WebOctave and Numerical Analysis tool

REPORT
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Abstract

This project discusses the Numerical Method analysis tool and Weboctave. Numerical Analysis tool consists of set of programs implemented in octave. For this, I explored numerical methods in engineering and science. After studying about the methods and the approach followed, I devised this tool which basically is collection of direct and iterative methods to solve problems of simultaneous and transcendental equations, matrices and ordinary differential equations.

The increasing importance of numerical methods in applied sciences have led to enhanced demand to deal with techniques of numerical analysis. The reason for this is that numerical methods can give the solution to applied problems when ordinary analytical methods fail.

Futhermore, it deals with Weboctave which is web interface to use octave i.e. anyone can use this service and need not have octave installed on their systems and can use this service remotely.

Also, this project is completely open source and the entire code is available to the user as and when required. There is Complete developer's Documentation as well as User manual alongwith it that helps using it a lot easier.

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1.1 Introduction to organisation

Figure 1.1: Guru Nanak Dev Engineering College

I had my Six Months Industrial Training at TCC-Testing And Consultancy Cell, GNDEC Ludhiana. Guru Nanak Dev Engineering College was established by the Nankana Sahib Education Trust Ludhiana. The Nankana Sahib Education Trust i.e NSET was founded in memory of the most sacred temple of Sri Nankana Sahib, birth place of Sri Guru Nanak Dev Ji. With the mission of Removal of Economic Backwardness through Technology Shiromani Gurudwara Parbandhak Committee i.e SGPC started a Poly technical was started in 1953 and Guru Nanak Dev Engineering College was established in 1956.

NSET resolved to uplift Rural areas by admitting 70% of students from these rural areas ever year. This commitment was made to nation on 8th April, 1956, the day foundation stone of the college building was laid by Dr. Rajendra Prasad Ji, the First President of India. The College is now ISO 9001:2000 certified.

Guru Nanak Dev Engineering College campus is spread over 88 acres of prime land about 5 Km s from Bus Stand and 8 Kms from Ludhiana Railway Station on Ludhiana-Malerkotla Road. The college campus is well planned with beautifully laid out tree plantation, pathways, flowerbeds besides the well maintained sprawling lawns all around. It has beautiful building for College,Hostels,Swimming Pool,Sports and Gymnasium Hall Complex, Gurudwara Sahib, Bank, Dispensary, Post Office etc. There are two hostels for boys and one for girls with total accommodation of about 550 students. The main goal of this institute is:

- To build and promote teams of experts in the upcoming specialisations.
- To promote quality research and undertake research projects keeping in view their relevance to needs and requirements of technology in local industry.
- To achieve total financial independence.
- To start online transfer of knowledge in appropriate technology by means of establishing multipurpose resource centres.

1.2 Testing and Consutancy Cell

My Six Months Institutional Training was done by me at TCC i.e Testing And Consultancy Cell, GNDEC Ludhiana under the guidance of Dr. H.S.Rai Dean Testing and Consultancy Cell. Testing and Consultancy Cell was established in the year 1979 with a basic aim to produce quality service for technical problems at reasonable and affordable rates as a service to society in general and Engineering fraternity in particular.

Figure 1.2: Testing and Consultancy Cell

Consultancy Services are being rendered by various Departments of the College to the industry, Sate Government Departments and Entrepreneurs and are extended in the form of expert advice in design, testing of materials & equipment, technical surveys, technical audit, calibration of instruments, preparation of technical feasibility reports etc. This consultancy cell of the college has given a new dimension to the development programmers of the College. Consultancy projects of over Rs. one crore are completed by the Consultancy cell during

financial year 2009-10.

Ours is a pioneer institute providing Consultancy Services in the States of Punjab, Haryana, Himachal, J&K and Rajasthan. Various Major Clients of the Consultancy Cell are as under:

- Northern Railway, Govt. of India
- Indian Oil Corporation Ltd.
- Larson & Turbo.
- Multi National Companies like AFCON & PAULINGS.
- Punjab Water Supply & Sewage Board
- Power Grid Corporation of India.
- National Building Construction Co.
- Punjab State Electricity Board.
- Punjab Mandi Board.
- Punjab Police Housing Corporation.
- National Fertilizers Ltd.
- GLADA, Ludhiana

1.3 Introduction to Project

Numerical methods Methods designed for the constructive solution of mathematical problems requiring particular numerical results, usually on a computer. A numerical method is a complete and unambiguous set of procedures for the solution of a problem, together with computable error estimates (see error analysis). The study and implementation of such methods is the province of numerical analysis.
Numerical analysis A branch of mathematics/computer science dealing with the study of algorithms for the numerical solution of problems formulated and studied in other branches of mathematics. Numerical analysis now plays a central role in engineering and in the quantitative parts of pure and applied science. The tasks of numerical analysis include the development of fast and reliable numerical methods together with the provision of a suitable error analysis. The algorithms are developed as computer programs, taking full account of machine architectures such as parallelism.

Introduction to Numerical Analysis Tool

Numerical Analysis Tool consists of set of programs implemented in octave The set of problems covered are:

- Bisection Method
- Secant Method
- Newton Raphson Method
- Gauss Jordan
- Gauss Elimination
- Gauss Seidel
- Euler's Method
- Modified Euler Method
- Adam's Method
- RK Method

1.3.1 Bisection Method

Bisection method is the simplest among all the numerical schemes to solve the transcendental equations. Consider a transcendental equation f (x) = 0 which has a zero in the interval [a,b] and f (a) * f (b) <0. Bisection scheme computes the zero, say c, by repeatedly halving the interval [a,b]. That is, starting with $c = (a+b)/2$ the interval [a,b] is replaced either with [c,b] or with [a,c] depending on the sign of f (a) * f (c) . This process is continued until the zero is obtained. Since the zero is obtained numerically the value of c may not exactly match with all the decimal places of the analytical solution of f (x) = 0 in the interval [a,b].

Given a function f (x) continuous on an interval [a,b] and f (a) * f (b) <0
Do
c = (a+b)/2

if f (a) * f (c) <0 then b = c
else a = c
while (condition is true)

1.3.2 Secant Method

The secant method requires two initial approximations $x0$ and $x1$,preferrably both reasonably close to the solution $x*$. This is an improvement over the method of false position as it does not require the condition $f((x0)f(x1))$<0.Here also the graph of the function $y = f(x)$ is approximated by a secant line but at each iteration, two most recent approximations to the root are used to find the next approximation. Also it is not necessary that the interval must contain the root.
The general formula for successive approximation is, therefore, given by
$x_{n+1} = x_n - \frac{x_n - x_{n-1}}{f(x_n - f(x_{n-1})} f(x_n), n \geq 1.$

1.3.3 Newton Raphson

Unlike the earlier methods, this method requires only one appropriate starting point x_0 as an initial assumption of the root of the function $f(x) = 0$. At $(x_0, f(x_0))$ a tangent to $f(x) = 0$ is drawn. Equation of this tangent is given by $y = f'(x_0)(x-x_0)+f(x_0)$ The point of intersection, say , of this tangent with x-axis (y = 0) is taken to be the next approximation to the root of f(x) = 0. So on substituting y = 0 in the tangent equation we get $x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$ If $|f(x_1)| < \epsilon = 10^{-6}$ (say) we have got an acceptable approximate root of $f(x) = 0$, otherwise we replace x_0 by , and draw a tangent to $f(x) = 0$ at $(x_1, f(x_1))$ and consider its intersection, say , with x-axis as an improved approximation to the root of f(x)=0. If $|f(x_2)| > \epsilon$, we iterate the above process till the convergence criteria is satisfied. In general Newton-Raphson formula is given by
$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$ (n=0,1,2...)

1.3.4 Gauss Jordan and Gauss Elimination

It is the method involving elimination of unknowns,ultimately reducing system to a diagonal matrix form i.e. each equation involving only one unknown. From these equations, the unknowns x,y,z can be obtained readily. Thus in this method, the labour of back-substitution for finding the unknowns is saved at the cost of addiitional calculations.
In this method, the unknowns are eliminated successively and the system is reduced to an upper triangular system from which the unknowns are found by back substitution. The method is quite general and is well-adapted for computer operations. Here we shall explain it by considering a system of three equations for sake of clarity.

Consider the equations
$a_1x + b_1y + c_1z = d_1$
$a_2x + b_2y + c_2z = d_2$

$a_3x + b_3y + c_3z = d_3$

Step I. To eliminate x from second and third equations.

$$a_1x + b_1y + c_1z = d_1$$

$$b'_2y + c'_2z = d'_2$$

$$b'_3y + c'_3z = d'_3$$

Step II. To eliminate y from third equation in (2)

$$a_1x + b_1y + c_1z = d_1$$

$$b'_2y + c'_2z = d'_2$$

$$c'_3z = d"_3$$

Step III. To evaluate the unknowns

i.e equation (1), (2) and (3).

1.3.5 Jacobi Method

It is the simplest iterative method to solve the system of equations. Consider the equations

$$\{\, a_1\, x + b_1y + c_1z = d_1 a_2x + b_2y + c_2z = d_2 a_3x + b_3y + c_3z = d_3 \ldots (1)$$

If a_1, b_2, c_3 are large as compared to other coefficients, solve for x, y, z respectively. Then the system can be written as

$$\{\, x = \frac{1}{a_1}(d_1 - b_1y - c_1z) y = \frac{1}{b_2}(d_2 - a_2x - c_2z) z = \frac{1}{c_3}(d_3 - a_3x - b_3y) \ldots (2)$$

Let us start with the initial approximations x_0, y_0, z_0 for the values of x, y, z respectively. Substituting these on the right sides of (2), the first approximations are given by
$x_1 = \frac{1}{a_1}(d_1 - b_1y_0 - c_1z_0)$
$y_1 = \frac{1}{b_2}(d_2 - a_2x_0 - c_2z_0)$
$z_1 = \frac{1}{c_3}(d_3 - a_3x_0 - b_3y_0)$

Substituting the values x_1, y_1, z_1 on the right sides of (2), the second approximations are given by
$x_2 = \frac{1}{a_1}(d_1 - b_1y_1 - c_1z_1)$
$y_2 = \frac{1}{b_2}(d_2 - a_2x_1 - c_2z_1)$
$z_2 = \frac{1}{c_3}(d_3 - a_3x_1 - b_3y_1)$

This process is repeated till the difference between two consecutive approximations is negligible.

1.3.6 Gauss Seidel

You will now look at a modification of the Jacobi method called the Gauss-Seidel method, named after Carl Friedrich Gauss (17771855) and Philipp L. Seidel (18211896). This modification is no more difficult to use than the Jacobi method, and it often requires fewer iterations to produce the same degree of accuracy. With the Jacobi method, the values of xi obtained in the nth approximation remain unchanged until the entire (n+1)th approximation has been calculated. With the Gauss-Seidel method, on the other hand, you use the new values of each as soon as they are known. That is, once you have determined from the first equation, its value is then used in the second equation to obtain the new $x2$. Similarly, the new $x1$ and $x2$ are used in the third equation to obtain the new $x3$ and so on.
This is a modification of Jacobi's method. As before the system of equations:

$$\{\, a_1\, x + b_1 y + c_1 z = d_1 a_2 x + b_2 y + c_2 z = d_2 a_3 x + b_3 y + c_3 z = d_3 \ldots (1)$$

is written as

$$\{\, x = \frac{1}{a_1}(d_1 - b_1 y - c_1 z) y = \frac{1}{b_2}(d_2 - a_2 x - c_2 z) z = \frac{1}{c_3}(d_3 - a_3 x - b_3 y) \ldots (2)$$

Here also we start with the initial approximations $x_0, y_0, z_0 for x, y, z$ respectively which may each be taken as zero. Substituting

$$y = y_0, z = z_0$$

in the first of the equation (2), we get

$$x_1 = \frac{1}{a_1}(d_1 - b_1 y_0 - c_1 z_0)$$

Then putting $x = x_1, z = z_0$ in the second of the equations(2), we have

$$y_1 = \frac{1}{b_2}(d_2 - a_2 x_1 - c_2 z_0)$$

Next substituting

$$x = x_1, y = y_1$$

in the third of the equations(2), we obtain

$$z_1 = \frac{1}{c_3}(d_3 - a_3 x_1 - b_3 y_1)$$

and so on i.e. as soon as a new approximation for an unknown is found, it is immediately used in the next step.

This process of iteration is repeated till the values of x, y, z are obtained to desired degree of accuracy.

1.3.7 Euler's Method

Now we will work with a general initial value problem

$$\begin{aligned} \frac{dy}{dt} &= f(y) \\ y(0) &= y_0 \end{aligned}$$

We will again form an approximate solution by taking lots of little steps. We will call the distance between the steps h and the various points (t_j, y_j) . To get from one step to the next, we will form the linear approximation at t_j . The derivative at this point is given by the differential equation: $\frac{dy}{dt} = f(y)$. The linear approximation is then

$$l(t) = y_j + f(y_j)(t - t_j)$$

so that

$$y_{j+1} = l(t_{j+1}) = y_j + f(j_j)h.$$

This technique is called Euler's Method.

1.3.8 Modified Euler's Method

The Euler forward scheme may be very easy to implement but it can't give accurate solutions. A very small step size is required for any meaningful result. In this scheme, since, the starting point of each sub-interval is used to find the slope of the solution curve, the solution would be correct only if the function is linear. So an improvement over this is to take the arithmetic average of the slopes at x_i and x_{i+1}(that is, at the end points of each sub-interval). The scheme so obtained is called modified Euler's method. It works first by approximating a value to yi+1 and then improving it by making use of average slope.

In order to use Euler's Method to generate a numerical solution to an initial value problem of the form:

$y = f(x, y)$

$y(x_0) = y_0$

we decide upon what interval, starting at the initial condition, we desire to find the solution. We split this interval into small subdivisions of length h. Then, using the initial condition as our starting point, we generate the rest of the solution by using the iterative formulas:

$x_{n+1} = x_n + h$

$y_{n+1} = y_n + hf(x_n, y_n)$

to find the coordinates of the points in our numerical solution. We terminate this process when we have reached the right end of the desired interval.

1.3.9 Adam's Method

Adams' method is a numerical method for solving linear first-order ordinary differential equations of the form $(dy)/(dx) = f(x, y)$.
A finite-difference method for solving Cauchy's problem for systems of first-order differential equations

1.3.10 RK Method

A method of numerically integrating ordinary differential equations by using a trial step at the midpoint of an interval to cancel out lower-order error terms. The second-order formula is

$$k_1 = hf(x_n, y_n) \tag{1.1}$$

$$k_2 = hf(x_{n+1}/2h, y_{n+1}/2k_1) \tag{1.2}$$

$$y_(n + 1) = y_n + k_2 + O(h^3) \tag{1.3}$$

(where O(x) is a Landau symbol), sometimes known as RK2, and the fourth-order formula is

$$k_1 = hf(x_n, y_n) \tag{1.4}$$

$$k_2 = hf(x_n + 1/2h, y_n + 1/2k_1) \tag{1.5}$$

$$k_3 = hf(x_n + 1/2h, y_n + 1/2k_2) \tag{1.6}$$

$$k_4 = hf(x_n + h, y_n + k_3) \tag{1.7}$$

$$y_(n + 1) = y_n + 1/6k_1 + 1/3k_2 + 1/3k_3 + 1/6k_4 + O(h^5) \tag{1.8}$$

1.4 Objectives

- To implement the concepts of numerical methods using programming in Octave.
- To give interactive graphical representations of the results.
- To provide a web interface for using these services

1.5 Problem Formulation

When analytical solution of the mathematically defined problem is possible but it is time-consuming and the error of approximation we obtain with numerical solution is acceptable. In this case the calculations are mostly made with use of computer because otherwise its highly doubtful if any time is saved. It is indivually to decide what do we mean by "time-consuming analytical solution". In my discipline even very simple mechanical problems are solved numerically simply because of laziness.

When analytical solution is impossible means that we have to apply numerical methods in order to find the solution. This does not define that we must do calculations with computer although it usually happens so because of the number of required operations.

1.6 Recognization of Need

Numerical methods of civil engineering is a subject which involves various iterative and sequential methods which are solved by students. They are given differen numerical problems and they use calculators or excel to solve these problems. The aim of this project is to provide easy and convenient programs where they can try their numerical problems and can even plot graphs. This approach will help them to solve problems earlier and in convenient way.
Weboctave is a web interface which doesn't require installation by every user and is helpful in teaching purposes.

1.7 Existing System

There are various softwares:

MATLAB is a widely used proprietary software for performing numerical calculations. It comes with its own programming language, in which numerical algorithms can be implemented.

GNU Octave is a high-level language, primarily intended for numerical computations. It provides a convenient command line interface for solving linear and nonlinear problems numerically, and for performing other numerical experiments using a language that is mostly compatible with MATLAB. Octave includes GUI as of Version 3.8, released December 31, 2013.

This tool is based on Octave which is distributed under the terms of the GNU General Public License. It includes various methods which can implemented by using both Octave and MATLAB.

There are various services which provides a platform to run your programs online i.e. through a web interface like tutorialspoint,octave-online.net etc. These provides a mechanism through user can run his/her programs online and get results.Such services provide features like uploading, downloading .m files, saving files etc.

1.8 Proposed System

The proposed system is a learning tool which helps civil engineers or researchers to solve their numerical problems programatically. The system uses Octave for it's working which is freely available and provides an open source alternative to MATLAB.
WebOctave is a web-service which enables to user octave remotely through browser. User can issue commands and great results.

1.9 Unique Features of the System

1. Simple and easy programs for civil engineers to understand the implementation of the numerical methods.
2. Graphical output is possible and user can make changes as required as the code is available to all under the GNU General Public License (GNU GPL or GPL)
3. Anonymous and User accounts creation in Weboctave.
4. Download the plots
5. Define your own problems.
6. View all the defined prroblems.

Chapter 2

Requirement Analysis and System Specification

2.1 Feasibility Study

Feasibility study is made to see if the project on completion will serve the purpose of the organization for the amount of work, effort and the time that spend on it. Feasibility study lets the developer foresee the future of the project and the usefulness. A feasibility study of a system proposal is according to its workability, which is the impact on the organization, ability to meet their user needs and effective use of resources. Carrying out a feasibility study involves information assessment, information collection and report writing. The information assessment phase identifies the information that is required to answer the three questions set out above. Once the information has been identified, you should question information sources to discover the answers to these questions Thus when a new application is proposed it normally goes through a feasibility study before it is approved for development.

A feasibility study is designed to provide an overview of the primary issues related to a business idea. The purpose is to identify any make or break issues that would prevent your business from being successful in the marketplace. In other words, a feasibility study determines whether the business idea makes sense. A thorough feasibility analysis provides a lot of information necessary for the business plan. For example, a good market analysis is necessary in order to determine the projects feasibility. This information provides the basis for the market section of the business plan.

The document provide the feasibility of the project that is being designed and lists various areas that were considered very carefully during the feasibility study of this project such as Technical, Economic and Operational feasibilities.Feasibilityis defined as the practical extent to which a project can be performed successfully. To evaluate feasibility, a feasibility study is performed, which determines whether the solution considered to accomplish the requirements is practical and workable in the software. Information such as resource availability, cost estimation for software development, benefits of the software to the organization after it is developed and cost to be incurred on its maintenance are considered during the feasibility study. The objective of the feasibility study is to establish the reasons for developing the software that is acceptable to users, adaptable to change and conformable to established standards.

Objectives of feasibility study are listed below.

- To analyze whether the software will meet organizational requirements
- To determine whether the software can be implemented using the current technology and within the specified budget and schedule
- To determine whether the software can be integrated with other existing software.

2.1.1 Types of Feasibility

Various types of feasibility that are commonly considered include technical feasibility, operational feasibility, and economic feasibility.

2.1.1.1 Technical Feasibility

Technical feasibilityis one of the first studies that must be conducted after theprojecthas been identified. In large engineering projects consulting agencies that have large staffs of engineers and technicians conduct technical studies dealing with the projects. In individual agricultural projects financed by local agricultural credit corporations, the technical staff composed of specialized agricultural engineers, irrigation and construction engineers, and other technicians are responsible for conducting suchfeasibility studies. Thetechnical feasibilityassessment is focused on gaining an understanding of the present technical resources of the organization and their applicability to the expected needs of the proposed system. It is an evaluation of the hardware and software and how it meets the need of the proposed system. This assessment is based on an outline design of system requirements, to determine whether the company has the technical expertise to handle completion of the project. When writing a feasibility report, the following should be taken to consideration:

- A brief description of the business to assess more possible factors which could affect the study
- The part of the business being examined
- The human and economic factor
- The possible solutions to the problem

The system must be evaluated from the technical point of view first. The assessment of this feasibility must be based on an outline design of the system requirement in the terms of input, output, programs and procedures. Having identified an outline system, the investigation must go on to suggest the type of equipment, required method developing the system, of running the system once it has been designed. Technical feasibility assesses the current resources (such as hardware and software) and technology, which are required to accomplish user requirements in the software within the allocated time and budget. For this, the software development team ascertains whether the current resources and technology can be upgraded or added in the software to accomplish specified user requirements.Technical feasibility also performs the following tasks.

- Analyzes the technical skills and capabilities of the software development team members

- Determines whether the relevant technology is stable and established
- Ascertains that the technology chosen for software development has a large number of users so that they can be consulted when problems arise or improvements are required.

Technical issues raised during the investigation are:

- Does the existing technology sufficient for the suggested one?
- Can the system expand if developed?

The project should be developed such that the necessary functions and performance are achieved within the constraints. The project is developed within latest technology. Through the technology may become obsolete after some period of time, due to the fact that never version of same software supports older versions, the system may still be used. So there are minimal constraints involved with this project. The system has been developed using Java the project is technically feasible for development.

2.1.1.2 Economic Feasibility

The purpose of the economic feasibility assessment is to determine the positive economic benefits to the organization that the proposed system will provide. It includes quantification and identification of all the benefits expected. This assessment typically involves a cost/ benefits analysis.

Economic feasibility is the cost and logistical outlook for a business project or endeavor.Prior to embarking on a new venture, most businesses conduct an economic feasibility study, which is a study that analyzes data to determine whether the cost of the prospective new venture will ultimately be profitable to the company. Economic feasibility is sometimes determined within an organization, while other times companies hire an external company that specializes in conducting economic feasibility studies for them.

The purpose of business in a capitalist society is to turn a profit, or to earn positive income. While some ideas seem excellent when they are first presented, they are not always economically feasible. That is, that they are not always profitable or even possible within a company's budget. Since companies often determine their budget's several months in advance, it is necessary to know how much of the budget needs to be set aside for future projects. Economic feasibility helps companies determine what that dollar amount is before a project is ultimately approved. This allows companies to carefully manage their money to insure the most profitable projects are undertaken. Economic feasibility also helps companies determine whether or not revisions to a project that at first seems unfeasible will make it feasible.

The developing system must be justified by cost and benefit. Criteria to ensure that effort is concentrated on project, which will give best, return at the earliest. One of the factors, which affect the development of a new system, is the cost it would require. Economic feasibility determines whether the required software is capable of generating financial gains for an organization. It involves the cost incurred on the software development team, estimated cost of hardware and software, cost of performing feasibility study, and so on. For this, it is

essential to consider expenses made on purchases (such as hardware purchase) and activities required to carry out software development. In addition, it is necessary to consider the benefits that can be achieved by developing the software. Software is said to be economically feasible if it focuses on the issues listed below.

- Cost incurred on software development to produce long-term gains for an organization.
- Cost required to conduct full software investigation (such as requirements elicitation and requirements analysis).
- Cost of hardware, software, development team, and training.

The following are some of the important financial questions asked during preliminary investigation:

- The costs conduct a full system investigation.
- The cost of the hardware and software.
- The benefits in the form of reduced costs or fewer costly errors.

Since the system is developed as part of project work, there is no manual cost to spend for the proposed system. Also all the resources are already available, it give an indication of the system is economically possible for development.

2.1.1.3 Behavioral Feasibility

Behavioral feasibility assesses the extent to which the required software performs a series of steps to solve business problems and user requirements. It is a measure of how well the solution of problems or a specific alternative solution will work in the organization. It is also measure of how people feel about the system. If the system is not easy to operate, than operational process would be difficult. The operator of the system should be given proper training. The system should be made such that the user can interface the system without any problem.

Operational feasibility is a measure of how well a proposed system solves the problems, and takes advantage of the opportunities identified during scope definition and how it satisfies the requirements identified in the requirements analysis phase of system development. The operational feasibility assessment focuses on the degree to which the proposed development projects fits in with the existing business environment and objectives with regard to development schedule, delivery date,corporate culture, and existing business processes.

To ensure success, desired operational outcomes must be imparted during design and development. These include such design-dependent parameters such as reliability, maintainability, supportability, usability, producibility, disposability, sustainability, affordability and others. These parameters are required to be considered at the early stages of design if desired operational behaviors are to be realized. A system design and development requires appropriate and timely application of engineering and management efforts to meet the previously mentioned parameters. A system may serve its intended purpose most effectively when its technical and operating characteristics are engineered into the design. Therefore, operational feasibility is

a critical aspect of systems engineering that needs to be an integral part of the early design phasesThis feasibility is dependent on human resources (software development team) and involves visualizing whether the software will operate after it is developed and be operative once it is installed. Operational feasibility also performs the following tasks.

- Determines whether the problems anticipated in user requirements are of high priority.
- Determines whether the solution suggested by the software development team is acceptable.
- Analyzes whether users will adapt to a new software.
- Determines whether the organization is satisfied by the alternative solutions proposed by the software development team.

This includes the following questions:

- Is there sufficient support for the users?
- Will the proposed system cause harm?
- The project would be beneficial because it satisfies the objectives when developed and installed. All behavioral aspects are considered carefully and conclude that the project is behaviorally feasible.

2.2 Software Requirement Analysis

Software requirement analysis is a process of gathering and interpreting facts, diagnosing problems and the information to recommend improvements on the system. It is a problem solving activity that requires intensive communication between the system users and system developers. System analysis or study is an important phase of any system development process. The system is studied to the minutest detail and analyzed. The system analyst plays the role of the interrogator and dwells deep into the working of the present system. The system is viewed as a whole and the input to the system are identified. The outputs from the organizations are traced to the various processes. System analysis is concerned with becoming aware of the problem, identifying the relevant and decisional variables, analyzing and synthesizing the various factors and determining an optimal or at least a satisfactory solution or program of action.

A detailed study of the process must be made by various techniques like interviews, questionnaires etc. The data collected by these sources must be scrutinized to arrive to a conclusion. The conclusion is an understanding of how the system functions. This system is called the existing system. Now the existing system is subjected to close study and problem areas are identified. The designer now functions as a problem solver and tries to sort out the difficulties that the enterprise faces. The solutions are given as proposals. The proposal is then weighed with the existing system analytically and the best one is selected. The proposal is presented to the user for an endorsement by the user. The proposal is reviewed on user request and suitable changes are made. This is loop that ends as soon as the user is satisfied with proposal.

Preliminary study is the process of gathering and interpreting facts, using the information for further studies on the system. Preliminary study is problem solving activity that requires intensive communication between the system users and system developers. It does various feasibility studies. In these studies a rough figure of the system activities can be obtained, from which the decision about the strategies to be followed for effective system study and analysis can be taken.

A Software Requirements Analysis for a software system is a complete description of the behavior of a system to be developed. It include functional Requirements and Software Requirements. In addition to these, the SRS contains non-functional requirements. Non-functional requirements are requirements which impose constraints on the design or implementation.

- **Purpose**: WebOctave and Numerical Methods Analysis Tool are built with purpose:
    1. To Perform most of difficult Calculation work.
    2. To work remotely without installaton of Ocatve.
    3. To plot graphs and download them.

- **Users of the System**

  Researcher or Student-: They have knowledge of working of procedures and what input is being provided. WebOctave can be installed and used by anyone who wants to perform any numerical computation using Octave.

2.2.1 Functional Requirements

- **Specific Requirements**: This phase covers the whole requirements for the system. After understanding the system we need the input data to the system then we watch the output and determine whether the output from the system is according to our requirements or not. So what we have to input and then what well get as output is given in this phase. This phase also describe the software and non-function requirements of the system.

- **Input Requirements of the System**

  1. Guess points
  2. Precision
  3. Step-size in case of iterative methods.
  4. Required point at which value is to be found

- **Output Requirements of the System**

  1. Final output after iterations.
  2. Graphs wherever possible in form of images.

- **Software Requirements**

  1. Programming language: Ocatve 4.0
  2. software: LaTeX
  3. Web Languages: php
  4. Database: Mysql
  5. Documentation: Doxygen 1.8.3
  6. Text Editor: Vim
  7. Operating System: Ubuntu 14.04 or up
  8. Revision System: Git

2.3 Facilities required for proposed work

2.3.1 Hardware Requirements

- Operating System: Linux/Windows
- Processor Speed: 512KHz or more
- RAM: Minimum 256MB

2.3.2 Software Requirements

- Software: GNU Ocatve, Gnuplot(for plots if not using default toolkit),git(version control). Weboctave requires php, mysql and apache for it's installation.
- Programming Language: Octave

2.4 Methodology

- Studying various methods available to solve different problems of numerical analysis.
- Deciding various input and output parameters of methods.
- Making the approach modular
- Graphical representation of solutions wherever possible
- Generating documentation

2.5 Project Work

Studied Previous System:
Before starting the project,

Learn octave:
Before starting with project, we have to go through the basics of Octave, such that there should not be any problem proceeding with project.

Get Familiar with Different methods and their algorithms:
We have gone through algorithms of these algorithms. Then implementation becomes easy

Functions:
The user has been provided some test functions which he can use to test various.

Plots:
Octave provides fltk as the default toolkit. But we can use gnuplot for more accurate plotting by setting them as default toolkit.

Input:
Input values are taken from user or default values defined in the file are used.

Output:
The iterations are performed and it returns the output with the expected precision.

Chapter 3

Implementation, Testing and Maintenance

3.1 Ubuntu: An open source OS

During my training, I also got familiar with a great and open source Operating System, Ubuntu. Firstly, it was quite difficult for a regular MS Windows user to port to Ubuntu. I did all of my project work using this vast operating system. Ubuntu (/ubuntu/ oo-BOON-too) is a Debian-based Linux operating system, with Unity as its default desktop environment. It is based on free software and named after the Southern African philosophy of ubuntu (literally, "human-ness"), which often is translated as "humanity towards others" or "the belief in a universal bond of sharing that connects all humanity".

Ubuntu's goal is to be secure "out-of-the box". By default user's programs run with low privileges and cannot corrupt the operating system or other user's files. For increased security, the sudo tool is used to assign temporary privileges for performing administrative tasks, which allows the root account to remain locked and helps prevent inexperienced users from inadvertently making catastrophic system changes or opening security holes.

3.2 Apache

Apache is a web server software notable for playing a key role in the initial growth of the World Wide Web. Apache is developed and maintained by an open community of developers under the auspices of the Apache Software Foundation. The application is available for a wide variety of operating systems, including Unix, FreeBSD, Linux, Solaris, Novell NetWare, Mac OS X, Microsoft Windows, OS/2, TPF, and eComStation. Released under the Apache License, Apache is open-source software.
The goal of this project is to provide a secure, efficient and extensible server that provides HTTP services in sync with the current HTTP standards.

3.2.1 Features of Apache Server

- Apache supports a variety of features, many implemented as compiled modules which extend the core functionality. These can range from server-side programming language

support to authentication schemes.

- Apache features configurable error messages, DBMS-based authentication databases, and content negotiation. It is also supported by several graphical user interfaces (GUIs).
- It supports password authentication and digital certificate authentication. Apache has a built in search engine and an HTML authorizing tool and supports FTP.

3.2.2 Installation of Apache Server

Apache web server can be installed using following commands:

```
$ sudo apt-get install apache2
```

3.3 Shell Scripting

Normally shells are interactive. It means shell accept command from you (via keyboard) and execute them. But if you use command one by one (sequence of 'n' number of commands) , the you can store this sequence of command to text file and tell the shell to execute this text file instead of entering the commands. This is know as shell script. Shell script defined as series of command written in plain text file. Shell script is just like batch file is MS-DOS but have more power than the MS-DOS batch file. why to Write Shell Script ?

1. Shell script can take input from user, file and output them on screen.
2. Useful to create our own commands.
3. Save lots of time.
4. To automate some task of day today life.
5. System Administration part can be also automated.

Execute your script as syntax:

```
chmod 755 your-script-name
sh your-script-name
./your-script-name
```

3.4 Introduction to LaTeX

LaTeX, I had never heard about this term before doing this project, but when I came to know about it's features, found it excellent. LaTeX (pronounced /letk/, /letx/, /ltx/, or /ltk/) is a document markup language and document preparation system for the TeX typesetting program. Within the typesetting system, its name is styled as LaTeX.

Within the typesetting system, its name is styled as LaTeX. The term LaTeX refers only to the language in which documents are written, not to the editor used to write those documents. In order to create a document in LaTeX, a .tex file must be created using some form of text

editor. While most text editors can be used to create a LaTeX document, a number of editors have been created specifically for working with LaTeX.

LaTeX is most widely used by mathematicians, scientists, engineers, philosophers, linguists, economists and other scholars in academia. As a primary or intermediate format, e.g., translating DocBook and other XML-based formats to PDF, LaTeX is used because of the high quality of typesetting achievable by TeX. The typesetting system offers programmable desktop publishing features and extensive facilities for automating most aspects of typesetting and desktop publishing, including numbering and cross-referencing, tables and figures, page layout and bibliographies.

LaTeX is intended to provide a high-level language that accesses the power of TeX. LaTeX essentially comprises a collection of TeX macros and a program to process LaTeXdocuments. Because the TeX formatting commands are very low-level, it is usually much simpler for end-users to use LaTeX.

3.4.1 Typesetting

LaTeX is based on the idea that authors should be able to focus on the content of what they are writing without being distracted by its visual presentation. In preparing a LaTeX document, the author specifies the logical structure using familiar concepts such as chapter, section, table, figure, etc., and lets the LaTeX system worry about the presentation of these structures. It therefore encourages the separation of layout from content while still allowing manual typesetting adjustments where needed.

```
\documentclass[12pt]{article}
\usepackage{amsmath}
\title{\LaTeX}
\date{}
\begin{document}
  \maketitle
  \LaTeX{} is a document preparation system
  for the \TeX{} typesetting program.
   \par
   $E=mc^2$
\end{document}
```

3.5 Introduction to Github

GitHub is a Git repository web-based hosting service which offers all of the functionality of Git as well as adding many of its own features. Unlike Git which is strictly a command-line tool, Github provides a web-based graphical interface and desktop as well as mobile integration. It also provides access control and several collaboration features such as wikis, task management, and bug tracking and feature requests for every project.

GitHub offers both paid plans for private repto handle everything from small to very large projects with speed and efficiency. ositories, and free accounts, which are usually used to host open source software projects. As of 2014, Github reports having over 3.4 million users,

making it the largest code host in the world.

GitHub has become such a staple amongst the open-source development community that many developers have begun considering it a replacement for a conventional resume and some employers require applications to provide a link to and have an active contributing GitHub account in order to qualify for a job.

The Git feature that really makes it stand apart from nearly every other Source Code Management (SCM) out there is its branching model.

Git allows and encourages you to have multiple local branches that can be entirely independent of each other. The creation, merging, and deletion of those lines of development takes seconds.

This means that you can do things like:

- Frictionless Context Switching.
  Create a branch to try out an idea, commit a few times, switch back to where you branched from, apply a patch, switch back to where you are experimenting, and merge it in.

- Role-Based Code lines.
  Have a branch that always contains only what goes to production, another that you merge work into for testing, and several smaller ones for day to day work.

- Feature Based Work flow.
  Create new branches for each new feature you're working on so you can seamlessly switch back and forth between them, then delete each branch when that feature gets merged into your main line.

- Disposable Experimentation.
  Create a branch to experiment in, realize it's not going to work, and just delete it - abandoning the workwith nobody else ever seeing it (even if you've pushed other branches in the meantime).

Notably, when you push to a remote repository, you do not have to push all of your branches. You can choose to share just one of your branches, a few of them, or all of them. This tends to free people to try new ideas without worrying about having to plan how and when they are going to merge it in or share it with others.

There are ways to accomplish some of this with other systems, but the work involved is much more difficult and error-prone. Git makes this process incredibly easy and it changes the way most developers work when they learn it.

3.5.1 What is Git?

Git is a distributed revision control and source code management (SCM) system with an emphasis on speed, data integrity, and support for distributed, non-linear workflows. Git was initially designed and developed by Linus Torvalds for Linux kernel development in 2005, and

has since become the most widely adopted version control system for software development.

As with most other distributed revision control systems, and unlike most clientserver systems, every Git working directory is a full-fledged repository with complete history and full version-tracking capabilities, independent of network access or a central server. Like the Linux kernel, Git is free and open source software distributed under the terms of the GNU General Public License version 2 to handle everything from small to very large projects with speed and efficiency.

Git is easy to learn and has a tiny footprint with lightning fast performance. It outclasses SCM tools like Subversion, CVS, Perforce, and ClearCase with features like cheap local branching, convenient staging areas, and multiple workflows.

3.5.2 Installation of Git

Installation of git is a very easy process. The current git version is: 2.0.4. Type the commands in the terminal:

$ sudo apt-get update

$ sudo apt-get install git

This will install the git on your pc or laptop.

3.5.3 Various Git Commands

Git is the open source distributed version control system that facilitates GitHub activities on your laptop or desktop. The commonly used Git command line instructions are:-

3.5.3.1 Create Repositories

Start a new repository or obtain from an exiting URL

$ git init [project-name]
Creates a new local repository with the specified name

$ git clone [url]
Downloads a project and its entire version history

3.5.3.2 Make Changes

Review edits and craft a commit transaction

$ git status
Lists all new or modified files to be committed

$ git diff
Shows file differences not yet staged

$ git add [file]
Snapshots the file in preparation for versioning

$ git reset [file]
Unstages the file, but preserve its contents

$ git commit -m "[descriptive message "]
Records file snapshots permanently in version history

3.5.3.3 Group Changes

Name a series of commits and combine completed efforts

$ git branch
Lists all local branches in the current repository

$ git branch [branch-name]
Creates a new branch

$ git checkout [branch-name]
Switches to the specified branch and updates the working directory

$ git merge [branch]
Combines the specified branchs history into the current branch

$ git branch -d [branch-name]
Deletes the specified branch

3.5.3.4 Save Fragments

Shelve and restore incomplete changes

$ git stash
Temporarily stores all modified tracked files

$ git stash pop
Restores the most recently stashed files

$ git stash list
Lists all stashed changesets

$ git stash drop
Discards the most recently stashed changeset

3.5.3.5 Synchronize Changes

Register a repository bookmark and exchange version history

$ git fetch [bookmark]
Downloads all history from the repository bookmark

$ git merge [bookmark /[branch]]
Combines bookmarks branch into current local branch

$ git push [alias [branch]]
Uploads all local branch commits to GitHub

$ git pull
Downloads bookmark history and incorporates changes

3.6 Introduction to Octave

GNU Octave is a high-level interpreted language, primarily intended for numerical computations. It provides capabilities for the numerical solution of linear and nonlinear problems, and for performing other numerical experiments. It also provides extensive graphics capabilities for data visualization and manipulation. Octave is normally used through its interactive command line interface, but it can also be used to write non-interactive programs. The Octave language is quite similar to Matlab so that most programs are easily portable.

Octave is distributed under the terms of the GNU General Public License.

GNU/Linux systems

Executable versions of Octave for GNU/Linux systems are provided by the individual distributions. Distributions known to package Octave include: Debian, Fedora, Gentoo, and SuSE. These packages are created by volunteers. The delay between an Octave source release and the availability of a package for a particular GNU/Linux distribution varies. The Octave project has no control over that process. BSD systems

Executable versions of Octave for BSD systems are provided by the individual distributions. Both FreeBSD and OpenBSD have Octave packages. These packages are created by volunteers. The delay between an Octave source release and the availability of a package for a particular GNU/Linux distribution varies. The Octave project has no control over that process.

- **OS X**

  The Wiki has some instructions for installing Octave on OS X systems.

- **Windows**

  Windows binaries with corresponding source code can be downloaded from `ftp.gnu.org/gnu/octave/windows`

- **Sources** The latest released version of Octave is always available from `ftp://ftp.gnu.org/gnu/octave`

  The simplest way to compile this package is:

- 'cd' to the directory containing the package's source code and type './configure' to configure the package for your system.

  Running 'configure' might take a while. While running, it prints some messages telling which features it is checking for.

- Type 'make' to compile the package.

- Optionally, type 'make check' to run any self-tests that come with the package, generally using the just-built uninstalled binaries.

- Type 'make install' to install the programs and any data files and documentation. When installing into a prefix owned by root, it is recommended that the package be configured and built as a regular user, and only the 'make install' phase executed with root privileges.
- Optionally, type 'make installcheck' to repeat any self-tests, but this time using the binaries in their final installed location. This target does not install anything. Running this target as a regular user, particularly if the prior 'make install' required root privileges, verifies that the installation completed correctly.
- You can remove the program binaries and object files from the source code directory by typing 'make clean'. To also remove the files that 'configure' created (so you can compile the package for a different kind of computer), type 'make distclean'. There is also a 'make maintainer-clean' target, but that is intended mainly for the package's developers. If you use it, you may have to get all sorts of other programs in order to regenerate files that came with the distribution.
- Often, you can also type 'make uninstall' to remove the installed files again. In practice, not all packages have tested that uninstallation works correctly, even though it is required by the GNU Coding Standards.
- Some packages, particularly those that use Automake, provide 'make distcheck', which can by used by developers to test that all other targets like 'make install' and 'make uninstall' work correctly. This target is generally not run by end users.

Numerical Method Analysis Tool consists of various methods programmed in Octave. It contains Functions folder.This folder contains test methods in which functions are defined. You can use these to test your problems or you can define your own functions.

After placing NMCE folder at your desired location, you can either copy the function file you want to the respective folder

Inorder to use fsolv function:

- cd to the location where NMCE is located:
- cd NMCE/
- cp Functions/fsolv.m Bisection/

  Or you even addpath and savepath of the Functions folder inorder to let Octave locate them for you.
- cd to the location where NMCE is located:
- cd NMCE/
- Use addpath("Functions/");
- savepath;

Doxygen is a documentation generator, a tool for writing software reference documentation. The documentation is written within code, and is thus relatively easy to keep up to date. Doxygen can cross reference documentation and code, so that the reader of a document can easily refer to the actual code.

Doxygen supports multiple programming languages, especially C++, C, C#, Objective-C, Java, Python, IDL, VHDL, Fortran and PHP.[2] Doxygen is free software, released under the terms of the GNU General Public License.

3.6.1 Features of Doxygen

- Requires very little overhead from the writer of the documentation. Plain text will do, Markdown is support, and for more fancy or structured output HTML tags and/or some of doxygen's special commands can be used.
- Cross platform: Works on Windows and many Unix flavors (including Linux and Mac OS X).
- Comes with a GUI frontend (Doxywizard) to ease editing the options and run doxygen. The GUI is available on Windows, Linux, and Mac OS X.
- Automatically generates class and collaboration diagrams in HTML (as clickable image maps) and LaTeX (as Encapsulated PostScript images).
- Allows grouping of entities in modules and creating a hierarchy of modules.
- Doxygen can generate a layout which you can use and edit to change the layout of each page.
- Can cope with large projects easily.

3.6.2 Installation of Doxygen

Doxygen can be installed using following commands:

```
$ git clone https://github.com/doxygen/doxygen.git
$ cd doxygen
$ ./configure
$ make
```

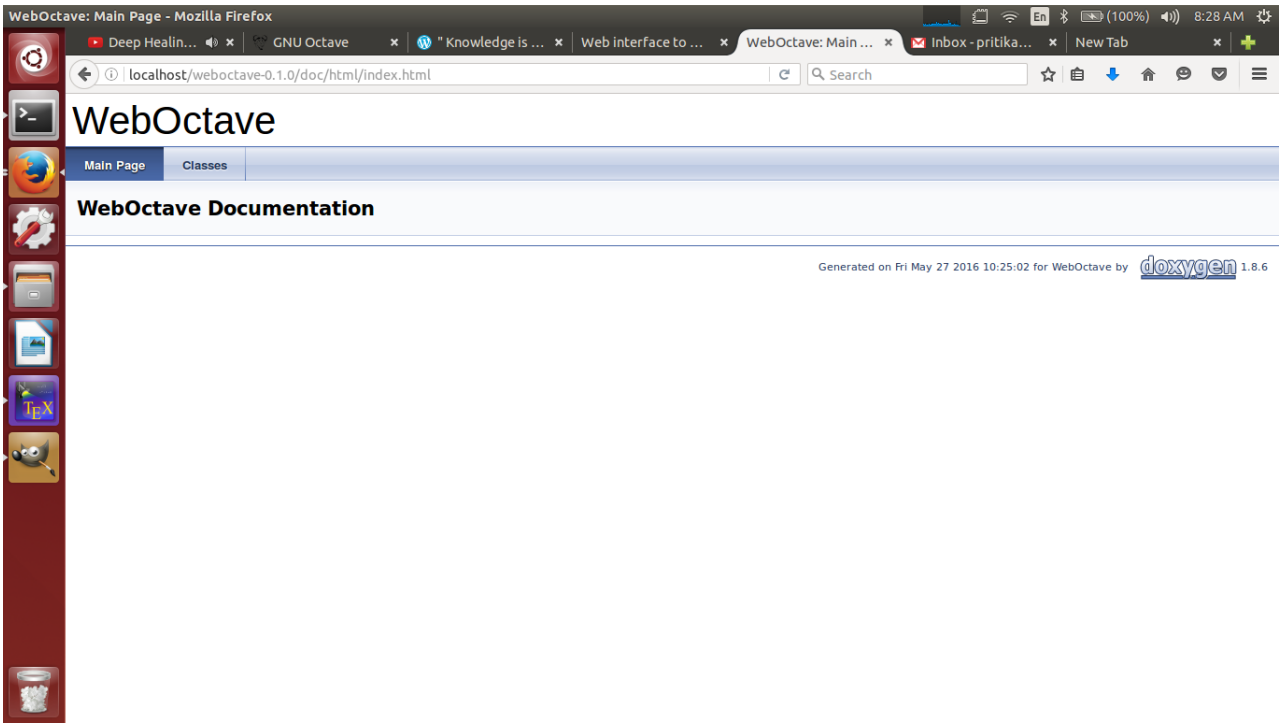

Figure 3.1: Doxygen documentation of WebOctave

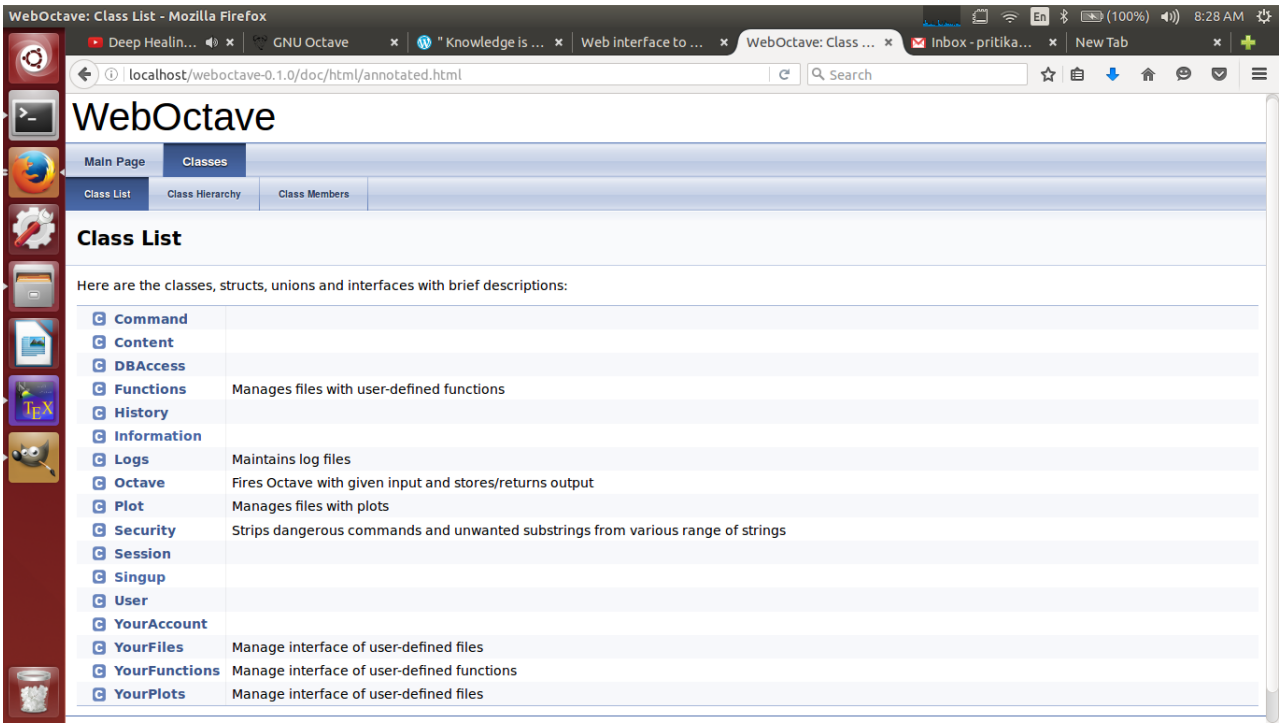

Figure 3.2: Documentation using Doxygen(list of Classes)

Chapter 4

Experimental Results and Comparison

Bisection method consists of two files: main.m and bisection.m. Main file calls bisection method. User has to input initial guess points and Precision values.

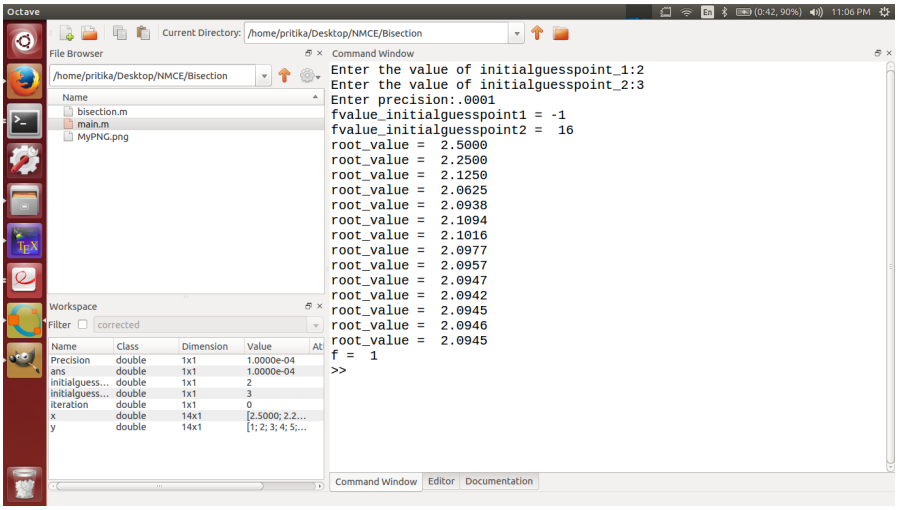

Figure 4.1: Bisection Method

After the user gets the approximate value, he final gets a plot which is saved in the same folder with name MYPNG.png as seen from Figure 4.2

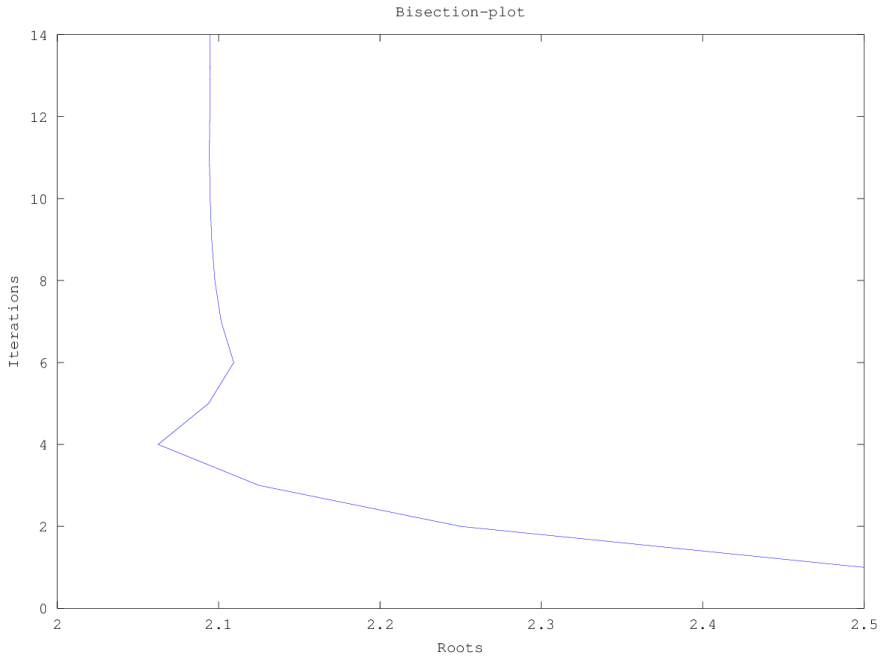

Figure 4.2: Bisection method plot

Similarly in Euler's method, main method calls euler method. User inputs initial values of x and y and step-size and the final value of x at which y is to be calculated.

Th plot can be seen by Figure 4.4
User can find the plot saved in the same folder with name myeuler.png.

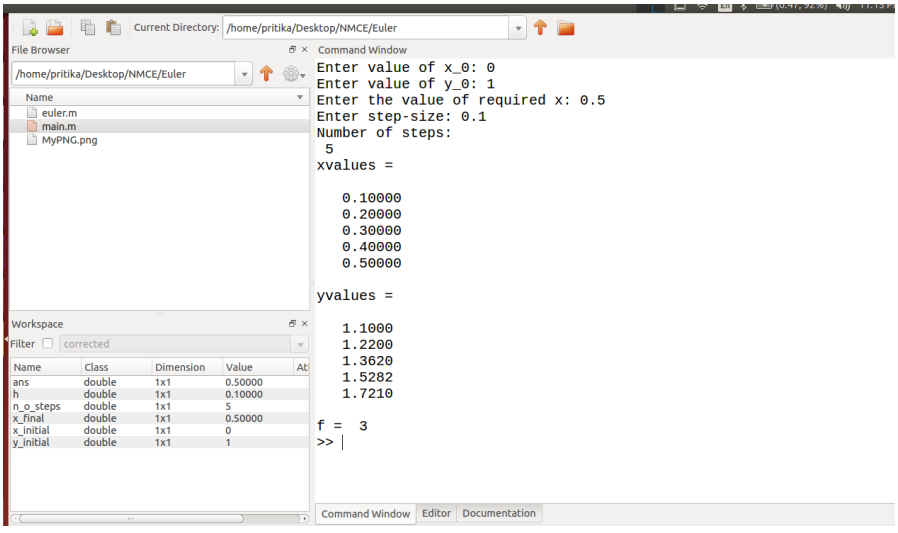

Figure 4.3: Euler's Method

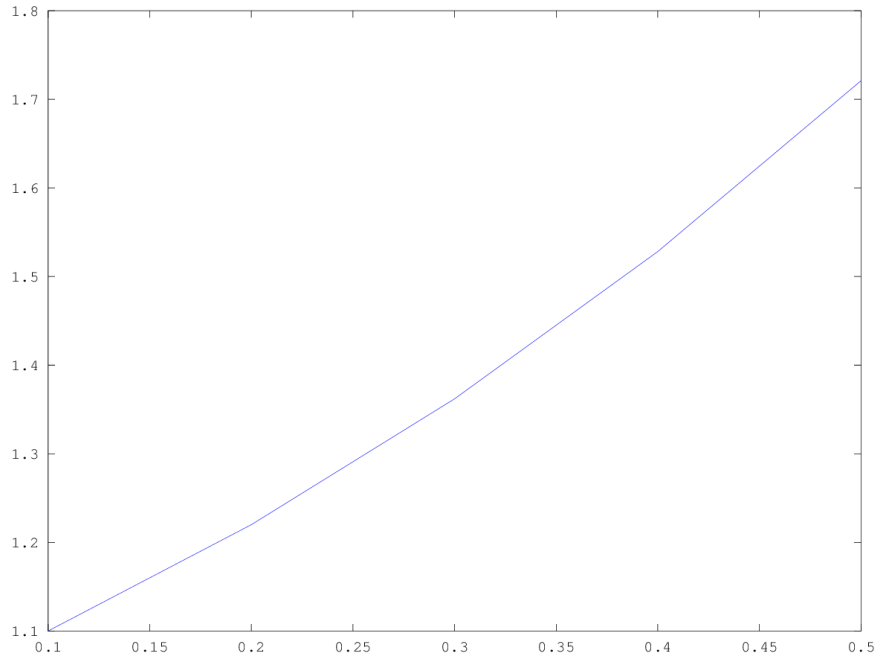

Figure 4.4: Euler's method plot

For methods dealing with matrices like, **Gauss Jordan** the user inputs the augmented matrix in the file and get the results:

Gauss Elimination The result for input matrix:

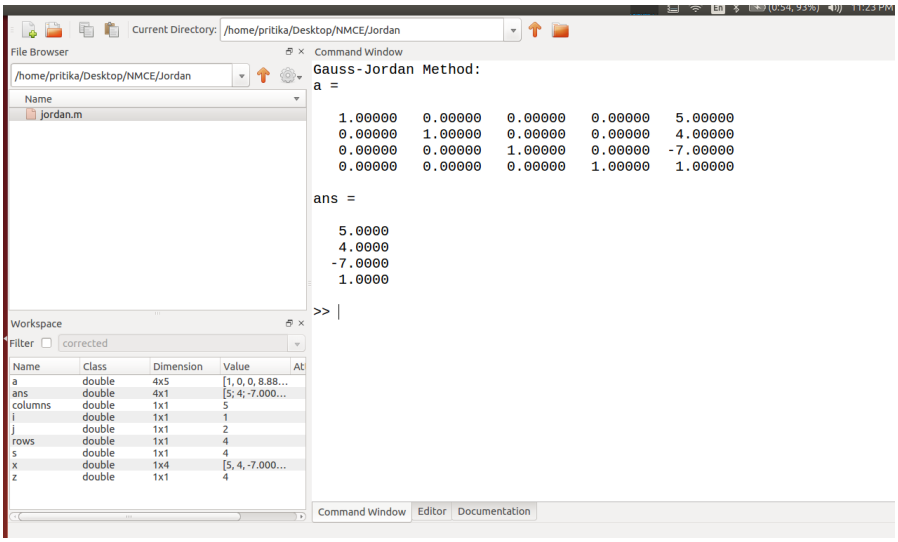

Figure 4.5: Jordan method

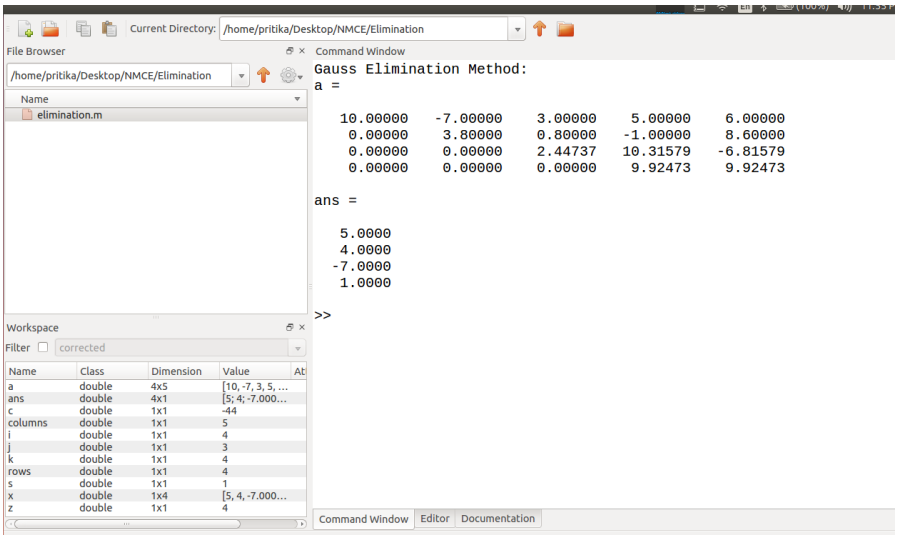

Figure 4.6: Elimination method

Weboctave is a web interface to octave:

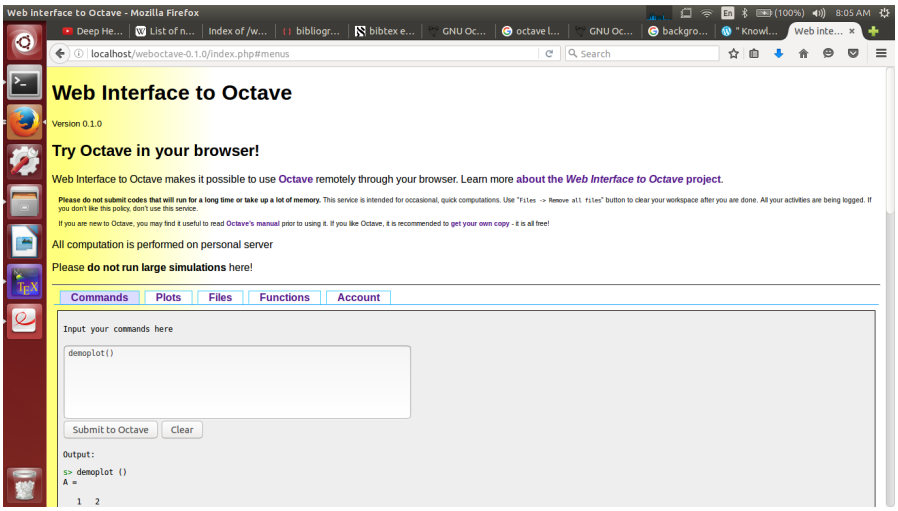

Figure 4.7: Weboctave Interface

The first query with which a user is greeted is:

```
function demoplot()
A = [1,2;3,4]
eig(A)
y = x = linspace(0,10); [X,Y] = meshgrid(x,y);
mesh(X,Y,sin(X).*cos(Y).*X);
endfunction
```

And it's result can be seen by:

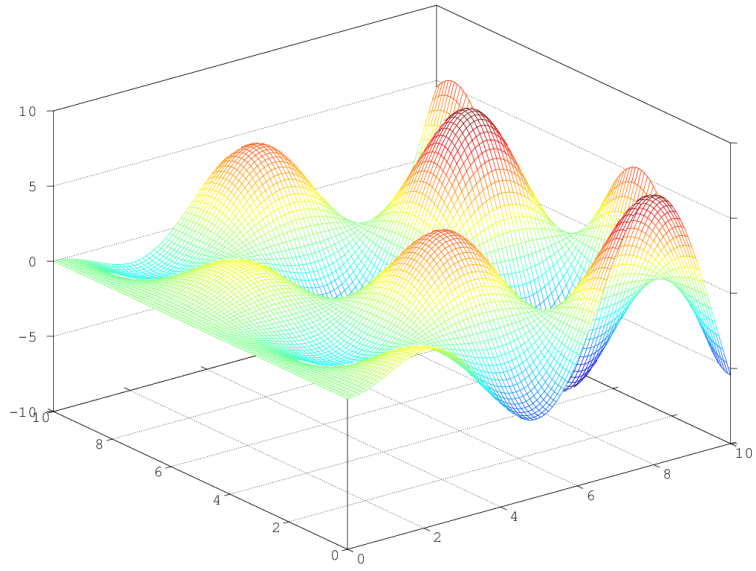

Figure 4.8: Mesh

The plots obtained can be downloaded:

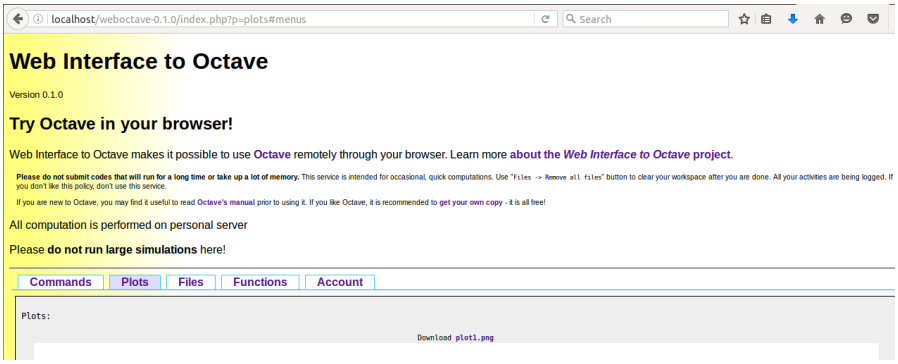

Figure 4.9: Web Interface

User can create his/her account:

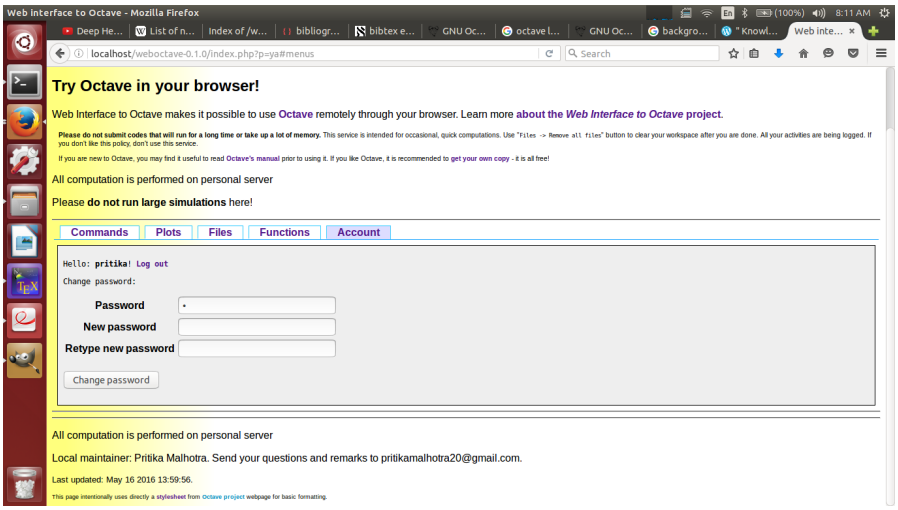

Figure 4.10: User Accounts

Chapter 5

Conclusion,Summary and Future Scope

5.1 Future Scope

Numerical Methods Analysis tool is a learning tool for students. At this point it contains different methods which solve simultanoeus, transcendental and matrix problems. It has ten such programs whereas in future it can be developed into a more requirement fulfilling tool by adding more methods. Octave is open source altenative to MATLAB. It provides for various mathematical and scientific functionalities and is being continuously improved by a wide community which is contributing for its development. Weboctave is web interface to octave. We can add more features like improving the login functionality by using LDAP.

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