Automatic Mitochondrial Event Localisation using Deep Learning

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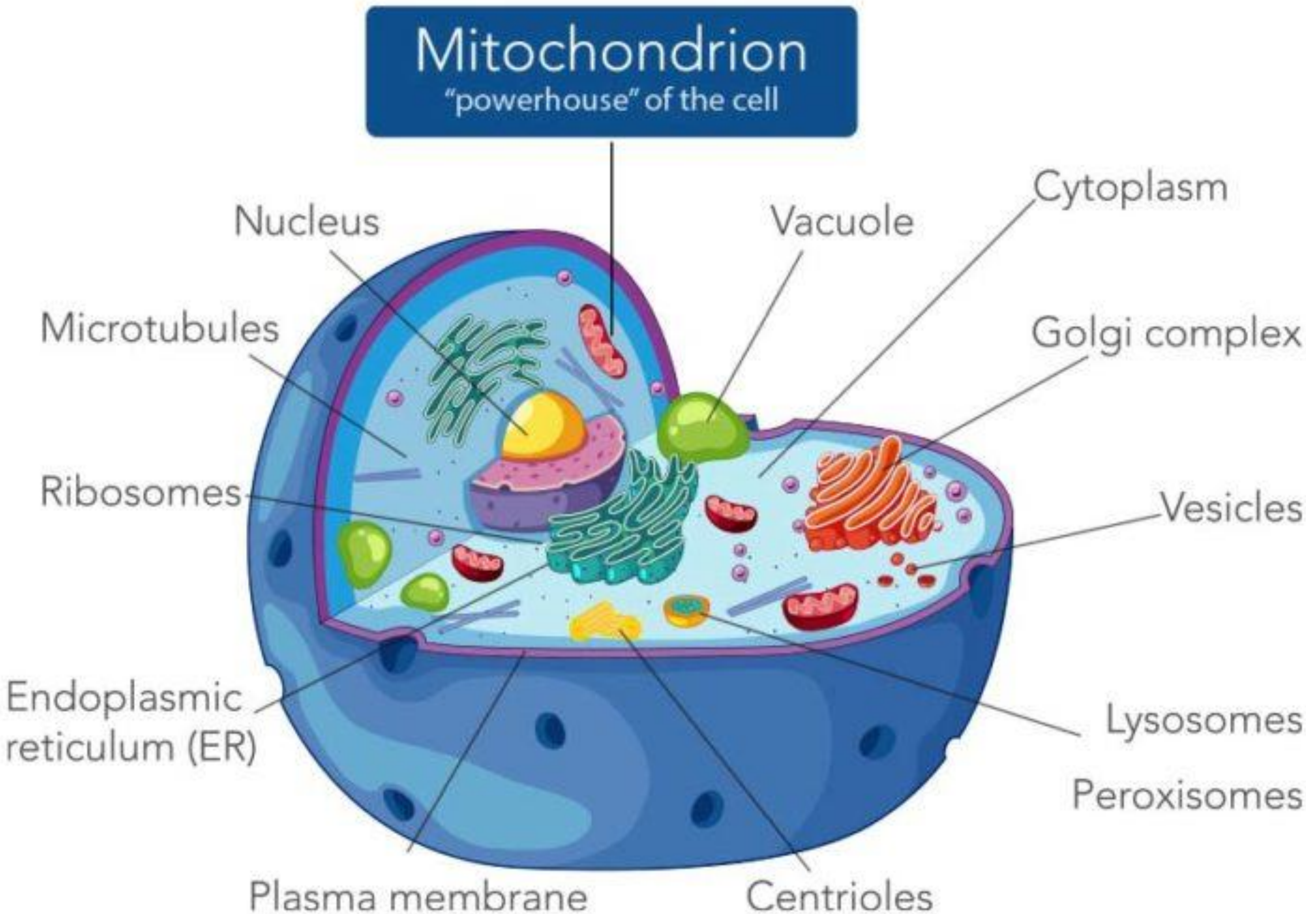
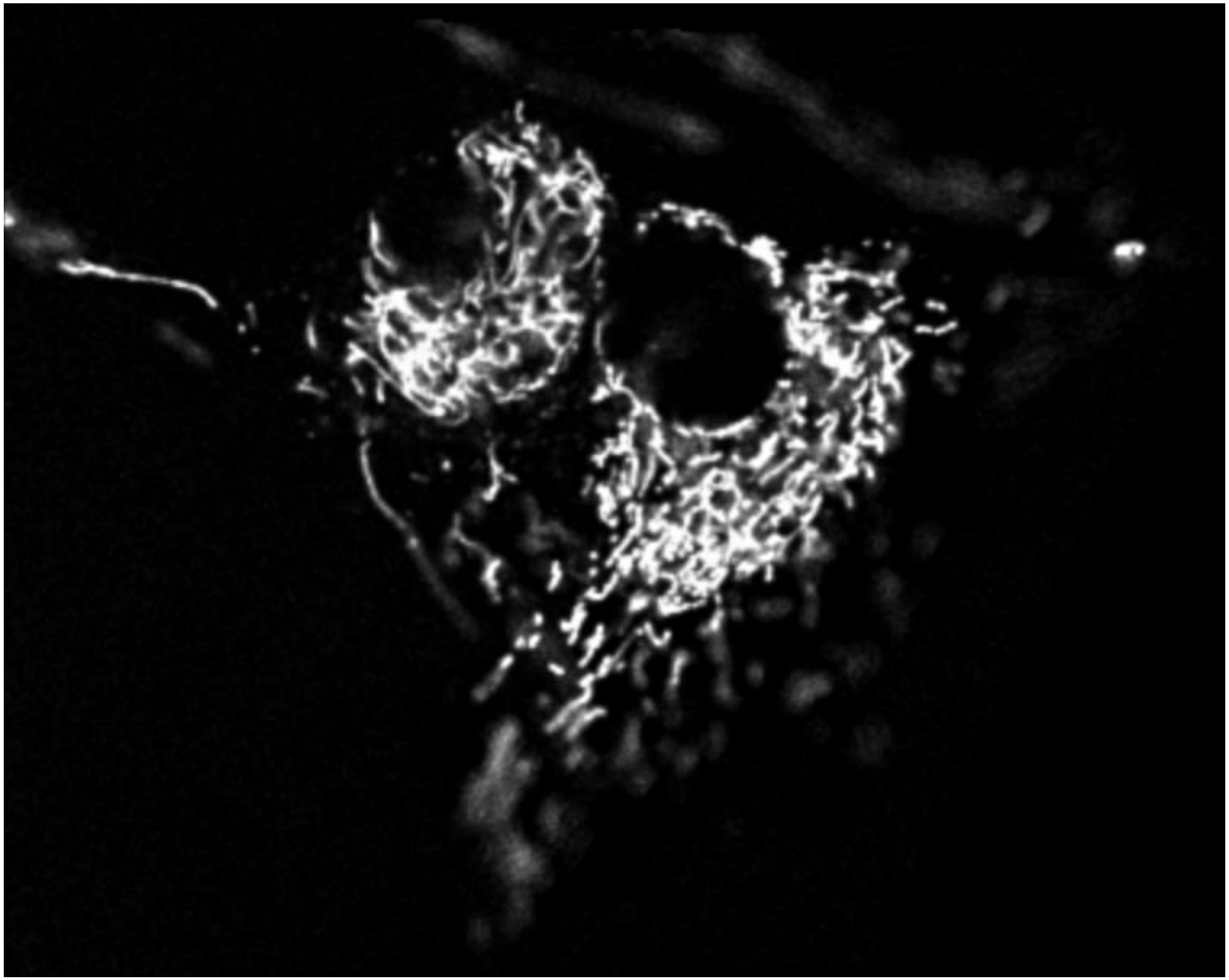
forward together · saam vorentoe · masiye phambili

