In [109…
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score
import pickle
```

In [119…
```
file_path = "final.csv"
dataset = pd.read_csv(file_path)
dataset.head
```

Out[119…
```
<bound method NDFrame.head of       Unnamed: 0  urine_output  urine_flow_rate  catheter_bag_volume  \
0              0     97.131536        98.872967             0.000000
1              1     99.346882       100.763500             0.266756
2              2    101.285898        96.603298             0.533511
3              3    118.937229       121.835150             0.800267
4              4     85.055654        77.605240             1.067022
...          ...           ...              ...                  ...
2995        2995    119.699002       113.404649           798.932978
2996        2996     84.333825        86.112174           799.199733
2997        2997    115.705107       119.858386           799.466489
2998        2998     77.013908        76.538159           799.733244
2999        2999    120.628318       126.819734           800.000000

      remaining_catheter_bag_volume       time
0                        800.000000  720.00000
1                        799.839968  720.00000
2                        799.679936  720.00000
3                        799.519904  720.00000
4                        799.359872  719.03968
...                             ...        ...
2995                     320.704141    0.96032
2996                     320.544109    0.72024
2997                     320.384077    0.48016
2998                     320.224045    0.24008
2999                     320.064013    0.00000

[3000 rows x 6 columns]>
```

In [111…
```
X = dataset[[ "catheter_bag_volume"]]
y = dataset["time"]
```

In [112…
```
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

In [113…
```
X_train, X_temp, y_train, y_temp = train_test_split(X_scaled, y, test_size=0.3)  # 70% training
X_val, X_test, y_val, y_test = train_test_split(X_temp, y_temp, test_size=0.5)

model = LinearRegression()
model.fit(X_train, y_train)
```

Out[113…
```
▾ LinearRegression
LinearRegression()
```

In [114…
```
y_val_pred = model.predict(X_val)
```

In [115…
```
val_mse = mean_squared_error(y_val, y_val_pred)
val_mae = mean_absolute_error(y_val, y_val_pred)
val_r2 = r2_score(y_val, y_val_pred)

print("\n VALIDATION RESULTS:")
print(f"Validation MSE: {val_mse}")
print(f"Validation MAE: {val_mae}")
print(f"Validation R²: {val_r2}")
```

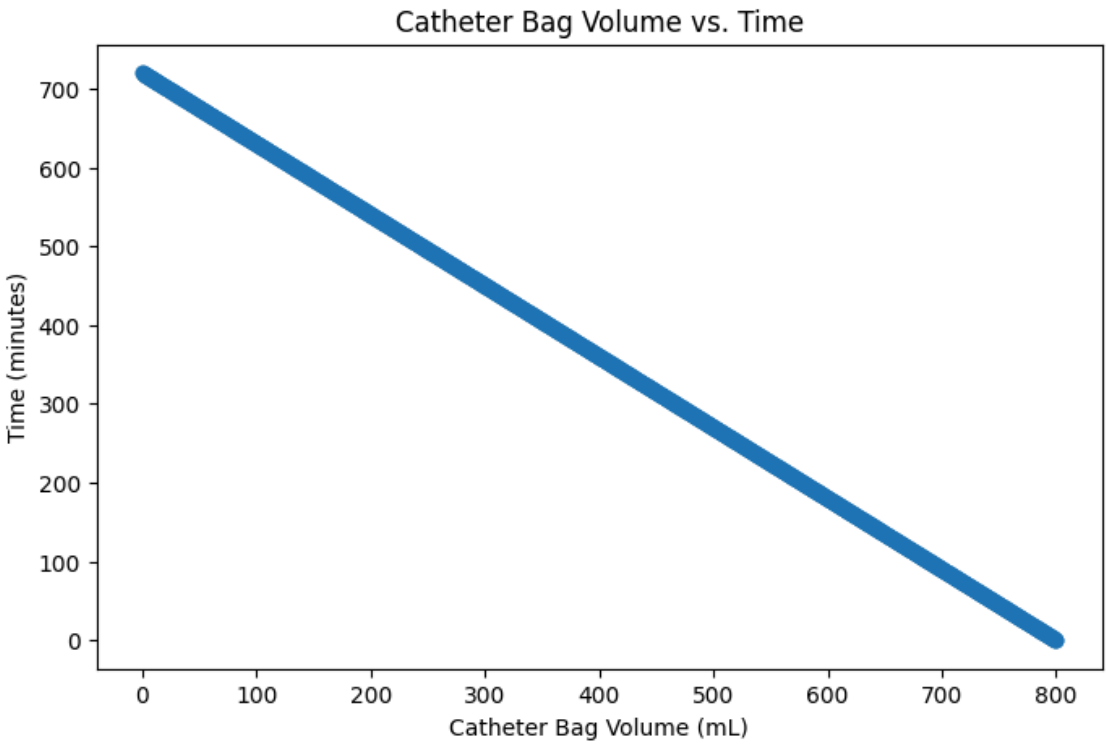
```
 VALIDATION RESULTS:
Validation MSE: 0.00012808537471389615
Validation MAE: 0.000533541033262469
Validation R²: 0.9999999970514053
```

In [116…
```python
y_test_pred = model.predict(X_test)

test_mse = mean_squared_error(y_test, y_test_pred)
test_mae = mean_absolute_error(y_test, y_test_pred)
test_r2 = r2_score(y_test, y_test_pred)

print("\n TEST RESULTS:")
print(f"Test MSE: {test_mse}")
print(f"Test MAE: {test_mae}")
print(f"Test R²: {test_r2}")
```

```
 TEST RESULTS:
Test MSE: 0.0016651098831032413
Test MAE: 0.0026675853050511238
Test R²: 0.9999999608804873
```

In [117…
```python
with open("model_1.pkl", "wb") as file:
    pickle.dump(model, file)
with open("scaler.pkl", "wb") as file:
    pickle.dump(scaler, file)
```

In [118…
```python
import matplotlib.pyplot as plt

plt.figure(figsize=(8,5))
plt.scatter(dataset["catheter_bag_volume"], dataset["time"], alpha=0.5)
plt.xlabel("Catheter Bag Volume (mL)")
plt.ylabel("Time (minutes)")
plt.title("Catheter Bag Volume vs. Time")
plt.show()
```



In [ ]: