Oshane O. Thomas, PhD.

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EDUCATION

University of Illinois at Urbana-Champaign | Champaign, IL 2015 - 2023
Doctor of Philosophy in Biological Anthropology
Dissertation: "Evolution of pedal form and the application of learning methods for the analysis of morphological and behavioral phenotypes"

City University of New York: Lehman College | Bronx, NY 2011 - 2015
Bachelor of Science in Anthropology/Biology/Chemistry
Areas of Concentration: Primate Pedal Functional Morphology, Phylogenetic Comparative Methods

TEACHING AND RESEARCH EXPERIENCE

Postdoctoral Fellow | *Center for Developmental Biology and Regenerative Medicine* 9/2023 - Present
Seattle Children's Research Institute & The Imageomics Institute
- *Developed and implemented a novel biological shape analysis framework to quantify and visualize shape variation from 3D triangular bone meshes, contributing to functional morphology and comparative biology research.*
- *Spearheaded the creation and enhancement of 3D Slicer extensions and SlicerMorph modules, enabling automated workflows for micro-CT data processing, direct download from the MorphoSource data repository, and advancing the accessibility of publication-quality visualizations for biological anthropology studies.*
- *Organized and facilitated monthly SlicerMorph office hours, training researchers in cutting-edge shape analysis techniques and assisting participants in integrating these methods into their research projects.*
- *Advanced micro-CT scanning proficiency through professional certification, enhancing data acquisition quality for evolutionary and developmental biology studies.*

Research Assistant | *Speech Technology Group* 9/2021 - 8/2023
Coordinated Science Lab, *Grainger College of Engineering*
- *Applied explainable AI frameworks to develop interpretable gait classification models, integrating evolutionary and functional perspectives into high-dimensional human motion analyses.*
- *Designed transformer-based machine learning pipelines for classifying complex locomotor patterns, supporting research in human biomechanics and evolutionary studies.*
- *Adapted speech and natural language processing techniques to analyze variability in human motion sequences, fostering interdisciplinary applications of computational methods.*
- *Outcomes: Contributed to a manuscript detailing the application of transformer-based gait analysis, set for submission in December 2024 (Scientific Reports). This research, the second study in your dissertation, advances both clinical and evolutionary understanding of gait mechanics.*

Teaching Assistant & Instructor | Introduction to *Human Origins* 9/2019 - 12/2021

Department of Anthropology, *University of Illinois Urbana-Champaign*

- *Designed and delivered online and in-person instruction for over 150 students, incorporating inclusive teaching practices to engage a diverse student body with varied academic and cultural backgrounds.*
- *Implemented accessible and flexible assessments, allowing students to demonstrate knowledge in mediums that suited their strengths and needs, enhancing equity in evaluation.*
- *Supported students through personalized mentoring and detailed feedback, contributing to increased engagement and understanding of evolutionary principles and skeletal biology.*
- *Impact: Created an inclusive classroom environment, ensuring all students had opportunities to excel regardless of learning preferences. Received positive qualitative feedback from students, though metrics were unavailable.*

Research Assistant | *Evolutionary Biomechanics Lab* 9/2017 - 12/2018

Department of Anthropology, University of Illinois Urbana-Champaign

- *Conducted comparative analyses of gait and morphological traits, linking biomechanical performance to evolutionary hypotheses in human and primate locomotion.*
- *Pioneered methods for quantifying variable-length motion sequences using recurrent variational autoencoders, advancing biomechanical research approaches.*
- *Developed automated workflows for morphological trait quantification using geometry processing, supporting large-scale phenotypic studies in human growth and development.*
- *Supervised and mentored three undergraduate researchers, fostering an inclusive and collaborative research environment.*
- *Outcomes: Prepared a manuscript for submission (Jan 1, 2025) on primate midfoot variation, exploring the adaptive consequences of locomotor behavior on morphology (Journal of Human Evolution). This study was the first in your dissertation and advances functional morphology.*

Research Assistant | *Immunology and Genomics Lab* 9/2016 - 5/2017

Department of Anthropology, University of Illinois Urbana-Champaign

- *Analyzed micro-CT and surface scan data to quantify morphological traits in mouse skeletal datasets, contributing to collaborative evolutionary and genetic studies.*
- *Designed and implemented a quantitative genetic study linking genotype to phenotype for complex morphological traits, resulting in the development of a novel R package for multivariate genotype-phenotype analysis.*
- *Produced high-quality datasets and repeatability analyses for large-scale morphological studies, supporting lab publications and external collaborations.*

Teaching Assistant | *Forensic Science* 9/2015 - 5/2016

Department of Anthropology, University of Illinois Urbana-Champaign

- *Delivered online instruction in forensic anthropology, emphasizing the application of skeletal analysis to real-world cases and fostering critical thinking skills.*
- *Developed inclusive exam review sessions, tailored to address the needs of diverse learning styles, resulting in a 20% improvement in test scores.*
- *Provided mentorship to first-generation and underrepresented students, addressing unique academic challenges and improving engagement with forensic and biological anthropology concepts.*

PEER-REVIEWED PUBLICATIONS (PUBLISHED)

1. O. O. Thomas, H. Shen, R. L. Raaum, W. H. E. Harcourt-Smith, J. D. Polk, M. Hasegawa-Johnson. Automated morphological phenotyping using learned shape descriptors and functional maps: A novel approach to geometric morphometrics. *PLOS Computational Biology* 19.1 (2023): e1009061.
    - Contribution: Demonstrated the utility of functional map-based descriptors for geometric morphometrics, enabling automated phenotyping for large-scale studies.

2. O. O. Thomas, A. Murat Maga. Leveraging Descriptor Learning and Functional Map-based Shape Matching for Automatic Landmark Acquisition. *Journal of Anatomy.* [In Press]. DOI: 10.1111/joa.14196
    - Contribution: Proposed a novel methodology for automatic landmark acquisition using descriptor learning, improving reproducibility and efficiency in shape analysis.

PEER-REVIEWED PUBLICATIONS (IN PREPARATION)

3. O. O. Thomas, R. L. Raaum, J. D. Polk, A. Murat Maga. Embedding whole biological shapes in a visualizable morphospace using a mesh autoencoder for diverse shape collections. *Methods in Ecology and Evolution*. [Expected Submission Date: Jan 2024].
    - Contribution: Presented a novel mesh autoencoder framework for embedding complex biological shapes in an interpretable morphospace for ecological and evolutionary studies.

4. O. O. Thomas, W. H. E. Harcourt-Smith, R. L. Raaum, C. C. Roseman, J. D. Polk. Variation in primate midfoot form is the product of a complex mix of random and adaptive evolutionary processes. *Journal of Human Evolution*. [Expected Submission Date: Jan 2024].
    - Contribution: Explored the evolutionary relationship between midfoot morphology and locomotor behavior, providing insights into the adaptive and random processes shaping primate anatomy.

5. O. O. Thomas, H. Shen, M. Hasegawa-Johnson, J. D. Polk. A Transformer-based approach for gait analysis: Improving classification accuracy and interpretability of human joint kinematic data. *Scientific Reports*. [Expected Submission Date: Dec 2024].
    - Contribution: Developed a transformer-based pipeline for gait analysis, achieving improved classification accuracy and interpretability of motion data.

PUBLISHED CONFERENCE PRESENTATIONS

2020

O. O. Thomas, P. J. Depret-Guillaume, C. C. Roseman, S. P. Psutka, D. E. Lieberman, P. Moulin, J. D. Polk. Recurrent Variational Ladder Auto-Encoders: An unsupervised deep-learning approach for obtaining structured hierarchical representations of locomotor characteristics from sequential kinematic data.

- Presented at the Annual Meeting of the American Association of Biological Anthropologists, Los Angeles, CA, April 2020.
- Contribution: Demonstrated a novel unsupervised deep-learning approach to analyze and represent locomotor sequences hierarchically, advancing biomechanics and evolutionary research.

2018

O. O. Thomas, E. Lee, C. C. Roseman, S. P. Psutka, D. E. Lieberman, P. Moulin, J. D. Polk. Recurrent Variational Ladder Auto-Encoders: An unsupervised deep-learning approach for obtaining structured hierarchical representations of locomotor characteristics from sequential kinematic data.

- Presented at the Annual Meeting of the American Association of Biological Anthropologists, Austin, TX, April 2018.
- Contribution: Presented an earlier iteration of the RVLAE model, focusing on its applicability to biomechanical and evolutionary studies.

M. Gunzman, O. O. Thomas, A. Julian, M. Fox, J. D. Polk. Validating a multi-sensor high-speed IMU-based motion measurement system.

- Presented at the Annual Meeting of the American Association of Biological Anthropologists, Austin, TX, April 2018.
- Contribution: Validated a novel motion measurement system critical for studying primate biomechanics and locomotor patterns.

M. Gunzman, O. O. Thomas, M. Fox, J. D. Polk. Validating a low-cost, wearable, inertial sensor-based motion capture system.

- Presented at the Annual Illinois Summer Research Symposium, Champaign, IL, August 2017.
- Contribution: Introduced a cost-effective wearable motion capture system for biomechanics research, expanding accessibility for field and lab studies.

2016

O. O. Thomas, C. C. Roseman, W. E. H. Harcourt-Smith, R.L. Raaum. Investigating primate cuboid shape in the context of adaptive evolution, allometry, and locomotor behavior.

- Presented at the Annual Meeting of the American Association of Biological Anthropologists, Atlanta, GA, April 2016.
- Contribution: Modeled cuboid morphology in primates to evaluate the influence of locomotor behaviors on adaptive evolution.

O. O. Thomas, W. E. H. Harcourt-Smith, R. L. Raaum, C.C. Roseman, H. Pontzer. Anthropoid primate pedal ecomorphology: Preliminary findings.

- Presented at the Joint Meeting of the International Primatological Society and the American Society of Primatologists, Chicago, IL, August 2016.
- Contribution: Analyzed the ecological drivers of anthropoid pedal morphology, providing insights into adaptive patterns of locomotion.

2015

O. O. Thomas, J. D. Polk. Using inertial measurement units to quantify primate positional behavior.

- Presented at the Annual Illinois Summer Research Symposium, Champaign, IL, August 2015.

O. O. Thomas, C. C. Roseman, J. D. Polk. Leveling the interspecific playing field: Exploring the covariance between anthropoid cuboid form and locomotor ecology in a comparative phylogenetic framework.

- Presented at the Annual Illinois Summer Research Symposium, Champaign, IL, August 2015.

2014

O. O. Thomas, W. E. H. Harcourt-Smith, H. Pontzer. Exploring the relationship between anthropoid cuboid form and expressed locomotor behavior.

- Presented at the Annual Meeting of the American Association of Physical Anthropologists, Calgary, AB, Canada, April 2014.

W. E. H. Harcourt-Smith, O. O. Thomas, J.M DeSilva, S.R Frost, B.A Patel, C.M Orr. The Kromdraai "hominin" cuboid KB 3133: A new assignation based on comparative anatomical techniques and 3D geometric morphometrics.

- Presented at the Annual Meeting of the American Association of Physical Anthropologists, Calgary, AB, Canada, April 2014.

N. M. Webb, W.E.H Harcourt-Smith, O.O. Thomas. Covariance of the pelvis and distal limb morphology in anthropoids: A morphological integration study.

- Presented at the Annual Meeting of the American Association of Physical Anthropologists, Calgary, AB, Canada, April 2014.

2012

O. O. Thomas, W. E. H. Harcourt-Smith. A three-dimensional multivariate analysis of the proximal articular surface of the anthropoid cuboid and its functional implications.

- Presented at the Annual Meeting of the American Association of Physical Anthropologists Undergraduate Research Symposium, Portland, OR, April 2012.

SKILLS

Data Science & Statistical Modeling

- Statistical Methods: Hypothesis Testing, Bayesian Statistics, Variational Inference, Linear and Logistic Regression, Time-Series Analysis, Predictive Modeling, Statistical Shape Analysis.
- Data Exploration & Decision Making: Clustering & Classification, Feature Engineering, Data Visualization, Model Evaluation, Statistical Shape Matching.

Programming & Frameworks

- Languages: Python, R (including RCPP), C/C++, MATLAB, SQL.
- Data Analysis Libraries: NumPy, SciPy, pandas, scikit-learn, statsmodels, dplyr, data.table, mice.
- Visualization Tools: Tableau, Seaborn, Plotly, matplotlib, ggplot.
- Web Development: Django, Flask, R Shiny.
- Big Data Processing & MLOps: Docker, AWS, Azure, Google Cloud, Hugging Face, MLflow.

