Longju Bai

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Education

University of Michigan, Ann Arbor *Ann Arbor, MI*

M.S. in Electrical and Computer Engineering (Track: Signal and Image Processing and Machine Learning) *Sept 2022 - Current*

- **Selected Courses: (GPA: 3.75/4.0)** EECS 501 Probability and Random Processes, EECS 551 Matrix Methods, EECS 442 Computer Vision, EECS 553 Machine Learning, EECS 559 Optimization Methods, ROB 530 Mobile Robotics, ROB 535 Self-Drving Cars, EECS598 Causal Machine Learning

University of California, Los Angeles *Los Angeles, CA*

Summer School *Jun 2021 - Sep 2021*

- **Course:** ECE100: Electric and Electronic Circuits (A+)

Beijing Forestry University *Beijing, China*

B.S. in Electrical Engineering and the Automatization Speciality *Sep 2018 - Jun 2022*

- **Selected Courses: (GPA: 87.55/100)** Microcontroller(95), Java Development and Practice(92), C++ Program Design(93), Mathematical Modeling(97), Signal and System(93), Data Structure(99)

Research Experience

Annotations on a Budget: Leveraging Geo-Data Similarity to Balance Model Performance and Annotation Cost *COLING 2023*

Supervisor: Dr. Oana Ignat, Prof. Rada Mihalcea, University of Michigan, Ann Arbor *Aug 2023 - Oct 2023*

- **Research Objective:** Investigate methods to balance data representation in vision-language models by annotating images from underrepresented countries while minimizing annotation costs.
- Analyzed visual diversity across 52 countries and 94 topics using three visual representations: CLIP, BLIP-2, and ALIGN, to understand common topic distribution.
- Identified underrepresented countries and topics in the training data of vision-language models, suggesting areas for improved data collection.
- Utilized cosine similarity with CLIP representation to identify visually similar cross-country data, augmented the data from underrepresented countries with data samples from their most similar countries, demonstrated that this kind of data augmentation method improves performance of underrepresented countries.
- **Research Conclusion:** Successfully identified underrepresented countries and topics in vision-language model training data and demonstrated that supplementing data from visually similar countries can improve model performance while reducing annotation costs. The results and resources provided can guide future efforts in creating more inclusive and affordable vision-language models and datasets.

Balanced VQA: A Cause-Effect Look at multimodal Bias *EECS 598 Project*

Supervisor: Asst. Prof. Maggie Makar, University of Michigan, Ann Arbor *Sep 2023 - Dec 2023*

- Proposed an extension to Counterfactual VQA to improve VQA models by incorporating object detector to remove the visual bias confounder.
- Explored the potential of having distinct 'untreated' outputs for the three models (VA, QA, and VQA) in the system, training them separately to minimize Language and multimodal bias.
- Proposed "Multimodal Bias Analysis" by using Hilbert-Schmidt Conditional Independence Criterion (HSCIC). to monitor and identify both visual and language biases in VQA models.
- Proposed the method of using the HSCIC as a regularization penalty to improve the model performance

Implementation and Extension of Loc-NeRF for Real-time Monte Carlo Localization *EECS 568 Project*

Supervisor: Asst. Prof. Maani Ghaffari , University of Michigan, Ann Arbor *Feb 2023 - Apr 2023*

- **Research Objective:** Propose Loc-NeRF++, an adaptive vision-based robot localization approach that combines Monte Carlo localization and Neural Radiance Fields (NeRF).
- Reimplemented the Loc-NeRF real-time Monte Carlo localization method using PyTorch, as presented by MIT-SPARK Lab.
- Proposed an adaptive particle filter technique to adjust the number of particles used in the Monte Carlo localization method, which can better reflect the dynamic performance of robot localization.
- Scaled up localization to larger environments by leveraging bigger NeRF models and faster NeRF rendering techniques, which helped reduce computation time.
- Conducted experiments to evaluate the Position error, Rotation error, and Particle number curve of Loc-NeRF++ in different environments and compared it with Loc-NeRF.
- **Research Conclusion:** Implementation successfully improves the computational efficiency and capability of handling large environment without harming its localization performance.

