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Conference Paper · January 2018

DOI: 10.2991/icammce-18.2018.70

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Knowledge Reasoning Based on Knowledge Graph

Tian Chujun^{1,a}, Yu Hongzhi^{2,b} and Meng Xianghe^{3,c,*}

¹Key Laboratory of National language intelligent processing, China, Gansu Province, Lanzhou, 730030

²Key Lab of China's National Linguistic Information Technology, China, Lanzhou, 730030

³Key Laboratory of National language intelligent processing, China, Gansu Province, Lanzhou, 730030

1279525626@qq.com, wanfucheng@126.com, 554597360@qq.com

*Meng Xianghe

Key words: Knowledge Reasoning, Knowledge Graph, Rule Reasoning, Neural Network.

Abstract. Nowadays, with the rapid development of Internet technology and application mode, the scale of Internet data is growing geometrically, and a large number of valuable knowledge are also in it. How to organize and express these knowledge and carry out in-depth calculation and analysis have aroused widespread concern. Grow up under the environment. Knowledge reasoning based on knowledge graph is one of the hotspots in knowledge graph research. It plays an important role in vertical search, intelligent answering and other applications. Knowledge reasoning oriented to knowledge graph aims at reasoning out new knowledge or identifying wrong knowledge based on existing knowledge. Unlike traditional knowledge reasoning, the knowledge reasoning method facing knowledge graph is also more diverse because of the concise, flexible and flexible knowledge representation in knowledge graph. This article will be based on the basic knowledge reasoning. The concept of knowledge based knowledge reasoning is introduced in recent years. In particular, knowledge reasoning can be divided into single step and multistep reasoning, because the methods are not the same. Each class can be divided into rule based reasoning, distributed representation, reasoning based on the divine network, and mixed reasoning.

1. Introduction to knowledge inference

1.1 Basic concepts of knowledge reasoning

As for the basic concept of knowledge reasoning, various definitions have been given. Wang believes that reasoning is people of all kinds of things and decision analysis, synthesis, starting from the known facts, use has acquired knowledge, find out the fact that it contains, induces new facts or process ^[1]. Strictly speaking, it is known by the judgment to launch a new judgment according to certain strategy thought process. More specifically, Kompridis definition reasoning as a series of general ability, including the ability to consciously to understand things, the ability to establish and verify the facts, the ability to use logic and based on new or existing knowledge to change or verify the ability of the existing system. Tari similarly defined knowledge reasoning based on certain rules and constraints, get new knowledge from existing knowledge. In general, knowledge reasoning is the process of using the known knowledge with new knowledge.

1.2 Knowledge reasoning for knowledge graph

Knowledge-based reasoning based on knowledge graph is based on existing knowledge graph facts, reasoning new facts or identifying false knowledge. For example, DBpedia. Known triples (for X, birthplace, Y), to a large extent can reason out the lack of a triple formally said, knowledge graph usually use (head entities, relationships, end entity) triples expressed things attributes, and the semantic relations between the things ^[2], the things and the attribute value as a triad of entities,

attributes and relationships as the ternary group in the relationship. Knowledge graph completion is, in fact, given any two elements in the triad, trying to deduce another missing elements. In other words, a given head of entities and relationships (relations and tail entity), find out the effective triple tail entity (entity), also known as entity, by the same token, the head of a given entity and entity, find out the relationship between the formation of effective triples, also known as the relationship between forecasting. Both entity or relationship forecasting the final selection and given element into to form ternary group are more likely to be effective entity/relationship as reasoning forecast results. The validity can be by rules or scoring function to derivation based on certain assumptions. Knowledge graph denoising is actually judging whether the triples are correct. Although knowledge graph completion completely focused on expanding knowledge graph, knowledge graph denoising focus on knowledge graph inside three tuple is correct judgment, essentially evaluation of the effectiveness of the triad. Knowledge graph is essentially a kind of semantic network, the things in the real world and their mutual relations can be formally described, is a directed graph with tags, attributes, and through things visual expression of the semantic relationship between things, it's easy to find the node related knowledge, production, etc. Of knowledge graph in a structured way to express knowledge, the semantic relationships between attributes, and things that explicitly represented; Compared to the structured expression forms, such as frame, script, etc. knowledge graph in the things of the relationship between the properties and things of the characterization, in the form of a triple more concise intuitive, flexible, rich. Flexible framework reflected in do not need to use.

2. Reasoning based on traditional methods

2.1 A method based on traditional rule inference

The method of traditional rule inference is mainly based on the rule inference method in traditional knowledge inference, which USES simple rules or statistical characteristics to deduce the knowledge graph. And NELL internal reasoning components of knowledge graph by first-order relationship between probability of first-order language model is put forward by reasoning learning algorithm ProPPR (Programming with Personalized PageRank) knowledge reasoning in knowledge graph. PROPR to figure the clause, node corresponding to the target form structural connection or reasoning, including starting node is the query clause, step edge corresponds to the rules or reasoning, from one sentence to another clause, and the edge of the weight that is associated with characteristic vector^[3].

2.2 Method based on ontology reasoning

The ontology-based reasoning method mainly USES the more abstract ontological hierarchy of frequent patterns, constraints or paths. Buhmann and lehmann propose a pattern-based knowledge graph. First, frequent atomic patterns are found in the statistical analysis of multiple ontologies. And then we can look up these atomic patterns and related data on the specific knowledge graph, and get the candidate atomic set, which is an example of the atomic pattern, For example: atomic mode " $A \equiv B \cap \exists r. C$ " The corresponding atoms could be "SoccerPlayer \equiv Person $\cap \exists$ team. SoccerClub"; Finally, based on the correctness statistics in the knowledge graph, each candidate score was calculated and the knowledge graph was completed by using the candidate with threshold value greater than the threshold value^[4].

3. Single step reasoning

Step reasoning refers to the direct relationship between the knowledge graph the fact tuples in learning and reasoning, according to the method is different, the concrete can be divided into rule-based reasoning, based on the distributed said reasoning, reasoning based on neural network and hybrid reasoning.

3.1 Reasoning based on distributed representation

In single step reasoning, said first by expression of reasoning based on distribution model to study knowledge graph in fact a tuple, and received a low dimensional vector said knowledge graph, and then forecast reasoning based on the said model into a simple vector operation. Based on the distributed according to the single step reasoning based on transfer, based on tensor/matrix decomposition and the method based on the spatial distribution and other classes.

3.2 Reasoning based on neural networks

In single step reasoning, reasoning based on neural network using the neural networks directly to modeling of the fact that knowledge graph tuple, get the facts of tuple element vector said, for further reasoning. The method is still a kind of method based on the score function, different from other methods, the whole networks constitute a scoring function, the output of the neural network is the score values.

3.3 Mixed reasoning

Every single step reasoning method has its advantages and disadvantages. Combining with their advantages, the combination of multiple single-step reasoning is mixed reasoning. For example, the high accuracy based on rule reasoning, said reasoning based on distributed computing, point based on neural network inference ability and generalization ability. Hybrid step reasoning includes the rules and distributed, said as well as the hybrid neural network and a distributed reasoning.

4. Multi-step reasoning

In single step reasoning model on the basis of further step modeling is more relationship. Multi-step relationship is a kind of constraint, such as the following examples of relations between the two step: relationship between a and b r_1 , r_2 relationship between b and c existence, the two-step path corresponding to the direct relationship between the existing relationships is a and c r_3 . The introduction of multi-step relationship, some information can be more simulation, effect is better than the single step reasoning. According to the different method of reasoning, the multi-step equally divided into rule-based reasoning, based on the distributed said reasoning, reasoning based on neural network and hybrid reasoning.

4.1 Rule-based reasoning

Rule-based reasoning, multistep and single step are also different. Step of reasoning is often used is a simple experience rules or some frequent statistics. Many steps reasoning rules is more complex, such as transitivity rules. Given the effective and widely used transfer rules of high cost, these rules are usually made of entity the path between the approximate^[5]. According to the introduction of local structure, rule-based multi-step inference can be divided into the rule inference based on global structure and local structure.

4.2 Reasoning based on distributed representation

Based on distributed said one step and multiple step reasoning, is conducted through knowledge graph vectorization reasoning. However, multi-step reasoning in the process, the introduction of the multistep constraint relationship, entities and relationships of reasoning forecast will have more advantages.

4.3 Reasoning based on neural networks

Based on neural network reasoning in multi-step reasoning, this paper aims to use neural network modeling to learn the multi-step reasoning process, including modeling multi-step path and simulating the inference of computer or human brain.

4.4 Mixed reasoning

Hybrid reasoning in multi-step reasoning can achieve complementary advantages by mixing different multi-step methods. Distributed representation is usually used to mix with other methods because of its computational convenience. Hybrid multistep reasoning includes hybrid PRA and distributed representation, mixed rules and distributed representation, mixed rules, and neural network reasoning.

5. A typical application of knowledge reasoning

In the vertical Search field, in foreign countries, Google puts forward Knowledge Graph and Knowledge Vault, Facebook launches Graph Search and Microsoft launches Bing Satori. At home, Sougou came up with the knowledge cube and Baidu launched the Chinese knowledge graph search. Knowledge reasoning can better understand the user's search intention, provide close to specific, precise and deep vertical search, and answer complex reasoning questions. For example, Google search, enter a query in the Google search engine, and search engines use the exact answer directly give reasoning knowledge graph, display the search results on the right side of the entry of the deep information. Baidu's search, supported by the knowledge graph, can also better understand users' search intentions, similar to the precise answer of reasoning, with information sources. Quiz, IBM's Watson, Google now, apple's Siri, amazon's Alexa, Microsoft's Dana and little ice, and Baidu's secret is the most recent representative Q&A system. These systems provide accurate and concise answers based on knowledge graphs.

6. Summary of knowledge inference

Knowledge reasoning can be divided into single step and multi-step reasoning, because the method is not the same, each type and can be divided into rule-based reasoning, based on the distributed said reasoning, reasoning based on neural network and hybrid reasoning. The summary of various methods is shown in table1.

Category	Subclass	Methods described	Methods the advantages	Method shortcomings
Single step Reasoning	Rule-based reasoning	Use simple rules, statistical characteristics and other reasoning.	Strong interpretability; When the rules are correct, the accuracy is high.	The rules are not easy to obtain, not comprehensive, leading to low recall rate of reasoning results;
	Reasoning based on distributed representation	Using the knowledge graph representation model, the low-dimensional vector representation of the knowledge graph is expressed by the direction. The quantitative operation is predicted by inference.	The calculation is convenient and quick.	It is usually only considered to satisfy the constraints of the knowledge graph fact tuple, without considering further groups. With semantic information, reasoning ability is limited.
	Neural network Complex reasoning	The knowledge graph is directly modeled by neural network. Fact tuples.	Good reasoning ability.	Compared to reasoning based on distributed representation. The complexity is higher and the interpretability is weaker.
	Mixed reasoning	Mixing a variety of single-step reasoning methods.	Different reasoning methods have complementary advantages.	At present, it is still in the shallow mixing, that is, one method is the main and the other is auxiliary. There is a lack of a deeper hybrid model.
Multi-step reasoning	Rules-based reasoning	By mining global or local complex rules, The main reason is the transfer rules.	Automatic mining of complex rules, not through. Expert build.	The rules of mining are inevitably noisy. Sound, misleading reasoning.
	Distributed syllogism	The entities and relationships in the quantified fact tuple. At the same time, modeling multi-step relationship constraints.	Obtain a better knowledge graph to the scale. The ability of reasoning to predict is improved.	There may be cascading errors.
	Neural network. Complex reasoning	Use neural network to learn multi-step reasoning, straight. Modeling multistep path or inference process.	Expressive ability, strong reasoning ability.	Further enhancement of the interpretability is required.
	Mixed reasoning	Mixed multi - step reasoning method.	By taking advantage of different multi-step reasoning methods, a more effective hybrid model appears. Type: common modeling, strong reasoning ability	A mixture of two methods.

Summary of knowledge reasoning (table 1)

7. Conclusion

Along with the development of the information age, knowledge graph as a structured and semantic knowledge expression, caused widespread concern. Knowledge graph as the main

approach to complement and digestion of knowledge, the vertical search, intelligent question answering and machine translation etc played an important role. It has good application prospects in many fields such as disease diagnosis, financial security and abnormal data analysis.

Acknowledgement

This research was financially supported by the Central University Fundamental Research Funds Special Fund Project of Northwest Minzu University (Grant NO. 31920150034).

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