Jacob M. Graving

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Research Interests Computational models for the study of animal behavior, Bayesian statistical inference, machine/deep learning, probabilistic programming, nonlinear dynamics

Positions

2020 – Present

Independent Research Fellow
Max Planck Institute of Animal Behavior
Department of Biology, University of Konstanz
Centre for the Advanced Study Collective Behaviour, University of Konstanz
Role: Working with researchers from the Department of Migration (Wikelski), Department of Collective Behavior (Couzin), and Department for the Ecology of Animal Societies (Crofoot) to develop novel, general-purpose methods for the study of animal behavior in laboratory and field environments using drones, advanced telemetry sensors, computer vision, machine/deep learning, and modern statistical techniques.

Education

2020 (submitted)

Ph.D., Biology
Department of Collective Behaviour, Max Planck Institute of Animal Behavior
Department of Biology, University of Konstanz
Centre for the Advanced Study Collective Behaviour, University of Konstanz
International Max Planck Research School (IMPRS) for Organismal Biology

2015

M.S., Biology
Department of Biological Sciences, Bowling Green State University

2013

B.S., Biology
Department of Biological Sciences, Bowling Green State University

Publications

In Preparation

Bath, D.E., Walter, T., **Graving, J.M.**, Vizcaíno, J.P., Couzin, I.D. Collective detection and processing of distributed information by fish schools. In prep.

In Review

Li, L., Nagy, M., **Graving, J.M.**, Bak-Coleman, J., Guangming X., Couzin, I.D. Schooling fish save energy by vortex-phase matching. In review

Preprints

Graving, J.M., Couzin, I.D. (2020). VAE-SNE: a deep generative model for simultaneous dimensionality reduction and clustering. bioRχiv: https://doi.org/10.1101/2020.07.17.207993

2019

Graving, J.M., Chae, D., Naik, H., Li, L., Koger, B., Costelloe, B.R., Couzin, I.D. (2019). DeepPoseKit, a software toolkit for fast and robust animal pose estimation using deep learning. eLife, 8. https://doi.org/10.7554/elife.47994
bioRχiv: https://doi.org/10.1101/620245 Code: https://github.com/jgraving/deepposekit
Press: Quanta Magazine, Nature Methods, Nature News & Views, eLife Science Digests

2018

Alarcón-Nieto, G.*, **Graving, J.M.***, Klarevas-Irby, J.A.*, Maldonado-Chaparro, A.A., Mueller, I., and Farine, D.R. (2018) An automated barcode tracking system for behavioural studies in birds. Methods in Ecology and Evolution 9 (6), 1536-1547. https://doi.org/10.1111/2041-210X.13005 bioRχiv: https://doi.org/10.1101/201590 *contributed equally

2017

Graving, J.M., Bingman, V.P., Hebets, E.A., and Wiegmann, D.D. (2017). Development of site fidelity in the nocturnal amblypygid *Phrynus marginemaculatus*. Journal of Comparative Physiology A, 203(5), 313-328. https://doi.org/10.1007/s00359-017-1169-5

Bingman, V.P., **Graving, J.M.**, Hebets, E.A., and Wiegmann, D.D. (2017). Importance of the antenniform legs, but not vision, for homing by the neotropical whip spider *Paraphrynus laevifrons*. Journal of Experimental Biology, 220(5), 885-890. https://doi.org/10.1242/jeb.149823
Press: Discover Magazine, National Geographic

2016 Wiegmann, D.D., Hebets, E.A., Gronenberg, W., **Graving, J.M.**, and Bingman, V.P. (2016). Amblypygids: model organisms for the study of arthropod navigation mechanisms in complex environments. Frontiers in Behavioral Neuroscience, 10, 47. https://doi.org/10.3389/fnbeh.2016.00047

Teaching

2019 **ASAB 2019 Summer Conference, University of Konstanz**
Workshop Organizer and Lecturer
– Seminar on "Machine Learning in the Behavioral Sciences"
– Practical Workshop on "Quantifying Behavior with Machine Learning"

2016–now **University of Konstanz, Department of Biology**
Lecturer and Project Advisor, Intensive Research Course for Master's Students
– Measuring Animal Behavior with Computer Vision
– Analyzing Behavioral Data
– Introduction to Programming in Python

2013–2015 **Department of Biological Sciences, Bowling Green State University**
Graduate Assistant
– Advanced Biostatistics (for Graduate Students)
– Introduction to Biostatistics
– Population and Community Ecology
– Introductory Biology for Non-Science Majors
– Guest Lecture on "Arthropod Navigation", Animal Behavior

Invited Talks

2019 **Revealing the Behavioral Algorithms of Social Animals Using Deep Learning**
Princeton Neuroscience Institute (PNI)
Princeton University, Princeton, New Jersey, USA
July 2, 2019

2018 **Perception and Motion in Locust Swarms**
Integrated Behavioral Research Group (IBRG)
Princeton University, Princeton, New Jersey, USA
March 16, 2018

Perception and Motion in Locust Swarms
Department of Biological Sciences Seminar Series
Bowling Green State University, Bowling Green, Ohio, USA
February 28, 2018

Outreach

2017 **Konstanzer Lange Nacht Der Wissenschaft**
"Long Night of Science" Public Outreach Event
Volunteer
Konstanz, Germany

2016 **Das Schwarmverhalten der Fische**
Public Seminar by Prof. Jens Krause
Volunteer Co-organizer
Konstanz, Germany

2013–2014 **Kid's Tech University, Bowling Green State University**

Public Outreach Event for Schoolchildren Grades K–8
Volunteer
Bowling Green, Ohio, USA

Advisees

Graduate

Simon Gommel, M.S. Biology, University of Konstanz
Taylor Carter, M.S. Biology, University of Konstanz
Ingabritta Hormann, M.S. Biology, University of Konstanz

Undergraduate

Nicole Meister, B.S. Computer Science, Princeton University
Chiara Hirschkorn, B.S. Biology, University of Konstanz
Daniel Chae, B.S. Computer Science, Princeton University
Connie Santangelo, B.S. Biology, Bowling Green State University
Lindsey Cunningham, B.S. Biology, Bowling Green State University
Tracy Togba, B.S. Biology, Bowling Green State University

Peer Review

Journals: eLife, Science Advances, PNAS, Methods in Ecology and Evolution
Grants: IMPRS Project Grant, IMPRS Travel Grant

Skills

Languages: Python (Expert), R (Intermediate), MATLAB (Intermediate)
Applications: Bayesian inference, statistical analysis, data visualization, machine learning, deep learning, computer vision, and image processing
Libraries: Stan, TensorFlow, PyTorch, scikit-learn, OpenCV

References

Iain D. Couzin
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Professor, University of Konstanz
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Verner P. Bingman
Distinguished Research Professor
Bowling Green State University
Department of Psychology
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Daniel D. Wiegmann
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Sheryl L. Coombs
Professor Emeritus
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Department of Biological Sciences
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