

Understanding Physical Behaviour and Behavioural Change: How We Can Derive Context Rich Outcomes from Body-worn Accelerometer Data

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The Aims

1. Understand the Physical Behaviours model
2. Understand the difference between global measures of Physical Activity and the patterns of these Physical Activities
3. Understand how event-based analysis can provide a context rich classification of Physical Activities

Outline

- **Concepts**
 - Physical Behaviours Model
 - Accelerometer data
 - Events
 - Context
- **Practical**
 - Introduction to practical
 - Doing it!
 - Discussion of results
- **Summary and real world example**

Current Models

INACTIVE

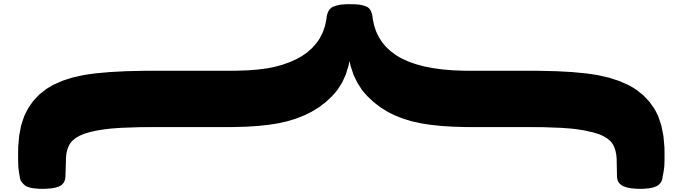
LIGHT

MODERATE

VIGOROUS

Current Models

Physical Activity (PA)



INACTIVE

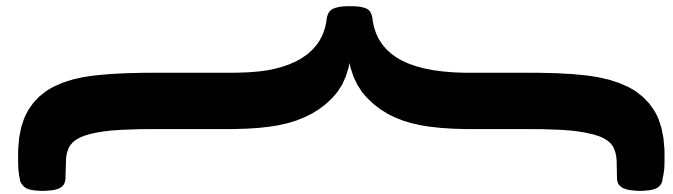
LIGHT

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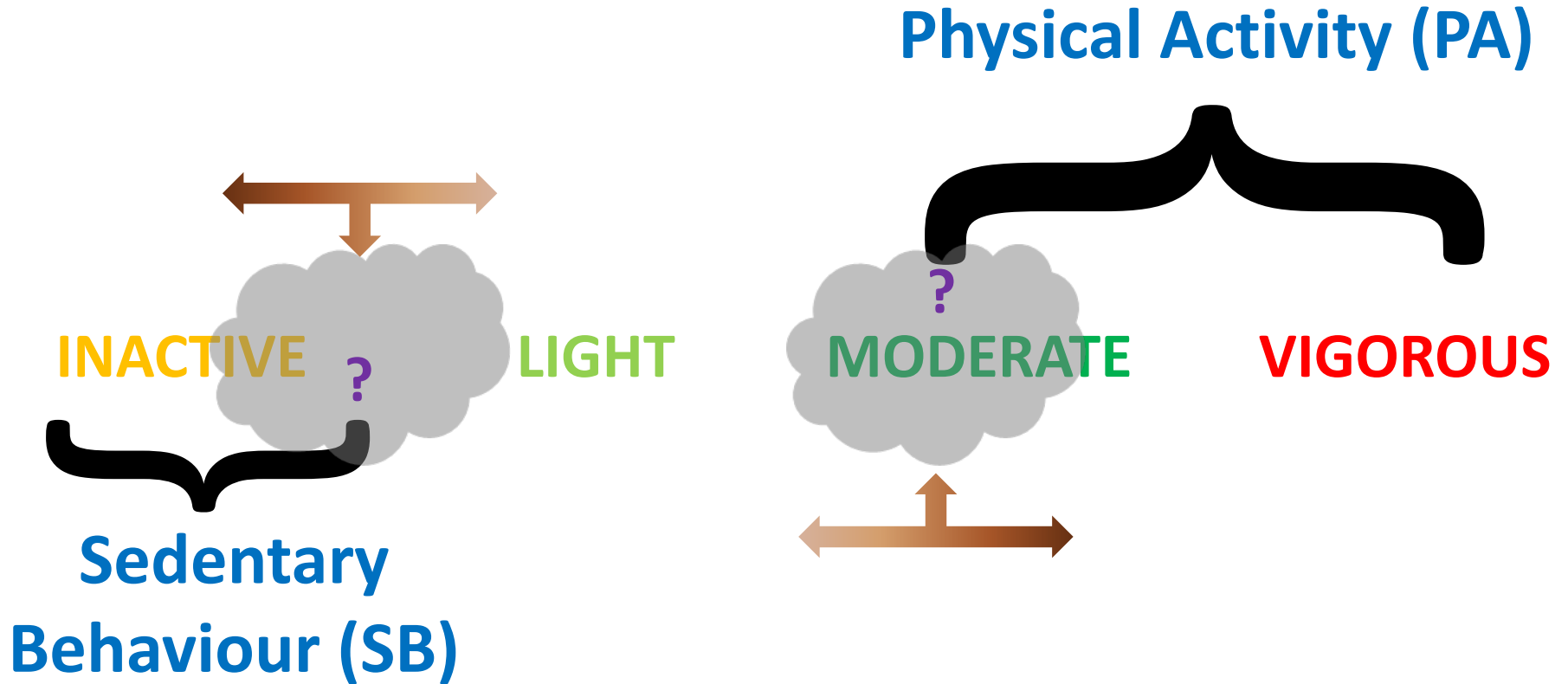
VIGOROUS



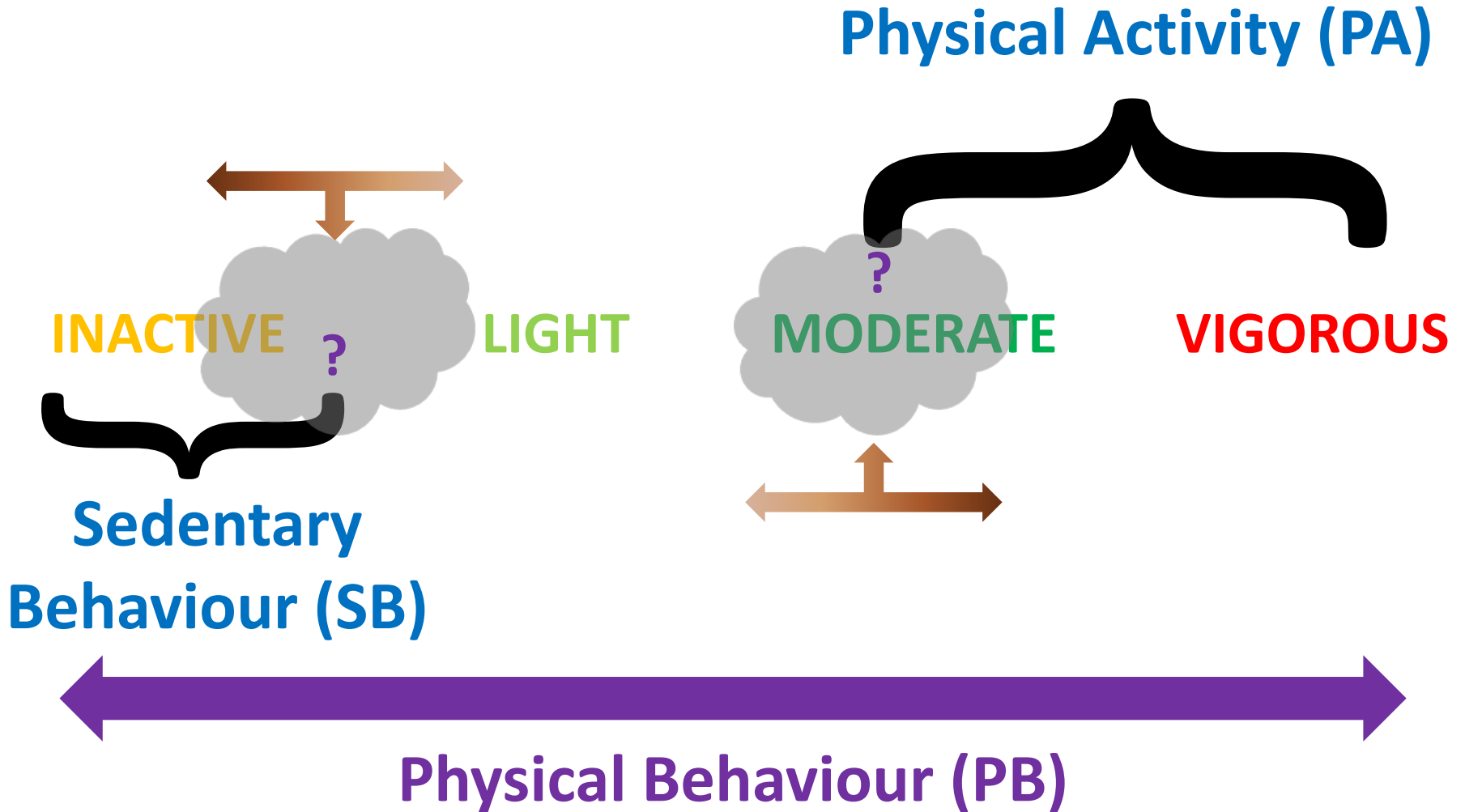
Sedentary
Behaviour (SB)



Current Models



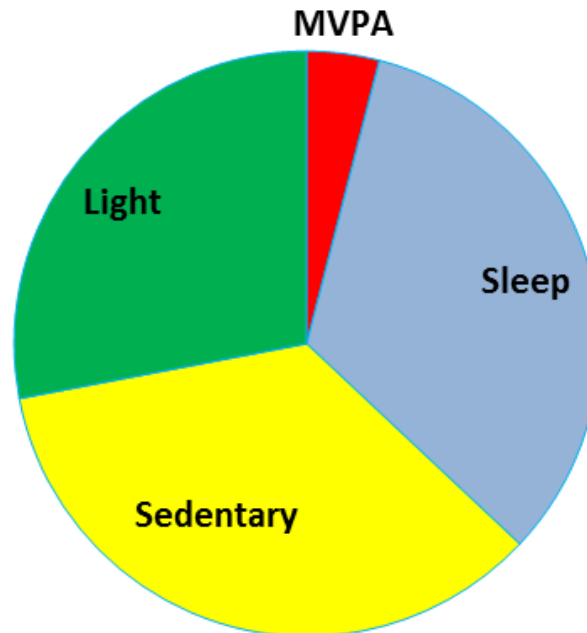
Physical Behaviours Model



Physical Behaviours Model

“Measurement of sleep in research: not a waste of time”

Jean-Philippe Chaput



Physical Behaviours Model

- **Physical Behaviours (PB)** encompasses all **Physical Activities**

Physical Behaviours Model

- **Physical Behaviours (PB)** encompasses all **Physical Activities**
- **PB** lead to **Energy Expenditure**

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- **Interventions aim to change PB**

Physical Behaviours Model

- **Physical Behaviours (PB)** encompasses all **Physical Activities**
- **PB** lead to **Energy Expenditure**
- **Interventions aim to change PB**
- **Need to measure and quantify PB**

Where do we put our sensor(s)?

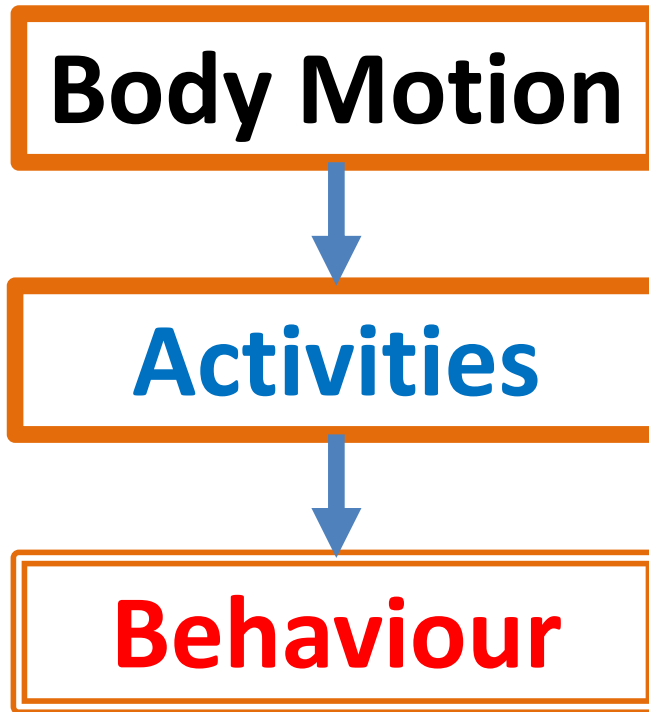
Where do we put our sensor(s)?

Location....

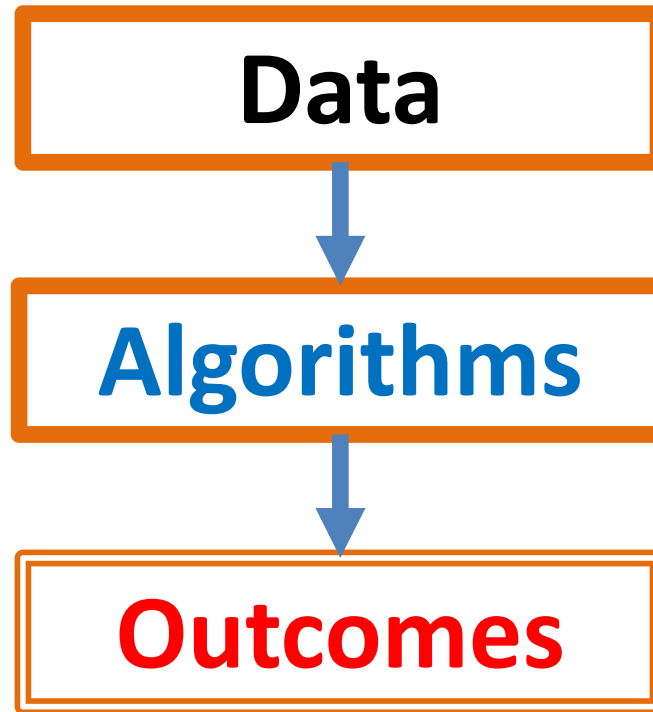
Location....

Location....

The Construct



Quantifying Accelerometry Data



Quantifying Accelerometry Data

**Body
Motion**

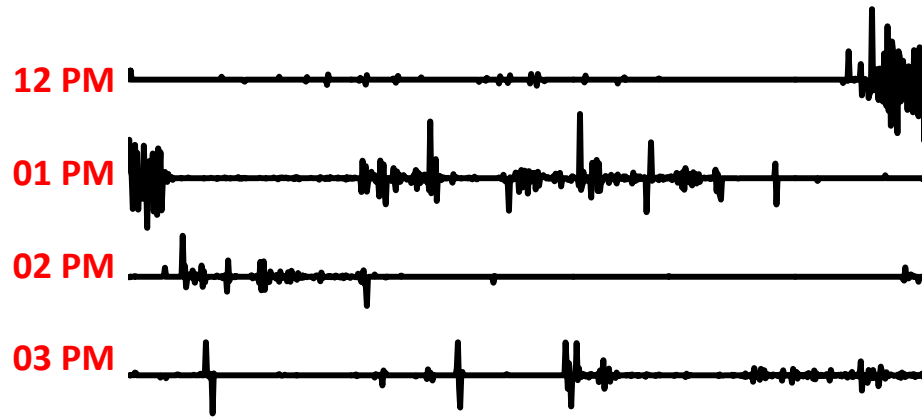
Quantifying Accelerometry Data

Body
Motion

Waist worn device

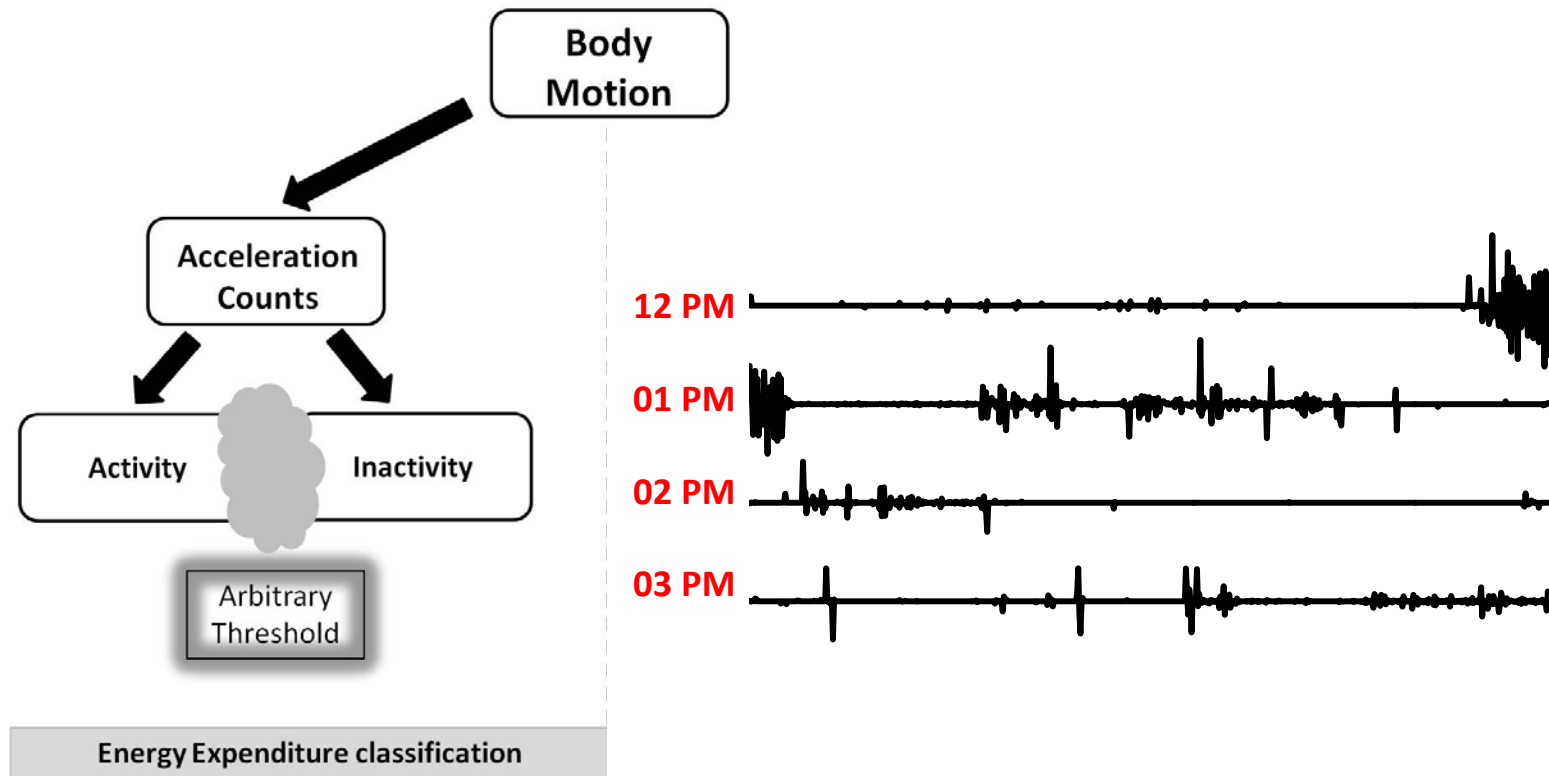
Quantifying Accelerometry Data

Body
Motion



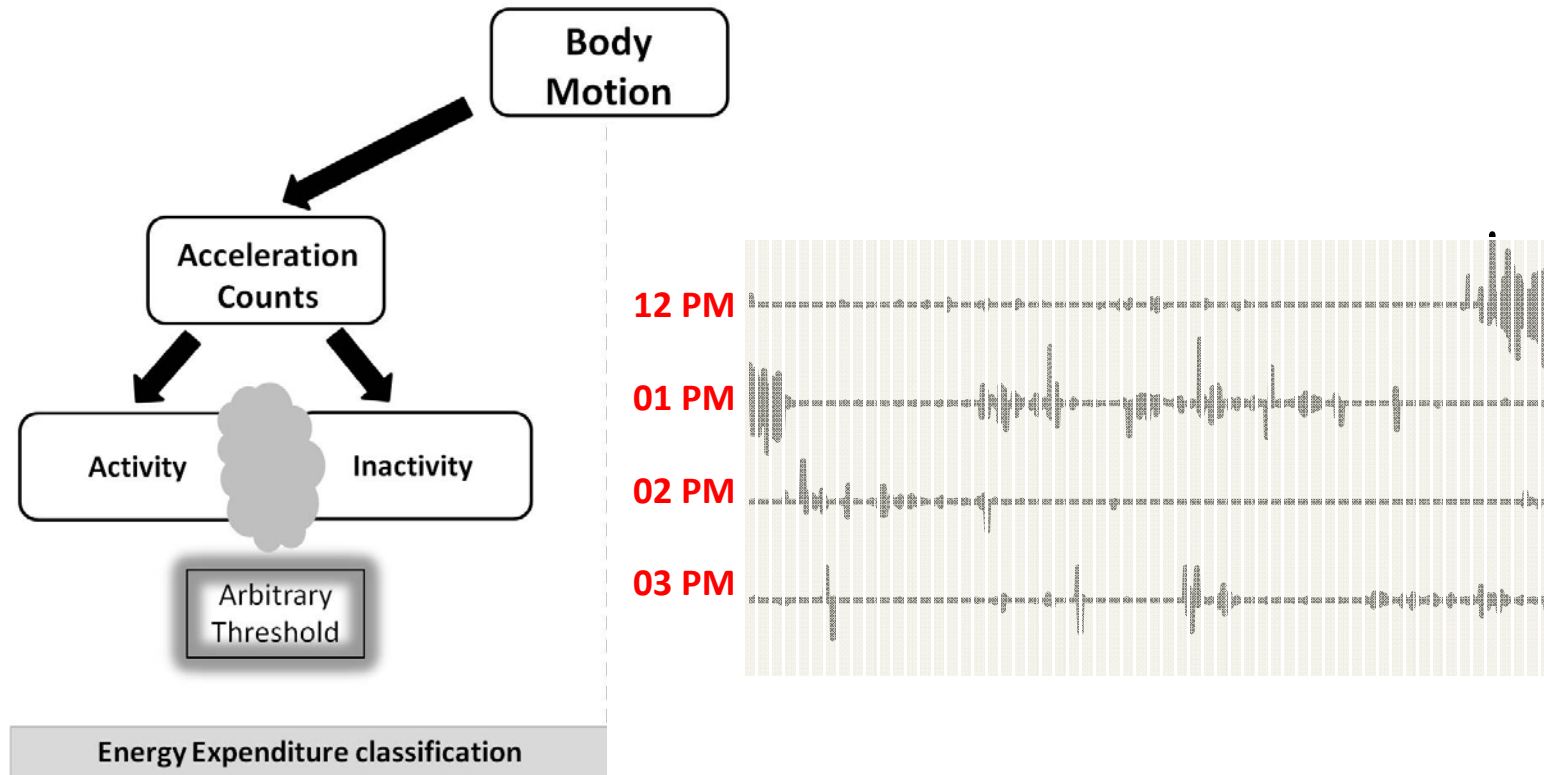
Waist worn device

Quantifying Accelerometry Data



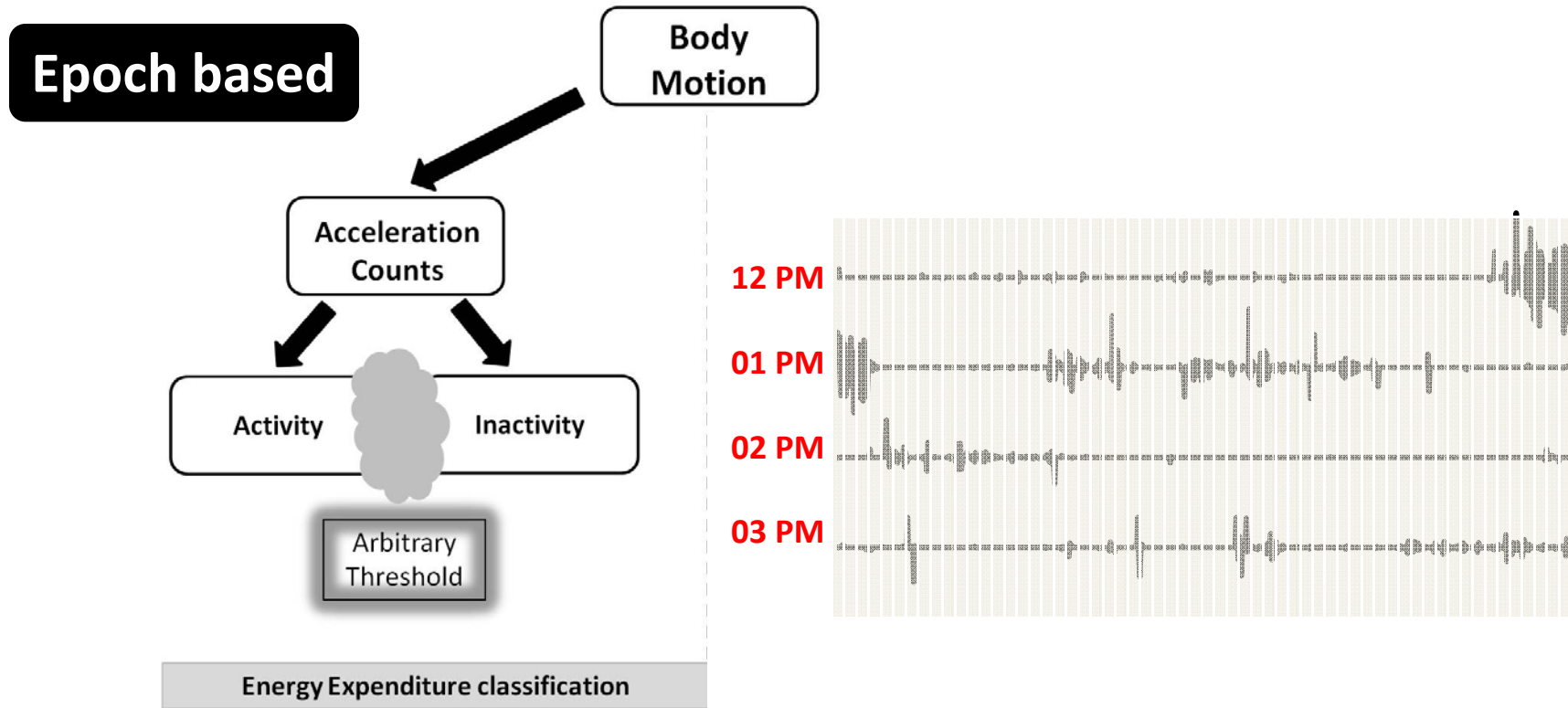
Waist worn device

Quantifying Accelerometry Data



Waist worn device

Quantifying Accelerometry Data



Waist worn device

Epochs

- **Epoch**

a **user defined period** (usually 1 minute or 15 seconds) with a **single value** representing the **acceleration** in that time period.

Quantifying Accelerometry Data

Body
Motion

Thigh worn device

Quantifying Accelerometry Data

Body
Motion

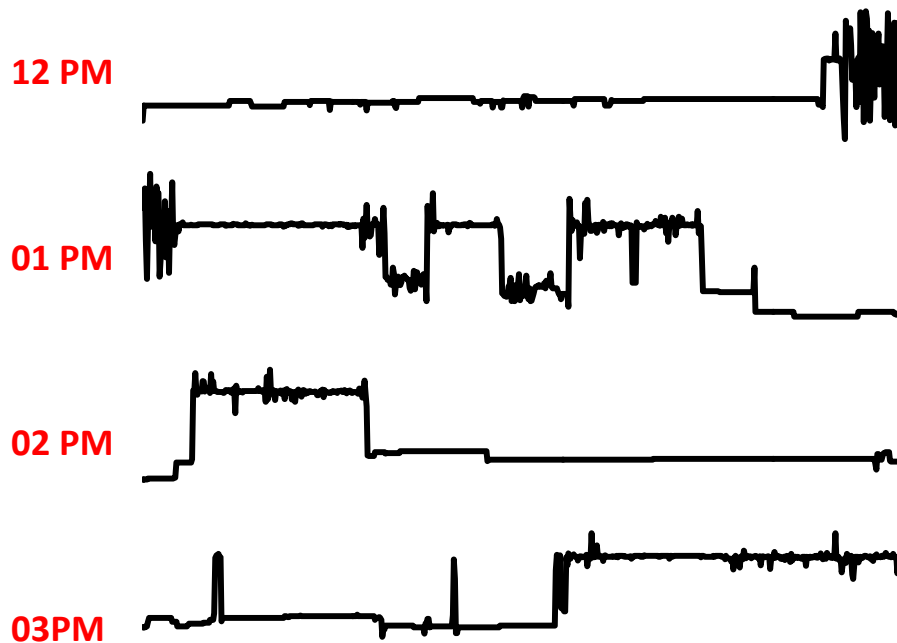


Thigh worn device

Quantifying Accelerometry Data



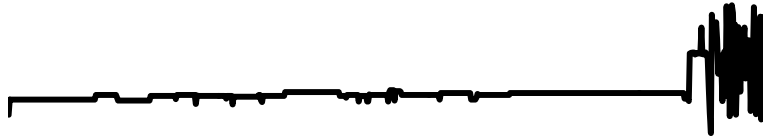
Quantifying Accelerometry Data



Quantifying Accelerometry Data



12 PM



Quantifying Accelerometry Data



12 PM

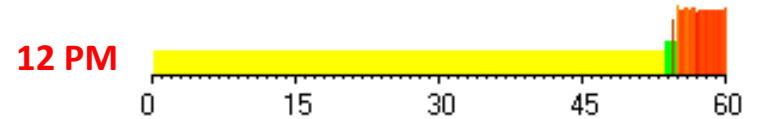


Sitting/Lying

Standing

Walking

Quantifying Accelerometry Data

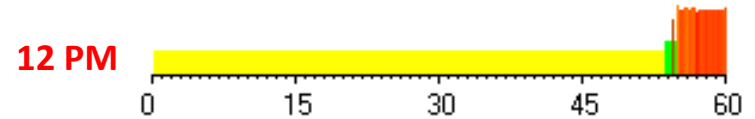
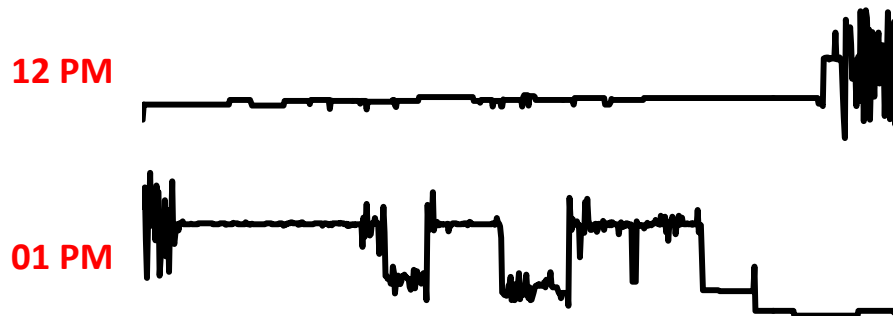


Sitting/Lying

Standing

Walking

Quantifying Accelerometry Data

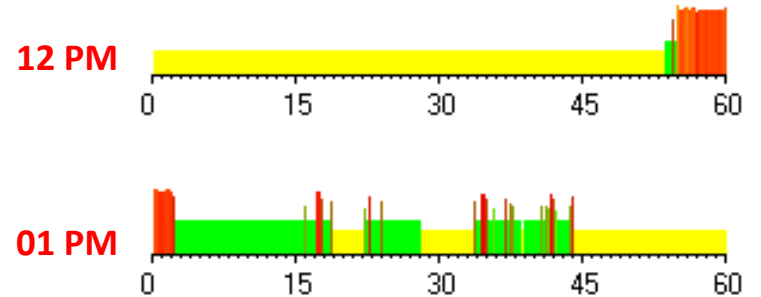
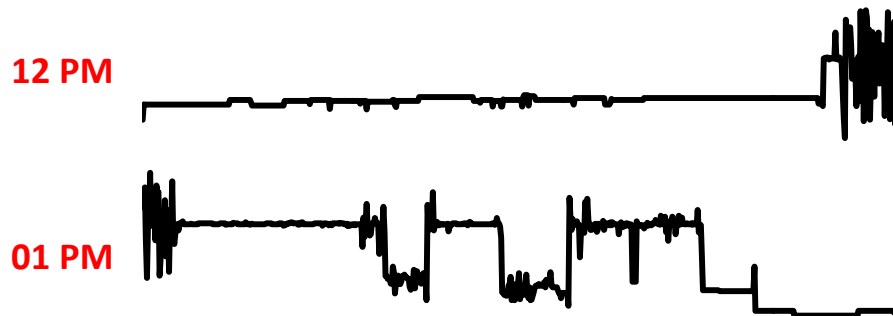


Sitting/lying

Standing

Walking

Quantifying Accelerometry Data

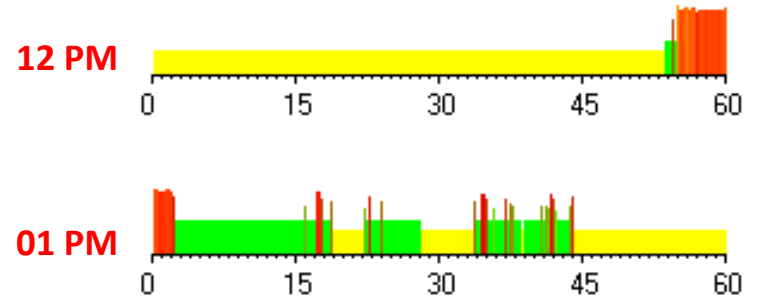
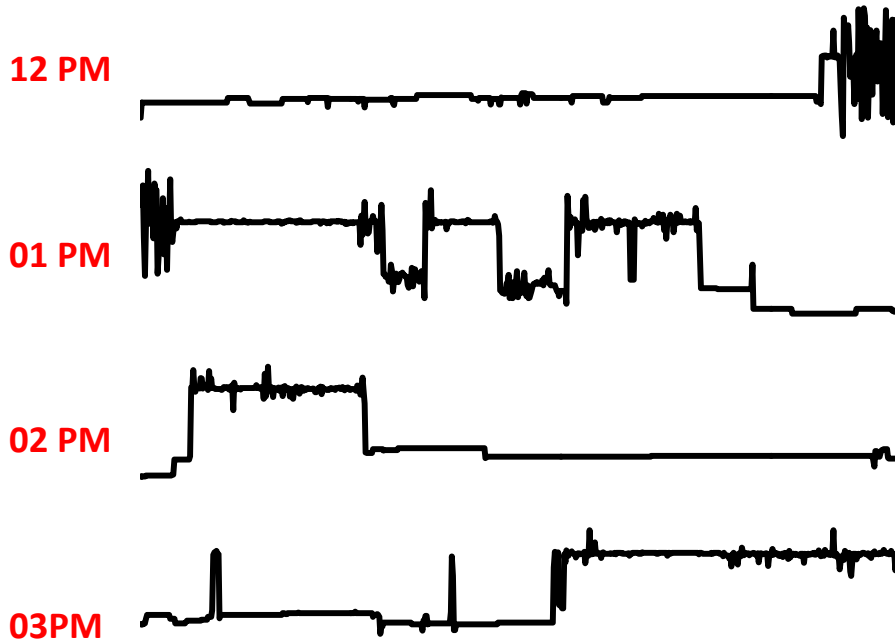


Sitting/lying

Standing

Walking

Quantifying Accelerometry Data

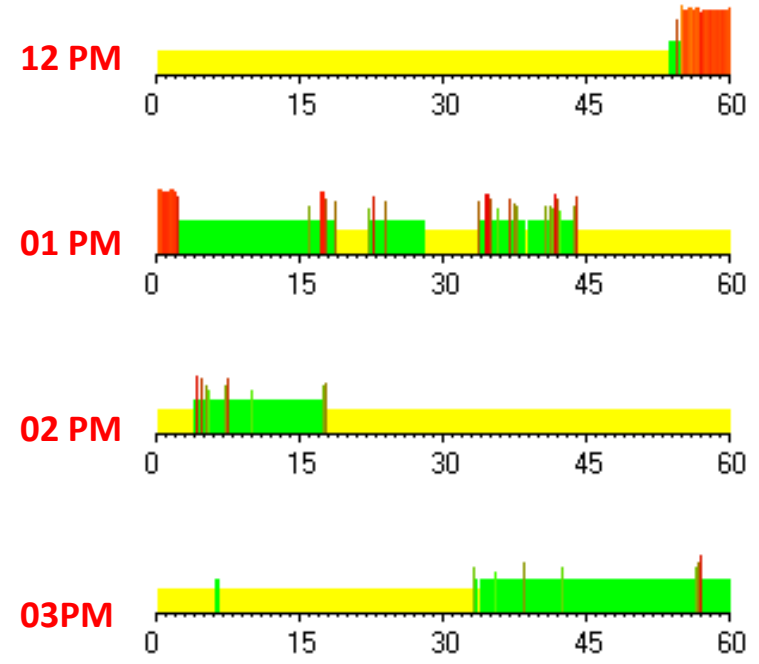
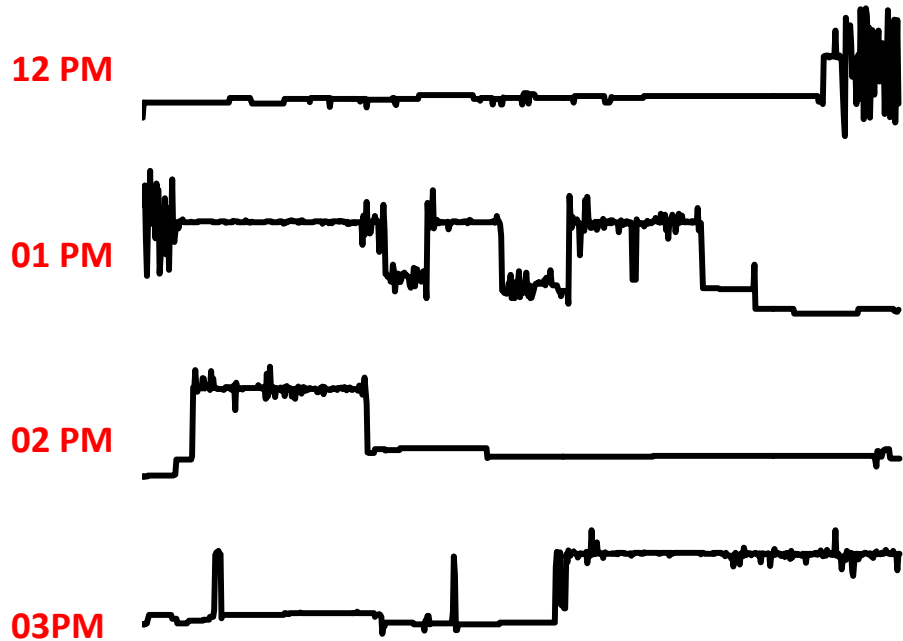


Sitting/Lying

Standing

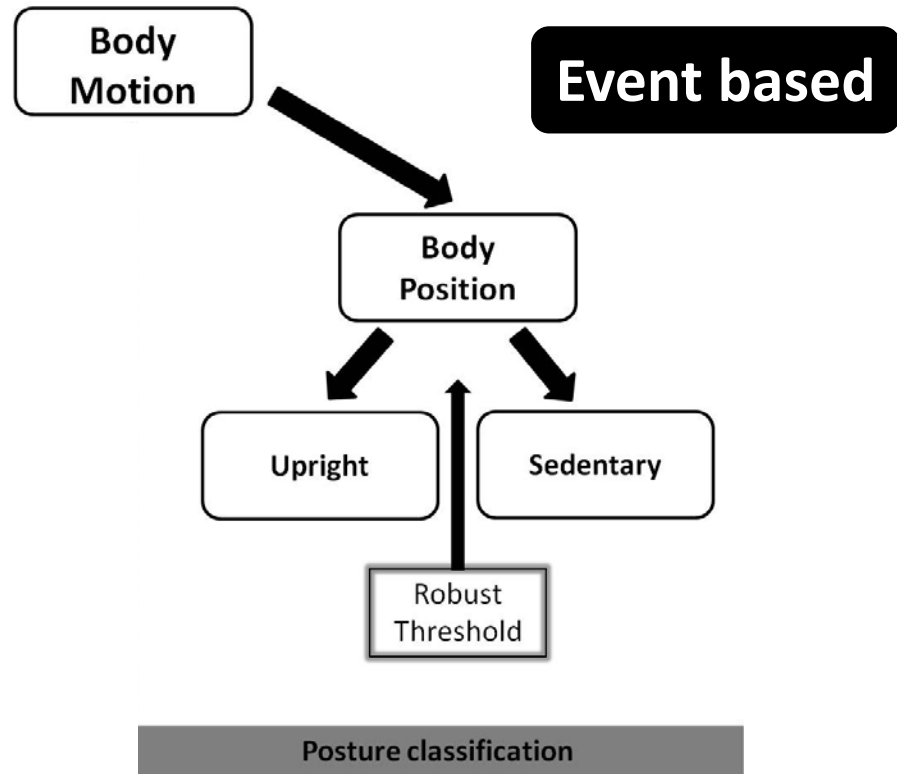
Walking

Quantifying Accelerometry Data



Sitting/lying
Standing
Walking

Quantifying Accelerometry Data



Thigh worn device

Events

- **Epoch**

a user defined period (usually 1 minute or 15 seconds) with a **single value** representing the **acceleration** in that time period.

- **Event**

a continuous physical activity belonging to a single class with a defined **start time** and **duration**.

Deriving Context

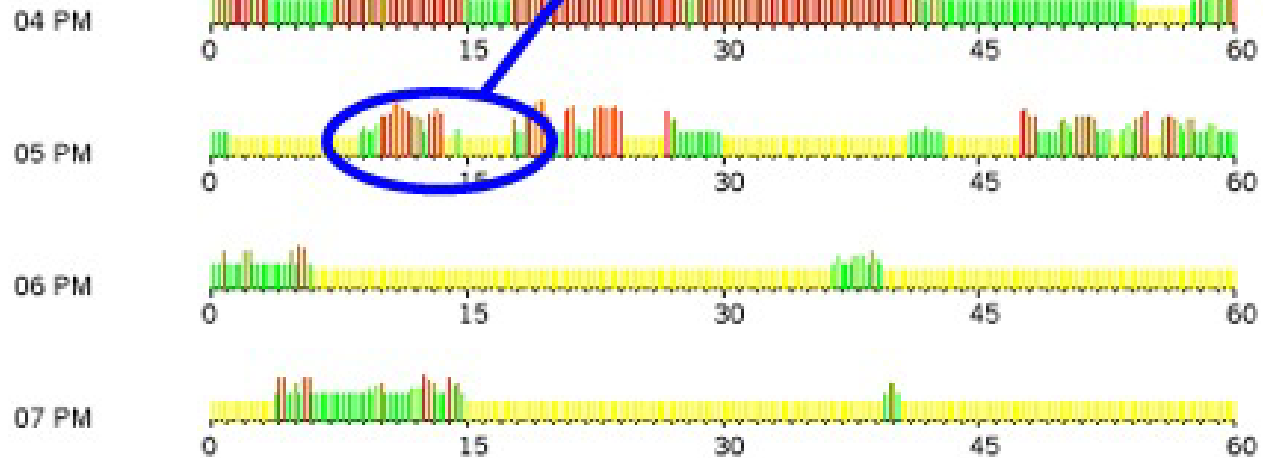


Sitting/Lying

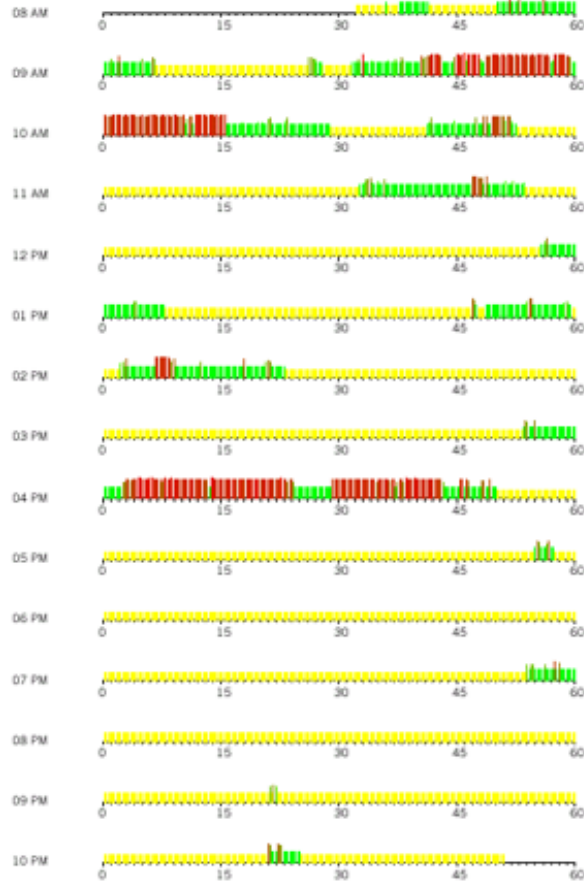
Standing

Walking

Walking periods are highlighted in red, quiet standing in green and sitting and lying in yellow.



Deriving Context

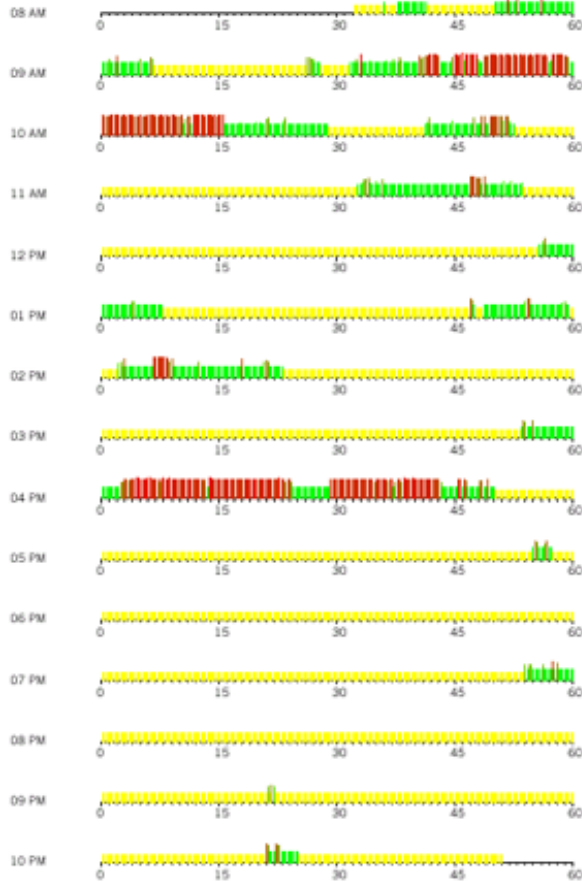


**72 year old hip-replacement
male**

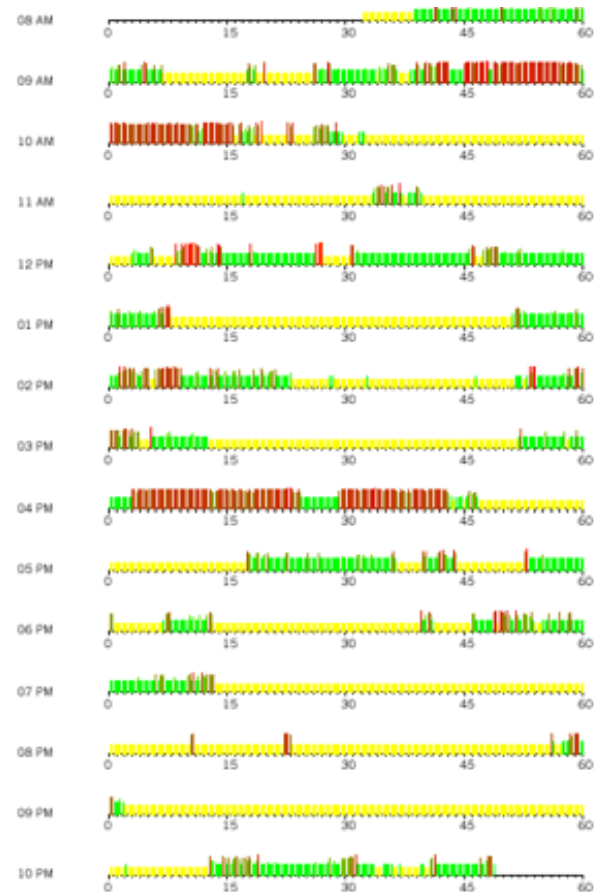
Waking day recording

Workshop: Deriving Context Rich Outcomes from
Accelerometer Data, ALR Conference, San Diego 2014

Deriving Context



72 year old hip-replacement male

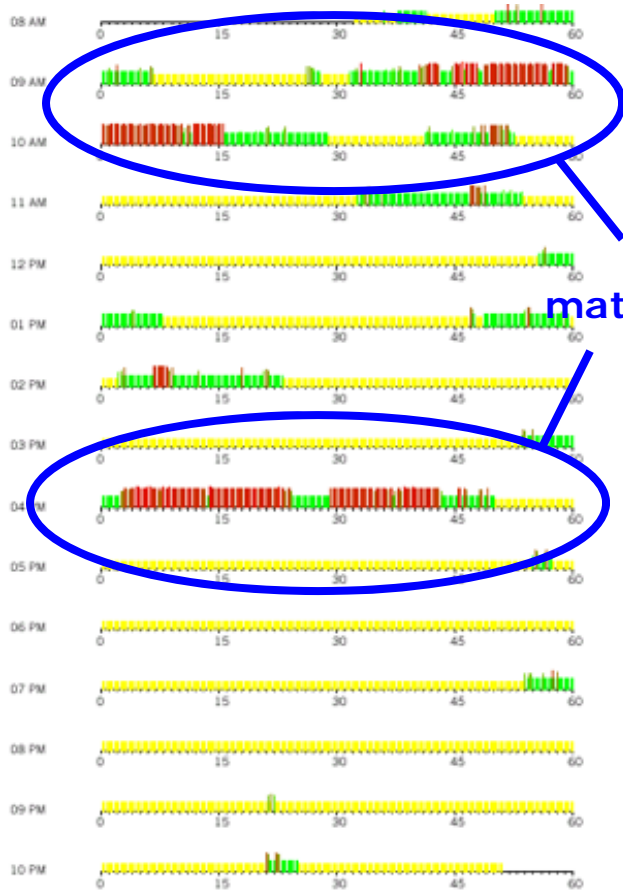


65 year old spouse

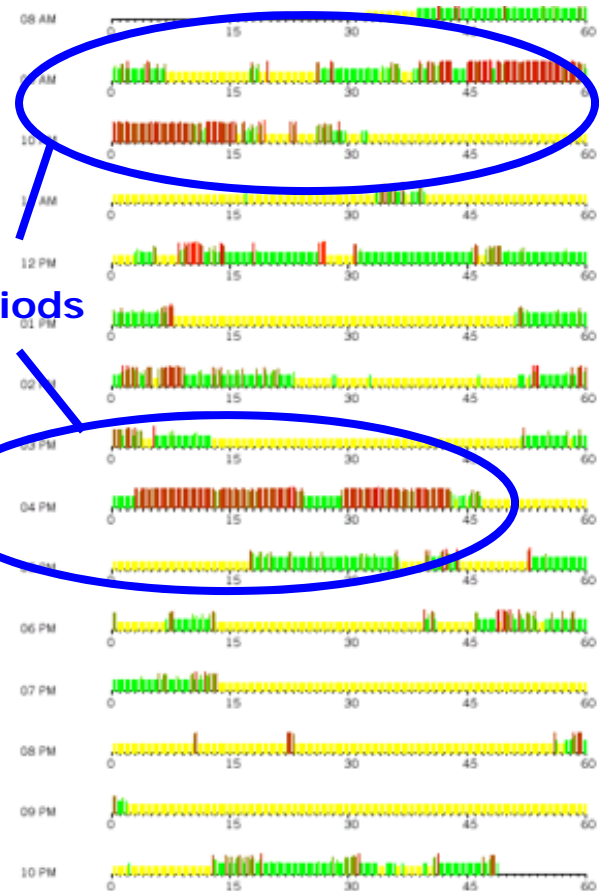
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Deriving Context



72 year old hip-replacement male

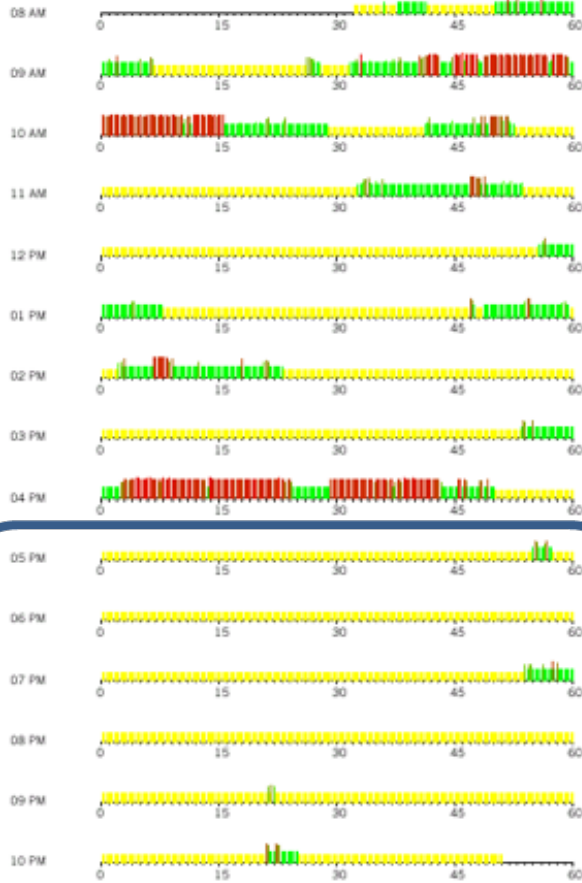


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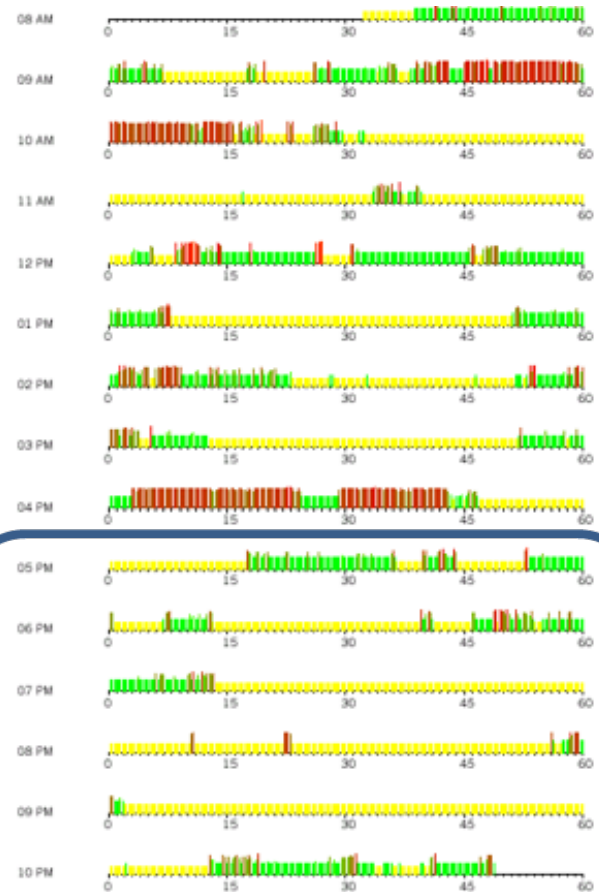
Waking day recording

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Deriving Context



72 year old hip-replacement male



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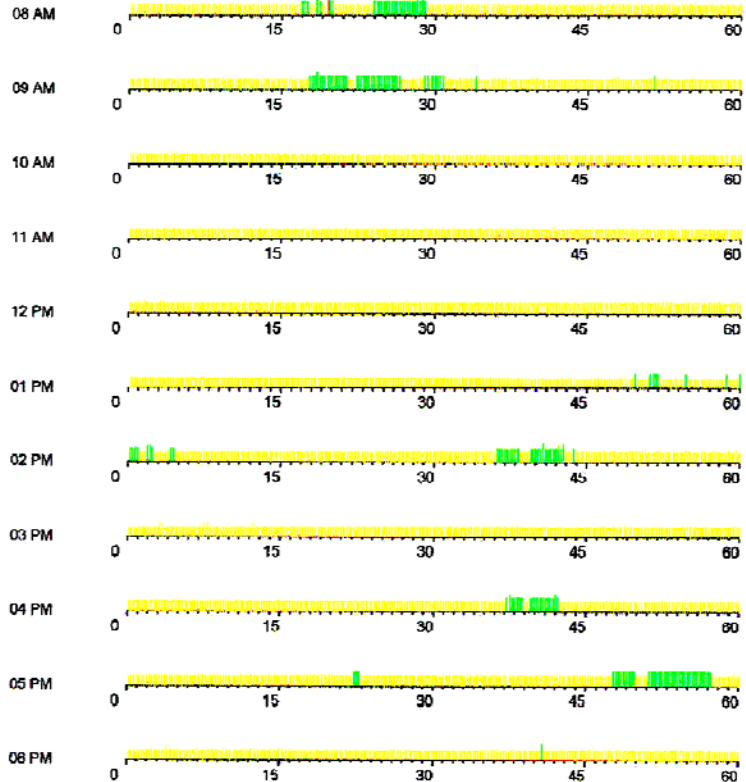
Waking day recording

Workshop: Deriving Context Rich Outcomes from Accelerometer Data, ALR Conference, San Diego 2014

Context: **A Tale of two in-patients**

Age = 80

Walking speed = 0.28m/s



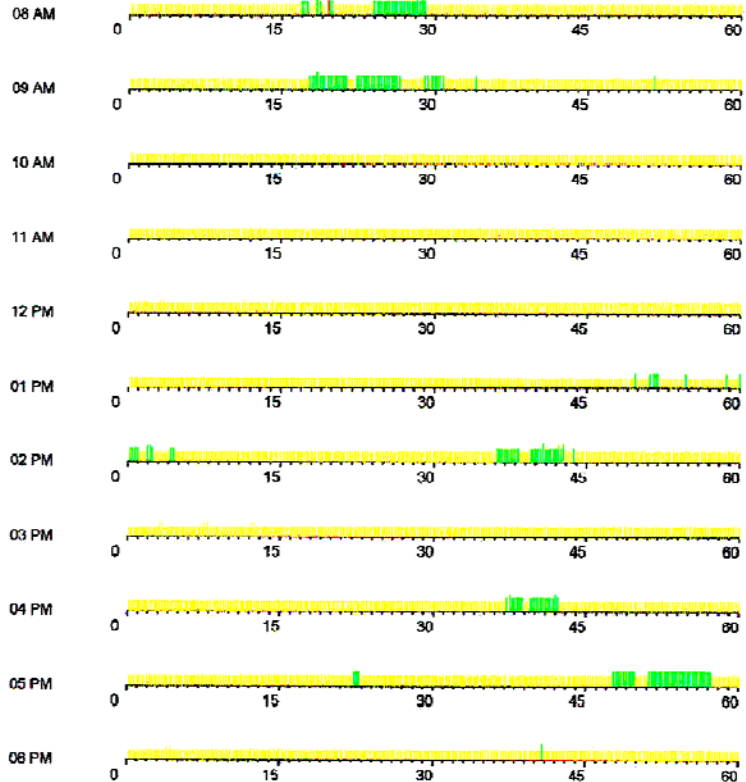
Context: A Tale of two in-patients

Age = 80

Walking speed = 0.28m/s

Age = 75

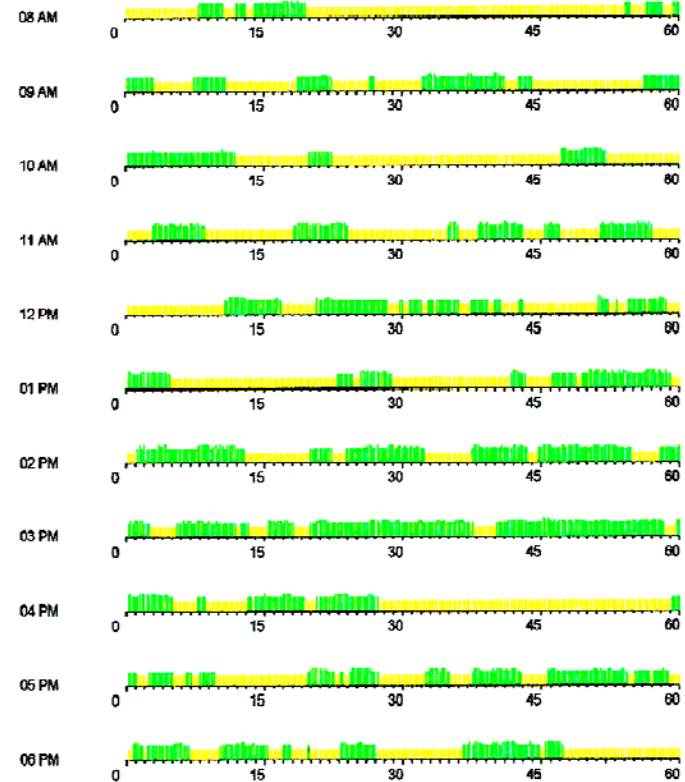
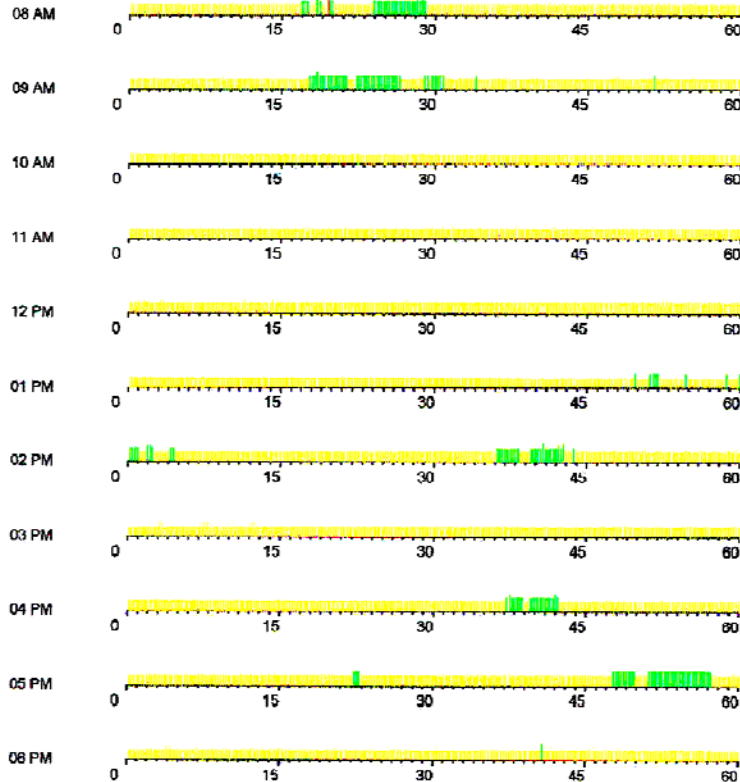
Walking speed = 0.14m/s



Context: **A Tale of two in-patients**

Age = 80
Walking speed = 0.28m/s

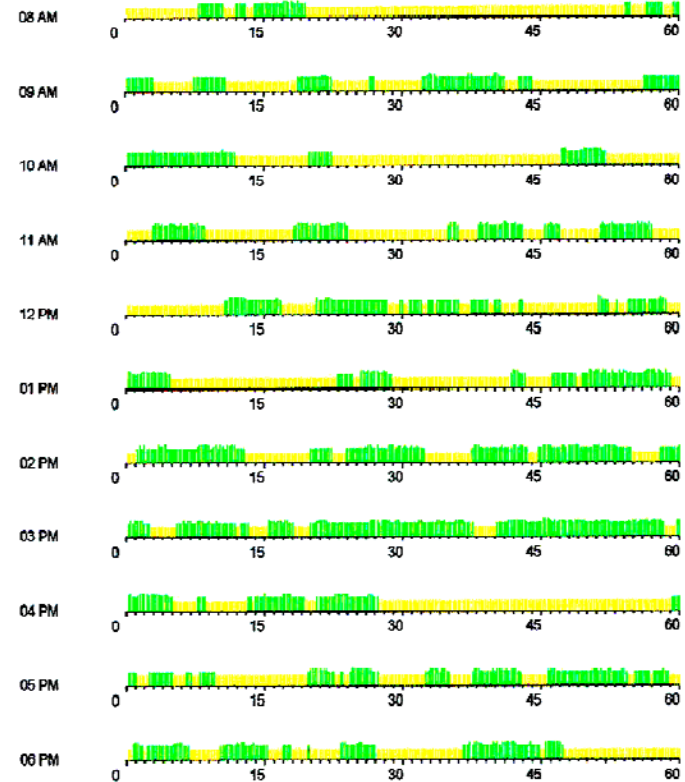
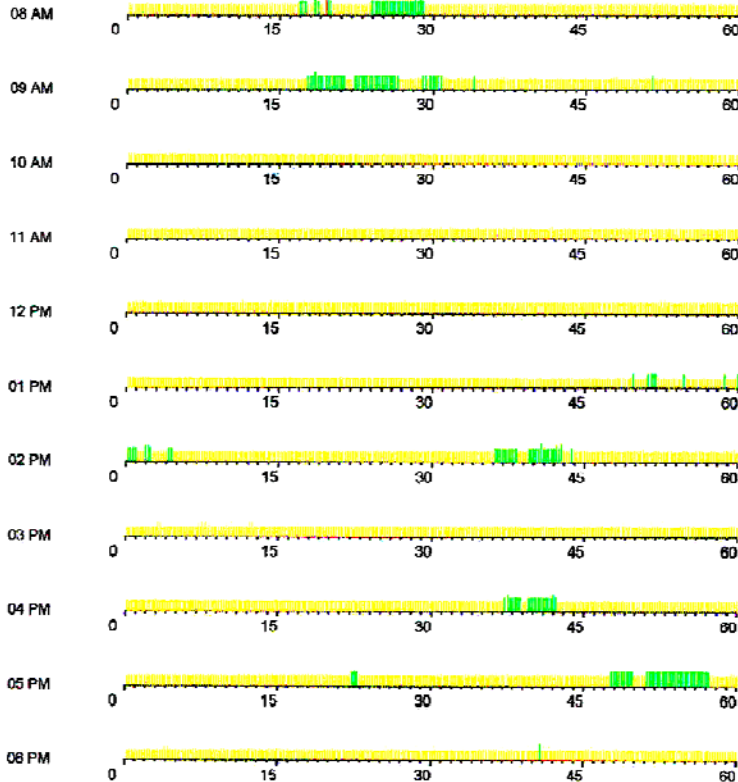
Age = 75
Walking speed = 0.14m/s



Context: A Tale of two in-patients

Age = 80
Walking speed = 0.28m/s

Age = 75
Walking speed = 0.14m/s

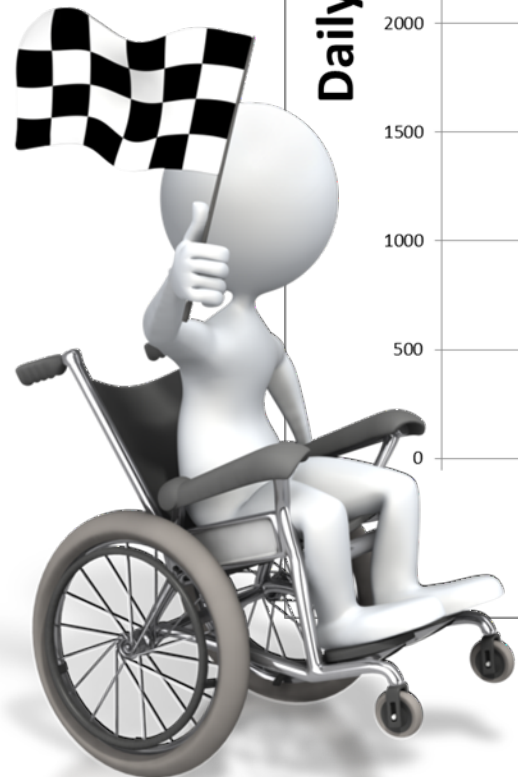
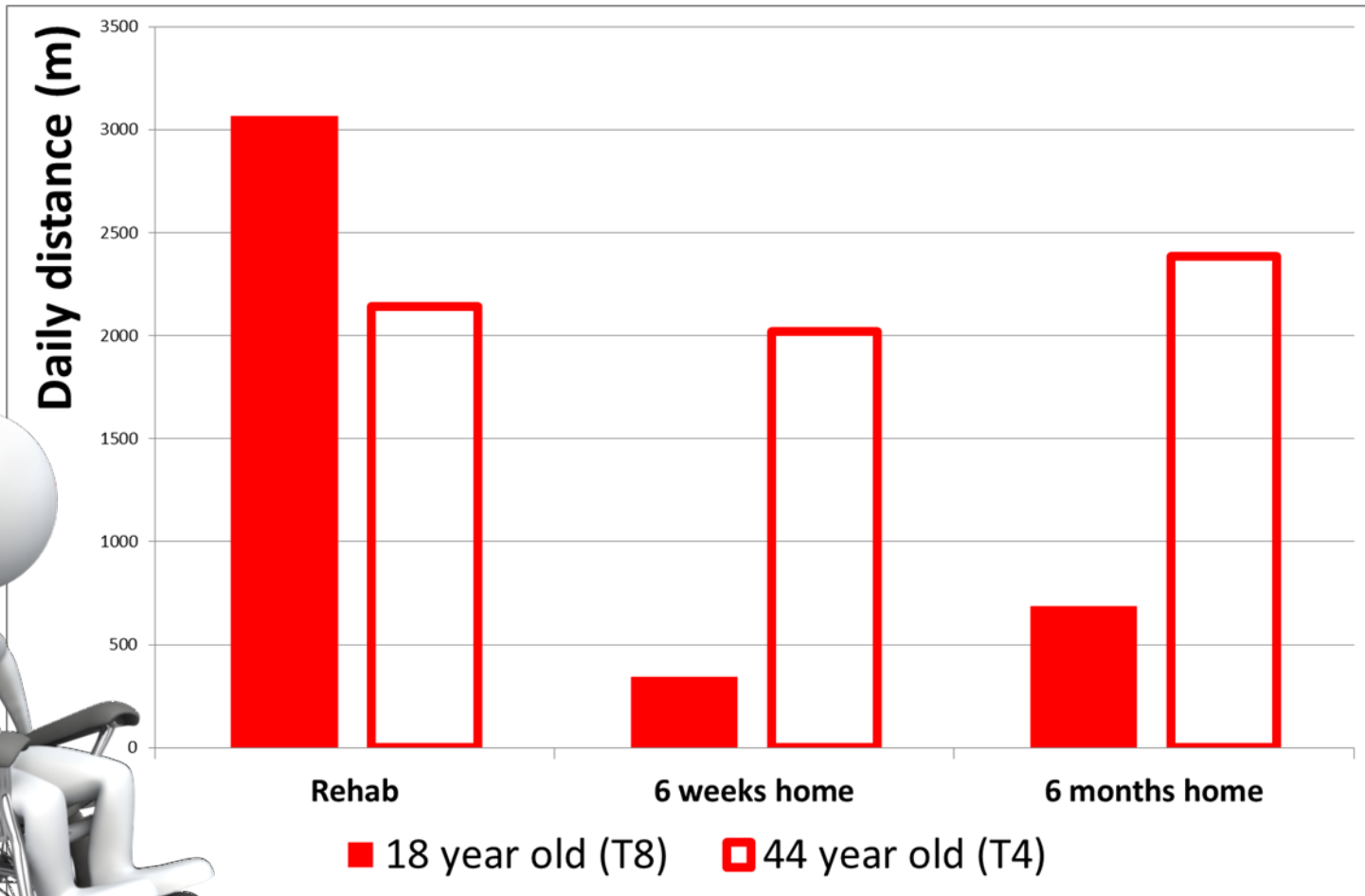


Non SMOKER

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SMOKER

Context: Ability or Participation?



Introduction to Practical

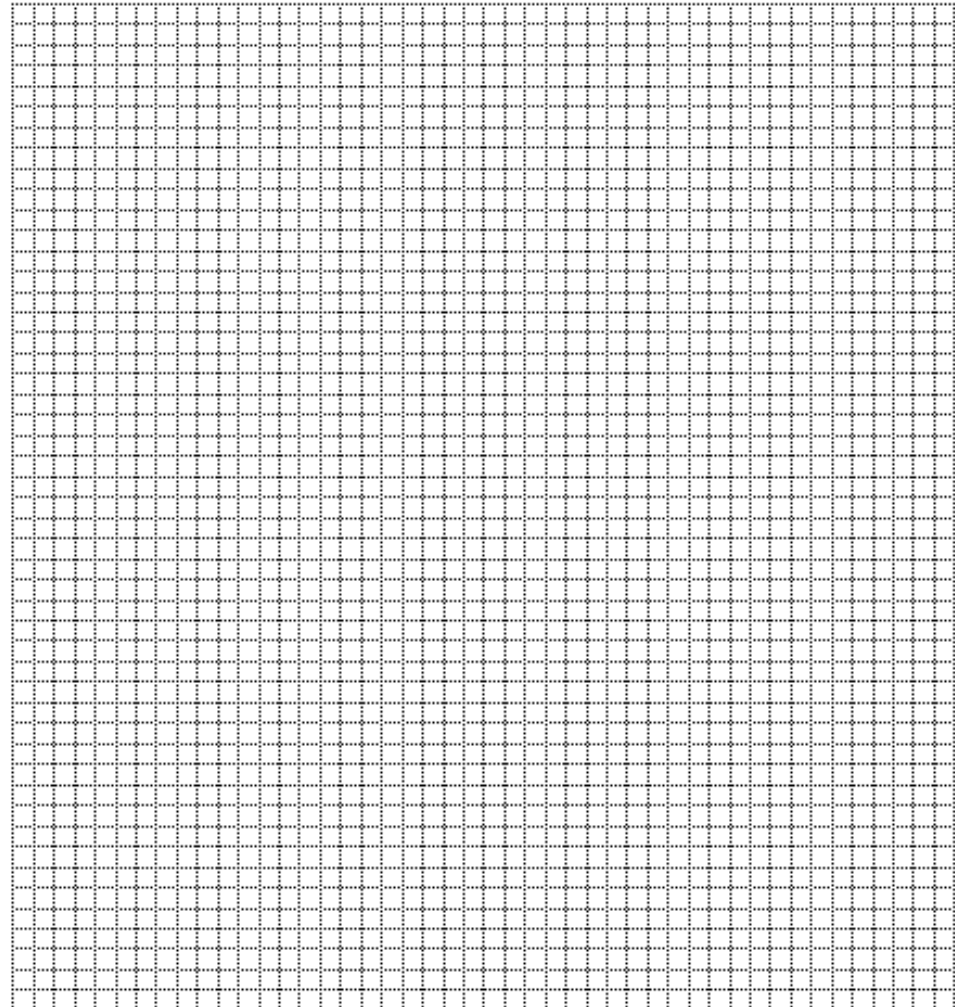
1. Tables of four people (**Get into pairs!**)
2. Each pair will look at one set of data and analyse it
3. Discuss with group of four and derive outcomes and context
4. General discussion

The Analysis

Analysis:

Visualisation:

| | | SEDENTARY | | UPRIGHT | | STEPPING | | MVPA | |
|-----------|-----------|-----------|--------|---------|--------|----------|-------|------|-------|
| HOUR | | time | events | time | events | time | steps | time | steps |
| NIGHT | mid-night | | | | | | | | |
| | 1AM | | | | | | | | |
| | 2AM | | | | | | | | |
| | 3AM | | | | | | | | |
| | 4AM | | | | | | | | |
| | 5AM | | | | | | | | |
| TOTAL | | | | | | | | | |
| MORNING | 6AM | | | | | | | | |
| | 7AM | | | | | | | | |
| | 8AM | | | | | | | | |
| | 9AM | | | | | | | | |
| | 10AM | | | | | | | | |
| | 11AM | | | | | | | | |
| TOTAL | | | | | | | | | |
| AFTERNOON | noon | | | | | | | | |
| | 1PM | | | | | | | | |
| | 2PM | | | | | | | | |
| | 3PM | | | | | | | | |
| | 4PM | | | | | | | | |
| | 5PM | | | | | | | | |
| TOTAL | | | | | | | | | |
| EVENING | 6PM | | | | | | | | |
| | 7PM | | | | | | | | |
| | 8PM | | | | | | | | |
| | 9PM | | | | | | | | |
| | 10PM | | | | | | | | |
| | 11PM | | | | | | | | |
| TOTAL | | | | | | | | | |
| DAY TOTAL | | | | | | | | | |

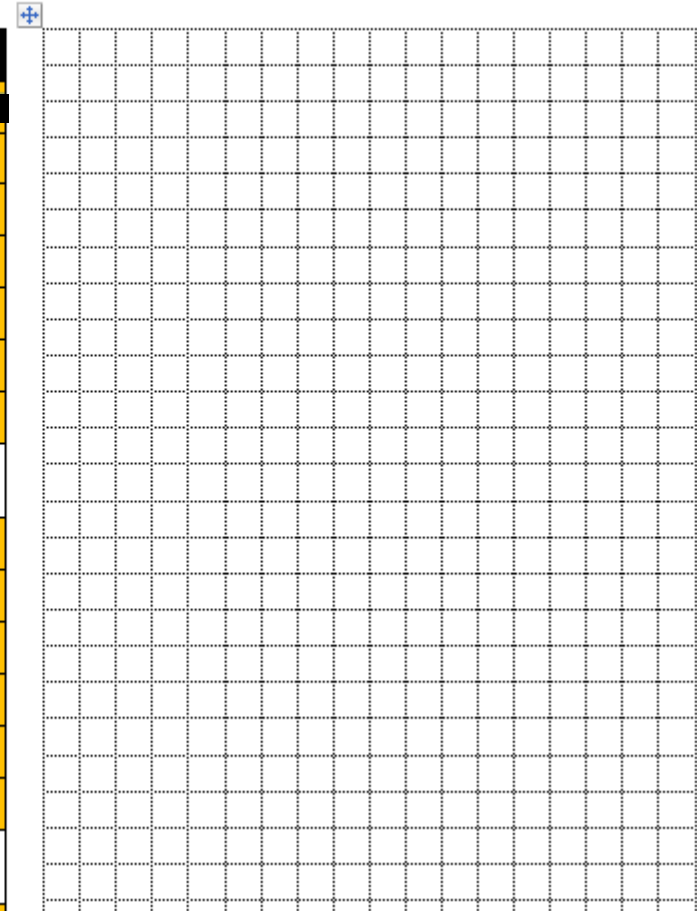


The Analysis

Analysis:

| | | SEDENTARY | | UPRIGHT | | STEPPING | | MVPA | | |
|--------------|-------|-----------|--------|---------|--------|----------|-------|------|------|-------|
| | HOUR | time | events | time | events | time | steps | | time | steps |
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| TOTAL | | | | | | | | | | |
| MORNING | 6AM | | | | | | | | | |
| | 7AM | | | | | | | | | |
| | 8AM | | | | | | | | | |
| | 9AM | | | | | | | | | |
| | 10AM | | | | | | | | | |
| | 11AM | | | | | | | | | |
| TOTAL | | | | | | | | | | |

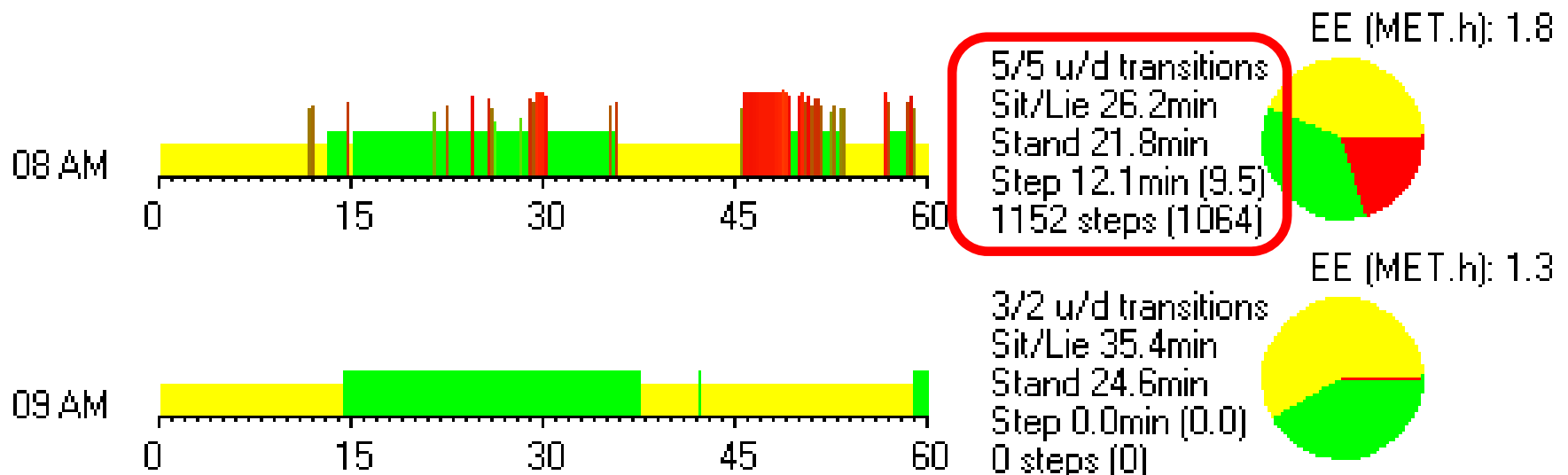
Visualisation:



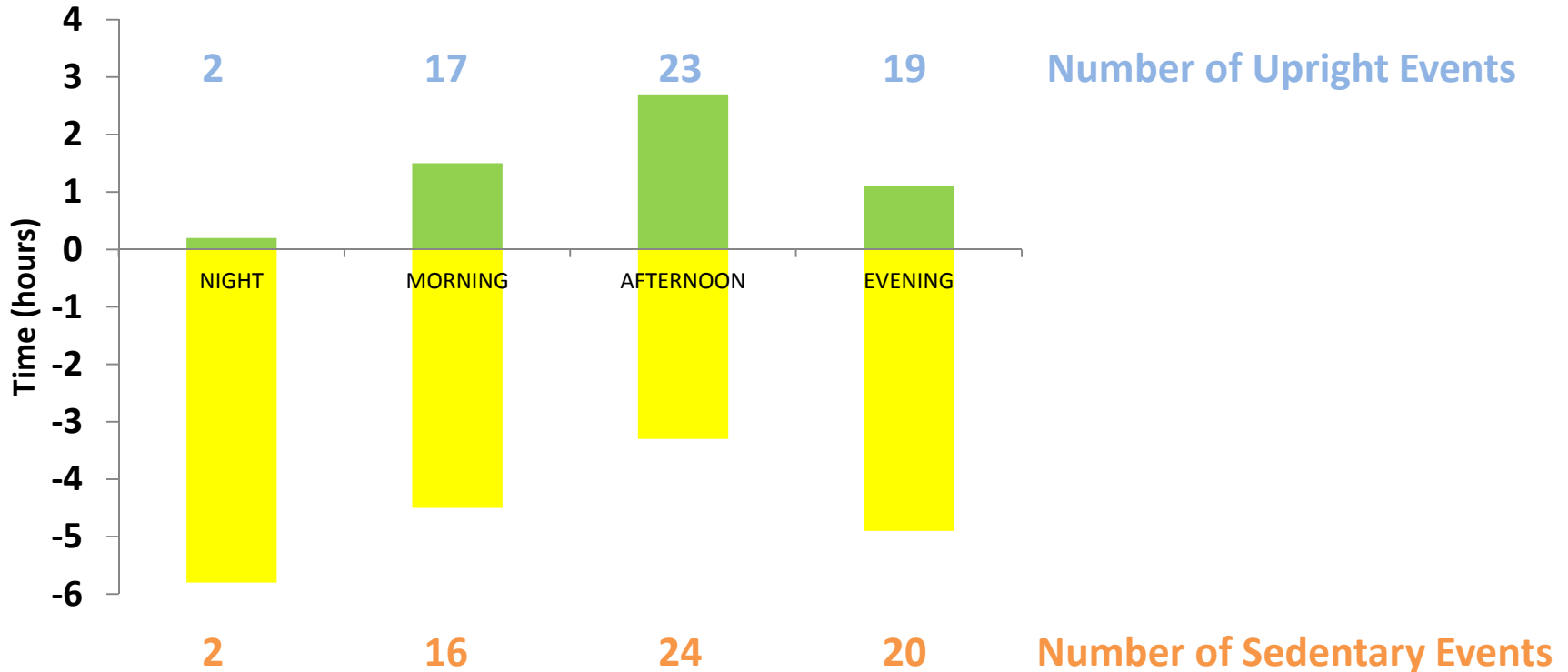
The Data

- up transition => upright event, down => sedentary event
- Sit/Lie [Sedentary] times
- Standing time
- Stepping time (MVPA Stepping time)
- Steps (MVPA Steps)

Upright time = Standing time + Stepping time



Visualisation

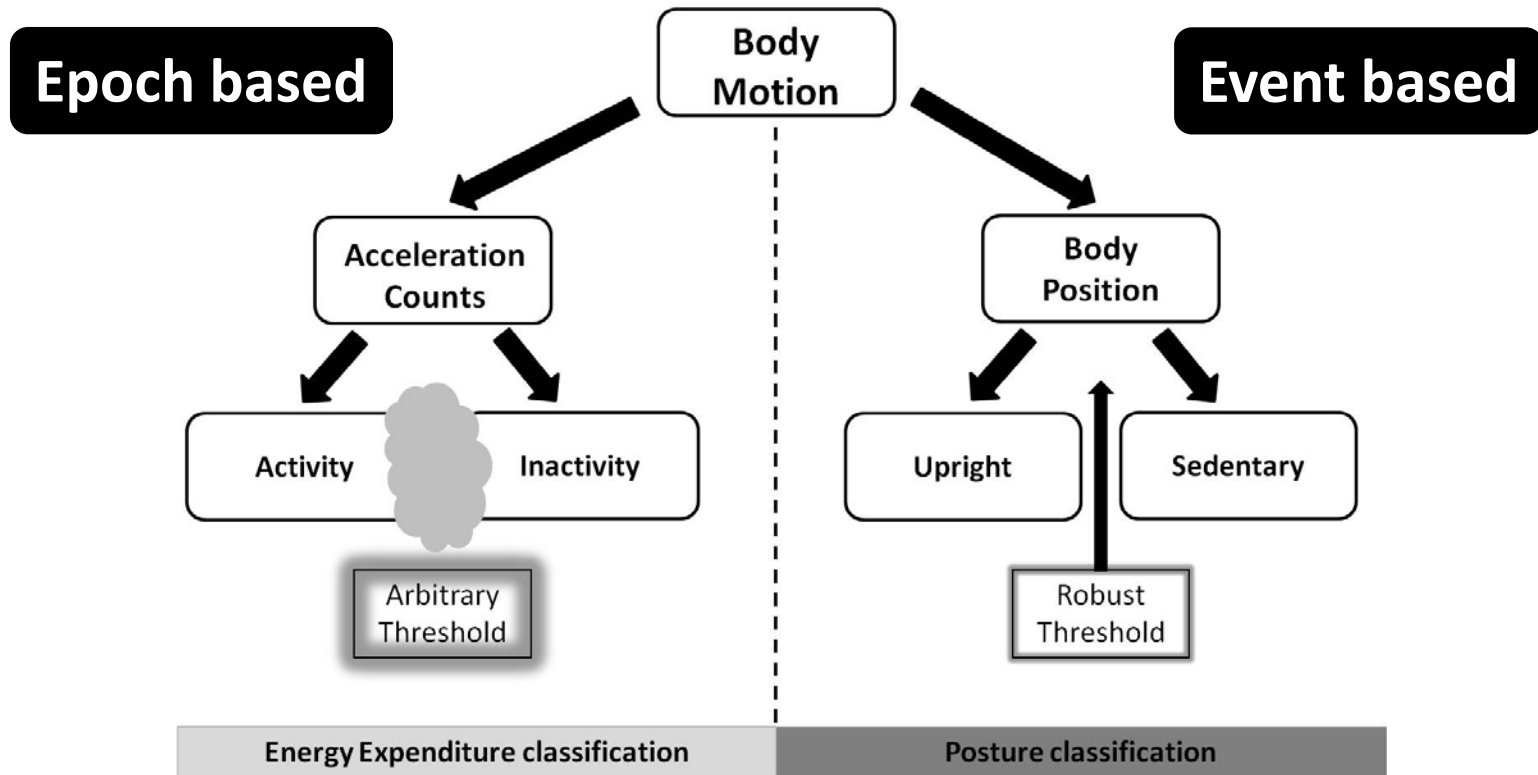


- ? Try your own visualisation for stepping and MVPA

Summary

- Conceptual approaches
- Epochs and Events
- Event-based analysis
- Real world public health example

Conceptual approaches



Epochs and Events

- **Epoch**

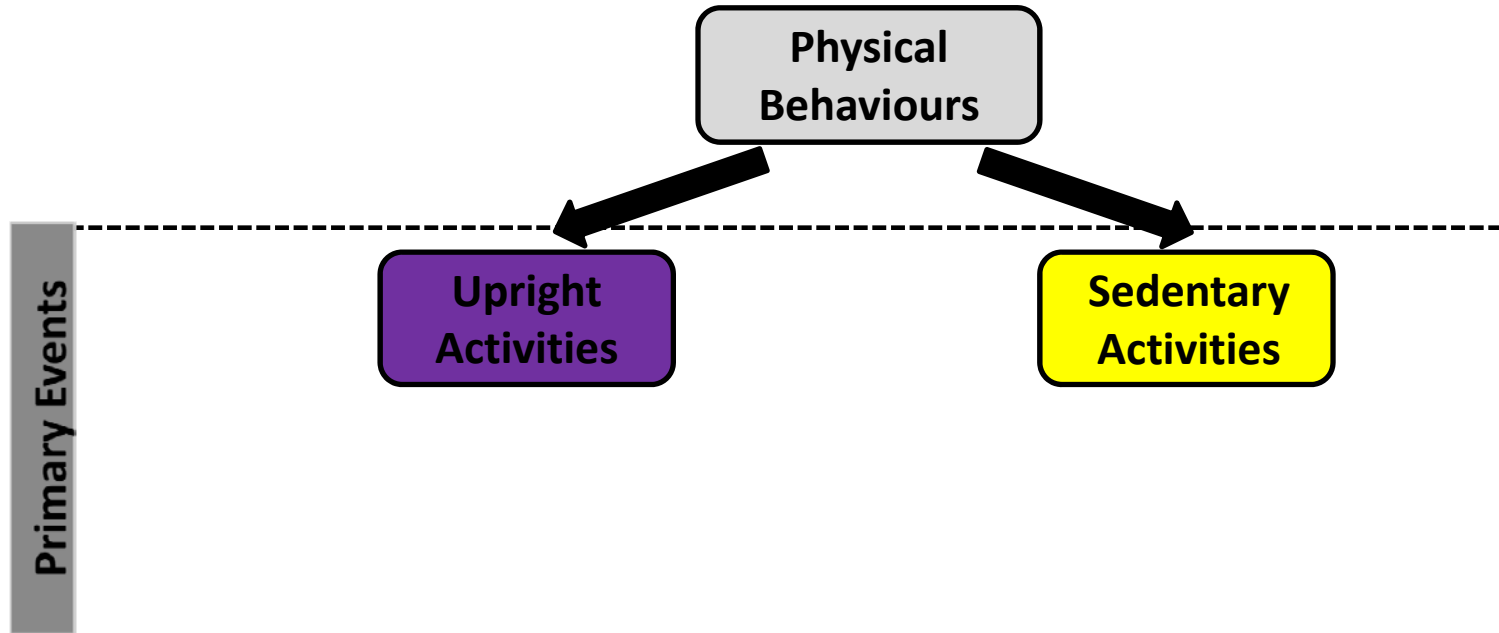
a user defined period (usually 1 minute or 15 seconds) with a **single value** representing the **acceleration** in that time period.

- **Event**

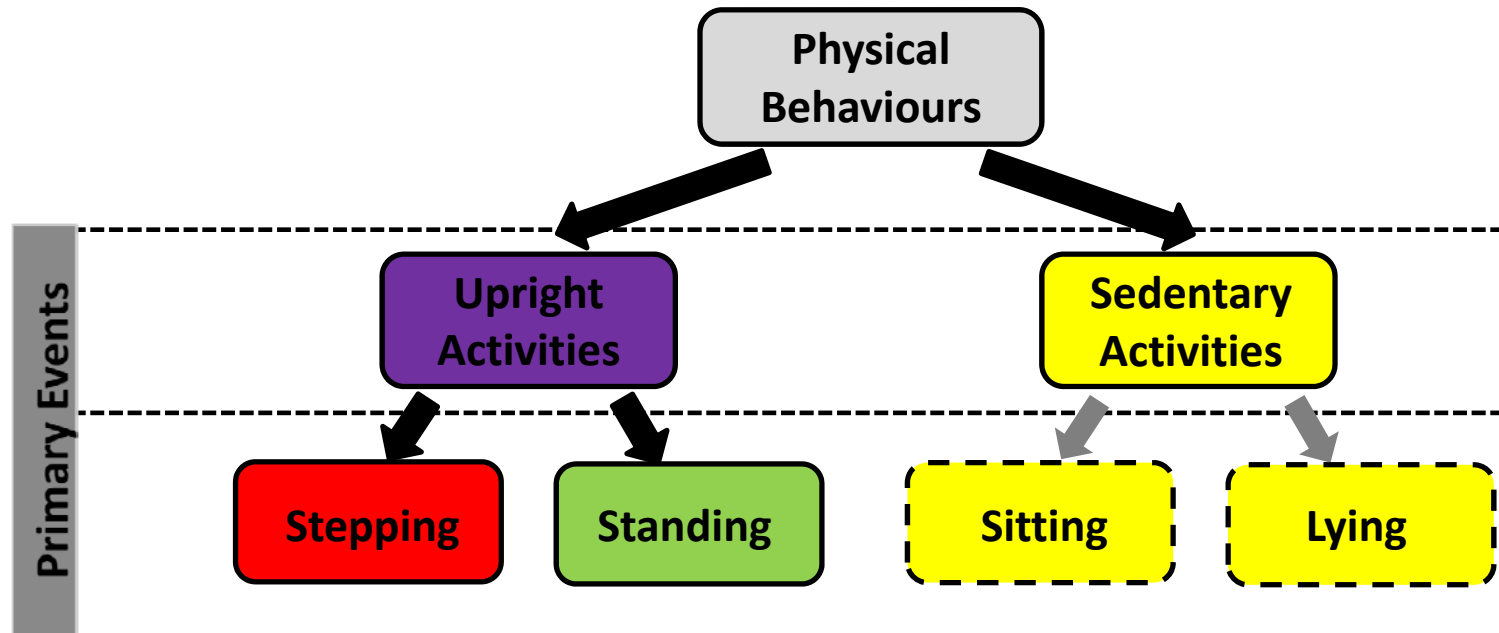
a continuous physical activity belonging to a single class with a defined **start time** and **duration**.

It may have another parameter(s) associated with it.

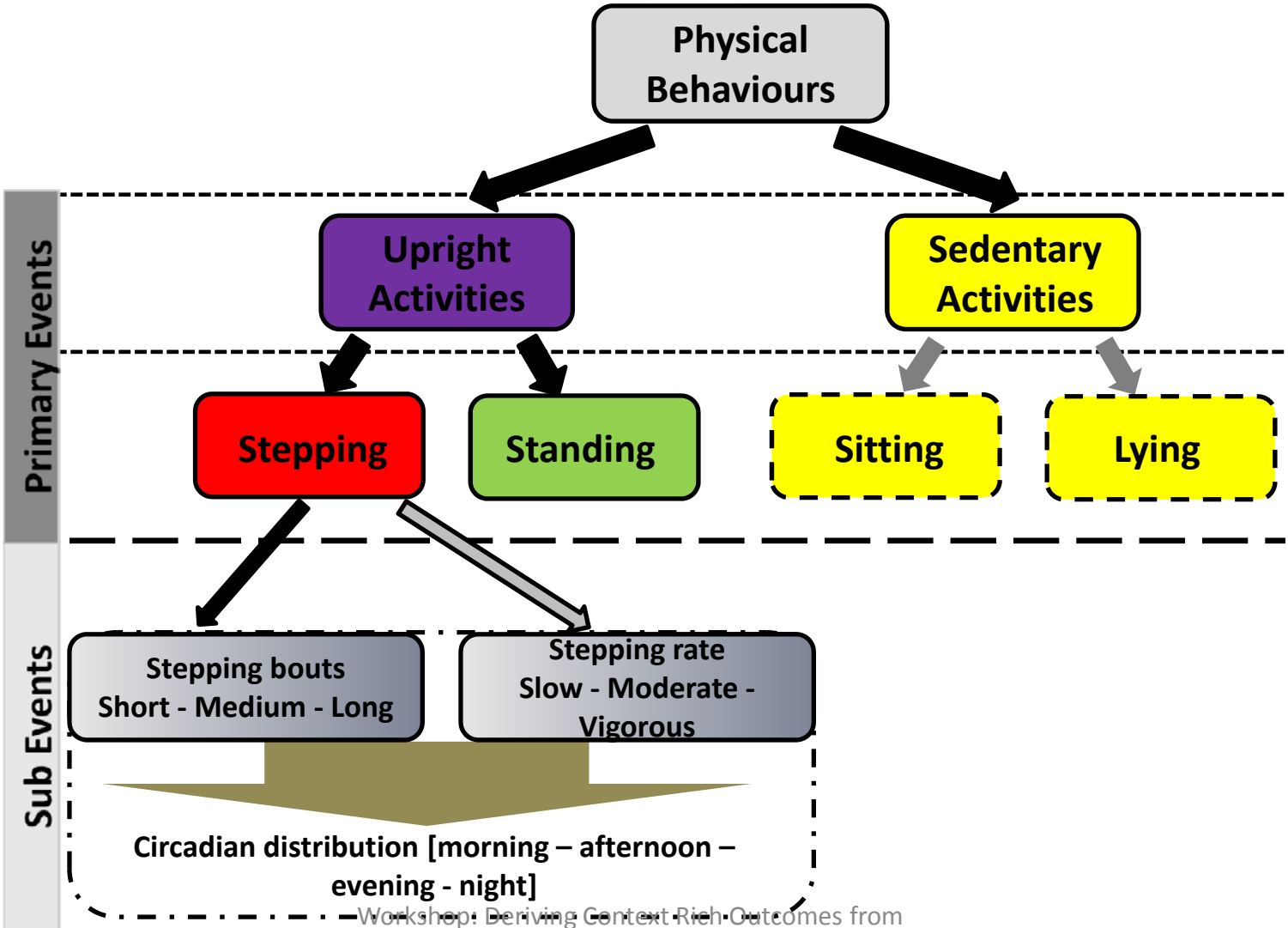
Event-based approach



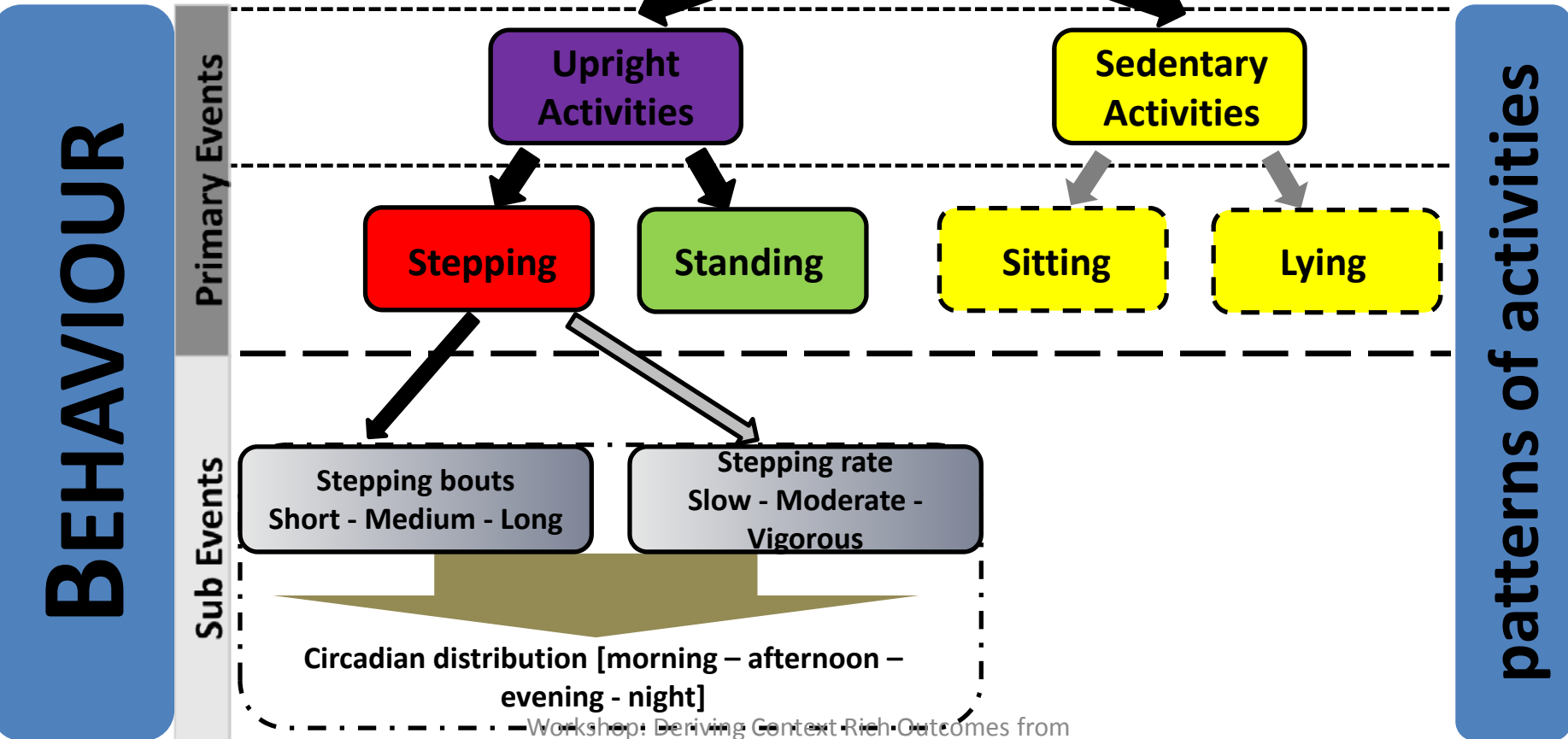
Event-based approach



Quantification of Physical Behaviours



Quantification of Physical Behaviours

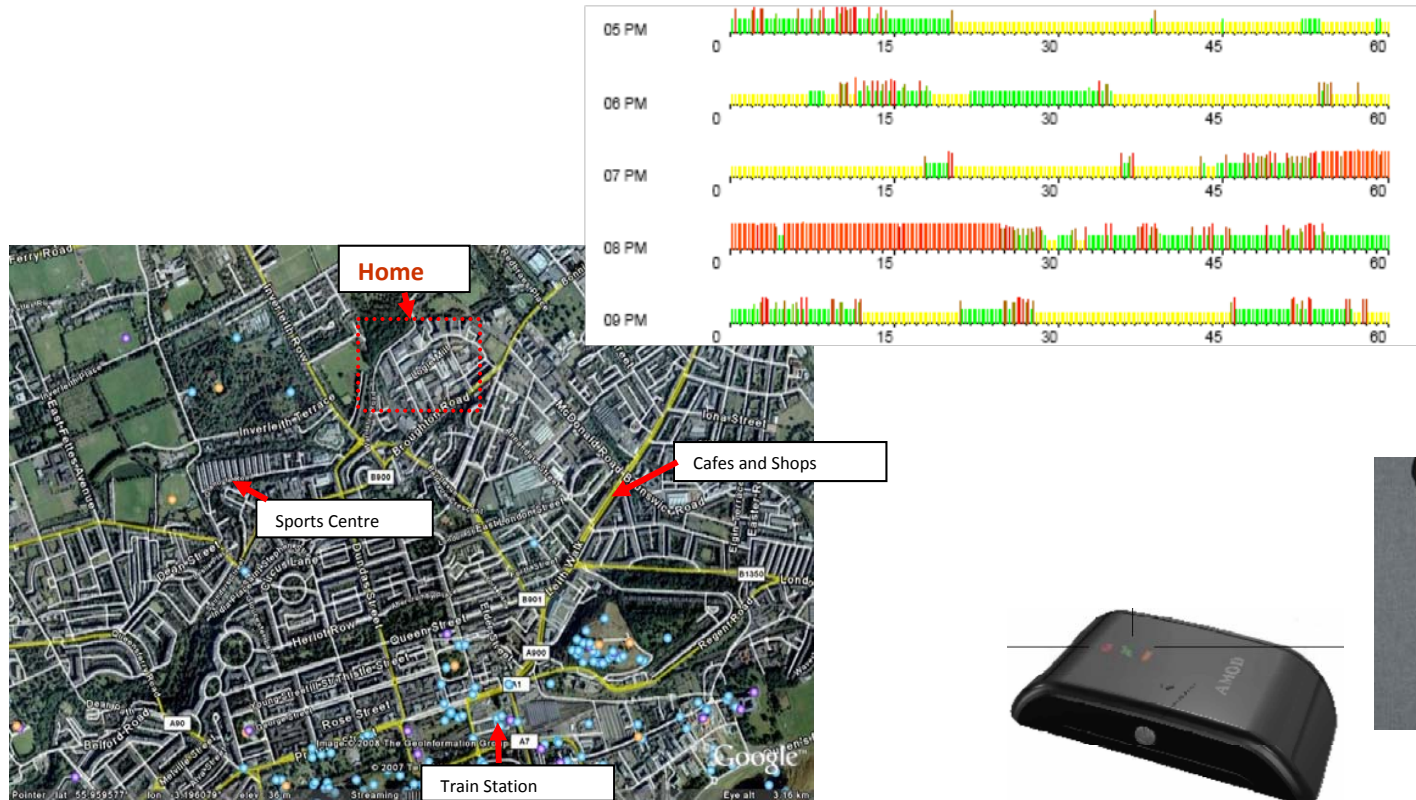


Example - Active Commuting

Office Workers - Active Commuting

- How important is commuting activity?
 - Evidence is variable
 - Main problem is quantification
- Main method of quantification
 - Questionnaires
 - Some GPS type monitoring
- New quantification
 - **Combine GPS with activity monitoring**

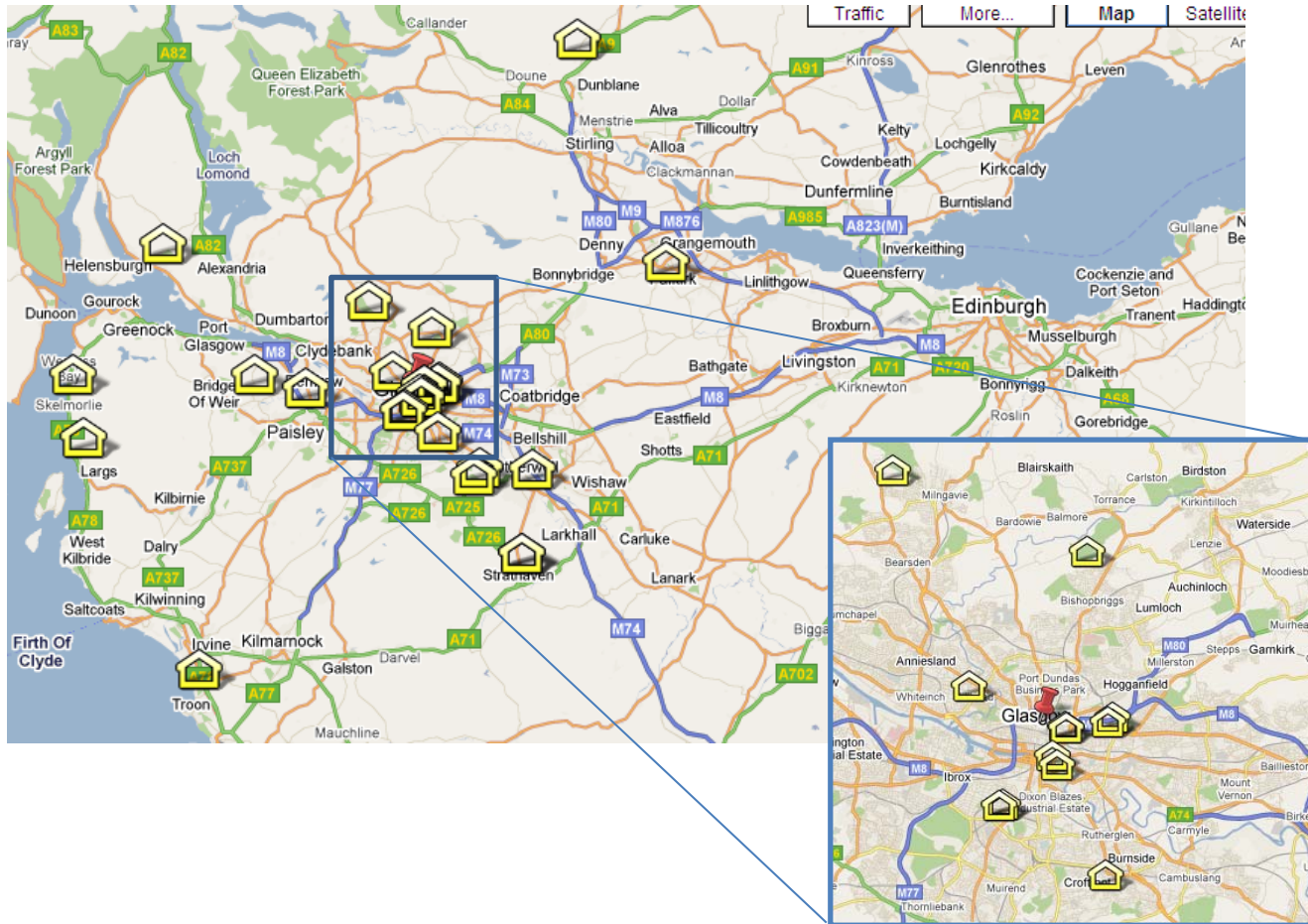
Office Workers - Active Commuting



Amod AGL3080 GPS logger

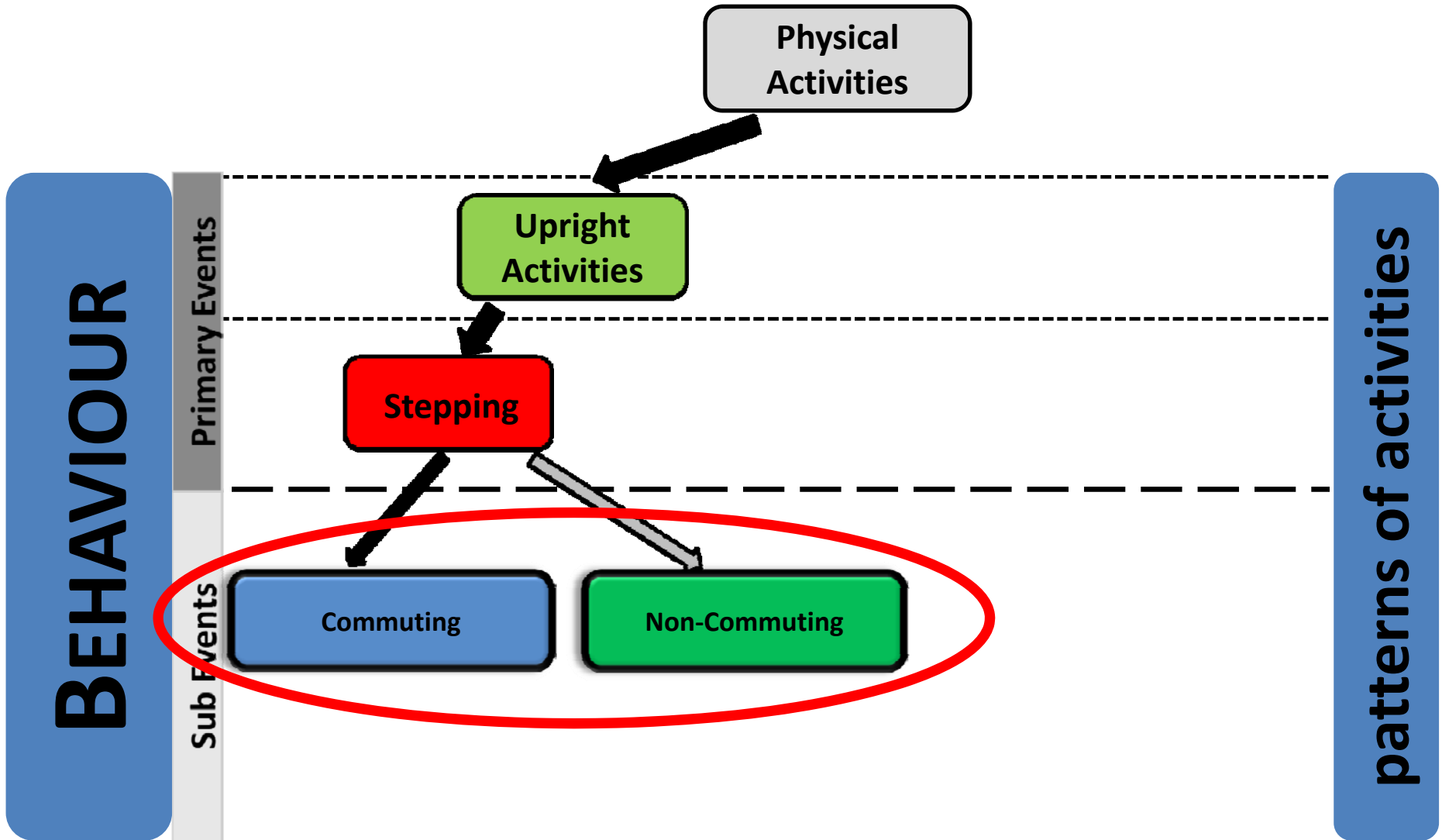


Office Workers - Active Commuting



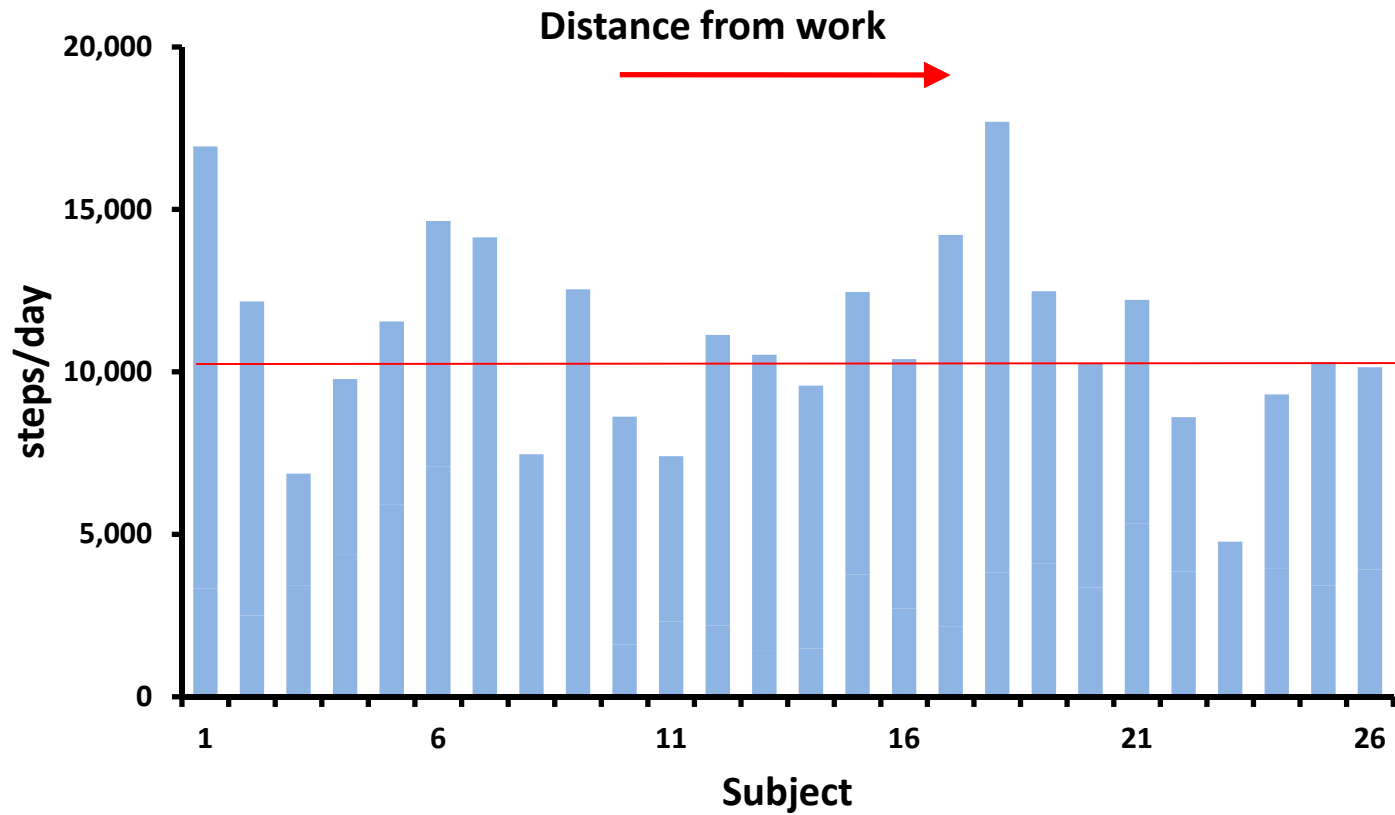
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Office Workers – Analysis of Events



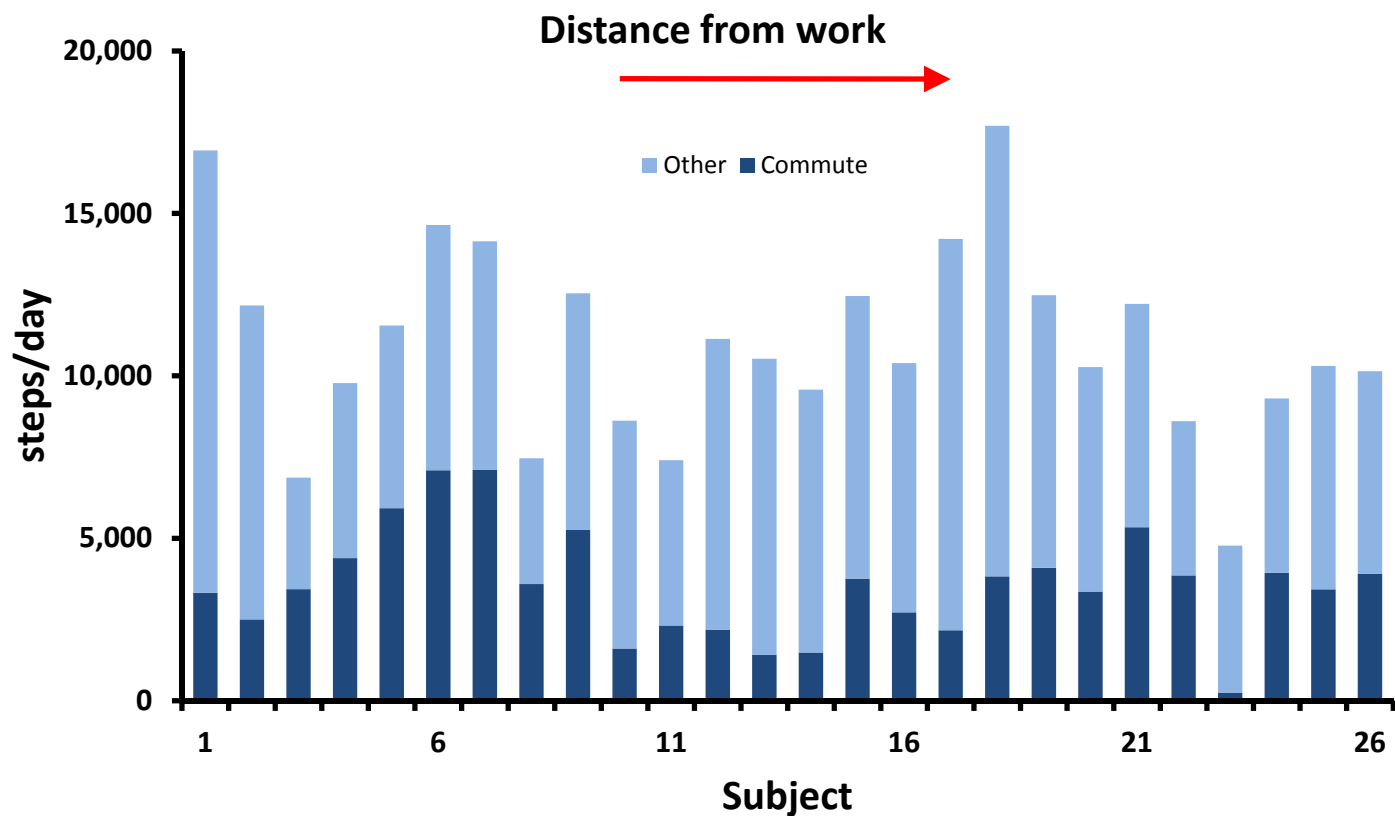


Office Workers - Active Commuting



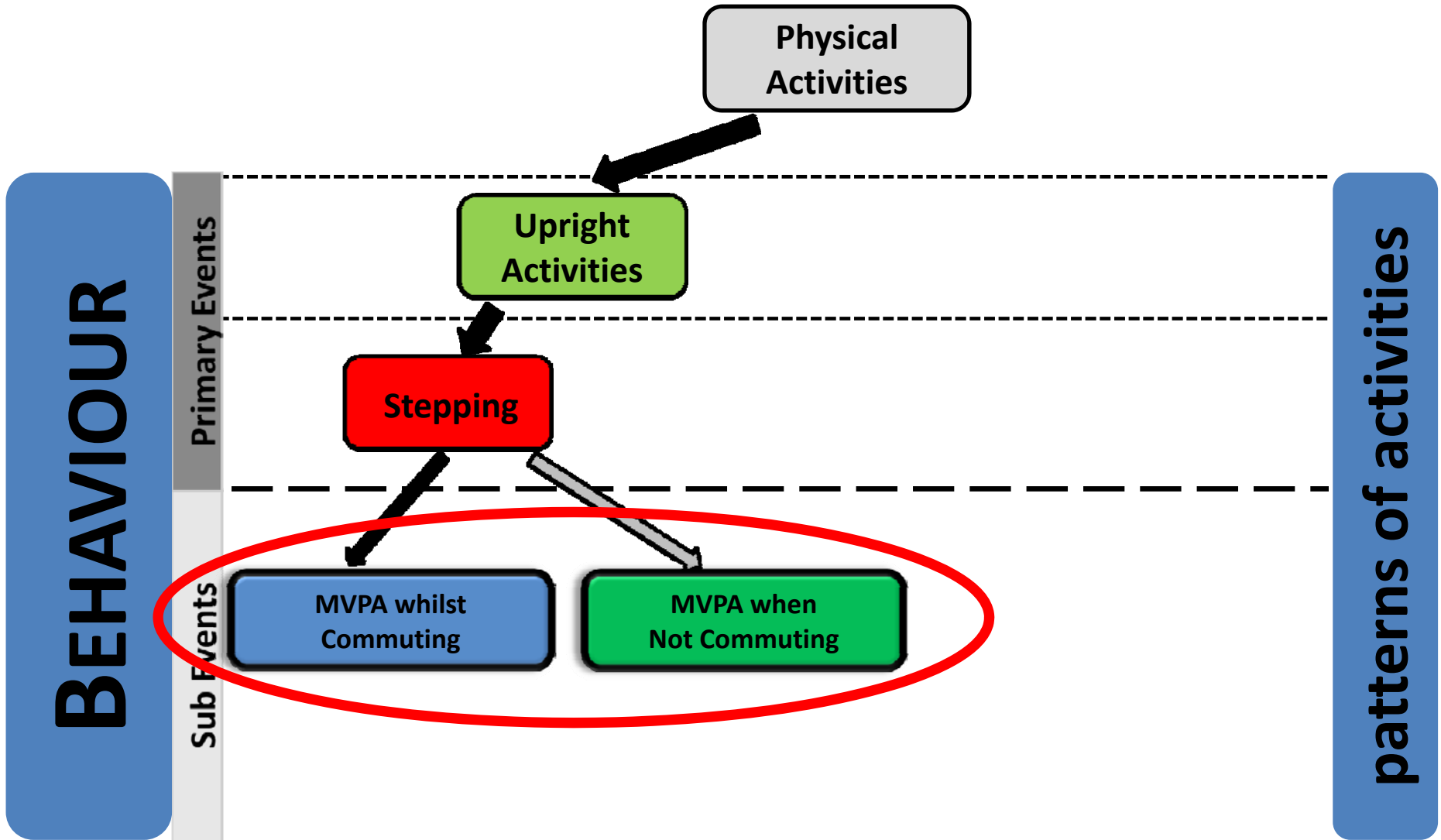


Office Workers - Active Commuting



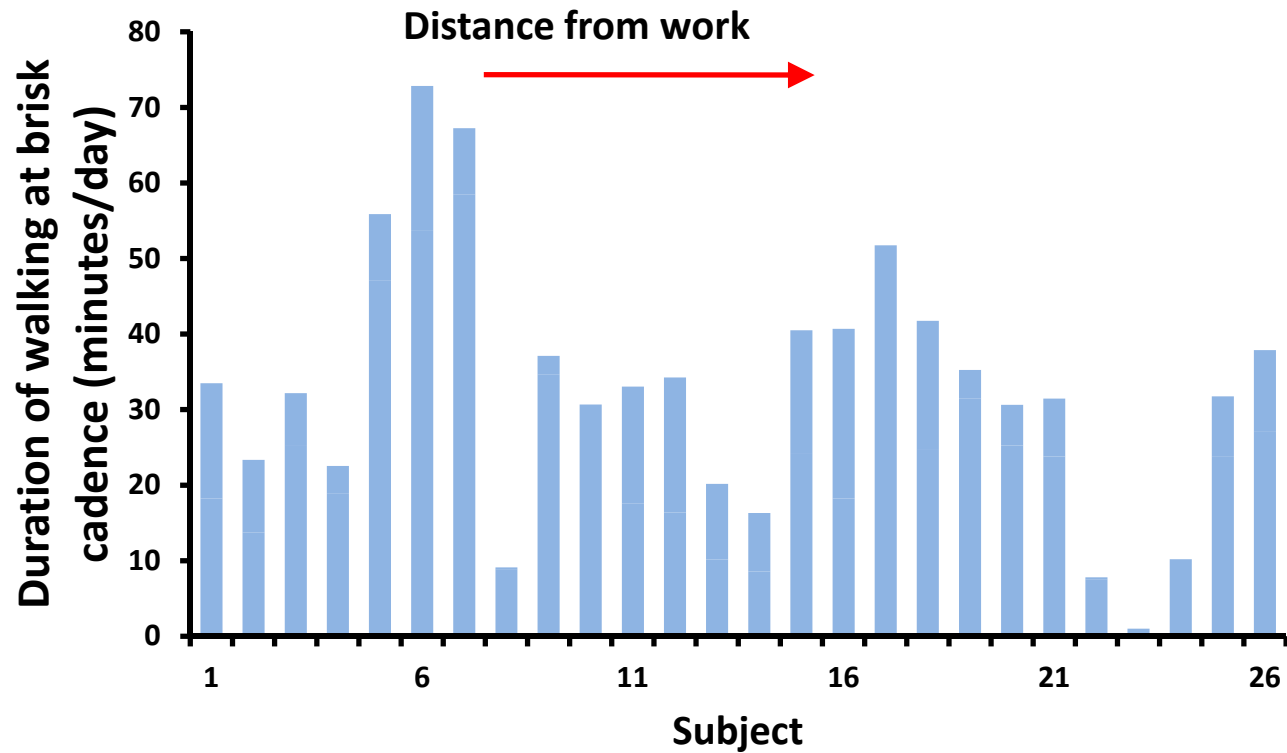
32% of weekly total steps due to commuting

Office Workers – Analysis of Events

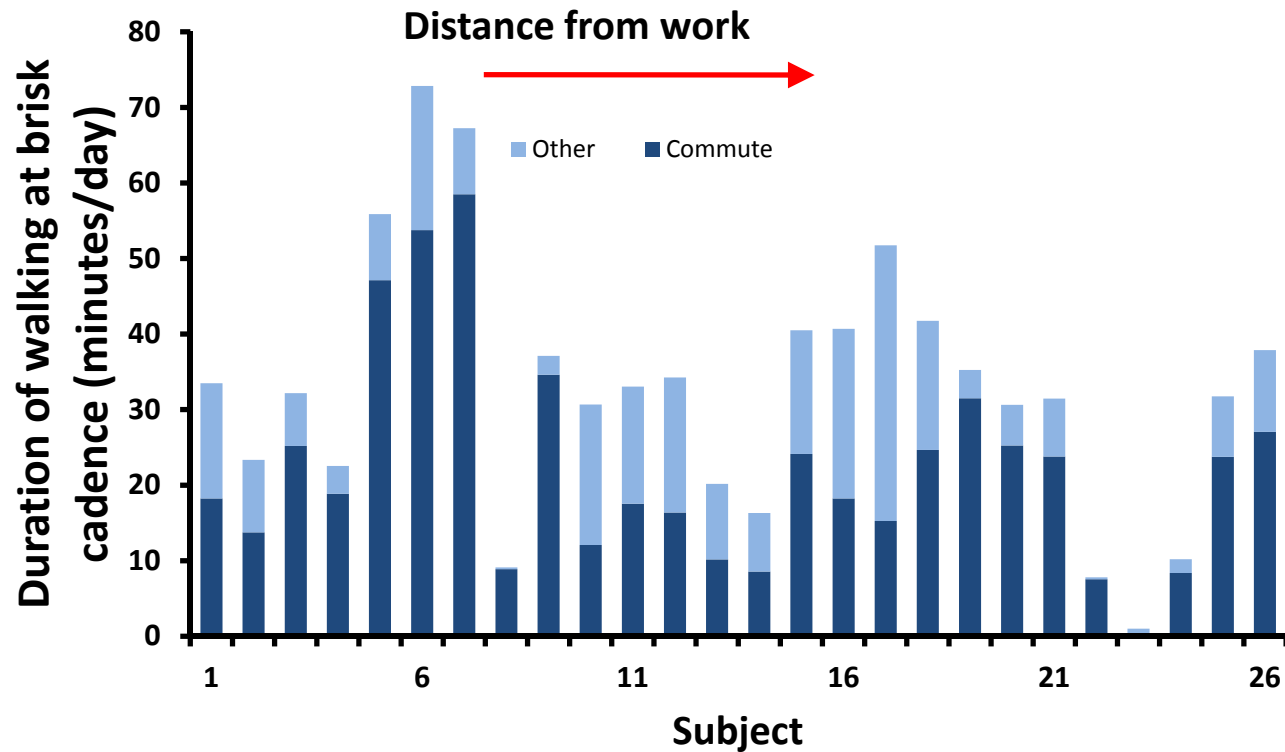




Office Workers - Active Commuting

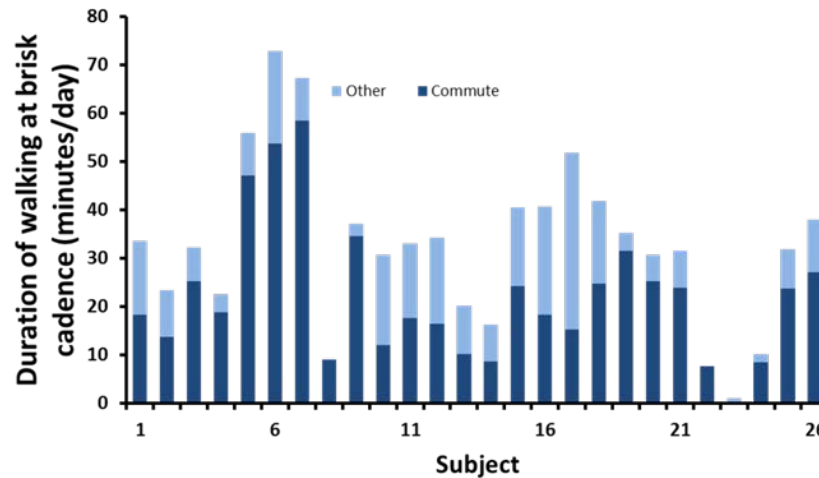
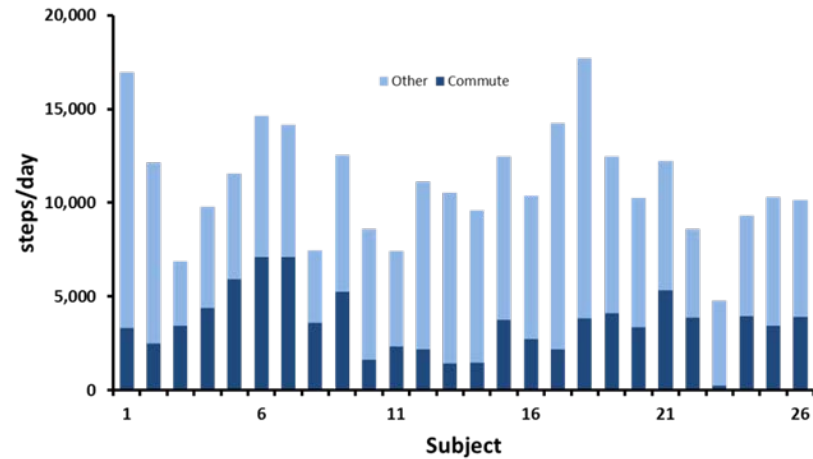


Office Workers - Active Commuting

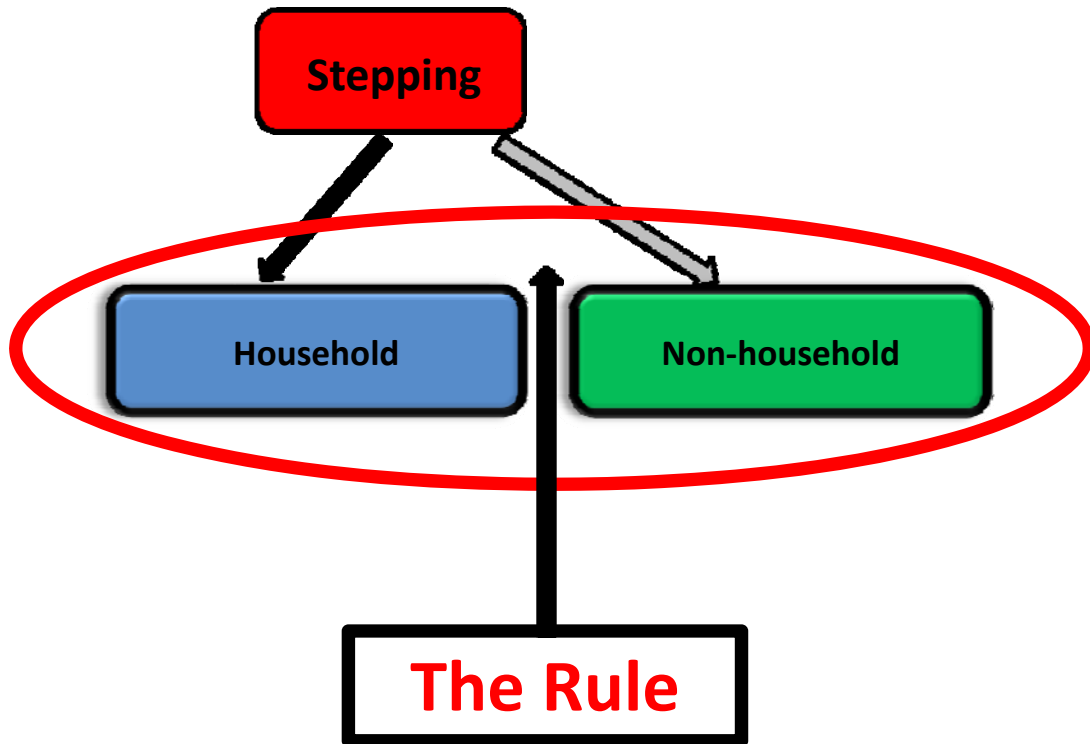


66% of weekly total due to commuting

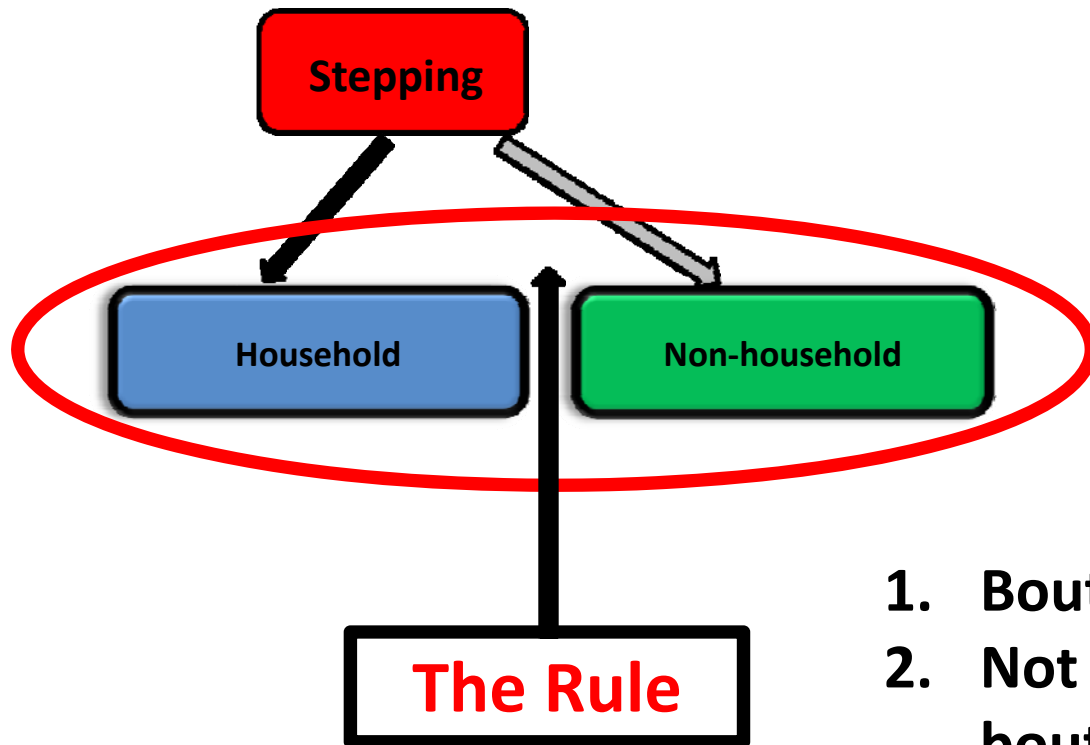
Office Workers - Active Commuting



Household and Community



Household and Community



1. Bout length < 1 minute
2. Not in upright container with bouts > 1 minute
3. Time of day??
4. Proximity to other activity

Thank you for participating



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