Applied Machine Learning

Convolutional Neural Networks

Convolutional Neural Networks

- Receptive field

- Deep Convolutional Neural Network for Image Classification

- Preprocessing images

Stacking Convolutional Layers

- Stacks of convolutional layers

  - Input: $x \times y \times 1$ $\qquad 12 \times 12 \times 1$

  - Layer 1: Convolutional + ReLU

    - strides 3, kernel $\qquad 3 \times 3 \times 1$

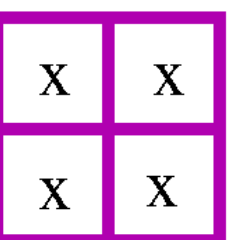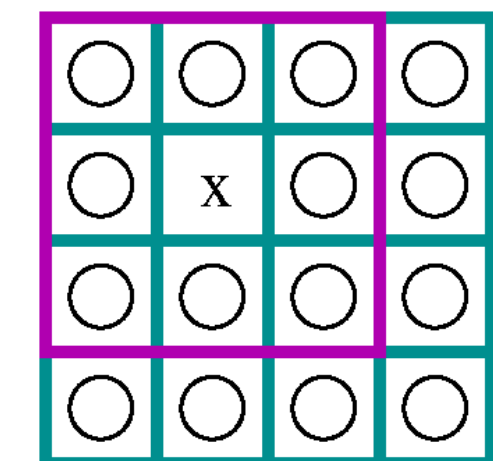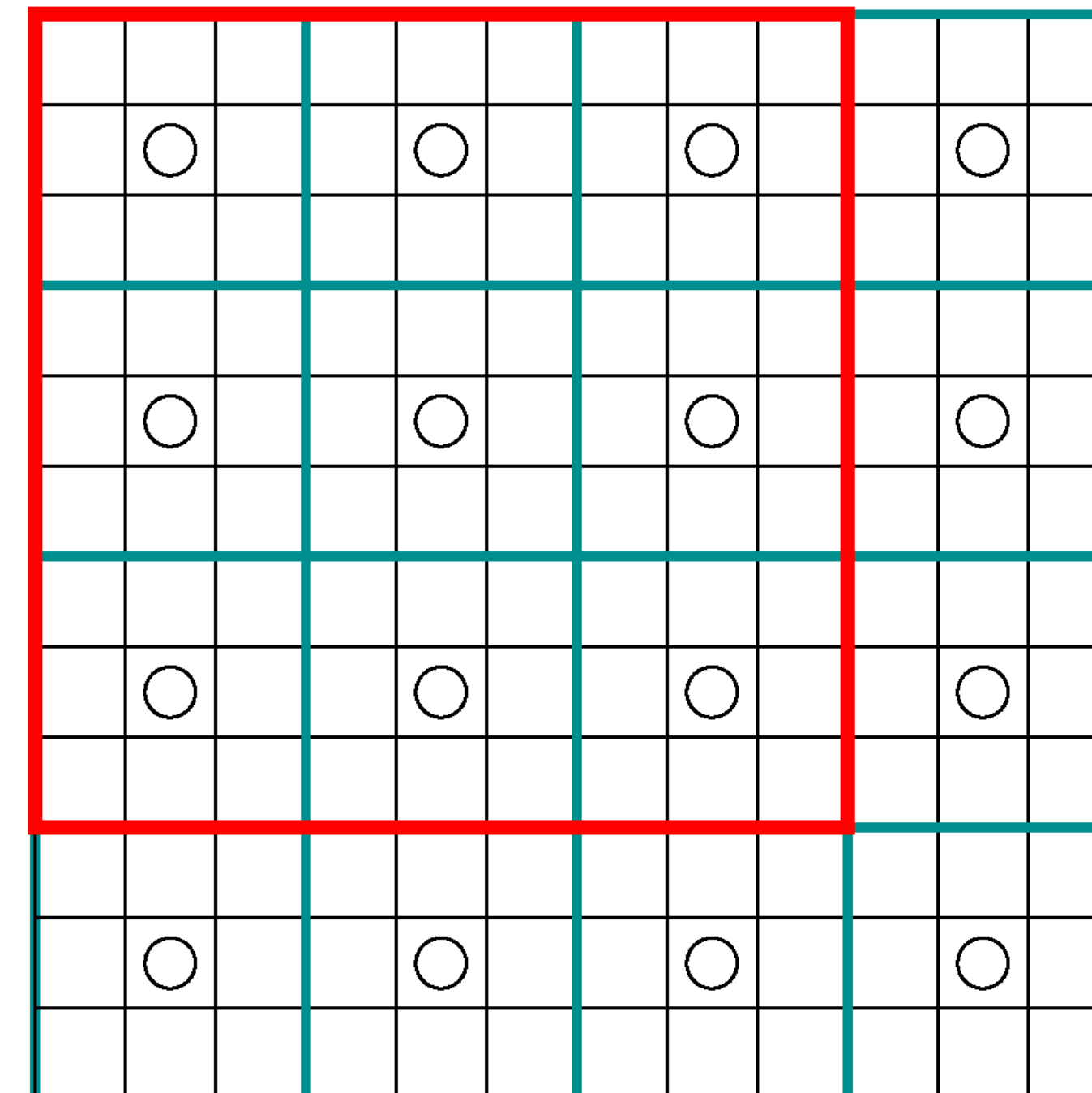   - Output $\dfrac{x}{3} \times \dfrac{y}{3} \times 1$ $\qquad 4 \times 4 \times 1$

    - Receptive field: $\qquad 3 \times 3$

  - Layer 2: Convolutional + ReLU

   - strides 2, kernel $\qquad 3 \times 3 \times 1$

    - Output: $\dfrac{x}{2} \times \dfrac{y}{2} \times 1$ $\qquad 2 \times 2 \times 1$

    - Receptive field: $\qquad 9 \times 9$

Stacking Layers and Receptive Fields

- The size of the Receptive Field

  - depends on kernel size and stride length at all previous layers

- Resolution:

  - from finer grain to coarser grain

- Receptive field in Pooling Layer is similar

  - stride length and patch size

- Frequently

  - Layer 1: stride lenght of 1, kernels: n

  - Next layers: stride length of 2 or more, kernels: increase by some factor, at least 2
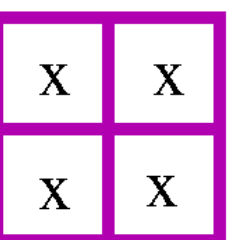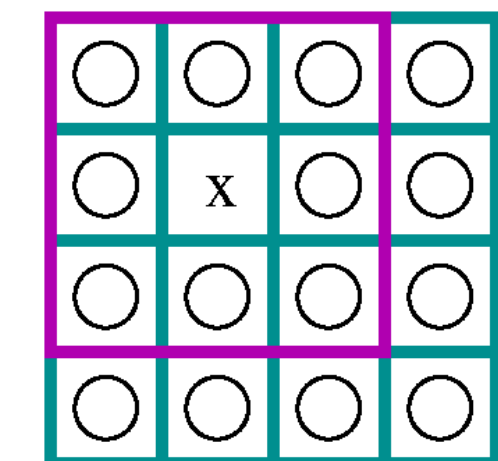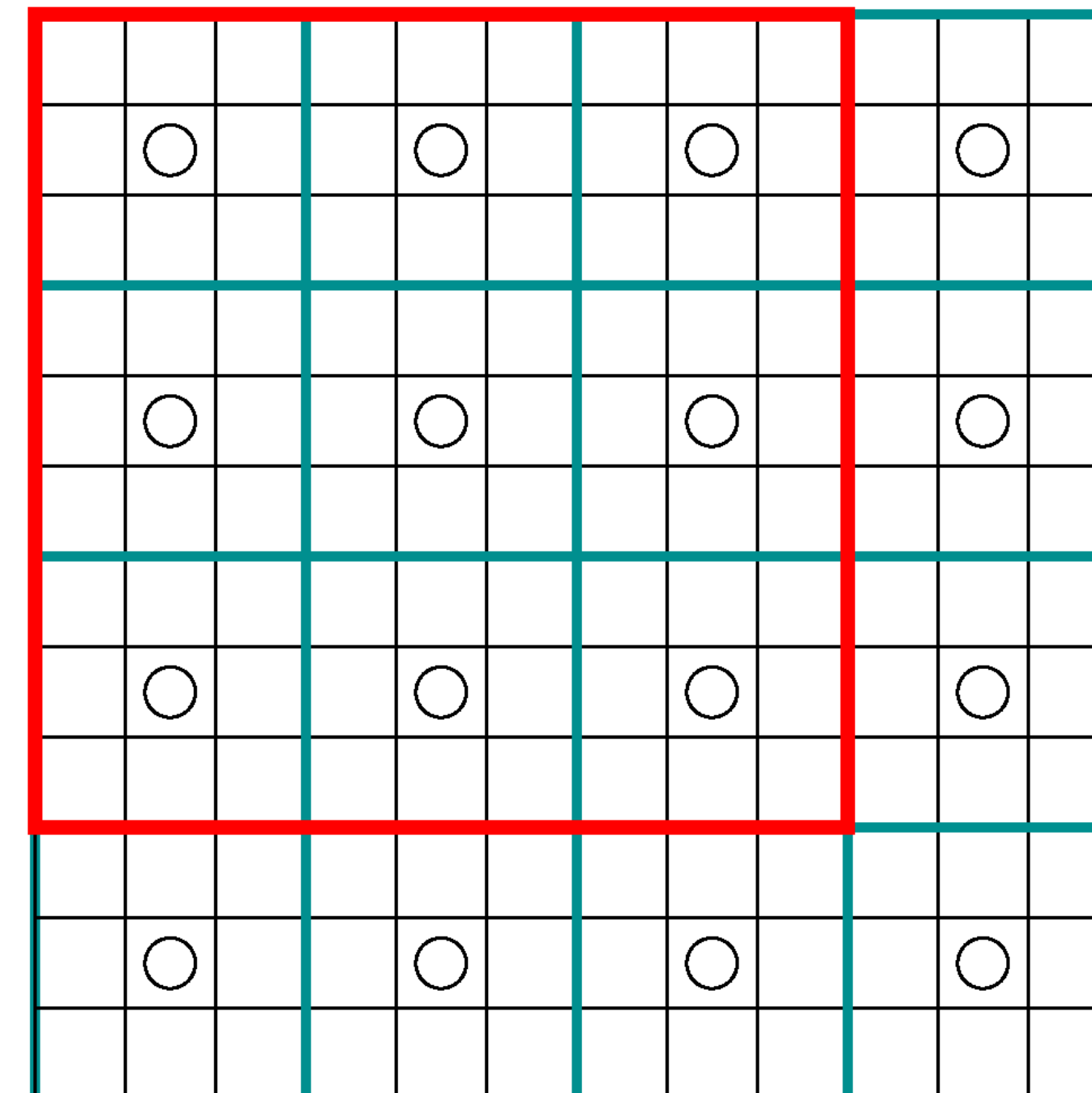
Image Classification

- Image classification

  - Input: Image $x \times y \times c$

  - Input Layer: Convolutional + ReLU, stride 1

  - Intermediate Layers:

    - Convolutional: stride 2 or more, occasionally 1

    - Non-linear (ReLU or others)

    - Pooling: stride 2, patch $[2 \times 2]$

    - One last fully connected layer + ReLU to flatten

  - Output Layer: Fully Connected + ReLU + softmax

    - One output per class

    - dropout probability

x,y,f

Conv+ReLU:[Kx,Ky,c],f, stride 1 , padding

Input x,y,c
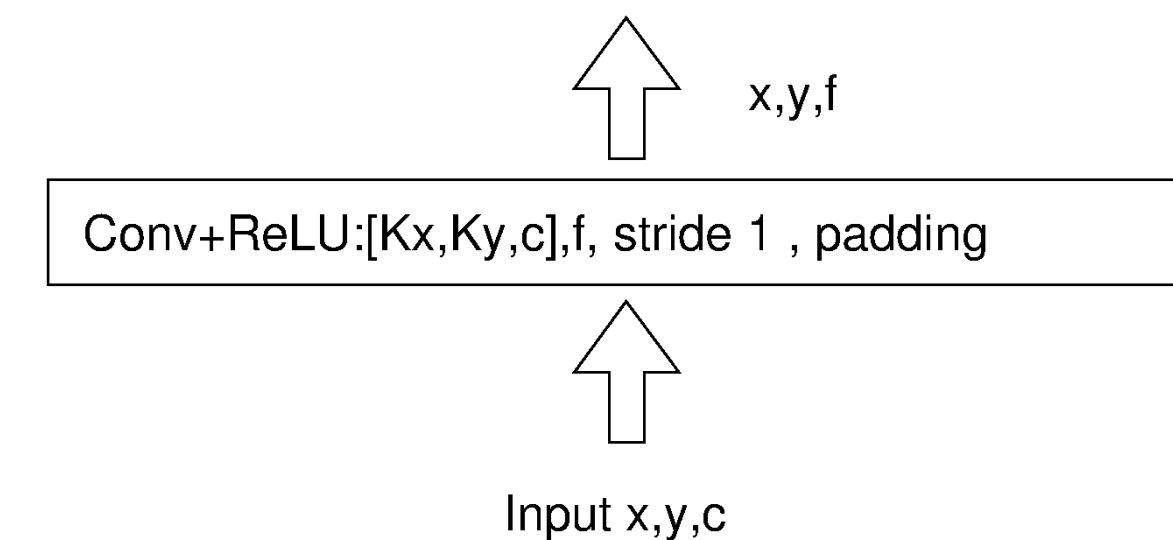
Image Classification

- Training

  - Input dataset

    - large and representative

    - if different networks will be compared, they should be trained with the same dataset

  - preprocessing input

    - size

    - normalization

    - channels

    - brightness

    - images with dominant colors

      - $pixel_{i,j} - mean_{i,j}$

  - hardware: GPUs allow parallelization
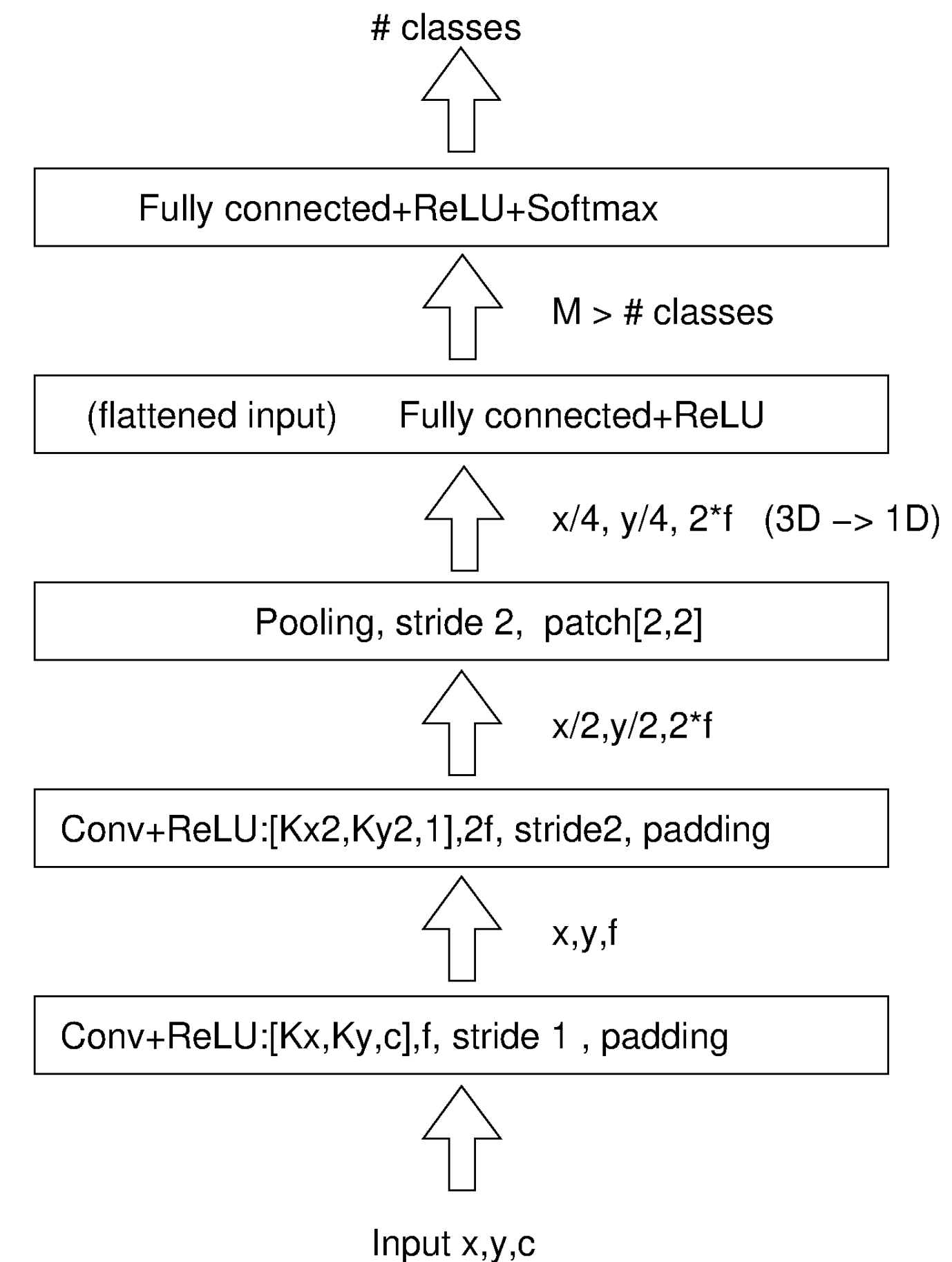
classes

⬆

Fully connected+ReLU+Softmax

⬆ M > # classes

(flattened input)   Fully connected+ReLU

⬆ x/4, y/4, 2*f (3D –> 1D)

Pooling, stride 2, patch[2,2]

⬆ x/2,y/2,2*f

Conv+ReLU:[Kx2,Ky2,1],2f, stride2, padding

⬆ x,y,f

Conv+ReLU:[Kx,Ky,c],f, stride 1 , padding

⬆

Input x,y,c

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