MAI4CAREU

Master programmes in Artificial Intelligence 4 Careers in Europe

University of Cyprus

HUMAN-CENTERED INTELLIGENT USER INTERFACES - MAI648

Marios Belk

2022

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Final Revision and Group Project Presentations

CONTENTS

See midterm revision slides for midterm-related topics

- Introduction to IUIs
- Human-Computer Interaction
- Human-Centered Computing
- Human Cognition
- Affective Computing
- Adaptive User Interfaces

After midterm-related topics

- Adaptive Usable Security
- Intelligent Biometrics
- Conversational UIs and Voice UIs
- Explainable AI
- Evaluating IUIs

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Adaptive Usable Security

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Learning Outcomes

- Know definitions in adaptive usable security
- List the main categories of user authentication
- Evaluate the applicability of human factors in adaptive usable security mechanisms
- Understand the effects of human factors on security aspects of interactive systems

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Usable Security

- Designing security systems that people can use
- One of the 11 hard problems to achieve cyber security [U.S. Dept. of Homeland Security]
- Security policies are reactive and not planned in advance which compromises usability

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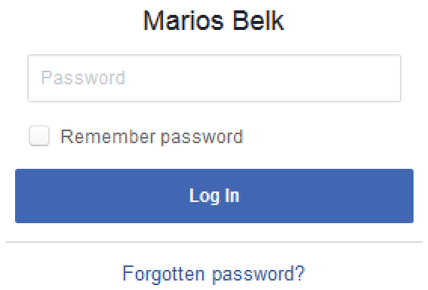
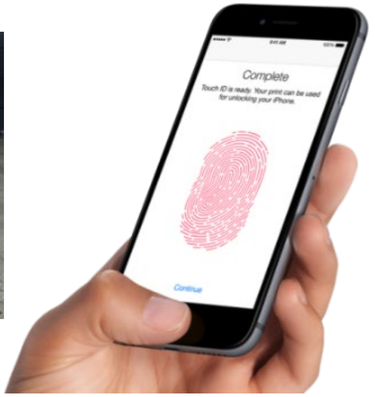
User Authentication oldest and mostly researched Usable Security topic

- Αὐθεντικός; meaning real or genuine, aims to confirm the authenticity of the user
- One of the most important security mechanisms of any infrastructure today





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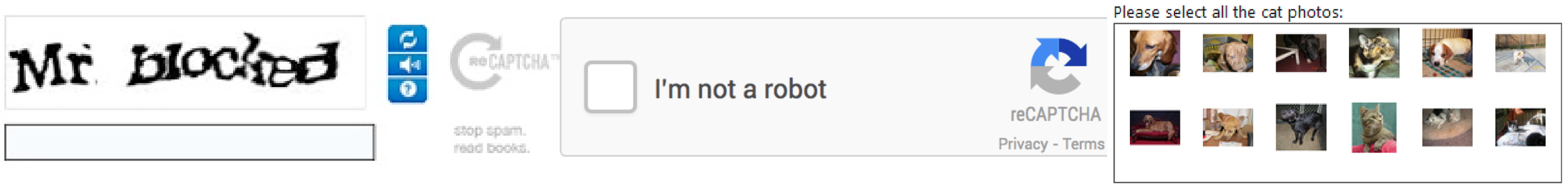
Human Interaction Proofs highly researched Usable Security topic

- Protect Web systems against automated software agents
- Verifies that the entity interacting with a system is a human being, and not a software agent



U.S. Department of Homeland Security (2009). A Roadmap for Cybersecurity Research. Available online: https://www.dhs.gov/publication/csd-roadmap

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On the Importance of Usable Security in Authentication and CAPTCHA

- Almost **every computer user owns** a password-protected account and **logs in every day** multiple times *[Florencio & Herley]*
- **95% of people reuse** their passwords across accounts *[inc.com]*
- Over **200 million reCAPTCHA** are completed daily *[Bursztein et al.]*
- Over 80% of users are **fed up with unnecessary CAPTCHA challenges** *[Fidas et al.]*
- More than **40% of help desk calls** are customer requests for **password resets** *[Economics of Security]*

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On the Importance of Usable Security in Authentication and CAPTCHA

- Each password reset request can range from $50 to $150 in labor costs *[Gartner Research]*
- Major companies such as Yahoo, eBay, Sony, Uber faced **password hacks** and data breaches which **affected billions of customer accounts** *[Wired]*
- Sony's password hack in 2011 cost the company over $170M and affected 70M customer accounts *[Wired]*

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Methods on User Authentication

- Knowledge-based
- Token-based
- Biometric-based
- and Multi-factor authentication

[Passfaces, 2009; von Zezschwitz et al., 2015, Winkler et al., 2015; Hajashi et al., 2009; Apple; Google Android]

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Methods on User Authentication

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Intelligent Biometrics

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Evaluation Techniques

- **Exploratory techniques:** in the field with users
  - User observation
  - Field studies (multiple users)
  - Semi-structured interviews
  - Completion of questionnaires

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What are biometrics?

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What are biometrics?

- *ISO/IEC 2382-37 definition: ”automated recognition of individuals based on their biological and behavioural characteristics”*

- *Wikipedia: “Biometrics are body measurements and calculations related to human characteristics”*

“Information technology — Vocabulary — Part 37: Biometrics,” standard, International Organization for Standardization, Geneva, CH, 2012.
https://en.wikipedia.org/wiki/Biometrics

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Biometric identifiers

- Distinctive, measurable characteristics used to label and describe individuals

- **Types of biometrics**
  - Physiological characteristics
  - Behavioral characteristics

https://en.wikipedia.org/wiki/Biometrics

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Physiological characteristics

- Characteristics of the human body
- *Examples:*
  - Fingerprint
  - Face
  - DNA
  - Palm print
  - Hand geometry
  - Iris

https://en.wikipedia.org/wiki/Biometrics

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Behavioral characteristics

- Patterns of human behavior
- *Examples:*
  - Mouse movement
  - Typing rhythm
  - Gait
  - Signature
  - Behavioral profiling

https://en.wikipedia.org/wiki/Biometrics

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What are intelligent biometrics?

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What are intelligent biometrics?

- Mechanisms and techniques using artificial intelligence aiming to identify, recognize, and/or authenticate individuals based on the analysis of their physiological and/or behavioral biometric characteristics

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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

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Examples of intelligent biometrics

- Biometric identification and authentication for user identification and access control
  - Apple Face ID for unlocking smartphones
  - Fingerprint technology on laptops, smartphones, etc.
- Continuous user identification
  - Behavioral analysis based on users' smartphone usage
- Surveillance

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TRUSTID Project

- Intelligent and Continuous Online Student Identity Management for Improving Security and Trust in European Higher Education Institutions

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Conversational UIs and Voice UIs

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Great examples of conversational UIs

- Chatbots
- Voice assistants

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Chatbots vs. voice assistants

Chatbots

- Used as information acquisition tool
- Lack understanding human emotions
- Mostly scripted and do not maintain conversational flow

Voice assistants

- Provide assistance
- Can have empathy and understand human emotions
- Maintain conversational flow

Naveen Joshi (2018). Yes, Chatbots And Virtual Assistants Are Different! - https://www.forbes.com/sites/cognitiveworld/2018/12/23/yes-chatbots-and-virtual-assistants-are-different/?sh=417aed946d7d

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Voice User Interfaces

- *“A voice-user interface (VUI) makes spoken human interaction with computers possible, using speech recognition to understand spoken commands and answer questions, and typically text to speech to play a reply. A voice command device (VCD) is a device controlled with a voice user interface.”*
- https://en.wikipedia.org/wiki/Voice_user_interface

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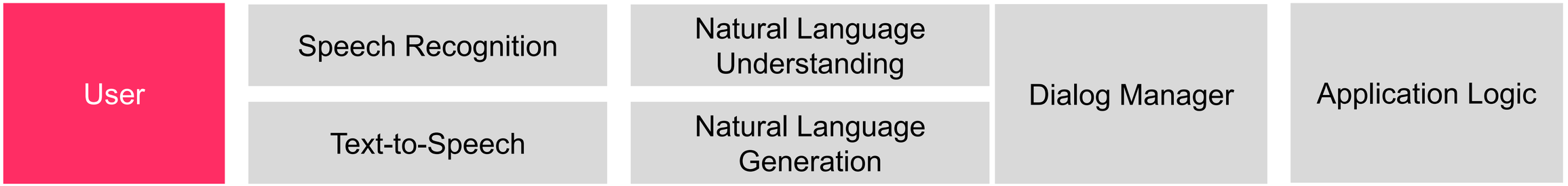
Voice UI Procedure



https://lekta.ai/
https://www.infostretch.com/blog/view-from-the-labs-voice-user-interfaces-a-short-history-and-a-bright-future/

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Speech Recognition

- Aims to filter out noise and capture the user's commands
- Main steps
  - Remove background noise and echo
  - Separate user's voice from other sounds in the room
  - Adjust to approximate the user's distance from the device

https://www.infostretch.com/blog/view-from-the-labs-voice-user-interfaces-a-short-history-and-a-bright-future/

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Natural Language Processing

- Enables the system to interact with the user naturally
- Aims to mimic a natural conversation with the user
- Systems process a large range of conversational input

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Properties of a Good VUI

- **Design voice-first UIs**, hands-free and eyes-free UIs.
  - Even in case a device has a screen
  - Screens can complement the voice interaction
  - Some tasks might be inefficient to complete with voice only, like scrolling through the search results
- **Human-like, natural conversation**
  - Interaction should feel like an interaction with a human, not a robot
  - Conversation should resemble natural human conversation
  - Use everyday language

https://www.smashingmagazine.com/2022/02/voice-user-interfaces-guide/

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Properties of a Good VUI

- **Personalization**
  - Personalize the interaction
  - Examples?
- **Voice Tone**
  - Create good impressions
  - Give to the VUI a personality - create the right brand persona

https://www.smashingmagazine.com/2022/02/voice-user-interfaces-guide/

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Properties of a Good VUI

- **Context of Use**
  - Understand where and in which context the VUI will be used
- **Perceived Trust**
  - Privacy-preservation
  - Avoid offensive content
  - Avoid promotional content

https://www.smashingmagazine.com/2022/02/voice-user-interfaces-guide/

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Modern VUIs

- Examples of popular voice-based assistants
  - Alexa, Siri, Google assistant
- These systems use microphone-based devices that are connected to the internet
  - Thin clients
- AI runs on the cloud
- Can be customized
  - E.g., Amazon enables developers to create their own services – namely skills

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HCI principles when designing VUIs

- Think about the main principles we covered during the HCI-related class
- Which HCI principles can be applied in VUIs?
- Which HCI principles do not exist in VUIs?

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HCI principles when designing VUIs

- No affordances
- HCI principles that are important in VUIs
  - Consistent design, what design? Lexical
  - Feedback, can be visual, acoustic, spoken
  - Metaphors, how?
- Putting logical constraints in VUI
- Error tolerance in ambiguities

Andreas Butz. Intelligent User Interfaces (IUI). Voice User interfaces

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Design guidelines for VUIs

- Inform the users what they can do when they interact with the system
- Inform the users where they are
- Provide examples rather than instructions
- Limit the amount of information
  - Short-term memory of users
- Use visual feedback

Voice User Interfaces - https://www.interaction-design.org/literature/topics/voice-user-interfaces
Andreas Butz. Intelligent User Interfaces (IUI). Voice User interfaces

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Process to design VUIs

- Design a dialog structure
- Think of alternatives
  - structure
  - wording
- Try out your dialog
  - wizard of Oz technique
  - use outside people
- Refine, Revise, Repeat

From Andreas Butz. Intelligent User Interfaces (IUI). Voice User interfaces

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Challenges and opportunities when designing VUIs

- **1. Inform the user what the VUI can do**, what they can ask, etc.
- How does the user know what they can ask, how much information they will receive, can they make follow up questions?
- VUIs need to educate the users what more is possible
  - e.g., Apple Siri has list of possible questions the user can ask
  - Is it enough?

Arnita Saini (2016). Voice User Interfaces — 15 challenges and opportunities for design. https://uxdesign.cc/why-is-it-so-difficult-to-use-and-design-voice-uis-87f2976aa796

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Challenges and opportunities when designing VUIs

- **2. Inform the user what the VUI cannot do**
- **3. Visibility of system status**
  - Communicating the system's status
- **4. Error correction**
  - One way is to ask the user to say the whole sentence again
  - What else could be done?

