Realtime predictive analytics

using scikit-learn & RabbitMQ

Michael Becker

#pycon2014

@beckerfuffle

Who Is This Guy?

Data guy @ AWeber

@beckerfuffle

beckerfuffle.com

These slides and more @ github.com/mdbecker

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

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

What I'll Cover

- Scikit-learn overview

What I'll Cover

- Scikit-learn overview
- Model Distribution

What I'll Cover

- Scikit-learn overview
- Model Distribution
- Data flow

What I'll Cover

- Scikit-learn overview
- Model Distribution
- Data flow
- RabbitMQ

What I'll Cover

- Scikit-learn overview
- Model Distribution
- Data flow
- RabbitMQ
- Demo

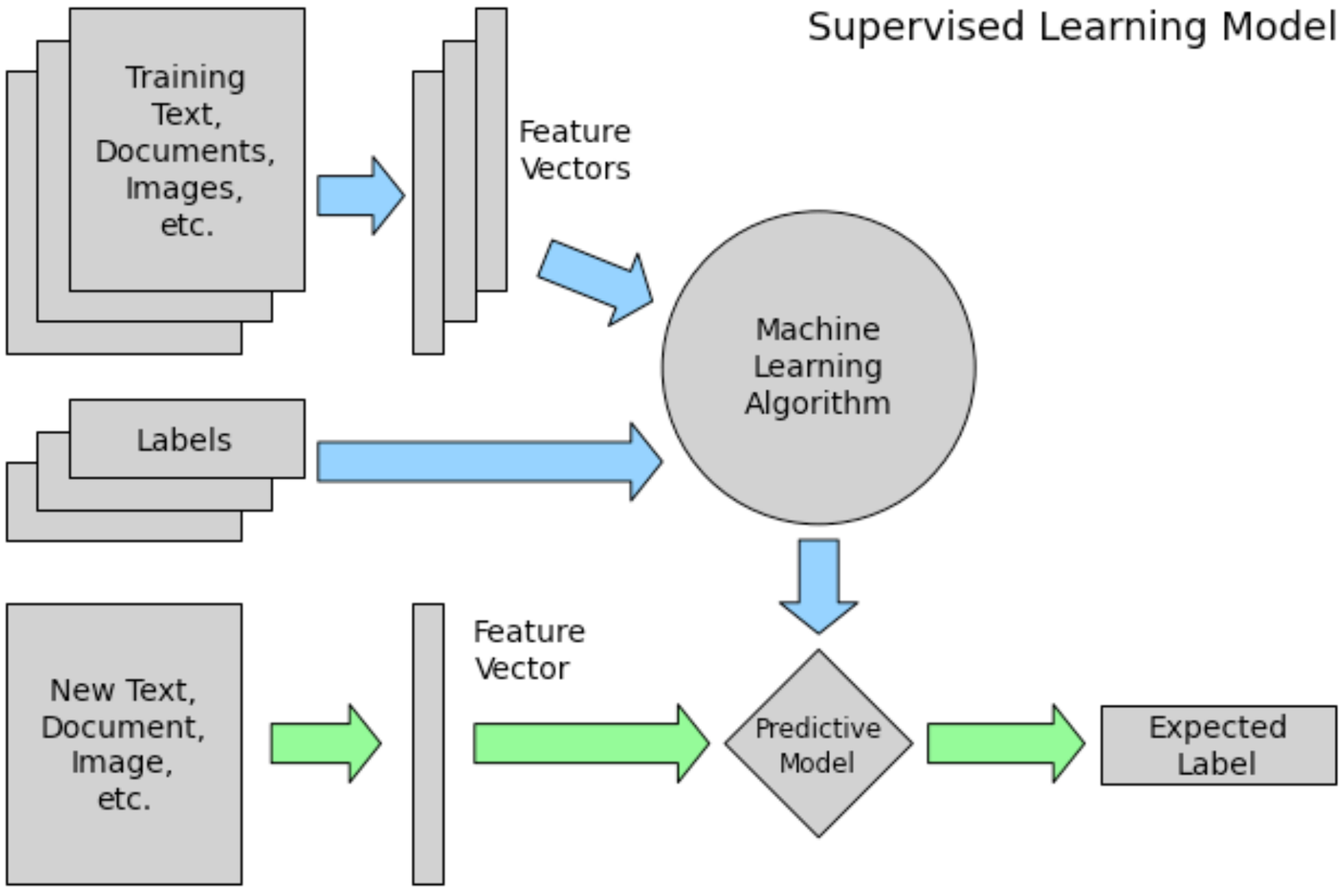
What I'll Cover

- Scikit-learn overview
- Model Distribution
- Data flow
- RabbitMQ
- Demo
- Scalability

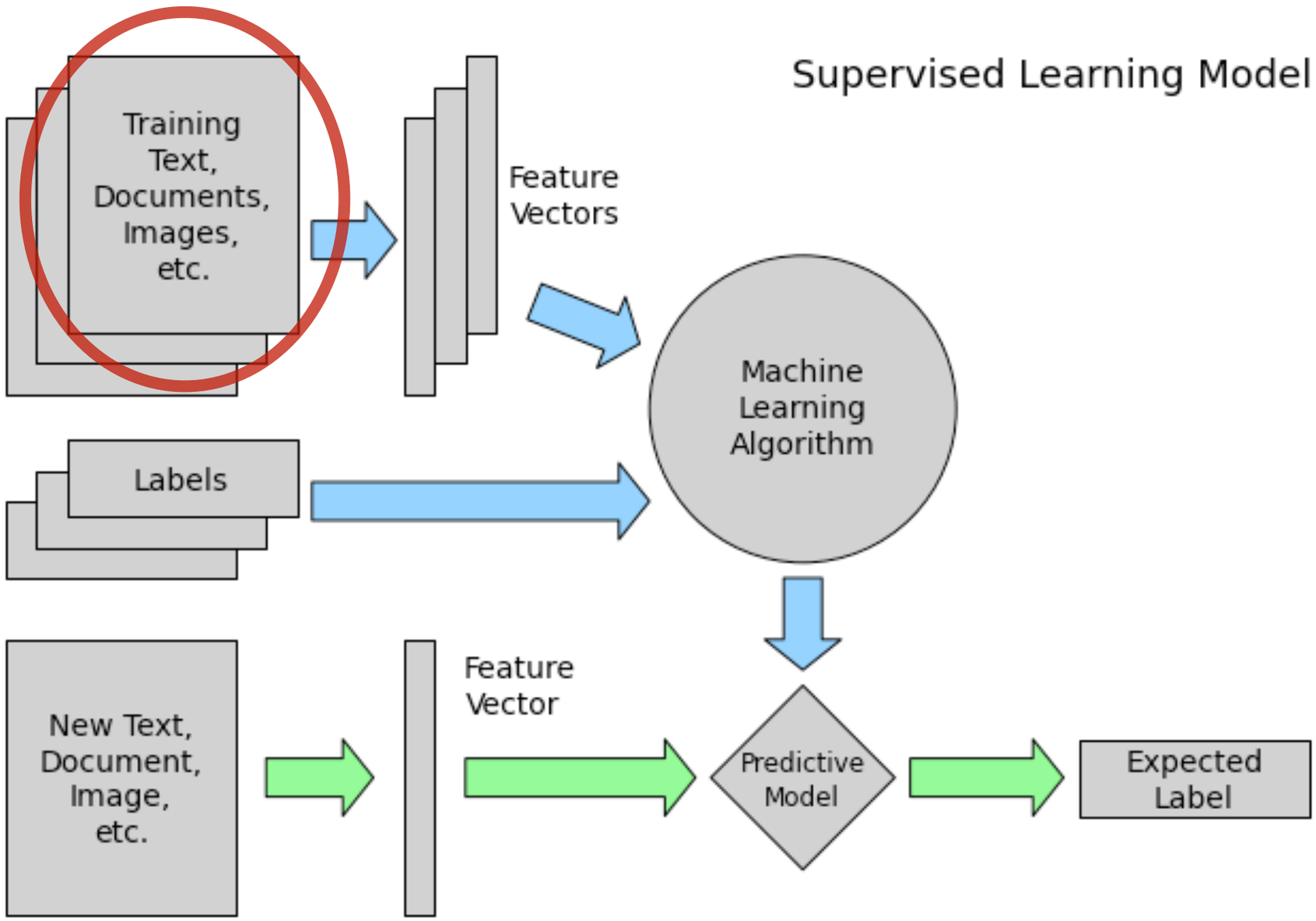
What I'll Cover

- Scikit-learn overview
- Model Distribution
- Data flow
- RabbitMQ
- Demo
- Scalability
- Other considerations

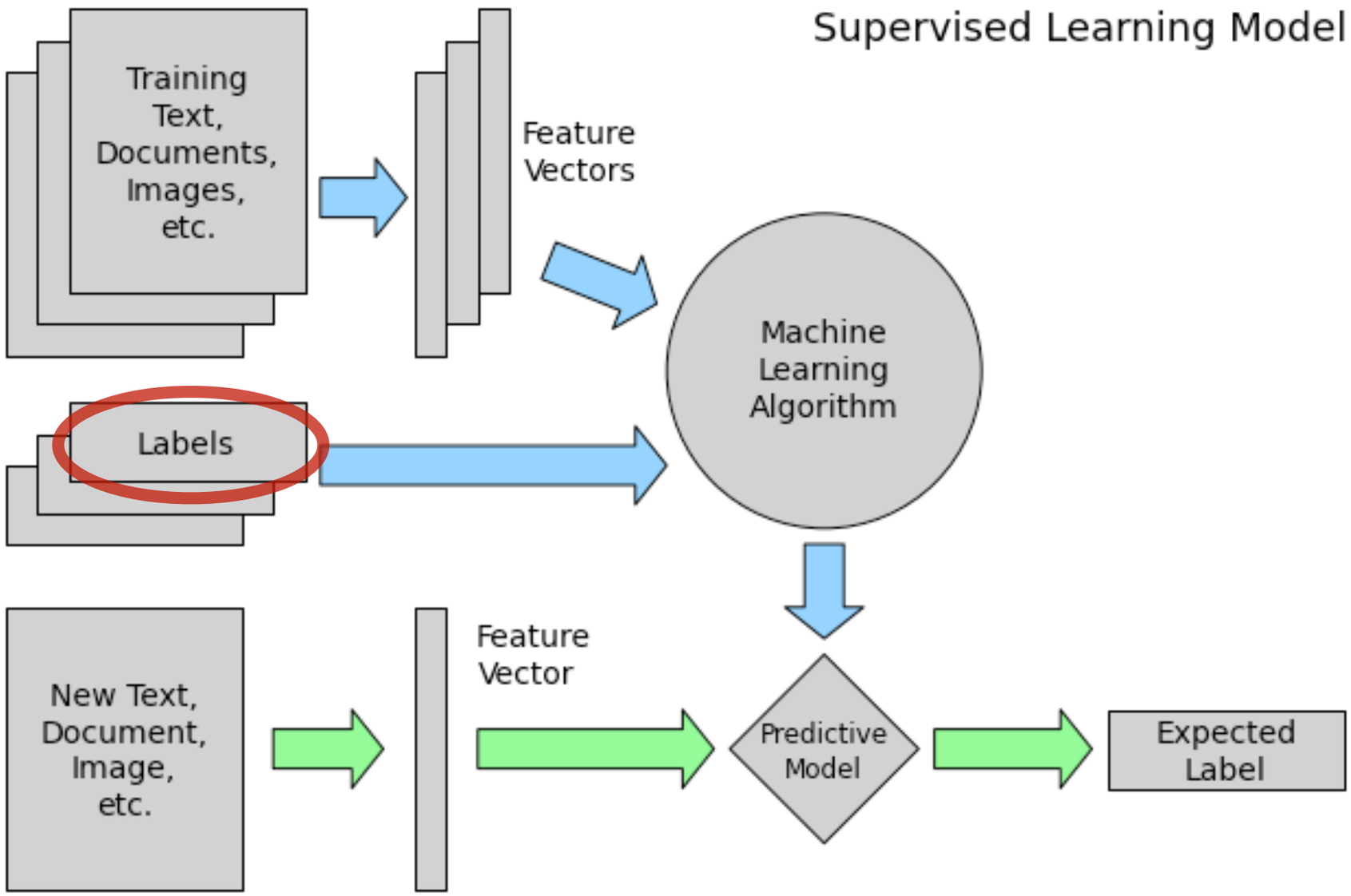
Supervised Learning



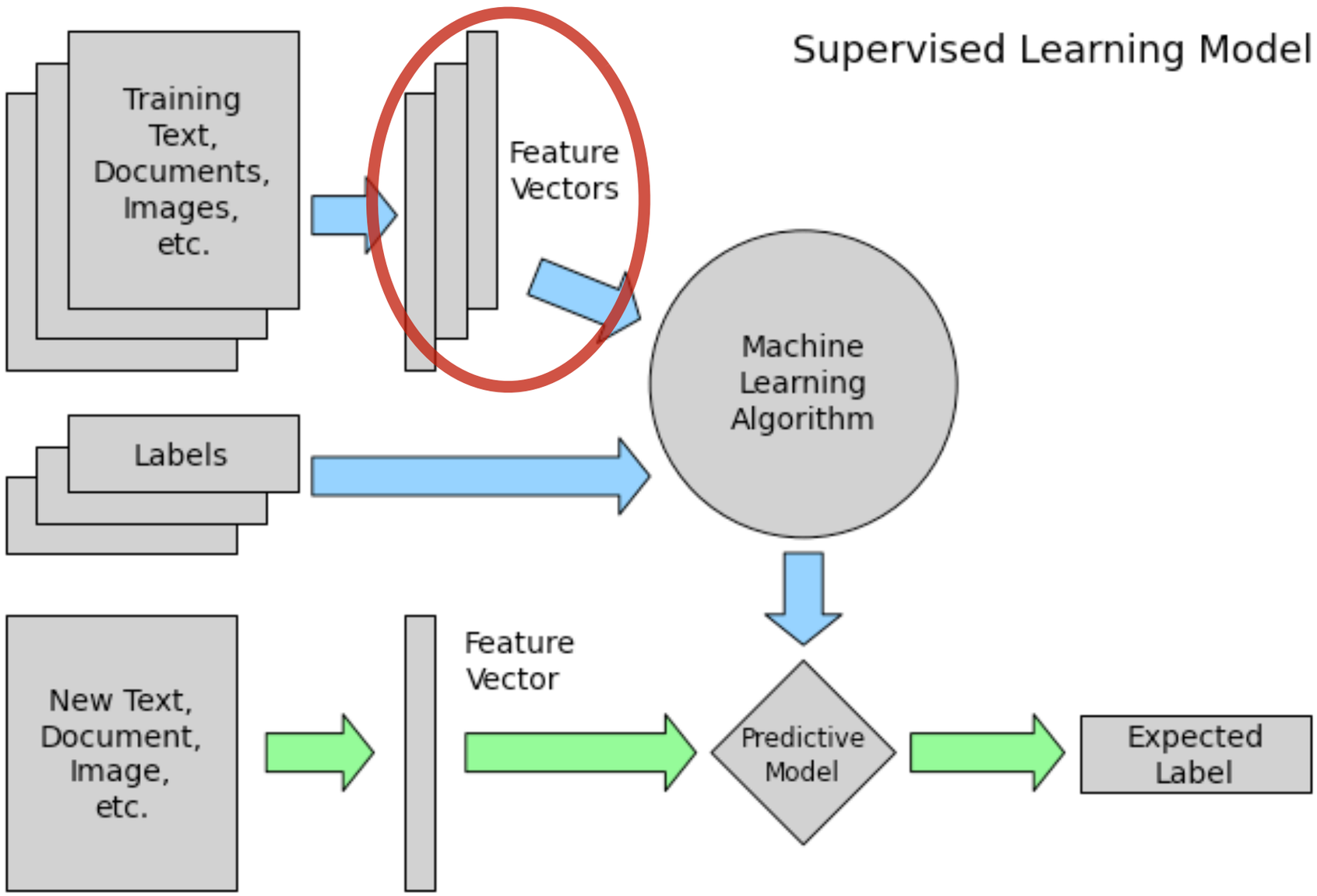
Supervised Learning



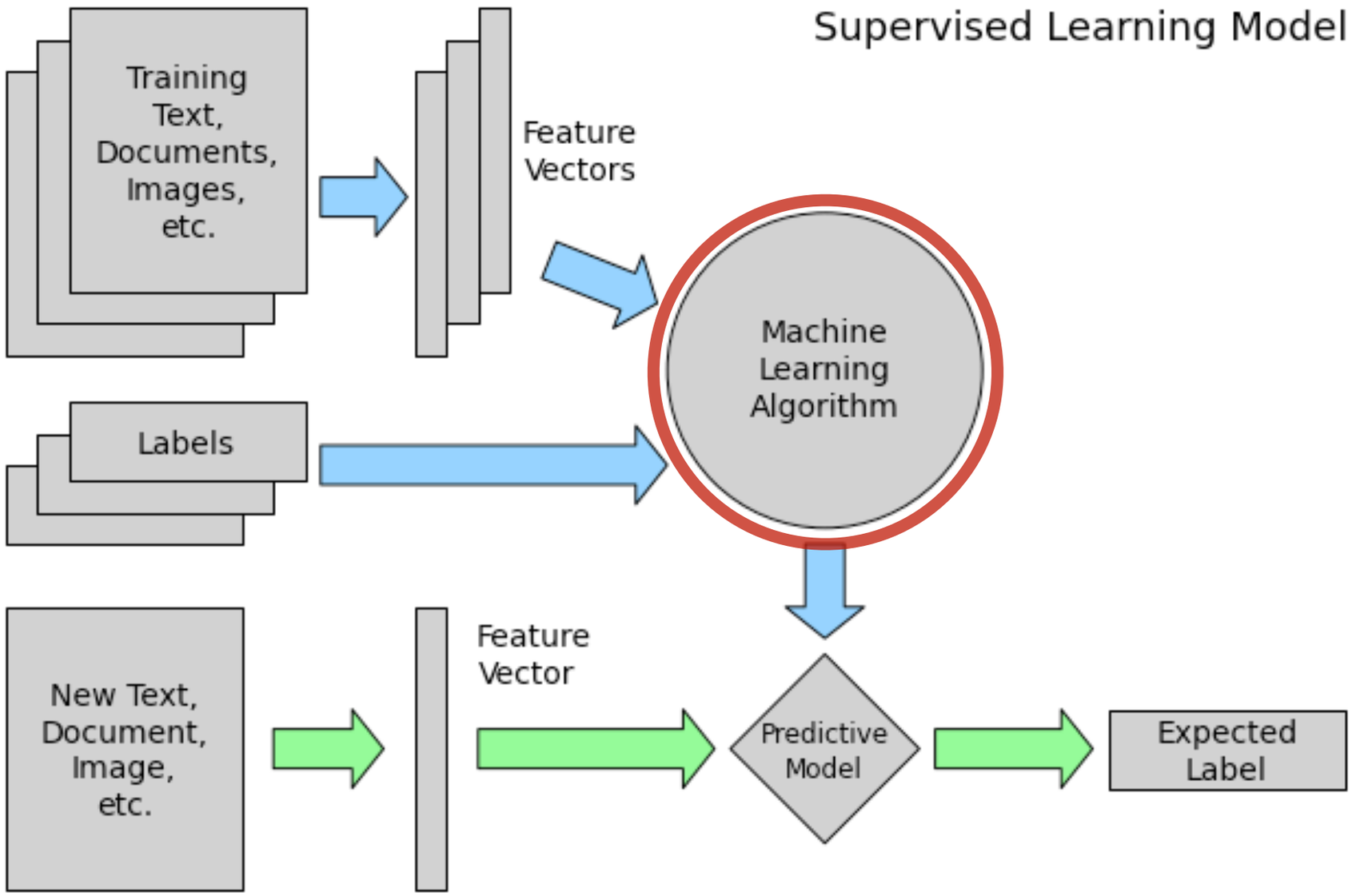
Supervised Learning



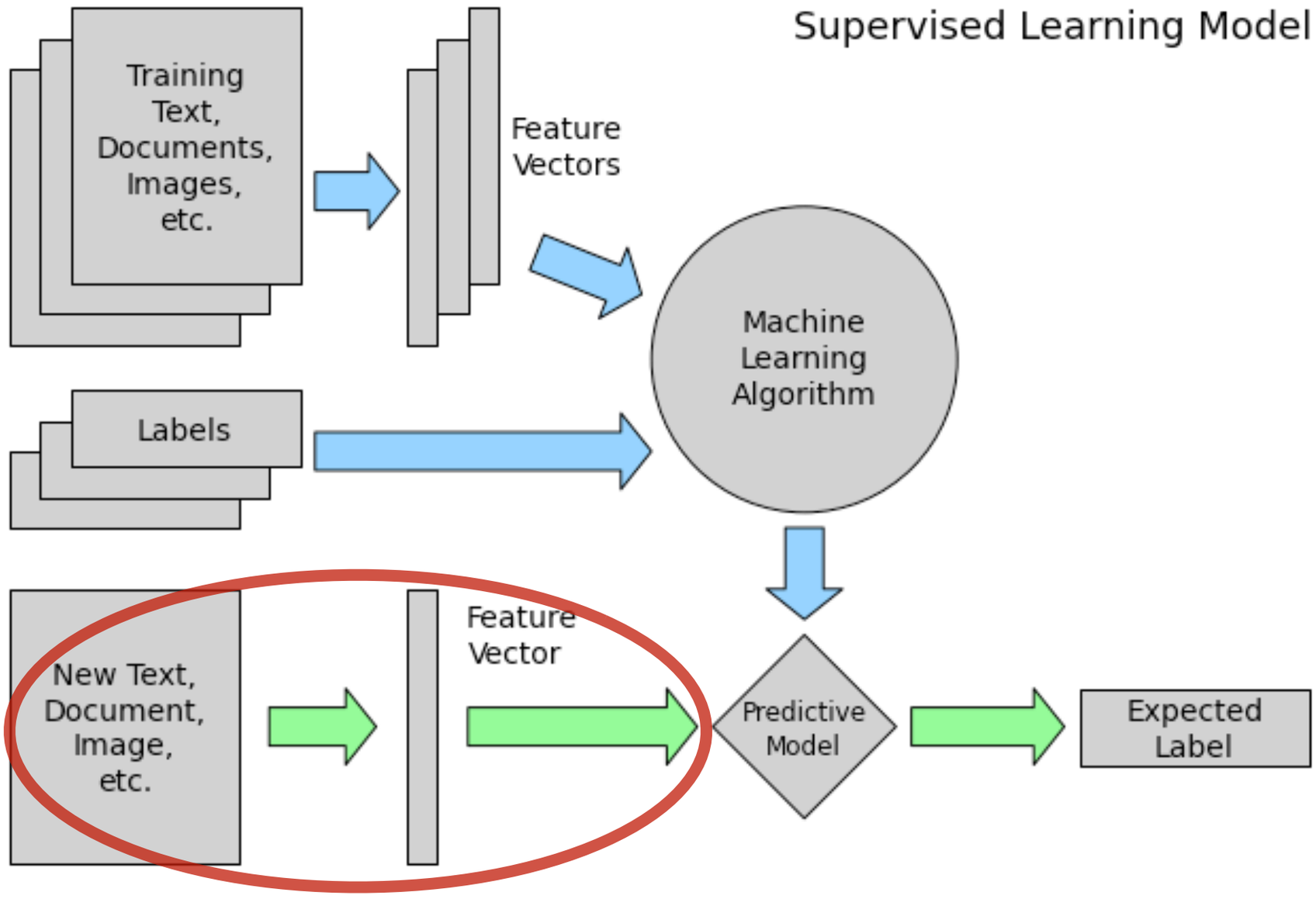
Supervised Learning



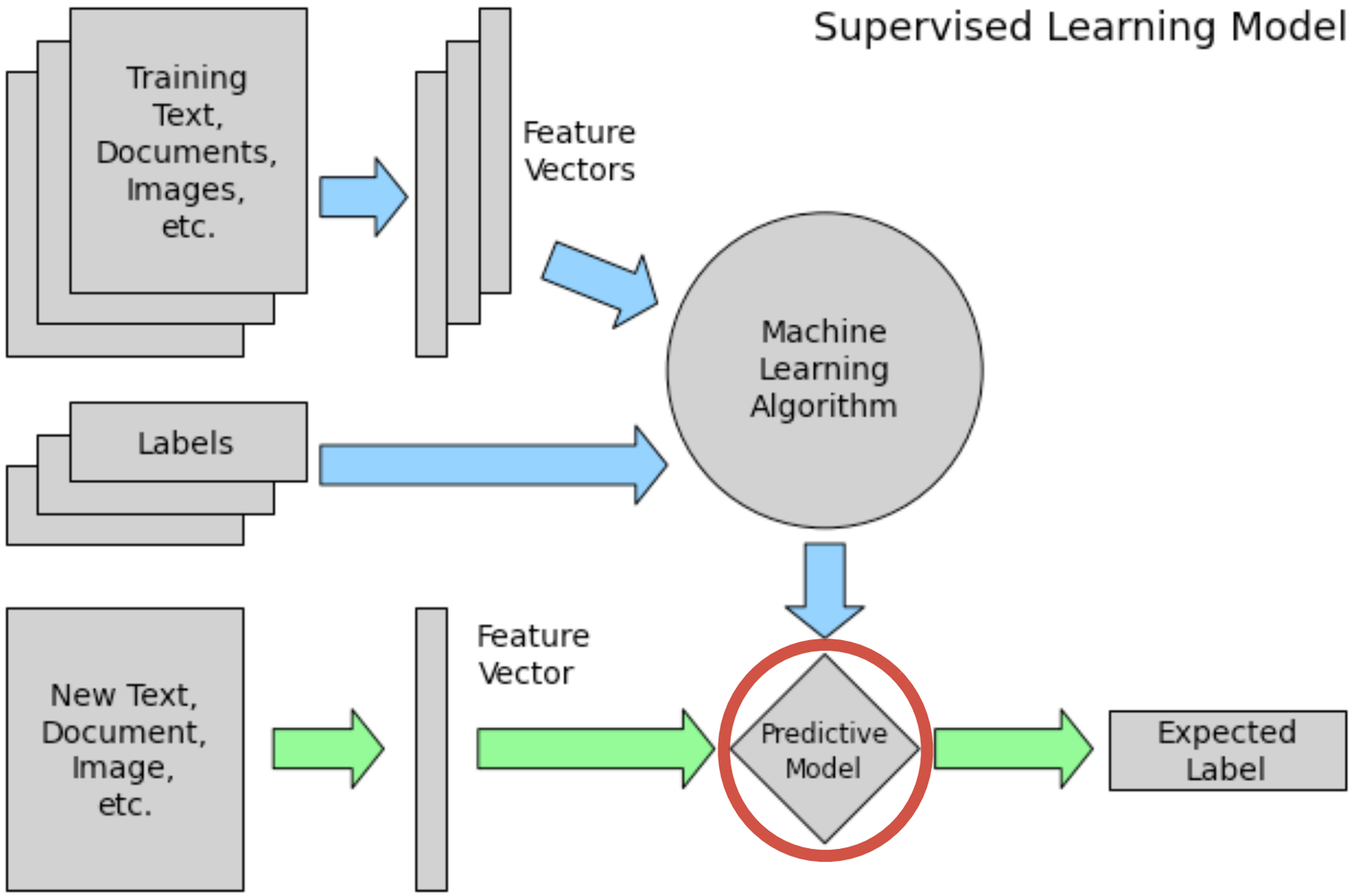
Supervised Learning



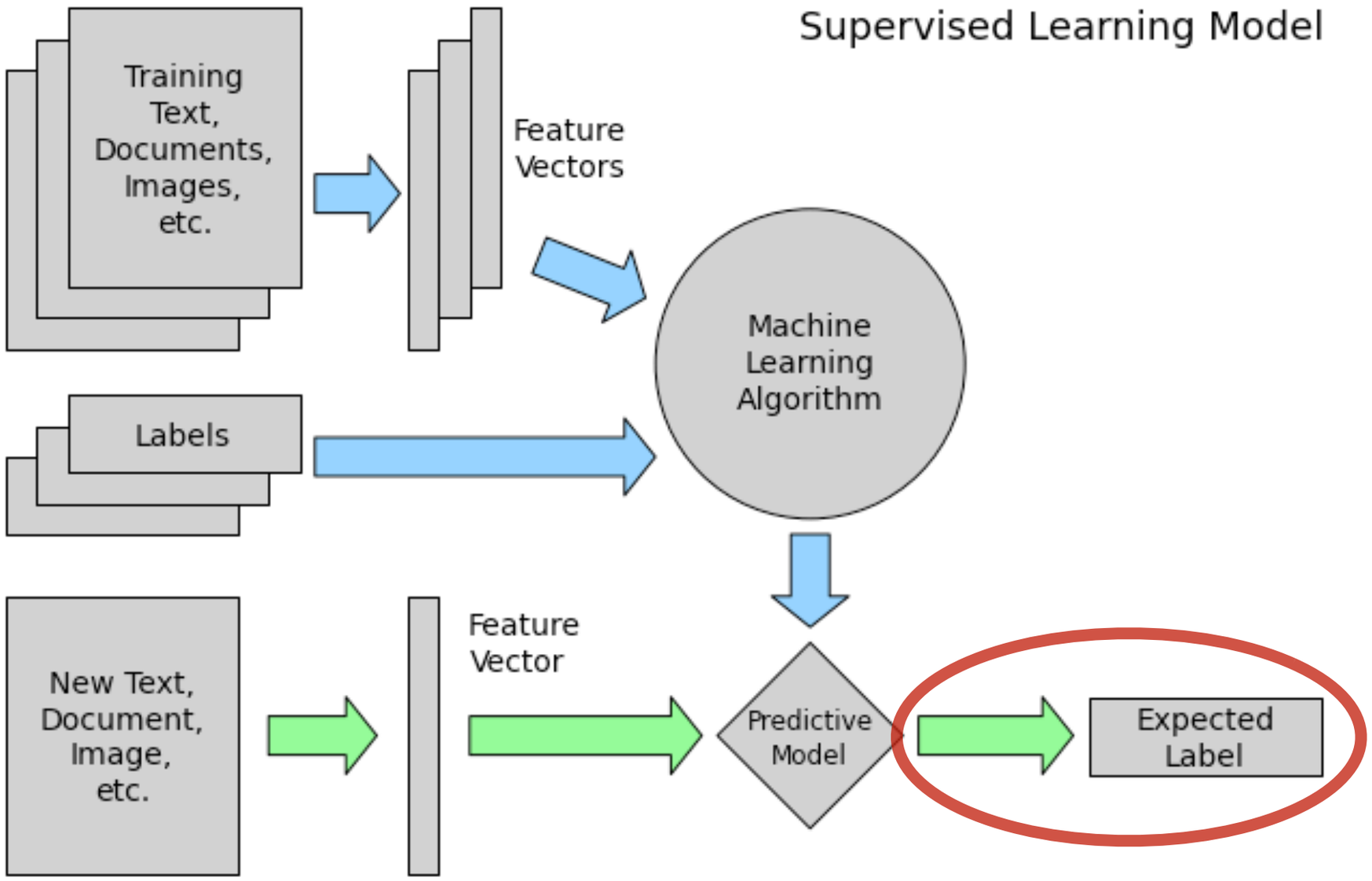
Supervised Learning



Supervised Learning



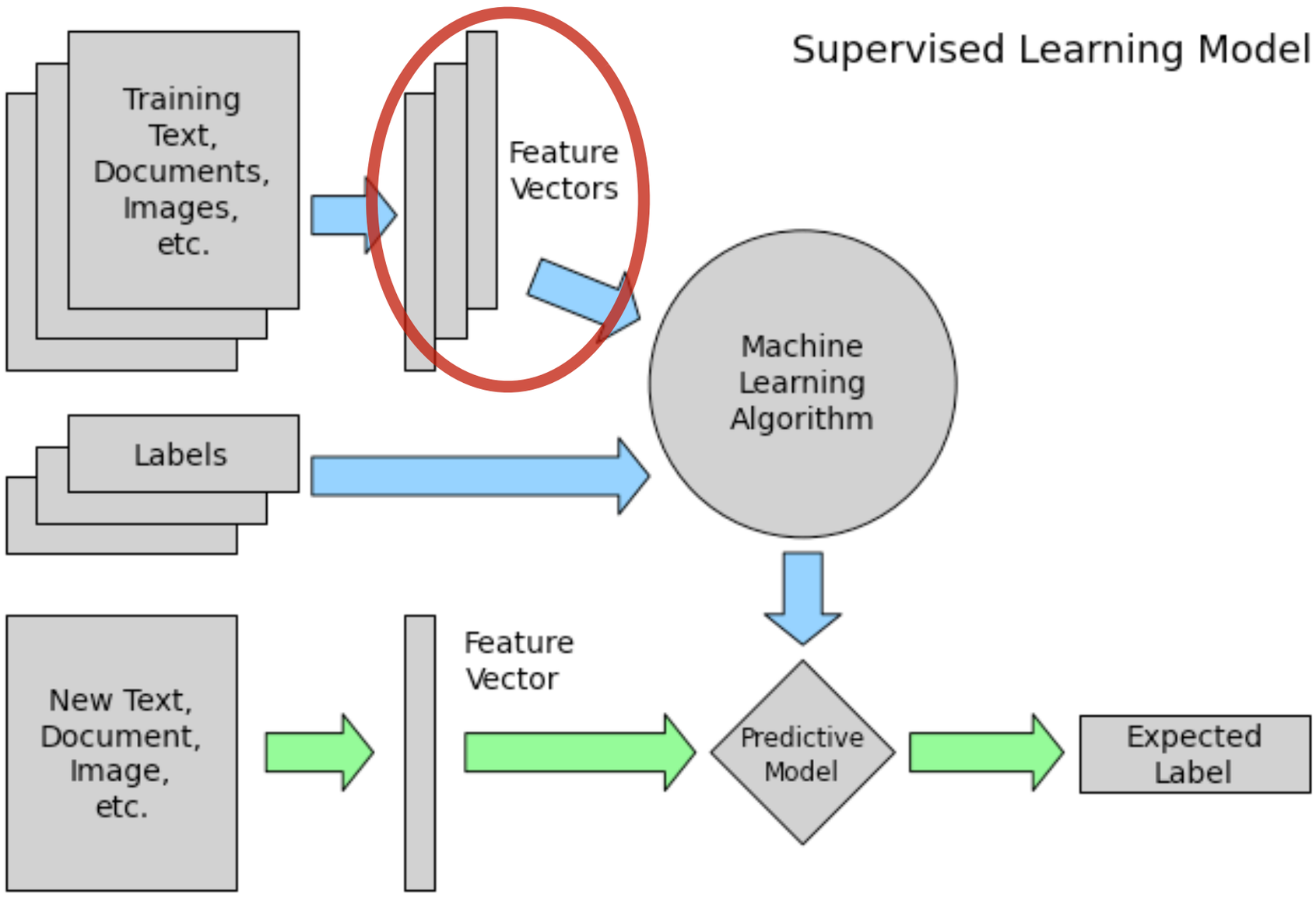
Supervised Learning

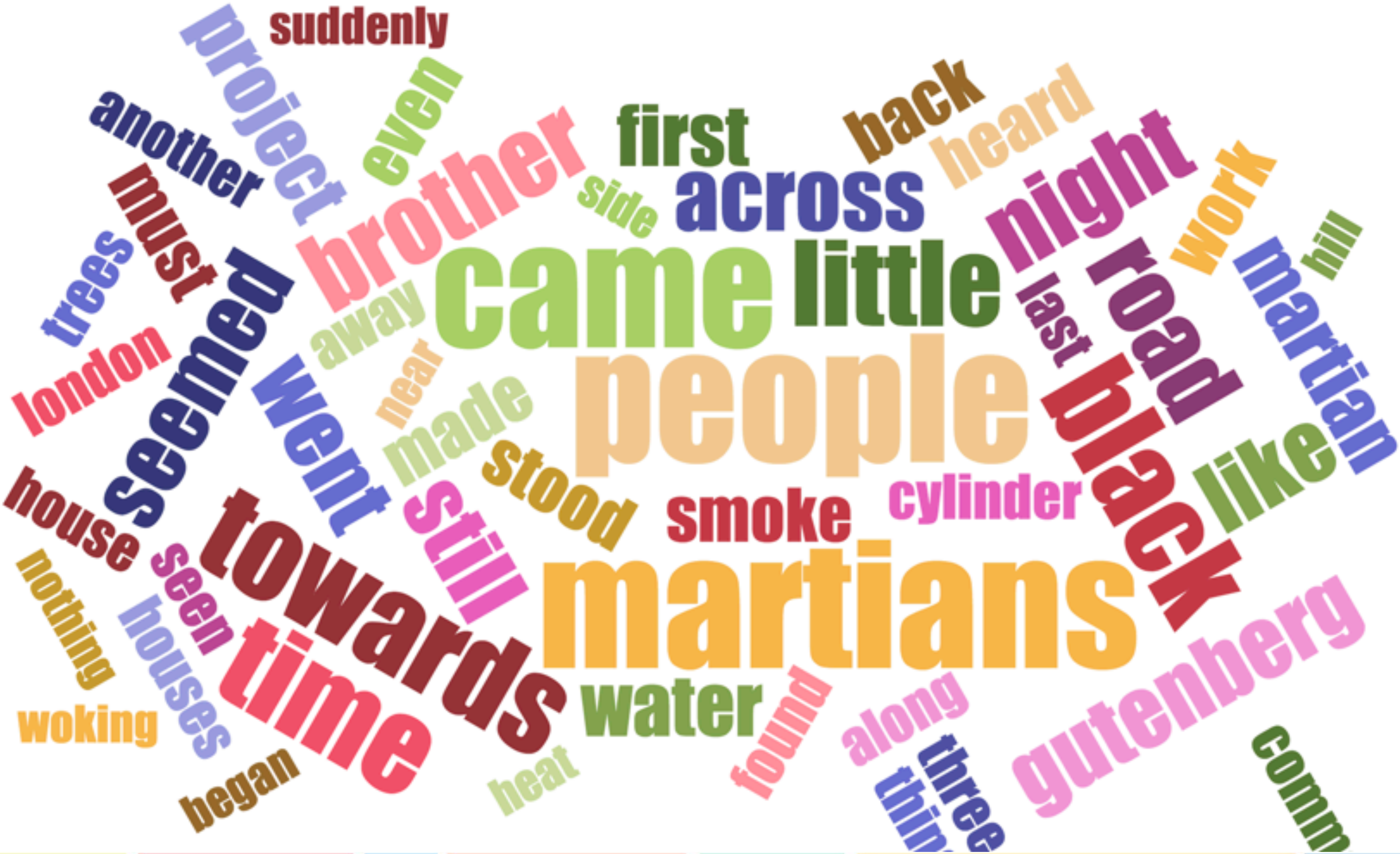


38 Top Wikipedias

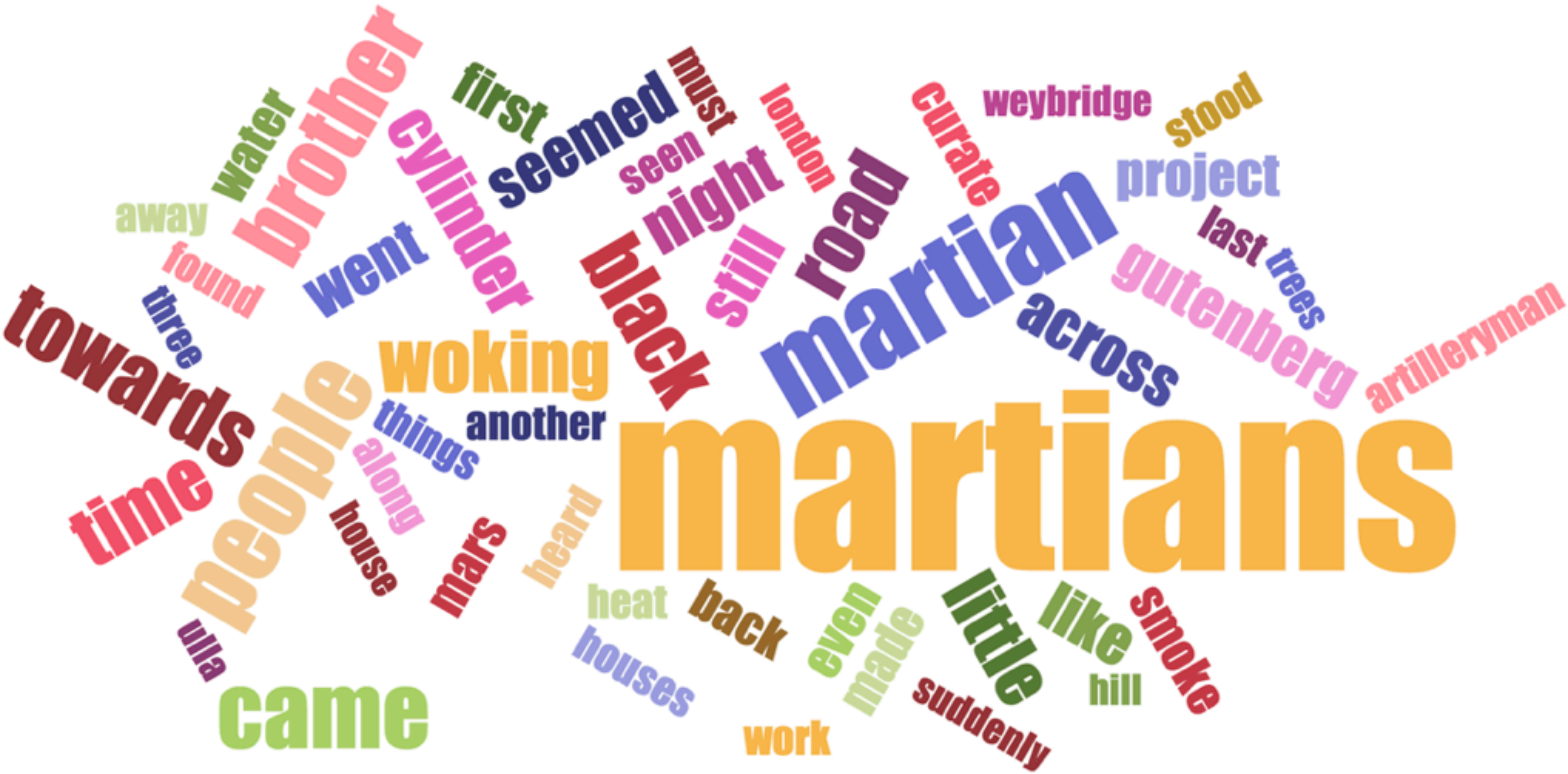
Arabic: العربية
Bulgarian: Български
Catalan: Català
Czech: Čeština
Danish: Dansk
German: Deutsch
English: English
Spanish: Español
Estonian: Eesti
Basque: Euskara
Persian: فارسی
Finnish: Suomi
French: Français
Hebrew: עברית
Hindi: हिन्दी
Croatian: Hrvatski
Hungarian: Magyar
Indonesian: Bahasa Indonesia
Italian: Italiano
Japanese: 日本語
Kazakh: Қазақша
Korean: 한국어
Lithuanian: Lietuvių
Malay Bahasa: Melayu
Dutch: Nederlands
Norwegian: Norsk (Bokmål)
Polish: Polski
Portuguese: Português
Romanian: Română
Russian: Русский
Slovak: Slovenčina
Slovenian: Slovenščina
Serbian: Српски / Srpski
Swedish: Svenska
Turkish: Türkçe
Ukrainian: Українська
Vietnamese: Tiếng Việt
Waray-Waray: Winaray

Vectorizing Text

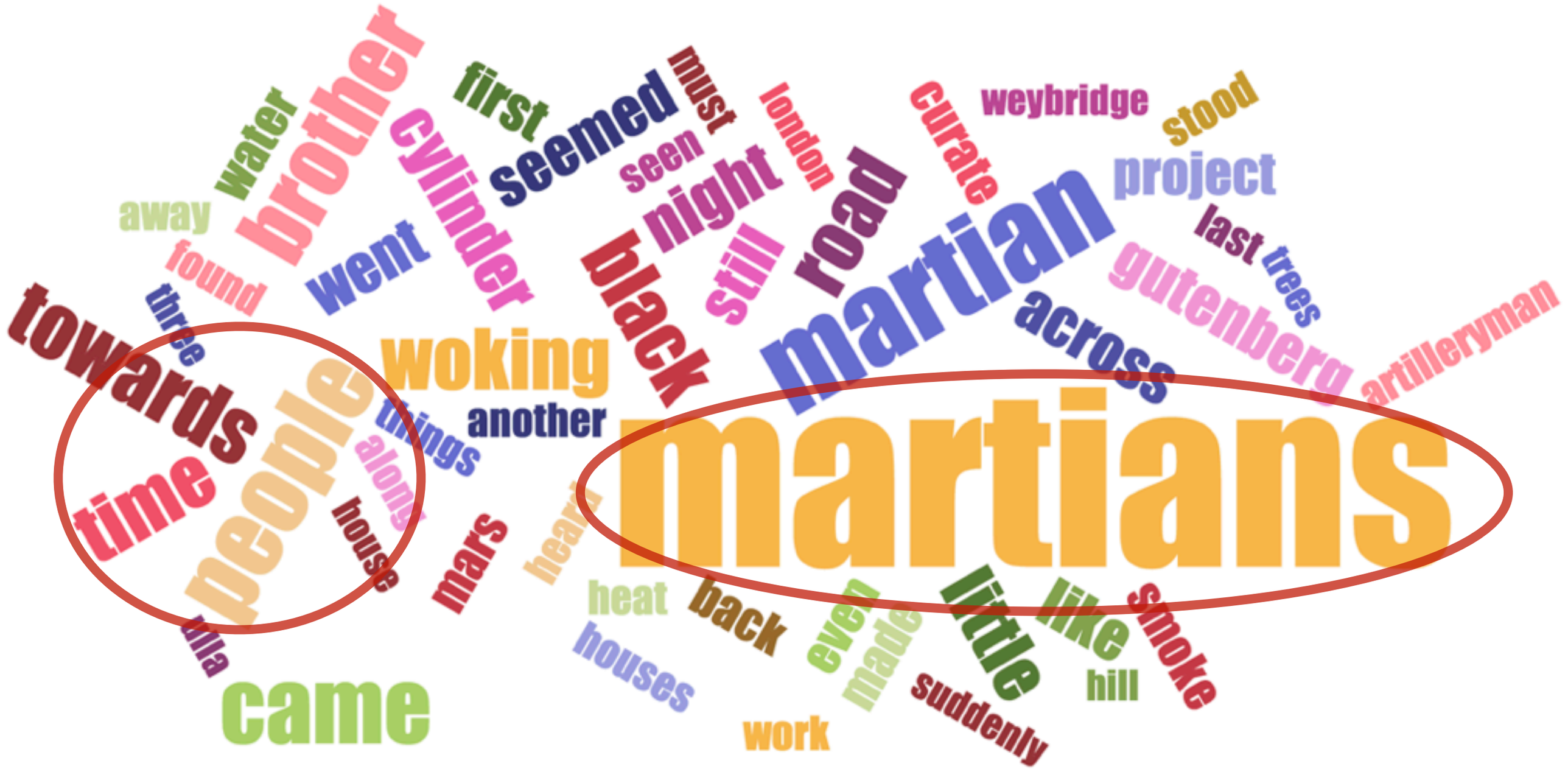



suddenly
project
another
even
brother
first
back
heard
across
side
night
work
must
trees
seemed
came
little
last
road
martian
hill
away
london
people
near
went
made
black
like
stood
cylinder
smoke
still
house
towards
martians
nothing
seen
houses
time
gutenberg
water
woking
found
along
began
heat
three
comm

```
CountVectorizer(analyzer='word', ngram_range=(1, 1))
```


martians
martian
brother
water
first
seemed
must
london
curate
weybridge
stood
cylinder
seen
night
road
project
away
found
went
still
last
trees
towards
three
black
across
gutenberg
artilleryman
woking
people
things
another
time
along
house
mars
heard
heat
back
even
made
little
like
smoke
ulla
houses
hill
came
work
suddenly

```
TfidfVectorizer(analyzer='word', ngram_range=(1, 1))
```

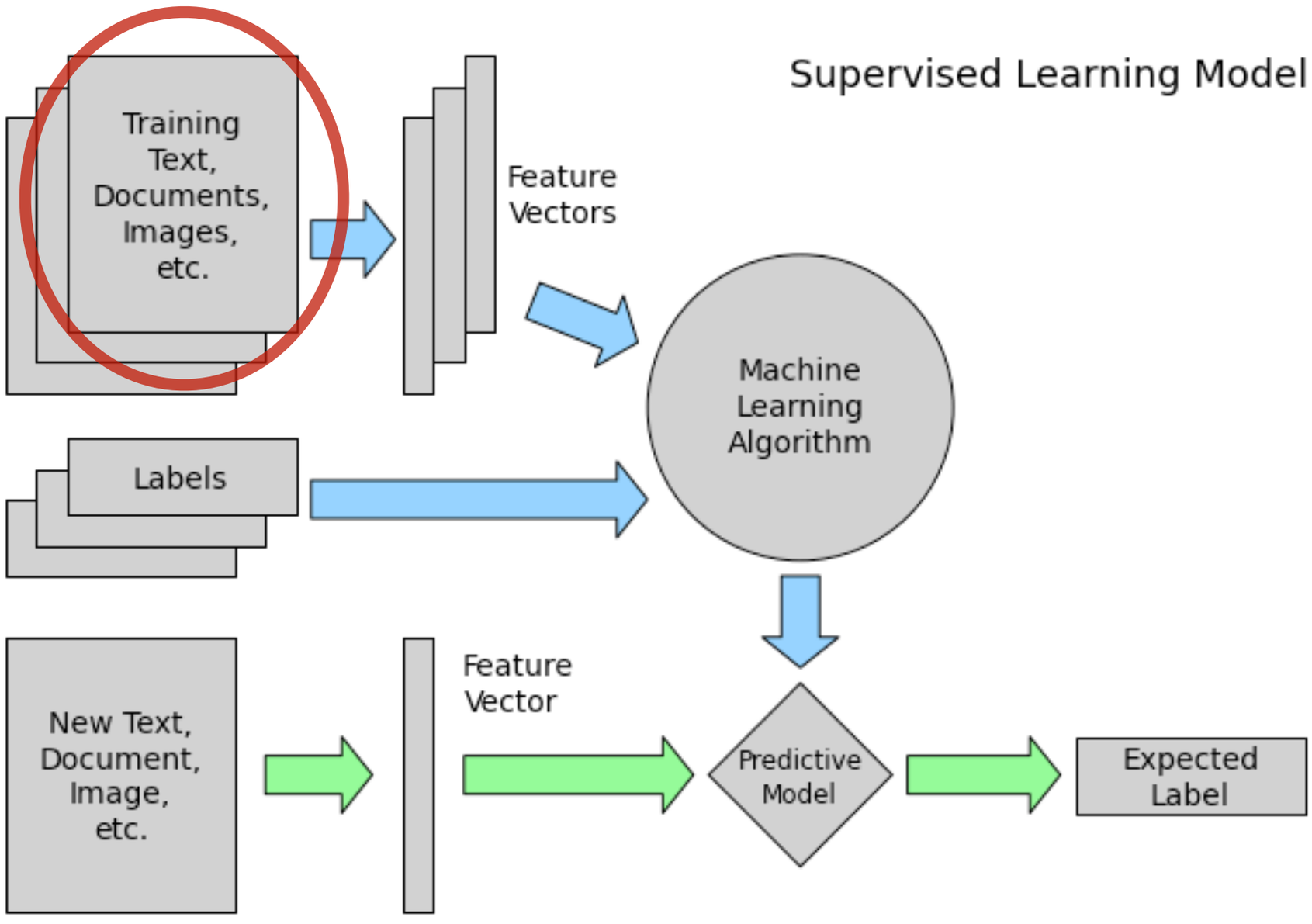


The Model

```
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)
```

Supervised Learning

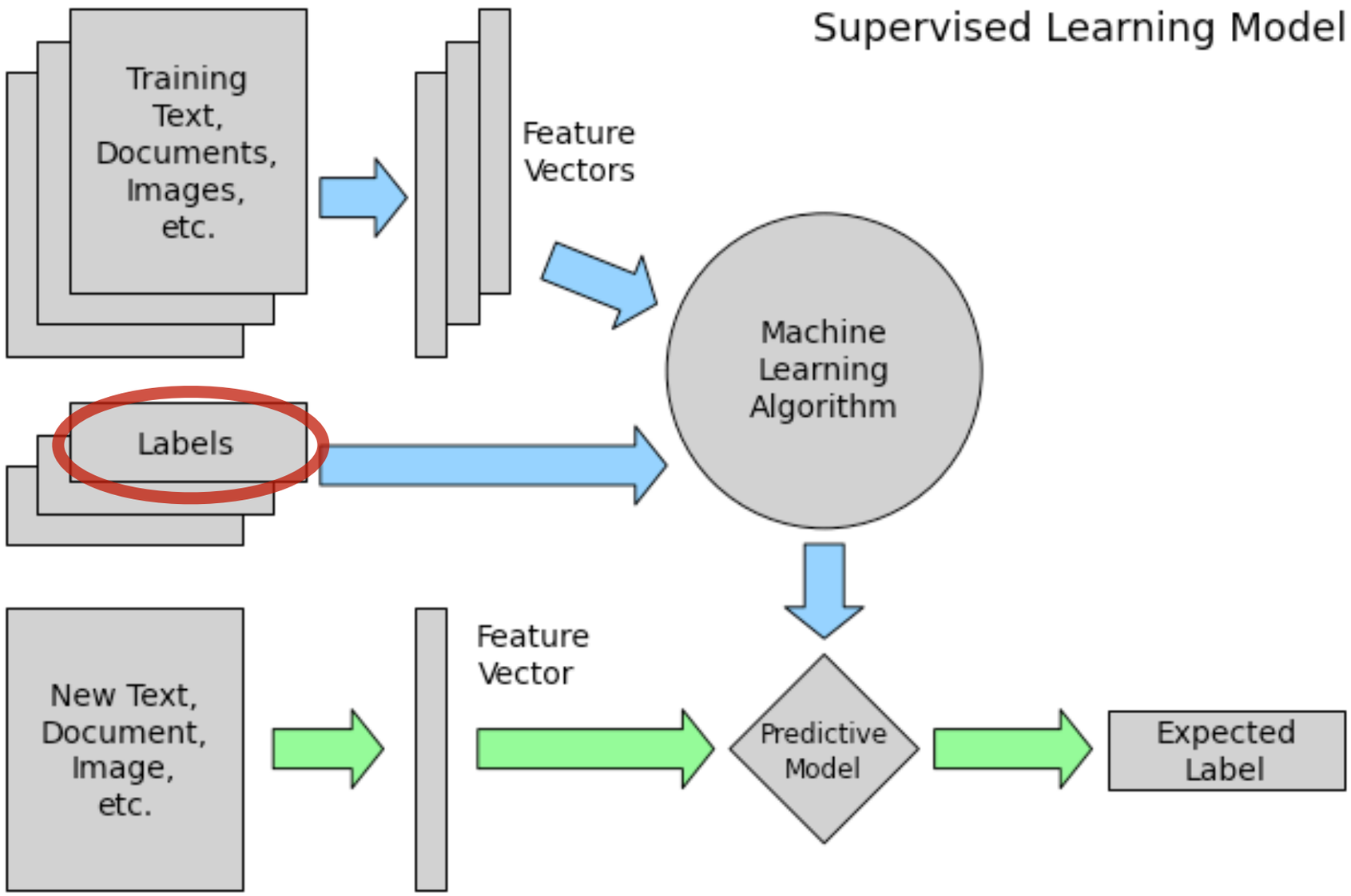


X_train

```
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])
```

Dimensionality Reduction

```
from sklearn.decomposition import RandomizedPCA
```

```
vect = TfidfVectorizer(analyzer='char', ngram_range=(2, 3)
pca = RandomizedPCA(n_components=50, whiten=True)
clf = SVC()
text_clf = Pipeline([
    ('vect', vect),
    ('pca', pca),
    ('clf', clf),
])
text_clf = text_clf.fit_transform(X_train, y_train)
```

Dimensionality Reduction

```
vect = TfidfVectorizer(analyzer='char', ngram_range=(2, 3)
X1_train = vect.fit_transform(X_train)
X1_train.shape
```

```
(47221, 1048576)
```

Dimensionality Reduction

```
vect = TfidfVectorizer(analyzer='char', ngram_range=(2, 3)
X1_train = vect.fit_transform(X_train)
X1_train.shape
```

```
(47221, 1048576)
```

```
pca = RandomizedPCA(n_components=50, whiten=True)
X2_train = pca.fit_transform(X1_train)
X2_train.shape
```

```
(47221, 50)
```

Dimensionality Reduction

```
pca.explained_variance_ratio_
```

```
array([ 0.36366957,  0.0984124 ,  0.04520123,  0.04459129,  0.03954548,
        0.03202782,  0.02943691,  0.02429984,  0.01907511,  0.01890865,
        0.01858178,  0.0171858 ,  0.016482  ,  0.01596849,  0.01584665,
        0.01499711,  0.01378617,  0.01368058,  0.01190577,  0.01173788,
        0.01131731,  0.01045798,  0.01029921,  0.01004662,  0.00951628,
        0.00803825,  0.00728402,  0.00700877,  0.00667922,  0.00664124,
        0.00574287,  0.00548161,  0.00500291,  0.00433605,  0.003948  ,
        0.00283822,  0.00241628,  0.00189858,  0.00168776,  0.00160769,
        0.001431  ,  0.00137901,  0.00132682,  0.00129177,  0.00126926,
        0.0012235 ,  0.00117239,  0.00114645,  0.00110811,  0.00106229])
```

Dimensionality Reduction

```
pca.explained_variance_ratio_
```

```
array([ 0.36366957,  0.0984124 ,  0.04520123,  0.04459129,  0.03954548,
        0.03202782,  0.02943691,  0.02429984,  0.01907511,  0.01890865,
        0.01858178,  0.0171858 ,  0.016482  ,  0.01596849,  0.01584665,
        0.01499711,  0.01378617,  0.01368058,  0.01190577,  0.01173788,
        0.01131731,  0.01045798,  0.01029921,  0.01004662,  0.00951628,
        0.00803825,  0.00728402,  0.00700877,  0.00667922,  0.00664124,
        0.00574287,  0.00548161,  0.00500291,  0.00433605,  0.003948  ,
        0.00283822,  0.00241628,  0.00189858,  0.00168776,  0.00160769,
        0.001431  ,  0.00137901,  0.00132682,  0.00129177,  0.00126926,
        0.0012235 ,  0.00117239,  0.00114645,  0.00110811,  0.00106229])
```

```
pca.explained_variance_ratio_.sum()
```

```
0.999999999999999
```

Don’t Do What I Just Did!

sklearn.decomposition.TruncatedSVD

class `sklearn.decomposition.`**`TruncatedSVD`**(*n_components=2, algorithm='randomized', n_iterations=5, random_state=None, tol=0.0*)

Dimensionality reduction using truncated SVD (aka LSA).

This transformer performs linear dimensionality reduction by means of truncated singular value decomposition (SVD). It is very similar to PCA, but operates on sample vectors directly, instead of on a covariance matrix. This means it can work with scipy.sparse matrices efficiently.

In particular, truncated SVD works on term count/tf–idf matrices as returned by the vectorizers in sklearn.feature_extraction.text. In that context, it is known as latent semantic analysis (LSA).

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_
```

```
0.96647677939899623
```

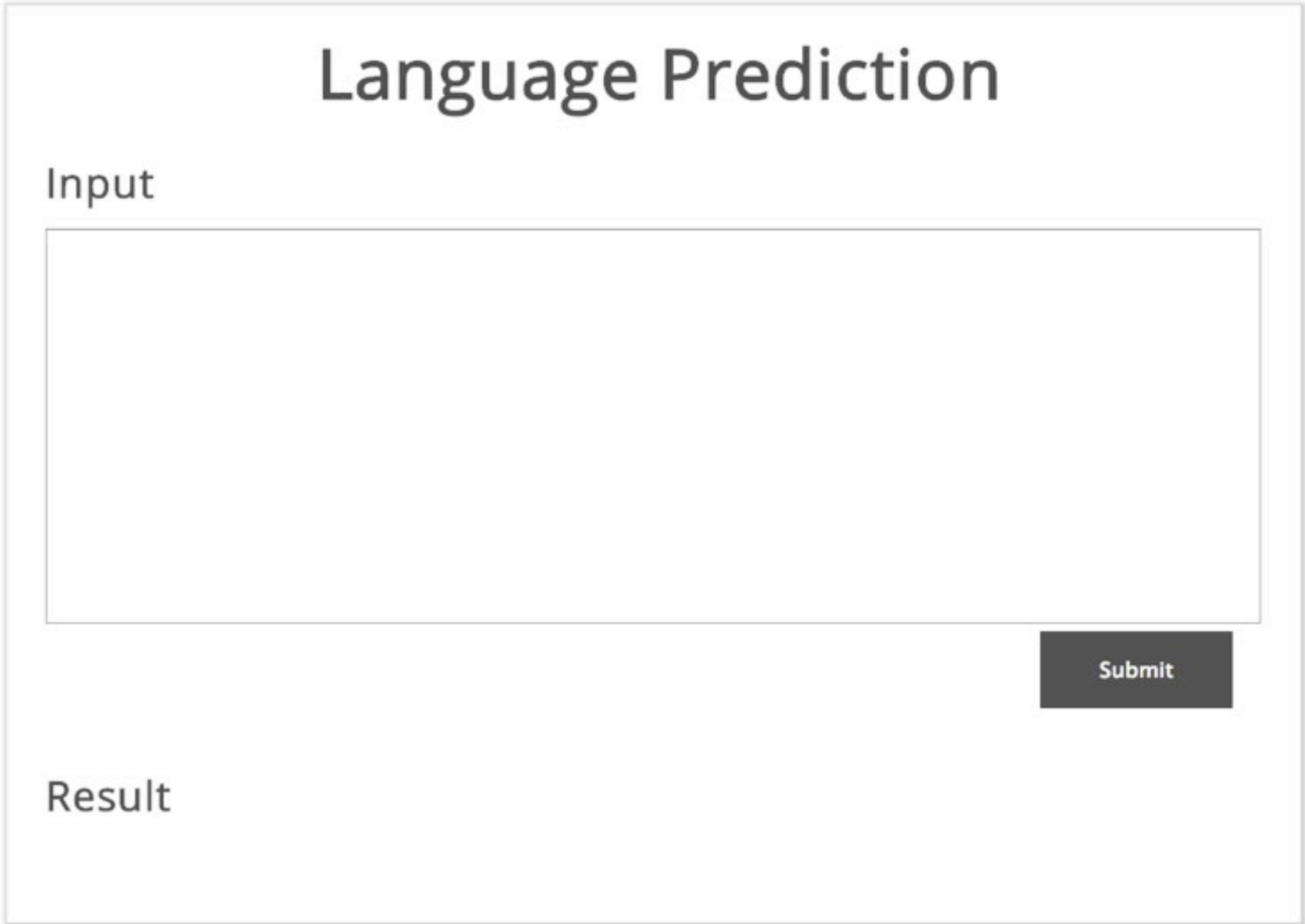
```
random_search.best_params_
```

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

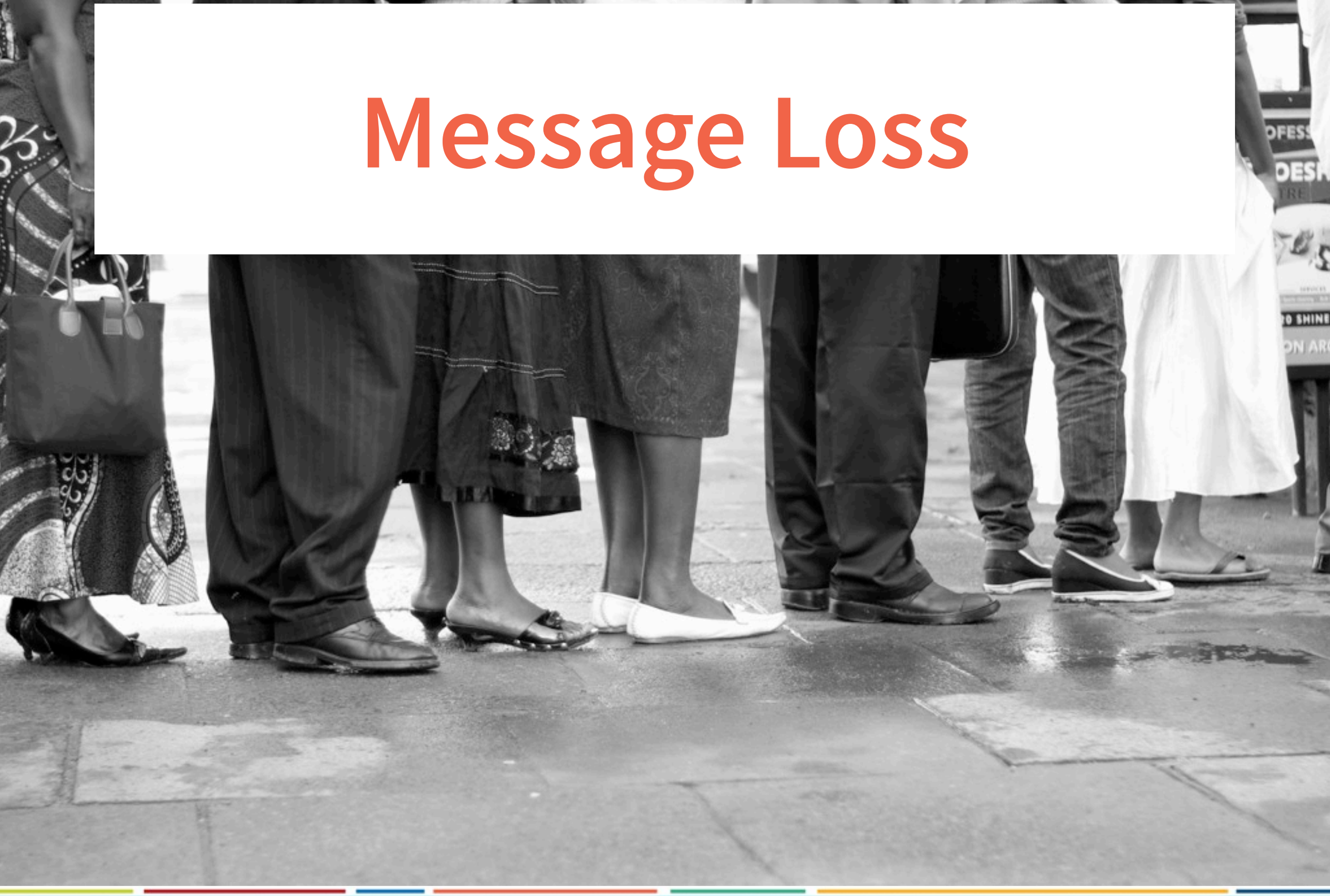
Distributing The Model

Data Input

The Client



Message Loss



Enter RabbitMQ

Flexible Routing

Reliability

Clustering

HA Queues

Many clients

Enter RabbitMQ

Flexible Routing

Reliability

Clustering

HA Queues

Many clients

Using the Blocking Connection to consume messages from RabbitMQ

The `BlockingChannel.basic_consume` method assign a callback method to be called every time that RabbitMQ delivers messages to your consuming application.

When pika calls your method, it will pass in the channel, a `pika.spec.Basic.Deliver` object with the delivery tag, the redelivered flag, the routing key that was used to put the message in the queue, and the exchange the message was published to. The third argument will be a `pika.spec.BasicProperties` object and the last will be the message body.

Example of consuming messages and acknowledging them:

```
import pika


def on_message(channel, method_frame, header_frame, body):
    print method_frame.delivery_tag
    print body
    print
    channel.basic_ack(delivery_tag=method_frame.delivery_tag)


connection = pika.BlockingConnection()
channel = connection.channel()
channel.basic_consume(on_message, 'test')
try:
    channel.start_consuming()
except KeyboardInterrupt:
    channel.stop_consuming()
```

RabbitMQ
Messaging that just works

by

Features Installation Documentation **Tutorials** Services Community Blog

Search RabbitMQ

These tutorials cover the basics of creating messaging applications using RabbitMQ. You need to have the RabbitMQ server installed t
the tutorials – please see the **installation guide.**

1 "Hello World!"

The simplest thing that does *something*

Python | Java | Ruby | PHP | C#

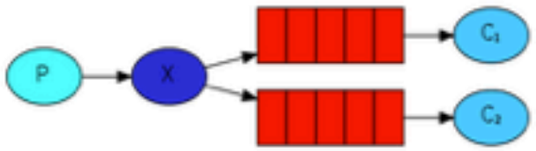
2 Work queues

Distributing tasks among workers

Python | Java | Ruby | PHP | C#

3 Publish/Subscribe

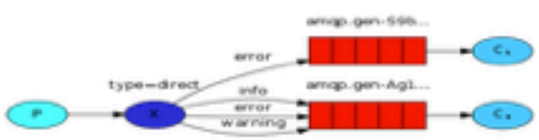
Sending messages to many consumers at once



Python | Java | Ruby | PHP | C#

4 Routing

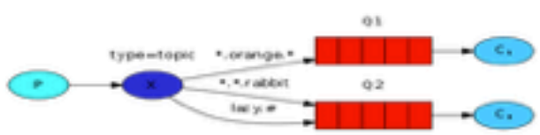
Receiving messages selectively



Python | Java | Ruby | PHP | C#

5 Topics

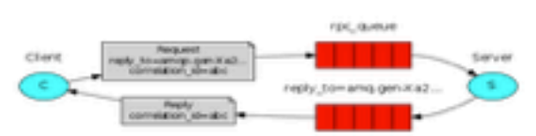
Receiving messages based on a pattern



Python | Java | Ruby | PHP | C#

6 RPC

Remote procedure call implementation



Python | Java | Ruby | PHP | C#

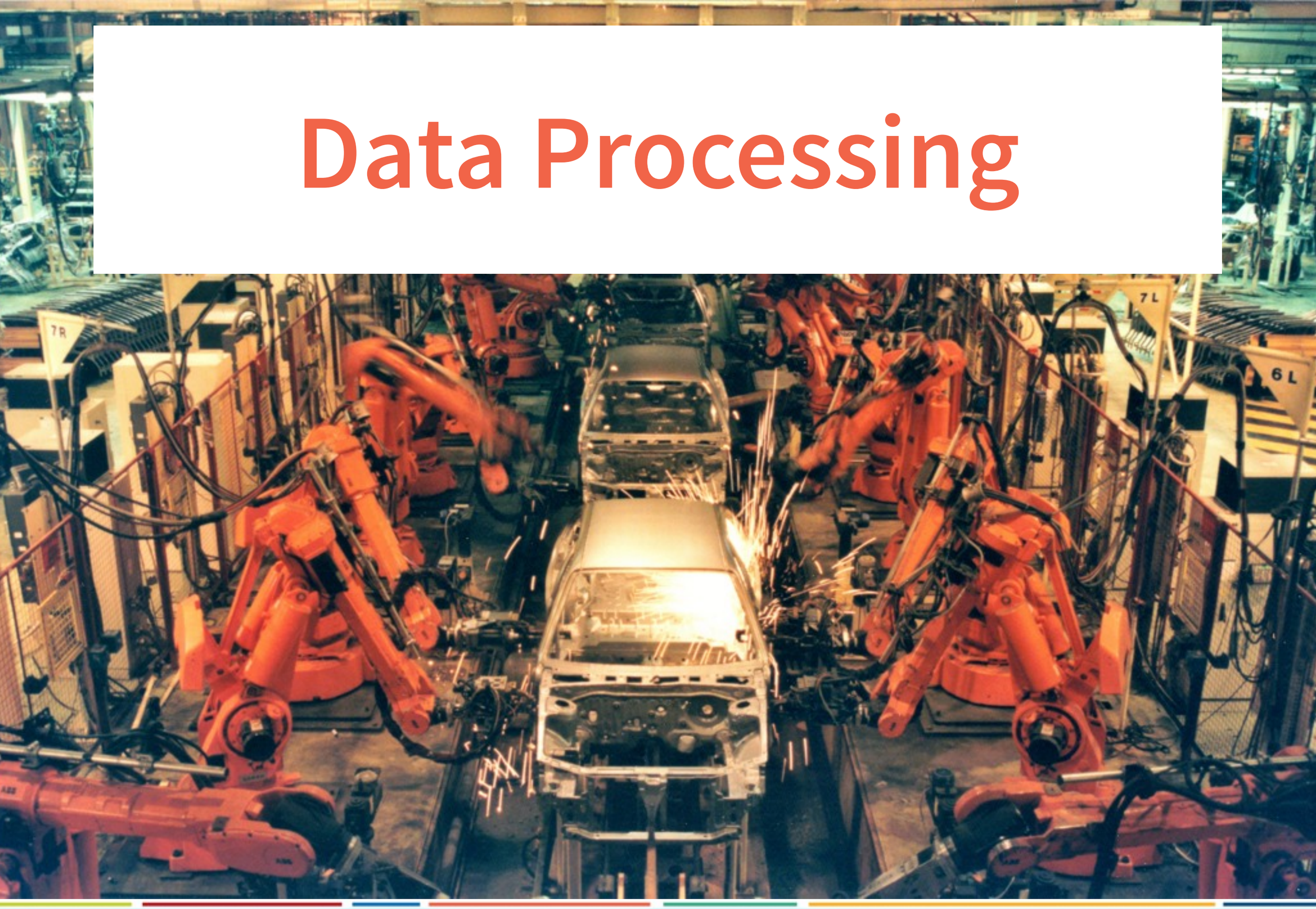
RabbitMQ
IN DEPTH

Gavin M. Roy

All the things!

beanstalkd

Data Processing



The Consumer

```
class LanguagePredictorWorker(object):

    classifier, label_encoder = load_pickled_files(clf)
    def __init__(self):
        subscribe_to_queue()
        self.language_coll = get_db_collection()

    def process_event(self, body, message):
        text = body['text']
        _id = body['id']
        language = self.predict_language_for_text(text)
        result = self.language_coll.update(
            {'_id': ObjectId(_id), 'text_input': text},
            {'$set': {'language': language}},
        )
        message.ack()

    def predict_language_for_text(self, text):
        lang_vector = self.classifier.predict([text])
        lang_labels = self.label_encoder.inverse_transform(lang_vector)
        return lang_labels[0]

worker = LanguagePredictorWorker()
worker.main()
```

The Consumer

```
class LanguagePredictorWorker(object):

    classifier, label_encoder = load_pickled_files(clf)
    def __init__(self):
        subscribe_to_queue()
        self.language_coll = get_db_collection()

    def process_event(self, body, message):
        text = body['text']
        _id = body['id']
        language = self.predict_language_for_text(text)
        result = self.language_coll.update(
            {'_id': ObjectId(_id), 'text_input': text},
            {'$set': {'language': language}},
        )
        message.ack()

    def predict_language_for_text(self, text):
        lang_vector = self.classifier.predict([text])
        lang_labels = self.label_encoder.inverse_transform(lang_vector)
        return lang_labels[0]

worker = LanguagePredictorWorker()
worker.main()
```

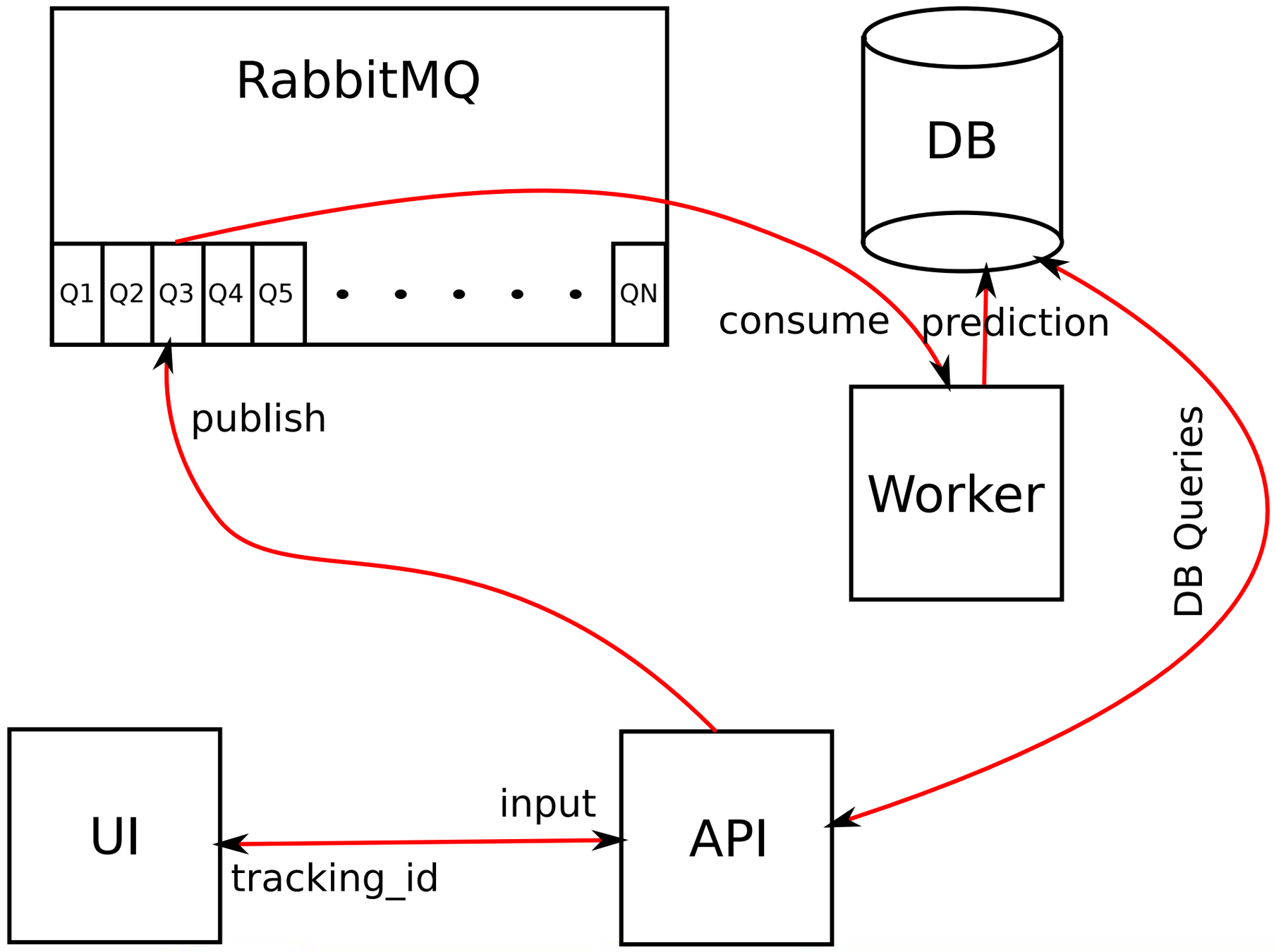
The Consumer

