HCI @METU: Multimodal Interaction through Visual and Haptic Modalities

TGMIS
Turkish German Multimodal Interaction Summit
Istanbul, Turkey

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ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

COGNITIVE SCIENCE PROGRAM

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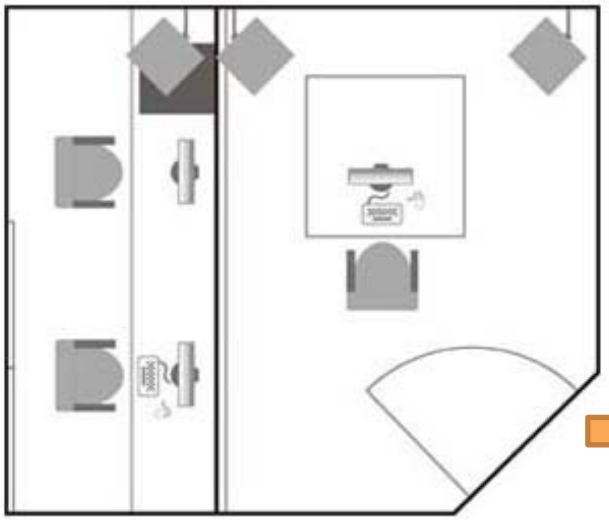
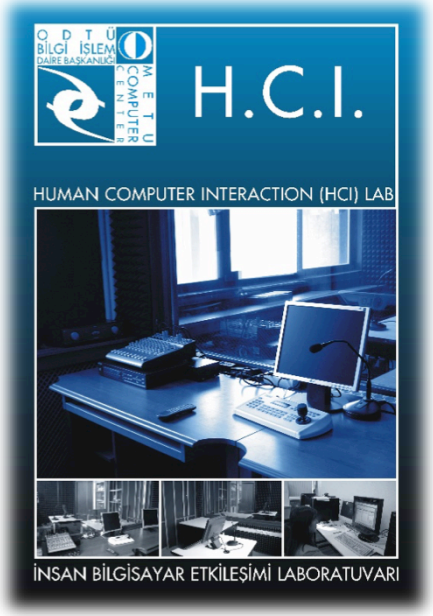
- METU is a state university
- Three campuses (Ankara, Erdemli, Northern Cyprus):
  - Ankara in the main campus
- 1200 full-time teaching faculty members in
  - **5 Faculties and 5 institutes** offering 40 undergraduate and 166 graduate programs
  - **21 Interdisciplinary Research Centers**
- Student profile: 28,000 students (40% graduate students)
  - Over 1700 international students from 94 different countries

Background and research interests

- Background
  - B.Sc. ’98 (METU, Mechanical Engineering)
  - M.Sc. ‘05 (METU, Informatics Institute, Cognitive Science)
  - PhD ‘10 (University of Hamburg, Germany, Knowledge and Language Processing)
- Research interests
  - Visual cognition and eye tracking
  - Visual and haptic perception of lines and closed curves
  - Text comprehension and psychology of reading
- Relevant Research Groups
  - METU Human Computer Interaction Research Group
  - MINT (Multimodal Interaction research group)

- HCI Research Group (2005)
- Group Leader: Prof. Dr. Kürşat Çağıltay





- Eye tracking facilities (since 2005)




- Haptic exploration and gesture recognition (since 2008)


Interaction through haptics, gestures, and eye movements

- Öztek (funded by Tubitak, 2005-2008)
- The goal: To develop innovative, technology enhanced learning environments to support Special education of children and investigate effectiveness of such learning environments
- Three major components
  - Interactive multi-touch table/board, which eliminates the requirement keyboard and mouse use
  - Smart/interactive toys
  - Interactive multimedia educational software that will detect body movements

Öztek outputs

- Multi-touch table and tablets

Öztek outputs

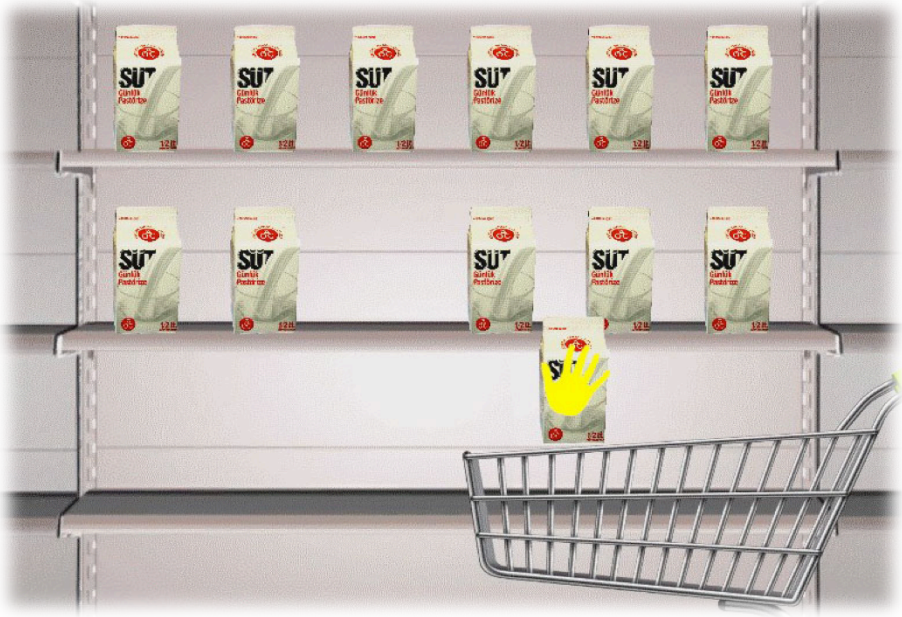
- Smart toys

RFID-based story-telling

Öztek outputs

- Bodily interaction

Accomplishing basic tasks, such as virtual shopping



Lessons learned from Öztek

- Video models are necessary
- Short stories, adequate illustrations, selection of objects from everyday life
- Buttons are helpful in navigation
- Control buttons should enable teachers to provide supervision
- Verbal instructions are necessary
  - Verbal instruction characteristics is important (stress, tone of voice, apparentness)

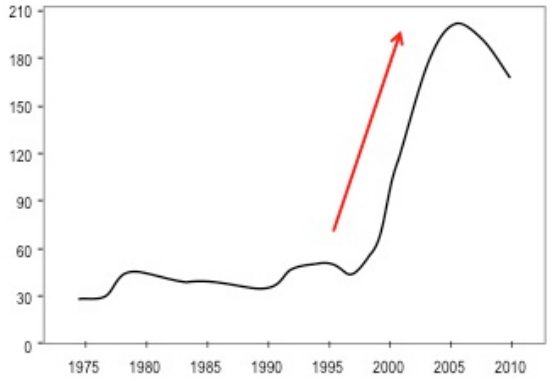
- Designing the “simple” is difficult!

Comprehension and learning from multiple representations

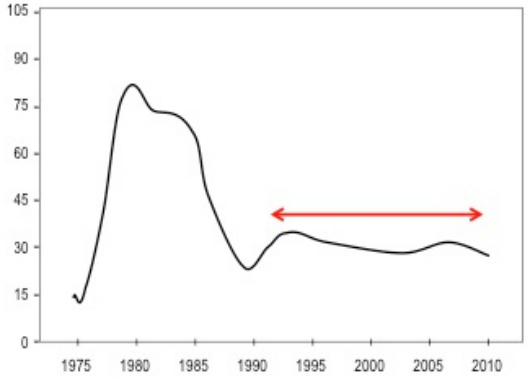
- Learning from text and diagrams
  - Mobile multimedia learning through QR codes (2011)
  - Learning under secondary task settings, e.g., spatial tapping

Özçelik, E. & Acartürk, C. (2011). Reducing the spatial distance between printed and online information sources by means of mobile technology enhances learning: Using 2D barcodes. *Computers & Education*, 57(3), 2077-2085. doi: 10.1016/j.compedu.2011.05.019.

