ARISTEIDIS SOTIRAS

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Research Associate
Section of Biomedical Image Analysis
University of Pennsylvania

APPOINTMENTS

2016 – present	**Center for Biomedical Image Computing and Analytics** **University of Pennsylvania, Philadelphia, PA** *Research Associate*
2012 – 2016	**Center for Biomedical Image Computing and Analytics** **University of Pennsylvania, Philadelphia, PA** *Postdoctoral Research Scholar*. Supervisor: Christos Davatzikos

RESEARCH INTERESTS

Medical imaging	Computer aided diagnosis, computational anatomy, computer vision in biomedical imaging, image registration, image segmentation, multi-atlas segmentation, tumor segmentation
Machine learning	Support vector machines, sparse learning, dictionary learning, non-negative matrix factorization, graphical models, markov random fields
Clinical applications	Brain development, healthy aging, Alzheimer's disease, disease heterogeneity

EDUCATION

2007 – 2011	**École Centrale Paris (ECP), France – Inria Saclay** *Ph.D. in Applied Mathematics,* with the highest distinction and the compliments of the jury for the excellent quality of the work. Discrete Image Registration: a *Hybrid* Paradigm. Supervisor: Nikos Paragios
2006 – 2007	**École Polytechnique – École Normale Supérieure (ENS), Cachan, France** *M.Sc. in Mathematics, Vision and Machine Learning*, with distinction.
2001 – 2006	**National Technical University of Athens, Greece** *Diploma in Electrical and Computer Engineering.*

AWARDS AND HONORS

2016	*CBICA-UPenn* **Seed Grant Award** (PI), Jun. 2016-Jun. 2017. Budget=$50,000.
2016	**First rank** in *Multimodal brain tumor segmentation challenge (BRATS)*.
2016	*MICCAI'16*, **Student Travel Award**
2015	*MICCAI'15*, **Student Travel Award**
2015	*IEEE ISBI*, **Best Student Paper Award Finalist**
2015	**Top rank** in *Multimodal brain tumor segmentation challenge (BRATS)*.
2014	**Top rank** in *Alzheimer's Disease Big Data DREAM Challenge.*
2010	*IEEE ISBI*, **Best Student Paper Award**

2007 – 2010 **Panagiotis Triantafyllidis Scholarship** awarded by the *Greek Ministry of Education*
2007 – 2008 **Scholarship for Excellence** awarded by *École Polytechnique*

EXECUTIVE SUMMARY

Publications (h-index=12, citations>1250)

- 5 papers in acclaimed journals with high impact factor (impact factor >8).
- 1st author ***Proc. Natl. Acad. Sci.*** paper on brain development (broad scientific and popular **press** interest).
- Landmark survey paper on image registration (**>500** citations; most popular and cited papers in *IEEE Trans. Med. Imaging*)
- Highly cited discrete registration paper in *Annu. Rev. Biomed. Eng.* (**>100** citations).
- Highly cited DRAMMS registration paper in *Med. Image Anal.* (**>200** citations; ScienceDirect 25 Hottest Articles, Medical Image Analysis, 2011; Most Cited Medical Image Analysis Articles by Scopus for 2010-2014, 2011-2015).

Contributions to Science

Image registration and segmentation: pioneered the use of discrete optimization techniques and probabilistic graphical models for efficient image registration.

- Novel **hybrid pairwise registration** coupling landmark and intensity information.
- Novel discrete framework for **groupwise registration** and atlas creation.
- Novel discrete **multi-atlas segmentation** framework that solves the atlas-to-target registrations and label fusion steps simultaneously.
- DRAMMS: discrete **feature-based pairwise registration**.
- DRAMMS registration **software** (**>1000** downloads; used extensively in NIH funded studies).
- Robust **statistical-based registration** for oncologic imaging.

Development of novel machine learning tools for large heterogeneous studies:

- **Non-negative matrix factorization** for interpretable data reduction and biomarker extraction.
- Novel **semi-supervised machine learning** tools for disentangling **heterogeneity** in cross-sectional and longitudinal studies.
- Novel method for **adaptive discriminative smoothing** for multivariate inference.

Multivariate pattern analysis of large neuroimaging studies:

- Novel delineation of **cortical organization** in large neurodevelopmental study (findings published in ***Proc. Natl. Acad. Sci.***).
- Novel **data-driven definition of neuroanatomical subtypes** in Alzheimer's Disease (findings published in *Brain* and *NeuroImage*).

Grant-writing experience

- Intra-mural CBICA **Seed Grant Award (PI):** *Characterization of regional neurodevelopment in adolescence through non-negative pattern analysis*
- NIH multi-PI (PIs: Davatzikos, Sotiras) **R01** Grant submission (NIBIB BMIT-B): *Quantifying the heterogeneity of multi-modal brain imaging patterns using machine learning: towards dimensional neuroimaging of brain diseases*

PUBLICATIONS

Working papers

W1) S. Bakas, G. Shukla, H. Akbari, G. Erus, **A. Sotiras**, M. Rozycki, R. T. Shinohara, & C. Davatzikos, (2017). Survival prediction in glioblastoma patients using integrative analysis of radiomic features: from advanced to basic magnetic resonance imaging acquisition protocols. Under Review.

W2) M. Habes, **A. Sotiras**, G. Erus, J. B. Toledo, D. Janowitz, D. A. Wolk, H. Shou, N. Bryan, J. Doshi, H. Völzke, U. Schminke, W. Hoffmann, S. M. Resnick, H. J. Grabe, & C. Davatzikos, (2017). Spatial heterogeneity of white matter hyperintensities: links to vascular risk factors, cognition, atrophy and Alzheimer's genetics. Under Revision in Neurology.

W3) R. Nassar*, A. N. Kaczkurkin*, C. Xia, **A. Sotiras**, et al., (2017). Gestational Age is Dimensionally Associated with Structural Brain Network Abnormalities in Adolescence. In Progress.

W4) D. P. Varikuti, S. Genon, **A. Sotiras**, H. Schwender, F. Hoffstaedter, C. Jockwitz, S. Caspers, S. Moebus, K. Amunts, C. Davatzikos, & S. B. Eickhoff, (2017). Evaluation of non-negative matrix factorization of gray matter in age prediction. In Progress.

W5) E. Varol, **A. Sotiras**, & C. Davatzikos, (2017). MIDAS: Multivariate inference with discriminative adaptive smoothing. In Progress.

W6) A. Dong, **A. Sotiras**, E. Varol, J. Doshi, R. T. Shinohara, S. M. Resnick, & C. Davatzikos, (2017). HELIOS: Parsing the Heterogeneity of Longitudinal Imaging through Integrated Clustering and Spatiotemporally Regularized Spline Curve Fitting. In Progress.

Journals

J1) M. Pehlivanova, D. H. Wolf, **A. Sotiras**, et al., (2018). Diminished cortical thickness is associated with impulsive choice in adolescence. **Accepted** for publication in the Journal of Neuroscience. **(Impact Factor: 6.34)**

J2) C. Davatzikos, et al., (2017). Cancer Imaging Phenomics Toolkit (CaPTk): Quantitative Imaging Analytics for Precision Diagnostics and Predictive Modeling of Treatment Response. **Accepted** for publication in the Journal of Medical Imaging.

J3) S. Bakas, H. Akbari, **A. Sotiras**, M. Bilello, M. Rozycki, J. S. Kirby, J. B. Freymann, K. Farahani, & C. Davatzikos, (2017). Advancing The Cancer Genome Atlas glioma MRI collections with expert segmentation labels and radiomic features expansion. *Nature Scientific Data*, 4, 170117. **(Impact Factor: 4.84)**

J4) **A. Sotiras**, J. B. Toledo, R. C. Gur, R. E. Gur, T. D. Satterthwaite[1], & C. Davatzikos*, (2017). Patterns of coordinated cortical remodeling during adolescence: associations with functional specialization and evolutionary expansion. *Proceedings of the National Academy of Sciences*, 114(13), 3527-3532. **(Impact Factor: 9.66)**

J5) E. Varol, **A. Sotiras**, & C. Davatzikos, (2017). HYDRA: Revealing heterogeneity of imaging and genetic patterns through a multiple max-margin discriminative framework. *NeuroImage*, 145, Part B, 346-364. **(Impact Factor: 5.84)**

J6) S. Alchatzidis, **A. Sotiras**, E. I. Zacharaki, & N. Paragios, (2017). A discrete MRF framework for integrated multi-atlas registration and segmentation. *International Journal of Computer Vision*, 121(1), 169-181. **(Impact Factor: 8.22)**

[1] Authors contributed equally to this work.

J7) A. Dong*, J. B. Toledo*, N. Honnorat, J. Doshi, E. Varol, **A. Sotiras**, D. Wolk, J. Q. Trojanowski, C. Davatzikos, & Alzheimer's Disease Neuroimaging Initiative, (2017). Heterogeneity of neuroanatomical patterns in prodromal Alzheimer's disease: links to cognition, progression and biomarkers. *Brain*, 140(3), 735-747. **(Impact Factor: 10.29)**

J8) G. I. Allen, et al., (2016). Crowdsourced estimation of cognitive decline and resilience in Alzheimer's disease. *Alzheimer's & Dementia*, 12(6), 645-653. **(Impact Factor: 9.48)**

J9) K. Zeng, G. Erus, **A. Sotiras**, R. T. Shinohara, & C. Davatzikos, (2016). Abnormality detection via iterative deformable registration and basis-pursuit decomposition. *IEEE Transactions on Medical Imaging*, 35(6), 1937-1951. **(Impact Factor: 3.94)**

J10) **A. Sotiras**, S. M. Resnick, & C. Davatzikos, (2015). Finding imaging patterns of structural covariance via Non-Negative Matrix Factorization. *NeuroImage*, 108, 1-16. **(Impact Factor: 5.84)**

J11) **A. Sotiras**, C. Davatzikos, & N. Paragios, (2013). Deformable medical image registration: A survey. *IEEE Transactions on Medical Imaging*, 32(7), 1153-1190. **(Impact Factor: 3.94; > 500 citations)**

J12) B. Glocker*, **A. Sotiras*,** N. Komodakis, & N. Paragios, (2011). Deformable medical image registration: Setting the state of the art with discrete methods. *Annual Review of Biomedical Engineering*, 13, 219-244. **(Impact Factor: 10.51, > 100 citations)**

J13) Y. Ou, **A. Sotiras,** N. Paragios, & C. Davatzikos, (2011). DRAMMS: Deformable registration via attribute matching and mutual-saliency weighting. *Medical Image Analysis*, 15(4), 622-639. **(Impact Factor: 4.19, > 200 citations, > 1000 downloads)**

Peer-reviewed conferences

C1) K. Zeng, **A. Sotiras**, & C. Davatzikos, (2018). Statistically-constrained robust diffeomorphic registration. *IEEE International Symposium on Biomedical Imaging*

C2) E. Varol, **A. Sotiras**, & C. Davatzikos, (2018). Regionally discriminative multivariate statistical mapping. *IEEE International Symposium on Biomedical Imaging*

C3) E. Varol, **A. Sotiras**, & C. Davatzikos, (2016). Structured Outlier Detection in Neuroimaging Studies with Minimal Convex Polytopes. *International Conference on Medical Image Computing and Computer-Assisted Intervention*, 9900, 300-307. **Student travel award. (Acceptance Rate: 30.1%)**

C4) K. Zeng, S. Bakas, **A. Sotiras**, H. Akbari, M. Rozycki, S. Rathore, S. Pati, & C. Davatzikos, (2016). Segmentation of Gliomas in Pre-Operative and Post-Operative Multimodal Magnetic Resonance Imaging Volumes Based on a Hybrid Generative-Discriminative Framework. *International Workshop on Brainlesion: Glioma, Multiple Sclerosis, Stroke and Traumatic Brain Injuries*, 10154, 184-194.

C5) E. Varol, **A. Sotiras**, & C. Davatzikos, (2015). Disentangling disease heterogeneity with max-margin multiple hyperplane classifier. *International Conference on Medical Image Computing and Computer-Assisted Intervention*, 9349, 702-709. **Student travel award. (Acceptance Rate: 32.5%)**

C6) A. Gastounioti, **A. Sotiras**, K. S. Nikita & N. Paragios, (2015). Graph-based motion-driven segmentation of the carotid atherosclerotique plaque in 2D ultrasound sequences. *International Conference on Medical Image Computing and Computer-Assisted Intervention*, 9351, 551-559. **(Acceptance Rate: 32.5%)**

C7) V. Fécamp, **A. Sotiras**, & N. Paragios, (2015). Modular linear iconic matching using higher order graphs. *IEEE International Symposium on Biomedical Imaging*, 1097-1101. **Best student paper award finalist.**

C8) S. Alchatzidis, **A. Sotiras**, & N. Paragios, (2015). Local atlas selection for discrete multi-atlas segmentation. *IEEE International Symposium on Biomedical Imaging*, 363-367. **Oral presentation. (Oral Acceptance Rate: 18.2%)**

C9) S. Bakas, K. Zeng, **A. Sotiras**, H. Akbari, M. Rozycki, S. Rathore, S. Pati, & C. Davatzikos, (2015). GLISTRboost: combining multimodal MRI segmentation, registration, and biophysical tumor growth modeling with gradient boosting machines for glioma segmentation. *International Workshop on Brainlesion: Glioma, Multiple Sclerosis, Stroke and Traumatic Brain Injuries*, 9556, 144-155.

C10) V. Fécamp, **A. Sotiras**, & N. Paragios, (2015). Simultaneous linear and deformable registration through a higher order MRF model. *Medical Image Computing and Computer-Assisted Intervention Workshop on Bayesian and Graphical Models for Biomedical Imaging*.

C11) S. Alchatzidis, **A. Sotiras**, & N. Paragios, (2014). Discrete multi-atlas segmentation using agreement constraints. *Proceedings of the British Machine Vision Conference*. **Oral presentation. (Oral Acceptance Rate: 7%)**

C12) K. Karantzalos, **A. Sotiras**, & N. Paragios, (2014). Efficient and automated multimodal satellite data registration through MRFs and linear programming. *IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, 335-342.

C13) K. Gkirtzou, J.-F. Deux, G. Bassez, **A. Sotiras**, A. Rahmouni, T. Varacca, N. Paragios, & M. B. Blaschko, (2013). Sparse Classification with MRI Based Markers for Neuromuscular Disease Categorization. *International Workshop on Machine Learning in Medical Imaging*, 8184, 33-40.

C14) B. Gaonkar, **A. Sotiras**, & C. Davatzikos, (2013). Deriving Statistical Significance Maps for Support Vector Regression Using Medical Imaging Data. *International Workshop on Pattern Recognition in Neuroimaging*, 13-16.

C15) **A. Sotiras**, & N. Paragios, (2012). Discrete symmetric image registration. *IEEE International Symposium on Biomedical Imaging*, 342-345. **Oral presentation. (Oral Acceptance Rate: 19%)**

C16) S. Alchatzidis, **A. Sotiras**, & N. Paragios, (2011). Efficient parallel message computation for MAP inference. *IEEE International Conference on Computer Vision*, 1379-1386. **(Acceptance Rate: 23.7%)**

C17) **A. Sotiras**, Y. Ou, B. Glocker, C. Davatzikos, & N. Paragios, (2010). Simultaneous geometric-iconic registration. *International Conference on Medical Image Computing and Computer-Assisted Intervention*, 6362, 676-683. **(Acceptance Rate: 32%)**

C18) M. Savinaud, **A. Sotiras**, S. Maitrejean, & N. Paragios, (2010). Bioluminescence enhancement through fusion of optical imaging and cinematic video flow. *IEEE International Symposium on Biomedical Imaging*, 688-691. **Oral presentation. (Oral Acceptance Rate: 15%)**

C19) **A. Sotiras**[*], R. Neji[*], J.-F. Deux, N. Komodakis, G. Fleury, & N. Paragios, (2010). A kernel-based graphical model for diffusion tensor registration. *IEEE International Symposium on Biomedical Imaging*, 524-527. **Oral presentation. Best student paper award. (Oral Acceptance Rate: 15%)**

C20) **A. Sotiras**, N. Komodakis, B. Glocker, J.-F. Deux, & N. Paragios, (2009). Graphical models and deformable diffeomorphic population registration using global and local metrics. *International Conference on Medical Image Computing and Computer-Assisted Intervention*, 5761, 672-679. **(Acceptance Rate: 30%)**

C21) **A. Sotiras**, N. Komodakis, G. Langs, & N. Paragios, (2009). Atlas-based deformable mutual population segmentation. *IEEE International Symposium on Biomedical Imaging*, 5-8.

Abstracts

A1) S. Genon*, D. P. Varikuti*, **A. Sotiras**, H. Schwender , F. Hoffstaedter, K. Patil, C. Jockwitz, S. Caspers, S. Moebus , K. Amunts, C. Davatzikos, & S. B. Eickhoff, (2018). Localized compression of grey matter maps for age prediction in healthy & clinical populations. *Organization for Human Brain Mapping (OHBM)*.

A2) Ji Chen, et al., (2018). Modeling the Psychopathology in Schizophrenia via Machine Learning: A Worldwide Multi-Center Study. *Organization for Human Brain Mapping (OHBM)*.

A3) G. Shukla, S. Bakas, S. Rathore, H. Akbari, **A. Sotiras**, & C. Davatzikos, (2017). Radiomic Features from Multi-Institutional Glioblastoma MRI Offer Additive Prognostic Value to Clinical and Genomic Markers: Focus on TCGA-GBM Collection. *International Journal of Radiation Oncology• Biology• Physics*, 99(2), E107-E108.

A4) S. Bakas, G. Shukla, H. Akbari, **A. Sotiras**, G. Erus, M. Rozycki, G. S. Alexander, J. Lombardo, R. T. Shinohara & Christos Davatzikos, (2017). Accurate and generalizable pre-operative prognostic stratification of gioblastoma patients using integrative quantitative radiomic analysis of conventional MRI. *Neuro-Oncology*, 19(Suppl_6), vi151.

A5) **A. Sotiras**, J. B. Toledo, R. C. Gur, R. E. Gur, T. D. Satterthwaite, & C. Davatzikos, (2017). Coordinated cortical remodeling: connections to functional specialization and evolutionary expansion. *Organization for Human Brain Mapping (OHBM)*.

A6) E. Varol, **A. Sotiras**, & C. Davatzikos, (2017). Brain mapping through regional multivariate pattern analysis and discriminative adaptive smoothing. *Organization for Human Brain Mapping (OHBM)*.

A7) D. P. Varikuti, **A. Sotiras**, S. Genon, H. Schwender, F. Hoffstaedter, C. Jockwitz, S. Caspers, S. Moebus, K. Amunts, C. Davatzikos, & S. B. Eickhoff, (2017). Evaluation of non-negative matrix factorization of gray matter in age prediction. *Organization for Human Brain Mapping (OHBM)*. **Oral presentation.**

A8) T. Jeon, **A. Sotiras**, M. Ouyang, M. Chen, L. Chalak, C. Davatzikos, & H. Huang, (2016). Spatiotemporal dynamics and patterns of cortical mean kyrtosis and fractional anisotropy in the preterm brains. *International Society for Magnetic Resonance in Medicine (ISMRM)*.

A9) **A. Sotiras**, S. M. Resnick, & C. Davatzikos, (2015). Multivariate spatial patterns of amyloid deposition revealed through non-negative matrix factorization. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association*, 11(7), Supplement, P553-554.

A10) **A. Sotiras**, T. D. Satterthwaite, R. C. Gur, R. E. Gur, & C. Davatzikos, (2015). Mapping Developmental Topography of Brain Morphology through Non-Negative Matrix Factorization. *Organization for Human Brain Mapping (OHBM)*.

A11) **A. Sotiras**, R. C. Gur, R. E. Gur, T. D. Satterthwaite, & C. Davatzikos, (2014). Extracting Spatial Patterns of Cortical Thickness Covariance via Non-Negative Matrix Factorization. *Organization for Human Brain Mapping (OHBM)*.

Technical reports

T1) **A. Sotiras**, C. Davatzikos, & N. Paragios, (2012). Deformable medical image registration: a survey. *INRIA Research Report*, RR-7919.

T2) **A. Sotiras**, N. Komodakis, & N. Paragios, (2009). MRF-based diffeomorphic population deformable registration & segmentation. *INRIA Research Report*, RR-6837.

T3) **A. Sotiras**, R. Neji, J.-F. Deux, N. Komodakis, M. Maatouk, A. Rahmouni, G. Bassez, G. Fleury, & N. Paragios, (2009). Diffusion tensor registration using probability kernels and discrete optimization. *INRIA Research Report*, RR-6943.

Book chapters

B1) **A. Sotiras**, B. Gaonkar, H. Eavani, N. Honnorat, E. Varol, A. Dong, & C. Davatzikos, (2016). Machine Learning as a Means Toward Precision Diagnostics and Prognostics. *Machine Learning and Medical Imaging*.

B2) **A. Sotiras**, Y. Ou, N. Paragios, & C. Davatzikos, (2015). Graph-based deformable registration. *Handbook of Biomedical Imaging; Methodologies and Clinical Research*.

Patents

P1) S. Alchatzidis, **A. Sotiras**, & N. Paragios, (2014). Method and device for efficient parallel message computation for map inference. US Patent 8890862.

INVITED TALKS

Dec. 2016	*Challenges in big data analysis in neuroimaging*. Rutgers University.
Jun. 2015	*Harmonizing sMRI data via robust preprocessing*. NIMH-sponsored Organization for Human Brain Mapping (OHBM) satellite meeting: "Harmonize This: Analyzing Diverse Neuroimaging Datasets".
Jul. 2013	*Deformable registration: deformations, similarity metrics, & optimization*. Biomedical imaging summer school. Institut Henri Poincaré.
Oct. 2012	*Registration, rigid and non-rigid*. International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI) tutorial: "From Minimally Invasive Image-Guided Interventions To Non-Invasive Ultrasound based Interventions".
Feb. 2012	*Discrete Hybrid Image Registration*. Imperial College London.
Jan. 2012	*Discrete Hybrid Image Registration*. NeuroSpin.

TEACHING EXPERIENCE

Guest lecturer	Statistical methods for neuroimaging, (2017). Prof. R. T. Shinohara, University of Pennsylvania.
	Biomedical image analysis, (2015, 2017). Prof. P. Yushkevich, University of Pennsylvania.
Teaching assistant	Signal processing, (2010). Prof. I. Kokkinos, École Centrale Paris.
	Computer vision, (2009). Prof. I. Kokkinos, École Centrale Paris.
Research supervision	Supervision of the Ph.D. work of Maria Peifer, Aoyan Dong, Erdem Varol and Ke Zeng (with Prof. C. Davatzikos, University of Pennsylvania). Supervision of the Ph.D.

work of Stavros Alchatzidis and Vivien Fécamp (with Prof. N. Paragios, École Centrale Paris).

PROFFESIONAL ACTIVITIES

Co-organizer	2017 Medical Image Computing and Computer-Assisted Intervention Workshop: *GRAIL: Graphs in Biomedical Image Analysis.* 2015 International Symposium on Biomedical Imaging special session: *Current Challenges and Methodological Advances in Biomedical Image Registration*.
Journal & Conference Reviewer	Ad-hoc reviewer for IEEE (T-PAMI, TMI, JHBI, TBME); Springer IJCV; Elsevier (MEDIA, CVIU, NIMG, NBA, PatRec) journals, as well as for conferences including MICCAI, CVPR, BMVC, ICCV, ECCV, and ISBI.
Funding Body Reviewer	National Institute of Standards and Technology, US-Israel Binational Industrial Research and Development (BIRD) Foundation
Program committee	2015 Medical Image Computing and Computer-Assisted Intervention Workshop: Bayesian and graphical models for biomedical imaging.
Ph.D. committee	Dr. Vivien Fécamp (École CentraleSupélec, N. Paragios), 12 Jan. 2016.