Yunzhe Wang

MSCS Student, Columbia University
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Research Interests

Robot Learning/Perception, Computer Vision, Representation Learning, Natural Language Processing, Reinforcement Learning, Machine Learning, Human-Centered Artificial Intelligence

Education

Columbia University – GPA: 3.89/4.0 **New York, NY**

- Master of Science in Computer Science Sep 2021 – Present
  - Related Coursework: Machine Learning, Unsupervised Learning, Natural Language Processing, Reinforcement Learning, Advanced Algorithms, Introduction to Database, Computer Networks, Network and Crowds

University of Southern California – GPA: 3.83/4.0 **Los Angeles, CA**

- Bachelor of Art in Applied and Computational Mathematics Aug 2017 – May 2021
  - Related Coursework: Statistics, Probability Theory, Mathematical Optimization, Numerical Analysis, Applied Combinatorics, Mathematics of Machine Learning, Differential Equations, Linear Algebra, Calculus
- Bachelor of Science in Computational Neuroscience Aug 2017 – May 2021
  - Related Coursework: Cognitive Neuroscience, Sensation and Perception, Neurobiology, Brain Architecture, Cellular and Molecular Neuroscience, General Biology, General Chemistry, Physics: Mechanics and Thermodynamics, Physics: Electricity and Magnetism
- 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, Blockchain

Publications

1. Yuhang Hu, Yunzhe Wang, Boyuan Chen, Yingke Wang, Jiong Lin, Hod Lipson
   Lip synchronization for Animatronic Robot Face
   In Preparation at Science Robotics (**Science Robotics**), 2022
2. Yuhang Hu, Boyuan Chen, Jiong Lin, Yunzhe Wang, Yingke Wang, Cameron Mehlman, Hod Lipson
   Human-Robot Facial Co-expression
   In Preparation at Nature (**Nature**), 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
   Accepted to Association for the Advancement of Artificial Intelligence 2021 Fall Symposium Series: Computational Theory of Mind for Human-Machine Teams (**AAAI-FSS**), 2021

Research Experience

Learning Robot Morphology Representation from Kinematic Data
Creative Machines Lab, Columbia University Jun 2022 – Present
Supervisor/Mentor: **Prof. Hod Lipson**

- Developed a multiclass-multioutput classifier with seven prediction heads that predicts the morphology coding of a 12-DoF quadruped robots given its dynamics, which is represented as multinomial timeseries of robot states. The robot's structure can be configured in countless ways.
- Experimented with various encoding architectures such as *Transformer*, *CNN*, and *PointNet*, with data representation as raw timeseries, spectrograms, and independent points respectively.
- Developed a *Variational Auto-Encoder* and modeled robot generation via controlling latent space.
- Experimented with future-prediction *Self-Supervised Learning* to pre-train representation.
- Collaborated with three mechanical engineering students in discussing possible Sim-to-Real limitations to design data-collection strategies within hardware constraints.
- Applied the trained representation to *Model Predictive Control* robots with unseen morphology.
- Designed *Multi-Tasks Learning* Objectives and *Auxiliary Tasks* with tasks difficulty automatic balancing mechanism to improve performance.

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

- Developed a deep regression model, Audio2Landmark, that generates lip-synced facial landmark movements given speech audio alone in real-time. Applied the model to lip-sync a face robot.
- Self-Supervisely pre-trained a speech embedding model using *Autoregressive Predictive Coding (APC)*, improving data generalization ability to unseen speakers and languages.
- Preprocessing of the *VoxCeleb2* Dataset (speech enhancement, landmark extraction & alignment).
- Experimented with various facial landmark normalization techniques (rotation and scaling, affine alignment, and 3D alignment by shifting viewing frustum)
- Applied Head Pose Estimation to score training data difficulty for curriculum learning.
- Surveyed *NeRF*-like rendering techniques for taking face video generation.

Route Optimization on Graphs Using Reinforcement Learning
Institute for Creative Technologies, University of Southern California Jun 2020 – Sep 2021
Supervisor/Mentor: **Dr. Volkan Ustun**

- Applied *Graph Transformer* models and reinforcement learning for efficiently and approximately solving route optimization problems such as the *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 to solve a Search-and-Rescue task in a Minecraft environment.
- Developed a Markov Decision Process Semantic Graph environment for abstraction and conducted deep reinforcement learning experiment with *Proximal Policy Optimization (PPO)* on the environment for route optimization.
- Devised *Mixed-Integer Programming (MIP)* Solutions for the task.
- Proposed and applied Multi-dimentional Scaling (MDS) and Johnson–Lindenstrauss Transform (JLT) to turn pairwise distances into Euclidian points.
- First author paper accepted to AAAI 2021 Fall Symposium Series (peer reviewed)

(Py)Sigma Cognitive Architecture
Institute for Creative Technologies, University of Southern California Mar 2020 – Jun 2020
Supervisor/Mentor: **Dr. Volkan Ustun and Prof. Paul Rosenbloom**

- Unit Testing and front-end development to the (Py)Sigma Cognitive Architecture
- Surveyed various message-passing inference algorithms for probabilistic graphical models.

Teaching Experience

Applied Computer Vision (Course Assistant) Spring 2023
Introduction to Natural Language Processing (Course Assistant) Fall 2022
Introduction to Natural Language Processing (Course Assistant) Summer 2022

Awards & Honors

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

Technical Skills

- Expert in: Python, PyTorch, scikit-learn, NumPy, Matplotlib, PyBullet, LaTeX
- Comfortable with: C++, MATLAB, Java, TensorFlow, pandas, OpenCV, nltk, librosa, NetworkX
- Other Research Skills: Web Scraping, Web Development, Linux, Video Editing,