Yuxin Yao

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Education

University of Cambridge — Cambridge, UK
PhD in Engineering — September 2023 - Present
- Research about Computer Vision and Geometric Deep Learning.

University College London — London, UK
MEng Mathematical Computation — September 2019 - June 2023
- First Class Honours

Publications

- Hockey, C., **Yao, Y.**, Lasenby, J. **Simplifying and Generalising Equivariant Geometric Algebra Networks**. The 9th conference on Applied Geometric Algebras in Computer Science and Engineering (*Abstract accepted*)
- Yan, Y., Schaffter, T., Bergquist, T., ...**Yao, Y.**.,... DREAM Challenge Consortium. (2021). **A Continuously Benchmarked and Crowdsourced Challenge for Rapid Development and Evaluation of Models to Predict COVID-19 Diagnosis and Hospitalization.** JAMA network open, 4(10), e2124946-e2124946.

Technical Skills

- **Programming**: Proficient in Python (5 years), PyTorch (4 years), Numpy, Scipy, Pandas, Scikit-learn, and TensorFlow.
- **Deep Learning**: Experienced with Transformers, U-Nets, Autoencoders, diffusion models (including custom training with Hugging Face).
- 3D **Vision**: Skilled in 4D reconstruction, Gaussian splatting, and Colmap for SLAM tasks. Proficient in working with the SMPL-X human body model and tools like Blender and CloudCompare.

Research Experience

Video-to-4D Reconstruction and Novel View Synthesis — June 2024 - Present
University of Cambridge — Department of Engineering

- **Dynamic 4D Reconstruction**: Developed free-viewpoint Gaussian splatting for 4D reconstruction in realistic video scenes, incorporating semantic segmentation and depth estimation for moving objects.
- **Diffusion Guided Novel View Synthesis**: Applied Score-Distillation Sampling (SDS) loss with pretrained generative models, including stable video diffusion and view-conditioned image generation, to refine Gaussian splatting.
- **Camera Pose Estimation**: Engineered efficient batch camera pose estimation using Gaussian splattings, achieving or surpassing SOTA performance in handling videos with moving objects in specific scenarios.
- **Dynamic Motion Modeling**: Modelled dynamic object motions with motion field applied with deep neural network using PyTorch. Optimized the motion field with prior knowledge of the semantics of the video.

Simplified and Generalized Geometric Algebra Network — November 2023 - April 2024
University of Cambridge — Department of Engineering

- **Developed CGATr**: A novel transformer architecture Simplifeid and Generalized Geometric Algebra Transformer(CGATr) leveraging geometric deep learning with Geometric Algebra, improving on Geometric Algebra Transformer by removing constraints and achieving superior results.

- **Tensorflow Implementation**: Built CGATr using TensorFlow's TFGA module, generalizing it to all dimensional spaces, and simplified distance-aware dot attention with sigmoid-gated non-linearity to preserve equivariance and enhance performance.
- **Better Performance with Lower Cost**: Achieved 30–50% better performance with fewer parameters: Distance Map MAE of 1.79 for protein structure prediction and 0.0016 MSE on N-body simulation with just 5,000 parameters (2% of GATr parameters).

Geometric Algebra in Geometric Transform Attention Feburary 2024 - June 2024
University of Cambridge Department of Engineering

- **Improved Novel View Synthesis**: Reduced LPIPS loss by 2% using Geometric Deep Learning Transformers and Clifford Group Equivariant neural networks.
- **Refined Attention Mechanisms**: Applied geometric layers to transform attention blocks, optimizing input embeddings to capture relative geometric transformations between tokens.

Unsupervised Visual Relocalization - Deep Learning September 2022 - May 2023
University College London Department of Computer Science

- **Eexpertise in 3D transformations**: Applied SE3 transformations to 3D point clouds and inferred 3D world points using RGB images, depth maps, and extrinsic matrices via the pinhole camera model.
- **Constructed U-Net models**: Designed networks to infer feature maps and saliency maps from 2D images, extracting critical features and masking moving objects.
- **Optimized image alignment**: Utilized direct image alignment with Gauss-Newton optimization to determine relative transformations between query and reference images.

Human Motion Prediction on Egocentric Dataset July 2022 - August 2022
ETH Zurich Computer Vision and Learning Group

- **Human Motion Analysis with Deep Learning**: Applied SMPL and SMPL-X models with AMASS and EgoBody datasets to train body regressors and marker predictors using advanced deep learning architectures, including conditional VAEs with DLow and GRU.
- **Motion Prior Training**: Trained motion priors on the EgoBody dataset, predicting robust future human motions in egocentric social interaction scenarios.
- **Long-Term Motion Generatio**n: Utilized roll-out training techniques with extended motion sequences to improve the stability and reliability of deep learning models for long-term motion prediction.

Covid-19 Prediction with Large Scale Dataset June 2020 - August 2020
University College London Department of Computer Science

- **COVID-19 Prediction**: Utilized random forests and feature engineering to predict COVID-19 test results, achieving an AUROC of 0.83.
- **Clinical Data Management**: Processed and optimized large-scale clinical datasets with vectorization, achieving a 90% speed-up in preprocessing workflows.
- **Docker**: Deployed and containerized testing scripts using Docker for streamlined submission workflows.
- **Publication**: Co-authored a paper published in JAMA Network Open showcasing the development and analysis of the machine learning model.

Conference and Seminar Experience

- Contributed Talk: Simplifying and Generalising Equivariant Geometric Algebra Networks *Aug 2024*
  9th conference on Applied Geometric Algebras in Computer Science and Engineering (Amsterdam, NL)