Irina Tolkova

https://avokloti.github.io/
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Summary

I am an **Edward W. Rose Postdoctoral Scholar** working with the **K. Lisa Yang Center for Conservation Bioacoustics** at the **Cornell Lab of Ornithology**. As a graduate student at Harvard, I conducted interdisciplinary research incorporating optimization, machine learning, and robotics. Later in my PhD, I transitioned to adapting techniques from these fields for the development of **conservation technology**. I am now working on improving **automated passive acoustic monitoring** of vocal wildlife, with a particular focus on the development and implementation of robust methods for **sound source separation and localization**. I'm also interested in broader applications of technology for sustainability and social impact.

Postdoctoral Fellow 2023-
Advised by Prof. Holger Klinck
K. Lisa Yang Center for Conservation Bioacoustics, Cornell Lab of Ornithology, Cornell University (Ithaca, NY)

Education

Harvard University (Cambridge, MA) 2017-2023
Advised by Prof. L Mahadevan and Prof. Scott Kuindersma
PhD in Applied Mathematics
MS in Applied Mathematics

University of Washington (Seattle, WA) 2012-2017
BS in Applied and Computational Mathematical Sciences
BS in Computer Science with Honors

Work Experience

Software Engineering Intern at MathWorks Summer 2021

- Working with the Control Design and Reinforcement Learning teams, prototyped data-driven learning of Koopman embeddings for simulation and control of nonlinear dynamical systems (*MATLAB Deep Learning Toolbox, Model Predictive Control*).

Research Intern at the Honda Research Institute Summer 2020

- As part of HRI's Curious Minded Machines program, designed and evaluated structured latent representations of high-dimensional environments. Then, formalized and implemented curious exploration for RL agents (*disentangled VAEs, contrastive learning*, *OpenAI Gym, PyTorch, Stable Baselines*).

Ongoing Research

In collaboration with Marissa Garcia, implemented time-difference-of-arrival-based association and statistical modeling for acoustic abundance estimation of North Atlantic right whales (Cape Cod Bay, MA, USA). *Manuscript in preparation.*

Utilizing a co-located tetrahedral microphone array, developed a sound source separation and tracking algorithm, and demonstrated improved species-level classification performance with BirdNET in complex natural environments. *Manuscript in preparation.*

Designed and implemented an interactive interface for time-difference-of-arrival-based synchronization and localization of hydrophone array data, with the aim of assessing the spatiotemporal distribution of Cuvier's beaked whales (offshore Guam, USA).

In collaboration with Dr. Jordan Kennedy of Indigenous Led, deployed 10 SwitfOne units for passive acoustic monitoring of ecosystem biodiversity following a reintroduction of American bison (Chief Mountain region, Blackfeet Reservation, MT, USA).

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Publications

* *indicates equal contribution*

Tolkova, I. (2023). Acoustic Source Separation, Contour Classification, and Trajectory Optimization. *Doctoral dissertation, Harvard University*.

Marantan, A.*, **Tolkova, I**.*, Mahadevan, L. (2023). Image cognition using contour curvature statistics. *Proceedings of the Royal Society A*, *479*(2274), 20220662.

Swaminathan S*, **Tolkova I***, Baker L, Revi DA, Awad L, Walsh C, Mahadevan L. (2022). "A Continuous Statistical-Geometric Framework for Normative and Impaired Gaits." *Journal of the Royal Society Interface.*

Tolkova I, Klinck H (2022). "Source Separation with an Acoustic Vector-Sensor for Terrestrial Bioacoustics." *The Journal of the Acoustical Society of America*, 152(2), 1123-1134.

Cram DL, van der Wal J, Uomini N, …. **Tolkova I** (co-author 37/42)… (2022). "The Ecology and Evolution of Human-Wildlife Cooperation". *People and Nature.*

van der Wal J, Spottiswoode C, Uomini N, …. **Tolkova I** (co-author 38/43)… (2022). "Safeguarding Human-Wildlife Cooperation". *Conservation Letters.*

Chandra J*, Muthupalaniappan S*, Shang Z*, Deng R*, Lin R, **Tolkova I**, Butts D, Sul D, Marzouk S, Bose S, Chen A (2021). "Screening of Parkinson's Disease Using Geometric Features Extracted from Spiral Drawings". *Brain Sciences.*

Tolkova I*, Chu B*, Hedman M*, Kahl S, Klinck H (2021). "Parsing Birdsong with Deep Audio Embeddings." AI for Social Good Workshop, *IJCAI 2021*.

Tolkova I (2021). "Feature Representations for Conservation Bioacoustics: Review and Discussion." AI for Social Good Workshop, *IJCAI 2021*.

Ciannelli L, **Tolkova I**, Lauth R, Puerta P, Helser T, Gitelman A, Thompson G (2019). "Spatial, Interannual, and Generational Sources of Trait Variability in a Marine Population." *Ecology*.

Torres LG, Orben RA, **Tolkova I**, Thompson DR. (2017) "Classification of Animal Movement Behavior through Residence in Space and Time." *PLOS ONE*.

Additional Research

Graduate: 2017-

- Developed novel non-convex trajectory optimization algorithm (*ADMM, augmented Lagrangian methods*), benchmarked in simulation for multiple robot platforms (*quadrotor, Kuka Arm, RoboBee*) against commonly used solvers (*SNOPT, IPOPT*), and integrated with the Drake robotics toolbox (*C++*). [link]
- Trained a convolutional denoising autoencoder for signal enhancement of birdsong within outdoor recordings (*PyTorch, Librosa*). [link]
- Demonstrated high classification accuracy in training a multilayer perceptron to detect adversarial noise (*Fast Gradient Sign, DeepFool*). [link]

Undergraduate: 2016-2017

- Adapted and demonstrated successive convexification algorithm for real-time trajectory planning for quadrotor drones.
- Constructed data collection framework including point cloud processing and segmentation (*ROS, PCL*) for graph-based inverse optimal control for learning manipulation tasks from demonstration on the Baxter robot. [link]

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Presentations

Oral presentation at ASA 2023 Chicago May 2023

IEEE Signal Processing Invited Seminar at the University of Rhode Island June 2022

Oral presentation at Northeast Regional Environmental Acoustics Symposium May 2022

Departmental seminar at the Max Planck Institute for Animal Behavior Mar. 2022

Oral presentation at IJCAI 2021 AI for Social Good Workshop Aug. 2021

Oral presentation at UCI CMCF Early Career Researcher Symposium Apr. 2021

Oral presentation at IJCAI 2021 AI for Social Good Workshop Jan. 2021

Oral presentation at ASA 2017 Boston June 2017

Poster presentation at Annual Science Conference, Copenhagen Sept. 2015

Teaching

Lecturer for NTRES 3150: Introduction to Conservation Bioacoustics Fall 2023
Prepared and taught four lectures and two labs on machine learning and acoustic localization.

Invited Lecturer for NTRES 3150: Introduction to Conservation Bioacoustics Fall 2022
Prepared and taught an acoustic localization module.

Teaching Fellow for APMTH 104: Complex Analysis Fall 2022
Prepared weekly materials, held office hours, graded homework.

Teaching Fellow for GENED 1080: Engineering the Acoustical World Fall 2021
Led laboratory sessions, developed assignments, held office hours, graded homework.

Head Teaching Fellow for APMTH 22a: Solving and Optimizing Fall 2020
Prepared weekly materials, held office hours, graded homework.

Teaching Fellow for ES 159/259: Introduction to Robotics Spring 2020
Led laboratory sessions, developed assignments, held office hours, graded homework.

Head Teaching Fellow for APMTH 22a: Solving and Optimizing Fall 2019
Prepared weekly materials, taught section, held office hours, graded homework.

Teaching Fellow for CS 182: Introduction to Artificial Intelligence Fall 2018
Prepared weekly section materials, taught section, held exam review and office hours.

Skills

Fluent in English and Russian
Proficient in Python, C++, C, MATLAB, Java, R
Machine Learning: TensorFlow, PyTorch
Hardware: Arduino, Teensy, BeagleBone
Tools: Git, ROS, OpenMP

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Awards

Rose Postdoctoral Fellowship (Cornell Lab of Ornithology) 2023-2026
Animal Bioacoustics Best Student Presentation Award (Acoustical Society of America) 2023
Quantitative Biology Fellowship (Harvard NSF Simons Center) 2022-2023
Quantitative Biology Fellowship (Harvard NSF Simons Center) 2021-2022
Quantitative Biology Fellowship (Harvard NSF Simons Center) 2020-2021
Certificate of Distinction in Teaching (Harvard Derek Bok Center) 2019-2021
Outstanding Graduating Senior (Applied Math Department, UW) 2017
Paradise Scholarship (Robinson Center for Young Scholars, UW) 2015
Annual Dean's List (UW) 2012-2017

Outreach

Mentor for Bioacoustics Equipment and Training program in Indonesia and Malaysia. 2023-
Volunteer for Insectapalooza and CLO Open House outreach events. 2023
Webinar Panelist for Migration Celebration outreach event. 2022
Mentor for Veritas AI Bootcamp and Fellowship programs. 2022
Mentor for undergraduate project at the Global Alliance for Medical Innovation. 2020-2022
CovEd tutor for public school student. 2020-2021
Tutor for APMTH 104: Complex and Fourier Analysis. 2020
Weekly **tutor** at local public school through Cambridge School Volunteers. 2018-2019
Volunteer at math competitions (GEMS, MathDay, Math Hour Olympiad). 2013-2017

Service

Reviewer for *Journal of the Acoustical Society of America*, *Methods in Ecology and Evolution*, *Ecological Informatics*, *Remote Sensing in Ecology and Conservation*, *Computers and Electronics in Agriculture*.

Lead Organizer for Quantitative Ecology/Ethology/Evolution Seminars 2020-2022
Coordinated over two dozen virtual talks on a diverse range of topics,
with speakers spanning five continents. [link]

President of the Harvard GSAS Photography Society 2019-2022
Organized trips, photo competitions, guest speakers, and photographed events and performances for numerous organizations on campus.