01_manifold_learning_intro

September 29, 2021

[1]:
```
%matplotlib inline
from pathlib import Path
import pandas as pd
import numpy as np
from numpy.random import choice, randint, uniform, randn
import seaborn as sns
import matplotlib.pyplot as plt
import ipyvolume as ipv
from ipywidgets import HBox
from sklearn.datasets import fetch_mldata, make_swiss_roll, make_s_curve
```

[2]:
```
pd.options.display.float_format = '{:,.2f}'.format
```

0.0.1 Manifold Examples

[3]:
```
n_points, noise = 1000, 0.1
angles = uniform(low=-np.pi, high=np.pi, size=n_points)
x = 2 * np.cos(angles) + noise * randn(n_points)
y = np.sin(angles) + noise * randn(n_points)

theta = np.pi/4 # 45 degree rotation
rotation_matrix = np.array([[np.cos(theta), -np.sin(theta)],
                            [np.sin(theta), np.cos(theta)]])

rotated = np.column_stack((x, y)).dot(rotation_matrix)
x, y = rotated[:, 0], rotated[:, 1]

z = .2 * x  + .2 * y + noise * randn(n_points)
data = np.vstack((x, y, z)).T
```

Plot 3D Elipse

[4]:
```
ipv.quickscatter(*data.T, size=1, marker='sphere', color='blue')
```

```
VBox(children=(Figure(camera=PerspectiveCamera(fov=46.0, position=(0.0, 0.0, 2.
↪0), quaternion=(0.0, 0.0, 0.0, …
```

0.0.2 Non-linear Manifold

[5]:
```
n_samples = 10000
palette = sns.color_palette('viridis', n_colors=n_samples)
```

[6]:
```
swiss_X, swiss_val = make_swiss_roll(
    n_samples=n_samples, noise=.1, random_state=42)
swiss_X = swiss_X[swiss_val.argsort()[::-1]]
```

[7]:
```
scurve_X, scurve_val = make_s_curve(
    n_samples=n_samples, noise=.1, random_state=42)
scurve_X = scurve_X[scurve_val.argsort()[::-1]]
```

Plot toy examples

[8]:
```
HBox([
    ipv.quickscatter(*swiss_X.T, size=1, marker='sphere', color=palette),
    ipv.quickscatter(*scurve_X.T, size=1, marker='sphere', color=palette)
])
```

```
HBox(children=(VBox(children=(Figure(camera=PerspectiveCamera(fov=46.0,␣
↪position=(0.0, 0.0, 2.0), quaternion=(…
```

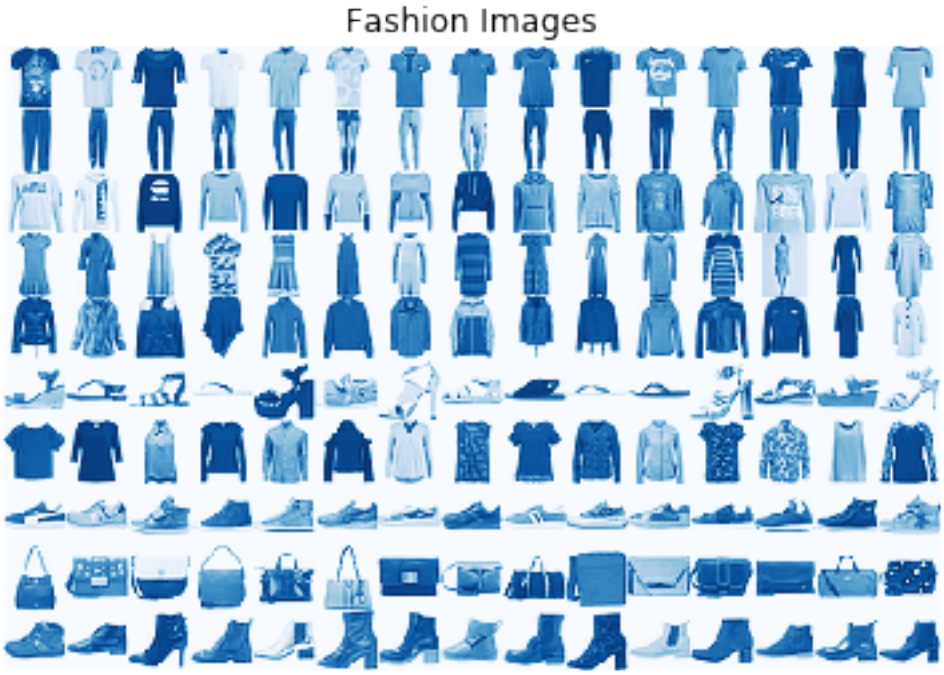
0.0.3 Load Fashion MNIST Data

[11]:
```
fashion_mnist = pd.read_csv(Path('data') / 'fashion-mnist_train.csv.gz')
fashion_label = fashion_mnist.label
fashion_data = fashion_mnist.drop('label', axis=1).values
classes = sorted(np.unique(fashion_label).astype(int))
```

[12]:
```
image_size = int(np.sqrt(fashion_data.shape[1])) # 28 x 28 pixels
n_samples = 15
```

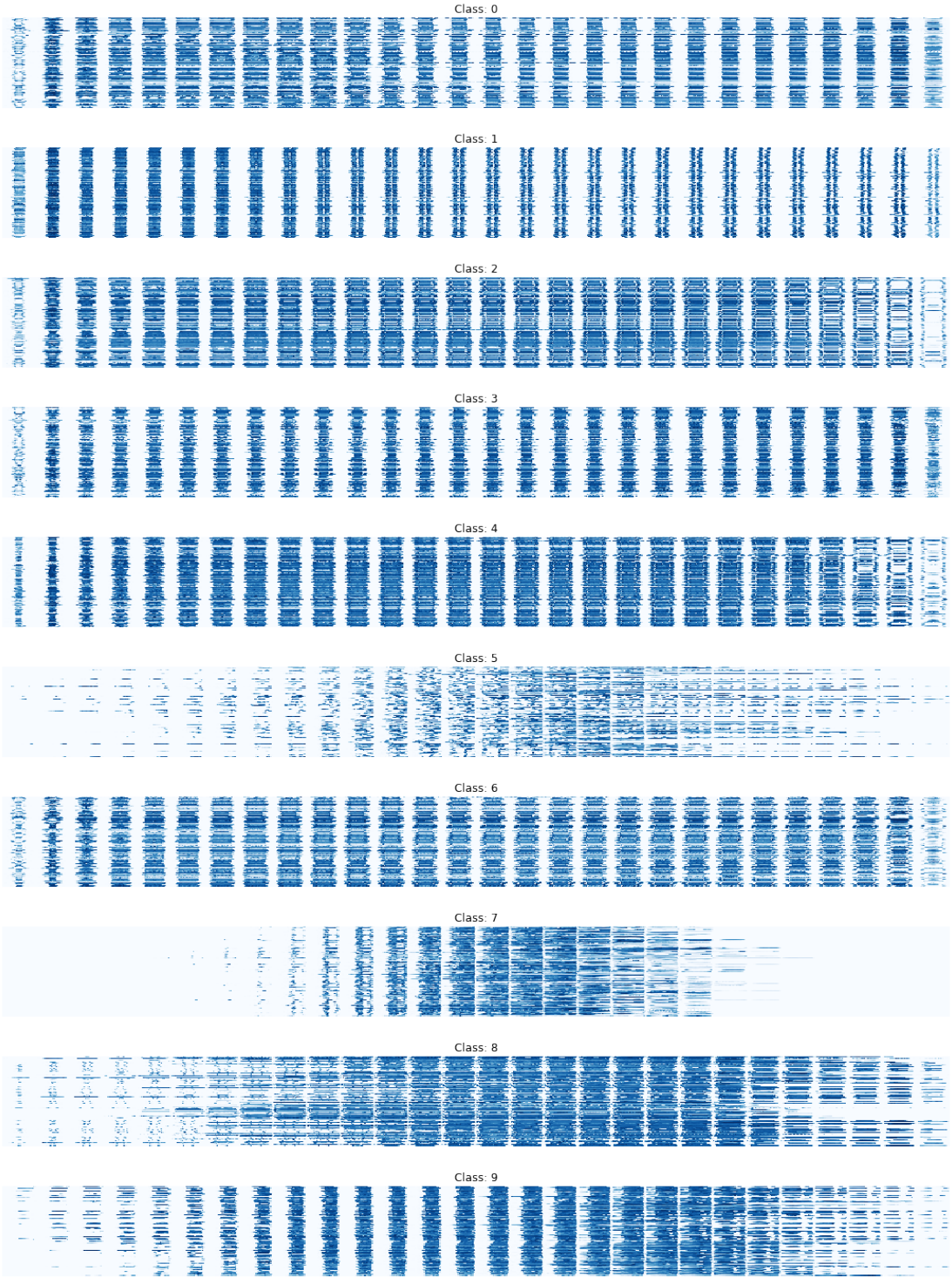
[13]:
```
fig, ax = plt.subplots()
fashion_sample = np.empty(shape=(image_size * len(classes),
                                 image_size * n_samples))
for row, label in enumerate(classes):
    label_data = np.squeeze(np.argwhere(fashion_label == label))
    samples = choice(label_data, size=n_samples, replace=False)
    i = row * image_size
    for col, sample in enumerate(samples):
        j = col * image_size
        fashion_sample[i:i+image_size,
                       j:j + image_size] = fashion_data[sample].
↪reshape(image_size, -1)

ax.imshow(fashion_sample, cmap='Blues')
plt.title('Fashion Images')
```

```
plt.axis('off')
plt.tight_layout();
```



0.0.4 Pixel structure of random images

[14]:
```
fig, axes = plt.subplots(nrows=len(classes), figsize=(15, 20))
n = 100
samples = []
for i, label in enumerate(classes):
    label_data = np.squeeze(np.argwhere(fashion_label == label))
    sample = choice(label_data, size=n, replace=False)
    sns.heatmap(fashion_data[sample], cmap='Blues', ax=axes[i], cbar=False)
    axes[i].set_title('Class: {:.0f}'.format(label))
    axes[i].axis('off')
fig.tight_layout(h_pad=.1);
```


Class: 0
Class: 1
Class: 2
Class: 3
Class: 4
Class: 5
Class: 6
Class: 7
Class: 8
Class: 9

0.0.5 Compare with random data

[15]:
```
fig, ax = plt.subplots()
sns.heatmap(np.random.randint(low=0, high=255, size=(100, 784)), cmap='Blues',␣
 ↪ax=ax)
plt.axis('off');
```