Yunzhe Wang

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Research Interests

Robotics, Representation Learning, Computer Vision, Natural Language Processing, Speech Recognition, Reinforcement Learning, Machine Learning, Artificial Intelligence

Education

Columbia University **New York, NY**

- Master of Science in Computer Science (in progress) **GPA: 3.83** Sep 2021 – Present
  - Related Coursework: Advanced Algorithms, Introduction to Database, Machine Learning, Natural Language Processing, Network and Crowds, Reinforcement Learning for Information Systems, Computer Networks

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

- Bachelor of Science in Computational Neuroscience **GPA: 3.84** Aug 2017 – May 2021
  - Related Coursework: Cognitive Psychology, Neurobiology, Sensation and Perception, Cellular and Molecular Neuroscience, Brain Architecture, General Biology, General Chemistry, Physics: Mechanics and Thermodynamics, Physics: Electricity and Magnetism
- Bachelor of Art in Applied and Computational Mathematics **GPA: 3.84** Aug 2017 – May 2021
  - Related Coursework: Statistics, Probability Theory, Applied Combinatorics, Mathematics of Machine Learning, Numerical Methods, Mathematical Optimization, Calculus, Linear Algebra, Differential Equations
- Minor in Computer Science Aug 2017 – May 2021
  - Related Coursework: Introduction to Artificial Intelligence, Introduction to Robotics, Algorithms and Theory of Computing, Applied Machine Learning for Games, Data Structure, Discrete Mathematics, Web Development

Publications

1. Yuhang Hu, Yunzhe Wang, Boyuan Chen, Yingke Wang, Jiong Lin, Hod Lipson
   Lip synchronization for Animatronic Robot Face
   In preparation at Nature (**Nature**), 2022
2. Yuhang Hu, Boyuan Chen, Jiong Lin, Yunzhe Wang, Yingke Wang, Cameron Mehlman, Hod Lipson
   Human-Robot Facial Simexpression
   In preparation at Science Robotics (**Science Robotics**), 2022
3. Yunzhe Wang, Nikolos Gurney, Jincheng Zhou, David V Pynadath, Volkan Ustun
   Neural Heuristics for Route Optimization in Service of a Search and Rescue Artificial Social Intelligence Agent
   Association for the Advancement of Artificial Intelligence 2021 Fall Symposium Series: Computational Theory of Mind for Human-Machine Teams (**AAAI-FSS**), 2021

Research Experience

Emotion Stylizable Talking Face Generation (Ongoing)
Creative Machines Lab, Columbia University Aug 2022 – Present
Supervisor/Mentor: **Prof. Hod Lipson**

- Developed a generative model that synthesize facial landmark movements synching up with a given speech audio wav. The model can *zero-shot learning* to unknown speakers and languages.
- Applied self-supervised representation learning to disentangle speech audio signal into content representation and prosody (emotion) representation via *information bottleneck*.
- Aiming to stylize talking emotion by controlling the prosody representation and synthesize photo-realistic videos of talking faces with authentic lips movement, facial expression, and head poses

Meta Self-Model: A Single Model That Can Control over 1024 Differently Configured Legged Robot in Simulation (Ongoing)
Creative Machines Lab, Columbia University Jun 2022 – Present
Supervisor/Mentor: **Prof. Hod Lipson**

- Developed a single model that can predicts the future states (position, orientation, and joint angles) of 1024 differently configured legged robots each with 12 degree of freedom (4 legs each 3 joints), giving robots a sense of self-configuration and motion dynamics.
- Given forward baseline motion, I optimize the trajectories by applying *Beam Search* with added action noise, which improves robots' performance in forward baseline motion and could perform unlearned tasks such as turning and backward movement with custom reward function.
- Conducted a comprehensive literature review on Point Cloud Representation/Classification
- Designed *Multi-Tasks Learning (MTL)* Objectives and *Auxiliary Tasks* to automatically balance training tasks difficulties

Lip synchronization for Animatronic Robot Face
Creative Machines Lab, Columbia University Sep 2021 – Aug 2022
Supervisor/Mentor: **Prof. Hod Lipson**

- Designed and created a pipeline that can generate facial landmarks (lips and holistic facial expression) synchronized with a given speech audio. The landmarks are then converted into robot face motor commands via an inverse model.
- The pipeline supports real-time inference and *zero-shot learn* to unknown languages and speakers
- Pretrained an *Autoregressive Predictive Coding (APC)* model for speech audio embedding
- Data Processing of the *VoxCeleb2 Dataset* (Landmark extraction, speech enhancing, landmark alignment, etc.)

Human-Robot Facial Simultaneous Expression
Creative Machines Lab, Columbia University Sep 2021 – Aug 2022
Supervisor/Mentor: **Prof. Hod Lipson**

- Developed a predictive model that anticipates human facial expression changes thereby realizing simultaneous human facial expression mimicking (Simexpression).
- Attempted various facial landmark alignment techniques (rotation and scaling, affine alignment, 3D alignment by shifting viewing frustum)
- Extracted facial landmarks and applied *Head Pose Estimation* to remove lateral faces

Route Optimization in Service of a Search and Rescue Artificial Social Intelligence Agent
Institute for Creative Technologies, University of Southern California Jul 2020 – Sep 2021
Supervisor/Mentor: **Prof. Paul Rosenbloom and Dr. Volkan Ustun**

- Investigated various *Graph Transformer* models for efficiently and approximately solving route optimization problems such as *Travelling Salesman Problem (TSP)* and *Capacitated Vehicle Routing Problem (CVRP)*.
- Designed a *Coorperative Multi-Agent Reinforcement Learning* system where agents with different roles and capabilities use the said *Graph Transformer* models as the oracle to get approximately optimal paths and coorperate to solve a Search-and-Rescue task in a Minecraft environment.
- Developed a *Markov Decision Process (MDP)* Semantic Graph environment to simulate search and rescue tasks and conduct deep reinforcement learning experiment with *Proximal Policy Optimization (PPO)* on the environment for route optimization
- Devised *Mixed-Integer Programming (MIP)* Solutions to Discounted Reward Travelling Salesman Problem for Search and Rescue Tasks

PySigma Cognitive Architecture
Institute for Creative Technologies, University of Southern California May 2020 – Jul 2020
Supervisor/Mentor: **Prof. Paul Rosenbloom and Dr. Volkan Ustun**

- Unit Testing and front-end development to PySigma Cognitive Architecture
- Literature review on message-passing inference algorithms for probabilistic graphical models.

Chinese Part of Speech Tagging Error Correction
Institute of Computing Technology, Chinese Academy of Sciences May 2019 – Aug 2019
Supervisor/Mentor: **Prof. Cungen Cao**

- Developed a Rule-Based Expert System that corrects *Chinese Part of Speech (POS)* Tagging errors made by neural language models.
- Designed a pipeline that discovers new POS tagging rules based on similarity analysis between the POS tagging results from Stanford CoreNLP and NLPIR-ICTCLAS POS Tagging System

Teaching Experience

Natural Language Processing (Teaching Assistant) Summer 2022
Natural Language Processing (Teaching Assistant) Fall 2022

Awards & Honors

USC Graduate with Distinction (Magna Cum Laude) May 2021
USC Academic Achievement Award Spring 2021
USC Dornsife Dean's List Fall 2020
USC Dornsife Dean's List Spring, Fall 2019
USC Dornsife Dean's List Spring, Fall 2018
USC Dornsife Dean's List Fall 2017

Skills

- Programming Languages: Python, C++, Java, SQL, MATLAB, Julia, JavaScript/TypeScript, HTML/CSS
- Packages & Tools: NumPy, Pandas, scikit-learn, PyTorch, TensorFlow, LaTeX, ffmpeg