Kristin Branson

SENIOR GROUP LEADER
HEAD OF COMPUTATION & THEORY

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Summary

My goal is to develop new and impactful ways to use machine vision and learning to gain insight into biological questions, and usable software so that these methods are broadly adopted. My work has contributed to and advanced the role of quantitative analysis of animal behavior in neuroscience and biology more generally.

Education

University of California, San Diego   *La Jolla, CA*
PH.D., M.S., COMPUTER SCIENCE   *2007, 2002*
- Dissertation Title: *Tracking Multiple Mice through Severe Occlusions*
- Advisors: Serge Belongie and Sanjoy Dasgupta

Harvard University   *Cambridge, MA*
A.B., *Cum Laude*, COMPUTER SCIENCE   *2000*

Experience

HHMI Janelia Research Campus   *Ashburn, VA*
SENIOR GROUP LEADER AND HEAD OF COMPUTATION & THEORY   *2017 - PRESENT*
GROUP LEADER (LEVEL 2)   *2013 - 2017*
GROUP LEADER (LEVEL 1)   *2010 - 2013*

California Institute of Technology   *Pasadena, CA*
POSTDOCTORAL RESEARCHER   *2007 - 2010*
- Advisors: Pietro Perona and Michael Dickinson

Honors and Awards

- Selected as one of Cell's "40 under 40" scientists in commemoration of their 40th anniversary, 2015.
- Faculty of 1000 Recommendation for JAABA, 2013.
- NASA Graduate Student Researcher Program Fellowship, 2003-2006.

Selected Publications

1. I. S. Kwak, D. Kriegman, and K. Branson, "Detecting the starting frame of actions in video," *WACV*, 2020.
2. B. Sauerbrei, J.-Z. Guo, M. Mischiati, W. Guo, M. Kabra, N. Verma, B. Mensch, K. Branson, and A. Hantman, "Cortical pattern generation during dexterous movements is input-driven," *Nature*, vol. 577 pp. 386–391, 2019.
3. D. J. Im, H. Ma, G. W. Taylor, and K. Branson, "Quantitatively evaluating GANs with divergences proposed for training," in *International Conference on Learning Representations*, 2018.
4. A. A. Robie, J. Hirokawa, A. W. Edwards, L. A. Umayam, A. Lee, M. L. Phillips, G. M. Card, W. Korff, G. M. Rubin, J. H. Simpson, M. B. Reiser, and K. Branson, "Mapping the neural substrates of behavior," *Cell*, vol. 170, no. 2, pp. 393–406, 2017.
5. E. Eyjolfsdottir, K. Branson, Y. Yue, and P. Perona, "Learning recurrent representations for hierarchical behavior modeling," in *International Conference on Learning Representations*, 2017.

6. S. R. Egnor and K. Branson, "Computational analysis of behavior," *Annual Review of Neuroscience*, vol. 39, pp. 217–236, 2016.

7. J.-Z. Guo, A. R. Graves, W. W. Guo, J. Zheng, A. Lee, J. Rodriguez-Gonzalez, N. Li, J. J. Macklin, J. W. Phillips, B. D. Mensh, K. Branson, and A. Hantman, "Cortex commands the performance of skilled movement," *eLife*, vol. 4, p. e10774, 2015.

8. N. Verma and K. Branson, "Sample complexity of learning mahalanobis distance metrics," in *Advances in Neural Information Processing Systems*, pp. 2584–2592, 2015.

9. M. Kabra, A. Robie, and K. Branson, "Understanding classifier errors by examining influential neighbors," in *Computer Vision and Pattern Recognition*, June 2015.

10. Y. Aso, D. Sitaraman, T. Ichinose, K. R. Kaun, K. Vogt, G. Belliart-Guérin, P.-Y. Plaçais, A. A. Robie, N. Yamagata, C. Schnaitmann, W. J. Rowell, R. M. Johnston, T.-T B. Ngo, N. Chen, W. Korff, M. N. Nitabach, U. Heberlein, T. Preat, K. Branson, H. Tanimoto, and G. M. Rubin, "Mushroom body output neurons encode valence and guide memory-based action selection in *Drosophila*," *eLife*, vol. 3, p. e04580, 2014.

11. F. Amat, W. Lemon, D. P. Mossing, K. McDole, Y. Wan, K. Branson, E. W. Myers, and P. J. Keller, "Fast, accurate reconstruction of cell lineages from large-scale fluorescence microscopy data," *Nature Methods*, vol. 11, no. 9, p. 951, 2014.

12. D. G. Tervo, M. Proskurin, M. Manakov, M. Kabra, A. Vollmer, K. Branson, and A. Y. Karpova, "Behavioral variability through stochastic choice and its gating by anterior cingulate cortex," *Cell*, vol. 159, no. 1, pp. 21–32, 2014.

13. M. Kabra, A. A. Robie, M. Rivera-Alba, S. Branson, and K. Branson, "JAABA: An interactive machine-learning tool for automatic annotation of animal behavior," *Nature Methods*, vol. 10, pp. 64–67, 2013.

14. K. Branson, A. A. Robie, J. Bender, P. Perona, and M. Dickinson, "High-throughput ethomics in large groups of *Drosophila*," *Nature Methods*, vol. 6, pp. 451–457, 2009.

All Publications

1. J. Z. Guo, B. Sauerbrei, J. Cohen, M. Mischiatti, A. Graves, K. Branson, and A. Hantman. "Disrupting cortico-cerebellar communication impairs dexterity", *accepted, eLife*.

2. C. E. Schretter, Y. Aso, M. Dreher, A. A. Robie, M.-J. Dolan, N. Chen, M. Ito, T. Yang, R. Parekh, K. Branson, and G. M. Rubin, "Neuronal circuitry underlying female aggression in *Drosophila*, *eLife*, eLife 2020;9:e58942, 2020.

3. D. J. Im, I. S. Kwak, and K. Branson, "Evaluation metrics for behavior modeling," arXiv:2007.12298, 2020.

4. I. S. Kwak, D. Kriegman, and K. Branson, "Detecting the starting frame of actions in video," *WACV*, 2020.

5. B. Sauerbrei, J.-Z. Guo, M. Mischiati, W. Guo, M. Kabra, N. Verma, B. Mensch, K. Branson, and A. Hantman, "Cortical pattern generation during dexterous movements is input-driven," *Nature*, vol. 577 pp. 386–391, 2019.

6. D. J. Im, S. Prakhya, J. Yan, S. Turaga, and K. Branson, "Importance weighted adversarial variational autoencoders for spike inference from calcium imaging data," *CoRR*, vol. abs/1906.03214, 2019.

7. J.-Z. Guo, B. Sauerbrei, J. D. Cohen, M. Mischiati, A. Graves, F. Pisanello, K. Branson, and A. W. Hantman, "The pontine nuclei are an integrative cortico-cerebellar link critical for dexterity," *bioRxiv*, 2019.

8. J. M. Ache, S. Namiki, A. Lee, K. Branson, and G. M. Card, "Context-dependent decoupling of sensory and motor circuits underlies behavioral flexibility," *Nature Neuroscience*, vol. 22, no. 7, 2019.

9. D. J. Im, N. Verma, and K. Branson, "Stochastic neighbor embedding under f-divergences," *CoRR*, vol. abs/1811.01247, 2018.

10. Daniel Jiwoong Im, H. Ma, G. W. Taylor, and K. Branson, "Quantitatively evaluating GANs with divergences proposed for training," in *International Conference on Learning Representations*, 2018.

11. K. McDole, L. Guignard, F. Amat, A. Berger, G. Malandain, L. A. Royer, S. C. Turaga, K. Branson, and P. J. Keller, "In toto imaging and reconstruction of post-implantation mouse development at the single-cell level," *Cell*, vol. 175, no. 3, pp. 859–876, 2018.

12. I. F. Rodriguez, R. Megret, R. Egnor, K. Branson, J. L. Agosto, T. Giray, and E. Acuna, "Multiple animals tracking in videousing part affinity fields," in *Visual Observation and Analysis of Vertebrate And Insect Behavior*, 2018.

13. I. F. Rodriguez, K. Branson, E. Acuna, J. L. Agosto-Rivera, T. Giray, and R. Megret, "Honeybee detection and pose estimation using convolutional neural networks," in *Reconnaissance des Formes, Image, Apprentissage et Perception*, 2018.

14. K. Branson, "A deep (learning) dive into a cell," *Nature Methods*, vol. 15, no. 4, p. 253, 2018.

15. A. A. Robie, J. Hirokawa, A. W. Edwards, L. A. Umayam, A. Lee, M. L. Phillips, G. M. Card, W. Korff, G. M. Rubin, J. H. Simpson, M. B. Reiser, and K. Branson, "Mapping the neural substrates of behavior," *Cell*, vol. 170, no. 2, pp. 393–406, 2017.

16. R. Sen, M. Wu, K. Branson, A. Robie, G. M. Rubin, and B. J. Dickson, "Moonwalker descending neurons mediate visually evoked retreat in Drosophila," *Current Biology*, vol. 27, no. 5, pp. 766–771, 2017.

17. A. A. Robie, K. M. Seagraves, S. R. Egnor, and K. Branson, "Machine vision methods for analyzing social interactions," *Journal of Experimental Biology*, vol. 220, no. 1, pp. 25–34, 2017.

18. D. J. Im, M. Tao, and K. Branson, "An empirical analysis of deep network loss surfaces," *CoRR*, vol. abs/1612.04010, 2016.

19. E. Eyjolfsdottir, K. Branson, Y. Yue, and P. Perona, "Learning recurrent representations for hierarchical behavior modeling," in *International Conference on Learning Representations*, 2017.

20. S. R. Egnor and K. Branson, "Computational analysis of behavior," *Annual Review of Neuroscience*, vol. 39, pp. 217–236, 2016.

21. J.-Z. Guo, A. R. Graves, W. W. Guo, J. Zheng, A. Lee, J. Rodriguez-Gonzalez, N. Li, J. J. Macklin, J. W. Phillips, B. D. Mensh, K. Branson, and A. Hantman, "Cortex commands the performance of skilled movement," *eLife*, vol. 4, p. e10774, 2015.

22. K. Branson and J. Freeman, "Imaging the neural basis of locomotion," *Cell*, vol. 163, no. 3, pp. 541–542, 2015.

23. W. C. Lemon, S. R. Pulver, B. Höckendorf, K. McDole, K. Branson, J. Freeman, and P. J. Keller, "Whole-central nervous system functional imaging in larval *Drosophila*," *Nature Communications*, vol. 6, p. 7924, 2015.

24. T. Ohyama, C. M. Schneider-Mizell, R. D. Fetter, J. V. Aleman, R. Franconville, M. Rivera-Alba, B. D. Mensh, K. M. Branson, J. H. Simpson, J. W. Truman, *et al.*, "A multilevel multimodal circuit enhances action selection in *Drosophila*," *Nature*, vol. 520, no. 7549, p. 633, 2015.

25. N. Verma and K. Branson, "Sample complexity of learning mahalanobis distance metrics," in *Advances in Neural Information Processing Systems*, pp. 2584–2592, 2015.

26. M. Kabra, A. Robie, and K. Branson, "Understanding classifier errors by examining influential neighbors," in *Computer Vision and Pattern Recognition*, June 2015.

27. K. Branson, "Distinguishing seemingly indistinguishable animals with computer vision," *Nature Methods*, vol. 11, no. 7, p. 721, 2014.

28. A. I. Dell, J. A. Bender, K. Branson, I. D. Couzin, G. G. de Polavieja, L. P. Noldus, A. Pérez-Escudero, P. Perona, A. D. Straw, M. Wikelski, *et al.*, "Automated image-based tracking and its application in ecology," *Trends in Ecology & Evolution*, vol. 29, no. 7, pp. 417–428, 2014.

29. Y. Aso, D. Sitaraman, T. Ichinose, K. R. Kaun, K. Vogt, G. Belliart-Guérin, P.-Y. Plaçais, A. A. Robie, N. Yamagata, C. Schnaitmann, W. J. Rowell, R. M. Johnston, T.-T B. Ngo, N. Chen, W. Korff, M. N. Nitabach, U. Heberlein, T. Preat, K. Branson, H. Tanimoto, G. M. Rubin, "Mushroom body output neurons encode valence and guide memory-based action selection in *Drosophila*," *eLife*, vol. 3, p. e04580, 2014.

30. F. Amat, W. Lemon, D. P. Mossing, K. McDole, Y. Wan, K. Branson, E. W. Myers, and P. J. Keller, "Fast, accurate reconstruction of cell lineages from large-scale fluorescence microscopy data," *Nature Methods*, vol. 11, no. 9, p. 951, 2014.

31. D. G. Tervo, M. Proskurin, M. Manakov, M. Kabra, A. Vollmer, K. Branson, and A. Y. Karpova, "Behavioral variability through stochastic choice and its gating by anterior cingulate cortex," *Cell*, vol. 159, no. 1, pp. 21–32, 2014.

32. M. Kabra, A. A. Robie, M. Rivera-Alba, S. Branson, and K. Branson, "JAABA: An interactive machine-learning tool for automatic annotation of animal behavior," *Nature Methods*, vol. 10, pp. 64–67, 2013.

33. F. Zabala, P. Polidoro, A. Robie, K. Branson, P. Perona, and M. H. Dickinson, "A simple strategy for detecting moving objects during locomotion revealed by animal-robot interactions," *Current Biology*, vol. 22, no. 14, pp. 1344–1350, 2012.

34. A. D. Straw, K. Branson, T. R. Neumann, and M. H. Dickinson, "Multi-camera real-time three-dimensional tracking of multiple flying animals," *Journal of The Royal Society Interface*, vol. 8, no. 56, pp. 395–409, 2010.

35. K. Branson, A. A. Robie, J. Bender, P. Perona, and M. Dickinson, "High-throughput ethomics in large groups of *Drosophila*," *Nature Methods*, vol. 6, pp. 451–457, 2009.

36. S. Agarwal, K. Branson, and S. Belongie, "Higher order learning with graphs," in *Proceedings of the 23rd international*

conference on Machine learning, pp. 17–24, ACM, 2006.

37. K. Branson and S. Belongie, "Tracking multiple mouse contours (without too many samples)," in *2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05)*, vol. 1, pp. 1039–1046, IEEE, 2005.

38. K. Branson, V. Rabaud, and S. Belongie, "Three brown mice: See how they run," in *In VS-PETS Workshop at ICCV*, Citeseer, 2003.

39. G. W. Cottrell, K. M. Branson, and A. J. Calder, "Do expression and identity need separate representations?," in *Proceedings of the Annual Meeting of the Cognitive Science Society, 24 (24)*, 2002.

Open-Source Software

I lead, co-developed, and co-maintain the following open-source pieces of software:

- APT: The Animal Part Tracker, `http://kristinbranson.github.io/APT/`
- BABAM: The Browsable Atlas of Behavior-Anatomy Maps, `https://kristinbranson.github.io/BABAM/`
- BIAS: Basic Image Acquisition Software `http://stuff.iorodeo.com/notes/bias/`
- JAABA: Janelia Automatic Animal Behavior Annotator, `http://jaaba.sourceforge.net/`
- Ctrax: The Caltech Multiple Walking Fly Tracker, `http://ctrax.sourceforge.net/`

Conferences Organized

- Janelia Conference: Women in Computational Biology, November 2019.
- Bioimage Computing Workshop, CVPR, June 2019.
- Society for Neuroscience Virtual Conference on Machine Learning, June 2019.
- Janelia Junior Scientist Workshop on Machine Learning and Computer Vision, April 2019, October 2017, October 2016, October 2015.
- Janelia Conference: What Can Machine Learning Do for Neuroscience and Vice-Versa?, November 2010.

Scientific Leadership

- As part of Senior Leadership at Janelia, participate in institute-wide planning and decision-making, 2017-present.
- As Head of the Computation and Theory Research Area, manage recruiting, hiring, and renewal of Group Leaders, and manage budgets for 9 labs, 2017-present.
- Co-created the Janelia Diversity, Equity, and Inclusion Committee, 2018. Chaired committee 2018-2020. Participate 2020-present. As part of this committee, we have researched and proposed initiatives to Janelia leadership, invited speakers to present at Janelia, and started a DEI reading group.
- Started, co-organize, and contribute to Computer Vision and Machine Learning weekly reading group and internal seminar series at Janelia, 2014-present.
- Worked with Scientific Computing Systems Group at Janelia to design and create a GPU cluster for Janelia researchers, 2018-present.
- Started and co-organize the Janelia Computation and Theory Seminar series, bi-weekly, 2018-present.
- Participate in and lead a Women's Mentoring Group at Janelia, 2018-present.
- Started and co-organize Janelia Computation and Theory "Fancy Friday" social event to build community at Janelia, 2018-present.

Outreach

- Started and organize "Hour of Code" bi-monthly outreach activity for Janelia scientists to share their enthusiasm for and the impact of programming with grade-school children at local elementary schools and libraries, 2017-present.
- Worked with high school teachers at Loudoun Academies of Science to develop a machine learning course for high school students, 2018. Volunteer to provide project mentorship to students in these classes, 2018-present.
- Participate in "Raising Excitement for Science, Engineering, and Technology" (RESET) Education Outreach Program, 2018-present.

- Taught/mentored in several summer and winter schools, including Neuromatch, FENS, Cajal, Cold Spring Harbor, and FLiACT.
- Member of Loudoun Education Foundation STEAM Committee 2019-present.

Mentorship

Name	Years in lab	Degree received	Current Position
Alice Robie	2010-present		Senior Scientist in my lab
Mayank Kabra	2011-2013		Machine learning consultant, Kabra Consulting
Marta Rivera-Alba	2013-2016		Lead Data Scientist, Clarity AI
Nakul Verma	2013-2017		Teaching Faculty, Computer Science, Columbia University
Kelly Seagraves	2015-2016		C.V. Starr Fellow, Princeton University
Roian Egnor	2015-present		Senior Scientist in my lab
Iljung (Sam) Kwak	2015-present	PhD, Computer Science, UCSD, 2019	Machine Learning Researcher in my lab
Jiwoong (Daniel) Im	2016-2020		PhD student, Computer Science, NYU
Rutuja Patil	2017-present		Software Engineer in my la.
Ivan (Felipé) Rodriguez	2017-2018	M.S., Computer Science, University of Puerto Rico, 2019	PhD student, Cognitive Science, Brown University

With members of my lab, I've also co-mentored two undergraduate students and three high school students. 2/3 of my mentees have been from groups historically marginalized in STEM. As Head of Computation and Theory, I also provide mentorship and advice to the other 8 Group Leaders within this Research Area.

Invited Talks

- CVPR Computer Vision for Animals Workshop, June, 2021.
- CVPR Multi-Agent Behavior Workshop, June, 2021.
- World Wide Neuro/Tubingen Neuroscience Seminar Series, May, 2021.
- HHMI Science Meeting, December, 2020.
- Life Sciences Across the Globe, October, 2020.
- Georgetown Biology Seminar Series, October, 2020.
- ECCV BioImage Computing Workshop, August, 2020.
- CVPR Workshop on Fine-Grained Visual Categorization, June, 2020.
- NEUBIAS Symposium, Keynote, February, 2020.
- COSYNE Workshop on Interpretable Computational Neuroscience, February, 2020.
- Visipedia Conference, February, 2020.
- Max Planck Institute Future of Neuroscience Symposium, November, 2019.
- Janelia Junior Scientist Workshop on Theoretical Neuroscience, October, 2019.
- Stanley Center Symposium, September, 2019.
- Cajal Course on Interacting with Neural Circuits, July, 2019.
- NSF Scholarship fund for excellence in Computer Science and Mathematics, University of Puerto Rico, Recinto de Rio Piedras, April, 2019.
- Swartz Seminar Series, Yale, March, 2019.
- HHMI Food for Thought, HHMI Headquarters, Februrary, 2019.
- FENS Winter School on Innate Behavior, January, 2019.
- NSF Machine Learning and Biology Workshop, Harvard University Physics of the Living Systems, December, 2018.
- Center for Theoretical Neuroscience, Columbia University, November, 2018.
- International Brain Lab Annual Meeting, May, 2018.
- Keynote, Simons Collaboration for the Global Brain Annual Meeting, September, 2018.

- GRASS Fellows Seminar at Marine Biology Lab, August, 2018.
- Cajal Course on the Behavior of Neural Systems, July, 2018.
- International Symposium on Biomedical Imaging, April, 2018.
- BigNeuro Workshop, NIPS, December, 2017.
- Janelia Coference on Emerging Tools for Acquisition and Interpretation of Whole-Brain Functional Data, November, 2017.
- HHMI Science Meeting, October, 2017.
- Champalimaud Neuroscience Seminar, September, 2017.
- Keynote, INCF Neuroinformatics Congress, August, 2017.
- Kavli Workshop on Neural Circuits and Behavior of Drosophila, July, 2017.
- Puerto Rico INBRE and COBRE Scientific Symposium, May, 2017.
- Universisty of Pennsylvania, GRASP Seminar, April, 2017.
- Univesity of Texas, Houston Graduate Student Invited Neuroscience Seminar, February, 2017.
- Workshop on High-Dimensional Neuro-Behavioral Analyses, Cosyne, February, 2017.
- Johns Hopkins Biology Department Seminar, February, 2017.
- Simons Collaboration on the Global Brain Quantitative Behavior Workshop, November, 2016.
- Society for Neuroscience Minisymposium, November, 2016.
- Coordinating Global Brain Projects, September, 2016.
- HHMI Science Meeting, September, 2016.
- Journal of Experimental Biology Evolution of Social Behavior Workshop, March, 2016.
- Stanford Neuroscience Seminar, February, 2016.
- MIT Neurotech Symposium, November, 2015.
- Janelia Conference on Emerging Tools for Acquisition and Interpretation of Whole-Brain Functional Data, November, 2015.
- EMBO Workshop on Neural circuits and behaviour of Drosophila, June, 2015.
- BioImage Computing Workshop, CVPR, June, 2015.
- Biophysical Society Annual Meeting, February, 2015.
- Neuroscience Graduate Program Seminar, Brown, October 2014.
- Janelia Conference on Life in the Aggregate: Mechanisms and Features of Social Dynamics, October, 2014.
- Measuring Behavior, August, 2014.
- Mathematical Biosciences Institute Workshop on Analysis of Large Collections of Imaging Data, April, 2014.
- AAAS Neuroscience and Data Sharing Symposium, 2014.
- Advisory Committee to the NIH Director BRAIN Working Group, July, 2013.
- FliACT Training Workshop, April, 2013.
- International Symposium on Neuroethology, August, 2012.
- Janelia Machine Learning Conference, May, 2012.
- Cold Spring Harbor Conference on High-Throughput Automated Phenotyping, April, 2012.
- Society for Integrative and Comparative Biology Annual Meeting, January, 2012.
- Annual Drosophila Research Conference, April, 2010.