Convolutional Neural Networks for Direct Text Deblurring

(Hradiš et al)

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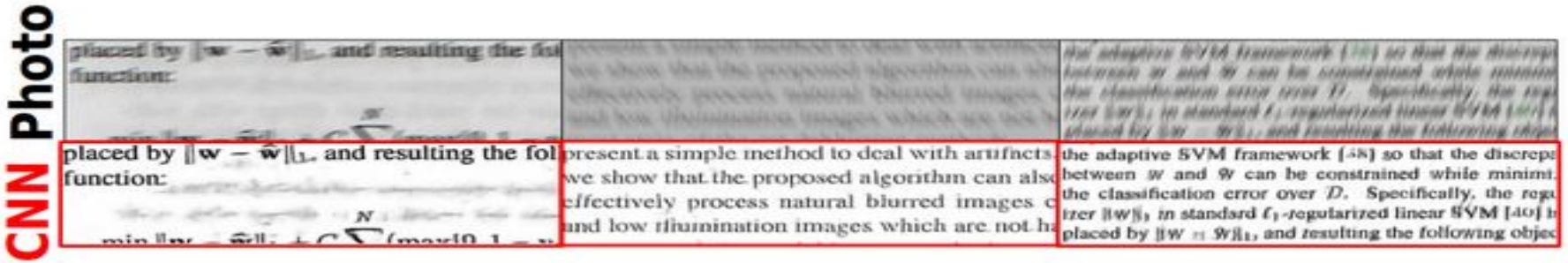


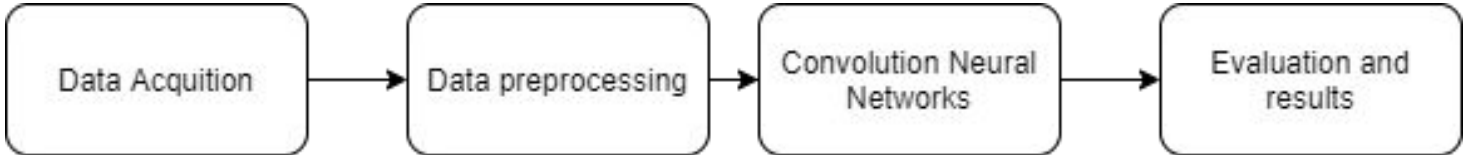
Problem Statement

- Blurring is a common phenomena
- Blurring can cause loss of information
- Can occur due to various reasons such as defocusing and camera shake

Convolutional Neural Networks have proven very powerful for Computer Vision problems in recent years.

We use a CNN and train it for the restoration of **good-quality text images** directly from blurry inputs without assuming any **specific blur** or **noise models**

Overall Pipeline



Dataset Details

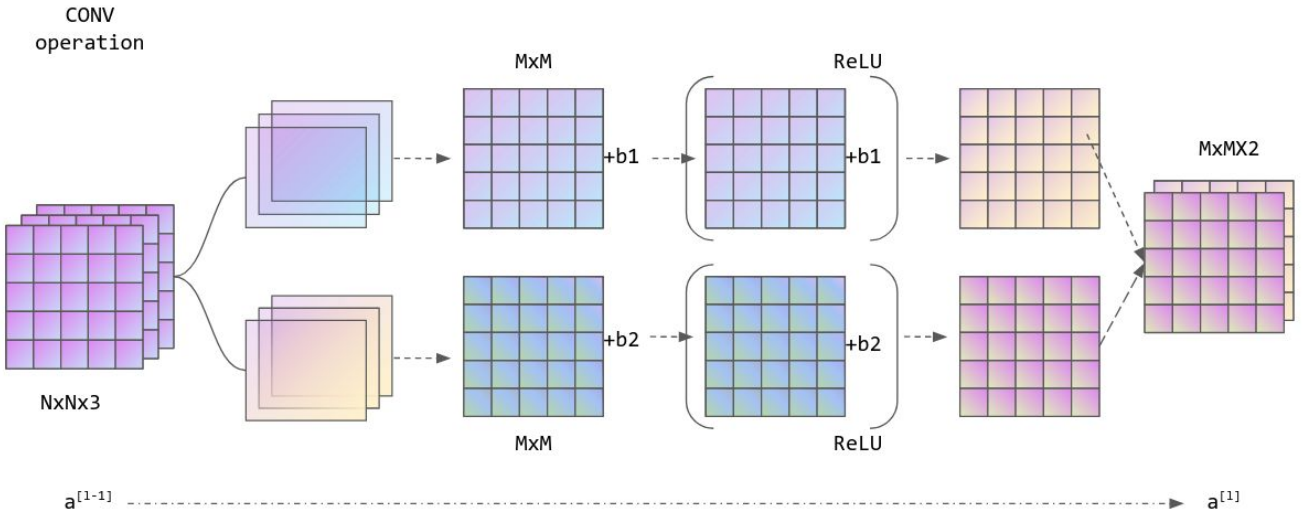
- Patches sampled from documents downloaded from CiteSeerX repository (available online on HRADIŠ' website: https://www.fit.vutbr.cz/~ihradis/CNN-Deblur/)
- Mix of different content types **(text, equations, tables, images, and diagrams)**
- 50k files for training and 2k files for validation
- Original Patch Dimensions: **(300 x 300 x 3)**
- Randomly sampled a patch from each patch
- Our Dimensions: **(64 x 64 x 3)**
    - Reason: Computation cost
- Normalized all images from 0 to 1

Convolutional Neural Networks - Rationale

- Filters can provide us with useful information from the image

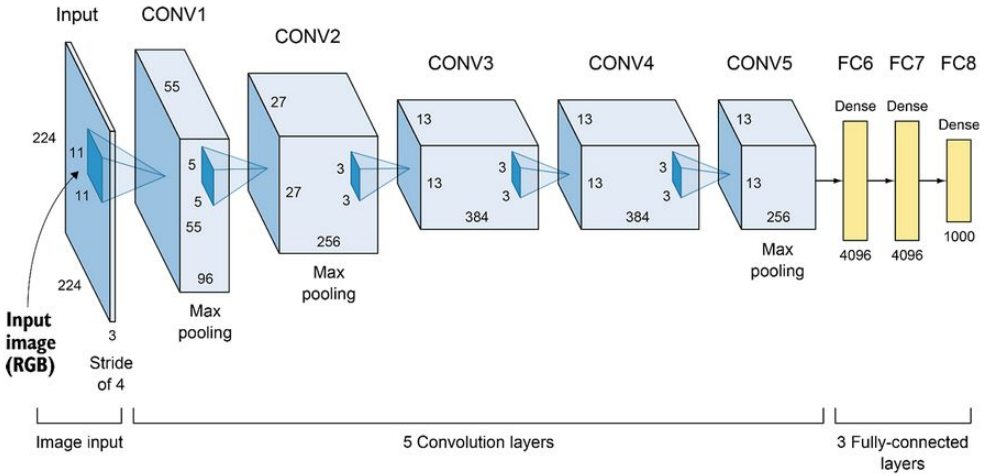
Convolutional Neural Networks - Rationale

- Idea: Use multiple filters to extract different ‘kind’ of useful information about the image
- Learn these filters automatically to suit our desired task => CNNs



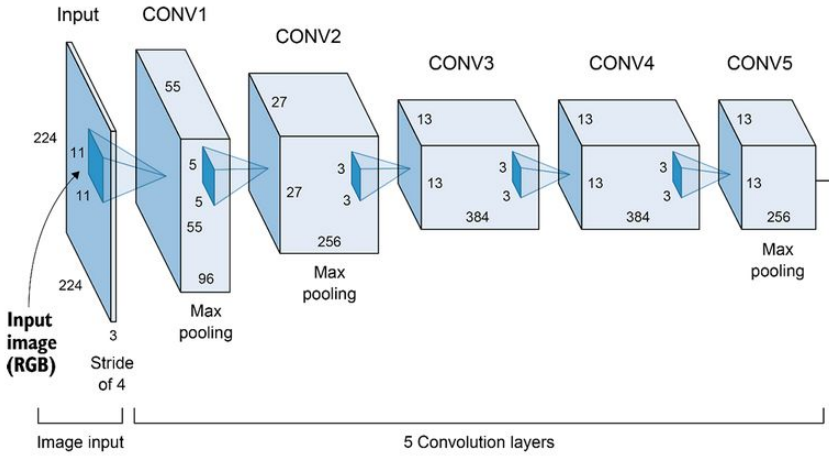
Convolutional Neural Networks - AlexNet

- Winner of the 2012 ImageNet challenge => kick-started the Deep Learning revolution in Computer Vision
- Conv - Pool - Conv - Pool - Conv - Conv - Conv - Pool - Flatten - Dense - Dense - Output



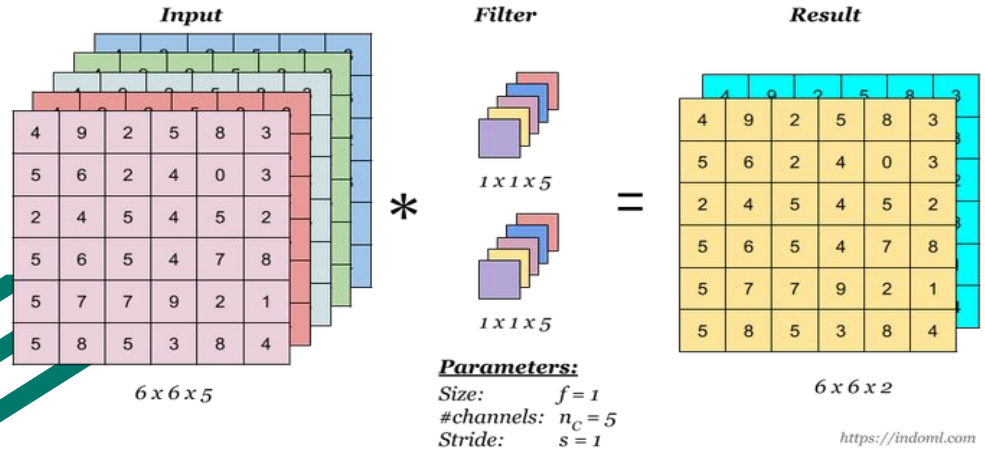
Convolutional Neural Networks - Task at Hand

- Our task is not related to image classification => we want an image at the output
- Idea: Use a fully convolutional network with no dense layers



Convolutional Neural Networks - 1x1 Convolutions

- 1x1 Convolutions are often used to change the number of channels without using as many parameters as a conventional filter (3x3, 5x5, etc.)
- They can also be thought of as applying intensity transforms (without any consideration for the neighbours)



Our Architecture

- Architecture proposed by the authors
  - L-15:
    - Consists of successive convolutional layers
    - Ends up having the same dimension as the image

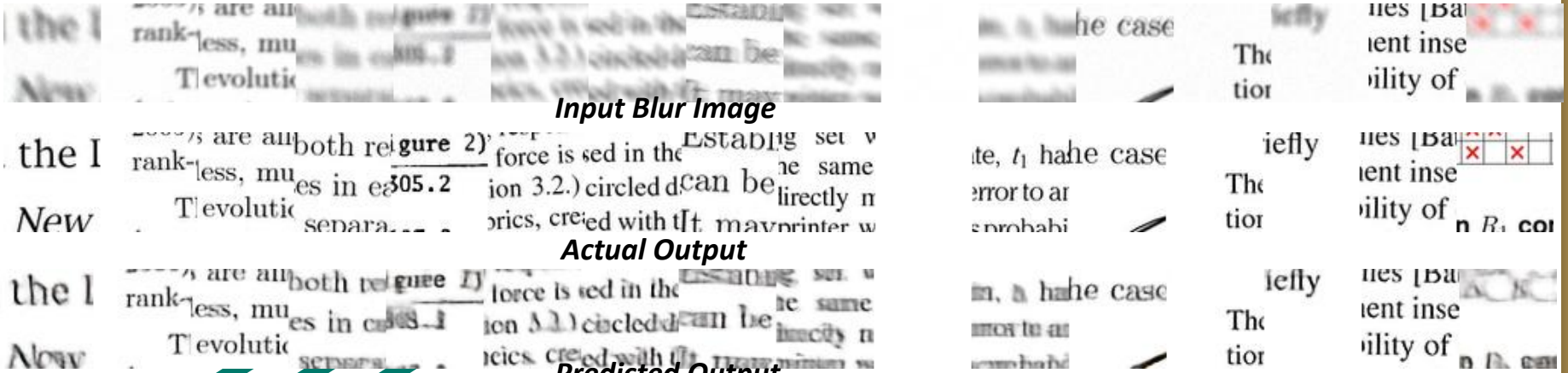
Layer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L15	19×19	1×1	1×1	1×1	1×1	3×3	1×1	5×5	5×5	3×3	5×5	5×5	1×1	7×7	7×7
	128	320	320	320	128	128	512	128	128	128	128	128	256	64	3

Our Architecture (Contd.)

- Training parameters:
  - 15 Layers CNN model
  - Padding: same
  - No. of Epochs: 20
  - Avg. time per epoch: 54 mins 12 sec
  - Batch size: 16
  - Optimizer: Adam
  - Activation Functions: ReLU, Sigmoid => last layer)
  - Loss: Mean squared loss (according to the paper)

Results

- Results per 5 Epoch intervals on validation set:
- Epoch 5:



Input Blur Image

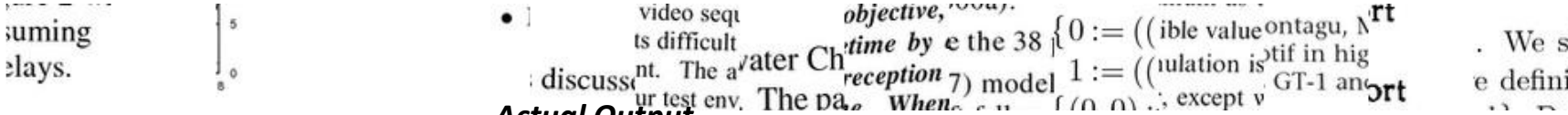
Actual Output

Predicted Output

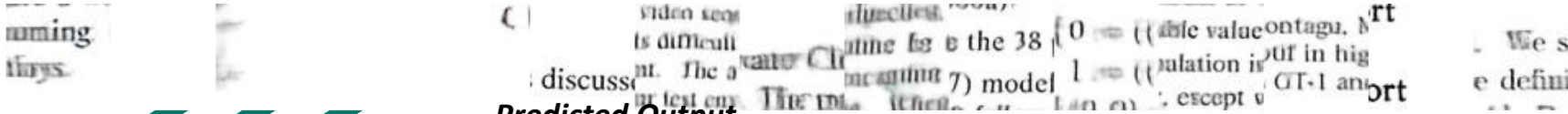
Results

- Epoch 10:

Input Blur Image



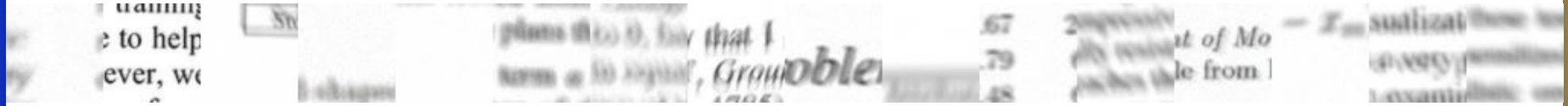
Actual Output



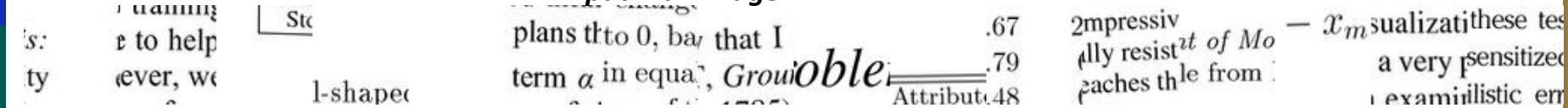
Predicted Output

Results

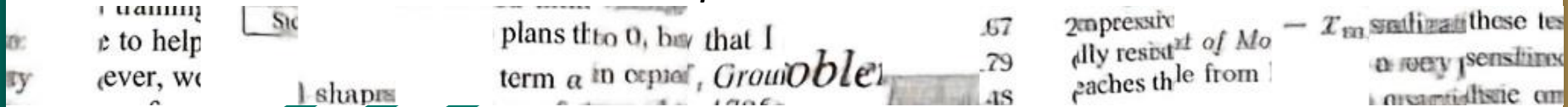
- Epoch 15:



Input Blur Image



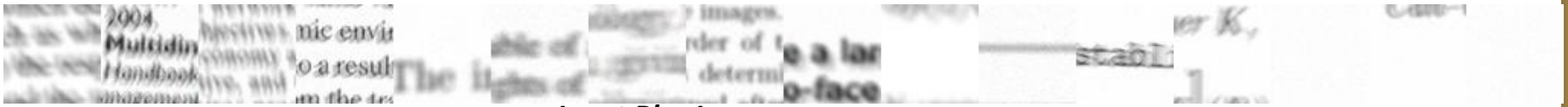
Actual Output



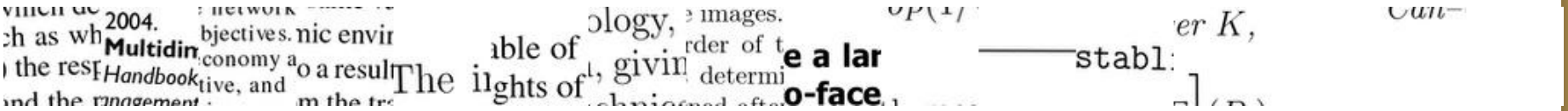
Predicted Output

Results

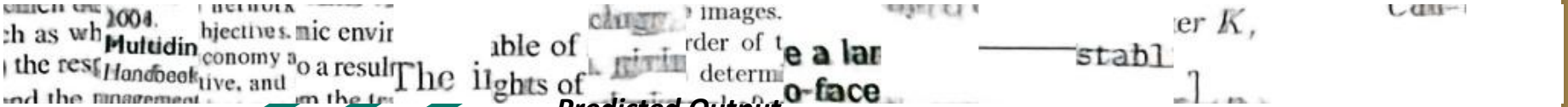
- Epoch 20:



Input Blur Image



Actual Output

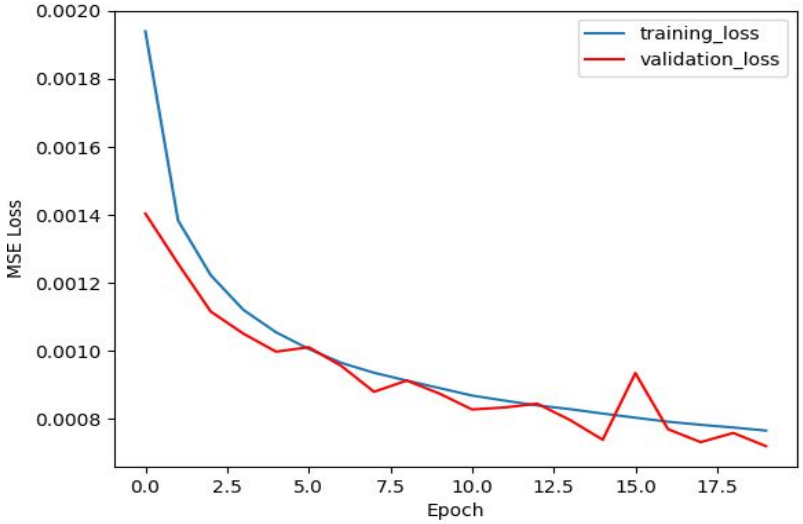


Predicted Output

Results

- From 64x64x3 (RGB input)
- To 64x64x3 (output)

Validation avg PSNR: 19.6 (final epoch)
Validation MSE: 0.000720 (final epoch)
- 0.001257 (first epoch)



Learning curve

Future Directions

- Training for more epochs
- Using recent architectures (U-Net, FCN)
- Regularization techniques (batch normalization, dropout)
- Hardware availability

References

[1]. https://www.semanticscholar.org/paper/The-Analysis-and-Implementation-of-Edge-Detection-Yang-Jin/c9c233dc29dd3f3b10a94e7fb0a0d28b2d47af08

[2] https://github.com/dair-ai/ml-visuals

[3] https://indoml.com/2018/03/07/student-notes-convolutional-neural-networks-cnn-introduction/

[4] https://livebook.manning.com/book/grokking-deep-learning-for-computer-vision/chapter-5/v-3/

[5] https://www.fit.vut.cz/research/publication-file/10922/hradis15CNNdeblurring.pdf

Thank you for the opportunity professor !!
We learnt a lot :)

Any Questions?