```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
from sklearn.preprocessing import StandardScaler
from tensorflow.keras.datasets import fashion_mnist

# ----------------------------
# Step 1: Load Fashion-MNIST
# ----------------------------
(x_train, y_train), (x_test, y_test) = fashion_mnist.load_data()

class_names = ["T-shirt/top", "Trouser", "Pullover", "Dress", "Coat",
               "Sandal", "Shirt", "Sneaker", "Bag", "Ankleboot"]

print("Training shape:", x_train.shape, y_train.shape)
print("Test shape:", x_test.shape, y_test.shape)


print("\nClasses in dataset are: ")
for i, cl in enumerate(class_names):
  print(f'{i+1}. {cl}')
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/train-labels-idx1-ubyte.gz
29515/29515 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/train-images-idx3-ubyte.gz
26421880/26421880 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/t10k-labels-idx1-ubyte.gz
5148/5148 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-datasets/t10k-images-idx3-ubyte.gz
4422102/4422102 ━━━━━━━━━━━━━━━━━━━━ 1s 0us/step
Training shape: (60000, 28, 28) (60000,)
Test shape: (10000, 28, 28) (10000,)

Classes in dataset are:
1. T-shirt/top
2. Trouser
3. Pullover
4. Dress
5. Coat
6. Sandal
7. Shirt
8. Sneaker
9. Bag
10. Ankleboot
```

```
# ----------------------------
# Step 2: Display 5 sample images
# ----------------------------
plt.figure(figsize=(10, 2))
```

```
for i in range(5):
    plt.subplot(1, 5, i+1)
    plt.imshow(x_train[i], cmap="gray")
    plt.title(class_names[y_train[i]])
    plt.axis("off")

plt.show()
```


```
# ----------------------------
# Step 3: Preprocess (flatten + scale)
# ----------------------------
x_train = x_train.reshape(x_train.shape[0], -1)
x_test = x_test.reshape(x_test.shape[0], -1)

scaler = StandardScaler()
x_train = scaler.fit_transform(x_train.astype(np.float32))
x_test = scaler.transform(x_test.astype(np.float32))

# SVM is slow on 60k samples → take subset
n_train, n_test = 10000, 2000
x_train, y_train = x_train[:n_train], y_train[:n_train]
x_test, y_test = x_test[:n_test], y_test[:n_test]
```

```
# ----------------------------
# Step 4: Train SVM with different hyperparameters
# ----------------------------
kernels = ["linear", "rbf", "poly"]
C_values = [0.1, 1, 5 ,  10 , 15 , 20 ]

results = {}
for kernel in kernels:
    for C in C_values:
        print(f"")
        svm = SVC(kernel=kernel, C=C, gamma="scale")
        svm.fit(x_train, y_train)
        y_pred = svm.predict(x_test)
        acc = accuracy_score(y_test, y_pred)
        results[(kernel, C)] = acc
        print(f"SVM with kernel={kernel}  C={C} -> Accuracy = {acc:.4f}")
```

```
SVM with kernel=linear  C=0.1 -> Accuracy = 0.8340
SVM with kernel=linear  C=1 -> Accuracy = 0.8170
SVM with kernel=linear  C=5 -> Accuracy = 0.8010
SVM with kernel=linear  C=10 -> Accuracy = 0.7985
SVM with kernel=linear  C=15 -> Accuracy = 0.7985
SVM with kernel=linear  C=20 -> Accuracy = 0.7985
SVM with kernel=rbf  C=0.1 -> Accuracy = 0.8035
SVM with kernel=rbf  C=1 -> Accuracy = 0.8560
SVM with kernel=rbf  C=5 -> Accuracy = 0.8705
SVM with kernel=rbf  C=10 -> Accuracy = 0.8715
SVM with kernel=rbf  C=15 -> Accuracy = 0.8690
SVM with kernel=rbf  C=20 -> Accuracy = 0.8685
SVM with kernel=poly  C=0.1 -> Accuracy = 0.7085
SVM with kernel=poly  C=1 -> Accuracy = 0.8280
SVM with kernel=poly  C=5 -> Accuracy = 0.8600
SVM with kernel=poly  C=10 -> Accuracy = 0.8630
SVM with kernel=poly  C=15 -> Accuracy = 0.8660
SVM with kernel=poly  C=20 -> Accuracy = 0.8665
```

```
import pandas as pd

# Create a DataFrame from the results
results_df = pd.DataFrame.from_dict(results, orient='index', columns=['Accuracy'])
# Create a new MultiIndex with the desired names
new_index = pd.MultiIndex.from_tuples(results_df.index, names=['Kernel', 'C'])
# Assign the new MultiIndex to the DataFrame
results_df.index = new_index
display(results_df)
```

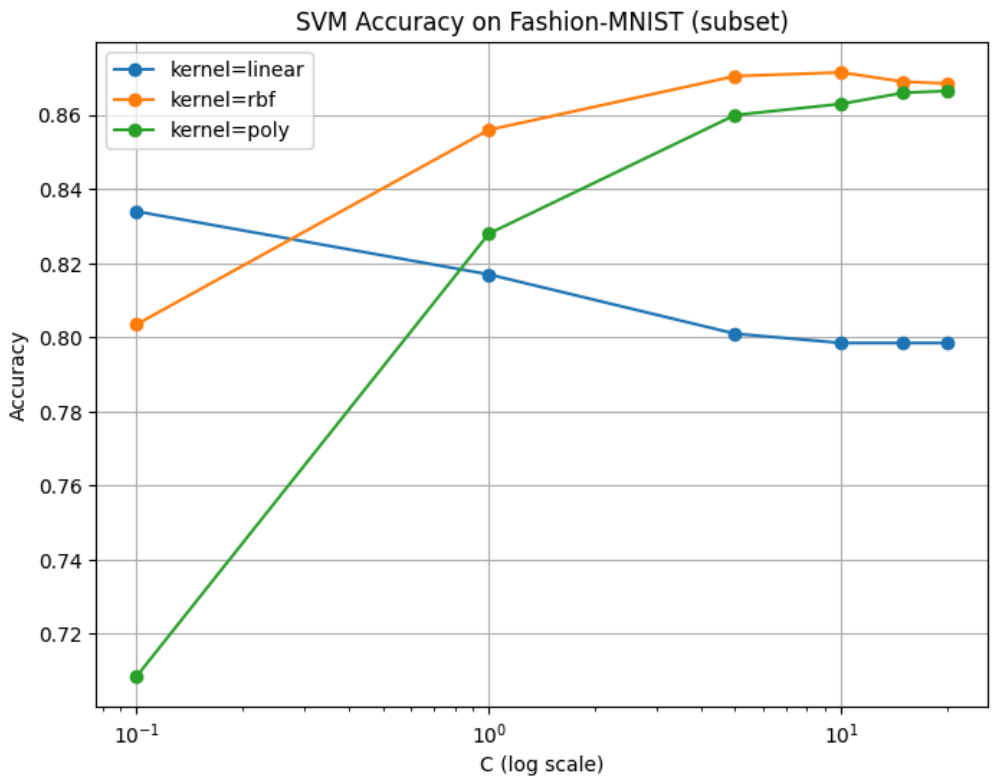
Kernel	C	Accuracy
linear	0.1	0.8340
	1.0	0.8170
	5.0	0.8010
	10.0	0.7985
	15.0	0.7985
	20.0	0.7985
rbf	0.1	0.8035
	1.0	0.8560
	5.0	0.8705
	10.0	0.8715
	15.0	0.8690
	20.0	0.8685
poly	0.1	0.7085
	1.0	0.8280
	5.0	0.8600
	10.0	0.8630
	15.0	0.8660
	20.0	0.8665

Next steps: Generate code with `results_df` New interactive sheet

```
# ----------------------------
# Step 5: Plot accuracy results
# ----------------------------
plt.figure(figsize=(8,6))
for kernel in kernels:
    accs = [results[(kernel, C)] for C in C_values]
    plt.plot(C_values, accs, marker="o", label=f"kernel={kernel}")

plt.xscale("log")
plt.xlabel("C (log scale)")
plt.ylabel("Accuracy")
plt.title("SVM Accuracy on Fashion-MNIST (subset)")
plt.legend()
plt.grid(True)
```

```
plt.show()
```




```
# Find the row with the maximum accuracy in results_df
best_result = results_df.loc[results_df['Accuracy'].idxmax()]

# Print the best result
print("Best SVM Hyperparameters and Accuracy:")
print(best_result)
```

```
Best SVM Hyperparameters and Accuracy:
Accuracy    0.8715
Name: (rbf, 10.0), dtype: float64
```