Patent Analysis on Generative Language Models

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Abstract - *Nowadays the evolution of Artificial Intelligence is covering the large area of applications. The Generative AI models gaining more popularity as they are capable of generating the new content as humans using Machine Learning and Neural Networks. In this patent analysis paper, we are collecting the patents related to Generative Language Models and analyzing them in terms of number of patents per year, assignee and geographical area. This growth of number of patents in Generative Language Models provides us the way for future research work.*

Keywords: **Artificial Intelligence, Generative AI, Generative Language Models, Machine Learning and Neural Networks**

1.INTRODUCTION

Deep learning is a subset of artificial intelligence that is based on the neural networks. The neural networks can be trained using supervised, unsupervised and semi-supervised algorithms [1]. Deep learning has wide area of applications including computer vision, natural language processing, medical image processing. Generative AI (GenAI) is a type of AI technology capable of generating new data like text, image, video and other based on the data it is trained. GenAI is the subset of deep learning, uses artificial neural networks. It can process labeled and unlabeled data using supervised, unsupervised and semi-supervised models. It is capable of generating new data like text, image, video and other based on the data it is trained.

2 GENERATIVE LANGUAGE MODEL

Generative language model is an Artificial Intelligence used to generate the text that are relevant to the context based on the prompt it received. This model is trained on vast amount of text data in order to understand and interact in the way the humans are. Some of the examples of Generative Language Models are GPT (Generative Pre-trained Transformer), BERT (Bidirectional Encoder Representations from Trnasformers), T5 (Text-To-Text Transfer Trnasformer), XLNet, OpenAI Codex.

2.1 Working

Generative language models are trained on large training datasets which are both labeled and unlabeled [2]. The training datasets is large and comprising of diverse text from various data sources including books, internet, articles and other.

A deep learning neural network is used to make the model to learn patterns and relationships in the text to mimic human. The neural network architecture used is the transformer architecture. This architecture is based on self-attention mechanism the essential one to understand the language [3].

Tokens are the smaller units of text used by the language models to process the text. The statistical relationship between the tokens are analysed and the next token is predicted in the text sequence. Tokenization varies from model to model.

Reinforcement Learning from Human Feedback(RLHF) is used to train the language models. RLHF is a technique which allow the language model to align to human preferences. It has been evolved from Preference-based Reinforcement Learning (PbRL) and has wide area of application including natural language processing and computer vision [4].

2.2. Applications

Generative language models are evolving randomly and have significant role in various domain.

Text generation- Language models can generate coherent, contextually relevant text and controllable text. A transformer-based pre-trained language model is used with some modification to generate controllable text [5, 6, 7].

Language Translation- Language models are used to translate text from one language to another.

Content creation- Generative Language Model can be used to create the new contents including text, audio, video and it is often cannot be distinguished from human content [8].

Conversational AI– generative AI models like ChatGPT, chatbots and virtual assistants are used in variety of tasks during conversation like generating text, summarizing text and answering questions.

3. PATENT ANALYSIS

A patent is an intellectual property right, to protect inventions and gives legal right to the owner for limited

period of time [9]. Analysing a patent is a detailed examination of various factors affecting it. The patent analysis directs us in the way of problem solving, decision making and finding the research gap. Number of analysis frameworks are available to analyse the patent which include Strengths, Weakness, Opportunity and Challenges/Strengths, Weakness, Opportunity and Threats analysis [10, 11, 12, 13, 14], Advantages, Benefits, Constraints and Disadvantages analysis [15, 16, 17], Political, Economic, Social, Technological, Environmental and Legal factors analysis [18, 19, 20], Competitive forces analysis [21] and much more. The detailed analysis of the patent can be done using the above frameworks.

Patent analysis is done for the following reasons [2]:

- Prediction of emerging technologies
- Technology trends identification
- Estimation of technological impact
- Assessing the industrial opportunity
- Patents as indicators of corporate technological strength
- Analysing the functional dynamics of technological innovation systems
- Strategic planning for technology development with patent analysis

3.1 Patent Analysis Frameworks

Objectives and theme of the patent analysis decides which framework to be used. There are many frameworks to analyse the patent such as [2],

Patent Opportunity Analysis- this analysis identifies the opportunities of the patent based on the technology it used, claims and solutions it provides.

Patent Performance Analysis- this analysis evaluates the performance of the patents based on the claims.

Patent Innovation Analysis- this analyse the innovations based on the technology of the patent.

Patent Technology Analysis- the technology used in the patent is analysed and its effects in various aspects.

Patent Value Analysis- based on the various attributes of the patent, its business value is analysed on different stakeholders.

Patent analysis can be done in two ways- individual patent analysis and group patent analysis. Individual patent analysis involves detailed analysis of single patent filed by an individual or group of people. In group patent analysis, a group of patents related to single technology or industry or model are analysed and compared.

In our study we are performing the group patent analysis. The patents related to generative language model are taken for analysis. Python is used to analyse the patent data. The steps involved in analysis are:

3.2 Data collection

It is the process of collecting the for analysis. Patent data can be collected from different patent databases. There are several patent databases are available. Few of them are,

Free Databases:

- Google Patents (https://patents.google.com/)
- USPTO (https://patents.google.com/?office=USPTO)
- EPO (https://worldwide.espacenet.com/)
- WIPO (https://patentscope.wipo.int/)

Commercial Tools:

- PatSnap
- Innography
- PatentSight

The patent data for our analysis is taken from the google patents [22]. The search keyword used is generative language model. The patents from 01-01-2018 are taken. The search url is:

https://patents.google.com/?q=%28generative+language+model%29&after=priority:20180101&language=ENGLISH&sort=old

from the above search we got 7485 patents data with 11 attributes. The attributes or properties we obtained are id, country, title, assignee, inventor/author, priority date, filing/creation date, publication date, grant date, result link and representative figure link. We analyzed 7482 patents. We performed 1) Trend analysis 2) Assignee analysis and 3) Geographical analysis.

3.3 Data Preprocessing

Data preprocessing is the step to detect, correct, remove noisy data in the dataset. The duplicate data are deleted and the data is normalized. To perform the geographical analysis we need country name for that a new field named country is added and the values are filled from the id field. Assignee and dates are standardized.

3.4 Data Analysis

Data is collected and preprocessed and prepared for analysis. The analysis is performed as follow:

Trend analysis: It analyzes the growth and development trends of technology over time. The number of patents published per year are counted and sorted in ascending order of the year. The line graph is plotted using the matplotlib library of python. The line chart is given in Figure 1.
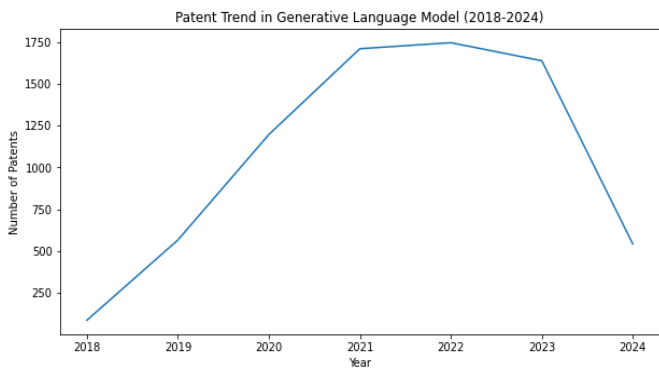

Figure 1: Number of Patents per Year

Assignee analysis: Assignee is the organization or person who have the ownership of the patent. This analysis provides the details about the patent holders related generative language model. In our dataset there are around 2700 assignees. The number of patents under each assignee is counted and sorted in descending order and bar chart is plotted for only top 10 assignees. The bar chart is given in figure 2.
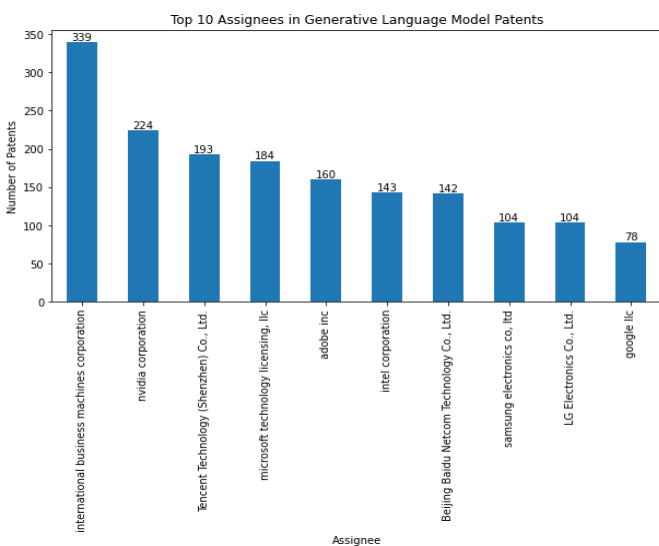

Figure 2: Top 10 Assignees of patents in generative language model

Geographical analysis: This analyzes the geographical distribution of patents. There are 21 countries having patents with respect to generative language model in our dataset. The number of patents based on the country is counted and sorted in descending order and a bar chart is plotted. The chart is as given in figure 3.
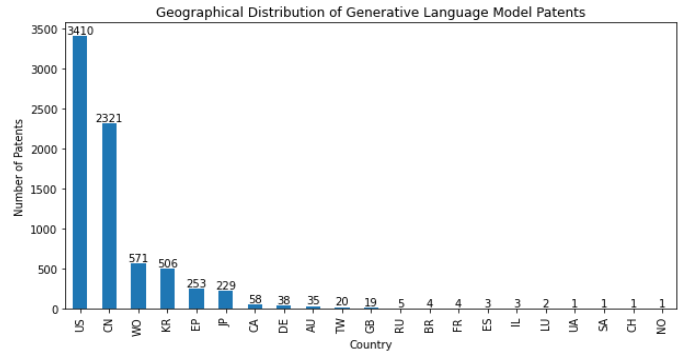
4. CONCLUSION

In this analysis we selected the patents datasets from 2018 onwards related generative language models from Google Patents. The Trends analysis, Assignee analysis and Geographical analysis on the patents dataset. Initially there were very few patents and on years the number of patents increased. The assignee analysis provides the number of patents owned by the entity. The geographical analysis shows there were many countries having the patents related to generative language models. From this analysis we understood that the Generative Language Models are current trend. The research work can be conducted in this area as it has applications in many domains like Business, Education, Research and many.

REFERENCES

[1]   Striuk, O. L. E. K. S. A. N. D. R., & Kondratenko, Y. U. R. I. Y. (2021). Generative adversarial neural networks and deep learning: successful cases and advanced approaches. *International Journal of Computing*, *20*(3), 339-349.

[2]   https://zapier.com/blog/how-does-chatgpt-work

[3]   Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. *Advances in neural information processing systems*, *30*.

[4]   Kaufmann, T., Weng, P., Bengs, V., & Hüllermeier, E. (2023). A survey of reinforcement learning from human feedback. *arXiv preprint arXiv:2312.14925*.

[5]   Dathathri, S., Madotto, A., Lan, J., Hung, J., Frank, E., Molino, P., ... & Liu, R. (2019). Plug and play language models: A simple approach to controlled text generation. *arXiv preprint arXiv:1912.02164*.

[6] Li, J., Tang, T., Zhao, W. X., Nie, J. Y., & Wen, J. R. (2024). Pre-trained language models for text generation: A survey. *ACM Computing Surveys*, *56*(9), 1-39.

[7] Zhang, H., Song, H., Li, S., Zhou, M., & Song, D. (2023). A survey of controllable text generation using transformer-based pre-trained language models. *ACM Computing Surveys*, *56*(3), 1-37.

[8] Feuerriegel, S., Hartmann, J., Janiesch, C., & Zschech, P. (2024). Generative ai. *Business & Information Systems Engineering*, *66*(1), 111-126.

[9] Aithal, P. S., & Aithal, S. (2018). Patent analysis as a new scholarly research method. *International Journal of Case Studies in Business, IT, and Education (IJCSBE),(2018)*, *2*(2), 33-47.

[10] Revathi, R., Madhushree, L. M. & Aithal, P. S. (2018). Business Strategy of Top Indian Company: L&T InfoTech. *International Journal of Case Studies in Business, IT and Education (IJCSBE), 2*(1), 64-89. DOI: http://dx.doi.org/10.5281/zenodo.1302770.

[11] Aithal, P. S. and Suresh Kumar, P. M. (2015). Applying SWOC Analysis to an Institution of Higher Education. *International Journal of Management, IT and Engineering (IJMIE)*, 5(7), 231-247. DOI: http://doi.org/10.5281/zenodo.163425.

[12] Madhushree, L. M., Revathi, R., Anil Kumar, Aithal, P.S., (2018). Business Strategies of Top Indian IT Company: Mindtree. *International Journal of Case Studies in Business IT and Education (IJCSBE), 2*(1), 22-36. DOI: http://dx.doi.org/10.5281/zenedo.1249871.

[13] Jithin Raj, K. & Krishna Prasad, K. (2018). A Critical Study on Business Strategies of 3i Infotech Ltd. *International Journal of Case Studies in Business, IT and Education (IJCSBE)*, 2(1), 13-21. DOI: http://dx.doi.org/10.5281/zenodo.1247319.

[14] Sneha, M. S. & Krishna Prasad, K. (2018). Analysis of Business Strategies of Salesforce.com Inc. *International Journal of Case Studies in Business, IT and Education (IJCSBE), 2*(1), 37-44. DOI: http://dx.doi.org/10.5281/zenodo.1252028.

[15] Aithal, P. S., V.T. Shailashree, P. M. Suresh Kumar, (2015). A New ABCD Technique to Analyze Business Models & Concepts. *International Journal of Management, IT and Engineering (IJMIE)*, 5(4), 409 – 423. DOI :http://doi.org/10.5281/zenodo.61652.

[16] Aithal, P. S., (2016). Study on ABCD Analysis Technique for Business Models, Business Strategies, Operating Concepts & Business Systems. *International Journal in Management and Social Science*, 4(1), 98-115. DOI: http://doi.org/10.5281/zenodo.161137.

[17] Aithal, P. S., (2017). ABCD Analysis as Research Methodology in Company Case Studies. *International Journal of Management, Technology, and Social Sciences (IJMTS)*, 2(2), 40-54. DOI: http://dx.doi.org/10.5281/zenodo.891621.

[18] Gupta, A. (2013). Environment & PEST analysis: an approach to external business environment. *International Journal of Modern Social Sciences*, *2*(1), 34-43.

[19] Aithal P. S., (2017). Impact of Domestic, Foreign, and Global Environments on International Business Decisions of Multinational Firms: A Systematic Study. *International Journal of Management, Technology, and Social Sciences (IJMTS)*, 2(2), 57-73. DOI: http://dx.doi.org/10.5281/zenodo.1067103.

[20] Aithal P. S. (2017). A critical study on Various Frameworks used to analyze International Business and its Environment. *International Journal of Applied Engineering and Management Letters (IJAEML)*, 1(2), 74-98. DOI:http://dx.doi.org/10.5281/zenodo.1053578.

[21] Porter, M. E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance.* New York: The Free Press.

[22] https://patents.google.com/ (accessed on 18 July 2024)