

5. Artificial Intelligence

10x10 – Introduction to Biomedical Informatics & Artificial Intelligence
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Artificial intelligence (AI) in biomedicine and health

New and old

Hype and reality

Major but not only part of biomedical and health informatics

Disrupting health and healthcare today and tomorrow

Perspective of unit will focus on health and clinical applicability, based on research, and implemented in ethical and trustworthy ways

- Because quantity voluminous and quality mixed, aim to present exemplar research with positive or negative results and its collation in systematic reviews

Artificial intelligence (AI)

AI – information systems and algorithms capable of performing tasks associated with human intelligence (Stanford, 2024)

- Modern AI success due to machine learning (ML): “Field of study that gives computers the ability to learn without being explicitly programmed” (McCarthy, 1990)

Three “epochs” of AI
(Howell, 2024), leading to
current classification of

- Predictive AI
- Generative AI

Approximate beginning year	1950s	2011	2018-2022
	AI 1.0 Symbolic AI and probabilistic models	AI 2.0 Deep learning	AI 3.0 Foundation models
Core functionality and key features	Follows directly encoded rules (if-then rules or decision trees)	Predicts and/or classifies information Task-specific (1 task at a time); requires new data and retraining to perform new tasks	Generates new content (text, sound, images) Performs different types of tasks without new data or retraining; prompt creates new model behaviors
Training method	Rules based on expert knowledge are hand-encoded in traditional programming	Learning patterns based on examples labeled as ground truth	Self-supervised learning from large datasets to predict the next word or sentence in a sequence
Performance capabilities	Follows decision path encoded in its rules. <i>Eg, ask a series of questions to determine whether a picture is a cat or a dog.</i>	Classifies information based on training: <i>“Is this a cat or a dog?”</i> <i>“How many dogs will be in the park at noon?”</i>	Interprets and responds to complex questions: <i>“Explain the difference between a cat and a dog.”</i>
Examples of performance	IBM’s Deep Blue beat the world champion in chess Health care: Rule-based clinical decision support tools	Photo searching without manual tagging, voice recognition, language translation Health care: diabetic retinopathy detection, breast cancer and lung cancer screening, skin condition classification, predictions based on electronic health records	Writing assistants in word processors, software coding assistants, chatbots Health care: Med-PaLM and Med-PaLM-2, medically tuned large language models, PubMedGPT, BioGPT
Examples of challenges and risks	Human logic errors and bias in encoded rules lead to limited capability with real-world situations	Out-of-distribution problems (real-time data differs from training data) Catastrophic forgetting (not remembering early parts of a long sequence of text) Bias related to underlying training data	Hallucinations (plausible but incorrect responses based solely on predictions) Grounding and attribution Bias related to underlying training data and semantics of language in datasets

AI in just about every other place in course

Unit 1 – introduction

Unit 2 – enabling hardware and impact on programming

Unit 3 – EHR data entry

Unit 4 – impact in standards

Unit 6 – natural language processing (NLP)

Unit 8 – generative information retrieval (IR)

Unit 9 – research informatics

Unit 10 – other areas of informatics, e.g., public health and nursing

Unit 5 topics

Machine Learning

Data Science

Predictive AI

Generative AI

Trustworthy AI