```
class LanguagePredictorWorker(object):

    classifier, label_encoder = load_pickled_files(clf)
    def __init__(self):
        subscribe_to_queue()
        self.language_coll = get_db_collection()

    def process_event(self, body, message):
        text = body['text']
        _id = body['id']
        language = self.predict_language_for_text(text)
        result = self.language_coll.update(
            {'_id': ObjectId(_id), 'text_input': text},
            {'$set': {'language': language}},
        )
        message.ack()

    def predict_language_for_text(self, text):
        lang_vector = self.classifier.predict([text])
        lang_labels = self.label_encoder.inverse_transform(lang_vector)
        return lang_labels[0]

worker = LanguagePredictorWorker()
worker.main()
```

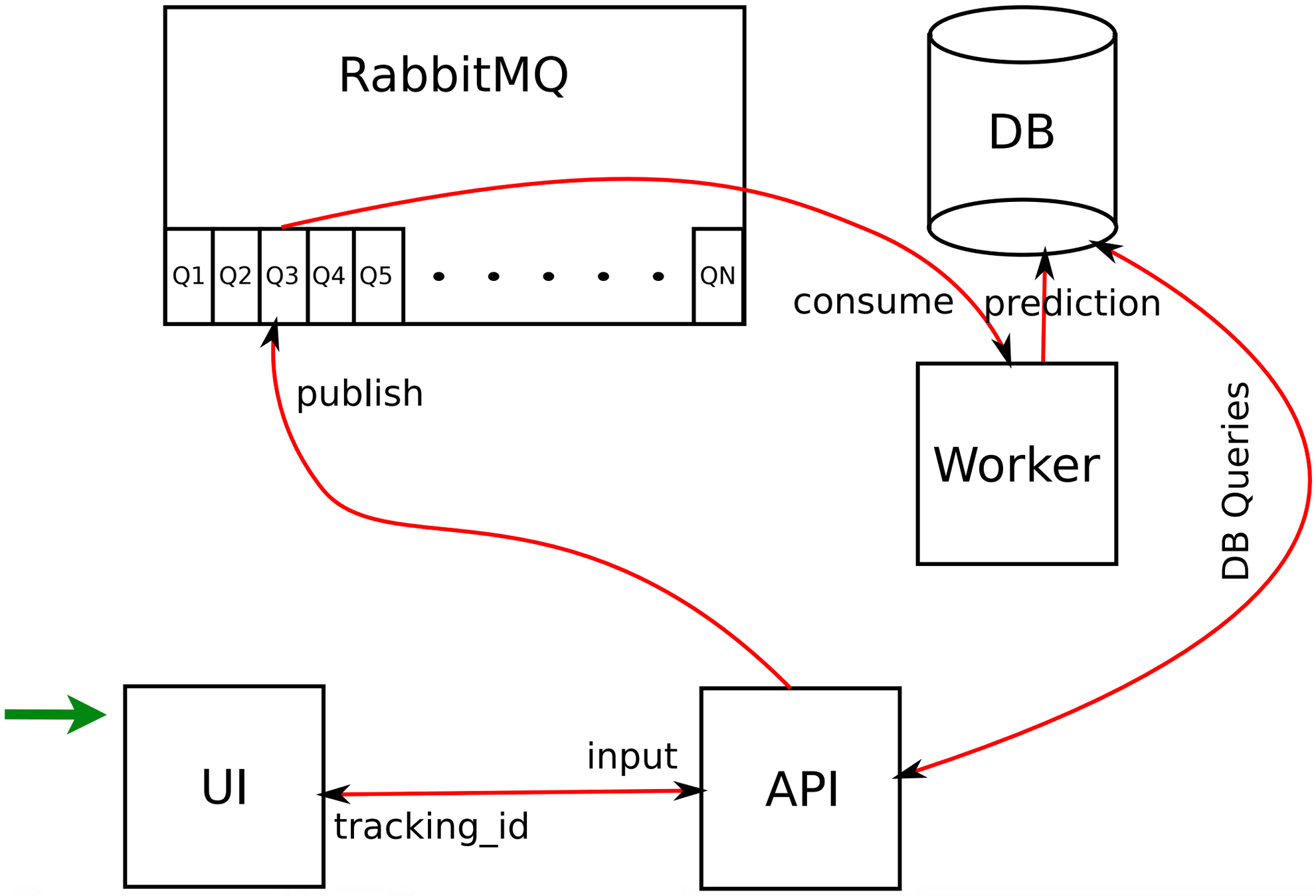
The Consumer

```
class LanguagePredictorWorker(object):

    classifier, label_encoder = load_pickled_files(clf)
    def __init__(self):
        subscribe_to_queue()
        self.language_coll = get_db_collection()

    def process_event(self, body, message):
        text = body['text']
        _id = body['id']
        language = self.predict_language_for_text(text)
        result = self.language_coll.update(
            {'_id': ObjectId(_id), 'text_input': text},
            {'$set': {'language': language}},
        )
        message.ack()

    def predict_language_for_text(self, text):
        lang_vector = self.classifier.predict([text])
        lang_labels = self.label_encoder.inverse_transform(lang_vector)
        return lang_labels[0]

worker = LanguagePredictorWorker()
worker.main()
```

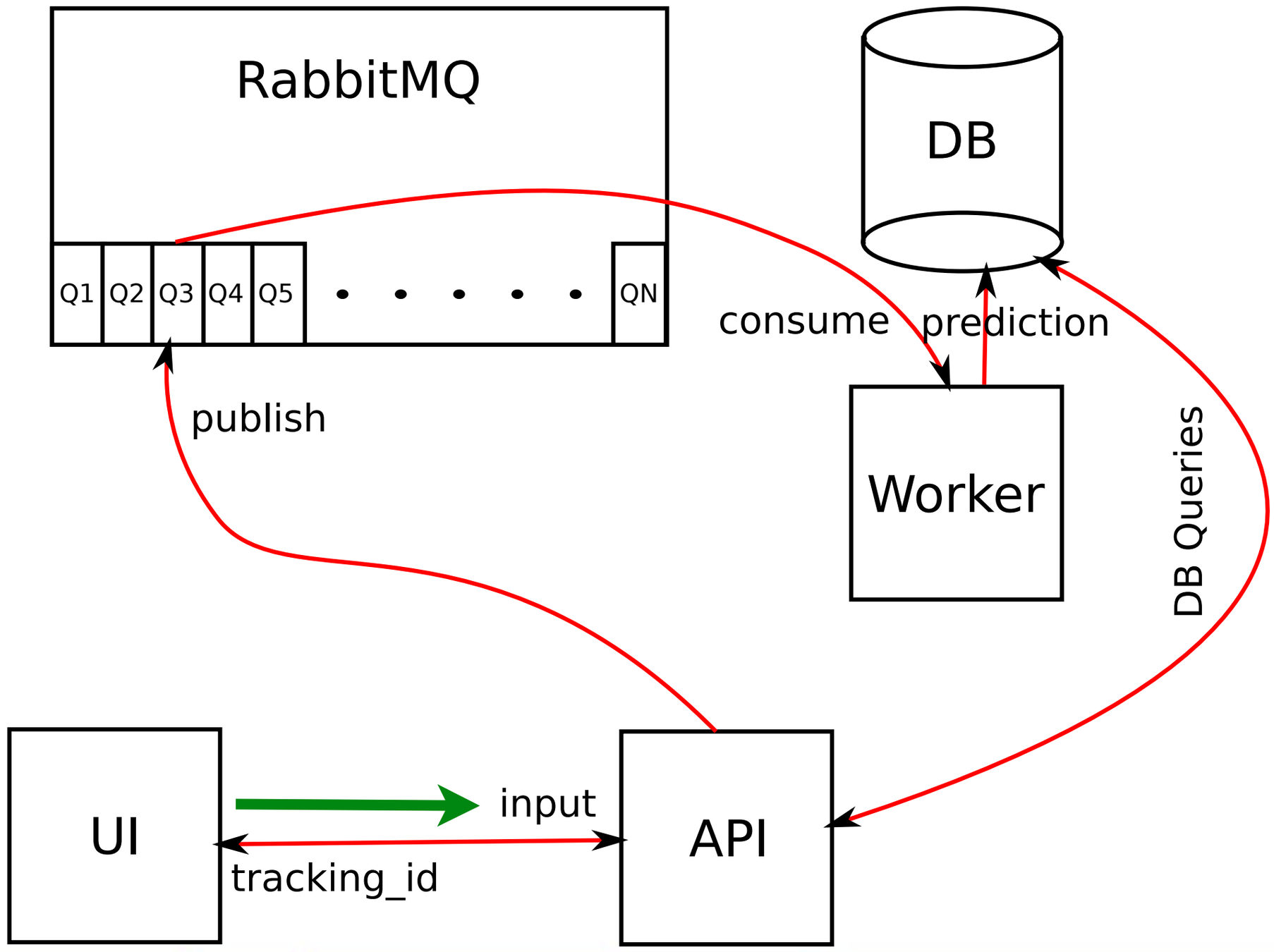
The Design


RabbitMQ
Q1
Q2
Q3
Q4
Q5
QN
DB
consume
prediction
publish
Worker
DB Queries
UI
input
tracking_id
API

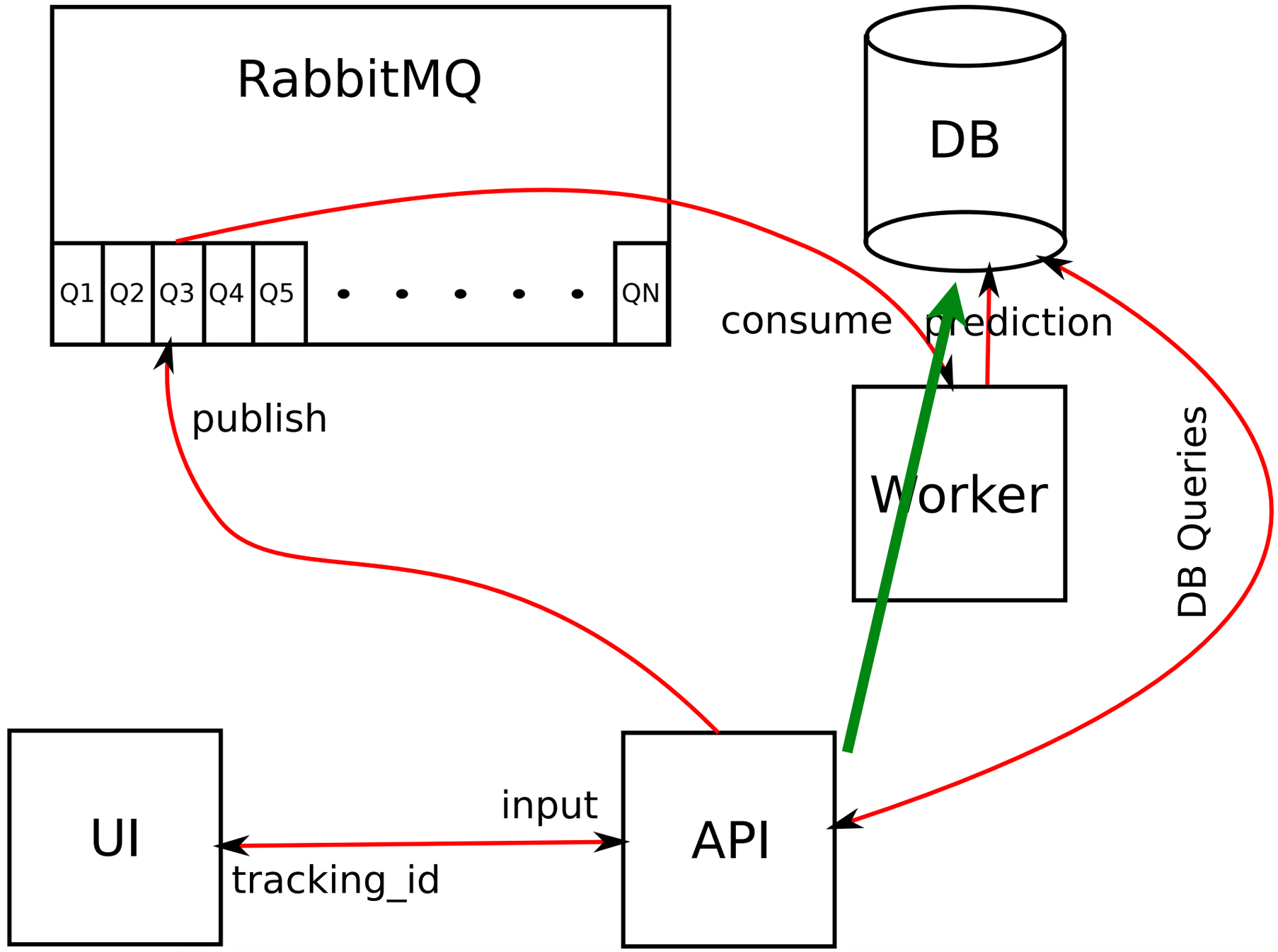
The Design


RabbitMQ
Q1
Q2
Q3
Q4
Q5
QN
DB
consume
prediction
publish
Worker
DB Queries
UI
input
tracking_id
API

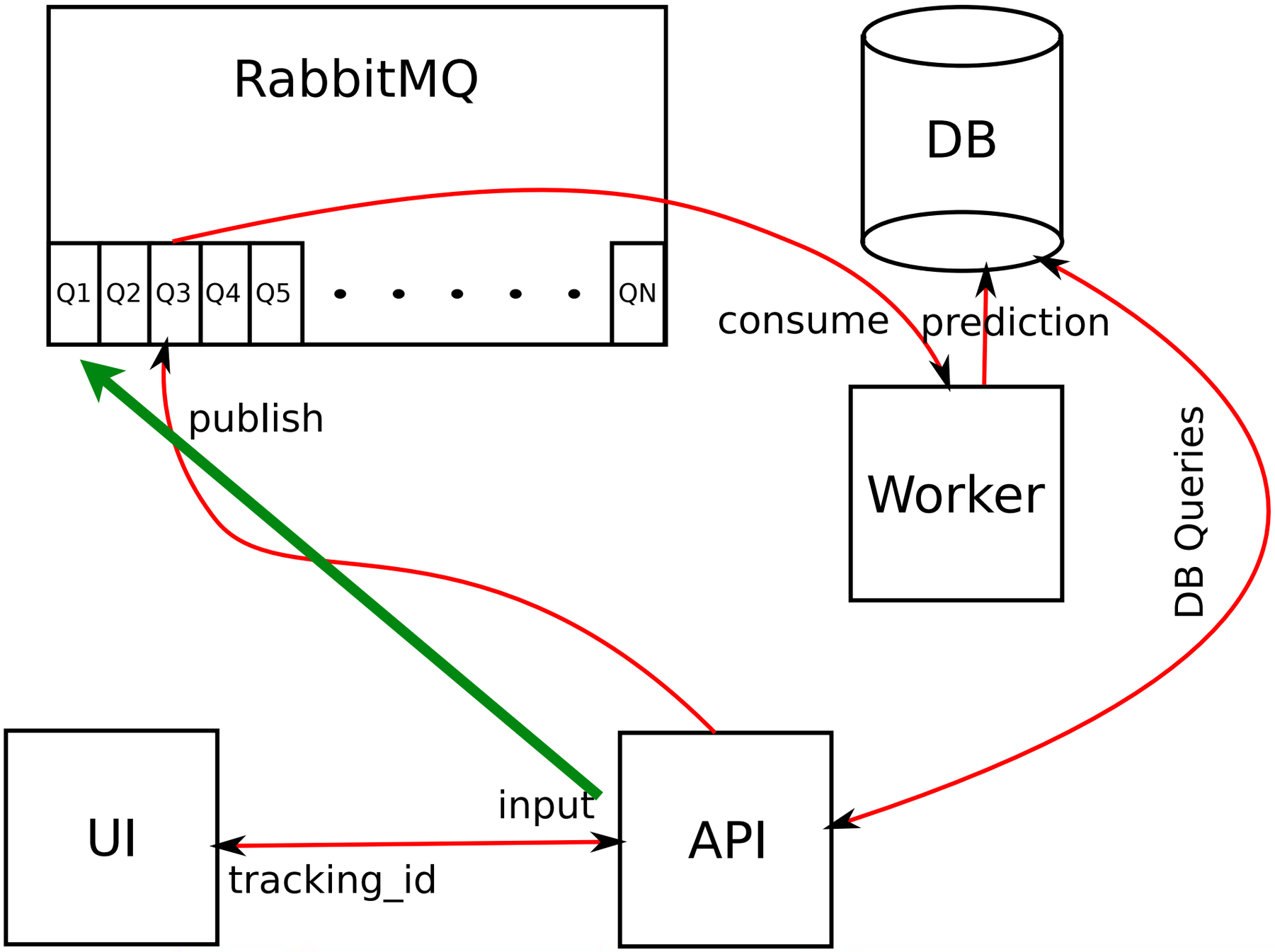
The Design


RabbitMQ
Q1
Q2
Q3
Q4
Q5
QN
DB
consume
prediction
publish
Worker
DB Queries
UI
input
tracking_id
API

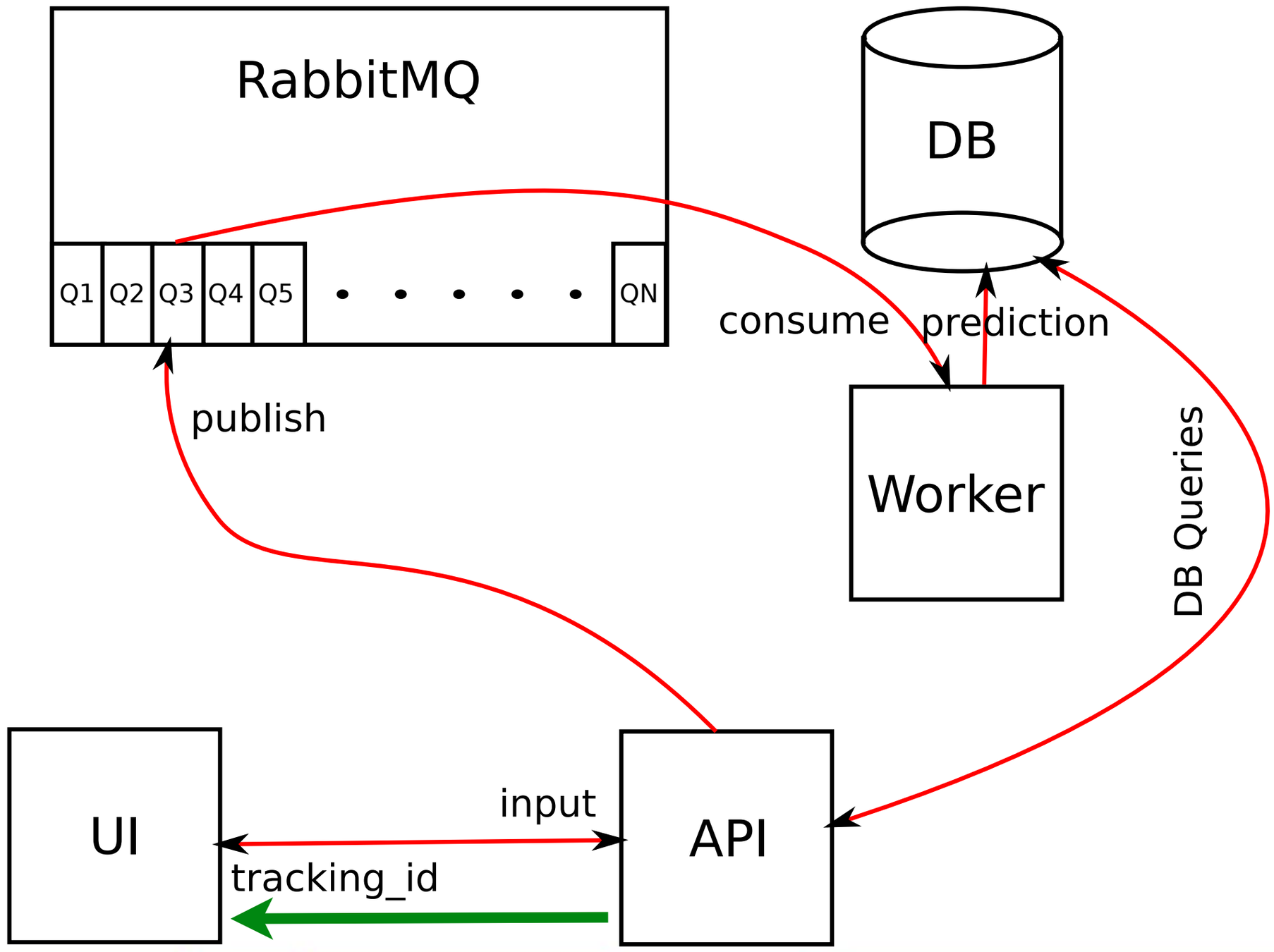
The Design


RabbitMQ
Q1
Q2
Q3
Q4
Q5
QN
DB
consume
prediction
publish
Worker
DB Queries
UI
input
tracking_id
API

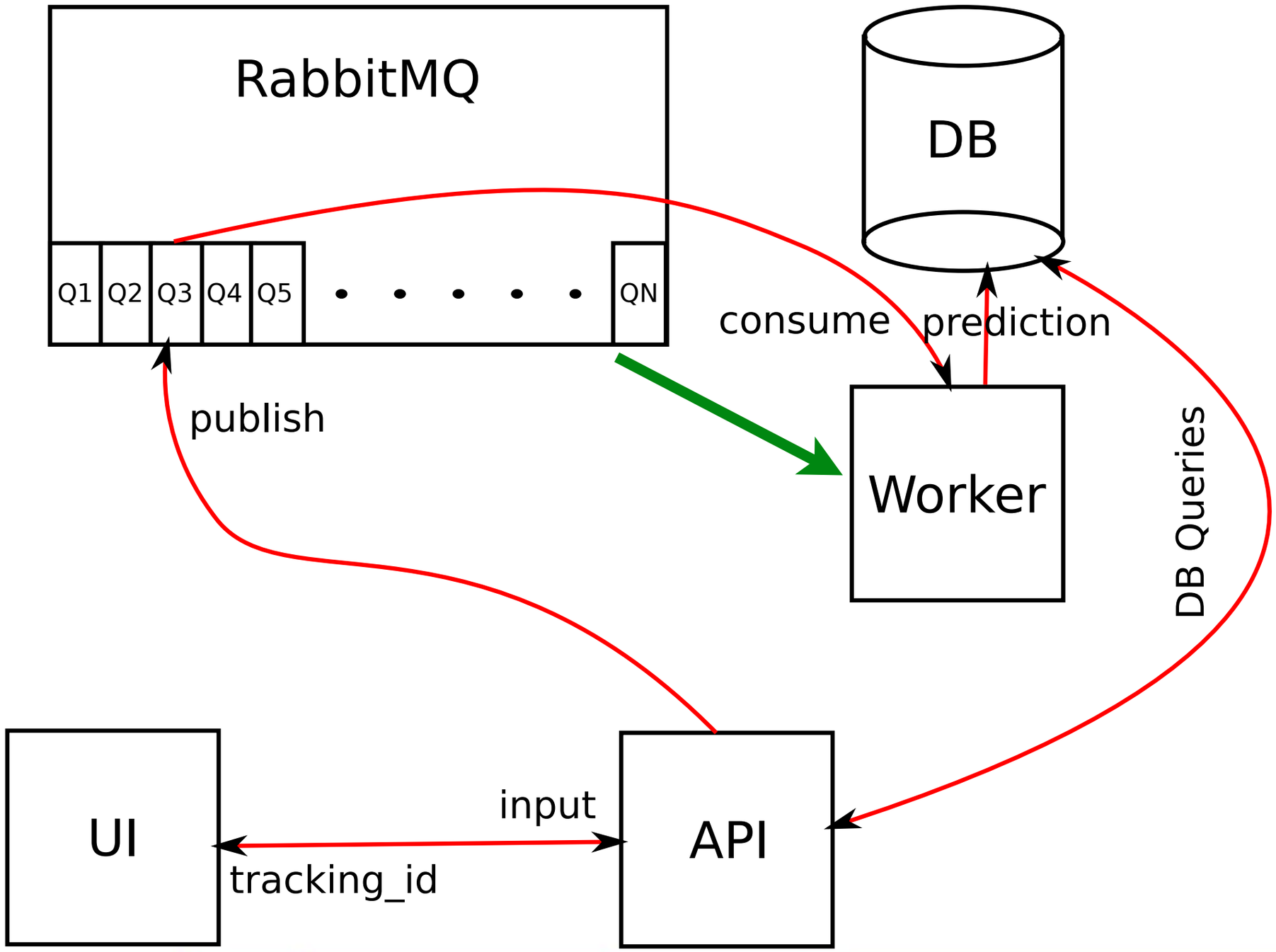
The Design


RabbitMQ
DB
Q1
Q2
Q3
Q4
Q5
QN
consume
prediction
publish
Worker
DB Queries
input
UI
API
tracking_id

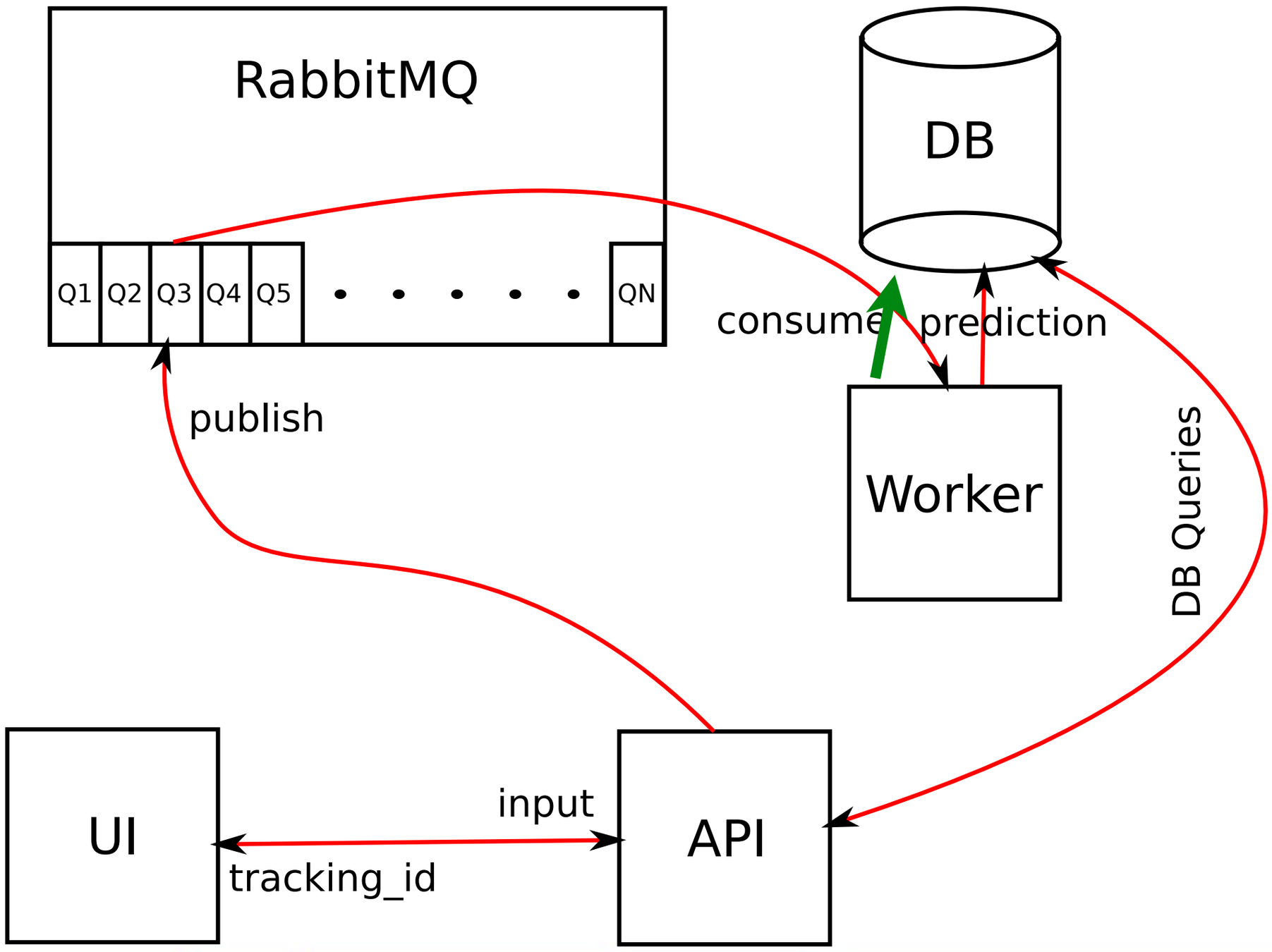
The Design


RabbitMQ
Q1
Q2
Q3
Q4
Q5
QN
DB
consume
prediction
publish
Worker
DB Queries
UI
input
tracking_id
API

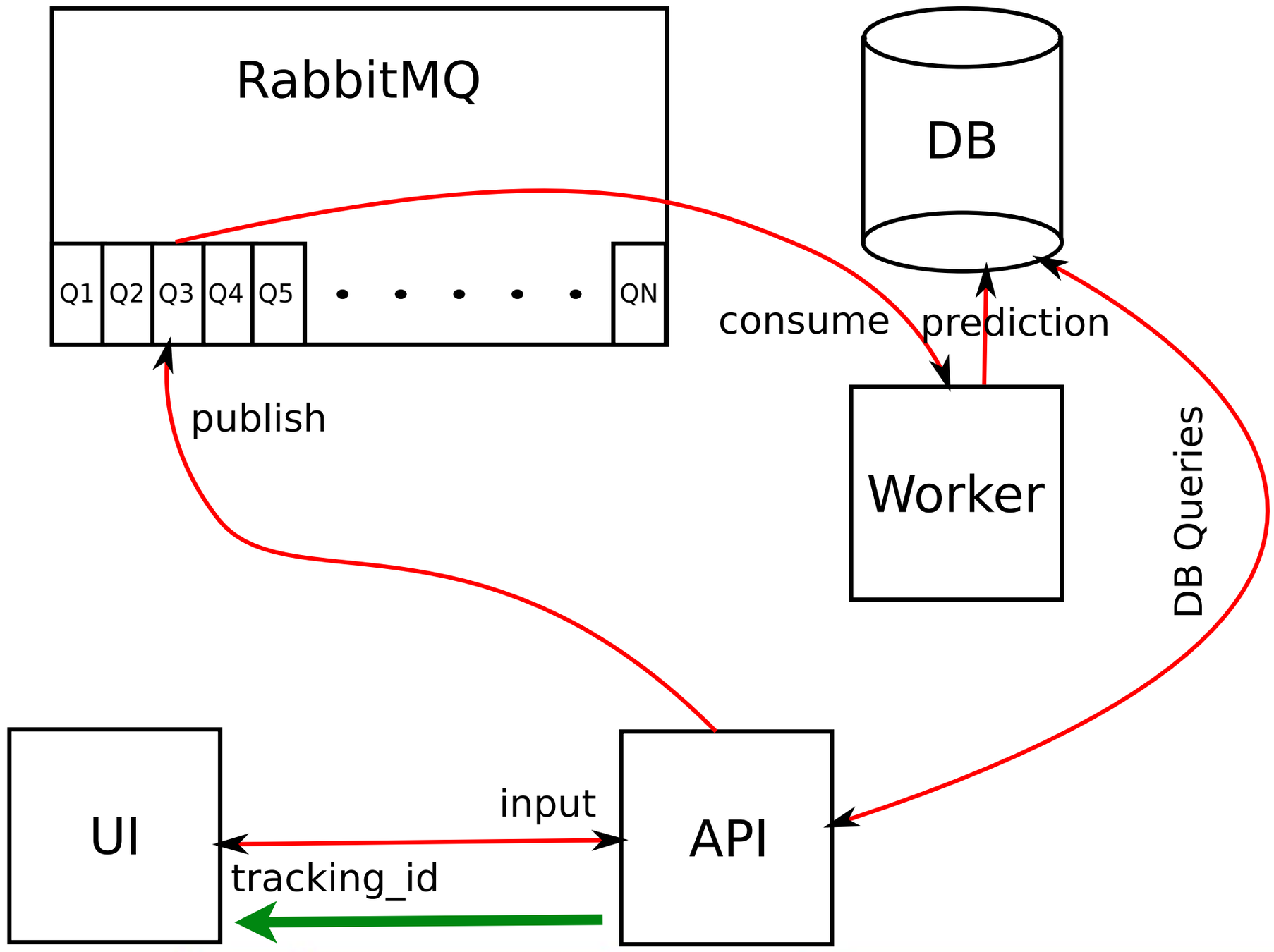
The Design


RabbitMQ
Q1
Q2
Q3
Q4
Q5
QN
DB
consume
prediction
publish
Worker
DB Queries
UI
input
tracking_id
API

The Design


RabbitMQ
Q1
Q2
Q3
Q4
Q5
QN
DB
consume
prediction
publish
Worker
DB Queries
UI
input
tracking_id
API

The Design


RabbitMQ
Q1
Q2
Q3
Q4
Q5
QN
DB
consume
prediction
publish
Worker
DB Queries
UI
input
tracking_id
API

Demo Time!

Language Prediction

Input

Adolf II av Holstein
Adolf II av Holstein, född 1128, död 6 juli 1164 (stupad vid Verchen i Demmin), begravd i Minden, var greve av Holstein 1131–1164. Son till greve Adolf I av Holstein (död 1131) och Hildewa.
Biografi[redigera]

Adolf II efterträdde fadern i Schauenburg och Holstein-Wagrien. I flera år låg dock Wagrien under kontroll av Pribislaw av Mecklenburg. I tyska tronkriget stod Adolf på welfisk sida, och han var 1138–1142 förjagad av Albrekt Björnen då Adolf vägrade erkänna denne som sachsisk hertig. Som ny greve i Holstein och Stormarn insatte Albrekt då Heinrich von Badwide, men denne kunde Adolf senare driva ut med welfisk hjälp. 1143 återfick Adolf av Henrik Lejonet sitt tidigare grevskap mot en stor summa pengar, och detta år förenades landskapet Wagrien slutgiltigt med Holstein.
Adolf grundade 1134 Segeberg vars borg senare brändes ned av den av Adolf på flykt fördrivne Heinrich von Badwide. Borgen återuppbyggdes och blev Adolfs viktigaste stödjepunkt. 1143 grundade Adolf även Alt-Lübeck som förstördes 1147 av furst Niklot av obotriterna. Området överlämnades slutligen till Henrik Lejonet vilken 1158 nygrundade Lübeck.

Submit

Result

Swedish Svenska

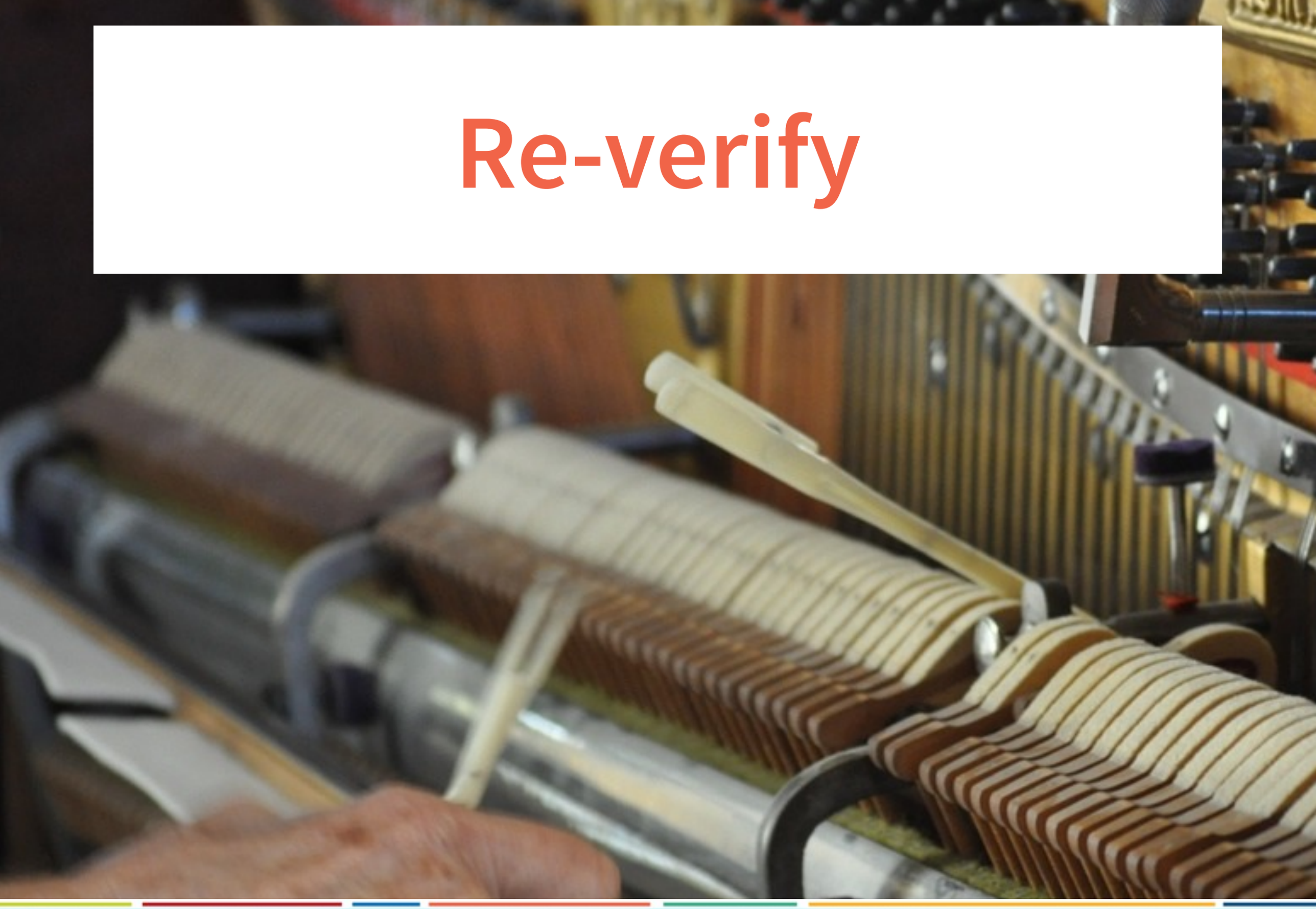
Scaling

Realtime vs Batch

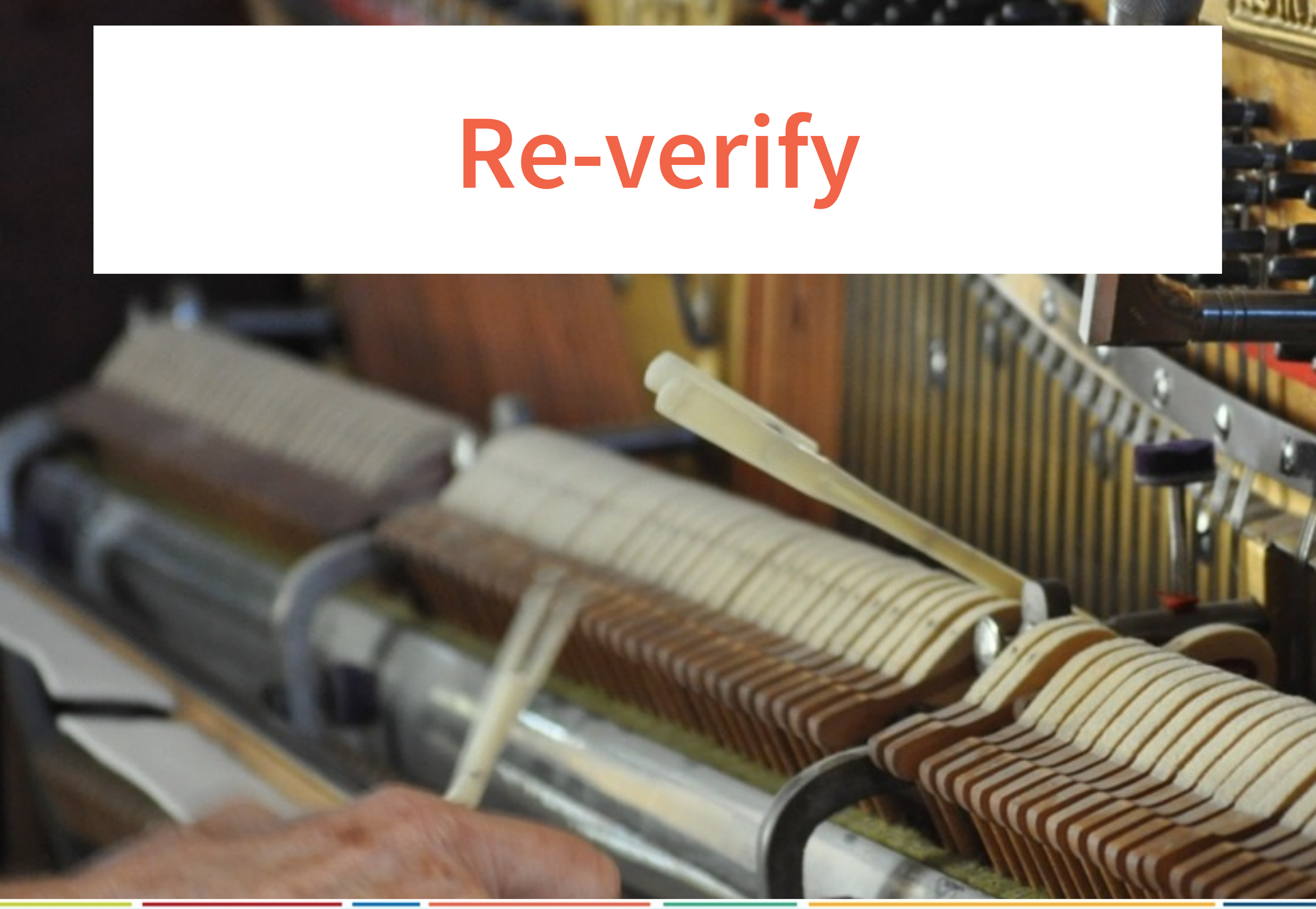
Monitoring

Load

Re-verify



Re-verify



Thank You!

API & Consumer: Kelly O'Brien (linkedin.com/in/kellyobie)

UI: Matt Parke (ordinaryrobot.com)

Classifier: Michael Becker (github.com/mdbecker)

Images: Wikipedia; flickr.com users: kohsa, spenceyc, statefarm, klara, rh2ox, nasahqphoto, frickfrack

My Info

Twitter: @beckerfuffle

Blog: beckerfuffle.com

These slides and more @ github.com/mdbecker

Demo time!

Language Prediction

Input

Adolf II av Holstein
Adolf II av Holstein, född 1128, död 6 juli 1164 (stupad vid Verchen i Demmin), begravd i Minden, var greve av Holstein 1131–1164. Son till greve Adolf I av Holstein (död 1131) och Hildewa.
Biografi[redigera]

Adolf II efterträdde fadern i Schauenburg och Holstein-Wagrien. I flera år låg dock Wagrien under kontroll av Pribislaw av Mecklenburg. I tyska tronkriget stod Adolf på welfisk sida, och han var 1138–1142 förjagad av Albrekt Björnen då Adolf vägrade erkänna denne som sachsisk hertig. Som ny greve i Holstein och Stormarn insatte Albrekt då Heinrich von Badwide, men denne kunde Adolf senare driva ut med welfisk hjälp. 1143 återfick Adolf av Henrik Lejonet sitt tidigare grevskap mot en stor summa pengar, och detta år förenades landskapet Wagrien slutgiltigt med Holstein.
Adolf grundade 1134 Segeberg vars borg senare brändes ned av den av Adolf på flykt fördrivne Heinrich von Badwide. Borgen återuppbyggdes och blev Adolfs viktigaste stödjepunkt. 1143 grundade Adolf även Alt-Lübeck som förstördes 1147 av furst Niklot av obotriterna. Området överlämnades slutligen till Henrik Lejonet vilken 1158 nygrundade Lübeck.

Submit

Result

Swedish Svenska

Demo time!

Language Prediction

Input

Manhattanprosjektet (engelsk: Manhattan Project) var et forsknings- og utviklingsprogram, som under amerikansk ledelse og med deltakelse av Storbritannia og Canada førte til fremstillingen av de første atombombene under andre verdenskrig. Fra 1942 til 1946 ble prosjektet ledet av generalmajor Leslie Groves fra den amerikanske hærens ingeniørkorps (US Army Corps of Engineers). Hærens del av prosjektet fikk betegnelsen Manhattan District. Manhattan avløste etter hvert det offisielle kodenavnet Development of Substitute Materials som betegnelse for hele prosjektet. Underveis slukte Manhattanprosjektet også den tidligere britiske motparten, kalt Tube Alloys. Blant fysikerne som tok del i Manhattanprosjektet var Albert Einstein, Edward Teller og danske Niels Bohr.
Manhattanprosjektet begynte i det små i 1938, men det vokste raskt og tilsammen beskjeftiget det over 130 000 personer og kostet nesten 2 milliarder dollar (tilsvarende ca. 150 milliarder i 2012[1]). Over 90 % av pengene gikk til byggingen av fabrikker og produksjonen av spaltbart materiale, mens under 10 % gikk til selve utviklingen av våpnene. Forskning og utvikling foregikk på mer enn 30 forskjellige steder rundt om i USA, Storbritannia og Canada, og noen av disse var hemmelige.
Det ble bygget to typer atombomber under andre verdenskrig. En forholdsvis enkel uranbombe som benyttet uran-235, som er en relativt sjelden uranisotop som kun utgjør 0,7 % av naturlig

Submit

Result

Norwegian (Bokmål) Norsk (Bokmål)

Demo time!

Language Prediction

Input

مره أخرى لأنه ينفذ أوامر القادة.
ولد (بول تيبيتس) في عام 1915 م واسم والدته "اينولا جاي اشتهر تيبيتس بانه أفضل طياري الجيش الأمريكي وقتها وكان تيبيتس، الذي اشتهر بانه أفضل طياري الجيش الأمريكي وقتها، وفي عام 1945 م ترقي إلي رتبة كولونيل وهي تعادل رتبة (عقيد)في سلاح الجو الأمريكي في 6 -8- 1945 قاد الطائرة الأمريكية التي ألقت القنبلة الذرية على هيروشيما في اليابان وهي قنبلة تحتوي على 60 كيلوغراما (130 رطلا) من مادة اليورانيوم ـ 235 هيروشيما هي مدينة في اليابان، تقع في جزيرة "هونشو"، وتشرف على "خليج هيروشيما".وكان تعداد سكانها عام 1945 م وأما الطائرة التي تحمل القنبلة فكانت قاذفة من (Little Boy 350,000 نسمة وكان اسم الطائرة الكودي (بالشفرة السرية) هو (الولد الصغير النوع (بي 29) وفكان بول تيبيتس أول من اختبر هذه الطائرة وأطلق عليها اسم أمه "اينولا جاي". وتقرر تنفيذ مهمة قصف هيروشيما يوم 6-8- 1945 م حيث كان الطقس مواتيا لتنفيذ المهمة الخطيرة بعد أيام من السحب التي تجمعت فوق هيروشيما، فانطلق بول تيبيتس بطائرته وهي تحمل القنبلة الذرية من قاعدة «نورث فيلد» في جزيرة تنيان، غرب المحيط الهادئ، مصحوباً بطائرتين أخريين. وقبل القصف بساعة اكتشف نظام الإنذار المبكر الياباني دخول الطائرات للمجال الجوي الياباني فنبه السلطات في كبرى المدن بما فيها هيروشيما. لكن بول تيبيتس كان في طريقه للمدينة المستهدفة يقود الطائرة القاذفة، واستطاع أن يتهرب من الدفاعات اليابانية ليصل مدينة هيروشيما وحوالي الساعة الثامنة صباحا تمكنت أجهزة الرادار في هيروشيما من تحديد الطائرات الأميركية لكن المسؤولين العسكريين قرروا ان عددها الصغير لا يستدعي التصدي لها بطائرات مضادة على ضوء سياستهم الرامية لتوفير وقود الطائرات0 وفي تمام الساعة الثامنة والربع قصف بول تيبيتس القنبلة الرهيبة من طائرته «بي 29» على

Submit

Result

Arabic العربية