Email Clustering Using Lingo Algorithm
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ABSTRACT
Email plays a vital role in our day to day life. Human beings can never be satisfied. The hunger never ends. Due to this, in every sector, the advancement in technology never stops. We use emails daily for our official work, personal work etc. to make email system easier, labels and clusters are generated. Thousands of emails are present in our inbox, to access a particular email, we have to go through those random thousands of mails. The existing techniques used in generating labels and clusters are not much efficient, and therefore a new and much more efficient technique of automatic generation of labels and clusters (Lingo Algorithm) have been used in our project. The advance feature added in our project is of Single Sign-On method, which will be proved beneficial to users in many aspects.

Keywords:- Lingo Algorithm, Single Sign-On, Clustering Of Emails, SMTP, POP3.

I. INTRODUCTION
Email is an easiest and best form of electronic messaging service. Due to this, the use of email is increasing extensively day by day. The main source for official messages nowadays is email service. As per survey, it is found that a normal human being spends 90 min of his/her day on email. A person gets so many emails from different sites. But they are not in clustered form, the proposed system will help to cluster these data and will generate a meaningful label. Lingo algorithm is a very powerful clustering technique for generating clusters and labels.

A. Existing System
There are many mail service providers on internet today like yahoo, MSN etc. Mails being one of the most popularly used service by all sector of life, corporate as well as personal to contact each other. And that too with no restriction on location and of course free of cost. Users have mail accounts on different mail servers. One cannot access email from other mail servers in existing mail accounts.

B. Disadvantages Of Existing System
The disadvantages of current system are

1) Need to remember different User-Id and Passwords.
2) Waste of time creating new sessions of each service providers by logging into their respective domains.
3) More waste of Bandwidth and download capacity.
4) People cannot access mails from different mail server at the same time from a single server.
5) Labels can be generated manually only.

As we saw that our existing system has so many drawbacks. We need to overcome these drawbacks. We can overcome these drawback by applying some modification to our existing system, so that the advantages of our existing system remains as it is on the other side we can also remove the demerits of our existing system. We saw mainly four major drawbacks which our existing systems are facing.

1) Need to remember different user-id and passwords
   To overcome this, we are using Single sign on method. Through this, a user does not need to remember various passwords. He/She can access all his/her account by using a single user-id and password.

2) Waste of time creating new sessions of each service providers by logging into their respective domains.
   In the existing system, whenever a user logs in, mail server of that particular domain creates a new session for that specific user. Time is wasted while creating these session for different different logins. If there is a single login, then there won't be different session created from different accounts.

3) More waste of bandwidth and download capacity.
   The bandwidth used by single account for any transfer of messages will be more.

4) People cannot access mails from different mail server at the same time from a single server.
   A person having a gmail account cannot switch to yahoo without getting log out from gmail. We can achieve this by using Single Sign On technique, in which a user can simultaneously work on different mail servers without switching from one to another.

5) Labels can be generated manually.
   Here we can create folders for similar content and we can place those content inside that particular folder. To do
this process automatically, we are using lingo algorithm. Lingo algorithm generates semantic labels and clusters. In this approach crucial is the careful selection of cluster labels – the algorithm must ensure that the labels both differ significantly from each other and at the same time cover most of documents.

II. RELATED WORK

As we nowadays are so much used to our emails, they have become an important part of our corporate and social life. The data are in extensive quantity and the labels or clusters which are been given by the existing system are not very useful to ease our work. To find a particular document, we have to unnecessarily sift through a random list of emails. In this paper the main focus is on Lingo clustering algorithm, which we believe is able to capture thematic threads in a search result, that is discover groups of related documents and describe the subject of these groups in a way meaningful to a human. Lingo combines several existing methods to put special emphasis on meaningful cluster descriptions, in addition to discovering similarities among documents.

III. LINGO ALGORITHM

A brief algorithm of the current Lingo is given below:

1) Preprocess documents
   - Extract frequent phrases and single words as cluster label candidates.
   - Determine the assigned documents for each label candidate.
   - Filter out the label candidates that contain less number of documents than the minimum cluster size threshold.

2) Build the term-document matrix using the stems of the label candidates (except the stop words in the label candidates)

3) Reduce the term-document matrix to the term-abstract concept matrix according to the desired cluster count base threshold.

4) Match the abstract concepts with the cluster label candidates.

5) Select the cluster label candidates that matched with an abstract concept as the labels of the determined clusters.

6) Merge clusters that share higher percentage of documents than the cluster merging threshold.

7) Form the final clusters for presentation.

A. Pseudo-Code Of Lingo Algorithm[2]

Ist phase (Preprocessing)
1) Dc ← Set of input documents
2) for all d ∈ Dc do
3) perform text segmentation of d;
   {Detect word boundaries etc.}
4) if language of d recognized then
5) now apply stemming and mark stop-words in d;
   {stemming removes the ‘ing’ and maintains stems of frequent similar words.}
6) end if
7) end for

II ndPhase(Frequent Phrase Extraction)
8) concatenate all documents;
9) Fc ← discover complete phrases;
10) Ff ← f : {f ∈ Fc ∈ frequency(f) > Term Frequency Threshold};

III rdPhase(Cluster Label Induction)
11) A ← term-document matrix of terms not marked as stop-words and with frequency higher than the Term Frequency Threshold;
12) Σ, U, V ← SVD(A);
   {Product of SVD decomposition of A}
13) k ← 0;
   {Start with zero clusters}
14) n ← rank(A);
15) repeat
16) k ← k + 1;
17) q ← (Fki=1 Σii)/(Fni=1 Σii);
18) until q < Candidate Label Threshold;
19) F ← phrase matrix for Ff;
20) for all columns of UT k F do
21) find the largest component mi in the column;
22) add the corresponding phrase to the Cluster Label Candidates set;
23) labelScore ← mi;
24) end for
25) calculate cosine similarities between all pairs of candidate labels;
26) identify groups of labels that exceed the Label Similarity Threshold;
27) for all groups of similar labels do
28) select one label with the highest score;
29) end for

4th Phase (Cluster Content Discovery)
30) for all CL ∈ Cluster Label Candidates do
31) create cluster C described with CL;
32) add to C all documents whose similarity to C exceeds the Snippet Assignment Threshold;
33) end for
34) put all unassigned documents in the “Others” group;

5th Phase (Final Cluster Formation)
35) for all clusters do
36) clusterScore ← labelScore × kCk;
37) end for

B. PREPROCESSING

Stemming and stop words removal are very common operations in Information Retrieval. Interestingly, their influence on results is not always positive in certain applications stemming yielded no improvement to overall quality.

1) Stemming: The main aim of stemming is to reduce derivationally relate forms of words to a common base
form by finding the roots i.e stem of a word. Stemming, is a technique for finding a semantic representation of an inflected word (usually a lemma) to decrease the impact of a language’s syntax.

**Example of Stemming**

<table>
<thead>
<tr>
<th>Words</th>
<th>Stems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
<td>Man</td>
</tr>
<tr>
<td>Man</td>
<td>Man</td>
</tr>
<tr>
<td>Manhood</td>
<td>Man</td>
</tr>
<tr>
<td>Manisha</td>
<td>Man</td>
</tr>
<tr>
<td>Common</td>
<td>Com</td>
</tr>
<tr>
<td>Computer</td>
<td>Com</td>
</tr>
<tr>
<td>Complex</td>
<td>Com</td>
</tr>
</tbody>
</table>

Table 1. Example Of Stemming

2) **Stop Words Marking:** The other clustering algorithm usually deletes the stop words, but lingo algorithm marks the stop words inorder to generate a meaningful label.

<table>
<thead>
<tr>
<th>A</th>
<th>An</th>
<th>The</th>
<th>And</th>
<th>are</th>
<th>As</th>
</tr>
</thead>
<tbody>
<tr>
<td>At</td>
<td>As</td>
<td>Be</td>
<td>By</td>
<td>for</td>
<td>Has</td>
</tr>
<tr>
<td>He</td>
<td>In</td>
<td>Is</td>
<td>It</td>
<td>on</td>
<td>of</td>
</tr>
</tbody>
</table>

Table 2. Example Of Stop-words

3) **Text-segmentation** : Text-segmentation is a technique for dividing text into words and sentences that has many implementations.

4) **Text-filtering**: It filters the documents i.e it removes unnecessary tags, symbols and words.

**B. Frequent Phrase Extraction**

We define frequent phrases as recurring ordered sequences of terms appearing in the input documents. To be a candidate for a cluster label, a frequent phrase or a single term must:

- It should appear in the input documents at least certain number of times (term frequency threshold).
- The particular word should have been occurred for frequent number of time in the whole document.
- It should not cross sentence boundaries.
- There are sentence boundaries in a sentence, it should not cross those sentence boundaries.
- It should be a complete phrase.
- A complete phrase is a substring of collected text.
- It must not begin nor end with a stop word.

**C. Singular Value Decomposition**

Singular value decomposition is used to reduce the dimentionality of the matrix and thus reduce the sparsity. SVD also has a effect of smoothing the values. The post-SVD column dimension of the matrix are minimum of 10% of the actual column dimensions or 300. Thus if the original column dimension were more than 3000, then the matrix is reduced to 300 columns. Each row represents the content. Thus the matrix translates into context vectors at each row of the matrix which are later clustered.

**D. Cluster Label Induction**

Once frequent phrases (and single frequent terms) that exceed term frequency thresholds are known, they are used for cluster label induction. There are three steps to this: term-document matrix building, abstract concept discovery, phrase matching and label pruning.

**E. Cluster Content Discovery**

In the cluster content discovery phase, the classic Vector Space Model is used to assign the input documents to the cluster labels induced in the previous phase. In a way, we re-query the input document set with all induced cluster labels.

**F. Final Cluster Formation**

Finally, clusters are sorted for display based on their score, calculated using the following simple formula: \( C_{\text{score}} = \text{label score} \times k_C \), where \( k_C \) is the number of documents assigned to cluster C. The scoring function, although simple, prefers well-described and relatively large groups over smaller, possibly noisy ones. For the time being, no cluster merging strategy or hierarchy induction is proposed for Lingo.

1. **An illustrative example**[2]

Let us assume that the following input data is given:

- \( t = 5 \) terms
- T1: Information
- T2: Singular
- T3: Value
- T4: Computations
- T5: Retrieval
- \( p = 2 \) phrases
- P1: Singular Value
The normalized, tfidf-weighted term-document matrix $b$ is shown below together with matrix $U$ (part of the SVD decomposition):

\[
\begin{bmatrix}
0 & 0 & 0.56 & 0.56 & 0.0 & 1 & 0 \\
0.49 & 0.71 & 0 & 0 & 0 & 0.71 & 0 \\
0.49 & 0.71 & 0 & 0 & 0 & 0.71 & 0 \\
0.72 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0.83 & 0.83 & 0 & 0 & 0 \\
0 & 0.75 & 0 & 0 & 0 & -0.66 & 0 \\
0.65 & 0 & -0.28 & 0 & 0 & 0 & -0.71 \\
0.65 & 0 & -0.28 & 0 & 0 & 0 & 0.71 \\
0.39 & 0 & 0.92 & 0 & 0 & 0 & 0 \\
0 & 0 & 0.66 & 0 & 0 & 0.75 & 0
\end{bmatrix}
\]

Now, we look for the value of $k$ – the estimated number of clusters. Let us define quality threshold $q = 0.9$. Then the process of estimating $k$ is as follows: $k = 0 \rightarrow q = 0.62$, $k = 1 \rightarrow q = 0.856$, $k = 2 \rightarrow q = 0.959$, so the number of clusters $k = 2$. To find descriptions of our clusters ($k = 2$ columns of matrix $U$), we calculate $M = U^T P$, where $P$ is a term-document-like matrix created out of our frequent phrases and terms (values in $P$ tfidf-weighted and normalized):

\[
\begin{bmatrix}
0 & 0.56 & 1 & 0 & 0 & 0 & 0 \\
0.71 & 0 & 0 & 1 & 0 & 0 & 0 \\
0.71 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0.83 & 0 & 0 & 0 & 0 & 1 \\
0.92 & 0 & 0 & 0.65 & 0.65 & 0.39 & 0 \\
0.97 & 0.75 & 0 & 0 & 0 & 0.66 & 0
\end{bmatrix}
\]

Rows of matrix $M$ represent clusters, columns – their descriptions. For each row we select the column with maximum value – the two clusters are: Singular Value (score: 0.92) and Information Retrieval (score: 0.97). We skip label pruning as it is not needed in this example. Finally, documents are assigned to clusters by applying matrix $Q$, created out of cluster labels, back to the original matrix $b$ Atfidf:

\[
\begin{bmatrix}
0 & 0 & 0.71 & 0 & 0 & 0.83 \\
0 & 0 & 0 & 0 & 1 & 0.56 \\
0 & 0 & 0 & 0 & 0 & 0.56
\end{bmatrix}
\]

**IV. PROPOSED SYSTEM**

The proposed work of the system gives us an idea about how our system is actually going to work. The proposed system is Email Clustering System Using Lingo Algorithm which includes Single Sign-In. In our proposed system third party server forms clusters according to the content of the emails that are available in Inbox. It is a desktop based application in which it will first fetch the emails from inbox and then forms cluster, to form the clusters we are using Lingo algorithm. For Single Sign-On, the user will have to initially enter the username and passwords of all the email accounts he wants to access with a single login. The system will generate a unique user id and password for the user and after that the user can access all the other mail accounts with a single login, without switching from one email account to other.

**A. Application**

The application of lingo algorithm is in each and every field of networking where the job of the server is to form clusters of the mails received in the inbox of an account and finally reduces space and time complexity. Large number of mails can be handled simultaneously by the server depending on the network load. Also the account holder doesn’t get distributed while the clustering is in progress. So it saves a large amount of time of administrator and also the space on the server.
All account holders store their information by registering themselves at server side. It request for the validation of the user’s authentication. Administrator maintains the database which contains user information and information about account holders. Admin view the request and gives response to it accordingly. The architecture above shows that the overall external structure of our system. In this we can see a main server which is our proposed system. This main server is connected to three different mail servers. They are connected through internet. Client application is an intermediate between user and main server. User sends the inbox to the main server. The main server then clusters the inbox and send the clustered inbox to the user.

V. RESULTS

There are two parameters based on which our systems performance is based Precision and Recall. Let us consider D be the set of documents, set A of documents was retrieved for users query is the set of documents that are relevant to documents present in D. RA be the intersection of R and A. Definition — Precision is the fraction of the retrieved documents which is relevant: Precision = |RA|/|A| Definition — Recall is the fraction of the relevant documents which has been retrieved: Recall = | RA |/|R|

Consider a dataset for email system which contains 100 emails regarding different topics. Data is fetched from the email server to the database and the lingo algorithm works on these emails content. Hence we present result of our system. We calculated the Precision and Recall measures for each and every cluster shown by our system.

VI. CONCLUSION

An email clustering approach is proposed through this project. The main aim is to perform text similarities on emails. It shows how text similarities can be used to form clusters in emails. The proposed technique is implemented using open source technology java. The mails will be finally in a clustered format so as to minimize the job of searching for the users. Hence this will also reduce the consumption and make browsing user friendly. The future scope of the work could be incorporating the similarity of the email attachments etc. for the more accurate clustering of the emails. The other direction of the proposed work could be applying the proposed email similarity function for the more email mining operations like thread summarization, automatic answering, and applying the same Techniques for other Email datasets for participating all the attributes of the emails and achieving more accurate results.

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