

Yunzhe Wang

MSCS Student, Columbia University

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Research Interests

Robot Learning, Representation Learning, Computer Vision, Reinforcement Learning, Machine Learning, Artificial Intelligence

Education

Columbia University

New York, NY

- Master of Science in Computer Science **GPA: 3.83** 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

Los Angeles, CA

- Bachelor of Art in Applied and Computational Mathematics **GPA: 3.83** 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 **GPA: 3.83** Aug 2017 – May 2021
 - Related Coursework: Cognitive Psychology, 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
Submitted to Nature (**Nature**), 2022
2. Yuhang Hu, Boyuan Chen, Jiong Lin, Yunzhe Wang, Yingke Wang, Cameron Mehlman, Hod Lipson
Human-Robot Facial Simexpression
Submitted to 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
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

Representation Learning of Robot Dynamics for Morphology Prediction

Creative Machines Lab, Columbia University

Jun 2022 – Present

Supervisor/Mentor: **Prof. Hod Lipson**

- Developed a multiclass-multioutput classification model that predicts the morphology of a 12-DoF quadruped robots given its dynamics, which is represented as multinomial timeseries of robot position, and joint angles. The robot's structure can be configured in countless ways.
- Experimented with various encoding architectures such as *Transformer*, *ResNet*, and *PointNet*, treating data as raw timeseries, spectrograms, and independent points respectively.
- Developed a *Variational Auto-Encoder* and modeled the latent space to control robot generation.
- Employed future-prediction self-supervised learning to pre-train representation.
- Collaborated with three mechanical engineering students to design data-collection strategies avoiding 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.

Lip synchronization for 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. Applied the model to lip-sync a face robot.
- Pre-trained a speech embedding model using *Autoregressive Predictive Coding* (APC), improving data generalization ability.
- 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.
- Second author paper submitted to *Nature*.

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 *Cooperative 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 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.
- Proposed and applied Multi-dimensional 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)

PySigma 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 (Py)Sigma 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 NLPRI-ICTCLAS POS Tagging System

Teaching Experience

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: presentation, Linux, video editing, web scraping, web development

References

Hod Lipson (Research Director/Supervisor)

- Professor of Engineering and Data Science
- Columbia University
- (607) 592-4383
- hod.lipson@columbia.edu

Kathleen McKeown (Course Instructor)

- Professor of Computer Science
- Columbia University
- (212) 939-7118
- kathy@cs.columbia.edu

Volkan Ustun (Research Director/Supervisor)

- Director of Cognitive Architecture
- USC Institute for Creative Technologies
- ustun@ict.usc.edu