EDA on Uninformative Features

May 5, 2021

1 Exploratory Data Analysis on Uninformative Features

[4]:
```
import pandas as pd
import numpy as np
from sklearn.decomposition import PCA, SparsePCA


import matplotlib.pyplot as plt
import seaborn as sns
```

[192]:
```
## Import Data

# all features scaled (words are one hot encoded)
#scaled = np.load('Data/Bad_Features/ONEHOT_SCALED.npy')

# only unscaled features without any word features
#no_words = pd.read_csv('Data/Bad_Features/log_onehot_no_words.csv')
#no_words= no_words.drop(['datetime', 'anomaly'], axis = 1)




## Future: perform PCA on windowed data
#window_size = 10
#windows = []

## Make Windows
#for row in range(scaled.shape[0]-window_size):
#    windows += [scaled[row:row+window_size, :]]

#windows = pd.Series(windows)
#print('Object: ONEHOT_WINDOWS\nSize:', sys.getsizeof(windows)/1000000000,␣
↪'GiB')
```

[150]:
```
# First row of scaled. Note column identifiers are removed but there would␣
↪otherwise be 128 features
scaled[0]
```

[150]:
```
array([8.00000000e-02, 0.00000000e+00, 1.10758587e-01, 1.90128090e-02,
       1.93348801e-04, 1.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 1.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 1.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
       0.00000000e+00, 0.00000000e+00, 0.00000000e+00, 0.00000000e+00])
```

[146]:
```
# Unscaled dataset without message features

no_words.head()
```

[146]:
```
   words_per_event  delta_t  evnts_in_10min  evnts_in_1min  evnts_in_1s  \
0                5        0           71880           4074            2
1               11        0           71879           4073            1
2                5        1           72054           4201           11
3                5        0           72053           4200           10
4                5        0           72052           4199            9

   prio_0  prio_1  cat_0  cat_1  cat_2  cat_3  cat_4  cat_5  cat_6  cat_7  \
0       1       0      0      0      0      0      1      0      0      0
1       1       0      0      0      0      0      0      0      0      1
```

```
2       1       0       0       0       0       0       1       0       0       0
3       1       0       0       0       0       0       1       0       0       0
4       1       0       0       0       0       0       0       1       0       0
```

```
   cat_8
0      0
1      0
2      0
3      0
4      0
```

[33]:
```
## Import anomaly labels
anom_labels = pd.read_feather('Data/Checkpoints/labeled_blks.feather')
anom_labels
```

```
Object: anom_labels
Size: 943.003212 MiB
```

[33]:

	blkID	anomaly
0	blk_-1608999687919862906	0
1	blk_-1608999687919862906	0
2	blk_-1608999687919862906	0
3	blk_-1608999687919862906	0
4	blk_-1608999687919862906	0
…	…	…
11175624	blk_-6171368032583208892	0
11175625	blk_6195025276114316035	0
11175626	blk_-3339773404714332088	0
11175627	blk_1037231945509285002	0
11175628	blk_4258862871822415442	0

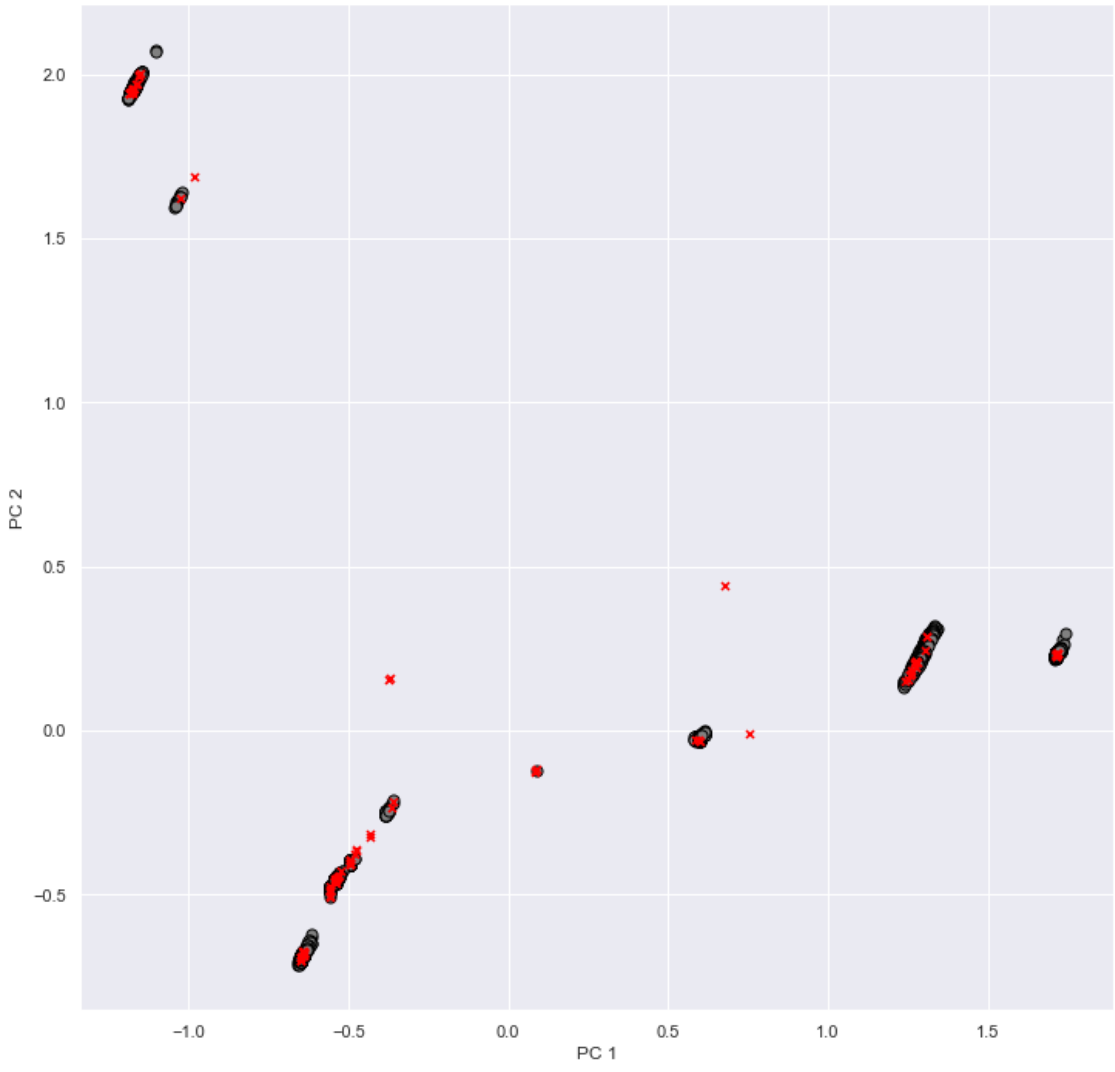
[11175629 rows x 2 columns]

1.0.1 PCA on every 3000th event on scaled data

[166]:
```
plt.style.use('seaborn-white')
sns.set(rc={'figure.figsize':(12,12)})

step = 3000
ls, rs = 0, 11175628

idx_anom = np.array(anom_labels.anomaly[ls:rs:step], dtype = bool)
idx_norm = np.array(1-idx_anom, dtype = bool)

data_small = scaled[ls:rs:step]
pca = PCA().fit(data_small)
pca_2d = pca.transform(data_small)
```

```
plt.scatter(pca_2d[idx_norm, 0], pca_2d[idx_norm, 1], s=50, c='grey',␣
 ↪edgecolors='black', marker='o')
plt.scatter(pca_2d[idx_anom, 0], pca_2d[idx_anom, 1], s=25, c='red',␣
 ↪edgecolors='black', marker='x')

plt.xlabel('PC 1')
plt.ylabel('PC 2')
plt.legend(loc='lower left')

plt.savefig('PCA_3000.png', dpi=100)
plt.show()
```

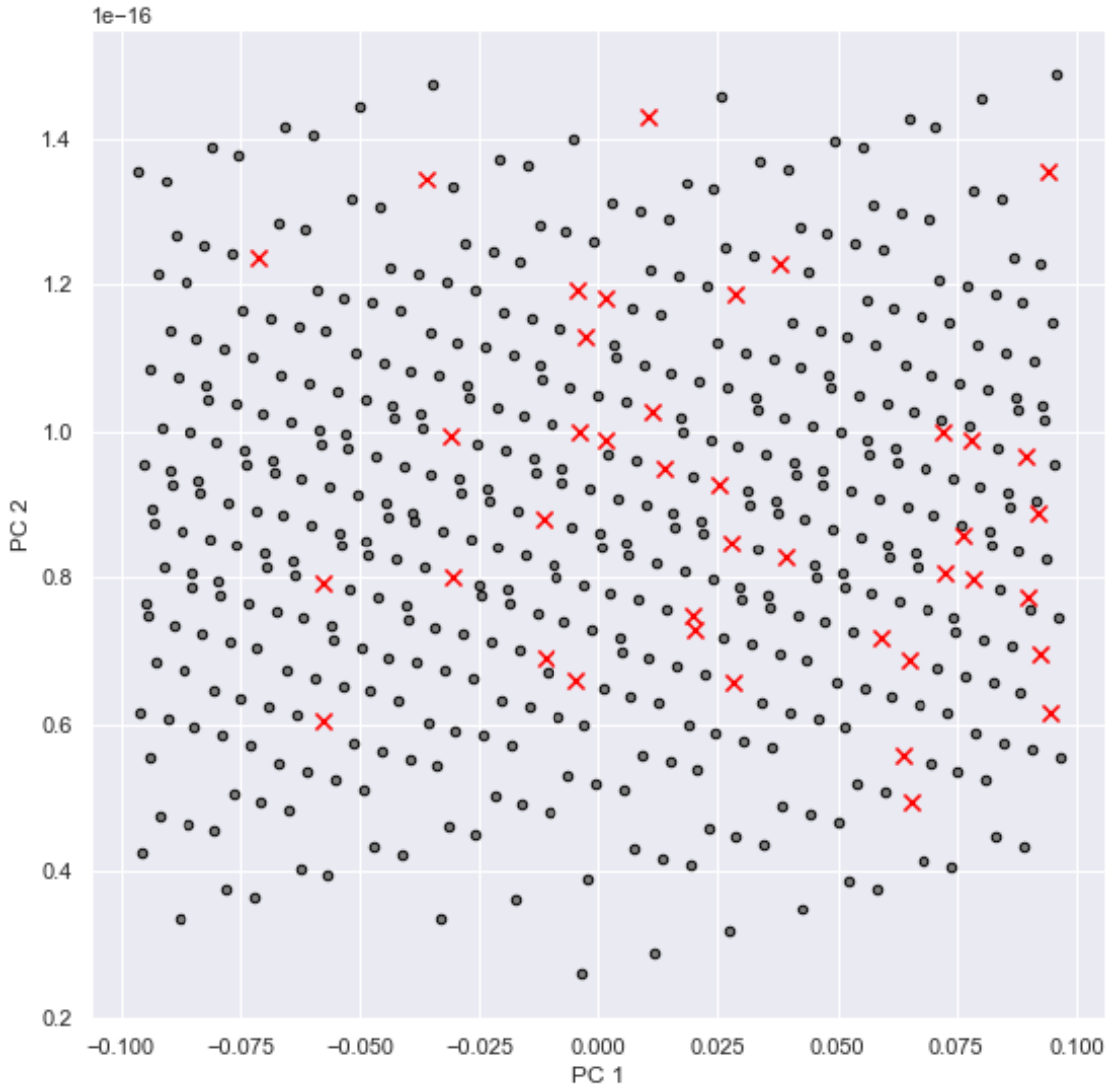
```
No handles with labels found to put in legend.
```



1.0.2 Zoomed in PCA on every 2nd event on scaled data

[157]:
```
plt.style.use('seaborn-white')
sns.set(rc={'figure.figsize':(9,9)})

step = 2
ls, rs = int(2e6), int(2001000)

idx_anom = np.array(anom_labels.anomaly[ls:rs:step], dtype = bool)
idx_norm = np.array(1-idx_anom, dtype = bool)

data_small = scaled[ls:rs:step]
pca = PCA().fit(data_small)
pca_2d = pca.transform(data_small)

plt.scatter(pca_2d[idx_norm, 0], pca_2d[idx_norm, 1], s=20, c='grey',␣
 ↪edgecolors='black', marker='o')
plt.scatter(pca_2d[idx_anom, 0], pca_2d[idx_anom, 1], s=65, c='red',␣
 ↪edgecolors='black', marker='x')

plt.xlabel('PC 1')
plt.ylabel('PC 2')
plt.legend(loc='lower left')

plt.savefig('PCA_zoom_scaled.png', dpi=100)
plt.show()
```

```
No handles with labels found to put in legend.
```

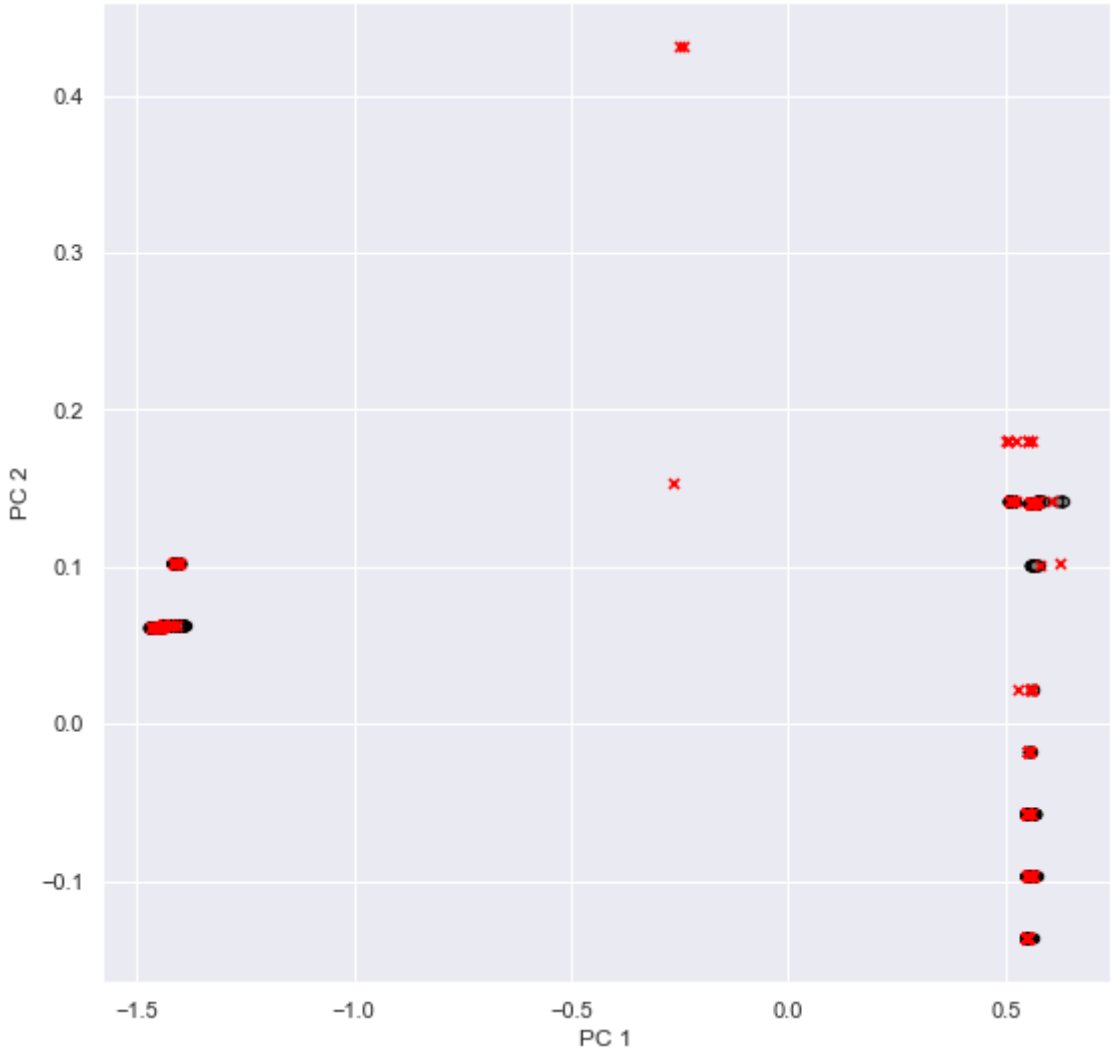


