JUNTANG ZHUANG

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EDUCATION

Yale University
Ph.D. Candidate in Biomedical Engineering (Advisor: James S. Duncan) Sep 2016 - Now
Dissertation: Machine Learning Methods to Model Continuous Evolution of Brain States

Yale University
M.A. in Statistics, M.Phil in Biomedical Engineering (GPA:4.0/4.0) Sep 2017 - May 2018

Tsinghua University
B.E. in Engineering Physics Sep 2012 - May 2016

RESEARCH EXPERIENCE

MALI: a memory efficient and reverse accurate integrator for Neural ODEs Sep - Nov 2020
Mentor: James S. Duncan, Sekhar Tatikonda Yale University

- Proposed MALI, which is a new solver for Neural ODEs. Every numerical step in MALI is accurately invertible, so MALI can achieve accuracy in reverse-time trajectory, hence accuracy in gradient estimation for Neural ODEs. Due to the numerical invertibility, intermediate states can be deleted and later on reconstructed, hence MALI achieves a constant memory cost w.r.t integration time.
- Due to the accuracy and memory efficiency, MALI is suitable for large-scale Neural ODEs, such as FFJORD, and large ODE-CNNs on ImageNet. MALI achieves new state-of-the-art for image generation with continuous models.
- Paper accepted by International Conference on Learning Representations (ICLR 2021) [project page]

Evolutionary causal modeling of brain states from task-fMRI data Mar - Sep 2020
Mentor: James S. Duncan Yale University

- Modeled the effective connectome of the brain, which is the directional influence between different regions of the brain. Developed a differential equation model to simulate the dynamical evolution of brain states.
- Developed a method to efficiently learn the dynamical model from high-dimensional fMRI data, based on previous machine-learning projects such as AdaBelief Optimizer, Adaptive Checkpoint Adjoint and Invertible Networks (see details below).
- Paper accepted by 27th International Conference on Information Processing in Medical Imaging (IPMI 2021).

AdaBelief optimizer: a fast, accurate and stable optimizer for deep learning Jan - June 2020
Mentor: James S. Duncan, Sekhar Tatikonda Yale University

- Developed an optimizer for deep learning models. To our knowledge, it's the first to achieve three goals simultaneously: fast training speed, good generalization performance, and stability of training. Performed extensive validation in computer vision tasks, language modeling and generative adversarial networks (GAN) and reinforcement learning.
- Paper is accepted as Spotlight Presentation by NeurIPS 2020. [project page]

Adaptive checkpoint adjoint method for gradient estimation in neural ODE Jun - Dec 2019
Mentor: James S. Duncan, Sekhar Tatikonda Yale University

- Proposed and implemented a family of adaptive ODE solvers for accurate gradient estimation, which is a core factor of most deep learning models. Achieved both accuracy and computation efficiency.
- To our knowledge, our method is the first to enable neural-ODE to achieve comparable results to state-of-the-art discrete-layer models on benchmark classification tasks.
- Our method enables the real-world application of deep learning models combined with physical and biological knowledge in the form of differential equations. For example, our method is applied to estimate the mass of stars in a three-body problem, and learn the dynamical evolution of brain networks in fMRI data.
- Paper accepted by International Conference on Machine Learning (ICML 2020). [project page]

Invertible networks for model decision interpretation Jan - June 2019
Mentor: James S. Duncan, Nicha C. Dvornek Yale University

- Proposed a two-stage model for classification tasks, an invertible transform from input domain to feature domain, and a linear classifier in the feature domain. With invertible networks, we explicitly determine the decision boundary in the input domain, and calculate the projection of a point onto the decision boundary. The difference between a point and its projection onto the decision boundary can be viewed as the explanation for model decision.

- Applied the proposed method on fMRI data, selected biomarkers for ASD, and validated biomarkers in prediction of phenotype scores.
- Papers accepted by ICCV Workshop on Interpreting and Explaining Visual Artificial Intelligence Models (ICCV 2019, XAIC) and International Conference on Medical Image Computing & Computer Assisted Intervention (MICCAI 2019).

ShelfNet for real-time semantic segmentation Aug - Nov 2018
Mentor: Nicha C. Dvornek Yale University

- Proposed ShelfNet, a multi-path network with a shelf-like structure for real-time semantic segmentation. Achieved both faster running speed and higher mIoU than state-of-the-art real-time semantic segmentation models such as BiSeNet.
- Paper accepted by ICCV Workshop on Computer Vision for Road Scene Understanding and Autonomous Driving (ICCV 2019, CVRSUAD).

PUBLICATIONS

1. **J. Zhuang**, N. Dvornel, et al. MALI: a memory efficient and reverse accurate integrator for Neural ODEs, *International Conference on Learning Representations* (ICLR 2021)
2. **J. Zhuang**, N. Dvornel, et al. Multiple-shooting adjoint method for whole-brain dynamic causal modeling , *Information Processing in Medical Imaging* (IPMI 2021)
3. **J. Zhuang**, T. Tang, et al. AdaBelief Optimizer: adapting stepsizes by the belief in observed gradients, *Conference on Neural Information Processing Systems* (NeurIPS 2020, spotlight, acceptance rate 4%)
4. **J. Zhuang**, N. C. Dvornek, et al. Adaptive Checkpoint Adjoint Method for Gradient Estimation in Neural ODE, *International Conference on Machine Learning* (ICML 2020)
5. **J. Zhuang**, J. Yang, et al., ShelfNet for fast semantic segmentation, *Workshop on Computer Vision for Road Scene Understanding and Autonomous Driving* (CVRSUAD 2019)
6. **J. Zhuang**, N. C. Dvornek, et al., Decision Explanation and Feature Importance for Invertible Networks, *Workshop on Interpretating and Explaining Visual Artificial Intelligence Models* (XAIC 2019) [*oral*]
7. **J. Zhuang**, N. C. Dvornek, et al., Invertible Network for Classification and Biomarker Selection for ASD , *International Conference on Medical Image Computing & Computer Assisted Intervention* (MICCAI 2019)
8. **J. Zhuang**, N. C. Dvornek, et al., Prediction of Pivotal response treatment outcome with task fMRI using random forest and variable selection, *International Symposium on Biomedical Imaging* (ISBI 2018)
9. **J. Zhuang**, N. C. Dvornek,et al., Prediction of severity and treatment outcome for ASD from fMRI, *International Workshop on PRedictive Intelligence In MEdicine* (PRIME 2018)
10. N. C. Dvornek, X. Li, **J. Zhuang**, et al., Demographic-Guided Attention in Recurrent Neural Networks for Modeling Neuropathophysiological Heterogeneity (MLMI 2020)
11. X. Li, N. C. Dvornek, M. Zhang, **J. Zhuang**, et al., Pooling Regularized Graph Neural Network for fMRI Biomarker Analysis, (MICCAI 2020)
12. J. Yang, N. C. Dvornek, F. Zhang, **J. Zhuang**, et al. , Domain-Agnostic Learning with Anatomy-Consistent Embedding for Cross-Modality Liver Segmentation, *Visual Recognition for Medical Images* (VRMI 2019)
13. X. Li, N.C. Dvornek, Y. Zhou, **J. Zhuang**, et al., Graph Neural Network for Interpreting Task-fMRI Biomarkers, (MICCAI 2019)
14. **J. Zhuang** LadderNet: Multi-path networks based on U-Net for medical image segmentation, ArXiv 2018

OPEN-SOURCE PROJECTS

AdaBelief-optimizer; TorchDiffEqPack; ShelfNet

WORK EXPERIENCE

Internship at Tencent AI Lab on segmentation of pathological images. Bellevue, W.A. USA, June-Sep 2019

AWARDS & SCHOLARSHIPS

- Graduate fellowship, Yale University 2016
- Award for excellent learning performance, Tsinghua University 2015
- Meritorious award for Mathematical Contest in Modeling (top 10% teams worldwide) 2015
- National encouragement award (for excellent learning performance), Tsinghua University 2014
- Sparks Program (Undergraduate High-tech Club) membership, Tsinghua University 2014

SKILLS

C/C++, R, Python, MATLAB, PyTorch, Keras