“Even I can do AI!” Some examples of machine learning in aiding medical education and clinical practice.

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Abstract

Artificial intelligence (AI) is rapidly becoming an integral part of our modern lives. From a clinical and biomedical perspective, AI promises much for accelerating our diagnostic and prediction abilities as well as better serving the healthcare needs of our communities. However, the speed at which these modalities continue to develop and the ongoing challenge of bridging the divide between the highly technical language of neural networks and its application by non-expert users, has proved a formidable obstacle. In the following study, we present examples of exploratory uses of AI technology by DMU faculty, staff and students and highlight resources as well the application of these technologies to members of the healthcare and medical education community.

Introduction

As members of a health sciences university, we are often challenged to keep pace with emerging technologies in medical education. A prime example, is the recent proliferation and development of machine learning models (a subcomponent of AI) and the myriad of potential clinical and biomedical applications which seem set to revolutionize our existing clinical, teaching and research processes. One of the biggest obstacles to the adoption of these technologies has been the technical challenge of applying these models. Most machine learning algorithms are developed using highly specialized tools (e.g., TensorFlow and Pytorch) which not only require technical expertise in model building but often also incur a financial cost as many of these resources require some form of cloud computing to implement a model. To this end the following study provides a few examples of the potential application and use of freely available AI tools in medical education with some discussion of the challenges we encountered using these freeware. In our examples we used the following list of AI enabled software: Googles-Teachable Machine, OpenAI's –ChatGPT 3.5, and Orbit Image Analysis (Model building module). Links to these tools are available in the References section. Teachable machine is a web-based tool (i.e., Works in your browser) for making machine learning models. It uses a process known as supervised machine learning to help create simple algorithms of detecting patterns in images, audio or poses. Teachable machine users a simple three step process: 1) gathering data; 2) train the model; 3) export the model for use in other applications.

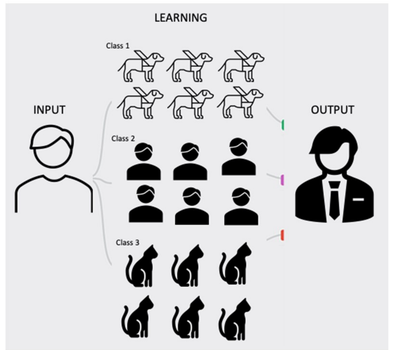

Figure 1: An overview of the workflow to apply supervised machine learning in Teachable machine. Note that the process is the same for Orbit Image Analysis except that the output is a resultant segmentation of a region/cell type of interest in your imaging dataset. Unlike Orbit Image Analysis which can only take 2D images as input, Teachable Machine can also make use of audio and video as input.

Methods and Results

Teachable Machine

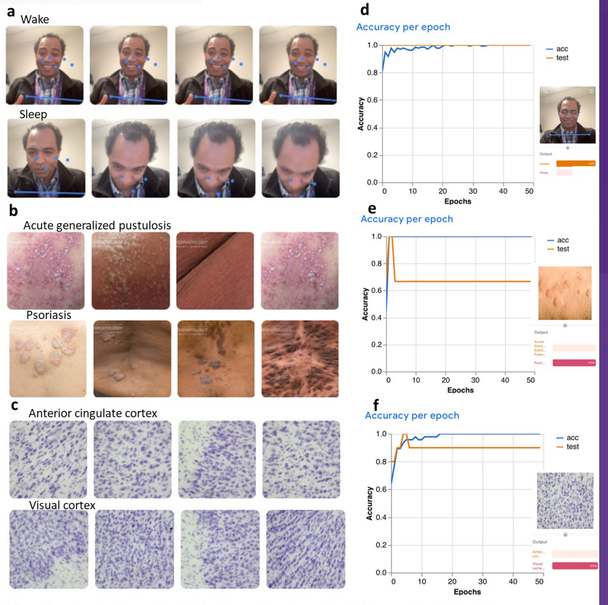

Figure 2: a-c Input data used for training three different models; d-f the associated plots of the accuracy per epoch for each model. Accuracy is the percentage of classifications that a model gets right (i.e., 0.7 means the model get 70/100 samples correct). An epoch means that each sample in the dataset has been fed into the training set at least once. In our models the epoch was set to 50 which means that the entire training dataset is fed into the model 50 times. The larger the number the better the training. Here we used a batch size of 16 and learning rate of 0.001. A batch is the set of samples used in one iteration of training (i.e., if sample consists of 50 images and you choose a batch size of 16, then the sample will be split in 50/16 = 3 batches.

Accuracy per class		Accuracy per class		Accuracy per class	
CLASS	ACCURACY	CLASS	ACCURACY	CLASS	ACCURACY
Awake	1.00	Acute Generalized ...	1.00	Anterior cingulate...	0.80
Sleep	1.00	Psoriasis	0.50	Visual cortex	1.00

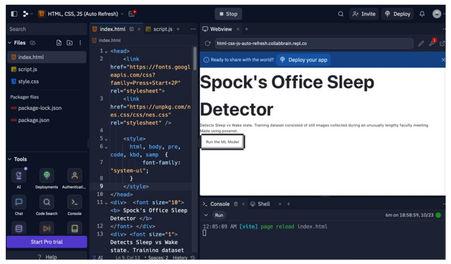

Figure 3: Screenshot demonstrating script from Teachable machine, exported and prepared for app deployment in REPLIT

ChatGPT

= A form of AI that uses deep learning algorithms to perform natural language processing!

Faculty	Student
Concept reinforcement: ChatGPT can help reinforce concepts covered in lectures or readings. Students can ask questions about specific anatomical structures, functions, or systems, and ChatGPT can provide concise explanations or descriptions to reinforce the information.	**Personalized learning:** ChatGPT can provide personalized learning experiences by tailoring responses to individual student needs. By analyzing the specific queries and responses, instructors can gain insights into areas where students may be struggling or need additional support.
Case studies and clinical scenarios: Present students with clinical cases or scenarios related to anatomy and have them interact with ChatGPT to explore differential diagnoses, anatomical considerations, and treatment options. ChatGPT can simulate patient interactions and provide insights based on anatomical knowledge. Simulated patients- what is the student's impression of the simulated patient, racial-gender-socio-economic biases	**Collaborative learning:** Encourage collaborative learning by incorporating group discussions with ChatGPT. Students can work together to explore complex anatomical concepts and engage in dialogue with ChatGPT to deepen their understanding through peer-to-peer interactions.
Interactive Q&A sessions: Use ChatGPT to facilitate interactive question-and-answer sessions. Students can take turns asking questions, and ChatGPT can provide immediate responses. This can encourage active participation and provide additional clarification on complex topics.	**Revision and review:** Students can use ChatGPT as a revision tool by asking questions related to previously learned content. This interactive review process can help reinforce knowledge retention and identify areas that require further study.
Virtual anatomy demonstrations: ChatGPT can act as a virtual guide, providing step-by-step explanations of anatomical dissections or procedures. It can describe the anatomical structures being observed, their functions, and their clinical relevance, enhancing students' understanding of real-world applications.	**Research and exploration:** ChatGPT can assist students in conducting research on specific anatomical topics or exploring recent advancements in the field. By providing relevant information and suggesting credible resources, ChatGPT can foster independent learning and critical thinking skills

Concept reinforcement Provide a series of responses to reinforce knowledge on decussation of the corticospinal tract and clinical signs on the body	**Personalized learning:** Help me study the corticospinal tract. What should I know? I'm currently learning about the corticospinal tract. Convert the key lessons from this topic into engaging stories and metaphors to aid my learning and memorization I am having difficulty with multiple choice lesion questions involving the corticospinal tract. Can you help me learn this How would you explain the corticospinal tract to a 3rd grader, a 10th grade high schooler and a college educated non science professional
Case studies and clinical scenarios: Generate a clinical case study where the patient has injury to the corticospinal tract in the left hemisphere of the brain	**Interactive Q&A sessions:** Tell us about the development of the corticospinal tract? Where does the corticospinal tract originate from? What disease states do you often observe injury of the corticospinal tract?
	Virtual anatomy demonstrations: Serve as a virtual guide, providing a step-by-step explanation of the anatomical dissection of the lateral hemisphere of the brain in coronal views to reveal the corticospinal tract
Revision and review: I have been learning about the corticospinal tract. Provide 2 multiple choice clinical questions to review my knowledge I am currently learning about the corticospinal tract. Provide me with a 5 question multiple choice quiz to test my knowledge. Do not provide the answers until I ask for them. I am currently learning about the corticospinal tract. Ask me a series of 5 questions that will test my knowledge. Identify knowledge gaps in my answers and give me better answers to fill those gaps.	**Collaborative learning:** Assume you are A.T. Still. What treatment would be recommended for a patient who had a stroke impacting the left corticospinal tract
	Research and exploration: What is unique about the corticospinal tract in the pangolin Suggest credible scientific resources to learn more about the pangolin corticospinal tract what scientific article would you recommend to learn more about the unusual pangolin corticospinal tract How do I cite you in a scientific publication? what is the date range of your training dataset

Blooms taxonomy as a guide to prompting: Prompting with the intent of developing higher order thinking. Why Blooms framework is important? Move beyond recall to application, analysis, synthesis creation, evaluation

Blooms Taxonomy	Sample Prompts
Level 1 – Remember: This level helps us recall foundational or factual information: names, dates, formulas, definitions, components, or methods.	How would you define...?; List the _____ in order. What are the components of the Kreb Cycle
Level 2 Understand: Understanding means that we can explain main ideas and concepts and make meaning by interpreting, classifying, summarizing, inferring, comparing, and explaining.	How would you differentiate between _____ and _____? What is the main idea of _____? Why did...?
Level 3 Apply: Application allows us to recognize or use concepts in real-world situations and to address when, where, or how to employ methods and ideas.	Why does _____ work? How would you change_____? How would you develop a set of instructions about...?
Level 4 Analyze: Analysis means breaking a topic or idea into components or examining a subject from different perspectives. It helps us see how the “whole” is created from the “parts.” It’s easy to miss the big picture by getting stuck at a lower level of thinking and simply remembering individual facts without seeing how they are connected. Analysis helps reveal the connections between facts.	How does this element contribute to the whole, what is the significance of this ___, How would you group this?
Level 5 Synthesize: Synthesizing means considering individual elements together for the purpose of drawing conclusions, identifying themes, or determining common elements. Here you want to shift from “parts” to “whole.”	Develop a proposal that would... How can you paraphrase this information into 1-2 concise sentences? What make the___ similar and different from___
Level 6 Evaluate: Evaluating means making judgments about something based on criteria and standards. This requires checking and critiquing an argument or concept to form an opinion about its value. Often there is not a clear or correct answer to this type of question. Rather, it’s about making a judgment and supporting it with reasons and evidence.	What is your opinion about___ what evidence and reasons support this opinion? How would you improve this? What argument or approach is stronger? Why?
Level 7 Create: Creating involves putting elements together to form a coherent or functional whole. Creating includes reorganizing elements into a new pattern or structure through planning. This is the highest and most advanced level of Bloom’s Taxonomy.	How would you create a model and use tit to teach this information to others? What experiment can you make to demonstrate or test this information? How can this information be told in the form of a story or poem?

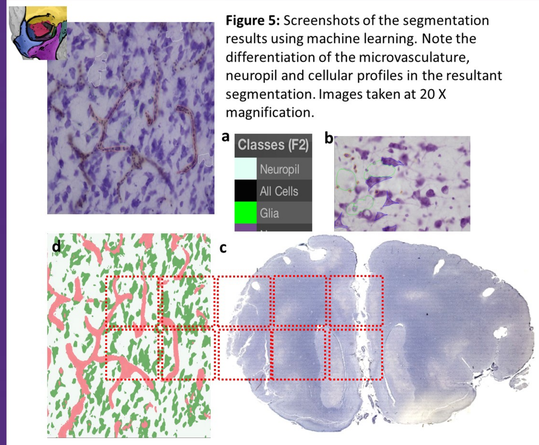

Figure 4: Workflow summary as screenshots from OrbitImage Analysis for the application of machine learning to a histology dataset. a- Define classes ; b- Classify and Train dataset; c- ROI testing and accuracy inspections or Batch processing; d- Object segmentation for quantification of number of objects or size parameters

Figure 5: Screenshots of the segmentation results using machine learning. Note the differentiation of the microvasculature, neuropil and cellular profiles in the resultant segmentation. Images taken at 20 X magnification.

Discussion & Conclusion

Here we demonstrated the development and use of machine learning models using imaging or pose data with applications for biomedical and clinical research. These machine models can be readily exported to REPLIT for app development and deployment.

We also demonstrated the use of large language models (LLM’s) such as ChatGPT with specific focus for student and faculty. We outline 8 key areas where we feel LLMs could be used from a learning perspective. We also provide examples of prompting for chat-GPT which develop a framework for student learning embedded in Blooms taxonomy.

As with all models we encourage users to be mindful of the data included in their studies and the limitations as well as inherent biases used when building there models.

References

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https://openai.com/blog/chatgpt

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