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Analyzing of Bio computing and Synthetic Biology by using EDAS method

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Abstract: *The integration of biological systems with computational approaches has led to the emergence of Bio-Computing, a field where biological processes are harnessed for information processing and computational tasks. Synthetic Biology, on the other hand, involves the design and construction of novel biological systems or the redesign of existing ones for specific purposes. This paper investigates the intersection of these fields and their impact on various scientific and technological domains. Bioinformatics allows the analysis of large-scale genomic data, aiding in the understanding of genetic variations, identifying disease markers, and developing personalized medicine. Synthetic biology is used to engineer microbial strains for enhanced production of bio fuels, pharmaceuticals, and industrial chemicals. Designing microbial cell factories allows for the sustainable production of valuable compounds. It evaluates the appropriateness of options by assessing their proximity to the mean solution. The EDAS method, through this assessment, identifies the most favorable solution based on the average evaluation and its distance from the mean solution. The analysis indicates that the EDAS method prioritizes solutions with shorter distances from the ideal solution while penalizing those with negative distances, indicating a preference for solutions closer to the ideal. Despite the lack of significant differences in the comparison of these distances among alternatives, the EDAS method continues to be the preferred approach for evaluating solutions due to its unique effectiveness in Multiple Criteria Decision Making (MCDM). From the result optical computing is first rank and whereas Neuromorphic Computing is lowest rank.*

Keywords: *Intellectual capital, Pharmaceuticals industry, India, Intangible assets, Business performance.*

1. INTRODUCTION

Enhancing microbial endoglucanases for innovative applications. By leveraging synthetic biology, researchers can engineer microorganisms to produce tailored endoglucanases with improved catalytic efficiency and substrate specificity. Biocomputational tools aid in the rational design of these enzymes, predicting optimal modifications for enhanced performance. These advancements enable the development of microbial endoglucanases with customized features, crucial for applications in various industries, such as biofuel production and bioremediation. Through a synergistic combination of synthetic biology and biocomputational strategies, the potential for creating efficient and versatile endoglucanases expands, driving progress towards sustainable solutions and novel biotechnological applications.[1] The "Biocomputing and Synthetic Biology in Cells" special issue of Cells explores the intersection of biocomputing and synthetic biology within cellular systems. This collection of articles delves into innovative approaches where biological entities, such as cells, are harnessed as computing elements and manipulated for synthetic biology applications. The issue aims to advance our understanding of how cellular processes can be engineered and programmed, paving the way for the development of novel bio-computational tools and synthetic biological systems with diverse applications in medicine, biotechnology, and beyond.[2] Distributed computation represents the forefront of advancements in synthetic biology devices, signaling a paradigm shift. This emerging wave entails the decentralized processing of information across interconnected components, mimicking the collaborative nature of biological systems. By distributing computational tasks among various elements, these synthetic biology devices enhance efficiency, scalability, and adaptability, thereby unlocking new possibilities for complex and dynamic applications in the realm of biotechnology and beyond.[3]Harnessing synthetic biology, researchers are transforming exoelectrogens a group of microorganisms capable of extracellular electron transfer—for innovative applications in biotechnology. By manipulating their genetic makeup, scientists aim to enhance the efficiency and versatility of these microorganisms for diverse applications, such as microbial fuel cells and bioremediation. This approach opens doors to sustainable and customizable solutions by leveraging the potential of exoelectrogens in novel biotechnological processes.[4] Biocomputing with nanostructures on lipid bilayers represents a cutting-edge approach in merging nanotechnology and computational processes within biological systems. By integrating nanostructures onto lipid bilayers, researchers create a platform for precise and programmable interactions at the nanoscale. This innovative synergy enables the development of biocomputational devices, facilitating intricate information processing and manipulation at the interface of synthetic nanostructures and biological lipid membranes, promising advancements in fields like biosensing and drug delivery.[5] Extending synthetic biology beyond the lab poses both promise and challenges. Applications range from environmental remediation to healthcare. Challenges include ethical considerations, bio safety, and regulatory frameworks. Addressing these demands collaborative efforts, robust risk assessment, and public engagement. Meeting the needs for responsible deployment ensures the transformative potential of synthetic biology is harnessed beneficially beyond controlled laboratory settings.[6] Bacteria-based biocomputing employs cellular computing circuits that enable sensing, decision-making, signaling, and actuation within bacterial systems. These engineered circuits allow bacteria to sense specific environmental cues, process information, and execute predefined actions. This innovative approach holds potential for applications in environmental monitoring, medical diagnostics, and targeted drug delivery. By leveraging the inherent capabilities of bacteria, this biocomputing paradigm offers a versatile platform for creating programmable, responsive biological systems for diverse practical uses.[7] "A living foundry for synthetic biological materials" outlines a roadmap in synthetic biology towards advanced materials. Acting as a transformative paradigm, it envisions a dynamic platform capable of engineering living organisms to produce novel materials. This approach integrates biological processes with materials science, offering sustainable, customizable solutions. The roadmap envisions a future where living organisms serve as versatile foundries, producing a wide array of advanced materials with applications in medicine, electronics, and beyond, revolutionizing material design and production.[8] Data integration strategies play a crucial role in informing computational design within synthetic biology. By merging diverse biological datasets, these strategies provide a comprehensive understanding of cellular processes. This integrated data serves as a foundation for computational models, facilitating the prediction and optimization of genetic circuits and biological systems. The synergy between data integration and computational design accelerates advancements in synthetic biology, enabling more precise and efficient engineering of biological entities for diverse applications.[9] A computational workflow for the automated generation of models in genetic design streamlines the modeling process. It begins with input specifications, translating genetic designs into computational representations. Automated tools then analyze these inputs, generating mathematical models that capture the dynamics of genetic circuits. Subsequent simulation and optimization steps refine and validate these models, providing insights into the expected behavior of engineered biological systems. This systematic and automated workflow accelerates the design-build-test cycle in synthetic biology, facilitating the rapid and efficient development of genetically engineered constructs.[10] The design, analysis, and computational methods for engineering synthetic biological networks involve a systematic approach to create functional biological systems. Employing mathematical modeling, these methods enable the prediction and optimization of network behavior. By integrating advanced computational tools, researchers can design and analyze synthetic biological networks with enhanced precision, fostering the development of robust and predictable genetic circuits for diverse applications in biotechnology and medicine.[11] In biological engineering, significant strides have been made with advanced computational tools to enhance the predictability of design outcomes. These tools incorporate sophisticated algorithms and modeling approaches, enabling researchers to foresee and optimize the behavior of engineered biological systems. Such progress marks a critical step toward achieving reliability and precision in the field, promising more effective and tailored applications in areas like medicine, agriculture, and environmental management.[12]The Special Issue on Computational Synthetic Biology serves as a comprehensive exploration into the evolving landscape of computational methodologies within synthetic biology. This collection aims to elucidate cutting-edge research, methodologies, and applications, providing insights into the transformative impact of computational approaches on the design, analysis, and optimization of synthetic biological systems, fostering a deeper understanding and advancement within this rapidly evolving interdisciplinary field.[13]

2. MATERIALS & METHODS

2.1. Alternative parameter: Quantum Computing, Neuromorphic Computing, Optical Computing, DNA Data Storage, Swarm Computing, Conventional Computing.
2.2. Evaluation parameters: Efficiency, Accuracy, Ethical Concerns, Regulatory Compliance.

2.3. Neuromorphic Computing: Neuromorphic computing refers to a paradigm in computer architecture that draws inspiration from the structure and functioning of the human brain. Mimicking the brain's neural networks, neuromorphic systems use artificial neurons and synapses to process information in a way that resembles the parallel and distributed nature of biological neural networks. These systems aim to perform cognitive tasks efficiently, such as pattern recognition and learning, by leveraging principles of neuroscience. Neuromorphic computing holds potential for applications in artificial intelligence, machine learning, and robotics, as it seeks to emulate the brain's capabilities in terms of energy efficiency and adaptability to complex, real-world problems.

2.4. Optical Computing: Optical computing refers to the use of photons (light particles) instead of traditional electronic bits to perform computation and process information. In optical computing systems, light waves carry and process data, exploiting properties such as interference, diffraction, and polarization. Optical computing has the potential to overcome some limitations of traditional electronic computing, offering advantages such as faster data transfer, reduced heat generation, and increased parallelism. Research in optical computing explores ways to develop practical devices and systems that harness the properties of light for performing complex computational tasks efficiently.

2.5. DNA Data Storage: DNA data storage involves encoding digital information into the sequence of nucleotides (adenine, thymine, cytosine, and guanine) that make up DNA molecules. This method leverages the inherent information-carrying capacity of DNA, allowing for vast data storage in a highly compact and durable form. DNA data storage has the potential to address the growing challenges of digital data preservation, offering long-term stability and high information density. Encoding and decoding technologies enable the retrieval of digital data from DNA, making it a promising solution for the future of data storage.

2.6. Swarm Computing: Swarm computing, inspired by the collective behavior of social insect colonies, refers to a decentralized approach to problem-solving in which a large number of simple, often autonomous entities, called agents or drones, interact with each other and their environment to achieve a common goal. These entities communicate locally, typically through simple rules, and together exhibit emergent intelligence, allowing the system to perform tasks more efficiently or robustly than an individual agent. Swarm computing finds applications in various fields, including robotics, optimization, and artificial intelligence, where it offers scalable and adaptable solutions for complex tasks.

2.7. Conventional Computing: Conventional computing, also known as classical computing, refers to the traditional model of computing based on classical bits, which are binary units of information represented as 0s and 1s. In conventional computers, data is processed using classical logic gates, and computations follow classical physics principles. These computers operate with deterministic algorithms and rely on the principles of Boolean logic for information processing. Classical computers have been the dominant computing paradigm for decades, and most everyday computing devices, such as personal computers and servers, adhere to this conventional model.

2.8. Efficiency: Efficiency refers to the ability to achieve maximum productivity with the least amount of wasted resources, time, or effort. In various contexts, efficiency can be measured by the ratio of output to input, emphasizing the optimal utilization of resources to accomplish a specific task or goal. In systems, processes, or organizations, high efficiency implies effectiveness in achieving objectives while minimizing waste, redundancy, or unnecessary complexity. Improving efficiency often involves streamlining processes, enhancing resource allocation, and adopting technologies or methodologies that maximize output and minimize input.

2.9. Accuracy: Accuracy refers to the degree of correctness or precision in a measurement, calculation, or representation of data. It signifies how closely a value, result, or representation aligns with the true or intended value. In various fields, such as science, engineering, statistics, and computing, accuracy is a critical metric for evaluating the reliability and quality of data or results. A high degree of accuracy implies that the information is close to the actual or desired value, indicating minimal errors or deviations. Accuracy is often distinguished from precision, with precision referring to the degree of repeatability or consistency in measurements.

2.11 Ethical Concerns: Ethical concerns refer to issues and considerations related to moral principles, values, and norms that arise in various contexts, such as science, technology, business, and personal conduct. These concerns involve evaluating the potential impact of actions or decisions on individuals, communities, and society as a whole. Ethical considerations often revolve around questions of fairness, justice, transparency, privacy, and respect for human rights. Identifying and addressing ethical concerns is essential in guiding responsible behavior and decision-making, ensuring that actions align with ethical standards and contribute positively to the well-being of individuals and society.

2.12. Regulatory Compliance: Regulatory compliance refers to the adherence of individuals, organizations, or processes to laws, regulations, standards, and guidelines set by governing authorities or regulatory bodies. These regulations are established to ensure that specific industries, activities, or practices operate within legal and ethical boundaries. Achieving regulatory compliance involves understanding and implementing the necessary measures, policies, and procedures to meet the requirements laid out by relevant regulatory frameworks. Non-compliance may result in legal consequences, penalties, or reputational damage. Various industries, including finance, healthcare, and environmental management, must navigate and maintain regulatory compliance to ensure lawful and responsible conduct.

2.13. Method: The determination of installed energy for a manufacturing plant relies on the EDAS score, primarily influenced by the proximity to the suggested agreement machine. Concerning solar energy and geothermal electricity, the reliability of expert opinions and calculations is questionable. Although solar power is considered a sustainable energy source, experts value it for its extensive availability and accessibility (ranked 2nd in the fuzzy AHP space). However, its high setup costs (4th in EDAS) make solar power economically unfavorable for electricity generation, along with its subpar performance [14].When confronted with conflicting standards, EDAS proves to be a powerful method for stock type and dealer choice across multiple criteria. Critical metrics such as positive distance from mean (PDA) and negative distance from mean (NDA) are considered in this approach, enabling the tracking of differences between each option and the recommended response [15]. EDAS is discrete and calculates based on average reaction incredible separation from the alternate suggested solution awful distance, taking into account the type of criterion. Furthermore, each opportunity is evaluated using the CVPFRS model to determine its average appraisal value, and scores are calculated. Subsequently, a comprehensive evaluation of the options using the EDAS technique results in a rating for each item, with options ordered based on decreasing evaluation score values [16]. EDAS evaluation techniques are also applied to alternatives for hydrogen mobility roll-ups, assisting in ranking and determining a smoothness rating, acknowledging the inherent conflicts in selecting an ideal Hydrogen Mobility Roll-up alternative, each with its own advantages and disadvantages [17].The suggested EDAS strategy stands out for its accuracy and efficiency, requiring fewer mathematical computations than other classification methods. EDAS is consistently applied in assessing available options, providing a scale and form for the standard solution. An extended EDAS method for provider identification is proposed based on the character replacement's location. In choosing the location for waste elimination, an intuitively recommended fuzzy model based entirely on EDAS is employed. Additionally, EDAS is utilized in this work to analyze boundaries for renewable energy improvement [18].The application of EDAS technology in Multiple Attribute Group Decision Making (MAGDM) is diverse and extends across various domains. Initially, a distant learning approach and a concise definition of projects are briefly discussed. The conventional EDAS methodology, inspired by the classical EDAS method [19], is then enhanced under real circumstances. An innovative solution involves employing inverse housing in the EDAS technique to address the MCDM problem, offering a novel and environmentally friendly approach. The EDAS version is expanded by incorporating AVS to prioritize selections, coupled with a robust waste disposal website PDA and NDA in the EDAS approach for evaluation [20].The EDAS method is further applied to Multiple Criteria Group Decision Making (MCGDM). Additionally, EDAS integrates multiple algorithms for facile eneutrosophic selection. Despite considerable attention from students, there is a gap in extending EDAS to q-Rung; presenting an opportunity for future exploration [21].To tackle MCDM issues, a new system named EDAS is introduced, serving as a foundational framework. A literature review suggests that employing a prolonged EDAS model is most effective when entirely dependent on intuitive parametric difference measures. The approach incorporates an empirical method for sanitary disposal, aiding in selecting first-time waste disposal methods for hygienic purposes. Evaluation of contemporary methodologies validates the actions taken [22].In the context of enabling Indian Smart Cities, the EDAS approach is extended to the DHHFL framework for zero-carbon operations, aiming to significantly reduce carbon footprints by 2050. The EDAS approach relies on distance, utilizing Sweet and nadir statistical elements as parameters in the ranking approach, which is an average [23].While EDAS is acknowledged as one of the greatest and widely used MCDM techniques, there is a suggestion that a superior option exists: the EDAS method [24]. The methodology for supplier selection involves employing the Estimation of Distribution Algorithm Solution (EDAS) approach. Despite our extensive knowledge, there is currently no documented analysis of the Multiple Attribute Decision Making (MADM) problem using the EDAS method in the existing scholarly literature. Consequently, the application of EDAS in MADM represents a promising avenue for research, aiming to rank and determine the optimal potential within a clear, unified, and neutrosophic framework [25].The EDAS method, known for its innovation and effectiveness, is proposed and utilized to address issues related to stock types. The efficiency of the EDAS method is validated through a comparison with other Multiple Criteria Decision Making (MCDM) approaches. There is a recommendation to expand the application of the fuzzy EDAS and employ it in solving supplier selection problems. Furthermore, a user-friendly variant of the EDAS approach is developed to identify a suitable waste disposal site. In addition, various methods based on the EDAS technique are suggested for decision-making with neutrosophic units [26]. An ordering strategy, considering both supplier evaluation and context, is proposed using the EDAS approach. The assessment of providers adhering to environmental standards is carried out through the application of EDAS method stages and Interval Type-2 Fuzzy Sets (IT2FS) mathematical functions.

For each provider, this evaluation yields two factors: positive ratings and negative scores. A multi-objective linear programming model, incorporating purchase expenses and fixed parameters, is formulated to calculate the order quantity from each supplier. Fuzzy programming is employed within this multi-objective paradigm to solve the problem effectively [27].

3. RESULT AND DISCUSSION

TABLE 1. Analyzing of Bio computing and Synthetic Biology

	Efficiency	Accuracy	Ethical Concerns	Regulatory Compliance
Quantum Computing	0.85	0.92	0.20	0.80
Neuromorphic Computing	0.78	0.88	0.30	0.70
Optical Computing	0.92	0.95	0.10	0.90
DNA Data Storage	0.84	0.85	0.25	0.75
Swarm Computing	0.80	0.90	0.10	0.85
Conventional Computing	0.88	0.70	0.15	0.95
AVj	0.84500	0.86667	0.18333	0.82500

Table 1 shows the Alternative: Quantum Computing, Neuromorphic Computing, Optical Computing, DNA Data Storage, Swarm Computing, and Conventional Computing. Evaluation preference: Efficiency, Accuracy, Ethical Concerns, Regulatory Compliance. In the above tabulation, from the above table the other value is being calculated. Average value of Efficiency 0.84500, Accuracy 0.86667, Ethical Concerns 0.18333, Regulatory Compliance 0.82500.

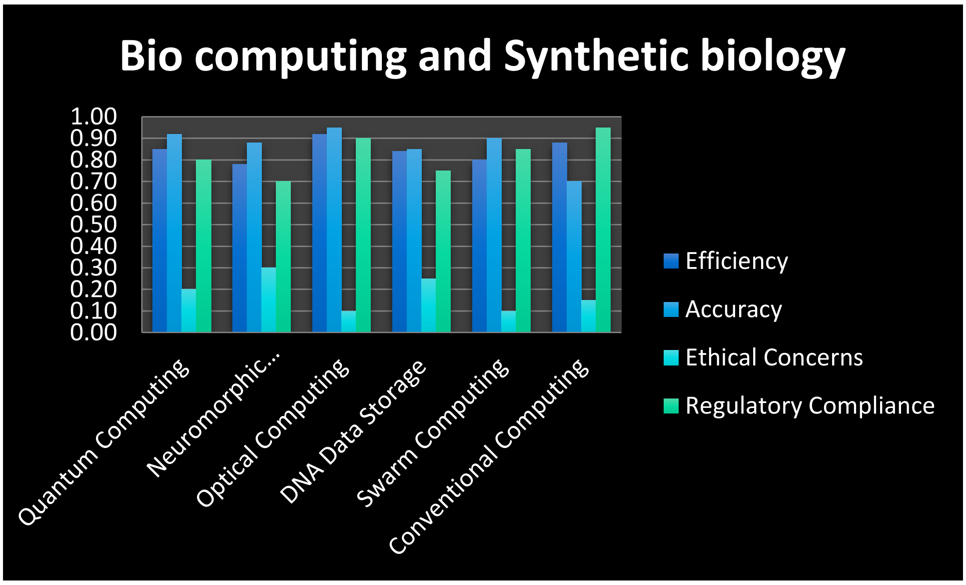

FIGURE 1. Analyzing of Bio computing and Synthetic Biology

Figure 1 illustrate the graphical representation of Analyzing of Bio computing and Synthetic Biology

TABLE 2. Positive Distance from Average (PDA)

Positive Distance from Average (PDA)			
0.01	0.06	0.00	0.03
0.00	0.02	0.00	0.15
0.09	0.10	0.45	0.00
0.00	0.00	0.00	0.09
0.00	0.04	0.45	0.00
0.04	0.00	0.18	0.00

Table 2 shows the positive distance from the average it calculates from the average of the first table this value is calculated for the later calculation to get the final rank.

TABLE 3. Negative Distance from Average (NDA)

Negative Distance from Average (NDA)			
0.00000	0.00000	0.09091	0.00000
0.07692	0.00000	0.63636	0.00000
0.00000	0.00000	0.00000	0.09091
0.00592	0.01923	0.36364	0.00000
0.05325	0.00000	0.00000	0.03030
0.00000	0.19231	0.00000	0.15152

Table 3 shows the negative distance from the average it calculates from the sum of the average of the first table this value is calculated for the later calculation to get the final rank.

TABLE 4. Weight

Weight			
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25

Table 4 shows the Weight value of 0.25

TABLE 5. Weighted PDA (SPi)

Weighted PDA				SPi
0.00148	0.01538	0.00000	0.00758	0.02444
0.00000	0.00385	0.00000	0.03788	0.04172
0.02219	0.02404	0.11364	0.00000	0.15986
0.00000	0.00000	0.00000	0.02273	0.02273
0.00000	0.00962	0.11364	0.00000	0.12325
0.01036	0.00000	0.04545	0.00000	0.05581

Table 5 shows the Weighted PDA the value of weighted PDA is product of the positive distance average to get the SPi value.

TABLE 6. Weighted NDA (SNi)

Weighted NDA				SNi
0.00000	0.00000	0.02273	0.00000	0.02273
0.01923	0.00000	0.15909	0.00000	0.17832
0.00000	0.00000	0.00000	0.02273	0.02273
0.00148	0.00481	0.09091	0.00000	0.09720
0.01331	0.00000	0.00000	0.00758	0.02089
0.00000	0.04808	0.00000	0.03788	0.08596

Table 6 shows the Weighted NDA the value of weighted NDA is product of the Negative distance average to get the SNi value.

TABLE 7. Spi&Sni&ASI&Rank

NSPi	NSPi	ASi	Rank
0.15288	0.87255	0.51271	3
0.26100	0.00000	0.13050	6
1.00000	0.87255	0.93627	1
0.14217	0.45494	0.29855	5
0.77098	0.88286	0.82692	2
0.34911	0.51797	0.43354	4

Table 7 shows the Analyzing of Bio computing and Synthetic Biology final result of this paper DNA Data Storage is in 5th rank, Optical Computing is in 1st rank, Swarm Computing is in 2nd rank. Quantum Computing is in 3rd rank, Neuromorphic Computing is in 6th rank, Conventional Computing is in 4thrank, and the final result is done by using the EDAS method.

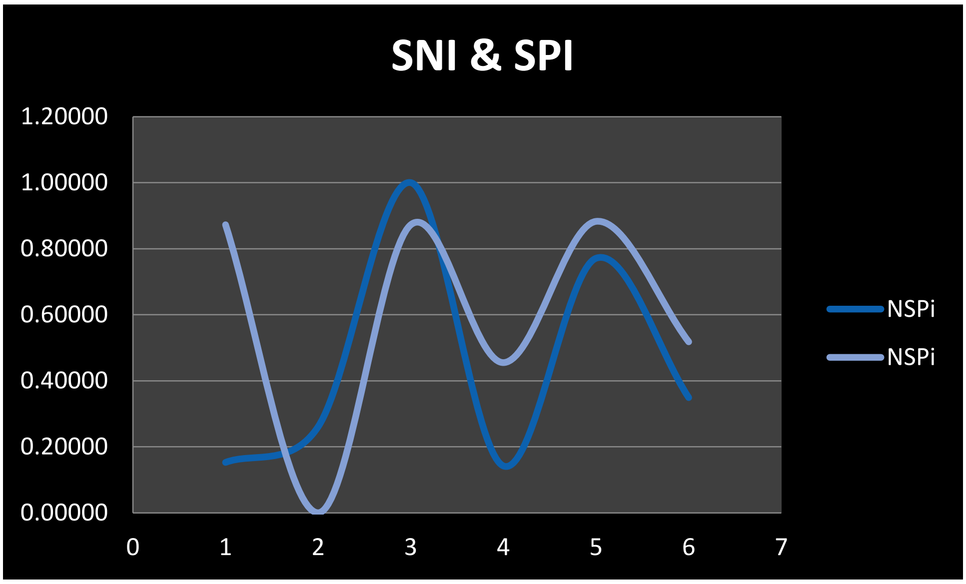

FIGURE 2. Sni&Spi

Figure 2 shows the graphical representation Analyzing of Bio computing and Synthetic Biology SPi refers to positive average value and SNi refers to negative average value.

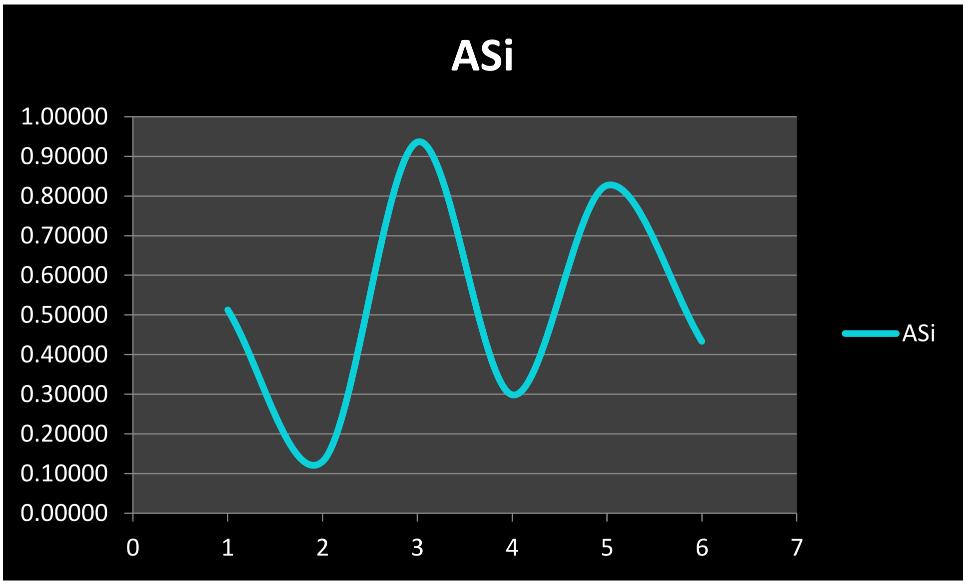

FIGURE 3. ASi

Figure 3 shows the graphical representation Analyzing of Bio computing and Synthetic Biology ASi value. Calculate the average value for positive and negative values. Quantum Computing is 0.51271; Neuromorphic Computing is 0.93627 Optical Computing 0.93627, DNA Data Storage 0.29855, Swarm Computing, Conventional Computing 0.43354.

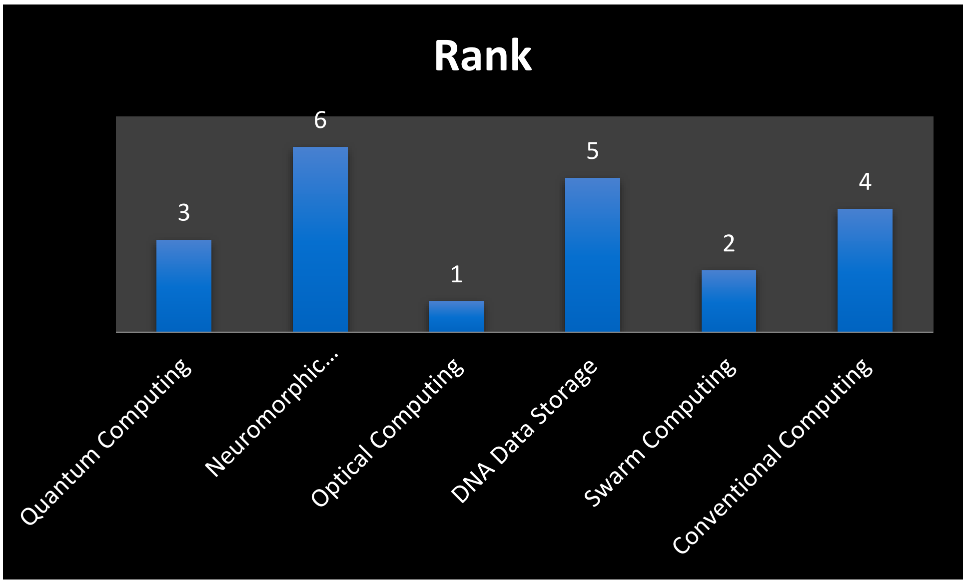

FIGURE 4. Ranks

Figure 4 shows optical computing is first rank and whereas Neuromorphic Computing is lowest rank.

4. CONCLUSION

The intertwining fields of bio computing and synthetic biology hold immense promise for revolutionizing various aspects of science, medicine, and technology. Bio computing, with its focus on harnessing biological entities for computation, opens avenues for efficient data processing and problem-solving. Leveraging the inherent parallelism and intricacies of living systems, bio computing may offer novel solutions to complex computational challenges. On the other hand, synthetic biology, by enabling the engineering of biological components and systems, empowers scientists to design and construct artificial life forms with tailored functionalities. This discipline holds the potential to create bio-inspired technologies, produce bio fuels sustainably, and engineer customized organisms for therapeutic applications. The synergy between bio computing and synthetic biology amplifies their individual capabilities, paving the way for innovative approaches to computing, data storage, and molecular programming. However, ethical considerations surrounding the manipulation of living organisms and potential environmental impacts require careful attention. In essence, the convergence of bio computing and synthetic biology heralds a transformative era in science, poised to reshape our understanding of life and redefine the boundaries of what is possible.

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