A U-Net like Solution to the 2018 Data Science Bowl Challenge

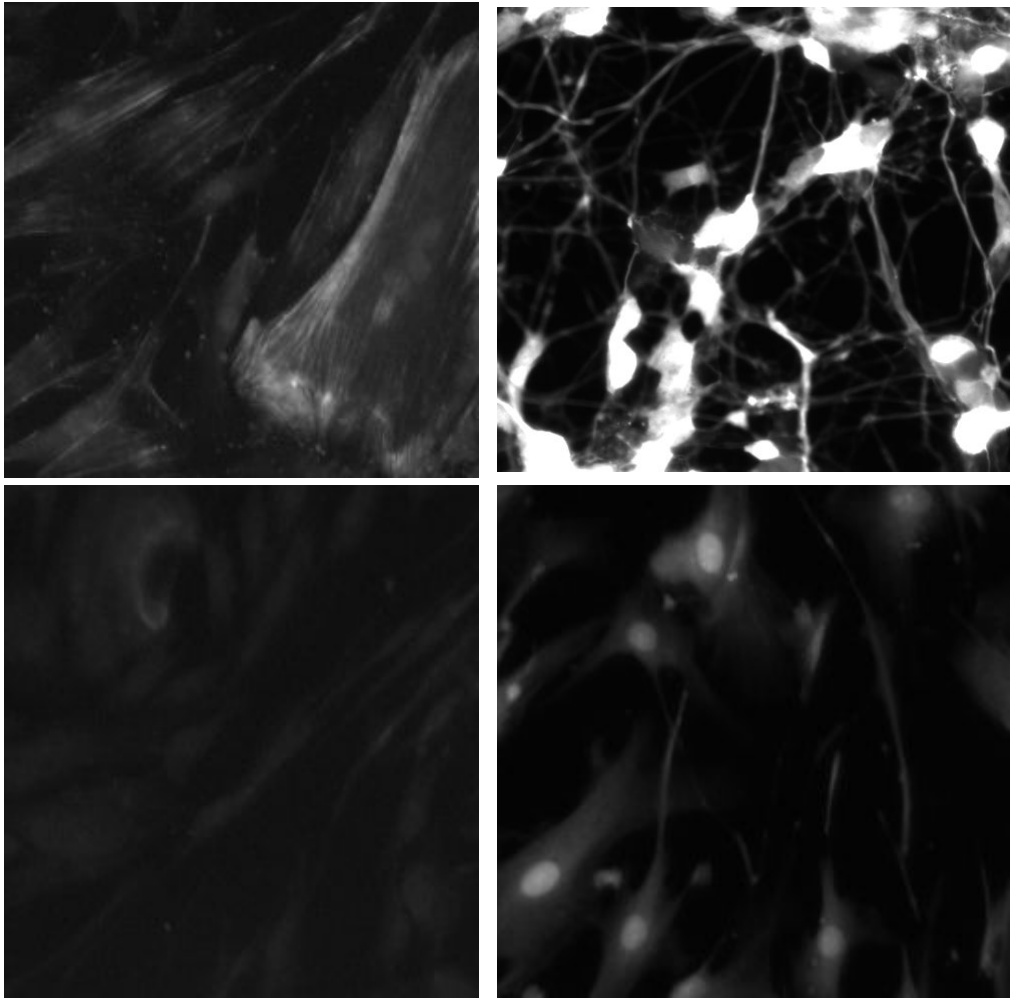
François Delarbre, Nathan Greffe and Pierre Keutgen

Problem

- Spot nuclei in images of cells

- Images are very heterogeneous

- Small dataset



Solution

Instance Segmentation are usually solved using either

- Semantic segmentation network (U-Net) + post-processing (mainly watershed transform)