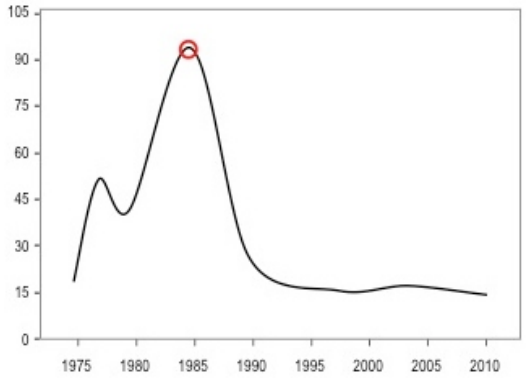
Communication through graphs (2012)



A process-graph



A durative-state-graph



A punctual-state-graph

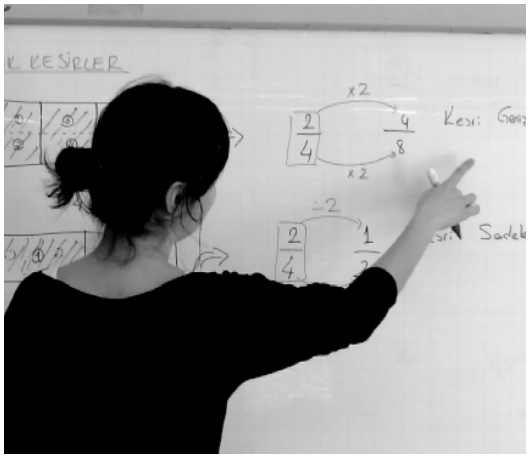
A representational gesture (diagonal)

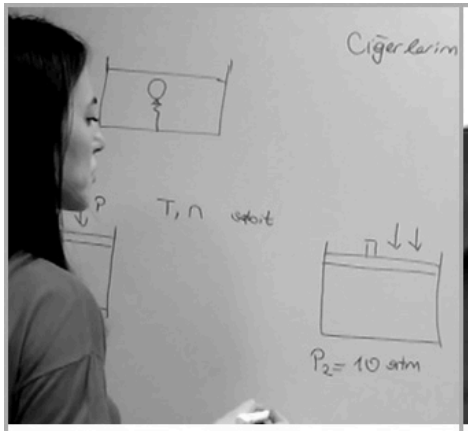
A representational gesture (horizontal)

A deictic gesture (pointing)

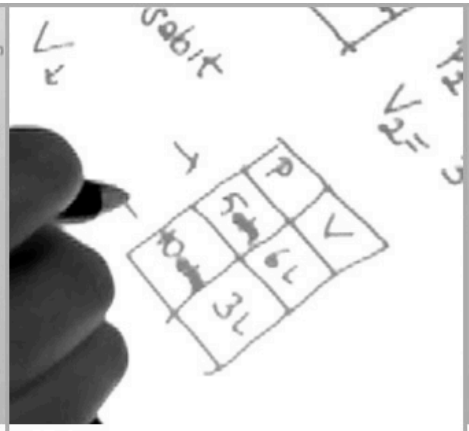
Communication through diagrams (2014)

- Production of pointing gestures and arrows in teaching settings

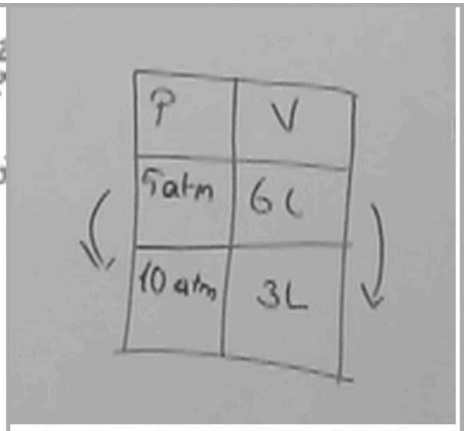




An Iconic Arrow
illustrating pressure



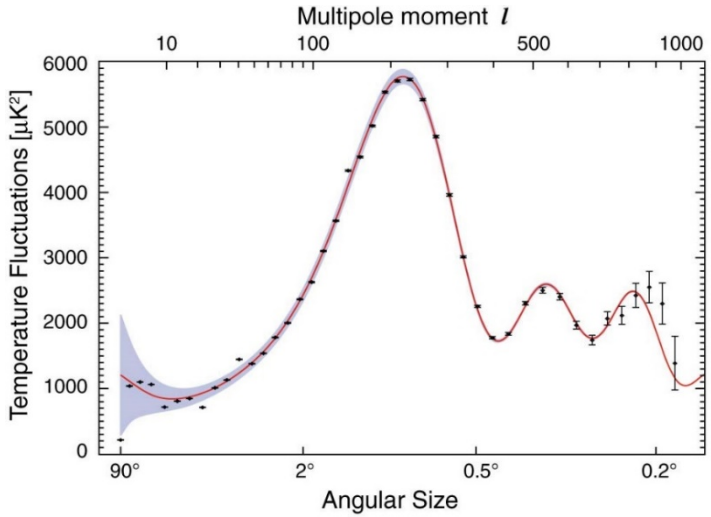
A Deictic Arrow
pointing to the table

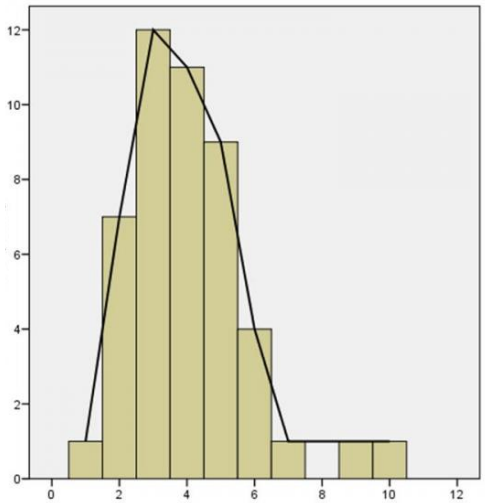


A Relational Arrow
showing relation between two values

Comprehension and learning from multiple representations

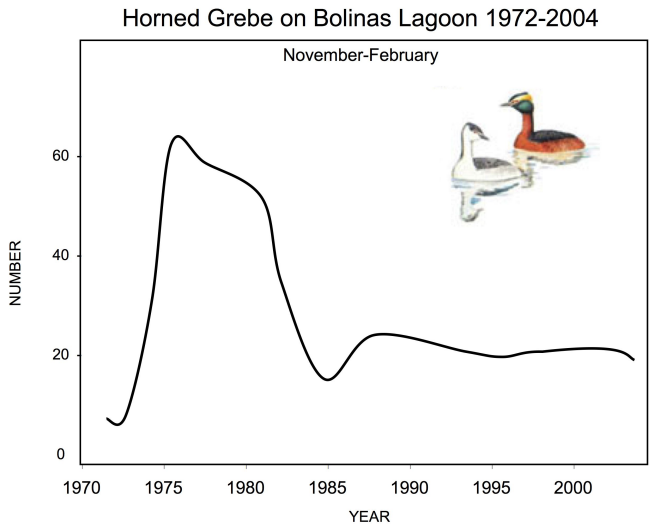
- Line graphs in time domain (since 2006)
- Motivation for studying line graphs
  - Graphs are abundant: Both spoken and written communication settings
  - Competent use of graphs facilitates scientific reasoning
  - Graphing skills are important for social inclusion





Graph comprehension

- Graphs are multimodal in two dimensions
  - Language always accompanies graphs (representational modality)
  - Sonified graphs and haptic graphs may also be accompanied by language (sensory modality)
- Language of graphs contains spatial terms (an almost close set)



Bolinas Lagoon Population Trends

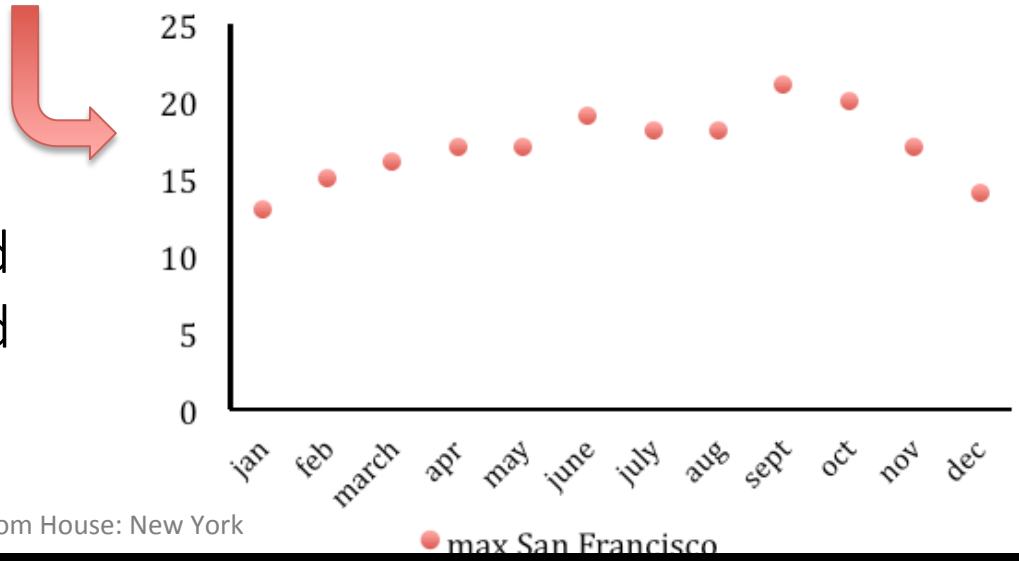
From a peak of about 60 wintering birds in 1976, numbers have declined to about 20 birds currently.

Source: http://www.prbo.org, Waterbird Census Report, Bolinas Lagoon.

Representing graphs visually

- Graphs are drawn by using statistical data in the form of tables
- An example: Average daily maximal temperature (amxt) at San Francisco (data from Pearce & Smith 1998)

month	amxt	month	amxt	month	amxt	month	amxt
jan	13	apr	17	july	18	oct	20
feb	15	may	17	aug	18	nov	17
mar	16	june	19	sept	21	dec	14

