Machine Learning in Health

Using ML/DL in medical applications

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Image Data Analysis
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Scientific Background

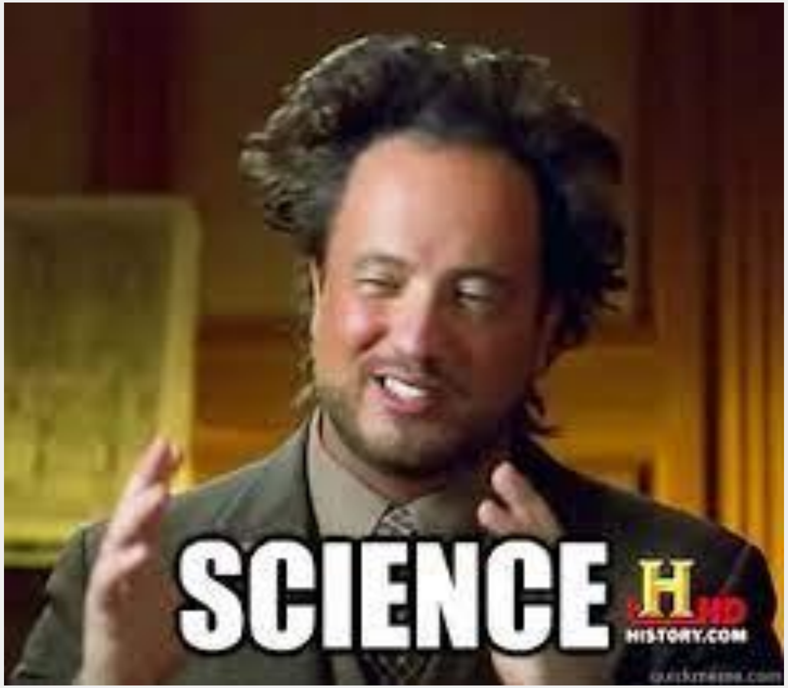
Bachelors
Bangalore

Technische Universität München

Masters
TUM

PhD
Berlin

MDC
MAX-DELBRÜCK-CENTRUM
FÜR MOLEKULARE MEDIZIN
IN DER HELMHOLTZ-GEMEINSCHAFT



Masters Project

Technical University of Munich

HelmholtzZentrum münchen
German Research Center for Environmental Health

Institute of Computational Biology

Neural cell fate prediction using time-lapse microscopy images

Cell reprogramming

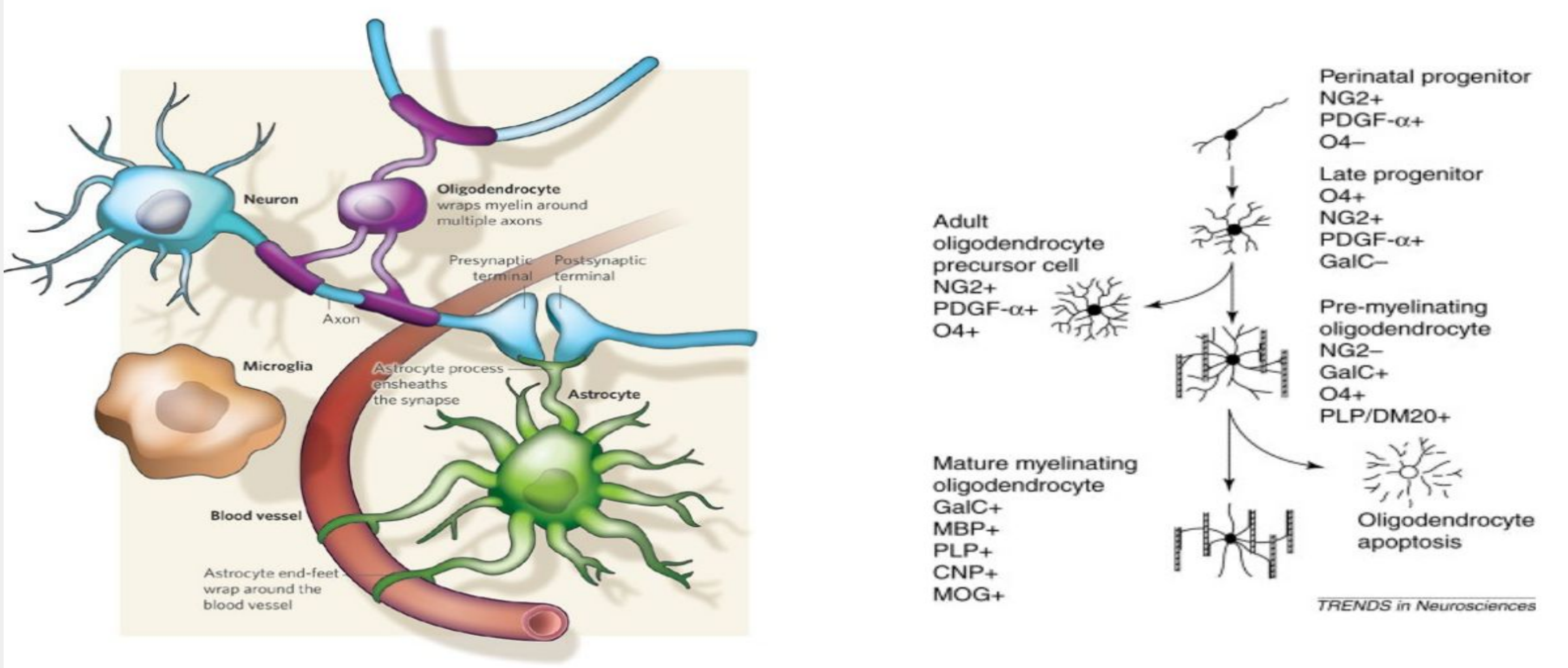
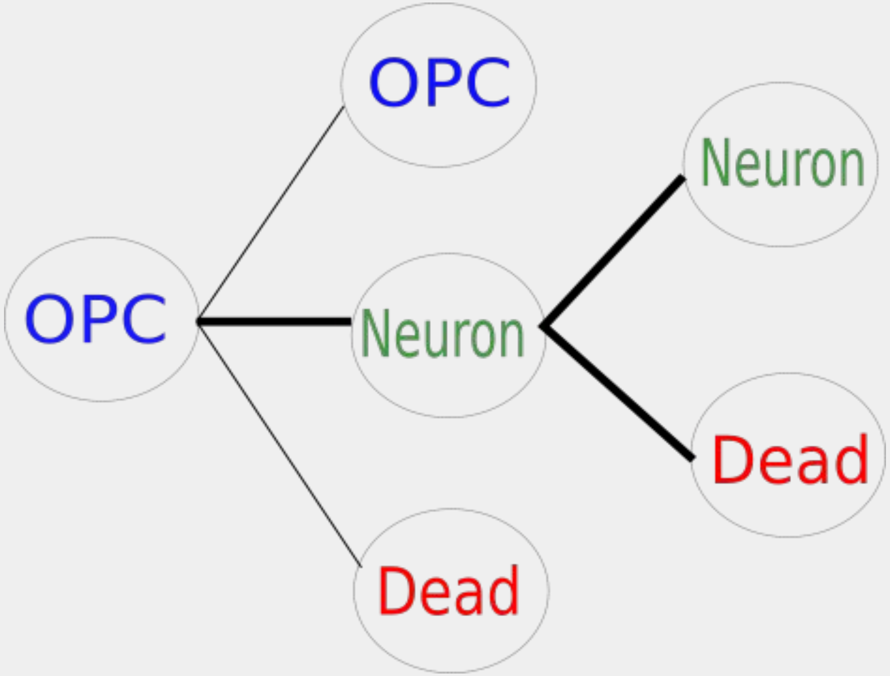


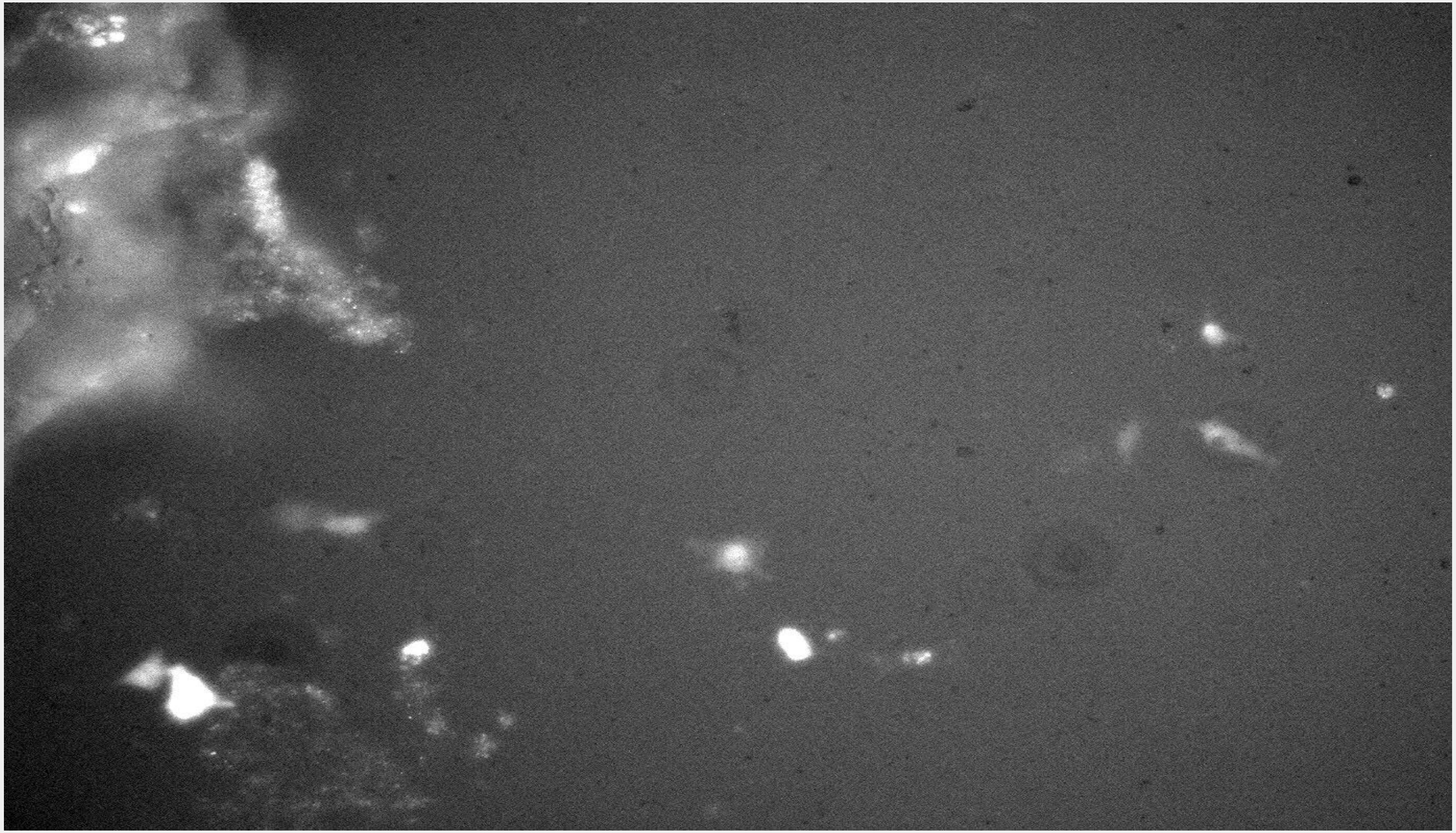
Fig: Left part of the image is taken from [2] and the right side of the image is taken from [4]

Applications: For cell-based replacement therapy for traumatic brain injury or neurodegenerative disease.

