International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Implementation Patterns of Natural Language Processing Using Pre-Trained Deep Learning Models

Sinan Adnan Diwan

Submitted: 13/10/2022 **Revised:** 30/11/2022 **Accepted:** 26/12/2022

Abstract: When it comes to computer programming, Natural Language Processing (NLP) is all about creating computers that can read and respond to information in the same way that humans do, and then generate their text or speech in response. "Natural language processing" is an area of artificial intelligence (AI) that aims to give computers the ability to understand written and spoken language in the same way humans do (NLP). Using a combination of computational linguistics and statistics, machine learning, and deep learning models, NLP uses a set of programmable rules to describe human language. When text and voice data are combined, computers may 'understand' human language, including the speaker's or writer's intent and emotion, in the form of text or audio data. To put it another way, NLP is the driving force behind computer systems that translate text across languages, respond to spoken commands, and summaries massive volumes of information quickly—even in real-time. When it comes to voice-activated GPS, digital assistants, speech-to-text software, and customer support chatbots, you've utilized NLP as a consumer. Improved operational efficiency, increased employee productivity, and simplified mission-critical business operations are all benefits of using NLP in corporate solutions. Assorted deep learning systems for NLP analytics and research aspects are presented in the manuscript.

Keywords: *Deep Learning, Pre-Trained Deep Learning Models, Natural Language Processing.*

1. Introduction

Artificial neural networks (A.N.N.) are used in Deep Learning to model and mimic the human brain's functions [1]. This is one of the most important fields of A.I. To learn from vast amounts of data, these neural networks attempt to mimic the brain's function. Hidden layers can improve the accuracy of predictions made by a single-layer neural network, which may only be able to make approximations. Numerous artificial intelligence applications and services rely on deep learning to automate a wide range of analytical and physical tasks [2-6]. One of the most widely-used techniques in today's society is deep learning. Following are a few of the key applications of deep learning in real-world domains:

- Real-Time Computer Vision and Image Analytics
- Stock Trading and Financial Data Analytics
- Virtual Assistant
- Automated Manufacturing
- Data Science and Engineering
- Speech Recognition (Vocal Artificial Intelligence)
- Entertainment and Musical Notations
- Shopping Patterns Analysis in E-commerce
- Sentiment Analysis on Social Media
- Customer relationship management systems
- Autonomous vehicles, Self-Driving Cars, and Drones
- Natural Language Processing (NLP)
- Advertising and Promotional Activities
- Emotional intelligence
- Fraud detection and Cyber Security
- Healthcare and Medical Diagnosis
- Investment modeling

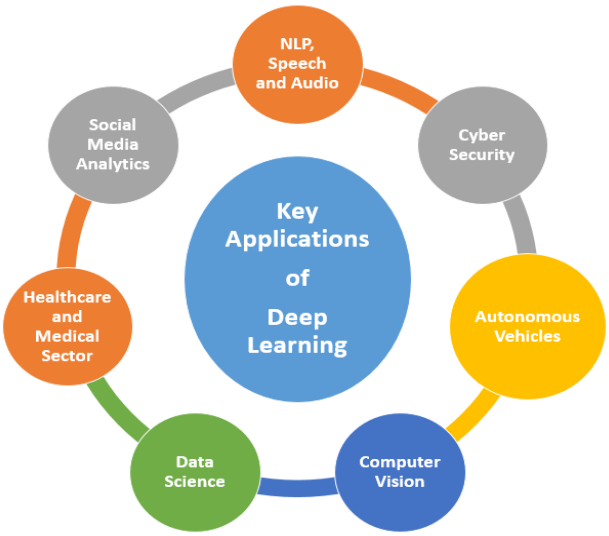

Fig.1. Key Applications of Deep Learning

Computer science and Information Technology College, Wasit University, Iraq
** Corresponding Author Email: sinan.alalwan@yahoo.com*

Figure 1 depicts the assorted key applications associated with deep learning which includes security, privacy, data science, computer vision, healthcare, medical sector, natural language processing and many others. Nowadays, deep learning is used in many high performance domains in which there is need of huge levels of integrity and accuracy.

1.1. Taxonomy of models in deep learning

There are a variety of deep learning models that are tailored to the unique application. A specific deep learning model is used in each field of study and application to attain a greater degree of efficacy, performance, and accuracy [7-15].

Table 1. Deep learning models and use cases

Deep Learning Model	Use Case
Classic Neural Networks (Multilayer Perceptrons)	Tabular Data Analysis, Classification, and Regression-based Problem Solving
Boltzmann Machines	Monitoring and Surveillance based Applications
CNN	Image Datasets, Optical Character Recognition (OCR) Intelligence
RNN	Image Classification, Image Captioning, Sentiment Analysis, Video Classification
SOM	Dimensionality Reduction, Music, Video
Encoders	Huge Datasets, Recommendation Engines, Dimensionality Reduction

2. Research Method and Key Perspectives

The pre-trained models are used to implement deep learning rapidly with high accuracy. The pre-trained models are having weights that can be imported by the researcher and scientists to deploy the deep learning application quickly in a particular domain without modeling from scratch [16-21].

Table 2. Prominent pre-trained deep learning models for assorted applications

Natural Language Processing	• OpenAI GPT-3 • Google BERT • Google ALBERT • Google Transformer-XL • ULMFiT • Facebook RoBERTa • Microsoft CodeBERT • ELMo • XLNet
Audio and Speech	• Wavenet • Lip Reading • MusicGenreClassification • Audioset • DeepSpeech • Waveglow • Loop • TTS • ESPNET • MXNET-Audio

2.1. Key advantages and reasons to use pre-trained models based libraries

- Inclusion of Pre-Trained Weights with NLP Architectures
- Inclusion of Fine-tuning with Preprocessing
- Easy to use Scripts and APIs
- Multilingual Support with International and Regional Languages
- Compatibility with Graphics Processing Unit (GPU)
- Pre-Programmed Algorithms from top companies

2.2. Installation and working with pre-trained natural language processing

HuggingFace (URL: *https://huggingface.co/)* as shown in Figure 2 is one of the key platforms that provide pre-trained models for Natural Language Processing (NLP). HuggingFace is cloud-based and can be integrated with Google Colab for running the scripts. This platform integrates hundreds of pre-trained models and architectures of artificial intelligence with machine learning in multiple research based applications.

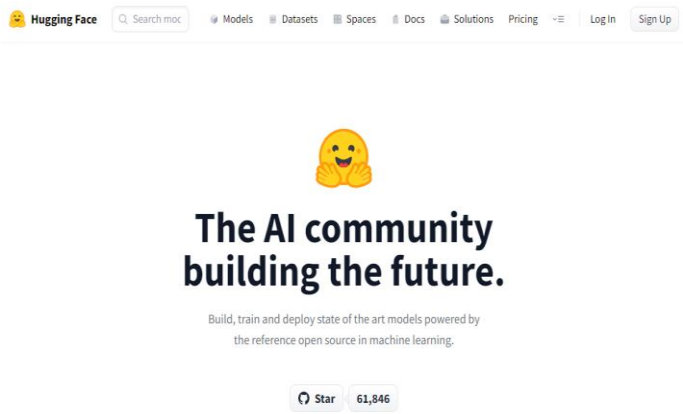

Fig.2. Online platform hugging face.co for pre-trained models

To install the Pre-Trained NLP-based Pre-Trained Models in Google Colab, execute the following

! pip install pytorch-transformers

! pip install transformers

! pip install sentence piece

3. Results and Analytics:

prediction of the next sequence as in google search

As we write some text on Google Search, the next sequence is suggested by the back-end library of Google [22-25] as shown in Figure 3. For example, if we want to predict the next word after what is the name of the Indian, the following transformer can be used [26]. Using the pre-trained models of natural language processing, such types of applications can be deployed for custom deployments.

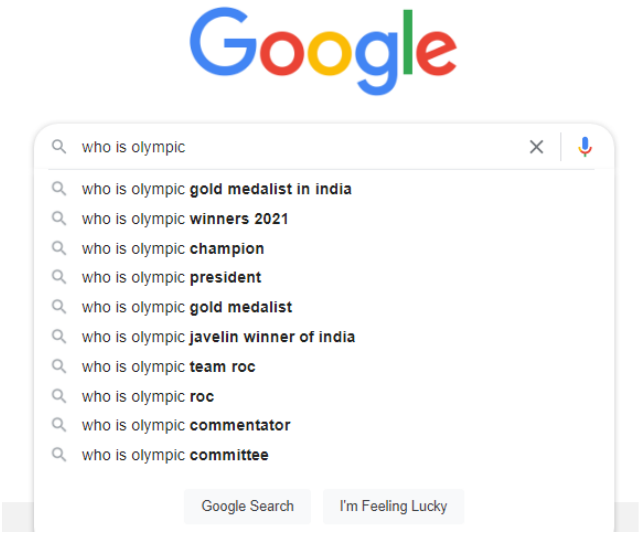

Fig. 3. Prediction of next sequence in google search

```
mytokenizer = Tokenizer.from_pretrained('2')
# Encode a ThisText inputs
this text = "what is the name of the Indian  "
IndexCurrented_tokens = mytokenizer.encode(ThisText)
tokens_tensor = torch.tensor([IndexCurrented_tokens])
model = LMHeadModel.from_pretrained('2')
model.eval()
tokens_tensor = tokens_tensor.to('cuda')
model.to('cuda')
with torch.no_grad():
    outs = model(tokens_tensor)
    preds = outs[0]
pred_IndexCurrent = torch.argmax(preds[0, -1, :]).item()
pred_ThisText = tokenizer.decode(IndexCurrented_tokens + [pred_IndexCurrent])
print(pred_ThisText)
```

Output

The output from the execution of code will be predicted depending on the following

- flag
- parliament
    - and many others depending upon the search

HuggingFace is providing the models for enormous applications and is being used by numerous corporate giants including Microsoft, Google, Grammarly, SpeechBrain, Facebook, Amazon Web Services and many others as shown in Figure 4. The algorithms developed and deployed by these organizations can be used for research based applications by the practitioners and researchers for enormous domains.

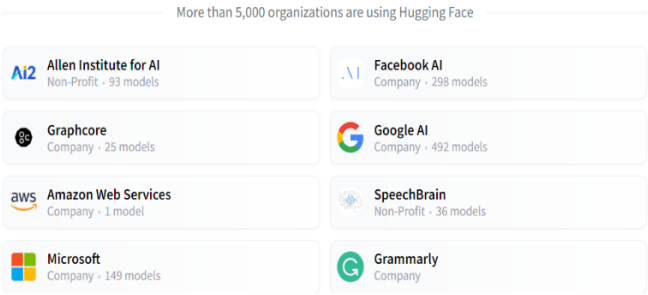

Fig. 4. Key organizations using hugging face.co

3.1. Prediction of the word like filling a blank in real world searching

The classical case of fill in the blank with real-time search can be solved using the pre-trained model of NLP [27]. Following is the case example to predict the word in place of [MASK].

```
myprediction = pipeline('bert specifications')
myprediction ("This is a [MASK].")
```

Output

```
[{'CurrentScore': 0.03235777094960213,
 'sequence': 'this is a dream.',
```

'KeyToken': 3959,

'KeyToken_str': 'dream'},

{'CurrentScore': 0.030467838048934937,

'sequence': 'this is a mistake.',

'KeyToken': 6707,

'KeyToken_str': 'mistake'},

{'CurrentScore': 0.028352534398436546,

'sequence': 'this is a test.',

'KeyToken': 3231,

'KeyToken_str': 'test'},

{'CurrentScore': 0.025175178423523903,

'sequence': 'this is a game.',

'KeyToken': 2208,

'KeyToken_str': 'game'},

{'CurrentScore': 0.024909017607569695,

'sequence': 'this is a lie.',

'KeyToken': 4682,

'KeyToken_str': 'lie'}]

```
unmasker = pipeline('bert model')
myprediction ("He is a [MASK].")
```

Output

[{'CurrentScore': 0.17371997237205505,

'sequence': 'he is a christian.',

'KeyToken': 3017,

'KeyToken_str': 'christian'},

{'CurrentScore': 0.08878538012504578,

'sequence': 'he is a democrat.',

'KeyToken': 7672,

'KeyToken_str': 'democrat'},

{'CurrentScore': 0.06659623980522156,

'sequence': 'he is a republican.',

'KeyToken': 3951,

'KeyToken_str': 'republican'},

{'CurrentScore': 0.03911091387271881,

'sequence': 'he is a vegetarian.',

'KeyToken': 23566,

'KeyToken_str': 'vegetarian'},

{'CurrentScore': 0.036758508533239365,

'sequence': 'he is a catholic.',

'KeyToken': 3234,

'KeyToken_str': 'catholic'}]

Text preparation is the initial step in every NLP effort. It's only a matter of getting the data into a form that can be analyzed [28]. Creating an outstanding NLP application is an essential stage. Tokenization is the most crucial of them. What it's about is the process of dividing a stream of textual material into meaningful tokens called tokens. It's a kind of decomposition [29, 30]. Tokenization may be done using a variety of open-source technologies. The necessity of tokenization and the many forms of tokenization will be explored in this segment, as will several tools that perform tokenization and the difficulties they face [31, 32]. A document's token occurrences may be used as a vector to represent that document. In addition, they may be exploited by a computer to activate helpful activities and reactions . Then again, they may be utilized as features in a machine learning pipeline to set off more complicated judgments or actions [33].

Table 2. It shows the consistency in execution time

Scenario	Execution Time (Seconds)
1	0.00049
2	0.00042
3	0.00053
4	0.00041
5	0.00042

The results fetched from the simulation attempts and implementations in terms of consistency of execution. The algorithms and pre-trained models are used from huggingface and integrated with Google Colab so that the outcomes cab be evaluated effectively as shown in Table 2 and Figure 5.

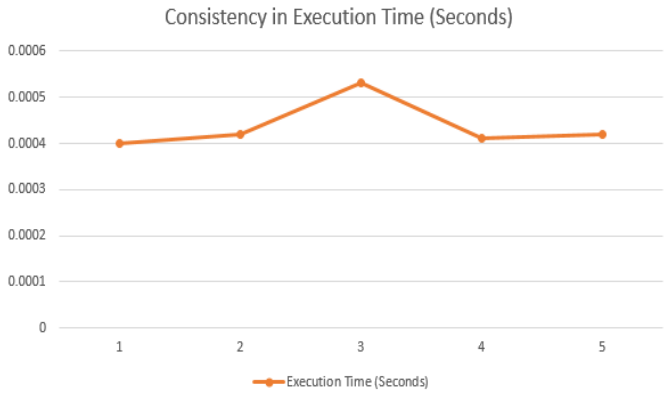

Fig. 5. Consistency analysis with execution time

From the results and graphical depictions, it is evident that the NLP based pre-trained models are quite effective and performance aware in terms of consistently very less execution time which presents that these algorithms and models can be integrated for multiple applications without any specific requirements and with the integrity aware results. These models can be associated with Google Colab or even open source hardware including Raspberry Pi, Arduino or any other so that real time applications can be development and deployment for multiple segments.

4. Conclusion

For research in the areas of audio, voice, and natural language processing by academics and practitioners, free and open-source pre-trained models may be used to achieve better tuning, accuracy, and performance on real-world datasets. Audio forensics, voice recognition, speech-to-text conversion, audio translation, and other dynamic applications benefit greatly from the models available on cloud-based systems. Linguistics and cognitive computing are two fields that deal with how computers and natural languages interact, particularly how to construct computers that can process and analyze large amounts of natural language. As a goal, we aim to create software that can "understand" not just the content of documents but also the context in which they are written. There will be no need for humans to go through and manually sort and categorize documents, as this technology will do it for them automatically.

References

[1] I. Lauriola, A. Lavelli, and F. Aiolli, "An introduction to deep learning in natural language processing: Models, techniques, and tools," Neurocomputing, vol. 470, pp. 443-456, 2022.

[2] R. Haque, N. Islam, M. Islam, and M. M. Ahsan, "A comparative analysis on suicidal ideation detection using NLP, machine, and deep learning," Technologies, vol. 10, no. 3, p. 57, 2022.

[3] S. S. Sundaram, S. Gurajada, M. Fisichella, and S. S. Abraham, "Why are NLP Models Fumbling at Elementary Math? A Survey of Deep Learning based Word Problem Solvers," arXiv preprint arXiv:.15683, 2022.

[4] R. A. Azeez, M. K. Abdul-Hussein, M. S. Mahdi, "Design a system for an approved video copyright over cloud based on biometric iris and random walk generator using watermark technique," Periodicals of Engineering Natural Sciences, vol. 10, no. 1, pp. 178-187, 2022.

[5] T. H. Jasim, S. A. Abed, and A. Ghazi, "Concepts Of Bi-supra Topological Space Via graph Theory," Wasit Journal of Computer and Mathematics Sciences, vol. 1, no. 2, 2022.

[6] K. H. K. Al-Saedi, "Implementation Patterns of AquaSim for Simulation of Underwater Acoustic Wireless Sensor Networks," Wasit Journal of Computer and Mathematics Science, pp. 84-92, 2021.

[7] K. Koskenniemi, Two-level morphology: A general computational model for word-form recognition and production. University of Helsinki, Department of General Linguistics Helsinki, Finland, 1983.

[8] A. K. Joshi and S. Weinstein, "Control of Inference: Role of Some Aspects of Discourse Structure-Centering," in IJCAI, 1981, pp. 385-387.

[9] R. a. M. A. a. Abdul Hadi M. Alaidi, Haider TH. Salim ALRikabi, Ibtisam A. Aljazaery, Saif Hameed Abbood, "Dark web illegal activities crawling and classifying using data mining techniques," International Journal of Interactive Mobile Technologies (iJIM), vol. 16, no. 10, 2022.

[10] A. S. Mohamad, "Machine Learning Empowered Software Prediction System," Wasit Journal of Computer and Mathematics Sciences, vol. 1, no. 3, pp. 52-61, 2022.

[11] Y. S. Mezaal, D. A. Hammood, and M. H. Ali, "OTP encryption enhancement based on logical operations," in 2016 Sixth International Conference on Digital Information Processing and Communications (ICDIPC), 2016: IEEE, pp. 109-112.

[12] I. A. Aljazaery, and A. H. M. Alaidi, "Encryption of Color Image Based on DNA Strand and Exponential Factor," International Journal of Online Biomedical Engineering, vol. 18, no. 3, pp. 101-113, 2022.

[13] S. A. Diwan, S. Perumal, and A. J. Fatah, "Complete security package for USB thumb drive," Computer Engineering and Intelligent System, 2014.

[14] H. T. ALRikabi and H. T. Hazim, "Enhanced Data Security of Communication System Using Combined Encryption and Steganography," International Journal of Interactive Mobile Technologies, vol. 15, no. 16, 2021.

[15] J. Kh-Madhloom, "Dynamic Cryptography Integrated Secured Decentralized Applications with Blockchain Programming," Wasit Journal of Computer and Mathematics Sciences, vol. 1, no. 2, pp. 21-33, 2022.

[16] G. Guida and G. Mauri, "Evaluation of natural language processing systems: Issues and approaches," Proceedings of the IEEE, vol. 74, no. 7, pp. 1026-1035, 1986.

[17] H. Al-ogaili and A. M. Shadhar, "the Finger Vein Recognition Using Deep Learning Technique," Wasit Journal of Computer and Mathematics Sciences, vol. 1, no. 2, pp. 1-11, 2022.

[18] H. Salim, J. S. Qateef, A. M. Alaidi, and R. M. Al_airaji, "Face Patterns Analysis and recognition System based on Quantum Neural Network QNN," International Journal of Interactive Mobile Technologies (iJIM), vol. 16, no. 9, 2022.

[19] S. Khairy, and H. Salim, "The Detection of Counterfeit Banknotes Using Ensemble Learning Techniques of AdaBoost and Voting," International Journal of Intelligent Engineering and Systems, vol. 14, no. 1, pp. 326-339, 2021.

[20] H. Tauma. and H. ALRikabi, "Secure Chaos of 5G Wireless Communication System Based on IOT Applications," International Journal of Online and Biomedical Engineering(iJOE), vol. 18, no. 12, pp. 89-102, 2022.

[21] M. H. Abd, "Dynamic Data Replication for Higher Availability and Security," Wasit Journal of Computer and Mathematics Science, pp. 31-42, 2021.

[22] Y. Goldberg, "A primer on neural network models for natural language processing. ArXiv," arXiv preprint arXiv:.00726, 2015.
[23] I. Goodfellow, Y. Bengio, and A. Courville, Deep learning. MIT press, 2016.
[24] R. Jozefowicz, O. Vinyals, M. Schuster, N. Shazeer, and Y. Wu, "Exploring the limits of language modeling," arXiv preprint arXiv:.02410, 2016.
[25] H. Verma, "Internet of Robotics Things (IoRT) Based Integration of Robotic Applications for Advanced Research," Wasit Journal of Computer and Mathematics Science, pp. 9-16, 2021.
[26] E. Charniak, "Parsing as language modeling," in Proceedings of the 2016 Conference on Empirical Methods in Natural Language Processing, 2016, pp. 2331-2336.
[27] O. Vinyals, Ł. Kaiser, T. Koo, S. Petrov, I. Sutskever, and G. Hinton, "Grammar as a foreign language," Advances in neural information processing systems, vol. 28, 2015.
[28] A. Turchin and L. F. Florez Builes, "Using natural language processing to measure and improve quality of diabetes care: a systematic review," Journal of Diabetes Science Technology, vol. 15, no. 3, pp. 553-560, 2021.
[29] T. Winograd, "Procedures as a representation for data in a computer program for understanding natural language," MASSACHUSETTS INST OF TECH CAMBRIDGE PROJECT MAC, 1971.
[30] R. C. Schank and R. P. Abelson, Scripts, plans, goals, and understanding: An inquiry into human knowledge structures. Psychology Press, 2013.
[31] M. Johnson, "How the statistical revolution changes (computational) linguistics," in Proceedings of the EACL 2009 Workshop on the Interaction between Linguistics and Computational Linguistics: Virtuous, Vicious or Vacuous?, 2009, pp. 3-11.
[32] P. Resnik, "Four revolutions," Language Log, February, vol. 5, 2011.
[33] M. Trabelsi, P. Kakosimos, and H. Komurcugil, "Mitigation of grid voltage disturbances using quasi-Z-source based dynamic voltage restorer," in 2018 IEEE 12th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG 2018), 2018: IEEE, pp. 1-6.