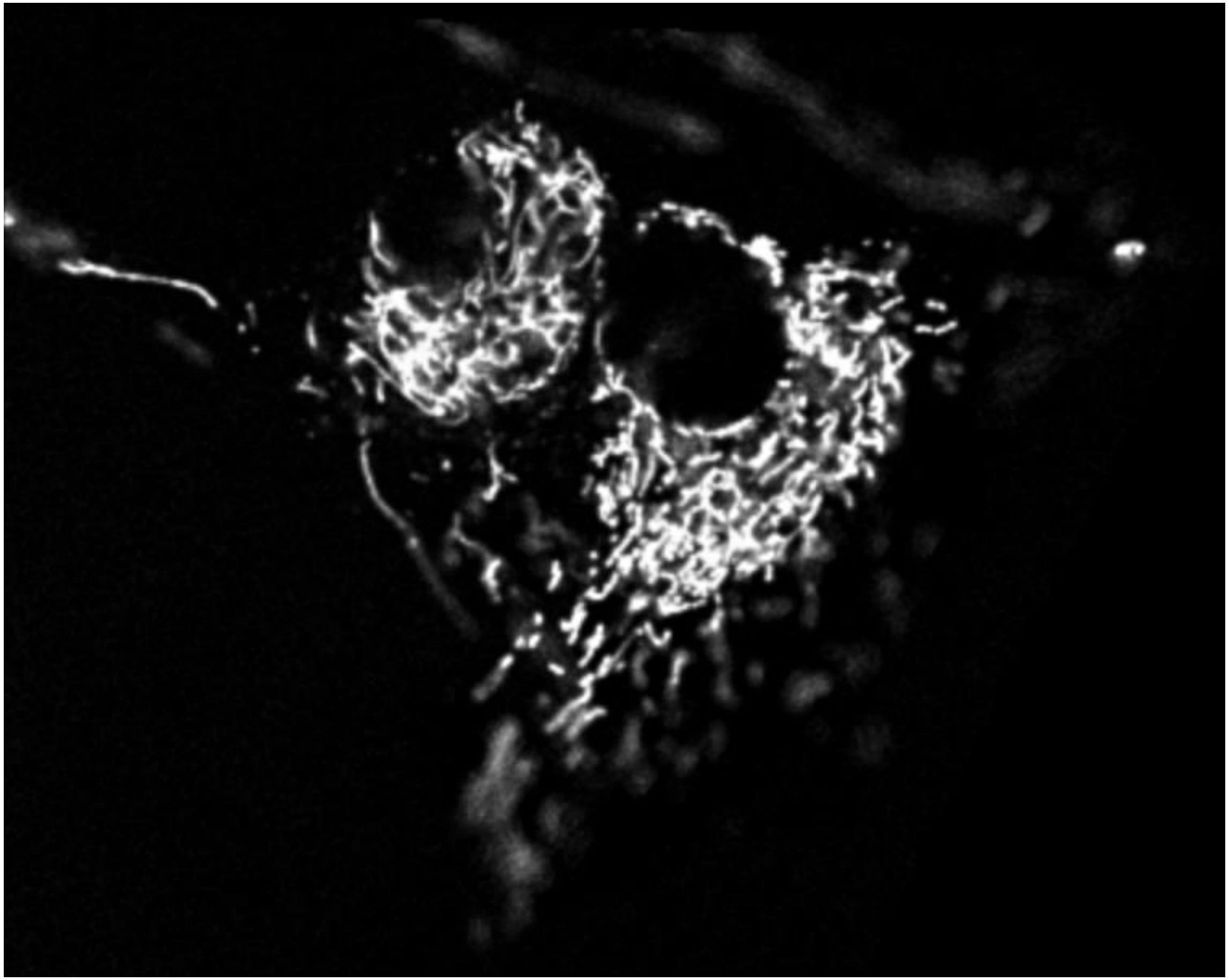
Mitochondria



Real mitochondria



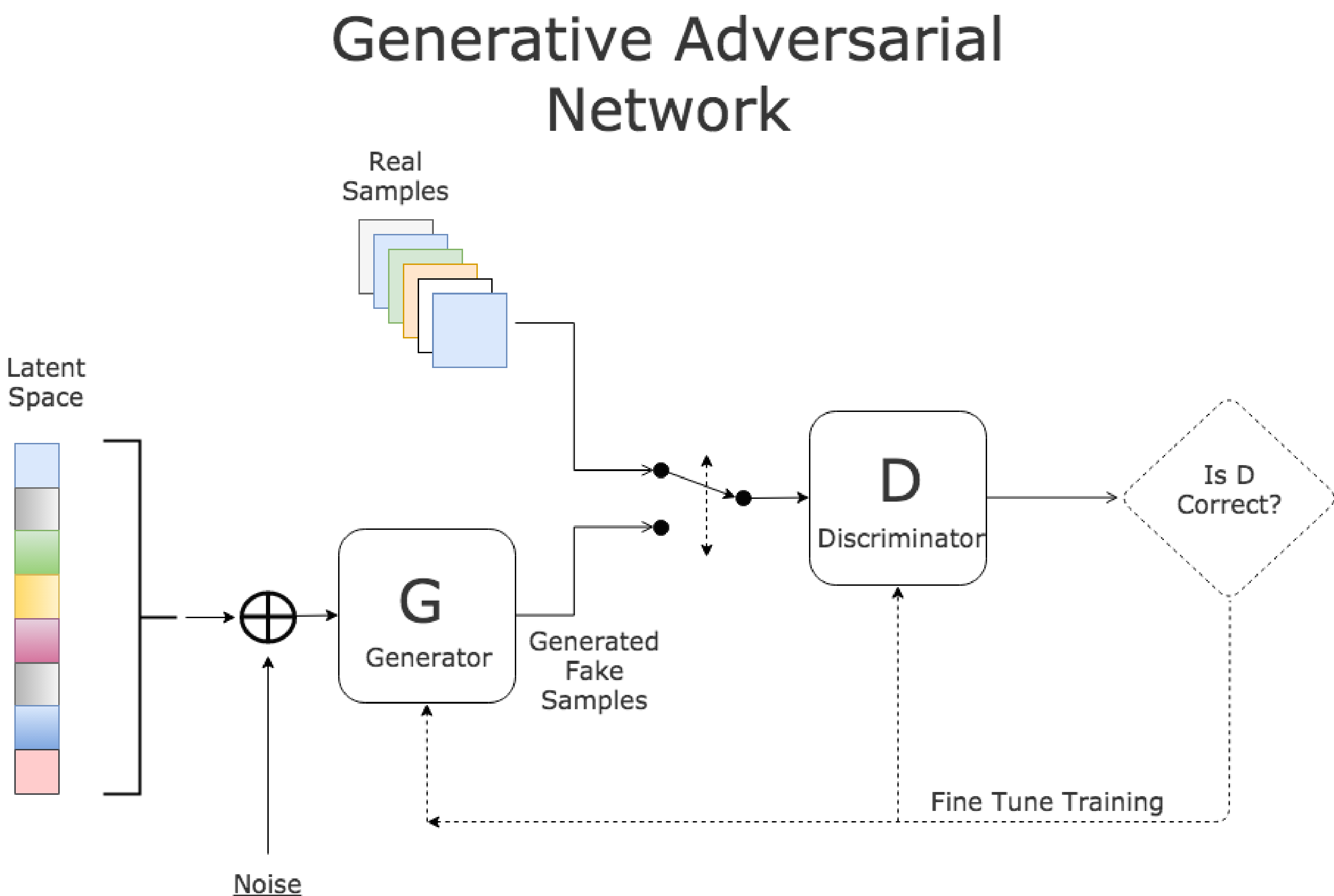
What we want to achieve



Why?

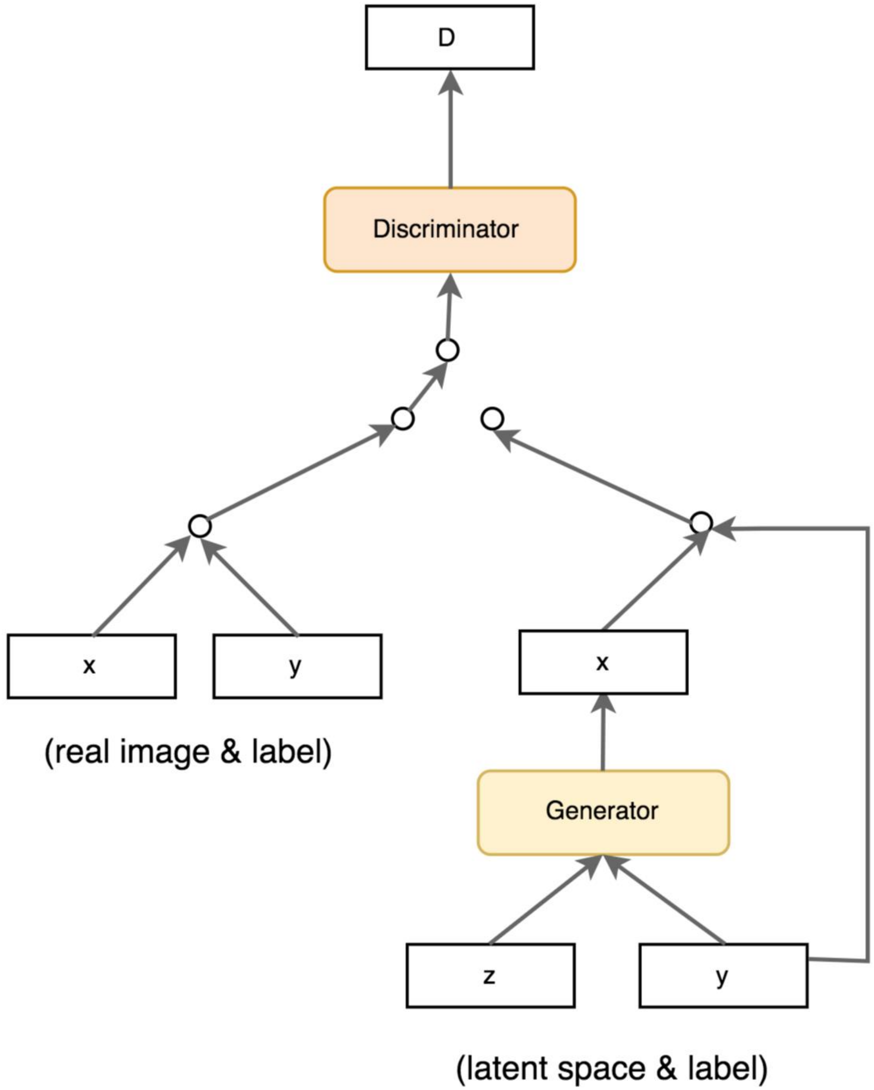
- Mitochondrial disorders are often presented as neurological disorders such as Alzheimer’s disease.
- Fission/fusion events play a critical role in maintaining functional mitochondria when cells experience metabolic or environmental stresses.
- Having a system that can automatically predict the **number of mitochondrial events** as well as their **location** will help researchers gain insights mitochondrial function which in turn could lead to improved treatment of neurological disorders.

Generative adversarial network



https://www.kdnuggets.com/2017/01/generative-adversarial-networks-hot-topic-machine-learning.html

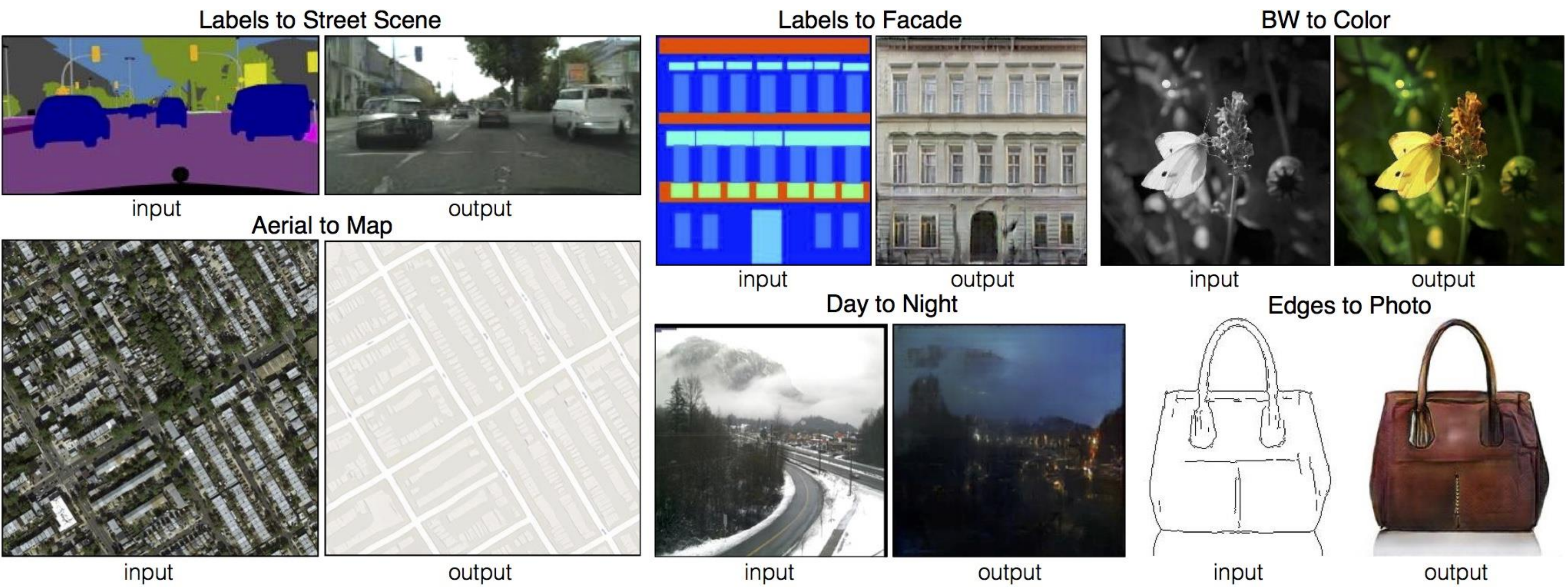
Conditional GAN



https://medium.com/@jonathan_hui/gan-cgan-infogan-using-labels-to-improve-gan-8ba4de5f9c3d

