In [2]:

```
import pandas as pd
import os
import numpy as np
import matplotlib.pyplot as plt
import numpy.matlib as M
from numpy.matlib import rand,zeros,ones,empty,eye
from matplotlib import rcParams
rcParams.update({'figure.autolayout': True})
np.set_printoptions(precision=3)

%matplotlib inline
plt.style.use('ggplot')
```

Importing Data

In [3]:

```
site_list = ['Saginaw Malleable','Pontiac North Industrial','Linden Road','Bay City Powertrain','Coldwater Road','Davison Road','Greenpoint','Hemphill','Saginaw Malleable Peninsula','Van Buren','Buick City','Flint West (Kettering)','Danville','Allison Gas Turbine','Framingham','Massena','Salina', 'Tonawanda','Elyria','Toledo']
# Loads Previously Created Data (3D matrix, depth = 100, columns are criteria, rows are sites)
results = np.load('results.npy')

N=100 # number of simulations is N-1, referred to as N

# Import weights, use as np.dot(A,wgts)
# 1 Incentives, 2 Permitting, 3 Substation, 4 Environmental, 5 Proximity to Partners,
# 6 Weather, 7 Access, 8 Solar Radiation, 9 Land Stabillity
eyes = eye((11)).A
arr = np.array([20., 16., 15., 15., 8., 5., 5., 5., 4., 4., 3.])/100
wgts = eyes*arr
```

Sensitivity Analysis - Part 2

In [3]:

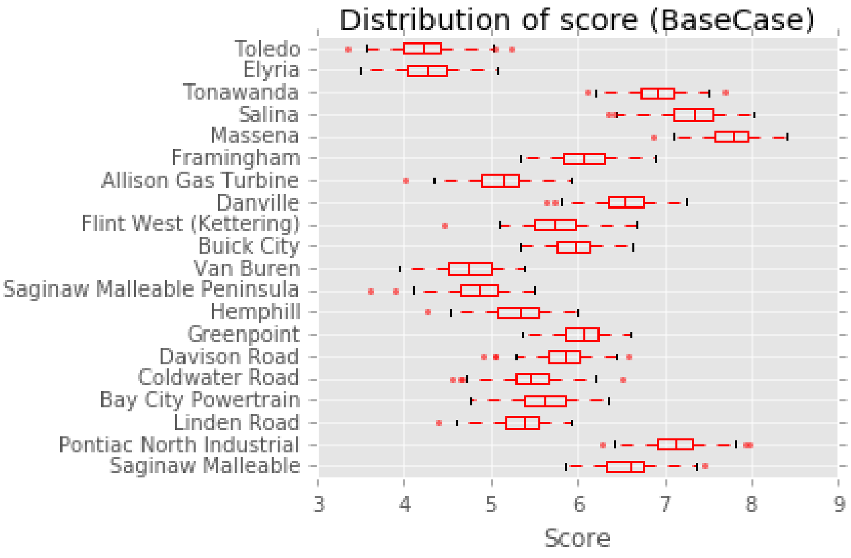
```
# Analysis setting all (1) Incentives, (2) Permitting, (3) Substation, and (4) Environmental Equal
```

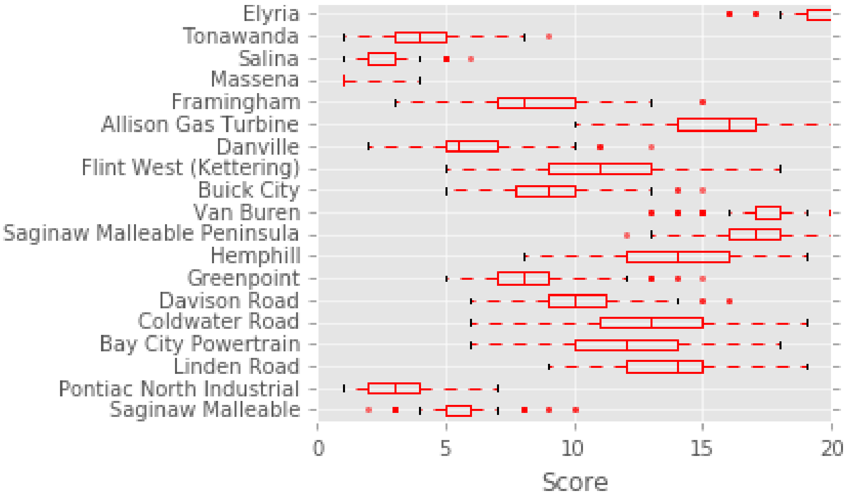
Use for BaseCase

In [8]:

```
qualifier = 'BaseCase'
t2 = '$N=100$, $\sigma = 1$'
def plot_res(_type, _qualifiertext, _arr, _n, _wgts, _site_list):
    # _type is 'score' or 'rank'
    score_list = []

    if _type == 'score':
        for i in range(0, _n):
            score_list.append(pd.Series(data=np.sum(np.dot(_arr[:, :, i], _w
gts), axis=1), index=[k for k in _site_list]))
    if _type == 'rank':
        for i in range(0, _n):
            score_list.append(pd.Series(data=np.sum(np.dot(_arr[:, :, i], _w
gts), axis=1), index=[k for k in _site_list]).rank(ascending=False))

    scores = pd.DataFrame(score_list)

    # Plot as 10 histograms of distribution of scores
    flierprops = dict(marker='.', markerfacecolor='red', alpha=0.6,
markersize=6, markeredgecolor='none')
    bp = scores.boxplot(vert=0, flierprops=flierprops)
    plt.setp(bp['boxes'], color='red')
    plt.setp(bp['whiskers'],color='red')
    plt.setp(bp['fliers'],color='red')
    plt.tight_layout()
    plt.xlabel('Score')
    plt.title('Distribution of ' + _type + ' (' + _qualifiertext + ')')
    plt.savefig(r'results/' + _qualifiertext + r'_' + _type + '.png', transp
arent=True, dpi=1000)
    plt.show()

    return scores

basescores = plot_res('score', qualifier, results, N, wgts, site_list)
baseranks = plot_res('rank', qualifier, results, N, wgts, site_list)
```

```
/Users/Spencer/Distributions_et_al/anaconda/envs/pandahacks/lib/python2.7/s
packages/ipykernel/__main__.py:18: FutureWarning:
The default value for 'return_type' will change to 'axes' in a future relea
se.
 To use the future behavior now, set return_type='axes'.
 To keep the previous behavior and silence this warning, set return_type='d
ict'.
```





Incentives

In [27]:

```
# Set all of the (20, c1, 101) to "5" .. or 0 .. or 10?
results_uni = np.copy(results)
results_uni[:,0,:]=5
qualifier = 'Incentives'
```

Permitting

In [37]:

```
# Set all of the (20, c1, 101) to "5" .. or 0 .. or 10?
results_uni = np.copy(results)
results_uni[:,1,:]=5
qualifier = 'Permitting'
```

Substation

In [33]:

```
# Set all of the (20, c1, 101) to "5" .. or 0 .. or 10?
results_uni = np.copy(results)
results_uni[:,2,:]=5
qualifier = 'Substation'
```

Evironmental

In [35]:

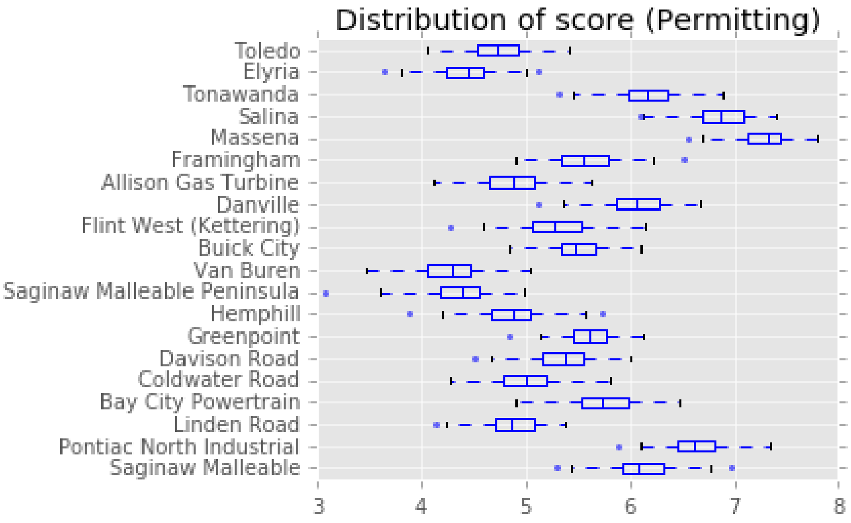
```
# Set all of the (20, c1, 101) to "5" .. or 0 .. or 10?
results_uni = np.copy(results)
results_uni[:,3,:]=5
qualifier = 'Environmental'
```

In [38]:

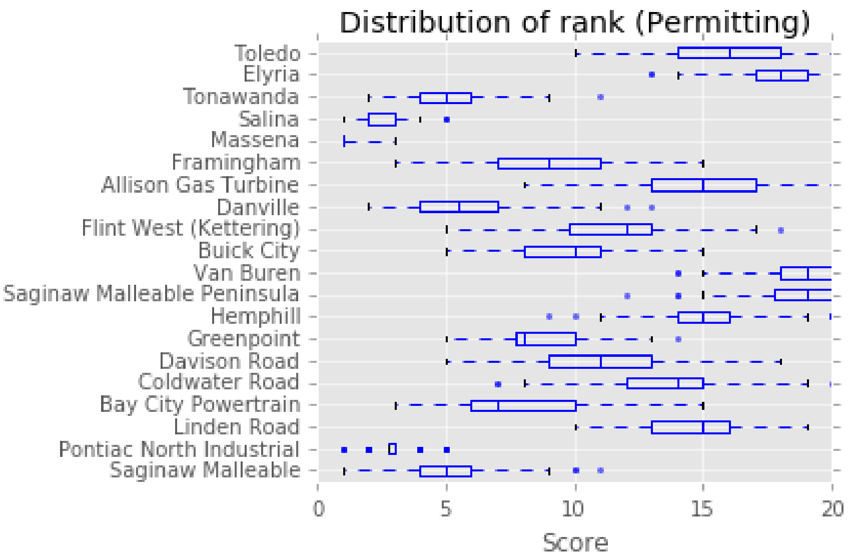
```
# Run one of the above criteria cells first
```

```python
def plot_res(_type, _qualifiertext, _arr, _n, _wgts, _site_list):
    # _type is 'score' or 'rank'
    score_list = []

    if _type == 'score':
        for i in range(0, _n):
            score_list.append(pd.Series(data=np.sum(np.dot(_arr[:, :, i], _wgts), axis=1), index=[k for k in _site_list]))
    if _type == 'rank':
        for i in range(0, _n):
            score_list.append(pd.Series(data=np.sum(np.dot(_arr[:, :, i], _wgts), axis=1), index=[k for k in _site_list]).rank(ascending=False))

    scores = pd.DataFrame(score_list)
    # Plot as 10 historgrams of distribution of scores
    flierprops = dict(marker='.', markerfacecolor='blue', alpha=0.6, markersize=6, markeredgecolor='none')
    bp = scores.boxplot(vert=0, flierprops=flierprops)
    plt.setp(bp['boxes'], color='blue')
    plt.setp(bp['whiskers'],color='blue')
    plt.setp(bp['fliers'],color='blue')
    plt.setp(bp['medians'], color='blue')
    plt.tight_layout()
    plt.xlabel('Score')
    plt.title('Distribution of ' + _type + ' (' + _qualifiertext + ')')
    plt.savefig(r'results/' + _qualifiertext + r'_' + _type + '.png', transparent=True, dpi=1000)
    plt.show()

    return scores

scores = plot_res('score', qualifier, results_uni, N, wgts, site_list)
ranks = plot_res('rank', qualifier, results_uni, N, wgts, site_list)
```

```
/Users/Spencer/Distributions_et_al/anaconda/envs/pandahacks/lib/python2.7/s
packages/ipykernel/__main__.py:15: FutureWarning:
The default value for 'return_type' will change to 'axes' in a future relea
se.
 To use the future behavior now, set return_type='axes'.
 To keep the previous behavior and silence this warning, set return_type='d
ict'.
```



Score



In [6]:

```
# Hierarchical index 0 is Base, 1 is Uniform on One Variable
df_ranks = pd.concat([baseranks, ranks], keys=[i for i in range(0,100)])
df_ranks.index = df_ranks.index.set_levels([['Original','Uniform
Incentives'],[i for i in range(0,100)]])
df_ranks = df_ranks.unstack(0); df_ranks
```

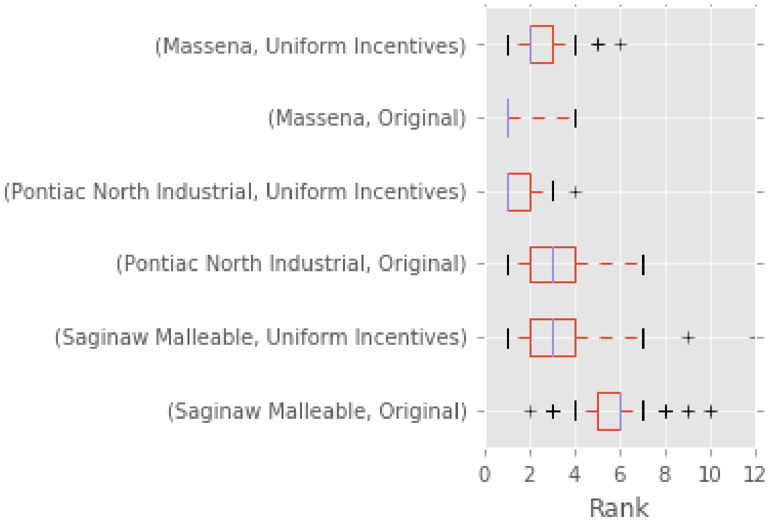
```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-6-6efd2221df98> in <module>()
      1 # Hierarchical index 0 is Base, 1 is Uniform on One Variable
----> 2 df_ranks = pd.concat([baseranks, ranks], keys=[i for i in range(0,10
0)])
      3 df_ranks.index = df_ranks.index.set_levels([['Original','Uniform
Incentives'],[i for i in range(0,100)]])
      4 df_ranks = df_ranks.unstack(0); df_ranks

NameError: name 'baseranks' is not defined
```

In [126]:

```
# Plotting Saginaw, Pontiac North, and Massena
df_ranks[['Saginaw Malleable','Pontiac North Industrial','Massena']].boxplo
t(vert=0)
plt.title('Ranking for Uniform Incentives')
plt.xlabel('Rank')
plt.tight_layout()
plt.savefig('Incentives_Plot1.pdf')
plt.show()
```

```
/home/spencer/Apps/anaconda2/lib/python2.7/site-
packages/ipykernel/__main__.py:2: FutureWarning:
The default value for 'return_type' will change to 'axes' in a future relea
se.
 To use the future behavior now, set return_type='axes'.
 To keep the previous behavior and silence this warning, set return_type='d
ict'.
  from ipykernel import kernelapp as app
```

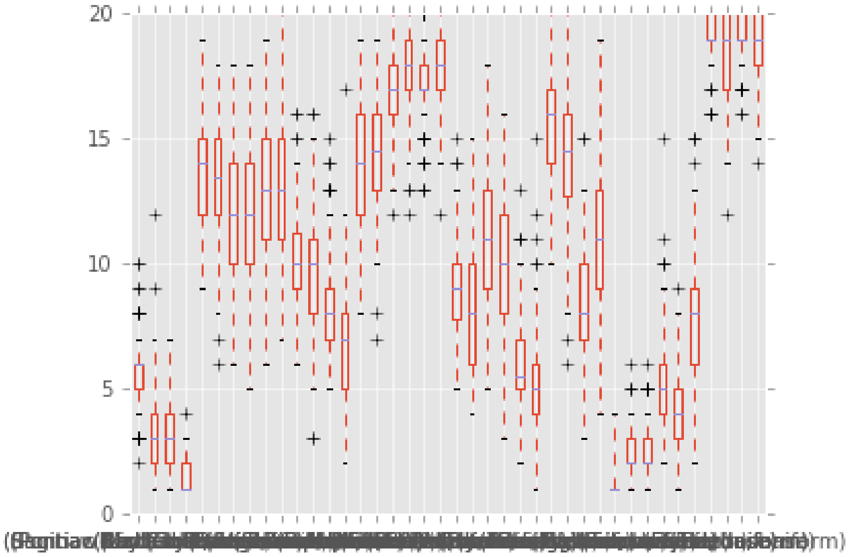
Ranking for Uniform Incentives



In [113]:

```
df_ranks.boxplot(); plt.show()
```

```
/home/spencer/Apps/anaconda2/lib/python2.7/site-
packages/ipykernel/__main__.py:1: FutureWarning:
The default value for 'return_type' will change to 'axes' in a future relea
se.
 To use the future behavior now, set return_type='axes'.
 To keep the previous behavior and silence this warning, set return_type='d
ict'.
  if __name__ == '__main__':
```



In [ ]: