

Psychology-Driven Design of Intelligent Interfaces

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BYOYO
01/07/20



Intelligent User Interfaces Group

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MIT (MS '01) MIT (PhD '06)



postdoc



visiting appointments



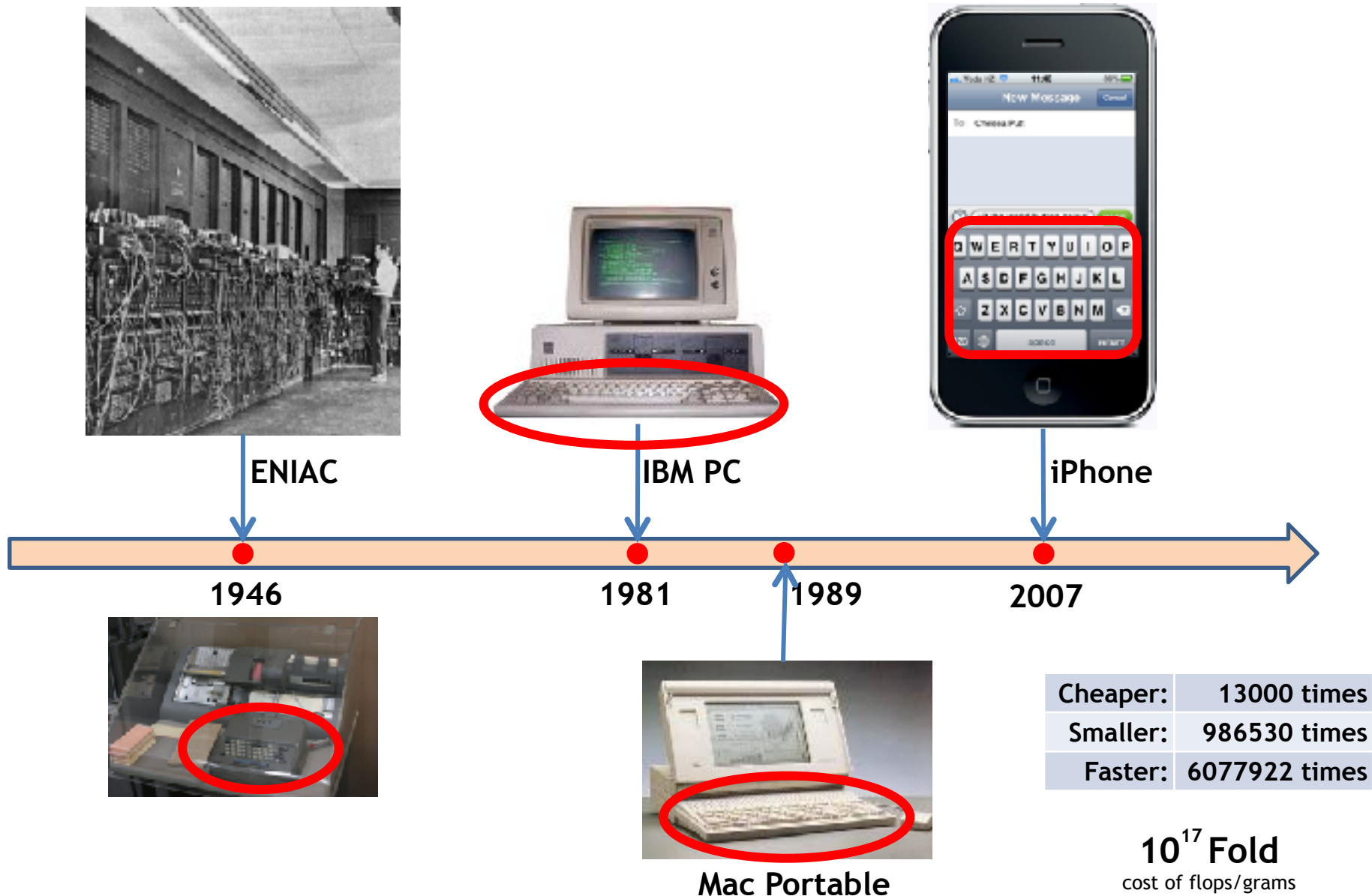
- 20+ graduate students
- ~15 TL million sponsored projects
 - International
 - European Union
 - CHIST-ERA
 - DARPA
 - National
 - Research Council of Turkey
 - Ministry of Science, Industry & Tech.
 - Industrial
 - Türk Telekom
 - Koç Sistem

- Areas of expertise
 - Intelligent User Interfaces
 - Machine learning
 - Multimodal interfaces



KOÇ UNIVERSITY
Intelligent User Interfaces Laboratory

History of Human Computer Interaction

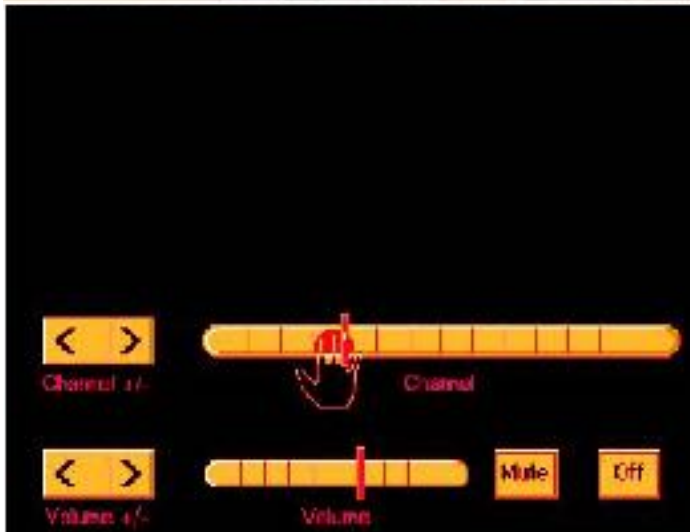


Attempts at intelligent interaction

5 Lessons

Controlling a television set remotely through hand gestures seemed to be exciting for the people who tried the prototype. This may or may not be due to the novelty of such control.

The open hand gesture was found to be somewhat tiring for extended viewing.



Television Control by Hand Gestures
William T. Freeman, Craig D. Weissman
MERL Report: TR94-24

Attempts at intelligent interaction



Freeman '94



Unidentified Samsung User '14

Attempts at intelligent interaction have failed!

Solution: leverage natural human behavior

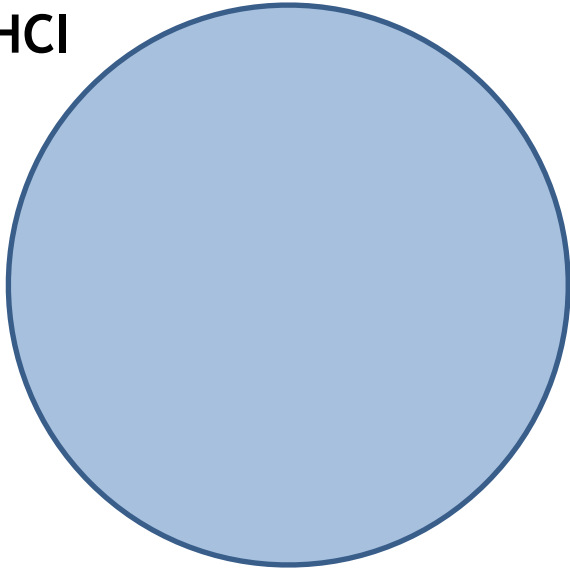
The Problem

Too little effort towards understanding interaction

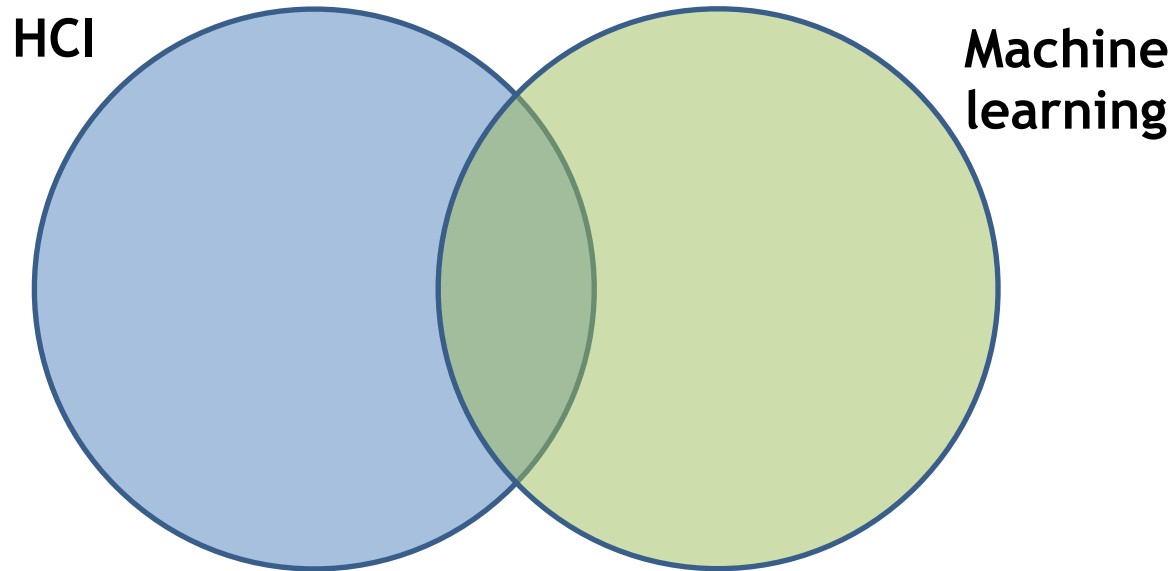
$$\begin{aligned}\sum_{n=0}^{N-1} |y[n]|^2 &= \sum_{k=0}^{N-1} |Y(k)|^2 \\&= \sum_{k=0}^{N-1} \left| \sum_l H(k + lN) \cdot F(k + lN) \right|^2 \\&= \sum_{k=0}^{N-1} \sum_l |H(k + lN) \cdot F(k + lN)|^2 \\&\quad + \sum_{k=0}^{N-1} \sum_{l \neq m} H(k + lN) \cdot F(k + lN) \\&\quad \cdot H^*(k + mN) \cdot F^*(k + mN).\end{aligned}$$

Strategy: Leverage natural human behavior

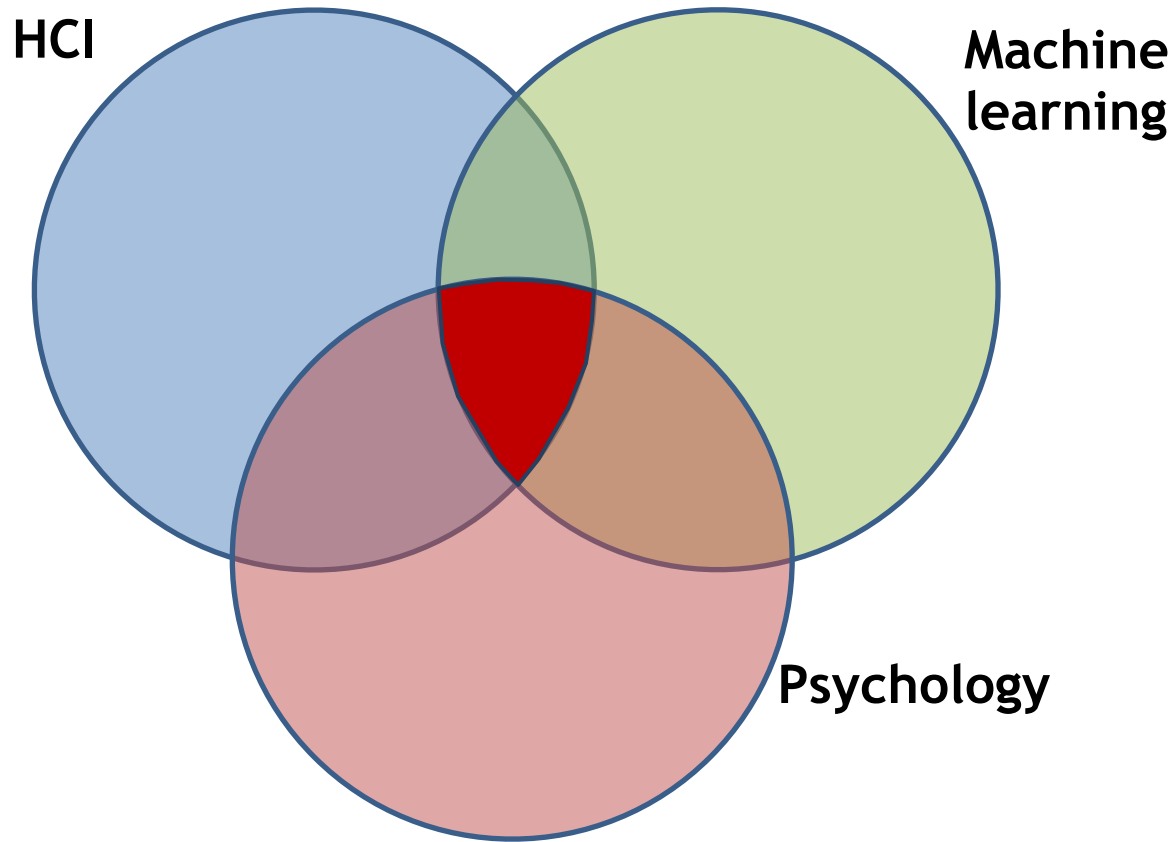
HCI



Strategy: Leverage natural human behavior



Strategy: Leverage natural human behavior



Strategy

- **Understand the human**
 - Perception
 - Behaviour
- **Computational models of**
 - Human perception
 - Human behavior (intent)
- **Build novel interfaces (HW & SW)**
 - Natural
 - Intelligent
 - Multimodal

Case #1

- **Exercise**
 - **Draw objects**
- **Observe human behavior**

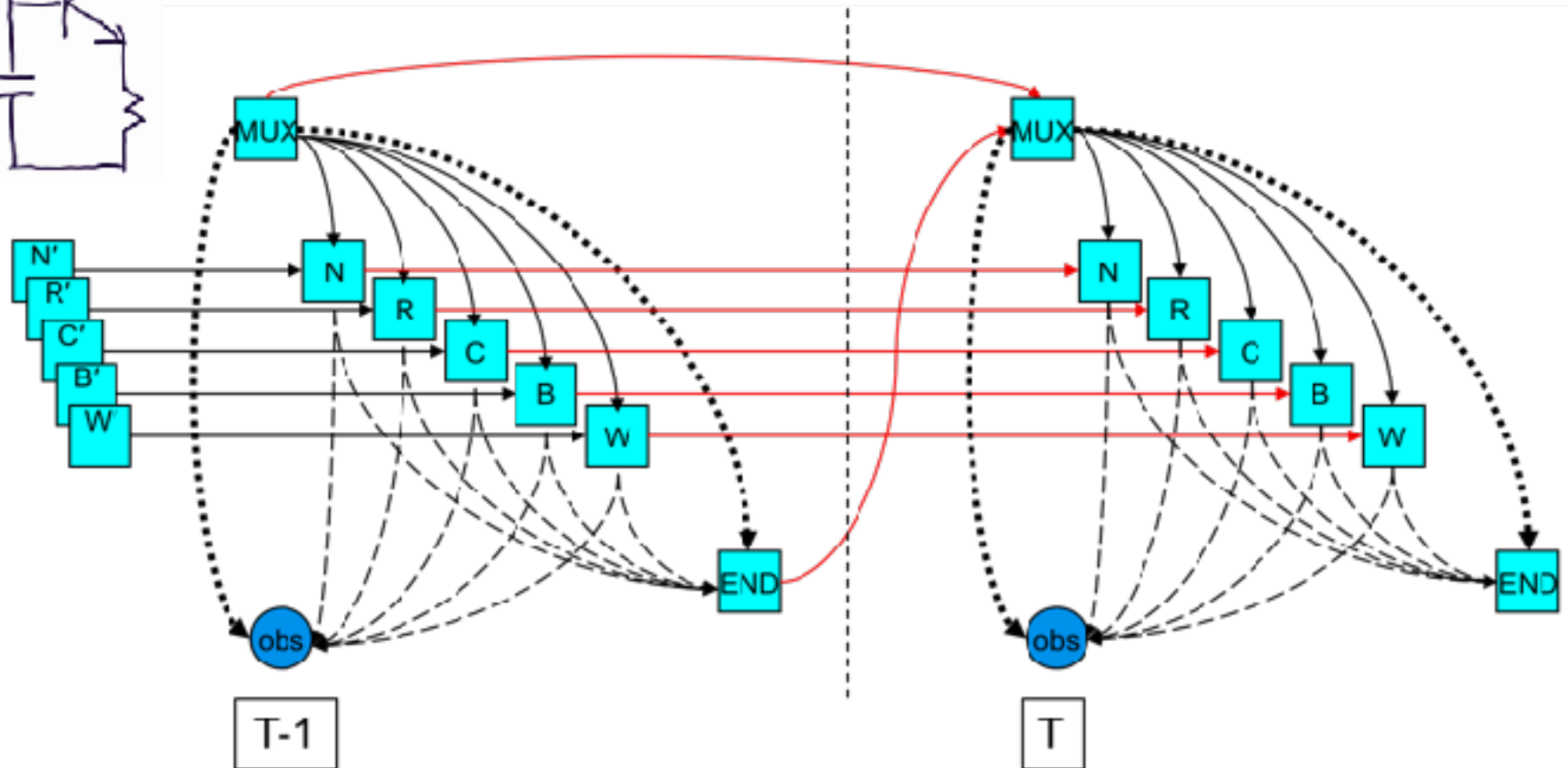
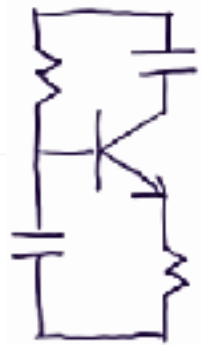
Observe human behavior



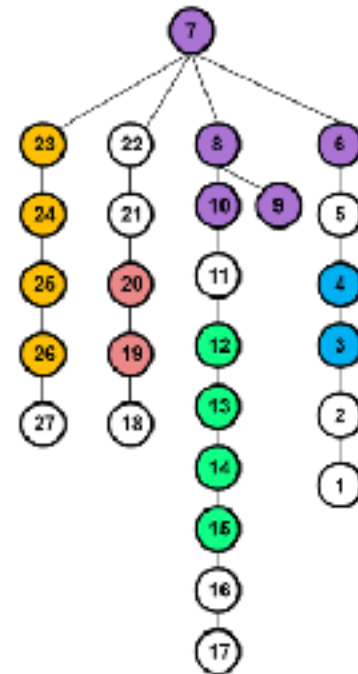
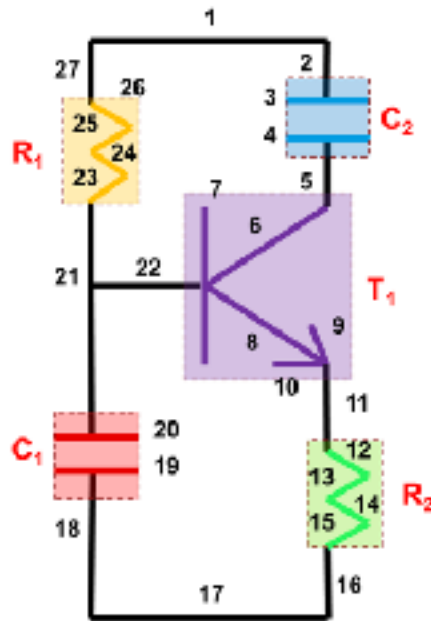
Case #1

- **Exercise**
 - Draw objects
- **Observe human behavior**
- **Practical use**
 - Sketch recognition
 - Auto-completion of drawings

Online Sketch Recognition



Offline Sketch Recognition

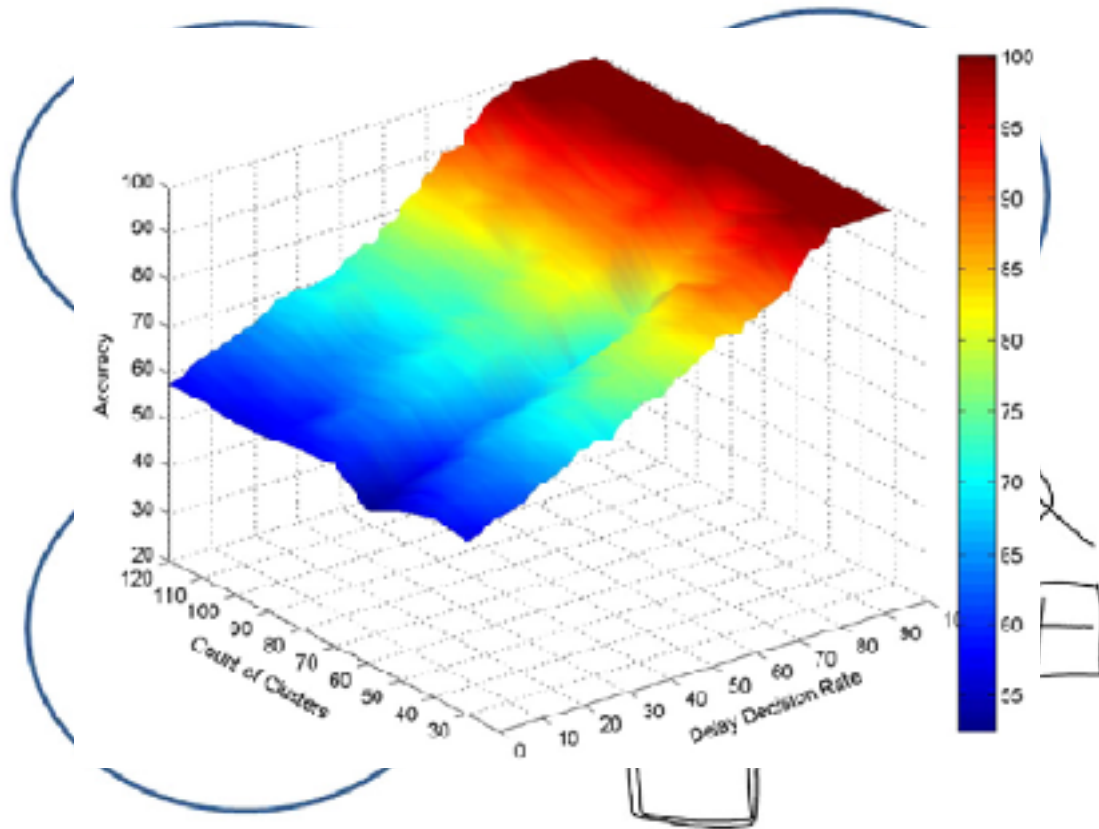


Work Funded under the National Science Foundation Priority Areas Call

Auto-completion



Auto-completion

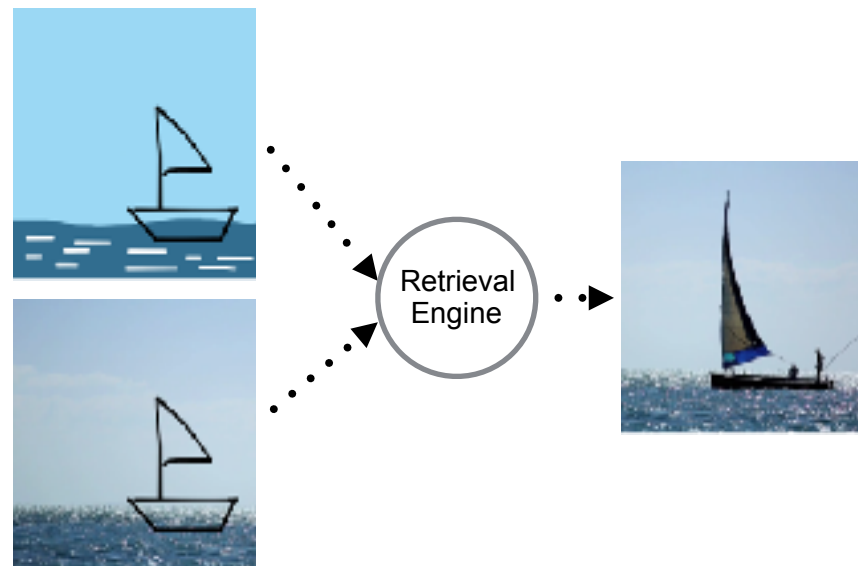


T. M. Sezgin and R. Davis, Sketch Recognition in Interspersed Drawings Using Time-Based Graphical Models. Computers & Graphics Journal, Volume 32 , Issue 5, pp: 500-510 (2008).

