U-Net

Convolutional Networks for Biomedical Image Segmentation

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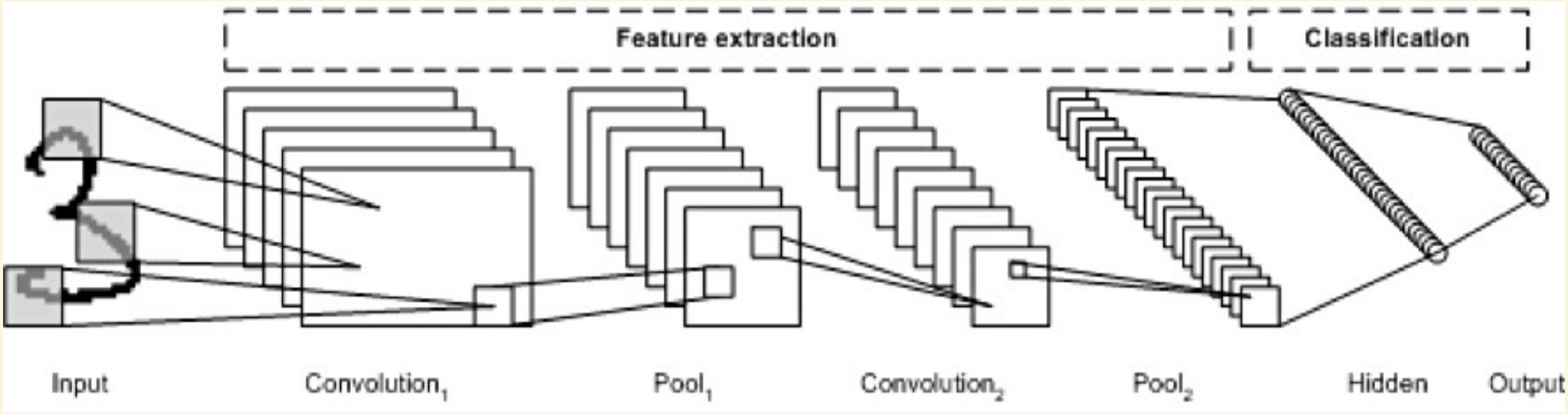
Table of Contents

Prior Knowledge

1) CNN

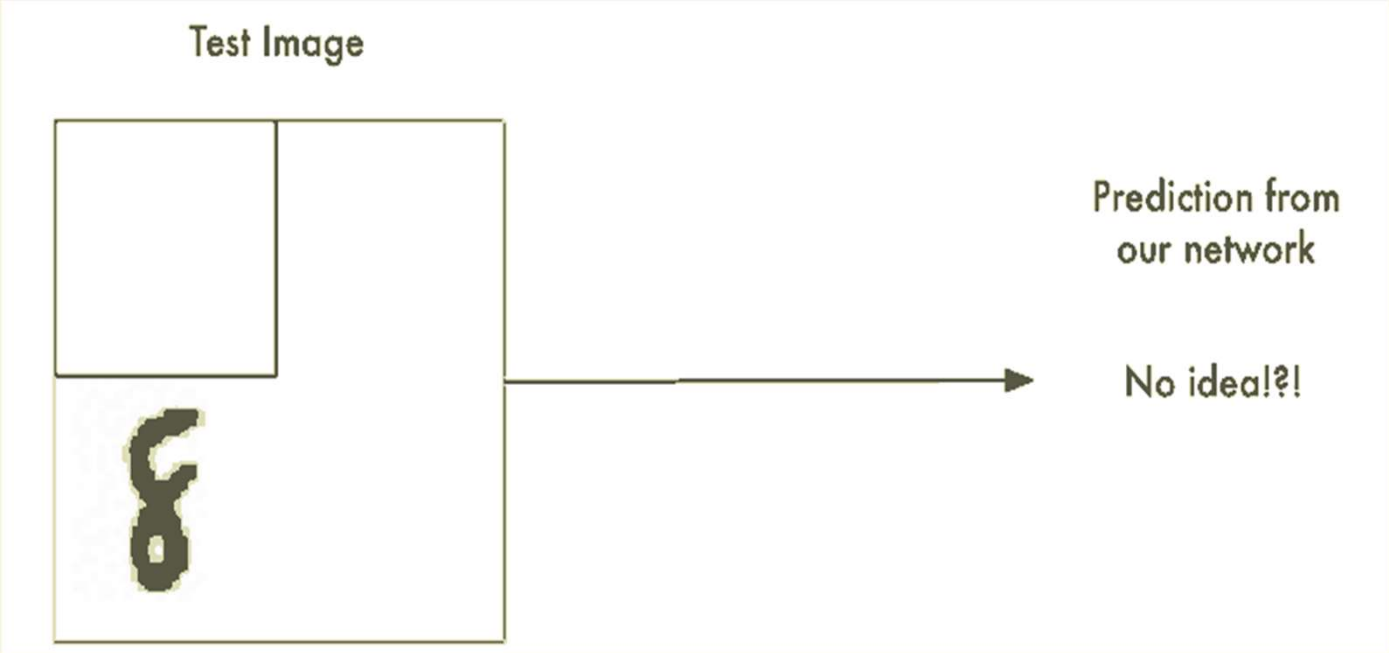
Convolution layer	Pooling layer	Fully Connected layer
이미지 특징 추출, 축약		추출된 특징을 사용해 입력에 속하는 범주 분류



