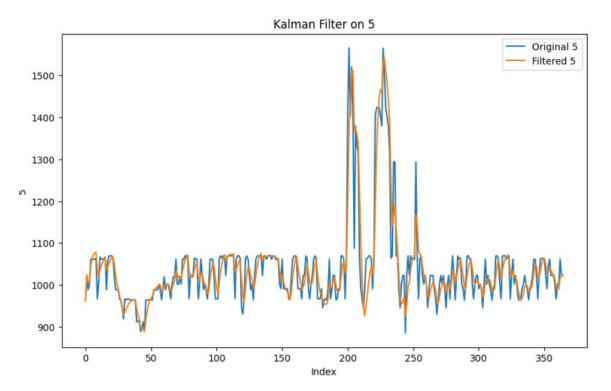
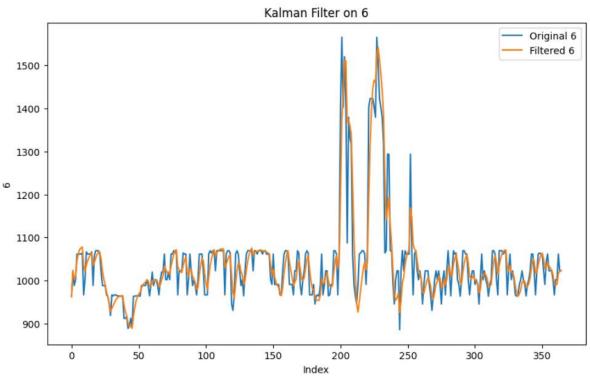
```
# Change the delimiter to ';' to match the file
    data2 = np.loadtxt("data.csv",encoding='latin-1', delimiter=';', skiprows=1, usecols=(5, 6, 7), dtype=float)
                                                       Ngày 1 2 3 4 5 6 7 8 9 ... 39 40 41 42 43 44 45
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        48
    0 01/01/2021 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964.4 964
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    2 01/03/2021 988.4 988.4 988.4 988.4 988.4 988.4 988.4 988.4 988.4 988.4 988.4 ... 988.4 988.4 988.4 988.4 988.4
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    3 01/04/2021 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.0 1002.1 ... 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8 1010.8
    4 01/05/2021 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1061.5 1
5 rows × 49 columns
    # Rename the column if necessary
      feats= ['Ngày','5','6','7']
    df[feats].head()
                                                       Ngày 5 6 7
    0 01/01/2021 964.4 964.4 964.4
    1 01/02/2021 1019.7 1019.7 1019.7
    2 01/03/2021 988.4 988.4 988.4
    3 01/04/2021 1002.0 1002.0 1002.0
    4 01/05/2021 1061.5 1061.5 1061.5
```

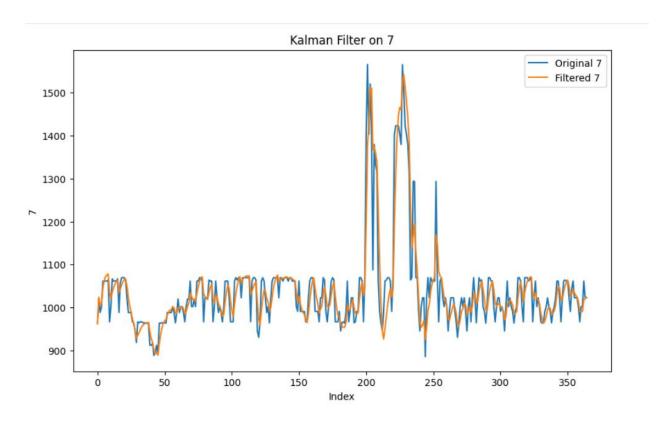
Đọc dữ liệu và chọn 3 cột 5, 6, 7.

```
from filterpy.kalman import KalmanFilter
import numpy as np
# Function to apply Kalman Filter
def apply_kalman_filter(data):
   kf = KalmanFilter(dim_x=2, dim_z=1)
   kf.x = np.array([0., 0.]) # initial state (location and velocity)
   kf.F = np.array([[1., 1.], [0., 1.]]) \# state transition matrix
   kf.H = np.array([[1., 0.]]) # Measurement function
   kf.P *= 1000.
                                  # covariance matrix
   kf.R = 5
                                   # state uncertainty
   kf.Q = np.array([[0.1, 0.1], [0.1, 0.1]]) # process uncertainty
   filtered_data = []
   for z in data:
       kf.predict()
       kf.update(z)
        filtered_data.append(kf.x[0])
    return filtered_data
# Áp dụng Kalman Filter cho cột thứ 5
filtered_feature_5 = apply_kalman_filter(X[:, 0])
# So sánh dữ liệu gốc và dữ liệu đã lọc
plt.figure(figsize=(10, 6))
plt.plot(X[:, 0], label='Original ' + df.columns[5])
plt.plot(filtered_feature_5, label='Filtered ' + df.columns[5])
plt.title('Kalman Filter on ' + df.columns[5])
plt.xlabel('Index')
plt.ylabel(df.columns[5])
plt.legend()
plt.show()
```

Khởi tạo mô hình Kalman







Vẽ Biểu đồ kết quả của mô hình Kalman với 3 cột 5,6,7

```
# Khởi tạo HMM
model = hmm.GaussianHMM(n_components=2, covariance_type="full", n_iter=1000)
# Huấn luyện HMM với dữ liệu quan sát
model.fit(data2)
# In ra các tham số của mô hình sau khi huấn luyện
print("Start probabilities: ", model.startprob_)
print("Transition matrix: ", model.transmat_)
print("Means: ", model.means_)
print("Covariances: ", model.covars_)
Model is not converging. Current: 2761.26687783799 is not greater than 2761.277476190575. Delta is -0.01059835258502062
Start probabilities: [0. 1.]
Transition matrix: [[5.07917682e-25 1.000000000e+00]
[1.11759628e-02 9.88824037e-01]]
Means: [[ 961.45536206 961.45536206 961.43050553]
 [1041.10669692 1041.10669692 1041.10669692]]
84.73838989
                                               85.13747039]
                  84.21391722
                                 84.61051207]
    85.13747039
                  84.61051207
                                  85.00897472]]
 [[11077.54398339 11077.54398339 11077.54398339]
  [11077.54398339 11077.54398339 11077.54398339]
 [11077.54398339 11077.54398339 11077.54398339]]]
```

Khởi tạo mô hình HMM và in ra các giá trị

```
# Dự đoán trạng thái ẩn cho các quan sát hiện có
hidden_states = model.predict(data2)
print("Hidden states: ", hidden_states)
# Lấy mẫu mới từ mô hình đã huấn luyện
X, Z = model.sample(5) # Lấy mẫu 5 quan sát mới
print("Sampled observations: ", X)
print("Sampled hidden states: ", Z)
Sampled observations: [[ 948.32352262 948.32352188 948.32352188]
[1087.57593264 1087.57593505 1087.57593505]
[1081.22433744 1081.22433599 1081.22433599]
[1048.29114224 1048.29114146 1048.29114146]
[1003.30922515 1003.30922687 1003.30922687]]
Sampled hidden states: [1 1 1 1 1]
```

```
# Vẽ các trạng thái ẩn dự đoán
def plot_hidden_states(hidden_states, title):
    plt.figure(figsize=(10, 2))
    plt.plot(hidden_states, marker='o')
    plt.title(title)
    plt.xlabel("Time")
    plt.ylabel("Hidden State")
    plt.show()
plot_hidden_states(hidden_states, "Predicted Hidden States")
# Vẽ các quan sát mẫu
def plot_observations(observations, title):
    plt.figure(figsize=(10, 2))
    plt.plot(observations)
    plt.title(title)
    plt.xlabel("Time")
    plt.ylabel("Observation")
    plt.show()
plot_observations(X, "Sampled Observations")
```