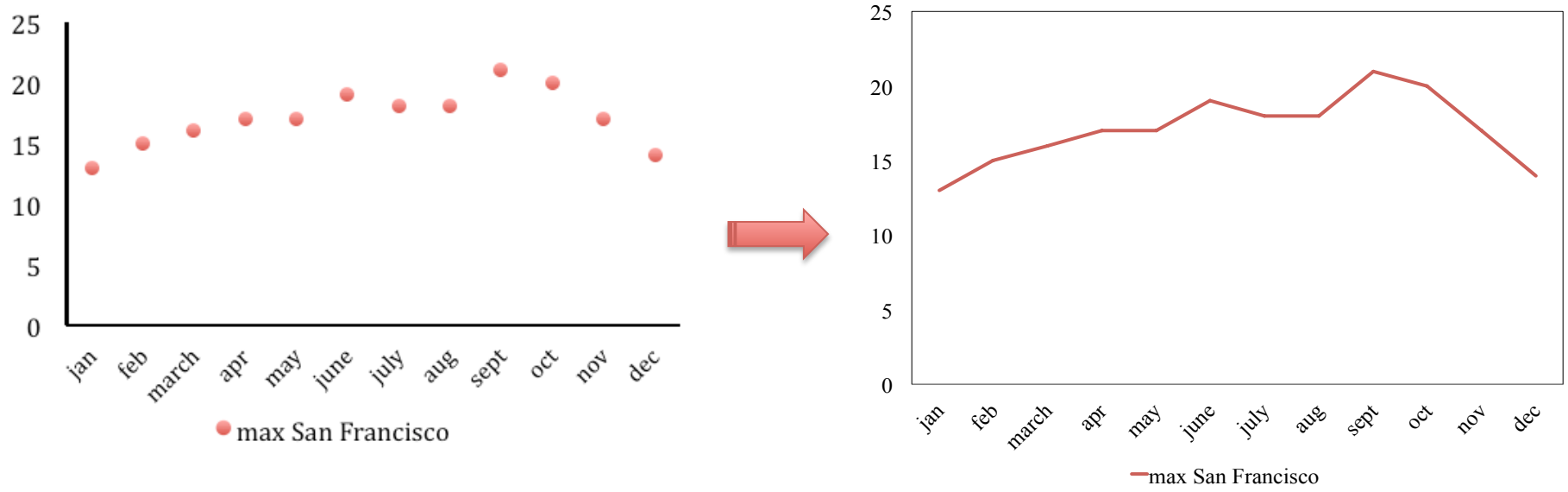


- A set of data points (specified by the table) that is visualized by a data point graph

Pearce, E.A. & Smith, C.G. (1998). Fodor's World Weather Guide. Random House: New York

Representing graphs haptically

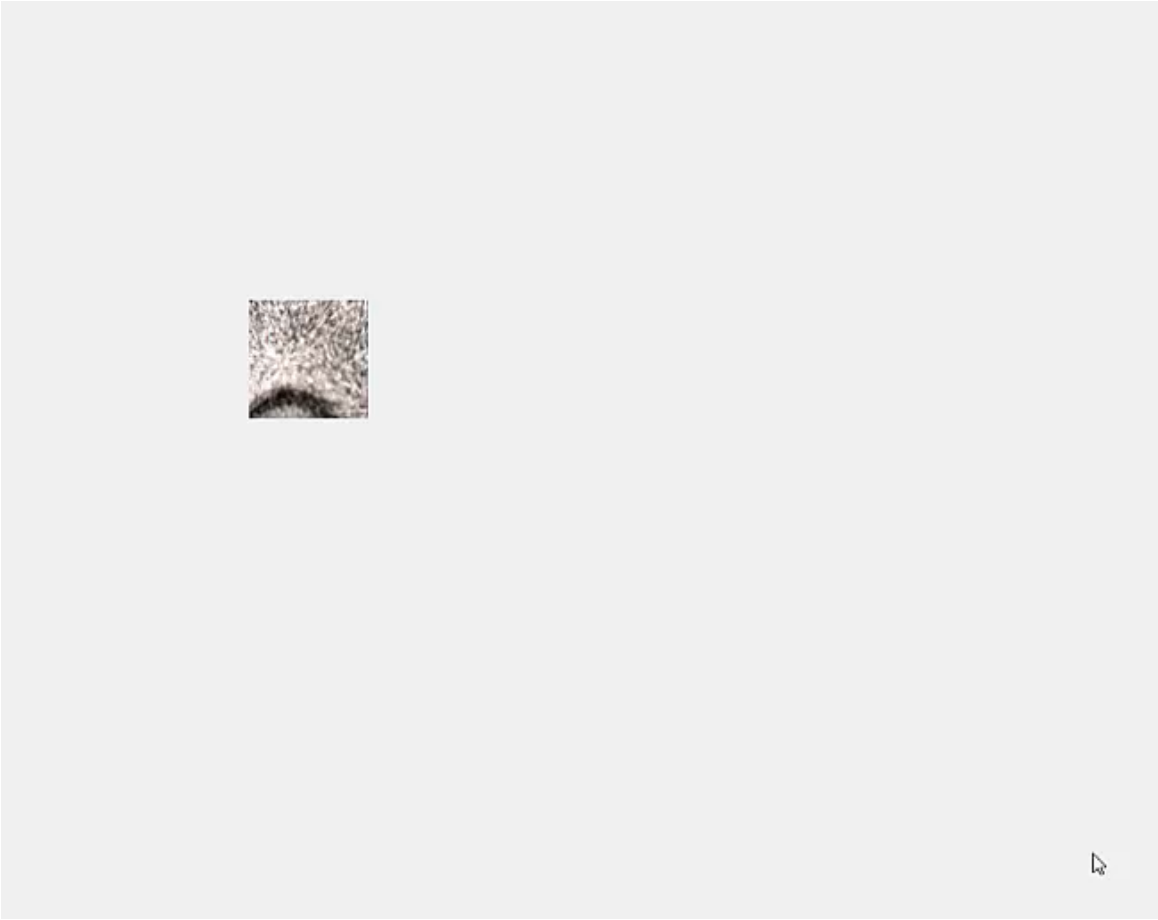
- Human visual processing leads to the visual impression of a linear whole, namely a line difficult to verbalize
  (cf. Gestalt principles)



