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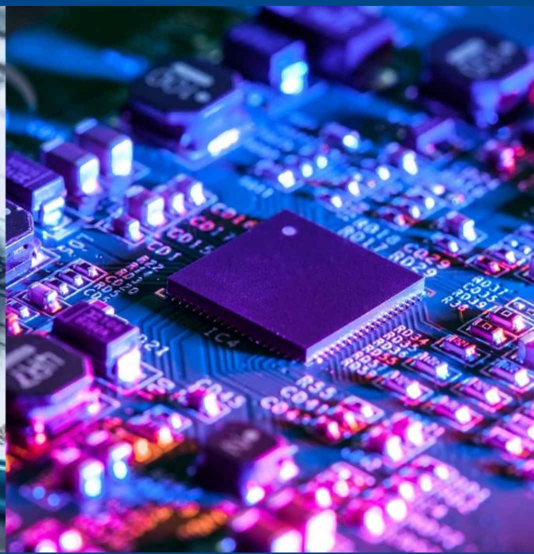

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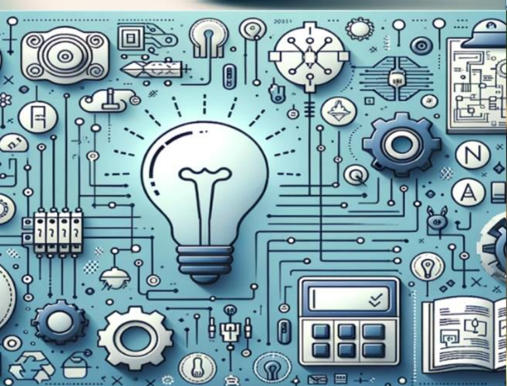

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Neuro-Inspired Computing: Connecting AI and Neuroscience

Dr. V. Geetha, Dr.C.K.Gomathy, P N S S Manohara Sarma, P Naveen

Department of CSE, SCSVMV Deemed to be University, Enathur, Tamil Nadu, India

ABSTRACT: Neuro-inspired computing, also referred to as neuromorphic computing, focuses on emulating the intricate functions of the human brain in computational frameworks. By applying neuroscience concepts, researchers aim to develop artificial intelligence (AI) systems that exhibit adaptive learning, real-time processing, and energy efficiency. This article explores the fundamental principles of neuro-inspired computing, its applications in fields such as robotics and healthcare, and the innovations driving progress in this discipline. It also discusses the challenges faced, including the complexity of biological systems and the need for interdisciplinary collaboration, while outlining potential future developments that could revolutionize multiple sectors.

KEYWORDS: Neuro-inspired computing, Neuromorphic computing, Sustainable computing

I. INTRODUCTION

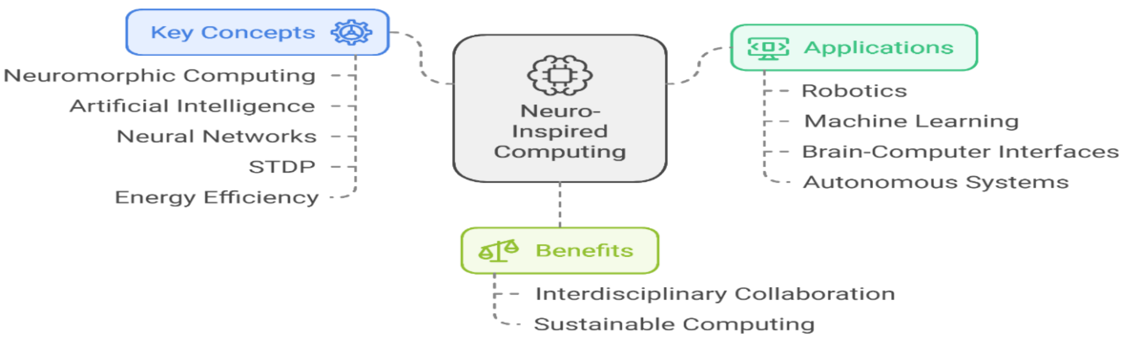
Neuro-inspired computing signifies a transformative shift in artificial intelligence (AI) by drawing inspiration from the complexities of biological neural networks. As researchers deepen their understanding of human brain mechanisms, the potential for developing sophisticated AI systems capable of learning, adapting, and processing information in real time becomes increasingly achievable. This article examines the core principles, applications, advancements, and challenges associated with neuro-inspired computing, supported by practical examples.
Neuro-inspired computing aims to replicate the structure and function of the human brain. Key elements include:

- **Artificial Neural Networks (ANNs)**: Mathematical constructs of interconnected nodes (neurons) that process information similarly to biological neurons. Each node performs simple computations, and their combined outputs result in complex behaviors.
- **Learning Mechanisms**: Techniques like Spike Timing-Dependent Plasticity (STDP) allow systems to learn from experiences by adjusting synaptic strengths based on activation timing, facilitating associative learning.
- **Energy Efficiency**: Neuromorphic systems are designed for minimal energy consumption, mirroring the human brain's ability to process vast amounts of information efficiently.

II. CORE PRINCIPLES OF NEURO-INSPIRED COMPUTING

Neural Architecture

Neuro-inspired systems are designed to mirror the connectivity of biological neurons, enabling parallel processing and enhancing the system's ability to perform complex tasks without a centralized processing unit.



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Learning and Adaptation

- **Spike Timing-Dependent Plasticity (STDP)**: This mechanism alters synaptic strength based on the timing of neuron activations, crucial for learning sequences over time.
- **Plasticity**: Neuroplasticity refers to the brain's ability to adapt based on experiences. Computational models that simulate this adaptability can enhance learning outcomes.

Real-Time Processing

Neuro-inspired systems process data asynchronously, enabling rapid responses to stimuli, which is essential in applications that require immediate feedback, such as robotic navigation and autonomous vehicles.

III. APPLICATIONS OF NEURO-INSPIRED COMPUTING

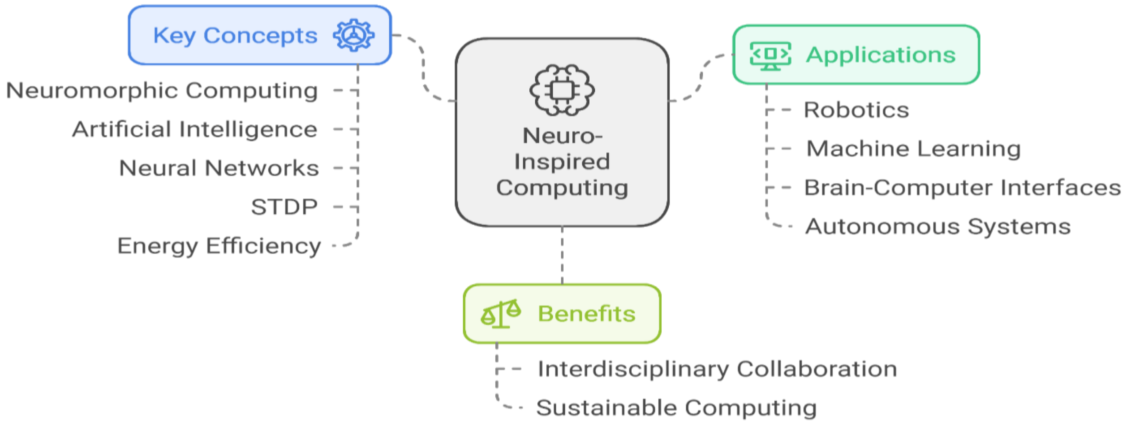
Neuro-inspired computing has broad implications across various fields:

- **Robotics**: Algorithms enhance robots' learning and navigation through sensory input, enabling adaptation to dynamic environments and improved real-time performance.
- **Image and Speech Recognition**: Deep learning methods, particularly Convolutional Neural Networks (CNNs), achieve human-level performance in image and speech recognition tasks.
- **Healthcare**: AI models utilizing neurological data aid in diagnosing and managing diseases like Alzheimer's by analyzing patient data for insights and personalized treatment plans.
- **Gaming**: Neuro-inspired algorithms enhance non-player character (NPC) adaptability, allowing them to learn from player interactions and adjust strategies for a more engaging experience.
- **Autonomous Systems**: Self-driving vehicles employ neuro-inspired computing for real-time data processing and decision-making, mimicking human cognitive functions to navigate complex environments safely.

IV. ADVANCEMENTS IN NEURO-INSPIRED COMPUTING

Recent technological innovations are rapidly advancing the field of neuro-inspired computing:

- **Brain-Computer Interfaces (BCIs)**: BCIs facilitate direct communication between the brain and external devices, enabling control through neural signals, which benefits rehabilitation and assistive technologies.
- **Neuromorphic Hardware Development**: Companies like Intel and IBM are creating specialized chips for spiking neural networks, enhancing efficiency in learning and inference.
- **Hybrid Models**: Integrating traditional AI with neuro-inspired architectures improves performance and adaptability, enabling more effective problem-solving.
- **Evolutionary Algorithms**: These algorithms, inspired by biological evolution, optimize neural network architectures by selecting the best-performing models over generations.



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V.CHALLENGES IN NEURO-INSPIRED COMPUTING

Despite its vast potential, neuro-inspired computing faces several challenges:

- **Complexity of Biological Systems**: Fully replicating brain functionalities is intricate due to its complexity. Ongoing research is essential for improving model accuracy and effectiveness.
- **Scalability Issues**: Developing large-scale systems that match brain processing capabilities presents significant engineering challenges, particularly in maintaining efficiency and performance as systems scale.
- **Data Limitations**: Effective training of neuro-inspired models often requires extensive datasets, which may not always be available, directly impacting learning capabilities.
- **Need for Interdisciplinary Collaboration**: Bridging the gap between AI and neuroscience requires collaboration across various fields, including computer science, biology, and engineering, to drive innovation.

VI. FUTURE SCOPE OF NEURO-INSPIRED COMPUTING

The future of neuro-inspired computing is promising, with several exciting developments on the horizon:

- **Enhanced Learning Algorithms**: Continued research into sophisticated learning mechanisms is likely to yield improved adaptability and efficiency in AI systems, potentially mirroring human cognitive processes.
- **Integration with Quantum Computing**: Combining neuro-inspired approaches with quantum computing may provide unprecedented processing power and capabilities, revolutionizing problem-solving in various domains.
- **Personalized AI Systems**: Future models may offer highly personalized experiences, adapting to individual user preferences and behaviors, transforming industries such as healthcare and education.
- **Sustainable Computing**: As energy efficiency becomes increasingly crucial, neuro-inspired computing could lead to more sustainable solutions, mimicking the brain's low-energy operation to reduce power consumption.

VII. CONCLUSION

Neuro-inspired computing is at the forefront of an AI revolution, merging insights from neuroscience with advanced computational techniques. By leveraging the brain's architecture and learning processes, researchers are developing systems that promise enhanced efficiency, adaptability, and performance across various applications. While challenges remain, ongoing collaboration between neuroscientists and computer scientists will drive innovation in this field. As we look to the future, neuro-inspired computing holds the potential to reshape our interactions with technology, providing solutions that reflect the complexity and efficiency of the human brain.

REFERENCES

1. Dr.V.Geetha and Dr.C K Gomathy, Anomaly Detection System in Credit Card Transaction Dataset, AIP Conference Proceedings,https://doi.org/10.1063/5.0212564 Vol3028, Issue 01 2024
2. Dr.V.Geetha and Dr.C K Gomathy, Crime data analysis and prediction using machine learning, AIP Conference Proceedings,https://doi.org/10.1063/5.0212566 Vol3028, Issue 01 2024
3. Dr.C K Gomathy and Dr.V.Geetha House price prediction using machine learning, AIP Conference Proceedings,https://doi.org/10.1063/5.0212559 Vol3028, Issue 01 2024
4. Dr.V.Geetha and Dr.C K Gomathy,Identification of birds species using deep learning, AIP Conference Proceedings,https://doi.org/10.1063/5.0212968 Vol3028, Issue 01 2024
5. Dr.V.Geetha and Dr.C K Gomathy,Missing child recognition system using deep learning, AIP Conference Proceedings,https://doi.org/10.1063/5.0212567 Vol3028, Issue 01 2024
6.Dr.V.Geetha and Dr.C K Gomathy,Price forecasting of agricultural commodities, AIP Conference Proceedings,) https://doi.org/10.1063/5.0212568 Vol3028, Issue 01 2024
7. Dr.V.Geetha and Dr.C K Gomathy,The customer churn prediction using machine learning , AIP Conference Proceedings,https://doi.org/10.1063/5.0212569Vol 3028, Issue 01 2024
8. Dr.C K Gomathy and Dr.V.Geetha, Fall detection for elderly people using machine learning, AIP Conference Proceedings,https://doi.org/10.1063/5.0212561 Vol3028, Issue 01 2024
9. Dr.C K Gomathy and Dr.V.Geetha, Fall Navigation and obstacle detection for blind, AIP Conference Proceedings,https://doi.org/10.1063/5.0212560 Vol3028, Issue 01 2024

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

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10. Dr.V.Geetha and Dr.C K Gomathy,Securing medical image based on improved ElGamal encryption technique, AIP Conference Proceedings,) https://doi.org/10.1063/5.0212570 Vol3028, Issue 01 2024
11. Dr.C K Gomathy and Dr.V.Geetha, Software error estimation using machine learning algorithms, AIP Conference Proceedings,https://doi.org/10.1063/5.0212562 Vol3028, Issue 01 2024
12. Dr.V.Geetha and Dr.C K Gomathy,Web scraping using robotic process automation, AIP Conference Proceedings,) https://doi.org/10.1063/5.0212571 Vol3028, Issue 01 2024
13. Dr.C K Gomathy and Dr.V.Geetha, Crypto sharing DAAP, AIP Conference Proceedings,https://doi.org/10.1063/5.0212563 Vol3028, Issue 01 2024
14. Dr.V.Geetha and Dr.C K Gomathy,Company employee profile using QR code, AIP Conference Proceedings,) https://doi.org/10.1063/5.0212572 Vol3028, Issue 01 2024
15. Dr.V.Geetha and Dr.C K Gomathy,Unified platform for advertising with predictive analysis, AIP Conference Proceedings,) https://doi.org/10.1063/5.0212573 Vol3028, Issue 01 2024
16. Gomathy, C.K., Geetha, V., Lakshman, G., Bharadwaj, K. (2024). A Blockchain Model to Uplift Solvency by Creating Credit Proof. In: Mandal, J.K., Jana, B., Lu, TC., De, D. (eds) Proceedings of International Conference on Network Security and Blockchain Technology. ICNSBT 2023. Lecture Notes in Networks and Systems, vol 738. Springer, Singapore. https://doi.org/10.1007/978-981-99-4433-0_39
17. CK.Gomathy, MangantiDhanush, SikharamSaiPushkar, V.Geetha ,Helmet Detection and Number Plate Recognition using YOLOv3 in Real-Time 3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA 2023) DVD Part Number: CFP23K58-DVD; ISBN: 979-8-3503-4362-5,DOI:10.1109/ICIMIA60377.2023.10425838, 979-8-3503-4363-2/23/$31.00 ©2023 IEEE
18.Dr.V.Geetha and Dr.C K Gomathy, Cloud Network Management System, International Journal of Early Childhood Special Education (INT-JECSE) DOI:10.9756/INTJECSE/V14I5.69 ISSN: 1308-5581 Vol 14, Issue 05 2022
19.Dr.C K Gomathy and Dr.V.Geetha,Fake Job Forecast Using Data Mining Techniques, International Journal of Early Childhood Special Education (INT-JECSE) DOI:10.9756/INTJECSE/V14I5.70 ISSN: 1308-5581 Vol 14, Issue 05 2022
20.Dr.V.Geetha and Dr.C K Gomathy,Cyber Attack Detection System, International Journal of Early Childhood Special Education (INT-JECSE) DOI:10.9756/INTJECSE/V14I5.71 ISSN: 1308-5581 Vol 14, Issue 05 2022
21.Dr.V.Geetha and Dr.C K Gomathy,Attendance Monitoring System UsingOpencv, International Journal of Early Childhood Special Education (INT-JECSE) DOI:DOI:10.9756/INTJECSE/V14I5.68ISSN: 1308-5581 Vol 14, Issue 05 2022
22. Dr.C K Gomathy and Dr.V.Geetha,The Vehicle Service Management System, International Journal of Early Childhood Special Education (INT-JECSE) DOI:10.9756/INTJECSE/V14I5.66ISSN: 1308-5581 Vol 14, Issue 05 2022
23.Dr.C K Gomathy and Dr.V.Geetha, Multi-Source Medical Data Integration AndMining For Healthcare Services, International Journal of Early Childhood Special Education (INT-JECSE) DOI: DOI:10.9756/INTJECSE/V14I5.67ISSN: 1308-5581 Vol 14, Issue 05 2022
24.Dr.V.Geetha and Dr.C K Gomathy, An Efficient Way To Predict The Disease UsingMachine Learning, International Journal of Early Childhood Special Education (INT-JECSE) DOI:10.9756/INTJECSE/V14I5.98ISSN: 1308-5581 Vol 14, Issue 05 2022
25.Dr.C K Gomathyand Dr.V.Geetha, Music Classification Management System, International Journal of Early Childhood Special Education (INT-JECSE) DOI: DOI:10.9756/INTJECSE/V14I5.72ISSN: 1308-5581 Vol 14, Issue 05 2022
26. Dr. C.K. Gomathy , Dr. V.Geetha ,G.S.V.P.Praneetha , M.Sahithisucharitha. (2022). Medicine Identification Using OpenCv. Journal of Pharmaceutical Negative Results, 3718–3723.https://doi.org/10.47750/pnr.2022.13.S09.457
27. Dr. V.Geetha ,Dr. C.K. Gomathy , KommuruKeerthi , NallamsettyPavithra. (2022). Diagnostic Approach To Anemia In Adults Using Machine Learning. Journal of Pharmaceutical Negative Results, 3713–3717.https://doi.org/10.47750/pnr.2022.13.S09.456
28. Dr. C. K. Gomathy, " A Cloud Monitoring Framework Perform in Web Services, International Journal of Scientific Research in Computer Science, Engineering and Information Technology(IJSRCSEIT), ISSN : 2456-3307, Volume 3, Issue 5, pp.71-76, May-June-2018.
29. Dr. C. K. Gomathy, " Supply Chain - Impact of Importance and Technology in Software Release Management, International Journal of Scientific Research in Computer Science, Engineering and Information Technology(IJSRCSEIT), ISSN : 2456-3307, Volume 3, Issue 6, pp.01-04, July-August-2018.

30. Dr.C.K.Gomathy, Dr.V.Geetha, Peddireddy Abhiram, "The Innovative Application for News Management System," International Journal of Computer Trends and Technology, vol. 68, no. 7, pp. 56-62, 2020. Crossref, https://doi.org/10.14445/22312803/IJCTT-V68I7P109

31. Dr. C. K.Gomathy, " A Semantic Quality of Web Service Information Retrieval Techniques Using Bin Rank, IInternational Journal of Scientific Research in Computer Science, Engineering and Information Technology(IJSRCSEIT), ISSN : 2456-3307, Volume 3, Issue 1, pp.1568-1573, January-February-2018.

32. Gomathy, C. K., et al. "A Location Based Value Prediction for Quality of Web Service." International Journal of Advanced Engineering Research and Science, vol. 3, no. 4, Apr. 2016.

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