Applying AI and Ontologies to the Covid Pandemic

Waralak Vongdoiwang Siricharoen(✉)

Faculty of Information and Communication Technology, Silpakorn University Nonthaburi, Pak Kret 11120, Thailand
siricharoen_w2@su.ac.th

Abstract. The application of Artificial Intelligence (AI) and ontologies to the COVID-19 pandemic has been an active area of research and development. AI techniques such as machine learning, computer vision, and natural language processing have been used to analyze vast amounts of data generated by the pandemic, such as medical records, scientific literature, and social media posts. Ontologies, on the other hand, provide a structured representation of knowledge, which can be used to standardize data and facilitate data integration, enabling more efficient and effective data analysis.

Keywords: AI · Ontologies · Covid · Sematic Web

1 Introduction

The COVID-19 pandemic has shown us the importance of ontologies in disease control and prevention. By understanding the relationships between different concepts, we can better design systems and processes to respond to fast-changing circumstances. In this post, we'll explore how ontologies can be used in the context of a pandemic, and some of the challenges involved. We will also look at how the use of ontologies might change in the future as we learn more about diseases like COVID-19 (Kachaoui et al., 2020). an ontology related to the COVID-19 pandemic might represent the various entities involved in the pandemic, such as viruses, diseases, symptoms, and treatments, as well as the relationships between these entities. For example, an ontology might represent the fact that the COVID-19 virus is a type of coronavirus, and that it can cause symptoms such as fever, cough, and difficulty breathing. This information could then be used by computer systems to provide more intelligent services related to the pandemic, such as personalized advice or recommendations for preventing and treating the virus (Oyelad and Ezugwu, 2020). AI has been used in various ways to help stop the spread of covid-19. Some examples of AI-powered tools that have been used to help stop the spread of the virus include (Dhatterwal et al., 2021; Mcheick et al., 2022):

- AI-powered algorithms that can analyze large amounts of data, such as medical records and surveillance footage, to help identify potential outbreaks and track the spread of the virus.

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- AI-powered tools that can analyze medical images, such as CT scans and X-rays, to help doctors diagnose diseases more accurately and quickly.
- AI-powered chatbots and virtual assistants that can provide information and support to people who are self-isolating or have questions about the virus.
- AI-powered systems can assist with contact tracing, which involves identifying people who may have come into contact with someone who has tested positive for the virus, in order to prevent further transmission.

Overall, these AI-powered tools can help in the fight against covid-19 by providing doctors and public health officials with valuable tools and insights that can help improve diagnosis, treatment, and containment efforts.

2 AI and Ontologies

AI and ontologies are related in that ontologies are often used to provide a structured and organized framework for representing knowledge and information, which can then be used by AI systems to improve their performance. An ontology is a formal representation of a set of concepts within a domain, and the relationships between those concepts. It provides a common vocabulary that can be shared and understood by humans and machines, which enables them to communicate and reason about a particular domain (Lin et al., 2021).

For example, an ontology for the domain of medicine could define concepts such as diseases, symptoms, treatments, and so on, as well as the relationships between them. This ontology could then be used by an AI system to help it understand and reason about medical knowledge and data. For instance, the AI system could use the ontology to classify and diagnose diseases, or to recommend treatments based on a patient's symptoms. In this way, ontologies can provide a critical foundation for AI systems to operate effectively and make more accurate decisions.

AI is not a part of ontologies, but rather ontologies are used to provide a structured and organized framework for representing knowledge and information that can be used by AI systems. An ontology is a formal representation of a set of concepts within a domain, and the relationships between those concepts. It provides a common vocabulary that can be shared and understood by humans and machines, which enables them to communicate and reason about a particular domain (Schneider and Šimkus, 2020).

AI, on the other hand, refers to the ability of machines to perform tasks that typically require human intelligence, such as learning, problem-solving, and decision-making. AI systems can use ontologies as a source of structured and organized knowledge and information, which can help them to better understand and reason about a particular domain. However, AI is not a part of ontologies in the same way that, for example, the wheels are a part of a car. Instead, ontologies and AI are separate but related fields, with ontologies providing a useful tool for AI systems to operate more effectively (Groza, 2020).

In the context of the Co-vid pandemic, ontologies are being developed and applied in order to improve our understanding of the disease and its Spread. In particular, ontologies can be used to represent different aspects of the pandemic, including the symptoms, transmission routes, epidemiology and treatment options. By doing so, ontologies can

provide a common language for researchers to share and query data about the pandemic (Sherimon et al., 2020). Additionally, they can be used to support decision-making by identifying gaps in knowledge or areas where further research is needed (Fig. 1).

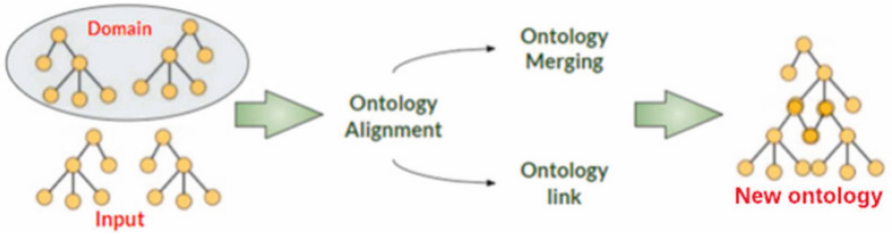

Fig. 1. Example of Methodology of creation of COVID-19 Pandemic ontology. (Source: https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.html?title=Click%20on%20image%20to%20zoom&p=PMC3&id=8677430_gr3_lrg.jpg).

One of an ontology being used in the context of Co-vid is the Semantic Web for Health Care and Life Sciences (SWHL) ontology. The SWHL ontology is a modular ontology that can be used to represent different aspects of health care, including diseases, treatments and clinical trials. The ontology has been used to represent data from the Co-vid Open Research Dataset (CORD-19), a dataset of scientific papers about the pandemic. By representing this data in an ontology, it becomes possible to query the dataset in order to answer specific questions about the pandemic. For example, the SWHL ontology can be used to find all papers that mention a particular symptom or transmission route.

The use of ontologies in the context of Co-vid highlights some of the advantages of using this approach. In particular, ontologies can provide a way to share and query data that is spread across different sources. Additionally, they can support decision-making by identifying gaps in knowledge or areas where further research is needed. However, there are also some challenges associated with using ontologies in this context. In particular, developing an ontology that accurately represents the domain of interest can be a challenging task.

Ontologies have been used in a number of ways to support the study and understanding of the COVID-19 pandemic. One example is the use of ontologies to represent the various entities involved in the pandemic (Sonntag, 2020), such as viruses, diseases, symptoms, and treatments, as well as the relationships between these entities. This can help to organize and structure large amounts of data and information related to the pandemic and can make it easier for computer systems to process and reason with that information.

Additionally, ontologies can be used to represent the various types of data that are relevant to the study of the pandemic, such as genetic sequences, clinical records, and epidemiological data, and can provide a common framework for representing and linking these data types. This can facilitate the integration and analysis of data from multiple sources and can support the development of more effective and efficient algorithms for

studying the pandemic. Overall, the use of ontologies can help to improve our understanding of the COVID-19 pandemic and can support the development of more effective response strategies.

There are many different ontology languages that could be used to represent information related to the COVID-19 pandemic. Some examples of languages that could be used for this purpose include OWL (Web Ontology Language), RDF (Resource Description Framework), and OWL-S (OWL for Services). These languages provide a way to represent ontologies on the web, which allows for the representation of complex concepts and relationships in a way that can be understood by machines (Patel et al., 2021).

These languages could be used to represent the various entities involved in the pandemic, such as viruses, diseases, symptoms, and treatments, as well as the relationships between these entities (Dutta and DeBellis, 2020). This information could then be used by computer systems to provide more intelligent services related to the pandemic, such as personalized advice or recommendations for preventing and treating the virus (El Bolock et al., 2021). Ultimately, the choice of ontology language will depend on the specific requirements and goals of the system, as well as the domain in which it will be used.

3 Covid Knowledge Representative

Human coronaviruses are responsible for a succession of severe epidemics that have negatively impacted global public health. China's citizens are in danger as a consequence of this development, which precipitated the current scenario. The inability of computers to analyse deconstructed and non-interoperable information hinders computer-assisted reasoning, the cornerstone of artificial intelligence.

It is thought that a lack of bioinformatics tools that can rapidly combine and evaluate a large range of data and information is one of the key challenges to the creation of effective anti-coronavirus treatments. Openness and interoperability of ontologies are fundamental needs when it comes to data integration and sharing. The construction of good ontologies that were appropriate for expressing such themes at the time needed more than the formation of taxonomies alone. This required the commencement of the collection of diverse data (He, 2022).

This creation of the ontology 'CIDO,' which was ridiculed as the community-driven source of the illness and which demonstrated the independent links relations with different hierarchies with the development of the illness process in a patient is due to the patient's infection with the virus (Saba et al., 2022). By modelling and visualising the host-coronavirus interaction pathways, it might be feasible to develop effective treatments and vaccines.

With the use of the Ontofox software, the subbranches of these ontologies including the mapped medications and their associated characteristics were extracted. Coronavirus vaccinations are modelled, represented, and analysed with Vaccine Ontology (CIDO). It is conceivable to apply CIDO in conjunction with VO to facilitate the extraction of gene-gene interactions linked with vaccines from published studies (He et al., 2020). The Coronavirus Infectious Disease Ontology (CIDO) is a community-based ontology that supports coronavirus disease knowledge and data standardization, integration, sharing, and analysis(He et al., 2020) (Fig. 2).

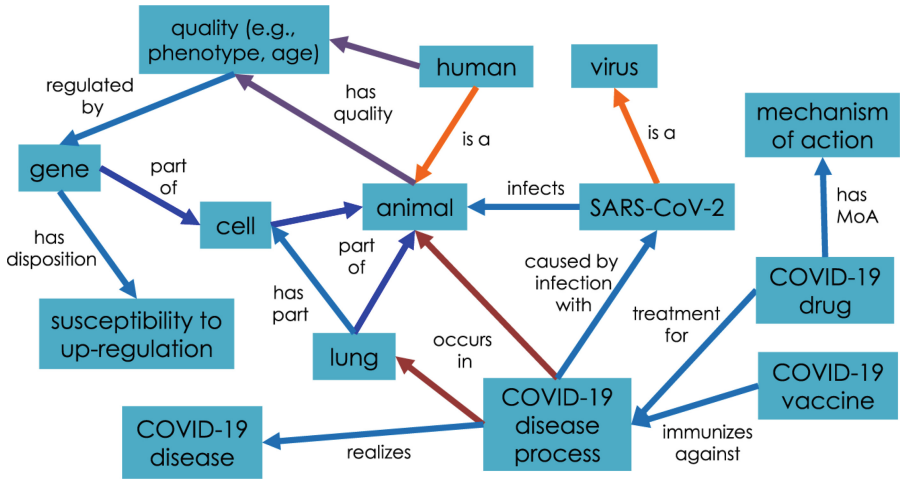

Fig. 2. The design pattern of CIDO for logically representing and linking different components related to a coronavirus disease, e.g., COVID-19.
(Source: https://media.springernature.com/lw685/springer-static/image/art%3A10.1038%2Fs41597-020-0523-6/MediaObjects/41597_2020_523_Fig1_HTML.png?as=webp).

This standard may be used to assess data from clinical and fundamental research, as well as to correlate the sickness phenotype and transmission data with the underlying mechanisms that were discussed in the prior aims. We foresee the development and deployment of ground-breaking computational and statistical approaches and tools that will support basic research of processes as well as translational applications such as the prediction of drugs and vaccinations (Liu et al., 2021).

However, there is still much work to be done in terms of understanding the full extent of the Co-vid pandemic and how it is affecting different parts of the world. However, the use of ontologies is an important step in ensuring that the latest information is properly represented and can be used to improve the response to the pandemic.

4 Ontologies Application for Covid-19

Organizations are turning to ontologies to help them manage the COVID-19 pandemic. An ontology is a knowledge representation that uses a formal vocabulary to describe relationships between concepts. This can be used to represent information about the pandemic, such as the symptoms of the disease, the transmission methods, and the treatments.

The use of ontologies allows different organizations to share information about COVID-19. This is because ontologies provide a common vocabulary that can be used by computers to interpret the data. This way, organizations can exchange information about COVID-19 without needing to agree on every individual piece of data.

Ontologies can also be used to support decision-making during the pandemic. By representing different pieces of information in a formal way, ontologies can help decision-makers see the big picture and identify potential solutions. For example, an ontology

could be used to represent the different types of data that are needed to make a decision about whether or not to implement a lockdown (Kesgavarzi and Ghaffary, 2022).

The use of ontologies is not limited to COVID-19. They have been used in other domains, such as healthcare and finance. However, the COVID-19 pandemic has highlighted the need for better ways of sharing information between organizations. As the world continues to grapple with the pandemic, ontologies will play an important role in helping us manage the crisis (Wang and He, 2021).

In addition, it appears that combining information from various sources can be an effective method for the purposes of analysis and visualisation of the application to COVID-19, as it is necessary to investigate the various factors and aspects that could potentially alter the patterns of mutations, as well as other aspects such as RNA expressions, productions and functions of protein, and metabolism, which could also influence the clinical outcomes (Hwerbi, 2020).

An example is the comprehension of protein, which might be the important component and foundation for the AI's representation and reasoning, since it acts as the essential basis for the aspect. Moreover, the development of the algorithms and tools on the interperable ontologies would also help to increase the efficacy of AI learning machine technology (Wang and He, 2021), as the performance has been influenced by the collection of large amounts of omics data and knowledge, which demonstrates that the application can be used to model, standardise, and integrate into the experiment and clinical anti-covid-19 medications.

In addition, for the paradigm ship, it is essential to comprehend the foundation of the ontology theories and frameworks by presenting precision omics, which may be the impact aspect, in order to complete the correct application process.

Applying AI and ontology to the COVID-19 epidemic can provide several benefits and is considered necessary for various reasons. Here are some key points that illustrate why it's essential:

1. **Data Management and Analysis:** The COVID-19 pandemic has generated an enormous amount of data, including infection rates, genomic sequences, clinical data, and more. AI can help manage and analyze this data more efficiently than traditional methods. Ontologies can structure and categorize the data, making it easier to understand and use.
2. **Early Detection and Prediction:** AI can be used to develop predictive models that help identify potential outbreaks and hotspots early. Machine learning algorithms can analyze historical data to forecast the spread of the virus, allowing authorities to take preventive measures in advance.
3. **Drug Discovery and Vaccine Development:** AI and machine learning are being used to expedite drug discovery and vaccine development processes. These technologies can analyze molecular structures and identify potential candidates for treatments or vaccines, significantly accelerating research efforts.
4. **Resource Allocation:** During a pandemic, resources like hospital beds, ventilators, and medical personnel become crucial. AI can help optimize resource allocation by predicting the demand for healthcare services in different regions, ensuring that resources are distributed efficiently.

5. **Contact Tracing:** Contact tracing is vital in controlling the spread of the virus. AI-powered contact tracing apps can identify potential exposures more quickly and accurately than manual methods, helping health authorities contain outbreaks.
6. **Public Health Policy:** AI can assist policymakers by simulating various scenarios and their potential outcomes. This helps in making data-driven decisions about lockdowns, social distancing measures, and vaccination strategies.
7. **Research Assistance:** Ontologies can help researchers categorize and understand the vast amount of scientific literature related to COVID-19. This can facilitate knowledge discovery and collaboration among scientists.
8. **Real-time Monitoring:** AI systems can continuously monitor data streams and news sources to provide real-time updates on the pandemic's status. This information can be invaluable for both the public and healthcare professionals.
9. **Personalized Healthcare:** AI can analyze patient data to provide personalized treatment recommendations, helping healthcare providers tailor care to individual needs and improve outcomes.
10. **Public Awareness and Communication:** AI-powered chatbots and virtual assistants can provide accurate information to the public, combat misinformation, and answer common questions about COVID-19, promoting public health awareness.

In summary, applying AI and ontology to the COVID-19 epidemic is necessary because it can significantly enhance our ability to manage and respond to the crisis effectively. These technologies enable better data management, analysis, prediction, and decision-making, ultimately helping to save lives and mitigate the impact of the pandemic.

The advantages and disadvantages of applying AI and ontologies to the COVID-19 pandemic:

Advantages:

1. **Efficient Data Management**: AI and ontologies can efficiently categorize and manage the vast amount of data related to COVID-19, making it easier for researchers and healthcare professionals to access and utilize this information.
2. **Data Analysis and Insights**: AI can analyze complex datasets to extract valuable insights, such as predicting disease spread patterns, identifying potential treatment options, and assessing the impact of public health interventions.
3. **Early Detection**: AI-powered models can detect potential outbreaks and hotspots early, enabling timely response measures to contain the virus's spread.
4. **Drug Discovery and Vaccine Development**: AI accelerates the drug discovery process by analyzing vast molecular datasets and predicting potential candidates for treatments and vaccines.
5. **Resource Allocation**: AI helps optimize the allocation of healthcare resources, ensuring that medical facilities have the necessary equipment and staff to respond to the pandemic effectively.
6. **Contact Tracing**: AI-driven contact tracing apps can identify potential exposures quickly and accurately, helping to break the chain of transmission.
7. **Public Health Policy**: AI models can simulate different scenarios, aiding policymakers in making informed decisions about public health measures and vaccination strategies.

8. **Real-time Monitoring**: AI can continuously monitor data sources, providing up-to-date information to healthcare professionals and the public, which is crucial for informed decision-making.
9. **Research Assistance**: Ontologies help researchers categorize and understand scientific literature, facilitating knowledge sharing and collaboration among scientists.
10. **Personalized Healthcare**: AI enables personalized treatment recommendations based on patient data, improving healthcare outcomes.

Disadvantages:

1. **Data Privacy Concerns**: The use of AI for contact tracing and data analysis may raise concerns about data privacy and surveillance, leading to potential privacy breaches and misuse of personal information.
2. **Data Quality**: AI models heavily rely on the quality of data. Inaccurate or biased data can lead to flawed predictions and recommendations.
3. **Ethical Concerns**There can be ethical dilemmas, such as deciding who should have access to potentially life-saving treatments and vaccines when resources are limited.
4. **Algorithm Bias**: AI models may exhibit bias, which can result in unequal outcomes for different populations, exacerbating healthcare disparities.
5. **Complexity and Cost**: Implementing AI and ontologies requires significant resources, including infrastructure, expertise, and funding, which may not be readily available in all regions.
6. **Dependency on Technology**: Overreliance on AI could lead to a lack of human expertise and decision-making, which is essential in complex situations.
7. **Misinformation**: AI can be used to spread misinformation and false narratives, making it crucial to verify information from credible sources.
8. **Regulatory Challenges**: Regulating AI in healthcare and pandemic response can be challenging, as the technology evolves rapidly, and there may be a lack of clear guidelines.
9. **Limited Generalization**: AI models may not generalize well across different regions or situations, making it necessary to adapt them for local contexts.

In conclusion, while applying AI and ontologies to the COVID-19 pandemic offers significant advantages in terms of data analysis, early detection, and resource allocation, it also raises important concerns related to privacy, bias, ethics, and the potential for misuse. A balanced approach that addresses these challenges while leveraging the benefits of AI is crucial for effective pandemic response.

The specific applications of AI and ontology to the COVID-19 pandemic:

1. Early Detection and Prediction:

- **AI Models for Early Warning**: AI algorithms can analyze various data sources, including social media, hospital admissions, and travel patterns, to detect early signs of outbreaks or unusual disease activity.
- **Ontologies for Data Standardization**: Ontologies can standardize data related to symptoms, cases, and geographical locations, making it easier to detect trends and anomalies.

2. Contact Tracing and Monitoring:

- **AI-Powered Contact Tracing**: AI can enhance contact tracing efforts by processing large datasets, identifying potential contacts, and tracking transmission chains.
- **Ontologies for Contact Data**: Ontologies can structure contact data, ensuring consistency and interoperability between contact tracing systems.

3. Drug Discovery and Treatment:

- **Drug Repurposing**: AI can analyze existing drug databases and scientific literature to identify existing drugs that could be repurposed for COVID-19 treatment.
- **Ontologies for Drug Data**: Ontologies can organize drug-related data, facilitating the discovery of potential treatments and their mechanisms of action.

4. Vaccine Development:

- **AI-Driven Vaccine Design**: AI algorithms can help design new vaccines by predicting antigen structures and optimizing vaccine candidates.
- **Ontologies for Vaccine Data**: Ontologies can standardize vaccine-related information, aiding in the development and distribution of vaccines.

5. Healthcare Resource Allocation:

- **Resource Optimization**: AI can predict the demand for medical resources, such as ventilators and ICU beds, and recommend allocation strategies.
- **Ontologies for Resource Data**: Ontologies can structure data on healthcare facilities and resources, ensuring efficient allocation.

6. Public Health Policy and Decision Support:

- **Scenario Simulation**: AI models can simulate different pandemic scenarios, helping policymakers evaluate the impact of various interventions.
- **Ontologies for Policy Data**: Ontologies can categorize policies and interventions for better decision-making.

7. Real-time Monitoring and Alerts:

- **AI-Powered Dashboards**: AI can create real-time dashboards that provide up-to-date information on COVID-19 cases, hospitalizations, and vaccine distribution.
- **Ontologies for Data Integration**: Ontologies can integrate data from diverse sources, ensuring comprehensive monitoring.

8. Research and Literature Review:

- **Literature Mining**: AI can analyze scientific literature to extract relevant information, trends, and potential research gaps.
- **Ontologies for Scientific Data**: Ontologies can categorize research findings and concepts for better collaboration among researchers.

9. Personalized Healthcare:

- **Patient Risk Assessment**: AI can assess individual patient risks based on medical history and demographics, aiding in treatment decisions.

- **Ontologies for Healthcare Data**: Ontologies can standardize patient data for personalized healthcare applications.

These applications highlight how AI and ontologies can be instrumental in various aspects of the COVID-19 pandemic, from early detection and contact tracing to drug discovery, vaccine development, resource allocation, policy-making, real-time monitoring, and personalized healthcare. Implementing these technologies effectively can contribute to better pandemic management and response.

5 Conclusion

As the world races to find a cure for the Co-vid pandemic, ontologies are being applied in ways that could help speed up the process. By understanding the relationships between the different concepts related to the disease, researchers can more quickly identify potential treatments and cures. The application of ontologies in this context is still in its early stages but has great potential to help us better understand and fight this global threat.

AI has been used in various ways to help stop the spread of covid-19. For example, AI-powered tools can be used to analyze medical images, such as CT scans and X-rays, to help doctors diagnose the disease more accurately and quickly. AI-powered algorithms can also be used to analyze large amounts of data, such as medical records and surveillance footage, to help identify potential outbreaks and track the spread of the virus.

Additionally, AI-powered chatbots and virtual assistants can help provide information and support to people who are self-isolating or have questions about the virus. Overall, AI can help in the fight against covid-19 by providing doctors and public health officials with valuable tools and insights that can help improve diagnosis, treatment, and containment efforts. Instead, ontologies and AI are separate but related fields, with ontologies providing a useful tool for AI systems to operate more effectively.

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