KAIBO TANG

Undergraduate Researcher at UNC BRAIN Lab
Intern at Martinos Center
Honors Carolina Student, Class of 2025

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SUMMARY

I am a senior at UNC-Chapel Hill double majoring in Biostatistics, BSPH, and Mathematics, BS with a minor in Chemistry. I haved worked as a undergraduate researcher at UNC BRAIN Lab since my freshman year. In Summer 2024, I work as an intern at Martinos Center. Currently, I am seeking an Ph.D. position for Fall 2025.

SKILLS

Languages:	Python, Java, LaTeX, HTML, Markdown
Professional Softwares:	FreeSurfer, FSL, ANTs, Paraview, DSI-Studio, ITK, VTK, CMake, MATLAB, SAS
Others:	Git, Docker, PyTorch, TensorFlow, MONAI

EDUCATION

8/2021 - Present — **Biostatistics, BSPH, Mathematics, BS, and minor in Chemistry** — **UNC-Chapel Hill**
Accelerated Research Program | Dean's List, all semesters
Honors: Honors Carolina, Phi Beta Kappa
Cumulative GPA: 3.937/4.0

8/2018 - 5/2021 — **High school degree** — **The Stony Brook School**
Honors: Summa Cum Laude
Cumulative GPA: 4.185/4.3

EXPERIENCE

5/2021 – Present — **Summer Intern** — Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital, Charlestown, MA
- Currently working on a project on developing novel reconstruction method that will offer significant acceleration for mesoscale diffusion MRI (dMRI) acquisition.
- **Skills:** Medical Image Analysis (Image Reconstruction), MATLAB, Deep Learning

9/2021 – Present — **Undergraduate Research Assistant** — Biomedical Research and Imaging Center (BRIC), UNC-Chapel Hill, Chapel Hill, NC
- Completed a preliminary research project in Summer 2022 on leveraging auxiliary data to improve infant brain MR image registration.
- Currently working on an independent project on building age-conditioned infant brain atlases with anatomically realistic segmentation maps using generative adversarial networks (GANs).
- **Skills:** Medical Image Analysis (Image Registration, Image Segmentation), PyTorch, TensorFlow, SLURM, Deep Learning

1/2023 – Present — **Undergraduate Lab Assistant** — Department of Biology, UNC-Chapel Hill, Chapel Hill, NC
- Currently working as a Lab Assistant for BIOL 252L Fundamentals of Human Anatomy and Physiology Lab.
- Responsible for answering questions in class, holding office hours before exams, and proctoring exams.
- **Skills:** Teaching

1/2023 – Present — **Undergraduate Volunteer** — Emergency Department, UNC Medical Center
- Currently working 2 hours every Monday in the Emergency Department at UNC Medical Center.
- Responsible for answering call bells, rounding on patients, and helping with tubing stations.

6/2019 – 7/2019 — **Student Researcher** — National Advanced Driver Simulator (NADS), Coralville, IA
- Partly responsible for a meta-analysis project.
- Focused on setting up and benchmarking a computer cluster for the lab.
- The final project was awarded the Best Peer Review Award.

PUBLICATIONS AND MANUSCRIPTS

- **Kaibo Tang**, Registering Infant Brain MR Images with Auxiliary Data. 2022. Poster available at Carolina Digital Repository.

- **Kaibo Tang**, Liangjun Chen, Zhengwang Wu, Fenqiang Zhao, Ya Wang, Weili Lin, Li Wang, Gang Li. Generation of anatomy-realistic 4D infant brain atlases with tissue maps using generative adversarial networks. Accepted to ISBI 2024 (Oral).

- **Kaibo Tang**, Xiuyu Dong, Zhengwang Wu, Ya Wang, Laifa Ma, Fenqiang Zhao, Li Wang, Weili Lin, He Zhang, Gang Li. Surface-Guided Construction of 4D Volumetric Atlases of Fetal Brains. Under review.

SELECTED PROJECTS

Contribution	**Contributed to DIPY/DIPY**	**github.com/dipy/dipy**

Opened and merged pull request #3237, which deprecates the old `rbf_interpolation` function in favor of the newly added `interp_rbf` function that supports interpolation of tensor-valued spherical functions.

Contribution	**Contributed to Project MONAI/MONAI**	**github.com/Project-MONAI/MONAI**

- Opened and merged pull request #7178 in response to a feature request proposed in issue #5484, which adds a new `VoxelMorph` class to the existing MONAI Core and can serve as a general framework based on which one can easily construct a deep learning network for 2D/3D image registration.
- Opened and merged pull request #7272, which adds a new registration regularizer `DiffusionLoss` in addition to the existing `BendingEnergyLoss`.

Contribution	**Contributed to Project MONAI/tutorials**	**github.com/Project-MONAI/tutorials**

- Opened and merged pull request #1566, which adds a tutorial on leveraging the newly implemented `VoxelMorph` class to perform 3D image registration task on Learn2Reg 2021 Task 3 (OASIS dataset).
- Opened and merged pull request #1589, which adds a notebook demonstrating the scaling laws regarding the newly added `BendingEnergyLoss` and `DiffusionLoss`.

Tool	**Pituitary Segmentation**	**github.com/kvttt/Pituitary_Segmentation**

Created a Python-based and a bash-based command line tool for atlas-based segmentation of the pituitary on MR images. The tool supports using multiple atlases to improve the robustness of the segmentation result.

Tool	**Spherical-Harmonics-Fitting**	**mathworks.com/matlabcentral/fileexchange/168591-spherical-harmonics-fitting**

An unofficial MATLAB re-implementation of selected tools for fitting Spherical Harmonics in DIPY. The package is re-implemented such that the functionality (e.g. support for vectorization) and behavior (e.g., Condon–Shortley phase factor) is entirely consistent with the DIPY implementation. In addition, the package includes a generic function for spherical harmonics.

Tool	**Patch2Self_MATLAB**	**mathworks.com/matlabcentral/fileexchange/168596-patch2self_matlab**

Re-implemented Patch2Self in MATLAB based on the original paper and the official DIPY implementation. Patch2Self is a widely used self-supervised learning method for denoising diffusion MRI data. However, the use case of my current project (and many others) requires running Patch2Self as part of a MATLAB pipeline. Re-implementation of Patch2Self in MATLAB allows for seamless integration of Patch2Self into such pipeline.

Tool	**ICON_OASIS**	**github.com/kvttt/ICON_OASIS**

A reproduction of ICON and GradICON on the OASIS dataset based on the ICON original paper and GradICON original paper. This re-implementation uses `MONAI.networks.nets.VoxelMorph` and `MONAI.losses.DiffusionLoss`. This project provides an example of how to integrate the ICON and GradICON loss functions into an existing training pipeline.

Tool	**UnstructuredInterpolation**	**github.com/kvttt/UnstructuredInterpolation**

Created a utility for unstructured interpolation of 2D/3D data at any number of arbitrary locations based on `torch.nn.functional.grid_sample`. Cases where this is useful include applying a displacement field predicted at discrete voxel locations to a densely and continuously sampled surface represented by a set of vertices.

Tool	**PerfusionDSA**	**github.com/kvttt/PerfusionDSA**

Created an interactive command line tool that takes as input a series of $2D+t$ images produced by cerebral X-ray Digital Subtraction Angiogram (DSA) and produces parametric images including cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT), and time to maximum flow-scaled residue function (Tmax).

Tool	**N4BiasFieldCorrection**	**github.com/kvttt/N4BiasFieldCorrection**

Created an easy-to-use command line tool that performs N4 bias field correction on a 3D volume based on a SimpleITK tutorial.

Tool	**XRayPanomara**	**github.com/kvttt/XRayPanorama**

Created an interactive command line tool with simple GUI that, given the hip, knee, and ankle images of the same subject, stitches the three images together based on a SimpleITK tutorial. Additional functionalities were added to enhance the appearance of the resulting panorama.

Tool	**SpectralProfile**	**github.com/kvttt/SpectralProfile**

Created a little script that can be easily used on any PyTorch project to visualize the spectral profile of a generated (or any) image (either 2D or 3D) based on Fast Fourier Transform (FFT).

Documentation	**OpenNFT-Note**	opennft-notes.readthedocs.io/en/latest/

Created a personal notebook of my experience with Open-NFT, a Python/MATLAB-based tool for real-time fMRI neurofeedback training. The notebook includes details from how to setup the environment to how to run a trial run and is available both in Chinese and English.

NOTES PRODUCED

On Spherical Harmonics — **Spherical Harmonics Fitting** — **Link to Note**

Developed a 7-page note which serves as an accompanying note for the MATLAB toolbox Spherical Harmonics Fitting. The note covers both the technical aspect, which includes three different formulations of the least squares problem associated with spherical harmonics fitting and the derivation of a regularizer, and the practical aspect, which includes line-by-line explanation of the usage of the toolbox.

On Statistical Estimation — **Score Matching** — **Link to Note**

Developed a 6-page note that provides an in-depth explanation of score matching originally proposed by Hyvärinen. The note provides more detailed explanations of the theorems presented in the paper with elementary but more rigorous proofs. The note also includes explanation of the motivation behind score matching and clarification of some of the mild yet essential regularity assumptions omitted by the author.

On Ill-posed Inverse Problems — **Plug-and-Play ADMM using MATLAB and PyTorch** — **Link to Note**

Developed a 6-page tutorial on how to implement the Plug-and-Play ADMM algorithm using MATLAB and PyTorch. MATLAB is used to for solving the regularized least-squares problem associated with the first step. PyTorch is used to export a pre-trained denoiser model, which is plugged into the ADMM algorithm.

On Image Registration — **Converting ANTs affine matrix to a 4×4 homogeneous matrix** — **Link to Note**

Developed a 4-page note that demonstrates two methods of converting an affine matrix obtained from ANTs to a 4×4 homogeneous matrix, which can be subsequently incorporated into a pipeline dealing with both image volumes and surfaces.

On Image Registration — **Deformable Image Registration** — **Link to Note**

Developed a 2-page note that clarifies matrix notations and concepts that are frequently abused and confused in the field of deformable image registration. The note also provide definitions of important terms and their mathematical formulations.

On Real Analysis — **Review Notes for MATH 522: Advanced Calculus II** — **Link to Note**

Developed a 40-page note that summarizes the materials covered in MATH 522: Advanced Calculus II. Topics covered in this note include: metric spaces, Jordan content and Riemann integration, differential forms, surfaces, functional analysis, ODE theory, Lebesgue measure and integration.

VIDEOS PRODUCED

Youtube Video — **Biography of Jewel Plummer Cobb: The Woman Who Breaks "Filters"** — youtu.be/qRK7K-cbvdQ

Developed a 10-minute video introducing the life of Jewel Plummer Cobb, an African American biochemist who made significant contributions to the field of cancer research and devoted her life to increasing representation for underrepresented groups in science. This video is produced as the final project for CHEM 430H (Introduction to Biological Chemistry Honors).

Youtube Video — **Pretraining in the field of medical imaging: Swin UNETR vs Models Genesis** — youtu.be/dKMKGDvNAHc

Developed a 21-minute video comparing two state-of-the-art deep learning model used in the field of medical imaging.

Youtube Video — **CVAE for Autism** — youtu.be/mtEqjc_BGKo

Developed a 13-minute video explaining in detail the design of the Contrastive Variational Autoencoder (CVAE) model used in one of the recently published articles in Science.

Youtube Video — **The Mathematical Basis of DARTEL in Simple Math** — youtu.be/M-yeL2f7J_U

Developed an 8-minute video explaining the important mathematical concepts behind DARTEL, a toolbox in SPM designated to perform diffeomorphic registration between two images.

Youtube Video — **Multivariable Calculus Final Review** — youtu.be/qRK7K-cbvdQ

Developed an 8-minute video explaining Green's Theorem, Stokes' Theorem, and the Divergence Theorem as a preparation for the final exam for MATH 233H (Multivariable Calculus Honors).

AWARDS