Ç. Tırkaz, B. Yanıkoğlu, T. M. Sezgin, Sketched Symbol Recognition with Auto Completion. Pattern Recognition, vol 45, issue 11, pp 3926-3937 (2012).

Auto-completion

- **Drives multimedia retrieval UI**
- **iMotion European Commission ERA-NET Project**
 - U. Basel (Switzerland)
 - U. Mons (Belgium)



Grant:

*European Commission ERA-Net Program, CHIST-ERA Intelligent User Interfaces Call
Intelligent Multimodal Augmented Video Motion Retrieval System*

Strategy: Leverage natural human behavior



UNIVERSITY OF
CAMBRIDGE

Computer Laboratory - Rainbow Group

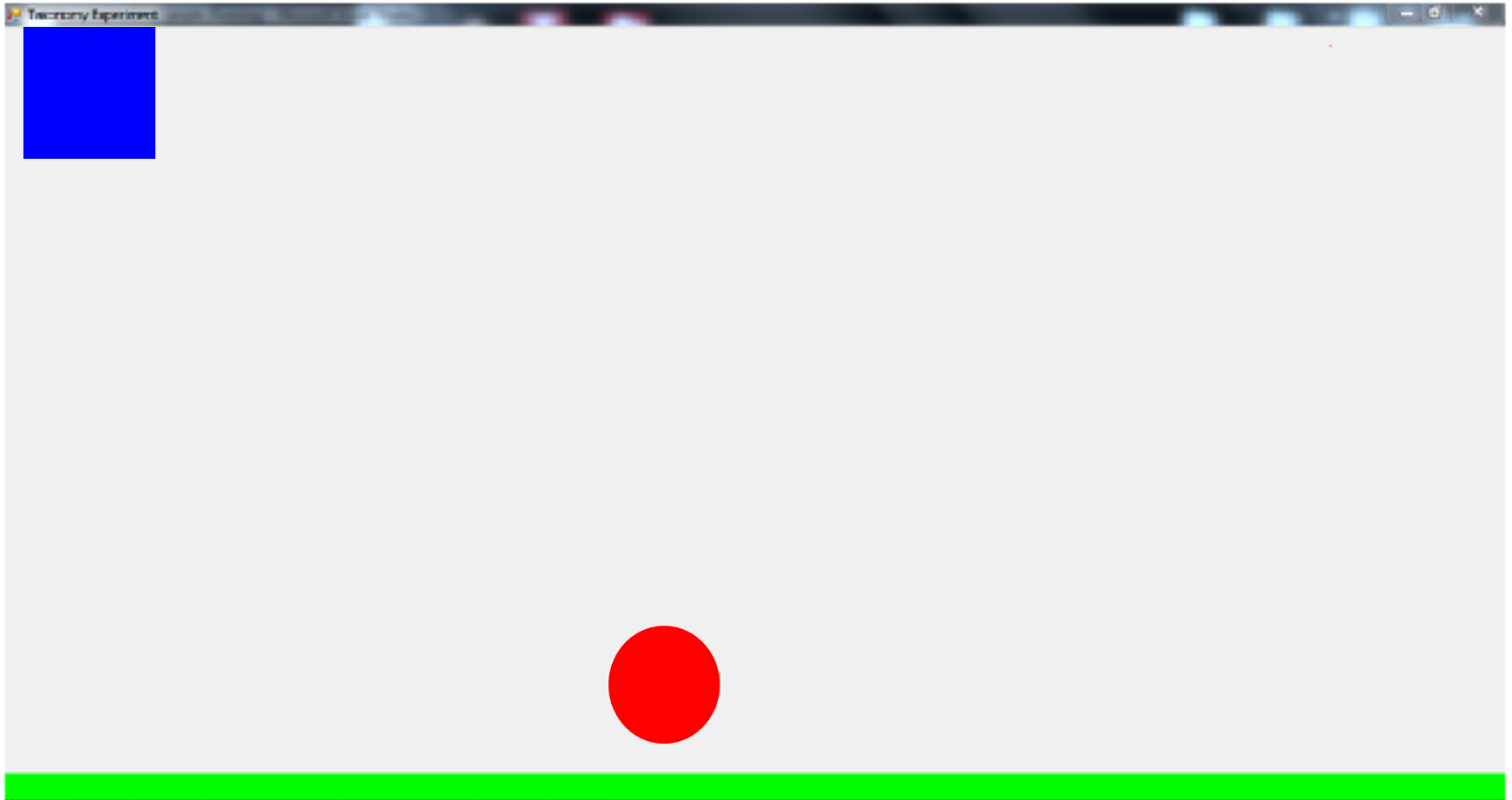
Multimodal **I**ntelligent **R**oad Design **A**ssistant

Alexander Blessing
Metin Sezgin

Case #2

- **Exercise**
 - **Object manipulation**

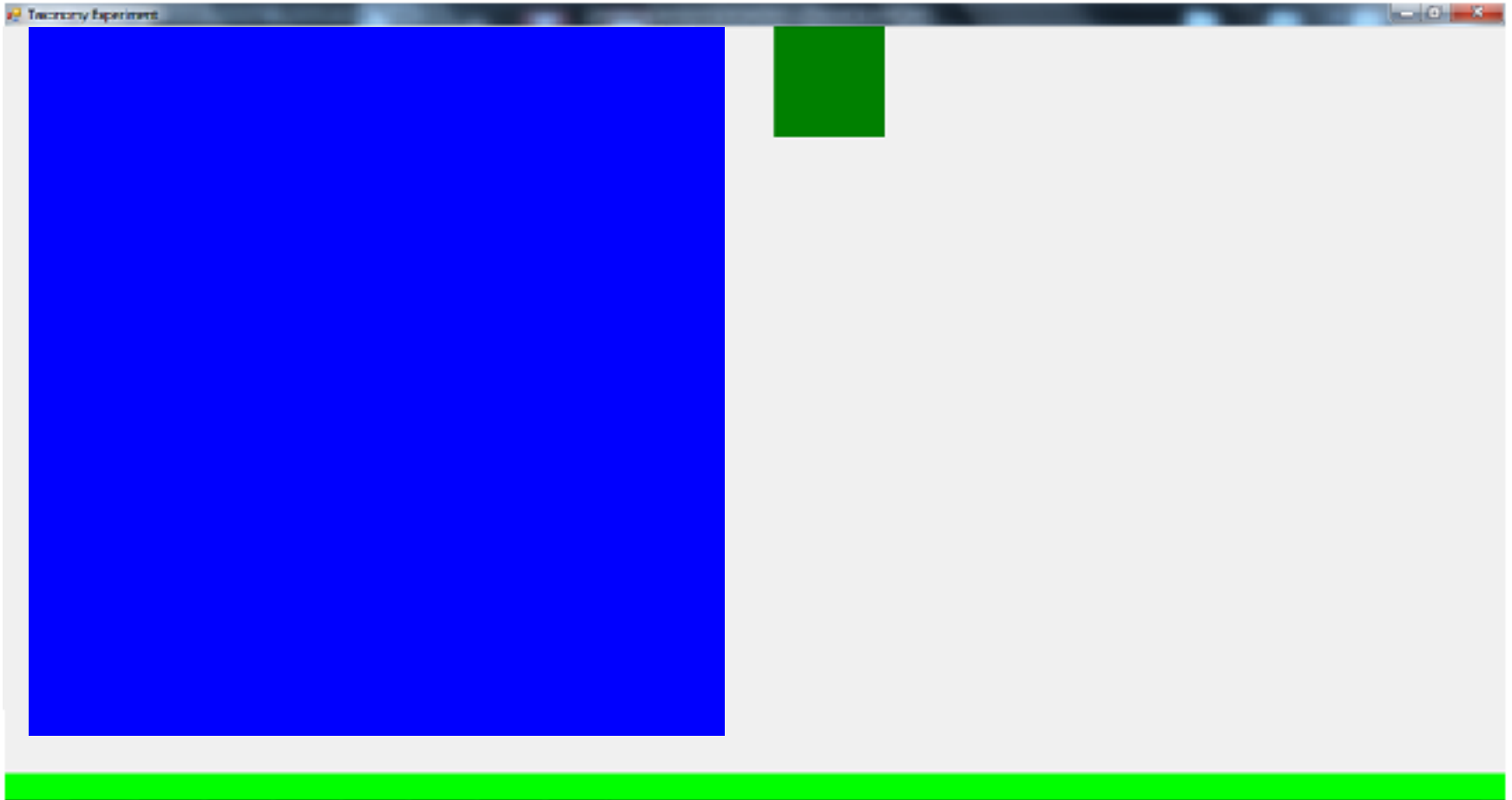
Virtual Interaction Task – Drag



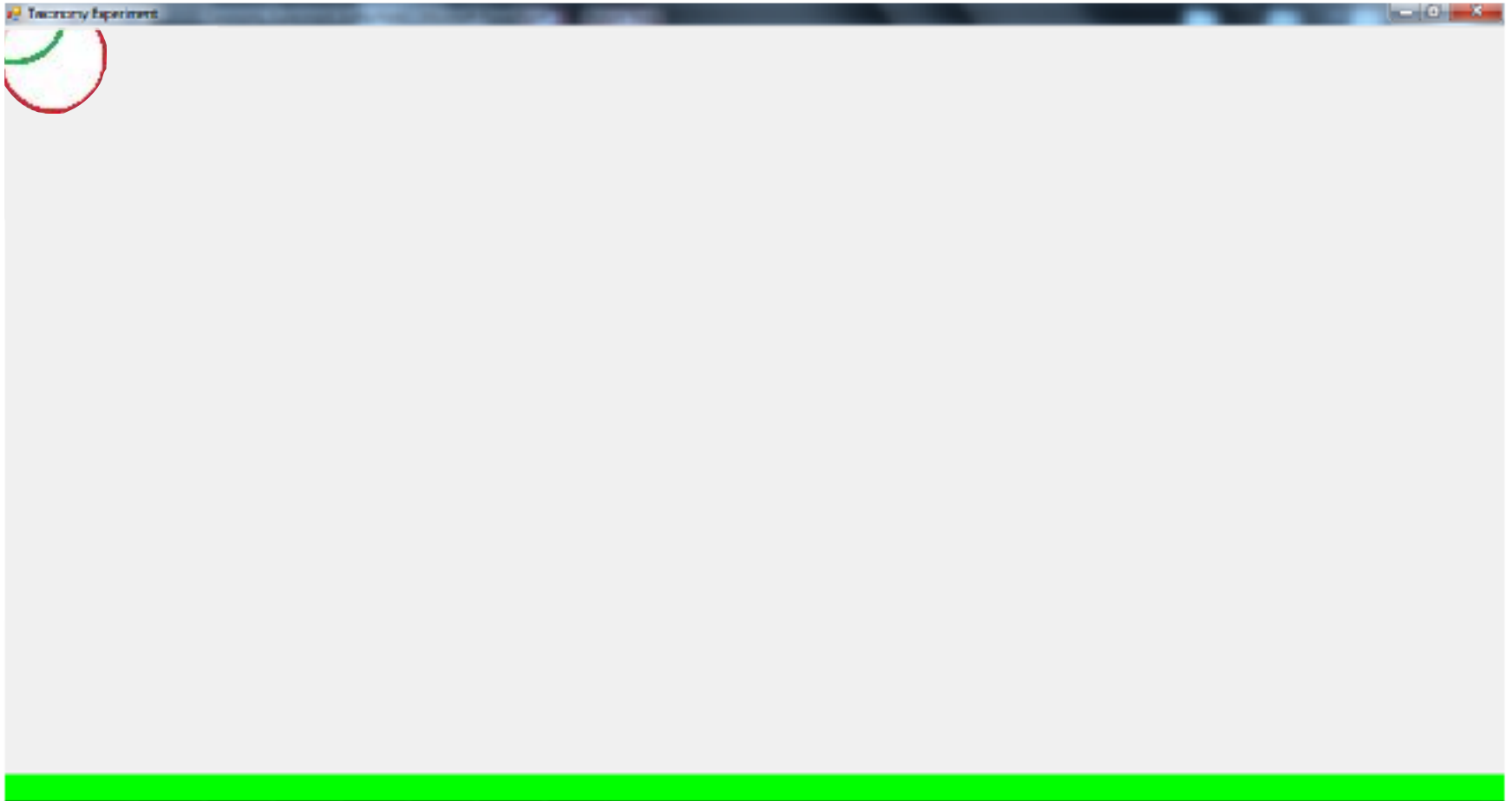
Virtual Interaction Task – Maximize



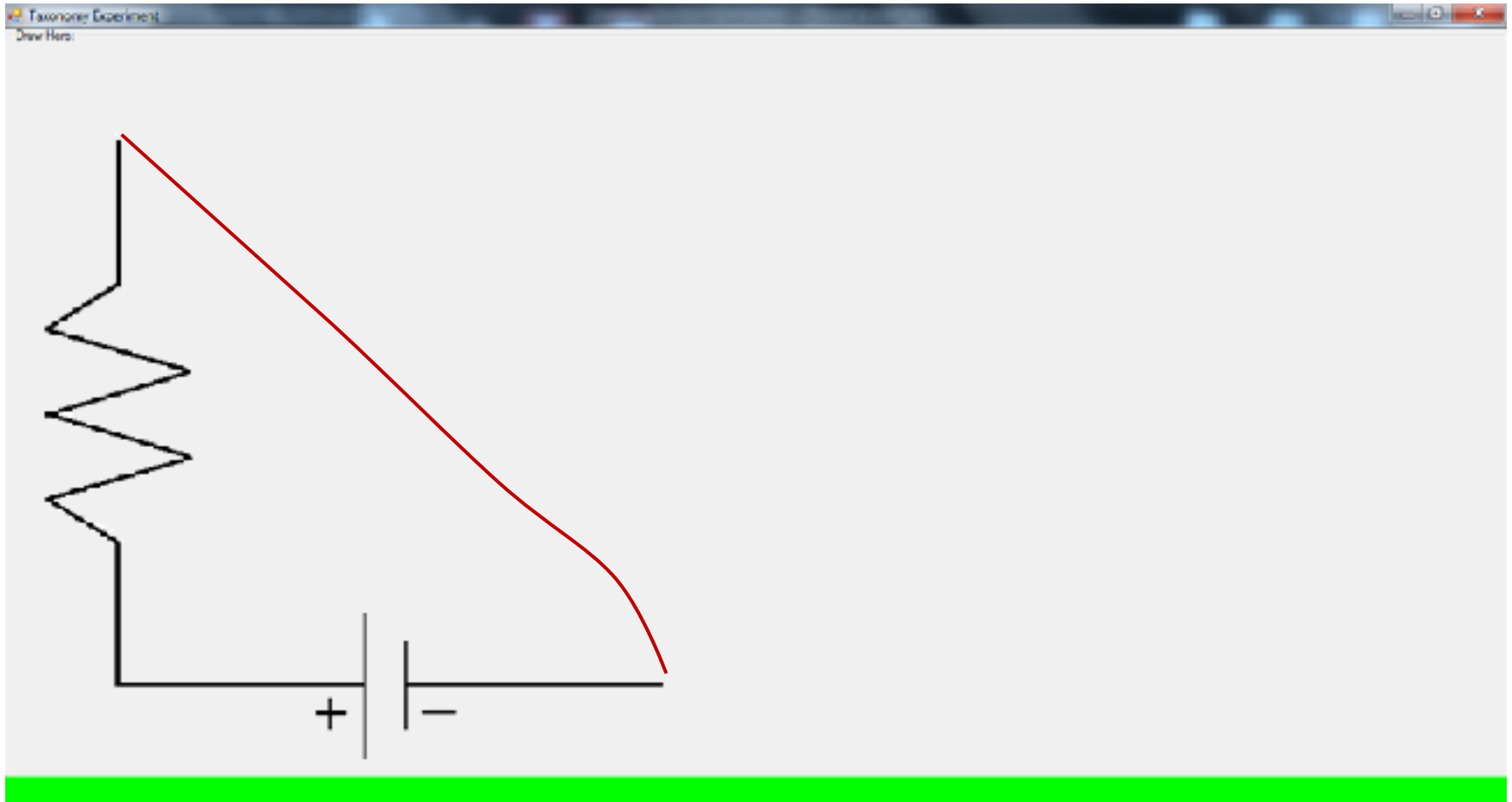
Virtual Interaction Task – Minimize



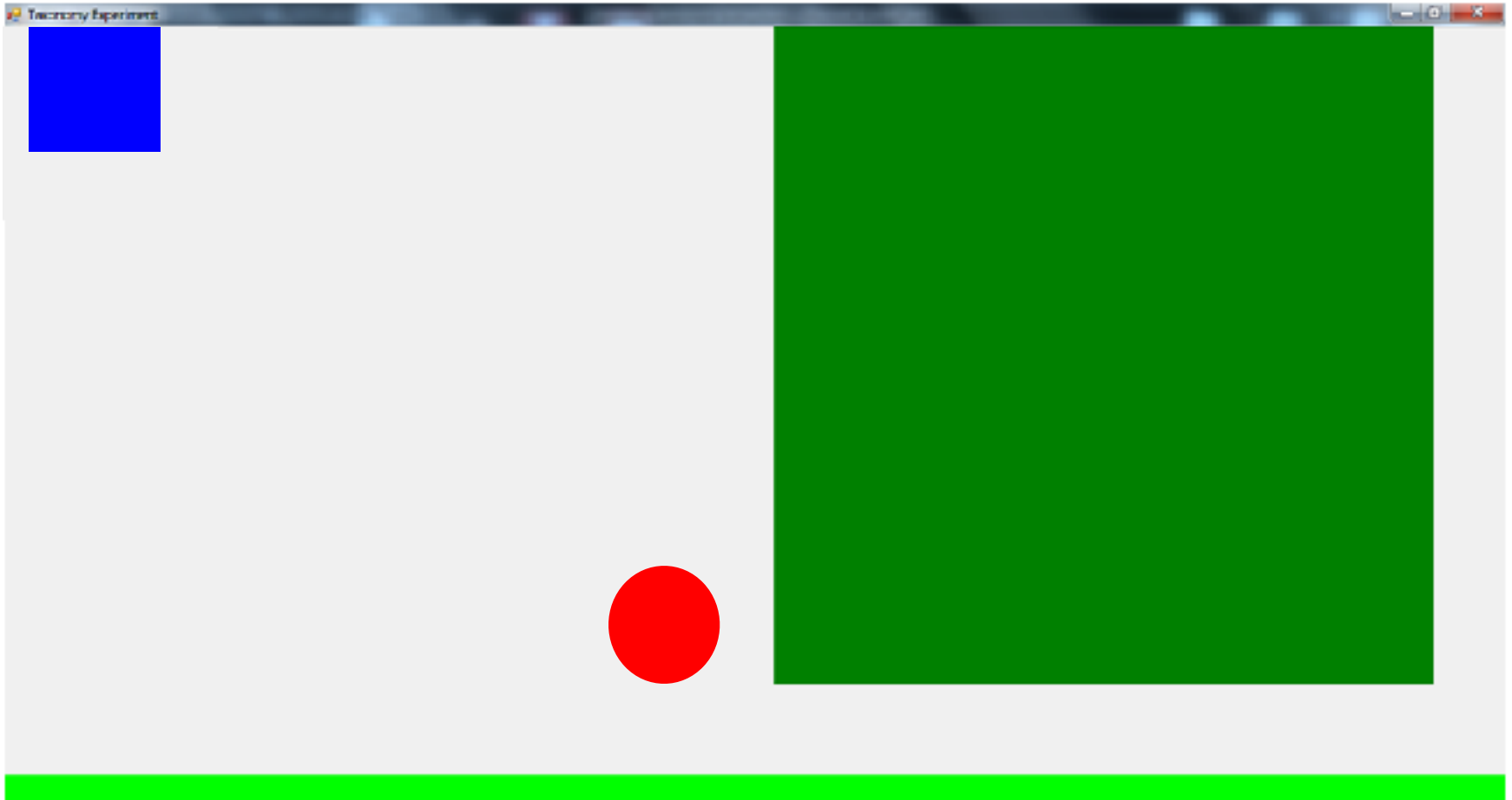
Virtual Interaction Task – Scroll



Virtual Interaction Task – Free-Form Drawing

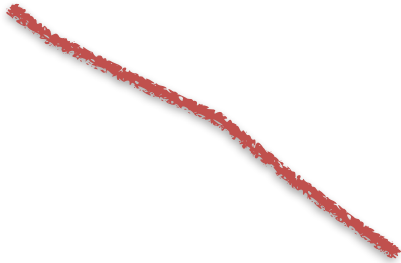


Virtual Interaction Task: Your turn

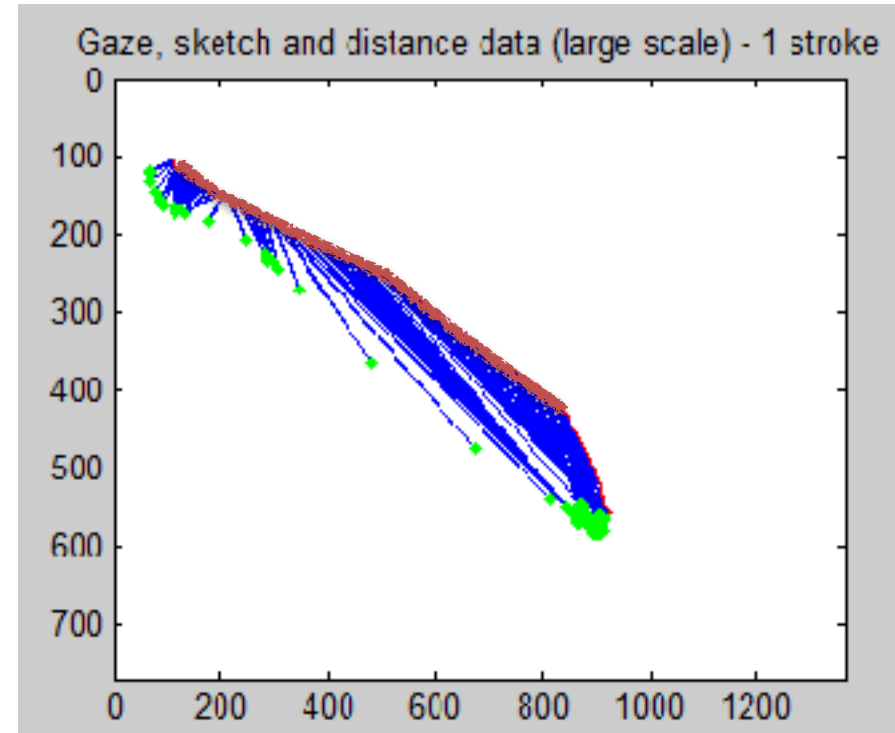
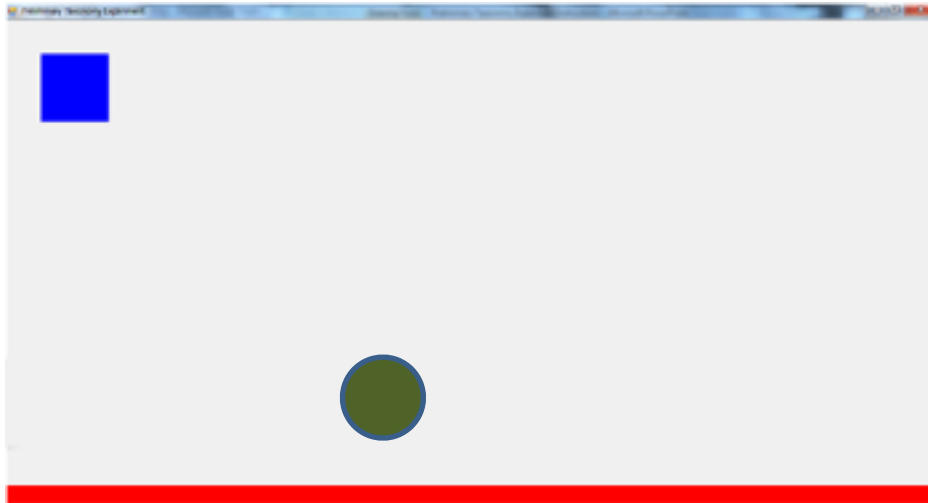


Case #2

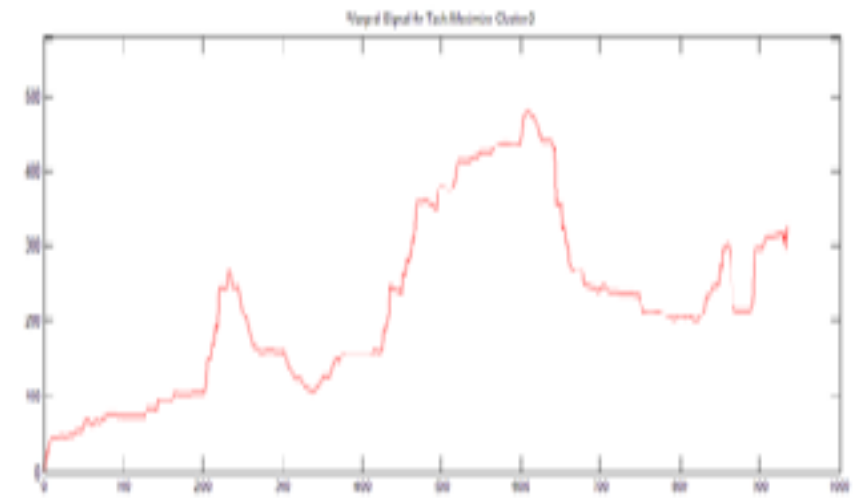
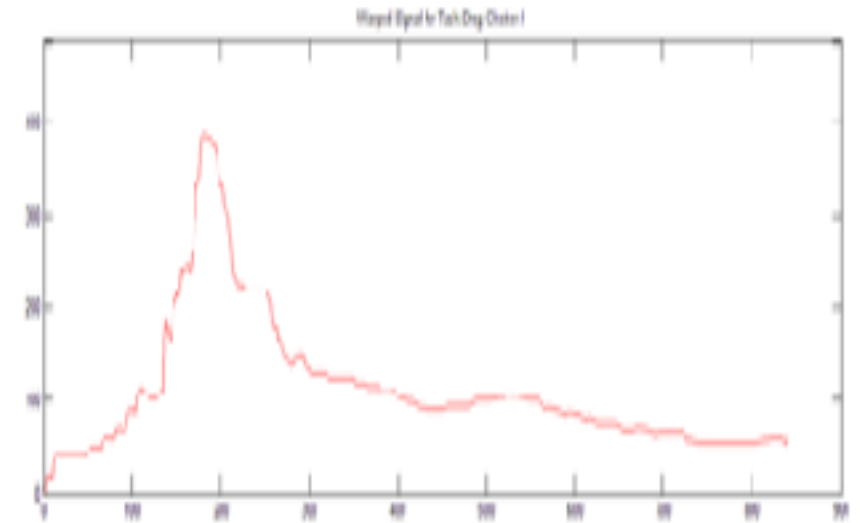
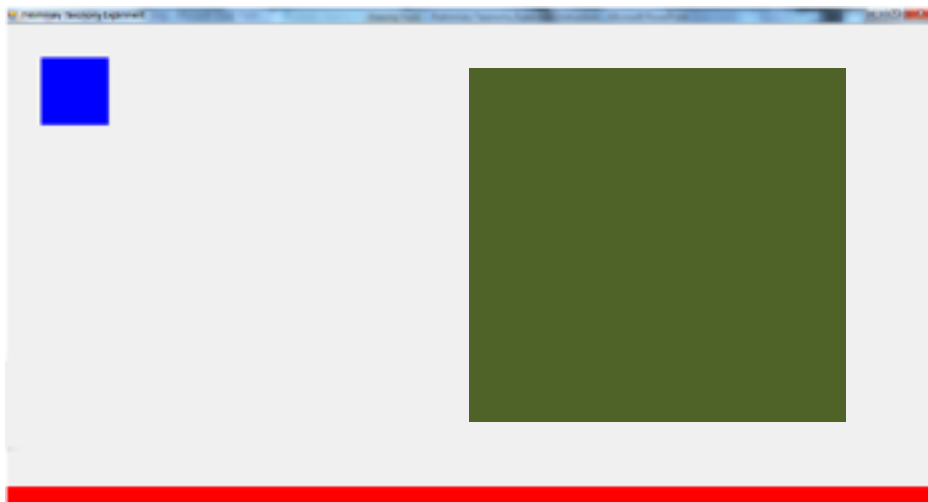
- **Exercise**
 - **Object manipulation**
- **Observe human behavior**



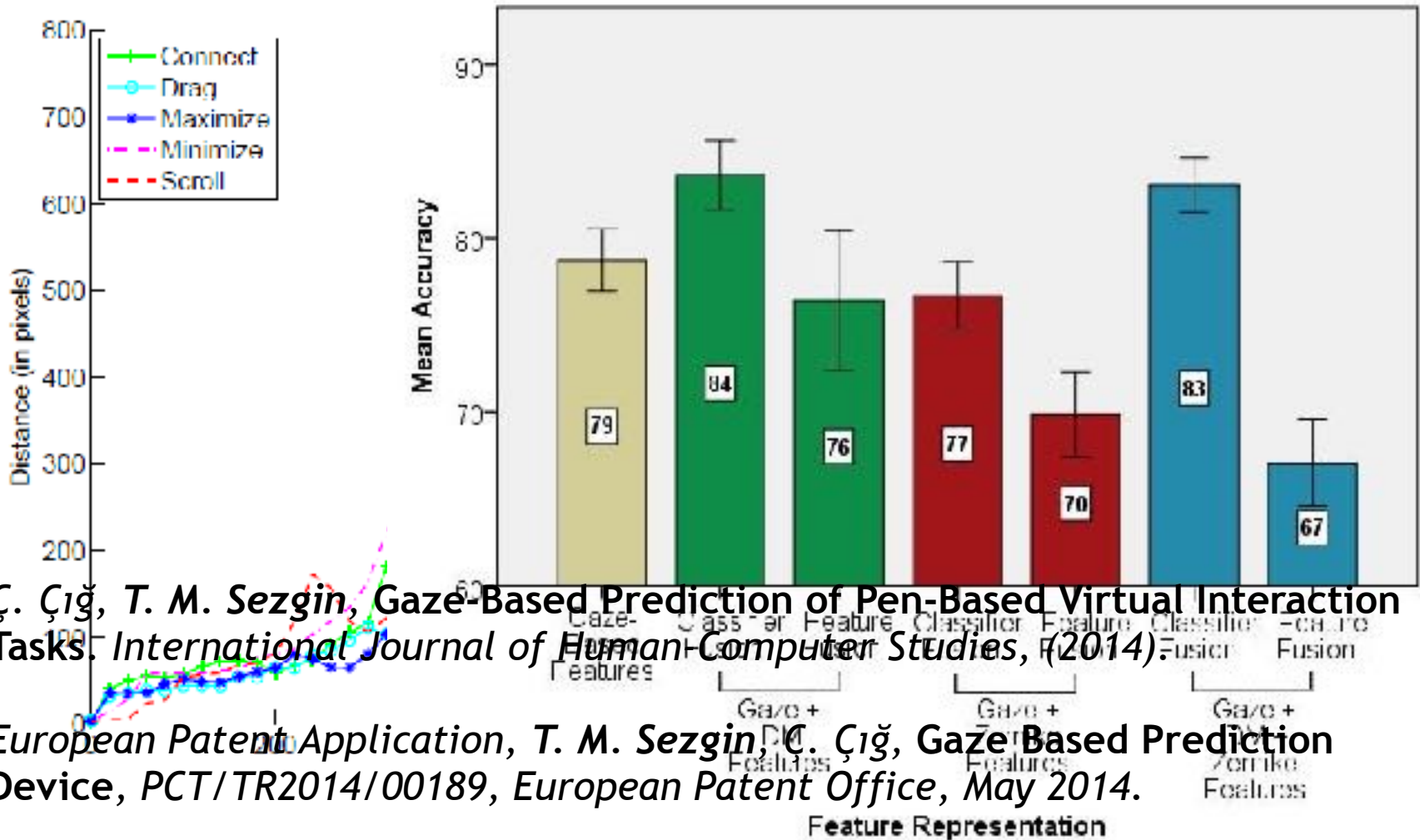
Case #2



Case #2

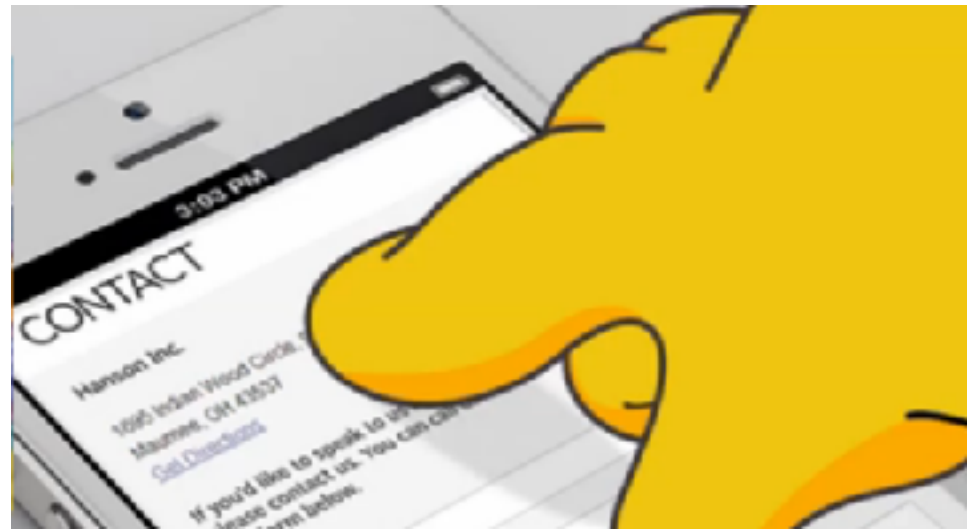


Case #2



Case #2

- **Exercise**
 - Manipulate objects
- **Observe human behavior**
- **Practical use**
 - Proactive UIs
 - Intent recognition
 - Fat finger problem



Novel use of eye gaze

How do I detect recognition errors?



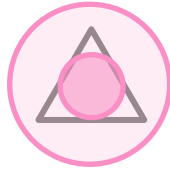
Novel use of eye gaze



- **Immediate return to the misrecognition**



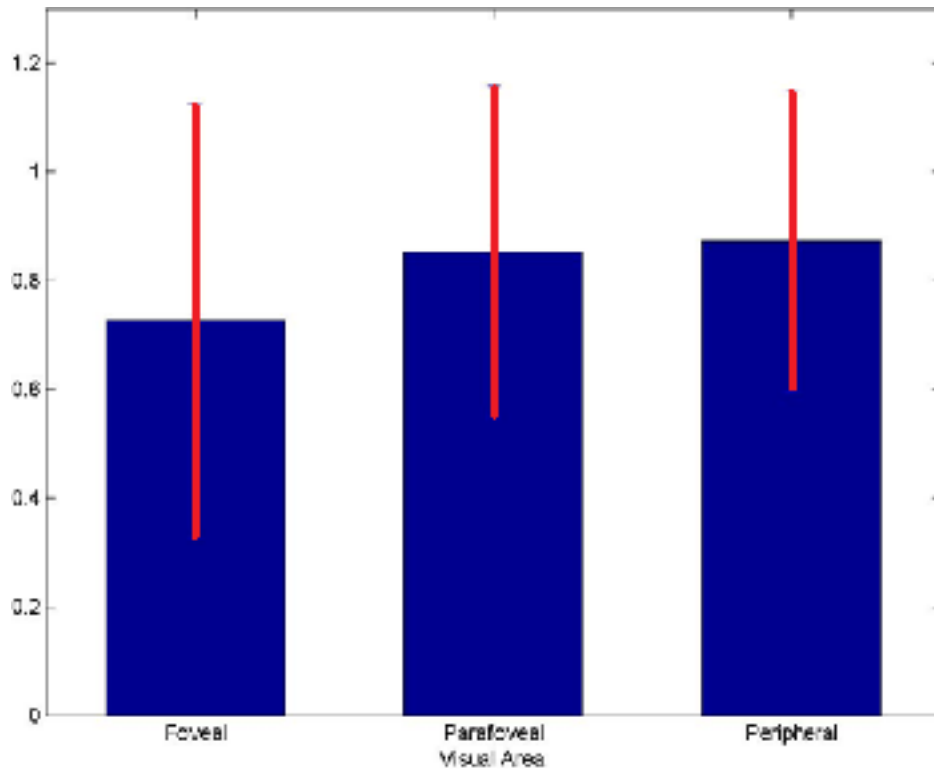
Novel use of eye gaze



- **Immediate return to the misrecognition**
- **Double take at the misrecognition**



Novel use of eye gaze



- Immediate return to the misrecognition
- Double take at the misrecognition

Research highlights

- **Recognition technologies**
 - Perception-based
 - Machine learning
- **Multimodal interaction**
 - Development
 - Evaluation

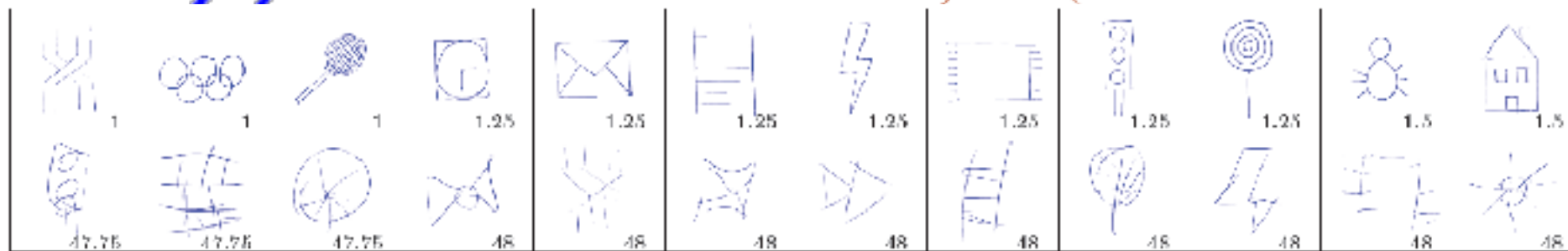
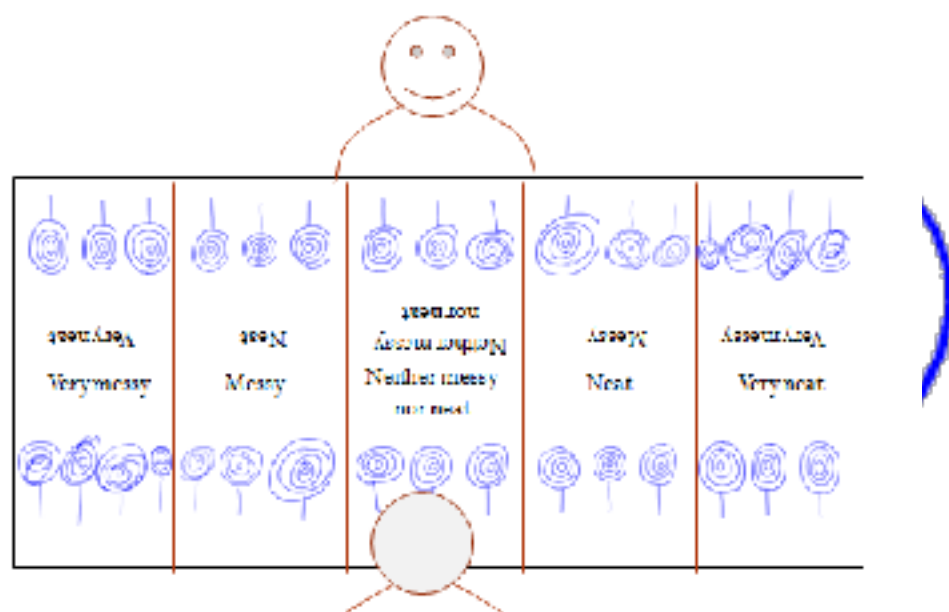
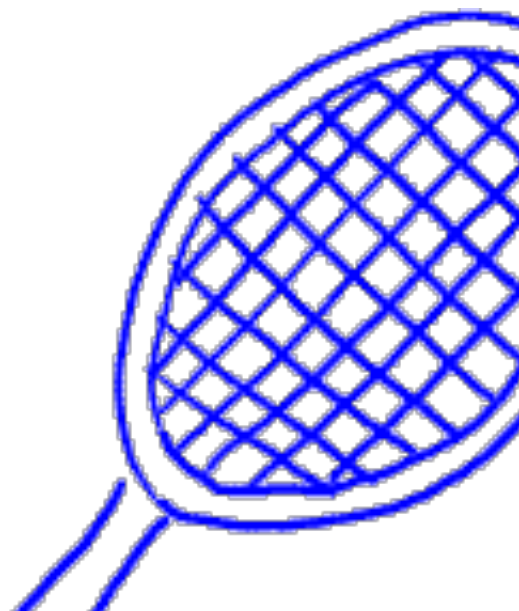
Recognizing Sketches



Grant:

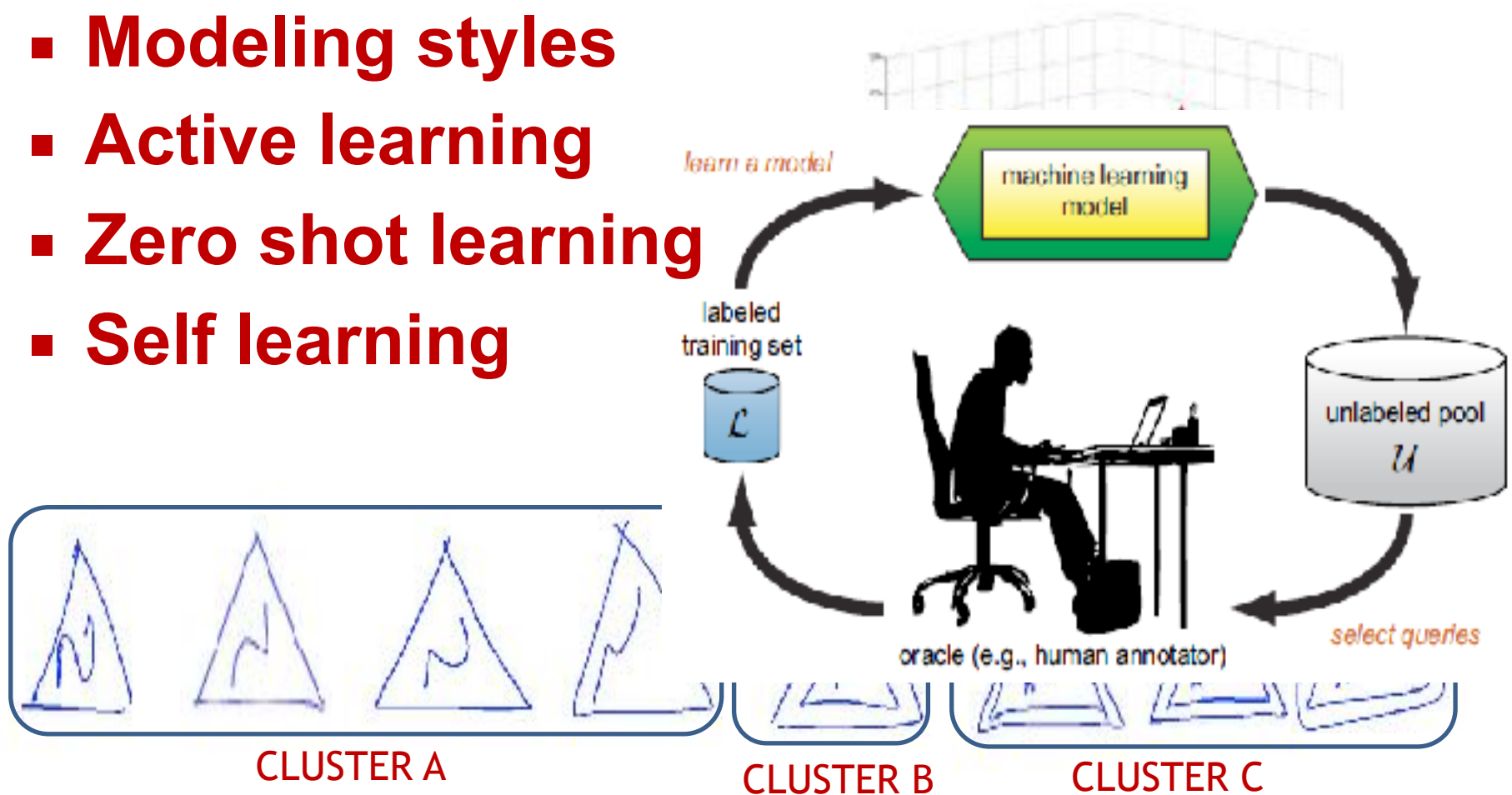
Funded under the National Science Foundation Priority Areas Call

Learning a scale of messiness



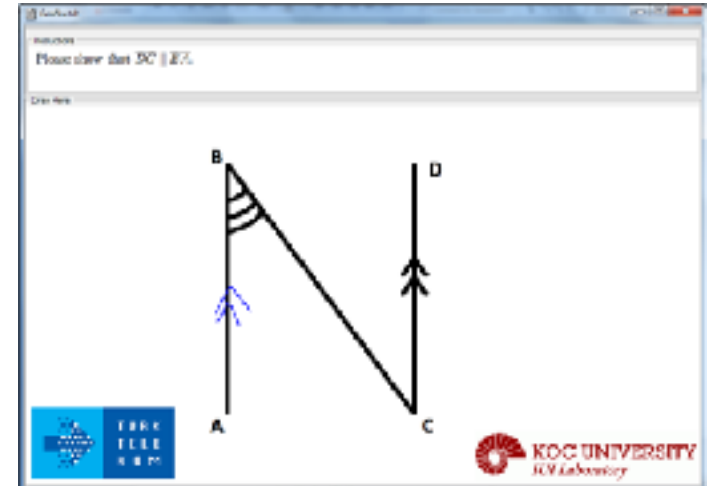
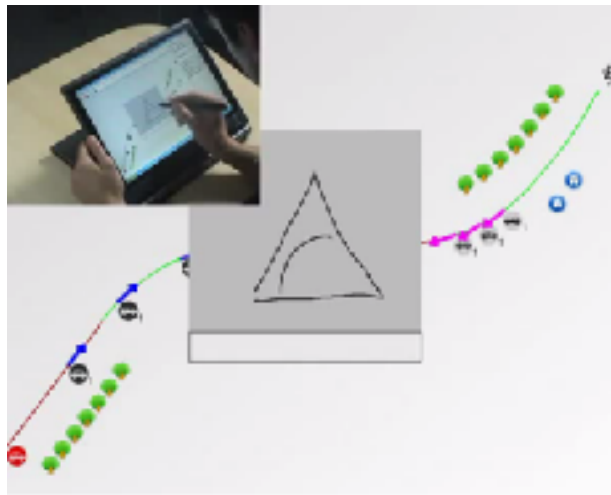
Recognition with few examples, scarce resources

- Modeling styles
- Active learning
- Zero shot learning
- Self learning

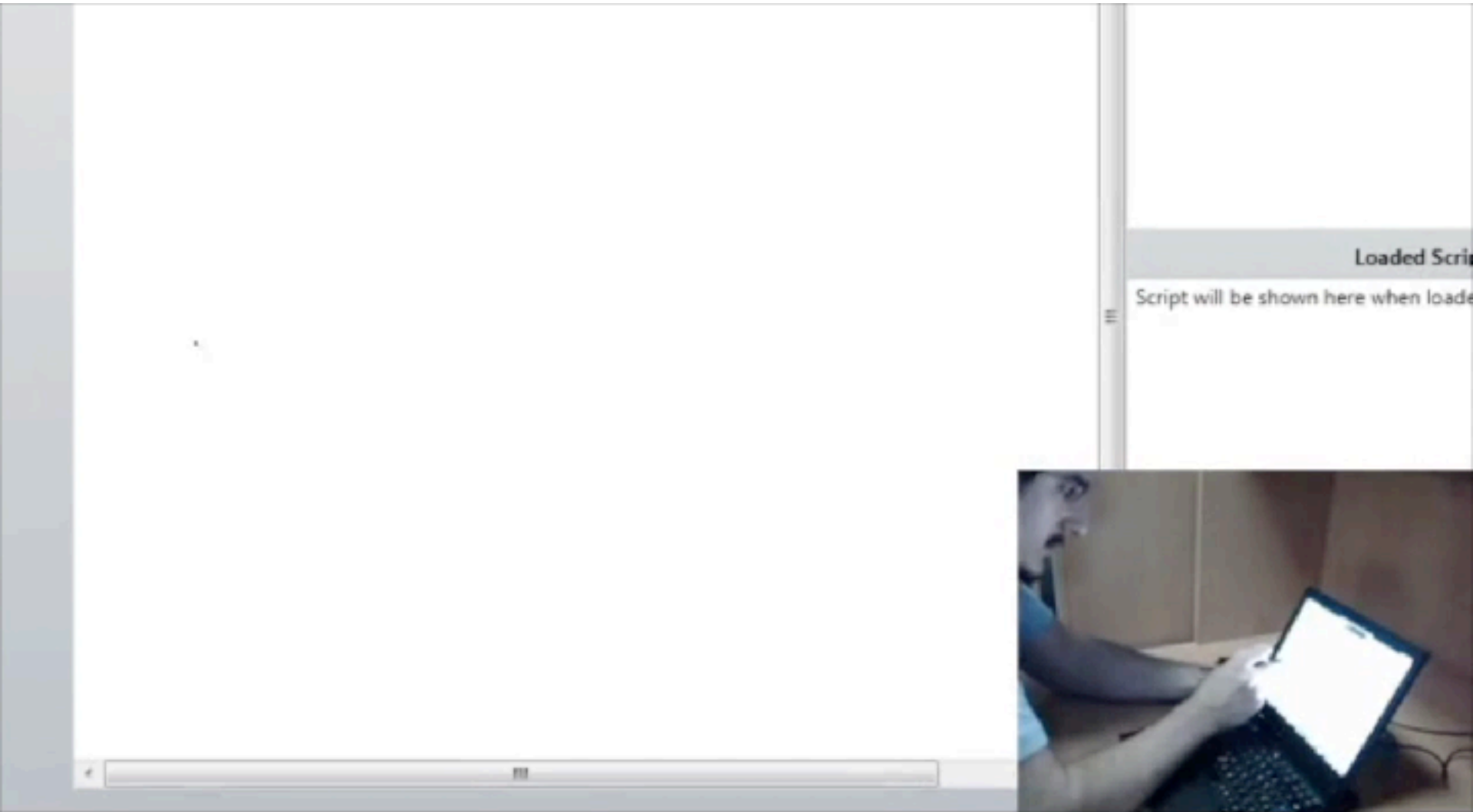


Pen-based interfaces

- Design
- E-learning
- Animation
- Entertainment



Multimodal Storyboarding Assistant



Intelligent User Interfaces



multimedia
retrieval



rehabilitation of
autism conditions



gaze-based intent
recognition



smart stylus



affective robotics



HRI



Affective interaction with robots

- Robots with a sense of humor
- JOKER – European Commission ERA-NET Project
 - LIMSI/CNRS (France)
 - Trinity College Dublin (Ireland)
 - University of Mons (Belgium)



Grant:

*European Commission ERA-Net Program, CHIST-ERA Intelligent User Interfaces Call
Joke and Empathy of a Robot/ECA: Towards Social and Affective Relations with a Robot*

Affective interaction with robots



Grant:

European Commission ERA-Net Program, CHIST-ERA Intelligent User Interfaces Call Joke and Empathy of a Robot/ECA: Towards Social and Affective Relations with a Robot

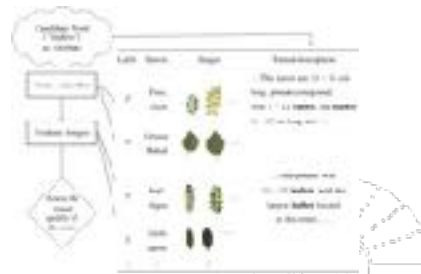
Affective interaction with robots



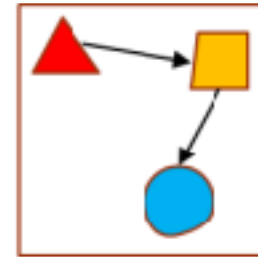
Grant:

European Commission ERA-Net Program, CHIST-ERA Intelligent User Interfaces Call Joke and Empathy of a Robot/ECA: Towards Social and Affective Relations with a Robot

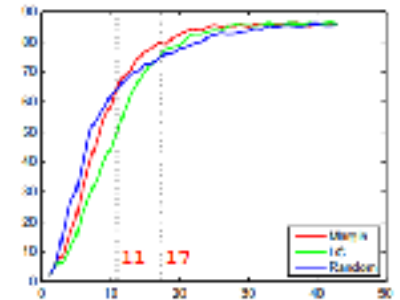
Learning, vision, language



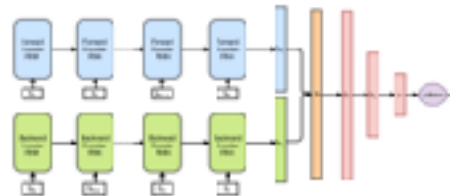
learning visual attributes



learning from few examples



active learning

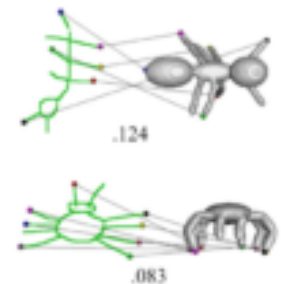


deep stroke segmentation



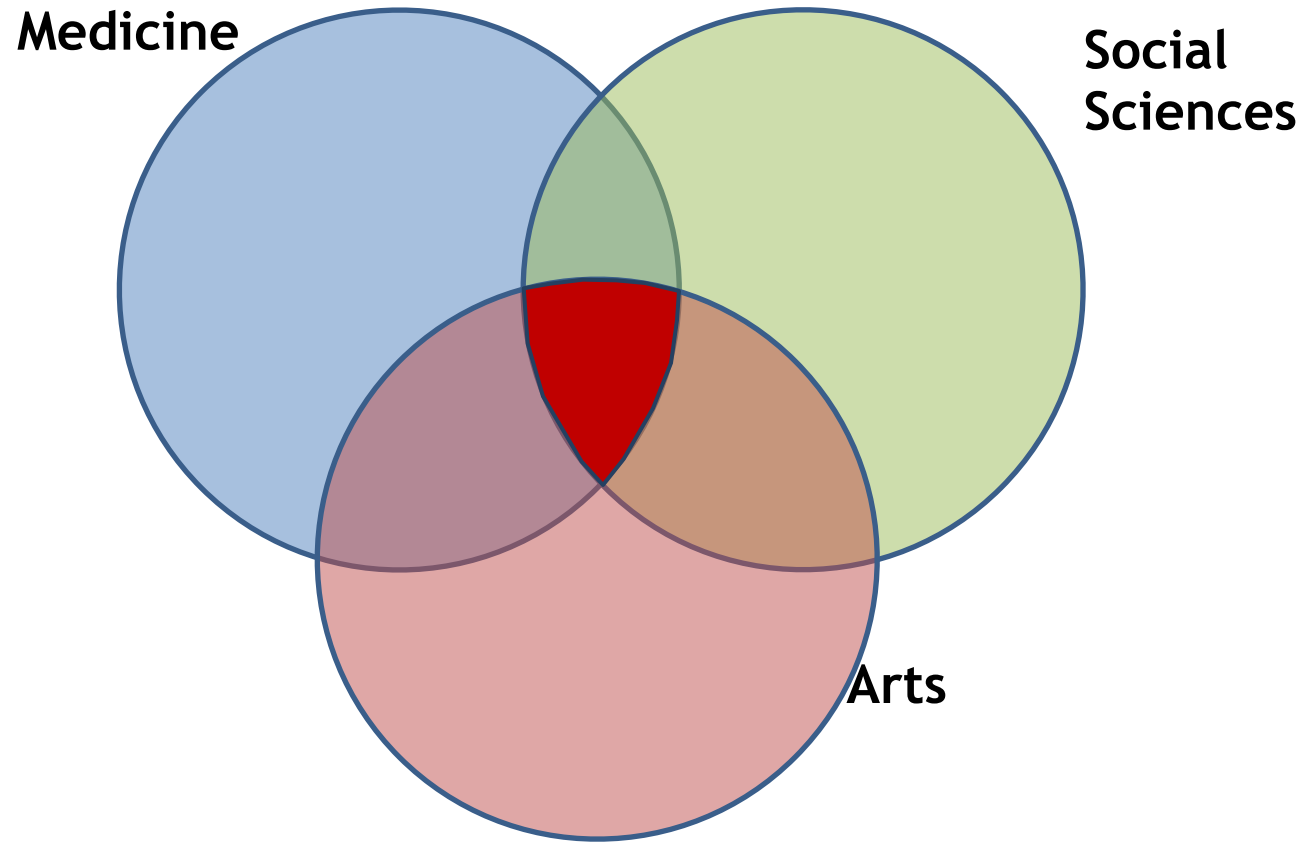
Figure 5: Overview of the IVDTON system and features.

explainable AI



shape retrieval

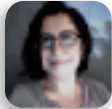
Looking forward



Alumni Profiles



Dr. Yusuf Sahillioğlu, Visiting Researcher
Assoc. Prof., Middle East Technical Univ.



Dr. Başak Alper, Postdoc
NASA - Jet Propulsion Laboratory



Neşe Alyüz Çivitci, Postdoc
Intel Labs, Intel Corporation



Senem Ezgi Emgin, PhD Student
Apple



Zana Buçinca, MS Student
Harvard University



Çağlar Tırkaz, PhD Student
Amazon



Ayşe Küçükyılmaz, PhD Student
Nottingham University (Asst. Prof.)



Kurmanbek Kaiyrbekov, MSc Student
John Hopkins University



Cansu Şen, MSc Student
University of Massachusetts Med. School



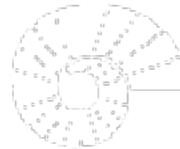
Tuğrulcan Elmas, Summer Researcher
École Polytech. Fédérale de Lausanne



Arda İçmez, Summer Researcher
Facebook



Mustafa Emre Acer, Summer Researcher
Google



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Intelligent User Interfaces Laboratory

Acknowledgements

■ Postdocs

- Basak Alper
- Nese Alyuz
- Yusuf Sahillioglu

■ PhD students

- Sinan Tumen
- Berker Turker
- Ayse Kucukyilmaz
- Caglar Tirkaz
- Cagla Cig
- Ezgi Emgin

■ MS students

- Serike Cakmak
- Ozem Kalay
- Cansu Sen
- Erelcan Yanik
- Atakan Arasan
- Banucicek Gurcuoglu
- Kemal Tugrul

■ Undergraduate students

- Anil Uluturk
- Furkan Bayraktar
- Ozan Okumusoglu
- 30+

■ Collaborators

- Berrin Yanikoglu
- Engin Erzgin
- Yucel Yemez
- Cagatay Basdogan

■ Sponsors

- DARPA
- The European Commission
- TÜBİTAK
- Türk Telekom
- Koç Sistem
- Ministry of Science Industry & Technology



Questions



Questions

References

Invention Disclosures

*Under review, O. Kalay., T. M. Sezgin, BBF # 2014.10.X
Koç University, Research, Project Development and Technology Transfer Directorate*

*Gaze-Based Mode Inference for Pen-Based Interaction, Ç. Çığ, T. M. Sezgin, BBF # 2013.03.002
Koç University, Research, Project Development and Technology Transfer Directorate*

*Auto-Completion in Sketch Recognition, T. M. Sezgin, B. Yanıkoğlu, Ç. Tırkaz, BBF # 2011.03.X
Koç University, Research, Project Development and Technology Transfer Directorate*

European Patent Application, T. M. Sezgin, Ç. Çığ, Gaze Based Prediction Device, PCT/TR2014/00189, European Patent Office, May 2014.

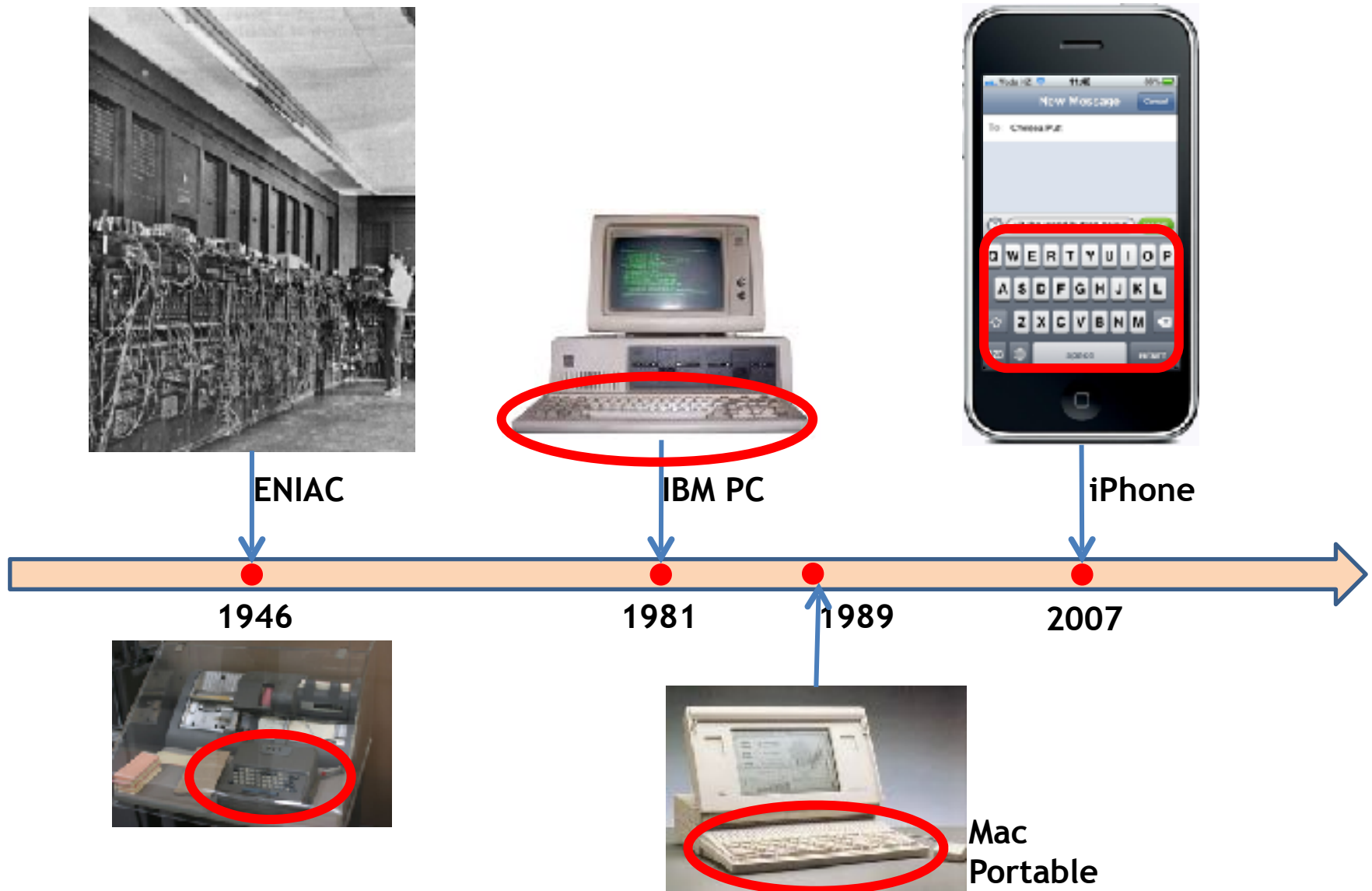
Publications

Ç. Çığ, T. M. Sezgin, Gaze-Based Virtual Task Predictor. Proceedings of International Conference on Multimodal Interfaces, Workshop Eye Gaze in Intelligent Human Machine Interaction: Eye-Gaze and Multimodality, Accepted for publication (2014).

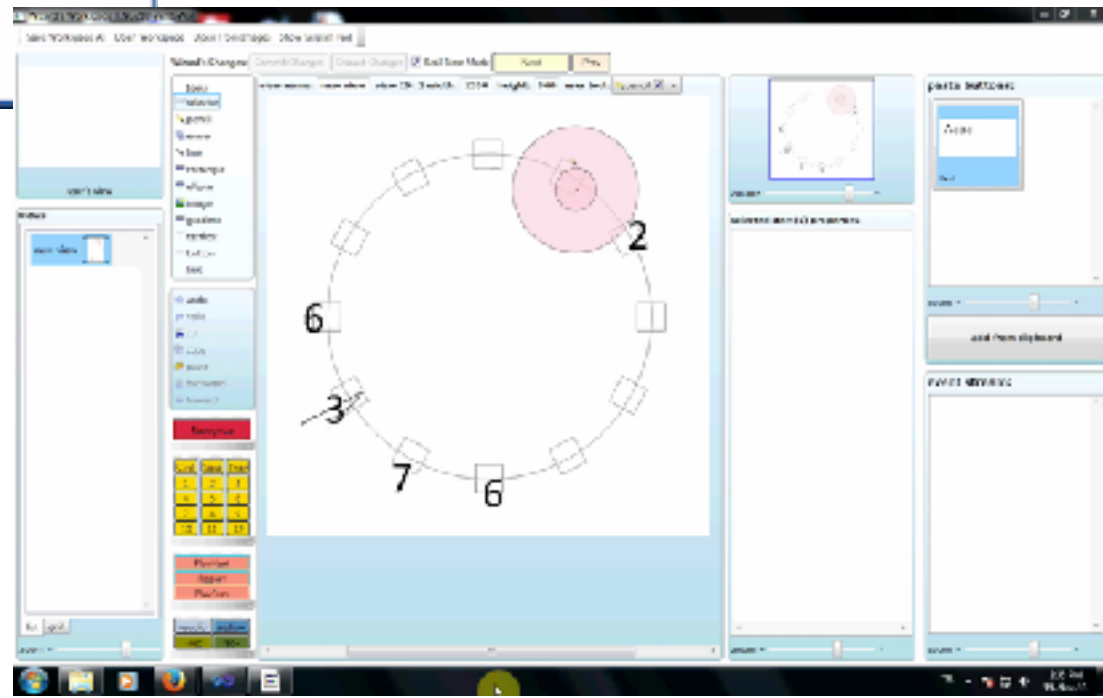
Ç. Çığ, T. M. Sezgin, Gaze-Based Prediction of Pen-Based Virtual Interaction Tasks. International Journal of Human-Computer Studies, Accepted for publication, (2014).

Ç. Tırkaz, B. Yanıkoğlu, T. M. Sezgin, Sketched Symbol Recognition with Auto Completion. Pattern Recognition, vol 45, issue 11, pp 3926-3937 (2012).

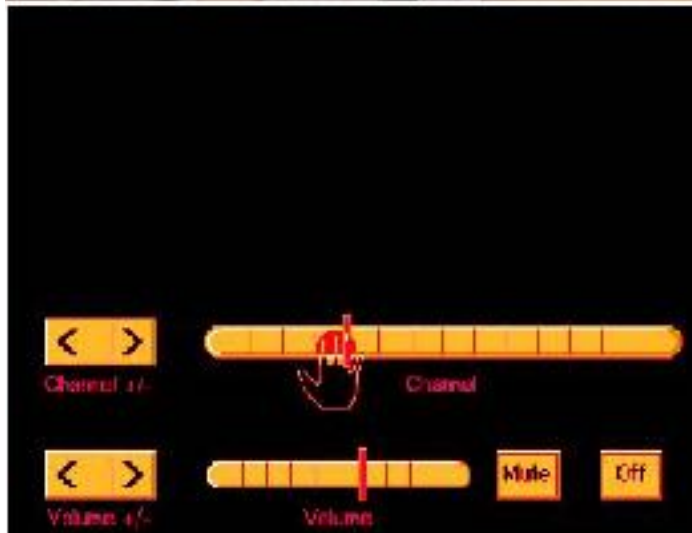
History of Human Computer Interaction



Wizard of Oz Method



The confession



5 Lessons

Controlling a television set remotely through hand gestures seemed to be exciting for the people who tried the prototype. This may or may not be due to the novelty of such control.

The open hand gesture was found to be somewhat tiring for extended viewing. An improvement may be to maintain the open hand as a trigger gesture, but allow a more restful command gesture, once the trigger gesture has been detected and the hand located. The contour tracking algorithms of Blake and Isard [3] may be useful for such commands.

Television Control by Hand Gestures

William T. Freeman, Craig D. Weissman

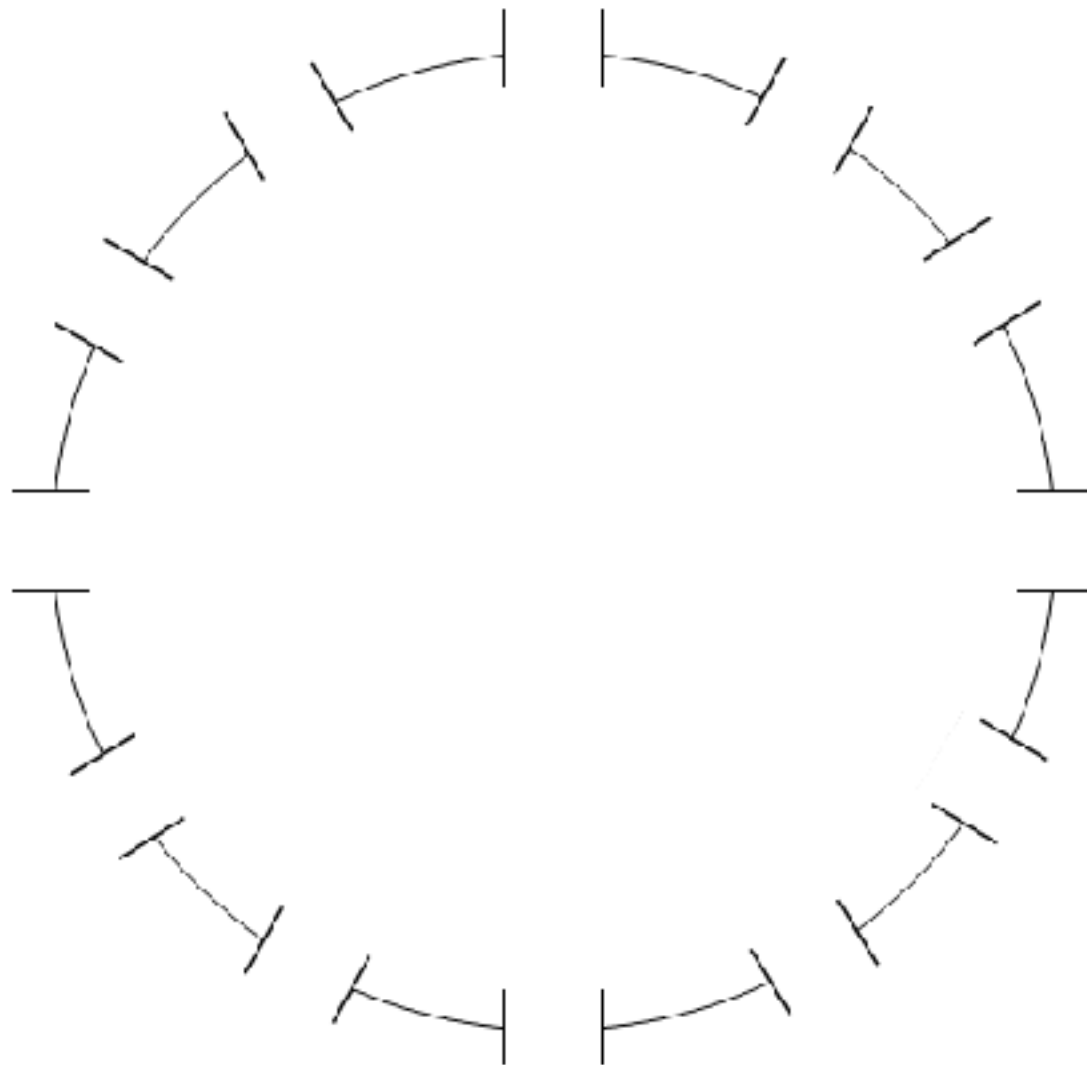
MERL Report: TR94-24

The Problem

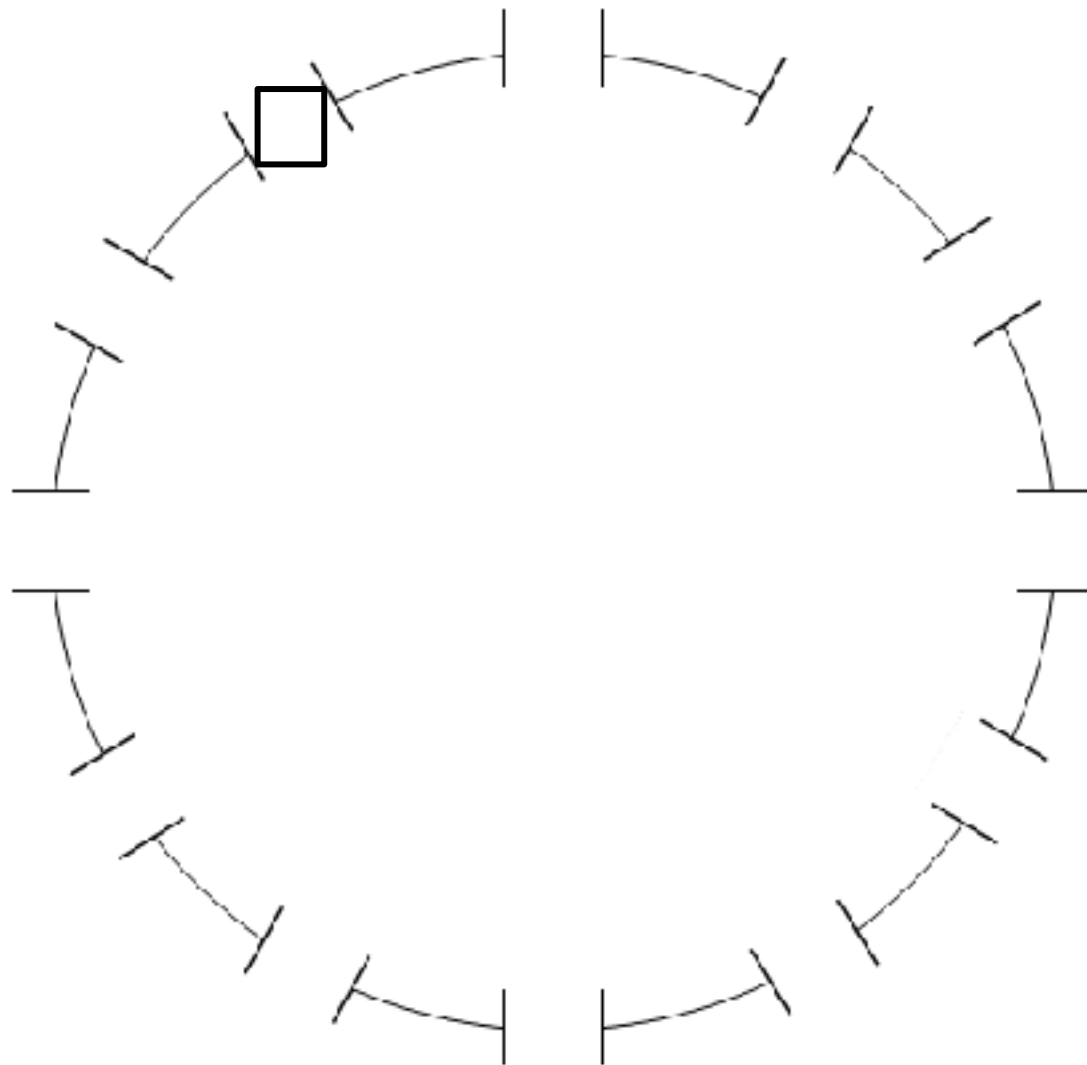
Too little effort towards understanding interaction

$$\begin{aligned}\sum_{n=0}^{N-1} |y[n]|^2 &= \sum_{k=0}^{N-1} |Y(k)|^2 \\&= \sum_{k=0}^{N-1} \left| \sum_l H(k + lN) \cdot F(k + lN) \right|^2 \\&= \sum_{k=0}^{N-1} \sum_l |H(k + lN) \cdot F(k + lN)|^2 \\&\quad + \sum_{k=0}^{N-1} \sum_{l \neq m} H(k + lN) \cdot F(k + lN) \\&\quad \cdot H^*(k + mN) \cdot F^*(k + mN).\end{aligned}$$

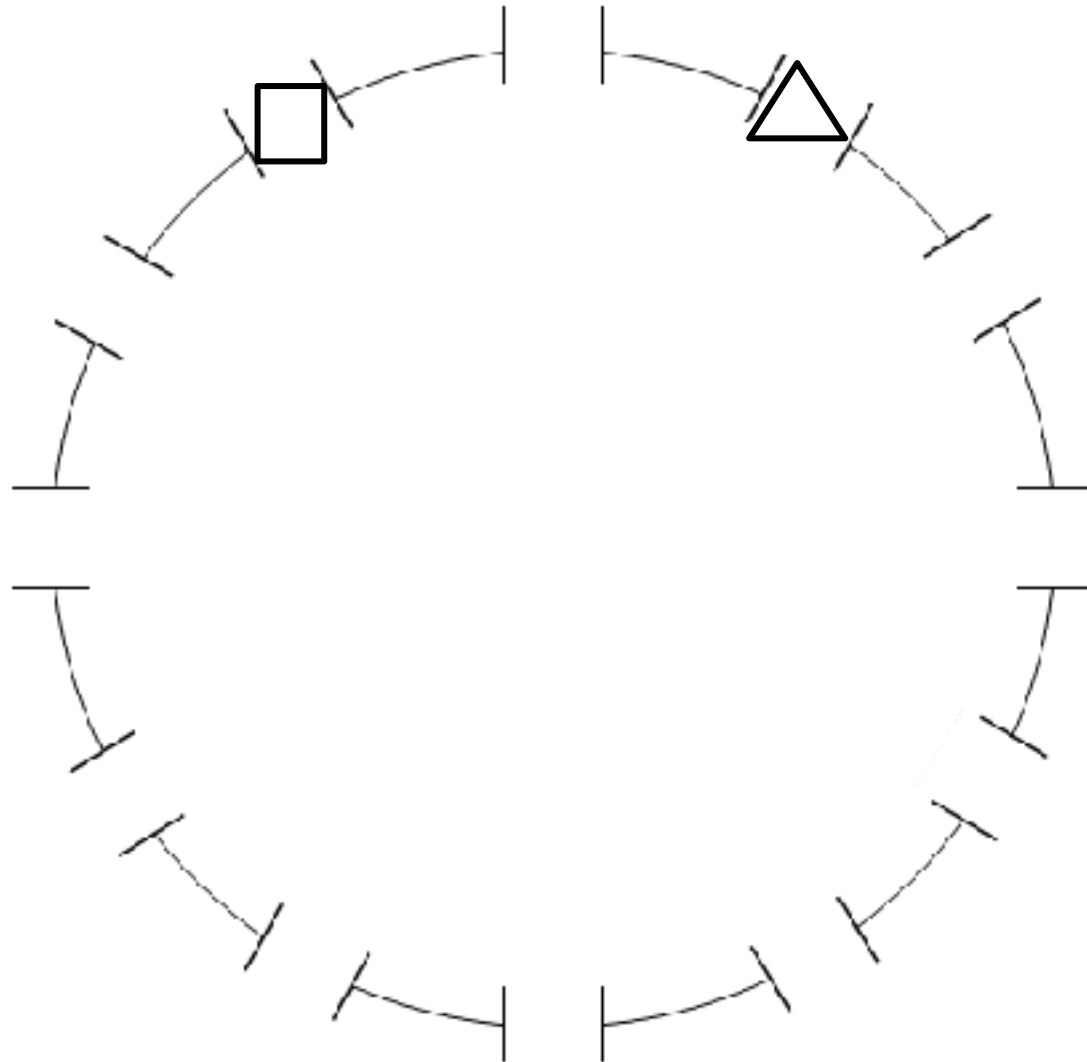
Case study 3



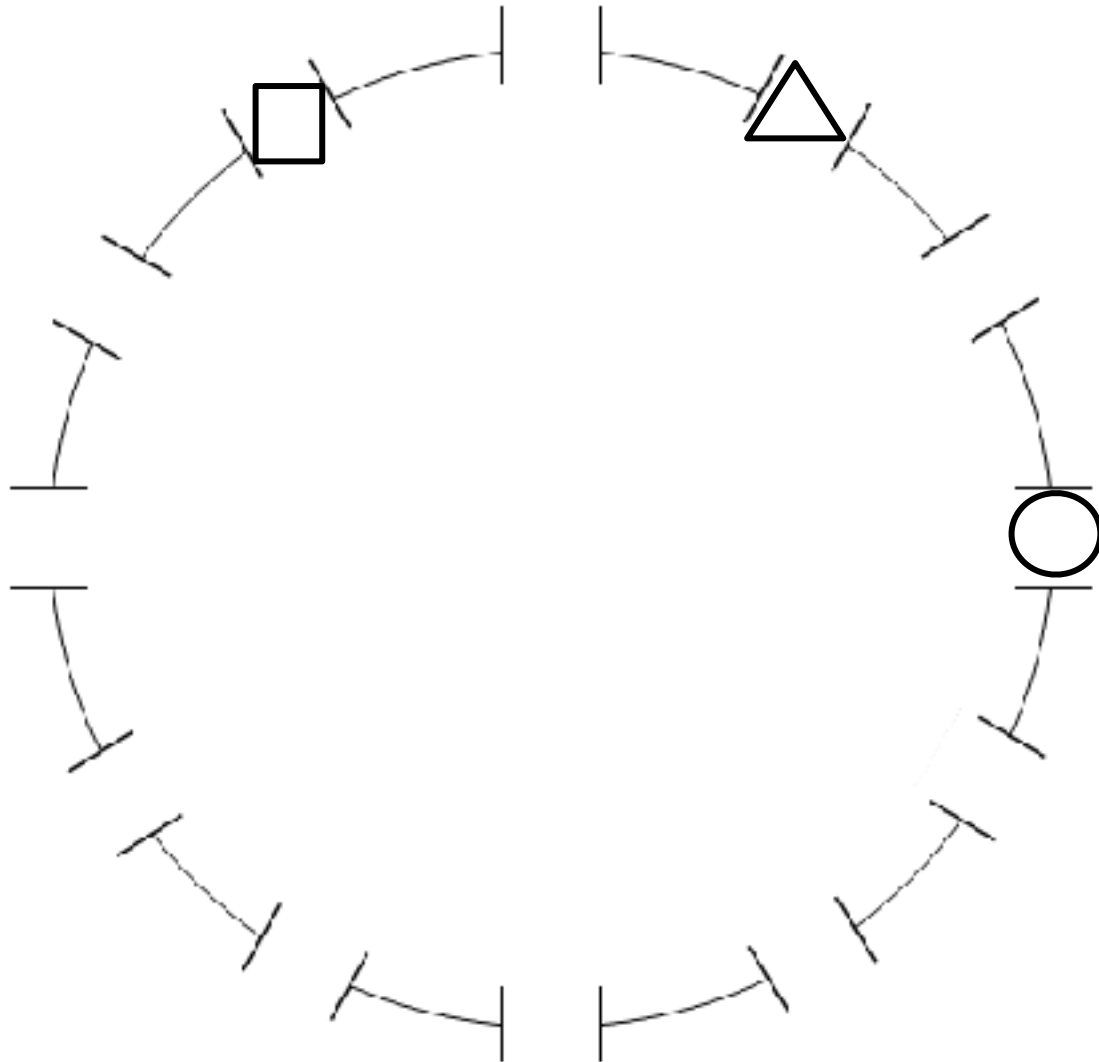
Case study 3



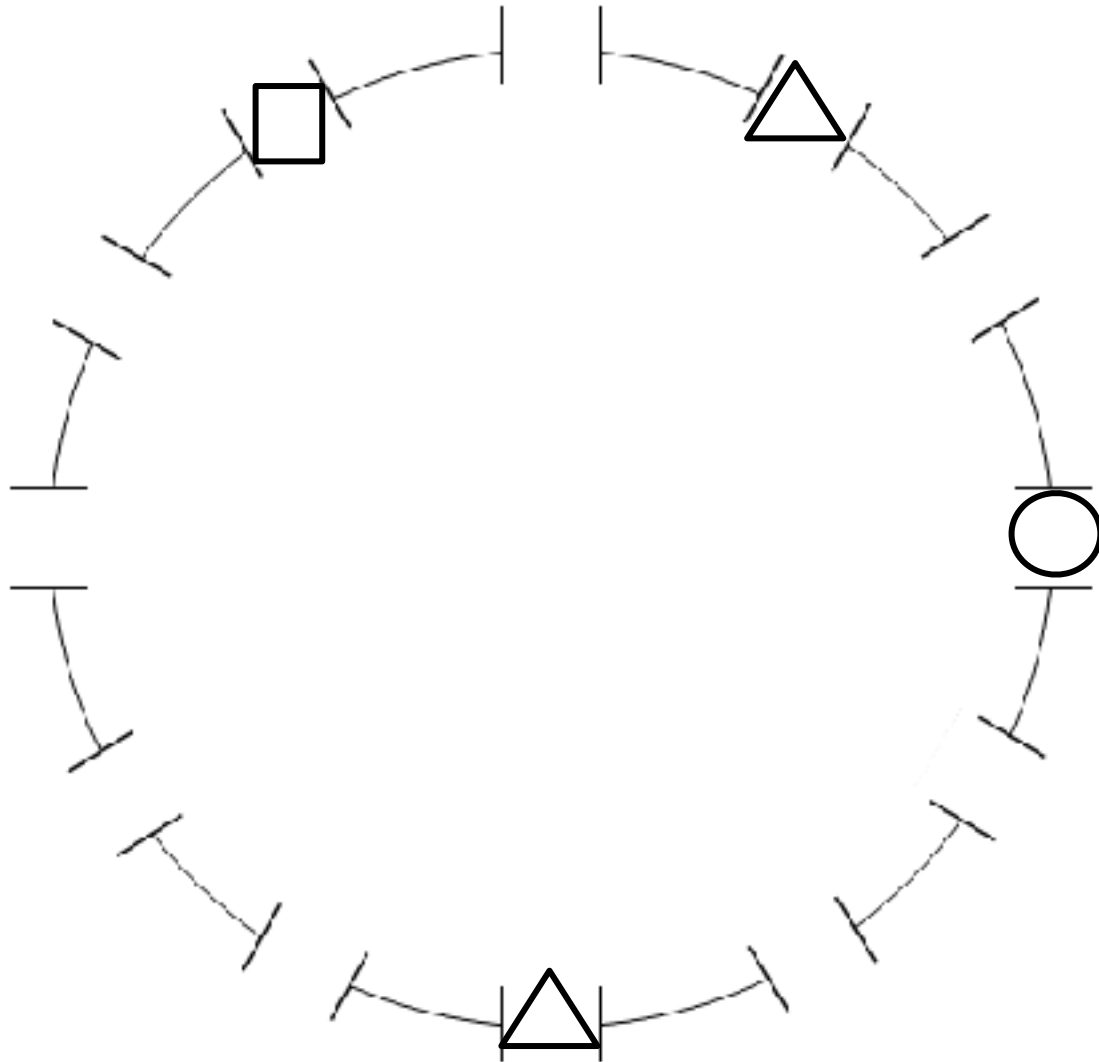
Case study 3



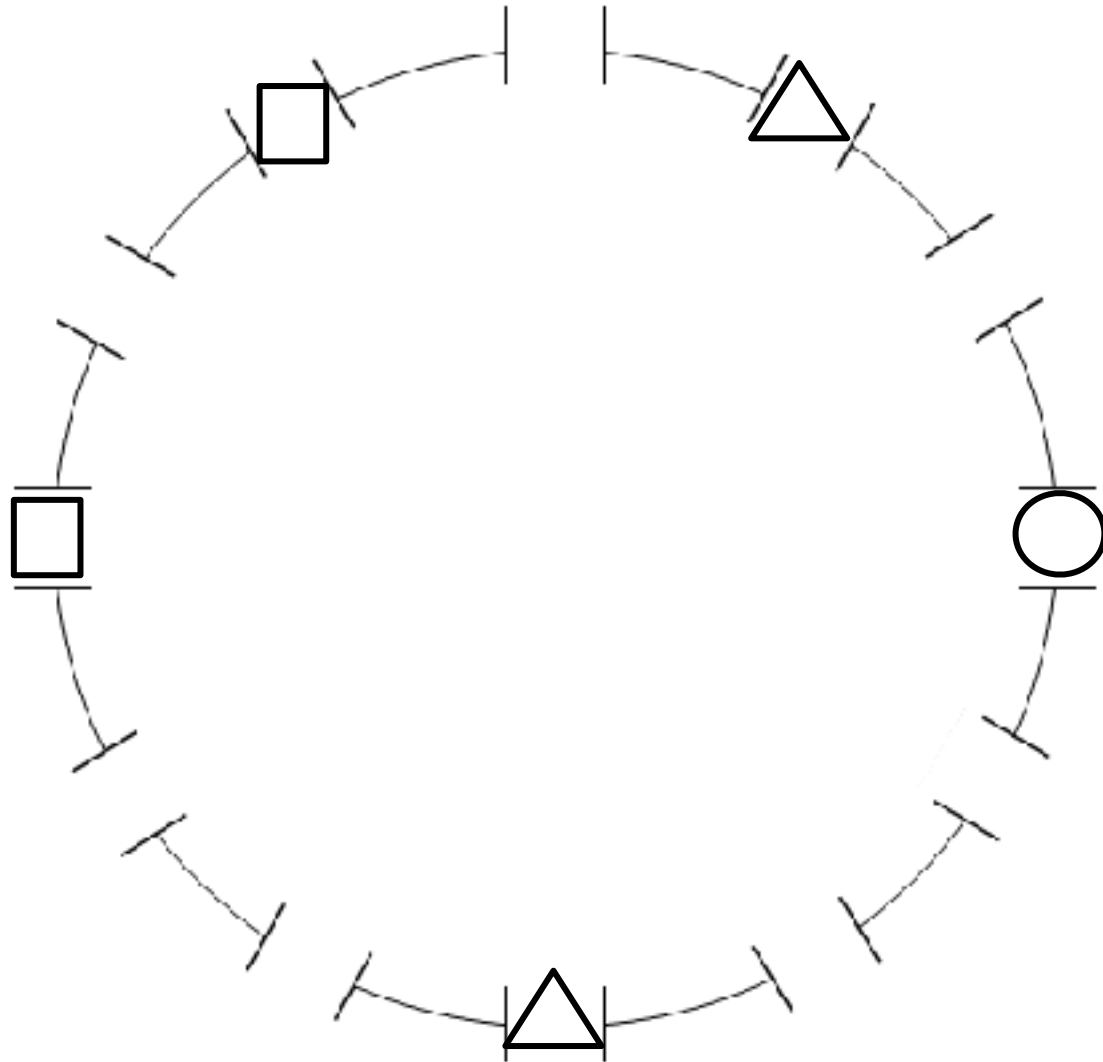
Case study 3



Case study 3



Case study 3



Natural & Intelligent User Interfaces

■ Understanding the user

- Natural modalities
- Collecting realistic data (observe the user in her space)
- Meet the user needs
 - Real-time, seamless interaction
 - Predictive interfaces

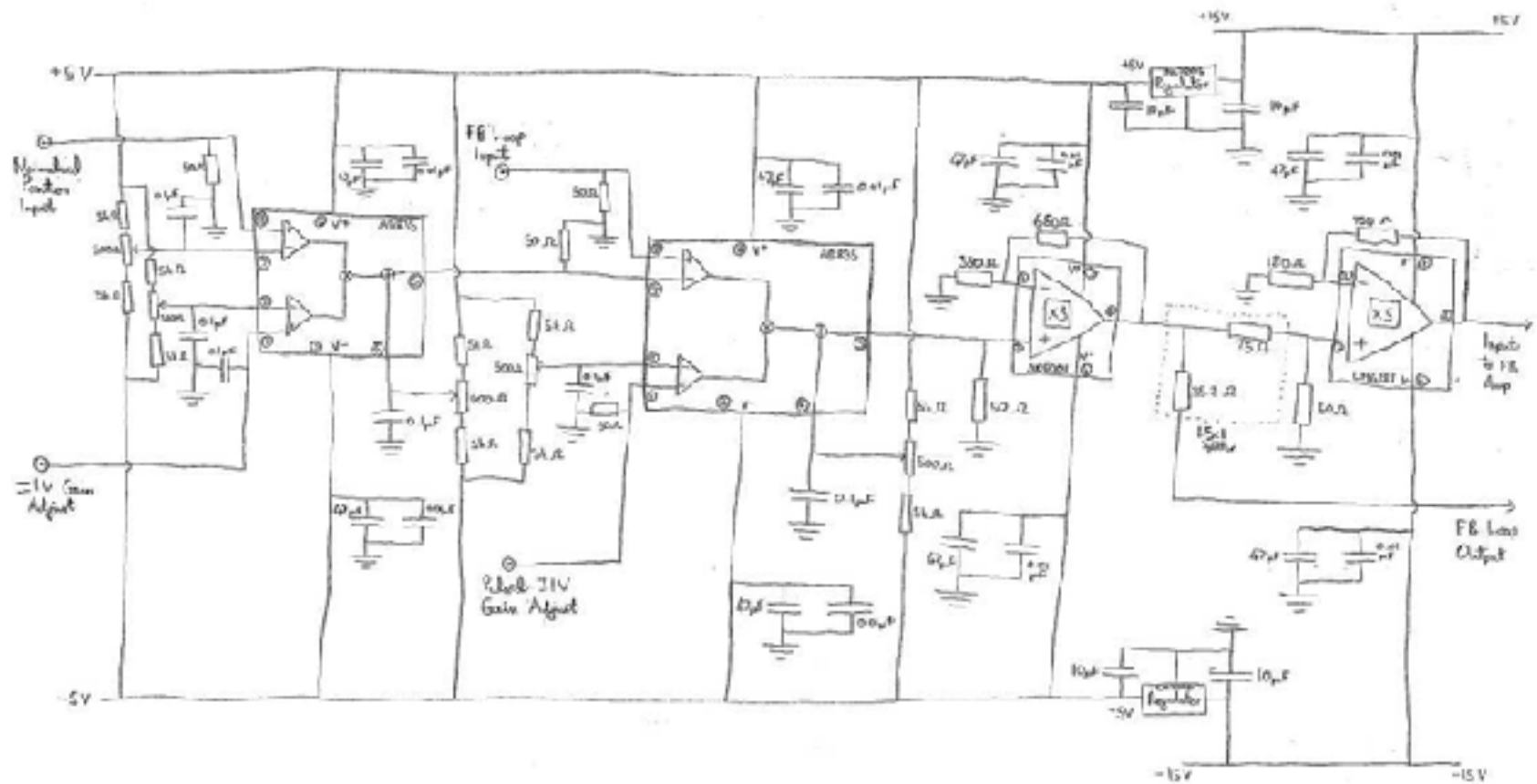
■ Understanding machine learning

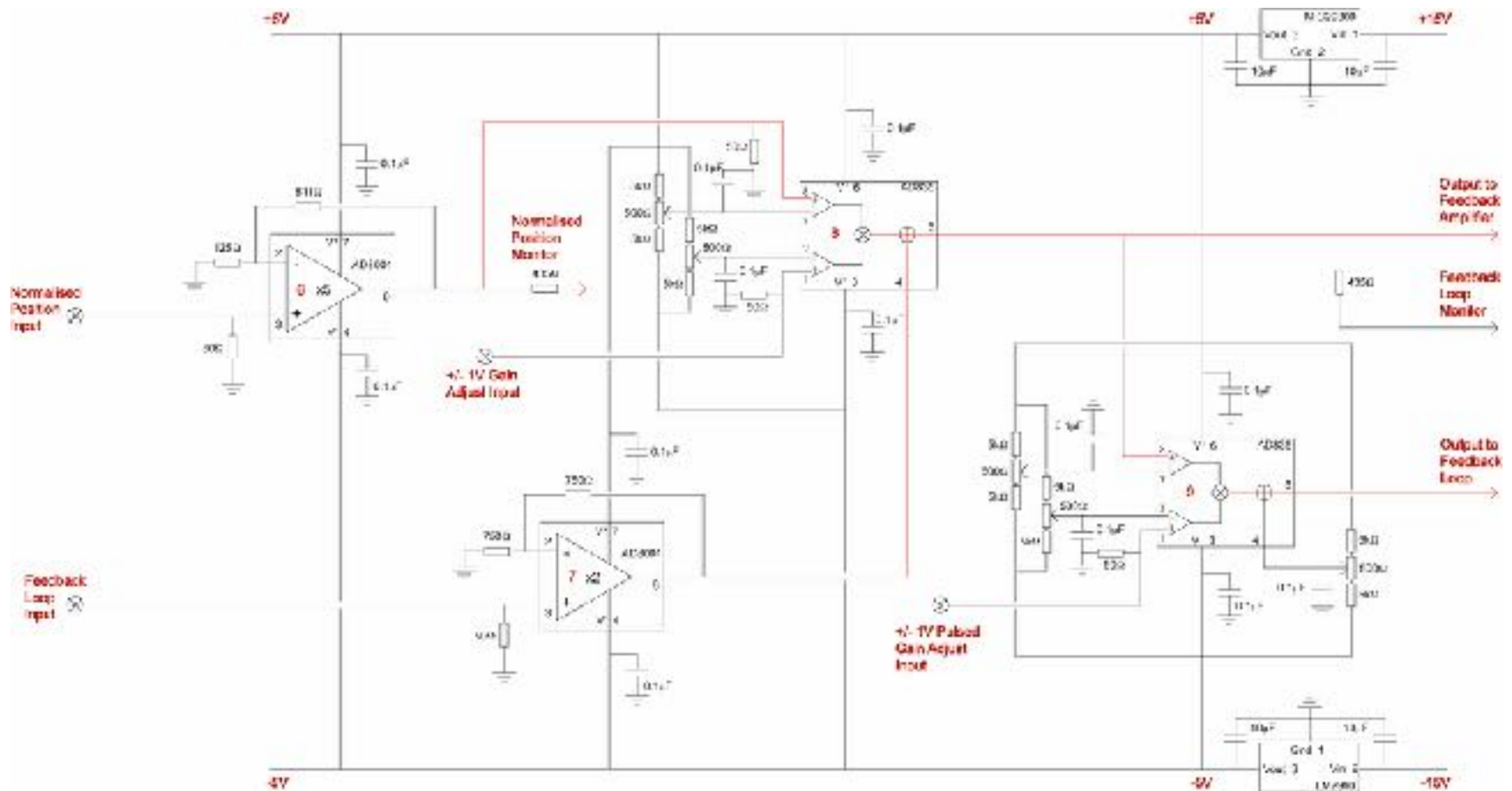
- Adaptation to the user
- Labeling large data sets (active learning)
- Getting better accuracies
 - Classifier combination
 - Feature selection
- Co-training, active learning
 - Co-reference resolution



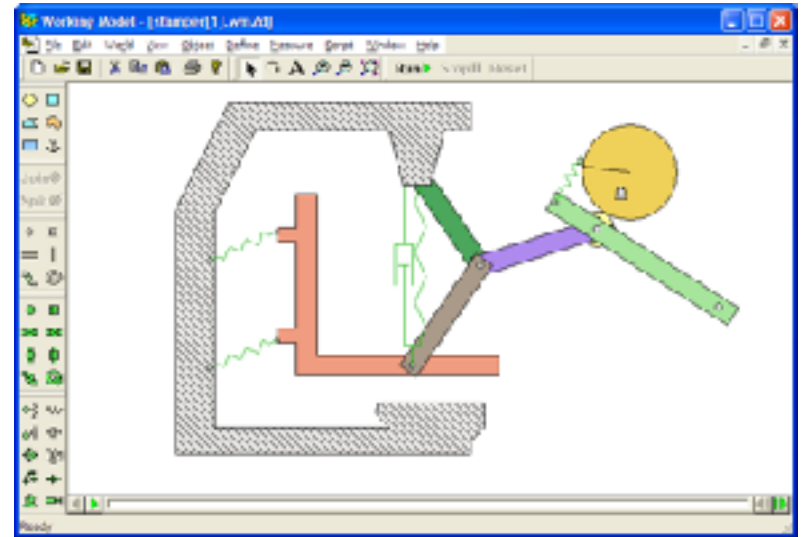
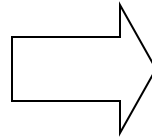
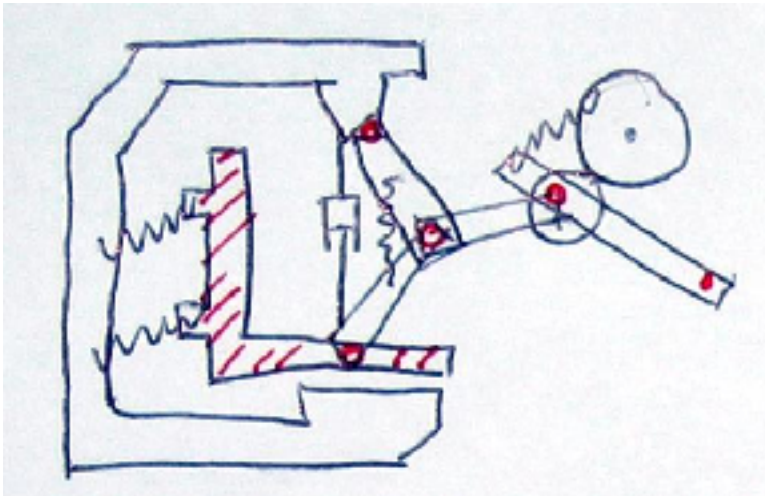
Important theme...

Electrical Engineers Draw Sketches

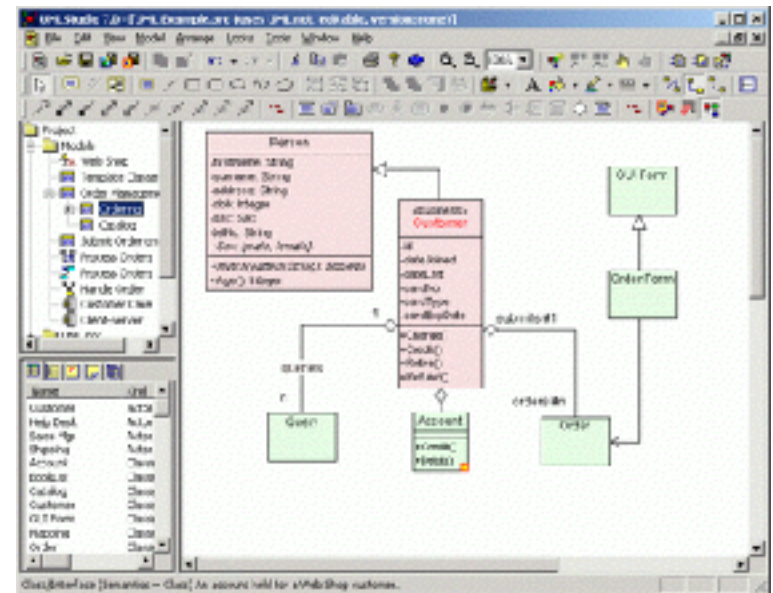
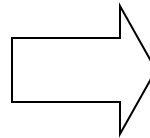
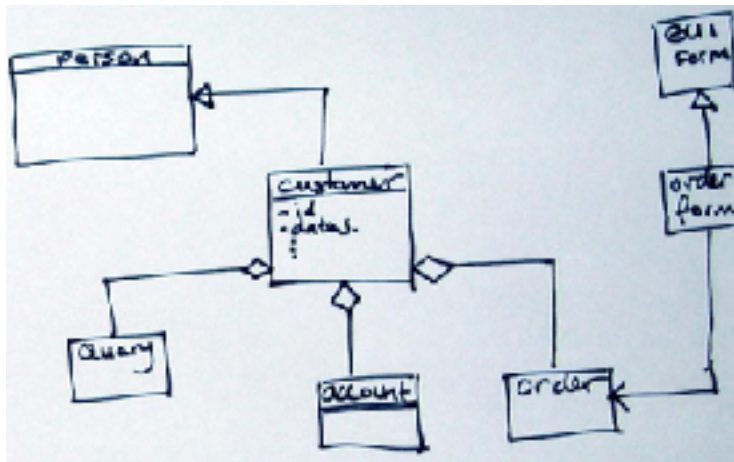




Mechanical Engineers



Software Engineers



Sketch recognition

- **Sketches are:**

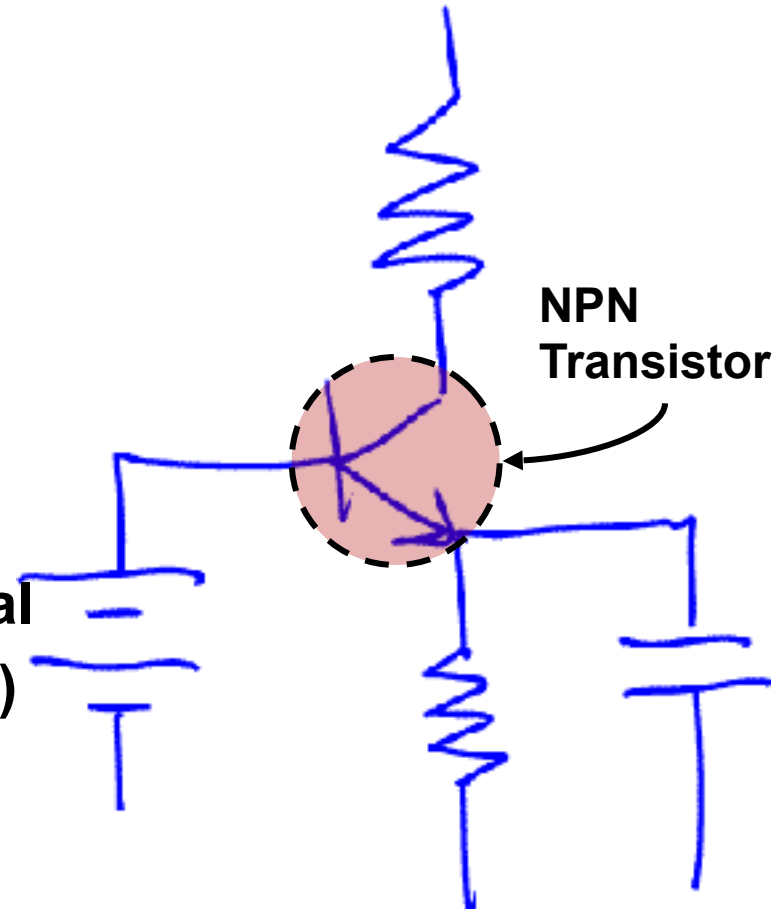
- Informal
- Messy
- Highly variable

- **Focus:**

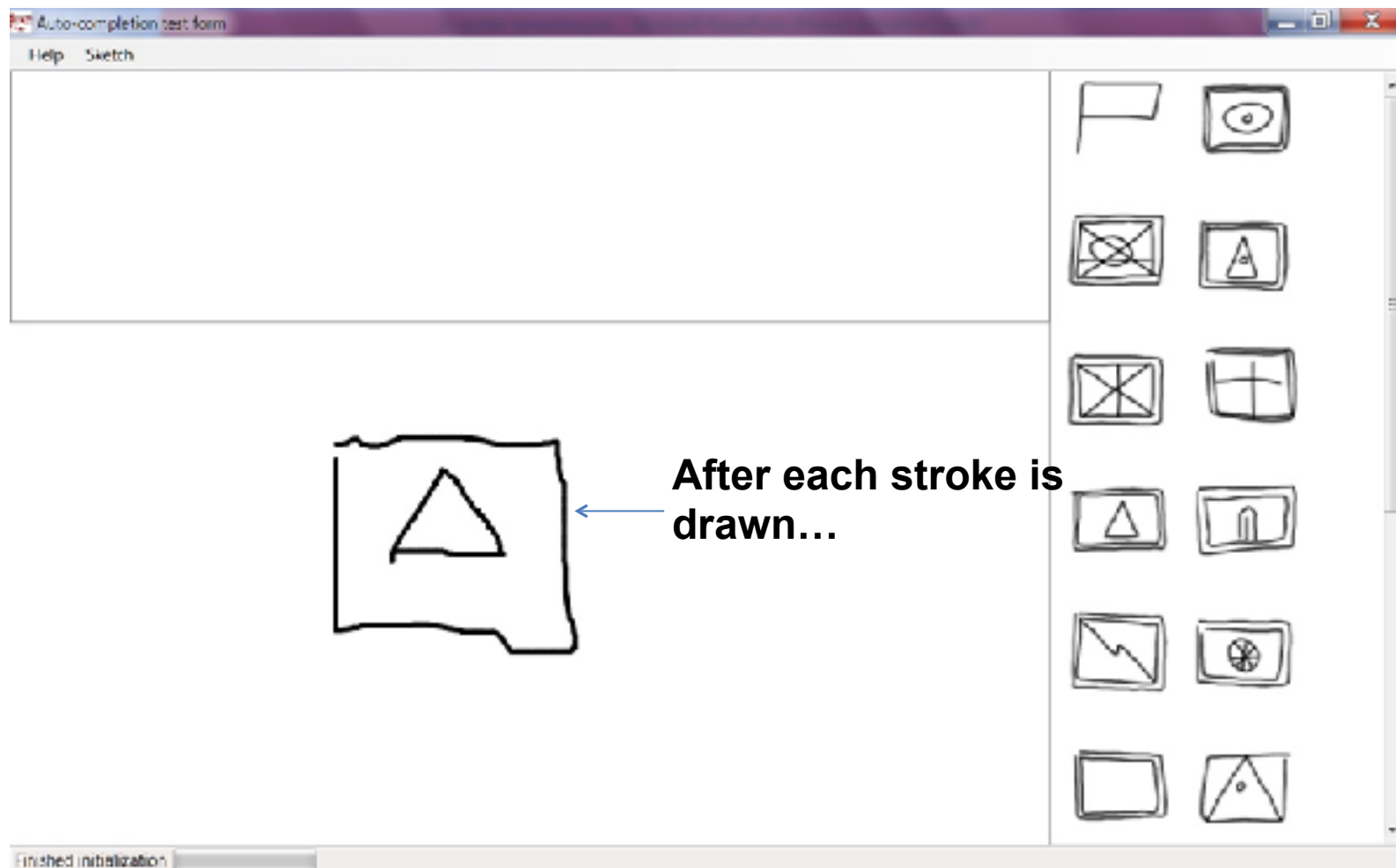
- Iconic objects
- Compositional and hierarchical
- Online sketching (incremental)

- **Our goal is to find:**

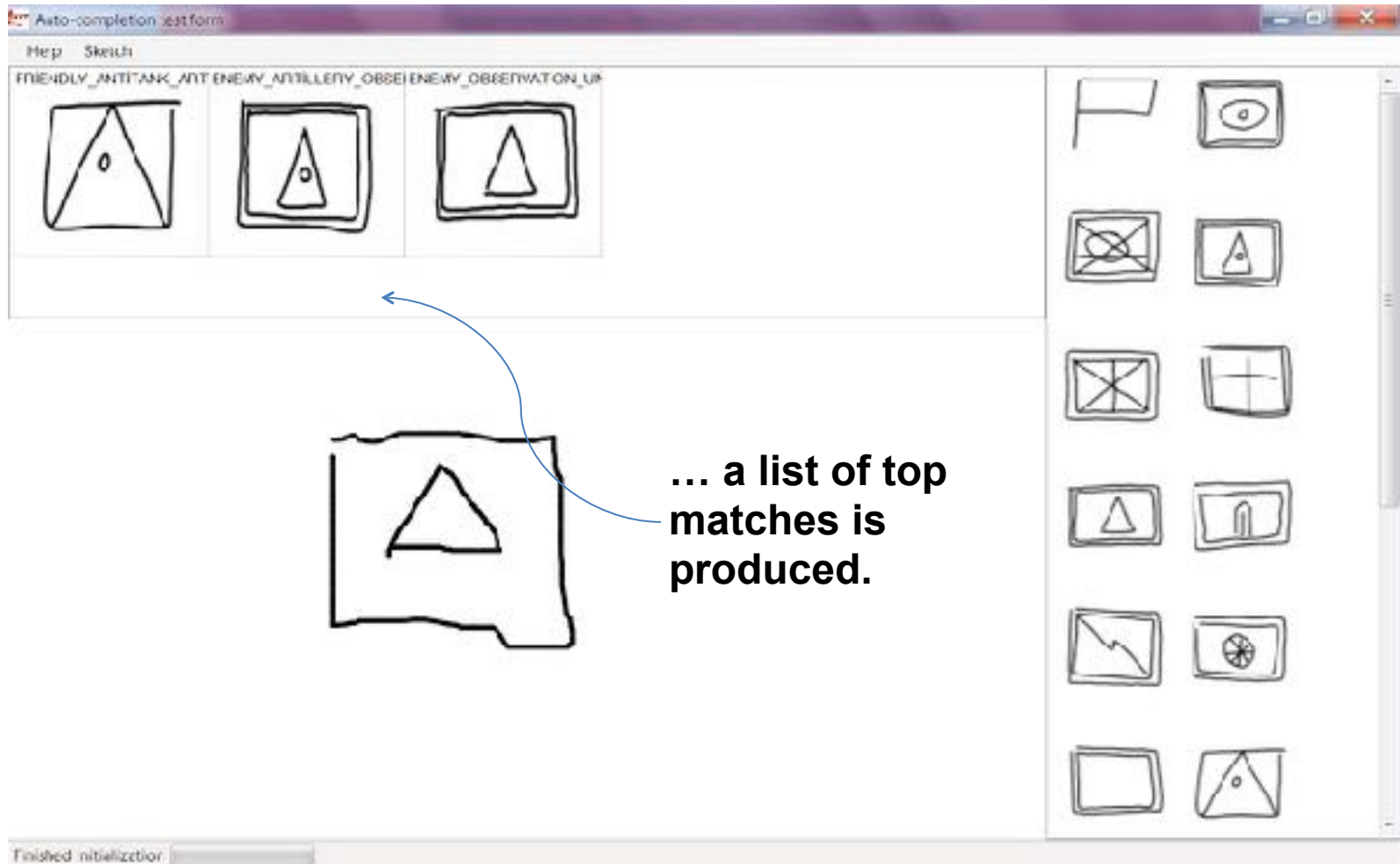
- The correct segmentation
- The correct class



Sketch recognition at work

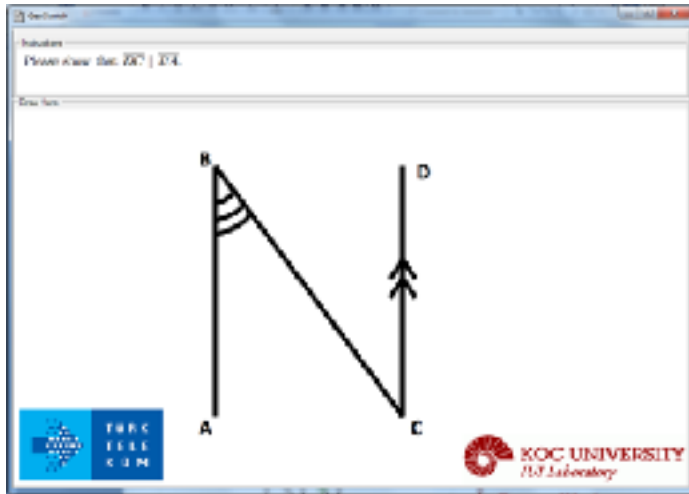


Sketched Symbol Recognition with Auto-Completion

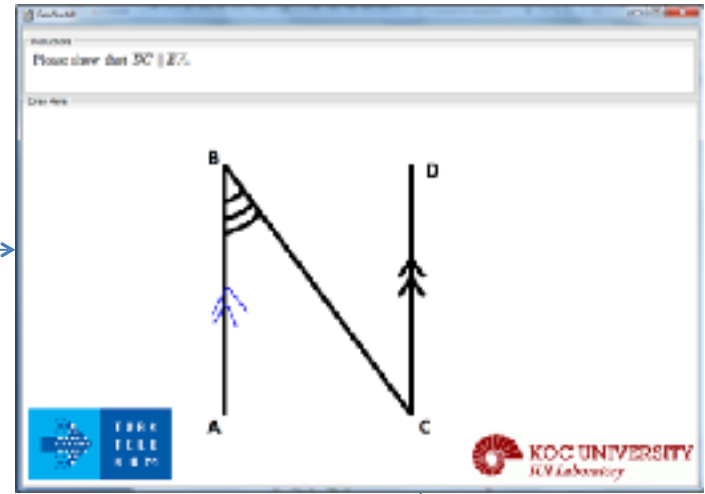


Predictive interfaces, Feature select
Classifier combination, Co-training

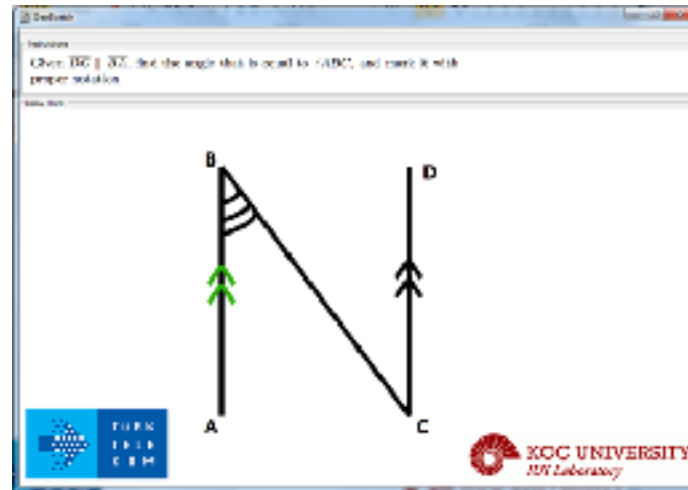
Sketch recognition at work



Input
by
stylus



Recognition



Seamless integration, Natural modality

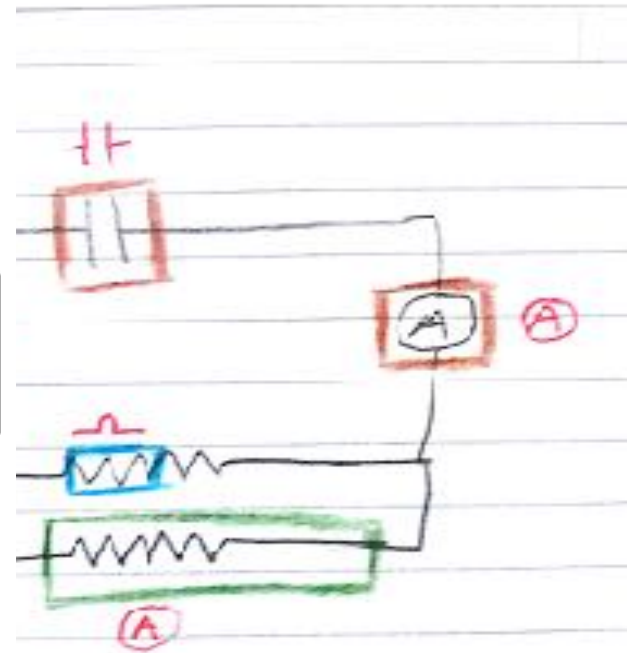
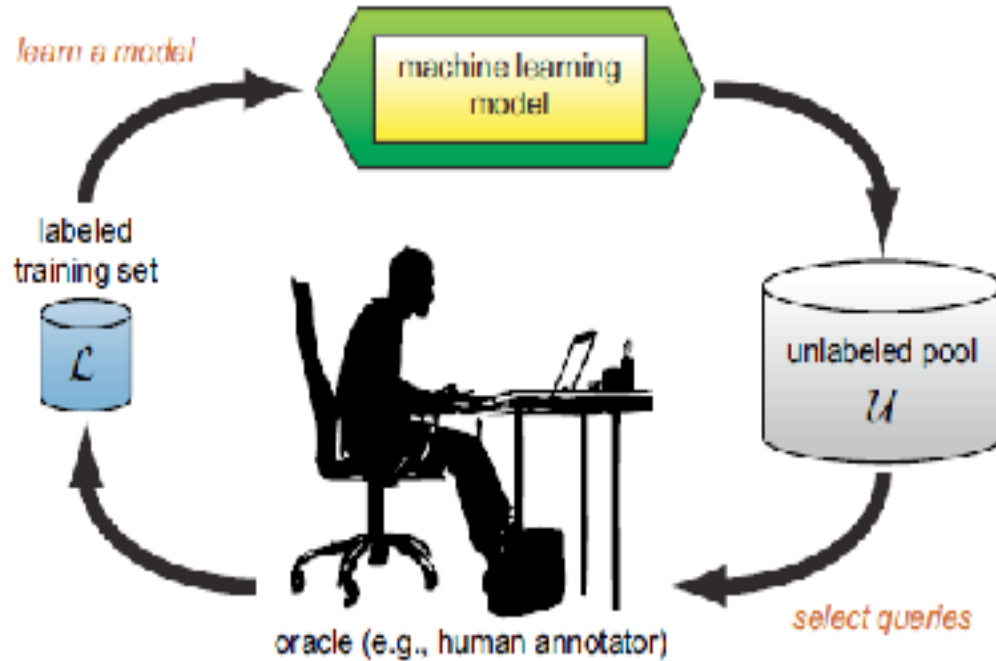
Machine learning technology & IUIs

Designing interfaces and data collection



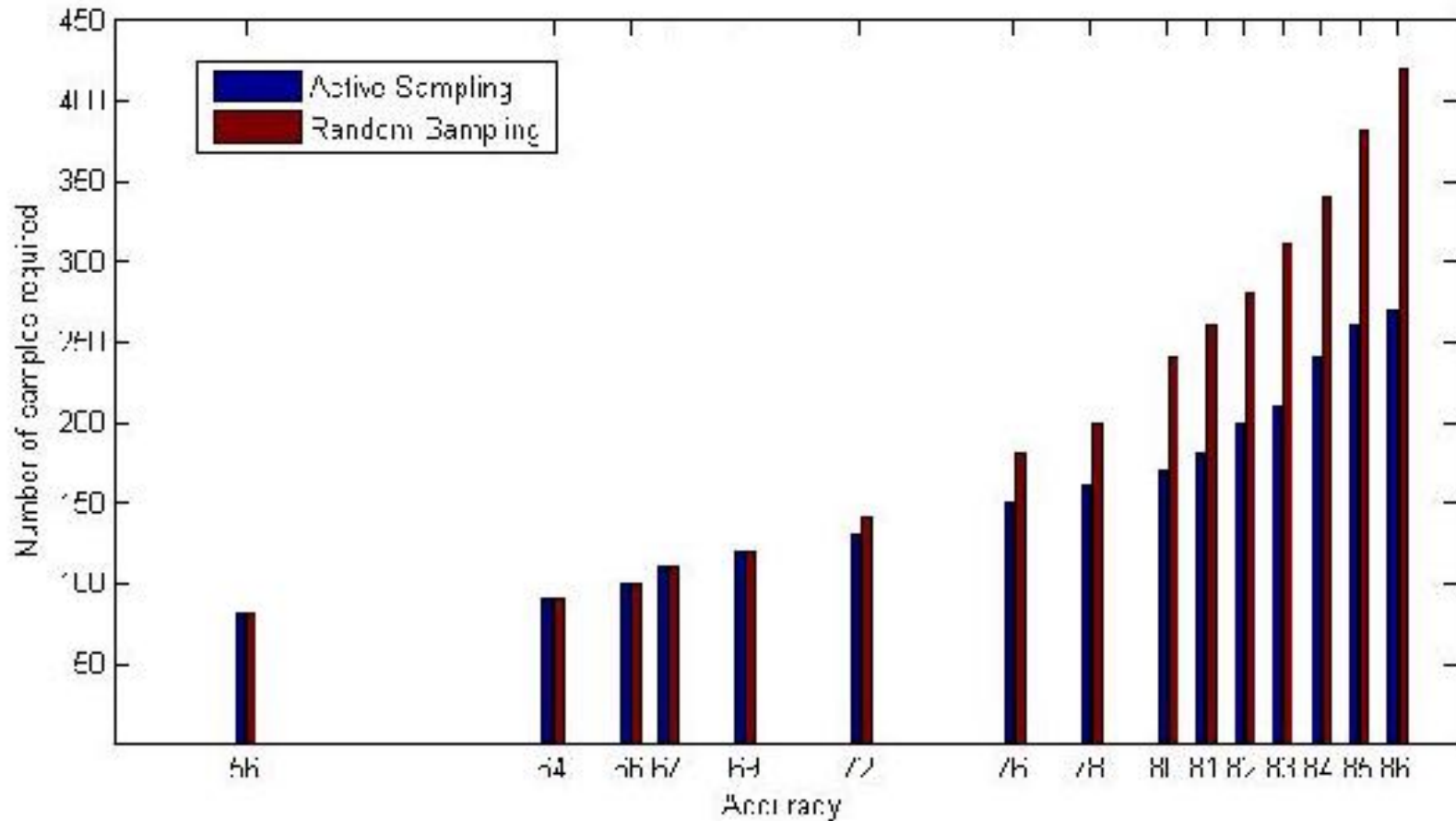
Machine learning technology & IUIs

Data labeling



Machine learning technology & IUIs

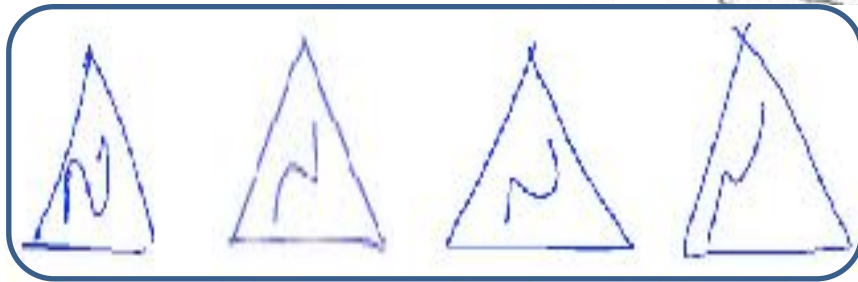
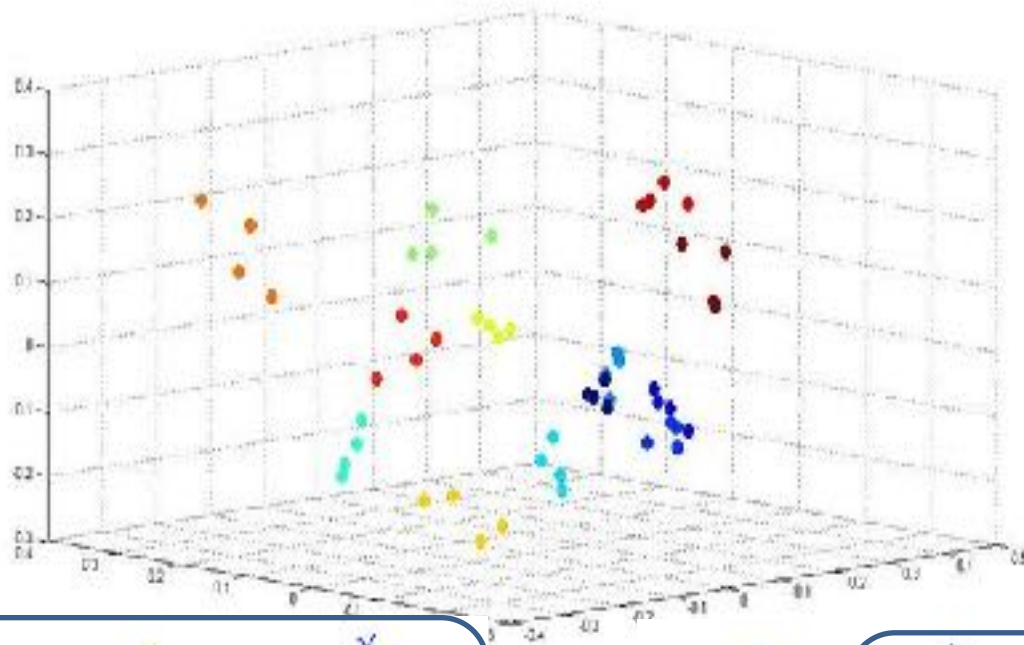
Data labeling



Active learning

Machine learning technology & IUIs

User styles



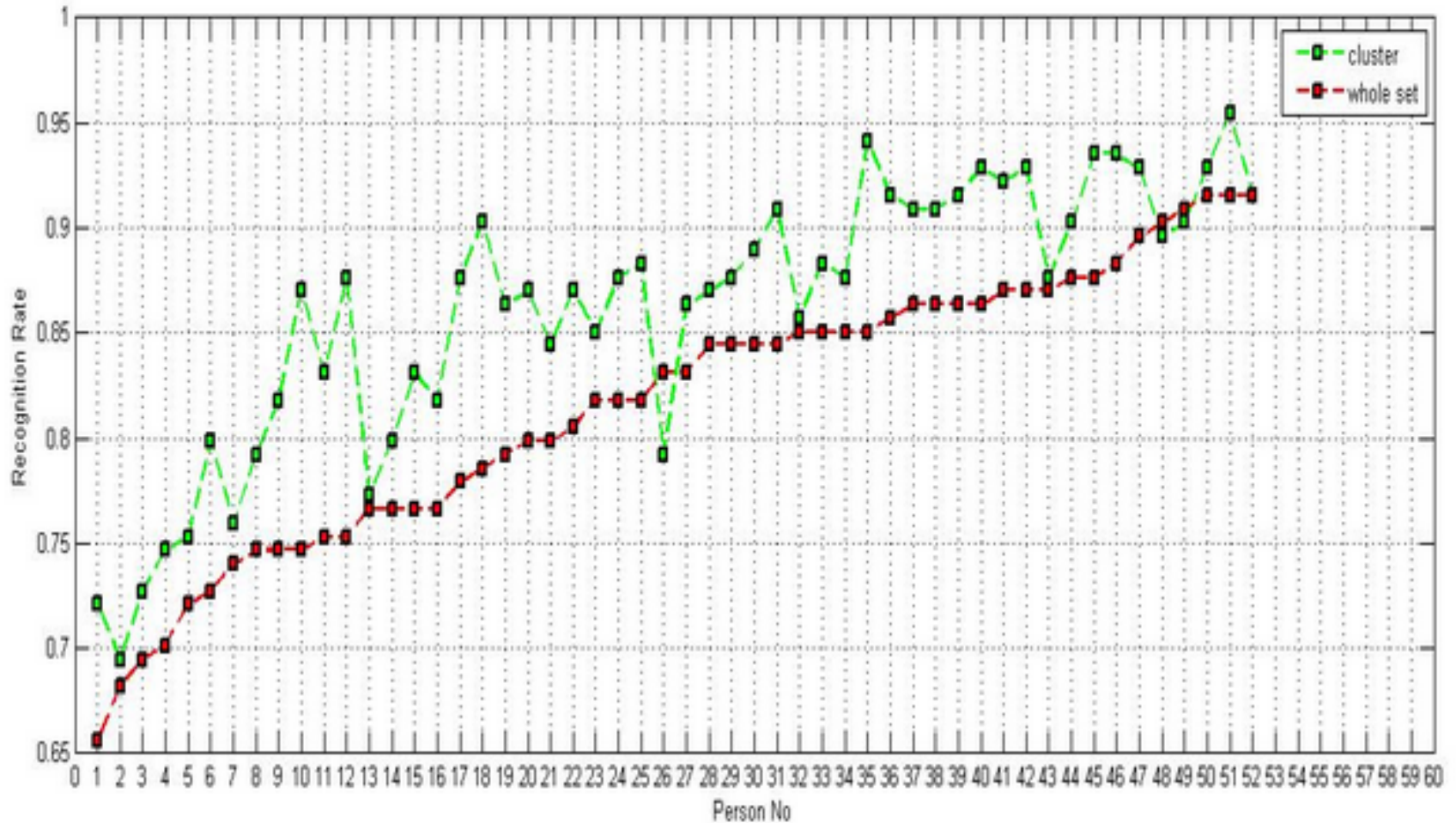
CLUSTER A



CLUSTER B

Machine learning technology & IUIs

Data labeling, User styles



Adaptation to user styles

Multimodal Input and IUIs



Led TV

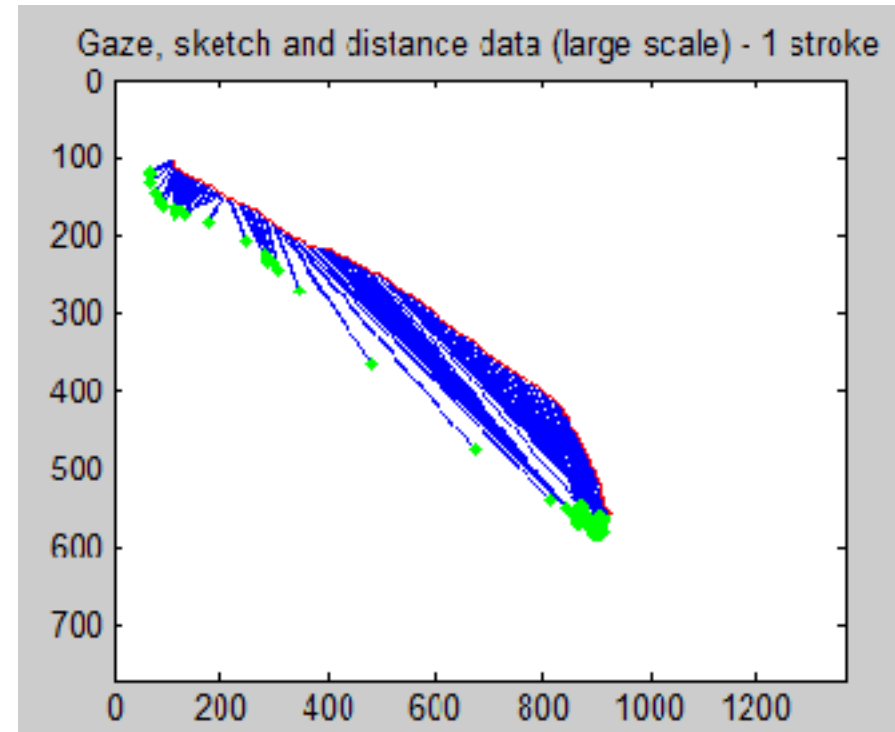
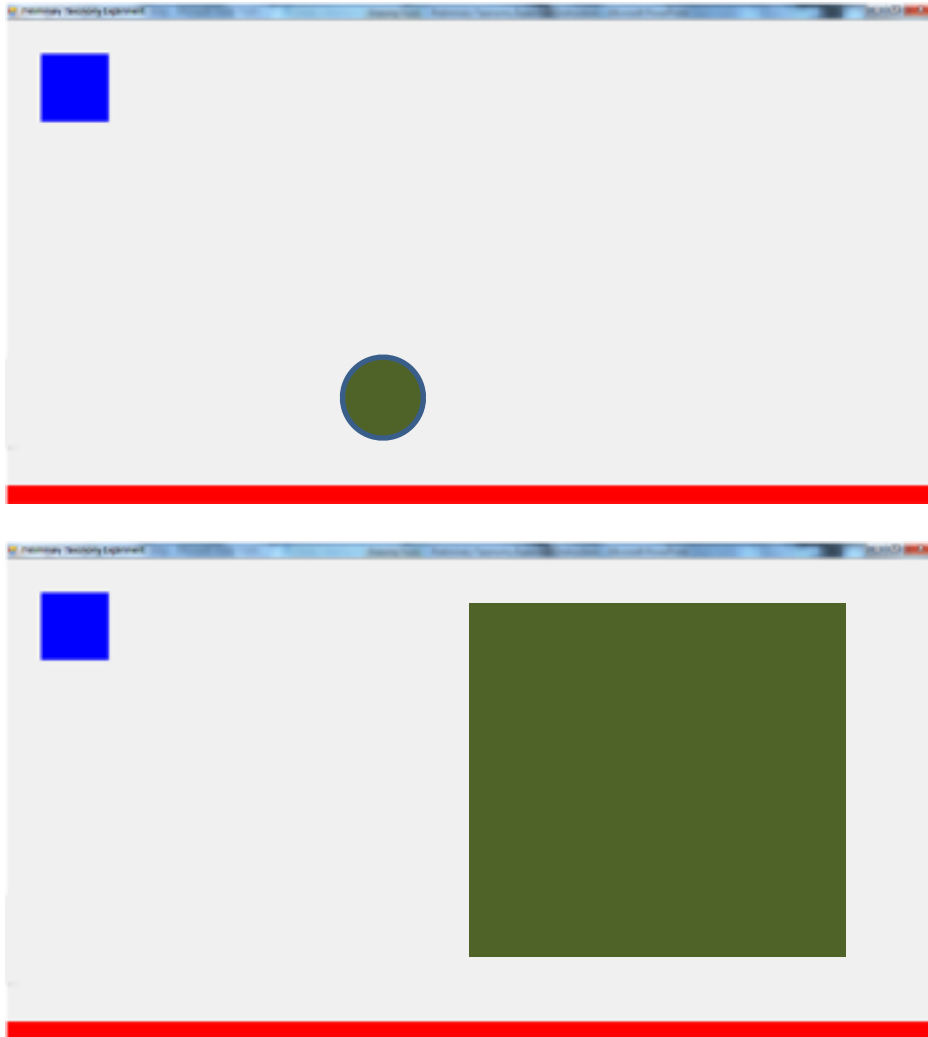
Tobii
X120

