# CAMT Seminar

## “Automated tissue segmentation of micro-CT images by deep learning and its application to comparative morphology”

Ms. Evropi Toulkeridou

Ph.D. candidate, Okinawa Institute of Science and Technology Graduate University (OIST)
1919-1 Tancha, Onna-son, Okinawa, 9094-0495 Japan

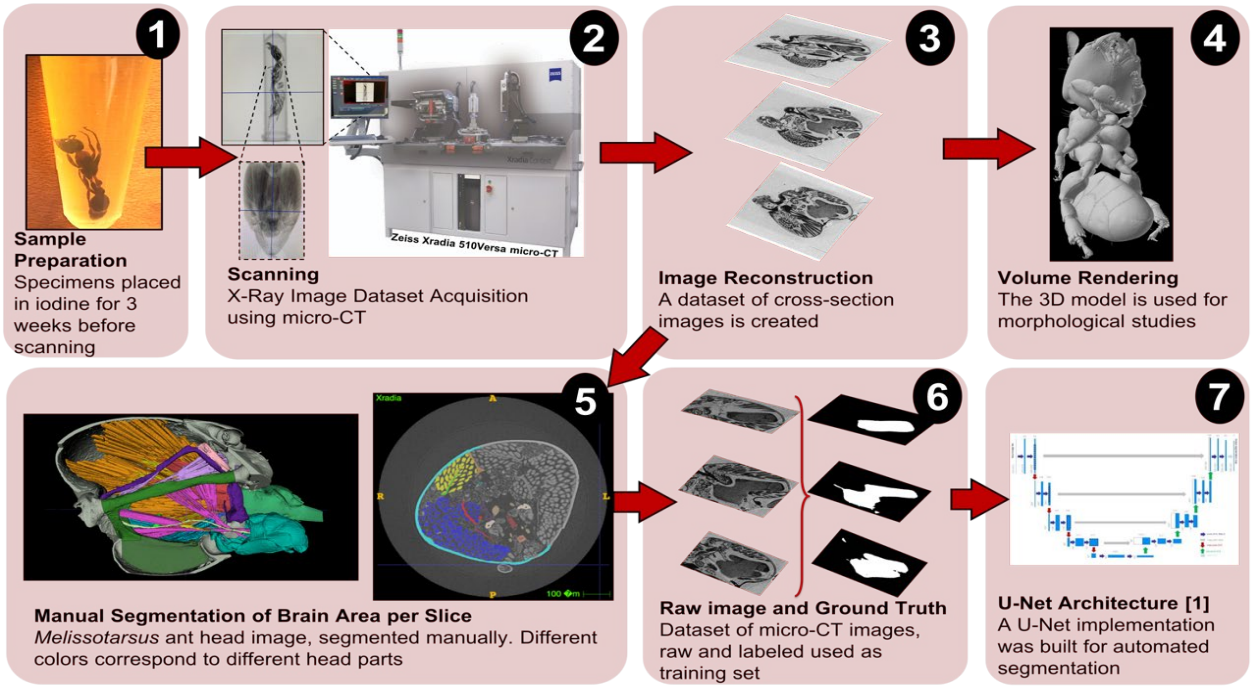
Date: 10 March, 2021 (Wed)  10:30-11:30
Location: Main Conference Room (1st floor), Bldg. A12
Center for Atomic and Molecular Technologies (CAMT)
(A12 棟 1 階会議室)

### Abstract

Three-dimensional (3D) scanning (e.g. confocal scanning or micro-computed tomography, micro-CT) which produces data-rich volumetric images of insects is a non-invasive technique that has become popular for its simplicity and precision. The acquired data are both high-resolution and 3D, thus enabling the users to visualize both the morphology and the anatomy of their specimens. Ants are well-known for their significance in ecology as they are extraordinarily diverse and combine both collective behavior and division of labor. Though numerous studies have focused on their behavior and anatomy, their evolution still remains largely unclear. Micro-CT scanning of ants has enabled a more thorough view of their morphological and anatomical characteristics, which has led to the discovery of new species and to the analysis of their evolution. Supported by genetic comparison, morphological comparison between species enables the investigation of fundamental biological questions such as the social brain hypothesis, which connects the adaptability of the social behavior of animals to modifications in their ecosystem and social structure with changes in brain investment. Therefore, the creation of a 3D, bias-free atlas of ants can provide a major boost to evolutionary studies. However, a key challenge for the use of micro-CT lies in the analysis of these data: indeed, the most common segmentation method to date is still by manual processing, which is extremely time-consuming and often inaccurate. Deep learning techniques can help overcome the limitations of manual image segmentation using Convolutional Neural Networks (CNNs). This work proposes a novel, transdisciplinary approach to solve this problem: the goal is to create new software tools that automates the segmentation of micro-CT images of ants, making morphological quantification and comparison easier and more efficient, and paving the way for

new discoveries in evolutionary studies. First, samples are placed in iodine to enhance tissue contrast in raw images (step 1), then scanned by micro-CT (step 2). The output raw images (step 3) are used both as a database and for volume rendering. The result of the latter is used for morphological comparison between different ant species (step 4). Mask images are created by manual segmentation of the raw images of heads, starting with the brain (step 5). The database of both raw and labeled images is used for training (step 6). A CNN of the U-Net architecture [1] is used for brain segmentation (step 7). The outcome can be of great importance as no similar software exists that uses deep learning techniques to segment micro-CT images of any taxa. Exploration of features of the U-Net CNN and modifications in various parameters can lead to the expansion of the developed software, towards fast, automated segmentation of images of numerous species. Therefore, the proposed software could also be used for segmentation of any micro-CT images with similar patterns.

[1] O. Ronneberger, P. Fischer, and T. Brox, (2015), arXiv:1505.04597 [cs.CV]




**(Host: Satoshi Hamaguchi Ext:7913)**