Yiran Li

PhD Candidate @ Visualization & Interface Design Innovation Lab, VIDI
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RESEARCH

My research focuses on **interactive data visualization** and **human-computer interaction (HCI)**. Specifically, I develop scalable visual analytical interfaces for achieving reliable, trustworthy, and human-centered AI, with the help of mechanistic interpretation, vulnerability diagnosis, and human-in-the-loop evaluation.

- **Mechanistic Interpretation**
  I designed interactive visualizations for interpreting the multi-head self-attentions of **vision transformers** through head perturbation, attention distribution analysis, and pattern summarization, successfully revealing novel attention patterns across multiple transformer layers. Additionally, I developed HCI systems for analyzing the multi-modal cross attentions of **large vision-language models (e.g., CLIP and BLIP)** by using attention aggregation and gradient-weighted attention mapping.
- **Vulnerability Diagnosis**
  Utilizing mechanistic interpretation techniques, I also developed user interfaces enabling users to interactively identify weaknesses in vision transformers for image classification tasks. Moreover, I also developed interactive systems to diagnose the vulnerabilities of **CNNs** against adversarial attacks by monitoring image perturbations, visualizing receptive fields, and identifying susceptible neurons.
- **Human-in-the-Loop Evaluation**
  I designed data-centric model evaluation strategies and human-in-the-loop visual steering systems for large vision-language models, facilitating more efficient image exploration and more accurate image captioning through prompt engineering.
- **Real World Applications**
  I developed HCI systems for evaluating machine learning models for processing electronic health records (EHRs) using comparative analysis, SHAP value analysis, and feature consistency analysis. I also developed interactive and explainable visual surrogate models for better understanding water distribution simulations and improving optimization processes.

I am familiar with **statistical analysis, time series analysis, large-scale text processing.** I also have experiences with **graph neural networks**, training **diffusion models** for visualization generation, and integrating state-of-the-art **large language models** with frontend/backend systems for language synthesis, text embedding and interactive visual analytics.

SKILLS

ML Frameworks: PyTorch, TensorFlow, HuggingFace, Scikit-Learn
Foundation Models: BLIP, LLaVA, DDPM, Stable Diffusion, LLAMA, GPT2, GPT4v, GPT4o
Frontend/Backend Development: D3, Bootstrap, Vue, Flask
Programming Languages: R, Python, JavaScript/CSS/HTML, C/C++, Docker
Data Science: SQL, MATLAB
Software Engineering: Git, CI/CD

EDUCATION

Sep. 2018 – Sep. 2024 (Expected)
PhD Candidate in Computer Science
University of California – Davis, United States
Advisor: Dr. Kwan-Liu Ma
Thesis: Visual Analytics Assistance to Interpreting, Analyzing and Improving Machine Learning Models

Sep. 2014 – Jun. 2018
Bachelor of Science in Mathematics and Applied Mathematics, Bachelor of Arts in English
Chu Kochen Honors College, Zhejiang University, Hangzhou, China
Advisor: Dr. Zhiyi Tan
Thesis: A Survey on Integer Programming Solvers in MATLAB and Python

Jun. 2017 – Sep. 2017
Exchange Undergraduate Researcher
University of California – Davis, United States
Advisor: Dr. Kwan-Liu Ma
Project: Uncertainty-Aware Visual Analytics of Dark Matter Simulation Data

Jun. 2016 – Sep. 2016
Exchange Undergraduate Student
Harvard University, United States

PROFESSIONAL EXPERIENCE

Sep. 2018 – Present
University of California – Davis
Graduate Research Assistant, with Dr. Kwan-Liu Ma
- Research on visual analytics for machine learning interpretability, model diagnosis and improvement.

Jun. 2023 – Sep. 2023
Visa Research
Research Internship, with Dr. Junpeng Wang
- Research on efficient image exploration and image caption steering using vision-language transformers.
- Development of a visual analytics system that integrates image and text exploration and steering.

Jun. 2022 –
Visa Research

Sep. 2022 *Research Internship, with Dr. Junpeng Wang*

- Research on interpretation of vision transformers and their large-scale attentions.
- Development of a visual analytics system enabling efficient exploration of attentions across heads in vision transformers.

Jun. 2017 – Sep. 2017 **University of California – Davis**

Summer Research Program, with Dr. Annie Preston and Dr. Kwan-Liu Ma

- Research on uncertainty visualization of dark matter simulations.
- Development of an approach quantifying uncertainty based on bootstrapping on small samples of simulation data.

PUBLICATIONS

2024 **Visual Analytics for Efficient Image Exploration and User-Guided Image Captioning**
Yiran Li, Junpeng Wang, Prince Aboagye, Chin-Chia Michael Yeh, Yan Zheng, Liang Wang, Wei Zhang, and Kwan-Liu Ma
TVCG *IEEE PacificVis TVCG Journal Track,* ***Acceptance Rate: 11.5% (15 out of 131)***

EHRFlow: A Visual Analytics Approach to Studying Healthcare professionals' Communication Effectiveness and Efficiency
Hsiao-Ying Lu, **Yiran Li**, and Kwan-Liu Ma
CHASE *IEEE/ACM CHASE 2024 Conference*

2023 **How Does Attention Work in Vision Transformers? A Visual Analytics Attempt**
Yiran Li, Junpeng Wang, Xin Dai, Liang Wang, Chin-Chia Michael Yeh, Yan Zheng, Wei Zhang, and Kwan-Liu Ma
TVCG *IEEE PacificVis Conference,* ***Best Paper Honorable Mention and published in TVCG***

Visual Analytics of Neuron Vulnerability to Adversarial Attacks on Convolutional Neural Networks
Yiran Li, Junpeng Wang, Takanori Fujiwara, and Kwan-Liu Ma
TIIS *ACM Transactions on Interactive Intelligent Systems, Special Issue on Human-Centered Explainable AI*

A Study of Healthcare Team Communication Networks using Visual Analytics
Hsiao-Ying Lu, **Yiran Li**, Brittany Garcia, Shin-Ping Tu, and Kwan-Liu Ma
ICMHI *ACM International Conference on Medical and Health Informatics*

2021 **A Visual Analytics System for Water Distribution System Optimization**
Yiran Li, Erin Musabandesu, Takanori Fujiwara, Frank J. Loge, and Kwan-Liu Ma
VIS *IEEE Visualization Conference (Short Paper)*

ChartStory: Automated Partitioning, Layout, and Captioning of Charts into Comic-Style Narratives
Jian Zhao, Shenyu Xu, Senthil Chandrasegaran, Chris Bryan, Fan Du, Aditi Mishra, Xin Qian, **Yiran Li**, and Kwan-Liu Ma
TVCG *IEEE Transaction on Visualization and Computer Graphics*

2020 **A Visual Analytics System for Multi-Model Comparison on Clinical Data Predictions**
Yiran Li, Takanori Fujiwara, Yong K. Choi, Kathering Kim, and Kwan-Liu Ma
Visual Informatics *IEEE PacificVis Conference (VisMeetsAI Workshop), published in Visual Informatics*

Comparative visual analytics for assessing medical records with sequence embedding
Rongchen Guo, Takanori Fujiwara, **Yiran Li**, Kelly M. Lima, Soman Sen, Nam K. Tran, and Kwan-Liu Ma
Visual Informatics *IEEE PacificVis Conference (VisMeetsAI Workshop), published in Visual Informatics*

Umbra: A Visual Analysis Approach for Defense Construction Against Inference Attacks on Sensitive Information
Xumeng Wang, Chris Bryan, **Yiran Li**, Rusheng Pan, Yang Liu, Wei Chen, and Kwan-Liu Ma
TVCG *IEEE Transaction on Visualization and Computer Graphics*

2018 **Visual Analysis of Simulation Uncertainty Using Cost-Effective Sampling**
Annie Preston, **Yiran Li**, Franz Sauer, and Kwan-Liu Ma
LDAV *IEEE Symposium on Large Data Analysis and Visualization*

AWARDS AND HONORS

2023, 2024 Spring Research Fellowship from the Graduate Group in Computer Science of UC Davis

2023 Best Paper Honorable Mention on IEEE PacificVis

2023 Research Fellowship for Spring 2023 from the Graduate Group in Computer Science of UC Davis

COMPUTER SKILLS

Programming Languages: Python, JavaScript/CSS/HTML, C/C++, MATLAB
Frontend/Backend Libraries: D3, Bootstrap, Vue, Flask
Machine Learning: PyTorch, TensorFlow

SERVICE AND OUTREACH

Program Committee

2023 Workshop on Visual Analytics in Healthcare (VAHC)

Conference and Journal Reviewer

2024 IEEE PacificVis TVCG Track Papers

2024 AAAI ICWSM

2023 IEEE VIS Full Papers

2023 IEEE PacificVis Full Papers

2023 ChinaVis Full Papers

2023 IEEE VIS VAHC Workshop

2022 ChinaVis Full Papers