Data Engineering 101: Building your first data product

July 9th, 2014

Today

Disclaimer:

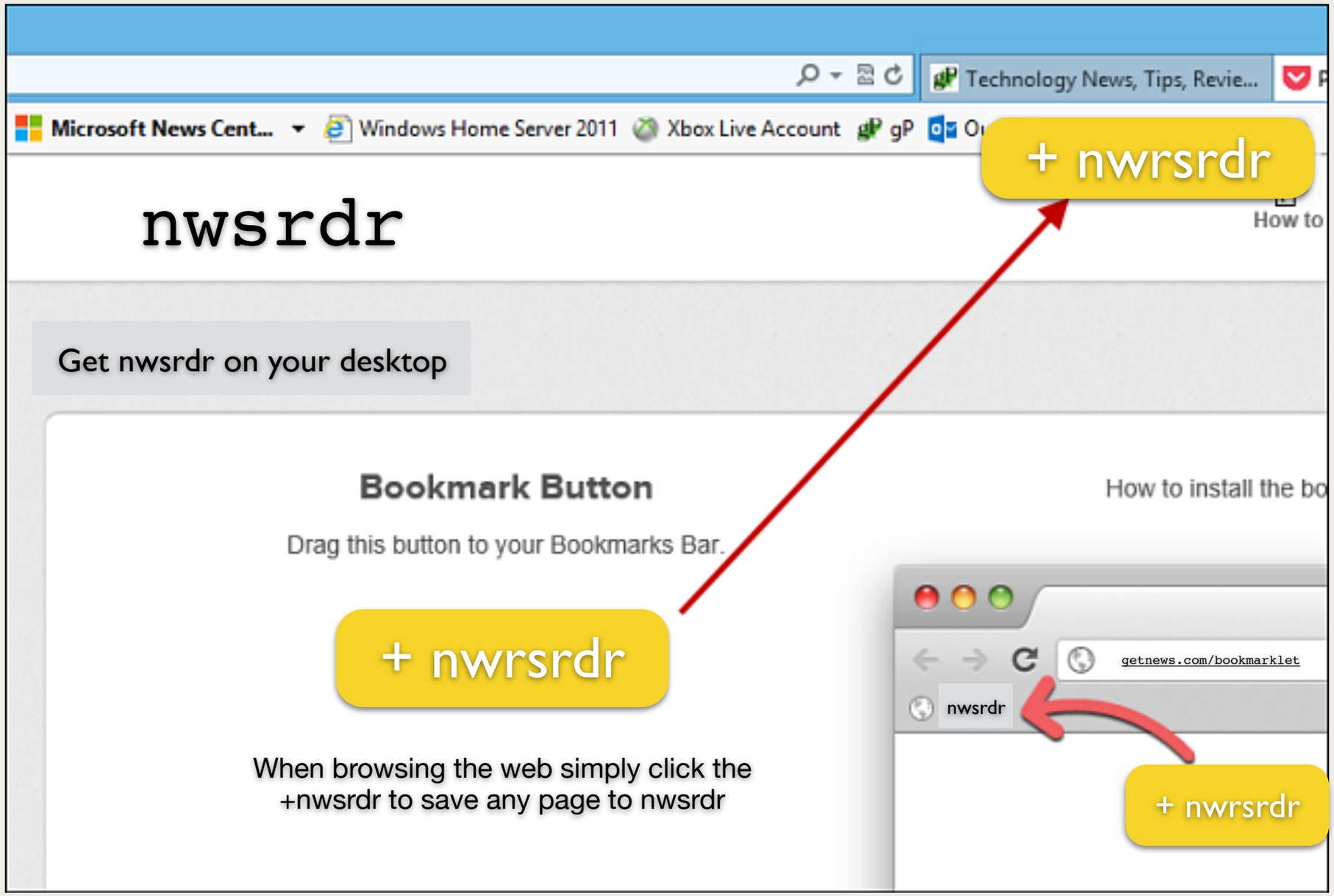
All characters appearing in this presentation are fictitious. Any resemblance to real persons, living or dead, is purely coincidental.

Today

Disclaimer:

This presentation contains strong opinions that you may or may not agree with. All thoughts are my own.

nwsrdr (News Reader)



Source: http://www.groovypost.com/wp-content/uploads/2013/05/Bookmark-Button.png

nwsrdr

It's like Prismatic + Pocket + Google Reader (RIP) + Delicious!

- Auto-categorize Articles
- Find Similar Articles
- Recommend articles
- Suggest Feeds to Follow
- No Ads!

nwsrdr

It's like Prismatic + Pocket + Google Reader (RIP) + Delicious!

- Naive Bayes (classification)
- Clustering (unsupervised learning)
- Collaborative Filtering
- Triangle Closing
- Real Business Model!

Data Products

Product Built on Data
(that you sell)

OR

Data Products

Product that Generates Data

OR

Data Products

Product that Generates Data
(that you sell)

OR

Data Products

Product that Generates Data
(that you sell)

OR

i.e. Facebook

Data Products

Source: http://gifgif.media.mit.edu/

Data Products

Source: http://www.adamlaiacano.com/post/57703317453/data-generating-products

Data Generating Products

Source: http://www.adamlaiacano.com/post/57703317453/data-generating-products

Data Generating Products

Products that enhance a users' experience the more "data" a user provides

Ex: Recommender Systems

Data Engineering

Josh Wills
@josh_wills

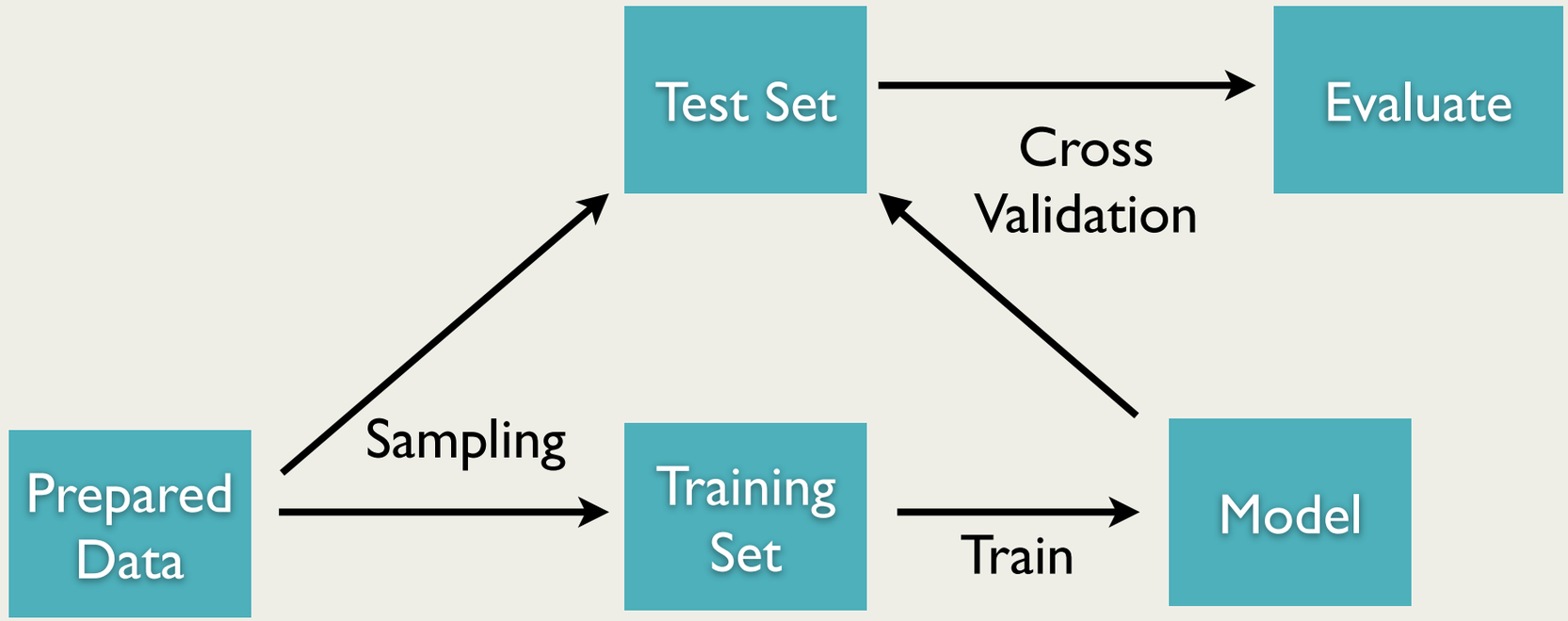
Follow

Engineer

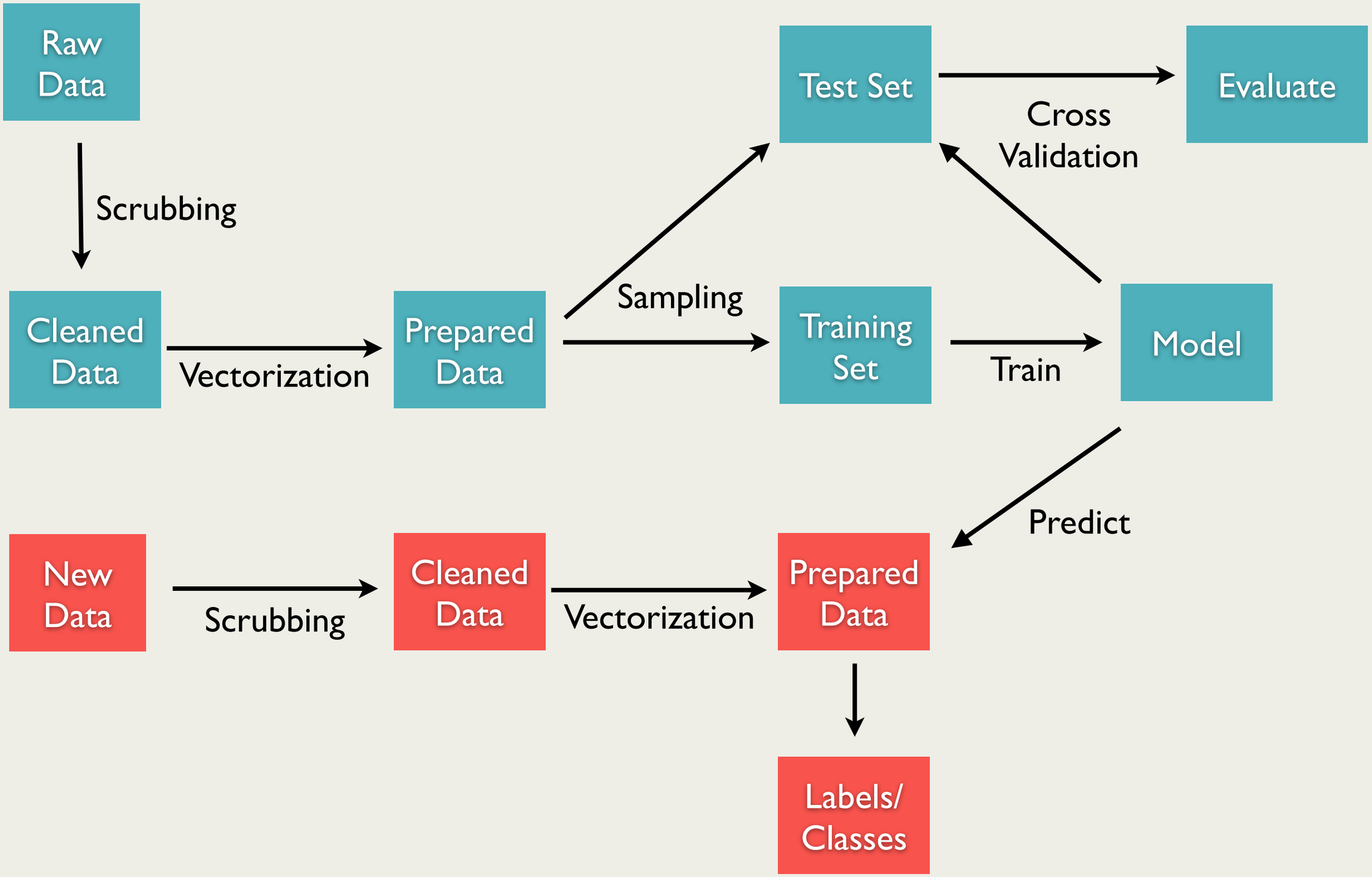
Data ~~Scientist~~ (n.): Person who is better at statistics than any software engineer and better at software engineering than any ~~statistician.~~ Data Scientist

Reply Retweet Favorite More

Data Science



Data Engineering



What

- Naive Bayes (classification)
- Clustering (unsupervised learning)
- Collaborative Filtering
- Triangle Closing
- Real Business Model

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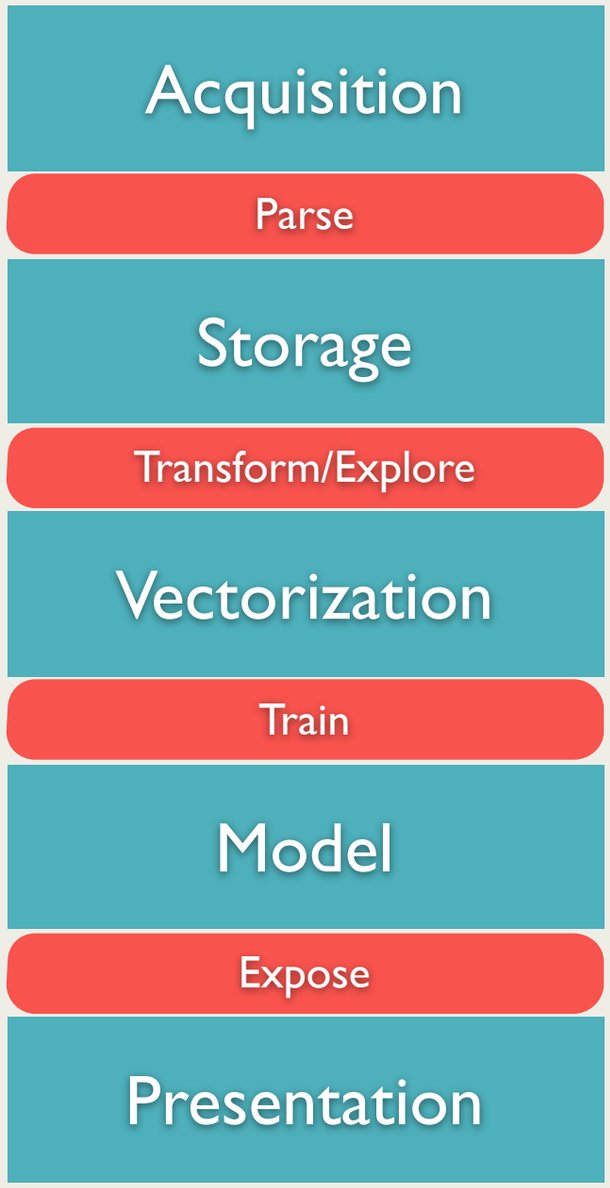
How

Abstraction (Cake)

(ABK)

Source: http://media.tumblr.com/tumblr_lakcynCyG31qbzcoy.jpg

Obligatory Name Drop



requests

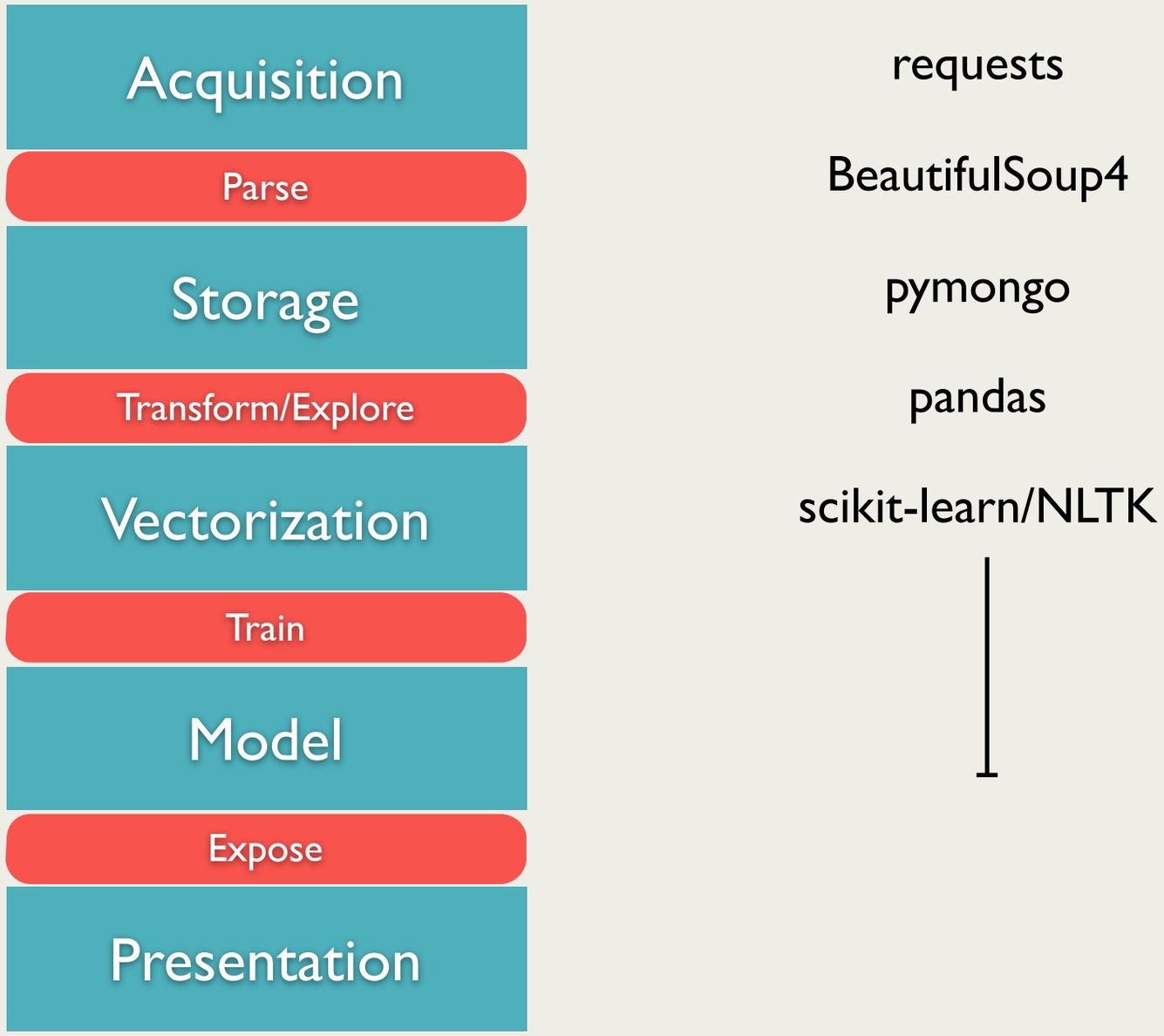
BeautifulSoup4

pymongo

pandas

scikit-learn/NLTK

Obligatory Name Drop



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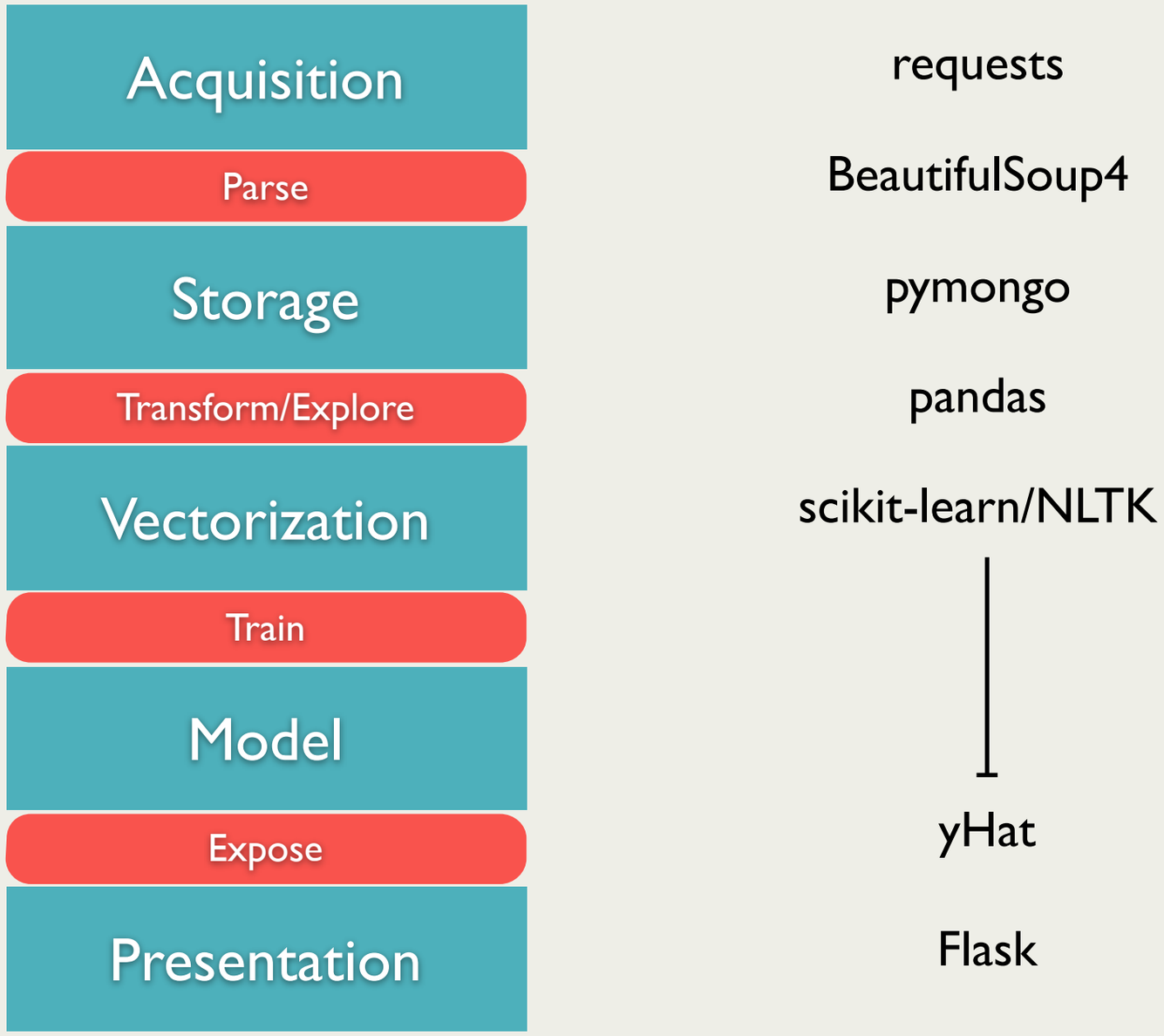

requests

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scikit-learn/NLTK

yHat

Flask

Obligatory Name Drop

At Scale

scrapy

Hadoop Streaming
(w/ BeautifulSoup4)

Snakebite (HDFS)

mrjob or
Mortar (w/ Python UDF)

MLlib (pySpark)

yHat

Flask

Locally

requests

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yHat

Flask

Acquisition

Parse

Storage

Transform/Explore

Vectorization

Train

Model

Expose

Presentation

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Pipeline

Iteration 0:

- Find out how much data
- Run locally
- Experiment

Acquire

At Scale

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Flask

Acquire

Retrieve Meta-data for ALL NYT articles

Acquire

```
api_key='xxxxxxxxxxxxx'


url = 'http://api.nytimes.com/svc/search/v2/
articlesearch.json?fq=section_name.contains:("Arts"
"Business Day" "Opinion" "Sports" "U.S."
"World")&sort=newest&api-key=' + api_key


# make an API request
api = requests.get(url)
```

Acquire

```
# parse resulting JSON and insert into a mongoDB collection
for content in api.json()['response']['docs']:
    if not collection.find_one(content):
        collection.insert(content)
```

```
# only returns 10 per page
"There are only %i docuemtns returned 0_o" % \
   len(api.json()[‘response']['docs'])
```

Acquire

```
# there are many more than 10 articles however
total_art = articles_left = api.json()['response']['meta']['hits']

print "There are currently %s articles in the NYT archive" % total_art

#=> There are currently 15277775 articles in the NYT archive
```

Gotchas!

- Rate Limiting
- Page Limiting

Iterate

Iteration 1:

- (Meaningful) Sample of Data
- Prototype — “Close the Loop”

Acquire

Retrieve Meta-data for ALL NYT articles (take 2)

Acquire

Iteration 0.5

```
# let us loop (and hopefully not hit our rate limit)
while articles_left > 0 and page_count < max_pages:
    more_articles = requests.get(url + "&page=" + str(page) + "&end_date=" + str(last_date))
    print "Inserting page " + str(page)
    # make sure it was successful
    if more_articles.status_code == 200:
        for content in more_articles.json()['response']['docs']:
            latest_article = parser.parse(content['pub_date']).strftime("%Y%m%d")
        if not collection.find_one(content) and content['document_type'] == 'article':
            print "No dups"
            try:
                print "Inserting article " + str(content['headline'])
                collection.insert(content)
            except errors.DuplicateKeyError:
                print "Duplicates"
                continue
        else:
            print "In collection already”
…
```

Acquire

```
articles_left -= 10
        page += 1
        page_count += 1
        cursor_count += 1
        final_page = max(final_page, page)
    else:
        if more_articles.status_code == 403:
            print "Sleepy..."
            # account for rate limiting
            time.sleep(2)
        elif cursor_count > 100:
            print "Adjusting date”
            # account for page limiting
            cursor_count = 0
            page = 0
            last_date = latest_article
        else:
            print "ERRORS: " + str(more_articles.status_code)
            cursor_count = 0
            page = 0
            last_date = latest_article
```

Acquire

Download HTML content of

articles from NYT.com

(and store in MongoDB™)

Acquire

```
# now we can get some content!
#limit = 100
limit = 10000

for article in collection.find({'html' : {'$exists' : False} }):
    if limit and limit > 0:
        if not article.has_key('html') and article['document_type'] == 'article':
            limit -= 1
            print article['web_url']
            html = requests.get(article['web_url'] + "?smid=tw-nytimes")

        if html.status_code == 200:
            soup = BeautifulSoup(html.text)

            # serialize html
            collection.update({ '_id' : article['_id'] }, { '$set' :
                                    { 'html' : unicode(soup), 'content' : [] }
                                } )

            for p in soup.find_all('div', class_='articleBody'):
                collection.update({ '_id' : article['_id'] }, { '$push' :
                                        { 'content' : p.get_text()
                                    } })
```

Parse

At Scale

scrapy

Hadoop Streaming
(w/ BeautifulSoup4)

Snakebite (HDFS)

mrjob or
Mortar (w/ Python UDF)

MLlib (pySpark)

yHat

Flask

Acquisition

Parse

Storage

Transform/Explore

Vectorization

Train

Model

Expose

Presentation

Locally

requests

BeautifulSoup4

pymongo

pandas

scikit-learn/NLTK

yHat

Flask

Parse

Parse HTML with BeautifulSoup and Extract the article Body (and store in MongoDB™)

Parse

```
# parse HTML content of articles
for article in collection.find({'html' : {'$exists' : True} }):
    print article['web_url']
    soup = BeautifulSoup(article['html'], 'html.parser')
    arts = soup.find_all('div', class_='articleBody')
    if len(arts) == 0:
        arts = soup.find_all('p', class_='story-body-text')

  …
```

Store

At Scale

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Flask

Store

```
for p in arts:
        collection.update({ '_id' : article['_id'] }, { '$push' :
          { 'content' : p.get_text() }
})
```

Explore

At Scale

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Explore

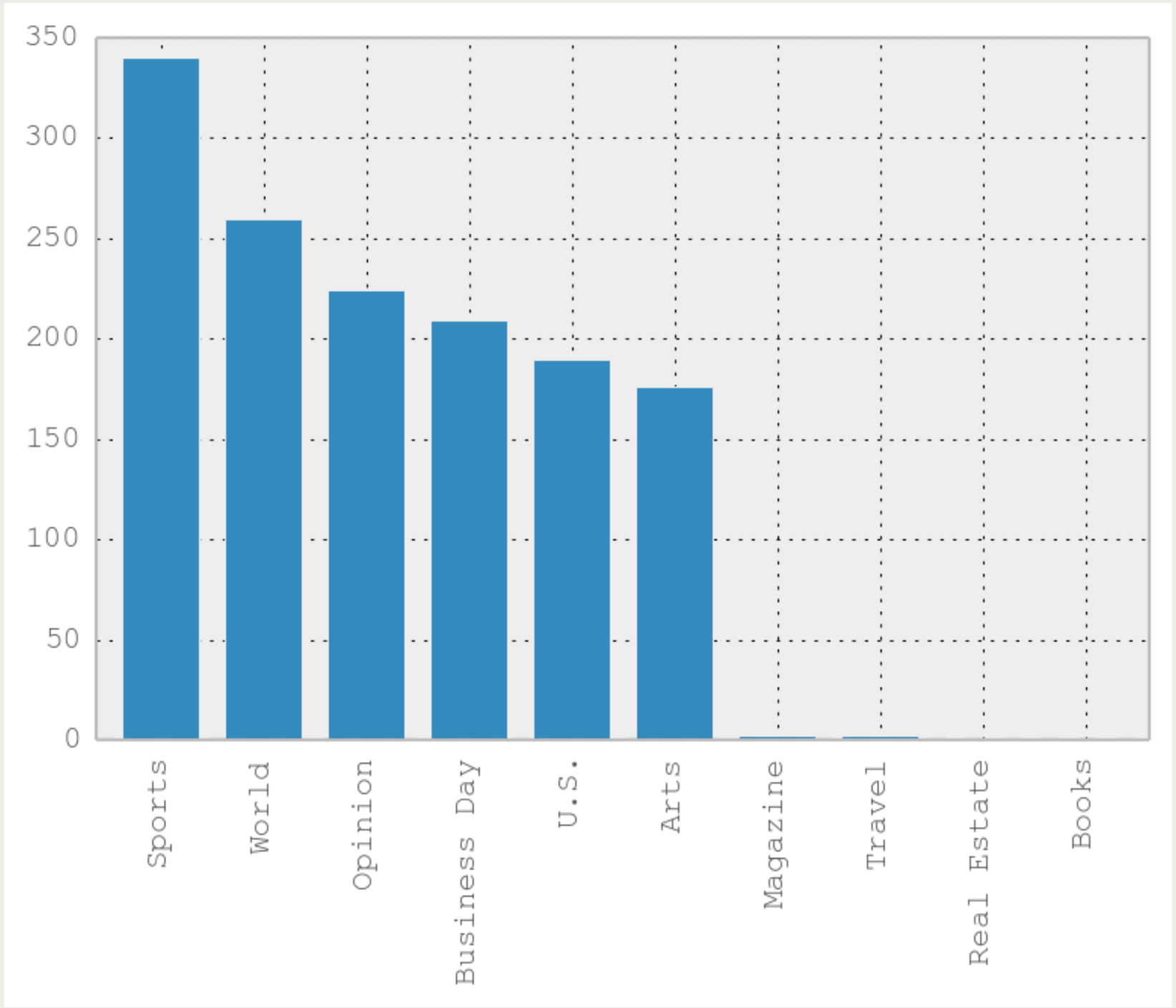
Exploratory Data Analysis with pandas

Explore

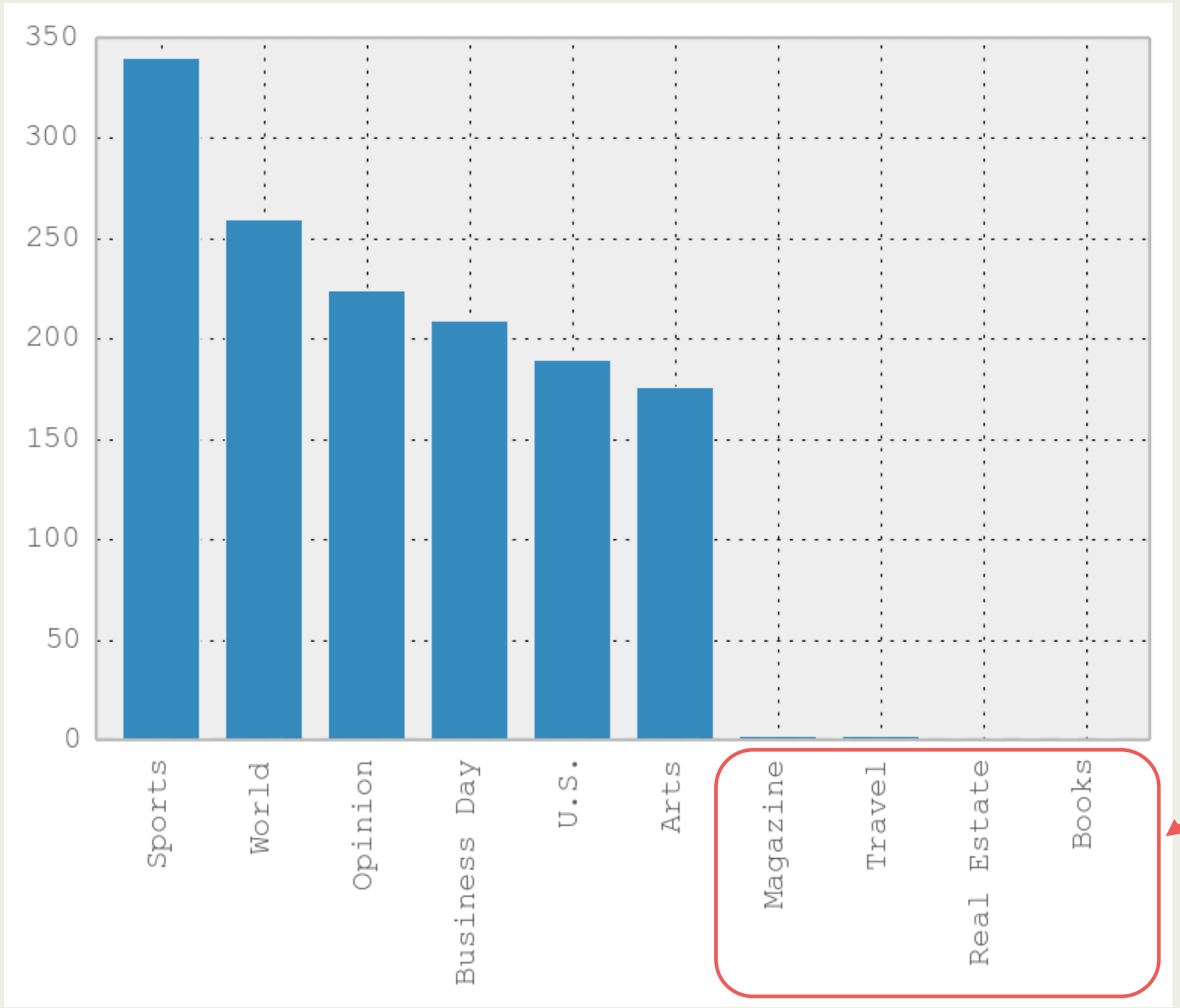
```
articles.describe()
#           text   section
# count     1405   1405
# unique    1397   10
```

```
fig = plt.figure()
# histogram of section counts
articles['section'].value_counts().plot(kind='bar')
```

Explore


350
300
250
200
150
100
50
0
Sports
World
Opinion
Business Day
U.S.
Arts
Magazine
Travel
Real Estate
Books

Explore



error with NYT API

Explore

```
api_key='xxxxxxxxxxxxx'


url = 'http://api.nytimes.com/svc/search/v2/
articlesearch.json?fq=section_name.contains:("Arts"
"Business Day" "Opinion" "Sports" "U.S."
"World")&sort=newest&api-key=' + api_key


# make an API request
api = requests.get(url)
```

error with
NYT API

Vectorize

At Scale

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yHat

Flask

Vectorize

Tokenize article text and

create feature vectors with NLTK

Vectorize

```
wnl = nltk.WordNetLemmatizer()

def tokenize_and_normalize(chunks):
    words = [ tokenize.word_tokenize(sent) for sent in
tokenize.sent_tokenize("".join(chunks)) ]
    flatten = [ inner for sublist in words for inner in sublist ]
    stripped = []

    for word in flatten:
        if word not in stopwords.words('english'):
            try:

stripped.append(word.encode('latin-1').decode('utf8').lower())
            except:
                print "Cannot encode: " + word

    no_punks = [ word for word in stripped if len(word) > 1 ]
    return [wnl.lemmatize(t) for t in no_punks]
```

Train

At Scale

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Presentation

Train

Train and score a model with scikit-learn

Train

```
# cross validate
from sklearn.cross_validation import train_test_split

xtrain, xtest, ytrain, ytest =
                    train_test_split(X, labels, test_size=0.3)
```

```
# train a model
alpha = 1
multi_bayes = MultinomialNB(alpha=alpha)

multi_bayes.fit(xtrain, ytrain)
multi_bayes.score(xtest, ytest)
```

Train

Gotchas!

- Model only exists locally on Laptop
- Not Automated for realtime prediction

Exposé

Iteration 2:

- Expose your model
- Automate your processes

Exposé

Getting that model off your lap(top)

Exposé

A model is just a function

Exposé

Inputs...

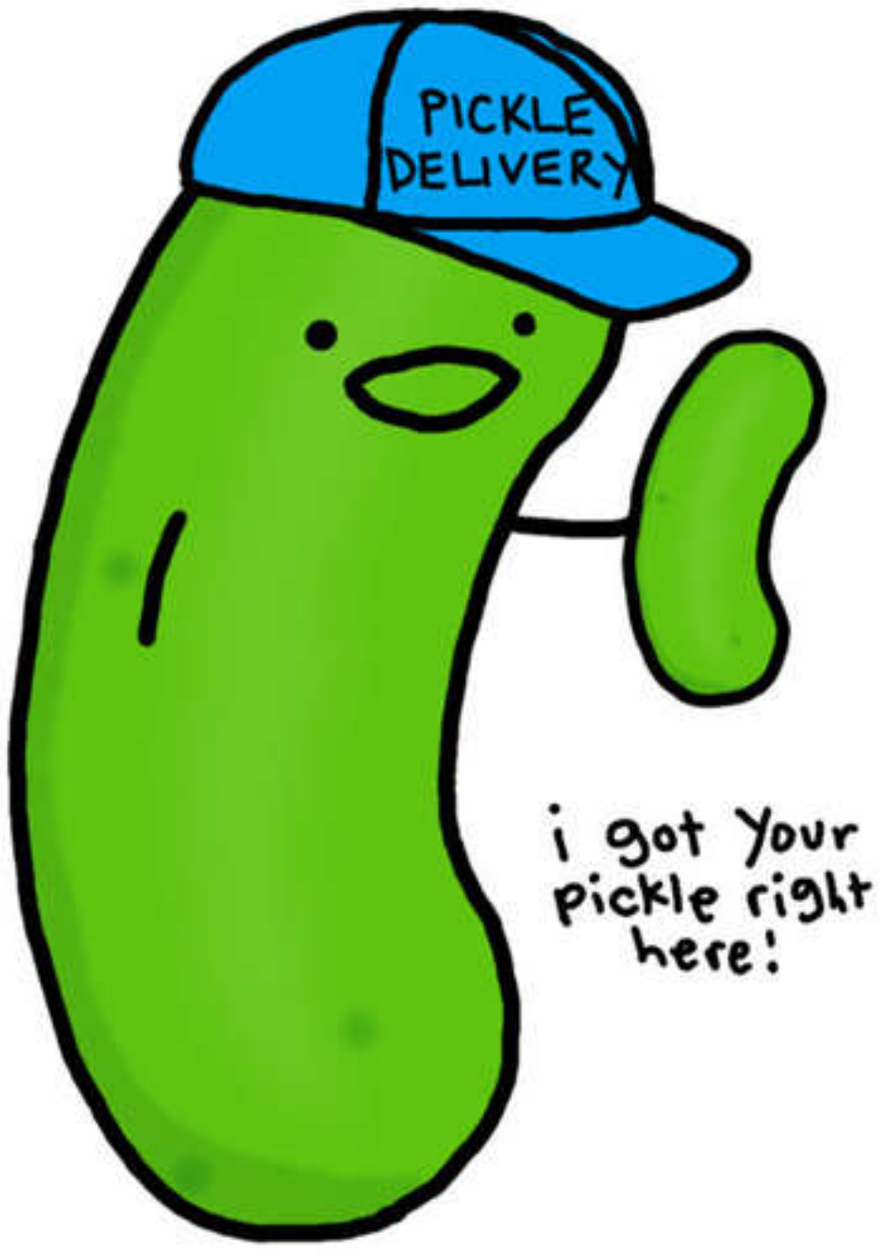
Exposé

Outputs...

Persistence

Serialize your model with pickle
(or cPickle or joblib)

Persistence

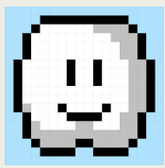


Source: http://www.glogster.com/mrsallenballard/pickles-i-love-em-/g-6mevh13be74mgnc9i8qifa0

Persistence

SerDes

- Disk
- Database
- Memory



Exposé

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Exposé

Deploy your Model to yHat

Exposé

```
class DocumentClassifier(YhatModel):
    @preprocess(in_type=dict, out_type=dict)
    def execute(self, data):
        featureBody = vectorizer.transform([data['content']])
        result = multi_bayes.predict(featureBody)
        list_res = result.tolist()
        return {"section_name": list_res}

clf = DocumentClassifier()
yh = Yhat("jonathan@zipfianacademy.com", “xxxxxx",
                                    "http://cloud.yhathq.com/")
yh.deploy("documentClassifier", DocumentClassifier, globals())
```

Present

At Scale

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Flask (on Heroku)

Present

Create a Flask application to
expose your model on the web

Present

```
yh = Yhat("<USERNAME>", "<API KEY>", "http://cloud.yhathq.com/")

@app.route('/')
def index():
    return app.send_static_file('index.html')
```

```
@app.route('/predict', methods=['POST'])
def predict():
    article = request.form['article']
    results = yh.predict("documentClf", { 'content': article })
    return jsonify({"results": results})
```

Pipeline

Only Data should Flow

Pipeline

Remember to Remember
(Lineage)

Acquisition

Parse

Storage

Transform/Explore

Vectorization

Train

Model

Expose

Presentation

Data

Pipeline

Immutable append only set of Raw Data

Computation is a view on data

*Lambda Architecture by Nathan Marz

Functional

Functional Data Science

- Modularity
- Define interfaces
- Separate data from computation
- Data Lineage

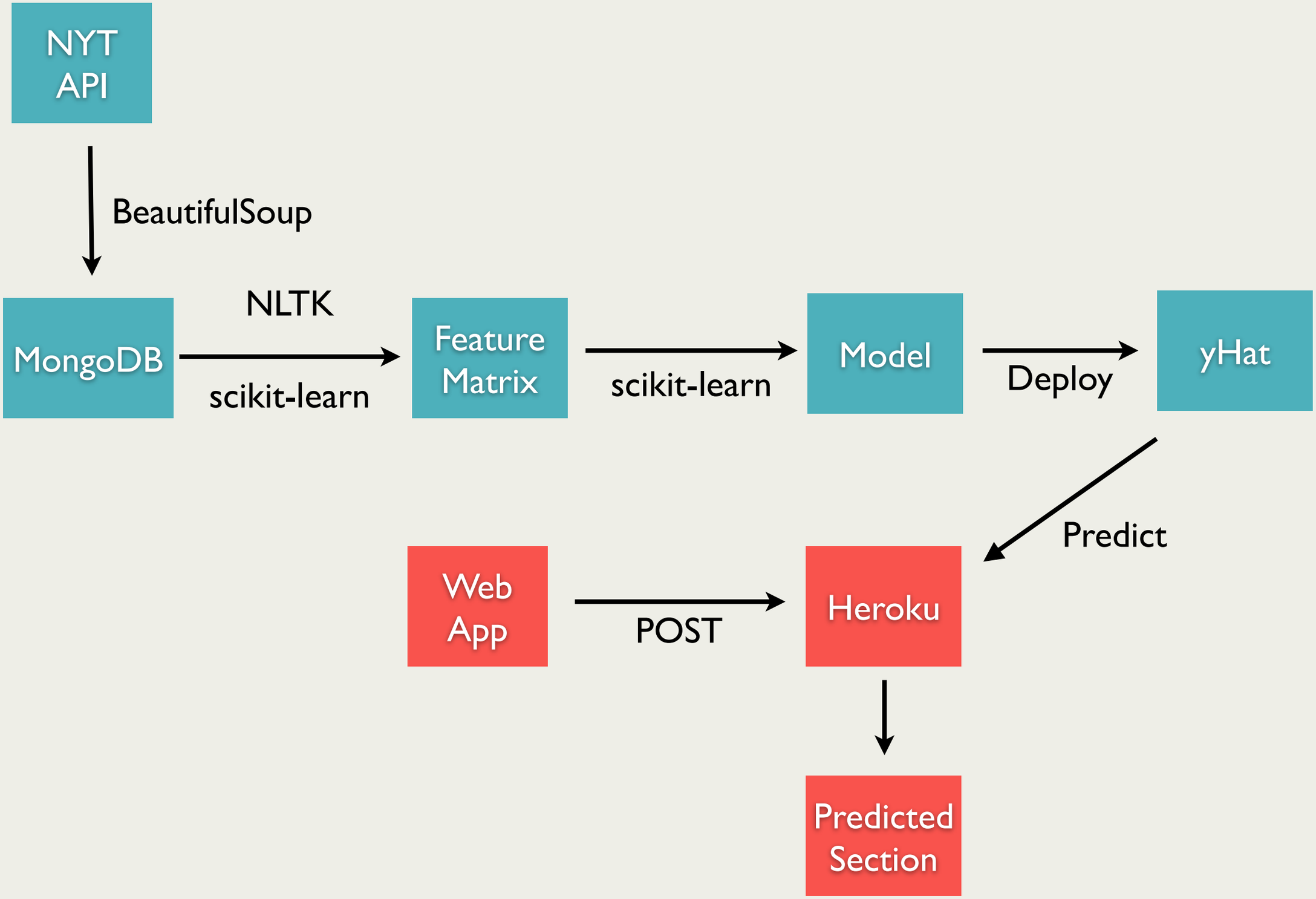
Pipeline

Need Robust and Flexible Pipeline!

Pipeline

Whatever you do, DO NOT cross the streams

Where we are


NYT API
BeautifulSoup
MongoDB
NLTK
scikit-learn
Feature Matrix
scikit-learn
Model
Deploy
yHat
Predict
Web App
POST
Heroku
Predicted Section

Gotchas

Gotchas!

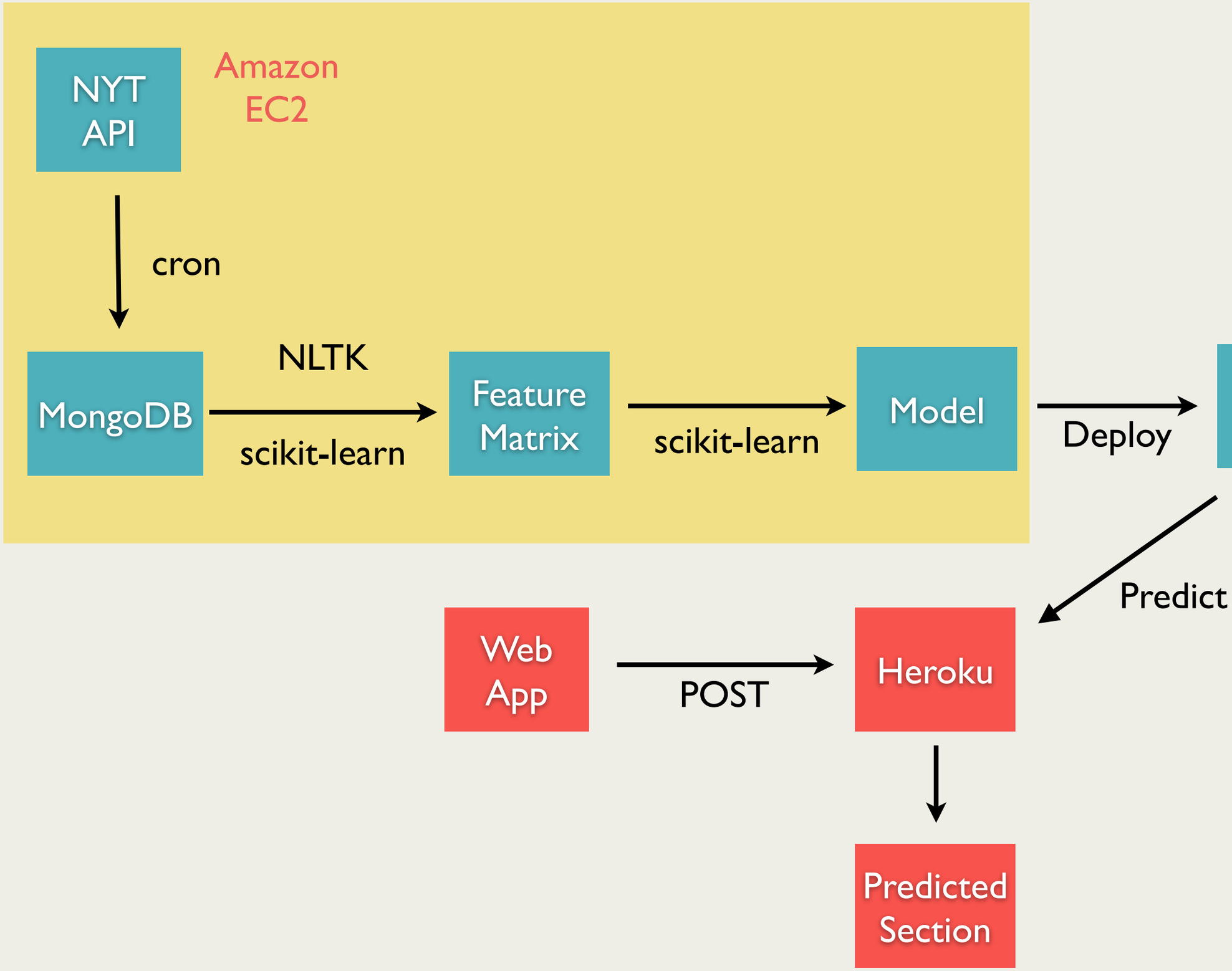
- Only have a static subset of articles
- Pipeline not automated for re-training

Iterate

Iteration 3:

Source: http://vninja.net/wordpress/wp-content/uploads/2013/03/KCaAutomate.png

Where we are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Amazon EC2
cron
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scikit-learn
Feature Matrix
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yHat
Predict
Web App
POST
Heroku
Predicted Section

Fraud

Payments app

POST

Model/ Scoring service

automatically clear

Legit Payments

Deposit

Piggy Bank

Manual clear

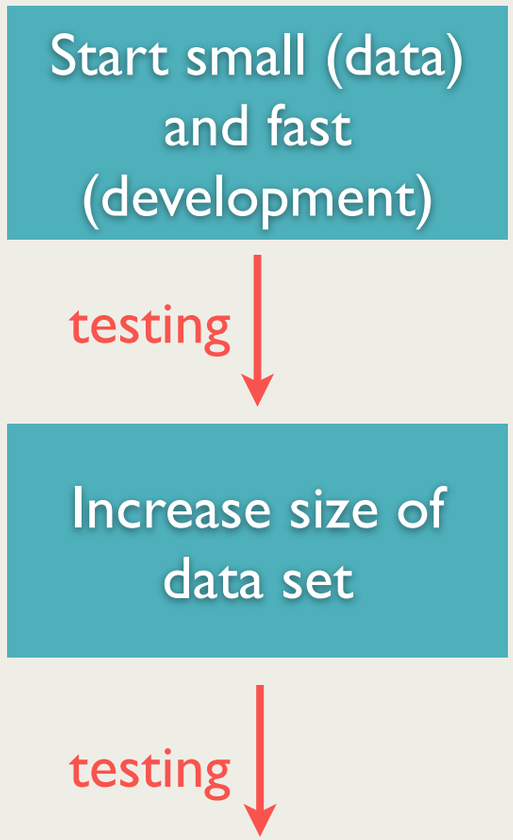
Needs Review

Manual Review (Web App)

Freeze Transaction

Investigation

How to Scale


Start small (data) and fast (development)
testing
Increase size of data set
testing
Optimize and productionize
$$$
PROFIT!

How to Scale

Can also use a streaming algorithm or single machine disk based "medium data" technologies (i.e. database or memory mapped files)

Products

If you build it...

Products

Source: http://nateemery.com/wp-content/uploads/2013/05/field-of-dreams.jpg

Appendix

Data Sources

Obtain

(ranked by ease of use)

1. DaaS -- Data as a service
2. Bulk Download
3. APIs
4. Web Scraping

Data Sources

DaaS

(Data as a Service)

- Time Series/Numeric: Quandl
- Financial Modeling: Quantopian
- Email Contextualization: Rapleaf
- Location and POI: Factual

Data Sources

Bulk Download

(just like the good ol' days)

- File Transfer Protocol (FTP): CDC
- Amazon Web Services: Public Datasets
- Infochimps: Data Marketplace
- Academia: UCI Machine Learning Repository

Data Sources

APIs

(if it's not RESTed, I'm not buying)

- Geographic: Foursquare
- Social: Facebook
- Audio: Rdio
- Content: Tumblr
- Realtime: Twitter
- Hidden: Yahoo Finance

Data Sources

Web Scraping
(DIY for life)

1. wget and curl
2. Web Spider/Crawler
3. API scraping
4. Manual Download

Data Formats

- Delimited Values
  - TSV
  - CSV
  - WSV
- JSON
- XML
- Ad Hoc Formats (avoid these if you can)

Data Formats

- JSON is made up of hash tables and arrays
  - Hash tables: `{ “foo” : 1, “bar” : 2, baz : “3” }`
  - Arrays: `[1, 2, 3]`
  - Arrays of arrays: `[[1, 2, 3], [‘foo’, ‘bar’, ‘baz’]]`
  - Array of hashes: `[{‘foo’:1, ‘bar’:2}, {‘baz’:3}]`
  - Hashes of hashes: `{‘foo’: {‘bar’: 2, ‘baz’: 3}}`

Data Formats

```
{"widget": {
    "debug": "on",
    "window": {
        "title": "Sample Konfabulator Widget",
        "name": "main_window",
        "width": 500,
        "height": 500
    },
    "image": {
        "src": "Images/Sun.png",
        "name": "sun1",
        "hOffset": 250,
        "vOffset": 250,
        "alignment": "center"
    },
    "text": {
        "data": "Click Here",
        "size": 36,
        "style": "bold",
        "name": "text1",
        "hOffset": 250,
        "vOffset": 100,
        "alignment": "center",
        "onMouseUp": "sun1.opacity = (sun1.opacity / 100) * 90;"
    }
}}
```

Data Formats

- XML is a recursive self-describing container

```
<container>
    <item>Foo</item>
    <item>Bar</item>
        <container>
            <item attr=”SomethingAboutBaz”>Baz</item>
        </container>
    </item>
<container>
```

Data Formats

```
<widget>
    <debug>on</debug>
    <window title="Sample Konfabulator Widget">
        <name>main_window</name>
        <width>500</width>
        <height>500</height>
    </window>
    <image src="Images/Sun.png" name="sun1">
        <hOffset>250</hOffset>
        <vOffset>250</vOffset>
        <alignment>center</alignment>
    </image>
    <text data="Click Here" size="36" style="bold">
        <name>text1</name>
        <hOffset>250</hOffset>
        <vOffset>100</vOffset>
        <alignment>center</alignment>
        <onMouseUp>
            sun1.opacity = (sun1.opacity / 100) * 90;
        </onMouseUp>
    </text>
</widget>
```

Data Formats

- Ad hoc data formats
  - Fixed-width (Census data)
  - Graph Edgelists
  - Voting records
  - etc.

Data Formats

- 7-5-5 format
  - `Sam  foo  bar`
  - `Roger  baz  6`
  - `Jane  314  99`

Data Formats

- Directed Graph Format

```
1   2

1   3

1   4

2   3

4   4
```

Data Formats

- Directed Graph Format

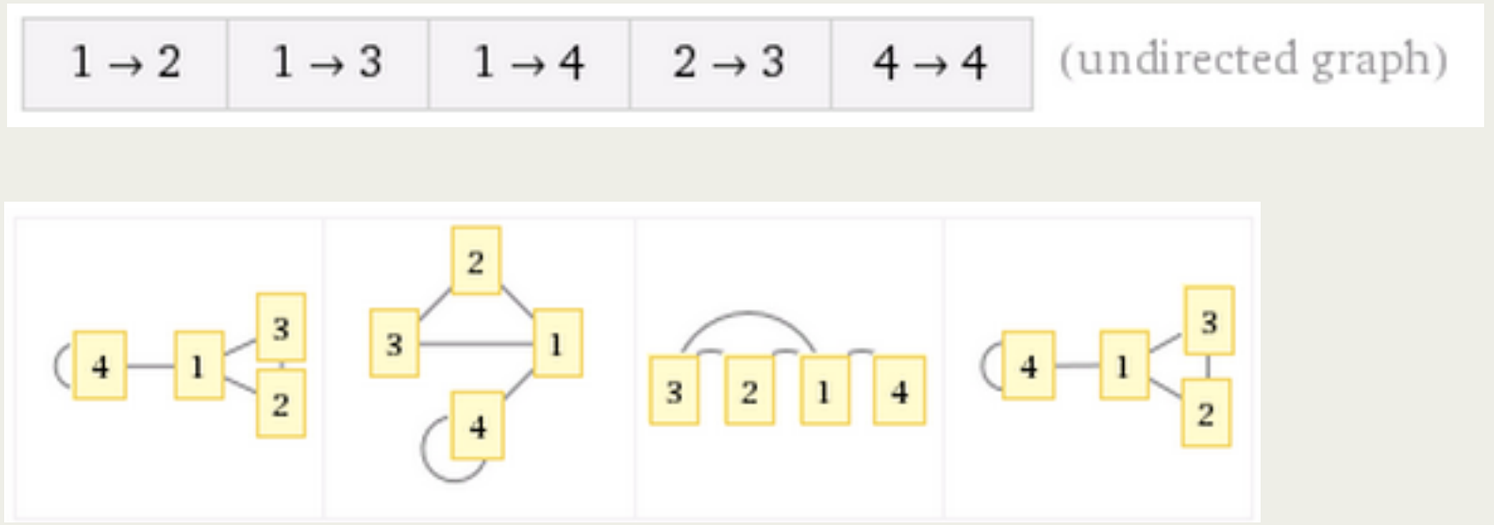
  1 2

  1 3

  1 4

  2 3

  4 4



Data Formats

Programming languages like Python, Ruby, and R have built in parsers for data formats such as JSON and CSV. For other esoteric formats you will probably have to write your own