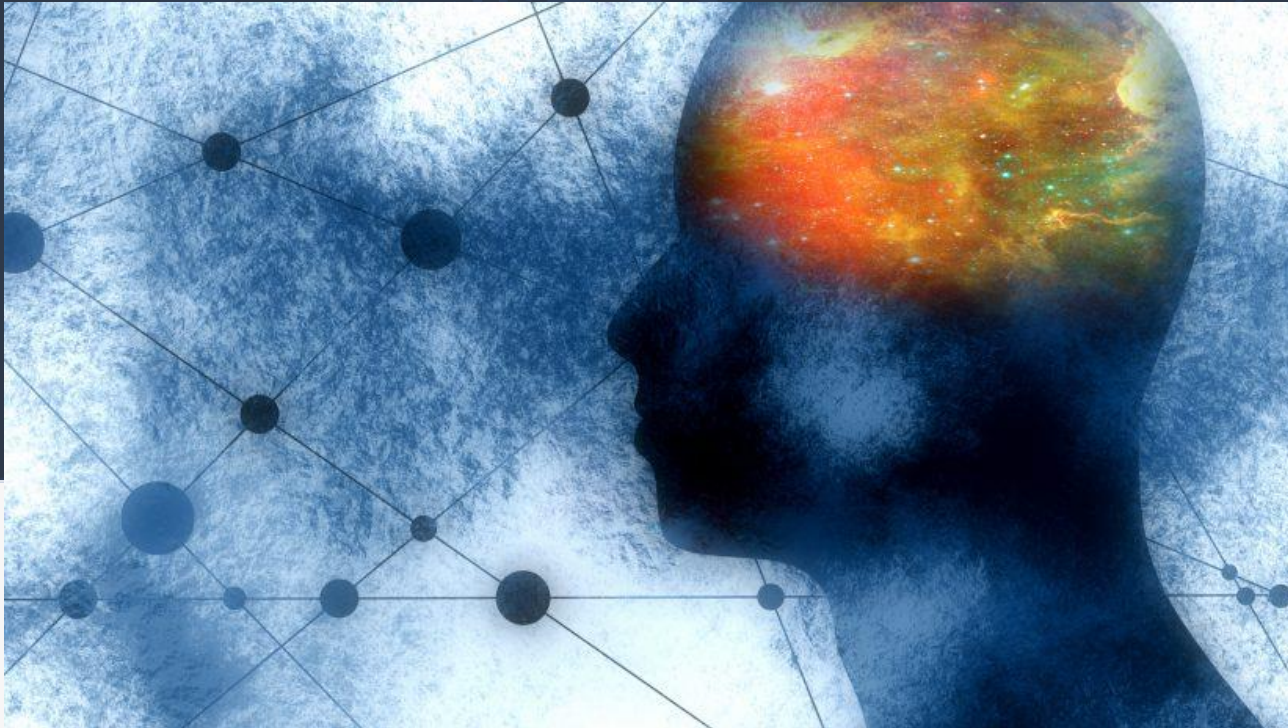


Brain Tumor Diagnosis

Deep Learning





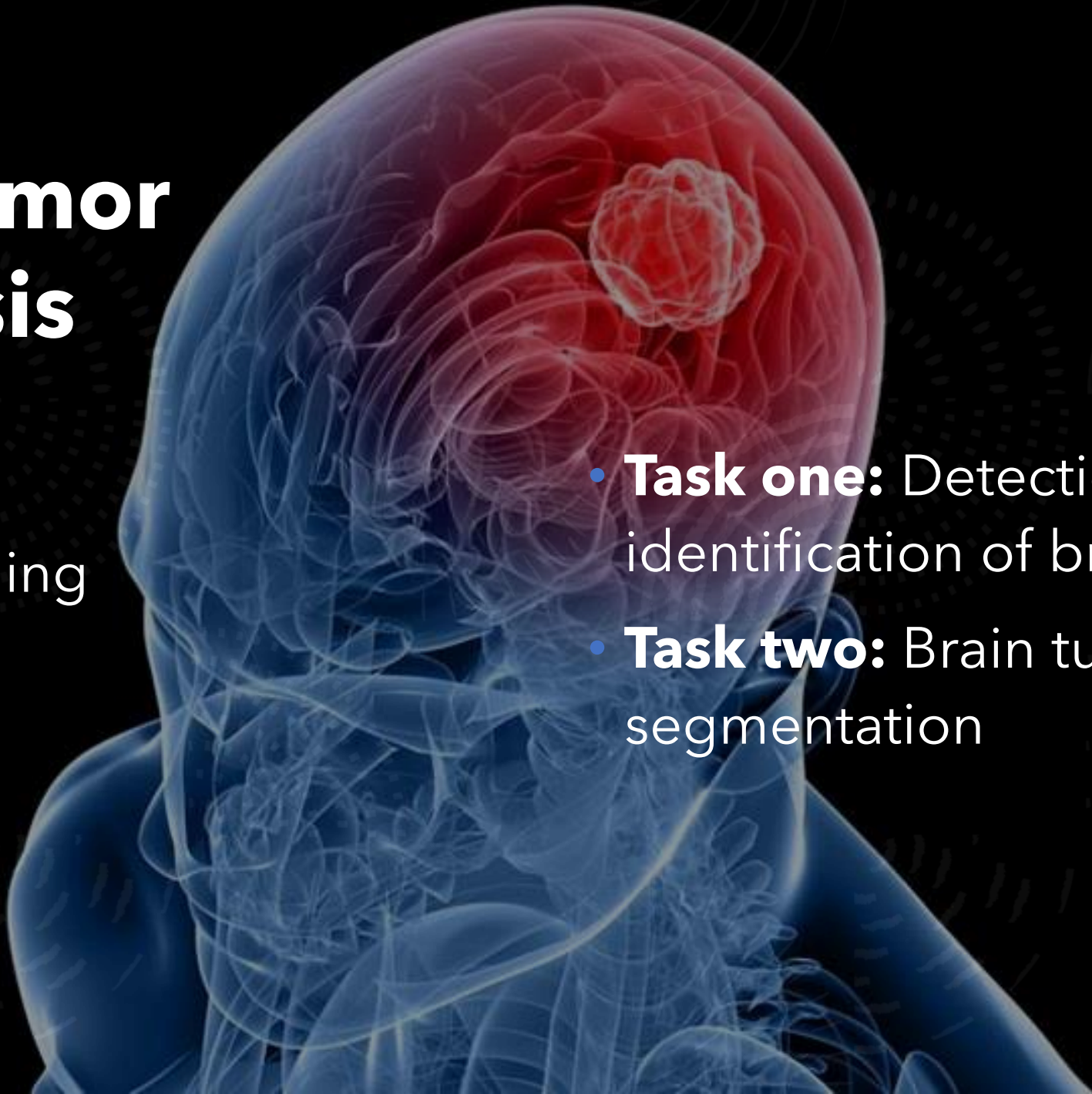
Brain Tumor Diagnosis

- Brain Tumor one of deadliest form of cancer
- Importance of Early detection
- There are 120 types of brain tumors.
- Examine three types :
 - Glioma
 - Meningioma
 - Pituitary

Brain tumor diagnosis

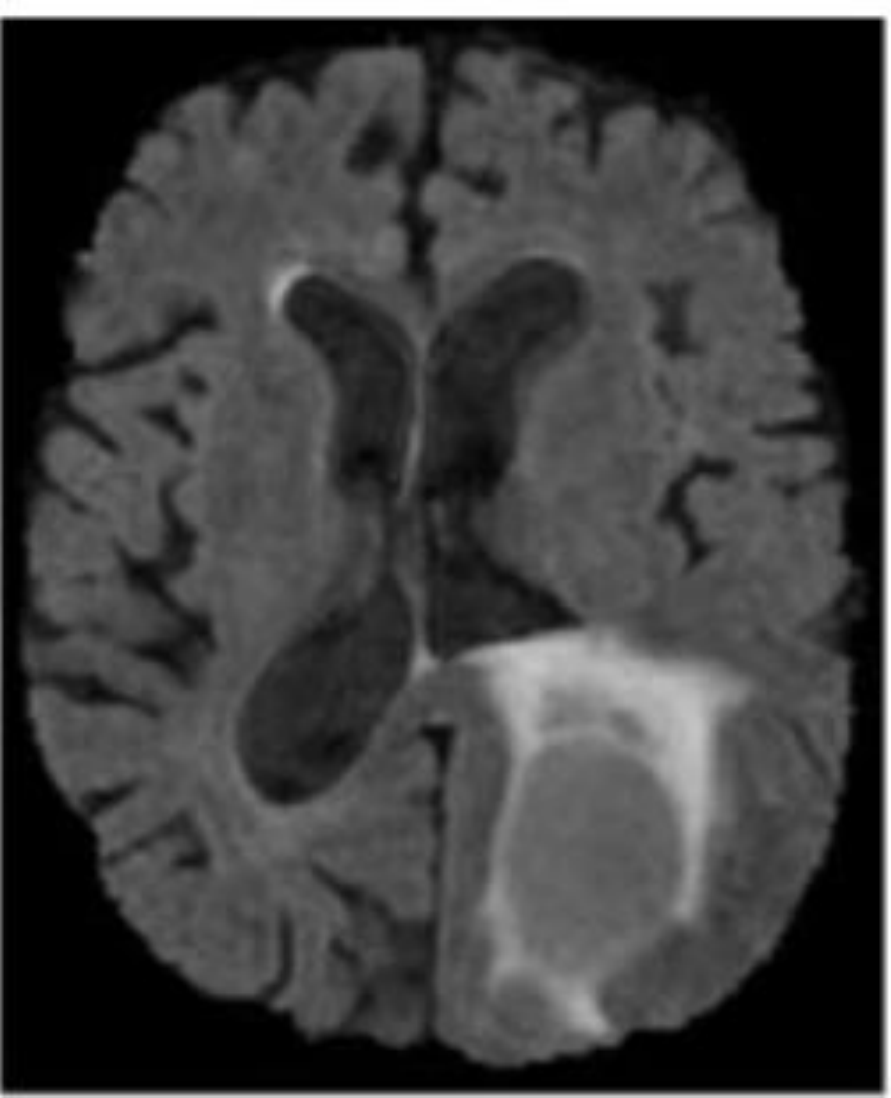
Difficult
Time consuming
Tedious
Error prone

- **Task one:** Detection and identification of brain tumor
- **Task two:** Brain tumor segmentation



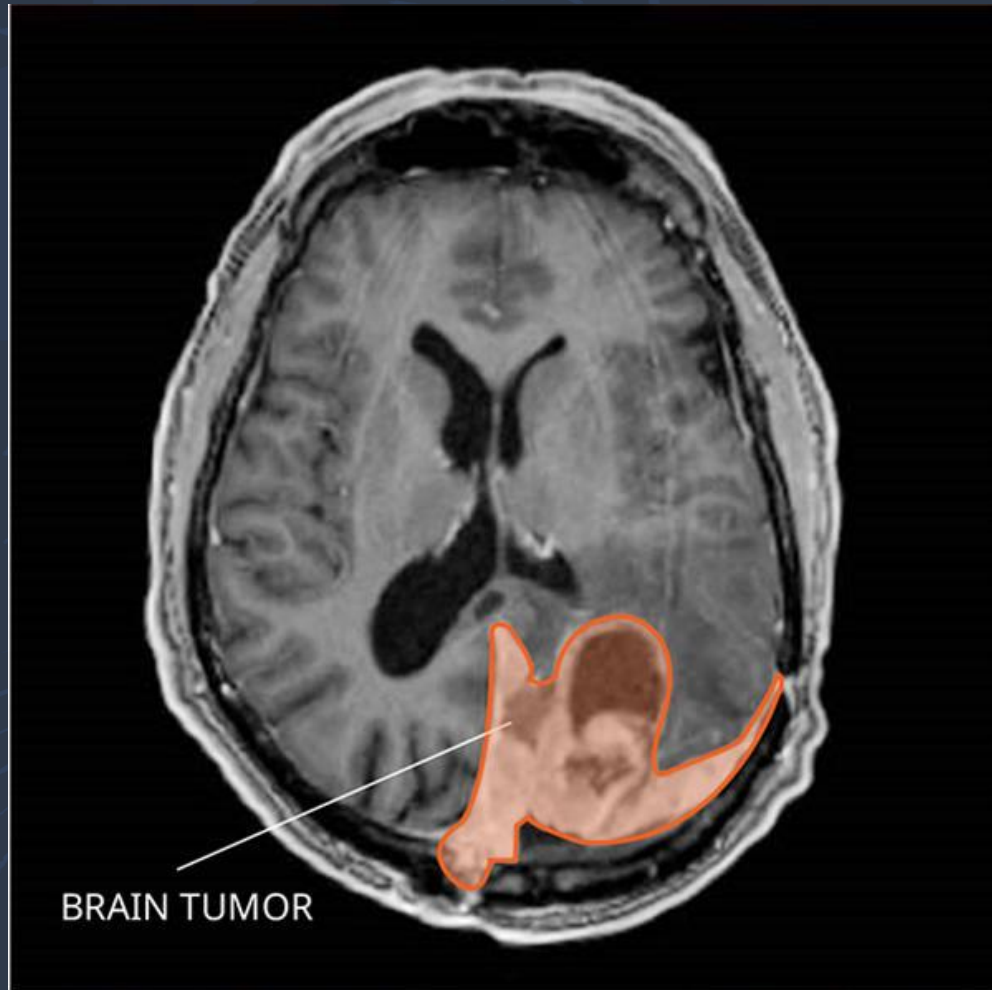
Glioma

- Glioma tumor occurs in the brain and the spine
 - Most common, most aggressive type of brain tumor
 - Surgery dramatically improves patient outcome
 - Extremely valuable to rapidly and accurately determine location of tumor



Meningioma

- The type of tumor the is in most cases benign





<https://www.mayfieldclinic.com>

Pituitary

Abnormal growth that develop in the pituitary gland.

Most of cases in benign

Cause loss of vision, consciousness, and pituitary function

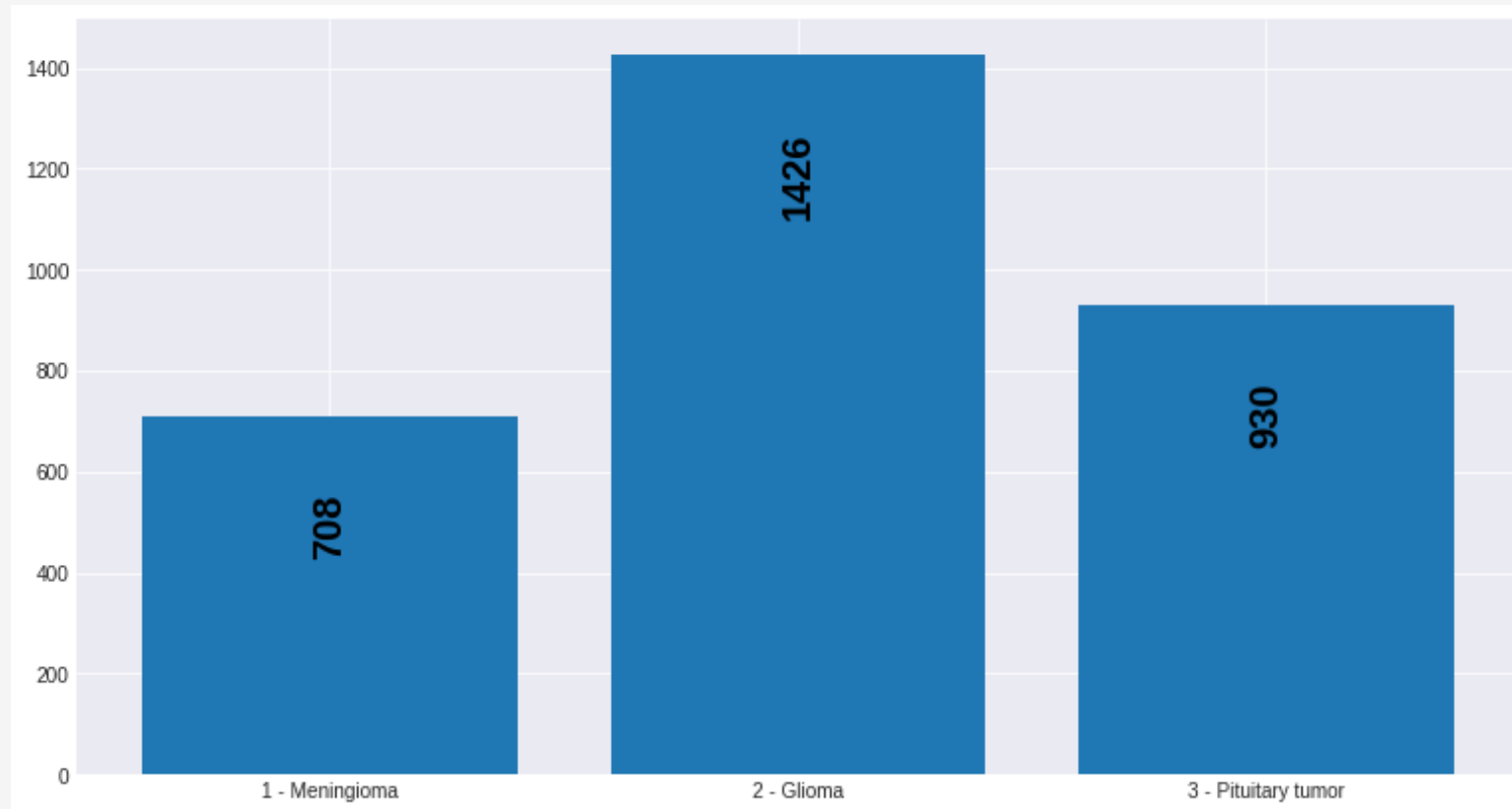


DATA

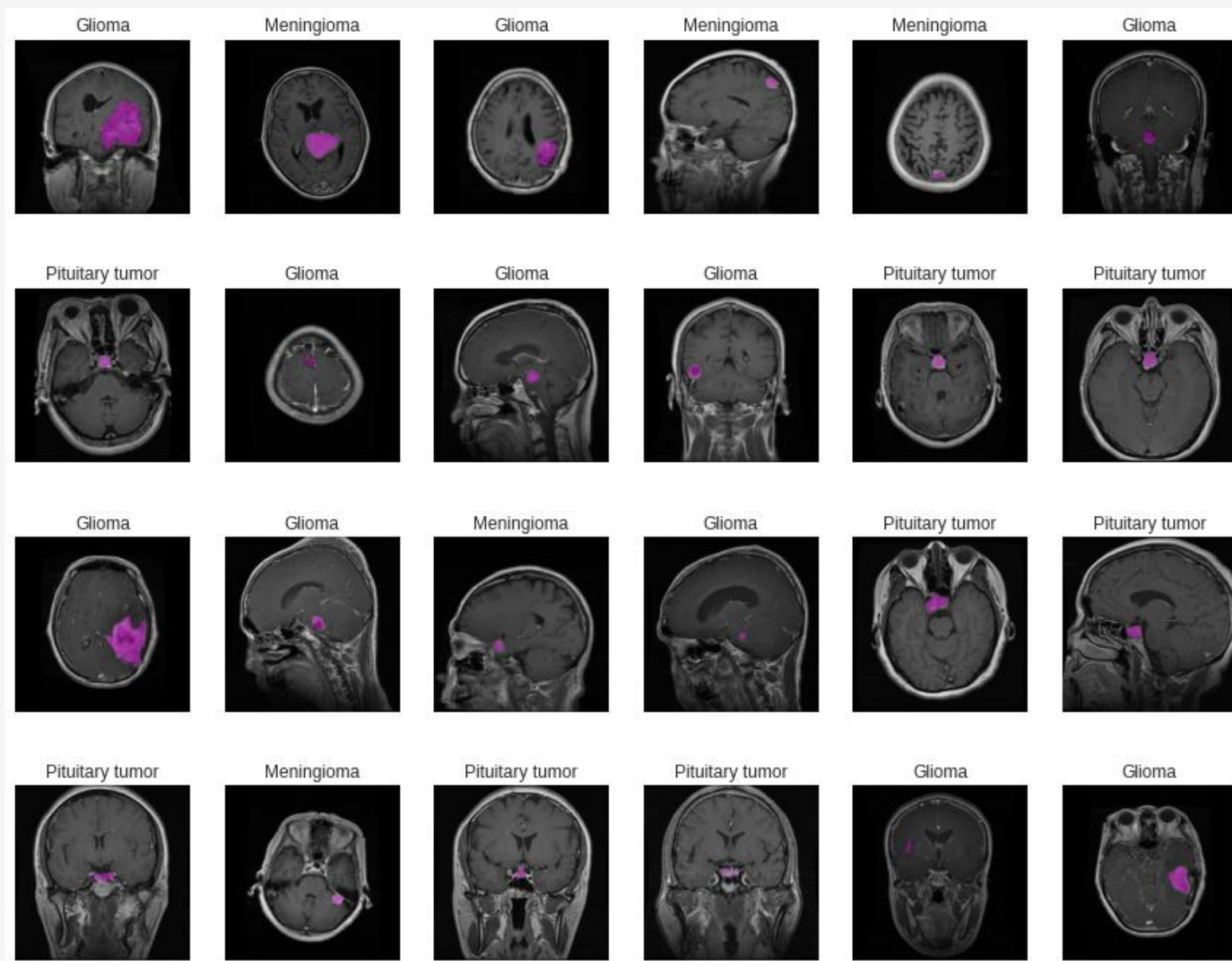
Figshare Brain Tumor Dataset: 3064 Brain MRI images from 233 patients who have one of the three types of brain tumors

*Brain tumor dataset. [Online; accessed 27. Sep. 2019]. Apr. 2017.
url: https://figshare.com/articles/brain_tumor_dataset/1512427/5.*

Data Distribution



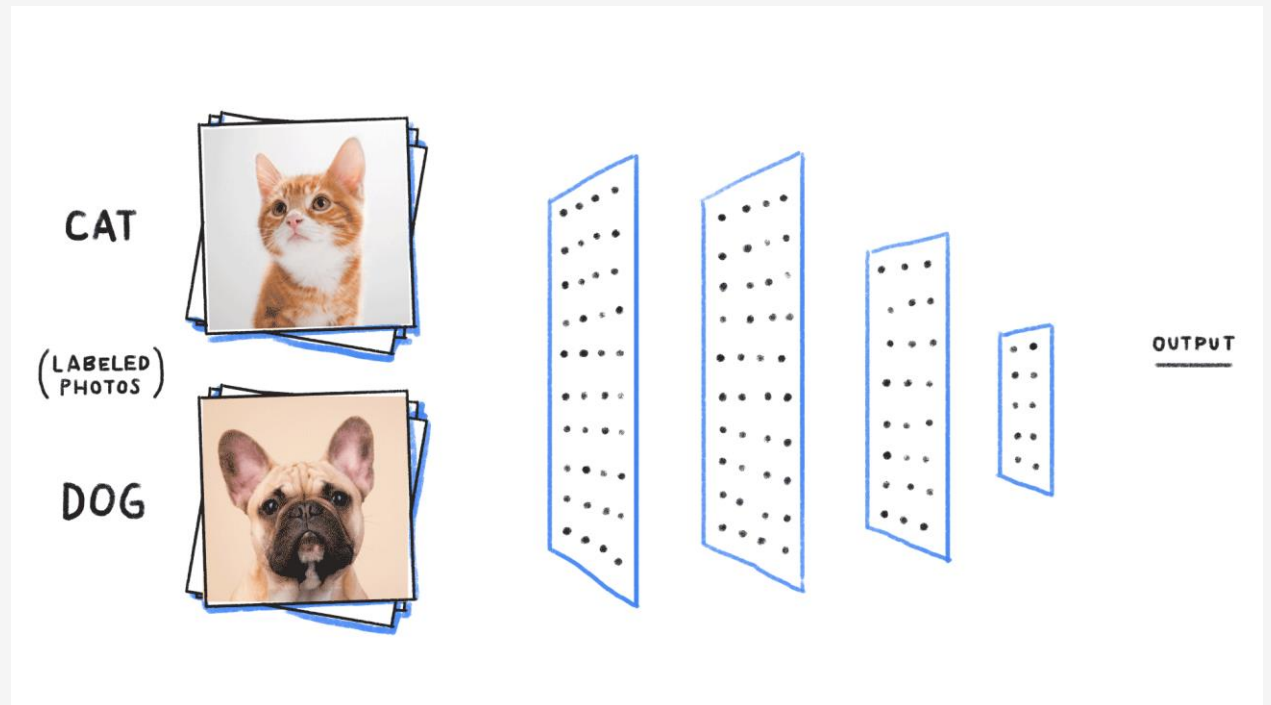
Images and Masks



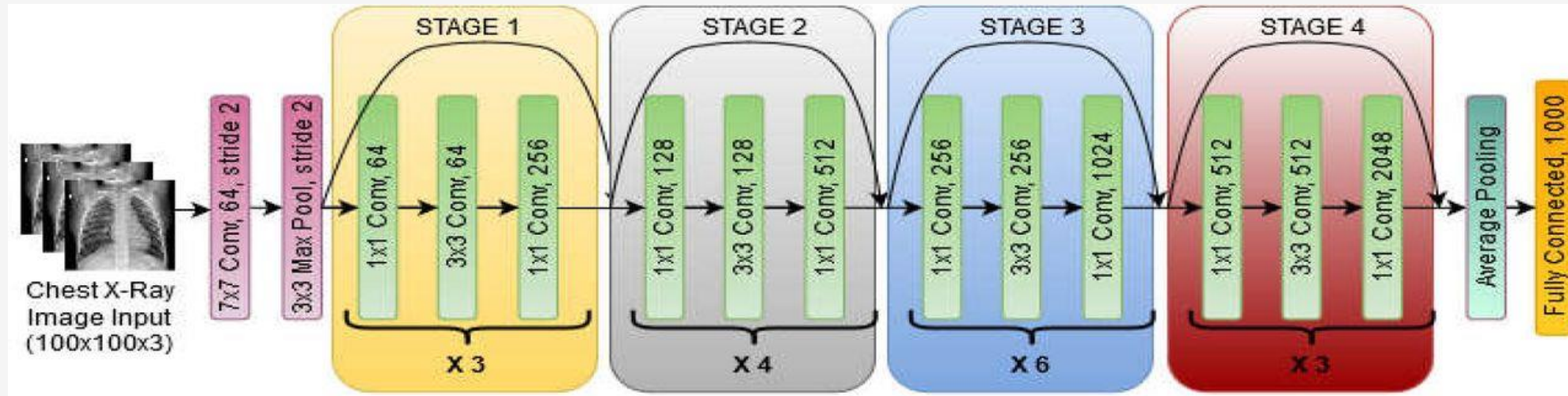
TASK 1: Detection & Identification

Transfer learning Models

- ResNet 50
- Vgg16
- Set all the pretrained weights
- Optimize the top layer by creating a custom output sequential layer
- Training: 50 epochs, optimizer SGD, learning rate 0.0003



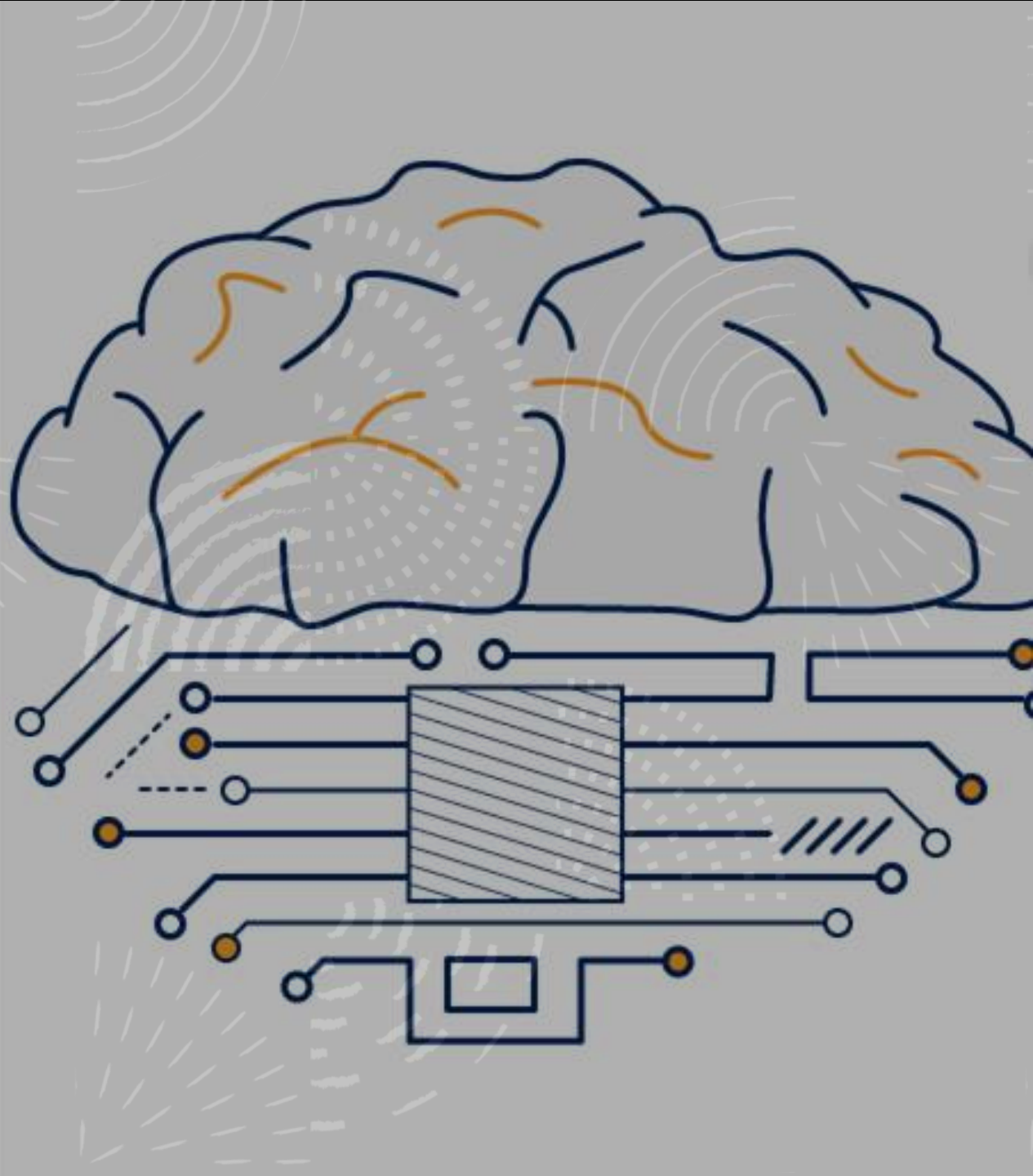
ResNet 50



VGG-16



RESULTS






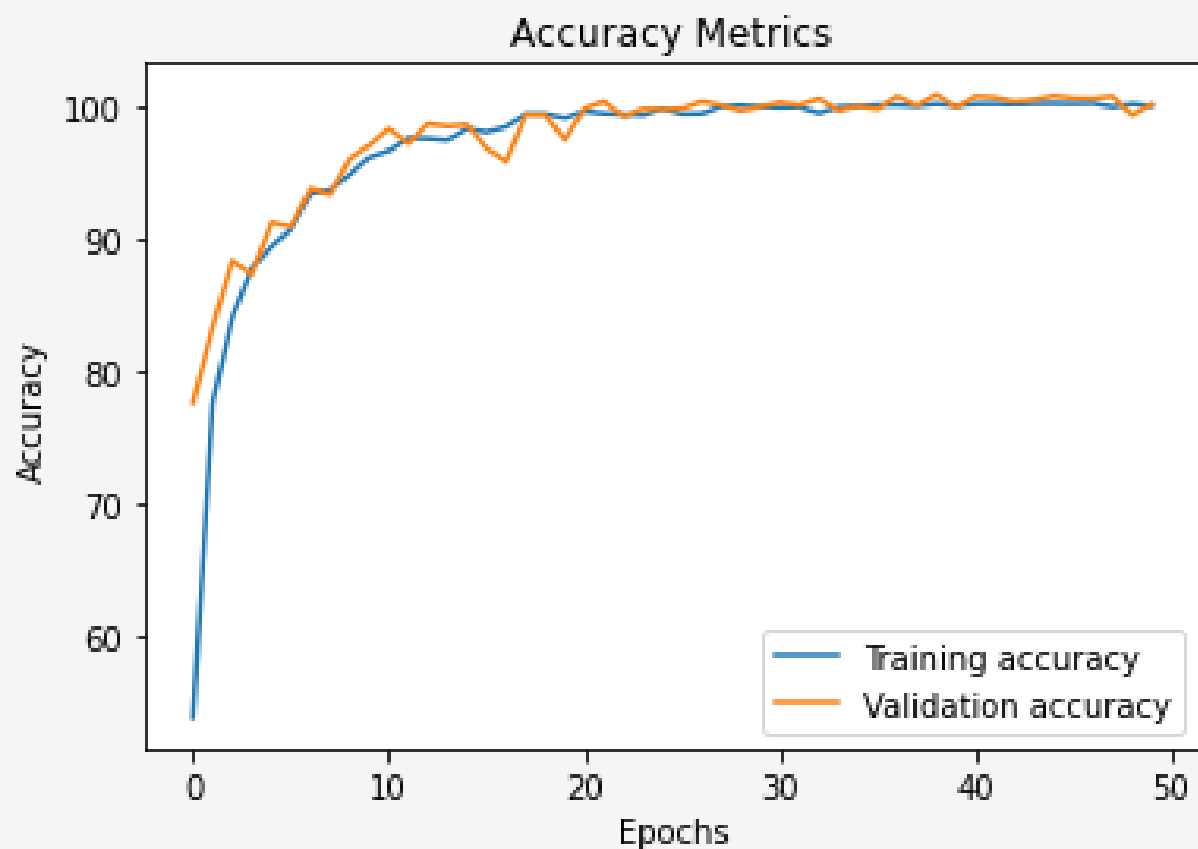
RestNet 50 Model

- **Validation accuracy: 98.90%**
- **Test accuracy: 98.99%**
- **Recall 97-100%**
- **Precision 98-100%**
- **False negative: 0% pituitary, 0.2% glioma, 0.9% meningioma**

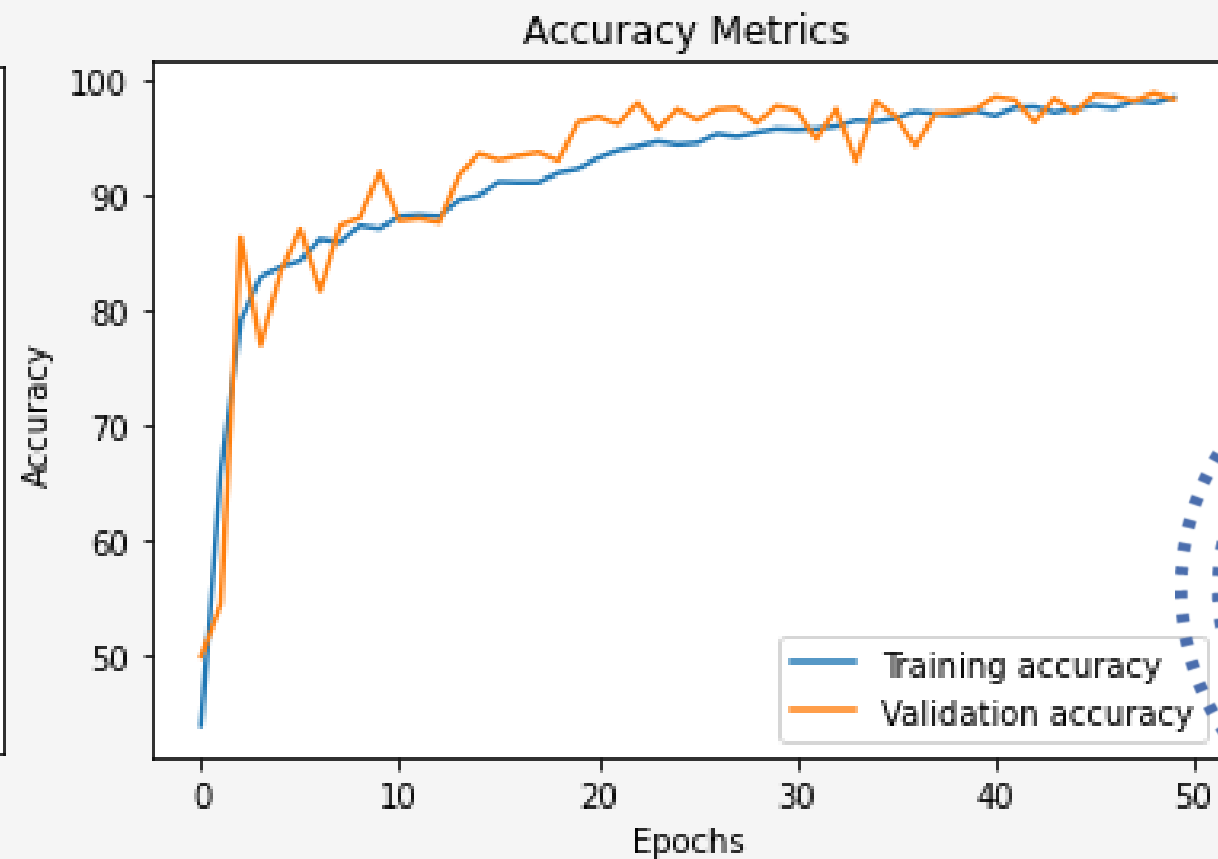
Vgg16 Model

- **Validation accuracy: 97.12%**
 - **Test accuracy: 97.12%**
 - **Recall 92-99%**
 - **Precision 96-99%**
 - **False negative: 1% pituitary, 0.3% glioma, 1.9% meningioma**
- 

ResNet 50



Vgg16

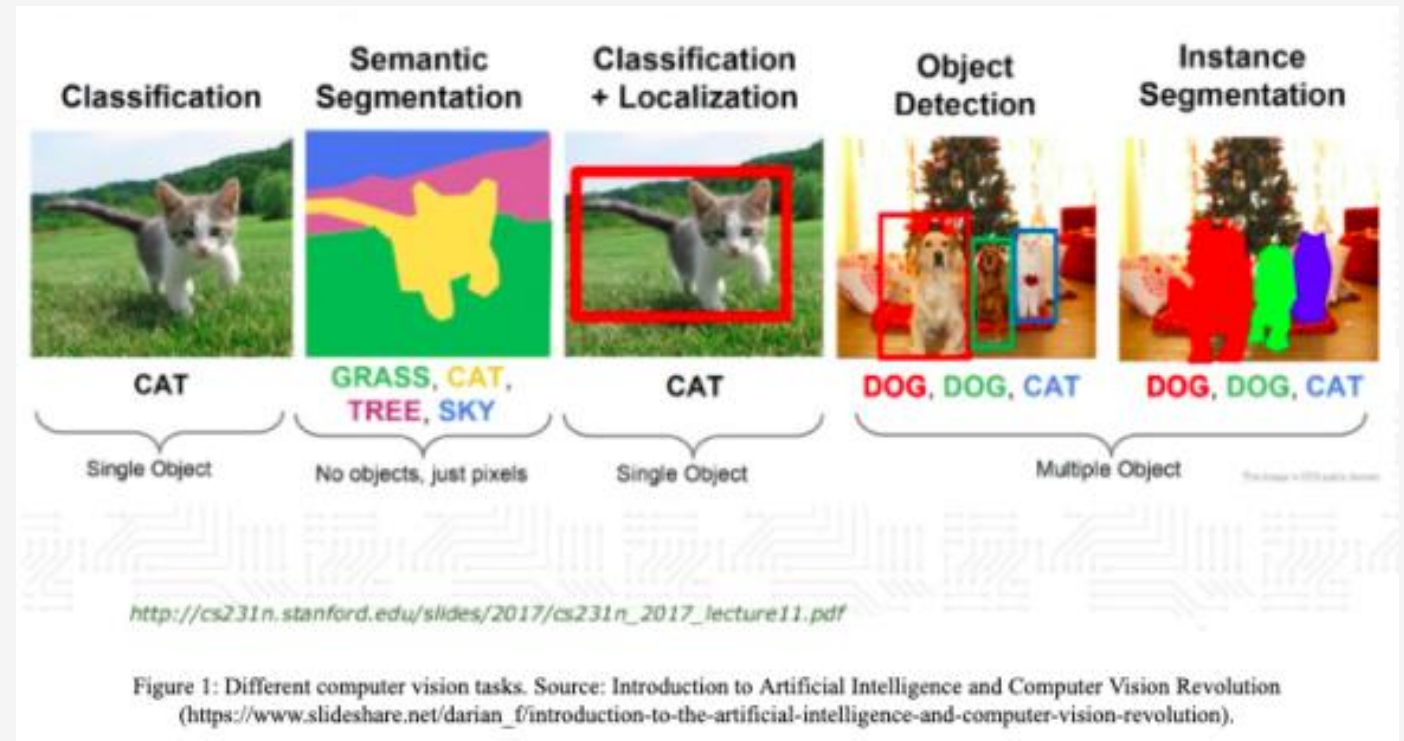


TASK 2: Brain Tumor Segmentation

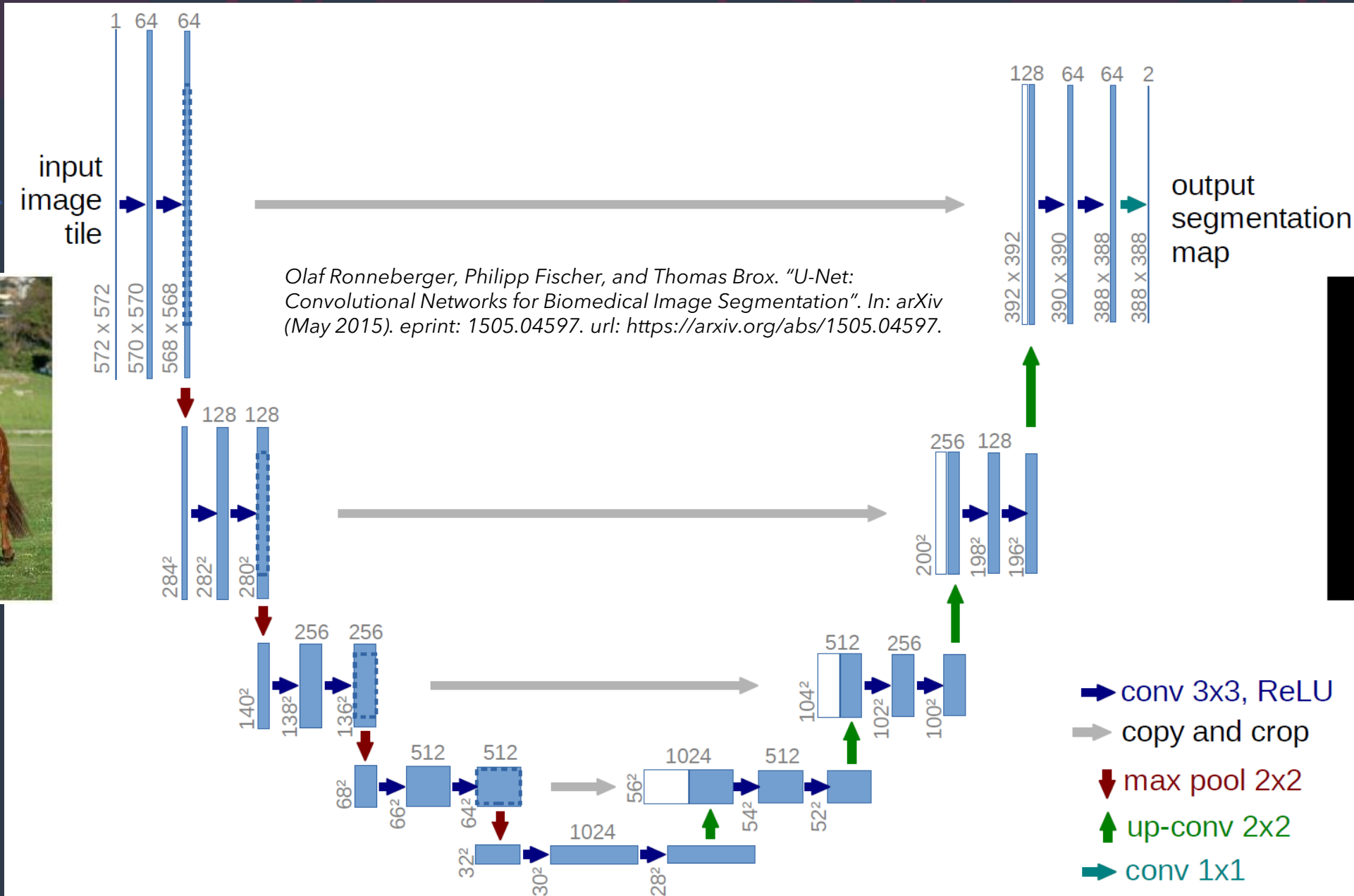
Models Built:

- UNet
- ResUnet
- Deep ResUnet
- ONet
- Dynamic Unet

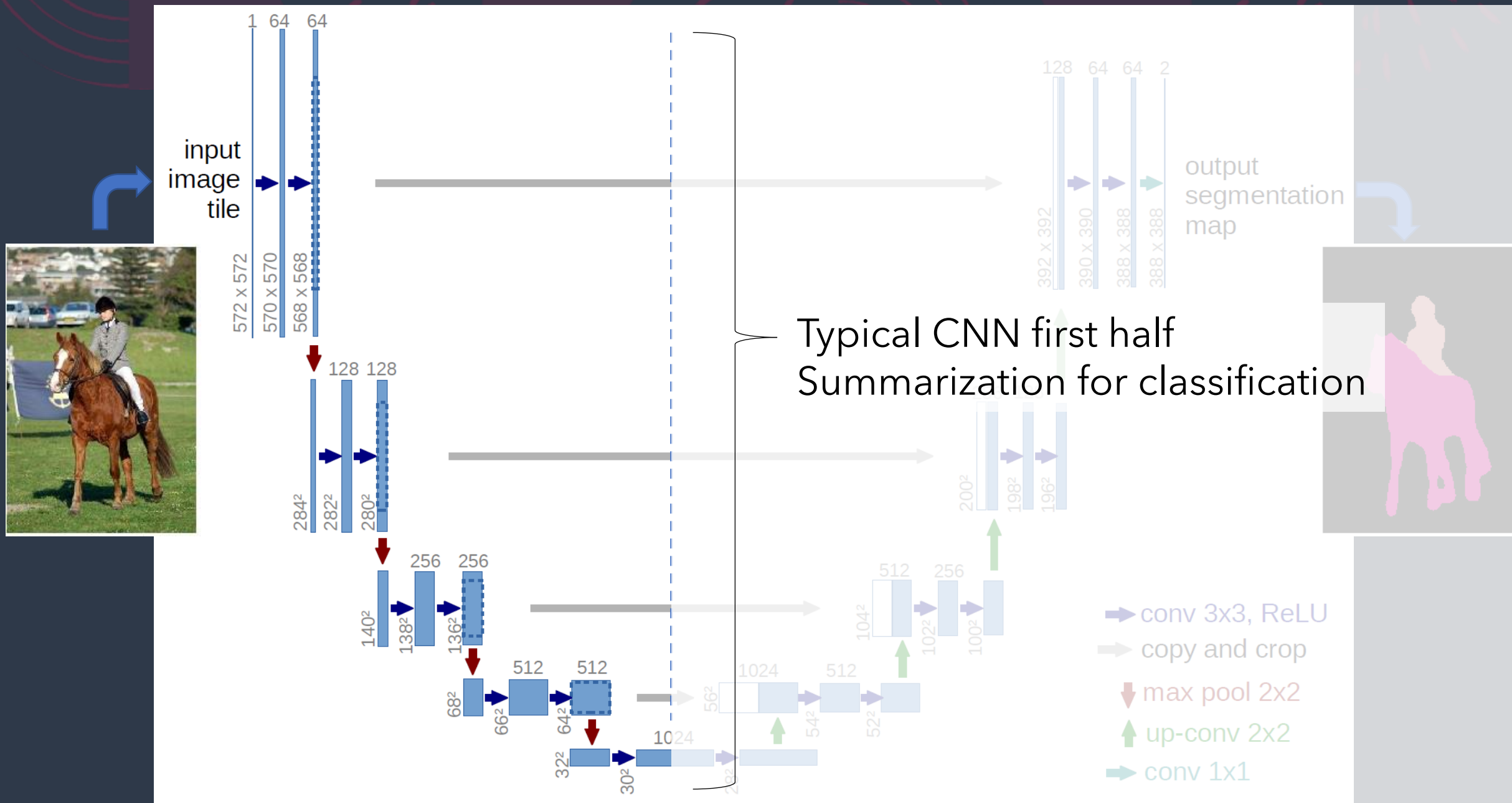
Configuration: 100 epochs, learning of 0.001, batch size=2 images



UNet Model



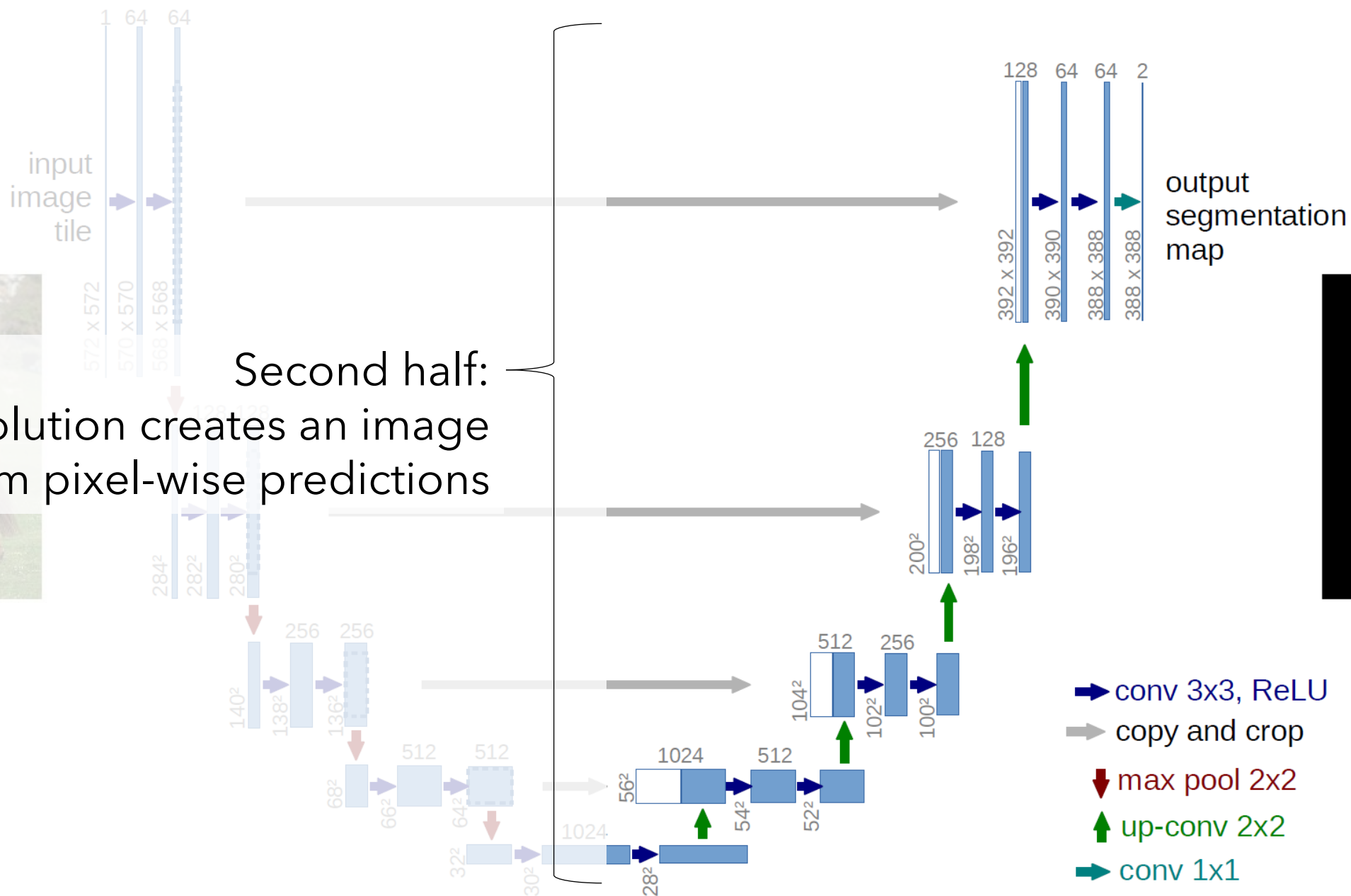
UNet Model



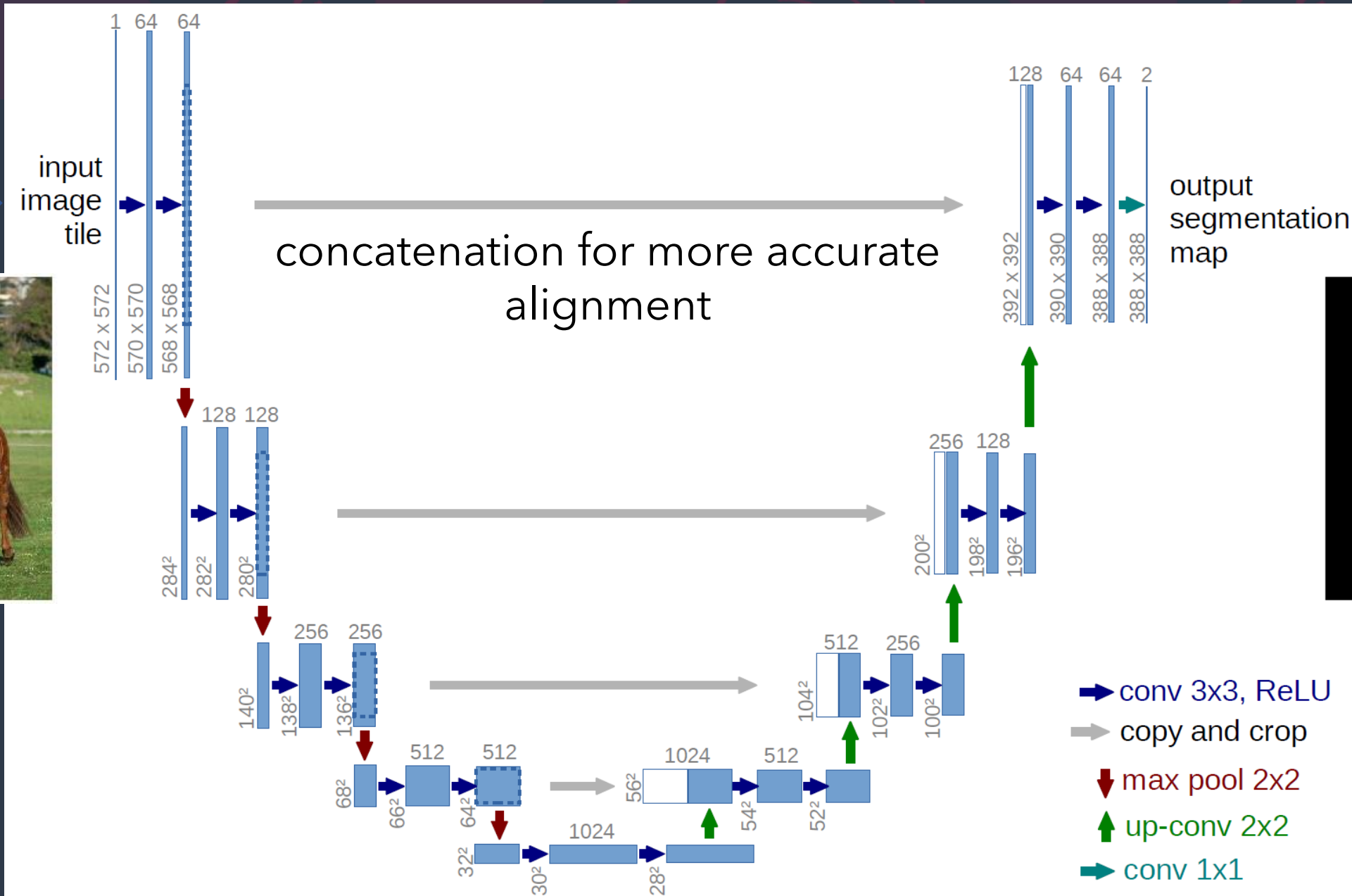
UNet Model



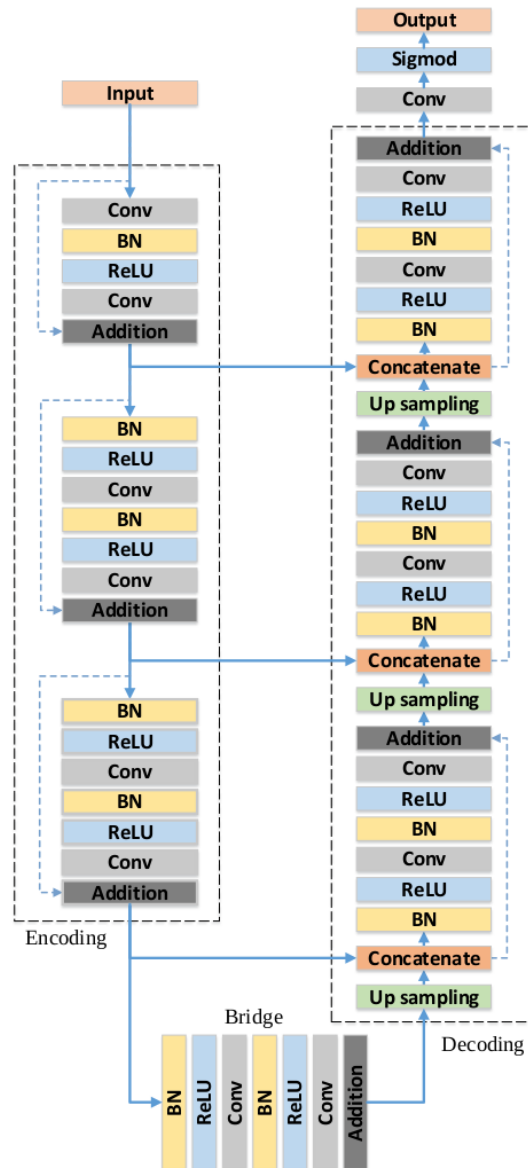
Second half:
Deconvolution creates an image
from pixel-wise predictions



UNet Model

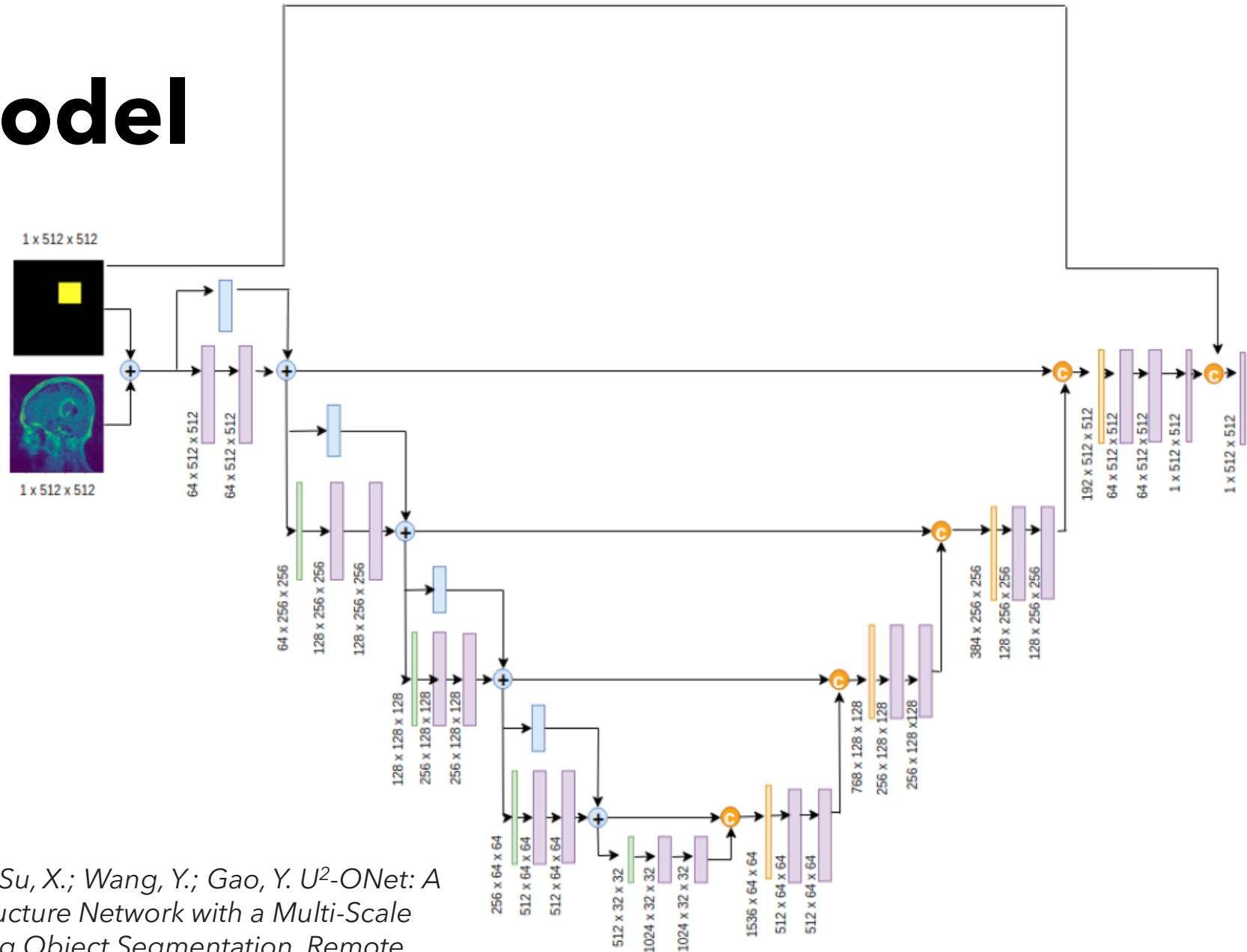


ResUNet Model



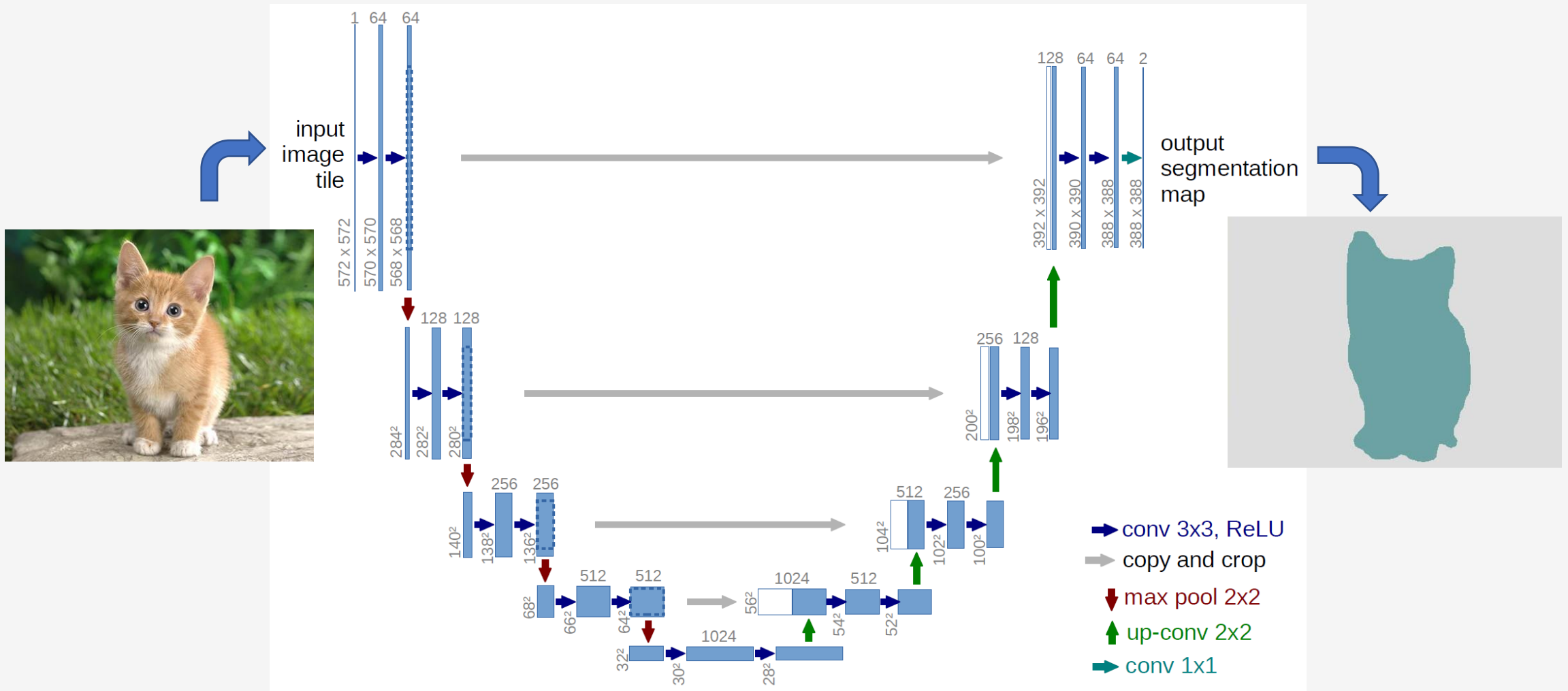
Md Zahangir Alom et al. "Recurrent Residual Convolutional Neural Network based on U-Net (R2U-Net) for Medical Image Segmentation". In: arXiv (Feb. 2018). eprint: 1802.06955. url: <https://arxiv.org/abs/1802.06955>.

ONet Model

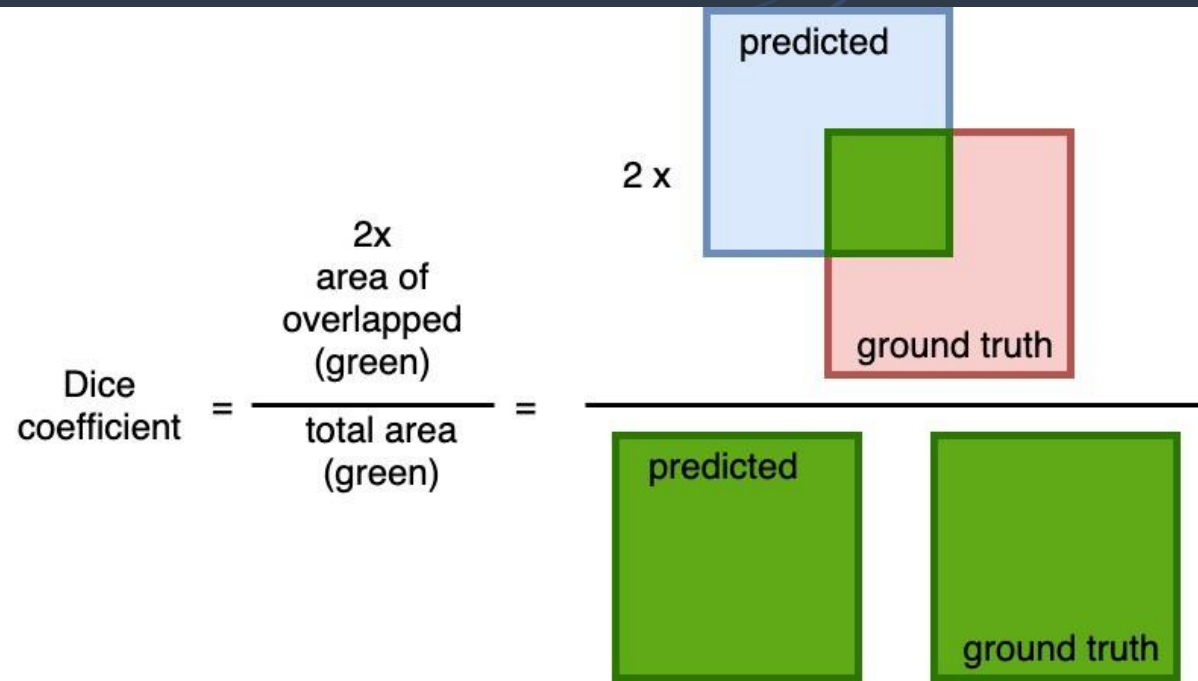


Wang, C.; Li, C.; Liu, J.; Luo, B.; Su, X.; Wang, Y.; Gao, Y. U²-ONet: A Two-Level Nested Octave U-Structure Network with a Multi-Scale Attention Mechanism for Moving Object Segmentation. *Remote Sens.* **2021**, *13*, 60. <https://doi.org/10.3390/rs13010060>

Dynamic UNet Model



F. Isensee et al, Brain Tumor Segmentation and Radiomics Survival Prediction: Contribution to the BRATS 2017 Challenge. Computer Vision and Pattern Recognition. [arXiv:1802.10508v1](https://arxiv.org/abs/1802.10508v1)



$$Dice = \frac{2 \times TP}{(TP + FP) + (TP + FN)}$$

Dice Coefficient

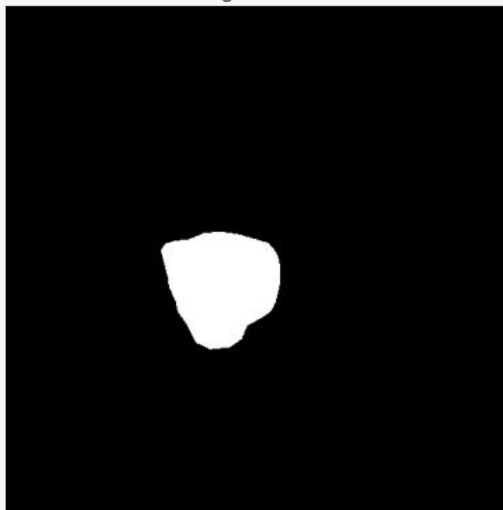
Result: Model Evaluation

Model	Dice score
UNet	0.75
Deep ResUNet	0.75
ResUNet	0.76
ONet	0.80
Dynamic UNet	0.80

