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Hierarchical contrastive learning for multi-label text classification

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Multi-label text classification presents a significant challenge within the field of text classification, particularly due to the hierarchical nature of labels, where labels are organized in a tree-like structure that captures parent-child and sibling relationships. This hierarchy reflects semantic dependencies among labels, with higher-level labels representing broader categories and lower-level labels capturing more specific distinctions. Traditional methods often fail to deeply understand and leverage this hierarchical structure, overlooking the subtle semantic differences and correlations that distinguish one label from another. To address this shortcoming, we introduce a novel method called Hierarchical Contrastive Learning for Multi-label Text Classification (HCL-MTC). Our approach leverages the contrastive knowledge embedded within label relationships by constructing a graph representation that explicitly models the hierarchical dependencies among labels. Specifically, we recast multi-label text classification as a multi-task learning problem, incorporating a hierarchical contrastive loss that is computed through a carefully designed sampling process. This unique loss function enables our model to effectively capture both the correlations and distinctions among labels, thereby enhancing the model's ability to learn the intricacies of the label hierarchy. Experimental results on widely-used datasets, such as RCV1-v2 and WoS, demonstrate that our proposed HCL-MTC model achieves substantial performance gains compared to baseline methods.

Keywords Contrastive learning, Hierarchical structure, Multi-task, Multi-label text classification

The task of text classification, a cornerstone of natural language processing (NLP), has recently attracted increased interest. Its applications span a wide range of fields, including sentiment analysis[1–3], document categorization[4], medical codes prediction[5], legal studies[6], patent classification[7], and financial analysis[8]. Among these, Multi-label Text Classification (MTC) stands out as a particularly complex challenge. In MTC, the goal is to assign multiple labels to a given text, where the set of labels often exhibits a hierarchical structure. This structure implies a relationship between labels, such that information pertaining to one label can influence the inference of another, thereby adding complexity to the classification task.

The current approaches to the MTC task can be broadly classified into two categories: (1) methods that predict labels using textual information alone, and (2) approaches that combine both label and textual information for prediction. The first category of methods relies on local and global features extracted by text encoders to forecast labels. Notable examples include CNN-based models[9,10] that address data imbalance issues caused by a lack of samples for child labels. Other works in this category focus on incorporating semantic information from text[11]. While these methods are effective at capturing textual subtleties, they generally fail to account for relationships between labels.

The second category of methods aims to integrate textual and label information. Strategies include weight initialization[12], learning label hierarchies[13–15], and the use of capsule networks[16,17]. These approaches improve the efficiency of MTC by leveraging label information but often achieve only a superficial understanding of the label hierarchy. The graph convolutional network (GCN)-based model[18] shows promise in learning a deep label hierarchy but does not fully exploit label information, focusing exclusively on correlative aspects and overlooking label distinctiveness.

Despite substantial progress, a critical gap in research persists: the majority of current methods do not effectively utilize both the distinctive and correlative aspects of label information to optimize hierarchical multi-label classification. This shortcoming restricts the effectiveness of these models, especially in complex, hierarchical label structures where both types of information are essential for accurate classification.

The concurrent consideration of correlative and distinctive information is fundamental to achieving a deep understanding of the label hierarchy, thus improving the effectiveness of MTC. As depicted in Fig. 1, the similarity s_{23} between nodes 2 and 3 represents distinctive information, which is presumed to be maximized

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October 2019 The 56 full papers presented in this volume were carefully reviewed and selected from 134 submissions They were organized in topical sections named linguistics and cognitive science fundamental theory and methods of computational linguistics information retrieval and question answering text classification and summarization knowledge graph and information extraction machine translation and multilingual information processing minority language processing language resource and evaluation social computing and sentiment analysis NLP applications *KDD ...* ,2003 International Journal of Market Research ,2010 **CIKM 2004** David A. Evans,2004 **Proceedings of the ... International Conference on Information and Knowledge Management** ,2004 **Proceedings of the ... SIAM International Conference on Data Mining** ,2005 **Journal of Machine Learning Research** ,2007 An international forum covering all areas of machine learning *Handbook of Research on Web Log Analysis* Bernard J. Jansen,Amanda Spink,Isak Taksai,2009 This book reflects on the multifaceted themes of Web use and presents various approaches to log analysis Provided by publisher **IEEE Workshop on Content-Based Access of Image and Video Libraries (CBAIVL 2001)** ,2001 This workshop held in December 2001 on Kauai discussed various means for retrieving information from digital images and video The proceedings features 20 papers grouped into the four themes of image content analysis and object based retrieval video content analysis content based querying and v **Proceedings of the ... Annual International ACMSIGIR Conference on Research and Development in Information Retrieval** ,2005 **Advances in Intelligent Data Analysis** ,2003

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Proceedings, 12th International Conference on Image Analysis and Processing ,2003 The organization of the ICIAP 2003 proceedings reflects the main topics of the Conference shape analysis and reconstruction 3D models early vision and image analysis pattern recognition and image inference visual processing for communication and various application domains The major topics discussed in the text are on use of image analysis and processing techniques and tools both in standard application environments and in the new scenario of internet based delivery of information **Algorithms for Synthetic Aperture Radar Imagery** ,2005

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