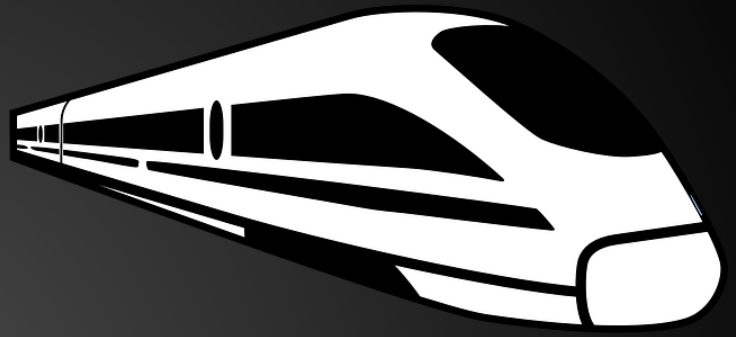
Environmental

Mobility Context

1) None - You are not moving and your environment is not changing (ignoring fading etc).

Scan less frequent, or not at all?

2) Moderate - You are moving considerably, the environment around you is changing. Frequent scans needed.



3) High - You are travelling at high speed (relative to the world). Should we scan at all at these speeds? What about stopping at station?[2]

Measuring Mobility

Options

1. Velocity
    - Gives us a quantified metric
2. Categorisation via a Classifier
    - Binary, i.e. Significant movement
    - Types of movement, e.g. None, moderate, high.

Measuring Mobility

Gives us more information

Possibilities

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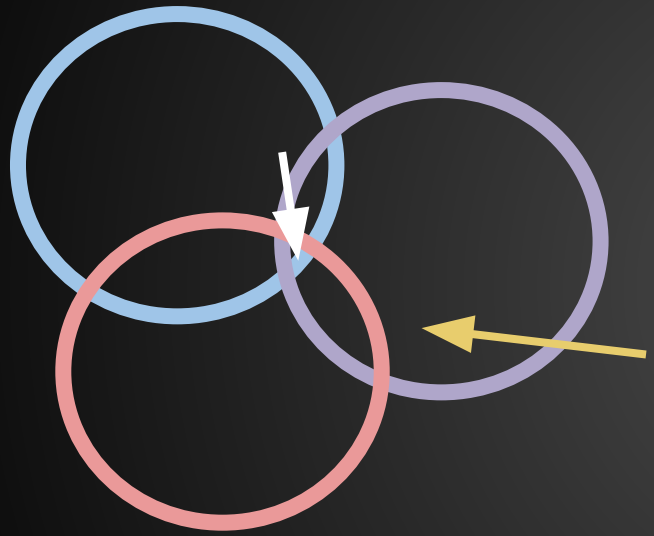
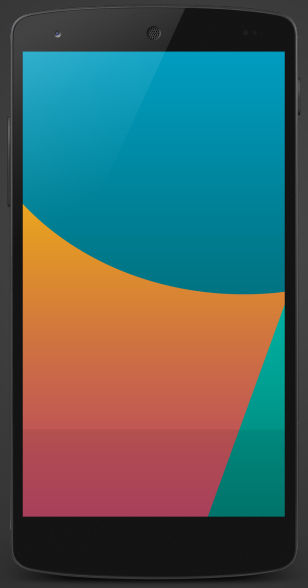
How to collect

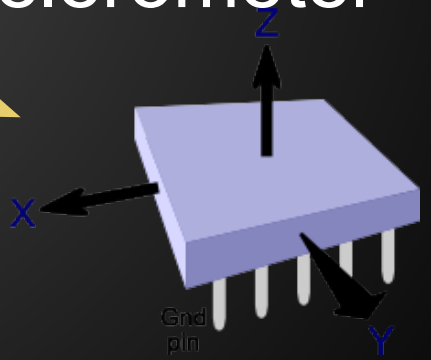


Triangulation

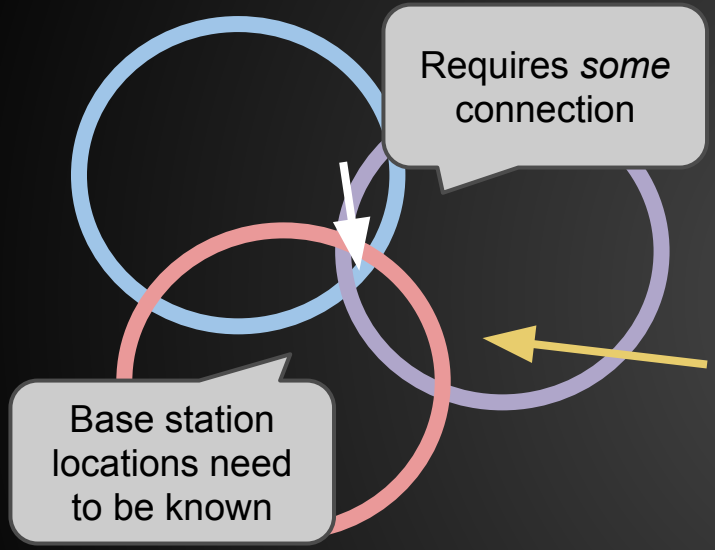


GPS

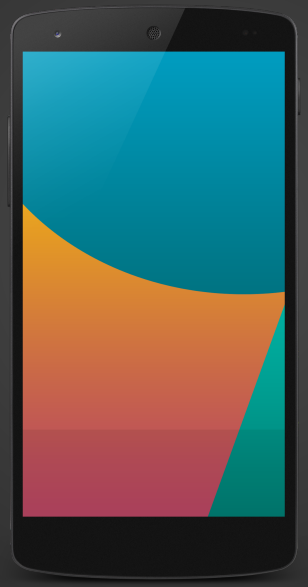
Accelerometer



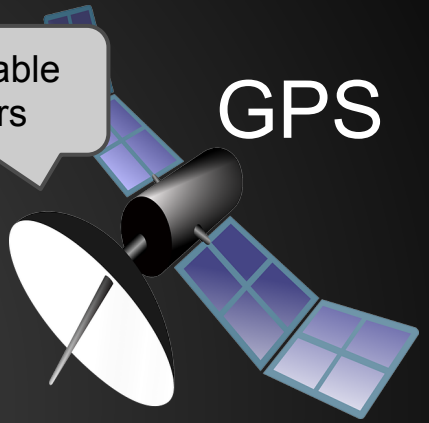
How to collect