- Mask-RCNN based methods

Preprocessing

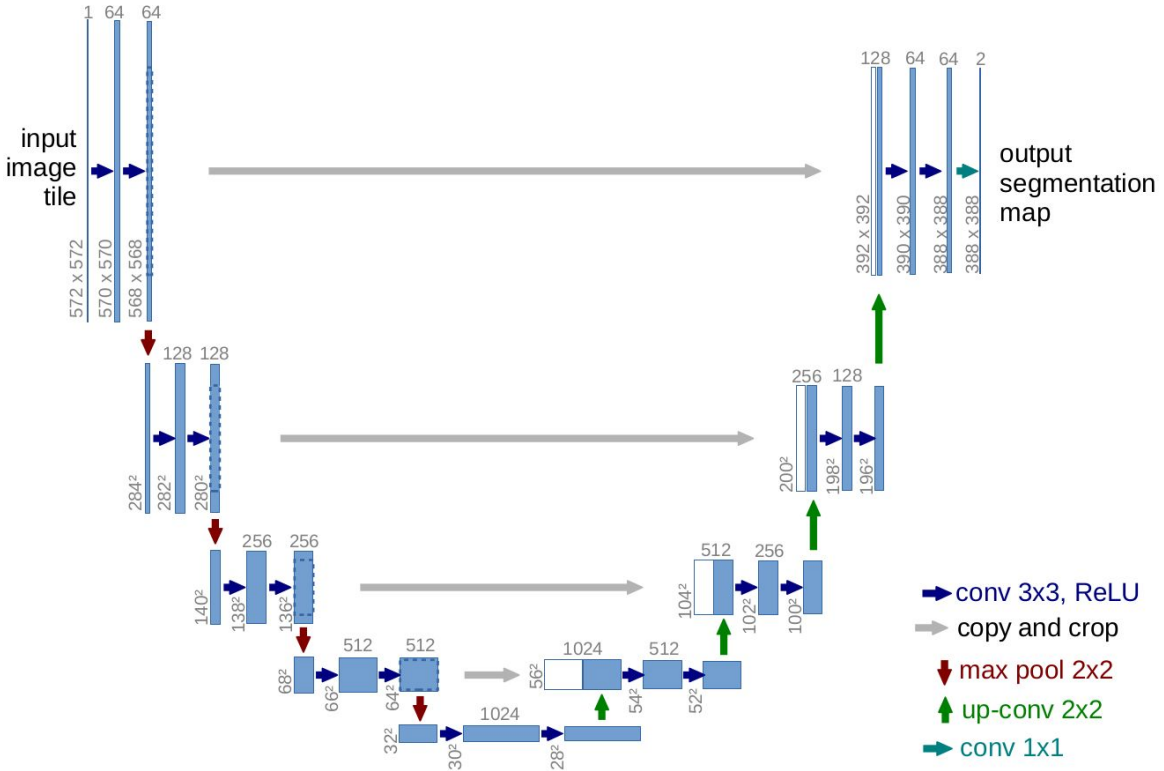
- Additional masks : Union, borders and centers

- Additional dataset from another competition

- Heavy data augmentation

Semantic Segmentation (1) : U-NET

- Downsampling path
- Upsampling path
- Skip connections between both
- Can be adapted for many architectures (ResNet, XCeption, MobileNetV2, …) and encoder weights can be pretrained (e.g. on ImageNet)
- Paper introduced many other ideas

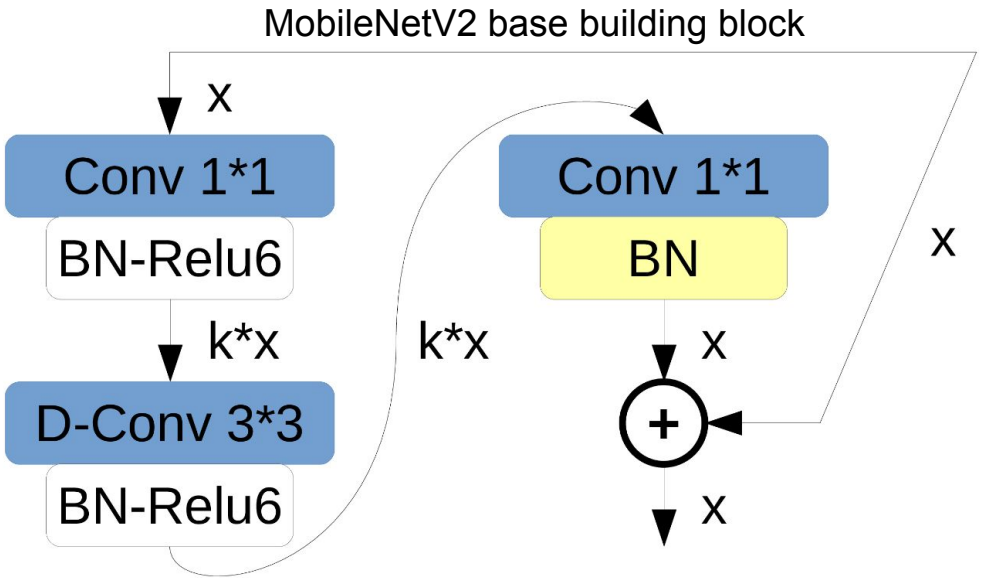


Semantic Segmentation (2)

After some experiments we choose to use:

- Pretrained weights
- MobileNetV2-inspired Architecture (ResNet/ResNeXt/DenseNet were tested as well)
- Adam optimizer
- Loss is a composition of binary-cross-entropy and soft Dice Loss:

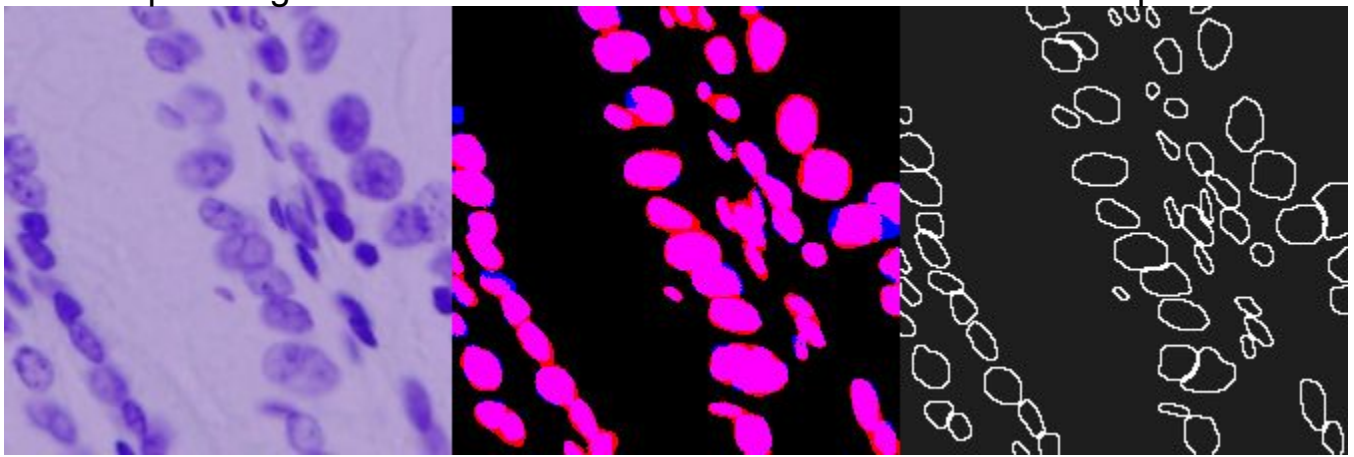
$$softDC = \frac{2 * sum(y\_true * y\_pred) + 1}{sum(y\_true + y\_pred) + 1}$$



Semantic Segmentation (3)

- Weight more importantly pixels from borders of cells (idea used in U-Net)

Input image | Prediction | Border pixels



Purple: TP Dark: TN
Blue: FN Red: FP

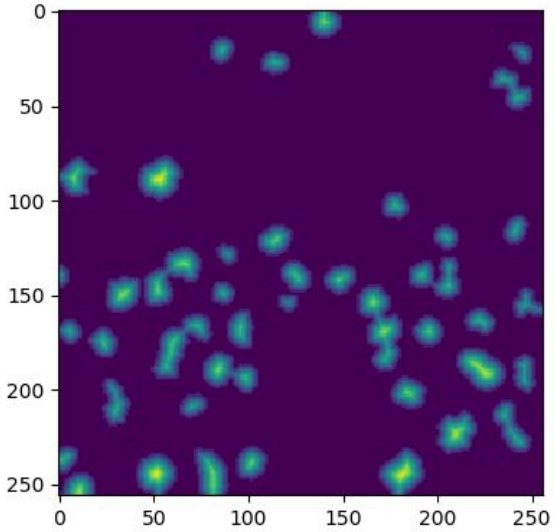
Post Processing

Watershed transform: critical part is to place the markers

1) Markers as local minima of the distance transform on “is a cell mask”

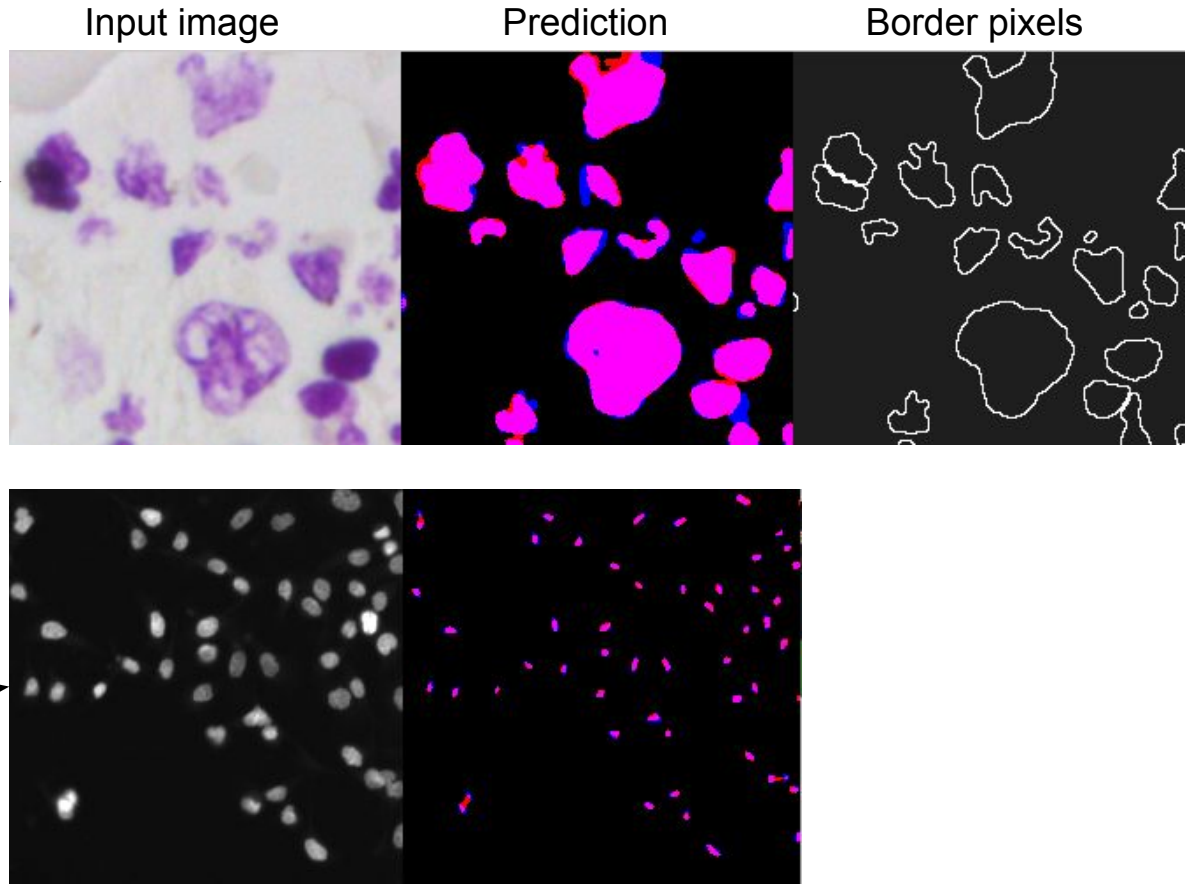
2) 1) helped by the predicted borders

3) Predicted centers as markers



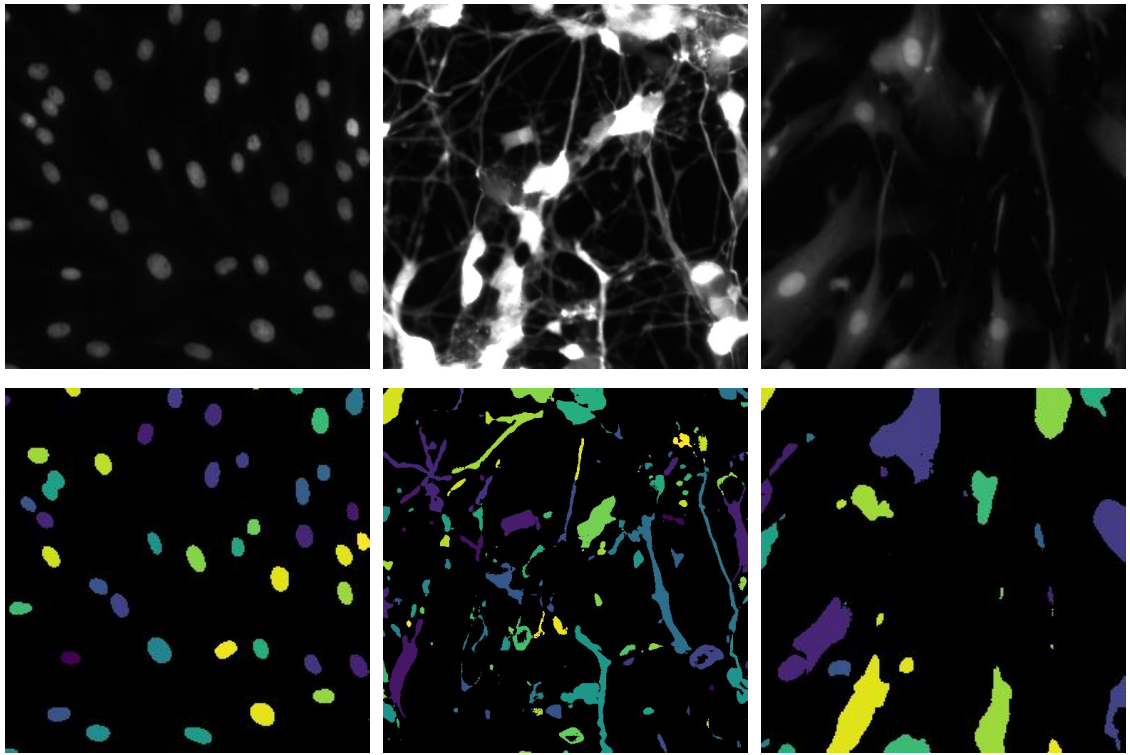
Final solution

- U-Net + emphasis on borders for semantic segmentation mask
- Watershed with the predicted centers as markers
- U-Net with same architecture for centers



Scores with our final solution

- The score is computed following the competition formula
- On our validation set: 0.279
- On our test set: 0.226



To go further

- More post-processing
- Deep-watershed transform
- Larger dataset
- Deeper networks