An Ontological Chinese Legal Consultation System

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ABSTRACT We propose an ontological Chinese legal consultation system (CLCS) based on Chinese legal characteristics by integrating statutes and judicial precedents to facilitate the retrieval of relevant statutes and judgments for the general public. Ontology, an emerging research topic in recent years, incorporates a hierarchical structure and supports logical reasoning, which can reduce semantic ambiguities and extract implied semantic information. We constructed statutes ontology and a case ontology using a bottom-up method and a top-down method, respectively. Then, to test the retrieval precision of the proposed CLCS, we performed experiments using emotional damage compensation as an example by combining genetic algorithm and k-nearest neighbor approaches. Experimental results demonstrate that the proposed method improves retrieval precision.

INDEX TERMS Case similarity, google distance, legal ontology, legal retrieval, semantic recognition.

I. INTRODUCTION

Computer and network technology have profoundly changed the methods that are used to acquire law-related information. In addition to with more electronic court record system of court proceedings, novel information and communication technologies are constantly being introduced in the field of legal information retrieval. The legal system in China has undergone profound changes in the past decade, and the most significant change has been the publication of cases and the use of information technology. The Chinese case guidance system,[1] which was officially launched in 2010, provided similar guiding cases for judges to use as references. In 2015, the Supreme People's Court further stipulated that the guiding cases could be quoted in court. According to a third party evaluation report on the informatization of Chinese courts, courts at all levels have digitized case information.[2]

As of July 30, 2016, China Judgments Online, the official Chinese court document database, includes 19,706,614 judicial documents, and the system is updated daily.[3] A survey of the use of guided cases compiled by the Supreme Court indicates that, as of November 30, 2015, 241 cases had quoted guided cases, primarily civil cases.[4] An efficient and effective retrieval mechanism is required to help judges and other parties involved in litigation access relevant regulations and judicial cases.[5]

Common search platforms such as Google and Baidu have expended considerable effort to improve automatic search capabilities for legal information. The massive amount of information is often overwhelming, and few resources are available to help people search effectively. Keyword-based searches have some limitations. They often return results with poor semantic identification and output isolated information in a non-uniform format that requires significant manual screening. To overcome these drawbacks, legal ontologies

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[1]The case guidance system is a unique Chinese system that differs from the case law system used in the United States. In China, prior to the establishment of the case guidance system, previous judicial cases could not be used as references for later court cases. The guidance system allows certain cases selected by the Supreme People's Court of China to be quoted and referenced in court.

[2]CASS Law Institute, National Centre for the Study of the Rule of Law Index and the Index Innovation Project of the Rule of Law. Third Party Evaluation Report on the Informatization of Chinese Courts, China Social Sciences Press, 2016, pp 10-77.

[3]China Judgments Online is an open platform of Chinese court documents, http://wenshu.court.gov.cn (last visit: 30-7-2016).

[4]Report on the use of guided cases in 2015 by China Supreme Court, http://www.chinalawinfo.com/News/NewsFullText.aspx?NewsId=79047, last visit Mar. 29, 2017.

[5]Here, ''judicial cases'' refers to cases wherein a judge has determined a sentence through certain judicial processes.

based on legal intelligence and artificial intelligence (AI) have attracted increasing attention. Ontologies are used to facilitate knowledge sharing and reuse [1]. Typically, ontologies have a hierarchical structure and support logical reasoning, which can eliminate semantic ambiguity and extract implied semantic information. Legal ontologies are required to bring legal knowledge into the semantic web and to make it searchable and usable.

Ontology research primarily focuses on acquiring knowledge, expression, and reasoning, and it emphasizes domain concepts, the nature of concepts, parent–child term relationships, and the general pattern of concepts. In addition, it benefits from knowledge mining. Ontology research also involves machine readable knowledge inputs and expresses knowledge in a particular format. Therefore, ontology provides the possibility of knowledge-sharing, interoperability, and reuse of the same or different knowledge systems. Ontological knowledge is categorized according to the principle of logical reasoning and has intelligent reasoning and identification capabilities for new inputs. Therefore, ontology-based information retrieval can help a user clearly understand the semantic relationship between requested and existing normative information, partially solve the problems in a semantic expression, and greatly improve recall and precision by determining what is relevant and irrelevant to rapidly obtain the requested information [2].

Pioneering studies on legal ontologies indicate that such ontologies improve the management of legal information. Chinese statutes[6] are a family of rules based on constitutions, laws, regulations, directives, judicial interpretations, and standards. China primarily depends on written statutes, and most studies on Chinese legal retrieval systems focus on establishing legal ontologies for statute retrieval. While, people come to realize that legal concepts may not be as accurate as we expected and three-stage deductive reasoning[7] has some deficients; thus, a case guidance system with a robust legal consultation system that combines statutes and case-based legal reasoning is required. However, building a practical Chinese legal ontology is challenging. First, the natural language is complex and varied, and creating a system to address the essence of terms, clarifying their relations, and applying reasoning techniques are difficult, particularly for Chinese words with significant synonymy and ambiguity. Thus, it is difficult to create a Chinese legal ontology that can help people who are unfamiliar with the law and are confused about law-related issues understand the true meaning and implications of the natural language. Second, an ontology-based retrieval system primarily extracts case features from judgment reports. However, Chinese judgment report features vary significantly and are difficult to measure, which

will also lead to the extraction of inaccurate case features. Third, case-based reasoning (CBR) similarity is related to the designed case feature weight; however, the weight is difficult to be represented as a linear relation. A genetic algorithm (GA) searches for an optimal solution by simulating natural evolution [3]. Unlike neural networks (NN), which tend to converge to a local optimal, a GA can search for the global optimal point based on stochastic rules. In addition, GAs can be easily integrated with other technologies to solve complex problems. In this paper, to improve the retrieval of similar cases, we employ a GA integrated with a k-nearest neighbor (KNN) algorithm.

To facilitate the retrieval of relevant judgments for the general public, this paper proposes a practical ontology-based system, which we refer to as the Chinese Legal Consultation System (CLCS). The remainder of this paper is organized as follows. Section 2 presents a literature review. In Section 3, the proposed CLCS is described. We also describe the construction of a framework for Chinese statutes and judicial cases and discuss semantic recognition of input statements that use common vocabulary and case similarity. In Section 4, the ability of the proposed CLCS to provide related statutes and judicial precedents is evaluated using emotional damage compensation as an example. Conclusions and suggestions for future work are provided in Section 5.

II. LITERATURE REVIEW

Here, we review research related to ontology-based legal information retrieval from three perspectives: enhancing semantic recognition, building legal ontologies, and determining the similarity of cases.

A. ENHANCING INPUTS THROUGH TEXT MINING

Most legal ontologies are designed for users who are familiar with the law; thus, the needs of the general public are seldom considered. Various automatic systems that employ Internet technologies, such as LexisNexis (2012) and Westlaw (2012), have been developed to satisfy the demands of the public. However, users must form queries using a list of keywords and must be familiar with query interfaces, which can restrict the public from accessing legal information [4].

We must consider a system that can handle input statements that use ordinary, daily vocabulary. To improve the practical aspects of a legal consultation system, text-mining techniques that allow the general public to use everyday vocabulary to search for and retrieve statutes and judgments should be implemented in a legal ontology. Saravanan [5] constructed a legal knowledge base to enhance user queries. He used a proposed legal ontology that generalized the corpus of a judgment. Zhong presented an effective pattern discovery technique for text mining by determining the property of words in a pattern rather than in the text to improve the accuracy of the weight of the words [6]. Chen (2013) automatically extracted and selected the top-*n* keywords from legal statutes with the highest frequency as inputs for back-propagation NNs (BPNN) [4]. These methods can improve the semantic

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[6]Here, "statutes" refer to the general terms of codes, regulations, rules, legal explanations, judicial explanations, and directives. Appointed legislative branches are responsible for the enactment and amendment of statutes.

[7]Three-stage reasoning is often adopted in civil law countries. It takes statutes as the primary premise and the details of fact as the secondary premise to derive a verdict.

recognition of inputs; however, text mining techniques should pay careful attention to the syntax and diction of people who are unfamiliar with the law.

B. LEGAL ONTOLOGY RETRIEVAL

Ontology techniques have been used in many fields. For example, Huang used an artificial NN to align biological ontologys [7]. In addition, McGuiness (2003) stated that legal ontologies have *come of age* with the maturity of ontological engineering [8], [9]. The precision rate can be increased by preventing retrieval of irrelevant information when the same terms are used differently and by retrieving relevant information using vocabulary that differs but has similar meaning [10]. As Bench-Capon et al. pointed out, AI takes the form of logic represented by binding precedents and statutory rules [11].

Legal systems involve large and complicated conceptual groups; thus, most significant legal ontologies have focused on representing legal knowledge. In over more than 30 years of development, a considerable number of legal ontologies have been proposed in a variety of legal and other domains, including misappropriation of trade secrets (HYPO and CATO), tax law (TAX-HYPO and CABARET), and bankruptcy (BankXX) [12]. The current typology of legal ontologies is quite broad in terms of granularity (domain-specific vs. core), degree of formality (highly axiomatized vs. lexical- or language-oriented), development methodologies (top-down vs. bottom-up and middle-out), and knowledge sources for concept and term extraction (official legal sources vs. legal expert interviews and ethnographic work) [12]. Valente) developed the Functional Ontology for Law (FOLaw) in 1999 [13]. FOLaw categorizes knowledge as normative, world, responsibility, reactive, meta-legal, and creative knowledge from the perspective of social roles and legal functions. However, FOLaw is essentially a cognitive framework that pays little attention to legal domain knowledge. In 2004, the Leibnitz Law Centre developed the LRI Core Legal Ontology retrieval system based on common sense knowledge at abstract and concrete levels using Holland's criminal law system as an example [14]. LRI-core considers the concepts in the top abstract layer as physical (and includes legal behaviors, rules, and offenses), mental (criminal motivation), social (indicates the social relations and includes the judicial organization, such as a criminal court. This system provides a framework to obtain a coherent view of a specific legal domain and allows for the inheritance of well-defined terms [14]; however, it has some limitations relative to detailed descriptions and reasoning. The Legal Knowledge Interchange Format (LKIF) core ontology was proposed by considering the ontology at the top, middle, and lower legal layers [9]. The LKIF Core Ontology is more of a library of ontologies relevant to a specific legal domain than a monolithic body of definitions.

With the development of semantic and data processing techniques, advancements have been made in the legal ontology domain. For example, Corcho et al. introduced a methodology to build an ontology in the legal domain using the ontology engineering workbench WebODE [12]. Vi-sit et al. proposed the Framework of Automatic Thai Law Ontology, which can automatically generate a seed ontology and extend the ontology using an ant colony algorithm [15]. Jelali proposed a legal information retrieval system that addressed the problem of matching a disputant case description (primarily expressed in concise natural language without formal organization) with court decisions (typically structured, lengthy, well-written, and characterized by judicial language patterns [16]. Wang proposed a Chinese legal affairs information service platform based on cloud computing [17]. Guido et al. developed Eunomos, an advanced legal document and knowledge management system based on legislative XML and ontologies [18].

The Chinese legal system is composed of many written laws and regulations. Thus, pioneering studies regarding Chinese legal retrieval systems have focused on establishing a legal ontology for statutes. Huang discussed approaches to acquire legal information in the Internet environment [19]. He et al. extended LRI to include sub-elements to build the Dolegal System [7]. Wang proposed the Legal Affairs Service Platform based on unstructured information management architecture and semantics. Tang presented an extraction process for ontology-based legal knowledge representation from original legal sources using an NLP tool named Institute of Computing Technology, Chinese Lexical Analysis System (ICTCLAS) and linguistic pattern s [20]. In addition, Guiqing She (2016) constructed a legal ontology for criminal cases [21].

These legal ontologies perform better in knowledge management systems compared with those using legal reasoning to simulate judges' court decisions. Building a practical legal ontology involves several challenges. First, legal concepts are closely related to seemingly explicit content, such as politics, economics, ethics, etc., and are difficult to control. If the law is limited to statutes and regulations, something eternal such as economic, social factor is ignored, and this can cause various problems, such as many regulations going unused, the inconformity of legislation and judicial decisions, and legal education that does not conform to legal practice. Second, legal ontology retrieval is an analog for human thinking, and logical reasoning is the bridge to statutes and judicial precedents. When legal reasoning is incomplete, the practicability of a legal ontology is restricted.

