# Johns Hopkins and Duke develop PandemicLLM to revolutionise infectious disease forecasting



The recent development of an innovative artificial intelligence tool could significantly reshape how we predict and manage infectious diseases, particularly in the wake of the Covid-19 pandemic. Researchers at Johns Hopkins University and Duke University have unveiled PandemicLLM, a large language model designed to forecast the spread of various infectious diseases, including bird flu, monkeypox, and RSV. This ground-breaking tool promises to enhance public health strategies by allowing for more accurate predictions based on complex, real-time data.

According to Lauren Gardner, a key figure in this research and creator of the widely used Covid dashboard, the Covid crisis elucidated the challenges inherent in forecasting disease spread, particularly when faced with rapidly changing conditions. “When conditions were stable the models were fine. However, when new variants emerged or policies changed, we were terrible at predicting the outcomes,” Gardner explained. The newly developed tool aims to fill this crucial gap in pandemic response modelling.

PandemicLLM employs a sophisticated framework that considers a multitude of factors, such as recent infection spikes, emerging variants, and public health policies. This multifaceted approach allows it to leverage data from sources previously untapped in pandemic predictions, including hospitalization rates, vaccination data, policy characteristics, and state-level demographics. Retroactively applying its capabilities to the Covid pandemic, the model was able to accurately assess metrics across 50 states over a 19-month period, outperforming existing forecasting methods.

Hao "Frank" Yang, an assistant professor at Johns Hopkins, remarked, “Traditionally we use the past to predict the future, but that doesn’t give the model sufficient information to understand and predict what’s happening. Instead, this framework uses new types of real-time information.” As a testament to its efficacy, PandemicLLM demonstrated its capabilities particularly well during periods of uptick and uncertainty within the pandemic landscape.

Research indicates that far-reaching implications extend beyond just Covid-19. With a resurgence of diseases like H5N1 bird flu and measles, the need for effective forecasting tools is increasingly pressing. Vaccination rates have faced a worrying decline since the pandemic, raising fears that progress in public health could regress significantly. Gardner warns, “We know from Covid-19 that we need better tools so that we can inform more effective policies. There will be another pandemic, and these types of frameworks will be crucial for supporting public health responses.”

The potential of large language models in epidemiological forecasting is further underscored by other studies exploring similar methodologies. For instance, the integration of OpenAI's ChatGPT into transmission modelling has shown promise in enhancing public health preparedness, albeit within specific case studies. Similarly, the University of Florida is working on an algorithm to predict COVID-19 variants, which may help preempt potential outbreaks linked to emerging mutations.

As the landscape of infectious disease management continues to evolve, tools like PandemicLLM highlight the critical need for robust, flexible models capable of addressing not just current health crises but also preparing us for future challenges. The lessons learned from Covid-19 underscore a crucial truth: the importance of advanced predictive technologies in safeguarding public health remains paramount.

### 📌 Reference Map:

* Paragraph 1 – [[1]](https://www.independent.co.uk/news/health/ai-pandemic-covid-artificial-intelligence-b2765177.html), [[2]](https://arxiv.org/abs/2404.06962)
* Paragraph 2 – [[1]](https://www.independent.co.uk/news/health/ai-pandemic-covid-artificial-intelligence-b2765177.html), [[4]](https://pubmed.ncbi.nlm.nih.gov/39286528/)
* Paragraph 3 – [[1]](https://www.independent.co.uk/news/health/ai-pandemic-covid-artificial-intelligence-b2765177.html), [[5]](https://engineering.tamu.edu/news/2020/09/researchers-harness-big-data-and-artificial-intelligence-to-predict-future-pandemic-spread.html)
* Paragraph 4 – [[1]](https://www.independent.co.uk/news/health/ai-pandemic-covid-artificial-intelligence-b2765177.html), [[6]](https://pmc.ncbi.nlm.nih.gov/articles/PMC8192906/)
* Paragraph 5 – [[1]](https://www.independent.co.uk/news/health/ai-pandemic-covid-artificial-intelligence-b2765177.html), [[7]](https://news.ufl.edu/2025/03/ai-can-help-predict-the-next-pandemic/)

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## Bibliography

1. <https://www.independent.co.uk/news/health/ai-pandemic-covid-artificial-intelligence-b2765177.html> - Please view link - unable to able to access data
2. <https://arxiv.org/abs/2404.06962> - This study introduces PandemicLLM, a novel framework employing multi-modal Large Language Models (LLMs) to forecast the spread of infectious diseases. By integrating diverse data sources, including epidemiological time series, viral biology, and public health policies, PandemicLLM reformulates real-time forecasting as a text reasoning problem. Applied to the COVID-19 pandemic across all 50 U.S. states, the model demonstrated high performance, effectively capturing the impact of emerging variants and providing timely, accurate predictions. The research highlights the potential of LLMs in enhancing pandemic forecasting and crisis management.
3. <https://arxiv.org/abs/2505.12738> - EpiLLM is a framework tailored for spatio-temporal epidemic forecasting, leveraging Large Language Models (LLMs). It introduces a dual-branch architecture to align complex epidemic patterns with language tokens, enabling fine-grained token-level alignment. The autoregressive modeling paradigm reformulates epidemic forecasting into next-token prediction, and spatio-temporal prompt learning techniques enhance LLM perception of epidemics. Extensive experiments on real-world COVID-19 datasets show that EpiLLM significantly outperforms existing baselines, exhibiting scaling behaviour characteristic of LLMs, and demonstrates the potential of LLMs in epidemic forecasting.
4. <https://pubmed.ncbi.nlm.nih.gov/39286528/> - This study explores the integration of OpenAI's ChatGPT, a Large Language Model (LLM), into infectious disease transmission modelling for public health preparedness. Through a case study, ChatGPT collaborated with a public health practitioner to co-design a mathematical transmission model. The validated model replicated the epidemic curve and estimated key epidemiological parameters, highlighting the advantages of using maximum likelihood estimation with Poisson distribution over least squares methods. The research underscores the potential of LLMs in accelerating model development and enhancing pandemic preparedness, particularly in resource-constrained settings.
5. <https://engineering.tamu.edu/news/2020/09/researchers-harness-big-data-and-artificial-intelligence-to-predict-future-pandemic-spread.html> - Researchers at Texas A&M University have developed a deep-learning computational model that utilises artificial intelligence and existing big data related to population activities and mobility to predict the future spread of COVID-19 cases at a county level. The model accounts for features such as movement within a community, census data, social-distancing data, past case count growth, and social demographics, achieving 64% accuracy, which is twice the accuracy of an untrained model. The research demonstrates the potential of big data and AI in improving pandemic surveillance, prediction, and policy development.
6. <https://pmc.ncbi.nlm.nih.gov/articles/PMC8192906/> - This scoping review examines the role of machine learning (ML) in forecasting infectious disease dynamics and the effects of interventions. Forty studies utilised ML to identify factors influencing disease spread, fit epidemic curves, and forecast infectious disease dynamics or effects of interventions. The review highlights that while ML has been applied to augment traditional modelling approaches, especially early in the pandemic when data were limited, as more data became available, ML was leveraged to analyse temporal COVID-19 data and integrate additional data sources, such as health and demographic information, to provide more accurate predictions.
7. <https://news.ufl.edu/2025/03/ai-can-help-predict-the-next-pandemic/> - Researchers at the University of Florida’s Emerging Pathogens Institute have developed an algorithm capable of predicting which COVID-19 variant in circulation is most likely to become dominant in the next three months. By training these algorithms on publicly available genetic sequences of SARS-CoV-2, scientists can predict which mutations will pose the greatest threat to public health, potentially preventing future outbreaks and enhancing preparedness.