Whole-brain microscopy image analysis

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Fluorescence

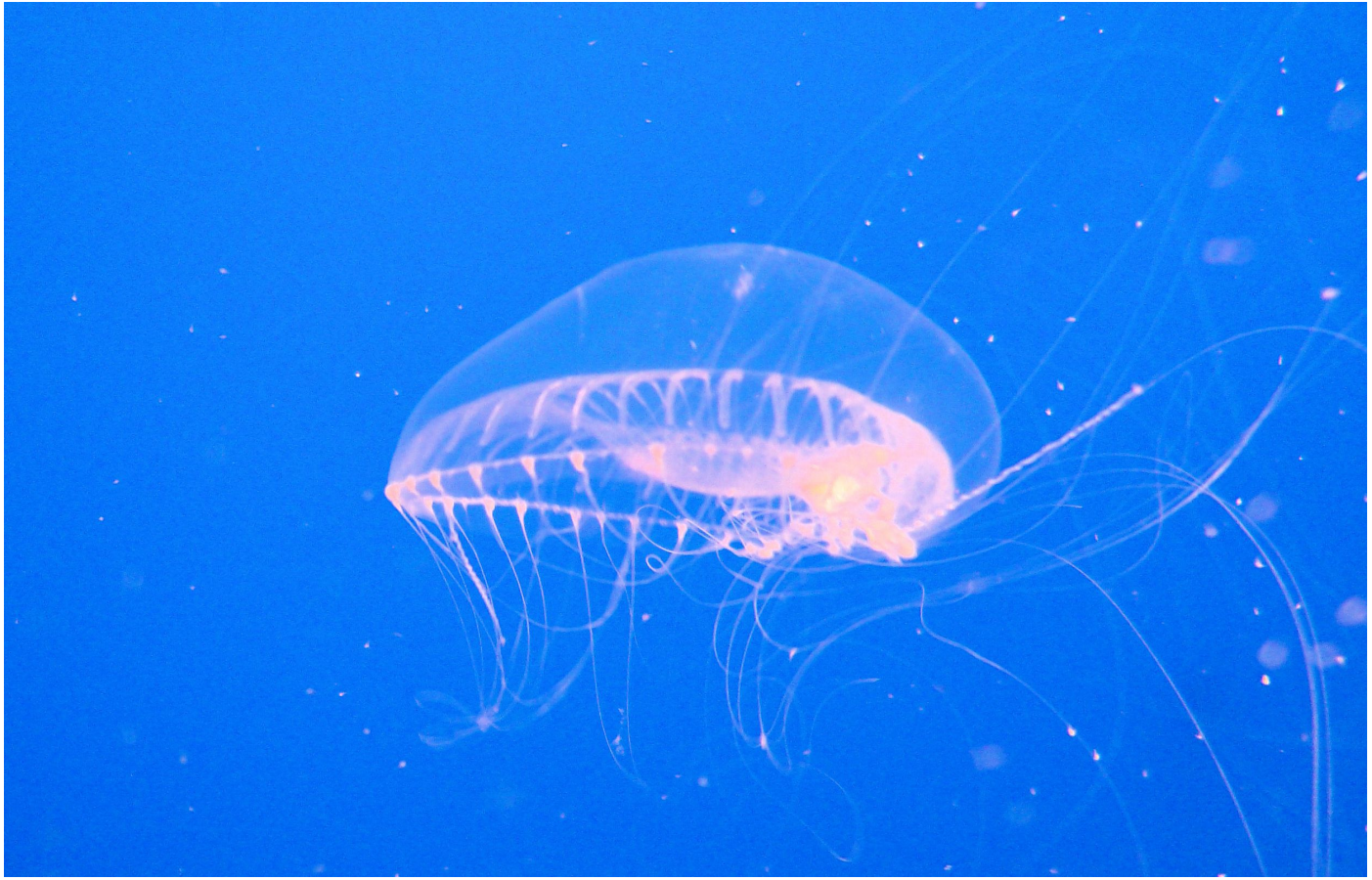
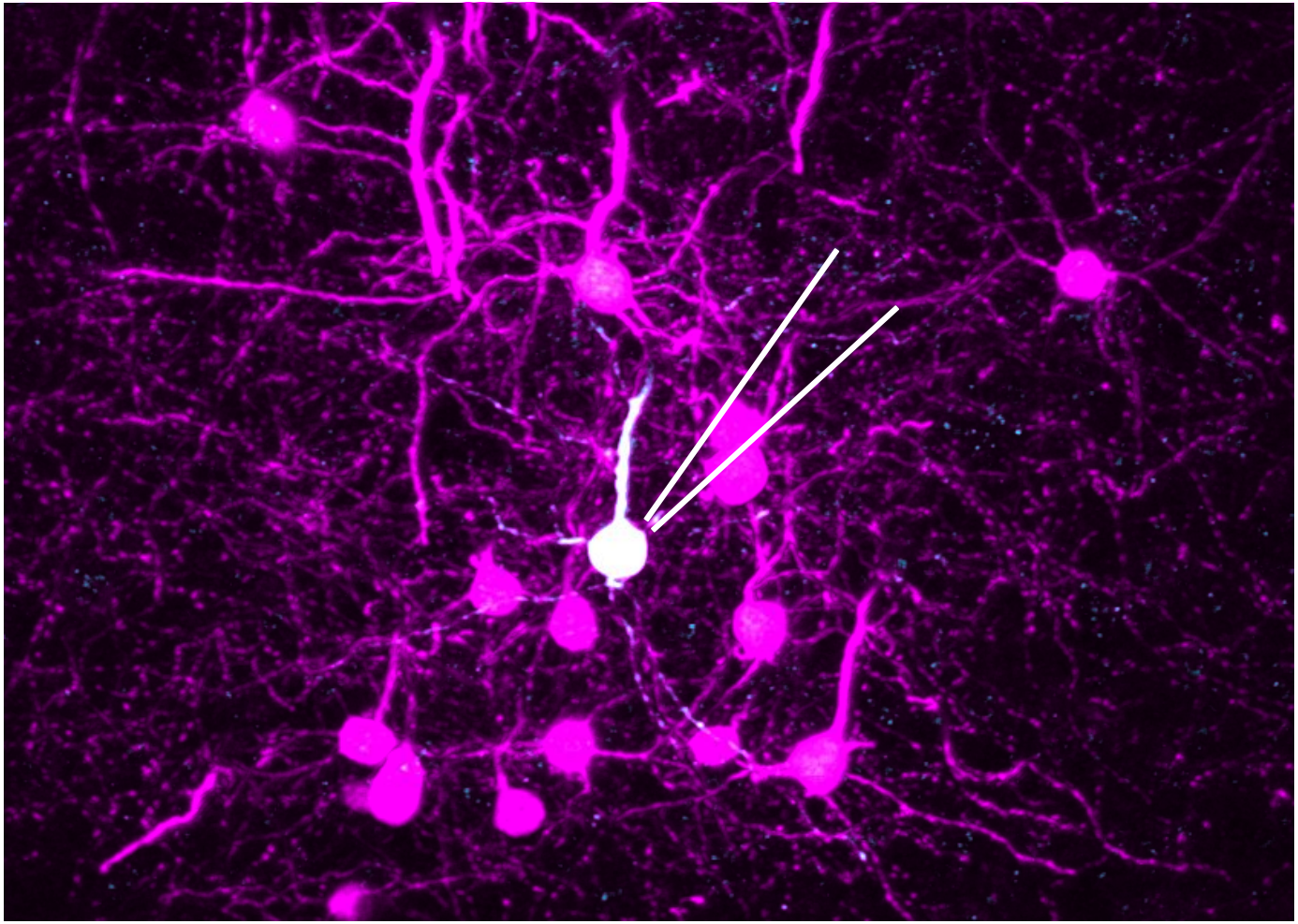


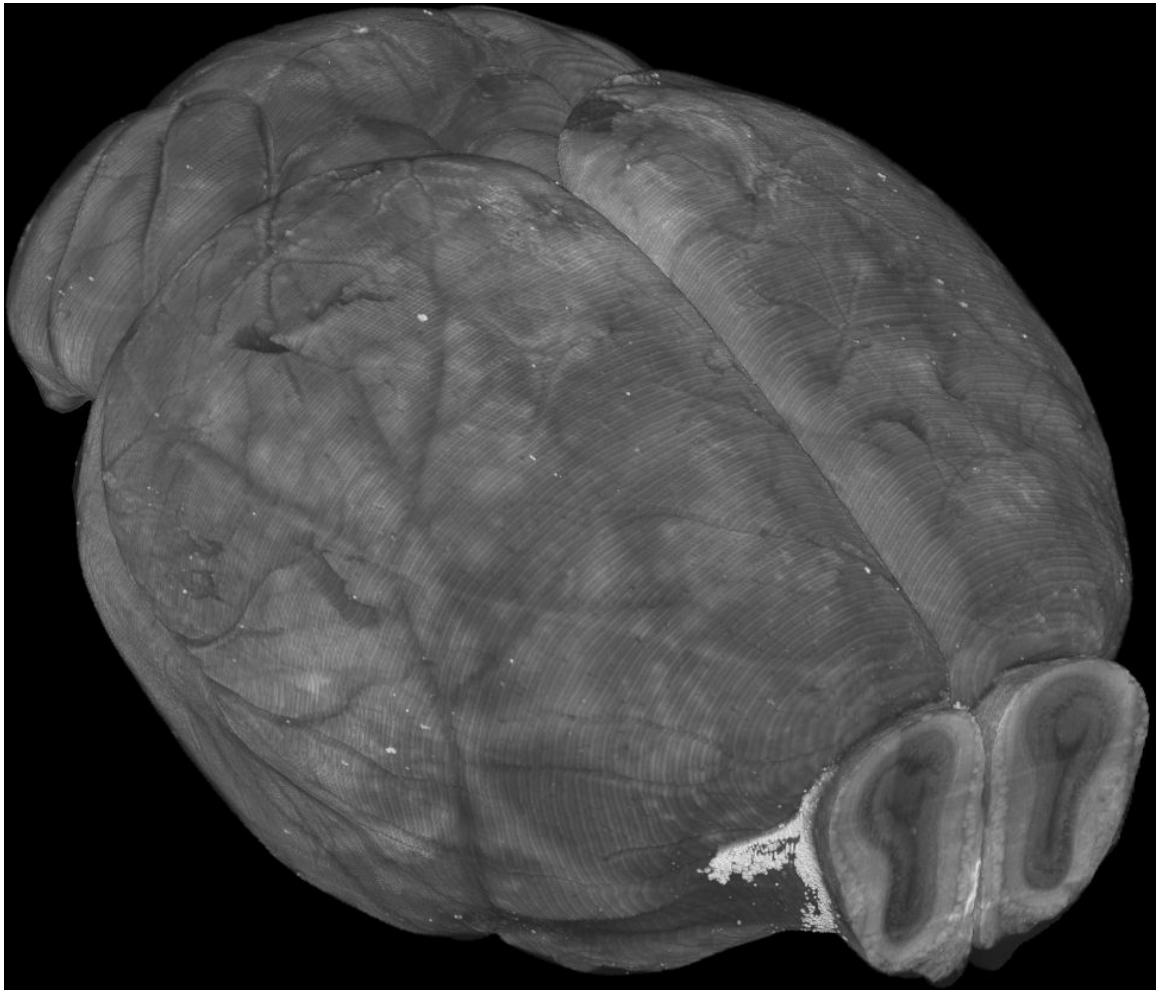
Photo: https://www.flickr.com/photos/jimg944/5085398602/

Viral tracing



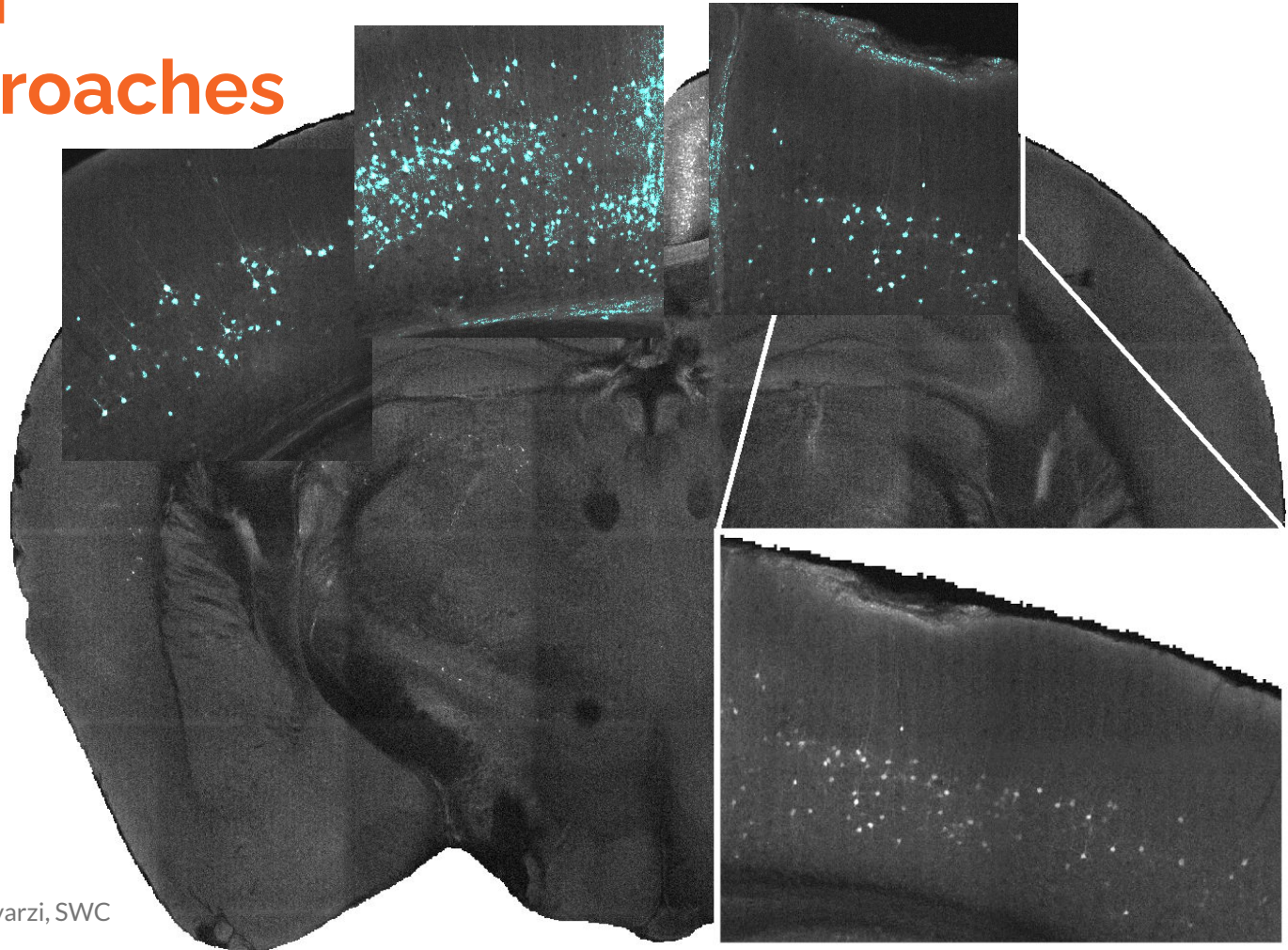
Data: Mateo Veléz-Fort, SWC

Whole-brain microscopy



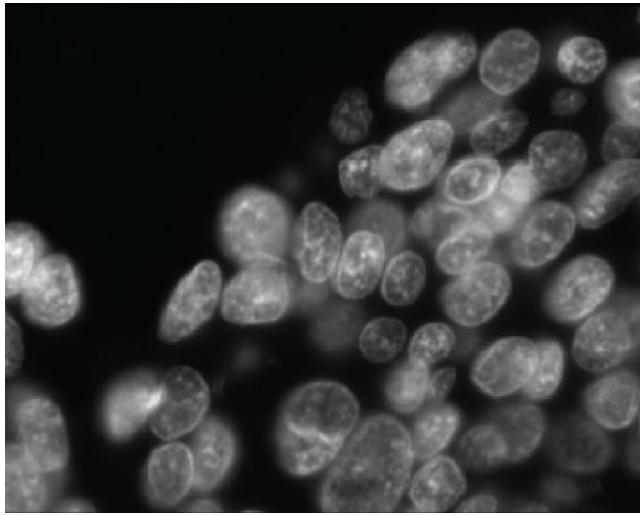
Data: Chryssanthi Tsitoura & Sepiedeh Keshavarzi, SWC

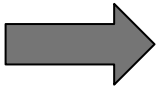
Cell detection -classical approaches

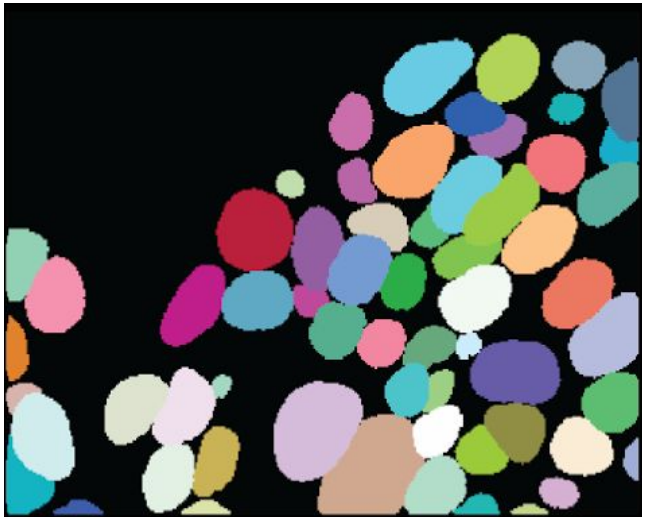


Data: Chryssanthi Tsitoura & Sepiedeh Keshavarzi, SWC

Cell detection - deep learning

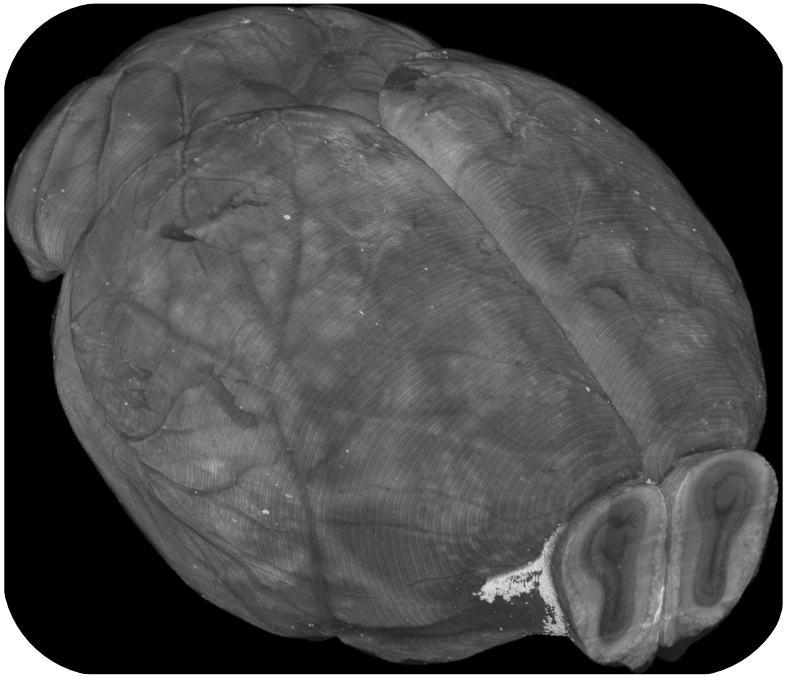






StarDist - Weigert et al. (2020) *WACV*

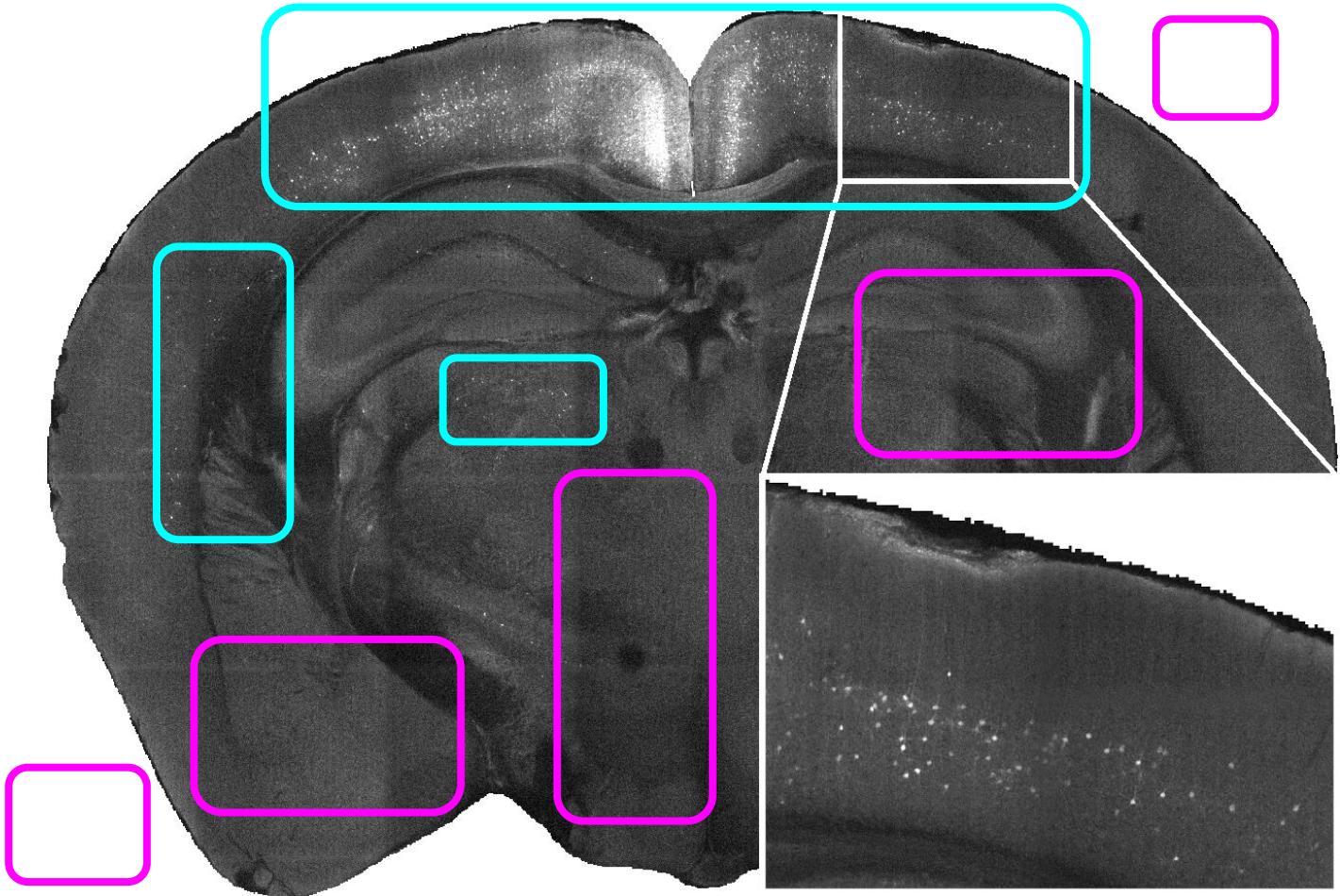
Cell detection - deep learning



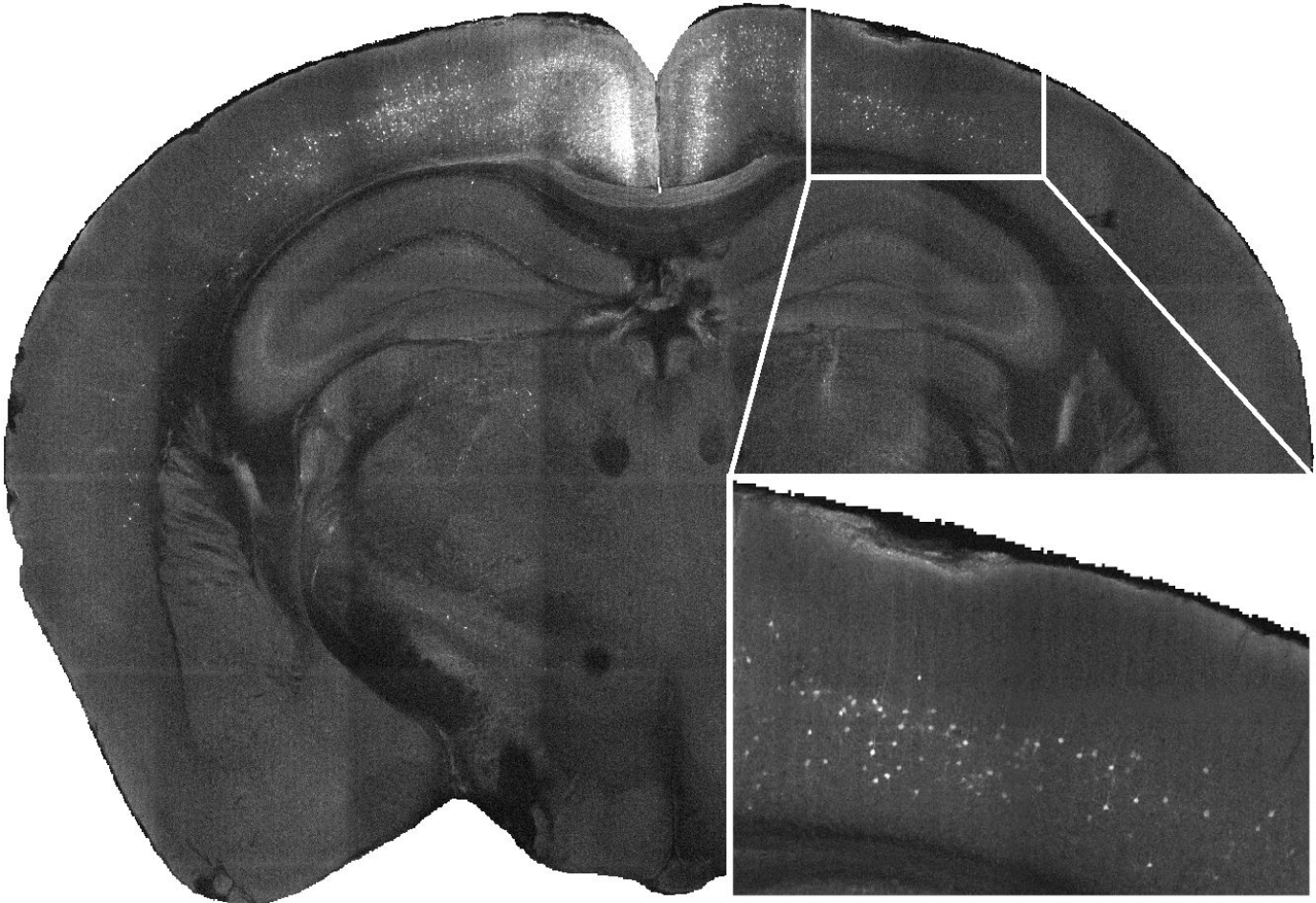
200-1000 GB

24GB VRAM

