**Ethical Algorithms for the Modern Clinician:**

An Introduction to Algorithmic Analysis for Patient Care

**Course Description:**

With increasing adaptation of sophisticated algorithms such as artificial intelligence and generative machine learning models, it is crucial for future clinicians to have a working understanding of how these algorithms work and how they might impact patient care. While novel algorithms and technologies can improve the delivery of clinical medicine, research has shown that patients from minority backgrounds and those traditionally underrepresented in medicine may be inadvertently harmed in the process. It is important for future clinicians to be able to *identify* these limitations in clinical workflows and implement meaningful solutions to address them. To this end, the goal of this course is to evaluate modern algorithms with a critical lens, considering perspectives such as how algorithms may impact the fairness of clinical care, patient privacy, and physician understanding of how algorithmic outputs are computed. This discussion-based course will help aspiring physicians gain a working understanding of the foundational ethics involving machine learning algorithms, and how to use these technologies for positive patient impact in medicine. The course website can be found [here](https://eamc-penn.github.io/).

**Learning Objectives:**

1. **Define** an algorithm and what makes machine learning similar to and different from conventional algorithms;
2. **Identify** the key applications of machine learning and when computational algorithms might be helpful (or harmful) for patient care;
3. **Define** algorithmic bias as a property of an algorithm, and **characterize** bias mitigation strategies and how to better achieve fairness in clinical decision making;
4. **Define** privacy and anonymity, and **describe** existing anonymization techniques and pitfalls as they pertain to patient data;
5. **Analyze** how current data acquisition practices can affect minority patient populations;
6. **Describe** the accuracy-interpretability tradeoff and **reflect** on the role of interpretability in clinical algorithms and decision-making;
7. **Define** generative AI and **characterize** the new challenges facing patients and clinicians as a result of the adaption of generative AI software.

**Course Leadership:**

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**Background:**

*Ethical Algorithms for the Modern Clinician* teaches future clinicians the basics of machine learning (ML) and artificial intelligence (AI) as they pertain to clinical practice. Specifically, the course focuses on the ethical challenges and implications surrounding the adaptation of sophisticated technologies into clinical practice, and how novel algorithms can affect patients in both intended and unintentional ways.

This course does ***not*** discuss how machine learning algorithms work or how to build ML models. Instead, we introduce ML from clinical practitioner's perspective and discuss what ML does right, where it falls short, and how it will impact patient care. We focus on five key aspects:

* + - 1. [Introduction to Machine Learning](https://eamc-penn.github.io/ml.html): What is machine learning? How is it similar to and different from conventional software?
      2. [Bias and Fairness](https://eamc-penn.github.io/bias.html): How can algorithms be biased against different patient groups? How can we quantify, detect, and reduce bias in clinical decision making algorithms?
      3. [Privacy and Anonymization](https://eamc-penn.github.io/privacy.html): How can we anonymize patient data? Why does anonymization often fall short in protecting patient identities? How can we ensure that clinicians maintain patient privacy?
      4. [Algorithmic Interpretability](https://eamc-penn.github.io/interpretability.html): What does mean for an algorithm to be interpretable? Is it important for us to be able to explain how an algorithm works in order to use it in clinical practice?
      5. [Generative AI](https://eamc-penn.github.io/genai.html): What is generative AI, and how might it be used for patient care? What are the new challenges and opportunities associated with generative AI models?

Just as epidemiology was introduced in medical school curricula alongside the rise of evidence-based guidelines ([Fowkes FG et al.](https://pubmed.ncbi.nlm.nih.gov/6519897/)), **it is crucial for future clinicians to have a working understanding of machine learning algorithms** as they become increasingly prevalent in clinical practice. *Ethical Algorithms for the Modern Clinician* is intended as foundational knowledge for medical students *of all backgrounds* - prior experience with machine learning is *not* required.

We believe the most effective and fruitful way to learn the content herein is in **small, discussion-based** classroom environments. Many of the discussion questions included in each module have *no single right answer*, and it is often helpful to learn how peers are thinking about challenging topics, too. To facilitate this learning environment, the content has been broken down into five modules that can each be covered in one-hour sessions.

**Program Format:**

The series consists of 5 sessions. Each session will be approximately an hour, taught by an expert in the field, and will consist of an overview presentation followed by a small, discussion-based group workshop to discuss relevant literature and hands-on tutorials specifically designed for this course. There will be no preparation needed for these sessions except for the reading assignments assigned for each module.

**Program Requirements:**

* **Attendance:** Students are required to attend at least 4 of the 5 sessions (full-length). Exceptions will be made for those requiring accommodations.
* **Participation:** Students are expected to actively participate during class discussions.
* **Grading:** This course will be graded as “Pass-Fail” (P-F).
* **Course Evaluation:** Evaluations will be sent out at the end of the course to gauge efficacy and solicit constructive feedback.