

Kristin Branson

SENIOR GROUP LEADER

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Summary

I develop new and impactful ways to use computer vision (CV) and machine learning (ML) to gain insight into scientific questions. I do this by 1) finding new scientific questions that can be framed as CV&ML problems, 2) engineering practical and integrative solutions, and 3) making these systems usable by others so that these methods are broadly adopted and applied to new problems. I was a pioneer of video-based analysis of animal behavior, and my work helped establish this as an important and ubiquitous technique in neuroscience and biology more generally.

Education

University of California, San Diego

PH.D., M.S., COMPUTER SCIENCE

- Dissertation Title: *Tracking Multiple Mice through Severe Occlusions*
- Advisors: Serge Belongie and Sanjoy Dasgupta

La Jolla, CA

2007, 2002

Harvard University

A.B., *Cum Laude*, COMPUTER SCIENCE

Cambridge, MA

2000

Experience

HHMI Janelia Research Campus

SENIOR GROUP LEADER

HEAD OF COMPUTATION & THEORY

GROUP LEADER

Ashburn, VA

2017 - PRESENT

2017 - 2022

2010 - 2017

California Institute of Technology

POSTDOCTORAL RESEARCHER

- Advisors: Pietro Perona and Michael Dickinson

Pasadena, CA

2007 - 2010

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 Browseable 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

- Multi-Agent Behavior Workshop, CVPR, June, 2022.
- 4D Cellular Physiology Reimagined: Theory as a Principal Component, September, 2021.
- 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.

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.

Scientific Leadership

- Established the Computation and Theory Research Area at Janelia (10 labs) and served as inaugural Head from 2017-2022. Set the overall vision and direction for computational research at Janelia; recruited, made hiring and renewal decisions, and set budgets for Group Leaders; initiated development of Janelia's GPU cluster; initiated Janelia's Theory Fellow program.
- As part of Senior Leadership at Janelia, participated in institute-wide planning and decision-making, 2017-2022.
- Co-created the Janelia Diversity, Equity, and Inclusion Committee, 2018. Chaired committee 2018-2020. Participated 2020-2022. 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-organized, and contributed to Computer Vision and Machine Learning weekly reading group and internal seminar series at Janelia, 2014-present.
- Started and co-organized the Janelia Computation and Theory Seminar series, bi-weekly, 2018-present.
- Participated in and led a Women and Non-binary Scientist Mentoring Group at Janelia, 2018-present.
- Started and co-organized Janelia Computation and Theory social event to build community at Janelia, 2018-2020.

Outreach

- Directed the Cajal Machine Learning for Neuroscience Summer School (Summer, 2023).
- Taught classes on quantitative analysis of fly behavior at the Marine Biology Lab (June-July, 2022) and Howard University, an HBCU (September-November, 2022).
- Started and organized "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, 2017-2020. This was the first student outreach activity at Janelia, and instigated Janelia to build a Community Relations group to support future efforts.
- 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.
- Participated in "Raising Excitement for Science, Engineering, and Technology" (RESET) Education Outreach Program, 2018-2020, program organized by lab member Alice Robie.
- Taught/mentored in several summer and winter schools, including Neuromatch, FENS, Cajal, Cold Spring Harbor, Jackson Laboratory, and FLiACT. Example of a Colab notebook developed for this purpose: <https://bit.ly/jaxpose>.

Publications

1. C. E. Schretter, T. H. Sten, N. Klapoetke, M. Shao, A. Nern, M. Dreher, D. Bushey, A. A. Robie, A. L. Taylor, K. Branson, A. Otopalik, V. Ruta, G. M. Rubin. "Social state gates vision using three circuit mechanisms in *Drosophila*." *Nature*, in press.
2. B. Gorko, I. Siwanowicz, K. Close, C. Christoforou, K. L. Hibbard, M. Kabra, ... K. Branson, G. Ihrke, S. J. Huston, . "Motor neurons generate pose-targeted movements via proprioceptive sculpting." *Nature*, 628(8008), 596-603, 2024.
3. R. Vaxenburg, I. Siwanowicz, J. Merel, A. A. Robie, C. Morrow, G. Novati, Z. Stefanidi, G. M. Card, M. B. Reiser, M. M. Botvinick, K. Branson, Y. Tassa, S. C. Turaga. "Whole-body simulation of realistic fruit fly locomotion with deep reinforcement learning." *bioRxiv* 2024.03.11.584515, 2024.

4. M. Isaacson, J. Eliason, A. Nern, E. Rogers, G. Lott, T. Tabachnik, W. Rowell, A. Edwards, W. Korff, G. Rubin, K. Branson. "Small-field visual projection neurons detect translational optic flow and support walking control." *bioRxiv* 2023:2023-06, 2023.
5. H. Chiu, A. Robie, K. Branson, T. Vipra, S. Epstein, G. Rubin, D. Anderson, C. Schretter. "Cell type-specific contributions to a persistent aggressive internal state in female *Drosophila*." *eLife* 12:RP88598, 2023.
6. J. J. Sun, A. Ulmer, D. Chakraborty, B. Geuther, E. Hayes, H. Jia, V. Kumar, Z. Partridge, A. Robie, C. E. Schretter, C. Sun, K. Sheppard, P. Uttarwar, P. Perona, Y. Yue, K. Branson, and A. Kennedy. "The MABe22 Benchmarks for Representation Learning of Multi-Agent Behavior." *International Conference on Machine Learning*, 2023.
7. J. Z. Guo, B. Sauerbrei, J. Cohen, M. Mischiatti, A. Graves, K. Branson, and A. Hantman. "Disrupting cortico-cerebellar communication impairs dexterity", *eLife* 2021;10:e65906, 2021.
8. 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*, 2020;9:e58942, 2020.
9. D. J. Im, I. S. Kwak, and K. Branson, "Evaluation metrics for behavior modeling." *arXiv* 2007.12298, 2020.
10. I. S. Kwak, D. Kriegman, and K. Branson, "Detecting the starting frame of actions in video." *WACV*, 2020.
11. B. Sauerbrei, J.-Z. Guo, M. Mischiatti, 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.
12. D. J. Im, S. Prakhya, J. Yan, S. Turaga, and K. Branson, "Importance weighted adversarial variational autoencoders for spike inference from calcium imaging data." *arXiv* 1906.03214, 2019.
13. J.-Z. Guo, B. Sauerbrei, J. D. Cohen, M. Mischiatti, A. Graves, F. Pisanello, K. Branson, and A. W. Hantman, "The pontine nuclei are an integrative cortico-cerebellar link critical for dexterity." *bioRxiv*, 2019.
14. 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.
15. D. J. Im, N. Verma, and K. Branson, "Stochastic neighbor embedding under f-divergences." *arXiv*, 1811.01247, 2018.
16. 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.
17. 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.
18. 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.
19. 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.
20. K. Branson, "A deep (learning) dive into a cell." *Nature Methods*, vol. 15, no. 4, p. 253, 2018.
21. 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.
22. 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.
23. 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.
24. D. J. Im, M. Tao, and K. Branson, "An empirical analysis of deep network loss surfaces." *CoRR*, vol. abs/1612.04010, 2016.
25. E. Eyjolfsson, K. Branson, Y. Yue, and P. Perona, "Learning recurrent representations for hierarchical behavior modeling." in *International Conference on Learning Representations*, 2017.
26. S. R. Egnor and K. Branson, "Computational analysis of behavior." *Annual Review of Neuroscience*, vol. 39, pp. 217–236, 2016.
27. 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. Mensch, K. Branson, and A. Hantman, "Cortex commands the performance of skilled movement." *eLife*, vol. 4, p. e10774, 2015.
28. K. Branson and J. Freeman, "Imaging the neural basis of locomotion." *Cell*, vol. 163, no. 3, pp. 541–542, 2015.

29. 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.
30. 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.
31. N. Verma and K. Branson, "Sample complexity of learning mahalanobis distance metrics." in *Advances in Neural Information Processing Systems*, pp. 2584–2592, 2015.
32. M. Kabra, A. Robie, and K. Branson, "Understanding classifier errors by examining influential neighbors." in *Computer Vision and Pattern Recognition*, June 2015.
33. K. Branson, "Distinguishing seemingly indistinguishable animals with computer vision." *Nature Methods*, vol. 11, no. 7, p. 721, 2014.
34. 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.
35. 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.
36. 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.
37. 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.
38. 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.
39. 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.
40. 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.
41. 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.
42. 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.
43. 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.
44. K. Branson, V. Rabaud, and S. Belongie, "Three brown mice: See how they run." in *In VS-PETS Workshop at ICCV*, Citeseer, 2003.
45. 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.

Mentorship

<i>Name</i>	<i>Years in lab</i>	<i>Degree received</i>	<i>Current Position</i>
Alice Robie	2010-present		Senior Scientist in my lab
Mayank Kabra	2011-2013		Machine learning consultant, Kabra Consulting
Marta Rivera-Alba	2013-2016		Head of Data Science at Causal Foundry
Nakul Verma	2013-2017		Professor, Computer Science, Columbia U.
Kelly Seagraves	2015-2016		Senior Advisor in the U.S. Department of State's Office of the Special Envoy for Critical and Emerging Technology
Roian Egnor	2015-present		Senior Scientist in my lab
Iljung (Sam) Kwak	2015-2023	PhD, CS, UCSD, 2019	3D Machine Learning Engineer at Nuwa
Jiwoong (Daniel) Im	2016-2020		PhD student, CS, NYU
Rutuja Patil	2017-2024		Software Engineer in my lab
Ivan (Felipé) Rodriguez	2017-2018	M.S., CS, U. Puerto Rico, 2019	PhD student, Cognitive Science, Brown University
Lingqi Zhang	2023-present		Theory Fellow with my lab
Aniket Ravan	2024-present		Machine Learning Researcher in my lab
Eyrun Eyjolfssdottir	2024-present		Machine learning consultant

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 provided mentorship and advice to the other 9 Group Leaders within this Research Area.

Outside the lab

- I love rock climbing, hiking, and generally being outside in the sun. My favorite is brainstorming zany machine learning and science ideas while doing these activities with other scientists.
- I enjoy word puzzles, particularly crossword puzzles.