



Integrating AI into Physical Therapy Education:

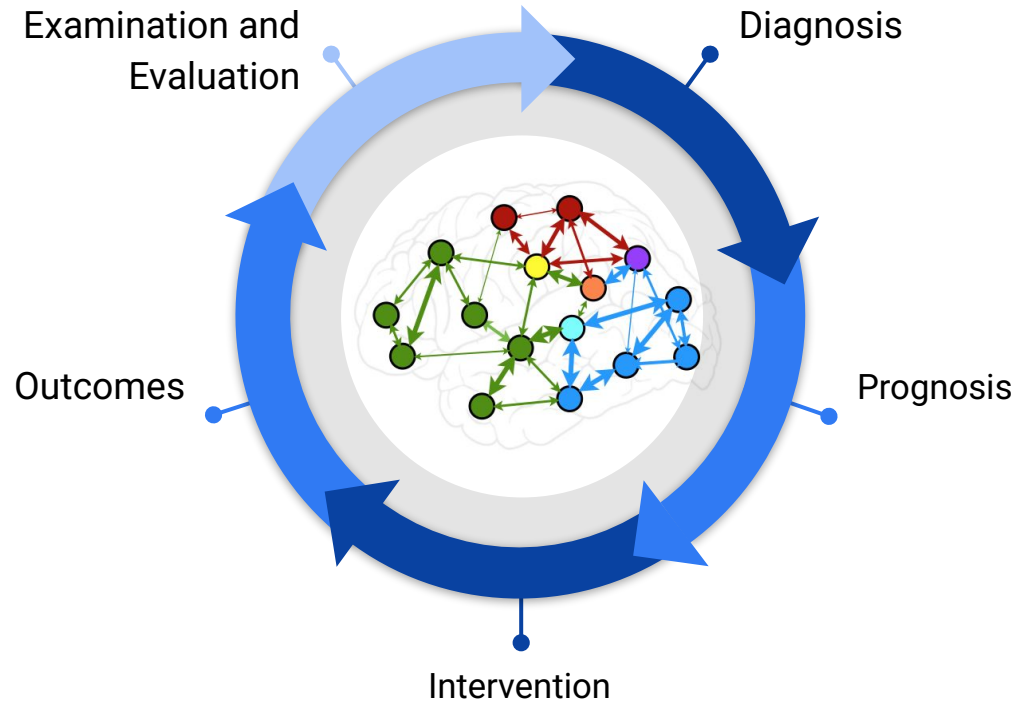
Preparing Future Clinicians for AI-Driven Healthcare

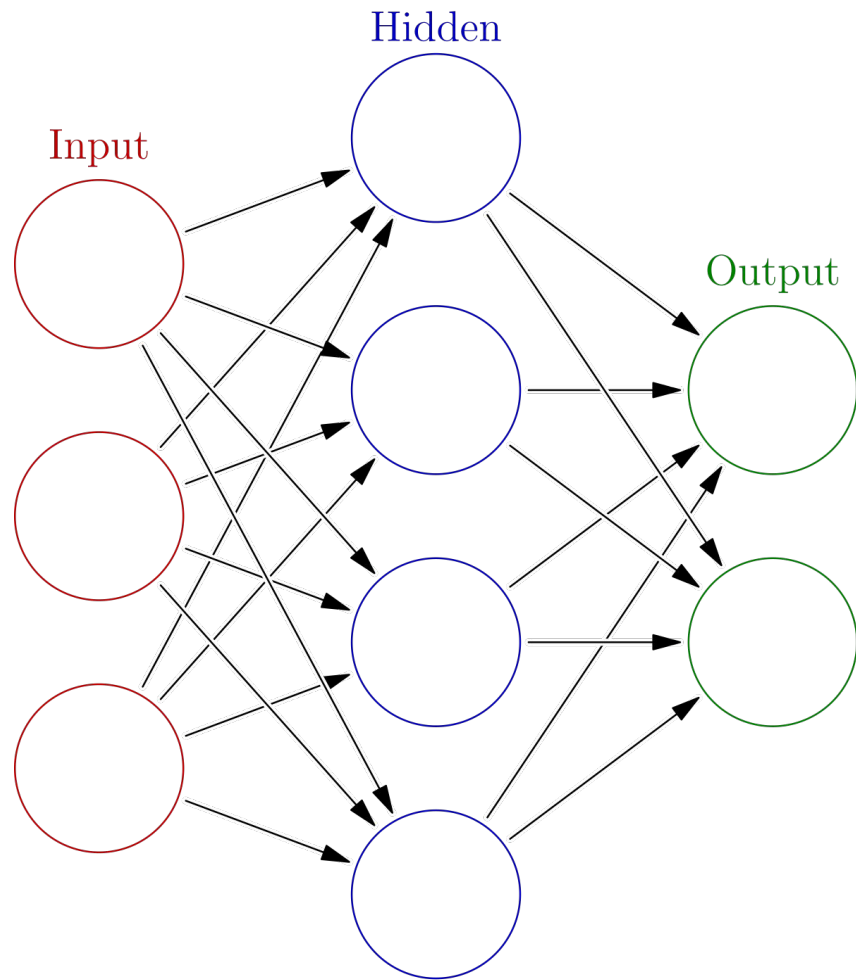
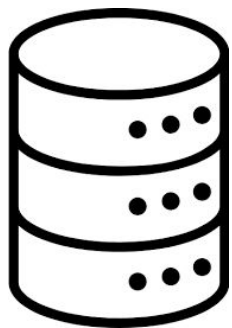
Nathan Morelli, PT, DPT, PhD

Principal Clinical Scientist
Medtronic Neuromodulation, Medtronic

EXPECTATION...









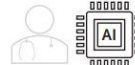


The Why for AI

Why do we need to teach and embrace AI/ML?

What do students need to know?

How can PT education prepare them?

	Assistive AI algorithms		Autonomous AI algorithms		
	Level 1  Data presentation	Level 2  Clinical decision-support	Level 3  Conditional automation	Level 4  High automation	Level 5  Full automation
Event monitoring	AI	AI	AI	AI	AI
Response execution	Clinician	Clinician and AI	AI	AI	AI
Fallback	Not applicable	Clinician	AI, with a backup clinician available at AI request	AI	AI
Domain, system, and population specificity	Low	Low	Low	Low	High
Liability	Clinician	Clinician	Case dependent	AI developer	AI developer
Example	AI analyses mammogram and highlights high-risk regions	AI analyses mammogram and provides risk score that is interpreted by clinician	AI analyses mammogram and makes recommendation for biopsy, with a clinician always available as backup	AI analyses mammogram and makes biopsy recommendation, without a clinician available as backup	Same as level 4, but intended for use in all populations and systems

Bitterman et al. 2020

Core AI Competencies for PT Students

Fundamentals and
literacy



AI in Clinical Decision
Support



AI Ethics & Bias in PT



AI Fundamentals & Literacy



Technical Understanding

- Types of models
- How models are trained
- Evaluating model performance



Critical Appraisal

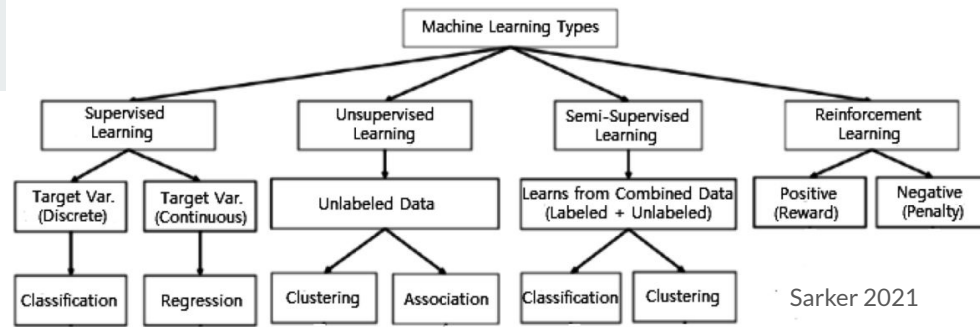
- Data source and quality
- Model appropriateness
- Training, validation, and testing appropriateness
- Model performance metrics



Clinical Application

- Asses clinical relevance
- Generalizability
- Usability and clinical integration
- Breadth of evidence
- Regulatory approval

Types of AI Models



Sarker 2021

Supervised Learning Models (Labeled Data)

- **Regression Models (Continuous Predictions)**
 - *Example:* Predicting a patient's recovery time based on initial functional assessments.
 - *Key Metric:* Mean Squared Error (MSE) or R^2 Score.
- **Classification Models (Categorical Predictions)**
 - *Example:* Classifying fall risk as "low," "moderate," or "high."
 - *Key Metrics:* Sensitivity, Specificity, ROC-AUC.

Unsupervised Learning Models (Pattern Recognition)

- **Clustering (Identifying Patient Subgroups)**
 - *Example:* Grouping patients by response to rehabilitation for personalized treatment.
 - *Techniques:* k-Means, Hierarchical Clustering.
- **Dimensionality Reduction (Simplifying Complex Data)**
 - *Example:* Reducing wearable sensor data for movement analysis.
 - *Techniques:* Principal Component Analysis (PCA).

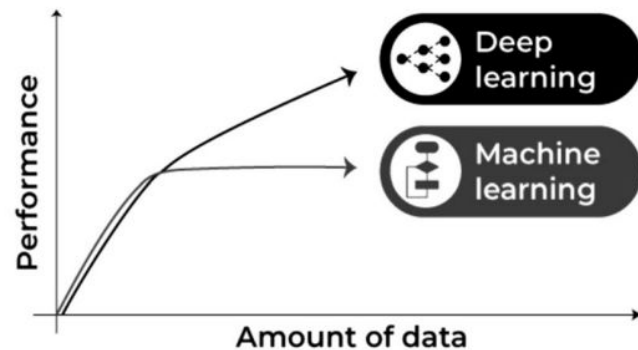
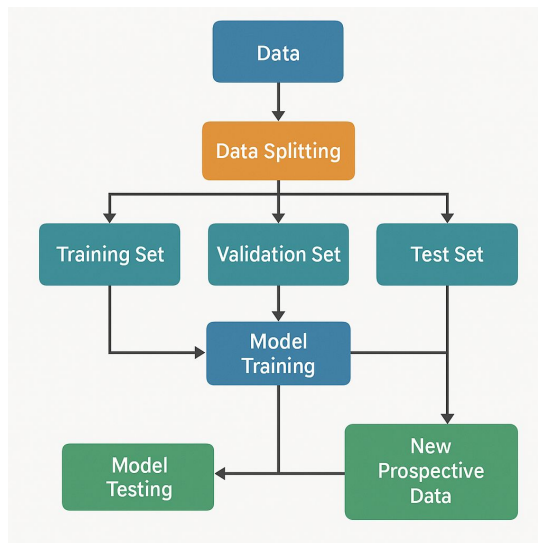
Reinforcement Learning (Decision Optimization & Adaptive Learning)

- **Policy Optimization for Rehabilitation Therapy**
 - *Example:* AI recommending real-time adjustments to PT exercise difficulty based on patient feedback and performance.
 - *Techniques:* Deep Q-Networks (DQN), Proximal Policy Optimization (PPO).
- **AI-Driven Personalized Rehabilitation Plans**
 - *Example:* Adaptive gait training where AI refines motor learning protocols based on patient progress.
 - *Techniques:* Markov Decision Processes (MDP), Actor-Critic Models.

How AI Models Are Trained

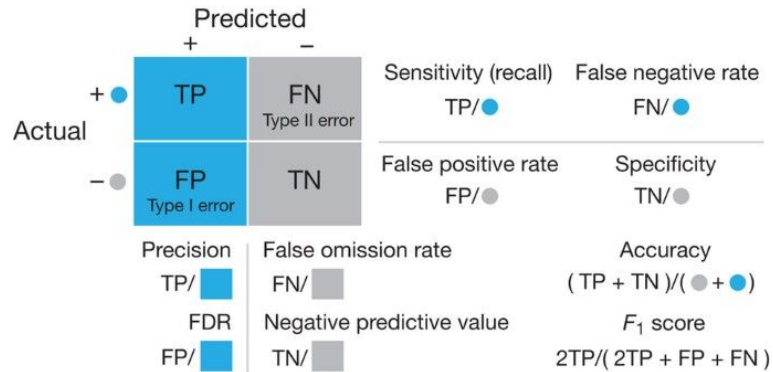
Model Training Process

- Training, Validation, and Testing Sets
 - Training: AI learns from data.
 - Validation: AI tunes parameters.
 - Testing: AI is evaluated on unseen data.



Evaluating AI Model Performance

Classification Model Evaluation (For Diagnosis & Risk Prediction)



Lever et al. 2016

Regression Model Evaluation (For Continuous Outcomes)

- **Mean Absolute Error:** Measures average prediction error.
- **Mean Squared Error:** Penalizes larger errors more heavily.
- **R² Score:** Explains how much variance is captured by the model.



Critical Appraisal Tools for AI/ML Research

CONSORT-AI

NATURE MEDICINE		CONSENSUS STATEMENT	
Table 1 CONSORT-AI checklist			
Section	CONSORT 2010 item*	CONSORT-AI item	Addressed average number†
Title and abstract	1a	CONSORT-AI 1a Identification of a randomized trial in the title	1
Background and objectives	2a	CONSORT-AI 2a Scientific background and explanation of objectives	2
Methods	2b	CONSORT-AI 2b Scientific objectives or hypotheses	2
Trial design	3a	CONSORT-AI 3a Description of trial design (such as parallel, factorial) including allocation ratios	3
	3b	CONSORT-AI 3b Important changes to methods after trial commencement (such as eligibility criteria), with reasons	3
Participants	4a	CONSORT-AI 4a Eligibility criteria for participants	4
	4b	CONSORT-AI 4b State the inclusion and exclusion criteria at the level of participants	4
	4c	CONSORT-AI 4c State the inclusion and exclusion criteria at the level of the input data	4
	4d	CONSORT-AI 4d Describe how the AI intervention was integrated into the trial setting, including any data or device requirements	4
Interventions	5	CONSORT-AI 5 Settings and locations where the data were collected	5
	5a	CONSORT-AI 5a Specify which version of the algorithm was used	5
	5b	CONSORT-AI 5b Describe how the input data were acquired and used	5
	5c	CONSORT-AI 5c Describe how user safety or evaluative input data were assessed and handled	5
	5d	CONSORT-AI 5d Specify whether there was human-AI interaction in the handling of the input data, and level of expertise of any required users	5
	5e	CONSORT-AI 5e Specify the output of the AI intervention	5
	5f	CONSORT-AI 5f Explain how the AI intervention's inclusion and exclusion criteria were derived or other elements of critical practice	5
Outcomes	6a	CONSORT-AI 6a Complete, defined pre-specified primary and secondary outcome measures, including how and when they were assessed	6
	6b	CONSORT-AI 6b Any changes to trial outcomes after the trial commenced, with reasons	6
Sample size	7a	CONSORT-AI 7a How sample size was determined	7
	7b	CONSORT-AI 7b When applicable, explanation of any interim analyses and stopping guidelines	7

AI in Clinical Trials

TRIPOD-AI



Version: 15/01/2024

Section/Topic	Item	Development/Explanation	Checklist Item	Reported (of page)
TITLE	1	IDE	1	---
ABSTRACT	1	IDE	1	---
INTRODUCTION	1	IDE	1	---
BACKGROUND	1a	IDE	1	---
	1b	IDE	1	---
	1c	IDE	1	---
	1d	IDE	1	---
OBJECTIVES	1	IDE	1	---
METHODS	1a	IDE	1	---
	1b	IDE	1	---
	1c	IDE	1	---
Participants	4a	IDE	4	---
	4b	IDE	4	---
	4c	IDE	4	---
	4d	IDE	4	---
Data preparation	7	IDE	7	---
Outcome	5b	IDE	5	---
	5c	IDE	5	---
Prognosis	5a	ID	5	---
	5b	IDE	5	---
	5c	IDE	5	---
	5d	IDE	5	---
Sample size	10	IDE	10	---
Missing data	11	IDE	11	---
Statistical methods	12a	ID	12	---
	12b	ID	12	---
	12c	ID	12	---
	12d	ID	12	---
	12e	ID	12	---
	12f	ID	12	---
	12g	ID	12	---
	12h	ID	12	---
	12i	ID	12	---
	12j	ID	12	---
	12k	ID	12	---
	12l	ID	12	---
	12m	ID	12	---
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	12r	ID	12	---
	12s	ID	12	---
	12t	ID	12	---
	12u	ID	12	---
	12v	ID	12	---
	12w	ID	12	---
	12x	ID	12	---
	12y	ID	12	---
	12z	ID	12	---
Discussion	11	IDE	11	---
Conclusions	11	IDE	11	---
Model impact	11	ID	11	---

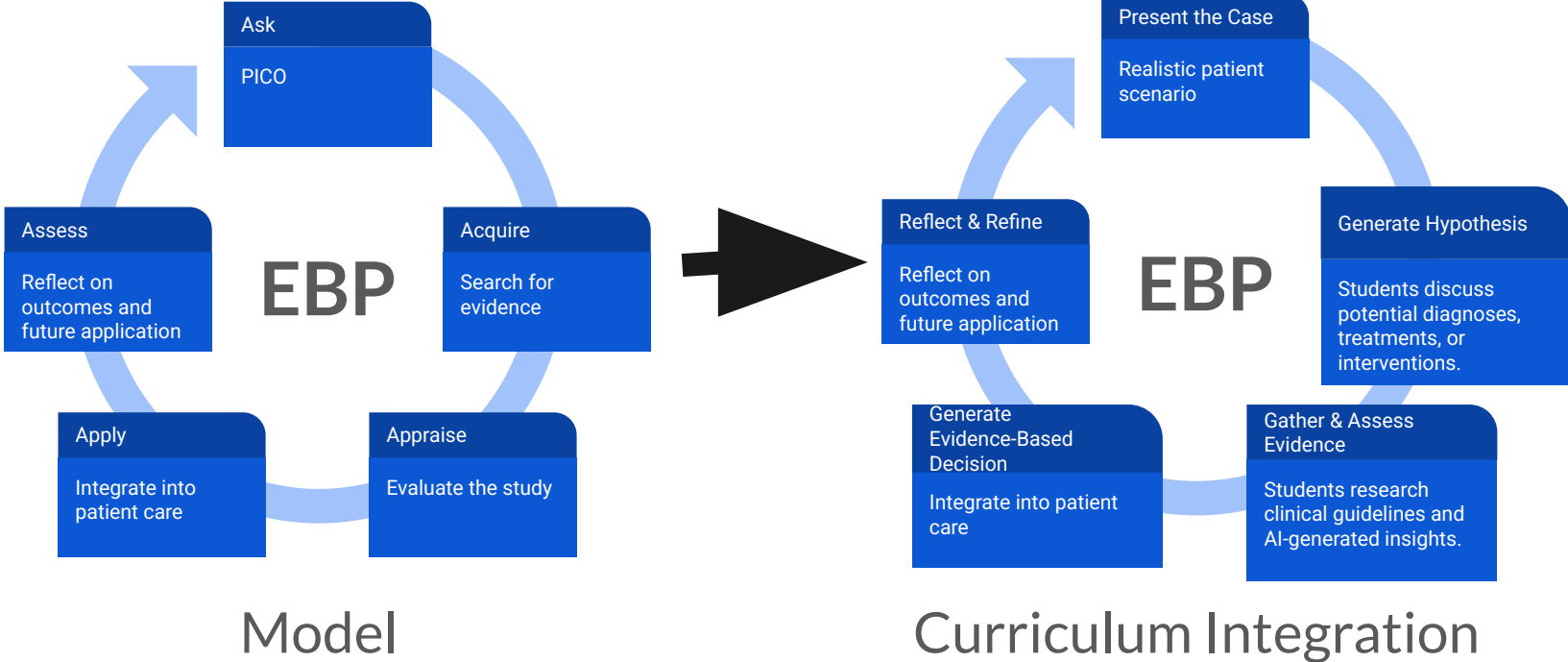
AI/ML Algorithm Development Studies

DECIDE-AI

CONSENSUS STATEMENT		NATURE MEDICINE	
Table 2 DECIDE-AI checklist			
Item number	Item	Theme	Recommendation
1-17	AI-specific reporting items		
1-8	General reporting items		
Title and abstract			
1	Title	Identify the study as an early clinical evaluation of a decision support system based on AI or machine learning, specifying the problem addressed	1
1	Abstract	Provide a structured summary of the study. Consider including: intended uses of the AI system; type of underlying algorithm, study setting, number of patients and users included; primary and secondary outcomes; study safety outcomes; human factors evaluated; main results and conclusions	1
Introduction			
2	Intended use	a) Describe the targeted medical condition(s) and problem(s), including the current standard practice, and the intended patient population(s) b) Describe the intended uses of the AI system, its planned integration in the care pathway, and the potential effect, including patient outcomes, that it is intended to have State the study objectives	2
3	Objectives	Describe how patients were recruited, during the inclusion and exclusion criteria at both patient and data level, and how the number of recruited patients was calculated	3
4	AI system	a) Identify the AI system, specifying its version and type of underlying algorithm used. Describe or provide a brief reference to the characteristics of the patient population on which the algorithm was trained and its performance in practical development/validation studies b) Identify the data used as inputs. Describe how the data were acquired, the process used to enter the input data, the pre-processing applied, and how missing/low-quality data were handled c) Describe the AI system output and how they were assessed in the users (see range table for users)	4
5	Implementation	a) Describe the settings in which the AI system was evaluated b) Describe the clinical workflow and pathway in which the AI system was evaluated, the timing of its use, and how the final supported decision was reached and by whom Specify any primary and secondary outcome measures	5
6	Safety and errors	a) Provide a description of how significant errors/malfunctions were defined and identified	6
7	Human factors	Describe how any risks to patient safety or instances of harm were identified, analysed, and minimised	7
8	Outcomes	Describe the statistical methods by which the primary and secondary outcomes were evaluated, as well as any pre-specified additional analyses, including subgroup analyses and their rationale	8
9	Ethics	Describe whether specific methodologies were used to fulfil an ethics-related goal (such as algorithmic fairness) and their rationale	9
10	Patient involvement	State how patients were involved in any aspect of the development of the research question, the study design, and the conduct of the study	10
Results			
11	Participants	a) Describe the baseline characteristics of the patients included in the study and report on input data imbalances b) Describe the baseline characteristics of the users included in the study	11
12	Implementation	a) Report on the user exposure to the AI system, on the number of instances the AI system was used, and on the user adherence to the intended implementation b) Report any significant changes to the clinical workflow or care pathway caused by the AI system Report on the specific clinical outcomes, including outcomes for any comparison group if applicable Report on the differences in the main outcomes according to the pre-specified subgroups Report on changes made to the AI system or its human pathway during the study. Report the timing of these modifications, the outcomes for each, and any changes in outcomes observed after each of them	12
13	Main results	Report on the differences in the main outcomes according to the pre-specified subgroups	13
14	Subgroup analysis	Report on the differences in the main outcomes according to the pre-specified subgroups	14
15	Modifications	Report on changes made to the AI system or its human pathway during the study. Report the timing of these modifications, the outcomes for each, and any changes in outcomes observed after each of them	15

Continued

AI in Clinical Decision Support: Fostering Evidence-Based Clinicians



Pitfalls to Avoid for Clinicians Applying AI Research to Clinical Practice

- Blind Trust in AI Predictions
- Failure to Understand Model Limitations
- Data Bias & Inequities in AI Models
- Over Reliance on AI Without Clinical Context
- Not Keeping Up with AI Advancements & Validation Studies
- Ignoring Regulatory & Ethical Considerations



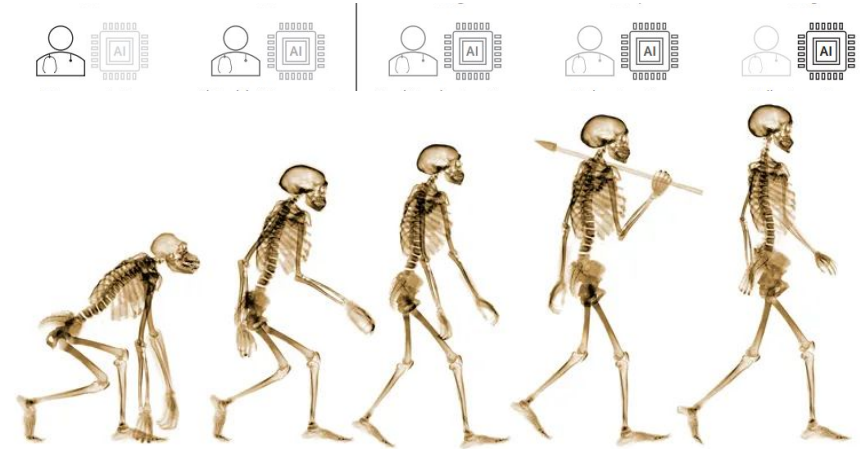
Pitfalls in Teaching AI to PT Students

- Overcomplicating Technical Concepts
- Not Teaching AI/ML Limitations & Biases
- Neglecting Hands-on Applications
- Assuming AI Will Replace Clinical Judgment
- Not Addressing Ethical & Legal Implications
- Failing to Teach Critical Appraisal of AI Research



Preparing students for tomorrow

- **AI is a Tool to Enhance, Not Replace, Clinical Decision-Making**
 - Clinicians must combine AI insights with their expertise and patient-centered care.
- **Critical Appraisal of AI Research is Essential**
 - Understand data sources, model limitations, and ethical considerations before applying AI in practice.
- **AI Education Should Be Integrated Thoughtfully**
 - Use case-based learning and real-world applications to teach AI effectively while avoiding overreliance.



Thank you.

Nathan Morelli, PT, DPT, PhD

nathan.a.morelli@gmail.com



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