Durham University

COMP 3647
Human-AI Interaction Design

Topic 1: *Introduction*
From Usability to UX and HAIID

Prof. Effie L-C Law

Mini-Survey

Why did you choose this module?

A. Curiosity (the content sounds interesting)
B. Word of mouth (peers say it's good)
C. Less technical module (no programming, no math)
D. Coursework-based module (no exam)
E. By elimination (all other options are not that appealing)
F. None of the above

Lecture Overview

- What this module is about?
- Why are we doing this module?
- Human-centred approaches
- From Us to UX to HAIID

What this module is about?

Curricula Context

Math	COMP1021 Mathematics for Computer Science – Linear Algebra, Calculus
	COMP2271 Data Science – Probability
Programming	COMP1051 Computational Thinking – Python, NumPy, Matplotlib, …
	COMP1081 Algorithms and Data Structures – Sorting, Searching, Graph, String
Design/HCI	COMP2281 Software Engineering – Requirements Engineering
	COMP2281 Software Engineering – Human-Computer Interaction
AI/ML	COMP2261 Artificial Intelligence – Machine Learning
	COMP2261 Artificial Intelligence – Bias in AI
	COMP3547 Deep Learning and Reinforcement Learning
HCI + AI	**COMP3647 Human-AI Interaction Design**

Industry? Academia?

Aims & Learning Objectives

- To discuss how the design of Human-AI interactions may affect user experience (UX).
- To introduce methods and tools for designing and evaluating interactive AI systems.
- To develop ethical and societal principles in the design of interactive AI systems.
- Explore the future of AI research and practice

***

- An ability to analyse how the interaction design of AI-infused interactive systems are different from their non-AI counterparts.
- An ability to develop a good understanding of how AI-infused applications of Large Language Models (LLMs) and Affective Computing (AC) are integrated into people's everyday life and their impacts.
- An ability to apply HAII frameworks to evaluate the interaction design of LLM applications (LLMAs) and emotion recognition applications (ERAs) and trust in these applications

Schedule (Week 1-5/ Topic #1 – 10)

Week/#	Date	Topics
1/1	07/10	Introduction: From Usability to User Experience (UX) and to HAII
1/2	09/10	Mental Models
2/3	14/10	User Needs
2/4	16/10	Emotion and Affect
3/5	21/10	Think Aloud: Methods
3/6	23/10	Think Aloud: Applications
4/7	28/10	Thought Cloning & Models of Interestingness
4/8	30/10	Large Language Model Applications (LLMAs)
5/9	04/11	Case Study of LLMAs: Customer Service Banking Apps
5/10	06/11	Affective Computing: Emotion Recognition Tools (ERTs)

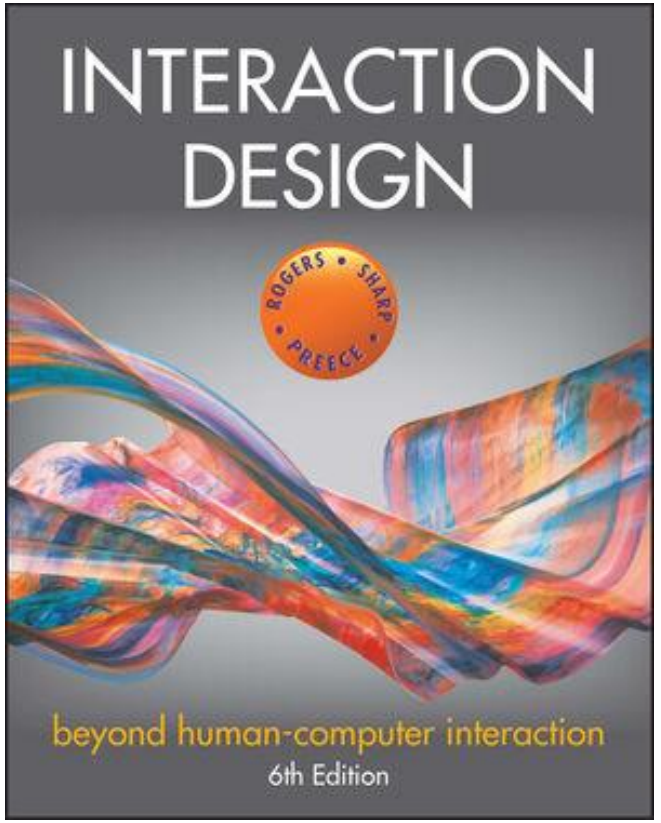
Schedule (Week 6-10/ Topic #11-20)

Week/#	Date	Topics
6/11	11/11	Case Study of ERTs: Mental Health and Wellbeing
6/12	13/11	Human-in-the-Loop: Trustworthy Autonomous Systems (TAS)
7/13	18/11	Explainable AI (XAI) and Trust
7/14	20/11	Prototyping
8/15	25/11	Design Patterns in HCI
8/16	27/11	UX Design Challenges for HAII
9/17	02/12	Methods and Tools for HAII Evaluation
9/18	04/12	Guidelines for HAII
10/19	09/12	Ethics for HAII
10/20	11/12	Grand Challenges for Future HAII

Recommended Readings

General

Yvonne Rogers, Helen Sharp, and Jennifer Preece (2023). ***Interaction Design: Beyond Human-Computer Interaction*** (6th Ed.). Wiley

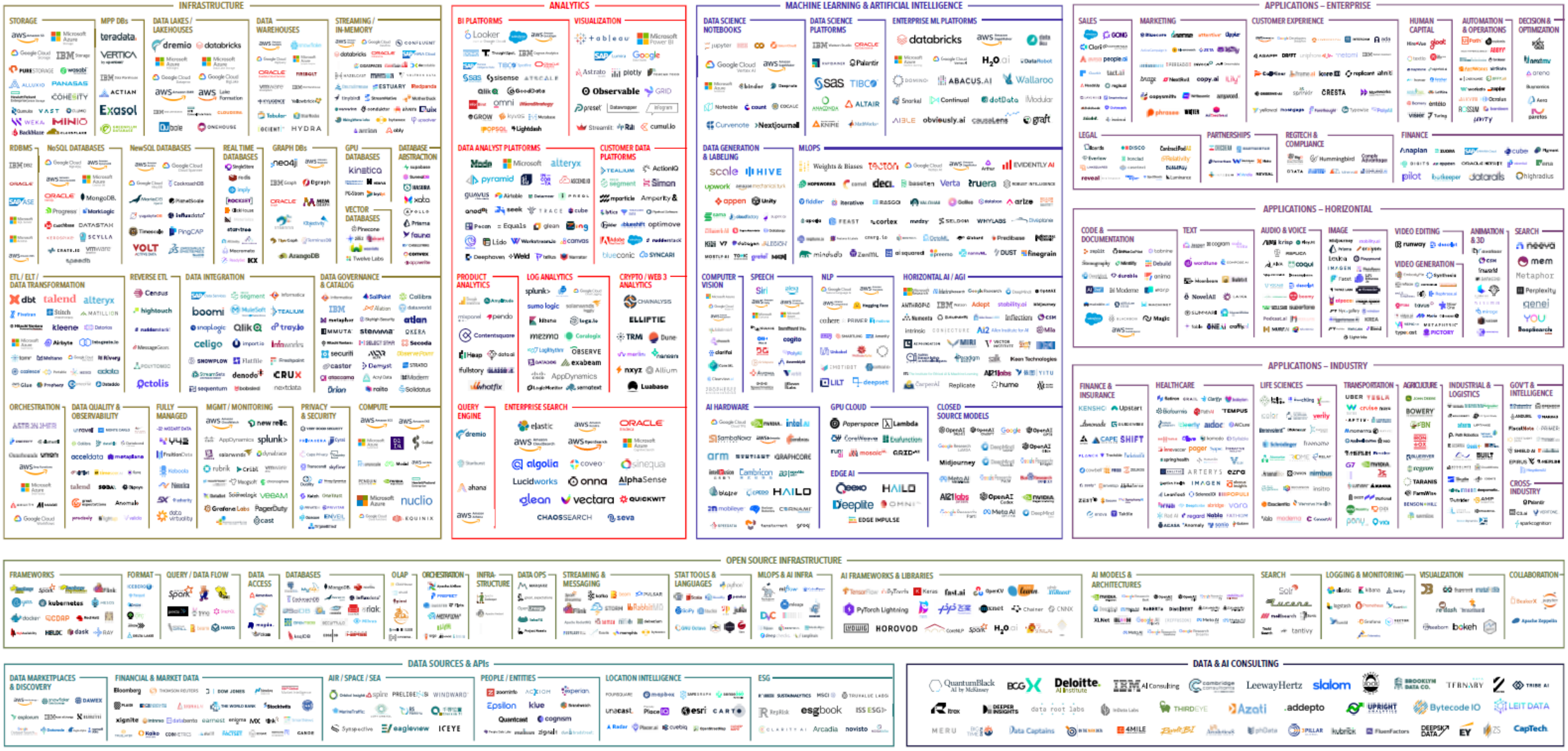


Topic-specific

List of references for each slide stack.

Why are we doing this module?

The 2024 MAD (ML, AI & Data) Landscape (https://mad.firstmark.com/), Matt Turck



Potentials and Risks of AI Technology

GETTY IMAGES

The use of facial recognition payment is now commonplace in China's largest cities.

https://www.nytimes.com/2019/06/17/opinion/letters/facial-recognition-new-york-city-police-department.html

The same technology used by police to identify criminals.

AI-based Decision-Making

GETTY IMAGES

Cheriss May / reuters

(from BBC & The Guardian)

Durham University

Responsible AI

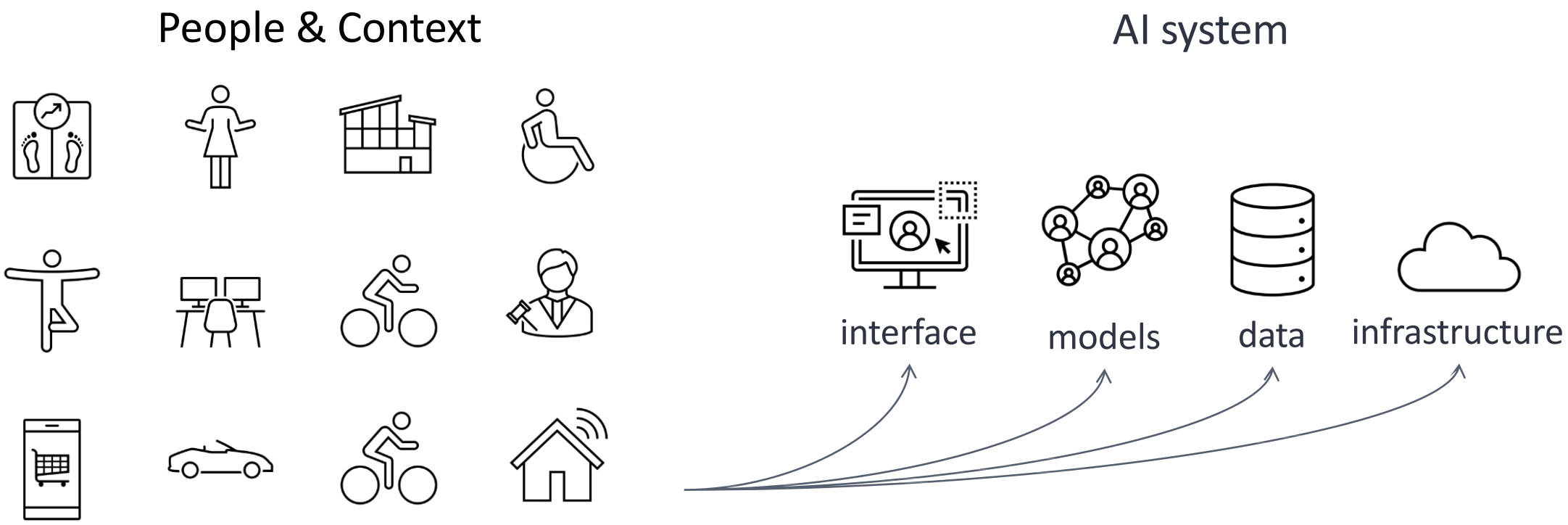
Challenges to creating AI responsibly

- Cultural – shifting mindsets and embracing diversity
- Organisational – aligning business and responsible AI objectives
- Technical – building AI technologies

Building AI responsibly requires adopting human-centred practices.

- Ensuring that **what we build** benefits people and society, and that **how we build it** begins and ends with people in mind.

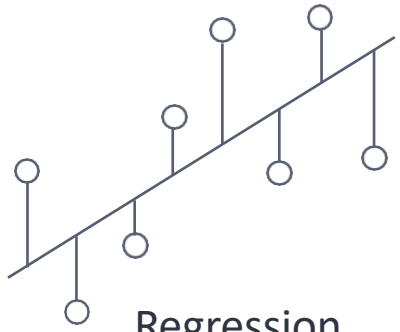
How to build AI in a human-centred way

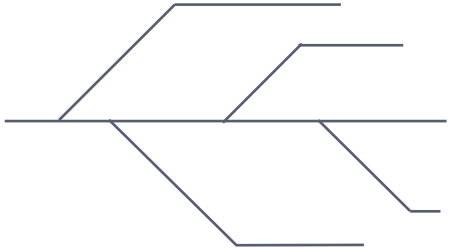


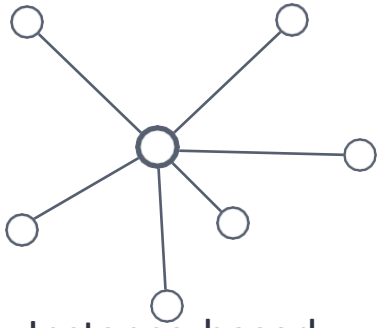
How to build AI in a human-centred way

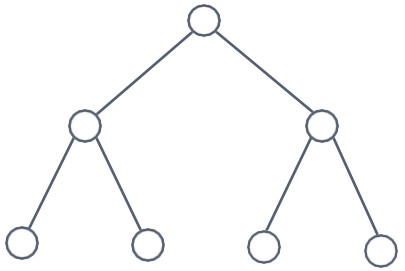
- Tie all technical decisions back to user needs
- Involve diverse perspectives early and throughout
- Plan for failures so users can recover when things go wrong
- …

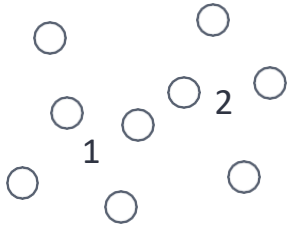
From modules to real projects


Regression

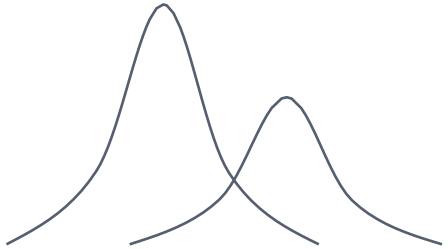

Regularisation

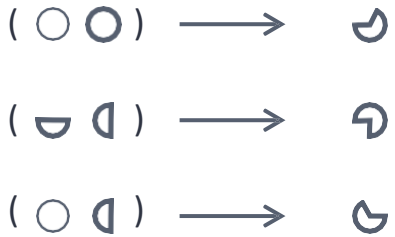

Instance-based

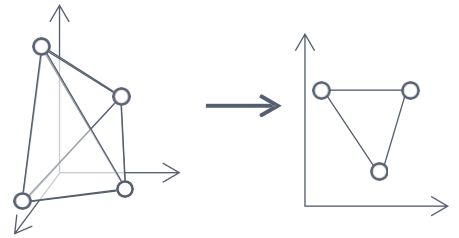

Tree-based

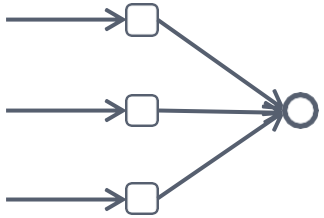


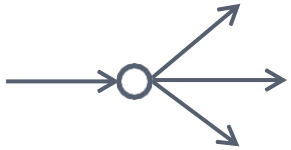
Clustering


Bayesian

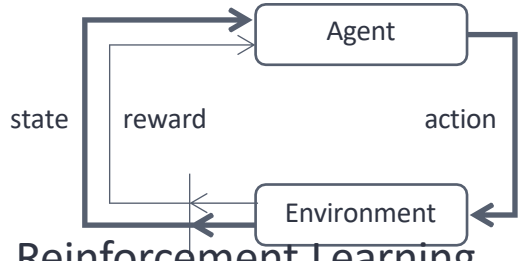

Associated Rule Learning


Dimensionality Reduction


Ensemble


Neural Network


Deep Learning



Reinforcement Learning

From modules to real projects

Beautiful math…

$$H(X) = -\sum_{i=1}^{n} P(x_i) \log_b P(x_i)$$

$$\ell(\{l\}) = \prod_{i=1}^{m} \left(\frac{2^{(w_y^T x_i + b_y)}}{\sum_{j=1}^{k} 2^{(w_j^T x_i + b_j)}} \right)^{z_i}$$

$$f^* = \arg\max_{x \in \{0,1\}^n} \sum_{i=1}^{m} \left[y_i - \frac{1}{2} \right] \sum_{i=1}^{m} \left[y_i (x \cdot x_i - b) \right]$$

…, but for building usable, useful, and trustworthy interactive AI apps

….

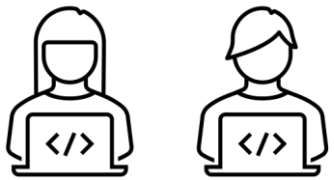
Durham University

From modules to real projects

Math → CS → ML/DL/RL

↘

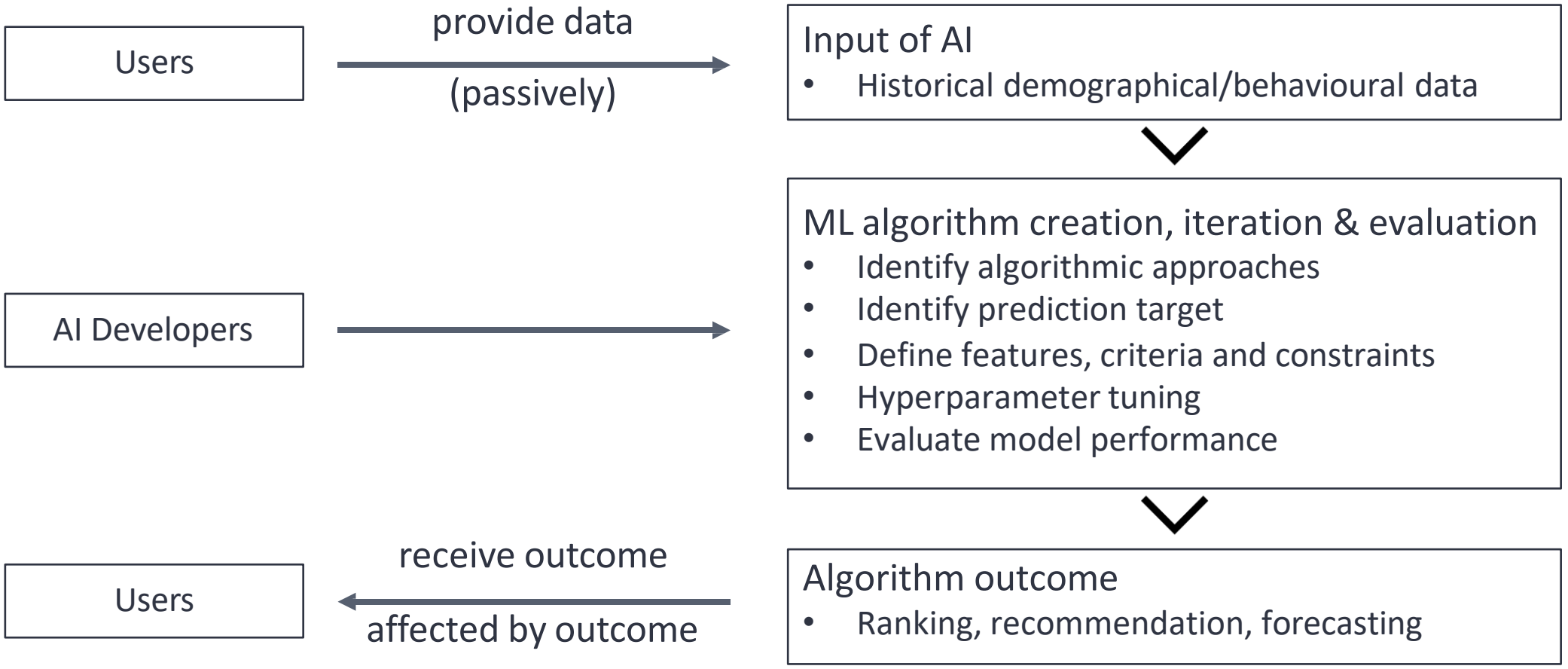
MLE/Programmer



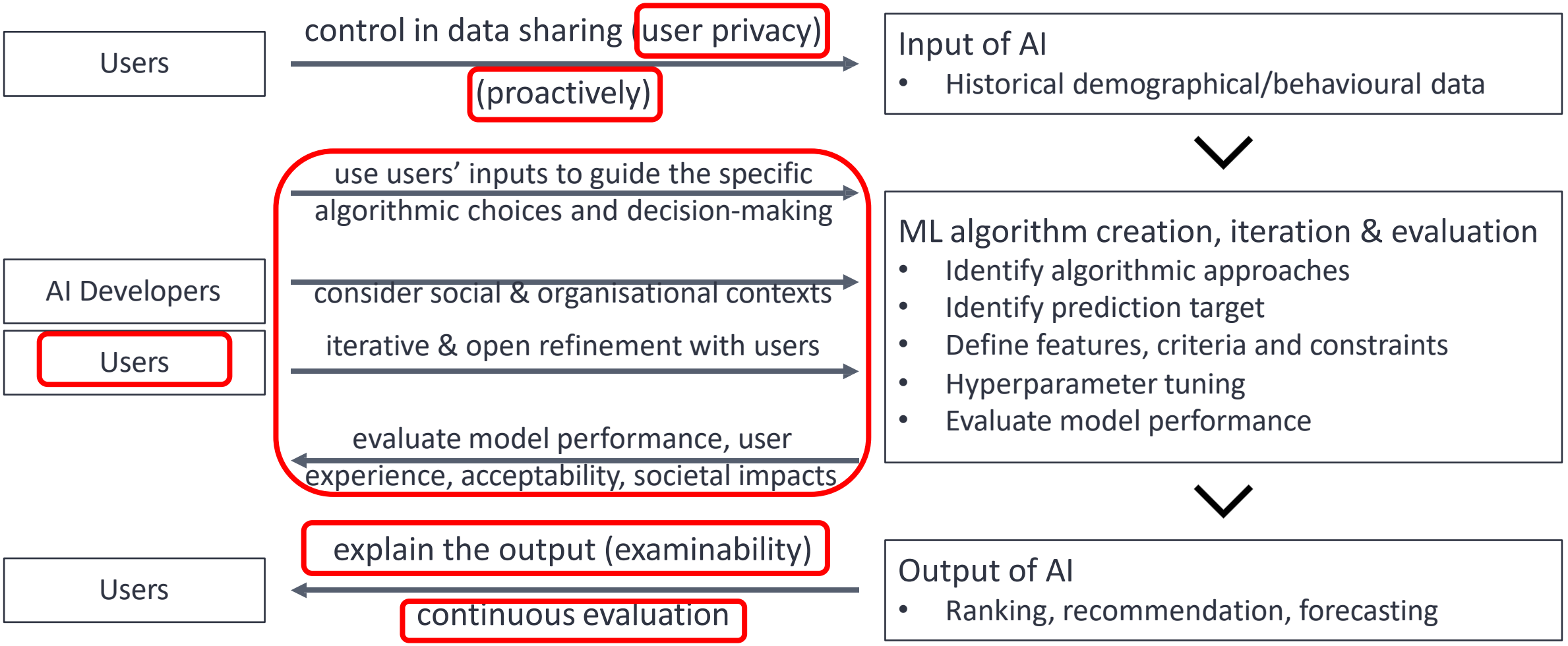
- thinking from the perspective of system/data
- disconnected from real-world problems
- Considering “user interfaces” or human aspects as an afterthought

Human-Centred Approach

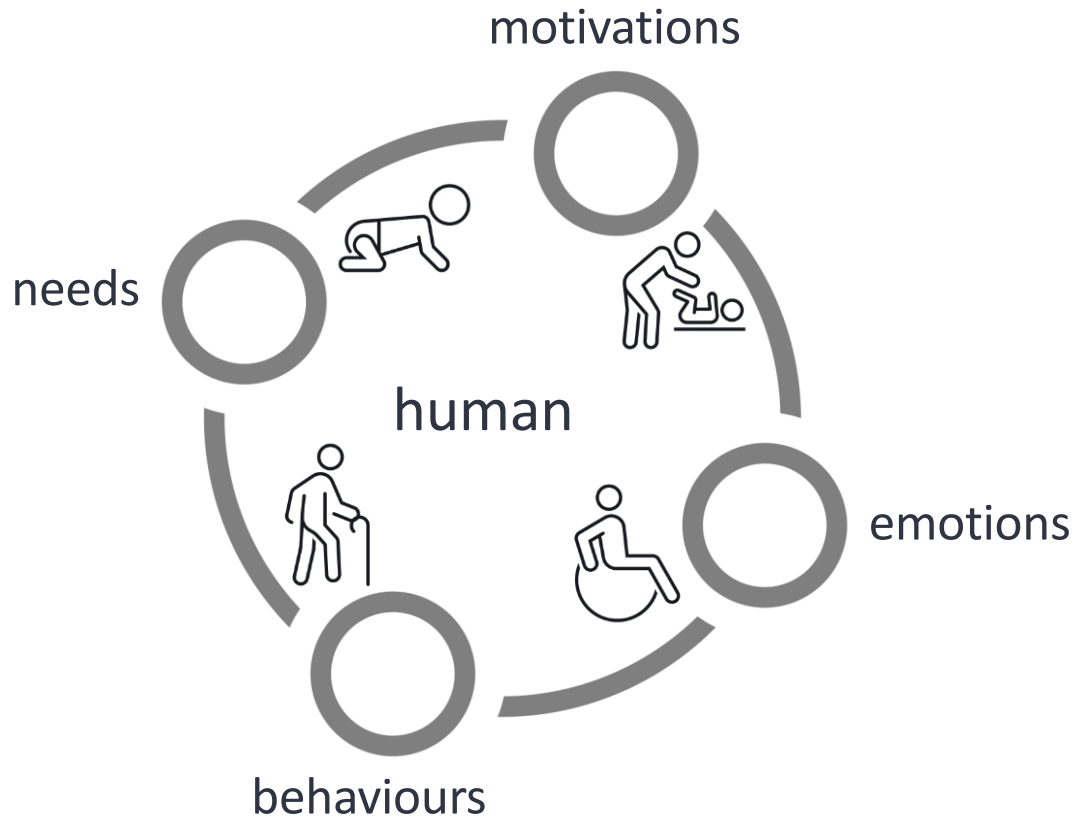
Traditional AI Development Pipeline



Human-Centred AI Development Pipeline



Human-Centred Approach



prior experiences desires ambitions interests irrational decision making …

Human-Centred Approach

> “Smart technologies are unlikely to engender smart outcomes unless they are designed to promote smart adoption on the part of human end users. Just as adding more intelligent people to a team can result in its effectiveness being diminished, so can AI result in “artificial stupidity” if poorly designed, implemented, or adapted to the human social context.”

Jim Guszcza
(Data Scientist, Deloitte Consulting)
Wired, 2018

https://www.wired.com/brandlab/2018/05/ai-needs-human-centered-design/

Coursework

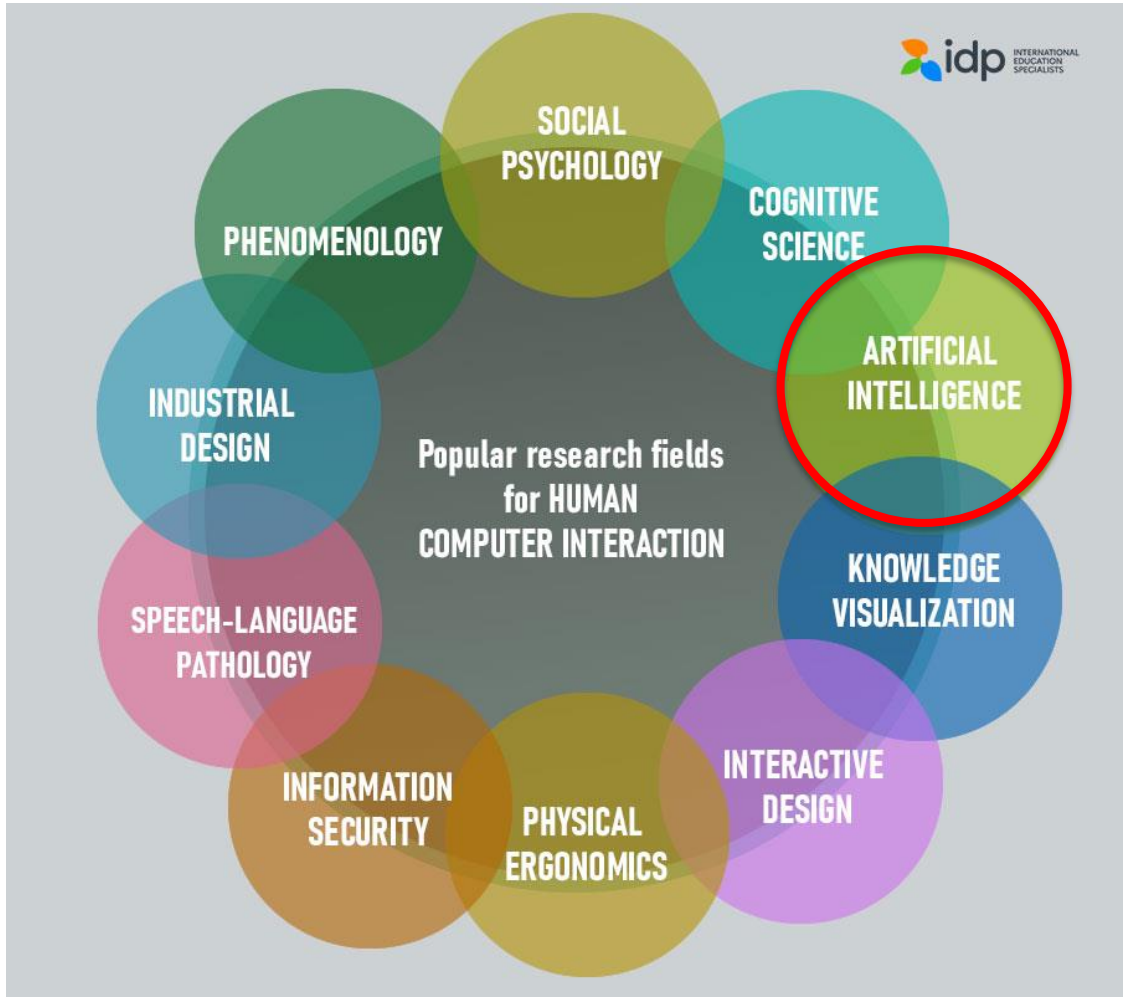
- Individual
- Empirical
- Analytical

Two parts: **Summative Part 1 (20%)** and **Summative Part 2 (80%)**

	Release Date	Due Date
Part 1	**23 Oct 2024**	**14 Nov 2024**
Part 2	**1 Nov 2024**	**14 Jan 2025**

From Usability to UX to HAIID

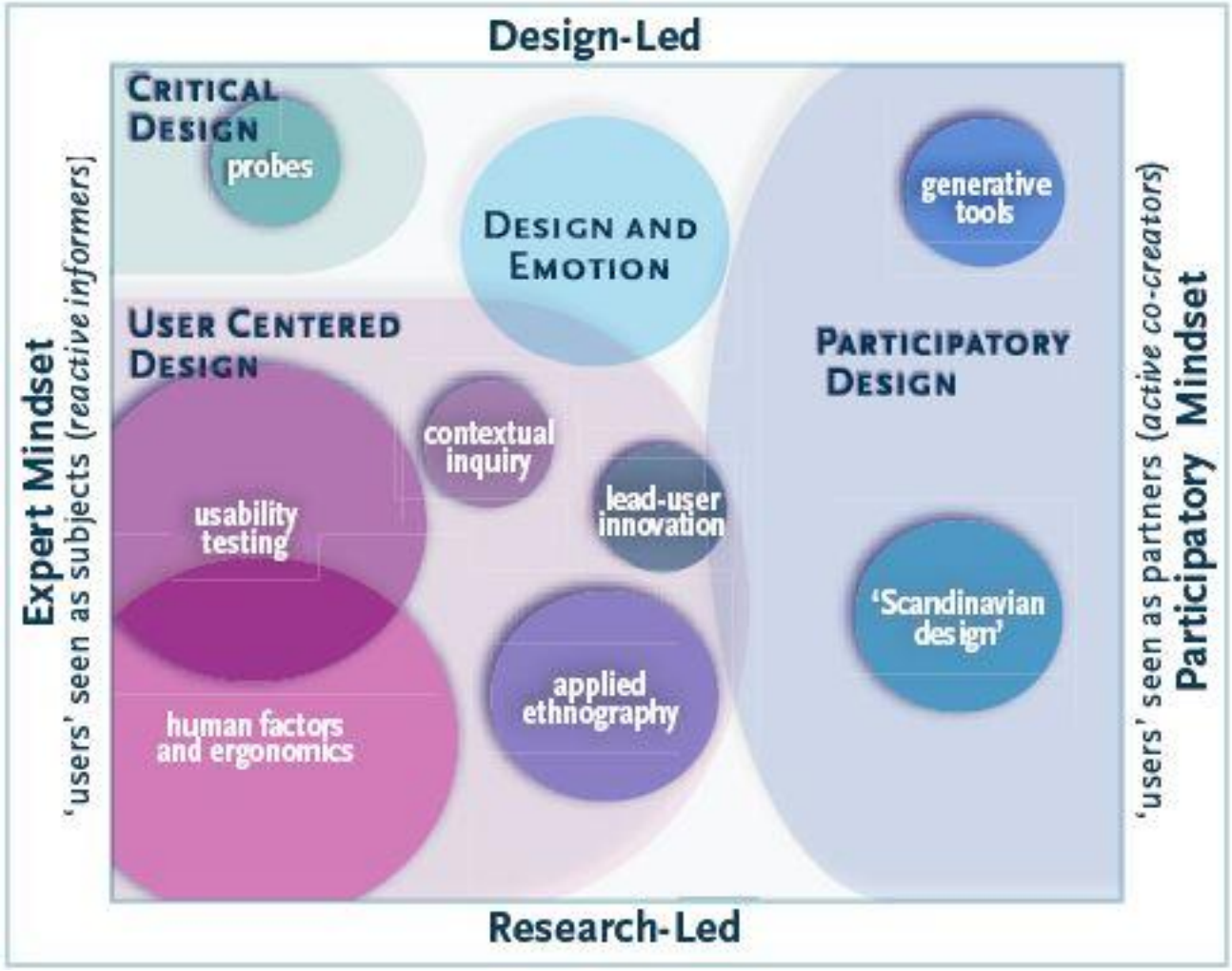
HCI & SE & HAI


idp
SOCIAL PSYCHOLOGY
PHENOMENOLOGY
COGNITIVE SCIENCE
ARTIFICIAL INTELLIGENCE
INDUSTRIAL DESIGN
Popular research fields for HUMAN COMPUTER INTERACTION
KNOWLEDGE VISUALIZATION
SPEECH-LANGUAGE PATHOLOGY
INFORMATION SECURITY
PHYSICAL ERGONOMICS
INTERACTIVE DESIGN


integration
software
Usability
Human-Computer
Engineering
HCI
interaction
development
design
engineering
Software
usability
Interaction

Main Areas in Human-Computer Interaction

- User-Centred Design (UCD)
- Participatory Design (PD)
- Usability (U)
- User Experience (UX)



What is Usability?

Usability is only one of many qualities a system can have ...

Usability is closely related to ease-of-use (user-friendly), but more than that ...

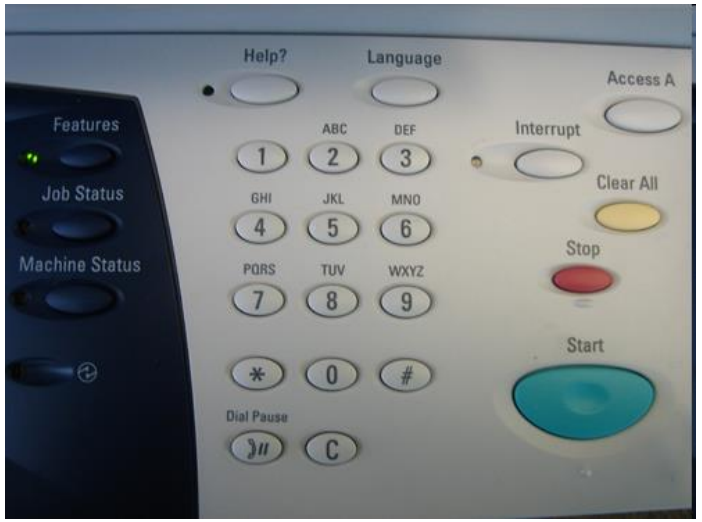
Designing a usable website or system means understanding users' needs and taking them into consideration all the time!

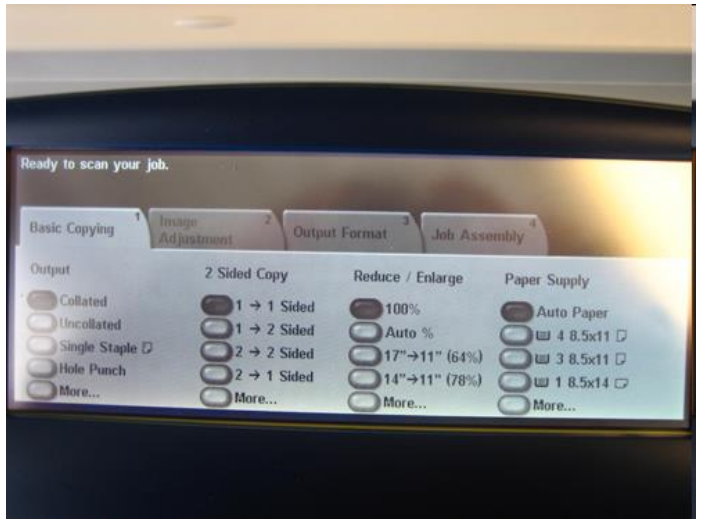
Why is Good Usability Important?

Durham University

- Usability is the end-user's view of system quality
- Expect sit-down-and-use computers and software
  - People don't read the manuals
- Usability is critical to software sales:
  - In magazine ratings
  - “User friendly”
  - “Positive user experience”
- Novices will be more *effective*; Experts more *efficient*
- Can help identify what is *really* needed
  - What will be useful and what is *not* needed

Classical Example of HCI





Task 1: Print out a two-sided copy from 2 one-sided sheets

Task 2: Shrink a two-sided layout into one page

Suchman, Lucy (1987). Plans and Situated Action: The Problem of Human-Machine Communication

Usability of Interactive Medical Device

Multi-channel Infusion Pump

- Cases of medical errors – wrong dosage
- Lethal consequences; more severe than inconvenience

Decimal Point

Definition & Metrics

ISO 9241-110: 2020: Ergonomics of human-system interaction — Part 110: Interaction principles

"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"

Effectiveness: Accuracy and completeness of the goals are achieved

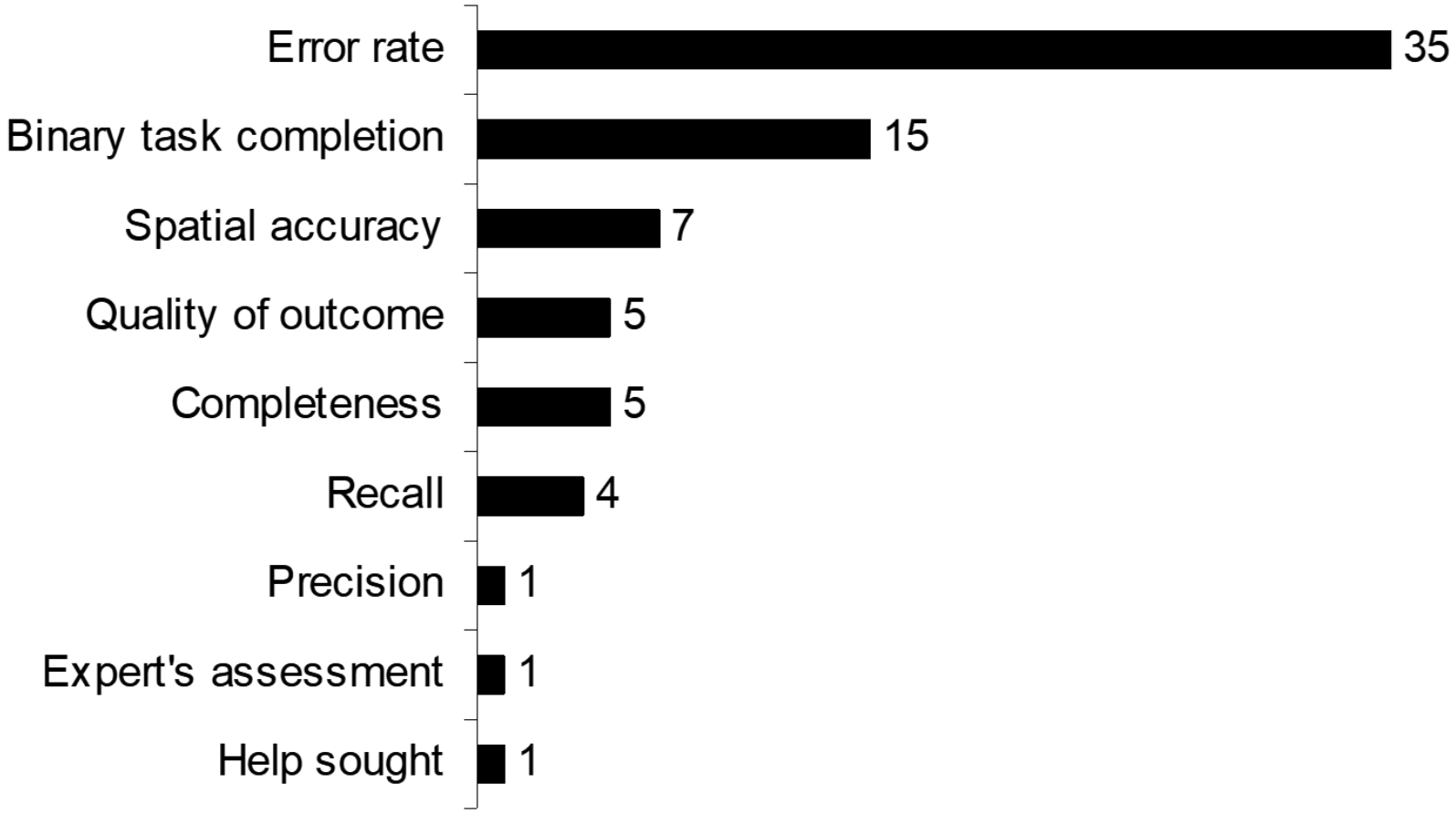
Efficiency: Resources expended in relation to effectiveness

Satisfaction: Freedom from discomfort and positive attitude

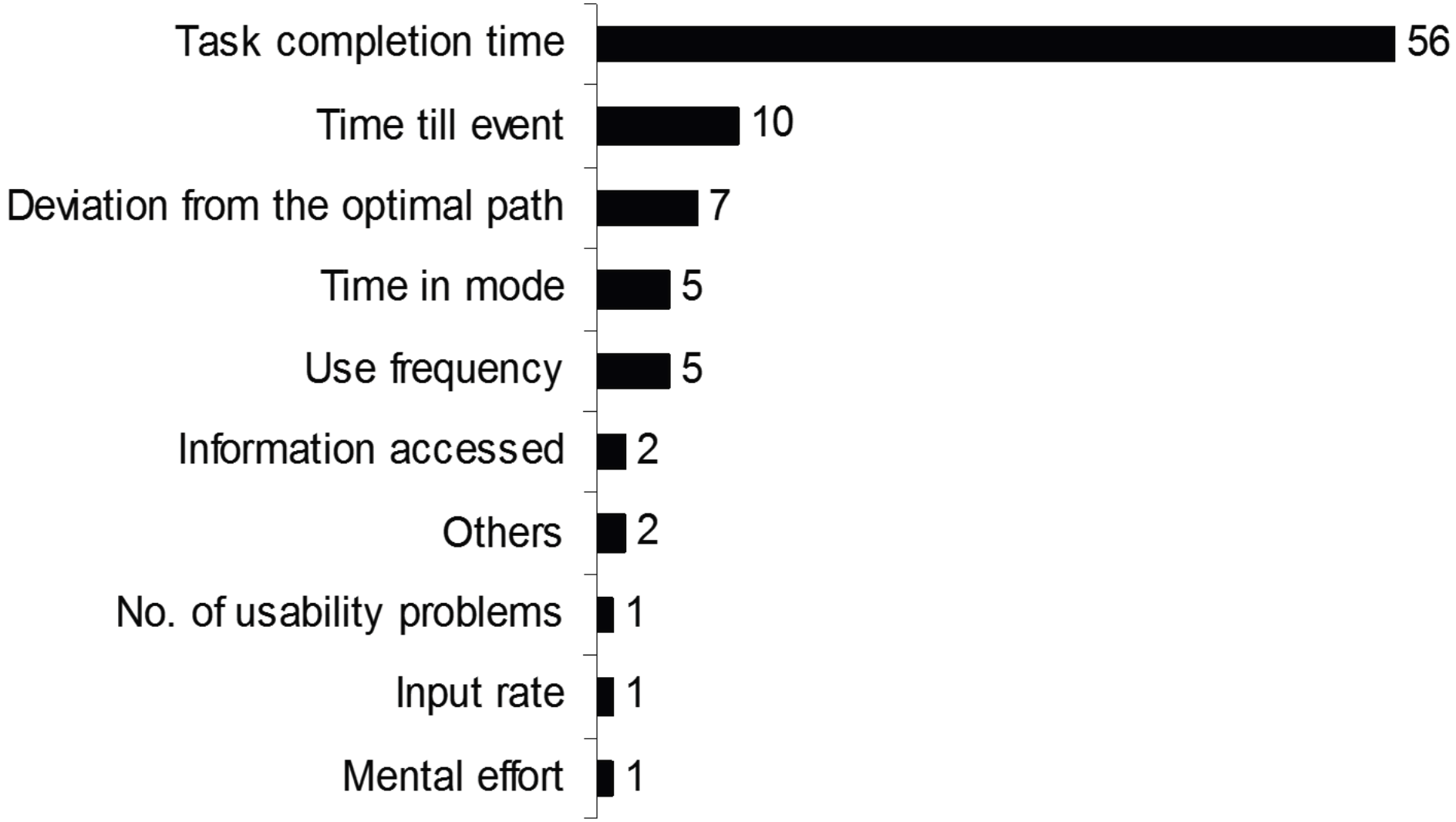
Common Measures of Effectiveness

Durham University

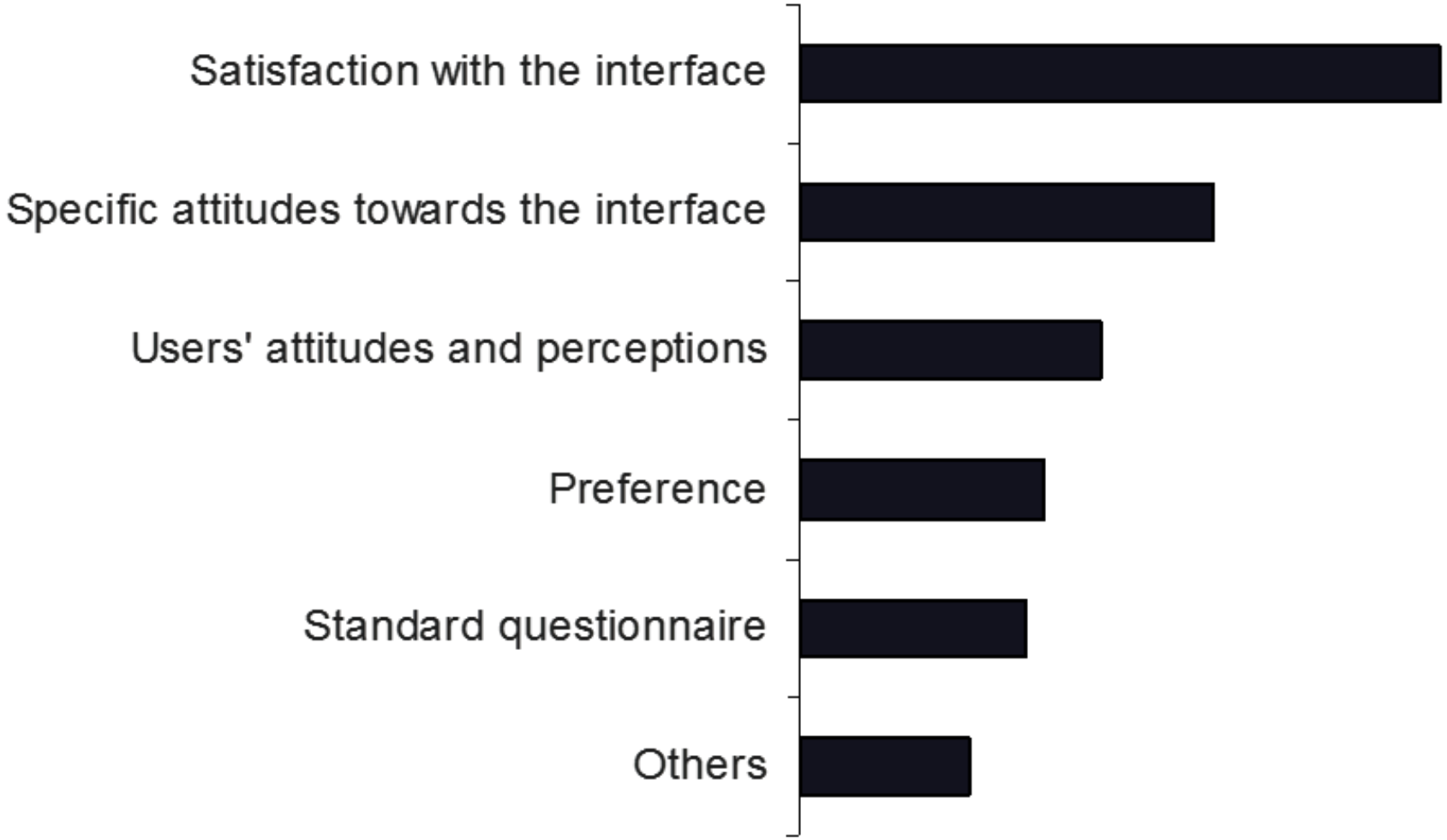
Raw data of 73 studies published in qualified HCI journals and conferences



Common Measures of Efficiency



Common Satisfaction Measures



System Usability Scale (SUS)

	The System Usability Scale Standard Version		Strongly disagree				Strongly agree
			1	2	3	4	5
1	I think that I would like to use this system.		○	○	○	○	○
2	I found the system unnecessarily complex.		○	○	○	○	○
3	I thought the system was easy to use.		○	○	○	○	○
4	I think that I would need the support of a technical person to be able to use this system.		○	○	○	○	○
5	I found the various functions in the system were well integrated.		○	○	○	○	○
6	I thought there was too much inconsistency in this system.		○	○	○	○	○
7	I would imagine that most people would learn to use this system very quickly.		○	○	○	○	○
8	I found the system very cumbersome to use.		○	○	○	○	○
9	I felt very confident using the system.		○	○	○	○	○
10	I needed to learn a lot of things before I could get going with this system.		○	○	○	○	○

Two Common Usability Evaluation Methods

- Analytic Expert Review:
  Heuristic Evaluation

- Empirical User Study: *Think aloud*

Expert Review: Heuristic Evaluation

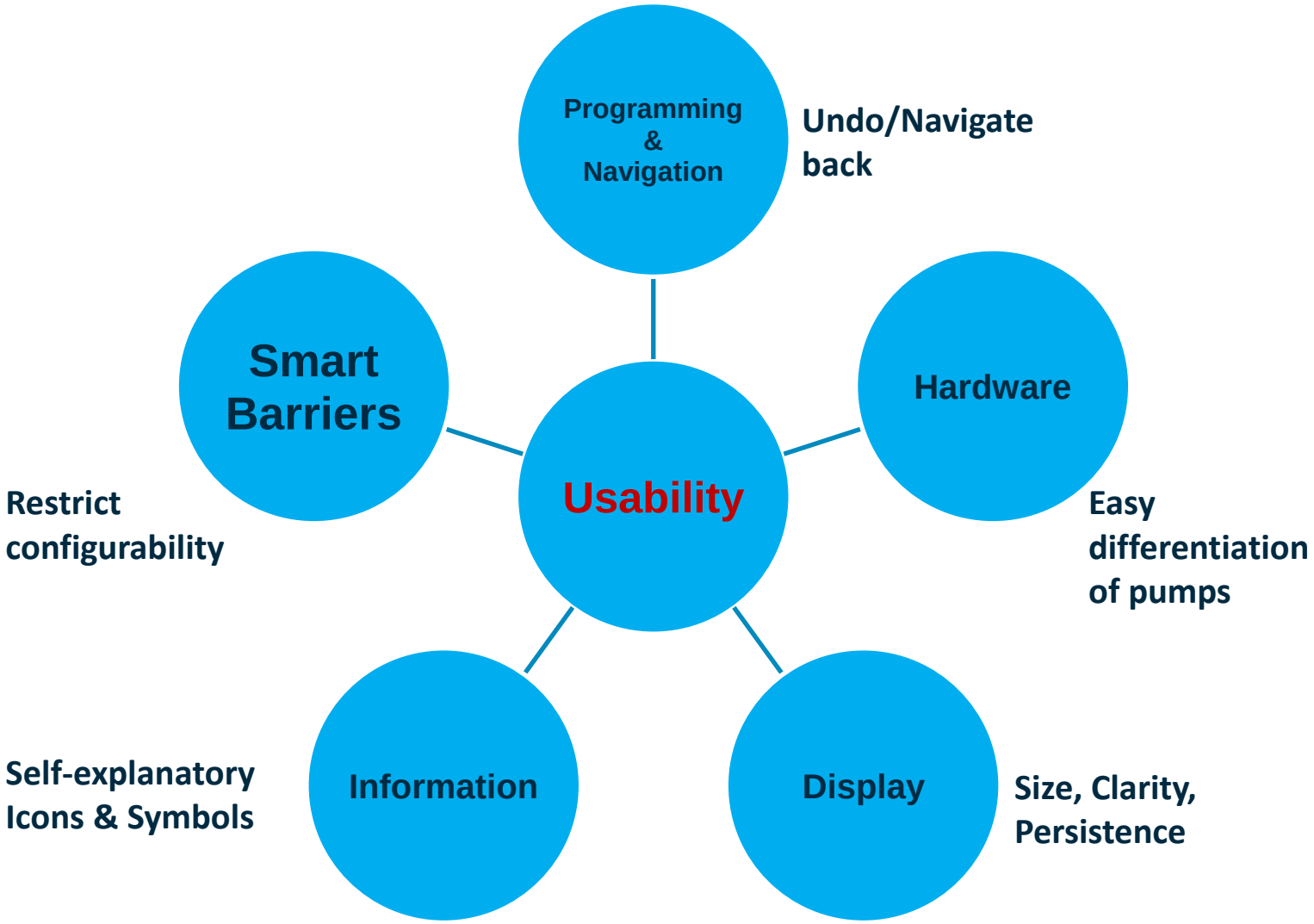
Jakob Nielsen (2000) “Usability Principles”

- Visibility of system status
- Match between system and the real world
- User control and freedom
- Consistency and standards
- Help users recognize, diagnose and recover from errors
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help and documentation

How to do Heuristic Evaluation

- Systematic inspection of system
- Multiple evaluators are better
  - More data, but costly (time and effort)
  - Evaluator effect – conflicting views
- Trained evaluators are better
  - 22% vs. 41% vs. 60% of errors found
- Go through the whole interface twice
  - Browse
  - Inspect closely (better with a use scenario)
- Results:
  - list of usability problems
  - heuristics violated
  - proposed fixes

Recommendations



Why Hard to Design UIs?

Durham University

"It is easy to make things hard. It is hard to make things easy."

- **No silver bullet**

- User Interface design is a creative process
- Designers have difficulty thinking like users
  - Often need to understand task domain
  - Can't "unlearn" something

Why Difficult? … Specifications

- Specifications are always wrong!!
  - “Only slightly more than 30% of the code developed in application software development ever gets used as intended by end-users. The reason for this statistic may be a result of developers not understanding what their users need.”

-- Hugh Beyer and Karen Holtzblatt, "Contextual Design: A Customer-Centric Approach to Systems Design,“
ACM Interactions, Sep+Oct, 1997, iv.5, p. 62.

- Need for prototyping and iteration

Why Difficult?… Domain-specificity

- Tasks and domains are complex
    - Medical devices
    - Cockpit
- Existing theories and guidelines are not sufficient
    - Too specific and/or too general
    - Standard does not address all issues
- Adding graphics can make it *worse*
    - Beauty ≠ Usability

Why Difficult?.... Quality Tradeoffs

- All UI design involves tradeoffs:
  - Standards (style guides, related products)
  - Graphic design (artistic)
  - Technical writing (Documentation)
  - Internationalization
  - Performance
  - Multiple platforms (hardware, browsers, etc.)
  - High-level and low-level details
  - External factors (social issues)
  - Legal issues
  - Time to develop and test (“time to market”)

HCI Design & Evaluation Methods

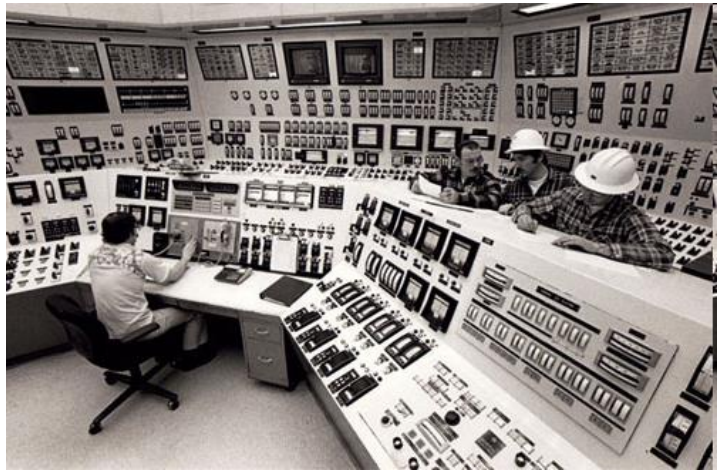
Durham University

- Affinity Diagrams
- Card Sorting
- Cognitive Dimensions
- Cognitive Walkthrough
- Contextual Design
- Contextual Inquiry
- Diary Studies
- Interviews
- Focus Groups
- Heuristic Evaluation
- KLM and GOMS
- Log Analysis
- Personas
- Prototyping
- Questionnaires
- Scenarios
- Surveys
- Task Analysis
- **Think Aloud**
- Use Cases
- Wizard of Oz
- ….

The story goes on…

“Migration” to User Experience (UX)

HCI Waves



Process Controls of Safety Critical Systems

Guidelines

Systematic testing

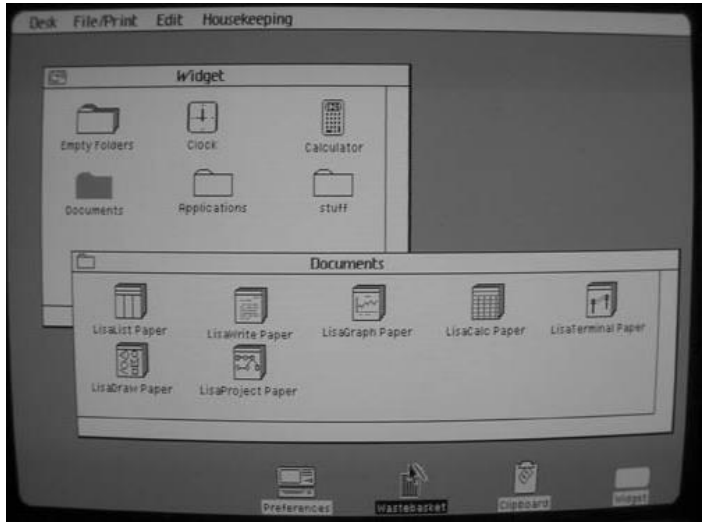
Engineering Human Factors

Formal Methods

User Modelling

First Wave

Human fActors



Productivity of Office Systems

Participatory Design

Prototyping

Contextual Inquiry

Cognitive Science

Second Wave

Community of Practice

Activity Theory

Situated Action

Third HCI Wave

Experience

Meaning-making

Totality

3rd-Wave HCI

Affective Computing

Mobile, Transmedial IxD

Aesthetic Interactions

Entertainment Computing

UbiComp

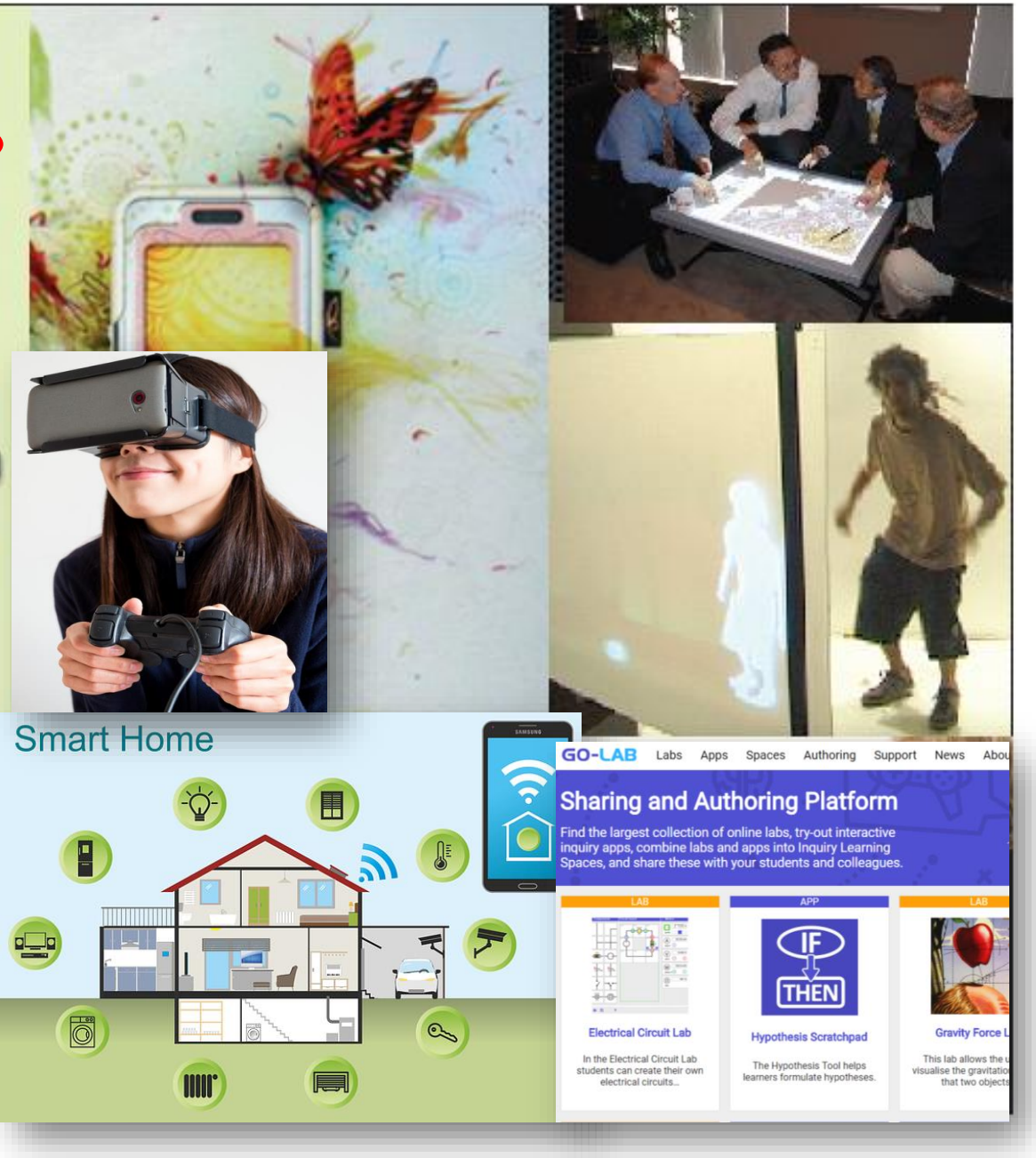
Domestic Computing

Interactive Visualizations

Embodied Interaction

Social Computing

Experience Design

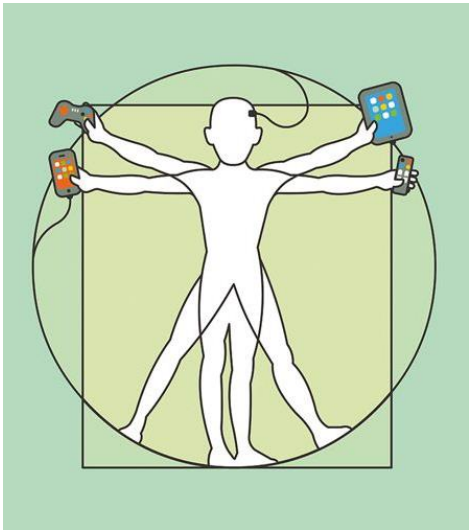


Fourth Wave in HCI?

Positive Computing

- Wellbeing
- Wisdom
- Human potential

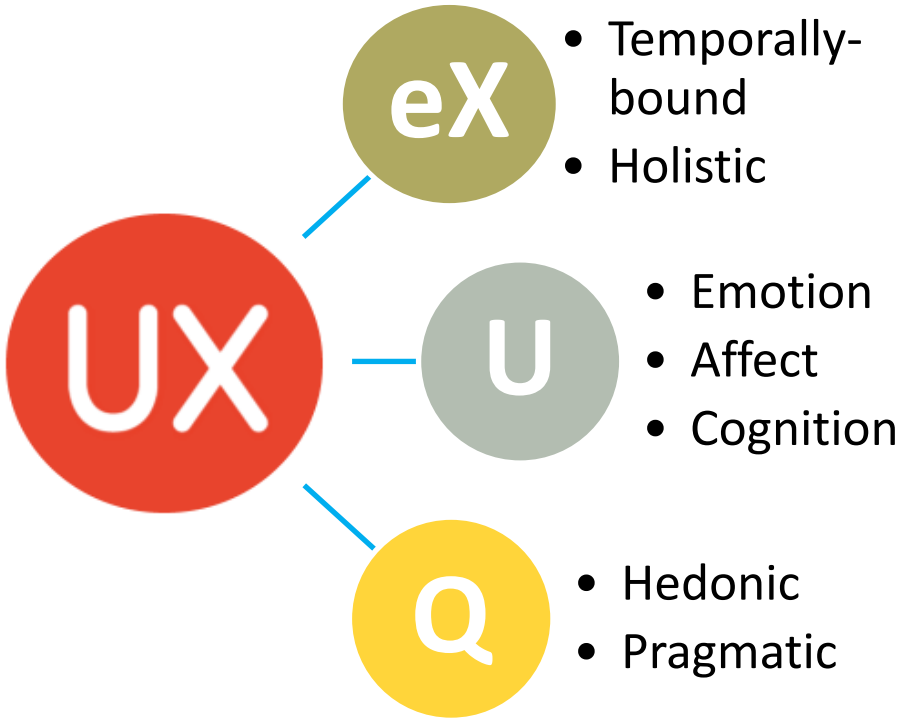
(Calvo & Peters, 2014)



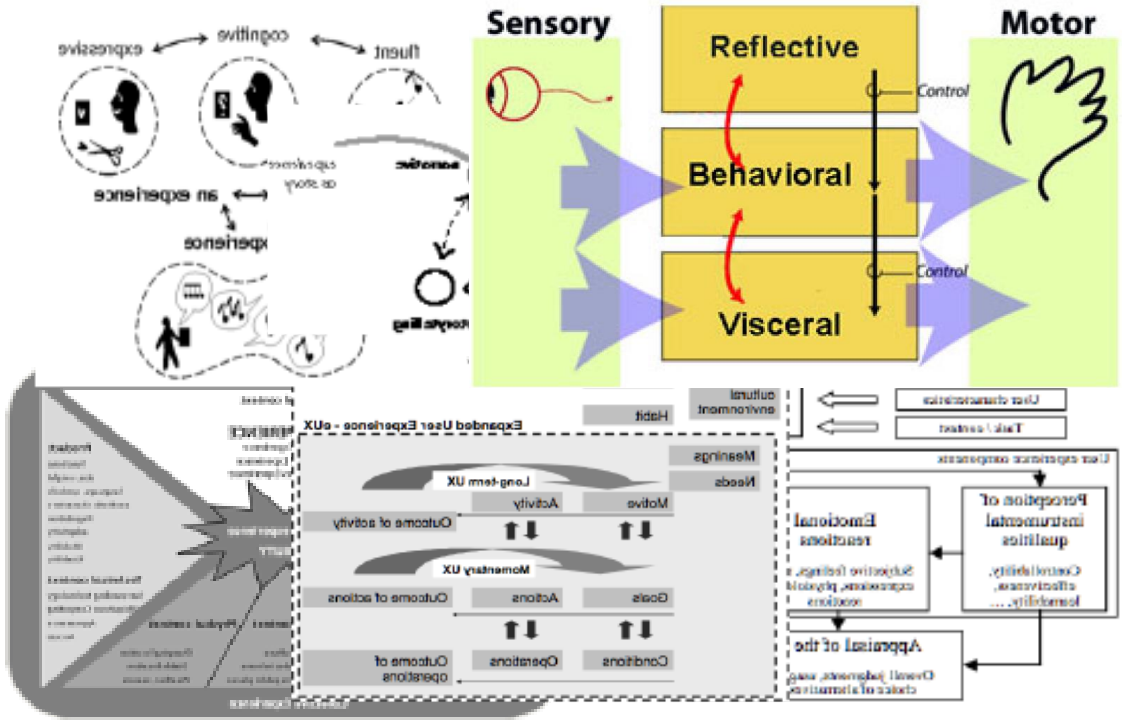
Human-AI Interaction (HAII)

What is UX?

No common understanding of what UX is!



- Temporally-bound
- Holistic
- Emotion
- Affect
- Cognition
- Hedonic
- Pragmatic



UX Definitions

- ***ISO 9241-210: 2010 (Section 2.15)*: A person's perceptions and responses that result from the use and/or **anticipated** use of a product, system or service.
  - 3 notes

- ***Wikipedia***: UX highlights the **experiential, affective, meaningful** and **valuable** aspects of human-computer interaction and product ownership, but it also includes a person's perceptions of the practical aspects such as **utility, ease of use** and **efficiency** of the system.

Effect (Usability) vs. Affect (UX)

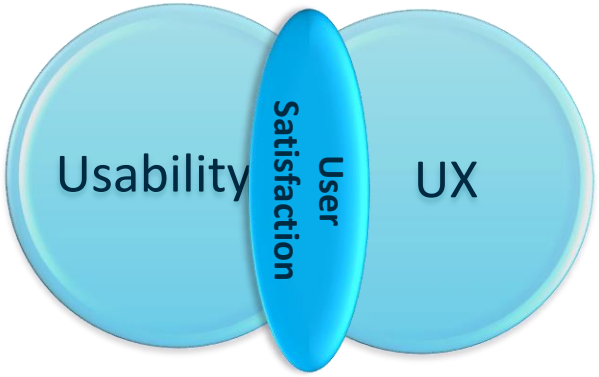
Usability

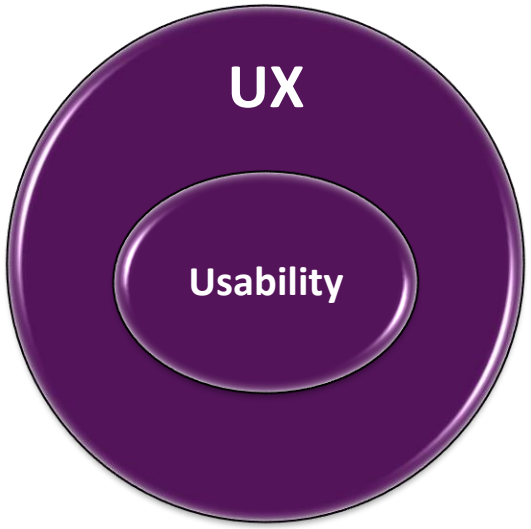
- **Pragmatic quality**
- ***do-goal (to find an e-book)***
- **Product: performance, task**
- **Componential**
- **Partly objective**
- **Relatively persistent**
- **Standard usability metrics exist**
  (Efficiency, Effectiveness, Satisfaction)

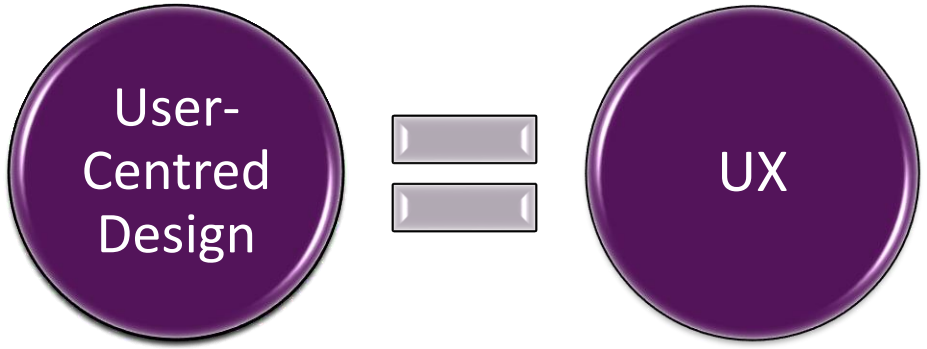
UX

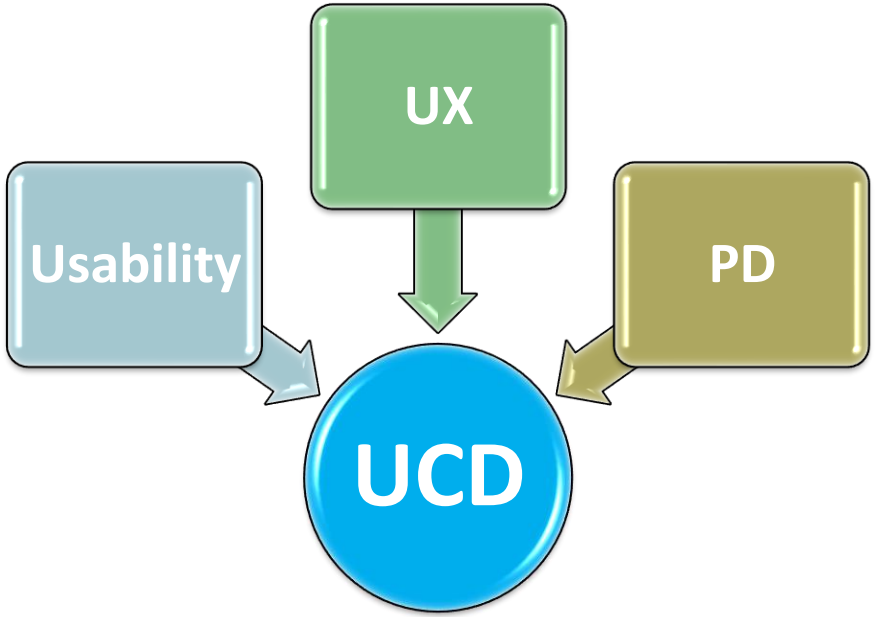
- **Hedonic quality**
- ***be-goal (to feel competent)***
- **Experience: emotion, affect**
- **Holistic**
- **Highly subjective**
- **Inherently dynamic**
- **Standard UX metrics yet to be created (cf. Note 3)**

Relations between Usability and UX









Summary

- HAII is a fast-growing area in HCI
- Usability is a fundamental concept in HCI. It is *NOT* dead!
- UX is more than usability, emphasis on the emotional aspect of interacting with computing technologies.
- UX is critical for HAII ("capacity uncertainty", "output complexity")

If an AI-infused application is not usable, causing poor user experience and loss of trust, users abandon the application and cannot benefit from it.

References

- Hassenzahl, M., Burmester, M., & Koller, F. (2021). User experience is all there is: twenty years of designing positive experiences and meaningful technology. *i-com, 20*(3), 197-213.
- Hornbæk, K., & Oulasvirta, A. (2017, May). What is interaction?. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (pp. 5040-5052).
- Law, E. L. C., Hvannberg, E., & Cockton, G. (2007). Maturing Usability: Quality in Software, Interaction and Value (Human-Computer Interaction Series). Springer-Verlag.
- Tractinsky, N. (2018). The usability construct: a dead end?. *Human–Computer Interaction, 33*(2), 131-177. (with Commentaries)
- https://measuringu.com/ {Jeff Sauro}