University of Hertfordshire

7COM1018 – Data Mining

Practical Text Mining Investigation

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Introduction

In my investigation I have decided to study the impact of using the stemming technique in text mining against the impact of not using stemming. According to the authors Jasmeet Singh and Vishal Gupta who published an article in September 2016, Stemming can be defined as a process where variant word forms are mapped to their base forms.(ACM Computing Surveys Volume 49Issue 3 September 2017 Article No.: 45pp 1–46). It is also important to note that stemming is a pre-processing technique that is used before text mining can be performed.

They are many stemming algorithms that have been developed over the past and I used the Lovin stemmer algorithm which is available in Weka the data mining tool I have used. This algorithms works very well like any other stemmer. It simply works by removing suffixes from the text and it also has a large data set with all suffixes. It is really fast an effective this can be supported by authors M bounabi, K.El Moutaouakil and Kh.Satori in their article where they did experiments using Lovin, iterated lovins and snowball stemmer in an experiment and the Lovin gave a better performance in the results. The Lovin achieved a best accuracy f up to 97% in the first database. (BDCA'17: Proceedings of the 2nd international Conference on Big Data, Cloud and Applications March 2017 Article No.: 43Pages 1–9). Which is the reason behind my choosing of this technique.

I performed my experiment to investigate the impact of stemming over not using stemming and the results that I achieved convinced me that it has an impact. This was a result of my observation of the results. My results were convincingly conclusive that stemming has a greater impact in the text mining experiment that I performed.

I have chosen to investigate on this topic because I find it very interesting because it something that is used in Search Engine Optimization (SEO), and it has made queries easy to really predict. Companies like Microsoft and Google are using this for information retrieval and also for machine learning and natural language processing.

Methodology and Outcomes

Now in this section I am going to talk about the procedures and results that I observed and give an evaluation. Firstly, the first thing was to get my data set and load it into Weka. The dataset on its own cannot be loaded into the Weka as it is since the system does not know what to do with it. So, it gives me the option to select ways in which we can load this data. And I selected the option to load it as a TextDirectoryLoader. And in this file, there are two classes labelled business and tech.

So now the next thing I had to do was go on filters and select the Unsupervised and then it branched into Attributes and instances. I went on to choose the attributes and selected the StringToWordVector and after that I clicked apply the filter. After that I was able to see all attributes and they were 1,486 in total. The next thing I had to do was to create two Arff files that I was meant to use for training. By visualising the data that I had the two classes business and tech they are not balanced at all. So, for me to have better accuracy I needed to have two class labels with the same number of instances which led me to perform another pre-processing step to make sure we have balanced data. There are two ways that I know how to make the data balanced and that is either to under sample or oversample the dataset.

Balancing the dataset in Weka is also something that can be done since it supports that and has the feature. For under sampling (this means reduced the number of data items in one major class to match the minority class). Oversampling means we populate the minority class and also try to match the other class. Weka supports SMOTE and SpreadSubSample which can be used to oversample and under sample our training dataset respectively.

For me to be able to do that I selected the class label from the drop down on my hand panel and I went on to select filters whilst I am still on the pre-processing tab. In the filters I selected the supervised and underneath it I selected the instances and from there we can see what options we have. I went on to under sample the training set. To do that you select SpreadSubSample and a dialog box will appear and I had to input the parameters. I will be showing my parameters through the use of a table and explain why I would have done so.

Fig 1.1 Table Showing parameters for SpreadSubSample

adjustWeights	False
DistributionSpread	1.0
maxCount	0.0
randomSeed	1

I changed the distribution spread from 0.0 to 1.0 and the other parameters I left them as they were. So, what it means is just I want to under sample the first-class label which had 510 so that it matches the minority class that had 401 and after doing that. I clicked OK and then applied it on the dataset and I ended up having the same number of instances in both classes which is 401.

Now the next step is where we have to split our two files into two Arff files. So, since I am investigating if a model performs well when stemming is applied against when it is not applied. My first step is to apply stemming filter before any classifier is applied. Under the filters I went to the Unsupervised and then under attribute I selected the StringToWordVectors. Then I clicked on it and a dialog box appeared and this is where I made the changes.

These are the parameters I put in place.

IDF Transform - False	AttributeIndices – First - last
TF Transform - False	LowerCaseTokens – False
Stemmer – Lovin Stemmer	Stopwords - weka
Usestoplist – True	WordsToKeep – 1000

The other parameters are set on default so I did not need to make any changes to then and since I selected the Lovin stemmer it means my dataset will have to reduce in size my attribute count. And also enabled the Stop list to be true.

The results after clicking apply came as Attribute count changed from 1,486 to 1,445. And this means that our stemmer has been applied and after that I clicked save on the panels on top and saved the file in a directory of my choice. And I named the file Stemmer, and it was saved as an arff. I closed the application and went on to redo the process of loading the file and converting it and balancing the dataset. Then I just went on to save it after that and renamed it non-Stemmer and the setting on the parameters for StringToWordVector was set to null stemmer and saved it an arff and closed the weka, this is how I converted my two datasets into Arff files.

The next stage now I had to work with the two datasets I had created, and I worked on them one by one starting with non-stemmer, and I applied some parameters and used three different classifiers and I have explained each step and the outcomes and included visuals to see the changes so as to evaluate the performances.

Non-Stemmer

In the Weka I loaded the dataset that I had created with the name non-stemmer.arff file which I saved in my directory of choice. Now the next step is to start applying the classifiers. I started with the Naïve Bayes classifier. So, on top of the screen there was a tab which named classify and under that are a lot of functions available. I opened the file named Bayes and I selected Naïve bayes as required by the assessment guideline.

Before training the model, I had to find out if I change parameters is there any change and how does the model perform. So, I did I changed the split percentage and made a table where I recorded every accuracy after selecting a certain percentage. Split is simply the percentage of the data set that you give to the model to use it as training data. I went on to select from 10 - 90 where in each instance I record all the details as they are coming under accuracy header. For example, the split is 10 and I selected random seed to be 1 then record then accuracy 1 and on the same split I changed the random seed to 50 and record the accuracy under accuracy 2. I did this for all the splits and all the classifiers to follow.

Then after that the next thing is I had to calculate the mean of accuracies and that was my overall accuracy for Naïve bayes when stemmer is not applied. Below is a table which shows all the splits and accuracies.

Naïve Bayes Performance.

Split	Accuracy 1 (Seed 1)	Accuracy 2 (Seed 50)	Mean Accuracy
10	98.25	98.25	98.25
20	97.04	96.72	96.88
30	96.96	96.61	96.785
40	96.88	96.88	96.88
50	96.88	96.5	96.69
60	97.5	95.95	96.725

70	97.92	95.43	96.675
80	96.87	94.37	95.62
90	96.25	96.25	96.25

The overall performance of the Naïve bayes after calculating the average of mean accuracy of all the ten splits will gives us a percentage of 96.75% which is not bad at all. According to the table above the lesser the training split the higher the accuracy.

Next one after this is the Decision tree: J48. While on the classify table I clicked classifier and there were subfolders, and I opened the one that is named tree and that's where I found the J48 and selected it. The next thing is to choose my parameters for the j48. And I did not have to change any of the parameters to I just used the training set with different splits and different random seed value which I was alternating between 1 and 50 as I did with the naïve Bayes. These are the parameters for the j48 tree: J48 -C 0.25 -M 2.

After that came the results and they were not as good as from the naïve bayes they were fairly low. At an average of 86.45% that was the overall performance and below is the table of all accuracies and splits for this classifier.

Decision Tree J48

Split	Accuracy 1 (Seed1)	Accuracy 2 (Seed 50)	Mean Accuracy
10	81.57	76.31	78.94
20	84.26	83.33	83.795
30	91.62	83.77	87.695
40	86.69	85.86	86.275
50	88.27	84.03	86.15
60	90.03	82.24	86.135
70	84.64	87.96	86.3
80	88.75	90.62	89.685
90	91.25	95	93.125

The best performance in this classifier can be seen from the split 90 that is then we had a better performance of 93.125%. It did not perform very well therefore we need to find out about the other classifier.

The next classifier I used is a Support Vector Machine (SVM). On this classifier, there are parameters that I used to come up with the best performance. I used two kernels to train the model and see which one was better. These two kernels are Radial Basis Function (RBF) and the Linear Kernel. For the best performance I had to determine which values would I use for the cost and the gamma values. However, our Weka data mining tool will do that for us easily by the use of a special function called the grid search. I selected the classifier tab and then from the list I selected meta and from that I was able to choose grid search. The next step was to select my parameters for this and the first kernel I used is the RBF. When I clicked the grid search here are the parameters used.

Xbase – 10.0	XExpression – pow(BASE,I)	XMax - 5.0
XMin - -2.0	Xproperty – classifier.cost	Xstep -1.0
Ybase – 10.0	YExpression – pow(BASE,I)	YMax - 5.0
YMin - -2.0	Yproperty – classifier.gamma	Ystep -1.0
Evaluation – Accuracy	debug – false	Filter – All Filters

Classifier – LibSVM

After that I clicked on the LibSVM and selected the parameters for that as well and I only changed the kernel to RBF and normalisation turned to true and these are the rest of the parameters set.

```
LibSVM -S 0 -K 2 -D 3 -G 0.0 -R 0.0 -N 0.5 -M 40.0 -C 1.0 -E 0.001 -P 0.1 -Z
```

After training the model trying all the split percentages and the random seed I cam up with a table and the mean accuracy. The overall mean of the RBF kernel came to be 96.92% accuracy. And the grid search found the cost and the gamma values for us as well. The cost was 100,000 and the gamma was 0.01.

Next, I used the same parameters as above, however the only change was that I selected the linear kernel instead of the RBF kernel and trained the model using the same training set as before and I achieved an accuracy of 97.12% which is way better than the RBF kernel. In conclusion I decided to take the kernel with the best performance and that is the linear kernel.

Here are the results I recorded in form of a table.

<u>Support Vector Machine</u>

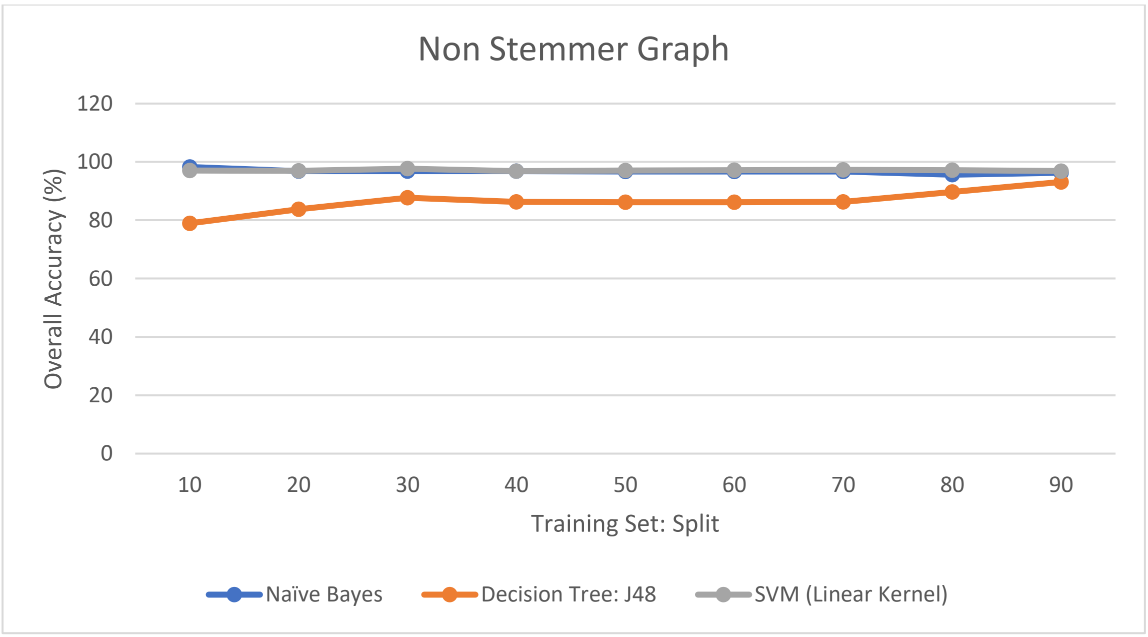
	Radial Basis Function				Linear kernel	
split	accuracy 1	accuracy 2	Mean	accuracy 1	accuracy 2	mean
10	100	100	100	96.95	97.22	97.085
20	96.1	95.01	95.555	96.88	97.04	96.96
30	96.25	96.61	96.43	97.68	97.68	97.68
40	96.04	96.88	96.46	96.88	96.88	96.88
50	96.01	96.25	96.13	96.75	97.25	97
60	96.57	96.57	96.57	97.19	97.19	97.19

70	97.92	96.26	97.09	98.34	96.26	97.3
80	98.12	95	96.56	98.75	95.62	97.185
90	100	95	97.5	98.75	95	96.875

And here is an overview of all the three classifiers to visualise the how the performed on each split.

Split	Naïve Bayes	Decision Tree: J48	SVM (Linear Kernel)
10	98.25	78.94	97.085
20	96.88	83.795	96.96
30	96.785	87.695	97.68
40	96.88	86.275	96.88
50	96.69	86.15	97
60	96.725	86.135	97.19
70	96.675	86.3	97.3
80	95.62	89.685	97.185
90	96.25	93.125	96.875

Above are the performances of the three classifiers that I used, and the following is the graph that was plotted for the overall mean accuracy against the split. And we can see that the two classifiers, naïve bayes and the SVM were performing good and decision tree showed a poor performance.



<u>Stemmer</u>

After training my model on a dataset that I labelled non stemmer I closed my Weka and loaded the dataset labelled Stemmer.arff. I used the same methods as I have mentioned above and used the same parameters on just a new dataset which has a fewer attributes than the other. I started with the Naïve Bayes as before and using the same parameters I was able to achieve the best accuracy of 97.31% which is slightly higher than that of the non-stemmer. The figures of how each split performed are given in the following table.

<u>Naïve Bayes</u>

Split	Accuracy 1 (Seed 1)	Accuracy 2 (Seed 50)	Mean Accuracy
10	97.5	96.39	96.945
20	97.97	97.19	97.58
30	97.68	98.03	97.855
40	97.71	97.5	97.605
50	97.25	96.75	97
60	97.5	96.57	97.035
70	97.09	97.09	97.09
80	96.25	98.12	97.185
90	96.25	98.75	97.5

After the Naïve bayes I went on to train the model using a decision tree (J48) classifier with the dataset which I had used the Lovin stemmer, and I was able to achieve an accuracy that was slightly higher than that of the previous one. I achieved an accuracy of 89.28% and it is much better and because of that I could see how stemming was useful. And here is the table with the values.

<u>Decision Tree: J48</u>

Split	Accuracy 1 (Seed)	Accuracy 2 (Seed 50)	Mean Accuracy
10	85.04	73.68	79.36
20	85.35	80.06	82.705
30	88.41	92.15	90.28
40	91.68	86.48	89.08
50	93.76	89.02	91.39
60	90.03	89.4	89.715
70	94.19	90.45	92.32
80	93.75	95	94.375
90	92.5	96.25	94.375

Lastly, I used the SVM with both linear and RBF kernels. I used the same parameters also the same as I did in the previous experiment. After using the grid search to calculate the best cost and gamma value it was able to report the values to be cost – 100,000.0 and gamma value – 100,000.0. Now the RBF and the Linear Kernel gave me different results in their accuracies and the Linear kernel came out on top with a higher performance than the RBF and the model achieved an overall mean accuracy of 97.3% with the Linear Kernel ahead of the RBF with 97.10%. So, in this case again I went on to choose the Liner Kernel which proved to have done even better than the previous SVM with no stemmer. Here are the results of the SVM classifier.

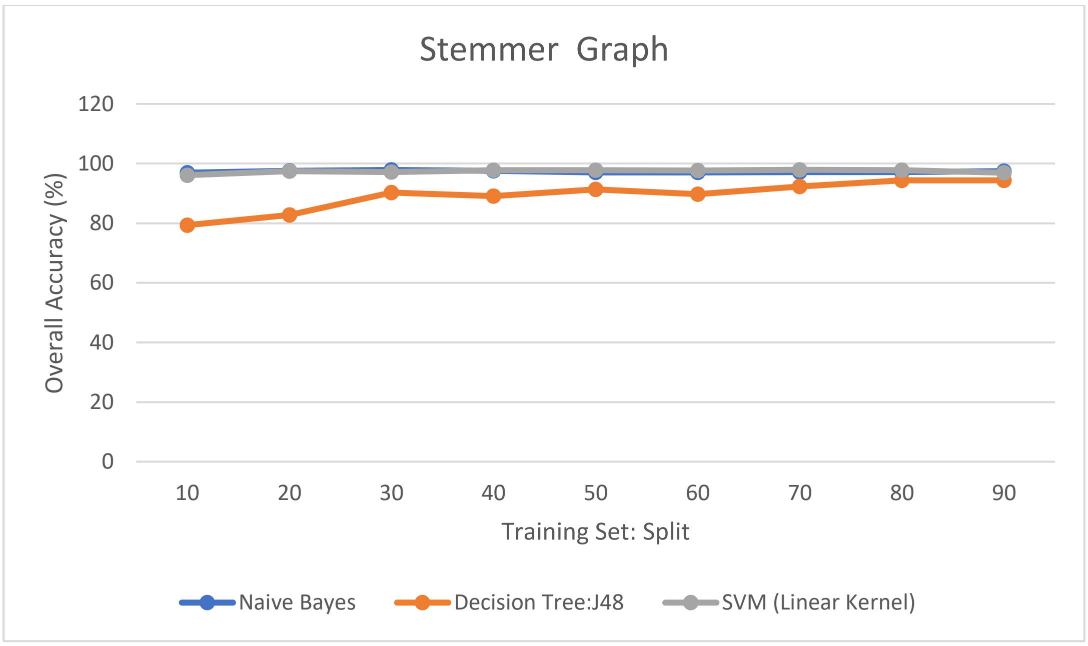
Support Vector Machine

	RBF Kernel				Linear kernel	
Split	Accuracy 1	Accuracy 2	Mean Accuracy	Accuracy 1	Accuracy 2	Mean
10	96.26	94.45	95.355	95.84	96.39	96.115
20	96.88	95.95	96.415	97.19	97.81	97.5
30	97.32	96.96	97.14	96.96	97.32	97.14
40	98.33	97.5	97.915	97.71	97.92	97.815
50	98	97.5	97.75	97.75	97.75	97.75
60	98.13	96.57	97.35	98.13	97.19	97.66
70	97.51	97.09	97.3	97.92	97.92	97.92
80	97.5	98.12	97.81	96.87	98.75	97.81
90	95	98.75	96.875	95	98.75	96.875

Now overall the table with the performances of these classifiers is shown below with the graph that I have also plotted.

Split	Naive Bayes	Decision Tree: J48	SVM (Linear Kernel)
10	96.945	79.36	96.115
20	97.58	82.705	97.5
30	97.855	90.28	97.14
40	97.605	89.08	97.815
50	97	91.39	97.75
60	97.035	89.715	97.66
70	97.09	92.32	97.92
80	97.185	94.375	97.81
90	97.5	94.375	96.875

And now I will show a graph to visualise the performances and the changes between the two methods. The graph shown below tells us how better of a performance using a stemmer is as unlike not using it in text mining. From the graph we can see that naïve bayes and SVM seem to be doing better and there is only a slight difference between them but they all above unlike the decision tree it is performing poorly it is the only one in the 80s region and much lower than any other classifier.



Conclusion

When I started my investigation, my primary objective was to find out the impact of Stemming on a data set over not using it at all. I am happy to report that I have used the appropriate methodology and parameters and come up with conclusive results. These are the mean performances of each algorithm for both Non-Stemmer and Stemmer.

	Naïve Bayes	Decision Tree J48	SVM Linear Kernel
Non-Stemmer	96.75%	86.45%	97.12%
Stemmer	97.31%	89.28%	97.39%
Difference	0.56%	2.83%	0.27%

We can draw the conclusion that yes, the use of stemming had an impact on the performances since it is visible that naïve bayes was able to increase its performance by 0.56% after applying it. And the Decision tree J48 had a major increase which was an increase by 2.83%. Which shows how much of an impact it has made on the model. Lastly the SVM (Linear Kernel) achieved an increase of 0.27%. I believe the best algorithm that has showed the best results and performance is the SVM with linear kernel.

References

1. ACM Computing Surveys Volume 49Issue 3 September 2017 Article No.: 45pp 1–46
2. BDCA'17: Proceedings of the 2nd international Conference on Big Data, Cloud and Applications March 2017 Article No.: 43Pages 1–9