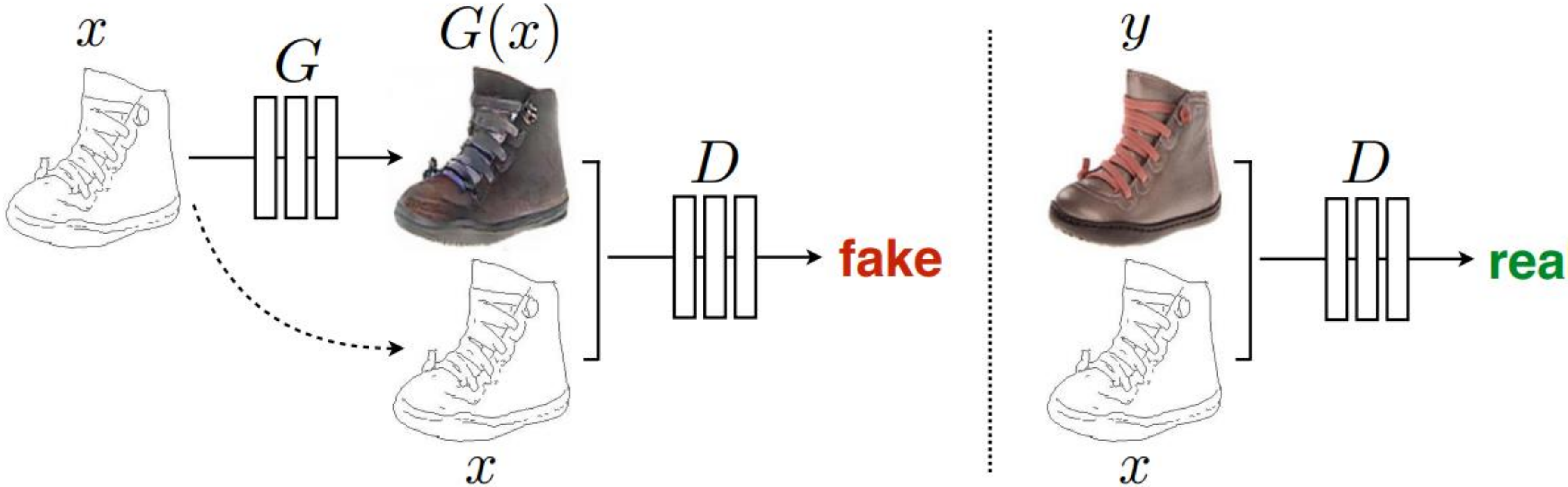
Image to image translation

- Uses conditional adversarial networks



https://github.com/phillipi/pix2pix

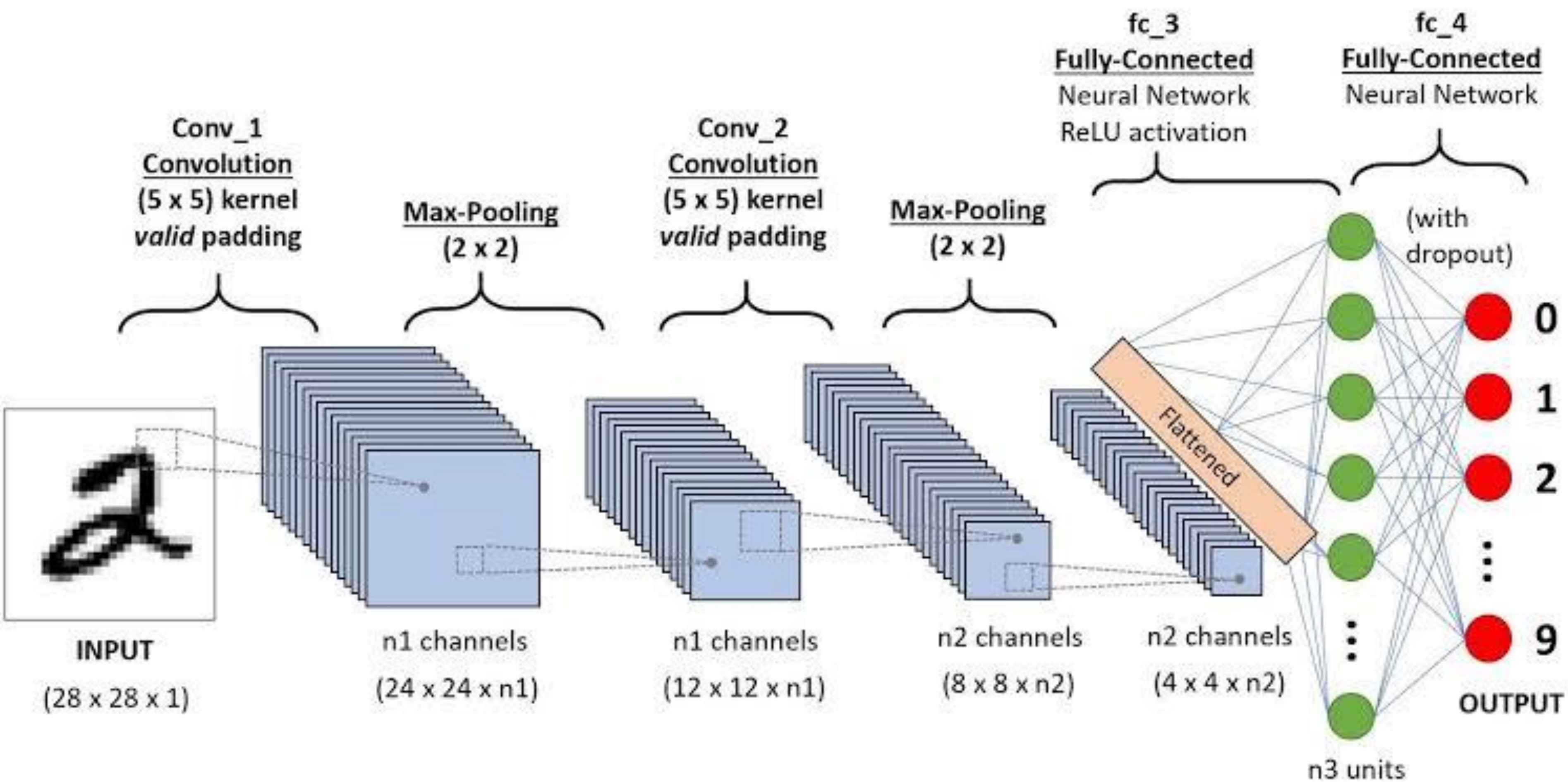
https://affinelayer.com/pixsrv/



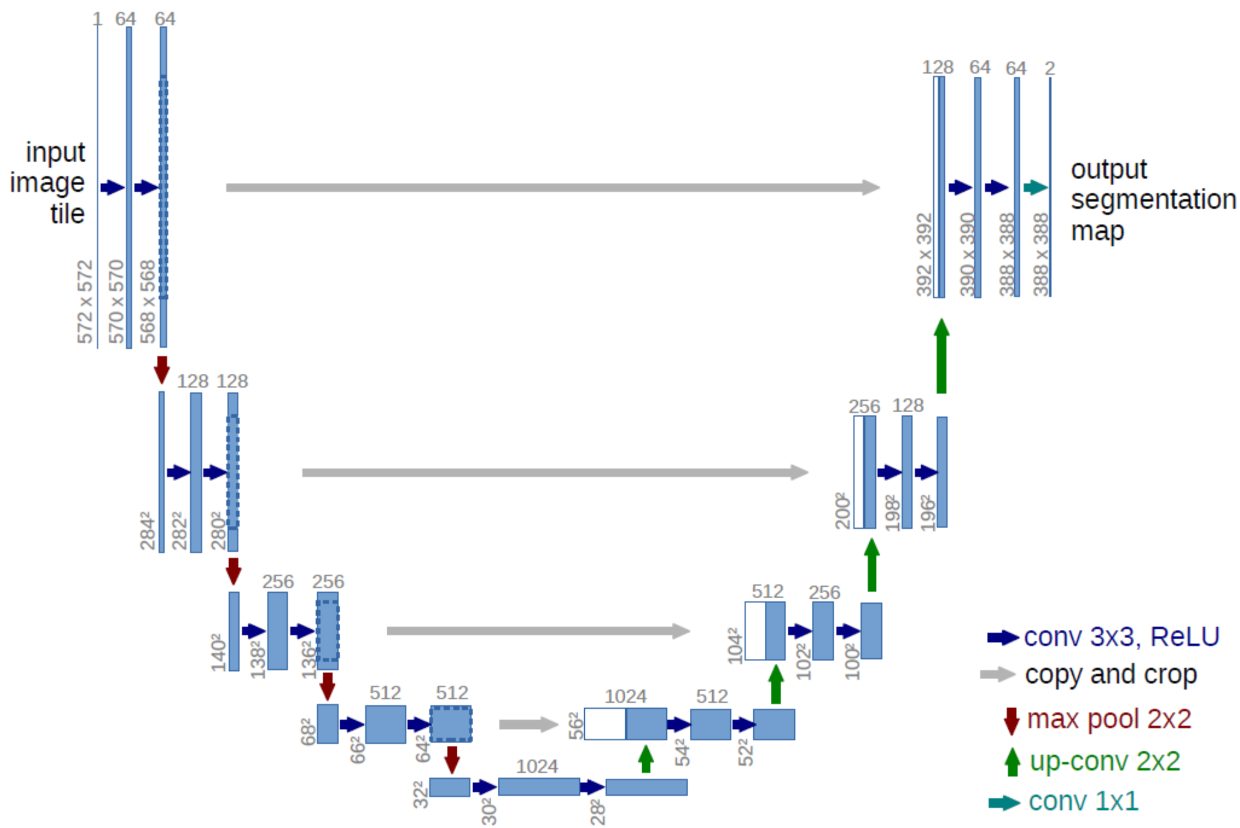
x
G
$G(x)$
D
fake
x
y
D
real
x

Example of CNN usage

- Image classification

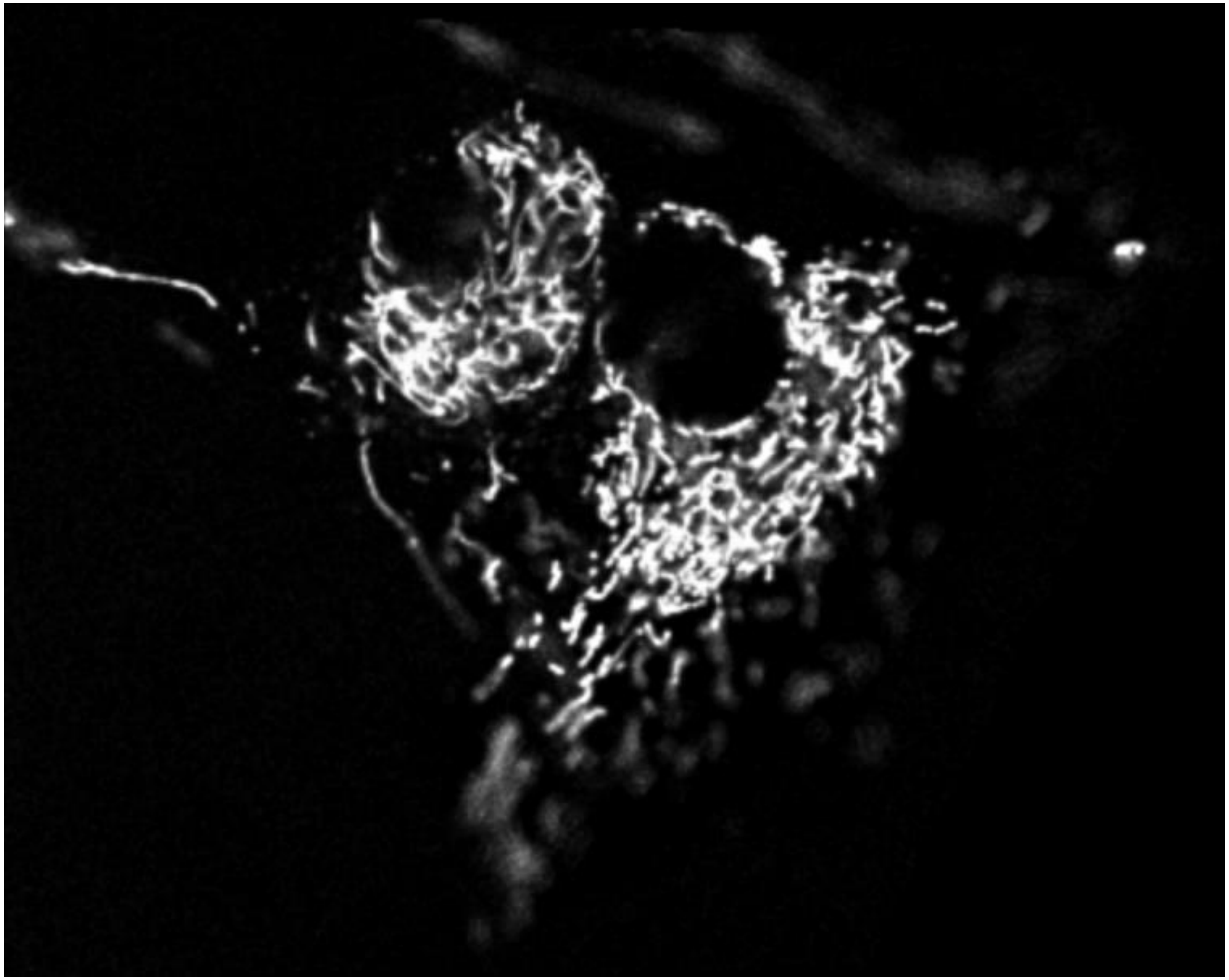


U-Net



https://arxiv.org/abs/1505.04597

What we want to achieve



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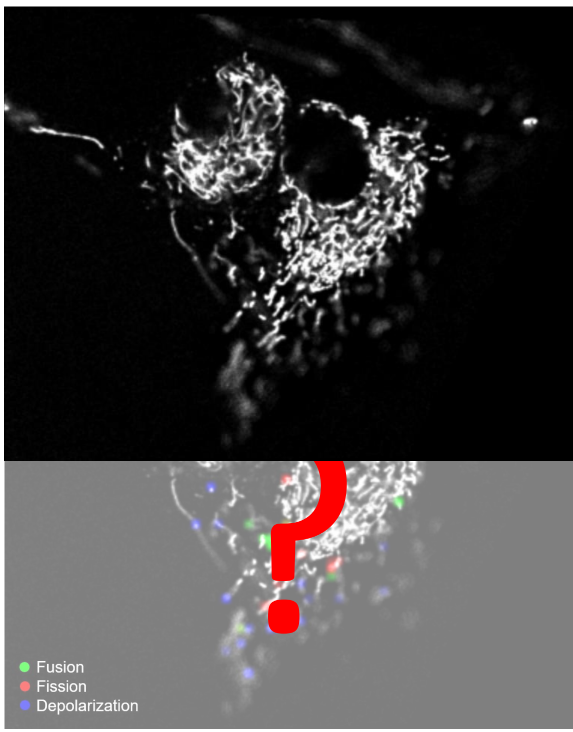
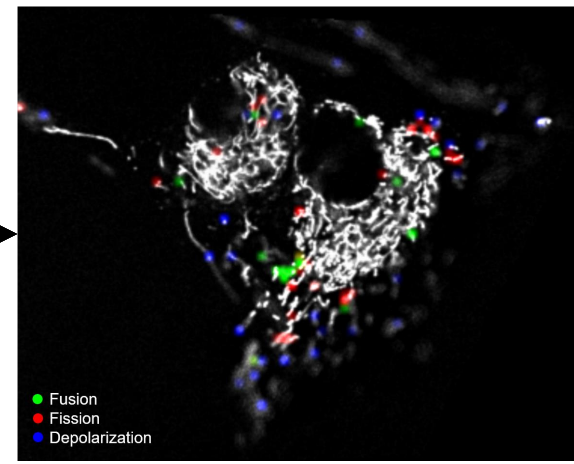