2) Sliding Windows

Sliding Window

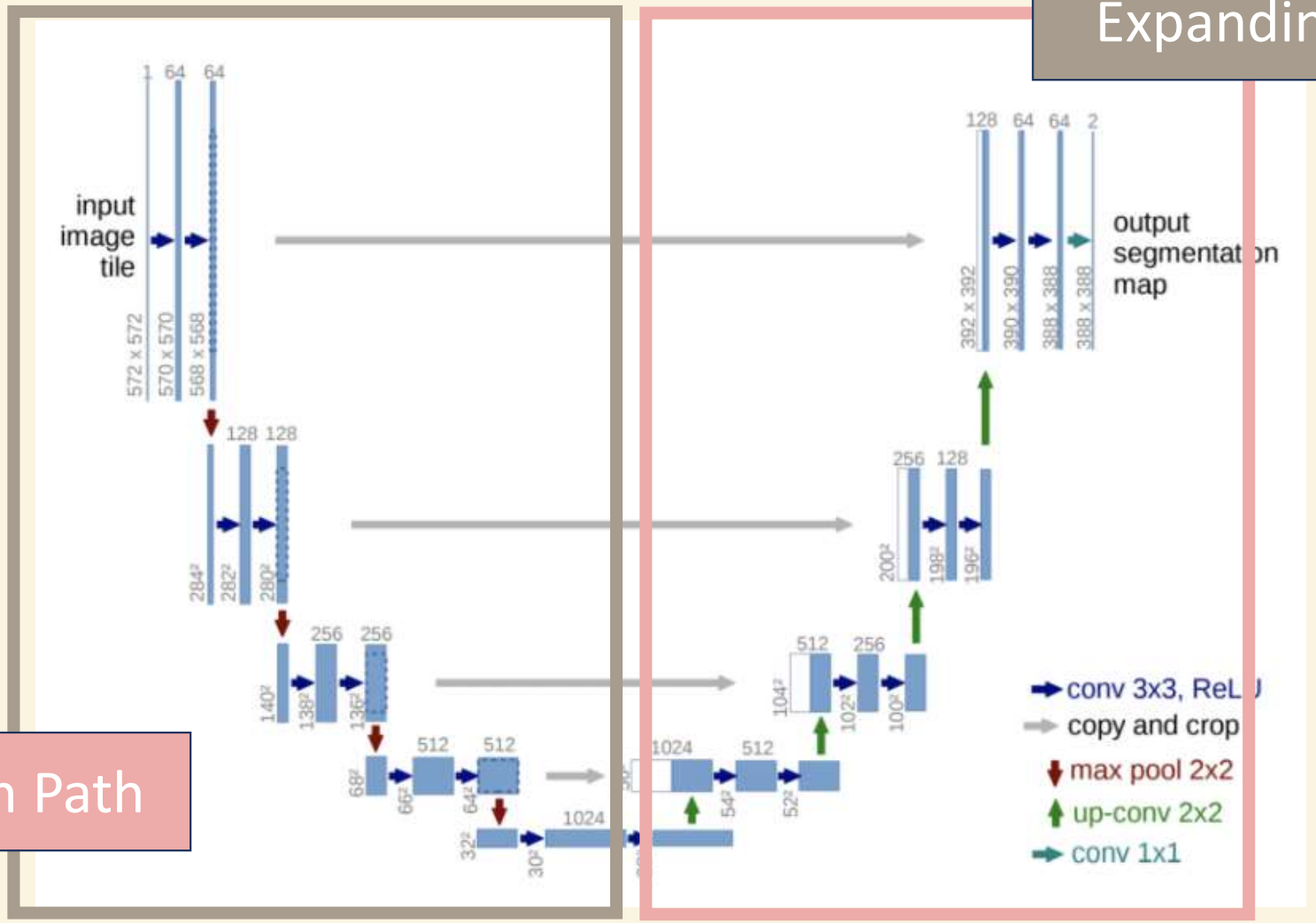
사진을 윈도우 크기에 맞춘 다음 매 윈도우로 잘린 이미지를 입력 값으로 모델을 통과해서 결과를 얻는 방법



https://medium.com/@jongdae.lim/%EA%B8%B0%EA%B3%84-%ED%95%99%EC%8A%B5-machine-learning-%EC%9D%80-%EC%A6%90%EA%B2%81%EB%8B%A4-part-3-928a841a3aa

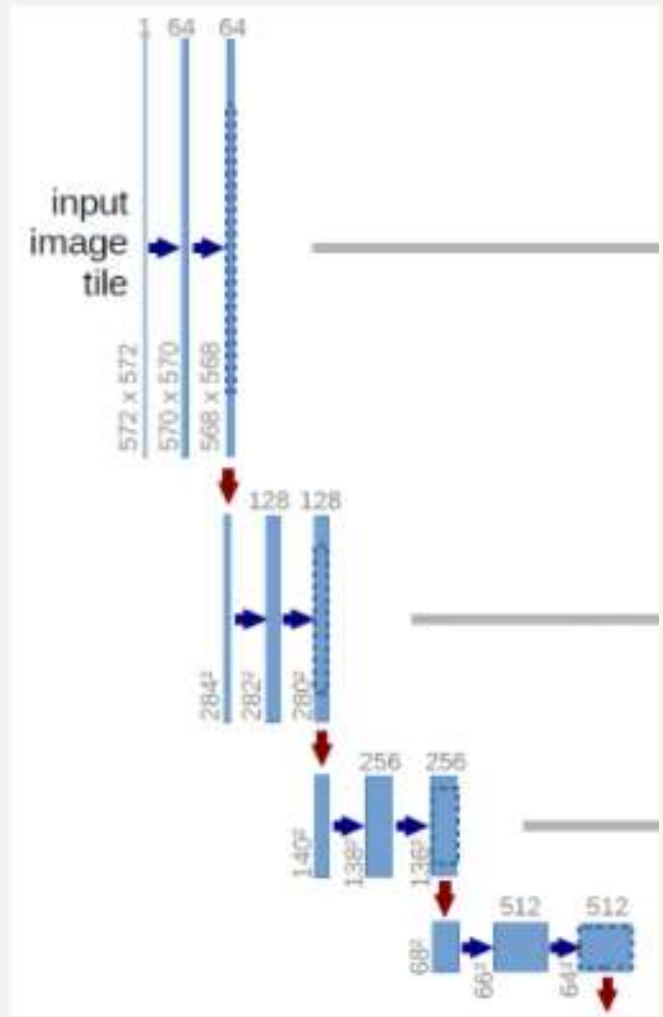
U-Net Architecture

Expanding Path



Contraction Path

Contraction Path



- Contraction Path 특징

1. 전형적인 Convolution network 수행
-> Padding이 없어서 feature map이 조금씩 줄어든다.

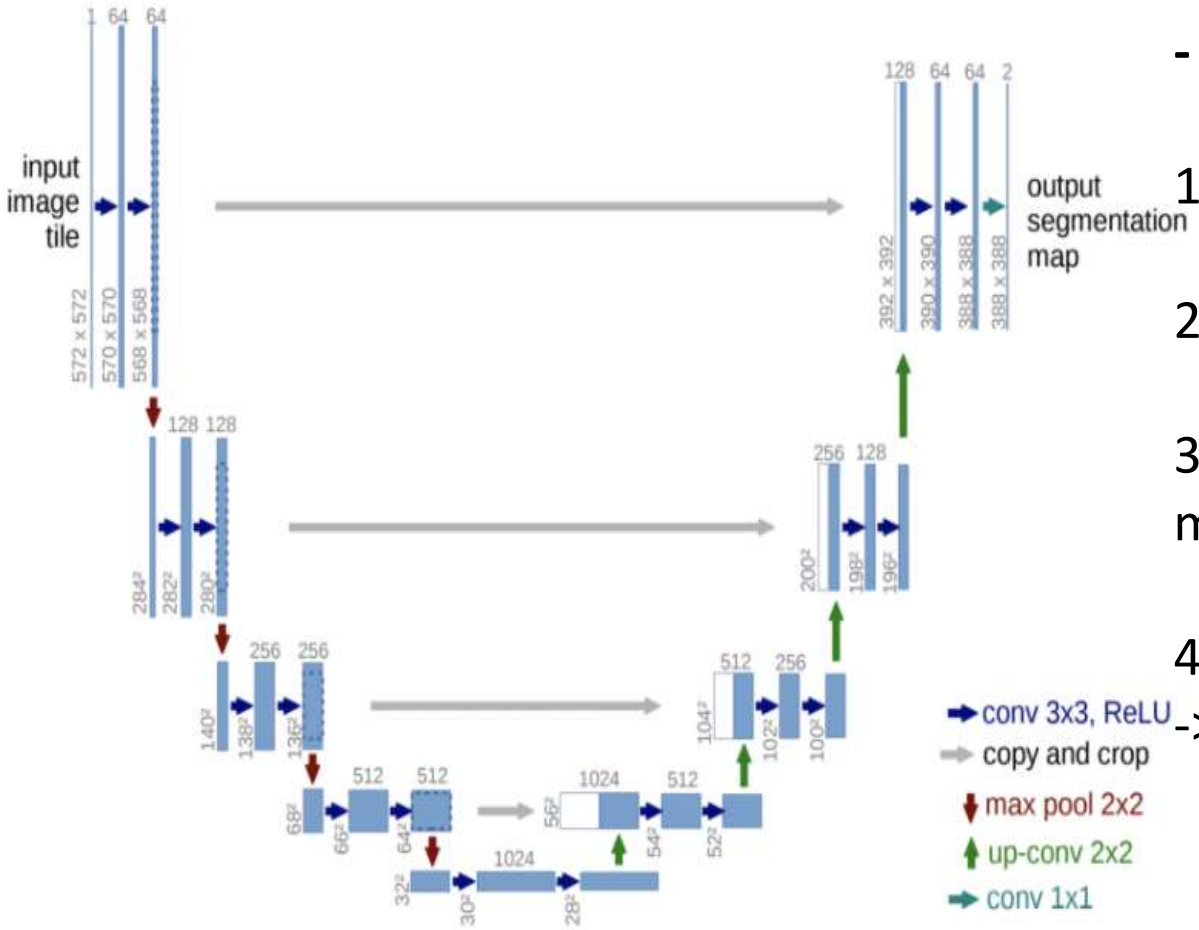
2. 3x3 conv 후, RelU 사용

3. 2X2 max-pooling(stride 2)
-> 크기가 절반으로 줄어든다.

4. down-sampling시 채널 수 2배

5. VGG 기반 아키텍쳐

Expansive Path



- Expansive Path 특징

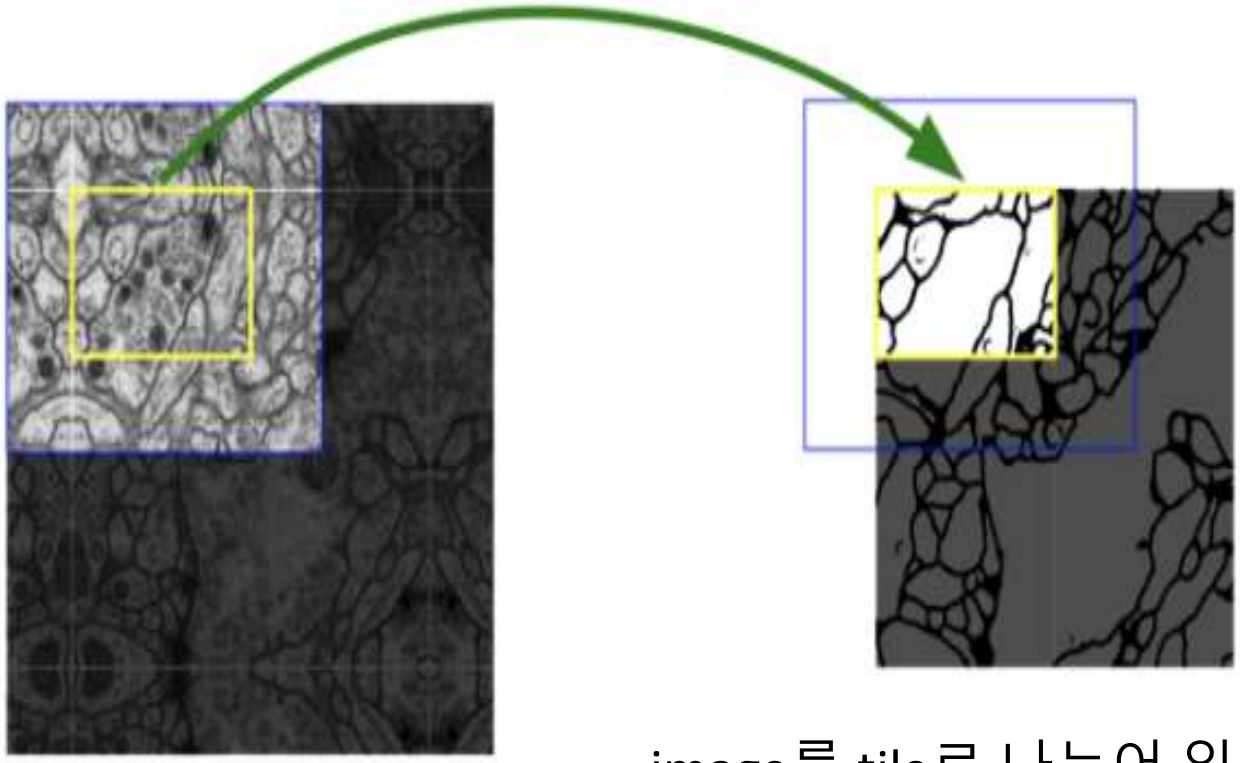
1. Up-sampling, 채널 수 절반 줄어듬

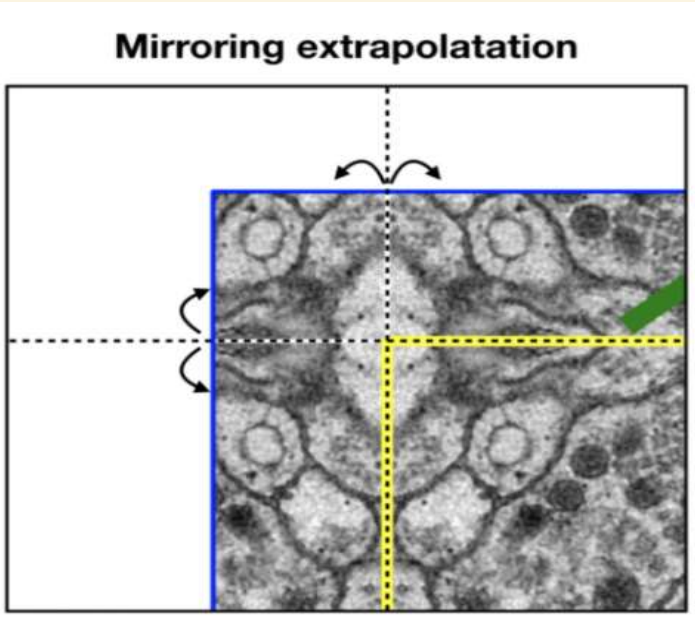
2. 3x3 conv 후, RelU 사용

3. Contraction Path에서 추출된 feature map을 가져와 부착

4. 마지막에 1x1 conv layer를 둠
-> 비선형 예측을 위해(세포막 구분)

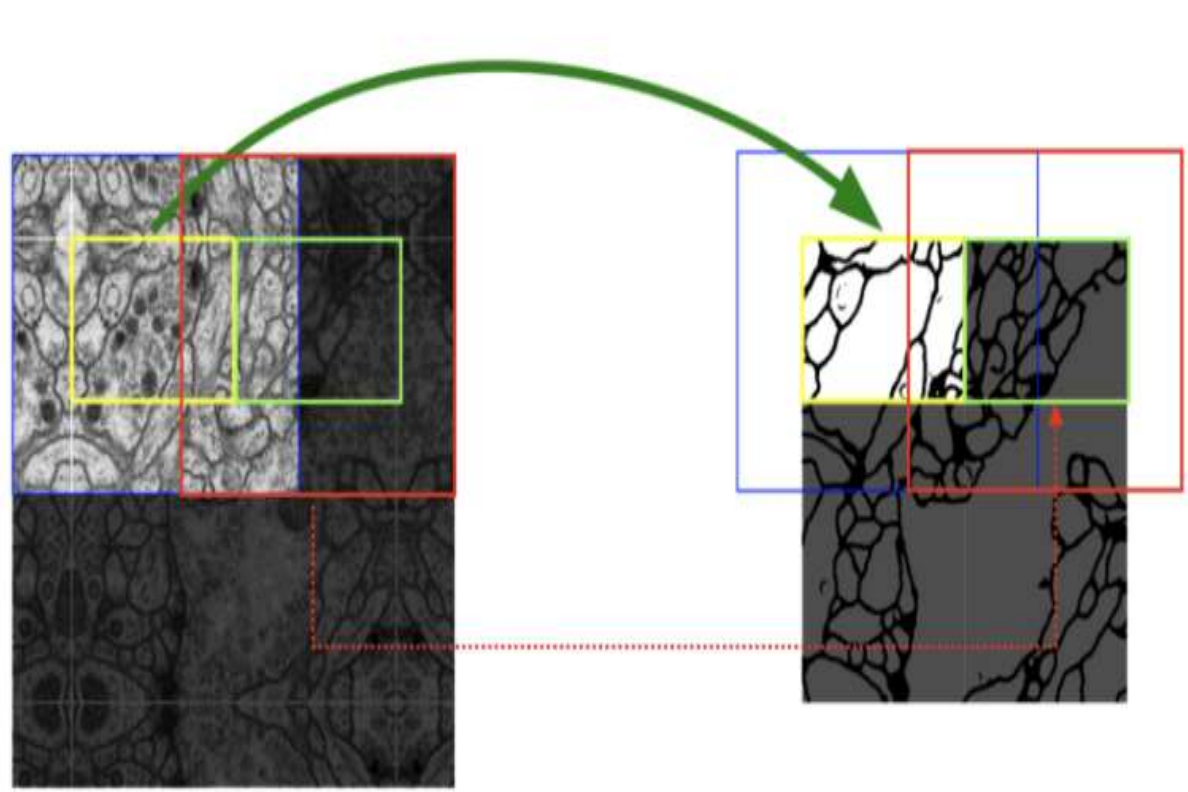
Overlap-tite Input



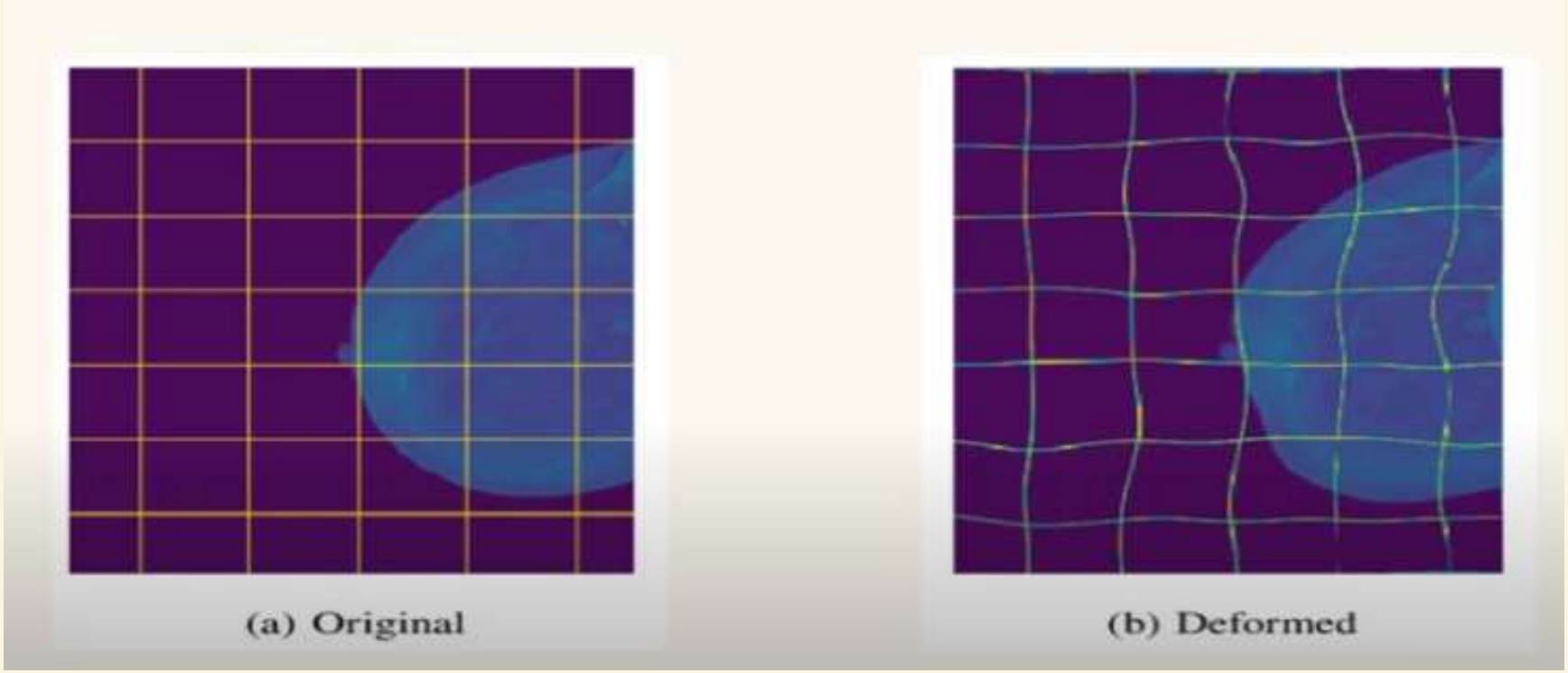


image를 tile로 나누어 입력으로 사용한다.
파란 영역의 image를 입력으로 사용하면 노란 영역의 segmentation 결과를 얻을 수 있다.

Overlap-tite Input

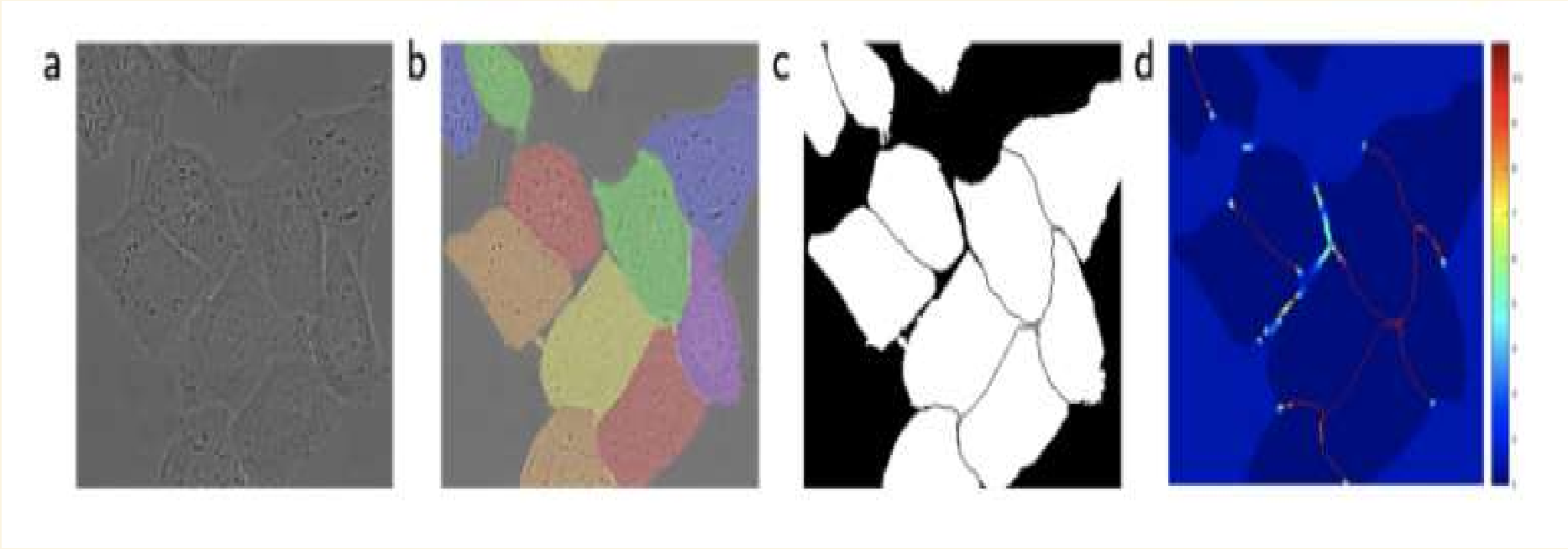


Data Augmentation Method



선형 변환에 확률적으로 노이즈를 추가

Touching cells separation



pixel-wise loss를 활용한 이미지

Touching cells separation

W(x): the weight map equation

x : 두 세포 사이에 존재하는 pixel

$$w(x) = w_c(x) + w_0 \cdot e^{-\frac{(d_1(x)+d_2(x))^2}{2\sigma^2}}$$

where $w_c: \Omega \rightarrow \mathbb{R}$ is the weight map to balance the class frequencies

$d_1: \Omega \rightarrow \mathbb{R}$ denotes the distance to the border of the nearest cell

$d_2: \Omega \rightarrow \mathbb{R}$ denotes the distance to the border of the second nearest cell

Train

$$E = \sum_{\mathbf{x} \in \Omega} w(\mathbf{x}) \log(p_{\ell(\mathbf{x})}(\mathbf{x}))$$

$\ell : \Omega \to \{1, \ldots, K\}$

$w : \Omega \to \mathbb{R}$

Table 1. Ranking on the EM segmentation challenge [14] (march 6th, 2015), sorted by warping error.

Rank	Group name	Warping Error	Rand Error	Pixel Error
	** human values **	0.000005	0.0021	0.0010
1.	u-net	**0.000353**	0.0382	0.0611
2.	DIVE-SCI	0.000355	0.0305	0.0584
3.	IDSIA [1]	0.000420	0.0504	0.0613
4.	DIVE	0.000430	0.0545	**0.0582**
⋮				
10.	IDSIA-SCI	0.000653	**0.0189**	0.1027

Q & A

U-Net
https://arxiv.org/pdf/1505.04597.pdf)%e5%92%8c%5bTiramisu%5d(https://arxiv.org/abs/1611.09326.pdf
U-Net 리뷰
https://medium.com/@msmapark2/u-net-%EB%85%BC%EB%AC%B8-%EB%A6%AC%EB%B7%B0-u-net-convolutional-networks-for-biomedical-image-segmentation-456d6901b28a
https://www.youtube.com/watch?v=O_7mR4H9WLk
https://jlog1016.tistory.com/85
https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/
https://everyday-image-processing.tistory.com/58

Thank you!