Progetto Computational and Statistical Learning

(Dataset CIFAR-10)

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OBIETTIVI

- Descrizione e analisi del dataset **CIFAR-10**
- Descrizione della progettazione (**incrementale)** dei modelli: partire da metodologie semplici come **K-Nearest** per avere una performance di base per poi implementare modelli sempre più complessi come **Random Forest** e **CNN**
- Studiare l'effetto della **PCA** sui modelli
- **Confronto** delle **performance** e dei **tempi**

1. Descrizione dataset CIFAR-10

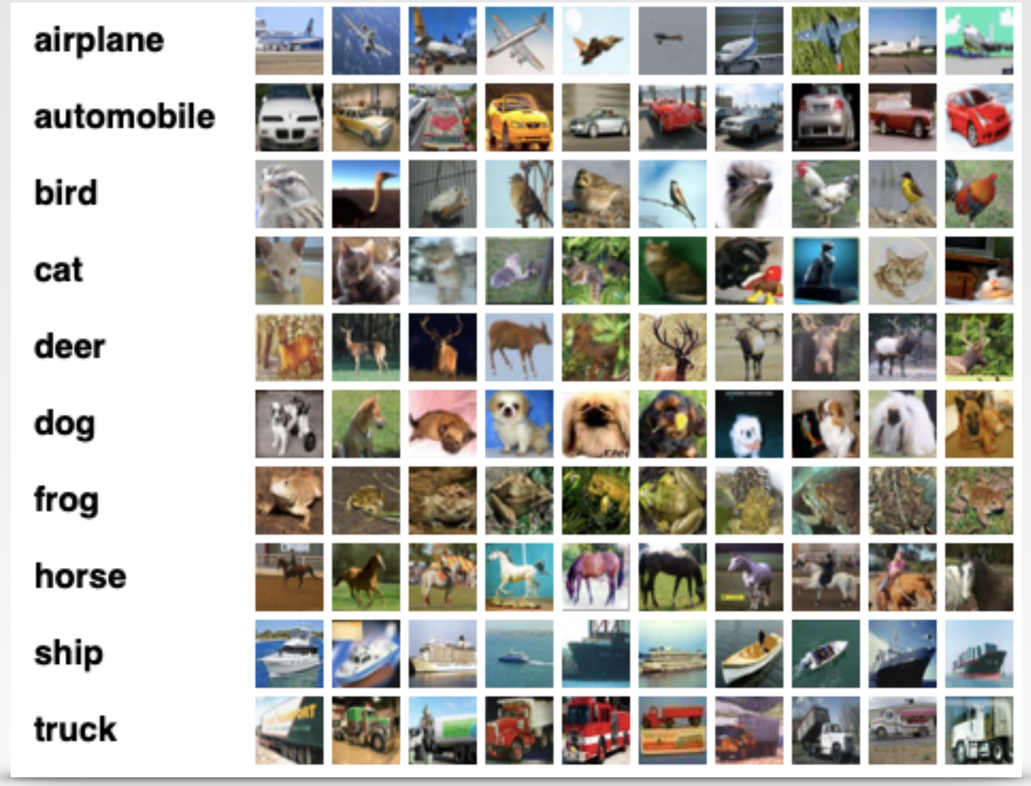
2. Progettazione modelli previsionali

3. Valutazione e confronto modelli

DATASET CIFAR-10

- **60000 immagini** 32x32 pixel a 3 canali (RGB da 0 a 255)
- **10 classi** (mutuamente esclusive) con 6000 immagini per classe
- 50000 immagini di train (5000 immagini per classe) e 10000 immagini di test (1000 immagini per classi)
- **Train e test bilanciati**
- Immagini salvate **row-major** (60000x3072)
- Label codificate con interi da 0 a 9
- Dimensione: **163MB**

OBIETTIVO: creazione e confronto di modelli previsionali in grado di effettuare **classificazione multipla di immagini**.



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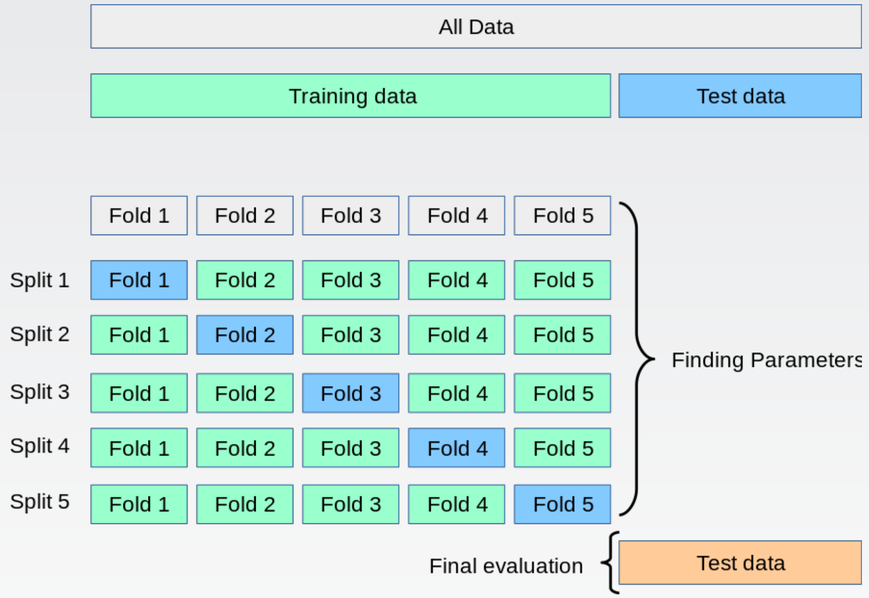
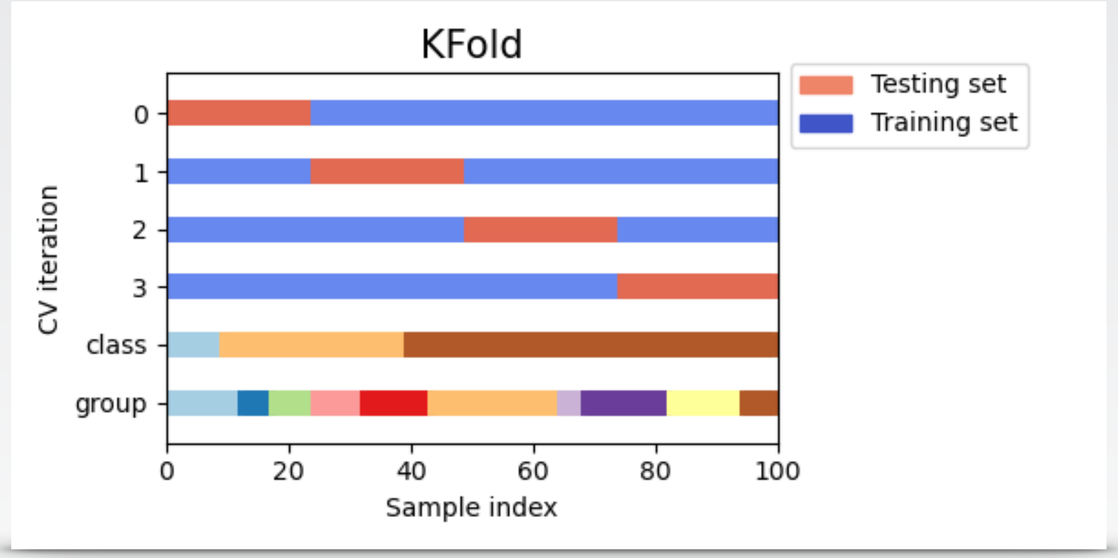
GRID-SEARCH e CROSS-VALIDATION

Grid-Search con **CV** come metodo di ricerca dei parametri migliori:



Metrica = **accuratezza**

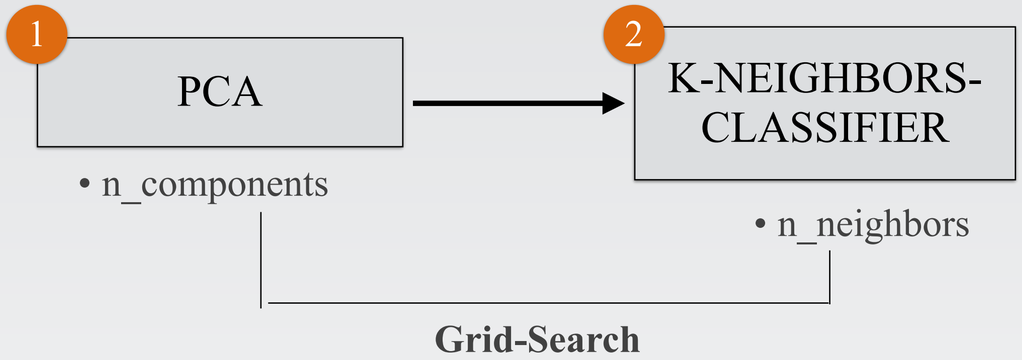
Strategia di **splitting CV** (utilizzo KFold con **K=5**):



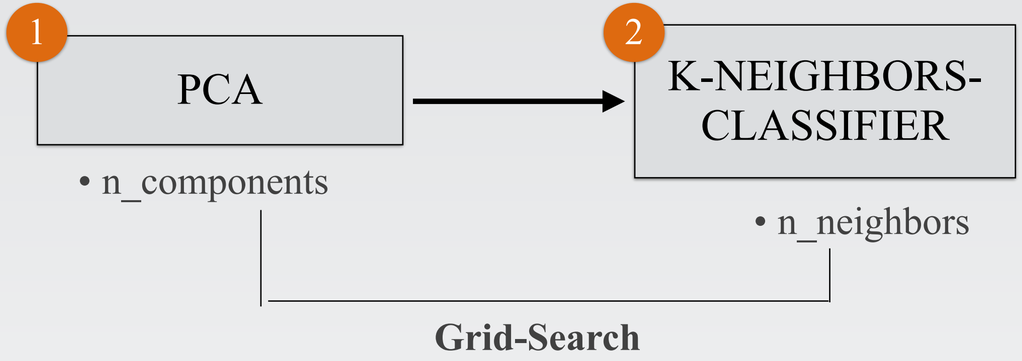
Ad ogni iterazione CV:

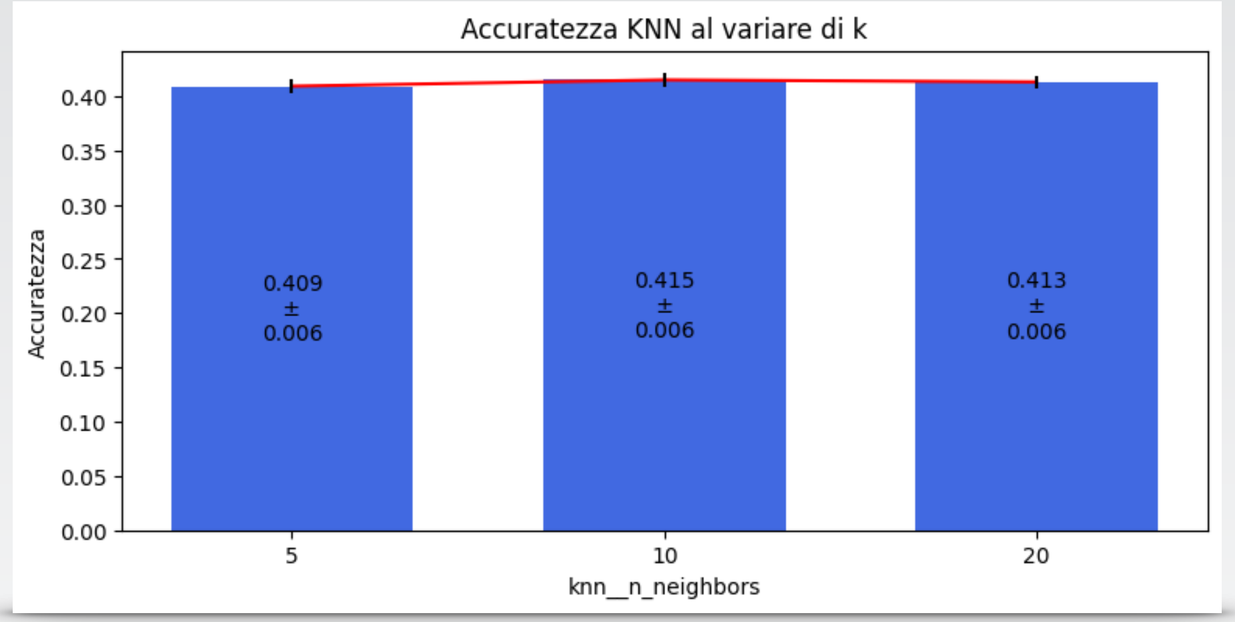
- Train size = 40000 immagini
- Test size = 10000 immagini

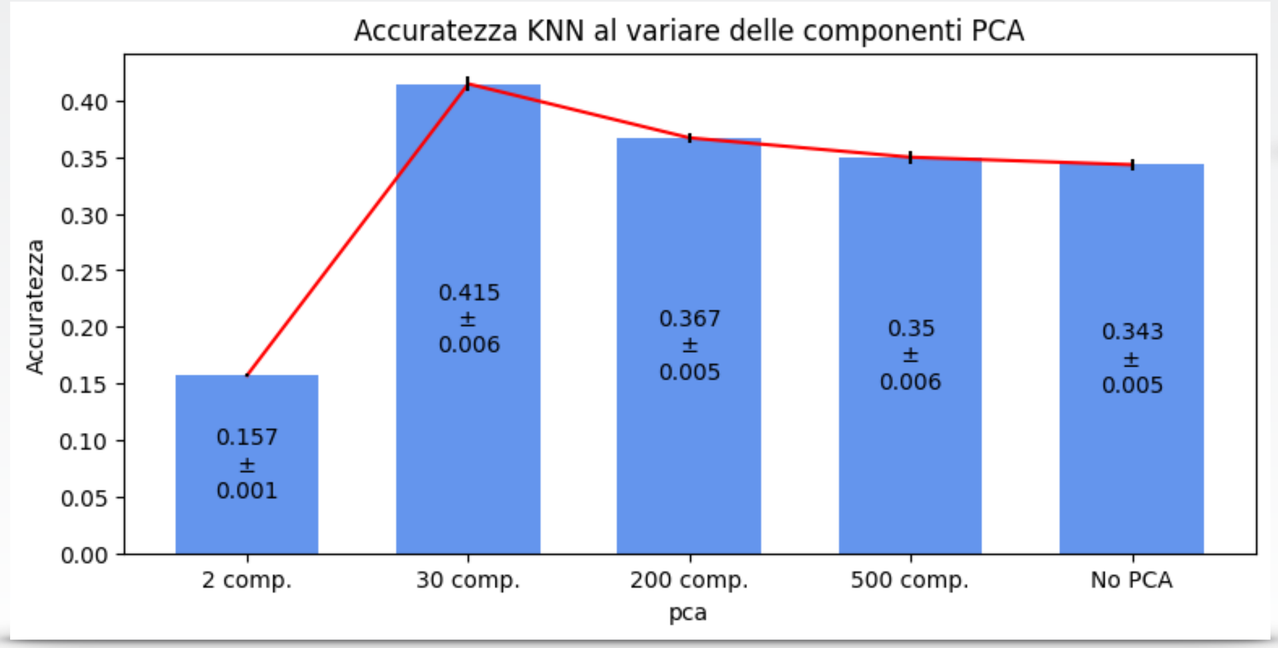
K-NEIGHBORS-CLASSIFIER



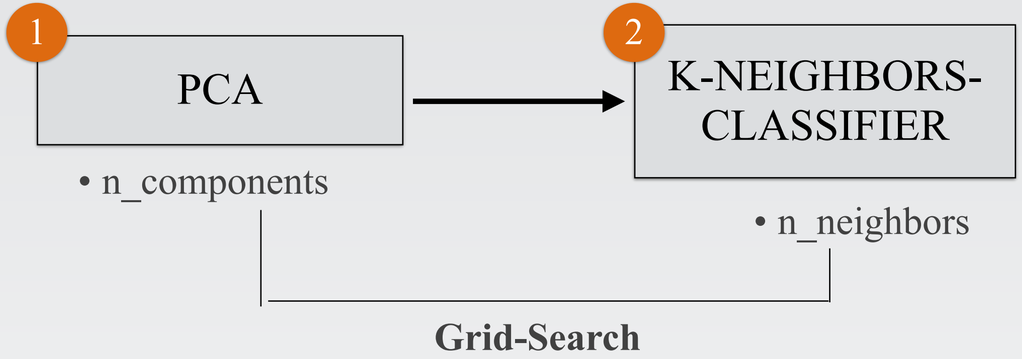
K-NEIGHBORS-CLASSIFIER

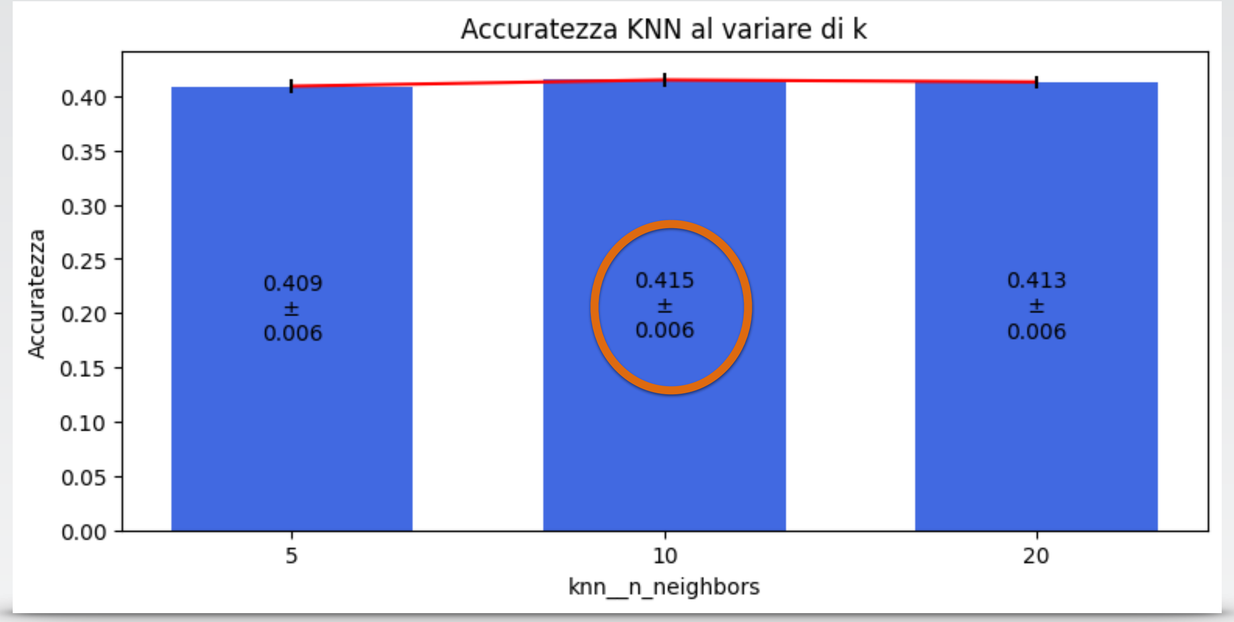


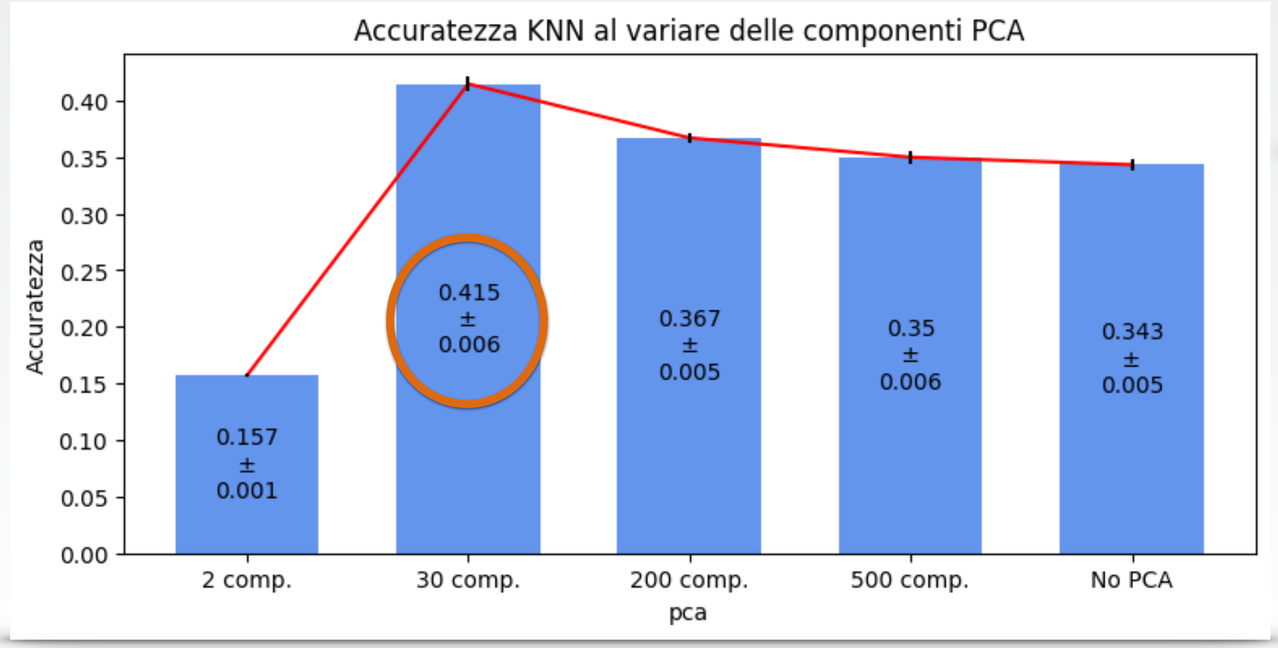




K-NEIGHBORS-CLASSIFIER



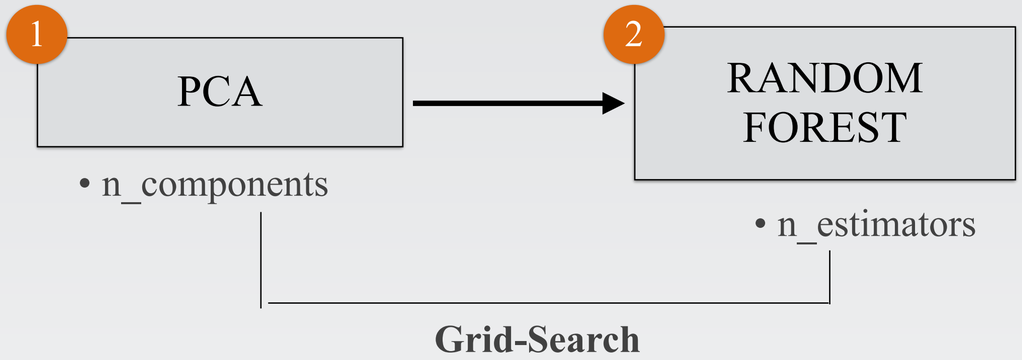




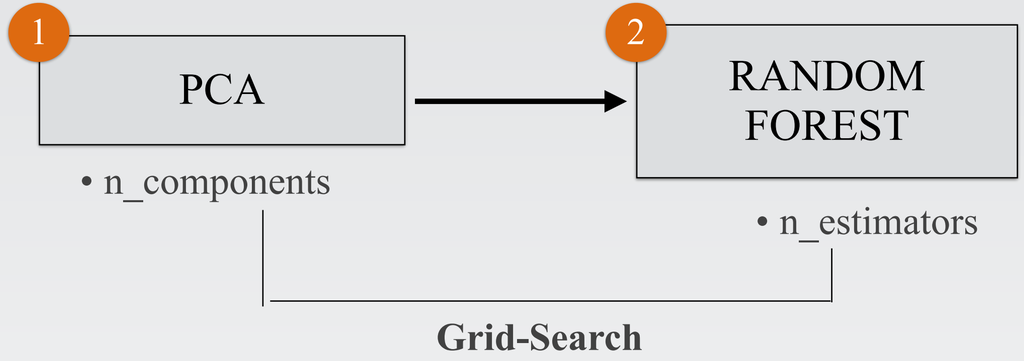
Parametri migliori

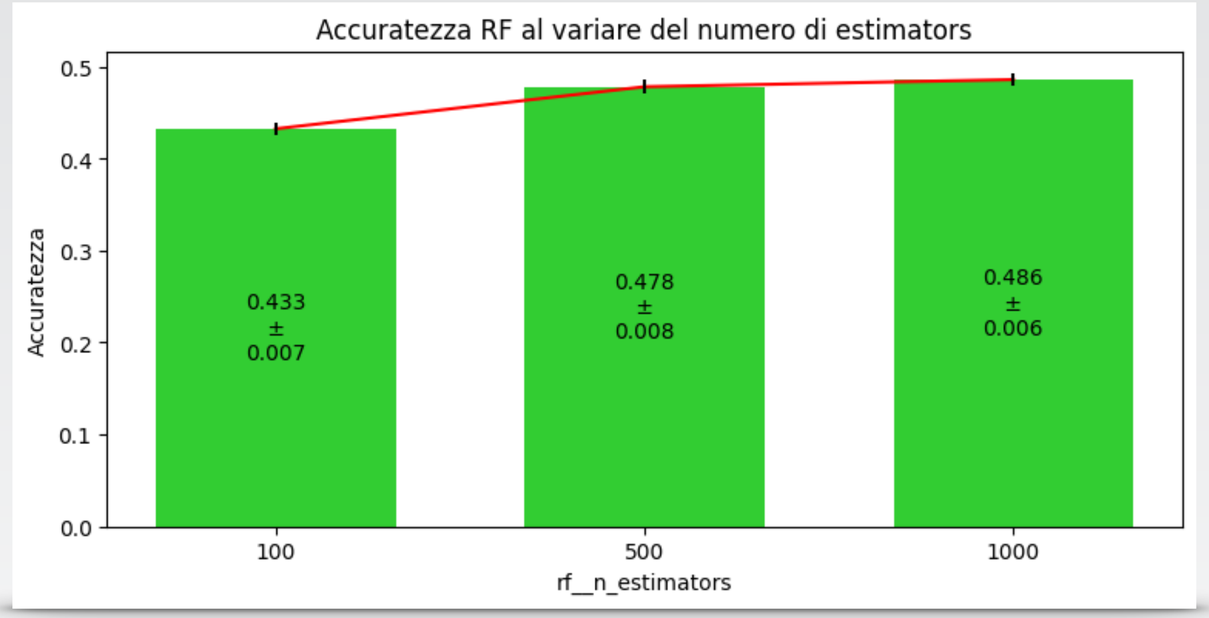
PCA	KNN
n_components = 30	n_neighbors = 10

