

# heart

August 4, 2024

```
[2]: import pandas as pd
```

```
[3]: df = pd.read_csv('/home/a3-403a-11/Desktop/33348/Heart.csv')
```

```
[4]: df
```

```
[4]:
```

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	\
0	1	63.0	1	typical	145.0	233.0	1	2	150.0	
1	2	67.0	1	asymptomatic	160.0	286.0	0	2	108.0	
2	3	67.0	1	asymptomatic	120.0	229.0	0	2	129.0	
3	4	37.0	1	nonanginal	130.0	250.0	0	0	187.0	
4	5	41.0	0	nontypical	130.0	204.0	0	2	172.0	
..	...	...	...	...	...	...	...			
298	299	45.0	1	typical	110.0	264.0	0	0	132.0	
299	300	68.0	1	asymptomatic	144.0	193.0	1	0	141.0	
300	301	57.0	1	asymptomatic	130.0	131.0	0	0	115.0	
301	302	57.0	0	nontypical	130.0	236.0	0	2	174.0	
302	303	38.0	1	nonanginal	138.0	175.0	0	0	173.0	

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
0	0	2.3	3	0.0	fixed	No
1	1	1.5	2	3.0	normal	Yes
2	1	2.6	2	2.0	reversable	Yes
3	0	3.5	3	0.0	normal	No
4	0	1.4	1	0.0	normal	No
..	...	...	...	...	...	
298	0	1.2	2	0.0	reversable	Yes
299	0	3.4	2	2.0	reversable	Yes
300	1	1.2	2	1.0	reversable	Yes
301	0	0.0	2	1.0	normal	Yes
302	0	0.0	1	NaN	normal	No

[303 rows x 15 columns]

```
[5]: df.head()
```

```
[5]:
```

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	\
0	1	63.0	1	typical	145.0	233.0	1	2	150.0	
1	2	67.0	1	asymptomatic	160.0	286.0	0	2	108.0	
2	3	67.0	1	asymptomatic	120.0	229.0	0	2	129.0	
3	4	37.0	1	nonanginal	130.0	250.0	0	0	187.0	
4	5	41.0	0	nontypical	130.0	204.0	0	2	172.0	

  

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
0	0	2.3	3	0.0	fixed	No
1	1	1.5	2	3.0	normal	Yes
2	1	2.6	2	2.0	reversable	Yes
3	0	3.5	3	0.0	normal	No
4	0	1.4	1	0.0	normal	No

```
[6]: df.tail()
```

```
[6]:
```

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	\
298	299	45.0	1	typical	110.0	264.0	0	0	132.0	
299	300	68.0	1	asymptomatic	144.0	193.0	1	0	141.0	
300	301	57.0	1	asymptomatic	130.0	131.0	0	0	115.0	
301	302	57.0	0	nontypical	130.0	236.0	0	2	174.0	
302	303	38.0	1	nonanginal	138.0	175.0	0	0	173.0	

  

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
298	0	1.2	2	0.0	reversable	Yes
299	0	3.4	2	2.0	reversable	Yes
300	1	1.2	2	1.0	reversable	Yes
301	0	0.0	2	1.0	normal	Yes
302	0	0.0	1	NaN	normal	No

```
[7]: # Finding shape of the dataset
shape = df.shape
print("Shape of the dataset- ",shape)
```

Shape of the dataset- (303, 15)

```
[8]: pivot_table = df.pivot_table(index='ChestPain', columns='Sex', values='Chol',
    ↪aggfunc='mean')
print("Pivoted Data:")
print(pivot_table)
```

```
Pivoted Data:
Sex                0                1
ChestPain
asymptomatic    268.475000    243.605769
nonanginal      262.294118    232.235294
nontypical      251.444444    241.031250
typical         247.000000    235.052632
```

```
[9]: df.shape
```

```
[9]: (303, 15)
```

```
[10]: df_stacked = df.stack()
df_stacked
```

```
[10]: 0      Unnamed: 0      1
      Age      63.0
      Sex      1
      ChestPain  typical
      RestBP    145.0
      ...
302  ExAng      0
      Oldpeak    0.0
      Slope      1
      Thal      normal
      AHD        No
Length: 4535, dtype: object
```

```
[11]: df.isnull().sum().sum()
```

```
[11]: 10
```

```
[12]: # Find missing values
missing_values = df.isnull().sum()
print("Missing values:\n", missing_values)
```

```
Missing values:
  Unnamed: 0    0
Age         0
Sex         0
ChestPain   0
RestBP      1
Chol        1
Fbs         0
RestECG     0
MaxHR       1
ExAng       0
Oldpeak     0
Slope       0
Ca          5
Thal        2
AHD         0
dtype: int64
```

```
[13]: # Finding datatypes of each column
df.dtypes
```

```
[13]: Unnamed: 0      int64
Age      float64
Sex      int64
ChestPain  object
RestBP    float64
Chol      float64
Fbs      int64
RestECG   int64
MaxHR     float64
ExAng     int64
Oldpeak   float64
Slope     int64
Ca        float64
Thal      object
AHD       object
dtype: object
```

```
[14]: # Sort by Age in ascending order
sorted_df_age = df.sort_values(by='Age')
print("Sorted by Age:")
sorted_df_age
```

Sorted by Age:

```
[14]: Unnamed: 0  Age  Sex  ChestPain  RestBP  Chol  Fbs  RestECG  MaxHR  \
132      133  29.0    1  nontypical   130.0  204.0    0         2  202.0
101      102  34.0    1    typical   118.0  182.0    0         2  174.0
225      226  34.0    0  nontypical   118.0  210.0    0         0  192.0
283      284  35.0    1  nontypical   122.0  192.0    0         0  174.0
117      118  35.0    0 asymptomatic  138.0  183.0    0         0  182.0
..      ...  ...  ...
42       43  71.0    0  nontypical   160.0  302.0    0         0  162.0
273      274  71.0    0 asymptomatic  112.0  149.0    0         0  125.0
233      234  74.0    0  nontypical   120.0  269.0    0         2  121.0
257      258  76.0    0  nonanginal   140.0  197.0    0         1  116.0
161      162  77.0    1 asymptomatic  125.0  304.0    0         2  162.0

      ExAng  Oldpeak  Slope  Ca  Thal  AHD
132      0      0.0      1  0.0  normal  No
101      0      0.0      1  0.0  normal  No
225      0      0.7      1  0.0  normal  No
283      0      0.0      1  0.0  normal  No
117      0      1.4      1  0.0  normal  No
..      ...      ...      ...  ...  ...
```

42	0	0.4	1	2.0	normal	No
273	0	1.6	2	0.0	normal	No
233	1	0.2	1	1.0	normal	No
257	0	1.1	2	0.0	normal	No
161	1	0.0	1	3.0	normal	Yes

[303 rows x 15 columns]

```
[15]: # Finding out zero's
(df==0).sum().sum()
```

[15]: 985

```
[16]: # Zero's in each row
(df==0).sum()
```

```
[16]: Unnamed: 0      0
Age           0
Sex           97
ChestPain     0
RestBP        0
Chol          0
Fbs          258
RestECG       151
MaxHR         0
ExAng         204
Oldpeak       99
Slope         0
Ca           176
Thal          0
AHD           0
dtype: int64
```

```
[17]: # finding mean of age
print("Mean of all the ages - ")
age_mean = df['Age'].mean()
age_mean
```

Mean of all the ages -

[17]: 54.51162790697675

```
[18]: df["Age"].fillna(age_mean, inplace=True)
```

```
[19]: df.isnull().sum()
```

```
[19]: Unnamed: 0    0
      Age         0
      Sex         0
      ChestPain   0
      RestBP      1
      Chol        1
      Fbs         0
      RestECG     0
      MaxHR       1
      ExAng       0
      Oldpeak     0
      Slope       0
      Ca          5
      Thal        2
      AHD         0
      dtype: int64
```

```
[20]: ChestPain_mode = df['ChestPain'].mode()[0]
```

```
[21]: ChestPain_mode
```

```
[21]: 'asymptomatic'
```

```
[22]: df["ChestPain"].fillna(ChestPain_mode, inplace=True)
```

```
[23]: df.isnull().sum()
```

```
[23]: Unnamed: 0    0
      Age         0
      Sex         0
      ChestPain   0
      RestBP      1
      Chol        1
      Fbs         0
      RestECG     0
      MaxHR       1
      ExAng       0
      Oldpeak     0
      Slope       0
      Ca          5
      Thal        2
      AHD         0
      dtype: int64
```

```
[24]: element = df.iloc[55, 3]
```

```
[25]: element
```

```
[25]: 'asymptomatic'
```

```
[26]: df.to_csv('/home/a3-403a-11/Desktop/33348/Heart.csv', index=False)
```

```
[27]: df_selected = df[['Age', 'Sex', 'ChestPain', 'RestBP', 'Chol']]
df_selected
```

```
[27]:
```

	Age	Sex	ChestPain	RestBP	Chol
0	63.0	1	typical	145.0	233.0
1	67.0	1	asymptomatic	160.0	286.0
2	67.0	1	asymptomatic	120.0	229.0
3	37.0	1	nonanginal	130.0	250.0
4	41.0	0	nontypical	130.0	204.0
..	...	...	...	...	...
298	45.0	1	typical	110.0	264.0
299	68.0	1	asymptomatic	144.0	193.0
300	57.0	1	asymptomatic	130.0	131.0
301	57.0	0	nontypical	130.0	236.0
302	38.0	1	nonanginal	138.0	175.0

[303 rows x 5 columns]

```
[28]: from sklearn.model_selection import train_test_split
```

```
[29]: # Splitting dataset into training (80%) and testing (20%)
train_df, test_df = train_test_split(df_selected, test_size=0.2,
↳random_state=42)
```

```
[30]: # The random_state parameter in train_test_split function is used to control
↳the random number generator
#for splitting the data into training and testing sets.
```

```
[31]: train_df.to_csv('/home/a3-403a-11/Desktop/33348/train_dataset.csv', index=False)
test_df.to_csv('/home/a3-403a-11/Desktop/33348/test_dataset.csv', index=False)
```

```
[32]: # Splitting data into test data and train data using - 1) Leave one out 2) k-fold
```

```
[61]: # Leave One out ->>
from sklearn.model_selection import LeaveOneOut
```

```
[62]: loo = LeaveOneOut()
```

```
[86]: X = df[:10]
for train_index, test_index in loo.split(X):
    X_train, X_test = X.iloc[train_index], X.iloc[test_index]
    print(f"Train index: {train_index[0]}, Test index: {test_index[0]}")
    #Y_train, Y_test = Y.iloc[train_index], Y.iloc[test_index]
```

```

Train index: 1, Test index: 0
Train index: 0, Test index: 1
Train index: 0, Test index: 2
Train index: 0, Test index: 3
Train index: 0, Test index: 4
Train index: 0, Test index: 5
Train index: 0, Test index: 6
Train index: 0, Test index: 7
Train index: 0, Test index: 8
Train index: 0, Test index: 9

```

```

[87]: for train_index, test_index in loo.split(X):
      X_train, X_test = X.iloc[train_index], X.iloc[test_index]
      print(f"Train Data: {X_train}")
      print(f"Test data: {X_test}")
      □
      ↪ print("-----")

```

		Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR	\								
1	2	67.0	1	asymptomatic	160.0	286.0	0	2	108.0
2	3	67.0	1	asymptomatic	120.0	229.0	0	2	129.0
3	4	37.0	1	nonanginal	130.0	250.0	0	0	187.0
4	5	41.0	0	nontypical	130.0	204.0	0	2	172.0
5	6	56.0	1	nontypical	120.0	236.0	0	0	178.0
6	7	62.0	0	asymptomatic	140.0	268.0	0	2	160.0
7	8	57.0	0	asymptomatic	120.0	354.0	0	0	163.0
8	9	63.0	1	asymptomatic	130.0	254.0	0	2	147.0
9	10	53.0	1	asymptomatic	140.0	203.0	1	2	155.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
1	1	1.5	2	3.0	normal	Yes
2	1	2.6	2	2.0	reversible	Yes
3	0	3.5	3	0.0	normal	No
4	0	1.4	1	0.0	normal	No
5	0	0.8	1	0.0	normal	No
6	0	3.6	3	2.0	normal	Yes
7	1	0.6	1	0.0	normal	No
8	0	1.4	2	1.0	reversible	Yes
9	1	3.1	3	0.0	reversible	Yes

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG		
Test data:										
MaxHR	ExAng	\								
0	1	63.0	1	typical	145.0	233.0	1	2	150.0	0

	Oldpeak	Slope	Ca	Thal	AHD
0	2.3	3	0.0	fixed	No

-----

-----



Train Data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								
0	1	63.0	1	typical	145.0	233.0	1	2 150.0
2	3	67.0	1	asymptomatic	120.0	229.0	0	2 129.0
3	4	37.0	1	nonanginal	130.0	250.0	0	0 187.0
4	5	41.0	0	nontypical	130.0	204.0	0	2 172.0
5	6	56.0	1	nontypical	120.0	236.0	0	0 178.0
6	7	62.0	0	asymptomatic	140.0	268.0	0	2 160.0
7	8	57.0	0	asymptomatic	120.0	354.0	0	0 163.0
8	9	63.0	1	asymptomatic	130.0	254.0	0	2 147.0
9	10	53.0	1	asymptomatic	140.0	203.0	1	2 155.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
0	0	2.3	3	0.0	fixed	No
2	1	2.6	2	2.0	reversable	Yes
3	0	3.5	3	0.0	normal	No
4	0	1.4	1	0.0	normal	No
5	0	0.8	1	0.0	normal	No
6	0	3.6	3	2.0	normal	Yes
7	1	0.6	1	0.0	normal	No
8	0	1.4	2	1.0	reversable	Yes
9	1	3.1	3	0.0	reversable	Yes

Test data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								
1	2	67.0	1	asymptomatic	160.0	286.0	0	2 108.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
1	1	1.5	2	3.0	normal	Yes

Train Data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								
0	1	63.0	1	typical	145.0	233.0	1	2 150.0
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3	4	37.0	1	nonanginal	130.0	250.0	0	0 187.0
4	5	41.0	0	nontypical	130.0	204.0	0	2 172.0
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7	8	57.0	0	asymptomatic	120.0	354.0	0	0 163.0
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9	10	53.0	1	asymptomatic	140.0	203.0	1	2 155.0

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4	0	1.4	1	0.0	normal	No
5	0	0.8	1	0.0	normal	No

6	0	3.6	3	2.0	normal	Yes				
7	1	0.6	1	0.0	normal	No				
8	0	1.4	2	1.0	reversable	Yes				
9	1	3.1	3	0.0	reversable	Yes				
Test data:		Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	
MaxHR \										
2		3	67.0	1	asymptomatic	120.0	229.0	0	2	129.0
ExAng		Oldpeak	Slope	Ca	Thal	AHD				
2	1	2.6	2	2.0	reversable	Yes				

---

Train Data:		Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	
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6	0	3.6	3	2.0	normal	Yes				
7	1	0.6	1	0.0	normal	No				
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Test data:		Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	
MaxHR \										
3		4	37.0	1	nonanginal	130.0	250.0	0	0	187.0

ExAng		Oldpeak	Slope	Ca	Thal	AHD				
3	0	3.5	3	0.0	normal	No				

---

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9	1	3.1	3	0.0	reversable	Yes

Test data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	
MaxHR \									
4	5	41.0	0	nontypical	130.0	204.0	0	2	172.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
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---

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Test data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								

5	6	56.0	1	nontypical	120.0	236.0	0	0	178.0
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	ExAng	Oldpeak	Slope	Ca	Thal	AHD
5	0	0.8	1	0.0	normal	No

---

Train Data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								
0	1	63.0	1	typical	145.0	233.0	1	2 150.0
1	2	67.0	1	asymptomatic	160.0	286.0	0	2 108.0
2	3	67.0	1	asymptomatic	120.0	229.0	0	2 129.0
3	4	37.0	1	nonanginal	130.0	250.0	0	0 187.0
4	5	41.0	0	nontypical	130.0	204.0	0	2 172.0
5	6	56.0	1	nontypical	120.0	236.0	0	0 178.0
7	8	57.0	0	asymptomatic	120.0	354.0	0	0 163.0
8	9	63.0	1	asymptomatic	130.0	254.0	0	2 147.0
9	10	53.0	1	asymptomatic	140.0	203.0	1	2 155.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
0	0	2.3	3	0.0	fixed	No
1	1	1.5	2	3.0	normal	Yes
2	1	2.6	2	2.0	reversable	Yes
3	0	3.5	3	0.0	normal	No
4	0	1.4	1	0.0	normal	No
5	0	0.8	1	0.0	normal	No
7	1	0.6	1	0.0	normal	No
8	0	1.4	2	1.0	reversable	Yes
9	1	3.1	3	0.0	reversable	Yes

Test data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								
6	7	62.0	0	asymptomatic	140.0	268.0	0	2 160.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
6	0	3.6	3	2.0	normal	Yes

---

Train Data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								
0	1	63.0	1	typical	145.0	233.0	1	2 150.0
1	2	67.0	1	asymptomatic	160.0	286.0	0	2 108.0
2	3	67.0	1	asymptomatic	120.0	229.0	0	2 129.0
3	4	37.0	1	nonanginal	130.0	250.0	0	0 187.0
4	5	41.0	0	nontypical	130.0	204.0	0	2 172.0
5	6	56.0	1	nontypical	120.0	236.0	0	0 178.0
6	7	62.0	0	asymptomatic	140.0	268.0	0	2 160.0
8	9	63.0	1	asymptomatic	130.0	254.0	0	2 147.0
9	10	53.0	1	asymptomatic	140.0	203.0	1	2 155.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD					
0	0	2.3	3	0.0	fixed	No					
1	1	1.5	2	3.0	normal	Yes					
2	1	2.6	2	2.0	reversable	Yes					
3	0	3.5	3	0.0	normal	No					
4	0	1.4	1	0.0	normal	No					
5	0	0.8	1	0.0	normal	No					
6	0	3.6	3	2.0	normal	Yes					
8	0	1.4	2	1.0	reversable	Yes					
9	1	3.1	3	0.0	reversable	Yes					
Test data:	Unnamed:	0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG		
MaxHR	\										
7	8	57.0	0	asymptomatic	120.0	354.0	0	0	163.0		

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
7	1	0.6	1	0.0	normal	No

---

		Unnamed:	0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
Train Data:	MaxHR	\								
0	1	63.0	1	typical	145.0	233.0	1	2	150.0	
1	2	67.0	1	asymptomatic	160.0	286.0	0	2	108.0	
2	3	67.0	1	asymptomatic	120.0	229.0	0	2	129.0	
3	4	37.0	1	nonanginal	130.0	250.0	0	0	187.0	
4	5	41.0	0	nontypical	130.0	204.0	0	2	172.0	
5	6	56.0	1	nontypical	120.0	236.0	0	0	178.0	
6	7	62.0	0	asymptomatic	140.0	268.0	0	2	160.0	
7	8	57.0	0	asymptomatic	120.0	354.0	0	0	163.0	
9	10	53.0	1	asymptomatic	140.0	203.0	1	2	155.0	

	ExAng	Oldpeak	Slope	Ca	Thal	AHD					
0	0	2.3	3	0.0	fixed	No					
1	1	1.5	2	3.0	normal	Yes					
2	1	2.6	2	2.0	reversable	Yes					
3	0	3.5	3	0.0	normal	No					
4	0	1.4	1	0.0	normal	No					
5	0	0.8	1	0.0	normal	No					
6	0	3.6	3	2.0	normal	Yes					
7	1	0.6	1	0.0	normal	No					
9	1	3.1	3	0.0	reversable	Yes					
Test data:	Unnamed:	0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG		
MaxHR	\										
8	9	63.0	1	asymptomatic	130.0	254.0	0	2	147.0		

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
8	0	1.4	2	1.0	reversable	Yes

Train Data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								
0	1	63.0	1	typical	145.0	233.0	1	2 150.0
1	2	67.0	1	asymptomatic	160.0	286.0	0	2 108.0
2	3	67.0	1	asymptomatic	120.0	229.0	0	2 129.0
3	4	37.0	1	nonanginal	130.0	250.0	0	0 187.0
4	5	41.0	0	nontypical	130.0	204.0	0	2 172.0
5	6	56.0	1	nontypical	120.0	236.0	0	0 178.0
6	7	62.0	0	asymptomatic	140.0	268.0	0	2 160.0
7	8	57.0	0	asymptomatic	120.0	354.0	0	0 163.0
8	9	63.0	1	asymptomatic	130.0	254.0	0	2 147.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
0	0	2.3	3	0.0	fixed	No
1	1	1.5	2	3.0	normal	Yes
2	1	2.6	2	2.0	reversable	Yes
3	0	3.5	3	0.0	normal	No
4	0	1.4	1	0.0	normal	No
5	0	0.8	1	0.0	normal	No
6	0	3.6	3	2.0	normal	Yes
7	1	0.6	1	0.0	normal	No
8	0	1.4	2	1.0	reversable	Yes

Test data:	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG
MaxHR \								
9	10	53.0	1	asymptomatic	140.0	203.0	1	2 155.0

	ExAng	Oldpeak	Slope	Ca	Thal	AHD
9	1	3.1	3	0.0	reversable	Yes

-----

-----

```
[89]: for i, (train_index, test_index) in enumerate(loo.split(X)):
      X_train, X_test = X.iloc[train_index], X.iloc[test_index]
      train_filename = f'train_{i+1}.csv'
      test_filename = f'test_{i+1}.csv'
      X_train.to_csv(train_filename, index=False)
      X_test.to_csv(test_filename, index=False)
```

```
[90]: # k fold splitting -
```

```
[93]: from sklearn.model_selection import KFold
      kf = KFold(n_splits = 10, shuffle = True, random_state = 42)
```

```
[101]: for i, (train_index, test_index) in enumerate(kf.split(df)):
       print(f"Fold {i+1}:")
       print(f"  Train: index={len(train_index)}")
       print(f"  Test:  index={len(test_index)}")
```

```

df_train = df.iloc[train_index]
df_test = df.iloc[test_index]

train_filename = f"training_fold{i+1}.csv"
test_filename = f"testing_fold{i+1}.csv"

df_train.to_csv(train_filename, index = False)
df_test.to_csv(test_filename, index = False)

print("

```

Fold 1:

```

Train: index=272
Test:  index=31

```

Fold 2:

```

Train: index=272
Test:  index=31

```

Fold 3:

```

Train: index=272
Test:  index=31

```

Fold 4:

```

Train: index=273
Test:  index=30

```

Fold 5:

```

Train: index=273
Test:  index=30

```

Fold 6:

```

Train: index=273
Test:  index=30

```

Fold 7:

```

Train: index=273
Test:  index=30

```

```
-----
Fold 8:
  Train: index=273
  Test:  index=30
-----
```

```
-----
Fold 9:
  Train: index=273
  Test:  index=30
-----
```

```
-----
Fold 10:
  Train: index=273
  Test:  index=30
-----
```

```
[98]: for i, (train_index, test_index) in enumerate(kf.split(df)):
      print(f"Fold {i}:")
      print(f"  Train: index={train_index}")
      print(f"  Test:  index={test_index}")
      ↵
      ↵print("-----")
```

```
Fold 0:
  Train: index=[ 0  1  2  3  4  6  7  8 10 11 12 13 14 15 16 17
18 19
20 21 22 23 24 26 27 28 29 30 31 32 34 35 36 37 38 39
40 41 42 43 44 47 48 49 50 51 52 53 54 55 56 57 58 59
61 62 63 64 65 66 67 68 69 70 71 72 74 75 76 77 78 79
80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97
98 99 100 102 103 104 105 106 107 108 110 112 113 114 115 116 117 120
121 122 123 124 126 127 128 129 130 131 132 133 134 135 136 137 138 140
141 142 143 144 145 147 148 149 150 151 153 154 155 156 157 158 159 160
161 162 163 164 165 166 167 168 169 170 171 172 173 174 176 177 178 180
181 182 183 184 185 186 187 188 189 190 191 193 194 195 196 197 198 199
200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217
218 219 220 221 222 224 225 226 227 229 230 232 233 234 235 236 237 238
239 240 241 242 243 244 245 247 248 249 250 251 252 253 255 256 257 258
259 260 261 262 263 264 265 266 267 270 271 273 274 275 276 277 278 280
281 282 284 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300
301 302]
  Test:  index=[ 5  9 25 33 45 46 60 73 101 109 111 118 119 125 139 146
152 175
179 192 223 228 231 246 254 268 269 272 279 283 285]
-----
```

```
-----
Fold 1:
```



```

Train: index=[ 0  1  2  3  4  5  6  8  9 10 11 12 13 14 15 16
18 19
20 21 22 23 25 26 27 28 29 30 31 32 33 34 35 36 37 38
39 40 41 43 44 45 46 47 48 49 50 51 52 53 54 55 56 58
59 60 61 62 64 65 66 67 68 69 70 71 72 73 74 75 79 80
81 83 84 85 86 87 88 89 91 93 94 95 96 97 98 99 100 101
102 103 105 106 107 108 109 110 111 112 113 114 115 117 118 119 120 121
122 123 124 125 126 127 128 129 130 131 133 134 135 136 138 139 140 141
142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159
160 161 162 163 164 165 166 167 169 170 171 172 173 174 175 176 177 178
179 180 181 182 183 185 186 187 188 189 190 191 192 194 195 196 197 199
200 201 202 203 205 206 207 208 209 210 211 212 213 214 215 216 217 218
220 221 222 223 224 225 226 227 228 229 230 231 233 234 235 237 238 239
240 241 242 243 244 245 246 247 248 250 252 253 254 256 257 258 259 260
261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278
279 280 282 283 285 286 287 288 289 290 291 293 294 295 296 297 298 299
301 302]
Test: index=[ 7 17 24 42 57 63 76 77 78 82 90 92 104 116 132 137
168 184
193 198 204 219 232 236 249 251 255 281 284 292 300]

```

---

Fold 2:

```

Train: index=[ 0  1  2  3  4  5  7  8  9 10 11 12 13 14 15 16
17 18
20 21 23 24 25 26 27 28 29 31 32 33 34 35 36 37 38 39
40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 57 58
60 61 62 63 64 65 67 68 69 70 71 73 74 76 77 78 80 81
82 83 85 86 87 88 89 90 91 92 94 95 96 97 98 99 100 101
102 103 104 105 106 107 108 109 110 111 112 115 116 117 118 119 120 121
122 123 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140
141 142 145 146 147 148 149 150 151 152 153 154 155 156 157 159 160 161
162 163 165 166 168 169 170 171 172 173 174 175 178 179 180 181 182 183
184 185 186 187 188 189 190 191 192 193 194 195 198 199 200 201 203 204
205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222
223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240
241 243 245 246 247 248 249 251 252 253 254 255 256 257 259 260 261 262
263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280
281 283 284 285 286 288 289 290 291 292 293 294 295 296 297 298 299 300
301 302]
Test: index=[ 6 19 22 30 56 59 66 72 75 79 84 93 113 114 124 143
144 158
164 167 176 177 196 197 202 242 244 250 258 282 287]

```

---

Fold 3:

```

Train: index=[ 0  1  2  3  4  5  6  7  8  9 11 12 13 14 17 19
20 21

```

```

22 23 24 25 26 27 28 29 30 32 33 34 35 36 38 39 40 41
42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
60 61 62 63 64 65 66 70 71 72 73 74 75 76 77 78 79 80
81 82 83 84 85 87 88 89 90 91 92 93 94 95 98 99 100 101
102 103 104 105 106 107 109 110 111 112 113 114 115 116 117 118 119 120
121 122 123 124 125 127 128 129 130 131 132 133 134 135 136 137 138 139
140 141 142 143 144 145 146 147 149 150 151 152 153 156 157 158 159 160
161 162 164 165 166 167 168 169 170 171 172 173 174 175 176 177 179 180
181 182 184 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200
201 202 203 204 205 207 208 209 210 211 212 213 214 215 216 217 218 219
220 221 222 223 224 225 226 227 228 231 232 233 234 235 236 237 238 239
240 241 242 243 244 245 246 247 248 249 250 251 252 254 255 256 257 258
259 260 261 262 263 264 265 266 267 268 269 270 271 272 274 275 276 277
278 279 280 281 282 283 284 285 286 287 290 292 293 294 296 297 298 299
300 301 302]
Test: index=[ 10 15 16 18 31 37 67 68 69 86 96 97 108 126 148 154
155 163
178 183 185 206 229 230 253 273 288 289 291 295]

```

Fold 4:

```

Train: index=[ 0 1 3 4 5 6 7 8 9 10 11 12 13 14 15 16
17 18
19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37
39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 56 57
58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 75 76
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 113
114 116 118 119 121 122 123 124 125 126 128 130 131 132 133 134 135 136
137 138 139 141 142 143 144 145 146 148 149 150 151 152 153 154 155 156
157 158 159 160 161 162 163 164 166 167 168 169 171 174 175 176 177 178
179 183 184 185 187 188 189 190 191 192 193 194 195 196 197 198 199 200
201 202 203 204 205 206 207 208 209 212 213 214 216 217 218 219 220 221
222 223 224 225 226 227 228 229 230 231 232 233 235 236 237 238 240 241
242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259
260 261 263 264 265 266 267 268 269 270 271 272 273 275 276 277 278 279
281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 299
300 301 302]
Test: index=[ 2 29 38 55 74 112 115 117 120 127 129 140 147 165 170 172
173 180
181 182 186 210 211 215 234 239 262 274 280 298]

```

Fold 5:

```

Train: index=[ 0 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
17 18
19 20 21 22 23 24 25 27 29 30 31 32 33 34 36 37 38 39
40 42 43 44 45 46 47 48 49 50 52 53 54 55 56 57 58 59

```

```

60 61 62 63 64 66 67 68 69 70 71 72 73 74 75 76 77 78
79 80 81 82 84 86 87 88 90 91 92 93 94 96 97 98 99 100
101 102 103 104 105 106 108 109 110 111 112 113 114 115 116 117 118 119
120 121 122 123 124 125 126 127 128 129 130 132 134 135 137 138 139 140
141 143 144 145 146 147 148 149 150 151 152 153 154 155 156 158 160 161
162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179
180 181 182 183 184 185 186 187 188 189 190 191 192 193 196 197 198 199
200 201 202 204 205 206 207 209 210 211 212 214 215 216 217 219 220 223
224 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243
244 245 246 247 249 250 251 252 253 254 255 256 257 258 259 260 261 262
263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280
281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 297 298 299
300 301 302]
Test: index=[ 12 26 28 35 41 51 65 83 85 89 95 107 131 133 136 142
157 159
194 195 203 208 213 218 221 222 225 226 248 296]

```

Fold 6:

```

Train: index=[ 1 2 3 5 6 7 8 9 10 12 13 14 15 16 17 18
19 20
21 22 23 24 25 26 28 29 30 31 33 34 35 37 38 39 40 41
42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
60 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78
79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
97 99 101 102 104 105 106 107 108 109 110 111 112 113 114 115 116 117
118 119 120 121 123 124 125 126 127 128 129 130 131 132 133 134 135 136
137 139 140 142 143 144 145 146 147 148 149 151 152 153 154 155 156 157
158 159 160 161 163 164 165 166 167 168 169 170 172 173 174 175 176 177
178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195
196 197 198 199 201 202 203 204 205 206 207 208 210 211 212 213 214 215
216 217 218 219 220 221 222 223 225 226 227 228 229 230 231 232 234 235
236 239 240 241 242 243 244 245 246 248 249 250 251 252 253 254 255 256
257 258 260 262 263 264 266 267 268 269 270 272 273 274 276 278 279 280
281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298
300 301 302]
Test: index=[ 0 4 11 27 32 36 61 98 100 103 122 138 141 150 162 171
200 209
224 233 237 238 247 259 261 265 271 275 277 299]

```

Fold 7:

```

Train: index=[ 0 1 2 3 4 5 6 7 9 10 11 12 13 15 16 17
18 19
20 21 22 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
41 42 43 45 46 48 49 50 51 52 53 54 55 56 57 58 59 60
61 63 65 66 67 68 69 71 72 73 74 75 76 77 78 79 80 82
83 84 85 86 87 88 89 90 91 92 93 95 96 97 98 99 100 101

```

```

102 103 104 105 106 107 108 109 111 112 113 114 115 116 117 118 119 120
121 122 124 125 126 127 129 130 131 132 133 134 136 137 138 139 140 141
142 143 144 145 146 147 148 149 150 151 152 154 155 157 158 159 160 161
162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179
180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197
198 200 201 202 203 204 205 206 208 209 210 211 213 214 215 217 218 219
220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237
238 239 241 242 243 244 246 247 248 249 250 251 252 253 254 255 256 257
258 259 261 262 264 265 266 268 269 270 271 272 273 274 275 276 277 279
280 281 282 283 284 285 286 287 288 289 290 291 292 295 296 297 298 299
300 301 302]
Test: index=[ 8 14 23 39 40 44 47 62 64 70 81 94 110 123 128 135
153 156
199 207 212 216 240 245 260 263 267 278 293 294]

```

---

Fold 8:

```

Train: index=[ 0 2 4 5 6 7 8 9 10 11 12 14 15 16 17 18
19 20
21 22 23 24 25 26 27 28 29 30 31 32 33 35 36 37 38 39
40 41 42 44 45 46 47 48 50 51 54 55 56 57 58 59 60 61
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79
81 82 83 84 85 86 87 89 90 92 93 94 95 96 97 98 99 100
101 102 103 104 106 107 108 109 110 111 112 113 114 115 116 117 118 119
120 121 122 123 124 125 126 127 128 129 130 131 132 133 135 136 137 138
139 140 141 142 143 144 146 147 148 149 150 151 152 153 154 155 156 157
158 159 160 162 163 164 165 167 168 169 170 171 172 173 174 175 176 177
178 179 180 181 182 183 184 185 186 187 188 189 191 192 193 194 195 196
197 198 199 200 202 203 204 206 207 208 209 210 211 212 213 214 215 216
218 219 221 222 223 224 225 226 228 229 230 231 232 233 234 235 236 237
238 239 240 242 244 245 246 247 248 249 250 251 252 253 254 255 257 258
259 260 261 262 263 265 267 268 269 270 271 272 273 274 275 276 277 278
279 280 281 282 283 284 285 287 288 289 291 292 293 294 295 296 298 299
300 301 302]
Test: index=[ 1 3 13 34 43 49 52 53 80 88 91 105 134 145 161 166
190 201
205 217 220 227 241 243 256 264 266 286 290 297]

```

---

Fold 9:

```

Train: index=[ 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17
18 19 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
38 39 40 41 42 43 44 45 46 47 49 51 52 53 55 56 57 59
60 61 62 63 64 65 66 67 68 69 70 72 73 74 75 76 77 78
79 80 81 82 83 84 85 86 88 89 90 91 92 93 94 95 96 97
98 100 101 103 104 105 107 108 109 110 111 112 113 114 115 116 117 118
119 120 122 123 124 125 126 127 128 129 131 132 133 134 135 136 137 138

```

139 140 141 142 143 144 145 146 147 148 150 152 153 154 155 156 157 158  
159 161 162 163 164 165 166 167 168 170 171 172 173 175 176 177 178 179  
180 181 182 183 184 185 186 190 192 193 194 195 196 197 198 199 200 201  
202 203 204 205 206 207 208 209 210 211 212 213 215 216 217 218 219 220  
221 222 223 224 225 226 227 228 229 230 231 232 233 234 236 237 238 239  
240 241 242 243 244 245 246 247 248 249 250 251 253 254 255 256 258 259  
260 261 262 263 264 265 266 267 268 269 271 272 273 274 275 277 278 279  
280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297  
298 299 300]

Test: index=[ 20 21 48 50 54 58 71 87 99 102 106 121 130 149 151 160  
169 174  
187 188 189 191 214 235 252 257 270 276 301 302]

-----  
-----

[ ]: