International Journal of Academic Information Systems Research (IJAISR)
ISSN: 2643-9026
Vol. 10 Issue 7 July - 2026, Pages: 74-78

Intelligent Optimization of Classical Sorting Algorithms Through Deep Learning and Reinforcement Learning

Mohammed Almadani , Samy S. Abu-Naser

Department of Information Technology,
Faculty of Engineering and Information Technology,
Al-Azhar University, Gaza, Palestine

Abstract: *Sorting is one of the most fundamental and most studied operations in computer science. Classical comparison-based algorithms such as Quicksort, Merge Sort, and Heap Sort have been refined for decades until they approach their theoretical limits, and further human improvement has become very difficult. Recent advances in artificial intelligence have reopened the question of whether machines can rethink sorting itself. This paper surveys two complementary directions in which deep learning and reinforcement learning are reinventing classical sorting. The first direction, learning to sort, replaces the discrete sorting operator with differentiable approximations — such as Pointer Networks and NeuralSort — so that ordering can be embedded directly inside trainable neural pipelines. The second direction, learning to discover, uses deep reinforcement learning to search the space of low-level programs and uncover faster correct algorithms, exemplified by DeepMind's AlphaDev, whose discovered routines were added to the LLVM C++ standard sorting library. We compare the methodology, results, strengths, and limitations of both directions. We conclude that AI does not replace classical sorting but extends it: enabling end-to-end learning on one side and superhuman low-level optimization on the other.*

Keywords : Sorting algorithms; Deep learning; Reinforcement learning; AlphaDev; Differentiable sorting; NeuralSort; Pointer networks; Algorithm discovery.

1. Introduction

Sorting — arranging a collection of items into a defined order — is among the most widely executed operations in computing. Fundamental routines such as sorting and hashing are used trillions of times every day, underpinning everything from database queries and search ranking to data compression and scientific computing. Because of this scale, even a small improvement in a core sorting routine can translate into large savings in time and energy across the world's computers.

Classical sorting is also one of the best understood problems in the field. Comparison-based algorithms are bounded below by $\Omega(n \log n)$ comparisons, and well-known methods such as Quicksort, Merge Sort, and Heap Sort already operate close to this limit. Decades of engineering have squeezed these algorithms to a point where additional gains are extremely hard to obtain, for human experts and for traditional automated search alike.

Artificial intelligence interacts with sorting in two distinct ways, and this paper treats them as the two faces of "reinventing" sorting. The first is learning to sort: instead of calling a fixed algorithm, a neural network learns to produce an ordering, and the sorting step itself is made differentiable so it can sit inside a larger machine-learning pipeline trained end-to-end. The second is learning to discover: a reinforcement-learning agent treats the construction of a sorting program as a game and searches for new routines that are provably correct yet faster than the best human designs.

This is a survey paper. Rather than running new experiments, it organizes, explains, and compares the main published methods and benchmark results in both directions, and discusses what each approach can and cannot do in practice.

2. Objectives

The objectives of this paper are:

- To review classical sorting algorithms and explain why they are difficult to improve further.
- To examine deep-learning approaches that make the sorting operator differentiable, including Pointer Networks and NeuralSort.
- To examine reinforcement-learning approaches that discover faster low-level sorting routines, focusing on AlphaDev.
- To compare the reported results and benchmarks of these approaches against classical baselines.
- To discuss the strengths, limitations, and practical implications of using AI to reinvent sorting.

3. Problem Statement

Reinventing sorting with AI faces two separate technical obstacles, one for each direction studied in this paper.

The first obstacle is differentiability. Modern deep learning is trained with gradient descent, which requires every operation in the pipeline to be differentiable. The sorting operator, however, is discrete: a tiny change in the input either leaves the output order unchanged or flips two elements abruptly. Its gradient is therefore zero almost everywhere and undefined at the switching points. This blocks any attempt to train a model end-to-end when ranking or ordering is part of the objective, for example in learning-to-rank, top-k selection, or differentiable nearest-neighbour models.

The second obstacle is optimality. Classical sorting routines are already highly optimized and, for small fixed sizes, are implemented as branchless sorting networks that are very close to optimal.

Improving them is hard precisely because the search space of valid programs is enormous and a single wrong instruction makes the whole routine incorrect. Traditional automated search struggles here, so the question is whether a learning agent can navigate this space and find correct routines that are genuinely faster than the human state of the art.

4. Literature Review

4.1 Classical foundations

The theory of comparison-based sorting is mature. Hoare's Quicksort (1962) and the classic Merge Sort and Heap Sort all achieve O(n log n) average behaviour, matching the comparison lower bound up to constants. For very small inputs, the state of the art is the sorting network: a fixed sequence of compare-and-swap operations that contains no data-dependent branches, which makes it fast and predictable on modern CPUs. These small networks are important because larger sorting functions call them many times as base cases, so their efficiency affects the overall cost of sorting any input.

4.2 Neural and differentiable sorting

The first deep-learning method able to learn an ordering of a set was the Pointer Network of Vinyals, Fortunato, and Jaitly (2015). It is an encoder–decoder architecture in which the attention mechanism is used as a pointer that selects an element of the input at each output step. Because the output is a position in the input rather than a token from a fixed vocabulary, Pointer Networks can handle variable-length sequences and were shown to learn to sort numbers and to generalize beyond the lengths seen during training.

A more direct line of work makes the sorting operation itself differentiable. Grover, Wang, Zweig, and Ermon (2019) introduced NeuralSort, a continuous relaxation of the argsort operator. Instead of producing a hard permutation matrix, NeuralSort produces a unimodal row-stochastic matrix — each row sums to one and has a distinct maximum — controlled by a temperature parameter; as the temperature approaches zero, the relaxation converges to the exact permutation. This makes ordering differentiable and was used to build, for example, a fully differentiable k-nearestneighbour classifier. Related operators followed: Cuturi et al. (2019) cast sorting as an optimaltransport problem solved with the Sinkhorn algorithm; Blondel et al. (2020) proposed differentiable sort and rank operators running in O(n log n) time; and Petersen et al. (2021, 2022) developed differentiable and monotonic sorting networks for scalable ranking supervision.

4.3 Reinforcement learning for algorithm discovery

A different idea is to use AI not to approximate sorting but to discover better sorting code. This direction builds on AlphaZero, the reinforcement-learning system that mastered Go, chess, and shogi through self-play. Mankowitz et al. (2023) adapted this approach in AlphaDev, which treats the construction of a low-level sorting routine as a single-player game and searches for assembly programs that are both correct and fast. AlphaDev is the first case in which an AI-discovered algorithm was accepted into a widely used standard library, marking the first change to the C++ standard sorting routines in over a decade.

5. Methodology

5.1 Survey approach

This paper follows a descriptive survey methodology. The relevant methods were grouped into two paradigms — learning to sort and learning to discover — and each was analysed in terms of its problem formulation, model, training signal, and reported results. The comparison in Section 6 relies on benchmark numbers published in the original peer-reviewed papers rather than on new experiments, so the reported figures reflect the authors' own measurements.

5.2 Learning to sort: differentiable and neural methods

In this paradigm the goal is to embed ordering inside a trainable network. Pointer Networks frame sorting as sequence-to-sequence prediction: an encoder reads the input elements into hidden states, and at each decoding step a content-based attention distribution over the inputs is interpreted as a pointer that selects the next element of the sorted output. Training uses supervised pairs of unsorted and sorted sequences.

Differentiable operators such as NeuralSort take a different route. They replace the hard permutation matrix that represents a sort with a soft, row-stochastic approximation parameterized by a temperature. Because this soft matrix is differentiable, gradients can flow through the ordering step, so the surrounding model can be trained end-to-end and the relaxation can be tightened toward a true sort as training proceeds. Optimal-transport, fast-rank, and differentiable-sortingnetwork variants offer the same capability with different trade-offs in accuracy and computational cost.

5.3 Learning to discover: reinforcement learning over programs

AlphaDev formulates algorithm discovery as a single-player "AssemblyGame." The state is the sequence of assembly instructions generated so far together with the current state of the CPU registers and memory. At each turn the agent chooses the next legal instruction to append. The episode ends when the program is complete, and the reward combines two terms: correctness, measured by running the candidate program on test inputs and checking the outputs, and latency, measured as the actual execution speed of the program (with measured latency computed only for a small fraction of candidates to control cost).

The learning algorithm extends AlphaZero: a deep neural network, using a Transformer-based representation of the assembly program, guides a Monte-Carlo Tree Search through the space of possible instruction sequences. Because a single wrong instruction can invalidate the entire routine, the search space is extremely sparse and unforgiving, which is what makes the problem hard and the result notable. AlphaDev was applied to both fixed-length sorting (Sort 3, 4, 5) and variable-length sorting (VarSort 3, 4, 5).

6. Results

The two paradigms are evaluated against different baselines, so their results are reported separately and then summarized together.

For algorithm discovery, AlphaDev produced sorting routines that were shorter and faster than the human state of the art. It found programs with fewer instructions than the human benchmark for Sort 3 and Sort 5 and matched it for Sort 4, and for variable sorting it discovered a VarSort4 routine that was 29 assembly instructions shorter than the human design. Two novel instruction patterns, named the AlphaDev swap and copy moves, each removed an instruction relative to the conventional implementation. When reverse-engineered to C++ and integrated into the LLVM libc++ standard library, the new routines were up to 70% faster for short sequences of around five elements and roughly 1.7% faster for sequences longer than 250,000 elements. The same approach also improved certain hashing functions by up to about 30%. These were the first changes to the C++ standard sorting routines in more than a decade.

For learning to sort, the results are reported as task accuracy rather than execution speed. NeuralSort enabled differentiable models that learned correct orderings on sorting benchmarks and powered a differentiable k-nearest-neighbour classifier with strong accuracy on standard image datasets. Pointer Networks learned to sort variable-length sequences from examples alone and generalized to lengths beyond those seen in training. These methods are not meant to replace a library sort; their value is that ordering becomes a trainable component inside a larger model.

The table below summarizes the comparison.

Approach	Goal	Correctness	Reported result
Classical (Quicksort / sorting networks)	Baseline generalpurpose sorting	Always correct	O(n log n); near-optimal small-case networks
Pointer Networks (2015)	Learn ordering of a set	Probabilistic / learned	Sorts variable lengths; generalizes beyond training length
NeuralSort (2019)	Differentiable sorting inside ML pipelines	Approximate (temperature-controlled)	Enables end-to-end training; differentiable kNN

AlphaDev (2023)	Discover faster lowlevel routines	Provably correct, verified	Up to 70% faster (short) / ~1.7% (very large); added to libc++

7. Discussion

The two directions reinvent sorting in different senses and answer to different needs. Learning to sort changes where sorting lives: it turns ordering into a soft, trainable operation so that ranking and selection can be optimized jointly with the rest of a neural model. The price is correctness. A differentiable or learned sort is only approximate — it is correct in the limit or with high probability, not by guarantee — so it is unsuitable as a drop-in replacement for a library sort, but well suited to machine-learning tasks where the ordering is a means to an end.

Learning to discover changes how sorting is implemented. AlphaDev keeps the output exactly correct — its programs are verified — and competes directly on speed, which is why its routines could be shipped in a real standard library. Its limitations are scope and cost: the gains are concentrated on small fixed sizes, the search is computationally expensive, and the discovered routines are tightly tied to specific instruction sets and CPU architectures. The headline numbers also need careful reading: the large 70% figure applies to very short sequences, while the improvement on very large inputs is a much smaller 1.7%. Even so, because these base cases are called so often, the aggregate effect at global scale is significant in both time and energy.

Taken together, the results support a clear message: AI is not replacing the classical theory of sorting, which still provides the correctness guarantees and the asymptotic bounds. Instead, AI extends sorting at both ends — making it differentiable for learning systems, and pushing lowlevel constant-factor performance beyond what manual engineering had reached. Open challenges remain, including scaling RL discovery to larger and more general routines, providing guarantees for learned sorters, and reducing the substantial computational cost of the search.

8. Conclusion

This paper surveyed how deep learning and reinforcement learning are reinventing the classical problem of sorting. Two complementary paradigms were examined. The first, learning to sort, uses Pointer Networks and differentiable operators such as NeuralSort to make ordering a trainable, gradient-friendly component of larger models, accepting approximate correctness in exchange for end-to-end learnability. The second, learning to discover, uses reinforcement learning over lowlevel programs — most notably AlphaDev — to find provably correct routines that are faster than decades of human optimization, to the point of being adopted into the C++ standard library.

Neither paradigm overturns classical sorting; both build on it. The classical algorithms supply the correctness and the asymptotic limits, while AI contributes differentiability for learning pipelines and superhuman constant-factor speed for core routines. Future work is likely to focus on extending RL-based discovery to larger and more general algorithms, on giving formal guarantees to learned sorters, and on lowering the cost of the search so that these techniques can be applied more broadly.

References

[1] Mankowitz, D. J., Michi, A., Zhernov, A., Gelmi, M., Selvi, M., Paduraru, C., et al. (2023). Faster sorting algorithms discovered using deep reinforcement learning. Nature, 618(7964), 257–263.
[2] Vinyals, O., Fortunato, M., & Jaitly, N. (2015). Pointer Networks. Advances in Neural Information Processing Systems (NeurIPS) 28.
[3] Grover, A., Wang, E., Zweig, A., & Ermon, S. (2019). Stochastic Optimization of Sorting Networks via Continuous Relaxations (NeuralSort). International Conference on Learning Representations (ICLR).
[4] Cuturi, M., Teboul, O., & Vert, J.-P. (2019). Differentiable Ranking and Sorting using Optimal Transport. Advances in Neural Information Processing Systems (NeurIPS) 32.
[5] Blondel, M., Teboul, O., Berthet, Q., & Djolonga, J. (2020). Fast Differentiable Sorting and Ranking. International Conference on Machine Learning (ICML).
[6] Petersen, F., Borgelt, C., Kuehne, H., & Deussen, O. (2021). Differentiable Sorting Networks for Scalable Sorting and Ranking Supervision. International Conference on Machine Learning (ICML).
[7] Petersen, F., Borgelt, C., Kuehne, H., & Deussen, O. (2022). Monotonic Differentiable Sorting Networks. International Conference on Learning Representations (ICLR).
[8] Silver, D., Hubert, T., Schrittwieser, J., et al. (2018). A general reinforcement learning algorithm that masters chess, shogi, and Go through self-play (AlphaZero). Science, 362(6419), 1140–1144.
[9] Hoare, C. A. R. (1962). Quicksort. The Computer Journal, 5(1), 10–16.
[10] Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to Algorithms (3rd ed.). MIT Press.
[11] Knuth, D. E. (1998). The Art of Computer Programming, Vol. 3: Sorting and Searching (2nd ed.).
[12] Google DeepMind. (2023). AlphaDev discovers faster sorting algorithms. DeepMind Blog.
[13] Hamed, Mohammed A, et al., "Artificial Intelligence in Agriculture: Enhancing Productivity and Sustainability", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 8, pp. 1-5, 2024.
[14] El-Ghoul, Mostafa, et al., "Artificial Intelligence as a Frontline Defense: Preventing Cyberattacks in a Connected World", 2025.
[15] Alzamily, Jawad YI, et al., "Artificial Intelligence in Healthcare: Transforming Patient Care and Medical Practices", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 8, pp. 1-9, 2024.
[16] Al-Bayed, Mohran H, et al., "Intelligent Multi-Language Plagiarism Detection System", International Journal of Academic Information Systems Research (IJAISR), vol. 2, no. 3, pp. 19-34, 2018.
[17] Nasser, Basma S Abu, et al., "Artificial Intelligence in Digital Media: Opportunities, Challenges, and Future Directions", International Journal of Academic and Applied Research (IJAAR), vol. 8, no. 6, pp. 1-10, 2024.
[18] Hamad, Malak S, et al., "Harnessing Artificial Intelligence to Enhance Medical Image Analysis", International Journal of Academic Health and Medical Research (IJAHMR), vol. 8, no. 9, pp. 1-7, 2024.
[19] Qwaider, Sabreen R, et al., "Harnessing Artificial Intelligence for Effective Leadership: Opportunities and Challenges", International Journal of Academic Information Systems Research(IJAISR)(IJAISR), vol. 8, no. 8, pp. 9-15, 2024.
[20] Hamadaqa, Mohammed Hazem M, et al., "Leveraging Artificial Intelligence for Strategic Business Decision-Making: Opportunities and Challenges", International Journal of Academic Information Systems Research(IJAISR), vol. 8, no. 8, pp. 16-23, 2024.
[21] El_Jerjawi, Nesreen Samer, et al., "The Role of Artificial Intelligence in Revolutionizing Health: Challenges, Applications, and Future Prospects", International Journal of Academic Applied Research (IJAAR), vol. 8, no. 9, pp. 7-15, 2024.
[22] Al Ijla, Mohamed Sabri, et al., "Perspective on Intelligent Assistive Devices in Rehabilitation", International Journal of Academic Engineering Research (IJAER), vol. 4, no. 11, pp. 31-36, 2020.
[23] Salman, Fatima M, et al., "COVID-19 Detection using Artificial Intelligence", International Journal of Academic Engineering Research (IJAER), vol. 4, no. 3, pp. 18-25, 2020.
[24] Taha, Abu, et al., "The Intersection of Nanotechnology and Artificial Intelligence: Innovations and Future Prospects", 2025.
[25] Elqassas, Randa, et al., "Convergence of Nanotechnology and Artificial Intelligence: Revolutionizing Healthcare and Beyond", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 10, pp. 25-30, 2024.
[26] Akkila, Alaa N, et al., "Navigating the Ethical Landscape of Artificial Intelligence: Challenges and Solutions", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 8, pp. 68-73, 2024.
[27] Abu Nasser, Besan S, et al., "Implications and Applications of Artificial Intelligence in the Legal Domain", International Journal of Academic Information Systems Research (IJAISR), vol. 7, no. 12, pp. 18, 2024.
[28] Anderson, JR, et al., "Adaptation of Problem Presentation and Feedback in an Intelligent Mathematics Tutor.", Information Technology Journal, vol. 5, no. 5, pp. 167-207, 2005.
[29] Mettleq, Alaa Soliman Abu, et al., "Revolutionizing Drug Discovery: The Role of Artificial Intelligence in Accelerating Pharmaceutical Innovation", International Journal of Academic Engineering Research (IJAER), vol. 8, no. 10, pp. 45-52, 2024.
[30] Alrakhawi, Hazem AS, et al., "Transforming Human Resource Management: The Impact of Artificial Intelligence on Recruitment and Beyond", International Journal of Academic Information Systems Research (IJAISR), vol. 8, no. 8, pp. 1-8, 2024.
[31] Hissi, H El-, et al., "Medical Informatics: Computer Applications in Health Care and Biomedicine.", Journal of Artificial Intelligence, vol. 3, no. 4, pp. 78-85, 2008.
[32] Altayeb, Jehad M, et al., "AI-Driven Innovations in Agriculture: Transforming Farming Practices and Outcomes", International Journal of Academic Applied Research (IJAAR), vol. 8, no. 9, pp. 1-6, 2024.
[33] El-Ghoul, Mostafa, et al., "AI in HRM: Revolutionizing Recruitment, Performance Management, and Employee Engagement", International Journal of Academic Applied Research (IJAAR), vol. 8, no. 9, pp. 16-23, 2024.
[34] Megdad, Mosa MM, et al., "Ethics in AI: Balancing Innovation and Responsibility", International Journal of Academic Pedagogical Research (IJAPR), vol. 8, no. 9, pp. 20-25, 2024.
[35] Al-Bayed, Mohran H, et al., "AI in Leadership: Transforming Decision-Making and Strategic Vision", International Journal of Academic Pedagogical Research (IJAPR), vol. 8, no. 9, pp. 1-7, 2024.
[36] Samara, Faten YA Abu, et al., "The Role of AI in Enhancing Business Decision-Making: Innovations and Implications", International Journal of Academic Pedagogical Research (IJAPR), vol. 8, no. 9, pp. 8-15, 2024.
[37] Taha, Ashraf MH, et al., "The Evolution of AI in Autonomous Systems: Innovations, Challenges, and Future Prospects", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 10, pp. 1-7, 2024.
[38] Mosa, Msbah J, et al., "AI and Ethics in Surveillance: Balancing Security and Privacy in a Digital World", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 10, pp. 8-15, 2024.
[39] Bakeer, Hani, et al., "AI and Human Rights", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 10, pp. 16-24, 2024.
[40] El-Habibi, Mohammed F, et al., "Generative AI in the Creative Industries: Revolutionizing Art, Music, and Media", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 10, pp. 71-74, 2024.
[41] Abu Nasser, Basma S, et al., "Leveraging AI for Effective Fake News Detection and Verification", Arab Media Society, no. 37, 2024.
[42] Alnajjar, Mohammad, et al., "AI in Climate Change Mitigation", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 10, pp. 31-37, 2024.
[43] Karaja, Mohammed B, et al., "AI-Driven Cybersecurity: Transforming the Prevention of Cyberattacks", International Journal of Engineering and Information Systems (IJEAIS), vol. 8, no. 10, pp. 38-44, 2024.
[44] El-Mashharawi, Hosni Qasim, et al., "AI in Mental Health: Innovations, Applications, and Ethical Considerations", International Journal of Academic Engineering Research (IJAER), vol. 8, no. 10, pp. 53-58, 2024.
[45] Abu-Saqer, Mohammed M, et al., "AI Regulation and Governance", International Journal of Academic Engineering Research (IJAER), vol. 8, no. 10, pp. 59-64, 2024.
[46] Al-Dahdooh, Rami, et al., "Explainable AI (XAI)", International Journal of Academic Engineering Research (IJAER), vol. 8, no. 10, pp. 65-70, 2024.
[47] Qaoud, Alaa NN, et al., "Human-Centered AI: The Role of Explainability in Modern AI Systems", 2025.
[48] Al-Bayed, Mohran H, et al., "Surveillance in the Age of AI: Navigating Ethical Boundaries and Human Rights", 2025.
[49] Al Qatrawi, Mohammed, et al., "AI and Climate Action: Technology's Role in Mitigating Environmental Challenges", 2025.
[50] Jamala, Mohammed, et al., "The Intersection of Generative AI and Creative Expression: Opportunities and Ethical Challenges", 2025.
[51] Wishah, Nida D, et al., "Balancing Innovation and Control: The Framework for AI Regulation", 2025.
[52] Sabah, Ahmed S, et al., "The intersection of AI and human rights: Challenges and opportunities", 2025.
[53] Samhan, Lamis F, et al., "Future Directions: Emerging trends and future potential of AI in autonomous systems.", 2025.
[54] Alkurd, Yahya Mohammed, et al., "A proposed accurate system for diagnosing hypertension", 2025.
[55] Bliede, HMM, et al., "Students perceptions of artificial intelligence in education", International Journal of Academic Management Science Research (IJAMSR), vol. 7, pp. 105-116, 2023.
[56] Abu Naser, Samy S, "Developing visualization tool for teaching AI searching algorithms", Information Technology Journal, Scialert, vol. 7, no. 2, pp. 350-355, 2008.
[57] Elkahlout, Mohammed, et al., "AI-Driven Organizational Change: Transforming Structures and Processes in the Modern Workplace", International Journal of Academic Information Systems Research (IJAISR), vol. 8, no. 8, pp. 24-28, 2024.
[58] Alkayyali, Zakaria KD, et al., "Using MODWPT-Based Feature Extraction: A Comparative Study", vol. 3, pp. 225, 2025.
[59] Saikly, Eng. Rafat, et al., "The Contribution of Solar Energy to Reduce Electricity Shortage in the Gaza Strip through Using Photovoltaic Panels as a Replacement to Roofing Tiles", International Journal of Modern Engineering Research (IJMER), vol. 4, no. 1, pp. 98-104, 2014.
[60] FATAYER, TAMER S, et al., "DEVELOPING A HYBRID LOG-FILE–BASED COVERT CHANNEL FOR SECURE DIGITAL FORENSIC DOCUMENT TRANSMISSION", Journal of Theoretical and Applied Information Technology, vol. 104, no. 4, pp. 444-458, 2026.
[61] Abu Naser, Samy S., et al., "Design and Development of Mobile Blood Donor Tracker", Journal of Multidisciplinary Engineering Science Studies (JMESS), vol. 2, no. 2, pp. 284-300, 2016.
[62] Abu Naser, Samy S., et al., "Design and Development of Mobile University Student Guide", Journal of Multidisciplinary Engineering Science Studies (JMESS), vol. 2, no. 1, pp. 193-197, 2016.
[63] Nasser, Ibrahim M, et al., "Web Application for Generating a Standard Coordinated Documentation for CS Students' Graduation Project in Gaza Universities", International Journal of Engineering and Information Systems (IJEAIS), vol. 1, no. 6, pp. 155-167, 2017.
[64] Elzamly, Abdelrafe, et al., "A New Conceptual Framework Modelling for Cloud Computing Risk Management in Banking Organizations", International Journal of Grid and Distributed Computing, vol. 9, no. 9, pp. 137-154, 2016.
[65] Elzamly, Abdelrafe, et al., "Critical cloud computing risks for banking organizations: Issues and challenges", Religación. Revista de Ciencias Sociales y Humanidades, vol. 4, no. 18, pp. 673-682, 2019.
[66] Abusharekh, Nader H, et al., "Knowledge Management Processes and Their Role in Achieving Competitive Advantage at Al-Quds Open University", International Journal of Academic Accounting, Finance & Management Research (IJAAFMR), vol. 3, no. 9, pp. 1-18, 2019.
[67] Li, Dongyu, et al., "A novel distributed index method for cloud computing", International Journal of Grid and Distributed Computing, vol. 1, no. 1, pp. 8, 2016.
[68] Elzamly, Abdelrafe, et al., "Assessment Risks for Managing Software Planning Processes in Information Technology Systems", International Journal of Advanced Science and Technology, vol. 28, no. 1, pp. 327-338, 2019.
[69] Alsharif, Fawzy, et al., "Mechanical Reconfigurable Microstrip Antenna", International Journal Of Microwave And Optical Technology, vol. 11, no. 3, 2016.
[70] Aboufoul, Tamer, et al., "A novel UWB wearable antenna", World Wide Journal of Multidisciplinary Research and Development, vol. 2, no. 9, pp. 32-37, 2015.
[71] Amro, Eng Mazen Abu, et al., "MODELLING FOR CROSS IGNITION TIME OF A TURBULENT COLD MIXTURE IN AMulti BURNER COMBUSTOR", International Journal on Computational Science & Applications (IJCSA), vol. 6, no. 1, pp. 35-47, 2016.
[72] ljerjawi, Nesreen S, et al., "Artificial Intelligence for Intelligent Waste Sorting: An Efficient and Scalable System", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 114-117, 2025.
[73] Aljerjawi, Nesreen S, et al., "AI-Assisted Multi-Criteria Sorting for Decision Support in Healthcare Systems", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 90-93, 2025.
[74] Aljerjawi, Nesreen S, et al., "AI-Enhanced Sorting of Genomic Sequences for Accelerated Bioinformatics Analysis", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 105-109, 2025.
[75] Alnajjar, Khaleel, et al., "SmartSort: An Intelligent Framework for Optimizing Sorting Efficiency Using AI in Real-Time Systems", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 80-85, 2025.
[76] Aljerjawi, Nesreen S, et al., "AI-Powered Sorting in E-commerce: Personalization and Performance Optimization", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 110-113, 2025.
[77] Aljerjawi, Nesreen S, et al., "Large-Scale Data Processing AI-Driven Adaptive Sorting Techniques", International Journal of Academic Engineering Research (IJAER), vol. 9, no. 8, 2025.
[78] Al-Aydi, Beesan Mohammed, et al., "Comparative Study of Traditional and AI-Enhanced Sorting Algorithms: QuickSort, MergeSort, HeapSort, and TimSort", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 70-79, 2025.
[79] Miqdad, Sojoud Mahmoud, et al., "Efficient Sorting of Financial Transactions Using Artificial Intelligence for Fraud Detection and Risk Assessment", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 147-154, 2025.
[80] Almoghrabi, Altaher, et al., "AI-Driven Adaptive Sorting Algorithms for Large-Scale Data Processing", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 155-161, 2025.
[81] Aljerjawi, Nesreen S, et al., "Effective Sorting of Business Transactions Using AI for Fraud Detection and Threat Assessment", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 139-146, 2025.
[82] Aljerjawi, Nesreen S, et al., "SmartSort: An Intelligent Framework for Optimizing Sorting Efficiency Using AI", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 134-138, 2025.
[83] Aljerjawi, Nesreen S, et al., "Improving Sorting Algorithms Using Artificial Intelligence: A Cross Tactic", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 8, pp. 118-125, 2025.
[84] Aljerjawi, Nesreen S, et al., "Reinventing Classical Sorting with Deep Learning and Reinforcement Techniques", International Journal of Academic Information Systems Research (IJAISR), vol. 9, no. 6, pp. 126-133, 2025.