Menoua Keshishian

menoua.github.io | GitHub | LinkedIn | Google Scholar | menoua.k@columbia.edu

RESEARCH INTERESTS

Deep Learning, Speech Understanding, Digital Signal Processing (Biomedical, Audio), Neuroscience

EDUCATION

COLUMBIA UNIVERSITY | Graduate School of Arts and Sciences — New York, NY
MS/PhD in Electrical Engineering, Cumulative GPA: 4.07/4.00 — Sep 2017 — Expected Dec 2023

SHARIF UNIVERSITY OF TECHNOLOGY | School of Electrical Engineering — Tehran, Iran
BS in Electrical Engineering, Minor in Computer Science — Sep 2012 — Jul 2017

SKILLS

General - Research, Data Science, (Neural) Signal Processing, Software Engineering, Linear Algebra
Programming - Python, MATLAB, Rust, Java, C++, Bash, HTML/CSS, LaTeX
Machine Learning - Deep Learning, Automatic Speech Recognition, Natural Language Processing, Unsupervised Learning, Large Language Models, Developing custom networks and loss functions
ML Frameworks - NumPy, Pandas, Scikit-learn, PyTorch, TensorFlow, Hugging Face Transformers
Algorithms & Data Structures - Time and Space Complexity Analysis, Dynamic Programming, Recursion, BFS, DFS, Hash Function, Combinatorics, Heaps, Trees, Graphs, etc.

EXPERIENCE

COLUMBIA UNIVERSITY | Graduate Researcher — New York, NY
Advisor: Dr. Nima Mesgarani — Sep 2017 — Present

Interpretable modeling of speech processing in auditory cortex

- Developed a method to interpret the nonlinear mechanisms of neural processing of speech in the human auditory cortex using convolutional neural networks
- *Research areas: computational neuroscience, deep learning, neural network function analysis*

Temporal context analysis of black-box time-series models

- Developed a method to measure how much temporal context a time-series model uses to calculate its response to stimuli, based on a method originally devised for studying biological neurons
- *Research areas: deep learning, automatic speech recognition, temporal processing, neural network function analysis*

Open source neural data processing toolbox

- Collaborated in developing a neural data processing toolbox in python for time-series neural data
- *Research areas: neuroscience, signal processing, signal filtering, data preprocessing, open source toolbox*

Characterizing linguistic components in spoken word recognition

- Calculated where and how well different levels of linguistic information of speech are represented throughout the speech processing pathway
- *Research areas: auditory neuroscience, linguistics, neurolinguistics, linear regression, representation analysis*

Modeling spoken word recognition with automatic speech recognition

- Modeled the biological speech processing pathway with end-to-end trained speech recognition model (RNN-Transducer)
- Calculated where and how well different levels of linguistic information of speech are represented throughout the layers of the RNN-Transducer
- *Research areas: neuroscience, linguistics, speech recognition, neural network representation analysis*

INST. FOR RESEARCH IN FUNDAMENTAL SCIENCES | Research Assistant — Tehran, Iran
Advisor: Dr. Reza Lashgari — Oct 2016 — Jul 2017

- Analyzed similarities of features extracted from simultaneously recorded local field potential (LFP) and single unit activity (SUA) signals in primary visual cortex of macaque monkeys
- *Research areas: visual neuroscience, signal processing, feature extraction*

ACADEMIC HONORS AND AWARDS

COLUMBIA UNIVERSITY — New York, NY

MS Award of Excellence (awarded to fewer than 5% of the EE MS candidates) — 2020
MS Armstrong Memorial Award (awarded to one outstanding EE MS candidate) — 2019

MISCELLANEOUS — Tehran, Iran

33rd place in Iran's National University Entrance Exam (top 0.01%) — 2012
Bronze medal in Iran's National Computer Olympiad — 2011

PUBLICATIONS

JOURNALS

Gavin Mischler, Vinay Raghavan, Menoua Keshishian, Nima Mesgarani. "**naplib-python: Neural Acoustic Data Processing and Analysis Tools in Python**." *Software Impacts (2023)*

Menoua Keshishian, Serdar Akkol, Jose Herrero, Stephan Bickel, Ashesh D Mehta, Nima Mesgarani. "**Joint, distributed and hierarchically organized encoding of linguistic features in the human auditory cortex**." *Nature Human Behaviour (2023)*

Gavin Mischler, Menoua Keshishian, Stephan Bickel, Ashesh D Mehta, Nima Mesgarani. "**Deep neural networks effectively model neural adaptation to changing background noise and suggest nonlinear noise filtering methods in auditory cortex**." *NeuroImage (2023)*

Menoua Keshishian, Hassan Akbari, Bahar Khalighinejad, Jose Herrero, Ashesh D Mehta, Nima Mesgarani. "**Estimating and interpreting nonlinear receptive field of sensory neural responses with deep neural network models**." *eLife (2020)*

CONFERENCES

Menoua Keshishian, Sam Norman-Haignere, Nima Mesgarani. "**Understanding Adaptive, Multiscale Temporal Integration In Deep Speech Recognition Systems**." *Advances in Neural Information Processing Systems 34 (NeurIPS 2021)*

OPEN SOURCE CODE

Dynamic spectro-temporal receptive field analysis — github.com/naplab/DSTRF
A python library for dynamic spectro-temporal receptive field (dSTRF) analysis, an interpretable method for modeling stimulus-response mapping of biological neurons using feed-forward neural networks

Temporal context invariance analysis github.com/naplab/PyTCI
A python library for measuring the amount of temporal context used by black-box time-series models, and how it changes based on the properties of the stimulus

Neural data processing toolbox github.com/naplab/naplib-python
A python library for preprocessing, storing and analyzing time-series neural data (EEG/iEEG) aiming to facilitate research in the field of auditory neuroscience

Cognitive/behavioral experiments github.com/menoua/cog-task
A (experimental) low-latency and cross-platform GUI application written in Rust that allows the user to define and execute a wide range of audiovisual stimulus presentation and behavioral tasks, organized in a tree-based ordering system, useful for cognitive neuroscience research

TEACHING EXPERIENCE

COLUMBIA UNIVERSITY | Teaching Assistant — New York, NY
Quantum Computing and Communication, Dr. Alexei Ashikhmin — Fall 2021
Sparse & Low-dimensional Models for High-dimensional Data, Dr. John Wright — Spring 2021

SHARIF UNIVERSITY OF TECHNOLOGY | Teaching Assistant — Tehran, Iran
Advanced Programming, Dr. Matin Hashemi — Spring, Fall 2016
Principles of Electronics, Dr. Mohammad Fakharzadeh — Spring, Fall 2015— 2016
Computer Architecture, Dr. Matin Hashemi — Spring 2016

REFERENCES

DR. NIMA MESGARANI | Associate Professor
Columbia University, Department of Electrical Engineering
nima@ee.columbia.edu

SELECTED COURSE PROJECTS

COLUMBIA UNIVERSITY — New York, NY

Speech & Audio Processing - Trained a CNN for instrument activity detection in polyphonic music
Natural Language Processing - Trained an LSTM for abstractive text summarization
Sparse & Low-dim Models for High-dim Data - Modeled dynamics of neural speech processing with convolutional sparse coding in MATLAB
Probabilistic Machine Learning - Modeled dynamics of neural speech processing using a Kalman filter with external inputs using the Pyro probabilistic programming library
Brain Computer Interfaces (BCI) Lab - Developed an online system to classify imagined hand movement from electroencephalography (EEG) with common spatial pattern (CSP) filters
Consciousness & Attention - Wrote a review paper: "On the Prospects of Artificial Consciousness"
Intro to Genomic Information Science - Trained a ResNet model to classify mixed patterns of proteins in confocal microscopy images of cells (a Kaggle competition)

SHARIF UNIVERSITY OF TECHNOLOGY — Tehran, Iran

Advanced Programming - Developed a database management system (DBMS) in Java with desktop, web, and Android interfaces
Microprocessors - Wrote a MATLAB-like matrix manipulation program in 8086 assembly
Operating Systems - Created a custom shell for Linux in C