

# Research on the Transmission Path of COVID-19 Based on Knowledge Graph Reasoning Technology

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**Abstract:** The transmission process of the COVID-19 is complex. Traditional research on the transmission process mainly focuses on studying the overall transmission patterns or trends of infectious diseases at the macro level. It cannot analyze the transmission relationship between specific cases at the individual level or accurately locate the transmission path of the epidemic. And it is difficult to support precise prevention and control of infectious diseases. It is urgent to consider both spatiotemporal and semantic characteristics to study the transmission process of infectious diseases. This paper attempts to apply the knowledge reasoning technology in the Knowledge graph to the research on the transmission path of the COVID-19 epidemic based on the analysis of the population migrating from Wuhan during the COVID-19 epidemic, with a view to providing ideas.

**Keywords:** COVID-19; Knowledge Graph; Carnival; Knowledge Reasoning Technology

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## 1. Introduction

Since the announcement of the "lockdown" in Wuhan on January 23, 2020, many areas in Hubei Province have also quickly adopted the "lockdown" strategy to block crowd flow. However, according to information released by the Hubei Provincial Government on the evening of January 26, 2020, before the "lockdown" of Wuhan, more than 5 million people had left Wuhan, with an outflow rate of 35.7%. The fate of this group of people has become one of the focuses of research on the transmission path of the epidemic.

With the joint efforts of all sectors of society, information about the COVID-19 epidemic has gradually accumulated. Meanwhile, with the rapid development of the internet industry, there has been a significant increase in the amount of information, resulting in a mixture of effective and redundant information. However, the COVID-19 prevention and control information that has not been processed and integrated is difficult to achieve visual information display, and there are difficulties in the follow-up in-depth application.

In recent years, due to the outstanding performance of Knowledge graph in interactive knowledge reasoning and discovery, the research of Knowledge graph has attracted more and more attention. Knowledge graph, which is called knowledge domain visualization or knowledge domain mapping map in the library and information industry, is a series of different graphs that show the relationship between the development process and structure of knowledge. It uses visualization technology to describe knowledge resources and their carriers, and mine, analyze, build, draw and display knowledge and their relationships. This paper attempts to introduce the Knowledge graph into the study of the transmission path of COVID-19 epidemic. The main idea is to use Big data technology to sort out the movement track of infected people, track the contact history of people, establish a Knowledge graph, and provide important information for accurate positioning of the epidemic transmission path, prevention and control of the spread of the epidemic.

## 2. Literature Review

At present, the research on the spread of novel coronavirus pneumonia is mainly divided into two aspects. One is to rely on a warehouse model to analyze the peak of epidemic transmission, basic regeneration numbers, and epidemic control measures. Another

approach is to directly establish a model for the basic number of outbreaks, analyze the likelihood and trend of outbreaks, and study the factors that can affect the effective number of outbreaks.

In terms of warehouse model, Joseph T Wu et al. established a SEIR model using data from December 31 to January 28, and estimated the basic regeneration number using the number of departing passengers in Wuhan. Using the basic regeneration number, the model parameters were inversely deduced, and a conclusion was reached that as of January 25, 75815 people in Wuhan had been infected with the virus.

In terms of modeling the basic reproduction number directly, Shi Zhao et al. established an Exponential growth model of virus transmission, and concluded that the basic reproduction number of novel coronavirus pneumonia was between 2.89 and 3.58, and inferred that novel coronavirus pneumonia was about to break out. Wu Wentao, Bai Ruhai, and others established a SIR model based on epidemic data in Guangdong Province, calculated the effective number of outbreaks in Guangdong Province, and predicted that the effective number of outbreaks in Guangdong Province will decrease to below 1 around January 20th, when the epidemic will be under control.

Since the outbreak of COVID-19 epidemic, OpenKG has organized a series of COVID-19 related Knowledge graph, including COVID-19 scientific research Knowledge graph built by Chen Zhuo of Zhejiang University, COVID-19 event Knowledge graph built by Xiaomi Artificial Intelligence Laboratory and Hohai University, COVID-19 health Knowledge graph built by Xu Bin of Qinghua University, and COVID-19 concept Knowledge graph built by Zhang Yuzhou of Harbin Institute of Technology, The COVID-19 Epidemic Knowledge graph built by Li Jing of IBM China Research Institute, the COVID-19 Clinical Knowledge graph built by Cai Jiahui, the COVID-19 Hero Knowledge graph built by Wang Zhifeng, the COVID-19 Materials Knowledge graph built by Liu Yu of Wuhan University of Science and Technology, and the COVID-19 Encyclopedia Knowledge graph built by Wang Haofen and Qi Guilin. Domingo Fern á ndez and others proposed the Knowledge graph of COVID-19's physiological and pathological direction.

### **3. Theoretical Framework**

In May 2012, Google put forward the concept of Knowledge graph, which aims to optimize the performance of the browser's search engine to improve the comprehensiveness and accuracy of the search results. With the emergence of Knowledge graph, knowledge reasoning oriented to Knowledge graph as a basic service supporting upper application has aroused widespread concern.

Domestic research mainly focuses on two categories of methods: path rules and embedded representation learning. Random non directional random walks do not perform well in finding useful formulas, and may even mislead reasoning due to the introduction of noise. Deep reasoning based on large-scale knowledge bases requires a large number of formulas, but it is not possible to manually create all formulas. Although there are already algorithms that use random walks to obtain formulas, due to the diversity of formulas, they still cannot function well. In order to solve this problem, Zhouyu Wei et al. proposed a new object-oriented reasoning algorithm in 2016.

As the brain knowledge base of intelligent machines, the Knowledge graph has great potential in artificial intelligence, Natural language processing and other fields. Knowledge reasoning is of great significance in improving the construction process of the Knowledge graph, and has always been the focus of academic research. Therefore, in today's Big data era, the research on Knowledge graph construction technology based on data mining has innovative value and important scientific significance.

## **4. Analysis of Knowledge Graph Reasoning Technology**

### **4.1 Rule-Based Reasoning**

Rule based reasoning is a commonly used reasoning method in intelligent systems, and many knowledge system development tools also use it. Rule based reasoning has the advantage of intuitive reasoning.

Rule based reasoning is a special type of reasoning that uses "if then else" rule statements for inference. A rule is an inference engine search for patterns in data that match simple patterns and pattern rules. If "means" when the condition is true ", " then "means" take action A ", and" other "means" take action B when the condition is incorrect ".

Rule based reasoning is based on the knowledge and experience of domain experts, and its rule based representation is generally as follows:

IF  
AND  
Condition 2 AND  
Condition n  
THEN  
Conclusion 1 or Operation 1  
Conclusion 2 or Operation 2  
Conclusion m or Operation m

Rule based reasoning can be referred to as forward reasoning or data-driven reasoning because of their data or facts, and they begin to search for rules that apply to the facts until the goal is achieved. Rules can also be reverse reasoning, also known as goal driven reasoning, because they apply rules from the same goal and appearance to that goal until a conclusion is reached.

Rule: A rule is an expression based on Field Constraints, which includes several conditions and defines the actions that should be taken when these conditions are met.

## 4.2 Application of Knowledge Graph Reasoning Technology

Vertically concatenating the authorized location data of mobile phone users at different time periods can effectively draw the movement trajectory. This kind of individual data can track the disease transmission path of the infected person and locate the source of infection. With the Knowledge graph, it can lock the people who have been contacted by the infected person, so that prevention and control measures such as isolation and treatment can be taken in time to avoid the spread of the epidemic in a wider range.

Define the following rules:

Security\_ Verify (x):

-Place (p, x)

Security\_ Check (o, p)

X is the infected person, p is the location where x was infected, and o is the other person in p. When o is confirmed as an infected person, the output result is true.

## 4.3 Advantages and Disadvantages of Knowledge Graph Reasoning Technology

The Knowledge graph uses a map composed of nodes and relationships to intuitively model various scenes in the real world. It uses "graph", a basic and universal "language", to express various relationships in this colorful world in a "high fidelity" manner. It is very intuitive, natural, direct and efficient. It does not need intermediate process conversion and processing, simplifies the problem, but contains a lot of valuable information at the same time.

But there are also some drawbacks. Knowledge reasoning relies heavily on large-scale training data and is difficult to handle the problem of open world reasoning. At present, the quality of publicly available knowledge base data is not high and the data specifications are not uniform. Neural network-based knowledge reasoning is very sensitive to noise during training, and incorrect or ambiguous data will lead to learning bias. This type of problem is particularly evident in the hybrid reasoning process based on the combination of distributed representation learning and neural networks. The open world reasoning problem means that the current knowledge reasoning is still difficult to deal with the new things and new knowledge outside the Knowledge graph, and the interaction ability is insufficient. The application scenarios are mainly limited to using the existing information inside the Knowledge graph to supplement and reduce noise, and the function expansion is limited.

## 5. Conclusion

This paper believes that the basic idea of applying this reasoning technology to the transmission path of COVID-19 epidemic is feasible. However, with the continuous development of science and technology today, how to incorporate the Knowledge graph reasoning technology into the study of the transmission path of infectious diseases still needs to be constantly tried. I hope that the exploration of this technology can promote understanding and development in this field.

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