Flood Image Classification Model · From Single Fixed Camera History

In [1]:

```
cd ../
```

```
C:\Users\luisr\Desktop\Repositories\Data Science Projects\Hackaton COR IV - Centro de Operações do RJ\INCUBAÇÃO
\Cameras
```

General purpose parameters

In [2]:

```
random_state = 0 # seed for random generator
replacement = False
```

Import libraries

In [3]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns; sns.set()
from imblearn.under_sampling import RandomUnderSampler
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import classification_report
from sklearn.model_selection import learning_curve
```

```
c:\Users\luisr\anaconda3\lib\site-packages\pandas\core\computation\expressions.py:20: UserWarning: Pandas requir
es version '2.7.3' or newer of 'numexpr' (version '2.7.1' currently installed).
  from pandas.core.computation.check import NUMEXPR_INSTALLED
```

Class to load frames from labeled videos as labeled images

In [4]:

```
import os, cv2, numpy as np
from IPython.display import clear_output as co

class VideoLoader:

    def __init__(self, dim=3):
        """  """
        self.dim = dim

    def frames_from_labeled_videos(self, paths, labels, print_each=None):
        i, n  = 0, max(len(paths), len(labels))
        x, y = [], []
        for path, label in zip(paths, labels):
            frames = self.frames_from_video(path)
            x += frames; y += [label] * len(frames)
            i += 1
            if print_each is not None and i % print_each == 0:
                co(True); print(f'CAPTURE LABELED VIDEOS · OPEN: {i}/{n}')
        return np.array(x), np.array(y)

    def frames_from_video(self, path):
        cap = cv2.VideoCapture(path)
        if not cap.isOpened():
            print(f"CANNOT OPEN VIDEO CAPTURE · PATH: {path}")
            return []
        frames = []
        while True:
            ret, frame = cap.read()
            if not ret:
                break # stream finished
            if self.dim == 1: # 1D flat frame
                frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
                frame = np.reshape(frame, -1)
            if self.dim == 2: # 2D gray scale frame
                frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
            frames.append(frame)
        cap.release(); cv2.destroyAllWindows()
        return frames
```

Function to display train and test classes counting

In [5]:

```
import pandas as pd

def split_class_count(y_train, y_test):
    display(pd.concat([
        pd.Series(y_train).value_counts().to_frame('Train set'),
        pd.Series(y_test).value_counts().to_frame('Test set')
    ], axis=1))
```

Function to display mislabeled images

In [6]:

```
import numpy as np
import matplotlib.pyplot as plt

def display_mislabeled_images(X_test, y_test, y_pred, display_max=5, random=True, img_shape=(854, 480), n_cols=3):

    error_msk = y_test != y_pred
    n_mis = error_msk.sum()

    x_test_mis = X_test[error_msk]
    y_test_mis = y_test[error_msk]
    y_pred_mis = y_pred[error_msk]

    n_imgs = min(n_mis, display_max)

    index_show = list(range(n_imgs))
    if random:
        index_show = np.random.choice(index_show, size=n_imgs, replace=False)

    mis_samples = x_test_mis[index_show]
    mis_labels = y_test_mis.iloc[index_show]
    mis_preds = y_pred_mis[index_show]

    n_rows = n_imgs // n_cols + 1
    fig = plt.figure(figsize=(6 * n_cols, 4.5 * n_rows))
    axs = [fig.add_subplot(n_rows, n_cols, i) for i in range(1, n_imgs + 1)]

    for i, (xi, yi, ypi, tstamp) in enumerate(zip(mis_samples, mis_labels, mis_preds, mis_labels.index)):
        ax = axs[i]
        img_reshape = np.reshape(xi, tuple(reversed(img_shape)))
        ax.imshow(img_reshape)
        ax.set(title=f'{tstamp} · True: {yi} · Predicted: {ypi}')

    plt.show()
```

Reload labeled flood videos dataset

In [7]:

```
import pandas as pd

videos = pd.read_csv('Dados/Rotulos/1475_2023-02-07.csv')

# preprocessing
videos['timestamp'] = pd.to_datetime(videos['timestamp'])
videos = videos.set_index('timestamp', drop=True).sort_index()

# drop videos larger than `video_max_bytes`
video_max_bytes = 5e6 # 5 Mb
videos = videos[videos['blob_size'] < video_max_bytes]

display(videos[['blob_name', 'tag']].head())
print(f'Shape: {videos.shape}')
```

	blob_name	tag
timestamp		
2023-02-07 19:25:00	polygons/flood-unlabeled/1/1475/CODE1475 2023-...	alagamento
2023-02-07 19:30:00	polygons/flood-unlabeled/1/1475/CODE1475 2023-...	alagamento
2023-02-07 19:35:00	polygons/flood-unlabeled/1/1475/CODE1475 2023-...	alagamento
2023-02-07 19:40:00	polygons/flood-unlabeled/1/1475/CODE1475 2023-...	alagamento
2023-02-07 19:50:00	polygons/flood-unlabeled/1/1475/CODE1475 2023-...	alagamento

```
Shape: (163, 8)
```

Video Data Preprocessing

Binarize target variable categories

In [8]:

```
replace_tags = {
    'acúmulo': ['lâmina', 'bolsão', 'alagamento'],
    'normalidade': ['poça', 'normalidade'],
}

y_true = []
for tag in videos['tag']:
    for key, values in replace_tags.items():
        if tag in values: y_true.append(key)

y_true = pd.Series(y_true, index=videos.index)

display(y_true.value_counts().to_frame('Video Samples'))
```

	Video Samples
normalidade	128
acúmulo	35

Optional · Video Data Sampling

Optional · Under sampling videos from majority class · Drop exceeding class members

In [9]:

```
from imblearn.under_sampling import RandomUnderSampler

sampling_strategy = 1.0

# Sampler instance
rus = RandomUnderSampler(sampling_strategy, random_state, replacement)
# Resample operation
x_res, y_res = rus.fit_resample(videos, y_true)

display(y_res.value_counts().to_frame('Videos Under-Sampled'))
```

```
c:\Users\luisr\anaconda3\lib\site-packages\imblearn\utils\_validation.py:587: FutureWarning: Pass sampling_strat
egy=1.0, random_state=0, replacement=False as keyword args. From version 0.9 passing these as positional argumen
ts will result in an error
  warnings.warn(
```

	Videos Under-Sampled
acúmulo	35
normalidade	35

Optional · Train and test split of video samples

In [10]:

```
from sklearn.model_selection import train_test_split

t_size = 0.25
e_size = 0.25

X, Y = x_res, y_res # pre-sampled
# X, Y = videos, y_true

xt, xe, yt, ye = train_test_split(
    X, Y, test_size=e_size, train_size=t_size,
    random_state=random_state, shuffle=True, stratify=Y
)

# complete x and y sequences
yy = pd.concat([yt, ye], axis=0)
xx = pd.concat([xt, xe], axis=0)

split_class_count(yt, ye)
display(yy.value_counts().to_frame('Complete set'))
```

	Train set	Test set
normalidade	9	9
acúmulo	8	9

	Complete set
normalidade	18
acúmulo	17

Load images and class labels from selected videos

In [12]:

```
folder = 'Dados/flood-video-collection'

XX, YY = xx, yy # pre-sampled videos dataset
# XX, YY = videos, y_true # load frames from full loaded videos dataset

videos_paths = [f'{folder}/{blob_name}'.replace(':', '-') for blob_name in XX['blob_name']]
videos_labels = YY.tolist()

video_loader = VideoLoader(dim=1)
frames, labels = video_loader.frames_from_labeled_videos(videos_paths, videos_labels, print_each=1)

print(f'\nVideos Selected: {len(XX)}')
print(f'Frames Loaded: {len(frames)}')
print(f'Length of frame first dimension: {len(frames[0])}')
print()

display(pd.Series(labels).value_counts().to_frame('Image Samples'))
```

```
CAPTURE LABELED VIDEOS · OPEN: 35/35

Videos Selected: 35
Frames Loaded: 1111
Length of frame first dimension: 409920
```

	Image Samples
normalidade	589
acúmulo	522

Image Data Sampling

Under sampling images from majority class · Drop exceeding class members

In [13]:

```
from imblearn.under_sampling import RandomUnderSampler

sampling_strategy = 1.0

rus = RandomUnderSampler(sampling_strategy, random_state, replacement)

X_res, Y_res = rus.fit_resample(frames, labels)
Y_res = pd.Series(Y_res)

display(Y_res.value_counts().to_frame('Images Under-Sampled'))
```

```
c:\Users\luisr\anaconda3\lib\site-packages\imblearn\utils\_validation.py:587: FutureWarning: Pass sampling_strat
egy=1.0, random_state=0, replacement=False as keyword args. From version 0.9 passing these as positional argumen
ts will result in an error
  warnings.warn(
```

	Images Under-Sampled
acúmulo	522
normalidade	522

Learning Curve Analysis

Train test split image samples

In [72]:

