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Validating the Detection of Everyday Concepts in Visual Lifelogs

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Overview

- **Introduction**
  - **Introduction to lifelogging & the challenges involved**
  - **Why Semantic Concept Detection in Lifelogs?**
- Concept Detection Approach
  - Selecting concepts
  - Processing concepts
  - Image and event thresholds
- Experimental Set-Up
- Results
- Conclusions
  - Future research

Lifelogging

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Lifelogging is about digitally recording your daily life

Sometimes its for a reason

Work	e.g. security personnel, medical staff, etc.
Personal	e.g. diaries, etc.

Sometimes its for posterity

Recording vacations, family gatherings, social occasions

Sometimes its because we can

And we’re not yet sure what we’ll do with it e.g. MyLifeBits

Lifelogging Devices

Tano *et. al.* University of Electro-Communications, Tokyo, Japan

SenseCam

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SenseCam is a Microsoft Research Prototype

Multi-sensor device

Colour camera
3 accelerometers
Light meter
Passive infrared sensor

1GB flash memory storage

Smart image capture ~3 images/min

Since April 2006 we've had two SenseCams … in 2007 we received 5 more

How to Review Images?

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Make a 2 minute movie of your day!

SenseCam & Memory

- SenseCam may be a very powerful memory aid
- In autobiographical (long-term) memory
    - **“Cued Recall” better than “Free Recall”**
    - **Visual Encoding has strong effect on retrieval**
- Memory studies on-going
    - **Cambridge, U.K.**
    - **Leeds, U.K.**
    - **Toronto, Canada**
    - **Illinois, USA**
    - **etc.**

Lifelog Processing

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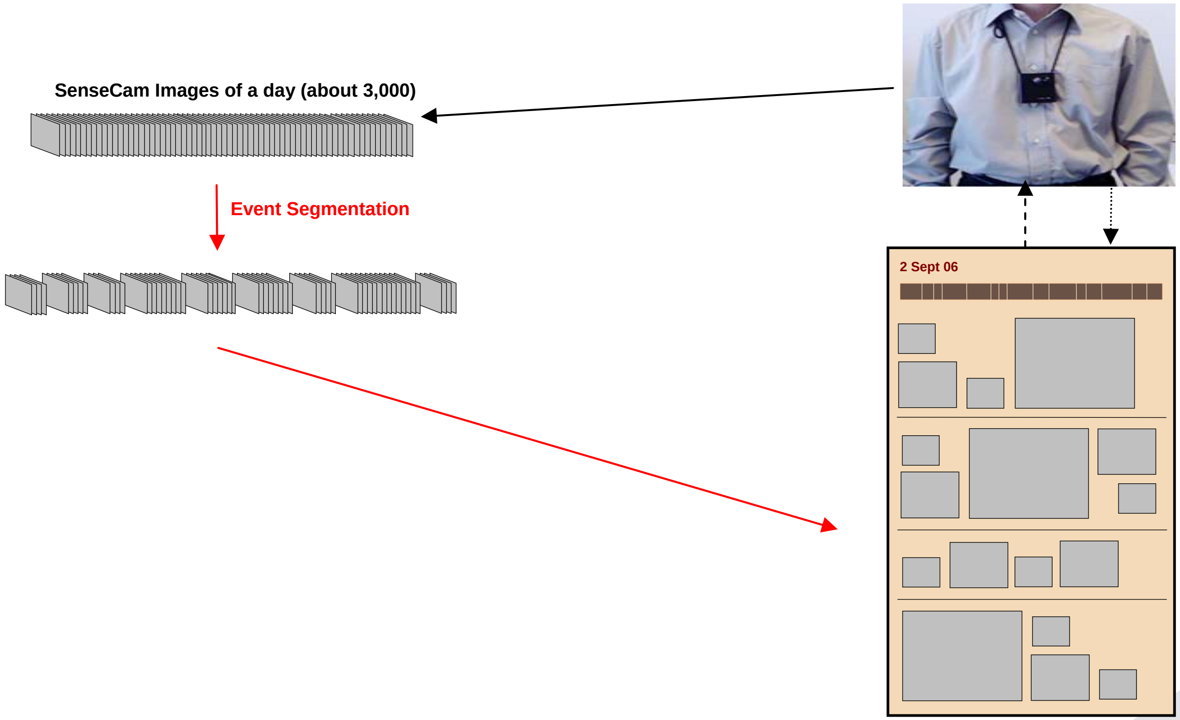
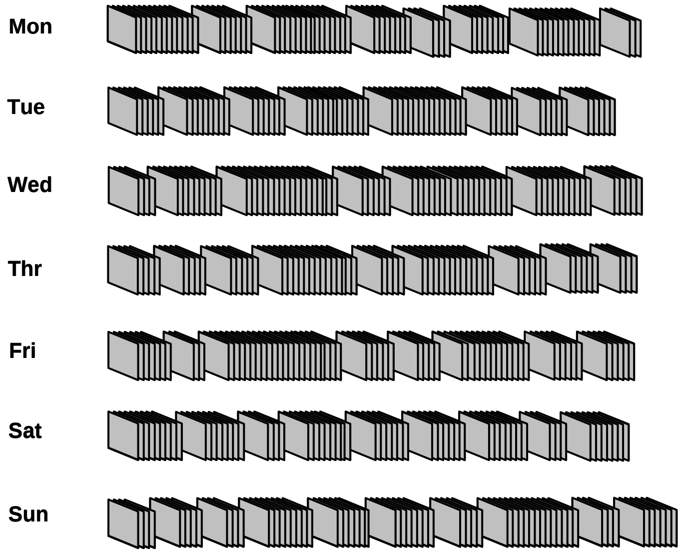


http://www.cdvp.dcu.ie/SenseCam

Can’t “recognise” events



We can detect this event

We know when this event is

BUT

We don’t RECOGNISE the event i.e. we don’t know “the what” of this event

Contributions of this work…

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- Exploration of applying semantic concept detection to the novel domain of lifelogging

- In-depth evaluation of concept detectors

- Allows possibilities to “gist” human lifestyle activities

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Selecting Representative Concepts

- A subset of 5 user's collection was visually inspected by playing images in video-like fashion

- 150 concepts initially identified

- Through refinement we narrowed down to **27 concepts**
  - **Most representative concepts selected**
  - **Concepts should be generalisable across users & collections**

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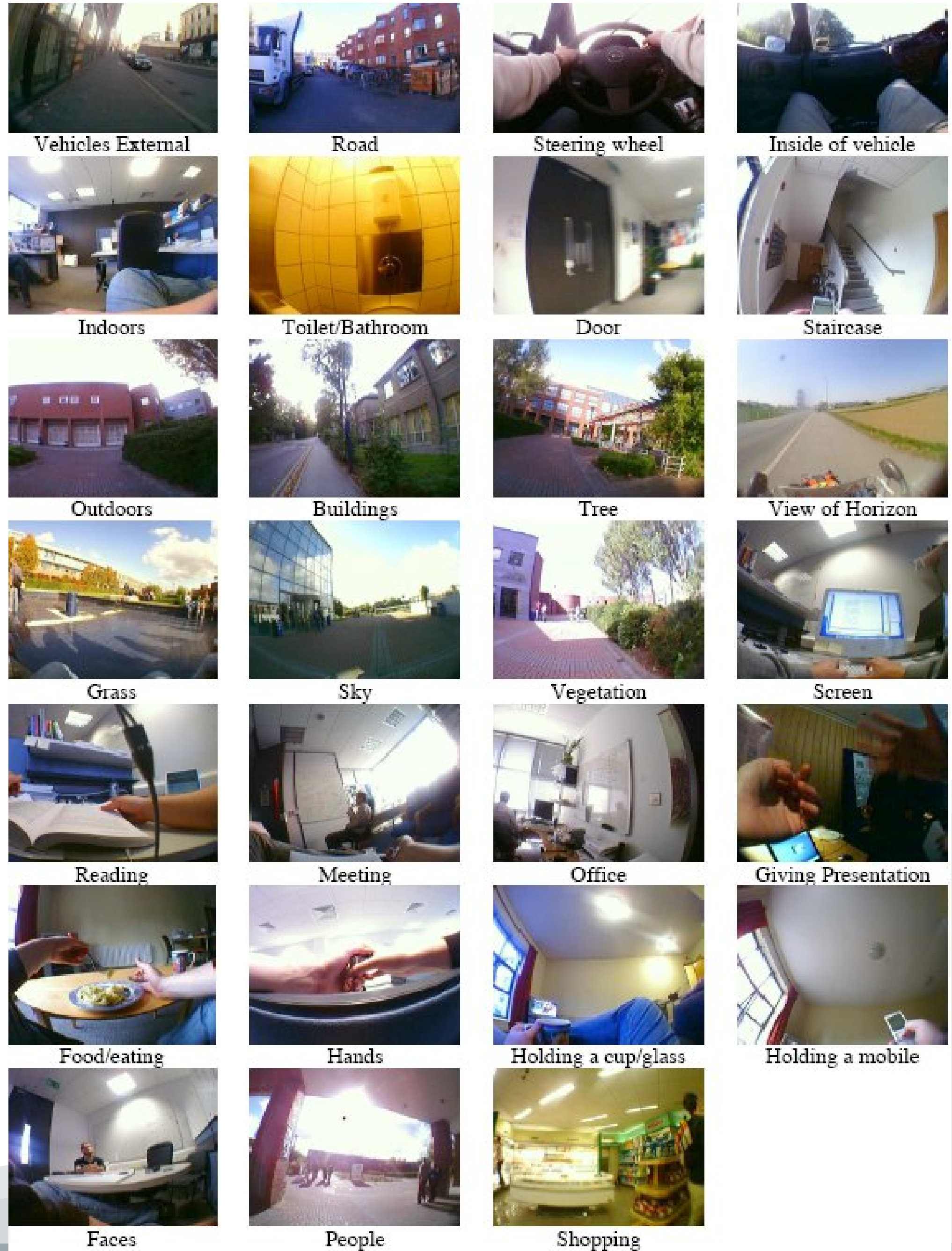


Concept detection process

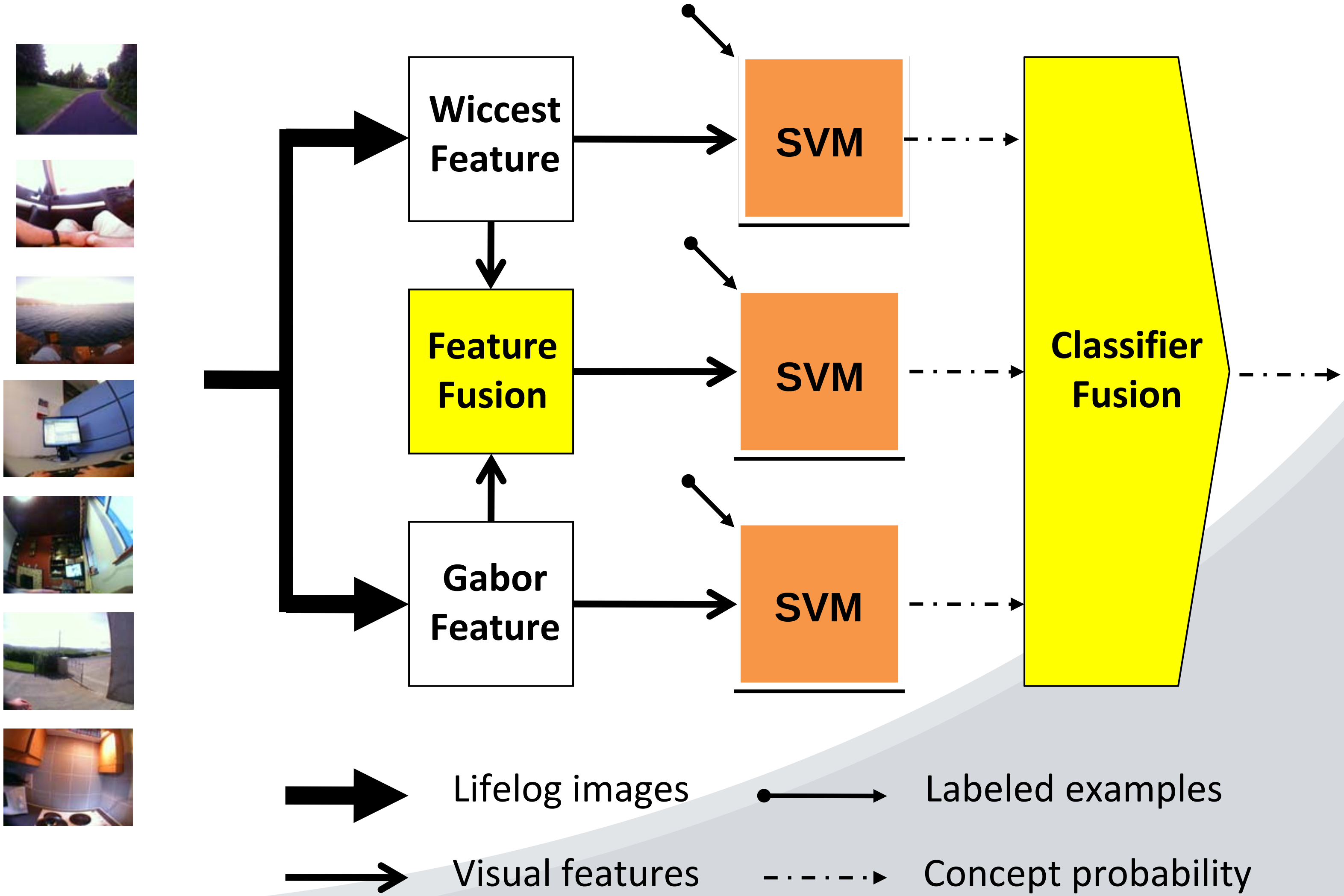
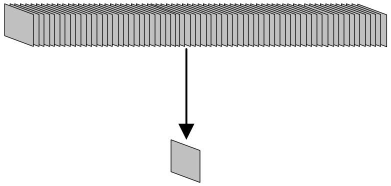


Image confidence values

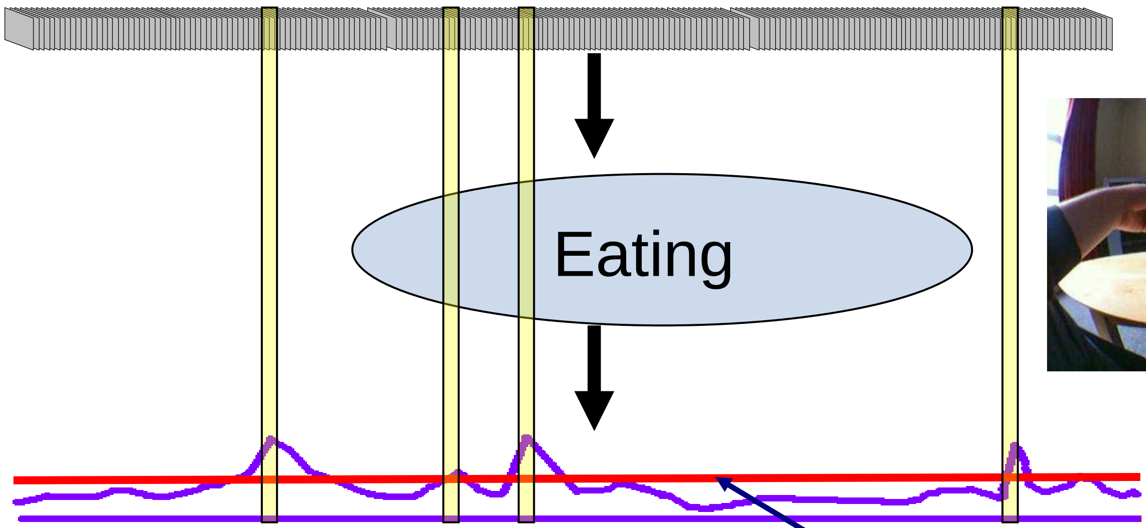


Vehicles External = *0.002*
Road = *0.007*
Steering wheel = *0.003*
Sky = *0.002*
…
screen = *0.863*
People = *0.012*
Shopping = *0.003*

All values are independent

Where are the <eating> images?

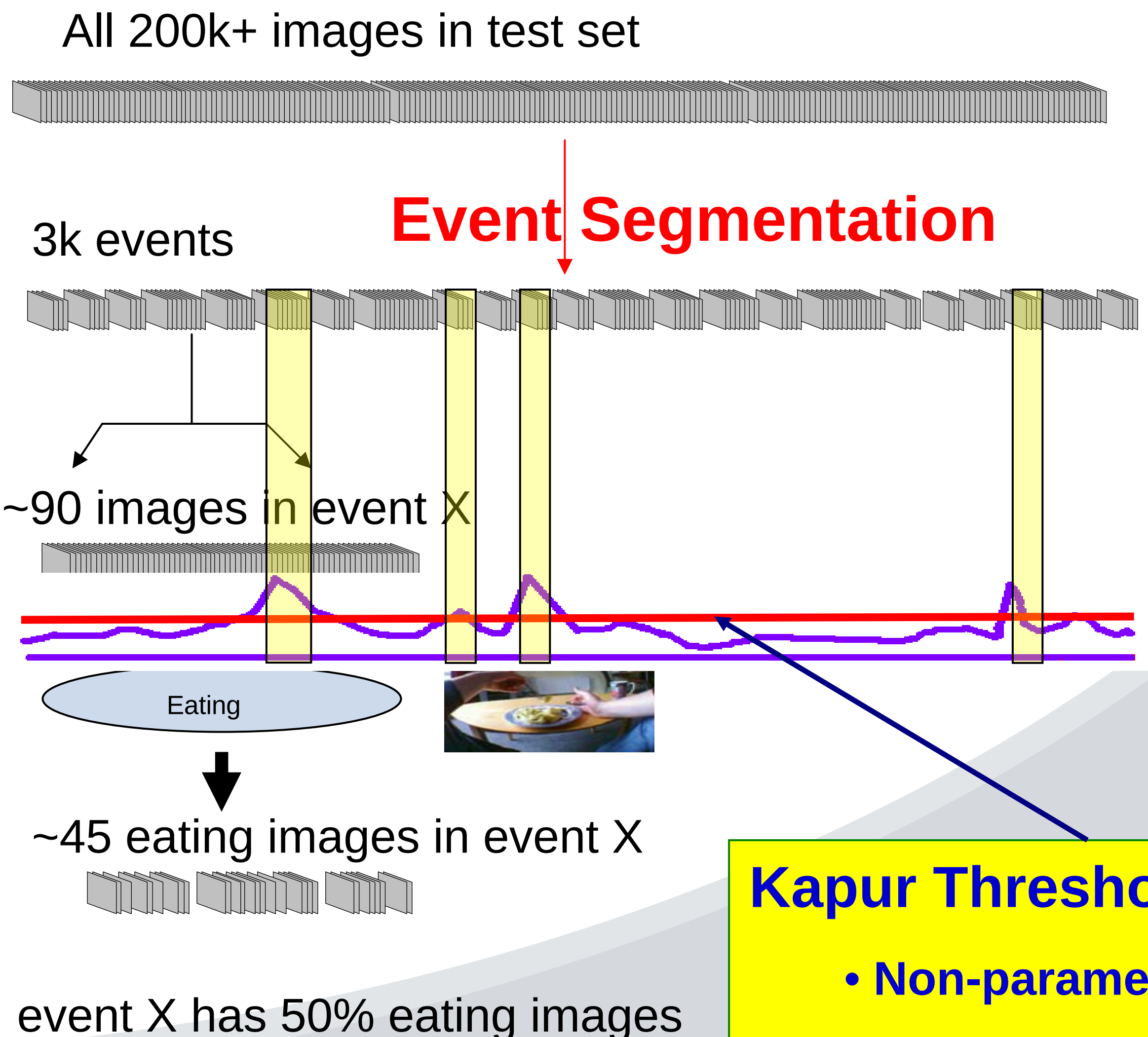
All 200k+ images in test set



Kapur Thresholding

- **Non-parametric**
- **Entropy based**

Where are the <eating> events?



Kapur Thresholding

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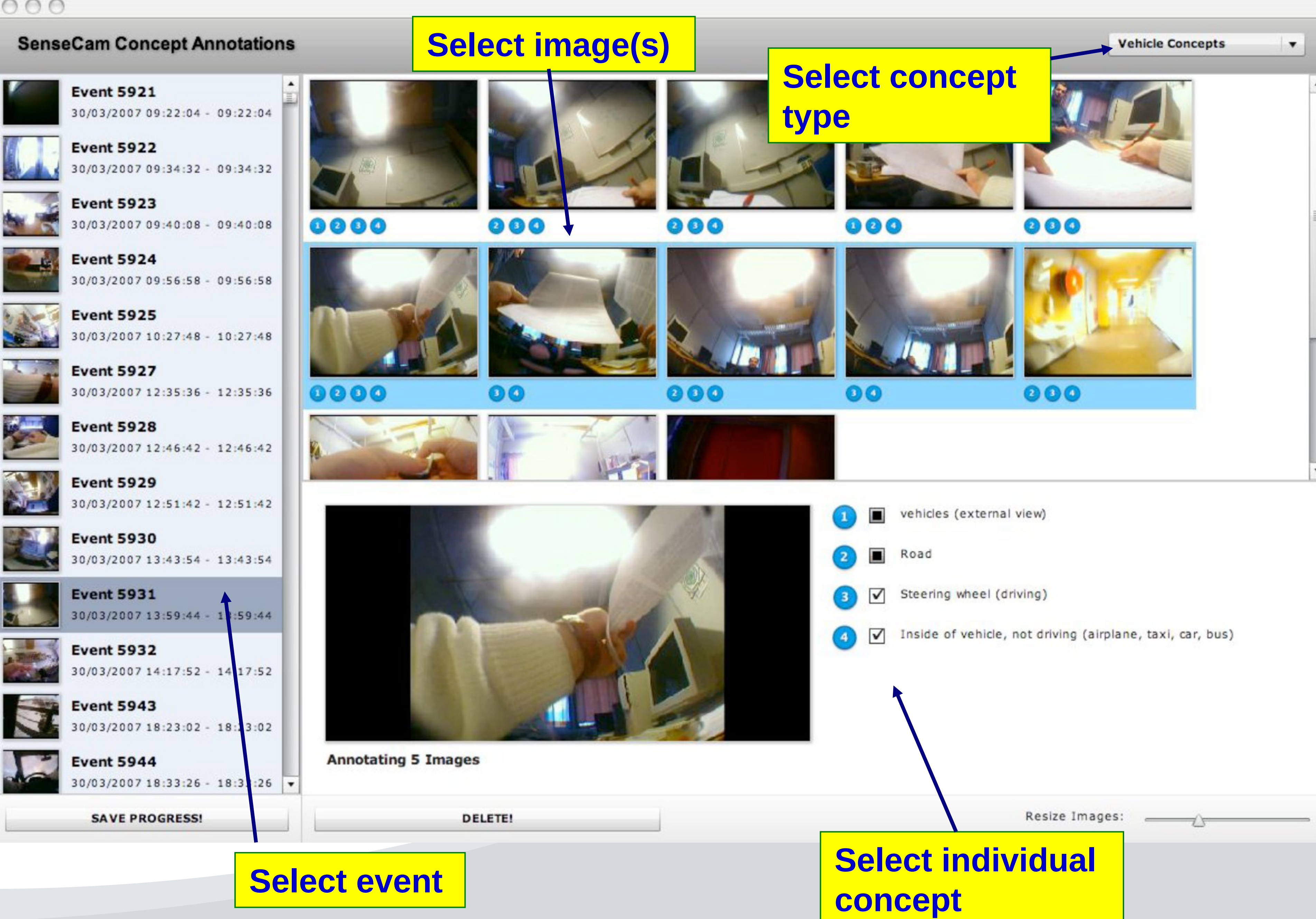
Experimental Setup

- 5 users
- 1 month period each
- 257,518 images
- 3,030 events

- Firstly create annotated training set
  - **Every 5th image selected for training set**


SenseCam Concept Annotations
Select image(s)
Select concept type
Vehicle Concepts
Event 5921
30/03/2007 09:22:04 - 09:22:04
Event 5922
30/03/2007 09:34:32 - 09:34:32
Event 5923
30/03/2007 09:40:08 - 09:40:08
Event 5924
30/03/2007 09:56:58 - 09:56:58
Event 5925
30/03/2007 10:27:48 - 10:27:48
Event 5927
30/03/2007 12:35:36 - 12:35:36
Event 5928
30/03/2007 12:46:42 - 12:46:42
Event 5929
30/03/2007 12:51:42 - 12:51:42
Event 5930
30/03/2007 13:43:54 - 13:43:54
Event 5931
Event 5932
Event 5943
Event 5944
vehicles (external view)
Road
Steering wheel (driving)
Inside of vehicle, not driving (airplane, taxi, car, bus)
Annotating 5 Images
SAVE PROGRESS!
DELETE!
Resize Images:
Select event
Select individual concept

After annotation

- 38,206 images annotated (training set = 14.8%)

- 219,312 in test set (test set = 85.2%)

- **THEN we validated accuracy of detectors on test set**
    - 9 judges to validate system concepts
    - Each judge shown 200 positive & 200 negative images per concept
    - 50 “set” positive images & 50 “set” negative images per concept shown to all users (to investigate judge agreement)
    - **95,907 judgments made on test set!!!**

Validation tool

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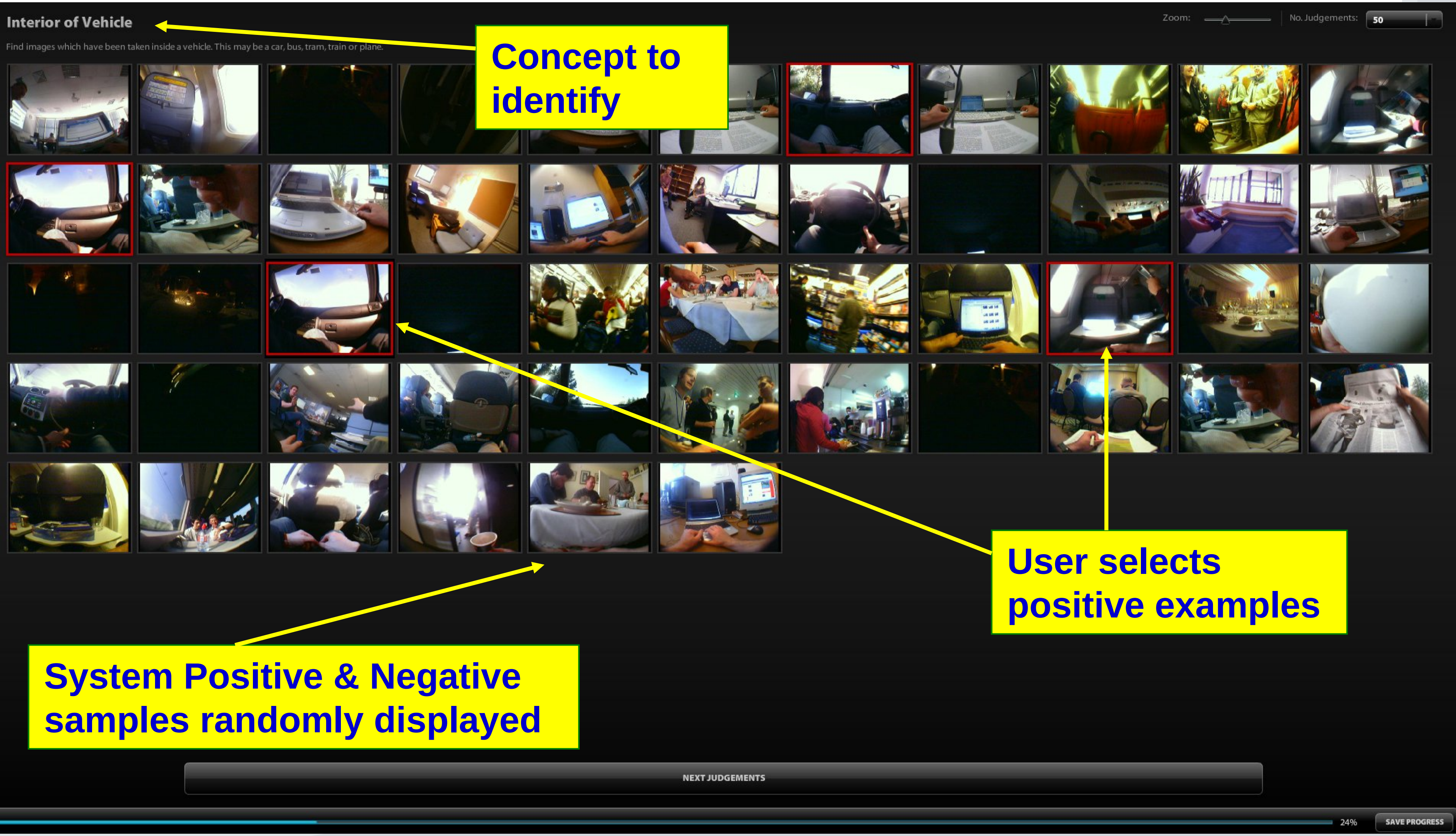

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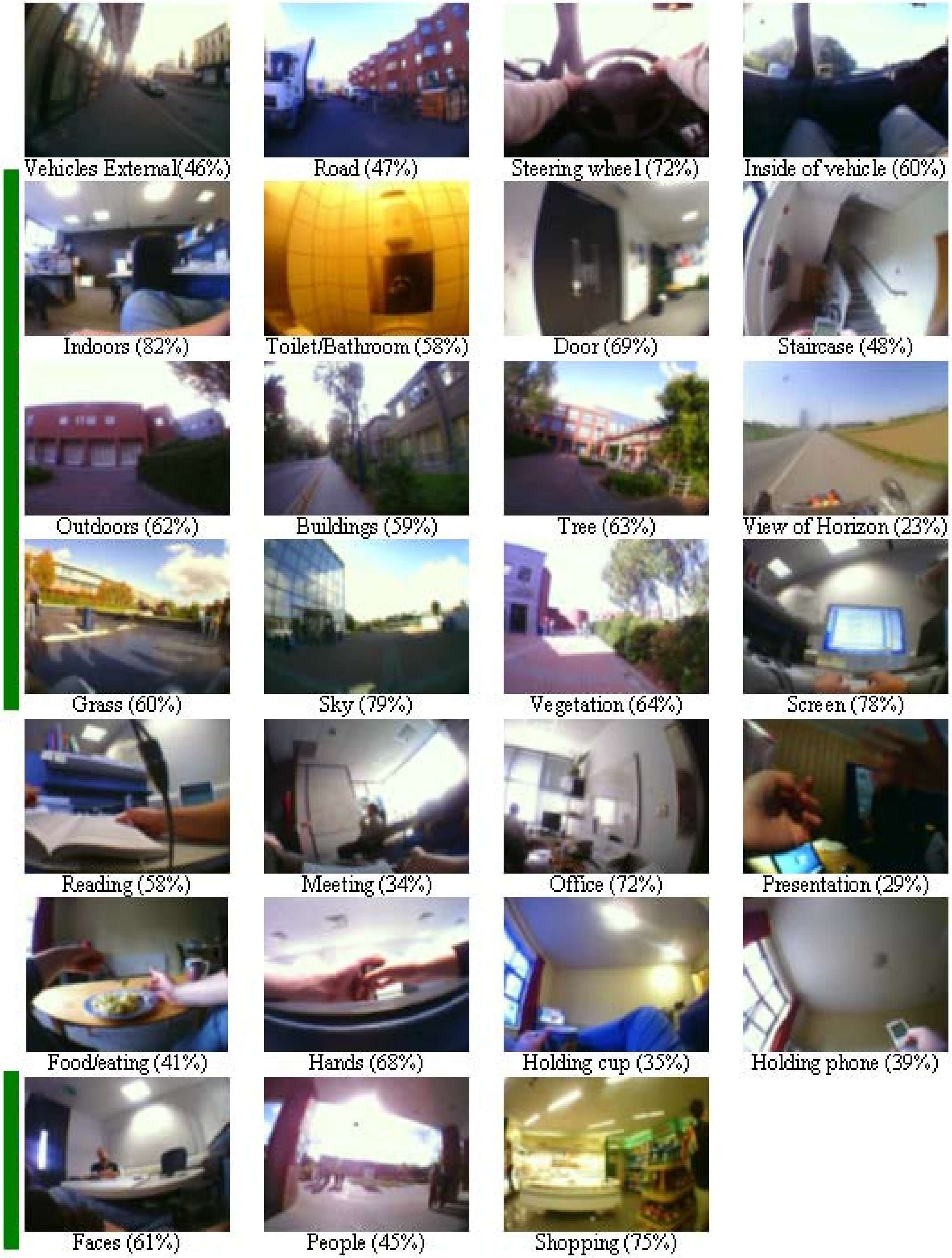
Results

- Precision
  - **Average = 0.57**
  - **Median = 0.60**
- Judge Agreement
  - **Fleiss's Kappa = 0.68**
- Strong correlation of 0.75 between the number of concept training samples and test set performance



Results

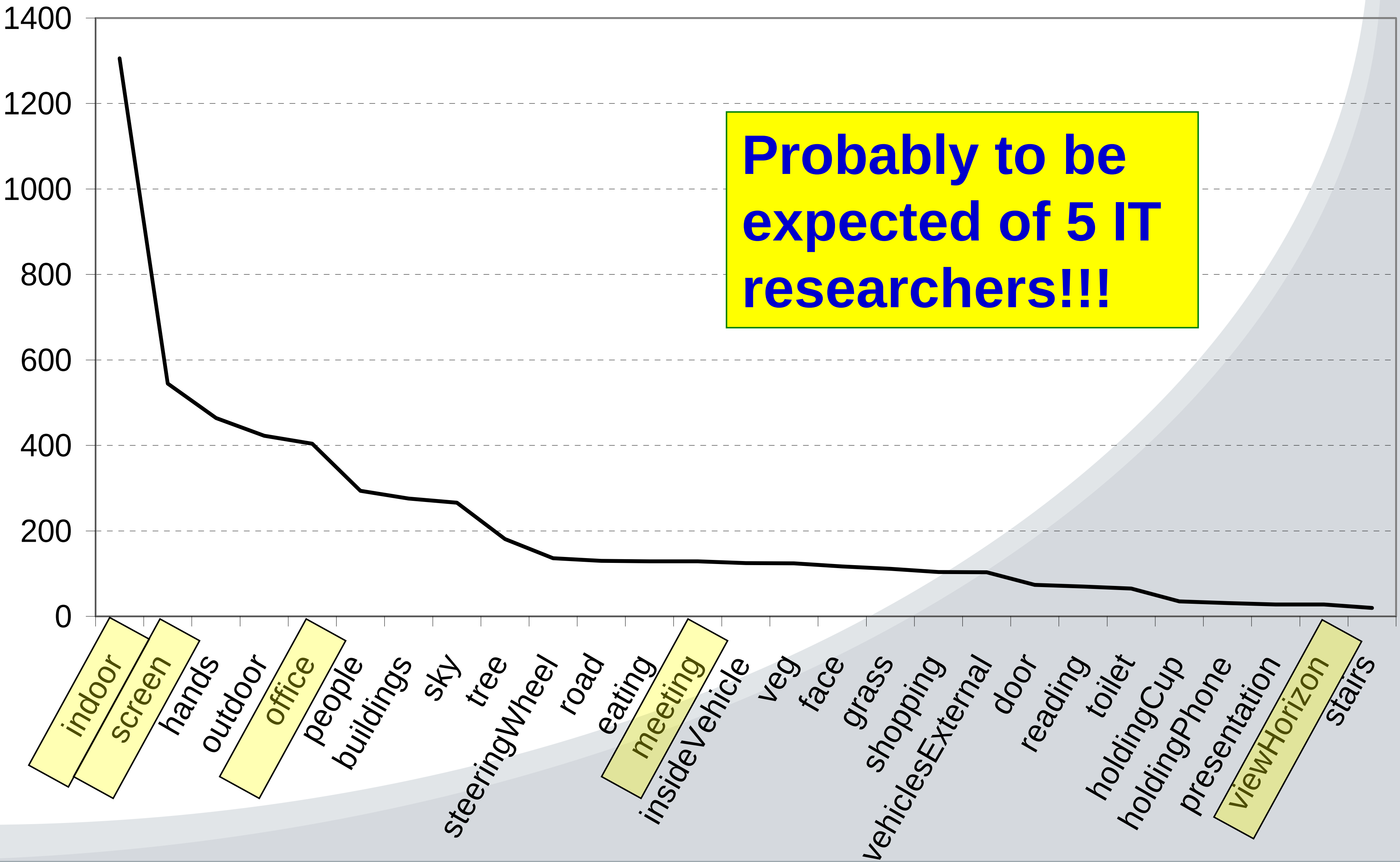
BUT applying on image level isn't so interesting

- **Many SenseCam images are blurred, grainy, obscured by hands, etc.**

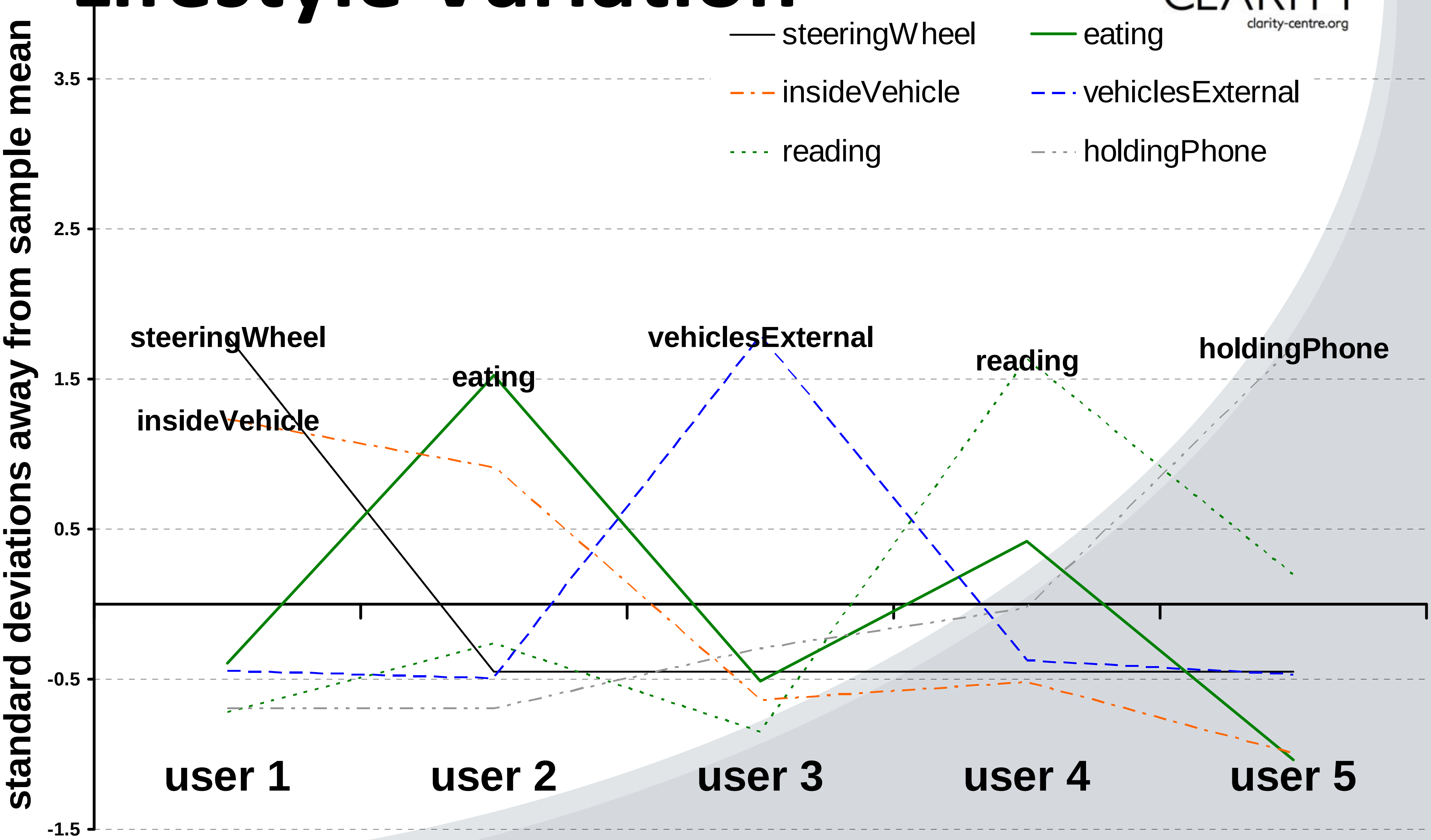
HOWEVER

- **Considering groups of images (i.e. CONSIDERING EVENTS)**
    - Reduces inaccuracies
    - Allows us map "macro trends"

Num Events Across 5 Users



Lifestyle Variation



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Conclusions

- For a long time focus of lifelogging community was on hardware minituratisation and storage

- Recently focus has shifted to data management

- Potential significance of SenseCam as memory aid

- However recent efforts only focused on “detection”, not **“recognition”**

Conclusions

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- Standard concept detection techniques applied to new exciting field of lifelogging

- Extensive evaluation carried out
  - 27 concepts selected from 257,518 images
  - 38,206 images annotated for training set
  - 95,907 test set images manually evaluated
  - 17 concepts with > 60% precision

Conclusions

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- Investigating concepts at the event level is exciting
    - Allows us to identify “macro” lifestyle trends/profiles/signatures
    - Enables us to compare lifestyles of individuals

Future Work

- **Improve concept performance**
  - Include sensor values
  - Investigate “bag of words” approach
  - Adaptively learn new concepts
- **Use concepts in search**
  - Perhaps along with GPS & Bluetooth
- **Broadcast lifestyle signature/profile**
  - e.g. in the last week I’ve been spending a lot of time in front of the PC but not so much time in the park

Thank You

further information:

http://www.cdvp.dcu.ie/SenseCam

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