

# Aula 15 – Classificação de imagens

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- Um problema de classificação
- Pipelines de classificação
- Modelos de aprendizado
- Validação cruzada
- Avaliação dos resultados

# UM PROBLEMA DE CLASSIFICAÇÃO

# Um problema de classificação

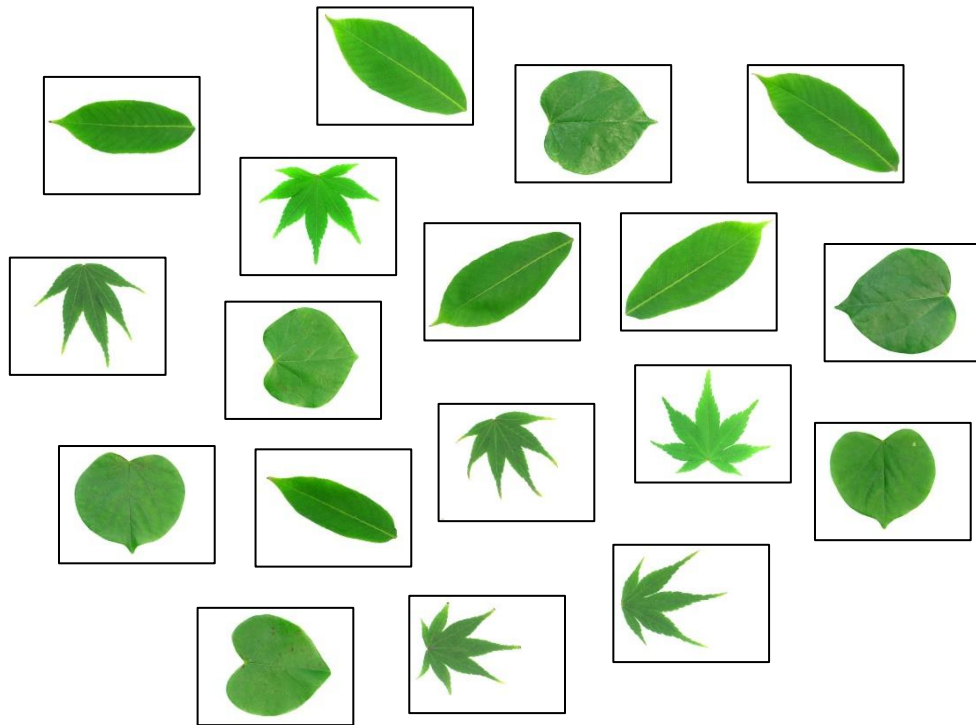
- Aprender a classificar três tipos (classes) de folhas a partir de imagens.

- Flavia leaf dataset:

- <http://flavia.sourceforge.net/>
- 1.907 imagens
- 33 classes

- Seleccionamos 3 classes:

- *aesculus chinensis*
- *acer palmatum*
- *cercis chinensis*



# Um problema de classificação

- Aprender a classificar três tipos (classes) de folhas a partir de imagens.

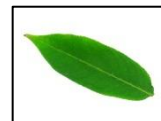
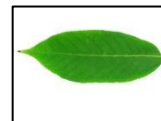
- Extração de características:

- Selecionar características das imagens que podem ser usadas para distinguir entre as classes.

- Características podem ser:

- Formas
- Cores
- Texturas
- Histograma de gradientes (HoG)
- *Bag of Visual Words*
- *Fisher Vectors*
- ...

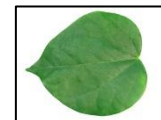
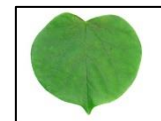
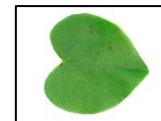
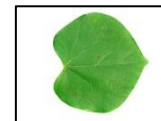
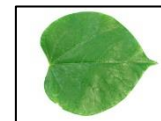
*aesculus chinensis*



*acer palmatum*



*cercis chinensis*



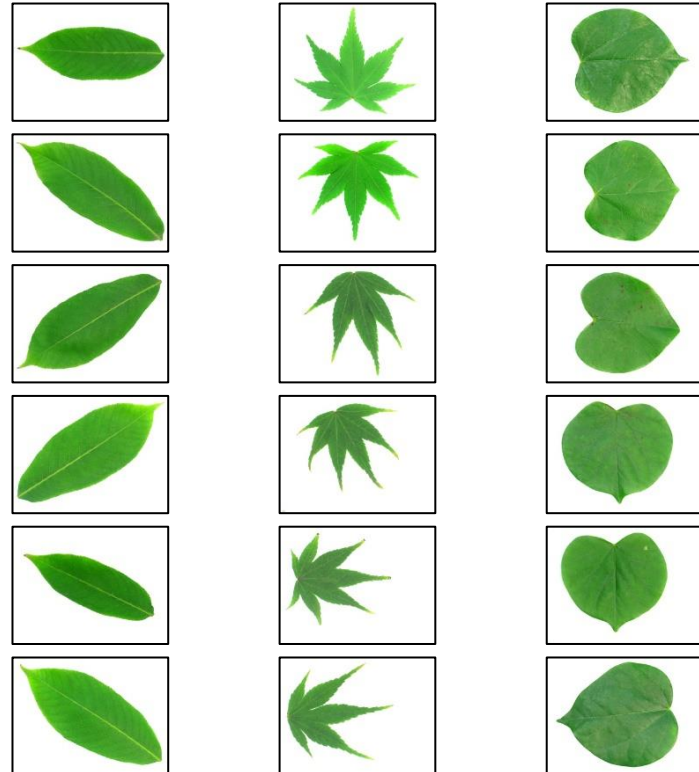
# Um problema de classificação

- Características de forma:

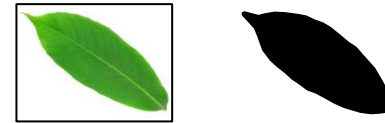
*aesculus chinensis*

*acer palmatum*

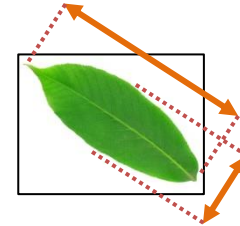
*cercis chinensis*



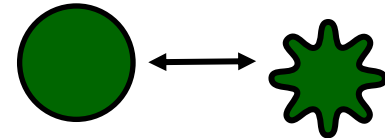
Área:



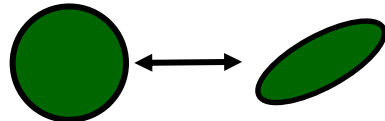
Eixos:



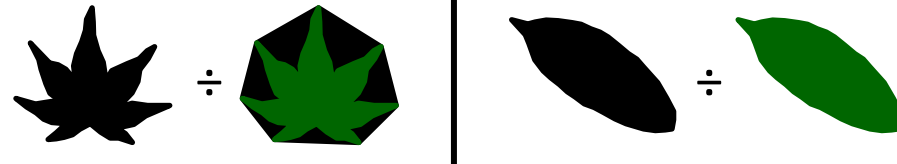
Circularidade:



Excentricidade:

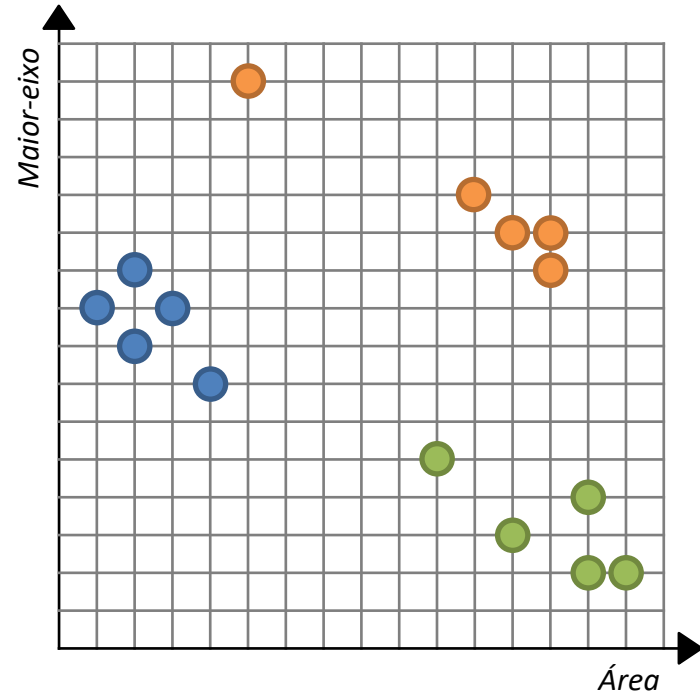
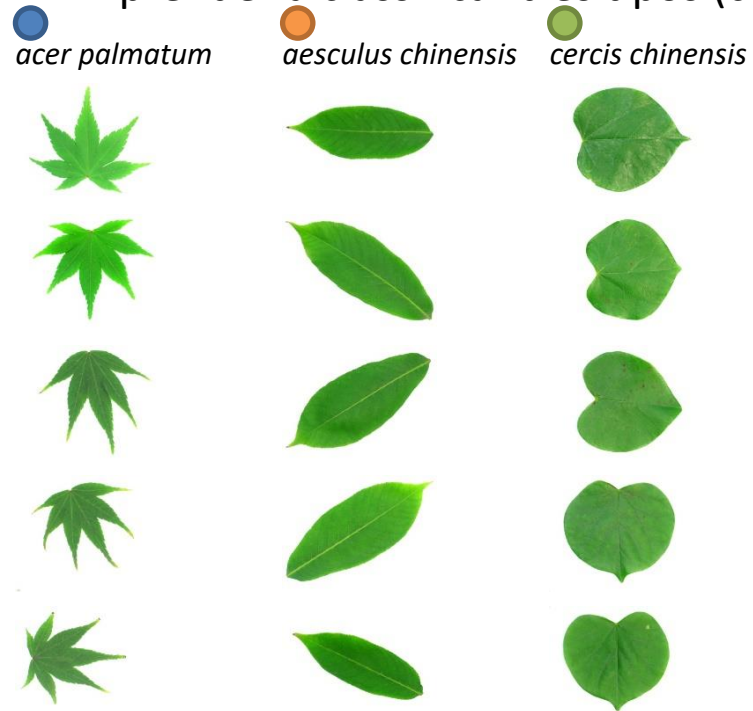


Solidez:



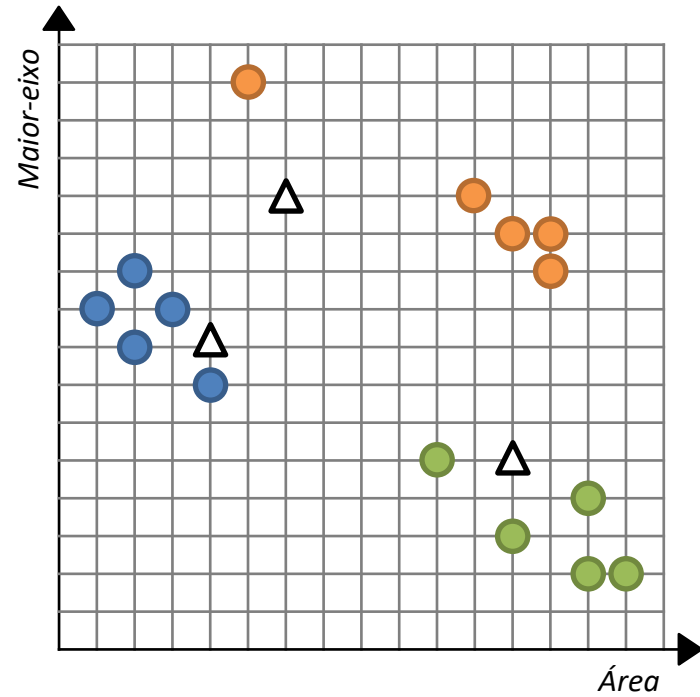
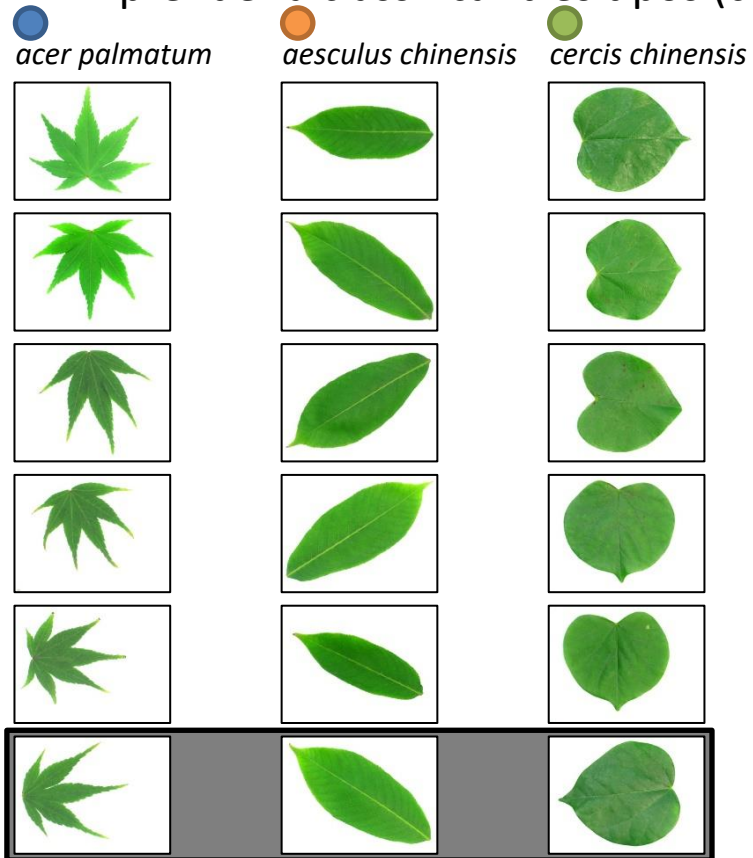
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- Aprender a classificar três tipos (classes) de folhas a partir de imagens.



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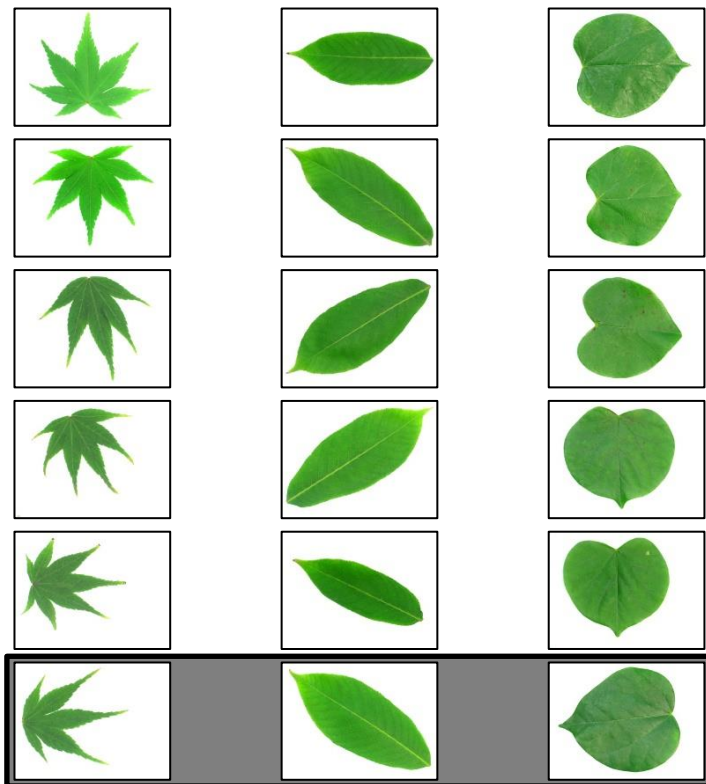




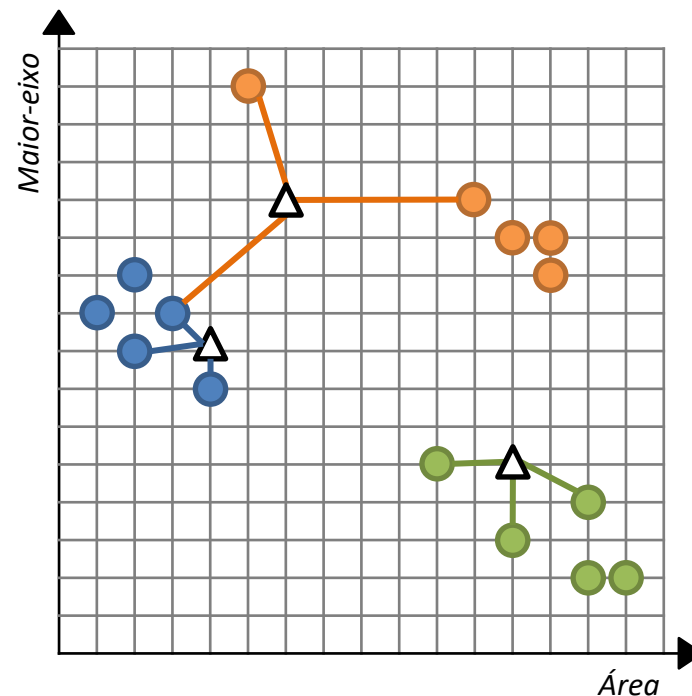
# K-vizinhos mais próximos

- Aprender a classificar três tipos (classes) de folhas a partir de imagens.

● *acer palmatum*    
 ● *aesculus chinensis*    
 ● *cercis chinensis*



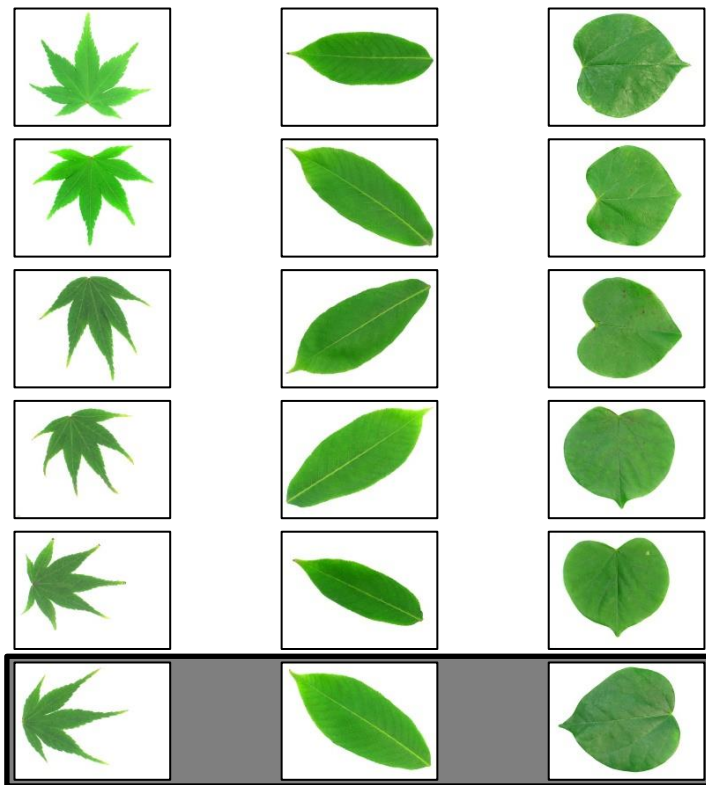
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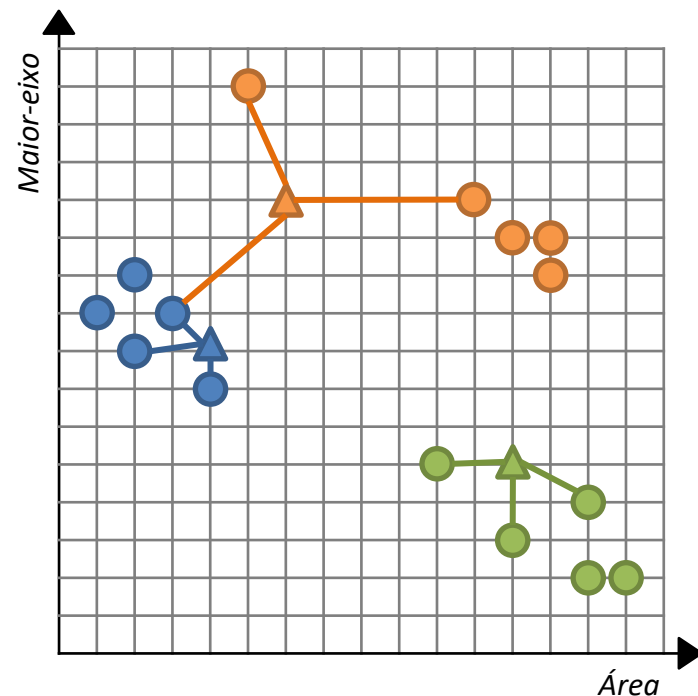
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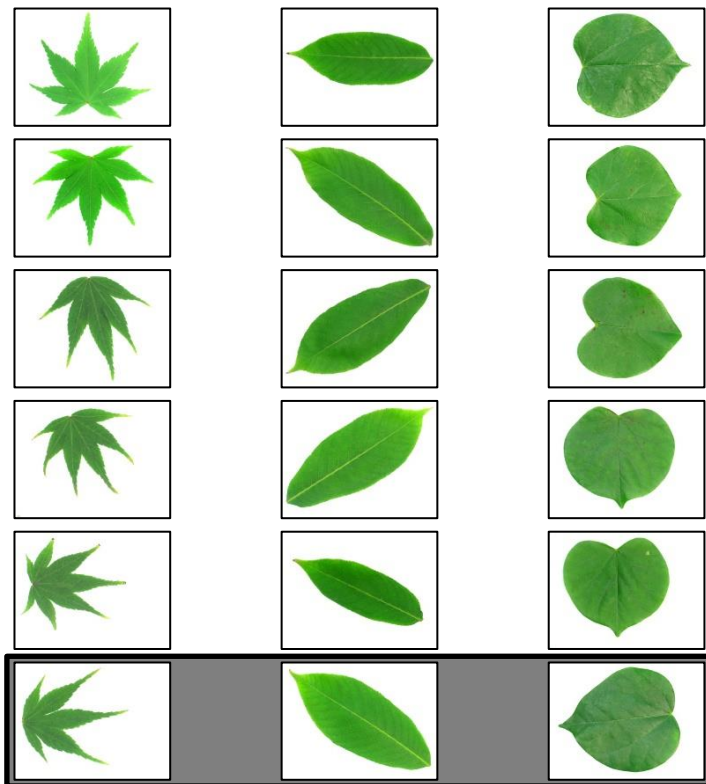
$k = 3$



