End-to-End Automated Medical Image Analysis on the UCSF Clinical PACS

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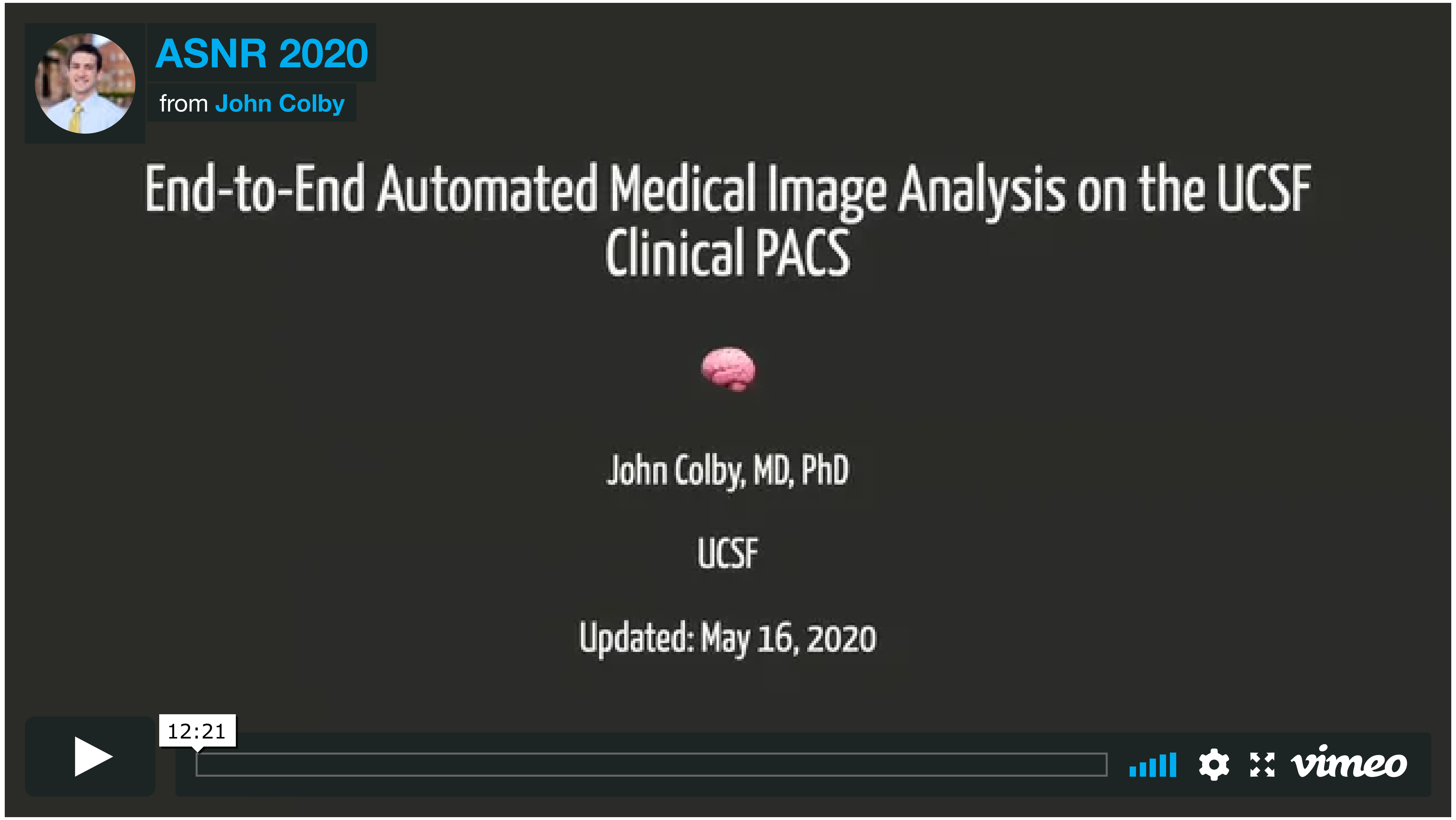
UCSF

Updated: May 17, 2020

Video presentation



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More info

- Slides: johncolby.github.io/asnr2020
- Repo: github.com/johncolby/asnr2020

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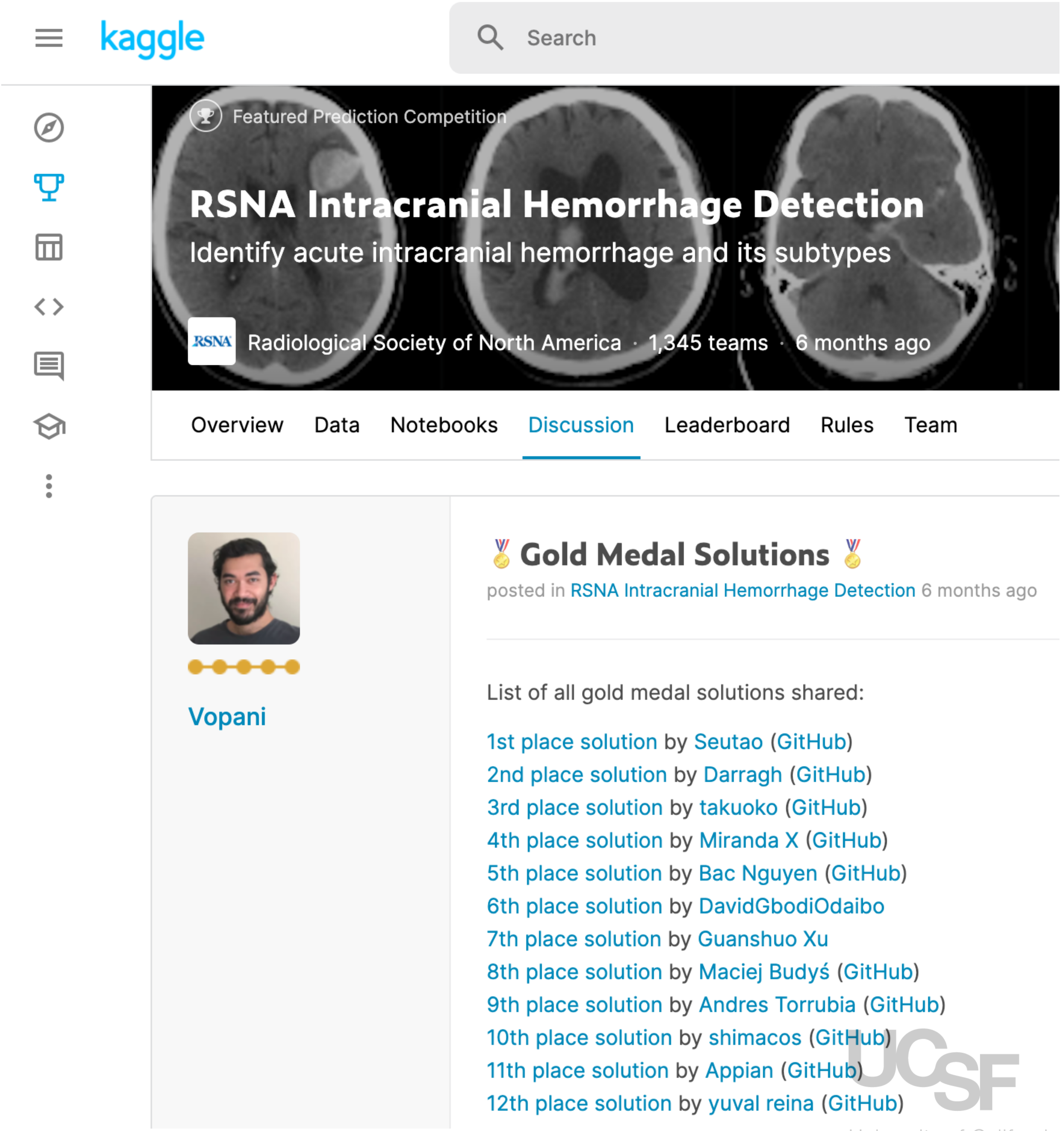
Rationale

- Algorithms are free.



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- Algorithms are free.
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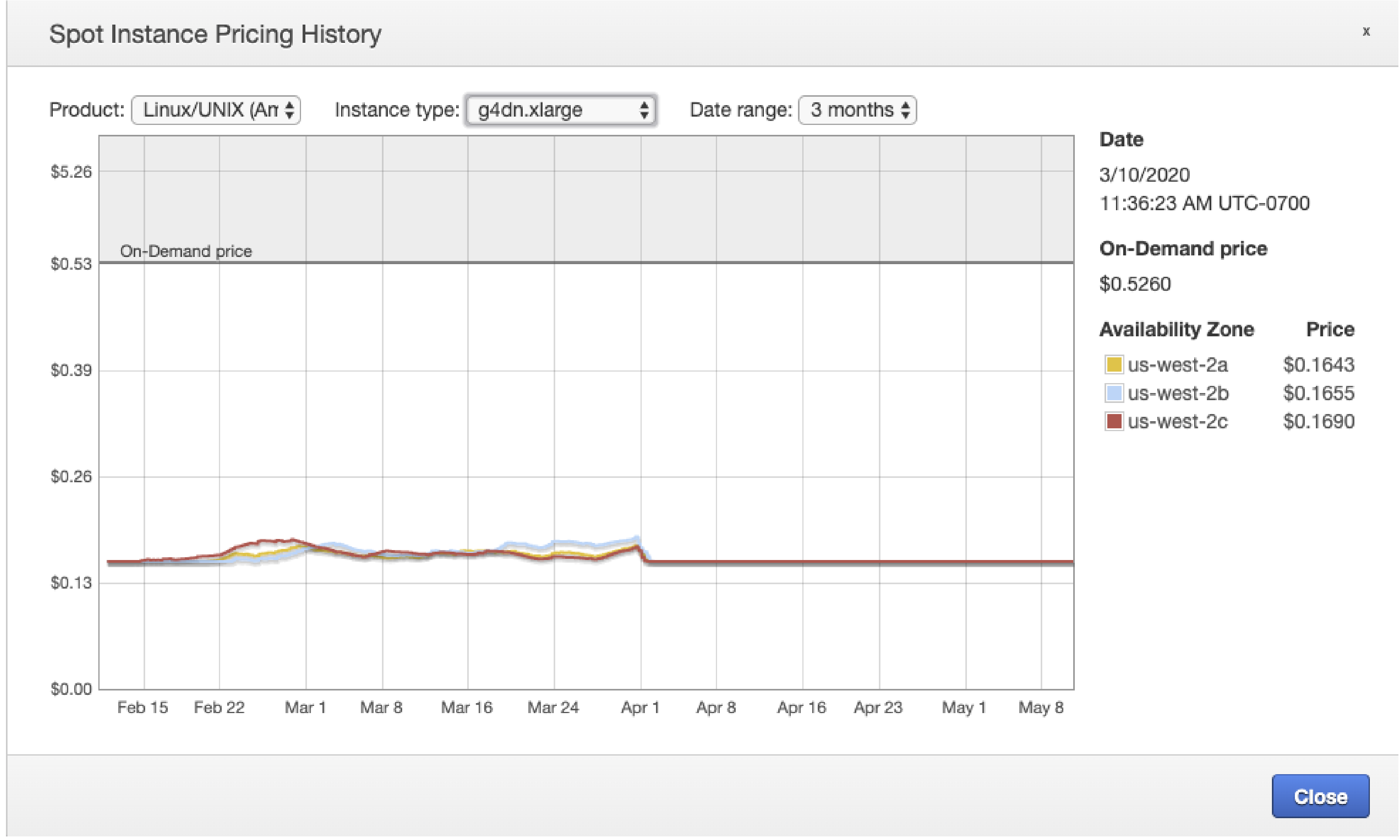

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Rationale

- Algorithms are free.
- Computers are cheap.
- Data are *expensive*.

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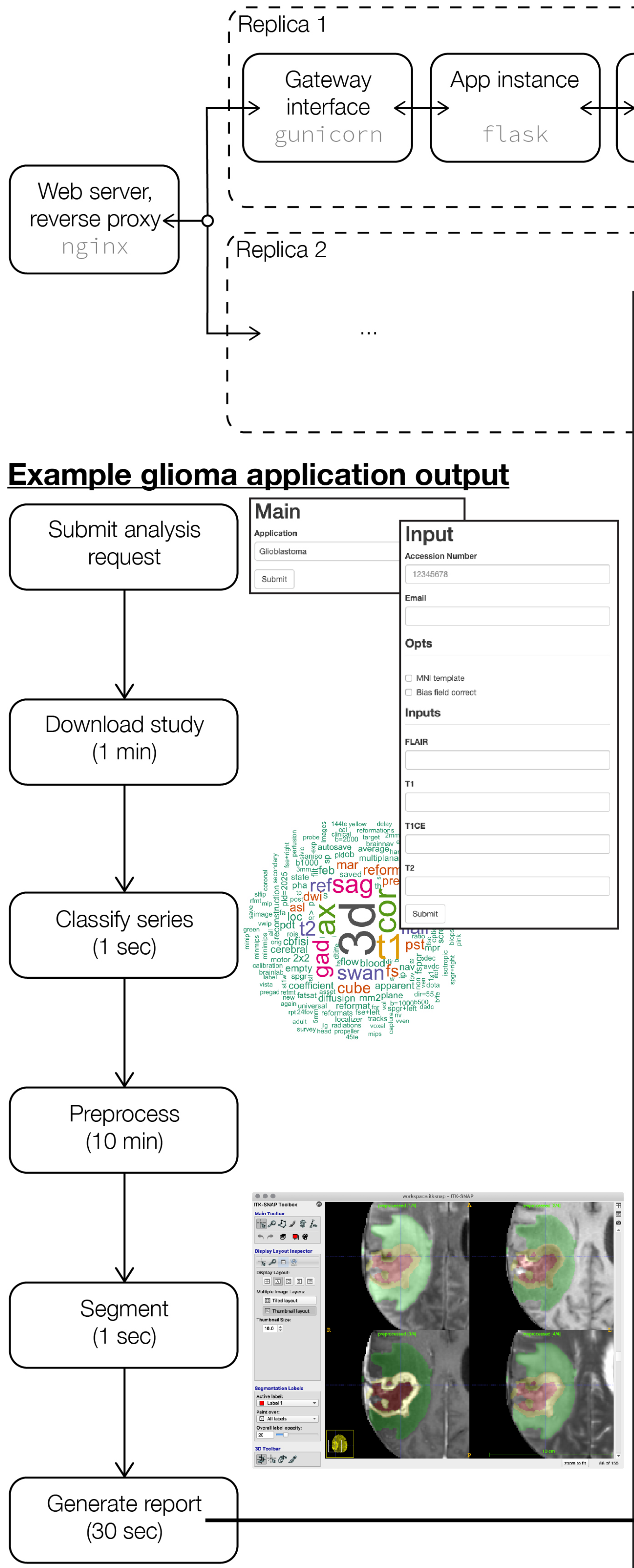
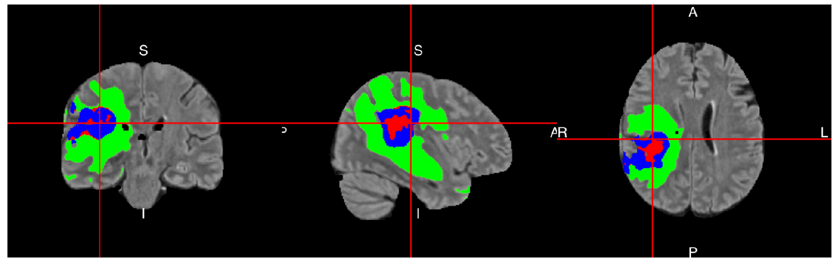
Overview





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08/29/2019 00:59:00

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Glioma tumor quantification report

About

This report includes tumor subregion volumes for glioblastoma brain tumors. It uses a U-Net deep learning convolutional neural network based segmentation algorithm (Ronneberger, Fischer, and Brox 2015) that has been pretrained on the Brain Tumor Segmentation (BraTS) 2018 dataset (Menze et al. 2015; Bakas et al. 2017).

Analysis

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Figure 1: Tumor segmentation

Table 1: Tumor volumes

Subtype	Volume (cm^3)	Volume (%)	Volume (%TBV)
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References

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Ronneberger, Olaf, Philipp Fischer, and Thomas Brox. 2015. "U-Net: Convolutional Networks for Biomedical Image Segmentation," May.

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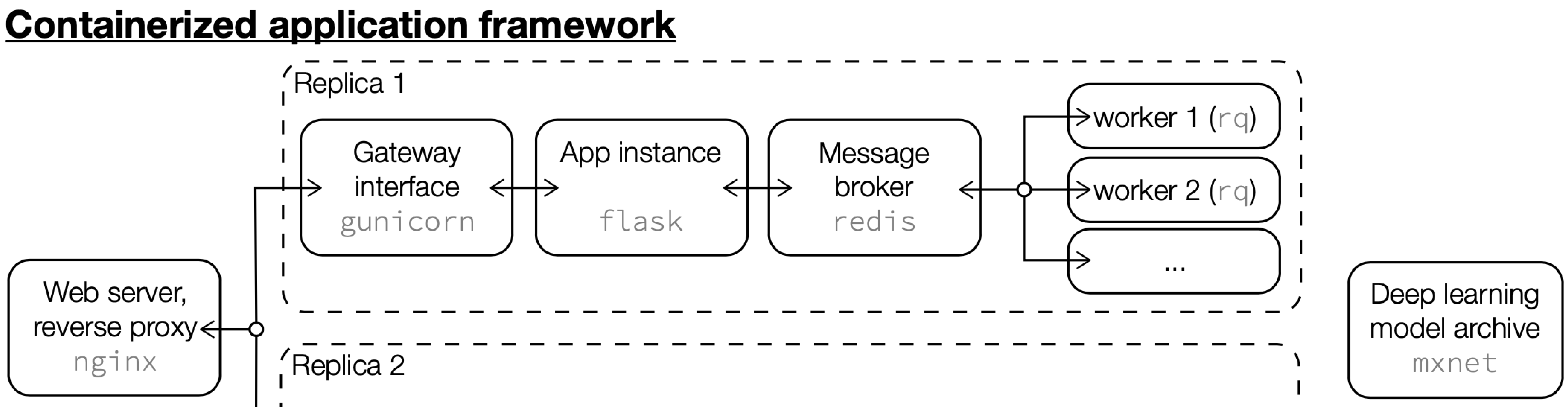
Extensible application framework

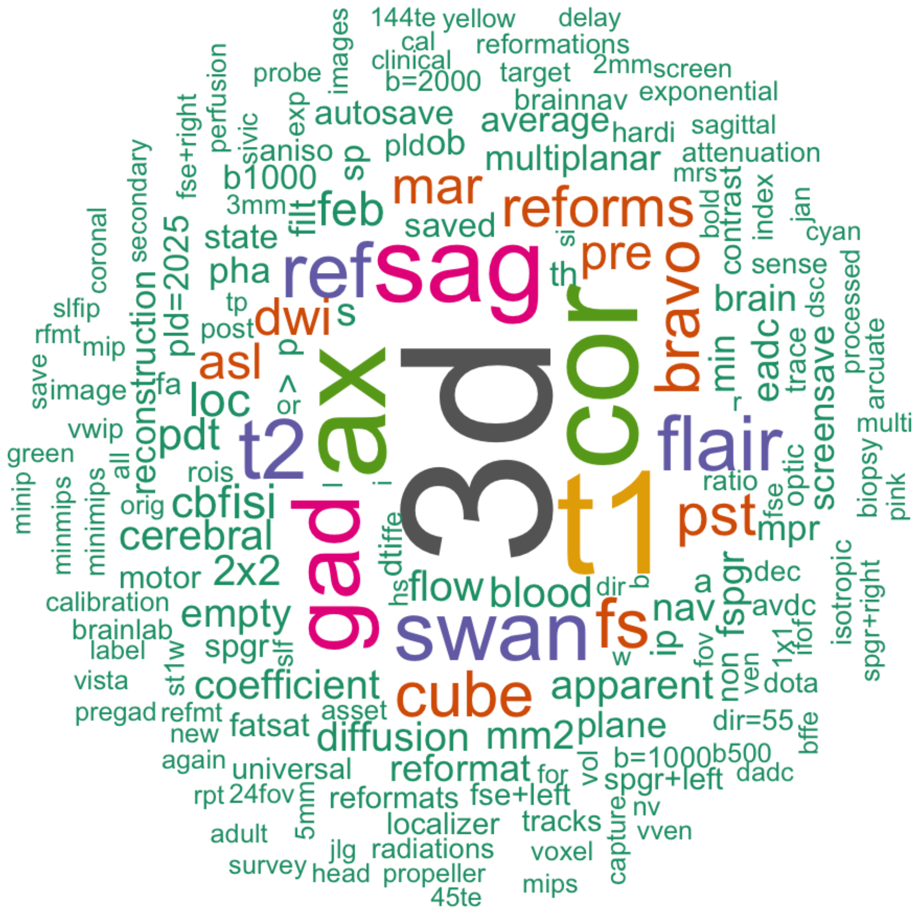
- `johncolby/rad_apps`
- Simple web frontend.
- API for submitting analysis requests.
- Docker/swarm for scalability and redundancy.
- Can extend base application plugin template for different uses.



Wrangle data

- `johncolby/dcmclass`: R package for classifying series from DICOM header metadata (study description, TR, TE, scanner code, etc.)

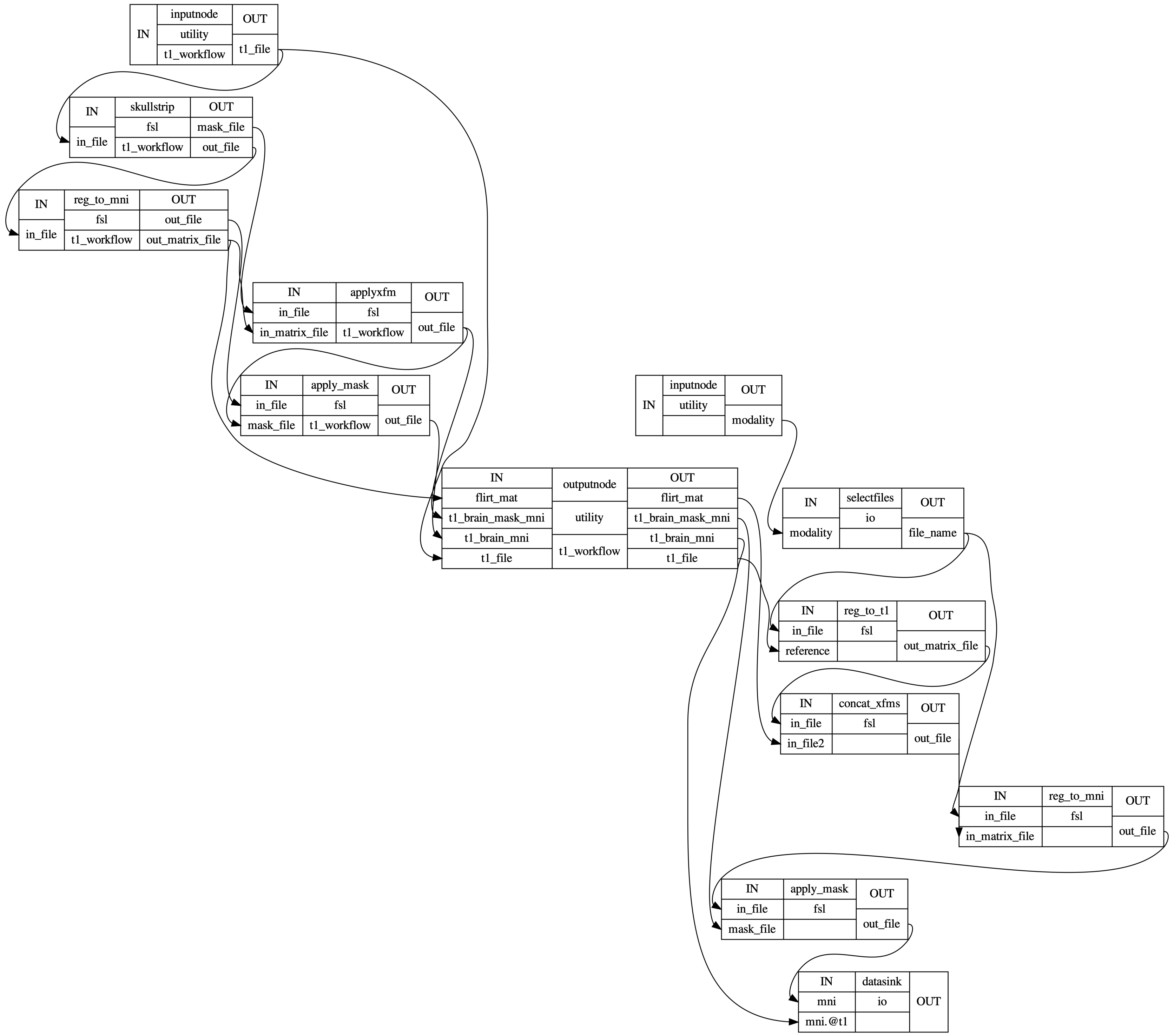
T1, T2, T1 post, FLAIR



other series

Preprocessing

- Can be trivial (straight DICOMs).
- More complex analyses need more complex preprocessing.
- E.g. multichannel tumor segmentation.
- Mature pipelining tools already exist in the neuroimaging community: `nipype`



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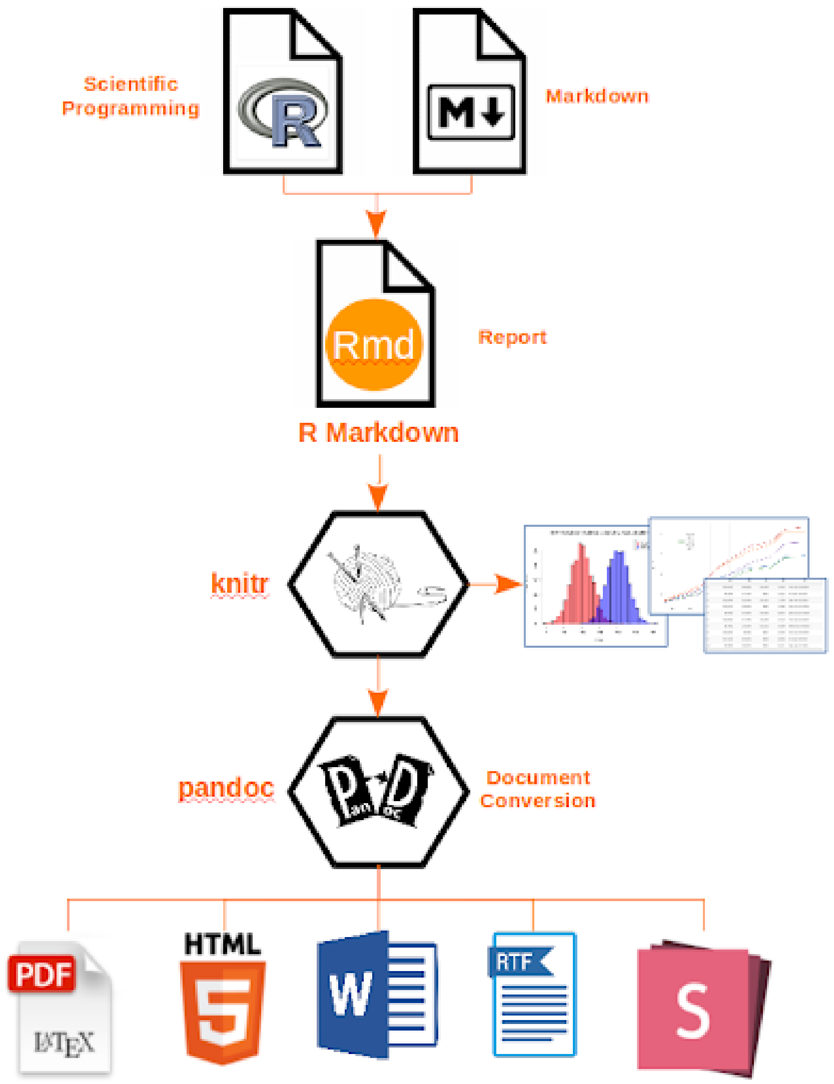
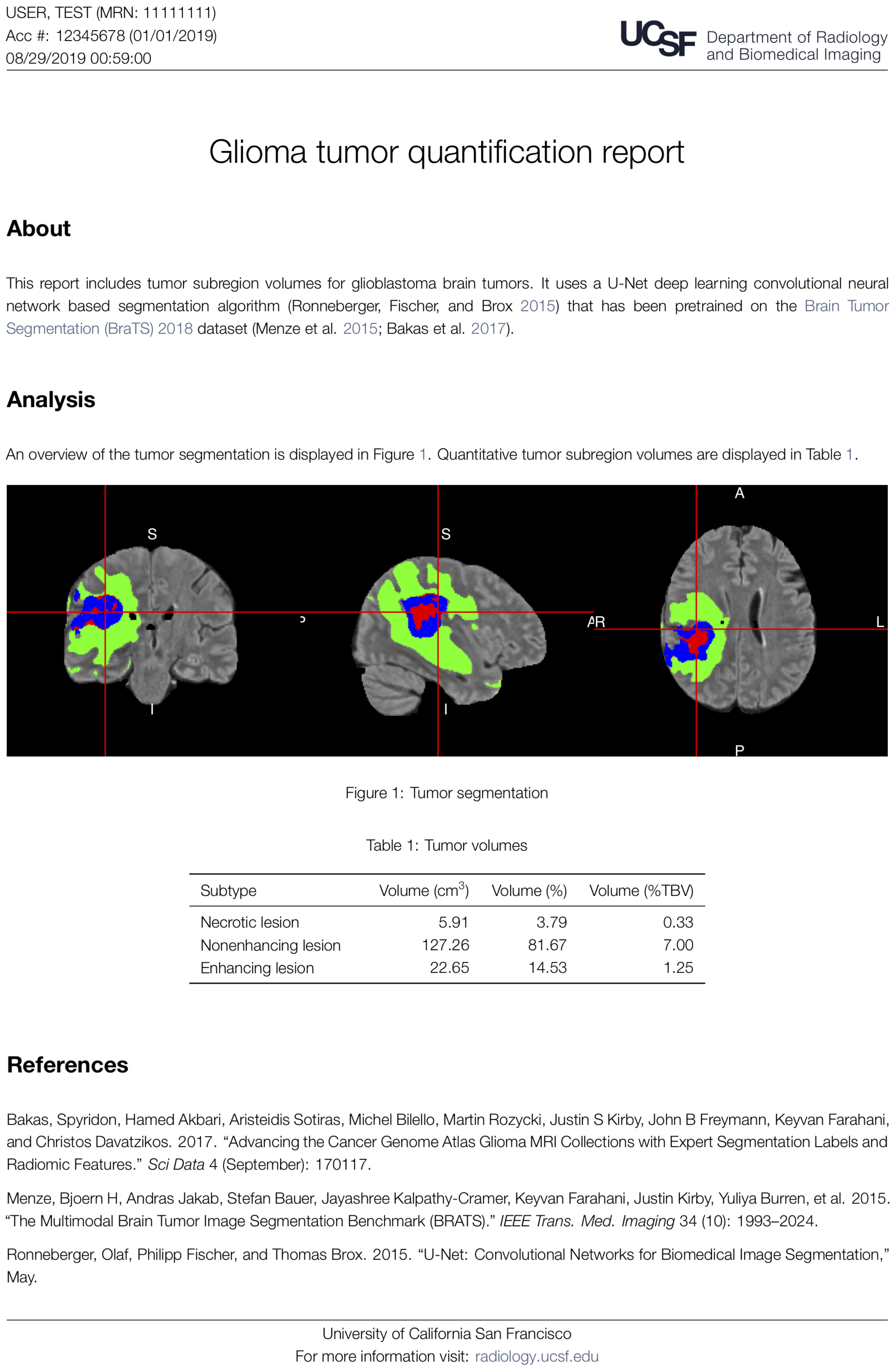
Deep learning inference

- Many modern workflows use DL models, and can benefit from GPUs.
- Can make sense to split off from the rest of processing.
- `awslabs/multi-model-server`
    - Containerized, scalable, DL model server.
    - [*A flexible and easy to use tool for serving deep learning models trained using any ML/DL framework.*]
    - Open Neural Network Exchange (ONNX): Compatability between torch, mxnet, tensorflow, etc.

Report

- R Markdown.
- Reproducible, dynamic, analysis reports.
- Mix prose, stats, visualization.
- Can output to web, PDF, others





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Example: Hemorrhage detection at noncontrast CT

- RSNA Intracranial Hemorrhage Detection challenge
- Hemorrhage ∈ [none, any, epidural, intraparenchymal, intraventricular, subarachnoid, subdural]
- 2D CNN deep learning model `johncolby/rsna_heme`

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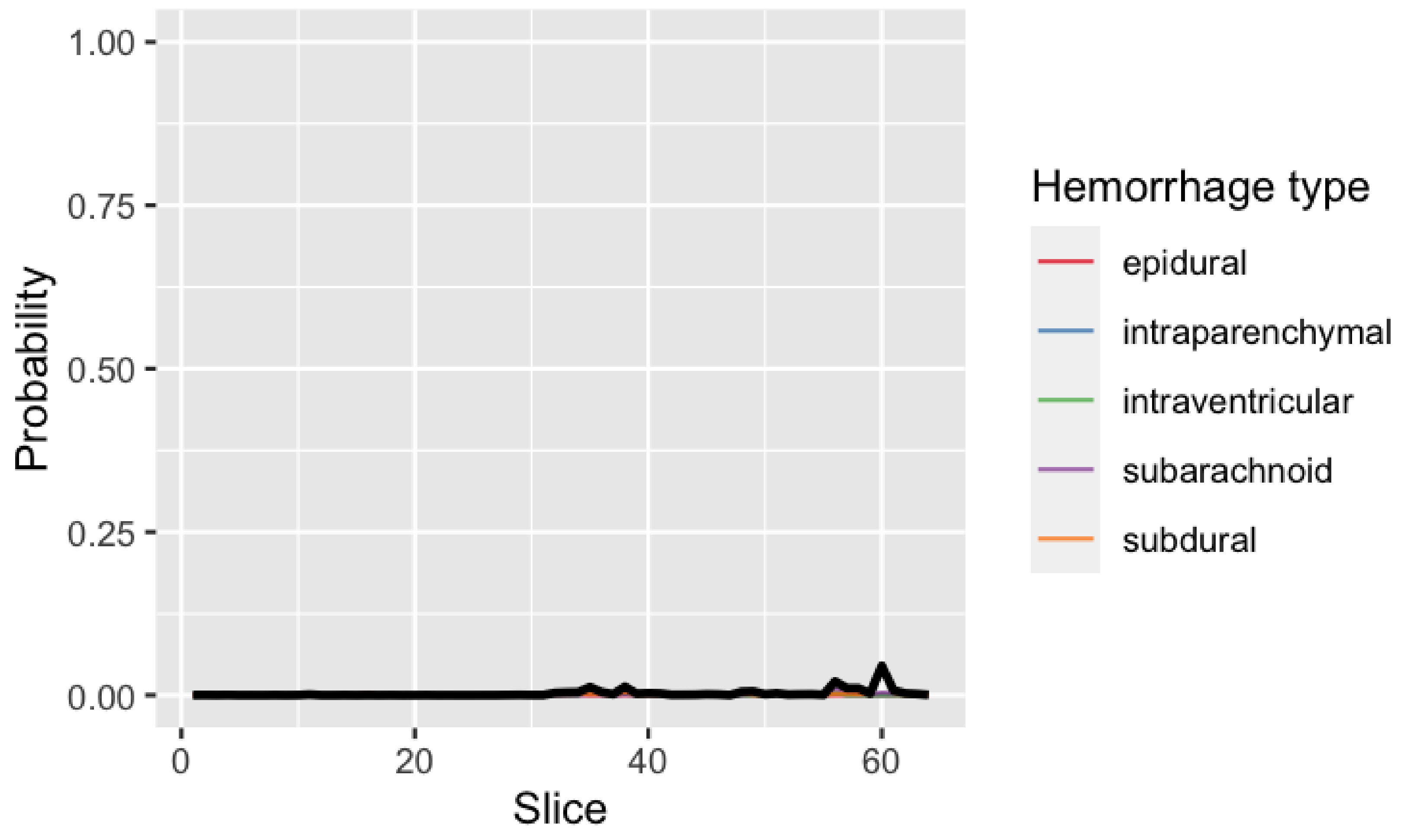
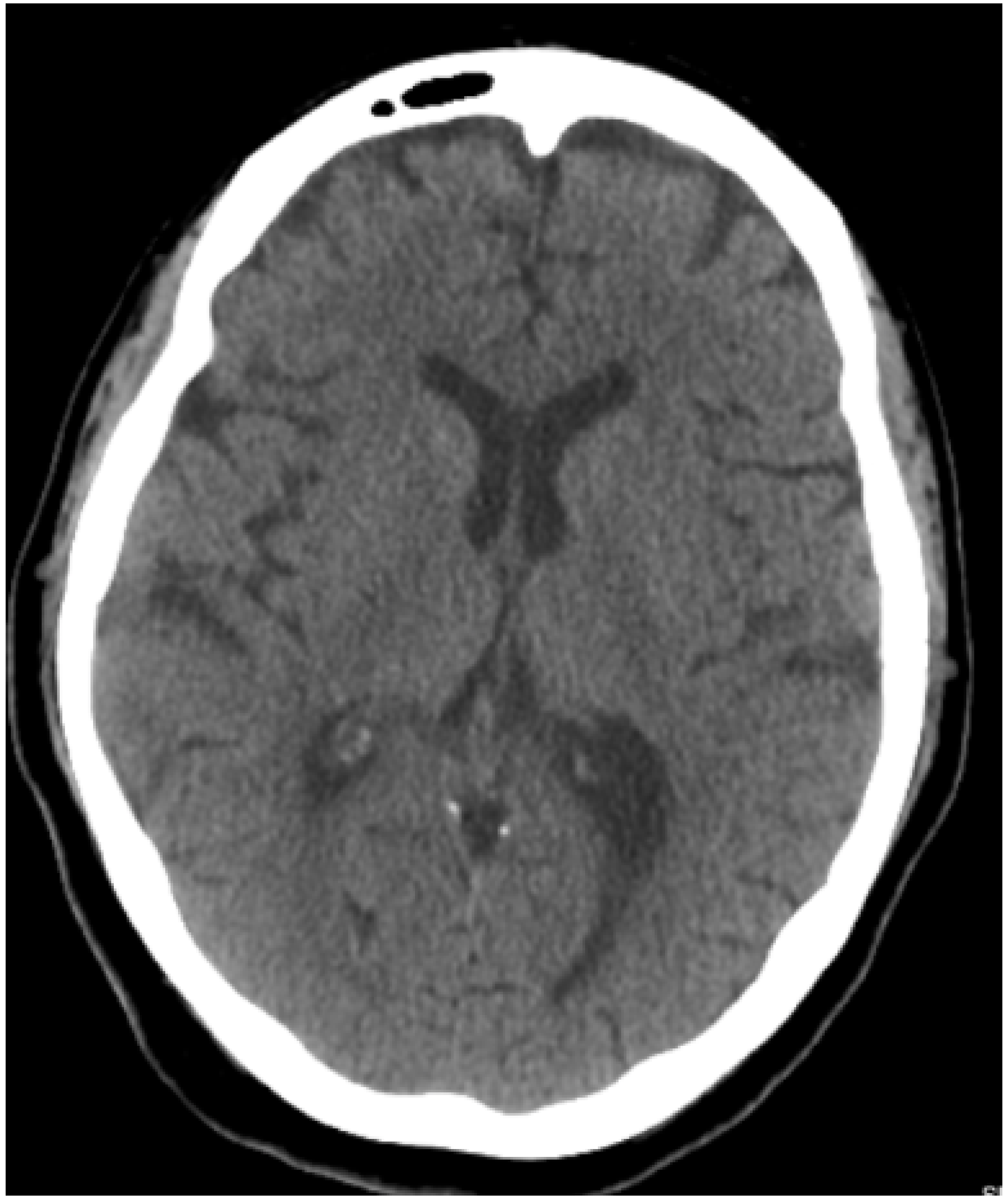
Negative 1





