
HyperOpt Examples

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HYPERPARAMETER OPTIMIZATION

Tutorials concerning Hyperparameter optimization

1.1 hyperparameter optimization with Model class for NNs

```
from ai4water.functional import Model
from ai4water.datasets import busan_beach
from ai4water.utils.utils import get_version_info
from ai4water.hyperopt import Categorical, Real, Integer

for k,v in get_version_info().items():
    print(f"{k} version: {v}")
```

```
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/sklearn/experimental/enable_hist_gradient_boosting.py:17:
↳UserWarning: Since version 1.0, it is not needed to import enable_hist_gradient_
↳boosting anymore. HistGradientBoostingClassifier and HistGradientBoostingRegressor are
↳now stable and can be normally imported from sklearn.ensemble.
"Since version 1.0, "
python version: 3.7.9 (default, Oct 19 2020, 15:13:17)
[GCC 7.5.0]
os version: posix
ai4water version: 1.06
xgboost version: 1.6.2
easy_mpl version: 0.21.2
SeqMetrics version: 1.3.4
tensorflow version: 2.7.0
keras.api._v2.keras version: 2.7.0
numpy version: 1.21.6
pandas version: 1.3.5
matplotlib version: 3.5.3
h5py version: 3.7.0
joblib version: 1.2.0
```

```
data = busan_beach()
print(data.shape)
```

```
(1446, 14)
```

```
input_features = data.columns.tolist()[0:-1]
print(input_features)
```

```
['tide_cm', 'wat_temp_c', 'sal_psu', 'air_temp_c', 'pcp_mm', 'pcp3_mm', 'pcp6_mm',
↪ 'pcp12_mm', 'wind_dir_deg', 'wind_speed_mps', 'air_p_hpa', 'mslp_hpa', 'rel_hum']
```

```
output_features = data.columns.tolist()[-1:]
print(output_features)
```

```
['tetx_coppml']
```

build the model

```
lookback = 14

model = Model(
    model = {"layers": {
        "Input": {"shape": (lookback, len(input_features))},
        "LSTM": {"units": Integer(10, 20, name="units"),
            "activation": Categorical(["relu", "elu", "tanh"], name="activation")},
        "Dense": 1
    }},
    lr=Real(0.00001, 0.01, name="lr"),
    batch_size=Categorical([4, 8, 12, 16, 24], name="batch_size"),
    train_fraction=1.0,
    split_random=True,
    epochs=50,
    ts_args={"lookback": lookback},
    input_features=input_features,
    output_features=output_features,
    x_transformation="zscore",
    y_transformation={"method": "log", "replace_zeros": True, "treat_negatives": True},
)
```

```
building DL model for
regression problem using Model
Model: "model"
```

Layer (type)	Output Shape	Param #
Input (InputLayer)	[(None, 14, 13)]	0
LSTM (LSTM)	(None, 17)	2108
Dense (Dense)	(None, 1)	18

=====
Total params: 2,126
Trainable params: 2,126
Non-trainable params: 0

```
dot plot of model could not be plotted due to ('You must install pydot ('pip install_
```

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```

→pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
→) ', 'for plot_model/model_to_dot to work.')

```

```

optimizer = model.optimize_hyperparameters(
    data=data,
    num_iterations=25,
    process_results=False,
    refit=False,
)

```

Iteration No.	Validation Score
0	726462473540633624576.000000 -726462473540633624576.000000
1	2.67351 -1.67351
2	689.21594 -688.21594
3	527.67830 -526.67830
WARNING:tensorflow:5 out of the last 9 calls to <function Model.make_predict_function. →<locals>.predict_function at 0x7fecdd54dedd0> triggered tf.function retracing. Tracing →is expensive and the excessive number of tracings could be due to (1) creating @tf. →function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing →Python objects instead of tensors. For (1), please define your @tf.function outside of →the loop. For (2), @tf.function has experimental_relax_shapes=True option that relaxes →argument shapes that can avoid unnecessary retracing. For (3), please refer to https:// →www.tensorflow.org/guide/function#controlling_retracing and https://www.tensorflow.org/ →api_docs/python/tf/function for more details.	
4	1.08681 -0.08681
WARNING:tensorflow:6 out of the last 11 calls to <function Model.make_predict_function. →<locals>.predict_function at 0x7fecdd45c4560> triggered tf.function retracing. Tracing →is expensive and the excessive number of tracings could be due to (1) creating @tf. →function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing →Python objects instead of tensors. For (1), please define your @tf.function outside of →the loop. For (2), @tf.function has experimental_relax_shapes=True option that relaxes →argument shapes that can avoid unnecessary retracing. For (3), please refer to https:// →www.tensorflow.org/guide/function#controlling_retracing and https://www.tensorflow.org/ →api_docs/python/tf/function for more details.	
5	5.97746 -4.97746
6	1.04858 -0.04858
7	165132267.56762 -165132266.56762
8	102.12408 -101.12408
9	22085.72568 -22084.72568
10	1.59101 -0.59101
11	29.25840 -28.25840
12	276.89809 -275.89809
13	41.22146 -40.22146
14	27.15423 -26.15423
15	38.06921 -37.06921
16	26.47467 -25.47467
17	45.46555 -44.46555
18	38.64113 -37.64113
19	27.20578 -26.20578
20	19.77687 -18.77687
21	29.88066 -28.88066

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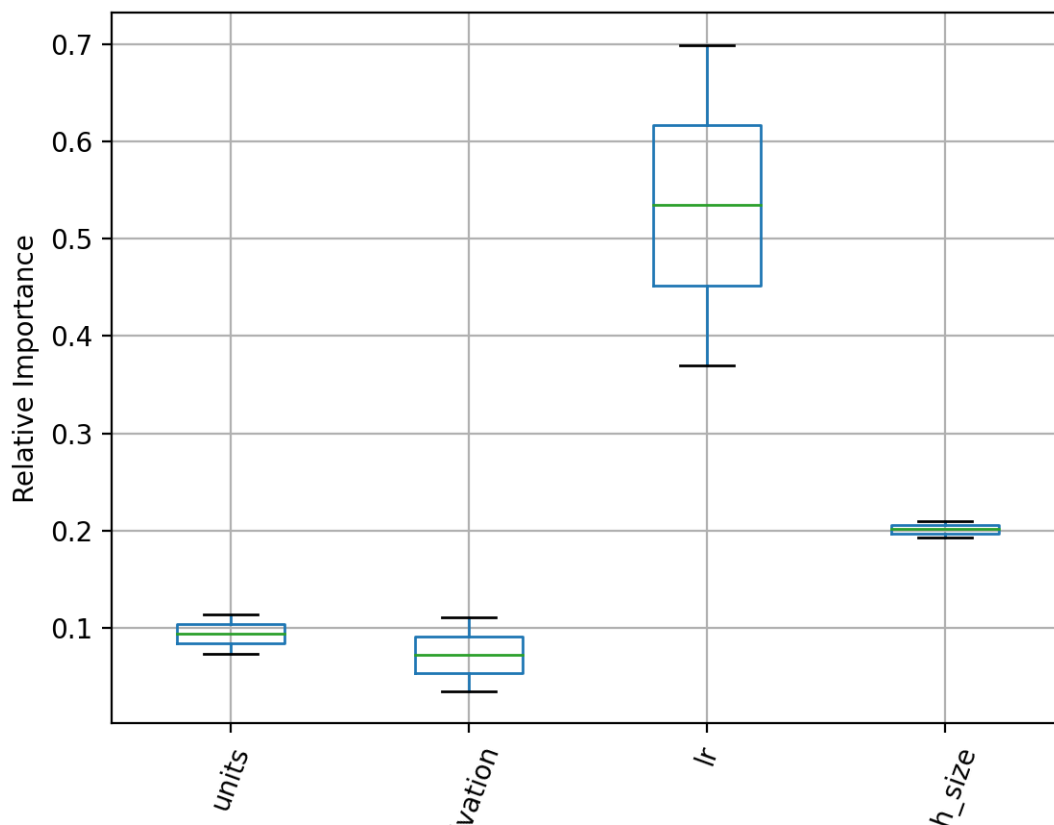
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```

22          37.45994          -36.45994
23          26.60292          -25.60292
24          38.55547          -37.55547
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/utils/utils.py:818: UserWarning: 0 is not equal to 25_
↳so can not perform ranking
    warnings.warn(f"{num_folders} is not equal to {len(results)} so can not perform ranking
↳")

```

```
_ = optimizer.plot_importance(save=False)
```



Total running time of the script: (3 minutes 46.639 seconds)

1.2 hyperparameter optimization with Model class

```
from ai4water.functional import Model
from ai4water.datasets import busan_beach
from ai4water.utils.utils import get_version_info
from ai4water.hyperopt import Categorical, Real, Integer
```

```
for k,v in get_version_info().items():
    print(f"{k} version: {v}")
```

```
python version: 3.7.9 (default, Oct 19 2020, 15:13:17)
[GCC 7.5.0]
os version: posix
ai4water version: 1.06
xgboost version: 1.6.2
easy_mpl version: 0.21.2
SeqMetrics version: 1.3.4
tensorflow version: 2.7.0
keras.api._v2.keras version: 2.7.0
numpy version: 1.21.6
pandas version: 1.3.5
matplotlib version: 3.5.3
h5py version: 3.7.0
joblib version: 1.2.0
```

```
# prepare the data
data = busan_beach()
print(data.shape)
```

```
(1446, 14)
```

```
input_features = data.columns.tolist()[0:-1]
print(input_features)
```

```
['tide_cm', 'wat_temp_c', 'sal_psu', 'air_temp_c', 'pcp_mm', 'pcp3_mm', 'pcp6_mm',
↪ 'pcp12_mm', 'wind_dir_deg', 'wind_speed_mps', 'air_p_hpa', 'mslp_hpa', 'rel_hum']
```

```
output_features = data.columns.tolist()[-1:]
print(output_features)
```

```
['tetx_coppml']
```

build the model

```
model = Model(
    model = {"XGBRegressor": {
        "iterations": Integer(low=10, high=30, name='iterations', num_samples=10),
        "learning_rate": Real(low=0.09, high=0.3, prior='log', name='learning_rate', num_
↪ samples=10),
        "l2_leaf_reg": Real(low=0.5, high=5.0, name='l2_leaf_reg', num_samples=10),
```

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```

        "model_size_reg": Real(low=0.1, high=10, name='model_size_reg', num_samples=10),
        "rsm": Real(low=0.1, high=0.5, name='rsm', num_samples=10),
        "border_count": Integer(low=32, high=50, name='border_count', num_samples=10),
        "feature_border_type": Categorical(categories=['Median', 'Uniform',
↪ 'UniformAndQuantiles',
        'MaxLogSum', 'MinEntropy', 'GreedyLogSum'], name='feature_border_
↪ type'),
        "n_jobs": 0,
    }},
    train_fraction=1.0,
    split_random=True,
    input_features=input_features,
    output_features=output_features,
    x_transformation="zscore",
    y_transformation={"method": "log", "replace_zeros": True, "treat_negatives": True},
)

```

building ML model for
regression problem using XGBRegressor

```

optimizer = model.optimize_hyperparameters(
    data=data,
    num_iterations=25,
    process_results=False # we can set it to True if we want post-processing of results
)

```

```

Iteration No.   Validation Score
[01:53:00] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪ size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪ used
but getting flagged wrongly here. Please open an issue if you find any such cases.

0               0.76321               0.23679
[01:53:00] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪ size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪ used
but getting flagged wrongly here. Please open an issue if you find any such cases.

1               0.65969               0.34031
[01:53:01] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_

```

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```
↪size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being

```
↪used
```

but getting flagged wrongly here. Please open an issue if you find any such cases.

```
2                0.85585                0.14415
```

```
[01:53:01] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being

```
↪used
```

but getting flagged wrongly here. Please open an issue if you find any such cases.

```
3                0.29644                0.70356
```

```
[01:53:02] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being

```
↪used
```

but getting flagged wrongly here. Please open an issue if you find any such cases.

```
4                1.30347                -0.30347
```

```
[01:53:02] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being

```
↪used
```

but getting flagged wrongly here. Please open an issue if you find any such cases.

```
5                0.59253                0.40747
```

```
[01:53:03] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being

```
↪used
```

but getting flagged wrongly here. Please open an issue if you find any such cases.

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```

6          0.60976          0.39024
[01:53:03] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being↳
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

7          0.78775          0.21225
[01:53:04] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being↳
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

8          0.71816          0.28184
[01:53:04] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being↳
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

9          0.96965          0.03035
[01:53:06] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being↳
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

10         1.17726          -0.17726
[01:53:07] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being↳
↳used

```

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but getting flagged wrongly here. Please open an issue if you find any such cases.

```
11          1.32955          -0.32955
```

```
[01:53:08] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being_↵
↳used

but getting flagged wrongly here. Please open an issue if you find any such cases.

```
12          0.98610          0.01390
```

```
[01:53:09] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being_↵
↳used

but getting flagged wrongly here. Please open an issue if you find any such cases.

```
13          0.76427          0.23573
```

```
[01:53:10] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being_↵
↳used

but getting flagged wrongly here. Please open an issue if you find any such cases.

```
14          0.29686          0.70314
```

```
[01:53:12] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being_↵
↳used

but getting flagged wrongly here. Please open an issue if you find any such cases.

```
15          1.00601          -0.00601
```

```
[01:53:13] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

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```

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪used
but getting flagged wrongly here. Please open an issue if you find any such cases.

16          1.38017          -0.38017
[01:53:15] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪used
but getting flagged wrongly here. Please open an issue if you find any such cases.

17          0.28935          0.71065
[01:53:16] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪used
but getting flagged wrongly here. Please open an issue if you find any such cases.

18          0.24302          0.75698
[01:53:18] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪used
but getting flagged wrongly here. Please open an issue if you find any such cases.

19          0.26081          0.73919
[01:53:20] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↪size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪used
but getting flagged wrongly here. Please open an issue if you find any such cases.

20          0.29716          0.70284
[01:53:21] WARNING: ../src/learner.cc:627:

```

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```
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

```
21          0.31398          0.68602
[01:53:23] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

```
22          1.15949          -0.15949
[01:53:25] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

```
23          0.33662          0.66338
[01:53:26] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

```
24          0.60774          0.39226
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/utils/utils.py:818: UserWarning: 0 is not equal to 25
↳so can not perform ranking
  warnings.warn(f"{num_folders} is not equal to {len(results)} so can not perform ranking
↳")
```

```
***** Removing Examples with nan in labels *****
```

```
***** Training *****
```

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```

input_x shape: (174, 13)
target shape: (174, 1)

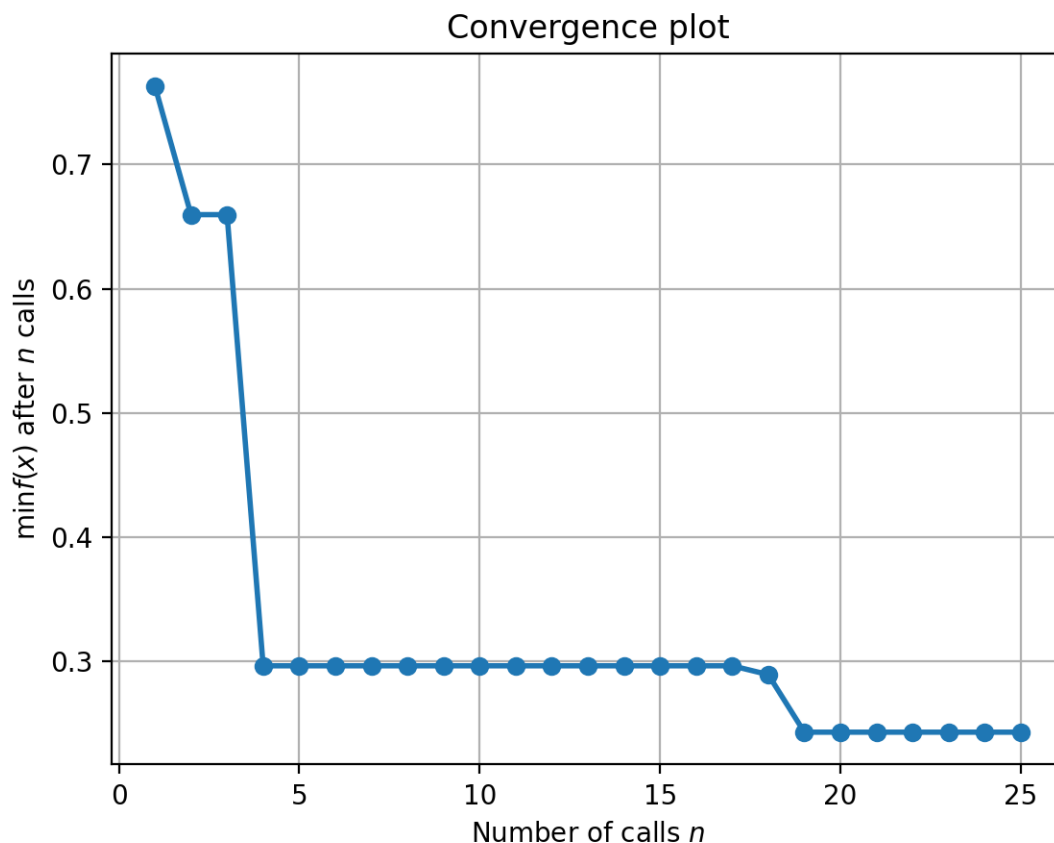
***** Removing Examples with nan in labels *****

**** Validation ****
input_x shape: (44, 13)
target shape: (44, 1)
[01:53:28] WARNING: ../src/learner.cc:627:
Parameters: { "border_count", "feature_border_type", "iterations", "l2_leaf_reg", "model_
↳size_reg", "rsm" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being↳
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

```

```
optimizer._plot_convergence()
```



```

<AxesSubplot:title={'center':'Convergence plot'}, xlabel='Number of calls $n$', ylabel='
↳$\min f(x)$ after $n$ calls'>

```



```
optimizer.best_iter()
```

```
18
```

```
optimizer.best_paras()
```

```
{'iterations': 12, 'learning_rate': 0.16261580301200218, 'l2_leaf_reg': 4.
↪ 300786492314255, 'model_size_reg': 0.5512921764936062, 'rsm': 0.44119249704395946,
↪ 'border_count': 37, 'feature_border_type': 'MinEntropy'}
```

```
print(model.config['model'])
```

```
{'XGBRegressor': {'iterations': 12, 'learning_rate': 0.16261580301200218, 'l2_leaf_reg': ↵
↪ 4.300786492314255, 'model_size_reg': 0.5512921764936062, 'rsm': 0.44119249704395946,
↪ 'border_count': 37, 'feature_border_type': 'MinEntropy', 'n_jobs': 0, 'random_state': ↵
↪ 313}}
```

```
print(model._model)
```

```
XGBRegressor(base_score=0.5, booster='gbtree', border_count=37, callbacks=None,
             colsample_bylevel=1, colsample_bynode=1, colsample_bytrees=1,
             early_stopping_rounds=None, enable_categorical=False,
             eval_metric=None, feature_border_type='MinEntropy', gamma=0,
             gpu_id=-1, grow_policy='depthwise', importance_type=None,
             interaction_constraints='', iterations=12,
             l2_leaf_reg=4.300786492314255, learning_rate=0.16261580301200218,
             max_bin=256, max_cat_to_onehot=4, max_delta_step=0, max_depth=6,
             max_leaves=0, min_child_weight=1, missing=nan,
             model_size_reg=0.5512921764936062, monotone_constraints='()',
             n_estimators=100, n_jobs=0, ...)
```

Total running time of the script: (0 minutes 29.646 seconds)

1.3 hyperparameter optimization using HyperOpt

There are two ways of optimization of hyperparameters in AI4Water. The `ai4water.hyperopt.HyperOpt` class is the lower level api while `Model.optimize_hyperparameters()` is the higher level api. For using HyperOpt class, the user has to define the objective function and hyperparameter space explicitly. Moreover, the user has to instantiate the HyperOpt class and call the fit method on it.

This example shows, how to use HyperOpt class for optimization of hyperparameters.

```
import os
import math

import numpy as np

from skopt.plots import plot_objective
from SeqMetrics import RegressionMetrics
```

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```
from ai4water.functional import Model
from ai4water.datasets import busan_beach
from ai4water.utils.utils import get_version_info
from ai4water.utils.utils import jsonize, dateandtime_now
from ai4water.hyperopt import HyperOpt, Categorical, Real, Integer

# sphinx_gallery_thumbnail_number = 2

for k,v in get_version_info().items():
    print(f"{k} version: {v}")
```

```
python version: 3.7.9 (default, Oct 19 2020, 15:13:17)
[GCC 7.5.0]
os version: posix
ai4water version: 1.06
xgboost version: 1.6.2
easy_mpl version: 0.21.2
SeqMetrics version: 1.3.4
tensorflow version: 2.7.0
keras.api.v2.keras version: 2.7.0
numpy version: 1.21.6
pandas version: 1.3.5
matplotlib version: 3.5.3
h5py version: 3.7.0
joblib version: 1.2.0
```

```
data = busan_beach()

SEP = os.sep
```

```
PREFIX = f"hpo_{dateandtime_now()}"
ITER = 0
```

```
# Optimizing the hyperparameters usually involves four steps
```

1.3.1 1) define objective function

```
def objective_fn(
    prefix=None,
    **suggestions)->float:
    """This function must build, train and evaluate the ML model.
    The output of this function will be minimized by optimization algorithm.
    """

    suggestions = jsonize(suggestions)
    global ITER

    # build model
    _model = Model(model={"XGBRegressor": suggestions},
                    prefix=prefix or PREFIX,
```

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```

        train_fraction=1.0,
        split_random=True,
        verbosity=0,
    )

    # train model
    _model.fit(data=data)

    # evaluate model
    t, p = _model.predict(data='validation', return_true=True, process_results=False)
    val_score = RegressionMetrics(t, p).r2_score()

    if not math.isfinite(val_score):
        val_score = 1.0

    # since the optimization algorithm solves minimization algorithm
    # we have to subtract r2_score from 1.0
    # if our validation metric is something like mse or rmse,
    # then we don't need to subtract it from 1.0
    val_score = 1.0 - val_score

    ITER += 1

    print(f"{ITER} {val_score}")

    return val_score

```

1.3.2 2) define parameter space

the parameter space determines the pool of candidates from which hyperparameters will be chosen during optimization

```

num_samples=10
space = [
    Integer(low=5, high=50, name='n_estimators', num_samples=num_samples),
    # Maximum tree depth for base learners
    Integer(low=3, high=10, name='max_depth', num_samples=num_samples),
    Real(low=0.01, high=0.5, name='learning_rate', prior='log', num_samples=num_samples),
    Categorical(categories=['gbtree', 'gblinear', 'dart'], name='booster'),
]

```

1.3.3 3) initial state

this step is optional but it is always better to provide a good initial guess to the optimization algorithm

```
x0 = [5, 4, 0.1, "gbtree"]
```

1.3.4 4) run optimization algorithm

```
# Now instantiate the HyperOpt class and call .fit on it
# algorithm can be either `random`, `grid`, `bayes`, `tpe`, `bayes_rf`
#
optimizer = HyperOpt(
    algorithm="bayes",
    objective_fn=objective_fn,
    param_space=space,
    x0=x0,
    num_iterations=25,
    process_results=False,
    opt_path=f"results{SEP}{PREFIX}",
    verbosity=0,
)

results = optimizer.fit()
```

```
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
1 3.3545373739474798
[01:53:30] WARNING: ../src/learner.cc:627:
Parameters: { "max_depth" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↳used
but getting flagged wrongly here. Please open an issue if you find any such cases.

/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
2 2.0520282748400933
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
```

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```

3 85.34741701261791
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
4 57.93200291381492
[01:53:31] WARNING: ../src/learner.cc:627:
Parameters: { "max_depth" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
used
but getting flagged wrongly here. Please open an issue if you find any such cases.

/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
5 1.1031883493609647
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
6 80.5761592501049
[01:53:32] WARNING: ../src/learner.cc:627:
Parameters: { "max_depth" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
used
but getting flagged wrongly here. Please open an issue if you find any such cases.

/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
7 2.0432265000454426
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
8 0.8490724296302107
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please

```

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```

        use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
9 26.434907636320624
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
10 1.29135540429111
[01:53:33] WARNING: ../src/learner.cc:627:
Parameters: { "max_depth" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
used
but getting flagged wrongly here. Please open an issue if you find any such cases.

/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
11 1.6868754195571543
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
12 0.8407231971333186
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
13 1.1143701900672454
[01:53:37] WARNING: ../src/learner.cc:627:
Parameters: { "max_depth" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
used
but getting flagged wrongly here. Please open an issue if you find any such cases.

/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
14 1.2753129265425647
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/

```

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```

↪python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
15 0.8407073086853296
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↪python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
16 0.8273212958234943
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↪python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
17 3.980753838627524
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↪python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
18 0.9232753877513347
[01:53:42] WARNING: ../src/learner.cc:627:
Parameters: { "max_depth" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪used
but getting flagged wrongly here. Please open an issue if you find any such cases.

/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↪python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
19 1.2168845498351057
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↪python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead.""")
20 0.8195065206713756
[01:53:44] WARNING: ../src/learner.cc:627:
Parameters: { "max_depth" } might not be used.

This could be a false alarm, with some parameters getting used by language bindings but
then being mistakenly passed down to XGBoost core, or some parameter actually being
↪used
but getting flagged wrongly here. Please open an issue if you find any such cases.

```

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```
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
```

```
21 1.1730027482061778
```

```
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
```

```
22 0.817172841842378
```

```
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
```

```
23 0.8421553091640155
```

```
[01:53:48] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "max_depth" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being

↳used but getting flagged wrongly here. Please open an issue if you find any such cases.

```
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
```

```
24 1.0660594830784598
```

```
[01:53:49] WARNING: ../src/learner.cc:627:
```

```
Parameters: { "max_depth" } might not be used.
```

This could be a false alarm, with some parameters getting used by language bindings but then being mistakenly passed down to XGBoost core, or some parameter actually being

↳used but getting flagged wrongly here. Please open an issue if you find any such cases.

```
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/ai4water/_main.py:1978: UserWarning:
    argument validation is deprecated and will be removed in future. Please
    use 'predict_on_validation_data' method instead.
    use 'predict_on_{data}_data' method instead."")
```

```
25 1.0519174212020213
```

```
print(f"optimized parameters are \n{optimizer.best_paras()}")
```

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```
print(np.min(optimizer.func_vals()))
```

```
optimized parameters are
{'n_estimators': 7, 'max_depth': 3, 'learning_rate': 0.02182676683717076, 'booster':
↪ 'dart'}
0.817172841842378
```

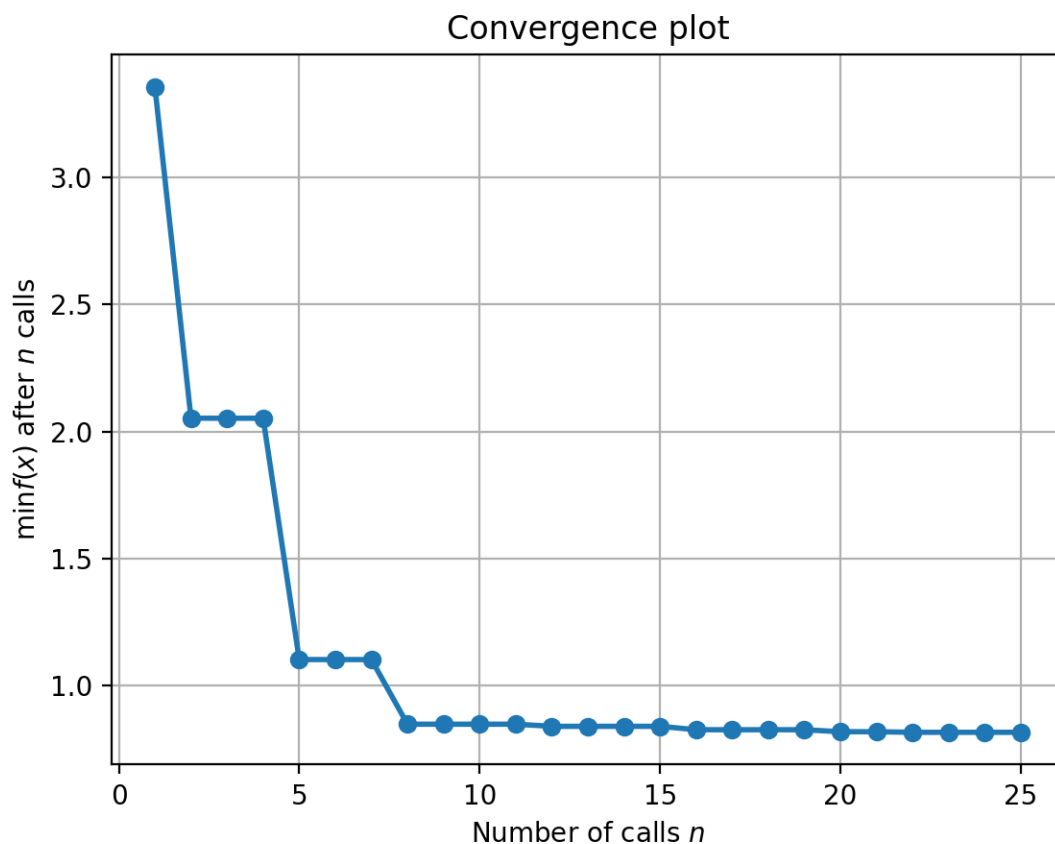
1.3.5 postprocessing of results

save hyperparameters at each iteration

```
optimizer.save_iterations_as_xy()
```

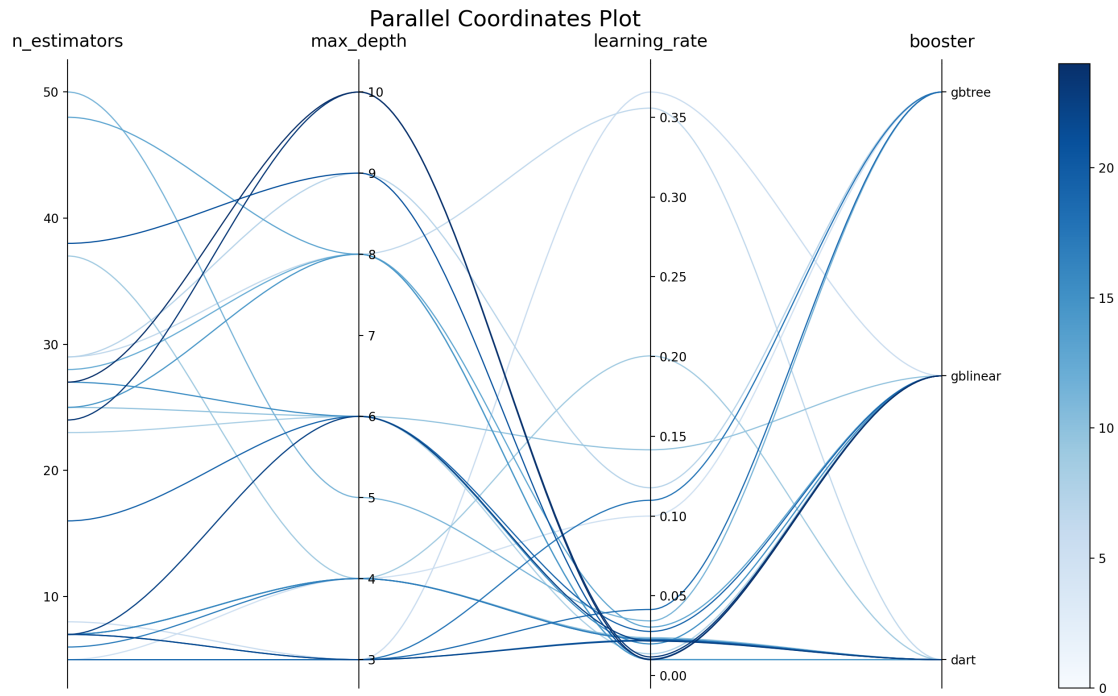
save convergence plot

```
optimizer._plot_convergence(save=False)
```

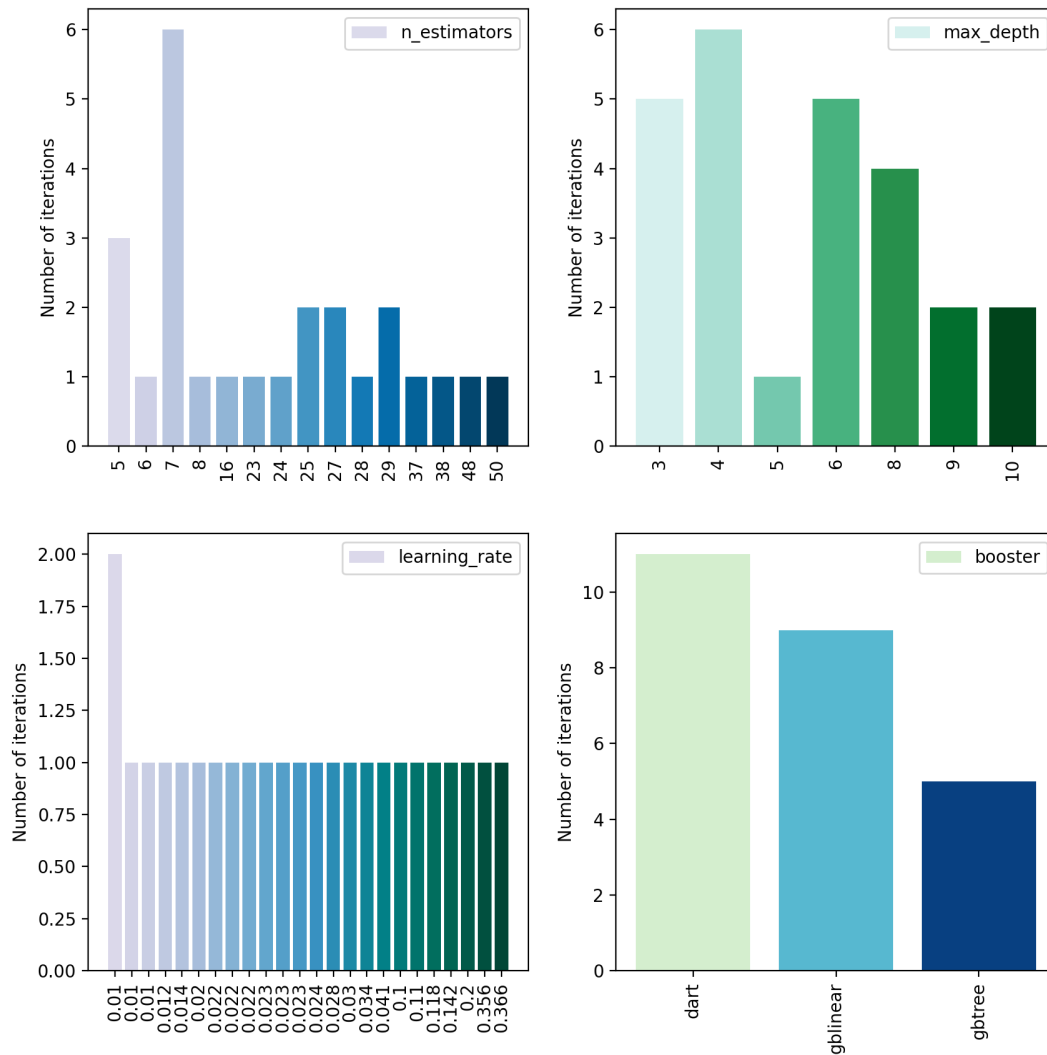


```
<AxesSubplot:title={'center':'Convergence plot'}, xlabel='Number of calls $n$', ylabel='
↪ $\min f(x)$ after $n$ calls'>
```

```
optimizer._plot_parallel_coords(figsize=(14, 8), save=False)
```

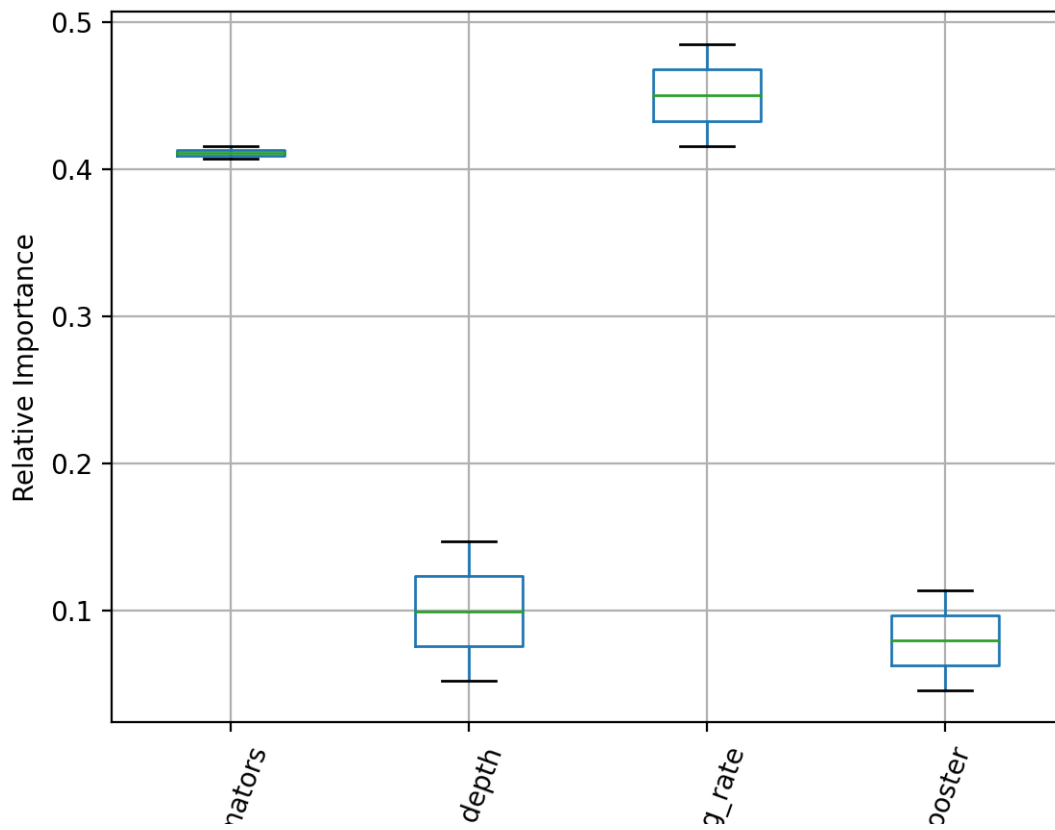


```
optimizer._plot_distributions(save=False)
```



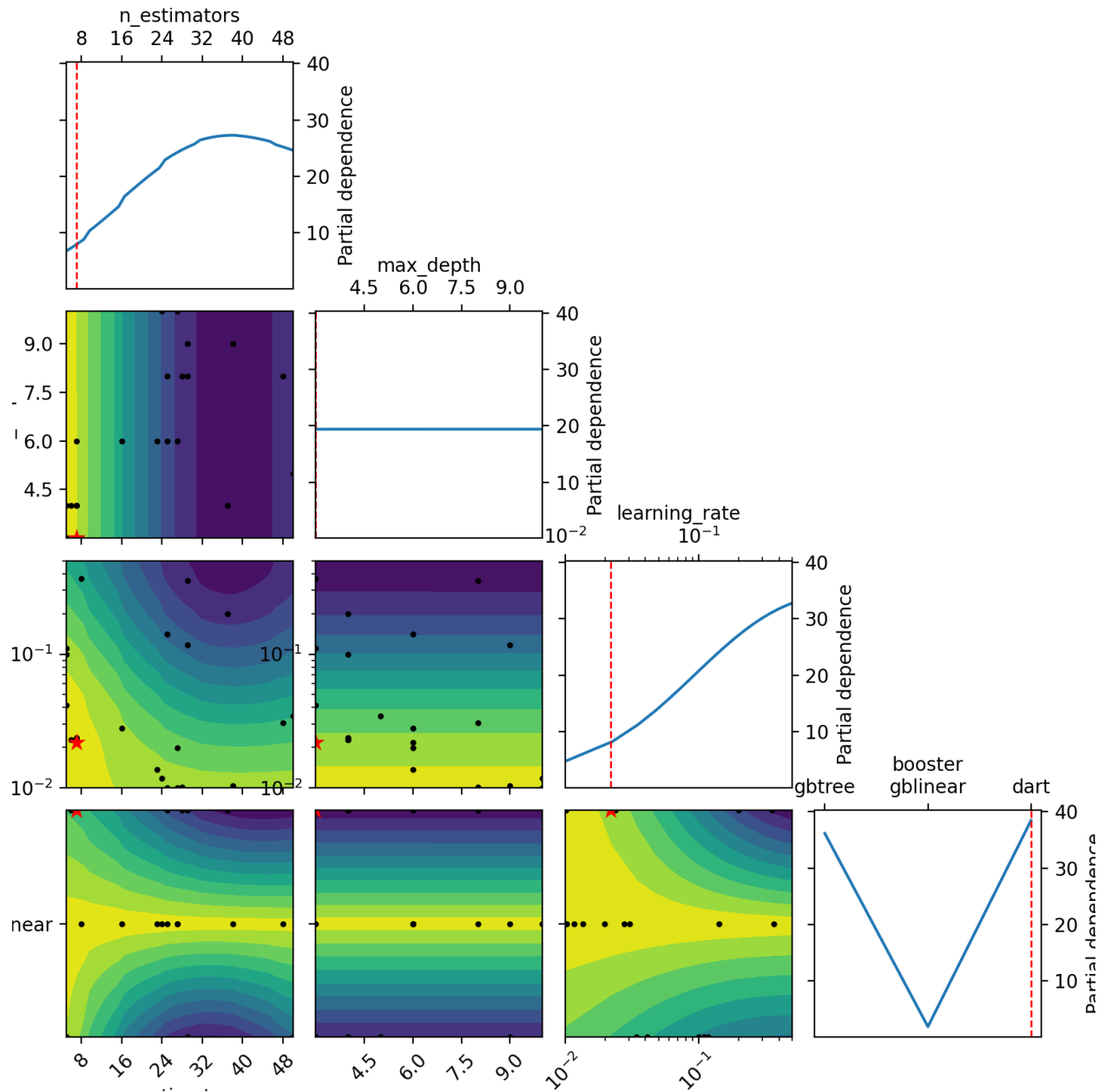
<Figure size 1000x1000 with 4 Axes>

```
optimizer.plot_importance(save=False)
```

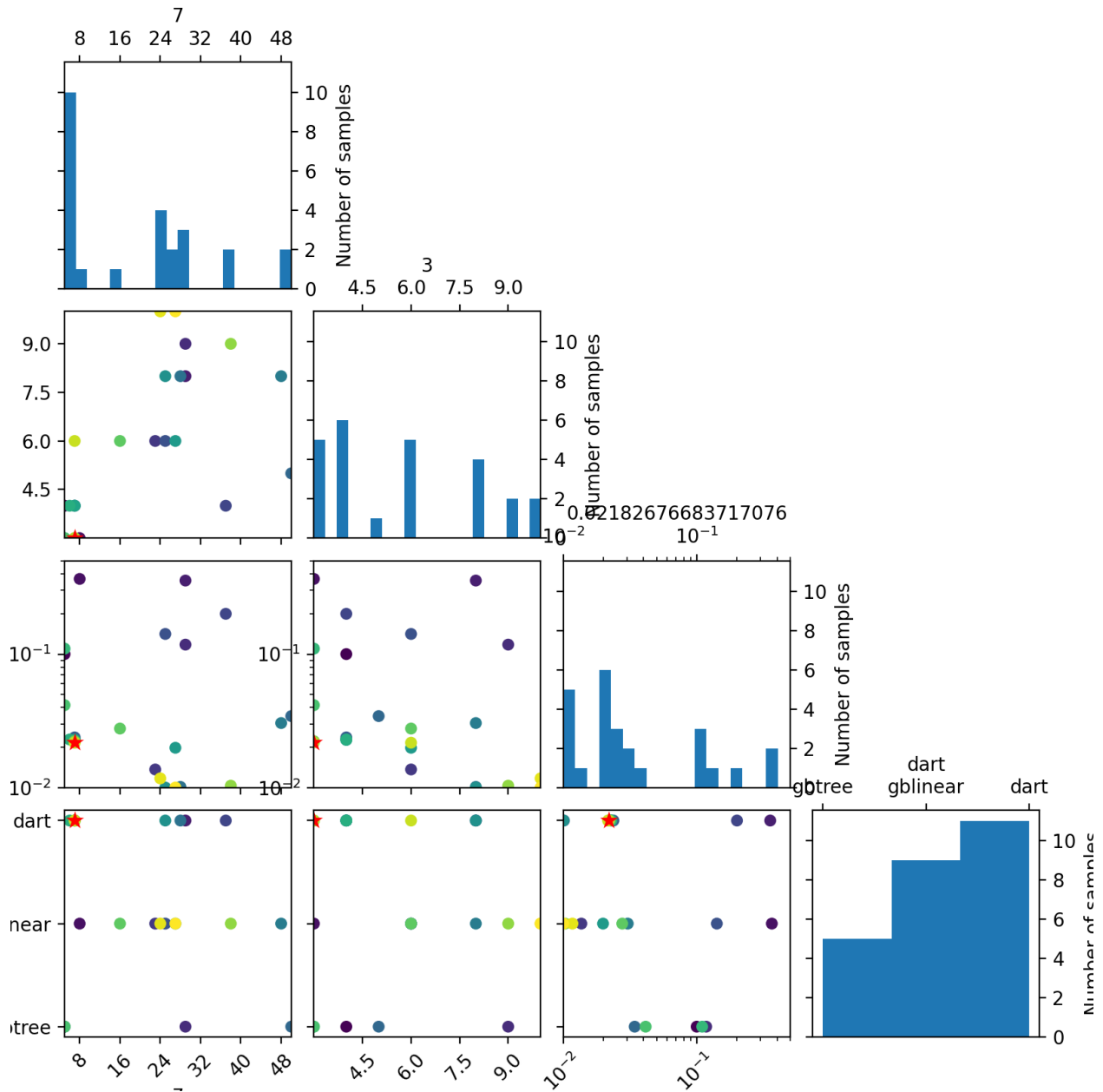


```
<AxesSubplot:ylabel='Relative Importance'>
```

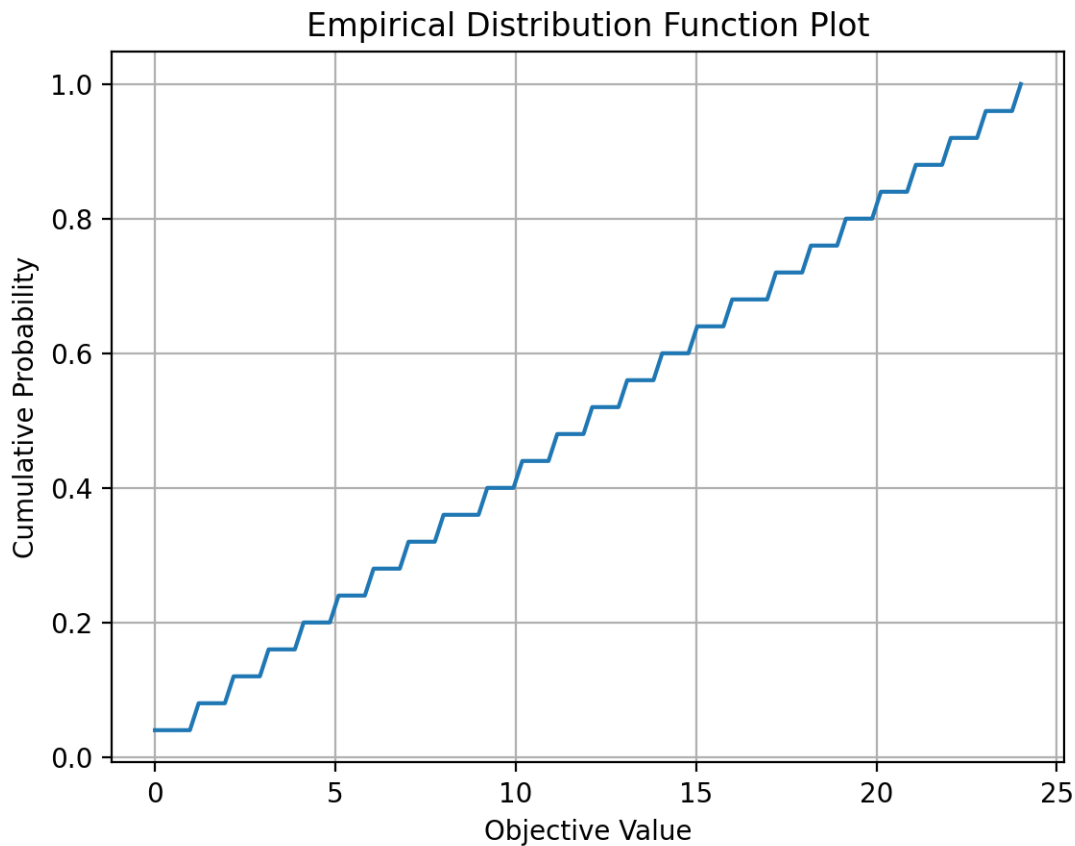
```
_ = plot_objective(results)
```



```
optimizer._plot_evaluations(save=False)
```



```
optimizer._plot_edf(save=False)
```



```
# Above, If you set ``process_results`` to True, all of the results are automatically
# saved in the optimization directory.
```

```
print(f"All the results are save in {optimizer.opt_path} directory")
```

```
All the results are save in results/hpo_20230105_015329 directory
```

Total running time of the script: (0 minutes 30.211 seconds)

1.4 HyperOpt for neural networks

This file shows how to optimize number of layers, neurons/units/filters in layers and activation functions of layers using HyperOpt class of AI4Water. The HyperOpt class provides a lower level API for hyperparameter optimization. It provides more control to the user. However, the user has to write the objective function, define parameter space and initial values itself.

```
import site
site.addsitedir("D:\\mytools\\AI4Water")
import os
import math
from typing import Union
```

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```
import numpy as np
from SeqMetrics import RegressionMetrics

from ai4water import Model
from ai4water.datasets import busan_beach
from ai4water.models import LSTM
from ai4water.utils.utils import get_version_info
from ai4water.utils.utils import jsonize, dateandtime_now
from ai4water.hyperopt import HyperOpt, Categorical, Real, Integer

for k,v in get_version_info().items():
    print(f"{k} version: {v}")
```

```
python version: 3.7.9 (default, Oct 19 2020, 15:13:17)
[GCC 7.5.0]
os version: posix
ai4water version: 1.06
xgboost version: 1.6.2
easy_mpl version: 0.21.2
SeqMetrics version: 1.3.4
tensorflow version: 2.7.0
keras.api.v2.keras version: 2.7.0
numpy version: 1.21.6
pandas version: 1.3.5
matplotlib version: 3.5.3
h5py version: 3.7.0
joblib version: 1.2.0
```

```
data = busan_beach()
```

```
SEP = os.sep
```

```
PREFIX = f"hpo_nn_{dateandtime_now()}"
ITER = 0
num_iterations = 25

# these seeds are randomly generated but we keep track of the seed
# used at each iteration, so that when we rebuilt the model with optimized
# hyperparameters, we get reproducible results
SEEDS = np.random.randint(0, 1000, num_iterations)
# to keep track of seed being used at every optimization iteration
SEEDS_USED = []
SUGGESTIONS = {}

# It is always a good practice to monitor more than 1 performance metric,
# even though our objective function will not be based upon these
# performance metrics.
MONITOR = {"mse": [], "nse": [], "r2": [], "pbias": [], "nrmse": []}
```


1.4.1 1) define objective function

```
def objective_fn(
    prefix: str = None,
    return_model: bool = False,
    epochs: int = 50,
    verbosity: int = 0,
    predict : bool = False,
    seed=None,
    **suggestions
)->Union[float, Model]:
    """This function must build, train and evaluate the ML model.
    The output of this function will be minimized by optimization algorithm.

    In this example we are considering same number of units and same activation for each
    layer. If we want to have (optimize) different number of units for each layer,
    will have to modify the parameter space accordingly. The LSTM function
    can be used to have separate number of units and activation function for each layer.

    Parameters
    -----
    prefix : str
        prefix to save the results. This argument will only be used after
        the optimization is complete
    return_model : bool, optional (default=False)
        if True, then objective function will return the built model. This
        argument will only be used after the optimization is complete
    epochs : int, optional
        the number of epochs for which to train the model
    verbosity : int, optional (default=1)
        determines the amount of information to be printed
    predict : bool, optional (default=False)
        whether to make predictions on training and validation data or not.
    seed : int, optional
        random seed for reproducibility. During optimization, its value will
        be None and we will use the value from SEEDS. After optimization,
        we will again call the objective function but this time with fixed
        seed.
    suggestions : dict
        a dictionary with values of hyperparameters at the iteration when
        this objective function is called. The objective function will be
        called as many times as the number of iterations in optimization
        algorithm.

    Returns
    -----
    float or Model
    """
    suggestions = jsonize(suggestions)
    global ITER

    # build model
    _model = Model(
```

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```

    model=LSTM(units=suggestions['units'],
                num_layers=suggestions['num_layers'],
                activation=suggestions['activation'],
                dropout=0.2),
    batch_size=suggestions["batch_size"],
    lr=suggestions["lr"],
    prefix=prefix or PREFIX,
    train_fraction=1.0,
    split_random=True,
    epochs=epochs,
    ts_args={"lookback": 14},
    input_features=data.columns.tolist()[0:-1],
    output_features=data.columns.tolist()[-1:],
    x_transformation="zscore",
    y_transformation={"method": "log", "replace_zeros": True, "treat_negatives":
↪ True},
    verbosity=verbosity)

# ai4water's Model class does not fix numpy seed
# below we fix all the seeds including numpy but this seed it itself randomly
↪ generated
    if seed is None:
        seed = SEEDS[ITER]
        SEEDS_USED.append(seed)

    _model.seed_everything(seed)
    SUGGESTIONS[ITER] = suggestions

    # train model
    _model.fit(data=data)

    # evaluate model
    t, p = _model.predict_on_validation_data(data=data, return_true=True)
    metrics = RegressionMetrics(t, p)
    val_score = metrics.rmse()

    for metric in MONITOR.keys():
        val = getattr(metrics, metric)()
        MONITOR[metric].append(val)

    # here we are evaluating model with respect to mse, therefore
    # we don't need to subtract it from 1.0
    if not math.isfinite(val_score):
        val_score = 9999

    print(f"{ITER} {val_score} {seed}")

    ITER += 1

    if predict:
        _model.predict_on_training_data(data=data)
        _model.predict_on_validation_data(data=data)

```

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```

        _model.predict_on_all_data(data=data)

    if return_model:
        return _model

    return val_score

```

1.4.2 2) define parameter space

parameter space

```

param_space = [
    Integer(10, 15, name="units"),
    Integer(1, 2, name="num_layers"),
    Categorical(["relu", "elu", "tanh"], name="activation"),
    Real(0.00001, 0.01, name="lr"),
    Categorical([4, 8, 12, 16, 24], name="batch_size")
]

```

1.4.3 3) initial state

initial values

```
x0 = [14, 1, "relu", 0.001, 8]
```

1.4.4 4) run optimization algorithm

initialize the HyperOpt class and call fit method on it

```

optimizer = HyperOpt(
    algorithm="bayes",
    objective_fn=objective_fn,
    param_space=param_space,
    x0=x0,
    num_iterations=num_iterations,
    process_results=False, # we can turn it False if we want post-processing of results
    opt_path=f"results{SEP}{PREFIX}"
)

results = optimizer.fit()

```

```

dot plot of model could not be plotted due to ('You must install pydot ('pip install
→ pydot') and install graphviz (see instructions at https://graphviz.gitlab.io/download/
→ ), 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)

```

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```

0 523884732.9733869 714
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
1 6583039.795916777 288
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
2 6753422.45793642 271
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
3 5950490.696894164 205
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
4 8825502.838275902 6
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
5 7454927.891606732 90
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
6 6334369.644302106 362
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')

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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
7 14551102.11724954 816
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (4, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/scipy/stats/stats.py:961: RuntimeWarning: overflow encountered_
↳in multiply
    s *= a_zero_mean
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/scipy/stats/stats.py:959: RuntimeWarning: overflow encountered_
↳in square
    s = s**2
8 8240782918148.917 465
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (4, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
9 6637346.830008509 468
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
10 7099087.363433697 902
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
11 7135103.557971391 170
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)

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```

12 6307560.721090206 785
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
13 8397534.250823868 421
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
14 7241680.506631592 8
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/skopt/optimizer/optimizer.py:449: UserWarning: The objective
↳has been evaluated at this point before.
  warnings.warn("The objective has been evaluated "
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
15 8291178.198967865 332
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
16 8513380.563411457 281
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
17 7215784.696814616 531
dot plot of model could not be plotted due to ('You must install pydot (`pip install
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)

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```

18 7783264.154127624 404
/home/docs/checkouts/readthedocs.org/user_builds/hyperopt-examples/envs/latest/lib/
↳python3.7/site-packages/skopt/optimizer/optimizer.py:449: UserWarning: The objective_
↳has been evaluated at this point before.
    warnings.warn("The objective has been evaluated "
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
19 7013211.76037798 800
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
20 6021461.3236589 439
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
21 7103595.978997679 549
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
22 33269573.857774135 699
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
23 6353615.268115626 196
dot plot of model could not be plotted due to ('You must install pydot (`pip install_
↳pydot`) and install graphviz (see instructions at https://graphviz.gitlab.io/download/
↳) ', 'for plot_model/model_to_dot to work.')
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
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assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)

```

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```
24 10460735.739808744 321
```

```
best_iteration = optimizer.best_iter()

seed_on_best_iter = SEEDS_USED[int(best_iteration)]

print(f"optimized parameters are \n{optimizer.best_paras()} at {best_iteration} seed
↪{seed_on_best_iter}")
```

```
optimized parameters are
{'units': 11, 'num_layers': 2, 'activation': 'elu', 'lr': 0.004531349711775078, 'batch_
↪size': 12} at 3 seed 205
```

we are interested in the minimum value of following metrics

```
for key in ['mse', 'nrmse', 'pbias']:
    print(key, np.nanmin(MONITOR[key]), np.nanargmin(MONITOR[key]))
```

```
mse 35408339533824.0 3
nrmse 0.16509043815368105 3
pbias -99.99984282620667 11
```

we are interested in the maximum value of following metrics

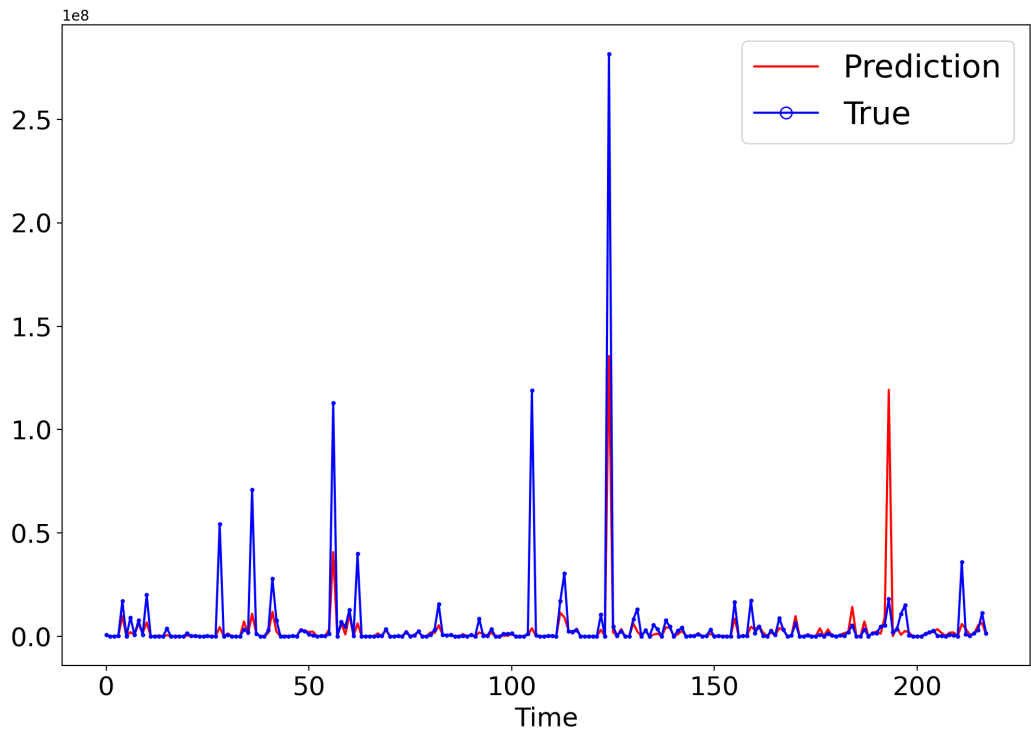
```
for key in ['r2', 'nse']:
    print(key, np.nanmax(MONITOR[key]), np.nanargmax(MONITOR[key]))
```

```
r2 0.6848985450318372 18
nse 0.13201932970768548 3
```

```
# we can now again call the objective function with best/optimum parameters
```

1.4.5 train with best hyperparameters

```
model = objective_fn(prefix=f"{PREFIX}{SEP}best",
                    seed=seed_on_best_iter,
                    return_model=True,
                    epochs=200,
                    verbosity=1,
                    predict=True,
                    **optimizer.best_paras())
```

building DL model for
regression problem using Model

Model: "model"

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	[(None, 14, 13)]	0
LSTM_0 (LSTM)	(None, 14, 11)	1100
Dropout (Dropout)	(None, 14, 11)	0
LSTM_1 (LSTM)	(None, 11)	1012
Flatten (Flatten)	(None, 11)	0
Dense_out (Dense)	(None, 1)	12

Total params: 2,124
Trainable params: 2,124
Non-trainable params: 0

dot plot of model could not be plotted due to ('You must install pydot ('pip install pydot') and install graphviz (see instructions at <https://graphviz.gitlab.io/download/>) ' , 'for plot_model/model_to_dot to work.')

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```

***** Removing Examples with nan in labels *****

***** Training *****
input_x shape: (174, 14, 13)
target shape: (174, 1)

***** Removing Examples with nan in labels *****

***** Validation *****
input_x shape: (44, 14, 13)
target shape: (44, 1)
Epoch 1/200
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)

 1/15 [=>.....] - ETA: 22s - loss: 181.2920
 7/15 [=====>.....] - ETA: 0s - loss: 151.7792
13/15 [=====>.....] - ETA: 0s - loss: 128.3961
    to IteratorGetNext:0 with shape (None, 14, 13)

15/15 [=====] - 2s 32ms/step - loss: 170.4385 - val_loss: 156.
    7401
Epoch 2/200

 1/15 [=>.....] - ETA: 0s - loss: 81.5177
 7/15 [=====>.....] - ETA: 0s - loss: 86.7619
13/15 [=====>.....] - ETA: 0s - loss: 64.4284
15/15 [=====] - 0s 13ms/step - loss: 63.5559 - val_loss: 52.2259
Epoch 3/200

 1/15 [=>.....] - ETA: 0s - loss: 47.0746
 7/15 [=====>.....] - ETA: 0s - loss: 36.2753
13/15 [=====>.....] - ETA: 0s - loss: 36.5185
15/15 [=====] - 0s 13ms/step - loss: 35.4975 - val_loss: 33.0306
Epoch 4/200

 1/15 [=>.....] - ETA: 0s - loss: 14.3931
 7/15 [=====>.....] - ETA: 0s - loss: 21.5608
13/15 [=====>.....] - ETA: 0s - loss: 21.3751
15/15 [=====] - 0s 13ms/step - loss: 21.1119 - val_loss: 23.7169
Epoch 5/200

 1/15 [=>.....] - ETA: 0s - loss: 20.2075
 7/15 [=====>.....] - ETA: 0s - loss: 16.0363
13/15 [=====>.....] - ETA: 0s - loss: 13.2013
15/15 [=====] - 0s 13ms/step - loss: 12.8459 - val_loss: 11.3649
Epoch 6/200

 1/15 [=>.....] - ETA: 0s - loss: 16.3270
 7/15 [=====>.....] - ETA: 0s - loss: 10.2512
13/15 [=====>.....] - ETA: 0s - loss: 8.6714

```

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15/15 [=====] - 0s 13ms/step - loss: 8.3968 - val_loss: 7.5358
Epoch 7/200

1/15 [=>.....] - ETA: 0s - loss: 8.1717
7/15 [=====>.....] - ETA: 0s - loss: 7.1265
13/15 [=====>.....] - ETA: 0s - loss: 6.3782
15/15 [=====] - 0s 13ms/step - loss: 6.4813 - val_loss: 7.0469
Epoch 8/200

1/15 [=>.....] - ETA: 0s - loss: 4.1148
7/15 [=====>.....] - ETA: 0s - loss: 5.2342
13/15 [=====>.....] - ETA: 0s - loss: 8.7992
15/15 [=====] - 0s 13ms/step - loss: 8.3413 - val_loss: 6.1108
Epoch 9/200

1/15 [=>.....] - ETA: 0s - loss: 3.7610
7/15 [=====>.....] - ETA: 0s - loss: 3.8362
13/15 [=====>.....] - ETA: 0s - loss: 4.6247
15/15 [=====] - 0s 13ms/step - loss: 4.6494 - val_loss: 5.8744
Epoch 10/200

1/15 [=>.....] - ETA: 0s - loss: 2.5499
7/15 [=====>.....] - ETA: 0s - loss: 3.4465
13/15 [=====>.....] - ETA: 0s - loss: 4.0957
15/15 [=====] - 0s 13ms/step - loss: 4.3490 - val_loss: 4.3273
Epoch 11/200

1/15 [=>.....] - ETA: 0s - loss: 4.7402
7/15 [=====>.....] - ETA: 0s - loss: 3.5897
13/15 [=====>.....] - ETA: 0s - loss: 4.1021
15/15 [=====] - 0s 12ms/step - loss: 4.0327 - val_loss: 4.4349
Epoch 12/200

1/15 [=>.....] - ETA: 0s - loss: 2.6870
7/15 [=====>.....] - ETA: 0s - loss: 3.1761
13/15 [=====>.....] - ETA: 0s - loss: 3.3916
15/15 [=====] - 0s 13ms/step - loss: 3.7013 - val_loss: 3.7288
Epoch 13/200

1/15 [=>.....] - ETA: 0s - loss: 2.8164
7/15 [=====>.....] - ETA: 0s - loss: 3.2819
13/15 [=====>.....] - ETA: 0s - loss: 3.6446
15/15 [=====] - 0s 12ms/step - loss: 3.7347 - val_loss: 4.3796
Epoch 14/200

1/15 [=>.....] - ETA: 0s - loss: 5.7558
7/15 [=====>.....] - ETA: 0s - loss: 3.4961
13/15 [=====>.....] - ETA: 0s - loss: 3.5181
15/15 [=====] - 0s 13ms/step - loss: 3.5069 - val_loss: 2.9868
Epoch 15/200

1/15 [=>.....] - ETA: 0s - loss: 6.6244

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```

7/15 [=====>.....] - ETA: 0s - loss: 4.6767
13/15 [=====>.....] - ETA: 0s - loss: 3.8021
15/15 [=====] - 0s 12ms/step - loss: 3.8355 - val_loss: 3.1433
Epoch 16/200

1/15 [=>.....] - ETA: 0s - loss: 1.4305
7/15 [=====>.....] - ETA: 0s - loss: 2.7546
13/15 [=====>.....] - ETA: 0s - loss: 2.9541
15/15 [=====] - 0s 12ms/step - loss: 3.1683 - val_loss: 3.2015
Epoch 17/200

1/15 [=>.....] - ETA: 0s - loss: 4.3201
7/15 [=====>.....] - ETA: 0s - loss: 2.7211
13/15 [=====>.....] - ETA: 0s - loss: 3.1382
15/15 [=====] - 0s 12ms/step - loss: 3.1482 - val_loss: 3.3887
Epoch 18/200

1/15 [=>.....] - ETA: 0s - loss: 3.5297
7/15 [=====>.....] - ETA: 0s - loss: 2.7508
13/15 [=====>.....] - ETA: 0s - loss: 2.9307
15/15 [=====] - 0s 12ms/step - loss: 2.8268 - val_loss: 3.1350
Epoch 19/200

1/15 [=>.....] - ETA: 0s - loss: 2.7005
7/15 [=====>.....] - ETA: 0s - loss: 2.2263
13/15 [=====>.....] - ETA: 0s - loss: 2.9550
15/15 [=====] - 0s 12ms/step - loss: 3.0039 - val_loss: 3.5407
Epoch 20/200

1/15 [=>.....] - ETA: 0s - loss: 3.1367
7/15 [=====>.....] - ETA: 0s - loss: 2.6719
13/15 [=====>.....] - ETA: 0s - loss: 3.0561
15/15 [=====] - 0s 13ms/step - loss: 3.0321 - val_loss: 2.4793
Epoch 21/200

1/15 [=>.....] - ETA: 0s - loss: 2.4910
7/15 [=====>.....] - ETA: 0s - loss: 2.7993
13/15 [=====>.....] - ETA: 0s - loss: 3.0190
15/15 [=====] - 0s 12ms/step - loss: 2.9060 - val_loss: 3.5735
Epoch 22/200

1/15 [=>.....] - ETA: 0s - loss: 6.9295
7/15 [=====>.....] - ETA: 0s - loss: 3.8054
13/15 [=====>.....] - ETA: 0s - loss: 3.2375
15/15 [=====] - 0s 12ms/step - loss: 3.0435 - val_loss: 2.8504
Epoch 23/200

1/15 [=>.....] - ETA: 0s - loss: 1.9562
7/15 [=====>.....] - ETA: 0s - loss: 3.2063
13/15 [=====>.....] - ETA: 0s - loss: 2.9215
15/15 [=====] - 0s 12ms/step - loss: 2.9502 - val_loss: 2.7448
Epoch 24/200

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```

1/15 [=>.....] - ETA: 0s - loss: 1.7540
7/15 [=====>.....] - ETA: 0s - loss: 3.0508
13/15 [=====>.....] - ETA: 0s - loss: 2.3787
15/15 [=====] - 0s 12ms/step - loss: 2.7308 - val_loss: 3.6905
Epoch 25/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.0651
7/15 [=====>.....] - ETA: 0s - loss: 2.3428
13/15 [=====>.....] - ETA: 0s - loss: 2.4820
15/15 [=====] - 0s 13ms/step - loss: 2.4473 - val_loss: 2.4295
Epoch 26/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.2643
7/15 [=====>.....] - ETA: 0s - loss: 2.4319
13/15 [=====>.....] - ETA: 0s - loss: 2.4962
15/15 [=====] - 0s 12ms/step - loss: 2.6481 - val_loss: 2.7489
Epoch 27/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.9471
7/15 [=====>.....] - ETA: 0s - loss: 2.3202
13/15 [=====>.....] - ETA: 0s - loss: 2.2089
15/15 [=====] - 0s 12ms/step - loss: 2.2987 - val_loss: 2.5001
Epoch 28/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.5125
7/15 [=====>.....] - ETA: 0s - loss: 2.0786
13/15 [=====>.....] - ETA: 0s - loss: 2.2016
15/15 [=====] - 0s 12ms/step - loss: 2.2342 - val_loss: 2.7377
Epoch 29/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.1622
7/15 [=====>.....] - ETA: 0s - loss: 2.1734
13/15 [=====>.....] - ETA: 0s - loss: 2.3455
15/15 [=====] - 0s 12ms/step - loss: 2.3965 - val_loss: 2.6056
Epoch 30/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.3980
7/15 [=====>.....] - ETA: 0s - loss: 2.0011
13/15 [=====>.....] - ETA: 0s - loss: 2.2674
15/15 [=====] - 0s 12ms/step - loss: 2.1293 - val_loss: 2.8995
Epoch 31/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.8434
7/15 [=====>.....] - ETA: 0s - loss: 1.7148
13/15 [=====>.....] - ETA: 0s - loss: 2.3370
15/15 [=====] - 0s 12ms/step - loss: 2.4283 - val_loss: 2.6780
Epoch 32/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 3.1943
7/15 [=====>.....] - ETA: 0s - loss: 2.2654
13/15 [=====>.....] - ETA: 0s - loss: 2.6840

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15/15 [=====] - 0s 13ms/step - loss: 2.6186 - val_loss: 2.2427
Epoch 33/200

1/15 [=>.....] - ETA: 0s - loss: 1.0455
7/15 [=====>.....] - ETA: 0s - loss: 2.1843
13/15 [======>....] - ETA: 0s - loss: 2.0883
15/15 [=====] - 0s 12ms/step - loss: 2.0411 - val_loss: 2.7167
Epoch 34/200

1/15 [=>.....] - ETA: 0s - loss: 1.4272
7/15 [=====>.....] - ETA: 0s - loss: 2.0566
13/15 [======>....] - ETA: 0s - loss: 2.1307
15/15 [=====] - 0s 12ms/step - loss: 2.0125 - val_loss: 2.5595
Epoch 35/200

1/15 [=>.....] - ETA: 0s - loss: 1.5844
7/15 [=====>.....] - ETA: 0s - loss: 2.1959
13/15 [======>....] - ETA: 0s - loss: 2.1721
15/15 [=====] - 0s 12ms/step - loss: 2.1954 - val_loss: 2.2978
Epoch 36/200

1/15 [=>.....] - ETA: 0s - loss: 0.7090
7/15 [=====>.....] - ETA: 0s - loss: 1.9376
13/15 [======>....] - ETA: 0s - loss: 1.9586
15/15 [=====] - 0s 12ms/step - loss: 2.1269 - val_loss: 2.4213
Epoch 37/200

1/15 [=>.....] - ETA: 0s - loss: 2.0413
7/15 [=====>.....] - ETA: 0s - loss: 2.5456
13/15 [======>....] - ETA: 0s - loss: 2.1992
15/15 [=====] - 0s 12ms/step - loss: 2.1275 - val_loss: 2.3281
Epoch 38/200

1/15 [=>.....] - ETA: 0s - loss: 1.4713
7/15 [=====>.....] - ETA: 0s - loss: 2.0535
13/15 [======>....] - ETA: 0s - loss: 2.1511
15/15 [=====] - 0s 12ms/step - loss: 2.1542 - val_loss: 2.3722
Epoch 39/200

1/15 [=>.....] - ETA: 0s - loss: 3.4741
7/15 [=====>.....] - ETA: 0s - loss: 2.0628
13/15 [======>....] - ETA: 0s - loss: 2.0460
15/15 [=====] - 0s 12ms/step - loss: 1.9200 - val_loss: 2.5583
Epoch 40/200

1/15 [=>.....] - ETA: 0s - loss: 2.6831
7/15 [=====>.....] - ETA: 0s - loss: 1.7678
13/15 [======>....] - ETA: 0s - loss: 1.9308
15/15 [=====] - 0s 12ms/step - loss: 2.1053 - val_loss: 2.5287
Epoch 41/200

1/15 [=>.....] - ETA: 0s - loss: 2.2368

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```

7/15 [=====>.....] - ETA: 0s - loss: 2.6010
13/15 [=====>.....] - ETA: 0s - loss: 2.1830
15/15 [=====] - 0s 12ms/step - loss: 2.2609 - val_loss: 2.5082
Epoch 42/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.3671
7/15 [=====>.....] - ETA: 0s - loss: 1.9358
13/15 [=====>.....] - ETA: 0s - loss: 1.9123
15/15 [=====] - 0s 13ms/step - loss: 1.8459 - val_loss: 2.2151
Epoch 43/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.4508
7/15 [=====>.....] - ETA: 0s - loss: 2.0102
13/15 [=====>.....] - ETA: 0s - loss: 1.9328
15/15 [=====] - 0s 12ms/step - loss: 1.8890 - val_loss: 2.5237
Epoch 44/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.2964
7/15 [=====>.....] - ETA: 0s - loss: 1.6105
13/15 [=====>.....] - ETA: 0s - loss: 1.9242
15/15 [=====] - 0s 13ms/step - loss: 2.0740 - val_loss: 2.0939
Epoch 45/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.6043
7/15 [=====>.....] - ETA: 0s - loss: 2.1742
13/15 [=====>.....] - ETA: 0s - loss: 1.9705
15/15 [=====] - 0s 12ms/step - loss: 1.9740 - val_loss: 2.1589
Epoch 46/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.5436
7/15 [=====>.....] - ETA: 0s - loss: 1.8677
13/15 [=====>.....] - ETA: 0s - loss: 2.1182
15/15 [=====] - 0s 12ms/step - loss: 2.0157 - val_loss: 2.1192
Epoch 47/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.2618
7/15 [=====>.....] - ETA: 0s - loss: 1.3646
13/15 [=====>.....] - ETA: 0s - loss: 1.7510
15/15 [=====] - 0s 12ms/step - loss: 1.6784 - val_loss: 2.8600
Epoch 48/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.3500
7/15 [=====>.....] - ETA: 0s - loss: 1.8789
13/15 [=====>.....] - ETA: 0s - loss: 1.8269
15/15 [=====] - 0s 12ms/step - loss: 1.8800 - val_loss: 2.1776
Epoch 49/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.0914
7/15 [=====>.....] - ETA: 0s - loss: 1.6548
13/15 [=====>.....] - ETA: 0s - loss: 1.8203
15/15 [=====] - 0s 12ms/step - loss: 1.7845 - val_loss: 2.3271
Epoch 50/200

```

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```

1/15 [=>.....] - ETA: 0s - loss: 1.6002
7/15 [=====>.....] - ETA: 0s - loss: 1.9195
13/15 [=====>.....] - ETA: 0s - loss: 2.1987
15/15 [=====] - 0s 12ms/step - loss: 2.0871 - val_loss: 2.2704

```

Epoch 51/200

```

1/15 [=>.....] - ETA: 0s - loss: 1.3326
7/15 [=====>.....] - ETA: 0s - loss: 1.3155
13/15 [=====>.....] - ETA: 0s - loss: 1.4167
15/15 [=====] - 0s 12ms/step - loss: 1.6277 - val_loss: 2.1128

```

Epoch 52/200

```

1/15 [=>.....] - ETA: 0s - loss: 0.6007
7/15 [=====>.....] - ETA: 0s - loss: 1.4804
13/15 [=====>.....] - ETA: 0s - loss: 1.8867
15/15 [=====] - 0s 13ms/step - loss: 1.9740 - val_loss: 1.9432

```

Epoch 53/200

```

1/15 [=>.....] - ETA: 0s - loss: 1.0130
7/15 [=====>.....] - ETA: 0s - loss: 1.5715
13/15 [=====>.....] - ETA: 0s - loss: 1.7376
15/15 [=====] - 0s 12ms/step - loss: 1.6613 - val_loss: 2.6059

```

Epoch 54/200

```

1/15 [=>.....] - ETA: 0s - loss: 3.2794
7/15 [=====>.....] - ETA: 0s - loss: 2.1145
13/15 [=====>.....] - ETA: 0s - loss: 1.9973
15/15 [=====] - 0s 13ms/step - loss: 1.9761 - val_loss: 2.2372

```

Epoch 55/200

```

1/15 [=>.....] - ETA: 0s - loss: 0.7988
7/15 [=====>.....] - ETA: 0s - loss: 1.5999
13/15 [=====>.....] - ETA: 0s - loss: 1.5060
15/15 [=====] - 0s 12ms/step - loss: 1.7264 - val_loss: 2.2590

```

Epoch 56/200

```

1/15 [=>.....] - ETA: 0s - loss: 0.9411
7/15 [=====>.....] - ETA: 0s - loss: 1.5651
13/15 [=====>.....] - ETA: 0s - loss: 1.8032
15/15 [=====] - 0s 12ms/step - loss: 1.9184 - val_loss: 2.4503

```

Epoch 57/200

```

1/15 [=>.....] - ETA: 0s - loss: 2.0639
7/15 [=====>.....] - ETA: 0s - loss: 1.9148
13/15 [=====>.....] - ETA: 0s - loss: 1.6166
15/15 [=====] - 0s 12ms/step - loss: 1.6989 - val_loss: 2.0215

```

Epoch 58/200

```

1/15 [=>.....] - ETA: 0s - loss: 2.3265
7/15 [=====>.....] - ETA: 0s - loss: 1.5509
13/15 [=====>.....] - ETA: 0s - loss: 1.5846

```

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```
15/15 [=====] - 0s 12ms/step - loss: 1.6238 - val_loss: 2.7183
Epoch 59/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.8367
7/15 [=====>.....] - ETA: 0s - loss: 2.2212
13/15 [=====>.....] - ETA: 0s - loss: 2.0888
15/15 [=====] - 0s 12ms/step - loss: 1.9921 - val_loss: 2.6818
Epoch 60/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.8403
7/15 [=====>.....] - ETA: 0s - loss: 1.4948
13/15 [=====>.....] - ETA: 0s - loss: 1.6015
15/15 [=====] - 0s 12ms/step - loss: 1.6716 - val_loss: 2.0888
Epoch 61/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.1502
7/15 [=====>.....] - ETA: 0s - loss: 1.2716
13/15 [=====>.....] - ETA: 0s - loss: 1.4524
15/15 [=====] - 0s 12ms/step - loss: 1.5052 - val_loss: 2.7474
Epoch 62/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.2197
7/15 [=====>.....] - ETA: 0s - loss: 1.6219
13/15 [=====>.....] - ETA: 0s - loss: 1.9339
15/15 [=====] - 0s 12ms/step - loss: 1.8444 - val_loss: 2.5861
Epoch 63/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.7391
7/15 [=====>.....] - ETA: 0s - loss: 1.8355
13/15 [=====>.....] - ETA: 0s - loss: 1.8596
15/15 [=====] - 0s 12ms/step - loss: 1.8269 - val_loss: 2.2567
Epoch 64/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.9505
7/15 [=====>.....] - ETA: 0s - loss: 1.0283
13/15 [=====>.....] - ETA: 0s - loss: 1.3340
15/15 [=====] - 0s 12ms/step - loss: 1.3984 - val_loss: 2.0575
Epoch 65/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 2.8785
7/15 [=====>.....] - ETA: 0s - loss: 1.9518
13/15 [=====>.....] - ETA: 0s - loss: 1.7943
15/15 [=====] - 0s 13ms/step - loss: 1.9182 - val_loss: 2.5545
Epoch 66/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.8911
7/15 [=====>.....] - ETA: 0s - loss: 2.0795
13/15 [=====>.....] - ETA: 0s - loss: 1.8668
15/15 [=====] - 0s 12ms/step - loss: 1.8622 - val_loss: 2.0557
Epoch 67/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.1443
```

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```

7/15 [======>.....] - ETA: 0s - loss: 1.4161
13/15 [======>.....] - ETA: 0s - loss: 1.4596
15/15 [=====] - 0s 12ms/step - loss: 1.5549 - val_loss: 2.2761
Epoch 68/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.0947
7/15 [======>.....] - ETA: 0s - loss: 1.6113
13/15 [======>.....] - ETA: 0s - loss: 1.5478
15/15 [=====] - 0s 12ms/step - loss: 1.4926 - val_loss: 2.0966
Epoch 69/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.4827
7/15 [======>.....] - ETA: 0s - loss: 1.1943
13/15 [======>.....] - ETA: 0s - loss: 1.4451
15/15 [=====] - 0s 12ms/step - loss: 1.5560 - val_loss: 2.6685
Epoch 70/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.9981
7/15 [======>.....] - ETA: 0s - loss: 1.2220
13/15 [======>.....] - ETA: 0s - loss: 1.5914
15/15 [=====] - 0s 12ms/step - loss: 1.5563 - val_loss: 2.6246
Epoch 71/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.6771
7/15 [======>.....] - ETA: 0s - loss: 1.5078
13/15 [======>.....] - ETA: 0s - loss: 1.6059
15/15 [=====] - 0s 12ms/step - loss: 1.6196 - val_loss: 2.4088
Epoch 72/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.2297
7/15 [======>.....] - ETA: 0s - loss: 1.4016
13/15 [======>.....] - ETA: 0s - loss: 1.5983
15/15 [=====] - 0s 12ms/step - loss: 1.5935 - val_loss: 2.6093
Epoch 73/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.2176
7/15 [======>.....] - ETA: 0s - loss: 1.1048
13/15 [======>.....] - ETA: 0s - loss: 1.5559
15/15 [=====] - 0s 12ms/step - loss: 1.5602 - val_loss: 2.2521
Epoch 74/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 2.6703
7/15 [======>.....] - ETA: 0s - loss: 1.7432
13/15 [======>.....] - ETA: 0s - loss: 1.6443
15/15 [=====] - 0s 12ms/step - loss: 1.6503 - val_loss: 2.5060
Epoch 75/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.3084
7/15 [======>.....] - ETA: 0s - loss: 2.1022
13/15 [======>.....] - ETA: 0s - loss: 1.7481
15/15 [=====] - 0s 12ms/step - loss: 1.7291 - val_loss: 2.2003
Epoch 76/200

```

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```

1/15 [=>.....] - ETA: 0s - loss: 1.8409
7/15 [=====>.....] - ETA: 0s - loss: 1.3679
13/15 [=====>.....] - ETA: 0s - loss: 1.6177
15/15 [=====] - 0s 12ms/step - loss: 1.6144 - val_loss: 2.1971
Epoch 77/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 3.4332
7/15 [=====>.....] - ETA: 0s - loss: 1.8480
13/15 [=====>.....] - ETA: 0s - loss: 1.7060
15/15 [=====] - 0s 12ms/step - loss: 1.8159 - val_loss: 2.5883
Epoch 78/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.3707
7/15 [=====>.....] - ETA: 0s - loss: 1.9318
13/15 [=====>.....] - ETA: 0s - loss: 1.6385
15/15 [=====] - 0s 12ms/step - loss: 1.5415 - val_loss: 2.5017
Epoch 79/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.0350
7/15 [=====>.....] - ETA: 0s - loss: 1.4686
13/15 [=====>.....] - ETA: 0s - loss: 1.4734
15/15 [=====] - 0s 12ms/step - loss: 1.4445 - val_loss: 2.4314
Epoch 80/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.9205
7/15 [=====>.....] - ETA: 0s - loss: 1.4972
13/15 [=====>.....] - ETA: 0s - loss: 1.6104
15/15 [=====] - 0s 12ms/step - loss: 1.6179 - val_loss: 2.3490
Epoch 81/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.8275
7/15 [=====>.....] - ETA: 0s - loss: 1.0077
13/15 [=====>.....] - ETA: 0s - loss: 1.2505
15/15 [=====] - 0s 13ms/step - loss: 1.2437 - val_loss: 2.3982
Epoch 82/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.3305
7/15 [=====>.....] - ETA: 0s - loss: 0.9866
13/15 [=====>.....] - ETA: 0s - loss: 1.4693
15/15 [=====] - 0s 12ms/step - loss: 1.5641 - val_loss: 2.1205
Epoch 83/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.8722
7/15 [=====>.....] - ETA: 0s - loss: 1.5545
13/15 [=====>.....] - ETA: 0s - loss: 1.5060
15/15 [=====] - 0s 12ms/step - loss: 1.5190 - val_loss: 2.2322
Epoch 84/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.3480
7/15 [=====>.....] - ETA: 0s - loss: 1.5045
13/15 [=====>.....] - ETA: 0s - loss: 1.4051

```

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15/15 [=====] - 0s 12ms/step - loss: 1.4388 - val_loss: 2.9242
Epoch 85/200

1/15 [=>.....] - ETA: 0s - loss: 0.6633
7/15 [=====>.....] - ETA: 0s - loss: 1.4092
13/15 [======>.....] - ETA: 0s - loss: 1.4334
15/15 [=====] - 0s 13ms/step - loss: 1.3995 - val_loss: 2.2357
Epoch 86/200

1/15 [=>.....] - ETA: 0s - loss: 0.7584
7/15 [=====>.....] - ETA: 0s - loss: 1.5924
13/15 [======>.....] - ETA: 0s - loss: 1.3992
15/15 [=====] - 0s 12ms/step - loss: 1.4247 - val_loss: 2.0411
Epoch 87/200

1/15 [=>.....] - ETA: 0s - loss: 0.9663
7/15 [=====>.....] - ETA: 0s - loss: 1.3629
13/15 [======>.....] - ETA: 0s - loss: 1.5430
15/15 [=====] - 0s 12ms/step - loss: 1.4854 - val_loss: 2.3002
Epoch 88/200

1/15 [=>.....] - ETA: 0s - loss: 1.0043
7/15 [=====>.....] - ETA: 0s - loss: 1.2375
13/15 [======>.....] - ETA: 0s - loss: 1.2005
15/15 [=====] - 0s 12ms/step - loss: 1.3195 - val_loss: 2.8045
Epoch 89/200

1/15 [=>.....] - ETA: 0s - loss: 1.4922
6/15 [=====>.....] - ETA: 0s - loss: 1.4943
12/15 [======>.....] - ETA: 0s - loss: 1.3564
15/15 [=====] - 0s 13ms/step - loss: 1.4116 - val_loss: 2.1198
Epoch 90/200

1/15 [=>.....] - ETA: 0s - loss: 1.2238
7/15 [=====>.....] - ETA: 0s - loss: 1.4129
13/15 [======>.....] - ETA: 0s - loss: 1.5632
15/15 [=====] - 0s 12ms/step - loss: 1.4924 - val_loss: 2.0940
Epoch 91/200

1/15 [=>.....] - ETA: 0s - loss: 0.4030
7/15 [=====>.....] - ETA: 0s - loss: 1.1599
13/15 [======>.....] - ETA: 0s - loss: 1.0133
15/15 [=====] - 0s 12ms/step - loss: 1.1229 - val_loss: 2.1933
Epoch 92/200

1/15 [=>.....] - ETA: 0s - loss: 0.9224
7/15 [=====>.....] - ETA: 0s - loss: 1.0578
13/15 [======>.....] - ETA: 0s - loss: 1.1559
15/15 [=====] - 0s 13ms/step - loss: 1.2740 - val_loss: 2.5692
Epoch 93/200

1/15 [=>.....] - ETA: 0s - loss: 0.4947

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```

7/15 [=====>.....] - ETA: 0s - loss: 0.9502
13/15 [=====>.....] - ETA: 0s - loss: 1.1097
15/15 [=====>.....] - 0s 12ms/step - loss: 1.1633 - val_loss: 2.2535
Epoch 94/200

1/15 [=>.....] - ETA: 0s - loss: 1.1757
7/15 [=====>.....] - ETA: 0s - loss: 1.4009
13/15 [=====>.....] - ETA: 0s - loss: 1.2568
15/15 [=====>.....] - 0s 12ms/step - loss: 1.2325 - val_loss: 2.2088
Epoch 95/200

1/15 [=>.....] - ETA: 0s - loss: 0.6956
7/15 [=====>.....] - ETA: 0s - loss: 1.2903
13/15 [=====>.....] - ETA: 0s - loss: 1.3145
15/15 [=====>.....] - 0s 12ms/step - loss: 1.2485 - val_loss: 2.3338
Epoch 96/200

1/15 [=>.....] - ETA: 0s - loss: 0.4345
7/15 [=====>.....] - ETA: 0s - loss: 0.9395
13/15 [=====>.....] - ETA: 0s - loss: 1.1969
15/15 [=====>.....] - 0s 12ms/step - loss: 1.1765 - val_loss: 2.5660
Epoch 97/200

1/15 [=>.....] - ETA: 0s - loss: 3.4727
7/15 [=====>.....] - ETA: 0s - loss: 1.6843
13/15 [=====>.....] - ETA: 0s - loss: 1.4186
15/15 [=====>.....] - 0s 12ms/step - loss: 1.3607 - val_loss: 2.5837
Epoch 98/200

1/15 [=>.....] - ETA: 0s - loss: 1.4162
7/15 [=====>.....] - ETA: 0s - loss: 1.3460
13/15 [=====>.....] - ETA: 0s - loss: 1.3089
15/15 [=====>.....] - 0s 13ms/step - loss: 1.3013 - val_loss: 2.8387
Epoch 99/200

1/15 [=>.....] - ETA: 0s - loss: 0.9048
7/15 [=====>.....] - ETA: 0s - loss: 1.0662
13/15 [=====>.....] - ETA: 0s - loss: 1.1458
15/15 [=====>.....] - 0s 12ms/step - loss: 1.1344 - val_loss: 2.0548
Epoch 100/200

1/15 [=>.....] - ETA: 0s - loss: 1.7596
7/15 [=====>.....] - ETA: 0s - loss: 1.2737
13/15 [=====>.....] - ETA: 0s - loss: 1.1687
15/15 [=====>.....] - 0s 12ms/step - loss: 1.1304 - val_loss: 2.2093
Epoch 101/200

1/15 [=>.....] - ETA: 0s - loss: 0.6808
7/15 [=====>.....] - ETA: 0s - loss: 1.0144
13/15 [=====>.....] - ETA: 0s - loss: 1.2914
15/15 [=====>.....] - 0s 12ms/step - loss: 1.2739 - val_loss: 2.0634
Epoch 102/200

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```

1/15 [=>.....] - ETA: 0s - loss: 1.4625
7/15 [=====>.....] - ETA: 0s - loss: 1.3130
13/15 [=====>.....] - ETA: 0s - loss: 1.4357
15/15 [=====] - 0s 12ms/step - loss: 1.4455 - val_loss: 2.5222
Epoch 103/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.1621
7/15 [=====>.....] - ETA: 0s - loss: 1.3640
13/15 [=====>.....] - ETA: 0s - loss: 1.1010
15/15 [=====] - 0s 12ms/step - loss: 1.0979 - val_loss: 2.0870
Epoch 104/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.7378
7/15 [=====>.....] - ETA: 0s - loss: 1.4592
13/15 [=====>.....] - ETA: 0s - loss: 1.2705
15/15 [=====] - 0s 12ms/step - loss: 1.2479 - val_loss: 2.3211
Epoch 105/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.5747
7/15 [=====>.....] - ETA: 0s - loss: 1.0157
13/15 [=====>.....] - ETA: 0s - loss: 0.9012
15/15 [=====] - 0s 12ms/step - loss: 0.9520 - val_loss: 2.3625
Epoch 106/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.6226
7/15 [=====>.....] - ETA: 0s - loss: 0.8635
13/15 [=====>.....] - ETA: 0s - loss: 1.2449
15/15 [=====] - 0s 12ms/step - loss: 1.2562 - val_loss: 2.0478
Epoch 107/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.5797
7/15 [=====>.....] - ETA: 0s - loss: 1.2143
13/15 [=====>.....] - ETA: 0s - loss: 1.3034
15/15 [=====] - 0s 12ms/step - loss: 1.2672 - val_loss: 2.1165
Epoch 108/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.6544
7/15 [=====>.....] - ETA: 0s - loss: 0.7844
13/15 [=====>.....] - ETA: 0s - loss: 1.1015
15/15 [=====] - 0s 12ms/step - loss: 1.1511 - val_loss: 2.1028
Epoch 109/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.4959
7/15 [=====>.....] - ETA: 0s - loss: 1.4394
13/15 [=====>.....] - ETA: 0s - loss: 1.0784
15/15 [=====] - 0s 13ms/step - loss: 1.0512 - val_loss: 1.8269
Epoch 110/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.6413
7/15 [=====>.....] - ETA: 0s - loss: 1.2659
13/15 [=====>.....] - ETA: 0s - loss: 1.1927

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```
15/15 [=====] - 0s 13ms/step - loss: 1.1347 - val_loss: 2.6621
Epoch 111/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.4235
7/15 [=====>.....] - ETA: 0s - loss: 0.9875
13/15 [=====>.....] - ETA: 0s - loss: 1.1996
15/15 [=====] - 0s 13ms/step - loss: 1.1961 - val_loss: 2.6303
Epoch 112/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.5395
7/15 [=====>.....] - ETA: 0s - loss: 1.0854
13/15 [=====>.....] - ETA: 0s - loss: 1.0946
15/15 [=====] - 0s 12ms/step - loss: 1.1080 - val_loss: 2.2965
Epoch 113/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.0466
7/15 [=====>.....] - ETA: 0s - loss: 1.0484
13/15 [=====>.....] - ETA: 0s - loss: 1.1986
15/15 [=====] - 0s 12ms/step - loss: 1.2695 - val_loss: 1.9523
Epoch 114/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.9668
7/15 [=====>.....] - ETA: 0s - loss: 1.5339
13/15 [=====>.....] - ETA: 0s - loss: 1.3562
15/15 [=====] - 0s 12ms/step - loss: 1.3523 - val_loss: 2.6725
Epoch 115/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.1851
7/15 [=====>.....] - ETA: 0s - loss: 1.2211
13/15 [=====>.....] - ETA: 0s - loss: 1.2835
15/15 [=====] - 0s 13ms/step - loss: 1.2637 - val_loss: 2.5011
Epoch 116/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.5189
7/15 [=====>.....] - ETA: 0s - loss: 1.1549
13/15 [=====>.....] - ETA: 0s - loss: 1.2220
15/15 [=====] - 0s 12ms/step - loss: 1.2325 - val_loss: 2.2236
Epoch 117/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.6592
7/15 [=====>.....] - ETA: 0s - loss: 1.0288
13/15 [=====>.....] - ETA: 0s - loss: 1.0527
15/15 [=====] - 0s 12ms/step - loss: 1.1639 - val_loss: 1.9677
Epoch 118/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.8941
7/15 [=====>.....] - ETA: 0s - loss: 1.0981
13/15 [=====>.....] - ETA: 0s - loss: 1.4138
15/15 [=====] - 0s 13ms/step - loss: 1.4279 - val_loss: 2.7189
Epoch 119/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.5258
```

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```

7/15 [=====>.....] - ETA: 0s - loss: 1.2400
13/15 [=====>.....] - ETA: 0s - loss: 1.2840
15/15 [=====] - 0s 12ms/step - loss: 1.2965 - val_loss: 2.0886
Epoch 120/200

1/15 [=>.....] - ETA: 0s - loss: 0.4811
7/15 [=====>.....] - ETA: 0s - loss: 1.0280
13/15 [=====>.....] - ETA: 0s - loss: 1.1453
15/15 [=====] - 0s 12ms/step - loss: 1.0567 - val_loss: 2.5234
Epoch 121/200

1/15 [=>.....] - ETA: 0s - loss: 0.6248
7/15 [=====>.....] - ETA: 0s - loss: 0.8681
13/15 [=====>.....] - ETA: 0s - loss: 1.0284
15/15 [=====] - 0s 12ms/step - loss: 1.0128 - val_loss: 2.1767
Epoch 122/200

1/15 [=>.....] - ETA: 0s - loss: 0.6135
7/15 [=====>.....] - ETA: 0s - loss: 0.6475
13/15 [=====>.....] - ETA: 0s - loss: 1.0187
15/15 [=====] - 0s 12ms/step - loss: 1.0891 - val_loss: 2.5451
Epoch 123/200

1/15 [=>.....] - ETA: 0s - loss: 1.3741
7/15 [=====>.....] - ETA: 0s - loss: 0.9434
13/15 [=====>.....] - ETA: 0s - loss: 1.0246
15/15 [=====] - 0s 12ms/step - loss: 1.1692 - val_loss: 1.9127
Epoch 124/200

1/15 [=>.....] - ETA: 0s - loss: 1.1424
7/15 [=====>.....] - ETA: 0s - loss: 1.1413
13/15 [=====>.....] - ETA: 0s - loss: 1.1841
15/15 [=====] - 0s 12ms/step - loss: 1.2635 - val_loss: 2.2702
Epoch 125/200

1/15 [=>.....] - ETA: 0s - loss: 0.7925
7/15 [=====>.....] - ETA: 0s - loss: 0.7461
13/15 [=====>.....] - ETA: 0s - loss: 1.1152
15/15 [=====] - 0s 12ms/step - loss: 1.1856 - val_loss: 2.1506
Epoch 126/200

1/15 [=>.....] - ETA: 0s - loss: 0.6867
7/15 [=====>.....] - ETA: 0s - loss: 0.7181
13/15 [=====>.....] - ETA: 0s - loss: 1.0964
15/15 [=====] - 0s 13ms/step - loss: 1.1208 - val_loss: 2.0487
Epoch 127/200

1/15 [=>.....] - ETA: 0s - loss: 1.9348
7/15 [=====>.....] - ETA: 0s - loss: 0.9597
13/15 [=====>.....] - ETA: 0s - loss: 1.0841
15/15 [=====] - 0s 12ms/step - loss: 1.0388 - val_loss: 2.4648
Epoch 128/200

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```

1/15 [=>.....] - ETA: 0s - loss: 0.8304
7/15 [=====>.....] - ETA: 0s - loss: 0.8365
13/15 [=====>.....] - ETA: 0s - loss: 0.8433
15/15 [=====] - 0s 12ms/step - loss: 0.8662 - val_loss: 1.8202
Epoch 129/200

1/15 [=>.....] - ETA: 0s - loss: 0.9107
7/15 [=====>.....] - ETA: 0s - loss: 0.9630
13/15 [=====>.....] - ETA: 0s - loss: 0.8733
15/15 [=====] - 0s 12ms/step - loss: 0.8555 - val_loss: 2.0297
Epoch 130/200

1/15 [=>.....] - ETA: 0s - loss: 1.0718
7/15 [=====>.....] - ETA: 0s - loss: 1.0616
13/15 [=====>.....] - ETA: 0s - loss: 1.0300
15/15 [=====] - 0s 12ms/step - loss: 1.0001 - val_loss: 2.0865
Epoch 131/200

1/15 [=>.....] - ETA: 0s - loss: 1.0548
7/15 [=====>.....] - ETA: 0s - loss: 1.0354
13/15 [=====>.....] - ETA: 0s - loss: 0.8903
15/15 [=====] - 0s 12ms/step - loss: 0.9544 - val_loss: 2.0241
Epoch 132/200

1/15 [=>.....] - ETA: 0s - loss: 1.3050
7/15 [=====>.....] - ETA: 0s - loss: 0.7607
13/15 [=====>.....] - ETA: 0s - loss: 0.7852
15/15 [=====] - 0s 12ms/step - loss: 0.8129 - val_loss: 2.1968
Epoch 133/200

1/15 [=>.....] - ETA: 0s - loss: 0.6667
7/15 [=====>.....] - ETA: 0s - loss: 0.8162
13/15 [=====>.....] - ETA: 0s - loss: 1.0623
15/15 [=====] - 0s 13ms/step - loss: 1.0652 - val_loss: 1.8571
Epoch 134/200

1/15 [=>.....] - ETA: 0s - loss: 2.0597
7/15 [=====>.....] - ETA: 0s - loss: 1.0133
13/15 [=====>.....] - ETA: 0s - loss: 0.9201
15/15 [=====] - 0s 12ms/step - loss: 0.9763 - val_loss: 2.0213
Epoch 135/200

1/15 [=>.....] - ETA: 0s - loss: 0.7194
7/15 [=====>.....] - ETA: 0s - loss: 1.2892
13/15 [=====>.....] - ETA: 0s - loss: 1.1955
15/15 [=====] - 0s 12ms/step - loss: 1.1305 - val_loss: 1.8479
Epoch 136/200

1/15 [=>.....] - ETA: 0s - loss: 0.6678
7/15 [=====>.....] - ETA: 0s - loss: 0.6881
13/15 [=====>.....] - ETA: 0s - loss: 0.8227

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```
15/15 [=====] - 0s 12ms/step - loss: 0.7935 - val_loss: 2.3694
Epoch 137/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.6329
7/15 [=====>.....] - ETA: 0s - loss: 0.9452
13/15 [=====>.....] - ETA: 0s - loss: 0.8897
15/15 [=====] - 0s 12ms/step - loss: 0.8827 - val_loss: 2.1870
Epoch 138/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.7832
7/15 [=====>.....] - ETA: 0s - loss: 0.8335
13/15 [=====>.....] - ETA: 0s - loss: 0.7961
15/15 [=====] - 0s 12ms/step - loss: 0.8194 - val_loss: 2.8175
Epoch 139/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.5968
7/15 [=====>.....] - ETA: 0s - loss: 0.7627
13/15 [=====>.....] - ETA: 0s - loss: 0.9451
15/15 [=====] - 0s 12ms/step - loss: 0.9578 - val_loss: 1.9120
Epoch 140/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.2130
7/15 [=====>.....] - ETA: 0s - loss: 0.9536
13/15 [=====>.....] - ETA: 0s - loss: 0.9513
15/15 [=====] - 0s 12ms/step - loss: 0.9011 - val_loss: 1.6853
Epoch 141/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.9705
7/15 [=====>.....] - ETA: 0s - loss: 0.7795
13/15 [=====>.....] - ETA: 0s - loss: 0.7762
15/15 [=====] - 0s 12ms/step - loss: 0.8470 - val_loss: 2.2243
Epoch 142/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.0556
7/15 [=====>.....] - ETA: 0s - loss: 0.7408
13/15 [=====>.....] - ETA: 0s - loss: 1.0709
15/15 [=====] - 0s 12ms/step - loss: 1.0337 - val_loss: 2.3847
Epoch 143/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.5436
7/15 [=====>.....] - ETA: 0s - loss: 0.8937
13/15 [=====>.....] - ETA: 0s - loss: 0.9740
15/15 [=====] - 0s 12ms/step - loss: 0.9998 - val_loss: 2.0424
Epoch 144/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.5241
7/15 [=====>.....] - ETA: 0s - loss: 0.7466
13/15 [=====>.....] - ETA: 0s - loss: 0.7768
15/15 [=====] - 0s 12ms/step - loss: 0.8133 - val_loss: 1.9016
Epoch 145/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.9157
```

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```

7/15 [=====>.....] - ETA: 0s - loss: 1.3226
13/15 [=====>.....] - ETA: 0s - loss: 1.0269
15/15 [=====] - 0s 12ms/step - loss: 0.9647 - val_loss: 2.1023
Epoch 146/200

1/15 [=>.....] - ETA: 0s - loss: 0.4668
7/15 [=====>.....] - ETA: 0s - loss: 1.0914
13/15 [=====>.....] - ETA: 0s - loss: 0.9170
15/15 [=====] - 0s 12ms/step - loss: 1.0113 - val_loss: 1.9554
Epoch 147/200

1/15 [=>.....] - ETA: 0s - loss: 0.6931
7/15 [=====>.....] - ETA: 0s - loss: 1.0475
13/15 [=====>.....] - ETA: 0s - loss: 0.8992
15/15 [=====] - 0s 12ms/step - loss: 0.9277 - val_loss: 2.1267
Epoch 148/200

1/15 [=>.....] - ETA: 0s - loss: 0.5034
7/15 [=====>.....] - ETA: 0s - loss: 1.0832
13/15 [=====>.....] - ETA: 0s - loss: 0.9910
15/15 [=====] - 0s 12ms/step - loss: 0.9172 - val_loss: 2.0420
Epoch 149/200

1/15 [=>.....] - ETA: 0s - loss: 0.7639
7/15 [=====>.....] - ETA: 0s - loss: 0.8625
13/15 [=====>.....] - ETA: 0s - loss: 1.0017
15/15 [=====] - 0s 12ms/step - loss: 1.0126 - val_loss: 2.8888
Epoch 150/200

1/15 [=>.....] - ETA: 0s - loss: 2.2718
7/15 [=====>.....] - ETA: 0s - loss: 1.1285
13/15 [=====>.....] - ETA: 0s - loss: 1.4325
15/15 [=====] - 0s 12ms/step - loss: 1.5221 - val_loss: 2.3440
Epoch 151/200

1/15 [=>.....] - ETA: 0s - loss: 2.9352
7/15 [=====>.....] - ETA: 0s - loss: 1.2814
13/15 [=====>.....] - ETA: 0s - loss: 1.0919
15/15 [=====] - 0s 13ms/step - loss: 1.0493 - val_loss: 2.0816
Epoch 152/200

1/15 [=>.....] - ETA: 0s - loss: 0.4849
7/15 [=====>.....] - ETA: 0s - loss: 1.0224
13/15 [=====>.....] - ETA: 0s - loss: 0.9247
15/15 [=====] - 0s 12ms/step - loss: 0.9317 - val_loss: 2.0926
Epoch 153/200

1/15 [=>.....] - ETA: 0s - loss: 0.8387
7/15 [=====>.....] - ETA: 0s - loss: 0.8553
13/15 [=====>.....] - ETA: 0s - loss: 0.9288
15/15 [=====] - 0s 12ms/step - loss: 0.9175 - val_loss: 1.8078
Epoch 154/200

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```

1/15 [=>.....] - ETA: 0s - loss: 0.6392
7/15 [=====>.....] - ETA: 0s - loss: 0.6593
13/15 [=====>.....] - ETA: 0s - loss: 0.8029
15/15 [=====] - 0s 12ms/step - loss: 0.8704 - val_loss: 1.8763
Epoch 155/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.9114
7/15 [=====>.....] - ETA: 0s - loss: 0.7700
13/15 [=====>.....] - ETA: 0s - loss: 0.8778
15/15 [=====] - 0s 13ms/step - loss: 0.8691 - val_loss: 2.3898
Epoch 156/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.4266
7/15 [=====>.....] - ETA: 0s - loss: 0.7858
13/15 [=====>.....] - ETA: 0s - loss: 0.7893
15/15 [=====] - 0s 12ms/step - loss: 0.8337 - val_loss: 2.2552
Epoch 157/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.8406
7/15 [=====>.....] - ETA: 0s - loss: 0.7775
13/15 [=====>.....] - ETA: 0s - loss: 0.8695
15/15 [=====] - 0s 13ms/step - loss: 0.8520 - val_loss: 1.8591
Epoch 158/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.6674
7/15 [=====>.....] - ETA: 0s - loss: 1.0136
13/15 [=====>.....] - ETA: 0s - loss: 0.8167
15/15 [=====] - 0s 12ms/step - loss: 0.8573 - val_loss: 2.0629
Epoch 159/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.8392
7/15 [=====>.....] - ETA: 0s - loss: 0.7669
13/15 [=====>.....] - ETA: 0s - loss: 0.7987
15/15 [=====] - 0s 12ms/step - loss: 0.8846 - val_loss: 1.8954
Epoch 160/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.7112
7/15 [=====>.....] - ETA: 0s - loss: 0.5101
13/15 [=====>.....] - ETA: 0s - loss: 0.7831
15/15 [=====] - 0s 13ms/step - loss: 0.7523 - val_loss: 2.0645
Epoch 161/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.2595
7/15 [=====>.....] - ETA: 0s - loss: 0.7317
13/15 [=====>.....] - ETA: 0s - loss: 0.8436
15/15 [=====] - 0s 12ms/step - loss: 0.8074 - val_loss: 2.4716
Epoch 162/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.8633
7/15 [=====>.....] - ETA: 0s - loss: 0.8052
13/15 [=====>.....] - ETA: 0s - loss: 1.0638

```

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```
15/15 [=====] - 0s 12ms/step - loss: 1.0077 - val_loss: 1.7830
Epoch 163/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.5295
7/15 [=====>.....] - ETA: 0s - loss: 0.9684
13/15 [=====>.....] - ETA: 0s - loss: 0.9834
15/15 [=====] - 0s 12ms/step - loss: 0.9944 - val_loss: 1.9110
Epoch 164/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.5271
7/15 [=====>.....] - ETA: 0s - loss: 0.8627
13/15 [=====>.....] - ETA: 0s - loss: 0.9272
15/15 [=====] - 0s 12ms/step - loss: 0.8886 - val_loss: 1.9148
Epoch 165/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.7470
7/15 [=====>.....] - ETA: 0s - loss: 0.8168
13/15 [=====>.....] - ETA: 0s - loss: 0.7302
15/15 [=====] - 0s 12ms/step - loss: 0.8381 - val_loss: 1.8391
Epoch 166/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.3404
7/15 [=====>.....] - ETA: 0s - loss: 0.7285
13/15 [=====>.....] - ETA: 0s - loss: 0.7236
15/15 [=====] - 0s 12ms/step - loss: 0.7243 - val_loss: 2.3339
Epoch 167/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.0984
7/15 [=====>.....] - ETA: 0s - loss: 0.5973
13/15 [=====>.....] - ETA: 0s - loss: 0.7345
15/15 [=====] - 0s 12ms/step - loss: 0.7060 - val_loss: 1.8992
Epoch 168/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.5015
7/15 [=====>.....] - ETA: 0s - loss: 0.9411
13/15 [=====>.....] - ETA: 0s - loss: 0.8554
15/15 [=====] - 0s 12ms/step - loss: 0.8175 - val_loss: 1.7593
Epoch 169/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.4614
7/15 [=====>.....] - ETA: 0s - loss: 0.8250
13/15 [=====>.....] - ETA: 0s - loss: 0.8220
15/15 [=====] - 0s 12ms/step - loss: 0.7752 - val_loss: 1.8975
Epoch 170/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 1.1787
7/15 [=====>.....] - ETA: 0s - loss: 0.7762
13/15 [=====>.....] - ETA: 0s - loss: 0.8103
15/15 [=====] - 0s 12ms/step - loss: 0.8378 - val_loss: 2.5398
Epoch 171/200
```

```
1/15 [=>.....] - ETA: 0s - loss: 0.6021
```

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```

7/15 [======>.....] - ETA: 0s - loss: 0.9179
13/15 [======>.....] - ETA: 0s - loss: 1.0071
15/15 [=====] - 0s 13ms/step - loss: 1.0101 - val_loss: 2.4155
Epoch 172/200

1/15 [=>.....] - ETA: 0s - loss: 0.4858
7/15 [======>.....] - ETA: 0s - loss: 0.7319
13/15 [======>.....] - ETA: 0s - loss: 0.8059
15/15 [=====] - 0s 12ms/step - loss: 0.8596 - val_loss: 2.0365
Epoch 173/200

1/15 [=>.....] - ETA: 0s - loss: 0.9322
7/15 [======>.....] - ETA: 0s - loss: 0.7031
13/15 [======>.....] - ETA: 0s - loss: 0.6961
15/15 [=====] - 0s 12ms/step - loss: 0.6849 - val_loss: 1.9582
Epoch 174/200

1/15 [=>.....] - ETA: 0s - loss: 0.6231
7/15 [======>.....] - ETA: 0s - loss: 0.9291
13/15 [======>.....] - ETA: 0s - loss: 0.8811
15/15 [=====] - 0s 12ms/step - loss: 0.9098 - val_loss: 1.8660
Epoch 175/200

1/15 [=>.....] - ETA: 0s - loss: 0.5843
7/15 [======>.....] - ETA: 0s - loss: 0.8012
13/15 [======>.....] - ETA: 0s - loss: 0.7742
15/15 [=====] - 0s 12ms/step - loss: 0.7758 - val_loss: 2.0706
Epoch 176/200

1/15 [=>.....] - ETA: 0s - loss: 0.3513
7/15 [======>.....] - ETA: 0s - loss: 0.8743
13/15 [======>.....] - ETA: 0s - loss: 0.7726
15/15 [=====] - 0s 12ms/step - loss: 0.7617 - val_loss: 2.1138
Epoch 177/200

1/15 [=>.....] - ETA: 0s - loss: 0.4382
7/15 [======>.....] - ETA: 0s - loss: 0.8877
13/15 [======>.....] - ETA: 0s - loss: 0.7988
15/15 [=====] - 0s 12ms/step - loss: 0.7692 - val_loss: 2.8164
Epoch 178/200

1/15 [=>.....] - ETA: 0s - loss: 0.6719
7/15 [======>.....] - ETA: 0s - loss: 0.7333
13/15 [======>.....] - ETA: 0s - loss: 0.7607
15/15 [=====] - 0s 12ms/step - loss: 0.7772 - val_loss: 1.9122
Epoch 179/200

1/15 [=>.....] - ETA: 0s - loss: 0.3871
7/15 [======>.....] - ETA: 0s - loss: 0.6935
13/15 [======>.....] - ETA: 0s - loss: 0.8227
15/15 [=====] - 0s 12ms/step - loss: 0.8234 - val_loss: 2.0525
Epoch 180/200

```

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```

1/15 [=>.....] - ETA: 0s - loss: 0.7553
7/15 [=====>.....] - ETA: 0s - loss: 0.6966
13/15 [=====>.....] - ETA: 0s - loss: 0.7489
15/15 [=====] - 0s 12ms/step - loss: 0.8096 - val_loss: 2.1681
Epoch 181/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.5238
7/15 [=====>.....] - ETA: 0s - loss: 0.8019
13/15 [=====>.....] - ETA: 0s - loss: 0.8136
15/15 [=====] - 0s 12ms/step - loss: 0.9027 - val_loss: 2.1411
Epoch 182/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.8867
7/15 [=====>.....] - ETA: 0s - loss: 0.8808
13/15 [=====>.....] - ETA: 0s - loss: 0.6612
15/15 [=====] - 0s 12ms/step - loss: 0.6851 - val_loss: 2.3409
Epoch 183/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 1.1011
7/15 [=====>.....] - ETA: 0s - loss: 0.7449
13/15 [=====>.....] - ETA: 0s - loss: 0.7618
15/15 [=====] - 0s 12ms/step - loss: 0.8364 - val_loss: 2.5134
Epoch 184/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.8517
7/15 [=====>.....] - ETA: 0s - loss: 1.1462
13/15 [=====>.....] - ETA: 0s - loss: 1.0567
15/15 [=====] - 0s 13ms/step - loss: 1.0396 - val_loss: 2.2396
Epoch 185/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.7482
7/15 [=====>.....] - ETA: 0s - loss: 0.5148
13/15 [=====>.....] - ETA: 0s - loss: 0.6535
15/15 [=====] - 0s 12ms/step - loss: 0.7005 - val_loss: 2.1887
Epoch 186/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.4476
7/15 [=====>.....] - ETA: 0s - loss: 0.6709
13/15 [=====>.....] - ETA: 0s - loss: 0.6320
15/15 [=====] - 0s 12ms/step - loss: 0.6647 - val_loss: 2.4125
Epoch 187/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.9371
7/15 [=====>.....] - ETA: 0s - loss: 0.6336
13/15 [=====>.....] - ETA: 0s - loss: 0.7138
15/15 [=====] - 0s 12ms/step - loss: 0.6710 - val_loss: 2.4674
Epoch 188/200

```

```

1/15 [=>.....] - ETA: 0s - loss: 0.4492
7/15 [=====>.....] - ETA: 0s - loss: 0.7212
13/15 [=====>.....] - ETA: 0s - loss: 0.8027

```

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15/15 [=====] - 0s 12ms/step - loss: 0.8205 - val_loss: 2.2311
Epoch 189/200

1/15 [=>.....] - ETA: 0s - loss: 0.3585
7/15 [=====>.....] - ETA: 0s - loss: 0.5861
13/15 [======>....] - ETA: 0s - loss: 0.6485
15/15 [=====] - 0s 12ms/step - loss: 0.6604 - val_loss: 2.3496
Epoch 190/200

1/15 [=>.....] - ETA: 0s - loss: 0.5472
7/15 [=====>.....] - ETA: 0s - loss: 0.7030
13/15 [======>....] - ETA: 0s - loss: 0.6718
15/15 [=====] - 0s 13ms/step - loss: 0.6742 - val_loss: 2.1473
Epoch 191/200

1/15 [=>.....] - ETA: 0s - loss: 0.3372
7/15 [=====>.....] - ETA: 0s - loss: 0.5297
13/15 [======>....] - ETA: 0s - loss: 0.6568
15/15 [=====] - 0s 12ms/step - loss: 0.6967 - val_loss: 1.7989
Epoch 192/200

1/15 [=>.....] - ETA: 0s - loss: 0.4792
7/15 [=====>.....] - ETA: 0s - loss: 0.7513
13/15 [======>....] - ETA: 0s - loss: 0.7630
15/15 [=====] - 0s 12ms/step - loss: 0.8046 - val_loss: 2.1071
Epoch 193/200

1/15 [=>.....] - ETA: 0s - loss: 1.1358
7/15 [=====>.....] - ETA: 0s - loss: 0.9317
13/15 [======>....] - ETA: 0s - loss: 0.8898
15/15 [=====] - 0s 12ms/step - loss: 0.8281 - val_loss: 2.5788
Epoch 194/200

1/15 [=>.....] - ETA: 0s - loss: 0.5042
7/15 [=====>.....] - ETA: 0s - loss: 0.4612
13/15 [======>....] - ETA: 0s - loss: 0.7050
15/15 [=====] - 0s 12ms/step - loss: 0.7239 - val_loss: 1.9998
Epoch 195/200

1/15 [=>.....] - ETA: 0s - loss: 0.8135
7/15 [=====>.....] - ETA: 0s - loss: 0.6105
13/15 [======>....] - ETA: 0s - loss: 0.9310
15/15 [=====] - 0s 12ms/step - loss: 0.8840 - val_loss: 2.5661
Epoch 196/200

1/15 [=>.....] - ETA: 0s - loss: 1.4881
7/15 [=====>.....] - ETA: 0s - loss: 0.6750
13/15 [======>....] - ETA: 0s - loss: 0.7211
15/15 [=====] - 0s 12ms/step - loss: 0.7183 - val_loss: 2.4717
Epoch 197/200

1/15 [=>.....] - ETA: 0s - loss: 0.7202

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```

7/15 [=====>.....] - ETA: 0s - loss: 0.9092
13/15 [=====>.....] - ETA: 0s - loss: 0.7918
15/15 [=====] - 0s 12ms/step - loss: 0.8038 - val_loss: 1.7631
Epoch 198/200

1/15 [=>.....] - ETA: 0s - loss: 1.1549
7/15 [=====>.....] - ETA: 0s - loss: 0.9070
13/15 [=====>.....] - ETA: 0s - loss: 0.9109
15/15 [=====] - 0s 12ms/step - loss: 0.8816 - val_loss: 2.2060
Epoch 199/200

1/15 [=>.....] - ETA: 0s - loss: 0.5789
7/15 [=====>.....] - ETA: 0s - loss: 0.5545
13/15 [=====>.....] - ETA: 0s - loss: 0.5975
15/15 [=====] - 0s 13ms/step - loss: 0.5930 - val_loss: 2.9432
Epoch 200/200

1/15 [=>.....] - ETA: 0s - loss: 0.5004
7/15 [=====>.....] - ETA: 0s - loss: 1.0158
13/15 [=====>.....] - ETA: 0s - loss: 0.9368
15/15 [=====] - 0s 12ms/step - loss: 0.8939 - val_loss: 2.3559
***** Successfully loaded weights from weights_140_1.68529.hdf5 file *****

***** Removing Examples with nan in labels *****

***** Validation *****
input_x shape: (44, 14, 13)
target shape: (44, 1)
assigning name input_1 to IteratorGetNext:0 with shape (None, 14, 13)

1/2 [=====>.....] - ETA: 0s
2/2 [=====] - 0s 3ms/step
25 16243831.77715406 205

***** Removing Examples with nan in labels *****

***** Training *****
input_x shape: (174, 14, 13)
target shape: (174, 1)

1/6 [====>.....] - ETA: 0s
6/6 [=====] - 0s 3ms/step

***** Removing Examples with nan in labels *****

***** Validation *****
input_x shape: (44, 14, 13)
target shape: (44, 1)

1/2 [=====>.....] - ETA: 0s
2/2 [=====] - 0s 3ms/step

```

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```
***** Removing Examples with nan in labels *****

***** Training *****
input_x shape: (174, 14, 13)
target shape: (174, 1)

***** Removing Examples with nan in labels *****

***** Validation *****
input_x shape: (44, 14, 13)
target shape: (44, 1)
***** Test *****
input_x shape: (0,)
target shape: (0,)

1/7 [==>.....] - ETA: 0s
7/7 [=====] - 0s 3ms/step
```

Total running time of the script: (6 minutes 47.340 seconds)

INDICES AND TABLES

- `genindex`
- `modindex`
- `search`