Editor's Page

Machine Learning in Imaging: What is JASE Looking For?

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Over the last ten years, there has been tremendous growth in artificial intelligence (AI) and machine learning (ML) research. Particularly with deep learning, AI has unlocked significantly more opportunities to analyze information and find subtle relationships between diagnostics and disease. This is particularly true in medical imaging, which provides rich information and large historical datasets that can inform the training of ML algorithms.

For clinicians, there is an increased awareness of the need to understand and critically appraise AI applications as well as AI literature. Given the rapid rise of the field, many new specialty journals have arisen (NEJM AI, RSNA AI, NPJ Digital Medicine, Lancet Digital Health, and others). At JASE, we have a particular focus on echocardiography, but we similarly aim to keep our audience informed about the latest developments and applications of AI to echocardiography. Here we outline the AI content of particular interest to JASE.

Focus on Echocardiography

AI has been applied to all forms of medical imaging, and echocardiography is no exception. Recent work in AI for echocardiography has ranged from applying ML to the structured elements of reports[1] to applying AI to actual ultrasound images. In contrast to CT/MRI in which the sequence or protocol is labeled, echocardiographic image data are often unstructured, and this poses additional challenges. Thus, fundamental tasks in development of AI algorithms for echocardiography have involved classification of views from echocardiographic images.[2] From workflows to quantify key measurements to algorithms to detect rare disease, at JASE we are excited about all applications of AI/ML that advance the frontier of what is possible with cardiovascular ultrasound. This includes work to expand the access of cardiac ultrasound to novice users (such as AI to guide novice users to acquire echocardiographic images[3]) as well as algorithms to detect disease (diagnosis of cardiac amyloidosis,[4] heart failure with preserved ejection fraction,[5] aortic stenosis,[6] and mitral regurgitation[7]) and improve precision and prognostic value of common measurements (including measurements as fundamental as left ventricular ejection fraction and longitudinal strain).[8] Herein, we highlight how JASE evaluates AI/ML manuscripts as well as particular areas of research we encourage.

Methodologic Rigor and Research Topics

ML offers the option to address challenges in data analysis that are not well addressed by typical regression approaches.[9] For example, to predict the occurrence of an outcome, regression methods utilize prespecification of a model structure and the selection of potential predictor variables based on prior understanding of relationships between risk factors and outcomes. ML models allow greater flexibility for handling large and labyrinthine datasets and are better able to account for nonlinear relationships, interactions, and large numbers of possible predictors. This is particularly important in imaging as pixel-based information is difficult to handle with typical regression approaches. Furthermore, the handling of missing data can explored in novel ways including chained imputation using random forests to the automated inclusion of missing data indicators in the ML algorithm.

At JASE, we are interested in sound approaches, clearly specified so that it is possible for others to reproduce the results. Traditional statistical considerations still apply to AI research, particularly in the context of evaluating the implementation or utility of AI algorithms in practice. Structured standards (CONSORT-AI for a clinical trial with AI, STARD for diagnostic performance, and other frameworks) are recommended to improve the reporting of results. Methodologies that will be unfamiliar to many should be explained or referenced. Efforts must be made to explain the inner workings of the model; saliency plots and SHAP explainers are examples of how this may be done. The approach to management of missing data must be clearly specified.

There are additional specific areas of attention are required for ML model development.[10] Sample size and power calculation are important considerations, although the justification of the sample size may not necessarily rely on ‘power analyses’. Training of a new model usually requires large amounts of data. Pattern recognition algorithms like convolutional neural networks have tendency to over fit to a given dataset – even when there are split sample techniques used to reserve a testing (‘validation’) dataset, so testing should be performed with an independent data set to assess reproducibility and generalizability. Here, independence is often best assured by an external dataset as there could be some limits to generalizability imposed by data collected at a single center. Models should be built and tested using a realistic or clinically typical mix of data (not just normal versus a specific disease). In order to benefit all patients, models should include diverse populations. As we seek to provide models that improve our understanding of disease and advance patient care, we must keep in mind current benchmark refence standards, including their precision and subjectivity. At JASE, we are also interested in novelty which may include new model development or application of an existing model to a new population. Despite the growth of AI research, there have been few clinical trials of AI in healthcare; we encourage trials of AI in echocardiography.[11] Although model development maybe a very complicated process, ultimately, simplification may be necessary to illustrate the model and to implement it in clinical practice.

JASE looks favorably upon works that share implementation code and training and testing datasets. The ability for other researchers to independently validate one’s work greatly improves the rigor of research. Given the rising complexity of AI/ML and research codebases, multiple sets of eyes inevitably strengthen a work. The National Institute of Health has formalized data sharing policies for sponsored research,[12] and we support such efforts. ASE continues to expand its registry with the intent of promoting the sharing of large echocardiographic datasets.[13]

Conclusions

Fundamentally, AI and ML remain a series of mathematical calculations and supporting software. However, particularly in medicine, human factors will continue to be important, as we seek to understand how AI/ML can and already has changed our practice. Given the shifting landscape, this is an opportunity to learn from other communities – including computer scientists who have shared data and code. Scientific review will continue to evolve, but the complexity of ML approaches requires new and evolving approaches. The processes of data acquisition, model tuning, and software engineering that are required to develop ML approaches warrant special consideration during peer review.

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