archeological site prediction

May 7, 2018

1 Archeological Site Prediction

```
This notebook predicts the locations of archeological sites
in the neolithic era using different types of machine
learning models, mostly classification models
```

1.1 Import data on site, nonsite, and prediction csvs

may need to drop a few columns

```
In [1]: from randomSiteSampling import randomSamplingFromDF

In [2]: import numpy as np
        import pandas as pd
        import sklearn as ml
        import matplotlib
        %matplotlib inline

        import pprint
        pp = pprint.PrettyPrinter(indent=4).pprint

        """
        Importing data
        """
        raw_site_file = 'common_sites_V3.csv'
        raw_pred_file = 'ireland_sites_V3.csv'

        raw_site_df = pd.read_csv(raw_site_file, low_memory=False, error_bad_lines=False, encodi
        raw_pred_df = pd.read_csv(raw_pred_file, low_memory=False, error_bad_lines=False, encodi

        site_df = raw_site_df.copy()
        nonsite_df, pred_df = randomSamplingFromDF(raw_site_df, raw_pred_df)

        ireland_site_df = site_df.where(site_df['country'] == 'Ireland')

        """
        Making sure all dataframes have the same columns
```

```
    We do this by finding all the columns which are
    not shared between all dataframes. We then keep
    only the columns common to all the dataframes
    """
    site_attr     = set(site_df)
    nonsite_attr  = set(nonsite_df)
    pred_attr     = set(pred_df)

    common_attr   = site_attr & nonsite_attr & pred_attr
    uncommon_attr = (site_attr | nonsite_attr | pred_attr) - common_attr

    # create list of columns to drop
    drop_site     = site_attr    & uncommon_attr
    drop_nonsite  = nonsite_attr & uncommon_attr
    drop_pred     = pred_attr    & uncommon_attr

    # drop columns
    site_df       = site_df.drop(columns=drop_site)
    nonsite_df    = nonsite_df.drop(columns=drop_nonsite)
    pred_df       = pred_df.drop(columns=drop_pred)

    """
    Take care of na values by propogating values forward then backward
    """
    site_df       = site_df.fillna   (method='ffill').fillna(method='bfill')
    nonsite_df    = nonsite_df.fillna(method='ffill').fillna(method='bfill')
    pred_df       = pred_df.fillna   (method='ffill').fillna(method='bfill')
```

2 Combining our site and nonsite data

```
In [3]: site_df['site'] = 1
        nonsite_df['site'] = 0
        data = pd.concat([site_df, nonsite_df])

        target = data['site']
        data = data.drop(columns=['site'])
```

3 Splitting the Data into Training and Test Sets

```
In [4]: from sklearn.model_selection import train_test_split

        train_size=0.7

        train_data, test_data, train_target, test_target = train_test_split(data, target, train_

/Users/WillC/miniconda2/envs/ML/lib/python2.7/site-packages/sklearn/model_selection/_split.py:20
  FutureWarning)
```

4 Train using Different Models

1. SVC Model (Linear kernel)

2. K-Neighbors Classifier

4. Decision Forest Classifier

4. Random Forest Classifier

5. Gradient Boosting Classifier

6. Ada Boosting Classifier

4.0.1 The 'predictions' dataframe will be used to store the results of the following training models

In [5]:
```
predictions = pred_df.copy(deep=True)
```

In [6]:
```
from plotPredicted import plotPredictedFromDF
```

4.1 1. Linear SVC Model

Training the Linear SVC Model

In [7]:
```
from sklearn import svm

SVCModel = svm.SVC(kernel='linear', C=.5)
SVCModel.fit(train_data, train_target)
```

Out[7]:
```
SVC(C=0.5, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='linear',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
```

Testing the Linear SVC Model

In [8]:
```
from sklearn import metrics

model = SVCModel
"""
Fit the training data
and observe the metrics
"""
preds = model.predict(train_data)
```

```
        targs = train_target
        args = (targs, preds)
        print "Training Data"
        print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
        print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
        print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
        print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")

        """
        Fit the test data
        and observe the metrics
        """
        preds = model.predict(test_data)
        targs = test_target
        args = (targs, preds)
        print "\n"
        print "Test Data"
        print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
        print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
        print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
        print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")
```

