# **Variational Auto-Encoder for Imputing Imaging Mass Spectrometry from Serial Two-Photon Tomography**

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**Abstract**

*Serial Two-Photon Tomography (STPT) and Imaging Mass Spectrometry (IMC) are two popular imaging techniques in tumour analysis. STPT images describe tumour morphology, whereas IMC images describe protein abundance. Having both data modalities for the same tissue sample is often beneficial in clinical applications, as it is likely that two adjacent tissues do not share the same properties. However, it is difficult to obtain both data modalities for a single tissue sample. To mitigate this issue, I present a Variational Auto-Encoder that, for the same tissue sample, only requires STPT images to impute corresponding IMC images.*

# **Background**

## **Serial Two-Photon Tomography (STPT)**

STPT is an automated imaging technique that produces high-throughput imaging by integrating two-photon microscopy and tissue sectioning [1]. The general workflow is as follows. First, place the specimen on the XYZ stage under the objective of a two-photon microscope; second, image an optical section as a mosaic of fields of view; third, cut off a slice of tissue using a vibrating blade; repeat. The two main strengths in STPT are versatility and speed. The vibrating blade enables usage of specimens prepared by procedures that have minimal detrimental effects on fluorescence and morphology and STPT uses high-speed galvanometric scanning [2].

## **Imaging Mass Spectrometry (IMC)**

IMC is an imaging technique that can analyze the protein abundance of a specimen at a high resolution. In IMC, an antibody-stained tissue sample is ablated and sent to undergo ionization where cell-specific signals are captured [3]. The result of IMC is an **n** x **m** matrix where the rows correspond to pixels and the columns to spectral bins. One can visualize the spatial distribution of biomolecular ions by

plotting intensities for a spectral bin (single column) across all pixels; the resulting visualization is called an ion image.

# **Project Details**

## **Motivation**

STPT describes cell morphology, whereas IMC describes protein abundance. Having both data modalities can aid in understanding patient-specific tumour micro-environments, and thus inform patient-specific treatments. However, it is difficult to obtain both data modalities from the same tissue sample, because stained tissue samples compromise the integrity of the tissue in the case of IMC, and the tissue is destroyed in the case of STPT. Therefore, if there exists a generative model that accurately imputes IMC images given STPT images, this difficulty can be bypassed.

## **Goal**

The main goal for this project is twofold: identify and perform appropriate image preprocessing steps for input images and implement a VAE that imputes an IMC image given STPT images with good accuracy and within a reasonable time frame.

# **Expected Outcomes**

After training, the VAE should be able to generate a set of IMC images given input STPT images.

# **References**

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3. Julian Taranda and Sevin Turcan. “3D Whole-Brain Imaging Approaches to Study Brain Tumours.” *Cancers*, 13(8):1897, 2021