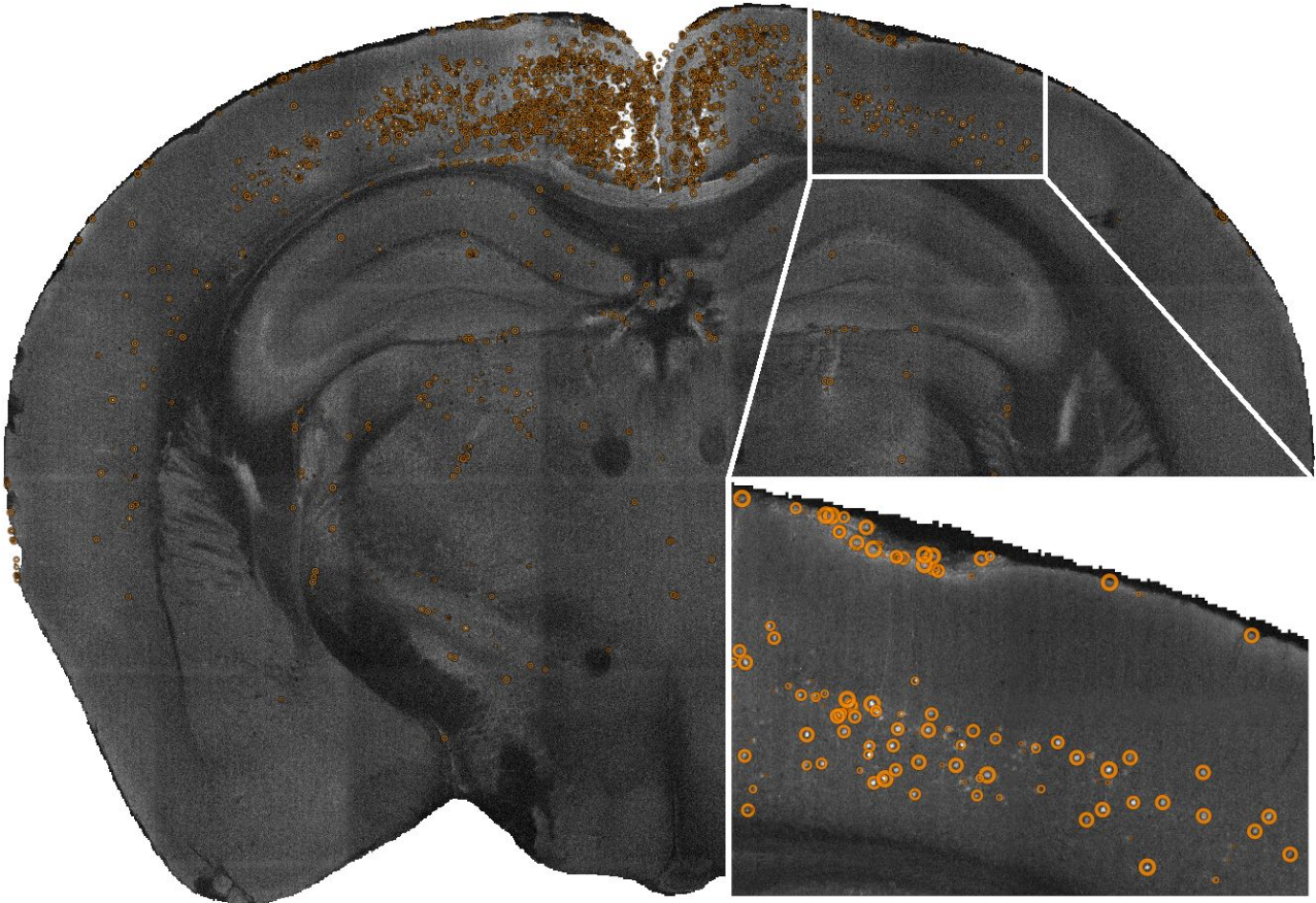
Cell detection - data reduction



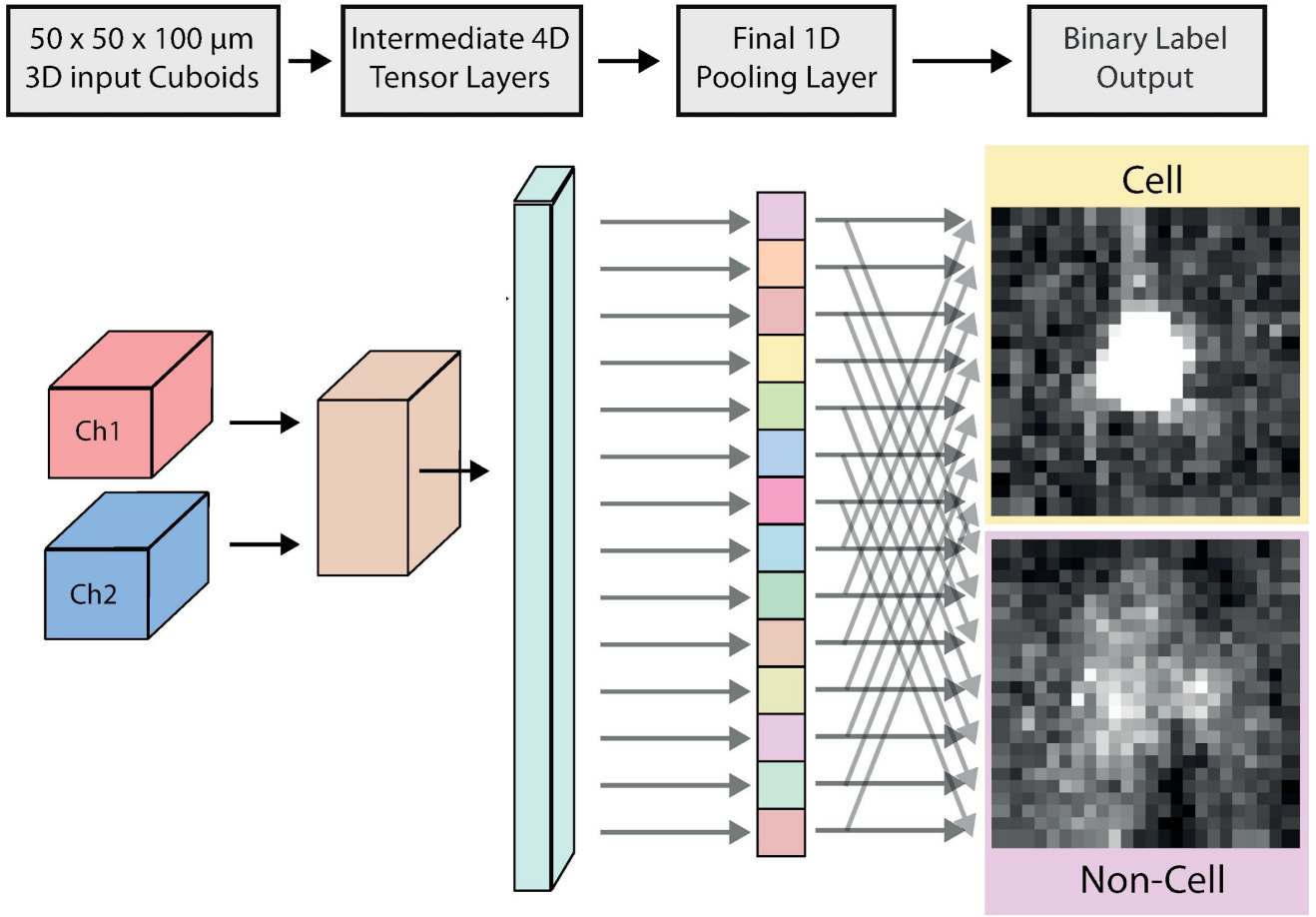
Cell detection - data reduction



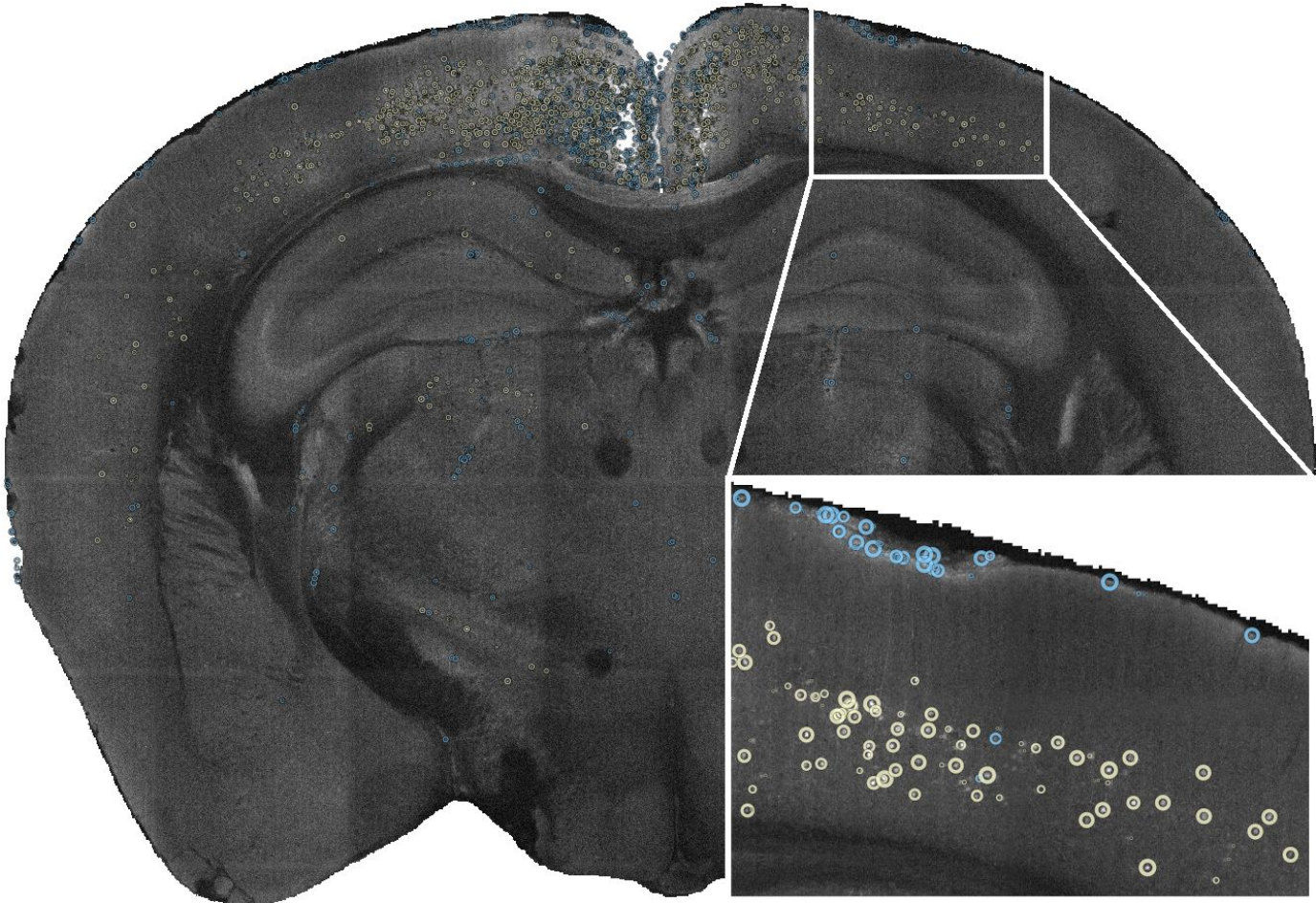
Cell detection - detection



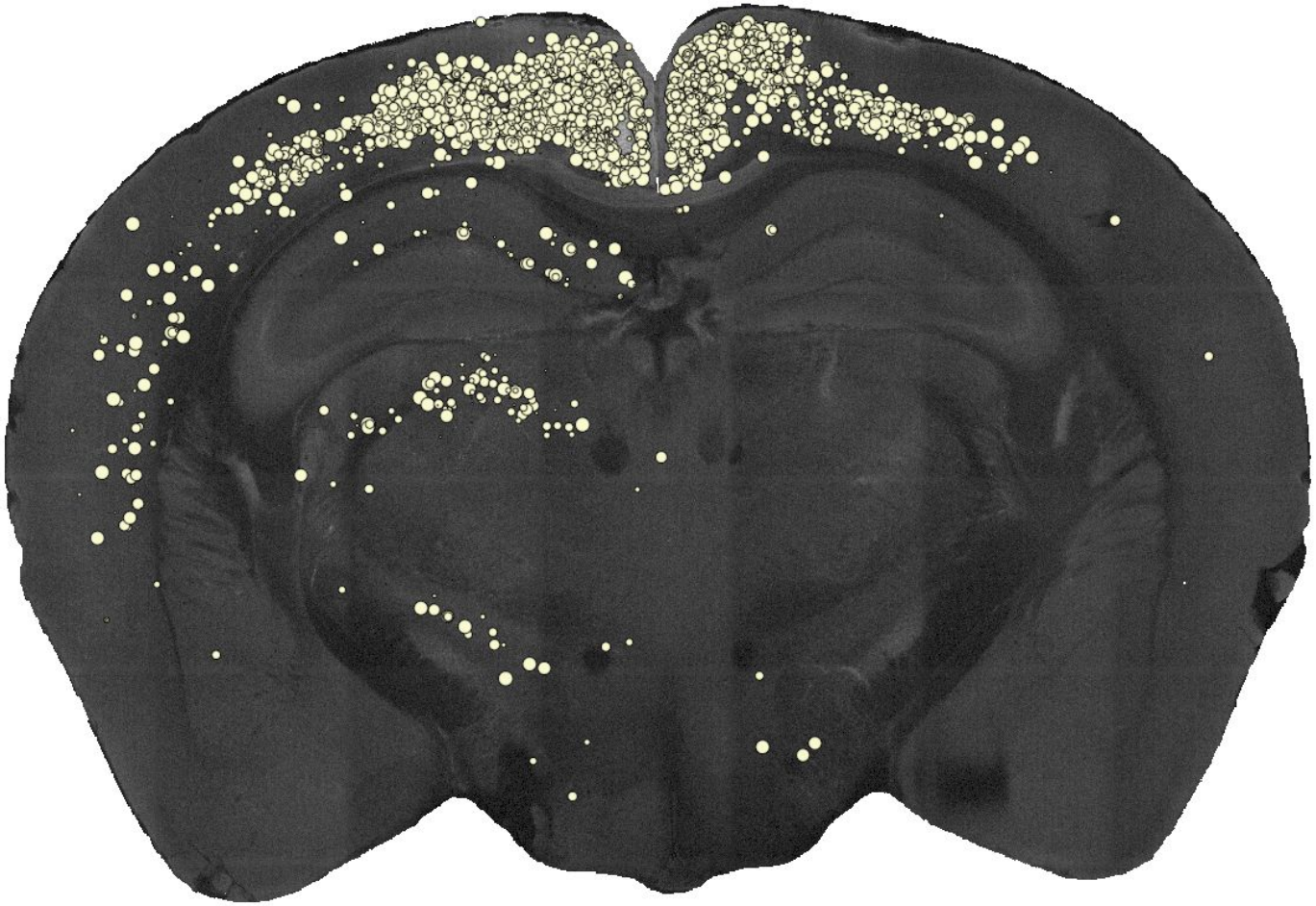
Cell detection - classification



Cell detection - classification

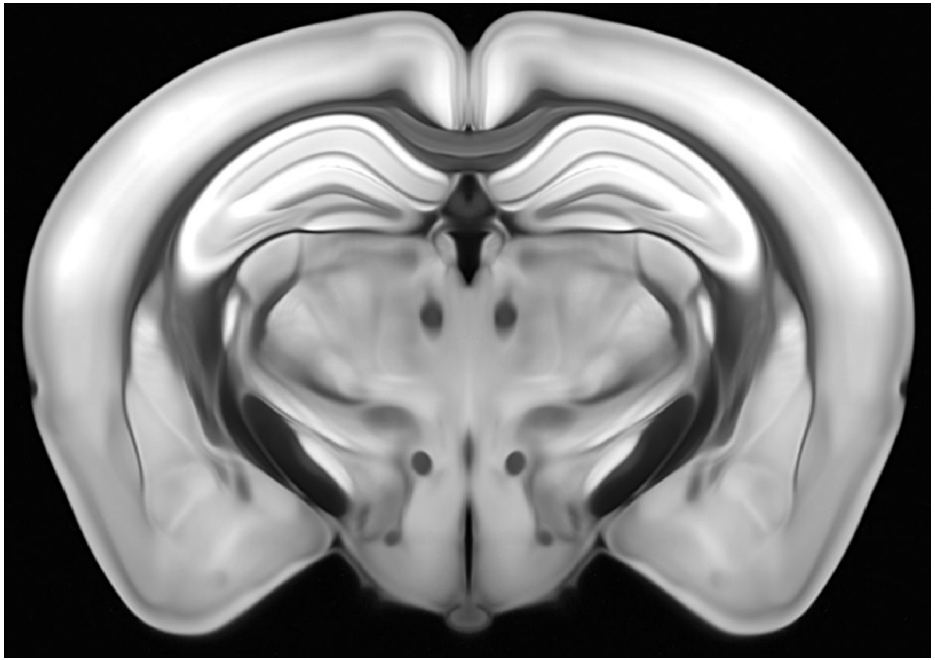


Brain segmentation



Registration

Allen mouse brain reference atlas

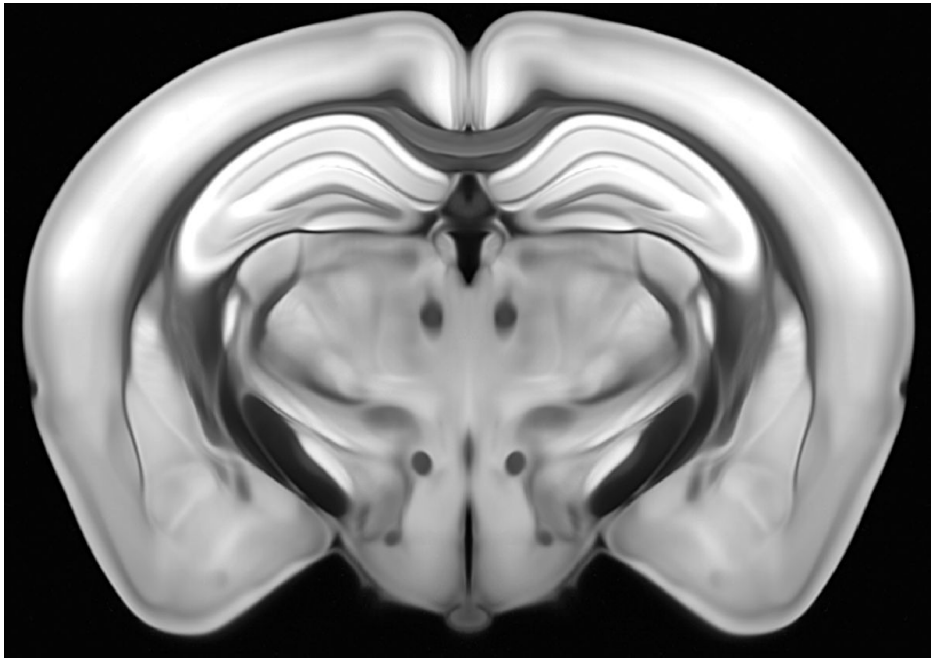