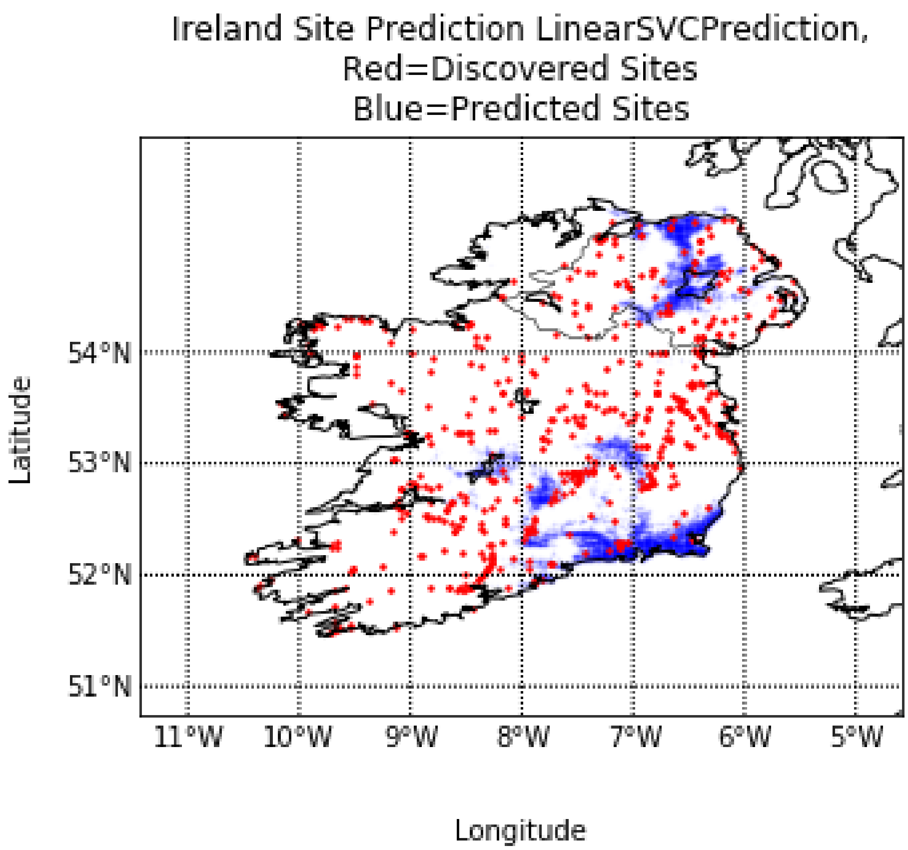
```
Training Data
accuracy  : 84.713%
precision : 93.526%
recall    : 75.046%
f1        : 83.273%


Test Data
accuracy  : 83.991%
precision : 90.859%
recall    : 74.376%
f1        : 81.796%
```

Linear SVC Prediction

```
In [43]: model_name = 'LinearSVCPrediction'
         predictions[model_name] = SVCModel.predict(pred_df)

         site_exists = predictions[predictions[model_name] == 1]
         site_nexists = predictions[predictions[model_name] != 1]
         num_site_exists = site_exists[model_name].count()
         num_site_nexists = site_nexists[model_name].count()

         print 'Sites exists         : %d ' % (num_site_exists)
         print 'Sites does not exists: %d ' % (num_site_nexists)
```

```
print 'Percentage of sites predicted having an archeological site: %.3f%s' % \
(100.0*float(num_site_exists)/float(num_site_exists+num_site_nexists), '%')

# plot the map
plotPredictedFromDF(raw_site_df,
                    predictions,
                    model_name=model_name,
                    country='Ireland',
                    resolution='i',
                    alpha_predicted=.01)
```

```
Sites exists         : 40491
Sites does not exists: 618446
Percentage of sites predicted having an archeological site: 6.145%
```



4.2 2. K-Neighbors Classifier

Training the K-Neighbors Classifier Model

```
In [21]: from sklearn import neighbors

         n_neighbors=20
         KNeighborsModel = neighbors.KNeighborsClassifier(n_neighbors=n_neighbors)
         KNeighborsModel.fit(train_data, train_target)
```

```
Out[21]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                    metric_params=None, n_jobs=1, n_neighbors=20, p=2,
                    weights='uniform')
```

Testing the K-Neighbors Classifier Model

```
In [22]: from sklearn import metrics

         model = KNeighborsModel
         """
         Fit the training data
         and observe the metrics
         """
         preds = model.predict(train_data)
         targs = train_target
         args = (targs, preds)
         print "Training Data"
         print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
         print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
         print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
         print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")

         """
         Fit the test data
         and observe the metrics
         """
         preds = model.predict(test_data)
         targs = test_target
         args = (targs, preds)
         print "\n"
         print "Test Data"
         print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
         print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
         print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
         print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")
```

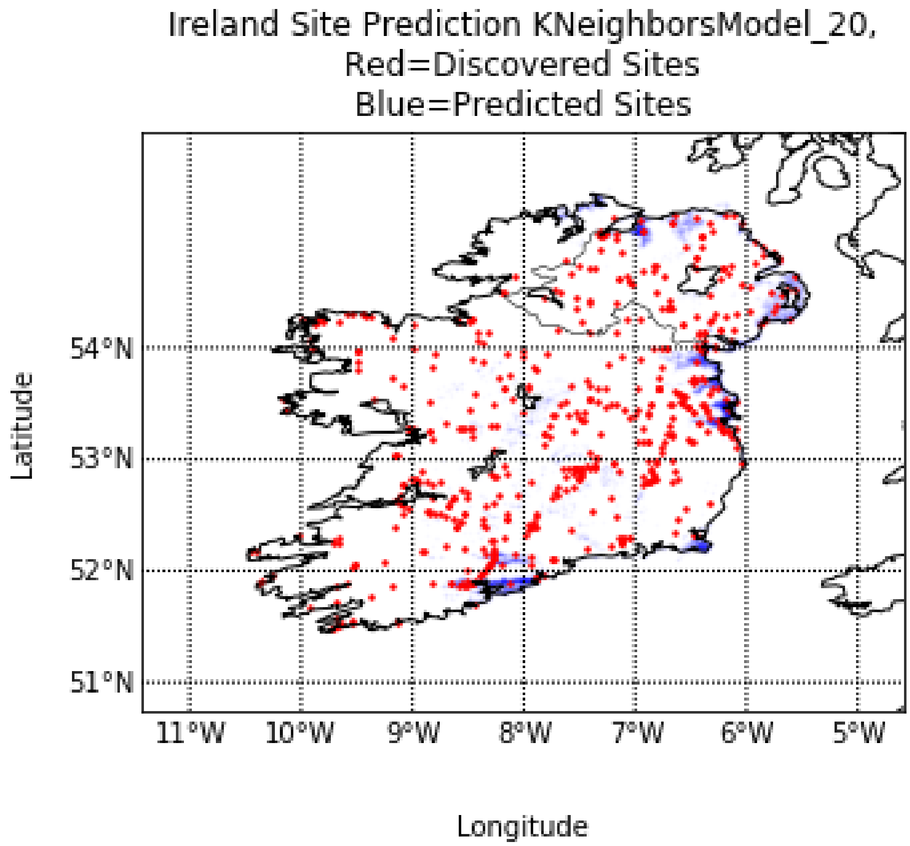
```
Training Data
accuracy  : 84.760%
precision : 97.243%
recall    : 71.985%
f1        : 82.729%
```

```
Test Data
accuracy  : 84.649%
precision : 96.308%
recall    : 70.975%
f1        : 81.723%
```

K-Neighbors Prediction

```
In [42]: model_name = 'KNeighborsModel_%d' % n_neighbors
         predictions[model_name] = KNeighborsModel.predict(pred_df)

         site_exists      = predictions[predictions[model_name] == 1]
         site_nexists     = predictions[predictions[model_name] != 1]
         num_site_exists  = site_exists[model_name].count()
         num_site_nexists = site_nexists[model_name].count()

         print 'Sites exists         : %d ' % (num_site_exists)
         print 'Sites does not exists: %d ' % (num_site_nexists)
         print 'Percentage of sites predicted having an archeological site'
         print 'Percentage of sites predicted having an archeological site: %.3f%s' % \
         (100.0*float(num_site_exists)/float(num_site_exists+num_site_nexists), '%')

         # plot the map
         plotPredictedFromDF(raw_site_df,
                             predictions,
                             model_name=model_name,
                             country='Ireland',
                             resolution='i',
                             alpha_predicted=.01)
```

```
Sites exists         : 15240
Sites does not exists: 643697
Percentage of sites predicted having an archeological site
Percentage of sites predicted having an archeological site: 2.313%
```



4.3 3. Decision Tree Classification

```
In [25]: from sklearn import tree

         DecisionTree = tree.DecisionTreeClassifier()
         DecisionTree.fit(train_data, train_target)

Out[25]: DecisionTreeClassifier(class_weight=None, criterion='gini', max_depth=None,
                     max_features=None, max_leaf_nodes=None,
                     min_impurity_decrease=0.0, min_impurity_split=None,
                     min_samples_leaf=1, min_samples_split=2,
                     min_weight_fraction_leaf=0.0, presort=False, random_state=None,
                     splitter='best')
```

Testing the Decision Tree Classifier Model

```
In [26]: from sklearn import metrics

         model = DecisionTree
         """
```

```
        Fit the training data
        and observe the metrics
        """
        preds = model.predict(train_data)
        targs = train_target
        args = (targs, preds)
        print "Training Data"
        print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
        print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
        print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
        print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")

        """
        Fit the test data
        and observe the metrics
        """
        preds = model.predict(test_data)
        targs = test_target
        args = (targs, preds)
        print "\n"
        print "Test Data"
        print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
        print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
        print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
        print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")
```

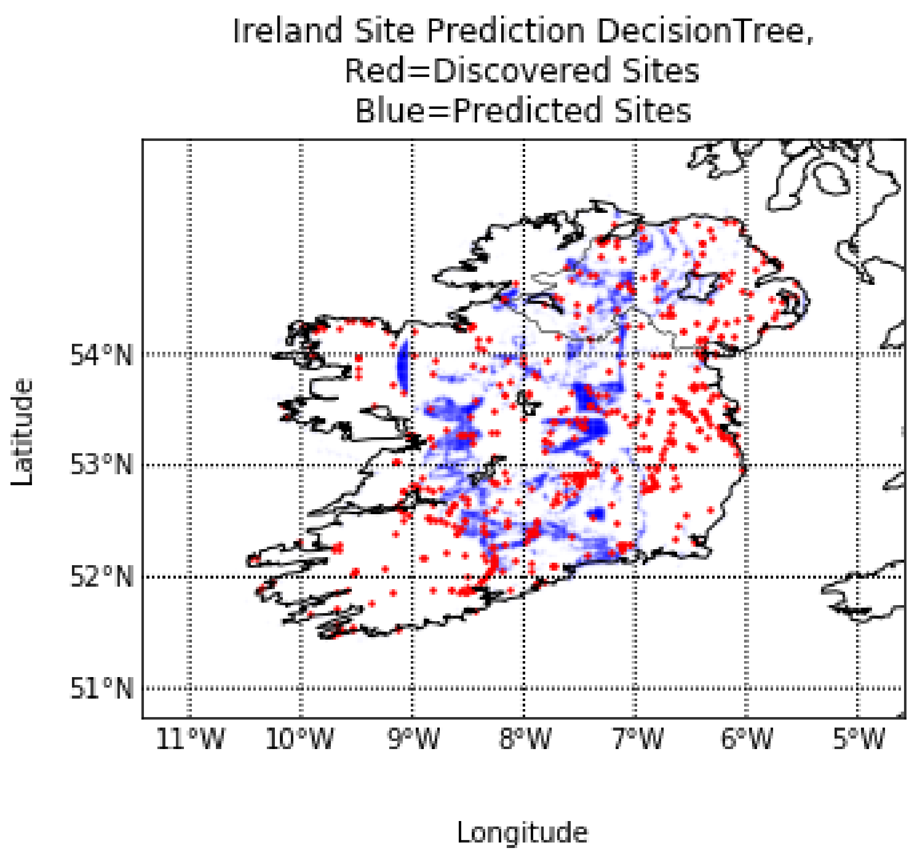
```
Training Data
accuracy  : 100.000%
precision : 100.000%
recall    : 100.000%
f1        : 100.000%


Test Data
accuracy  : 93.311%
precision : 92.411%
recall    : 93.878%
f1        : 93.138%
```