C. DETERMINING CASE SIMILARITY

Legal retrieval involves searching a database for a similar case, reusing the analog case to infer a solution to the new case, and then revising the old solution and preserving the new solution for future use [22]. Thus, determining case similarity is very important for the output of a consultation system. Traditional methods to determine CBR similarity include nearest-neighbor, inductive inference, and knowledge-based indexing methods [23]. The inductive inference method extracts case features and forms a hierarchical

structure that is similar to a discrimination network, which is better for cases where features are interdependent. The knowledge-based indexing method determines the importance of a feature based on known knowledge, which is better for cases with certain dynamics and direction. The nearest-neighbor method takes the eigenvector of a case as a point in high-dimensional space, finds a matching point in the target case in a problem space, and returns an over-threshold similarity value [24].Recently, other methodologies have been used in CBR analyses, such as NNs, GAs, and gray correlation analyses. Guiqing She (2016) used a GA to weight related factors in order to determine similarity among criminal cases. Boonchom (2010) used an ant colony algorithm for succession and family law cases in Thailand [15]. These attempts improved case similarity; however, the retrieval effect should be further inspected.

III. CLCS FRAMEWORK

In this section, we describe the construction of a framework for Chinese statutes and judicial cases based on BPNNs.

A legal application is the communication process between law and facts [25], and legal reasoning integrates rigorous mental logic and abundant legal experiences. Logic mind reflects in statutes and legal experiences lie in judicial judgments. China primarily depends on written statutes; however, actual judicial decisions cannot be derived by simple three-stage reasoning. First, the descriptions of conditions and conclusions are inadequate in the written statutes. It is difficult for a judge to derive a verdict by considering statutes as the primary premise and the details of fact as the secondary premise. Second, laws and local regulations can overlap and conflict, and determining which statutes to use for determining a verdict depends on the judge. Third, in countries where judicial cases cannot be quoted directly, verdicts depend on the judge's judicial interpretation; however, such judicial interpretations cannot cover all legal issues, and the judge will make a determination based on the consequences of infringement and other circumstances. Thus,judicial precedents are the hallmark of the judicial system and create an effective measure to explain statutes and fill legal gaps in written law. Most existing AI experiments in law recognize that the body of legal knowledge is derived from formal law in constitutions, statutes, and regulations as interpreted by case law precedents and by experienced domain experts [26].

In fact, statutes contribute more to the qualitative knowledge of a legal case, whereas judicial precedents contribute more to quantitative knowledge. At present, China has an established unique judicial system, i.e., a case guidance system, which was officially launched in 2010. This system utilizes similar cases to provide judges with references,[8] which help address legal loopholes and create uniform sentencing. A Chinese legal ontology would benefit from the integration of inductive and deductive reasoning based on judicial cases.

[8]Two case-guided regulations were enacted by the Supreme People's Procuratorate and the Supreme People's Court in 2010; this confirmed the role of judicial precedents.

Therefore, we should pay more attention to judicial cases when building a Chinese legal ontology.

The proposed ontology-based CLCS attempts to provide the most similar cases and related statutes using BPNNs. We consider emotional damage in medical disputes as an example. First, the CLCS attempts to improve semantic recognition by considering the needs of the general public. The system uses ICTCLAS 2015, an effective word segmentation tool, to handle semantic recognition for user statements formed using everyday vocabulary. Second, we construct the legal ontology framework by integrating statutes and judicial cases based on ontological techniques. Third, to output similar cases, we employ a GA integrated with a KNN algorithm

When a user inputs information about a legal issue, the CLCS can help them find useful statutes and related judicial precedents. The overall design of the CLCS is shown in Figure 1. The workflow of the CLCS is as follows.

FIGURE 1. Overall design of the CLCS.

Step 1 (Input User Statement): The user inputs a short paragraph describing their legal issue using general terms and everyday vocabulary.

*Step 2 (Identification):*The input statement is segmented using ICTCLAS and Google Distance (GD) to improve semantic recognition.

Step 3 (Ontology Contribution): Ontologies of statutes and judicial precedents are established.

Step 4 (Output): The CLCS provides related statutes and judgments according to similarity determined using the GA–KNN algorithm.

A. PREPROCESSING

Here, we address the problem of extracting legal keywords from input query statements.

Legal terms are "terms of art," i.e., words with specific meanings in a specific context that are unlikely to be used in everyday, informal communication. A legal term is a word or phrase with a specific meaning in a legal context. We refer to terms used by legal professionals or in formal legal documents as legal terms, e.g., "contractual offers" and

"civil infringement." Popular terms are common, informal words used by the general public when describing legal problems or cases. Note that some popular terms can also be legal terms, e.g., "depression" and "steal" [4].

China is a very large country with many different ethnic groups who speak multiple languages. Language blending and changes aggravate the complexity and multiplicity. In addition, Chinese expressions can have obscure meanings, e.g., when the tone or punctuation changes, the meaning also changes. Chinese characters are relatively more sophisticated and vague compared with English expressions. When the user inputs a short paragraph using common vocabulary to express a legal problem, we can enhance understanding using text mining techniques. In this context, word segmentation divides a Chinese character sequence into separate words.

Various word segmentation systems have been proposed, e.g., SCWS, FudanNLP, HTTPCWS, IKAnalyzer 3.x, and CKIP. ICTCLAS,[9] which was developed by experts from the Chinese Academy of Sciences, is a highly precise semantic segmentation tool that includes part-of-speech (POS) tagging, entity recognition, and a user lexicon. To reduce noise from word segmentation and obtain a better term list, POS tagging is adopted to select meaningful candidate terms. For example, we can determine verbs ("push"), nouns ("cigarettes"), and gens[10] ("steal"). Here, "steal" is not a verb, but it can form a composite word by combining with other Chinese words. Thus, ICTCLAS 2015 has been adopted in this study.

A user query is segmented into multiple terms using ICTCLAS. In our study, we previously extracted a number of terms from emotional damage compensation judgments.

B. ENHANCING SEMANTIC RECOGNITION OF A QUERY STATEMENT

Some semantic tools have powerful functions, e.g., Ling-Bench, which was developed by Natlanco, has strong semantic analysis functions based on Web 3.0. LingBench can decipher the true meaning of a query statement by joining independent language models. GD is a semantic similarity measure based on the number of items returned by the Google search engine for a given set of keywords.

The Normalized GD (NGD) between two search terms x and y is expressed as follows[11]:

$$\text{NGD}(x, y) = \frac{\max\{\log f(x), \log f(y)\} - \log f(x, y)}{\log N - \min\{\log f(x), \log f(y)\}}, \quad (1)$$

where N is the total number of web pages searched by Google multiplied by the average number of singleton search terms occurring on the pages; $f(x)$ and $f(y)$ are the number of hits for search terms x and y, respectively; and $f(x, y)$ is the number of web pages on which both x and y occur.

[9]http://www.oschina.net/p/freeictclas
[10]A gen is the root of a Chinese word that can form a composite word by combining with other words.
[11]https://en.wikipedia.org/wiki/Normalized_Google_distance (last visit: April 7, 2017)

A study on legal document text mining shows that GD can effectively increase semantic recognition of legal information [4]. Thus, NGD is adopted in this study to improve the semantic recognition of common expressions.

C. ONTOLOGY CONSTRUCTION

Here, we describe the construction of a framework of a Chinese legal ontology for statutes and judicial cases. The three general approaches to construct a legal ontology model are the top-down, bottom-up, and middle-out methods. The top-down method involves asking domain experts to agree on a unique point of view relative to their specializations. The bottom-up method involves extracting domain concepts and terminology from appropriate documents to induce, cluster, and generalize the concepts and terminology to construct an ontology. The middle-out method begins with a group of core concepts and expands the concept models. China has had a relatively complete system of statutes and regulations for a long time [27]; thus, we can use the bottom-up method to construct the statutes ontology. However, the case-guided system has only been in place since 2010; thus, the number of documents is insufficient to derive adequate case features. Therefore, we employ the top-down method to extract case features from judicial reports [28].

D. ONTOLOGY FOR STATUTES AND REGULATIONS

A three-layer ontology model was proposed by Dumontier [29]. The top layer describes the category, attributes, and forms using common concepts that are independent of certain domains or problems, such as space, time, physical objects, events, actions, etc. The second layer is the domain ontology that details the top-layer concepts formed by the static knowledge in the domain. The third layer is the application ontology that describes the related concepts and knowledge in a certain domain [30]. Note that LKIF-core includes abstract concepts, basic concepts, and legal concepts [14]. Most abstract concepts are defined in five closely related modules: top, place, mereology, time, and space–time. Basic-level concepts are distributed across four modules: process, role, action and expression, and legal concepts, which comprise legal actions, legal roles, and norms.

Chinese normative documents are part of a vast system comprising the Constitution, laws, regulations, legal interpretations, judicial interpretations, administrative regulations, local directives, regulations, standards, and other normative documents. Here, "standards" refer to both industry standards and technical regulations. A legal system can be classified in many ways. Here, we consider the most commonly used Chinese way to classify it, i.e., Constitutional, Civil Law, Criminal Law, and Administrative or Procedural Law, according to the adjusted object and the adjusted methods of law [27]. The meta-elements of the statutes differ according to the properties of the statutes.

The most popular databases for Chinese commercial cases are the *Magic Weapon of Peking University*, *Tiantong*,
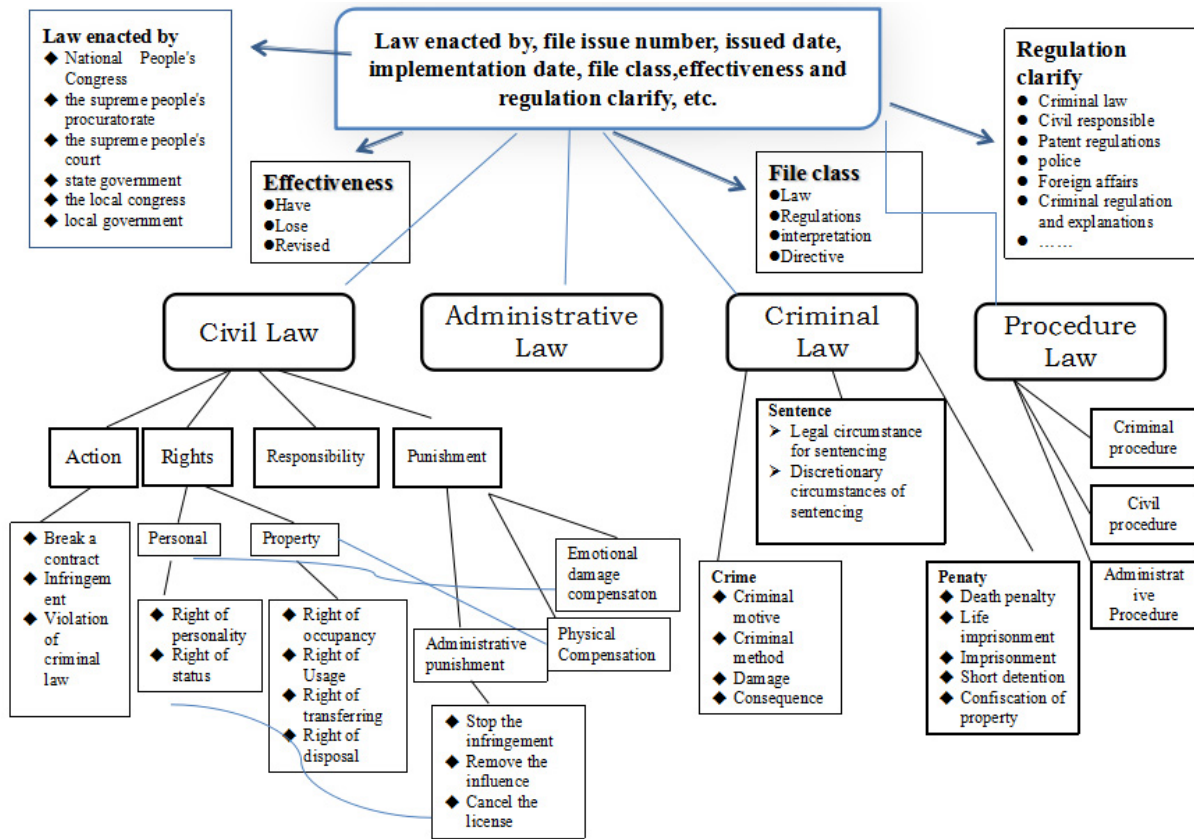
Law enacted by
◆ National People's Congress
◆ the supreme people's procuratorate
◆ the supreme people's court
◆ state government
◆ the local congress
◆ local government

Law enacted by, file issue number, issued date, implementation date, file class, effectiveness and regulation clarify, etc.

