

Toward a “Cognitive” Quantified Self

Activity Recognition for the Mind



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Overview

Physical Activity Recognition becomes Mainstream

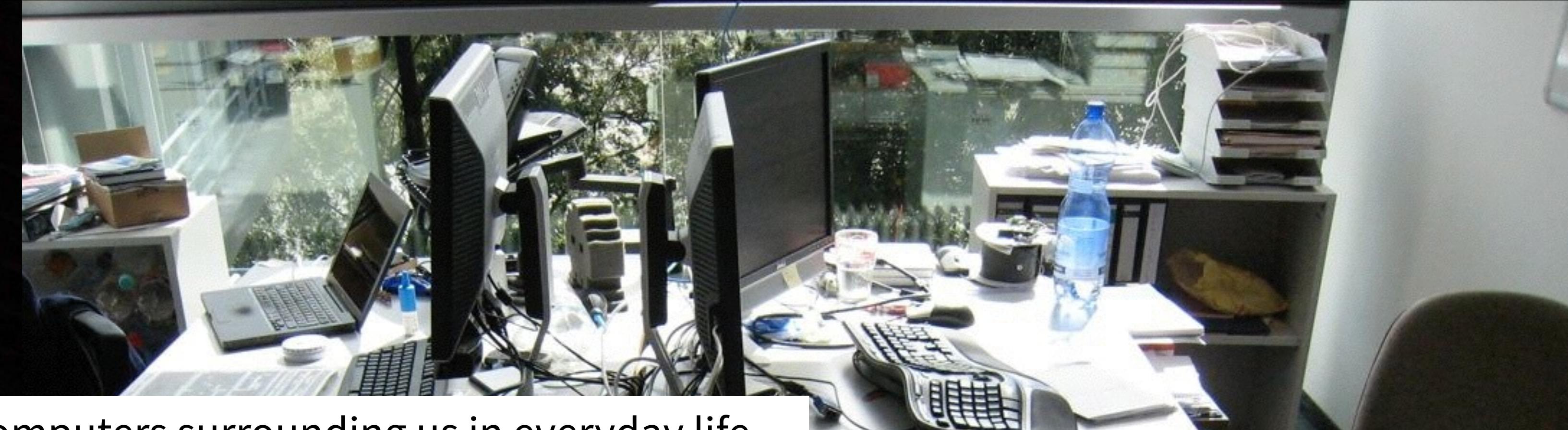
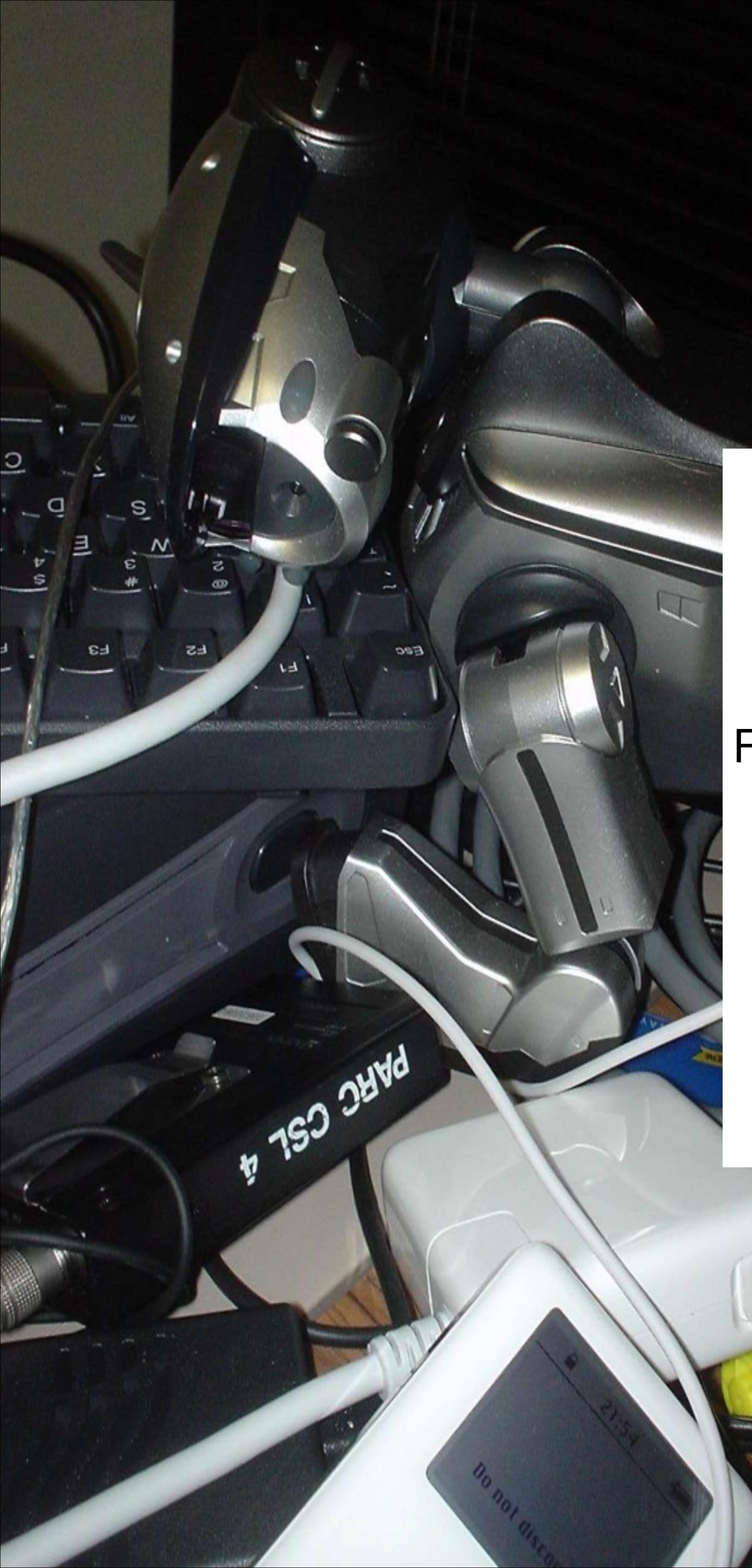
Toward Activity Recognition for the Mind

Focus on Reading Activities

How much/what are you reading?

How much do you understand?

Some Demos (hopefully)



With the computers surrounding us in everyday life,
the performance bottle neck is
Human Attention.

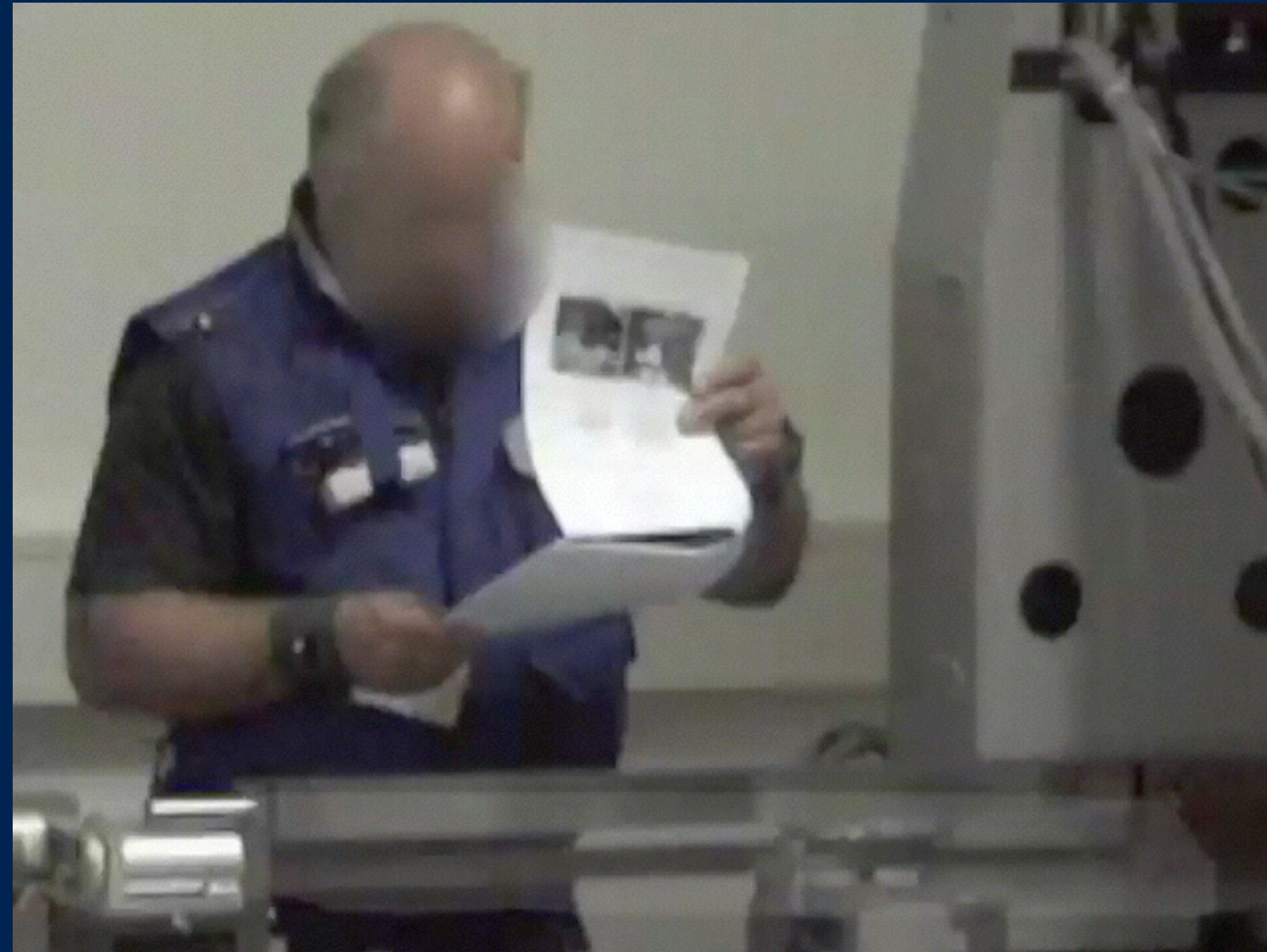
For Computing to become useful in everyday situations,
the interface needs to vanish
as much as possible.

Computing needs to become pro-active

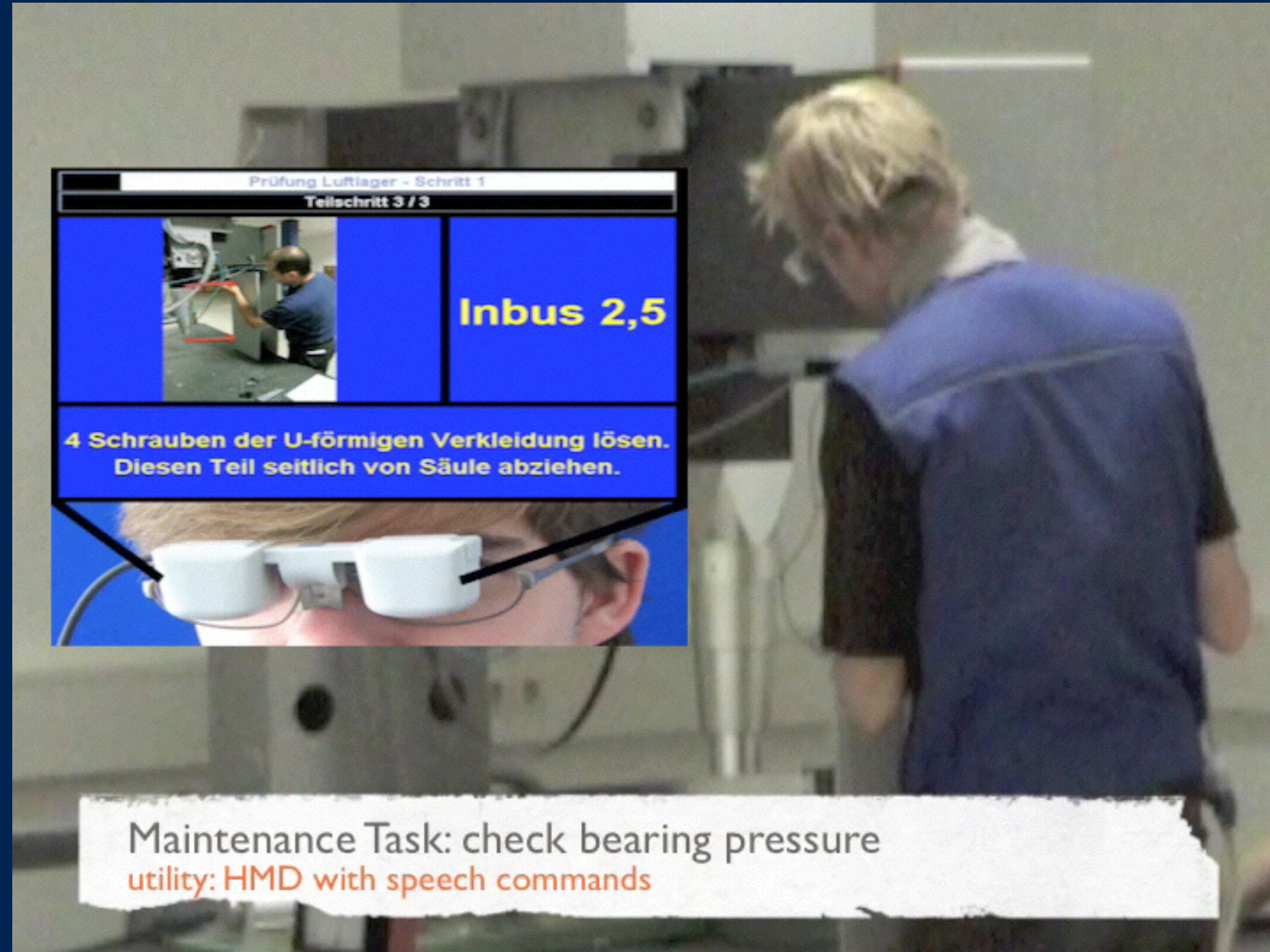
Activity Recognition → Context-Aware Systems



Applications -Maintenance Scenario-



Applications -Maintenance Scenario-



Applications -Maintenance Scenario-



Kai Kunze, Florian Wagner, Ersun Kartal, Ernesto Morales Kluge, Paul Lukowicz: Does Context Matter? - A Quantitative Evaluation in a Real World Maintenance Scenario. Pervasive 2009, Nara, Japan.

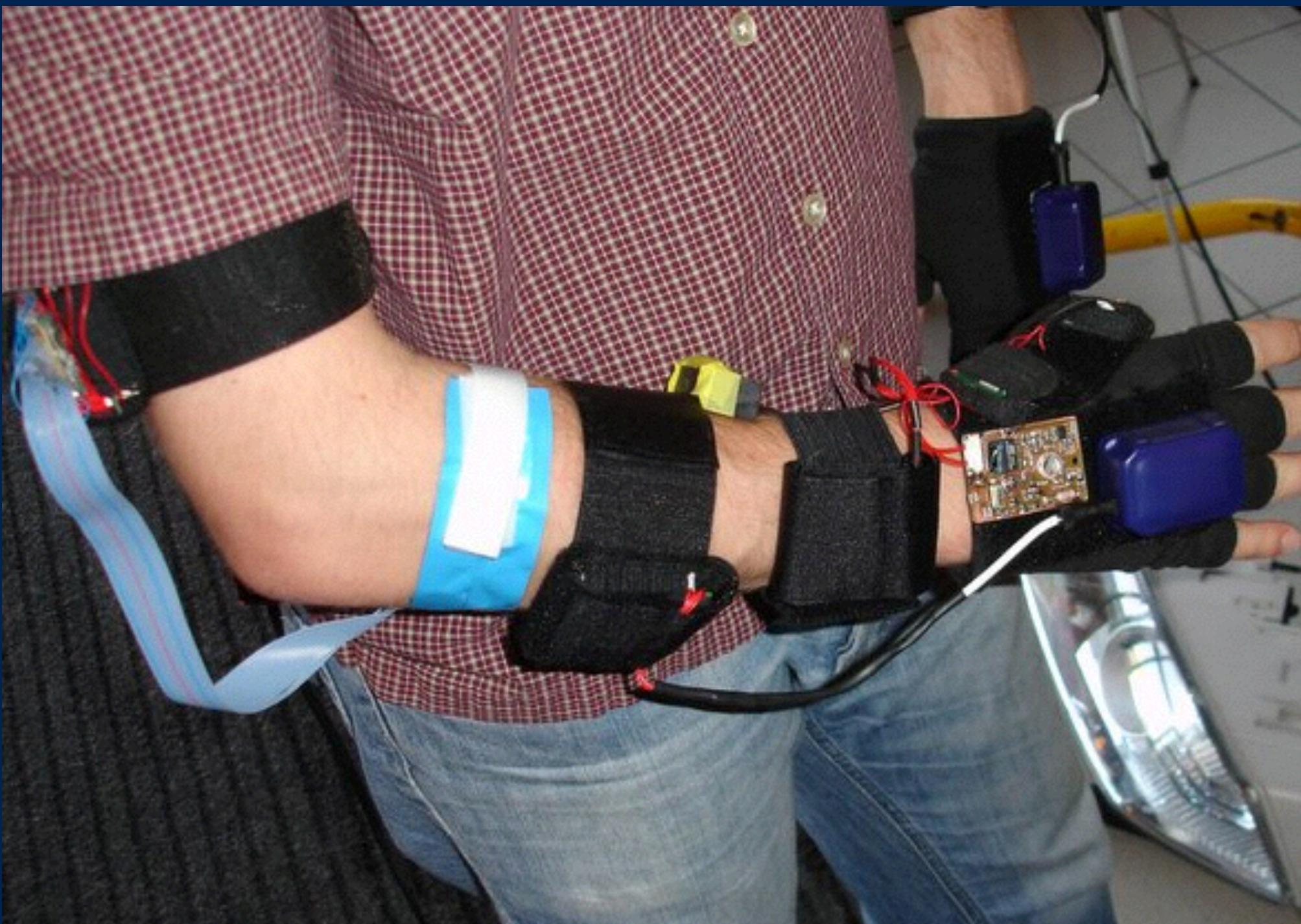
25c3 Talk: About Cyborgs and Gargoyles
<http://www.youtube.com/watch?v=Jex8z57-tQU>

ZEISS

Physical Activity Recognition



However, can you imagine your grandmother wearing sensors?



However, can you imagine your grandmother wearing sensors?

Maybe*



*if you're a PhD. student
working on Wearable Computing

Kunze Kai. Compensating for On-Body
Placement Effects in Activity
Recognition, 2011.

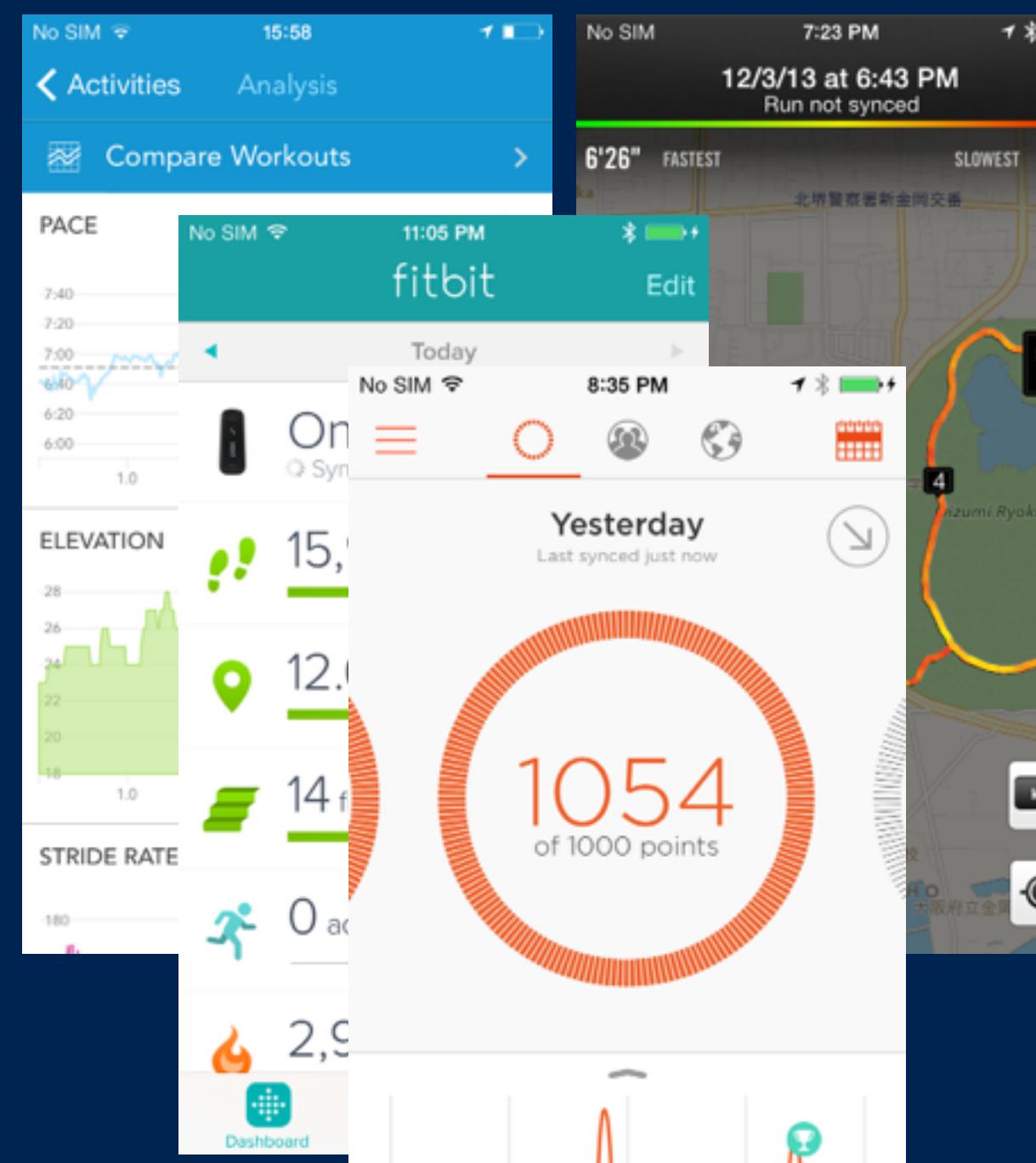
Physical Activity Recognition is becoming Mainstream

Sensors in everyday objects, clothes, accessories ...

We see the first commodity devices tracking physical activity

-> towards physiological sensing

May soon extend to cognitive tasks



NeuroOn

Cognitive Task Recognition

obvious approach: track brain activity directly

drawback: often obtrusive, expensive hardware,

most interesting (wearable etc.):

Electroencephalography (EEG) and Functional Near-Infrared Spectroscopy (fNIRS)

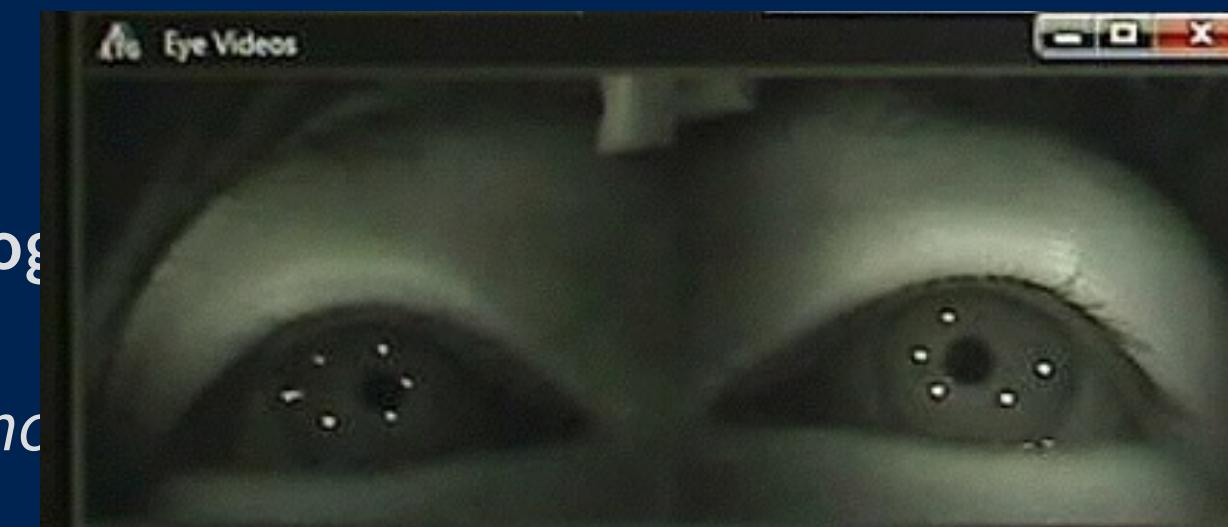
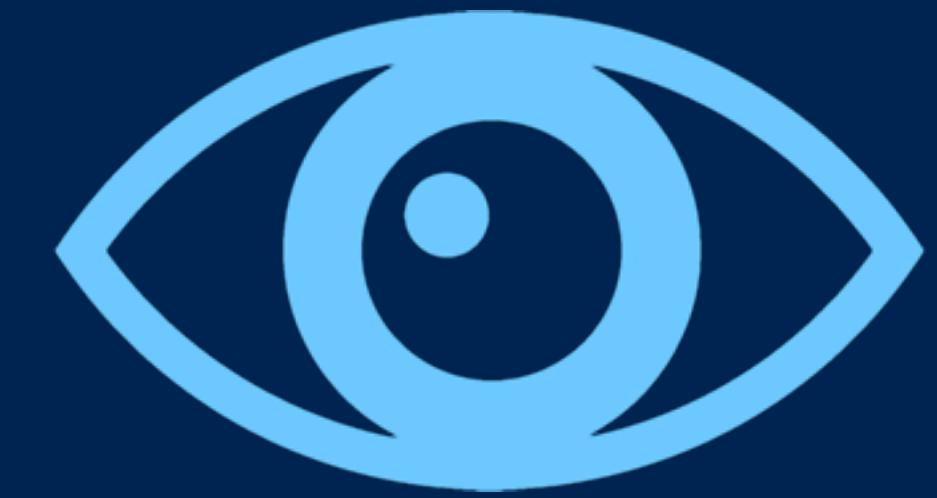
or using secondary sensing:

especially eye gaze

two prominent ways to do eye tracking:

Electrooculography (EOG)*

optical, usually using infrared light/cameras



*Eye Movement Analysis for Activity Recognition Using Electrooculography
Andreas Bulling, Jamie A. Ward, Hans Gellersen and Gerhard Tröster
(2011), in: *IEEE Transactions on Pattern Analysis and Machine Intelligence*

Tracking Reading Habits

Quantified approach to reading (knowledge acquisition)

People who read more

higher vocabulary skill

higher general knowledge [1]

If you give quantified feedback people can improve their habits

similar to apps/devices that track fitness and health

“Can I copy the habits of my thesis advisor to become a better researcher?”

they have been shown to improve physical fitness

very Few In-Situ Studies related to reading[2]



[1] A. Cunningham and K. Stanovich. What reading does for the mind. *Journal of Direct Instruction*, 1(2):137–149, 2001.

[2] A. Bulling, J. A. Ward, and H. Gellersen. Multimodal Recognition of Reading Activity in Transit Using Body-Worn Sensors. *ACM Trans. on Applied Perception*

Reading Life Log - Document Image Retrieval and Eye Gaze



Image from Eyetracker

The eyeBook

Using Eye Tracking to Enhance the Reading Experience

Ralf Biedert · Georg Buscher · Andreas Dengel

Introduction

The development of eye tracking technology has been observed in recent years. Today's eye trackers can determine the current focus point of the eye precisely while being relatively unobtrusive in their application.

Also, a variety of research and commercial groups have been working on this technology, and there is a growing interest for such devices on the market. Eye tracking has great potential and it can be assumed that it will advance further and might become a widespread technology used at a large number of personal or office computer workplaces. Approaches using simple webcams for eye tracking already exist, for example webcams integrated into laptop computers by default. Thus, they allow for new kinds of applications using eye gaze data.

However, not only eye tracking technology is advancing rapidly to an easily usable state. Additionally, during the past two years researchers gathered a considerable amount of knowledge on eye movements, why and how they occur, and what they might mean.

So, today we have the technology and knowledge for tracking and analysing eye movements, making an excellent starting point for sophisticated interactive gaze-based applications.

Some approaches where gaze data is directly employed for interacting with the system, e.g., pressing buttons on the screen with the "click of an eye" generally have serious problems, because the eyes are regarded for perceiving the world and not for interacting with it.

Retrieved page

HAUPTBEITRAG / THE EYEBOOK

The eyeBook

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However, a slightly promising approach is just to observe eye movements of the user during his or her daily work in front of the computer, to infer user intentions based on eye movement behavior, and to provide assistance when helpful. Gaze can be seen as a proxy for the user's attention, and eye movements are known to be usually tightly coupled with cognitive processes in the brain, so that a great deal about those processes can be observed by eye tracking. For example, by interpreting eye movements, reading behavior of the user can be detected, which most likely entails cognitive processes of understanding with regard to the currently read text.

In this paper we are focusing particularly on reading behavior since reading is probably the most common activity of knowledge workers sitting in front of a computer screen. We present an approach for online reading detection based on eye tracking data and introduce an application for assisted and augmented reading called the eyeBook.

The idea behind the eyeBook is to create an interactive and enriching reading experience. The system observes, which fixations are currently being made by the user on the screen and generates appropriate effects such as playing sounds, presenting graphics etc.

Doc ID

Document Name

itrack35_000

FPS

16.67

Gauss Mask Size

read word

Word

rapid

Event

Fixation

Recognized event



How much are you reading?

What are you reading?

How much do you understand?

How much are you reading?

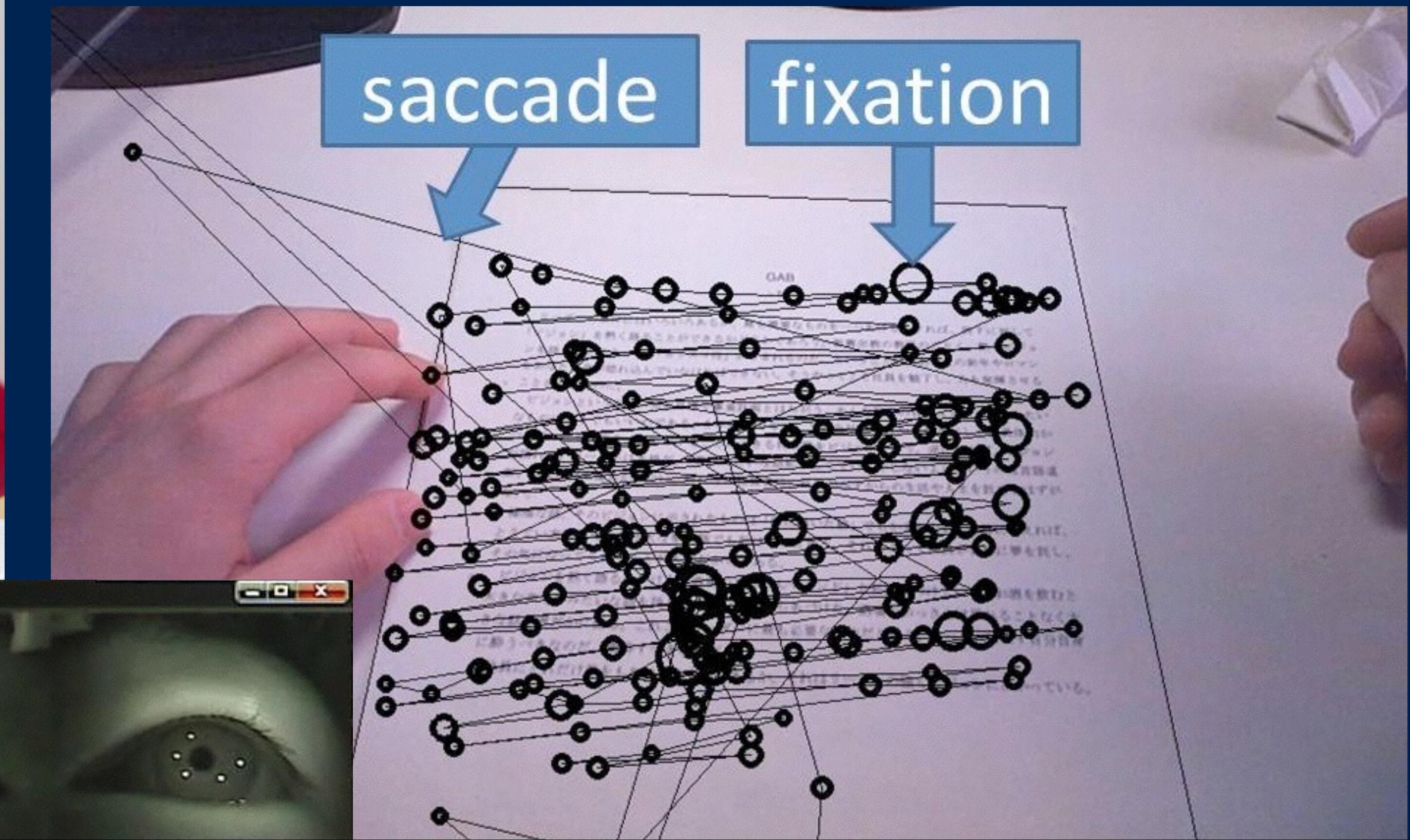
What are you reading?

How much do you understand?



Wordometer

using eye tracker to count
number of lines read
-> estimate words read.



Wordometer

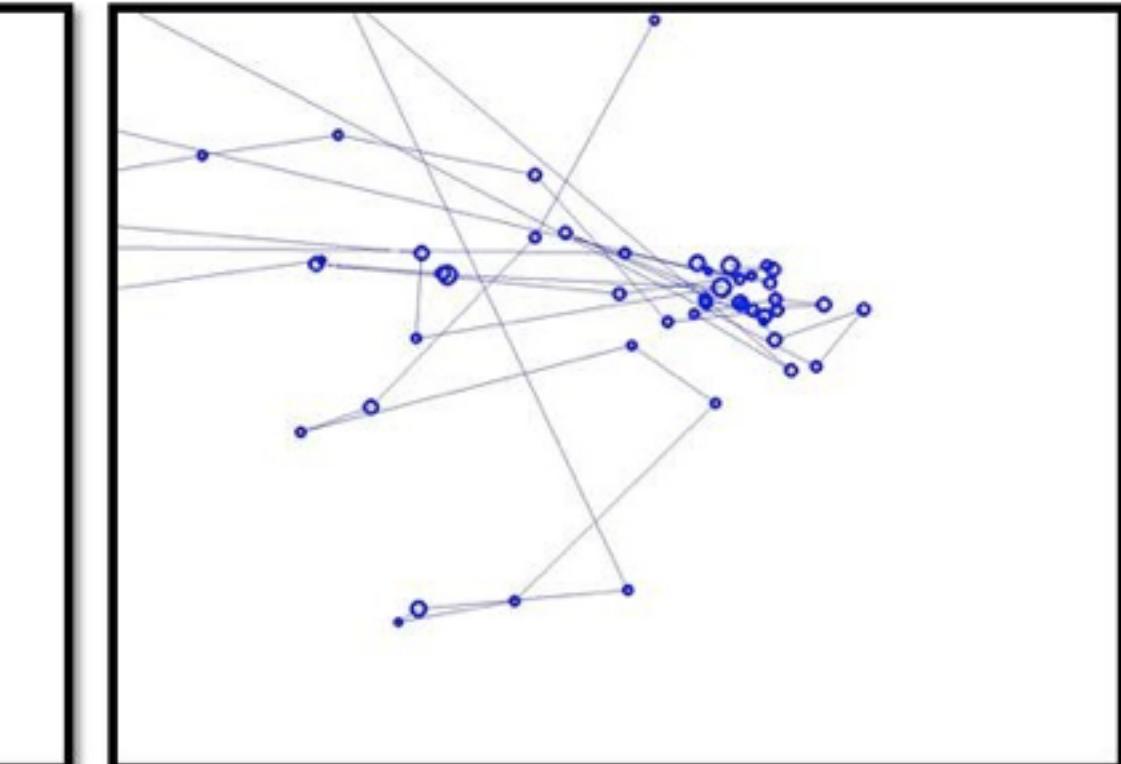
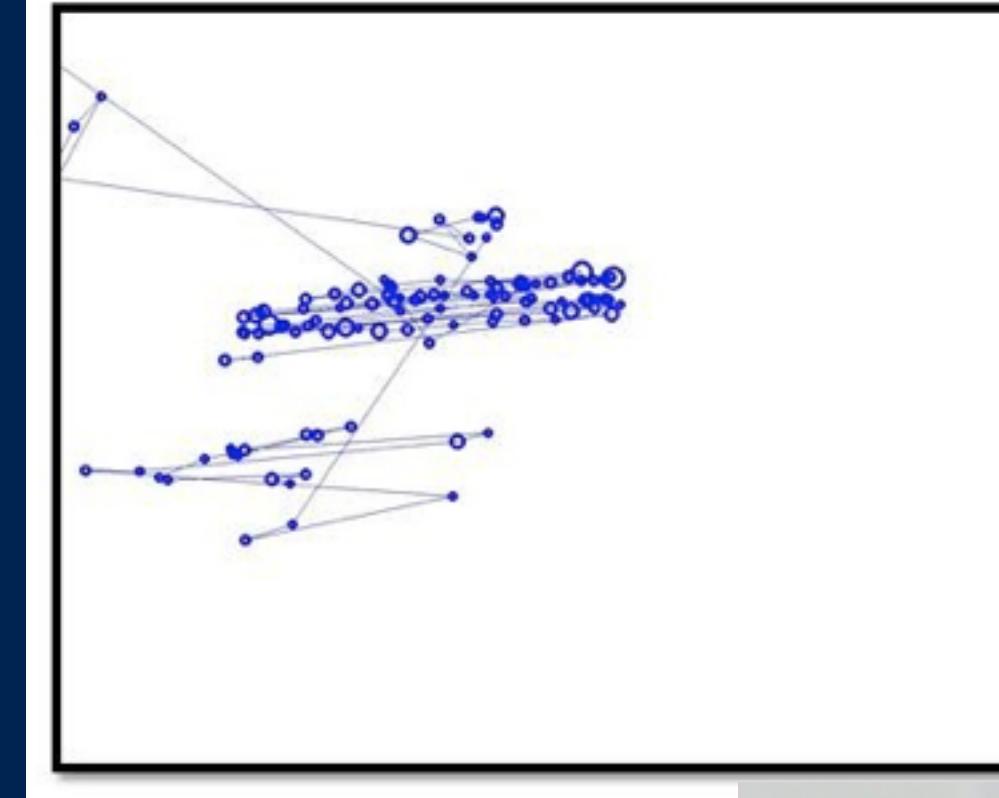
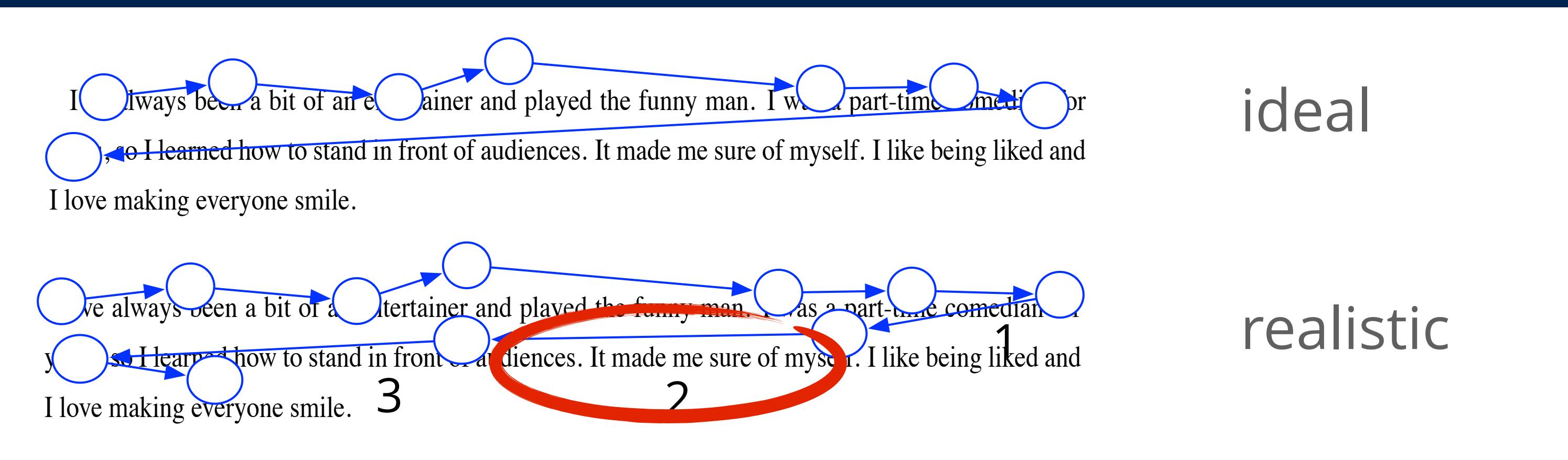
Reading/Not Reading Detection

Estimation of Lines Read

Approximate Word Count (10 users, 14 documents)

with Document Image Retrieval Error: ~8 %

without Document Image Retrieval (only eye gaze) ~ 13 %





How much are you reading?

What are you reading?

How much do you understand?

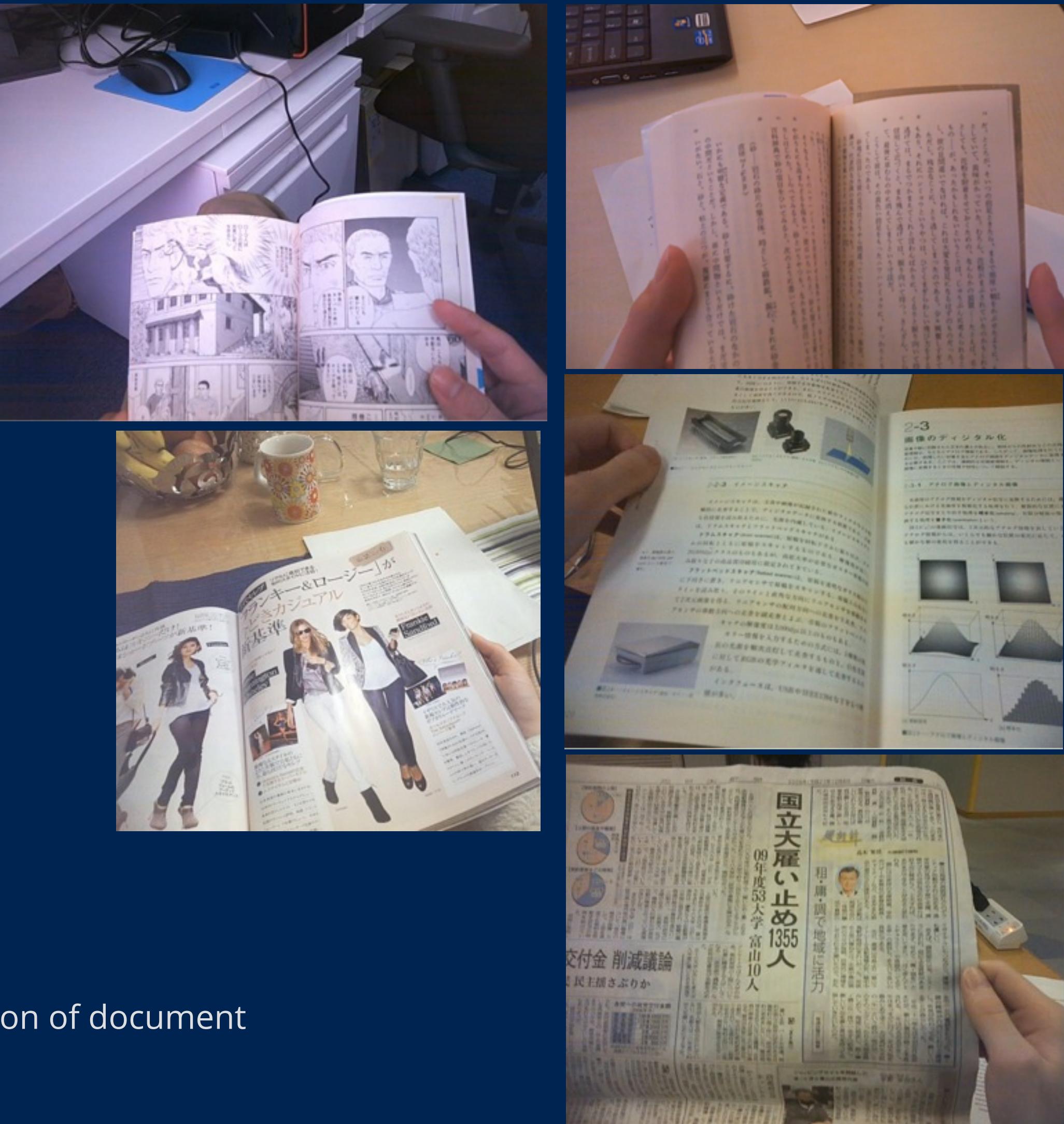
Distinguishing Document Types using Eye Gaze

Recording eye gaze using the SMI mobile eye-tracker of
10 users,
5 document types,
5 environments

Documents differ in text-layout (Yokogaki/Tategaki),
number of images, etc.

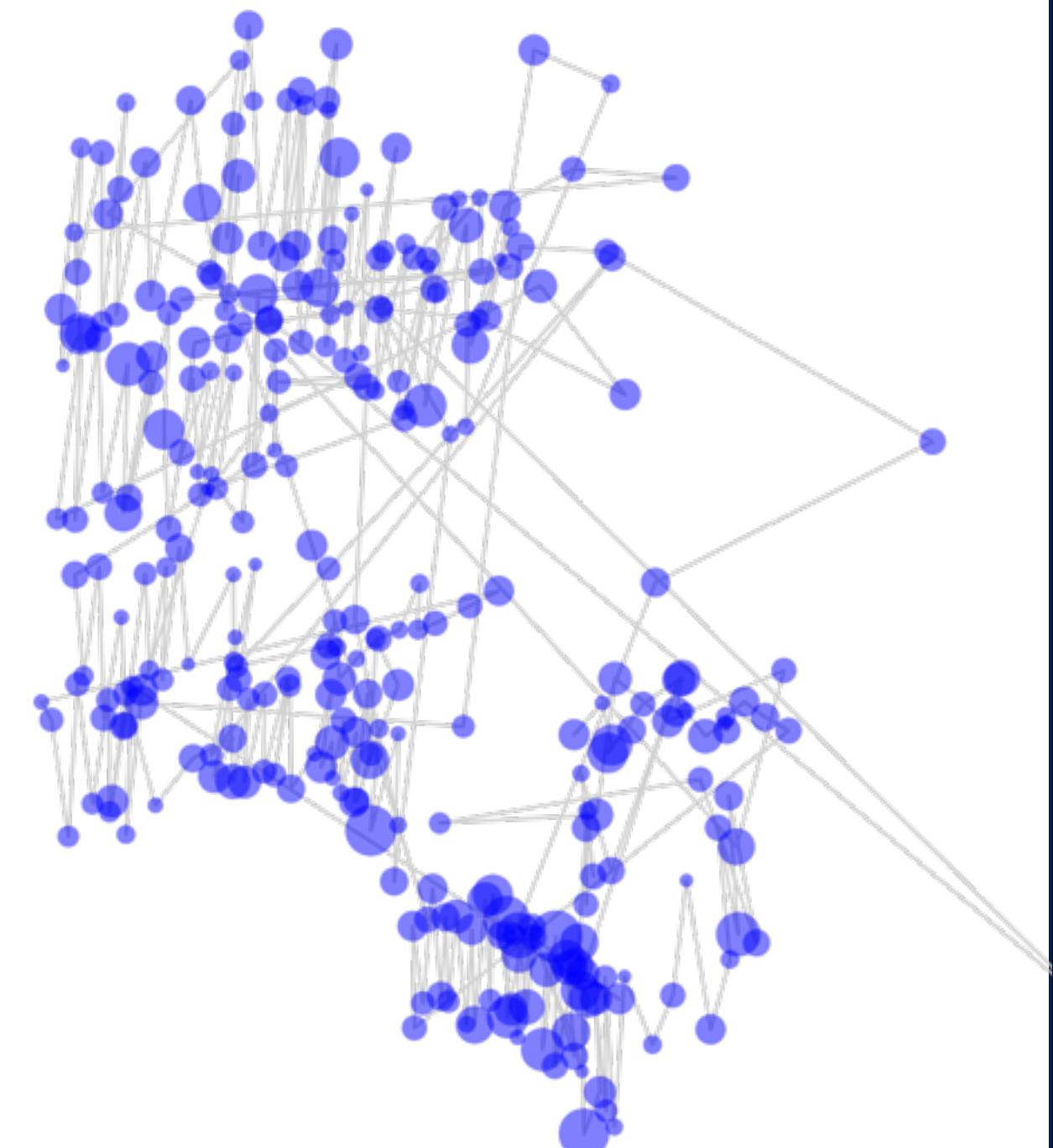
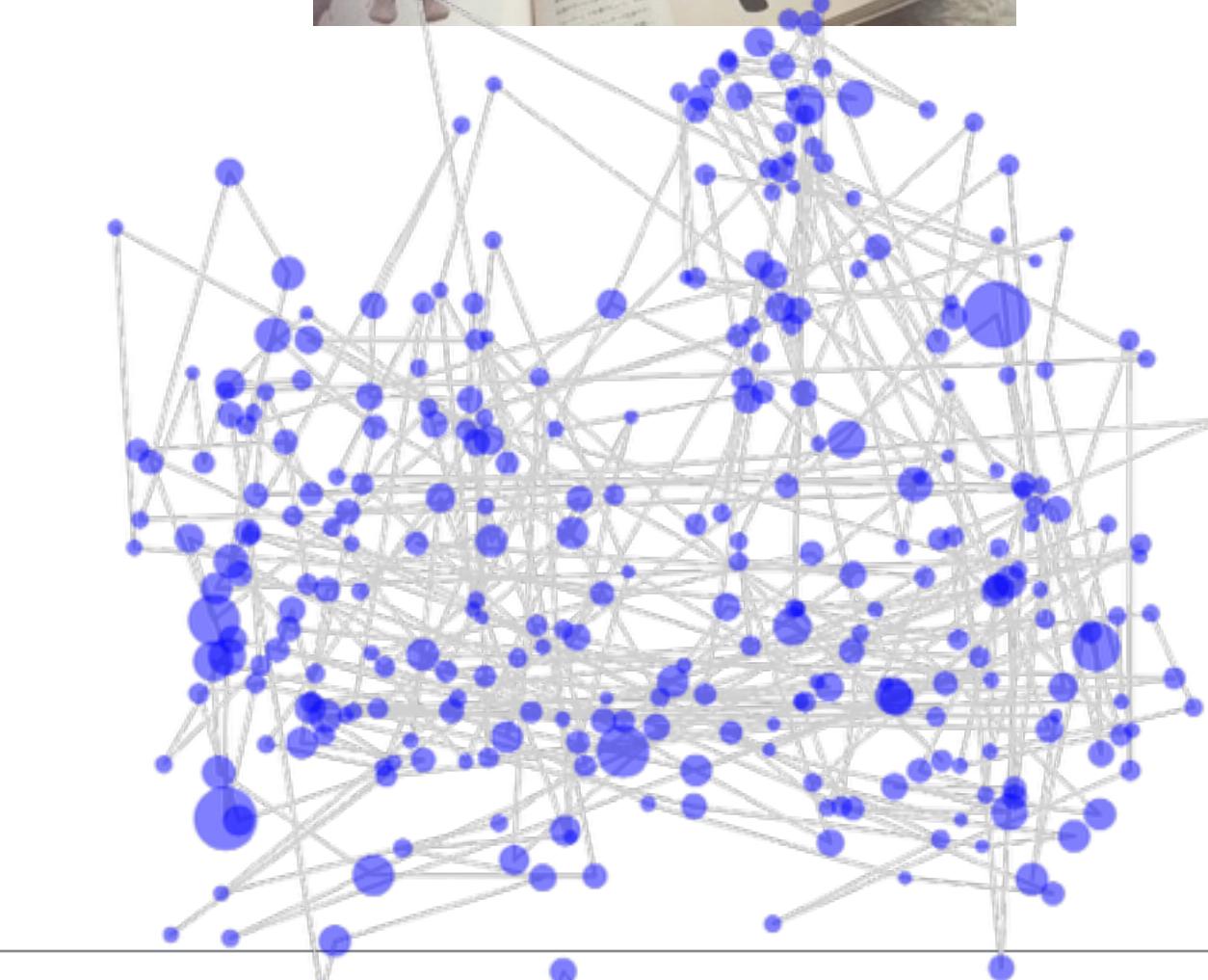
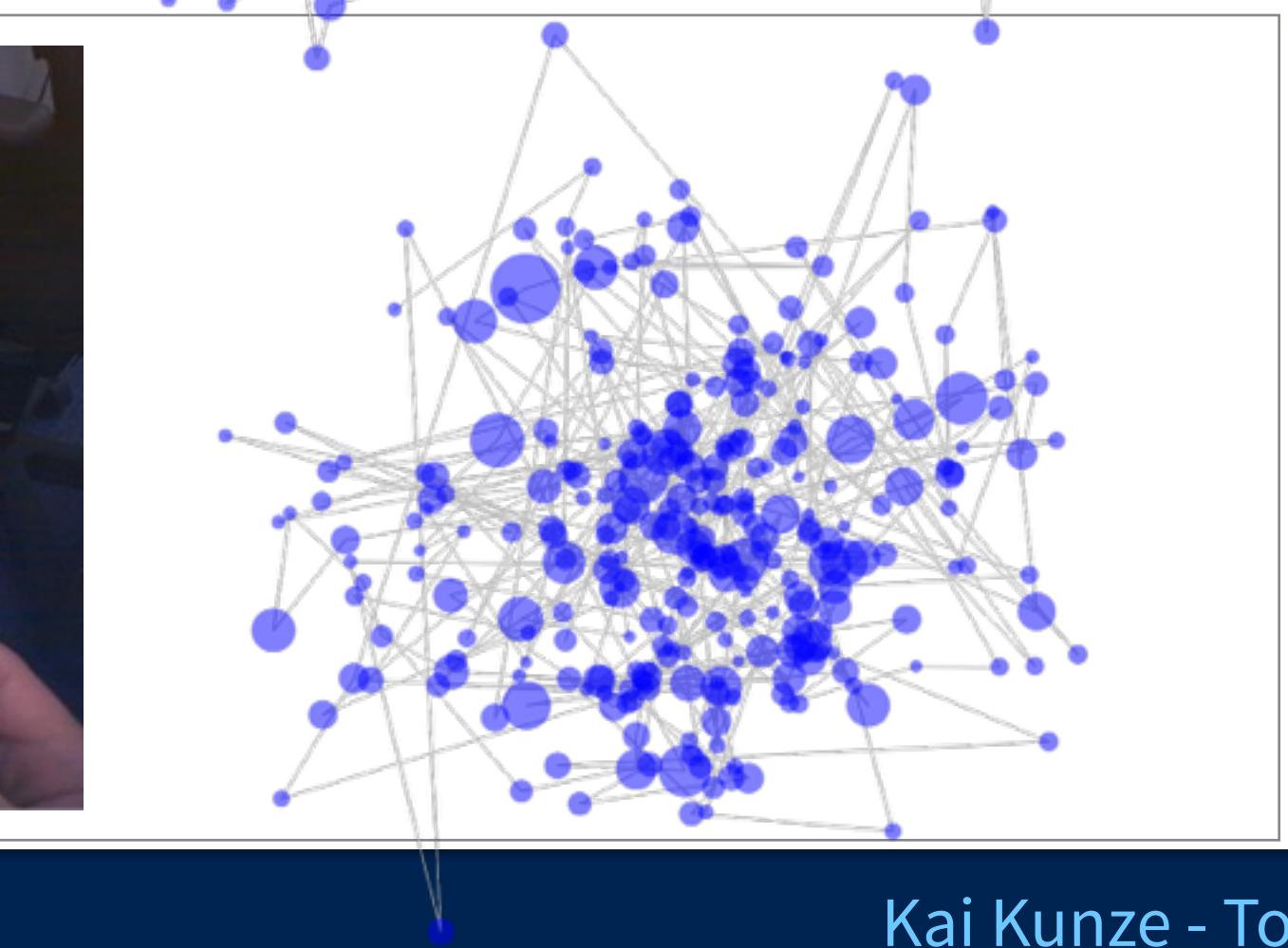
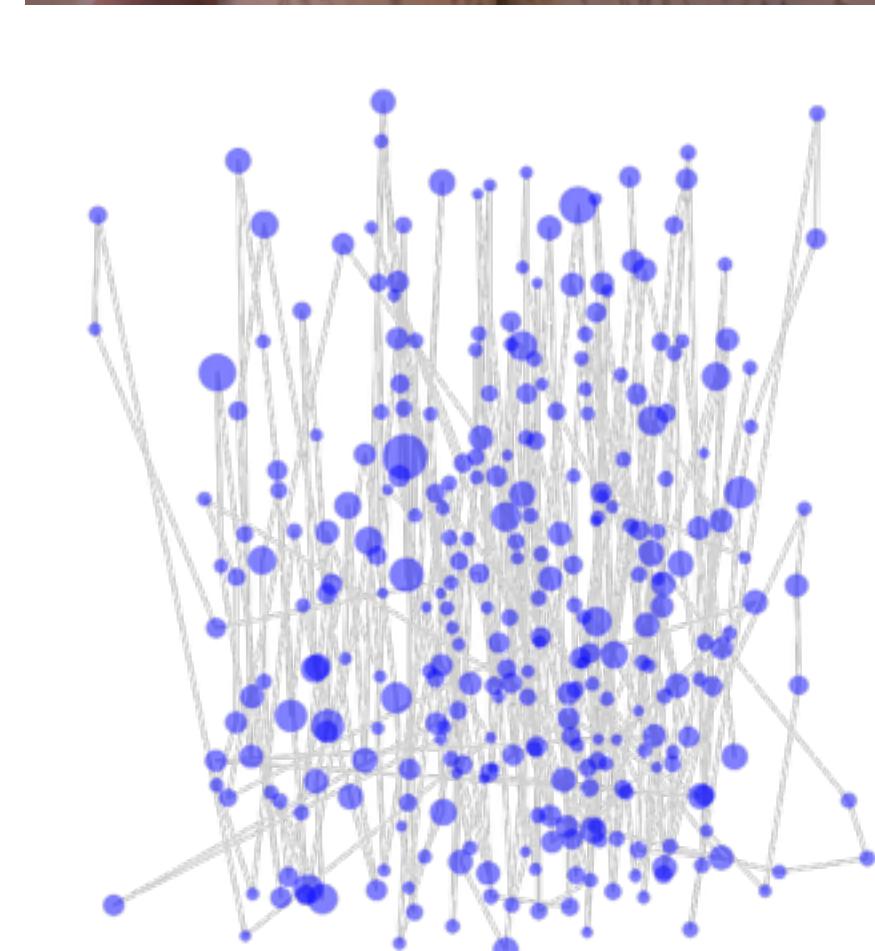
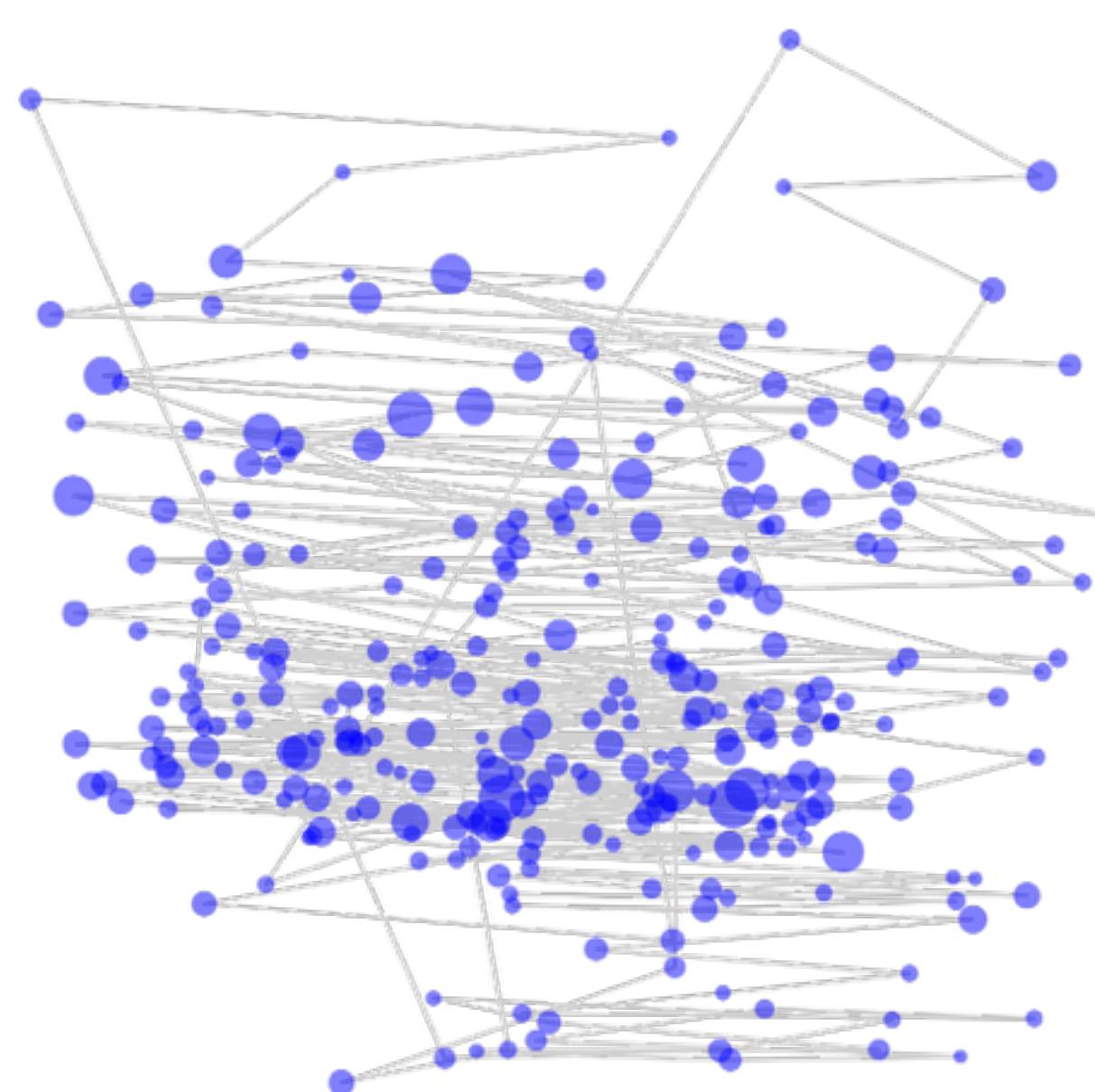
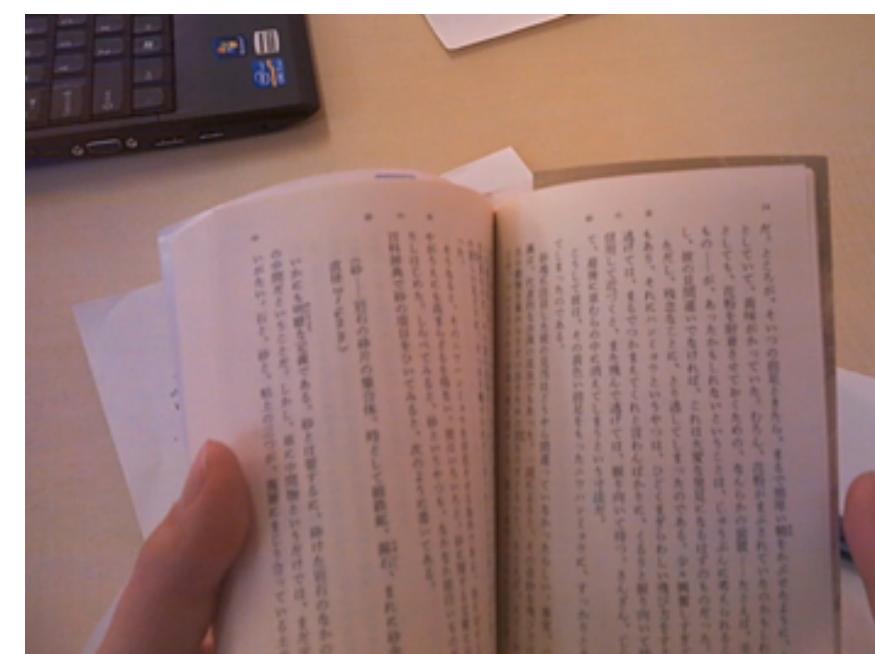
User independent: 74 % (frame -by-frame)

User dependent: 98 %



Kai Kunze, Andreas Bulling, Yuzuko Utsumi, Koichi Kise. I know what you are reading – Recognition of document types using mobile eye tracking, ISWC 2013, Zurich.

K. Kunze, Y. Shiga, S. Ishimaru, Y. Utsumi, K. Kise. Reading activity recognition using an off-the-shelf EEG – detecting reading activities and distinguishing genres of documents, ICDAR, Washington D.C., 2013.

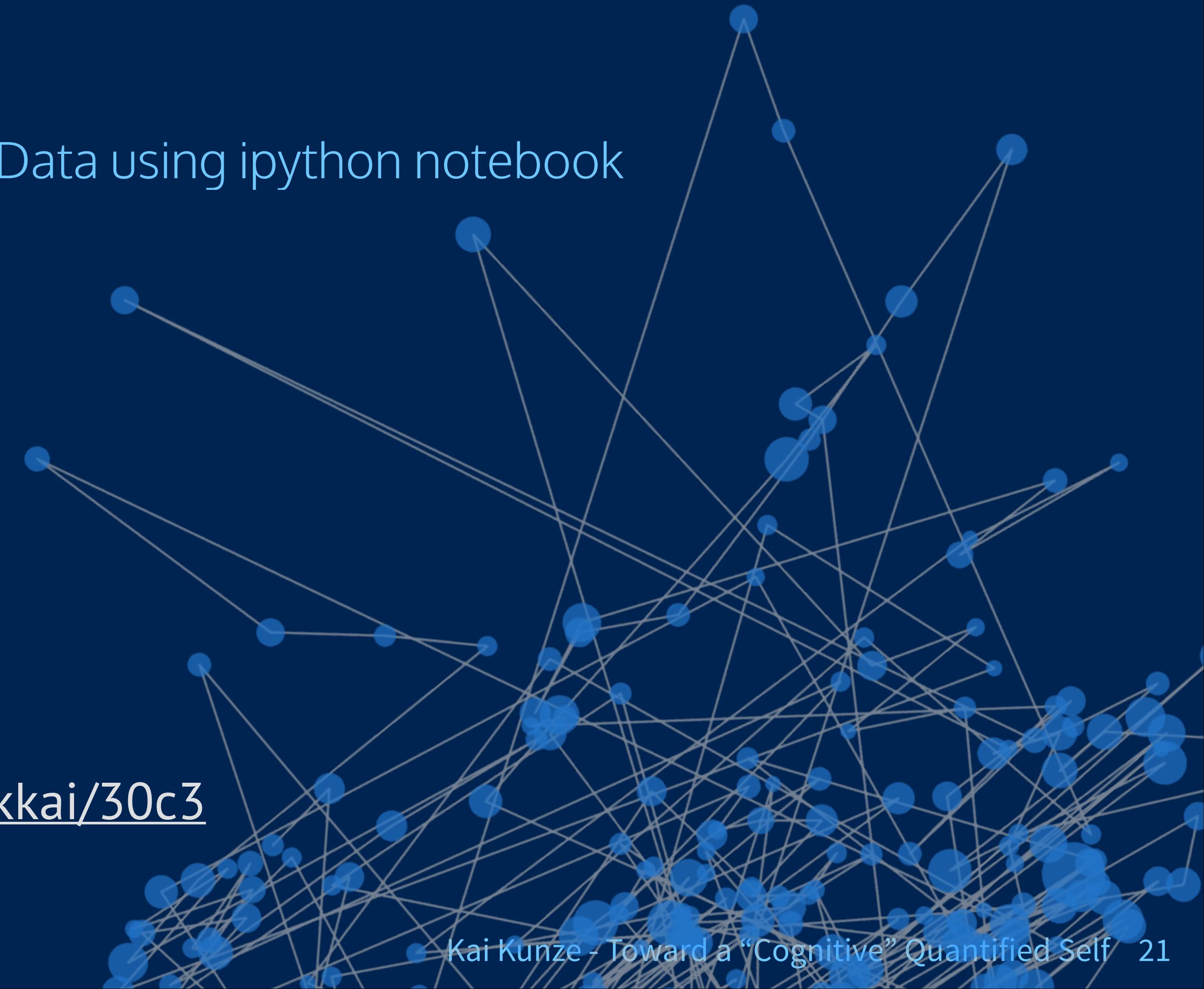


Demonstration

Exploring Eye Gaze Data using ipython notebook



<https://github.com/kkai/30c3>



Additional Info

<http://ipython.org/>

interesting packages: scikit learn, matplotlib, pandas

easy to install: Scipy Superpack (Mac) <http://fonnesbeck.github.io/ScipySuperpack/>

<https://github.com/ipython/ipython/wiki/A-gallery-of-interesting-IPython-Notebooks>

<https://github.com/CamDavidsonPilon/Probabilistic-Programming-and-Bayesian-Methods-for-Hackers>

advice about programming in machine learning/ activity recognition research:

<http://arkitus.com/PRML/>

<http://www.theexclusive.org/2012/08/principles-of-research-code.html>

https://github.com/kkai/data_intro (with an classification example for motion data)

general paper writing advice:

<http://research.microsoft.com/en-us/um/people/simonpj/papers/giving-a-talk/writing-a-paper-slides.pdf>

How much are you reading?

What are you reading?

How much do you understand?



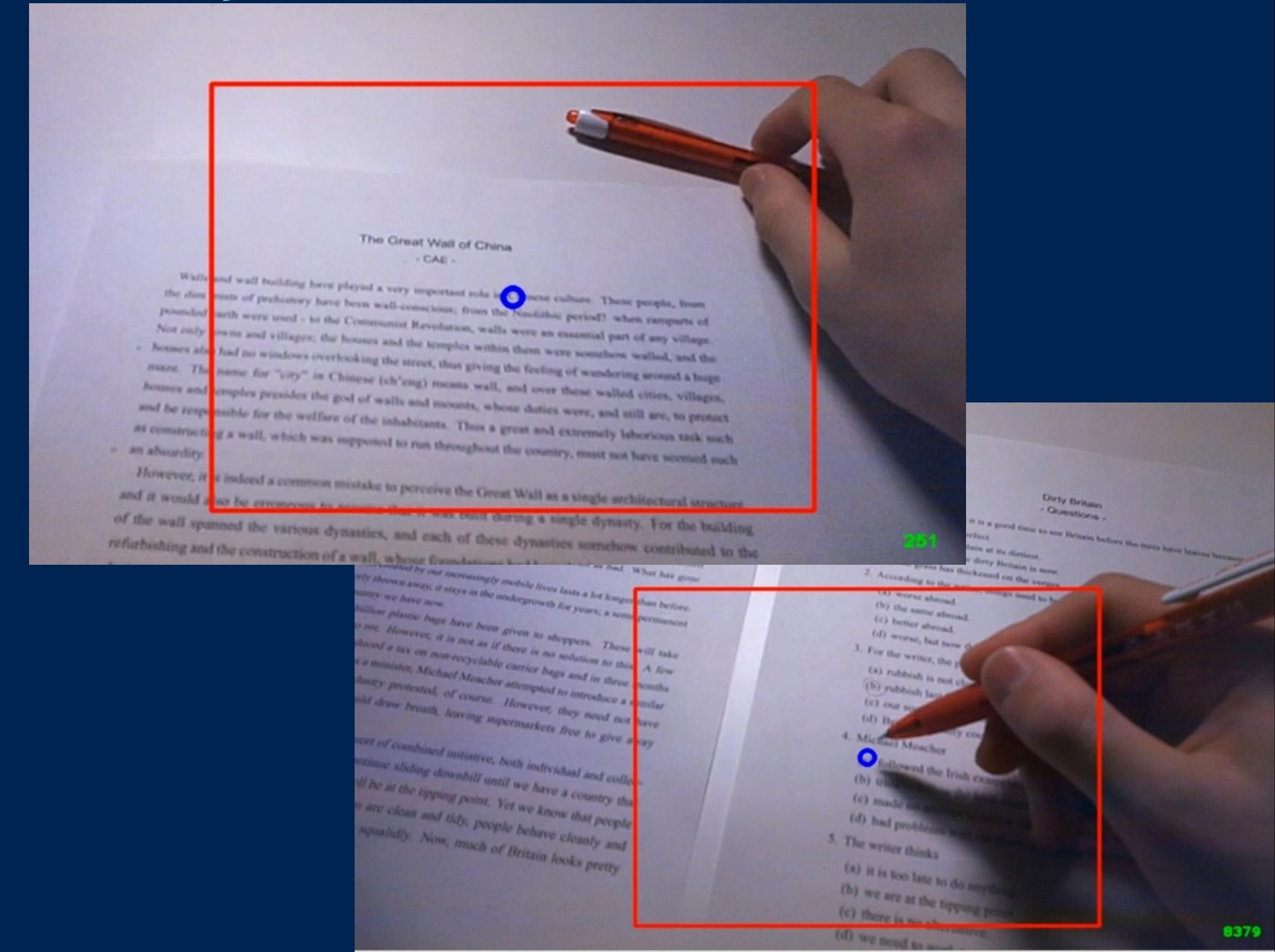
Estimating Reading Comprehension

Participants read
a Text Comprehension Section
standardized test (TOIEC)
with mobile eye tracker
Answer questions afterwards

Mark difficult words

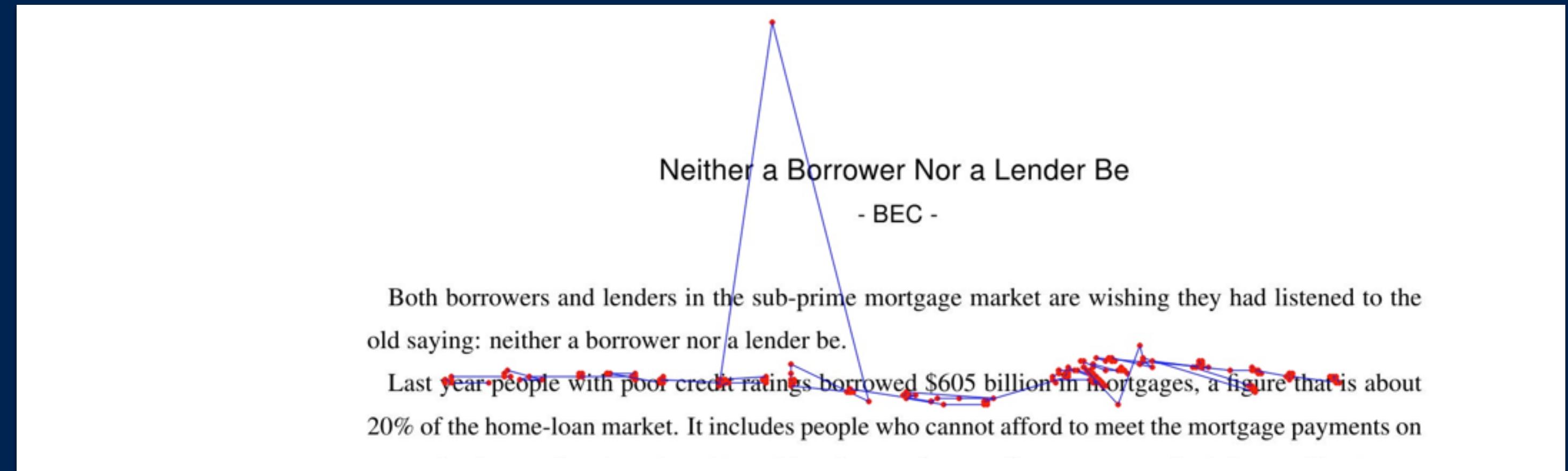
10 participants

10 text comprehens

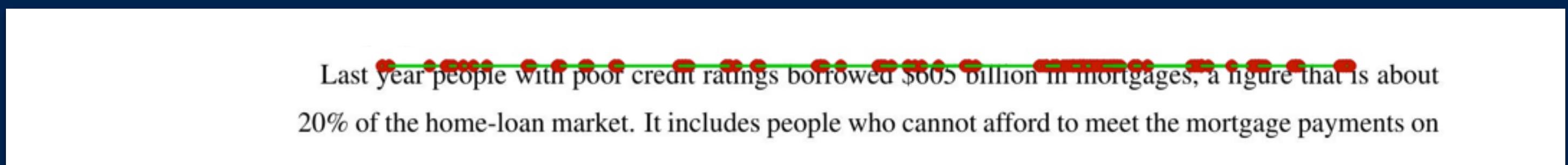


K. Kunze, H. Kawaichi, K. Yoshimura, K. Kise. Towards inferring language expertise using eye tracking.
accepted as Work in Progress at ACM SIGCHI Conference on Human Factors in Computing Systems,
Paris, France 2013.

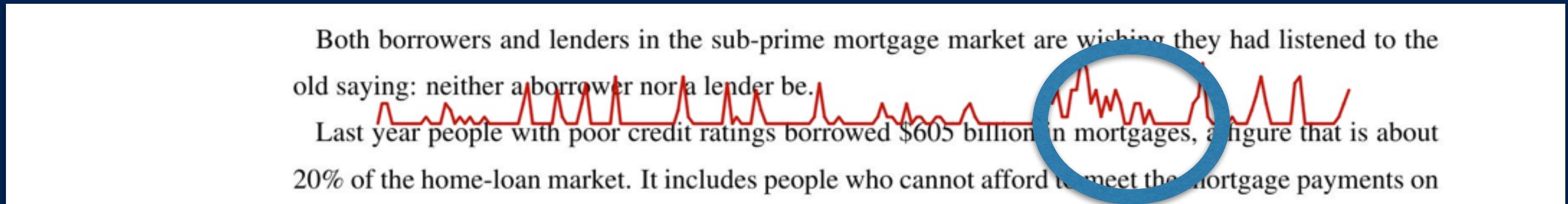
Detecting difficult words



Eye-gaze translated to document coordinate system using LLAH

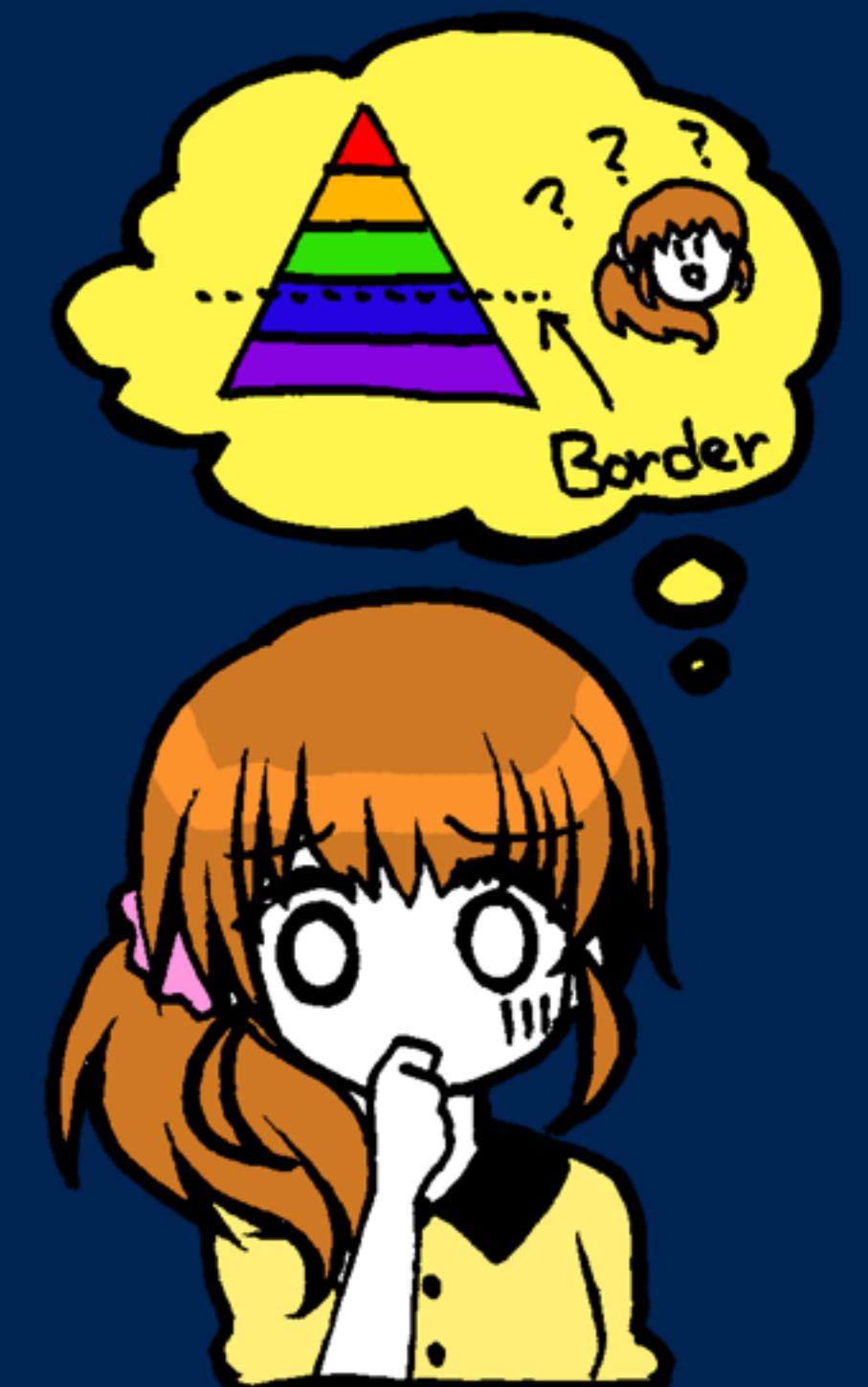
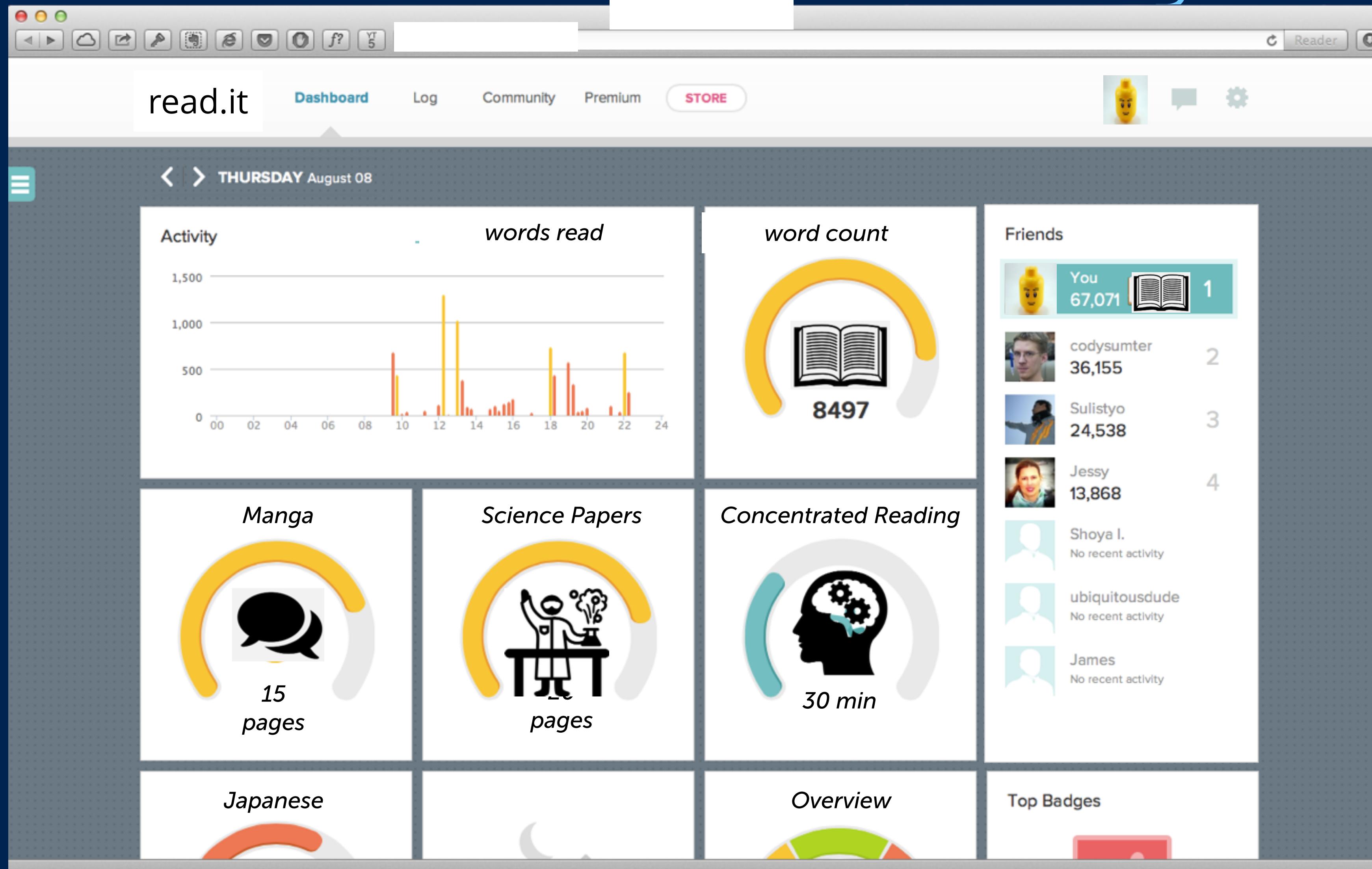


Horizontal projection to a line



fixation histogram

Future Work - Fibit for Reading?



however, eye tracking hardware is expensive ...

Ok, there are some concerns if people want to wear it ...



True, yet might change with the next version of glass ...



Google Glass - Very Hackable Hardware

Warning: you void your warranty and might leave the device in an unrecoverable state!

you can easily get root

installing stock Android/ Ubuntu/ Debian is straight forward

Google provides you with the factory firmware

<https://developers.google.com/events/io/sessions/332704837>

```
adb devices  
adb reboot-bootloader  
fastboot devices
```

```
fastboot oem unlock
```

```
fastboot flash boot boot.img  
fastboot reboot  
adb root  
adb shell
```

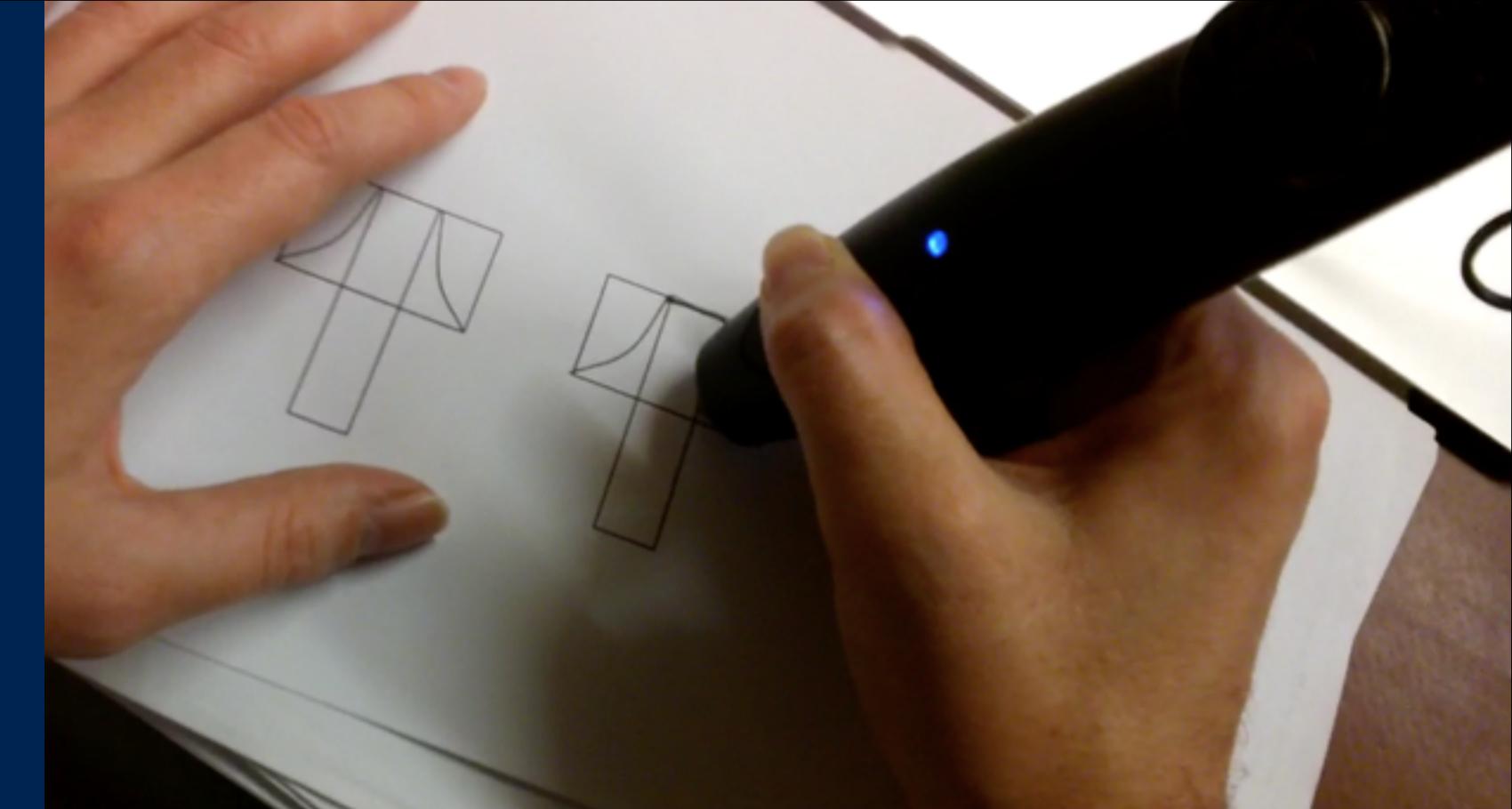
```
fastboot flash boot boot.img  
fastboot flash system system.img  
fastboot flash recovery recovery.img  
fastboot flash userdata userdata.img  
fastboot erase cache
```

“Thanks! You are awesome!”



Privacy Enhancement for Glass

Scene Camera why?



a fleece with duct tape might be better ...

<http://kaikunze.de/posts/hacking-glass/>

Demonstration

Blinking with Google Glass



Open Source Eye Tracking Efforts

<http://www.eyewriter.org>

http://blog.brandynwhite.com/new-glass-input-methods_eye-tracking_touch-sensitive-clothing

<https://code.google.com/p/pupil/>

Lukander, Kristian, et al. "OMG!: A new robust, wearable and affordable open source mobile gaze tracker." Proceedings of the 15th international conference on Human-computer interaction with mobile devices and services. ACM, 2013.

however, eye tracking hardware is expensive ...

Ok, there are some concerns if people want to wear it ...



True, yet might change with the next version of glass ...



Can't we use commodity devices?

Demonstration

Towards Software Only Eye Tracking



Backup video (in case demo fails ...)

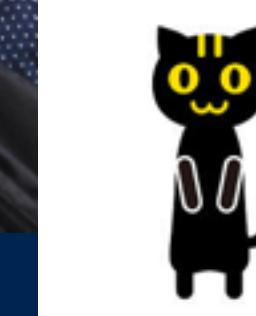


Thanks to

Koichi Kise, Masakazu Iwamura, Motoi Iwata, Yuzuko Utsumi,
Andreas Dengel, Andreas Bulling, David Bannach, Takumi Toyama,
Tsutomu Terada, Seiichi Ushida, Stephan Sigg,
Christoph Schuba, Cody Sumter, Paul Lukowicz, Bernhard Sick,
Jingyuan Cheng, Kamil Kloch, Gerald Pirkl, Albrecht Schmidt,
Niels Henze, Alireza Sahami, Tilman Dingler, Bastian Pfleging,
Dawud Gordon, Till Riedel, Ulf Blanke, Yusuke Sugano,
Hans Gellersen, Christian Weichel, Matthias Schaff, Anton Dollmaier,
Gernot Bahle, Masahiko Inami, Josef Neuburger

Special Thanks to the Students (who actually did the work)

Katsuma Tanaka



Shoya Ishimaru



Wakana Suzuki



Kazuyo Yoshimura



Hitoshi Kawaichi



Yuuki Shiga

Riki Kudo

"Viel Spass am Gerät!"

Ayano Okoso

Hiroki Fujiyoshi

Mizuki Matsubara

Olivier le Bas de Bouclans



Questions, Remarks, Violent Dissent?

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“30c3”, “Speed Reading App” or “Eye Gaze Python” in Subject Line

shameless advertisements:

Augmented Human 2014, Kobe

<http://bit.ly/augmented2014>

Paper Deadline: Jan 11, 2014

Conference: March 7-9, 2014

Gait for iPhone5s

Step Counter for Introverts

<http://kaikunze.de/Gait/>

“Viel Spass am Gerät!”