Decision Tree Prediction

```
In [38]: model_name = 'DecisionTree'
         predictions[model_name] = DecisionTree.predict(pred_df)

         site_exists     = predictions[predictions[model_name] == 1]
         site_nexists    = predictions[predictions[model_name] != 1]
         num_site_exists  = site_exists[model_name].count()
```

```python
num_site_nexists = site_nexists[model_name].count()

print 'Sites exists          : %d ' % (num_site_exists)
print 'Sites does not exists: %d ' % (num_site_nexists)
print 'Percentage of sites predicted having an archeological site'
print 'Percentage of sites predicted having an archeological site: %.3f%s' % \
(100.0*float(num_site_exists)/float(num_site_exists+num_site_nexists), '%')

# plot the map
plotPredictedFromDF(raw_site_df,
                    predictions,
                    model_name=model_name,
                    country='Ireland',
                    resolution='i',
                    alpha_predicted=.01)
```

```
Sites exists          : 51006
Sites does not exists: 607931
Percentage of sites predicted having an archeological site
Percentage of sites predicted having an archeological site: 7.741%
```



4.4 4. Random Forest Classification

In [28]:
```
from sklearn import ensemble

n_estimators=10
RandomForest = ensemble.RandomForestClassifier(n_estimators=10)
RandomForest.fit(train_data, train_target)
```

Out[28]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=10, n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
```

Testing the Random Forest Classifier Model

In [29]:
```
from sklearn import metrics

model = RandomForest
"""
Fit the training data
and observe the metrics
"""
preds = model.predict(train_data)
targs = train_target
args = (targs, preds)
print "Training Data"
print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")

"""
Fit the test data
and observe the metrics
"""
preds = model.predict(test_data)
targs = test_target
args = (targs, preds)
print "\n"
print "Test Data"
print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")
```

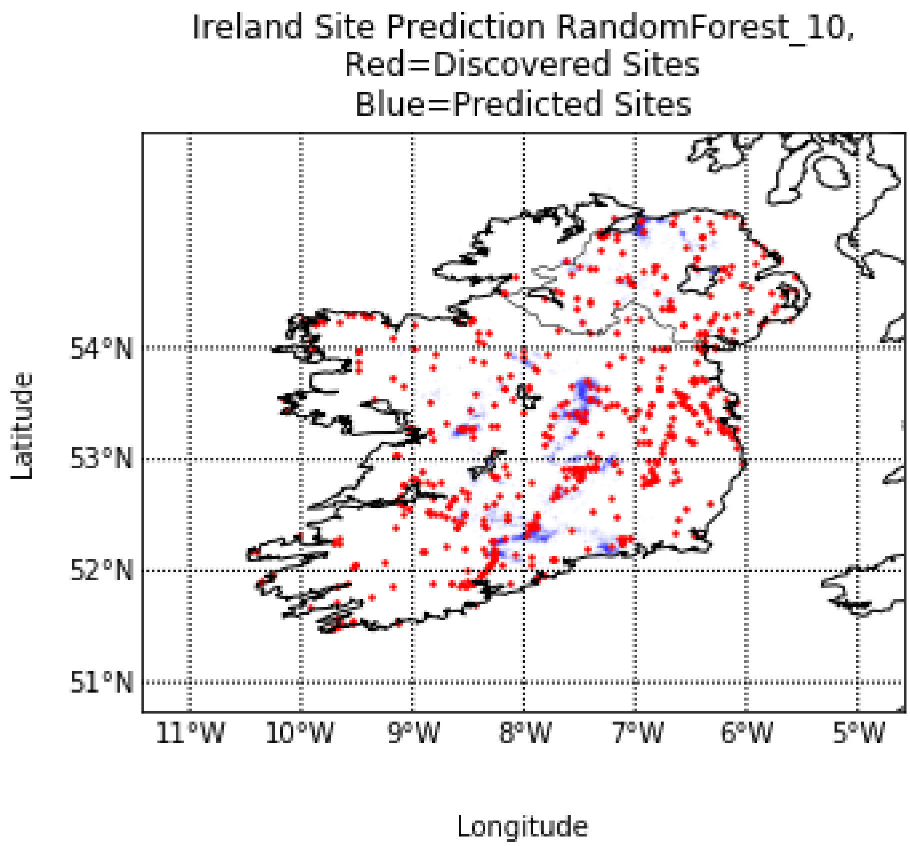
```
Training Data
accuracy  : 99.577%
```

```
precision : 100.000%
recall    : 99.165%
f1        : 99.581%


Test Data
accuracy  : 93.969%
precision : 98.010%
recall    : 89.342%
f1        : 93.476%
```

Random Forest Prediction

```
In [39]: model_name = 'RandomForest_%d' % (n_estimators)
         predictions[model_name] = RandomForest.predict(pred_df)

         site_exists       = predictions[predictions[model_name] == 1]
         site_nexists      = predictions[predictions[model_name] != 1]
         num_site_exists   = site_exists[model_name].count()
         num_site_nexists = site_nexists[model_name].count()

         print 'Sites exists         : %d ' % (num_site_exists)
         print 'Sites does not exists: %d ' % (num_site_nexists)
         print 'Percentage of sites predicted having an archeological site'
         print 'Percentage of sites predicted having an archeological site: %.3f%s' % \
         (100.0*float(num_site_exists)/float(num_site_exists+num_site_nexists), '%')

         # plot the map
         plotPredictedFromDF(raw_site_df,
                             predictions,
                             model_name=model_name,
                             country='Ireland',
                             resolution='i',
                             alpha_predicted=.01)
```

```
Sites exists         : 11342
Sites does not exists: 647595
Percentage of sites predicted having an archeological site
Percentage of sites predicted having an archeological site: 1.721%
```



4.5 5. Gradient Boosting Classification

```
In [31]: from sklearn import ensemble

         GradientBoosting = ensemble.GradientBoostingClassifier()
         GradientBoosting.fit(train_data, train_target)

Out[31]: GradientBoostingClassifier(criterion='friedman_mse', init=None,
                       learning_rate=0.1, loss='deviance', max_depth=3,
                       max_features=None, max_leaf_nodes=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=100,
                       presort='auto', random_state=None, subsample=1.0, verbose=0,
                       warm_start=False)
```

Testing the Gradient Boosting Classifier

```
In [32]: from sklearn import metrics
```

```
model = GradientBoosting
"""
Fit the training data
and observe the metrics
"""
preds = model.predict(train_data)
targs = train_target
args = (targs, preds)
print "Training Data"
print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")

