

**MAI4CAREU**

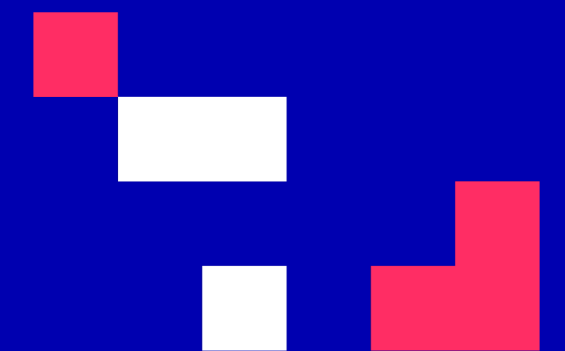
Master programmes in Artificial  
Intelligence 4 Careers in Europe

University of Cyprus

# HUMAN-CENTERED INTELLIGENT USER INTERFACES - MAI648

Marios Belk

2022



**CONTENT 1**

# Introduction to Human-centered Intelligent User Interfaces

**CONTENTS**

- Introduction to Intelligent User Interfaces
  - History of IUI
  - Paradigm Shifts of Interactive Systems
  - Usability and User Experience (UX)
  - Factors affecting the User Experience
- One-size-fits-all vs. Personalization
  - Evolution of Internet Usage and Intelligent and Adaptive Interactive Systems
  - Conclusive Framework for Defining an Intelligent and Adaptive Interactive System
  - Research in Intelligent and Adaptive Interactive Systems

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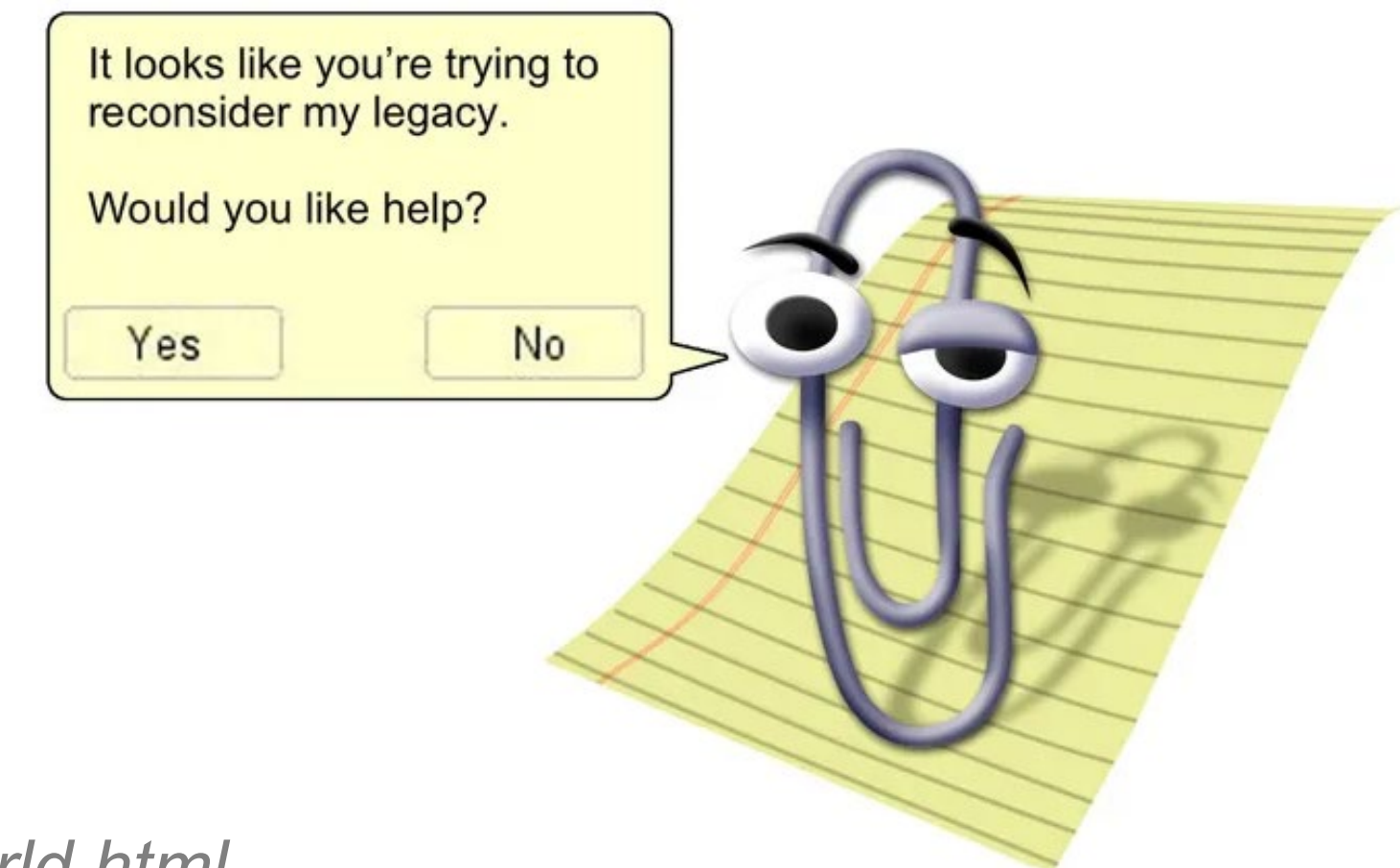
# Learning Outcomes

- Understand the interdisciplinary nature of intelligent user interfaces
- Describe the main principles of intelligent user interfaces
- Name the core components of a human-centered intelligent user interface

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# What is an Intelligent User Interface - IUI?

- A **user interface (UI)** that involves some aspect of **artificial intelligence (AI)**
- *Many modern examples of IUIs, with the most famous (or infamous) “Clippy”, Microsoft’s Office Assistant*



[https://en.wikipedia.org/wiki/Intelligent\\_user\\_interface](https://en.wikipedia.org/wiki/Intelligent_user_interface)

<https://nymag.com/vindicated/2016/10/clippy-didnt-just-annoy-you-he-changed-the-world.html>

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# What is an Intelligent User Interface - IUI?

- An IUI involves a computing machine having knowledge of the context and characteristics of the user, enabling the interactive system to better **understand the user's needs** and **personalize** or **guide** the user interaction

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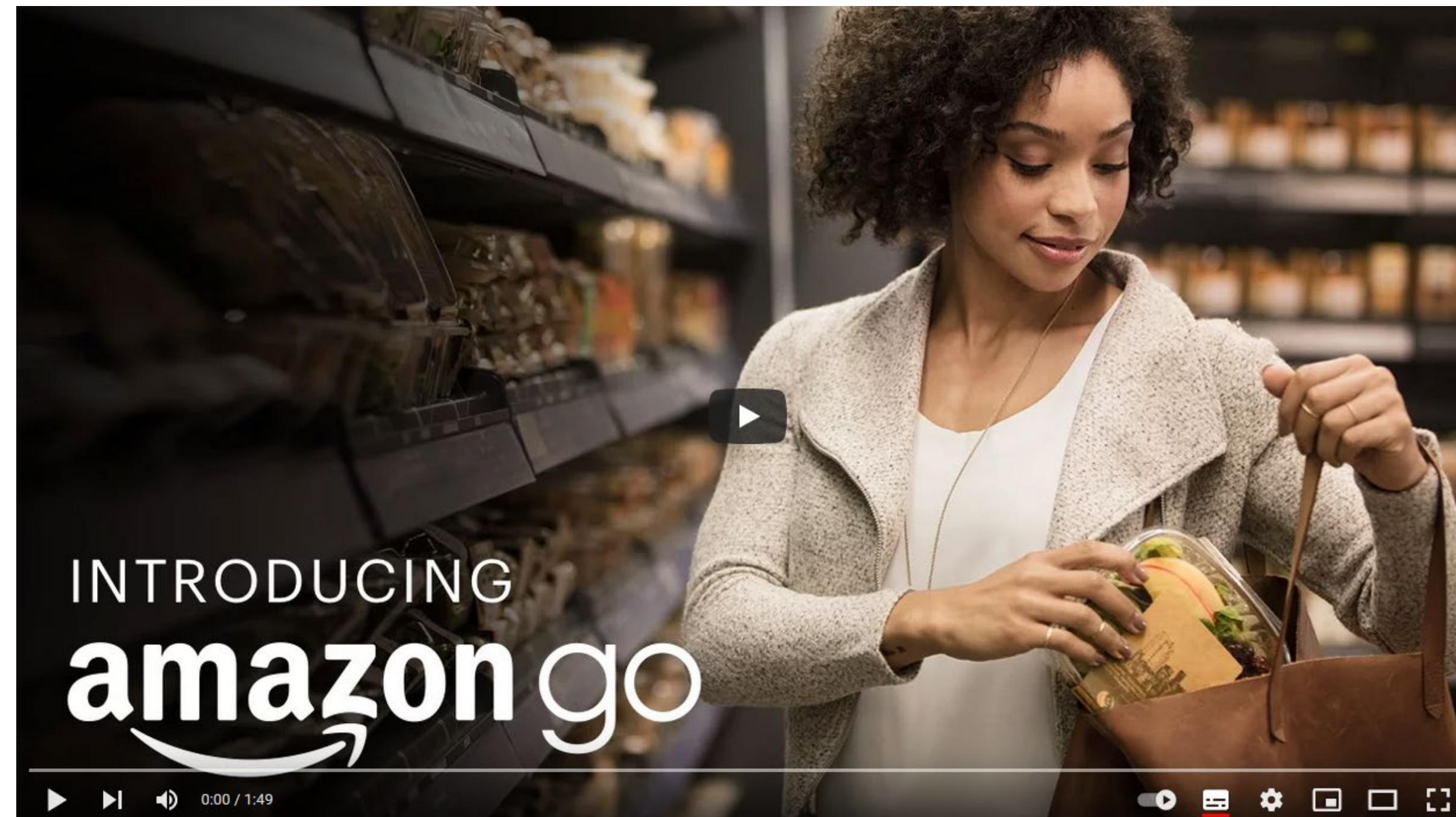
# Examples of Intelligent User Interfaces



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# “Just walk out” Technology

<https://www.youtube.com/watch?v=NrmMk1Myrxc>





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## “Just walk out” Technology

- Amazon Go is a new kind of store with no lines and no checkout
- First stores opened in Seattle, Washington, January 22, 2018



[https://www.amazon.jobs/en/business\\_categories/amazongo](https://www.amazon.jobs/en/business_categories/amazongo)

<https://techandcoolstuff.com/amazon-go-the-artificial-intelligence-stores-you-need-to-know-about/>



## CONTENT 1

# “Just walk out” Technology

- Why is it considered intelligent?

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## “Just walk out” Technology

- Why is it considered intelligent?
  - Combination of machine learning, algorithms, computer vision, and sensors are used for efficient and accurate tracking of items picked by shoppers
  - Cameras and sensors at shops create a digital model of the store that keeps on updating itself in real-time as the items and shoppers move around the store

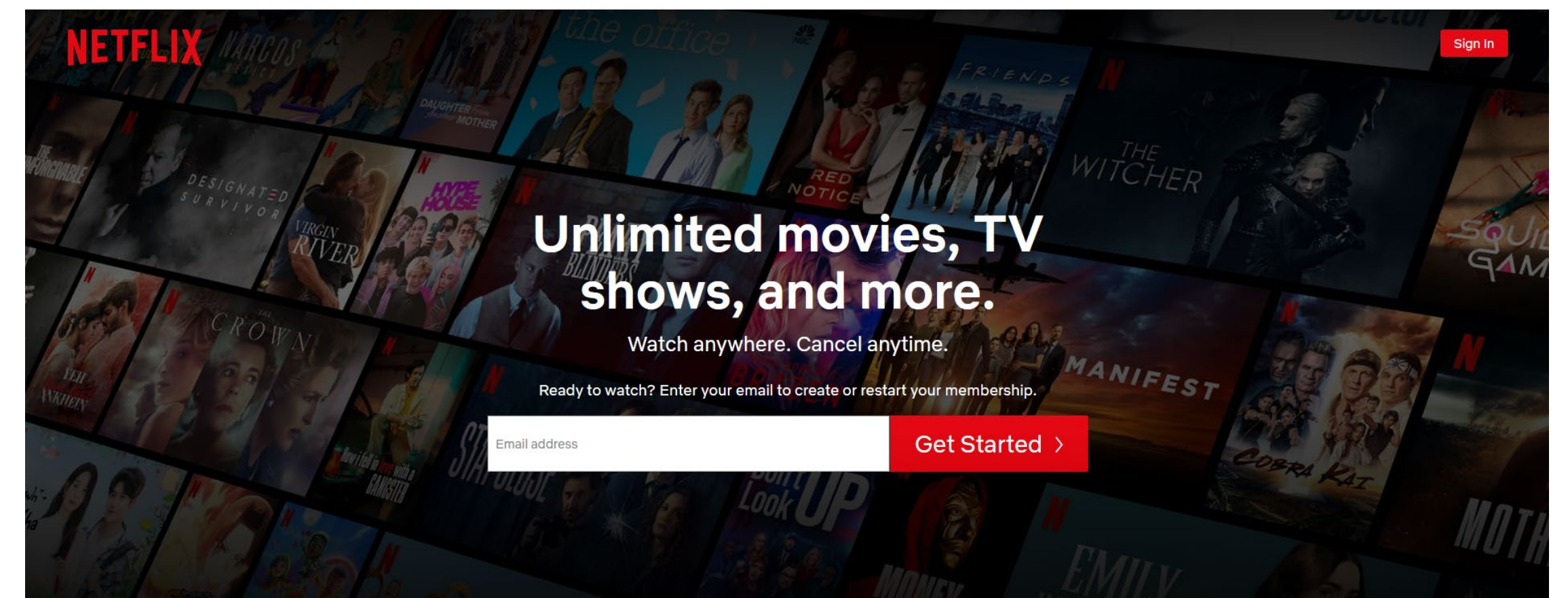
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# Recommender Systems

- Mechanisms that recommend “best-fit” items to users
  - relevant movies, products, etc.
- Do recommender systems affect the user experience?
- How do recommender systems work?

amazon

YouTube





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# Voice User Interfaces

- Voice user interfaces enable end-users to interact with a system through voice commands
- *Advantages:* they allow hands-free and eyes-free interaction with a system
- Popular examples
  - Apple Siri
  - Google Assistant
  - Amazon Alexa



# Intelligent Biometrics



- Intelligent biometrics are used as a form of identification and access control
- Users provide information about what they are, e.g., face data, voice data, fingerprint data, behavioral data to authenticate, make payments, etc.
- Increased convenience and user experience

[https://www.ey.com/en\\_gl/digital/how-biometrics-could-finally-replace-pins-and-passwords-when-we](https://www.ey.com/en_gl/digital/how-biometrics-could-finally-replace-pins-and-passwords-when-we)

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## Even more examples...

- Text Suggestions
- Text Analytics
- Natural Language Translation
- Intelligent Touch
- Intelligent Recruiting

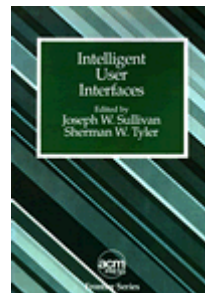
*Albrecht Schmidt, Sven Mayer, Daniel Buschek. CHI '21 Course: An Introduction to Intelligent User Interfaces. Overview of AI and ML Terms, Concepts and Tools*



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# History of IUI

- **1988.** Research workshop held in Monterey, California “Architectures for Intelligent Interfaces”
- **1991.** Book on Intelligent User Interfaces by Joe Sullivan and Sherman Tyler, organizers of the workshop
  - Main papers presented in the workshop



<http://www.iuiconf.org/IUI/History>



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# History of IUI

- **1993.** Organization of the First International Workshop on Intelligent User Interfaces, in Orlando, Florida by Bill Hefley and Dianne Murray
  - Sponsored by ACM
  - Researchers defined the field as a novel and promising intersection of Artificial Intelligence and Human-Computer Interaction

<http://www.iuiconf.org/IUI/History>

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# History of IUI

- Angel Puerta and Ernest Edmonds led an effort to create a permanent leading forum for research in intelligent user interfaces.
- **1997.** First Conference on Intelligent User Interfaces
  - yearly event
  - focusing on high quality research in the field of IUI
- **2023.** 28<sup>th</sup> Conference on Intelligent User Interfaces



<http://www.iuiconf.org/IUI/History>



# Where HCI Meets AI

## 28th Annual Conference on Intelligent User Interfaces

Sydney, Australia

Mar 27-31, 2023

CALL FOR PAPERS

<https://iui.acm.org/2023>



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# ACM Intelligent User Interfaces Conference

- **ACM IUI 2023 is the 28th annual meeting of the intelligent interfaces community and serves as a premier international forum for reporting outstanding research and development on intelligent user interfaces.**
- ACM IUI is where the Human-Computer Interaction (HCI) community meets the Artificial Intelligence (AI) community. The conference is interested in contributions from related fields, such as psychology, behavioral science, cognitive science, computer graphics, design, the arts, etc.

<https://iui.acm.org/2023>

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## Relevant Journal

- ACM Transactions on Interactive Intelligent Systems (TiiS)
- The ACM Transactions on Interactive Intelligent Systems (TiiS) publishes cutting-edge research in Human-Centered AI, in particular, concerning the design, development, and evaluation of interactive intelligent systems with two distinct characteristics: machine intelligence and user interaction

<https://dl.acm.org/journal/tiis>



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# Difference between an Intelligent System vs. an Intelligent User Interface

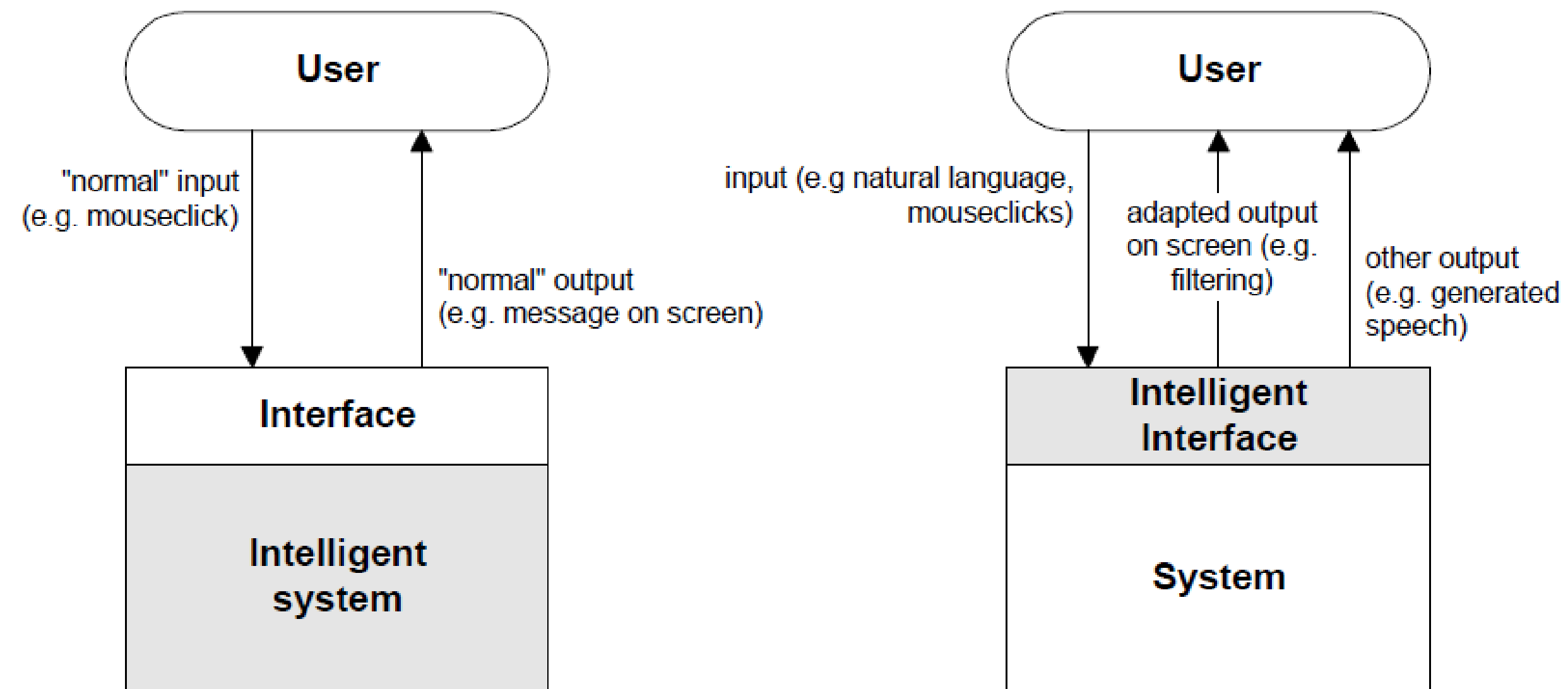


Figure 2: An intelligent system versus an intelligent interface

Figure from Ehlert, P. (2003). Intelligent User Interfaces: Introduction and Survey. Technical Report, DKS03-01 / ICE 01, Delft University of Technology

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# Intelligent **User** Systems

- **Intelligent User Interfaces** offer an alternative by adapting content, and functionality according to the users' unique characteristics, in order to improve efficiency, effectiveness and user experience

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# Usability

- ISO 9241-11 definition for Usability:
  - “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”
  - Usability is focused so that a task is carried out successfully

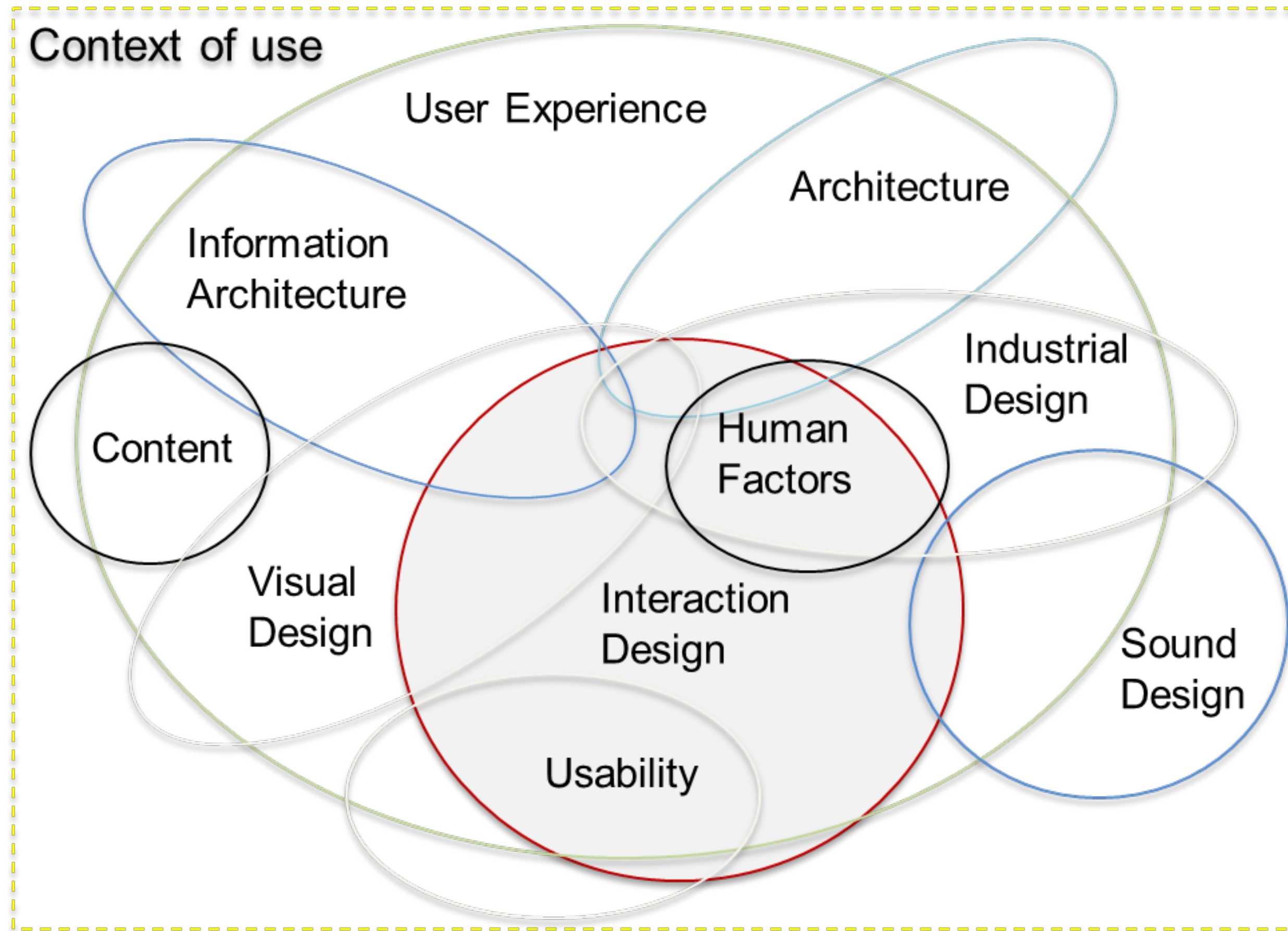


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# User Experience (UX)

- ISO 9241-210 defines User Experience (UX) as:
  - “a person's perceptions and responses that result from the use or anticipated use of a product, system or service”
  - Extends traditional task-based analysis and evaluation
  - Focuses on aesthetic and affective aspects (e.g., thoughts, feelings) that result through user interaction

## Factors affecting the User Experience



- *Example:*
- 3D Game
  - Visual Design
  - Sound Design
  - Content
  - Focus on aesthetics, feelings
  - What happens if we remove sound?
- ATM machine
  - Usability
  - Carry out task successfully without being frustrated
  - Aesthetics come to second priority

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# General IUI Architecture

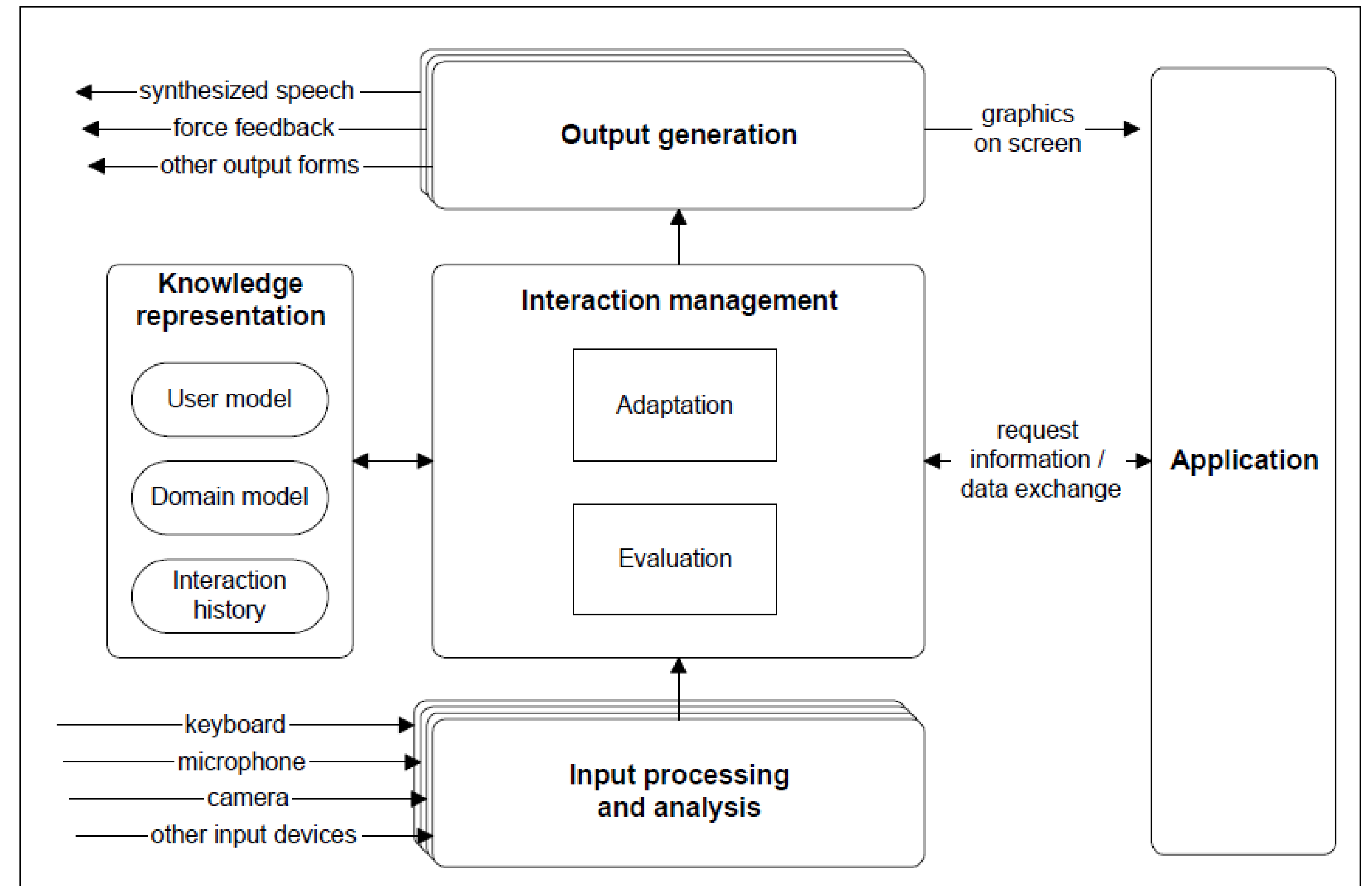


Figure from Ehlert, P. (2003). Intelligent User Interfaces: Introduction and Survey. Technical Report, DKS03-01 / ICE 01, Delft University of Technology

Figure 3: general IUI architecture





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# Research in Intelligent User Interfaces

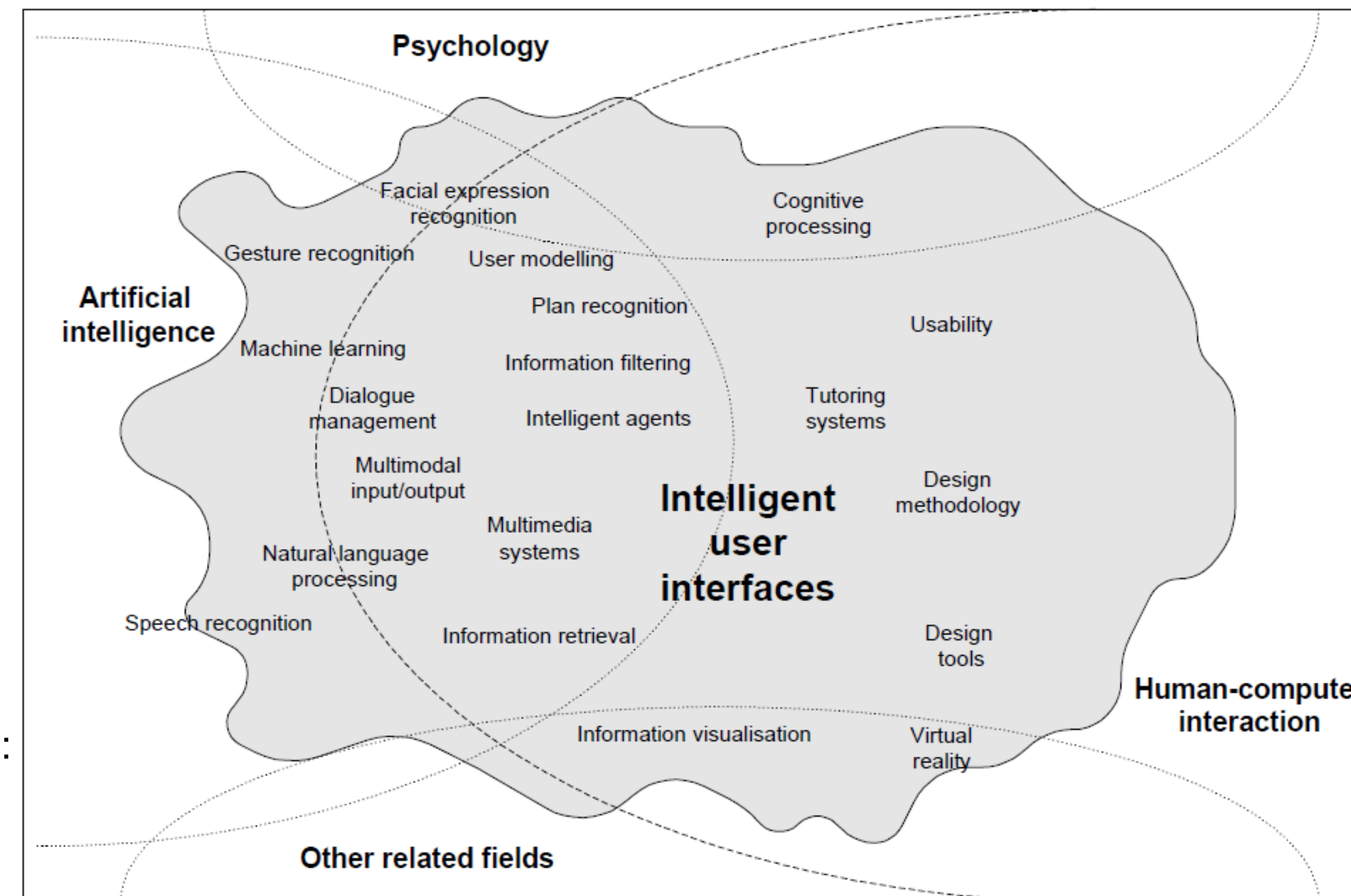


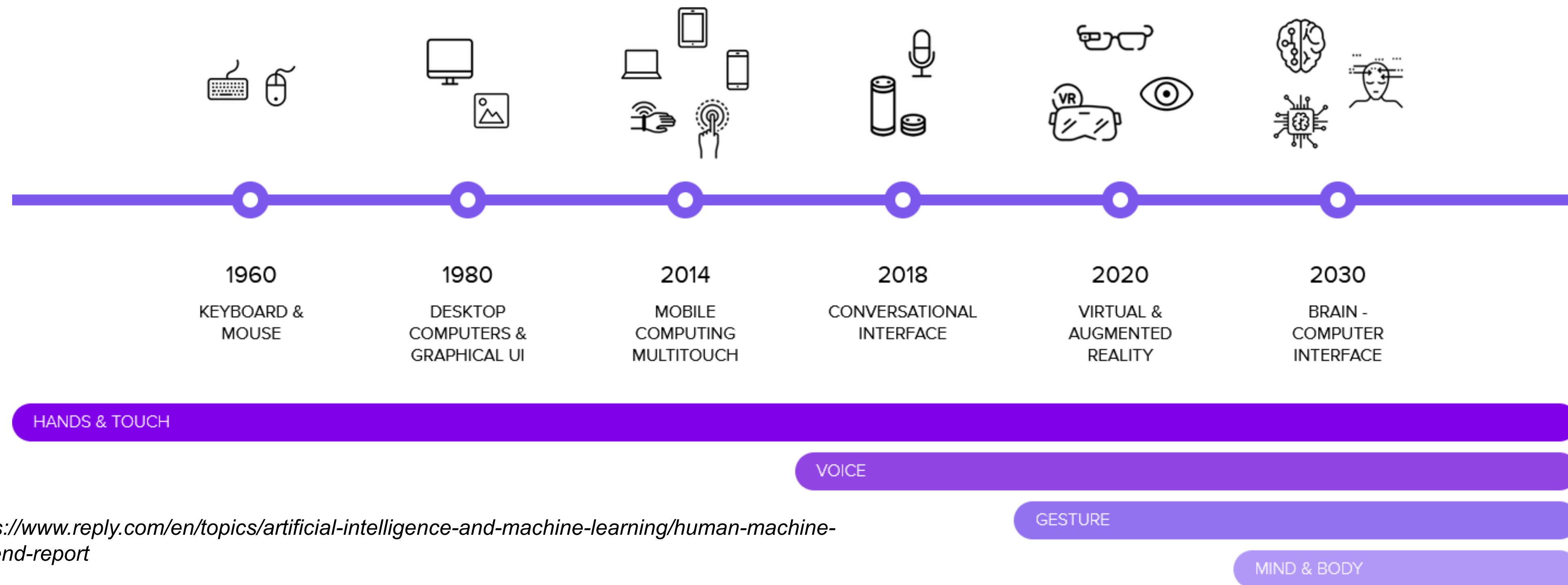
Figure from Ehlert, P. (2003). Intelligent User Interfaces: Introduction and Survey. Technical Report, DKS03-01 / ICE 01, Delft University of Technology

Figure 1: The intelligent user interfaces research field and some of its topics.



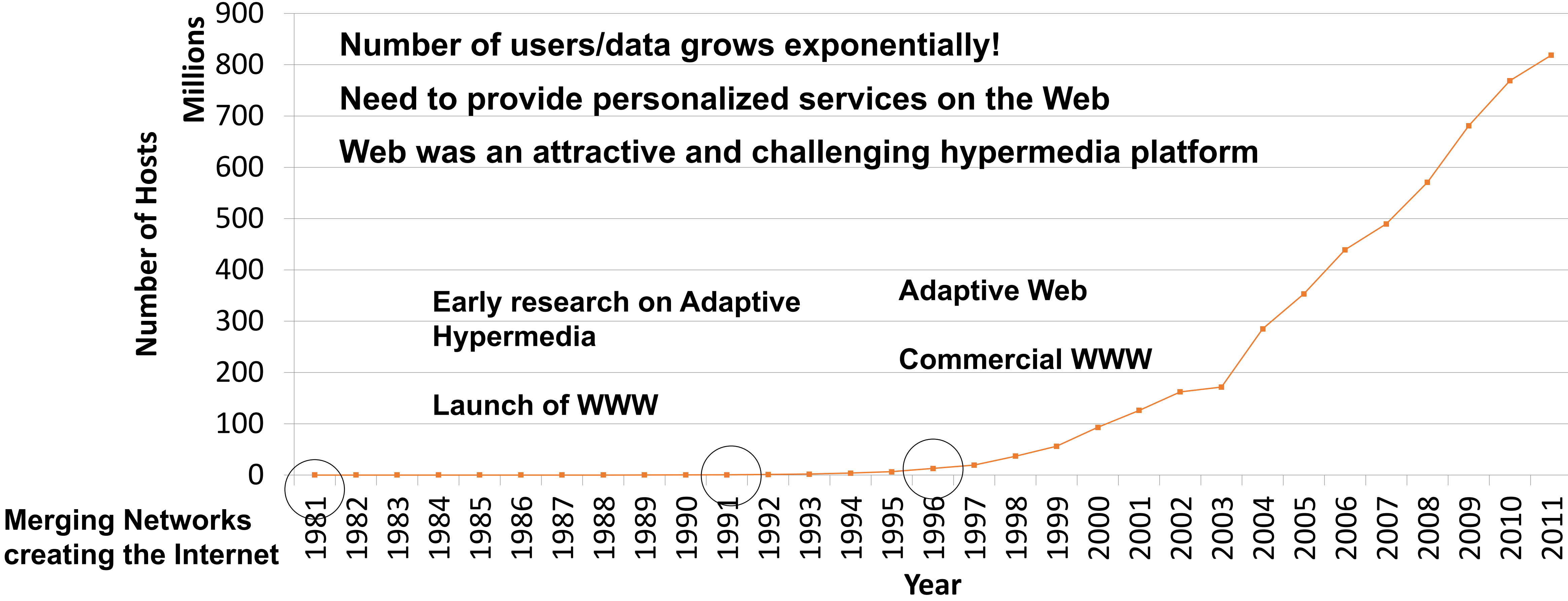
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# Human-Computer Interaction Evolution – 1960-2030



Source: <https://www.reply.com/en/topics/artificial-intelligence-and-machine-learning/human-machine-interfaces-trend-report>

# Evolution of Internet Usage and Intelligent and Adaptive Interactive Systems



**Merging Networks creating the Internet**





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## One-size-fits-all vs. Personalization

- Ineffective practice of usability in today's interactive systems do not naturally embed the users' characteristics in the design process
- Ignores the fact that users are different
  - different characteristics
  - develop different structural and functional mental models
  - need individual scaffolding
- It is necessary to understand in depth the interdependencies among the user characteristics and the tasks taking place during user interactions

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# User Modeling, Adaptation and Personalization

- ACM UMAP – User Modelling, Adaptation and Personalization Conference (<http://um.org/umap2022>)
- The premier international conference for researchers and practitioners working on systems that adapt to individual users, to groups of users, and that collect, represent, and model user information
- ACM UMAP is the successor to the biennial User Modeling and Adaptive Hypermedia and Adaptive Web-based Systems conferences that were merged in 2009

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# ACM UMAP 2023 will be held in Cyprus!

- <https://cyprusconferences.org/umap2023/>





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# User Modeling, Adaptation and Personalization

- **Related Journal**
- User Modeling and User-Adapted Interaction - UMUAI (<http://www.umuai.org>) is one of the journals mostly related to UMAP which provides an interdisciplinary forum for the dissemination of novel original research results about interactive computer systems that can be adapted or adapt themselves to their current users, and on the role of user models in the adaptation process.

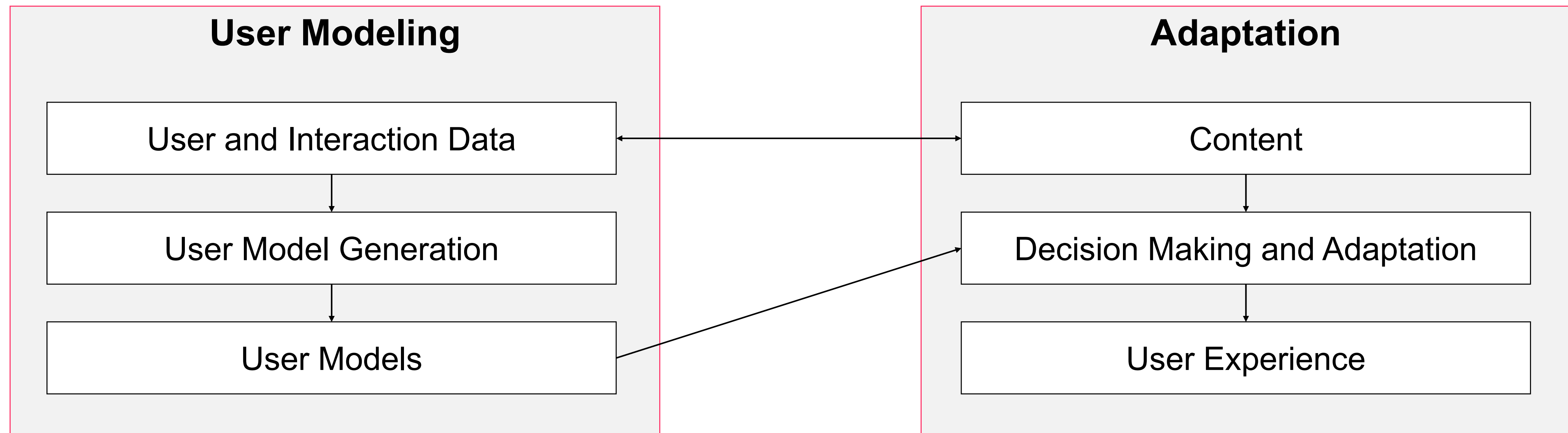
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# User Modeling, Adaptation and Personalization

- **Other Related Conferences**
- Artificial Intelligence in Education - AIED (<https://link.springer.com/conference/aied>)

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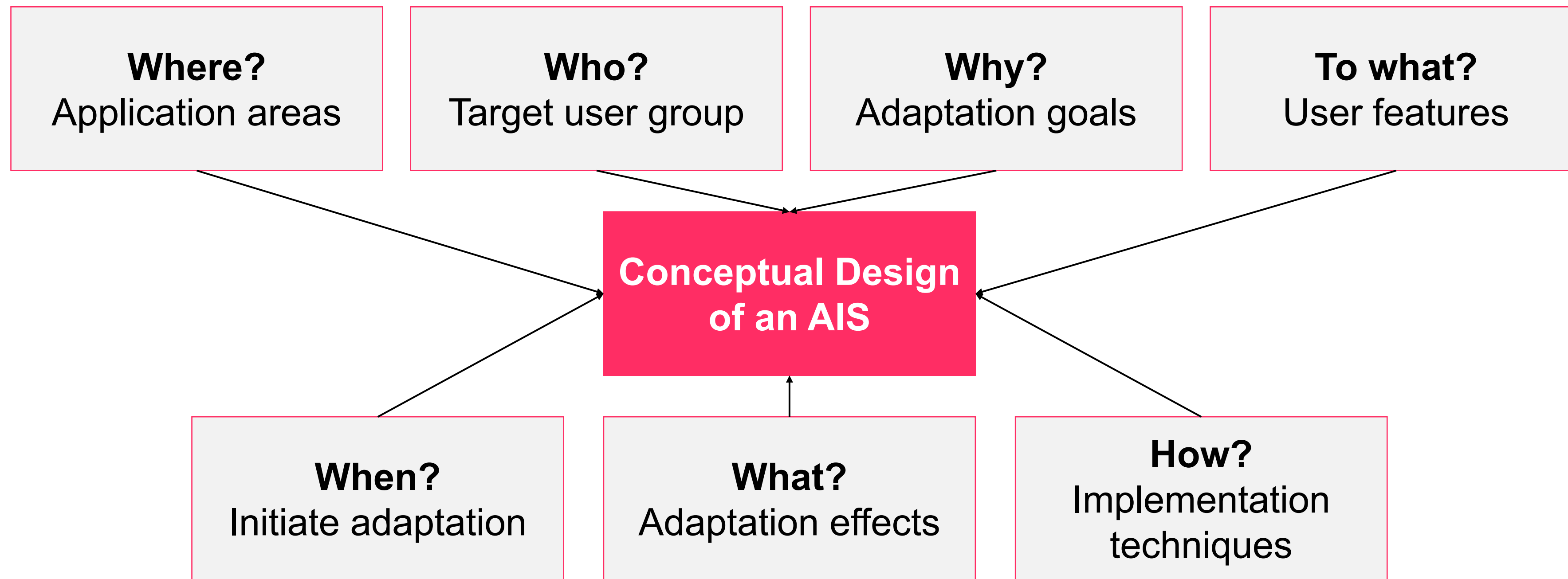
# High-level Adaptive Interactive System Architecture





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# Conclusive Framework for Defining an AIS



**Example**

**Where:** Educational  
**Who:** 1<sup>st</sup> year Students  
**Why:** Learn effectively  
**To What:** Knowledge  
**When:** Recognize invalid user behavior  
**What:** Additional explanations  
**How:** Track progress of the user for user knowledge modeling and expand content explanations

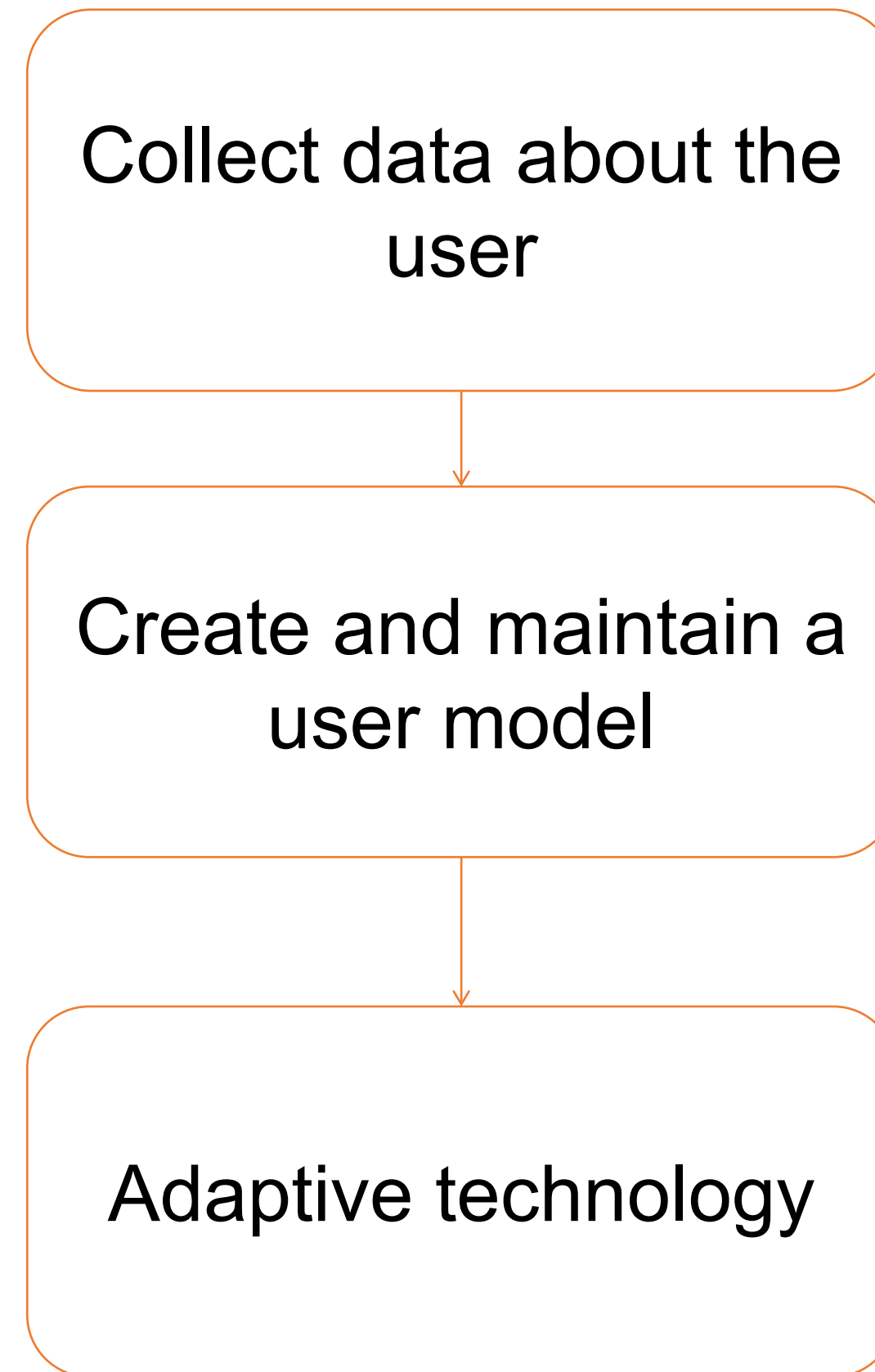


## Personalization Process Paradigm

**Name:** Anna  
**Gender:** Female  
**Age:** 19  
**Profession:** 1<sup>st</sup> year CS student  
**Bought:** Matrix Revolutions Movie  
**Navigation behaviour data (e.g., time spent on pages, ratings on products)**

**Interests:** Like Sci-fi movies  
**Individual traits:** Imager cognitive style

**Content level adaptation**  
Provide more images  
**Link level adaptation**  
Recommend new Sci-fi movies



### user modeling

deals with what information represents the user in a particular context and how to learn and represent this information

### adaptation

deals with what adaptation types and mechanisms need to be performed and how to communicate them to the adaptive user interface

improve its **usability** and **user experience**

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# Research in Adaptive Interactive Systems

- **User Modeling**
  - Which parameters are considered important?
  - Study the effects of human factors on UX design
- **Evaluation and User Experience**
  - How to evaluate the UX in personalization systems?
  - Measure success for adaptivity



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# Research in Adaptive Interactive Systems

- **Adaptation and Personalization**
  - How to represent content?
  - How to optimize decision making mechanisms?
  - Design efficient and effective algorithms
  - Study the effects of content adaptation
    - What visible aspects should be adapted and why?

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# Personalization in Interactive Systems

- Personalization strategies have been embraced by researchers and practitioners aiming to improve the user experience and tackle one-size-fits-all issues in interactive systems

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# Personalization in Interactive Systems

- Main factors being modeled for personalization [Brusilovsky et al., 2007]
  - Information about the users: knowledge, interests, preferences, needs and goals;
  - Information about the interaction device: screen size, input type;
  - Information about the context of use: physical, social

Are these factors sufficient today for personalizing  
interactive systems?



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# Multiple devices - HCI is processed on a cognitive and an emotional level

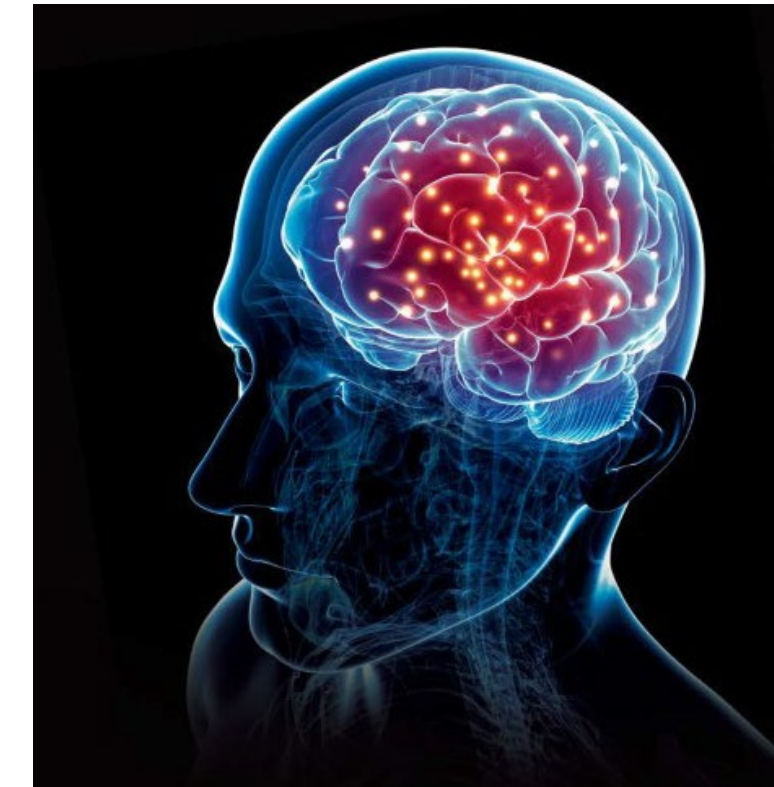


<https://apple.com>

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# Personalization based on **Human Factors**

- Human-computer interactions are processed on a cognitive and emotional level
  - Users respond to various stimuli through the use of logical and rational thinking in cognitive processing that has also a certain degree of emotional influence



<https://apple.com>

<https://www.nature.com/articles/d42473-019-00256-8>

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## Personalization based on **Human Factors**

- Personalize the visual and interaction design to the individuals' preferred cognitive processing characteristics and emotional states

**Human cognitive and emotional characteristics** should be investigated and integrated in the user interface design process of interactive systems



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# Challenges

- Which human factors are important for personalizing interactive systems?
  - How to elicit and model these factors?
  - What are the effects of human factors on the design characteristics?

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# Challenges

- What visible aspects could be adapted for improving the usability and user experience?
  - How to adapt the content?
  - How to adapt the navigation?
- How to design, develop and integrate all the entities under an extensible interoperable system?

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**Thank you.**