Regulation clarify
● Criminal law
● Civil responsible
● Patent regulations
● police
● Foreign affairs
● Criminal regulation and explanations
● ....

Effectiveness
● Have
● Lose
● Revised

File class
● Law
● Regulations
● interpretation
● Directive

Civil Law

Administrative Law

Criminal Law

Procedure Law

Action

Rights

Responsibility

Punishment

Sentence
➤ Legal circumstance for sentencing
➤ Discretionary circumstances of sentencing

Criminal procedure

Civil procedure

◆ Break a contract
◆ Infringement
◆ Violation of criminal law

Personal

Property

Emotional damage compensaton

◆ Right of personality
◆ Right of status

◆ Right of occupancy
◆ Right of Usage
◆ Right of transferring
◆ Right of disposal

Administrative punishment

Physical Compensation

Crime
◆ Criminal motive
◆ Criminal method
◆ Damage
◆ Consequence

Penaty
◆ Death penalty
◆ Life imprisonment
◆ Imprisonment
◆ Short detention
◆ Confiscation of property

Administrative Procedure

◆ Stop the infringement
◆ Remove the influence
◆ Cancel the license

FIGURE 2. Framework for the Chinese statutes ontology.

and *Jurist*, which emphasize the management of legal documents. For example, core terms, the focus of the controversy, and the main point of each case are added to the judicial case data in the *Magic Weapon of Peking University*, which makes cases easier to reference and meet the requirements of a user's one-stop shop for researching judicial precedents. We suggest that such elements be added to court reports.

We adopt a three-layer ontology to describe the ontology of the statutes.

The first layer is basic legal information, which generally describes legal normative documents as legal files, legal regulations, and judicial papers and includes the law enacted by, file issue number, date of issue, implementation date, file class, the valid legal category, etc.

The second layer organizes and describes the abovementioned legal information. According to the adjusted object and adjusted methods of law, a legal system can be classified as constitutional law, civil law, criminal law, and administrative or procedural law or as criminal law, civil law, commercial law, intellectual property law, maritime law, administrative law, state compensation law, and law enforcement. A more detailed legal system is classified as constitutional law, administrative law, civil and family law, commercial law, economic law, labor law, social security law, military law, environmental law, criminal law, and procedural law [27].

The third layer is the description of concrete legal information, where elements may differ according to the clarity of the legal regulations. For civil law, the information can be described as an action, right, obligation, or punishment. Criminal law includes both crime and punishment. A crime can be described by aspects such as criminal motive, criminal method, damages, consequences, etc. Punishment includes legal and discretionary circumstances for sentencing. Generally, third-layer information is scattered, vague, and difficult to describe. Several things should be noted here. 1 The legislative effect hierarchy is related to the departments that enacted the regulations. The general departments include the National People's Congress, the Supreme People's Procuratorate, the Supreme People's Court, the state government, the local congress, and the local government. 2) The legal category is highly refined for normative files and indicates the domain, such as criminal law, civil responsibility, patent regulations, police, foreign affairs, criminal regulations and explanations, etc. 3) Regulations can be divided into civil law, criminal law, administrative law, and procedural law. 4) The descriptions of the regulations may differ according to the category of law. For example, the core of civil law comprises rights and obligations. Thus, it will be generalized as actions, rights, obligations, and punishments in the system. The action can be initially judged as lawful or illegal

according to the normative document, and the rights can be defined for a lawful action. Then, the system will show the suggested punishment.

The framework of the three-layer ontology for Chinese statutes is shown in Figure 2. Civil law is a combination of action, rights, responsibility, and punishment. An action includes breaking a contract, infringement, and violation of criminal law. Rights are divided into personal and property rights, where the former includes the right of personality and the right of status and the latter includes the right of occupancy, the right of usage, the right of transfer, and the right of disposal. Punishment includes emotional damage compensation, property compensation, and administrative punishment, which can be subdivided into stopping infringement, removing the influence, and canceling a license.

The legal system is full of hierarchies, and some overlap and conflict are bound to occur. A legal hierarchy is presupposed for the interior legal force of the state's legal sources. Generally, statutes that are placed lower in the hierarchy are enacted to benefit upper-level statutes, which represent the upper limit. Such lower statutes are more explicit, operable, and foreseeable; thus, in practice, the executive force of lower hierarchical statutes is stronger than that of upper-level hierarchical statutes even though the power exists in a top-down structure (Figure 3).
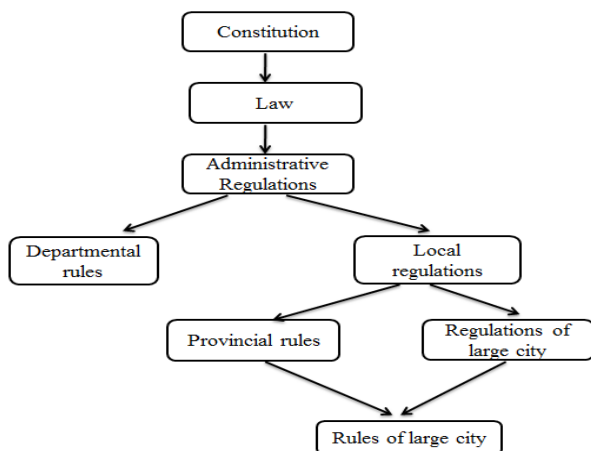

FIGURE 3. Hierarchy of written statutes.

The hierarchy can provide a generally effective order for written statutes; however, actual implementation of statutes is far more complex than the above-referenced hierarchy owing to duplicative and contradictory legislation. For example, a medical dispute involves the General Rules of Civil Law (1997), regulations addressing medical accidents (2002), judicial explanations for emotional damage compensation (2001), and judicial explanations for personal injury compensation (2004). For material damage compensation, the fixed period of compensation for death in General Rules of Civil Law is longer than that of the regulations regarding the handling of medical accidents. Thus, the former is more frequently adopted by judges, whereas, for emotional

damage compensation, the latter is often adopted owing to its operability. Therefore, the relevant order of statutes also depends on the application of the statutes presented in judicial cases.

E. ONTOLOGY FOR JUDICIAL CASES

Normative documents describe legal concepts from a qualitative perspective in order to make concepts more intuitive, and judicial cases are supplementary from a quantitative point of view. Judicial cases include many discretionary factors. Thus, it is better to use the bottom-up method to grasp the correlated characteristics for certain types of cases. Case properties may differ significantly by case type; thus, except for general information, we use emotional damage compensation in a medical dispute as an example to determine the structure of cases. Saravanan categorized case features as persons, things, events, facts, and acts [5]. The meta-elements of a criminal case feature include the means of violence, the weapon used, injuries, damages, the circumstances of sentencing, and punishment [21].

The judicial court documents include the substance of the case, case number, judge, file class, conclusion date, and conclusion court, etc. Chinese legal judgments are semi-structured, and case features may differ significantly for different cases; thus, we select a specific type of case to explain the method. By observing the cases of tort law, we find four meta-elements to describe judicial cases, i.e., general information, main judicial points, factual information, and the court decision (Figure 4).

The meta-elements of cases can be explained as follows.

1) The general information of a case includes the allegations in the case, the judge, court number, conclusion date, the procedure, participants, time, addresses, etc.

Participants: petitioner, respondent, appellant, and appellee. If the participant is a person, the ontology should include their name, gender, age, designation, marital status, occupation, and address. If the participant is an institution or organization, the ontology should list the legal representative, the type of ownership, company name, address, etc.

Time: What time did the incident occur? The time of the injury is important.

Place: Where did the incident occur? Different locations involve different types of compensation. In China, differences in per capita income are significant between urban and rural residents and among different provinces. For example, the urban per capita disposable income in Shanghai in 2009 was RMB 23,622.73, whereas the rural per capita income was only 2,786.77 in 2007 in Henan Province.

Proceedings: first trial, second trial, retrial, etc.

2) The main judicial points are a brief introduction to the case. The regulations governing the main points of a case in civil and criminal law provide explicit information about the case. A judgment in the application of the law includes the perspective of the judge, the methods used to make the determination, understanding of judicial concepts, etc. The main judicial points are the generalized trial points
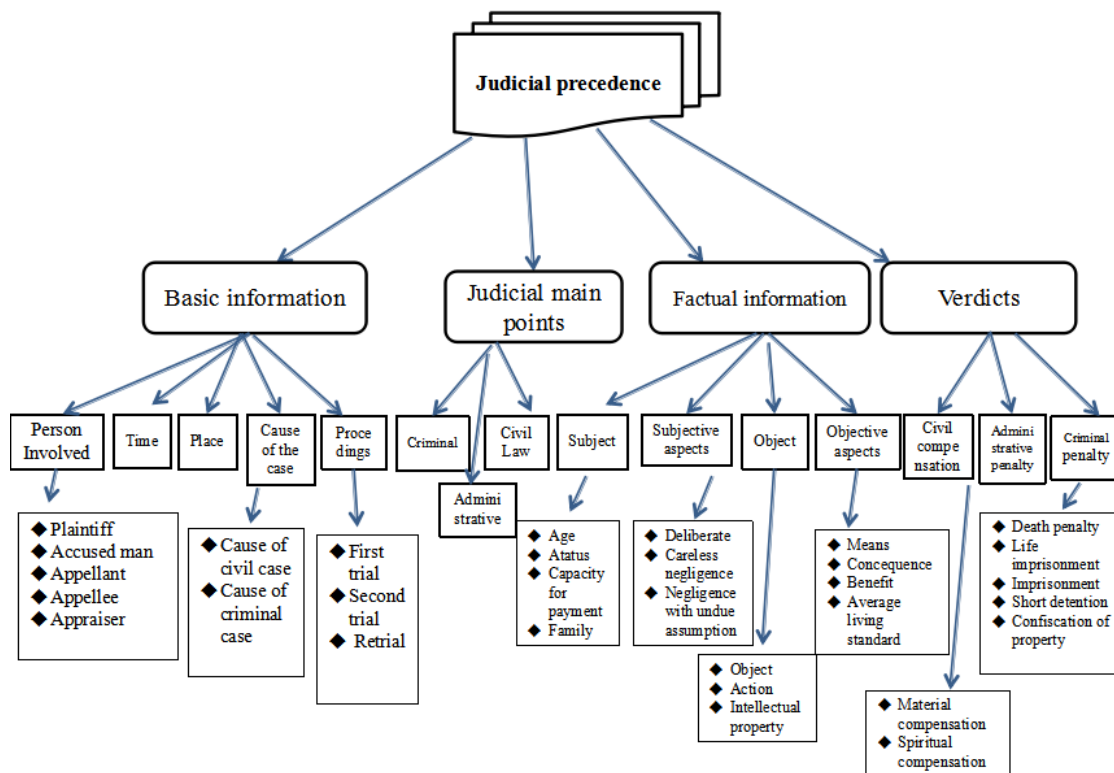
FIGURE 4. Ontology framework for judicial cases.

and serve as universal instructions and references for similar future cases. For example, a judge may quote regulations referenced in an argument.

3) The factual information of the case comprises facts determined by the judge, which should include statutory or discretionary circumstances for sentencing. Generally, this information includes the subject, subjective aspects, object, and objective aspects. The subject of the case is the person(s) involved, and the age or status of the subject is a key factor for discretionary circumstances relative to sentencing in the commission of a crime or in assuming responsibility. The subjective aspects of the case include the attitude of the litigant in committing acts that may be deliberate or negligent. The object of the case may be concrete or abstract, such as an object, action, or intellectual property in a civil relationship, as well as the legal interest or object of a crime that is an interest protected by criminal law but violated by criminality. The objective aspects of a case involve the objective environment in which an incident occurs. This embodies the concrete plots of a crime, such as the intent to deceive in fraud and infringement means, consequences, benefits, and the average living standard in infringement cases. The four aspects referenced above may seem somewhat abstract; however, in different types of cases, they may change. For example, in cases involving compensation for emotional damage, factual information can be summarized through seven factors, i.e., the degree of disability, the plaintiff's contributing factors, causation, the

compensation capabilities of the hospital or medical staff, damage to the victim's future career and personal life, the victim and their family situation, and other types of compensation for physical injury.

