Tianzhe Chu

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EDUCATION

- **ShanghaiTech University** — Shanghai, China
  B.Eng in Computer Science and Technology, GPA:3.75/4.0 — Sep 2020 - Jun 2024
  Selected Courses: Introduction to Machine Learning, Probability and Statistics, Computer Architecture I, Data Structure and Algorithms, Discrete Mathematics, Signals and Systems, Mathematical Analysis.

- **University of California, Berkeley** — Berkeley, CA, US
  Visiting undergraduate in EECS — Aug 2022 - May 2023
  Graduate Level Courses: Deep Learning, Deep Reinforcement Learning, Foundation of Graphics, Applications of Parallel Computing, Computer Vision, Optimization Model in Engineering

RESEARCH INTEREST

- Building scalable unsupervised/self-supervised representation learning techniques for multimodalities.
- Understanding the latent representation learned by modern deep neural networks and exploring interpretable designs.
- Seeking controllable generative models for consistent and trustworthy design.

PUBLICATIONS

(* means equal contribution)

- **Tianzhe Chu***, Yaodong Yu*, Shengbang Tong, Ziyang Wu, Druv Pai, Sam Buchanan, Yi Ma, *Emergence of Segmentation with Minimalistic White-Box Transformers*, https://arxiv.org/abs/2308.16271.
  Conference on Parsimony and Learning (CPAL) 2024 (Oral), https://cpal.cc,
  NeurIPS 2023 XAI Workshop (Oral), (4 orals of 59 posters)

- **Tianzhe Chu***, Shengbang Tong*, Tianjiao Ding*, Xili Dai, Benjamin D. Haeffele, René Vidal, Yi Ma, *Image Clustering via the Principle of Rate Reduction in the Age of Pretrained Models*, https://arxiv.org/abs/2306.05272,
  ICLR 2024

- Yaodong Yu, Sam Buchanan, Druv Pai, **Tianzhe Chu**, Ziyang Wu, Shengbang Tong, Benjamin D. Haeffele, Yi Ma, *White-Box Transformers via Sparse Rate Reduction*, https://arxiv.org/abs/2306.01129.
  NeurIPS 2023

- Druv Pai, Ziyang Wu, Sam Buchanan, **Tianzhe Chu**, Yaodong Yu, Yi Ma, *Masked Completion via Structured Diffusion with White-Box Transformers*,
  ICLR 2024,
  Conference on Parsimony and Learning (CPAL) 2024 (non-archival track)

- Yaodong Yu, Sam Buchanan, Druv Pai, **Tianzhe Chu**, Ziyang Wu, Shengbang Tong, Hao Bai, Yuexiang Zhai, Benjamin D. Haeffele, Yi Ma, *White-Box Transformers via Sparse Rate Reduction: Compression Is All There Is?*,
  https://arxiv.org/abs/2311.13110.
  Under Review, Journal of Machine Learning Research (JMLR)

RESEARCH EXPERIENCE

- **Berkeley Artificial Intelligence Research (BAIR) in UC Berkeley** — Berkeley, CA, US
  Undergraduate research assistant advised by Prof. Yi Ma — Nov 2022 - Now
  - In general, seeking low-dimensional structures of high-dimensional natural signals, i.e. images and languages
  - Empirically investigating the properties of white-box transformers
  - Exploring mathematically interpretable deep learning architectures driven by optimizing sparse rate reduction
  - Pushing the limits of image clustering in the age of pre-trained models

- **Shanghaitech Vision and Intelligent Perception (SVIP) Lab** — Shanghai, China
  Undergraduate research assistant advised by Prof. Shenghua Gao — Sep 2023 - Now
  - Exploring efficient and principled learning frameworks for 3D reconstruction and generation
  - Extending interpretable deep learning architectures into fine-grained vision tasks

Research Project Highlights

- **Emergence Properties in White-box Transformers** — Berkeley, CA, US
  Mentor: Prof. Yi Ma — *Summer 2023*
  - We discover that white-box transformer leads to the emergence of segmentation properties in the network's self-attention maps, solely through a minimalistic supervised training recipe.
  - Qualitatively, supervised white-box transformer(named CRATE) learns (i) explicit attention maps with semantic meanings; (ii) structured patch-wise representations with less spurious correlations.
  - Quantitatively, supervised CRATE, though not trained for segmentation, achieves a much higher segmentation score than supervised ViT.
  - This work is accepted by CPAL 2024 and NeurIPS 2023 XAI Workshop, both selected for oral presentation.

- **Clustering via Principle of rate reduction and Pretrained model** — Berkeley, CA, US
  Mentor: Prof. Yi Ma and Dr. Benjamin David Haeffele — *Mar 2023 - May 2023*
  - We propose a novel image clustering pipeline (named CPP) that integrates pre-trained models and rate reduction, enhancing clustering accuracy and introducing an effective self-labeling algorithm for unlabeled datasets at scale.
  - Our pipeline learns a highly clusterable image representation that can be extended to CIFAR-100/ImageNet-1k/LAION-Aesthetic/WikiArt, where few previous methods succeeded in achieving a decent performance.
  - Our pipeline goes beyond deep clustering via proposing solutions for (i) measuring optimal number of clusters; (ii) better image-to-image search; (iii) labeling clusters with semantic meanings.
  - This work is submitted to ICLR 2024.

- **White-box Transformers** — Berkeley, CA, US
  Mentor: Prof. Yi Ma — *Feb 2023 - Nov 2023*
  - We develop white-box transformer-like deep network architectures that are mathematically interpretable and achieve performance very close to ViT.
  - The white-box transformer(named CRATE) is designed as an unrolled optimization of the sparse rate reduction objective over layers. Layers and operators are designed with clear objectives, i.e. modified attention block designed for compression and ISTA block designed for sparsification.
  - The pipeline is evaluated on classification tasks with competitive performance against ViT in a parameter-efficient manner. CRATE has also been successfully extended to MAE, DINO, BERT, and more transformer-based frameworks.
  - Conference version accepted by NeurIPS 2023, Journal version submitted to JMLR.

Activities and Awards

- **Merit Student** — Shanghai, China
  Affiliation: ShanghaiTech University — *Dec 2023*
- **Outstanding Individual Award as Leader of Social Practice Group** — Enshi, Hubei, China
  Affiliation: ShanghaiTech University — *July 2021*
- **Outstanding Individual Award as Member of Industrial Practice Group** — Shanghai, China
  Affiliation: ShanghaiTech University — *July 2022*
- **Provincial First Prize for 35th National Physics Olympics Competition** — Nanjing, Jiangsu, China
  Affiliation: Suzhou High School of Jiangsu Province — *Sep 2018*

Skills

- **Languages:** Python, C/C++, Matlab, RISC-V, Mandarin (native), Cantonese, English (fluent)

- **Tools:** PyTorch, Jax, Markdown, git, LaTeX, Blender

Invited Talks

- Presented on White-Box Transformers @ SVIP Lab, Sep 25th, 2023

- Will present on Emergence of Segmentation in White-Box Transformers @ CPAL 2024, HKU, January, 2024