In [1]:

```
import os
os.environ["TF_CPP_MIN_LOG_LEVEL"] = "2"
```

In [2]:

```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
import matplotlib.pyplot as plt
import seaborn as sns
import csv

import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
from sklearn.preprocessing import StandardScaler
from threading import Timer
from timeit import default_timer as timer
from IPython.display import clear_output
```

In [3]:

```
start = timer()
prep_dataset1 = pd.read_csv('../datasets/dataset_test_02_07.csv', delimiter="

df = prep_dataset1.iloc[:,1:4]
```

In [4]:

```
WINDOW = 35

for i in np.arange(df.shape[0]):
    init = i*WINDOW
    init2 = (i+1)*WINDOW
    if(init2<df.shape[0]):
        df.iloc[init:init+WINDOW,2] =  df.iloc[init2,2]
```

In [5]:

```
df
```

Out[5]:

	temperature	label	delay
0	19.3024	1	126.251634
1	19.1652	1	126.251634
2	19175.0000	1	126.251634
3	19.1456	1	126.251634
4	19.1652	1	126.251634
...	...	...	...
4895	19.5768	0	420.416429
4896	19.5866	0	420.416429
4897	19567.0000	0	420.416429
4898	19.5572	0	420.416429
4899	19.5572	0	420.416429

4900 rows × 3 columns

In [6]:

```
train_size = int(len(df) * 0.8)
test_size = len(df) - train_size
train, test = df.iloc[0:train_size], df.iloc[train_size:len(df)]
```

In [7]:

```
test
```

Out[7]:

	temperature	label	delay
3920	17.5678	0	1121.053927
3921	17.5776	0	1121.053927
3922	17.5776	0	1121.053927
3923	17.5776	0	1121.053927
3924	17.5776	0	1121.053927
...	...	...	...
4895	19.5768	0	420.416429
4896	19.5866	0	420.416429
4897	19567.0000	0	420.416429
4898	19.5572	0	420.416429
4899	19.5572	0	420.416429

980 rows × 3 columns

In [14]:

```
def create_dataset(X, y, time_steps=1):
    Xs, ys = [], []
    for i in range(len(X) - time_steps):
        clear_output(wait=True)
        print('modeling to keras ',round((i/(len(X) - time_steps))*100,2), ('
        s = round(timer() - start)
        if(s>60):
            s /=60
            print(' ', s, ' seconds')
        v = X.iloc[i: (i+time_steps), 2:3].to_numpy()
        Xs.append(v)
        ys.append(y.iloc[i+time_steps])
    return np.array(Xs), np.array(ys)
```

In [15]:

```
def LSTMconf(X_train):
    print('Init config LSTM')
    model = keras.Sequential()
    model.add(
        keras.layers.Bidirectional(
            keras.layers.LSTM(
                 activation="relu",
                units=512,
                input_shape=(X_train.shape[1],X_train.shape[2])
            )
        ))
    model.add(keras.layers.Dense(units=512, activation="relu"))
    model.add(keras.layers.Dense(units=512, activation="relu"))
    model.add(keras.layers.Dense(units=512, activation="relu"))
    model.add(keras.layers.Dense(units=512, activation="relu"))
    model.add(keras.layers.Dropout(rate=0.2))
    model.add(keras.layers.Dense(units=1))

    loss ="mse"
    optim = tf.keras.optimizers.Adam(
    learning_rate=0.0001)
    metrics=["accuracy"]

    model.compile(loss=loss, optimizer=optim,
#              metrics=metrics
             )
    return model
```

In [16]:

```
def LSTMfit(model,X_train,Y_train):
    print('Init Train')
    start = timer()
    history = model.fit(
        X_train, Y_train,
        epochs=256,
        batch_size= 128,
        validation_split=0.1,
        shuffle=False,
    #     callbacks=[tensorboard_callback]
    )
    return history
```

In [17]:

```
X_train,Y_train = create_dataset(train, train.delay)
model = LSTMconf(X_train)
history = LSTMfit(model,X_train, Y_train)
```

```
modeling to keras  99.97 %  16.283333333333335  seconds
Init config LSTM
Init Train
Epoch 1/256
28/28 [==============================] - 11s 98ms/step - los
s: 22761422.0000 - val_loss: 9010.7344
Epoch 2/256
28/28 [==============================] - 2s 59ms/step - loss:
5108508.5000 - val_loss: 68.6824
Epoch 3/256
28/28 [==============================] - 2s 61ms/step - loss:
2085838.1250 - val_loss: 1513.5979
Epoch 4/256
28/28 [==============================] - 2s 68ms/step - loss:
2165918.2500 - val_loss: 20.0689
Epoch 5/256
28/28 [==============================] - 2s 68ms/step - loss:
1088626.1250 - val_loss: 613.3390
Epoch 6/256
28/28 [                              ] - 2s 64ms/step - loss:
```

In [18]:

```
Y_train.shape
```

Out[18]:

```
(3919,)
```

In [19]:

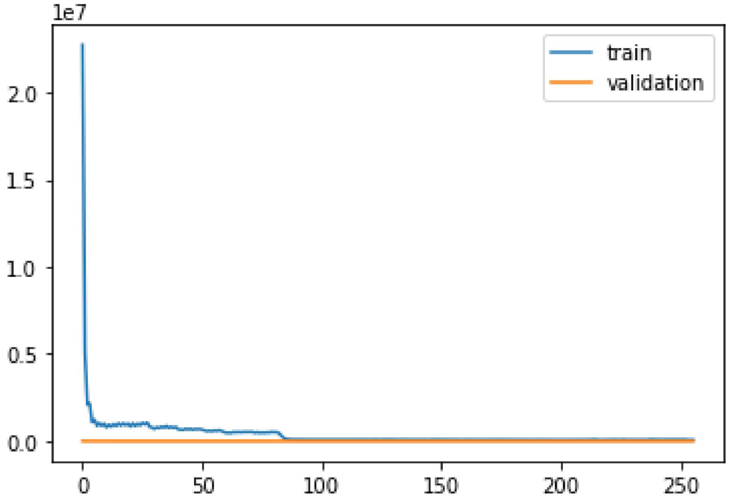
```
print('Saving Model')
model.save('models/lstm_mininet')
```

```
Saving Model
INFO:tensorflow:Assets written to: models/lstm_mininet\assets
```

loss training

In [20]:

```
fig1 = plt.figure()
ax1 = fig1.add_subplot(1,1,1)
ax1.plot(history.history['loss'], label='train')
ax1.plot(history.history['val_loss'], label='validation')
ax1.legend();
```



In [21]:

```
X_test,Y_test = create_dataset(test, test.delay)
```

```
modeling to keras  99.9 %  99.43333333333334  seconds
```

In [22]:

```
Y_test
```

Out[22]:

```
array([1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718,  140.13705254,  140.1370
5254,
```

predicting

In [23]:

```
y_pred = model.predict(X_test)
```

unormalizing

In [24]:

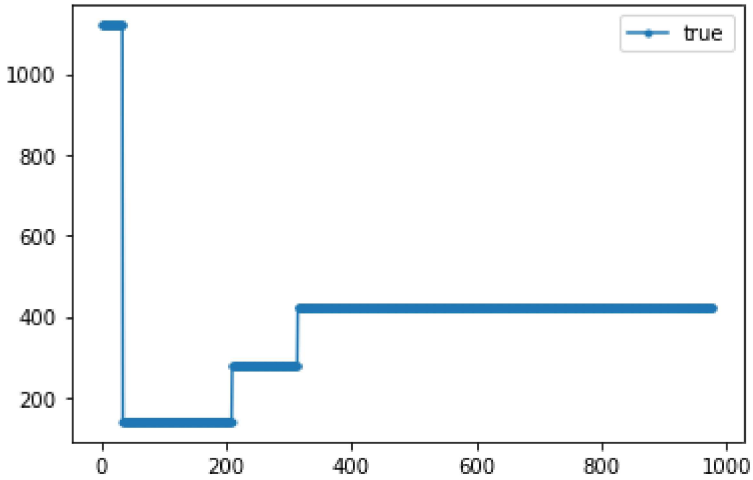
```
y_pred
```

Out[24]:

```
array([[1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
       [1110.2303 ],
```

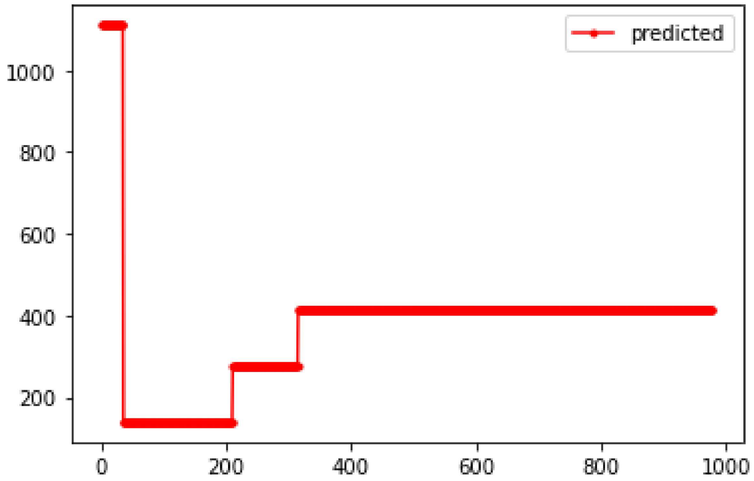
In [25]:

```
fig2 = plt.figure()
a2 = fig2.add_subplot(1,1,1)
a2.plot(Y_test, marker='.', label='true')
a2.legend();
```



In [26]:

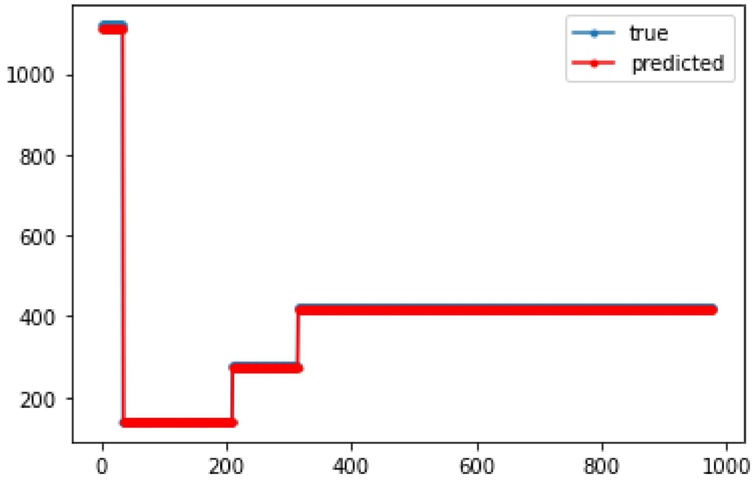
```
fig3 = plt.figure()
a3 = fig3.add_subplot(1,1,1)
a3.plot(y_pred,'r',marker='.', label='predicted')
a3.legend();
```



In [27]:

```
fig4 = plt.figure()
a4 = fig4.add_subplot(1,1,1)

a4.plot(Y_test, marker='.', label='true')
a4.plot(y_pred,'r',marker='.', label='predicted')
a4.legend();
```



In [28]:

```
from sklearn.metrics import mean_squared_error
from sklearn.metrics import median_absolute_error
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import mean_squared_log_error
from sklearn.metrics import explained_variance_score
```

In [29]:

```
size = np.min([y_pred.shape[0],Y_test.shape[0] ])
rmse =  mean_squared_error(Y_test[0:size], y_pred[0:size], squared=False)
mae =  mean_absolute_error(Y_test[0:size], y_pred[0:size])
median_mae = median_absolute_error(Y_test[0:size], y_pred[0:size])
evs = explained_variance_score(Y_test[0:size], y_pred[0:size])

print(rmse)
print(mae)
print(median_mae)
print('Explained Variance Score: ',evs)
```

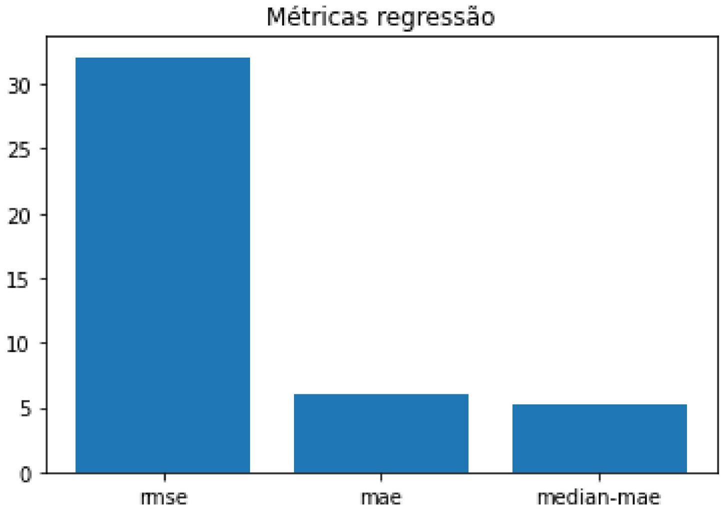
```
32.08913603003701
5.9401900188672005
5.310990810394287
Explained Variance Score:  0.967841375299376
```

In [30]:

```
objects = ('rmse', 'mae', 'median-mae')
y_pos = np.arange(3)
performance = [rmse,mae,median_mae]

plt.bar(y_pos, performance, align='center')
plt.xticks(y_pos, objects)
#plt.ylabel('Usage')
plt.title('Métricas regressão')

plt.show()
```



In [31]:

```
Y_test[0:size]
```

Out[31]:

```
array([1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718, 1121.05392718, 1121.0539
2718,
       1121.05392718, 1121.05392718,  140.13705254,  140.1370
5254,
```

In [ ]:

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