Exercise 0

In [1]:

```
import site
site.getsitepackages()
```

Out[1]:

```
['/usr/local/Cellar/python/3.7.4/Frameworks/Python.framework/Version
s/3.7/lib/python3.7/site-packages']
```

Exercise 1.1

In [2]:

```
import nltk
import pprint
from nltk.corpus import conll2000
print(conll2000.chunked_sents('train.txt')[99])
```

```
(S
  (PP Over/IN)
  (NP a/DT cup/NN)
  (PP of/IN)
  (NP coffee/NN)
  ,/,
  (NP Mr./NNP Stone/NNP)
  (VP told/VBD)
  (NP his/PRP$ story/NN)
  ./.)
```

In [3]:

```
print(conll2000.chunked_sents('train.txt', chunk_types=['NP'])[99])
```

```
(S
  Over/IN
  (NP a/DT cup/NN)
  of/IN
  (NP coffee/NN)
  ,/,
  (NP Mr./NNP Stone/NNP)
  told/VBD
  (NP his/PRP$ story/NN)
  ./.)
```

In [4]:

```
nltk.chunk.tree2conlltags(conll2000.chunked_sents('train.txt')[99])
```

Out[4]:

```
[('Over', 'IN', 'B-PP'),
 ('a', 'DT', 'B-NP'),
 ('cup', 'NN', 'I-NP'),
 ('of', 'IN', 'B-PP'),
 ('coffee', 'NN', 'B-NP'),
 (',', ',', 'O'),
 ('Mr.', 'NNP', 'B-NP'),
 ('Stone', 'NNP', 'I-NP'),
 ('told', 'VBD', 'B-VP'),
 ('his', 'PRP$', 'B-NP'),
 ('story', 'NN', 'I-NP'),
 ('.', '.', 'O')]
```

In [5]:

```
dev_set = conll2000.chunked_sents('train.txt', chunk_types=['NP'])
print(len(dev_set))
dev_train = dev_set[:-1000]
dev_test = dev_set[-1000:]
```

```
8936
```

Exercise 1.2

In [6]:

```
class UnigramChunker(nltk.ChunkParserI):
    def __init__(self, train_sents):
        train_data = [[(t,c) for w,t,c in nltk.chunk.tree2conlltags(sent)]
            for sent in train_sents]
        self.tagger = nltk.UnigramTagger(train_data)

    def parse(self, sentence):
        pos_tags = [pos for (word,pos) in sentence]
        tagged_pos_tags = self.tagger.tag(pos_tags)
        chunktags = [chunktag
                     for (pos, chunktag) in tagged_pos_tags]
        conlltags = [(word, pos, chunktag)
                     for ((word,pos),chunktag)
                     in zip(sentence, chunktags)]
        return nltk.chunk.conlltags2tree(conlltags)
```

In [7]:

```
unigram_chunker = UnigramChunker(dev_train)
print(unigram_chunker.evaluate(dev_test))
```

```
ChunkParse score:
    IOB Accuracy:  92.7%%
    Precision:     78.9%%
    Recall:        85.2%%
    F-Measure:     81.9%%
```

Exercise 1.3

In [8]:

```
def npchunk_features_0(sentence, i, history):
    word, pos = sentence[i]
    return {"pos": pos}
```

In [9]:

```
class ConsecutiveTagger(nltk.TaggerI):
    def __init__(self, train_sents, features=npchunk_features_0, learner=nltk.Na
iveBayesClassifier):
        self.features = features
        train_set = []
        for tagged_sent in train_sents:
            untagged_sent = nltk.tag.untag(tagged_sent)
            history = []
            for i, (word, tag) in enumerate(tagged_sent):
                featureset = features(untagged_sent, i, history)
                train_set.append( (featureset, tag) )
                history.append(tag)
        self.classifier = learner.train(train_set)

    def tag(self, sentence):
        history = []
        for i, word in enumerate(sentence):
            featureset = self.features(sentence, i, history)
            tag = self.classifier.classify(featureset)
            history.append(tag)
        return zip(sentence, history)
```

In [10]:

```
class Chunker(nltk.ChunkParserI):
    def __init__(self, train_sents,
        tagger=ConsecutiveTagger, **kwargs):
        tagged_sents = [[((w,t),c)
                         for (w,t,c) in nltk.chunk.tree2conlltags(sent)]
                         for sent in train_sents]
        self.tagger = tagger(tagged_sents, **kwargs)

    def parse(self, sentence):
        tagged_sents = self.tagger.tag(sentence)
        conlltags = [(w,t,c) for ((w,t),c) in tagged_sents]
        return nltk.chunk.conlltags2tree(conlltags)
```

In [11]:

```
chunker_0 = Chunker(dev_train, features=npchunk_features_0)
score_0 = chunker_0.evaluate(dev_test)
print(score_0)
```

```
ChunkParse score:
    IOB Accuracy:  92.7%%
    Precision:     78.9%%
    Recall:        85.2%%
    F-Measure:     81.9%%
```

In [12]:

```
score_0.f_measure()
```

Out[12]:

```
0.8189038295195408
```

Exercise 1.4

In [13]:

```
def npchunk_features_1(sentence, i, history):
    word, pos = sentence[i]
    if i == 0:
        prevword, prevpos = "<START>", "<START>"
    else:
        prevword, prevpos = sentence[i-1]

    return {"pos": pos, "prevpos": prevpos}

def npchunk_features_2(sentence, i, history):
    word, pos = sentence[i]

    if i == 0:
        prevword, prevpos = "<START>", "<START>"
    else:
        prevword, prevpos = sentence[i-1]

    return {"pos": pos, "word": word, "prevpos": prevpos}

def npchunk_features_3(sentence, i, history):
    word, pos = sentence[i]
    if i == 0:
        prevword, prevpos = "<START>", "<START>"
    else:
        prevword, prevpos = sentence[i-1]

    if i == len(sentence)-1:
        nextword, nextpos = "<END>", "<END>"
    else:
        nextword, nextpos = sentence[i+1]

    return {"pos": pos,
            "word": word,
            "prevpos": prevpos,
            "nextpos": nextpos,
            "prevpos+pos": "%s+%s" % (prevpos, pos),
            "pos+nextpos": "%s+%s" % (pos, nextpos),
            "tags-since-dt": tags_since_dt(sentence, i)}
```

In [14]:

```
def tags_since_dt(sentence, i):
     tags = set()
     for word, pos in sentence[:i]:
         if pos == 'DT':
             tags = set()
         else:
             tags.add(pos)
     return '+'.join(sorted(tags))
```

In [15]:

```
%%time
chunker_0 = Chunker(dev_train, features=npchunk_features_0)
score_0 = chunker_0.evaluate(dev_test)
print("feature 0: \n", score_0)
print(score_0.f_measure())

chunker_1 = Chunker(dev_train, features=npchunk_features_1)
score_1 = chunker_1.evaluate(dev_test)
print("feature 1: \n", score_1)
print(score_1.f_measure())


chunker_2 = Chunker(dev_train, features=npchunk_features_2)
score_2 = chunker_2.evaluate(dev_test)
print("feature 2: \n", score_2)
print(score_2.f_measure())


chunker_3 = Chunker(dev_train, features=npchunk_features_3)
score_3 = chunker_3.evaluate(dev_test)
print("feature 3: \n", score_3)
print(score_3.f_measure())
```

```
feature 0:
 ChunkParse score:
    IOB Accuracy:  92.7%%
    Precision:     78.9%%
    Recall:        85.2%%
    F-Measure:     81.9%%
0.8189038295195408
feature 1:
 ChunkParse score:
    IOB Accuracy:  93.3%%
    Precision:     80.6%%
    Recall:        86.8%%
    F-Measure:     83.6%%
0.8359571788413097
feature 2:
 ChunkParse score:
    IOB Accuracy:  94.1%%
    Precision:     83.0%%
    Recall:        88.4%%
    F-Measure:     85.6%%
0.8557852221430268
feature 3:
 ChunkParse score:
    IOB Accuracy:  94.7%%
    Precision:     84.7%%
    Recall:        88.8%%
    F-Measure:     86.7%%
0.8674756506466549
CPU times: user 17.4 s, sys: 438 ms, total: 17.8 s
Wall time: 18.9 s
```

Exercise 2.1

In [16]:

```
def npchunk_features_00(sentence, i, history):
    word, pos = sentence[i]
    return {"pos": pos,
            "predTag": history[-1] if len(history)>0 else ""}

def npchunk_features_01(sentence, i, history):
    word, pos = sentence[i]
    if i == 0:
        prevword, prevpos = "<START>", "<START>"
    else:
        prevword, prevpos = sentence[i-1]

    return {"pos": pos, "prevpos": prevpos,
            "predTag": history[-1] if len(history)>0 else ""}

def npchunk_features_02(sentence, i, history):
    word, pos = sentence[i]

    if i == 0:
        prevword, prevpos = "<START>", "<START>"
    else:
        prevword, prevpos = sentence[i-1]

    return {"pos": pos, "word": word, "prevpos": prevpos,
            "predTag": history[-1] if len(history)>0 else ""}

def npchunk_features_03(sentence, i, history):
    word, pos = sentence[i]

    if i == 0:
        prevword, prevpos = "<START>", "<START>"
    else:
        prevword, prevpos = sentence[i-1]

    if i == len(sentence)-1:
        nextword, nextpos = "<END>", "<END>"
    else:
        nextword, nextpos = sentence[i+1]

    return {"pos": pos,
            "word": word,
            "prevpos": prevpos,
            "nextpos": nextpos,
            "prevpos+pos": "%s+%s" % (prevpos, pos),
            "pos+nextpos": "%s+%s" % (pos, nextpos),
            "tags-since-dt": tags_since_dt(sentence, i),
            "predTag": history[-1] if len(history)>0 else ""}
```

In [17]:

```
%%time
chunker_00 = Chunker(dev_train, features=npchunk_features_00)
score_00 = chunker_00.evaluate(dev_test)
print("feature 00: \n", score_00)
print(score_00.f_measure())

chunker_01 = Chunker(dev_train, features=npchunk_features_01)
score_01 = chunker_01.evaluate(dev_test)
print("feature 01: \n", score_01)
print(score_01.f_measure())


chunker_02 = Chunker(dev_train, features=npchunk_features_02)
score_02 = chunker_02.evaluate(dev_test)
print("feature 02: \n", score_02)
print(score_02.f_measure())


chunker_03 = Chunker(dev_train, features=npchunk_features_03)
score_03 = chunker_03.evaluate(dev_test)
print("feature 03: \n", score_03)
print(score_03.f_measure())
```

```
feature 00:
 ChunkParse score:
    IOB Accuracy:  93.0%%
    Precision:     80.8%%
    Recall:        85.1%%
    F-Measure:     82.9%%
0.8290312300828552
feature 01:
 ChunkParse score:
    IOB Accuracy:  92.6%%
    Precision:     79.4%%
    Recall:        83.0%%
    F-Measure:     81.2%%
0.811575665520825
feature 02:
 ChunkParse score:
    IOB Accuracy:  94.3%%
    Precision:     83.6%%
    Recall:        88.0%%
    F-Measure:     85.7%%
0.8574386747371775
feature 03:
 ChunkParse score:
    IOB Accuracy:  94.8%%
    Precision:     85.5%%
    Recall:        88.1%%
    F-Measure:     86.8%%
0.8678151666398326
CPU times: user 19.2 s, sys: 248 ms, total: 19.4 s
Wall time: 20.4 s
```

Exercise 3

In [18]:

```
import numpy as np
import sklearn
from sklearn.naive_bayes import BernoulliNB
from sklearn.linear_model import LogisticRegression
from sklearn.feature_extraction import DictVectorizer
```

In [19]:

```
class ScikitSentenceTagger(nltk.TaggerI):
    def __init__(self, train_sents, clf=BernoulliNB(alpha=0.5), features=npchunk
_features_0):
        self.features = features
        train_features = []
        train_labels = []
        for tagged_sent in train_sents:
            untagged_sent = nltk.tag.untag(tagged_sent)
            history = []
            for i, (word, tag) in enumerate(tagged_sent):
                featureset = features(untagged_sent, i, history)
                train_features.append(featureset)
                train_labels.append(tag)
                history.append(tag)
        v = DictVectorizer()
        X_train = v.fit_transform(train_features)
        y_train = np.array(train_labels)
        clf.fit(X_train, y_train)
        self.classifier = clf
        self.dict = v

    def tag(self, sentence):
        test_features = []
        for i, word in enumerate(sentence):
            featureset = self.features(sentence, i, [])
            test_features.append(featureset)
            X_test = self.dict.transform(test_features)
            tags = self.classifier.predict(X_test)
        return zip(sentence, tags)
```

In [20]:

```
%%time
sci_chunker_0 = Chunker(dev_train, tagger=ScikitSentenceTagger, features=npchunk
_features_0)
sci_score_0 = sci_chunker_0.evaluate(dev_test)
print(sci_score_0)
print(sci_score_0.f_measure())

sci_chunker_1 = Chunker(dev_train, tagger=ScikitSentenceTagger, features=npchunk
_features_1)
sci_score_1 = sci_chunker_1.evaluate(dev_test)
print("feature 1: \n", sci_score_1)
print(sci_score_1.f_measure())

print("----------NLTK scores:----------")
print("feature 0: \n", score_0)
print(score_0.f_measure())
print("feature 1: \n", score_1)
print(score_1.f_measure())
```

```
ChunkParse score:
    IOB Accuracy:  92.7%%
    Precision:     78.9%%
    Recall:        85.2%%
    F-Measure:     81.9%%
0.8189038295195408
feature 1:
 ChunkParse score:
    IOB Accuracy:  93.3%%
    Precision:     80.7%%
    Recall:        87.0%%
    F-Measure:     83.7%%
0.8372569089048107
----------NLTK scores:----------
feature 0:
 ChunkParse score:
    IOB Accuracy:  92.7%%
    Precision:     78.9%%
    Recall:        85.2%%
    F-Measure:     81.9%%
0.8189038295195408
feature 1:
 ChunkParse score:
    IOB Accuracy:  93.3%%
    Precision:     80.6%%
    Recall:        86.8%%
    F-Measure:     83.6%%
0.8359571788413097
CPU times: user 25 s, sys: 243 ms, total: 25.2 s
Wall time: 26.5 s
```

Exercise 4.1

In [21]:

```
%%time
sci_chunker_00 = Chunker(dev_train, tagger=ScikitSentenceTagger,
                         clf=LogisticRegression(), features=npchunk_features_0)
sci_score_00 = sci_chunker_00.evaluate(dev_test)
print("feature 00: \n", sci_score_00)
print(sci_score_00.f_measure())

sci_chunker_01 = Chunker(dev_train, tagger=ScikitSentenceTagger,
                         clf=LogisticRegression(), features=npchunk_features_1)
sci_score_01 = sci_chunker_01.evaluate(dev_test)
print("feature 01: \n", sci_score_01)
print(sci_score_01.f_measure())

sci_chunker_02 = Chunker(dev_train, tagger=ScikitSentenceTagger,
                         clf=LogisticRegression(), features=npchunk_features_2)
sci_score_02 = sci_chunker_02.evaluate(dev_test)
print("feature 02: \n", sci_score_02)
print(sci_score_02.f_measure())

sci_chunker_03 = Chunker(dev_train, tagger=ScikitSentenceTagger,
                         clf=LogisticRegression(), features=npchunk_features_1)
sci_score_03 = sci_chunker_03.evaluate(dev_test)
print("feature 03: \n", sci_score_03)
print(sci_score_03.f_measure())
```

```
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logisti
c.py:432: FutureWarning: Default solver will be changed to 'lbfgs' i
n 0.22. Specify a solver to silence this warning.
  FutureWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logisti
c.py:469: FutureWarning: Default multi_class will be changed to 'aut
o' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)

feature 00:
 ChunkParse score:
    IOB Accuracy:  92.7%%
    Precision:     78.9%%
    Recall:        85.2%%
    F-Measure:     81.9%%
0.8189038295195408
feature 01:
 ChunkParse score:
    IOB Accuracy:  93.2%%
    Precision:     80.3%%
    Recall:        85.0%%
    F-Measure:     82.6%%
0.8257172375427164
feature 02:
 ChunkParse score:
    IOB Accuracy:  94.4%%
    Precision:     83.0%%
    Recall:        87.8%%
    F-Measure:     85.3%%
0.8529201430274136
feature 03:
 ChunkParse score:
    IOB Accuracy:  93.2%%
    Precision:     80.3%%
    Recall:        85.0%%
    F-Measure:     82.6%%
0.8257172375427164
CPU times: user 45.1 s, sys: 1.03 s, total: 46.1 s
Wall time: 44.5 s
```

Exercise 5

In [22]:

```
class ScikitWordTagger(nltk.TaggerI):
    def __init__(self, train_sents,
        features=npchunk_features_0,
        clf = BernoulliNB(alpha=0.5)):
        self.features = features
        train_features = []
        train_labels = []
        for tagged_sent in train_sents:
            untagged_sent = nltk.tag.untag(tagged_sent)
            history = []
            for i, (word, tag) in enumerate(tagged_sent):
                featureset = features(untagged_sent, i, history)
                train_features.append(featureset)
                train_labels.append(tag)
                history.append(tag)
        v = DictVectorizer()
        X_train = v.fit_transform(train_features)
        y_train = np.array(train_labels)
        clf.fit(X_train, y_train)
        self.classifier = clf
        self.dict = v

    def tag(self, sentence):
        history = []
        tags=[]
        for i, word in enumerate(sentence):
            featureset = self.features(sentence, i, history)
            test_features=[featureset]
            X_test = self.dict.transform(test_features)
            tag = self.classifier.predict(X_test)
            tags.extend(tag)
            history.extend(tag)
        return zip(sentence, tags)
```

In [23]:

```
%%time
sciword_chunker_01 = Chunker(dev_train, tagger=ScikitWordTagger,
                        clf=BernoulliNB(alpha=0.5), features=npchunk_features_1)
sciword_score_01 = sciword_chunker_01.evaluate(dev_test)
print("feature 1: \n", sciword_score_01)
print(sciword_score_01.f_measure())


sciword_chunker_001 = Chunker(dev_train, tagger=ScikitWordTagger,
                        clf=LogisticRegression(), features=npchunk_features_1)
sciword_score_001 = sciword_chunker_001.evaluate(dev_test)
print("feature 1: \n", sciword_score_001)
print(sciword_score_001.f_measure())
```

```
feature 1:
 ChunkParse score:
    IOB Accuracy:  93.3%%
    Precision:     80.7%%
    Recall:        87.0%%
    F-Measure:     83.7%%
0.8372569089048107

/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logisti
c.py:432: FutureWarning: Default solver will be changed to 'lbfgs' i
n 0.22. Specify a solver to silence this warning.
  FutureWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logisti
c.py:469: FutureWarning: Default multi_class will be changed to 'aut
o' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)


feature 1:
 ChunkParse score:
    IOB Accuracy:  93.2%%
    Precision:     80.3%%
    Recall:        85.0%%
    F-Measure:     82.6%%
0.8257172375427164
CPU times: user 21.1 s, sys: 263 ms, total: 21.3 s
Wall time: 22.1 s
```

Exercise 5.1

In [24]:

```
%%time
sciword_chunker_000 = Chunker(dev_train, tagger=ScikitWordTagger,
                        clf=LogisticRegression(), features=npchunk_features_00)
sciword_score_000 = sciword_chunker_000.evaluate(dev_test)
print("feature 000: \n", sciword_score_000)
print(sciword_score_000.f_measure())
```

```
feature 000:
 ChunkParse score:
    IOB Accuracy:  93.1%%
    Precision:     81.2%%
    Recall:        84.9%%
    F-Measure:     83.0%%
0.8301494684677485
CPU times: user 8.89 s, sys: 155 ms, total: 9.05 s
Wall time: 9.49 s
```

In [25]:

```
%%time
sciword_chunker_001 = Chunker(dev_train, tagger=ScikitWordTagger,
                        clf=LogisticRegression(), features=npchunk_features_01)
sciword_score_001 = sciword_chunker_001.evaluate(dev_test)
print("feature 001: \n", sciword_score_001)
print(sciword_score_001.f_measure())
```

```
feature 001:
 ChunkParse score:
    IOB Accuracy:  93.6%%
    Precision:     84.3%%
    Recall:        85.7%%
    F-Measure:     85.0%%
0.8498905198280755
CPU times: user 9.97 s, sys: 169 ms, total: 10.1 s
Wall time: 10.6 s
```

In [26]:

```
%%time
sciword_chunker_002 = Chunker(dev_train, tagger=ScikitWordTagger,
                        clf=LogisticRegression(), features=npchunk_features_02)
sciword_score_002 = sciword_chunker_002.evaluate(dev_test)
print("feature 002: \n", sciword_score_002)
print(sciword_score_002.f_measure())
```

```
feature 002:
 ChunkParse score:
    IOB Accuracy:  94.9%%
    Precision:     87.0%%
    Recall:        89.3%%
    F-Measure:     88.1%%
0.8810522918011622
CPU times: user 15.7 s, sys: 761 ms, total: 16.5 s
Wall time: 13.2 s
```

In [27]:

```
%%time
sciword_chunker_003 = Chunker(dev_train, tagger=ScikitWordTagger,
                        clf=LogisticRegression(), features=npchunk_features_03)
sciword_score_003 = sciword_chunker_003.evaluate(dev_test)
print("feature 003: \n", sciword_score_003)
print(sciword_score_003.f_measure())
```

```
feature 003:
 ChunkParse score:
    IOB Accuracy:  96.6%%
    Precision:     91.5%%
    Recall:        92.2%%
    F-Measure:     91.8%%
0.9183773216031281
CPU times: user 24.9 s, sys: 1.34 s, total: 26.3 s
Wall time: 19.8 s
```

Exercise 5.2

In [28]:

```
def get_acc_string(a):
    return str(round(a.accuracy(),3))
def get_fsc_string(a):
    return str(round(a.f_measure(), 3))
```

In [29]:

```
# Call get_cell_string for all the scores we need and put it in a dictionary
data_dict_acc = {
    "NLTK w/NB": [get_acc_string(score_0), get_acc_string(score_1),
                  get_acc_string(score_2), get_acc_string(score_3)],

    "NLTK w/NB + history": [get_acc_string(score_00), get_acc_string(score_01),
                            get_acc_string(score_02), get_acc_string(score_03)],

    "LogReg": [get_acc_string(sci_score_00), get_acc_string(sci_score_01),
               get_acc_string(sci_score_02), get_acc_string(sci_score_03)],

    "LogReg + history": [get_acc_string(sciword_score_000), get_acc_string(sciwo
rd_score_001),
                         get_acc_string(sciword_score_002), get_acc_string(sciwo
rd_score_003)],
}
data_dict_Fsc = {
    "NLTK w/NB": [get_fsc_string(score_0), get_fsc_string(score_1),
                  get_fsc_string(score_2), get_fsc_string(score_3)],

    "NLTK w/NB + history": [get_fsc_string(score_00), get_fsc_string(score_01),
                            get_fsc_string(score_02), get_fsc_string(score_03)],

    "LogReg": [get_fsc_string(sci_score_00), get_fsc_string(sci_score_01),
               get_fsc_string(sci_score_02), get_fsc_string(sci_score_03)],

    "LogReg + history": [get_fsc_string(sciword_score_000), get_fsc_string(sciwo
rd_score_001),
                         get_fsc_string(sciword_score_002), get_fsc_string(sciwo
rd_score_003)],
}
```

In [30]:

```
import pandas as pd
```

In [31]:

```
df_acc = pd.DataFrame(data_dict_acc)
print("Accuracies")
df_acc
```

```
Accuracies
```

Out[31]:

	NLTK w/NB	NLTK w/NB + history	LogReg	LogReg + history
0	0.927	0.93	0.927	0.931
1	0.933	0.926	0.932	0.936
2	0.941	0.943	0.944	0.949
3	0.947	0.948	0.932	0.966

In [32]:

```
df_fsc = pd.DataFrame(data_dict_Fsc)
print("F-scores")
df_fsc
```

```
F-scores
```

Out[32]:

	NLTK w/NB	NLTK w/NB + history	LogReg	LogReg + history
0	0.819	0.829	0.819	0.83
1	0.836	0.812	0.826	0.85
2	0.856	0.857	0.853	0.881
3	0.867	0.868	0.826	0.918

Exercise 6

What is the effect of adding more features?

- Adding more features with NLTK without history yields better results for both accuracy and F-score.

What happens when we add a feature for the previous chunk-tag to the earlier feature extractors?

- After adding history, the accuracy and F-score is increased a little.

Does adding the previous chunk-tag always improve the results?

- With NLTK feature 2, it decreased a little.

Do we get the same variation between the different feature extractors with and without the history?

- It is marginally better for all results, except going from feature 0 to 1. It seems that the difference between feature extractor 1 and 2 is higher for NLTK + history, otherwise, it is within margin.

Do we see the same variation between the feature extractors with LR as with NB?

- We see almost the same variation and increase of accuracy with both LR and NB

Does LR perform better than NB with all the extractors?

- Yes, LR performs better than NB with all the extractors. It is getting the highest accuracy and F-measure.

What happens when you add history and use the LR classifier?

- With history and the LR classifier, the scores get higher and higher with every feature. The difference from feature extractor 2 and 3 is 1.7%, going from 94.9% to 96.6%!

I think that if you would make a graph for the increase/decrease of the results, it would have been a lot easier to see the differences between NLTK and LogReg.

Exercise 7

In [33]:

```
from nltk import word_tokenize
# This replaces the old tag with the one from nltk.pos_tag
class NewChunker7(nltk.ChunkParserI):
    def __init__(self, train_sents,
        tagger=ConsecutiveTagger, **kwargs):
        tagged_sents = []

        for sent in train_sents:
            for (w,t,c) in nltk.chunk.tree2conlltags(sent):
                k = nltk.pos_tag(word_tokenize(w))[0][1]
                tagged_s.append(((w,k),c))
        self.tagger = tagger(tagged_sents, **kwargs)

    def parse(self, sentence):
        tagged_sents = self.tagger.tag(sentence)
        conlltags = [(w,t,c) for ((w,t),c) in tagged_sents]
        return nltk.chunk.conlltags2tree(conlltags)


sm = Chunker(dev_test, features=npchunk_features_03)
the_score = sm.evaluate(dev_test)
print("Score:", the_score)
```

```
Score: ChunkParse score:
    IOB Accuracy:  95.6%%
    Precision:     87.4%%
    Recall:        90.1%%
    F-Measure:     88.7%%
```

I thought it was a little strange to evaluate it on the same set, but with different POS-tags, So i'm guessing I did something wrong.

It looks like the gold pos-tagged set got it a bit better than nltk.pos_tag (96.6% acc vs 95.6% accuracy and 91.8% vs 88.7% F-measure).

Exercise 8

In [34]:

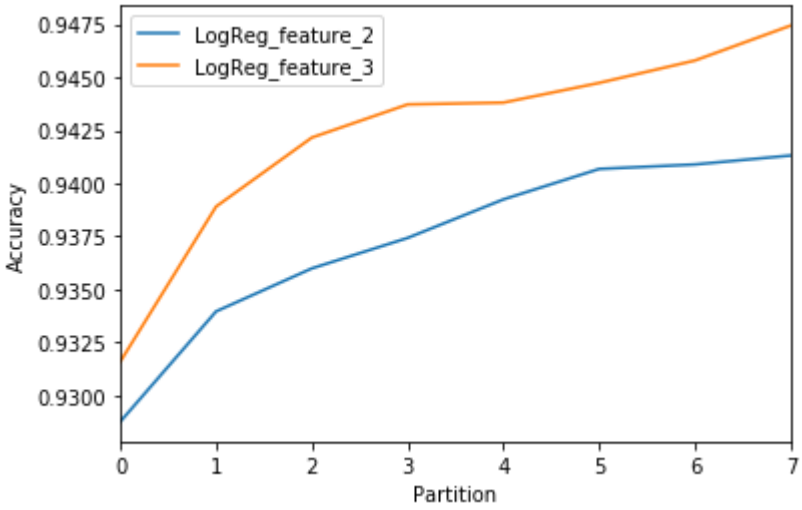
```
# 128,64,32,16,8,4,2,1
from collections import defaultdict
partition_sizes = [128,64,32,16,8,4,2,1]

accuracy = defaultdict(list)
fmeasure = defaultdict(list)

for s in partition_sizes:
    #train_size = len(dev_train) //s
    tmp_train  = dev_train[:len(dev_train)//s]

    chunker_2 = Chunker(tmp_train, features=npchunk_features_2)
    chunker_3 = Chunker(tmp_train, features=npchunk_features_3)
    score_2   = chunker_2.evaluate(dev_test)
    score_3   = chunker_3.evaluate(dev_test)

    accuracy['LogReg_feature_2'].append(score_2.accuracy())
    accuracy['LogReg_feature_3'].append(score_3.accuracy())

    fmeasure['LogReg_feature_2'].append(score_2.f_measure())
    fmeasure['LogReg_feature_3'].append(score_3.f_measure())
```

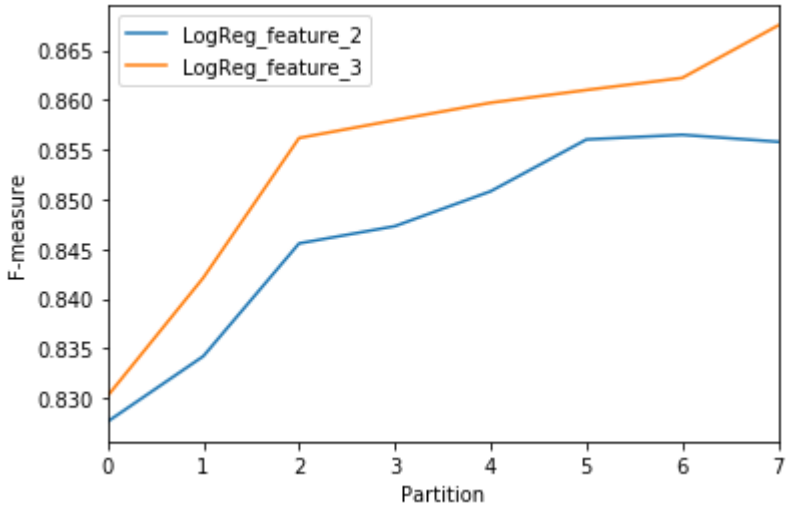
In [40]:

```
acc  = pd.DataFrame(accuracy)
fmea = pd.DataFrame(fmeasure)
plot_acc  = acc.plot()
plot_fmea = fmea.plot()


plot_acc.set_ylabel('Accuracy')
plot_fmea.set_ylabel('F-measure')
plot_acc.set_xlabel('Partition')
plot_fmea.set_xlabel('Partition')

plot_acc
plot_fmea
```

Out[40]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x12825f3d0>
```





Exercise 9

In [36]:

```
sample_size = len(dev_test)
from scipy import stats

bi = stats.binom.ppf([0.025, 0.975], 1000, 0.94)/1000
print(bi)
```

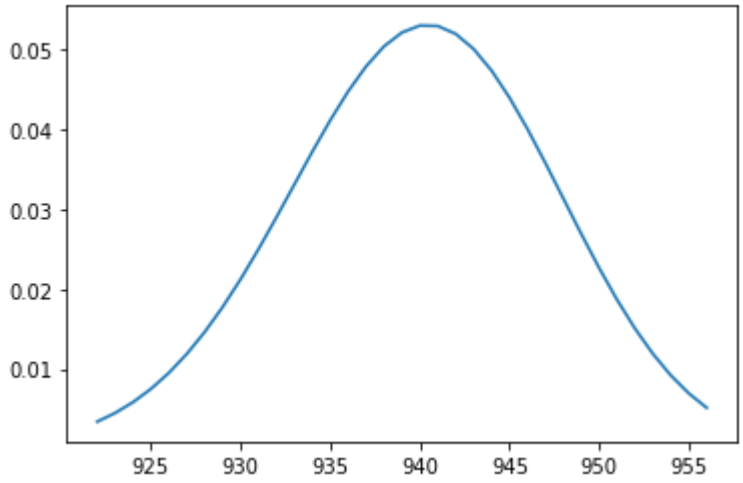
```
[0.925 0.954]
```

In [37]:

```
import matplotlib.pyplot as plt
x=np.arange(stats.binom.ppf(0.01, 1000, 0.94),
               stats.binom.ppf(0.99, 1000, 0.94))
plt.plot(x, stats.binom.pmf(x, 1000, 0.94))
```

Out[37]:

```
[<matplotlib.lines.Line2D at 0x120d4ae10>]
```



We can estimate the IOB accuracy for this chunker of the total population with a confidence interval. The interval gives us an estimation for where the true accurcy lies, in our case, with a 95% confidence

Exercise 10

In [38]:

```
test_set = conll2000.chunked_sents('test.txt', chunk_types=['NP'])

best_chunker = Chunker(dev_train, tagger=ScikitWordTagger,
                       clf=LogisticRegression(), features=npchunk_features_03)
best_score = best_chunker.evaluate(test_set)

print("LogReg + history npchunk_features_03: \n", best_score)
print(best_score.f_measure())
```

```
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logisti
c.py:432: FutureWarning: Default solver will be changed to 'lbfgs' i
n 0.22. Specify a solver to silence this warning.
  FutureWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logisti
c.py:469: FutureWarning: Default multi_class will be changed to 'aut
o' in 0.22. Specify the multi_class option to silence this warning.
  "this warning.", FutureWarning)

LogReg + history npchunk_features_03:
 ChunkParse score:
    IOB Accuracy:  96.5%%
    Precision:     92.0%%
    Recall:        92.0%%
    F-Measure:     92.0%%
0.9201046488227007
```

In [39]:

```
best_chunker_2 = Chunker(dev_set, tagger=ScikitWordTagger,
                       clf=LogisticRegression(), features=npchunk_features_03)
best_score_2 = best_chunker_2.evaluate(test_set)

print("LogReg + history npchunk_features_03 on whole dev-set: \n", best_score_2)
print(best_score_2.f_measure())
```

```
LogReg + history npchunk_features_03 on whole dev-set:
 ChunkParse score:
    IOB Accuracy:  96.6%%
    Precision:     92.2%%
    Recall:        92.2%%
    F-Measure:     92.2%%
0.9224328784768345
```

Do you see any changes by including what was earlier dev_test in your training data?

- We can see that including a bigger (~12.6%) test-set gave the chunker about 0.1-0.2% better accuracy and f-score

Exercise 11

Manual evaluation	True positive	False Positive	False Negative
different[3]	14	1	0
different[100]	20		0
different[550]	28	1	0
different[590]	13	0	0
different[600]	24	0	1
total	99	2	1

$$Recall: 99/100 = 0,99$$
$$Precision: 99/101 = 0,9801980198 \approx 0.98$$
$$F - score = 2 * \frac{Recall * Precision}{Recall + Precision} = 2 * \frac{0,99 * 0,9801980198}{0,99 + 0,9801980198} = 0.98507462686 \approx 0.985$$

In [ ]: