Deep Learning

Redes Neurais Convulocionais

Aula 6

Bom dia!

Eu sou Diego Dorgam

Alguma pergunta que você quer fazer?!

http://bit.ly/dl-unb6
https://t.me/DeepLearningUnB
@diegodorgam

Instruções Gerais

- ✓ Traga seu laptop
- ✓ Use Software Livre
- ✓ Não converse por voz
- ✓ Se não entender, pergunte!
- ✓ Se entender, explique!
- ✓ DIVIRTA-SE

O que Aprendemos na aula passada?

1. Intuição
    - Gradient Descent
    - Stochastic Gradient Descent
    - BackPropagation
    - Cross Validation
2. Prática
    - Evaluation
    - Improving
    - Tuning

O que vamos Aprender?

1. Intuição
    - O que são CNNs
    - Convolution Operation
    - Pooling
    - Flattening
    - Full Connection
2. Prática
    - Reconhecimento de imagens

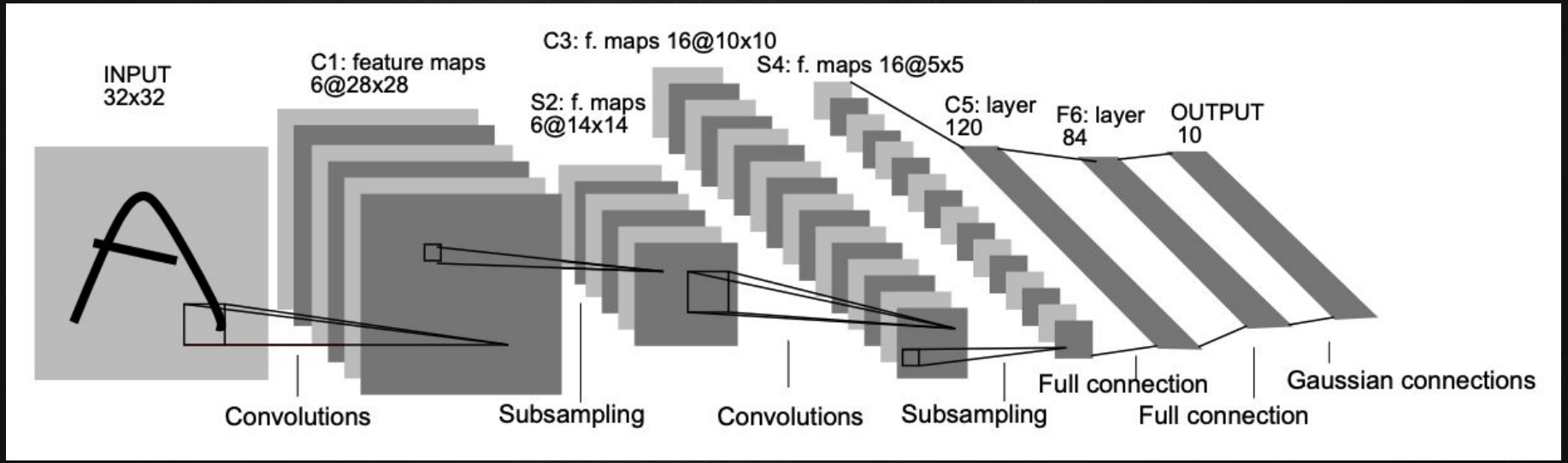
O que são CNNs

Redes Neurais Convolucionais

CNNs


CNNs

Gradient-Based Learning Applied to Document Recognition
Yann LeCun (1998)



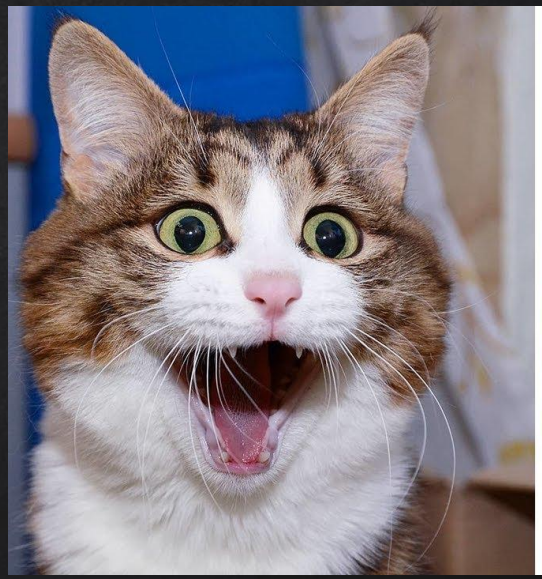
http://yann.lecun.com/exdb/publis/pdf/lecun-01a.pdf