- The observation: The graph “line” contains elements which have no origin in the data
- A set of challenges in designing haptic graphs (how to design line segments, how to solve the local-global maximum problem, etc.)

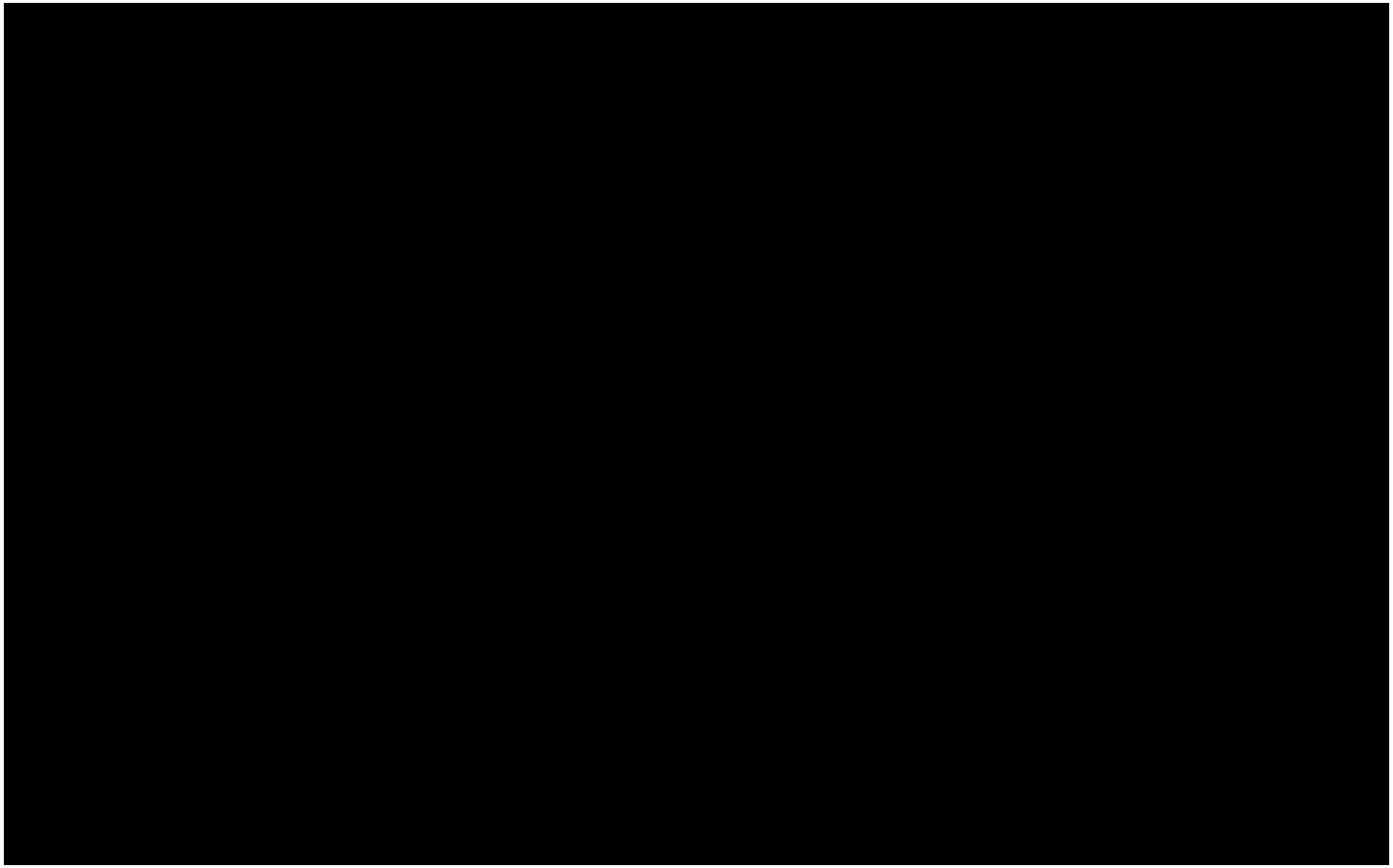
Gaze-contingent exploration through aperture

- The study of haptic exploration patterns by eye tracking (perception through an aperture): Object recognition



Gaze-contingent exploration

- The study of haptic exploration patterns by eye tracking (perception through an aperture): Graph line exploration



Natural communication through multimodal interaction

- The IRIS project (FP7-PEOPLE-2013-IAPP, 2014-2017)

Microsoft

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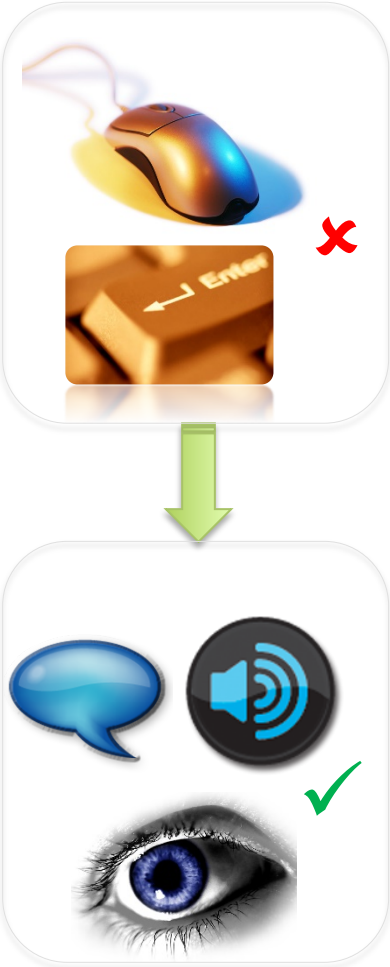
ieeta

faceinmotion

IRIS aims at developing a natural platform for people with mainly speech impairments, based on interaction scenarios

Natural communication through multimodal interaction

- Interaction through various modalities



Platform components: Silent speech recognition, assisted living environment, gaze-contingent interaction, gesture-based interaction

METU Researchers and Research Topics

- Kürşat Çağıltay
  (Computer Education and Instructional Technology)
  - Öztek (ongoing), gaze-contingent eye tracking, game-based learning, simulations and games in education
- Murat Perit Çakır & Cengiz Acartürk
  (Cognitive Science)
  - Eye tracking, dual eye tracking, fNIRS, collaborative problem solving
- Didem Gökçay (Cognitive Science & Health Informatics)
  - Emotion recognition, face recognition, fMRI, eye tracking
- Annette Hohenberger (Cognitive Science)
  - Child development, memory

THANKS

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