In […

```
import pandas as pd
#import tensorflow #as tf
#from tensorflow import keras
#from tensorflow.keras import layers
#import keras_tuner as kt
#from tensorflow.keras import layers


import os

#from keras import backend as K

#from keras.utils.vis_utils import plot_model

#import pickle
```

In […

```
#import it from the notebook
import import_ipynb


#import the .ipynb notebook as if it was a .py file
#file cc_fi_fcts_1 contains all the functions
#for creating and analyzing a DL NN
#model 1 where a distinct dataframe is considered
#per Origin Node
#import cc_fi_fcts_1
from cc_fi_fcts_1 import *

#import the file with the NN model
#import cc_fi_models_1
from cc_fi_models_1 import *

#import the with the input variables
#import cc_fi_input_variables
from cc_fi_input_variables import *
```

```
importing Jupyter notebook from cc_fi_fcts_1.ipynb
```

```
2023-07-18 21:25:36.453977: I tensorflow/core/platfo
rm/cpu_feature_guard.cc:193] This TensorFlow binary
is optimized with oneAPI Deep Neural Network Library
(oneDNN) to use the following CPU instructions in pe
rformance-critical operations:  AVX2 FMA
To enable them in other operations, rebuild TensorFl
ow with the appropriate compiler flags.
```

```
importing Jupyter notebook from cc_fi_models_1.ipynb
importing Jupyter notebook from cc_fi_input_variable
s.ipynb
```

In […

In […

```
# we obtain the results of the desired DL NN model de
di_best_trained_models,di_hist_when_search_best_epoch
di_hist_retrained_best_model,di_results_model_eval_te
va_test_dataset,va_mean_value_train_dataset,va_std_tr
va_id_first_future_observation,va_li_true_vals_test_s
va_name_figure_folder_metric,va_name_figure_metric=\
fct_best_approaches(
v_dataframe=val_dataframe,
v_s_stride=val_s_stride,
v_b_size=val_batch_size,
v_folder_figures=val_folder_figures,
v_nb_past_seq_lengths=val_nb_past_seq_lengths,
v_nb_future_seq_lengths=val_nb_future_seq_lengths,
v_s_length_train_model=val_s_length_train_model,
v_s_length_target=val_s_length_target,
v_name_col_origin=val_name_col_origin,
v_li_name_col_to_copy=val_li_name_col_to_copy,
v_name_column_date=val_name_column_date,
v_name_col_2_sort=val_name_col_2_sort,
v_name_target_variable=val_name_target_variable,
v_li_cols_to_ignore=val_li_cols_to_ignore,
v_proportion_train_set=val_proportion_train_set,
v_proportion_val_set=val_proportion_val_set,
v_name_fig=val_name_fig,
v_shuffle_tr_s=val_shuffle_tr_s,
v_shuffle_tr_t=val_shuffle_tr_t,
v_shuffle_v_s=val_shuffle_v_s,
v_shuffle_v_t=val_shuffle_v_t,
```

```
v_shuffle_t_s=val_shuffle_t_s,
v_shuffle_t_t=val_shuffle_t_t,
v_di_hypermodels=val_di_hypermodels,
v_key_hypermodel_class=val_key_hypermodel_class,
v_min_nb_lay_model=val_min_nb_lay_model,
v_max_nb_lay_model=val_max_nb_lay_model,
v_min_nb_units_model=val_min_nb_units_model,
v_max_nb_units_model=val_max_nb_units_model,
v_min_value_dropout_rate_model=val_min_value_dropout_
v_max_value_dropout_rate_model=val_max_value_dropout_
v_min_value_recurrent_dropout_rate_model=val_min_valu
v_max_value_recurrent_dropout_rate_model=val_max_valu
v_min_nb_filters_conv1d=val_min_nb_filters_conv1d,
v_max_nb_filters_conv1d=val_max_nb_filters_conv1d,
v_min_nb_kernel_size_conv1d=val_min_nb_kernel_size_cc
v_max_nb_kernel_size_conv1d=val_max_nb_kernel_size_cc
v_step_nb_kernel_size_conv1d=val_step_nb_kernel_size_
v_step_nb_layers_model=val_step_nb_layers_model,
v_step_nb_units_model=val_step_nb_units_model,
v_step_dropout_rate_model=val_step_dropout_rate_model
v_step_recurrent_dropout_rate_model=val_step_recurrer
v_min_pool_size=val_min_pool_size,
v_max_pool_size=val_max_pool_size,
v_step_pool_size=val_step_pool_size,
v_li_activ_fcts_model=val_li_activ_fcts_model,
v_li_optimizers_model=val_li_optimizers_model,
v_min_val_learning_rate_optimizer=\
val_min_val_learning_rate_optimizer,
v_max_val_learning_rate_optimizer=\
val_max_val_learning_rate_optimizer,
v_loss_fct_model=val_loss_fct_model,
v_metrics_model=val_metrics_model,
v_di_tuners=val_di_tuners,
v_key_tuner_class=val_key_tuner_class,
v_objective_metric_for_tuner_to_optimize=\
val_objective_metric_for_tuner_to_optimize,
v_mode=val_mode,
v_max_trials=val_max_trials,
v_executions_per_trial=val_executions_per_trial,
v_directory=val_directory,
v_metric_for_tuner_search_hp_callback=\
```

```
val_metric_for_tuner_search_hp_callback,
v_li_keys_tuners_optimizing_batch_size=\
val_li_keys_tuners_optimizing_batch_size,
v_epochs_tuner_search=val_epochs_tuner_search,
v_top_best_models=val_top_best_models,
v_batch_size=val_batch_size,
v_to_multiply_epoch_for_train_dur=\
val_to_multiply_epoch_for_train_dur,
v_metric_to_monitor_best_epoch_callbacks=\
val_metric_to_monitor_best_epoch_callbacks,
v_epochs_best_trained_model_search=\
val_epochs_best_trained_model_search,
v_overwrite=val_overwrite,
v_patience_during_tuner_search=\
val_patience_during_tuner_search,
v_verbose=val_verbose,
v_mode_callbacks=val_mode_callbacks,
v_patience_best_epoch_callbacks=\
val_patience_best_epoch_callbacks,
v_pkl_filename_best_model=\
val_pkl_filename_best_model,
v_pkl_filename_best_retrained_model=\
val_pkl_filename_best_retrained_model
)
```

```
Trial 4 Complete [15h 48m 56s]
val_mae: 22.441584587097168

Best val_mae So Far: 20.928422927856445
Total elapsed time: 1d 11h 50m 57s
INFO:tensorflow:Oracle triggered exit

Results summary
Results in flight_del_kt_test/untitled_project
Showing 10 best trials
Objective(name="val_mae", direction="min")

Trial 0 summary
Hyperparameters:
num_layers: 2
dropout_rate: 0.31008423753803815
```

```
rec_droput_lay: 0.454881344524269
activation: elu
layernorm_0: False
units_lay_0: 16
optimizer: rmsprop
loss: mse
lr: 0.00016814562004619342
layernorm_1: False
units_lay_1: 14
Score: 20.928422927856445

Trial 2 summary
Hyperparameters:
num_layers: 2
dropout_rate: 0.3574500857093269
rec_droput_lay: 0.4771283741112904
activation: selu
layernorm_0: False
units_lay_0: 14
optimizer: adagrad
loss: mse
lr: 0.008823370006991712
layernorm_1: True
units_lay_1: 17
Score: 21.571489334106445

Trial 3 summary
Hyperparameters:
num_layers: 2
dropout_rate: 0.4072660285278066
rec_droput_lay: 0.10921825499217097
activation: selu
layernorm_0: True
units_lay_0: 17
optimizer: adagrad
loss: mse
lr: 0.003979208380153469
layernorm_1: False
units_lay_1: 17
Score: 22.441584587097168
```

```
Trial 1 summary
Hyperparameters:
num_layers: 1
dropout_rate: 0.46812654741660886
rec_droput_lay: 0.39520560350313916
activation: tanh
layernorm_0: True
units_lay_0: 14
optimizer: rmsprop
loss: mse
lr: 0.00828879749889784
layernorm_1: True
units_lay_1: 15
Score: 24.60400091552734
Results Summary of the tuner None

IN FCT fct_search_best_model_using_tuner,    END TUN
ER SEARCH FOR FINDING BEST MODEL

In FCT fct_search_best_model_using_tuner,    val_top
_best_models 2


IN FCT fct_search_best_model_using_tuner,        hyp
erparameter number: 1
IN FCT fct_search_best_model_using_tunerr,        we
will search for the best trained model THAT IS THE B
EST EPOCH        AND RETRAIN THE BEST  MODEL using f
unction         get_best_trained_model
WE START FCT BEST_TRAINED_MODEL BY SEARCHING BEST EP
OCH
 IN FCT BEST_EPOCH, WE START SEARCH BEST EPOCH FOR H
P
In fct best_epoch, va_metric_to_monitor_best_epoch_c
allbacks val_loss

Epoch 1/20
713/713 [==============================] - 976s 1s/s
tep - loss: 1555.7960 - mae: 21.8737 - val_loss: 143
7.9640 - val_mae: 20.8990
Epoch 2/20
```

```
713/713 [==============================] - 940s 1s/s
tep - loss: 1540.8658 - mae: 22.0154 - val_loss: 143
5.6854 - val_mae: 21.7583
Epoch 3/20
713/713 [==============================] - 922s 1s/s
tep - loss: 1535.5591 - mae: 22.3673 - val_loss: 143
7.4653 - val_mae: 21.9406
Epoch 4/20
713/713 [==============================] - 946s 1s/s
tep - loss: 1533.4617 - mae: 22.4858 - val_loss: 144
0.5483 - val_mae: 22.2354
Epoch 5/20
713/713 [==============================] - 925s 1s/s
tep - loss: 1533.2227 - mae: 22.5477 - val_loss: 144
1.4502 - val_mae: 22.3233
Epoch 6/20
713/713 [==============================] - 921s 1s/s
tep - loss: 1532.2267 - mae: 22.5410 - val_loss: 144
1.6119 - val_mae: 22.3688
Epoch 7/20
713/713 [==============================] - 920s 1s/s
tep - loss: 1531.2819 - mae: 22.5629 - val_loss: 144
1.1978 - val_mae: 22.3728
Epoch 8/20
713/713 [==============================] - 926s 1s/s
tep - loss: 1530.6592 - mae: 22.5771 - val_loss: 144
1.4233 - val_mae: 22.3972
Epoch 9/20
713/713 [==============================] - 921s 1s/s
tep - loss: 1529.9683 - mae: 22.5927 - val_loss: 144
1.4559 - val_mae: 22.3933
Epoch 10/20
713/713 [==============================] - 920s 1s/s
tep - loss: 1529.2083 - mae: 22.5925 - val_loss: 144
2.1801 - val_mae: 22.4547
Epoch 11/20
713/713 [==============================] - 919s 1s/s
tep - loss: 1529.2909 - mae: 22.5938 - val_loss: 144
1.6553 - val_mae: 22.4188
Epoch 12/20
713/713 [==============================] - 924s 1s/s
```

```
tep - loss: 1528.5908 - mae: 22.5760 - val_loss: 144
2.7809 - val_mae: 22.4675
In fct best_epoch, val_loss_per_epoch-result history
: [1437.9639892578125, 1435.6854248046875, 1437.4653
3203125, 1440.54833984375, 1441.4501953125, 1441.611
9384765625, 1441.19775390625, 1441.42333984375, 1441
.4559326171875, 1442.1800537109375, 1441.6552734375,
1442.7808837890625]

Best epoch: 2

END FCT BEST EPOCH
Keras weights file (<HDF5 file "variables.h5" (mode
r+)>) saving:
...layers
......bidirectional
.........backward_layer
............cell
................vars
....................0
....................1
....................2
............vars
.........forward_layer
............cell
................vars
....................0
....................1
....................2
............vars
.........layer
............cell
................vars
............vars
.........vars
......bidirectional_1
.........backward_layer
............cell
................vars
....................0
....................1
```

```
.................2
...........vars
.........forward_layer
...........cell
.............vars
.................0
.................1
.................2
...........vars
.........layer
...........cell
.............vars
...........vars
.........vars
......dense
.........vars
...........0
...........1
......dropout
.........vars
......input_layer
.........vars
...optimizer
......vars
.........0
...vars
Keras model archive saving:
File Name
Modified             Size
config.json                                    2023-
07-20 12:22:42         3625
metadata.json                                  2023-
07-20 12:22:42           64
variables.h5                                   2023-
07-20 12:22:42       196864
IN FCT BEST_TRAINED MODEL         WE CREATED MODEL W
ITH BEST HP - WE WILL START RETRAIN IT        FOR A
LITTLE LONGER THAN THE BEST NUMBER OF EPOCHS
IN TRAIN+VAL SET
Epoch 1/3
1065/1065 [==============================] - 1249s 1
```

```
s/step - loss: 1516.2489 - mae: 21.6224
Epoch 2/3
1065/1065 [==============================] - 1228s 1
s/step - loss: 1502.3074 - mae: 22.0502
Epoch 3/3
1065/1065 [==============================] - 1226s 1
s/step - loss: 1498.7479 - mae: 22.1734
Keras weights file (<HDF5 file "variables.h5" (mode
r+)>) saving:
...layers
......bidirectional
.........backward_layer
............cell
..............vars
................0
................1
................2
............vars
.........forward_layer
............cell
..............vars
................0
................1
................2
............vars
.........layer
............cell
..............vars
............vars
.........vars
......bidirectional_1
.........backward_layer
............cell
..............vars
................0
................1
................2
............vars
.........forward_layer
............cell
..............vars
```

```
.................0
.................1
.................2
...........vars
.........layer
...........cell
.............vars
...........vars
.........vars
......dense
.........vars
...........0
...........1
......dropout
.........vars
......input_layer
.........vars
...metrics
......mean
.........vars
...........0
...........1
......mean_metric_wrapper
.........vars
...........0
...........1
...optimizer
......vars
.........0
.........1
.........10
.........11
.........12
.........13
.........14
.........2
.........3
.........4
.........5
.........6
.........7
```

```
.........8
.........9
...vars
Keras model archive saving:
File Name                                             
Modified             Size
config.json                                           2023-
07-20 13:24:25         3625
metadata.json                                         2023-
07-20 13:24:25           64
variables.h5                                          2023-
07-20 13:24:25       365048
IN FCT BEST_TRAINED_MODEL END RETRAINED MODEL-END FC
T
352/352 [==============================] - 95s 265ms
/step - loss: 1144.8755 - mae: 21.7100

IN FCT fct_search_best_model_using_tuner,        hyp
erparameter number: 2
IN FCT fct_search_best_model_using_tunerr,        we
will search for the best trained model THAT IS THE B
EST EPOCH        AND RETRAIN THE BEST  MODEL using f
unction         get_best_trained_model
WE START FCT BEST_TRAINED_MODEL BY SEARCHING BEST EP
OCH
 IN FCT BEST_EPOCH, WE START SEARCH BEST EPOCH FOR H
P
In fct best_epoch, va_metric_to_monitor_best_epoch_c
allbacks val_loss

Epoch 1/20
713/713 [==============================] - 904s 1s/s
tep - loss: 1545.8668 - mae: 21.9632 - val_loss: 143
8.2744 - val_mae: 21.9693
Epoch 2/20
713/713 [==============================] - 894s 1s/s
tep - loss: 1530.1785 - mae: 22.2765 - val_loss: 143
6.5897 - val_mae: 22.4373
Epoch 3/20
713/713 [==============================] - 903s 1s/s
tep - loss: 1523.0260 - mae: 22.4134 - val_loss: 143
```

```
6.6711 - val_mae: 22.7115
Epoch 4/20
713/713 [==============================] - 894s 1s/s
tep - loss: 1518.6697 - mae: 22.4774 - val_loss: 143
6.2362 - val_mae: 22.8508
Epoch 5/20
713/713 [==============================] - 897s 1s/s
tep - loss: 1515.8210 - mae: 22.5270 - val_loss: 143
4.7886 - val_mae: 22.9052
Epoch 6/20
713/713 [==============================] - 897s 1s/s
tep - loss: 1513.8279 - mae: 22.5681 - val_loss: 143
4.4686 - val_mae: 22.9504
Epoch 7/20
713/713 [==============================] - 916s 1s/s
tep - loss: 1512.0194 - mae: 22.5690 - val_loss: 143
2.9341 - val_mae: 22.9405
Epoch 8/20
713/713 [==============================] - 901s 1s/s
tep - loss: 1510.4321 - mae: 22.5893 - val_loss: 143
0.9689 - val_mae: 22.8958
Epoch 9/20
713/713 [==============================] - 901s 1s/s
tep - loss: 1509.1486 - mae: 22.6134 - val_loss: 143
0.4701 - val_mae: 22.9155
Epoch 10/20
713/713 [==============================] - 902s 1s/s
tep - loss: 1507.7576 - mae: 22.6059 - val_loss: 142
9.0372 - val_mae: 22.8864
Epoch 11/20
713/713 [==============================] - 897s 1s/s
tep - loss: 1506.4055 - mae: 22.6128 - val_loss: 142
7.3822 - val_mae: 22.8489
Epoch 12/20
713/713 [==============================] - 898s 1s/s
tep - loss: 1504.9724 - mae: 22.6041 - val_loss: 142
6.9685 - val_mae: 22.8828
Epoch 13/20
713/713 [==============================] - 902s 1s/s
tep - loss: 1503.7133 - mae: 22.5952 - val_loss: 142
6.7170 - val_mae: 22.9088
```

```
Epoch 14/20
713/713 [==============================] - 902s 1s/s
tep - loss: 1502.3925 - mae: 22.5885 - val_loss: 142
5.4078 - val_mae: 22.8817
Epoch 15/20
713/713 [==============================] - 902s 1s/s
tep - loss: 1501.2581 - mae: 22.5866 - val_loss: 142
5.1101 - val_mae: 22.8973
Epoch 16/20
713/713 [==============================] - 903s 1s/s
tep - loss: 1500.1613 - mae: 22.5769 - val_loss: 142
4.3837 - val_mae: 22.8864
Epoch 17/20
713/713 [==============================] - 1019s 1s/
step - loss: 1499.1193 - mae: 22.5808 - val_loss: 14
24.3827 - val_mae: 22.9093
Epoch 18/20
713/713 [==============================] - 1013s 1s/
step - loss: 1498.2830 - mae: 22.5779 - val_loss: 14
23.5809 - val_mae: 22.8875
Epoch 19/20
713/713 [==============================] - 951s 1s/s
tep - loss: 1497.4626 - mae: 22.5797 - val_loss: 142
3.4351 - val_mae: 22.9029
Epoch 20/20
713/713 [==============================] - 955s 1s/s
tep - loss: 1496.6838 - mae: 22.5808 - val_loss: 142
2.8494 - val_mae: 22.8842
In fct best_epoch, val_loss_per_epoch-result history
: [1438.2744140625, 1436.5897216796875, 1436.6711425
78125, 1436.2362060546875, 1434.78857421875, 1434.46
86279296875, 1432.93408203125, 1430.9688720703125, 1
430.4700927734375, 1429.0372314453125, 1427.38220214
84375, 1426.968505859375, 1426.717041015625, 1425.40
78369140625, 1425.110107421875, 1424.3836669921875,
1424.3826904296875, 1423.5809326171875, 1423.4350585
9375, 1422.849365234375]

Best epoch: 20

END FCT BEST EPOCH
```

```
Keras weights file (<HDF5 file "variables.h5" (mode
r+)>) saving:
...layers
......activation
.........vars
......bidirectional
.........backward_layer
............cell
...............vars
..................0
..................1
..................2
............vars
.........forward_layer
............cell
...............vars
..................0
..................1
..................2
............vars
.........layer
............cell
...............vars
............vars
.........vars
......bidirectional_1
.........backward_layer
............cell
...............vars
..................0
..................1
............vars
.........forward_layer
............cell
...............vars
..................0
..................1
............vars
.........layer
............cell
...............vars
```

```
............vars
.........vars
......dense
.........vars
............0
............1
......dropout
.........vars
......input_layer
.........vars
......layer_normalization
.........vars
............0
............1
...optimizer
......vars
.........0
...vars
Keras model archive saving:
File Name                                                 
Modified             Size                                 
config.json                                             2023-
07-20 18:31:53         4326                               
metadata.json                                           2023-
07-20 18:31:53           64                               
variables.h5                                            2023-
07-20 18:31:53       228200                               
IN FCT BEST_TRAINED MODEL         WE CREATED MODEL W
ITH BEST HP - WE WILL START RETRAIN IT        FOR A
LITTLE LONGER THAN THE BEST NUMBER OF EPOCHS
IN TRAIN+VAL SET
Epoch 1/30
1065/1065 [==============================] - 1276s 1
s/step - loss: 1507.7472 - mae: 21.7370
Epoch 2/30
1065/1065 [==============================] - 1239s 1
s/step - loss: 1495.1146 - mae: 21.9503
Epoch 3/30
1065/1065 [==============================] - 1255s 1
s/step - loss: 1488.6709 - mae: 22.0101
Epoch 4/30
```

```
1065/1065 [==============================] - 1273s 1
s/step - loss: 1484.2726 - mae: 22.0340
Epoch 5/30
1065/1065 [==============================] - 1243s 1
s/step - loss: 1481.0940 - mae: 22.0421
Epoch 6/30
1065/1065 [==============================] - 1229s 1
s/step - loss: 1478.3207 - mae: 22.0433
Epoch 7/30
1065/1065 [==============================] - 1235s 1
s/step - loss: 1475.9481 - mae: 22.0432
Epoch 8/30
1065/1065 [==============================] - 1282s 1
s/step - loss: 1474.4222 - mae: 22.0525
Epoch 9/30
1065/1065 [==============================] - 1313s 1
s/step - loss: 1473.0707 - mae: 22.0564
Epoch 10/30
1065/1065 [==============================] - 1267s 1
s/step - loss: 1471.9512 - mae: 22.0555
Epoch 11/30
1065/1065 [==============================] - 1263s 1
s/step - loss: 1470.9303 - mae: 22.0546
Epoch 12/30
1065/1065 [==============================] - 1322s 1
s/step - loss: 1469.9135 - mae: 22.0538
Epoch 13/30
1065/1065 [==============================] - 1240s 1
s/step - loss: 1469.0112 - mae: 22.0522
Epoch 14/30
1065/1065 [==============================] - 1264s 1
s/step - loss: 1468.1913 - mae: 22.0500
Epoch 15/30
1065/1065 [==============================] - 1277s 1
s/step - loss: 1467.4292 - mae: 22.0464
Epoch 16/30
1065/1065 [==============================] - 1260s 1
s/step - loss: 1466.6146 - mae: 22.0425
Epoch 17/30
1065/1065 [==============================] - 1243s 1
s/step - loss: 1465.8903 - mae: 22.0399
```

```
Epoch 18/30
1065/1065 [==============================] - 1249s 1
s/step - loss: 1465.1477 - mae: 22.0364
Epoch 19/30
1065/1065 [==============================] - 1250s 1
s/step - loss: 1464.5457 - mae: 22.0352
Epoch 20/30
1065/1065 [==============================] - 1234s 1
s/step - loss: 1463.9800 - mae: 22.0355
Epoch 21/30
1065/1065 [==============================] - 1212s 1
s/step - loss: 1463.4108 - mae: 22.0341
Epoch 22/30
1065/1065 [==============================] - 1216s 1
s/step - loss: 1462.9872 - mae: 22.0324
Epoch 23/30
1065/1065 [==============================] - 1213s 1
s/step - loss: 1462.4413 - mae: 22.0333
Epoch 24/30
1065/1065 [==============================] - 1212s 1
s/step - loss: 1462.0013 - mae: 22.0339
Epoch 25/30
1065/1065 [==============================] - 1214s 1
s/step - loss: 1461.6532 - mae: 22.0360
Epoch 26/30
1065/1065 [==============================] - 1215s 1
s/step - loss: 1461.1305 - mae: 22.0361
Epoch 27/30
1065/1065 [==============================] - 1212s 1
s/step - loss: 1460.7615 - mae: 22.0376
Epoch 28/30
1065/1065 [==============================] - 1215s 1
s/step - loss: 1460.4094 - mae: 22.0363
Epoch 29/30
1065/1065 [==============================] - 1212s 1
s/step - loss: 1460.0510 - mae: 22.0387
Epoch 30/30
1065/1065 [==============================] - 1212s 1
s/step - loss: 1459.7672 - mae: 22.0406
Keras weights file (<HDF5 file "variables.h5" (mode
r+)>) saving:
```

```
...layers
......activation
.........vars
......bidirectional
.........backward_layer
............cell
..............vars
................0
................1
................2
............vars
.........forward_layer
............cell
..............vars
................0
................1
................2
............vars
.........layer
............cell
..............vars
............vars
.........vars
......bidirectional_1
.........backward_layer
............cell
..............vars
................0
................1
............vars
.........forward_layer
............cell
..............vars
................0
................1
............vars
.........layer
............cell
..............vars
............vars
.........vars
```

```
......dense
.........vars
............0
............1
......dropout
.........vars
......input_layer
.........vars
......layer_normalization
.........vars
............0
............1
...metrics
......mean
.........vars
............0
............1
......mean_metric_wrapper
.........vars
............0
............1
...optimizer
......vars
.........0
.........1
.........10
.........11
.........12
.........13
.........14
.........2
.........3
.........4
.........5
.........6
.........7
.........8
.........9
...vars
Keras model archive saving:
File Name
```

```
Modified              Size
config.json                                     2023-
07-21 04:54:19         4326
metadata.json                                   2023-
07-21 04:54:19           64
variables.h5                                    2023-
07-21 04:54:19       422792
IN FCT BEST_TRAINED_MODEL END RETRAINED MODEL-END FC
T
352/352 [==============================] - 96s 263ms
/step - loss: 1076.2997 - mae: 19.4214

Search Best Epoch For Best retrained model : 1
metric loss
values per epoch: [1555.7960205078125, 1540.86584472
65625, 1535.55908203125, 1533.461669921875, 1533.222
65625, 1532.2266845703125, 1531.2818603515625, 1530.
6591796875, 1529.96826171875, 1529.208251953125, 152
9.2908935546875, 1528.5908203125]
metric mae
values per epoch: [21.873729705810547, 22.0154495239
2578, 22.367259979248047, 22.485843658447266, 22.547
748565673828, 22.540990829467773, 22.562877655029297
, 22.5771484375, 22.592655181884766, 22.592470169067
383, 22.593780517578125, 22.576021194458008]
metric val_loss
values per epoch: [1437.9639892578125, 1435.68542480
46875, 1437.46533203125, 1440.54833984375, 1441.4501
953125, 1441.6119384765625, 1441.19775390625, 1441.4
2333984375, 1441.4559326171875, 1442.1800537109375,
1441.6552734375, 1442.7808837890625]
metric val_mae
values per epoch: [20.898969650268555, 21.7583427429
19922, 21.940574645996094, 22.23537254333496, 22.323
270797729492, 22.368799209594727, 22.372774124145508
, 22.397239685058594, 22.393299102783203, 22.4546699
52392578, 22.418787002563477, 22.46745491027832]

Search Best Epoch For Best retrained model : 2
metric loss
values per epoch: [1545.8668212890625, 1530.17846679
```

```
6875, 1523.0260009765625, 1518.669677734375, 1515.82
1044921875, 1513.827880859375, 1512.0194091796875, 1
510.43212890625, 1509.1485595703125, 1507.7575683593
75, 1506.405517578125, 1504.972412109375, 1503.71325
68359375, 1502.3924560546875, 1501.258056640625, 150
0.1612548828125, 1499.1192626953125, 1498.2829589843
75, 1497.462646484375, 1496.683837890625]
metric mae
values per epoch: [21.963159561157227, 22.2764720916
74805, 22.413381576538086, 22.477426528930664, 22.52
7019500732422, 22.568069458007812, 22.56903839111328
, 22.589258193969727, 22.613401412963867, 22.6058521
27075195, 22.612802505493164, 22.604114532470703, 22
.595211029052734, 22.588499069213867, 22.58658790588
379, 22.576948165893555, 22.580760955810547, 22.5779
17098999023, 22.5797176361084, 22.58080291748047]
metric val_loss
values per epoch: [1438.2744140625, 1436.58972167968
75, 1436.671142578125, 1436.2362060546875, 1434.7885
7421875, 1434.4686279296875, 1432.93408203125, 1430.
9688720703125, 1430.4700927734375, 1429.037231445312
5, 1427.3822021484375, 1426.968505859375, 1426.71704
1015625, 1425.4078369140625, 1425.110107421875, 1424
.3836669921875, 1424.3826904296875, 1423.58093261718
75, 1423.43505859375, 1422.849365234375]
metric val_mae
values per epoch: [21.969274520874023, 22.4372711181
64062, 22.71146011352539, 22.850833892822266, 22.905
237197875977, 22.950393676757812, 22.94051170349121,
22.89582061767578, 22.91550064086914, 22.88643646240
2344, 22.84886932373047, 22.88275718688965, 22.90884
3994140625, 22.881675720214844, 22.897340774536133,
22.88644790649414, 22.909271240234375, 22.8875389099
1211, 22.90294075012207, 22.884180068969727]

Evaluation Best retrained model : 1
metric loss
values per epoch: [1516.2489013671875, 1502.30737304
6875, 1498.7479248046875]
metric mae
values per epoch: [21.622386932373047, 22.0501956939
```

```
69727, 22.173418045043945]

Evaluation Best retrained model : 2
metric loss
values per epoch: [1507.7471923828125, 1495.11462402
34375, 1488.6708984375, 1484.2725830078125, 1481.093
994140625, 1478.3206787109375, 1475.9481201171875, 1
474.4222412109375, 1473.0706787109375, 1471.95117187
5, 1470.9302978515625, 1469.9134521484375, 1469.0112
3046875, 1468.1912841796875, 1467.42919921875, 1466.
6146240234375, 1465.8902587890625, 1465.147705078125
, 1464.545654296875, 1463.97998046875, 1463.41076660
15625, 1462.9871826171875, 1462.4412841796875, 1462.
0013427734375, 1461.6531982421875, 1461.130493164062
5, 1460.761474609375, 1460.409423828125, 1460.051025
390625, 1459.7672119140625]
metric mae
values per epoch: [21.73699951171875, 21.95027732849
121, 22.010082244873047, 22.033985137939453, 22.0420
83740234375, 22.04332733154297, 22.043212890625, 22.
052488327026367, 22.056354522705078, 22.055494308471
68, 22.054611206054688, 22.053815841674805, 22.05219
6502685547, 22.050018310546875, 22.046367645263672,
22.042461395263672, 22.039934158325195, 22.036437988
28125, 22.035221099853516, 22.03554344177246, 22.034
10530090332, 22.03244972229004, 22.03325843811035, 2
2.03388786315918, 22.03599739074707, 22.0361328125,
22.03756332397461, 22.03632354736328, 22.03867340087
8906, 22.040555953979492]

Evaluation Test Set: Best retrained model : 1
Test metric loss
Test metric value: 1144.87548828125
Test metric mae
Test metric value: 21.71004295349121

Evaluation Test Set: Best retrained model : 2
Test metric loss
Test metric value: 1076.2996826171875
Test metric mae
Test metric value: 19.421432495117188
```

FIN

In [...

In [...

In [...
```
#for i,j in va_test_dataset.take(1):
#    print("i",i)
#    print("j",j)
```

In [...

In [...
```
#def create_time_steps(length):
#    return list(range(-length, 0))
```

In [...

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In […

In […

```
fct_analyze_results(
    va_di_best_models=\
    di_best_trained_models,
    va_test_dataset=\
    va_test_dataset,
    va_mean_value_train_dataset=\
    va_mean_value_train_dataset,
    va_std_train_dataset=\
    va_std_train_dataset,
    va_li_true_vals_test_set=\
    va_li_true_vals_test_set,
    va_id_first_future_observation=\
    va_id_first_future_observation,
    va_name_figure_folder_metric=\
    va_name_figure_folder_metric,\
    va_name_figure_metric_for_predicts=\
    val_name_figure_metric_for_predicts,\
    va_mae_test_set=val_mae_test_set,
    va_rmse_test_set=val_rmse_test_set,
    va_di_hist_when_search_best_epoch=\
    di_hist_when_search_best_epoch,
    va_li_colors=val_li_colors,
    va_li_markers=val_li_markers,
    va_name_figure_find_best_epoch=\
    val_name_figure_find_best_epoch,
    va_name_figure_loss_best_epoch=\
    val_name_figure_loss_best_epoch,
    va_title_best_epoch=val_title_best_epoch,
    va_di_hist_retrained_best_model=\
    di_hist_retrained_best_model,
    va_folder_figures=\
    val_folder_figures,
    va_name_figure_best_traind_model=\
    val_name_figure_best_traind_model,
    va_name_figure_loss_best_trained_model=\
    val_name_figure_loss_best_trained_model,
```

```
    va_di_results_model_eval_test_set=\
    di_results_model_eval_test_set,
    va_name_figure_plots_test_set=\
    val_name_figure_plots_test_set,\
    va_name_file_plot_graph=\
    val_name_file_plot_graph,
    va_nb_takes_plot_inferences=val_nb_takes_plot_inf
    val_x_label="Best Model ID",\
    val_y_label="Value Metric",\
    val_title="Metrics Test Set Per Each Best Model",
    val_title_best_trained_model=\
    "Train Set Metrics - Retrained Best Model",
    va_loc="best")
```

```
352/352 [==============================] - 98s 275ms
/step
352/352 [==============================] - 94s 264ms
/step
```

In […

In […

```
#import keras_tuner

#hp=keras_tuner.HyperParameters()

#for i in range(hp.Int('num_layers',\
#        min_value=2,\
#        max_value=4,\
#        step=1)):
#            print("hi",i)
```

In […

In […

In […