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Automatic generation and analysis of role relation network from emergency plans

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Abstract. In order to improve the efficiency of emergency response and optimize the utilization of emergency resources, domain experts actively create role network of emergency response. Creating emergency role network manually is a time-consuming and labor-intensive task. An approach to extracting role networks from emergency plans is proposed, and then the extracted role relation network is made a quantitative analysis in this paper. First, role relation network is generated from emergency plan, which includes the emergency department and personnel are identified through a Bi-LSTM-CRF network, coreference resolution is implemented based on RoBERTa-E2E-Coref model, role relation is extracted based on the RoBERTa-CasRel model, and role relation network of emergency response is generated based on identified roles and their relationship. Second, role relation network from emergency plan with different levels were analyzed quantitatively by using the complex network analysis methods. Finally, experiment evaluation and a case study are given based on the real data sets, and the results show that the proposed approach can be used to assist emergency decision-makers to create role relation networks of emergency response. In addition, through the analysis of the extracted role relationship network, the quality of the emergency plan can be indirectly reflected.

Keywords. emergency response; role relation network; coreference resolution; relationship extraction

1 Introduction

In recent years, a series of emergencies have occurred, threatening people's lives and property security and social stability, such as COVID-19 and typhoon In-Fa. Emergency response participants do their best to reduce disaster loss when emergencies occur. A large number of emergency plans developed by government offices at all levels are used to instruct emergency participants to perform response tasks^[1]. Specifically, the part of emergency response command system describes response departments and their response tasks, while the part of emergency response describes departmental interaction process^[2]. These two parts together contain organization structure information which is the action basis of multi-department coordinated emergency response^[3]. The diversity of emergency tasks and the dispersion of resources require multiple departments to cooperate and interact to deal with them. Domain experts actively create organizational network of emergency response to describe which emergency departments are involved and how they interact and collaborate^[4].

The role relation network of emergency response is a relatively stable collaborative structure, which can meet the changing environment through collective decision-making and joint action^[5]. Generally, social

network methods are utilized to analyze connection characteristics and interaction patterns of emergency response organizational networks [6]. The connection characteristics can be reflected by network density, the number of organizations and the number of connections in the network [7]. Interaction patterns include cooperation relationship between superior and subordinate, cooperative relationship between same level, composition relationship and messaging relationship. Currently, emergency response role relation networks are manually constructed by domain experts with rich experience [8]. It is a time-consuming and labor-intensive task. Interorganizational networks arose in the process of multi-role coordination and cooperation [9]. An approach is proposed to automatically extract role relation network from emergency plans in this paper. Emergency response department and personnel elements are identified through a deep neural network. The identified departments and personals are used to perform coreference resolution operations. The role relationship is extracted through deep learning relational feature words. An emergency response role relation network is generated based on the extracted role and role relationships. The generated role relation network is quantitatively analyzed, which is used to reflect role characteristics of emergency plans.

The rest of this paper is arranged as follows: the related work is introduced in Section 2; relevant definitions are introduced in Section 3; the generation and analysis of role relation network for emergency plan is detailed in Section 4; the relevant experimental analysis is presented in Section 5 and a detailed case study is introduced; and the summary is in the section 6.

2 Related work

2.1 Generation of role relation network for emergency plan

Department and personnel identification are regarded as named entity recognition task, it aims to extract and assign the entities of departments and personnels into predefined categories [10]. [11] proposed attention-based CNN-LSTM-CRF to recognize entities in Chinese clinical text. Coreference resolution identifies entity mentions and it refers to the same real-world entity in a document [12]. [13] proposed an end-to-end coreference resolution model and generated useful mention candidates from the space of all possible spans. [14] applied BERT to distinguish between related but distinct entities. Entity relationship extraction, as an important subtask of information extraction, aims to discover the relation between head entity and tail entity from large-scale unstructured text [15]. [16] proposed a novel cascade binary tagging framework (CASREL) and the model relations as functions that map subjects to objects in a sentence.

2.2 Analysis of role relation network for emergency plan

Complex network analysis is introduced to analyze the relationship between roles and network distribution through centrality and network density. [17] was concluded that complexity can be found in the global structural of relation between syndrome differentiation and acupoint selection. [18] proposed the results of the complex network analysis showed that anxiety and sleep disorder were closely related to THI score, and anxiety was more important than sleep disorder. [19] used two complex network analysis methods, network meta-analysis and network pharmacology, to explore the curative effect observation of Traditional Chinese medicine injection in the treatment of acute cerebral infarction. [20] proposed the method of constructing the corresponding complex network dynamics model and it is proved that this kind of complex network dynamics model is uniformly asymptotically stable in a large range.

3 Preliminaries

In order to facilitate understanding, some definitions are given.

Definition 1 An emergency response organization system is 3-tuple $EROS = \langle D, R, \delta \rangle$, where $D = \{d_0, d_1, \dots, d_m\}$ is the set of emergency departments, d_0 is the command center, d_1, d_2, \dots, d_m are member units, $R = \{r_0, r_1, r_2, \dots, r_n\}$ is the set of emergency roles, δ denotes subordinate superior relationship between emergency department and role, specifically $\delta(r) = d$ denotes the role r is subordinate to the department d .

Definition 2 Departmental relationship is defined as a 3-tuple $RD = \langle d_i, relationship, d_j \rangle$, where d_i and d_j are emergency departments, and *relationship* represents the relationship between d_i and d_j .

Four types of departmental relationship including *SL_cooperation*, *SS_cooperation*, *Composition* and *Message_passing*, are defined as follows:

- *SL_cooperation* describes a cooperative relationship between departments at the same level. $\forall d_i, d_j \in \{d_1, d_2, \dots, d_m\}$, d_i and d_j cooperate to complete the same emergency task, which is denoted as $\langle d_i, SL_cooperation, d_j \rangle$.
- *SS_cooperation* describes a cooperative relationship between superior and subordinate departments. $\forall d_i, d_j \in \{d_0, d_1, \dots, d_m\}$, assuming that d_i is the superior department and d_j is the subordinate department, if d_i and d_j cooperate to complete the same emergency task, there is a *SS_cooperation* relationship between d_i and d_j , which is denoted as $\langle d_i, SS_cooperation, d_j \rangle$.
- *Composition* describes a composition relationship between two different departments. $\forall d_i, d_j \in \{d_0, d_1, d_2, \dots, d_m\}$, if d_j is one of d_i 's member departments, there is a *Composition* relationship between d_i and d_j , which is denoted as $\langle d_i, Composition, d_j \rangle$.
- *Message_passing* describes a message passing relationship where d_i is a message sender and d_j is a message receiver, which is denoted as $\langle d_i, Message_passing, d_j \rangle$.

Both *SL_cooperation* and *SS_cooperation* indicated that there was a cooperative relationship between the two emergency departments, but the two departments in the former have the same level in the emergency plan, while the latter has obvious obedience relationship in the emergency plan, such as command relationship. The *Composition* relationship indicates that there is a composition relationship between the two departments. The two departments that have *Message_passing*, *SL_cooperation* or *SS_cooperation* may have *Composition* with the same department.

Definition 3 An interorganizational network of emergency response is defined as a 3-tuple $G = \{D, V, \varphi(D, V)\}$, where D is the set emergency departments, V is the set of the set of departmental relationships, and $\varphi(D, V)$ is a weight function specifying the frequency of interaction between different departments and $\varphi(D, V) \in \{1, 2, 3, 4\}$.

4 Generation and analysis

The emergency plan role relation network is a structure that can intuitively reflect the relationship between the departments, which can reflect cooperation and common decisions between the departments, such as Fig.1.

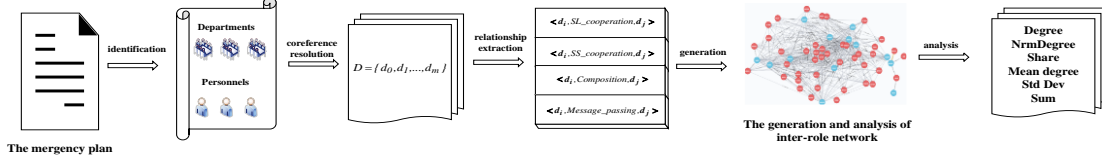


Fig.1. The research framework

4.1 Generation of role relation network

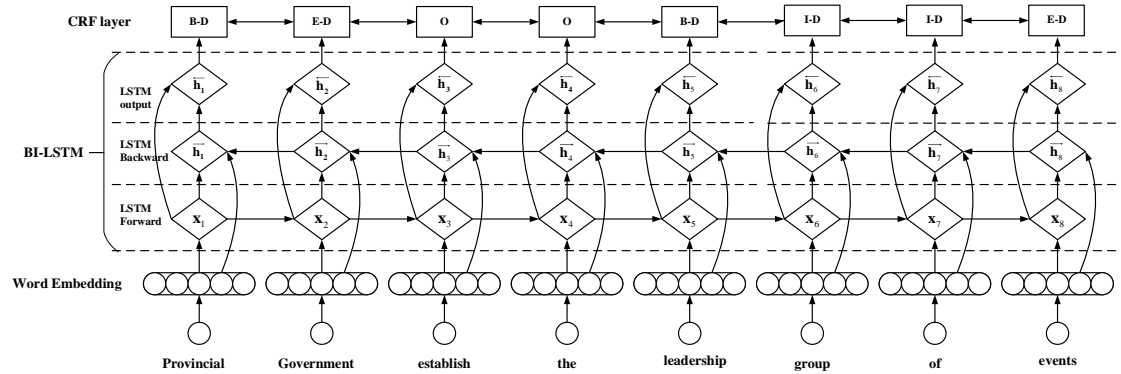


Fig.2. Bi-LSTM-CRF Model Structure

The same emergency role entity can appear multiple times in different sentences in an emergency response plan and the context information is different. RNN is a classical neural network model for processing sequence data. RNN cannot solve the problem of long distance dependence well. LSTM makes up for the defect of RNN and overcomes the problem of long distance dependence. The information of each word in a sentence is closely related to the information of its context, while the output of each step in LSTM is only determined by the current input and the previous input, without considering the future input. Bi-LSTM can effectively solve this defect. CRF module can take into account the relationship between tags and output text corresponding prediction tag. The Bi-LSTM-CRF model as showed in Fig.2 designed in this part can either excavate the internal configuration of the text and can obtain the dependence between long distance words. The characteristic vector enters to the BI-LSTM layer for training, using Bi-LSTM to model the context information. The number of invalid prediction labels is lowered after training through the CRF layer. For data labels, B means Begin indicating the start; I means intermediate indicating the middle; E means End indicating the end; O means other indicating other and used to mark independent characters.

In order to avoid repetition, habits, pronouns, title, and abbreviations to refer to the full name of the previous mentioned. Similarly, the same department will have different naming methods in the same text. In order to better reflect the relationship between different departments, this paper uses the coreference resolution method. In emergency plans, longer organizations are often given their full name when they first appear and only their abbreviation when they appear later. The RoBERTa-E2E-Coref does not rely on grammar analysis, and the core of the model is the vector representation of each span. Coreference resolution of roles is realized by considering all spans in the emergency plan and learning the possible referents of each span. The RoBERTa-E2E-Coref

overall architecture is shown in Fig.3.

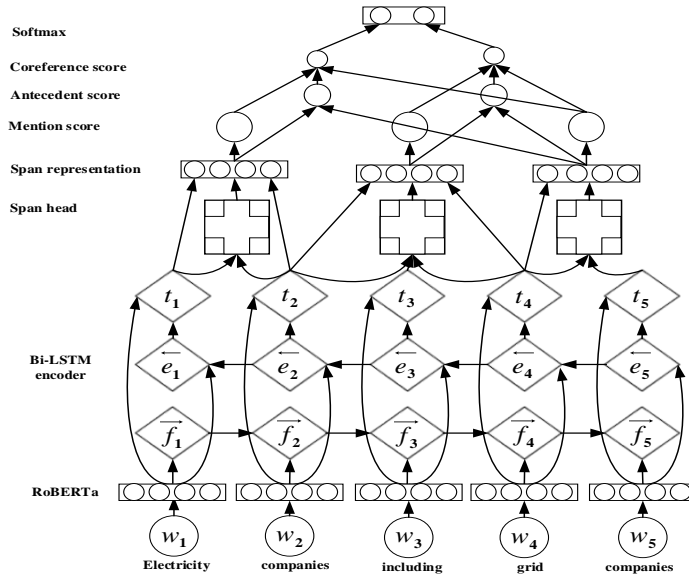


Fig.3. RoBRETa-E2E-Coref model

Such as Fig.3, first, the Chinese pre-training model RoBERTa is used to obtain word embedding. Calculating potential entities refer to score, score-lower spans are discarded, and score-higher spans are reserved. Second, antecedent scores are calculated by a pair of spans. The coreference score of a pair of spans is computed by summing the mention scores of both spans and their pairwise antecedent score. For span representations, we use Bi-LSTM to encode internal and external information of each span, and add an attention mechanism to each span to model head words.

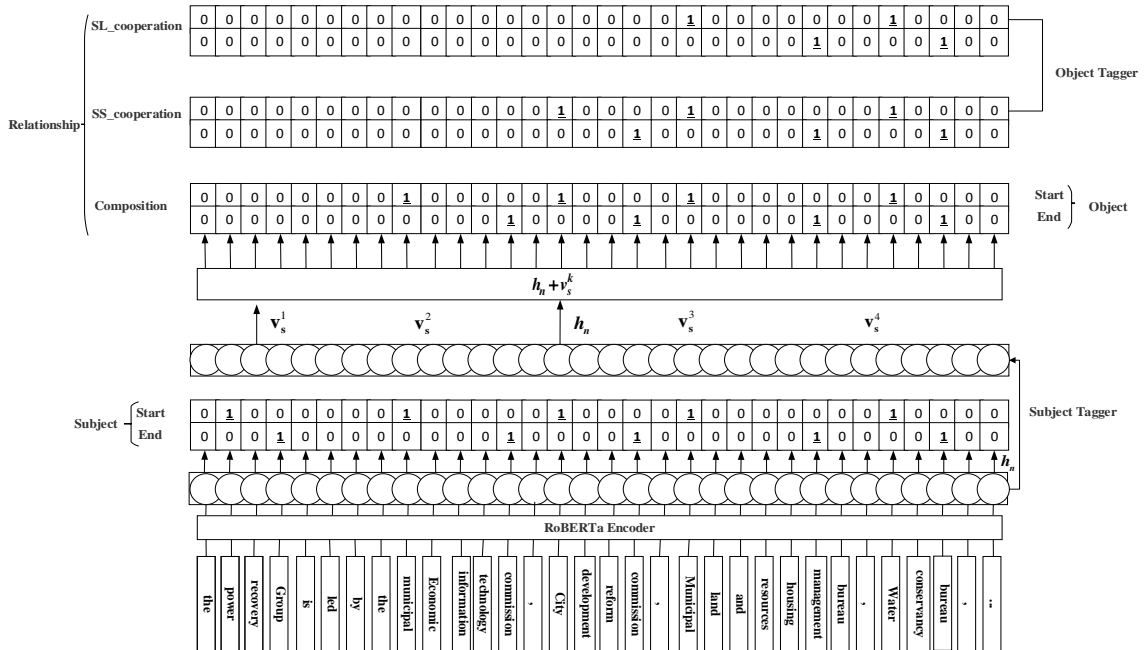


Fig.4. RoBRETa-CasRel model structure

There may be a variety of relationships in the emergency response text, and there may be overlapping phenomena in the 3-tuple. For example, in the sentence “The power recovery group is led by the municipal economic information power committee, consists of the municipal development and reform commission, the municipal land and resources housing management bureau, the municipal water

conservancy bureau. ” , “the Municipal Development and Reform Commission”, “the Municipal Land and Resources Housing Management Bureau” and “ the Municipal Water Conservancy Bureau ”exist the *SL_cooperation* relationship. These three departments exist *SS_cooperation* relationship with “the Municipal Economic Information Power Committee”, at the same time, the above four departments also compose “the power recovery group”, the above four departments and "the power recovery group" exist the *Composition* relationship. The extraction of the 3-tuple in a new perspective is defined in Fig.4. Rather than treating relationships as discrete labels as before, the framework model relationships as functions that map topics to objects in sentences, thus naturally dealing with overlap. Using RoBERTa-Casrel to solve the problem of 3-tuple overlap in the emergency plan text, and finally realize the extraction of the department relationship in the emergency plan text. This model extracts the relationship ternary group from the two levels steps. First, all the subjects in the input text which is a completed department entity should be detected. Then for each Subject, we check all our predefined relationships to find if there is a relationship that can pair the Subject and Object. So, the cascade decode consists of a subject tagger and a relation-object tagger. The model has two identical binary classifiers, the role of the binary classifier here is to detect and mark the start position and end position of the Subject. “The power recovery group is led by the Municipal Economic Information Power Committee, consists of the Municipal Development and Reform Commission, the Municipal Land and Resources Housing Management Bureau, the Municipal Water Conservancy Bureau” in the Fig.4, first of all , “the power recovery group”, “the Municipal Economic Information Power Committee”, “the Municipal Development and Reform Commission”, “the Municipal Land and Resources Housing Management Bureau”, “the Municipal Water Conservancy Bureau” are detected subjects, when $k = 3$, “the Municipal Development and Reform Commission” and “ the Municipal Land and Resources Housing Management Bureau” exist the *Cooperation* relationship, the result is shown as \langle *the Municipal Development and Reform Commission, Cooperation, the Municipal Land and Resources Housing Management Bureau* \rangle .

4.2 Analysis of role relation network.

Neo4j are used for the role relation network and Ucinet6 are used for data analysis. In the construction of the departmental relationship network, the relationship between the form of social network diagrams is adopted, using departmental correlations, departmental density to measure the association of the network between emergency plans, and display two departments in action relationship and through the centrality degree to judge the role of departments in the emergency plan. Degree, Nrmdegree, Share, Mean degree, Std Dev and Sum are used to analyze and evaluate role relation network. Degree refers to the number of other points directly connected with a certain point in a network graph. A large number indicates that the point is closely connected with others and reflects the central position of the point in the network. Absolute point centrality reflects the power status and influence distribution of nodes in the network. The higher the centrality is, the more the nodes are in the core position and can effectively control and influence the activities of other actors in the network. On the contrary, nodes with lower centrality are more marginal, rarely participate in interaction and have little influence on other nodes. The Degree, Nrmdegree, Sum, Mean and Share are defined as follows:

$$C_{Deg\ rec}(N_i) = \sum_j^n x_{ij}(i \neq j)$$

$$C_{Nrm\ deg\ rec}(N_i) = C_{deg\ rec}(N_i) / C_{deg\ rec}(N_j)_{max}$$

$$Sum = \sum_{m=1}^n C_{Deg\ rec}(N_m)$$

$$Mean = Sum / n$$

$$Share(N_i) = C_{Degree}(N_i) / Sum$$

where $C_{Degree}(N_i)$ indicates the degree of node i , $\sum_j x_{ij}$ is the sum of the relations between i and other nodes, $C_{Normdegree}(N_i)$ indicates the standard form of $C_{Degree}(N_i)$, Sum indicates the sum of role relations, Mean indicates the average number of relations for a role, Share indicates the proportion of N_i in the role relation network.

The analysis of the role relation network of emergency plan from two aspects. The first aspect is to analyze the network between the different provinces in the same type of emergency. The second aspect is to analyze the network from national, provincial and municipal perspectives.

5 Experimental analysis

5.1 Data set

This paper crawls out the emergency plan text as data from the public network of the government, municipal government, provincial government and national government. Among them, there are 1 national emergency plan, 11 provincial emergency plan and each level includes emergency plans for natural disasters and large-scale power failure.

5.2 Experimental results presentation.

The recognition results of departments are shown in Table 1.

Table 1. Department and personnel recognition results of BIEO

Tags	CRF			Bi-LSTM			Bi-LSTM-CRF		
	P	R	F1	P	R	F1	P	R	F1
B-D	0.85	0.80	0.82	0.87	0.82	0.85	0.92	0.86	0.90
I-D	0.87	0.83	0.85	0.89	0.83	0.86	0.96	0.90	0.91
E-D	0.85	0.80	0.82	0.85	0.80	0.82	0.92	0.88	0.90
B-P	0.70	0.69	0.69	0.69	0.69	0.69	0.76	0.71	0.74
I-P	0.68	0.80	0.74	0.70	0.83	0.75	0.72	0.84	0.76
E-P	0.74	0.58	0.65	0.75	0.55	0.67	0.82	0.60	0.70
O	0.95	0.95	0.95	0.94	0.94	0.94	0.99	0.99	0.99

The precision, recall and F1 of data set constructed in this paper are shown in the Table 3 by CRF, Bi-LSTM and Bi-LSTM-CRF. The Bi-LSTM-CRF is higher than the CRF and Bi-LSTM in the precision, the recall, and F1 value. The method of CRF relies on the selection of the characteristics and identifies the complex department name, the method of BI-LSTM automatically learns contextual information in sentences, Bi-LSTM-CRF method automatically learned information in the sentence, combined with the contextual relationship of the current word and does not depend on the selection of features, improves the identification effect.

The experimental results of the coreference resolution are in Table 2.

Table 2. Results of the coreference resolution

Methods	P	R	F1
Mention-pair	0.85	0.80	0.82
RoBRETa-E2E-Coref	0.93	0.92	0.92

The RoBRETa-E2E-Coref model can be achieved by grouping all spans in a set of antecedent predicted results. Evaluate the vector representation of each span and score each potential Mention that is a different representation of the same entity in the text accordingly. For each span, combine each of its words such as matrix concatenation to get a vector representation of the span. Then, the vector representation of span is nonlinearly mapped to obtain the score of each potential mention, and a certain number of mentions is obtained by pruning the mention with the score size. The antecedent score is calculated for each pair of vector representations of spans. By summing up the two span mention scores and their paired antecedent scores, the final common reference scores of a pair of spans are obtained.

The results of role relationship extraction are in Table 3.

Table 3. Results of the relation extraction

Methods	P	R	F1
Bi-LSTM-CRF	0.72	0.84	0.76
RoBRETa-CasRel	0.80	0.80	0.80

The RoBRETa-CasRel solves the overlapping 3-tuple problem where multiple relational triples of the department relationship of the emergency plans in the same sentence share the same departments.

The role relation network of natural disaster emergency plan and large-scale power failure emergency plan in Shandong and Hubei provinces are showed in Fig.5 and the centrality degree of some departments in natural disaster emergency plan of Shandong Province are shown in Table 4.

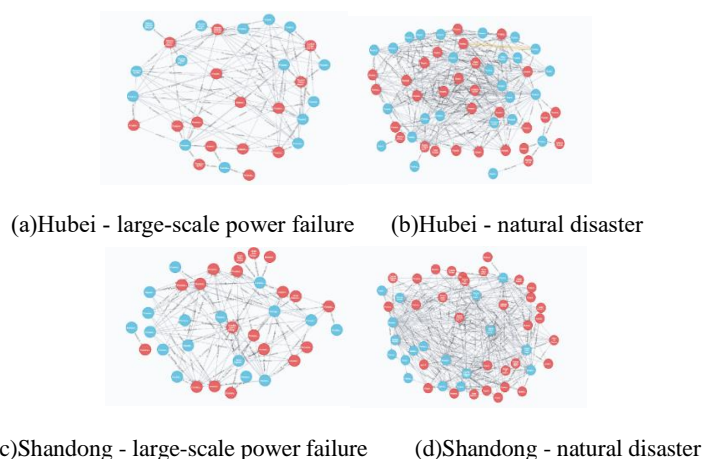


Fig.5. Role relation relationship network

Table 4. Some roles in natural disaster emergency plan of Shandong Province

Emergency roles	Degree	NrmDegree	Share
Provincial disaster reduction committee	35.000	51.471	0.031
Provincial government	34.000	50.000	0.030
Health department	33.000	48.529	0.029
Provincial Development and Reform Commission	33.000	48.529	0.029
Provincial Disaster Reduction Commission Office	1.000	1.471	0.001

The interaction density in the network reflects the correlation between the department. The greater the network density between the two departments, the greater the interaction between the two departments. Different duties, different management privileges and capacity can show key departments in emergency

plans. The more a department interacts with other departments, the more important the department is. In Fig.5, it can directly represent the relationship and close connection between all participating roles in the natural disaster emergency plan and large-scale power failure emergency plan, role relation network density is used to measure the degree of interaction between roles and display the relationship between roles in emergency plans, the greater the network density around a role, the greater the role's responsibility in the contingency plan. Such as in Table 4, the max degree role in natural disaster emergency plan of Shandong Province is provincial disaster reduction committee so it can be seen that provincial disaster reduction committee plays a central role in the natural disaster emergency plan. When natural disasters occur, a lot of work inevitably revolves around provincial disaster reduction committee.

The indicators of role relation network are shown in Table 5.

Table 5. Indicators of role relation network from provincial emergency plans

Province	Natural disaster		Large-scale power failure	
	Mean degree	Sum	Mean degree	Sum
Shandong	32.1	1126	11.5	230
Hubei	33.9	1660	14.5	246
Anhui	30.0	986	12.8	200
Fujian	28.5	760	17.6	180
Henan	20.7	676	17.3	176
Heilongjiang	18.9	468	12.5	140
Jiangsu	32.9	1084	15.2	330
Shanxi	20.8	702	9.6	168
Sichuan	38.5	2238	26.8	368
Yunnan	38.4	2408	17.9	366
Hainan	17.8	322	7.5	108

Table 6. Indicators of role relation network from different levels of emergency plans.

Administrative level	Natural disaster		Large-scale power failure	
	Mean degree	Sum	Mean degree	Sum
Nation	40.5	1808	28.7	386
Province	32.1	1126	11.5	230
Municipality	25.6	978	9.7	186
District	18.5	624	4.8	82

In Table 5, in the first aspect, the number of roles' relation in emergency plans for large-scale power failure is much smaller than the number of roles' relation in emergency plans for natural disasters, is to analyze the network between the different provinces. The second aspect is to analyze the network from different

levels of emergency plans. The sum and the mean degree of roles involved in emergency plans in Sichuan province and Yunnan Province are higher than those in other provinces, it shows that Sichuan province and Yunnan Province participate in a large number of role relations in the emergency plan and the relationship between the roles is very close. In the second aspect, such as in Table 6, for the same type of contingency plan, the total number of relations and Mean degree among participating roles in emergency plans for Nation, Province, municipality and District gradually decreased, it shows that the higher the hierarchy, the more roles involved and the closer the connections between the roles.

5.3 A case study

1. 省自然灾害救助应急指挥部组成如下：指挥长：省政府分管副省长；副指挥长：省民政厅厅长；成员：省委宣传部、省台办。

2. 灾害发生后，省减灾委办公室认定灾情达到启动标准，向省减灾委提出启动响应的建议。

3. 省减灾委主任主持召开会商会议协调落实省委、省政府关于救灾工作的指示。

4. 省减灾委办公室及时掌握灾情和救灾工作动态信息，每日向省委、省政府和国家减灾委办公室、民政部报告一次灾情和救灾工作动态信息。

5. 省政府、省民政厅、省财政厅向国务院、民政部、财政部上报请拨救灾应急资金和救灾物资的请示。

6. 省外侨办、省台办协助做好救灾的涉外和涉港澳台工作。

Fig.6 .An example of emergency plan

Taking part of the text of the emergency plan for sudden natural disasters as an example, Fig.6 shows an example of emergency plan, including 6 sentences, involving 14 departments ,4 relationships types and 53 relationships including 5 Composition,16 SS_cooperation,3 SL_cooperation,14 Message_passing. The extraction results of the 14 roles identification are shown in Table 7, the result of role relation extraction is shown in Table 8, the role relation network of emergency plan as shown in Fig.7 and the indicators of inter-role relationship network as shown in Table 9.

Table 7. The identified roles

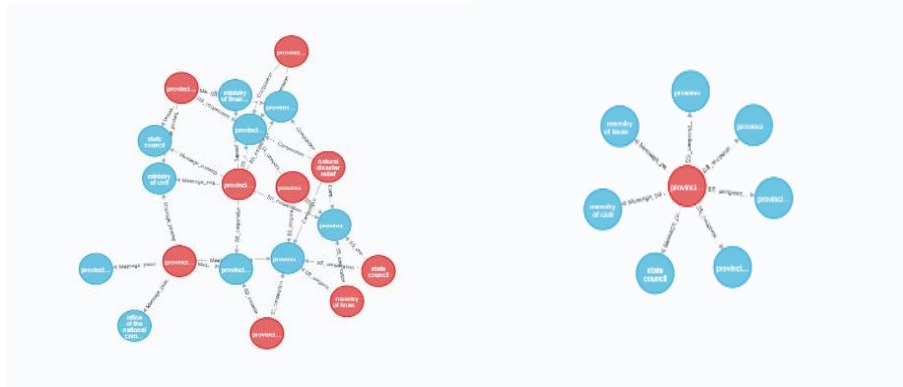
Roles	Meaning of symbol
d_1	“省自然灾害救助应急指挥部”
d_2	“省政府”
d_3	“省民政厅”
d_4	“省委宣传部”
d_5	“省台办”
d_6	“省减灾委办公室”
d_7	“省减灾委”
d_8	“省委”
d_9	“国家减灾委办公室”
d_{10}	“民政部”
d_{11}	“省财政厅”
d_{12}	“国务院”
d_{13}	“财政部”
d_{14}	“省外侨办”

Table 8. The extracted role relationship results

relationship	role relationship
Composition	$\langle d_1, \text{Composition}, d_2 \rangle, \langle d_1, \text{Composition}, d_3 \rangle, \langle d_1, \text{Composition}, d_4 \rangle, \langle d_1, \text{Composition}, d_5 \rangle, \langle d_4, \text{Composition}, d_5 \rangle$
SS_cooperation	$\langle d_8, \text{SS_cooperation}, d_7 \rangle, \langle d_2, \text{SS_cooperation}, d_7 \rangle, \langle d_2, \text{SS_cooperation}, d_3 \rangle, \langle d_2, \text{SS_cooperation}, d_4 \rangle, \langle d_2, \text{SS_cooperation}, d_5 \rangle, \langle d_3, \text{SS_cooperation}, d_4 \rangle, \langle d_3, \text{SS_cooperation}, d_5 \rangle, \langle d_2, \text{SS_cooperation}, d_{12} \rangle, \langle d_2, \text{SS_cooperation}, d_{10} \rangle, \langle d_2, \text{SS_cooperation}, d_{13} \rangle, \langle d_3, \text{SS_cooperation}, d_{12} \rangle, \langle d_3, \text{SS_cooperation}, d_{10} \rangle, \langle d_3, \text{SS_cooperation}, d_{13} \rangle, \langle d_{11}, \text{SS_cooperation}, d_{12} \rangle, \langle d_{11}, \text{SS_cooperation}, d_{10} \rangle, \langle d_{11}, \text{SS_cooperation}, d_{13} \rangle$
SL_cooperation	$\langle d_4, \text{SL_cooperation}, d_5 \rangle, \langle d_8, \text{SL_cooperation}, d_2 \rangle, \langle d_{14}, \text{SL_cooperation}, d_5 \rangle$
Message_passing	$\langle d_6, \text{Message_passing}, d_7 \rangle, \langle d_6, \text{Message_passing}, d_8 \rangle, \langle d_6, \text{Message_passing}, d_2 \rangle, \langle d_6, \text{Message_passing}, d_9 \rangle, \langle d_6, \text{Message_passing}, d_{10} \rangle, \langle d_2, \text{Message_passing}, d_{12} \rangle, \langle d_2, \text{Message_passing}, d_{10} \rangle, \langle d_2, \text{Message_passing}, d_{13} \rangle, \langle d_3, \text{Message_passing}, d_{12} \rangle, \langle d_3, \text{Message_passing}, d_{10} \rangle, \langle d_3, \text{Message_passing}, d_{13} \rangle, \langle d_{11}, \text{Message_passing}, d_{12} \rangle, \langle d_{11}, \text{Message_passing}, d_{10} \rangle, \langle d_{11}, \text{Message_passing}, d_{13} \rangle$

Table 9. Indicators of the generated role relation network

Roles	Degree	NrmDegree	Share
natural disaster relief and emergency response headquarters	13.000	100.000	0.186
provincial government	9.000	69.231	0.129
provincial civil affairs department	7.000	53.846	0.100
provincial commission of disaster reduction office	6.000	46.154	0.086
provincial Taiwan office	5.000	38.462	0.071
provincial propaganda department	4.000	30.769	0.057
provincial commission of disaster reduction	4.000	30.769	0.057
state council	4.000	30.769	0.057
ministry of civil affairs	4.000	30.769	0.057
ministry of finance	4.000	30.769	0.057
provincial party committee	3.000	23.077	0.043
provincial civil affairs department	3.000	23.077	0.043
office of the national commission of disaster reduction	2.000	15.385	0.029
provincial overseas Chinese affairs office	2.000	15.385	0.029



(a) Role relation network

(b) Sub-network about provincial government

Fig.7. Inter-role network generated from Fig.6

In Table 9, the role of max degree in the case is natural disaster relief and emergency response headquarters so it can be seen that natural disaster relief and emergency response headquarters plays a central role in the case emergency plan. The whole inter-role network of the case as shown in Fig.7. (a), it intuitively reflects the relation between the roles and the degree of intimacy. Fig.7. (b) is a local network diagrams of provincial government respectively. It can also be seen from Fig.7 that provincial government have the higher network density and are more closely connected with other roles

6 summary

Based on the text of emergency plan, this paper obtained the interorganizational network of emergency plan through four steps: collection and annotation, department and role extraction, coreference resolution, and relationship extraction and through complex network analysis the role relation network in two aspects. Compared with the text, the interorganizational network built in this paper makes more specific and more intuitive reflection in the emergency plan, and provides great help to quickly understand the contents of the relevant plan. The proposed approach can quantify and visualize the organizational network structure and relationship patterns in emergency plans. At the same time, it also provides an effective reference for the preparation, revision, and specific implementation of the emergency plan, it provides a more comprehensive and effective method for analyzing the text of emergency plan and the role relation network, and it is very important in practical significance.

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