

Max pooling



## Step 2 - Max Pooling

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A solid black horizontal bar, likely a placeholder for an image or a redacted section of the slide.

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*Image Source: Wikipedia*

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Why pooling? Because we want our neural network recognize every single one of the pictures.

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And also, we want to recognize all of the pictures above as cheetahs. Because their positions, lighting and so many other things are different.

For example, one of the features of the cheetahs is the tear shape below its eyes. And to be sure that we can recognize this feature in different positions, we should use a property called spatial invariance what does that mean is that it doesn't care anymore if the feature is in different angles.

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0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

Feature Map

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0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

Feature Map

Max Pooling


Pooled Feature Map

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0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

Feature Map

Max Pooling

1		

Pooled Feature Map

## Step 2 - Max Pooling

0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

Feature Map

Max Pooling

1	1	

Pooled Feature Map

## Step 2 - Max Pooling

0	1	0	0	0	
0	1	1	1	0	
1	0	1	2	1	
1	4	2	1	0	
0	0	1	2	1	

Feature Map

Max Pooling

1	1	0

Pooled Feature Map

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0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

Feature Map

Max Pooling

1	1	0
4		

Pooled Feature Map

## Step 2 - Max Pooling

0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

Feature Map

Max Pooling

1	1	0
4	2	

Pooled Feature Map

## Step 2 - Max Pooling

0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

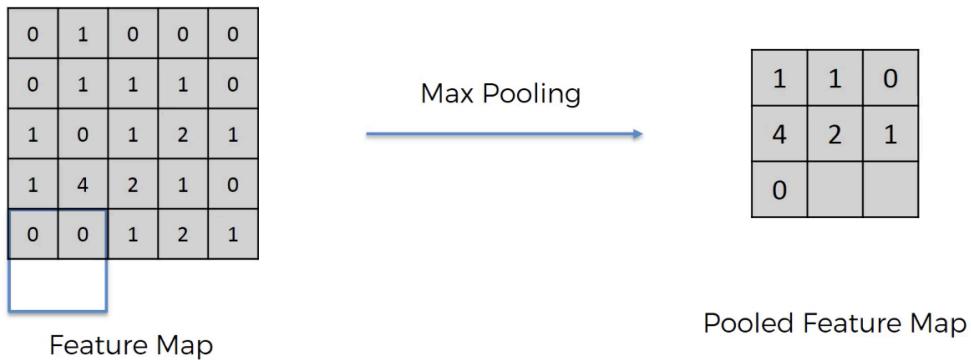
Feature Map

Max Pooling

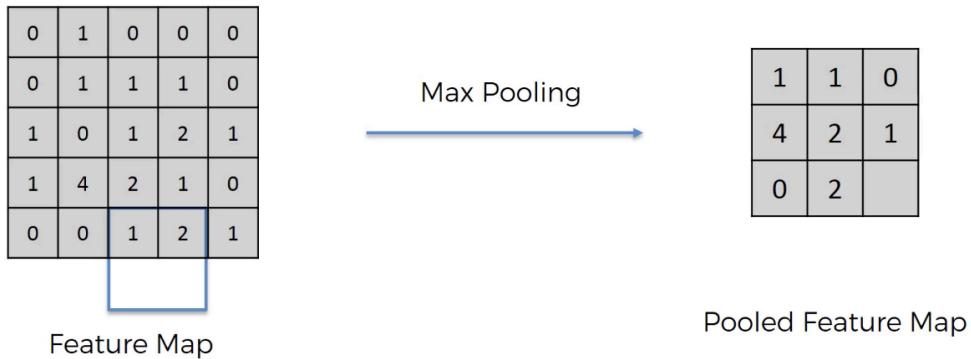
1	1	0
4	2	1

Pooled Feature Map

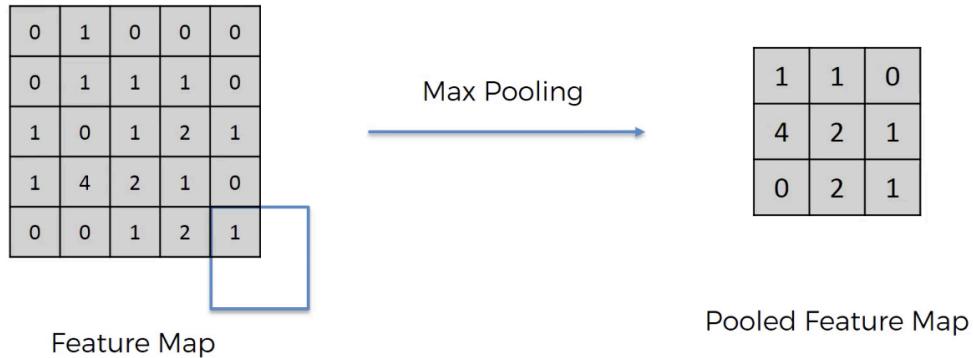
## Step 2 - Max Pooling



## Step 2 - Max Pooling



## Step 2 - Max Pooling



As you can see we make the picture more flexible in here. For example, for the tear shape in cheetahs we don't mind if it rotates one pixel to the left or right.

Benefits of pooling:

1. Preserve the feature for their possible spatial or textural or other kind of distortion.
2. reducing the size (by 75% in here)
3. introducing spatial invariant
4. reducing the number of parameters and preventing overfitting

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Additional Reading:

*Evaluation of Pooling Operations in Convolutional Architectures for Object Recognition*

By Dominik Scherer et al. (2010)

Link:

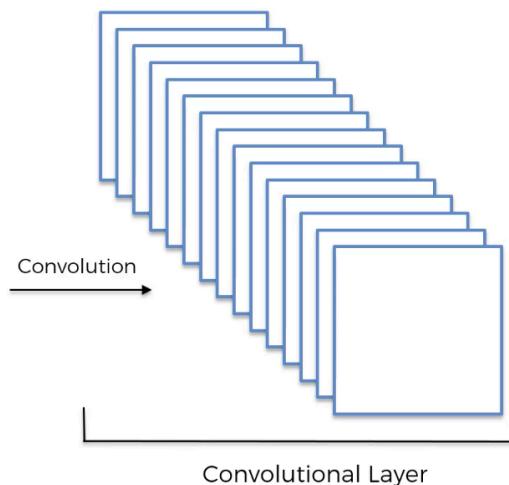
[http://ais.uni-bonn.de/papers/icann2010\\_maxpool.pdf](http://ais.uni-bonn.de/papers/icann2010_maxpool.pdf)



## Step 2 - Max Pooling

0	0	0	0	0	0	0	0
0	1	0	0	0	1	0	
0	0	0	0	0	0	0	
0	0	0	1	0	0	0	
0	1	0	0	0	1	0	
0	0	1	1	1	0	0	
0	0	0	0	0	0	0	

Input Image

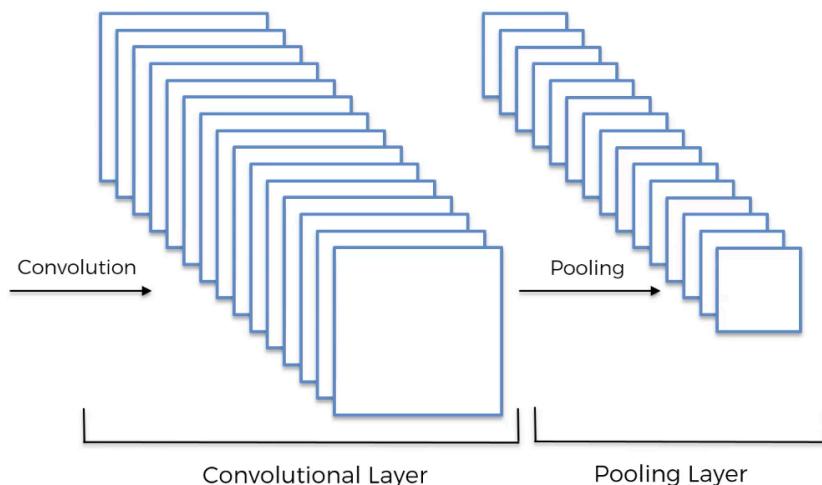


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0	0	0	0	0	0	0	0
0	1	0	0	0	1	0	
0	0	0	0	0	0	0	
0	0	0	1	0	0	0	
0	1	0	0	0	1	0	
0	0	1	1	1	0	0	
0	0	0	0	0	0	0	

Input Image



Pooling Layer

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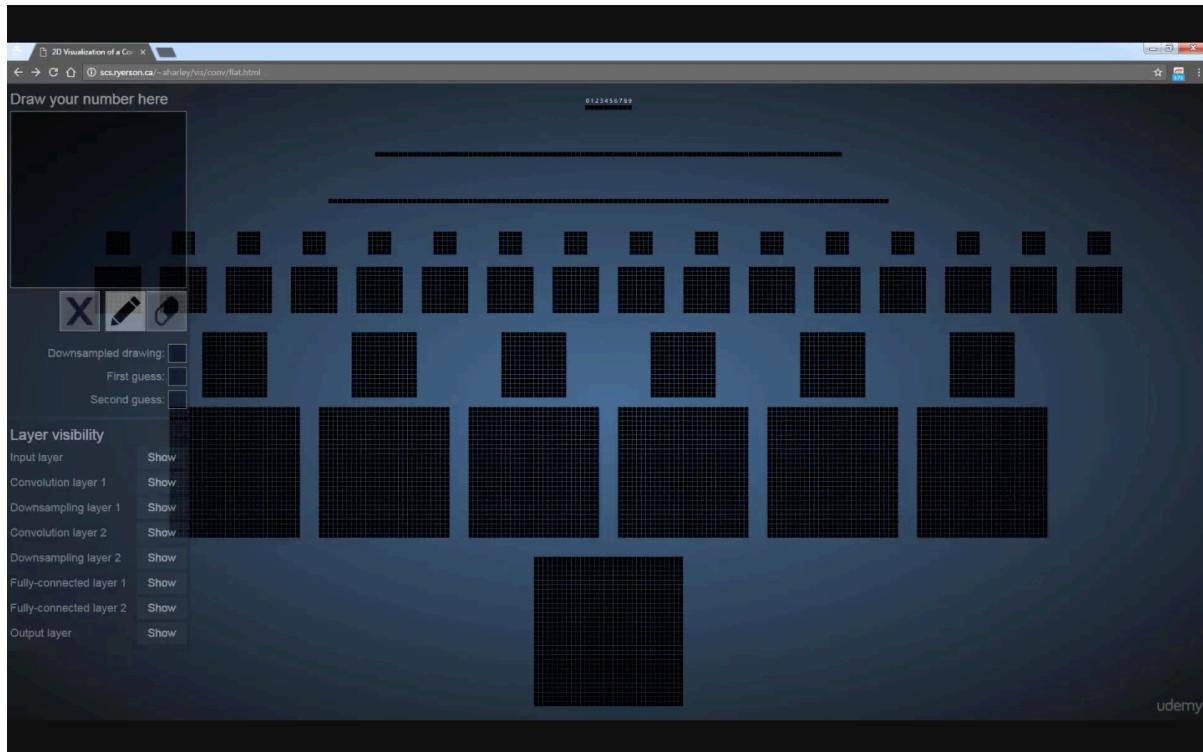
# Example

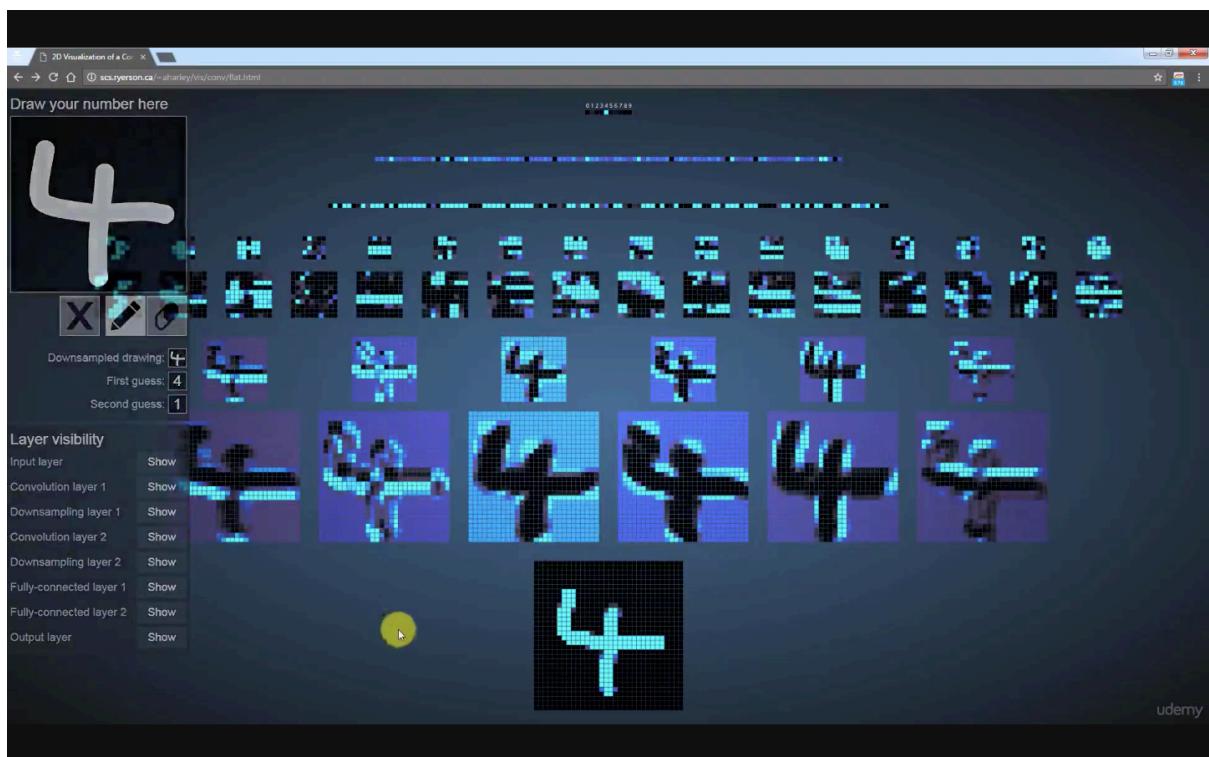
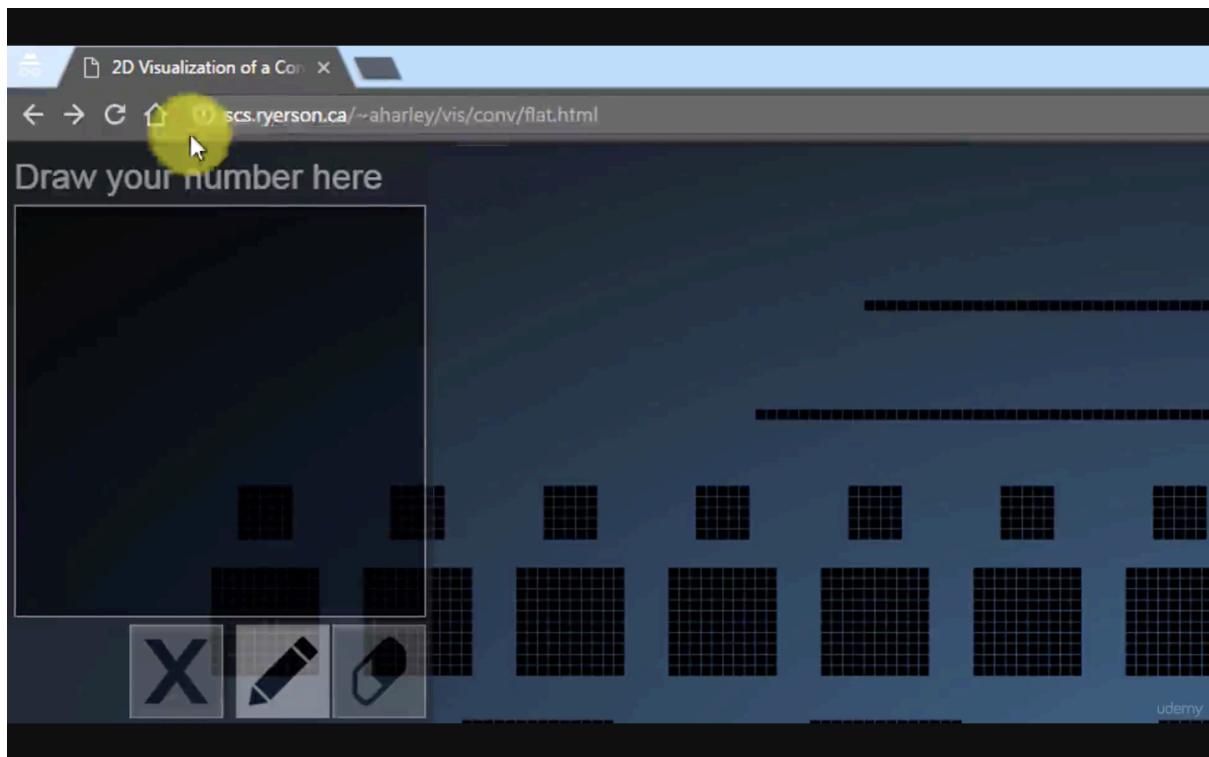


Image Source: [scs.ryerson.ca/~aharley/vis/conv/flat.html](http://scs.ryerson.ca/~aharley/vis/conv/flat.html)

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the first box in the bottom is the handwriting. The second row is the convolution and third is pooling. Pooling also called down sampling.

The number in above is its guess for the number.

If you hover over convolution or to the pooling you can see its previous used pixels.