GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES
ARGREVIEW: A REVIEW OF ARGUMENTATION MINING: CLASSIFICATION AND APPLICATIONS IN DECISION SUPPORT

Pooja K. Patel[*1] & Prof. Dhatri Pandya[2]
[*1]PG Student, M.E (Computer Engineering), Sarvajanik College of Engineering and Technology, Surat-395001, India
[2]Computer Engineering Department Sarvajanik College of Engineering and Technology Surat-395001, India

ABSTRACT
Argumentation Mining is currently new growing research in Artificial intelligence. Argumentation is multi disciplinary field that deal with the process of reasoning. The main aim of Argumentation Mining (AM) is extracting arguments from textual data. Extracting arguments from domains such as social media, philosophical views, research publications, debates, consumer reviews, persuasive essay and biological text documents produce qualitative information for decision making. Various machine learning algorithms such as Support Vector Machine (SVM), Random Forest (RF), Maximum Entropy (ME) and Naïve Bayes (NB) is being used for argument classification task. This paper contains the review of various Argument classification techniques, application scopes and challenges in Argumentation Mining.

Keywords: Argumentation Mining (AM); Argument Classification; Argumentation; Decision making; Model of Argumentation Mining.

I.   INTRODUCTION

Argumentation is branch of philosophy that deals with the process of forming reason and drawing conclusions according to the context of conversation [2]. Argumentation is multi-disciplinary research field that integrate various areas such as Artificial Intelligence (AI) and computational linguistics. The study of argumentation in AI provides the new direction for research in new discipline called computational argumentation. Major source of data for arguments are the web, social media, online newspapers, legal documents, debates, product reviews, blogs and many more where arguments can be found. The availability of such a data give the rise of new domain of research called Argumentation Mining (AM) [1].

Argumentation Mining (AM) is the processes of automatically identifying the arguments from unstructured data and provides structure data to make them capable for computational analysis. Arguing means you claim that something is true by providing evidence that support claim. Generally argument is consists of two components: 1) Premises that describe reason for claim and 2) Claim that denotes conclusion of the argument. It is possible that multiple premises will be present and one claim is derived based on those premises Ex-This phone is worst because **its battery lifetime is so poor.**

Conclusion (Claim)   Premise (Reason)

The system of Argumentation Mining is consists of three stages: 1) Argument Sentence Detection 2) Argument Component Detection and 3) Argument Structure Prediction. Each of these tasks corresponds to Machine Learning (ML) and Natural Language Processing (NLP) tasks such as information retrieval, textual entailment and text segmentation

Various kind of Argumentation Frameworks (AF) are used to perform the task of reasoning [21]. Argumentation Frameworks (AFs) provide a non-monotonic reasoning paradigm that consists of set of arguments and relation between arguments [3].

The major application of Argumentation Mining is in spoken discourse and in written text including Legal documents, Scientific text, Research papers, Patents, Online forums, User generated contents, Reviews and many more [1][2][22-24][26-28][30]. To analyze such a huge amount of information we can use Argumentation Mining based tool for information retrieval and decision making.

This paper will describe the current state and arts of Argument classification task. The rest of paper is organized as following: Section 2 gives the brief description of Argumentation Mining Model and related techniques. Then various techniques of argument classification are discussed in Section 3. In Section 4 summary of argument classification techniques and challenges are described. Further, Conclusion of the work is presented in Section 5.

II.   ARGUMENTATION MINING

A.   Model of Argumentation Mining

Generally the model of Argumentation Mining consists of three phase. First phase consists of argument detection and component boundary detection and later phase is argument structure prediction [2]. Figure 1 shows the model of AM. Each phase is performed corresponding task to the Natural Language Processing (NLP) such as text segmentation, information retrieval and text summarization.
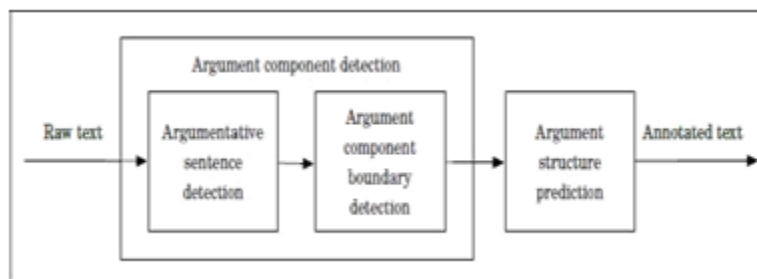

Fig. 1. Model of Argumentation Mining [2]

Argument Sentence Detection: In corpus not all the sentences contains arguments. Thus classification of argument sentences and non-argument sentences is required. There are three options to classify argumentative sentences that are use 1) a binary classifer to classify argumentative and non-argumentative sentences, 2) a multi-class classifier to separate argument component and a set of binary classifier [2]. This task can be accomplished using various statistical classifiers like Support Vector Machine (SVM), Random Forest (RF), Naïve Bayes (NB) and Maximum Entropy (ME). Moreover the work of classification of arguments is performed in [1-4][6][8-9] [29]using different features.

Argument Component Boundary Detection: In this phase argument component like claim and premises are detected. Premises and claim represents reason and conclusion respectively. Premise of an argument may be support or attack to claim or to other arguments. This task is similar to sentence segmentation that deal with decide where argument component start and end within argumentative sentence[2]. In [2] [5-7][10], the task of component boundry detection is performed. According to the granularity of input, there are three cases to decide boundry of argument that are:

Whole senetnce is considered as an argument.

One sentence contains one or more argument component.

Argument component may be span across multiple sentences [2].

Argument Structure Prediction: In this phase argument schemes are identified. The relation between the argument components (claim/premises) or between the arguments is predicted in this phase. There are two types of relation

304

between components (or arguments) that are support and attack. Argument structure can be adopted by using argument schemes. Argument Schemes provide pattern for reasoning [3]. The link between argument components is predicted in this phase. The output of this phase is in the form of graph connecting to argumentative component. Various rule based approaches [2] and context free grammar (CFG) are used for structure prediction. Textual Entailment (TE) is another research domain that deals with relation between two arguments [2].

III. STATE AND ART OF ARGUMENT CLASSIFICATION

Argument classification is task of extracting argumentative sentences from textual document. Various supervised machine learning classifiers such as Maximum Entropy (ME), Support Vector Machine (SVM), Naïve Bayes (NB) and Random Forest (RF) are used to classify the argumentative and non argumentative sentences. As Argumentation Mining is multidimensional field it can be applicable in Legal Domain, Biology and Medical, Humanities and User Generated Web Content. Features extraction plays very import role for argument classification.

R. Palau et al. [7] perform argumentation mining in legal domain. Research in this paper mainly focused on automatic identification of argument and argument structure from legal text. Araucaria structured dataset consists of 19 news paper, 4 parliamentary record, 5 court report and 6 magazines. The another corpus they used is ECHR (European Court of Human Rights) that consists of set of legal text. Two statistical classifier ME and SVM are used for argument detection. In a second step SVM is used to classify each argumentative sentence in premises and conclusions. Context free grammar is used to determine the structure of argument.

Alan Sergeant, [8] provide model for decision support by automatically extracting arguments from natural language. They examine premises and counter arguments to reach better decisions. They annotate Car Review Corpus (CRC) using Apache UIMA tools. They classified proposition in two part as premise and conclusion. They perform classification task by using Machine Learning (ML) Algorithms such as Support Vector Machine (SVM) and Maximum Entropy (ME) and Rule based approach. They obtain higher F1 measures in identifying propositions by using ML based classifier compared to rule based approach.

Work proposed by P. Poudyal et al. in [9] used SVM and Random Forest (RF) to identify Argumentative sentence. Three different type of experiment are carried out on ECHR corpus that are basic experiment, multi feature experiment and tree kernel experiment. The result of basic experiment shows that SVM perform better. In second they perform experiment with multiclass SVM in which they use features like punctuation, Average word length, sentence length, parse length, parse depth and PoS tag. Third experiment conducted on tree kernel that generate parse tree. Syntactic feature are used in this experiment. Among three experiment multi feature SVM perform best.

Kernel approach was proposed by N. Rooney et al. in [10] for argument detection and classification. Instead of using NLP based feature in this work they used convolution kernels that provide a mechanism for calculating the similarity between two documents, paragraph and sentences. AraucariaDB corpus is annotated in premises and conclusion using GATE plug-in. The accuracy of this approach is less than [7] but an advantage is that there is no requirement of choice of specialized feature because the features are selected based on heuristic choice.

C. Stab et al. in [4] proposed an approach for identifying argumentative component such as claim and premises that are connected with argumentative relation. They perform this task in two phases. In first phase components of arguments are identified using several classifiers (Support Vector Machine, Naïve Bayes, Random Forest and C4.5 Decision Tree). Based on comparative evaluation of result they found SVM as a best classifier with higher accuracy then others. For preprocessing the corpus they use Standford POS-Tagger and DKPro framework for parsing. DKPro-TC text classification framework is also used for classification of argument components with features such as structure, lexical, syntactic, indicators and contextual features.

J. Schneider et al. [11] perform the task of argument extraction on consumer opinion. They present a semi-automated, rule-based information extraction tool for identification of arguments in product review corpus. The main contribution of their work is to extract the statements about a topic and structure them into argument or against

it. Various Argumentation schemes that represent patterns of reasoning such as user classification, camera classification, combining schemes for camera evaluation and practical reasoning are used. General Architecture for Text Engineering (GATE) framework and Java Annotation Pattern Engine (JAPE) rules are use for argument extraction.

Major application of Argumentation Mining is for decision making. In the medical domain, the stream of scientific research contains several arguments and counter-arguments. Thus human or medical expert face difficulties to understand reason and evidences claim by the proponents and opponent. Thus the domain of argumentation is interleaving of the domain knowledge. A. Groza et al. [12] proposed argument based decision supporting system for the purpose of helping to healthcare professional. They developed Breast Cancer Grading Ontology (BCGO) that assigned a grade as being the part of biological process category. GATE editor and JAPE (Java Annotation Pattern Engine) rules are used to identify claim as well as premise that form argument structure. They also proposed pattern based algorithm to detect arguments from cancer documents. The performance of the system is analyzed by performing experiments on six different cancer documents. They achieve 0.86 F-measure for identifying claim and premises form the document.

Social Media is one of the platform on which people places their point of view in form of argument. M. Dusmanu et al. [13] mine the argument from twitter. In this work three tasks are performed. At first they apply supervised classification to classify argument tweets from non-argumentative ones. In second task they again apply supervised classification to recognize factual information that contains opinions only. The final task is identification of source information for argumentative tweets. They use annotated tweets form DART [14]. They work with total 1887 tweets for argument detection task among them 1459 tweets are argumentative and 428 tweets are non argumentative. They tested Logistic Regression (LR) and Random Forest (RF) classification algorithm using scikit-learn tool. Four different kinds of features such as lexical, twitter-specific, syntactic and sentiment are extracted from tweets. The experiment result shows highest f-measure for LR with all features. The most of the ironic tweets are miss-classified in their work. Moreover, F-measure for factual vs opinion classification and source detection is 0.80 and 0.67 respectively.

G. Rocha et al. [15] address the task of Argument Sentence Detection (ASD) using supervised machine learning approach. ArgMine corpus that is consists of the collection of news articles is used as dataset. Citius Tagger [16] NLP tool is used for preprocessing of corpus. Various semantic resources such as WordNet [17] for English language and CONTO.PT (Word net for Portuguese [18]) are used for conceptual analysis. The experiment performed by two approaches: i) Sentence-Based Approach and ii) Relational-Based Approach. In sentence based approach the sentence is classified as argumentative if sentence contains one of the argumentative components (Premise or Claim). In Relational-Based Approach, a binary classification is performed to determine whether a pair of sentences constitutes an argument or not. The sentence is argumentative if sentence contains the component such as premise and conclusion when pair with other sentence in the document. Different type of classifier such as SVM, ME, Adaptive Boosting algorithm using Decision Tress, RF, Multilayer Perceptron with Classifier with one hidden layer are used for classification. Among them ME classifier performed better for all experiments. F-measure is 0.67 and 0.43 for non-argumentative and argumentative sentences respectively by Sentence based approach. For relation based approach f-measure is 0.81 and 0.58 for non-argumentative and argumentative sentences respectively.

Y. Du et al. [19] proposed a framework to perform the task of argument component identification and relation prediction. They consider each pair of argument as a unit to perform classification. They perform experiment with machine learning classifier such as Logistic Regression and SVM on the persuasive essay datasets. The corpus is consists of 402 English essay consists of 7116 sentences and 147271 words. Among the four classifier the performance of decision tree is worst than other three. Moreover, features such as lexical, structural, syntactic and indicators are extracted from the documents. F-measure of this work is 0.6081 by logistic regression.

IV. SUMMARY OF EXISTING TECHNIQUES FOR ARGUMENT CLASSIFICATION

In the previous section state and art of various classification techniques and its related application domain are mentioned. Table 1 shows the summary of Argument Mining tasks, its application domain, dataset, classification techniques and tools that used in classification tasks are mentioned. Following are the terminology used in the table 1:

Domain: Represents application

Classification Techniques: Various Machine Learning based classifier and Rule-based

classification is used to extract the argument from dataset.

1. **Level of analysis:** Argument can classify either at sentence level or at document level.
2. **SD:** Argumentative Sentence Detection.
3. **CD:** Argumentative Component (Premise/Claim) Detection.
4. **SP:** Argument Structure Prediction.

5. **Tools:** There are different tools that are used for argument classification. Tools are also used for creating annotating corpus for Argumentation Mining.

Table I summary of existing techniques for argument classification

No.	Reference	Domain	Dataset	Level of Analysis	AM Task			Classification Technique	Tools	Performance of classifier
					SD	CD	SP			
1	R. Palau et al. [7]	Legal	ECHR, Araucaria DB	Document	—	-	—	ME SVM	-	SVM perform best
2	Alan Sergeant [8]	User Generated Content	CRC	Sentence	—	—	-	ME SVM Rule-based	Apache UIMA	ML perform best than rule based approach
3	P. Poudyal *et al.* [9]	Legal	ECHR	Document	—	-	-	SVM RF	-	SVM perform best
4	N. Rooney *et al.* [10]	Multi-Domain	Araucaria DB	Document	—	-	-	SVM	GATE	-
								SVM	DKPRo-	

5	C. Stab *et al.*[4]	Humanities	Persuasive Essays	Document	-	—	-	NB RF Decision Tress	Text Classificat ion	SVM perform best
6	J. Schneider et al. [11]	User generated Content	Amazon Product Review	Sentence	—	—	-	Rule based (JAPE rule)	GATE	-
7	A. Groza et al. [12]	Medical	Breast Cancer Document	Document	-	—	-	Pattern based Algorithm	GATE	-
8	M. Dusmanu et al. [13]	Social Media	Twitter	Sentence	—	-	-	LR RF	*Scikit-learn* tool	LR perform best
9	G. Rocha et al. [15]	Social Media	News articles	Document	—	-	-	SVM, ME, Adaptive Boosting algorithm using Decision Tress, RF, Multilayer Perceptron	Citius Tagger CONTO. PT	ME perform best
10	Y. Du et al. [19]	Humanities	Persuasive Essay	Document	-	—	—	LR SVM	-	LR perform best

Challenges for Argumentation Mining

Argumentation Mining shares some analogies of some other domain such as opinion mining, textual entailment and sentiment analysis. The main goal of opinion mining is *what* the people think about something where argumentation mining *why* people think about something [2]. As the process of AM is deal with reasoning that bring humans to relationally accept or reject the opinion or argument. Although there are various application domain still there is some open challenges that presents in this section.

Corpus creation: As AM is multi disciplinary field but the one of the major challenge is creation of argumentative corpus. Annotation of argument and its component is crucial and time consuming task. The pioneer work of creating argumentative corpus is start with law domain. Stab and Gurevych [4] create annotated corpus of persuasive essay. But still there is require creating annotated corpus for corpus for user generated content.

Domain dependency: Domain Dependency is a challenge that affect majority of all corpus-based area of Computational linguistics. It refers to the problem that classification model for one domain will not generalize for other domains [20]. This issue majorly effect to area such as sentiment analysis, argumentation mining and textual entailment.

Unstructured data: Another shortcoming is that most of the existing AM is work with structured data only. The major sources of argumentation are social media, e-commerce websites and blogs that produce unstructured data. To manage such unstructured data is one of the complex task for AM. However trend to work with unstructured or semi structured is also start up to limited scope.

Big data: Big data is one of the biggest challenge for all domains. The main sources of big data are Social media, blogs, product reviews and newspaper's articles. Nowadays Crowd Sourcing [2] approach is most widely used to create annotated corpus form such a big data.

V. CONCLUSION

Argumentation Mining is currently novel research area that deal with reasoning and provide decision support. Argumentation Mining has numerous interesting applications in domain such as Legal, Humanities, Philosophy, Biology, Medical and Social Media. This paper presents the basic model of argumentation mining that consists of Argument Sentence Detection, Argument Component Detection and Argument Structure Prediction. There are various machine learning classifier such as Support Vector Machine, Random Forest, Naïve Bayes, Maximum Entropy and Rule-Base approach which are being used for argument classification that are reviewed in this paper. One of the major challenging task in Argumentation Mining is the creation annotated corpus. In future the concept of argumentation mining can be also applied to the other field like market analysis and recommendation system for qualitative analysis.

REFERENCES

1. *E. Cambria and B. White, "Jumping NLP Curves: A Review of Natural Language Processing Research [Review Article]," in IEEE Computational Intelligence Magazine, vol. 9, no. 2, pp. 48-57, May 2014.*
2. *M. Lippi and P. Torroni, "Argumentation Mining: State of the Art and Emerging Trends," ACM Transaction on Internet Technology, USA, 2015, pp. 1-25.*
3. *M. Moens and K. Leuven, "Argumentation Mining: Where are we now, where do we want to be and how do we get there?," Post-Proceedings of the 4th and 5th Workshops of the Forum for Information Retrieval Evaluation ,India, 2013, pp. 1-7.*
4. *C. Stab and I. Gurevych, "Identify Argumentative Discourse Structures in Persuasive Essays,"2014 conference on Empirical Methods in Natural Language Processing, Qatar,2014,pp. 46-56.*
5. *A. S. Muhyiddin, M. A. Bijaksana and S. Sa'adah, "Semantics argument classification using Word/POS in constituent and left argument features," 2016 4th International Conference on Information and Communication Technology (ICoICT), Bandung, 2016, pp. 1-4.*

(C)Global Journal Of Engineering Science And Researches

6. T. Goudas, C. Louizos, G. Petasis and V. Karkaletsis, "Argument Extraction from News, Blogs and Social Media", Artificial Intelligence: Methods and Application, 8th conference on AI, springer, Greece, 2014, pp.287-29

7. R. Palau and M. Moens, "Argumentation Mining : The Detection, Classification and Structure of Arguments in Text," 12th International Conference on Artificial Intelligence and Law, Spain, 2009.

8. Alan Sergeant, "Automatic Argumentation Extraction," The Semantic Web: Semantics and Big Data. ESWC 2013, vol 7882, pp. no. 656-660, Berlin, 2013.

9. P. Poudyal, T. Goncalves and P. Quaresma, "Experiments on identification of argumentative sentences," 2016 10th International Conference on Software Knowledge Information Management & Applications (SKIMA), Chengdu, pp. 398-403,2016.

10. N. Rooney, H. Wang and F. Browne, " Applying Kernel Methods to Argumentation Mining,"25th International Florida Artificial Intelligence Research Society Conference (FLAIRS), 2012.

11. J. Schneider and A. Wyner, "Identifying Consumers' Argument in Text," Semantic Web and Information Extraction (SWAIE), Ireland, 2012.

12. A. Groza and O. M. Popa, "Mining arguments from cancer documents using Natural Language Processing and Ontologies," 2016 IEEE 12th International Conference on Intelligent Computer Communication and Processing (ICCP), Cluj-Napoca, 2016, pp. 77-84.

13. M. Dusmanu, E. Cabrio and S. Villata, " Argument Mining on Twitter: Arguments, Facts and Sources," Conference on Empirical Methods in Natural Language Processing, Denmark, 2017, pp. 2307-2312.

14. T. Bosc, E. Cabrio and S. Villata, "DART: a Dataset of Arguments and their Relations on Twitter," In Proceedings of the 10th edition of the Language Resources and Evaluation Conference, Slovenia, 2016, pp. 1258-1263.

15. G. Rocha and H. Cardoso, "Towards a Relational-Based Argument Extraction Model for Argumentation Mining," International Conference on Statistical Language and Speech Processing, Cham, 2017, pp. 94-105.

16. M. Garcia and P. Gamallo, "Yet another suite of multilingual NLP tools," In International Symposium on Languages, Applications and Technologies, Cham, 2015, pp. 65-75.

17. C. Fellbaum, " WordNet: An Electronic Lexical Databases Language, Sppech and communication," MIT press, Cambridge, 1998.

18. H. Oliveira, "CONTO. PT: groundwork for the automatic creation of a fuzzy Portuguese wordnet," In International Conference on Computational Processing of the Portuguese Language, cham, 2016, pp. 283-295.

19. Y. Du, M. Li and M. Li, "Joint extraction of argument components and relations," 2017 International Conference on Asian Language Processing (IALP), Singapore, 2017, pp. 1-4.

20. L. carstens, " Using Argumentation to Improve Classification in Natural Language Problem," Imperial College, London, 2016, pp. 1-197.

21. L. carstens, X. Fan, Y. Gao and F. Toni, "An Overview of Argumentation Frameworks for Decision Support," International Workshop on Graph Structures for Knowledge Representation and Reasoning, Springer, Cham, 2015, pp. 32-49.

22. MPG. Villalba and P. Saint-Dizier, "Some Facets of Argument Mining for Opinion Analysis," Computational Model of Argument, Proceedings of COMMA, France, 2012, pp. 23-34.

23. O. Cocarascu and F. toni, "Detecting deceptive reviews using Argumentation," Proceedings of the 1st International Workshop on AI for Privacy and Security, ACM, Netherland, 2016, pp. 1-8.

24. A. Groza and M. M. Nagy, "Harmonization of conflicting medical opinions using argumentation protocols and textual entailment - a case study on Parkinson disease," 2016 IEEE 12th International Conference on Intelligent Computer Communication and Processing (ICCP), Cluj-Napoca, 2016, pp. 163-170.

25. N. Azkalhaq, M. A. Bijaksana and S. Sa'adah, "Analysis of combined features at semantic argument classification," 2016 4th International Conference on Information and Communication Technology (ICoICT), Bandung, 2016, pp. 1-6.

26. H. Nguyen and D. Litman, "Argument Mining for Improving the Automated Scoring of Persuasive Essays," Association for the Advancement of Artificial Intelligence, 2018, pp. 1-9.

27. *N. Green, "Argumentation Mining in Scientific Discourse," 18th Workshop on Computational Models of Natural Argument, UK, 2017, pp. 7-13.*

28. *R. J. Sethi, "Spotting Fake News: A Social Argumentation Framework for Scrutinizing Alternative Facts," 2017 IEEE International Conference on Web Services (ICWS), Honolulu, HI, 2017, pp. 866-869.*

29. *S. Burhan ud Din Tahir, "Comparative analysis of supervised learning approaches for argument identification," 2017 International Multi-topic Conference (INMIC), Lahore, 2017, pp. 1-5.*

30. *S. Ferilli and A. Pazienza, "An Abstract Argumentation-Based Approach to Automatic Extractive Text Summarization," In Italian Research Conference on Digital Libraries , Springer, Cham, 2018, pp. 57-68.*