Data Science:

It's Easy as Py!

Michael Becker

@beckerfuffle

#PyDataNYC

What My Coworkers Think I Do

$$h_{w,b}(x) = g(w^T x + b)$$

$$\hat{\gamma}^{(i)} = y^{(i)}(w^T x + b)$$

$$\hat{\gamma} = \min_{i=1,\ldots,m} \hat{\gamma}^{(i)}$$

$$w^T \left(x^{(i)} - \gamma^{(i)} \frac{w}{||w||} \right) + b = 0$$

What I Actually Do

```
import pandas as pd
```

```
import seaborn as sns
```

```
from sklearn.svm import SVC
```

What I'll Cover

- What is Data Science?

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- What is Data Science?
- The OSEMN process

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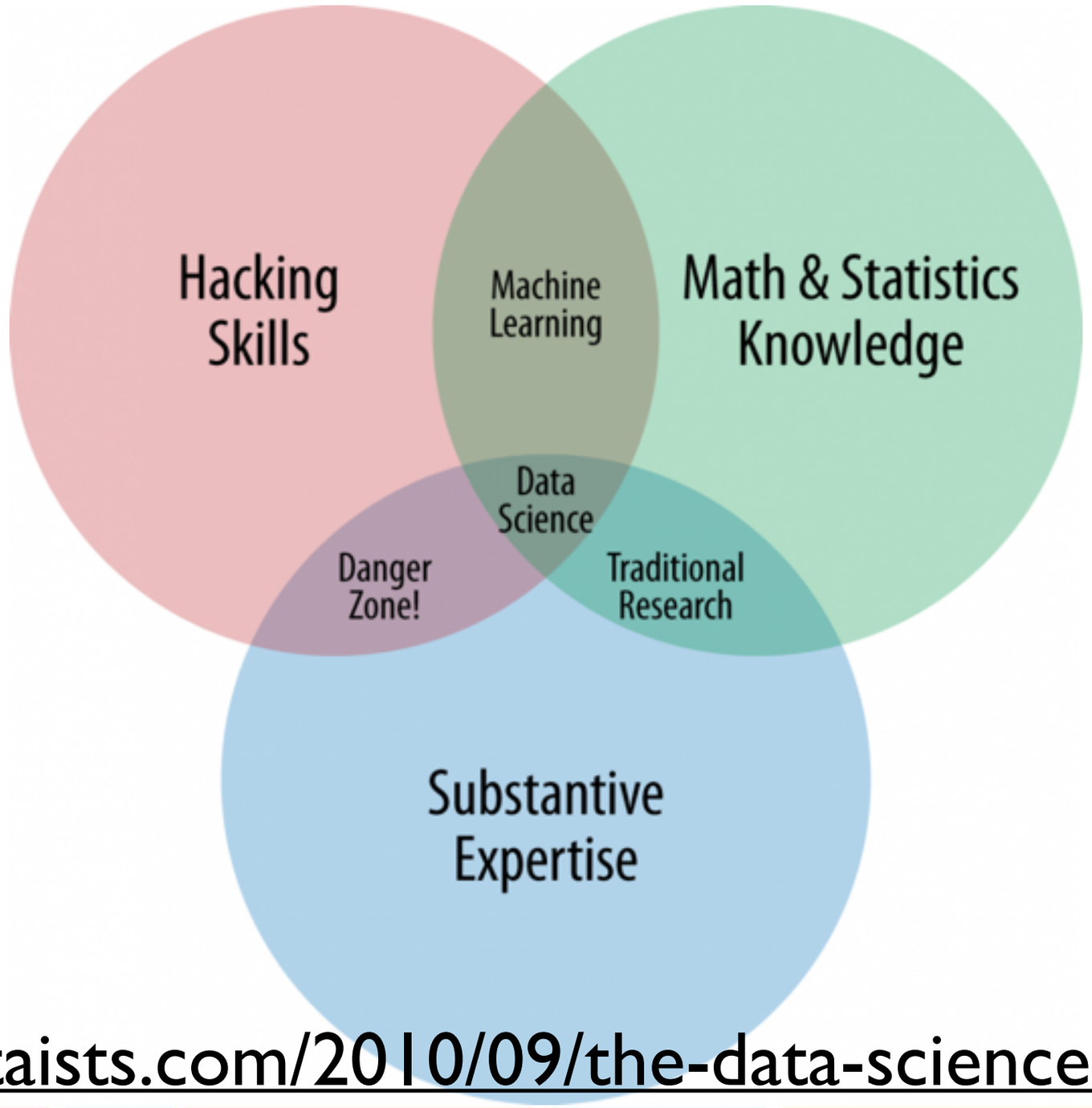
- Predictive Modeling

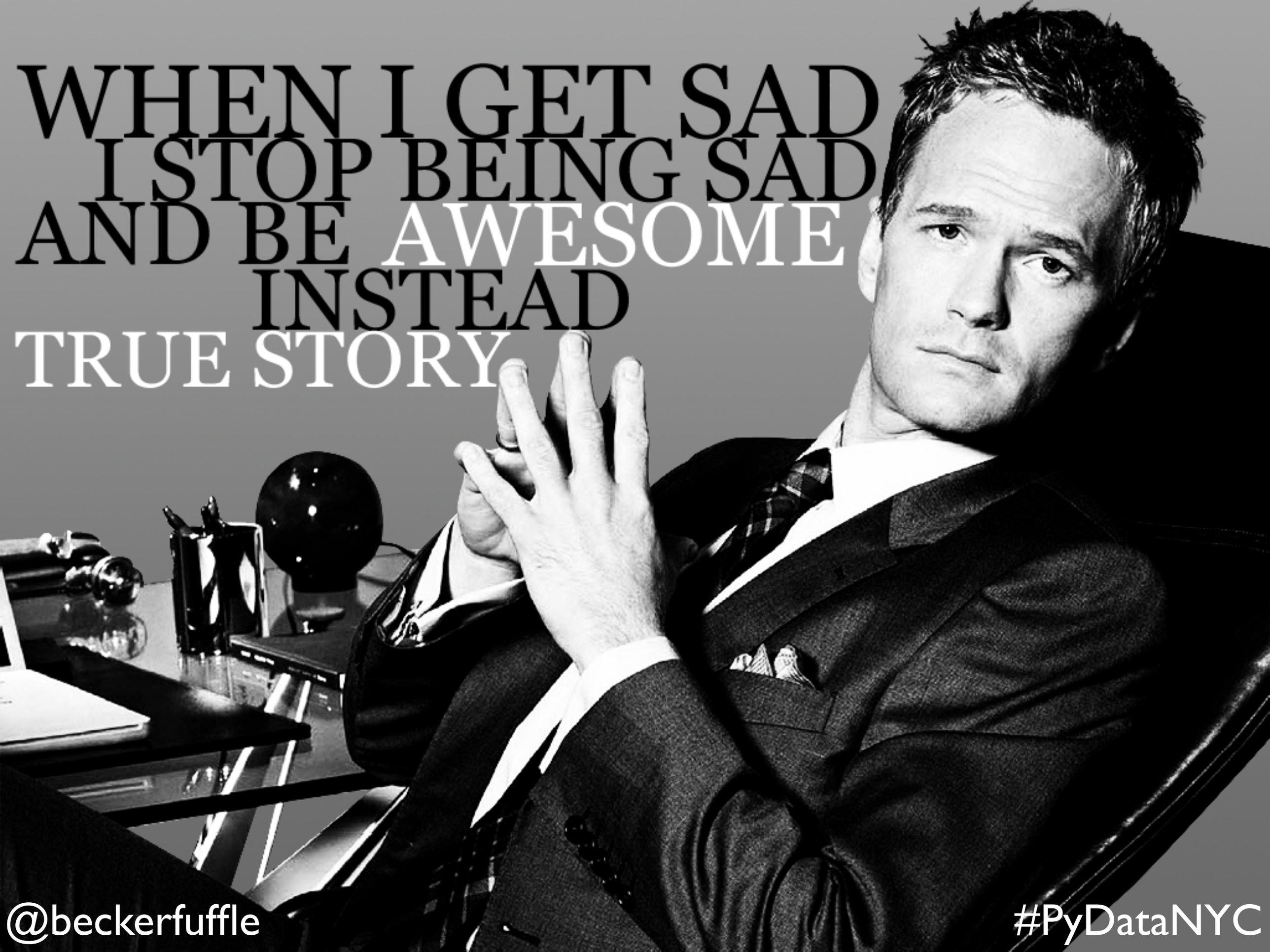
What is Data Science?



http://www.dataists.com/2010/09/the-data-science-venn-diagram/

WHEN I GET SAD I STOP BEING SAD AND BE AWESOME INSTEAD

TRUE STORY



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OSEMN!

- **O**btain

OSEMN!

- **O**btain
- **S**crub

OSEMN!

- **O**btain
- **S**crub
- **E**xplore

OSEMN!

- **O**btain
- **S**crub
- **E**xplore
- Model

OSEMN!

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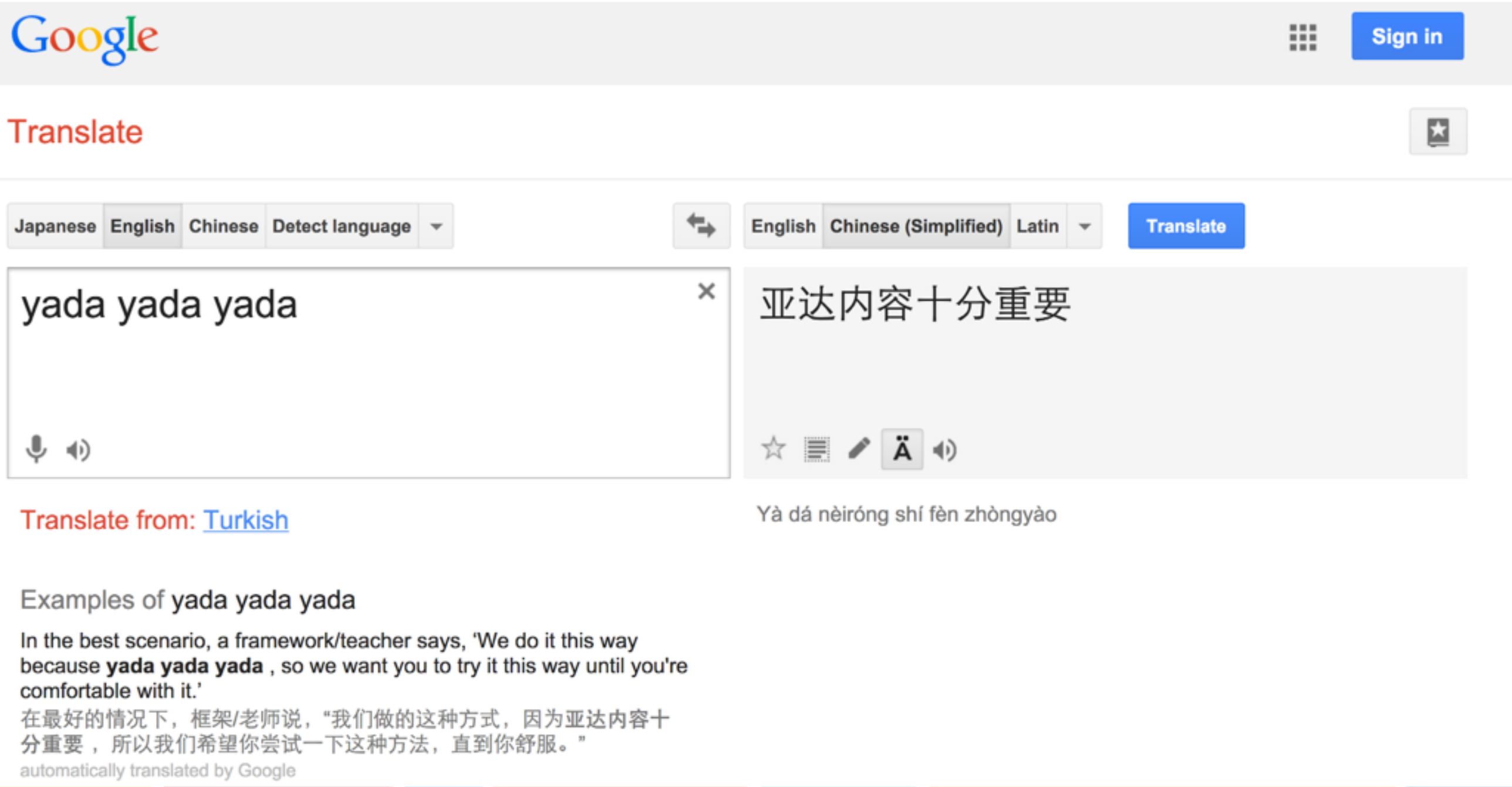
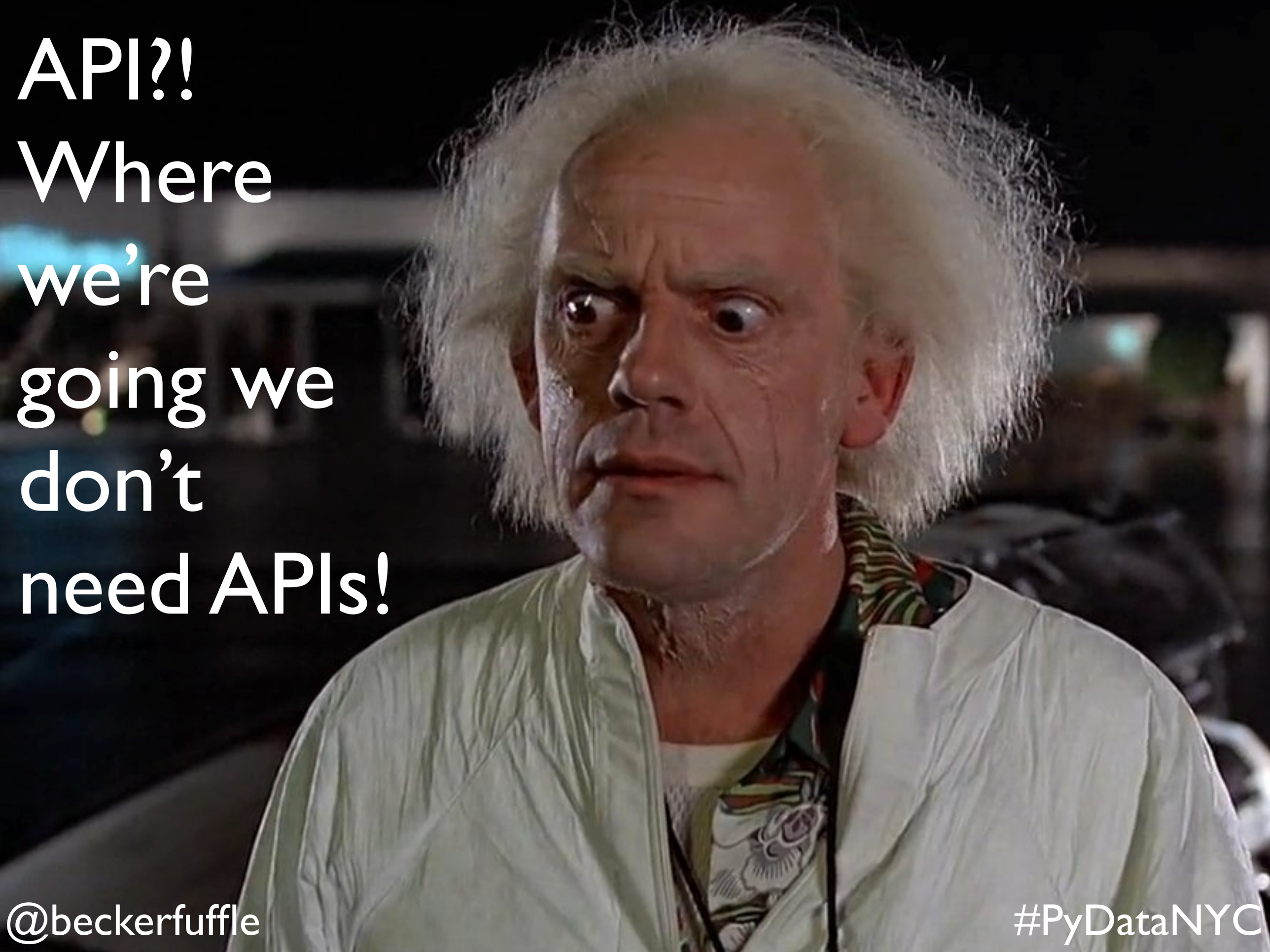
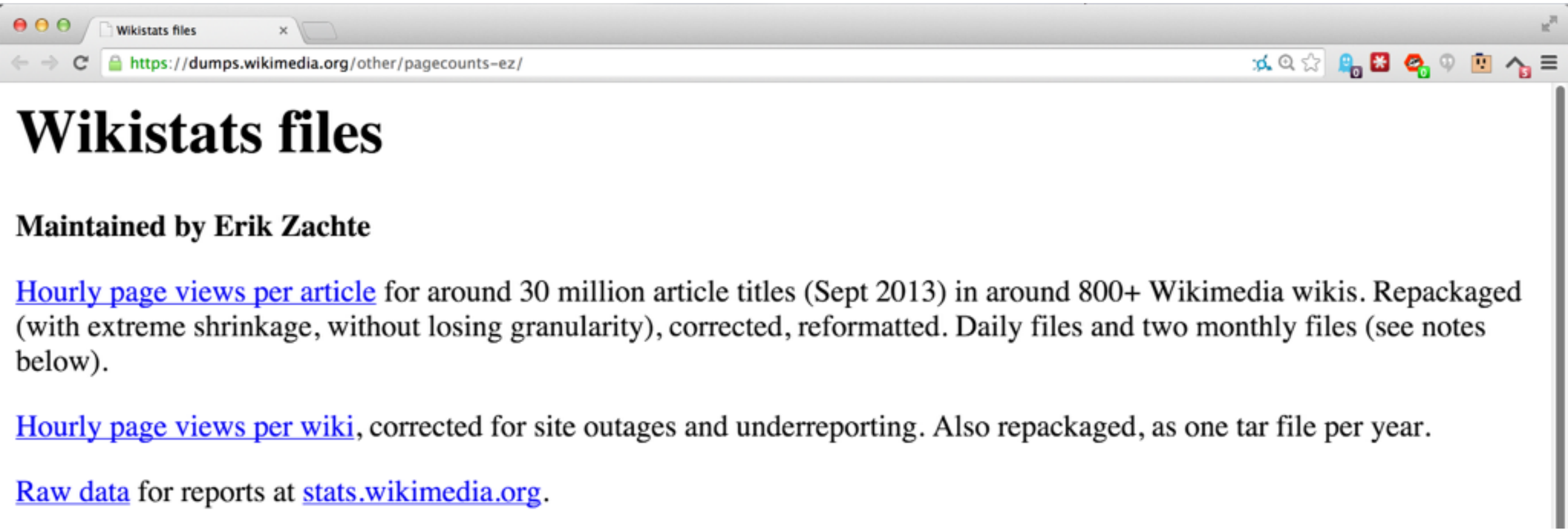
- **S**crub
- **E**xplore
- Model
- i**N**terpret

Language Classification




API?!
Where
we're
going we
don't
need APIs!
@beckerfuffle
#PyDataNYC

Scrape All The Things!



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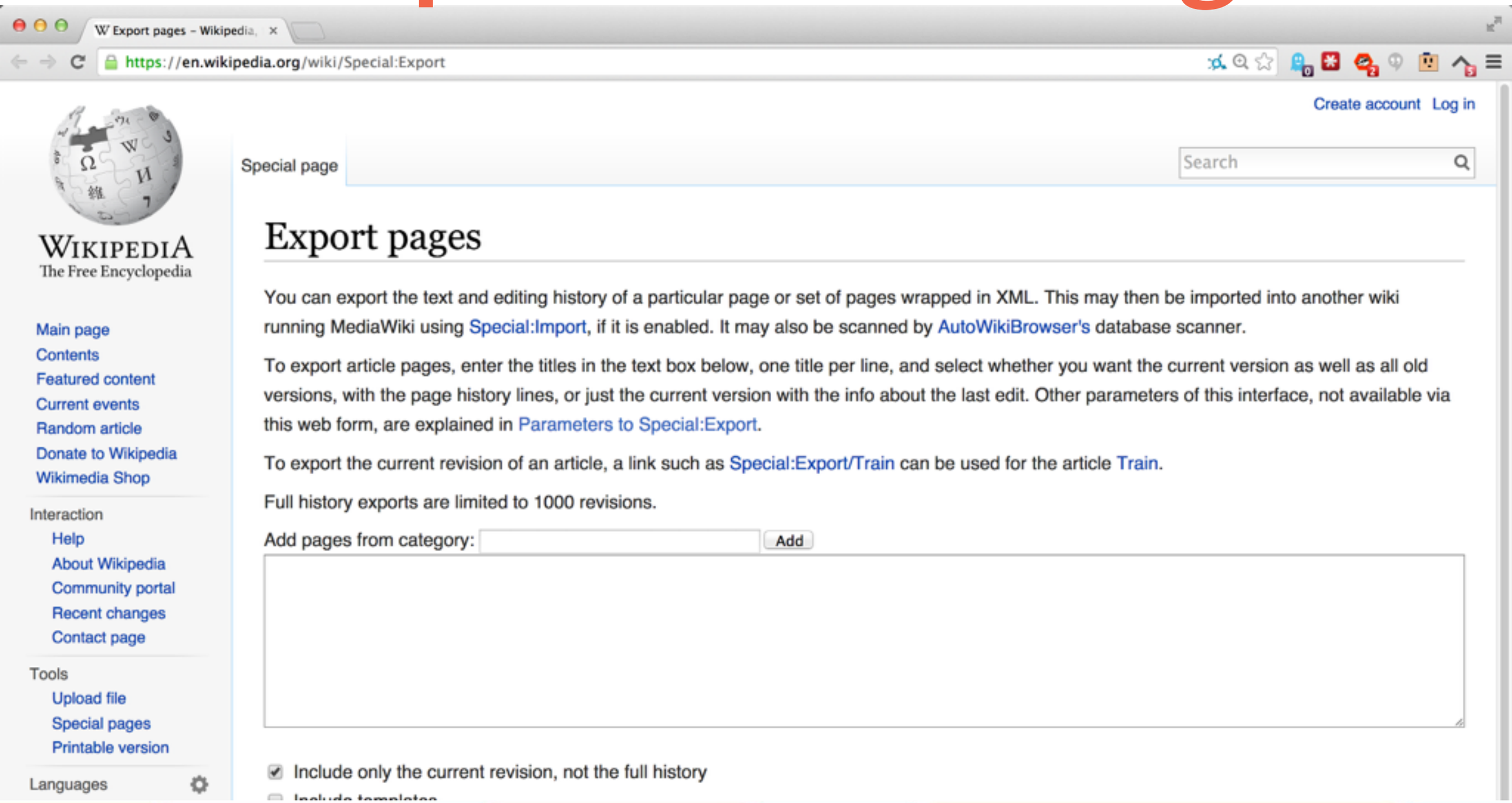