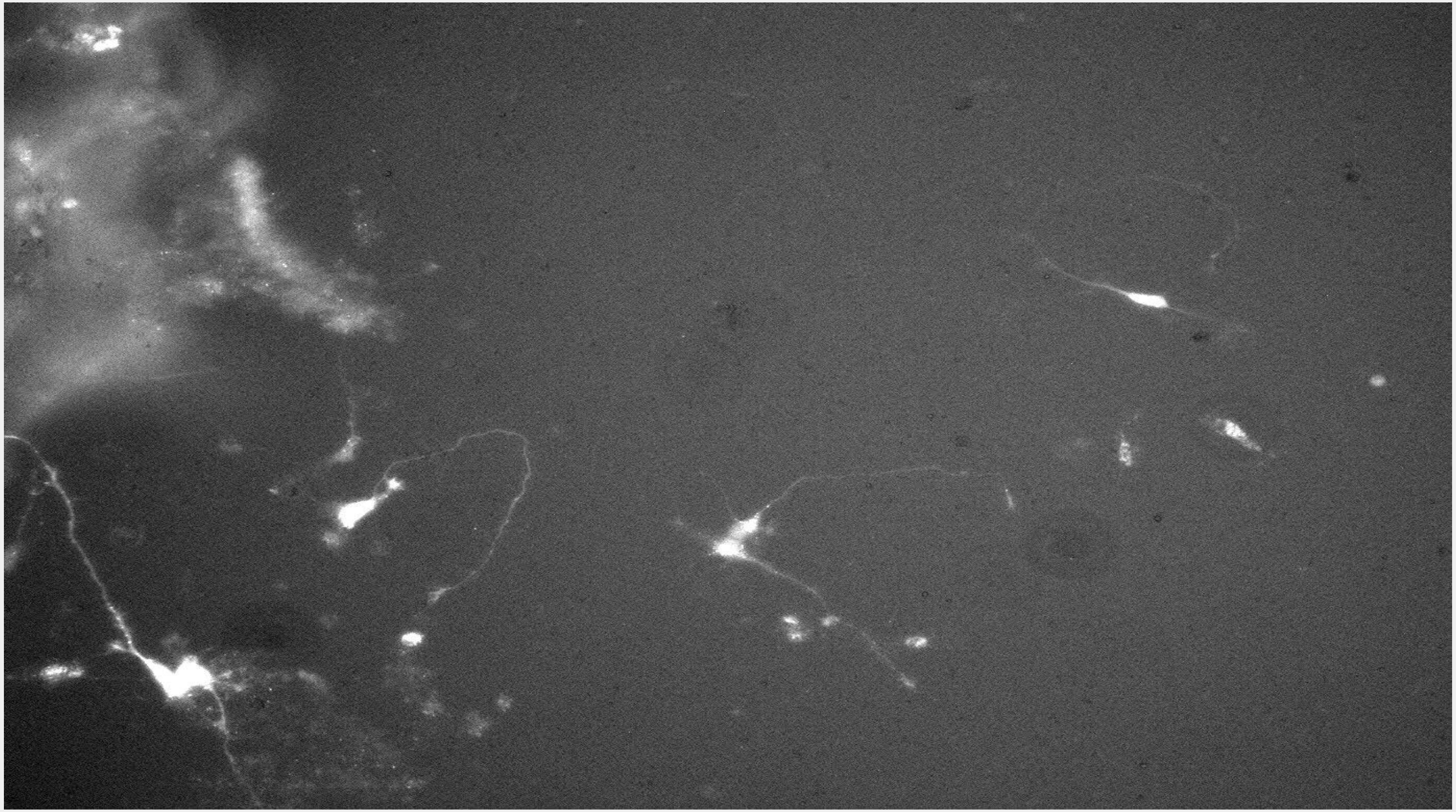
Cell reprogramming



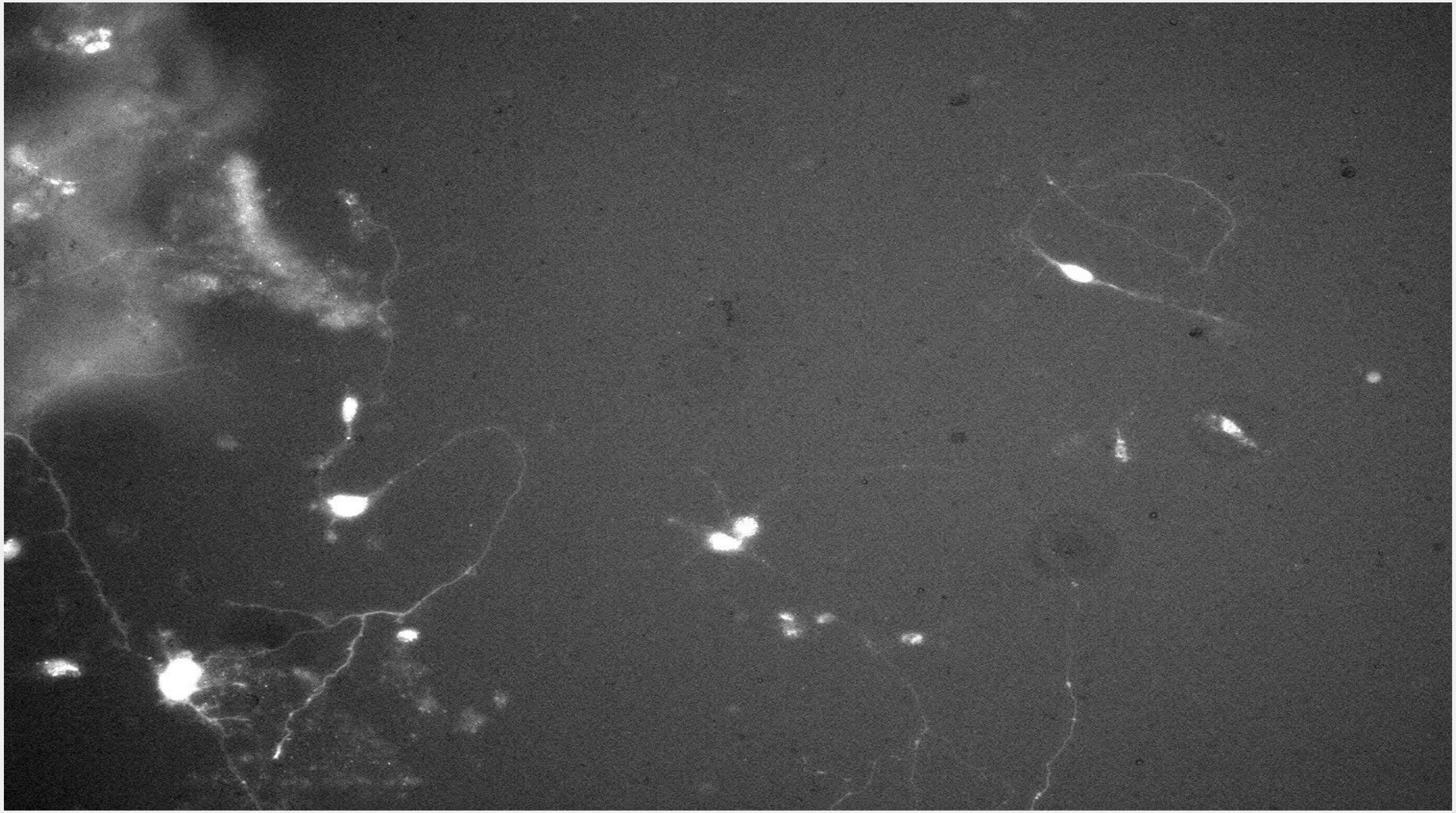
Data at 24 hours



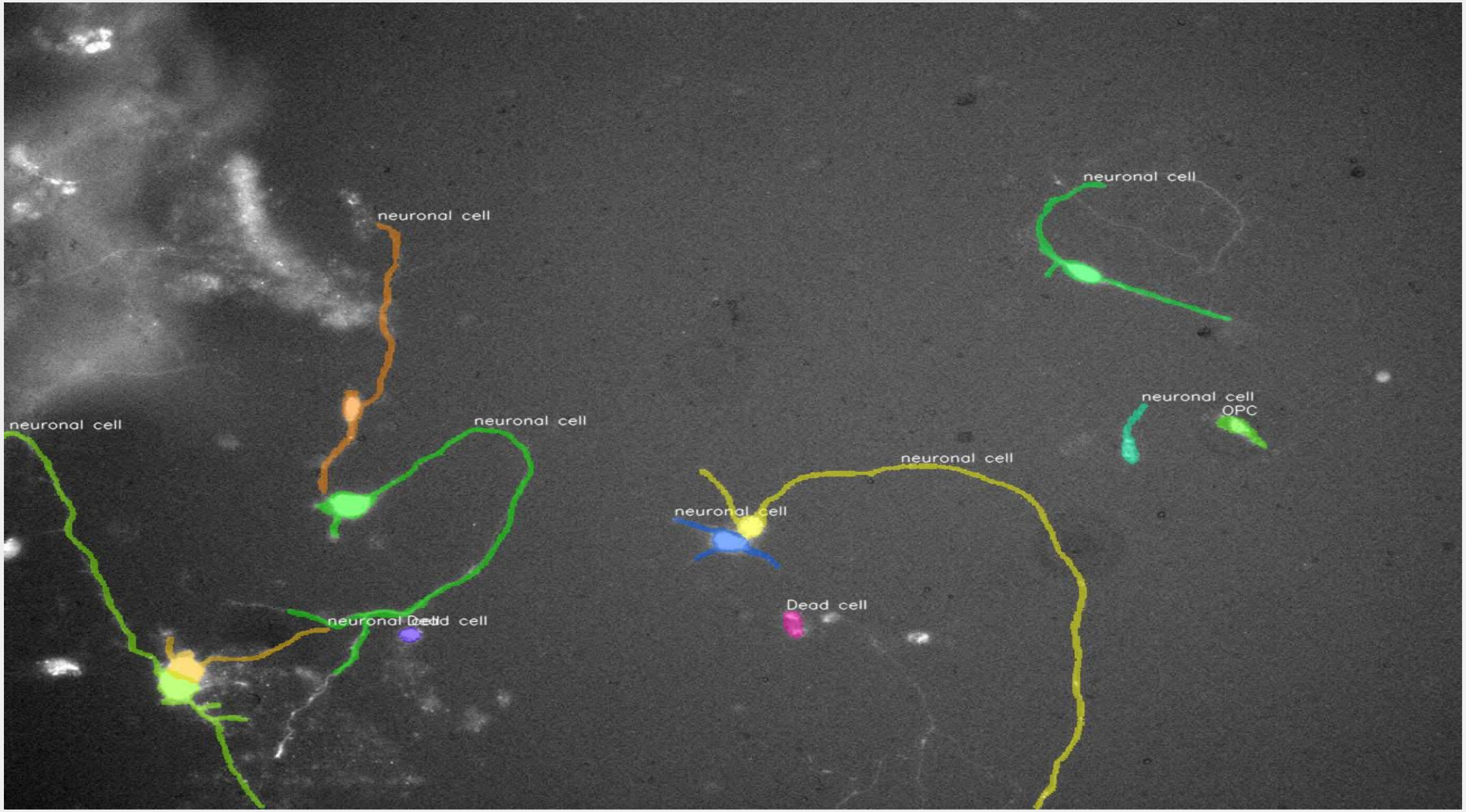
Data at 60 hours



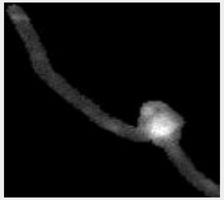
Data at 116 hours



Annotated data at 116 hours



Supervised Learning

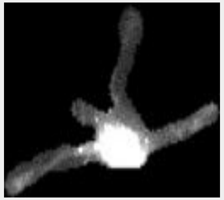


Input

Annotations

It"s a
neuron

Model



Predictions

It"s a
neuron

Reprogramming statistics

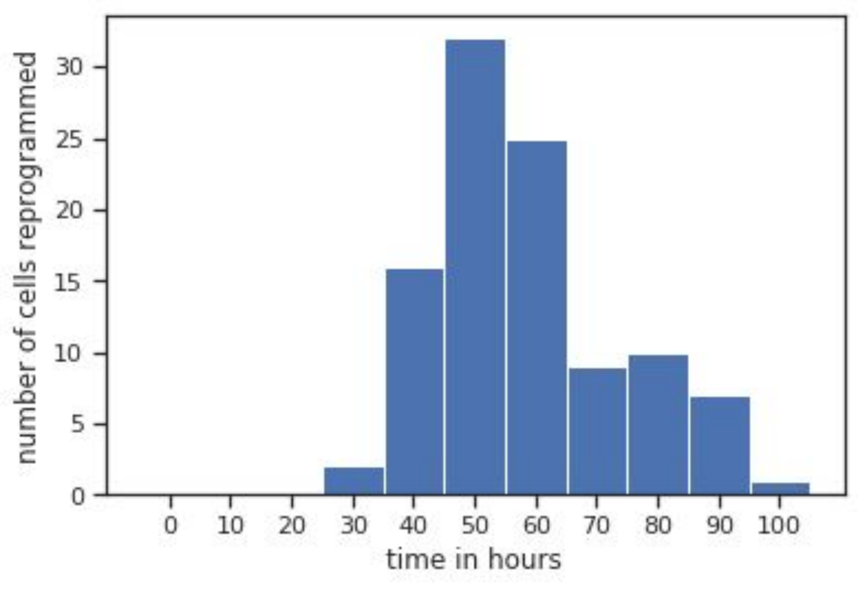


Fig: The graph shows the number of cells reprogrammed at the end of every 10 hours

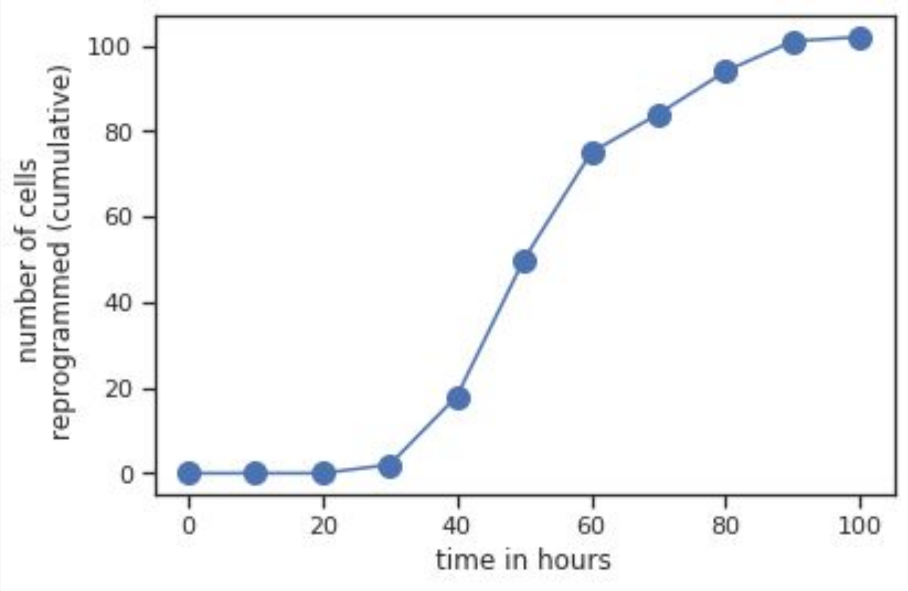
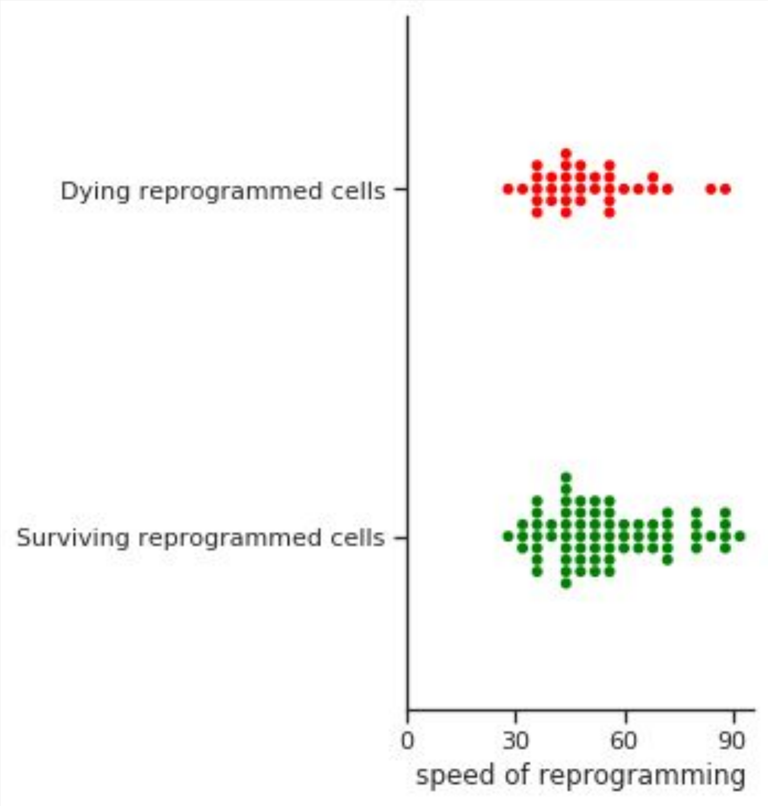


Fig: The number of cells cumulatively reprogrammed.

Speed of reprogramming

Relation between the 'speed of reprogramming' and 'cell fate'.
Early reprogramming - less than 48 hours, 50 cells, 62% survived.
Late reprogramming - 52 cells, 73% survived.
Wilcoxon test fails to reject null hypothesis at p 0.062.



Network architecture

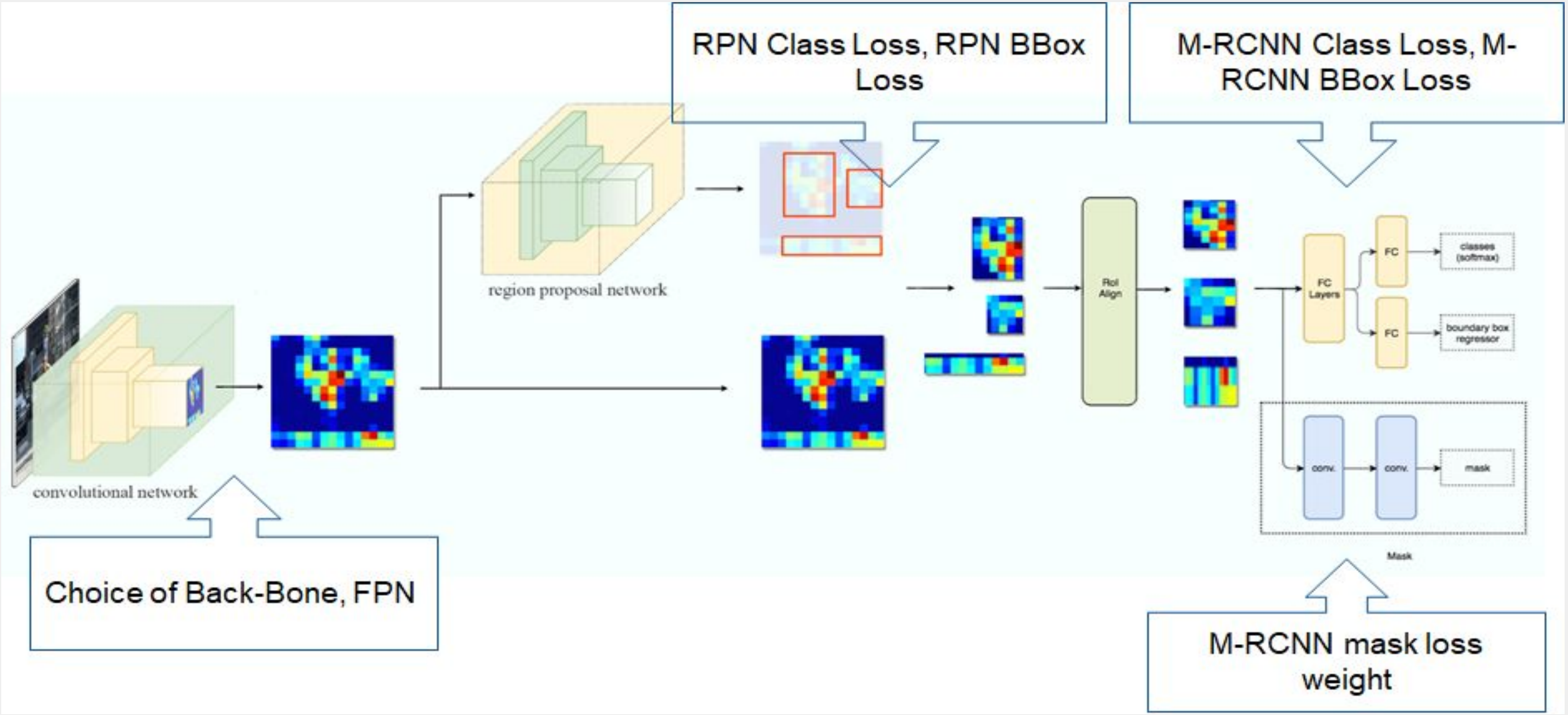
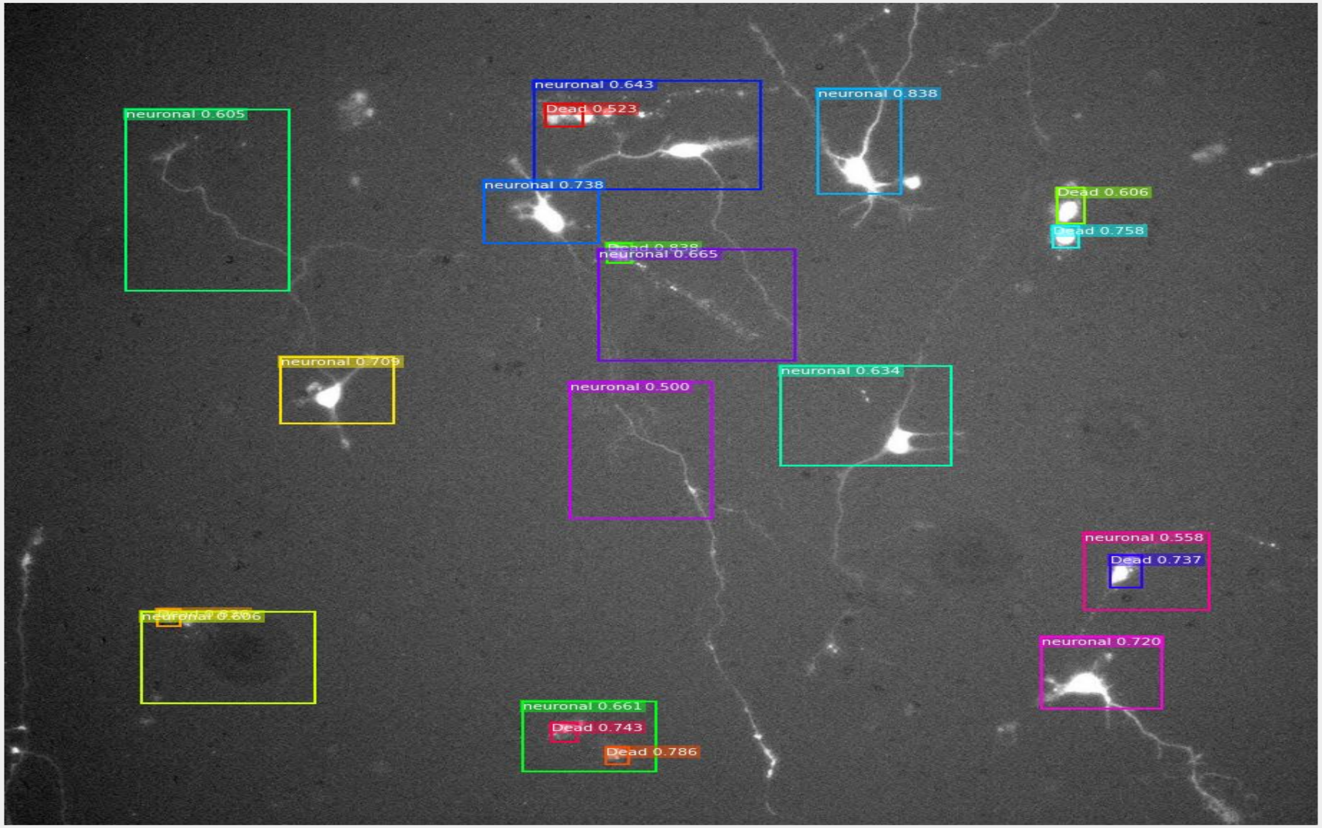


Fig: Illustration of Mask R-CNN architecture. Image taken from [8].

Detections obtained from the model



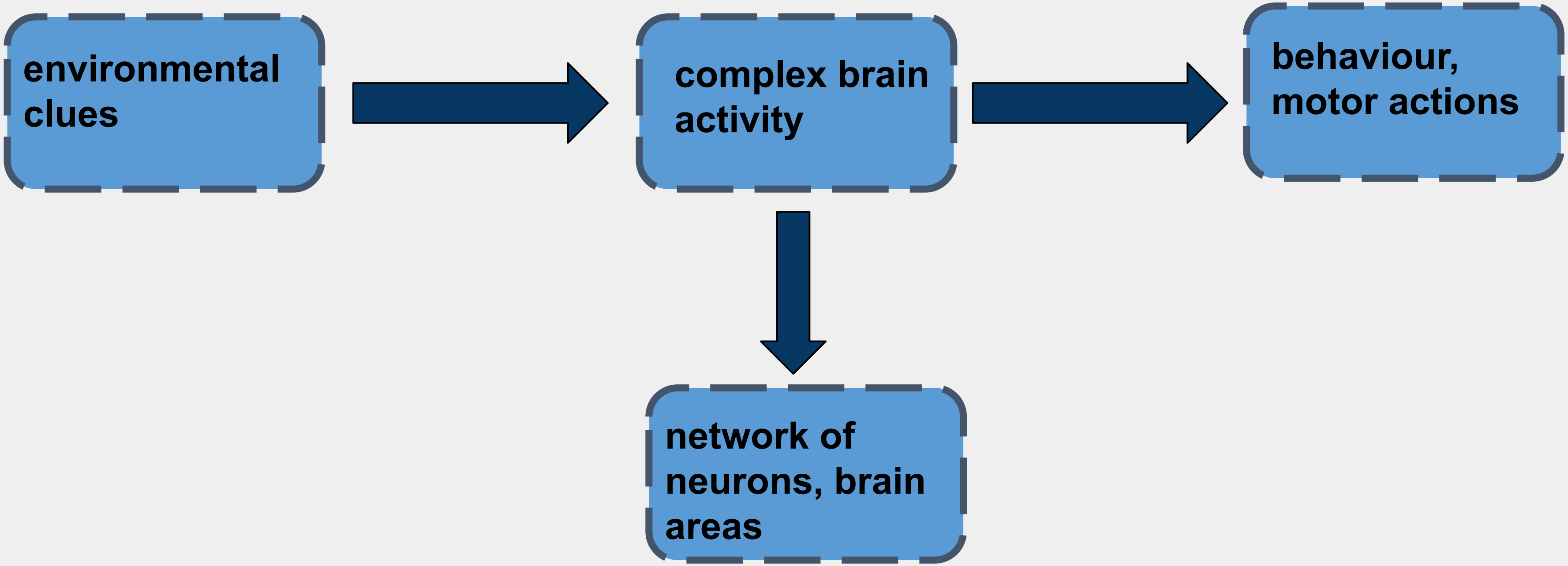
PhD Project

iNAMES
MDC-Weizmann Research School
Imaging from NAno to MESo

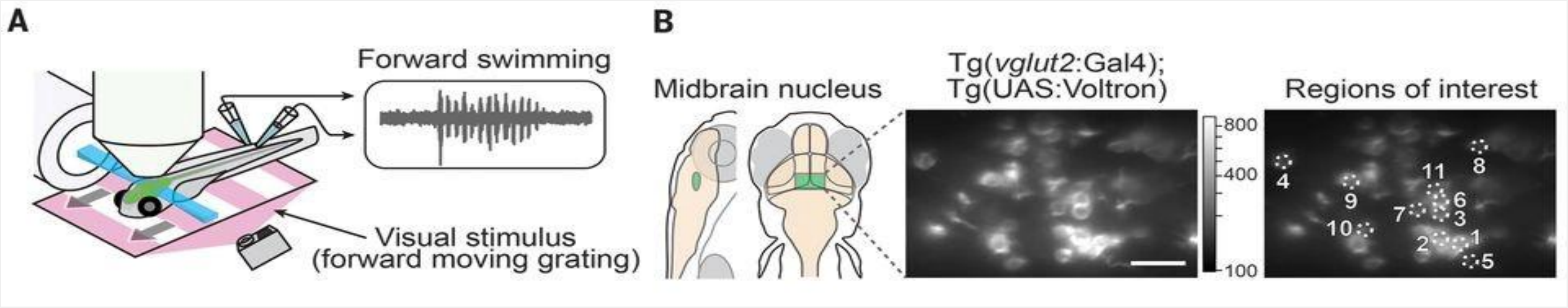
Computational Methods to Achieve Real-Time Whole Brain Imaging in Behaving Animals

Computational methods pave the way towards smart and active microscopy

Behaviour is influenced by environmental cues

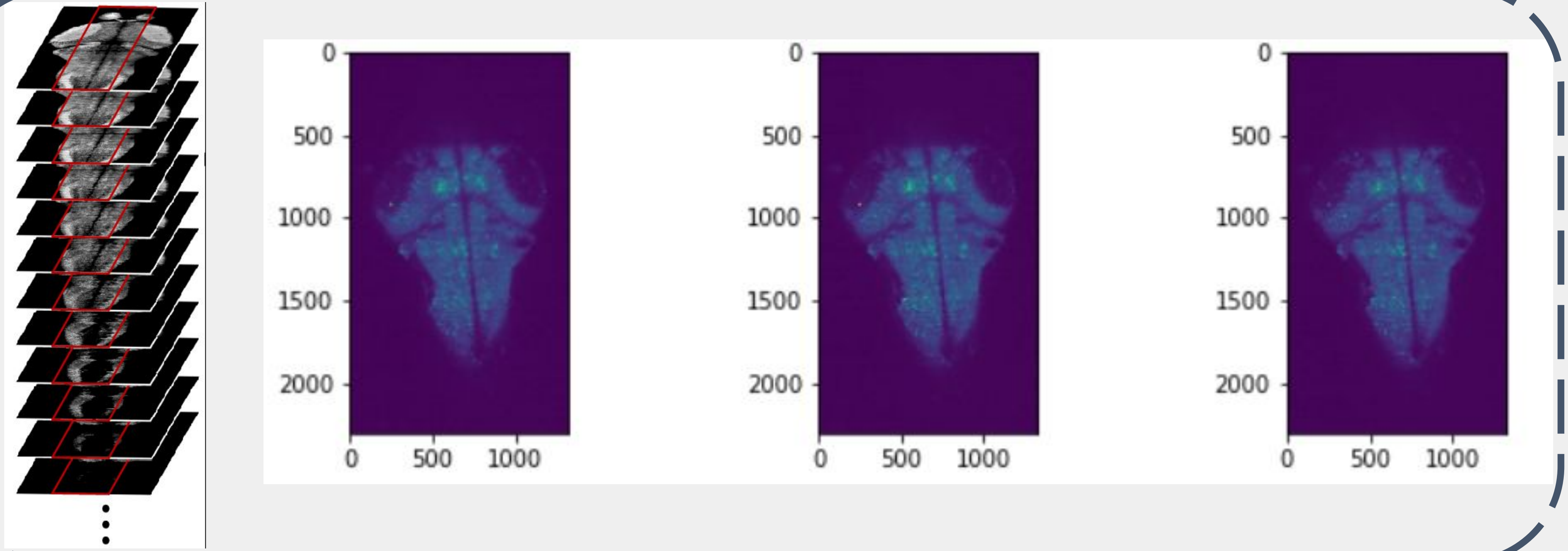


Spiking activity recorded with voltage imaging



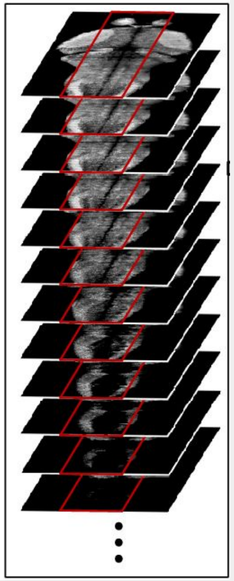
- Recently, Abelfattah et al[1] have succeeded in recording spiking activity of neurons in zebrafish with voltage imaging.
- We want to extend this to a brain-wide scale

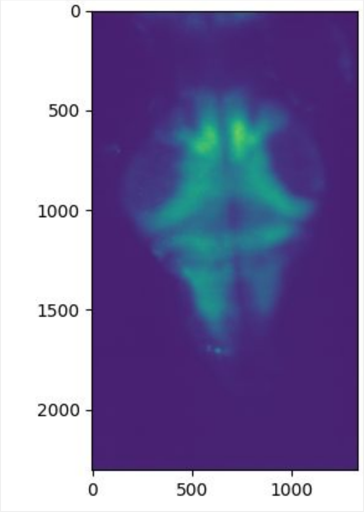
Data is a z-stack



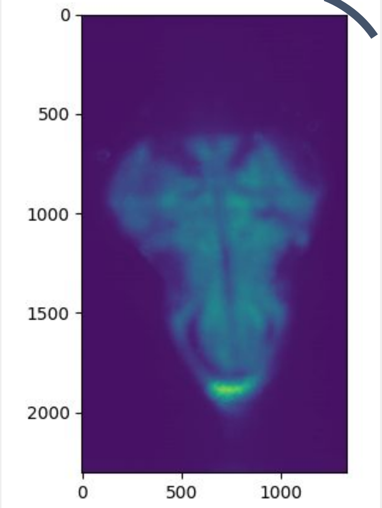
Z-stack images: each stack has 45 images. E.g: best focused images

Define an objective focus measure





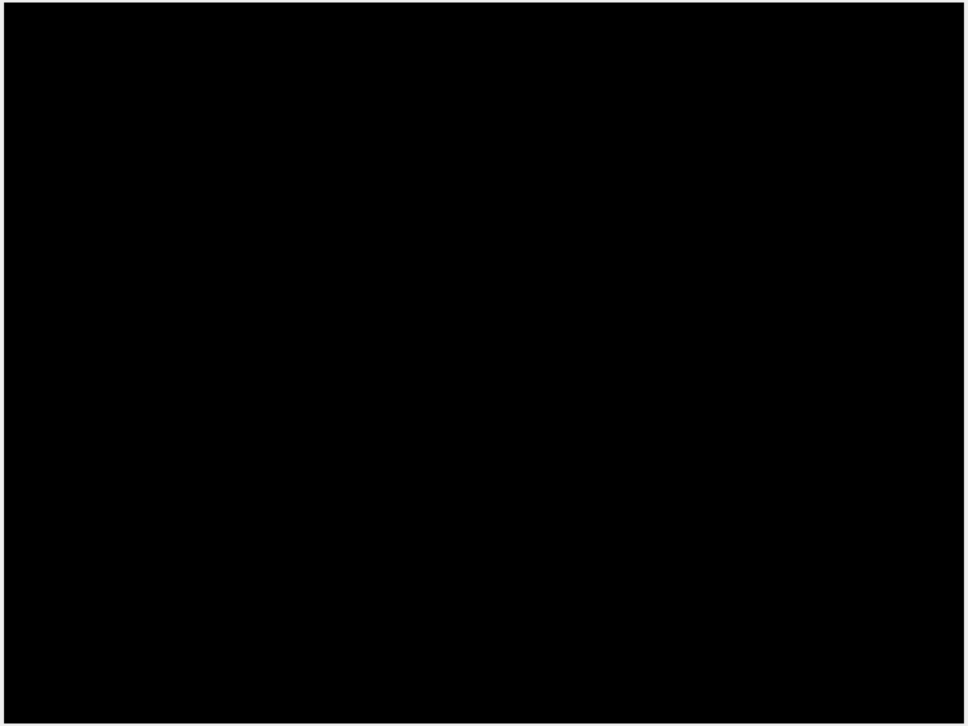
score: 0.65



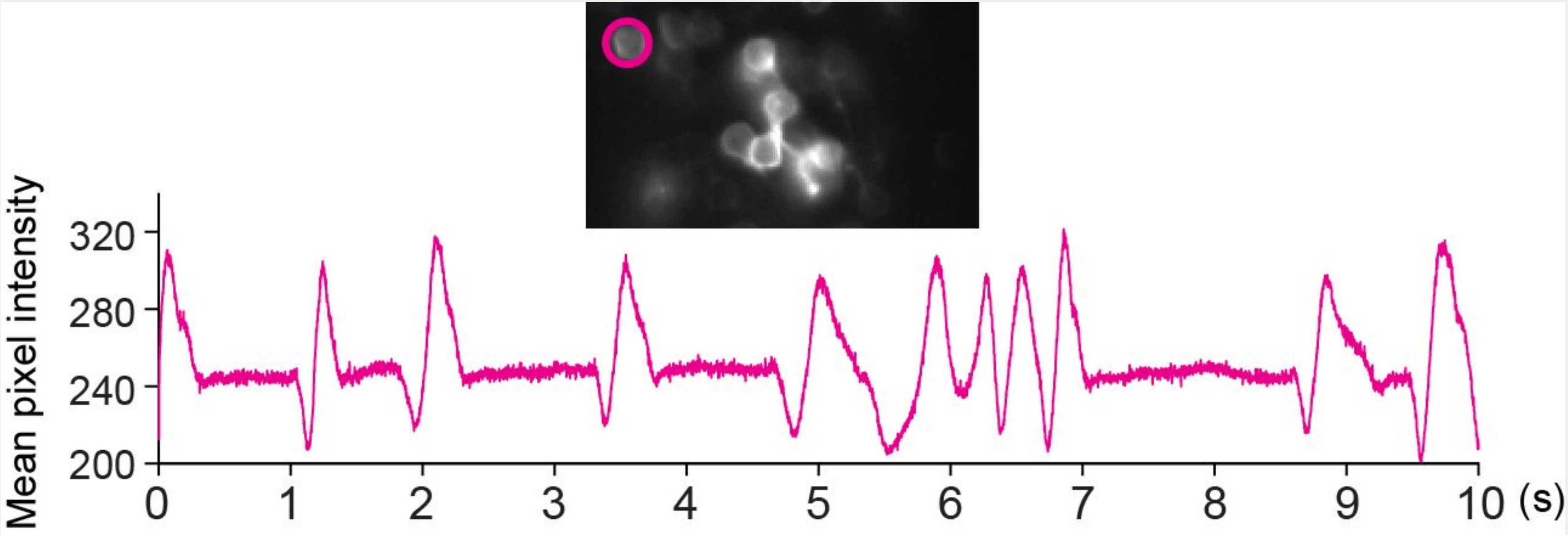
score: 0.68

- Faster image acquisition
- High quality image acquisition

Blood-flow artifact correction I



Blood-flow artifact correction II



- Time-series data

Blood-flow artifact correction III

Blood-flow artifacts

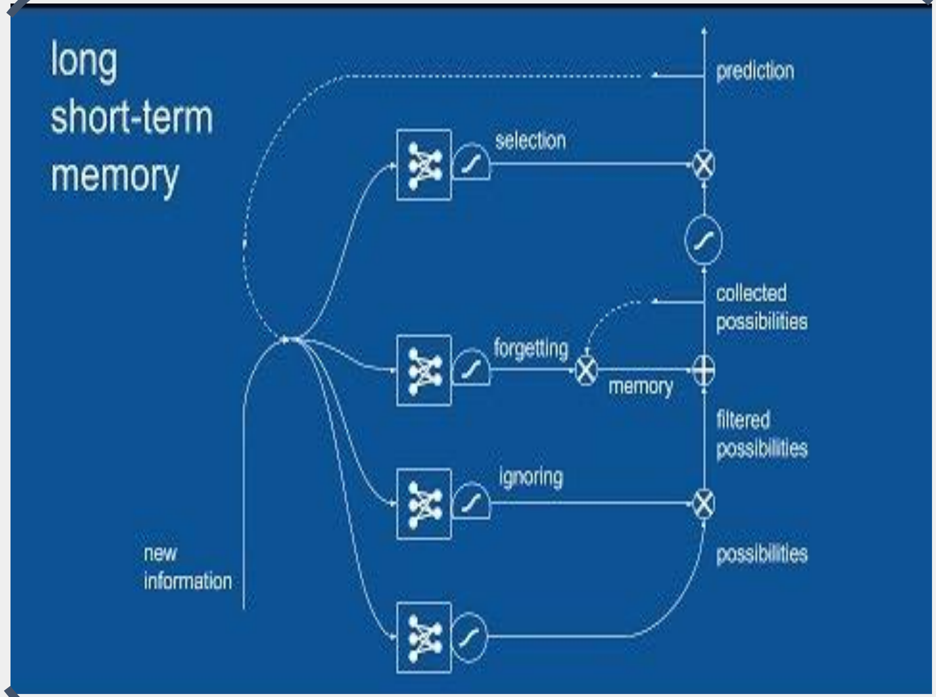


Image from [2]

Take home message

1. ML models are data driven
2. Supervised Learning has both inputs and annotations
3. Understanding data is key
4. Visualising always helps
5. There are different types of (image) data
6. You do not always need to use ML models
7. Simpler the model, the better

References

1) Abdelfattah*, Kawashima* et al., (2020). Bright and photostable chemigenetic indicators for extended in vivo voltage imaging. Science, 365 (6454). * co-first author.

2) Part of the End-to-End Machine Learning School Course 193, How Neural Networks Work at https://e2eml.school/193

3) Mahmoudzadeh, Amir Pasha, and Nasser H. Kashou. "Evaluation of interpolation effects on upsampling and accuracy of cost functions-based optimized automatic image registration." International Journal of Biomedical Imaging 2013 (2013).