3D MORPHOMETRICS AND IMAGE ANALYSIS WORKSHOP

Location: University of Washington, Friday Harbor Marine Laboratories, San Juan Island, WA
Course Dates: Sunday-Saturday, August 25-31, 2019
Course Website: https://SlicerMorph.github.io/2019_Summer_Workshop
Application deadline: May 1st, 2019 (11:59 PDT)
Online Application URL: http://bit.ly/SM-2019-application
Admission notification: May 15th, 2019

Target Audience: Course is directed for students, post-docs and junior faculty who are interested in conducting quantitative research into organismal form and function using 3D imaging. It is also appropriate for more established researchers who are looking for open-source alternatives to the proprietary pipelines they have been using. We anticipate more applicants than we can accommodate. Applicants whose host institution lack such curriculum and/or resources might be given preference.

Course Contents and Structure: Course is a combination of formal didactics (in the morning) and computer labs (in the afternoon and evenings). Guest lecturers will cover topics in theory of statistical shape analysis, applied imaging, and high-throughput image analysis. Labs will cover all aspects of conducting specimen-based research using 3D imaging. Practical topics (e.g., image processing and segmentation, visualization) will be taught using the open-source **3D-Slicer** visualization suite and the **SlicerMorph morphometrics toolkit** (statistical shape analysis) Additional lab topics include using 3D specimen repositories to obtain data, tools and methods for collaboration and reproducible research, introduction to data analysis through R/Python. Course material will be focused on volumetric (e.g., CT or microCT) 3D datasets, but will be equally applicable to data from 3D surface scanners. Tentative syllabus can be found in the next page.

Expectations from attendees: Course format will be highly collaborative, and labs will be done in small teams. Prior experience with the tools is not expected, but will positively impact the learning experience. Students are expected to come with a project (and/or bring a sample to be imaged with microCT) and present at the beginning and the conclusion of the workshop as lightning talks. Each attendee should bring a recent (last two years) laptop running Windows, Mac or Linux OSes (no netbooks or tablets). More information about computer requirements will be provided to the selected applicants.

Logistics: Selected applicants will be notified by May 15th. Due to the logistics of getting to the island and the pace of the workshop, partial attendance is not possible, and selected participants need to confirm their travel plans in two weeks or forfeit their admission. Participants will be housed at the shared dormitories on site. It is expected that the attendee will arrive FHL by Sunday August 25th PM and be present for the pre-course check-in/registration in the evening. Workshop will end Saturday evening. Attendees need to check out from dorms by noon the following day. Please consider these requirements when applying.

Course Fees and Travel Support: There are no course registration fees and all lodging and meals are covered thanks to generous support from the National Science Foundation Advances in Biological Informatics program (ABI-1759637, Adam Summers & Murat Maga). A limited number of scholarships to offset the cost of travel is available for under-represented minorities (URM) in STEM. Please indicate your interest during application.

Contact information: If you have any questions, please contact us at SlicerMorph@outlook.com and one of our course directors will respond to your inquiry.

Ready to apply? Submit your application. Please be prepared to give a short description of your research background, your career goals, your mentor's contact information (for non-faculty applicants) and provide a CV (two-page limit, NSF Biosketch format is preferred) as PDF. You will need an account registered with Google to upload documents.

	8/25	8/26	8/27	8/28	8/29	8/30	8/31	9/1
7:45-8:15		Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	Breakfast	
8:30-10:15		**Introduction / 3D Morphometrics and Imaging** Maga	**Introduction to Statistical Shape Analysis I: Landmark-based methods** Maga	**Template-based analysis and computational anatomy** Maga	**Auto3Dgm and landmark-free correspondence of biological form** Boyer/Shan	**Machine Learning and classification** Mercan	**Data processing in R: import/export data; intro to geomorph** Rolfe	
10:15-10:30		Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	
10:30-12:00		**Applied Imaging Concepts** Rolfe	**Introduction to Statistical Shape Analysis II: Semi-Landmarks and beyond** Rolfe	**Application of SSA: Modeling growth** Mercan	**Applications of SSA: Phylogenetics** Shan	**Biomechanics and 3D imaging** Summers	**Data processing in R: Plotting, modeling** Maga	Brunch / Checkout
12:15-12:45		Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	
1:00-2:30		Attendee project Presentations - Initial	**Slicer #1: UI, overview of functionality, extensions, finding help** Mercan	**Slicer #3: Measurements (angles, lines, 3D curves, landmarks) and Visualization** Rolfe	**SlicerMorph # 1: Statistical Shape Analysis: Work with sample data** Maga	**iPython Notebook for Slicer: Generating movies** Rolfe	Attendee project Presentations - Final	
2:30-2:45		Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	
2:45-4:45	Course Check-in Pre-course survey	**Tools for reproducible research: git/github, Rstudio** Shan	**Slicer #2: Data formats, getting data from M/S, saving** Maga	**Slicer #4: Segmentation, mesh conversion, 3D printing** Mercan	**SlicerMorph #2: Statistical Shape Analysis: Work with your own data**	**Auto3Dgm: Establishing Landmark-free correspondence** Shan	**Concluding remarks** SlicerMorph team	
4:45-5.30		Debrief	Debrief	Debrief	Debrief	Debrief	Post-course survey	
6:00-6:30		Dinner	Dinner	Dinner	Dinner	Dinner	Dinner	
7:00-8:00		Study Hall	Study Hall		Study Hall	Study Hall		

Instructors:

Murat Maga: is an assistant professor at the University of Washington Department of Pediatrics, and a principal investigator at the Seattle Children's Research Institute Center for Developmental Biology and Regenerative Medicine. Murat is a broadly trained quantitative morphologist and is interested in genetics and morphometrics of craniofacial development in mammals. He is the lead PI on the SlicerMorph project and the co-director of the summer workshops that accompany the project.

Adam Summers: is a professor at the University of Washington's Department of Biology and the School of Aquatic and Fisheries Sciences. He is interested in the comparative biomechanics of vertebrates in general and fish in particular. He has a mission to microCT scan every fish species. He is a co-investigator of the SlicerMorph project, and the co-director of the summer workshops that accompany the project.

Doug Boyer: is an associate professor of paleontology at Duke University. He is also the founder and the director of the MorphoSource 3D specimen repository and a co-investigator of the SlicerMorph project.

Sara Rolfe: is the lead scientific programmer on the SlicerMorph project. Sara specializes in biomedical image analysis and holds a PhD in Computer Engineering from University of Washington.

Ezgi Mercan: is a research scientist at the Seattle Children's Craniofacial Center, where she applies statistical shape analysis and modeling to study 3D skull growth in craniofacial skeleton both in normal and patient populations. Ezgi holds a PhD in Computer Science from University of Washington.

Shan Shan: is a senior graduate student at the Duke University Department of Mathematics working under the supervision of Dr. Ingrid Daubechies. She works on developing new methods to establish landmark-free correspondence of biological shape.

Synopsis of Lectures:

Morphometrics and Image Analysis: A general introduction to various 3D image modalities, their applications, limitations and how to extract quantitative information from 3D datasets.

Applied Imaging Concepts: This lecture will deal with some of the fundamental concepts in image processing and analysis, such as different types of image filters, segmentation, data visualization. Emphasis will be on the application.

Introduction to Statistical Shape Analysis I: Landmark-based methods: This lecture will introduce the fundamental concepts in 'geometric morphometrics', such as types of landmarks, superimposition, biological vs geometric homology, form vs shape space, nuisance parameters, Procrustes Analysis, distance metrics, decomposition of shape variance, visualization.

Introduction to Statistical Shape Analysis II: Semi-landmarks and beyond: This lecture will continue from the previous lecture and will deal with specific cases where anatomical landmarks are sparse or non-existent.

Template-based analysis and computational anatomy: This lecture will discuss how computational anatomy can facilitate high-throughput analysis in single species/population contexts by using non-linear image registration.

Application of SSA: Modeling growth: This lecture will focus on linear regression models used in geometric morphometric analysis. Concepts to be explored are size/shape relationship, allometry, modeling in shape space vs form space.

Machine Learning and classification: Basic concepts in machine learning will be introduced and showcased using histology datasets.

Biomechanics and 3D Imaging: Lecture will provide an introduction to levers and linkages and discuss using landmark data to map a morphospace into a functional space.

Auto3Dgm and landmark-free correspondence of biological form: We describe a new software tool for automatically spreading landmarks and aligning morphologically diverse samples representing homologous structures. We review the concept of homology and justify the method in that context.

Applications of SSA: Phylogenetics: This lecture provides an overview of using morphometrics in phylogenetic analyses.

NOTES:

Breakfast/Lunch/Dinner hours follow the FHL Dining Hall schedule. Note that Sunday Brunch is from 10:00 to 10:30. You can see sample menus at https://fhl.uw.edu/facilities-resources/fhl-dining-hall-menu/

All lectures and labs from Monday through Friday AM will be at the Lecture Hall (FHL Commons). Friday PM and Saturday labs will be held at Conference Room.

Debriefs are short collaborative discussions and reviews of the fundamental topics introduced during day's lectures and labs

Funding acknowledgement:

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