Nobrainer

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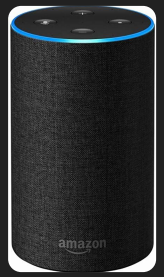
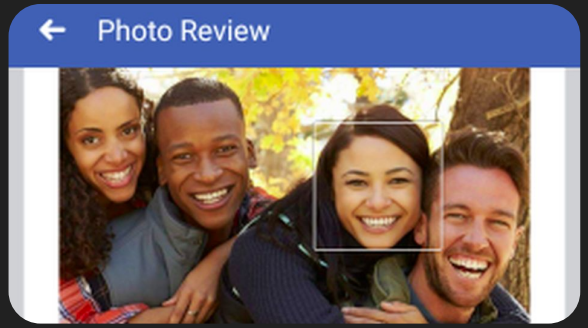
zoom





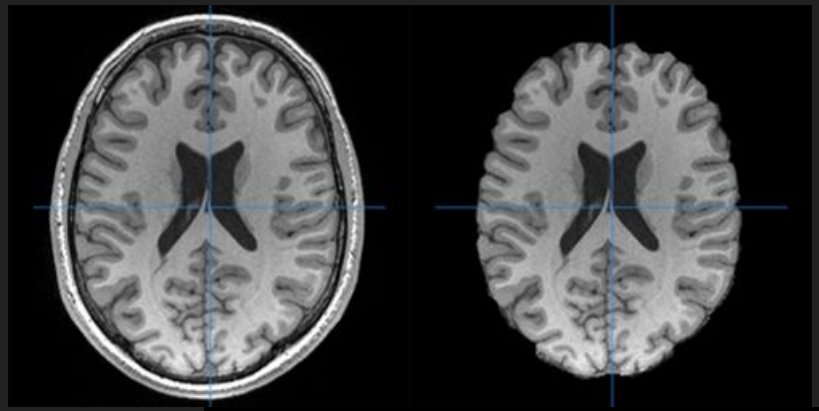
Deep learning and imaging

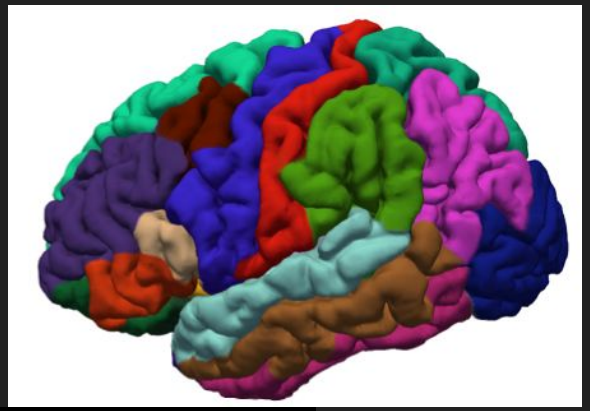
- Classification
- Segmentation (pixel-wise classification)
- Regression

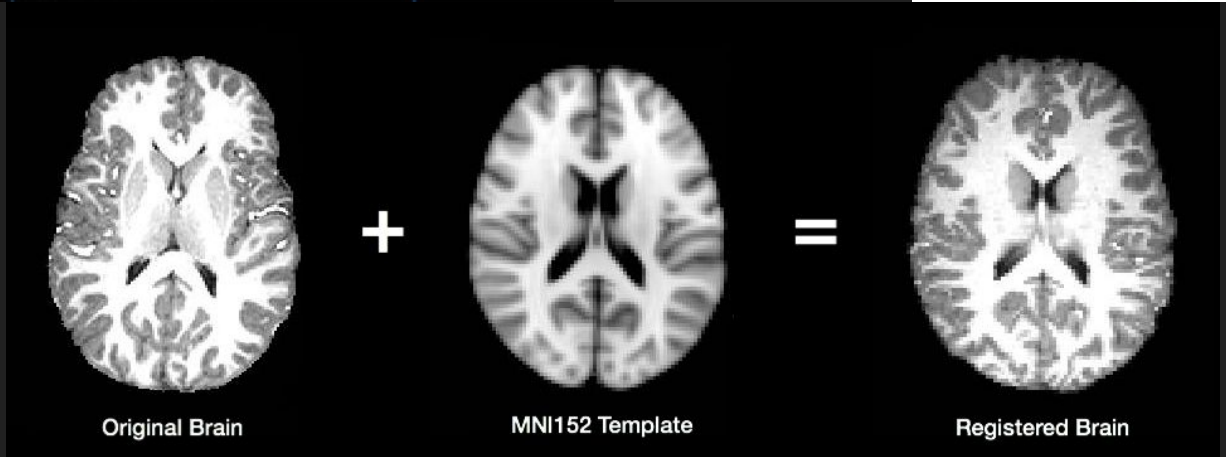
Explosion in popularity of deep learning since 2011

