Name: Prithviraj Chavan
Task code: ML
Task 1: LINEAR REGRESSION ON HOUSING PRICES

In [1]:
```
from sklearn.datasets import fetch_california_housing

california_housing = fetch_california_housing(as_frame=True)
```

In [3]:
```
print(california_housing.DESCR)
```

```
.. _california_housing_dataset:

California Housing dataset
--------------------------

**Data Set Characteristics:**

:Number of Instances: 20640

:Number of Attributes: 8 numeric, predictive attributes and the target

:Attribute Information:
    - MedInc        median income in block group
    - HouseAge      median house age in block group
    - AveRooms      average number of rooms per household
    - AveBedrms     average number of bedrooms per household
    - Population    block group population
    - AveOccup      average number of household members
    - Latitude      block group latitude
    - Longitude     block group longitude

:Missing Attribute Values: None

This dataset was obtained from the StatLib repository.
https://www.dcc.fc.up.pt/~ltorgo/Regression/cal_housing.html

The target variable is the median house value for California districts,
expressed in hundreds of thousands of dollars ($100,000).

This dataset was derived from the 1990 U.S. census, using one row per census
block group. A block group is the smallest geographical unit for which the U.S.
Census Bureau publishes sample data (a block group typically has a population
of 600 to 3,000 people).

A household is a group of people residing within a home. Since the average
number of rooms and bedrooms in this dataset are provided per household, these
columns may take surprisingly large values for block groups with few households
and many empty houses, such as vacation resorts.

It can be downloaded/loaded using the
:func:`sklearn.datasets.fetch_california_housing` function.

.. topic:: References

    - Pace, R. Kelley and Ronald Barry, Sparse Spatial Autoregressions,
      Statistics and Probability Letters, 33 (1997) 291-297
```

In [5]:
```
california_housing.frame.head()
```

Out[5]:

	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup	Latitude	Longit
0	8.3252	41.0	6.984127	1.023810	322.0	2.555556	37.88	-12
1	8.3014	21.0	6.238137	0.971880	2401.0	2.109842	37.86	-12
2	7.2574	52.0	8.288136	1.073446	496.0	2.802260	37.85	-12
3	5.6431	52.0	5.817352	1.073059	558.0	2.547945	37.85	-12
4	3.8462	52.0	6.281853	1.081081	565.0	2.181467	37.85	-12

In [7]:

```
california_housing.data.head()
```

Out[7]:

	MedInc	HouseAge	AveRooms	AveBedrms	Population	AveOccup	Latitude	Longit
0	8.3252	41.0	6.984127	1.023810	322.0	2.555556	37.88	-12
1	8.3014	21.0	6.238137	0.971880	2401.0	2.109842	37.86	-12
2	7.2574	52.0	8.288136	1.073446	496.0	2.802260	37.85	-12
3	5.6431	52.0	5.817352	1.073059	558.0	2.547945	37.85	-12
4	3.8462	52.0	6.281853	1.081081	565.0	2.181467	37.85	-12

In [9]:

```
california_housing.target.head()
```

Out[9]:

```
0    4.526
1    3.585
2    3.521
3    3.413
4    3.422
Name: MedHouseVal, dtype: float64
```

In [11]:

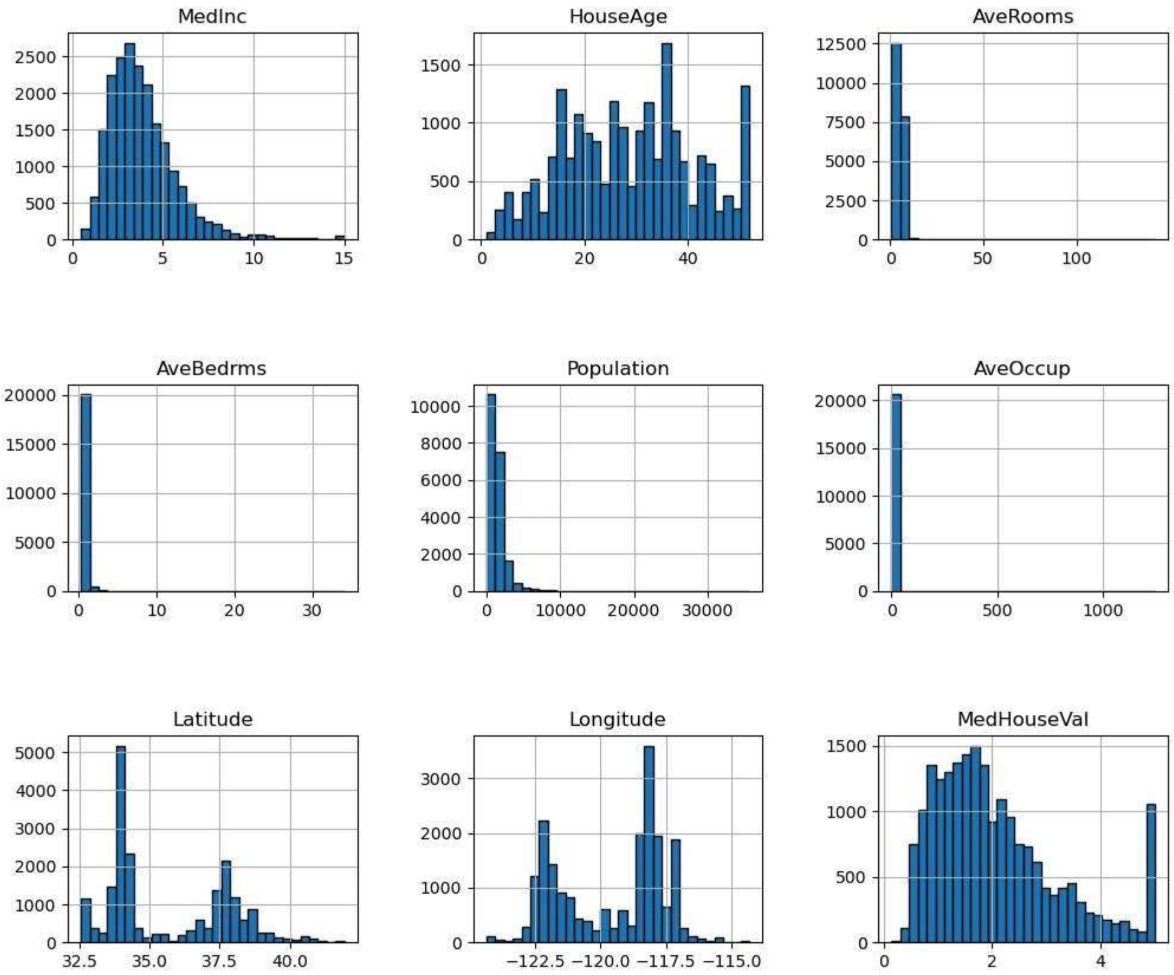
```
california_housing.frame.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20640 entries, 0 to 20639
Data columns (total 9 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   MedInc       20640 non-null  float64
 1   HouseAge     20640 non-null  float64
 2   AveRooms     20640 non-null  float64
 3   AveBedrms    20640 non-null  float64
 4   Population   20640 non-null  float64
 5   AveOccup     20640 non-null  float64
 6   Latitude     20640 non-null  float64
 7   Longitude    20640 non-null  float64
 8   MedHouseVal  20640 non-null  float64
dtypes: float64(9)
memory usage: 1.4 MB
```

In [13]:

```
import matplotlib.pyplot as plt
```

```
california_housing.frame.hist(figsize=(12, 10), bins=30, edgecolor="black")
plt.subplots_adjust(hspace=0.7, wspace=0.4)
```



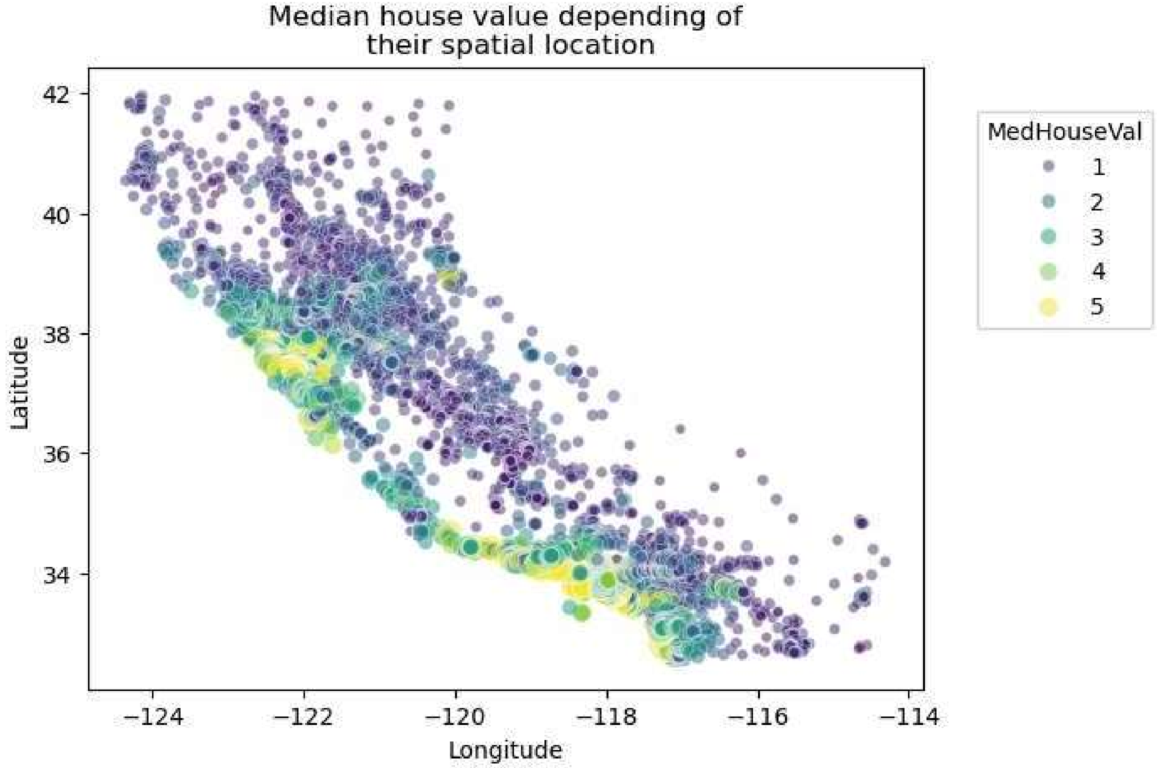
In [15]:
```
features_of_interest = ["AveRooms", "AveBedrms", "AveOccup", "Population"]
california_housing.frame[features_of_interest].describe()
```

Out[15]:

	AveRooms	AveBedrms	AveOccup	Population
count	20640.000000	20640.000000	20640.000000	20640.000000
mean	5.429000	1.096675	3.070655	1425.476744
std	2.474173	0.473911	10.386050	1132.462122
min	0.846154	0.333333	0.692308	3.000000
25%	4.440716	1.006079	2.429741	787.000000
50%	5.229129	1.048780	2.818116	1166.000000
75%	6.052381	1.099526	3.282261	1725.000000
max	141.909091	34.066667	1243.333333	35682.000000

In [17]:
```
import seaborn as sns

sns.scatterplot(
    data=california_housing.frame,
    x="Longitude",
    y="Latitude",
    size="MedHouseVal",
    hue="MedHouseVal",
    palette="viridis",
    alpha=0.5,
)
plt.legend(title="MedHouseVal", bbox_to_anchor=(1.05, 0.95), loc="upper left")
_ = plt.title("Median house value depending of\n their spatial location")
```



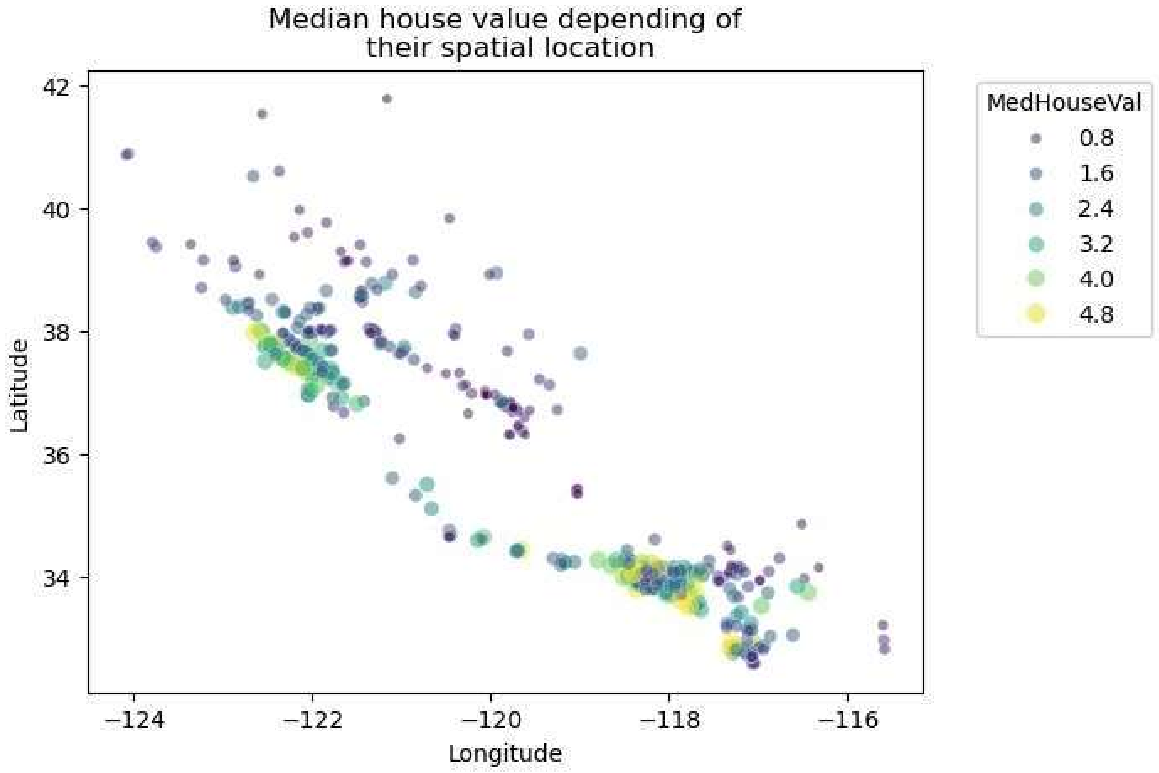
In [19]:

```
import numpy as np

rng = np.random.RandomState(0)
indices = rng.choice(
    np.arange(california_housing.frame.shape[0]), size=500, replace=False
)
```

In [21]:

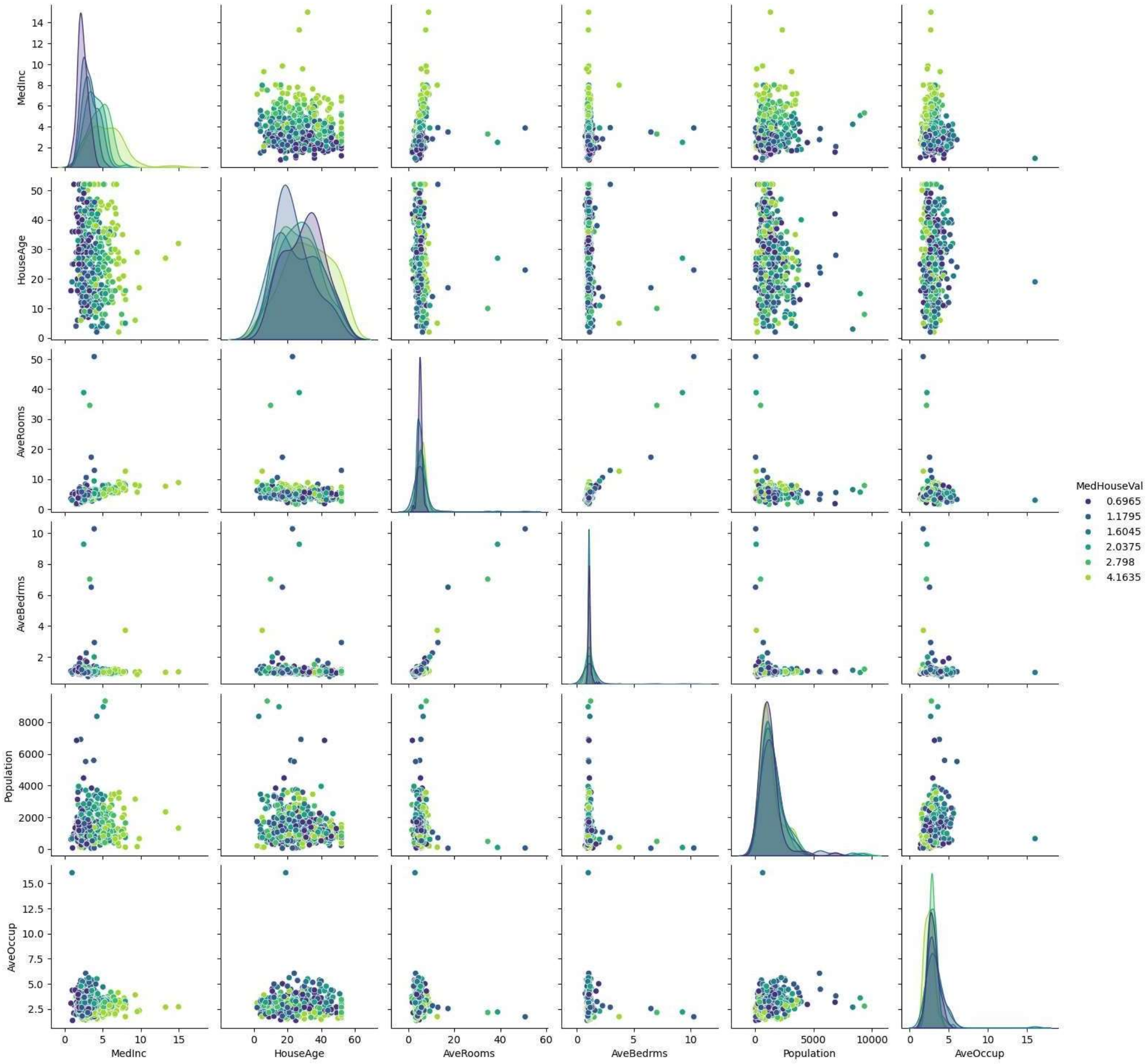
```
sns.scatterplot(
    data=california_housing.frame.iloc[indices],
    x="Longitude",
    y="Latitude",
    size="MedHouseVal",
    hue="MedHouseVal",
    palette="viridis",
    alpha=0.5,
)
plt.legend(title="MedHouseVal", bbox_to_anchor=(1.05, 1), loc="upper left")
_ = plt.title("Median house value depending of\n their spatial location")
```



In [23]:
```
import pandas as pd

# Drop the unwanted columns
columns_drop = ["Longitude", "Latitude"]
subset = california_housing.frame.iloc[indices].drop(columns=columns_drop)
# Quantize the target and keep the midpoint for each interval
subset["MedHouseVal"] = pd.qcut(subset["MedHouseVal"], 6, retbins=False)
subset["MedHouseVal"] = subset["MedHouseVal"].apply(lambda x: x.mid)
```

In [25]:
```
_ = sns.pairplot(data=subset, hue="MedHouseVal", palette="viridis")
```



In [27]:
```python
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import RidgeCV
from sklearn.pipeline import make_pipeline
from sklearn.model_selection import cross_validate

alphas = np.logspace(-3, 1, num=30)
model = make_pipeline(StandardScaler(), RidgeCV(alphas=alphas))
cv_results = cross_validate(
    model,
    california_housing.data,
    california_housing.target,
    return_estimator=True,
    n_jobs=2,
)
```

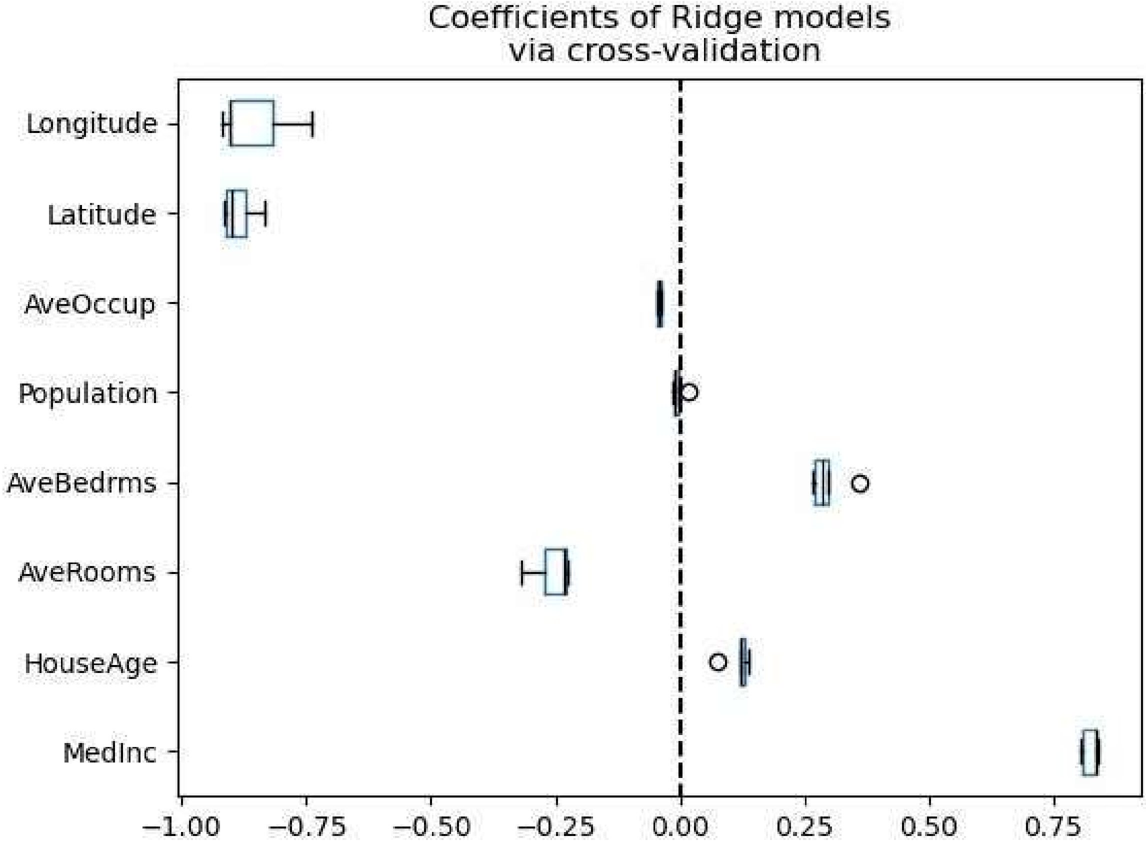
In [29]:
```python
score = cv_results["test_score"]
print(f"R2 score: {score.mean():.3f} ± {score.std():.3f}")
```

```
R2 score: 0.553 ± 0.062
```

In [31]:
```python
import pandas as pd

coefs = pd.DataFrame(
    [est[-1].coef_ for est in cv_results["estimator"]],
    columns=california_housing.feature_names,
)
```

In [33]:
```
color = {"whiskers": "black", "medians": "black", "caps": "black"}
coefs.plot.box(vert=False, color=color)
plt.axvline(x=0, ymin=-1, ymax=1, color="black", linestyle="--")
_ = plt.title("Coefficients of Ridge models\n via cross-validation")
```


Coefficients of Ridge models
via cross-validation
Longitude
Latitude
AveOccup
Population
AveBedrms
AveRooms
HouseAge
MedInc