Testing all four methods over parameters

December 17, 2018

1 Searching over parametergrid with Log-reg, SVM's, forests and MLP's

In [1]:
```
import numpy as np
import pandas as pd
import re
from sklearn.model_selection import train_test_split
import matplotlib
import matplotlib.pyplot as plt
from mpl_toolkits.axes_grid1 import make_axes_locatable
import random
from sklearn.metrics import r2_score, mean_squared_error, accuracy_score, log_loss
from sklearn import svm #support vector machines
from sklearn.feature_extraction.text import CountVectorizer

from sklearn.model_selection import cross_val_score
from sklearn.ensemble import RandomForestClassifier, VotingClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.neural_network import MLPClassifier

from sklearn.decomposition import PCA


from functions import *
```

```
C:\Users\Admin\Anaconda3\lib\site-packages\h5py\__init__.py:36: FutureWarning: Conversion of t
  from ._conv import register_converters as _register_converters
```

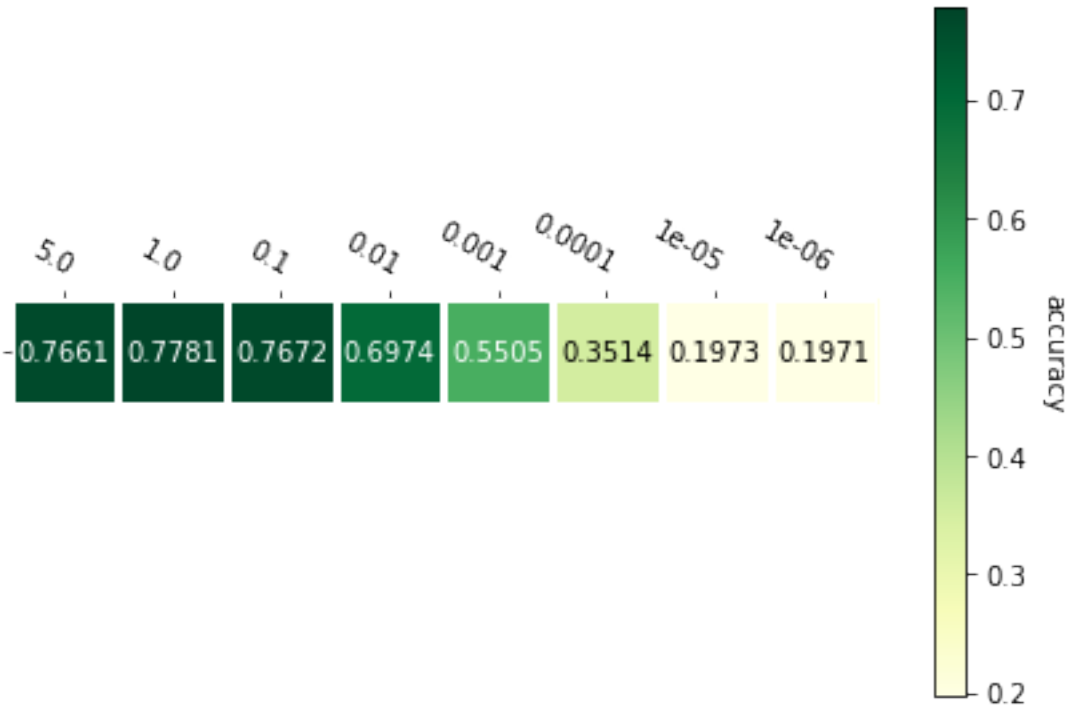
In [2]:
```
print("Importing design matrix ...")
X_train, y_train, features = get_design_matrix(cleaning_function = clean, min_df = 3)
print("Done.")
k = 3 # folds in the k-fold cross validation
plot = True # Set functions to plot heatmaps
```

```
Importing design matrix ...
Done.
```

2 Logistic regression

```
In [3]: # Setting up parameterlist
        log_p_list = [5, 1, .1, .01, .001, .0001, .00001, .000001]

        # k-fold cross validation over all parameteres and plotting
        print("Logistic regression: Cross validation over all parameters ...")
        log_scores = logistic_tester(X_train, y_train, C_list = log_p_list, folds = k, plot =
        print("Done.")
```

```
Logistic regression: Cross validation over all parameters ...
   p=
      q=5
      q=1
      q=0.1
      q=0.01
      q=0.001
      q=0.0001
      q=1e-05
      q=1e-06
```



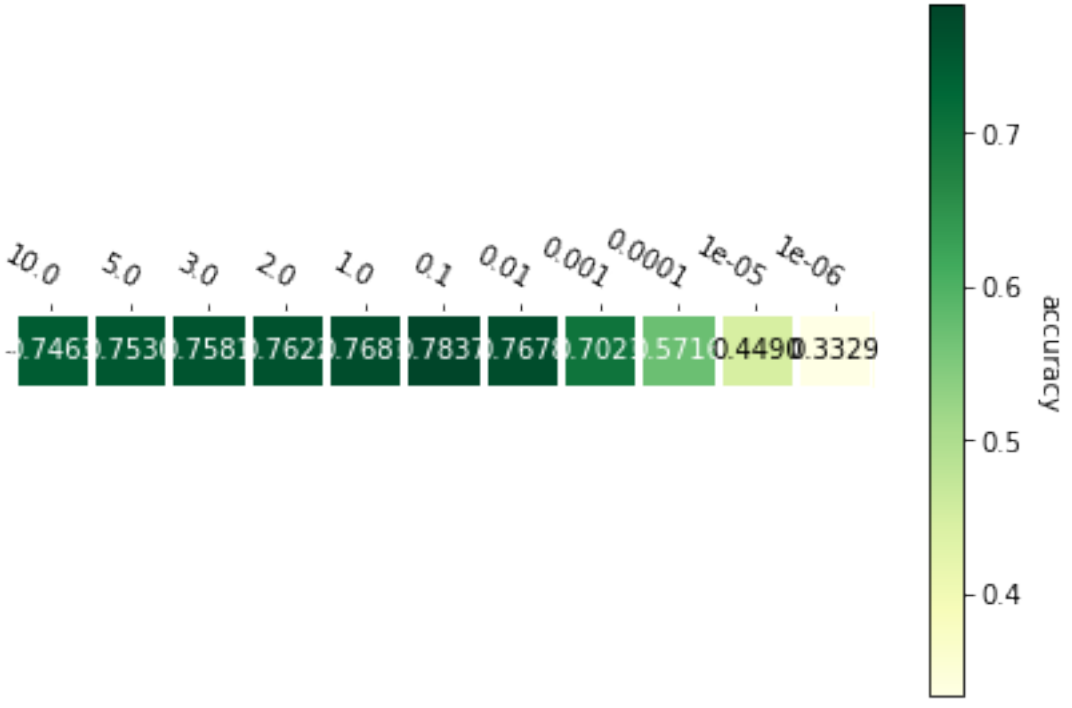

```
Done.
```

So we will continue with the regularization parameter set to 1.

3 Support vector machines

In [12]:
```
# Setting up parameterlist
svm_p_list = [10, 5, 3, 2, 1, .1, .01, .001, .0001, .00001, .000001]

# k-fold cross validation over all parameteres and plotting
print("Support vector machines: Cross validation over all parameters ...")
svm_scores = svm_tester(X_train, y_train, C_list = svm_p_list, folds = k, plot = plot)
print("Done.")
```

```
Support vector machines: Cross validation over all parameters ...
   p=
      q=10
      q=5
      q=3
      q=2
      q=1
      q=0.1
      q=0.01
      q=0.001
      q=0.0001
      q=1e-05
      q=1e-06
```



```
Done.
```

```
In [13]: print(svm_scores)
```

```
[[0.74629234 0.75295483 0.75813407 0.7621565  0.76869312 0.78365274
  0.76781258 0.70206656 0.57162994 0.44901306 0.33285615]]
```

So we will continue with margin parameter set to 0.1.

4 Random forests

```
In [6]: # Setting up parameterlist
        forest_trees_list = [10, 20, 30, 50, 100]
        forest_depth_list = [5, 10, 15, 30, 50, None]

        # k-fold cross validation over all parameteres and plotting
        print("Forest: Cross validation over all parameters ...")
        forest_scores = forrest_tester(
            X_train, y_train, trees_list = forest_trees_list, depth_list = forest_depth_list, r
        print("Done.")
```

```
Forest: Cross validation over all parameters ...
p=10
q=5
q=10
q=15
q=30
q=50
q=None
p=20
q=5
q=10
q=15
q=30
q=50
q=None
p=30
q=5
q=10
q=15
q=30
q=50
q=None
p=50
q=5
q=10
```

```
q=15
q=30
q=50
q=None
p=100
q=5
q=10
q=15
q=30
q=50
q=None
```


```
Done.
```

```
In [16]: # Setting up parameterlist
         forest_trees_list = [200, 300, 500, 700, 1000]
         forest_depth_list = [5, 10, 15, 30, 50, None]

         # k-fold cross validation over all parameteres and plotting
         print("Forest: Cross validation over all parameters ...")
         forest_scores = forrest_tester(
             X_train, y_train, trees_list = forest_trees_list, depth_list = forest_depth_list,
         print("Done.")
```

```
Forest: Cross validation over all parameters ...
   p=200
      q=5
      q=10
      q=15
      q=30
      q=50
      q=None
   p=300
      q=5
      q=10
      q=15
      q=30
      q=50
      q=None
   p=500
      q=5
      q=10
      q=15
      q=30
      q=50
      q=None
   p=700
      q=5
      q=10
      q=15
      q=30
      q=50
      q=None
   p=1000
      q=5
      q=10
      q=15
      q=30
      q=50
      q=None
```


```
Done.
```

So we will continue with unlimited tree depth and 1000 trees in the forest. (PS: Takes a long time to train)

5 Multilayered perceptrons

```
In [3]: # Setting up parameterlist
        net_nodes_list = [(10), (10,10), (20,20), (30,30), (40,40), (50,50)]
        net_alpha_list = [.00001, .0001, .001, .01, .1, 1]

        # k-fold cross validation over all parameteres and plotting
        print("Neural networks: Cross validation over all parameters ...")
        mlp_scores = mlp_tester(
            X_train, y_train, nodes = net_nodes_list, alpha_list = net_alpha_list, folds = k, p

        print("Done.")
```

```
Neural networks: Cross validation over all parameters ...
   p=10
      q=1e-05
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
    q=0.0001
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
    q=0.001
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
    q=0.01
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
    q=0.1
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=1

/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(10, 10)
      q=1e-05

/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001

/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001

/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01

/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(20, 20)
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(30, 30)
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

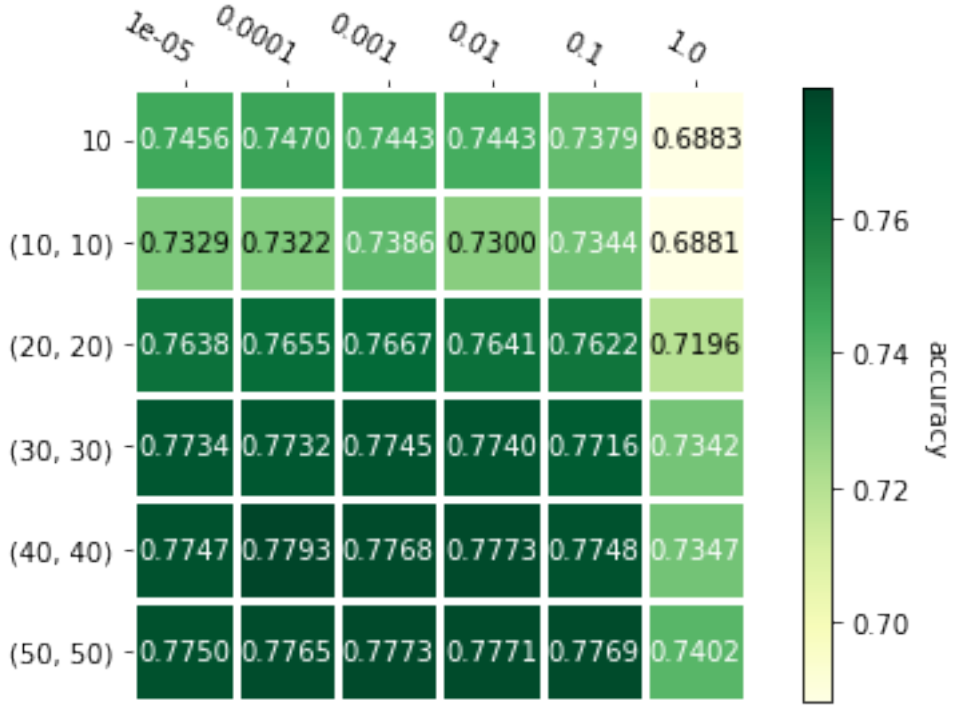
```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(40, 40)
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(50, 50)
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


Done.


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

In [5]:
```
# Plotting needs some special treatment because one of the axis are tuples in this cas
p_list = [str(n) for n in net_nodes_list]
q_list = net_alpha_list
scores_array = mlp_scores

fig, ax = plt.subplots()
im, cbar = heatmap(scores_array, np.array(p_list), np.array(q_list) , ax = ax, cmap =
texts = annotate_heatmap(im, valfmt="{x:.4f}")
fig.tight_layout()
plt.show()
```



In [4]:
```
# Setting up parameterlist
net_nodes_list = [(1500), (750, 750), (500,500,500), (375,375,375,375), (300,300,300,3
net_alpha_list = [.00001, .0001, .001, .01, .1]

# k-fold cross validation over all parameteres and plotting
print("Neural networks: Cross validation over all parameters ...")
mlp_scores2 = mlp_tester(
    X_train, y_train, nodes = net_nodes_list, alpha_list = net_alpha_list, folds = k, p
print("Done.")

# Plotting needs some special treatment because one of the axis are tuples in this cas
p_list = [str(n) for n in net_nodes_list]
q_list = net_alpha_list
```

```
        scores_array = mlp_scores2

        fig, ax = plt.subplots()
        im, cbar = heatmap(scores_array, np.array(p_list), np.array(q_list) , ax = ax, cmap = '
        texts = annotate_heatmap(im, valfmt="{x:.4f}")
        fig.tight_layout()
        plt.show()

Neural networks: Cross validation over all parameters ...
   p=1500
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
```

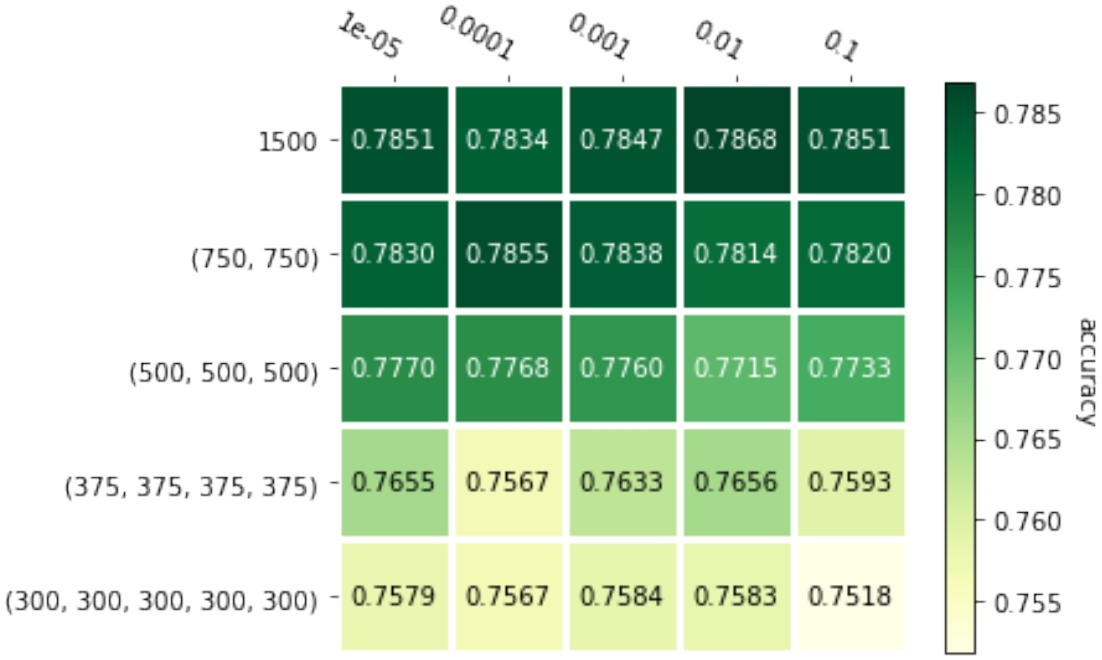
```
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(750, 750)
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(500, 500, 500)
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(375, 375, 375, 375)
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=(300, 300, 300, 300, 300)
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


Done.
```



In [3]:
```
# Setting up parameterlist
net_nodes_list = [(900), (1000), (1100), (1200), (1300), (1400), (1500), (1600), (1700)
net_alpha_list = [.00001, .0001, .001, .01, .1]

# k-fold cross validation over all parameteres and plotting
print("Neural networks: Cross validation over all parameters ...")
mlp_scores2 = mlp_tester(
    X_train, y_train, nodes = net_nodes_list, alpha_list = net_alpha_list, folds = k, p
print("Done.")

# Plotting needs some special treatment because one of the axis are tuples in this cas
p_list = [str(n) for n in net_nodes_list]
q_list = net_alpha_list
scores_array = mlp_scores2

fig, ax = plt.subplots()
im, cbar = heatmap(scores_array, np.array(p_list), np.array(q_list) , ax = ax, cmap =
texts = annotate_heatmap(im, valfmt="{x:.4f}")
fig.tight_layout()
plt.show()
```

```
Neural networks: Cross validation over all parameters ...
   p=900
      q=1e-05
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
    q=0.0001
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
    q=0.001
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
    q=0.01
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
    q=0.1
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
   p=1000
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=1100
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=1200
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=1300
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

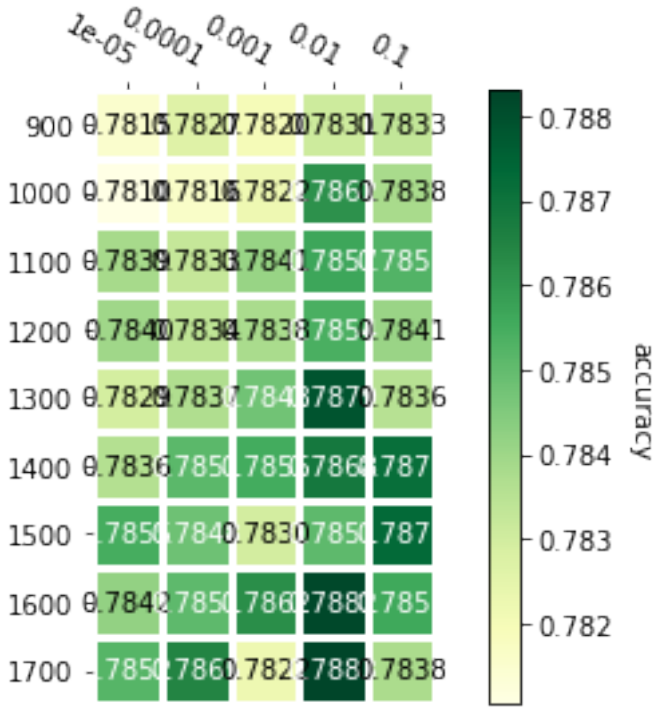
```
      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=1400
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=1500
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=1600
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


   p=1700
      q=1e-05


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
```

```
      q=0.0001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.001


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.01


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


      q=0.1


/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)
/home/jeanpylon/anaconda3/lib/python3.6/site-packages/sklearn/neural_network/multilayer_percept
  % self.max_iter, ConvergenceWarning)


Done.
```




```
In [4]: print(scores_array)
```

```
[[0.78154103 0.78267256 0.78199324 0.78310055 0.78332669]
 [0.78103846 0.78164221 0.78222034 0.78616682 0.78382918]
 [0.78385464 0.78327624 0.78410562 0.78568937 0.78528798]
 [0.78398004 0.78337646 0.78380405 0.78543754 0.78408112]
 [0.78294928 0.7837029  0.78475982 0.78790226 0.78355222]
 [0.78360279 0.78513618 0.78553889 0.78684586 0.78714722]
 [0.78548867 0.78483555 0.78297442 0.78508694 0.78729845]
 [0.7842061  0.78508635 0.78624259 0.78820385 0.78561346]
 [0.78521217 0.78646878 0.7822202  0.78830423 0.78377868]]
```

so we proceed with alpha=.01 and 1700 nodes, perhaps

6 Voting classifiers

6.1 Setting up the voting classifier

First we set up the basic classifiers with their optimal parameters

```
In [3]: logistic_clf = LogisticRegression(solver='lbfgs', multi_class='multinomial', C = 1)
        forrest_clf = RandomForestClassifier(n_estimators = 100, max_depth = None)
        mlp_clf = MLPClassifier(hidden_layer_sizes = (1000), alpha = 0.01, max_iter = 10)
        svm_clf = svm.LinearSVC(C = 0.1)
```

```
In [4]: #### We will ignore warnings from here on out
        # Voting classifiers allways throws a warning,
        # and since we have set max_iter = 10,
        # we will also get a warning whenever we try to fit the mlp_clf.
        import warnings
        warnings.simplefilter('ignore')
```

6.2 Trying different voting patterns

Now we go through combinations and voting styles. First we look at two classifiers voting. Here it only makes sense to use soft voting.

