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Article

A Comprehensive Review of Evaluating the Efficiency of Solving Time for Two-Dimensional Computational Problems

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Abstract: The growing importance of tackling 2D computational problems is examined in this research. These issues are crucial in computer graphics, robotics, medical imaging, and autonomous systems. In real-time applications that require quick and accurate decision-making, balancing computer efficiency and accuracy is crucial. These applications are especially affected by rising technology expectations. After recent advances in parallel computing, machine learning, and hardware acceleration, this study examines the latest two-dimensional problem-solving methods and their shifting environment. It illustrates both progress and problems that must be solved to maximize performance across several domains. This study examines two-dimensional computational problem-solving methodologies, strategies, and algorithms in detail, focusing on time efficiency. To identify published material, all indexed databases—ScienceDirect, ResearchGate, and Google Scholar—were searched. The criteria were used to choose 2020–2025 research based on publication names, study designs, interventions, and findings. The topic has seventy-nine relevant articles. The data analysis identified significant sentences pertinent to the coding framework, highlighted notable discoveries, and created a narrative assessment framework. The following table summarizes various studies comparing heuristic algorithms from different countries. German researchers compared beam search techniques (BS1, BS2, and BS3) to dynamic programming. They found that these algorithms improve speed and accuracy as item categories rise. A Chinese study found that a bandit-based system that incorporates multiple intelligent optimization strategies performed as well as the best current methods. Thai, Indian, Pakistani, and Iranian academics suggested self-sampling, heat transfer, and wavelet analysis algorithms for handling various problems. These works demonstrate the advances gained in computational techniques across a wide range of subject topics, each with its own challenges and computational complexity. The experiments found that heuristic methods, particularly beam search approaches, can reduce computation time compared to dynamic programming. More item types lead to a balance between accuracy and speed. Bandit algorithms have shown that adaptable frameworks can handle complex problems. Heuristics, parallel computing, and machine learning can increase performance and scalability for increasingly complex computational problems.
Keywords: Evaluating, Effectiveness, Solving Time, dan Two-Dimensional Computational Problems

1. INTRODUCTION

There has been a substantial emphasis placed on the urgent need for efficient algorithms and approaches that are capable of handling a wide range of computational challenges as a result of the increasing complexity and computational demands of modern scientific and engineering problems. These issues are present across a wide range of sectors and academic fields, all of which recognize the importance of high-performance computation to the development of new technologies and innovations. Out of all of these computational issues, two-dimensional (2D) computational problems stand out as an important area of research due to the fact that they are so widespread and have applications in a variety of fields. These fields include computer graphics, geometric processing, image analysis, robotics, and computer-aided design (CAD). As a result of the ability to solve problems involving two-dimensional data in an effective and efficient manner, there are wide-ranging implications for both theoretical developments and practical applications in domains such as machine learning, autonomous systems, medical imaging, and environmental modelling .

Numerous real-world scenarios that call for the precise manipulation and analysis of spatial data are examples of situations that can give rise to computing issues in two dimensions. Examples of jobs that largely rely on efficient 2D algorithms include displaying complicated visual images and executing geometric changes. These are examples of tasks that are performed in the field of computer graphics. When it comes to geometric processing, some of the issues that are frequently encountered include operations such as mesh generation, surface modeling, and form analysis. These operations will all need to be carried out with precision and speed. Similarly, algorithms need to be able to handle vast amounts of data in a short amount of time while maintaining precision in the output when used in image analysis applications. These applications include everything from object recognition to medical picture segmentation. The ability of machines to interact with their surroundings in a secure and efficient manner is made possible by the application of two-dimensional pathfinding and obstacle avoidance techniques in the field of robotics, particularly in autonomous navigation systems. The examples presented here shed light on the extensive nature of computational problems in two dimensions and demonstrate the fundamental role that these challenges play in the development of modern technology . The nature of computational issues in two dimensions poses a distinct set of obstacles, both in terms of correctness and the efficiency with which they may be computed. These challenges are inherently computationally complex, and as a result, they frequently need for solutions that not only include the processing of enormous volumes of data but also do so under stringent time limitations. In areas such as real-time rendering in computer graphics, where algorithms are required to interpret two-dimensional image input, which frequently consists of millions of pixels, and construct realistic visual representations in a fraction of a second, this becomes very obvious. For the sake of this discussion, the rate at which these computations are carried out is the factor that influences the overall performance and visual quality of applications such as video games, simulations, and virtual reality. One of the most important challenges is to find a way to strike a balance between high accuracy and fast calculation. This is because algorithms that are more accurate have a tendency to use more resources, while algorithms that are faster may compromise the quality of the outputs .

The intricacy of two-dimensional computing problems is illustrated by autonomous automobiles, which provide yet another illuminating example. When it comes to autonomous navigation, the requirement to interpret sensor data, such as lidar scans and camera images, and compute optimal pathways in surroundings that are dynamic and full of real-world elements gives rise to computational challenges in two dimensions. These algorithms have to take into consideration the presence of barriers, differences in topography, and the requirement for making decisions in real time. The capability of a vehicle to react quickly to these changes can be the deciding factor in whether or not a safe maneuver is performed or whether or not a catastrophic failure occurs. Therefore, the effectiveness of the algorithms that are utilized in these systems has a direct influence on both the safety and performance of autonomous vehicles. This exemplifies the significant significance that time efficiency plays in high-stakes, real-time applications . In the field of medical imaging, pattern recognition algorithms in two dimensions are utilized to identify cancers and other anomalies in diagnostic images. This presents a challenge that is comparable to the one described above. In this area of study, algorithms are required to process enormous amounts of data in a short amount of time, typically derived from two-dimensional scans like X-rays, CT scans, or MRIs, while retaining a high level of accuracy in order to guarantee accurate diagnosis and treatment. Therefore, the computing efficiency of these algorithms is of the utmost importance, since any delays or mistakes in the analysis might have severe repercussions for the care of patients. The ability to recognize and evaluate structures in two-dimensional images, such as tumors or lesions, is a task that must be done with both precision and speed. This is because the clinical outcomes are significantly dependent on the prompt and precise processing of these images .

The accuracy of the solution and the amount of time it takes to compute are the two key metrics that are typically used to measure the effectiveness of performing these 2D computational jobs. In many cases, the relationship between these two aspects is inverse. Algorithms that are tuned for higher accuracy typically demand more computer resources and processing time, whereas algorithms that are built for faster results may lose precision. This trade-off is most noticeable in disciplines such as computer vision, where the requirement for real-time processing is in direct opposition to the requirement for accurate data interpretation. It is still a major research challenge in the field of 2D computational problems to find a way to strike a balance between these two competing criteria. This is because applications continue to demand both high-speed performance and high-quality outputs. Significant breakthroughs in hardware technology, such as the creation of parallel processing systems and graphics processing units (GPUs), have significantly improved the efficiency of addressing 2D computing problems in recent years . These advancements have been made possible by recent progress in hardware technology. Through the implementation of these advancements, tasks that were previously computed in a sequential fashion can now be parallelized, which enables the processing of more complicated issues at speeds that have never been seen before. For instance, graphics processing units (GPUs), which were initially developed for the purpose of displaying visuals, have demonstrated remarkable efficacy in managing large-scale data processing jobs in a variety of fields, such as scientific computing, machine learning, and image processing. When it comes to real-time applications, where there is a great need for instantaneous outcomes, the influence of these hardware developments has been particularly substantial. The underlying algorithms, on the other hand, continue to be the most important component in determining the overall efficiency of the computational process . This is despite the fact that developments in hardware have played a substantial role in enhancing computational performance.

Over the course of recent study and beyond, significant progress has been done in terms of enhancing the effectiveness of solving 2D computational issues. On real-time image segmentation in medical diagnostics, a unique parallel processing approach was developed. This algorithm optimizes computing time by exploiting GPU architectures, which results in a roughly forty percent reduction in the amount of time required for segmentation when compared to existing methods. The processing speed of big two-dimensional medical images is greatly increased by this algorithm, which is an important development for real-time diagnoses in medical settings that are considered to be of essential importance .

To improve the navigation capabilities of autonomous vehicles, an improved pathfinding algorithm was provided. This approach coupled two-dimensional lidar data with dynamic obstacle avoidance algorithms. A deep learning strategy was added into their process, which enabled the vehicle to make judgments in real time with a small amount of latency in the computation. The findings of this study indicated a significant reduction in the amount of time required for pathfinding by thirty percent, which enables safer and more efficient navigation in complex urban situations. Additional progress has been made in the field of geometric processing, and a method that is optimized for two-dimensional shape recognition has been proposed. Using a hybrid machine learning method, their system was able to achieve a 20% gain in recognition accuracy while simultaneously reducing processing time by 15% for complicated shape datasets. This made the technique more viable for use in industrial inspection and real-time applications. These latest research highlight the significance of continuously refining algorithms and adopting new techniques in order to address the growing complexity of computational challenges that are based in two dimensions. It has been demonstrated that the combination of machine learning, parallel computing, and hardware acceleration is one of the most important aspects in improving the state of the art in the process of resolving these issues .

In addition to this, the review will investigate the impact that hardware acceleration and parallelism play in improving the computational efficiency of these algorithms. In light of the ongoing development of emerging technologies, there is a growing possibility of optimizing the time complexity of strategies for addressing two-dimensional problems. The review will also include a discussion of the practical ramifications of these breakthroughs, which will investigate how increases in computing efficiency affect applications in the real world, including those in the fields of robotics, image processing, computer graphics, and medical diagnostics. As the demand for complex and time-efficient solutions to 2D computational issues continues to rise, it is becoming even more important to have a solid understanding of the trade-offs and obstacles that are connected with finding solutions to these problems. This review will contribute to the ongoing effort to advance the field of computational science by providing valuable insights into how efficiency can be improved in solving 2D computational problems, and by extension, advanced the field of computational science as a whole . This review will be accomplished by drawing together key findings from a wide range of studies.

In order to provide a thorough and comprehensive assessment of the numerous approaches, strategies, and algorithms that are utilized in the process of addressing 2D computational issues, the purpose of this paper is to place a particular emphasis on the time efficiency of these problems. We will investigate both classical methods, which have been essential in the development of 2D computational geometry, and emerging advances in algorithmic design, parallel computing, and machine learning, which are beginning to transform the landscape of 2D problem-solving. Both of these approaches will be investigated. The purpose of this study is to emphasize the strengths, limits, and potential areas for additional research in the area of improving the efficiency of solving 2D computational problems. This will be accomplished by providing an in-depth review of the techniques that are currently considered to be state-of-the-art and by providing a synthesis of the available literature.

2. METHOD

Study design

In order to locate and evaluate articles that are closely linked to the subject matter that is being investigated, this research makes use of a process known as a systematic literature review (SLR), which is based on the PRISMA standard. A complete, objective, and open-minded synthesis of previously conducted research is something that the SLR approach is able to do, which has garnered widespread recognition. Through the utilization of this methodological framework, the review is guaranteed to be methodical, capable of being replicated, and able to minimize the danger of bias while simultaneously maximizing the reliability and validity of the findings achieved. The purpose of this research is to provide a solid basis for the review by adhering to the PRISMA criteria. This research will provide comprehensive documentation of each phase of the review process, including the search strategy, study selection, data extraction, and analysis.

To ensure that only the studies that were the most pertinent to the research questions were included, the review process was meticulously organized to ensure that the research questions were addressed with clarity. Using the PICOS framework (Population, Intervention, Comparison, Outcome, and Study Design), which is a strategy that is widely acknowledged for the purpose of conducting systematic reviews, inclusion criteria were rigorously specified in order to accomplish this goal. When it comes to the process of selecting studies, the PICOS framework acts as a guiding principle, supporting the establishment of defined guidelines for what constitutes research that is eligible for consideration. Not only does this framework offer a methodical approach to the selection of studies, but it also guarantees that the studies that are included are in accordance with the particular goals of the review.

Database and search strategy

In order to carry out our investigation, we utilized the services of ResearchGate, Google Scholar, and ScienceDirect. We applied the PICOS framework in order to ensure consistency and carry out thorough research while we were in the process of locating and selecting studies that were relevant to our investigation. Listed below are the components that are included in the framework:

Table 1. The keywords utilized in the literature search were determined using the PICO method

PICOS Component	
P (population)	No Population
I (intervention)	No Intervention
C (comparison)	No use a comparison group
O (outcome)	Solving Time for Two-Dimensional Computational Problems
S (study design)	Experiment

Identification of study

In the process of data extraction, our research team worked independently, paying close attention to a number of important features of each study. These aspects included the author(s), study design, research aims, and results. We were able to ensure that we captured the studies that were the most pertinent and of the highest quality, which were in line with the objectives of the research. Following the first search and identification, a total of 79 publications were discovered across a variety of academic databases. The distribution of these papers is as follows: There were a total of 32 publications drawn from Google Scholar, 25 articles drawn from ResearchGate, and 12 articles drawn from ScienceDirect. Immediately following the collection of the articles, we began the screening process in order to assess the quality and relevance of the articles. To confirm that the studies were directly connected to the issue of Solving Time for Two-Dimensional Computational Problems and that they satisfied the appropriate quality requirements, this phase comprised assessing the abstracts, titles, and methodology of the research. Following the completion of this screening, we chose seven papers for further in-depth investigation because we believed they were the most relevant and methodologically sound among the ones that were considered.

A detailed examination of the present status of research on two-dimensional computing problems was provided by the publications that were chosen. The articles specifically focused on the effectiveness of solving time in a variety of computational settings. These publications provided the reader with insightful information regarding the algorithms, methodologies, and computational strategies that were utilized to handle these issues, which contributed to the formation of a clear grasp of the current state of the field.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were closely adhered to throughout the study project in order to guarantee a selection procedure that was well-organized, objective, and open to public scrutiny. We verified that the discovery and inclusion of studies were carried out in a methodical manner by adhering to the PRISMA framework. This allowed us to eliminate any potential biases and ensure that the review process was both rigorous and replicable. To provide a visual depiction of the study selection process, the PRISMA flow diagram that was used throughout the study is provided below. This diagram provides a visual representation of the process, beginning with the identification of articles and ending with the selection of those that were included in the review. This figure highlights the transparent and rigorous approach that was used in selecting papers, which strengthens the reliability and validity of the conclusions that were obtained from the review. In order to show the PRISMA flow diagram that was utilized during the entirety of this approach, the following sample is provided:

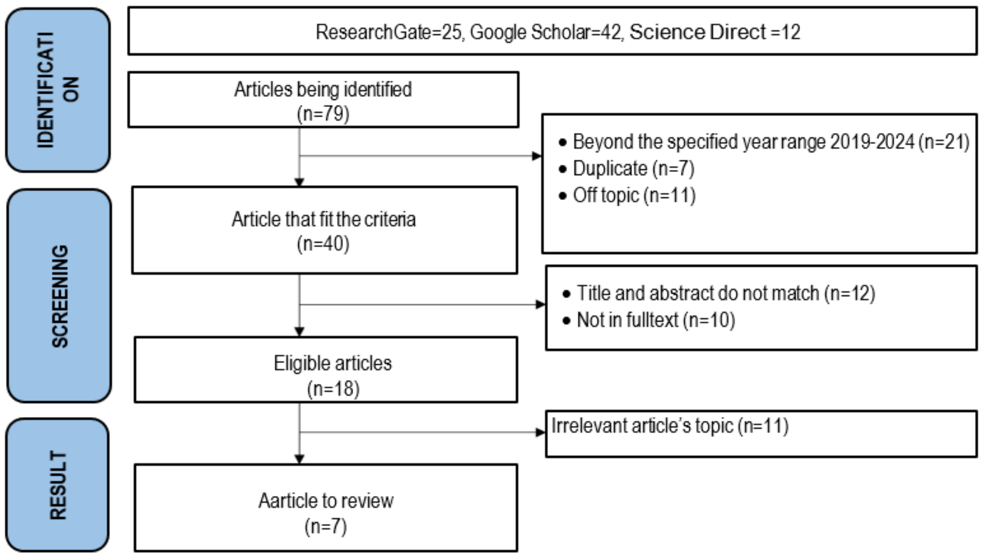

Figure 1: PRISMA Flow Diagram

3. RESULT

Table 2. The Result of Data Extraction

Country	Study Design	Results	Database
Germany	Experiment	Within this section, the performance of the heuristic algorithms that have been proposed is evaluated, and a comparison is made between them and the method that Afsharian et al. [3] have taken. On the other hand, the proposed beam search algorithms are referred to as BS1, BS2, and BS3, while the dynamic programming technique that was developed by Afsharian and colleagues is referred to as (DP). The performance of these algorithms is displayed in Tables 1, 2, and 3, with varied numbers of item kinds as the variables shown. As the number of item categories increases, the fraction of instances with zero deviation (IZD) falls, as can be seen in Table 1 (BS1), which displays this relationship. This pattern is also seen in BS2 and BS3, where the presence of additional item types results in a rise in the number of cuts and divisions, which adversely affects the process of finding the ideal solution. The information presented in Table 2 demonstrates that the average deviation of the objective function (DOV) reduces as the size of the item rises, but the IZD increases as the size of the huge object increases. This is due to the fact that larger objects lead	Science direct

		to a greater number of divisions, which in turn reduces the likelihood of discarding good solutions. As can be seen in Table 3, the average amount of time required to compute by BS3 is much less than that required by the DP method. Furthermore, the ratio begins to decrease as the number of item types grows. It is more difficult to find a solution to the problem as a result of the increasing complexity that comes with taking into consideration more divisions and more item types. Further evidence that the size of the huge object has an effect on the amount of time it takes for the algorithm to complete its task is shown by the fact that the computation time increases more quickly with larger plates in category #2 compared to category #1 .	
China	Experiment	There are five heuristic algorithms that are developed as bandit arms within the CBL framework. These algorithms are as follows: adaptive large neighborhood search (ALNS), ant colony optimization heuristic (ACO), heuristic dynamic programming (DP), a combination of ALNS and heuristic DP, and a combination of ACO and heuristic DP. One of the five heuristics algorithms is selected by the CBL framework in an adaptive manner in order to solve the subproblem. This is accomplished by learning from prior experiences. In the event that the CBL is unable to locate a more suitable solution to the subproblem, an exact dynamic programming technique is utilized in order to ensure adequate optimality. For the purpose of accelerating the solution, rounded capacity inequalities and accelerating tactics are introduced. According to the findings of a comprehensive computational investigation, the CBL-BPC is capable of solving all 800 instances in an optimal manner within a fair amount of time and is highly competitive with the most advanced exact and heuristics approaches now available .	Science direct
Thailand	Experiment	A link was found between higher levels of self-sampling anxieties and lower levels of intentions for self-sampling in both groups. This association was found to be significant. On the other hand, there was a correlation between higher levels of women's demand for autonomy and higher levels of intentions for self-sampling. The under-screened group exhibited a link between increasing age and decreased intentions for HPV testing and self-sampling. This correlation was found to be significant. On the other hand, stronger intents were associated with a shorter amount of time spent in Canada, which was less than 10 years	Science direct
India	Experiment	For the purpose of solving the multidimensional Black-Scholes model, this method integrated the concepts of the finite difference method with those of the finite difference method for solving the fractional-order heat equation. Both the conditional stability and the order of convergence were subjected to our examination. As an additional point of interest, numerical examples were	Science direct

		included in order to illustrate the process of determining option prices	
Pakistan	Experiment	When the linear system is solved, the wavelet coefficients that were previously unknown are obtained. These coefficients are then used to find the numerical solutions. The error, convergence, and stability analysis are then carried out, and a new error estimate is derived from the results of these analyses. As an additional step, numerical simulations are carried out in order to validate the scheme as well as the theoretical findings that have been gained (convergence and stability). In order to validate the performance of the current system, various error metrics such as $L\infty$, L2, root mean square (RMS), and relative error (RE) are obtained by numerical analysis. A comparison is also made between the scheme and the scale-2 Haar wavelets and radial basis functions based algorithms in terms of the amount of error that they produce. The conclusion that can be drawn from the overall evaluation is that the numerical results of the scheme that was designed are in good agreement with the exact solution and the methodologies that were discussed earlier in the literature .	Google scholar
Iran	Experiment	In order to address the governing inverse issue, an effective computational strategy that is based on a combination of a temporal integration scheme and a local meshless Petrov–Galerkin method has been created. To begin, a discretization of the model in the temporal direction is accomplished by the utilization of an implicit time integration approach. A collection of distributed nodes is used to represent the major spatial domain in order to fully discretize the model. Additionally, the radial point interpolation approach is utilized in order to create basis functions that are reliant on the received data. After that, the problem is discretized in the spatial direction by employing the local meshless Petrov–Galerkin approach. These numerical examples are offered in order to validate the accuracy and effectiveness of the technique that has been proposed. When the input data are contaminated with noise, the method's stability is evaluated to determine whether or not it is stable .	Google Scholar
United State	Experiment	In addition to making use of conjugate gradients, the Crank-Nicolson implicit technique is utilized in order to incorporate the transient heat equation into the time dimension.Solutions that are in accordance with analytical and boundary conditions can be computed successfully using these methods. It is possible to achieve convergence and stability while simultaneously capturing the transient thermal change. There is a gain of understanding regarding the impacts of discretization and iteration parameters.A simulation of two-dimensional conductive heat transport that is both accurate and efficient is demonstrated by the numerical framework. It contributes to the advancement of computational engineering by providing a template that can be extended	Research Gate

		to more complicated geometries and multiphysics phenomena .	
Nigeria	Experiment	We carried out trials using a variety of input datasets and documented the amount of time that each algorithm required to complete each trial. In addition, we carried out Halstead complexity measurements in order to determine the volume of each method under consideration for this investigation. In the following step, we compared the three different approaches in terms of the computing speed and the program complexity measured by Halstead metrics. The outcomes of the research indicate that the Greedy algorithm displays higher computing efficiency when compared to both the Dynamic Programming (D.P) algorithm and the FPTAS algorithm across a variety of test situations. Future study should concentrate on investigating the performance of alternative programming languages in handling combinatorial optimization issues. This would provide useful insights into the impact of language choice, which would be necessary for advancing our knowledge of the knapsack problem. In addition, the incorporation of parallel computing techniques has the potential to speed up the process of finding solutions for numerous large-scale problem instances	Research Gate

4. DICUSSION

In a wide variety of fields, the effective resolution of computing issues in two dimensions (2D) is of utmost importance. These challenges have an impact on both theoretical research and practical applications. As the pace of technological innovation quickens, the importance of efficiently addressing 2D computing issues, particularly in terms of computational time, has become a primary emphasis in a variety of industries, including computer graphics, robotics, medical imaging, and geometric processing. In this review, a complete analysis of the present state of research on the efficiency of solving time for 2D computational problems has been offered. This analysis has delved into algorithmic breakthroughs, new trends, and persistent issues. This section provides an expansion on the most important findings, notable patterns, and obstacles, as well as a discussion of the potential future directions that could influence the development of these algorithms .

A significant conclusion that emerged from this analysis was the inherent trade-off that exists between the amount of time spent computing and the level of precision achieved. In virtually every domain that was investigated, it became evident that algorithms that are optimized for higher accuracy frequently need a large increase in the amount of processing resources and time. This can be a barrier for applications that are time-sensitive, such as real-time rendering or autonomous navigation. On the other hand, algorithms that are built for speed may sacrifice solution precision, which eventually leads to outcomes that are either suboptimal or wrong. Due to the fact that real-time performance in video games, simulations, and virtual reality applications requires algorithms to process complex 2D visual data (such as textures, light mapping, and geometrical transformations) in fractions of a second, this delicate balance is particularly important in the field of computer graphics. Similarly, in the field of robotics, where autonomous cars and mobile robots rely on pathfinding algorithms to navigate real-world situations, the necessity for decision-making that is both quick and precise is of the utmost importance . It is possible for algorithms that place a higher priority on speed than accuracy to fail to provide safe pathways, which can result in system failures. On the other hand, those that are tuned for precision can cause delays in decision-making, which would ultimately compromise the responsiveness of the application. For sectors in which safety, efficiency, and real-time processing are of the utmost importance, the problem of finding an appropriate balance between speed and accuracy is fundamental . In medical imaging, algorithms for two-dimensional pattern recognition need to be able to analyze vast amounts of picture data in a short amount of time while yet maintaining diagnostic accuracy. The advancements that have been made in this field have the potential to result in the detection of abnormalities such as cancers in a more timely and accurate manner. This is especially beneficial in high-pressure areas such as imaging departments or emergency rooms. Numerous studies that were incorporated into this review demonstrated that the utilization of sophisticated machine learning methods, in particular deep learning models, has resulted in an increase in the effectiveness of two-dimensional picture segmentation and recognition. However, despite these gains, there is still a persistent difficulty that needs to be addressed: how to optimize deep learning models in order to reduce the amount of time spent on computation while still preserving a high level of accuracy .

The revolutionary role that parallel computing and the utilization of graphics processing units (GPUs) play in speeding the efficiency of 2D computational tasks is yet another key result that emerged from this analysis. Image processing and geometric modeling are two examples of fields that have been revolutionized by graphics processing units (GPUs). GPUs have made it possible to execute activities in parallel, which would have been historically conducted sequentially by central processing units (CPUs). The computing time required for tasks such as real-time rendering, image identification, and pathfinding has been significantly decreased as a result of this capacity, particularly in applications that need high resolution or huge datasets . Hardware acceleration has also been a factor in the broad adoption of real-time applications that rely on 2D computing techniques. This has made it possible for breakthroughs to be made in a variety of disciplines, including gaming and simulations, autonomous vehicles, and medical diagnostics. Furthermore, the increasing incorporation of machine learning and artificial intelligence (AI) into computing issues in two dimensions has resulted in the development of new advancements in algorithmic efficiency. Not only have algorithms that learn from data, such as convolutional neural networks (CNNs), been particularly successful in improving the speed at which they solve 2D image identification and segmentation tasks, but they have also been successful in improving their accuracy. There have also been applications of reinforcement learning approaches to pathfinding and optimization issues, which have resulted in speedier solutions. This is because these techniques enable algorithms to adapt and learn from real-time data while they are being executed .

When it comes to the creation of algorithms, there have been numerous significant patterns that have evolved, which have affected the way that academics approach problems that involve two-dimensional processing. The shift toward hybrid algorithms, which mix conventional optimization approaches with new machine learning techniques, is one of the most significant trends that has been observed recently. When it comes to optimizing complicated two-dimensional computational tasks, such as shape recognition and geometric optimization, hybrid techniques, such as merging evolutionary algorithms with neural networks, have demonstrated a great deal of potential. These hybrid algorithms take advantage of the benefits of both evolutionary algorithms, which search enormous solution spaces, and machine learning, which learns from data to generate predictions. As a result, they provide solutions that are more efficient than either of the two methods could deliver on their own . Approximation algorithms are becoming increasingly popular for solving problems that demand a compromise between accuracy and computing time. This is another topic that deserves considerable attention. For the purpose of delivering answers that are satisfactory in a short amount of time, approximation algorithms are being utilized in geometric processing and pathfinding. This is especially helpful in applications that operate in real time. In autonomous vehicles, for instance, approximation algorithms are used to discover safe courses that avoid obstacles and minimize travel time. This eliminates the need for extensive computations, which would otherwise be required. According to , these algorithms offer a practical solution in situations where accurate solutions would be too expensive to compute in real-time. Since they are essential in environments that are dynamic and time-sensitive, they are essential.

One further trend that is now gaining traction is the emphasis placed on algorithmic scalability, particularly in applications that deal with enormous datasets. For many applications, including image processing, medical diagnostics, and large-scale simulations, the effectiveness of algorithms is frequently contingent on their capacity to scale without causing major increases in the amount of time required for calculation. Offloading calculations to other servers or networks has been made possible by distributed computing and cloud-based processing, which have helped alleviate some of the scalability difficulties that have been encountered. Nevertheless, despite the existence of these technologies, a significant area of research focus is still on ensuring that algorithms continue to be scalable and efficient even as the complexity of the problems increases .

There are still a number of obstacles to overcome, despite the fact that great progress has been made in terms of improving the efficiency of solving 2D computational problems. A significant difficulty is scalability, which means that techniques that were previously effective when used to smaller problems may become ineffective when applied to larger datasets. This is because the size of datasets often rises. Real-time image processing within high-resolution photos or video, for instance, necessitates the utilization of algorithms that are capable of managing enormous amounts of data in real time. The scalability of algorithms is becoming increasingly crucial as technology continues to push the bounds of data collecting. For example, streaming video in 4K or 8K resolution makes this possible . However, despite the fact that parallel computing and GPU acceleration have made it possible to handle larger datasets in a shorter amount of time, not all computational contexts have access to high-performance hardware. Numerous applications, particularly those operating in contexts with limited resources, call for algorithms that are capable of performing effectively even in the absence of specialized hardware. Research into optimizing algorithms for low-power devices and edge computing contexts is becoming increasingly important as the demand for computational efficiency increases in mobile devices, the Internet of Things (IoT), and distributed networks .

The generalization of algorithms is yet another difficulty that still needs to be addressed. On the other hand, many algorithms are developed to solve certain computational issues in two dimensions; nevertheless, in order to apply them to new kinds of problems or datasets, they frequently need to undergo major modifications. The development of algorithms that are more generalizable and can be applied across a variety of 2D domains, such as picture segmentation, pathfinding, and geometric transformations, will significantly expand the utility capabilities of these methods. It is recommended that researchers concentrate their efforts on the development of algorithms that are able to maintain their efficiency and effectiveness over a wide variety of problem spaces without requiring substantial retraining or significant customisation . Even while machine learning techniques, and deep learning in particular, have shown excellent results, they continue to struggle with problems that are associated with the amount of data that is required for training and the amount of computational resources that are required. When it comes to training, deep learning models demand a significant amount of labeled data as well as a high level of computer power. This can be a barrier to their broad usage, particularly in settings where there are limited computational resources. Transfer learning is one strategy that can lessen the requirement for huge datasets by exploiting pre-trained models . Future research should focus on improving the efficiency of training procedures and studying strategies such as transfer learning.

These findings have extensive practical ramifications for a large variety of different businesses, as they were discovered in this review. When it comes to computer graphics, for instance, improving the efficiency of real-time rendering algorithms would immediately assist businesses such as gaming, entertainment, and virtual reality. These are all areas in which customers are rapidly demanding higher visual quality and faster performance. When it comes to autonomous vehicles, advancements in pathfinding algorithms have the potential to improve vehicle safety, decrease energy consumption, and boost operational efficiency in real-time navigation. The application of 2D image recognition algorithms that are both faster and more accurate has the potential to dramatically improve diagnostic procedures in the healthcare industry. This would result in the earlier detection of anomalies and the provision of more effective therapies. For example, in the field of medical imaging, the capability to detect cancers or other anomalies in X-rays or MRI scans in a timely and reliable manner could cut down on the amount of time patients have to wait for their examinations and enhance clinical outcomes.

5. CONCLUSION

The research that were examined shed light on the efficacy of a variety of heuristic algorithms in the process of addressing computing issues, particularly with regard to the efficiency of time and the correctness of the solutions. In terms of computational time, the suggested beam search methods (BS1, BS2, and BS3) perform better than the classic dynamic programming (DP) algorithms. However, the trade-off between accuracy and speed becomes more obvious as the number of item types increases. Furthermore, a competitive bandit algorithm framework (CBL) that selects heuristics in an adaptive manner was able to produce optimal solutions within tolerable time frames across a variety of scenarios. A number of other research have highlighted the significance of individual elements, such as autonomy, in the decision-making process. Additionally, these studies have highlighted the utilization of sophisticated computational methods for the resolution of complicated models, such as multidimensional equations and fractional heat equations. The findings of this research collectively indicate the promise of merging heuristic approaches, parallel computing, and advanced optimization methods in order to meet the increasing complexity and scale of modern computational challenges. In the future, the integration of these tactics with hardware solutions that are more scalable, such as parallel computing and machine learning, would most likely result in even better efficiency in the process of addressing complicated computational problems, including those that include two dimensions.

Conflict of interest

Have no conflict

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RJ is the one who penned the first draft of the document. It was MC and AS who were the ones who initially conceived up the idea for the piece. Everyone who contributed to the book has read it and given their stamp of approval to the final version.

Author Biography

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