

<b>School/Department:</b>	Econometric Institute Erasmus School of Economics
<b>Project Title:</b>	Ontology-Driven Deep Learning for Aspect-Based Sentiment Analysis
<b>Abstract:</b>	<p>Due to Web popularity, nowadays, we experience a rapid growth of online reviews where people express their opinions on products or services. As manually processing these vast amounts of data is impossible, automatic approaches have been devised to provide summaries of people's opinion, which benefit both customers and companies. One such solution is proposed by sentiment analysis (mining), where public sentiment in relation to products or services needs to be computed [1]. In the recent years a lot of attention has been given to a subfield of sentiment analysis called aspect-based sentiment analysis (ABSA), where the sentiment is gauged with respect to aspects (features) of products or services [2].</p> <p>If large amounts of annotated data are available, machine learning approaches seem to give the best results [2]. For relatively small data sets (acquiring annotated data is a usually a very costly process), one can boost the performance of machine learning approaches by making use of domain knowledge formalized in domain ontologies [3]. Often such extensions are introduced by means of advanced ontology features that build on the semantics of the text reviews to provide high-quality signals to machine learning solutions.</p> <p>In the last years, deep learning models were among the best performing machine learning algorithms in many fields including natural language processing. For ABSA, [4] proposes Long ShortTerm Memory (LSTM) based on single-attention. [5] determines the attention based on relative distance of the words with respect to the aspects present in a sentence. In order to consider also the words far from the current aspect, [6] employs a recurrent attention mechanism based on a customized memory for each aspect. [7] proposes two aspect attention mechanisms (local and global) at sentence level and [8] suggests an multi-hop attention model that iterates between aspect and context representations for ABSA.</p> <p>The aim of this research is to extend state-of-the-art deep learning models with information coming from domain ontologies to improve their working especially when small amounts of annotated data are available. Ontologies can play a role in the feature formation of deep learning solutions or can inject knowledge in the appropriate components of the used deep learning network architecture. While we have previously devised ontologies for ABSA for two domains,</p>

	<p>there is also room to improve the quality of these ontologies by, for example, automatizing the ontology construction process. The evaluation is done using existing standard data sets (from SemEval). Some preliminary work can be found in our recent research [9,10].</p> <p>[1] Bing Liu: Sentiment Analysis: Mining Opinions, Sentiments, and Emotions, Cambridge University Press, 2015</p> <p>[2] Kim Schouten and Flavius Frasincar: Survey on Aspect-Level Sentiment Analysis. IEEE Transactions on Knowledge and Data Engineering (TKDE), IEEE Computer Society, Volume 28, Number 3, pages 813-830, 2016</p> <p>[3] Kim Schouten and Flavius Frasincar: Ontology-Driven Sentiment Analysis of Product and Service Aspects, 15th Extended Semantic Web Conference (ESWC 2018), Lecture Notes in Computer Science, Volume 10843, pages 608-623, Springer, 2018</p> <p>[4] Yequan Wang, Minlie Huang, Xiaoyan Zhu, and Li Zhao: Attention-based LSTM for Aspect-level Sentiment Classification, Conference on Empirical Methods in Natural Language Processing 2016 (EMNLP 2016), pages 6066-6075, ACL, 2016</p> <p>[5] Duyu Tang, Bing Qin, Ting Liu: Aspect Level Sentiment Classification with Deep Memory Network, Conference on Empirical Methods in Natural Language Processing 2016 (EMNLP 2016), pages 214-224, ACL, 2016</p> <p>[6] Peng Chen, Zhongqian Sun, Lidong Bing, Wei Yang: Recurrent Attention Network on Memory for Aspect Sentiment Analysis, Conference on Empirical Methods in Natural Language Processing 2017 (EMNLP 2017), pages 452-461, ACL, 2017</p> <p>[7] Qiao Liu, Haibin Zhang, Yifu Zeng, Ziqi Huang and Zufeng Wu: Content Attention Model for Aspect Based Sentiment Analysis, The Web Conference 2018 (WWW 2018), pages 1023-1032, ACM, 2018</p> <p>[8] Shiliang Zheng, Rui Xia: Left-Center-Right Separated Neural Network for Aspect-Based Sentiment Analysis with Rotatory Attention, arXiv preprint arXiv:1802.0089, 2018</p> <p>[9] Olaf Wallaart and Flavius Frasincar: A Hybrid Approach for Aspect-Based Sentiment Analysis Using a Lexicalized Domain Ontology and Attentional Neural Models, 16th Extended Semantic Web Conference (ESWC 2019), Lecture Notes in Computer Science, Springer, 2019</p> <p>[10] Donatas Meskele and Flavius Frasincar: ALDONA: A Hybrid Solution for Sentence-Level Aspect-Based Sentiment Analysis Using a Lexicalised Domain Ontology and a Neural Attention Model, 34th Symposium on Applied Computing (SAC 2019), pages 2489-2496, ACM, 2019</p>
<b>Requirements of candidate:</b>	<p>Background: The candidate needs to be proficient with Python/Java programming, and have a good knowledge of machine learning and</p>

	<p>deep learning techniques. In addition, the candidate should possess knowledge of natural language processing techniques and Semantic Web technologies or be willing to learn the necessary topics in these fields in a relatively short amount of time. Excellent communication skills for both writing and speaking in English are expected, as well as willingness to collaborate with the various parties related to this project. Candidates are expected to be in the top segment of their class with respect to their grades and must show interest in an academic career, including both research and teaching/supervision activities.</p> <p>Master's degree: Yes</p> <p><b>English requirement:</b>        IELTS: 7.5 (min. 6.0 for all subs.)        or        TOEFL: 100 (internet) or 600 (paper)        and        GMAT-test or GRE-test: 85%</p>
<b>Supervisor information:</b>	<p>Dr. Flavius Frasincar  <a href="mailto:frasincar@ese.eur.nl">frasincar@ese.eur.nl</a>  <a href="http://people.few.eur.nl/frasincar/">http://people.few.eur.nl/frasincar/</a></p> <p>Promotor Prof. dr. ir. Rommert Dekker,  <a href="mailto:rdekker@ese.eur.nl">rdekker@ese.eur.nl</a>,  <a href="http://people.few.eur.nl/rdekker/">http://people.few.eur.nl/rdekker/</a></p> <p>Kim Schouten, Flavius Frasincar, Rommert Dekker, and Mark Riezebos:        Heracles: A Framework for Developing and Evaluating Text Mining Algorithms, Expert Systems with Applications (ESWA), Volume 127, pages 68-84, Elsevier, 2019</p> <p>Olaf Wallaart and Flavius Frasincar: A Hybrid Approach for Aspect-Based Sentiment Analysis Using a Lexicalized Domain Ontology and Attentional Neural Models, 16th Extended Semantic Web Conference (ESWC 2019), Lecture Notes in Computer Science, Springer, 2019</p> <p>Donatas Meskele and Flavius Frasincar: ALDONA: A Hybrid Solution for Sentence-Level Aspect-Based Sentiment Analysis Using a Lexicalised Domain Ontology and a Neural Attention Model, 34th Symposium on Applied Computing (SAC 2019), pages 2489-2496, ACM, 2019</p> <p>Kim Schouten, Onne van der Weijde, Flavius Frasincar, and Rommert Dekker: Supervised and Unsupervised Aspect Category Detection for Sentiment Analysis With Co-Occurrence Data, IEEE Transactions on Cybernetics (TCyb), Volume 48, Number 4, pages 1263-1275, IEEE Computer Society, 2018</p> <p>Kim Schouten and Flavius Frasincar: Ontology-Driven Sentiment Analysis of Product and Service Aspects, 15th Extended Semantic Web Conference</p>

	<p>(ESWC 2018), Lecture Notes in Computer Science, Volume 10843, pages 608-623, Springer, 2018</p> <p>Kim Schouten, Flavius Frasincar, and Franciska de Jong: OntologyEnhanced Aspect-Based Sentiment Analysis, 17th International Conference on Web Engineering (ICWE 2017), Lecture Notes in Computer Science, Volume 10360, pages 302-320, Springer, 2017</p> <p>Daan de Heij, Artiom Troyanovsky, Cynthia Yang, Milena Zychlinsky Scharff, Kim Schouten, and Flavius Frasincar: An Ontology-Enhanced Hybrid Approach to Aspect-Based Sentiment Analysis, 18th International Conference on Web Information Systems Engineering (WISE 2017), Lecture Notes in Computer Science, Volume 10570, pages 338-345, Springer, 2017</p> <p>Kim Schouten and Flavius Frasincar: Survey on Aspect-Level Sentiment Analysis, IEEE Transactions on Knowledge and Data Engineering (TKDE), IEEE Compute Society, Volume 28, Number 3, pages 813-830, 2016</p> <p>Frederik Hogenboom, Flavius Frasincar, Uzay Kaymak, Franciska de Jong, and Emiel Caron: A Survey of Event Extraction Methods from Text for Decision Support Systems, Decision Support Systems (DSS), Volume 85, pages 12-22, 2016</p> <p>Alexander Hogenboom, Flavius Frasincar, Franciska de Jong, and Uzay Kaymak: Using Rhetorical Structure in Sentiment Analysis Communications of the ACM (CACM), Volume 58, Number 7, pages 69-77, 2015</p> <p>Alexander Hogenboom, Flavius Frasincar, Franciska de Jong, and Uzay Kaymak: Polarity Classification using Structure-Based Vector Representations of Text, Decision Support Systems (DSS), Volume 74, pages 46-56, 2015</p> <p>Alexander Hogenboom, Daniella Bal, Flavius Frasincar, Malissa Bal, Franciska de Jong, and Uzay Kaymak: Exploiting Emoticons in Polarity Classification of Text, Journal of Web Engineering (JWE), Volume 14, Numbers 1-2, pages 22-40, Rinton Press, 2015</p> <p>Alexander Hogenboom, Malissa Bal, Flavius Frasincar, and Daniella Bal: Lexicon-Based Sentiment Analysis by Mapping Conveyed Sentiment to Intended Sentiment, International Journal of Web Engineering and Technology (IJWET), Volume 9, Number 2, pages 125-147, Inderscience Publishers, 2014</p>
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