PROMOTION RECOMMENDATION
THE UNIVERSITY OF MICHIGAN
MEDICAL SCHOOL
DEPARTMENT OF COMPUTATIONAL MEDICINE AND BIOINFORMATICS
COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Joshua D. Welch, Ph.D., assistant professor of computational medicine and bioinformatics, Department of Computational Medicine and Bioinformatics, Medical School, and assistant professor of electrical engineering and computer science, Department of Electrical Engineering and Computer Science, College of Engineering, is recommended for promotion to associate professor of computational medicine and bioinformatics, with tenure, Department of Computational Medicine and Bioinformatics, Medical School, and associate professor of electrical engineering and computer science, without tenure, Department of Electrical Engineering and Computer Science, College of Engineering.

Academic Degrees
Ph.D.   2017   University of North Carolina at Chapel Hill
M.S.   2016   University of North Carolina at Chapel Hill
B.S.   2012   The Ohio University
B.M.   2012   The Ohio University

Professional Record
2018 – present   Assistant Professor, Computational Medicine and Bioinformatics, University of Michigan
2018 – present   Assistant Professor, Computer Science and Engineering, University of Michigan, Ann Arbor, MI

Summary of Evaluation
Teaching: Dr. Welch actively participates in the educational mission of the department, both in the classroom and in the laboratory. He has trained undergraduate students, graduate students, postdoctoral fellows, and an advanced post-graduate fellow. His trainees have been highly successful in obtaining funding, including two institutional training grant positions, one NSF graduate fellowship, two Ruth L. Kirschstein National Research Service Awards, and a MIDAS Postdoctoral Fellowship. Didactically, he has served as a lecturer in five different courses. His lectures help incoming Bioinformatics graduate students immerse into the department, and explore fundamental concepts such as signal processing and machine learning in the context of translational bioinformatics. Dr. Welch also served as the co-instructor for BIOINF 602/603: Bioinformatics Journal Club, where he was instrumental in enacting needed improvements, which increased student satisfaction with this course. In the winter of 2020, Dr. Welch was a co-instructor in BIOINF 525: Introduction to Bioinformatics & Computational Biology; and Bioinformatics 593: Introduction to Biocomputing. In the fall of 2021, he co-developed (with Dr. Jie Liu) a new course on machine learning for computational biology problems. The course is cross-listed with the Division of Computer Science and Engineering and has proved to be very popular, with more than 90 students registering in fall 2022. His evaluation scores from the

inaugural fall 2021 course ranked him consistently in 4.0-4.8 on a 5.0 scale. Finally, he restructured the course to begin the course-related research projects earlier in the semester. This gave students more time to work on their projects.

Research: Dr. Welch's research expertise is in single-cell genomic data analyses. His work to date ranges from single-cell trajectory analyses to alternative splicing, and multi-omic integration. He developed *LIGER*, one of the first algorithms for single-cell data integration. This was based on his earlier work on *SPLICER* and *MATCHER*, two software tools that launched his independent research career. Dr. Welch has an extraordinary record of success in winning funding support. His current research has been funded by the National Institutes of Health, the Chan Zuckerberg Foundation, and the Cystic Fibrosis Foundation. In 2021, he was selected from among 18 University of Michigan faculty as the sole institutional nominee for the Pew Biomedical Scholars award. Dr. Welch has published 36 peer-reviewed manuscripts, which have been published in high-impact journals, including a first-author paper in *Nature*, a senior-author paper in *Cell*, two senior-author papers in *Nature Biotechnology*, and two consortium papers in *Nature*.

Recent and Significant Publications:
Kriebel A, Welch JD, "UINMF performs mosaic integration of single-cell multi-omic datasets using nonnegative matrix factorization," *Nature Communications* 13: 780, 2022.
Yu H, Welch JD, "MichiGAN: sampling from disentangled representations of single-cell data using generative adversarial networks," *Genome Biology* 22(1): 158, 2021. PM34016135/PMC8139054.
Gao C, Liu J, Kriebel AR, Preissl S, Luo C, Castanon R, Sandoval J, Rivkin A, Nery JR, Behrens MM, Ecker JR, Ren B, Welch JD, "Iterative single-cell multi-omic integration using online learning," *Nature Biotechnology* 39:1000-1007, 2021. PM33875866.
Yao Z, Liu H, Xie F, Fischer S, Adkins RS, Aldridge AI, Ament SA, Bartlett A, Behrens MM, Van den Berge K, Bertagnolli D, de Bézieux HR, Biancalani T, Booeshaghi AS, Bravo HC, Casper T, Colantuoni C, Crabtree J, Creasy H, Crichton K, Crow M, Dee N, Dougherty EL, Doyle WI, Dudoit S, Fang R, Felix V, Fong O, Giglio M, Goldy J, Hawrylycz M, Herb BR, Hertzano R, Hou X, Hu Q, Kancherla J, Kroll M, Lathia K, Li YE, Lucero JD, Luo C, Mahurkar A, McMillen D, Nadaf NM, Nery JR, Nguyen TN, Niu SY, Ntranos V, Orvis J, Osteen JK, Pham T, Pinto-Duarte A, Poirion O, Preissl S, Purdom E, Rimorin C, Risso D, Rivkin AC, Smith K, Street K, Sulc J, Svensson V, Tieu M, Torkelson A, Tung H, Vaishnav ED, Vanderburg CR, van Velthoven C, Wang X, White OR, Huang ZJ, Kharchenko PV, Pachter L, Ngai J, Regev A, Tasic B, Welch JD, Gillis J, Macosko EZ, Ren B, Ecker JR, Zeng H, Mukamel EA, "A transcriptomic and epigenomic cell atlas of the mouse primary motor cortex," *Nature* 598(7879): 103-110, 2021. PM34616066/PMC8494649.
Welch JD*, Kozareva V, Ferreira A, Vanderburg C, Martin C, Macosko EZ*, "Single-Cell Multi-omic Integration Compares and Contrasts Features of Brain Cell Identity," *Cell* 177(7): 1873-1887, 2019. PM31178122 *Co-senior authors.

Service: Dr. Welch has a strong institutional and national service record. He has co-organized the weekly seminar series for Computational Medicine and Bioinformatics for the past three years. He navigated the challenges of COVID-19 by transitioning between remote, hybrid, and in-person formats, with changes to maximize interest and involvement. He has served on many National Institutes of Health study sections as an ad hoc reviewer. He has been and ad hoc reviewer for

several leading journals such as *Nature*, *Nature Biotechnology*, *Nature Methods*, and *Bioinformatics*. He has served as a guest editor for *PLoS Computational Biology*. Dr. Welch has been invited to speak within the United States, including at the Broad Institute of Harvard and MIT, the MIT Computer Science Department, the University of Pennsylvania, and Michigan State University, among other institutions. He also presented his findings in non-academic settings, including a joint seminar hosted by Illumina and 10X Genomics, a presentation at Biogen, and an invited talk at the Chan Zuckerberg BioHub. He has received international invitations, including from the Chinese Statistical Association annual meeting (virtual), the University of Freiburg, Germany (virtual), and the Human Technopole in Italy (in-person). Dr. Welch has served on the program committee for ACM-BCB for multiple years, as well as the program committees for ISMB/ECCB (the main conference) and RegGen SIG (regulatory genomics track within ISMB). He co-organized a conference workshop on single-cell genomics at ACM-BCB 2021 and is currently co-organizing a workshop on tensor methods for the Joint Mathematics Meeting in January 2023.

External Reviewers:
Reviewer A: "…I have seen numerous talks by a variety of groups that regularly leverage the tools Dr. Welch is producing in his group to perform analysis and integration of complex datasets. This affirms Dr. Welch's key role and outsized contributions to the field, making him stand out among his peers and undoubtedly exceeding the established requirements for promotion at both my institute as well as those of the University of Michigan."

Reviewer B: "Dr. Welch is currently very well supported by multiple NIH his laboratory, with focus on technique development and application to brain datasets, as well as Co-I on several other grants that support the laboratory's research in related developmental and disease systems. His pending applications indicate an appropriately muscular approach to continuing his laboratory's adequate funding in the future. The overall level of support is more typical of a senior investigator than assistant professor in his first four years, illustrating that this scientist is clearly a rising star and worthy of strong support."

Reviewer C: "He is clearly one of the leading experts in developing single-cell (and more broadly machine learning) methods and tools. His work LIGER, etc. was one of the first tools in the domain that was widely used/referenced. Josh's computational work was often published in high impact journals such as Cell, Nature Biotech, Genome Biology, etc. It is impressive that he processes the depth in computer science, as well as the breadth in biological science, which is quite rare in the research community."
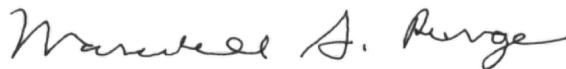
Reviewer D: "What also separates Josh from many other computational biologists is his strong ability to go beyond just developing new computational models but actually using the computational methods to derive new biological insights. He has co-authored papers related to direct cardiac reprogramming and skeletal regeneration by applying his computational methods. This is also strongly manifested in his funding record. Even though he has only started his lab a few years ago, he has already received multiple R01-like NIH grants, either as sole PI or multi-PI, which is remarkable for an early-stage junior investigator."

Reviewer E: "In terms of how Dr. Welch's standing in relation to others in his peer group, as above, he is quite simply leading this critical area of computational methods development. Further, his contributions to the discipline are outstanding, with memberships on several study sections, editorial boards and work as an ad hoc reviewer for several journals – all in addition to his exceptional productivity in papers published and grants awarded."

Reviewer F: "The high regard that the community has for Dr. Welch's work is evidenced by responsibilities and community service he has been trusted with – he has served on several NIH study sections and conference program committees – and by the amazing success he has had in securing highly competitive NIH grants."

Summary of Evaluation:
Dr. Welch has launched an impressive start to his academic career, distinguishing himself as a leading researcher and scholar in the field of computational methodology. Dr. Welch has made significant teaching contributions and has a strong service record locally and nationally. Given this excellent record of achievement, we recommend Joshua Welch, Ph.D. for promotion to associate professor of computational medicine and bioinformatics, with tenure, Department of Computational Medicine and Bioinformatics, Medical School, and associate professor of electrical engineering and computer science, without tenure, Department of Electrical Engineering and Computer Science, College of Engineering.

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Marschall S. Runge, M.D., Ph.D.
Executive Vice President of Medical Affairs
Dean, Medical School

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Alec D. Gallimore, Ph.D.
Robert J. Vlasic Dean of Engineering
College of Engineering

May 2023