Bangladesh Army International University Of Science And Technology

Title : ArNet A Deep Learning Architecture For Pixel-wise Semantic Segmentation Of Images

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Introduction

Segmentation - Process that classify object in image

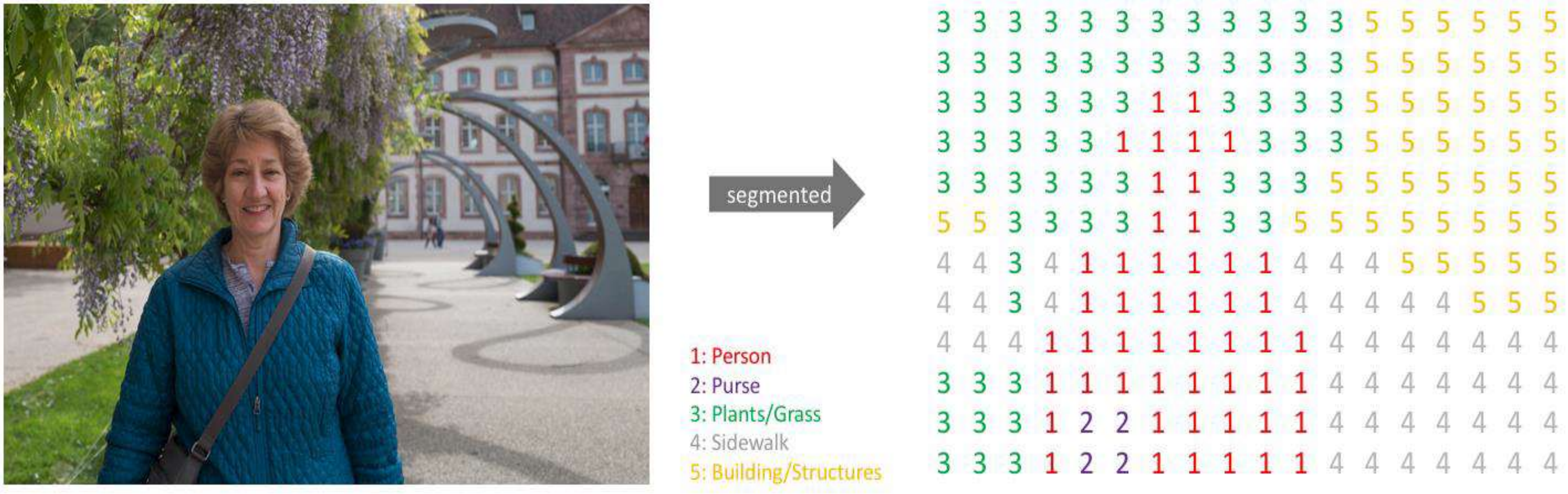


Figure 1: Visualization of how semantic segmentation works [1].

Challenges

- Building the DCNN
- Layer reduction
- Time reduction
- Add more classes
- Calculate the class weights

Motivation for Research

SegNet: A Deep Convolutional Encoder-Decoder Architecture for Image Segmentation [2]

- **Build to understand road scenes**
- **Model appearances and shapes**
- **Understand the spatial resolution between classes**
- **Used mostly for autonomous driving**

Literature Review

- **In *“Feedforward semantic segmentation with zoom-out features”* Mohammadreza Mostajabi, Payman Yadollahpour, and Gregory Shakhnarovich represented the statistical structure of a image by a purely feed forward network by mapping Superpixels using zoom-out features [3]**

- **In *“Convolutional Feature Masking for Joint Object and Stuff Segmentation ” Jifeng Dai, Kaiming He, and Jian Sun* image shape information was exploited by Convolutional Neural Network for object that are connected [4]**

Methodology

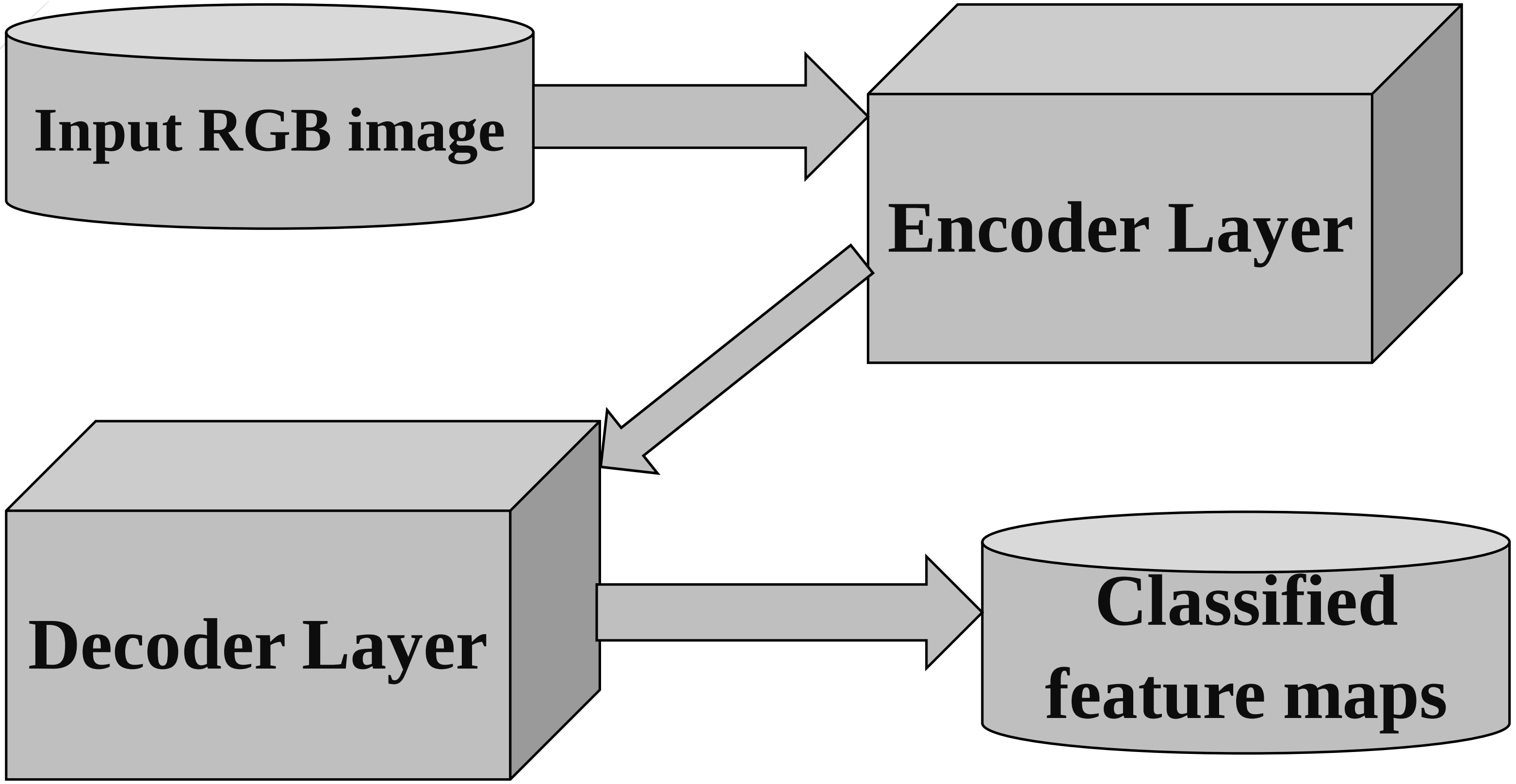


Figure 2: Overview of ArNet architecture.

