OMB No. 0925-0001 and 0925-0002 (Rev. 10/2021 Approved Through 09/30/2024)

**BIOGRAPHICAL SKETCH**

Provide the following information for the Senior/key personnel and other significant contributors.

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| --- |
| NAME: Tustison, Nicholas |
| eRA COMMONS USER NAME (credential, e.g., agency login): tustison |
| POSITION TITLE: Associate Professor |

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

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| INSTITUTION AND LOCATION | DEGREE (if applicable) | END DATE MM/YYYY | FIELD OF STUDY |
| Brigham Young University, Provo, Utah | BS | 04/1998 | Applied Physics: Computer Science Emphasis |
| University of Virginia, Charlottesville, VA | MS | 05/2000 | Biomedical Engineering |
| Washington University in Saint Louis, Saint Louis, Missouri | DSC | 08/2004 | Biomedical Engineering |

### **A. Personal Statement**

I have authored several articles detailing novel image analysis techniques, including registration and segmentation, for a variety organ applications. As a core developer of the open source Insight Toolkit (National Library of Medicine) and the popular Advanced Normalization Tools (ANTs), I have extensive experience with robust software and algorithm development and employing these tools in robust pipelines for large-scale imaging studies.

1. Tustison,Nicholas J.,, Yassa,Michael A.,, Rizvi,Batool,, Holbrook,Andrew J.,, Sathishkumar,Mithra T.,, Gee,James C.,, Stone,James R.,, Avants,Brian B.,. ANTsX neuroimaging-derived structural phenotypes of UK Biobank. [Preprint]. 2023 January 18. DOI: 10.1101/2023.01.17.23284693
2. Tustison NJ, Holbrook AJ, Avants BB, Roberts JM, Cook PA, Reagh ZM, Duda JT, Stone JR, Gillen DL, Yassa MA. Longitudinal Mapping of Cortical Thickness Measurements: An Alzheimer's Disease Neuroimaging Initiative-Based Evaluation Study. J Alzheimers Dis. 2019;71(1):165-183. PubMed PMID: 31356207.
3. Tustison NJ, Cook PA, Klein A, Song G, Das SR, Duda JT, Kandel BM, van Strien N, Stone JR, Gee JC, Avants BB. Large-scale evaluation of ANTs and FreeSurfer cortical thickness measurements. Neuroimage. 2014 Oct 1;99:166-79. PubMed PMID: 24879923.
4. Avants BB, Tustison NJ, Stauffer M, Song G, Wu B, Gee JC. The Insight ToolKit image registration framework. Front Neuroinform. 2014;8:44. PubMed Central PMCID: PMC4009425.

### **B. Positions, Scientific Appointments and Honors**

**Positions and Scientific Appointments**

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| --- | --- |
| 2018 - | Visiting Associate Researcher, Department of Neurobiology and Behavior, University of California, Irvine, Irvine, CA |
| 2017 - | Associate Professor, Department of Radiology and Medical Imaging, University of Virginia, Charlottesville, VA |
| 2016 - 2018 | Visiting Assistant Researcher, Department of Neurobiology and Behavior, University of California, Irvine, Irvine, CA |
| 2010 - 2017 | Assistant Professor, Department of Radiology and Medical Imaging, University of Virginia, Charlottesville, VA |
| 2005 - 2010 | Senior Research Investigator, Penn Image Computing and Science Laboratory, University of Pennsylvania, Philadephia, PA |
| 2004 - 2005 | Research Fellow, Penn Image Computing and Science Laboratory, University of Pennsylvania, Philadelphia, PA |

### **C. Contribution to Science**

1. Working with colleagues from the University of Pennsylvania, I have made important contributions (both practical and theoretical) to image registration—a fundamental processing step in many medical image analysis tasks. These include contributions to biological modeling using parsimonious transformations described by diffeomorphisms which are smooth transforms with differentiable inverses. The utility of such transforms spans the gamut of possible applications from cardiac and lung mechanics to brain mapping. Other utilities have included point set similarity metrics for other application domains. In support of open science and reproducibility, I have made these contributions available through the Insight Toolkit (ITK) of the National Institutes of Health for other researchers to use. Additionally, my colleagues and I have won several competitions related to our image registration contributions. Specifically, the EMPIRE10 (registration of CT lung images) and STACOM2014 (cardiac motion estimation) challenges were both won using our image registration contributions.
   1. Avants BB, Tustison NJ, Stauffer M, Song G, Wu B, Gee JC. The Insight ToolKit image registration framework. Front Neuroinform. 2014;8:44. PubMed Central PMCID: PMC4009425.
   2. Tustison NJ, Avants BB. Explicit B-spline regularization in diffeomorphic image registration. Front Neuroinform. 2013;7:39. PubMed Central PMCID: PMC3870320.
   3. Tustison NJ, Awate SP, Song G, Cook TS, Gee JC. Point set registration using Havrda-Charvat-Tsallis entropy measures. IEEE Trans Med Imaging. 2011 Feb;30(2):451-60. PubMed PMID: 20937578.
   4. Tustison NJ, Avants BB, Gee JC. Directly manipulated free-form deformation image registration. IEEE Trans Image Process. 2009 Mar;18(3):624-35. PubMed PMID: 19171516.
2. In general, my contributions have been methodological. Most importantly, these contributions have been made available as open source software through the Advanced Normalization Tools (ANTs) and the underlying Insight Toolkit (ITK) of the National Library of Medicine of the NIH. ANTs was first created to rapidly disseminate our latest research to the community of scientists who depend on imaging analytics and to allow them to study different organ systems, species or modalities with the same sound foundation. While originally focused on diffeomorphic image registration, ANTs now incorporates novel and cutting-edge methods for image cleaning, segmentation, feature extraction and, more recently, complete statistical pipelines via ANTsR. In 2014, there were nearly 2,000 citations to ANTs and the software is cloned, downloaded or otherwise accessed over 100-200 times per week, on average at github. The sourceforge site hosts a similar number of visits and downloads. ANTsR is accessed on average 50 times per week---a substantial number for new software. There are also over 500 discussion topics on the ANTs Sourceforge community site, nearly 100 topics on the GitHub site and over 50 help-focused emails to the personal addresses of developers. Generally, response time to requests for help is within a few hours with rare occasions taking up to a day or two and is primarily split between myself and my colleague, Brian Avants.
   1. Tustison NJ, Cook PA, Klein A, Song G, Das SR, Duda JT, Kandel BM, van Strien N, Stone JR, Gee JC, Avants BB. Large-scale evaluation of ANTs and FreeSurfer cortical thickness measurements. Neuroimage. 2014 Oct 1;99:166-79. PubMed PMID: 24879923.
   2. Avants BB, Tustison NJ, Wu J, Cook PA, Gee JC. An open source multivariate framework for n-tissue segmentation with evaluation on public data. Neuroinformatics. 2011 Dec;9(4):381-400. PubMed Central PMCID: PMC3297199.
   3. Avants BB, Tustison NJ, Song G, Cook PA, Klein A, Gee JC. A reproducible evaluation of ANTs similarity metric performance in brain image registration. Neuroimage. 2011 Feb 1;54(3):2033-44. PubMed Central PMCID: PMC3065962.
   4. Tustison NJ, Avants BB, Cook PA, Zheng Y, Egan A, Yushkevich PA, Gee JC. N4ITK: improved N3 bias correction. IEEE Trans Med Imaging. 2010 Jun;29(6):1310-20. PubMed Central PMCID: PMC3071855.
3. My colleagues and I have also raised very important critiques with respect to foundational tools used in neuroimaging research and general scientific practices. In one publication, we demonstrated how a common image mapping technique for determining statistical differences in populations results in significant false positives. This issue dovetails with related selection bias issues in the fMRI literature and in neuroscience research practices. We have also provided researchers and reviewers with guidelines for assessing the relative performance of scientific software and the pitfalls associated with instrumentation bias where software is viewed as a scientific instrument requiring proper usage.
   1. Tustison NJ, Avants BB, Cook PA, Kim J, Whyte J, Gee JC, Stone JR. Logical circularity in voxel-based analysis: normalization strategy may induce statistical bias. Hum Brain Mapp. 2014 Mar;35(3):745-59. PubMed Central PMCID: PMC6868960.
   2. Tustison NJ, Johnson HJ, Rohlfing T, Klein A, Ghosh SS, Ibanez L, Avants BB. Instrumentation bias in the use and evaluation of scientific software: recommendations for reproducible practices in the computational sciences. Front Neurosci. 2013;7:162. PubMed Central PMCID: PMC3766821.