```python
import numpy as np
from sklearn.manifold import TSNE
from sklearn.datasets import fetch_openml
import matplotlib.pyplot as plt
import plotly.express as px
import pandas as pd
from sklearn.decomposition import PCA
```

```python
# Load MNIST dataset
mnist = fetch_openml('mnist_784', version=1)
X = mnist.data / 255.0
y = mnist.target
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/datasets/
_openml.py:968: FutureWarning: The default value of `parser` will
change from `'liac-arff'` to `'auto'` in 1.4. You can set
`parser='auto'` to silence this warning. Therefore, an `ImportError`
will be raised from 1.4 if the dataset is dense and pandas is not
installed. Note that the pandas parser may return different data
types. See the Notes Section in fetch_openml's API doc for details.
  warn(
```

```python
print(X.shape)
print(y.shape)
```

```
(70000, 784)
(70000,)
```

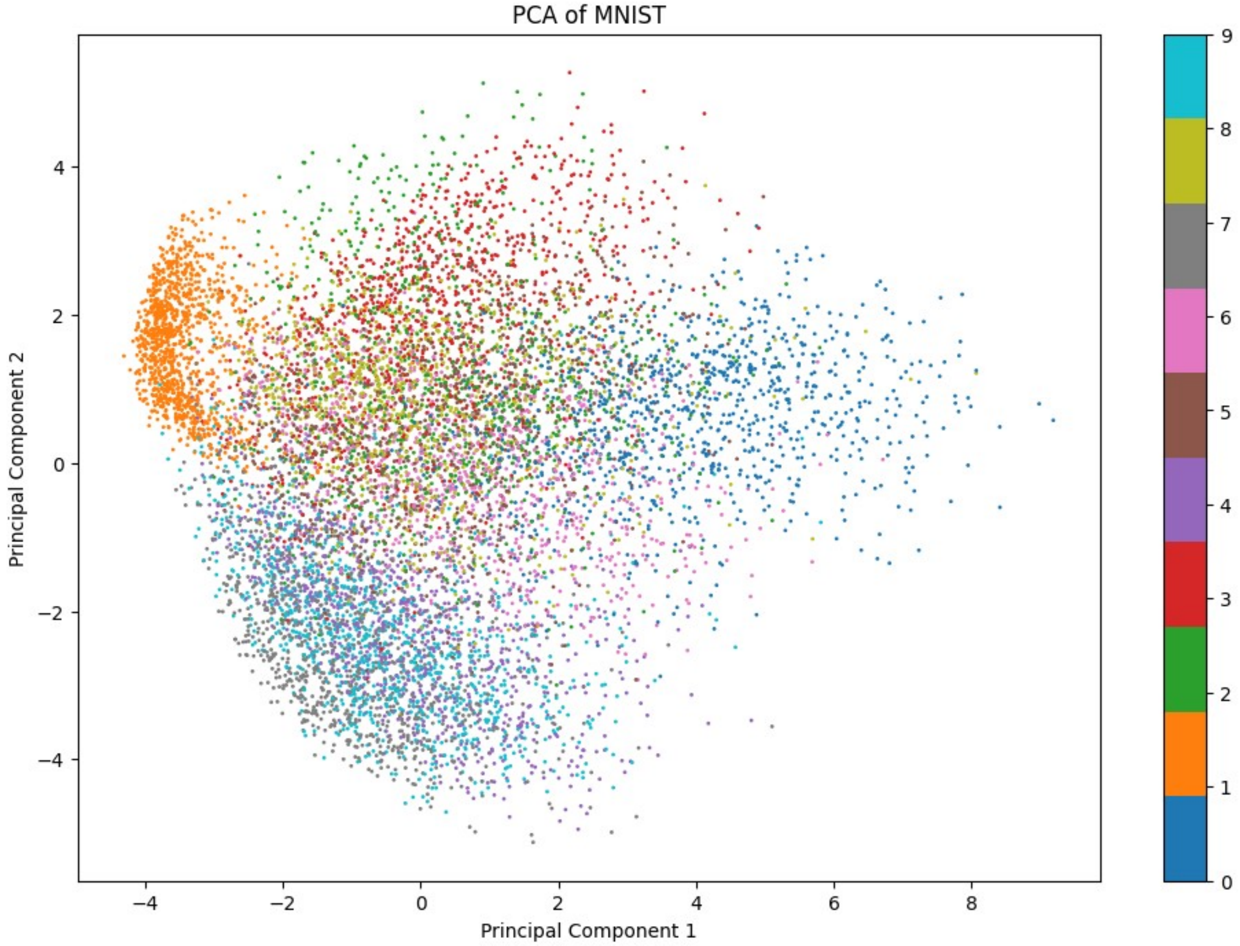
```python
# Select 10000 random points
np.random.seed(42)  # For reproducibility
indices = np.random.choice(range(X.shape[0]), size=10000,
replace=False)
X_subset = X.iloc[indices]
y_subset = y.iloc[indices]
```

```python
X_subset.shape
```

```
(10000, 784)
```

```python
# Apply PCA for initial dimensionality reduction
pca = PCA(n_components=2)
X_pca = pca.fit_transform(X_subset)
```

