Metalearning for Deep Learning Applications in Medical Image Analysis

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Introduction

- Deep learning models became state-of-the-art solutions for many problems in medical imaging.
- With higher model availablity choosing a model is not trivial anymore.
- Medical imaging problems share characteristics, as anatomy variations and scan methods are limited.
- Can choosing the best model be optimized?

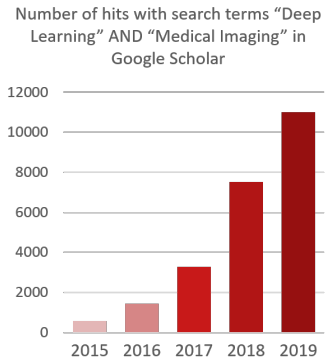

Fig. 1: Increase of deep learning usage in medical imaging.

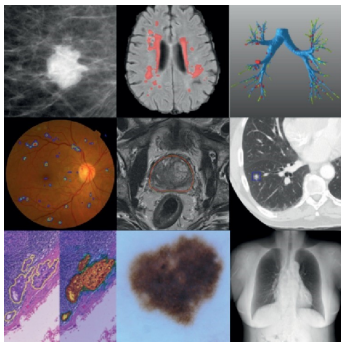

Fig. 2: Examples of medical imaging data. [1]

Methods

- Metalearning is learning based on previous knowledge. i.e. using metafeatures; compressed representations of datasets.

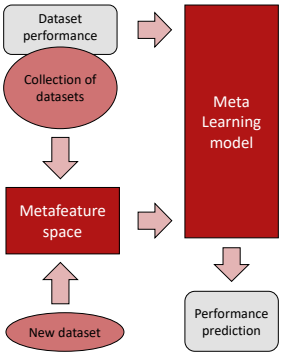

Fig. 3: Architecture of metalearning system.

- Metafeature extraction using statistical methods and VGG, Resnet and MobileNet models.
- Train and validation data from Decathlon segmentation Challenge (results of 19 methods on 10 datasets). [2]

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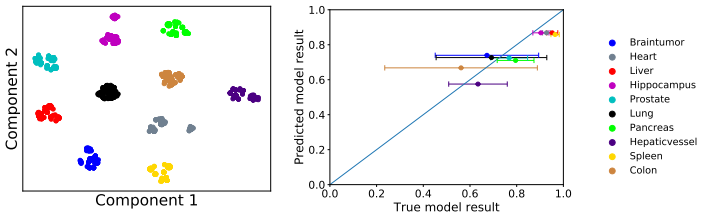
Experiments

- Univariate feature selection on metafeatures.
- Support Vector Regression (SVR) relates metafeatures to Dice segmentation scores of models.
- Cross-validation on Decathlon data for tuning of method.
- Testing on independent test sets with Decathlon data for training.



(a) t-SNE embedding **(b)** Decathlon prediction

Fig. 4: Result of metalearning system using SVR and VGG16 metafeature extraction with feature selection

Feature extractor	Feature selection	Decathlon	Test sets
Statistical	Yes	0.20	0.14
	No	0.21	**0.09**
VGG16	Yes	0.15	0.16
	No	0.24	0.17
ResNet50	Yes	**0.14**	0.21
	No	0.22	0.18
MobileNet	Yes	0.15	0.17
	No	0.24	0.18

Tab. 1: Results metalearning system. Mean Absolute Error (MAE) of Dice score between model prediction and actual model.

Discussion

- Medical datasets can be characterized in metafeature space, which shows promise for using metalearning in medical imaging.
- Number of training datasets should ideally be higher.
- What is a acceptable prediction error when applying this metalearning method?

References

[1] Litjens et al. (2017). A survey on deep learning in medical image analysis. *Medical Image Analysis.* 42, 60-88.

[2] Simpson et al. (2019). A large annotated medical image dataset for the development and evaluation of segmentation algorithms. *arXiv preprint arXiv:1902.09063.*