

# Assignment 4

January 23, 2022

```
[5]: import os
import json
from pathlib import Path
import zipfile
import email
from email.policy import default
from email.parser import Parser
from datetime import timezone
from collections import namedtuple

import pandas as pd
import s3fs
from bs4 import BeautifulSoup
from dateutil.parser import parse
from chardet.universaldetector import UniversalDetector

from pyspark.ml import Pipeline
from pyspark.ml.feature import CountVectorizer
from pyspark.ml.feature import HashingTF, Tokenizer
from pyspark.sql import SparkSession
from pyspark.sql.functions import col
from pyspark.ml.pipeline import Transformer
from pyspark.sql.functions import udf
from pyspark.sql.types import StructType, StringType, StructField

import pandas as pd

current_dir = Path(os.getcwd()).absolute()
results_dir = current_dir.joinpath('results')
results_dir.mkdir(parents=True, exist_ok=True)
data_dir = current_dir.joinpath('data')
data_dir.mkdir(parents=True, exist_ok=True)
enron_data_dir = data_dir.joinpath('enron')

output_columns = [
    'payload',
    'text',
```

```

'Message_D',
'Date',
'From',
'To',
'Subject',
'Mime-Version',
'Content-Type',
'Content-Transfer-Encoding',
'X-From',
'X-To',
'X-cc',
'X-bcc',
'X-Folder',
'X-Origin',
'X-FileName',
'Cc',
'Bcc'
]

columns = [column.replace('-', '_') for column in output_columns]

ParsedEmail = namedtuple('ParsedEmail', columns)

spark = SparkSession\
    .builder\
    .appName("Assignment04")\
    .getOrCreate()

```

```

[6]: current_dir = Path(os.getcwd()).absolute()
results_dir = current_dir.joinpath('results')
results_dir.mkdir(parents=True, exist_ok=True)
data_dir = current_dir.joinpath('data')
data_dir.mkdir(parents=True, exist_ok=True)
enron_data_dir = data_dir.joinpath('enron')

output_columns = [
    'payload',
    'text',
    'Message_D',
    'Date',
    'From',
    'To',
    'Subject',
    'Mime-Version',
    'Content-Type',
    'Content-Transfer-Encoding',
    'X-From',
    'X-To',
    'X-cc',
    'X-bcc',
    'X-Folder',
    'X-Origin',
    'X-FileName',
    'Cc',
    'Bcc'
]

```

```

'X-To',
'X-cc',
'X-bcc',
'X-Folder',
'X-Origin',
'X-FileName',
'Cc',
'Bcc'
]

columns = [column.replace('-', '_') for column in output_columns]

ParsedEmail = namedtuple('ParsedEmail', columns)

spark = SparkSession\
    .builder\
    .appName("Assignment04")\
    .getOrCreate()

```

The following code loads data to your local JupyterHub instance. You only need to run this once. This code reads emails and creates a Spark dataframe with three columns.

## 0.1 Assignment 4.1

```
[7]: def read_raw_email(email_path):
    detector = UniversalDetector()

    try:
        with open(email_path) as f:
            original_msg = f.read()
    except UnicodeDecodeError:
        detector.reset()
        with open(email_path, 'rb') as f:
            for line in f.readlines():
                detector.feed(line)
                if detector.done:
                    break
        detector.close()
        encoding = detector.result['encoding']
        with open(email_path, encoding=encoding) as f:
            original_msg = f.read()

    return original_msg
```

```
[8]: def make_spark_df():
    records = []
    for root, dirs, files in os.walk(enron_data_dir):
```

```

for file_path in files:
    ## Current path is now the file path to the current email.
    ## Use this path to read the following information
    ## original_msg
    ## username (Hint: It is the root folder)
    ## id (The relative path of the email message)
    current_path = Path(root).joinpath(file_path)
    username = os.path.basename(os.path.dirname(root))
    id = username+"/"+os.path.basename(root)+"/"+file_path
    record = {}
    record["id"] = id
    record["username"] = username
    record["original_msg"] = read_raw_email(current_path)
    records.append(record)

## TODO: Complete the code to code to create the Spark dataframe
schemaString = "id username original_msg"
fields = [StructField(field_name, StringType(), True) for field_name in
          schemaString.split()]
schema = StructType(fields)
return spark.createDataFrame(records, schema)

df = make_spark_df()

```

[9]: df.show()

	id	username	original_msg
reitmeyer-j sent_...	reitmeyer-j Message-ID: <2132...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <1823...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <2714...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <7509...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <1916...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <1979...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <1019...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <3023...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <2552...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <1957...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <2530...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <5298...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <2729...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <2880...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <2887...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <1482...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <1012...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <3970...		
reitmeyer-j sent_...	reitmeyer-j Message-ID: <2556...		

```
|reitmeyer-j/sent_...|reitmeyer-j|Message-ID: <1402...|
+-----+-----+
only showing top 20 rows
```

```
[10]: df.printSchema()
```

```
root
 |-- id: string (nullable = true)
 |-- username: string (nullable = true)
 |-- original_msg: string (nullable = true)
```

## 0.2 Assignment 4.2

Use plain\_msg\_example and html\_msg\_example to create a function that parses an email message.

```
[11]: plain_msg_example = """
Message-ID: <6742786.1075845426893.JavaMail.evans@thyme>
Date: Thu, 7 Jun 2001 11:05:33 -0700 (PDT)
From: jeffrey.hammad@enron.com
To: andy.zipper@enron.com
Subject: Thanks for the interview
Mime-Version: 1.0
Content-Type: text/plain; charset=us-ascii
Content-Transfer-Encoding: 7bit
X-From: Hammad, Jeffrey </O=ENRON/OU=NA/CN=RECIPIENTS/CN=NOTESADDR/
        ↳CN=CBBE377A-24F58854-862567DD-591AE7>
X-To: Zipper, Andy </O=ENRON/OU=NA/CN=RECIPIENTS/CN=AZIPPER>
X-cc:
X-bcc:
X-Folder: \Zipper, Andy\Zipper, Andy\Inbox
X-Origin: ZIPPER-A
X-FileName: Zipper, Andy.pst
```

Andy,

Thanks for giving me the opportunity to meet with you about the Analyst/Associate program. I enjoyed talking to you, and look forward to contributing to the success that the program has enjoyed.

Thanks and Best Regards,

Jeff Hammad  
"""

```
html_msg_example = """
Message-ID: <21013632.1075862392611.JavaMail.evans@thyme>
```

Date: Mon, 19 Nov 2001 12:15:44 -0800 (PST)  
From: insynconline.6jy5ympb.d@insync-palm.com  
To: tstaab@enron.com  
Subject: Last chance for special offer on Palm OS Upgrade!  
Mime-Version: 1.0  
Content-Type: text/plain; charset=us-ascii  
Content-Transfer-Encoding: 7bit  
X-From: InSync Online <InSyncOnline.6jy5ympb.d@insync-palm.com>  
X-To: THERESA STAAB <tstaab@enron.com>  
X-cc:  
X-bcc:  
X-Folder: \TSTAAB (Non-Privileged)\Staab, Theresa\Deleted Items  
X-Origin: Staab-T  
X-FileName: TSTAAB (Non-Privileged).pst

<html>

<html>

<head>

<title>Paprika</title>

<meta http-equiv="Content-Type" content="text/html;">

</head>

<body bgcolor="#FFFFFF" TEXT="#333333" LINK="#336699" VLINK="#6699cc" ALINK="#ff9900">

<table border="0" cellpadding="0" cellspacing="0" width="582">

<tr valign="top">

<td width="582" colspan="9"><nobr><a href="http://insync-online.p04.com/u.d?BEReaQA5eczXB=1"></a><a href="http://insync-online.p04.com/u.d?AkReaQA5eczXE=11"></a></nobr></td>

