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University of Strathclyde Glasgow

Human Factors and Ergonomics in Healthcare AI: a white paper

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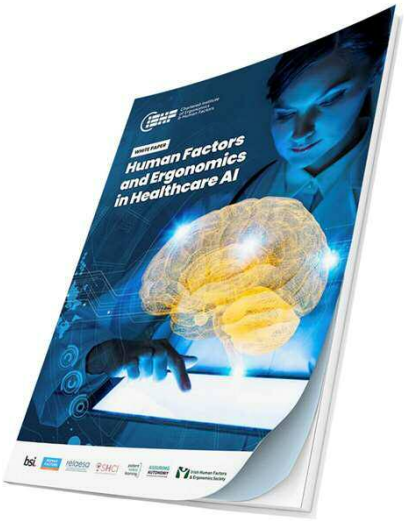

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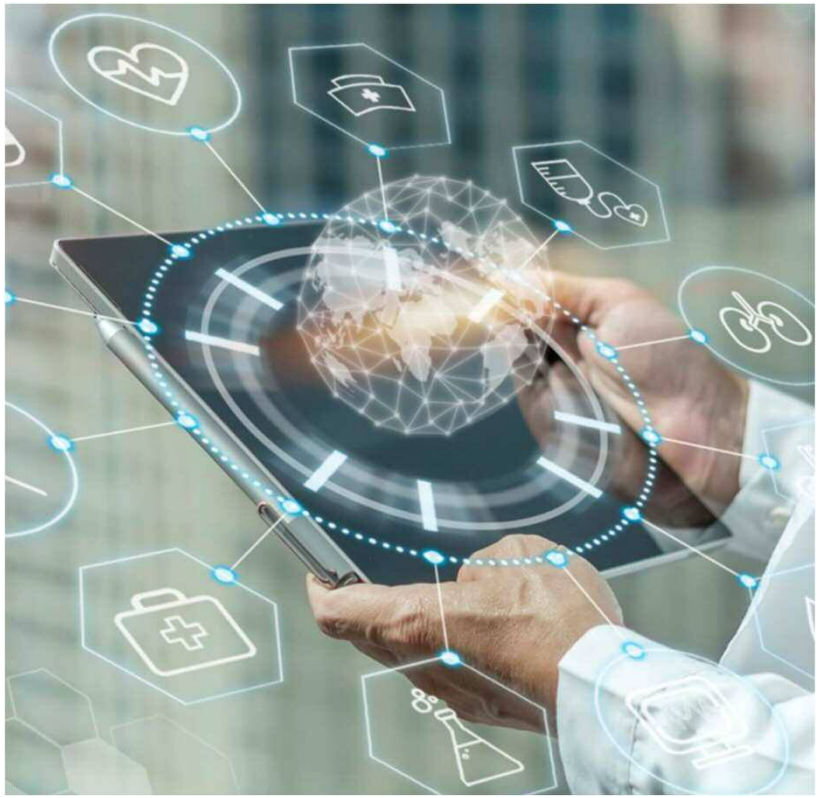
Healthcare AI



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Human Factors/Ergonomics

"The scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and other methods to optimise human well-being and overall system performance" -International Ergonomics Association (IEA)

"…the study of the interrelationship between humans, the tools and equipment they use in the workplace, and the environment in which they work" – to err is human (Kohn et al, 2006)

"The study of factors that make it easier to do work the right way" – World Health Organisation (WHO)

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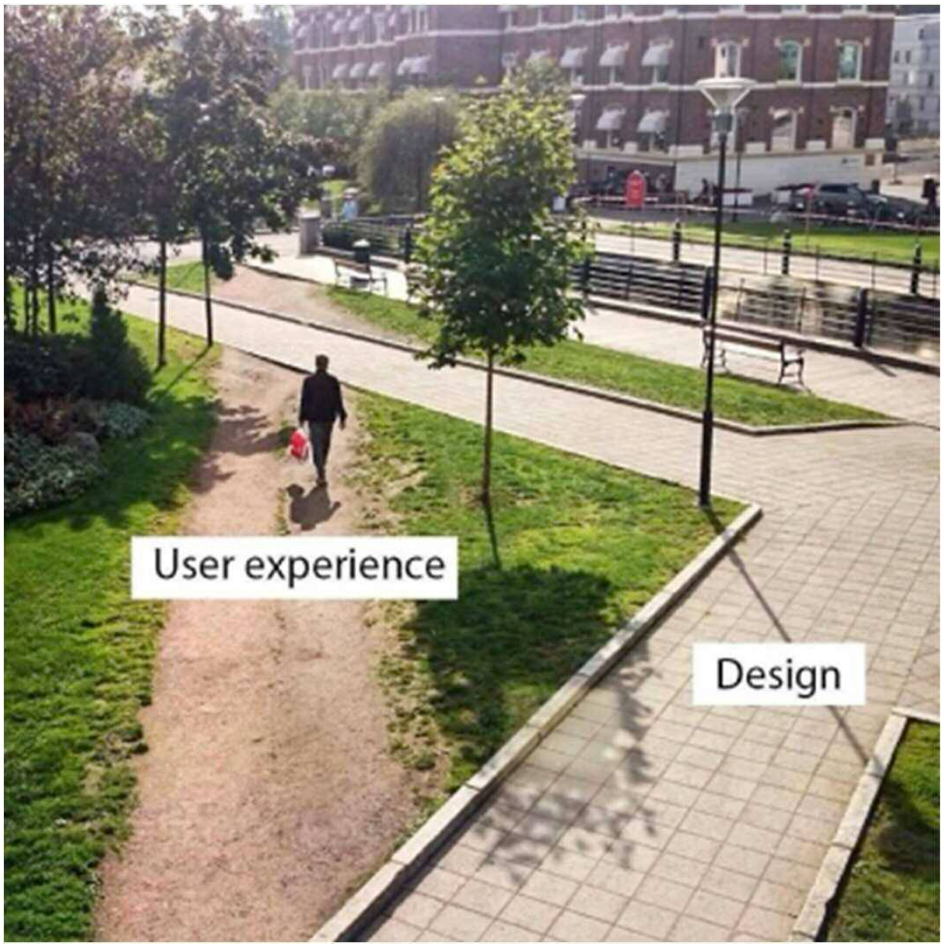