Tablet

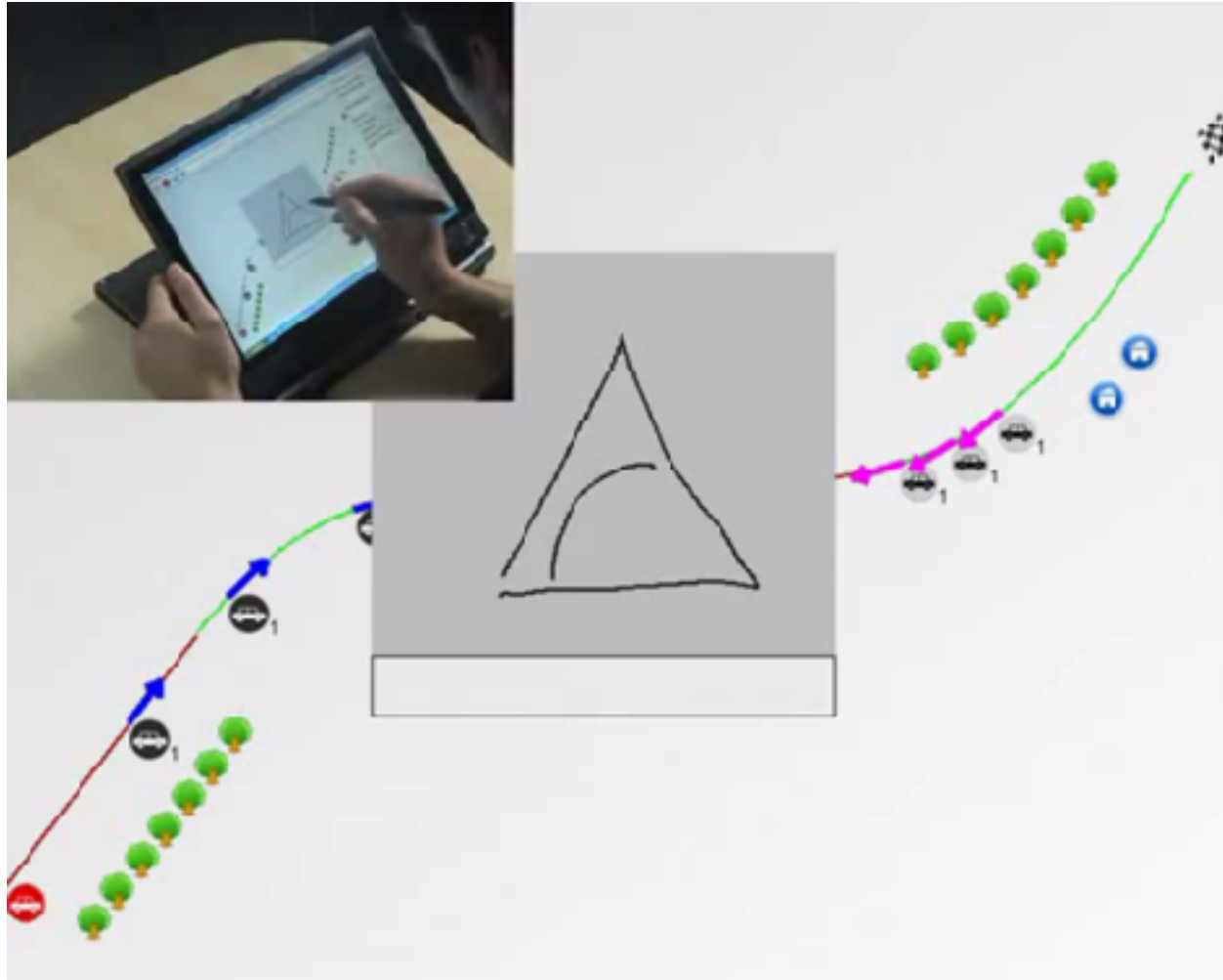


Multimodality matters

Multimodal Input and IUIs

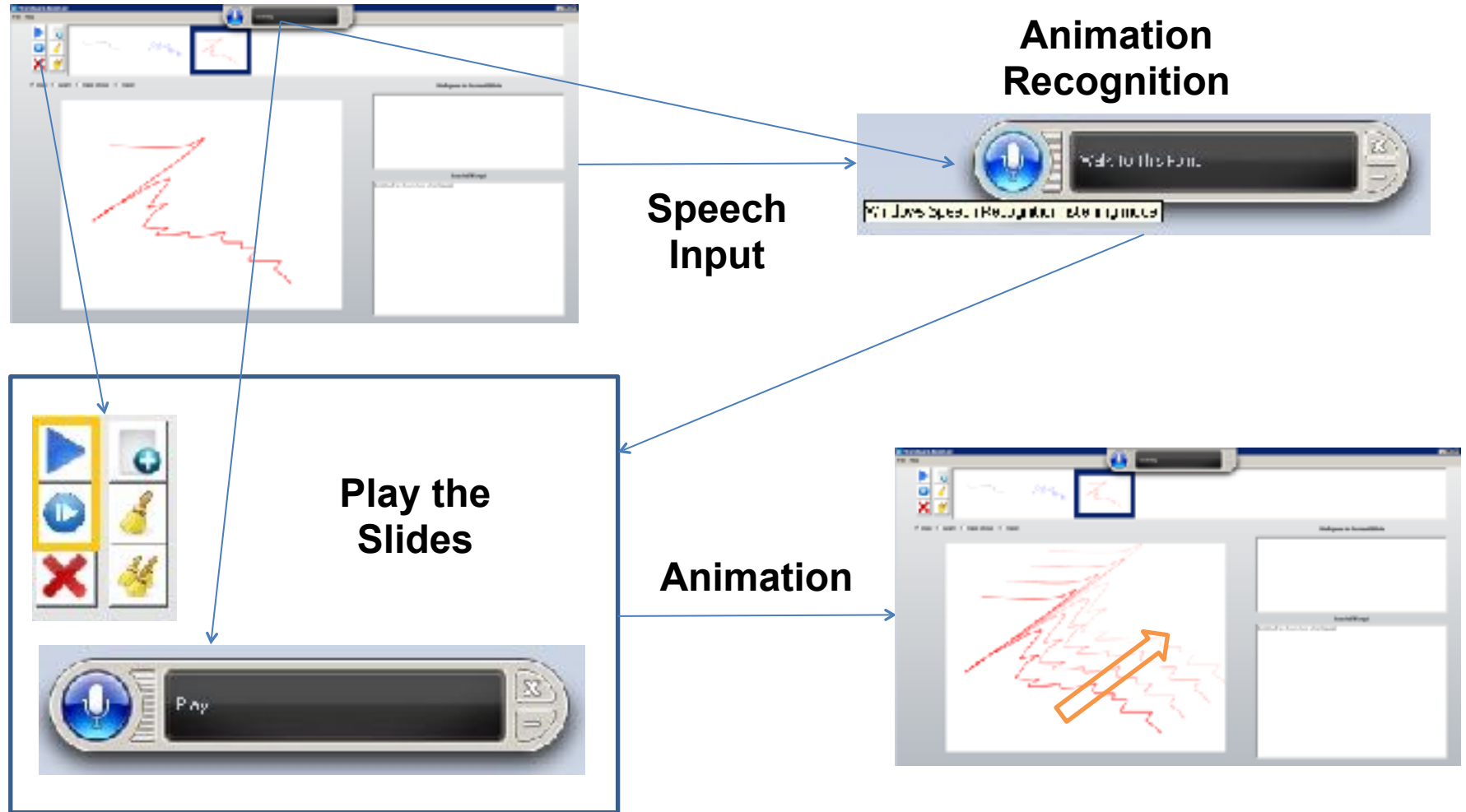


MIRA – Multi-Modal to Road Design Assistant



Natural modalities, Seamless integration,
Coreference Resolution

MISA – A Multi-Modal Approach to Storyboard Design



Natural modalities, Seamless integration
Coreference Resolution

Affect Recognition



Helping Children with Autism Spectrum Conditions

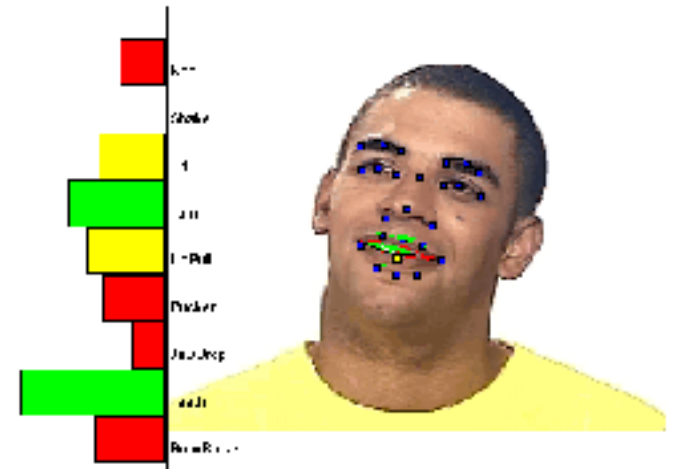


Helping Children with Autism Spectrum Conditions

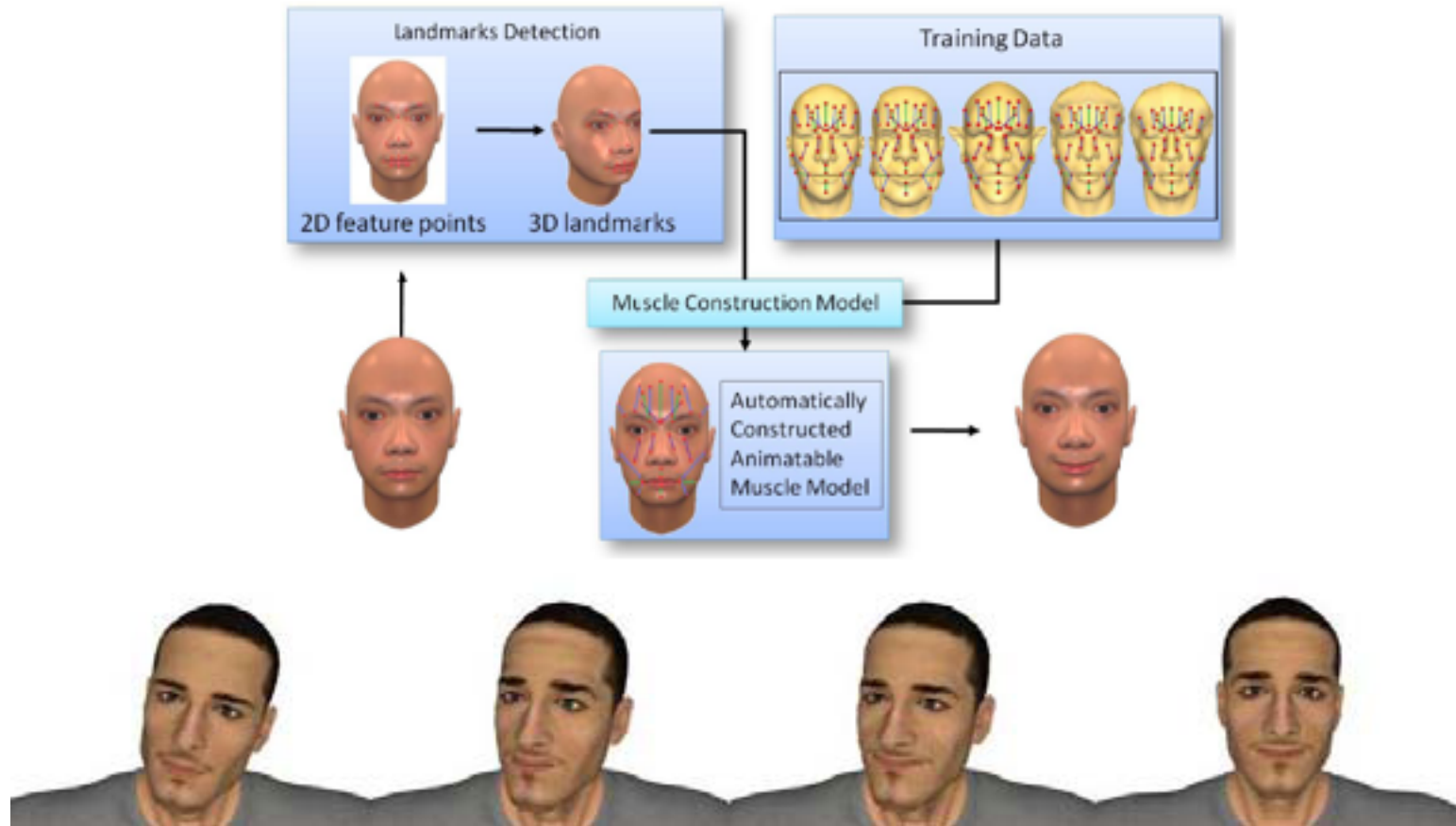


ASC-Inclusion

- **1% of the population**
 - Emotion recognition
 - Display of emotions
- **Learning through games**
 - Rehabilitation at a young age
 - Interactive learning
 - Formative assessment
- **Approach**
 - Affect recognition
 - Artificial intelligence
 - Intelligent interfaces
- **FP7 ASC-Inclusion**
 - International team (9 partners: Cambridge U., TUM ...)
 - Academic, clinical, commercial impact
 - Invaluable for the disadvantaged minorities



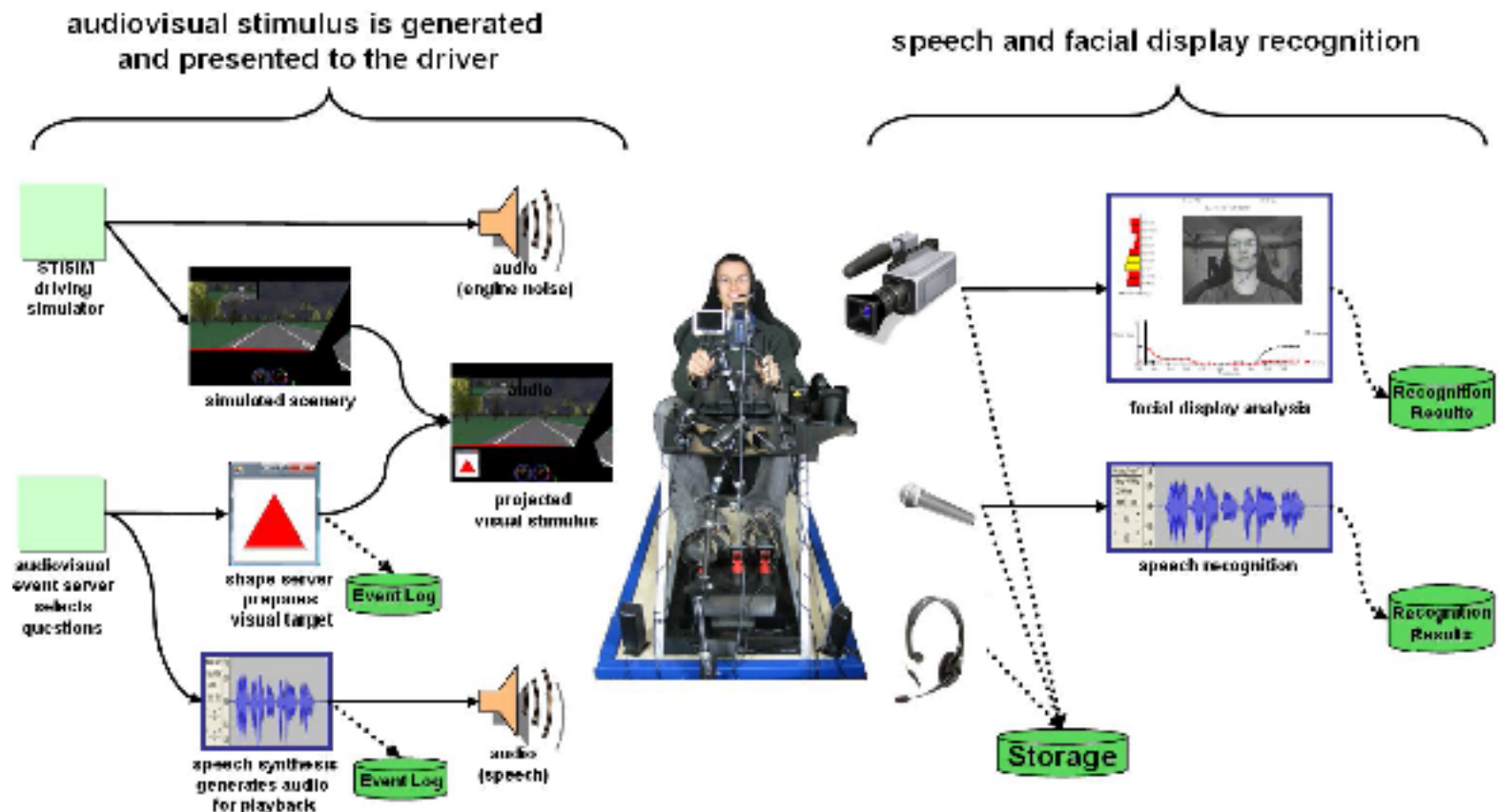
Affective interfaces – animation



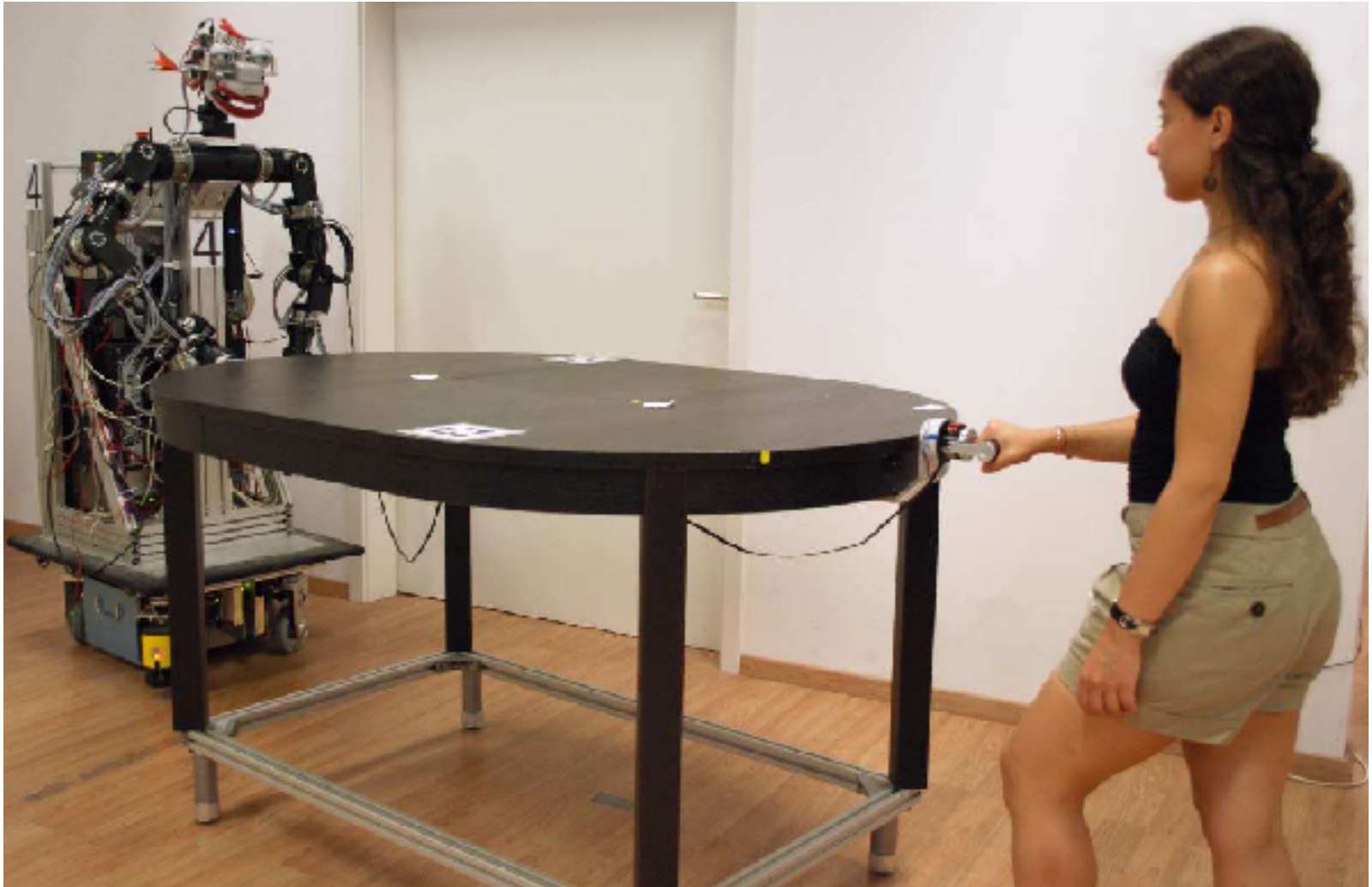
Affective interfaces – recognition



Affective interfaces – multiple modalities



Collaboration and Negotiation: humans vs. computers vs. robots



Know thy customer! Modalities matter

Goals

- **Create UI awareness**
 - Not just machine learning
 - Million ways to do it wrong
- **Showcase technology**
 - Sketch recognition
 - Multimodal interfaces
 - Eye-gaze
 - Speech
 - Sketching
 - Affect
 - Haptics

Acknowledgements

■ Postdocs

- Basak Alper
- Nese Alyuz
- Yusuf Sahillioglu

■ PhD students

- Sinan Tumen
- Ayse Kucukyilmaz
- Caglar Tirkaz
- Cagla Cig
- Ezgi Emgin
- Emre Karaman
- Ferhat Cagan

■ MS students

- Cansu Sen
- Burak Ozen
- Ozem Kalay
- Erelcan Yanik
- Atakan Arasan
- Banucicek Gurcuoglu
- Kemal Tugrul

■ Undergraduate students

- Anil Uluturk
- Furkan Bayraktar
- Ozan Okumusoglu

■ Collaborators

- Cagatay Basdogan
- Berrin Yanikoglu
- Engin Erzin
- Yucel Yemez

■ Sponsors

- DARPA
- European Commission
- National Science Foundation
- Türk Telekom
- Koç Sistem
- Ministry of Science Industry & Technology