4) The verdict or court decision is the discretionary decision of the judge, which includes a determination of guilt or innocence and the punishment, e.g., death penalty, life imprisonment, term imprisonment, short detention, confiscation of property, civil compensation, administrative detention, revocation of business licenses, etc. In emotional damage compensation cases, the verdict determines whether emotional damage compensation is supported, the compensation amount, etc.

IV. EXPERIMENTS AND ANALYSIS
In this section, we test the retrieval precision of the proposed CLCS taking emotional damage compensation as an example using the Chinese ICTCLAS segment tool and GD.

The goal of legal retrieval is to find a similar case from a database, reuse the analog case to infer a solution for a new case, revise the old solution, and then preserve a new solution for future use [22].Generally, there are three steps for case retrieval: 1) identify the case features, 2) search for a similar case in the database, and 3) sort and identify similar cases [31]. Therefore, the outputs of the CLCS should be relevant statutes and cases ranked by relevance.

Methods such as the nearest-neighbor, induction and inference, knowledge-based indexing, analytic hierarchy process, and GA methods are used to compute weight coefficients. For example, Boonchom (2010) used an ant colony algorithm in an expanding seed ontology legal retrieval context [15]. In his experiment, 26 ants, which were considered legal users, traversed the ontology to locate a target node. Such methods have advantages and disadvantages. The nearest-neighbor method is one of the most popular approaches to increase understanding without an initial weight and NN training; however, the computational burden in this approach is significant. Classic BPNNs have strong autostudying and error-correction capabilities and demonstrate good performance in solving nonlinear problems [32]; however, such NNs have some disadvantages, e.g., as running into local extreme point, low convergence rates, and the oscillation effect. GAs have excellent global optimization and rapid convergence; however, the results strongly depend on the initial population. In light of the fact that Chinese judgments are characterized by vague expressions, significant differences among cases, and multiple attitudes and that it is difficult to measure them quantitatively, a GA–KNN method is expected to show good performance in finding similar cases.

When the user enters a query statement, the CLCS processes the requirements through the ontology to find the most related cases using the GA–KNN approach. The steps for the system are as follows.

Step 1: Extract case properties that influence the compensation value.

Step 2: Input the extracted cases according to the ontological structure of these types of cases (70% of the cases for training and 30% for testing).

Step 3: Determine case similarity using the GA–KNN approach.

Before building a legal ontology, we performed the following procedure to determine case features. First, we observed the emotional damage compensation related statutes in order to understand the structure of statutory law. Second, we constructed a legal corpus to enhance user queries. Third, we determined the actual potential influencing factors by analyzing related statutes and reviewing judicial reports from the vague expressions. Case properties are chosen by observing the principles of stability, significant and clear hierarchy. We invited 10 law experts to determine the case properties for emotional damage compensation in medical disputes by reviewing judicial reports using an inductive method. By analyzing tort-related statutes and observing court reports regarding emotional damage compensation cases in medical disputes, we identified the following factors that affect the actual compensation: participation degrees for medical damage, infringement method, hospital grade, disability classes, patient age, family conditions, other aggravated circumstance, and other physical compensations [33], [34]. The related case properties are shown in Table 1.

TABLE 1. Case properties extracted from judgments.

No.	Factual factors	Mark No.	Description for the factors	Code
1	Participation degrees for medical damage	M1	Participation is given by Judge according to the malpractice report	
2	Infringement method	M2	Doctor without the license	1
		M3	Surgical errors	2
		M4	Drugs improper	3
		M5	Missed diagnosis	4
		M6	The patients is not fully be informed the corresponding medical risk	5
		M7	Nonstandard or manipulating medical record	6
		M8	Delayed treatment	7
		M9	Negligence in nursing service	8
3	Hospital grade	M10	Primary grade hospitals, including community hospital, health-center and Private clinic	1
		M11	Secondary hospitals	2
		M12	Tertiary hospital	3
4	Body injury degree	M13	Death	0
		M14	Grade 1 disability	1
		M15	Grade 2 disability	2
		M16	Grade 3 disability	3
		M17	Grade 4 disability	4
		M18	Grade 5 disability	5
		M19	Grade 6 disability	6
		M20	Grade 7 disability	7
		M21	Grade 8 disability	8
		M22	Grade 9 disability	9
		M23	Grade 10 disability	10
		M24	Not disability	11
		M25	Fetal death	12
5	Age of the patient	M26	Unborn Child	0
		M27	Child before 18	1
		M28	Young people from 18 to 60	2
		M29	Old people after 60	3
6	Family conditions	M30	Extremely poor in economic condition	1
		M31	Group person need be fostered	2
7	Other aggravated circumstance	M32	Career change	1
		M33	Endometrial ablation	2
		M34	Cosmetic failure	3
		M35	Infant disability	4

The abovementioned seven factors are considered the case properties of medical dispute cases involving emotional damage compensation; however, in fact, the former four factors have a significant influence on the compensation value for all cases. In addition, the latter three factors are the aggravated circumstances for some special cases that are also greatly influenced by the compensation value. As mental damage compensation in China is more like an equilibrium catalyst that balances compensation, when physical compensation

TABLE 2. Segmentation of the details of judicial cases.

No.	Partic ipate	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	Compe nsation rate
1	0.50	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1.68
2	0.70	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2.32
3	0.65	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1.27
4	0.30	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1.88
5	0.30	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1.46
6	0.20	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.22
7	0.90	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0.74
8	0.70	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.22
9	0.25	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.12
10	0.30	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1.07
11	0.30	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0.21
12	0.20	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1.91
13	0.30	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.12
14	0.80	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1.32
15	0.30	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0.62
16	0.30	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2.32
18	1.00	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0.12
19	0.90	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.72
20	0.20	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0.62
21	0.40	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1.08
22	0.50	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0.07
24	0.70	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0.62
25	0.25	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0.57
26	0.30	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0.67
27	0.20	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0.23
28	0.30	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0.30
30	0.20	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0.89

is greater, the corresponding mental damage compensation becomes less. Owing to district economy differences among Chinese cities, we selected the compensation rate to reduce the influence of such economic factors; compensation rate is the actual compensation value divided by the rural per capita net income or urban per capita disposable income.

To test the retrieval results of relevant judicial cases, we input the keywords ''spiritual compensation'' and then ''medical dispute.'' Out of a total of 462 cases, 116 cases in which spiritual compensation was not supported and 28 cases with poorly described judicial reports were eliminated. As a result, we found 318 cases related to emotional damage compensation in medical disputes from the Magic Weapon of Peking University database. To further observe the case features, we attempted to select judicial reports with details that describe the case and judgment reasons. Note that all cases occurred after 2009 (i.e., the year the Tort Liability Law was implemented). In addition, it was easier to obtain related judicial reports from cases that had occurred in the last five years owing to the digitization of the court documents. These 318 cases were used as an initial test set to evaluate the performance of the proposed CLCS and explain the method, which can be extended in the future.

We input the details of the cases into the Statistical Product and Service Solutions (SPSS) statistics software for further analysis. Table 2 shows the segmentation of inputs of judicial cases according to court reports released from the official website of a Chinese court.

To explain the relationships between these related case features and the compensation rates, we implemented the variable importance of each case feature using an NN with SPSS Clementine (see Figure 5).

The GA–KNN method allows a legal expert to estimate model parameters and improve the weights of the case features based on expert suggestions. We invited 10 legal experts to adjust the initial weights obtained by the KNN algorithm. We then obtained trained weights to search for the most
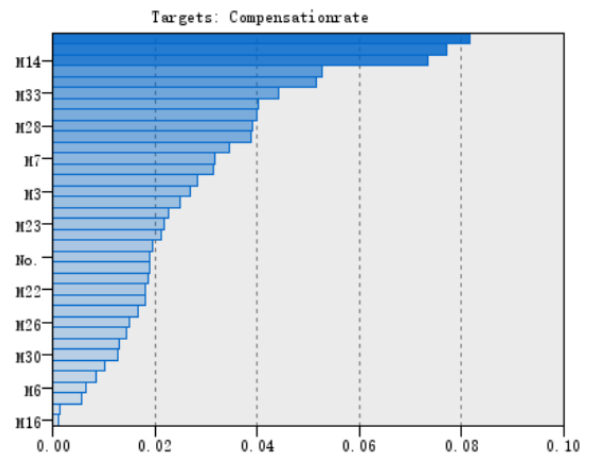

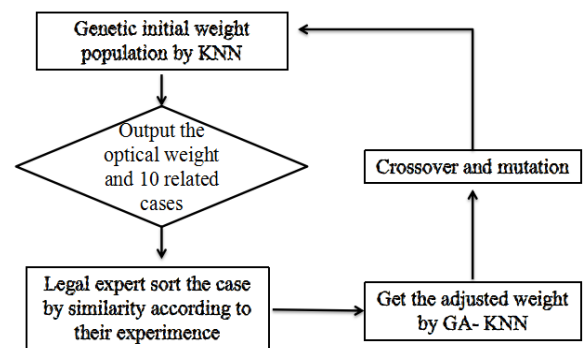**FIGURE 5.** Importance of the case features relative to the compensation rate.

FIGURE 6. Flow of the GN–KNN method.

related cases. The GA–KNN method determines the nearest neighbor according to the optimal weight obtained using the GA and a cross-validation search technique. The flow of the GN–KNN method is shown in Figure 6.

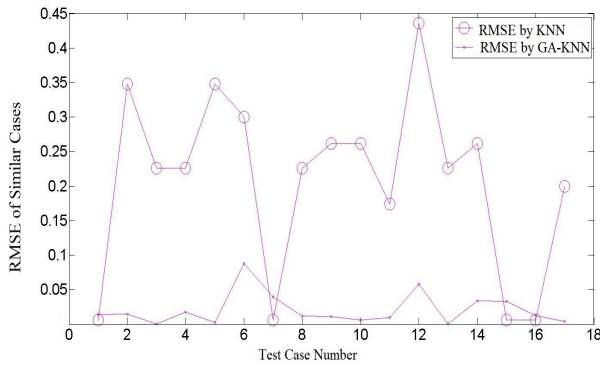First, we divided the 318 judicial cases into two parts, i.e., 260 cases for training and 58 cases for testing

FIGURE 7. Comparison of relative errors obtained using the KNN and GA–KNN methods.

TABLE 3. Comparison of retrieval results obtained by the KNN and GA–KNN methods.

	KNN	GA-KNN
Root mean square error	0.235	0.031
Maximum relative error	0.925	0.313
Average relative error	0.852	0.811

the coefficients. Here the often-used Euclidean distance $D(\chi, y) = \sqrt{\sum_{k=1}^{n}(\chi_\kappa - y_\kappa)^2}$ was adopted. Second, we used the KNN method during training to search for an initial weight and adjust the order of the related cases. Third, the weight was adjusted using the GA–KNN method to obtain optimal weights. Finally, using MATLAB, the system output the retrieval errors obtained by the two methods.

As can be seen in Fig. 7 and Table 3, the retrieval precision rate obtained using the GA–KNN method is much higher than that obtained using the KNN method. The GA–KNN method also reduced the root mean square error and maximum relative error. Thus, the proposed method improves precision for related cases.

V. CONCLUSION AND FUTURE WORK

There is an increasing need for more effective and smarter legal systems that can help the general public acquire related information in order to resolve legal issues. The goal of our study was to construct a framework for legal case and statutes retrieval that is suitable for the general public using common and informal vocabulary. By extensively considering current Chinese legal characteristics, the practical ontology-based CLCS was proposed. The proposed system uses the ICTCLAS Chinese segment tool to segment query statements and GD to improve semantic recognition. To construct legal ontology, the proposed CLCS uses a GA to integrate statutes and judicial precedents in order to provide related statutes and precedents according to their relevance. The results of the experiments demonstrate that the precision rate obtained using the proposed GA–KNN method is higher than that obtained using the classic KNN method. In addition, the

proposed method avoids convergence around local optimal solutions.

In the future, people may need to predict compensation rates for their own cases after obtaining related statutes and cases; thus, we plan to initially provide compensation values obtained using a BPNN. It is expected that deep learning methods with a strong semantic recognition capability can be used to build a legal ontology. In addition, to improve feature extraction from statutes and judicial cases, we plan to involve more legal experts and use more cases to further evaluate the proposed CLCS.

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