

Conceitos e aplicações da aprendizagem de máquina

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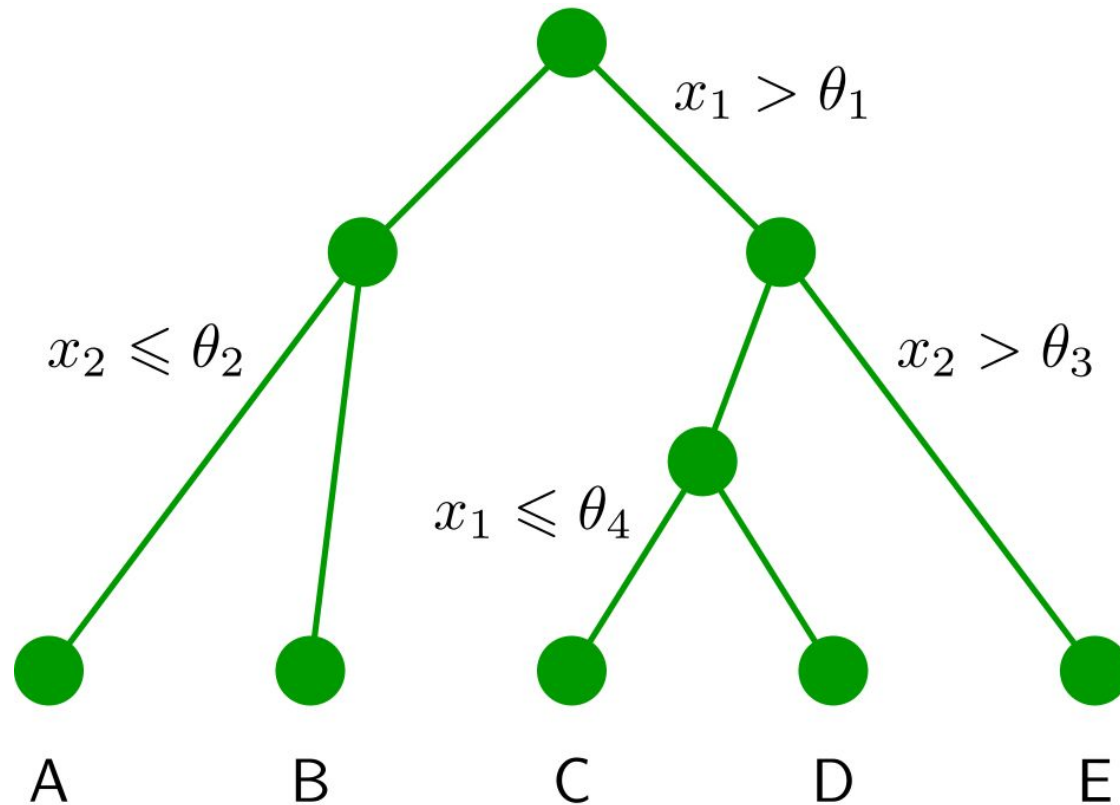
Propriedades desejáveis

Propriedades desejadas

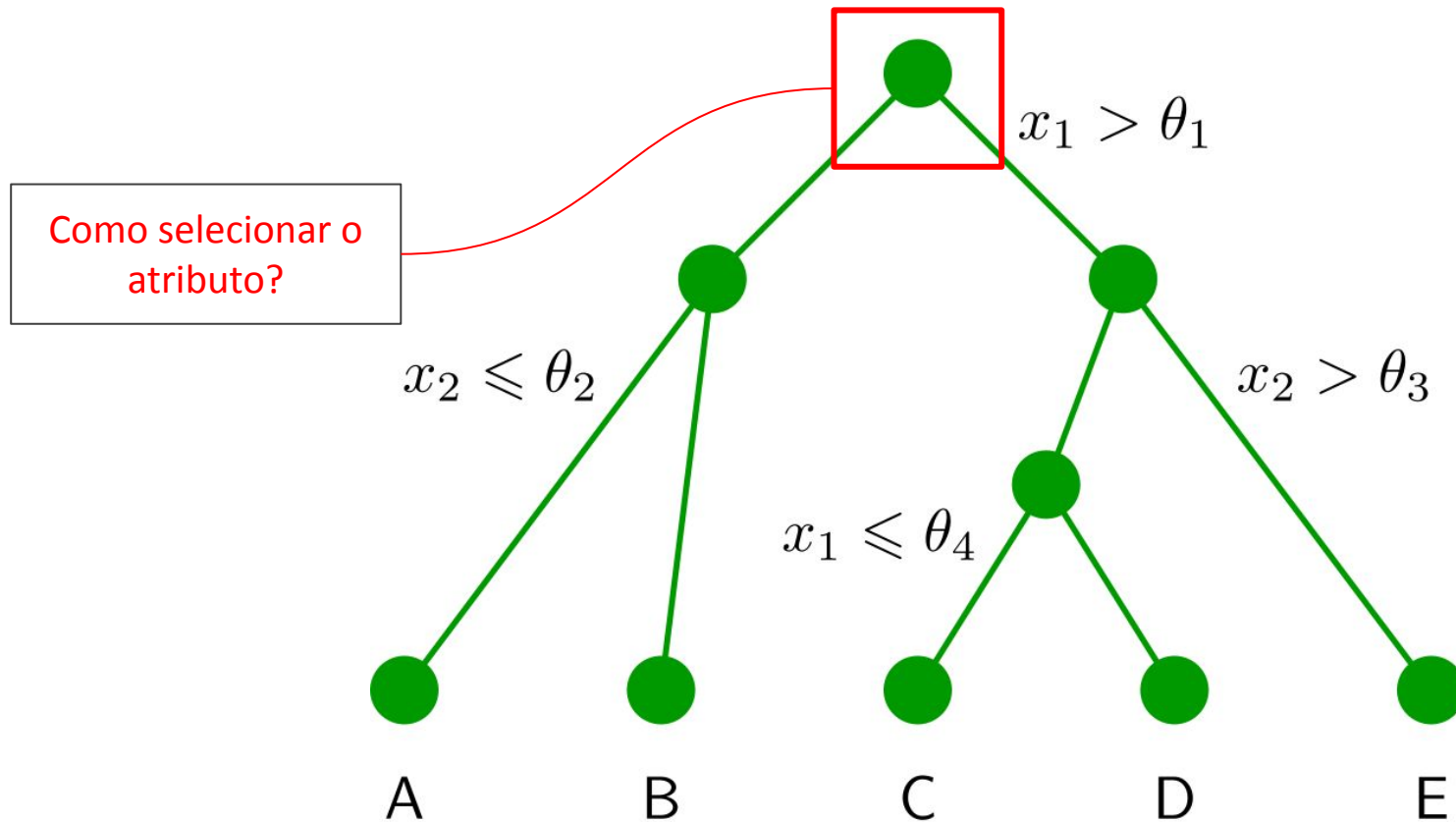
- Acurácia (generalidade)
- Simplicidade
- Interpretabilidade

Árvores de Decisão

Árvores de Decisão



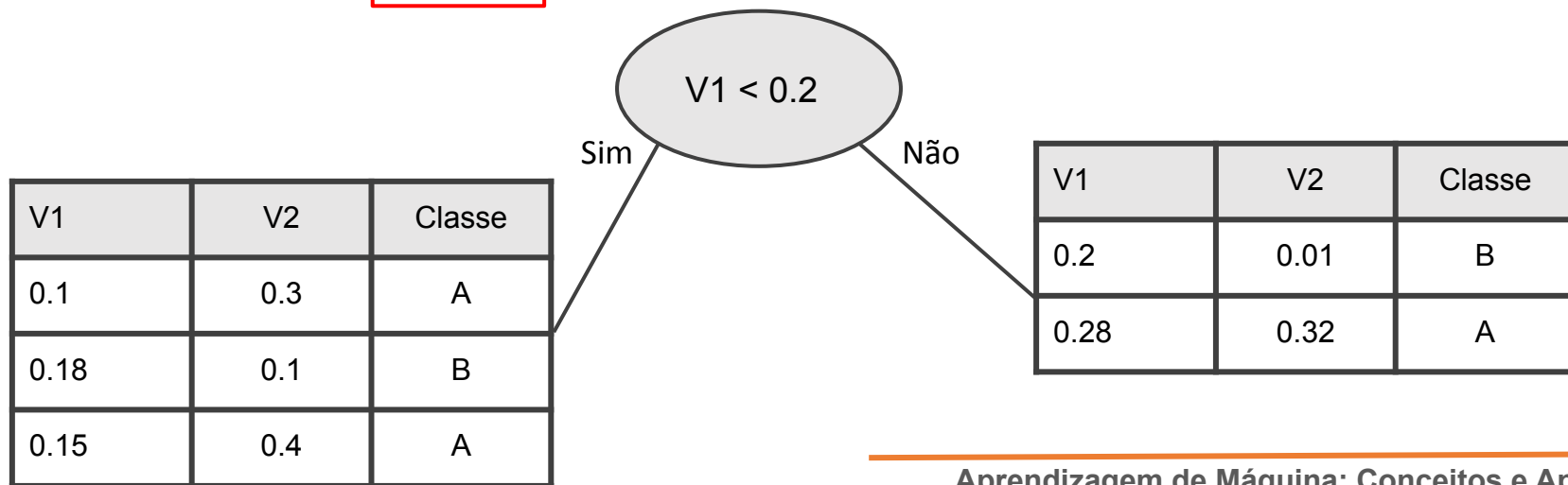
Árvores de Decisão



Árvores de Dec

Como seleccionar o atributo?

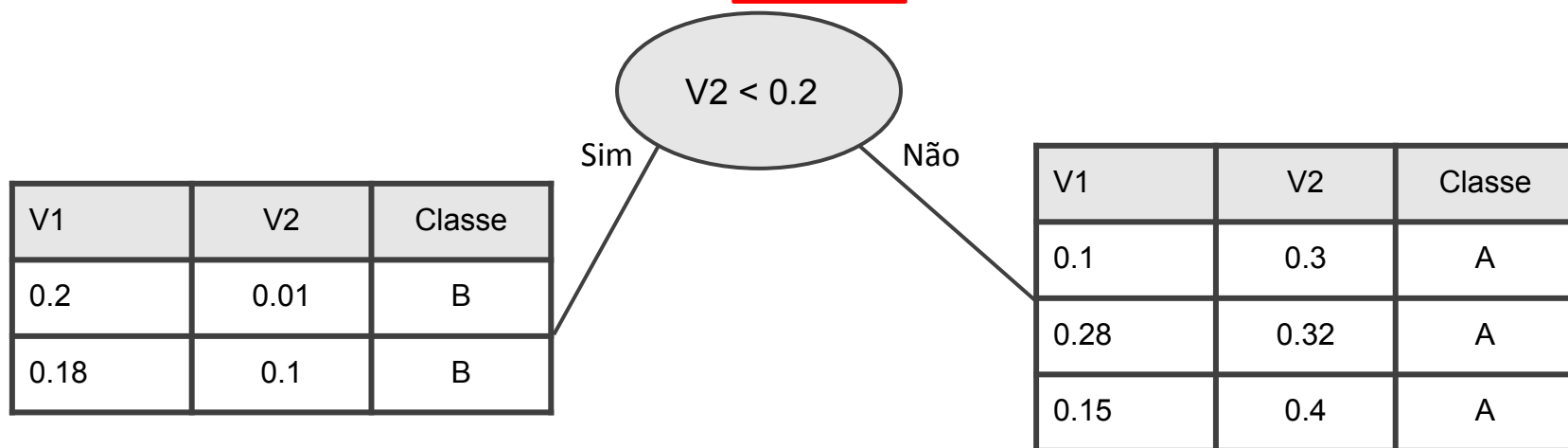
V1		V2	Classe
0.1		0.3	A
0.2		0.01	B
0.18		0.1	B
0.28		0.32	A
0.15		0.4	A



Árvores de Dec

Como seleccionar o atributo?

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0.15	0.4	A



Árvores de Decisão

Gini Index

$$Gini\ Index = 1 - \sum_{i=0}^{c-1} p_i(t)^2$$

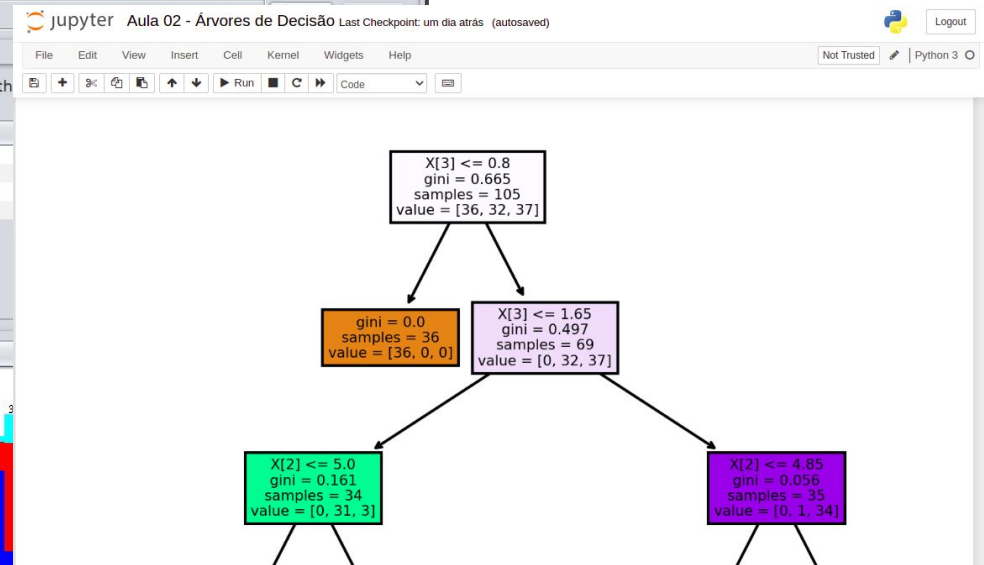
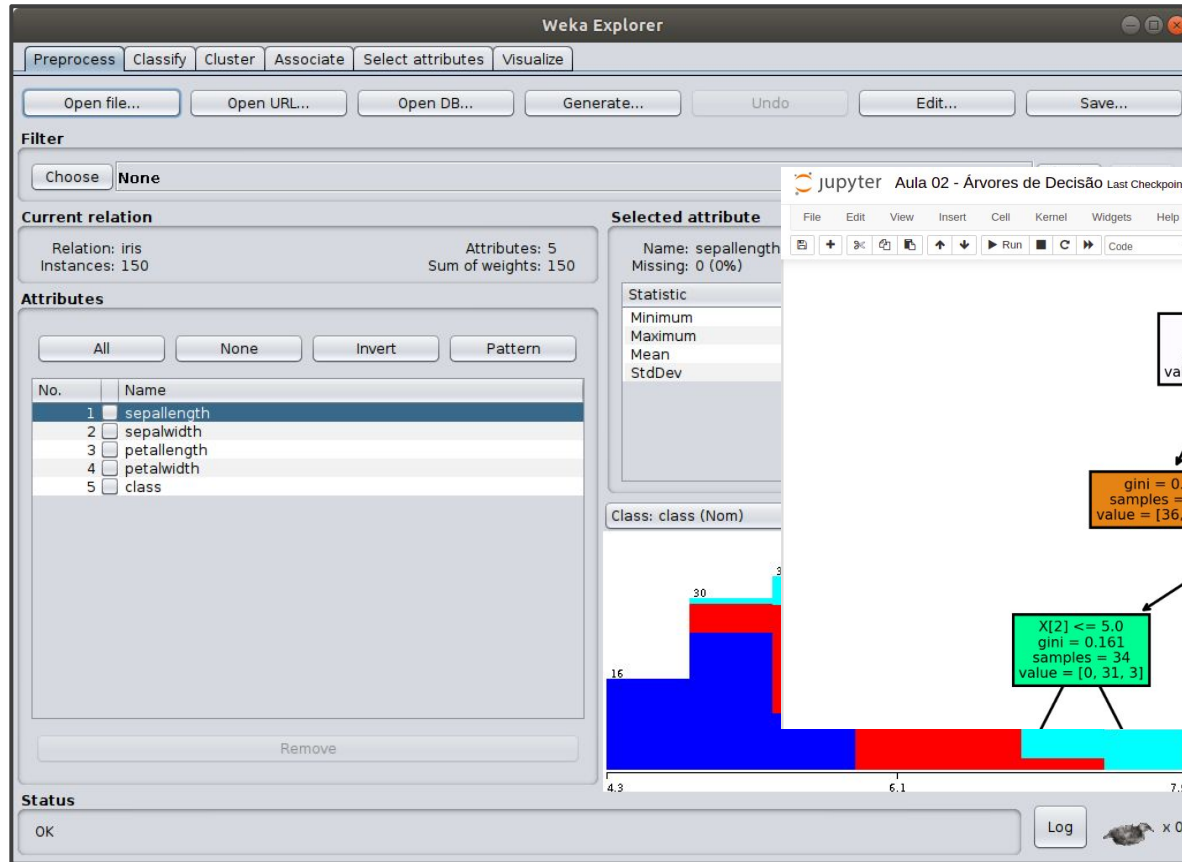
Entropy

$$Entropy = - \sum_{i=0}^{c-1} p_i(t) \log_2 p_i(t)$$

Misclassification error

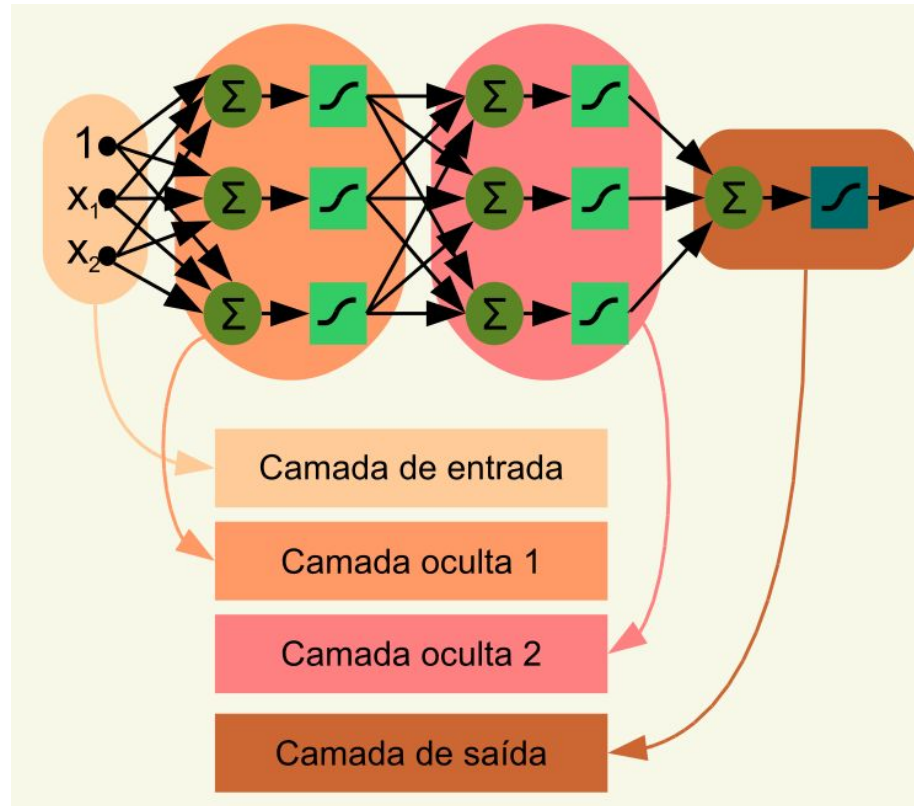
$$Classification\ error = 1 - \max[p_i(t)]$$

Prática

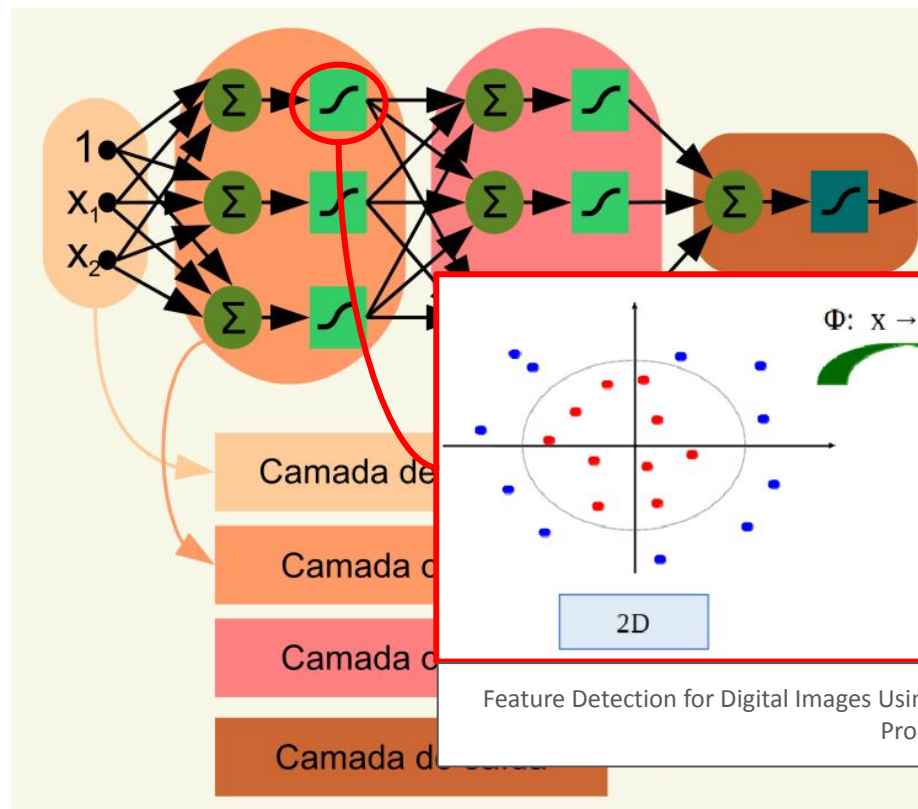


Redes Neurais Artificiais

Redes Neuronais



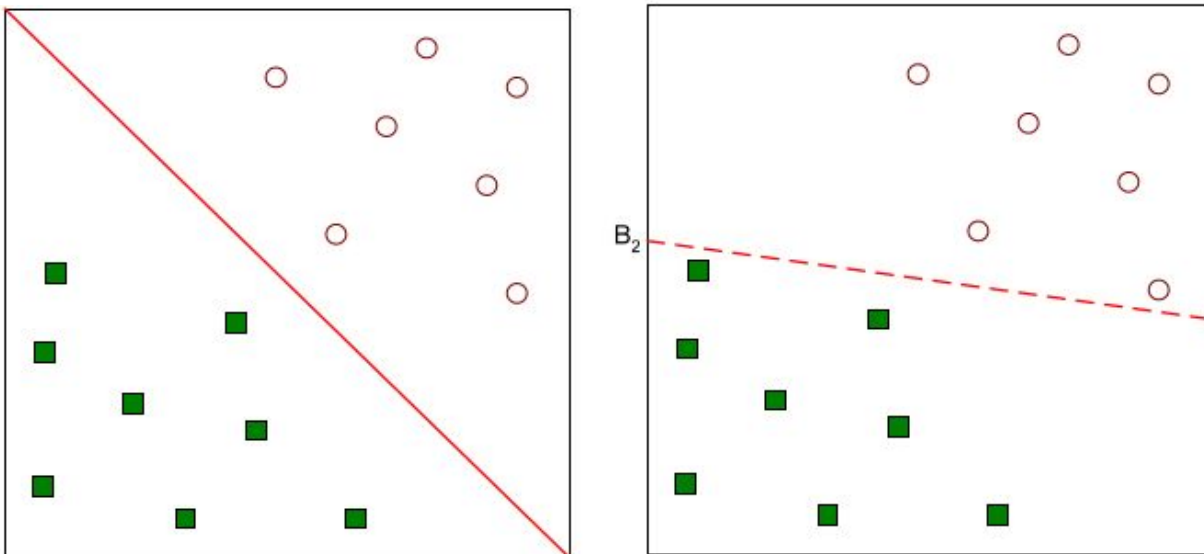
Redes Neuronais



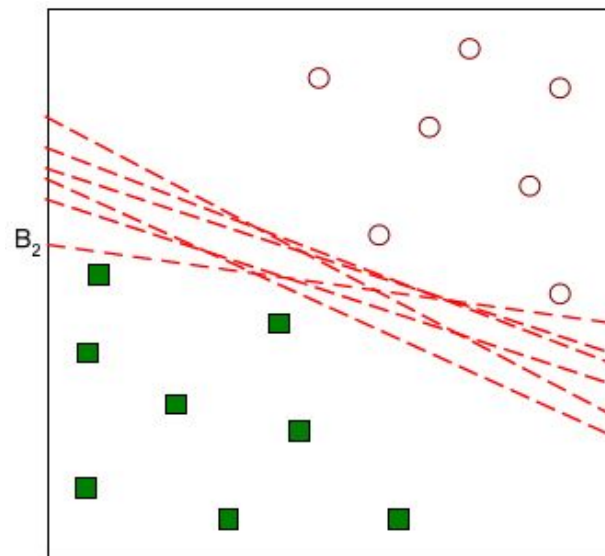
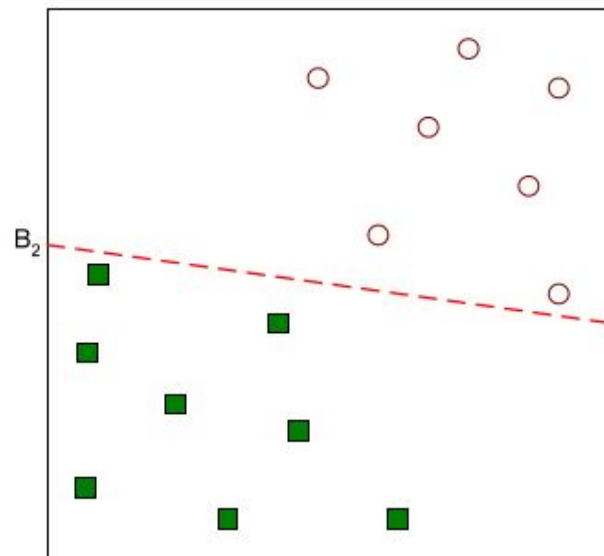
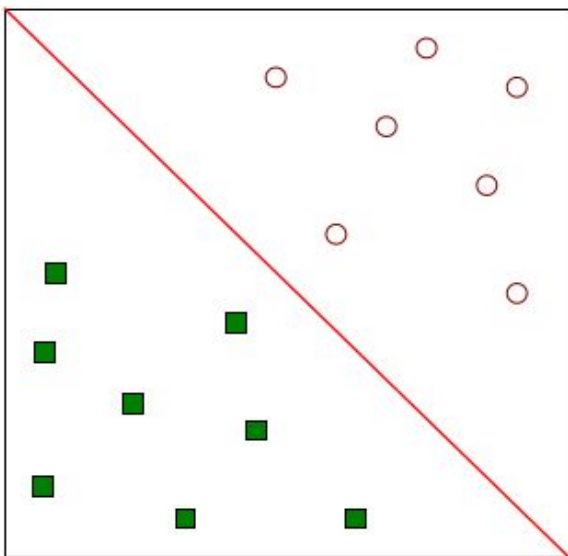
Feature Detection for Digital Images Using Machine Learning Algorithms and Image Processing. Tian, R.; Daigle, H.; Jiang, H.; 2018

Máquina de Vetores Suporte - SVM

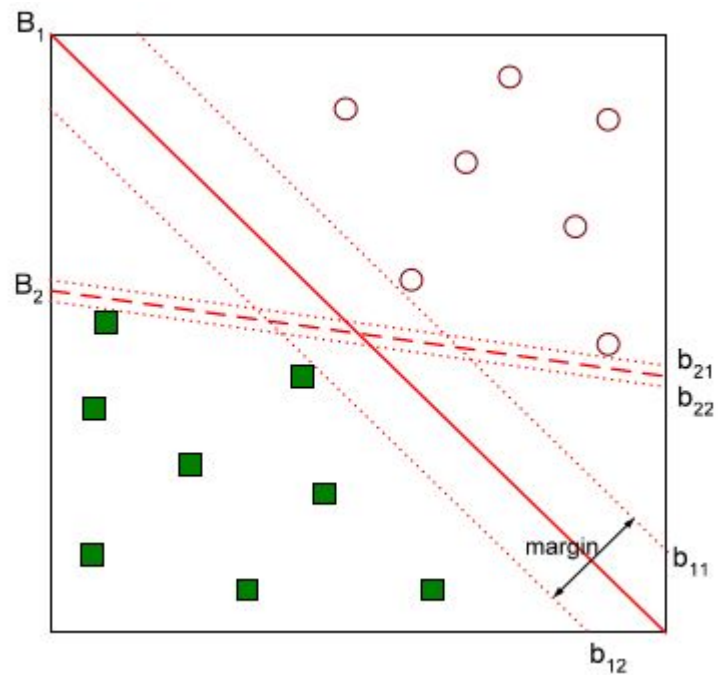
SVM



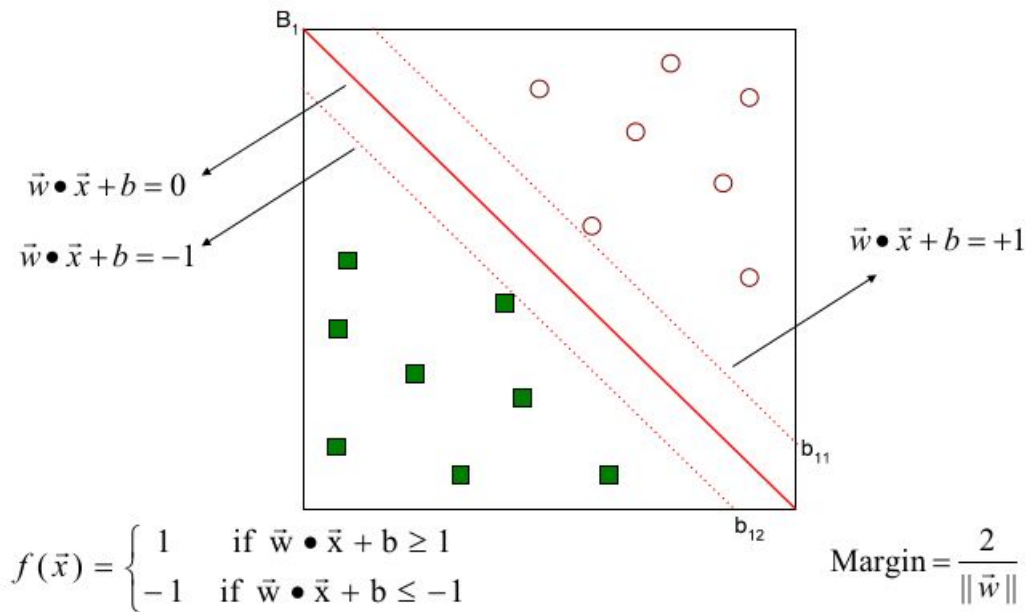
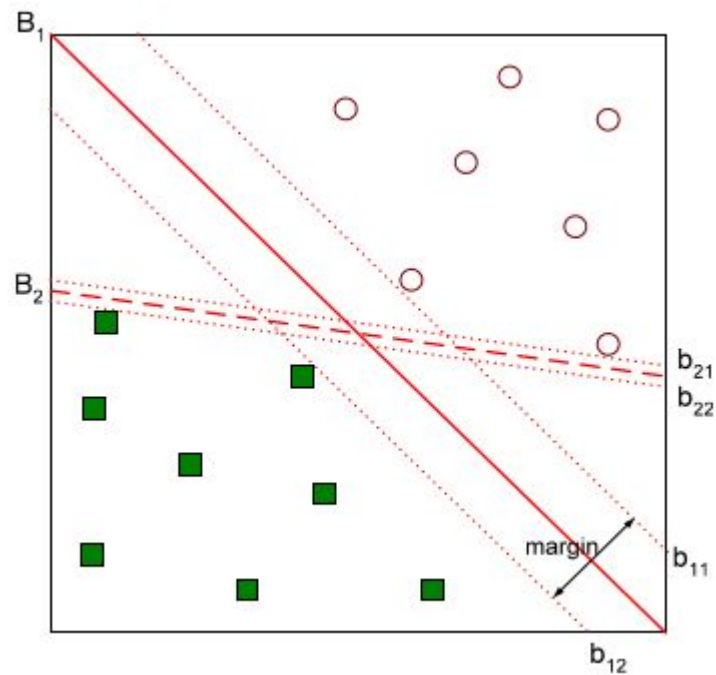
SVM



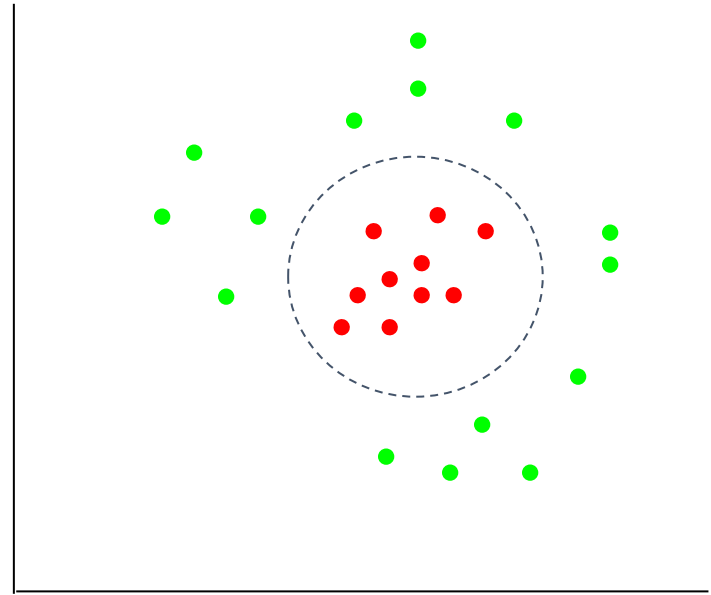
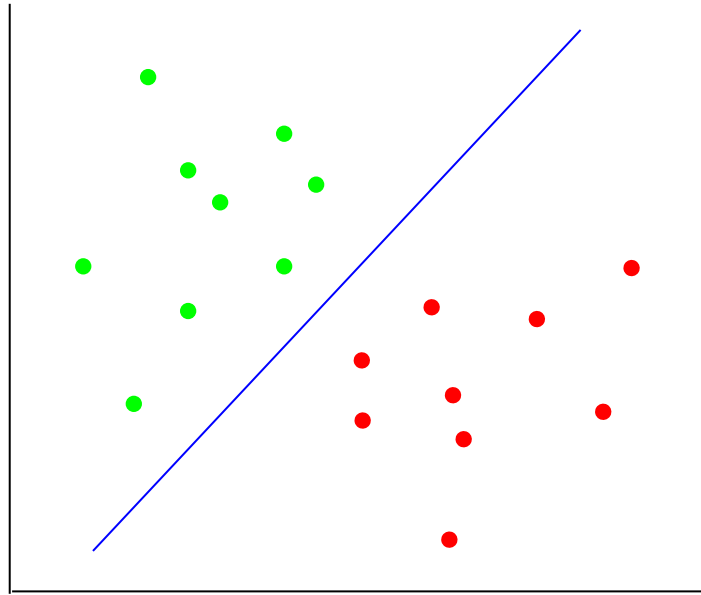
SVM



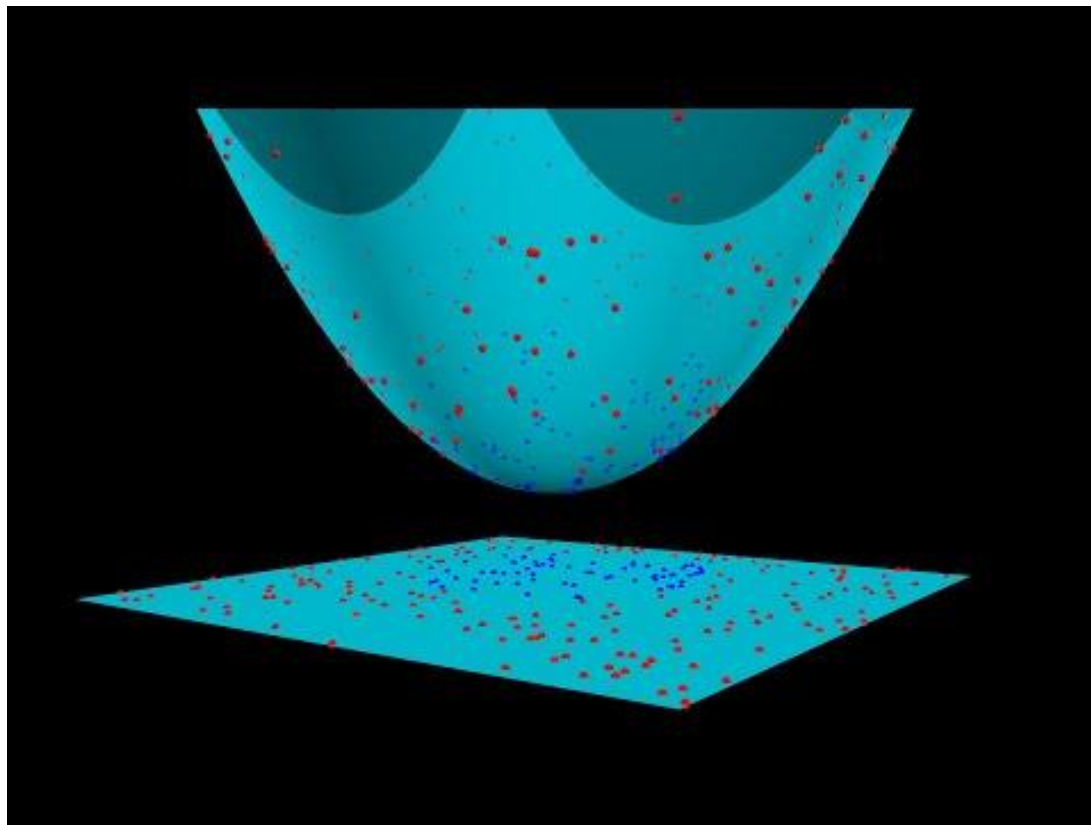
SVM



“Truque” do Kernel

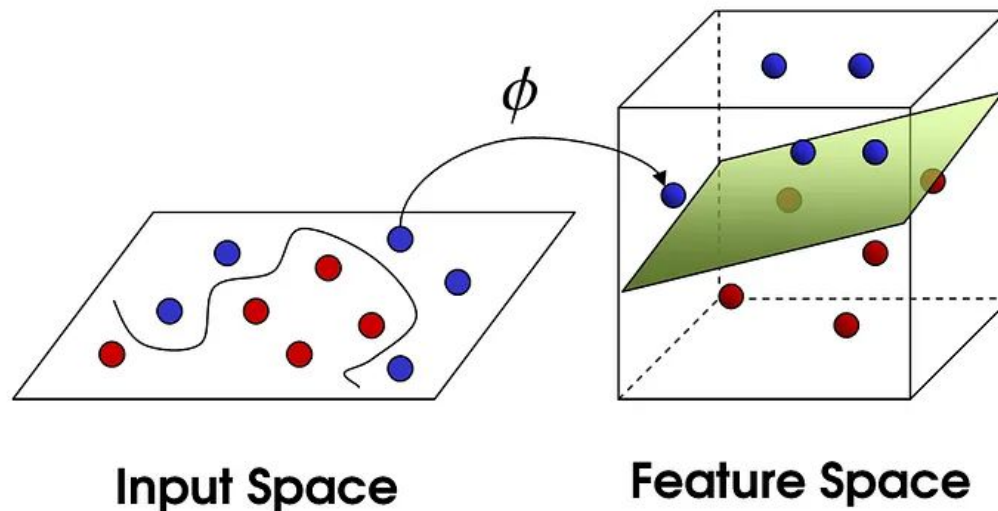


“Truque” do Kernel



“Truque” do Kernel

- The Kernel Trick in Support Vector Classification:
 - <https://towardsdatascience.com/the-kernel-trick-c98cdbcaeb3f>



“Truque” do Kernel

$$\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ x_{31} & x_{32} & \cdots & x_{3n} \\ x_{41} & x_{42} & \cdots & x_{4n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \begin{bmatrix} \theta_1 \\ \theta_2 \\ \vdots \\ \theta_n \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ \vdots \\ y_m \end{bmatrix}$$

$\mathbf{X} \quad \theta \quad = \quad \mathbf{y}$

“Truque” do Kernel

$$\begin{aligned}\mathbf{X}\theta &= \mathbf{y} \\ \mathbf{X}^\top \mathbf{X}\theta &= \mathbf{X}^\top \mathbf{y} \\ \theta &= (\mathbf{X}^\top \mathbf{X})^{-1} \mathbf{X}^\top \mathbf{y}\end{aligned}$$

“Truque” do Kernel

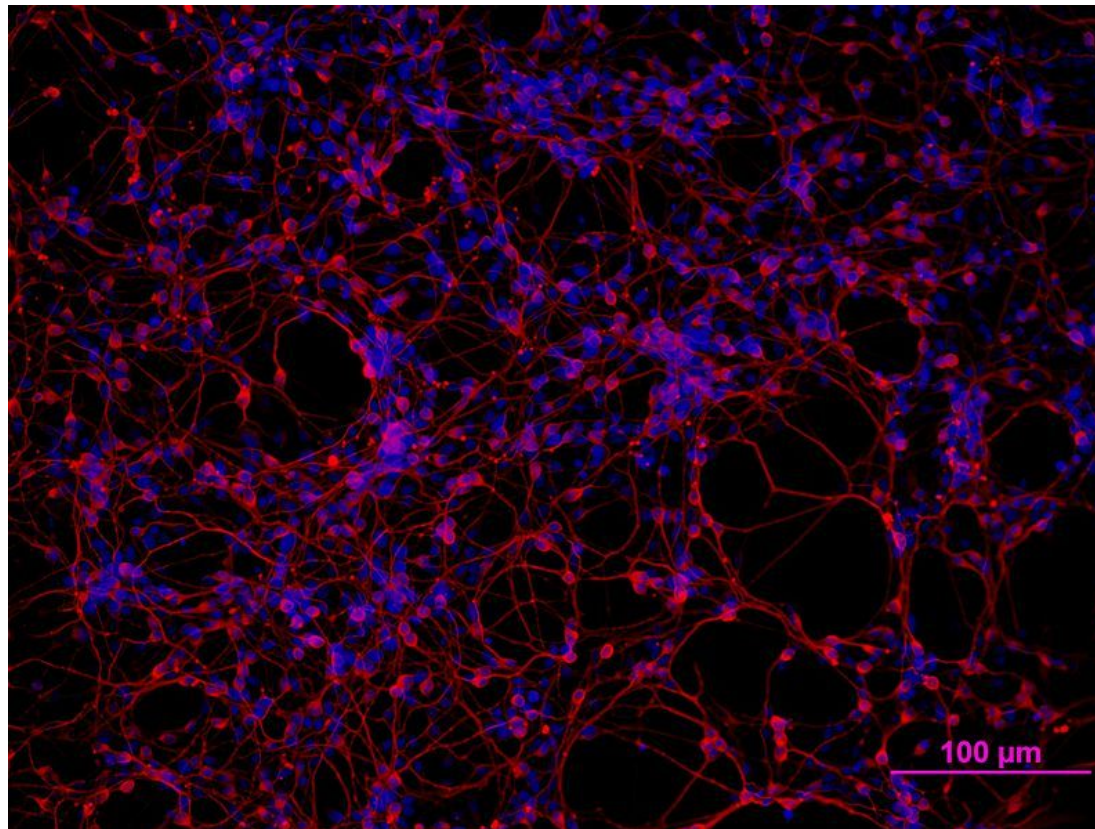
$$h(\mathbf{x}) = \sum_{i=0}^n \theta_i x_i = \theta^\top \mathbf{x}.$$

$$h(\mathbf{x}) = \sum_{i=0}^n \theta_i \phi(x_i) = \theta^\top \phi.$$

Kernel Gaussiano

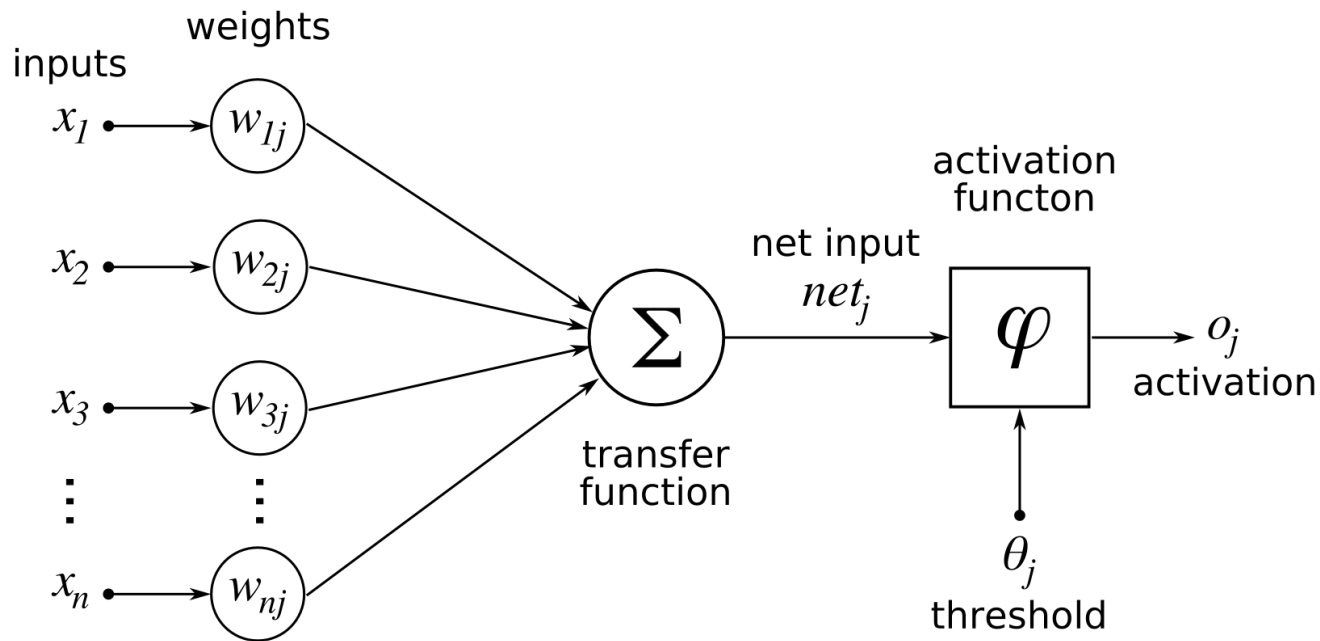
$$k(\mathbf{x}, \mathbf{y}) = e^{-\gamma \|\mathbf{x} - \mathbf{y}\|^2}, \gamma > 0$$

Redes Neurais



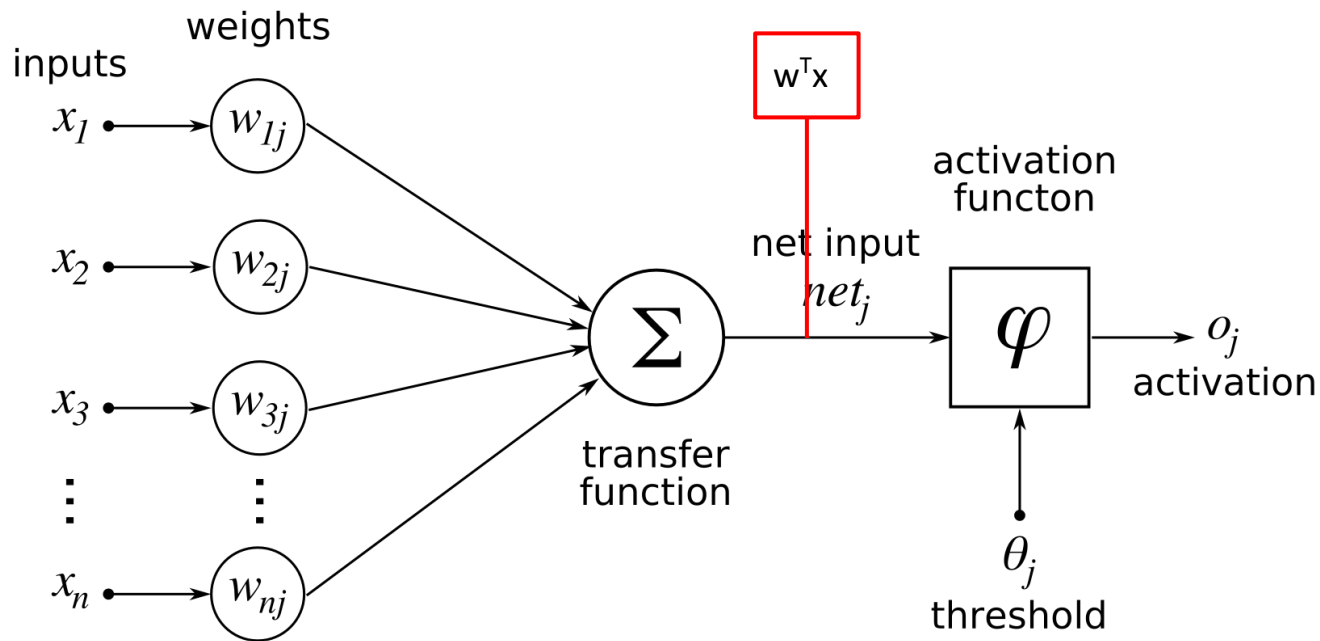
https://commons.wikimedia.org/wiki/File:Neuron_011910.JPG

Redes Neurais



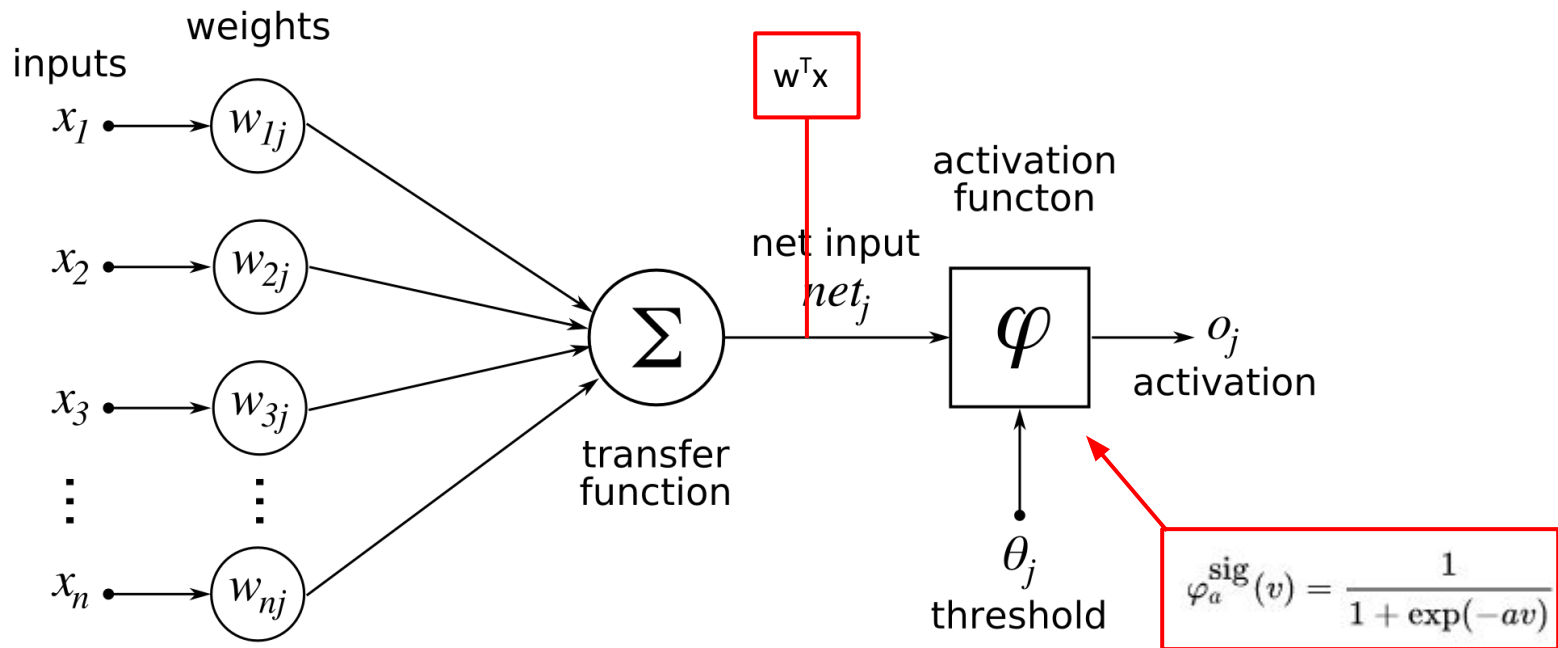
Introduction to Data Mining, 2nd Edition Tan, Steinbach, Karpatne, Kuma, 2018
https://www-users.cs.umn.edu/~kumar001/dmbook/slides/chap4_ann.pdf

Redes Neurais



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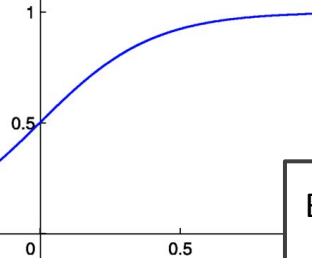
Redes Neurais



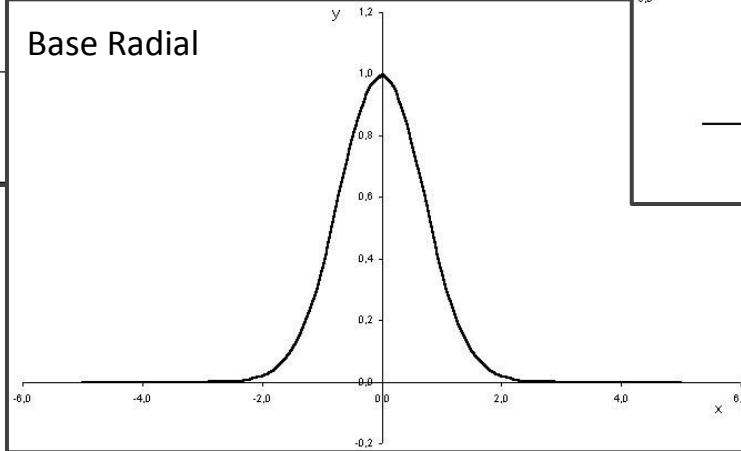
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Redes Neurais

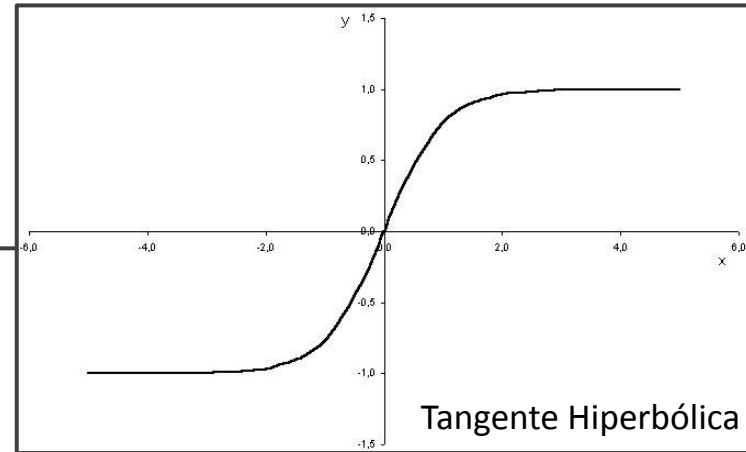
Logística



Base Radial

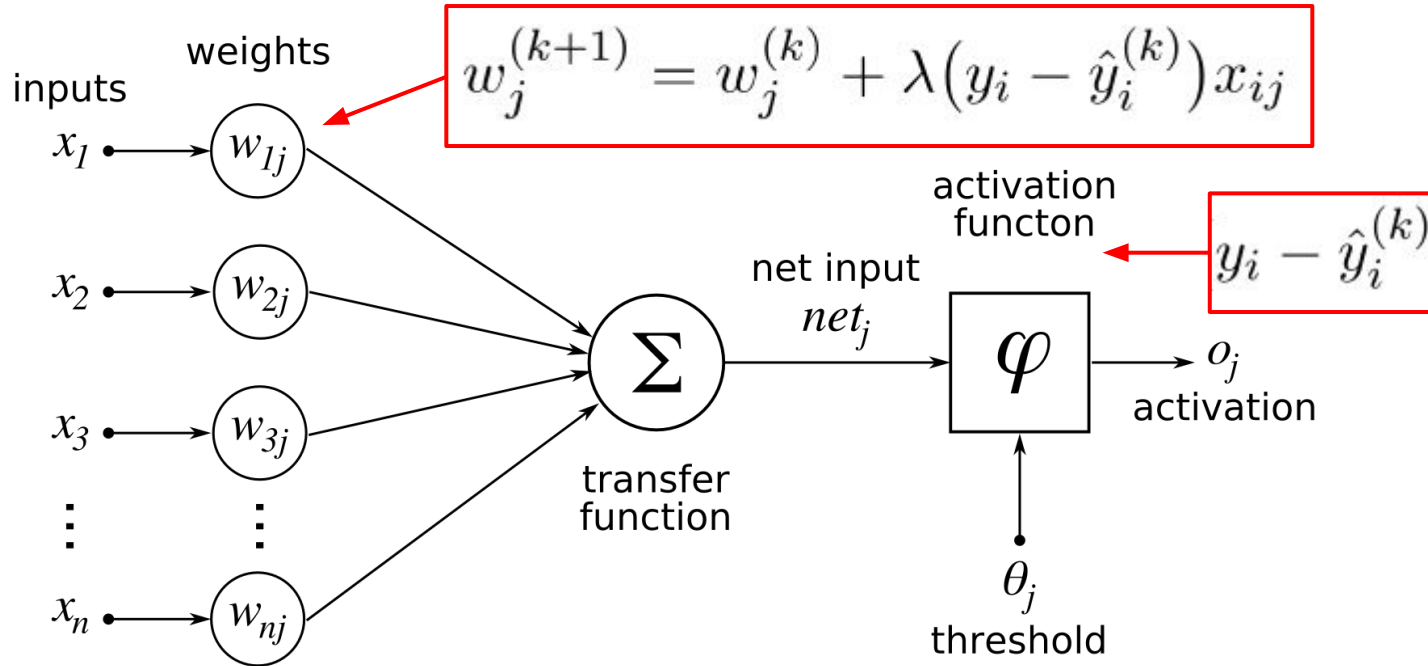


Tangente Hiperbólica

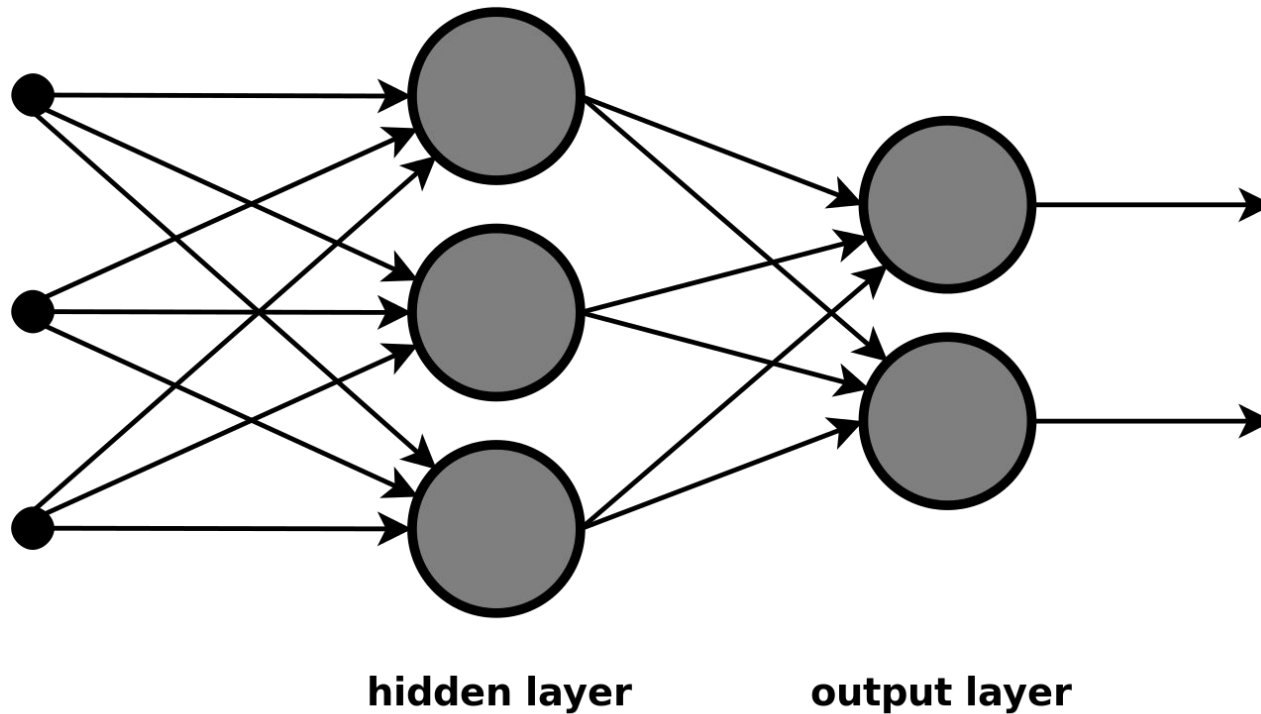


Introduction to Data Mining, 2nd Edition Tan, Steinbach, Karpapne, Kuma, 2018
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Redes Neurais

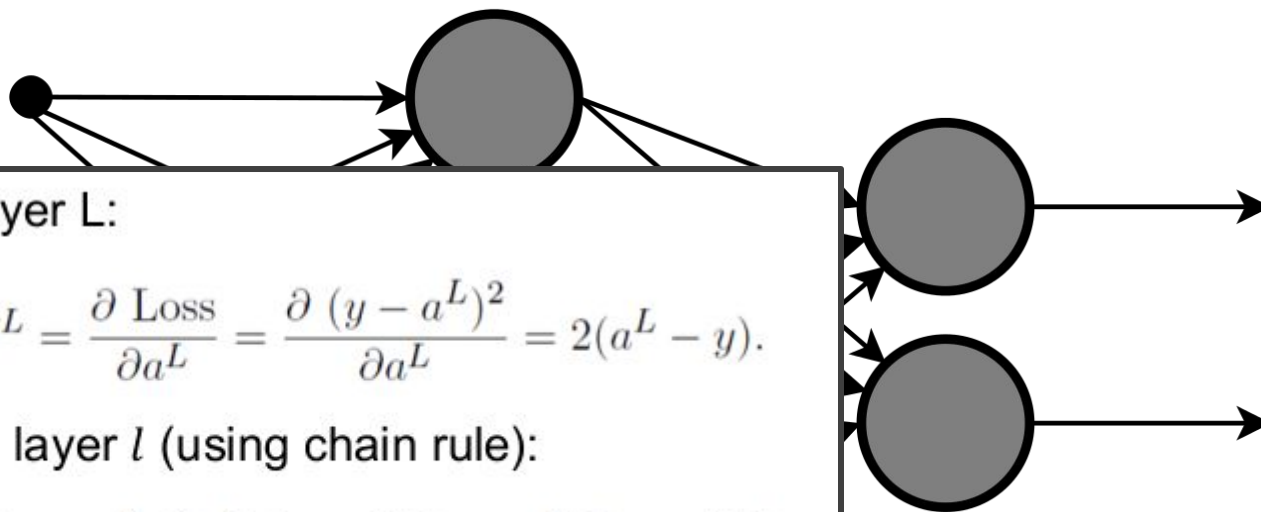


Redes Neurais



https://commons.wikimedia.org/wiki/Artificial_neural_network#/media/File:Multi-Layer_Neural_Network-Vector.svg

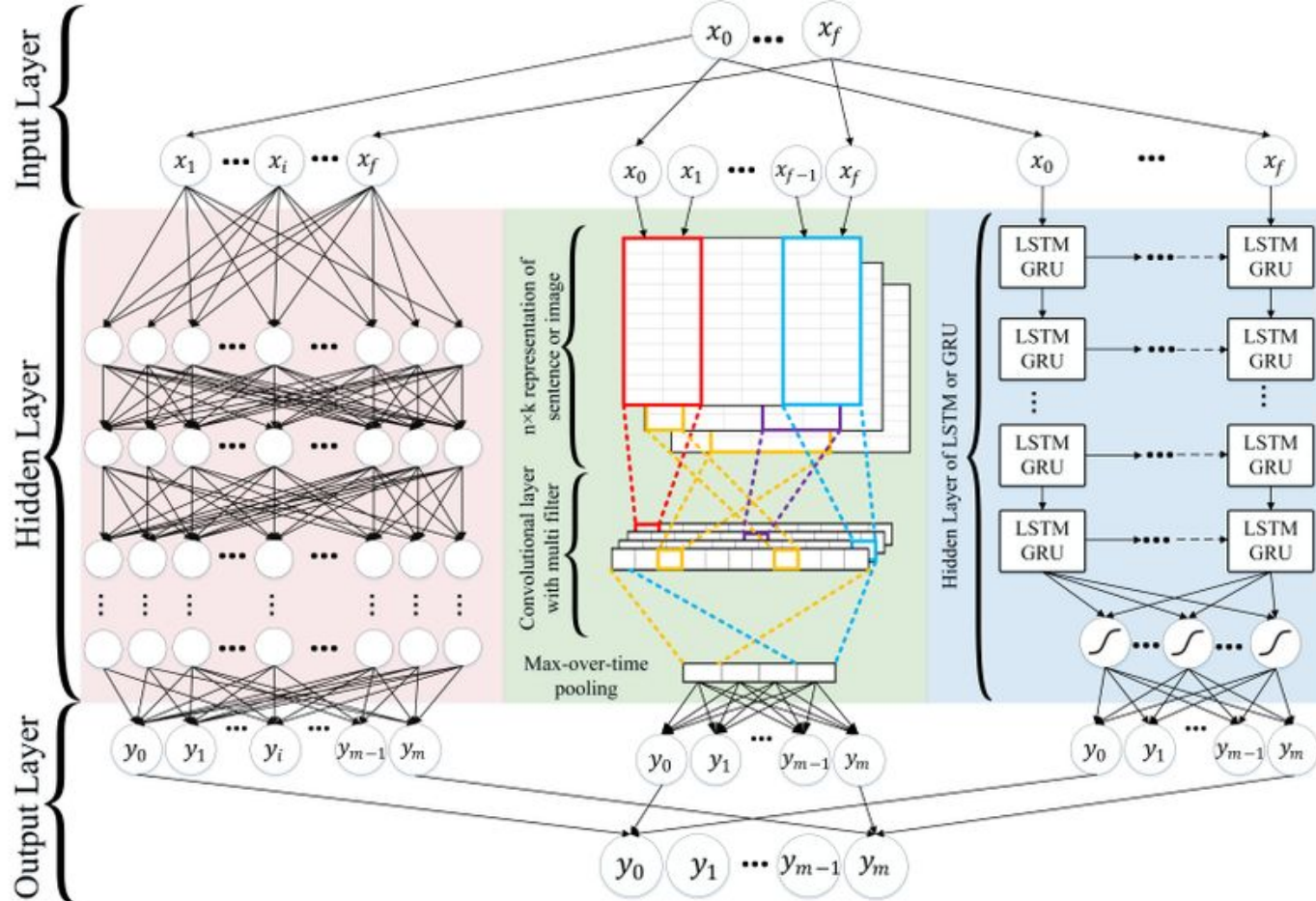
Redes Neurais



hidden layer

output layer

Redes



[https://commons.wikimedia.org/wiki/File:Random_Multimodel_Deep_Learning_\(RMDL\).png](https://commons.wikimedia.org/wiki/File:Random_Multimodel_Deep_Learning_(RMDL).png)

RMDL: Random Multimodel Deep Learning for Classification, Kowsari, K. et al., 2018

Como avaliar os modelos?

Como avaliar os modelos?

- Acurácia
- Matriz de confusão
- Precisão (precision)
- Revocação (Recall)
- F1 Score
- ...

Como avaliar os modelos?

Classes	Verdadeira Positivo (P)	Verdadeira Negativo (N)
Prevista Positivo (P)	TP	FP
Prevista Negativo (N)	FN	TN

True

False

Como avaliar os modelos?

- Acurácia

$$\frac{TP + TN}{TP + TN + FP + FN}$$

- Matriz de confusão

- Precisão (precision)

$$\frac{TP}{TP + FP}$$

- Revocação (Recall)

$$\frac{TP}{TP + FN}$$

- F1 Score

$$\frac{2 \times (\text{Precisão} \times \text{Revocação})}{\text{Precisão} + \text{Revocação}}$$

- ...

Como avaliar os modelos?

- Curva ROC e Área sob a curva ROC
 - ROC: Receiver Operating Characteristic
 - Gráfico que mostra o desempenho de um modelo de classificação para todos os limiares de discriminação (*thresholds*). Possui dois parâmetros:
 - Taxa de Verdadeiros Positivos (True Positive Rate - TPR)
 - Taxa de Falsos Positivos (False Positive Rate - FPR)

$$\text{TPR} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

(Sensitivity)

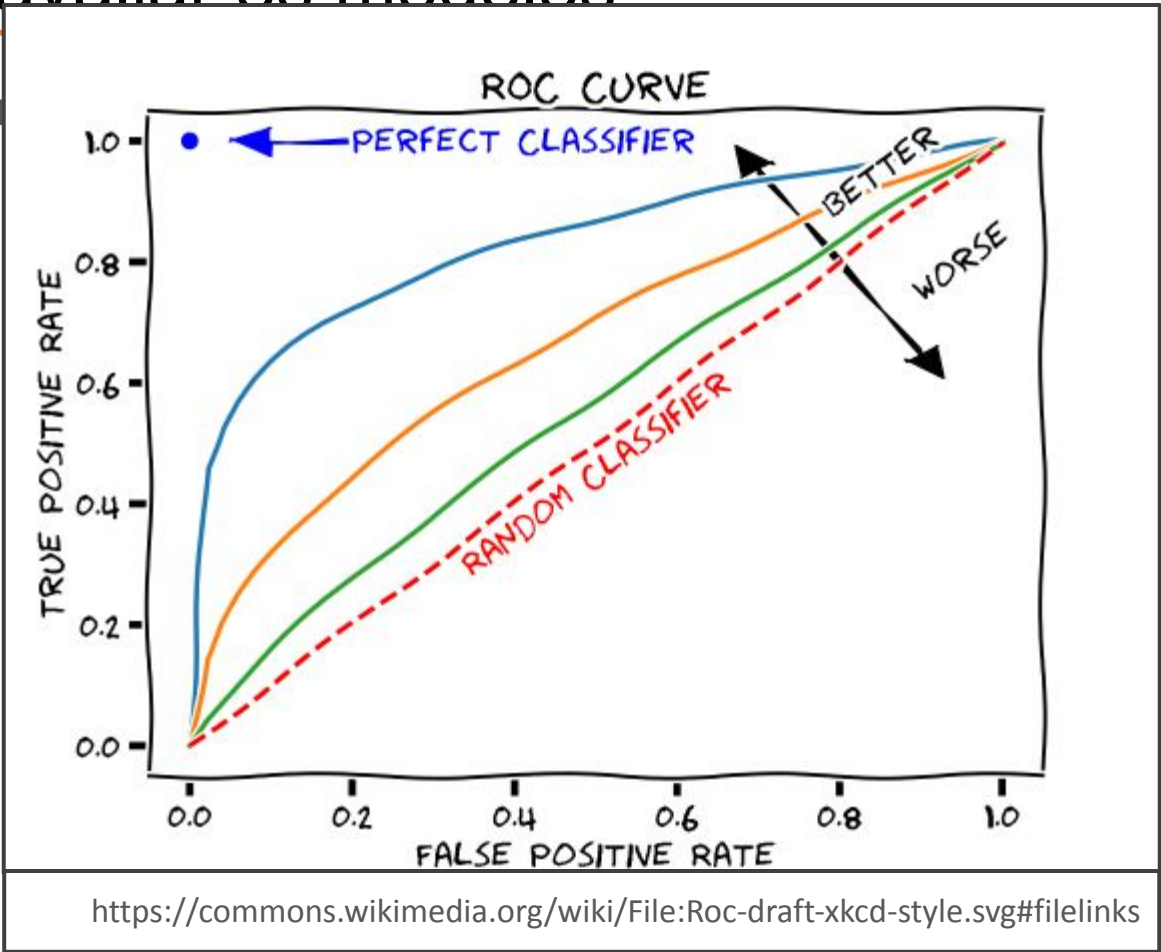
$$\text{FPR} = \frac{\text{FP}}{\text{FP} + \text{TN}}$$

(Specificity)

[https://developers.google.com/machine-learning/crash-course/classification/roc-and-auc#:~:text=An%20ROC%20curve%20\(receiver%20operating,False%20Positive%20Rate](https://developers.google.com/machine-learning/crash-course/classification/roc-and-auc#:~:text=An%20ROC%20curve%20(receiver%20operating,False%20Positive%20Rate)

Como avaliar os modelos?

- Cur
-
-



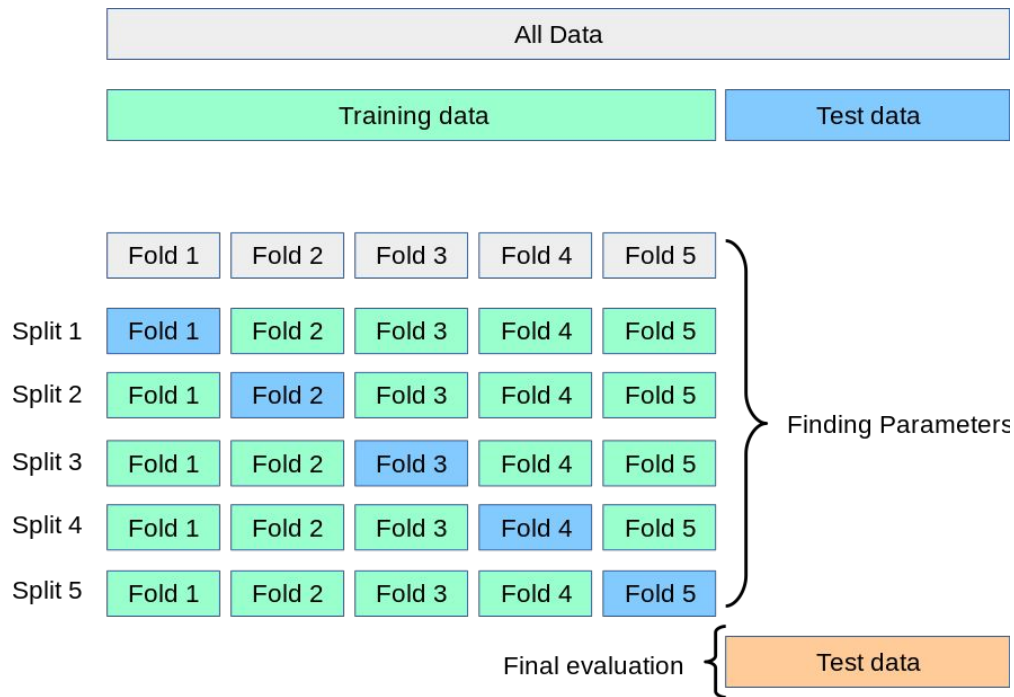
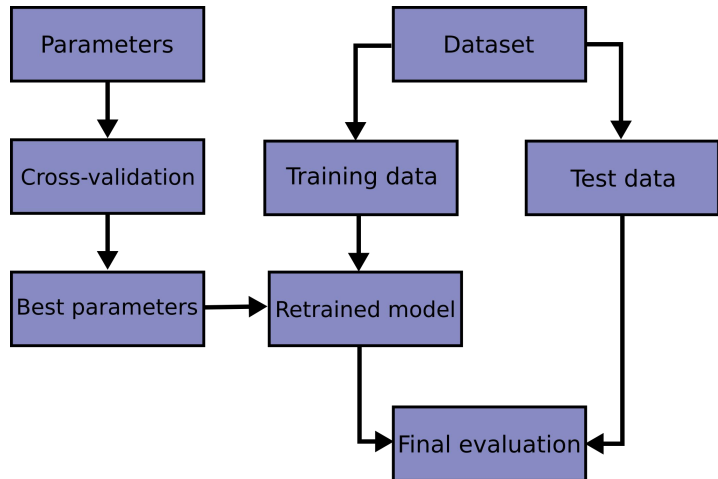
classificação para
ui dois parâmetros:
(e - TPR)
(FPR)

FP
FP + TN

h-course/classification/roc-and-auc
operating,False%20Positive%20Rate

Validação Cruzada

- Buscar por melhores parâmetros (seleção de modelos) sem afetar a avaliação final do modelo



https://scikit-learn.org/stable/modules/cross_validation.html

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