Digital Health - Machine Learning, Chair of Prof. Dr. Lippert
Master's Thesis Proposal

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Building a unified model selector for a medical imaging model zoo

Machine Learning models can solve ubiquitous problems in medical imaging e.g. to support radiologists in diagnosing. Typically, these models are targeted to specific tasks that are solved using a single dataset. When using this approach to address the needs of medical professionals, who have to solve many different problems everyday, this would mean that numerous specific deep learning models would have to be created. For instance, one model might draw bounding boxes around a lesion for computer-aided detection in mammography, another might segment organs-at-risk in radiotherapy, etc. In order to store and share such models, we have developed the Medical Imaging Model Zoo.

We are interested in the problem of model selection with a large set of pretrained models from our model zoo. Given an arbitrary user-selected image input and a set of existing models, the task is to return and apply those models that are appropriate for the input. For instance, such a selector might take a user-selected chest X-ray and then searches/retrieves all models that have been trained on chest X-rays, e.g. for lung segmentation or disease classification.

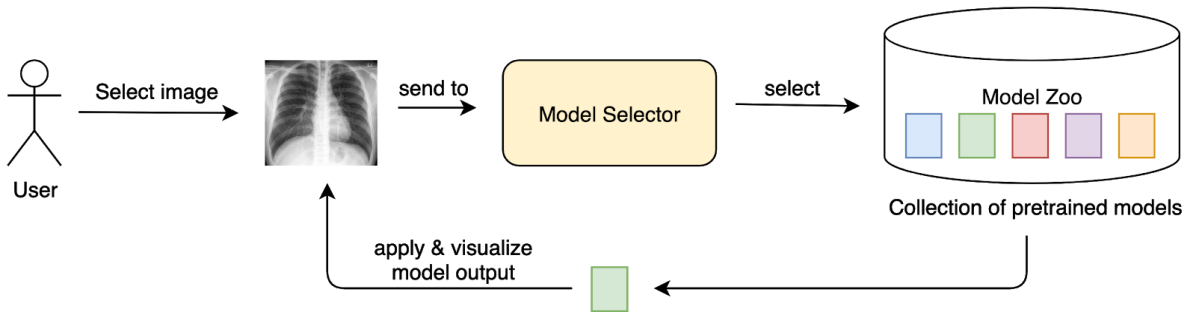

Fig. 1: Model Selector Workflow

Since only the user input and a set of pretrained models are available, the training data that has been used to create each task-specific model cannot be used for direct comparisons.

High-level thesis goals are:

1. Building a knowledge base, i.e. a set of task-specific models with a standard deep convolutional neural network architecture trained on selected datasets such as the Medical Segmentation Decathlon [1,2]
2. Building a model selector
3. Evaluating the key aspects of your approach with external datasets
4. Implement an automatic application workflow of such a selector from training to inference

One approach for such a selector might be based on the comparison of embeddings of both user input and prototypes from all task-specific models. A prototype is an instance/image that represents a given task model, e.g. by means of activation maximization [4] and/or Generative Adversarial Networks [5]. The selector, which creates these embeddings, might be trained on a big and diverse annotated dataset such as ROCO [3], which covers a broad range of images typically encountered in radiology.

With this thesis, you answer the question whether it is feasible to automatically select appropriate machine learning models based on exemplary inputs and the model alone. Prospectively, given a large database of pretrained models provided by individual developers, such a selector might be used as a go-to approach for transfer learning, or to consume given models without the need for training for use in a clinical setting.

Your Profile

You are studying towards your master's degree and you have a strong background in machine and deep learning, e.g. by taking respective courses of the chair or participating in applied project work. Additionally, a high interest in improving applied artificial intelligence systems is expected. Lastly, you should feel committed about the project and take responsibility e.g. by creating and pushing forward your own ideas and critically analysing your research. By the end of your thesis, you will have gained in-depth experience of applying deep learning usable for academia and industry. The outcome of your thesis directly contributes to our current master's project and the chair's research.

If you are interested in this applied deep learning project or if you have questions, contact us via mail above.

References

[1] Simpson, Amber L., et al. “A Large Annotated Medical Image Dataset for the Development and Evaluation of Segmentation Algorithms.”, 25 Feb. 2019, arxiv.org/abs/1902.09063.

[2] *Medical Segmentation Decathlon*, medicaldecathlon.com/.

[3] Pelka, Obioma, et al. “Radiology Objects in COntext (ROCO): A Multimodal Image Dataset.” *SpringerLink*, Springer, Cham, 16 Sept. 2018, link.springer.com/chapter/10.1007/978-3-030-01364-6_20.

[4] Nguyen, Anh, et al. “Synthesizing the Preferred Inputs for Neurons in Neural Networks via Deep Generator Networks.” *ArXiv.org*, 23 Nov. 2016, arxiv.org/abs/1605.09304.

[5] Goodfellow, Ian, et al. "Generative adversarial nets." Advances in neural information processing systems. 2014.