

An Analysis of Clickbait Detection Techniques

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Abstract— Clickbaits are links, usually sensationalized textual headlines or images, specifically created to make the reader click on them. Clickbaits are employed in order to gain more 'views' usually for the purpose of monetary gain. Identification of clickbait plays a vital role in filtering misleading content. Many researchers have worked on clickbait detection techniques based on Machine Learning and Deep Learning such as Decision Tree, Random Forest, Convolutional Neural Networks (CNN), and Recurrent Neural Networks (RNN). This paper aims to provide a comparative study of the different techniques used for clickbait detection.

Keywords— Clickbait, Deep Learning, CNN, RCNN, RNN.

I. INTRODUCTION

Clickbaits are headlines that exaggerate facts, and its primary goal is to gain attention and encourage visitor to click on a link to a webpage. The term 'bait' itself means to lure. Users are lured to click on titles which intend to create a curiosity gap. Users generally click on those over promising clickbait headlines or titles to fill their curiosity gap. Clickbaits can be categorized into eight types namely exaggeration, teasing, inflammatory, formatting, graphic, bait-and-switch, ambiguous and wrong [3]. Certain text formatting such as use of exclamations, upper case letters, adjectives and asking questions, make the titles look more appealing. It is vital to detect to detect and classify clickbait titles. This paper focuses on various techniques involving Machine Learning algorithms such as Support Vector Machine (SVM) [4] [15], Decision Trees [3], Random Forest [9] [12], Natural Language Processing [10], and Deep Learning algorithms such as Recurrent Neural Network (RNN) and Long Short-Term Memory (LSTM) [5][7], Parallel Neural Network [11] and Convolutional Neural Network (CNN) [6][2].

II. LITERATURE STUDY

In the papers given below, various techniques that are used to classify text and to detect clickbait are summarized. Each algorithm has different accuracy with different dataset. Most datasets are pre-processed and word embeddings are done with techniques like Word2Vec and GloVe. The techniques used for classification can be broadly classified into machine learning and deep learning based approaches.

2.1 Machine Learning based Techniques:

Machine learning algorithms have the ability to learn information based on past data. For the purpose of text classification, supervised machine learning algorithms are primarily used. In the following papers, different supervised machine learning algorithms such as Decision Trees, Random Forest, and Regression are studied.

2.2 Deep Learning based Techniques:

Deep Learning based approaches are inspired by the working of neurons in the human brain. A collection of such neurons forms a neural network. Deep Learning based approaches usually provide better accuracy as compared to machine learning algorithms. Convolutional Neural Networks (CNN) is mainly used for image classification has also shown remarkable accuracy in text classification. The following papers utilize various deep learning algorithms such as CNN, RNN, R-CNN, C-CNN for classifying text.

S. Lai, et al. [1] have presented a model based on bidirectional RNN that can capture long term contextual information from text. The model consists of the left and right context of the word. This allows the model to capture better contextual information than the traditional window-based model like CNN where small window sizes can result in loss of information and large window sizes can increase the parameter space. The model captures the contextual information using bidirectional RNN, then passes the output

to a max pooling layer which is used to find the most important semantic features in the document. Finally, a softmax layer is applied which converts the output numbers into probabilities.

J. Fu, et al. [2] have proposed a CNN based approach for Clickbait Detection. Previous work relied on using various handcrafted syntactic and lexical features. However, this requires very high expertise knowledge of feature extraction and cannot be applied to languages that do not share such features. Thus, this paper proposes a model that is not dependent on language specific features and applies it on the Chinese language. In this model, the convolution filters are used to extract local n-gram features and then a max pooling over time is done to select the most informative features. The model is based on the architecture by Kim et al. where the words are embedded into word vectors, fed into the CNN for feature extraction and a regression classifier is used for classification.

P. Biyani, et al. [3] have proposed a machine learning based model for clickbait detection. A number of features were extracted from the body, title and content and the degree of informality. The paper classifies clickbaits into eight different types and proposes the first machine learning model for detecting clickbaits. The classification types are: Exaggeration, Teasing, Inflammatory, Formatting, Graphic, Bait-and-switch, Ambiguous, and Wrong The paper captures various informality scores such as Coleman-Liau score (CLScore), RIX and LIX indices, and Formality measure to approximate the reading difficulty of the text. The dataset was collected from various news websites. The model makes use of the Gradient Boosted Decision Trees for the classification process.

A. Chakraborty et al. [4] have compares different machine learning approaches for clickbait detection. The paper also provides a clickbait dataset comprising of both 7,500 clickbait and non-clickbait titles. This paper uses various features such as the length of the words, the length of headlines, the usage of hyperbolic words, punctuation patterns, slangs and others for a total of 14 features. The paper also makes use of N-Gram model using all possible 1, 2, 3, and 4-grams. Parts-of-Speech Tagging was also done to identify the POS tags. The paper compares SVM, Radial Basis Function kernel, Decision Trees and Random Forests on different parameters. SVM performed better than other models achieving an accuracy of 93%. This paper shows that SVM achieves better accuracy than other machine learning approaches. The paper also presents a way to block clickbait using browser extension.

P. Dimpas et al. [5] uses a Bi-directional LSTM RNN based model to detect click-baits in Filipino and English language. The paper states that RNN usually suffer from vanishing/exploding gradients and thus RNN in practice are unable to learn the long-term dependencies. LSTM is thus used to solve the problem of RNN. This paper uses Bidirectional LSTM where the weights are updated after forward and backward passes. The dataset contains a mix of Filipino and English headlines. This paper explains and demonstrates the working of RNN with LSTM for Clickbait Detection on Filipino and English Language.

A. Agrawal et al. [6] proposes a model for detection of clickbait titles using Convolutional Neural Networks. This paper also presents a compiled clickbait corpus that is sourced from multiple social media websites to prevent bias. This also helps in creating a generalized model for clickbait detection. The proposed model uses a simple CNN having 1 layer of convolution. The first layer is used for embedding words to vector using word2vec. The next layer utilizes filters of multiple sizes (3, 4, and 5) to create convolutions over the word vectors. This paper shows that CNN can be used for clickbait detection with good accuracy. The accuracy can be further improved by using more and better layers in CNN.

V. Kumar et al. [7] have proposed a novel approach for clickbait detection based on social media post. Word Embedding is given as an input to a Siamese network. A bidirectional LSTM is trained with an attention mechanism. Convolutional Neural Networks are used to learn image embedding. The outputs of these components are concatenated and given as an input to a fully connected layer. RNNs suffer from a problem of vanishing gradients. This paper shows the use of Siamese network for capturing the context in similar terms. It also considers the textual and image features while classifying clickbait.

J. Shin et al. [8] have developed a system based on contextual convolution neural network for sentence classification. The previous studies were based on natural language processing but CNN based models have shown state-of-the-art performances on sentence classification tasks. They have proposed a novel CNN-based scheme that properly integrates feature extraction and context modulation. The main feature of C-CNN is the contextual layer that has recurrent structure. The module repeatedly computes convolution and the output updates itself over the time. The database for this model is taken from Sentiment Stanford

Trebank benchmark (SST). SST-5 consists of movie review with fine-grained labels (very positive, positive, neutral, negative, and very negative). They have used standard 8544/1101/2210 split for training/development/testing, and also use the phrase-level labelled dataset for training. After comparing the results of both R-CNN and C-CNN, it was concluded that the performance of R-CNN is better in convolution layers than C-CNN and the C-CNN achieves better performances than state-of-the-art models on SST5. Hence on the basis of experimental results, the researchers have demonstrated that the proposed model has a better CNN architecture for NLP tasks.

X. Cao et al. [9] had identified clickbait for a clickbait competition. Random Forest Regression and Feature engineering with their ranked 60 most important features are used to detect clickbait. An accuracy of 0.819 was achieved on a dataset from the clickbait challenge 2017. They have implemented a method to generate score of clickbait that rated how clickbaity a social media post is. In this paper, the top 60 features were selected to reduce run time and decrease noise interference. Collection of more high-quality data to expand the existing dataset not only in quantity, but also in vertical dimensions could be helpful to capture more information such as URL information or user comments.

P. Klarith et Al. [10] researchers have used the Natural Language Processing to detect Clickbait in Thai language news articles. They have referred research papers based on Machine Learning and Recurrent Neural Network. Among these papers, it was found that deep learning result is more promising. The proposed system was made from embedding layer and three different of networks in the hidden layer known as Bi-LSTM. The dataset used in this system was collected from well-known newspaper, community blog and online magazine with desired headline in non-clickbait category, but publisher which issue mass clickbait content are arranged to clickbait category. They have used Feed-Forward Neural Network as a multilayer network and the Long-short term memory (LSTM) for text classification. The implementation was based on the Keras framework, a high-level neural networks API on top of Google TensorFlow. The Bi-LSTM with word level embedding performs very well achieving accuracy rate of 0.98 and f1score of 0.98. From the above information, it is concluded that the deep learning techniques perform better on clickbaits as compare to the machine learning techniques and NLP is proved to be one of the best among them.

P. Adelson et al. [11] proposed a system using parallel convolution highway network. The dataset for this system consists of 19538 data points among which 4761 were clickbait and 14777 were non-clickbait. In PNN, they have extracted features from the different text using parallel convolution and have combined these features into new representation by concatenating them and running them through a linear layer. The researchers have used Linear Regression and SVM as baseline. The result of the PNN outperformed the result of the baseline model. CNN was also used for the same dataset but the results were worse than the baselines, indicating that article text and title are much less important in labelling an article clickbait. This paper showed that the PNN has better F1 score (0.648) than CNN (0.385) on titles. This paper also proves that the context of the title of an article is important for clickbait detection.

M. Potthast et al. [12] have proposed a machine learning approach for clickbait detection. Their model is based on 215 features. The features re pertaining to the teaser message, the linked web page, and Meta information. Random Forest algorithm is used to identify clickbait titles. They have compared the three learning algorithms Logistic Regression, Naive Bayes and Random Forest. This model achieved a precision of 0.76 on Twitter API. Clickbaits, with a contrast of different social media will result in an improved detection performance. Whereas, it's automatic detection will give readers a way of filtering their news stream.

Y. Zhang et al. [13] have done extensive experimental analysis of CNNs for sentence classification, they have experimented sentimental analysis of one layer of Convolution Neural Network to find the architecture component effect on the system. They focused on one convolutional layer due to their comparative simplicity and strong empirical performance. For this experiment the researchers have used nine datasets of different sentences and they are MR, SST-1, SST-2, Subj, TREC, CR, MPQA, Opi and Irony. As a baseline, they have used linear kernel SVM. The system first converted all the sentences in the tokenized form which are then converted into sentence matrix. The rows of which are word vector representations of each token. Such that they can then effectively treat the sentence matrix as an image and perform convolution on it through linear filters. The accuracy of 85.43% is achieved on SST-2 dataset. This paper showed the use of one convolutional layer for improvising their comparative simplicity and strong empirical performance.

S. Manjeshet. al [14] have compared multiple machine learning and deep learning models such as Gaussian Naïve Bayes, Bernoulli Naïve Bayes, Multinomial Naive Bayes, Multilayer Perceptron and Deep Learning using LSTMs to classify clickbait

article and News. They have collected data from various clickbait disseminator such as BuzzFeed, UpWorthy, etc and non-clickbait data from The Hindu, BBC, Washington Post, etc. For data pre-processing and features extraction, they have used beautifulsoup and pandas and have divided the dataset into training set, validation set and test with the proportion ratio of 60:20:20. The paper showed that the deep learning using LSTM gives better average F1 score and is closely competed by multilayer perceptron neural network.

III. ANALYSIS

The following table is the summary of various research papers on Clickbait Detection and Deep Learning.

TABLE 1
ANALYSIS TABLE

Sr. No.	Title	Technique Used	Dataset	Accuracy
1	8 Amazing Secrets for getting More Clicks: Detecting Clickbaits in News Streams Using Article Informality	Feature Engineering, Gradient Boosted Decision Trees	News Websites	F1 Score of 0.74 in identifying clickbaits
2	Recurrent Convolutional Neural Networks for Text Classification	Bi-Directional RNN	20NewsGroups, Fudan Set, ACL Anthology Network and Sentiment Treebank	Accuracy of 96.49%, 95.20%, 49.19%, and 47.21% for the respective datasets
3	A Convolutional Neural Network for Clickbait detection	CNN	Chakraborty et. Al (7500 clickbaits and 7500 non-clickbaits) UC Headlines (Chinese Dataset)	Precision of 0.98 for English dataset Precision 0.92 for the Chinese Dataset
4	Stop Clickbait: Detecting and Preventing Clickbaits in Online News Media	N-Gram, POS, SVM	Media Websites and Facebook API	Accuracy of 93%
5	Filipino and English Clickbait Detection Using a Long Short Term Memory Recurrent Neural Network	Word2Vec, RNN and Bi-directional LSTM architecture	Filipino Websites	Accuracy of 91.5%
6	Clickbait Detection using Deep Learning	Click-Scratch, Click-Word2Vec, CNN	Reddit, Facebook, Twitter API	Precision of 0.88 for Clickbaits using Click-Scratch and 0.85 for Clickbaits using Word2Vec
7	Identifying Clickbait: A Multi-Strategy Approach Using Neural Networks	Siamese Neural Networks, BiLSTM, CNN	Twitter API	Accuracy of 83.53
8	Contextual-CNN: A Novel Architecture Capturing Unified Meaning for Sentence Classification	C-CNN, R-CNN and CNN	SST-5 and SST-2	On SST-5 C-CNN gives (52.3) and R-CNN gives (50.6) accuracy and on SST-2 C-CNN gives (89.2) and R-CNN gives (88.2) accuracy
9	Clickbait: Didn't Read: Clickbait detection using Parallel Neural Networks	Parallel Convolutional Highway Network	Clickbait-Challenge 2017	PNN has better F1 score (0.648) than CNN (0.385) on titles
10	Thai Clickbait Detection Algorithms using Natural Language Processing with Machine Learning Techniques	Natural Language Processing	Thai News Headlines	Accuracy rate of 0.98 and F1 score of 0.98
11	Machine Learning Based Detection of Clickbait posts in Social Media	Random Forest Regression, Feature Engineering	Clickbait-Challenge 2017	Accuracy of 0.819
12	Clickbait Detection	Random Forest	Twitter API	Precision of 0.76
13	A Sensitivity Analysis of (and Practitioners' Guide to) Convolutional Neural Networks for Sentence Classification	Word2Vec, GloVe, and CNN	SST-2	Accuracy of 85.43%

The various algorithms used for text classification and clickbait detection are summarized in the above analysis table. From the table it can be seen that CNN and RNN present better accuracy as compared to the machine learning approaches.

IV. CONCLUSION

With the increase in online advertising and revenue generation through clicks, clickbait headlines have been growing on all social media platforms in order to increase revenue. Various Machine Learning and Deep Learning algorithms are effective in detecting clickbaits. Deep Learning approaches such as CNN, RNN, and LSTM networks have shown to be more accurate in classifying the headline as clickbait as compared to the machine learning models. In this paper, different machine learning and deep learning techniques have been studied and analysed. Here, large dataset of headlines consisting of clickbait and non-clickbait are used. It is evident from the studied papers that increasing the window sizes in CNN and utilizing LSTM networks have increased the accuracy of detecting clickbaits. In future, contextual classification of clickbaits may help in further increasing the accuracy.

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