Reference image

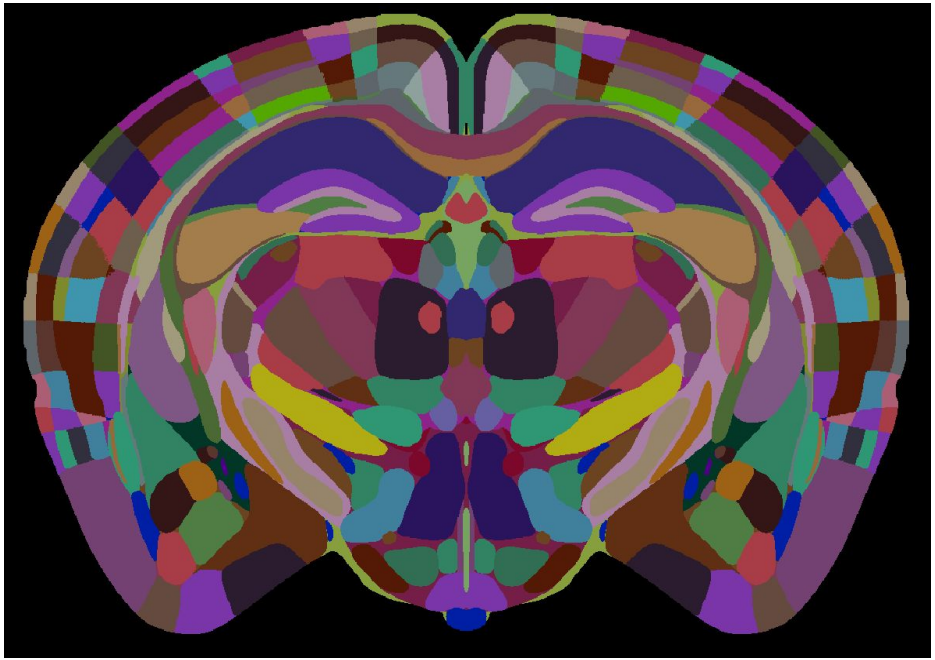
Allen Mouse Brain CCFv3 (Wang et al., 2020)

Registration

Allen mouse brain reference atlas



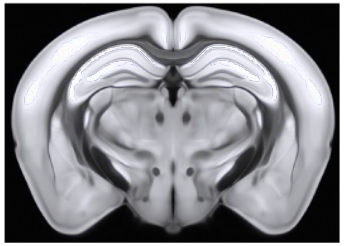
Reference image

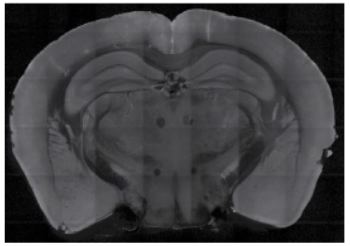


Annotation image

Allen Mouse Brain CCFv3 (Wang et al., 2020)

Registration





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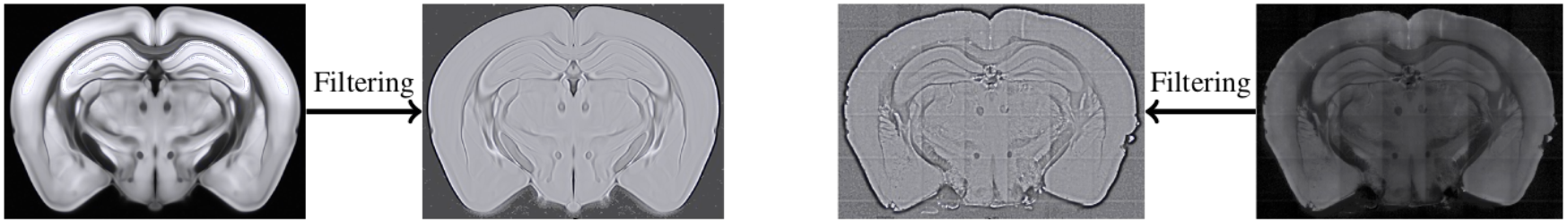

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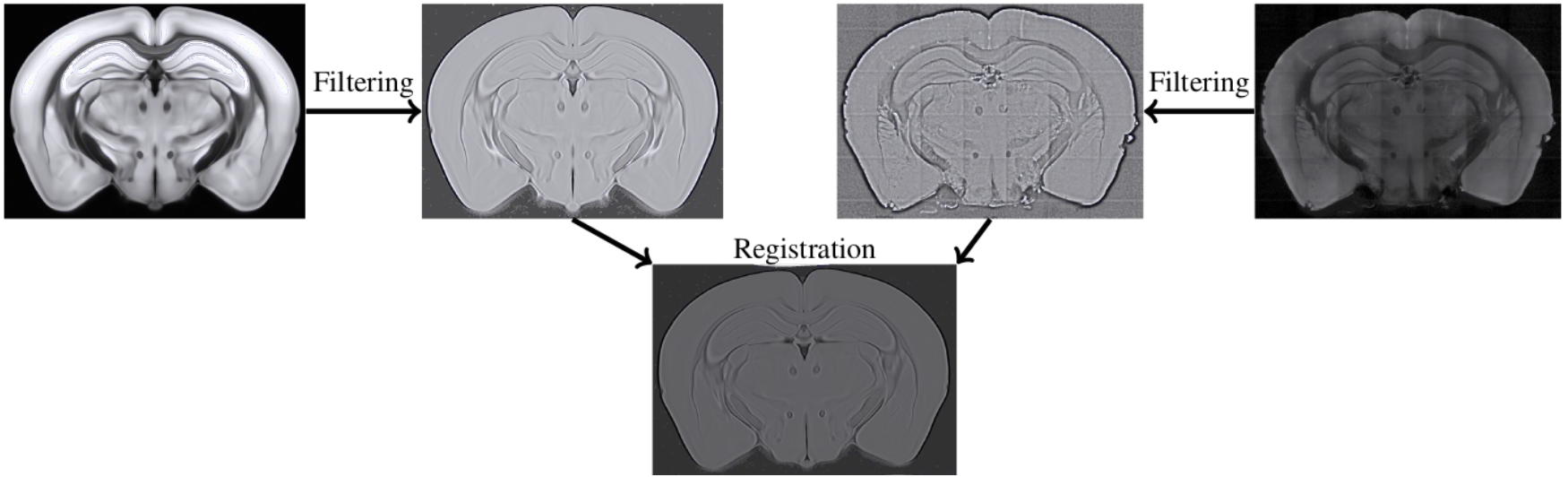
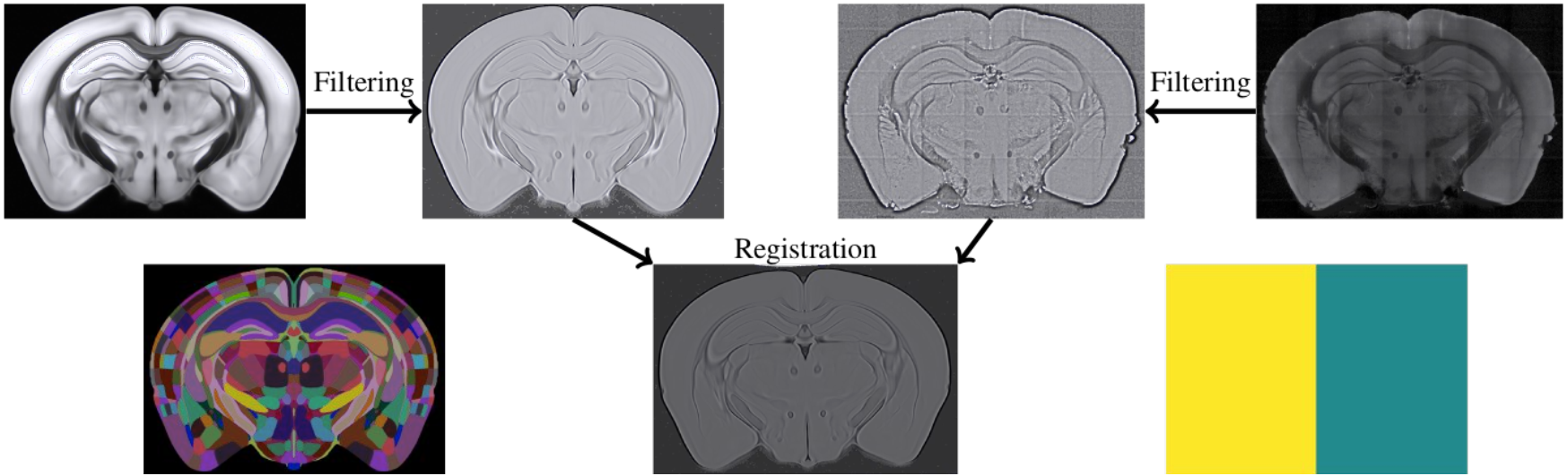
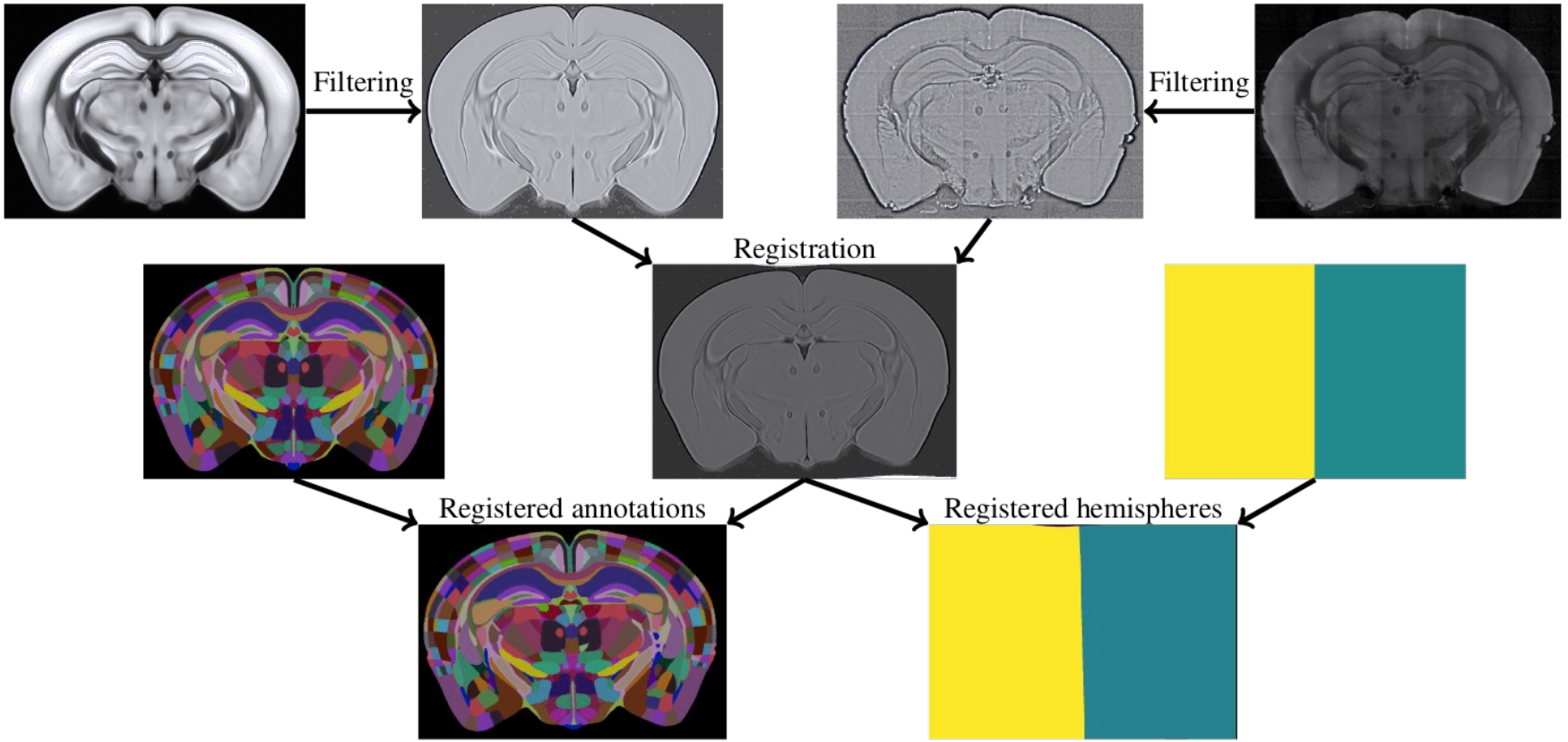


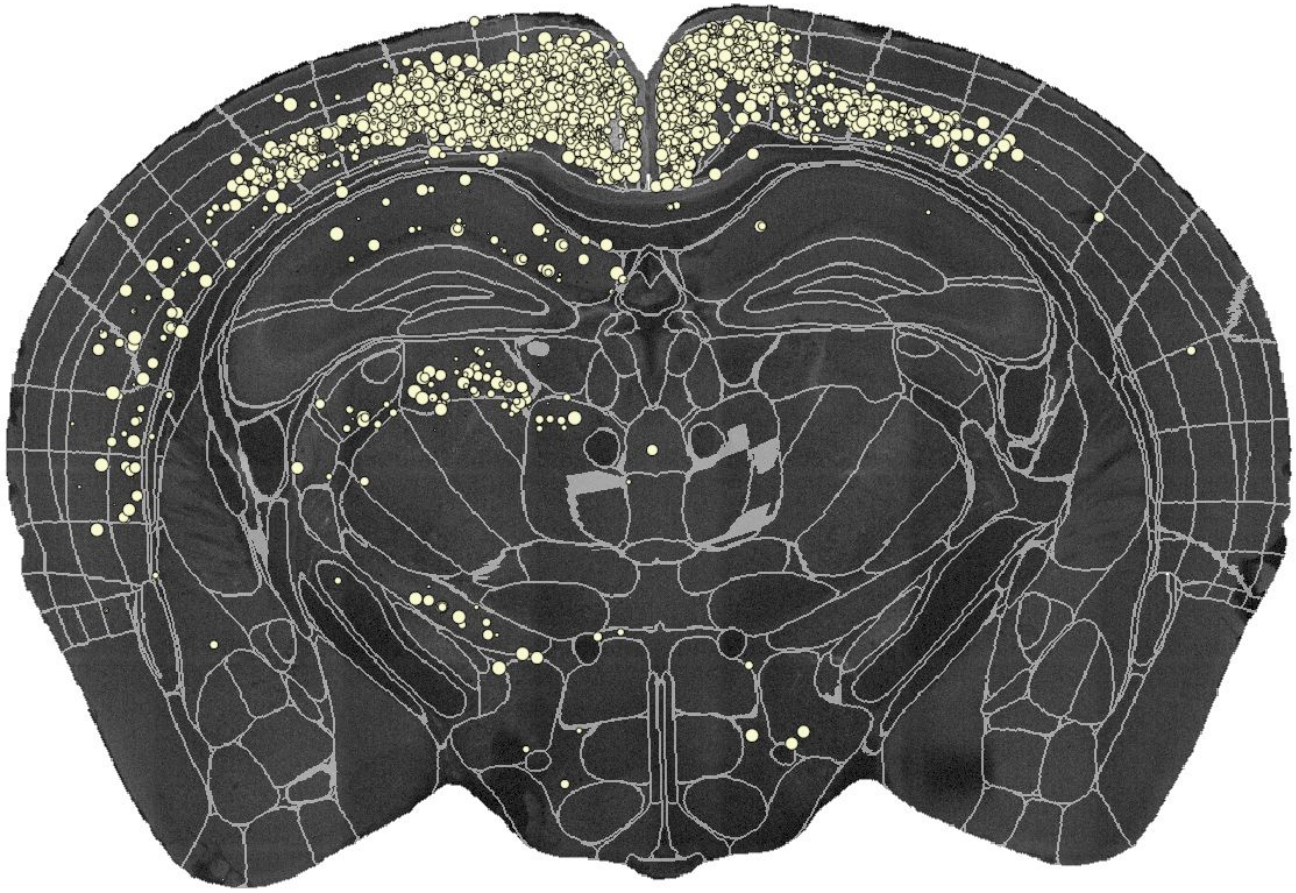
Registration



Registration



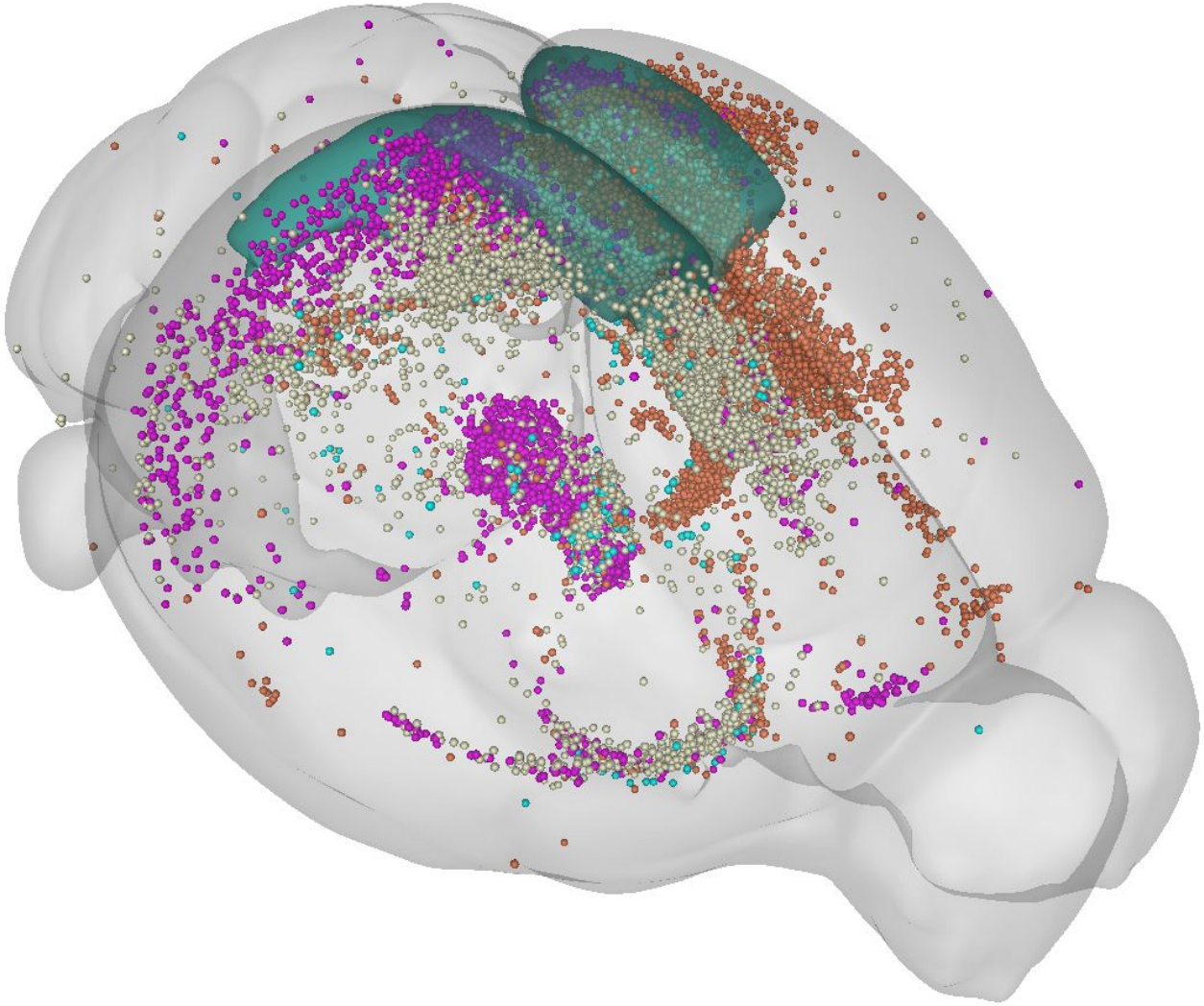
Registration



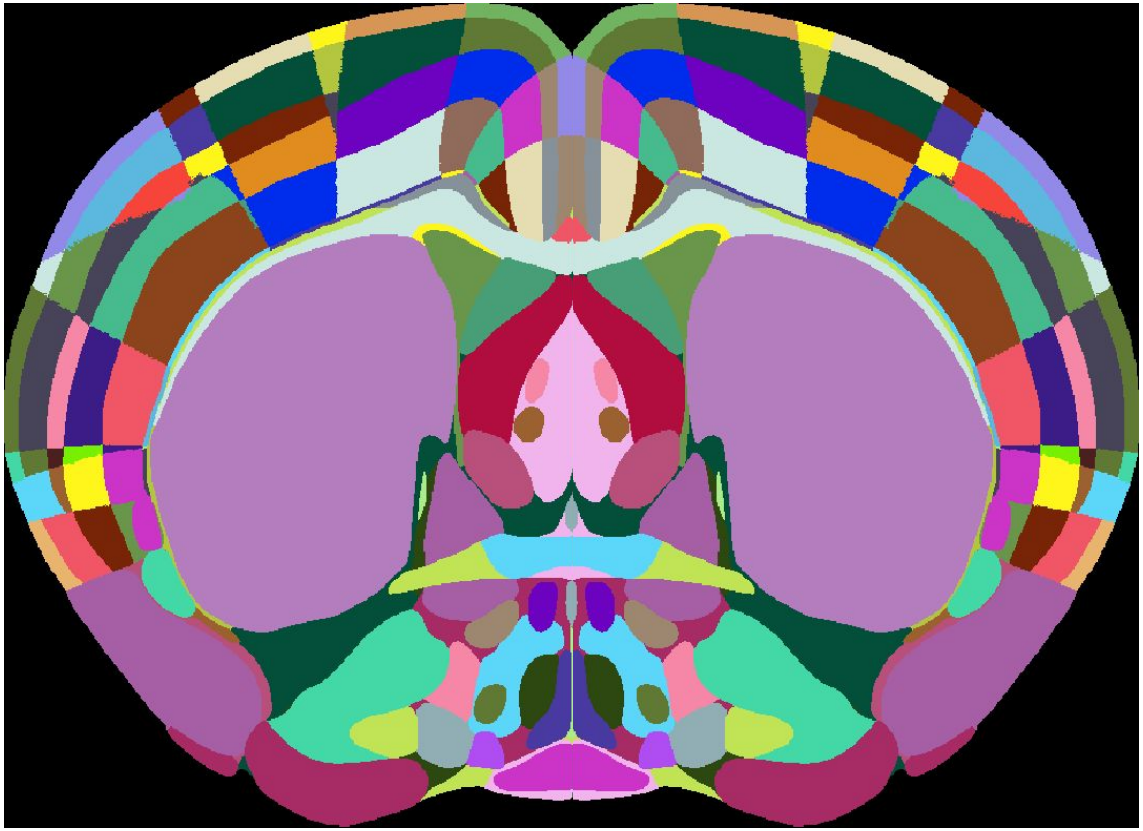
Registration

Brain structure name	Left hemisphere count	Right hemisphere count	Total count
Retrosplenial area, ventral part, layer 5	1853	814	2667
Lateral dorsal nucleus of thalamus	1541	0	1541
Retrosplenial area, ventral part, layer 2/3	163	686	849
Retrosplenial area, dorsal part, layer 5	561	82	643
Retrosplenial area, dorsal part, layer 2/3	194	245	439
Ventral anterior-lateral complex of the thalamus	412	0	412
Anterior cingulate area, dorsal part, layer 5	340	40	380
Anteroventral nucleus of thalamus	374	0	374
...	...	...	...

Registration



Brain atlases - mouse



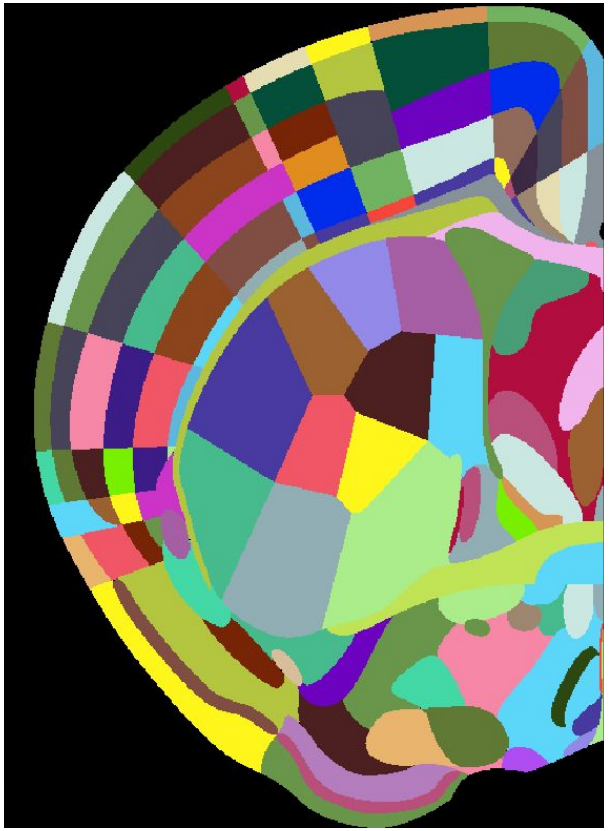
Allen Mouse Brain CCFv3
(Wang et al., 2020)

Brain atlases - mouse

Allen Mouse Brain CCFv3
(Wang et al., 2020)

Brain atlases - mouse

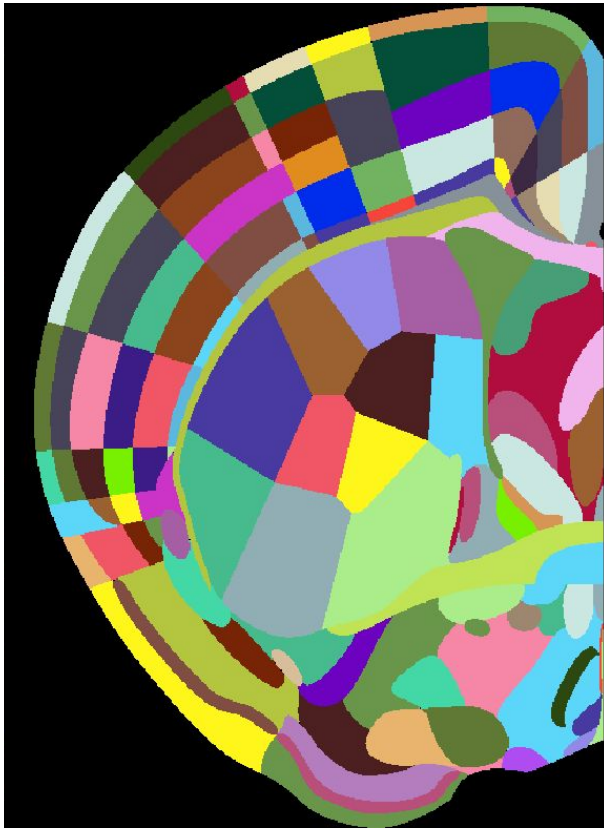
Allen Mouse Brain CCFv3
(Wang et al., 2020)



Enhanced and Unified Mouse
Brain Atlas (Chon et al., 2019).