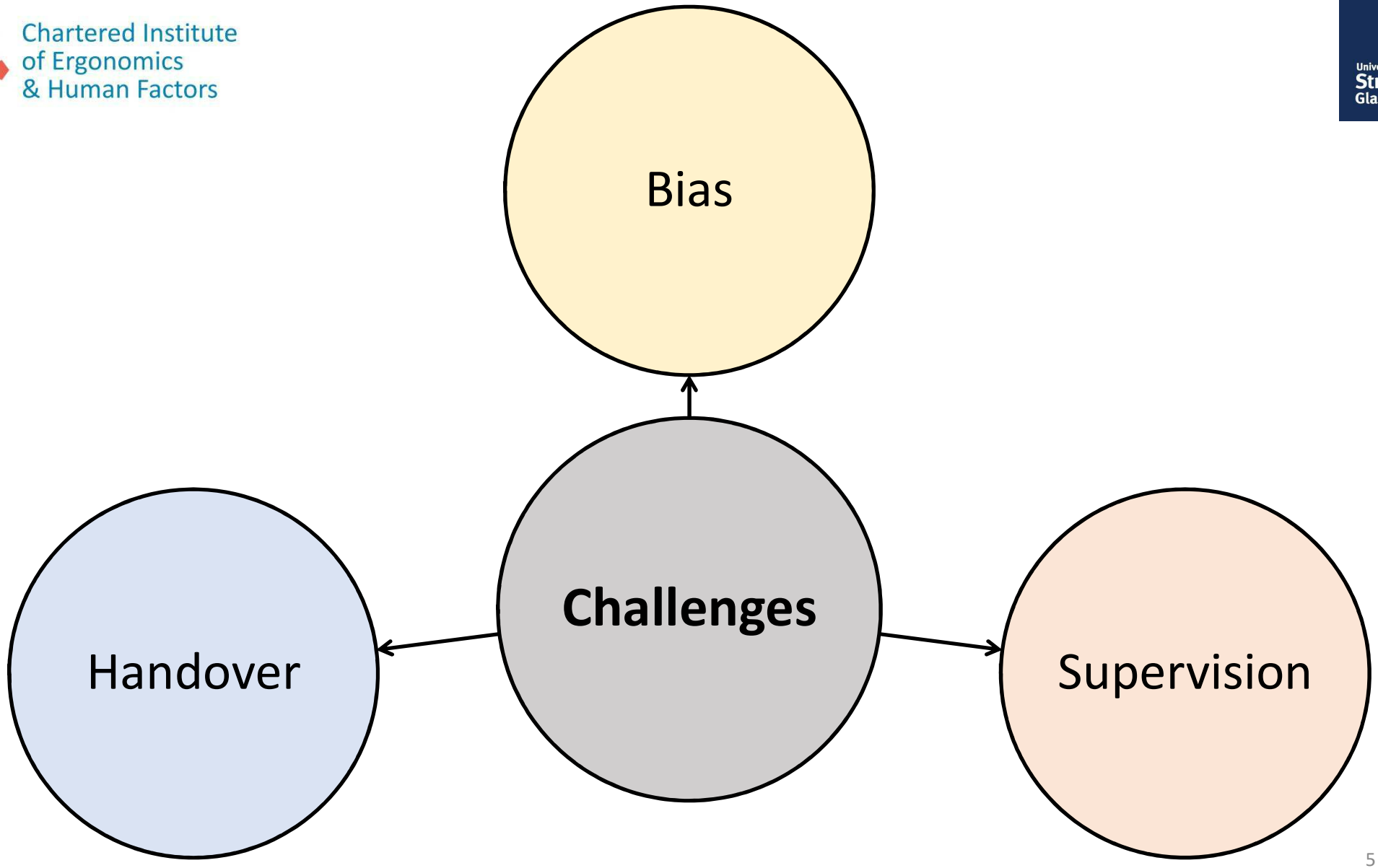
Bias
Handover
Challenges
Supervision

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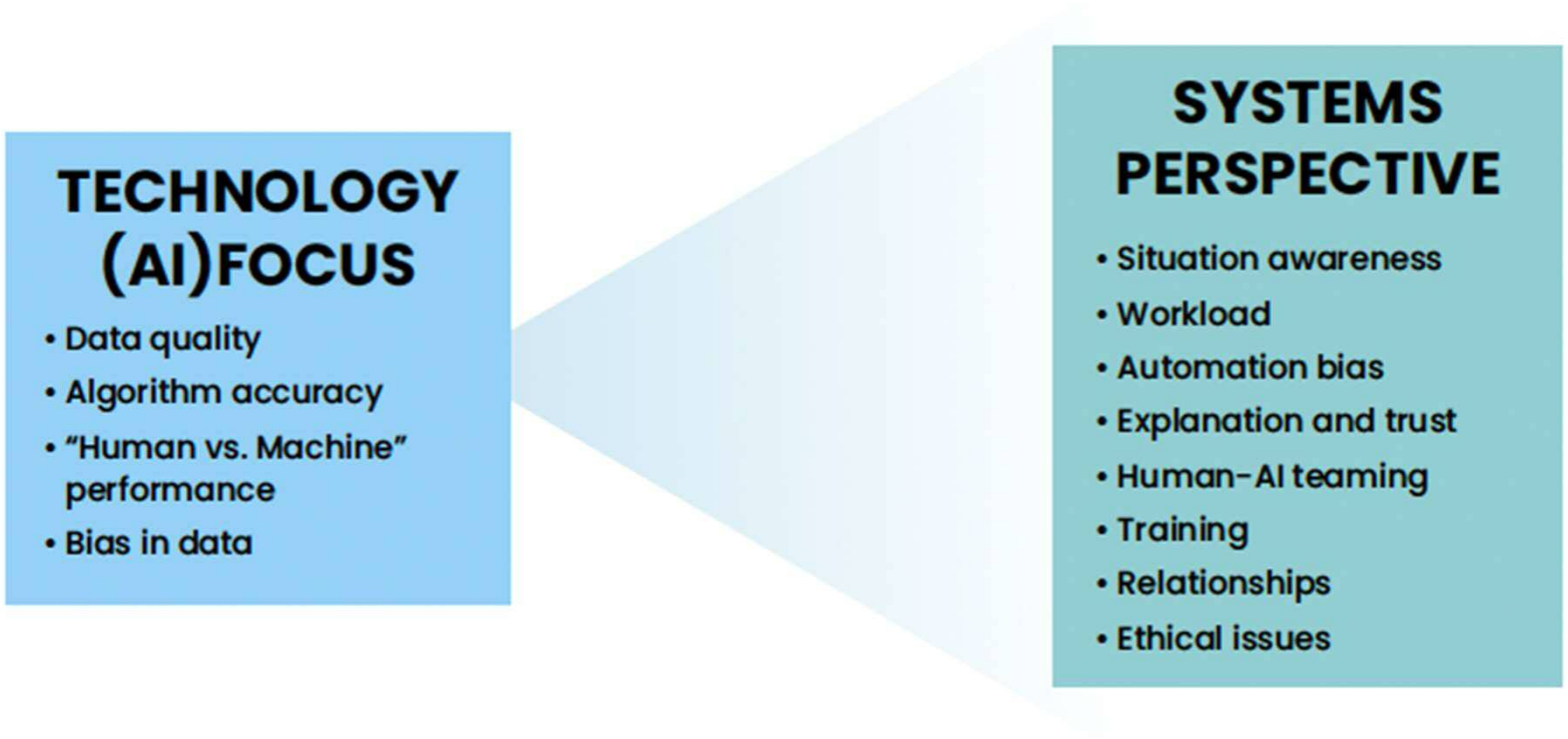

