

# A Primer on Artificial Intelligence for Healthcare Administrators

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## Appendix 1

TABLE A1:  
Glossary of key concepts in AI

Term	Description	Relevant methods	Examples of healthcare applications
Machine learning (ML)	A subset of artificial intelligence (AI), ML involves the development of algorithms to automatically learn patterns and make decisions based on data. ML enables systems to improve performance on a specific task over time without being explicitly programmed.	<ul style="list-style-type: none"> <li>Logistic regression</li> <li>Support vector machines (SVMs)</li> <li>Tree-based models (decision trees, random forest, XGBoost)</li> <li>K-means clustering</li> <li>Principal components analysis (PCA)</li> </ul>	<ul style="list-style-type: none"> <li>InsighTx: employs XGBoost for lung transplantation outcome prediction (Sage et al. 2023)</li> <li>Random forest: cohort identification from administrative data (Oliva et al. 2022)</li> </ul>
Neural network	Neural network is a computer system inspired by the way the human brain works, consisting of interconnected nodes that process information to perform tasks, such as pattern recognition and decision making. It utilizes gradient descent to minimize model error by iteratively adjusting its parameters.	<ul style="list-style-type: none"> <li>Feed-forward neural networks (FNNs)</li> <li>Convolutional neural networks (CNNs)</li> <li>Recurrent neural networks (RNNs)</li> <li>Graph neural networks (GNNs)</li> <li>Transformer models</li> </ul>	<ul style="list-style-type: none"> <li>AGILE platform: a GNN for mRNA vaccine development (Xu et al. 2023)</li> <li>SEER: a CNN for electrocardiogram-based prediction of cardiovascular mortality (Hughes et al. 2023)</li> </ul>

Term	Description	Relevant methods	Examples of healthcare applications
Deep learning (DL)	Deep learning (DL) is a subset of ML that focuses on neural networks with multiple layers. DL models automatically learn hierarchical representations of data, enabling them to understand intricate patterns and features without explicit feature engineering. DL includes a wide variety of potential applications, including but not limited to diagnostic imaging, disease detection and diagnosis, remote patient monitoring and drug discovery and development.	<ul style="list-style-type: none"> <li>Neural networks (FNN, CNN, RNN, GCN)</li> <li>Generative adversarial networks (GANs)</li> <li>Multi-layer perceptrons (MLPs)</li> <li>Autoencoders (e.g., variational autoencoders [VAEs])</li> </ul>	<ul style="list-style-type: none"> <li>SNF: a genome-wide data integration for personalized medical interventions (Wang et al. 2014)</li> <li>Iniquitate: employed a VAE to develop a simulation pipeline for single-cell RNA integration (Maan et al. 2024)</li> </ul>
Supervised learning	Supervised learning is a data-driven learning approach wherein a computer is trained on a <i>labelled</i> dataset to make predictions or classifications.	<ul style="list-style-type: none"> <li>Logistic regression</li> <li>Neural networks</li> <li>Tree-based models</li> </ul>	<ul style="list-style-type: none"> <li>BIONIC: a GCN that integrates information from biological networks to predict gene/protein interactions (Forster et al. 2022)</li> </ul>
Unsupervised learning	Unsupervised learning is a data-driven learning approach that uncovers hidden patterns in the data <i>without human supervision</i> .	<ul style="list-style-type: none"> <li>K-means clustering</li> <li>PCA</li> </ul>	<ul style="list-style-type: none"> <li>PCA: study of risk factors for nosocomial infections (Renes Carreño et al. 2022)</li> </ul>
Semi-supervised learning	Semi-supervised learning is a data-driven learning approach that combines labelled and unlabelled data during training, leveraging the limited labelled examples along with a larger pool of unlabelled data to improve model performance.	<ul style="list-style-type: none"> <li>Word embeddings</li> <li>Contrastive learning</li> <li>Autoencoders</li> </ul>	<ul style="list-style-type: none"> <li>Breast cancer prediction (Al-Azzam et al. 2021)</li> </ul>
Reinforcement learning	Reinforcement learning is an ML paradigm where an agent learns to make sequential decisions by interacting with an environment. The agent receives feedback in the form of rewards or punishments (reward/loss functions), guiding its learning process to optimize its behaviour over time.	<ul style="list-style-type: none"> <li>Q-learning</li> <li>Deep Q-network</li> <li>Policy gradient methods</li> </ul>	<ul style="list-style-type: none"> <li>Clinical decision support (Liu et al. 2020)</li> <li>Medication management optimization (Lin et al. 2018)</li> <li>Optimal individual target lab value (Weng et al. 2017)</li> </ul>
Natural language processing (NLP)	NLP is a branch of AI focused on enabling computers to understand, interpret and generate human language.	<ul style="list-style-type: none"> <li>RNNs</li> <li>Transformer models</li> <li>Word embeddings</li> </ul>	<ul style="list-style-type: none"> <li>Clinical camel: extraction of vital information from clinical notes (Toma et al. 2023)</li> </ul>
Transformer models	Transformer model is an architecture used in NLP that employs self-attention mechanisms for efficiently capturing contextual information across input sequences.	<ul style="list-style-type: none"> <li>Bidirectional encoder representations from transformers (BERT) (Devlin et al. 2019)</li> <li>Generative pre-trained transformer (GPT) (Radford et al. n.d.)</li> </ul>	<ul style="list-style-type: none"> <li>scGPT: decodes complex biological interactions between genes and cells, just as conventional language models capture the essence of words and sentences (Cui et al. 2024)</li> </ul>

Term	Description	Relevant methods	Examples of healthcare applications
<b>Computer vision</b>	Computer vision is the development of algorithms and models to enable machines to interpret and understand visual information, such as images or videos, mimicking human visual perception.	<ul style="list-style-type: none"> <li>• CNNs</li> <li>• Vision Transformers (ViTs)</li> <li>• GANs</li> </ul>	<ul style="list-style-type: none"> <li>• MedSAM: generalizable medical imaging segmentation (Ma et al. 2024)</li> </ul>
<b>Robotics</b>	Robotics have applications in neurosurgery, patient navigation and clinical tasks and are used in robotic-assisted surgery and pharmacy dispensing.	<ul style="list-style-type: none"> <li>• Reinforcement learning</li> <li>• Proportional-integral-derivative (PID) controllers</li> <li>• Simultaneous localization and mapping (SLAM)</li> </ul>	<ul style="list-style-type: none"> <li>• Robotic-assisted surgery</li> <li>• Pharmacy-dispensing robots</li> </ul>
<b>Generative AI</b>	Generative AI utilizes neural networks to create audio, visual and text content based on prompts. These models learn patterns and relationships from existing data to produce novel, previously unseen outputs, exhibiting a form of creative or generative capability.	<ul style="list-style-type: none"> <li>• GANs</li> <li>• VAEs</li> <li>• Transformers</li> </ul>	<ul style="list-style-type: none"> <li>• Clinical camel: extraction of vital information from clinical notes (Toma et al. 2023)</li> <li>• GLIDE: generation of simulated radiology data (Kather et al. 2022)</li> </ul>
<b>Large language models (LLMs)</b>	Extensively trained on vast amounts of textual data, these models are a subset of generative AI characterized by their immense size and complexity, allowing them to understand, generate and manipulate human-like language with a high degree of accuracy and versatility.	<ul style="list-style-type: none"> <li>• LLaMA (Touvron et al. 2023)</li> <li>• BERT (Devlin et al. 2019)</li> <li>• GPT (Radford et al. n.d.)</li> </ul>	<ul style="list-style-type: none"> <li>• DNABERT: deciphers intricate gene regulatory code in non-coding DNA, especially in scenarios with limited data (Ji et al. 2021)</li> </ul>
<b>Expert systems</b>	An expert system is any advanced computer program designed to mimic human decision making in specific areas using rules and knowledge bases for intelligent problem solving.	<ul style="list-style-type: none"> <li>• Neural networks</li> <li>• LLMs</li> </ul>	<ul style="list-style-type: none"> <li>• See examples above</li> </ul>
<b>Fuzzy logic</b>	Fuzzy logic is a mathematical approach handling uncertainty by allowing degrees of truth, beneficial for decision making in situations with vague or incomplete information.	<ul style="list-style-type: none"> <li>• Fuzzy control systems</li> <li>• Fuzzy expert systems</li> <li>• Fuzzy inference systems (FISs)</li> </ul>	<ul style="list-style-type: none"> <li>• Health monitoring (Ghosh et al. 2020)</li> </ul>

BIONIC = biological network integration using convolutions; DNA = deoxyribonucleic acid; GLIDE = guided language to image diffusion for generation and editing; mRNA = messenger RNA; RNA = ribonucleic acid; SNF = similarity network fusion.