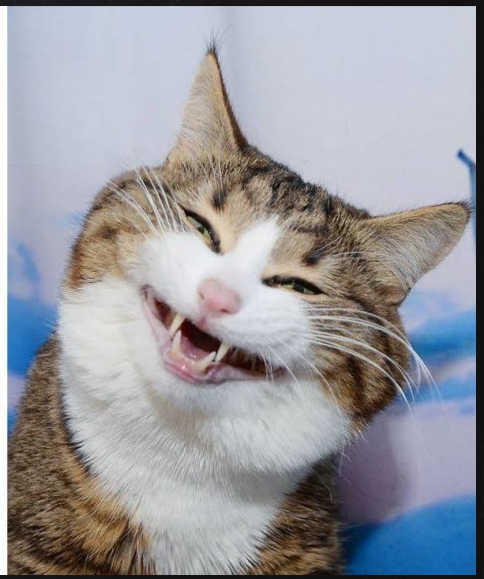
$$(f * g)(t) \stackrel{\text{def}}{=} \int_{-\infty}^{\infty} f(\tau)\, g(t-\tau)\, d\tau$$

Entendeu agora?


CNNs

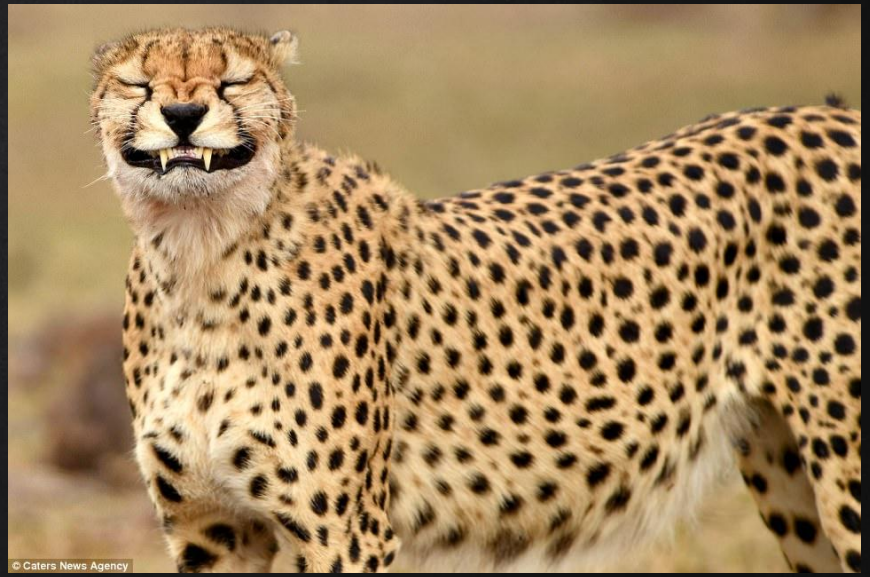
CNNs



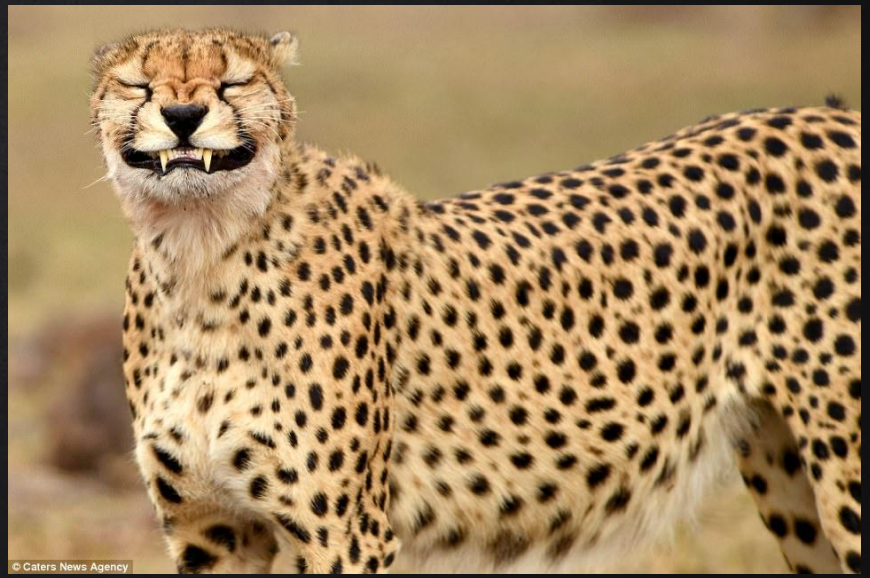



CNNs

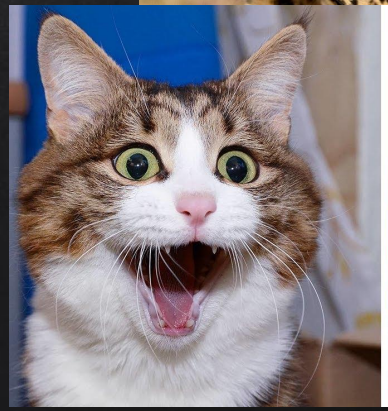

CNNs

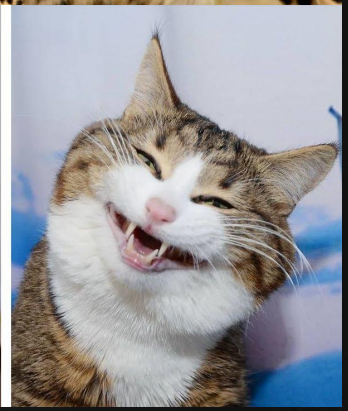

© Caters News Agency


CNNs


© Caters News Agency

CNNs





FEATURES

CARACTERÍSTICAS

Convolution Operation

Redes Neurais Convolucionais

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1				

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3			

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3		

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3	1	

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3	1	2

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3	1	2
1				

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3	1	2
1	2			

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3	1	2
1	2	3		

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3	1	2
1	2	3	1	

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3	1	2
1	2	3	1	2

Feature Map

Feature Mapping

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

Input Image

⊗

0	0	1
1	0	0
1	1	0

Feature Detector

=

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Feature Mapping

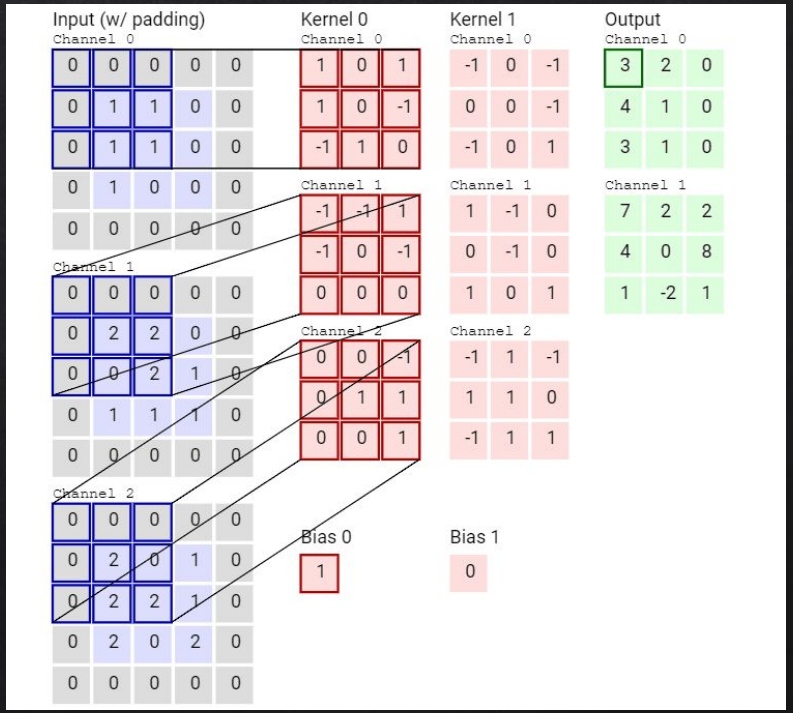
Image Matrix

1=1x1	**0**=0x0	**0**=0x0	1	1
1=1x1	**0**=0x0	**0**=1x0	1	1
0=0x0	**1**=1x1	**1**=1x1	0	1
0	1	0	1	0
1	1	1	0	1