</tr>

<tr valign="top">

<td width="4" bgcolor="#CCCCCC"></td>

<td width="20"></td>

<td width="165"><br><a href="http://insync-online.p04.com/u.d?LkReaQA5eczXL=21"></a><br></td>

```

<td width="20"></
→td>
<td width="165"><br><a href="http://insync-online.p04.com/u.d?
→BkReaQA5eczX0=31"></a><br></td>
<td width="20"></
→td>
<td width="165"><br><a href="http://insync-online.p04.com/u.d?
→JkReaQA5eczXRs=41"></a><br></td>
<td width="19"></
→td>
<td width="4" bgcolor="#CCCCCC"></td>
</tr>
</table>
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<td width="574"><br>
<table border="0" cellpadding="0" cellspacing="0" width="574" u
→bgcolor="#99ccff">
<tr>
<td width="50"></td>
<td width="474"><font face="verdana, arial" size="-2" color="#000000">
<br>
Dear THERESA,<br>
<br>
Due to overwhelming demand for the Palm OS&#174; v4.1 Upgrade with u
→Mobile Connectivity, we are
extending the special offer of 25% off through November 30, 2001. So u
→there's still time to significantly

```

increase the functionality of your Palm™ III, IIIx, IIIxe, IIIc, V or Vx handheld. Step up to the new Palm OS v4.1 through this extended special offer. You'll receive the brand new Palm OS v4.1 for just \$29.95 when you use Promo Code **OS41WAVE**. That's a \$10 savings off the list price.

<br><br>

<a href="http://insync-online.p04.com/u.d?NkReaQA5eczXRh=51">Click here to view a full product demo now</a>

<br><br>

<a href="http://insync-online.p04.com/u.d?MkReaQA5eczXRm=61"></a>

<br><br>

You can do a lot more with your Palm™ handheld when you upgrade to the Palm OS v4.1. All your favorite features just got even better and there are some terrific new additions:

<br><br>

<LI> Handwrite notes and even draw pictures right on your Palm™ handheld</LI>

<LI> Tap letters with your stylus and use Graffiti™ at the same time with the enhanced onscreen keyboard</LI>

<LI> Improved Date Book functionality lets you view, snooze or clear multiple alarms all with a single tap </LI>

<LI> You can easily change time-zone settings</LI>

<br><br>

<a href="http://insync-online.p04.com/u.d?WkReaQA5eczXRb=71"></a>

<br><br>

<LI> <nobr>Mask/unmask</nobr> private records or hide/unhide directly within the application</LI>

<LI> Lock your device automatically at a designated time using the new Autolocking feature</LI>

<LI> Always remember your password with our new Hint feature\*</LI>

<br><br>

<a href="http://insync-online.p04.com/u.d?VEReaQA5eczXRQ=81"></a>

<br><br>

<LI> Use your GSM compatible mobile phone or modem to get online and access the web</LI>

<LI> Stay connected with email, instant messaging and text messaging to  
 ↳GSM mobile phones</LI>  
 <LI> Send applications or records through your cell phone to schedule  
 ↳meetings and even "beam"  
     important information to others</LI>

<br><br>  
 All this comes in a new operating system that can be yours for just \$29.  
 ↳95! <a href="http://insync-online.p04.com/u.d?MkReaQA5eczXRV=91">Click here  
 ↳to  
     upgrade to the new Palm&#153; OS v4.1</a> and you'll also get the  
 ↳latest Palm desktop software. Or call  
     <nobr>1-800-881-7256</nobr> to order via phone.  
 <br><br>  
 Sincerely,<br>  
 The Palm Team  
 <br><br>  
 P.S. Remember, this extended offer opportunity of 25% savings  
 ↳absolutely ends on November 30, 2001  
     and is only available through the Palm Store when you use Promo Code  
 ↳<b><font color="#FF0000">OS41WAVE</font></b>.  
 <br><br>  
   
 <br>  
     </font></td>  
 <td width="50"></td>  
 </tr>  
 </table></td>  
 <td width="4" bgcolor="#CCCCCC"></td>  
 </tr>  
 <tr>  
 <td colspan="3"></td>  
 </tr>  
</table>  

||
||
||

```

<td width="54"></
→td>
<td width="474"><font face="arial, verdana" size="-2" color="#000000"><br>
 * This feature is available on the Palm™; IIIx, Palm™; IIIxe, and
→Palm™; Vx. <br><br>
 ** Note: To use the MIK functionality, you need either a Palm OS™;□
→compatible modem or a phone
 with <nobr>built-in</nobr> modem or data capability that has either an
→infrared port or cable exits. If you
 are using a phone, you must have data services from your mobile service
→provider. <a href="http://insync-online.p04.com/u.d?
→RkReaQA5eczXRK=101">Click here</a> for
 a list of tested and supported phones that you can use with the MIK. Cable
→not provided.
<br><br>
-----<br>
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→/insync-online.p04.com/u.d?KkReaQA5eczXRE=121">click here</a>.
 Or, unsubscribe by replying to this message, with "unsubscribe" as the
→subject line of the message.
<br><br>
-----<br>
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→PalmPix, Palm Powered, the Palm
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→Inc. All other brands and
 product names may be trademarks or registered trademarks of their
→respective owners.</font>
 </td>
<td width="54"></
→td>
</tr>
</table><br><br><br><br>
<!-- The following image is included for message detection --&gt;
&lt;img src="http://p04.com/1x1.dyn" border="0" alt="" width="1" height="1"&gt;
&lt;img src="http://p04.com/1x1.dyn?0vEGou8Ig30ba2L2bLn" width=1 height=1&gt;&lt;/body&gt;
&lt;/html&gt;
</pre>

```

```
</html>
"""
plain_msg_example = plain_msg_example.strip()
html_msg_example = html_msg_example.strip()
```

```
[24]: def parse_html_payload(payload):
    """
    This function uses BeautifulSoup to read HTML data
    and return the text. If the payload is plain text, then
    BeautifulSoup will return the original content
    """
    soup = BeautifulSoup(payload, 'html.parser')
    return str(soup.get_text()).encode('utf-8').decode('utf-8')

def parse_email(original_msg):
    result = {}
    msg = Parser(policy=default).parsestr(original_msg)
    ## TODO: Use Python's email library to read the payload and the headers
    ## https://docs.python.org/3/library/email.examples.html
    result['payload'] = msg.get_payload()
    result['text'] = parse_html_payload(result['payload'])
    for key, value in msg.items():
        result[key.replace('-', '_')] = value

    tuple_result = tuple([str(result.get(column, None)) for column in columns])
    return ParsedEmail(*tuple_result)
```

```
[25]: parsed_msg = parse_email(plain_msg_example)
```

```
[26]: print(parsed_msg.text)
```

Andy,

Thanks for giving me the opportunity to meet with you about the Analyst/Associate program. I enjoyed talking to you, and look forward to contributing to the success that the program has enjoyed.

Thanks and Best Regards,

Jeff Hammad

```
[27]: parsed_html_msg = parse_email(html_msg_example)
```

```
[28]: print(parsed_html_msg.text)
```

Paprika

Dear THERESA,

Due to overwhelming demand for the Palm OS® v4.1 Upgrade with Mobile Connectivity, we are

extending the special offer of 25% off through November 30, 2001. So there's still time to significantly

increase the functionality of your Palm III, IIIx, IIIxe, IIIc, V or Vx handheld. Step up to the

new Palm OS v4.1 through this extended special offer. You'll receive the brand new Palm OS v4.1

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[Click here](#) to view a full product demo now.

You can do a lot more with your Palm handheld when you upgrade to the Palm OS v4.1. All your favorite features just got even better and there are some terrific new additions:

Handwrite notes and even draw pictures right on your Palm handheld  
Tap letters with your stylus and use Graffiti® at the same time with the enhanced onscreen keyboard  
Improved Date Book functionality lets you view, snooze or clear multiple alarms all with a single tap  
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Always remember your password with our new Hint feature\*

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important information to others

All this comes in a new operating system that can be yours for just \$29.95! Click here to upgrade to the new Palm OS v4.1 and you'll also get the latest Palm desktop software. Or call 1-800-881-7256 to order via phone.

Sincerely,  
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and is only available through the Palm Store when you use Promo Code OS41WAVE.

\* This feature is available on the Palm IIIx, Palm IIIxe, and Palm Vx.

\*\* Note: To use the MIK functionality, you need either a Palm OS® compatible modem or a phone with built-in modem or data capability that has either an infrared port or cable exits. If you are using a phone, you must have data services from your mobile service provider. Click here for a list of tested and supported phones that you can use with the MIK. Cable not provided.

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### 0.3 Assignment 4.3

```
[17]: ## This creates a schema for the email data
email_struct = StructType()

for column in columns:
    email_struct.add(column, StringType(), True)

[18]: ## This creates a user-defined function which can be used in Spark
parse_email_func = udf(lambda z: parse_email(z), email_struct)

def parse_emails(input_df):
    new_df = input_df.select(
        'username', 'id', 'original_msg', parse_email_func('original_msg').
    →alias('parsed_email')
    )
    for column in columns:
        new_df = new_df.withColumn(column, new_df.parsed_email[column])

    new_df = new_df.drop('parsed_email')
    return new_df

class ParseEmailsTransformer(Transformer):
    def _transform(self, dataset):
        """
        Transforms the input dataset.

        :param dataset: input dataset, which is an instance of :py:class:
        `pyspark.sql.DataFrame`
        :returns: transformed dataset
        """
        return dataset.transform(parse_emails)

## Use the custom ParseEmailsTransformer, Tokenizer, and CountVectorizer
## to create a spark pipeline
parseemailtransformer = ParseEmailsTransformer()
tokenizer = Tokenizer(inputCol="text", outputCol="words")
countv = CountVectorizer(inputCol=tokenizer.getOutputCol(), □
    →outputCol="features")
email_pipeline = Pipeline(stages=[parseemailtransformer, tokenizer, countv])

model = email_pipeline.fit(df)
result = model.transform(df)

[19]: result.select('id', 'words', 'features').show()
```

```
+-----+-----+-----+
```

	id	words	features
reitmeyer-j/sent_...	[anything, new, o...	(108640, [0,1,7,8,...	
reitmeyer-j/sent_...	[i, do, not, have...	(108640, [0,2,3,7,...	
reitmeyer-j/sent_...	[carole, told, me...	(108640, [0,1,2,3,...	
reitmeyer-j/sent_...	[ok, , -----origi...	(108640, [0,1,8,9,...	
reitmeyer-j/sent_...	[could, thinking...	(108640, [0,1,2,3,...	
reitmeyer-j/sent_...	[i, know, how, mu...	(108640, [0,2,3,8,...	
reitmeyer-j/sent_...	[i, have, some, i...	(108640, [0,1,2,3,...	
reitmeyer-j/sent_...	[there, was, no, ...	(108640, [0,2,8,14...	
reitmeyer-j/sent_...	[i, know, you, ha...	(108640, [0,1,2,3,...	
reitmeyer-j/sent_...	[it, looks, great...	(108640, [0,1,2,3,...	
reitmeyer-j/sent_...	[have, a, safe, f...	(108640, [7,23,328...	
reitmeyer-j/sent_...	[nymex...2.70, op...	(108640, [0,3,9,46...	
reitmeyer-j/sent_...	[hi...here, is, a...	(108640, [0,7,9,12...	
reitmeyer-j/sent_...	[, , plus, we, ...	(108640, [0,2,12,2...	
reitmeyer-j/sent_...	[saturday, weathe...	(108640, [0,1,2,3,...	
reitmeyer-j/sent_...	[11:00pm, cdt..., ...	(108640, [0,5,7,23...	
reitmeyer-j/sent_...	[about, this...no...	(108640, [0,1,2,3,...	
reitmeyer-j/sent_...	[, , -----origina...	(108640, [0,1,2,3,...	
reitmeyer-j/sent_...	[i, don't, have, ...	(108640, [0,12,13,...	
reitmeyer-j/sent_...	[you, can, get, t...	(108640, [0,1,2,3,...	

only showing top 20 rows

[ ]: