

Assignment 4

April 14, 2021

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DSC650

Assignment 4

```
[1]: 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

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()

```

The following code loads data to your local JupyterHub instance. You only need to run this once.

```

[2]: def copy_data_to_local():
    dst_data_path = data_dir.joinpath('enron.zip')
    endpoint_url='https://storage.budsc.midwest-datascience.com'
    enron_data_path = 'data/external/enron.zip'

    with zipfile.ZipFile(dst_data_path) as f_zip:
        f_zip.extractall(path=data_dir)

copy_data_to_local()

```

This code reads emails and creates a Spark dataframe with three columns.

Assignment 4.1

```
[3]: 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

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)

            r = {}
            username = os.path.basename(os.path.dirname(root))
            id = username+"/"+os.path.basename(root)+"/"+file_path
            r["id"] = id
            r["username"] = username
            r["original_msg"] = read_raw_email(current_path)
            records.append(r)

    return spark.createDataFrame(records, ['id', 'username', 'original_msg'])

df = make_spark_df()

[4]: df.show()
```

+-----+-----+-----+

id	username	original_msg
may-1/sent_items/12_	Message-ID: <1810...	may-1
may-1/sent_items/14_	Message-ID: <3098...	may-1
may-1/sent_items/37_	Message-ID: <3259...	may-1
may-1/sent_items/28_	Message-ID: <1981...	may-1
may-1/sent_items/25_	Message-ID: <3327...	may-1
may-1/sent_items/19_	Message-ID: <5085...	may-1
may-1/sent_items/29_	Message-ID: <1492...	may-1
may-1/sent_items/35_	Message-ID: <9932...	may-1
may-1/sent_items/21_	Message-ID: <1423...	may-1
may-1/sent_items/34_	Message-ID: <1981...	may-1
may-1/sent_items/24_	Message-ID: <1032...	may-1
may-1/sent_items/20_	Message-ID: <1005...	may-1
may-1/sent_items/47_	Message-ID: <9943...	may-1
may-1/sent_items/26_	Message-ID: <4622...	may-1
may-1/sent_items/10_	Message-ID: <2829...	may-1
may-1/sent_items/2_	Message-ID: <2149...	may-1
may-1/sent_items/36_	Message-ID: <2816...	may-1
may-1/sent_items/11_	Message-ID: <1927...	may-1
may-1/sent_items/22_	Message-ID: <5107...	may-1
may-1/sent_items/39_	Message-ID: <2824...	may-1

only showing top 20 rows

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

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

Assignment 4.2

Use `plain_msg_example` and `html_msg_example` to create a function that parses an email message.

```
[6]: 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">

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```

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↳AkReaQA5eczXE=11"></a></noabr></td>
</tr>
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  <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?
↳JkReaQA5eczXR=41"></a><br></td>
  <td width="19"></
↳td>
  <td width="4" bgcolor="#CCCCCC"></td>

```

```

</tr>
</table>
<table border="0" cellpadding="0" cellspacing="0" width="582">
<tr valign="top">
  <td width="4" bgcolor="#CCCCCC"></td>
  <td width="574"><br>
    <table border="0" cellpadding="0" cellspacing="0" width="574"
↳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
↳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&#153; 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
          <b>for just $29.95 when you use Promo Code <font
↳color="#FF0000">OS41WAVE</font></b>. That's a
          <b>$10 savings</b> 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&#153; 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&#153;
↳handheld</LI>
          <LI> Tap letters with your stylus and use Graffiti&#174; at the same
↳time with the enhanced onscreen keyboard</LI>

```

 Improved Date Book functionality lets you view, snooze or clear
 ↳multiple alarms all with a single tap

 You can easily change time-zone settings

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

 Lock your device automatically at a designated time using the new
 ↳Autolocking feature

 Always remember your password with our new Hint feature*

 Use your GSM compatible mobile phone or modem to get online and
 ↳access the web

 Stay connected with email, instant messaging and text messaging to
 ↳GSM mobile phones

 Send applications or records through your cell phone to schedule
 ↳meetings and even "beam"
 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
 <nobr>1-800-881-7256</nobr> to order via phone.

 Sincerely,

 The Palm Team

 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
 ↳OS41WAVE.


```

        
        <br>
        </font></td>
        <td width="50"></td>
    </tr>
</table></td>
    <td width="4" bgcolor="#CCCCCC"></td>
</tr>
<tr>
    <td colspan="3"></td>
</tr>
</table>
<table border="0" cellpadding="0" cellspacing="0" width="582">
    <tr>
        <td width="54"></
↳td>
        <td width="474"><font face="arial, verdana" size="-2" color="#000000"><br>
        * This feature is available on the Palm&#153; IIIx, Palm&#153; IIIx, and
↳Palm&#153; Vx. <br><br>
        ** Note: To use the MIK functionality, you need either a Palm OS&#174;
↳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>
        To modify your profile or unsubscribe from Palm newsletters, <a href="http:/
↳/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>

```

```

    Copyright&#169; 2001 Palm, Inc. Palm OS, Palm Computing, HandFAX,
    ↪HandSTAMP, HandWEB, Graffiti,
    HotSync, iMessenger, MultiMail, Palm.Net, PalmConnect, PalmGlove,
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    ↪Inc. Palm, the Palm logo,
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    ↪PalmPix, Palm Powered, the Palm
    trade dress, PalmSource, Smartcode, and Simply Palm are trademarks of Palm,
    ↪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 -->

</body>
</html>

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

```

```

[7]: def parse_email(original_msg):

    msg = email.message_from_string(original_msg)

    if msg.is_multipart():
        for payload in b.get_payload():
            print(msg.get_payload())
    else:
        print(msg.get_payload())
        for part in msg.walk():
            if part.get_content_type():
                body = str(part.get_payload())
                soup = BeautifulSoup(body, 'html.parser')
                paragraphs = soup.find_all('body')
                for paragraph in paragraphs:
                    print(paragraph.text)

```

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

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,

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

```
<html>

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<head>
<title>Paprika</title>
<meta http-equiv="Content-Type" content="text/html;">
</head>
<body bgcolor="#FFFFFF" TEXT="#333333" LINK="#336699" VLINK="#6699cc"
ALINK="#ff9900">
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                <td width="474"><font face="verdana, arial" size="-2"color="#000000">
                    <br>
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                    <br><br>
                    Due to overwhelming demand for the Palm OS&#174; v4.1 Upgrade with
Mobile Connectivity, we are
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there's still time to significantly
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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 <font
 color="#FF0000">OS41WAVE. That's a
 \$10 savings off the list price.

 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
 You can easily change time-zone settings

 <nobr>Mask/unmask</nobr> private records or hide/unhide directly
 within the application
 Lock your device automatically at a designated time using the new
 Autolocking feature
 Always remember your password with our new Hint feature*

 Use your GSM compatible mobile phone or modem to get online and
 access the web
 Stay connected with email, instant messaging and text messaging to
 GSM mobile phones
 Send applications or records through your cell phone to schedule
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 important information to others

```

        <br><br>
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$29.95! <a href="http://insync-online.p04.com/u.d?MkReaQA5eczXRV=91">Click here
to
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Palm desktop software. Or call
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        <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>
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        <td colspan="3"></td>
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        * This feature is available on the Palm&#153; IIIx, Palm&#153; IIIx, and
Palm&#153; Vx. <br><br>
        ** Note: To use the MIK functionality, you need either a Palm OS&#174;
compatible modem or a phone

```

with <no>built-in</no> 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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<td width="54"></td>

</tr>

</table>

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</html>

</html>

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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
You can easily change time-zone settings

Mask/unmask private records or hide/unhide directly within the application
Lock your device automatically at a designated time using the new Autolocking
feature

Always remember your password with our new Hint feature*

Use your GSM compatible mobile phone or modem to get online and access the web
Stay connected with email, instant messaging and text messaging to GSM mobile
phones

Send applications or records through your cell phone to schedule meetings and
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Assignment 4.3

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

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

```
[11]: ## 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
stage_1 = ParseEmailsTransformer()
stage_2 = Tokenizer(inputCol='original_msg', outputCol='words')
stage_3 = CountVectorizer(inputCol='words', outputCol='features')

email_pipeline = Pipeline(stages=[stage_1, stage_2, stage_3])

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

```

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

```

+-----+-----+-----+
|          id|  words|   features|
+-----+-----+-----+
|may-1/sent_items/12_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/14_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/37_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/28_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/25_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/19_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/29_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/35_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/21_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/34_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/24_|[may-1]|(16,[3],[1.0])|

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|may-1/sent_items/20_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/47_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/26_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/10_|[may-1]|(16,[3],[1.0])|
| may-1/sent_items/2_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/36_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/11_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/22_|[may-1]|(16,[3],[1.0])|
|may-1/sent_items/39_|[may-1]|(16,[3],[1.0])|
+-----+-----+-----+
only showing top 20 rows

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