Convolved Matrix

4		

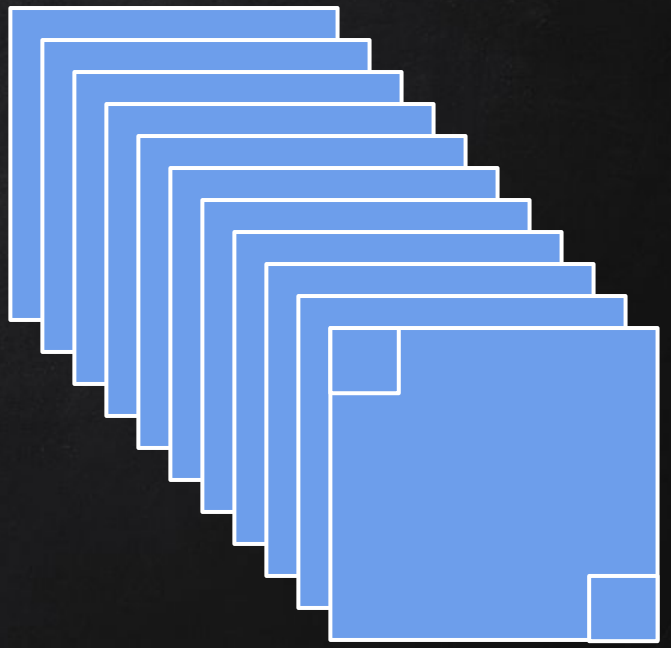
Feature Mapping



Feature Mapping

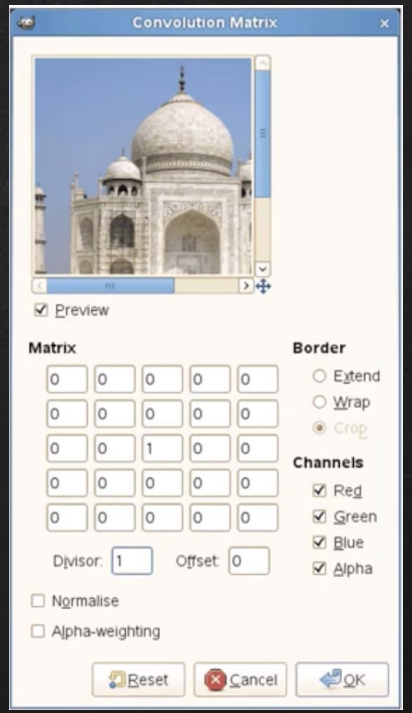
1	0	0	1	1	0	0
1	1	0	0	1	0	1
0	0	1	1	0	1	1
0	1	1	0	0	1	0
1	0	0	1	1	0	1
0	1	1	0	1	0	0
0	0	0	1	1	1	0

Input Image



Convolutional layer

Feature Mapping



Feature Mapping

0	0	0	0	0
0	0	-1	0	0
0	-1	5	-1	0
0	0	-1	0	0
0	0	0	0	0

Sharpen

Feature Mapping

0	0	0	0	0
0	0	0	0	0
0	-1	1	0	0
0	0	0	0	0
0	0	0	0	0

Edge Enhance

Feature Mapping

0	0	0	0	0
0	-2	-1	0	0
0	-1	1	1	0
0	0	1	2	0
0	0	0	0	0

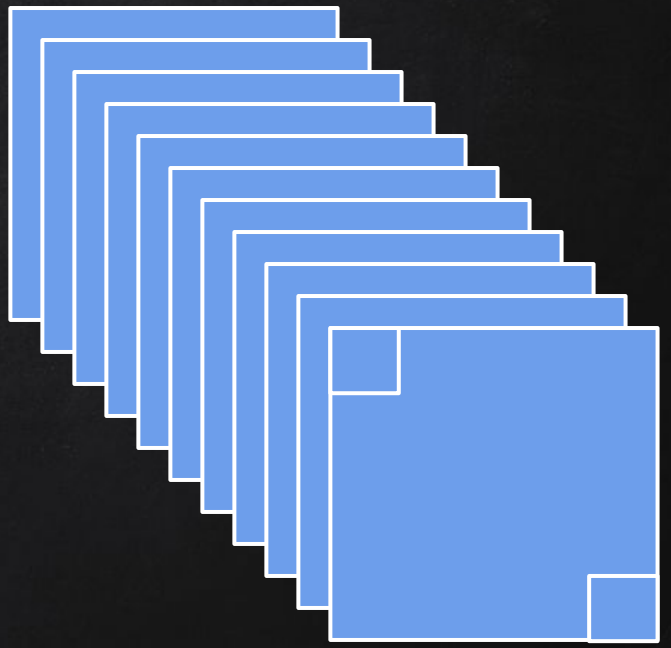
Emboss

Entendeu mesmo?

Feature Mapping

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

Input Image

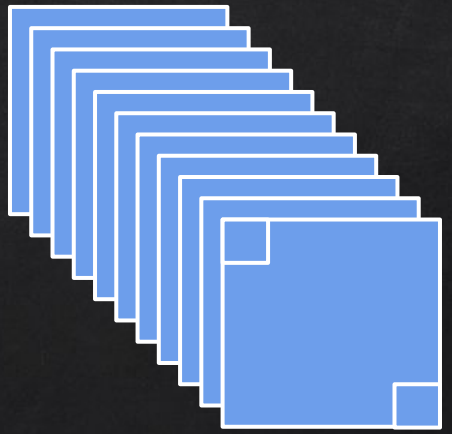


Convolutional layer

ReLU Layer

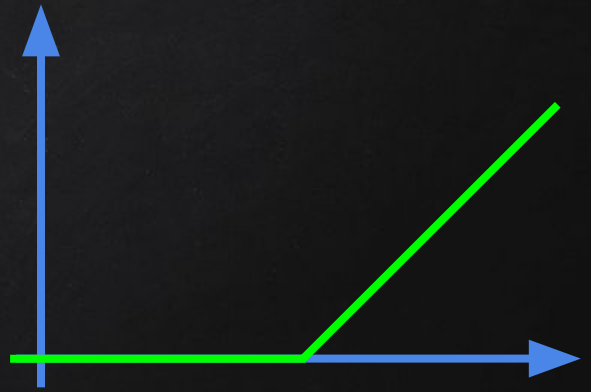
1	0	0	1	1	0	0
1	1	0	0	1	0	1
0	0	1	1	0	1	1
0	1	1	0	0	1	0
1	0	0	1	1	0	1
0	1	1	0	1	0	0
0	0	0	1	1	1	0

Input Image



Convolutional layer

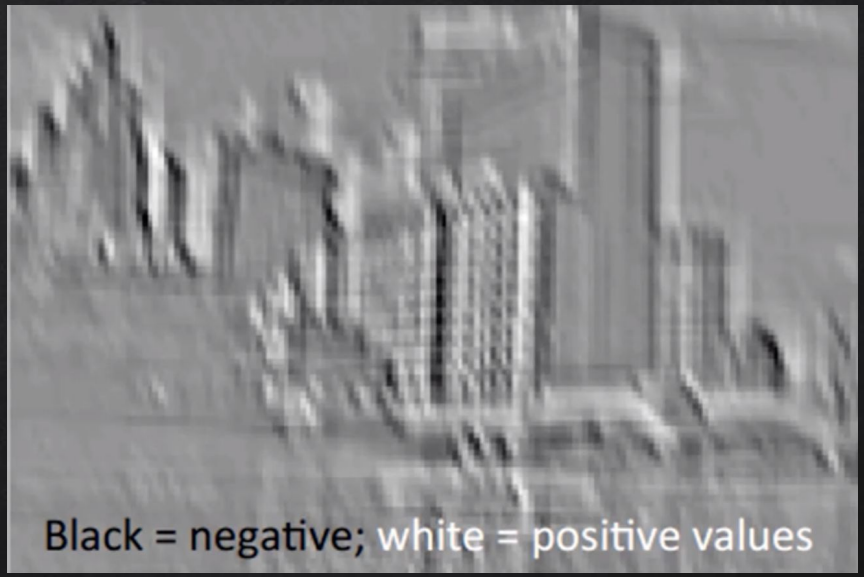
$$\phi(x) = \max(x, 0)$$



ReLU layer

ReLU Layer

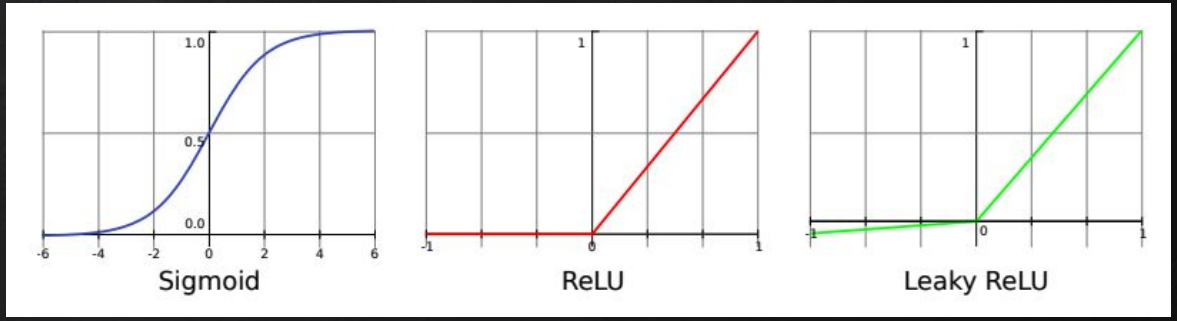
ReLU Layer



ReLU Layer

Understanding Convolutional Neural Networks with aa Mathematical Model

Jay Kuo (2016)



https://arxiv.org/pdf/1609.04112.pdf

Max Pooling

Redes Neurais Convolucionais

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3		

Pooled Feature Map

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3	3	

Pooled Feature Map

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3	3	2

Pooled Feature Map

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3	3	2
3		

Pooled Feature Map

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3	3	2
3	3	

Pooled Feature Map

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3	3	2
3	3	2

Pooled Feature Map

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3	3	2
3	3	2
2		

Pooled Feature Map

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3	3	2
3	3	2
2	3	

Pooled Feature Map

Feature Mapping

1	3	3	1	2
1	2	3	1	2
2	2	2	2	2
3	2	1	3	2
0	2	3	2	4

Feature Map

Max Pooling

3	3	2
3	3	2
2	3	4

Pooled Feature Map

Vamos ver

http://scs.ryerson.ca/~aharley/vis/

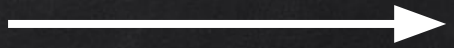
Flattening

Redes Neurais Convolucionais

3	3	2
3	3	2
2	3	4

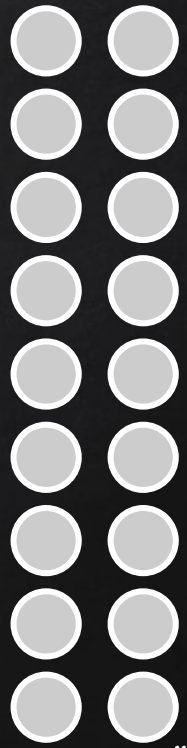
Pooled Feature Map

Flattening



Pooled Feature Maps

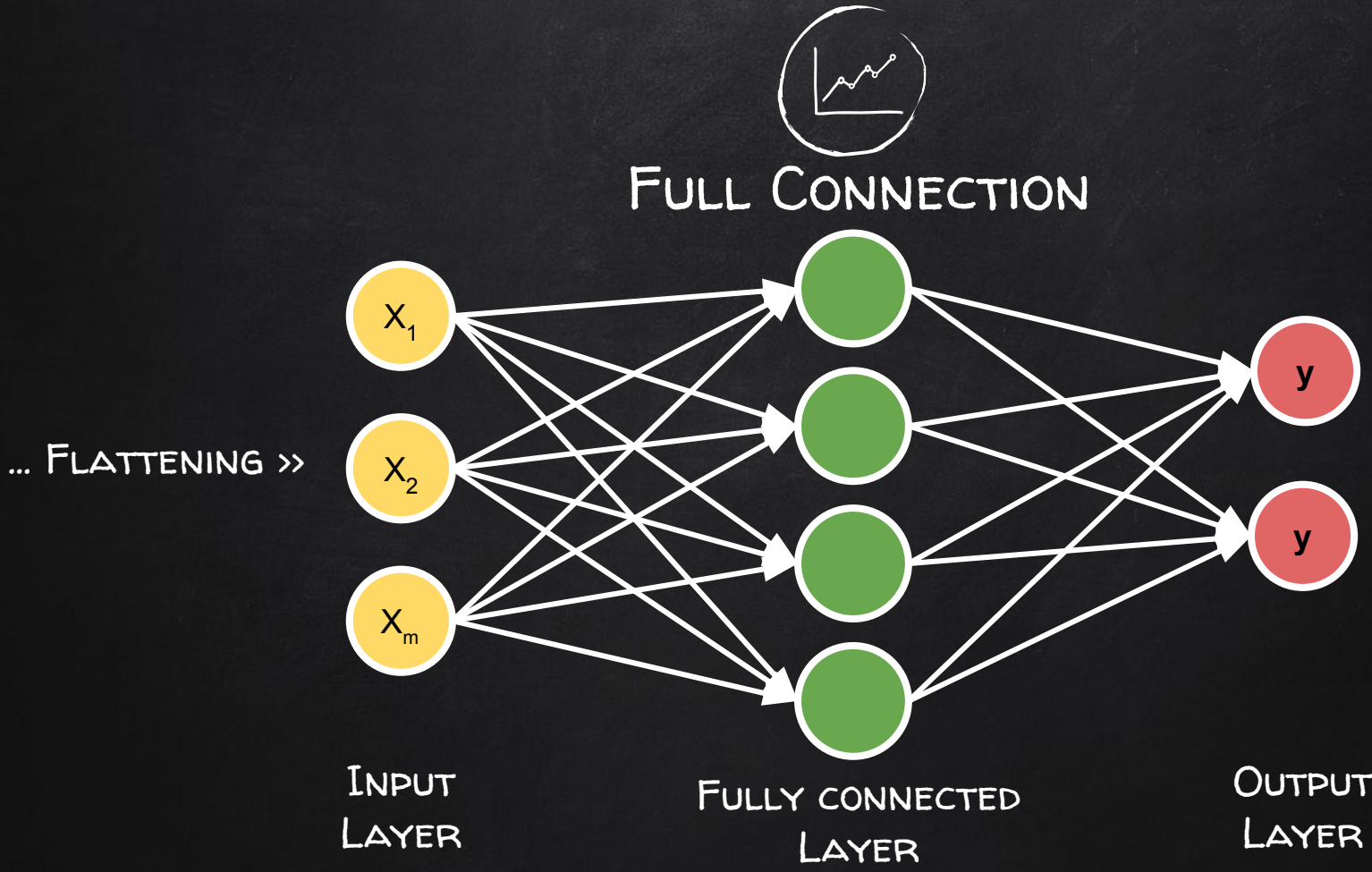
Flattening

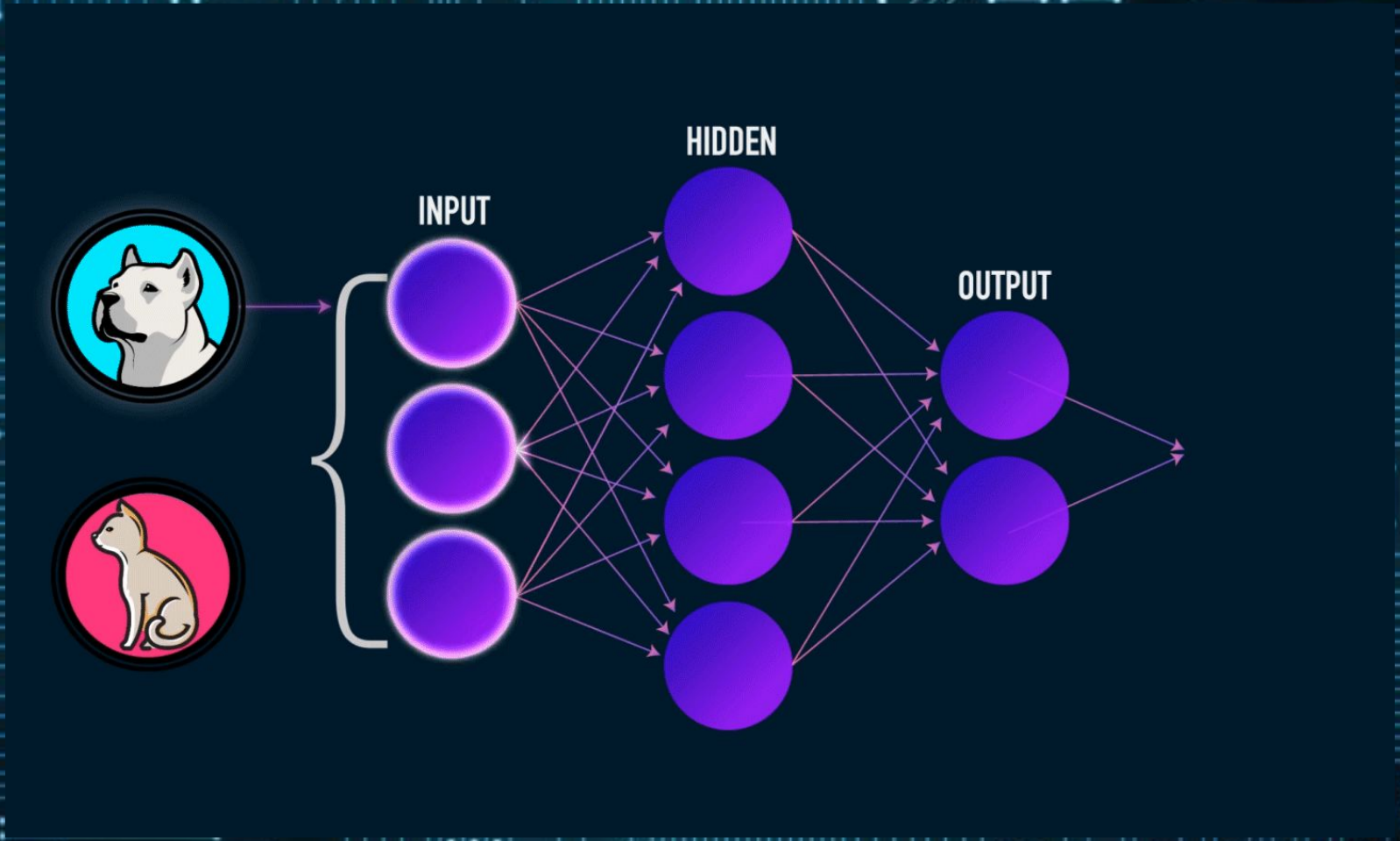


... future input layer

Full Connection

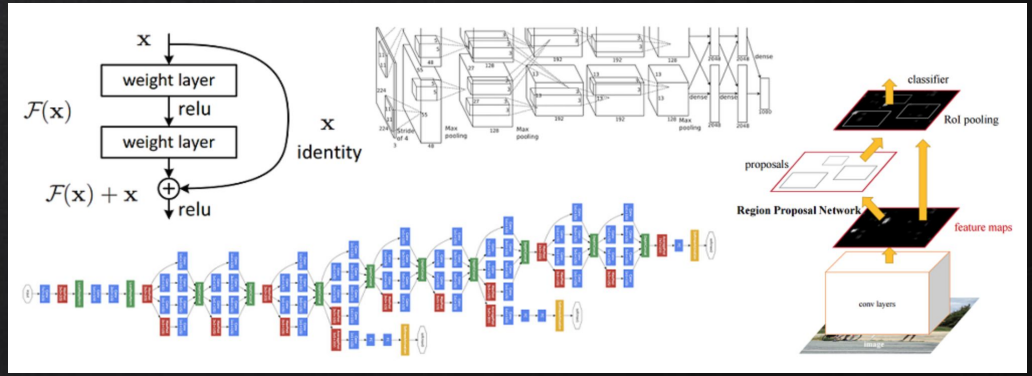
Redes Neurais Convolucionais


Full Connection
... Flattening >>
X_1
X_2
X_m
y
y
Input Layer
Fully connected Layer
Output Layer


HIDDEN
INPUT
OUTPUT

The 9 Deep Learning Papers You Need To Know About (Understanding CNNs Part 3)

Adit Deshpande (2016)

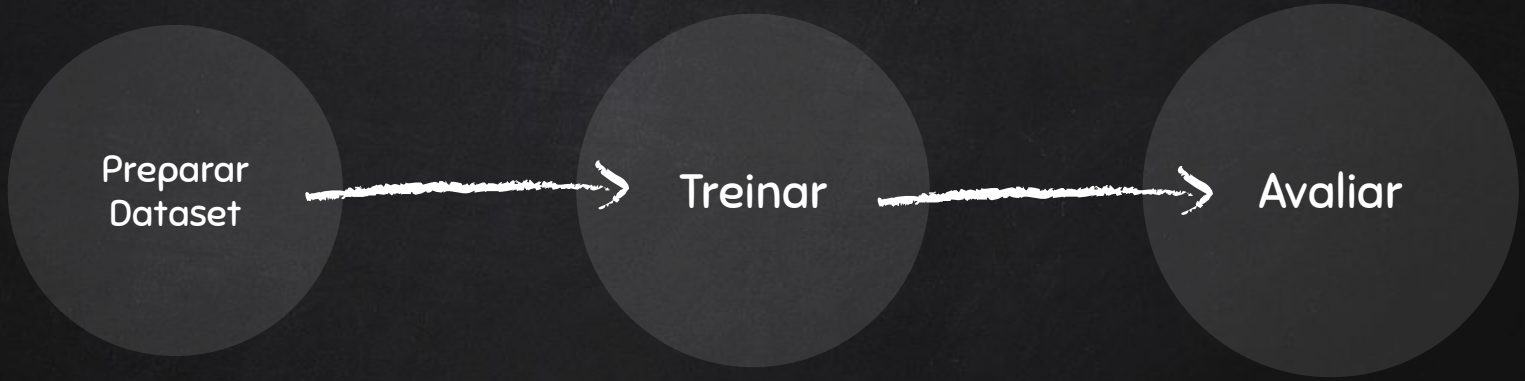


https://adeshpande3.github.io/adeshpande3.github.io/The-9-Deep-Learning-Papers-You-Need-To-Know-About.html

Prática
Building CNN

Reconhecimento de Imagem

Building CNN



https://github.com/deeplearningunb/building-cnn

Dever de Casa...

Valendo nota =)

1. Checkout na branch com seu usuário no github
2. Faça ajustes nos hyper parâmetros
3. Adicione mais camadas
4. Encontre uma acurácia > 80%
5. Commit do resultado (NA SUA BRANCH)

Obrigado!

Dúvidas?

http://bit.ly/dl-unb6
https://t.me/DeepLearningUnB
@diegodorgam

Credits

Special thanks to all the people who made and released these awesome resources for free:

- ✘ Presentation template by SlidesCarnival
- ✘ Photographs by Unsplash