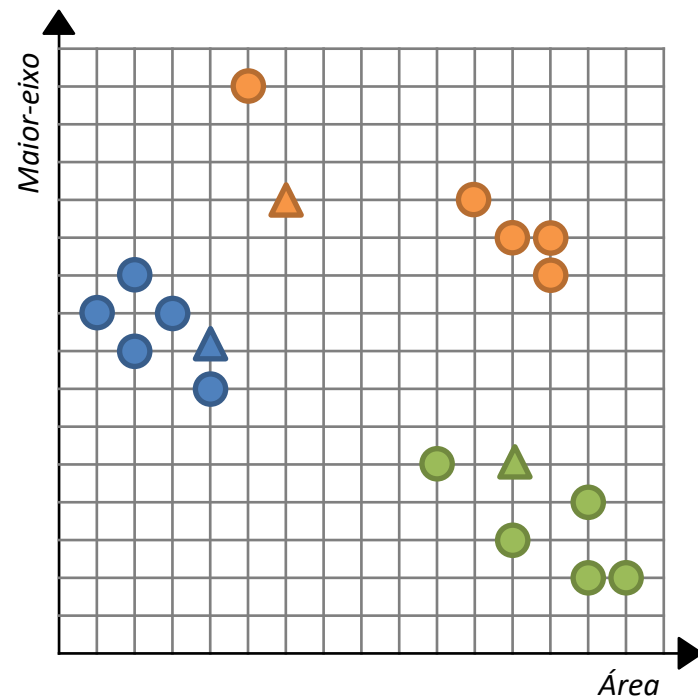
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 *acer palmatum*
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$k = 3$

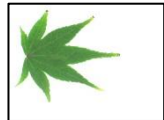


# Funções lineares (Perceptrons)

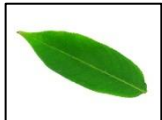
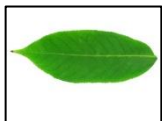
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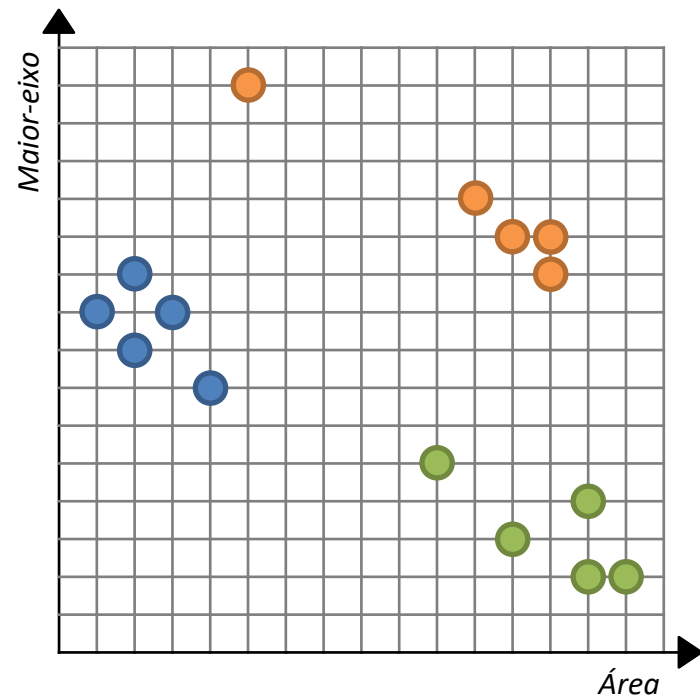
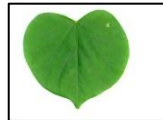
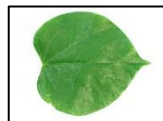
*acer palmatum*



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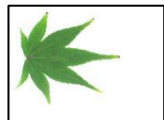


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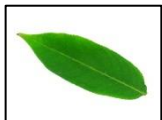
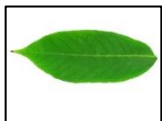
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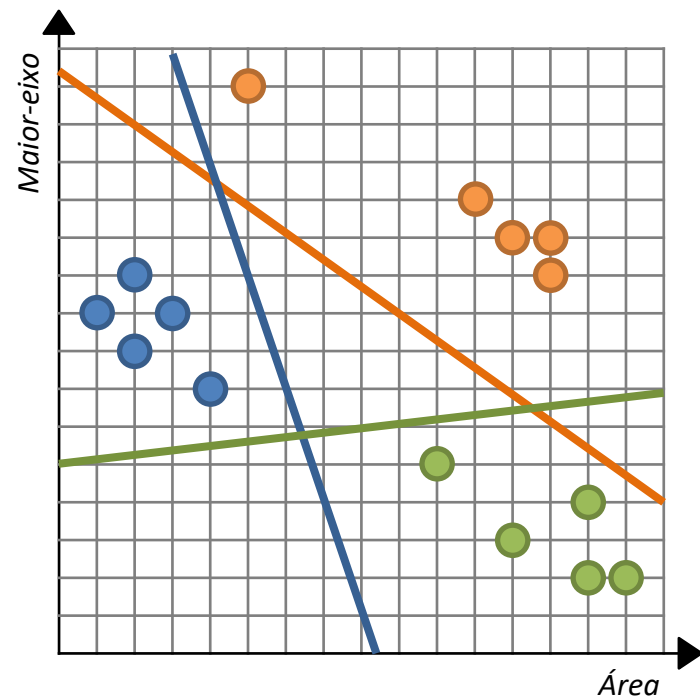
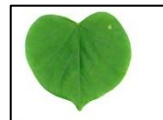
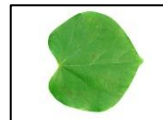
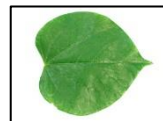
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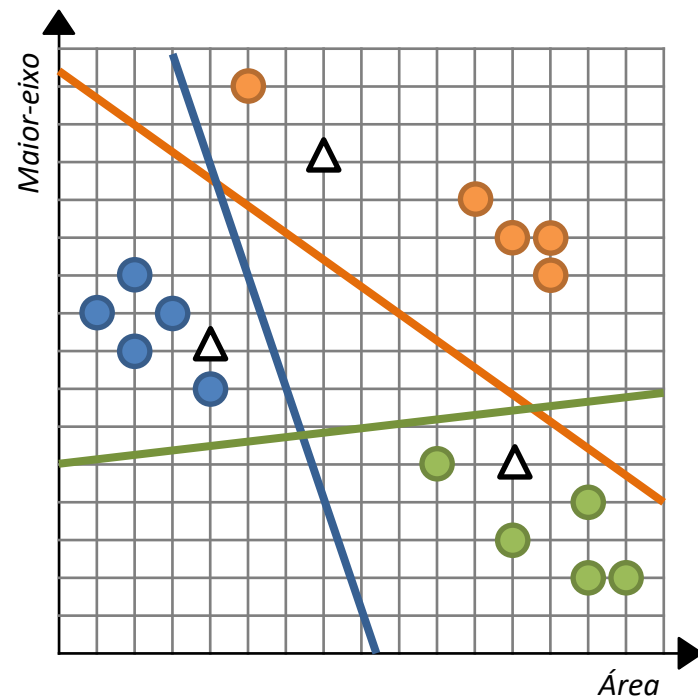
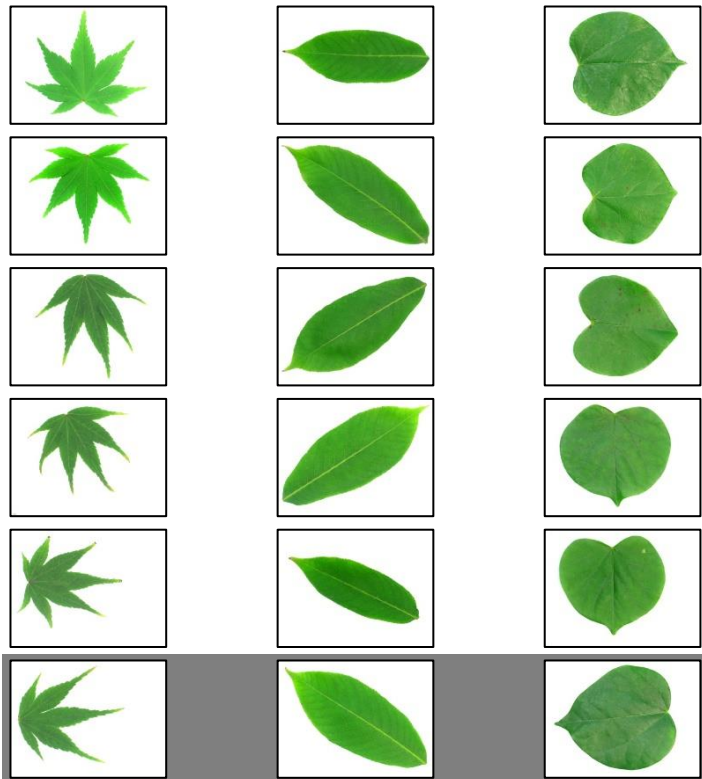
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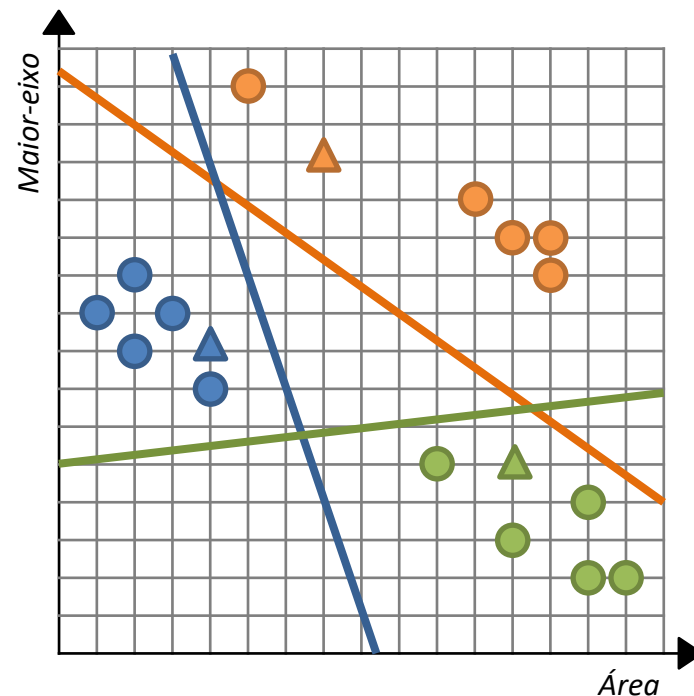
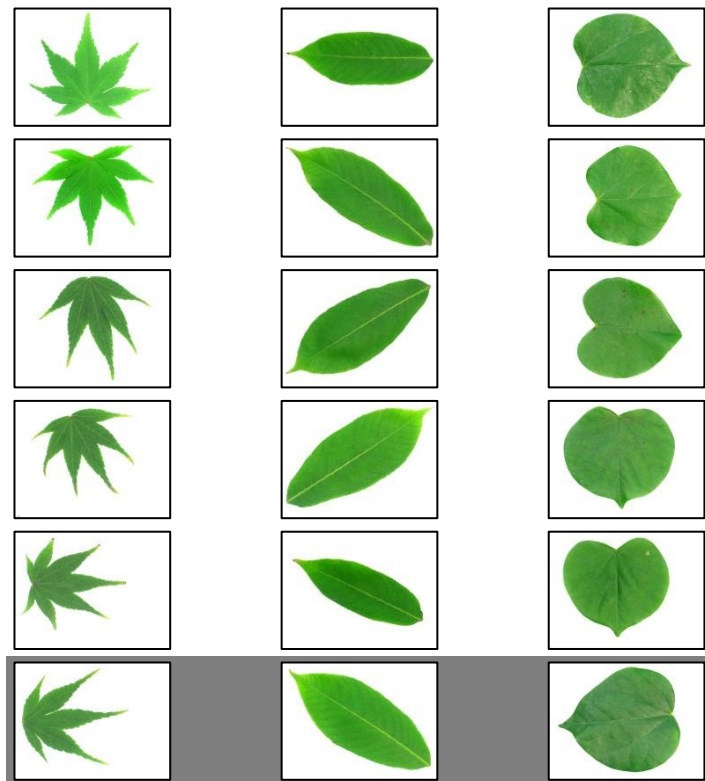
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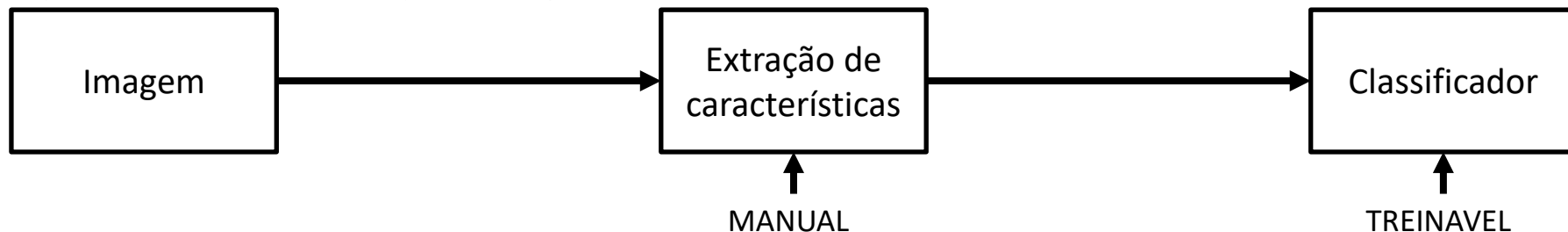


# PIPELINES DE CLASSIFICAÇÃO

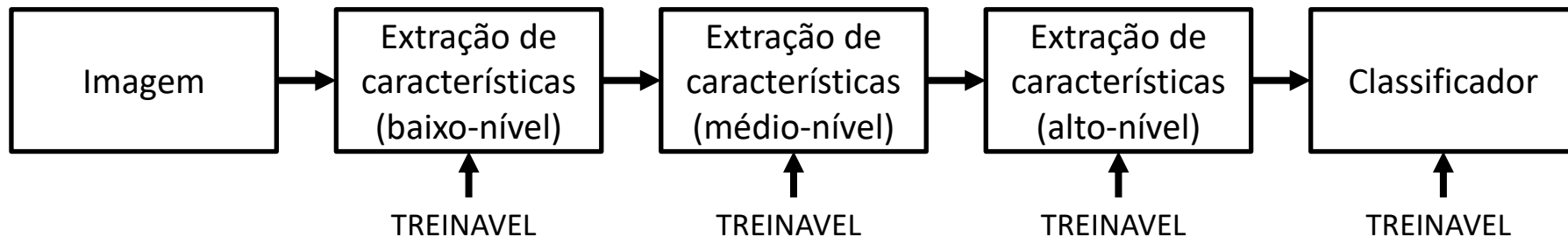


# Pipelines de classificação

Pipeline clássico de classificação de imagens



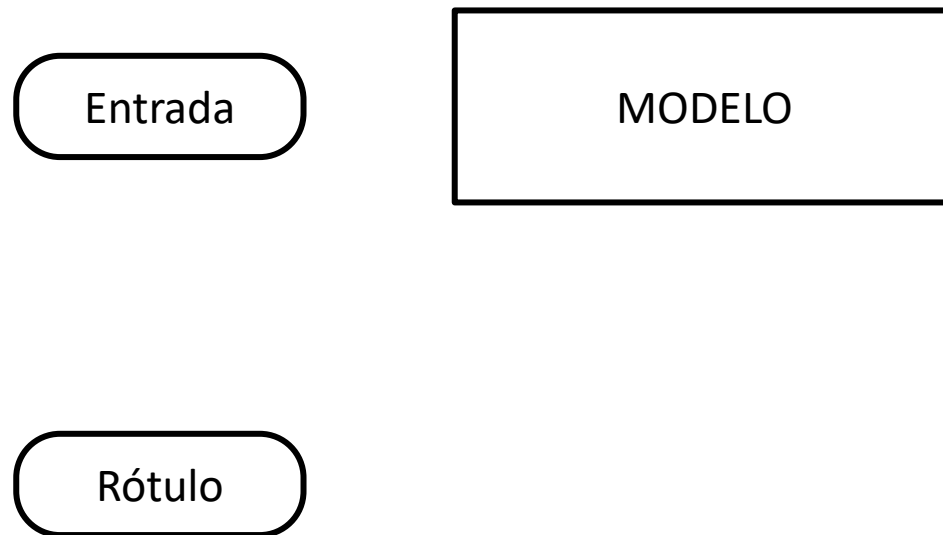
Deep Learning

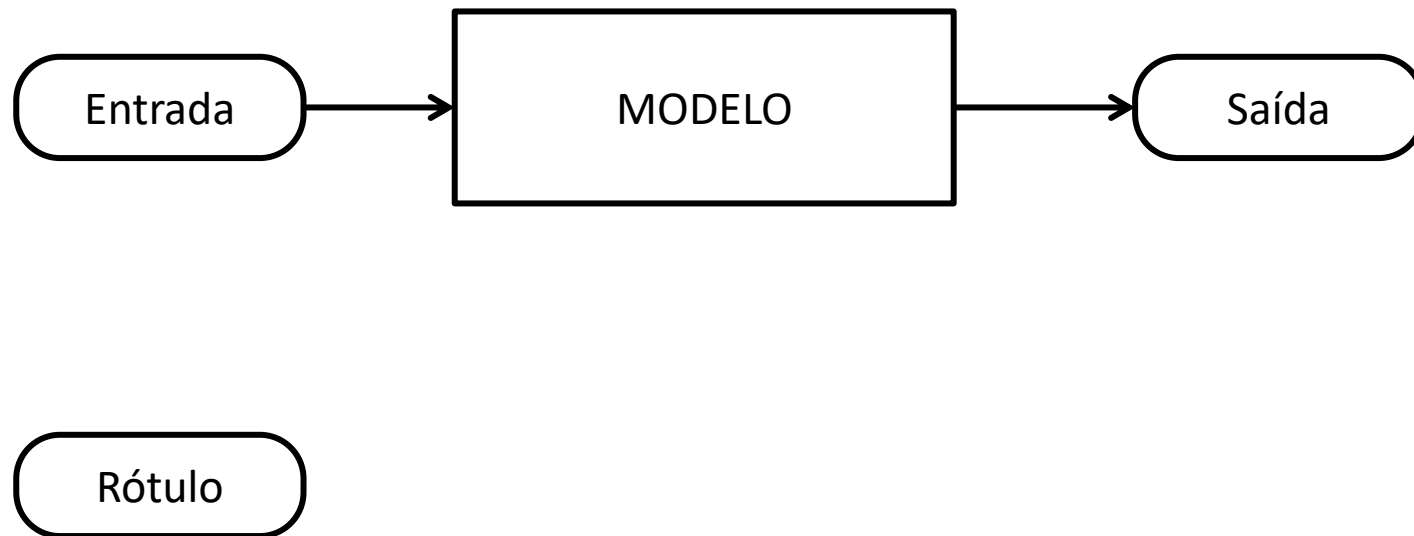


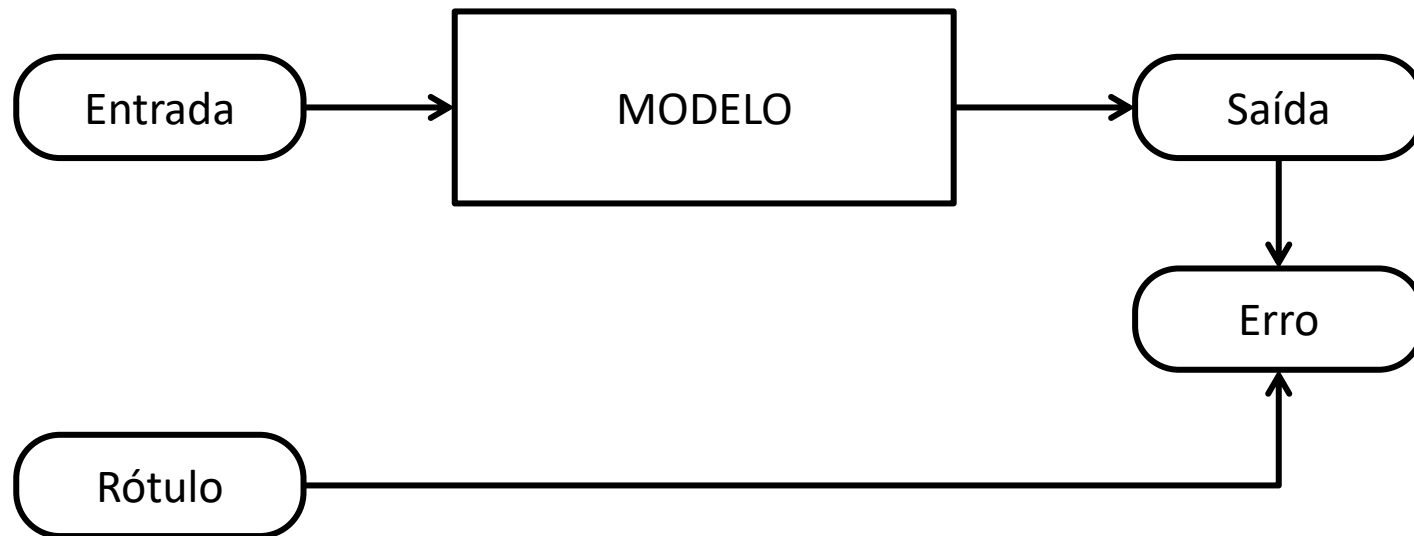
# MODELOS DE APRENDIZADO

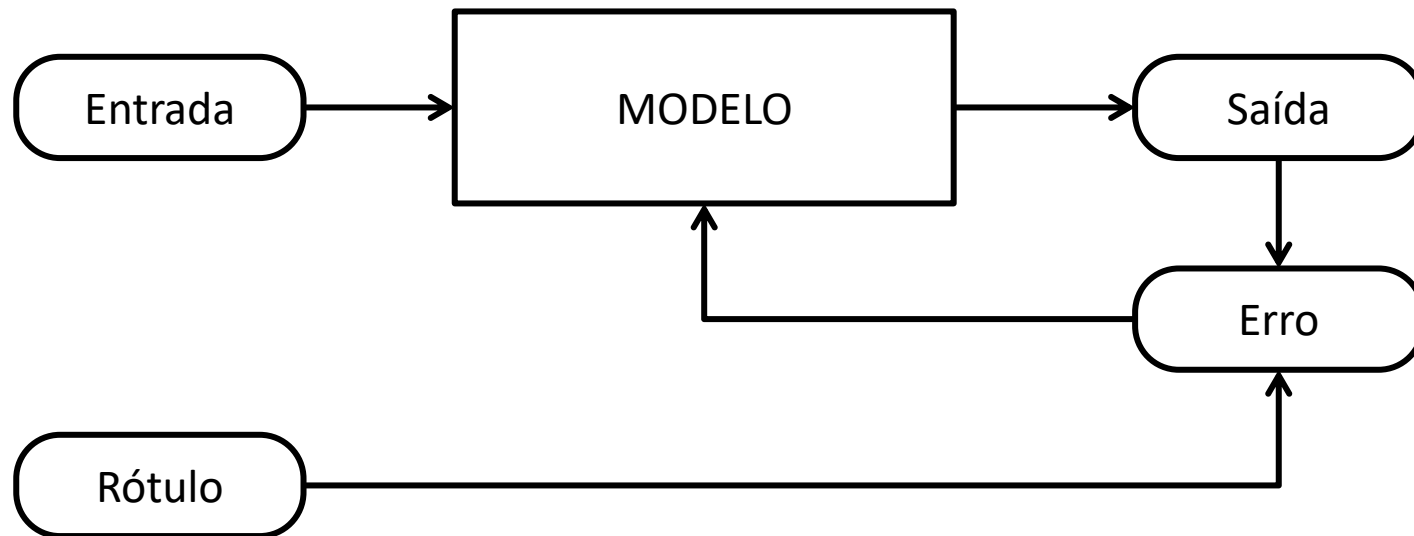
# Modelos de aprendizado

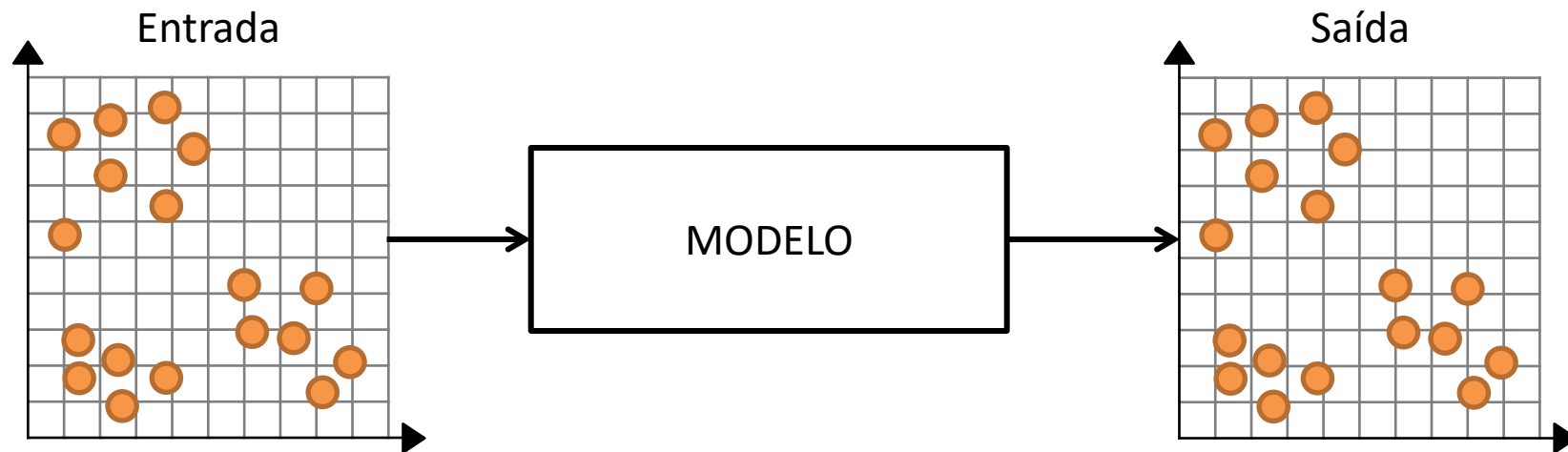
- Aprendizado supervisionado
- Aprendizado não supervisionado
- Aprendizado por reforço
- Aprendizado semi-supervisionado



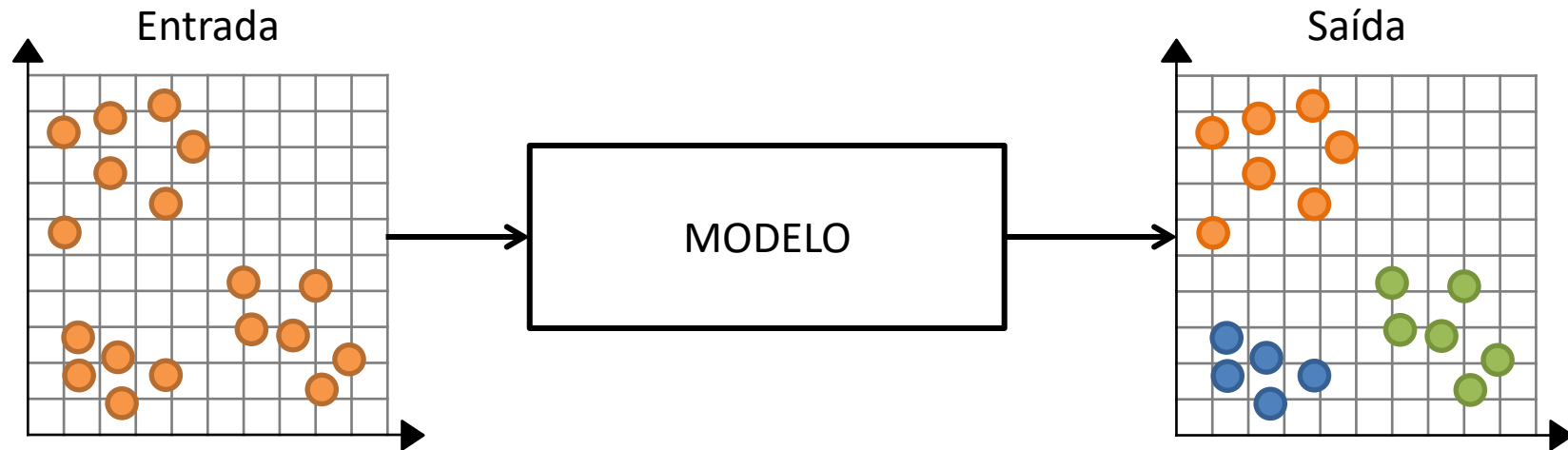


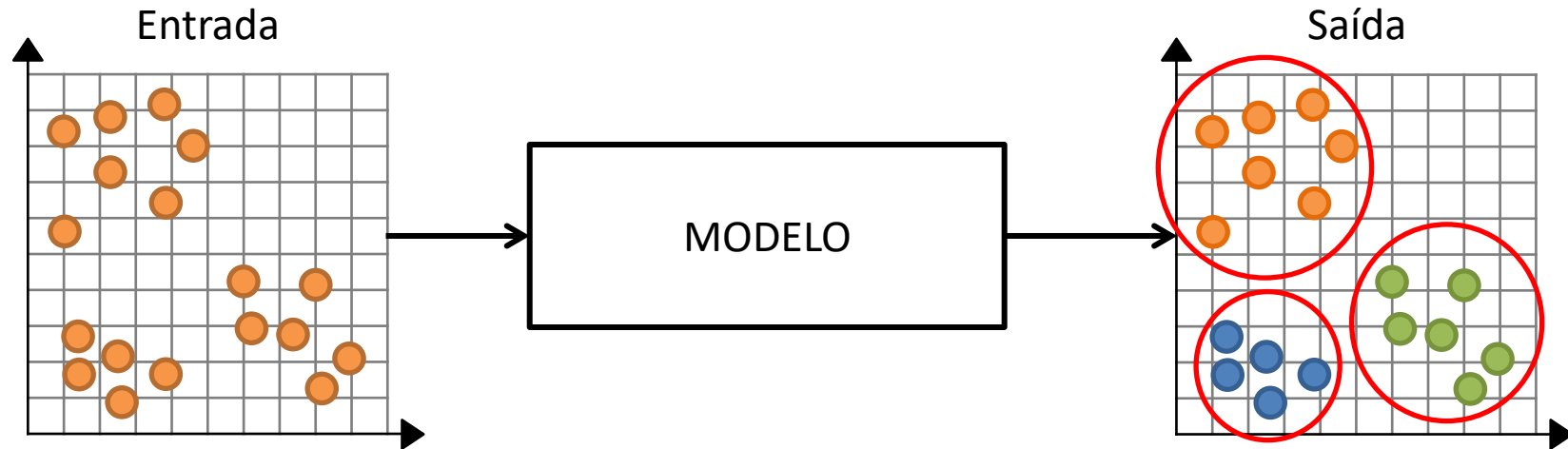




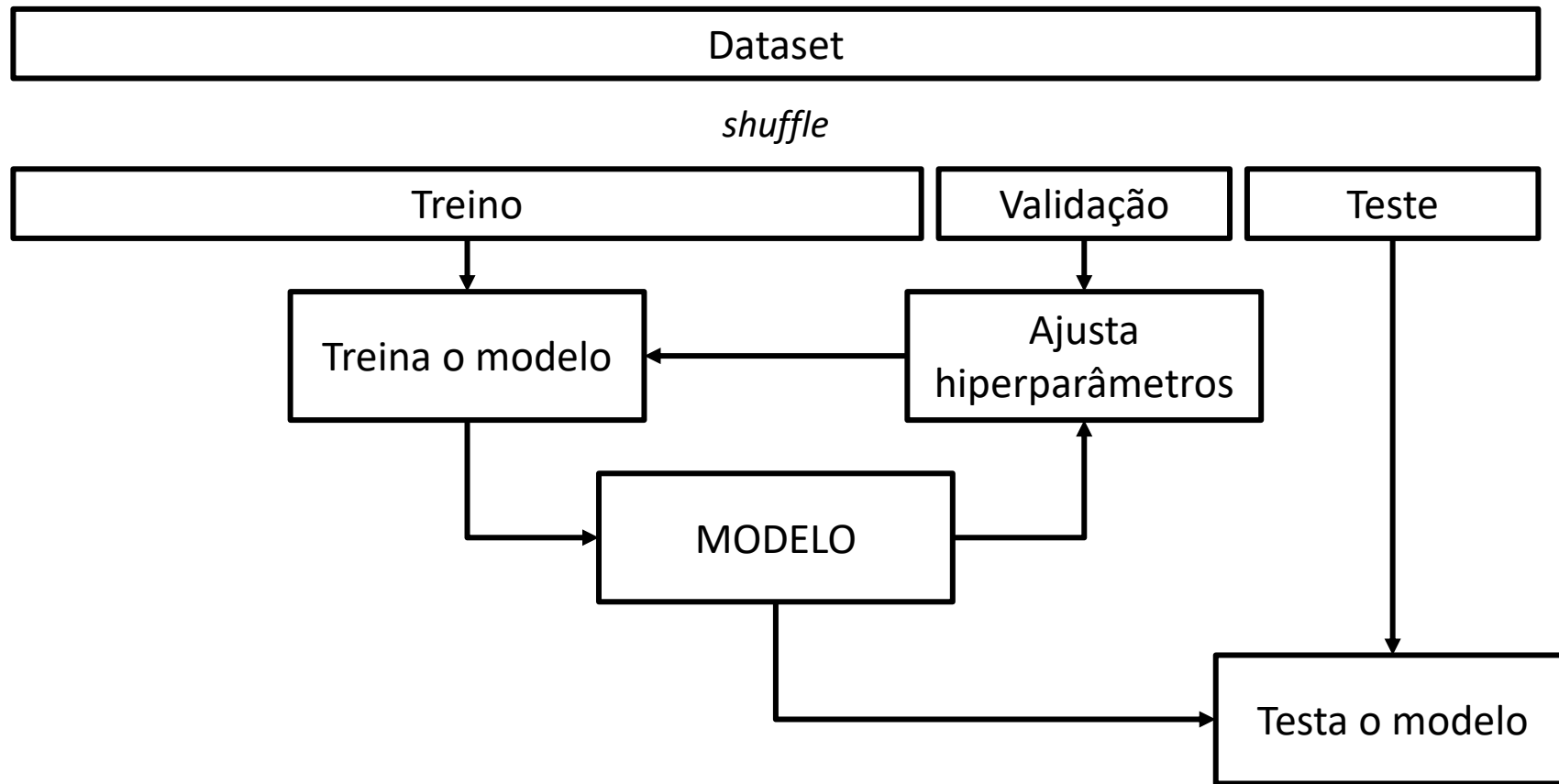








# VALIDAÇÃO CRUZADA



Dataset

*shuffle*

Treino

Teste

Treino

Validação

$k = 0$

Treino

Validação

Treino

$k = 1$

Treino

Validação

Treino

$k = 2$

Treino

Validação

Treino

$k = 3$

Validação

Treino

$k = 4$

# AVALIAÇÃO DOS RESULTADOS

# Matriz de confusão

- Verdadeiro positivo (TP):
  - Objetos da classe C1 classificados como C1.
- Verdadeiro negativo (TN):
  - Objetos de outras classes (C2 e C3) classificados como não sendo C1.
- Falso positivo (FP) (erro tipo I):
  - Objetos classificados como C1 mas pertencem a outras classes (C2 ou C3).
- Falso negativo (FN) (erro tipo II):
  - Objetos da classe C1 classificados como outras classes (C2 ou C3).

		Classificação			Soma
		Classe C1	Classe C2	Classe C3	
Classe real	Classe C1	5	3	0	8
	Classe C2	2	3	1	6
	Classe C3	0	2	11	13
	Soma	7	8	12	

		Classificação	
		Classe C1	Outras
Classe real	Classe C1	TP 5	FN 3
	Outras	FP 2	TN 17

# Acurácia, precisão, sensibilidade e F1-score

- Acurácia (*Accuracy*):
  - $Acurácia = (TP + TN) / (TP + TN + FP + FN)$
- Precisão (*Precision*):
  - $Precisão = TP / (TP + FP)$
- Sensitividade (*Recall*):
  - $Sensitividade = TP / TP + FN$
- Índice-F1 (*F1-score*):
  - $F1 = (2 * TP) / (2 * TP + FP + FN)$
- Suporte (*Support*):
  - $Suporte = TP + FP$



# Referencias

- GONZALEZ, R.C.; WOODS, R.E.; **Processamento Digital de Imagens**. 3ª edição. Editora Pearson, 2009.
- COSTA, L. DA F.; CESAR-JR., R. M. **Shape analysis and classification : theory and practice**. CRC Press, 2000. Capítulo 8.
- Yann LeCun', Alfredo Canziani. **Yann LeCun's Deep Learning Course at CDS - SPRING 2021**
  - <https://cds.nyu.edu/deep-learning/>

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  title = {Classificação de imagens},
  year = {2023},
  publisher = {GitHub},
  journal = {Introdução ao Processamento Digital de Imagens - UFV},
  howpublished = {\url{https://github.com/joaofmari/SIN392_Introduction-to-digital-image-processing_2023}}
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# FIM