Figure 1: Broadening the scope - from technology (AI) focus to systems perspective

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Eight Core Principles

SITUATION AWARENESS

Design options need to consider how AI can support, rather than erode, people's situation awareness

WORKLOAD

The impact of AI on workload needs to be assessed because AI can both reduce as well as increase workload in certain situations.

AUTOMATION BIAS

Strategies need to be considered to guard against people relying uncritically on the AI, e.g., the use of explanation and training.

EXPLANATION AND TRUST

AI applications should explain their behaviour and allow users to query it in order to reduce automation bias and to support trust.

HUMAN-AI TEAMING

AI applications should be capable of good teamworking behaviours to support shared mental models and situation awareness.

TRAINING

People require opportunities to practise and retain their skill sets when AI is introduced, and they need to have a baseline understanding of how the AI works.

RELATIONSHIPS BETWEEN STAFF AND PATIENTS

The impact on relationships needs to be considered, e.g., whether staff will be working away from the patient once more and more AI is introduced.

ETHICAL ISSUES

AI in healthcare raises ethical challenges including fairness and bias in AI models, protecting privacy, respecting autonomy, providing benefits and minimising harm.

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Situation awareness (SA)

- **What is situational awareness?**
- **Why is it important for healthcare AI?**
- **How can we account for situational awareness when developing healthcare AI?**

BOX 9: The 3-level model of situation awareness applied to anaesthesia

Anaesthesia is a highly dynamic, complex and safety-critical domain. AI has been used to support depth of anaesthesia monitoring, control of anaesthesia delivery, event prediction, ultrasound guidance, and pain management[45]. It is vital for patient safety and patient outcomes that anaesthetists have good SA[46]:

LEVEL 1
Perception of elements in current situation
The anaesthetist needs to have awareness of the patient's vital signs (e.g., heart rate, breathing rate, oxygen saturation), test and investigation results, treatments given, and the actions of other team members.

LEVEL 2
Comprehension of current situation
The anaesthetist needs to integrate and synthesise the data to enable them to explain what is going on, e.g., a sudden change in vital signs.

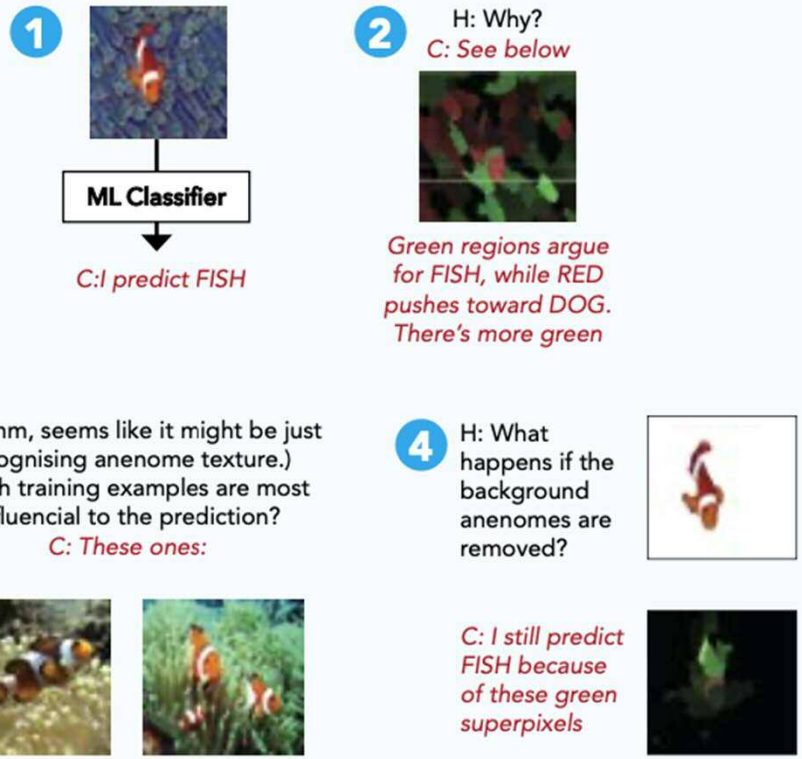
LEVEL 3
Projection of future status
The anaesthetist can anticipate likely future developments based on this understanding, such as the patient's likely physiological response to certain drugs and dosages.

BOX 14: Interactive explanation of AI decision-making (adapted from Weld & Bansal, 2019)[63]

Explanation can be thought of as a dialogue. An AI system that explains its decisions in an interactive way should enable the user to ask questions and perform exploratory actions, such as:

- Changing the comparator (or "foil"), i.e., asking the AI why not a different class or outcome was chosen.
- Asking for more detail.
- Asking for the rationale for a decision.
- Query the sensitivity of the model, i.e., asking what minimal changes in the data might have led to a different decision.
- Perturbing the data to investigate the effect on the decision and on the explanation.

The example below illustrates some of these principles using a mock dialogue between a user and an AI classifier system that distinguishes between fish and dogs on images.



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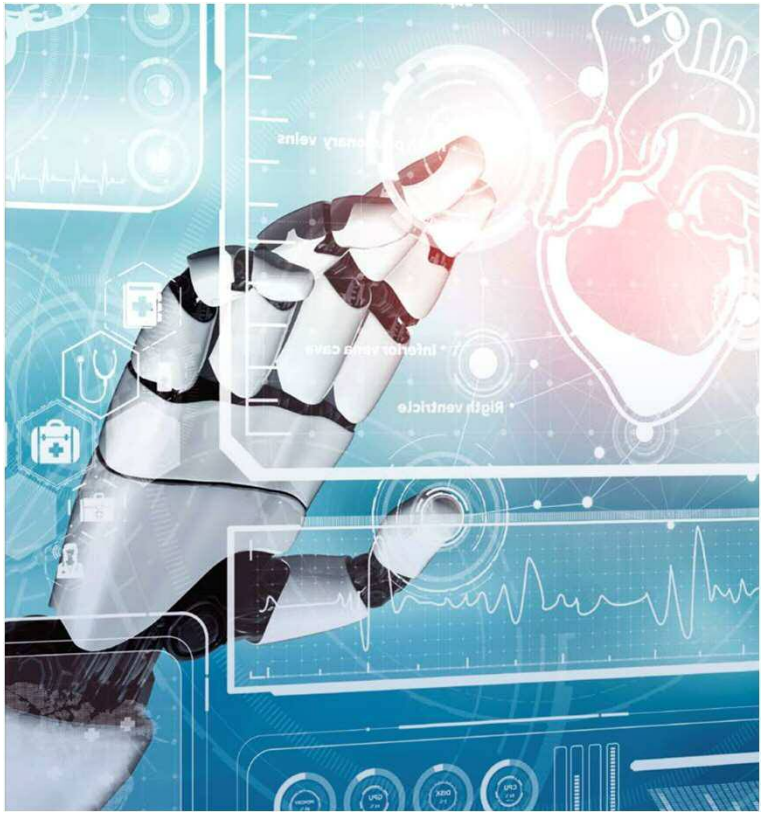
Human – AI Teaming

What is Human-AI teaming?

Why is it important for healthcare AI?

How can we ensure there is good human-AI teaming when developing healthcare AI?



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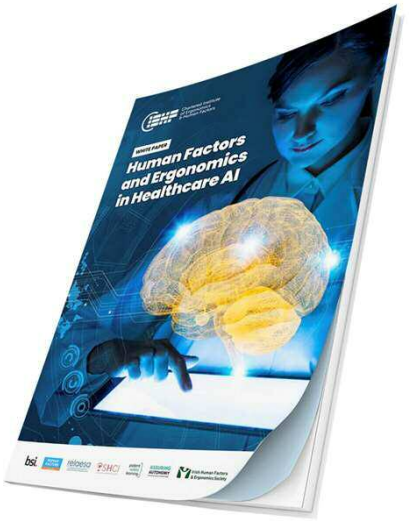
Conclusions



- **Need to take a systems perspective**
- **Designers and developers of AI should consider HF/E as an important part of product development**
- **Need further education on HF/E for both professionals and organisations**

Please spread the word about HF/E!

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