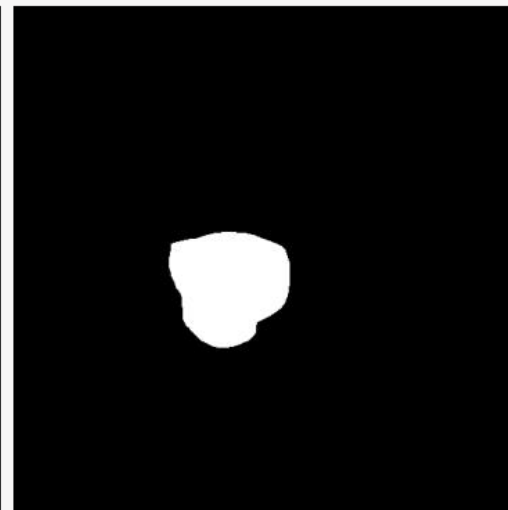
Random Image: Test data

Name: 75.png Dice Score: 0.97041

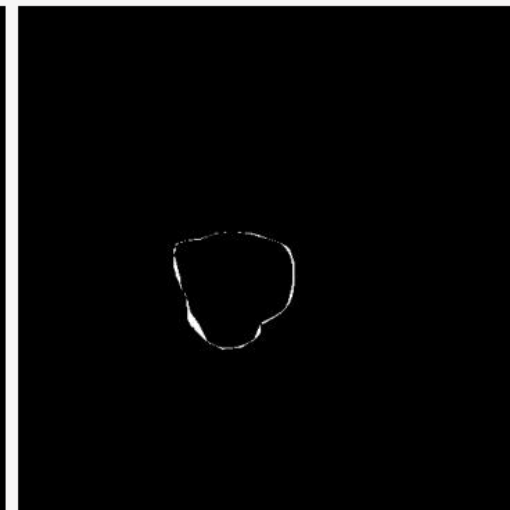
Original Mask



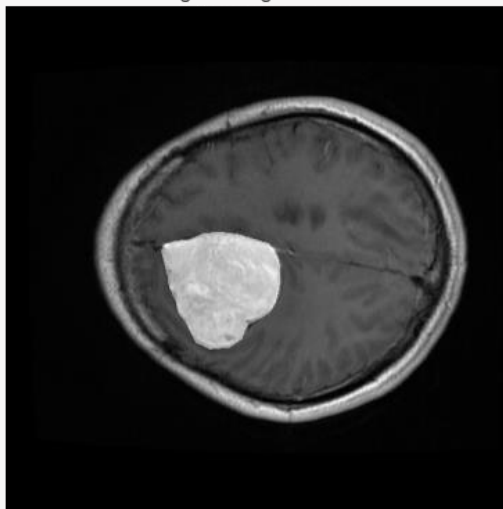
Predicted Mask



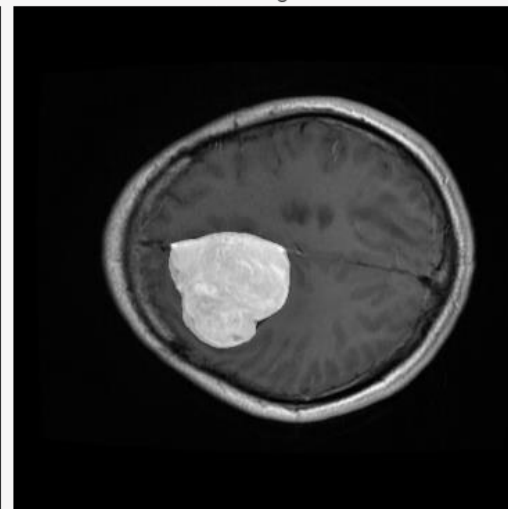
Mask Difference



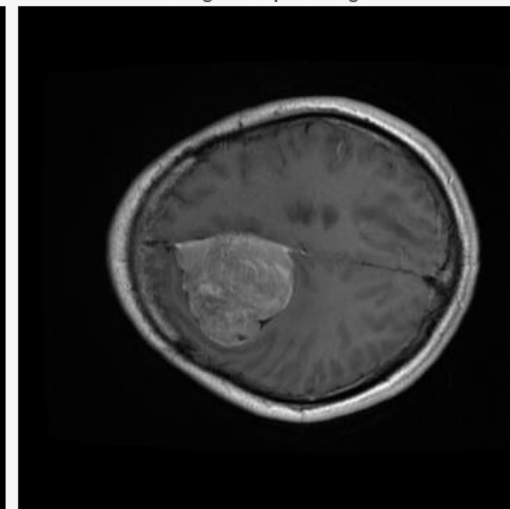
Original Segmentation



Predicted Segmentation

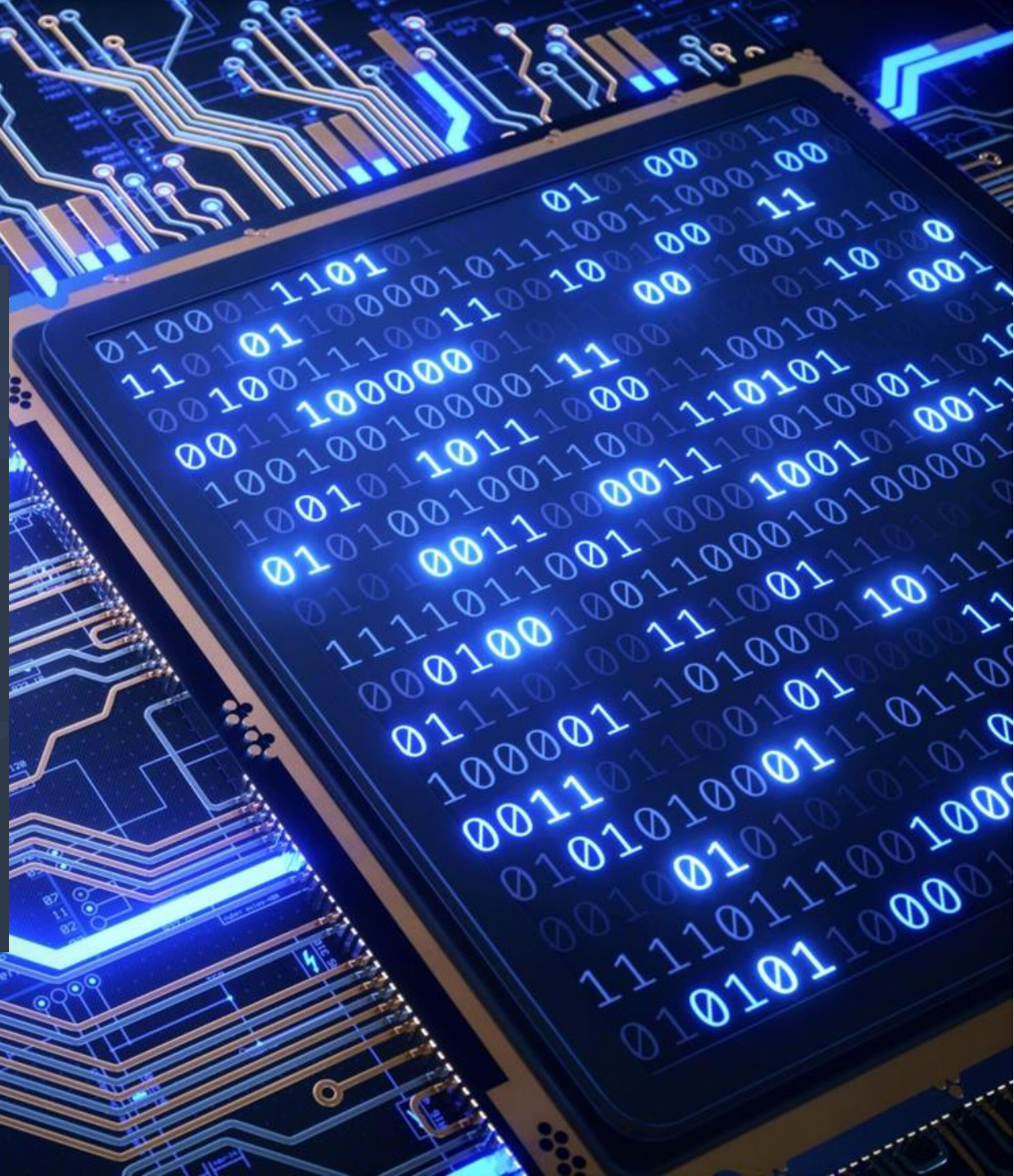


Original Input Image



CONCLUSION

- ResUNet 50 is best for brain tumor classification: 98.8% accuracy (test data)
- Onet and Dynamic Unet are best for brain tumor segmentation (dice coefficient 0.8 (test data))
- Complex models do not improve the segmentation process in out case.



RECOMMENDATION

- Use Deep learning CNN models for early detection and treatment of brain tumor.
- Incorporate Automatic identification of tumors models with MRI scan technology.
- Incorporate automatic segmentation model into radiology treatment technology.
- Incorporate segmentation maps for surgery operation or robotic surgery arms.
- App available for everyone on phone to visualize their MRI brain results.



BUSINESS VALUE

The background features a dark blue, almost black, field with faint, glowing white and light blue lines. A prominent white line graph with three data points is visible on the left side. The data points are small circles with a yellow-orange center. The graph shows a downward trend followed by an upward trend. In the background, there are also some blurred text elements, including the number '289.33' and '33'.

- 1) Fast, accurate, automatic detection, and segmentation process.
- 2) Decrease significantly the time of diagnosis and treatment.
- 3) Efficient treatment of brain tumors.
- 4) Decrease the workload on health workers
- 5) Decrease the number of health workers.
- 6) Diagnose and treat a huge number of patients.
- 7) Prevent spread cancer and save lives.

FUTURE WORK

- Develop a segmentation model for different stages of glioma tumor
- Develop one model for detection, identification (120 tumors), segmentation.
- Improve the architect of CNN model to achieve dice sore greater than 0.8.
- Apply different models' architecture on brain tumor dataset with opti,ization: Attention Unet, Unet++, UNet3+, Deep Lab V3+, 3D ResUNet, Multi ResUNet, TransUNet

REFERENCES

Md Zahangir Alom et al. "Recurrent Residual Convolutional Neural Network based on U-Net (R2U-Net) for Medical Image Segmentation". In: arXiv (Feb. 2018). eprint: 1802.06955. url: <https://arxiv.org/abs/180206955>

Brain tumor dataset. [Online; accessed 27. Sep. 2019]. Apr. 2017. url: https://figshare.com/articles/brain_tumor_dataset/1512427/5.

Kaiming He et al. "Identity Mappings in Deep Residual Networks". In: arXiv (Mar. 2016). eprint: 1603.05027. url: <https://arxiv.org/abs/1603.05027>.

Olaf Ronneberger, Philipp Fischer, and Thomas Brox. "U-Net: Convolutional Networks for Biomedical Image Segmentation". In: arXiv (May 2015). eprint: 1505.04597. url: <https://arxiv.org/abs/1505.04597>.

Zhengxin Zhang, Qingjie Liu, and Yunhong Wang. "Road Extraction by Deep Residual U-Net". In: arXiv (Nov. 2017). doi: 10.1109/LGRS.2018.

Wang, C.; Li, C.; Liu, J.; Luo, B.; Su, X.; Wang, Y.; Gao, Y. U2-ONet: A Two-Level Nested Octave U-Structure Network with a Multi-Scale Attention Mechanism for Moving Object Segmentation. Remote Sens. 2021, 13, 60. <https://doi.org/10.3390/rs13010060>

F. Isensee et al, Brain Tumor Segmentation and Radiomics Survival Prediction: Contribution to the BRATS 2017 Challenge. Computer Vision and Pattern Recognition. arXiv: 1802.10508v1.

QUESTIONS???





Thank you