

## ESP32-WROOM 32 CNN Evaluation

```
import numpy as np
from sklearn.metrics import accuracy_score, precision_score,
recall_score, f1_score, confusion_matrix, classification_report
from sklearn.metrics import roc_auc_score
```

## DATA

**Dataset:** 1088 entry **Test\_Dataset:** 96 entry

```
y_train =
[0.00,1.00,0.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,0.00,0.00,1.00
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,1.00,0.00,1.00,0.00,1.00,1.00,1.00,0.00,1.00,1.00,0.00,0.00,0.00,1.00
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,1.00,1.00,1.00,0.00,1.00,1.00,1.00,1.00,1.00,0.00,0.00,1.00,1.00,1.00
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,1.00,0.00,1.00,0.00,0.00,0.00,1.00,1.00,1.00,1.00,1.00,0.00,1.00,1.00]
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, 1.00, 1.00, 0.00, 0.00, 1.00, 1.00, 1.00, 0.00, 0.00, 0.00]
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y_train_pred =
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np.array([0.70, 0.99, 0.00, 0.98, 0.99, 0.99, 0.98, 0.99, 0.99, 0.24, 0.98, 0.00,
0.00, 0.99, 0.00, 0.00, 0.98, 0.00, 0.00, 0.98, 0.00, 0.99, 0.98, 0.99, 0.99, 0.99,
0.99, 0.00, 0.99, 0.06, 0.99, 0.00, 0.99, 0.99, 0.99, 0.00, 0.99, 0.90, 0.02, 0.25,
0.00, 0.99, 0.00, 0.00, 0.99, 0.00, 0.99, 0.00, 0.57, 0.99, 0.99, 0.00, 0.99, 0.00,
0.00, 0.99, 0.00, 0.00, 0.99, 0.25, 0.00, 0.00, 0.98, 0.05, 0.00, 0.98, 0.99, 0.00,
0.00, 0.99, 0.00, 0.99, 0.99, 0.99, 0.99, 0.98, 0.88, 0.25, 0.00, 0.00, 0.00, 0.00,
0.00, 0.07, 0.99, 0.99, 0.99, 0.00, 0.99, 0.99, 0.98, 0.99, 0.99, 0.00, 0.00, 0.99,
```

0.99,0.99,0.12,0.99,0.00,0.99,0.99,0.00,0.99,0.99,0.00,0.00,0.00,0.99,  
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0.92,0.89,0.91,0.99,0.00,0.00,0.99,0.98,0.99,0.99,0.99,0.00,0.98,0.00,
0.00,0.00,0.00,0.25,0.00,0.99,0.99,0.00,0.23,0.00,0.00,0.99,0.00,0.00,
0.00,0.99,0.14,0.98,0.00,0.00,0.99,0.77,0.99,0.99,0.00,0.02,0.00,0.99,
0.99,0.00,0.09,0.78,0.99,0.98,0.99,0.98,0.98,0.25,0.00,0.00,0.99,0.00,
0.99,0.16,0.99,0.00,0.98,0.00,0.00,0.98,0.99,0.99,0.00,0.00,0.00,0.98,
0.99,0.00,0.99,0.99,0.97,0.99,0.04,0.98,0.00,0.92,0.93,0.99,0.99,0.00,
0.99,0.99,0.00,0.98,0.99,0.58,0.00,0.98,0.06,0.99,0.99,0.74,0.99,0.00,
0.00,0.99,0.25,0.99,0.00,0.00,0.00,0.00,0.94,0.25,0.74,0.99,0.00,0.97,
0.00,0.00,0.99,0.99,0.98,0.99,0.99,0.06,0.00,0.99,0.99,0.00,0.00,0.99,
0.00,0.99,0.99,0.00,0.99,0.99,0.99,0.99,0.00,0.00,0.00,0.00,0.99,0.92,
0.78,0.00,0.99,0.06,0.00,0.97,0.00,0.98,0.00,0.02,0.06,0.97,0.00,0.00,
0.95,0.99,0.99,0.98,0.00,0.00,0.99,0.99,0.99,0.00,0.00,0.25])
y_test =
[1.00,1.00,0.00,1.00,1.00,1.00,0.00,1.00,1.00,1.00,1.00,1.00,0.00,0.00
,0.00,0.00,1.00,0.00,1.00,0.00,1.00,0.00,0.00,0.00,1.00,1.00,1.00,1.00
,0.00,1.00,1.00,0.00,0.00,1.00,0.00,1.00,1.00,0.00,1.00,1.00,1.00,1.00
,1.00,0.00,0.00,1.00,0.00,1.00,0.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00
,1.00,1.00,1.00,1.00,1.00,1.00,1.00,0.00,1.00,1.00,1.00,0.00,1.00,1.00
,0.00,1.00,0.00,0.00,0.00,1.00,1.00,0.00,1.00,0.00,1.00,0.00,1.00,1.00
,1.00,1.00,0.00,1.00,0.00,0.00,0.00,1.00,1.00,0.00,1.00,0.00]
y_test_pred =
np.array([0.70,0.99,0.00,0.98,0.99,0.99,0.98,0.99,0.99,0.24,0.98,0.00,
0.00,0.99,0.00,0.00,0.98,0.00,0.00,0.98,0.00,0.99,0.98,0.99,0.99,0.99,
0.99,0.00,0.99,0.06,0.99,0.00,0.99,0.99,0.99,0.00,0.99,0.90,0.02,0.25,
0.00,0.99,0.00,0.00,0.99,0.00,0.99,0.00,0.57,0.99,0.99,0.00,0.99,0.00,
0.00,0.99,0.00,0.00,0.99,0.25,0.00,0.00,0.98,0.05,0.00,0.98,0.99,0.00,
0.00,0.99,0.00,0.99,0.99,0.99,0.99,0.98,0.88,0.25,0.00,0.00,0.00,0.00,
0.00,0.07,0.99,0.99,0.99,0.00,0.99,0.99,0.98,0.99,0.99,0.00,0.00,0.99]
)

```

Set an "acceptance" limit

```

y_train_pred_bin = (y_train_pred >= 0.05).astype(int)
y_test_pred_bin = (y_test_pred >= 0.05).astype(int)

```

Helper function in order to evaluate our model

```

def evaluate_model(y_true, y_pred, dataset_name=""):
    print(f"=== Evaluation for {dataset_name} ===")

```

```

print(f"Accuracy: {accuracy_score(y_true, y_pred):.4f}")
print(f"Precision: {precision_score(y_true, y_pred):.4f}")
print(f"Recall: {recall_score(y_true, y_pred):.4f}")
print(f"F1 Score: {f1_score(y_true, y_pred):.4f}")
print("Matrice di confusione:")
print(confusion_matrix(y_true, y_pred))
print("Report dettagliato:")
print(classification_report(y_true, y_pred))
print("\n")

```

## Evaluation on training data

```
evaluate_model(y_train, y_train_pred_bin, "Training Set")
```

```
=== Evaluation for Training Set ===
```

```
Accuracy: 0.9274
```

```
Precision: 0.8844
```

```
Recall: 0.9966
```

```
F1 Score: 0.9372
```

```
Matrice di confusione:
```

```
[[420  77]
```

```
 [  2 589]]
```

```
Report dettagliato:
```

	precision	recall	f1-score	support
0.0	1.00	0.85	0.91	497
1.0	0.88	1.00	0.94	591
accuracy			0.93	1088
macro avg	0.94	0.92	0.93	1088
weighted avg	0.94	0.93	0.93	1088

```
auc = roc_auc_score(y_train, y_train_pred)
```

```
print("ROC AUC Score on training data:", auc)
```

```
ROC AUC Score on training data: 0.9925526083744429
```

## Evaluation on test data

```
evaluate_model(y_test, y_test_pred_bin, "Test Set")
```

```
=== Evaluation for Test Set ===
```

```
Accuracy: 0.5104
```

```
Precision: 0.6167
```

```
Recall: 0.6066
```

```
F1 Score: 0.6116
```

```
Matrice di confusione:
```

```
[[12 23]
```

```
[24 37]]
```

```
Report dettagliato:
```

	precision	recall	f1-score	support
0.0	0.33	0.34	0.34	35
1.0	0.62	0.61	0.61	61
accuracy			0.51	96
macro avg	0.47	0.47	0.47	96
weighted avg	0.51	0.51	0.51	96

```
auc = roc_auc_score(y_test, y_test_pred)
print("ROC AUC Score on test data:", auc)
```

```
ROC AUC Score on test data: 0.4749414519906323
```