Research on the Construction and Application of Knowledge Graph in Military Domain

XING Meng¹, YANG Chao-hong¹, JIN Li-ya¹, BI Jian-quan¹,
¹Department of Information and Communication, Army Academy of Armored Forces, Beijing, 100072, China
Address: no.21 yard, dujiakan, fengtai district, Beijing, tel: 15510676806.
* XING Meng’s e-mail: xingmykx@163.com

Abstract: Construction of military domain knowledge graph is the foundation of military application intelligence development, current research hotspots and development situation of domain knowledge graph at home and abroad are introduced, application scenarios of military domain knowledge graph is given in the state of peacetime and wartime respectively, points out the problems needing attention and corresponding countermeasures in each life cycle.

1. Introduction
Knowledge graph originated from semantic network, proposed by Google to optimize search results. With the rapid development of knowledge graph technology, it has been applied in various vertical fields. Domain-specific Knowledge Graph (DKG) refers to the Knowledge Graph focusing on a specific vertical Domain, the entities and concepts are almost related to the Domain [1].

The purpose of DKG is to give domain knowledge to machines instead of professionals to do simple knowledge work, this technology will further increase machine productivity and free up mental labor resources. Therefore, the introduction of KG technology in military domain and DKG constructing lay the foundation for Smart Q&A, knowledge engineering, reasoning decision-making, personalized recommendation and other artificial intelligence applications in the military domain. This paper introduces the current research status of DKG, including domestic and foreign research hot-spots and existing problems. Gives the application scenario of military DKG, points out the possible problems, countermeasures and evaluation criteria in the life cycle of military DKG construction. At last, the opportunities and challenges of military DKG are discussed.

2. Research status of DKG
At present, the research hotspots at home and abroad mainly include domain brain construction, storage and calculation of large-scale DKG, interaction of KG, application of DKG and so on.

Since the knowledge of GKG comes from data of various structures, while the DKG needs to deal with almost unstructured data when it is constructed. Therefore, in the construction of DKG, it is urgent to enhance the representation ability of domain knowledge, identify domain entities, extract relationships, and discover implicit relationships.

In terms of the storage and calculation of large-scale DKG, in addition to entity relationships, there are also time, space, rules, labels and other important data. Graph database cannot meet the storage requirements of multiple data structures alone, the hybrid storage model based on graph database has become a research hot-spot [2].
Reasoning technology based on GKG can not be transplanted into DKG well. Some scholars began to study knowledge reasoning from the perspective of procedural knowledge. How to transform this human thinking into a machine path in the form of procedural knowledge is a current research focus [3].

The application of DKG mainly includes intelligent search, intelligent Q&A, decision making, explanation and personalized recommendation. At present, DKG has been applied in medical, e-commerce, finance, military industry, electric power, justice, education, public security, oil and other fields, such as the application of credit evaluation, risk control, anti-fraud in the financial field, as well as the application of intelligent consultation in the medical field [4].

3. Application scenarios of military DKG
Application scenarios can be divided into peacetime application scenarios and wartime application scenarios according to the combat status of the troops. In peacetime there are intelligent questions and answers of military knowledge, personalized recommendation, hidden knowledge reasoning, etc. In wartime, it mainly includes combat planning and action control, auxiliary judgment and decision recommendation.

3.1. Peacetime application scenarios
At present, intelligent question-and-answer application based on DKG, application scenarios become complex and diversified, intelligent recommendation and other complex tasks appear. It is applied to the army's ordinary training scenes, such as tank shooting training, including learning and using the battle room, aiming and shooting, and other more than 200 exercises. The number of steps for each exercise varies from three to more than ten steps, and each step has corresponding completion conditions and implementation standards. For example, ask about the content and method of the "check before shooting", the intelligent question answering system based on DKG, practice content should be able to return accurate, such as "fire control computer self-checking, security protection function, hydraulic locking function, working mode function, night-vision units function", etc., and intelligent recommendation for the user to possible use of equipment and auxiliary tool in the practice, in the process of operation can always recommend related Q&A answers and solutions, such as "what preparation work of artillery control system check needed", "suggested goggles check" before the function checks, etc.

The war-fighter's demand for combat data is diversified and personalized, and the result of information retrieval system cannot meet the war-fighter's personalized demand. A promising solution to this problem is personalized recommendation based on DKGs, which studies war-fighters' information needs and points of interest, draws user portraits, and creates interest description files. The traditional statistical learning method uses word sets to describe users' interests. Due to the synonymy and polysemy of words, it cannot accurately and comprehensively summarize and describe users' characteristics. The military domain oriented knowledge graph entity is adopted to describe the user's interest range and reflect the user's concern about the entity range. Moreover, it is verified by the entity-attribute relationship in the knowledge graph to eliminate ambiguous wrong words and combine synonyms repeated terms, so as to describe the user interest more accurately.

3.2. Wartime application scenarios
The wartime application scenario is mainly based on the combat task as the traction, on the basis of the command information system, support the combat planning and operation control, auxiliary judgment and decision recommendation, etc.

Due to the rapid development of communication, computer, sensor and satellite technology, the combat data acquisition technology has made a breakthrough, making it impossible for the war-fighter to distinguish and obtain valuable information in the mass data. In the field of operational planning and control action, knowledge graph can according to the war-fighter application requirements, identification, selection and processing of information needed, based on the simulation of the human
cognitive mechanism, establish a commander fighting cognitive framework and action control theory model of thinking, through the knowledge of intelligent organization and visualization analysis technology, fight for the commander of the theory of multi-scale dynamic cognitive to offer help.

In the process of directing, DKG through learning military command combat ordinance, in-depth analysis of operational mechanism of the winning command, by studying the classic case of command decision-making mechanism, provide operational scheme based on similarity of the blues is recommended and decision support, thus forming forces combat experience and real-time situational data based auxiliary judgment and decision recommendation model, can realize the battlefield intelligence system, multi-dimensional and multi-level analysis, to support complex battlefield more comprehensive analysis and decision-making recommendations.

4. Issues and countermeasures of Military DKG life cycle

In the process of constructing the military DKG, there are mainly the following life cycles: knowledge representation, knowledge acquisition, knowledge management and knowledge application. Each link iterates in the construction process [5].

4.1. knowledge application

As an open knowledge management mechanism for man-machine collaboration, KG has specific value and cost, and can only solve limited problems. For different application problems, KG is not always the best solution [6]. The application scenarios of military DKG are much more complex than the GKG. The current domain knowledge system is mostly centered on the basic concepts and entities of domain data when it is built, which has natural defects in understanding user needs in complex application scenarios.

Practical experience shows that application scenarios should be carefully selected for knowledge graph, not only the maturity of technology should be evaluated, but also the adaptability of the technology to the corresponding application. In addition, the balance between cost and effect should be considered, so as to construct knowledge resources to meet the needs of the scenario. Knowledge graph is more likely to succeed in the application scenarios with the following characteristics, and the domain knowledge is relatively closed, less involved in common sense, and simple. The simplicity of the knowledge involved in the application scenario can be determined by setting three types of questions. The first category of questions: whether to use meta-knowledge, whether to use a single model, whether to use long-range reasoning, whether to involve multiple types of knowledge; The second kind of problems: whether knowledge is easy to change, whether it involves complex process description, whether it involves complex reasoning of branches; The third kind of questions: whether there is knowledge resource accumulation, such as domain ontology, thesaurus, domain dictionary, etc.

4.2. knowledge representation

The knowledge graph is not sufficient to express all semantics. For example, in application scenarios such as equipment maintenance and configuration in the military field, it is difficult to express if-then rules. For example, if A and B then C, the knowledge graph is difficult to express complex atomic expressions. Some military application scenarios add expressive elements such as spatial and temporal dimensions, far beyond the simple associative facts expressed by triples of knowledge graphs.

To enhance the representation ability of complex knowledge, knowledge graph can be combined with other representation methods. For example, in the current research on equipment fault diagnosis, production rules are introduced into knowledge graph. Military application scenarios with the addition of expression elements such as spatial and temporal dimensions can be realized by defining quaternions or quaternions, and some entities represented across media, such as those containing sound, pictures and video, can be realized by defining related attribute associations.
4.3. Knowledge Acquisition

Because the application scenarios in the military field are extremely serious, and the requirements for knowledge acquisition quality are very strict, the knowledge acquisition scheme should take into account the requirements and costs, so as to avoid the problems of missing knowledge base, mistakes and outdated information. In addition, compared with the GKG, the military DKG has the problem of small sample, and the knowledge extraction model construction technology based on small sample should be adopted.

Puts forward a few here on the premise of guarantee quality as far as possible to reduce the cost principle: first, clear the data source, according to the principle of refuge is Jane try to choose better quality and high degree of structured data sources, suggest the preferred command information system of structured data, and military comprehensive information network of semi-structured data, reduce knowledge acquisition cost. Secondly, it is necessary to avoid starting from scratch. In the process of military informatization construction, there are already many knowledge resources, such as ontology and thesaurus, which should be fully utilized. Finally, cross-domain migration, reusing knowledge of similar fields [7].

4.4. Knowledge Management

The main problem involved is the selection of management tools. Graph database and relational database are the most commonly used ones, and they have different applicable scale and operation complexity. Therefore, reasonable management schemes should be selected according to different scenarios.

From the map scale and complex operation, for millions, thousands of nodes, and the following the size of the knowledge graph can be used in a relational database or figure database, more than million node size chart is recommended for the database, involving complex operations such as calculation, complex global traversal of map figure database, it is necessary to adopt in order to realize efficient access [8]. In addition, the ease of use, popularity and maturity of the system should be taken into account.

References:
[1] He liang. Research on system and application of large-scale knowledge graphing service [D]. Hefei: university of science and technology of China,2018.
[2] hu fanghuai. Research on Chinese knowledge graph construction method based on multiple data sources [D]. Shanghai: east China university of science and technology,2015.
[3] guan saiping, jin xiaolong, jia yantao, et al. Progress in knowledge reasoning oriented to knowledge graphing [J]. Journal of software, 2008,29(10):2966-2994.
[4] Qi guilin, gao huan, wu tianxing. Progress in knowledge graphing research [J]. Information engineering,2017,3(1) : 4-25.
[5] Xu zenglin, sheng yongpan, he lirong, et al. Overview of knowledge graphing technology [J]. Journal of university of electronic science and technology of China,2016,45(4):589-606.
[6] xiao yanghua. Problems and countermeasures in the practice of DKGping [EB/OL].(2018-08-06).
[7] Li baozhen, su jing. DKG construction based on the content generated by experts [J]. Intelligence science, 2008,36(10):13-19.
[8] Li tao, wang qichen, li huakang. Development and construction of knowledge graph [J]. Journal of nanjing university of science and technology (natural science edition),2017,41(1):22-34