

# **Decision Briefing Generation on Meteorological Social Events**

**by Kaize Shi**

Thesis submitted in fulfilment of the requirements for  
the degree of

**Doctor of Philosophy**

under the supervision of Xueping Peng and Guodong Long

University of Technology Sydney  
Faculty of Engineering and Information Technology

August 2022



## CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Kaize Shi, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree at any other academic institution except as fully acknowledged within the text. This thesis is the result of a Collaborative Doctoral Research Degree program with Beijing Institute of Technology. This research is supported by the Australian Government Research Training Program.

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DATE: 9<sup>th</sup> August, 2022

PLACE: Sydney, Australia



## ABSTRACT

**M**eteorological disasters have the characteristics of suddenness, complexity, dynamics, and diversity, which have inflicted severe challenges on emergency decision support services in disaster environments. Nowadays, mobile internet technologies such as smartphones, social networks, wearable devices, and high-speed communication are widely used, making each user a ubiquitous social sensor integrating human and machine. Social sensors collect data from mobile devices worn or carried by humans, intuitively perceive the environmental conditions associated with a meteorological disaster through human senses, and have the advantages of comprehensive coverage, communication in real-time, and low cost.

Decision briefing is an effective support mode of emergency management services for sudden meteorological disasters, and it is also the primary way to deliver meteorological decision knowledge. This thesis focuses on the critical technologies for the automatic generation of meteorological event knowledge-enhanced decision briefing based on social sensor signals, providing meteorological decision support services focusing on accurate knowledge mining, efficient information integration, and formalized knowledge representation for decision-makers in the decision process of sudden meteorological disasters. The main research foci and innovations of this thesis are as follows:

1. Co-occurrence feature-based sudden meteorological event detection: Aiming at the low detection accuracy of meteorological events caused by limited coverage of physical sensor signal, poor timeliness, and lack of co-occurrence feature mining of meteorological events in previous research, **this thesis proposes a sentence-level feature-based meteorological event detection model**. The model is based on social sensor signals and introduces prior meteorological knowledge through the pre-trained language model in sentence vectorization. The wide-grained capsule network mines the attributes of the independent and co-occurrence features of meteorological events and then undertakes the real-time synchronous detection of multi-category co-occurrence meteorological events in a specific period. The proposed model achieves quantitative evaluation results of 0.941, 0.862, 0.738 and 0.795 on *Accuracy*,  $P_{micro}$ ,  $R_{micro}$  and  $F_{micro-1}$ , respectively, which is significantly better than other baseline models.

2. Multiple knowledge-enhanced meteorological decision briefing generation: Aiming at the low decision efficiency caused by information complexity, high chaos, and a large amount of data in the sudden meteorological disaster environment, **this thesis proposes a multiple knowledge-enhanced summarization model**. The model comprises a cascade structure of a summary generation module and a multiple knowledge

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enhancement module, which automatically generates meteorological decision briefing content by guiding the summary generation process with specific meteorological event and geographical location knowledge in the social sensor signal. The proposed model achieves 0.2025, 0.0807, and 0.1740 of the *ROUGE* – 1, *ROUGE* – 2, and *ROUGE* – *L* in the content evaluation and 0.656 of  $F_1$  score in the sentiment evaluation, significantly better than other baseline models.

3. Meteorological event knowledge-enhanced decision briefing optimization: Aiming at the weak decision support serviceability caused by the chaotic language style, colloquial text, and poor formatting of the social sensor signals-based meteorological briefing content, **this thesis proposes an event knowledge-enhanced briefing optimization module**. This module comprises a text form judgment model, a formalization words detection model, and an event knowledge guided text formalization model, which optimizes the transfer of the meteorological briefing content by calculating the text formalization judgment threshold, formalization word weight, and generates formalized words. The proposed model achieves quantitative evaluation results of 21.489 on the *BLEU*, which is significantly better than other baseline models.

In addition, this thesis reports on the construction of a prototype application of the meteorological decision briefing integrated with the above research foci, which showcases the use of social sensor signals to provide feedback on daily meteorological events, then provides decision support services based on meteorological decision briefing. This thesis presents interdisciplinary research on artificial intelligence, social computing, meteorological data mining, emergency management, and intelligent decision support services, which is a comprehensive analysis and extended application of interdisciplinary issues. This research has significant application value for improving the decision efficiency of meteorological departments and reducing the loss caused by sudden meteorological disasters.

## ACKNOWLEDGMENTS

I am about to graduate from the University of Technology Sydney in this jacaranda blooming season, drawing an end to my twenty-two years of student career. During these years, I have been with good teachers, supported by parents and accompanied by friends. Now I would like to take this opportunity to express my gratitude.

Thanks to my principal supervisor, Dr. Xueping Peng, who provided many pertinent academic suggestions that improved this thesis. Moreover, Dr. Peng also gave me a lot of help and care to adapt to life in Sydney. Thanks to my co-supervisor, Prof. Guodong Long, whose suggestions clarify the innovation and focus of this thesis. In addition, thanks to Prof. Chengqi Zhang and Dr. Jing Jiang from AAIL and Prof. Guandong Xu from DSMI for their help and support during my PhD. Thanks to Prof. Zhendong Niu from the Beijing Institute of Technology. Without his support, I would not have had the opportunity to research at UTS.

Thanks to my parents, their striving for excellence has always influenced me and kept me moving towards higher goals. Moreover, they are remarkably enlightened, never restricting my direction but supporting any decision I make, which has given me more opportunities to understand the world and make me more aware of my purpose in life. I am also grateful to my maternal uncle and aunt. They always took over the "baton" from my parents when they were busy so that I could focus on my study at any time. I couldn't get this PhD degree without the support of my parents and family.

Thanks to my friends, Zhuowei Wang, Jie Ma, Xiangmeng Wang, Shannan Guan, Wei Huang and Yakun Chen. It is unforgettable to explore the fun activities with you.

Thanks to the University of Technology Sydney. UTS provides a global platform, allowing me to exchange and study with top researchers from various cultural backgrounds worldwide, broadening my research and stimulating new research ideas.

The end of one story is the beginning of another. Each man is the architect of his fate. Think. Change. Do.





## LIST OF PUBLICATIONS

### RELATED TO THE THESIS :

1. **Kaize Shi**, Xueping Peng, Hao Lu, Yifan Zhu, Zhendong Niu: Application of Social Sensors in Natural Disasters Emergency Management: A Review. *IEEE Transactions on Computational Social Systems*. 2022, doi: 10.1109/TCSS.2022.3211552.
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3. **Kaize Shi**, Yusen Wang, Hao Lu, Yifan Zhu, Zhendong Niu: EKGTF: A knowledge-enhanced model for optimizing social network-based meteorological briefings. *Information Processing & Management*. 58(4): 102564 (2021)
4. **Kaize Shi**, Hao Lu, Yifan Zhu, Zhendong Niu: Automatic generation of meteorological briefing by event knowledge guided summarization model. *Knowledge-Based Systems*. 192: 105379 (2020)
5. **Kaize Shi**, Xueping Peng, Hao Lu, Yifan Zhu, Zhendong Niu: Automatic Generation of Meteorological Briefing by Multi Knowledge Enhanced Summarization Model. (Under review)
6. **Kaize Shi**, Xueping Peng, Hui He, Kun Yi, Zhendong Niu: Multi-KGS: A Multiple Knowledge Guided Summarization Model for Generating Social Network-based Meteorological Decision Report. (Under review)

### OTHERS :

8. Yifan Zhu, Qika Lin, Hao Lu, **Kaize Shi**, Donglei Liu, James Chambua, Shanshan Wan, Zhendong Niu. Recommending Learning Objects through Attentive Heterogeneous Graph Convolution and Operation-Aware Neural Network. *IEEE Transactions on Knowledge and Data Engineering*. (2021)

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  16. Yifan Zhu, James Chambua, Hao Lu, **Kaize Shi**, Zhendong Niu: An opinion based cross-regional meteorological event detection model. *Weather* 74 (2), 51-55 (2018)

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