Predict Bike Sharing Demand with AutoGluon Template

Project: Predict Bike Sharing Demand with AutoGluon

This notebook is a template with each step that you need to complete for the project.

Please fill in your code where there are explicit `?` markers in the notebook. You are welcome to add more cells and code as you see fit.

Once you have completed all the code implementations, please export your notebook as a HTML file so the reviews can view your code. Make sure you have all outputs correctly outputted.

`File-> Export Notebook As... -> Export Notebook as HTML`

There is a writeup to complete as well after all code implememtation is done. Please answer all questions and attach the necessary tables and charts. You can complete the writeup in either markdown or PDF.

Completing the code template and writeup template will cover all of the rubric points for this project.

The rubric contains "Stand Out Suggestions" for enhancing the project beyond the minimum requirements. The stand out suggestions are optional. If you decide to pursue the "stand out suggestions", you can include the code in this notebook and also discuss the results in the writeup file.

Step 1: Create an account with Kaggle

Create Kaggle Account and download API key

Below is example of steps to get the API username and key. Each student will have their own username and key.

1. Open account settings.  kaggle1.png  kaggle2.png
2. Scroll down to API and click Create New API Token.  kaggle3.png kaggle4.png
3. Open up `kaggle.json` and use the username and key. kaggle5.png

Step 2: Download the Kaggle dataset using the kaggle python library

Open up Sagemaker Studio and use starter template

1. Notebook should be using a `ml.t3.medium` instance (2 vCPU + 4 GiB)
2. Notebook should be using kernal: `Python 3 (MXNet 1.8 Python 3.7 CPU Optimized)`

Install packages

```
!pip install -U pip
!pip install -U setuptools wheel
!pip install -U "mxnet<2.0.0" bokeh==2.0.1
!pip install autogluon #--no-cache-dir
# Without --no-cache-dir, smaller aws instances may have trouble installing
```

```
Requirement already satisfied: pip in /usr/local/lib/python3.10/dist-packages (24.1.2)
Collecting pip
  Using cached pip-24.2-py3-none-any.whl.metadata (3.6 kB)
Using cached pip-24.2-py3-none-any.whl (1.8 MB)
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 24.1.2
    Uninstalling pip-24.1.2:
      Successfully uninstalled pip-24.1.2
Successfully installed pip-24.2
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-packages (
Collecting setuptools
  Using cached setuptools-75.1.0-py3-none-any.whl.metadata (6.9 kB)
Requirement already satisfied: wheel in /usr/local/lib/python3.10/dist-packages (0.44.
Using cached setuptools-75.1.0-py3-none-any.whl (1.2 MB)
Installing collected packages: setuptools
  Attempting uninstall: setuptools
    Found existing installation: setuptools 71.0.4
    Uninstalling setuptools-71.0.4:
      Successfully uninstalled setuptools-71.0.4
ERROR: pip's dependency resolver does not currently take into account all the packages
ipython 7.34.0 requires jedi>=0.16, which is not installed.
Successfully installed setuptools-75.1.0
Collecting mxnet<2.0.0
  Downloading mxnet-1.9.1-py3-none-manylinux2014_x86_64.whl.metadata (3.4 kB)
Collecting bokeh==2.0.1
  Downloading bokeh-2.0.1.tar.gz (8.6 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 8.6/8.6 MB 18.6 MB/s eta 0:00:00
  Preparing metadata (setup.py) ... done
Requirement already satisfied: PyYAML>=3.10 in /usr/local/lib/python3.10/dist-packages
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.10/dist-
Requirement already satisfied: Jinja2>=2.7 in /usr/local/lib/python3.10/dist-packages
Requirement already satisfied: numpy>=1.11.3 in /usr/local/lib/python3.10/dist-package
Requirement already satisfied: pillow>=4.0 in /usr/local/lib/python3.10/dist-packages
Requirement already satisfied: packaging>=16.8 in /usr/local/lib/python3.10/dist-packa
Requirement already satisfied: tornado>=5 in /usr/local/lib/python3.10/dist-packages (
Requirement already satisfied: typing_extensions>=3.7.4 in /usr/local/lib/python3.10/d
Requirement already satisfied: requests<3,>=2.20.0 in /usr/local/lib/python3.10/dist-p
Collecting graphviz<0.9.0,>=0.8.1 (from mxnet<2.0.0)
  Downloading graphviz-0.8.4-py2.py3-none-any.whl.metadata (6.4 kB)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packa
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (fr
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/d
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-pa
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-pa
Downloading mxnet-1.9.1-py3-none-manylinux2014_x86_64.whl (49.1 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 49.1/49.1 MB 42.6 MB/s eta 0:00:00
Downloading graphviz-0.8.4-py2.py3-none-any.whl (16 kB)
Building wheels for collected packages: bokeh
  Building wheel for bokeh (setup.py) ... done
  Created wheel for bokeh: filename=bokeh-2.0.1-py3-none-any.whl size=9080017 sha256=3
  Stored in directory: /root/.cache/pip/wheels/be/b4/d8/7ce778fd6e637bea03a561223a77ba
Successfully built bokeh
Installing collected packages: graphviz, mxnet, bokeh
  Attempting uninstall: graphviz
    Found existing installation: graphviz 0.20.3
    Uninstalling graphviz-0.20.3:
      Successfully uninstalled graphviz-0.20.3
  Attempting uninstall: bokeh
    Found existing installation: bokeh 3.4.3
    Uninstalling bokeh-3.4.3:
      Successfully uninstalled bokeh-3.4.3
ERROR: pip's dependency resolver does not currently take into account all the packages
holoviews 1.19.1 requires bokeh>=3.1, but you have bokeh 2.0.1 which is incompatible.
panel 1.4.5 requires bokeh<3.5.0,>=3.4.0, but you have bokeh 2.0.1 which is incompatib
Successfully installed bokeh-2.0.1 graphviz-0.8.4 mxnet-1.9.1
Collecting autogluon
  Downloading autogluon-1.1.1-py3-none-any.whl.metadata (11 kB)
Collecting autogluon.core==1.1.1 (from autogluon.core[all]==1.1.1->autogluon)
  Downloading autogluon.core-1.1.1-py3-none-any.whl.metadata (11 kB)
Collecting autogluon.features==1.1.1 (from autogluon)
  Downloading autogluon.features-1.1.1-py3-none-any.whl.metadata (11 kB)
Collecting autogluon.tabular==1.1.1 (from autogluon.tabular[all]==1.1.1->autogluon)
  Downloading autogluon.tabular-1.1.1-py3-none-any.whl.metadata (13 kB)
Collecting autogluon.multimodal==1.1.1 (from autogluon)
  Downloading autogluon.multimodal-1.1.1-py3-none-any.whl.metadata (12 kB)
Collecting autogluon.timeseries==1.1.1 (from autogluon.timeseries[all]==1.1.1->autoglu
  Downloading autogluon.timeseries-1.1.1-py3-none-any.whl.metadata (12 kB)
Requirement already satisfied: numpy<1.29,>=1.21 in /usr/local/lib/python3.10/dist-pac
Collecting scipy<1.13,>=1.5.4 (from autogluon.core==1.1.1->autogluon.core[all]==1.1.1-
  Downloading scipy-1.12.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.
Requirement already satisfied: scikit-learn<1.4.1,>=1.3.0 in /usr/local/lib/python3.10
Requirement already satisfied: networkx<4,>=3.0 in /usr/local/lib/python3.10/dist-pack
Requirement already satisfied: pandas<2.3.0,>=2.0.0 in /usr/local/lib/python3.10/dist-
Requirement already satisfied: tqdm<5,>=4.38 in /usr/local/lib/python3.10/dist-package
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (fr
Requirement already satisfied: matplotlib in /usr/local/lib/python3.10/dist-packages (
Collecting boto3<2,>=1.10 (from autogluon.core==1.1.1->autogluon.core[all]==1.1.1->aut
  Downloading boto3-1.35.22-py3-none-any.whl.metadata (6.6 kB)
Collecting autogluon.common==1.1.1 (from autogluon.core==1.1.1->autogluon.core[all]==1
  Downloading autogluon.common-1.1.1-py3-none-any.whl.metadata (11 kB)
Collecting ray<2.11,>=2.10.0 (from ray[default,tune]<2.11,>=2.10.0; extra == "all"->au
  Downloading ray-2.10.0-cp310-cp310-manylinux2014_x86_64.whl.metadata (13 kB)
Requirement already satisfied: hyperopt<0.2.8,>=0.2.7 in /usr/local/lib/python3.10/dis
Requirement already satisfied: Pillow<11,>=10.0.1 in /usr/local/lib/python3.10/dist-pa
Collecting torch<2.4,>=2.2 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading torch-2.3.1-cp310-cp310-manylinux1_x86_64.whl.metadata (26 kB)
Collecting lightning<2.4,>=2.2 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading lightning-2.3.3-py3-none-any.whl.metadata (35 kB)
Collecting transformers<4.41.0,>=4.38.0 (from transformers[sentencepiece]<4.41.0,>=4.3
  Downloading transformers-4.40.2-py3-none-any.whl.metadata (137 kB)
Collecting accelerate<0.22.0,>=0.21.0 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading accelerate-0.21.0-py3-none-any.whl.metadata (17 kB)
Collecting jsonschema<4.22,>=4.18 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading jsonschema-4.21.1-py3-none-any.whl.metadata (7.8 kB)
Collecting seqeval<1.3.0,>=1.2.2 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading seqeval-1.2.2.tar.gz (43 kB)
  Preparing metadata (setup.py) ... done
Collecting evaluate<0.5.0,>=0.4.0 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading evaluate-0.4.3-py3-none-any.whl.metadata (9.2 kB)
Collecting timm<0.10.0,>=0.9.5 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading timm-0.9.16-py3-none-any.whl.metadata (38 kB)
Collecting torchvision<0.19.0,>=0.16.0 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading torchvision-0.18.1-cp310-cp310-manylinux1_x86_64.whl.metadata (6.6 kB)
Collecting scikit-image<0.21.0,>=0.19.1 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading scikit_image-0.20.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_
Requirement already satisfied: text-unidecode<1.4,>=1.3 in /usr/local/lib/python3.10/d
Collecting torchmetrics<1.3.0,>=1.2.0 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading torchmetrics-1.2.1-py3-none-any.whl.metadata (20 kB)
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Collecting nptyping<2.5.0,>=1.4.4 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading nptyping-2.4.1-py3-none-any.whl.metadata (7.7 kB)
Collecting omegaconf<2.3.0,>=2.1.1 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading omegaconf-2.2.3-py3-none-any.whl.metadata (3.9 kB)
Collecting pytorch-metric-learning<2.4,>=1.3.0 (from autogluon.multimodal==1.1.1->autc
  Downloading pytorch_metric_learning-2.3.0-py3-none-any.whl.metadata (17 kB)
Collecting nlpaug<1.2.0,>=1.1.10 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading nlpaug-1.1.11-py3-none-any.whl.metadata (14 kB)
Requirement already satisfied: nltk<4.0.0,>=3.4.5 in /usr/local/lib/python3.10/dist-pa
Collecting openmim<0.4.0,>=0.3.7 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading openmim-0.3.9-py2.py3-none-any.whl.metadata (16 kB)
Requirement already satisfied: defusedxml<0.7.2,>=0.7.1 in /usr/local/lib/python3.10/d
Requirement already satisfied: jinja2<3.2,>=3.0.3 in /usr/local/lib/python3.10/dist-pa
Requirement already satisfied: tensorboard<3,>=2.9 in /usr/local/lib/python3.10/dist-p
Collecting pytesseract<0.3.11,>=0.3.9 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading pytesseract-0.3.10-py3-none-any.whl.metadata (11 kB)
Collecting nvidia-ml-py3==7.352.0 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading nvidia-ml-py3-7.352.0.tar.gz (19 kB)
  Preparing metadata (setup.py) ... done
Collecting pdf2image<1.19,>=1.17.0 (from autogluon.multimodal==1.1.1->autogluon)
  Downloading pdf2image-1.17.0-py3-none-any.whl.metadata (6.2 kB)
Collecting xgboost<2.1,>=1.6 (from autogluon.tabular[all]==1.1.1->autogluon)
  Downloading xgboost-2.0.3-py3-none-manylinux2014_x86_64.whl.metadata (2.0 kB)
Requirement already satisfied: fastai<2.8,>=2.3.1 in /usr/local/lib/python3.10/dist-pa
Collecting lightgbm<4.4,>=3.3 (from autogluon.tabular[all]==1.1.1->autogluon)
  Downloading lightgbm-4.3.0-py3-none-manylinux_2_28_x86_64.whl.metadata (19 kB)
Collecting catboost<1.3,>=1.1 (from autogluon.tabular[all]==1.1.1->autogluon)
  Downloading catboost-1.2.7-cp310-cp310-manylinux2014_x86_64.whl.metadata (1.2 kB)
Requirement already satisfied: joblib<2,>=1.1 in /usr/local/lib/python3.10/dist-packag
Collecting pytorch-lightning<2.4,>=2.2 (from autogluon.timeseries==1.1.1->autogluon.ti
  Downloading pytorch_lightning-2.3.3-py3-none-any.whl.metadata (21 kB)
Collecting gluonts==0.15.1 (from autogluon.timeseries==1.1.1->autogluon.timeseries[all
  Downloading gluonts-0.15.1-py3-none-any.whl.metadata (9.9 kB)
Collecting statsforecast<1.5,>=1.4.0 (from autogluon.timeseries==1.1.1->autogluon.time
  Downloading statsforecast-1.4.0-py3-none-any.whl.metadata (19 kB)
Collecting mlforecast<0.10.1,>=0.10.0 (from autogluon.timeseries==1.1.1->autogluon.tim
  Downloading mlforecast-0.10.0-py3-none-any.whl.metadata (11 kB)
Collecting utilsforecast<0.0.11,>=0.0.10 (from autogluon.timeseries==1.1.1->autogluon.
  Downloading utilsforecast-0.0.10-py3-none-any.whl.metadata (7.0 kB)
Collecting orjson~=3.9 (from autogluon.timeseries==1.1.1->autogluon.timeseries[all]==1
  Downloading orjson-3.10.7-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl
Collecting optimum<1.19,>=1.17 (from optimum[onnxruntime]<1.19,>=1.17; extra == "all"-
  Downloading optimum-1.18.1-py3-none-any.whl.metadata (18 kB)
Requirement already satisfied: psutil<6,>=5.7.3 in /usr/local/lib/python3.10/dist-pack
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-packages (
Requirement already satisfied: pydantic<3,>=1.7 in /usr/local/lib/python3.10/dist-pack
Requirement already satisfied: toolz~=0.10 in /usr/local/lib/python3.10/dist-packages
Requirement already satisfied: typing-extensions~=4.0 in /usr/local/lib/python3.10/dis
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packa
Requirement already satisfied: pyyaml in /usr/local/lib/python3.10/dist-packages (from
Collecting botocore<1.36.0,>=1.35.22 (from boto3<2,>=1.10->autogluon.core==1.1.1->autc
  Downloading botocore-1.35.22-py3-none-any.whl.metadata (5.7 kB)
Collecting jmespath<2.0.0,>=0.7.1 (from boto3<2,>=1.10->autogluon.core==1.1.1->autogl
  Downloading jmespath-1.0.1-py3-none-any.whl.metadata (7.6 kB)
Collecting s3transfer<0.11.0,>=0.10.0 (from boto3<2,>=1.10->autogluon.core==1.1.1->aut
  Downloading s3transfer-0.10.2-py3-none-any.whl.metadata (1.7 kB)
Requirement already satisfied: graphviz in /usr/local/lib/python3.10/dist-packages (fr
Requirement already satisfied: plotly in /usr/local/lib/python3.10/dist-packages (from
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from ca
Collecting datasets>=2.0.0 (from evaluate<0.5.0,>=0.4.0->autogluon.multimodal==1.1.1->
```

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  Downloading datasets-3.0.0-py3-none-any.whl.metadata (19 kB)
Collecting dill (from evaluate<0.5.0,>=0.4.0->autogluon.multimodal==1.1.1->autogluon)
  Downloading dill-0.3.8-py3-none-any.whl.metadata (10 kB)
Collecting xxhash (from evaluate<0.5.0,>=0.4.0->autogluon.multimodal==1.1.1->autogluon
  Downloading xxhash-3.5.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.
Collecting multiprocess (from evaluate<0.5.0,>=0.4.0->autogluon.multimodal==1.1.1->aut
  Downloading multiprocess-0.70.16-py310-none-any.whl.metadata (7.2 kB)
Requirement already satisfied: fsspec>=2021.05.0 in /usr/local/lib/python3.10/dist-pac
Requirement already satisfied: huggingface-hub>=0.7.0 in /usr/local/lib/python3.10/dis
Requirement already satisfied: pip in /usr/local/lib/python3.10/dist-packages (from fa
Requirement already satisfied: fastdownload<2,>=0.0.5 in /usr/local/lib/python3.10/dis
Requirement already satisfied: fastcore<1.8,>=1.5.29 in /usr/local/lib/python3.10/dist
Requirement already satisfied: fastprogress>=0.2.4 in /usr/local/lib/python3.10/dist-p
Requirement already satisfied: spacy<4 in /usr/local/lib/python3.10/dist-packages (fro
Requirement already satisfied: future in /usr/local/lib/python3.10/dist-packages (from
Requirement already satisfied: cloudpickle in /usr/local/lib/python3.10/dist-packages
Requirement already satisfied: py4j in /usr/local/lib/python3.10/dist-packages (from h
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packa
Requirement already satisfied: attrs>=22.2.0 in /usr/local/lib/python3.10/dist-package
Requirement already satisfied: jsonschema-specifications>=2023.03.6 in /usr/local/lib/
Requirement already satisfied: referencing>=0.28.4 in /usr/local/lib/python3.10/dist-p
Requirement already satisfied: rpds-py>=0.7.1 in /usr/local/lib/python3.10/dist-packag
Collecting lightning-utilities<2.0,>=0.10.0 (from lightning<2.4,>=2.2->autogluon.multi
  Downloading lightning_utilities-0.11.7-py3-none-any.whl.metadata (5.2 kB)
Requirement already satisfied: numba in /usr/local/lib/python3.10/dist-packages (from
Collecting window-ops (from mlforecast<0.10.1,>=0.10.0->autogluon.timeseries==1.1.1->a
  Downloading window_ops-0.0.15-py3-none-any.whl.metadata (6.8 kB)
Requirement already satisfied: gdown>=4.0.0 in /usr/local/lib/python3.10/dist-packages
Requirement already satisfied: click in /usr/local/lib/python3.10/dist-packages (from
Requirement already satisfied: regex>=2021.8.3 in /usr/local/lib/python3.10/dist-packa
Collecting antlr4-python3-runtime==4.9.* (from omegaconf<2.3.0,>=2.1.1->autogluon.mult
  Downloading antlr4-python3-runtime-4.9.3.tar.gz (117 kB)
  Preparing metadata (setup.py) ... done
Collecting colorama (from openmim<0.4.0,>=0.3.7->autogluon.multimodal==1.1.1->autogluo
  Downloading colorama-0.4.6-py2.py3-none-any.whl.metadata (17 kB)
Collecting model-index (from openmim<0.4.0,>=0.3.7->autogluon.multimodal==1.1.1->autog
  Downloading model_index-0.1.11-py3-none-any.whl.metadata (3.9 kB)
Collecting opendatalab (from openmim<0.4.0,>=0.3.7->autogluon.multimodal==1.1.1->autog
  Downloading opendatalab-0.0.10-py3-none-any.whl.metadata (6.4 kB)
Requirement already satisfied: rich in /usr/local/lib/python3.10/dist-packages (from c
Requirement already satisfied: tabulate in /usr/local/lib/python3.10/dist-packages (fr
Collecting coloredlogs (from optimum<1.19,>=1.17->optimum[onnxruntime]<1.19,>=1.17; ex
  Downloading coloredlogs-15.0.1-py2.py3-none-any.whl.metadata (12 kB)
Requirement already satisfied: sympy in /usr/local/lib/python3.10/dist-packages (from
Collecting transformers<4.41.0,>=4.38.0 (from transformers[sentencepiece]<4.41.0,>=4.3
  Downloading transformers-4.39.3-py3-none-any.whl.metadata (134 kB)
Collecting onnx (from optimum[onnxruntime]<1.19,>=1.17; extra == "all"->autogluon.time
  Downloading onnx-1.16.2-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.m
Collecting onnxruntime>=1.11.0 (from optimum[onnxruntime]<1.19,>=1.17; extra == "all"-
  Downloading onnxruntime-1.19.2-cp310-cp310-manylinux_2_27_x86_64.manylinux_2_28_x86_
Requirement already satisfied: protobuf>=3.20.1 in /usr/local/lib/python3.10/dist-pack
Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.10/dis
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages
Requirement already satisfied: tzdata>=2022.1 in /usr/local/lib/python3.10/dist-packag
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (fr
Requirement already satisfied: msgpack<2.0.0,>=1.0.0 in /usr/local/lib/python3.10/dist
Requirement already satisfied: aiosignal in /usr/local/lib/python3.10/dist-packages (f
Requirement already satisfied: frozenlist in /usr/local/lib/python3.10/dist-packages (
Collecting tensorboardX>=1.9 (from ray[default,tune]<2.11,>=2.10.0; extra == "all"->au
  Downloading tensorboardX-2.6.2.2-py2.py3-none-any.whl.metadata (5.8 kB)
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Requirement already satisfied: pyarrow>=6.0.1 in /usr/local/lib/python3.10/dist-packag
Requirement already satisfied: aiohttp>=3.7 in /usr/local/lib/python3.10/dist-packages
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  Downloading opencensus-0.11.4-py2.py3-none-any.whl.metadata (12 kB)
Requirement already satisfied: prometheus-client>=0.7.1 in /usr/local/lib/python3.10/d
Requirement already satisfied: smart-open in /usr/local/lib/python3.10/dist-packages (
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  Downloading virtualenv-20.26.5-py3-none-any.whl.metadata (4.5 kB)
Requirement already satisfied: grpcio>=1.42.0 in /usr/local/lib/python3.10/dist-packag
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Requirement already satisfied: tifffile>=2019.7.26 in /usr/local/lib/python3.10/dist-p
Collecting PyWavelets>=1.1.1 (from scikit-image<0.21.0,>=0.19.1->autogluon.multimodal=
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Requirement already satisfied: lazy_loader>=0.1 in /usr/local/lib/python3.10/dist-pack
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.10/dist-
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Requirement already satisfied: absl-py>=0.4 in /usr/local/lib/python3.10/dist-packages
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Requirement already satisfied: werkzeug>=1.0.1 in /usr/local/lib/python3.10/dist-packa
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Collecting nvidia-cuda-nvrtc-cu12==12.1.105 (from torch<2.4,>=2.2->autogluon.multimoda
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Collecting nvidia-cuda-cupti-cu12==12.1.105 (from torch<2.4,>=2.2->autogluon.multimoda
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Collecting nvidia-cudnn-cu12==8.9.2.26 (from torch<2.4,>=2.2->autogluon.multimodal==1.
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Collecting nvidia-cublas-cu12==12.1.3.1 (from torch<2.4,>=2.2->autogluon.multimodal==1
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Collecting nvidia-curand-cu12==10.3.2.106 (from torch<2.4,>=2.2->autogluon.multimodal=
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Collecting nvidia-cusolver-cu12==11.4.5.107 (from torch<2.4,>=2.2->autogluon.multimoda
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Collecting nvidia-nccl-cu12==2.20.5 (from torch<2.4,>=2.2->autogluon.multimodal==1.1.1
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Collecting nvidia-nvtx-cu12==12.1.105 (from torch<2.4,>=2.2->autogluon.multimodal==1.1
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Collecting triton==2.3.1 (from torch<2.4,>=2.2->autogluon.multimodal==1.1.1->autogluon
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Collecting tokenizers<0.19,>=0.14 (from transformers<4.41.0,>=4.38.0->transformers[ser
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Requirement already satisfied: sentencepiece!=0.1.92,>=0.1.91 in /usr/local/lib/pythor
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Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-pack
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Collecting pyarrow>=6.0.1 (from ray[default,tune]<2.11,>=2.10.0; extra == "all"->autog
  Downloading pyarrow-17.0.0-cp310-cp310-manylinux_2_28_x86_64.whl.metadata (3.3 kB)
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Requirement already satisfied: annotated-types>=0.6.0 in /usr/local/lib/python3.10/dis
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Requirement already satisfied: spacy-legacy<3.1.0,>=3.0.11 in /usr/local/lib/python3.1
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Collecting distlib<1,>=0.3.7 (from virtualenv!=20.21.1,>=20.0.24->ray[default,tune]<2.
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Requirement already satisfied: platformdirs<5,>=3.9.1 in /usr/local/lib/python3.10/dis
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  Downloading humanfriendly-10.0-py2.py3-none-any.whl.metadata (9.2 kB)
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Requirement already satisfied: google-api-core<3.0.0,>=1.0.0 in /usr/local/lib/python3
Collecting pycryptodome (from opendatalab->openmim<0.4.0,>=0.3.7->autogluon.multimodal
  Downloading pycryptodome-3.20.0-cp35-abi3-manylinux_2_17_x86_64.manylinux2014_x86_64
Collecting openxlab (from opendatalab->openmim<0.4.0,>=0.3.7->autogluon.multimodal==1.
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Requirement already satisfied: googleapis-common-protos<2.0.dev0,>=1.56.2 in /usr/loca
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Requirement already satisfied: shellingham>=1.3.0 in /usr/local/lib/python3.10/dist-pa
Requirement already satisfied: cloudpathlib<1.0.0,>=0.7.0 in /usr/local/lib/python3.10
Requirement already satisfied: soupsieve>1.2 in /usr/local/lib/python3.10/dist-package
Collecting filelock (from ray<2.11,>=2.10.0->ray[default,tune]<2.11,>=2.10.0; extra ==
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Collecting oss2>=2.17.0 (from openxlab->opendatalab->openmim<0.4.0,>=0.3.7->autogluon
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Collecting oss2<2.17.0 (from openxlab->opendatalab->openmim<0.4.0,>=0.3.7->autogluon.
  Downloading oss2-2.17.0.tar.gz (259 kB)
  Preparing metadata (setup.py) ... done
Collecting pytz>=2020.1 (from pandas<2.3.0,>=2.0.0->autogluon.core==1.1.1->autogluon.c
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  Downloading openxlab-0.1.0-py3-none-any.whl.metadata (3.8 kB)
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Downloading autogluon.timeseries-1.1.1-py3-none-any.whl (148 kB)
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Downloading nptyping-2.4.1-py3-none-any.whl (36 kB)
Downloading omegaconf-2.2.3-py3-none-any.whl (79 kB)
Downloading openmim-0.3.9-py2.py3-none-any.whl (52 kB)
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Downloading torchvision-0.18.1-cp310-cp310-manylinux1_x86_64.whl (7.0 MB)
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Downloading transformers-4.39.3-py3-none-any.whl (8.8 MB)
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Downloading utilsforecast-0.0.10-py3-none-any.whl (30 kB)
Downloading xgboost-2.0.3-py3-none-manylinux2014_x86_64.whl (297.1 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 297.1/297.1 MB 65.6 MB/s eta 0:00:00
Downloading botocore-1.35.22-py3-none-any.whl (12.6 MB)
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Downloading datasets-3.0.0-py3-none-any.whl (474 kB)
```

```
Downloading dill-0.3.8-py3-none-any.whl (116 kB)
Downloading jmespath-1.0.1-py3-none-any.whl (20 kB)
Downloading lightning_utilities-0.11.7-py3-none-any.whl (26 kB)
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   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 13.2/13.2 MB 129.6 MB/s eta 0:00:00
Downloading py_spy-0.3.14-py2.py3-none-manylinux_2_5_x86_64.manylinux1_x86_64.whl (3.6
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 3.0/3.0 MB 80.1 MB/s eta 0:00:00
Downloading pyarrow-17.0.0-cp310-cp310-manylinux_2_28_x86_64.whl (39.9 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 39.9/39.9 MB 45.4 MB/s eta 0:00:00
Downloading pywavelets-1.7.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.wh
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Downloading s3transfer-0.10.2-py3-none-any.whl (82 kB)
Downloading tensorboardX-2.6.2.2-py2.py3-none-any.whl (101 kB)
Downloading tokenizers-0.15.2-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.w
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 3.6/3.6 MB 94.1 MB/s eta 0:00:00
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Downloading aiohttp_cors-0.7.0-py3-none-any.whl (27 kB)
Downloading colorama-0.4.6-py2.py3-none-any.whl (25 kB)
Downloading coloredlogs-15.0.1-py2.py3-none-any.whl (46 kB)
Downloading colorful-0.5.6-py2.py3-none-any.whl (201 kB)
Downloading model_index-0.1.11-py3-none-any.whl (34 kB)
Downloading multiprocess-0.70.16-py310-none-any.whl (134 kB)
Downloading onnx-1.16.2-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (15
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 15.9/15.9 MB 130.3 MB/s eta 0:00:00
Downloading opencensus-0.11.4-py2.py3-none-any.whl (128 kB)
Downloading opendatalab-0.0.10-py3-none-any.whl (29 kB)
Downloading window_ops-0.0.15-py3-none-any.whl (15 kB)
Downloading xxhash-3.5.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1
Downloading distlib-0.3.8-py2.py3-none-any.whl (468 kB)
Downloading humanfriendly-10.0-py2.py3-none-any.whl (86 kB)
Downloading opencensus_context-0.1.3-py2.py3-none-any.whl (5.1 kB)
Downloading nvidia_nvjitlink_cu12-12.6.68-py3-none-manylinux2014_x86_64.whl (19.7 MB)
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Downloading openxlab-0.0.11-py3-none-any.whl (55 kB)
Downloading ordered_set-4.1.0-py3-none-any.whl (7.6 kB)
Downloading pycryptodome-3.20.0-cp35-abi3-manylinux_2_17_x86_64.manylinux2014_x86_64.w
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.1/2.1 MB 64.0 MB/s eta 0:00:00
Building wheels for collected packages: nvidia-ml-py3, antlr4-python3-runtime, seqeval
  Building wheel for nvidia-ml-py3 (setup.py) ... done
  Created wheel for nvidia-ml-py3: filename=nvidia_ml_py3-7.352.0-py3-none-any.whl siz
  Stored in directory: /root/.cache/pip/wheels/5c/d8/c0/46899f8be7a75a2ffd197a23c87977
  Building wheel for antlr4-python3-runtime (setup.py) ... done
  Created wheel for antlr4-python3-runtime: filename=antlr4_python3_runtime-4.9.3-py3-
  Stored in directory: /root/.cache/pip/wheels/12/93/dd/1f6a127edc45659556564c5730f6d4
  Building wheel for seqeval (setup.py) ... done
  Created wheel for seqeval: filename=seqeval-1.2.2-py3-none-any.whl size=16161 sha256
  Stored in directory: /root/.cache/pip/wheels/1a/67/4a/ad4082dd7dfc30f2abfe4d80a2ed5f
Successfully built nvidia-ml-py3 antlr4-python3-runtime seqeval
Installing collected packages: py-spy, opencensus-context, nvidia-ml-py3, distlib, col
  Attempting uninstall: scipy
    Found existing installation: scipy 1.13.1
    Uninstalling scipy-1.13.1:
      Successfully uninstalled scipy-1.13.1
  Attempting uninstall: pyarrow
    Found existing installation: pyarrow 14.0.2
    Uninstalling pyarrow-14.0.2:
      Successfully uninstalled pyarrow-14.0.2
  Attempting uninstall: nvidia-nccl-cu12
    Found existing installation: nvidia-nccl-cu12 2.23.4
```

```
    Uninstalling nvidia-nccl-cu12-2.23.4:
      Successfully uninstalled nvidia-nccl-cu12-2.23.4
  Attempting uninstall: xgboost
    Found existing installation: xgboost 2.1.1
    Uninstalling xgboost-2.1.1:
      Successfully uninstalled xgboost-2.1.1
  Attempting uninstall: scikit-image
    Found existing installation: scikit-image 0.23.2
    Uninstalling scikit-image-0.23.2:
      Successfully uninstalled scikit-image-0.23.2
  Attempting uninstall: lightgbm
    Found existing installation: lightgbm 4.5.0
    Uninstalling lightgbm-4.5.0:
      Successfully uninstalled lightgbm-4.5.0
  Attempting uninstall: tokenizers
    Found existing installation: tokenizers 0.19.1
    Uninstalling tokenizers-0.19.1:
      Successfully uninstalled tokenizers-0.19.1
  Attempting uninstall: jsonschema
    Found existing installation: jsonschema 4.23.0
    Uninstalling jsonschema-4.23.0:
      Successfully uninstalled jsonschema-4.23.0
  Attempting uninstall: transformers
    Found existing installation: transformers 4.44.2
    Uninstalling transformers-4.44.2:
      Successfully uninstalled transformers-4.44.2
  Attempting uninstall: torch
    Found existing installation: torch 2.4.0+cu121
    Uninstalling torch-2.4.0+cu121:
      Successfully uninstalled torch-2.4.0+cu121
  Attempting uninstall: torchvision
    Found existing installation: torchvision 0.19.0+cu121
    Uninstalling torchvision-0.19.0+cu121:
      Successfully uninstalled torchvision-0.19.0+cu121
  Attempting uninstall: accelerate
    Found existing installation: accelerate 0.34.2
    Uninstalling accelerate-0.34.2:
      Successfully uninstalled accelerate-0.34.2
ERROR: pip's dependency resolver does not currently take into account all the packages
albumentations 1.4.15 requires scikit-image>=0.21.0, but you have scikit-image 0.20.0
cudf-cu12 24.4.1 requires pyarrow<15.0.0a0,>=14.0.1, but you have pyarrow 17.0.0 which
ibis-framework 8.0.0 requires pyarrow<16,>=2, but you have pyarrow 17.0.0 which is inc
osqp 0.6.7.post0 requires scipy!=1.12.0,>=0.13.2, but you have scipy 1.12.0 which is i
torchaudio 2.4.0+cu121 requires torch==2.4.0, but you have torch 2.3.1 which is incomp
Successfully installed PyWavelets-1.7.0 accelerate-0.21.0 aiohttp-cors-0.7.0 antlr4-py
```

Setup Kaggle API Key

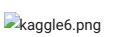
```
# create the .kaggle directory and an empty kaggle.json file
!mkdir -p /root/.kaggle
!touch /root/.kaggle/kaggle.json
!chmod 600 /root/.kaggle/kaggle.json


# Fill in your user name and key from creating the kaggle account and API token file
import json
kaggle_username = "sabaka2"
kaggle_key = "85d8d604804339013d8ca565fee9ec96"

# Save API token the kaggle.json file
with open("/root/.kaggle/kaggle.json", "w") as f:
    f.write(json.dumps({"username": kaggle_username, "key": kaggle_key}))
```

Download and explore dataset

Go to the bike sharing demand competition and agree to the terms



```
# Download the dataset, it will be in a .zip file so you'll need to unzip it as well.
!kaggle competitions download -c bike-sharing-demand
# If you already downloaded it you can use the -o command to overwrite the file
!unzip -o bike-sharing-demand.zip
```

```
Downloading bike-sharing-demand.zip to /content
100% 189k/189k [00:00<00:00, 712kB/s]
100% 189k/189k [00:00<00:00, 711kB/s]
Archive:  bike-sharing-demand.zip
  inflating: sampleSubmission.csv
  inflating: test.csv
  inflating: train.csv
```

```
import pandas as pd
from autogluon.tabular import TabularPredictor


# Create the train dataset in pandas by reading the csv
# Set the parsing of the datetime column so you can use some of the `dt` features in panda
train =  pd.read_csv('train.csv', parse_dates=['datetime'])
train.head()
```

	datetime	season	holiday	workingday	weather	temp	atemp	humidity	windspeed	cas
0	2011-01-01 00:00:00	1	0	0	1	9.84	14.395	81	0.0	
1	2011-01-01 01:00:00	1	0	0	1	9.02	13.635	80	0.0	
2	2011-01-01	1	0	0	1	9.02	13.635	80	0.0	

```
# Simple output of the train dataset to view some of the min/max/varition of the dataset f
print(train.describe())
```

```
                           datetime        season       holiday  \
count                         10886  10886.000000  10886.000000
mean   2011-12-27 05:56:22.399411968      2.506614      0.028569
min              2011-01-01 00:00:00      1.000000      0.000000
25%              2011-07-02 07:15:00      2.000000      0.000000
50%              2012-01-01 20:30:00      3.000000      0.000000
75%              2012-07-01 12:45:00      4.000000      0.000000
max              2012-12-19 23:00:00      4.000000      1.000000
std                              NaN      1.116174      0.166599

         workingday       weather          temp         atemp      humidity  \
count  10886.000000  10886.000000  10886.00000  10886.000000  10886.000000
mean       0.680875      1.418427     20.23086     23.655084     61.886460
min        0.000000      1.000000      0.82000      0.760000      0.000000
25%        0.000000      1.000000     13.94000     16.665000     47.000000
50%        1.000000      1.000000     20.50000     24.240000     62.000000
75%        1.000000      2.000000     26.24000     31.060000     77.000000
max        1.000000      4.000000     41.00000     45.455000    100.000000
std        0.466159      0.633839      7.79159      8.474601     19.245033

         windspeed        casual    registered         count
count  10886.000000  10886.000000  10886.000000  10886.000000
mean      12.799395     36.021955    155.552177    191.574132
min        0.000000      0.000000      0.000000      1.000000
25%        7.001500      4.000000     36.000000     42.000000
50%       12.998000     17.000000    118.000000    145.000000
75%       16.997900     49.000000    222.000000    284.000000
max       56.996900    367.000000    886.000000    977.000000
std        8.164537     49.960477    151.039033    181.144454
```

```
# Create the test pandas dataframe in pandas by reading the csv, remember to parse the dat
test = pd.read_csv('test.csv', parse_dates=['datetime'])
test.head()
```

	datetime	season	holiday	workingday	weather	temp	atemp	humidity	windspeed
0	2011-01-20 00:00:00	1	0	1	1	10.66	11.365	56	26.0027
1	2011-01-20 01:00:00	1	0	1	1	10.66	13.635	56	0.0000
2	2011-01-20 02:00:00	1	0	1	1	10.66	13.635	56	0.0000
	2011-01-20								

```
# Same thing as train and test dataset
submission = pd.read_csv('sampleSubmission.csv', parse_dates=['datetime'])
submission.head()
```

	datetime	count
0	2011-01-20 00:00:00	0
1	2011-01-20 01:00:00	0
2	2011-01-20 02:00:00	0
3	2011-01-20 03:00:00	0
4	2011-01-20 04:00:00	0

Step 3: Train a model using AutoGluon's Tabular Prediction

Requirements:

- We are predicting `count`, so it is the label we are setting.
- Ignore `casual` and `registered` columns as they are also not present in the test dataset.
- Use the `root_mean_squared_error` as the metric to use for evaluation.
- Set a time limit of 10 minutes (600 seconds).
- Use the preset `best_quality` to focus on creating the best model.

```
train = train.drop(columns=['casual', 'registered'])
```

```
predictor = TabularPredictor(label="count", eval_metric='root_mean_squared_error').fit(tra
```

```
No path specified. Models will be saved in: "AutogluonModels/ag-20240919_140434"
Verbosity: 2 (Standard Logging)
================== System Info ==================
AutoGluon Version:  1.1.1
Python Version:     3.10.12
Operating System:   Linux
Platform Machine:   x86_64
Platform Version:   #1 SMP PREEMPT_DYNAMIC Thu Jun 27 21:05:47 UTC 2024
CPU Count:          2
Memory Avail:       11.19 GB / 12.67 GB (88.3%)
Disk Space Avail:   65.05 GB / 107.72 GB (60.4%)
=================================================
Presets specified: ['best_quality']
Setting dynamic_stacking from 'auto' to True. Reason: Enable dynamic_stacking when use
Stack configuration (auto_stack=True): num_stack_levels=1, num_bag_folds=8, num_bag_se
DyStack is enabled (dynamic_stacking=True). AutoGluon will try to determine whether th
        This is used to identify the optimal `num_stack_levels` value. Copies of AutoG
        Running DyStack for up to 150s of the 600s of remaining time (25%).
        Running DyStack sub-fit in a ray process to avoid memory leakage. Enabling ray
2024-09-19 14:04:39,424 INFO worker.py:1743 -- Started a local Ray instance. View the
                Context path: "AutogluonModels/ag-20240919_140434/ds_sub_fit/sub_fit_h
(_dystack pid=5422) Running DyStack sub-fit ...
(_dystack pid=5422) Beginning AutoGluon training ... Time limit = 142s
(_dystack pid=5422) AutoGluon will save models to "AutogluonModels/ag-20240919_140434/
(_dystack pid=5422) Train Data Rows:    9676
(_dystack pid=5422) Train Data Columns: 9
(_dystack pid=5422) Label Column:       count
(_dystack pid=5422) Problem Type:       regression
(_dystack pid=5422) Preprocessing data ...
(_dystack pid=5422) Using Feature Generators to preprocess the data ...
(_dystack pid=5422) Fitting AutoMLPipelineFeatureGenerator...
(_dystack pid=5422)     Available Memory:                    11028.73 MB
(_dystack pid=5422)     Train Data (Original)  Memory Usage: 0.66 MB (0.0% of availabl
(_dystack pid=5422)     Inferring data type of each feature based on column values. Se
(_dystack pid=5422)     Stage 1 Generators:
(_dystack pid=5422)             Fitting AsTypeFeatureGenerator...
(_dystack pid=5422)                     Note: Converting 2 features to boolean dtype a
(_dystack pid=5422)     Stage 2 Generators:
(_dystack pid=5422)             Fitting FillNaFeatureGenerator...
(_dystack pid=5422)     Stage 3 Generators:
(_dystack pid=5422)             Fitting IdentityFeatureGenerator...
(_dystack pid=5422)             Fitting DatetimeFeatureGenerator...
(_dystack pid=5422)     Stage 4 Generators:
(_dystack pid=5422)             Fitting DropUniqueFeatureGenerator...
(_dystack pid=5422)     Stage 5 Generators:
(_dystack pid=5422)             Fitting DropDuplicatesFeatureGenerator...
(_dystack pid=5422)     Types of features in original data (raw dtype, special dtypes)
(_dystack pid=5422)             ('datetime', []) : 1 | ['datetime']
(_dystack pid=5422)             ('float', [])    : 3 | ['temp', 'atemp', 'windspeed']
(_dystack pid=5422)             ('int', [])      : 5 | ['season', 'holiday', 'workingd
(_dystack pid=5422)     Types of features in processed data (raw dtype, special dtypes
(_dystack pid=5422)             ('float', [])                : 3 | ['temp', 'atemp', '
(_dystack pid=5422)             ('int', [])                  : 3 | ['season', 'weather
(_dystack pid=5422)             ('int', ['bool'])            : 2 | ['holiday', 'workin
(_dystack pid=5422)             ('int', ['datetime_as_int']) : 5 | ['datetime', 'datet
(_dystack pid=5422)     0.2s = Fit runtime
(_dystack pid=5422)     9 features in original data used to generate 13 features in pr
(_dystack pid=5422)     Train Data (Processed) Memory Usage: 0.83 MB (0.0% of availabl
```

Review AutoGluon's training run with ranking of models that did the best.

```
performance = predictor.evaluate(train)
print(performance)
```

```
/usr/local/lib/python3.10/dist-packages/dask/dataframe/__init__.py:42: FutureWarning:
Dask dataframe query planning is disabled because dask-expr is not installed.

You can install it with `pip install dask[dataframe]` or `conda install dask`.
This will raise in a future version.

  warnings.warn(msg, FutureWarning)
{'root_mean_squared_error': -85.78142480758537, 'mean_squared_error': -7358.4528420194
```

```
predictor.fit_summary()
```

```
*** Summary of fit() ***
Estimated performance of each model:
                     model   score_val              eval_metric  pred_time_val    fit_t
0     WeightedEnsemble_L3  -55.123669  root_mean_squared_error      46.554677  374.16
1         LightGBM_BAG_L2  -55.159472  root_mean_squared_error      33.113358  286.81
2       LightGBMXT_BAG_L2  -60.897195  root_mean_squared_error      46.106592  334.87
3   KNeighborsDist_BAG_L1  -84.125061  root_mean_squared_error       0.101436    0.10
4     WeightedEnsemble_L2  -84.125061  root_mean_squared_error       0.102985    0.14
5   KNeighborsUnif_BAG_L1 -101.546199  root_mean_squared_error       0.112823    0.10
6  RandomForestMSE_BAG_L1 -116.548359  root_mean_squared_error       0.838605   21.57
7         LightGBM_BAG_L1 -131.054162  root_mean_squared_error       2.338241   48.48
8       LightGBMXT_BAG_L1 -131.460909  root_mean_squared_error      29.046163  112.63
9         CatBoost_BAG_L1 -132.353281  root_mean_squared_error       0.230176   64.66
Number of models trained: 10
Types of models trained:
{'StackerEnsembleModel_LGB', 'StackerEnsembleModel_KNN', 'StackerEnsembleModel_RF', 'W
Bagging used: True  (with 8 folds)
Multi-layer stack-ensembling used: True  (with 3 levels)
Feature Metadata (Processed):
(raw dtype, special dtypes):
('float', [])                : 3 | ['temp', 'atemp', 'windspeed']
('int', [])                  : 3 | ['season', 'weather', 'humidity']
('int', ['bool'])            : 2 | ['holiday', 'workingday']
('int', ['datetime_as_int']) : 5 | ['datetime', 'datetime.year', 'datetime.month', 'da
*** End of fit() summary ***
/usr/local/lib/python3.10/dist-packages/autogluon/core/utils/plots.py:169: UserWarning
  warnings.warn('AutoGluon summary plots cannot be created because bokeh is not instal
{'model_types': {'KNeighborsUnif_BAG_L1': 'StackerEnsembleModel_KNN',
  'KNeighborsDist_BAG_L1': 'StackerEnsembleModel_KNN',
  'LightGBMXT_BAG_L1': 'StackerEnsembleModel_LGB',
  'LightGBM_BAG_L1': 'StackerEnsembleModel_LGB',
  'RandomForestMSE_BAG_L1': 'StackerEnsembleModel_RF',
  'CatBoost_BAG_L1': 'StackerEnsembleModel_CatBoost',
  'WeightedEnsemble_L2': 'WeightedEnsembleModel',
  'LightGBMXT_BAG_L2': 'StackerEnsembleModel_LGB',
  'LightGBM_BAG_L2': 'StackerEnsembleModel_LGB',
  'WeightedEnsemble_L3': 'WeightedEnsembleModel'},
 'model_performance': {'KNeighborsUnif_BAG_L1': -101.54619908446061,
  'KNeighborsDist_BAG_L1': -84.12506123181602,
  'LightGBMXT_BAG_L1': -131.46090891834504,
  'LightGBM_BAG_L1': -131.054161598899,
  'RandomForestMSE_BAG_L1': -116.54835939455667,
  'CatBoost_BAG_L1': -132.35328109538457,
  'WeightedEnsemble_L2': -84.12506123181602,
  'LightGBMXT_BAG_L2': -60.8971952200934,
  'LightGBM_BAG_L2': -55.15947249599619,
  'WeightedEnsemble_L3': -55.123669206850366},
 'model_best': 'WeightedEnsemble_L3',
 'model_paths': {'KNeighborsUnif_BAG_L1': ['KNeighborsUnif_BAG_L1'],
  'KNeighborsDist_BAG_L1': ['KNeighborsDist_BAG_L1'],
  'LightGBMXT_BAG_L1': ['LightGBMXT_BAG_L1'],
  'LightGBM_BAG_L1': ['LightGBM_BAG_L1'],
  'RandomForestMSE_BAG_L1': ['RandomForestMSE_BAG_L1'],
  'CatBoost_BAG_L1': ['CatBoost_BAG_L1'],
  'WeightedEnsemble_L2': ['WeightedEnsemble_L2'],
  'LightGBMXT_BAG_L2': ['LightGBMXT_BAG_L2'],
  'LightGBM_BAG_L2': ['LightGBM_BAG_L2'],
  'WeightedEnsemble_L3': ['WeightedEnsemble_L3']},
```

Start coding or generate with AI.

Create predictions from test dataset

```
predictions = predictor.predict(test)
predictions.head()
```

	count
0	36.705181
1	43.758060
2	47.846897
3	52.561142
4	53.246292

dtype: float32

NOTE: Kaggle will reject the submission if we don't set everything to be > 0.

```
# Describe the `predictions` series to see if there are any negative values
predictions_description = predictions.describe()
print(predictions_description)
```

```
count    6493.000000
mean       99.240425
std        89.459610
min        -3.421120
25%        16.177315
50%        63.820770
75%       171.560120
max       367.068390
Name: count, dtype: float64
```

```
num_negative_values = (predictions < 0).sum()
print(f"Number of negative values: {num_negative_values}")
```

```
Number of negative values: 2
```

```
predictions[predictions < 0] = 0
```

Set predictions to submission dataframe, save, and submit

```
submission["count"] = predictions
print(submission["count"].head())
submission.to_csv("submission.csv", index=False)
```

```
0    36.705181
1    43.758060
2    47.846897
3    52.561142
4    53.246292
Name: count, dtype: float32
```

```
!kaggle competitions submit -c bike-sharing-demand -f submission.csv -m "original data sul
```

```
100% 188k/188k [00:00<00:00, 309kB/s]
Successfully submitted to Bike Sharing Demand
```

View submission via the command line or in the web browser under the competition's page - My Submissions

```
!kaggle competitions submissions -c bike-sharing-demand | tail -n +1 | head -n 10
```

```
fileName                    date                 description
--------------------------  -------------------  -----------------------------------
submission.csv              2024-09-19 14:29:24  original data submission1
submission_new_hpo.csv      2024-09-18 23:05:44  new features with hyperparameters-2
submission_new_hpo.csv      2024-09-18 22:46:12  new features with hyperparameters
submission_new_hpo.csv      2024-09-18 22:06:45  new features with hyperparameters
submission_new_hpo.csv      2024-09-18 21:36:14  new features with hyperparameters
submission_new_features.csv 2024-09-18 15:41:15  new features
submission_new_features.csv 2024-09-18 14:57:27  new features
submission_new_features.csv 2024-09-18 02:19:01  new features
```

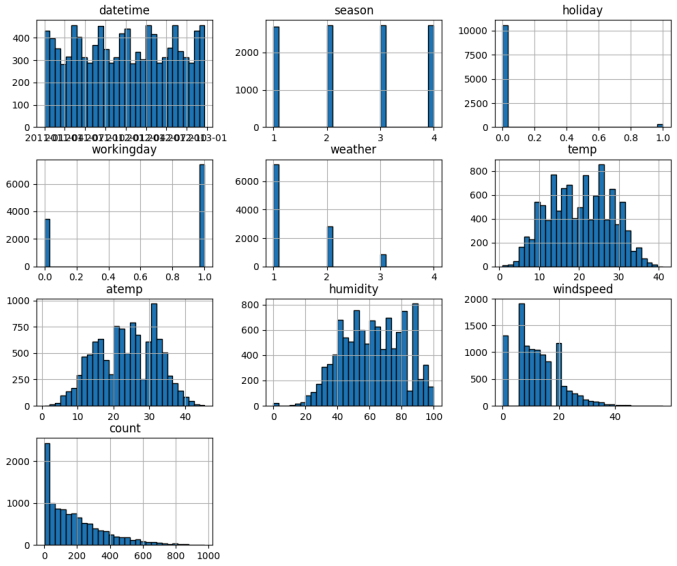
Initial score of ?

Step 4: Exploratory Data Analysis and Creating an additional feature

- Any additional feature will do, but a great suggestion would be to separate out the datetime into hour, day, or month parts.

```
# Create a histogram of all features to show the distribution of each one relative to the
train.hist(figsize=(12, 10), bins=30, edgecolor='black')
```

```
array([[<Axes: title={'center': 'datetime'}>,
        <Axes: title={'center': 'season'}>,
        <Axes: title={'center': 'holiday'}>],
       [<Axes: title={'center': 'workingday'}>,
        <Axes: title={'center': 'weather'}>,
        <Axes: title={'center': 'temp'}>],
       [<Axes: title={'center': 'atemp'}>,
        <Axes: title={'center': 'humidity'}>,
        <Axes: title={'center': 'windspeed'}>],
       [<Axes: title={'center': 'count'}>, <Axes: >, <Axes: >]],
      dtype=object)
```



```
# create a new feature
train['hour'] = train['datetime'].dt.hour
test['hour'] = test['datetime'].dt.hour
```

Make category types for these so models know they are not just numbers

- AutoGluon originally sees these as ints, but in reality they are int representations of a category.
- Setting the dtype to category will classify these as categories in AutoGluon.

```
def get_season(date):
    month = date.month
    if month in [12, 1, 2]:
        return 'Winter'
    elif month in [3, 4, 5]:
        return 'Spring'
    elif month in [6, 7, 8]:
        return 'Summer'
    elif month in [9, 10, 11]:
        return 'Fall'
    else:
        return 'Unknown'

def get_weather(atemp):
    if atemp < 10:
        return 'Cold'
    elif 10 <= atemp < 20:
        return 'Cool'
    elif 20 <= atemp < 30:
        return 'Warm'
    elif atemp >= 30:
        return 'Hot'
    else:
        return 'Unknown'  # In case of invalid input

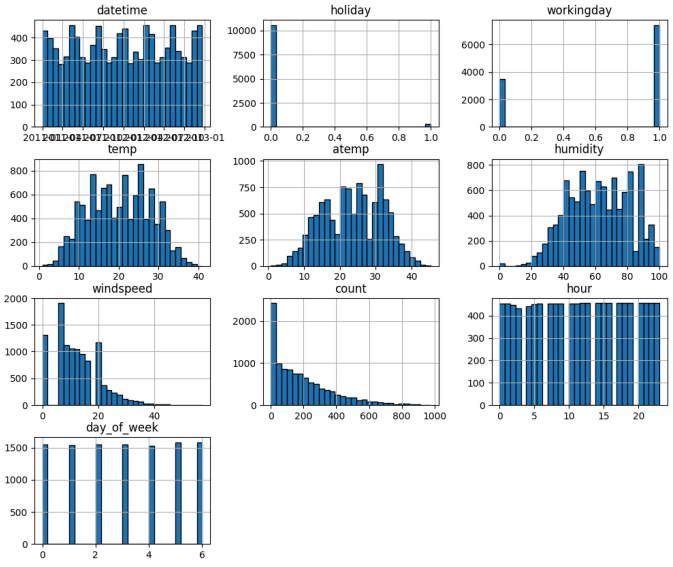

train['weather'] = train['atemp'].apply(get_weather)
train['weather'] = train['weather'].astype('category')
test['weather'] = test['atemp'].apply(get_weather)
test['weather'] = test['weather'].astype('category')
train['season'] = train['datetime'].apply(get_season)
train["season"] = train["season"].astype('category')
test["season"] = test['datetime'].apply(get_season)
test["season"] = test["season"].astype('category')
train['day_of_week'] = train['datetime'].dt.dayofweek
test['day_of_week'] = test['datetime'].dt.dayofweek


# View are new feature
train.head()
```

	datetime	season	holiday	workingday	weather	temp	atemp	humidity	windspeed	cou
0	2011-01-01 00:00:00	Winter	0	0	Cool	9.84	14.395	81	0.0	
1	2011-01-01 01:00:00	Winter	0	0	Cool	9.02	13.635	80	0.0	
2	2011-01-01	Winter	0	0	Cool	9.02	13.635	80	0.0	

```
# View histogram of all features again now with the hour feature
train.hist(figsize=(12, 10), bins=30, edgecolor='black')
```

```
array([[<Axes: title={'center': 'datetime'}>,
        <Axes: title={'center': 'holiday'}>,
        <Axes: title={'center': 'workingday'}>],
       [<Axes: title={'center': 'temp'}>,
        <Axes: title={'center': 'atemp'}>,
        <Axes: title={'center': 'humidity'}>],
       [<Axes: title={'center': 'windspeed'}>,
        <Axes: title={'center': 'count'}>,
        <Axes: title={'center': 'hour'}>],
       [<Axes: title={'center': 'day_of_week'}>, <Axes: >, <Axes: >]],
      dtype=object)
```



Step 5: Rerun the model with the same settings as before, just with more features

```
predictor_new_features2 = TabularPredictor(label="count", eval_metric='root_mean_squared_
```

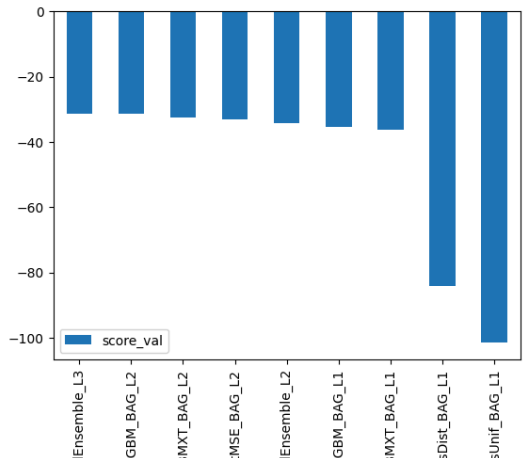
```
No path specified. Models will be saved in: "AutogluonModels/ag-20240919_194137"
Verbosity: 2 (Standard Logging)
=================== System Info ===================
AutoGluon Version:  1.1.1
Python Version:     3.10.12
Operating System:   Linux
Platform Machine:   x86_64
Platform Version:   #1 SMP PREEMPT_DYNAMIC Thu Jun 27 21:05:47 UTC 2024
CPU Count:          2
Memory Avail:       10.49 GB / 12.67 GB (82.8%)
Disk Space Avail:   62.01 GB / 107.72 GB (57.6%)
===================================================
Presets specified: ['best_quality']
Setting dynamic_stacking from 'auto' to True. Reason: Enable dynamic_stacking when use
Stack configuration (auto_stack=True): num_stack_levels=1, num_bag_folds=8, num_bag_se
DyStack is enabled (dynamic_stacking=True). AutoGluon will try to determine whether th
        This is used to identify the optimal `num_stack_levels` value. Copies of AutoG
        Running DyStack for up to 150s of the 600s of remaining time (25%).
                Context path: "AutogluonModels/ag-20240919_194137/ds_sub_fit/sub_fit_h
Leaderboard on holdout data (DyStack):
                  model  score_holdout   score_val              eval_metric  pred_tim
0    WeightedEnsemble_L3     -35.705168  -36.646665  root_mean_squared_error       18.
1    WeightedEnsemble_L2     -35.705168  -36.646665  root_mean_squared_error       18.
2      LightGBMXT_BAG_L1     -35.741613  -36.741612  root_mean_squared_error       18.
3  KNeighborsDist_BAG_L1     -92.031272  -89.946854  root_mean_squared_error        0.
4  KNeighborsUnif_BAG_L1    -109.161488 -107.445008  root_mean_squared_error        0.
        1        = Optimal   num_stack_levels (Stacked Overfitting Occurred: False)
        203s     = DyStack   runtime |  397s     = Remaining runtime
Starting main fit with num_stack_levels=1.
        For future fit calls on this dataset, you can skip DyStack to save time: `prec
Beginning AutoGluon training ... Time limit = 397s
AutoGluon will save models to "AutogluonModels/ag-20240919_194137"
Train Data Rows:    10886
Train Data Columns: 11
Label Column:       count
Problem Type:       regression
Preprocessing data ...
Using Feature Generators to preprocess the data ...
Fitting AutoMLPipelineFeatureGenerator...
        Available Memory:                    9823.83 MB
        Train Data (Original)  Memory Usage: 0.69 MB (0.0% of available memory)
        Inferring data type of each feature based on column values. Set feature_metada
        Stage 1 Generators:
                Fitting AsTypeFeatureGenerator...
                        Note: Converting 2 features to boolean dtype as they only cont
        Stage 2 Generators:
                Fitting FillNaFeatureGenerator...
        Stage 3 Generators:
                Fitting IdentityFeatureGenerator...
                Fitting CategoryFeatureGenerator...
```

```
                    Fitting CategoryMemoryMinimizeFeatureGenerator...
                Fitting DatetimeFeatureGenerator...
            Stage 4 Generators:
                Fitting DropUniqueFeatureGenerator...
            Stage 5 Generators:
                Fitting DropDuplicatesFeatureGenerator...
            Types of features in original data (raw dtype, special dtypes):
                ('category', []) : 2 | ['season', 'weather']
```

```
performance_new_features2 = predictor_new_features2.evaluate(train)
print(performance_new_features2)

predictor_new_features2.fit_summary()
predictor_new_features2.leaderboard(silent=True).plot(kind="bar", x="model", y="score_val"
```

```
{'root_mean_squared_error': -19.476397051538957, 'mean_squared_error': -379.3300421091
*** Summary of fit() ***
Estimated performance of each model:
                     model   score_val              eval_metric  pred_time_val    fit_t
0     WeightedEnsemble_L3  -31.366154  root_mean_squared_error      67.959713  373.306
1         LightGBM_BAG_L2  -31.462139  root_mean_squared_error      64.999748  288.377
2       LightGBMXT_BAG_L2  -32.561460  root_mean_squared_error      66.244080  294.026
3  RandomForestMSE_BAG_L2  -33.166791  root_mean_squared_error      65.088226  291.144
4     WeightedEnsemble_L2  -34.239538  root_mean_squared_error      64.112820  250.108
5         LightGBM_BAG_L1  -35.383666  root_mean_squared_error       7.904369   81.320
6       LightGBMXT_BAG_L1  -36.142399  root_mean_squared_error      56.119587  168.710
7   KNeighborsDist_BAG_L1  -84.125061  root_mean_squared_error       0.087809    0.056
8   KNeighborsUnif_BAG_L1 -101.546199  root_mean_squared_error       0.076701    0.055
Number of models trained: 9
Types of models trained:
{'WeightedEnsembleModel', 'StackerEnsembleModel_LGB', 'StackerEnsembleModel_KNN', 'Sta
Bagging used: True  (with 8 folds)
Multi-layer stack-ensembling used: True  (with 3 levels)
Feature Metadata (Processed):
(raw dtype, special dtypes):
('category', [])             : 2 | ['season', 'weather']
('float', [])                : 3 | ['temp', 'atemp', 'windspeed']
('int', [])                  : 3 | ['humidity', 'hour', 'day_of_week']
('int', ['bool'])            : 2 | ['holiday', 'workingday']
('int', ['datetime_as_int']) : 4 | ['datetime', 'datetime.year', 'datetime.month', 'da
*** End of fit() summary ***
/usr/local/lib/python3.10/dist-packages/autogluon/core/utils/plots.py:169: UserWarning
  warnings.warn('AutoGluon summary plots cannot be created because bokeh is not instal
<Axes: xlabel='model'>
```




```
# Remember to set all negative values to zero
predictions_new2 = predictor_new_features2.predict(test)
predictions_new2.head()
predictions_description_new2 = predictions_new2.describe()
print(predictions_description_new2)

num_negative_values_new2 = (predictions_new2 < 0).sum()
print(f"Number of negative values: {num_negative_values_new2}")
```

```
count    6493.000000
mean      147.626312
std       130.852676
min         2.053551
25%        48.401764
50%       115.637779
75%       202.952057
max       797.545349
Name: count, dtype: float64
Number of negative values: 0
```

```
predictions_new2[predictions_new2 < 0] = 0


# Same submitting predictions
submission["count"] = predictions_new2
print(submission["count"].head())
submission.to_csv("submission_new_features2.csv", index=False)
```

```
0    19.830393
1    15.760131
2    14.801182
3    11.409325
4     9.552790
Name: count, dtype: float32
```

```
!kaggle competitions submit -c bike-sharing-demand -f submission_new_features2.csv -m "ne
```

```
100% 188k/188k [00:01<00:00, 169kB/s]
Successfully submitted to Bike Sharing Demand
```

```
!kaggle competitions submissions -c bike-sharing-demand | tail -n +1 | head -n 12
```

```
fileName                        date                 description
------------------------------  -------------------  -----------------------------------
submission_new_features2.csv  2024-09-19 19:56:20  new features submission2
submission_new_hpo5.csv       2024-09-19 18:01:48  new features with hpo5
submission_new_hpo4.csv       2024-09-19 16:35:40  new features with hpo4
submission_new_hpo3.csv       2024-09-19 16:06:03  new features with hpo3
submission_new_hpo2.csv       2024-09-19 15:54:03  new features with hpo2
submission_new_hpo1.csv       2024-09-19 15:21:01  new features with hpo1
submission_new_features.csv   2024-09-19 14:57:42  new features submission1
submission.csv                2024-09-19 14:29:24  original data submission1
submission_new_hpo.csv        2024-09-18 23:05:44  new features with hyperparameters-2
submission_new_hpo.csv        2024-09-18 22:46:12  new features with hyperparameters
```

New Score of ?

Step 6: Hyper parameter optimization

- There are many options for hyper parameter optimization.
- Options are to change the AutoGluon higher level parameters or the individual model hyperparameters.
- The hyperparameters of the models themselves that are in AutoGluon. Those need the `hyperparameter` and `hyperparameter_tune_kwargs` arguments.

```
# hyperparameter_tune_kwargs = {
#     'num_trials': 20,             # Try 20 different configurations
#     'scheduler': 'local',         # Run on local machine
#     'searcher': 'random',         # Random search for hyperparameters
#     'max_t': 600                  # Max time for each trial is 600 seconds
# }


# Exclude poor-performing models and define hyperparameters for tuning
hyperparameters = {
    'GBM': [
        {
        'learning_rate': 0.05,   # Smaller learning rate for better generalization
        'num_leaves': 31,        # Maximum number of leaves per tree
        'feature_fraction': 0.8, # Random subset of features for each iteration
        'bagging_fraction': 0.8, # Random subset of data for each iteration
        'bagging_freq': 5,       # Bagging performed every 5 iterations
        'max_depth': 10,         # Depth of the trees (you can set to -1 for no limit)
        'num_boost_round': 1000, # Number of boosting rounds
        'early_stopping_rounds': 50  # Early stopping if performance doesn't improve
        }
    ],
    'RF': [
        {
            'n_estimators': 100,           # Number of trees in the forest
            'max_depth': 10,               # Maximum depth of each tree
            'min_samples_split': 5,        # Minimum number of samples required to split a
            'min_samples_leaf': 2,         # Minimum number of samples required to be at a
            'max_features': 'sqrt',        # Number of features to consider when looking f
            'bootstrap': True              # Whether bootstrap samples are used when build
        }
    ],
    'CAT': [
        {
            'learning_rate': 0.05,       # Smaller learning rate for more gradual training
            'depth': 6,                  # Depth of the trees
            'l2_leaf_reg': 3.0,          # Regularization to avoid overfitting
            'iterations': 1000,          # Number of boosting iterations
            'one_hot_max_size': 10,      # Maximum size of categorical features for one-ho
```

```
            'eval_metric': 'RMSE',       # Root Mean Squared Error (for regression tasks)
            'od_type': 'Iter',           # Early stopping based on the number of iteratior
            'od_wait': 100               # Wait for improvement in 100 iterations before s
        }
    ],
}

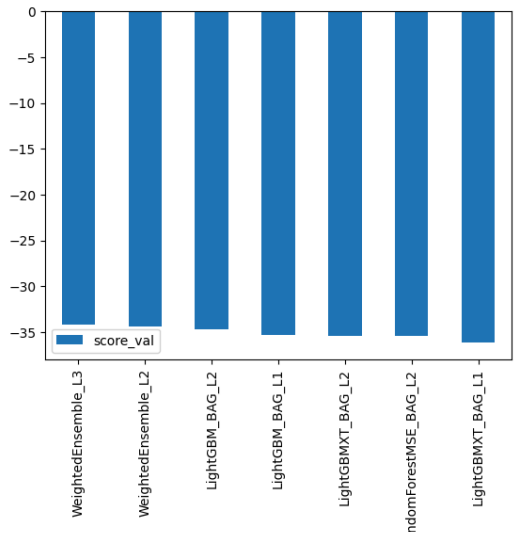

excluded_model_types = ['KNN']
time_limit = 600

# 1. only exclude models            hpo1
# 2. exclude models +  hyperparams  hpo2
# 3. increase time to 1000 sec      hpo3

predictor_new_hpo1 = TabularPredictor(
    label='count',
    eval_metric='root_mean_squared_error'
).fit(
    train_data=train,
    time_limit=time_limit,
    presets='best_quality',
    excluded_model_types=excluded_model_types,  # Exclude KNN
)
```

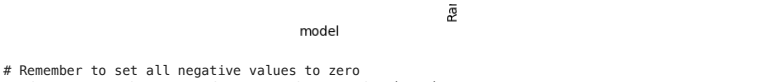
```
No path specified. Models will be saved in: "AutogluonModels/ag-20240919_150116"
Verbosity: 2 (Standard Logging)
================== System Info ==================
AutoGluon Version:  1.1.1
Python Version:     3.10.12
Operating System:   Linux
Platform Machine:   x86_64
Platform Version:   #1 SMP PREEMPT_DYNAMIC Thu Jun 27 21:05:47 UTC 2024
CPU Count:          2
Memory Avail:       9.91 GB / 12.67 GB (78.2%)
Disk Space Avail:   63.84 GB / 107.72 GB (59.3%)
=================================================
Presets specified: ['best_quality']
Setting dynamic_stacking from 'auto' to True. Reason: Enable dynamic_stacking when use
Stack configuration (auto_stack=True): num_stack_levels=1, num_bag_folds=8, num_bag_se
DyStack is enabled (dynamic_stacking=True). AutoGluon will try to determine whether th
        This is used to identify the optimal `num_stack_levels` value. Copies of AutoG
        Running DyStack for up to 150s of the 600s of remaining time (25%).
                Context path: "AutogluonModels/ag-20240919_150116/ds_sub_fit/sub_fit_h
Leaderboard on holdout data (DyStack):
                  model  score_holdout  score_val             eval_metric  pred_time_t
0    LightGBMXT_BAG_L1     -35.752301 -36.677531  root_mean_squared_error       35.673
1  WeightedEnsemble_L3     -35.752301 -36.677531  root_mean_squared_error       35.675
2  WeightedEnsemble_L2     -35.752301 -36.677531  root_mean_squared_error       35.676
        1        = Optimal   num_stack_levels (Stacked Overfitting Occurred: False)
        210s     = DyStack   runtime |  390s     = Remaining runtime
Starting main fit with num_stack_levels=1.
        For future fit calls on this dataset, you can skip DyStack to save time: `pred
Beginning AutoGluon training ... Time limit = 390s
AutoGluon will save models to "AutogluonModels/ag-20240919_150116"
```

```
{'root_mean_squared_error': -14.477321139849748, 'mean_squared_error': -209.592827386
*** Summary of fit() ***
Estimated performance of each model:
                     model  score_val              eval_metric  pred_time_val    fit_ti
0     WeightedEnsemble_L3 -34.182172  root_mean_squared_error      77.180456  330.845
1     WeightedEnsemble_L2 -34.355720  root_mean_squared_error      76.247625  259.242
2         LightGBM_BAG_L2 -34.708988  root_mean_squared_error      76.407416  294.626
3         LightGBM_BAG_L1 -35.300237  root_mean_squared_error      11.354382   81.920
4       LightGBMXT_BAG_L2 -35.410542  root_mean_squared_error      76.691324  293.069
5  RandomForestMSE_BAG_L2 -35.416246  root_mean_squared_error      77.018555  295.365
6       LightGBMXT_BAG_L1 -36.142399  root_mean_squared_error      64.892374  177.300
Number of models trained: 7
Types of models trained:
{'WeightedEnsembleModel', 'StackerEnsembleModel_LGB', 'StackerEnsembleModel_RF'}
Bagging used: True  (with 8 folds)
Multi-layer stack-ensembling used: True  (with 3 levels)
Feature Metadata (Processed):
(raw dtype, special dtypes):
('category', [])             : 2 | ['season', 'weather']
('float', [])                : 3 | ['temp', 'atemp', 'windspeed']
('int', [])                  : 3 | ['humidity', 'hour', 'day_of_week']
('int', ['bool'])            : 2 | ['holiday', 'workingday']
('int', ['datetime_as_int']) : 4 | ['datetime', 'datetime.year', 'datetime.month', 'da
*** End of fit() summary ***
/usr/local/lib/python3.10/dist-packages/autogluon/core/utils/plots.py:169: UserWarning
  warnings.warn('AutoGluon summary plots cannot be created because bokeh is not instal
<Axes: xlabel='model'>
```




```
Train Data Rows:    10886
Train Data Columns: 11
Label Column:       count
Problem Type:       regression
Preprocessing data ...
Using Feature Generators to preprocess the data ...
Fitting AutoMLPipelineFeatureGenerator...
        Available Memory:                    9870.65 MB
        Train Data (Original)  Memory Usage: 0.69 MB (0.0% of available memory)
        Inferring data type of each feature based on column values. Set feature_metada
        Stage 1 Generators:
                Fitting AsTypeFeatureGenerator...
                        Note: Converting 2 features to boolean dtype as they only cont
        Stage 2 Generators:
                Fitting FillNaFeatureGenerator...
        Stage 3 Generators:
                Fitting IdentityFeatureGenerator...
                Fitting CategoryFeatureGenerator...
                        Fitting CategoryMemoryMinimizeFeatureGenerator...
                Fitting DatetimeFeatureGenerator...
        Stage 4 Generators:
                Fitting DropUniqueFeatureGenerator...
        Stage 5 Generators:
                Fitting DropDuplicatesFeatureGenerator...
        Types of features in original data (raw dtype, special dtypes):
                ('category', []) : 2 | ['season', 'weather']
                ('datetime', []) : 1 | ['datetime']
                ('float', [])    : 3 | ['temp', 'atemp', 'windspeed']
```

```
performance_new_hpo1 = predictor_new_hpo1.evaluate(train)
print(performance_new_hpo1)
predictor_new_hpo1.fit_summary()
predictor_new_hpo1.leaderboard(silent=True).plot(kind="bar", x="model", y="score_val")
```




```
# Remember to set all negative values to zero
predictions_new_hpo1 = predictor_new_hpo1.predict(test)
predictions_new_hpo1.head()
predictions_description_new_hpo1 = predictions_new_hpo1.describe()
print(predictions_description_new_hpo1)
num_negative_values = (predictions_new_hpo1 < 0).sum()
print(f"Number of negative values: {num_negative_values}")
predictions_new_hpo1[predictions_new_hpo1 < 0] = 0
```

```
count    6493.000000
mean      190.406830
std       173.555099
min       -25.502981
25%        47.715908
50%       148.126572
75%       282.608582
max       886.808838
Name: count, dtype: float64
Number of negative values: 103
```

```
# Same submitting predictions
submission["count"] = predictions_new_hpo1
print(submission["count"].head())
submission.to_csv("submission_new_hpo1.csv", index=False)
```

```
0    17.823381
1     5.715229
2     4.324823
3     4.441064
4     4.176526
Name: count, dtype: float32
```

```
!kaggle competitions submit -c bike-sharing-demand -f submission_new_hpo1.csv -m "new feat
```

```
100% 188k/188k [00:00<00:00, 306kB/s]
Successfully submitted to Bike Sharing Demand
```

```
!kaggle competitions submissions -c bike-sharing-demand | tail -n +1 | head -n 10
```

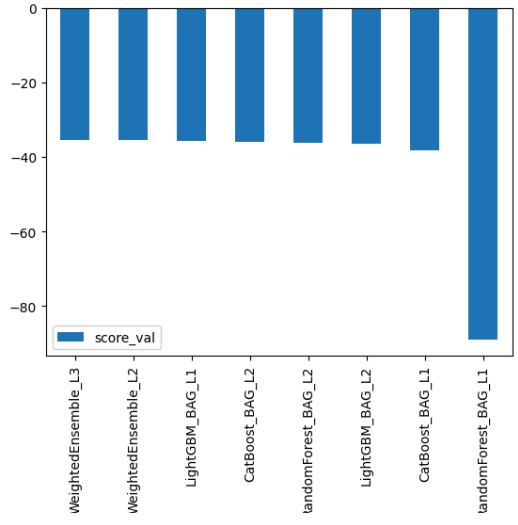
```
fileName                    date                 description
--------------------------  -------------------  -----------------------------------
submission_new_hpo1.csv     2024-09-19 15:21:01  new features with hpo1
submission_new_features.csv  2024-09-19 14:57:42  new features submission1
submission.csv              2024-09-19 14:29:24  original data submission1
submission_new_hpo.csv      2024-09-18 23:05:44  new features with hyperparameters-2
submission_new_hpo.csv      2024-09-18 22:46:12  new features with hyperparameters
submission_new_hpo.csv      2024-09-18 22:06:45  new features with hyperparameters
submission_new_hpo.csv      2024-09-18 21:36:14  new features with hyperparameters
submission_new_features.csv  2024-09-18 15:41:15  new features
```

```
# 2. exclude +  hyperparams hpo2
predictor_new_hpo2 = TabularPredictor(
    label='count',
    eval_metric='root_mean_squared_error'
).fit(
    train_data=train,
    time_limit=time_limit,  # Adjust time limit as needed
    presets='best_quality',
    hyperparameters=hyperparameters,
    excluded_model_types=excluded_model_types,
)
```

```
No path specified. Models will be saved in: "AutogluonModels/ag-20240919_152215"
Verbosity: 2 (Standard Logging)
================== System Info ==================
AutoGluon Version:  1.1.1
Python Version:     3.10.12
Operating System:   Linux
Platform Machine:   x86_64
Platform Version:   #1 SMP PREEMPT_DYNAMIC Thu Jun 27 21:05:47 UTC 2024
CPU Count:          2
Memory Avail:       10.12 GB / 12.67 GB (79.9%)
Disk Space Avail:   63.34 GB / 107.72 GB (58.8%)
=================================================
Presets specified: ['best_quality']
Setting dynamic_stacking from 'auto' to True. Reason: Enable dynamic_stacking when use
Stack configuration (auto_stack=True): num_stack_levels=1, num_bag_folds=8, num_bag_se
DyStack is enabled (dynamic_stacking=True). AutoGluon will try to determine whether th
        This is used to identify the optimal `num_stack_levels` value. Copies of AutoG
        Running DyStack for up to 150s of the 600s of remaining time (25%).
                Context path: "AutogluonModels/ag-20240919_152215/ds_sub_fit/sub_fit_h
Leaderboard on holdout data (DyStack):
                 model  score_holdout  score_val             eval_metric  pred_time_t
0  WeightedEnsemble_L3     -34.313818 -35.856210  root_mean_squared_error        4.664
1  RandomForest_BAG_L2     -34.328478 -36.547018  root_mean_squared_error        4.527
2      LightGBM_BAG_L2     -34.519507 -36.602138  root_mean_squared_error        4.578
3  WeightedEnsemble_L2     -34.698952 -35.991441  root_mean_squared_error        4.323
4      LightGBM_BAG_L1     -34.734827 -36.091769  root_mean_squared_error        3.583
5      CatBoost_BAG_L1     -37.106271 -38.735157  root_mean_squared_error        0.734
6  RandomForest_BAG_L1     -87.156784 -89.654221  root_mean_squared_error        0.125
        1        = Optimal   num_stack_levels (Stacked Overfitting Occurred: False)
        183s     = DyStack   runtime |  417s     = Remaining runtime
Starting main fit with num_stack_levels=1.
        For future fit calls on this dataset, you can skip DyStack to save time: `pred
Beginning AutoGluon training ... Time limit = 417s
AutoGluon will save models to "AutogluonModels/ag-20240919_152215"
Train Data Rows:    10886
Train Data Columns: 11
Label Column:       count
Problem Type:       regression
Preprocessing data ...
Using Feature Generators to preprocess the data ...
Fitting AutoMLPipelineFeatureGenerator...
        Available Memory:                    9972.13 MB
        Train Data (Original)  Memory Usage: 0.69 MB (0.0% of available memory)
        Inferring data type of each feature based on column values. Set feature_metada
        Stage 1 Generators:
                Fitting AsTypeFeatureGenerator...
                        Note: Converting 2 features to boolean dtype as they only cont
        Stage 2 Generators:
                Fitting FillNaFeatureGenerator...
        Stage 3 Generators:
                Fitting IdentityFeatureGenerator...
                Fitting CategoryFeatureGenerator...
                        Fitting CategoryMemoryMinimizeFeatureGenerator...
                Fitting DatetimeFeatureGenerator...
        Stage 4 Generators:
                Fitting DropUniqueFeatureGenerator...
        Stage 5 Generators:
```

```
performance_new_hpo2 = predictor_new_hpo2.evaluate(train)
print(performance_new_hpo2)
predictor_new_hpo2.fit_summary()
predictor_new_hpo2.leaderboard(silent=True).plot(kind="bar", x="model", y="score_val")
```

```
{'root_mean_squared_error': -22.379799921419355, 'mean_squared_error': -500.8554445227
*** Summary of fit() ***
Estimated performance of each model:
                 model  score_val             eval_metric  pred_time_val    fit_time
0  WeightedEnsemble_L3 -35.481964  root_mean_squared_error       3.591426  128.185781
1  WeightedEnsemble_L2 -35.579192  root_mean_squared_error       2.966970   91.557700
2      LightGBM_BAG_L1 -35.731527  root_mean_squared_error       2.838163   42.858309
3      CatBoost_BAG_L2 -35.942125  root_mean_squared_error       3.312475  125.781837
4  RandomForest_BAG_L2 -36.296722  root_mean_squared_error       3.475267   94.938793
5      LightGBM_BAG_L2 -36.596124  root_mean_squared_error       3.350437  119.260593
6      CatBoost_BAG_L1 -38.140505  root_mean_squared_error       0.127776   48.668673
7  RandomForest_BAG_L1 -88.924396  root_mean_squared_error       0.231329    1.039885
Number of models trained: 8
Types of models trained:
{'WeightedEnsembleModel', 'StackerEnsembleModel_CatBoost', 'StackerEnsembleModel_LGB',
Bagging used: True  (with 8 folds)
Multi-layer stack-ensembling used: True  (with 3 levels)
Feature Metadata (Processed):
(raw dtype, special dtypes):
('category', [])             : 2 | ['season', 'weather']
('float', [])                : 3 | ['temp', 'atemp', 'windspeed']
('int', [])                  : 3 | ['humidity', 'hour', 'day_of_week']
('int', ['bool'])            : 2 | ['holiday', 'workingday']
('int', ['datetime_as_int']) : 4 | ['datetime', 'datetime.year', 'datetime.month', 'da
*** End of fit() summary ***
/usr/local/lib/python3.10/dist-packages/autogluon/core/utils/plots.py:169: UserWarning
  warnings.warn('AutoGluon summary plots cannot be created because bokeh is not instal
<Axes: xlabel='model'>
```




```
predictions_new_hpo2 = predictor_new_hpo2.predict(test)
predictions_new_hpo2.head()
predictions_description_new_hpo2 = predictions_new_hpo2.describe()
print(predictions_description_new_hpo2)
num_negative_values = (predictions_new_hpo2 < 0).sum()
print(f"Number of negative values: {num_negative_values}")
predictions_new_hpo2[predictions_new_hpo2 < 0] = 0
```

```
count    6493.000000
mean      190.372559
std       173.766769
min       -23.048771
25%        47.012825
50%       147.574249
75%       285.164734
max       890.309570
Name: count, dtype: float64
Number of negative values: 96
```

```
submission["count"] = predictions_new_hpo2
print(submission["count"].head())
submission.to_csv("submission_new_hpo2.csv", index=False)
```

```
0    13.463066
1     2.278706
2     0.458701
3     2.398850
4     2.369717
Name: count, dtype: float32
```

```
!kaggle competitions submit -c bike-sharing-demand -f submission_new_hpo2.csv -m "new feat
```

```
100% 188k/188k [00:00<00:00, 296kB/s]
Successfully submitted to Bike Sharing Demand
```

```
!kaggle competitions submissions -c bike-sharing-demand | tail -n +1 | head -n 10
```

```
fileName                       date                 description
-----------------------------  -------------------  -----------------------------------
submission_new_hpo2.csv        2024-09-19 15:54:03  new features with hpo2
submission_new_hpo1.csv        2024-09-19 15:21:01  new features with hpo1
submission_new_features.csv    2024-09-19 14:57:42  new features submission1
submission.csv                 2024-09-19 14:29:24  original data submission1
submission_new_hpo.csv         2024-09-19 23:05:44  new features with hyperparameters-2
submission_new_hpo.csv         2024-09-18 22:46:12  new features with hyperparameters
submission_new_hpo.csv         2024-09-18 22:06:45  new features with hyperparameters
submission_new_hpo.csv         2024-09-18 21:36:14  new features with hyperparameters
```

```
time_limit = 1000
############################
# 3. only time limit hpo3
predictor_new_hpo3 = TabularPredictor(
    label='count',
    eval_metric='root_mean_squared_error'
).fit(
    train_data=train,
    time_limit=time_limit,  # Adjust time limit as needed
    presets='best_quality',
    hyperparameters=hyperparameters,
    excluded_model_types=excluded_model_types,
)
```

```
No path specified. Models will be saved in: "AutogluonModels/ag-20240919_155654"
Verbosity: 2 (Standard Logging)
=================== System Info ===================
AutoGluon Version:  1.1.1
Python Version:     3.10.12
Operating System:   Linux
Platform Machine:   x86_64
Platform Version:   #1 SMP PREEMPT_DYNAMIC Thu Jun 27 21:05:47 UTC 2024
CPU Count:          2
Memory Avail:       10.18 GB / 12.67 GB (80.4%)
Disk Space Avail:   63.29 GB / 107.72 GB (58.8%)
===================================================
Presets specified: ['best_quality']
Setting dynamic_stacking from 'auto' to True. Reason: Enable dynamic_stacking when use
Stack configuration (auto_stack=True): num_stack_levels=1, num_bag_folds=8, num_bag_se
DyStack is enabled (dynamic_stacking=True). AutoGluon will try to determine whether th
        This is used to identify the optimal `num_stack_levels` value. Copies of AutoG
        Running DyStack for up to 250s of the 1000s of remaining time (25%).
                Context path: "AutogluonModels/ag-20240919_155654/ds_sub_fit/sub_fit_h
Leaderboard on holdout data (DyStack):
                  model  score_holdout  score_val             eval_metric  pred_time_t
0  RandomForest_BAG_L2     -34.295004 -36.596313  root_mean_squared_error        6.125
1  WeightedEnsemble_L3     -34.343277 -35.811140  root_mean_squared_error        6.174
2      LightGBM_BAG_L2     -34.504998 -36.631856  root_mean_squared_error        6.165
3      CatBoost_BAG_L2     -34.595800 -36.256872  root_mean_squared_error        6.106
4  WeightedEnsemble_L2     -34.698648 -35.991181  root_mean_squared_error        5.941
5      LightGBM_BAG_L1     -34.734826 -36.091769  root_mean_squared_error        5.075
6      CatBoost_BAG_L1     -37.097182 -38.727802  root_mean_squared_error        0.862
7  RandomForest_BAG_L1     -87.156784 -89.654221  root_mean_squared_error        0.117
        1        = Optimal   num_stack_levels (Stacked Overfitting Occurred: False)
        223s     = DyStack   runtime |  777s     = Remaining runtime
Starting main fit with num_stack_levels=1.
        For future fit calls on this dataset, you can skip DyStack to save time: `pred
Beginning AutoGluon training ... Time limit = 777s
AutoGluon will save models to "AutogluonModels/ag-20240919_155654"
Train Data Rows:    10886
Train Data Columns: 11
Label Column:       count
Problem Type:       regression
Preprocessing data ...
Using Feature Generators to preprocess the data ...
Fitting AutoMLPipelineFeatureGenerator...
        Available Memory:                    10043.85 MB
```

```
Train Data (Original)  Memory Usage: 0.69 MB (0.0% of available memory)
Inferring data type of each feature based on column values. Set feature_metada
Stage 1 Generators:
        Fitting AsTypeFeatureGenerator...
                Note: Converting 2 features to boolean dtype as they only cont
Stage 2 Generators:
        Fitting FillNaFeatureGenerator...
Stage 3 Generators:
        Fitting IdentityFeatureGenerator...
        Fitting CategoryFeatureGenerator...
                Fitting CategoryMemoryMinimizeFeatureGenerator...
        Fitting DatetimeFeatureGenerator...
Stage 4 Generators:
        Fitting DropUniqueFeatureGenerator...
```

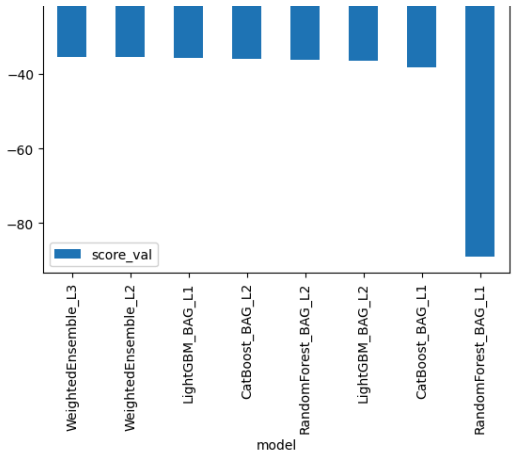
```
performance_new_hpo3 = predictor_new_hpo3.evaluate(train)
print(performance_new_hpo3)
predictor_new_hpo3.fit_summary()
predictor_new_hpo3.leaderboard(silent=True).plot(kind="bar", x="model", y="score_val")
```

```
predictions_new_hpo3 = predictor_new_hpo3.predict(test)
predictions_new_hpo3.head()
predictions_description_new_hpo3 = predictions_new_hpo3.describe()
print(predictions_description_new_hpo3)
num_negative_values = (predictions_new_hpo3 < 0).sum()
print(f"Number of negative values: {num_negative_values}")
predictions_new_hpo3[predictions_new_hpo3 < 0] = 0
```

```
submission["count"] = predictions_new_hpo3
print(submission["count"].head())
submission.to_csv("submission_new_hpo3.csv", index=False)

!kaggle competitions submit -c bike-sharing-demand -f submission_new_hpo3.csv -m "new feat
!kaggle competitions submissions -c bike-sharing-demand | tail -n +1 | head -n 10
```

```
{'root_mean_squared_error': -22.379799938813722, 'mean_squared_error': -500.8554453013
*** Summary of fit() ***
Estimated performance of each model:
                  model  score_val             eval_metric  pred_time_val    fit_time
0  WeightedEnsemble_L3 -35.481964  root_mean_squared_error       5.948557  152.741427
1  WeightedEnsemble_L2 -35.579192  root_mean_squared_error       5.243127  108.105030
2      LightGBM_BAG_L1 -35.731527  root_mean_squared_error       5.068578   50.760226
3      CatBoost_BAG_L2 -35.942125  root_mean_squared_error       5.652593  150.817706
4  RandomForest_BAG_L2 -36.296722  root_mean_squared_error       5.841776  111.087182
5      LightGBM_BAG_L2 -36.596124  root_mean_squared_error       5.733250  145.045569
6      CatBoost_BAG_L2 -38.140505  root_mean_squared_error       0.173509   57.314312
7  RandomForest_BAG_L1 -88.924396  root_mean_squared_error       0.304785    1.127600
Number of models trained: 8
Types of models trained:
{'WeightedEnsembleModel', 'StackerEnsembleModel_CatBoost', 'StackerEnsembleModel_LGB',
Bagging used: True  (with 8 folds)
Multi-layer stack-ensembling used: True  (with 3 levels)
Feature Metadata (Processed):
(raw dtype, special dtypes):
('category', [])             : 2 | ['season', 'weather']
('float', [])                : 3 | ['temp', 'atemp', 'windspeed']
('int', [])                  : 3 | ['humidity', 'hour', 'day_of_week']
('int', ['bool'])            : 2 | ['holiday', 'workingday']
('int', ['datetime_as_int']) : 4 | ['datetime', 'datetime.year', 'datetime.month', 'da
*** End of fit() summary ***
/usr/local/lib/python3.10/dist-packages/autogluon/core/utils/plots.py:169: UserWarning
  warnings.warn('AutoGluon summary plots cannot be created because bokeh is not instal
count    6493.000000
mean      190.372559
std       173.766769
min       -23.048771
25%        47.012825
50%       147.574249
75%       285.164703
max       890.309570
Name: count, dtype: float64
Number of negative values: 96
0    13.463066
1     2.278706
2     0.458701
3     2.398850
4     2.369717
Name: count, dtype: float32
100% 188k/188k [00:00<00:00, 289kB/s]
Successfully submitted to Bike Sharing DemandfileName                    date
---------------------------  -------------------  ---------------------------------
submission_new_hpo3.csv      2024-09-19 16:06:03  new features with hpo3
submission_new_hpo2.csv      2024-09-19 15:54:03  new features with hpo2
submission_new_hpo1.csv      2024-09-19 15:21:01  new features with hpo1
submission_new_features.csv  2024-09-19 14:57:42  new features submission1
submission.csv               2024-09-19 14:29:24  original data submission1
submission_new_hpo.csv       2024-09-18 23:05:44  new features with hyperparameters-2
submission_new_hpo.csv       2024-09-18 22:46:12  new features with hyperparameters
submission_new_hpo.csv       2024-09-18 22:06:45  new features with hyperparameters
```



New Score of ?

```
time_limit = 600
hyperparameters = {
    'GBM': [
        {
        'learning_rate': 0.01,  # Lower learning rate for more gradual updates
        'num_boost_round': 1500,  # More boosting rounds
        'num_leaves': 40,  # Increase leaves for more complex trees
        'feature_fraction': 0.8,  # Try lowering feature fraction for better generalizatio
        'bagging_fraction': 0.7,  # Decrease to reduce overfitting
        'bagging_freq': 5,  # Bagging every 5 iterations
        'max_depth': 15,  # Allow deeper trees
        'early_stopping_rounds': 100  # Early stop if no improvement
        }
    ],
    'CAT': [
        {
            'iterations': 1200,  # Increase iterations
            'depth': 8,  # Adjust depth
            'learning_rate': 0.03,  # Slightly lower learning rate
            'l2_leaf_reg': 4.0,  # Increase regularization to avoid overfitting
            'one_hot_max_size': 10,  # Categorical features with more categories use one-h
            'eval_metric': 'RMSE',  # Ensure you're optimizing for RMSE
            'od_type': 'Iter',  # Use iterative early stopping
            'od_wait': 50  # Early stopping after 50 iterations without improvement
            }
        ],
}

hyperparameter_tune_kwargs = {
    'num_trials': 20,              # Try 20 different configurations
    'scheduler': 'local',          # Run on local machine
    'searcher': 'random',          # Random search for hyperparameters
    'max_t': 600                   # Max time for each trial is 600 seconds
}
excluded_model_types = ['RandomForest', 'KNN']

##############################
# 4. hyperparams,hyperparameter_tune_kwargs, modelexclude  hpo4
predictor_new_hpo4 = TabularPredictor(
    label='count',
    eval_metric='root_mean_squared_error'
).fit(
    train_data=train,
    time_limit=time_limit,  # Adjust time limit as needed
    presets='best_quality',
    hyperparameters=hyperparameters,
    excluded_model_types=excluded_model_types,
    hyperparameter_tune_kwargs=hyperparameter_tune_kwargs
)
```

```
No path specified. Models will be saved in: "AutogluonModels/ag-20240919_162419"
Verbosity: 2 (Standard Logging)
================== System Info ==================
AutoGluon Version:  1.1.1
Python Version:     3.10.12
Operating System:   Linux
Platform Machine:   x86_64
Platform Version:   #1 SMP PREEMPT_DYNAMIC Thu Jun 27 21:05:47 UTC 2024
CPU Count:          2
Memory Avail:       10.63 GB / 12.67 GB (83.9%)
Disk Space Avail:   63.13 GB / 107.72 GB (58.6%)
================================================
Presets specified: ['best_quality']
Warning: hyperparameter tuning is currently experimental and may cause the process to
Setting dynamic_stacking from 'auto' to True. Reason: Enable dynamic_stacking when use
Stack configuration (auto_stack=True): num_stack_levels=1, num_bag_folds=8, num_bag_se
DyStack is enabled (dynamic_stacking=True). AutoGluon will try to determine whether th
        This is used to identify the optimal `num_stack_levels` value. Copies of AutoG
        Running DyStack for up to 150s of the 600s of remaining time (25%).
                Context path: "AutogluonModels/ag-20240919_162419/ds_sub_fit/sub_fit_h
Leaderboard on holdout data (DyStack):
                 model  score_holdout  score_val              eval_metric  pred_time_t
0  WeightedEnsemble_L3     -36.183063 -37.311221  root_mean_squared_error        5.066
1  WeightedEnsemble_L2     -36.183063 -37.311221  root_mean_squared_error        5.068
2   LightGBM_BAG_L1/T1     -36.244693 -37.390306  root_mean_squared_error        4.273
3      CatBoost_BAG_L1     -37.751362 -39.259314  root_mean_squared_error        0.796
        1        = Optimal   num_stack_levels (Stacked Overfitting Occurred: False)
        168s     = DyStack   runtime |  432s     = Remaining runtime
Starting main fit with num_stack_levels=1.
        For future fit calls on this dataset, you can skip DyStack to save time: `pred
Beginning AutoGluon training ... Time limit = 432s
AutoGluon will save models to "AutogluonModels/ag-20240919_162419"
Train Data Rows:    10886
Train Data Columns: 11
Label Column:       count
Problem Type:       regression
Preprocessing data ...
Using Feature Generators to preprocess the data ...
Fitting AutoMLPipelineFeatureGenerator...
        Available Memory:                    10097.20 MB
        Train Data (Original)  Memory Usage: 0.69 MB (0.0% of available memory)
        Inferring data type of each feature based on column values. Set feature_metada
        Stage 1 Generators:
                Fitting AsTypeFeatureGenerator...
                        Note: Converting 2 features to boolean dtype as they only cont
        Stage 2 Generators:
                Fitting FillNaFeatureGenerator...
        Stage 3 Generators:
                Fitting IdentityFeatureGenerator...
                Fitting CategoryFeatureGenerator...
                        Fitting CategoryMemoryMinimizeFeatureGenerator...
                Fitting DatetimeFeatureGenerator...
        Stage 4 Generators:
                Fitting DropUniqueFeatureGenerator...
        Stage 5 Generators:
                Fitting DropDuplicatesFeatureGenerator...
        Types of features in original data (raw dtype, special dtypes):
                ('category', []) : 2 | ['season', 'weather']
                ('datetime', []) : 1 | ['datetime']
                ('float', [])    : 3 | ['temp', 'atemp', 'windspeed']
                ('int', [])      : 5 | ['holiday', 'workingday', 'humidity', 'hour', '
        Types of features in processed data (raw dtype, special dtypes):
                ('category', [])            : 2 | ['season', 'weather']
                ('float', [])               : 3 | ['temp', 'atemp', 'windspeed']
                ('int', [])                 : 3 | ['humidity', 'hour', 'day_of_week']
                ('int', ['bool'])           : 2 | ['holiday', 'workingday']
                ('int', ['datetime_as_int']) : 4 | ['datetime', 'datetime.year', 'date
        1.0s = Fit runtime
        11 features in original data used to generate 14 features in processed data.
        Train Data (Processed) Memory Usage: 0.79 MB (0.0% of available memory)
Data preprocessing and feature engineering runtime = 1.06s ...
AutoGluon will gauge predictive performance using evaluation metric: 'root_mean_square
        This metric's sign has been flipped to adhere to being higher_is_better. The m
        To change this, specify the eval_metric parameter of Predictor()
User-specified model hyperparameters to be fit:
{
        'GBM': [{'learning_rate': 0.01, 'num_boost_round': 1500, 'num_leaves': 40, 'fe
        'CAT': [{'iterations': 1200, 'depth': 8, 'learning_rate': 0.03, 'l2_leaf_reg':
}
AutoGluon will fit 2 stack levels (L1 to L2) ...
Excluded models: [] (Specified by `excluded_model_types`)
Fitting 2 L1 models ...
Hyperparameter tuning model: LightGBM_BAG_L1 ... Tuning model for up to 129.31s of the
 0%                                                  0/20 [01:18<?, ?it/s]
        Fitting 8 child models (S1F1 - S1F8) | Fitting with ParallelLocalFoldFittingSt
        Stopping HPO to satisfy time limit...
Fitted model: LightGBM_BAG_L1/T1 ...
        -37.0566        = Validation score   (-root_mean_squared_error)
        78.38s   = Training   runtime
        7.21s    = Validation runtime
Hyperparameter tuning model: CatBoost_BAG_L1 ... Tuning model for up to 129.31s of the
        No hyperparameter search space specified for CatBoost_BAG_L1. Skipping HPO. Wi
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
Fitted model: CatBoost_BAG_L1 ...
        -36.8288        = Validation score   (-root_mean_squared_error)
        72.0s    = Training   runtime
        0.18s    = Validation runtime
Fitting model: WeightedEnsemble_L2 ... Training model for up to 360.0s of the 280.54s
        Ensemble Weights: {'CatBoost_BAG_L1': 0.545, 'LightGBM_BAG_L1/T1': 0.455}
        -36.29   = Validation score   (-root_mean_squared_error)
        0.02s    = Training   runtime
        0.0s     = Validation runtime
Excluded models: [] (Specified by `excluded_model_types`)
Fitting 2 L2 models ...
Hyperparameter tuning model: LightGBM_BAG_L2 ... Tuning model for up to 126.22s of the
 5%                                                  1/20 [02:06<20:26, 64.55s/it]
        Fitting 8 child models (S1F1 - S1F8) | Fitting with ParallelLocalFoldFittingSt
        Fitting 8 child models (S1F1 - S1F8) | Fitting with ParallelLocalFoldFittingSt
        Stopping HPO to satisfy time limit...
Fitted model: LightGBM_BAG_L2/T1 ...
        -36.7382        = Validation score   (-root_mean_squared_error)
        64.49s   = Training   runtime
        0.88s    = Validation runtime
Fitted model: LightGBM_BAG_L2/T2 ...
        -36.6001        = Validation score   (-root_mean_squared_error)
        61.57s   = Training   runtime
        1.49s    = Validation runtime
Hyperparameter tuning model: CatBoost_BAG_L2 ... Tuning model for up to 126.22s of the
```

```
        No hyperparameter search space specified for CatBoost_BAG_L2. Skipping HPO. Wi
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
Fitted model: CatBoost_BAG_L2 ...
        -36.4398        = Validation score   (-root_mean_squared_error)
        37.57s   = Training   runtime
        0.11s    = Validation runtime
Fitting model: WeightedEnsemble_L3 ... Training model for up to 360.0s of the 116.61s
        Ensemble Weights: {'CatBoost_BAG_L1': 0.308, 'LightGBM_BAG_L1/T1': 0.231, 'Lig
        -36.1594        = Validation score   (-root_mean_squared_error)
        0.05s    = Training   runtime
        0.0s     = Validation runtime
AutoGluon training complete, total runtime = 315.71s ... Best model: WeightedEnsemble_
TabularPredictor saved. To load, use: predictor = TabularPredictor.load("AutogluonMode
```

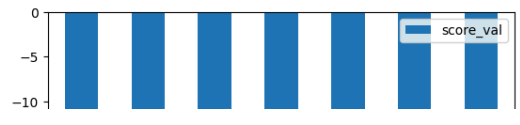
```
performance_new_hpo4 = predictor_new_hpo4.evaluate(train)
print(performance_new_hpo4)
predictor_new_hpo4.fit_summary()
predictor_new_hpo4.leaderboard(silent=True).plot(kind="bar", x="model", y="score_val")

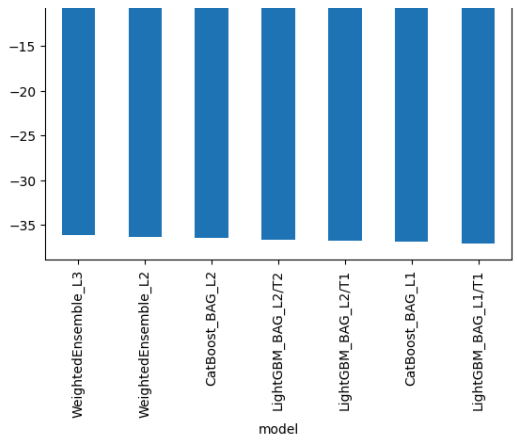

predictions_new_hpo4 = predictor_new_hpo4.predict(test)
predictions_new_hpo4.head()
predictions_description_new_hpo4 = predictions_new_hpo4.describe()
print(predictions_description_new_hpo4)
num_negative_values = (predictions_new_hpo4 < 0).sum()
print(f"Number of negative values: {num_negative_values}")
predictions_new_hpo4[predictions_new_hpo4 < 0] = 0


submission["count"] = predictions_new_hpo4
print(submission["count"].head())
submission.to_csv("submission_new_hpo4.csv", index=False)

!kaggle competitions submit -c bike-sharing-demand -f submission_new_hpo4.csv -m "new feat
!kaggle competitions submissions -c bike-sharing-demand | tail -n +1 | head -n 10
```

```
{'root_mean_squared_error': -26.451148962962055, 'mean_squared_error': -699.663281460
*** Summary of fit() ***
Estimated performance of each model:
                  model  score_val              eval_metric  pred_time_val    fit_time
0  WeightedEnsemble_L3 -36.159395  root_mean_squared_error       9.004457  249.571208
1  WeightedEnsemble_L2 -36.290011  root_mean_squared_error       7.397759  150.402372
2      CatBoost_BAG_L2 -36.439848  root_mean_squared_error       7.509053  187.953966
3   LightGBM_BAG_L2/T2 -36.600079  root_mean_squared_error       8.889277  211.945760
4   LightGBM_BAG_L2/T1 -36.738209  root_mean_squared_error       8.280383  214.872155
5      CatBoost_BAG_L1 -36.828813  root_mean_squared_error       0.183485   71.999720
6   LightGBM_BAG_L1/T1 -37.056601  root_mean_squared_error       7.212947   78.380610
Number of models trained: 7
Types of models trained:
{'WeightedEnsembleModel', 'StackerEnsembleModel_LGB', 'StackerEnsembleModel_CatBoost'}
Bagging used: True  (with 8 folds)
Multi-layer stack-ensembling used: True  (with 3 levels)
Feature Metadata (Processed):
(raw dtype, special dtypes):
('category', [])             : 2 | ['season', 'weather']
('float', [])                : 3 | ['temp', 'atemp', 'windspeed']
('int', [])                  : 3 | ['humidity', 'hour', 'day_of_week']
('int', ['bool'])            : 2 | ['holiday', 'workingday']
('int', ['datetime_as_int']) : 4 | ['datetime', 'datetime.year', 'datetime.month', 'da
*** End of fit() summary ***
/usr/local/lib/python3.10/dist-packages/autogluon/core/utils/plots.py:169: UserWarning
  warnings.warn('AutoGluon summary plots cannot be created because bokeh is not instal
count    6493.000000
mean      190.309570
std       172.785767
min       -10.918406
25%        47.419312
50%       148.868439
75%       284.332977
max       876.426147
Name: count, dtype: float64
Number of negative values: 32
0    13.938789
1     4.093366
2     1.929388
3     2.782651
4     2.931469
Name: count, dtype: float32
100% 188k/188k [00:01<00:00, 177kB/s]
Successfully submitted to Bike Sharing DemandfileName                    date
--------------------------  -------------------  ---------------------------------
submission_new_hpo4.csv     2024-09-19 16:35:40  new features with hpo4
submission_new_hpo3.csv     2024-09-19 16:06:03  new features with hpo3
submission_new_hpo2.csv     2024-09-19 15:54:03  new features with hpo2
submission_new_hpo1.csv     2024-09-19 15:21:01  new features with hpo1
submission_new_features.csv 2024-09-19 14:57:42  new features submission1
submission.csv              2024-09-19 14:29:24  original data submission1
submission_new_hpo.csv      2024-09-18 23:05:44  new features with hyperparameters-2
submission_new_hpo.csv      2024-09-18 22:46:12  new features with hyperparameters
```






```
hyperparameters = {
    'GBM': [
        {'extra_trees': True, 'ag_args': {'name_suffix': 'XT'}},
        {'learning_rate': 0.05, 'num_leaves': 31, 'feature_fraction': 0.8}
    ],
    'CAT': [
        {'depth': 6, 'l2_leaf_reg': 3.0},
        {'depth': 8, 'grow_policy': 'Depthwise'}
    ],
    'XGB': [
        {'max_depth': 6, 'learning_rate': 0.1},
        {'max_depth': 10, 'learning_rate': 0.05}
    ],
    'NN_TORCH': [
        {'num_layers': 3, 'hidden_size': 128, 'dropout_prob': 0.1, 'learning_rate': 0.001}
    ]
}

predictor_new_hpo5 = TabularPredictor(
    label='count',
    eval_metric='root_mean_squared_error'
).fit(
    train_data=train,
    time_limit=time_limit,  # Adjust time limit as needed
    presets='best_quality',
    hyperparameters=hyperparameters,
```

```
    excluded_model_types=excluded_model_types,
)
```

```
No path specified. Models will be saved in: "AutogluonModels/ag-20240919_173603"
Verbosity: 2 (Standard Logging)
================== System Info ==================
AutoGluon Version:  1.1.1
Python Version:     3.10.12
Operating System:   Linux
Platform Machine:   x86_64
Platform Version:   #1 SMP PREEMPT_DYNAMIC Thu Jun 27 21:05:47 UTC 2024
CPU Count:          2
Memory Avail:       10.10 GB / 12.67 GB (79.7%)
Disk Space Avail:   63.03 GB / 107.72 GB (58.5%)
=================================================
Presets specified: ['best_quality']
Setting dynamic_stacking from 'auto' to True. Reason: Enable dynamic_stacking when use
Stack configuration (auto_stack=True): num_stack_levels=1, num_bag_folds=8, num_bag_se
DyStack is enabled (dynamic_stacking=True). AutoGluon will try to determine whether th
        This is used to identify the optimal `num_stack_levels` value. Copies of AutoG
        Running DyStack for up to 150s of the 600s of remaining time (25%).
                Context path: "AutogluonModels/ag-20240919_173603/ds_sub_fit/sub_fit_h
Leaderboard on holdout data (DyStack):
                  model  score_holdout  score_val             eval_metric  pred_time_t
0    LightGBMXT_BAG_L1     -35.753145 -36.681132  root_mean_squared_error       39.621
1  WeightedEnsemble_L3     -35.753145 -36.681132  root_mean_squared_error       39.624
2  WeightedEnsemble_L2     -35.753145 -36.681132  root_mean_squared_error       39.626
        1        = Optimal   num_stack_levels (Stacked Overfitting Occurred: False)
        217s     = DyStack   runtime |  383s     = Remaining runtime
Starting main fit with num_stack_levels=1.
        For future fit calls on this dataset, you can skip DyStack to save time: `pred
Beginning AutoGluon training ... Time limit = 383s
AutoGluon will save models to "AutogluonModels/ag-20240919_173603"
Train Data Rows:    10886
Train Data Columns: 11
Label Column:       count
Problem Type:       regression
Preprocessing data ...
Using Feature Generators to preprocess the data ...
Fitting AutoMLPipelineFeatureGenerator...
        Available Memory:                    9950.74 MB
        Train Data (Original)  Memory Usage: 0.69 MB (0.0% of available memory)
        Inferring data type of each feature based on column values. Set feature_metada
        Stage 1 Generators:
                Fitting AsTypeFeatureGenerator...
                        Note: Converting 2 features to boolean dtype as they only cont
        Stage 2 Generators:
                Fitting FillNaFeatureGenerator...
        Stage 3 Generators:
                Fitting IdentityFeatureGenerator...
                Fitting CategoryFeatureGenerator...
                        Fitting CategoryMemoryMinimizeFeatureGenerator...
                Fitting DatetimeFeatureGenerator...
        Stage 4 Generators:
                Fitting DropUniqueFeatureGenerator...
        Stage 5 Generators:
                Fitting DropDuplicatesFeatureGenerator...
```

```
Types of features in original data (raw dtype, special dtypes):
        ('category', []) : 2 | ['season', 'weather']
        ('datetime', []) : 1 | ['datetime']
        ('float', [])    : 3 | ['temp', 'atemp', 'windspeed']
```

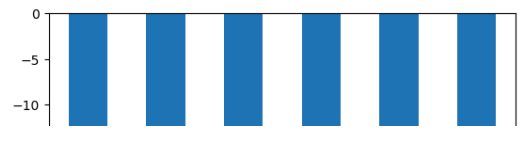
```
performance_new_hpo5 = predictor_new_hpo5.evaluate(train)
print(performance_new_hpo5)
predictor_new_hpo5.fit_summary()
predictor_new_hpo5.leaderboard(silent=True).plot(kind="bar", x="model", y="score_val")

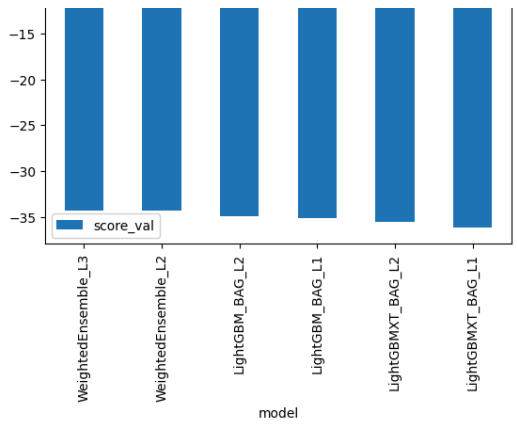

predictions_new_hpo5 = predictor_new_hpo5.predict(test)
predictions_new_hpo5.head()
predictions_description_new_hpo5 = predictions_new_hpo5.describe()
print(predictions_description_new_hpo5)
num_negative_values = (predictions_new_hpo5 < 0).sum()
print(f"Number of negative values: {num_negative_values}")
predictions_new_hpo5[predictions_new_hpo5 < 0] = 0


submission["count"] = predictions_new_hpo5
print(submission["count"].head())
submission.to_csv("submission_new_hpo5.csv", index=False)

!kaggle competitions submit -c bike-sharing-demand -f submission_new_hpo5.csv -m "new feat
!kaggle competitions submissions -c bike-sharing-demand | tail -n +1 | head -n 10
```

```
{'root_mean_squared_error': -14.601223582489723, 'mean_squared_error': -213.1957301058
*** Summary of fit() ***
Estimated performance of each model:
                  model  score_val             eval_metric  pred_time_val    fit_time
0  WeightedEnsemble_L3 -34.264396  root_mean_squared_error      96.341338  316.801059
1  WeightedEnsemble_L2 -34.350652  root_mean_squared_error      96.072733  276.197695
2      LightGBM_BAG_L2 -34.922211  root_mean_squared_error      96.339780  316.762206
3      LightGBM_BAG_L1 -35.104548  root_mean_squared_error      13.164066   86.320622
4    LightGBMXT_BAG_L2 -35.529800  root_mean_squared_error      96.670201  317.410384
5    LightGBMXT_BAG_L1 -36.142399  root_mean_squared_error      82.907528  189.850192
Number of models trained: 6
Types of models trained:
{'WeightedEnsembleModel', 'StackerEnsembleModel_LGB'}
Bagging used: True  (with 8 folds)
Multi-layer stack-ensembling used: True  (with 3 levels)
Feature Metadata (Processed):
(raw dtype, special dtypes):
('category', [])             : 2 | ['season', 'weather']
('float', [])                : 3 | ['temp', 'atemp', 'windspeed']
('int', [])                  : 3 | ['humidity', 'hour', 'day_of_week']
('int', ['bool'])            : 2 | ['holiday', 'workingday']
('int', ['datetime_as_int']) : 4 | ['datetime', 'datetime.year', 'datetime.month', 'da
*** End of fit() summary ***
/usr/local/lib/python3.10/dist-packages/autogluon/core/utils/plots.py:169: UserWarning
  warnings.warn('AutoGluon summary plots cannot be created because bokeh is not instal
count    6493.000000
mean      190.193268
std       173.355576
min       -34.301201
25%        48.061779
50%       147.612396
75%       283.574432
max       880.251160
Name: count, dtype: float64
Number of negative values: 142
0    19.087494
1     5.052511
2     3.375005
3     3.322581
4     3.186225
Name: count, dtype: float32
100% 187k/187k [00:00<00:00, 285kB/s]
Successfully submitted to Bike Sharing DemandfileName                    date
---------------------------  -------------------  -----------------------------------
submission_new_hpo5.csv      2024-09-19 18:01:48  new features with hpo5
submission_new_hpo4.csv      2024-09-19 16:35:40  new features with hpo4
submission_new_hpo3.csv      2024-09-19 16:06:03  new features with hpo3
submission_new_hpo2.csv      2024-09-19 15:54:03  new features with hpo2
submission_new_hpo1.csv      2024-09-19 15:21:01  new features with hpo1
submission_new_features.csv  2024-09-19 14:57:42  new features submission1
submission.csv               2024-09-19 14:29:24  original data submission1
submission_new_hpo.csv       2024-09-18 23:05:44  new features with hyperparameters-2
```






```
hyperparameter_tune_kwargs = {
    'num_trials': 20,              # Try 20 different configurations
    'scheduler': 'local',          # Run on local machine
    'searcher': 'random',          # Random search for hyperparameters
    'max_t': 600                   # Max time for each trial is 600 seconds
}


# Exclude poor-performing models and define hyperparameters for tuning
hyperparameters = {
    'GBM': [
        {'num_leaves': 31, 'learning_rate': 0.05, 'num_boost_round': 100},  # LightGBM_BA
        {'num_leaves': 64, 'learning_rate': 0.03, 'num_boost_round': 200, 'extra_trees': T
    ],
    'RF': [
        {'n_estimators': 200, 'max_depth': 20},  # RandomForestMSE_BAG_L2
    ],
    'CAT': [
        {'depth': 6, 'learning_rate': 0.1},  # CatBoost_BAG_L1 - optional exclusion
    ],
}

excluded_model_types = ['KNN', 'CAT']

predictor_new_hpo6 = TabularPredictor(
    label='count',
    eval_metric='root_mean_squared_error'
```

```
).fit(
    train_data=train,
    time_limit=2100,  # Adjust time limit as needed
    presets='best_quality',
    num_bag_folds=5,  # Enables bagging
    num_stack_levels=2,  # Adds stacking
    hyperparameters=hyperparameters,  # Apply the tuned hyperparameters
    excluded_model_types=excluded_model_types,  # Exclude KNN and optionally CatBoost
    hyperparameter_tune_kwargs=hyperparameter_tune_kwargs  # Apply hyperparameter tuning
)
```

```
No path specified. Models will be saved in: "AutogluonModels/ag-20240919_210933"
Verbosity: 2 (Standard Logging)
=================== System Info ===================
AutoGluon Version:  1.1.1
Python Version:     3.10.12
Operating System:   Linux
Platform Machine:   x86_64
Platform Version:   #1 SMP PREEMPT_DYNAMIC Thu Jun 27 21:05:47 UTC 2024
CPU Count:          2
Memory Avail:       10.11 GB / 12.67 GB (79.8%)
Disk Space Avail:   60.98 GB / 107.72 GB (56.6%)
===================================================
Presets specified: ['best_quality']
Warning: hyperparameter tuning is currently experimental and may cause the process to
Setting dynamic_stacking from 'auto' to True. Reason: Enable dynamic_stacking when use
Stack configuration (auto_stack=True): num_stack_levels=2, num_bag_folds=5, num_bag_se
DyStack is enabled (dynamic_stacking=True). AutoGluon will try to determine whether th
        This is used to identify the optimal `num_stack_levels` value. Copies of AutoG
        Running DyStack for up to 525s of the 2100s of remaining time (25%).
                Context path: "AutogluonModels/ag-20240919_210933/ds_sub_fit/sub_fit_h
Leaderboard on holdout data (DyStack):
                  model  score_holdout  score_val              eval_metric  pred_time
0      LightGBM_BAG_L3/T2     -37.279524 -39.929640  root_mean_squared_error       4.2
1    WeightedEnsemble_L3     -37.404102 -39.355225  root_mean_squared_error       3.8
2    LightGBM_2_BAG_L2/T3     -37.411525 -39.865502  root_mean_squared_error       3.2
3    WeightedEnsemble_L4     -37.470214 -39.311986  root_mean_squared_error       4.2
4    LightGBM_2_BAG_L3/T1     -37.568944 -40.392308  root_mean_squared_error       4.4
5      LightGBM_BAG_L3/T1     -37.658823 -40.170560  root_mean_squared_error       4.2
6    LightGBM_2_BAG_L2/T1     -37.719192 -39.971808  root_mean_squared_error       3.2
7    LightGBM_2_BAG_L3/T2     -37.756051 -40.295919  root_mean_squared_error       4.4
8      LightGBM_BAG_L2/T1     -38.092422 -40.213564  root_mean_squared_error       3.6
9      LightGBM_BAG_L2/T2     -38.120248 -39.928554  root_mean_squared_error       3.6
10     LightGBM_BAG_L2/T3     -38.296871 -40.409996  root_mean_squared_error       3.6
11   LightGBM_2_BAG_L2/T2     -38.590165 -40.558992  root_mean_squared_error       3.2
12    RandomForest_BAG_L3     -38.612729 -40.964605  root_mean_squared_error       4.6
13    RandomForest_BAG_L2     -39.088883 -40.771221  root_mean_squared_error       3.3
14    WeightedEnsemble_L2     -39.757861 -40.499792  root_mean_squared_error       2.6
15    RandomForest_BAG_L1     -41.087277 -41.512382  root_mean_squared_error       0.8
16     LightGBM_BAG_L1/T1     -41.821803 -43.712764  root_mean_squared_error       1.6
17     LightGBM_BAG_L1/T3     -41.879050 -43.574854  root_mean_squared_error       0.1
18     LightGBM_BAG_L1/T2     -41.936400 -44.086992  root_mean_squared_error       0.1
19   LightGBM_2_BAG_L1/T1     -71.819767 -72.673229  root_mean_squared_error       0.3
        2        = Optimal   num_stack_levels (Stacked Overfitting Occurred: False)
        471s     = DyStack   runtime |  1629s    = Remaining runtime
Starting main fit with num_stack_levels=2.
        For future fit calls on this dataset, you can skip DyStack to save time: `pred
Beginning AutoGluon training ... Time limit = 1629s
AutoGluon will save models to "AutogluonModels/ag-20240919_210933"
Train Data Rows:    10886
Train Data Columns: 11
Label Column:       count
Problem Type:       regression
Preprocessing data ...
Using Feature Generators to preprocess the data ...
Fitting AutoMLPipelineFeatureGenerator...
        Available Memory:                    9899.04 MB
        Train Data (Original)  Memory Usage: 0.69 MB (0.0% of available memory)
        Inferring data type of each feature based on column values. Set feature_metada
        Stage 1 Generators:
                Fitting AsTypeFeatureGenerator...
```

```
                        Note: Converting 2 features to boolean dtype as they only cont
        Stage 2 Generators:
                Fitting FillNaFeatureGenerator...
        Stage 3 Generators:
                Fitting IdentityFeatureGenerator...
                Fitting CategoryFeatureGenerator...
                        Fitting CategoryMemoryMinimizeFeatureGenerator...
                Fitting DatetimeFeatureGenerator...
        Stage 4 Generators:
                Fitting DropUniqueFeatureGenerator...
        Stage 5 Generators:
                Fitting DropDuplicatesFeatureGenerator...
        Types of features in original data (raw dtype, special dtypes):
                ('category', []) : 2 | ['season', 'weather']
                ('datetime', []) : 1 | ['datetime']
                ('float', [])    : 3 | ['temp', 'atemp', 'windspeed']
                ('int', [])      : 5 | ['holiday', 'workingday', 'humidity', 'hour', '
        Types of features in processed data (raw dtype, special dtypes):
                ('category', [])             : 2 | ['season', 'weather']
                ('float', [])                : 3 | ['temp', 'atemp', 'windspeed']
                ('int', [])                  : 3 | ['humidity', 'hour', 'day_of_week']
                ('int', ['bool'])            : 2 | ['holiday', 'workingday']
                ('int', ['datetime_as_int']) : 4 | ['datetime', 'datetime.year', 'date
        0.7s = Fit runtime
        11 features in original data used to generate 14 features in processed data.
        Train Data (Processed) Memory Usage: 0.79 MB (0.0% of available memory)
Data preprocessing and feature engineering runtime = 0.75s ...
AutoGluon will gauge predictive performance using evaluation metric: 'root_mean_square
        This metric's sign has been flipped to adhere to being higher_is_better. The m
        To change this, specify the eval_metric parameter of Predictor()
User-specified model hyperparameters to be fit:
{
        'GBM': [{'num_leaves': 31, 'learning_rate': 0.05, 'num_boost_round': 100}, {'n
        'RF': [{'n_estimators': 200, 'max_depth': 20}],
        'CAT': [{'depth': 6, 'learning_rate': 0.1}],
}
AutoGluon will fit 3 stack levels (L1 to L3) ...
Excluded models: ['CAT'] (Specified by `excluded_model_types`)
Fitting 3 L1 models ...
Hyperparameter tuning model: LightGBM_BAG_L1 ... Tuning model for up to 217.04s of the
 40%                                    8/20 [03:21<04:29, 22.44s/it]
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Stopping HPO to satisfy time limit...
Fitted model: LightGBM_BAG_L1/T1 ...
        -43.6557         = Validation score   (-root_mean_squared_error)
        22.24s   = Training   runtime
        0.2s     = Validation runtime
Fitted model: LightGBM_BAG_L1/T2 ...
        -43.9976         = Validation score   (-root_mean_squared_error)
        23.54s   = Training   runtime
        0.2s     = Validation runtime
```

```
Fitted model: LightGBM_BAG_L1/T3 ...
        -43.5776         = Validation score   (-root_mean_squared_error)
        21.34s   = Training   runtime
        0.15s    = Validation runtime
Fitted model: LightGBM_BAG_L1/T4 ...
        -43.4367         = Validation score   (-root_mean_squared_error)
        22.61s   = Training   runtime
        0.28s    = Validation runtime
Fitted model: LightGBM_BAG_L1/T5 ...
        -43.6695         = Validation score   (-root_mean_squared_error)
        23.49s   = Training   runtime
        0.23s    = Validation runtime
Fitted model: LightGBM_BAG_L1/T6 ...
        -43.7813         = Validation score   (-root_mean_squared_error)
        21.64s   = Training   runtime
        0.19s    = Validation runtime
Fitted model: LightGBM_BAG_L1/T7 ...
        -44.1694         = Validation score   (-root_mean_squared_error)
        23.95s   = Training   runtime
        0.16s    = Validation runtime
Fitted model: LightGBM_BAG_L1/T8 ...
        -43.7586         = Validation score   (-root_mean_squared_error)
        21.37s   = Training   runtime
        0.12s    = Validation runtime
Fitted model: LightGBM_BAG_L1/T9 ...
        -43.7813         = Validation score   (-root_mean_squared_error)
        21.06s   = Training   runtime
        0.27s    = Validation runtime
Hyperparameter tuning model: LightGBM_2_BAG_L1 ... Tuning model for up to 217.04s of t
 35%                                    7/20 [03:16<05:23, 24.86s/it]
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
        Stopping HPO to satisfy time limit...
Fitted model: LightGBM_2_BAG_L1/T1 ...
        -69.95   = Validation score   (-root_mean_squared_error)
        26.16s   = Training   runtime
        1.56s    = Validation runtime
Fitted model: LightGBM_2_BAG_L1/T2 ...
        -76.9394         = Validation score   (-root_mean_squared_error)
        22.15s   = Training   runtime
        0.71s    = Validation runtime
Fitted model: LightGBM_2_BAG_L1/T3 ...
        -70.8109         = Validation score   (-root_mean_squared_error)
        26.64s   = Training   runtime
        1.51s    = Validation runtime
Fitted model: LightGBM_2_BAG_L1/T4 ...
        -70.7685         = Validation score   (-root_mean_squared_error)
        23.96s   = Training   runtime
        0.52s    = Validation runtime
Fitted model: LightGBM_2_BAG_L1/T5 ...
        -72.617  = Validation score   (-root_mean_squared_error)
        25.38s   = Training   runtime
        0.62s    = Validation runtime
```

```
Fitted model: LightGBM_2_BAG_L1/T6 ...
	-73.3168	 = Validation score   (-root_mean_squared_error)
	23.47s	 = Training   runtime
	0.68s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L1/T7 ...
	-72.2232	 = Validation score   (-root_mean_squared_error)
	25.67s	 = Training   runtime
	1.29s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L1/T8 ...
	-76.101	 = Validation score   (-root_mean_squared_error)
	22.44s	 = Training   runtime
	0.68s	 = Validation runtime
Hyperparameter tuning model: RandomForest_BAG_L1 ... Tuning model for up to 217.04s of
	No hyperparameter search space specified for RandomForest_BAG_L1. Skipping HP(
Fitted model: RandomForest_BAG_L1 ...
	-40.8654	 = Validation score   (-root_mean_squared_error)
	17.72s	 = Training   runtime
	0.47s	 = Validation runtime
Fitting model: WeightedEnsemble_L2 ... Training model for up to 360.0s of the 1212.36s
	Ensemble Weights: {'RandomForest_BAG_L1': 0.667, 'LightGBM_BAG_L1/T4': 0.19, '
	-40.0196	 = Validation score   (-root_mean_squared_error)
	0.04s	 = Training   runtime
	0.0s	 = Validation runtime
Excluded models: ['CAT'] (Specified by `excluded_model_types`)
Fitting 3 L2 models ...
Hyperparameter tuning model: LightGBM_BAG_L2 ... Tuning model for up to 242.4s of the
 40%                    8/20 [03:44<04:59, 24.98s/it]
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Stopping HPO to satisfy time limit...
Fitted model: LightGBM_BAG_L2/T1 ...
	-40.0398	 = Validation score   (-root_mean_squared_error)
	23.79s	 = Training   runtime
	0.18s	 = Validation runtime
Fitted model: LightGBM_BAG_L2/T2 ...
	-39.7853	 = Validation score   (-root_mean_squared_error)
	22.77s	 = Training   runtime
	0.16s	 = Validation runtime
Fitted model: LightGBM_BAG_L2/T3 ...
	-40.128	 = Validation score   (-root_mean_squared_error)
	25.28s	 = Training   runtime
	0.13s	 = Validation runtime
Fitted model: LightGBM_BAG_L2/T4 ...
	-40.0333	 = Validation score   (-root_mean_squared_error)
	23.14s	 = Training   runtime
	0.14s	 = Validation runtime
Fitted model: LightGBM_BAG_L2/T5 ...
	-39.8851	 = Validation score   (-root_mean_squared_error)
	25.89s	 = Training   runtime
	0.35s	 = Validation runtime
Fitted model: LightGBM_BAG_L2/T6 ...
	-39.8578	 = Validation score   (-root_mean_squared_error)
	27.39s	 = Training   runtime
	0.11s	 = Validation runtime
Fitted model: LightGBM_BAG_L2/T7 ...
	-39.8439	 = Validation score   (-root_mean_squared_error)
	26.79s	 = Training   runtime
	1.11s	 = Validation runtime
Fitted model: LightGBM_BAG_L2/T8 ...
	-39.7976	 = Validation score   (-root_mean_squared_error)
	22.9s	 = Training   runtime
	0.21s	 = Validation runtime
Fitted model: LightGBM_BAG_L2/T9 ...
	-39.8645	 = Validation score   (-root_mean_squared_error)
	26.11s	 = Training   runtime
	0.11s	 = Validation runtime
Hyperparameter tuning model: LightGBM_2_BAG_L2 ... Tuning model for up to 242.4s of th
 0%                    0/20 [00:00<?, ?it/s]
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Stopping HPO to satisfy time limit...
Fitted model: LightGBM_2_BAG_L2/T1 ...
	-39.6762	 = Validation score   (-root_mean_squared_error)
	25.2s	 = Training   runtime
	0.82s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L2/T2 ...
	-40.1051	 = Validation score   (-root_mean_squared_error)
	25.86s	 = Training   runtime
	0.49s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L2/T3 ...
	-39.5166	 = Validation score   (-root_mean_squared_error)
	26.77s	 = Training   runtime
	0.4s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L2/T4 ...
	-39.6304	 = Validation score   (-root_mean_squared_error)
	23.51s	 = Training   runtime
	0.47s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L2/T5 ...
	-39.8126	 = Validation score   (-root_mean_squared_error)
	26.55s	 = Training   runtime
	0.49s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L2/T6 ...
	-39.8346	 = Validation score   (-root_mean_squared_error)
	25.14s	 = Training   runtime
	0.54s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L2/T7 ...
	-39.9881	 = Validation score   (-root_mean_squared_error)
	24.74s	 = Training   runtime
	0.58s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L2/T8 ...
	-39.8819	 = Validation score   (-root_mean_squared_error)
	25.92s	 = Training   runtime
	0.41s	 = Validation runtime
Fitted model: LightGBM_2_BAG_L2/T9 ...
	-39.7705	 = Validation score   (-root_mean_squared_error)
	23.59s	 = Training   runtime
	0.36s	 = Validation runtime
Hyperparameter tuning model: RandomForest_BAG_L2 ... Tuning model for up to 242.4s of
	No hyperparameter search space specified for RandomForest_BAG_L2. Skipping HP(
Fitted model: RandomForest_BAG_L2 ...
	-39.7641	 = Validation score   (-root_mean_squared_error)
	70.35s	 = Training   runtime
	0.6s	 = Validation runtime
Fitting model: WeightedEnsemble_L3 ... Training model for up to 360.0s of the 689.55s
	Ensemble Weights: {'RandomForest_BAG_L2': 0.421, 'LightGBM_2_BAG_L2/T3': 0.36(
	-38.9239	 = Validation score   (-root_mean_squared_error)
	0.05s	 = Training   runtime
	0.0s	 = Validation runtime
Excluded models: ['CAT'] (Specified by `excluded_model_types`)
Fitting 3 L3 models ...
Hyperparameter tuning model: LightGBM_BAG_L3 ... Tuning model for up to 206.83s of the
  0%|          | 0/20 [00:00<?, ?it/s]
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Fitting 5 child models (S1F1 - S1F5) | Fitting with ParallelLocalFoldFittingSt
	Stopping HPO to satisfy time limit...
Fitted model: LightGBM_BAG_L3/T1 ...
	-39.9303	 = Validation score   (-root_mean_squared_error)
```