```
In [5]: voting_lf_soft = VotingClassifier(estimators=[('logistic', logistic_clf), ('forrest', f
        print("Cross validation for soft voting with logistic and forrest.")
        score_lf_soft = np.mean(cross_val_score(voting_lf_soft, X_train, y_train, cv=3))
        print("The expected accuracy is %f" % score_lf_soft)
```

```
Cross validation for soft voting with logistic and forrest.
The expected accuracy is 0.793308
```

```
In [6]: voting_lmlp_soft = VotingClassifier(estimators=[('logistic', logistic_clf), ('mlp', mlp
        print("Cross validation for soft voting with logistic and mlp.")
        score_lmlp_soft = np.mean(cross_val_score(voting_lmlp_soft, X_train, y_train, cv=3))
        print("The expected accuracy is %f" % score_lmlp_soft)
```

```
Cross validation for soft voting with logistic and mlp.
The expected accuracy is 0.785866
```

```
In [7]: voting_fmlp_soft = VotingClassifier(estimators=[('forrest', forrest_clf), ('mlp', mlp_c
        print("Cross validation for soft voting with forrest and mlp.")
        score_fmlp_soft = np.mean(cross_val_score(voting_fmlp_soft, X_train, y_train, cv=3))
        print("The expected accuracy is %f" % score_fmlp_soft)
```

```
Cross validation for soft voting with forrest and mlp.
The expected accuracy is 0.798361
```

Then we try soft voting with all the probabalistic classifiers.

```
In [8]: voting_all_soft = VotingClassifier(estimators=[('forrest', forrest_clf), ('mlp', mlp_cl
        print("Cross validation for soft voting with forrest, mlp, and logistic.")
        score_all_soft = np.mean(cross_val_score(voting_all_soft, X_train, y_train, cv=3))
        print("The expected accuracy is %f" % score_all_soft)
```

```
Cross validation for soft voting with forrest, mlp, and logistic.
The expected accuracy is 0.796149
```

Then we try hard voting, using mlp, forrest and svm

```
In [9]: voting_hard = VotingClassifier(estimators=[('svm', svm_clf), ('forrest', forrest_clf),
        print("Cross validation for hard voting with svm and forrests and mlp.")
        score_hard = np.mean(cross_val_score(voting_hard, X_train, y_train, cv=3))
        print("The expected accuracy is %f" % score_hard)
```

```
Cross validation for hard voting with svm and forrests and mlp.
The expected accuracy is 0.798084
```

We also try hard voting using all four methods

```
In [10]: voting_hard_4 = VotingClassifier(estimators=[('svm', svm_clf), ('logistic', logistic_
         print("Cross validation for hard voting with svm, logistic, forrests, and mlp.")
         score_hard_4 = np.mean(cross_val_score(voting_hard_4, X_train, y_train, cv=3))
         print("The expected accuracy is %f" % score_hard_4)
```

```
Cross validation for hard voting with svm, logistic, forrests, and mlp.
The expected accuracy is 0.790843
```

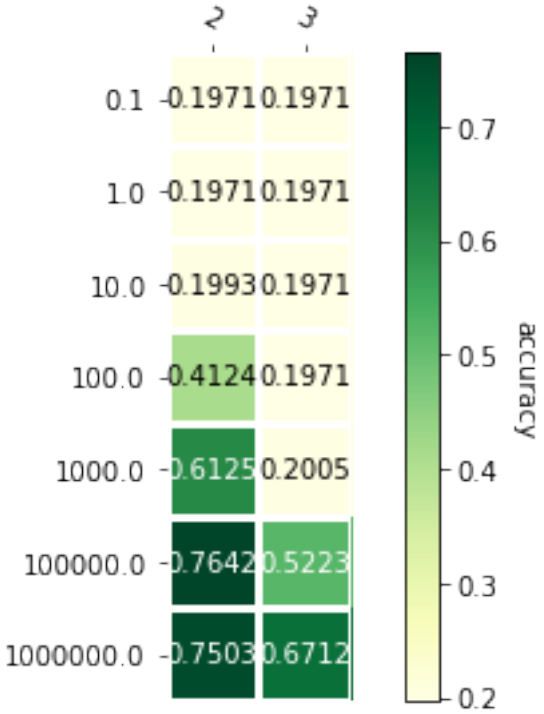
7 SVM Kernels

Now we look at two svm kernels: Poly and rbf.

```
In [12]: def poly_svm_tester(X_train, y_train, C_list = [0.1], degrees = [2], folds = 10, plot
             """
             Test the svm parameter C and the degree of the poly kernel
             using cross validation

             If plot is set to true, show a heatmap of the results
             """

             svm_constructor = (lambda p,q : svm.SVC(kernel = 'poly', C = p, degree = q))
             scores = clf_cross_validator(X_train, y_train, svm_constructor, C_list, degrees, 
             return scores

         poly_svm_tester(X_train, y_train, C_list = [0.1, 1, 10, 100, 1000, 100000, 1000000], 
```

```
p=0.1
   q=2
   q=3
p=1
   q=2
   q=3
p=10
   q=2
```

```
    q=3
p=100
    q=2
    q=3
p=1000
    q=2
    q=3
p=100000
    q=2
    q=3
p=1000000
    q=2
    q=3
```

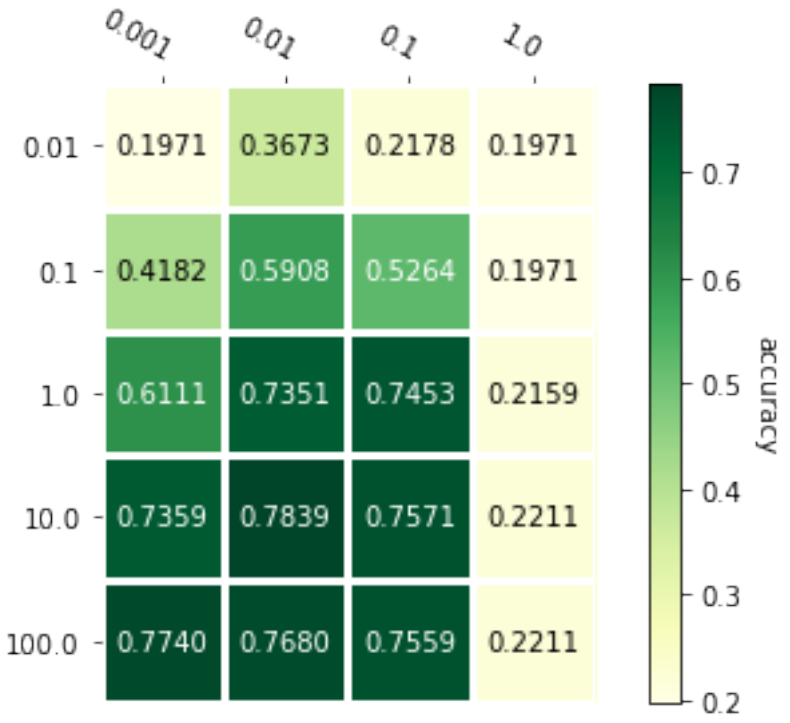



```
Out[12]: array([[0.19706342, 0.19706342],
                [0.19706342, 0.19706342],
                [0.19932623, 0.19706342],
                [0.4123805 , 0.19706342],
                [0.61248489, 0.20045765],
                [0.76421728, 0.52227571],
                [0.75028845, 0.67121641]])
```

```
In [3]: def rbf_svm_tester(X_train, y_train, C_list = [0.1], gamma_list = [0.1], folds = 10, pl
            """
```

```
        Test the svm parameters C and gamma of svm with rbf kernel
        using cross validation

        If plot is set to true, show a heatmap of the results
        """

        svm_constructor = (lambda p,q : svm.SVC(kernel = 'rbf', C = p, gamma = q))
        scores = clf_cross_validator(X_train, y_train, svm_constructor, C_list, gamma_list
        return scores

    rbf_svm_tester(X_train, y_train, C_list = [0.01, 0.1,1, 10, 100], gamma_list = [0.001,
```

```
p=0.01
   q=0.001
   q=0.01
   q=0.1
   q=1
p=0.1
   q=0.001
   q=0.01
   q=0.1
   q=1
p=1
   q=0.001
   q=0.01
   q=0.1
   q=1
p=10
   q=0.001
   q=0.01
   q=0.1
   q=1
p=100
   q=0.001
   q=0.01
   q=0.1
   q=1
```



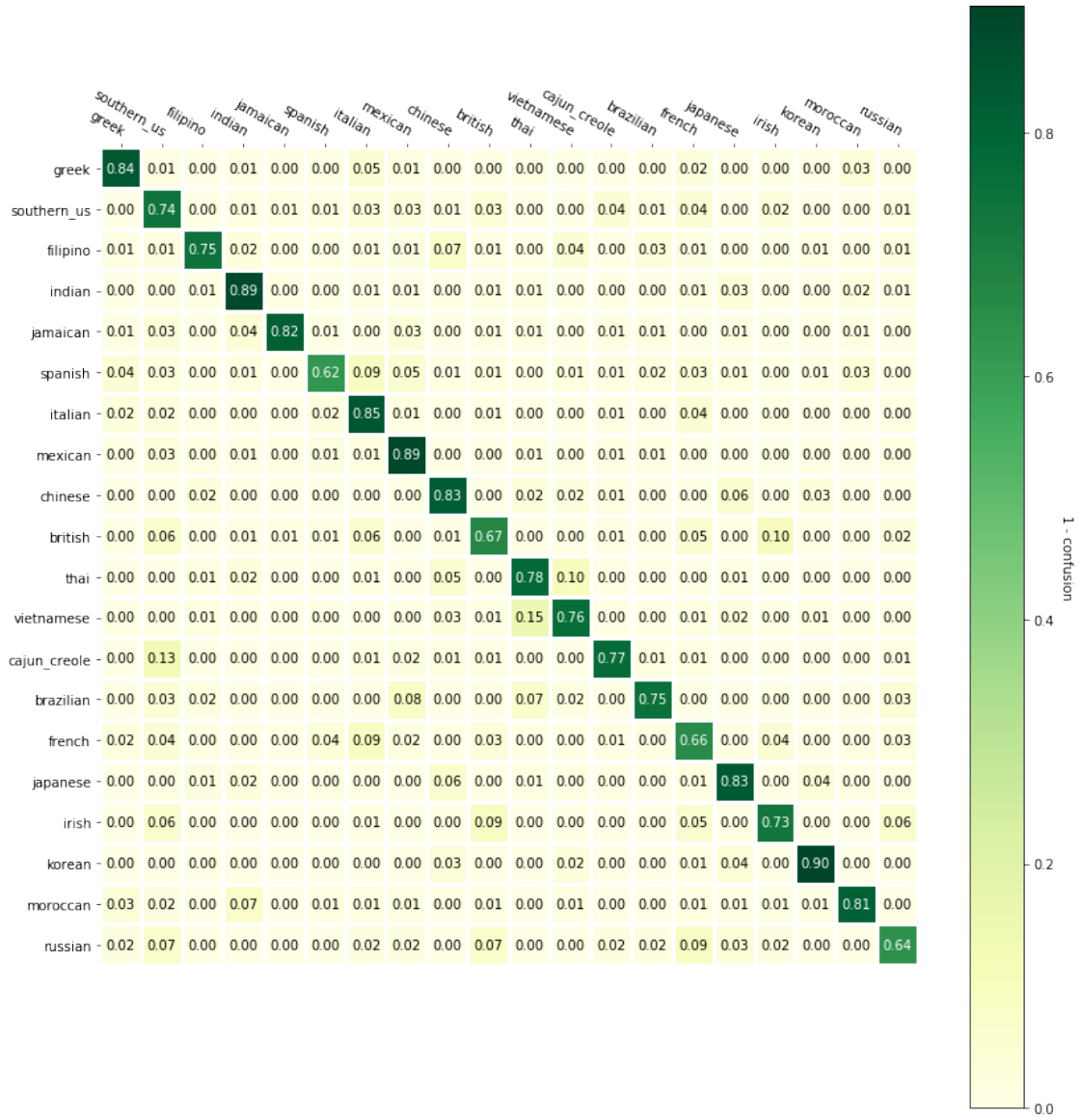

```
Out[3]: array([[0.19706342, 0.36730029, 0.21778012, 0.19706342],
               [0.41816275, 0.59083871, 0.52642476, 0.19706342],
               [0.61107811, 0.73507861, 0.74531125, 0.21594517],
               [0.73593335, 0.78387868, 0.75707763, 0.22109935],
               [0.77397349, 0.76796342, 0.75592098, 0.22109935]])
```

7.1 Confusion matrix

```
In [4]: x_train, x_test, y, y_test = train_test_split(X_train, y_train, test_size = 0.2)

        # The set of different cuisines
        data = pd.read_json('train.json')
        cuisines = data.cuisine.unique()

        logistic_clf = LogisticRegression(solver='lbfgs', multi_class='multinomial', C = 1)
        forrest_clf = RandomForestClassifier(n_estimators = 100, max_depth = None)
        mlp_clf = MLPClassifier(hidden_layer_sizes = (1000), alpha = 0.01, max_iter = 10)
        clf = VotingClassifier(estimators=[('forrest', forrest_clf), ('mlp', mlp_clf), ('logist
                                           voting='soft')
        clf_confusion(clf, x_train, y, x_test, y_test, cuisines, size = (12,12), normalize = '
```

```
C:\Users\Admin\Anaconda3\lib\site-packages\sklearn\neural_network\multilayer_perceptron.py:564
  % self.max_iter, ConvergenceWarning)
C:\Users\Admin\Anaconda3\lib\site-packages\sklearn\preprocessing\label.py:151: DeprecationWarni
```

```
if diff:
```



7.2 PCA test for svm

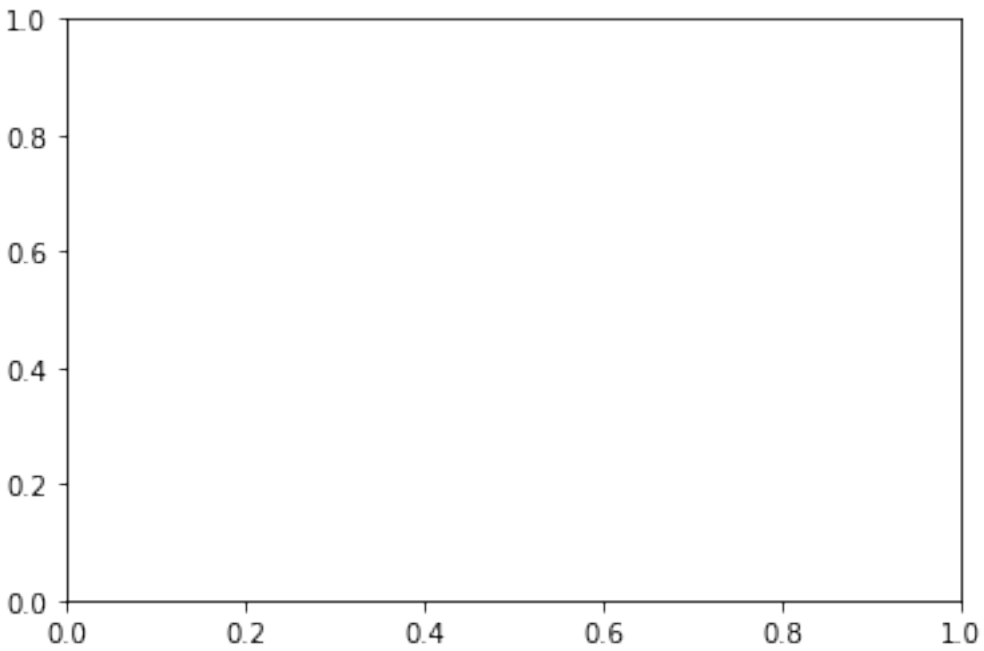
```
In [9]: svm_clf = svm.LinearSVC()

        scores = []

        pca_sizes = [500, 1000, 1500, 1800,2000]
        C_list = [0.01, 0.1, 1]
```

```
        X_array = X_train.toarray()

        for n in pca_sizes :
            print("Testing pca with %d components." % n)
            pca = PCA(n_components = n)
            pca.fit(X_array)
            pca_X = pca.transform(X_array)
            for C in C_list :
                print("    Testing C = %f" % C)
                svm_clf = svm.LinearSVC(C = C)
                score = np.mean(cross_val_score(svm_clf, pca_X, y_train, cv=3))
                scores.append(score)
                print("      Score: %f" % score)
            print("")

        # transform the scores to a len(pca_sizes) x len(X_list) shape array
        scores_array = np.array(scores).reshape(len(pca_sizes), len(C_list))

        # make heat map
        fig, ax = plt.subplots()
        im, cbar = heatmap(scores_array, np.array(pca_sizes), np.array(C_list) , ax = ax, cmap
        texts = annotate_heatmap(im, valfmt="{x:.4f}")
        fig.tight_layout()
        plt.show()
```

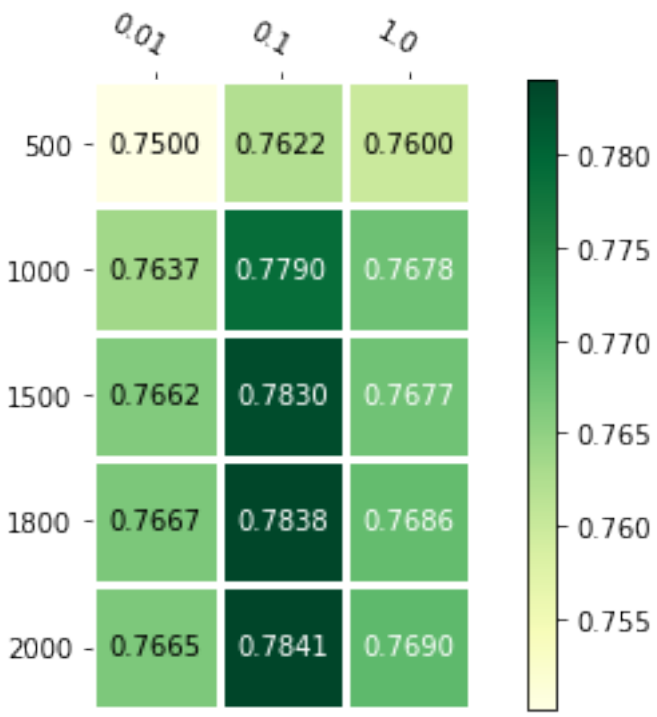
```
Testing pca with 500 components.
    Testing C = 0.010000
      Score: 0.750037
    Testing C = 0.100000
      Score: 0.762181
    Testing C = 1.000000
      Score: 0.759994

Testing pca with 1000 components.
    Testing C = 0.010000
      Score: 0.763689
    Testing C = 0.100000
      Score: 0.778976
    Testing C = 1.000000
      Score: 0.767839

Testing pca with 1500 components.
    Testing C = 0.010000
      Score: 0.766229
    Testing C = 0.100000
      Score: 0.782999
    Testing C = 1.000000
      Score: 0.767688
```

```
Testing pca with 1800 components.
    Testing C = 0.010000
      Score: 0.766706
    Testing C = 0.100000
      Score: 0.783803
    Testing C = 1.000000
      Score: 0.768618

Testing pca with 2000 components.
    Testing C = 0.010000
      Score: 0.766530
    Testing C = 0.100000
      Score: 0.784055
    Testing C = 1.000000
      Score: 0.769020
```

```
NameError                                 Traceback (most recent call last)

<ipython-input-9-ee4bb6a00412> in <module>()
 26 # make heat map
 27 fig, ax = plt.subplots()
---> 28 im, cbar = heatmap(scores_array, np.array(pca_sizes), np.array(C_list) , ax = ax, c
 29 texts = annotate_heatmap(im, valfmt="{x:.4f}")
 30 fig.tight_layout()


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



In [10]:
```
# make heat map
fig, ax = plt.subplots()
im, cbar = heatmap(scores_array, np.array(pca_sizes), np.array(C_list) , ax = ax, cma
texts = annotate_heatmap(im, valfmt="{x:.4f}")
fig.tight_layout()

plt.show()
```



In [ ]:
```
# Use 2-dim pca
two_dim_pca = PCA(n_components = 2)
two_dim_pca.fit(X_train)

# random list of 20 colors for plotting
color_list = ['#'+''.join([random.choice('0123456789ABCDEF') for j in range(6)]) for _
cusinine_to_int = {}
x_pca = two_dim_pca.transform(x_train)
colors =[color_list[i] for i in y_train]
```