- Due to improvements in hardware and availability of data. Theory has been around since the mid 20th century.

Deep learning and neuroimaging







Abundance of frameworks

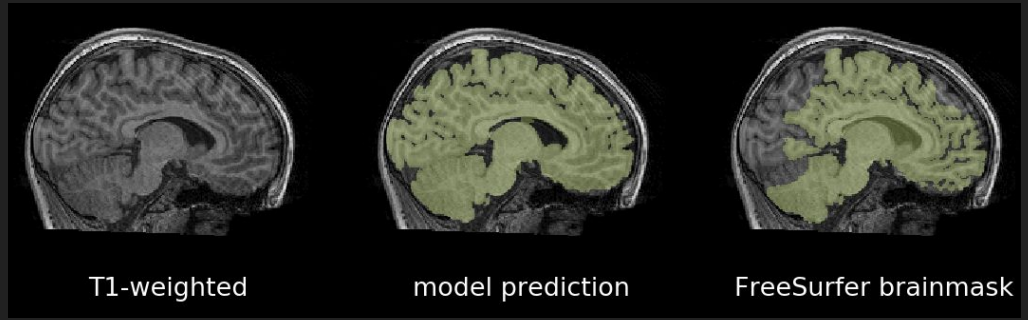
- TensorFlow (Google)
- Keras (now Google)
- PyTorch (Facebook)
- MXNet (Apache)
- CNTK (Microsoft)
- Chainer

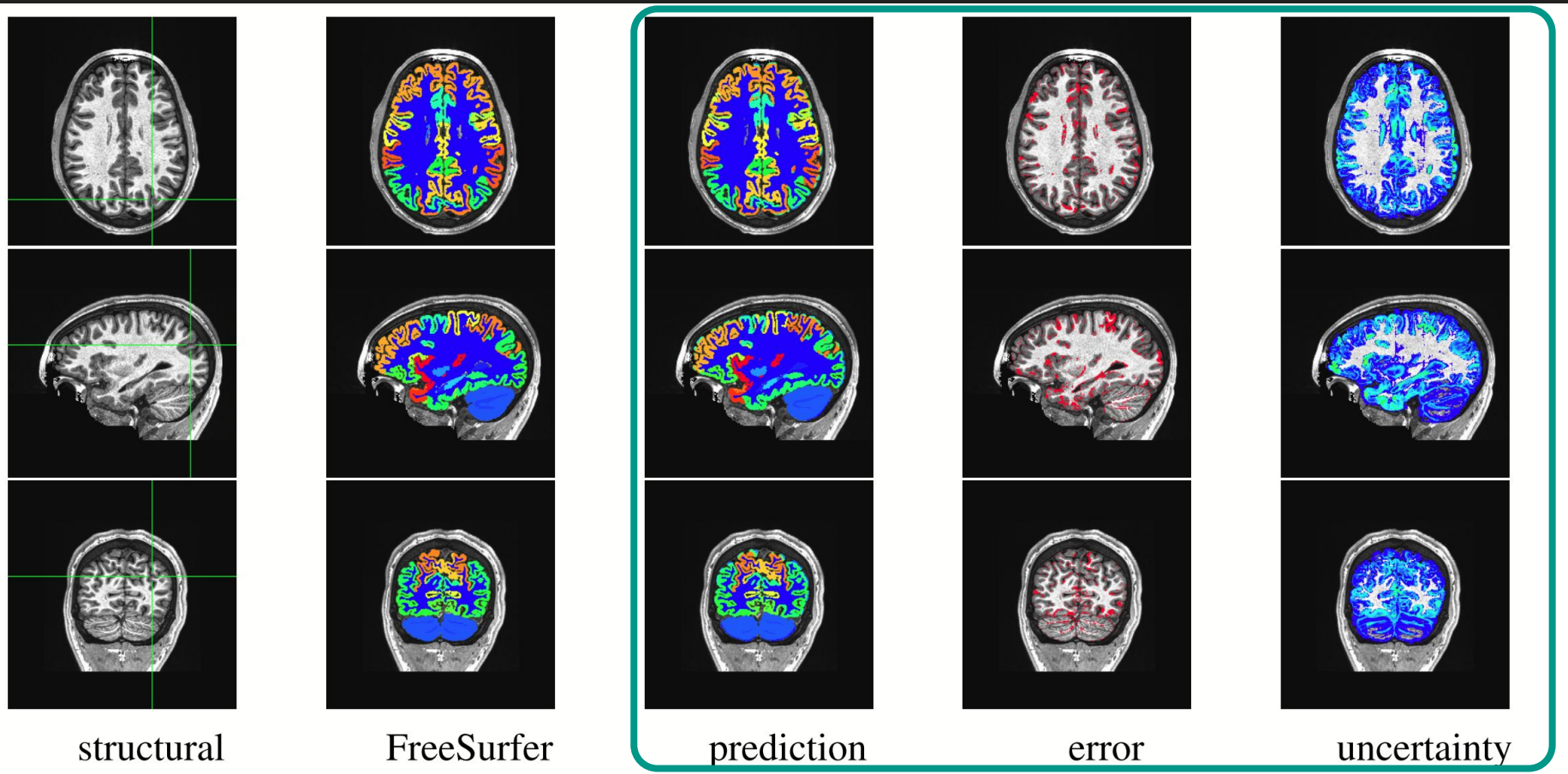
And probably many more…

Most have great built-in support for working with 2D images… but not 3D.

Nobrainer (https://github.com/neuronets/nobrainer)

- Framework for developing neural network models for 3D image processing
- Provides
  - Methods to convert data to deep learning framework-friendly formats
  - Data augmentation methods
  - Architectures, loss functions, and metrics from literature
  - Gallery of examples for processing data and training models
  - **Fully-trained models for 3D segmentation!!**
- Built on top of TensorFlow/Keras



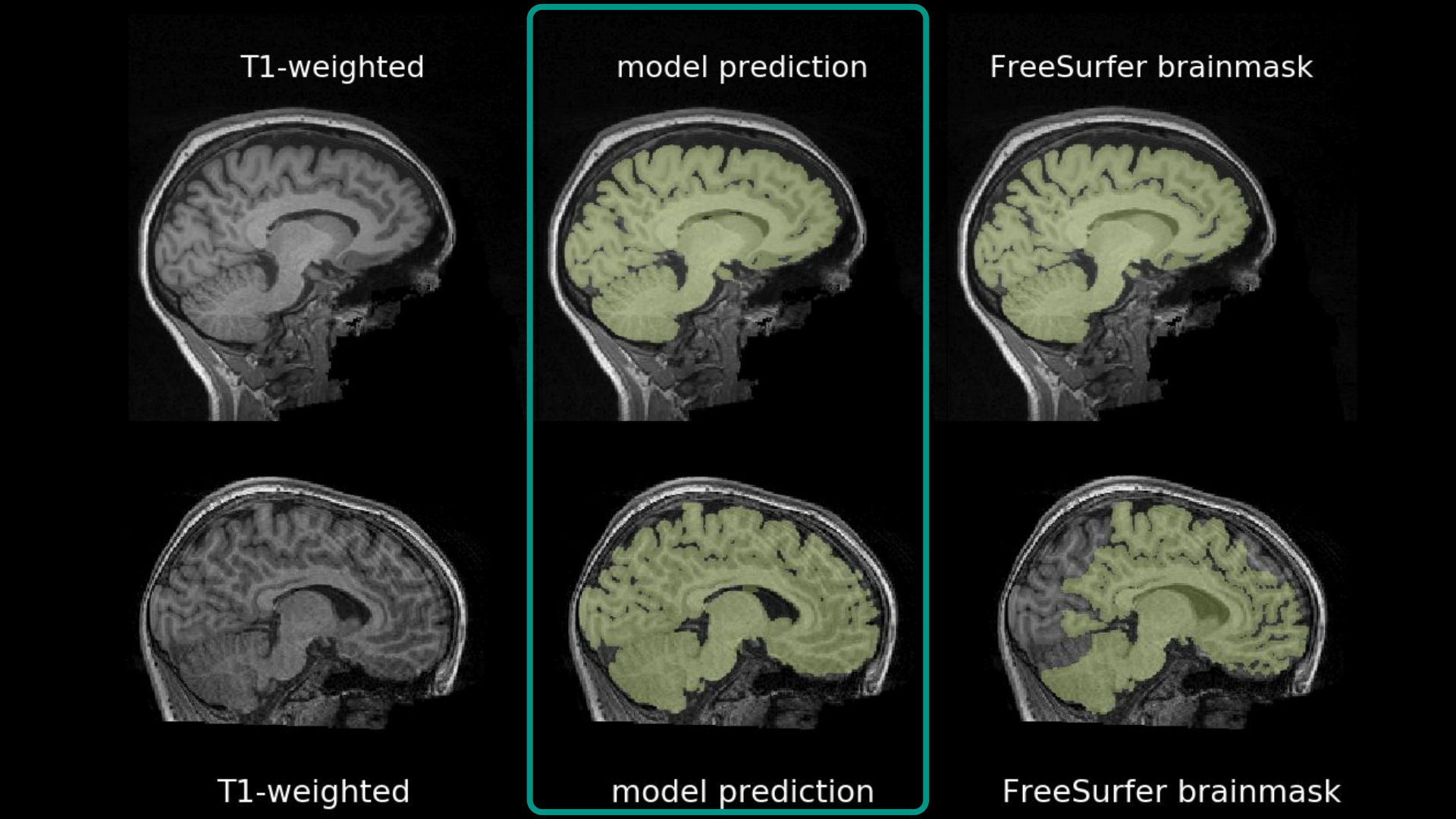

structural
FreeSurfer
prediction
error
uncertainty
3
uncertainty
0
3
uncertainty
0
3
uncertainty
0

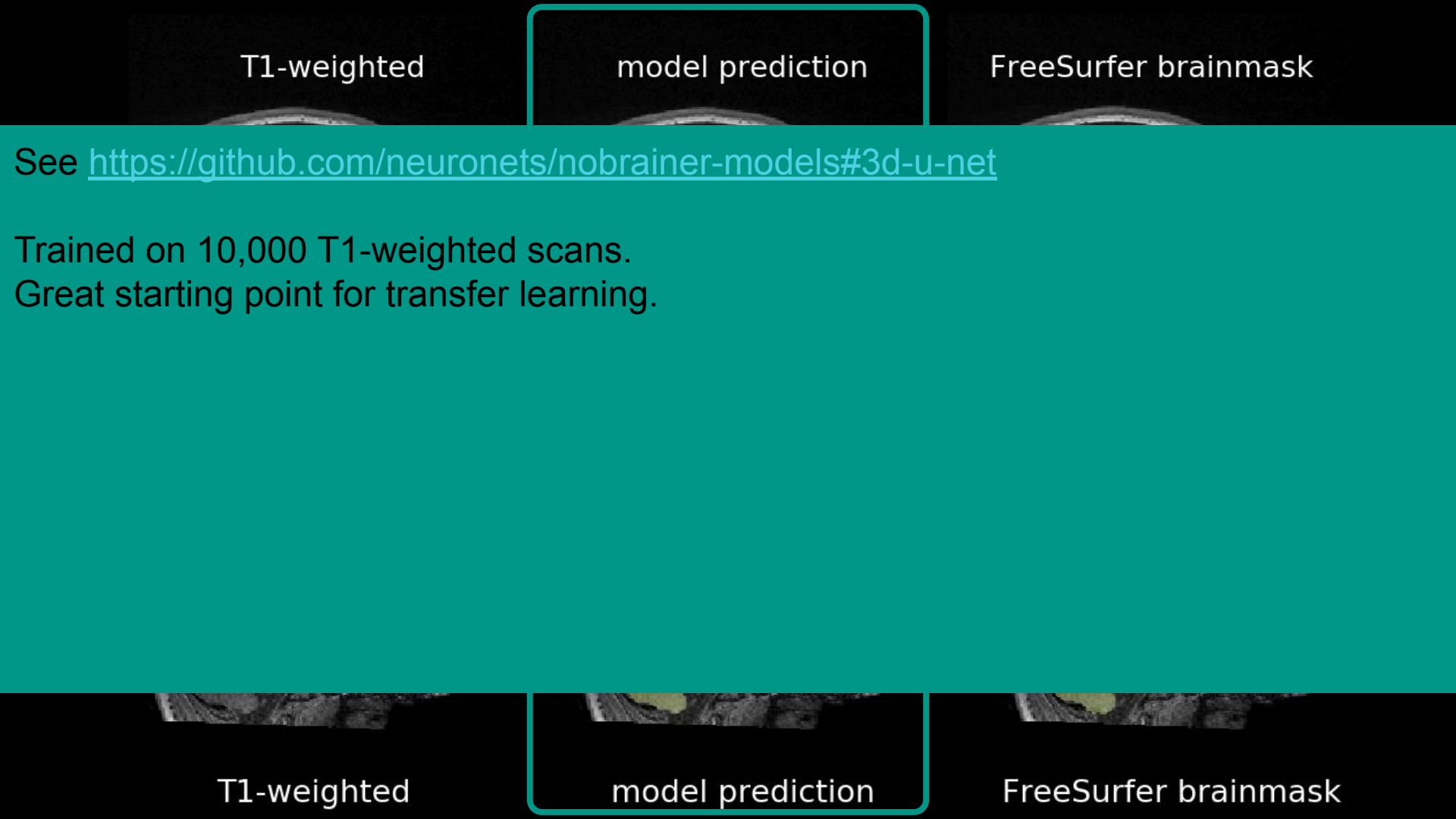
See https://github.com/neuronets/kwyk

Trained on over 20,000 brains by our collaborators at the National Institute of Mental Health. See https://doi.org/10.3389/fninf.2019.00067 for the manuscript.

Try the model on your own data! Warning: this tool is still experimental.

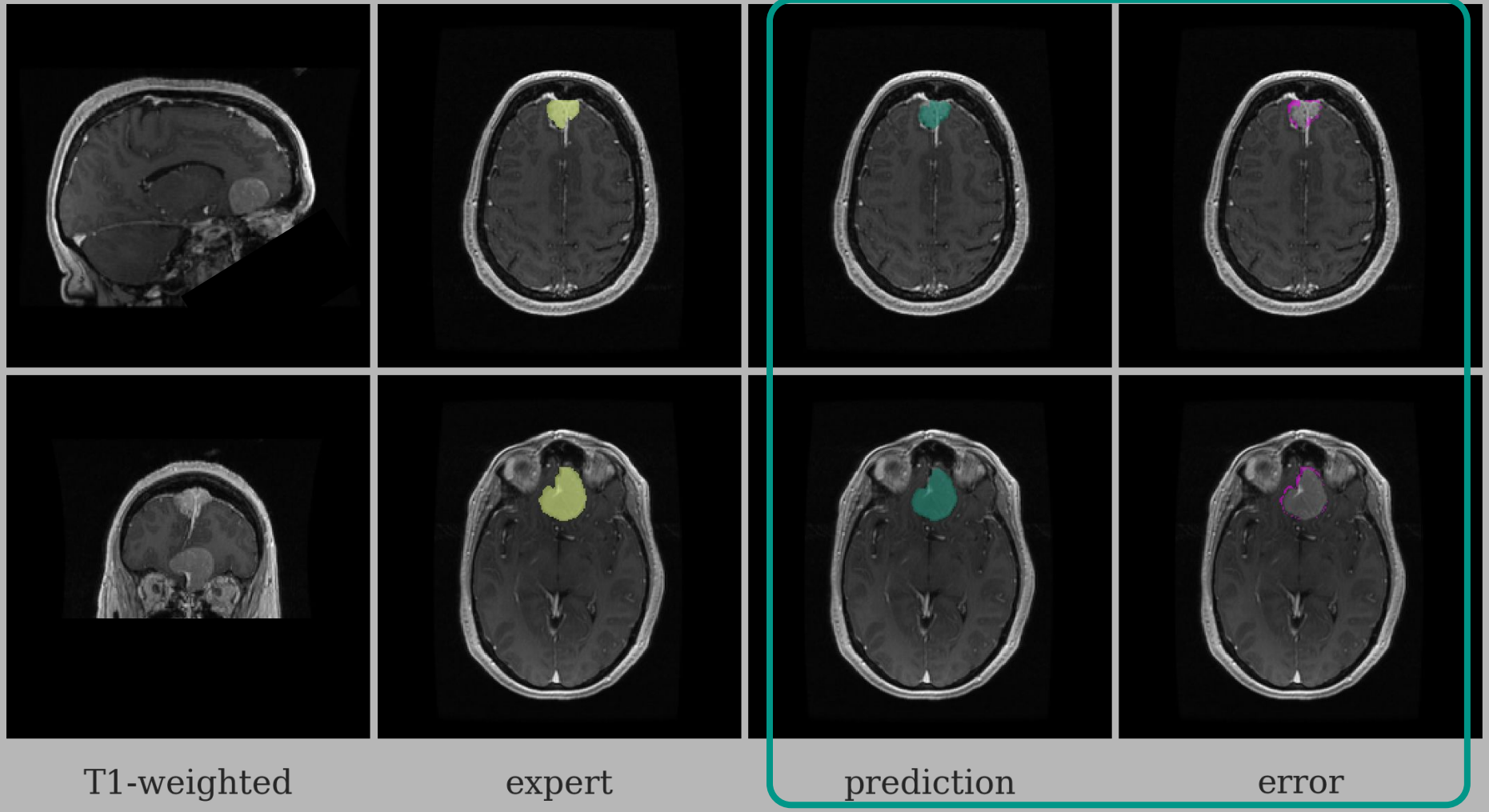
```
docker run -it --rm -v $(pwd):/data \
  neuronets/kwyk:latest-cpu \
    -m bvwn_multi_prior \
    --save-entropy \
    T1_001.nii.gz output
```

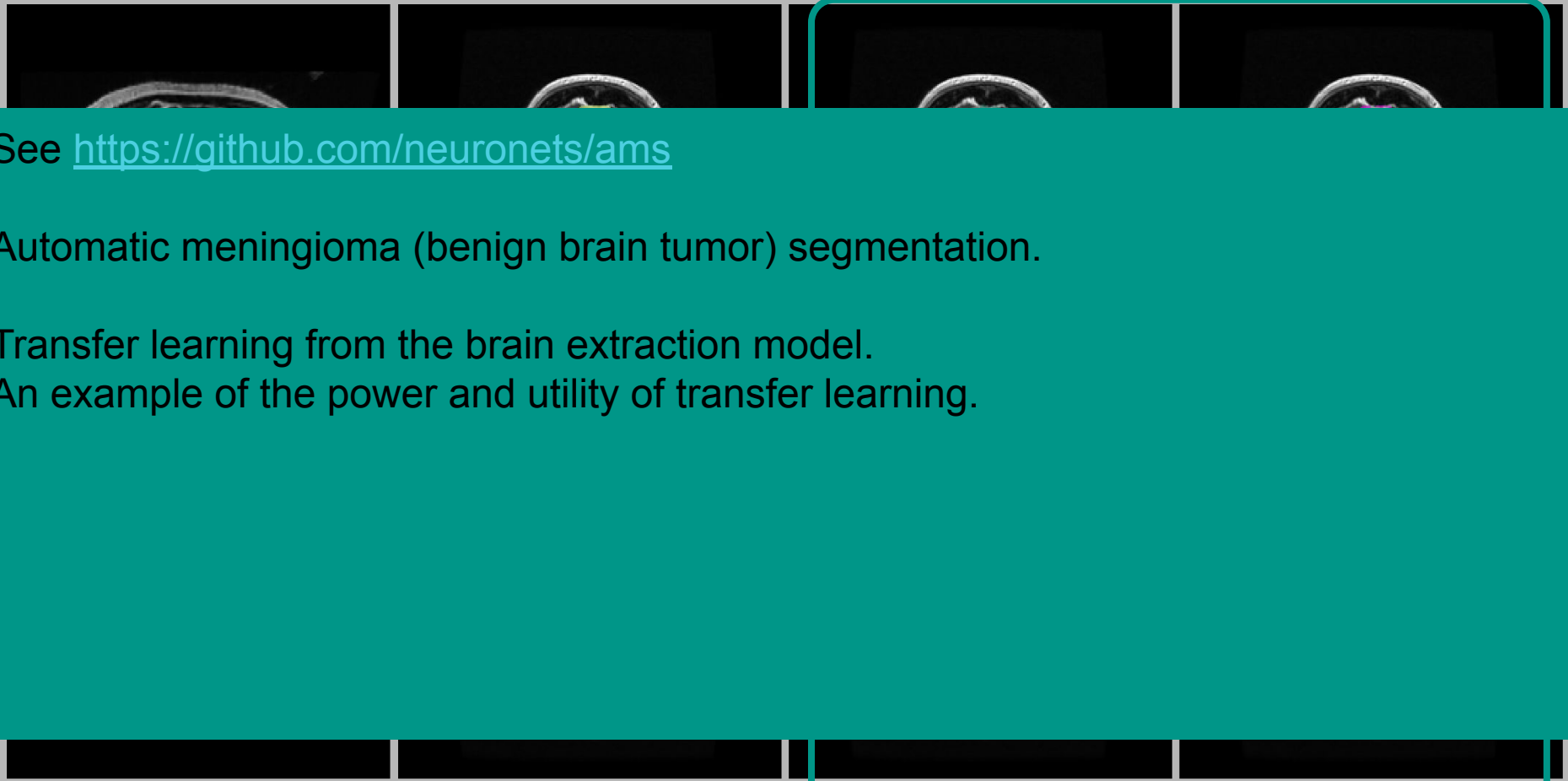

T1-weighted
model prediction
FreeSurfer brainmask
T1-weighted
model prediction
FreeSurfer brainmask



See https://github.com/neuronets/nobrainer-models#3d-u-net

Trained on 10,000 T1-weighted scans.
Great starting point for transfer learning.


T1-weighted
expert
prediction
error



See https://github.com/neuronets/ams

Automatic meningioma (benign brain tumor) segmentation.

Transfer learning from the brain extraction model.
An example of the power and utility of transfer learning.

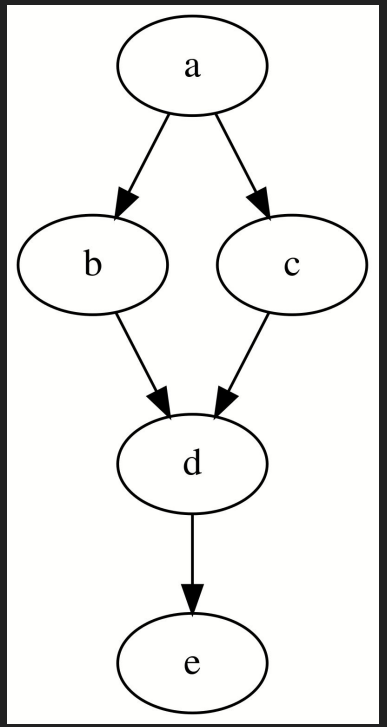
T1-weighted | expert | prediction | error

How can I do this?

Deep learning: workflow

0. Consider whether deep learning is the right tool for the job.

1. Get data (features and labels)
2. Create processing pipeline
    a. Standardize data, optionally augment
3. Choose a loss function
4. Choose a model (and implement)
5. Train model
6. Evaluate
7. Repeat



Thank you

I would like to acknowledge Satra Ghosh, the Gabrieli Lab at MIT, our collaborators at NIMH, our collaborators at Brigham and Women's Hospital, all of those who contributed to Nobrainer, and Stony Brook University School of Medicine.

Thank you, BrainHack School, for the opportunity to share my work with you.

Hands-on

Let’s do it!

Students:

- Those who have Google accounts (e.g., Gmail), open Colab notebook
- Those without, use Binder notebook (no GPU)
  - Don’t feel left out… The vast majority of the notebook does not require a GPU.
- The brave, open local Jupyter Notebook