Apple Siri

Arnita Saini (2016). Voice User Interfaces — 15 challenges and opportunities for design. https://uxdesign.cc/why-is-it-so-difficult-to-use-and-design-voice-uis-87f2976aa796

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Challenges and opportunities when designing VUIs

- **5. Error prevention**
- **6. Repeated activation**
  - Currently, applications have activation commands like “Alexa”, “Hey Siri”
  - However, in real-life we don’t call each other “Hey Mario” when we are in a conversation
  - Applications should keep a window open during a conversation
- **7. Short dialogues vs. accuracy of user intent**

Arnita Saini (2016). Voice User Interfaces — 15 challenges and opportunities for design. https://uxdesign.cc/why-is-it-so-difficult-to-use-and-design-voice-uis-87f2976aa796

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Challenges and opportunities when designing VUIs

- **8. Prototyping and testing**
  - No paper prototypes
  - Limited prototyping tools
- **9. Design guidelines**
  - Limited
  - Check out Amazon guidelines
    - https://developer.amazon.com/en-US/docs/alexa/custom-skills/voice-design-best-practices-legacy.html

Arnita Saini (2016). Voice User Interfaces — 15 challenges and opportunities for design. https://uxdesign.cc/why-is-it-so-difficult-to-use-and-design-voice-uis-87f2976aa796

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Challenges and opportunities when designing VUIs

- **10. Voice UI design documentation**
  - Difficult to cover all possible scenarios
- **11. Difficult to cover all possible visual interaction scenarios in voice interaction scenarios**
- **12. Designing regional and personalized assistants**
  - Accent and common phrases
  - *Try to ask Siri, “Hey Siri, call Argyris”*

Arnita Saini (2016). Voice User Interfaces — 15 challenges and opportunities for design. https://uxdesign.cc/why-is-it-so-difficult-to-use-and-design-voice-uis-87f2976aa796

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Challenges and opportunities when designing VUIs

- **13. The social awkwardness**
  - Do you remember of a time in which it was odd when people talked with headphones?
  - VUIs are still not totally embedded in our lives, yet
- **14. Hard to find niche use-cases**

Arnita Saini (2016). Voice User Interfaces — 15 challenges and opportunities for design. https://uxdesign.cc/why-is-it-so-difficult-to-use-and-design-voice-uis-87f2976aa796

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Explainable AI

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Definitions

- *Explainable AI (XAI) is AI in which the results of the solution can be understood by humans. It contrasts with the concept of the "black box" in machine learning where even its designers cannot explain why an AI arrived at a specific decision - Wikipedia*
- Also know as **Interpretable AI**, **Explainable Machine Learning**
- https://en.wikipedia.org/wiki/Explainable_artificial_intelligence

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Supervised Machine Learning

Explaining Data

Training Data

Explaining model facts: performance, limitations

Labels

Cats



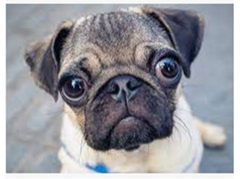

Dogs




Learning Model - Machine Learning Algorithm

Prediction Label: Dog

XAI aims to explain the model's decision



New Instance

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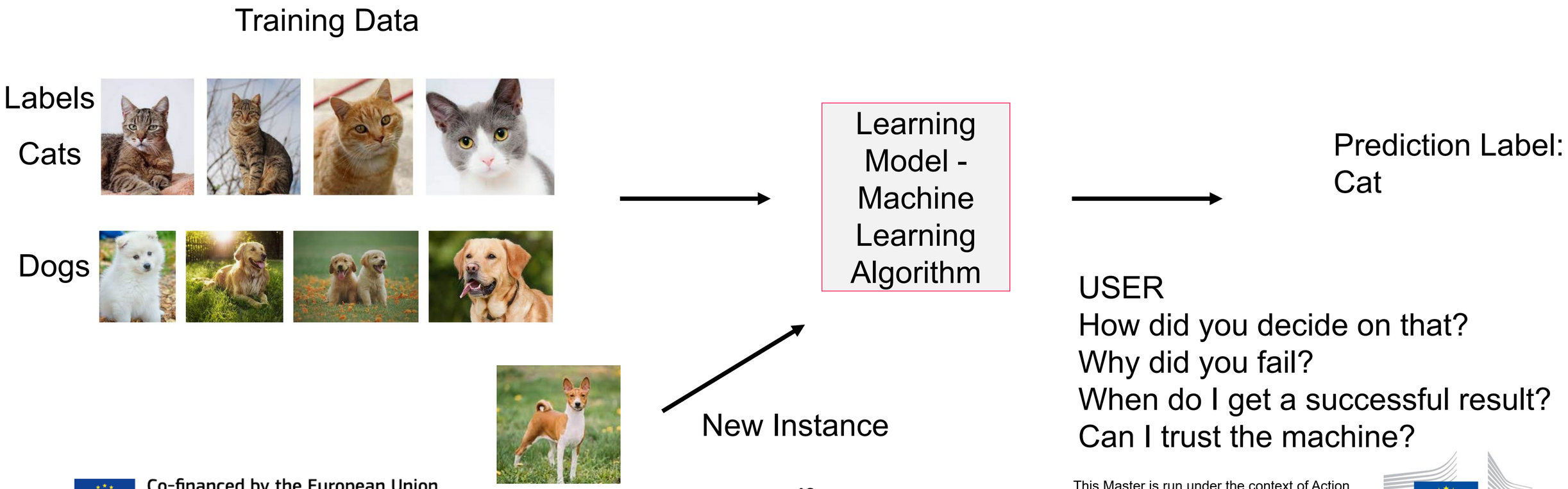
Supervised Machine Learning



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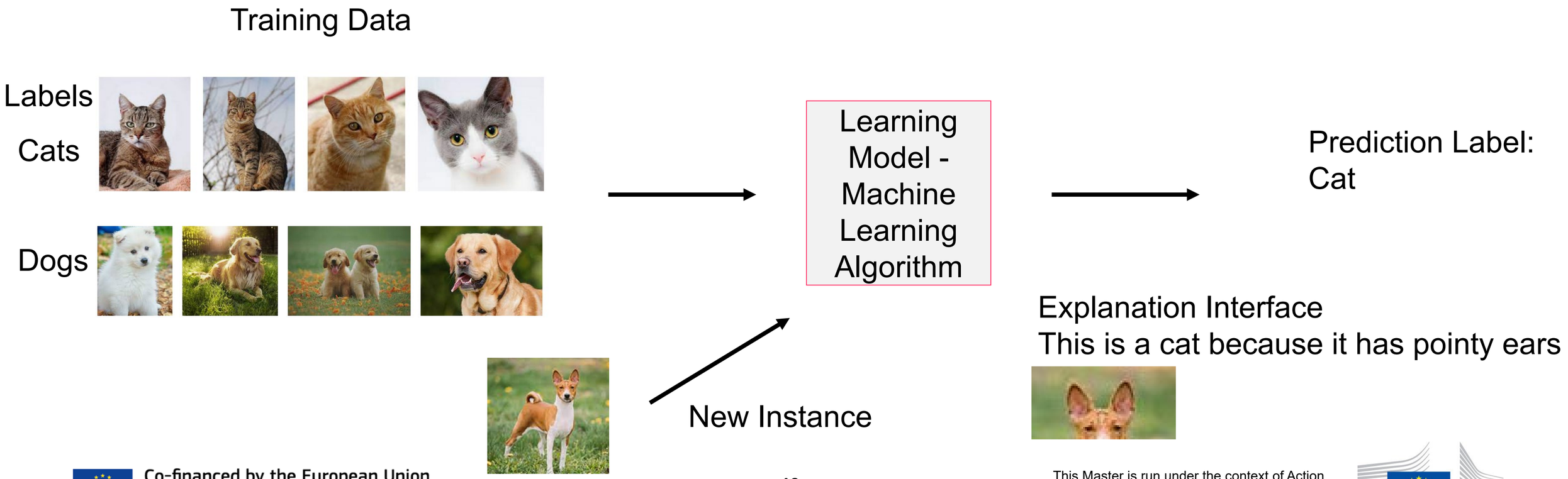
Supervised Machine Learning



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Types of Explainability

- **Validating Models:** Approaches that aim to eliminate bias in the training data
- **Debugging Models:** Provide insights on wrong predictions
- **Knowledge Discovery:** Provide new insights through data analysis

Sarah Theres Völkel. Explainable AI. Introduction to Intelligent User Interfaces

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Explanations

- Explanations are contrastive: Why C instead of Y?
- Explanations are selective: Show the most important information that contributed to a decision (at the cost of completeness)
- Explanations are credible: Be consistent with users‘ prior knowledge
- Explanations are conversational: Who reads an explanation? Allow users to raise queries

From Sarah Theres Völkel. Explainable AI. Introduction to Intelligent User Interfaces

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Evaluating IUIs

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Evaluation Types

- Evaluation in controlled/in-lab settings
- Evaluation in real-life settings

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CONTENT 13

Evaluation Techniques

- **Analytical techniques:** in the lab without user participation - evaluation by experienced scientists in the field (expert reviews)
  - Cognitive Walkthrough
  - Keystroke Level Model analysis
  - Heuristic Evaluation

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CONTENT 13

Evaluation Techniques

- **Experimental techniques:** in the lab with users
  - Usability testing
  - Think aloud protocol
  - User logging

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Thank you.

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