DATA.ML.300 Computer Vision Exercise 2

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1

a) The output of the hidden unit:
$net_h = w_1.i + b_1 = 1. - 2 + 2 = 0$
$y = \sigma(net_h) = \frac{1}{1+exp(-0)} = 0.5$

The output unit:
$out_o = w_2.out_h + b_2 = 0.5.4 + 0 = 2$

b) Loss result: $E = \frac{1}{2}(1-2)^2 = 0.5$

c) The derivative of the loss with respect to w_2:

$$\frac{\partial E}{\partial w_2} = \frac{\partial E}{\partial y} * \frac{\partial y}{\partial w_2}$$

$\frac{\partial E}{\partial y} = -1.(t-y) = -1.(1-2) = 1$

$\frac{\partial y}{\partial w_2} = y = 0.5$

Therefore, $\frac{\partial E}{\partial w_2} = 1 * 0.5 = 0.5$

c) The derivative of the loss with respect to w_1:

$$\frac{\partial E}{\partial w_1} = \frac{\partial E}{\partial out_h} * \frac{\partial out_h}{\partial net_h} * \frac{\partial net_h}{\partial w_1}$$

$\frac{\partial E}{\partial out_h} = \frac{\partial E}{\partial y} * \frac{\partial y}{\partial out_h} = 1 * w_2 = w_2 = 4$

$\frac{\partial out_h}{\partial net_h} = out_h(1 - out_h) = 0.5(1 - 0.5) = 0.25$

$\frac{\partial net_h}{\partial w_1} = i = 1$

Therefore, $\frac{\partial E}{\partial w_1} = 4 * 0.25 * 1 = 1$

2

a) Euclidean distance

$\mathbf{Q}$ and $\mathbf{A} = \begin{bmatrix}1 & 1 & 9 & 0 & 1\end{bmatrix}^T = \sqrt{12} = 3.46$

$\mathbf{Q}$ and $\mathbf{B} = \begin{bmatrix}1 & 0 & 4 & 9 & 9\end{bmatrix}^T = \sqrt{23} = 4.79$

Cosine similarity

$\mathbf{Q}$ and $\mathbf{A}$

$\mathbf{Q} \cdot \mathbf{A} = \begin{bmatrix}2 & 2 & 18 & 16 & 2\end{bmatrix}^T = 40$

$||\mathbf{Q}||\ .\ ||\mathbf{A}|| = \sqrt{61}\sqrt{31} = 43.49$

$\cos\theta = \frac{40}{43.49} = 0.92$

$\mathbf{Q}$ and $\mathbf{B}$

$\mathbf{Q} \cdot \mathbf{B} = \begin{bmatrix}6 & 1 & 24 & 4 & 10\end{bmatrix}^T = 45$

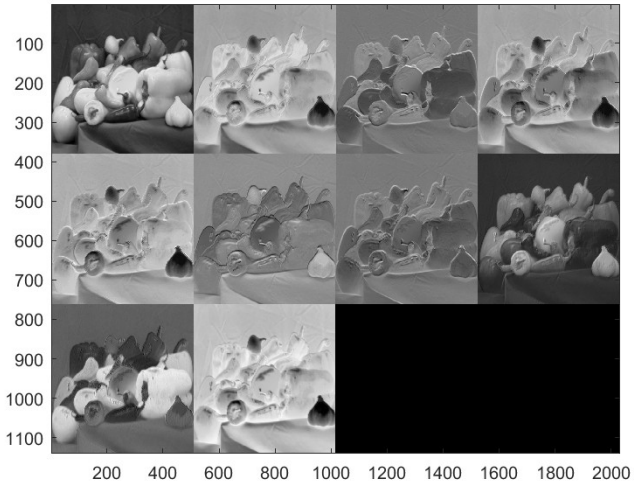
$||\mathbf{Q}||\ .\ ||\mathbf{B}|| = \sqrt{61}\sqrt{52} = 56.32$

$\cos\theta = \frac{45}{56.32} = 0.79$

b) The image $\mathbf{A}$ is more similar to the query image $\mathbf{Q}$ because it has a shorter Euclidean distance and a higher value of cosine similarity.

3

MATLAB answers


100
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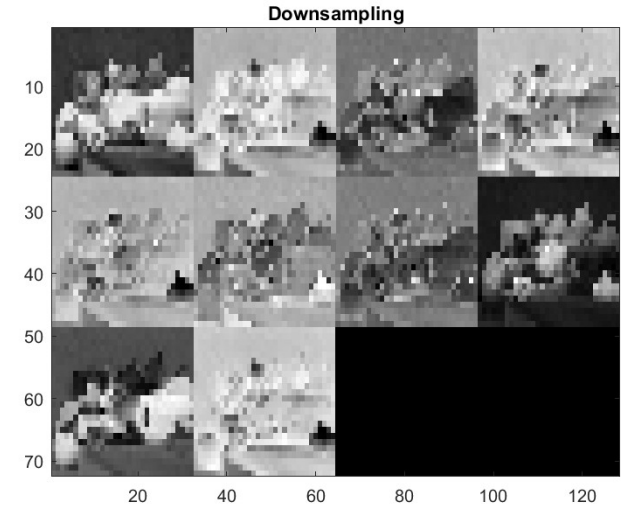
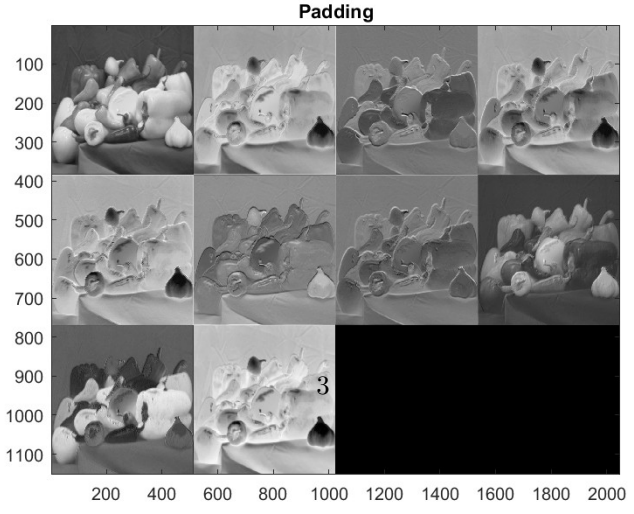
1200
1400
1600
1800
2000


Downsampling
10
20
30
40
50
60
70
20
40
60
80
100
120


Padding
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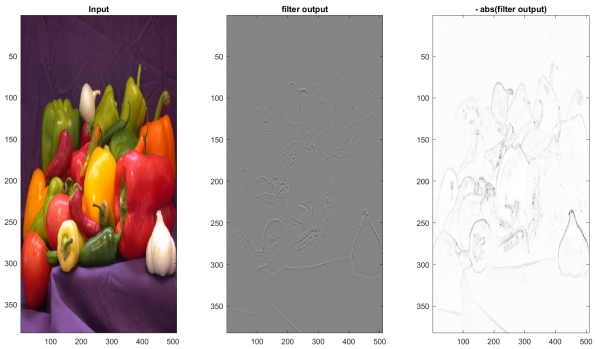
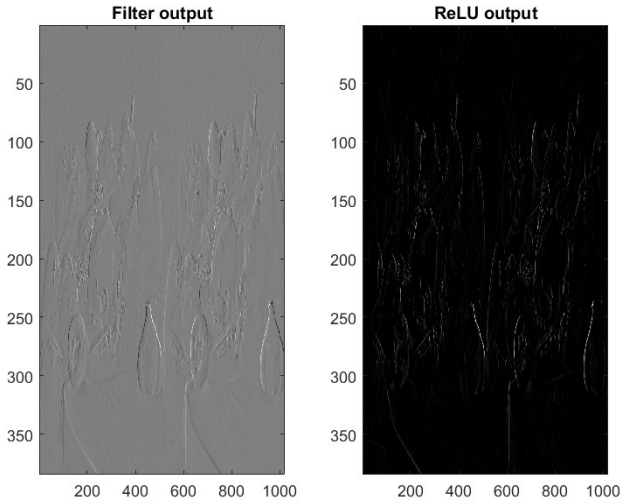
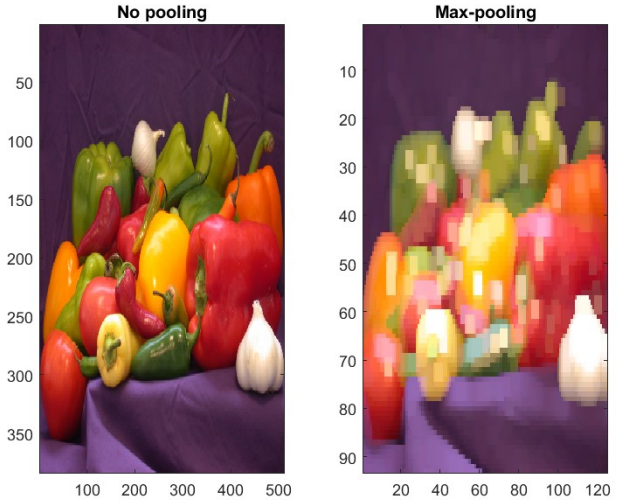

Input
filter output
- abs(filter output)


Filter output
ReLU output


No pooling
Max-pooling

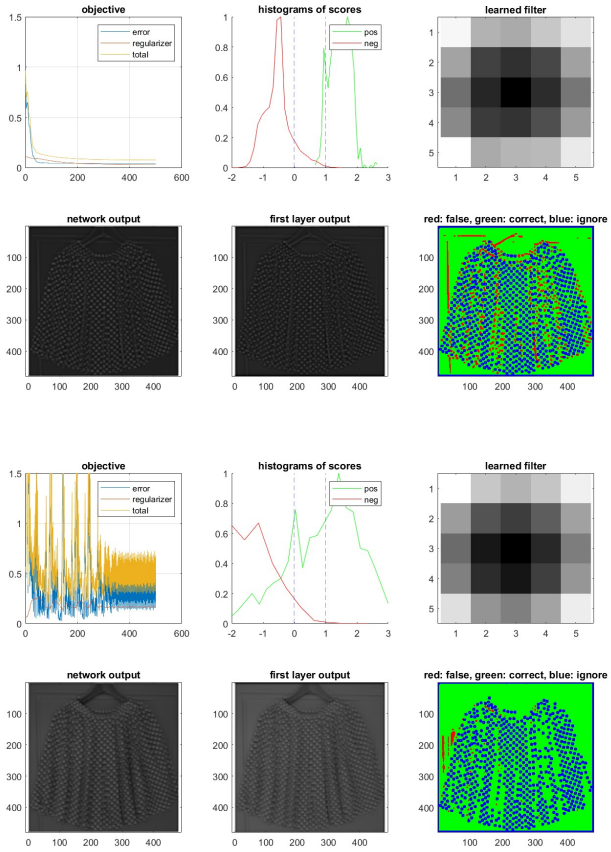


Figure 1: Doubled learning rate

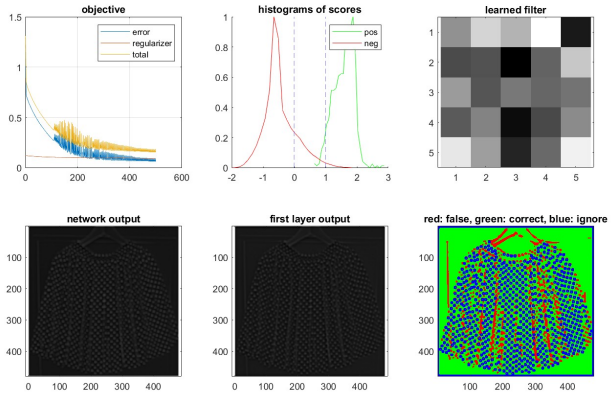


Figure 2: no momentum