```
t_size = 0.2
e_size = 0.1

X_train, X_test, y_train, y_test = train_test_split(
    X_res, Y_res, train_size=t_size, test_size=e_size,
    random_state=random_state, shuffle=True, stratify=Y_res
)

split_class_count(y_train, y_test)
```

	Train set	Test set
normalidade	104	53
acúmulo	104	52

Increase train size iteratively · Learning Curve Plot

In [73]:

```
from sklearn.model_selection import learning_curve

curve = learning_curve(gnb, X_train, y_train,  cv=5, verbose=3, n_jobs=-1, shuffle=False)

axs = plt.plot(curve[0], curve[1])
plt.title('Learning Curve')
plt.ylabel('Accuracy')
plt.xlabel('Samples')
plt.show()
```

```
[learning_curve] Training set sizes: [ 16  53  91 128 166]

[Parallel(n_jobs=-1)]: Using backend LokyBackend with 4 concurrent workers.
[Parallel(n_jobs=-1)]: Done   8 out of  25 | elapsed:   54.6s remaining:  1.9min
[Parallel(n_jobs=-1)]: Done  17 out of  25 | elapsed:  1.2min remaining:   34.1s
[Parallel(n_jobs=-1)]: Done  25 out of  25 | elapsed:  1.5min finished
```

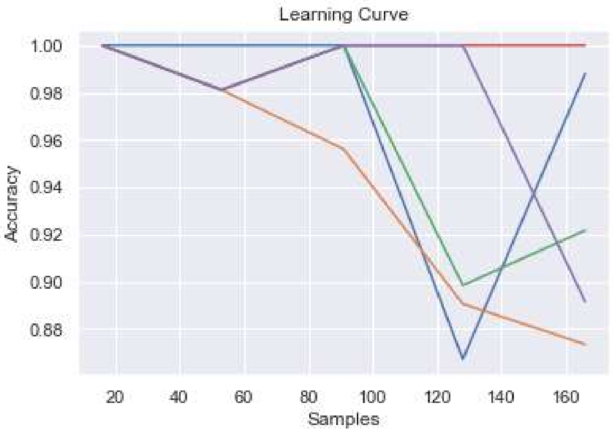


Image Classification Model Evaluation

Train and test split of image samples

In [68]:

```
t_size = 0.1
e_size = 0.6

X_train, X_test, y_train, y_test = train_test_split(
    X_res, Y_res, train_size=t_size, test_size=e_size,
    random_state=random_state, shuffle=True, stratify=Y_res
)

split_class_count(y_train, y_test)
```

	Train set	Test set
normalidade	52	314
acúmulo	52	313

Fit, predict and score base image classifier

In [69]:

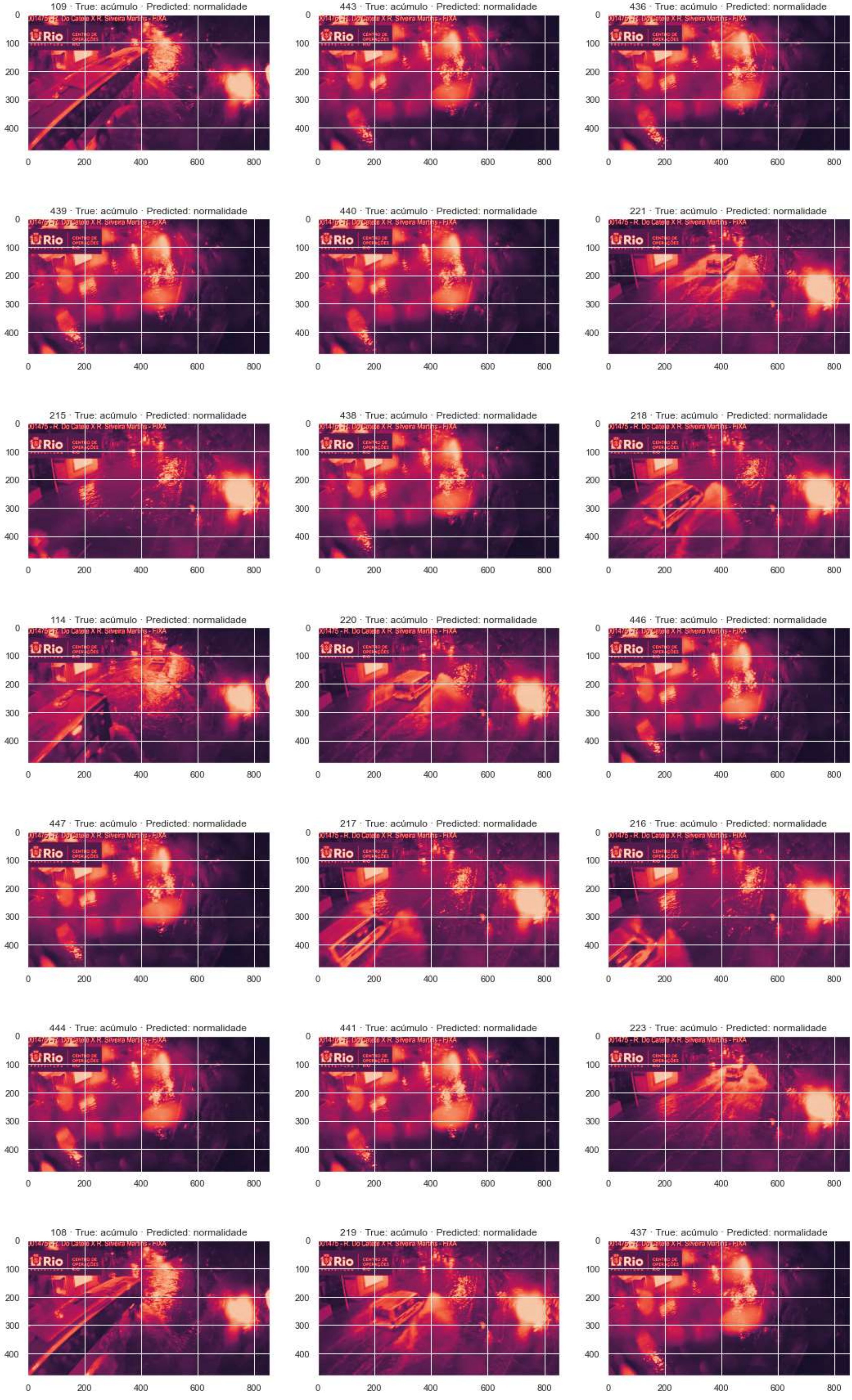
```
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import classification_report

gnb = GaussianNB()

y_pred = gnb.fit(X_train, y_train).predict(X_test)

print(
    "Number of mislabeled points out of a total of %d points : %d\n"
      % (X_test.shape[0], (y_test != y_pred).sum())
)

print(classification_report(y_test, y_pred))
```

```
Number of mislabeled points out of a total of 627 points : 22

              precision    recall  f1-score   support

     acúmulo       1.00      0.93      0.96       313
 normalidade       0.94      1.00      0.97       314

    accuracy                           0.96       627
   macro avg       0.97      0.96      0.96       627
weighted avg       0.97      0.96      0.96       627
```

Display mislabeled images

In [71]:

```
display_max = 22
random = True
n_cols = 3

display_mislabeled_images(X_test, y_test, y_pred, display_max, random, n_cols=n_cols)
```



109 · True: acúmulo · Predicted: normalidade

443 · True: acúmulo · Predicted: normalidade

436 · True: acúmulo · Predicted: normalidade

439 · True: acúmulo · Predicted: normalidade

440 · True: acúmulo · Predicted: normalidade

221 · True: acúmulo · Predicted: normalidade

215 · True: acúmulo · Predicted: normalidade

438 · True: acúmulo · Predicted: normalidade

218 · True: acúmulo · Predicted: normalidade

114 · True: acúmulo · Predicted: normalidade

220 · True: acúmulo · Predicted: normalidade

446 · True: acúmulo · Predicted: normalidade

447 · True: acúmulo · Predicted: normalidade

217 · True: acúmulo · Predicted: normalidade

216 · True: acúmulo · Predicted: normalidade

444 · True: acúmulo · Predicted: normalidade

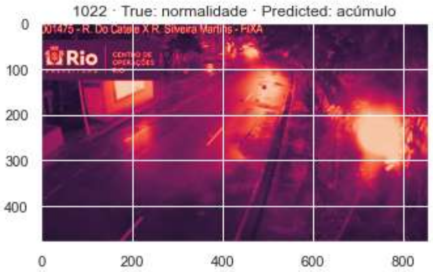
441 · True: acúmulo · Predicted: normalidade

223 · True: acúmulo · Predicted: normalidade

108 · True: acúmulo · Predicted: normalidade

219 · True: acúmulo · Predicted: normalidade

437 · True: acúmulo · Predicted: normalidade



1022 · True: normalidade · Predicted: acúmulo