1.0.3 SparsePCA on every 1000th event on scaled data

[159]:
```
plt.style.use('seaborn-white')
sns.set(rc={'figure.figsize':(9,9)})

step = 1000
ls, rs = int(0e6), int(11e6)

idx_anom = np.array(anom_labels.anomaly[ls:rs:step], dtype = bool)
idx_norm = np.array(1-idx_anom, dtype = bool)

data_small = scaled[ls:rs:step]
pca = SparsePCA().fit(data_small)
```

```
pca_2d = pca.transform(data_small)

plt.scatter(pca_2d[idx_norm, 0], pca_2d[idx_norm, 1], s=20, c='grey',␣
 ↪edgecolors='black', marker='o')
plt.scatter(pca_2d[idx_anom, 0], pca_2d[idx_anom, 1], s=25, c='red',␣
 ↪edgecolors='black', marker='x')


plt.xlabel('PC 1')
plt.ylabel('PC 2')
plt.legend(loc='lower left')

plt.savefig('PCA_sparse.png', dpi=100)
plt.show()
```

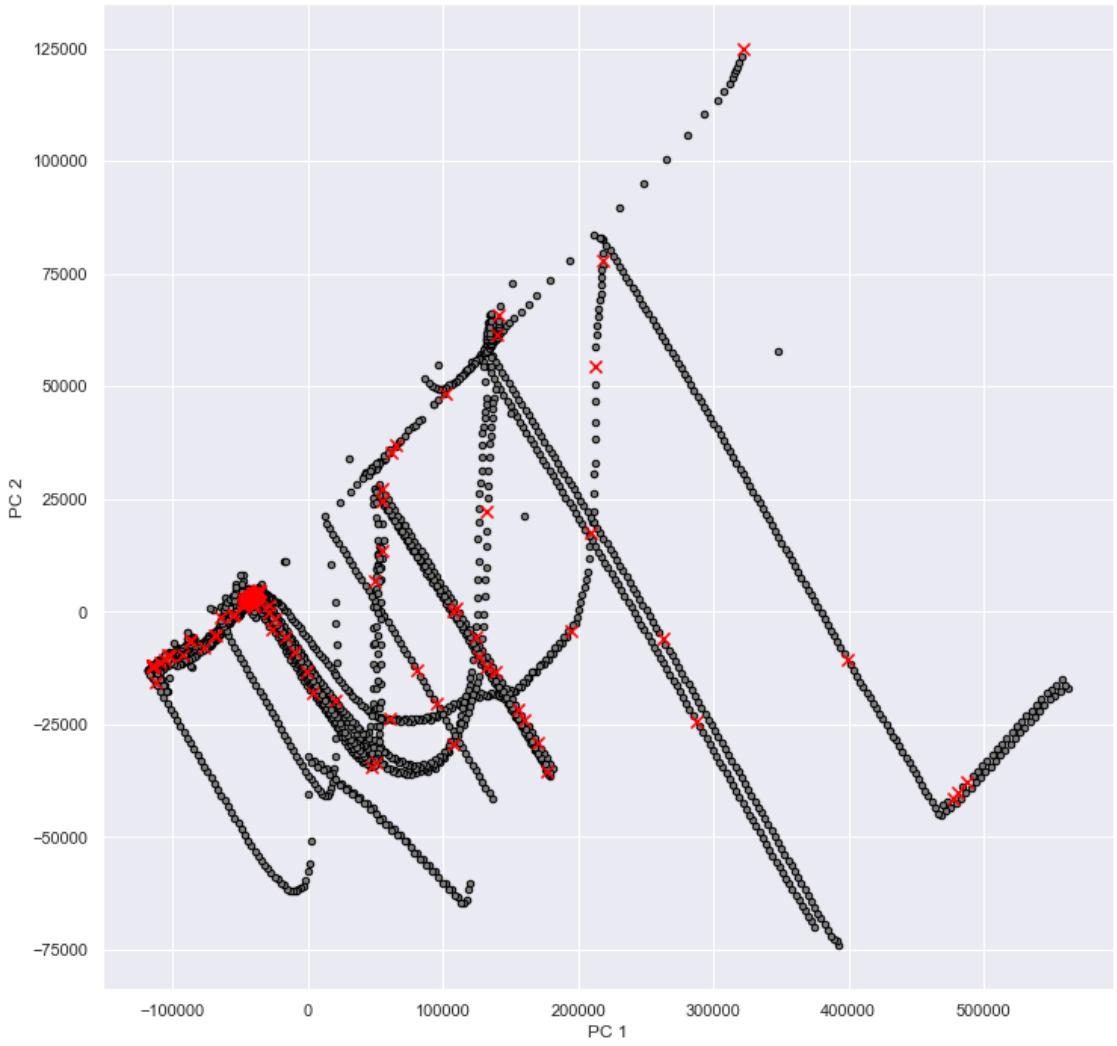
```
No handles with labels found to put in legend.
```



1.0.4 PCA on every 2000th event on data with no word features

[167]:
```
plt.style.use('seaborn-white')
sns.set(rc={'figure.figsize':(12,12)})

step = 2000
ls, rs = 0, 11175628

idx_anom = np.array(anom_labels.anomaly[ls:rs:step], dtype = bool)
idx_norm = np.array(1-idx_anom, dtype = bool)

data_small = no_words[ls:rs:step]
pca = PCA().fit(data_small)
pca_2d = pca.transform(data_small)

plt.scatter(pca_2d[idx_norm, 0], pca_2d[idx_norm, 1], s=20, c='grey',␣
 ↪edgecolors='black', marker='o')
plt.scatter(pca_2d[idx_anom, 0], pca_2d[idx_anom, 1], s=65, c='red',␣
 ↪edgecolors='black', marker='x')

plt.xlabel('PC 1')
plt.ylabel('PC 2')
plt.legend(loc='lower left')

plt.savefig('PCA_no_words.png', dpi=100)
plt.show()
```

```
No handles with labels found to put in legend.
```

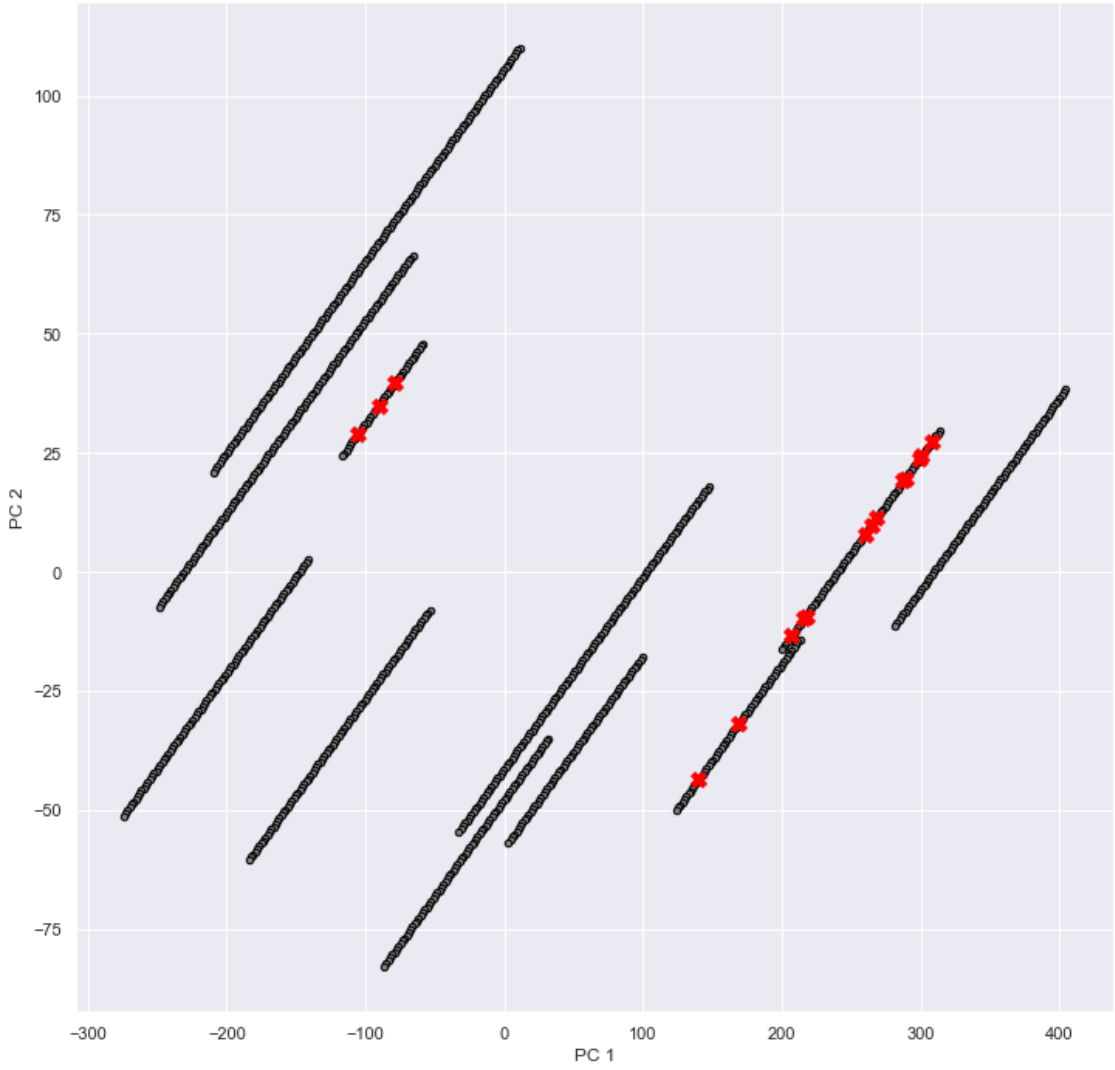


1.0.5 Zoomed PCA on data with no word features

[179]:
```
plt.style.use('seaborn-white')
sns.set(rc={'figure.figsize':(12,12)})

step = 1
n = np.random.randint(0, 11600000)
ls, rs = n, n+1000

idx_anom = np.array(anom_labels.anomaly[ls:rs:step], dtype = bool)
idx_norm = np.array(1-idx_anom, dtype = bool)

data_small = no_words[ls:rs:step]
pca = PCA().fit(data_small)
pca_2d = pca.transform(data_small)
```

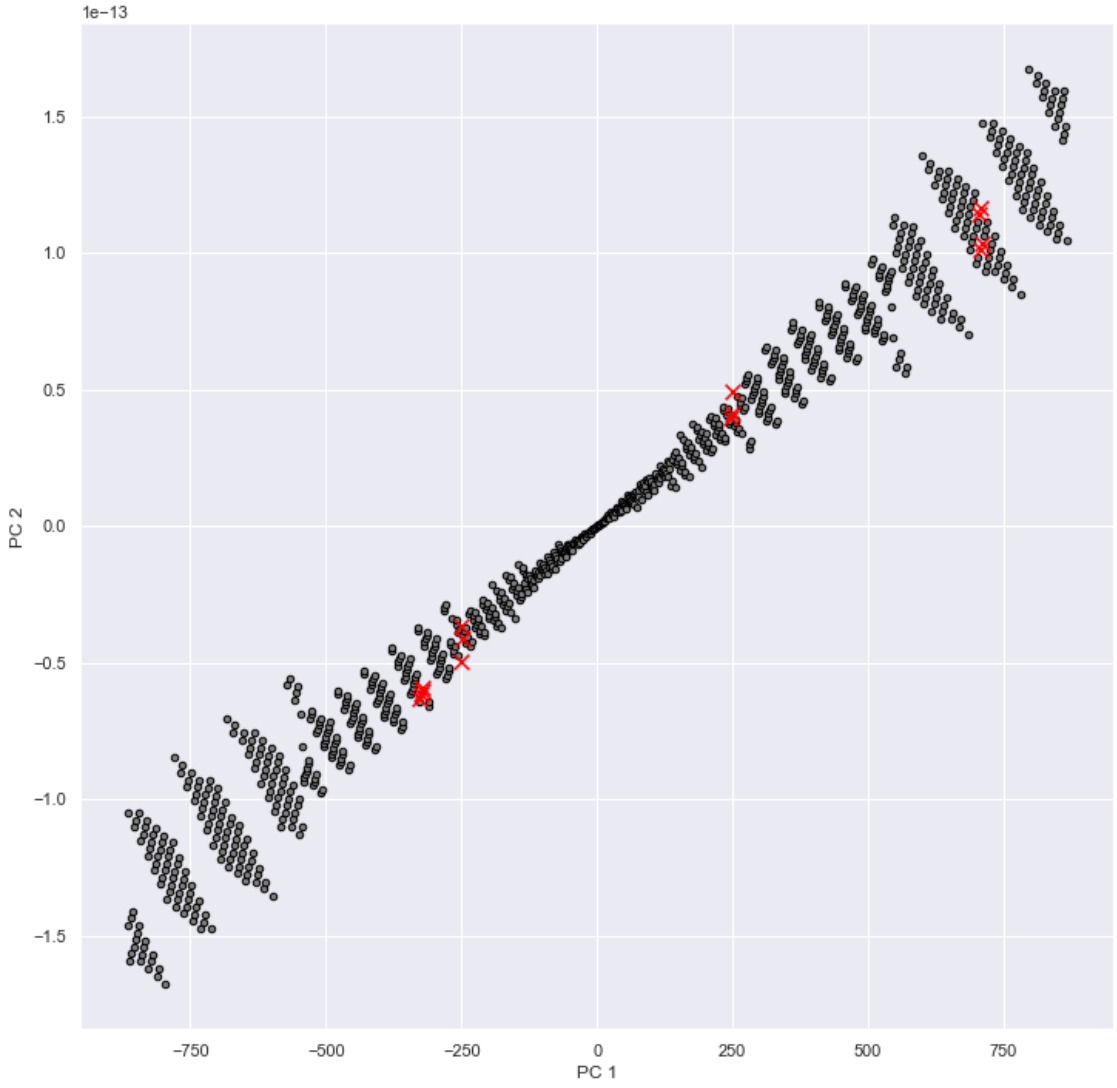
```
plt.scatter(pca_2d[idx_norm, 0], pca_2d[idx_norm, 1], s=20, c='grey',␣
 ↪edgecolors='black', marker='o')
plt.scatter(pca_2d[idx_anom, 0], pca_2d[idx_anom, 1], s=95, c='red',␣
 ↪edgecolors='red', marker='X')

plt.xlabel('PC 1')
plt.ylabel('PC 2')
plt.legend(loc='lower left')

plt.savefig('PCA_zoom_nowords.png', dpi=100)
plt.show()
```

```
No handles with labels found to put in legend.
```



[183]:
```
plt.style.use('seaborn-white')
sns.set(rc={'figure.figsize':(12,12)})

step = 1
n = 9178329 #np.random.randint(0, 11600000)
ls, rs = n, n+1000

idx_anom = np.array(anom_labels.anomaly[ls:rs:step], dtype = bool)
idx_norm = np.array(1-idx_anom, dtype = bool)

data_small = no_words[ls:rs:step]
pca = PCA().fit(data_small)
pca_2d = pca.transform(data_small)

plt.scatter(pca_2d[idx_norm, 0], pca_2d[idx_norm, 1], s=20, c='grey',␣
 ↪edgecolors='black', marker='o')
plt.scatter(pca_2d[idx_anom, 0], pca_2d[idx_anom, 1], s=95, c='red',␣
 ↪edgecolors='black', marker='x')

plt.xlabel('PC 1')
plt.ylabel('PC 2')
plt.legend(loc='lower left')

plt.savefig('PCA_zoom_nowords2.png', dpi=100)
plt.show()
```

```
No handles with labels found to put in legend.
```

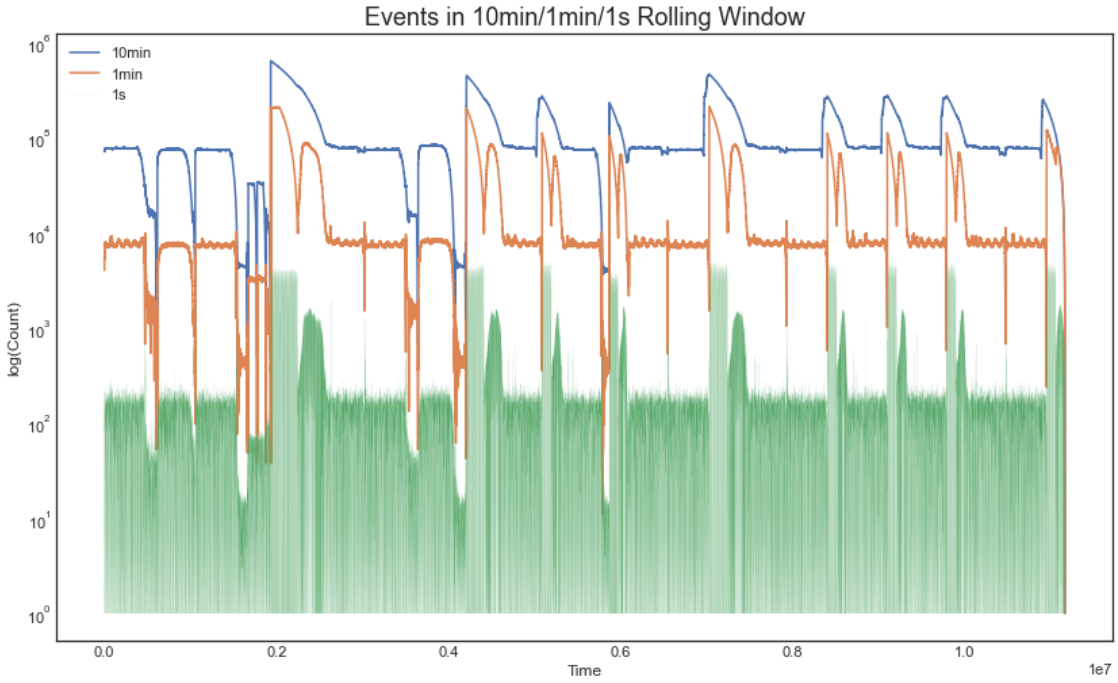


1.1 Other curious features

- Event frequencies in time windows
- Time intervals between events
- Words per Event

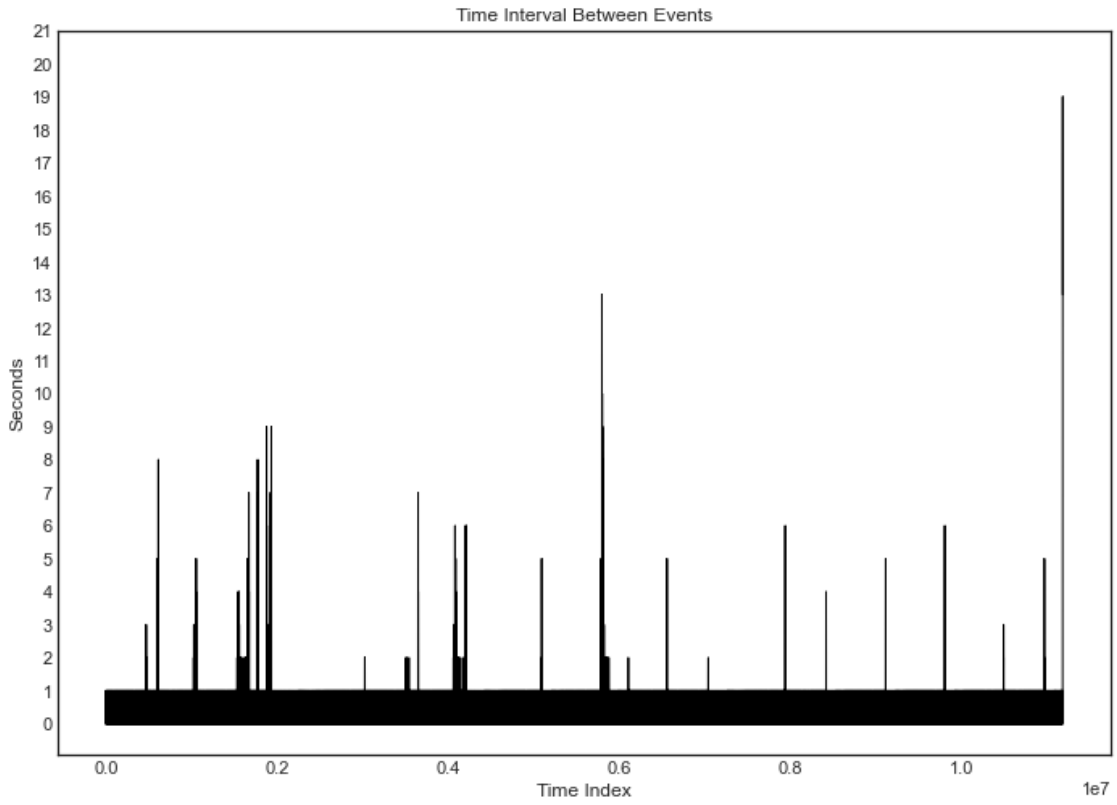
[184]:
```
%matplotlib inline
sns.set(rc={'figure.figsize':(14,8.27)})
plt.style.use('seaborn-white')

fig = plt.figure()
ax = plt.axes()

ax.plot(np.array(no_words.evnts_in_10min), label='10min')
```

```
ax.plot(np.array(no_words.evnts_in_1min), label='1min')
ax.plot(np.array(no_words.evnts_in_1s), lw=0.06, label='1s')

ax.set_xlabel('Time')
ax.set_yscale('log')
ax.set_ylabel('log(Count)')
ax.set_title('Events in 10min/1min/1s Rolling Window', fontsize=18)
ax.legend()

plt.show()
```

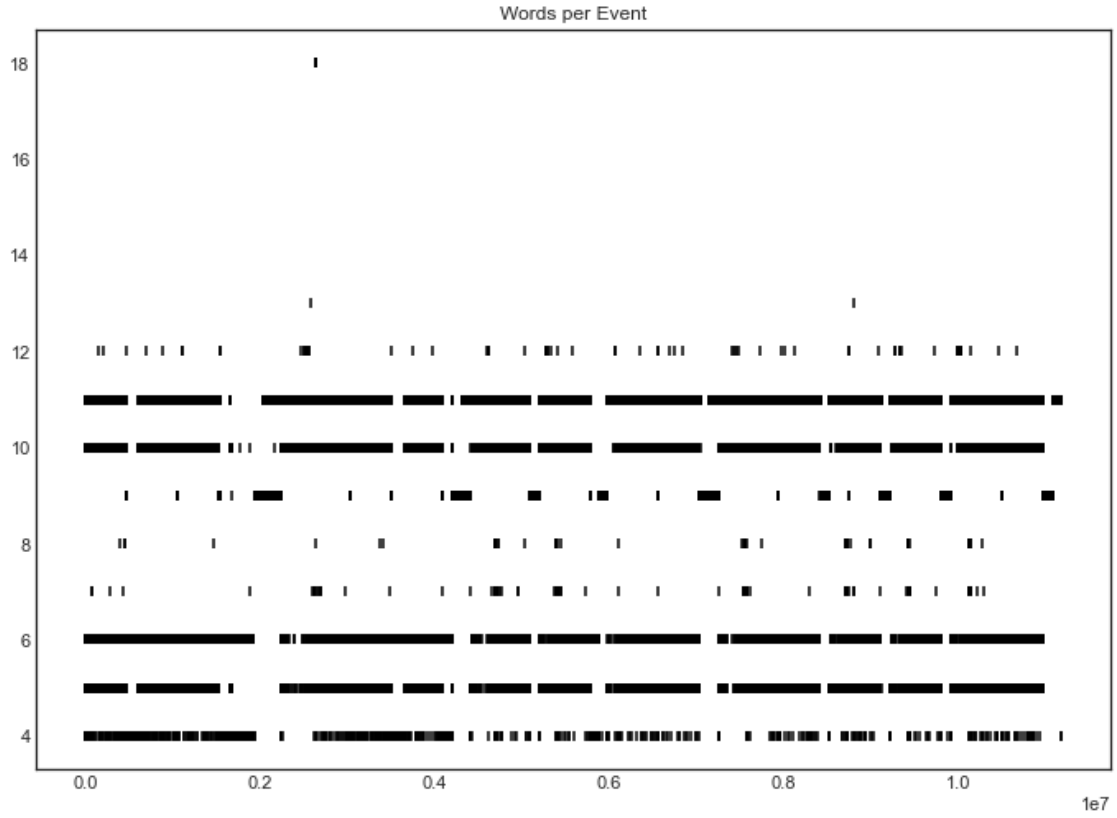


[186]:
```
%matplotlib inline
sns.set(rc={'figure.figsize':(11.7,8.27)})
plt.style.use('seaborn-white')

fig = plt.figure()
ax = plt.axes()

ax.plot(np.array(no_words.delta_t), c = 'black', lw = 1)
ax.set_yticks(np.arange(0,22,1))

ax.set_xlabel('Time Index')
ax.set_ylabel('Seconds')
ax.set_title('Time Interval Between Events')
```

```
plt.show()
```



[191]:
```
%matplotlib inline
sns.set(rc={'figure.figsize':(11.7,8.27)})
plt.style.use('seaborn-white')

fig, ax = plt.subplots()

idx = no_words.index[::100]
ax.scatter(idx, no_words.words_per_event[::100], c = 'black', marker = '|')
ax.set_title('Words per Event')


plt.show()
```


Words per Event
18
16
14
12
10
8
6
4
0.0
0.2
0.4
0.6
0.8
1.0
1e7