Brain atlases - mouse

Allen Mouse Brain CCFv3
(Wang et al., 2020)



Enhanced and Unified Mouse
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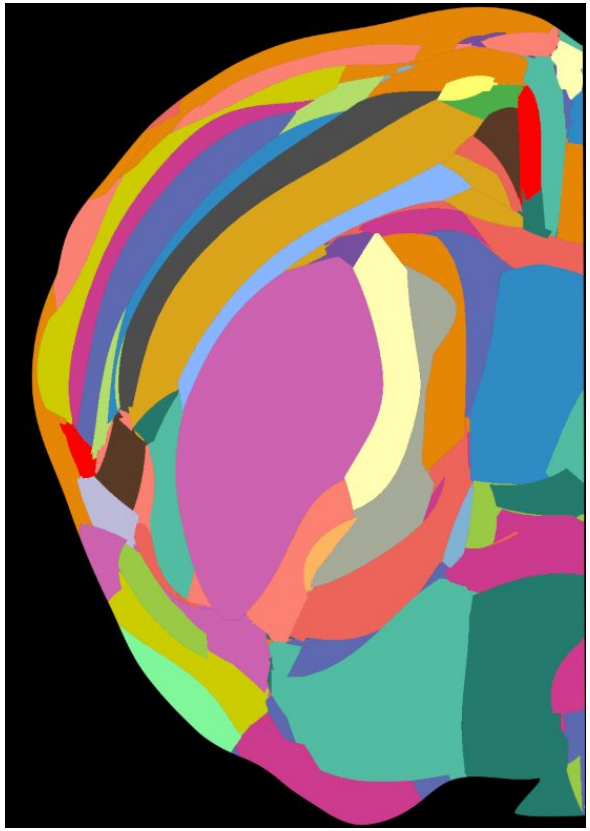
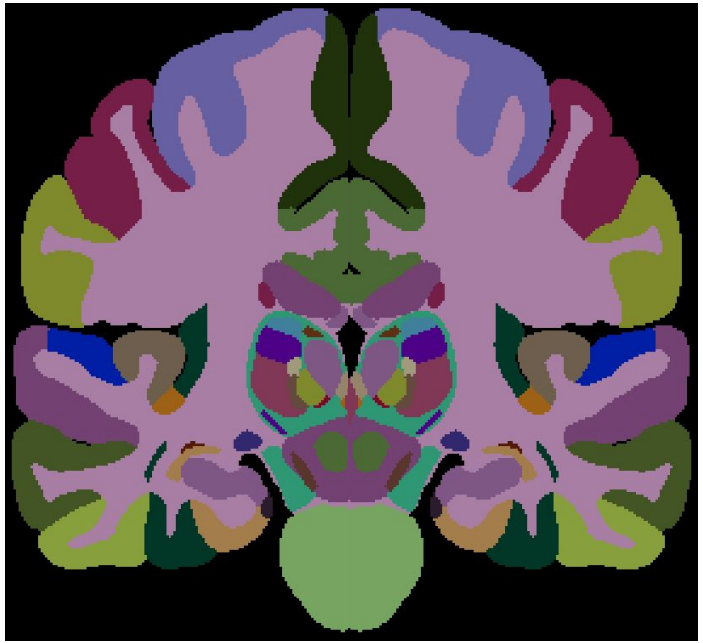


Molecular atlas of the adult
mouse brain (Ortiz et al., 2020)

Brain atlases - other species

Max Planck Larval Zebrafish Atlas
(Kunst et al., 2019)



Allen human atlas
(Ding et al., 2020)

Waxholm Space atlas of the Sprague Dawley rat brain (Papp et al., 2014).

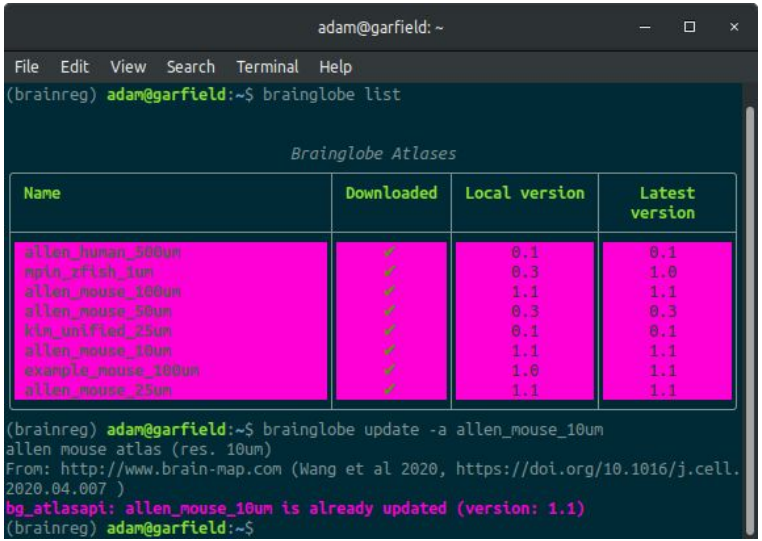
NeuroNames macaque atlas
(Rohlfing et al., 2012)

BrainGlobe Atlas API

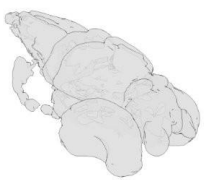
Python API

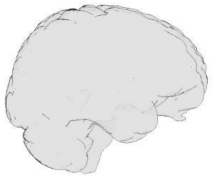
```python
from bg_atlasapi.bg_atlas import BrainGlobeAtlas
atlas = BrainGlobeAtlas("allen_mouse_25um")

# reference image
reference_image = atlas.reference
print(reference_image.shape)
# (528, 320, 456)

# hemispheres image (value 1 in left hemisphere, 2 in right)
hemispheres_image = atlas.hemispheres
print(hemispheres_image.shape)
# (528, 320, 456)

from pprint import pprint
VISp = atlas.structures["VISp"]
pprint(VISp)
# {'acronym': 'VISp',
#  'id': 385,
#  'mesh': None,
#  'mesh_filename': PosixPath('/home/user/.brainglobe/allen_mouse_25um_v0.3/meshes/385.obj'),
#  'name': 'Primary visual area',
#  'rgb_triplet': [8, 133, 140],
#  'structure_id_path': [997, 8, 567, 688, 695, 315, 669, 385]}
```

Command line interface



BrainGlobe Atlas API





Currently implemented atlases

- The Allen Mouse Brain Atlas (10, 25, 50 and 100 micron)
- The Allen Human Brain Atlas (100 micron)
- The Max Planck Zebrafish Brain Atlas (1 micron)
- The Enhanced and Unified Mouse Brain Atlas (10, 25, 50 and 100 micron)
- The Smoothed Kim et al. Mouse Brain Atlas (10, 25, 50 and 100 micron)

BrainGlobe

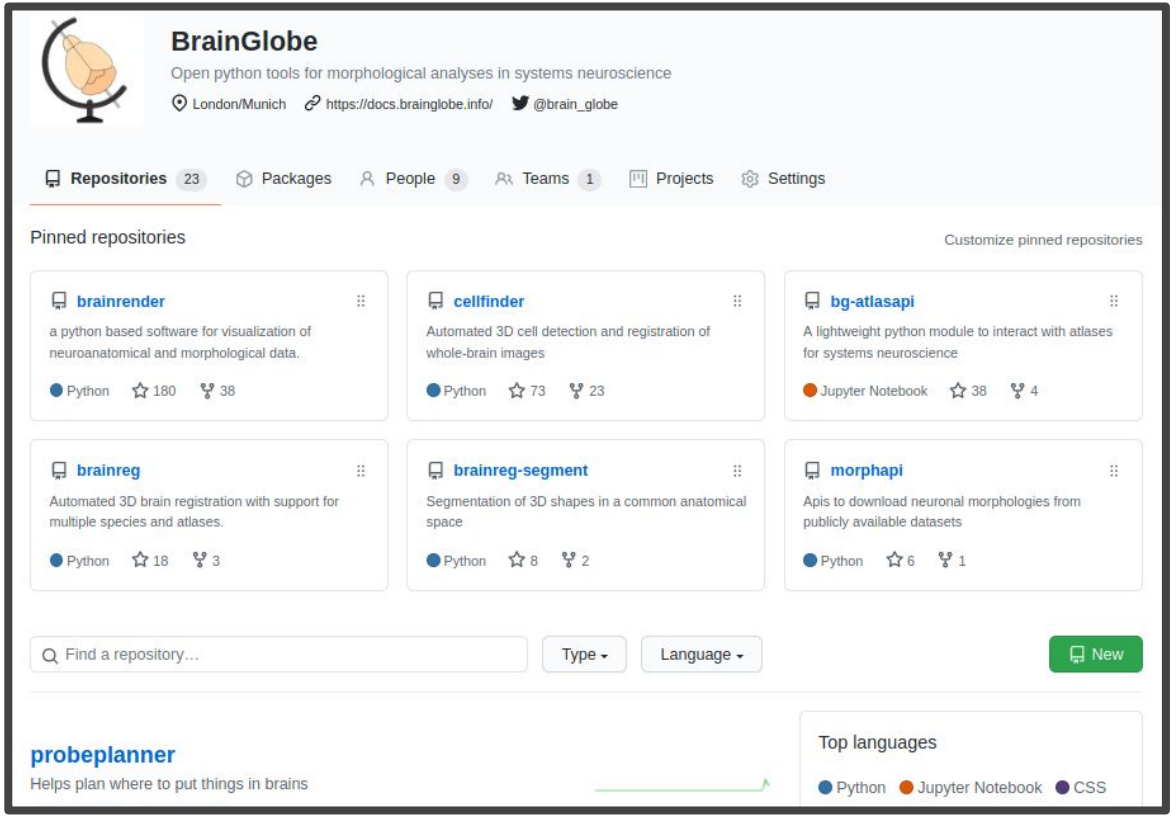
Building an open-source community

Currently

- 23 repositories
- 17 total contributors
- ~2.5k downloads/month

Future

- New contributors
- Biologists adopt tools
- Developers use core tools



Acknowledgements

Cell detection

Charly Rousseau[1,2]
Christian Niedworok[1]
Sepiedeh Keshavarzi[1]
Chryssanthi Tsitoura[1]
Lee Cossell[1]
Molly Strom[1]
Troy Margrie[1]

3D Atlas registration

Charly Rousseau[1,2]
Christian Niedworok[1]
Troy Margrie[1]

Funding

3D Visualisation

Federico Claudi[1]
Luigi Petrucco[2,3]
Ruben Portuges[2,3,4]
Troy Margrie[1]
Tiago Branco[1]

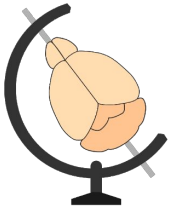
Atlas API

Federico Claudi[1]
Luigi Petrucco[3,4]
Ruben Portuges[3,4,5]
Troy Margrie[1]
Tiago Branco[1]

1) Sainsbury Wellcome Centre, UCL
2) Sorbonne Université, Institut du Cerveau - Paris Brain Institute - ICM, Inserm, CNRS
3) Institute of Neuroscience, Technical University of Munich
4) Max Planck Institute of Neurobiology
5) Munich Cluster for Systems Neurology (SyNergy)

Software

All available as part of the BrainGlobe computational neuroanatomy software suite:



github.com/brainglobe @brain_globe

docs.brainglobe.info gitter.im/BrainGlobe

Cell detection

cellfinder

github.com/brainglobe/cellfinder

@findingcells

Tyson, A. L., Rousseau, C. V., Niedworok, C. J., et al. (2021) "A deep learning algorithm for 3D cell detection in whole mouse brain image datasets' bioRxiv, doi.org/10.1101/2020.10.21.348771

3D atlas registration

brainreg

github.com/brainglobe/brainreg

Atlas API

BrainGlobe Atlas API

github.com/brainglobe/bg-atlasapi

Claudi, F., Petrucco, L., Tyson, A. L., et al. (2020) "BrainGlobe Atlas API: a common interface for neuroanatomical atlases" Journal of Open Source Software, v5(54), 2668 doi.org/10.21105/joss.02668

3D visualisation

brainrender

github.com/brainglobe/brainrender

Claudi, F., et al. (2021) "Visualizing anatomically registered data with Brainrender doi.org/10.7554/eLife.65751

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