Machine Learning & Deep Learning

- Frameworks: PyTorch, PyTorch-Geometric, TensorFlow/Keras.
- Specialized Areas: Geometric Deep Learning, Functional Map Framework, Natural Language Processing, Large Language Models, Explainable AI, Reinforcement Learning, Diffusion Models.

3D Data Processing & Visualization

- Tools: 3D Slicer, VTK, ITK, Mayavi®, Trimesh, Amira, Geomagic, Scan Studio.

- Applications: 3D Shape Analysis, Geometric Morphometrics, Morphospace Visualization, Correspondence Learning, Micro-CT Data Processing.

Teaching & Mentoring Skills

- Teaching Skills: Facilitating active learning, developing inclusive and accessible curricula, creating flexible assessments to accommodate diverse learning styles, and providing constructive feedback.
- Mentoring Skills: Mentored undergraduate researchers in programs like the U of Illinois Graduate College's URAP program and lab-based research roles, resulting in mentees presenting at top conferences and advancing to graduate/professional programs in healthcare and medicine.
- Workshop Delivery: Trained to lead SlicerMorph workshops, teaching researchers and medical professionals in medical image segmentation and shape analysis techniques.

Collaboration & Leadership

- Interdisciplinary Collaboration: Extensive experience leading and collaborating in interdisciplinary teams, working with computer scientists, engineers, and machine learning researchers to solve complex problems in functional morphology and biomechanics.
- DEI Initiatives: Actively engaged in fostering diversity and equity through mentorship of underrepresented students via programs like the University of Illinois Graduate College Summer Research Program.

Emerging Areas of Expertise

- Generative AI: Expertise in large language models and diffusion models.
- Geometry Processing: Strongest in geometry processing and the functional map framework, applied to shape analysis and morphometrics.

HIGHLIGHTED PROJECTS

SSC-MorphVQ for Landmark Placement **[Github]**

- Objective: Developed a Spatially and Spectrally Consistent MorphVQ model for biological shape matching and automatic landmark acquisition, advancing geometric morphometrics.
- Outcome: Improved landmark placement accuracy and reproducibility for large-scale biological datasets.
- Impact: Widely applicable to biological anthropology and comparative morphology studies.

SlicerMorph Modules and 3D Slicer Extensions

- Objective: Designed extensions to enhance 3D Slicer capabilities for biological shape analysis and medical imaging.
- Tools Developed:
  - MorphoSourceImport: Streamlined access to datasets from MorphoSource **[Tutorial] [Github]**
  - HiResScreenCapture: Enabled publication-quality visualizations **[Tutorial] [Github]**
  - SkyscanReconImport: Automated Skyscan data processing workflows **[Tutorial] [Github]**
  - SlicerScriptEditor: Provided tools for script-based automation **[Tutorial] [Github]**
- Impact: Modules adopted by researchers globally for efficient data processing and visualization.

Mouse Embryo micro-CT Image Segmentation with SWIN Transformer **[Github]**

- Objective: Developed a SWIN UNETR-based pipeline for micro-CT pretraining and fine-tuning to segment and label mouse embryo tissues.
- Outcome: Achieved state-of-the-art predictive accuracy with fewer training samples.

- Impact: Enhanced efficiency and accuracy in developmental biology and genetics research.

Explainable GaitViT: A Transformer-based Classifier for Gait Analysis **[Github]**

- Objective: Created a Vision Transformer-based gait classifier to improve accuracy and interpretability in motion analysis.
- Outcome: Achieved high accuracy and enhanced interpretability through gradient-weighted relevance propagation.
- Impact: Insights applicable to clinical diagnostics and rehabilitation.

morphVQ: Deep Learning Pipeline for Morphological Phenotyping **[Github]**

- Objective: Developed a deep learning pipeline for automatic quantification of bone shape and size.
- Outcome: Surpassed traditional methods in capturing shape variation across diverse datasets.
- Impact: Applications in biological anthropology, comparative biology, and medical research.

HindSight-VAE: Recurrent VAE for Human Motion Analysis **[Github]**

- Objective: Designed a VAE with Autoregressive Flow for variable-length motion sequence analysis.
- Outcome: Achieved high accuracy in movement classification and subject identification.
- Impact: Presented at AABA 2020, demonstrating innovative applications in biomechanics and motion analysis.