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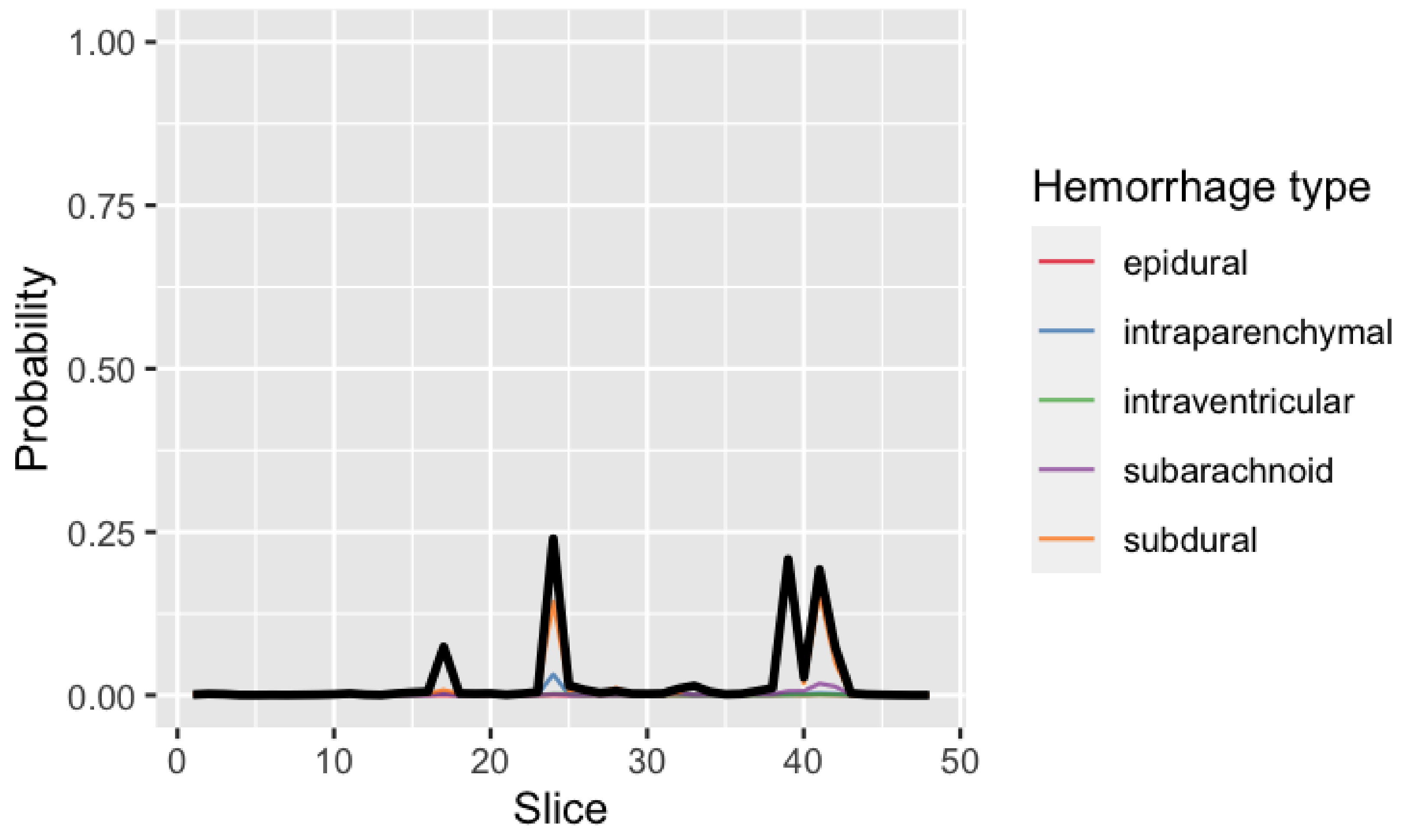
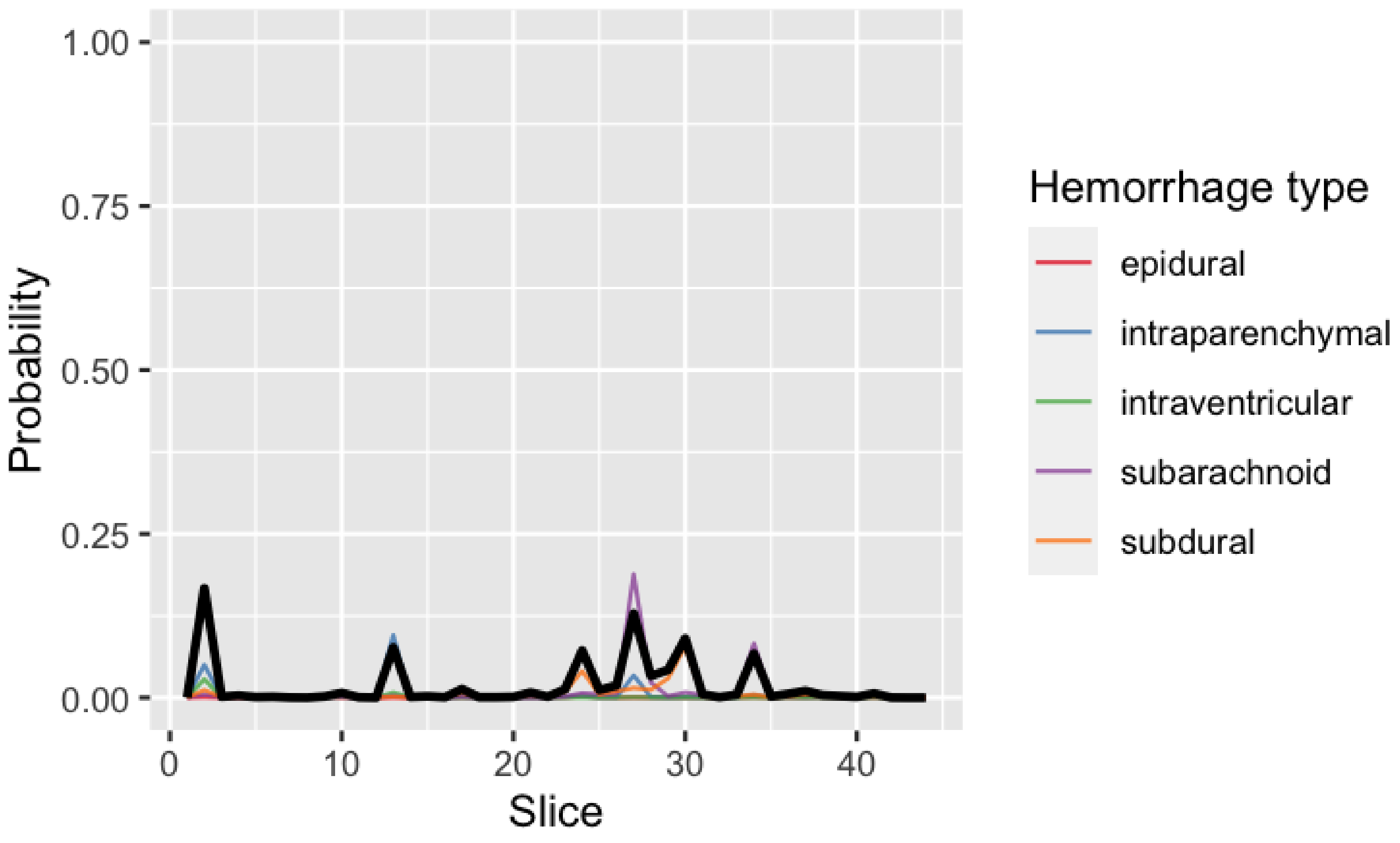
Negative 2


Probability
1.00
0.75
0.50
0.25
0.00
0
10
20
30
40
50
Slice
Hemorrhage type
epidural
intraparenchymal
intraventricular
subarachnoid
subdural

Negative 3



Probability
1.00
0.75
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0.00
0
10
20
30
40
Slice
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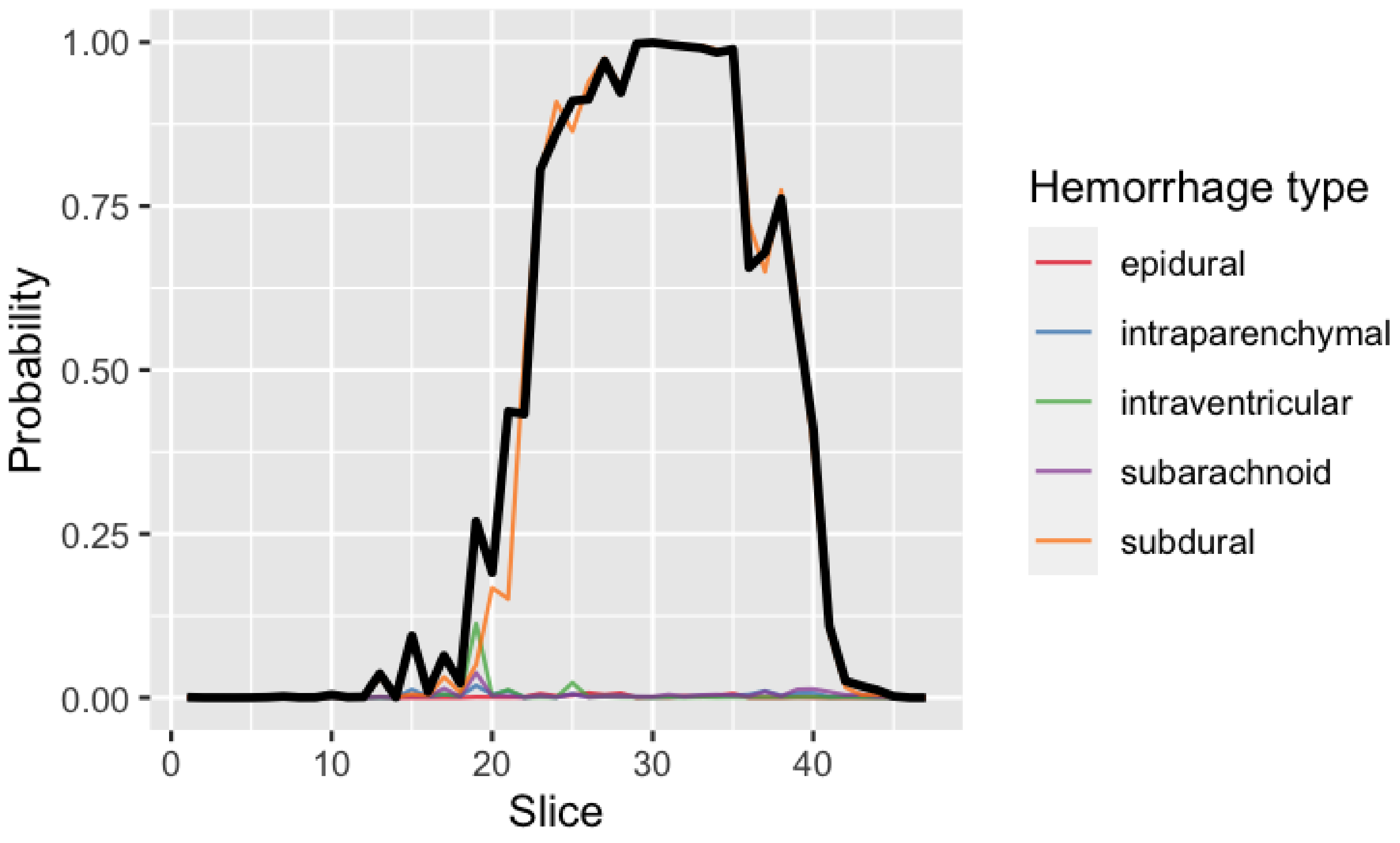
subarachnoid
subdural

Subdural



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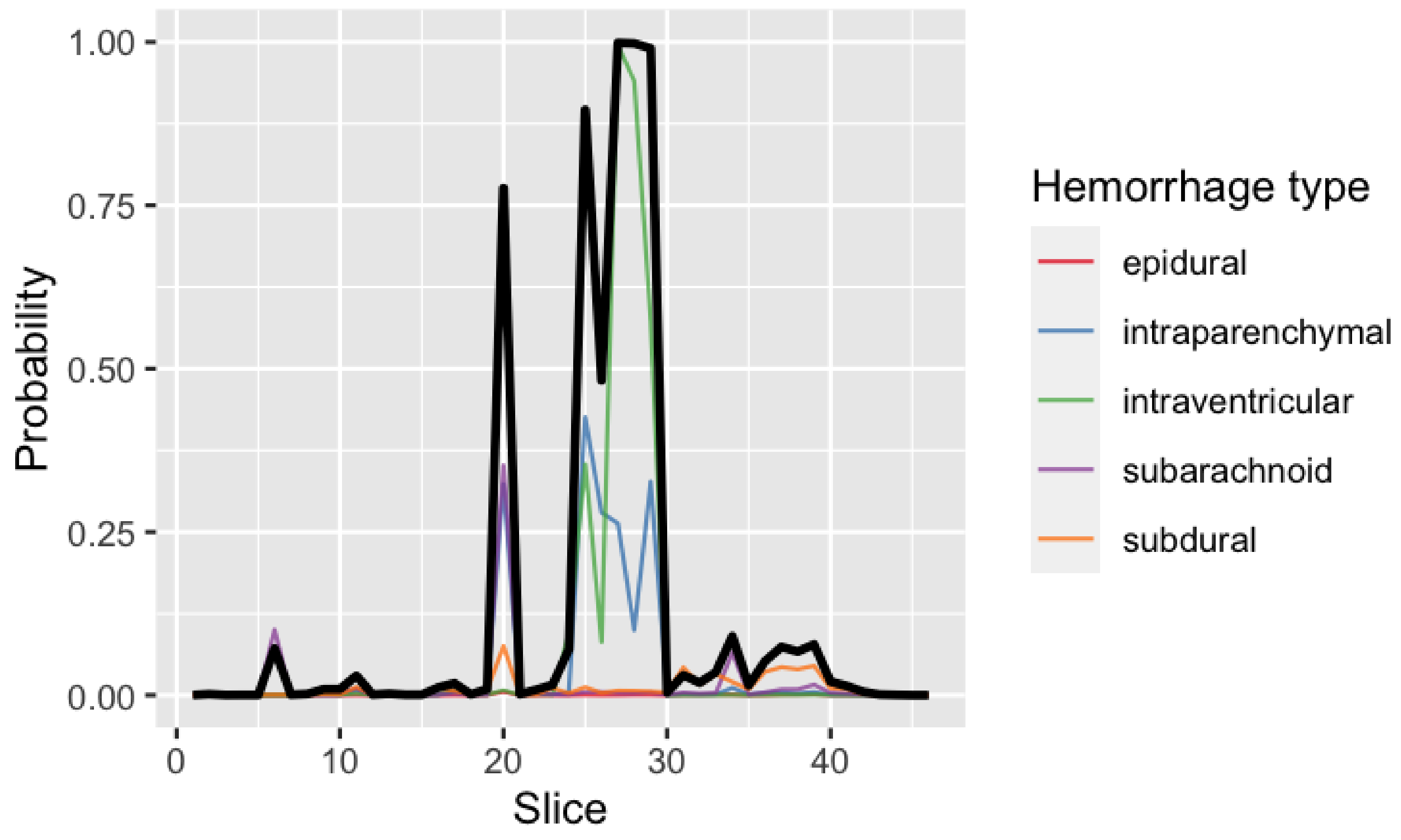
IVH



1.00
0.75
0.50
0.25
0.00
Probability
0
10
20
30
40
Slice
Hemorrhage type
epidural
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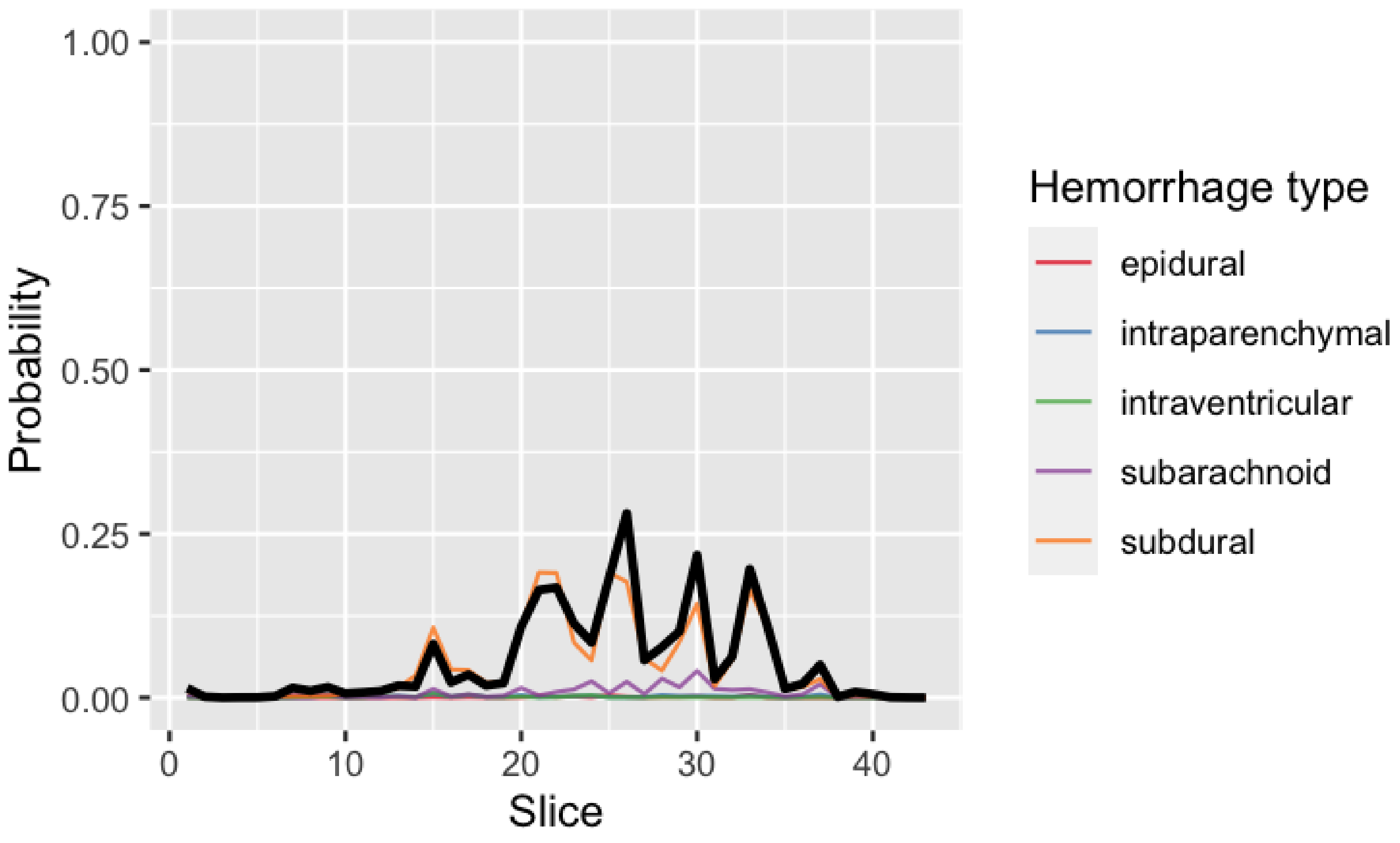
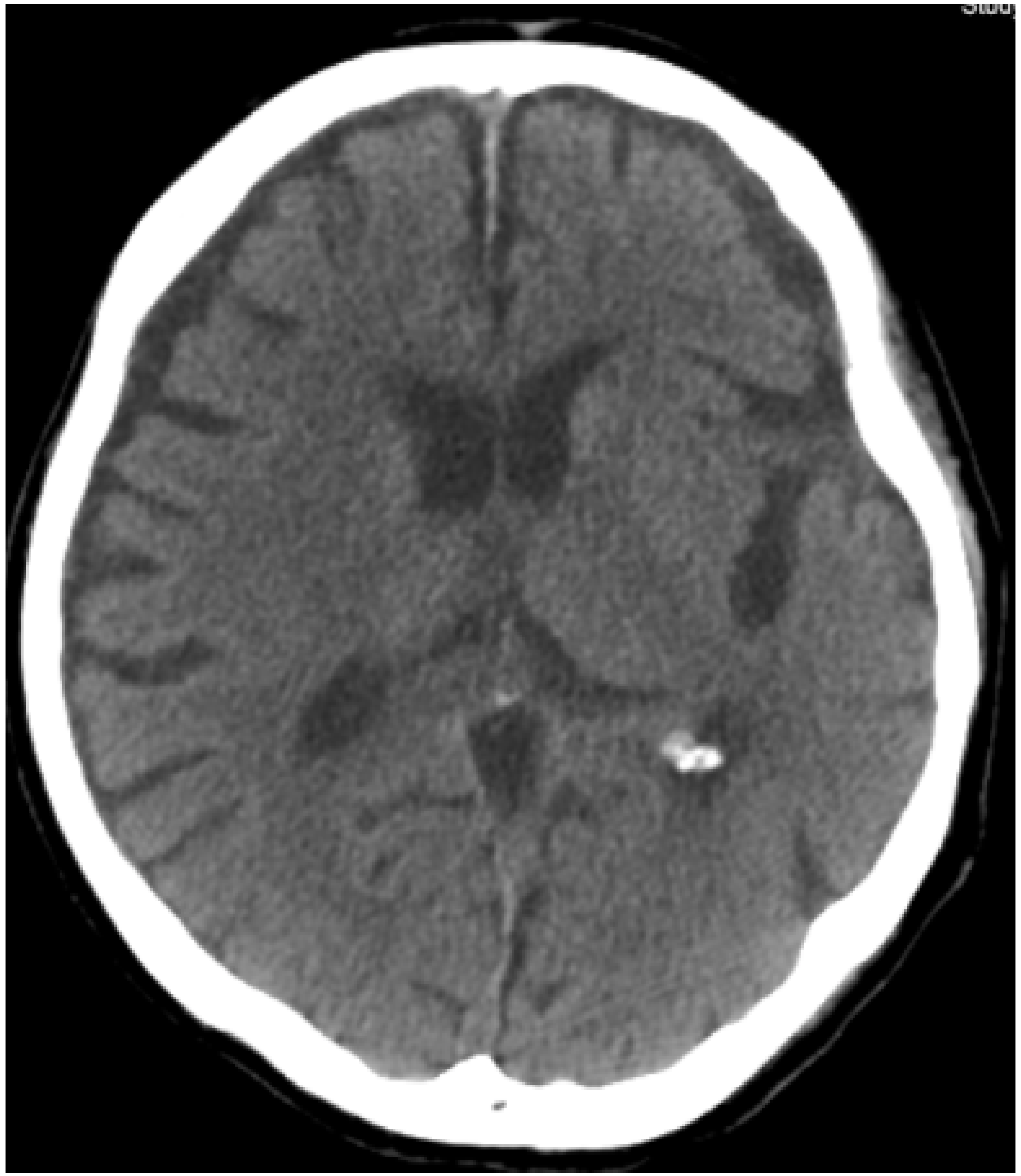
subarachnoid
subdural

Atrophy





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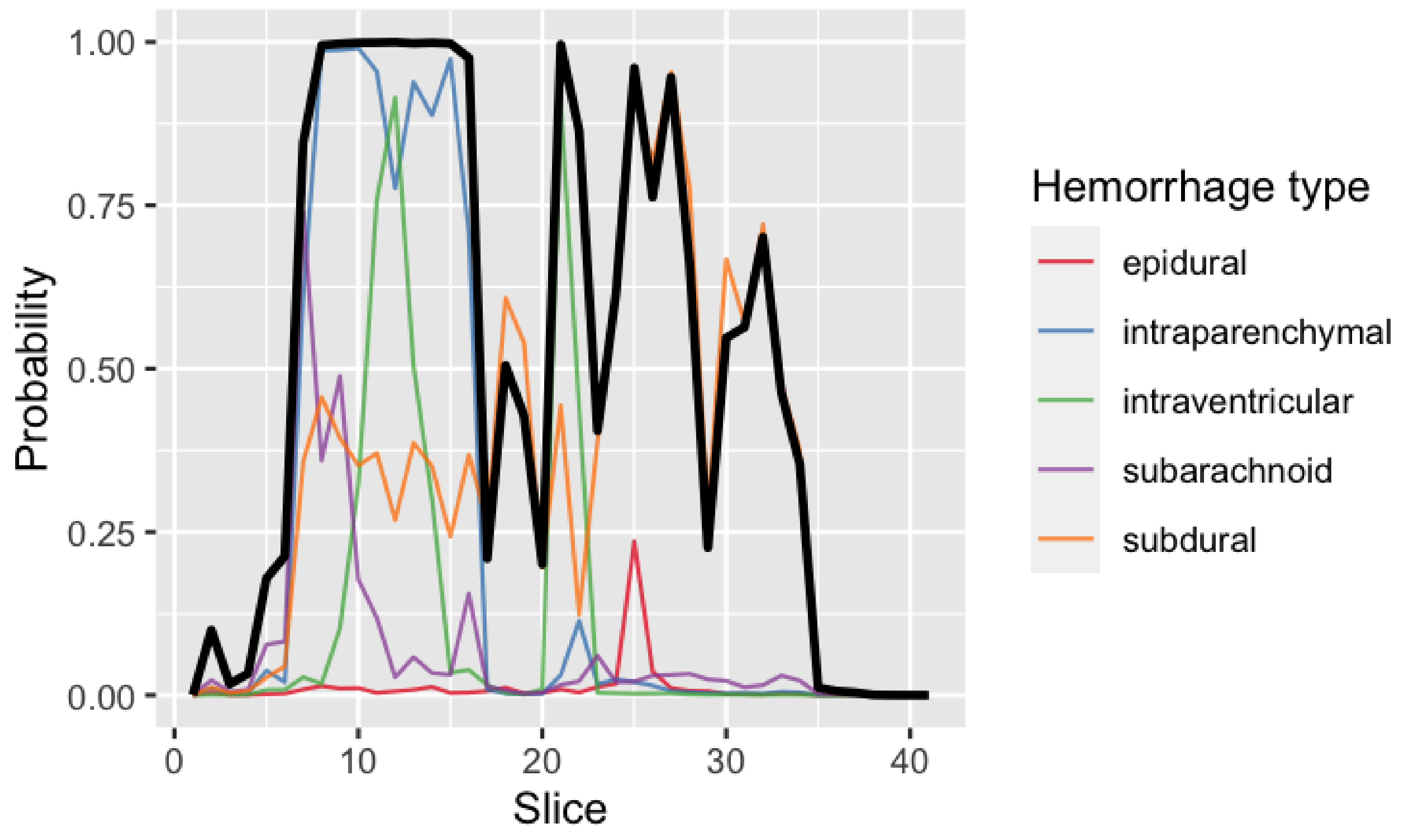
Post-op



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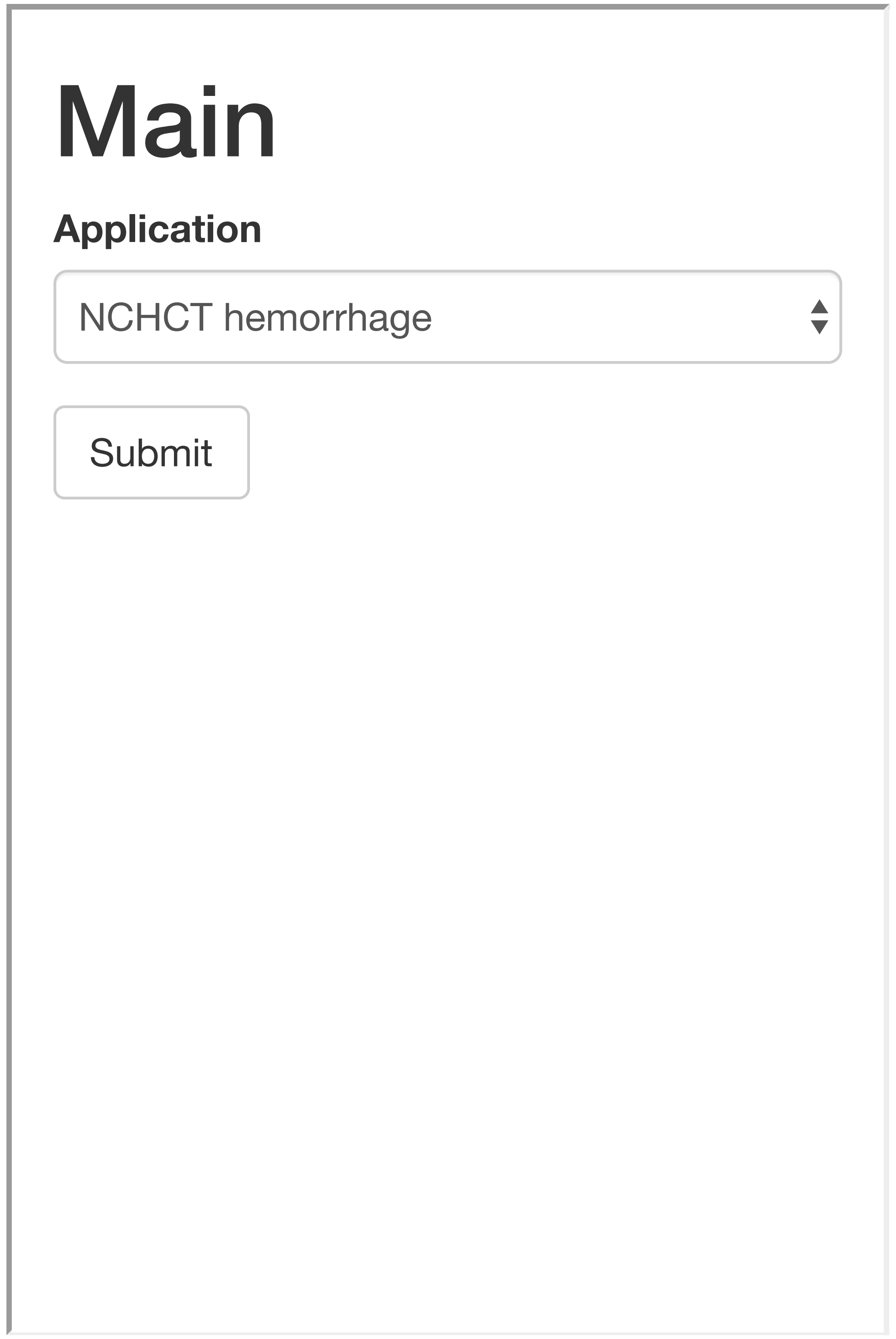
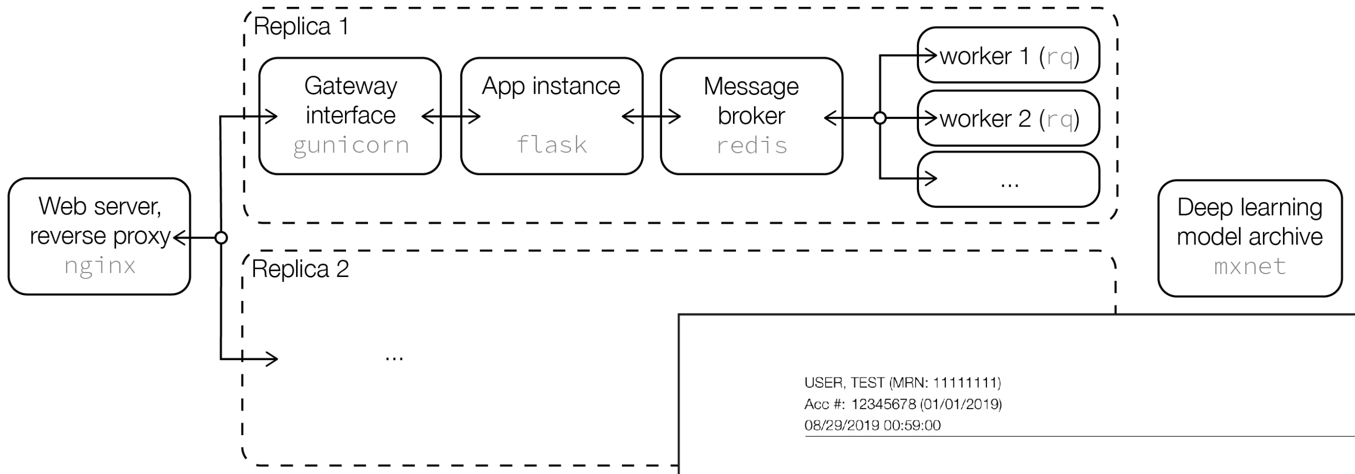
Live app server

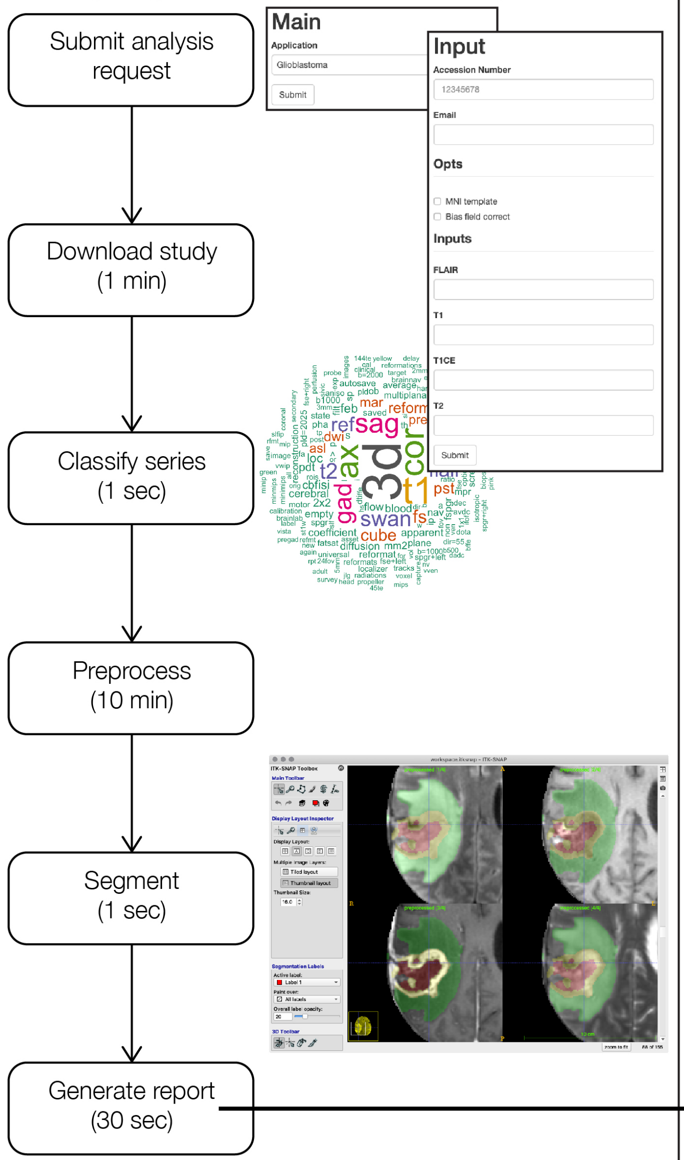


Overview

Containerized application framework



Example glioma application output



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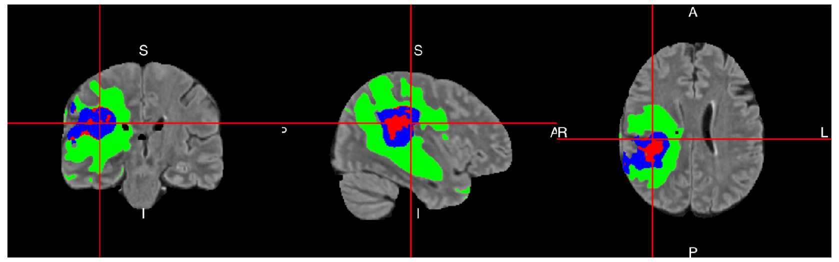

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