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Week 2

Human-Robot Interaction

Human Factors and Context

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Learning Outcomes

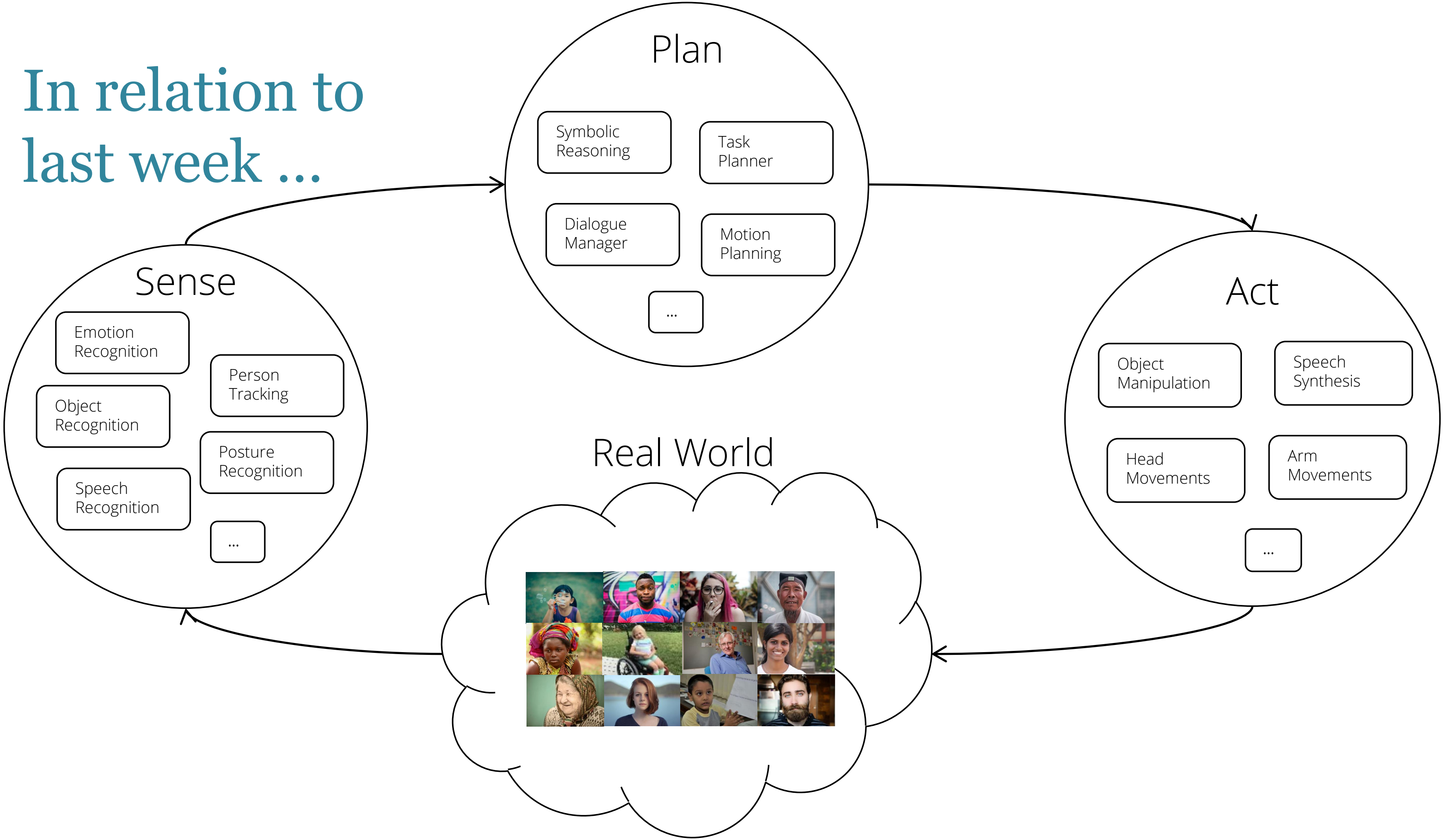
- Understand human characteristics and diversity that impact interaction with robots in different contexts
- Recognise the impact of context in relation to these attributes
- Recognise the impact and implications of these for HRI and design

Human Factors

- Knowledge about human abilities, human limitations, and other human characteristics that are relevant to design of technology

- Application of human factors enables the design of technology that is
    - Safe
    - Comfortable
    - Effective human use

In relation to last week ...



Interaction

Input Modalities

Physically: button, joystick, mouse, handling a robot or end effector, using touch-sensitive surfaces (screen or capacitive surfaces)
Visually: Eye tracking
Gestures: Finger, arm, head or full body movement or position tracking
Sound: Voice, Speech recognition
Physiological: EEG, EMG, Facial expression

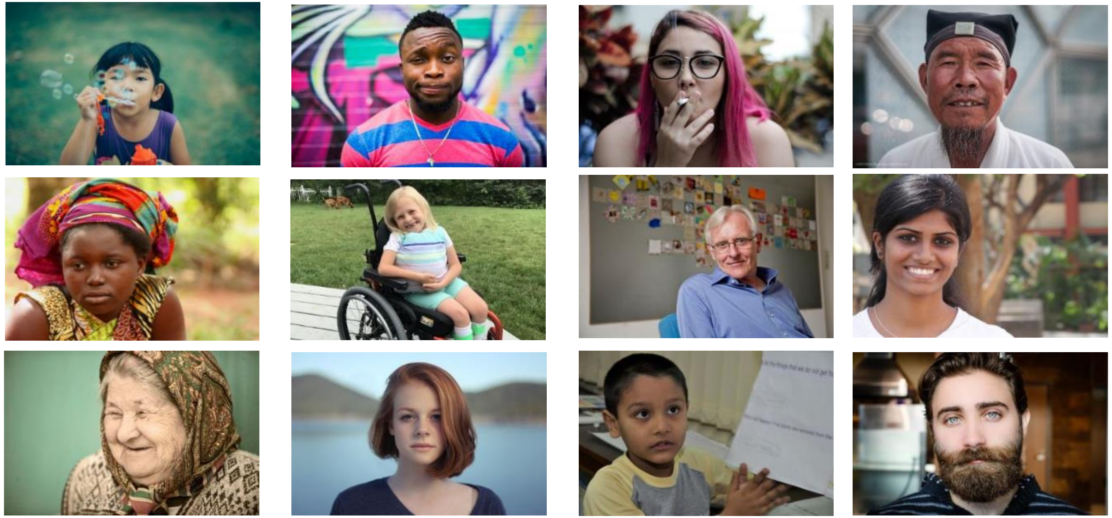
Output Modalities

Visual: Text, LED patterns and colours, images, icons, physical position of the robot or part of the robot, gesturing
Aural: Sounds, speech
Physical: Haptics (vibration, level of force, pressure patterns)

Direct Control ⟷ Fully Autonomous

Autonomy Level

Considering Human Diversity



- Physical and intellectual abilities
- Gender
- Cultural and behavioural attitudes and perceptions
- Domain knowledge
- Effect of stress or fatigue
- Age-related effects
- Chronic conditions

What differences in characteristics are important to consider for HRI?

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Human Characteristics to consider for Interaction with Assistive Robots

- Ageing Related Impairments
  - Vision
  - Hearing
  - Mobility
  - Cognition

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Discuss HF issues for interaction with the following

Assistive Robots

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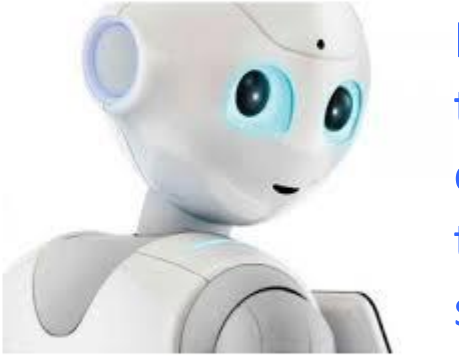
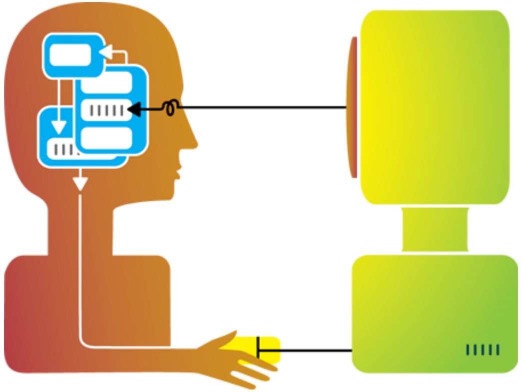
Mental Models

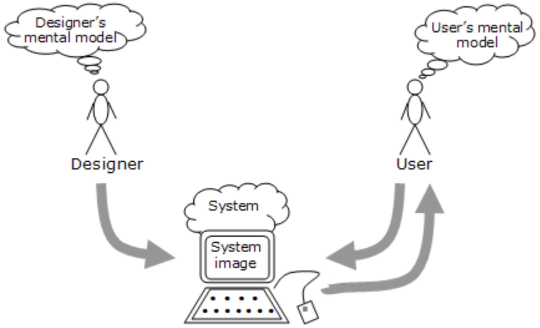
The understanding and knowledge that we possess of something is referred to as Mental Models



People develop mental models through interacting with systems, observing the relationship between their actions and behaviour of the system and the feedback in response to their action



So it is important that designers provide sufficient information in the interface for people to form and accurate mental model



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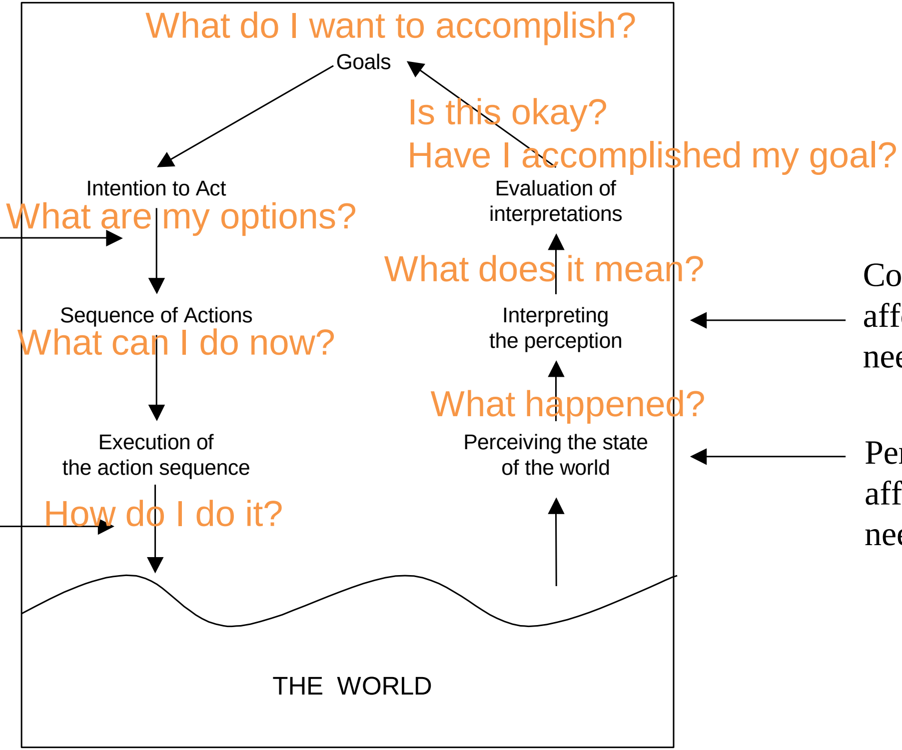
Norman’s 7 Stages of Action

Norman pointed out need for cognitive affordance here; perceptual affordance also needed here

