2024 RJOS/Zimmer Biomet Grant Winning Proposal:
The Reliable Open Science Engine
PI/Grant Winner: Dr. Amiethab Aiyer MD FAAOS

i. Specific aims

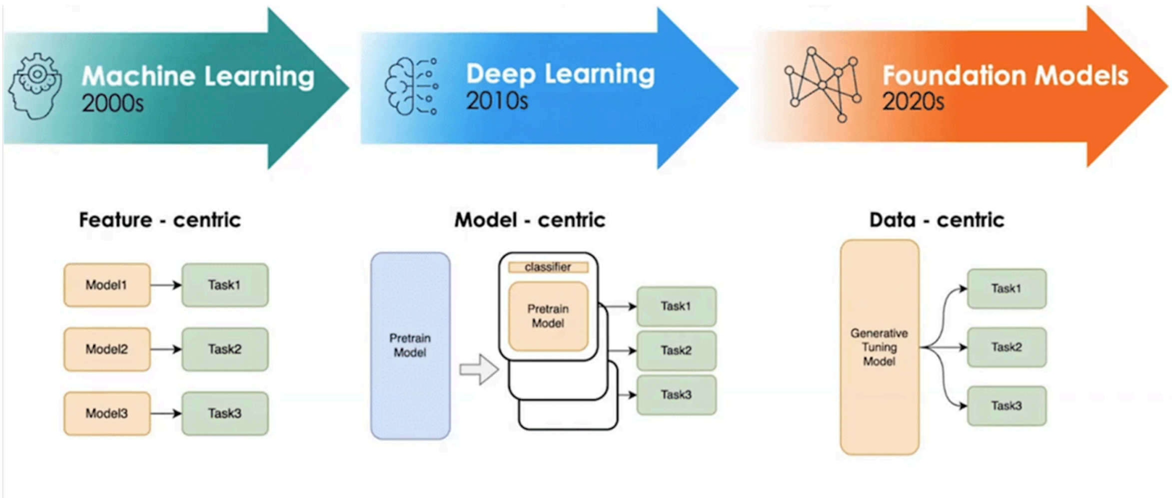
- The overarching objective of this research is to harness the power of generative AI to enhance the mentorship process for aspiring orthopaedic surgeons, especially those from marginalized backgrounds or from institutions without home orthopaedic residencies.
- Developmental Aim: To conceive, design, and develop a prototype model that employs generative AI techniques. This model aims to offer high-quality mentorship content tailored to individual needs, ensuring fair and equitable access to vital resources.
- Data Integration Aim: To amalgamate textbook quality data and open access publications related to orthopaedics with digitized insights procured from the clinical and personal experiences of our principal investigators. The goal is to produce a model that resonates with the standards set by eminent orthopaedic societies and in alignment with President Biden's AI Safety EO.
- Evaluation and Iteration Aim: To systematically evaluate the prototype's efficacy in generating pertinent and accurate content, iterating based on feedback to optimize and refine the model.

ii. Background and significance

The integration of AI screening in the 2023 residency cycle by the AAMC/Thalamus partnership signifies a monumental step in medical education and selection processes [11]. This incorporation promises efficiency and a potential paradigm shift in how candidates are assessed. Yet, it brings to the forefront concerns about inadvertent biases that might marginalize already underrepresented groups. For candidates eyeing a future in orthopaedics, especially those from institutions lacking home orthopaedic residencies, the challenge is two-fold: navigating the AI screening process and securing quality mentorship. Our initiative seeks to address the latter, offering a lifeline to these candidates by democratizing access to world-class mentorship through the power of generative AI [1-2]. The intent is to produce a bespoke quantum AI agent that marries technological innovation with the patient centered care of traditional medicine, ensuring every candidate, irrespective of their background, has a fair shot at success.

iii. Innovation

- This research stands at the confluence of technology and medical education, pioneering a unique solution to a long-standing challenge. Instead of relying on conventional mentorship models that are often limited by geographical and institutional boundaries, we propose a generative AI model that offers personalized mentorship, accessible to anyone, anywhere [6].



- Figure 1: Artificial Intelligence Time Course differentiating Machine Learning (ML), Deep Learning (DL) and Generative AI Foundation Models (FM).

The sheer capability of recent natural language processing advances, particularly in generative models, offers a tantalizing glimpse into a future where personalized content can be generated on-demand[12]. While state-of-the-art models are undeniably potent, they come with a hefty price tag, often spiraling into millions[10]. Our innovation is rooted in pragmatism. We target a sweet spot, a model size ranging from 100 million to 5 billion parameters, ensuring we practice fiduciary responsibility [8]. By melding this with rich data from quality open access sources and invaluable insights from our team's lived experiences, we ensure our AI model is grounded in reality, resonating with the ethos and equitable spirit of renowned orthopaedic societies like the Ruth Jackson Orthopaedic Society and the American Academy of Orthopaedic Surgeons [4].

iv. Approach (including statistical analysis)

Starting with open access publications in orthopaedics, amass a comprehensive dataset consisting of textbook quality data consisting of open access publications and custom inputs provided by orthopaedic thought leaders. These digitized insights will be reviewed by our team and adapted to our model to ensure appropriate depth of understanding and nuanced context.

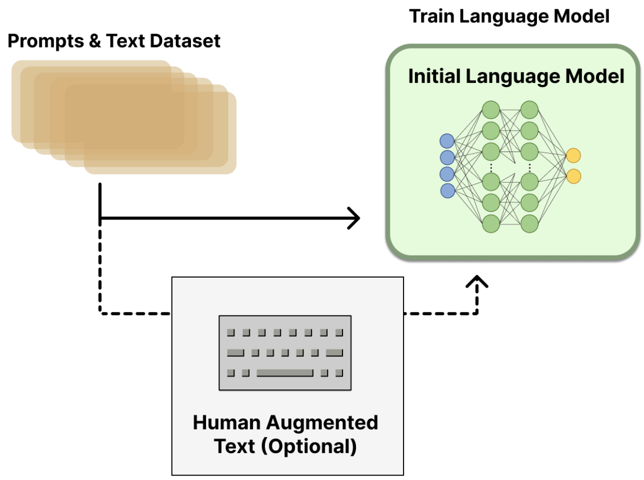


Figure 2: A flowchart depicting the stages of model development, from data collection to model training[13].

Model Development and Data Collection:

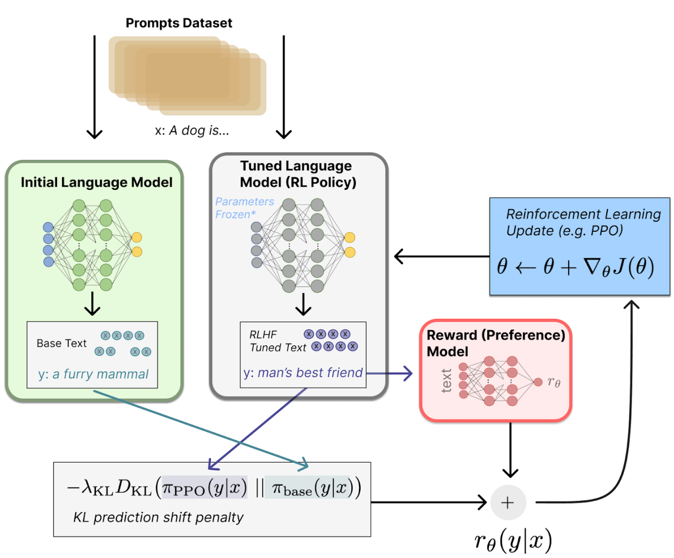


Figure 3: A schematic of how reinforcement learning with human feedback (RLHF) operates, showcasing iterative cycles of training and feedback [13].

Using the assembled dataset, the generative AI model will be trained based on generative AI industry standards. The model will be continually refined using RLHF and reinforcement learning with AI feedback (RLAIF) and Direct Preference Optimization (DPO) ensuring it remains aligned with human expert standards and expectations.Our AI model will be adept at natural language processing (NLP) and ocular character recognition (OCR), ensuring it aligns perfectly with AAMC and Thalamus AI standards.

Statistical Analysis:

Once developed, the model's efficacy will be scrutinized against a gold standard set by human experts. A suite of statistical metrics, including accuracy, specificity, sensitivity, and the industry standard metrics like the F1 score, will be deployed to gauge its performance [5,13]. Feedback will be gathered from a diverse set of aligned orthopaedic surgeon thought leaders from every level of training, with insights used for further model optimization. At the heart of our generative AI model lies a neural network, which is a system of algorithms that endeavors to recognize underlying relationships in a set of data through a process that mimics the way the human brain operates [9]. Neural networks are a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—allowing it to "learn" from vast amounts of data. While a neural network with a single layer can make approximate predictions, additional hidden layers can help to refine and perfect those predictions. Training a generative model involves feeding it a vast amount of data and allowing it to adjust its internal parameters to best represent this data. In our case, this data will be both structured (from open-access publications) and unstructured (insights from principal investigators) [3]. The model will learn to generate mentorship content that resonates with the aspirants' needs.

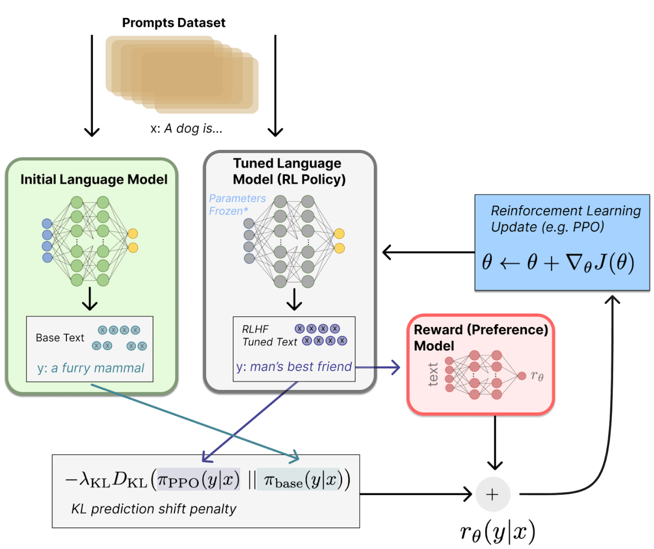


Figure 4: A visual representation of the training process, showcasing data input, model adjustments, and content generation [13].

Once the model has been initially trained, the next step is fine-tuning. Using industry standard techniques (RLHF/RLAIF/DPO), we'll expose the model to specific examples from our domain, adjusting its behavior based on feedback. This iterative process ensures that the generated content remains aligned with orthopaedic mentorship standards. Our model, once trained and fine-tuned, will not exist in isolation. It will be integrated into existing mentorship platforms, ensuring that aspirants have seamless access to the generated content. Whether it's through a web portal or a mobile application, the goal is to make the AI-driven mentorship accessible and user-friendly [2, 8]. To ensure continuous improvement, we'll implement feedback mechanisms, allowing users to rate and review the content. This feedback will be invaluable for future iterations of the model, ensuring it remains relevant and effective.

vii. Challenges and Limitation

Every pioneering venture faces challenges, and ours is no different. Here are potential challenges we anticipate the following major challenges:

1. Data Quality: While open-access publications are valuable, they vary in quality. Ensuring consistency and relevance will be crucial [1].
2. Hallucination/Unintentional Inference: The transformer architecture is fundamentally an inference engine. Like a medical student pimped on rounds for the very first time, generative AI models are known to produce unanticipated responses to queries. This is a collectively recognized issue that is being worked on currently. With the continually shifting landscape of generative AI regulation, our team felt it was prudent to identify that this known issue is likely to occur with our model [1, 2, 8].
3. Bias Mitigation: AI models can unintentionally perpetuate biases present in the training data. We'll need rigorous checks to prevent this.
4. Computational Costs: While our budget accounts for computational costs, unexpected expenses can arise, especially with large-scale models [10-11].
5. Integration Hurdles: Integrating our AI model with existing platforms may pose technical challenges.
6. US & International AI Regulatory Compliance: President Biden’s October 30 AI Executive Order and the EU AI Act are primary considerations which Amor Fati Labs has unique insight into as the founder is a former Intelligence Officer and current verified vendor for federal

viii. Conclusion and Future Directions

Our research plan represents a bold step towards democratizing mentorship for aspiring orthopaedic surgeons. By harnessing the power of generative AI, we aim to bridge gaps and level the playing field. While challenges lie ahead, our team is equipped with the expertise and determination to navigate them. Looking forward, once our prototype demonstrates success, we envisage expanding our model to other medical specialties [11]. The ultimate vision is a holistic AI-driven mentorship platform that caters to every medical aspirant, irrespective of their specialty or background. As quantum computing efforts by Microsoft, IBM, NVIDIA, Intel, and Google become more ubiquitous in alignment with the efforts of the National Institute of Standards of Technology (NIST) we will look to work on a new model aligned with these emerging technologies.

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