

The Advanced Normalization Tools (ANTs) is a state-of-the-art, open-source software toolkit for image registration, segmentation, and other functionality for comprehensive biological and medical image analysis. Historically, ANTs is rooted in advanced image registration techniques which have been at the forefront of the field due to seminal contributions that date back to the original elastic matching method of Bajcsy and co-investigators¹⁻³ and continues to set the standard in the field. Various independent platforms have been used to evaluate ANTs tools since their early development. In a landmark paper⁴, the authors reported an extensive evaluation using multiple neuroimaging datasets analyzed by fourteen different registration tools, including the Symmetric Normalization (SyN) algorithm⁵ found in ANTs⁶, and found that “ART, SyN, IRTK, and SPM’s DARTEL Toolbox gave the best results according to overlap and distance measures, with ART and SyN delivering the most consistently high accuracy across subjects and label sets.”

Since its inception, though, ANTs has expanded significantly beyond its image registration origins. Other core contributions include template building⁷, segmentation⁸, image preprocessing (e.g., bias correction⁹ and denoising¹⁰), joint label fusion^{11,12}, and brain cortical thickness estimation^{13,14}. Additionally, ANTs has been integrated into multiple, publicly available workflows such as fMRIPrep¹⁵ and the Spinal Cord Toolbox¹⁶. Frequently used ANTs pipelines, such as cortical thickness estimation¹⁴, have been integrated into Docker containers and packaged as Brain Imaging Data Structure (BIDS)¹⁷ and FlyWheel applications (i.e., “gears”). It has also been independently ported for various platforms including Neurodebian¹⁸ (Debian OS), Neuroconductor¹⁹ (the R statistical project), and Nipype²⁰ (Python). Even competing softwares, such as FreeSurfer²¹, have incorporated well-performing and complementary ANTs components^{9,10} into their own libraries.

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Competing interests

The authors declare no competing interests.