

# Yunzhe Wang

MSCS Student, Columbia University

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## Research Interests

Robot Learning, Computer Vision, Representation Learning, Natural Language Processing, Reinforcement Learning, Fairness, Machine Learning, Artificial Intelligence

## Education

### **Columbia University**

**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**

**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 Nature (**Nature**), 2022
2. Yuhang Hu, Boyuan Chen, Jiong Lin, Yunzhe Wang, Yingke Wang, Cameron Mehlman, Hod Lipson  
*Human-Robot Facial Co-expression*  
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*  
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

### **Robot Dynamics Representation Learning for Morphology Prediction**

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-Supervisedly 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.
- Experimented with talking face video rendering through *NeRF*.

### **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 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-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)

## **(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
- Literature review on message-passing inference algorithms for probabilistic graphical models.

## 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: Web Scraping, Web Development, Linux, Video Editing,

## References

Hod Lipson (Research Director/Supervisor)

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Volkan Ustun (Research Director/Supervisor)

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