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="
# prep_dataset2 = pd.read_csv('datasets/com_concept_drift/sdn_train_unormalize
# prep_dataset3 = pd.read_csv('datasets/com_concept_drift/sdn_train_unormalize
# prep_test = pd.read_csv('datasets/com_concept_drift/sdn_test_unormalized.csv

# prep_dataset1 = prep_dataset1[prep_dataset1.delay>0]
# prep_dataset2 = prep_dataset2[prep_dataset2.delay>0]
# prep_dataset3 = prep_dataset3[prep_dataset3.delay>0]
# prep_test = prep_test[prep_test.delay>0]
df = prep_dataset1.iloc[:,1:4]
train_size = int(len(df) * 0.7)
test_size = len(df) - train_size
train, test = df.iloc[0:train_size], df.iloc[train_size:len(df)]
```

In [4]:

```
df
```

Out[4]:

	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 [5]:

```
train
```

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
...	...	...	...
3425	22.6344	1	140.133064
3426	22.6442	1	140.133064
3427	22.7128	1	140.133064
3428	22.7324	1	140.133064
3429	22.7618	1	140.133064

3430 rows × 3 columns

In [6]:

```
test
```

Out[6]:

	temperature	label	delay
3430	22752.0000	1	140.125256
3431	22.7324	1	140.125256
3432	22752.0000	1	140.125256
3433	22.7912	1	140.125256
3434	22.7716	1	140.125256
...	...	...	...
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

1470 rows × 3 columns

Normalizing

In [7]:

```
def normalizing(df):
    f_columns = ['temperature']
    scaler1 = StandardScaler().fit(df)
    scaler2 = StandardScaler().fit(df)

    scaler1= scaler1.fit(df[f_columns].to_numpy())
    scaler2 = scaler2.fit(df[['delay']])

    df.loc[:,f_columns] = scaler1.transform(df[f_columns].to_numpy())
    df['delay'] = scaler2.transform(df[['delay']])
    return df


def unormalizing(df,Y_test,y_pred ):

    scaler = StandardScaler().fit(df)
    scaler = scaler.fit(df[['delay']])
    y_test_inv = scaler.inverse_transform(Y_test.reshape(1,-1))
    y_pred_inv = scaler.inverse_transform(y_pred)

    return y_test_inv, y_pred_inv
```

In [8]:

```
def saveFile(dataset, name='dataset'):
    print('saving: ',name, '......')
    f = open(name,'w')
    try:
        writer = csv.writer(f)
        writer.writerow(dataset.columns)
        for i in np.arange(int(dataset.shape[0])):
            writer.writerow(dataset.iloc[i,])
    finally:
        f.close()


def preprocessing(dataset, order):
    print(dataset)
    saveFile(dataset, 'datasets/mininet/sdn_train_mininet_unormalized_'+str(o
    norm = normalizing(dataset)
    saveFile(norm, 'datasets/mininet/sdn_train_mininet_normalized_'+str(order

    return norm
```

In [9]:

```
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), 1:3].to_numpy()
        Xs.append(v)
        ys.append(y.iloc[i+time_steps])
    return np.array(Xs), np.array(ys)
```

In [11]:

```
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 [12]:

```
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 [13]:

```
# train = pd.read_csv('datasets/mininet/sdn_train_mininet_normalized_train.csv
# test = pd.read_csv('datasets/mininet/sdn_train_mininet_normalized_test.csv'
X_train,Y_train = create_dataset(train, train.delay)
model = LSTMconf(X_train)
history = LSTMfit(model,X_train, Y_train)

# r = Timer(1.0, preprocessing, (prep_dataset.iloc[cont:cont+window,:]))
# r.start()
# print(X_train)
```

```
s: 0.0438 - val_loss: 0.0240
Epoch 10/256
25/25 [==============================] - 1s 54ms/step - los
s: 0.0530 - val_loss: 0.0416
Epoch 11/256
25/25 [==============================] - 1s 57ms/step - los
s: 0.0424 - val_loss: 0.0224
Epoch 12/256
25/25 [==============================] - 1s 56ms/step - los
s: 0.0486 - val_loss: 0.0286
Epoch 13/256
25/25 [==============================] - 1s 52ms/step - los
s: 0.0305 - val_loss: 0.0226
Epoch 14/256
25/25 [==============================] - 1s 51ms/step - los
s: 0.0365 - val_loss: 0.0343
Epoch 15/256
25/25 [==============================] - 1s 55ms/step - los
s: 0.0249 - val_loss: 0.0199
Epoch 16/256
```

In [14]:

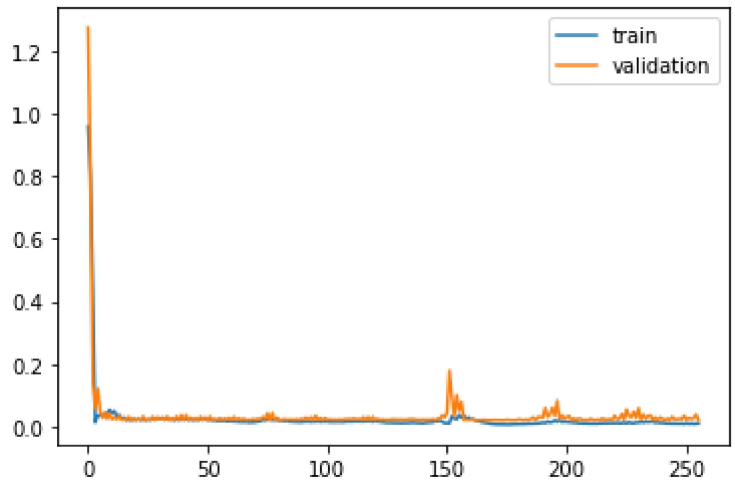
```
print('Saving Model')
model.save('models/lstm_mininet')
```

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

loss training

In [15]:

```
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 [24]:

```
# test_un = pd.read_csv('datasets/mininet/sdn_train_mininet_unormalized_test.
test = pd.read_csv('datasets/mininet/sdn_train_mininet_unormalized_test.csv',
X_test,Y_test = create_dataset(test, test.delay)
```

```
modeling to keras  99.93 %  50.4  seconds
```

predicting

In [25]:

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

unormalizing

In [26]:

```
y_test_inv, y_pred_inv = Y_test, y_pred
```

In [27]:

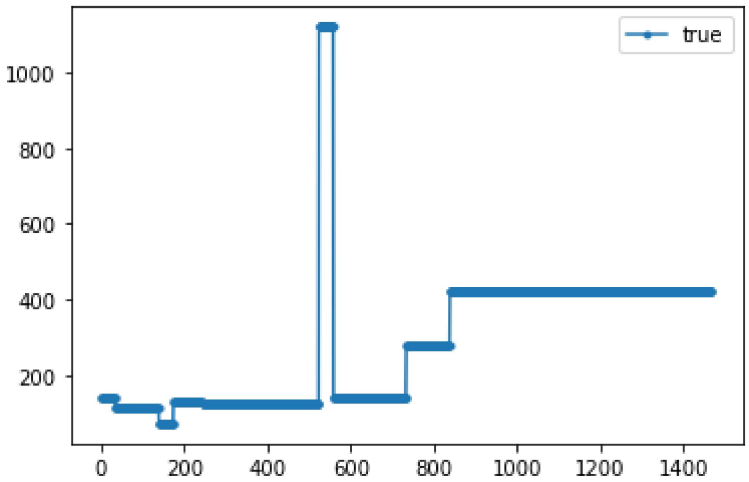
```
y_test_inv
```

Out[27]:

```
array([140.1252563 , 140.1252563 , 140.1252563 , ..., 420.41642
904,
       420.41642904, 420.41642904])
```

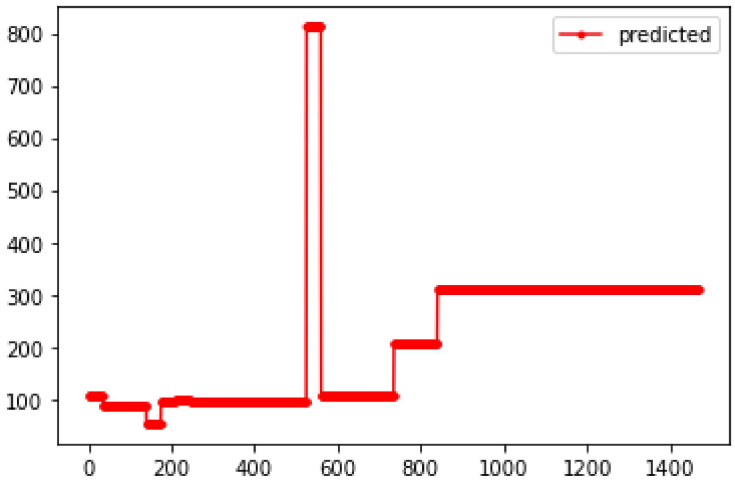
In [28]:

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



In [29]:

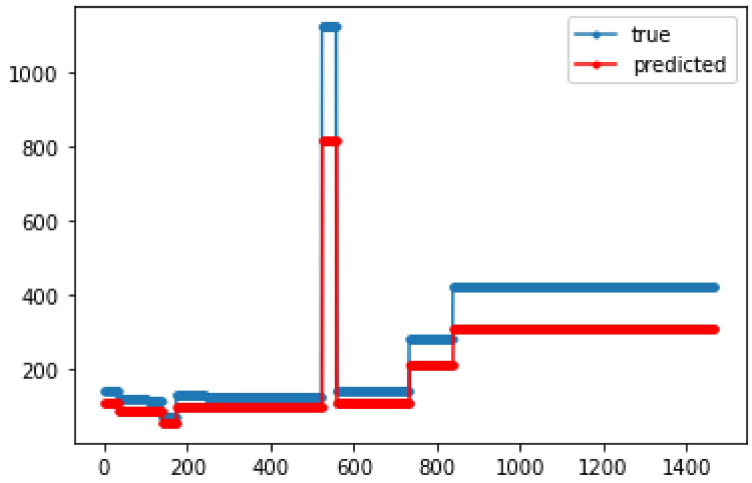
```
fig3 = plt.figure()
a3 = fig3.add_subplot(1,1,1)
a3.plot(y_pred_inv.flatten(),'r',marker='.', label='predicted')
a3.legend();
```



In [30]:

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

a4.plot(y_test_inv.flatten(), marker='.', label='true')
a4.plot(y_pred_inv.flatten(),'r',marker='.', label='predicted')
a4.legend();
```



In [34]:

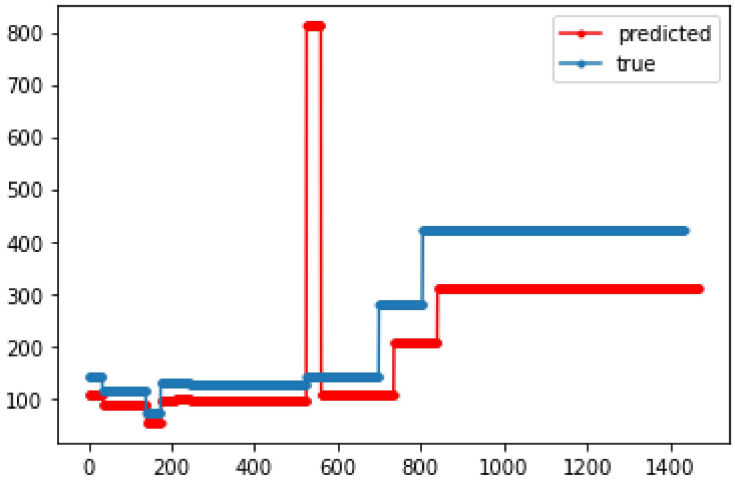
```
l1 = []
l2 = []
for i in np.arange(y_pred_inv.shape[0]):
    clear_output(wait=True)
    print('progress ',round((i/y_pred_inv.shape[0])*100,2), ('%'))
    if(y_pred_inv[i,0]<=1000):
        l1.append(y_pred_inv[i,0])
    if(y_test_inv[i]<=1000):
        l2.append(y_test_inv[i])

y_pred_inv2 = np.array(l1)
y_test_inv2 = np.array(l2)
```

```
progress  99.93 %
```

In [35]:

```
plt.plot(y_pred_inv2.flatten(),'r',marker='.', label='predicted')
plt.plot(y_test_inv2.flatten(), marker='.', label='true')
plt.legend();
```



In [36]:

```
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
```

In [37]:

```
size = np.min([y_pred_inv2.shape[0],y_test_inv2.shape[0] ])
rmse =  mean_squared_error(y_test_inv2[0:size], y_pred_inv2[0:size], squared=
mae =  mean_absolute_error(y_test_inv2[0:size], y_pred_inv2[0:size])
median_mae = median_absolute_error(y_test_inv2[0:size], y_pred_inv2[0:size])


print(rmse)
print(mae)
print(median_mae)
```

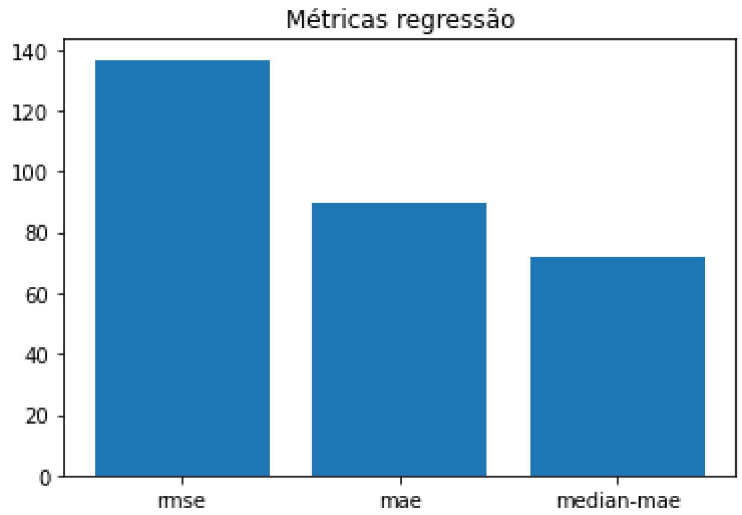
```
136.69494769389846
89.4805688520522
72.063731431961
```

In [38]:

```
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 [39]:

```
from sklearn.metrics import explained_variance_score
```

In [40]:

```
explained_variance_score(y_test_inv2[0:size], y_pred_inv2[0:size])
```

Out[40]:

```
0.23349145442842323
```

In [41]:

```
y_test_inv2[0:size]
```

Out[41]:

```
array([140.1252563 , 140.1252563 , 140.1252563 , ..., 420.41642
904,
       420.41642904, 420.41642904])
```

In [ ]:

In [ ]:

In [ ]: