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Review Article

How Large Language Models Can Be Used in the Field of Orthodontics

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Abstract

Large language models (LLMs) are a type of artificial intelligence algorithm that are neural networks with many parameters (typically billions of weights or more), trained on large quantities of unlabelled text using self-supervised learning. LLMs emerged around 2018 and performed well at various tasks, such as natural language understanding, generation, question answering, summarization, translation, and more. LLMs have the ability to generate realistic and coherent text that can pass the Turing test, write fiction, develop computer code, and speculate on the future. LLMs are also known as foundation models, as they can be fine-tuned or adapted to specific domains and applications.

Keywords: *Large Language Models (LLMs); Artificial Intelligence; Orthodontics; Turing Test*

Introduction

Large language models (LLMs) are a type of artificial intelligence algorithm that are neural networks with many parameters (typically billions of weights or more), trained on large quantities of unlabelled text using self-supervised learning [3]. LLMs emerged around 2018 and perform well at a wide variety of tasks, such as natural language understanding, natural language generation, question answering, summarization, translation, and more [2]. LLMs have the ability to generate natural and coherent text that can pass the Turing test, write fiction, develop computer code, and speculate on the future [1]. LLMs are also known as foundation models, as they can be fine-tuned or adapted to specific domains and applications [2].

One of the fields that could profit from LLMs is orthodontics, the branch of dentistry that deals with the diagnosis, prevention, and correction of malocclusion and jaws. Orthodontics is a complex and multidisciplinary field that requires a lot of knowledge and skills from practitioners, such as anatomy, biomechanics, materials science, radiology, diagnosis, treatment planning, appliance design, patient management, and more. Orthodontists must also communicate effectively with patients, colleagues, and other health professionals. In this article, we will explore some possible use case scenarios, problems that can be solved in orthodontic practice, current limitations, and future possibilities of LLMs in orthodontics.

Use case scenarios

Current iterations of LLMs can be used in orthodontics for various purposes, such as:

- **Information retrieval and summarization**: LLMs can help orthodontists find relevant and reliable information from large and diverse sources of data, such as scientific literature, clinical guidelines, case reports, patient records, radiographs, etc. LLMs can also help orthodontists summarize the key points and insights from these sources in a concise and understandable way.

- **Providing additional data to make clinical decisions**: LLMs can help orthodontists answer complex and specific questions related to orthodontic problems, such as diagnosis, treatment options, prognosis, risks, and benefits, etc. LLMs can also help orthodontists make informed and evidence-based decisions by providing suggestions and recommendations based on best practices and data analysis.
- **Natural language generation and communication**: LLMs can help orthodontists generate natural and coherent text for various purposes, such as writing discharge letters, progress notes, referrals, consent forms, educational materials, etc. LLMs can also help orthodontists communicate effectively with patients and other stakeholders by generating personalized and empathetic responses to their queries and feedback.
- **Creative appliances and content generation**: LLMs can help orthodontists generate creative content for various purposes, such as designing novel and customized appliances, creating engaging and interactive educational games or simulations for patients or students, generating realistic and diverse scenarios for training or testing purposes, etc.

Problems that can be solved in orthodontic practice

Training the existing LLMs with the appropriate datasets can help solve some of the common problems that orthodontists face in their practice, such as:

- **Information overload**: Orthodontists have to deal with a large amount of information from various sources that are constantly updated and sometimes conflicting. LLMs can help orthodontists filter out irrelevant or unreliable information and focus on the most important and useful ones.
- **Knowledge gap**: Orthodontists have to keep up with the latest advances and innovations in their field that are often beyond their expertise or experience. LLMs can help orthodontists learn new concepts and skills by providing explanations, examples, and feedback.
- **Time constraint**: Orthodontists have to manage multiple tasks and responsibilities within a limited time frame. LLMs can help orthodontists save time by automating some of the tedious or repetitive tasks, such as data entry, documentation, reporting, etc.
- **Patient satisfaction**: Orthodontists have to provide high-quality care and service to their patients who have different needs, expectations, and preferences. LLMs can help orthodontists improve patient satisfaction by providing personalized and tailored solutions, enhancing patient education and engagement, and building trust and rapport.

Current limitations

Despite the potential benefits of LLMs in orthodontics, there are also some challenges and limitations that need to be addressed, such as:

- **Data quality**: LLMs rely on large amounts of data to be trained effectively, but the data may not be always available, accurate, or representative of the target population or domain. For example, LLMs trained on general text corpora may not capture the specific terminology and concepts of orthodontics or may reflect biases and misinformation from the web sources. Therefore, LLMs need to be carefully curated and validated before being applied to orthodontic tasks.
- **Model complexity**: LLMs are very large and complex models that require a lot of computational resources to train and run. This poses challenges to the scalability and efficiency of LLMs in orthodontic settings. For example, LLMs may not be easily deployed on mobile devices or embedded systems that are commonly used by orthodontists or patients. Therefore, LLMs need to be optimized and compressed to reduce their size and latency without compromising their performance.
- **Model interpretability**: LLMs are often seen as black boxes that generate outputs without explaining how they arrived at them. This poses challenges for the transparency and accountability of LLMs in orthodontic settings. For example, LLMs may not provide sufficient evidence or justification for their recommendations or decisions or may generate outputs that are inconsistent or contradictory with human knowledge or expectations. Therefore, LLMs need to be augmented with interpretability techniques that can provide insights into their internal workings and outputs.

Future possibilities

Despite the current limitations of LLMs in orthodontics, there are also some promising opportunities and possibilities for future research and development, such as:

- **Data augmentation**: LLMs can help augment existing data sources for orthodontic tasks by generating synthetic data that can enrich or complement the real data. For example, LLMs can generate realistic images of teeth and jaws based on textual descriptions or sketches or can generate textual annotations for images based on visual features. This can help overcome data scarcity or imbalance issues and improve the quality and diversity of data for orthodontic tasks.
- **Knowledge extraction**: LLMs can help extract useful knowledge from unstructured data sources for orthodontic tasks by identifying relevant entities, relations, facts, events, etc. For example, LLMs can extract key information from scientific literature, clinical guidelines, case reports, patient records, radiographs, etc. and organize them into structured formats such as knowledge graphs or databases. This can help facilitate information retrieval and summarization and support question-answering and decision-making for orthodontic tasks.
- **Knowledge synthesis**: LLMs can help synthesize new knowledge from existing data sources for orthodontic tasks by generating novel hypotheses, insights, predictions, etc. For example, LLMs can generate new ideas for appliance design based on existing designs and patient preferences or can generate plausible scenarios for treatment outcomes based on existing cases and data analysis.

Conclusion

- Large language models (LLMs) are powerful and versatile tools that can be used in the field of orthodontics for various purposes, such as Information retrieval, Processing, and knowledge synthesis which has significant academic promise.
- LLMs can also help the clinician with treatment planning, decision-making, creative solutions, and Patient management by automating part of their practice.
- However, LLMs also have some challenges and limitations that need to be addressed, such as data quality, model complexity, and model interpretability. Therefore, LLMs need to be carefully curated and validated, optimized and compressed, and augmented with interpretability techniques before being applied to orthodontic tasks.
- It should be kept in mind that LLMs and other artificial intelligence algorithms are the worst that they will ever be. As of writing this article developments in this field are happening at an exponential rate. The field of Orthodontics must prepare for the next paradigm shift in society.

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We have used Chat GPT to formulate ideas and clarify the language of the same article.

Bibliography

1. Arora A and Arora A. "The promise of large language models in health care". *Lancet* 401.10377 (2023): 641.
2. Fan L., *et al*. A Bibliometric Review of Large Language Models Research from 2017 to 2023 (2023).
3. Wikipedia contributors. "Large language model". Wikipedia, The Free Encyclopedia (2023).

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