HIBALL Winter School

Report of Contributions

Contribution ID: **1** Type: **not specified**

A gentle introduction to deep learning

Tuesday 12 March 2024 13:30 (1h 50m)

In this session, participants will gain insights into the realm of deep learning. The session is structured to offer a comprehensive overview of fundamental concepts of deep learning and artificial neural networks (ANNs), including an exploration of backpropagation, which is the key algorithm underpinning learning in ANNs. Attendees will acquire an understanding of various ANN architectures, such as multi-layer perceptrons, convolutional, and recurrent networks. The session will also distinguish between supervised and self-supervised learning, providing insights into their roles in harnessing labeled and unlabeled data for model training.

To complement the theoretical knowledge, the session includes hands-on exercises where participants will apply their newfound knowledge to construct and train basic neural networks. Using Python and PyTorch, these exercises are designed to offer practical experience in implementing deep learning models.

Presenter: Prof. BAKHTIARI, Shahab K. (Université de Montréal, Systems Neuroscience and AI Lab (SNAIL))

Contribution ID: **2** Type: **not specified**

BigBrain data processing and scientific tool integration in CBRAIN

Monday 11 March 2024 14:45 (2h 45m)

CBRAIN is a web portal that provides seamless access to high-performance computing clusters, and is a component of the NeuroHub ecosystem of neuroinformatics tools. The tutorial will cover the main functionalities of CBRAIN for the processing and management of data, illustrate them on BigBrain data, and demonstrate their interaction. For more advanced users, an introduction will be provided about how to prepare their scientific application for integration in CBRAIN.

Expected learning outcomes:

In this tutorial, participants will learn to use the following infrastructure tools and services for analyzing data in HIBALL:

Part 1 (1h): CBRAIN to process BigBrain data on HPC clusters, such as that at JSC, through a web portal, including:

- Finding BigBrain datasets in CBRAIN
- Processing BigBrain datasets in CBRAIN
- Exploring and working with the processing results
- Downloading and sharing the results

(short break)

Part 2 (1h) : Scientific software containerization for tool integration into CBRAIN

- Introduction to Containerization
- Containerizing your tool with Apptainer
- Writing a Boutiques Descriptor for your tool
- Testing your Descriptor in CBRAIN

Presenter: Dr CARON, Bryan (McGill University, MCIN)

Contribution ID: **3** Type: **not specified**

The hippocampus: facts and myths

Monday 11 March 2024 13:30 (1 hour)

The hippocampus is a complex and architectonically heterogeneous structure located in the medial temporal lobe. It can be divided into several regions and subregions, each with distinct anatomical and functional characteristics, and has been subject of research for many centuries, its first description dating as far back as the late 16th century. The last years have seen a steady increase in the number of studies applying AI techniques, including machine learning and image analysis, to analyze complex data sets related to brain cytoarchitecture, in ways that can be challenging for traditional methods. While such AI methods enhance our ability to extract valuable insights from complex brain data, it's important to note they can only accelerate our understanding of the brain when the results are interpreted in the framework of domain-specific knowledge, i.e., of neuroanatomical expertise.

The bulk of literature on the hippocampus is enormous, and unfortunately peppered with false statements, such as the fact that it is allegedly a subcortical structure, directly abuts the neocortex, or constitutes the brain's "memory center". Surprisingly, some of these false statements are truly widespread!
At the end of this session you will have acquired basic knowledge concerning hippocampal cytoarchitecture: the main cell types of which it is composed and the layers they build. You will learn how hippocampal macroanatomy changes through brain development, resulting in the two interlocking "Cs"typical of cell body-stained coronal sections. You will also hear about the regions into which it can be divided, and why the intricacy of anatomical language has resulted in differences of opinion and discussions concerning their number. Finally, since the use of incorrect anatomical terminology results in a muddying of the waters rather than shedding light on shed light on hippocampal (or any other brain region) structure-function relationships, I will provide you with an overview of published misconceptions to ensure that with your research you do not contribute to their perpetuation.

Presenter: Prof. PALOMERO-GALLAGHER, Nicola (Institute for Neuroscience and Medicine, INM-1, Forschungszentrum Jülich)

Contribution ID: **4** Type: **not specified**

How to use EBRAINS atlas services with the online Siibra Explorer and Siibra Python tools

Tuesday 12 March 2024 15:40 (1h 50m)

siibra is a software tool suite that implements a multilevel atlas of the brain by providing streamlined access to reference templates at different spatial scales, complementary brain parcellations maps, and multimodal regional data from different sources which is linked to brain anatomy at different spatial scales. It addresses interactive exploration via an interactive 3D web viewer (siibra-explorer) and integration into data analysis and simulation workflows with a comprehensive Python library (siibra-python), supporting a broad range of workflows for anatomists, experimentalists and computational neuroscientists with varying experience levels, from beginners to those with a solid background in Python.

This session offers participants an immersive opportunity to explore the advanced tools and techniques for data analysis and visualization. We will briefly introduce the tool suite and highlight its features and benefits. Participants will learn to access 3D reference templates and maps, including anatomical, and connectivity atlases. We will interactively explore BigBrain cytoarchitectonic maps and cortical layer segmentation and extract region-specific information via the EBRAINS Knowledge Graph.

Moving beyond the graphical interface of siibra-explorer, the session will proceed with siibra-python. Participants will be guided through coding exercises demonstrating how to fetch brain region maps, access the BigBrain dataset, and extract multimodal regional features such as cortical thicknesses, cell and neurotransmitter densities, gene expressions, connectivity data, as well as AI-generated feature representations of cytoarchitectonic organization.

After completing the training, participants will have a first insight of the features of siibra-explorer and siibra-python to enhance their ability to explore brain atlases and perform advanced neuroimaging analyses.

Requirements: A laptop with an up-to-date web browser (Chrome or Firefox is recommended) is required for the hands-on examples. All examples will be run on pre-built Jupyter notebooks, which will be provided for downloading. Please register for an EBRAINS account in advance.

Presenters: SCHIFFER, Christian (Forschungszentrum Jülich); DICKSCHEID, Timo (Forschungszentrum Jülich)