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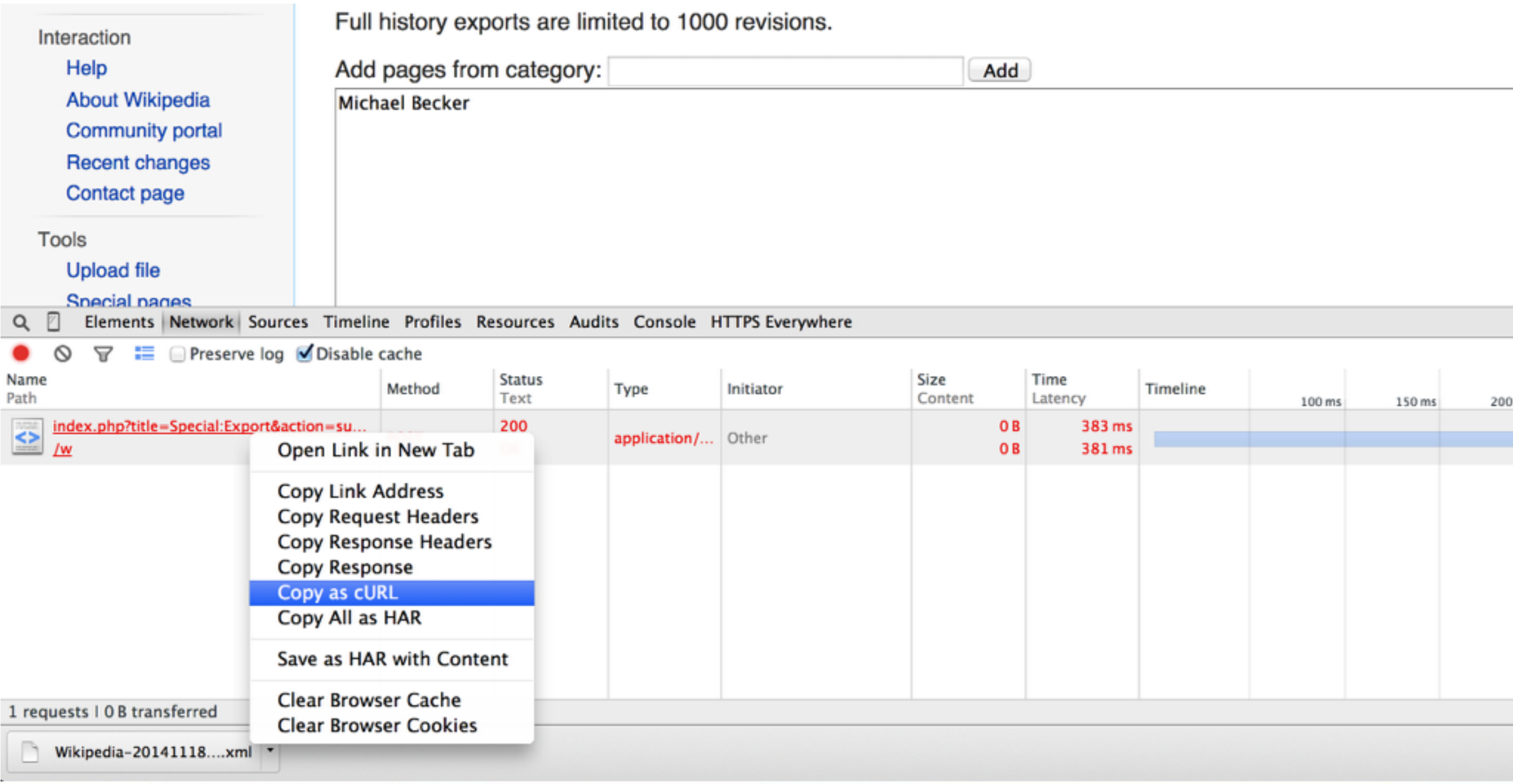

Scrape All The Things!

```
from uncurl import parse
```

```
print parse("curl 'https://en.wikipedia.org/w/index.php?title=Special:Expor
```

```
requests.post("https://en.wikipedia.org/w/index.php?title=Special:Export&a
ction=submit",
    data='catname=&pages=Michael+Becker&curonly=1&wpDownload=1',
    headers={
        "Accept": "text/html,application/xhtml+xml",
        "Accept-Encoding": "gzip,deflate",
        "Accept-Language": "en-US,en;q=0.8",
        "Cache-Control": "no-cache",
        "Connection": "keep-alive",
        "Content-Type": "application/x-www-form-urlencoded",
        "DNT": "1",
        "Origin": "https://en.wikipedia.org",
        "Pragma": "no-cache",
        "Referer": "https://en.wikipedia.org/wiki/Special:Export",
```

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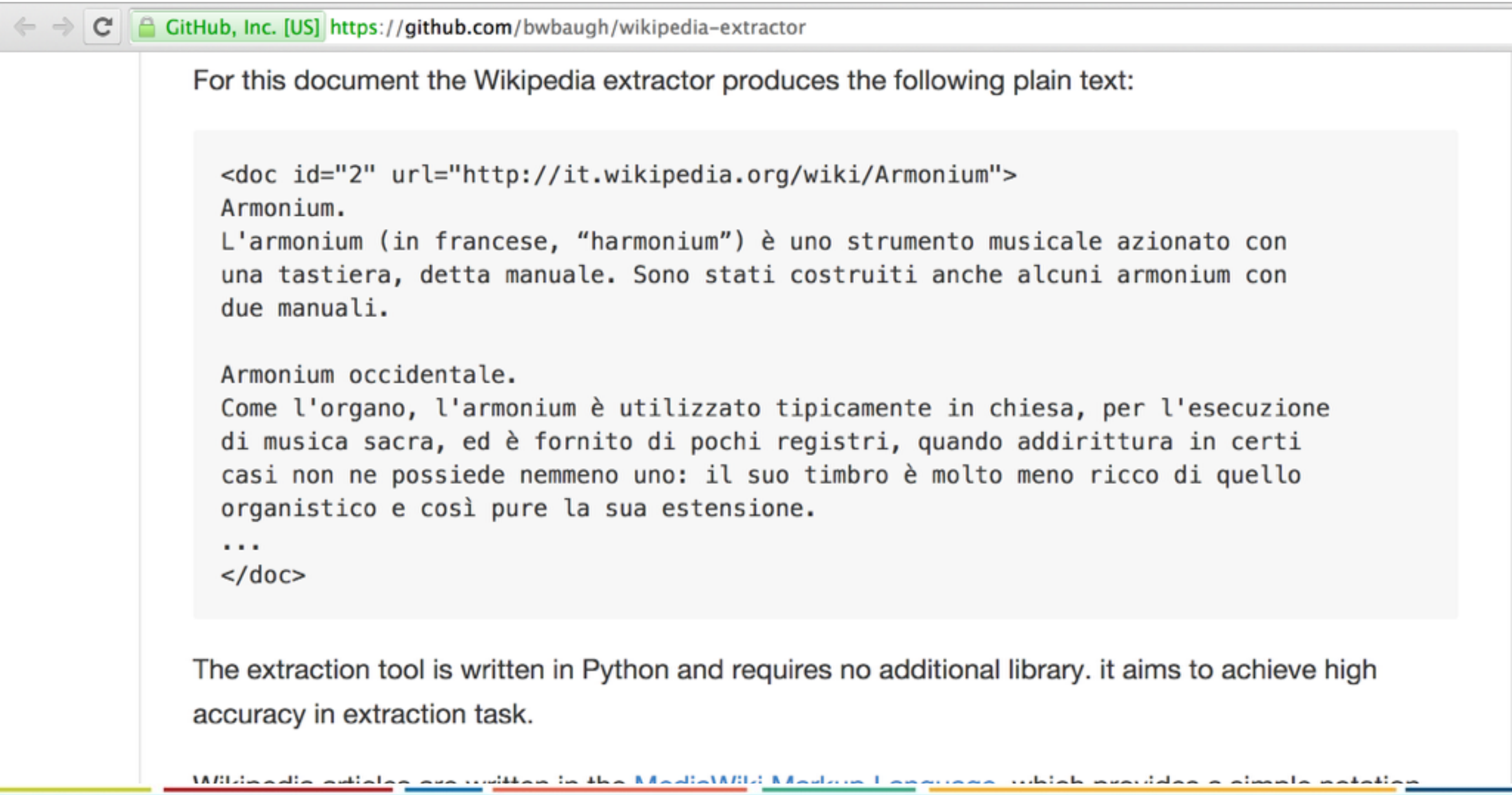
Scrub


GitHub, Inc. [US] https://github.com/bwbaugh/wikipedia-extractor
Wikipedia Extractor
Introduction
The project uses the *Italian Wikipedia* as source of documents for several purposes: as training data and as source of data to be annotated.
The Wikipedia maintainers provide, each month, an XML *dump* of all documents in the database: it consists of a single XML file containing the whole encyclopedia, that can be used for various kinds of analysis, such as statistics, service lists, etc.
Wikipedia dumps are available from Wikipedia database download.
The Wikipedia extractor tool generates plain text from a Wikipedia database dump, discarding any other information or annotation present in Wikipedia pages, such as images, tables, references and lists.

