MLP_classifier_parameter

September 15, 2025

[17]:
```
import ipynbname
import torch

if torch.cuda.is_available():
    device = torch.device("cuda")
elif torch.backends.mps.is_available():
    device = torch.device("mps")
else:
    device = torch.device("cpu")

print(f"Using device: {device}")
```

```
Using device: mps
```

[18]:
```
%load_ext autoreload
%autoreload 2
from libraries.embeddings_utils import *
from libraries.classifier_utils import *
from libraries.file_manager_utils import *
from libraries.EmbeddingNet_utils import *
from scipy.stats import randint
from scipy.stats import uniform

project_dir = f"{os.getcwd().
 ↪split('SIDS_revelation_project')[0]}SIDS_revelation_project/"
image_dataset_path = f"{project_dir}datasets/onback_onstomach_v3"
model_path_fd = f"{project_dir}/models/4.fd_weights/best.pt"
model_path_pe = f"{project_dir}/models/2.pe_weights/best.pt"

emb_builder = EmbeddingBuilder(model_path_fd, image_dataset_path,␣
 ↪"load",weights_path_pe=model_path_pe)
embeddings = emb_builder.create_embedding(flags=True,positions=True,␣
 ↪positions_normalized=True, geometric_info=True,k_positions_normalized=True␣
 ↪,k_geometric_info=True)
```

```
The autoreload extension is already loaded. To reload it, use:
  %reload_ext autoreload

Extracting dataset info from .coco.json
```

```
file:--------------------------------------------
Dataset contains 4158 valid samples, and labels are {'baby_on_back': 1,
'baby_on_stomach': 2}
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Loading features from
.csv------------------------------------------------------------
Features loaded succesfully, in particular there are 4158 files in the dataset
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Embedding builder initialized
successfully---------------------------------------------
Face detection model: 4 (YOLOv8)
Dataset: /Users/lorenzodimaio/Download/SIDS_revelation_project/datasets/onback_o
nstomach_v3
Dataset dimension: 4158
Dataset labels: {'baby_safe': 0, 'baby_unsafe': 1}
--------------------------------------------------------------------------------
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Embedding
creation------------------------------------------------------------------------
Features: ['flag_eye1', 'flag_eye2', 'flag_nose', 'flag_mouth', 'x_eye1',
'y_eye1', 'x_eye2', 'y_eye2', 'x_nose', 'y_nose', 'x_mouth', 'y_mouth',
'x_eye1_norm', 'y_eye1_norm', 'x_eye2_norm', 'y_eye2_norm', 'x_nose_norm',
'y_nose_norm', 'x_mouth_norm', 'y_mouth_norm', 'eye_distance',
'eye_distance_norm', 'face_vertical_length', 'face_vertical_length_norm',
'face_angle_vertical', 'face_angle_horizontal', 'symmetry_diff', 'head_ration',
'x_nose_k', 'y_nose_k', 'x_left_eye_k', 'y_left_eye_k', 'x_right_eye_k',
'y_right_eye_k', 'x_left_ear', 'y_left_ear', 'x_right_ear', 'y_right_ear',
'x_left_shoulder', 'y_left_shoulder', 'x_right_shoulder', 'y_right_shoulder',
'x_left_elbow', 'y_left_elbow', 'x_right_elbow', 'y_right_elbow',
'x_left_wrist', 'y_left_wrist', 'x_right_wrist', 'y_right_wrist', 'x_left_hip',
'y_left_hip', 'x_right_hip', 'y_right_hip', 'x_left_knee', 'y_left_knee',
'x_right_knee', 'y_right_knee', 'x_left_ankle', 'y_left_ankle', 'x_right_ankle',
'y_right_ankle', 'shoulders_dist', 'shoulder_hip_right_dist',
'shoulder_hip_left_dist', 'nose_shoulder_right', 'nose_shoulder_left',
'shoulder_left_knee_right', 'shoulder_right_knee_left', 'knee_ankle_right',
'knee_ankle_left', 'nose_hip_right', 'nose_hip_left',
'elbow_shoulder_hip_right', 'elbow_shoulder_hip_left',
'shoulder_elbow_wrist_right', 'shoulder_elbow_wrist_left',
'shoulder_hip_knee_right', 'shoulder_hip_knee_left', 'hip_knee_ankle_right',
'hip_knee_ankle_left', 'shoulders_line_inclination', 'hips_line_inclination',
'torsion']
FINISHED: 4158 embedding created
--------------------------------------------------------------------------------
```

```
----------
```

```
[19]: dataset = EmbeddingDataset(embeddings.to_numpy(),emb_builder.y,device=device)
      model = dataset.train_embeddings(embed_dim=32, epochs=50, batch_size=128,␣
       ↪lr=1e-3,verbose=False,weight_decay=1e-7,dropout_rate=0.05)
```

```
[20]: embeddings_new = dataset.extract_embeddings(model)
      embeddings_new= pd.DataFrame(embeddings_new.to_numpy(), columns=[f"f_{i}" for i␣
       ↪in range(embeddings_new.shape[1])])
      clf = Classifier(embeddings_new, dataset.y, emb_builder.classes_bs,figsize =␣
       ↪(10, 6))
      xgbc_1, results_xgbc_1 = clf.XGBC(verbose=True)
```

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--------------------------------------FIRST
ANALYSIS--------------------------------------
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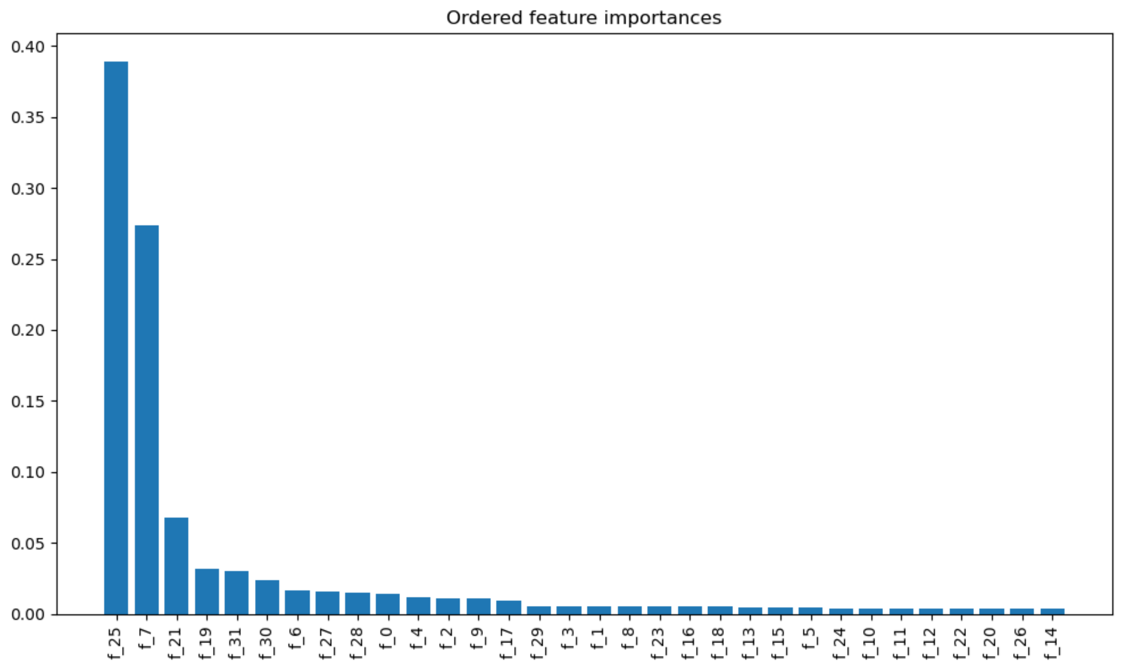
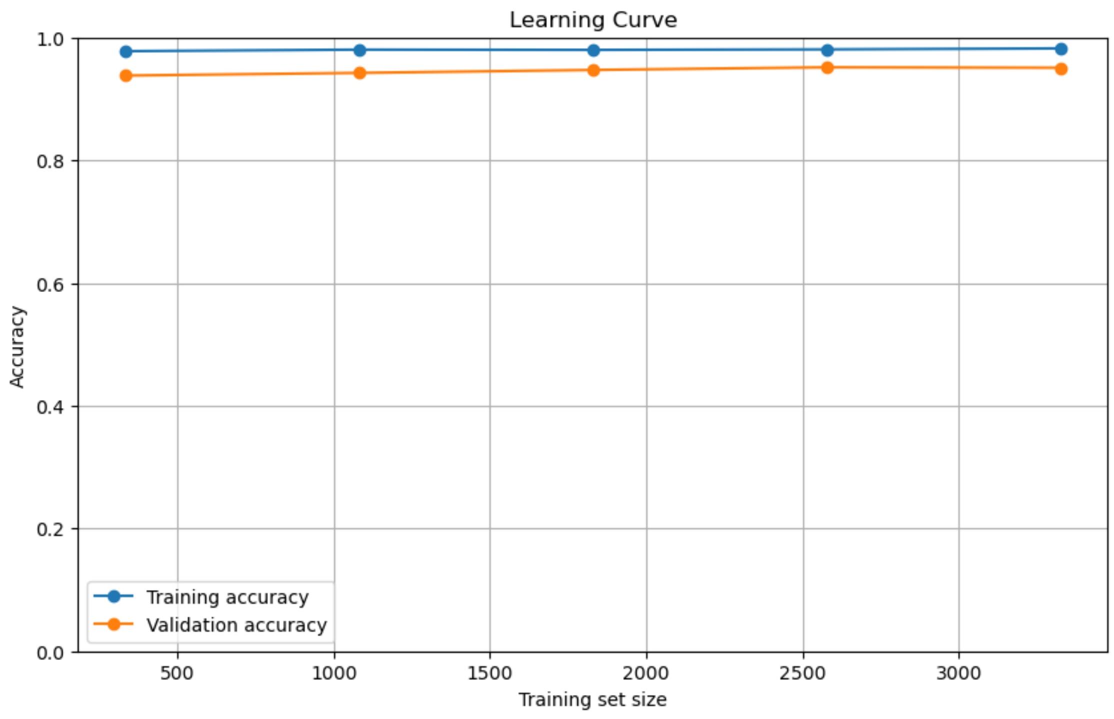
```





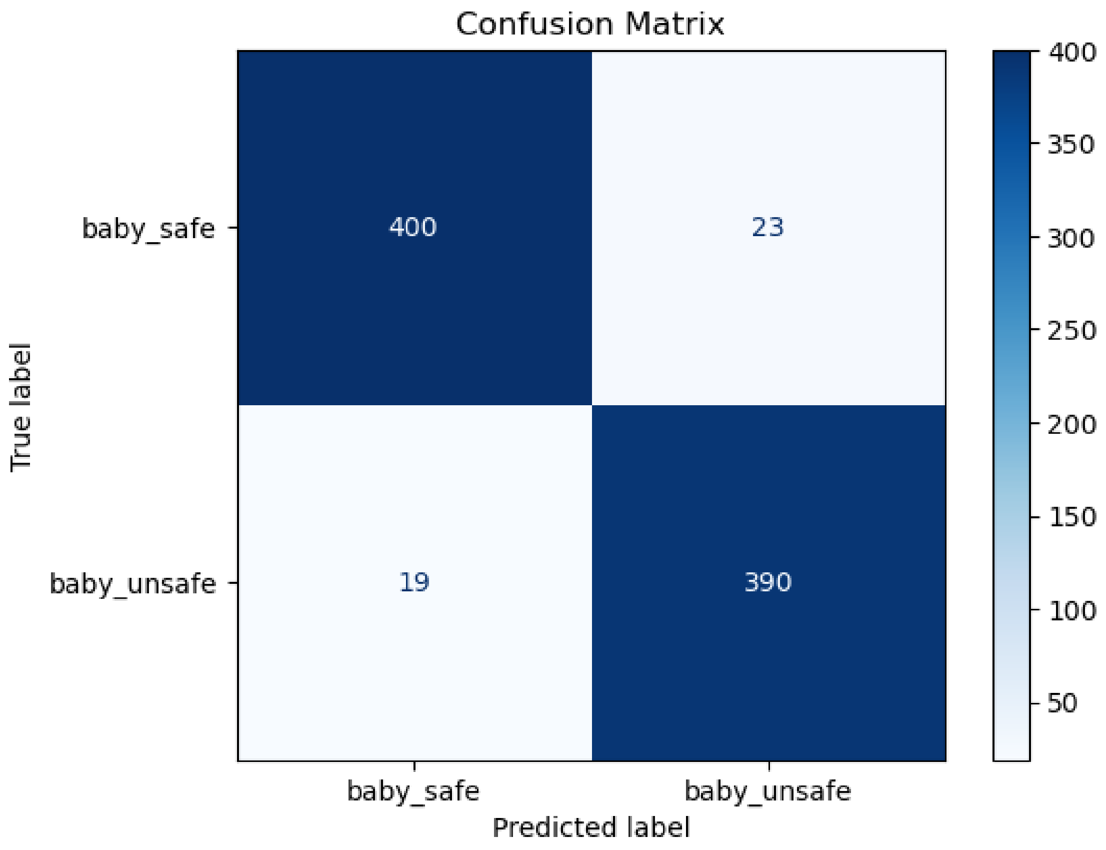
```
Dataset labels:---------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}

Report------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.95      0.95      0.95       423
 baby_unsafe       0.94      0.95      0.95       409

    accuracy                           0.95       832
   macro avg       0.95      0.95      0.95       832
weighted avg       0.95      0.95      0.95       832

Confusion matrix--------------------------------------
```



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---------------------------------TOP 10 FEATURES
ANALYSIS---------------------------------
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```
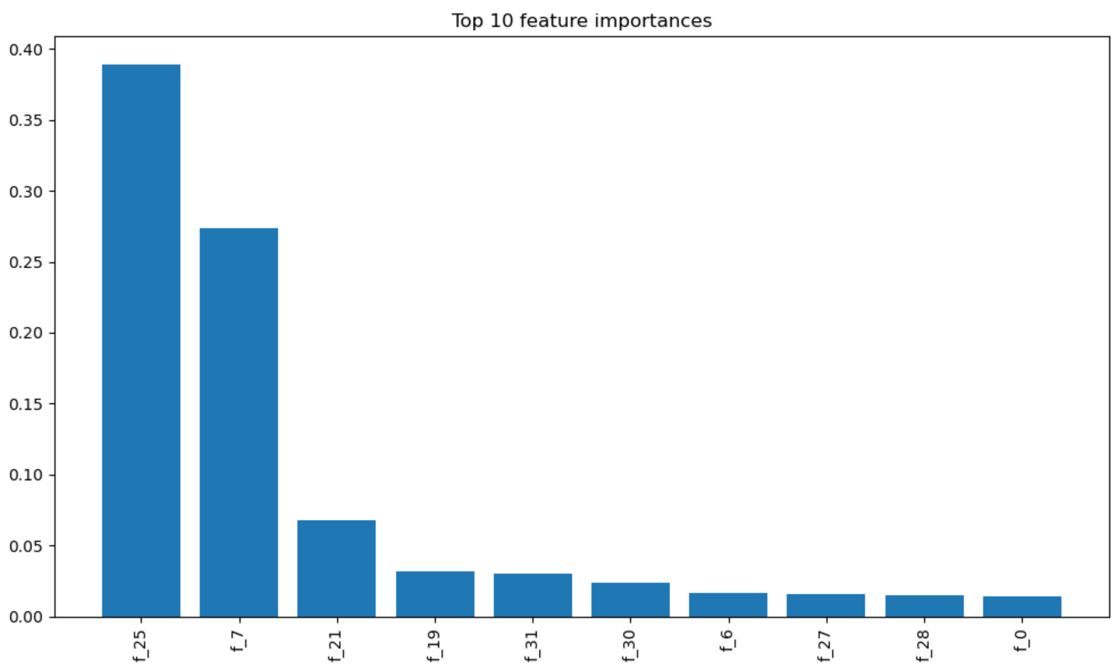
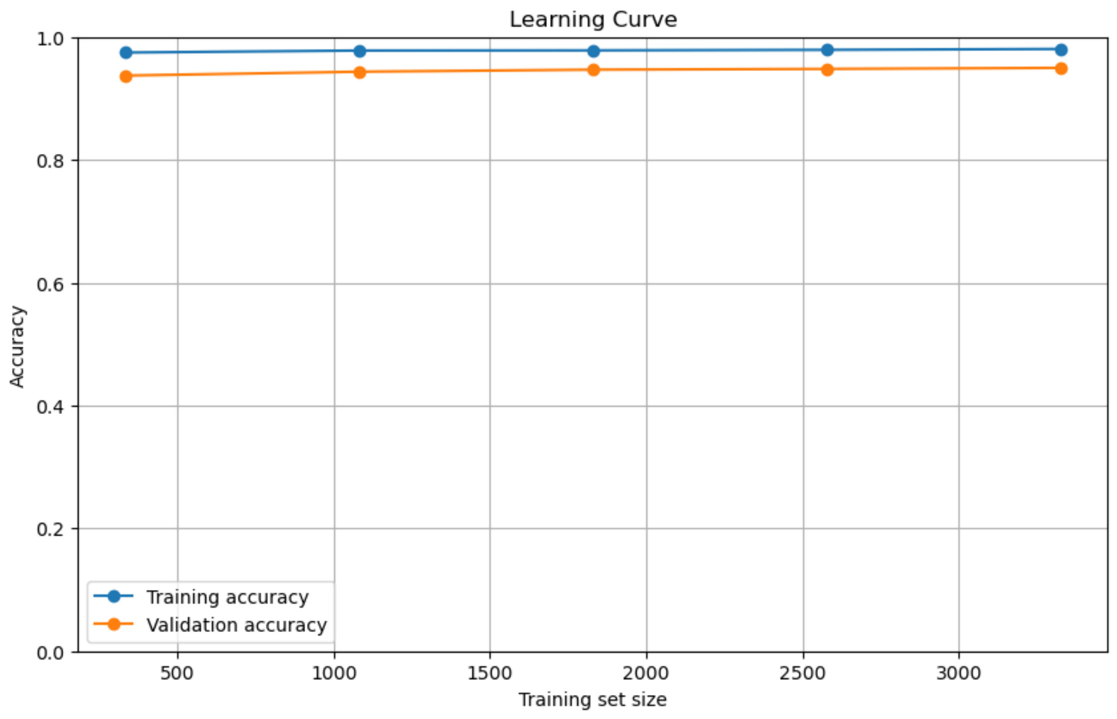
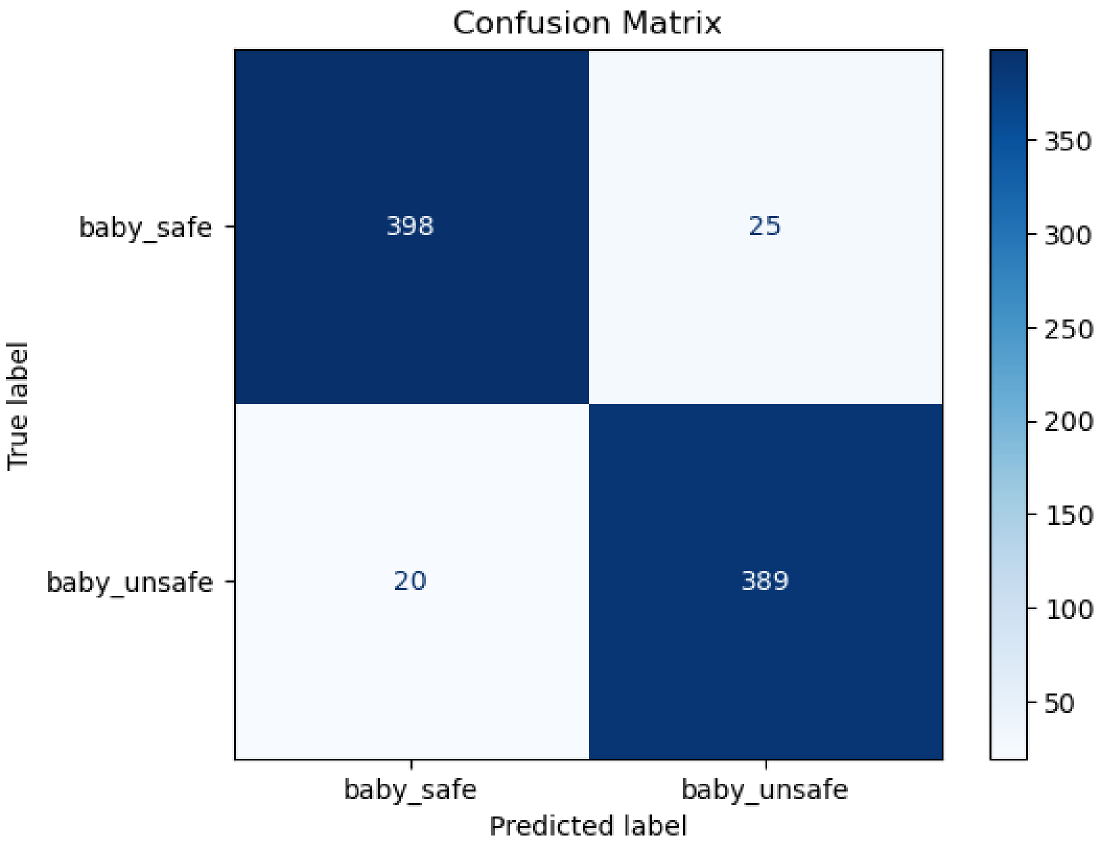





```
Dataset labels:----------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}
```

```
Report-------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.95      0.94      0.95       423
 baby_unsafe       0.94      0.95      0.95       409

    accuracy                           0.95       832
   macro avg       0.95      0.95      0.95       832
weighted avg       0.95      0.95      0.95       832

Confusion matrix---------------------------------------
```



```
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---------------------------------TOP 25 FEATURES
ANALYSIS---------------------------------
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```
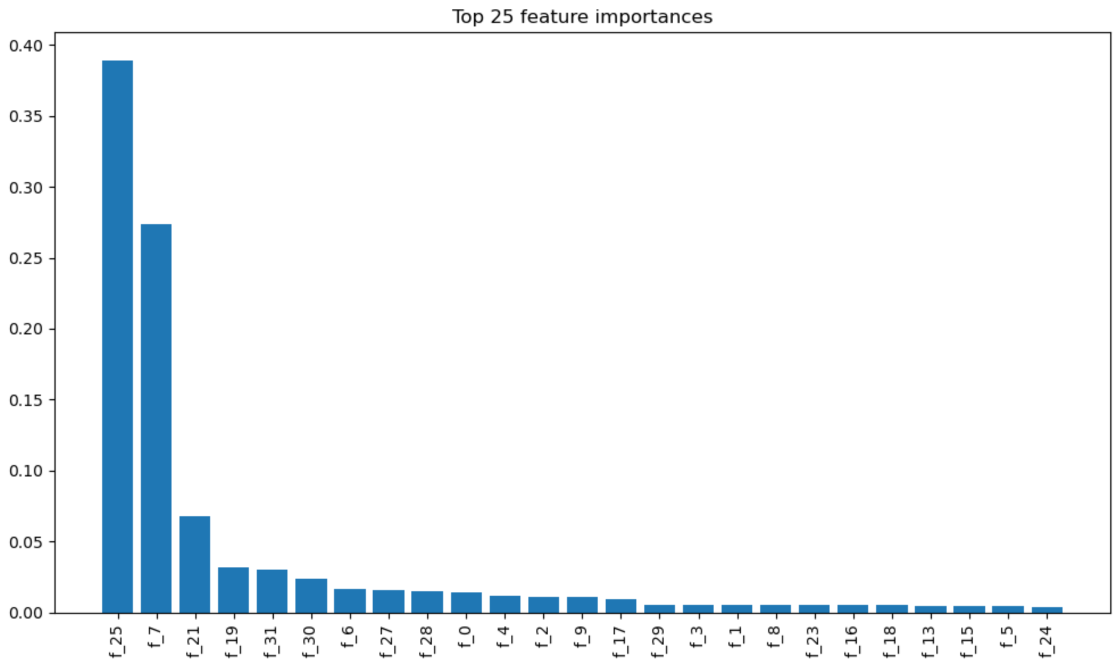
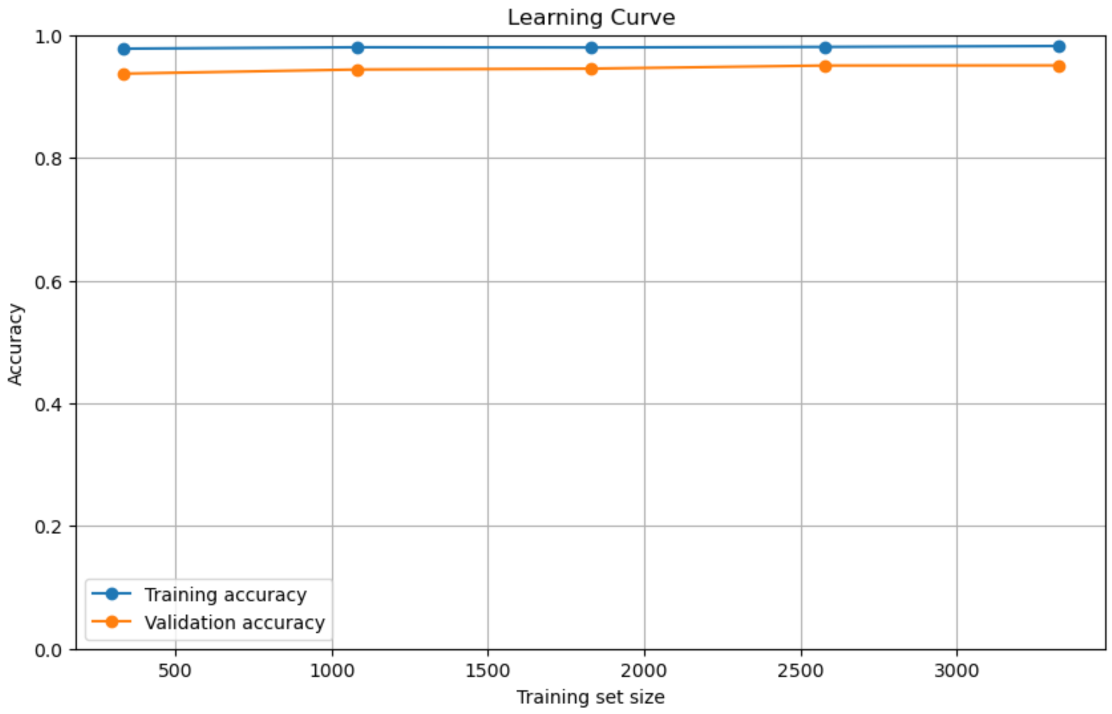
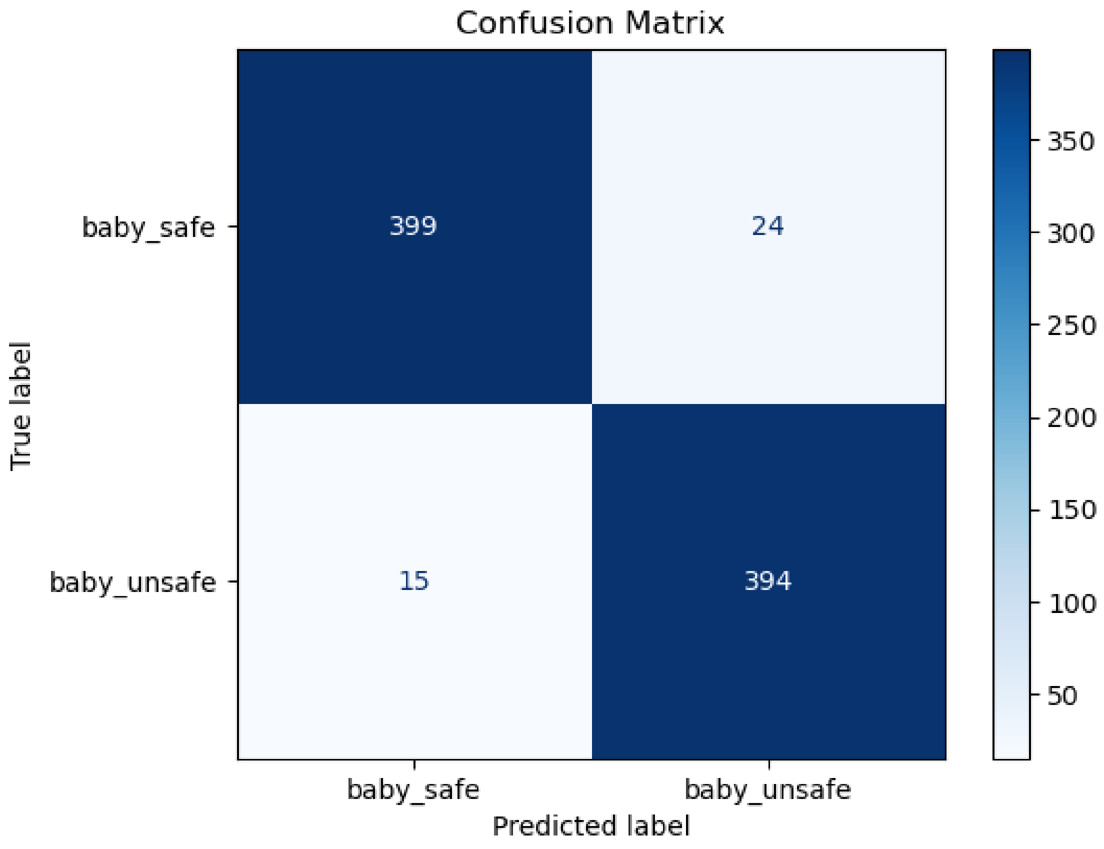





```
Dataset labels:----------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}
```

```
Report-------------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.96      0.94      0.95       423
 baby_unsafe       0.94      0.96      0.95       409

    accuracy                           0.95       832
   macro avg       0.95      0.95      0.95       832
weighted avg       0.95      0.95      0.95       832

Confusion matrix---------------------------------------
```



[21]:
```
clf.evaluation_pipeline_with_cv(xgbc_1,verbose=True)
```

```
--------------------------------------------------------------------------------
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-----------------------------K-FOLD CROSS-VALIDATION
ANALYSIS-----------------------------
--------------------------------------------------------------------------------
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```

```
Accuracy for each fold: [0.9519230769230769, 0.9555288461538461,
0.9567307692307693, 0.9446450060168472, 0.9530685920577617]
Average cross-validation accuracy: 0.9524
```

[21]:
```
np.float64(0.9523792580764603)
```

1 1) Ottimizziamo i parametri della rete

[22]:
```python
import itertools

param_grid = {
    "embed_dim": [32, 64],
    "batch_size": [64, 128],
    "lr": [1e-3, 1e-4],
    "epochs": [30,50, 100],
    "weight_decay": [1e-5, 1e-6, 1e-7],
    "dropout_rate": [0.0, 0.1, 0.2, 0.3]
}

best_acc = 0
best_params = None

for embed_dim, batch_size, lr, epochs, weight_decay, dropout_rate in itertools.
 ↪product(
        param_grid["embed_dim"],
        param_grid["batch_size"],
        param_grid["lr"],
        param_grid["epochs"],
        param_grid["weight_decay"],
        param_grid["dropout_rate"]):

    # La tua istanziazione del modello e il training
    model = EmbeddingNet(input_dim=dataset.X.shape[1], embed_dim=embed_dim,␣
 ↪dropout_rate=dropout_rate).to(device)

    trained_model, val_acc = dataset.train_and_evaluate(
        model=model,
        batch_size=batch_size,
        lr=lr,
        epochs=epochs,
        weight_decay=weight_decay,
        verbose=False
    )

    if val_acc > best_acc:
        best_acc = val_acc
        # Correzione: salva tutti gli iperparametri
        best_params = {
            "embed_dim": embed_dim,
            "batch_size": batch_size,
            "lr": lr,
            "epochs": epochs,
            "weight_decay": weight_decay,
            "dropout_rate": dropout_rate
        }

print("Best validation accuracy:", best_acc)
print("Best hyperparameters:", best_params)
```

```
Best validation accuracy: 0.9001203369434416
Best hyperparameters: {'embed_dim': 64, 'batch_size': 64, 'lr': 0.001, 'epochs':
100, 'weight_decay': 1e-07, 'dropout_rate': 0.3}
```

[23]:
```
model = dataset.train_embeddings(**best_params,verbose=False)
embeddings_new = dataset.extract_embeddings(model)
embeddings_new= pd.DataFrame(embeddings_new.to_numpy(), columns=[f"f_{i}" for i␣
 ↪in range(embeddings_new.shape[1])])

clf = Classifier(embeddings_new, dataset.y, emb_builder.classes_bs,figsize =␣
 ↪(10, 6))
xgbc_1,results_xgbc_1 = clf.XGBC(verbose=True)
```

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--------------------------------------FIRST
ANALYSIS---------------------------------------
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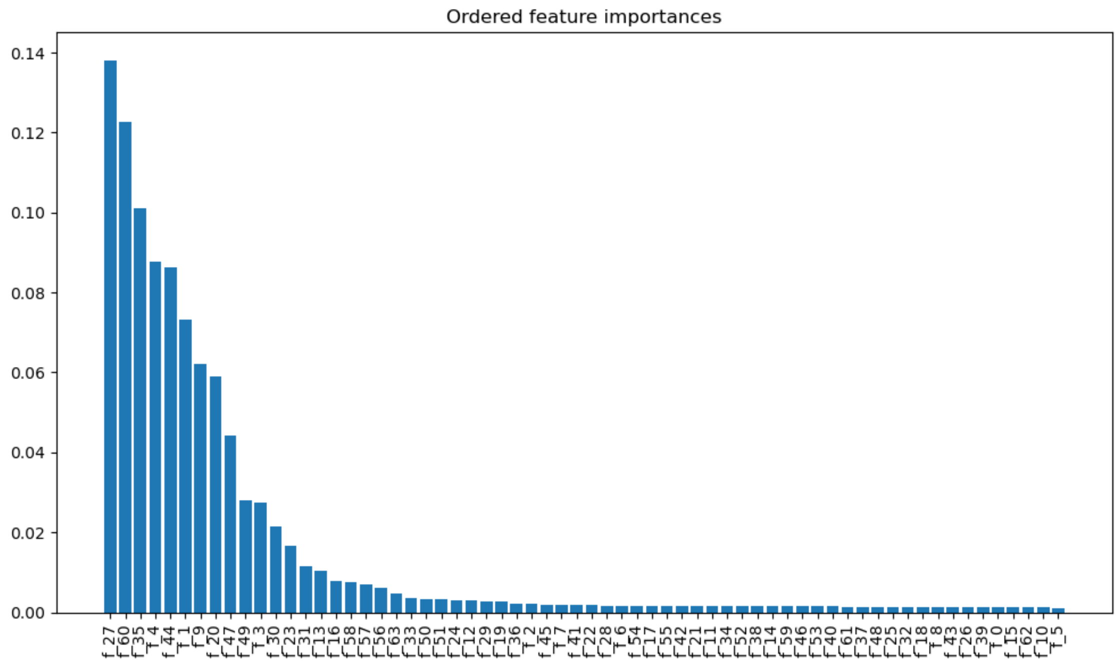
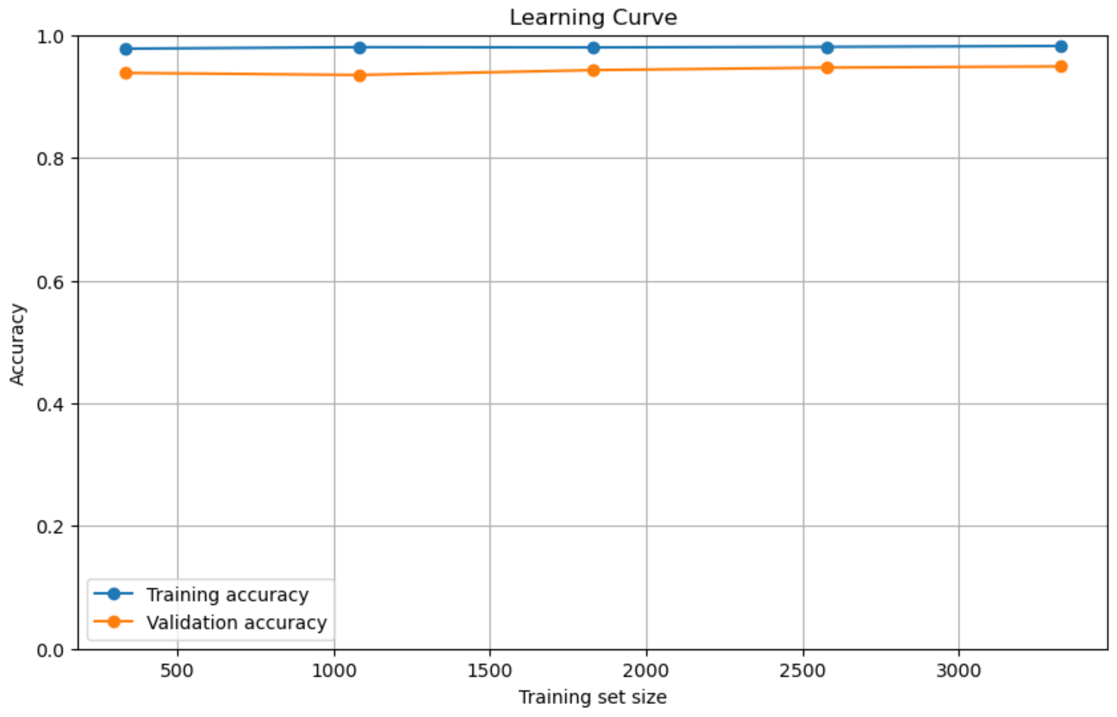
```





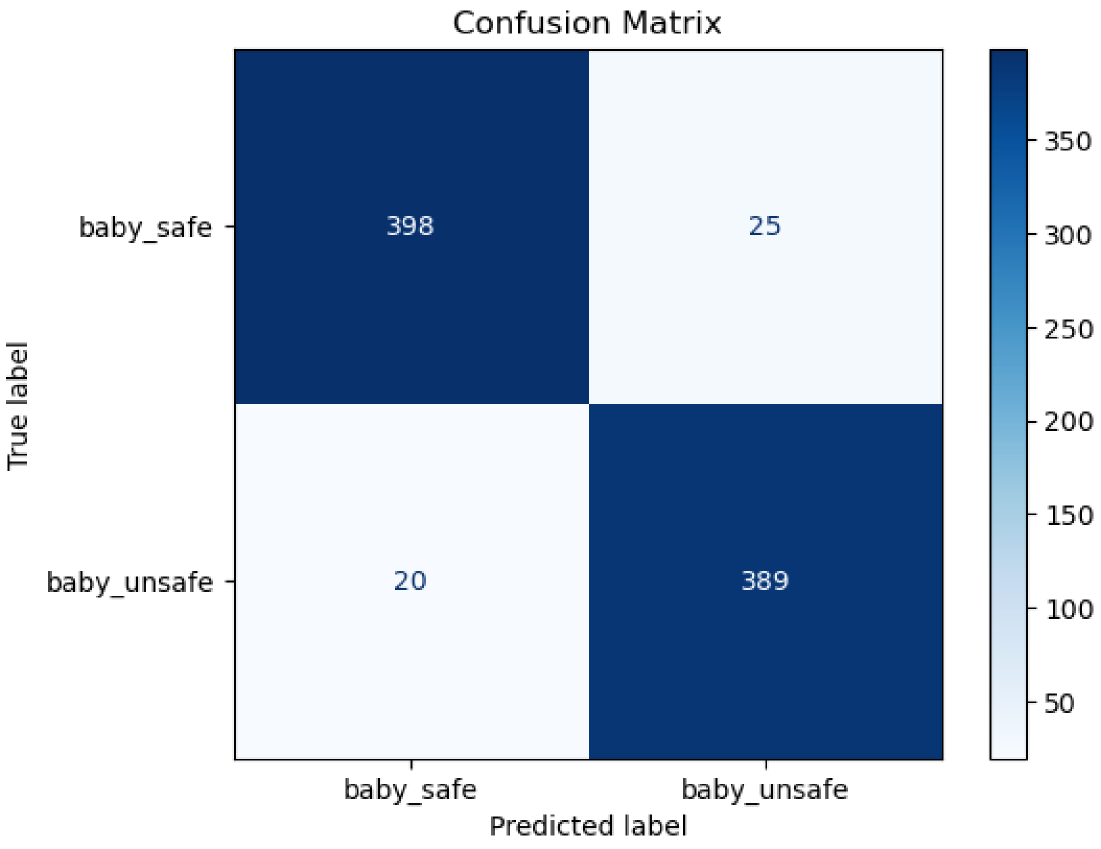
```
Dataset labels:-----------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}
```

```
Report-------------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.95      0.94      0.95       423
 baby_unsafe       0.94      0.95      0.95       409

    accuracy                           0.95       832
   macro avg       0.95      0.95      0.95       832
weighted avg       0.95      0.95      0.95       832

Confusion matrix---------------------------------------
```



```
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---------------------------------TOP 10 FEATURES
ANALYSIS---------------------------------
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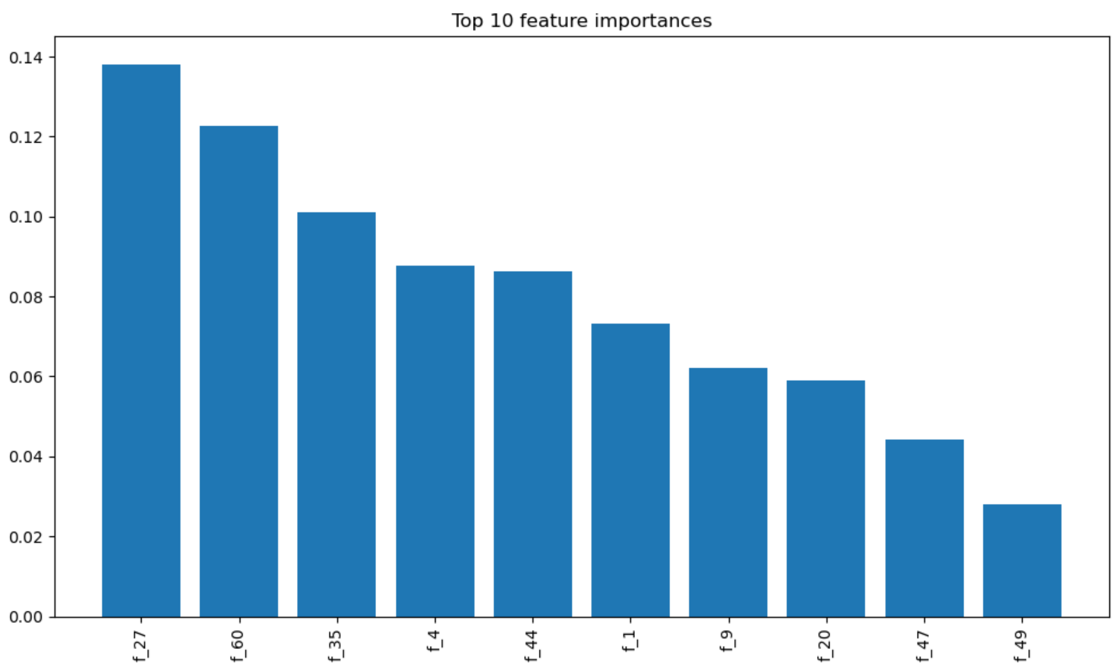
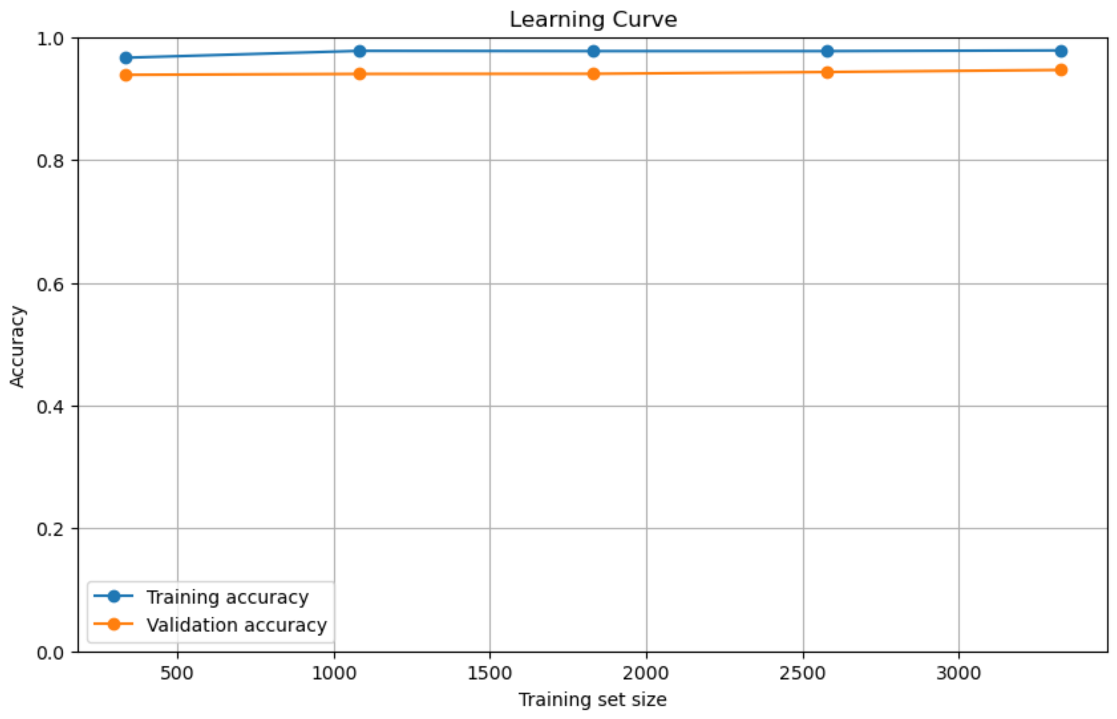
```





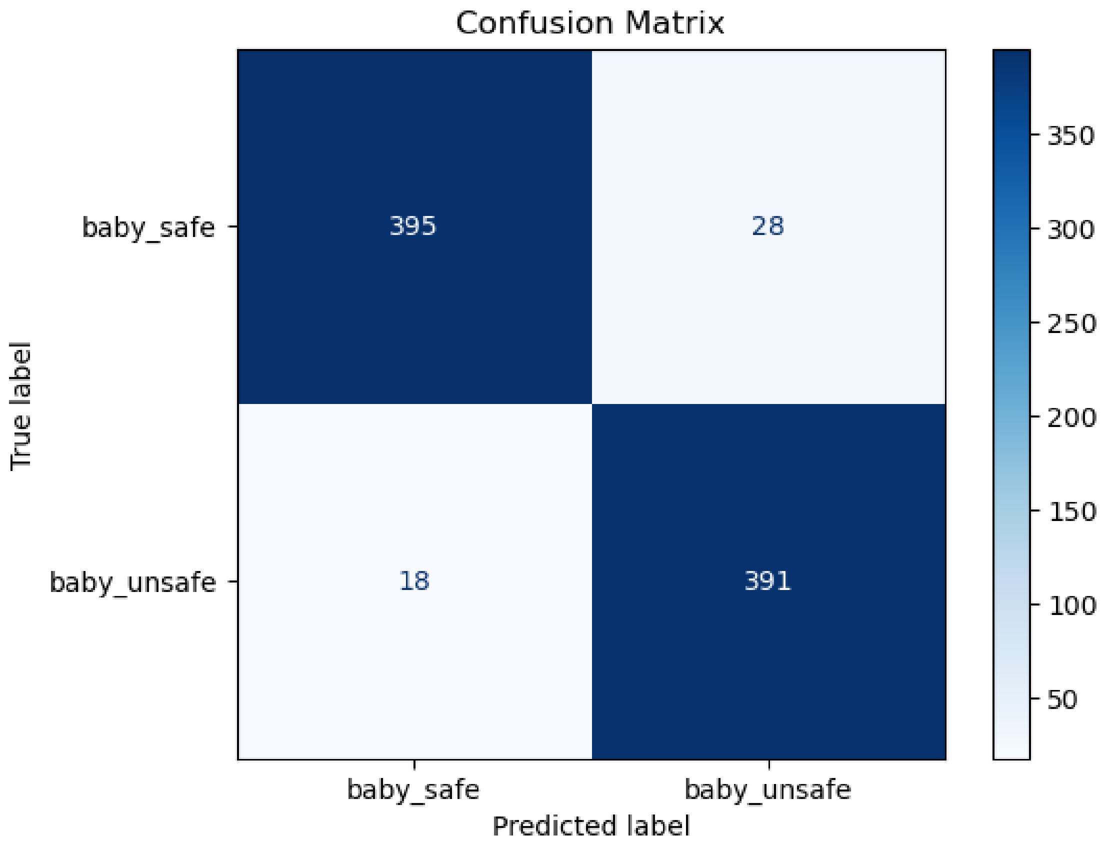
```
Dataset labels:---------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}
```

```
Report-------------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.96      0.93      0.94       423
 baby_unsafe       0.93      0.96      0.94       409

    accuracy                           0.94       832
   macro avg       0.94      0.94      0.94       832
weighted avg       0.94      0.94      0.94       832

Confusion matrix---------------------------------------
```



```
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---------------------------------TOP 25 FEATURES
ANALYSIS---------------------------------
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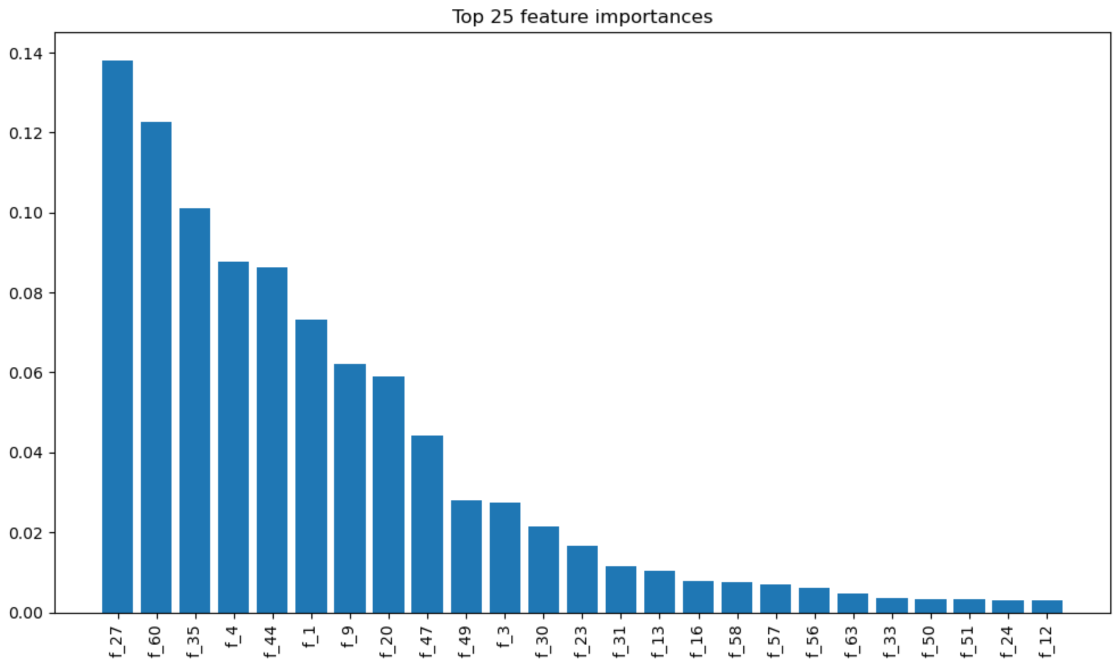
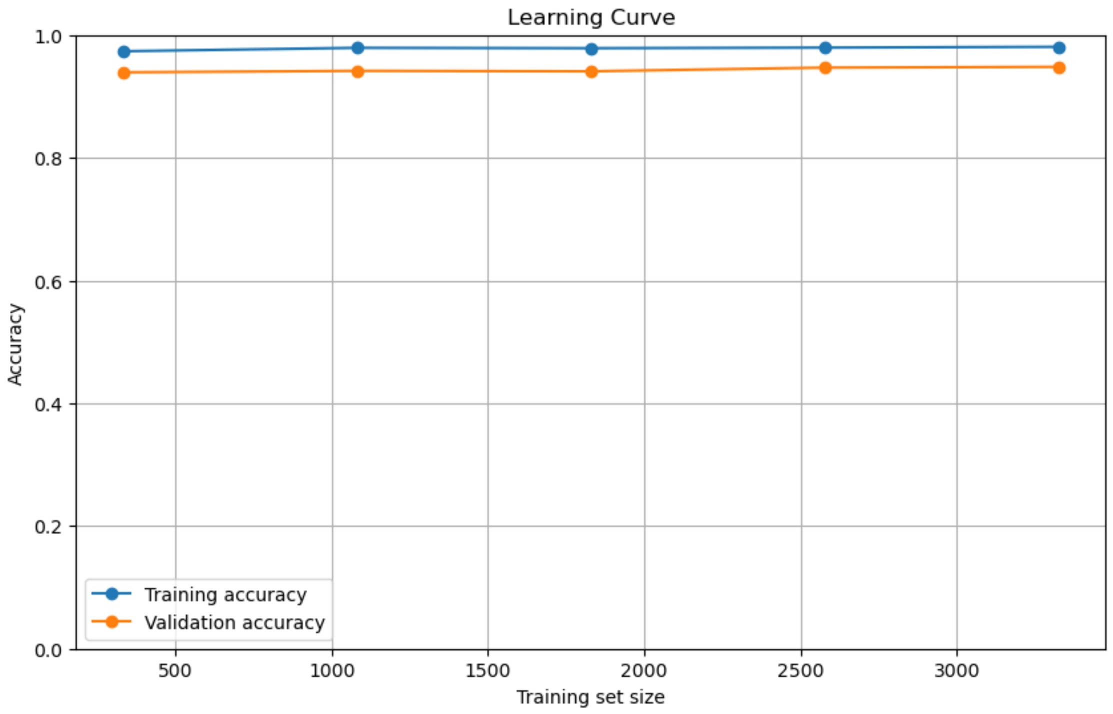
```





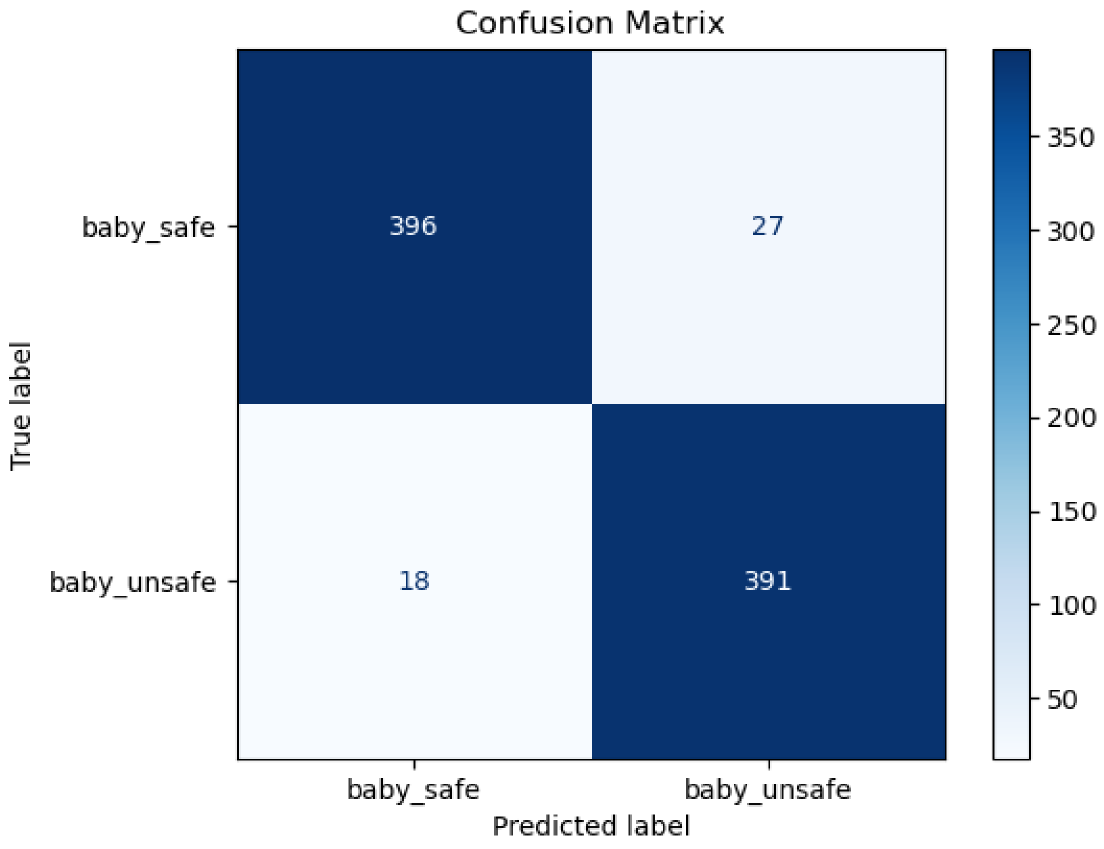
```
Dataset labels:------------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}
```

```
Report-------------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.96      0.94      0.95       423
 baby_unsafe       0.94      0.96      0.95       409

    accuracy                           0.95       832
   macro avg       0.95      0.95      0.95       832
weighted avg       0.95      0.95      0.95       832

Confusion matrix---------------------------------------
```



[24]:
```
clf.evaluation_pipeline_with_cv(xgbc_1,verbose=True)
```

```
--------------------------------------------------------------------------------
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-----------------------------K-FOLD CROSS-VALIDATION
ANALYSIS-----------------------------
--------------------------------------------------------------------------------
----------
```

```
Accuracy for each fold: [0.953125, 0.9567307692307693, 0.9543269230769231,
0.9434416365824309, 0.9446450060168472]
Average cross-validation accuracy: 0.9505
```

```
[24]: np.float64(0.9504538669813941)
```

2 2) Ottimizziamo i parametri del modello

```
[35]: from scipy.stats import randint
      from scipy.stats import uniform

      param_dist = {
          'n_estimators': randint(100, 500), # Numero di alberi da costruire
          'learning_rate': uniform(0.01, 0.3), # Passo di apprendimento
          'max_depth': randint(3, 10), # Profondità massima di un albero
          'subsample': uniform(0.6, 0.4), # Frazione di campioni da usare per␣
        ↪l'addestramento
          'colsample_bytree': uniform(0.6, 0.4), # Frazione di feature da usare per␣
        ↪la costruzione di ogni albero
          'gamma': uniform(0, 0.5) # Riduzione minima della perdita richiesta per␣
        ↪fare un'ulteriore partizione
          }
      best_params_xgbc = clf.optimize_model(xgbc_1, param_dist,verbose=True)
      xgbc_2 = XGBClassifier(**best_params_xgbc)
      results_xgbc_2 = clf.evaluation_pipeline(xgbc_2,verbose=True,optimized=True)
```

```
Start random search…

Random Search Results:
Best parameters found:  {'colsample_bytree': np.float64(0.7970472375971478),
'gamma': np.float64(0.1643758051437541), 'learning_rate':
np.float64(0.20002025629501774), 'max_depth': 5, 'n_estimators': 470,
'subsample': np.float64(0.8149053666856281)}
Best mean cross-validation accuracy:  0.9506929485876855

Evaluation of the best model on the test set:
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--------------------------------------FIRST
ANALYSIS---------------------------------------
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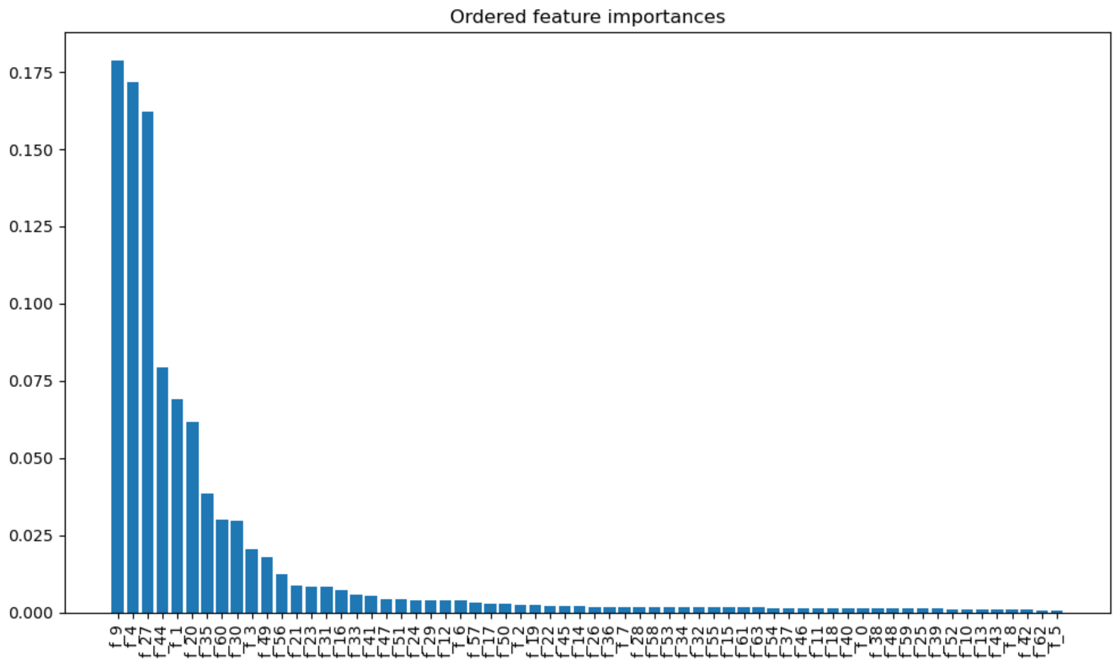
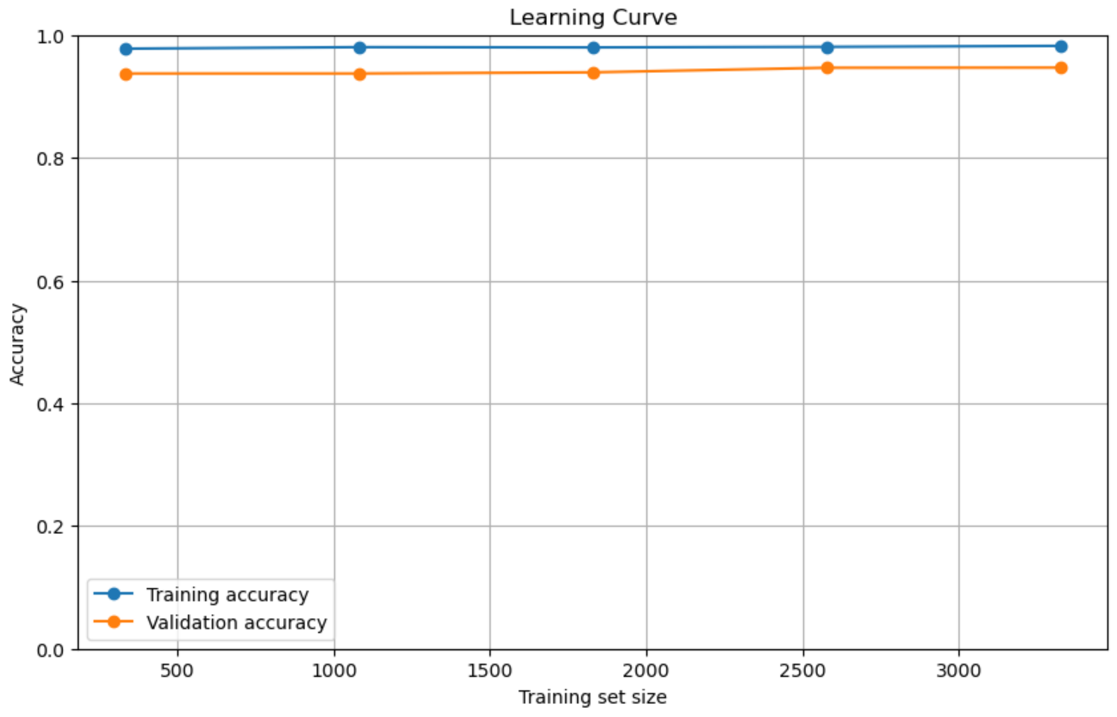
```





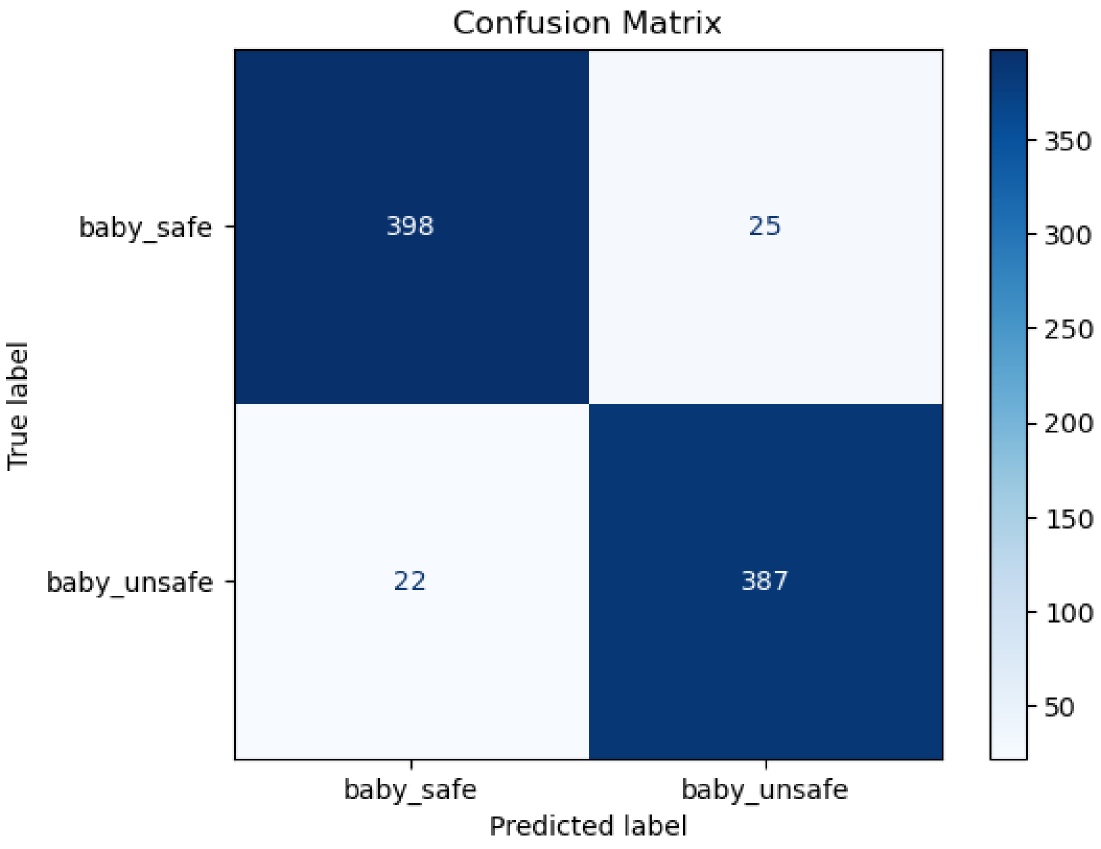
```
Dataset labels:----------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}
```

```
Report-------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.95      0.94      0.94       423
 baby_unsafe       0.94      0.95      0.94       409

    accuracy                           0.94       832
   macro avg       0.94      0.94      0.94       832
weighted avg       0.94      0.94      0.94       832

Confusion matrix---------------------------------------
```



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---------------------------------TOP 10 FEATURES
ANALYSIS---------------------------------
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```
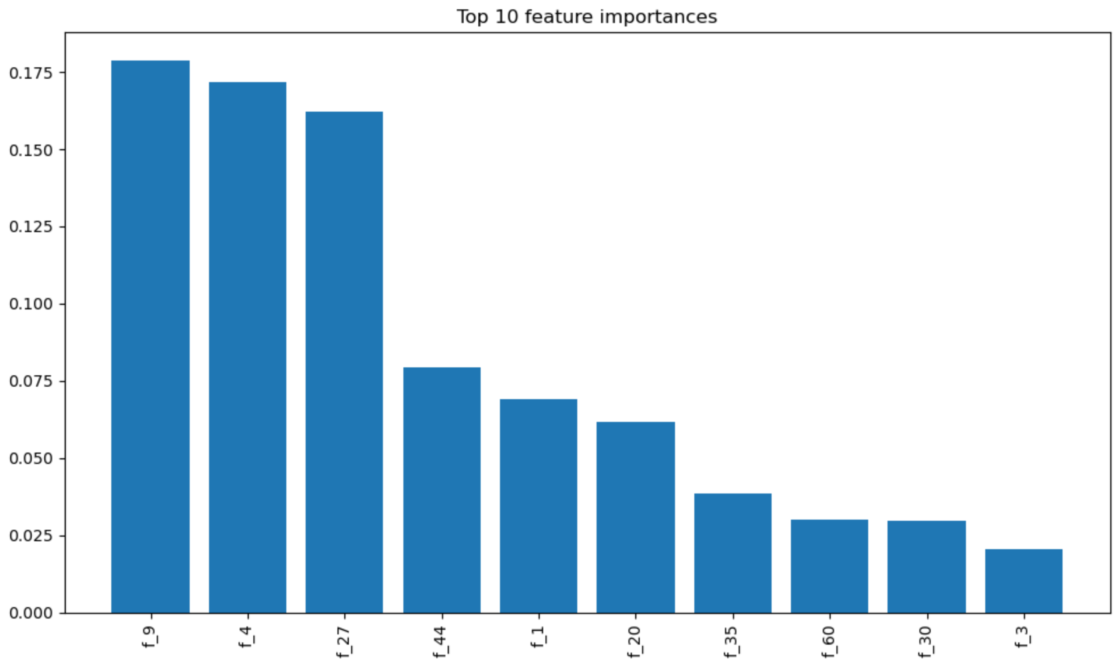
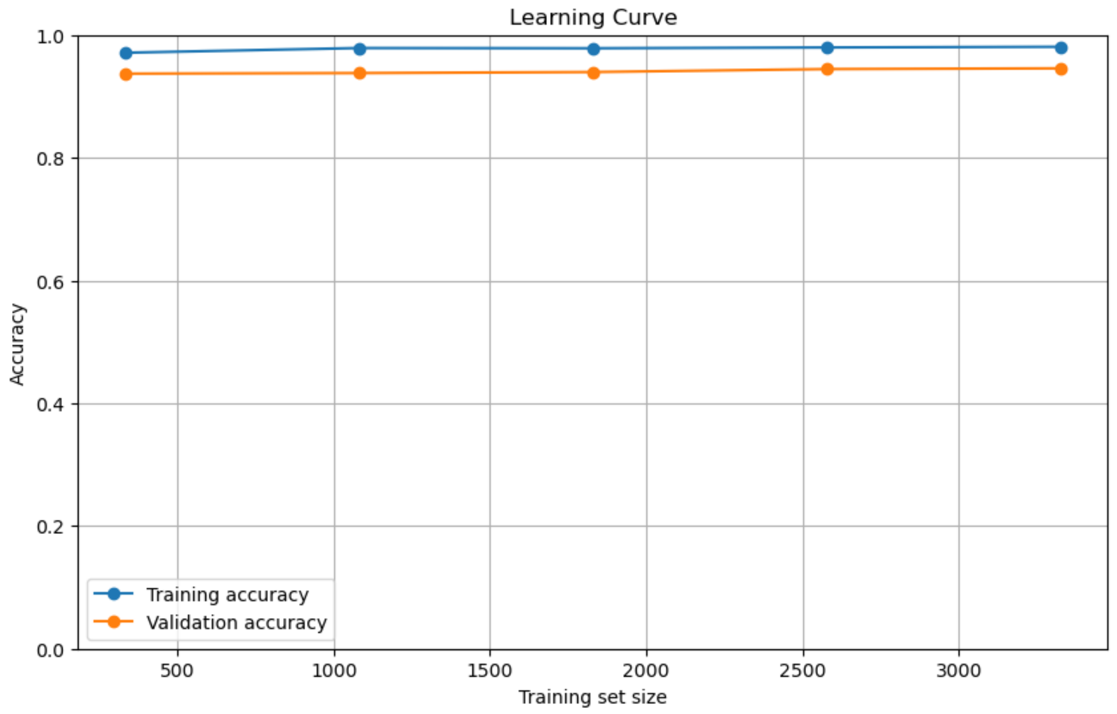
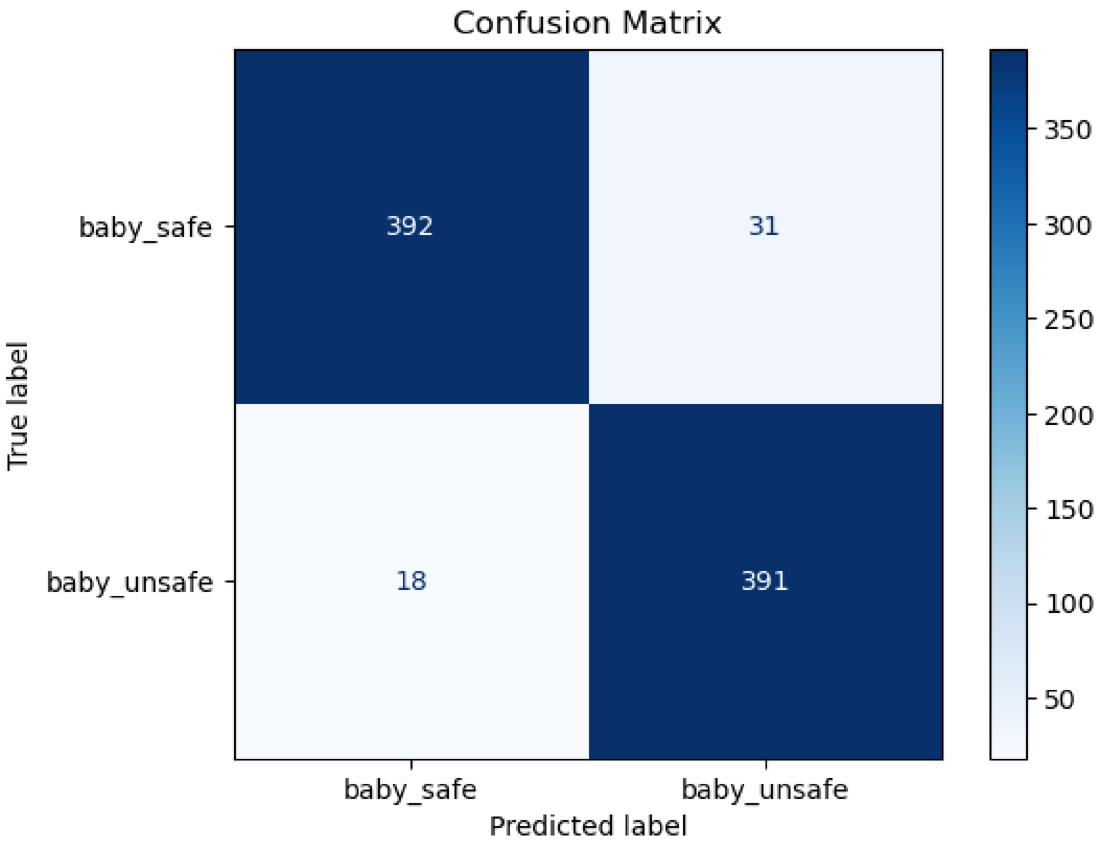





```
Dataset labels:----------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}
```

```
Report------------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.96      0.93      0.94       423
 baby_unsafe       0.93      0.96      0.94       409

    accuracy                           0.94       832
   macro avg       0.94      0.94      0.94       832
weighted avg       0.94      0.94      0.94       832

Confusion matrix---------------------------------------
```



```
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---------------------------------TOP 25 FEATURES
ANALYSIS---------------------------------
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```
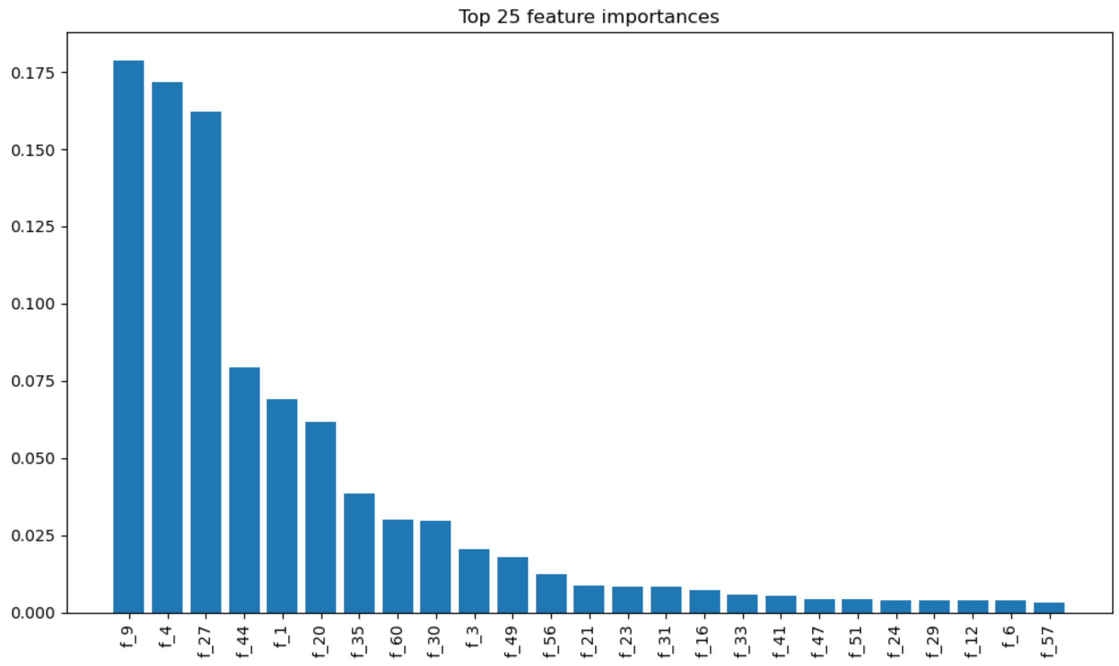
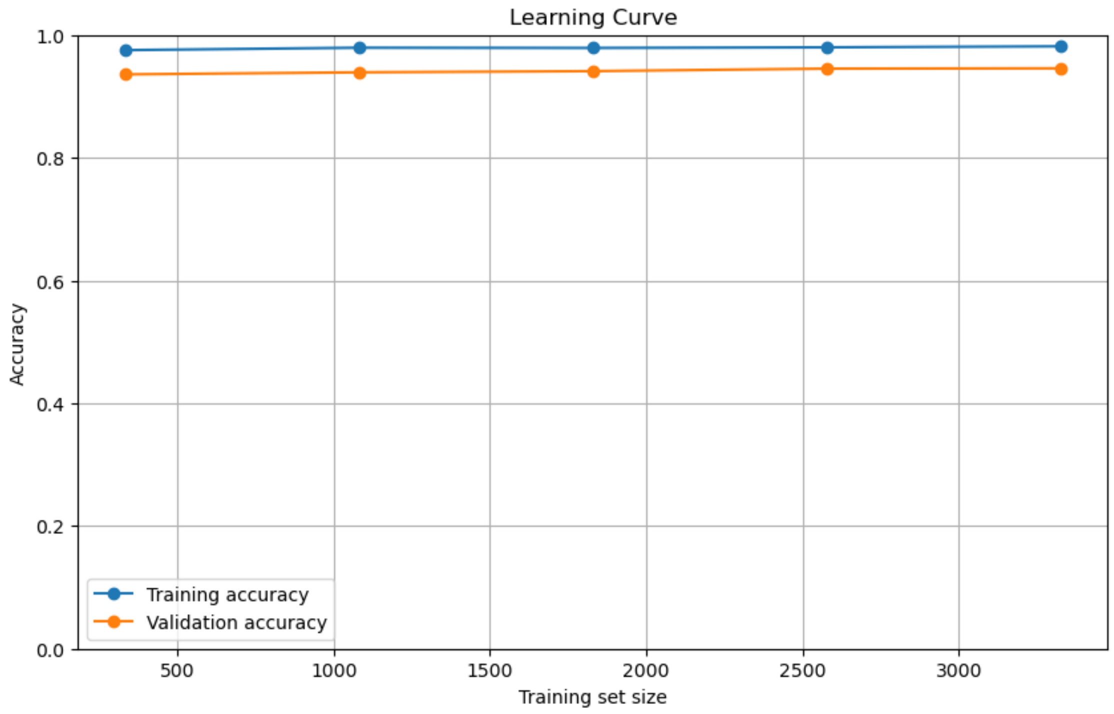
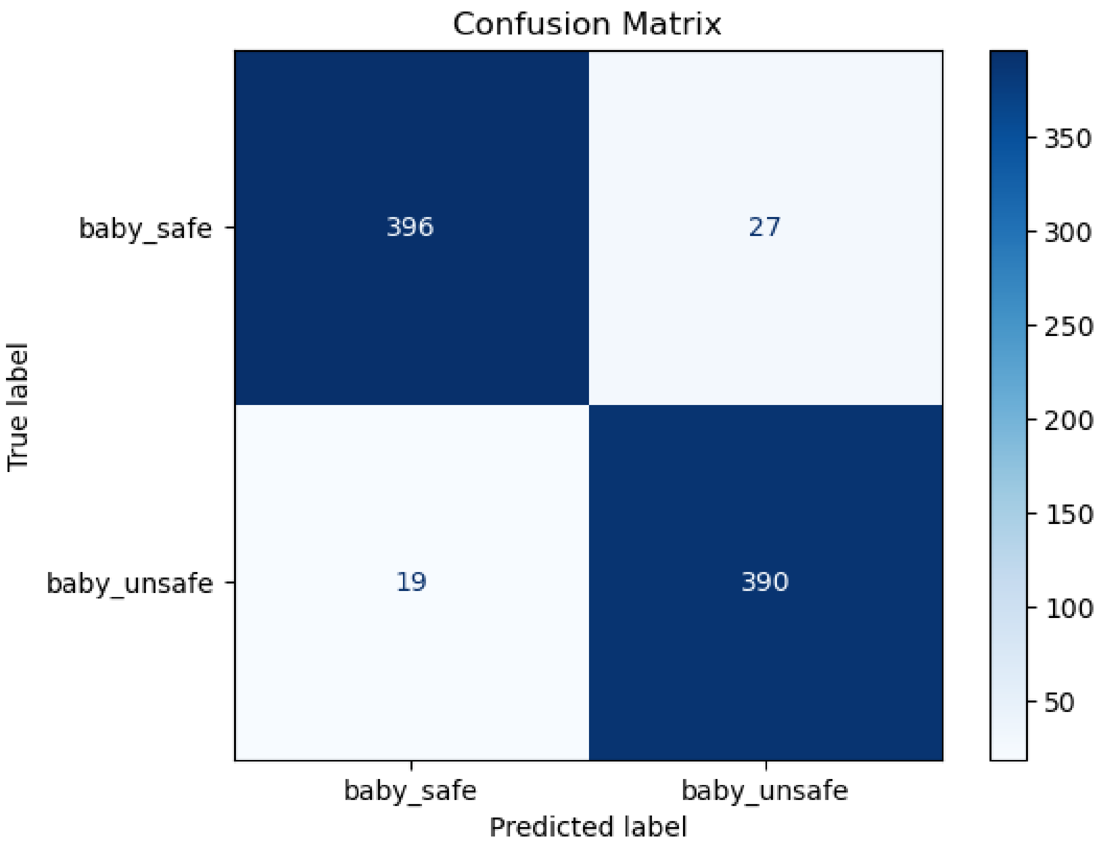





```
Dataset labels:-----------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}
```

```
Report--------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.95      0.94      0.95       423
 baby_unsafe       0.94      0.95      0.94       409

    accuracy                           0.94       832
   macro avg       0.94      0.94      0.94       832
weighted avg       0.94      0.94      0.94       832

Confusion matrix---------------------------------------
```



[37]:
```
dataset.save_embeddings(embeddings_new.iloc[:, :10])
```

[32]:
```
xgbc_3 = XGBClassifier(**best_params_xgbc)
clf.evaluation_pipeline_with_cv(xgbc_3,verbose=True)
```

```
--------------------------------------------------------------------------------
----------
-----------------------------K-FOLD CROSS-VALIDATION
```

```
ANALYSIS-----------------------------
--------------------------------------------------------------------------------
----------
Accuracy for each fold: [0.953125, 0.9555288461538461, 0.9507211538461539,
0.941034897713598, 0.9446450060168472]
Average cross-validation accuracy: 0.9490
```

[32]:
```
np.float64(0.9490109807460889)
```

3 3) Eseguiamo Ablazione

[38]:
```python
emb_reduced, history = clf.iterative_ablation(
    model=xgbc_2,
    embeddings=embeddings_new,
    y=dataset.y,
    classes_bs=emb_builder.classes_bs,
    max_cycles=20,
    n_very_big_groups=10,
    very_big_group_size=10,
    n_big_groups=10,
    big_group_size=6,
    n_medium_groups=3,
    medium_group_size=10,
    n_small_groups=10,
    small_group_size=2,
    verbose=False)
```

[39]:
```python
diff1 = set(embeddings_new.columns) - set(emb_reduced.columns)  # colonne in␣
 ↪df1 ma non in df2


print("Colonne presenti in df1 ma non in df2:", diff1)
```

```
Colonne presenti in df1 ma non in df2: {'f_8'}
```

[40]:
```python
clf = Classifier(emb_reduced, dataset.y, emb_builder.classes_bs)
xgbc_4 = XGBClassifier(**best_params_xgbc)
clf.evaluation_pipeline(xgbc_4, verbose=True,optimized=True)
```

```
--------------------------------------------------------------------------------
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--------------------------------------FIRST
ANALYSIS---------------------------------------
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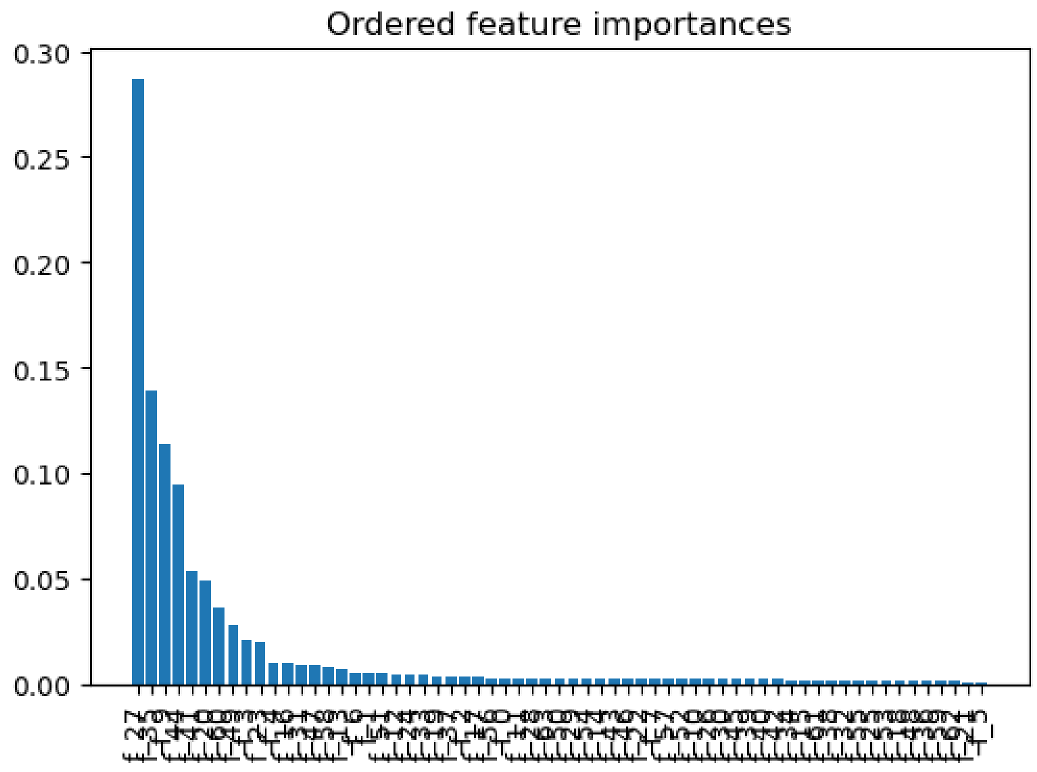
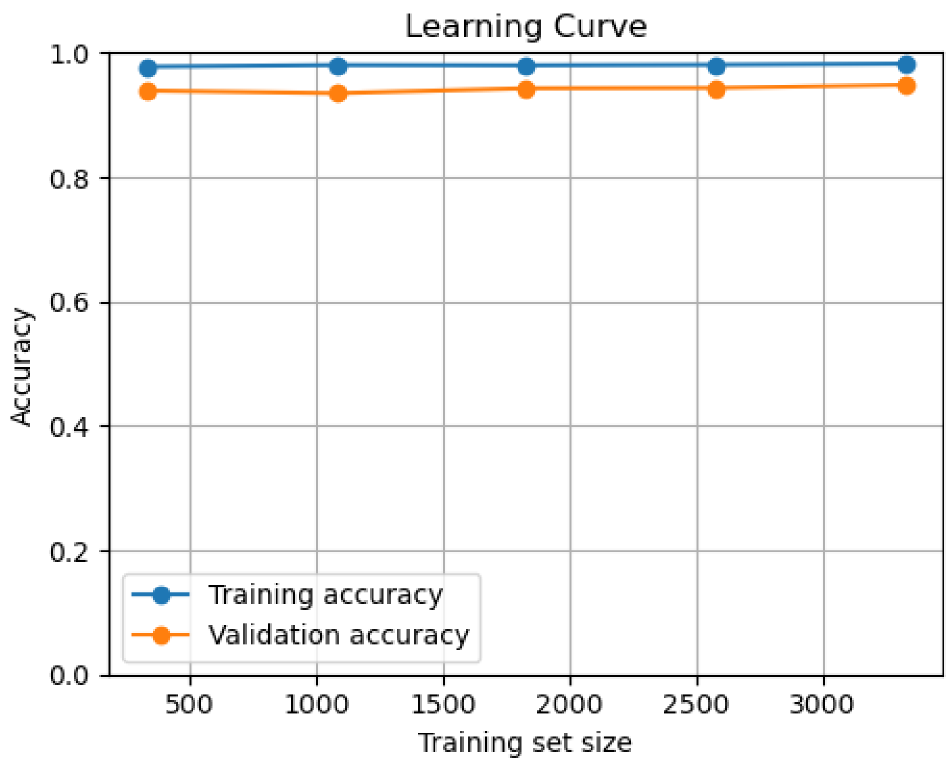
```


Ordered feature importances
0.30
0.25
0.20
0.15
0.10
0.05
0.00


Learning Curve
Accuracy
Training set size
Training accuracy
Validation accuracy
1.0
0.8
0.6
0.4
0.2
0.0
500
1000
1500
2000
2500
3000

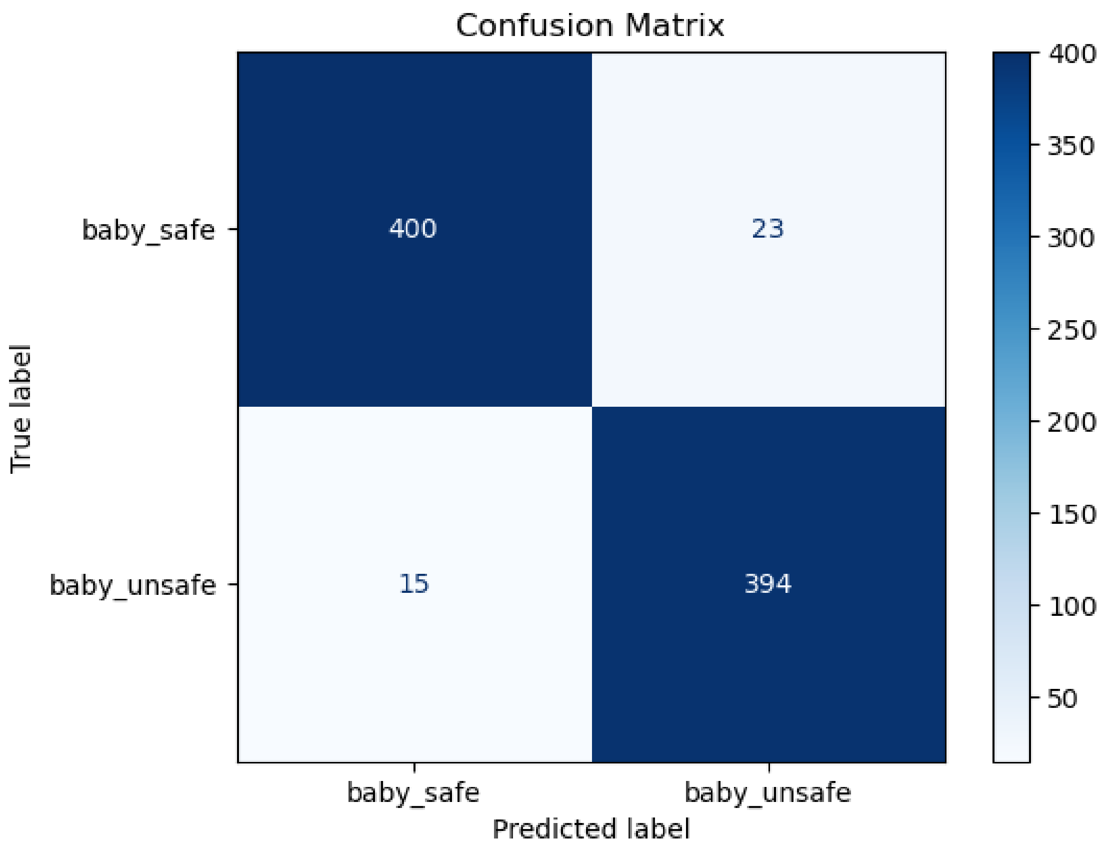
```
Dataset labels:----------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}

Report-------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.96      0.95      0.95       423
 baby_unsafe       0.94      0.96      0.95       409

    accuracy                           0.95       832
   macro avg       0.95      0.95      0.95       832
weighted avg       0.95      0.95      0.95       832

Confusion matrix---------------------------------------
```



```
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```

```
---------------------------------TOP 10 FEATURES
ANALYSIS---------------------------------
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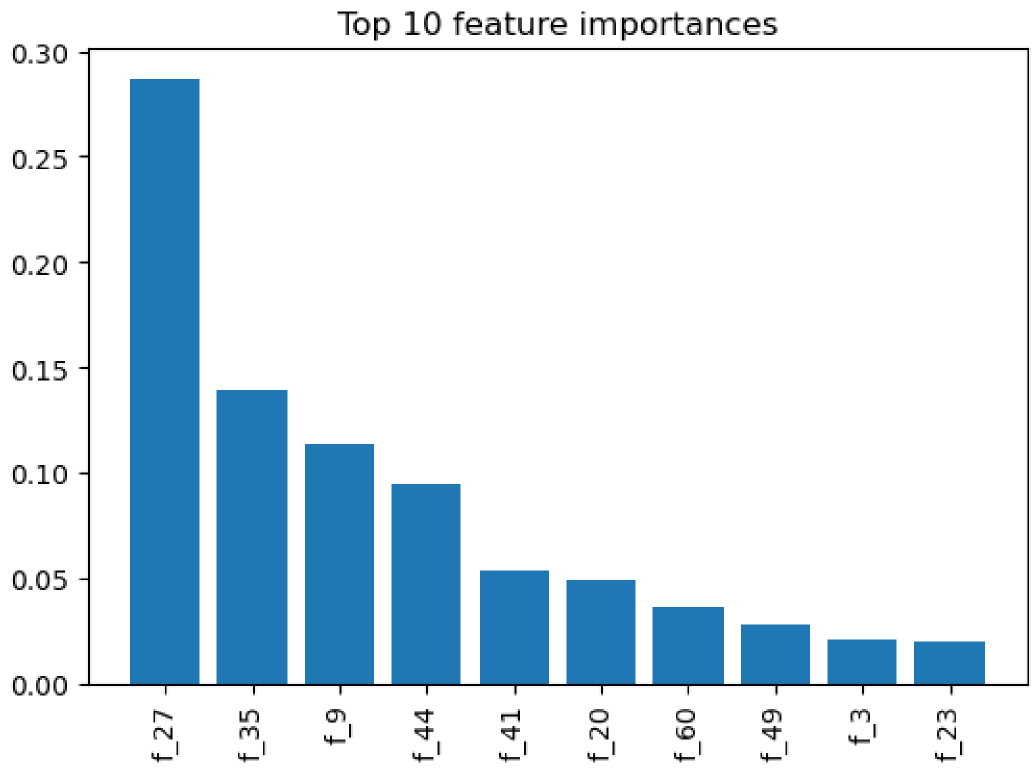
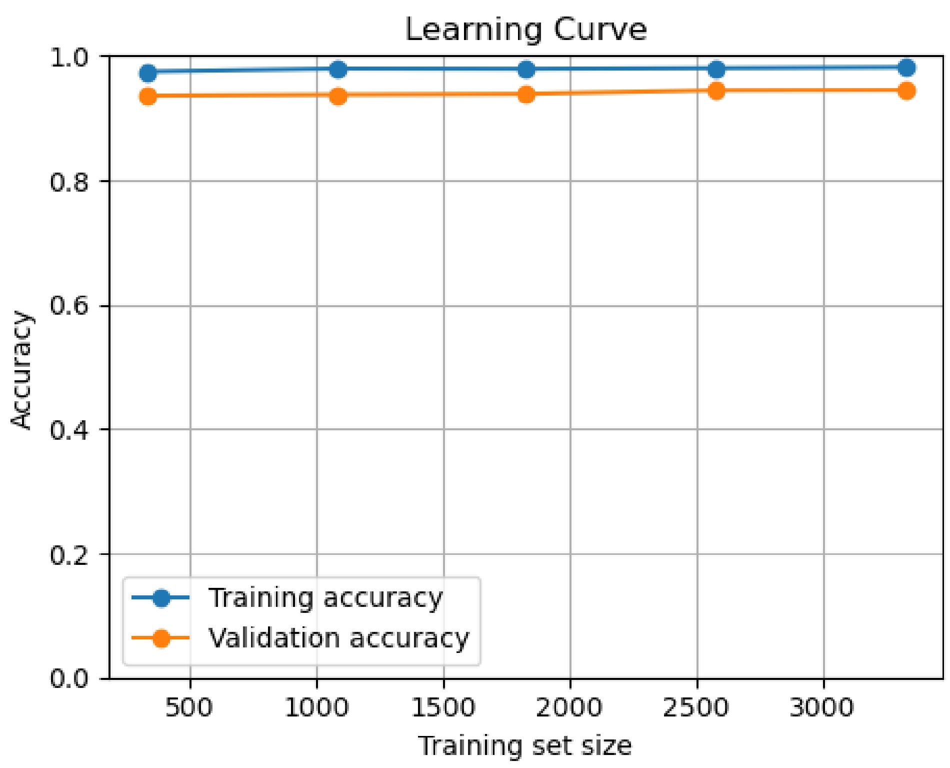
```





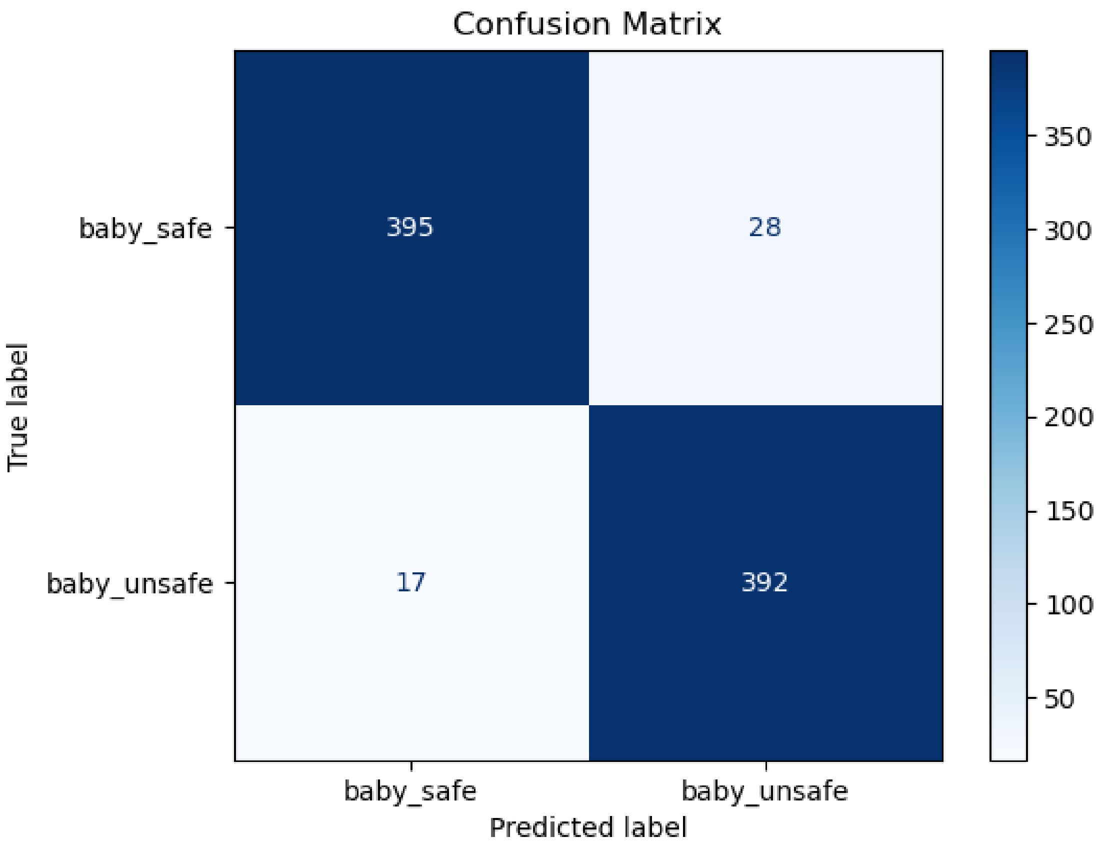
```
Dataset labels:---------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}

Report------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.96      0.93      0.95       423
 baby_unsafe       0.93      0.96      0.95       409

    accuracy                           0.95       832
   macro avg       0.95      0.95      0.95       832
weighted avg       0.95      0.95      0.95       832

Confusion matrix---------------------------------------
```



```
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----------
---------------------------------TOP 25 FEATURES
ANALYSIS---------------------------------
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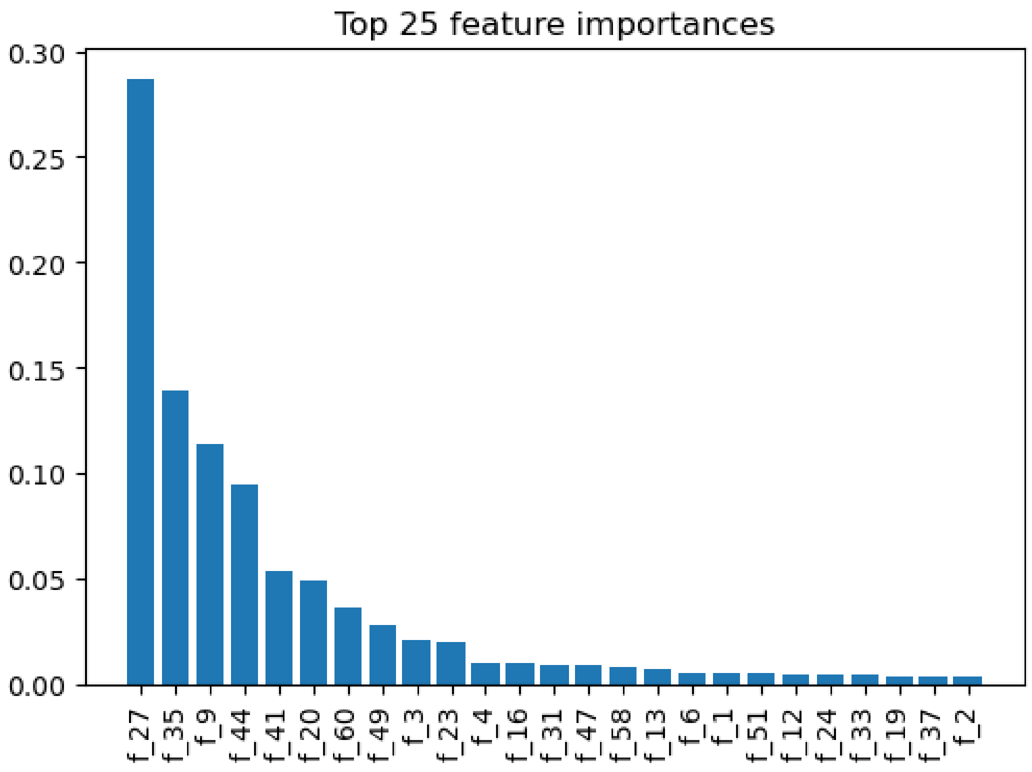
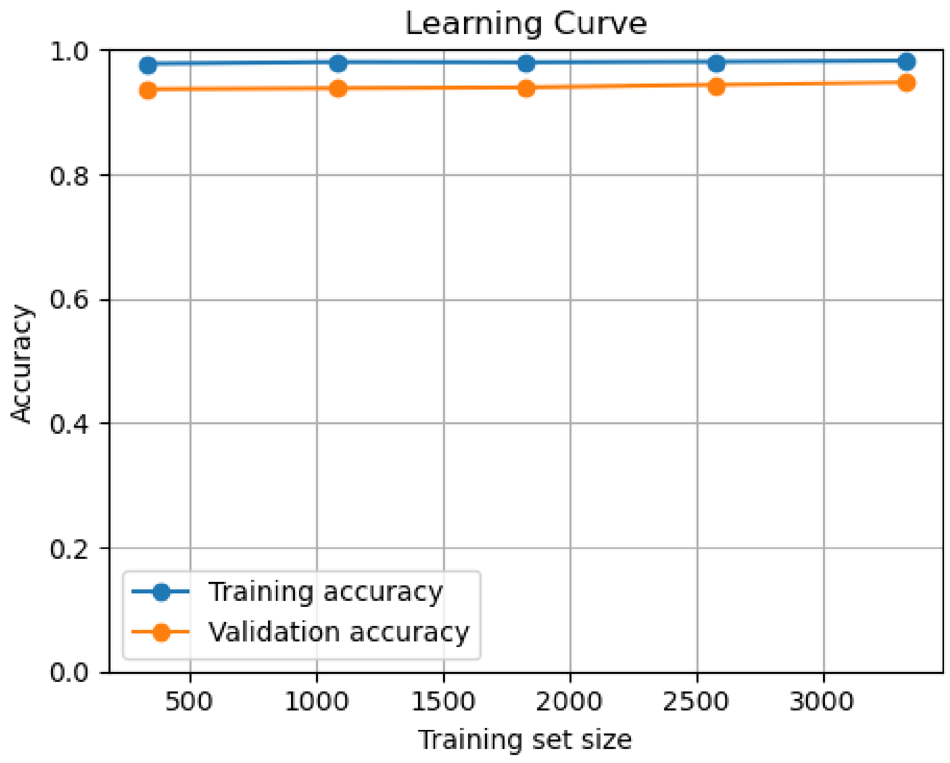
```


Top 25 feature importances
0.30
0.25
0.20
0.15
0.10
0.05
0.00
f_27
f_35
f_9
f_44
f_41
f_20
f_60
f_49
f_3
f_23
f_4
f_16
f_31
f_47
f_58
f_13
f_6
f_1
f_51
f_12
f_24
f_33
f_19
f_37
f_2


Learning Curve
Accuracy
1.0
0.8
0.6
0.4
0.2
0.0
500
1000
1500
2000
2500
3000
Training set size
Training accuracy
Validation accuracy

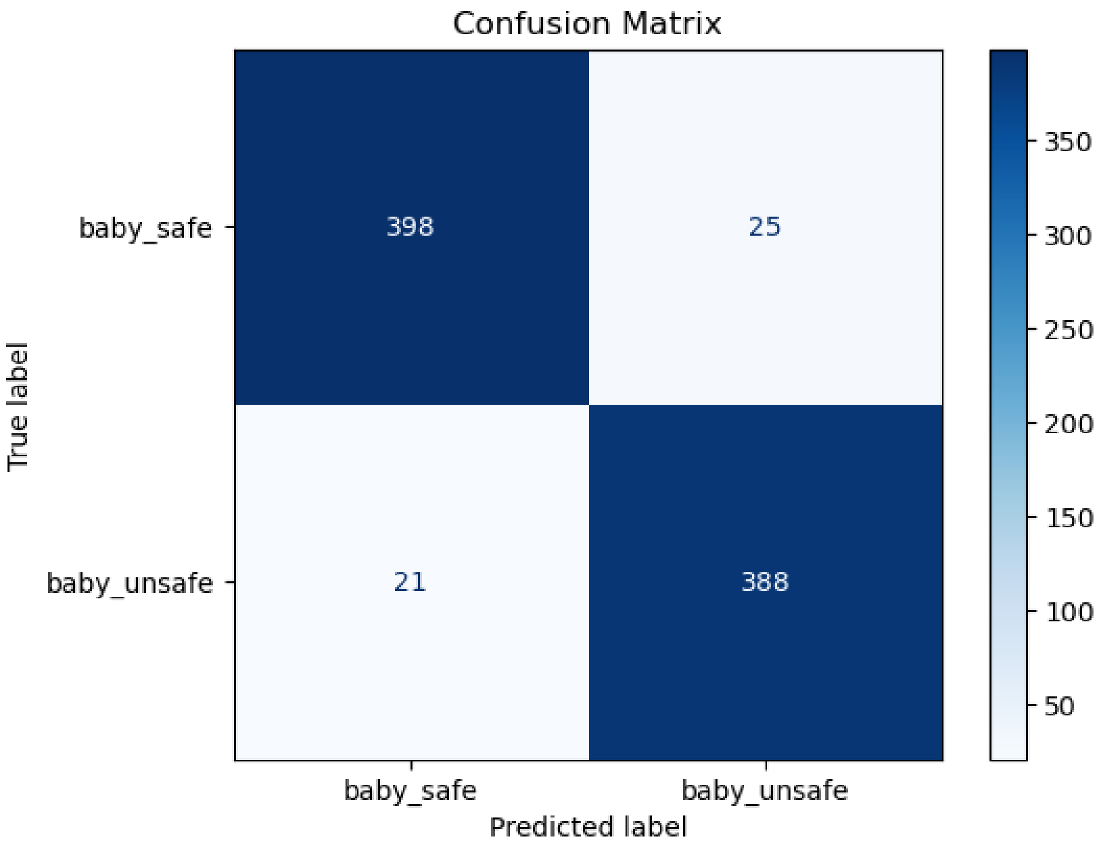
```
Dataset labels:----------------------------------------
{'baby_safe': 0, 'baby_unsafe': 1}

Report-------------------------------------------------
              precision    recall  f1-score   support

   baby_safe       0.95      0.94      0.95       423
 baby_unsafe       0.94      0.95      0.94       409

    accuracy                           0.94       832
   macro avg       0.94      0.94      0.94       832
weighted avg       0.94      0.94      0.94       832

Confusion matrix---------------------------------------
```



```
[40]: {'all_features': {'model': XGBClassifier(base_score=None, booster=None,
      callbacks=None,
                    colsample_bylevel=None, colsample_bynode=None,
                    colsample_bytree=np.float64(0.7970472375971478), device=None,
                    early_stopping_rounds=None, enable_categorical=False,
                    eval_metric=None, feature_types=None, feature_weights=None,
                    gamma=np.float64(0.1643758051437541), grow_policy=None,
                    importance_type=None, interaction_constraints=None,
                    learning_rate=np.float64(0.20002025629501774), max_bin=None,
                    max_cat_threshold=None, max_cat_to_onehot=None,
                    max_delta_step=None, max_depth=5, max_leaves=None,
                    min_child_weight=None, missing=nan, monotone_constraints=None,
                    multi_strategy=None, n_estimators=470, n_jobs=None,
                    num_parallel_tree=None, …),
        'X': array([[    -0.1247,    0.012603,     0.14913, …,    -0.22047,
      0.082049,     0.15007],
               [  -0.081928,    -0.14025,     0.15321, …,    -0.21451,    0.087326,
      -0.019009],
               [   -0.14457,   -0.029547,     0.15554, …,    -0.23851,    0.082482,
      0.11234],
               …,
               [   -0.14506,  -0.0065284,     0.15285, …,    -0.23238,    0.087467,
      0.13656],
               [   -0.13297,   0.0034594,     0.13928, …,    -0.20727,    0.081965,
      0.16009],
               [   -0.11506,   -0.031399,     0.16687, …,    -0.22957,    0.098249,
      0.11729]], shape=(4158, 63), dtype=float32),
        'y': array([0, 1, 0, …, 0, 0, 0], shape=(4158,))},
       'top_10_features': {'model': XGBClassifier(base_score=None, booster=None,
      callbacks=None,
                    colsample_bylevel=None, colsample_bynode=None,
                    colsample_bytree=np.float64(0.7970472375971478), device=None,
                    early_stopping_rounds=None, enable_categorical=False,
                    eval_metric=None, feature_types=None, feature_weights=None,
                    gamma=np.float64(0.1643758051437541), grow_policy=None,
                    importance_type=None, interaction_constraints=None,
                    learning_rate=np.float64(0.20002025629501774), max_bin=None,
                    max_cat_threshold=None, max_cat_to_onehot=None,
                    max_delta_step=None, max_depth=5, max_leaves=None,
                    min_child_weight=None, missing=nan, monotone_constraints=None,
                    multi_strategy=None, n_estimators=470, n_jobs=None,
                    num_parallel_tree=None, …),
        'X': array([[   -0.11771,   -0.068812,    0.030948, …,    0.088932,
      0.13121,    -0.12217],
               [  0.0016136,    0.070188,     0.13179, …,    -0.10022,     0.03058,
      0.076435],
               [   -0.10086,   -0.037679,    0.061949, …,    0.055472,     0.11399,
-0.09763],
         …,
         [   -0.12222,   -0.045986,    0.043369, …,    0.074299,     0.11156,
-0.12396],
         [   -0.13586,   -0.085682,    0.012979, …,     0.10869,     0.12254,
-0.13611],
         [    -0.1145,   -0.028314,    0.058142, …,    0.056774,     0.12513,
-0.077972]], shape=(4158, 10), dtype=float32),
  'y': array([0, 1, 0, …, 0, 0, 0], shape=(4158,)),
  'top_features_idx': array([26, 34,  8, 43, 40, 19, 59, 48,  3, 22])},
 'top_25_features': {'model': XGBClassifier(base_score=None, booster=None,
callbacks=None,
                colsample_bylevel=None, colsample_bynode=None,
                colsample_bytree=np.float64(0.7970472375971478), device=None,
                early_stopping_rounds=None, enable_categorical=False,
                eval_metric=None, feature_types=None, feature_weights=None,
                gamma=np.float64(0.1643758051437541), grow_policy=None,
                importance_type=None, interaction_constraints=None,
                learning_rate=np.float64(0.20002025629501774), max_bin=None,
                max_cat_threshold=None, max_cat_to_onehot=None,
                max_delta_step=None, max_depth=5, max_leaves=None,
                min_child_weight=None, missing=nan, monotone_constraints=None,
                multi_strategy=None, n_estimators=470, n_jobs=None,
                num_parallel_tree=None, …),
  'X': array([[   -0.11771,   -0.068812,    0.030948, …,   -0.066666,
-0.20229,     0.14913],
         [  0.0016136,    0.070188,     0.13179, …,    -0.12813,    -0.15578,
0.15321],
         [   -0.10086,   -0.037679,    0.061949, …,   -0.095126,    -0.18774,
0.15554],
         …,
         [   -0.12222,   -0.045986,    0.043369, …,   -0.083096,    -0.19705,
0.15285],
         [   -0.13586,   -0.085682,    0.012979, …,   -0.068441,    -0.20908,
0.13928],
         [    -0.1145,   -0.028314,    0.058142, …,   -0.084555,     -0.2168,
0.16687]], shape=(4158, 25), dtype=float32),
  'y': array([0, 1, 0, …, 0, 0, 0], shape=(4158,)),
  'top_features_idx': array([26, 34,  8, 43, 40, 19, 59, 48,  3, 22,  4, 15, 30,
46, 57, 12,  6,  1, 50, 11, 23, 32, 18, 36,  2])}}
```

[41]:
```
clf.evaluation_pipeline_with_cv(xgbc_4,verbose=True)
```

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--------------------------------------------------------------------------------
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-----------------------------K-FOLD CROSS-VALIDATION
ANALYSIS-----------------------------
--------------------------------------------------------------------------------
```

```
----------
Accuracy for each fold: [0.953125, 0.9579326923076923, 0.9495192307692307,
0.9398315282791817, 0.941034897713598]
Average cross-validation accuracy: 0.9483
```

```
[41]: np.float64(0.9482886698139404)
```

```
[112]: os.environ["PATH"] = "/Library/TeX/texbin:" + os.environ["PATH"]
       save_as_pdf(ipynbname.path())
```

```
[NbConvertApp] Converting notebook /Users/lorenzodimaio/Download/SIDS_revelation
_project/full_pipeline/reports/MLP_classifier_parameter.ipynb to pdf
[NbConvertApp] Support files will be in /Users/lorenzodimaio/Download/SIDS_revel
ation_project/full_pipeline/reports/reports/MLP_classifier_parameter(2025-09-
09)_files/
[NbConvertApp] Writing 70178 bytes to notebook.tex
[NbConvertApp] Building PDF
[NbConvertApp] Running xelatex 3 times: ['xelatex', 'notebook.tex', '-quiet']
[NbConvertApp] Running bibtex 1 time: ['bibtex', 'notebook']
[NbConvertApp] WARNING | bibtex had problems, most likely because there were no
citations
[NbConvertApp] PDF successfully created
[NbConvertApp] Writing 831636 bytes to /Users/lorenzodimaio/Download/SIDS_revela
tion_project/full_pipeline/reports/reports/MLP_classifier_parameter(2025-09-
09).pdf
```