# Brain MRI image segmentation (score 0)

**Homework X3 for Deep Learning, Autumn 2024**

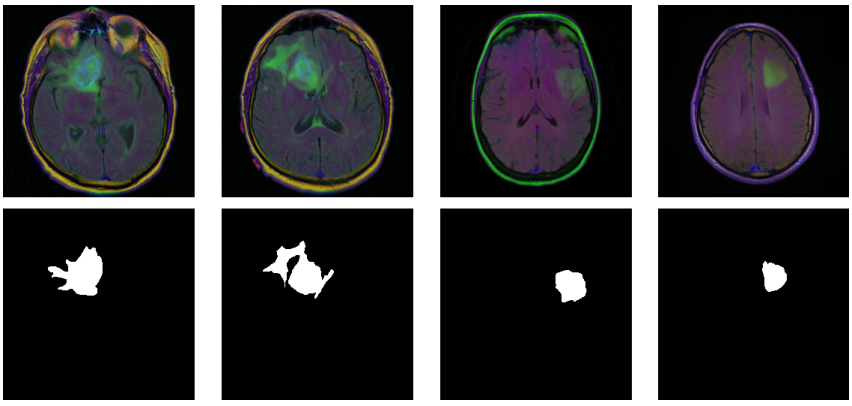
**Deadline: 2024.11.25 12:00**

## 1 Introduction

Brain MRI image segmentation is pivotal in the medical field as it greatly enhances the precision and effectiveness of neurological diagnosis and treatment. The accurate delineation of various brain structures from MRIs allows physicians to diagnose neurological disorders such as tumors and Alzheimer's disease more effectively, and consequently, to devise more precise treatment plans. Furthermore, it provides valuable guidance in neurosurgery, helping to prevent damage to healthy brain tissue. In the context of medical research, segmentation contributes to a better understanding of brain structure and disease effects. It also allows for monitoring of disease progression, thus informing treatment adjustments.

One dataset of brain MRI image is from the paper "Association of genomic subtypes of lower-grade gliomas with shape features automatically extracted by a deep learning algorithm". It provides preoperative imaging and genomic subtype data from 110 patients with lower-grade gliomas (WHO grade II and III) from The Cancer Genome Atlas, and becomes a standard dataset of brain MRI image segmentation.

Some examples are shown below. **Note**: During training, information about testing examples should never be used in any form.



You can download the dataset from
https://www.kaggle.com/datasets/mateuszbuda/lgg-mri-segmentation.

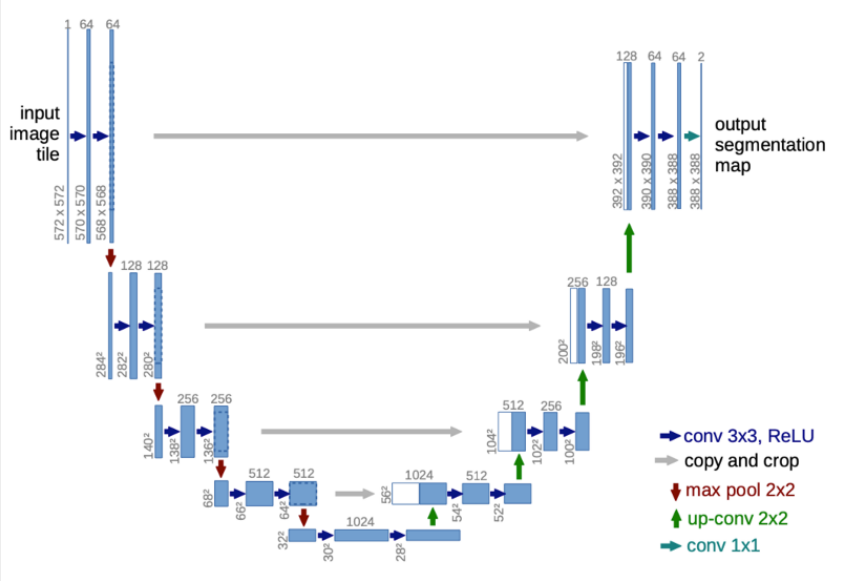
In this homework, you are required to implement a **U-Net** to perform Brain MRI image segmentation **at least**. You can implement more models. You should use **pytorch or mindspore** framework.

## 2 UNet for Brain MRI image segmentation

### 2.1 UNet Description

U-Net is a type of convolutional neural network (CNN) that is specifically designed for biomedical image segmentation. It was first introduced by Ronneberger et al. in a paper titled "U-Net: Convolutional Networks for Biomedical Image Segmentation" in 2015.

The architecture of U-Net is symmetric and has an encoder-decoder structure, which gives it a 'U' shape, hence the name. The encoder (also known as the contracting path) progressively captures the context in the image, while the decoder (also known as the expanding path) enables precise localization using transposed convolutions. Importantly, U-Net has skip connections that transmit feature maps from each level of the encoder directly to the corresponding level of the decoder, which helps to retain the high-resolution features necessary for precise segmentation.




Some papers introducing U-Net and updated U-Net are as follows, and you can choose to reproduce them:

- Ronneberger, O., Fischer, P., & Brox, T. (2015). U-net: Convolutional networks for biomedical image segmentation. In Medical Image Computing and Computer-Assisted Intervention–MICCAI 2015: 18th International Conference, Munich, Germany, October 5-9, 2015, Proceedings, Part III 18 (pp. 234-241). Springer International Publishing.
- Oktay, O., Schlemper, J., Folgoc, L. L., Lee, M., Heinrich, M., Misawa, K., ... & Rueckert, D. (2018). Attention u-net: Learning where to look for the pancreas. arXiv preprint arXiv:1804.03999.
- Alom, M. Z., Hasan, M., Yakopcic, C., Taha, T. M., & Asari, V. K. (2018). Recurrent residual convolutional neural network based on u-net (r2u-net) for medical image segmentation. arXiv preprint arXiv:1802.06955.
- other papers with U-Net you like.

## 3 Attention

- The website providing the dataset offers some code that you can reference, and you're also allowed to draw inspiration from other code you find (for instance, code that comes with papers) as long as you properly cite these sources in your report and **avoid plagiarism**. You're encouraged to use the code library provided on the Mindspore website.
- You need to submit all codes **and** a report (at least one page **in PDF format**). Delete the dataset before submit.

- The report should detail all improvement attempts and corresponding results.
- Do not paste a lot of codes in your report (only some essential lines could be included).
- If you have utilized Huawei's computing resources, please **acknowledge and thank Huawei Intelligent Foundation** in the report for providing these computing resources.