Dynamic Neural Representation for Sparse CT Reconstruction

EECS 542 Project

Supervisor: Asst. Prof. JJ (Jeong Joon) Park, Prof. Stella X. Yu, University of Michigan, Ann Arbor

Sep 2023 - Present

- Developed a method to reconstruct high-quality 3D CT volumes from sparse inputs using deep generative models, aiming to reduce radiation exposure and scan times in medical imaging.
- Applied Dynamic Neural Radiance Fields (D-NeRF) for lung CT reconstruction from sparse inputs, customizing the model to accurately represent patient anatomy in CT volumes.
- Utilized the DIR-Lab 4D-CT dataset of lung scans, creating sparse 1% input sets for training the D-NeRF model.
- Conducted quantitative evaluations using Mean Absolute Error (MAE), Peak Signal-to-Noise Ratio (PSNR), and Structural Similarity Index (SSIM) to measure the reconstruction error against ground truth data, hypothesizing that D-NeRF can accurately reconstruct anatomy from up to 100x fewer scan perspectives than typical protocols.

Depth Prediction using Lite-Mono Architecture

EECS 442 Project

Supervisor: Prof. David Forhey , University of Michigan, Ann Arbor

Feb 2023 - Apr 2023

- **Research Objective:** It is usually possible to conduct a 3D mapping from multiple angles in applications such as autonomous vehicles using epipolar geometry, but with applications such as augmented reality, we often only have one angle - the camera on the phone. Hence, we would like to explore monocular depth prediction.
- Reimplemented the Lite-Mono architecture, as proposed in the paper by Ning Zhang et al., using PyTorch.
- Evaluated the performance of the model on two popular datasets with Depth Error and Depth Accuracy, DIODE and NYUv2, by predicting depth maps from RGB images.
- Experimented with various hyper-parameters and model configurations to refine the Lite-Mono architecture and enhance its performance on the depth prediction task. Investigated the impact of varying the number of CDC and LGFI modules, kernel size, and the number of filters in each layer.
- Explored the use of different optimization algorithms such as Adam or LAMB, and adjusted their learning rates for faster convergence and model iteration, tuned weight decay to achieve better generalization performance

Implementation and Evaluation of YOLO v5 and YOLO v8 for Object Detection

EECS 553 Project

Supervisor: Prof. Clayton Scott, University of Michigan, Ann Arbor

Feb 2023 - Apr 2023

- **Research Objective:** The YOLO algorithm has gained widespread popularity as an efficient and effective object detection model for real-time applications, such as autonomous vehicles, surveillance systems, and robotics. we hope to improve the precision and efficiency of YOLO algorithm in practical applications.
- Reimplemented YOLO v5 and YOLO v8, and validated the implementations using the COCO dataset.
- Conducted a comprehensive review of the development of YOLO v1 to YOLO v8 and summarized how the model evolved over time, discussing the changes in the model architecture, training techniques, and optimization strategies that contributed to the performance improvement.
- **Research Conclusion:** Add two attention mechanisms to YOLO v8: self-attention mechanism and a parameter free attention mechanism. The performance was on-par with the baseline, which means that the attention mechanism might add too much model complexity and capacity which is no needed for the COCO dataset.

Autonomous Vehicle Control Development

ROB 535 Project

Supervisor: Prof. Anouck Girard, University of Michigan, Ann Arbor

Feb 2023 - Apr 2023

- **Research Objective:** To design an autonomous vehicle control system.
- Built the vehicle's dynamics in MATLAB, fine-tuned the parameters of PID to achieve the best result of trajectory tracking.
- Built the basic framework of PID controller, wrote the code for obstacle avoidance, and calculated the final desired trajectory.

Root Segmentation and Quantification of Populus tremula based on Deep Learning

Undergraduate Thesis

Supervisor: Asst. Prof. Yue Zhao, Beijing Forestry University

Nov 2021 - Jun 2022

- **Research Objective:** Study the quantitative characteristics of plant root systems from root images.
- Applied various deep learning models including FCN, SegNet, DeepLabV3+, PSPNet, and U-Net, with different backbones such as MobileNet and ResNet, for semantic segmentation of root systems. Fine-tuned the hyperparameters such as learning rate, batch size, and dropout rate of the models for better accuracy and performance. And achieved the highest values among existing methods (Recall 0.83, Accuracy 0.79, F1 score 0.80), completed the analysis of the growth condition of sample trees in one year based on the results obtained from the extraction.
- Analyzed and evaluated plant growth condition based on the extracted data.

Reconfiguration Performance of Power System based on Genetic-Ant Colony Algorithm

Power System Design Project

Supervisor: Prof. Junguo Zhang, Beijing Forestry University

Mar 2021 - Jun 2021

- **Research Objective:** Enhance the reliability of the urban power grid system and decrease the economic loss due to power network faults.
- Proposed an upgraded Genetic-Ant Colony Algorithm (GACA) for restructuring the urban distribution system, combined GAs and ACAs to overcome the limitations of the local optimum of GAs and low convergence speed of ACAs.
- Examined the impact of different algorithms on the restoration and reconfiguration of the distribution system based on MATLAB system simulation, taking the IEEE33-node system as the research object and network loss, maximum recovery of the power-loss load, and the number of switching operations as objective functions.
- Conducted experimental analysis and compared the results of the proposed GACA with the current distribution system reconfiguration algorithm. The proposed algorithm (GACA) has higher algorithm time efficiency and solution accuracy and can markedly decrease the recovery time and improve the impact of the distribution system in a short period.

Internship Experience

Optimizing Data Acquisition and Processing in White Light Interferometry *Research Assistant*

Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences *Mar 2022 - May 2022*

- Design of electrical control for white light interferometer, equipment component selection, control program writing based on STM32, and circuit diagram drawing.
- Realized the data acquisition, output, and processing of the white light interferometer.
- Participated in the operation, maintenance, and management of laboratory equipment, equipment procurement, and research project applications.

Teaching Experience

C++ Program Design *Teaching Assistant*

Beijing Forestry University *Sep 2021 - Jan 2022*

- Guiding junior students in course projects.
- Answering questions after class and explaining exercises.

Publications

Annotations on a Budget: Leveraging Geo-Data Similarity to Balance Model Performance and Annotation Cost
Oana Ignat, Longju Bai, Joan Nwatu, Mihalcea Rada
Submitted to COLING, 2024

A fixed clustering protocol based on random relay strategy for EHWSN
Xianquan Luo, Chunjiong Zhang, Longju Bai
Digital Communications and Networks 9.1 (2023) pp. 90–100. Elsevier, 2023

Reconfiguration performance of the urban power distribution system based on the genetic-ant colony fusion algorithm
Longju Bai
E3S Web of Conferences, 2021

An Efficient Resource and Topological Attribute-Based Configuration Algorithm of Virtual Networks
Xinyan Wang, Shunbin Li, Longju Bai
Security and Communication Networks 2021 (2021) pp. 1–13. Hindawi Limited, 2021

Extracurricular Activities

Beijing Forestry University Computer Association As volunteer to troubleshoot and fix computer issues.
University of Michigan NLP Reading Group As paper presenter to present recent impactful NLP research papers.
2023 Ann Arbor Marathon Finisher
Bamboo Flute Certification Level 8

Awards

2021 **Academic Excellence Scholarship,** Beijing Forestry University *China*
2021 **Outstanding Student Scholarship,** Beijing Forestry University *China*

Skills

Machine Learning PyTorch, TensorFlow, Scikit-learn, Hugging Face, OpenCV
Programming C, C++, Python, Java, Julia, Matlab, Assembly language
Statistical Pandas
Language Chinese (Native Level), English (GRE: 332, Verbal: 162, Quantitative: 170, AW: 4.0), Japanese (Beginner)
Others AWS, ROS, Linux, Matlab (Simulink), SolidWorks, AutoCAD, SLAM

Academic Activities

Michigan AI symposium

Oct 2023

- Participate in poster presentation with the latest research project
- Listening to the talk presented by Asst. Prof. Michael Bernstein: Generative Agents: Interactive Simulacra of Human Behavior
- Listening to the talk presented by Prof. Alexei “Alyosha” Efros: Understanding your data as the first step toward Responsible Responsible AI