

# Kristin Branson

SENIOR GROUP LEADER

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## Summary

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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

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### University of California, San Diego

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

La Jolla, CA

2007, 2002

Dissertation Title: *Tracking Multiple Mice through Severe Occlusions*

Advisers: Serge Belongie and Sanjoy Dasgupta

### Harvard University

A.B. *Cum Laude*, COMPUTER SCIENCE

Cambridge, MA

2000

## Experience

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### 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

Advisers: Pietro Perona and Michael Dickinson

Pasadena, CA

2007-2009

### NASA Intern

GRADUATE STUDENT RESEARCHER

Research Institute for Advanced Computer Science

UNDERGRADUATE RESEARCHER

NASA Academy Program

NASA Ames RC

Summer 2000 & 2001

NASA Armstrong Flight RC

Summer 1999

## Open-Source Software

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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

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- 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

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- 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

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- Led a lab from 2010-present.
- 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

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- 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

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1. J. A. Keller, I. S. Kwak, A. K. Stark, M. Pachitariu, K. Branson, J. T. Dudman. "Cortical control of innate behavior from subcortical demonstration." *bioRxiv* 2025.02.12.637930, 2025.
2. A. A. Robie, A. L. Taylor, C. E. Schretter, M. Kabra, K. Branson. "The Fly Disco: Hardware and software for optogenetics and fine-grained fly behavior analysis." *bioRxiv* 2024.11.04.621948, 2024.
3. 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*, 2024.
4. 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.
5. 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." *Nature, in press*.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. D. J. Im, I. S. Kwak, and K. Branson, "Evaluation metrics for behavior modeling." *arXiv* 2007.12298, 2020.
12. I. S. Kwak, D. Kriegman, and K. Branson, "Detecting the starting frame of actions in video." *WACV*, 2020.
13. 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.
14. 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.
15. 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.
16. 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.
17. D. J. Im, N. Verma, and K. Branson, "Stochastic neighbor embedding under f-divergences." *arXiv*, 1811.01247, 2018.
18. 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.
19. 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.
20. 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.
21. 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.

22. K. Branson, "A deep (learning) dive into a cell." *Nature Methods*, vol. 15, no. 4, p. 253, 2018.
23. 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.
24. 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.
25. 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.
26. D. J. Im, M. Tao, and K. Branson, "An empirical analysis of deep network loss surfaces." *CoRR*, vol. abs/1612.04010, 2016.
27. E. Eyjolfssdottir, K. Branson, Y. Yue, and P. Perona, "Learning recurrent representations for hierarchical behavior modeling." in *International Conference on Learning Representations*, 2017.
28. S. R. Egnor and K. Branson, "Computational analysis of behavior." *Annual Review of Neuroscience*, vol. 39, pp. 217–236, 2016.
29. 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.
30. K. Branson and J. Freeman, "Imaging the neural basis of locomotion." *Cell*, vol. 163, no. 3, pp. 541–542, 2015.
31. 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.
32. 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.
33. N. Verma and K. Branson, "Sample complexity of learning mahalanobis distance metrics." in *Advances in Neural Information Processing Systems*, pp. 2584–2592, 2015.
34. M. Kabra, A. Robie, and K. Branson, "Understanding classifier errors by examining influential neighbors." in *Computer Vision and Pattern Recognition*, June 2015.
35. K. Branson, "Distinguishing seemingly indistinguishable animals with computer vision." *Nature Methods*, vol. 11, no. 7, p. 721, 2014.
36. 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.
37. 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.
38. 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.
39. 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.
40. 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.
41. 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.
42. 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.
43. 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.

44. 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.
45. 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.
46. K. Branson, V. Rabaud, and S. Belongie, “Three brown mice: See how they run.” in *In VS-PETS Workshop at ICCV*, Citeseer, 2003.
47. 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.