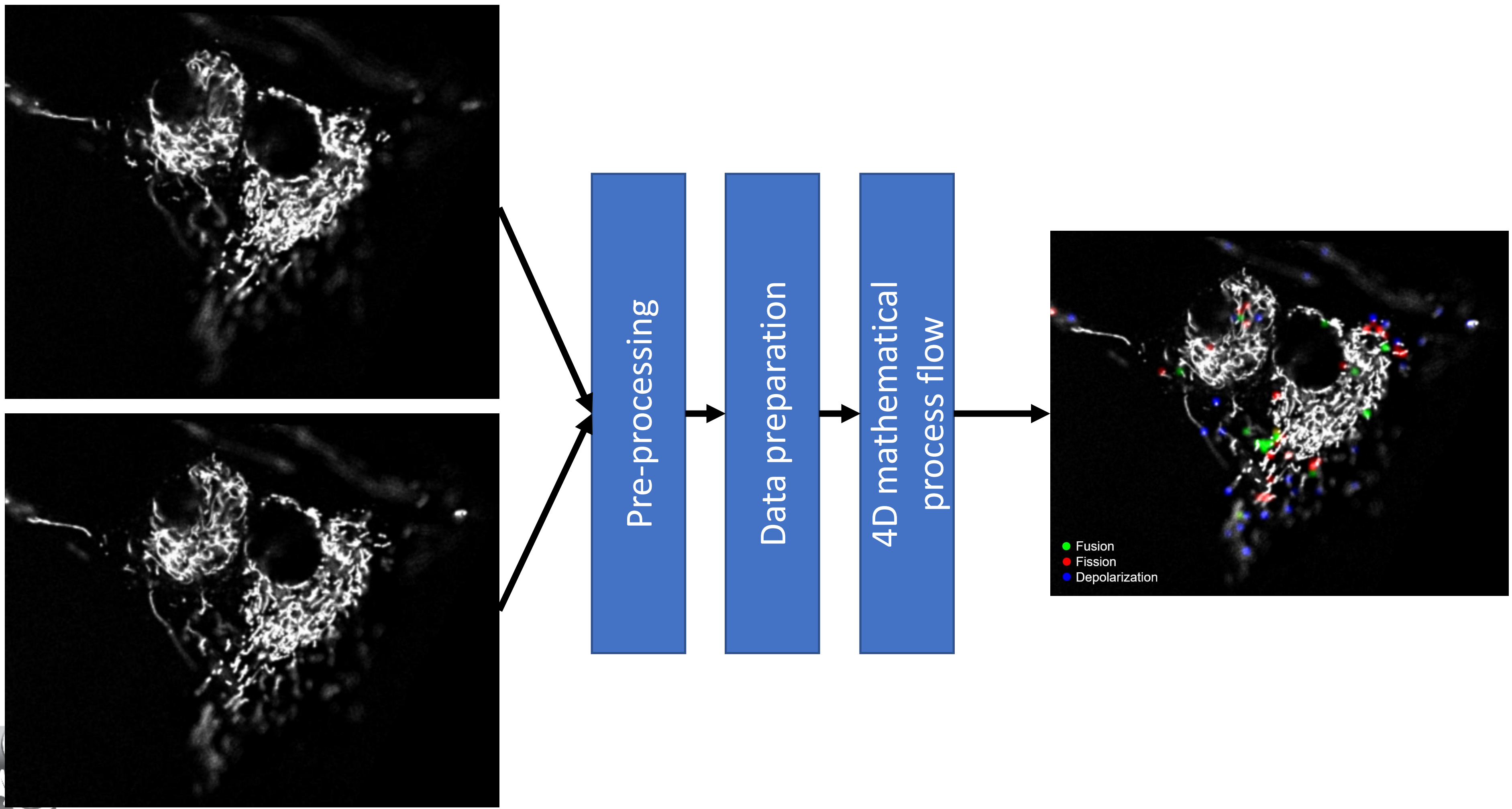


Neural net

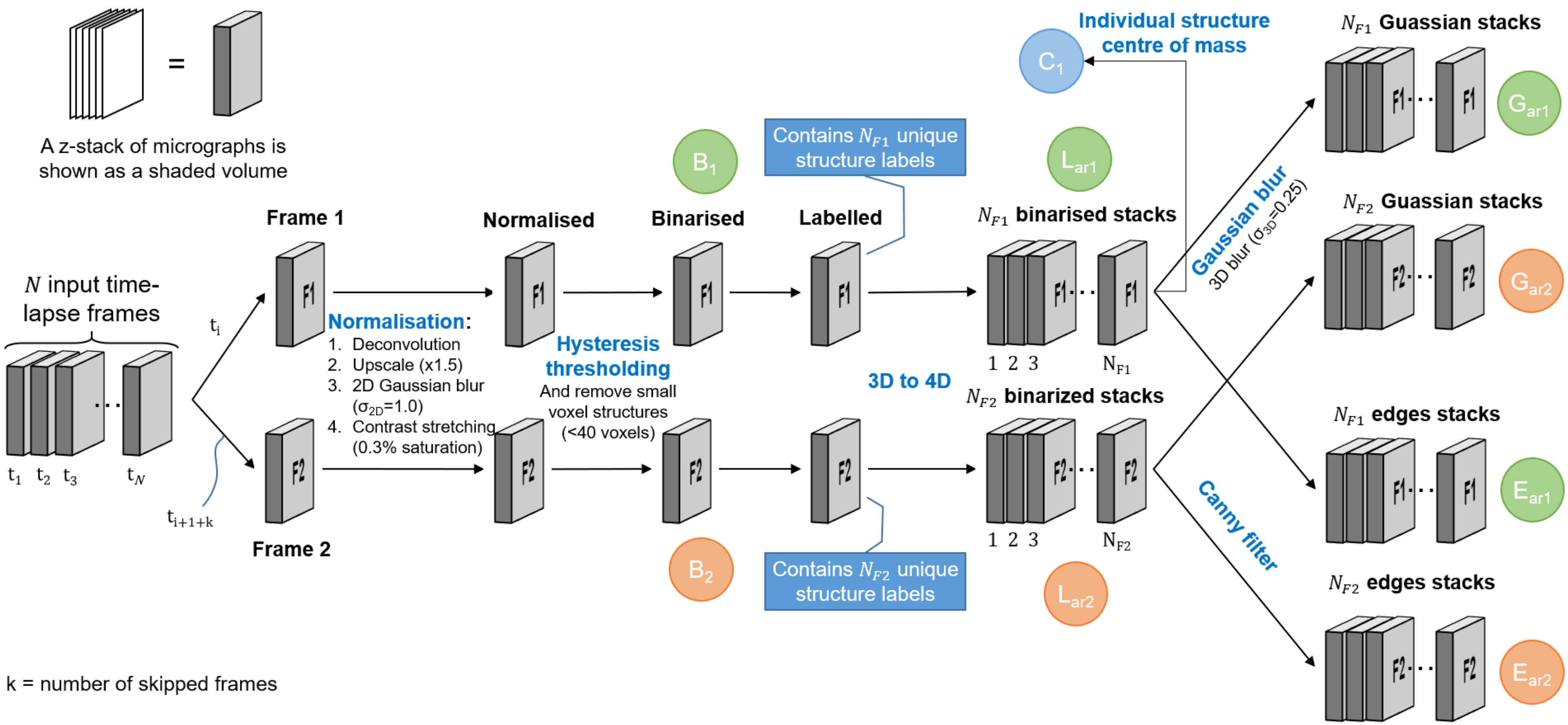
We need the ground truth! But we can't generate it by hand...

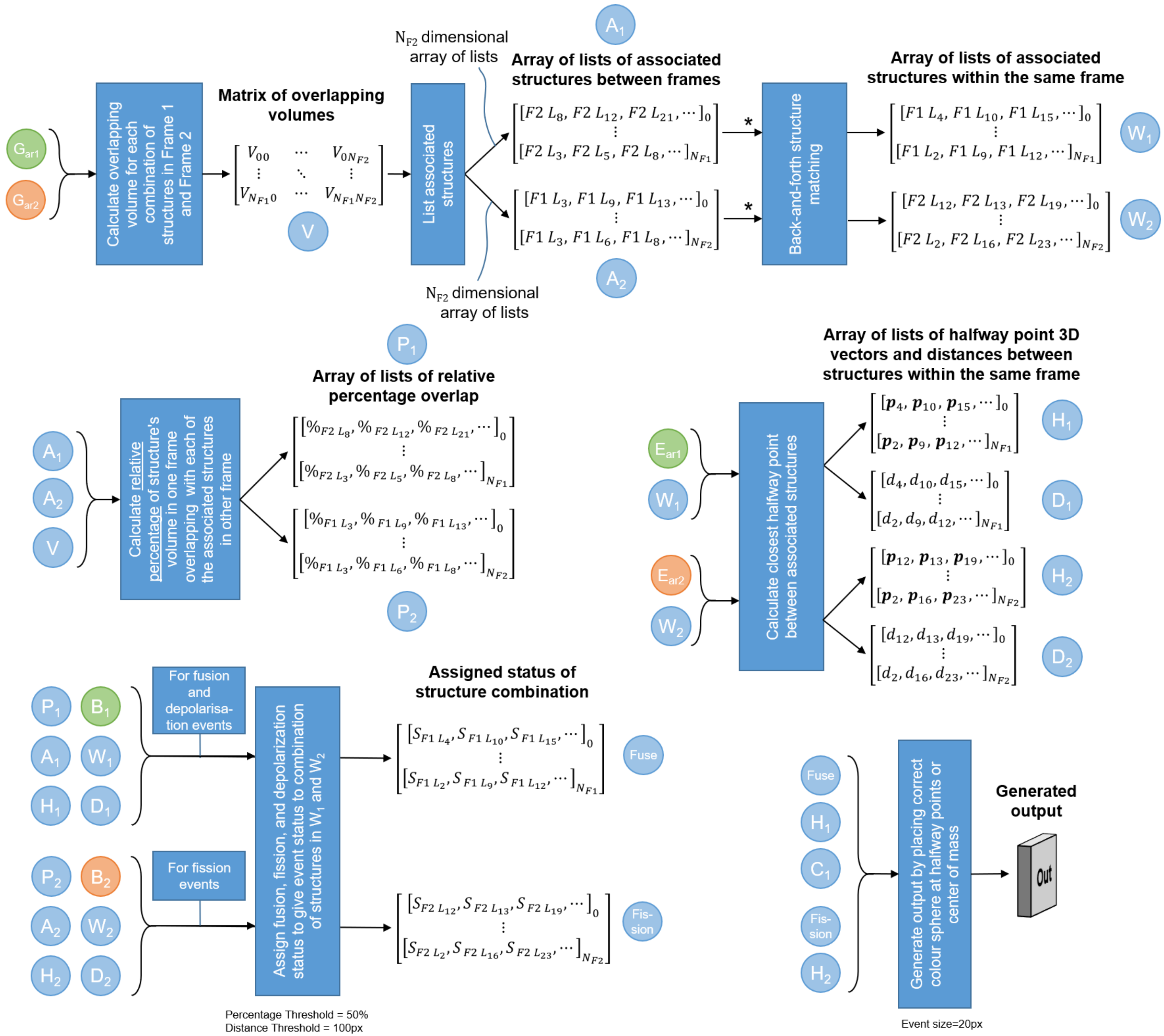
We need ground truth

- Use time-lapse sequence to generate ground truth

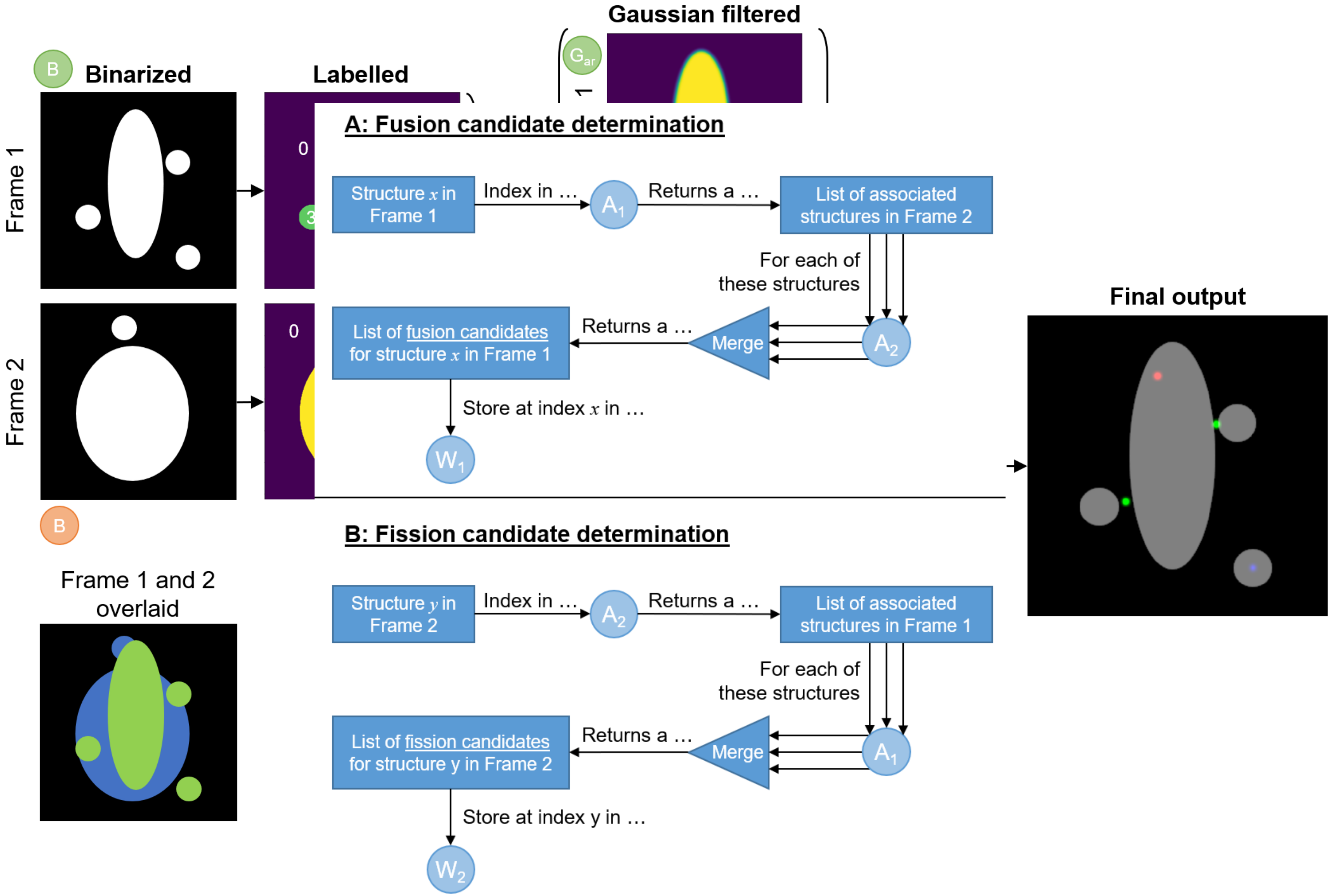


Mitochondrial event localiser



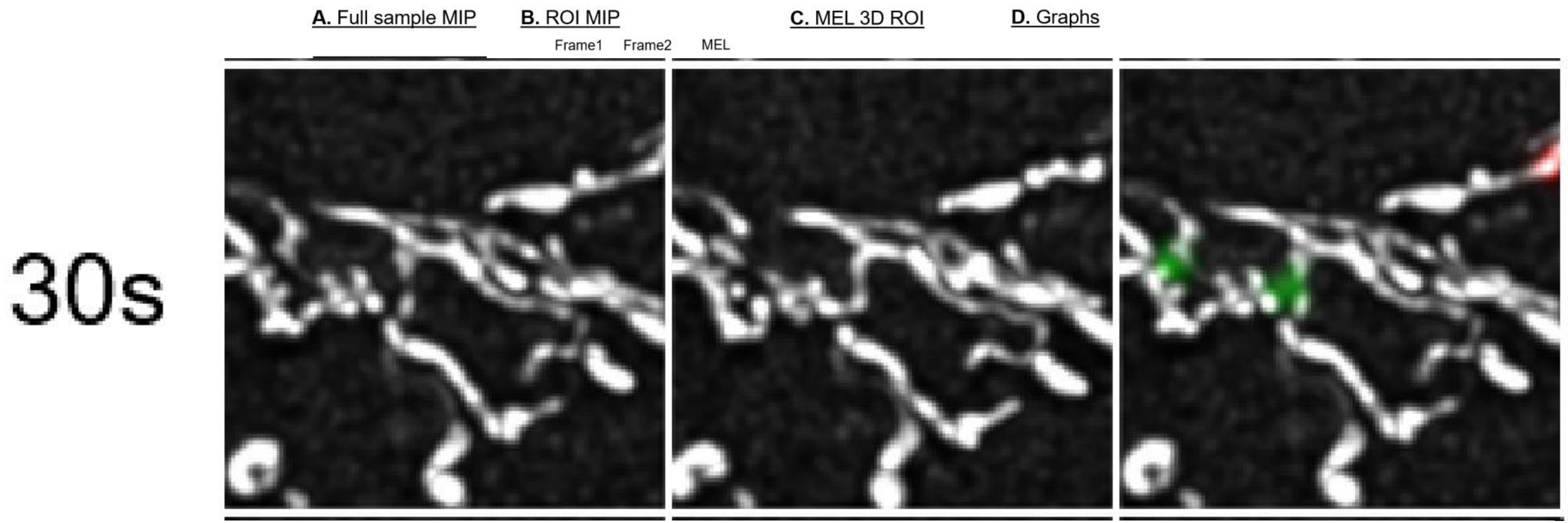


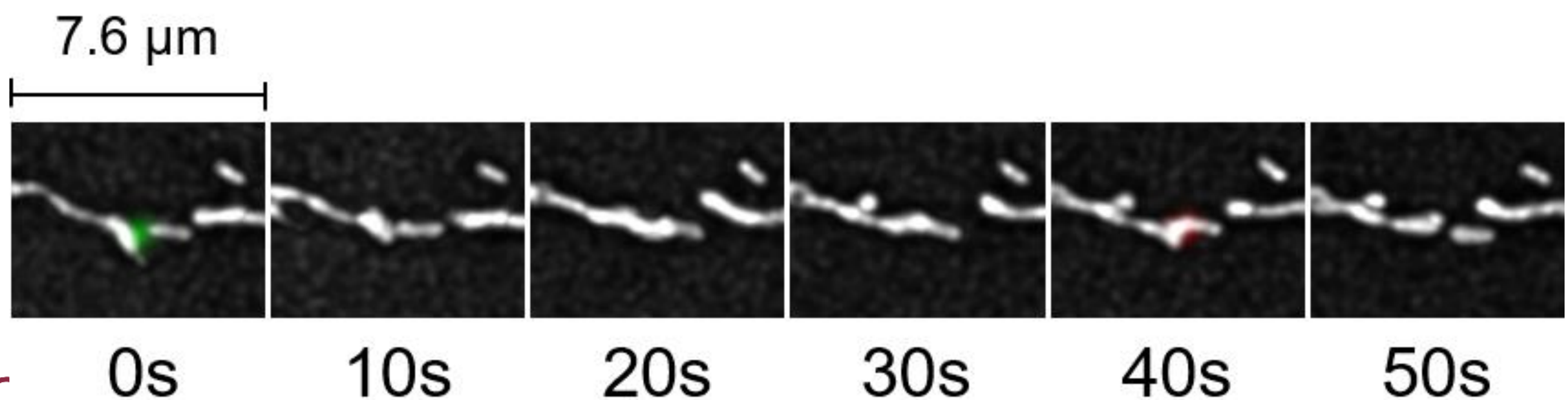
*If two arrows pass into a box, the function is called twice



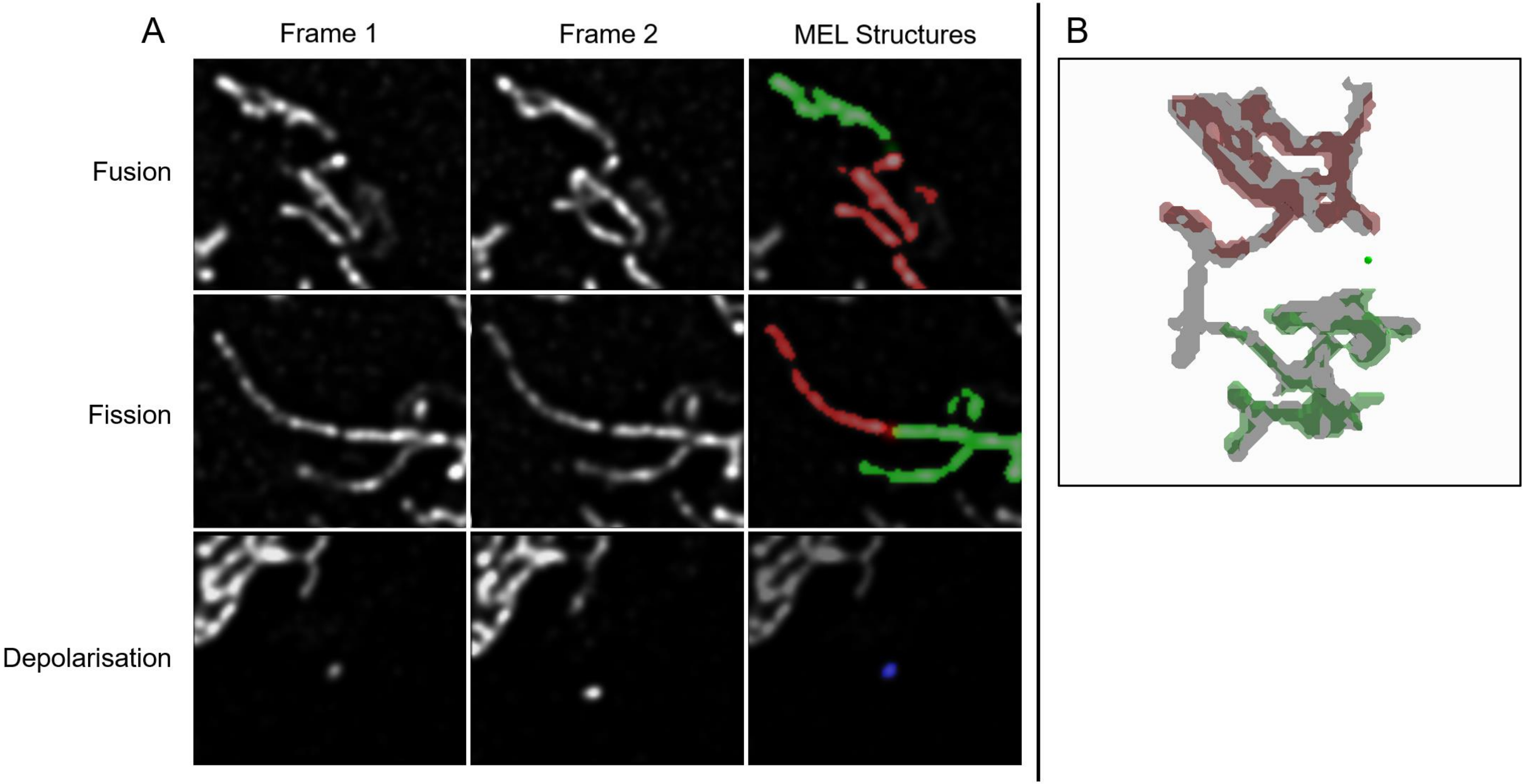
Gaussian filtered
Binarized
Labelled
Frame 1
Frame 2
Frame 1 and 2 overlaid
A: Fusion candidate determination
Structure x in Frame 1
Index in …
A_1
Returns a …
List of associated structures in Frame 2
For each of these structures
A_2
Merge
Returns a …
List of fusion candidates for structure x in Frame 1
Store at index x in …
W_1
B: Fission candidate determination
Structure y in Frame 2
Index in …
A_2
Returns a …
List of associated structures in Frame 1
For each of these structures
A_1
Merge
Returns a …
List of fission candidates for structure y in Frame 2
Store at index y in …
W_2
Final output

Example output





Some issues remain



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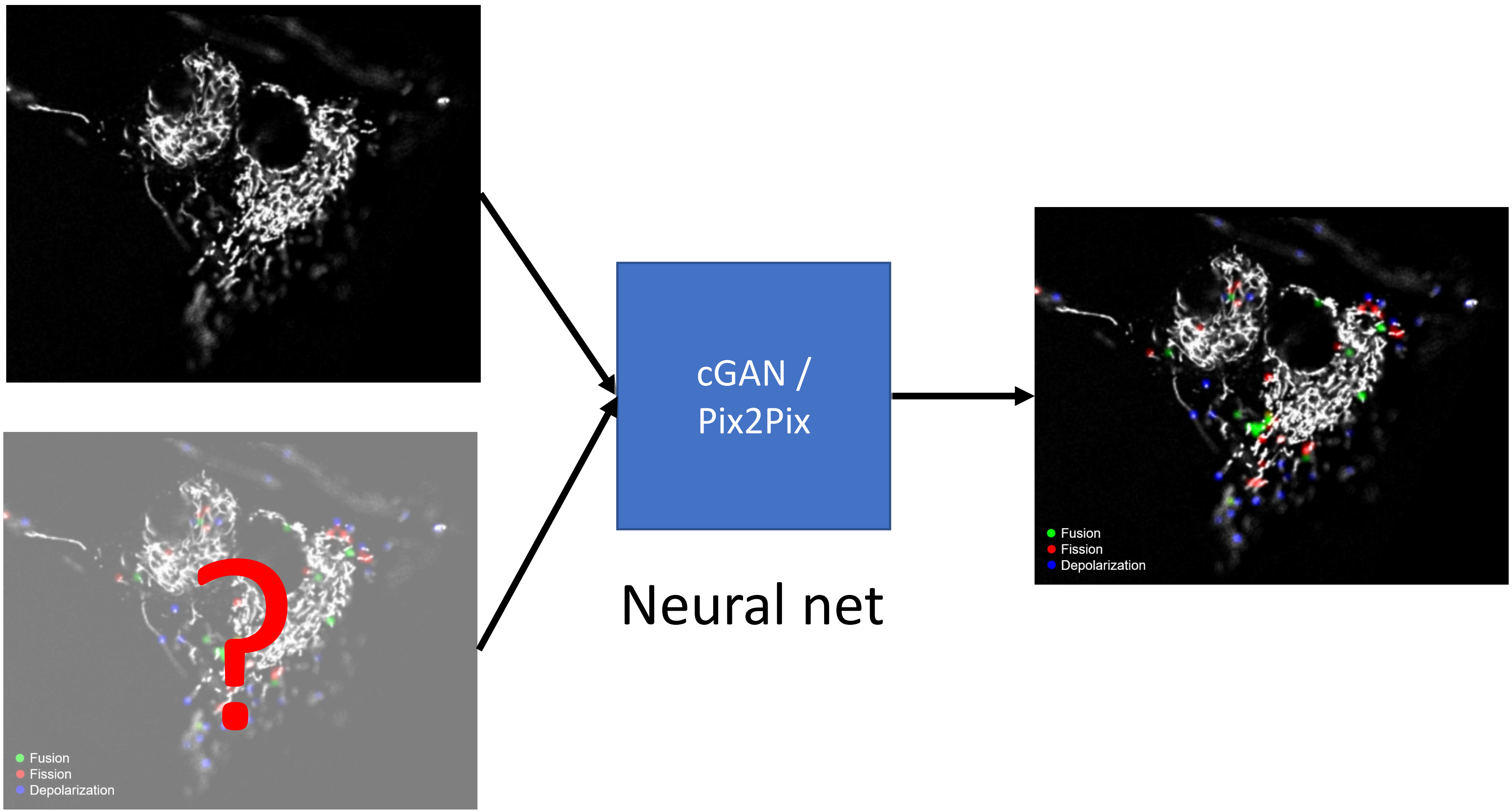
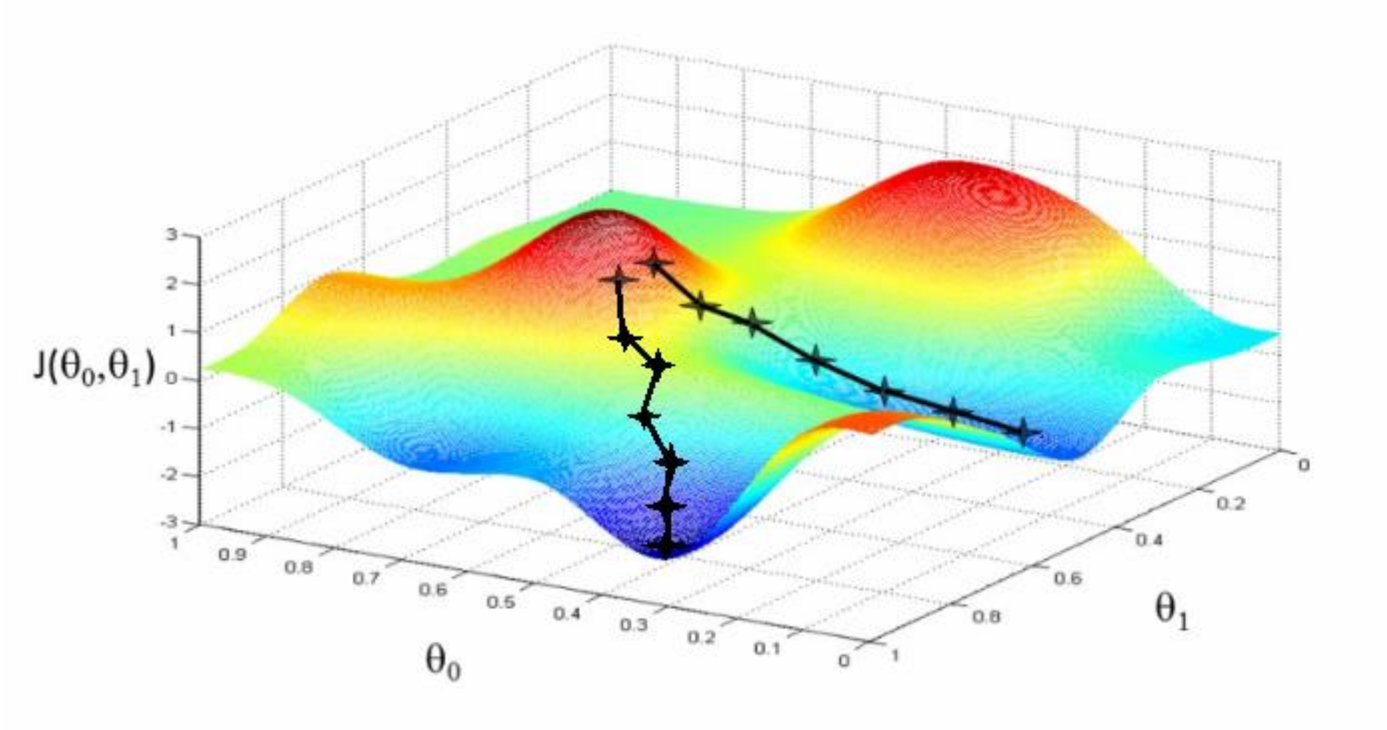
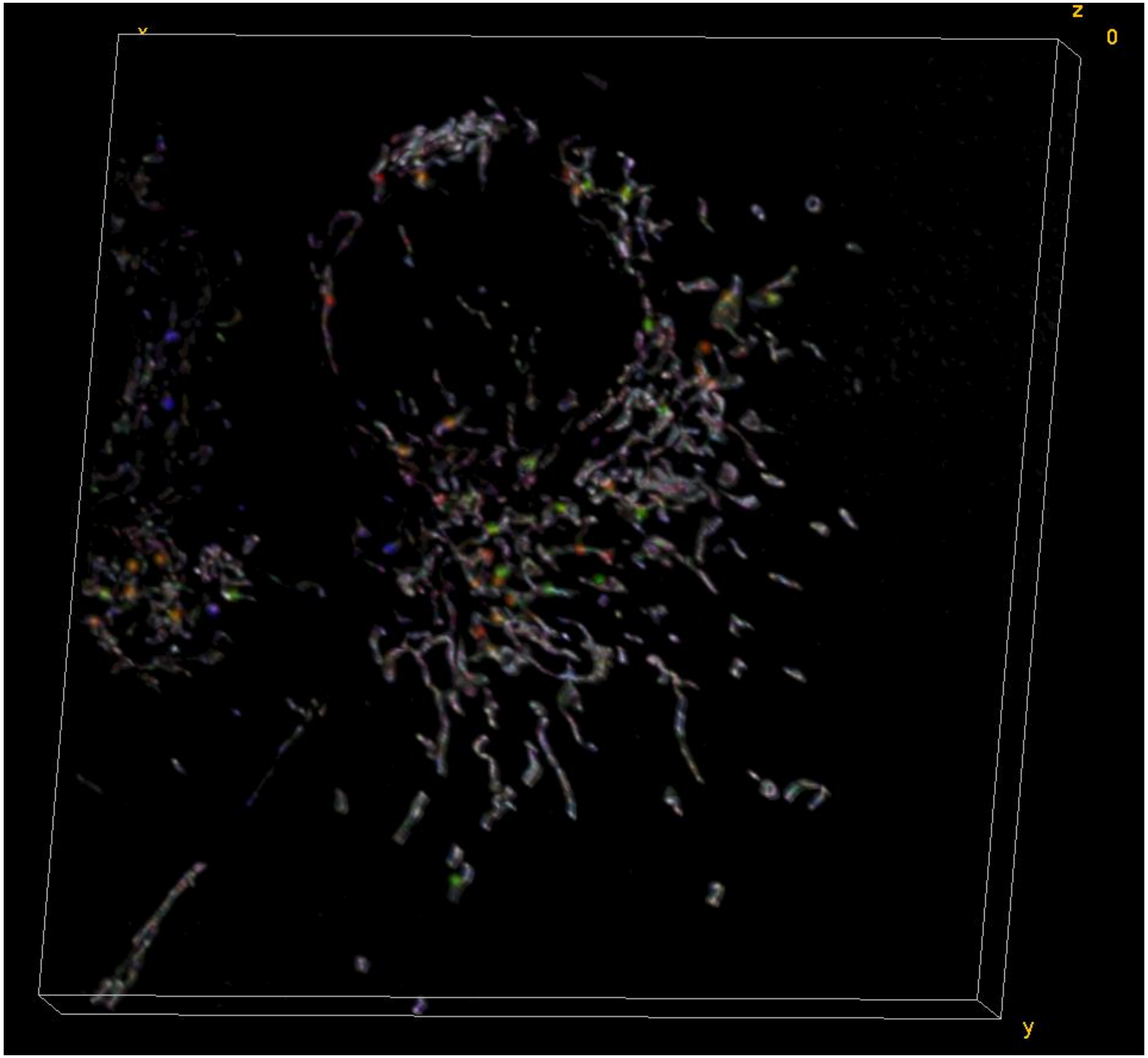


Gradient Descent

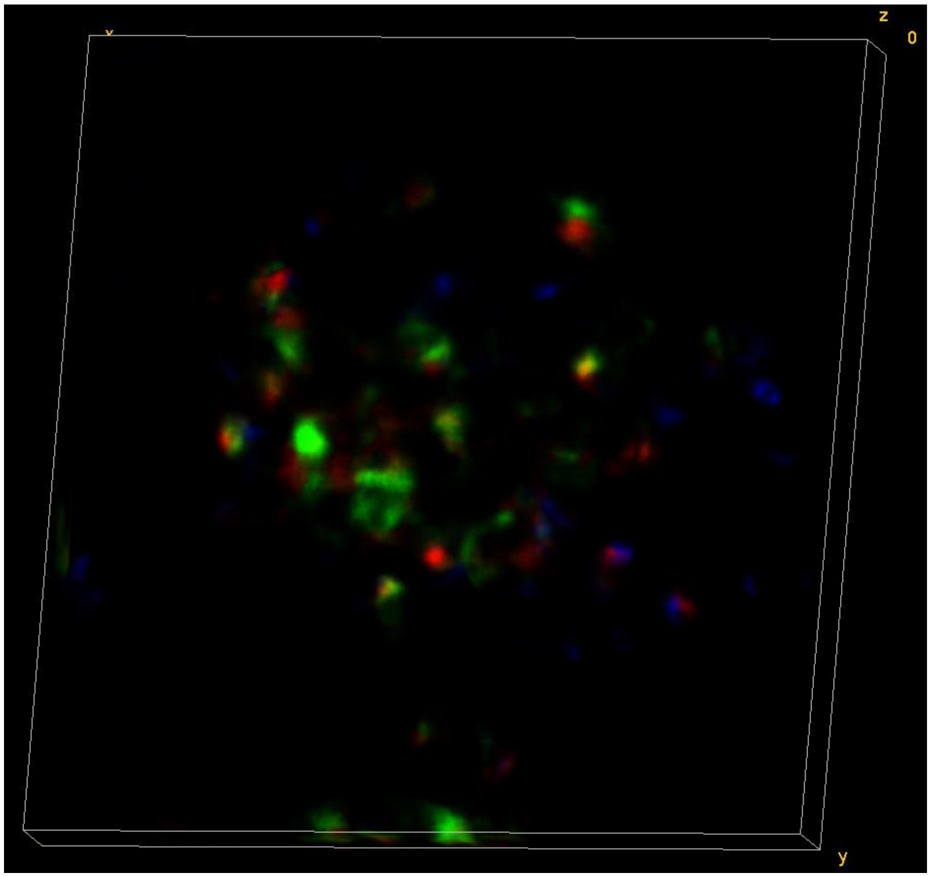
- Sometimes the objective function/loss function has more than one minima.

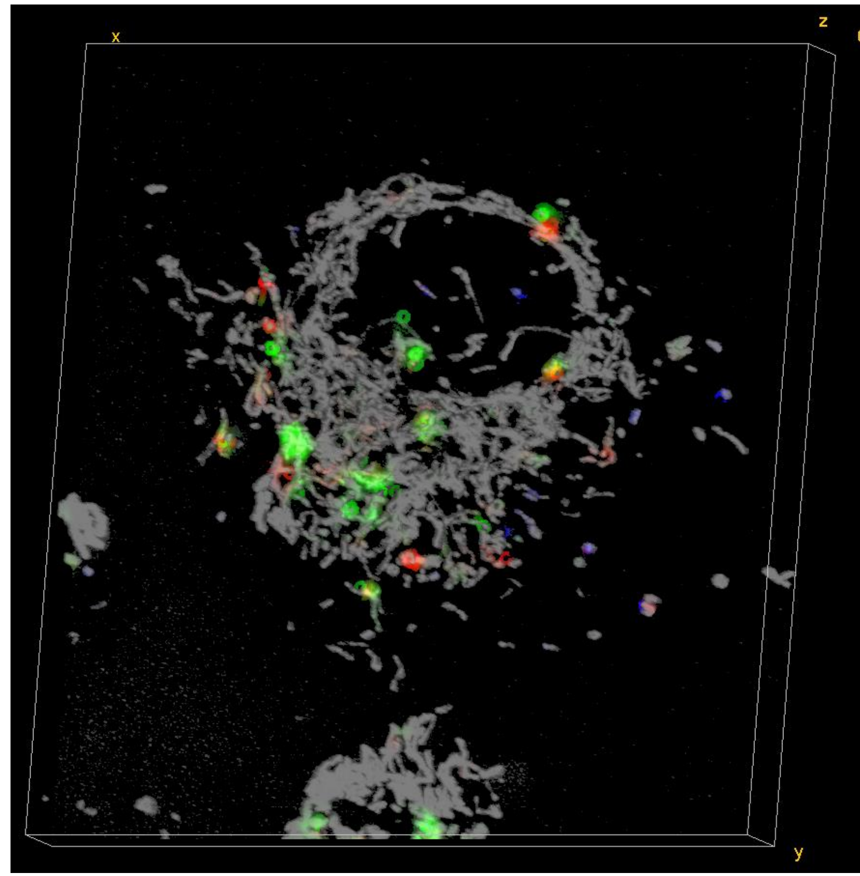


Some early results



Some early results





Thank you