Introduction to data science

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Plan for today

- Talk about the homework
- Basics of machine learning with SciKit-Learn

Projects!

First round due Nov 18th by 11:59 pm

Will then get comments

Give presentation in class

Turn in final assignment Dec 14 11:59 pm

Tentative….

- Nov 7: Stats and machine learning
- Nov 12: In class presentations
- Nov 14: 2016 Election polling postmortem
- Nov 19: Guest speaker
- Nov 21: CLASS CANCELED - THANKSGIVING
- Nov 26: Big data: Apache Spark
- Nov 28: Visualization 2
- Dec 3: Deep learning
- Dec 5: Final project presentations
- Dec 10: Final project presentations
- Dec 12: Final project presentations

Homework for Monday

- Speed talks: 2 minutes each + 1 question
- (No slides!)

Homework

- Answer 3 questions about the data set you had previously cleaned using statistics or machine learning methods

- Interpret the results

- State the assumptions and argue why they have been met

<u>Walk through examples!</u>

Introduction to machine learning with scikit-learn

- Learning problem considers a set of n samples of data and then tries to predict properties of unknown data.

- If each sample is more than a single number and, for instance, a multi-dimensional entry (aka multivariate data), it is said to have several attributes or features or dimensions.

    - This is a very small subset of the problems one may wish to reason about!

- scikit-learn.org/stable/tutorial/basic/tutorial.html#machine-learning-the-problem-setting

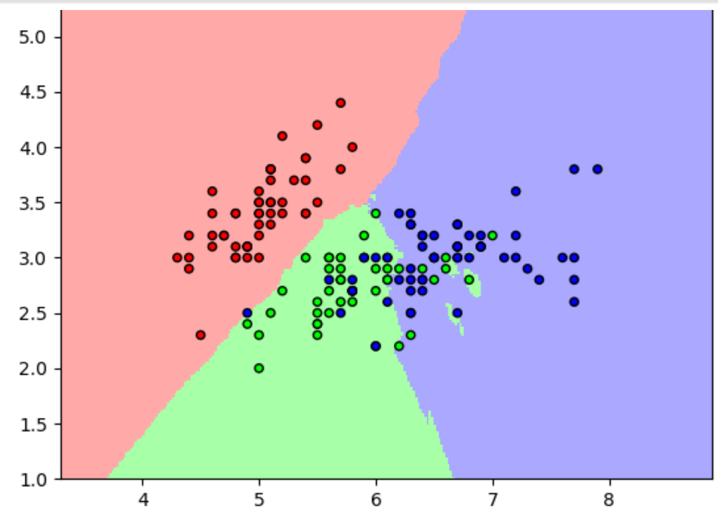
Categories of machine learning problems

- supervised learning, in which the data comes with additional attributes that we want to predict (Click here to go to the scikit-learn supervised learning page).This problem can be either:
    - classification:
    - regression:
- Unsupervised learning

Cross-validation

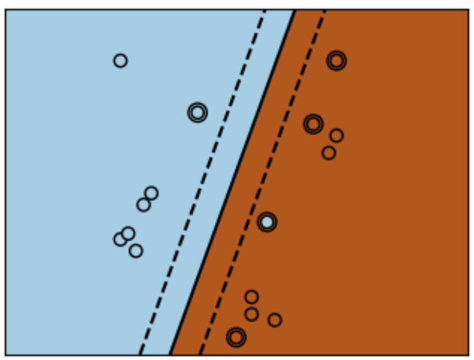
- Training set and testing set
- Machine learning is about learning some properties of a data set and applying them to new data (generalization).
- This is why a common practice in machine learning to evaluate an algorithm is to split the data at hand into two sets, one that we call the training set on which we learn data properties and one that we call the testing set on which we test these properties.

```
>>> # Split iris data in train and test data
>>> # A random permutation, to split the data randomly
>>> np.random.seed(0)
>>> indices = np.random.permutation(len(iris_X))
>>> iris_X_train = iris_X[indices[:-10]]
>>> iris_y_train = iris_y[indices[:-10]]
>>> iris_X_test  = iris_X[indices[-10:]]
>>> iris_y_test  = iris_y[indices[-10:]]
>>> # Create and fit a nearest-neighbor classifier
>>> from sklearn.neighbors import KNeighborsClassifier
>>> knn = KNeighborsClassifier()
>>> knn.fit(iris_X_train, iris_y_train)
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=1, n_neighbors=5, p=2,
           weights='uniform')
>>> knn.predict(iris_X_test)
array([1, 2, 1, 0, 0, 0, 2, 1, 2, 0])
>>> iris_y_test
array([1, 1, 1, 0, 0, 0, 2, 1, 2, 0])
```



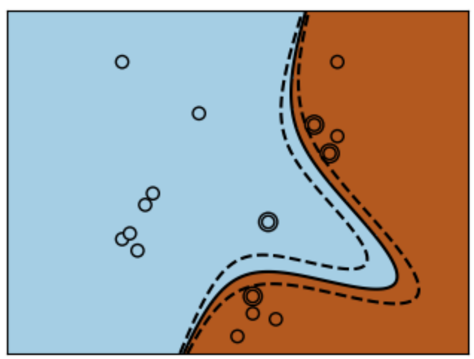
Classification: Support vector machines

```
>>> from sklearn import svm
>>> svc = svm.SVC(kernel='linear')
>>> svc.fit(iris_X_train, iris_y_train)
SVC(C=1.0, 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)
```



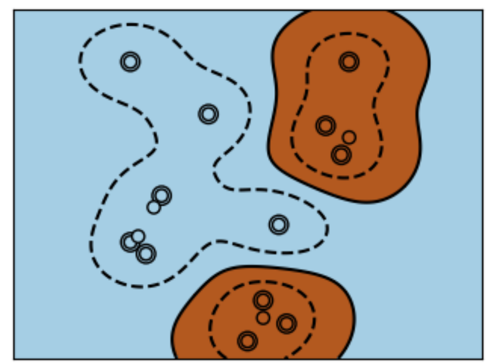
Linear

>>> svc = svm.SVC(kernel='linear')



Polynomial

>>> svc = svm.SVC(kernel='poly', degree=3)



RBF

>>> svc = svm.SVC(kernel='rbf')

K-fold cross validation

```
>>> from sklearn.model_selection import KFold, cross_val_score
>>> X = ["a", "a", "b", "c", "c", "c"]
>>> k_fold = KFold(n_splits=3)
>>> for train_indices, test_indices in k_fold.split(X):
...      print('Train: %s | test: %s' % (train_indices, test_indices))
Train: [2 3 4 5] | test: [0 1]
Train: [0 1 4 5] | test: [2 3]
Train: [0 1 2 3] | test: [4 5]
```

```
>>> [svc.fit(X_digits[train], y_digits[train]).score(X_digits[test], y_digits[test])
...          for train, test in k_fold.split(X_digits)]
[0.934891485809668284, 0.95659432387312182, 0.93989983305509184]
```

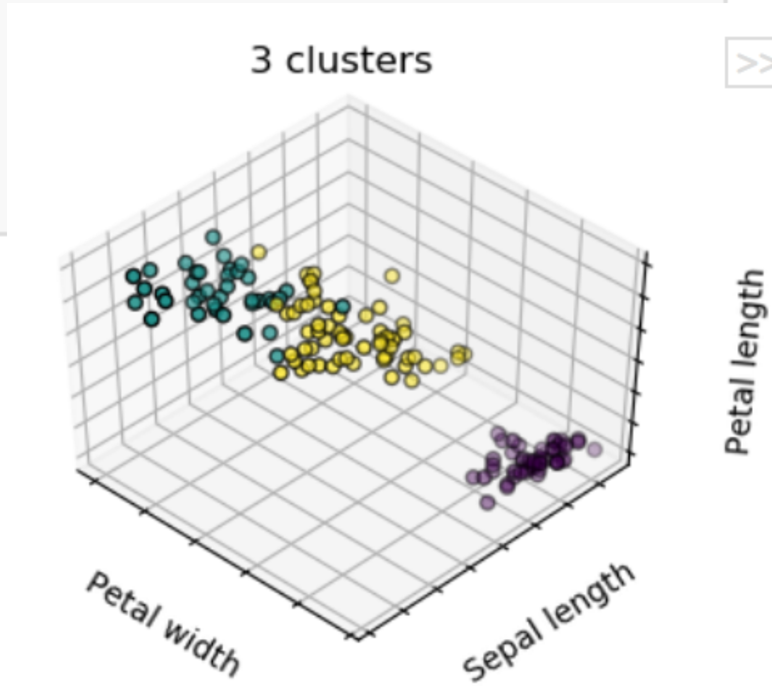
K-fold cross validation

```
>>> from sklearn import linear_model, datasets
>>> lasso = linear_model.LassoCV()
>>> diabetes = datasets.load_diabetes()
>>> X_diabetes = diabetes.data
>>> y_diabetes = diabetes.target
>>> lasso.fit(X_diabetes, y_diabetes)
LassoCV(alphas=None, copy_X=True, cv=None, eps=0.001, fit_intercept=True,
    max_iter=1000, n_alphas=100, n_jobs=1, normalize=False, positive=False,
    precompute='auto', random_state=None, selection='cyclic', tol=0.0001,
    verbose=False)
>>> # The estimator chose automatically its lambda:
>>> lasso.alpha_
0.01229...
```

Unsupervised: K means

```
>>> from sklearn import cluster, datasets
>>> iris = datasets.load_iris()
>>> X_iris = iris.data
>>> y_iris = iris.target

>>> k_means = cluster.KMeans(n_clusters=3)
>>> k_means.fit(X_iris)
KMeans(algorithm='auto', copy_x=True, init='k-means++', ...
>>> print(k_means.labels_[::10])
[1 1 1 1 1 0 0 0 0 0 2 2 2 2 2]
>>> print(y_iris[::10])
[0 0 0 0 0 1 1 1 1 1 2 2 2 2 2]
```

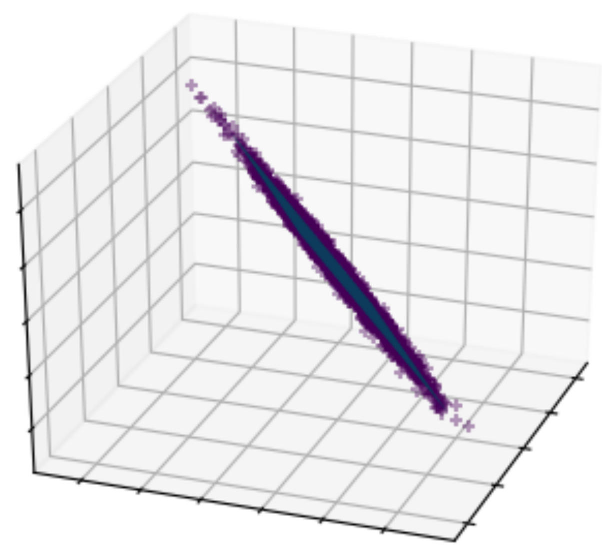


Unsupervised: PCA

```
>>> # Create a signal with only 2 useful dimensions
>>> x1 = np.random.normal(size=100)
>>> x2 = np.random.normal(size=100)
>>> x3 = x1 + x2
>>> X = np.c_[x1, x2, x3]

>>> from sklearn import decomposition
>>> pca = decomposition.PCA()
>>> pca.fit(X)
PCA(copy=True, iterated_power='auto', n_components=None, random_state=None,
  svd_solver='auto', tol=0.0, whiten=False)
>>> print(pca.explained_variance_)
[  2.18565811e+00   1.19346747e+00   8.43026679e-32]

>>> # As we can see, only the 2 first components are useful
>>> pca.n_components = 2
>>> X_reduced = pca.fit_transform(X)
>>> X_reduced.shape
(100, 2)
```



Spring course!

26:645:652 **STATISTICS AND MACHINE LEARNING** 3 credits Sections: **1** /

SEC	INDEX	MEETING TIMES / LOCATIONS				EXAM	INSTRUCTORS
01 OPEN	14705	Monday Wednesday	10:00 AM - 11:20 AM 10:00 AM - 11:20 AM	NWK NWK	ACK-123 ACK-123	A	YANG, C

Enroll!

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Evaluations!