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

[1]:
```
%matplotlib inline

import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.decomposition import PCA
from sklearn.manifold import TSNE
import umap
```

[2]:
```
sns.set_style('white')
np.random.seed(42)
```

1.2 Load equity returns

This example uses daily returns; remove the comment symbols to use weekly returns instead.

[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)).clip(lower=-.5,␣
↪upper=.5)
returns.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 4705 entries, 2000-01-04 to 2018-03-27
Columns: 1886 entries, A to ZQK
dtypes: float64(1886)
memory usage: 67.7 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

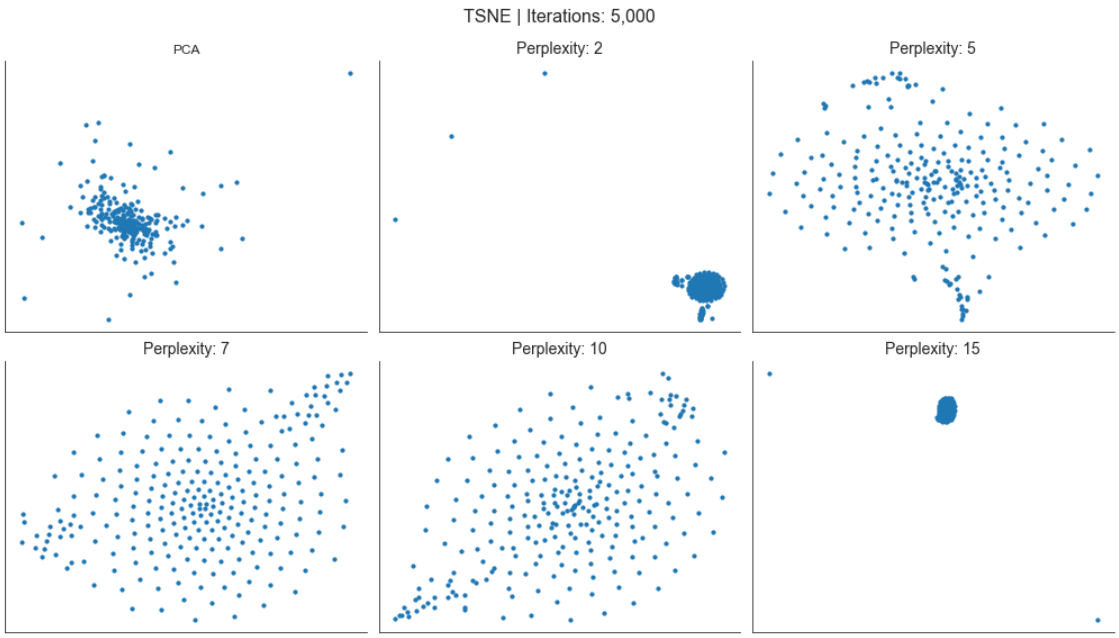
[7]:
```
n_iter = 5000
```

[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].axes.get_xaxis().set_visible(False)
axes[0].axes.get_yaxis().set_visible(False)

for i, p in enumerate([2, 5, 7, 10, 15], 1):
    embedding = TSNE(perplexity=p,
                     n_iter=n_iter).fit_transform(returns)
    axes[i].scatter(embedding[:, 0], embedding[:, 1], s=10)
    axes[i].set_title('Perplexity: {:.0f}'.format(p), fontsize=14)
    axes[i].axes.get_xaxis().set_visible(False)
    axes[i].axes.get_yaxis().set_visible(False)

fig.suptitle(f'TSNE | Iterations: {n_iter:,.0f}', fontsize=16)
sns.despine()
fig.tight_layout()
fig.subplots_adjust(top=.9)
```



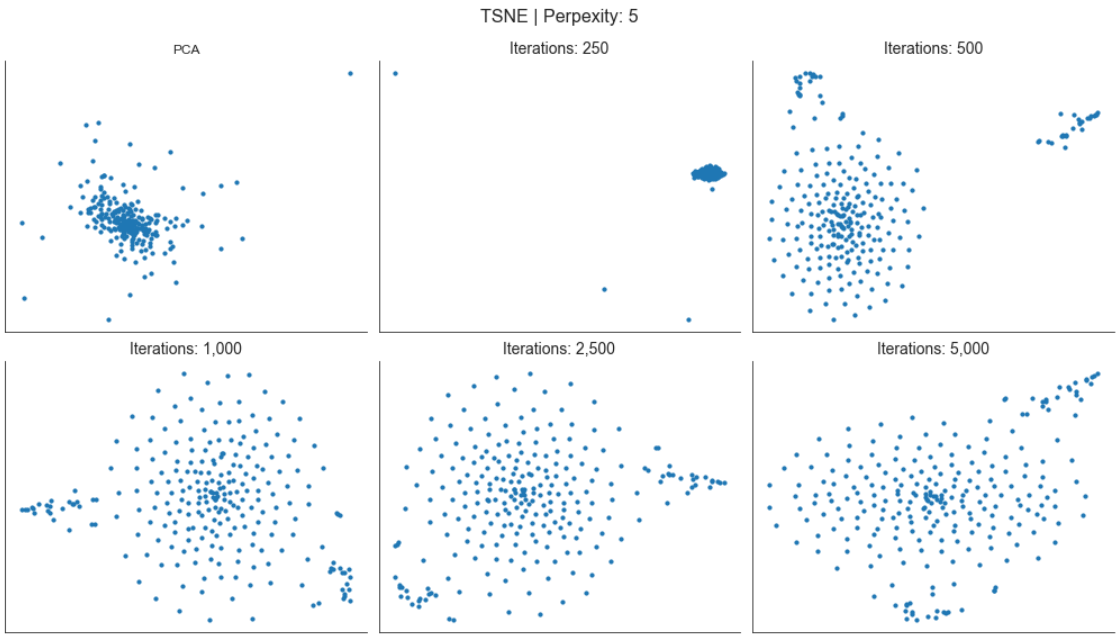
1.3.2 Convergence with `n_iter`

[9]:
```
perplexity = 5
```

[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].axes.get_xaxis().set_visible(False)
axes[0].axes.get_yaxis().set_visible(False)

for i, n in enumerate([250, 500, 1000, 2500, 5000], 1):
    embedding = TSNE(perplexity=perplexity,
                     n_iter=n).fit_transform(returns)
    axes[i].scatter(embedding[:, 0], embedding[:, 1], s=10)
    axes[i].set_title('Iterations: {:,.0f}'.format(n), fontsize=14)
    axes[i].axes.get_xaxis().set_visible(False)
    axes[i].axes.get_yaxis().set_visible(False)

fig.suptitle(f'TSNE | Perpexity: {perplexity:,.0f}', fontsize=16)
sns.despine()
fig.tight_layout()
fig.subplots_adjust(top=.9)
```



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

1.4.1 Neighbors

[11]:
```
min_dist = .1
```

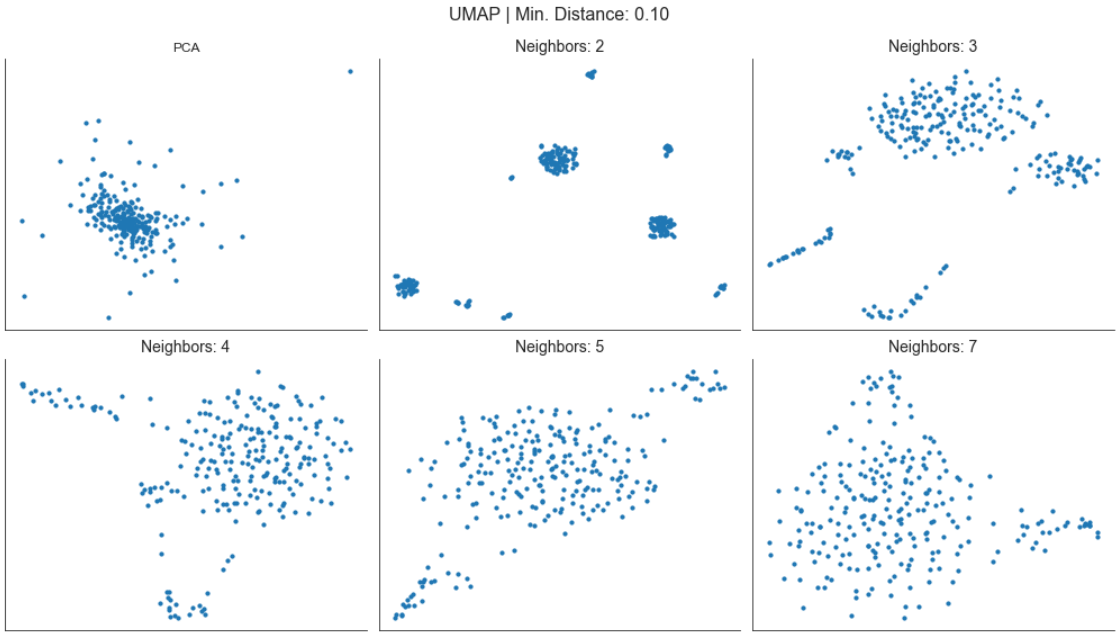
[12]:
```
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(14, 8))
axes = axes.flatten()

axes[0].scatter(*pca.fit_transform(returns).T, s=10)
axes[0].set_title('PCA')
axes[0].axes.get_xaxis().set_visible(False)
axes[0].axes.get_yaxis().set_visible(False)

for i, n in enumerate([2, 3, 4, 5, 7], 1):
    embedding = umap.UMAP(n_neighbors=n,
                          min_dist=min_dist).fit_transform(returns)
    axes[i].scatter(embedding[:, 0], embedding[:, 1], s=10)
    axes[i].set_title('Neighbors: {:.0f}'.format(n), fontsize=14)
    axes[i].axes.get_xaxis().set_visible(False)
    axes[i].axes.get_yaxis().set_visible(False)

fig.suptitle(f'UMAP | Min. Distance: {min_dist:,.2f}', fontsize=16)
sns.despine()
fig.tight_layout()
```

```
fig.subplots_adjust(top=.9)
```



1.4.2 Minimum Distance

[13]:
```
n_neighbors = 2
```

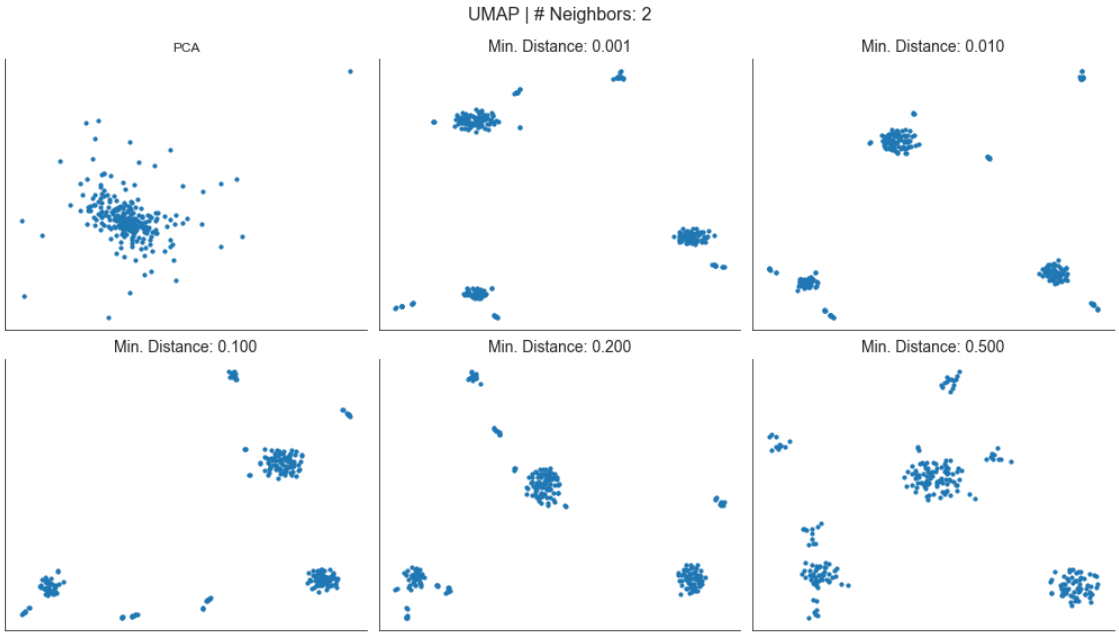
[14]:
```
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(14,8))
axes = axes.flatten()

axes[0].scatter(*pca.fit_transform(returns).T, s=10)
axes[0].set_title('PCA')
axes[0].axes.get_xaxis().set_visible(False)
axes[0].axes.get_yaxis().set_visible(False)

for i, d in enumerate([.001, .01, .1, .2, .5], 1):
    embedding = umap.UMAP(n_neighbors=n_neighbors,
                          min_dist=d).fit_transform(returns)
    axes[i].scatter(embedding[:, 0], embedding[:, 1], s=10)
    axes[i].set_title('Min. Distance: {:.3f}'.format(d), fontsize=14)
    axes[i].axes.get_xaxis().set_visible(False)
    axes[i].axes.get_yaxis().set_visible(False)


fig.suptitle(f'UMAP | # Neighbors: {n_neighbors:,.0f}', fontsize=16)
sns.despine()
fig.tight_layout()
```

```
fig.subplots_adjust(top=.9)
```



[ ]: