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ChatGPT and Artificial Intelligence (AI) Massive Transformation of Trainers' Education Sector Revolutionizing How Students Learn

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Abstract

The growth of artificial intelligence (AI) has significantly changed the field of education and is revolutionizing the ways trainees learn. AI has the capability to completely transform the way we teach and learn, improving accessibility, individualization, and effectiveness in the classroom. Intelligent tutoring systems (ITS) development is one of the primary areas where AI is having an impact. These systems analyze student data using algorithms and offer tailored feedback and direction depending on each student's unique needs and learning preferences. Another illustration of how technology is changing education is Chatbots that run on AI. These Chatbots give students immediate feedback, assist trainers in tracking students' development, and evaluate and pinpoint areas where students might be having challenges. Overall, the application of AI in education is changing how we teach and learn and improving access to, personalization of, and effectiveness of education. This research at Elmergib University focuses on methodologies to incorporate AI Chatbots in chemical engineering challenging disciplines ensuring that the technologies support student learning rather than replacing the role of critical thinking or human interaction. The incorporation of AI technology tools as instructing topics of process optimization, data analysis, safety, and communication. There are remarkable possibilities for AI technologies to expand significantly.

Keywords

Research on Educational AI Key Technology, artificial intelligence (AI), intelligent tutoring systems (ITS), AI Chatbots, and engineering curriculum development.

1. Introduction

The integration of AI systems and Chatbots into the academic field has indeed gained significant attention in recent years. AI technologies, such as natural language processing (NLP) and machine learning, have been applied to develop Chatbot systems that can interact with students, researchers, and academic professionals (Chen 2020). One prominent application of AI Chatbots in academia is in the field of online education. The improvement of efficiency and accuracy are indeed key benefits of using advanced technologies in research (Dignum 2018). Here are some ways in which technology can enhance research. Faster data collection and analysis; advanced technologies such as high-throughput sequencing, automated laboratory equipment, and data mining algorithms can accelerate the process of data collection and analysis. This enables researchers to gather and process large amounts of data in a shorter time, leading to faster research outcomes. Enhanced precision and accuracy; technologies like robotics, machine learning, and computer simulations can improve the precision and accuracy of experiments and measurements. Automation reduces human errors and variability, ensuring more reliable and reproducible results. Access to vast amounts of information; the internet and digital databases provide researchers with instant access to a wealth of scientific literature, research papers, and datasets. This accessibility allows scientists to stay up-to-date with the latest findings and build upon existing knowledge more efficiently. Collaborative research; technology facilitates collaboration among researchers, regardless of their geographic locations. Virtual meetings, video conferencing, shared online workspaces, and collaborative tools enable scientists to collaborate on projects, exchange ideas, and share resources seamlessly. Data visualization and modeling; Advanced visualization tools help researchers present complex data in a more understandable and insightful manner. Additionally, computer simulations and modelling techniques allow researchers to test hypotheses, predict outcomes, and explore scenarios before conducting experiments in the physical world. Remote monitoring and data collection; technologies such as remote sensors, wearables, and Internet of Things (IoT) devices enable researchers to collect data remotely from various environments and subjects. This capability expands the scope of research, enables long-term studies, and provides real-time monitoring of experiments or natural phenomena. Improved data storage and organization; digital storage systems and cloud-based platforms offer efficient and secure ways to store and organize research data. These technologies facilitate data sharing, collaboration, and long-term preservation, ensuring that valuable research information remains accessible for future studies. By leveraging these advancements, researchers can streamline their work processes, improve the quality of their research, and accelerate scientific discoveries.

One of the significant advantages of AI systems and Chatbots in education is their ability to personalize learning pathways for students (Hsu et al. (2023), Chen et al. (2023), Tapalova and Zhiyenbayeva (2022), and González-Calatayud (2021)). By leveraging the power of artificial intelligence, these systems can analyze vast amounts of data about each student's performance, preferences, and learning style. This enables them to tailor the learning experience to meet the individual needs of students. Here are some key benefits of personalized learning pathways facilitated by AI systems and Chatbots in education. Individualized instruction: AI systems can adapt the curriculum and instructional materials to match the unique learning requirements and pace of each student. This allows students to progress through the material at their speed, ensuring that they neither feel overwhelmed nor bored. Adaptive feedback and assessment: AI-powered Chatbots can provide immediate and personalized feedback to students based on their responses. These systems can identify areas where students are struggling and offer targeted support and resources to help them overcome challenges. Additionally, they can modify the assessment methods and difficulty levels based on the student's proficiency level. Customized content and resources; AI systems can curate and recommend learning materials, resources, and activities that align with the student's interests and learning style. This personalization ensures that students are engaged and motivated to learn, increasing their overall learning outcomes. Remedial support; for students who require additional assistance in certain topics or skills, AI systems can identify knowledge gaps and provide remedial support through targeted interventions, extra practice exercises, or supplementary materials. This helps students strengthen their weak areas and ensures a more comprehensive understanding of the subject matter. Advanced analytics and insights; AI systems can generate detailed analytics and insights about each student's progress, strengths, and weaknesses. Educators can leverage this information to gain a deeper understanding of individual student's needs and make informed decisions about instructional strategies and interventions. 24/7 accessibility and support; AI-powered Chatbots can offer round-the-clock support, allowing students to access learning materials and seek assistance whenever they need it. This flexibility accommodates different learning schedules and helps students overcome barriers to learning. By personalizing learning pathways, AI systems and Chatbots have the potential to

enhance student engagement, improve learning outcomes, and provide a more inclusive and tailored educational experience for every learner.

AI systems have the potential to greatly enhance online learning and increase accessibility to education, particularly for students in remote areas (Pelletier (2022), and Murtaza (2022)). Here are some ways in which AI can facilitate online learning; personalized Learning; AI can analyze individual student data and provide personalized recommendations and adaptive learning experiences. By understanding each student's strengths, weaknesses, and learning styles, AI systems can tailor educational content and resources to meet their specific needs. Intelligent Tutoring, AI-powered tutoring systems can provide real-time assistance to students, offering explanations, feedback, and guidance throughout their learning process. These virtual tutors can simulate one-on-one interactions and adapt their teaching strategies based on the student's progress and understanding. Automated Assessments; AI can automate the grading and assessment process, saving time for educators and providing instant feedback to students. Through natural language processing and machine learning algorithms, AI systems can evaluate written assignments, quizzes, and exams with high accuracy and consistency.

Content Curation; AI algorithms can assist in curating educational content from various online sources. By analyzing the relevance, quality, and credibility of resources, AI can help educators and students discover and access a wide range of learning materials tailored to their specific subjects and interests. Language Support; AI-powered language translation and transcription services can break down language barriers for students in remote areas. They can facilitate communication, provide real-time translations during online lectures, and transcribe content for students who may have difficulties with the language of instruction. Data Analytics; AI can analyze vast amounts of educational data, including student performance, engagement, and behavior, to identify patterns and insights that can inform instructional design and intervention strategies. This data-driven approach can help educators identify struggling students and implement targeted support mechanisms. Virtual Reality and Simulations; AI can enhance online learning experiences through virtual reality (VR) and simulations. VR can create immersive and interactive environments, allowing students to explore complex concepts and scenarios. Simulations can provide hands-on experiences in fields such as science, engineering, and healthcare, which may not be readily available in remote areas. By leveraging AI technologies in online learning platforms, educational institutions can extend their reach, improve learning outcomes, and ensure that students in remote areas have equal access to quality education. However, it's important to consider ethical considerations, data privacy, and the need for human guidance and interaction to ensure a balanced and effective educational experience.

ChatGPT is an AI system that was developed by Open AI and introduced in the year 2022 (Chen (2020), Chokri (2023)). It is based on the GPT-3.5 architecture and is designed to facilitate conversational interactions with users. ChatGPT is capable of understanding and generating human-like responses in natural language. In the academic field, the emergence of ChatGPT has had significant implications. It has been used as a tool to assist students, researchers, and educators in various ways. ChatGPT has been utilized in academia as personalized learning where ChatGPT can provide personalized learning experiences by tailoring information and resources to individual students. It can answer questions, explain concepts, and provide additional learning materials based on the specific needs of the student. It can help as a research assistant where researchers can use ChatGPT as a virtual assistant to help them with literature reviews, data analysis, and hypothesis generation. It can also provide suggestions for research methodologies and offer insights based on the existing body of knowledge. As a tool of writing support, ChatGPT can assist students and academics with writing tasks. It can help generate ideas, provide grammar and style suggestions, and offer feedback on drafts. This can be particularly useful for improving the writing skills of non-native English speakers. ChatGPT can act as an academic advisor, guiding students through course selection, career planning, and academic requirements. It can offer recommendations based on the student's interests, goals, and academic performance. As a classroom support, it can be in online or blended learning environments, ChatGPT also can serve as a virtual teaching assistant. It can answer student questions, provide additional explanations, and facilitate discussions to enhance the learning experience. However, it's important to note that while ChatGPT and similar AI systems can be valuable tools, they are not without limitations. They may occasionally generate inaccurate or misleading information, and their responses should always be critically evaluated. Nonetheless, the use of AI systems like ChatGPT has brought about exciting opportunities for innovation and advancement in the academic field.

Research on the ethical challenges associated with the use of Chatbots in education and research was already underway (Chokri 2023). Ethical considerations in the development and implementation of Chatbots in various domains, including education, have been a subject of scholarly discussion. Some highlights of the potential ethical challenges

related to Chatbots in education and research that researchers have explored can be summarized as follows. Privacy and data protection are what Chatbots often offer when collecting and processing personal data from users. Ensuring appropriate privacy safeguards and data protection measures becomes crucial to safeguard sensitive information. Bias and fairness of Chatbots might inadvertently incorporate biases from the data they are trained on, leading to unfair treatment or discriminatory outcomes. Researchers have examined the impact of bias in Chatbot interactions and strategies to mitigate it. The use of Chatbots raises questions about the extent of automation in education and research settings. Balancing the roles of Chatbots and human instructors or researchers and preserving individual agency and decision-making can be a significant ethical concern. Interacting with Chatbots that simulate human-like conversations may have psychological effects on users. Researchers have explored the potential impacts on emotional well-being, and mental health, and the importance of appropriate design to mitigate any negative consequences. Ethical Chatbot design necessitates transparency about their capabilities, limitations, and their nature as artificial entities. Users should be aware that they are interacting with Chatbots and have access to channels for feedback and complaint resolution. In education, maintaining the integrity of assessment and evaluation processes is crucial. Ethical considerations arise when Chatbots are involved in tasks such as grading assignments or providing feedback, requiring clear guidelines and ensuring that the evaluation process remains fair and accurate. Scholars have likely continued to explore these and other ethical challenges associated with Chatbots in education and research in recent years. We as the research team of this scientific work plan to consult academic databases, journals, or conference proceedings for the most up-to-date research on this subject.

As an AI language model, ChatGPT can assist with coding and programming in chemical engineering. However, it's important to note that my capabilities are primarily focused on providing guidance, explanations, and examples related to programming concepts and algorithms (Sobania et al. (2023), and White (2023)). ChatGPT can help students understand programming concepts, and syntax, and provide general guidance, it's essential as well to exercise caution and verify the correctness of the code. Complex chemical engineering problems often require domain expertise and thorough validation. Here are some ways ChatGPT can assist in the context of coding and programming in chemical engineering. It can help understand the syntax and usage of programming languages commonly used in chemical engineering, such as Python, MATLAB, or FORTRAN. It can assist in implementing numerical algorithms, optimization methods, or simulation techniques relevant to chemical engineering problems.

It can guide in handling and analyzing large datasets, statistical analysis, data visualization, and data manipulation using programming languages and libraries. It can help you understand and implement mathematical models used in chemical engineering, such as mass and energy balances, reaction kinetics, thermodynamics, transport phenomena, etc. If a written code for a specific problem exists, ChatGPT can help review the code for errors, suggest improvements, and assist with debugging. Remember, while ChatGPT can provide support, it's crucial to consult authoritative sources, and domain-specific references, and seek the guidance of experts in chemical engineering for rigorous validation and verification of any code related to safety-critical or sensitive applications.

ChatGPT can help chemical engineering students understand the mathematical formulation of the Poisson equation and provide guidance on numerical methods for solving it, such as finite difference, finite element, or spectral methods. It can also assist with implementing the numerical solution in programming languages like Python or MATLAB. Similar to the Poisson equation, it can provide explanations of the diffusion equation and numerical methods commonly used to solve it, such as finite differences or finite element methods. It can assist with implementing these methods and solving specific problems based on the diffusion equation. As for the case of incompressible Navier-Stokes equations in two dimensions, ChatGPT can help understand the governing equations of fluid flow, the incompressible Navier-Stokes equations, and their discretization methods, such as finite differences or finite volume methods. It can provide guidance on implementing numerical solvers for these equations and simulating fluid flow problems in two dimensions. It can assist in understanding the one-dimensional compressible flow equations, including the conservation laws for mass, momentum, and energy. It can help with numerical methods, such as the method of characteristics or finite volume methods, to solve these equations. It can also guide in implementing solvers for one-dimensional compressible flow problems. ChatGPT can help understand eigenvalues and eigenvectors and provide guidance on numerical methods for finding eigenvalues, such as power iteration, and inverse iteration algorithms. It can also assist with implementing these methods and finding the maximum eigenvalue of matrices using programming languages like Python or MATLAB. It can provide explanations of various methods for solving linear systems, including direct methods like Gaussian elimination or LU decomposition, as well as iterative methods such

as Jacobi, Gauss-Seidel, or conjugate gradient. It can assist with implementing these methods and solving specific linear systems using programming languages.

2. ChatGPT training to help students who are not native English speakers pursue careers in engineering while reducing the language barrier for engineering students

The study team behind this work is enthusiastic about including a set of breakthroughs defining the specific usage of AI language models to proofread scientific writing for grammatical errors, help with preliminary paragraph text drafting and outline, and produce more persuasive paragraphs. Additionally, they actively favor getting peer review criticism and constructive criticism through ChatGPT as can be shown in both ChatGPT_Box 1 and ChatGPT_Box 2 training practices.

ChatGPT_Box 1: Example of using ChatGPT to assist with paragraph composition



I need some assistance writing a paragraph for a scientific article. It would be a paragraph that would be added to the paperwork, and it would describe how the creation of chatGPT represents a significant advancement in the field of teaching non-native English speakers how to compose a paragraph. I'd want to start with ChatGPT in general before giving an example of paragraph authoring.



The development of ChatGPT represents a momentous leap forward in the realm of teaching non-native English speakers the art of composing coherent paragraphs. ChatGPT, built upon the robust GPT-3.5 architecture, offers an exceptional platform for interactive language learning. With its ability to generate human-like responses, provide real-time feedback, and engage in natural conversations, ChatGPT revolutionizes the process of paragraph authoring for non-native English speakers. By interacting with ChatGPT, learners can practice constructing paragraphs, receive instant guidance, and enhance their overall writing proficiency. For instance, a non-native English speaker can engage in a dialogue with ChatGPT, receive suggestions on grammar, structure, and vocabulary choices, and witness their paragraph gradually transform into a more polished and eloquent piece of writing. The innovative capabilities of ChatGPT offer immense potential for empowering non-native English speakers and facilitating their journey toward becoming proficient paragraph composers.

ChatGPT_Box 2: Example of using ChatGPT to assist in commenting and recommending of ChatGPT to restructure the writing style, and notify of any paragraph errors that were composed for our most recent scientific article, Edali et al. in Jan 2023 at Quality Assurance Journal for Academic Researches.



This passage, which may be found below, was created for our latest published scientific article, Edali et. al. in Jan 2023 at Quality Assurance Journal for Academic Researches . Could you comment on it in any way? Would you suggest making any writing style changes? Or do you detect some errors in the logic?

Since recent developments in digital technology, such as social media via tablets and smartphones, students have significantly more control over access and information sharing. That allows instructors and learners to collaborate to discover motivational and engagement tactics to improve their skills. New pedagogical methods and strategies evolve as instructors and students become more familiar with digital technology for teaching and learning. The innovations have influenced how education is structured and where learning occurs.