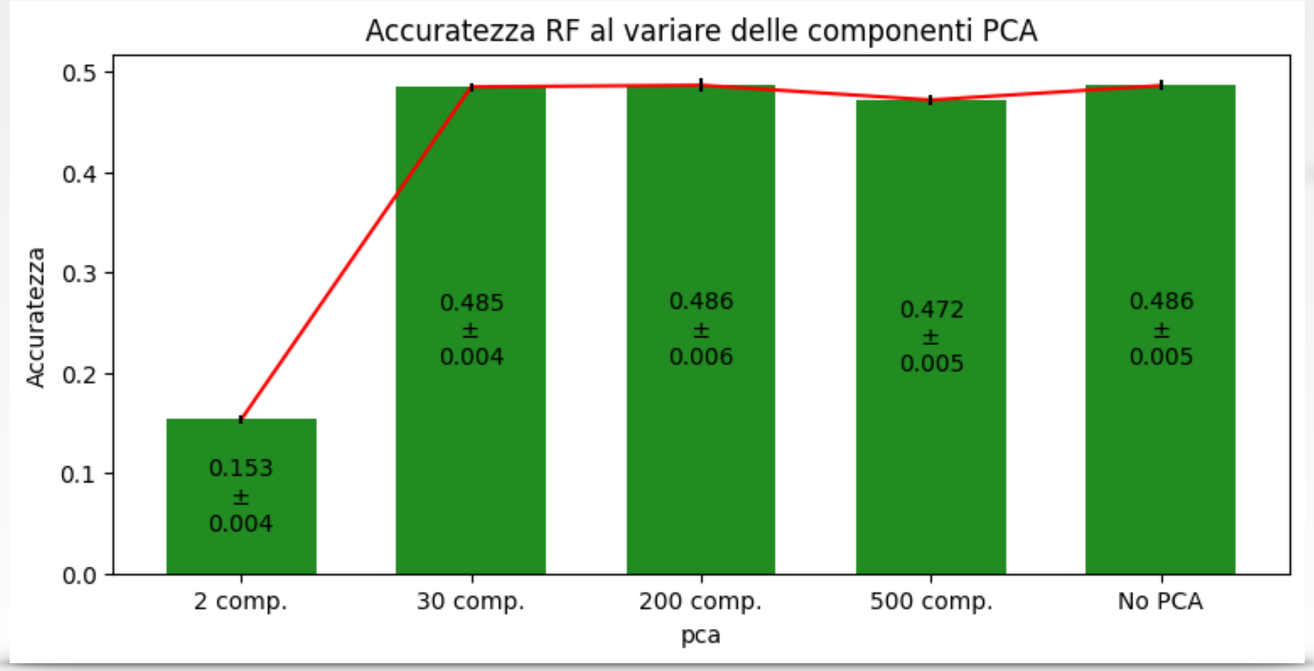
RANDOM FOREST



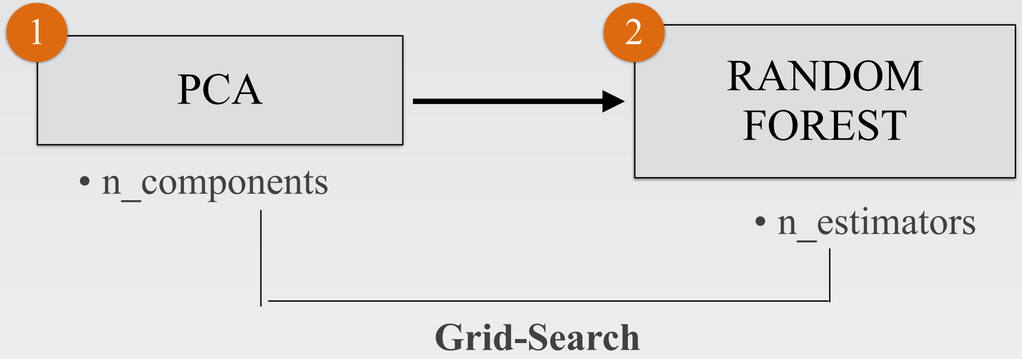
RANDOM FOREST

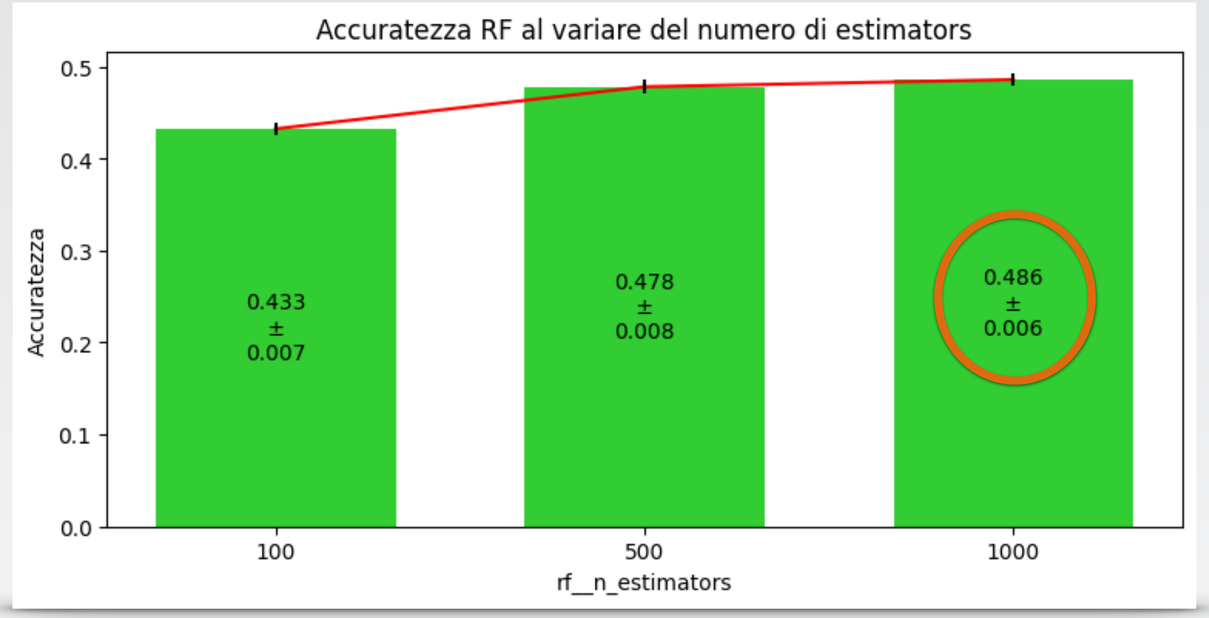


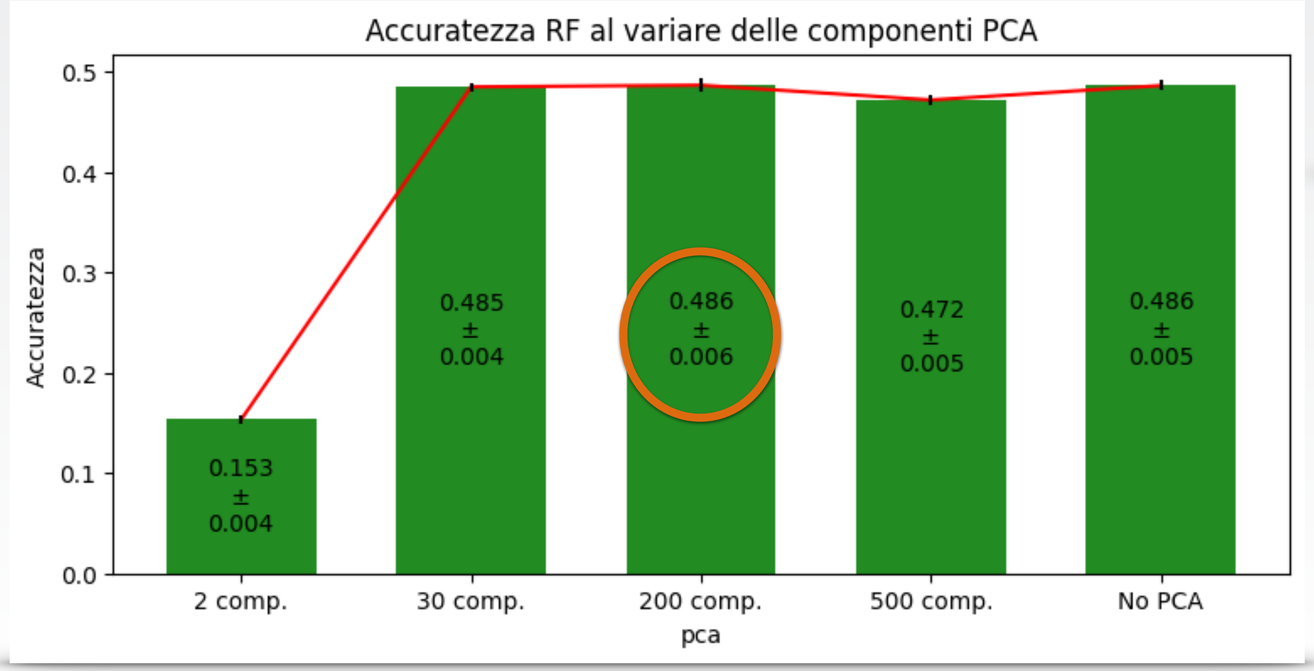




RANDOM FOREST







Parametri migliori

PCA	RANDOM FOREST
n_components = 200	n_estimators = 1000

Tempo train: **1029s (200 PCA)**
2382s (NO PCA)

CONVOLUTIONAL NEURAL NETWORK (CNN)

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 32, 32, 32)        896

 conv2d_1 (Conv2D)           (None, 32, 32, 32)        9248

 max_pooling2d (MaxPooling2D  (None, 16, 16, 32)       0
 )

 dropout (Dropout)           (None, 16, 16, 32)        0

 conv2d_2 (Conv2D)           (None, 16, 16, 64)        18496

 conv2d_3 (Conv2D)           (None, 16, 16, 64)        36928

 max_pooling2d_1 (MaxPooling  (None, 8, 8, 64)         0
 2D)

 dropout_1 (Dropout)         (None, 8, 8, 64)          0

 flatten (Flatten)           (None, 4096)              0

 dense (Dense)               (None, 128)               524416

 dropout_2 (Dropout)         (None, 128)               0

 dense_1 (Dense)             (None, 10)                1290

=================================================================
Total params: 591,274
Trainable params: 591,274
Non-trainable params: 0
```

One-Hot-Enconding label

Parametri Rete :

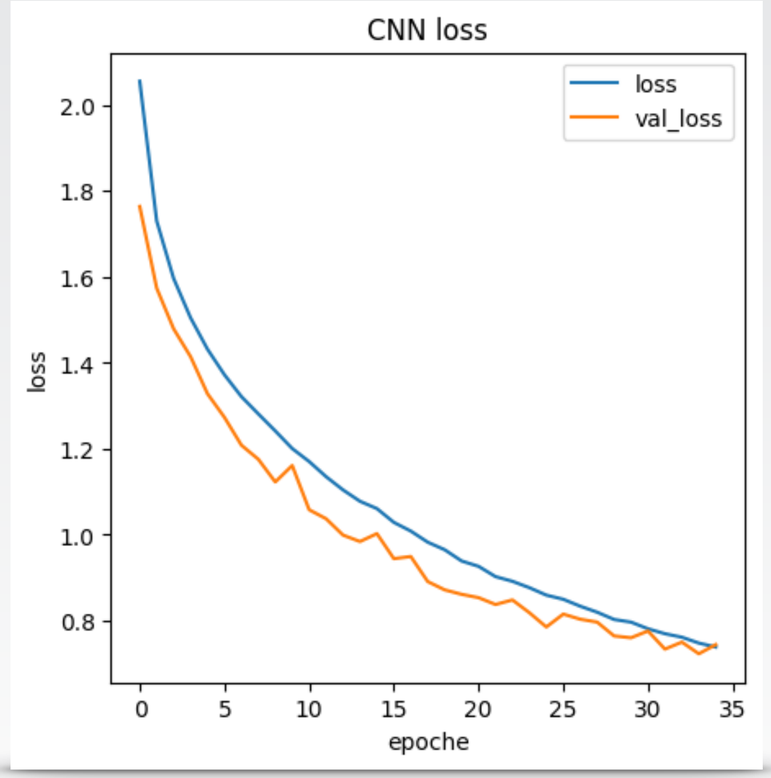
4 Layer Convolutivi:
- Kernel 3x3
- Funzione attivazione: ReLu
- Padding “same”
- Num. filtri: 32 e 64

Fully Connected:
- 128 nodi (ReLu)
- 10 nodi (SoftMax)

MaxPooling = 2x2

Dropout = 0.3

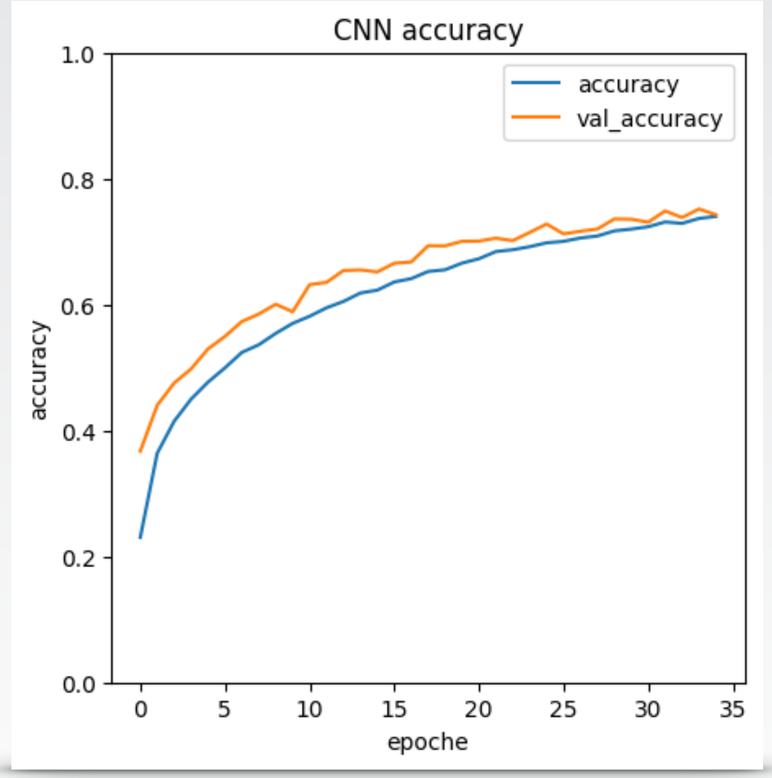
CNN TRAIN



Parametri train:

- Ottimizzatore: **SGD**
- Loss: **categorical_crossentropy**
- Metrica: **accuratezza**
- Epoche: **35**
- Batch size: **64**

Tempo train totale: **5423s**



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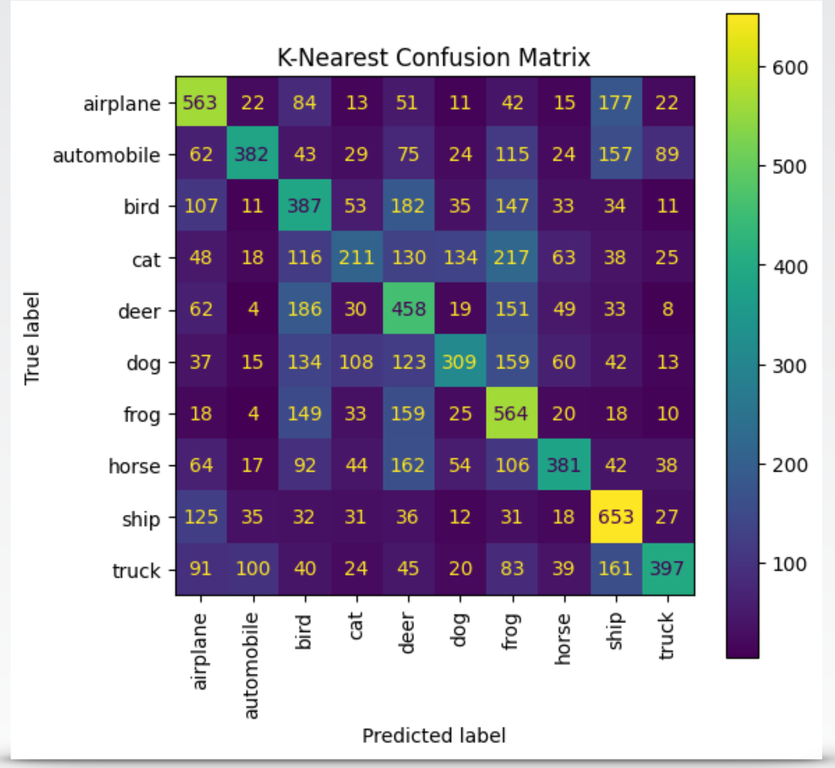
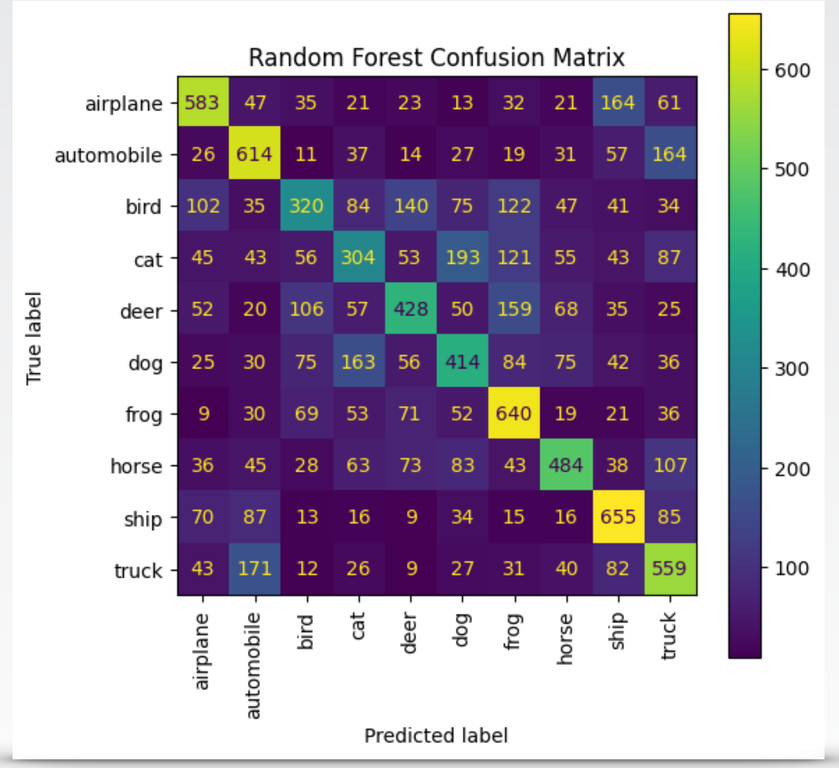
CONFUSION MATRIX

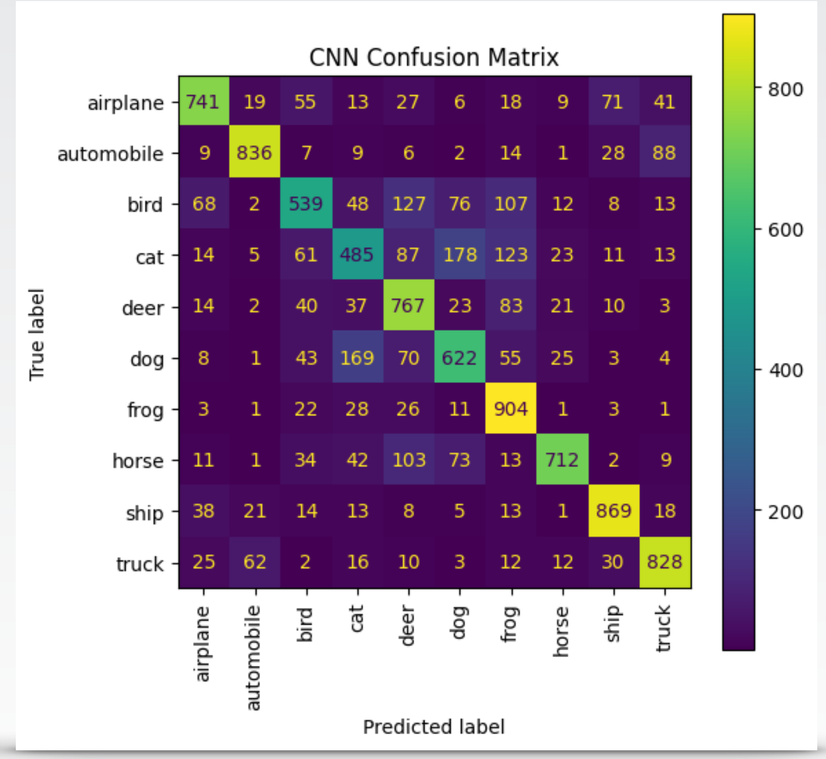
KNN



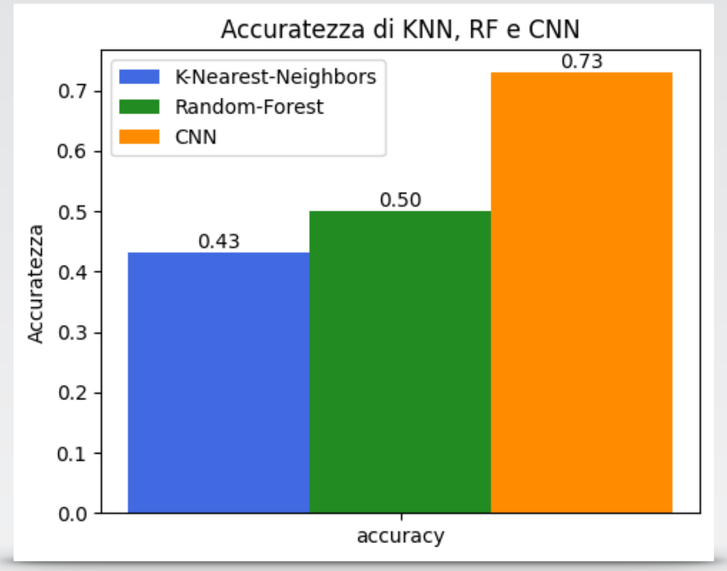
Random Forest



CNN

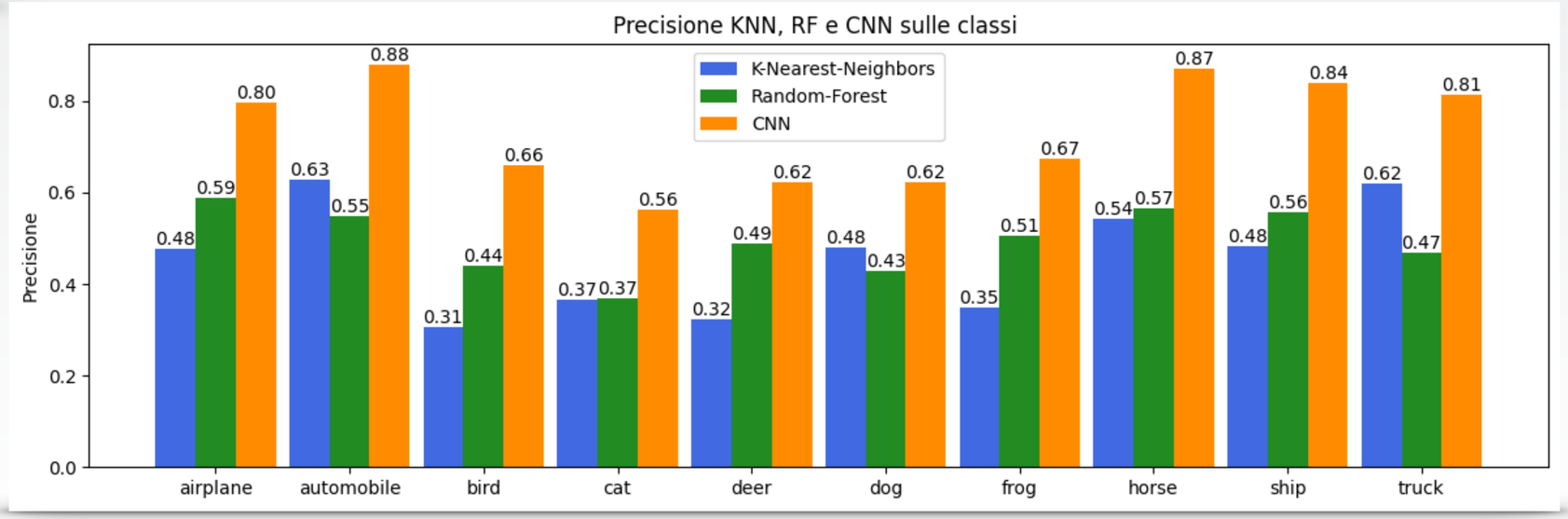


ACCURATEZZA

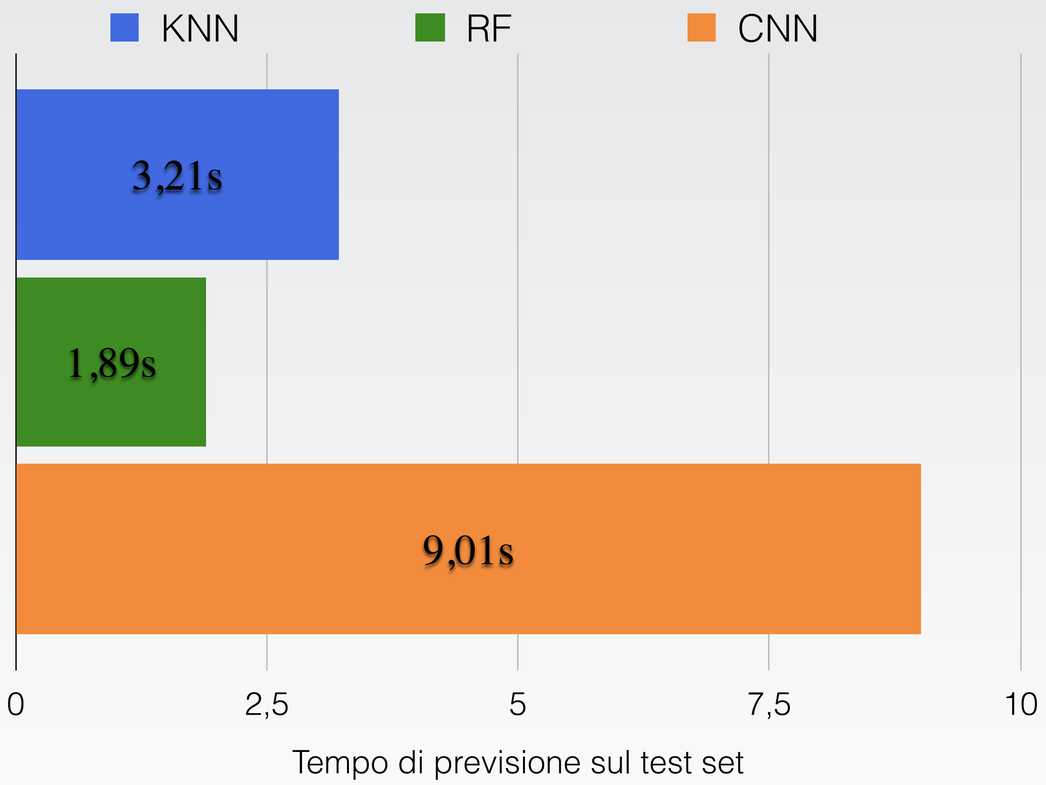


CNN ha un’accuratezza considerevolmente maggiore rispetto a KNN e RF

CNN ha precisione maggiore per tutte le classi mentre RF non sempre è migliore di KNN



TEMPI DI PREVISIONE



MacBook Air

CPU : Intel Core 1,8 GHz i5 dual-core
RAM : 8 GB

- CNN ha accuratezza migliore ma impiega più tempo per la previsione
- RF è il modello con tempi di previsione migliori

Grazie per l’attenzione