Neural Networks and Deep Learning: Introduction to Convolutionnal Neural Networks

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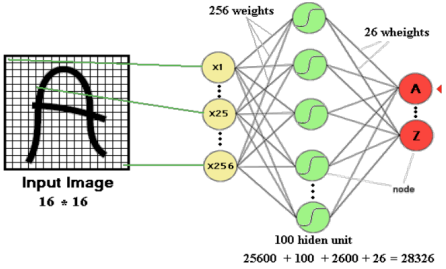
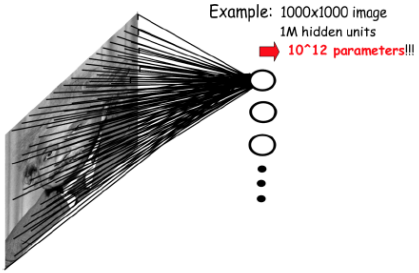
Limitations of Fully Connected Networks

- Scalability issue with Fully Connected Networks (MLP)

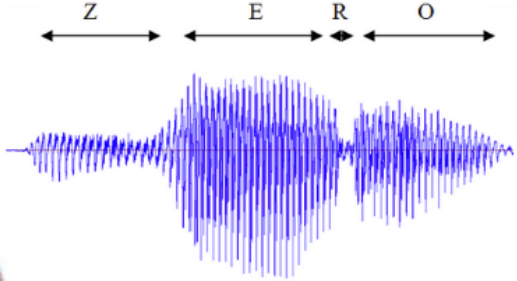


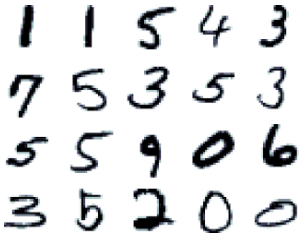


⇒ # **Parameter explosion even for a single hidden layer !**

Limitations of Fully Connected Networks

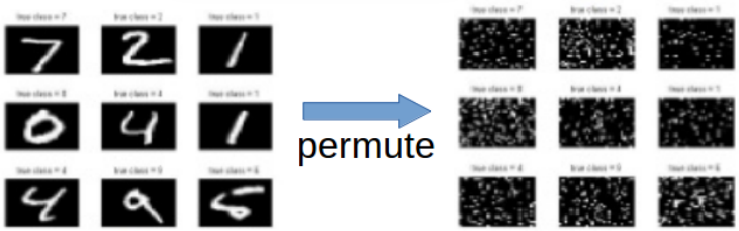
- **Signal data: importance of local structure**
  - 1D signals: local temporal structure
  - 2D signal data: local spatial structure





Limitations of Fully Connected Networks

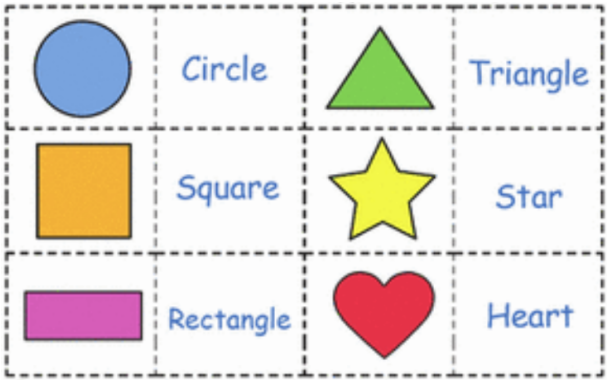
- **BUT: vectorial representation of inputs: dimensions are arbitrary!**



- Ex: MNIST classification
  - **Same performances with initial and permuted images!**
  - **Local spatial information is however obviously useful**

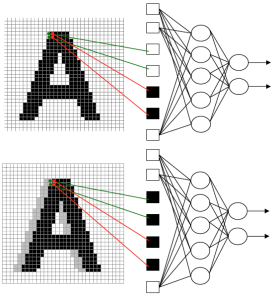
Limitations of Fully Connected Networks

- **Prior knowlege on data structure ⇒ useful**
- Example: MLP training for shape recognition from color images



Limitations of Fully Connected Networks

- **Invariance & robustness to deformations (stability)**
- Expectations:
  - Small deformation ⇒ similar representations
  - Large deformation ⇒ dissimilar representations
- Translation invariance difficult with Fully Connected Networks (not encoded in the network) ~ local scale, rotation, deformations, *etc*



154 input change
from 2 shift left
77 : black to white
77 : white to black

Convolutionnal Neural Networks

Overcome most of the aforementioned limitations:

- Able to significantly limit the number of free parameters
- Explicitly focus on local structure of the signal
- Able to gain invariance to local deformations
- All parameters remain trainable with error back-propagation