The passage you provided is clear and effectively highlights the impact of recent developments in digital technology on education. However, here are a few suggestions to further enhance the writing style and improve the logical flow:

1. Consider rephrasing the sentence: "That allows instructors and learners to collaborate to discover motivational and engagement tactics to improve their skills." This sentence can be made more concise and impactful. For example: "This collaborative environment facilitates the exploration of effective motivational and engagement tactics, thereby enhancing skills."
2. In the sentence: "New pedagogical methods and strategies evolve as instructors and students become more familiar with digital technology for teaching and learning," consider specifying the specific pedagogical methods and strategies being evolved. This will provide more clarity and depth to the statement. For example: "As instructors and students increasingly embrace digital technology for teaching and learning, new pedagogical methods such as flipped classrooms, gamification, and blended learning are emerging."
3. The sentence: "The innovations have influenced how education is structured and where learning occurs" could benefit from further elaboration. Provide specific examples or explain how the innovations in digital technology have impacted the structure of education and expanded learning environments. For instance: "These innovations have revolutionized the educational landscape by shifting traditional classroom-centric models to more flexible and personalized approaches, including online learning platforms, virtual classrooms, and remote education."

Overall, the passage effectively conveys the influence of digital technology on education. By incorporating the suggested improvements, you can further enhance the writing style, provide more specific examples, and ensure a smooth logical flow throughout the paragraph.

3. ChatGPT Training for Students in Chemical Engineering Numerical Algorithm Programming

Training ChatGPT specifically for students in chemical engineering numerical algorithm programming would require a specific dataset that focuses on this domain. The training data should ideally consist of programming examples, algorithms, and problem-solving techniques relevant to chemical engineering numerical computations. To create a training dataset for this purpose, students could compile various resources such as textbooks, lecture notes, online tutorials, and code repositories related to numerical algorithms in chemical engineering. These resources would provide a diverse range of programming problems, algorithms, and solutions specific to the field. The dataset could include code snippets or complete programs showcasing implementations of numerical algorithms used in chemical engineering, such as solving systems of equations, optimization methods, interpolation, integration, differential equations, etc. Additionally, it would be beneficial to include explanations and annotations for each code example to facilitate understanding. Once the dataset is compiled, it can be used to fine-tune the ChatGPT model. Fine-tuning involves training the model on the specific dataset to adapt its responses to the domain of chemical engineering numerical algorithm programming. The fine-tuning process typically involves providing input-output pairs to the model and updating its parameters based on the desired responses. It's important to note that creating and fine-tuning a domain-specific model requires considerable computational resources and expertise in machine learning. It may be more practical to leverage existing resources, such as textbooks, online tutorials, and interactive learning platforms, to provide tailored educational materials for students in chemical engineering numerical algorithm programming. Remember, while ChatGPT can provide guidance and support, it's essential for students to engage in active learning, practice coding, and consult domain-specific references to develop a deeper understanding of numerical algorithms in chemical engineering.

3.1 ChatGPT training for basic numerical algorithms using MATLAB.

ChatGPT needs to be trained specifically for the basic numerical algorithm of finding the roots of a function using MATLAB, which would need a dataset that consists of examples, explanations, and code snippets related to this specific algorithm in the MATLAB programming language. The following should be the steps to follow to create a training dataset for ChatGPT. Collect a variety of examples that showcase the usage of MATLAB for finding the roots of functions. These examples can come from textbooks, online tutorials, MATLAB documentation, or any reliable sources. Ensure that the examples cover different scenarios and functions to provide a diverse training dataset. Along with the code examples, include explanations and annotations that describe the algorithm and the steps involved in finding the roots using MATLAB. These explanations should cover concepts such as initial guesses, iterative methods, convergence criteria, and any relevant considerations. Organize the dataset into input-output pairs, where the input is a prompt or question related to finding the roots of a function, and the output is the corresponding MATLAB code or explanation. Structure the data in a way that ChatGPT can understand and learn from it. Use the dataset to fine-tune the pre-trained ChatGPT model. Fine-tuning involves providing the input-output pairs from the dataset and updating the model's parameters to generate appropriate responses. Fine-tuning requires access to computational resources and expertise in machine learning. OpenAI provides a detailed guide on fine-tuning GPT-3 models that researchers can refer to for this process. By training ChatGPT on a dataset specifically tailored to finding roots of functions using MATLAB, the model can learn to provide more relevant and accurate responses to questions and prompts related to this topic. The performance of the trained model will depend on the quality and diversity of the training dataset, as well as the fine-tuning process. It's also important to note that ChatGPT's responses are generated based on patterns observed in the training data and may not always be flawless or up-to-date. Therefore, it's recommended to verify the generated code and consult official MATLAB documentation or domain experts for critical and complex problems. If one doesn't have the resources or expertise to create and fine-tune a model, one can still leverage the model's general programming knowledge to get assistance with MATLAB code for finding roots of functions.

3.2 Finding a function's roots using the Newton technique in MATLAB.

We begin with a straightforward numerical algorithm. Finding a function's roots can be done in several different ways. One of them, the Newton technique, uses an iterative finite difference approach to approximate the derivative of the function to locate the root of a function $f(x)$.

A MATLAB code for the Newton approach is requested from ChatGPT. The input form and ChatGPT output are displayed in the grey boxes below ChatGPT_Box 3, and ChatGPT_Box 4.

ChatGPT_Box 3: A MATLAB code for the Newton approach is requested from ChatGPT



You

Write a MATLAB code for root finding using the Newton method



ChatGPT

Certainly! The Newton-Raphson method is an iterative root-finding algorithm. Here's a simple MATLAB code for finding the root of a function using the Newton method:

```
function [root, iterations] = newton_method(func, func_derivative, initial_guess,
tolerance, max_iterations)

% func: the function for which we want to find the root
% func_derivative: the derivative of the function
% initial_guess: initial guess for the root
% tolerance: the tolerance for stopping criterion
% max_iterations: maximum number of iterations allowed
iterations = 0;
x = initial_guess;
while true
    % Newton-Raphson iteration formula
    x_next = x - func(x) / func_derivative(x);
    iterations = iterations + 1;
    % Check for convergence
    if abs(x_next - x) < tolerance
        root = x_next;
        return;
    end
    % Check for maximum iterations
    if iterations >= max_iterations
        error('Maximum iterations reached without convergence!');
    end
    % Update the current guess
    x = x_next;
end
end
```

ChatGPT_Box 4. A detailed handling of a MATLAB code for the Newton approach as instructed by ChatGPT

To use this code, you need to define your own function and its derivative. Here's an example of how to use the `newtonMethod` function:

```
% Example usage:
% Solve the equation x^2 - 4 = 0
func = @(x) x^2 - 4;
func_derivative = @(x) 2*x;
initial_guess = 2; % Initial guess
tolerance = 1e-6; % Tolerance level for stopping criterion
max_iterations = 100; % Maximum number of iterations

[root, iterations] = newton_method(func, func_derivative, initial_guess,
tolerance, max_iterations);

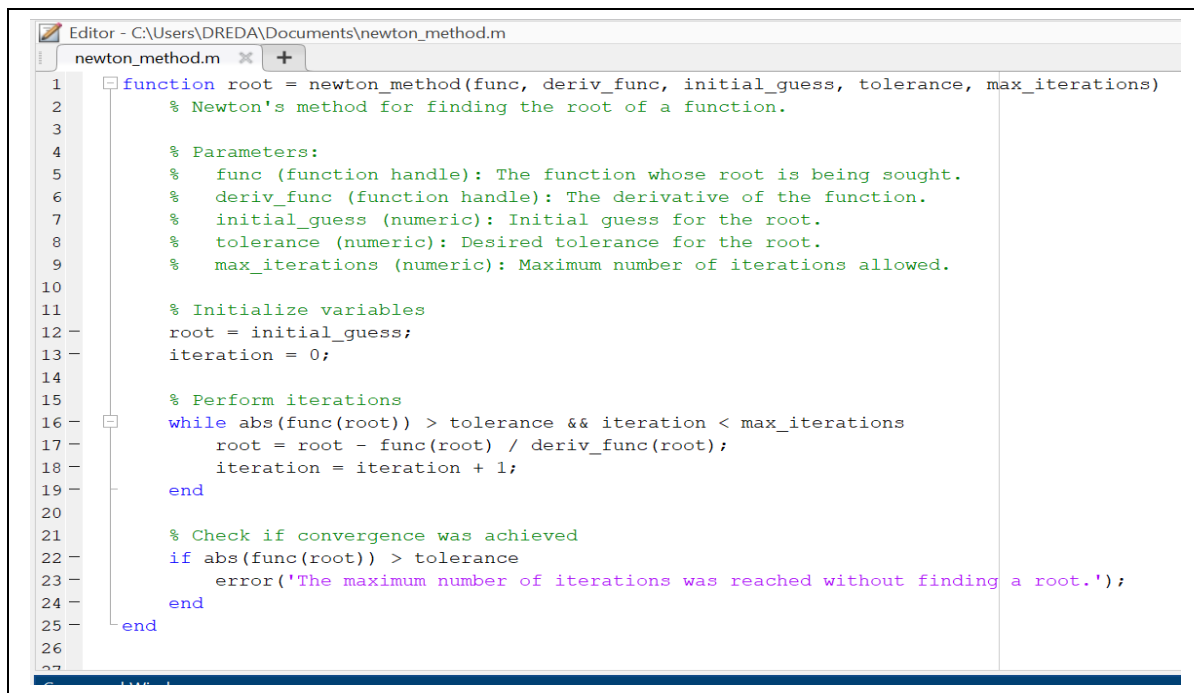
fprintf('Root: %f\n', root);
fprintf('Number of iterations: %d\n', iterations);
```

In this example, we use the function `f(x) = x^2 - 4` and its derivative `f'(x) = 2x`. The initial guess for the root is `2`, and we set a tolerance of `1e-6` and a maximum of `100` iterations. The code will output the approximated root and the number of iterations performed.

Feel free to modify the code according to your specific function and requirements.

Creating an M-file in MATLAB and solving a problem, can be done by following these steps. Launch MATLAB on a computer and at the MATLAB command window, a new M-file to be created by clicking on the New Script button or by going to the File menu and selecting a new script which will open the MATLAB Editor. In the MATLAB editor, MATLAB code can be written. For example, if you want to find a root using the solve function, you can write something like what is applied on the MATLAB platform in Figure 1, and its root results in Figure 2.

After writing the code, go to the "File" menu in the MATLAB Editor and select "Save". Choose a location and name for the M-file, and save it with a .m extension. For example, it can be saved as "newton_method.m". To run the code in the M-file, there are a few options; click on the "Run" button in the MATLAB command window, type the name of the file without the extension and press Enter. For example, if the file is named "solve_equations.m", type solve_equations and press Enter. The code will execute, and the output will be displayed in the MATLAB command window. By following these steps, an M-file can be created in MATLAB, and other codes can be done the same way, and solving various problems or implementing algorithms becomes easy to handle

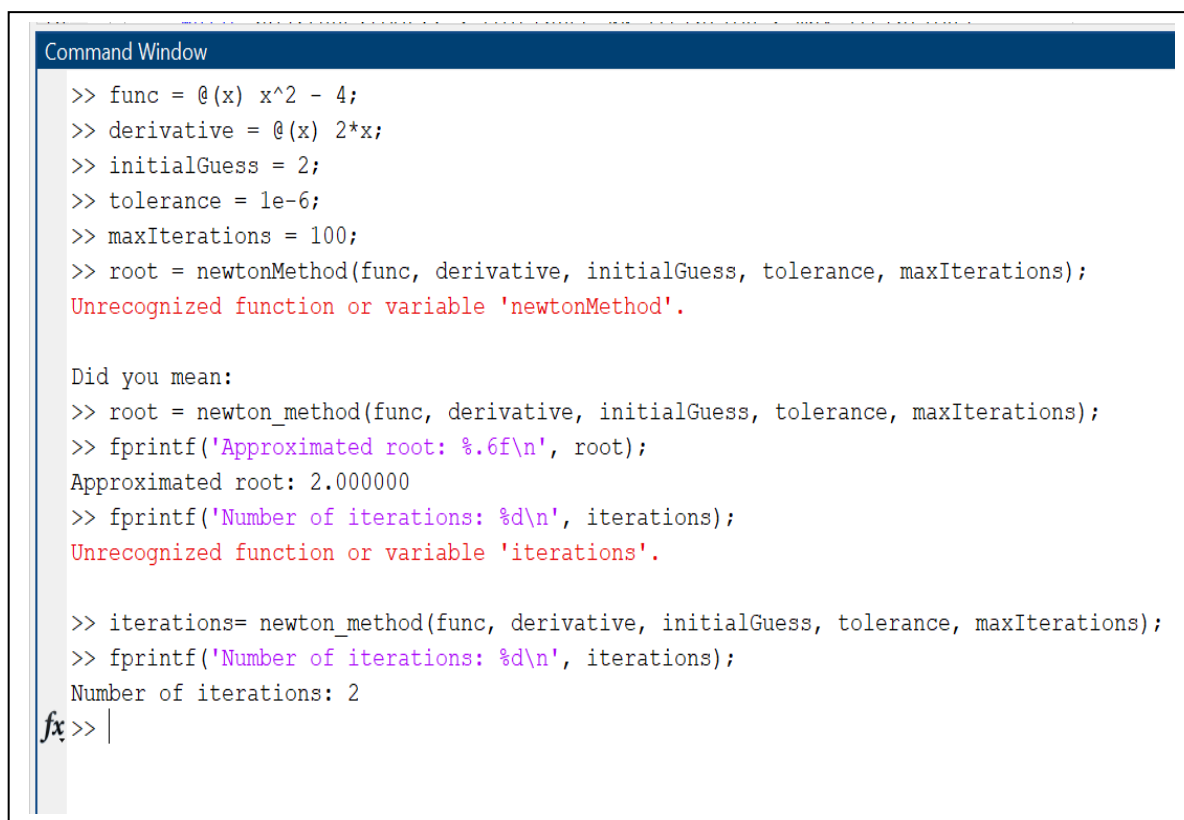


```

1 function root = newton_method(func, deriv_func, initial_guess, tolerance, max_iterations)
2     % Newton's method for finding the root of a function.
3
4     % Parameters:
5     %   func (function handle): The function whose root is being sought.
6     %   deriv_func (function handle): The derivative of the function.
7     %   initial_guess (numeric): Initial guess for the root.
8     %   tolerance (numeric): Desired tolerance for the root.
9     %   max_iterations (numeric): Maximum number of iterations allowed.
10
11     % Initialize variables
12     root = initial_guess;
13     iteration = 0;
14
15     % Perform iterations
16     while abs(func(root)) > tolerance && iteration < max_iterations
17         root = root - func(root) / deriv_func(root);
18         iteration = iteration + 1;
19     end
20
21     % Check if convergence was achieved
22     if abs(func(root)) > tolerance
23         error('The maximum number of iterations was reached without finding a root.');

```

Figure 1. Applying the ChatGPT MATLAB code, running it to produce its function root.



```

Command Window
>> func = @(x) x^2 - 4;
>> derivative = @(x) 2*x;
>> initialGuess = 2;
>> tolerance = 1e-6;
>> maxIterations = 100;
>> root = newtonMethod(func, derivative, initialGuess, tolerance, maxIterations);
Unrecognized function or variable 'newtonMethod'.

Did you mean:
>> root = newton_method(func, derivative, initialGuess, tolerance, maxIterations);
>> fprintf('Approximated root: %.6f\n', root);
Approximated root: 2.000000
>> fprintf('Number of iterations: %d\n', iterations);
Unrecognized function or variable 'iterations'.

>> iterations= newton_method(func, derivative, initialGuess, tolerance, maxIterations);
>> fprintf('Number of iterations: %d\n', iterations);
Number of iterations: 2
fx>>

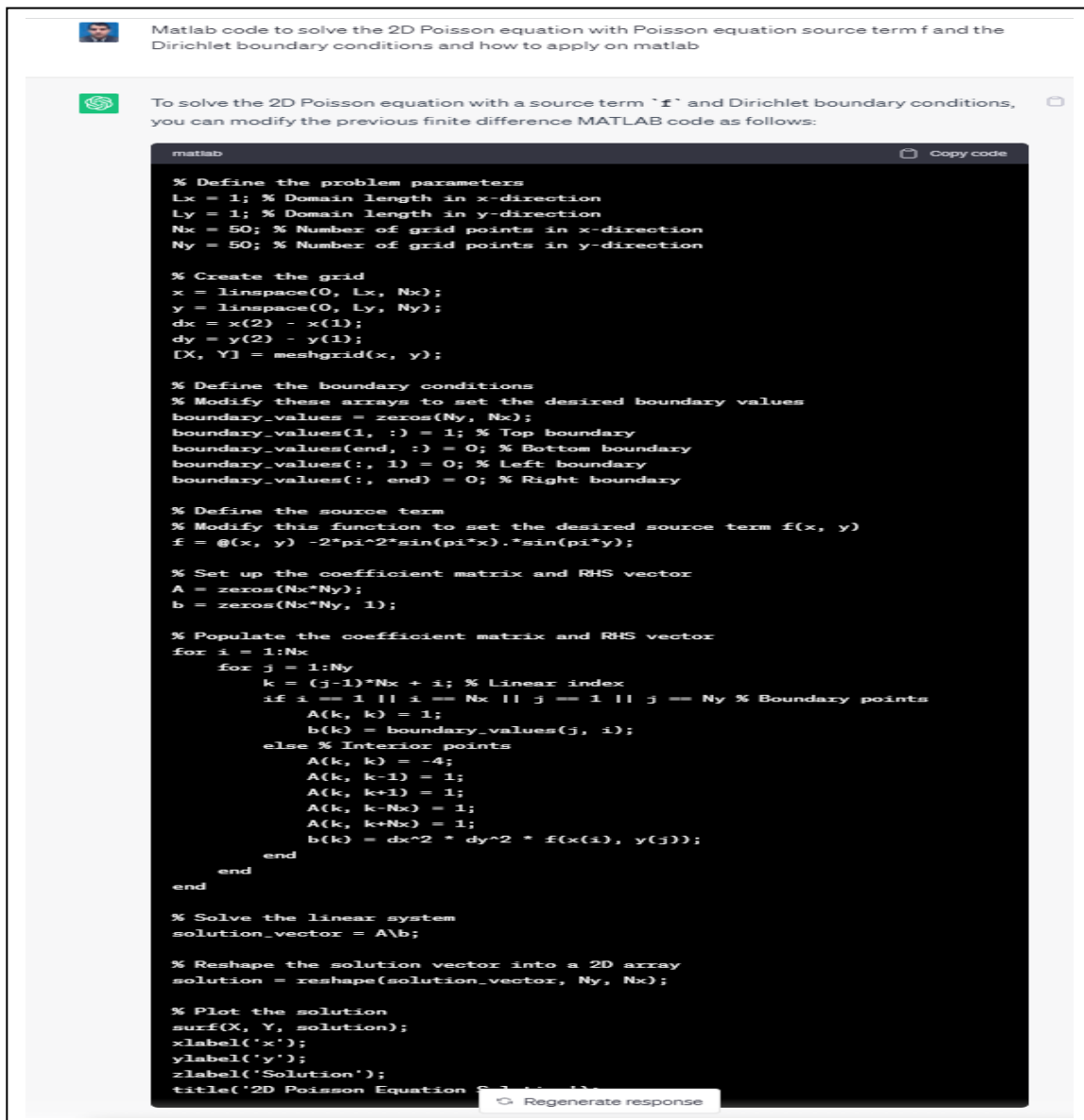
```

Figure 2. Analysing the ChatGPT MTLAB code command window, running it to produce its function root.

3.2.1 Solving the 2D Poisson Equation using MATLAB Code that Solves with Dirichlet Boundary Conditions using The Finite Difference Method

In this code shown in ChatGPT_Box 5, a standard second-order finite difference approximation to discretize the Laplacian operator in the Poisson equation was used. It is required to identify the parameters such as the domain length L and the number of grid points N . Then, it creates a grid using `linspace` and `meshgrid`. The Poisson equation source term f and the Dirichlet boundary conditions u_{left} , u_{right} , u_{top} , and u_{bottom} are defined accordingly. Next, the code constructs the coefficient matrix A using a loop, considering the interior points and the Dirichlet boundary conditions. The right-hand side vector b is created by evaluating the source term f on the grid and applying the boundary conditions. Finally, the code solves the linear system $A \setminus b$ to obtain the solution u . The solution is reshaped into a grid format and then plotted the solution using the `surf` function. Code can modify the Poisson equation source boundary conditions to suit any other case study problem as applied on the MATLAB platform in Figure 3, and its plot resulted in Figure 4.

ChatGPT_Box 5. A MATLAB code, solving standard second-order finite difference approximation to discretize the Laplacian operator in the Poisson equation is requested from ChatGPT



Matlab code to solve the 2D Poisson equation with Poisson equation source term f and the Dirichlet boundary conditions and how to apply on matlab

To solve the 2D Poisson equation with a source term f and Dirichlet boundary conditions, you can modify the previous finite difference MATLAB code as follows:

```

matlab
Copy code

% Define the problem parameters
Lx = 1; % Domain length in x-direction
Ly = 1; % Domain length in y-direction
Nx = 50; % Number of grid points in x-direction
Ny = 50; % Number of grid points in y-direction

% Create the grid
x = linspace(0, Lx, Nx);
y = linspace(0, Ly, Ny);
dx = x(2) - x(1);
dy = y(2) - y(1);
[X, Y] = meshgrid(x, y);

% Define the boundary conditions
% Modify these arrays to set the desired boundary values
boundary_values = zeros(Ny, Nx);
boundary_values(1, :) = 1; % Top boundary
boundary_values(end, :) = 0; % Bottom boundary
boundary_values(:, 1) = 0; % Left boundary
boundary_values(:, end) = 0; % Right boundary

% Define the source term
% Modify this function to set the desired source term f(x, y)
f = @(x, y) -2*pi^2*sin(pi*x).*sin(pi*y);

% Set up the coefficient matrix and RHS vector
A = zeros(Nx*Ny);
b = zeros(Nx*Ny, 1);

% Populate the coefficient matrix and RHS vector
for i = 1:Nx
    for j = 1:Ny
        k = (j-1)*Nx + i; % Linear index
        if i == 1 || i == Nx || j == 1 || j == Ny % Boundary points
            A(k, k) = 1;
            b(k) = boundary_values(j, i);
        else % Interior points
            A(k, k) = -4;
            A(k, k-1) = 1;
            A(k, k+1) = 1;
            A(k, k-Nx) = 1;
            A(k, k+Nx) = 1;
            b(k) = dx^2 * dy^2 * f(x(i), y(j));
        end
    end
end

% Solve the linear system
solution_vector = A\b;

% Reshape the solution vector into a 2D array
solution = reshape(solution_vector, Ny, Nx);

% Plot the solution
surf(X, Y, solution);
xlabel('x');
ylabel('y');
zlabel('Solution');
title('2D Poisson Equation Solution');
    
```

Regenerate response

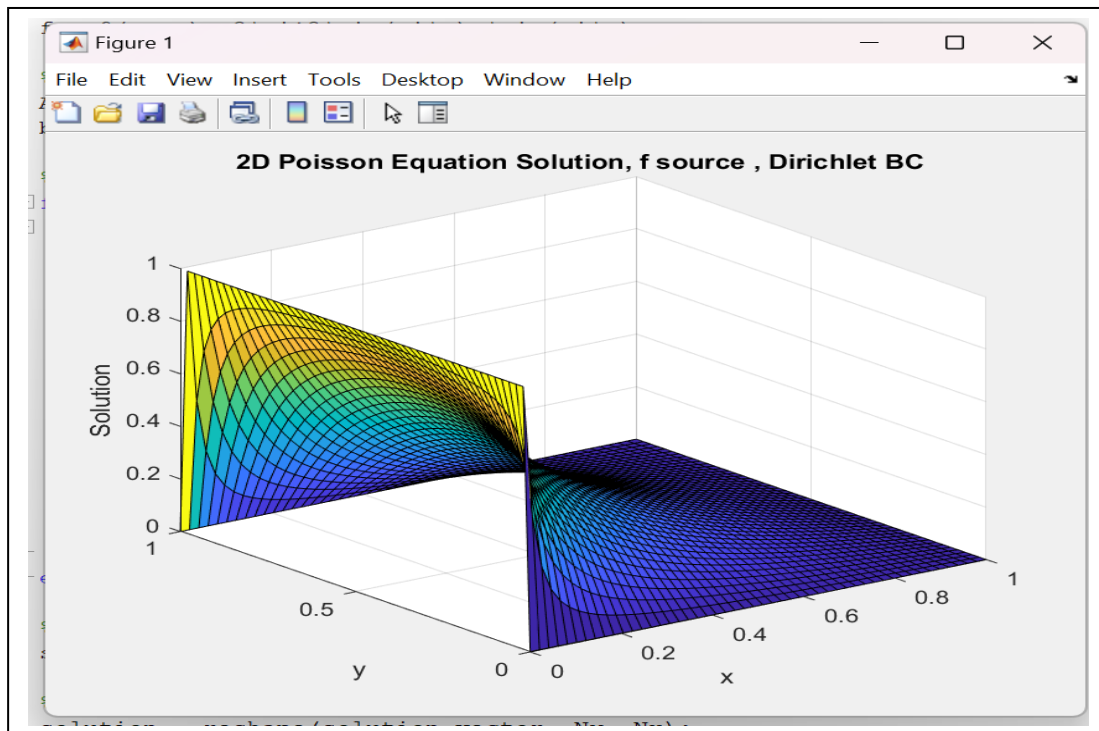
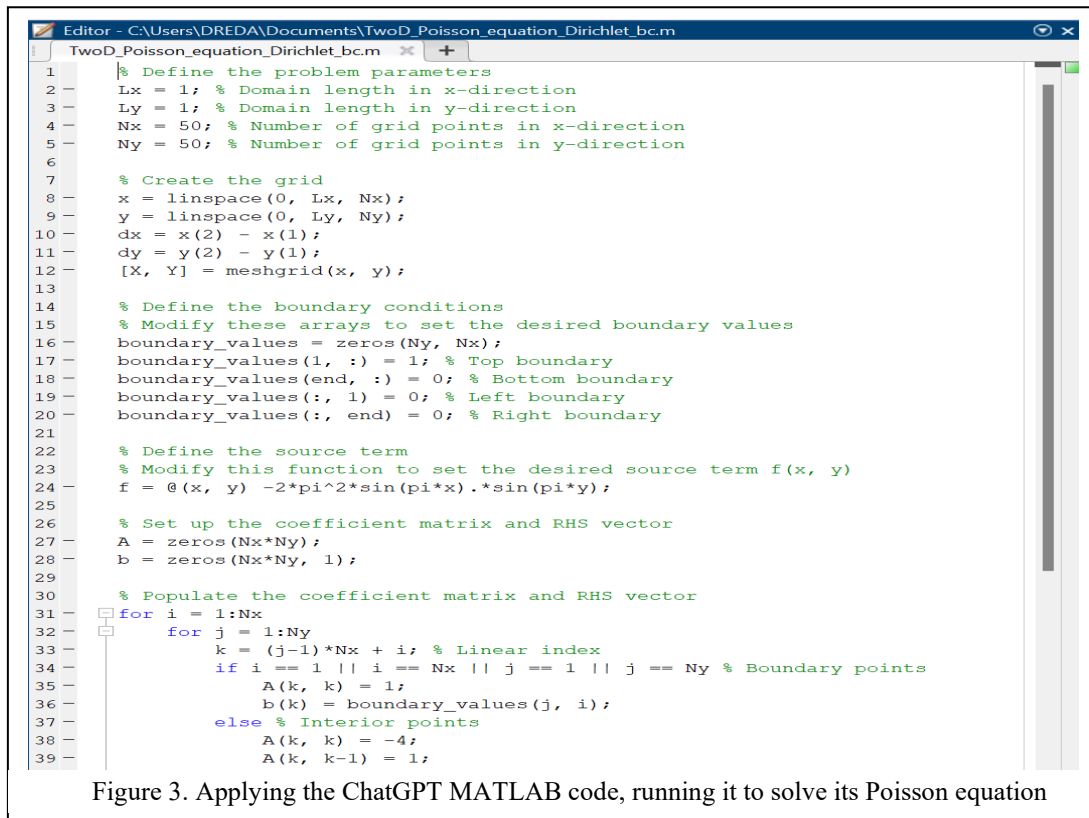
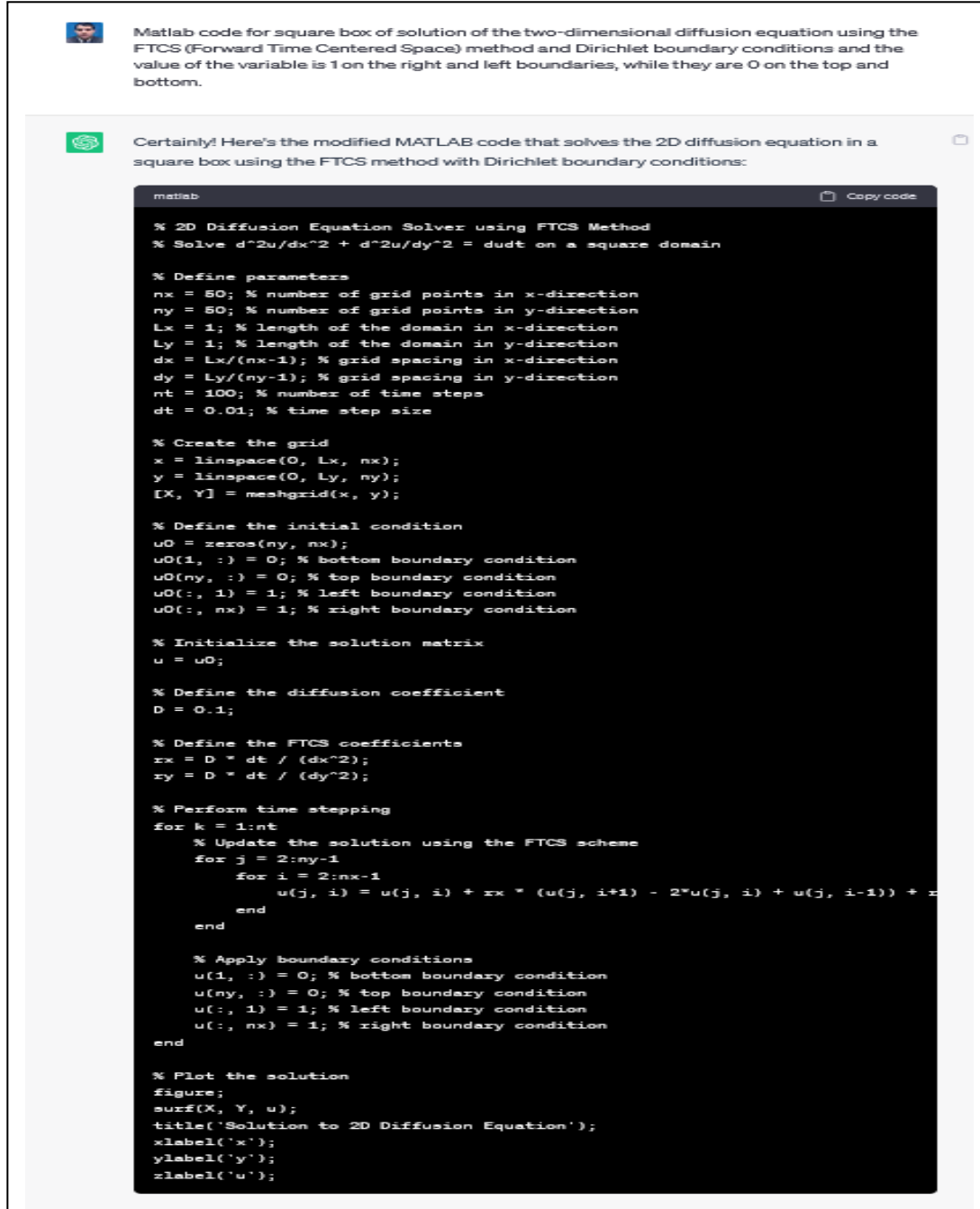


Figure 4. Produced solution of ChatGPT MATLAB code, solving 2D Poisson with Dirichlet BC

3.2.2 Solving the 2D Diffusion Equation using MATLAB Code that Solves with Dirichlet Boundary Conditions using The Finite Difference Method

In this code shown in ChatGPT_Box 6, the 2D domain is discretized using a grid, and the FTCS (Forward Time Centered Space) method is used to solve the diffusion equation. The Dirichlet boundary conditions are applied by directly setting the boundary values in each time step. The diffusion coefficient, time step size, and the number of time steps can be adjusted according to your specific problem. The solution is then plotted using the surf function as applied on the



Matlab code for square box of solution of the two-dimensional diffusion equation using the FTCS (Forward Time Centered Space) method and Dirichlet boundary conditions and the value of the variable is 1 on the right and left boundaries, while they are 0 on the top and bottom.

Certainly! Here's the modified MATLAB code that solves the 2D diffusion equation in a square box using the FTCS method with Dirichlet boundary conditions:

```

matlab
% 2D Diffusion Equation Solver using FTCS Method
% Solve  $d^2u/dx^2 + d^2u/dy^2 = du/dt$  on a square domain

% Define parameters
nx = 50; % number of grid points in x-direction
ny = 50; % number of grid points in y-direction
Lx = 1; % length of the domain in x-direction
Ly = 1; % length of the domain in y-direction
dx = Lx/(nx-1); % grid spacing in x-direction
dy = Ly/(ny-1); % grid spacing in y-direction
nt = 100; % number of time steps
dt = 0.01; % time step size

% Create the grid
x = linspace(0, Lx, nx);
y = linspace(0, Ly, ny);
[X, Y] = meshgrid(x, y);

% Define the initial condition
u0 = zeros(ny, nx);
u0(1, :) = 0; % bottom boundary condition
u0(ny, :) = 0; % top boundary condition
u0(:, 1) = 1; % left boundary condition
u0(:, nx) = 1; % right boundary condition

% Initialize the solution matrix
u = u0;

% Define the diffusion coefficient
D = 0.1;

% Define the FTCS coefficients
rx = D * dt / (dx^2);
ry = D * dt / (dy^2);

% Perform time stepping
for k = 1:nt
    % Update the solution using the FTCS scheme
    for j = 2:ny-1
        for i = 2:nx-1
            u(j, i) = u(j, i) + rx * (u(j, i+1) - 2*u(j, i) + u(j, i-1)) + ry * (u(j+1, i) - 2*u(j, i) + u(j-1, i));
        end
    end

    % Apply boundary conditions
    u(1, :) = 0; % bottom boundary condition
    u(ny, :) = 0; % top boundary condition
    u(:, 1) = 1; % left boundary condition
    u(:, nx) = 1; % right boundary condition
end

% Plot the solution
figure;
surf(X, Y, u);
title('Solution to 2D Diffusion Equation');
xlabel('x');
ylabel('y');
zlabel('u');
    
```

MATLAB platform in Figure 5, and its plot results in Figure 6. ChatGPT_Box 6. MATLAB code that solves with Dirichlet boundary conditions using the finite difference method equation is requested from ChatGPT

```

Editor - C:\Users\DREDA\Documents\TwoD_Diffusion_Equation_Solver_using_FTCS_Method.m
TwoD_Diffusion_Equation_Solver_using_FTCS_Method.m
1 % 2D Diffusion Equation Solver using FTCS Method
2 % Solve  $d^2u/dx^2 + d^2u/dy^2 = dudt$  on a square domain
3
4 % Define parameters
5 nx = 50; % number of grid points in x-direction
6 ny = 50; % number of grid points in y-direction
7 Lx = 1; % length of the domain in x-direction
8 Ly = 1; % length of the domain in y-direction
9 dx = Lx/(nx-1); % grid spacing in x-direction
10 dy = Ly/(ny-1); % grid spacing in y-direction
11 nt = 1000000; % number of time steps
12 dt = 0.0001; % time step size
13
14 % Create the grid
15 x = linspace(0, Lx, nx);
16 y = linspace(0, Ly, ny);
17 [X, Y] = meshgrid(x, y);
18
19 % Define the initial condition
20 u0 = zeros(ny, nx);
21 u0(1, :) = 0; % bottom boundary condition
22 u0(ny, :) = 0; % top boundary condition
23 u0(:, 1) = 1; % left boundary condition
24 u0(:, nx) = 1; % right boundary condition
25
26 % Initialize the solution matrix
27 u = u0;
28
29 % Define the diffusion coefficient
30 D = 0.1;
31
32 % Define the FTCS coefficients
33 rx = D * dt / (dx^2);
34 ry = D * dt / (dy^2);
35
36 % Perform time stepping
37 for k = 1:nt
38     % Update the solution using the FTCS scheme
39     for j = 2:ny-1
40         for i = 2:nx-1
41             u(i, j) = u(i, j) + rx * (u(i, j+1) - 2*u(i, j) + u(i, j-1)) + ry * (u(i+1, j) -

```

Figure 5. Applying the ChatGPT MATLAB code, running it to solve its FTCS (Forward Time Centered Space) method used to solve the diffusion equation with Dirichlet BC.

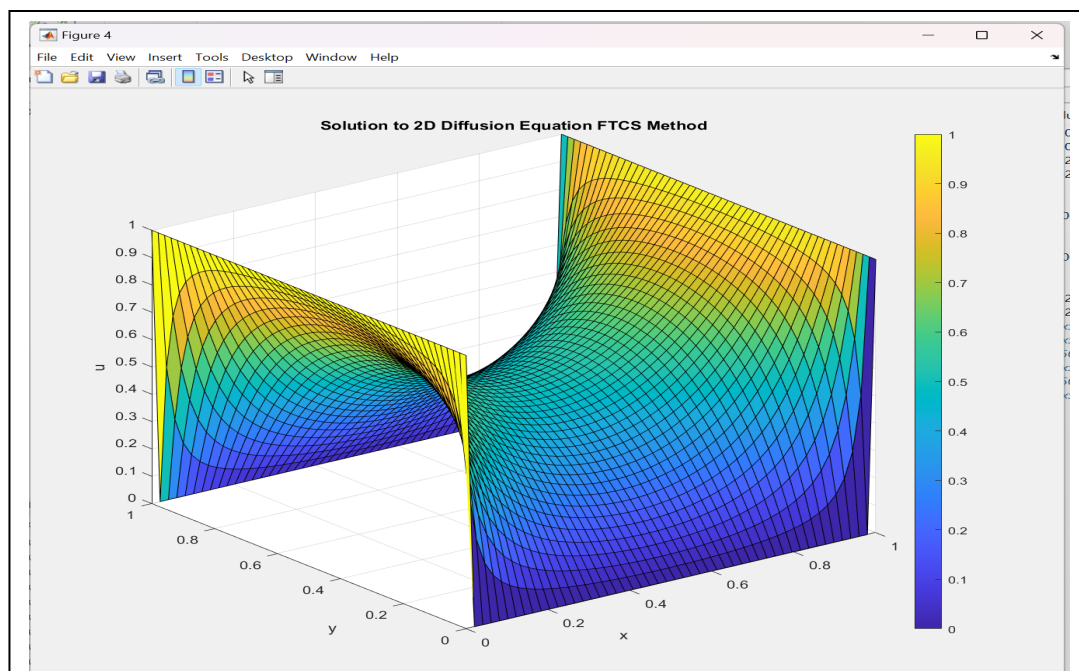


Figure 6. Produced solution of ChatGPT MATLAB code, solving 2D diffusion with Dirichlet BC

4. Utilizing a Chatbot to Serve as a Research Assistant

Researchers may receive assistance with writing academic papers by providing support and creating content. Here are a few ways a chatbot can facilitate the process for you: Creating parts or paragraphs: If you give me an outline or a list of your paper's main topics, I can help you write coherent sections or paragraphs. Giving explanations: Get in touch with me if you need help simplifying a complex theory or subject and providing a clear, succinct explanation. Helping with references and citations: I may produce citations and references in the preferred citation style (for instance, APA, MLA) using the information you supply. Providing services for editing and proofreading ChatGPT may ensure that the paper adheres to the standards for academic writing while also checking it for grammar, coherence, and clarity. Giving examples might help you with your writing by creating examples or sample sentences for specific themes or parts. It's important to remember that although ChatGPT can create content and be very helpful, researchers should still review and revise the completed product to make sure it adheres to their own study and writing style. Verifying references and citations is always necessary for maintaining academic integrity.

Academics can benefit from automation as a tool for streamlining repetitive work so they can spend more time and energy on more challenging tasks like analysis and interpretation. Here are several strategies for utilizing automation to support academic research. Research may be completed in a lot less time by automating data entry tasks. Researchers can use scripts or programming languages like MATLAB to harvest data from a variety of sources, including databases or spreadsheets, and automatically fill their study datasets with it. Efficiency is increased, and errors are reduced, by doing away with manual data entry.

On occasion, preprocessing and data cleansing require a lot of time. By automating tedious data cleaning operations like deleting duplicates, dealing with missing values, or standardizing data formats, researchers can create scripts or workflows. Researchers may minimize the data preparation step and focus on data analysis by automating these activities. Researchers can automate data analysis tasks by using tools like statistical software (like SPSS) for data analysis and visualization. Data visualization, regression models, and descriptive statistics are a few examples of repeated studies that can be automated through the development of scripts or workflows. Time is saved, and investigations are conducted consistently as a result. Automation can be utilized to help in report creation or research summaries. The most important findings, figures, and tables can be automatically loaded into a structured report using templates or scripts that researchers can build. As a result, researchers can produce reports quickly because there is no need to manually copy and paste text. Technologies that automate tasks can help academics conduct literature reviews. Tools like citation managers enable automated grouping, classification, and citation extraction. In addition, text mining and NLP techniques can aid in the automation of several aspects of literature review, including sentiment analysis, subject modelling, and summarization. By automating these tedious tasks, researchers can improve efficiency, reduce human error, and free up more time for critical thought, analysis, and interpretation of their study results. While automation can be quite useful, it's important to remember that the data generated by automated methods must be validated and verified. Careful analysis and interpretation of the automated outputs are still necessary to preserve accuracy and reliability.

5. Preventing the Inappropriate Use of Chatbots in Education

Although Chatbots can be helpful in education, it's critical to consider and deal with the danger of misuse. Here are some actions you may take to prevent Chatbots from being utilized improperly in educational settings. Establish clear guidelines defining how Chatbots should be used in educational settings. These guidelines should outline the purpose, moral principles, and acceptable behavior when interacting with the Chatbot. Make sure you let kids, teachers, and administrators know about these guidelines and expectations. Set up settings to keep an eye on and manage Chatbot conversations. This can call for immediate supervision by trainers or other designated moderators who can intervene if inappropriate or harmful content is discovered. Auditing the Chatbot logs regularly can help identify any abuse and enable remediation. Content filtering and filtering techniques Use content filtering technology to find inappropriate or undesirable content and prevent its distribution or display. Keyword filtering, sentiment analysis, or machine learning algorithms may be used to identify or prohibit information that contains offensive language, sensitive topics, or potentially dangerous material. Instruction and training on how to use Chatbots properly in a learning setting should be provided to students, teachers, and administrators. It is important to educate users about potential risks, proper online behavior, and the importance of respectful communication. To promote online safety and responsible digital citizenship while fostering a warm and inclusive environment. Regularly assess the effectiveness of your safety measures, user feedback, and the functioning of the Chatbots. Adapt standards, practices, and technical features based on this feedback to tackle any new problems or challenges. By implementing these safety measures, educational

institutions can lessen the risks associated with the improper use of Chatbots, promote a safe and comfortable learning environment, and ensure that the Chatbot effectively completes its intended educational aim. Open-ended questions can be a helpful addition to exams since they push students to think critically, clarify their ideas completely, and give innovative responses. It can be challenging for AI systems to accurately replicate this type of assessment. Here are some considerations to make when including open-ended questions on exams. When responding to open-ended questions, students must engage in higher-order thinking skills like analysis, synthesis, assessment, and creativity. These questions force students to exercise critical thinking skills and go beyond rote memorizing of facts or information. Regarding complexity and originality, open-ended questions provide students the chance to demonstrate their creative problem-solving abilities and present original opinions. Students have the opportunity to, rather than being restricted to, predefined responses.

Open-ended questions are more adaptable and flexible since they provide a range of potential solutions. Students are allowed to tailor their comments based on their knowledge, experiences, and insights. This adaptability promotes personalized learning and acknowledges the possibility of using several legitimate approaches or points of view. According to Communication Skills, open-ended questions force students to effectively explain their opinions, present convincing arguments, and offer supporting evidence, all of which assist students in improving their communication skills. The development of critical thinking and effective communication, which are crucial skills in a range of disciplines, can be accomplished through assessing students' ability to explain themselves logically and persuasively. Following the requirements, develop exact assessment criteria and rubrics that are designed especially for open-ended questions. The key components of a strong response, such as breadth of analysis, ingenuity, supporting details, and clarity of communication, should be highlighted by these scoring criteria. It is simpler to consistently and properly evaluate student responses when there are clear criteria. Evaluation and feedback from the teacher are frequently required for open-ended questions in order to gauge the quality and depth of the student's responses. By evaluating their work and offering constructive criticism, teachers play a significant role in assisting students in learning, developing their creative potential, and thinking critically. Even though AI technology can assist with some aspects of assessment, the evaluation of open-ended questions is best supported by human evaluators who can discern the intricacies, inventiveness, and originality of students' responses. By using open-ended questions in exams, educational institutions can promote students' critical thinking, creativity, and development of higher-order cognitive skills. This approach promotes a well-rounded educational experience and honors the complexity and originality of students' thoughts.

6. Conclusion

The employment of Chatbots as virtual teaching assistants can offer students individualized support by responding to their queries, helping with the course materials, and providing advice on a range of subjects. They can assist in making instructional content delivery more dynamic and interesting for students, improving their learning experience. In academic libraries, AI Chatbots have also been installed to help users find pertinent journal articles, books, or other resources. They can offer suggestions based on user preferences, help manage citations, and advise on how to use library resources efficiently. This facilitates quicker and more effective information access for scholars and students. Additionally, Chatbots can be used in academic institutions for administrative tasks. They can respond to common questions concerning enrollment, registration, financial assistance, and campus services, freeing up staff members' time to concentrate on more difficult responsibilities. Additionally, Chatbots can help with scheduling and remind users of key notifications, deadlines, and academic activities. Additionally, AI Chatbots can aid researchers in their work by helping with data analysis, literature reviews, and recommending prospective study topics based on the body of knowledge already available. They can facilitate research, assist in locating relevant studies, and give access to databases and resources. It is crucial to remember that while AI Chatbots may improve the academic experience, they are not intended to completely replace human connection. Instead of serving as a replacement for human direction and mentorship, they ought to be viewed as instruments that add to human expertise and support. In general, integrating AI systems and Chatbots into academic work has the potential to revolutionize several administrative, educational, and research duties while also delivering more individualized and effective services to students, researchers, and academic professionals.

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The authors used the ChatGPT software tools to generate the instructional strategies and training necessary to develop the curriculum with the help of Professor Elkamel of Waterloo University. We greatly appreciate the efforts put forth by the authors' creativity group in compiling all information about teaching tools and the time spent constructing the

majority of the work on the instructional website referred to in this paper, especially Mr. Sahem. The chemical engineering department of Elmergib University's associate professor Edali developed and evaluated the training methods made possible by AI Apps, as well as their presentations on teaching methodology and teaching philosophy. As shown in reference [24], they were subsequently supported in their use in classrooms and published on a website by the chemical engineering research group at Elmergib University, allowing any professor or engineering student anywhere in the world access to additional information on teaching methodology.

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Biographies

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