Physical & perceptual affordance needed here



Cognitive affordance needed here

Perceptual affordance needed here

Functional affordance needed here

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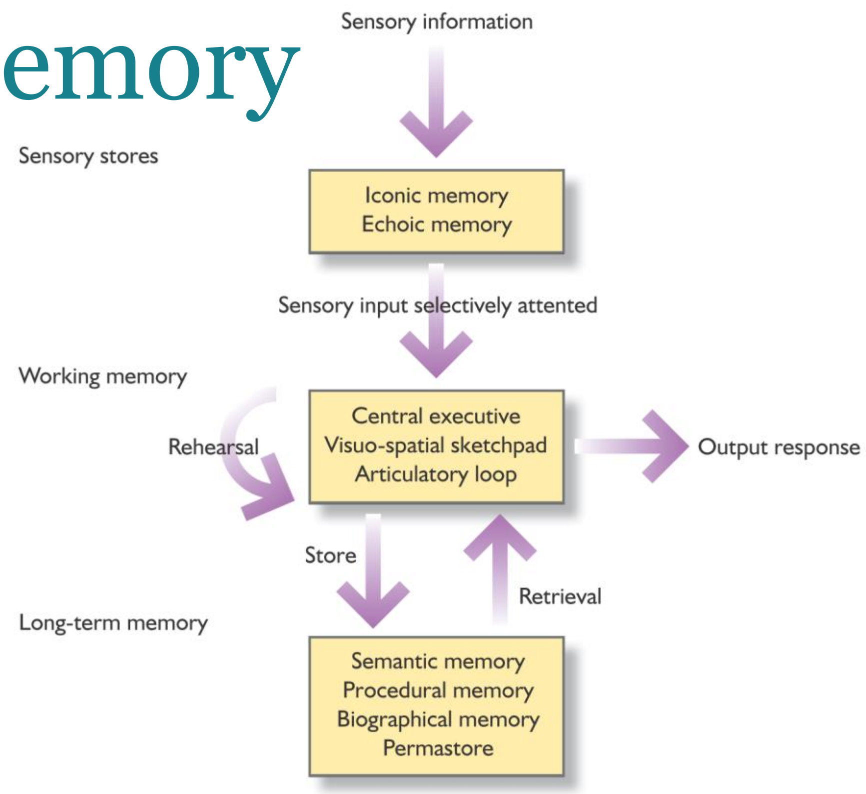
http://www.it.bton.ac.uk/staff/rng/teaching/notes/NormanGulfs.html

Example: HRI for Mediating Assistance via a Social Robot

HF issues to note:

1. User’s mental model
2. Interaction flow errors
3. Learnability and Adaptability
4. Structure of conversation
5. Memorability
6. Multimodal Feedback

Human Memory



A schematic model of multi-store memory

Short-Term Memory/Working Memory

- **Limited capacity**
  - Capacity can be perceived as improved by
    - Chunking – let us do a test
    - Association – one can train to pass information to long-term memory
- **Time Limited Storage**
  - Contents lost in ~30 seconds - decay
  - Can be refreshed by rehearsal
- **Needs closure**
- **Prone to loss of information by displacement**

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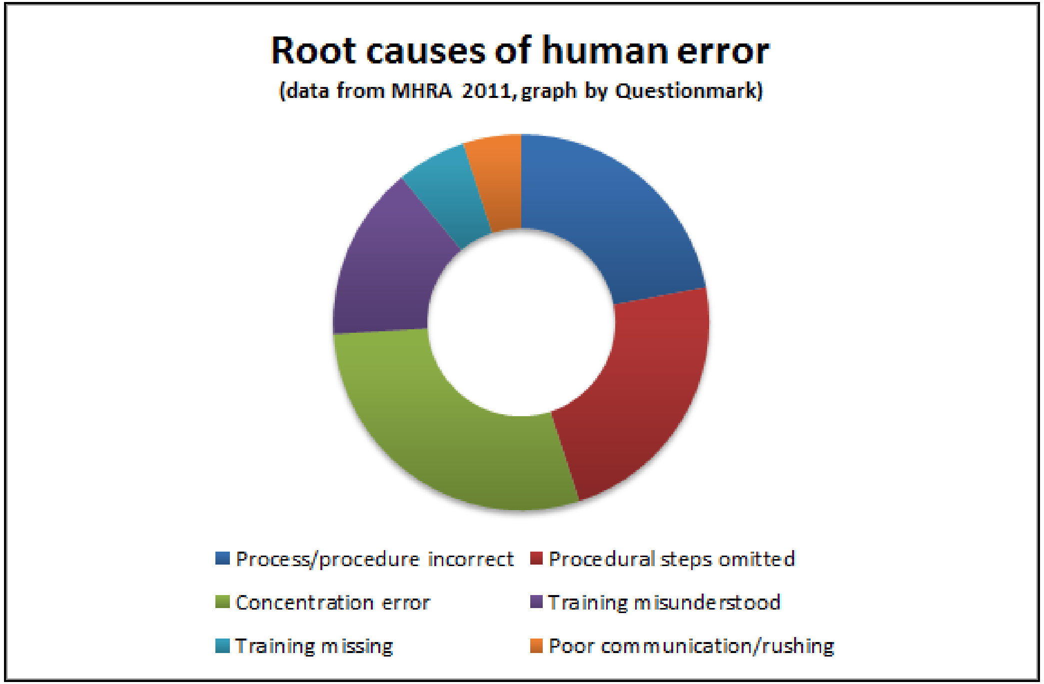
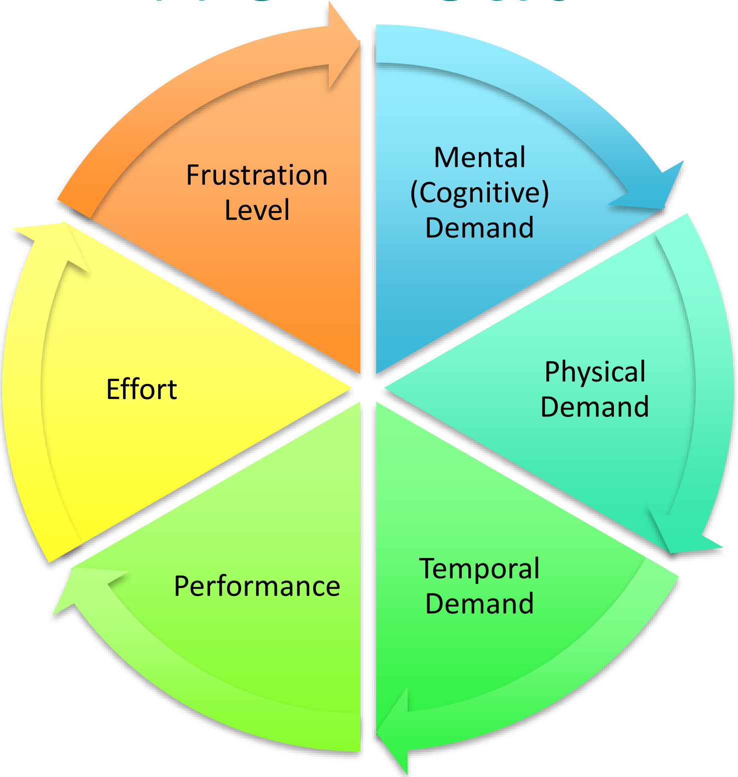
Human Error



Workload



Failure to provide clear physical constraints on erroneous actions

https://www.fda.gov/medicaldevices/productsandmedicalprocedures/generalhospitaldevicesandsupplies/tubingandluermisconnections/ucm313275.htm

Example: Human Factors Issues in a Physical Robot Assistance Dressing Support Task

HF Safety Related issues to note:

1. **Attention/Distraction** and potential for mishaps
2. **Situational awareness** and **proprioception**
3. Impact of **Cognitive Load and Stress** on the interaction

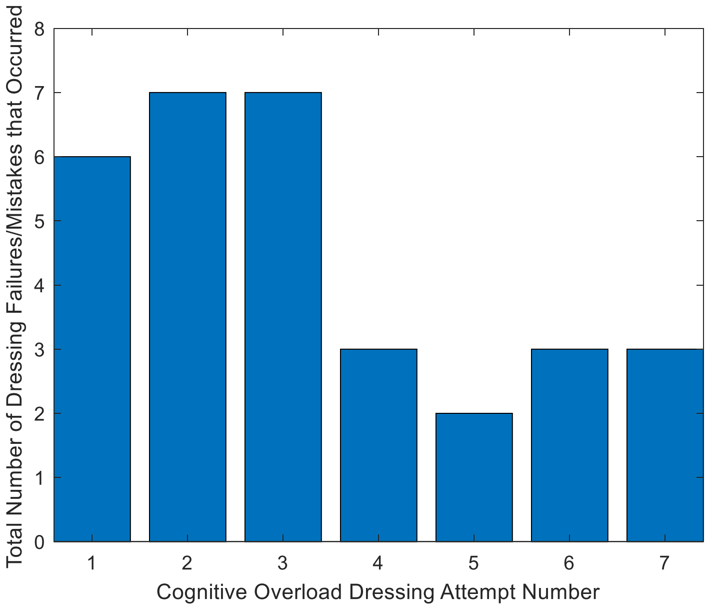
HF in Robot Assisted Dressing: Impact of Cognitive Overload

- Every recorded dressing issue occurred during cognitive overload section.

Dressing Issues	Stuck	Fail	Stuck or Fail
Total Number of users	11	6	17
% of total users	27%	15%	41%

- Mistakes occurred most frequently after the new distraction stimulus was first introduced.

- Participants adapted to the distraction and became more experienced at the dressing process during the experiment.



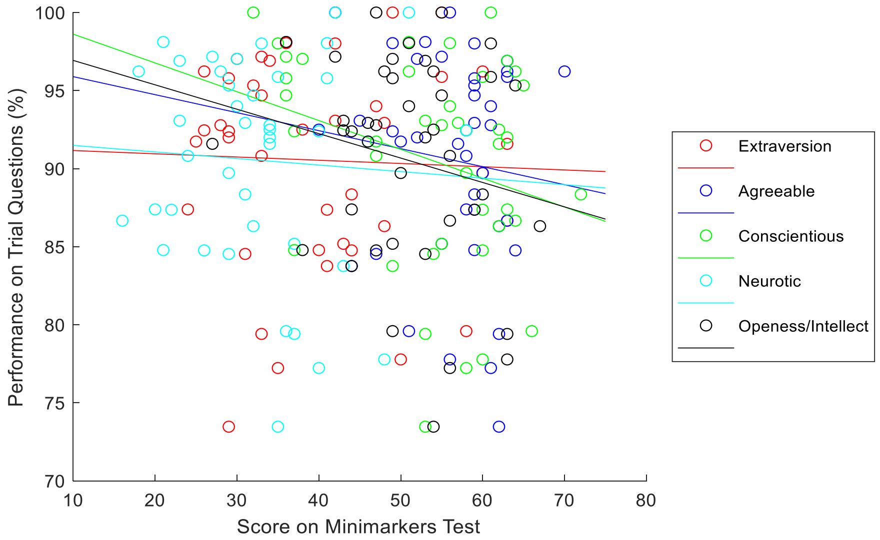
HF in Robot Assisted Dressing: Effects of Personality Type

Does personality matter in HRI?

- Likely to depend on context and other factors such as familiarity with task, confidence, who else is present, etc.

However

- Important to note that people's responses can be Affected by respondent bias (e.g. social desirability bias, habituation – giving similar responses)



- Linear regression for performance in questions against personality scores from the Mini-Markers test showed no evidence for correlation.
- ("Conscientious" had correlation at the 10% level)

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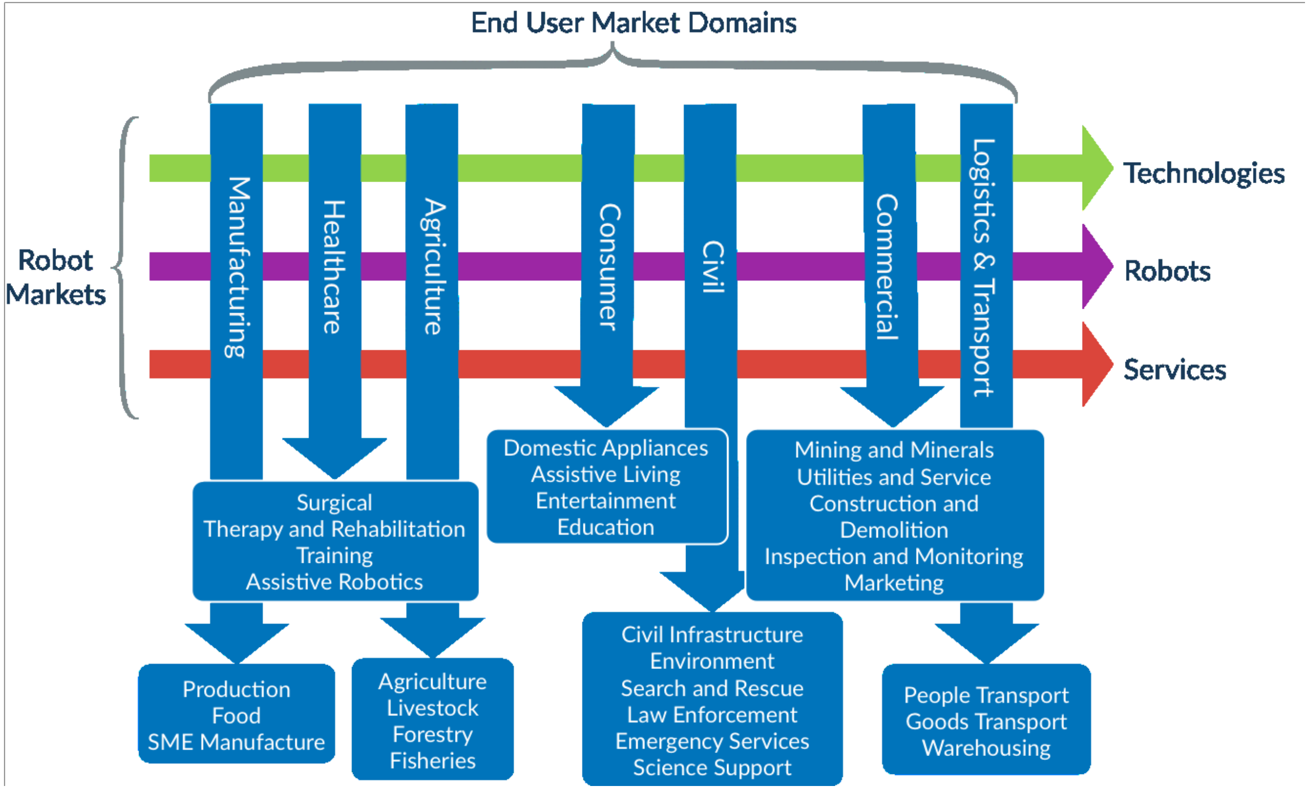
Reference for Mini-markers test:
Gerard Saucier (1994) Mini-Markers: A Brief Version of Goldberg's Unipolar Big-Five Markers, Journal of Personality Assessment, 63:3, 506-516, DOI: 10.1207/s15327752jpa6303_8

Diverse range of application areas - varying HRI contexts



- **Contexts**
  - Physical Environment
  - Social
  - Organisational

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Source: https://www.eu-robotics.net/cms/upload/topic_groups/H2020_Robotics_Multi-Annual_Roadmap_ICT-2017B.pdf

Recommended Reading

- https://www.interaction-design.org/literature/book/the-glossary-of-human-computer-interaction/human-factors
- Cuevas, H.M., Velázquez, J. and Dattel, A.R., 2017. *Human Factors in Practice: Concepts and Applications*. CRC Press. (Available via UWE library)
- Honig, S.S. and Oron-Gilad, T., 2018. Understanding and resolving failures in human-robot interaction: Literature review and model development. *Frontiers in psychology*, *9*, p.861.
- Tsarouchi, P., Makris, S. and Chryssolouris, G., 2016. Human–robot interaction review and challenges on task planning and programming. *International Journal of Computer Integrated Manufacturing*, *29*(8), pp.916-931
- Stanton, N.A., Salmon, P.M., Rafferty, L.A., Walker, G.H., Baber, C. and Jenkins, D.P., 2017. *Human factors methods: a practical guide for engineering and design*. CRC Press. (2013 version available via UWE library)
- Sheridan, T.B., 2016. Human–robot interaction: status and challenges. *Human factors*, *58*(4), pp.525-532.

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