

## Laboratório Aprendizagem de Máquina

### Lab6: Convolutional Neural Network - CNN

Avalie as CNN para o problema de classificação de meses do ano. Escreva um relatório avaliando os mesmo item do exercício anterior e também os parâmetros das camadas de convolução (tamanho do filtro, função de ativação, tipo de pooling, quantidade de camadas de convolução). Reporte seu melhor resultado juntamente com as matrizes de confusão.

Variação	Desempenho no conjunto de teste	
	Test accuracy	Test loss
I	0.8179	0.5885
II	0.8728	0.3849
III	0.8404	0.5082
IV	0.8229	0.5286
V	0.7955	0.6279
VI	0.6434	1.1187
VII	0.7930	0.6569
VIII	0.8129	0.4987
IX	0.7980	0.5694
X	0.8504	0.4635
XI	0.7631	0.7097
XII	0.6584	1.0233
XIII	0.4364	1.7093
XIV	0.7855	0.6492
XV	0.8628	0.4304

Neste experimento, avaliou-se o desempenho da CNN a partir de mudanças no tamanho do filtro em cada camada de convolução, na função de ativação usadas nas camadas Conv2D (selu, relu, softplus, linear), dois tipos de Pooling (MaxPooling2D, AveragePooling2D), além dos efeitos do aumento do número de camadas Conv2D concomitantemente com novas camadas de pooling. Ainda, nas camadas Conv2D testou-se variações do tamanho do passo da convolução (strides), o tamanho da janela dos filtros (kernel\_size) e, na camada de pooling o tamanho da janela (pool\_size). Em termos gerais, o aumento do tamanho do passo (strides), da janela dos filtros (kernel\_size) e do número de camadas Conv2D não proporcionou melhora na acurácia do modelo CNN. As variações nas camadas de pooling (strides, padding e pool\_size) não promoveram significativas melhoras na acurácia. Por fim, a **variação II** foi aquela que mostrou melhor desempenho para prever as imagens de meses do ano, cujo desempenho no conjunto de teste foi de 0.8728 (acurácia) e 0.3849 (loss). Todas as variações testadas estão na sequência, e mostram a configuração do modelo CNN, as matrizes de confusão e os gráficos comparativos das curvas de treinamento e teste. Para ajustar o modelo CNN foi fixado batch\_size = 128 e epochs = 20.

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## - Variação I

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Alguns parâmetros do modelo CNN:

**filters** = número de filtros;

**kernel\_size** = tamanho da janela dos filtros;

**activation** = função de ativação;

**input\_shape** = tamanho das imagens de entrada. O último número (3) representa a quantidade de canais da imagem. Em imagens coloridas são 3 (RGB);

**strides** = tamanho do passo da convolução ao longo da altura e largura da imagem;

**pool\_size** = pool máximo: é uma técnica de subamostragem. Uma janela de pooling (2 x 2) reduz pela metade a entrada em ambas as dimensões espaciais. Usando o pool máximo o maior valor será tomado, o qual representará o novo valor para a região; Quando “strides” não é especificada na camada MaxPooling2D, o padrão será pool\_size; e

**unit** = quantidade de neurônios na respectiva camada oculta;

**padding** = ‘valid’ ou ‘same’. O padrão é ‘valid’ tanto para as camadas de convolução (Conv2D) quanto para MaxPooling2D.

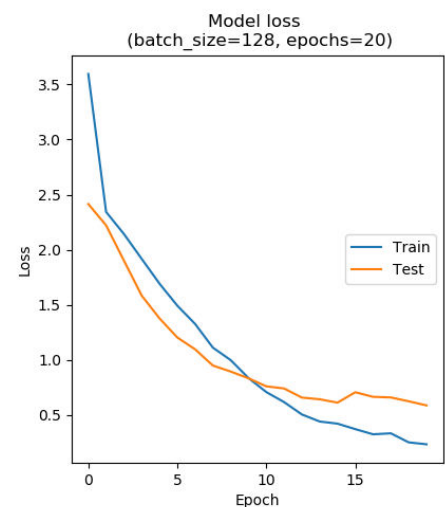
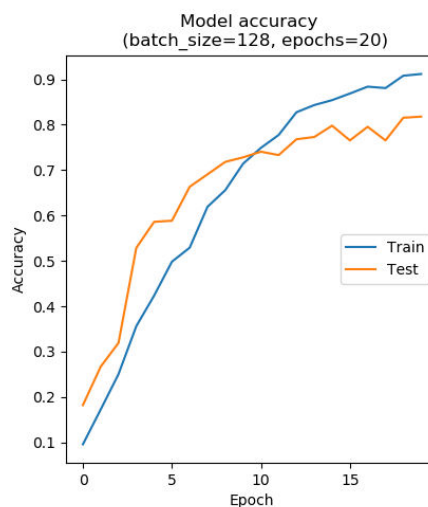
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(3, 3)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
Conv2D	64	(3, 3)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.8179551125167314

Test loss: 0.5884966477194332

```
[[32 4 0 0 0 2 1 0 0 0 0 0]
 [ 7 23 0 0 0 0 0 0 0 0 1 1]
 [ 0 0 35 0 0 0 0 0 1 0 0 0]
 [ 1 1 1 33 1 0 0 1 0 0 1 0]
 [ 0 1 0 2 32 0 2 0 0 1 0 0]
 [ 5 0 0 0 0 19 5 0 0 0 0 0]
 [ 3 0 0 0 1 3 25 0 0 0 0 0]
 [ 1 0 1 0 0 0 0 23 0 0 1 2]
 [ 0 1 0 1 0 2 0 0 24 1 1 1]
 [ 0 0 2 0 1 0 0 0 0 27 0 0]
 [ 0 0 0 0 0 0 0 1 1 0 32 0]
 [ 0 0 0 0 0 3 0 0 4 1 2 23]]
```



## - Variação II

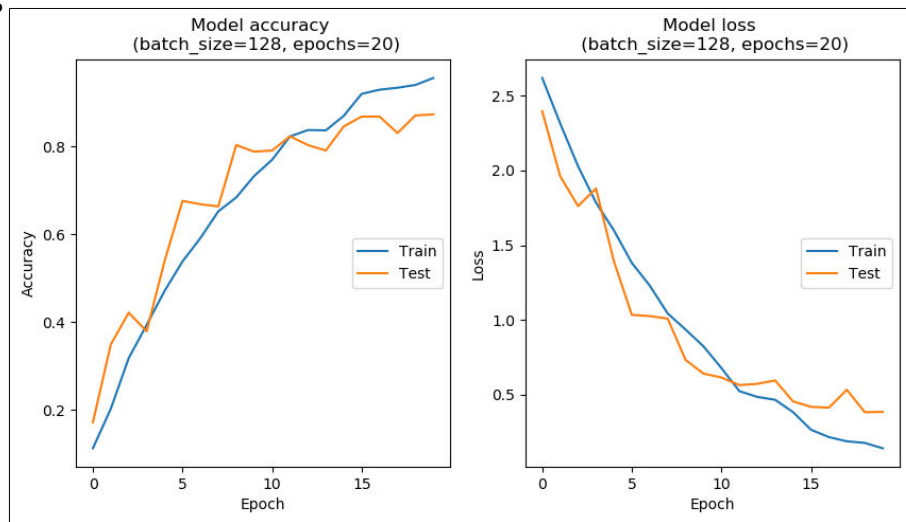
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(3, 3)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(3, 3)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.8728179554094995

Test loss: 0.3849914211436103

```
[[33 3 0 0 0 2 1 0 0 0 0 0]
 [2 30 0 0 0 0 0 0 0 0 0 0]
 [0 0 35 0 1 0 0 0 0 0 0 0]
 [0 0 0 37 1 0 0 1 0 0 0 0]
 [0 0 0 2 36 0 0 0 0 0 0 0]
 [4 0 0 0 0 23 2 0 0 0 0 0]
 [1 0 0 1 2 1 27 0 0 0 0 0]
 [0 0 1 0 0 0 0 26 0 0 0 1]
 [0 1 0 3 0 0 0 0 20 3 1 3]
 [0 0 0 0 0 0 0 0 0 30 0 0]
 [0 1 1 0 1 0 0 0 2 0 29 0]
 [0 1 0 0 1 1 0 1 3 1 1 24]]
```



## - Variação III

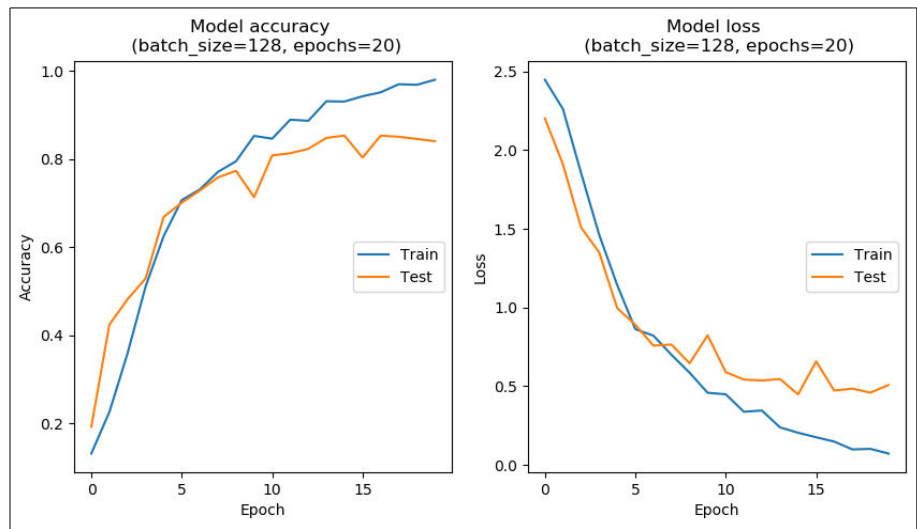
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(3, 3)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(3, 3)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	128	(3, 3)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.8403990029396856

Test loss: 0.5081522924049834

```
[[30 2 0 0 1 3 1 0 0 0 2 0]
 [4 24 0 0 0 0 0 0 3 0 0 1]
 [0 0 34 0 1 1 0 0 0 0 0 0]
 [0 0 0 35 0 0 1 2 1 0 0 0]
 [0 0 1 6 29 0 0 0 1 0 1 0]
 [2 0 0 0 0 24 2 0 1 0 0 0]
 [0 0 0 0 0 1 31 0 0 0 0 0]
 [0 0 1 0 2 0 0 22 0 0 1 2]
 [0 0 0 1 0 0 0 0 28 0 1 1]
 [0 0 0 0 0 0 0 0 5 24 1 0]
 [0 0 0 0 0 0 0 0 1 0 33 0]
 [0 0 0 0 0 0 0 1 3 0 6 23]]
```



## - Variação IV

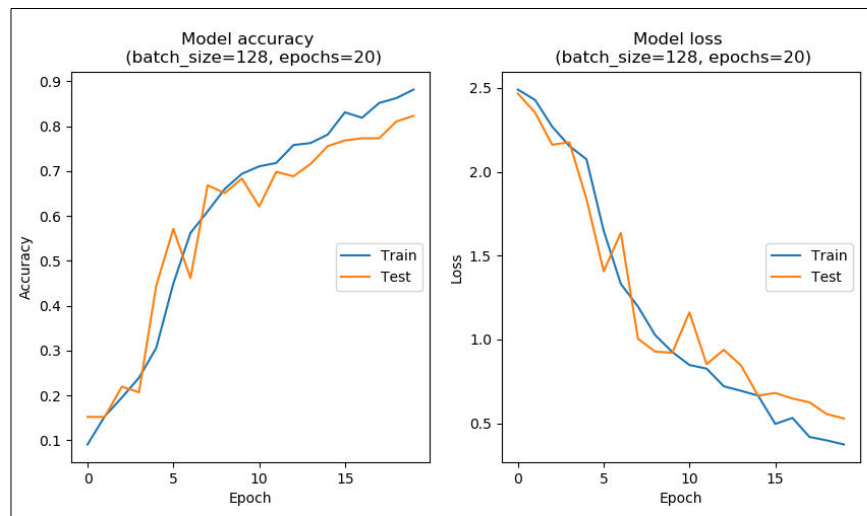
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(3, 3)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(3, 3)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	128	(3, 3)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	256	(3, 3)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	256	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

### • Matrizes de confusão

Test accuracy: 0.8229426436888012

Test loss: 0.5286361332843429

```
[[29 5 0 0 0 0 3 2 0 0 0 0]
 [3 22 0 0 2 0 0 1 0 1 3 0]
 [0 0 35 0 1 0 0 0 0 0 0 0]
 [0 0 0 36 2 0 1 0 0 0 0 0]
 [0 0 0 15 22 0 1 0 0 0 0 0]
 [4 0 0 0 0 21 3 1 0 0 0 0]
 [0 0 0 0 0 0 32 0 0 0 0 0]
 [0 0 1 0 1 0 0 24 0 0 1 1]
 [0 0 0 1 0 0 0 0 22 5 0 3]
 [0 0 0 0 0 0 0 0 1 28 0 1]
 [0 0 0 0 0 0 0 0 0 0 33 1]
 [0 1 0 0 0 1 0 2 1 0 2 26]]
```



## - Variação V

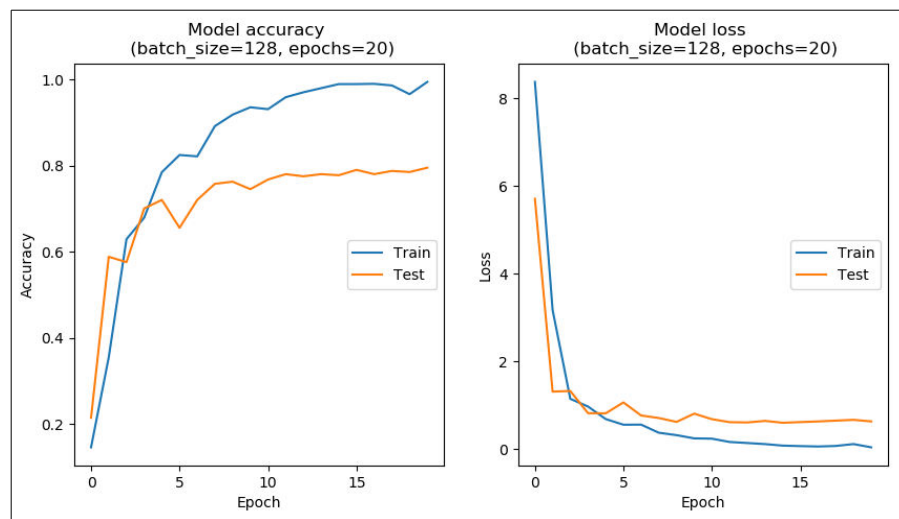
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(3, 3)	'selu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(3, 3)	'selu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'selu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.7955112222424172

Test loss: 0.6278798247959251

```
[[26 2 0 0 0 7 1 0 0 1 2 0]
 [ 4 24 0 0 0 0 0 0 0 1 2 1]
 [ 0 0 34 0 1 0 1 0 0 0 0 0]
 [ 0 0 0 32 5 0 0 1 1 0 0 0]
 [ 0 0 1 4 33 0 0 0 0 0 0 0]
 [ 2 0 0 0 0 24 2 1 0 0 0 0]
 [ 4 1 1 0 1 5 19 0 0 1 0 0]
 [ 0 0 0 0 0 0 1 23 0 0 1 3]
 [ 0 1 0 0 1 1 0 0 17 4 2 5]
 [ 0 0 1 0 1 0 0 0 0 28 0 0]
 [ 0 0 0 0 0 0 0 0 0 0 34 0]
 [ 0 0 0 1 0 3 0 0 2 1 1 25]]
```



## - Variação VI

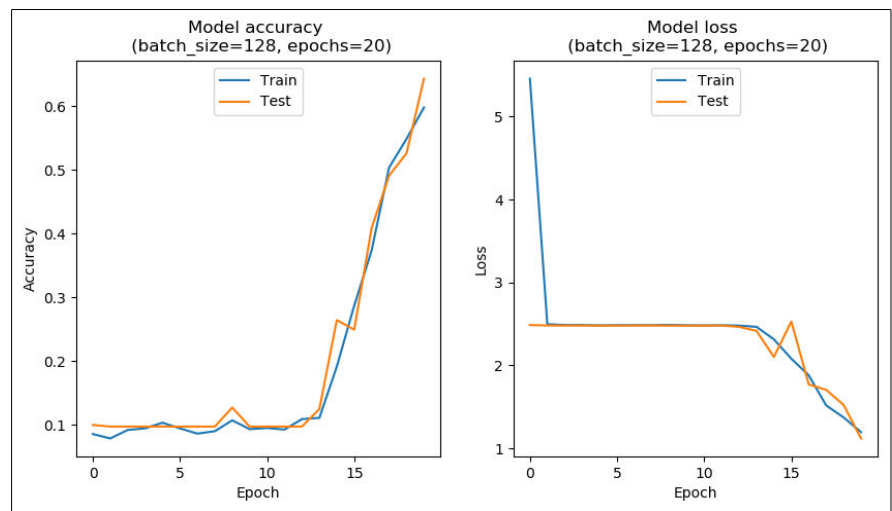
Camadas	filter	kernel_siz	activation	input_shap	strides	padding	pool_size	unit	value
Conv2D	32	(3, 3)	'softplus'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(3, 3)	'softplus'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'softplus'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.6433915216429276

Test loss: 1.118664500422014

```
[[37 0 0 0 0 0 0 0 0 0 2 0]
 [21 4 0 1 0 0 0 0 0 0 6 0]
 [ 1 0 32 1 0 0 0 1 0 0 0 1]
 [ 6 0 0 28 1 0 0 1 1 0 2 0]
 [ 5 0 1 3 19 0 1 2 0 6 1 0]
 [ 8 1 0 0 0 18 1 0 0 0 1 0]
 [ 3 0 0 0 1 4 22 0 0 1 1 0]
 [ 1 0 0 1 0 0 0 14 0 0 1 11]
 [ 4 0 0 1 0 0 0 0 9 10 7 0]
 [ 0 0 0 0 0 0 0 0 0 29 1 0]
 [ 0 0 0 1 2 0 0 0 0 1 30 0]
 [ 4 1 0 0 0 0 0 0 1 3 8 16]]
```



## - Variação VII

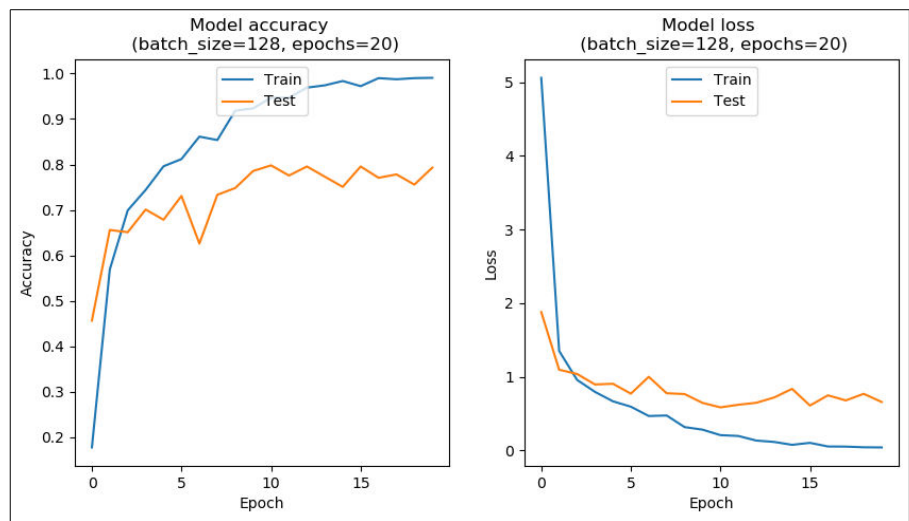
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(3, 3)	'linear'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(3, 3)	'linear'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'linear'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.7930174571023023

Test loss: 0.6569046143284463

```
[[23 6 0 0 0 6 2 0 1 0 1 0]
 [3 25 0 0 0 0 0 1 0 1 1 1]
 [0 0 32 0 1 0 3 0 0 0 0 0]
 [0 0 1 32 4 0 0 1 1 0 0 0]
 [0 0 0 3 35 0 0 0 0 0 0 0]
 [1 1 0 0 0 22 4 1 0 0 0 0]
 [5 0 0 0 0 4 22 0 0 1 0 0]
 [0 0 0 0 0 0 1 26 1 0 0 0]
 [0 0 0 1 0 0 0 0 24 2 4 0]
 [0 0 0 0 0 0 2 0 0 28 0 0]
 [0 2 0 0 0 0 0 0 1 0 31 0]
 [0 0 0 1 1 1 0 0 7 2 3 18]]
```





## - Variação VIII

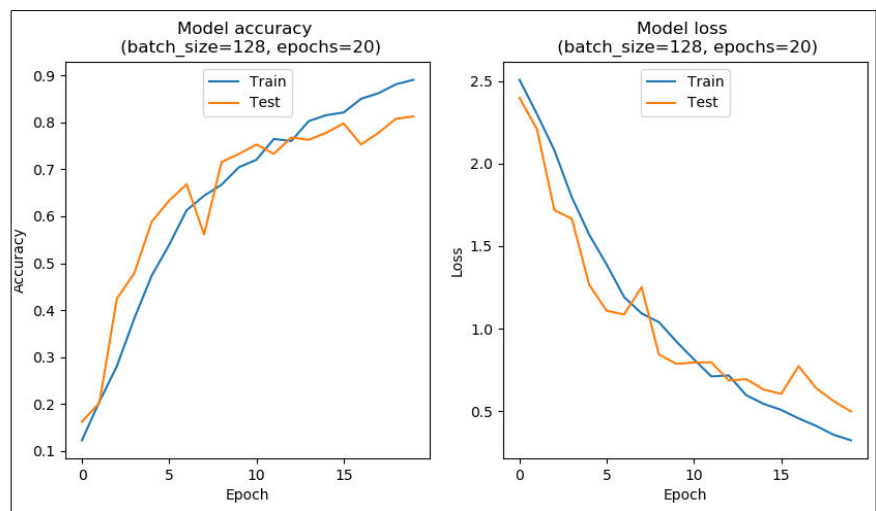
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(3, 3)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
AveragePooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(3, 3)	'relu'	-	-	'valid'	-	-	-
AveragePooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

### • Matrizes de confusão

Test accuracy: 0.8129675814933016

Test loss: 0.49872726276331114

```
[[27 5 0 0 1 2 2 1 1 0 0 0]
 [2 24 0 0 0 0 0 1 2 0 1 2]
 [0 0 34 0 0 0 0 1 1 0 0 0]
 [0 0 1 32 4 0 0 1 1 0 0 0]
 [0 0 0 3 34 0 0 0 1 0 0 0]
 [3 0 0 0 0 22 4 0 0 0 0 0]
 [1 0 0 0 0 2 29 0 0 0 0 0]
 [0 0 0 0 0 0 0 24 0 0 0 4]
 [0 0 0 1 0 0 0 0 24 2 1 3]
 [0 0 0 0 0 0 1 0 1 28 0 0]
 [0 2 0 0 0 0 0 0 5 0 25 2]
 [0 1 0 0 0 0 0 1 8 0 0 23]]
```



## - Variação IX

Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(2, 2)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(2, 2)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.7980049885716521

Test loss: 0.5694412379490764

```
[[21 4 0 0 0 7 6 0 0 0 0 1]
 [4 24 0 0 1 0 0 0 0 0 2 1]
 [0 0 35 1 0 0 0 0 0 0 0 0]
 [0 0 2 36 0 0 0 1 0 0 0 0]
 [0 0 0 4 33 0 0 0 1 0 0 0]
 [2 0 0 0 0 21 6 0 0 0 0 0]
 [3 0 0 0 0 1 28 0 0 0 0 0]
 [0 0 2 0 0 0 0 21 0 0 1 4]
 [0 1 0 1 0 0 0 0 20 2 3 4]
 [0 0 1 0 0 0 0 0 2 27 0 0]
 [0 0 0 0 0 0 0 0 0 0 32 2]
 [0 1 0 0 0 3 0 1 4 1 1 22]]
```



## - Variação X

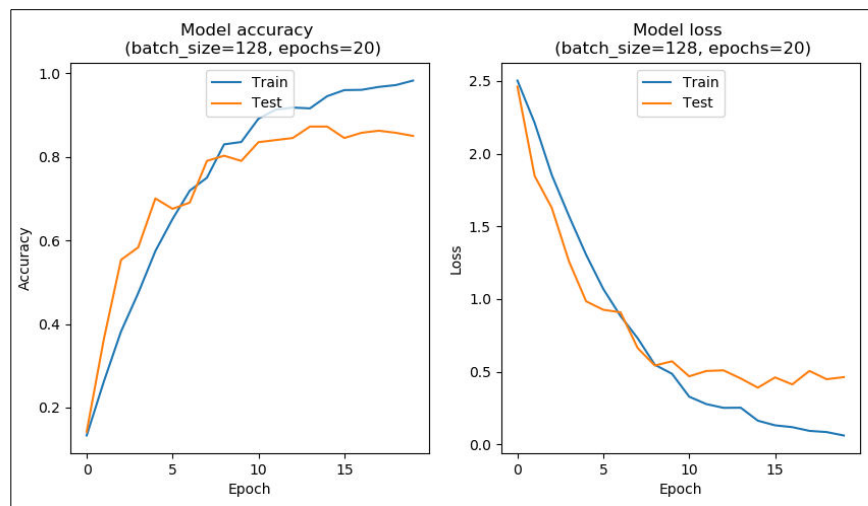
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(4, 4)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(4, 4)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.8503740657297453

Test loss: 0.46350687103081223

```
[[24 4 0 0 1 7 2 1 0 0 0 0]
 [1 29 0 0 0 0 0 1 0 1 0 0]
 [0 0 34 0 2 0 0 0 0 0 0 0]
 [0 0 1 28 7 0 1 1 0 1 0 0]
 [0 0 0 0 37 0 0 0 0 0 1 0]
 [2 0 0 0 0 24 3 0 0 0 0 0]
 [0 0 0 0 1 1 30 0 0 0 0 0]
 [0 0 0 0 1 0 0 25 0 0 0 2]
 [0 0 0 1 0 1 0 0 21 3 1 4]
 [0 0 0 0 0 0 0 0 0 30 0 0]
 [0 0 0 0 0 0 0 0 2 0 30 2]
 [0 0 0 0 0 2 0 1 0 0 1 29]]
```



## - Variação XI

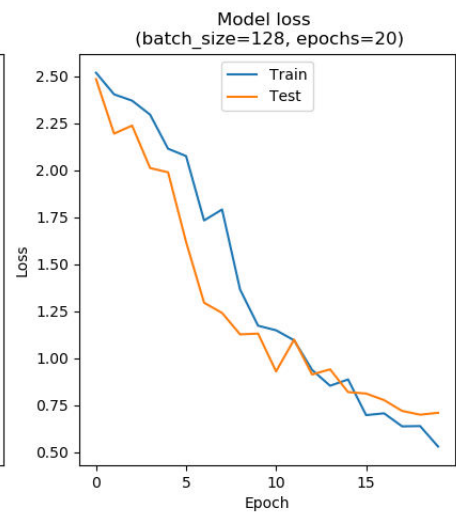
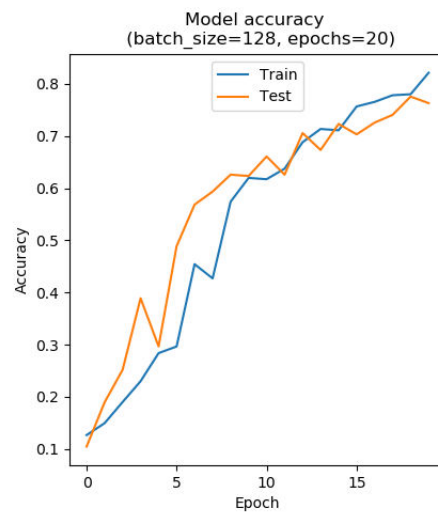
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(6, 6)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(6, 6)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.7630922699212433

Test loss: 0.7097120809733422

```
[[26 6 1 0 1 0 4 1 0 0 0 0]
 [ 6 22 0 2 0 0 0 2 0 0 0 0]
 [ 0 0 35 0 1 0 0 0 0 0 0 0]
 [ 1 0 0 34 2 0 0 0 1 1 0 0]
 [ 0 0 1 6 29 0 1 0 0 1 0 0]
 [ 4 1 0 0 0 14 4 5 1 0 0 0]
 [ 2 0 0 0 1 0 28 0 0 1 0 0]
 [ 0 0 0 0 1 0 0 25 0 0 1 1]
 [ 1 0 0 3 0 0 0 0 17 7 2 1]
 [ 0 0 0 1 0 0 0 0 0 29 0 0]
 [ 0 0 0 1 1 0 0 0 0 1 30 1]
 [ 0 2 0 0 0 0 0 3 2 2 7 17]]
```



## - Variação XII

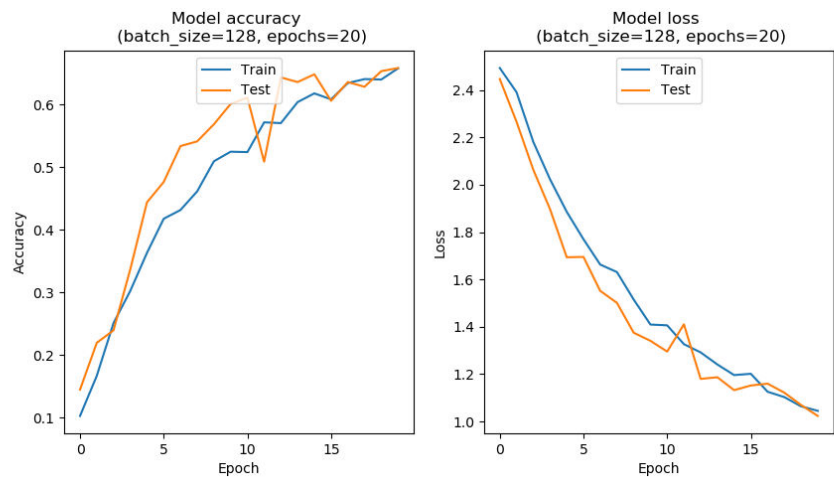
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(2, 2)	'relu'	(64, 64, 3)	(3, 3)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(2, 2)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

### • Matrizes de confusão

Test accuracy: 0.658354115456417

Test loss: 1.0232579375145738

```
[[28 7 1 0 0 2 0 0 0 0 0 1]
 [5 17 1 0 1 0 1 0 2 2 0 3]
 [2 0 30 1 0 0 2 0 1 0 0 0]
 [1 2 0 22 7 0 1 0 6 0 0 0]
 [1 2 0 4 21 0 0 0 4 1 2 3]
 [7 0 0 0 0 18 3 0 0 0 1 0]
 [3 0 0 0 2 0 25 0 0 1 0 1]
 [0 0 1 1 0 1 0 13 1 0 2 9]
 [2 2 0 1 0 0 0 0 18 2 2 4]
 [0 0 1 2 0 0 0 0 1 25 0 1]
 [0 2 1 0 1 0 0 0 1 0 29 0]
 [0 6 0 0 0 1 0 1 3 0 4 18]]
```



## - Variação XIII

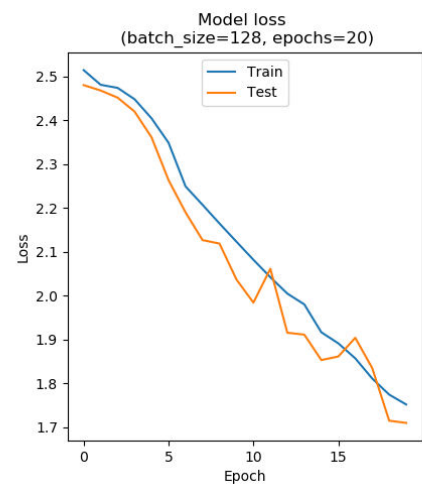
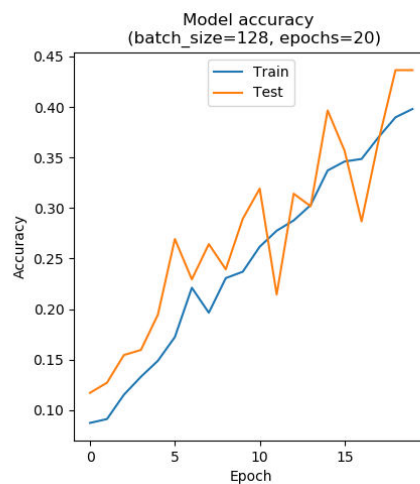
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(2, 2)	'relu'	(64, 64, 3)	(6, 6)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	64	(2, 2)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.43640897859658984

Test loss: 1.7093233776806

```
[[13 6 2 0 1 0 4 1 0 1 3 8]
 [2 10 2 0 2 0 2 0 1 4 3 6]
 [1 0 29 0 1 0 1 0 0 2 0 2]
 [0 0 1 11 12 0 1 0 2 6 5 1]
 [0 1 0 5 21 0 0 0 0 3 3 5]
 [7 0 2 1 1 2 9 1 0 1 0 5]
 [5 0 2 0 1 0 16 1 1 5 0 1]
 [0 1 1 1 0 1 1 6 0 2 1 14]
 [0 0 0 2 6 0 0 1 5 9 4 4]
 [0 0 0 1 0 0 0 0 0 22 5 2]
 [0 0 0 0 7 0 0 0 0 2 24 1]
 [1 1 1 1 1 0 1 0 2 0 9 16]]
```



## - Variação XIV

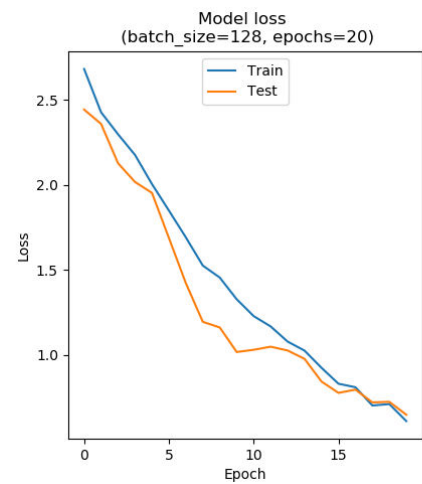
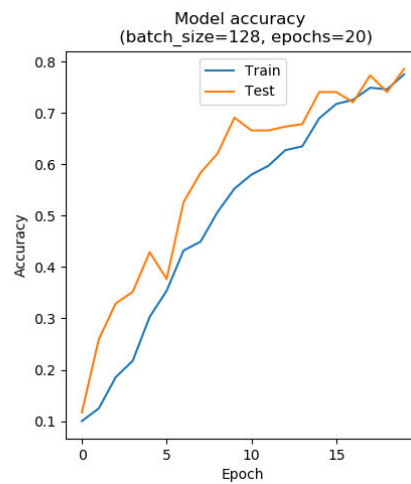
Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	32	(2, 2)	'relu'	(64, 64, 3)	(1, 1)	'same'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'same'	(2, 2)	-	-
Conv2D	64	(2, 2)	'relu'	-	-	'same'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'same'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	128	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.7855361603441976

Test loss: 0.6492257797509952

```
[[30 2 1 0 0 3 2 1 0 0 0 0]
 [5 21 2 1 1 0 0 0 0 0 2 0]
 [0 0 35 0 0 0 0 0 1 0 0 0]
 [0 0 0 38 0 0 0 1 0 0 0 0]
 [0 0 0 4 33 0 0 0 1 0 0 0]
 [4 0 0 0 0 22 3 0 0 0 0 0]
 [4 0 0 0 0 3 25 0 0 0 0 0]
 [0 0 2 0 0 0 0 23 1 0 1 1]
 [0 0 1 2 0 0 0 0 23 3 2 0]
 [0 0 1 1 0 0 0 0 3 25 0 0]
 [0 1 1 1 2 0 0 0 0 0 29 0]
 [0 3 0 1 1 1 0 6 7 0 3 11]]
```



## - Variação XV

Camadas	filters	kernel_size	activation	input_shape	strides	padding	pool_size	unit	value
Conv2D	64	(2, 2)	'relu'	(64, 64, 3)	(1, 1)	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Conv2D	128	(2, 2)	'relu'	-	-	'valid'	-	-	-
MaxPooling2D	-	-	-	-	pool_size	'valid'	(2, 2)	-	-
Dropout	-	-	-	-	-	-	-	-	0.25
Flatten	-	-	-	-	-	-	-	-	-
Dense	-	-	'relu'	-	-	-	-	256	-
Dropout	-	-	-	-	-	-	-	-	0.5
Dense	-	-	'softmax'	-	-	-	-	12	-

## • Matrizes de confusão

Test accuracy: 0.8628428935112799

Test loss: 0.4304324972659275

```
[[31 2 0 0 0 4 1 0 1 0 0 0]
 [3 27 0 1 0 0 0 0 0 0 1 0]
 [0 0 35 0 0 0 0 0 0 1 0 0]
 [0 0 1 35 0 0 0 3 0 0 0 0]
 [0 0 0 2 35 0 0 0 0 1 0 0]
 [1 0 0 0 0 25 3 0 0 0 0 0]
 [3 0 0 0 0 5 24 0 0 0 0 0]
 [0 0 0 0 0 0 0 26 0 0 1 1]
 [0 0 0 1 0 0 0 0 26 0 1 3]
 [0 0 0 0 0 0 0 0 1 29 0 0]
 [0 2 0 0 0 0 0 0 1 0 29 2]
 [0 0 0 0 0 2 0 1 4 0 2 24]]
```

