04_manifold_learning_asset_prices

September 29, 2021

1 Manifold Learning: t-SNE and UMAP for Equity Return

This notebook explores how t-SNE and UMAP perform on equity returns.

1.1 Imports & Settings

[ ]:

```
from pathlib import Path
from os.path import join
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 sklearn.datasets import fetch_openml, make_swiss_roll, make_blobs
from sklearn.decomposition import PCA
from sklearn.manifold import TSNE
import umap
from plotly.offline import init_notebook_mode, iplot
from plotly.graph_objs import *
import colorlover as cl
```

[2]:

```
%matplotlib inline
plt.style.use('ggplot')
pd.options.display.float_format = '{:,.2f}'.format
```

1.2 Load equity returns

[3]:

```
idx = pd.IndexSlice
with pd.HDFStore('../../data/assets.h5') as store:
    returns = (store['quandl/wiki/prices']
               .loc[idx['2000':'2018', :], 'adj_close']
               .unstack('ticker')
               .resample('W')
               .last()
               .pct_change())
```

[4]:

```
returns = returns.dropna(thresh=int(returns.shape[0] * .95), axis=1)
returns = returns.dropna(thresh=int(returns.shape[1] * .95))
returns.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 951 entries, 2000-01-16 to 2018-04-01
Freq: W-SUN
Columns: 1890 entries, A to ZQK
dtypes: float64(1890)
memory usage: 13.7 MB
```

[5]:

```
returns = returns.sample(n=250)
daily_avg = returns.mean(1)
returns = returns.apply(lambda x: x.fillna(daily_avg))
```

[6]:

```
pca = PCA(n_components=2)
```

1.3 T-Stochastic Neighbor Embedding (TSNE): Parameter Settings

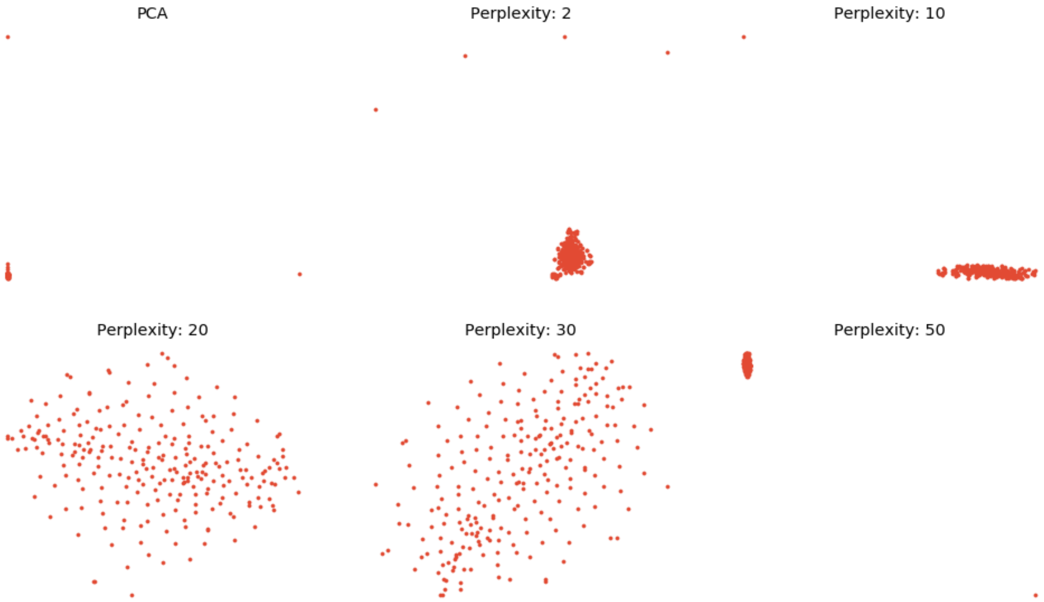
1.3.1 Perplexity: emphasis on local vs global structure

[7]:

```
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(14,8))
axes = axes.flatten()

axes[0].scatter(*pca.fit_transform(returns).T, s=10)
axes[0].set_title('PCA')
axes[0].axis('off')

for i, p in enumerate([2,10, 20, 30, 50], 1):
    embedding = TSNE(perplexity=p, n_iter=5000).fit_transform(returns)
    axes[i].scatter(embedding[:, 0], embedding[:, 1], s=10)
    axes[i].set_title('Perplexity: {:.0f}'.format(p))
    axes[i].axis('off')
fig.tight_layout()
```

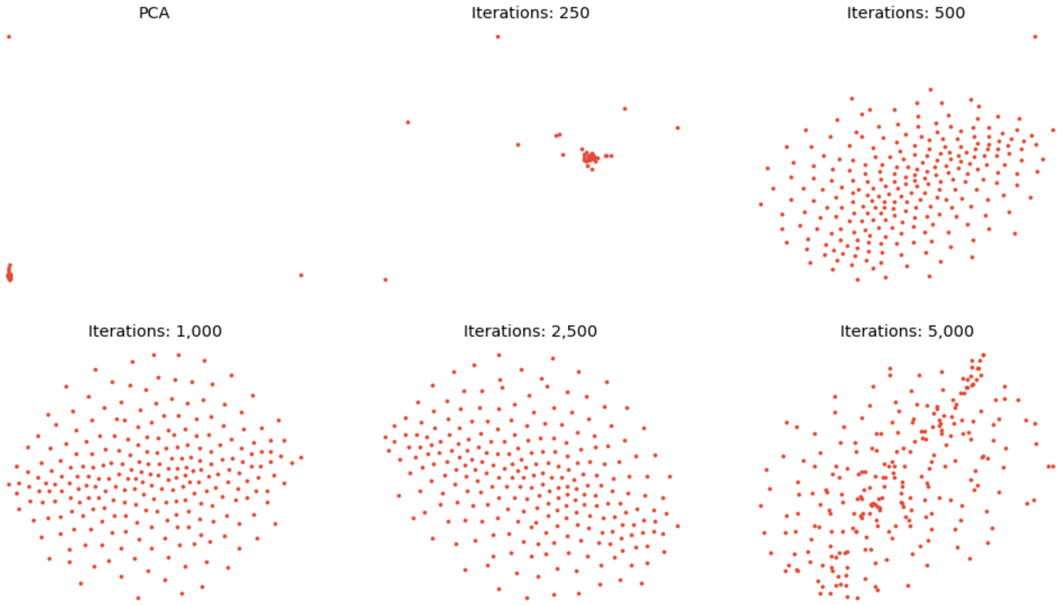


1.3.2 Convergence with n_iter

[8]:

```
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(14, 8))
axes = axes.flatten()
axes[0].scatter(*pca.fit_transform(returns).T, s=10)
axes[0].set_title('PCA')
axes[0].axis('off')

for i, n in enumerate([250, 500, 1000, 2500, 5000], 1):
    embedding=TSNE(perplexity=30, n_iter=n).fit_transform(returns)
    axes[i].scatter(embedding[:, 0], embedding[:, 1], s=10)
    axes[i].set_title('Iterations: {:,.0f}'.format(n))
    axes[i].axis('off')
fig.tight_layout()
```



1.4 Uniform Manifold Approximation and Projection (UMAP): Parameter Settings

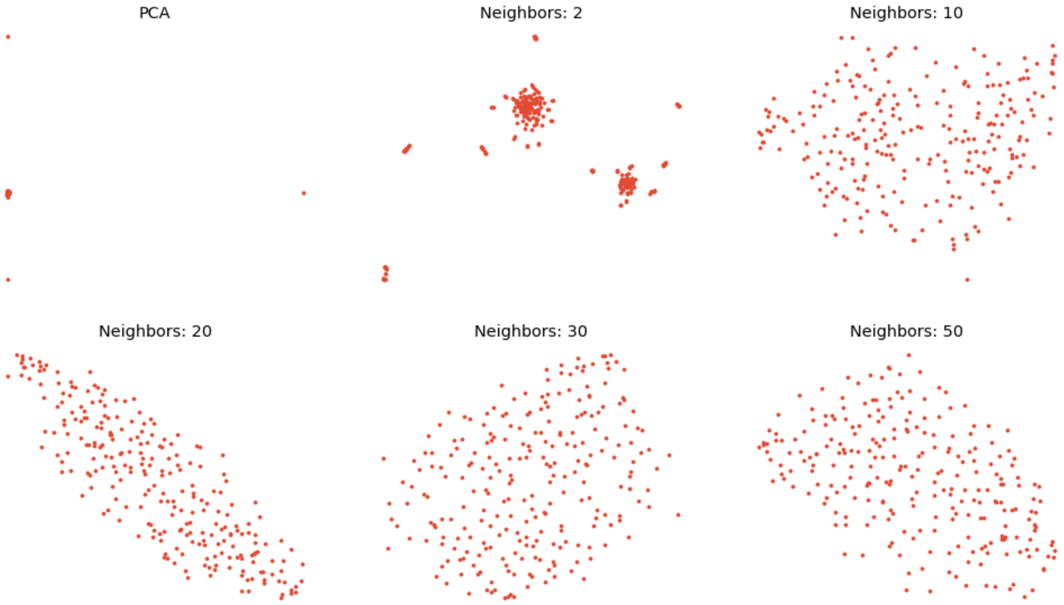
1.4.1 Neighbors

[9]:
```
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(14,8))
axes = axes.flatten()

axes[0].scatter(*pca.fit_transform(returns).T, s=10)
axes[0].set_title('PCA')
axes[0].axis('off')
for i, n in enumerate([2,10, 20, 30, 50], 1):
    embedding = umap.UMAP(n_neighbors=n, min_dist=0.1).fit_transform(returns)
    axes[i].scatter(embedding[:, 0], embedding[:, 1], s=10)
    axes[i].set_title('Neighbors: {:.0f}'.format(n))
    axes[i].axis('off')
fig.tight_layout()
```

```
/home/stefan/.pyenv/versions/miniconda3-latest/envs/ml4t/lib/python3.7/site-
packages/umap/spectral.py:229: UserWarning:

Embedding a total of 3 separate connected components using meta-embedding
(experimental)
```

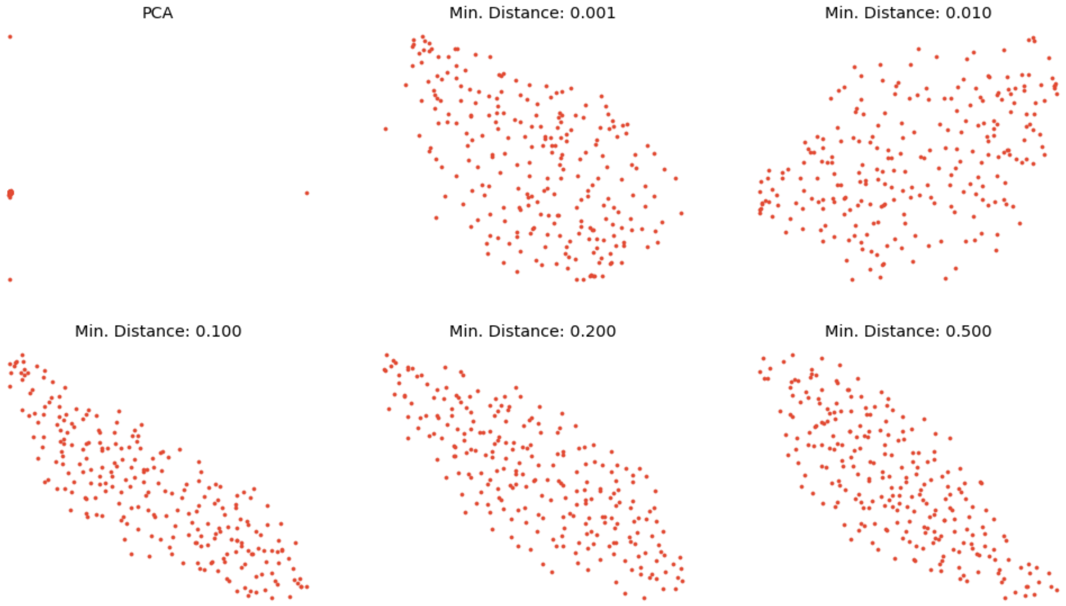


1.4.2 Minimum Distance

[10]:
```
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(14,8))
axes = axes.flatten()

axes[0].scatter(*pca.fit_transform(returns).T, s=10)
axes[0].set_title('PCA')
axes[0].axis('off')

for i, d in enumerate([.001, .01, .1, .2, .5], 1):
    embedding = umap.UMAP(n_neighbors=30, min_dist=d).fit_transform(returns)
    axes[i].scatter(embedding[:, 0], embedding[:, 1], s=10)
    axes[i].set_title('Min. Distance: {:.3f}'.format(d))
    axes[i].axis('off')
fig.tight_layout()
```


PCA
Min. Distance: 0.001
Min. Distance: 0.010
Min. Distance: 0.100
Min. Distance: 0.200
Min. Distance: 0.500