Encoder Layer

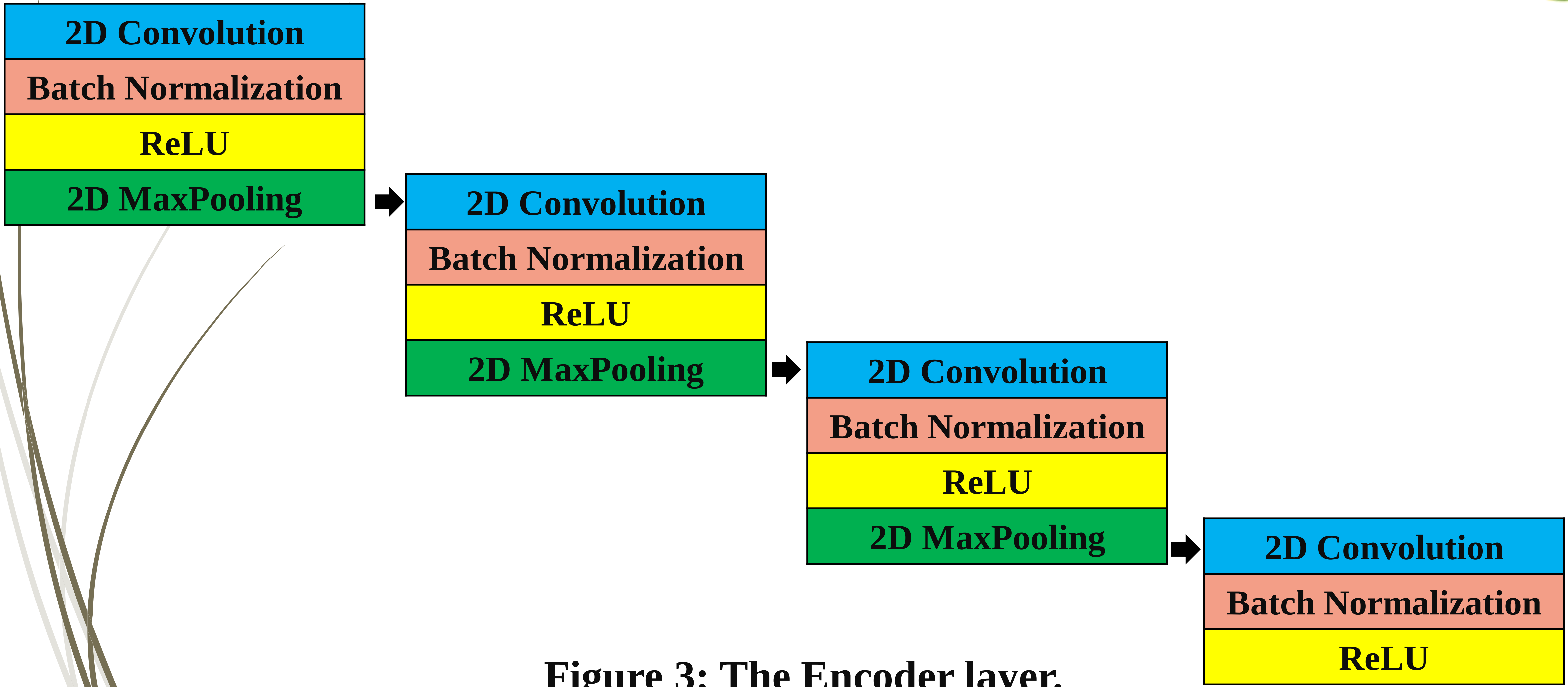
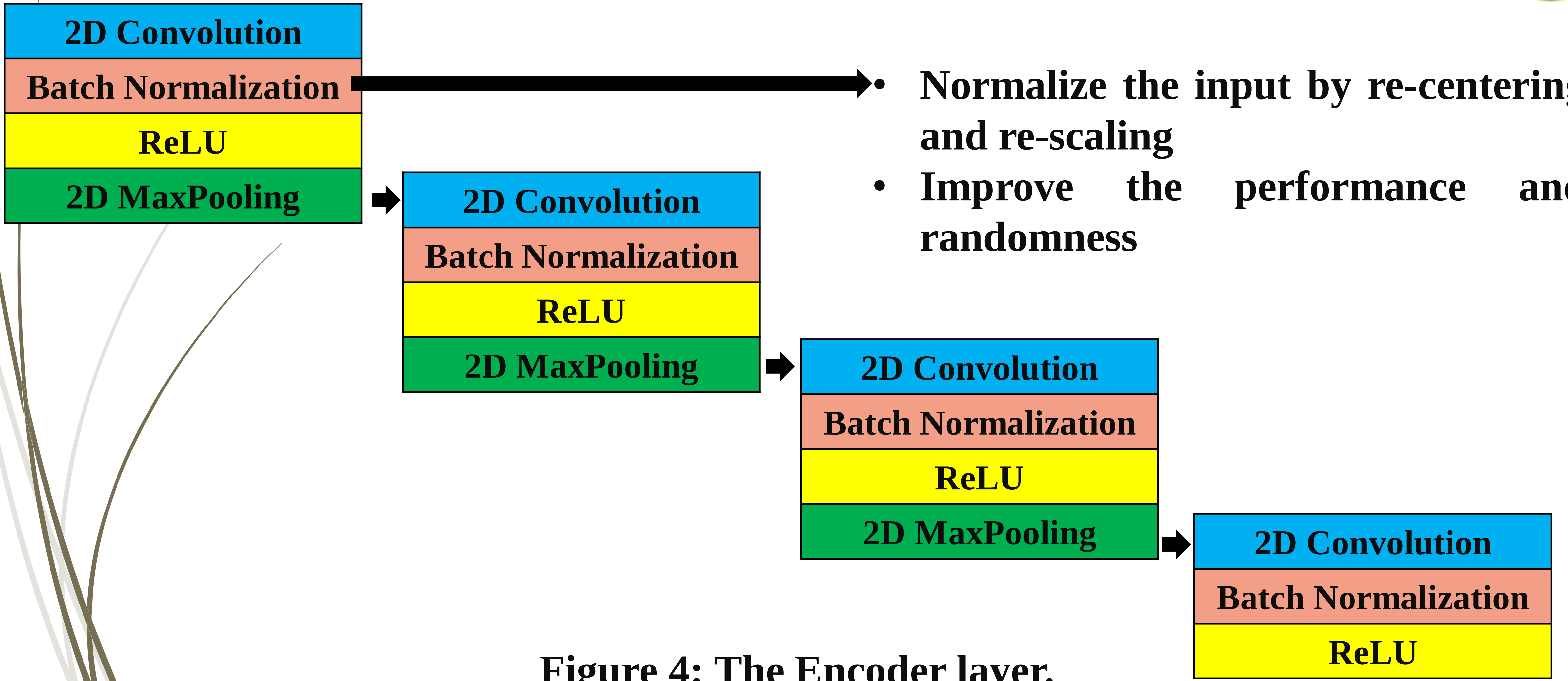


Figure 3: The Encoder layer.

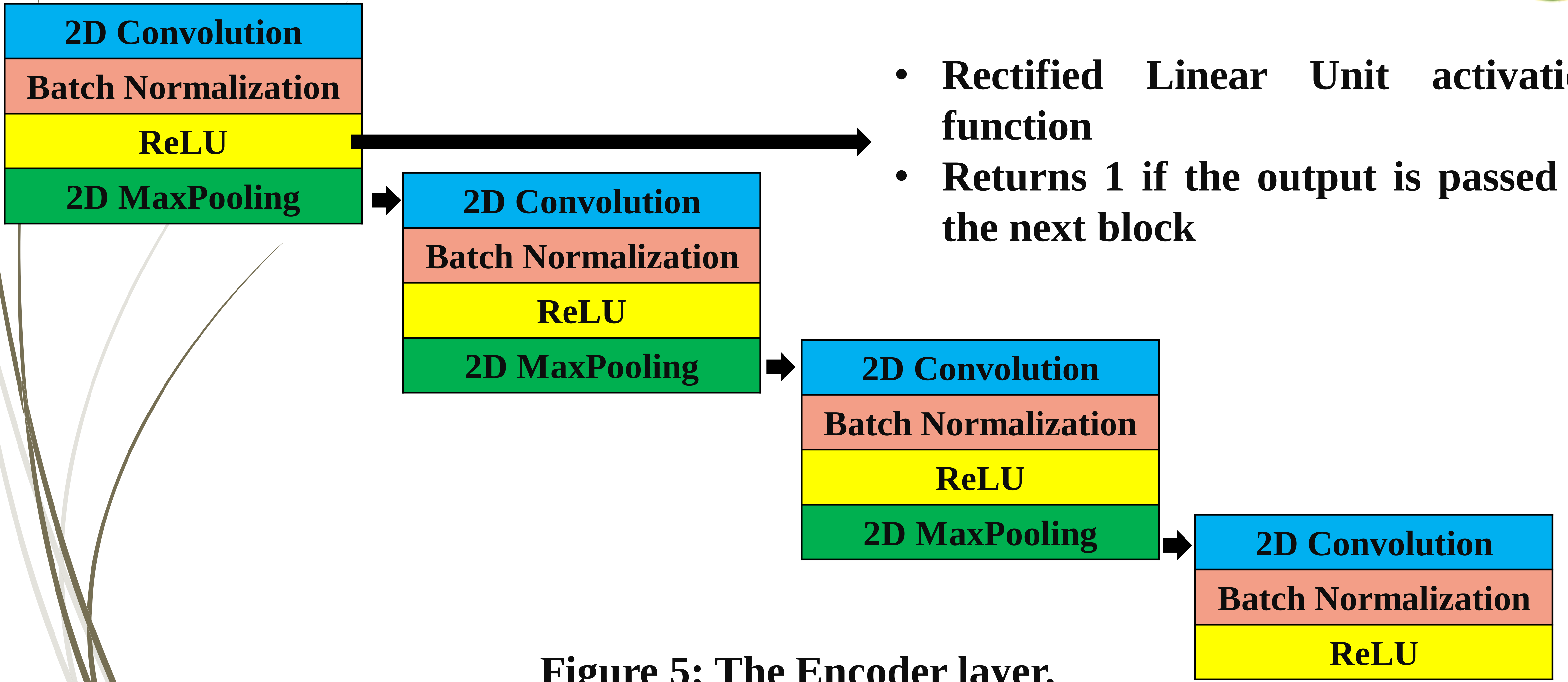
Encoder Layer



- **Normalize the input by re-centering and re-scaling**
- **Improve the performance and randomness**

Figure 4: The Encoder layer.

Encoder Layer



- Rectified Linear Unit activation function
- Returns 1 if the output is passed to the next block

Figure 5: The Encoder layer.

2D Convolution

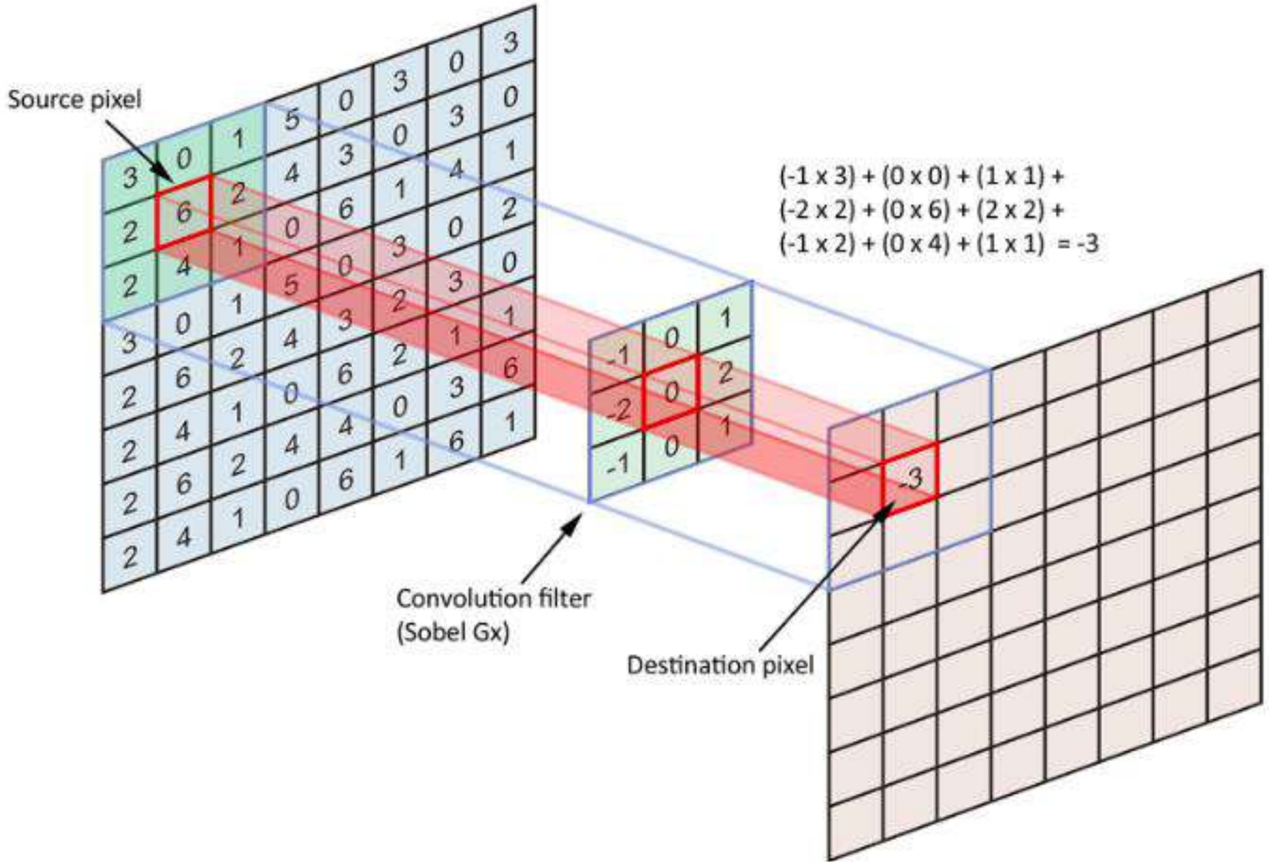
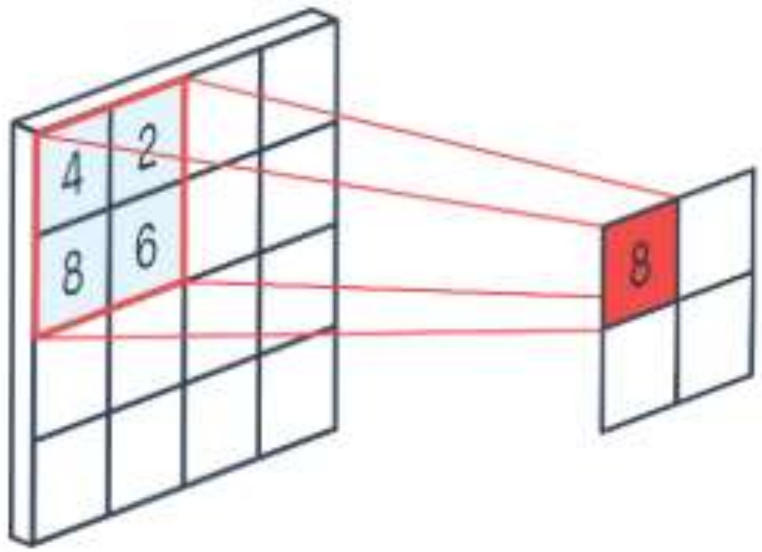


Figure 6: A 2D convolution operation [5].

2D MaxPooling



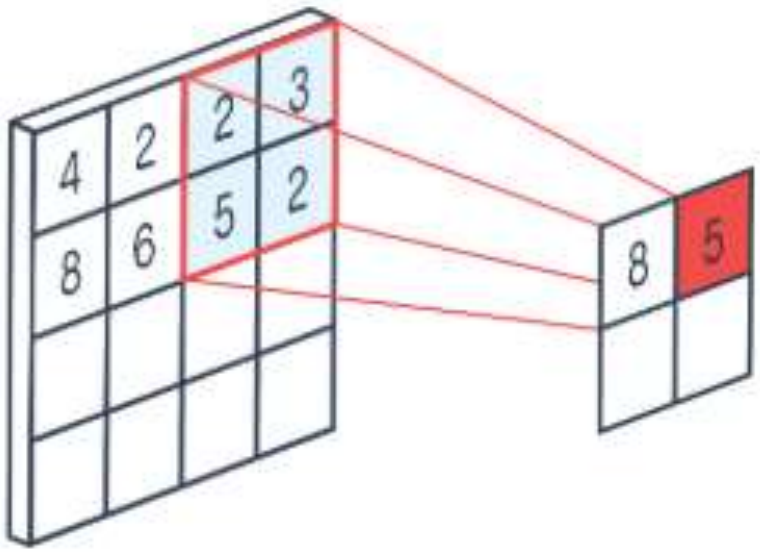


Figure 7: 2D MaxPooling [6].

Decoder Layer

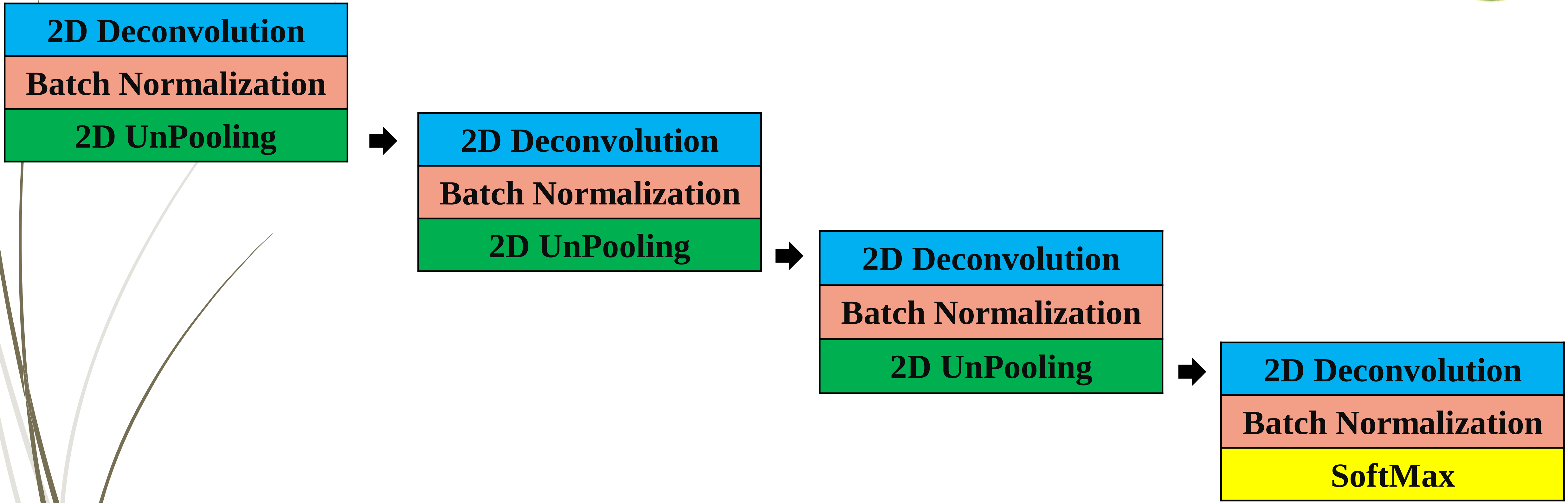


Figure 8: The Decoder layer.

Decoder Layer

- Exactly the opposite of 2D Convolution operation

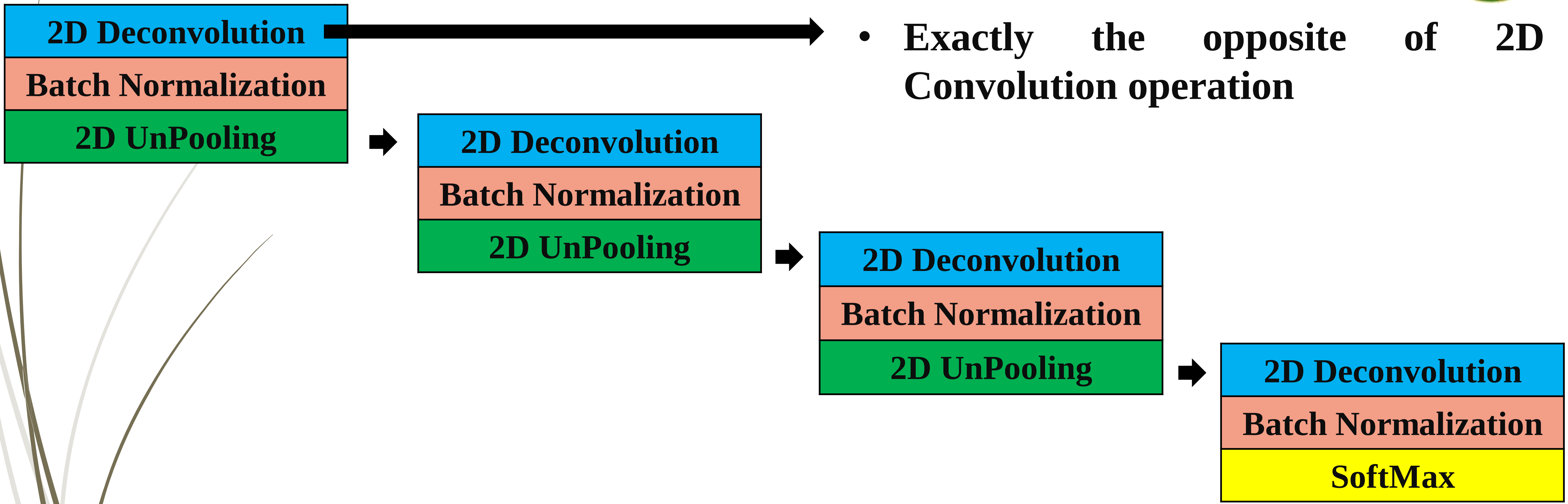


Figure 9: The Decoder layer.

Decoder Layer

2D Deconvolution
Batch Normalization
2D UnPooling

2D Deconvolution
Batch Normalization
2D UnPooling

2D Deconvolution
Batch Normalization
2D UnPooling

2D Deconvolution
Batch Normalization
SoftMax

- Exactly the opposite of 2D MaxPooling
- Remaining elements being set to zero

Figure 10: The Decoder layer.

Decoder Layer

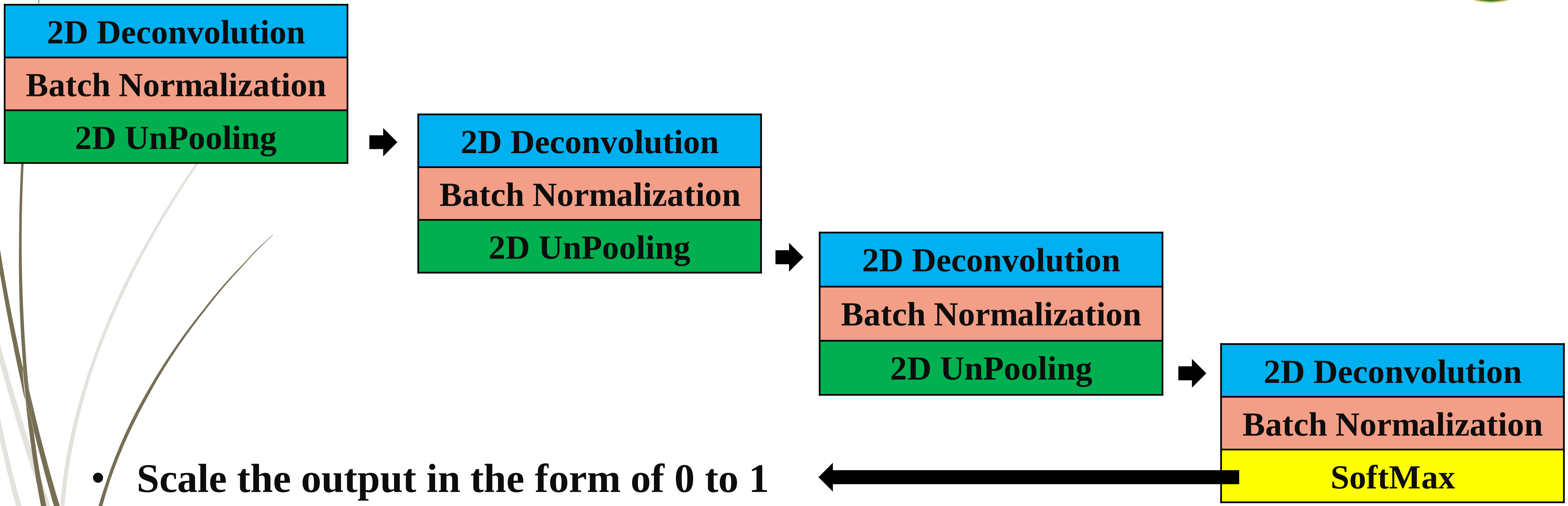


Figure 11: The Decoder layer.

Dataset

Figure 12: Some random image from the CamVid Dataset [2].

Result

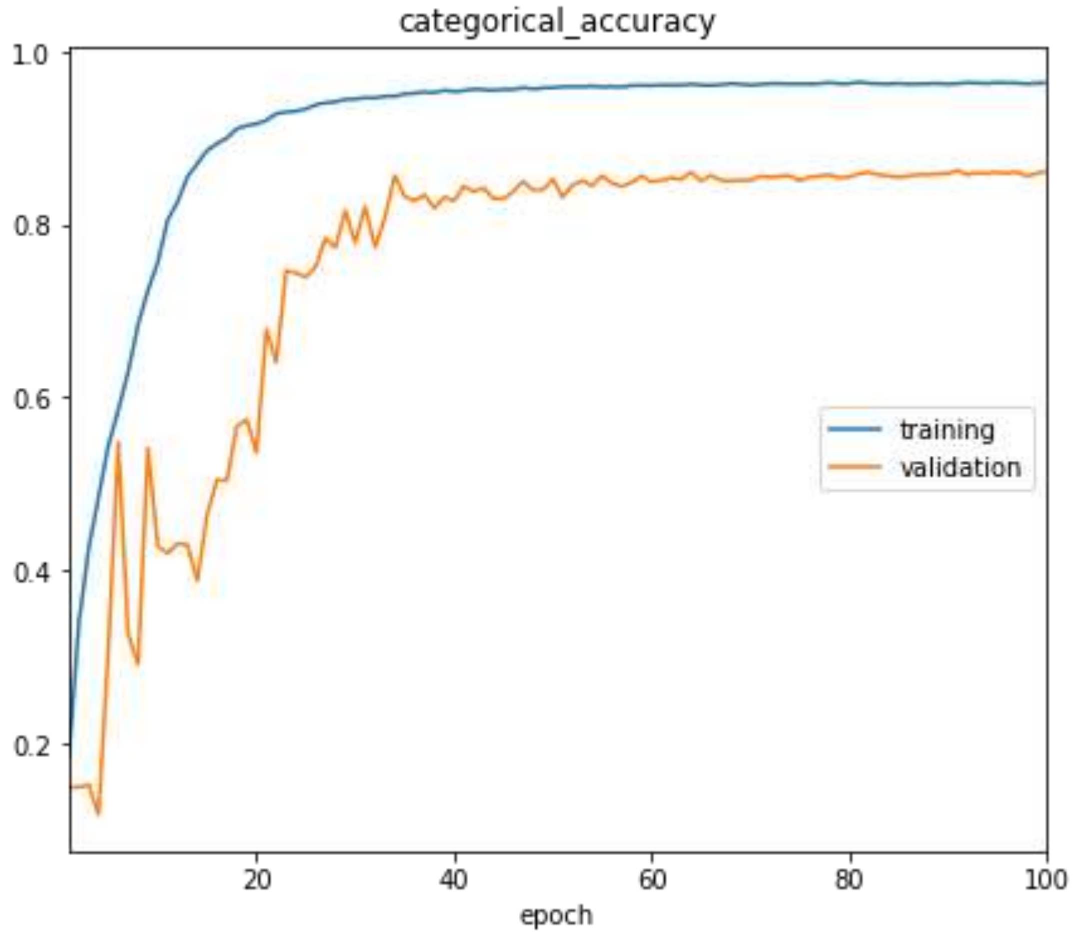
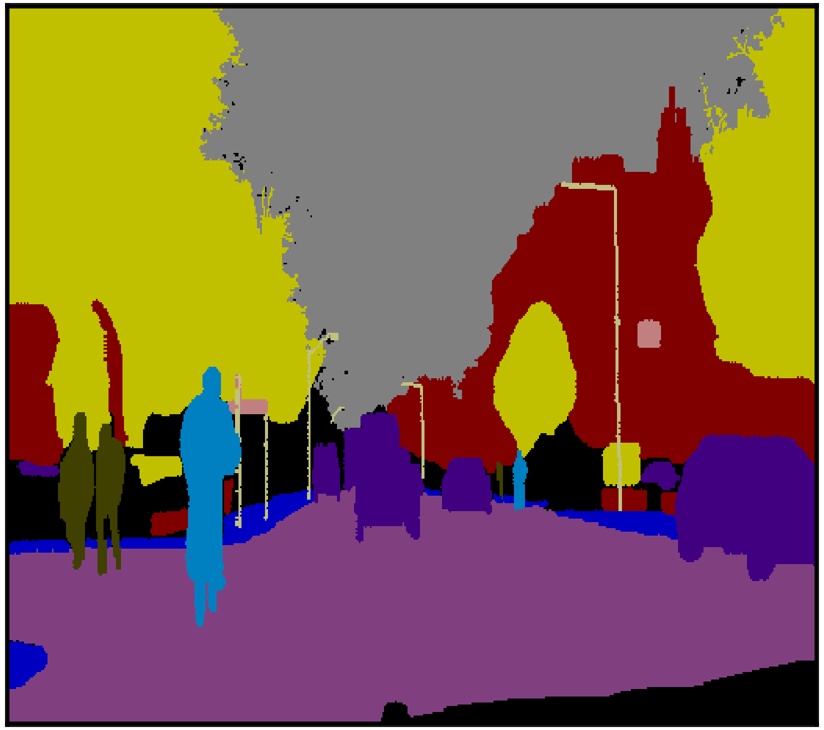


Figure 13: Categorical accuracy per epoch of the training and validation data.

Result

(a) Input Image



(b) Visualization of feature map

Figure 14: Visualizing the results of ArNet architecture.

Comparison

Table 1: Validation accuracy comparison between some the state-of-the-art architecture and ArNet.

Architecture	Validation Accuracy	Time Per Epoch (avg)
FCN8 [13]	62.5%	12 minutes
SegNet [18]	88.0%	1.6 hours
FC-DenseNet100 [19]	91.2%	13 hours (only one epoch was done completely)
ArNet	88.7%	32 minutes

Limitations

- Machine oriented architecture
- Very time consuming
  - 32 minutes per epoch on average
- Low number of dataset

Conclusion

- Improve machine visions
- Improve robotics
- Improve autonomous driving technology

Future Work

- Lower number of blocks
- Lower processing time
- More dataset
- Interface canny edge detector

References

1. A. A. Novikov, D. Lenis, D. Major, J. Hladůvka, M. Wimmer, K. Bühler, "Fully Convolutional Architectures for Multi-Class Segmentation in Chest Radiographs", Computer Vision and Pattern Recognition, (Submitted on 30 Jan 2017 (v1), last revised 13 Feb 2018 (this version, v4)).
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3. M. Mostajabi, P. Yadollahpour, G. Shakhnarovich, "*Feedforward semantic segmentation with zoom-out features* ", Computer Vision and Pattern Recognition, (Submitted on 2 Dec 2014). arXiv:1412.0774.
4. J. Dai, K. He, J. Sun, "*Convolutional Feature Masking for Joint Object and Stuff Segmentation*" The IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2015, pp. 3992-4000

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5. D. Torres, Alejandro (Nov 2, 2010). "*Origin and history of convolution*". 41 pgs. http://www.slideshare.net/Alexdfar/origin-adn-history-of-convolution. Cranfield, Bedford MK43 OAL, UK. Retrieved March 13, 2013.

6. Q. Zhao, S. Lyu, B. Zhang, and W. Feng, "*Multiactivation Pooling Method in Convolutional Neural Networks for Image Recognition*", Big IoT Data Analytics in Fog Computing, Volume- 2018, Article ID- 8196906, https://doi.org/10.1155/2018/8196906.

Thank you…..