Triangulation

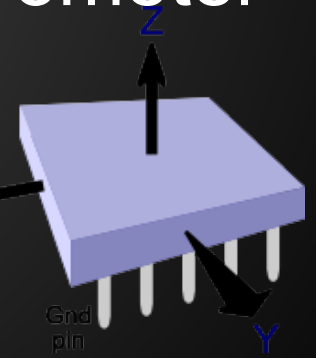


Not reliable indoors



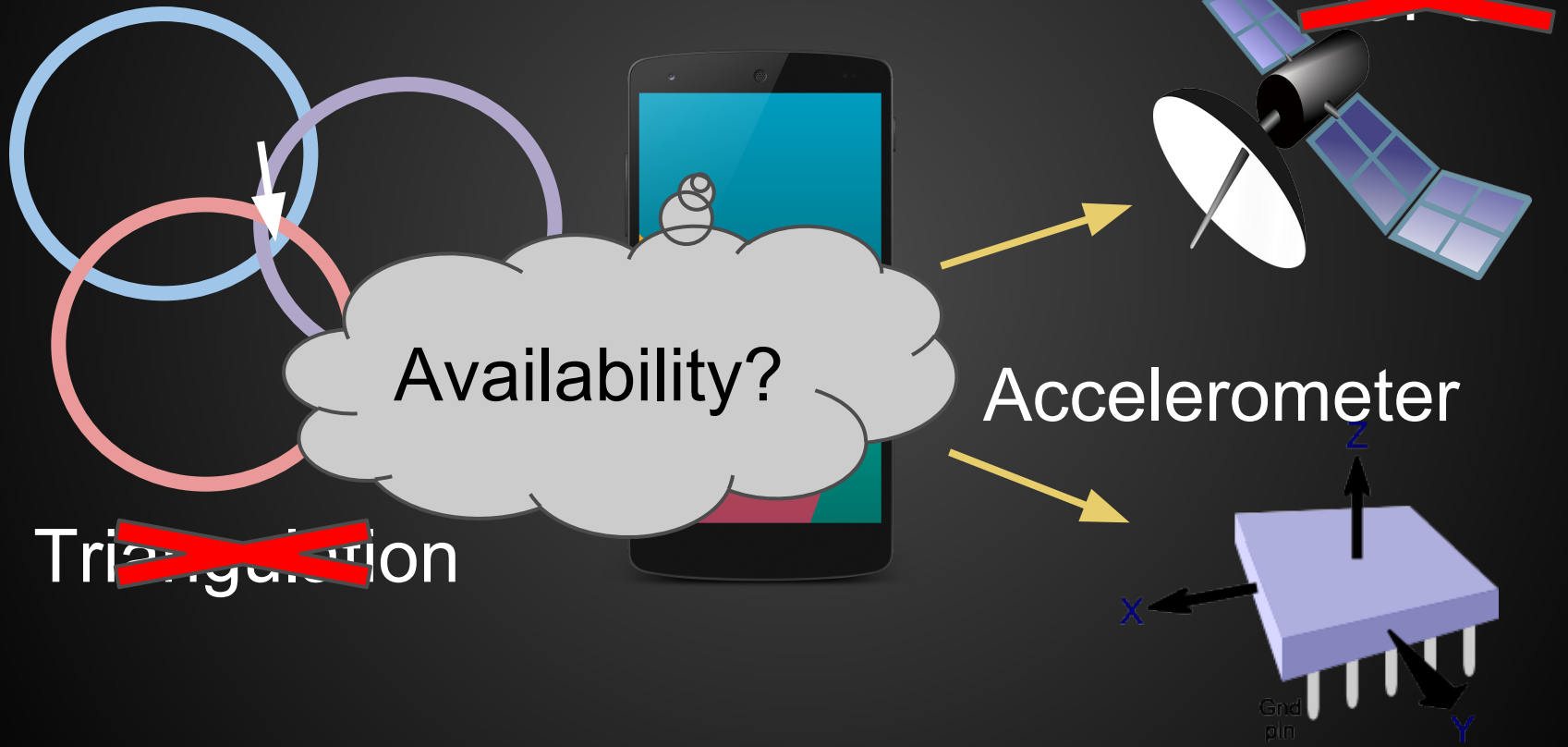
GPS

Accelerometer



Noisy

How to collect



Integrating Accelerometers

- Simple integral
  - Right?

$$\boldsymbol{v}(t) = \boldsymbol{v}(0) + \int_0^t \boldsymbol{a}\, dt$$

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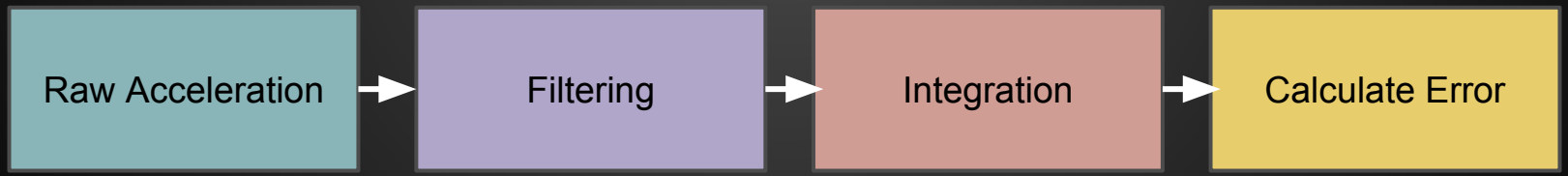
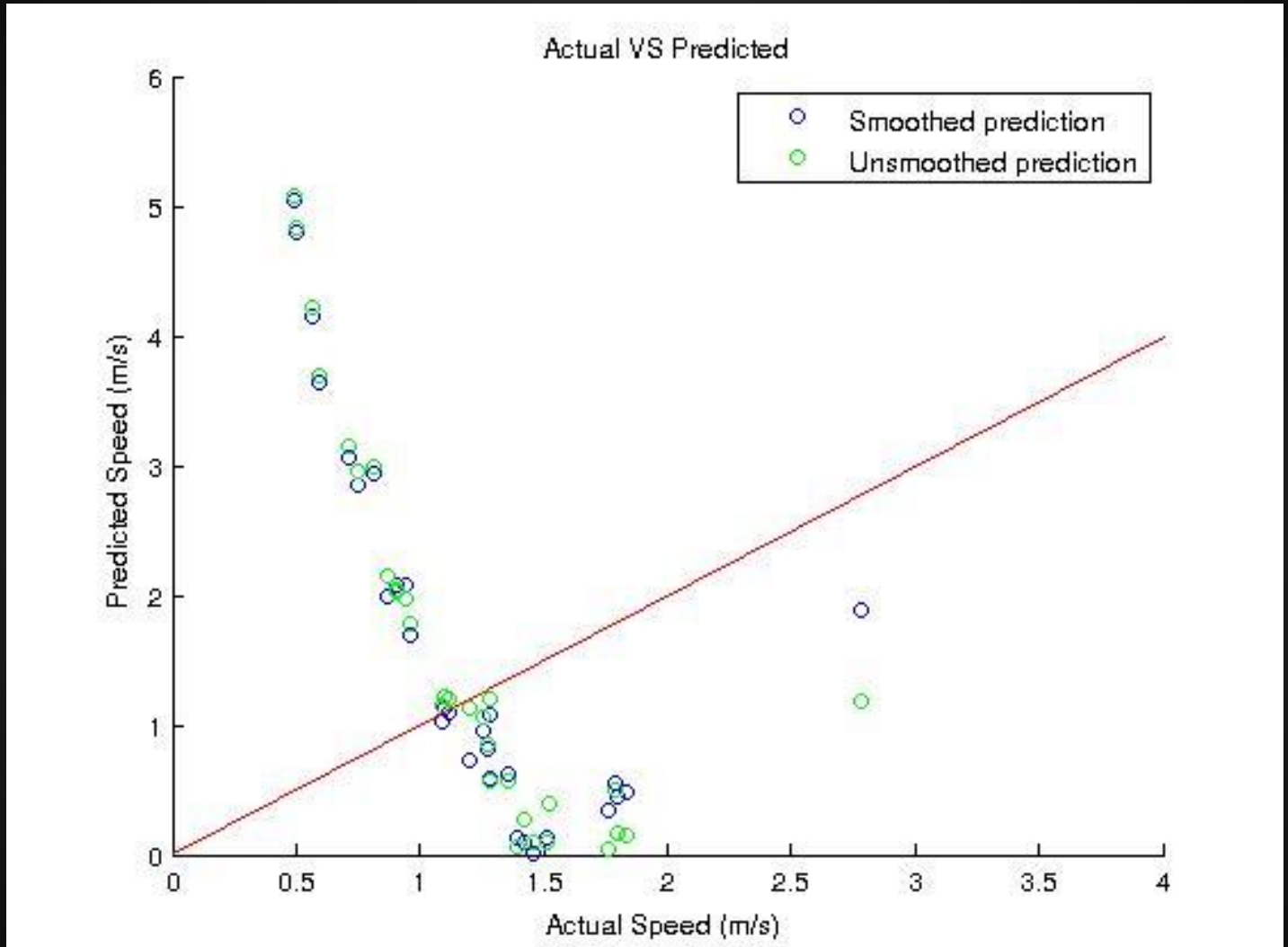
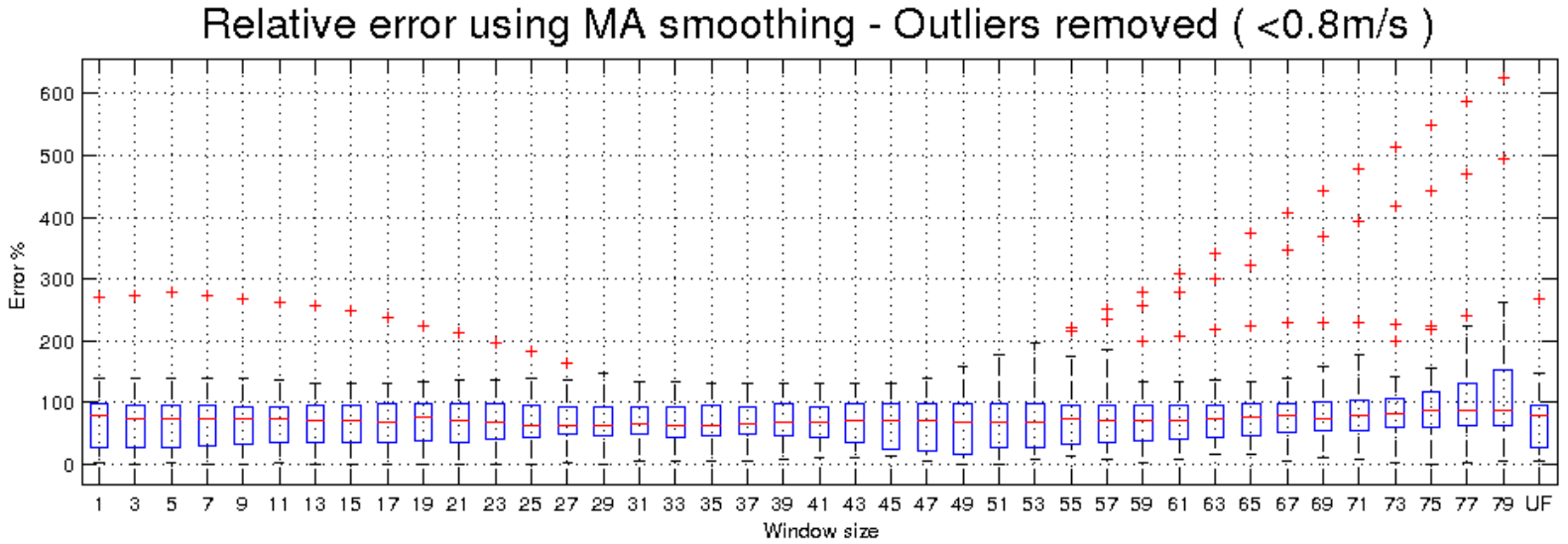
- Accelerometers are noisy
  - Not a good idea to integrate noise
- Problem known about
  - Little evidence to back up claims

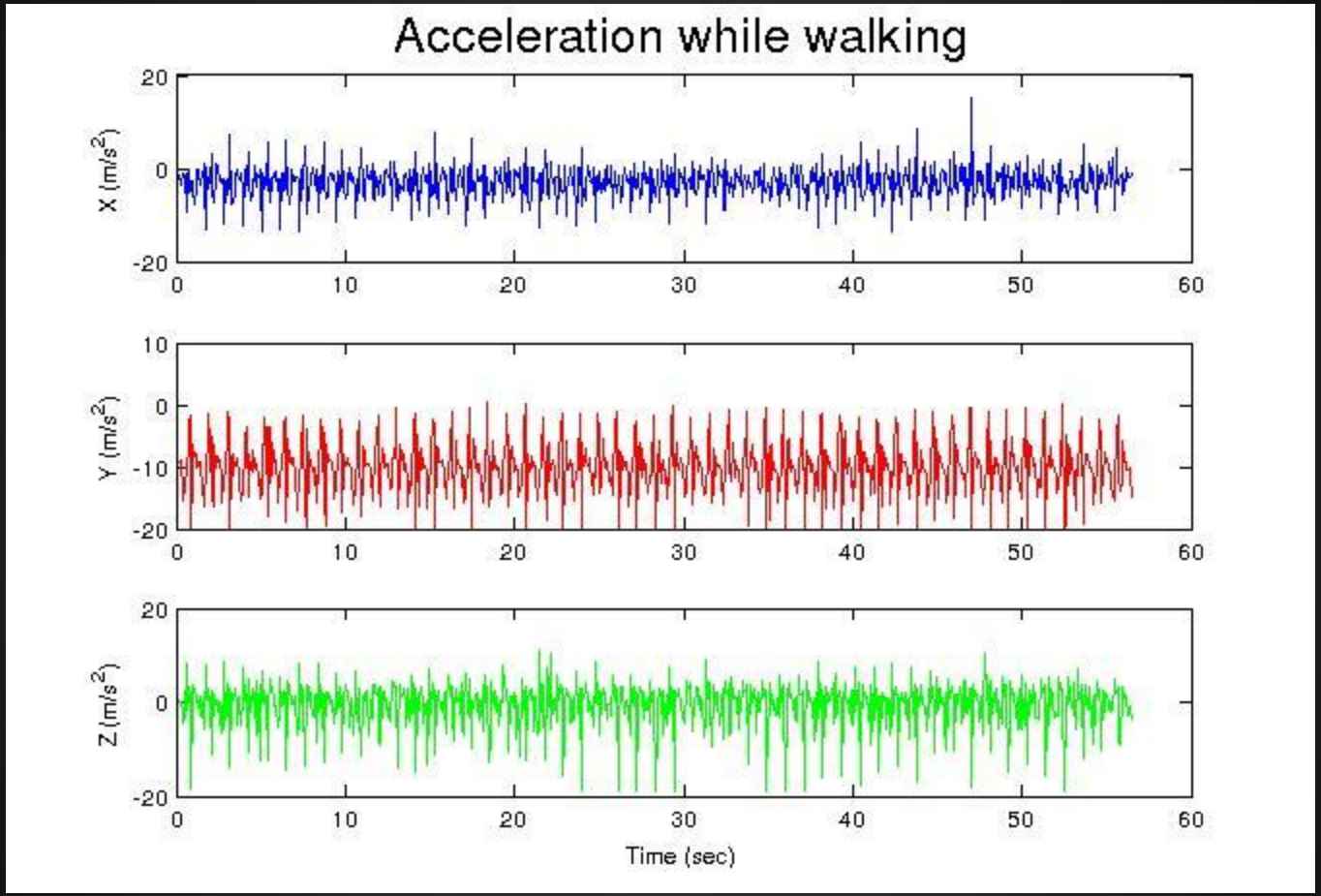
Experiment

- Simplified experiment
  - Only using one axis
  - Orientation known
  - Burst of acceleration at beginning
  - Recorded average velocity (m/s) = distance/time




Actual VS Predicted
Smoothed prediction
Unsmoothed prediction
Predicted Speed (m/s)
Actual Speed (m/s)
0
1
2
3
4
5
6
0
0.5
1
1.5
2
2.5
3
3.5
4


Relative error using MA smoothing - Outliers removed (<0.8m/s)
Error %
0
100
200
300
400
500
600
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 UF
Window size


Acceleration while walking
X (m/s²)
Y (m/s²)
Z (m/s²)
20
0
-20
10
-10
0
10
20
30
40
50
60
Time (sec)

Working

- How do results compare to walking data?
  - Multiple axis
  - Constant change of orientation
    - Need to factor in gravity

Working

- How do results compare to walking data?
  - Multiple axis
  - Constant change of orientation
    - Need to factor in gravity
- Error is over 1000%

$$\text{Error} = \frac{|\ \text{predicted-expected}\ |}{\text{expected}}$$

Experiment - Conclusions

- Getting velocity from accelerometers is hard
  - Experimental data to backup previous claims.
- Will classifiers work better?
  - Maybe - Some correlation, apply regression
- Accelerometers are not useless
  - Repeating pattern in walking data (steps)
  - Use number of steps as a level of mobility?

Questions