Scrub

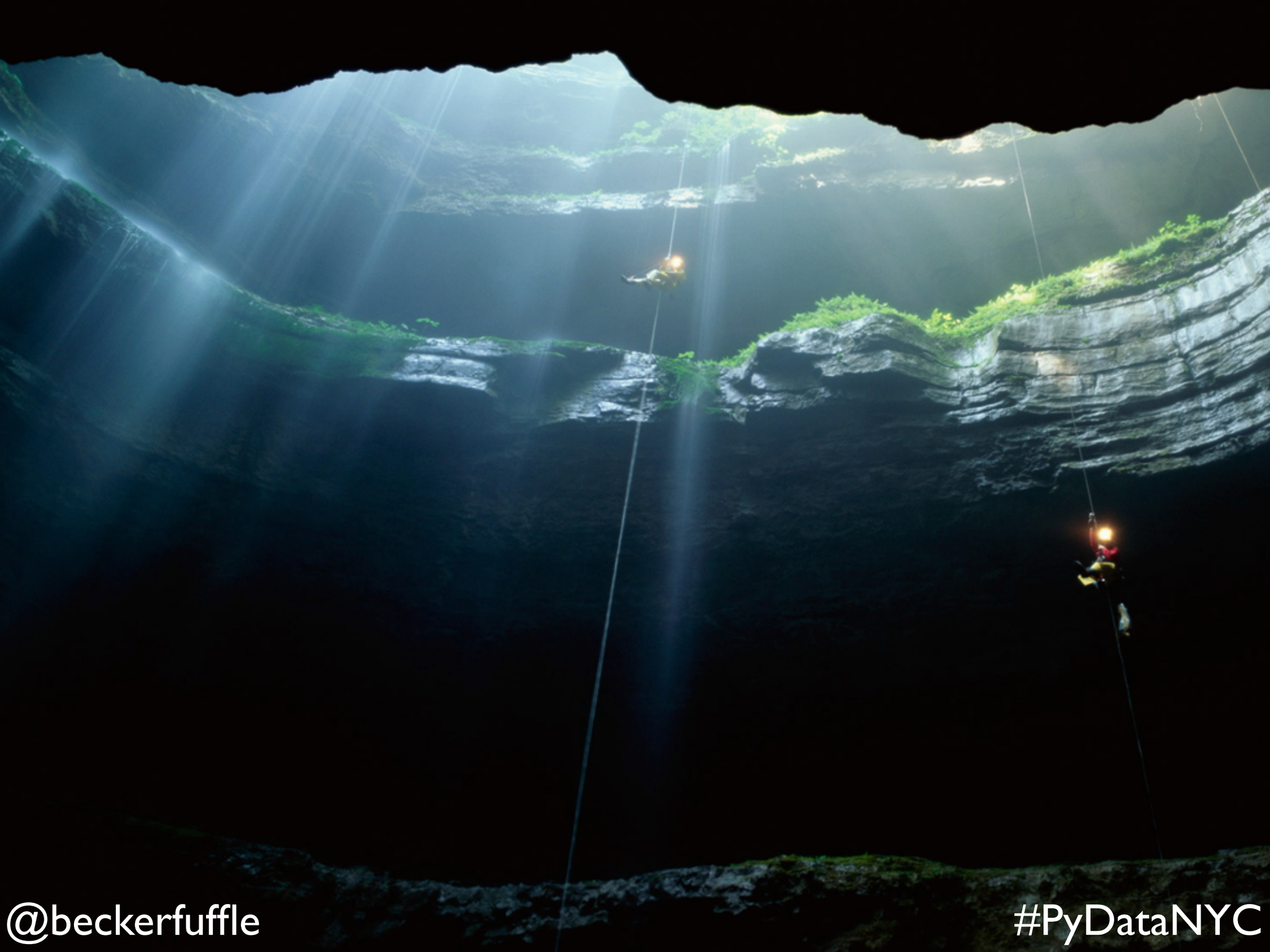

GitHub, Inc. [US] https://github.com/bwbaugh/wikipedia-extractor
For this document the Wikipedia extractor produces the following plain text:
<doc id="2" url="http://it.wikipedia.org/wiki/Armonium">
Armonium.
L'armonium (in francese, “harmonium”) è uno strumento musicale azionato con una tastiera, detta manuale. Sono stati costruiti anche alcuni armonium con due manuali.
Armonium occidentale.
Come l'organo, l'armonium è utilizzato tipicamente in chiesa, per l'esecuzione di musica sacra, ed è fornito di pochi registri, quando addirittura in certi casi non ne possiede nemmeno uno: il suo timbro è molto meno ricco di quello organistico e così pure la sua estensione.
...
</doc>
The extraction tool is written in Python and requires no additional library. it aims to achieve high accuracy in extraction task.

Scrub

```
import bz2
import re

article = re.compile(r'<doc id="(?P<id>\d+)" url="(?P<url>[^"]+)" t

def parse(filename):
  data = ""
  with bz2.BZ2File(filename, 'r') as f:
    for line in f:
      line = line.decode('utf-8')
      data += line
      if line.count('</doc>'):
        m = article.search(data)
        if m:
          yield m.groupdict()
        data = ""
```



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Explore

```
files = [f for f in os.listdir('.') if os.path.isfi
top_letters = []
for lang in files:
  print(lang)
  c = Counter()
  for article in parse(lang):
    c['num_articles'] += 1
    for letter in article['content']:
      c[letter] += 1
      c['num_letters'] += 1
  d = dict(c.most_common(2000))
  top_letters.append(d)
```

Pandas

```
from pandas import DataFrame
df = DataFrame(top_letters)
df.fillna(0, inplace=True)
df = df.set_index('lang')
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 127 entries, ace to zh
Columns: 10657 entries,  to □
dtypes: float64(10578), int64(79)
```

Pandas

```
df2 = df.join(df.div(df['num_letters']), axis='index'), rsuffix='_perc')
percs = [col for col in df2.columns if col.endswith('_perc')]
df3 = df2[percs]
df3
```

	_perc	_perc	_perc	!_perc	"_perc	#_perc	$_perc	%_perc	&_perc
lang									
ace	0	0.009957	0.143409	0.000000	0.002081	0.000000	0.000018	0.000208	0.00000
af	0	0.004649	0.154431	0.000012	0.003242	0.000001	0.000017	0.000099	0.00001
als	0	0.006280	0.150704	0.000031	0.004069	0.000002	0.000001	0.000756	0.00001
am	0	0.011811	0.185362	0.000098	0.001537	0.000003	0.000010	0.000159	0.00005
ar	0	0.003733	0.163212	0.000031	0.001961	0.000002	0.000022	0.000354	0.00000

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Visualize

```
from sklearn.decomposition import PCA
from sklearn.cluster import KMeans
import seaborn as sns

num_clusters = 4

palette = sns.color_palette("colorblind", num_clusters)
est = KMeans(num_clusters, max_iter=30000)  # 4 clusters
est.fit(df3.values)
y_kmeans = est.predict(df3.values)

pca = PCA(n_components=2)
pca.fit(df3.values)
X_trans = pca.transform(df3.values)
plt.scatter(X_trans[:, 0], X_trans[:, 1], c=[palette[y] for y in y_kmeans], s=50)
```

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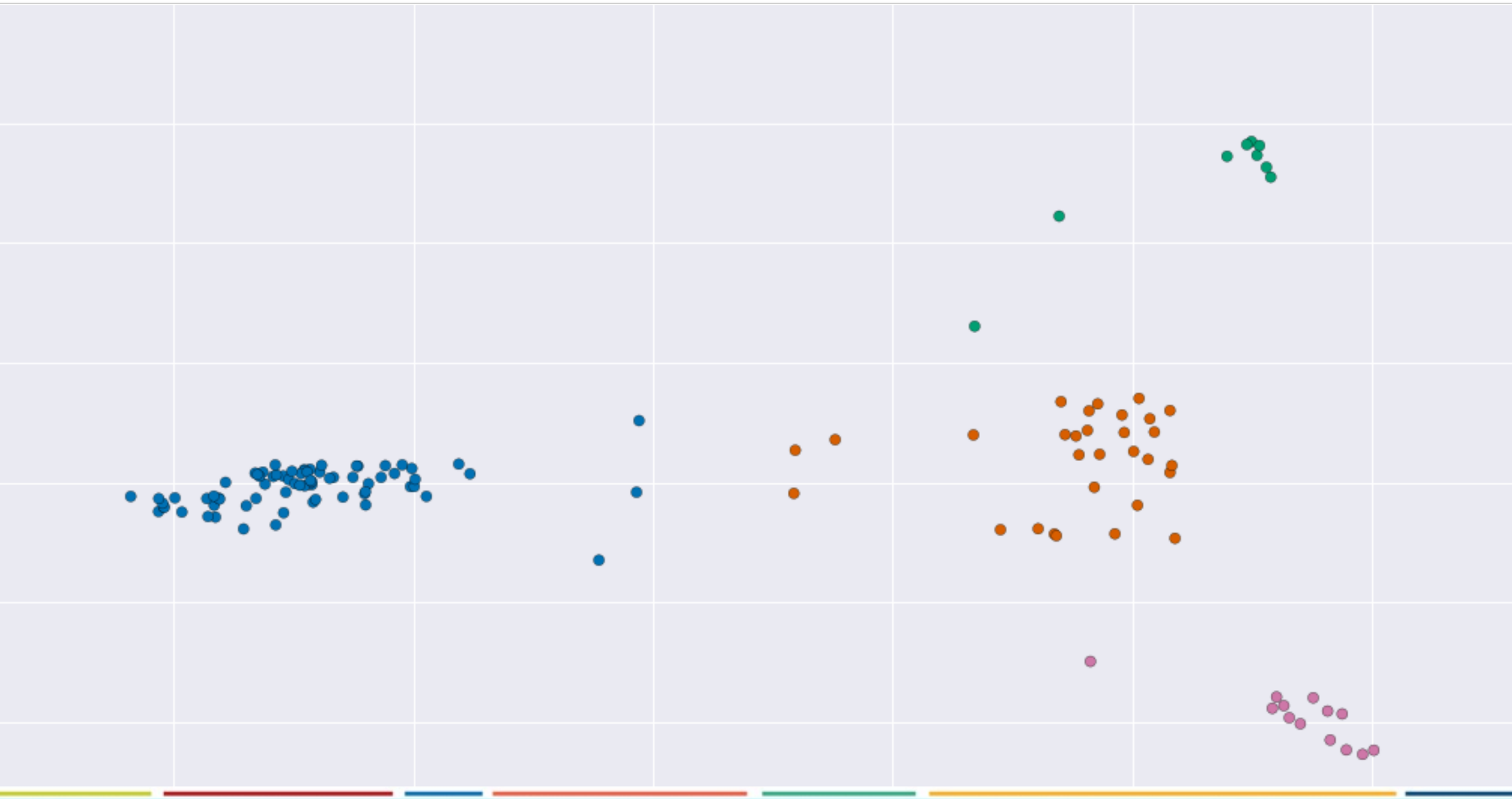


Explore More

```
from sklearn.metrics.pairwise import pairwise_distances

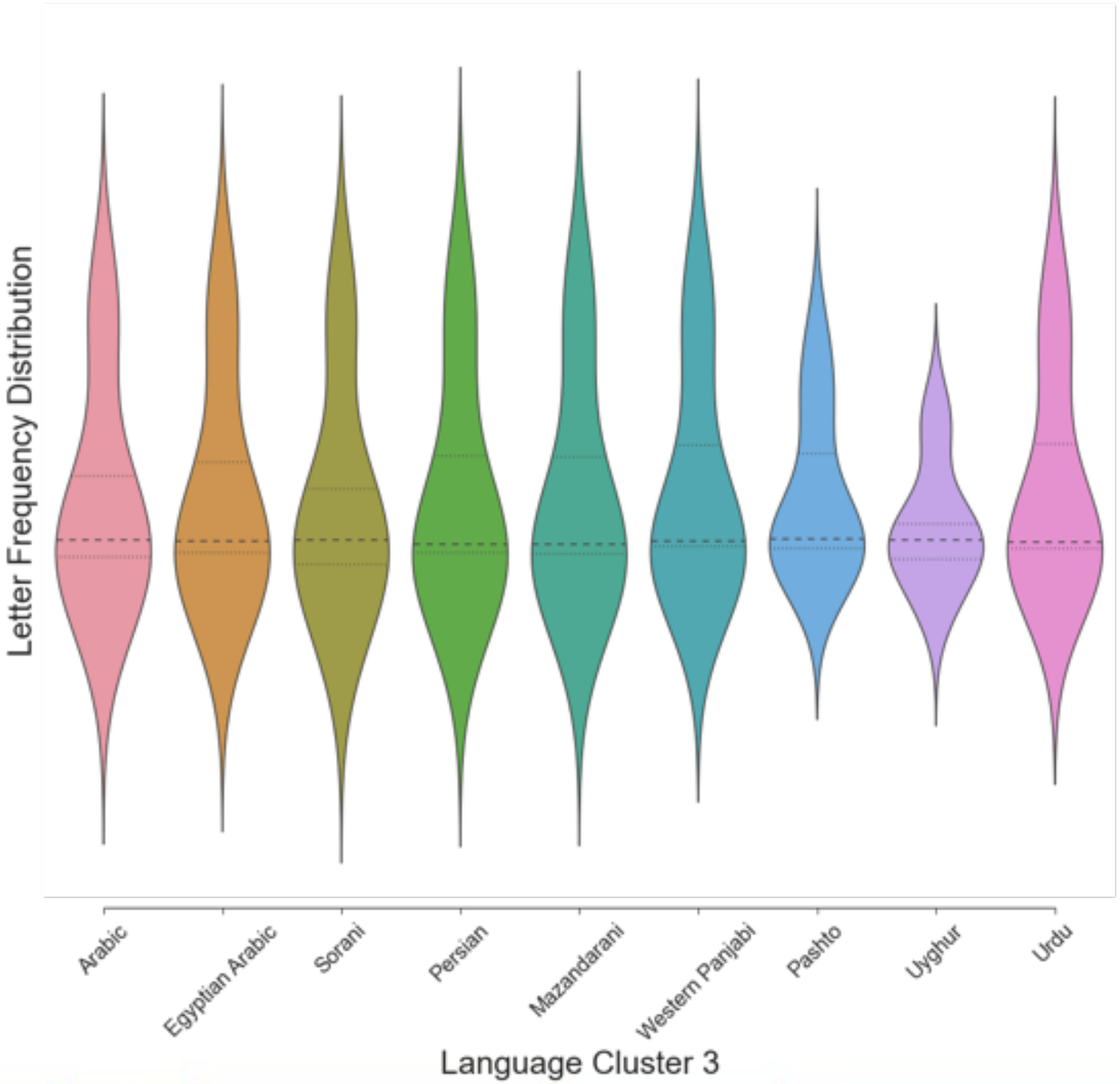
cluster_dfs = {}
cluster_langs = {}
cluster_distances = {}
for cluster_num in range(4):
    indexes = [i for i in range(y_kmeans.shape[0]) if y_kmeans[i] == cluster_num]
    cluster_langs[cluster_num] = [langs[i] for i in indexes]
    cluster_dfs[cluster_num] = df3.loc[cluster_langs[cluster_num],:]
```

```
# Calculate pairwise distances and display
print('Cluster #{0}'.format(cluster_num))
cluster_distances[cluster_num] = pairwise_distances(cluster_dfs[cluster_num].values)
n, m = cluster_distances[cluster_num].shape
distances = set([])
for i in range(n):
    for j in range(m):
        if i == j:
            continue
        distances.add((cluster_distances[cluster_num][i,j], tuple(sorted([i, j]))))
for a in sorted(distances)[:20]:
    print_sim(a[0], a[1][0], a[1][1], cluster_langs[cluster_num])
print()
```

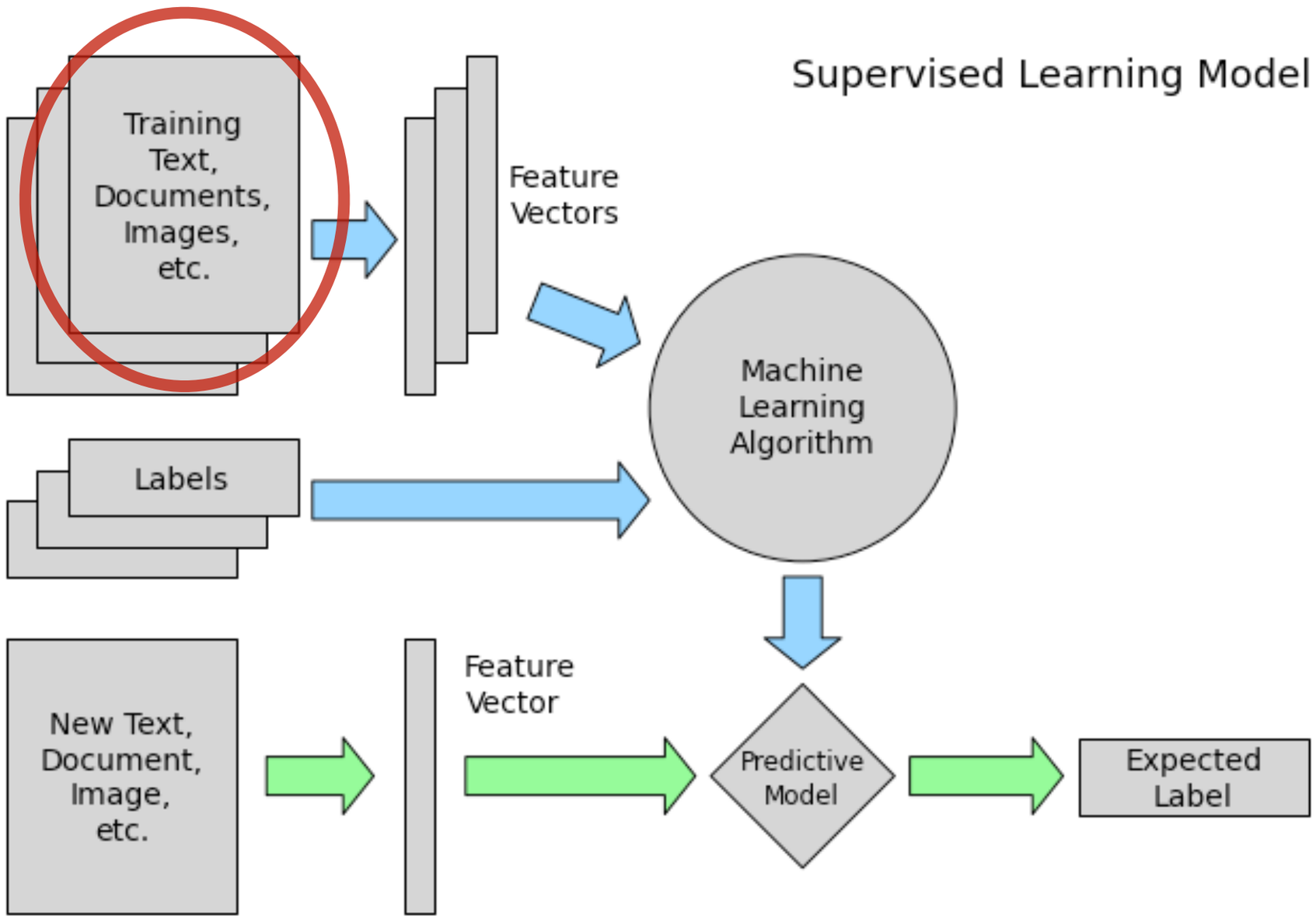
Explore More

```
Cluster #0
0.00382418517864 ('Croatian (Hrvatski)', 'Serbo-Croatian (Srpskohrvatski / Српскохрватски)')
0.00520780738783 ('Bosnian (Bosanski)', 'Croatian (Hrvatski)')
0.00589451786297 ('Bosnian (Bosanski)', 'Serbo-Croatian (Srpskohrvatski / Српскохрватски)')
0.00834338647842 ('Indonesian (Bahasa Indonesia)', 'Malay (Bahasa Melayu)')
0.01927256350 62 ('Danish (Dansk)', 'Norwegian (Bokmål) (Norsk (Bokmål))')
0.0232608076499 ('English (English)', 'Scots (Scots)')
Cluster #1
0.0392927583851 ('Arabic (العربية)', 'Egyptian Arabic (مصرى (Maṣri))')
0.0437481324993 ('Persian (فارسی)', 'Mazandarani (مَزروني)')
0.0508231659684 ('Western Panjabi (شاہ مکھی پنجابی (Shāhmukhī Pañjābī))', 'Urdu (اردو)')
Cluster #2
0.0414121771519 ('Wu (吴语)', 'Chinese (中文)')
0.0425573179877 ('Wu (吴语)', 'Cantonese (粵語)')
0.0454926761733 ('Cantonese (粵語)', 'Chinese (中文)')
0.0468059566543 ('Gan (贛語)', 'Cantonese (粵語)')
0.0532862863375 ('Gan (贛語)', 'Wu (吴语)')
Cluster #3
0.025823417882 ('Chechen (Нохчийн)', 'Russian (Русский)')
0.0352906788461 ('Bulgarian (Български)', 'Macedonian (Македонски)')
0.0460701274904 ('Bulgarian (Български)', 'Chechen (Нохчийн)')
0.0495084304888 ('Bulgarian (Български)', 'Russian (Русский)')
```

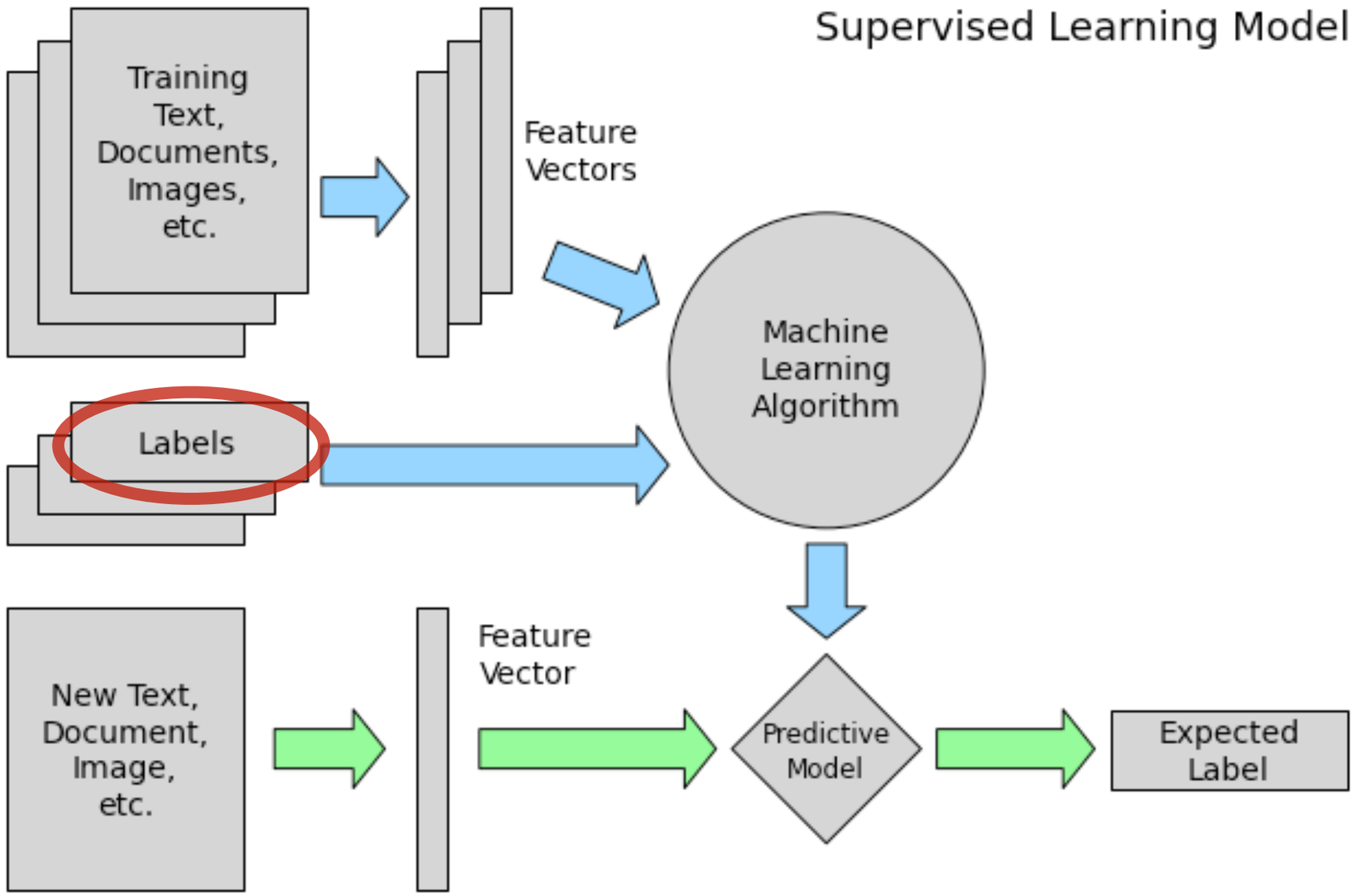
Explore Even More



Supervised Learning



Supervised Learning



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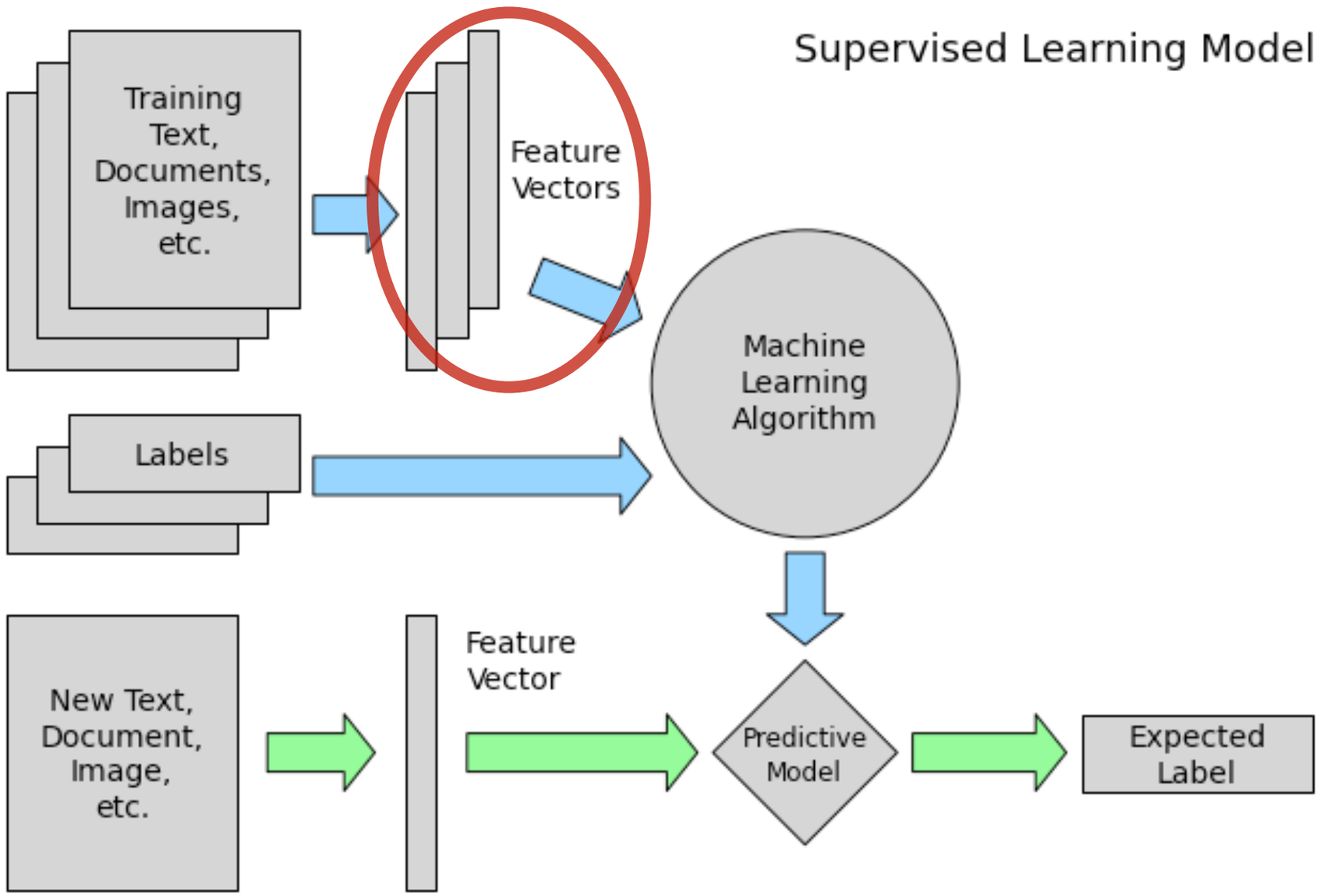

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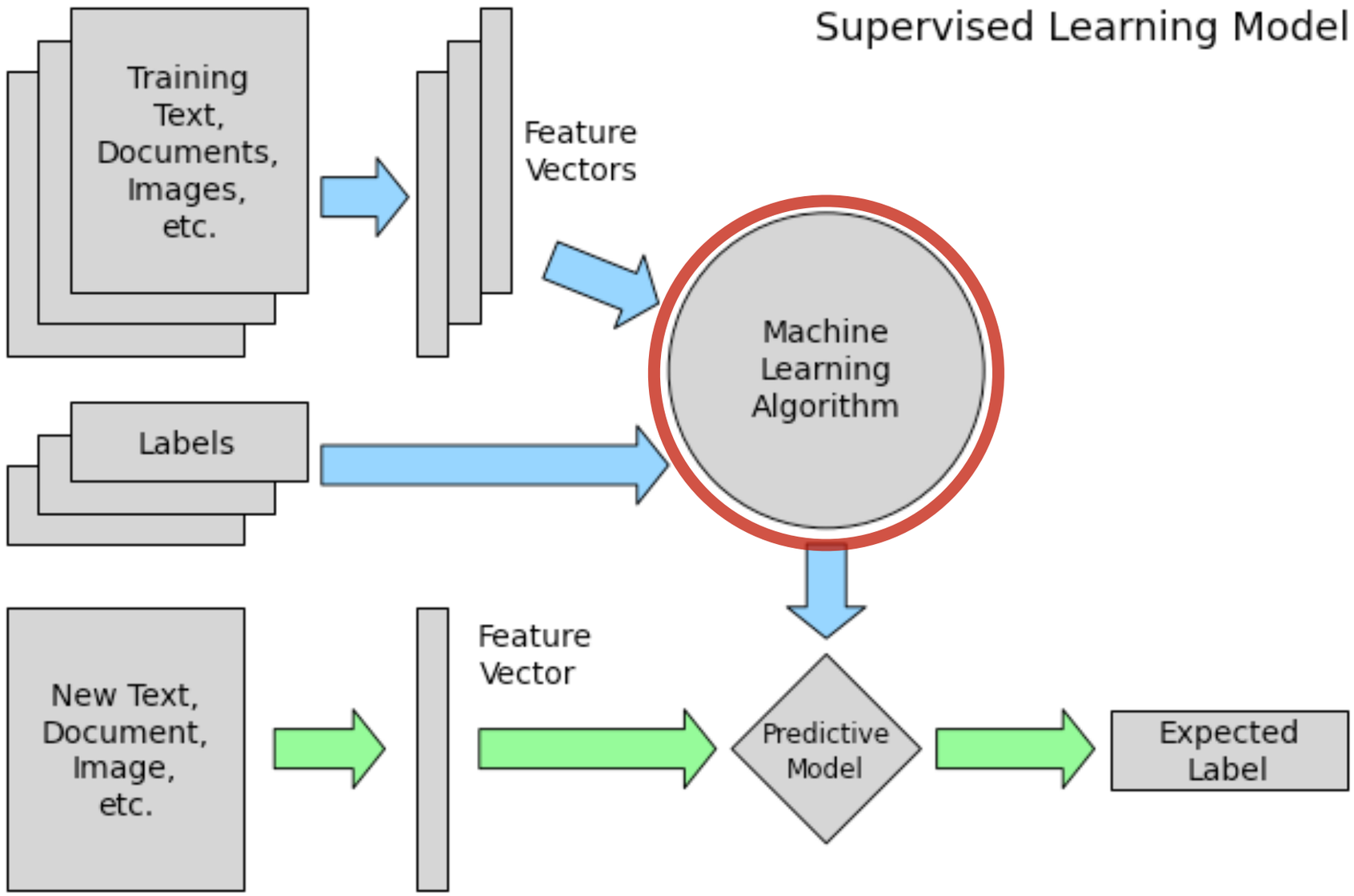

The Model

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.pipeline import Pipeline
from sklearn.svm import SVC
```

```
vect = TfidfVectorizer(analyzer='char', ngram_range=(2, 3))
clf = SVC()
text_clf = Pipeline([
    ('vect', vect),
    ('clf', clf),
])
text_clf = text_clf.fit_transform(X_train, y_train)
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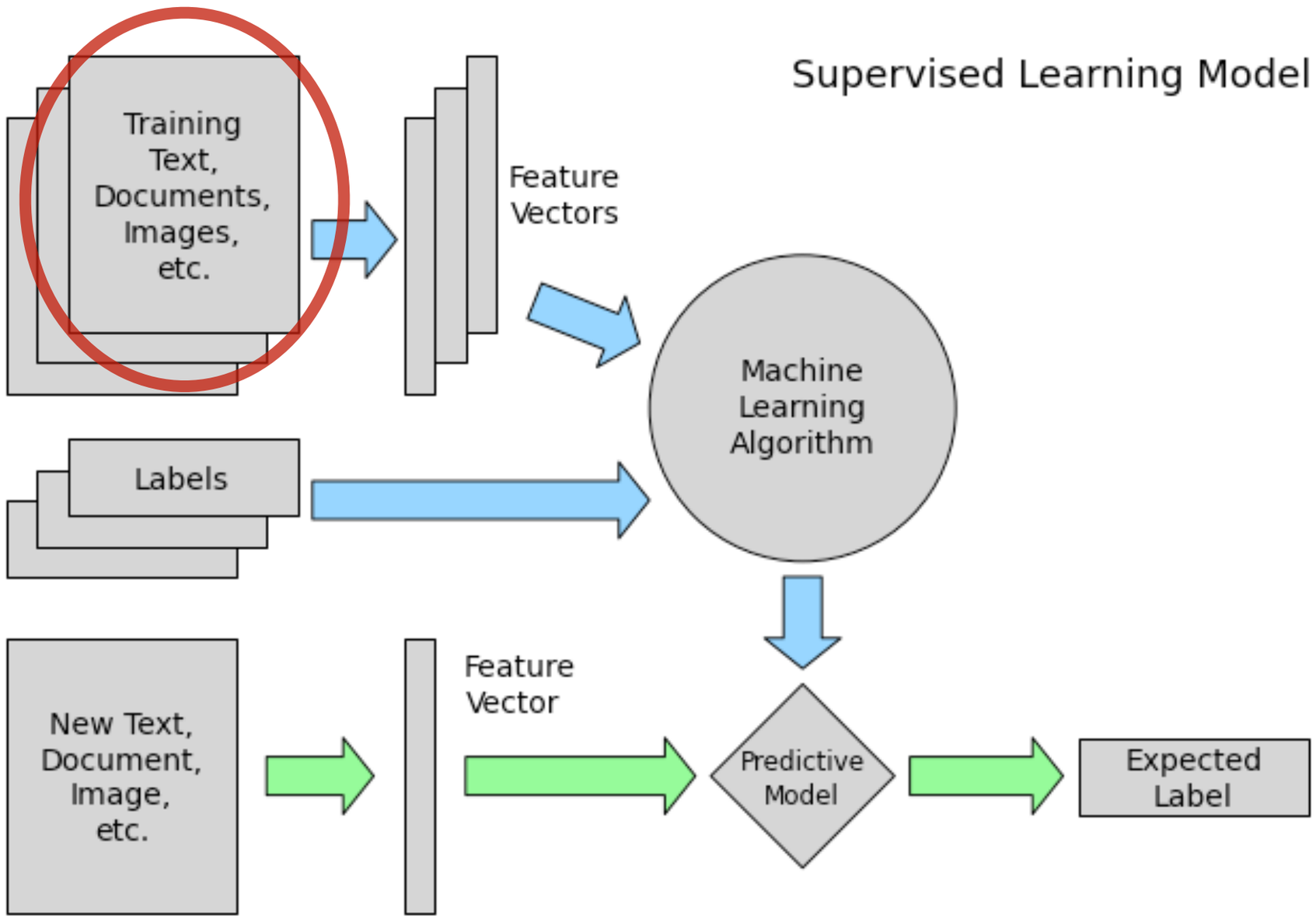
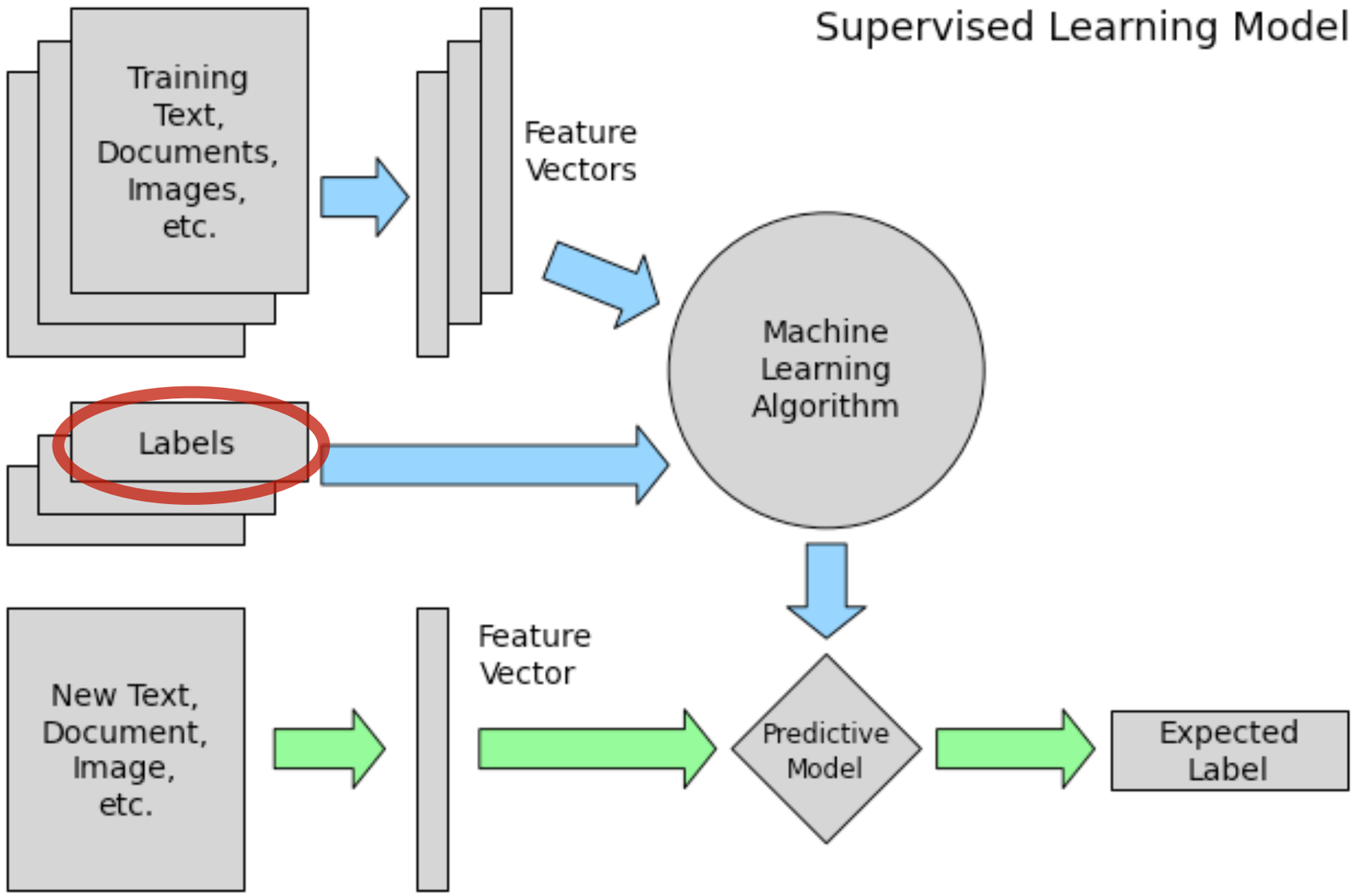


X_train

```
for x in X_train[:10]:
    print ' '.join(unicode(x, 'utf8')[:70].split())
```

```
Szöul Szöul (서울 특별시 Sŏul T'ŭkpyŏlsi, szoros átírásban: Szoul thukpjol
Sean Connery Cecil B. DeMille Award (1996) | baftaawards Beste hov
Nemecká demokratická republika Nemecká demokratická republika (NDR, h
Plastic A plastic material is any of a wide range of synthetic or sem
Phaistose ketas Phaistose ketas on põletatud savist ketas, mille leid
Soustava SI Soustava SI (zkratka z francouzského Le Système Internati
Баку Баку () је главни град Азербејџана. Налази се у јужном делу полу
Gottlob Frege nume Friedrich Ludwig Gottlob Frege
Belgrado Belgrado (Београд / Beograd em servo-croata ouça ) é a capi
Cálculo infinitesimal El cálculo infinitesimal o cálculo de infinites
```

Supervised Learning



y_train

```
y
```

```
['uk', 'cs', 'ko', 'es', 'war', 'de', 'de', 'pl', 'ar', 'cs']
```

```
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
y_train = le.fit_transform(y)
y_train
```

```
array([35,  3, 21, ...,  8, 18, 30])
```

Tuning

sklearn.svm.SVC

class `sklearn.svm.`**SVC**(*C=1.0, kernel='rbf', degree=3, gamma=0.0, coef0=0.0, shrinking=True, probability=False, tol=0.001, cache_size=200, class_weight=None, verbose=False, max_iter=-1, random_state=None*) ¶

C-Support Vector Classification.

The implementations is a based on libsvm. The fit time complexity is more than quadratic with the number of samples which makes it hard to scale to dataset with more than a couple of 10000 samples.

The multiclass support is handled according to a one-vs-one scheme.

For details on the precise mathematical formulation of the provided kernel functions and how gamma, coef0 and degree affect each, see the corresponding section in the narrative documentation: *Kernel functions*.

RandomizedSearchCV

```
from sklearn.grid_search import RandomizedSearchCV
from scipy.stats import uniform as sp_uniform
```

```
clf = SVC()
param_dist = {
    'C': sp_uniform(1, 4),
    'kernel': ['linear', 'rbf'],
}

random_search = RandomizedSearchCV(
    clf, param_distributions=param_dist, n_jobs=9)
random_search.fit(X_trans, y_train)
```

RandomizedSearchCV

```
random_search.best_score_
```

```
0.9664767793989962 3
```

```
random_search.best_params_
```

```
{'C': 3.3357996909950347, 'kernel': 'rbf'}
```

sklearn.metrics

- accuracy_score
- classification_report
- confusion_matrix

```
y_pred = clf.predict(X_test)
```

accuracy_score

```
from sklearn.metrics import accuracy_score
ac = accuracy_score(y_true, y_pred)
ac
```

```
0.9563603603603603
```

classification_report

```
from sklearn.metrics import classification_report
cr = classification_report(y_true, y_pred, target_names=target_names)
cr
```

```
             precision    recall  f1-score   support

         af       0.99      1.00      1.00      1500
        als       0.98      0.97      0.98      1500
         az       1.00      1.00      1.00      1500
        bar       0.97      0.98      0.98      1500
        bcl       0.95      0.96      0.95      1500
         bn       1.00      1.00      1.00      1500
         bs       0.42      0.62      0.50      1500

        vls       1.00      0.99      1.00      1500
        war       0.98      0.96      0.97      1500
         zh       1.00      1.00      1.00      1500

avg / total       0.96      0.96      0.95    111000
```

classification_report

```
from sklearn.metrics import classification_report
cr = classification_report(y_true, y_pred, target_names=target_names)
cr
```

```
             precision    recall  f1-score   support

         af       0.99      1.00      1.00      1500
        als       0.98      0.97      0.98      1500
         az       1.00      1.00      1.00      1500
        bar       0.97      0.98      0.98      1500
        bcl       0.95      0.96      0.95      1500
         bn       1.00      1.00      1.00      1500
         bs       0.42      0.62      0.50      1500

        vls       1.00      0.99      1.00      1500
        war       0.98      0.96      0.97      1500
         zh       1.00      1.00      1.00      1500

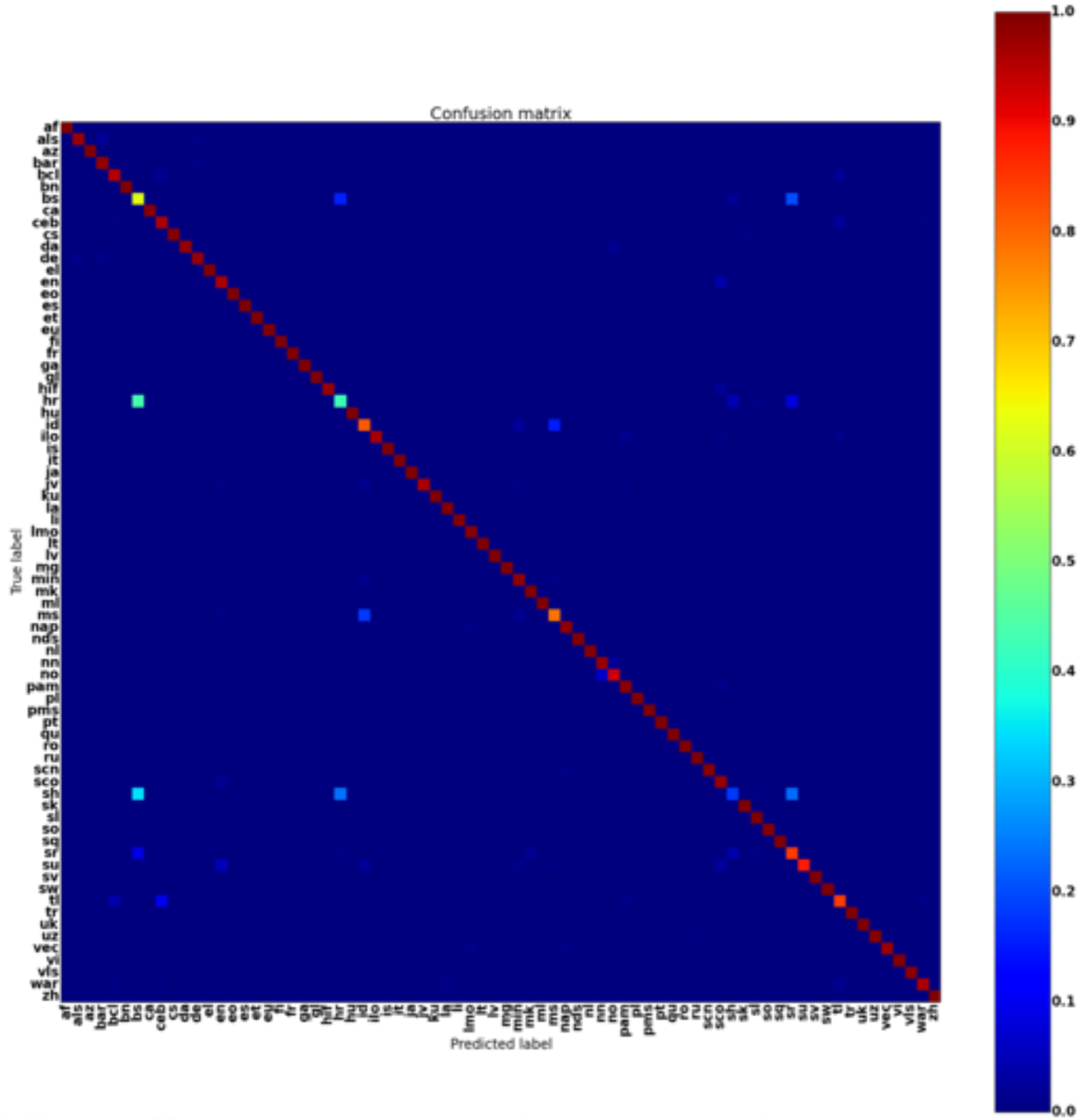
avg / total       0.96      0.96      0.95    111000
```

I'm Confused

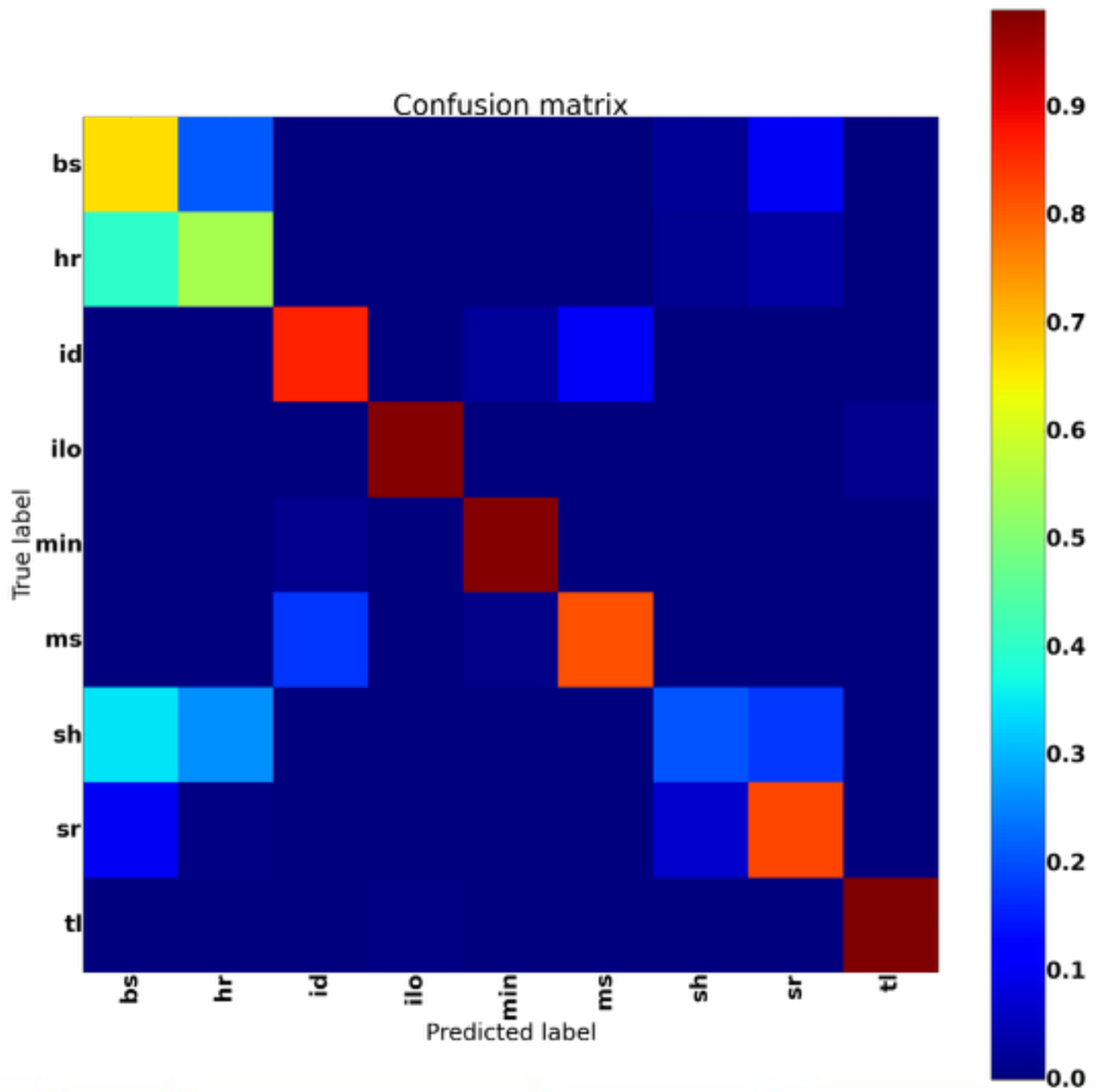
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_true, y_pred)
cm
```

```
array([[1497,    0,    0, ...,    0,    0,    0],
       [   0, 1461,    0, ...,    0,    0,    0],
       [   0,    0, 1499, ...,    0,    0,    0],
       ...,
       [   1,    0,    0, ..., 1487,    0,    0],
       [   0,    0,    0, ...,    0, 1439,    0],
       [   0,    0,    0, ...,    0,    0, 1499]])
```

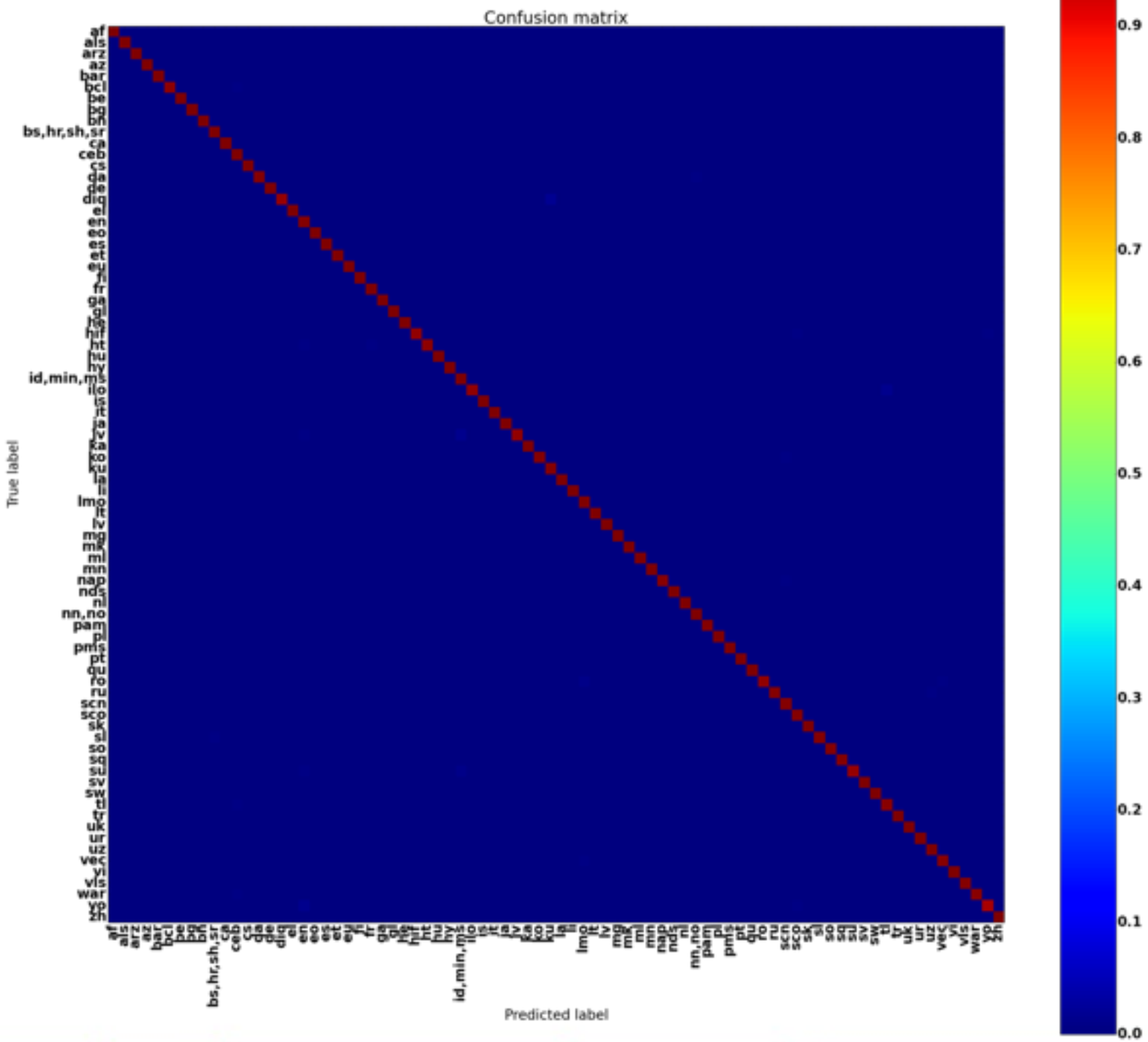
I’m Confused


Confusion matrix
True label
Predicted label
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

I’m Confused


Confusion matrix
bs
hr
id
ilo
min
ms
sh
sr
tl
True label
Predicted label
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

INterpret


Confusion matrix
True label
Predicted label
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

My Info

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