"""
Fit the test data
and observe the metrics
"""
preds = model.predict(test_data)
targs = test_target
args = (targs, preds)
print "\n"
print "Test Data"
print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")
```

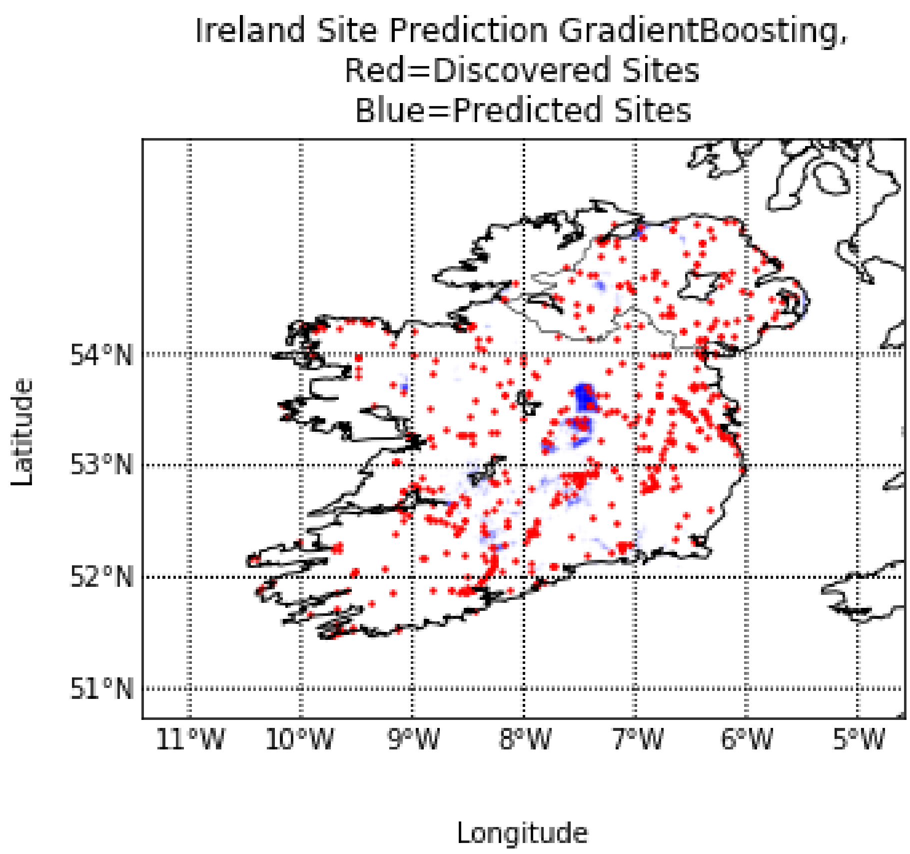
```
Training Data
accuracy  : 97.131%
precision : 100.000%
recall    : 94.341%
f1        : 97.088%


Test Data
accuracy  : 95.504%
precision : 98.780%
recall    : 91.837%
f1        : 95.182%
```

Gradient Boosting Classifier Prediction

In [40]:
```
model_name = 'GradientBoosting'
predictions[model_name] = GradientBoosting.predict(pred_df)

site_exists      = predictions[predictions[model_name] == 1]
```

```
site_nexists     = predictions[predictions[model_name] != 1]
num_site_exists  = site_exists[model_name].count()
num_site_nexists = site_nexists[model_name].count()

print 'Sites exists         : %d ' % (num_site_exists)
print 'Sites does not exists: %d ' % (num_site_nexists)
print 'Percentage of sites predicted having an archeological site:'
print 'Percentage of sites predicted having an archeological site: %.3f%s' % \
(100.0*float(num_site_exists)/float(num_site_exists+num_site_nexists), '%')

# plot the map
plotPredictedFromDF(raw_site_df,
                    predictions,
                    model_name=model_name,
                    country='Ireland',
                    resolution='i',
                    alpha_predicted=.01)
```

```
Sites exists         : 8044
Sites does not exists: 650893
Percentage of sites predicted having an archeological site:
Percentage of sites predicted having an archeological site: 1.221%
```



4.6 6. Ada Boosting Classification

In [35]:
```
from sklearn import ensemble

AdaBoosting = ensemble.AdaBoostClassifier()
AdaBoosting.fit(train_data, train_target)
```

Out[35]:
```
AdaBoostClassifier(algorithm='SAMME.R', base_estimator=None,
          learning_rate=1.0, n_estimators=50, random_state=None)
```

Testing the Ada Boosting Classification

In [36]:
```
from sklearn import metrics

model = AdaBoosting
"""
Fit the training data
and observe the metrics
"""
preds = model.predict(train_data)
targs = train_target
args = (targs, preds)
print "Training Data"
print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")

"""
Fit the test data
and observe the metrics
"""
preds = model.predict(test_data)
targs = test_target
args = (targs, preds)
print "\n"
print "Test Data"
print "accuracy  : %.03f%s" % (metrics.accuracy_score(*args)*100, "%")
print "precision : %.03f%s" % (metrics.precision_score(*args)*100, "%")
print "recall    : %.03f%s" % (metrics.recall_score(*args)*100, "%")
print "f1        : %.03f%s" % (metrics.f1_score(*args)*100, "%")
```

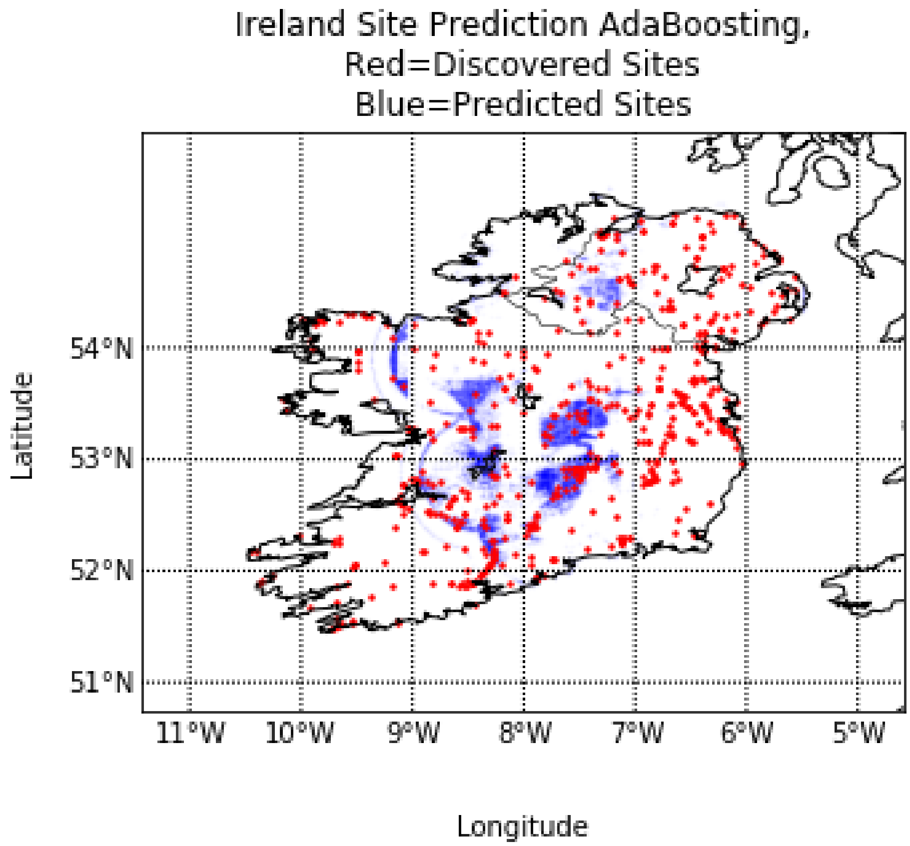
```
Training Data
accuracy  : 95.296%
precision : 98.225%
```

```
recall    : 92.393%
f1        : 95.220%


Test Data
accuracy  : 91.776%
precision : 92.558%
recall    : 90.249%
f1        : 91.389%
```

Ada Boosting Prediction

```
In [41]: model_name = 'AdaBoosting'
         predictions[model_name] = AdaBoosting.predict(pred_df)

         site_exists       = predictions[predictions[model_name] == 1]
         site_nexists      = predictions[predictions[model_name] != 1]
         num_site_exists   = site_exists[model_name].count()
         num_site_nexists = site_nexists[model_name].count()

         print 'Sites exists         : %d ' % (num_site_exists)
         print 'Sites does not exists: %d ' % (num_site_nexists)
         print 'Percentage of sites predicted having an archeological site: %.3f%s' % \
         (100.0*float(num_site_exists)/float(num_site_exists+num_site_nexists), '%')

         # plot the map
         plotPredictedFromDF(raw_site_df,
                             predictions,
                             model_name=model_name,
                             country='Ireland',
                             resolution='i',
                             alpha_predicted=.01)
```

```
Sites exists         : 34408
Sites does not exists: 624529
Percentage of sites predicted having an archeological site: 5.222%
```


Ireland Site Prediction AdaBoosting,
Red=Discovered Sites
Blue=Predicted Sites
54°N
53°N
52°N
51°N
11°W
10°W
9°W
8°W
7°W
6°W
5°W
Latitude
Longitude