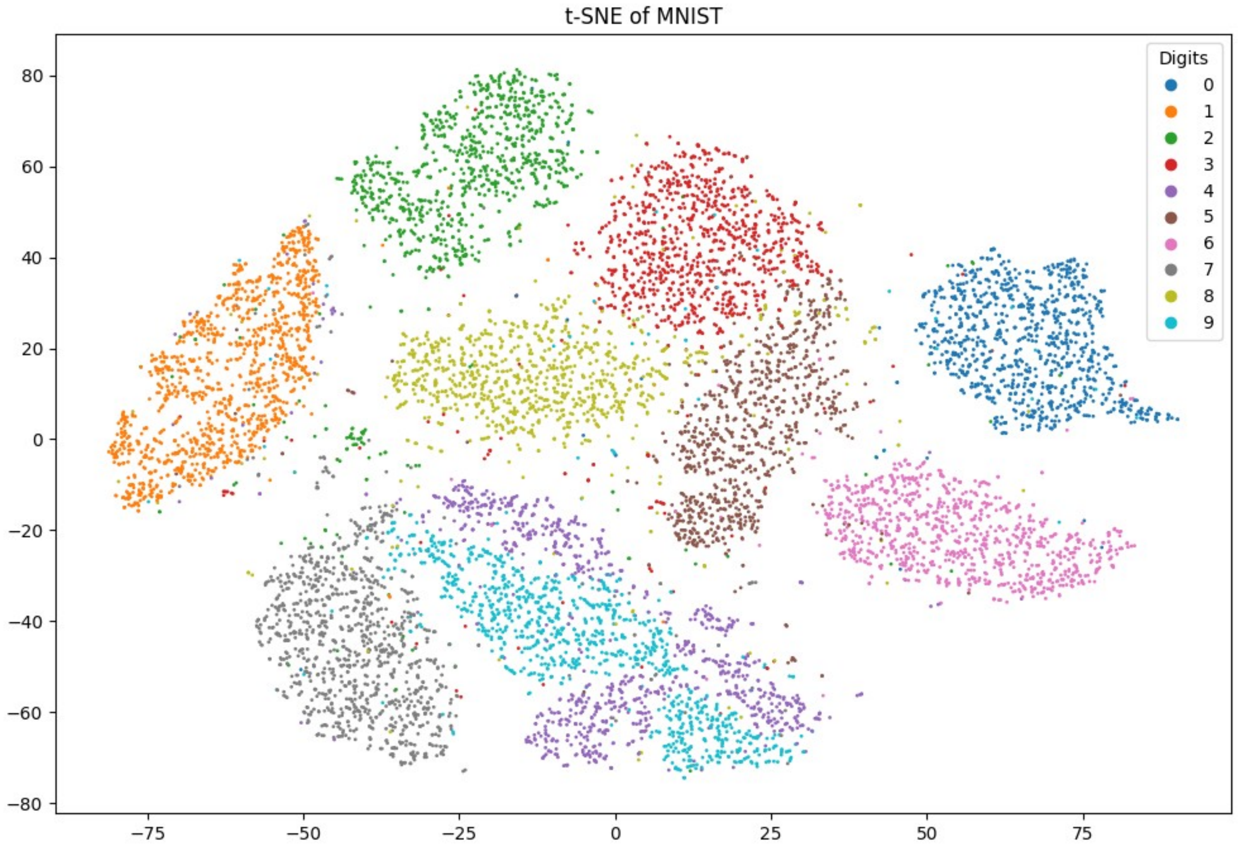
```python
# Plotting with Matplotlib
plt.figure(figsize=(12, 8))
scatter = plt.scatter(X_pca[:, 0], X_pca[:, 1],
c=y_subset.astype(int), cmap='tab10', s=1)
plt.colorbar(scatter)
plt.title('PCA of MNIST')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.show()
```



```
# Apply t-SNE
tsne = TSNE(n_components=2, perplexity=30, n_iter=1000,
random_state=42)
X_tsne = tsne.fit_transform(X_subset)

X_tsne.shape
```

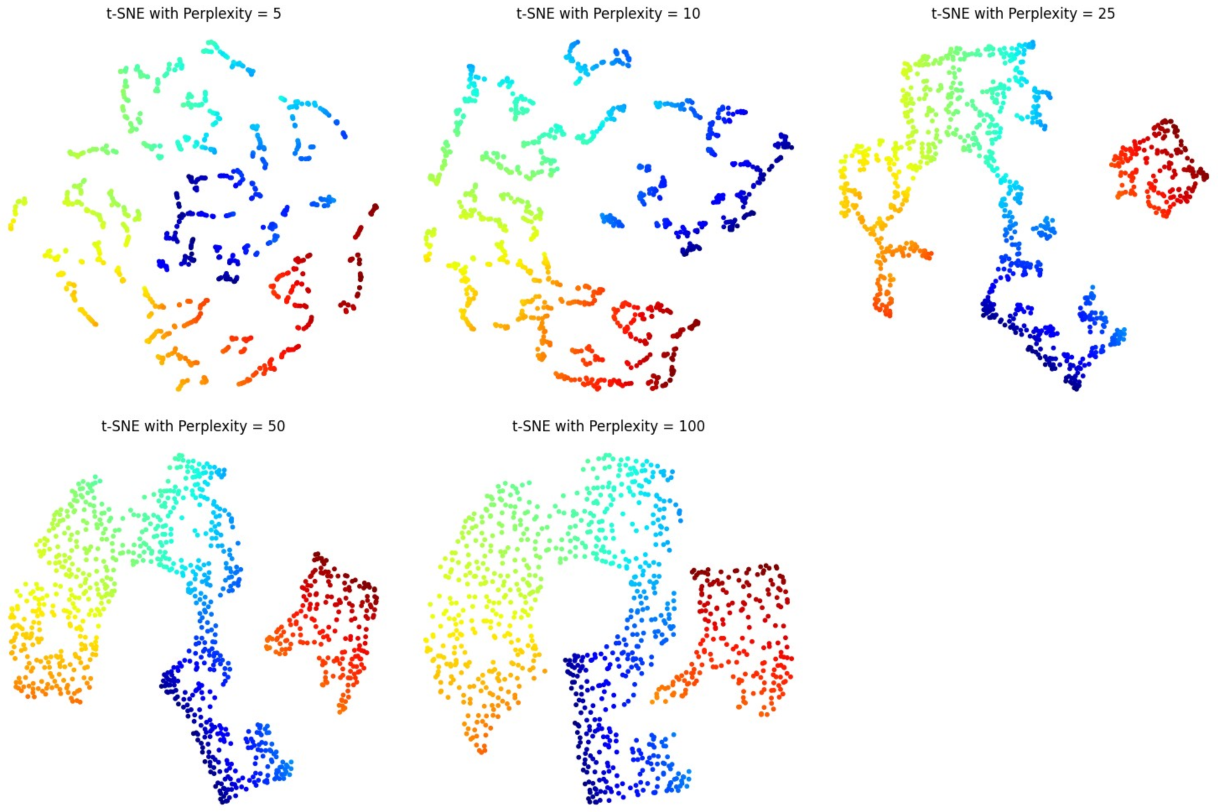
```
(10000, 2)
```

```
# Plot the result
plt.figure(figsize=(12, 8))
scatter = plt.scatter(X_tsne[:, 0], X_tsne[:, 1],
c=y_subset.astype(int), cmap='tab10', s=1)
plt.legend(*scatter.legend_elements(), title="Digits")
plt.title('t-SNE of MNIST')
plt.show()
```



```
tsne.embedding_

array([[ -8.333245 ,  15.28813  ],
       [ -1.0517446, -24.812382 ],
       [  9.558046 ,  22.50926  ],
       ...,
       [ 10.410067 ,  62.151695 ],
       [ 39.323532 ,  51.44707  ],
       [  2.5943046,  40.855995 ]], dtype=float32)

tsne.kl_divergence_

1.8184551000595093

tsne.learning_rate_

208.33333333333334

tsne.n_iter_

999

# Perplexity values to try
perplexities = [5, 10, 25, 50, 100]
```

```
# Prepare the plot grid
fig, axes = plt.subplots(2, 3, figsize=(15, 10))
axes = axes.flatten()

# Apply t-SNE with different perplexity values and plot
for i, perplexity in enumerate(perplexities):
    tsne = TSNE(n_components=2, perplexity=perplexity,
random_state=42, learning_rate='auto')
    X_tsne = tsne.fit_transform(X)

    ax = axes[i]
    scatter = ax.scatter(X_tsne[:, 0], X_tsne[:, 1], c=color,
cmap='jet', s=10)
    ax.set_title(f't-SNE with Perplexity = {perplexity}')
    ax.axis('off')

# Remove the empty subplot (if any)
for i in range(len(perplexities), len(axes)):
    fig.delaxes(axes[i])

plt.tight_layout()
plt.show()
```



t-SNE with Perplexity = 5

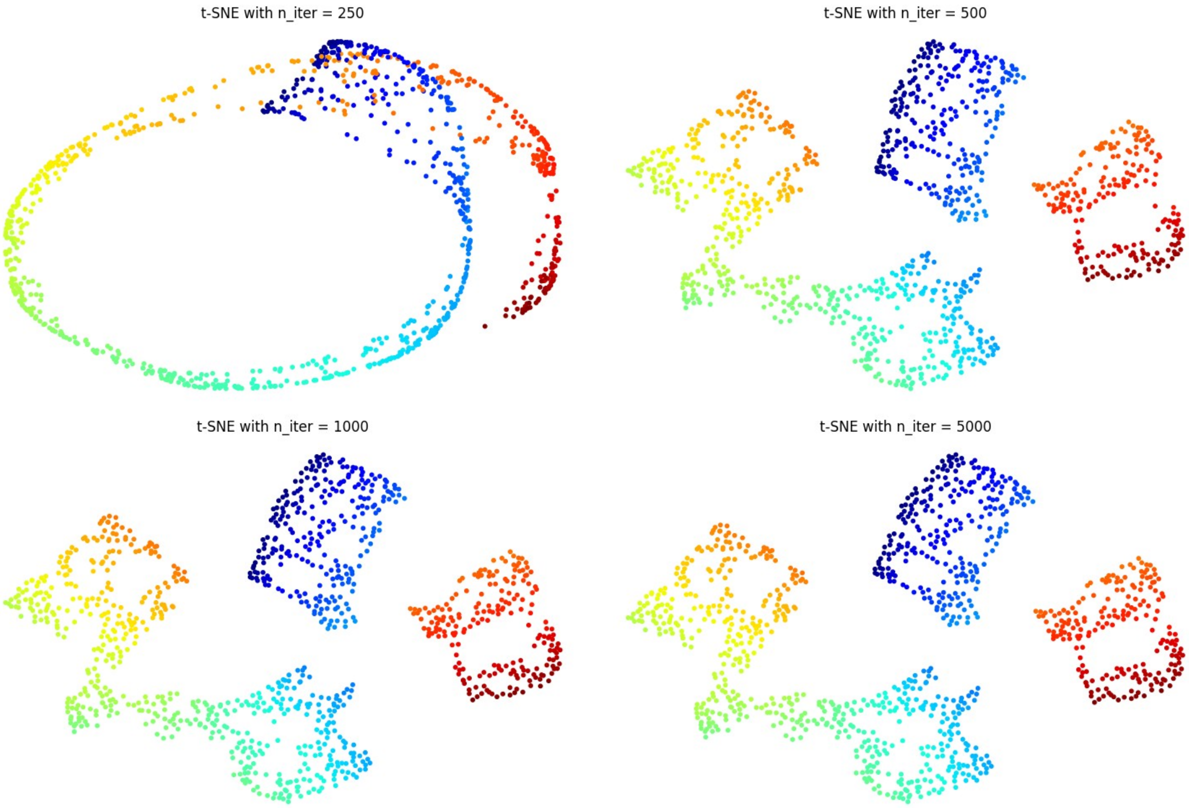
t-SNE with Perplexity = 10

t-SNE with Perplexity = 25

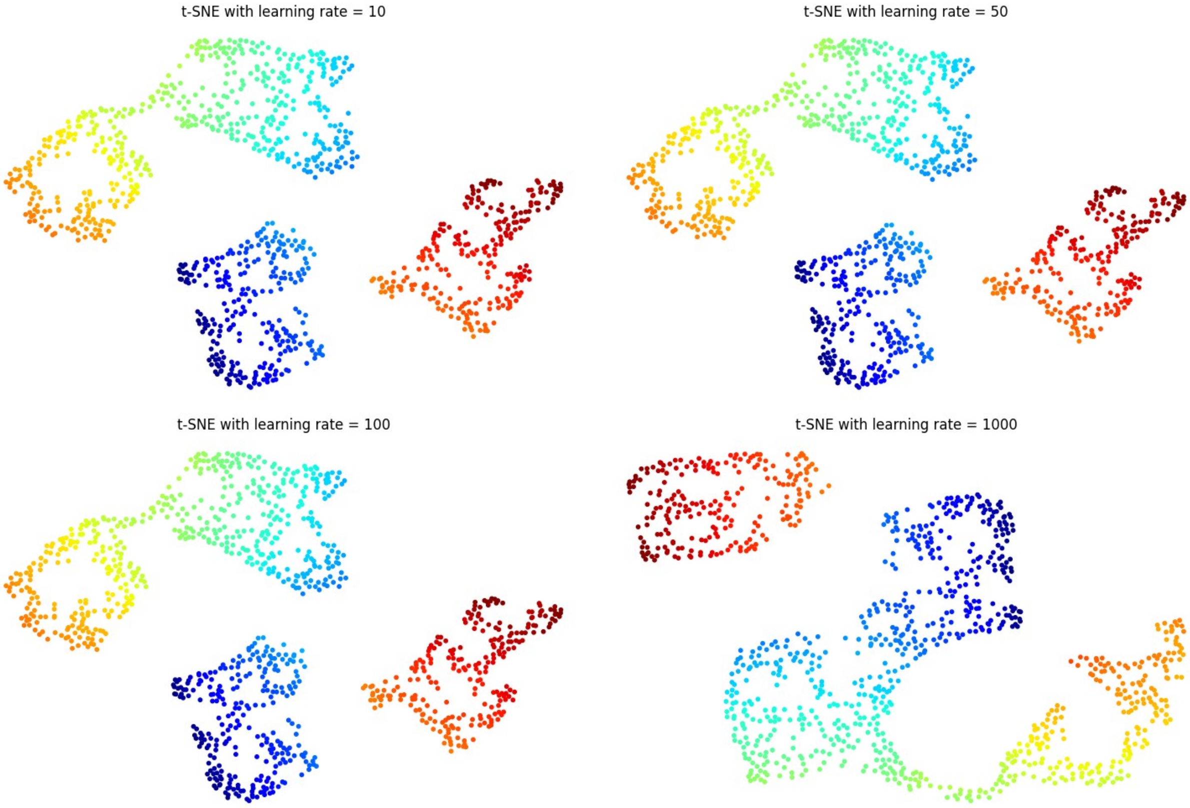
t-SNE with Perplexity = 50

t-SNE with Perplexity = 100

```python
from sklearn.datasets import make_swiss_roll
from sklearn.manifold import TSNE
import numpy as np
import matplotlib.pyplot as plt

# Generate a 3D Swiss Roll dataset
X, color = make_swiss_roll(n_samples=1000)

# Perplexity value
perplexity = 50

# Different n_iter values to try
n_iter_values = [250, 500, 1000, 5000]

# Prepare the plot grid
fig, axes = plt.subplots(2, 2, figsize=(15, 10))
axes = axes.flatten()

# Apply t-SNE with different n_iter values and plot
for i, n_iter in enumerate(n_iter_values):
    tsne = TSNE(n_components=2, perplexity=perplexity, n_iter=n_iter,
random_state=42)
    X_tsne = tsne.fit_transform(X)

    ax = axes[i]
    scatter = ax.scatter(X_tsne[:, 0], X_tsne[:, 1], c=color,
cmap='jet', s=10)
    ax.set_title(f't-SNE with n_iter = {n_iter}')
    ax.axis('off')

# Remove the empty subplot (if any)
for i in range(len(n_iter_values), len(axes)):
    fig.delaxes(axes[i])

plt.tight_layout()
plt.show()
```



```
from sklearn.datasets import make_swiss_roll
from sklearn.manifold import TSNE
import numpy as np
import matplotlib.pyplot as plt

# Generate a 3D Swiss Roll dataset
X, color = make_swiss_roll(n_samples=1000)

# Perplexity value
perplexity = 50

# Different n_iter values to try
lr_values = [10, 50, 100, 1000]

# Prepare the plot grid
fig, axes = plt.subplots(2, 2, figsize=(15, 10))
axes = axes.flatten()

# Apply t-SNE with different n_iter values and plot
for i, lr in enumerate(lr_values):
    tsne = TSNE(n_components=2, perplexity=perplexity, n_iter=5000,
learning_rate=lr, random_state=42)
    X_tsne = tsne.fit_transform(X)

    ax = axes[i]
    scatter = ax.scatter(X_tsne[:, 0], X_tsne[:, 1], c=color,
cmap='jet', s=10)
    ax.set_title(f't-SNE with learning rate = {lr}')
    ax.axis('off')

# Remove the empty subplot (if any)
for i in range(len(lr_values), len(axes)):
    fig.delaxes(axes[i])

plt.tight_layout()
plt.show()
```



t-SNE with learning rate = 10

t-SNE with learning rate = 50

t-SNE with learning rate = 100

t-SNE with learning rate = 1000