IMPLEMENTATION OF BROWSER BASED IDE TO CODE IN THE CLOUD

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ABSTRACT

Cloud computing is one of the latest computing paradigms and many companies are turning towards making it an integral component of their computing strategy. Cloud computing provides a way of taking applications online and all these applications and their associated data can be accessed with just an Internet connection and a web browser. Like many other softwares and applications, an Integrated Development Environment (IDE) can also be hosted on the cloud. This paper conveys the details of the implementation of a cloud based IDE for the Java language. This browser based IDE empowers the users to write, compile and run their Java language code with various devices like smart phones, laptops or desktops that allow Internet access. This IDE is implemented to accommodate sharing of projects and files among users. It also supports the feature of real time collaboration with peers; by which two or more people who have access to the same file can modify it at the same time and ensure that the changes are reflected to the others in real time. This IDE also provides users with the facility to download files so as to keep a copy of them on the user's local machine. This IDE integrates forums and blogs. The users who require instant help related to coding can make use of the integrated forum to post their queries. The users who wish to share their knowledge can post on the integrated technical blog. This IDE provides a lot of features under one single roof that the users can utilize even on-the-go with their mobile devices that have Internet access like laptops or smart phones. This IDE eliminates the need to download any software or desktop IDE because this application is present on the cloud and it also permits people working under various heterogeneous environments to code and collaborate and share knowledge with ease.

KEYWORDS: *Browser Based Ide, Cloud Computing, Integrated Development Environment.*

I. INTRODUCTION

The latest trend is to take desktop applications online and to provide them as a service. Many desktop applications are being hosted on the cloud to be made easily available and accessible. Google Docs editor is one such application on the cloud. Today, people are feeling the increasing need to write software programs on the go. They, at times, may also find that their machines do not have required software for coding. For example, they may want to code a Java program on a device that does not have an IDE or a JDK installed. In such cases, they will have to download hundreds of megabytes of software followed by a lengthy installation process. This can be very inconvenient. The solution to this problem can be an online IDE. (IDE is a program for the software developers that combine the functionality of a text editor, compiler, etc. [1]) An online IDE which can also be called a Browser

based IDE [2] is an online programming environment that is accessible to everyone through a web browser and an Internet connection.

II. RELATED WORK

There are a few browser based IDEs that have support for coding in various languages like C#.net, HTML, CSS, JavaScript, etc. The concept of a browser based IDE to code, compile and run Java language programs is a very recent development. A few existing browser based coding environments are Cloud9 IDE, CodeRun Studio, ideone, Eclipse Orion, eXo Cloud IDE, etc.
Cloud9 IDE supports HTML, CSS, JavaScript, etc [3]. It is mainly for web development. It has support for real time collaboration. Code Run Studio[4] supports ASP.net, C#.net, Silverlight as well as the languages supported by Cloud9 IDE. It allows sharing of code through hyperlinks.
Eclipse Orion [5] is mainly for web development and it supports HTML and JavaScript. All these above IDEs do not have support for Java language. Ideone [6] is not an IDE. It is like a pastebin that supports compilation and debugging of code in many languages including Java but it does not permit the creation of projects. eXo Cloud IDE is the only cloud-based IDE that supports programming in Java language [7]. But it does not support real time collaboration.

III. PROPOSED SYSTEM

This paper explains the implementation details of the browser based IDE which is present on the cloud as shown in Fig 1.

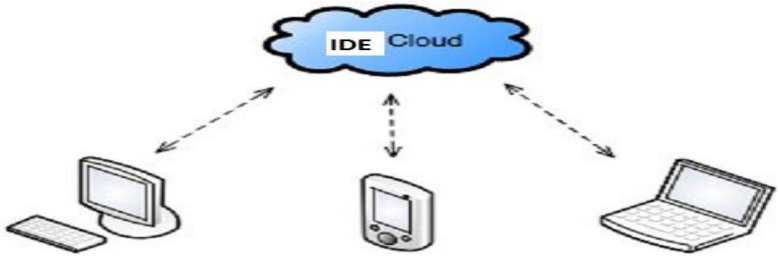


Fig 1. IDE present on the cloud accessible from various devices that provide internet access

This IDE is accessible from various devices like desktops, laptops and smart phones that have an Internet connection and a web browser. Internet connection and a web browser are the only requirements to access this IDE present on the cloud. This, thus, removes the need to download and install software. Also, as the application is present on the cloud, most of the operating system issues or hardware compatibility issues are eliminated [8].
This IDE allows users to collaborate to write Java language programs and compile and run them. Now a days, organizations conduct global projects in which various employees from across the world participate. They find the need for improved collaboration techniques. Collaboration can be made easy with applications hosted on the cloud. The IDE implemented provides real time collaboration by which multiple users with appropriate access rights for the files can access and modify the same files at the same time and their changes will be reflected to all others in real time. This IDE also provides a way to share projects with other peers by giving appropriate access rights.
The IDE also gives users the facility to take a backup of all the projects that they have created by downloading the project files on the user's local machines. The users can also download the files in the format of their choice. For example, some users who have created Java language files may want those files to be saved as a text file. They can do so by specifying the .txt extension or any other extension of their choice. Also, many times, the users developing applications encounter errors and exceptions in their programs. The browser based IDE provides, apart from easy sharing and collaboration, a method to get immediate help. The IDE integrates an online forum. All the users who have registered with the cloud based IDE will have access to this forum. They can ask queries or hold discussions in order to get their problems solved. The IDE also provides an integrated technical blog facility for all the users who wish to share their knowledge on various technical topics.

This paper describes how the cloud based IDE with additional features like easy sharing and collaboration, integrated forums and blogs was implemented to program, compile and run programs in the Java language. Rest of the paper is organized as follows. Section IV describes the advantages of the Browser Based IDE, section V describes the architecture , section VI describes the implementation details and section VII describes the experimental results.

IV. ADVANTAGES OF THE BROWSER BASED IDE

1. Virtually limitless computing power
The browser based IDE is present on the cloud. This means that the IDE has all the advantages of cloud hosting like virtually limitless computing power, scalability, risk protection etc [9]. Also, there is no large initial investment.
2. Easy collaboration with peers
It also provides for easy pair programming and sharing. It provides the feature of real time collaboration by which different users working on the same project or module can share it and modify it simultaneously. The changes made by one are visible to the others in real time. This enables easy collaboration.
3. Downloading and Saving of files
The developers can also download their files and save them on their own machines in the format of their choice. E.g.: Certain developers who are using a smart phone may want to save a java file as a .txt file.
4. Integrated Forums
The developers can also hold discussions, ask queries or answer them with the help of integrated forums. This will aid the developers who require any technical help.
5. Knowledge sharing with Blogs
The developers can share their knowledge by using the integrated blog facility. This will be of great use to them to share new ideas, knowledge or know-how.
6. Accessibility via variety of devices
The IDE is accessible from anywhere with devices like smart phones or laptops that have an Internet connection.
7. Increased Portability
This IDE also eliminates the operating system issues that may arise while downloading and installing different software because there is no need to perform any download and install operation to use this IDE. The IDE needs only a browser and an Internet connection.

V. SYSTEM ARCHITECTURE

The browser based IDE has four important modules [10] that themselves have many sub-modules as shown in Fig 2.

5.1 Registration and Login module

The first one is registration and login module. This module makes use of the table called ‘Users’. The users who want to access the cloud IDE have to first register themselves. Their details are stored in the ‘Users’ tables. The details from this table are used again, to authenticate the user at the time of login.

5.2 Editor module

There are many sub-modules in the second module.

5.2.1 Create , open, save and delete modules

The create module permits the users to create new files. The details of the file are stored in the 'Documents' table and the access details of the file for the user are stored in 'Access Rights' table. The owner has by default 'all access' access rights.
The user's who have already created files before or have shared access to the files created by someone else, can open those files. The permissions for the user are checked from the 'Access Rights' table.
The next module is the save module. The saving process is an automatic process in the IDE. The user does not have to explicitly hit the save button. The saving of the files is done automatically at regular intervals of time or when the users make changes in the file and an event is generated.
The users who have appropriate permissions can delete the files. When they do so, the entire file details are removed from the 'Documents' table. The users are also given a special type of delete option called as 'remove from the list'. When the user hits this option, the access rights for that user for that particular file is removed from the 'Access Rights' table but the file details and other user's access rights details are retained in the tables.

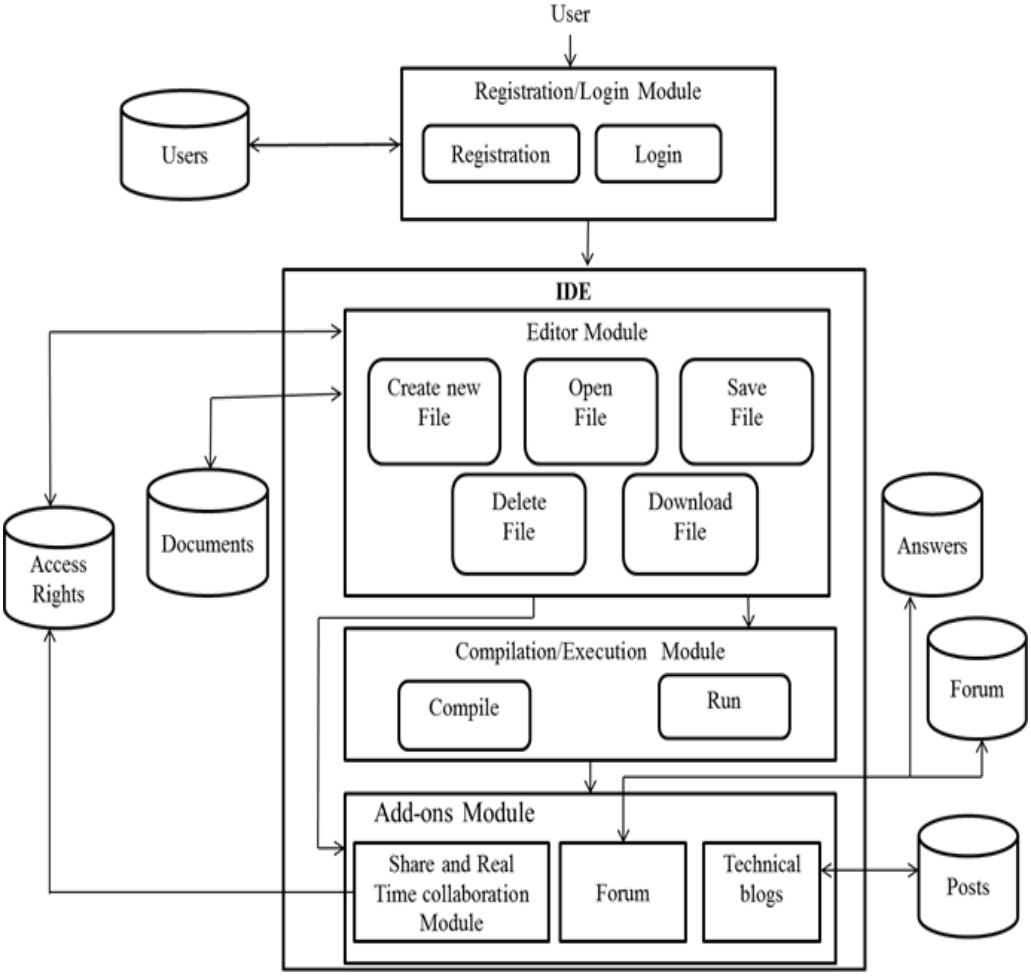


Fig 2 Block diagram of Browser Based IDE to Code in the Cloud

5.2.2 Download module

The users who have 'all access' access rights, are allowed to download the files onto their local machines for either backup or other purposes. The users will have to provide the extension with which they want the files to be stored on their machines. The new file with the extension of user's choice will be created on the user's machine and all the contents of the original file will be copied into the new local machine file.

5.3 Compilation and Execution module

The most important use of the IDE is to compile and run the Java programs. This is the next module. The users who create Java language programs can execute the programs by hitting the compile and run button. On doing so, the compiler will check for compilation errors. If there are errors, they will be reflected to the user in a text area. If there are no errors, the .class file will be created and the output of execution will be displayed to the user.

5.4 Add-ons module

This module contains all the additional features of the IDE.

5.4.1 Sharing and Real time collaboration

This module allows users to share their projects and files with others. The details of the users with whom they want to share a particular file is stored in the 'Access Rights' table. Either 'read only' or 'all access' access rights can be provided. After the files are shared between multiple users, 0all can access the same file and make changes into them at the same time. The changes made by one are immediately reflected to all others.

5.4.2 Integrated Forums

The IDE also integrates forums. The details of the queries that the users ask are stored in the 'Forums' table and the responses from other users are stored in the 'Answers table'.

5.4.3 Technical Blogs

The last module in the figure is integrated blogs. The users can post technical blogs and the details are stored in 'Posts' table. These blogs are accessible to all the users who have registered with the cloud IDE.

VI. IMPLEMENTATION DETAILS

The browser based IDE is a cloud application that is provided as a service. This IDE is mainly built to allow developers to code, compile and run Java language programs. The IDE has been implemented using CakePhp framework [11]. XAMPP Server 1.0, Apache Tomcat Server 6, My SQL Database and an Internet Explorer 6 web browser were used during the implementation of the IDE. Also, an Internet connection is needed.
The implementation details of all the modules, options and the features of the IDE are as below:

6.1 Registration and Login

The users can register themselves by providing the details like username, password, etc as shown in Fig 5. The password is hashed using the SHA1 algorithm which is a US Secure Hash Algorithm. These details are stored in the database tables and are used for authentication of the user at the time of login. After successful login users home page is displayed
In this page, the list of all the files that the user has access to are displayed. This list contains the files that the user has created and also those files which are shared by someone else with that user. The user can click on any file name from the list to open and view its contents and also make changes to the file.

6.2 Create, Open and Save Files

The users can create new files by clicking on the appropriate button. The user is asked to provide the name of the file at the time of creation as shown in Fig 7. The details of the new file including blank

content are stored in the database tables. After the successful creation of the file, it will be opened. Also, when a new file is created, the user who creates it is given 'all access' access rights for that file.
The users have access to the files that are listed in the user home page as it was shown in Fig 6. The names of the files are actually links to a new page where the file contents will be displayed and can be edited if the user has appropriate access right as shown in Fig 8. So, the user has to click on the name of the file in order to open it.
The files which the users have opened and are editing are saved through automatic process. The original file contents are displayed to the user in a text area when he opens the file as shown in Fig 8. The user can then modify the contents of the text area. The new contents of the text area are then sent by the client to the server at set intervals of time (500ms). The server then stores the new contents and this way, the files are saved automatically.

6.3 Compilation and Execution

The main functionality provided by the browser based IDE is the compilation and execution of Java language programs written by the users of the IDE. When the users press the compile and run button, the contents of the text area i.e. the program and the class name are retrieved. Then, it is checked whether there already exists a file with that particular name. If no such file exists, a new file is created on the cloud. The user is not given any information regarding the location of the file, etc. The new file is given a .java extension and it is given the same name as the class name retrieved. Then, this file is opened in both read write mode and it is filled with the contents that were initially retrieved.
If the file already exists on the cloud, then no new file is created. The existing file is opened in the read write mode. The contents retrieved are then over-written into the file.
Every time the user clicks on compile and run option, the .java file created on the cloud is written into. This is done so that the changes that the user makes to the file before compiling it are used and the latest copy of the file is compiled. After the .java file is created, the actual compilation takes place by the javac command is used. If errors are present, they are displayed to the user as shown in Fig 9.
If there is no error, then a new .class file with the same name is created if it doesn't already exist. If a .class file with the name same as the class name retrieved before already exists, then that .class file is first opened in the read write mode and all its contents are erased. Then, compilation takes place and this file is loaded with new byte code contents.
Now, after the .class file is generated, this class file is run using the java command. The output is obtained and displayed to the user on his screen as shown in Fig 10 and Fig 11.

6.4 Sharing Projects

This IDE facilitates the users to share their files and projects with others. To share a project with other user, the email id of that user has to be specified and the project that is to be shared needs to be mentioned as shown in Fig 13.
When this is done, the other user will be given access to the project. During sharing of the projects with others, the person who shares the file, should specify the access rights to be given to the other user. If the user is given a 'read only' access, then he cannot make changes to the contents of the files of that project. Also, if that user wishes to share the project with someone else, he will only be allowed to give the other new user a 'read only' access only. But, if the creator of the project shares it with some other user providing him an 'all access' access right for that project, then that user can share the project with others providing them either 'read only' or 'all access' access rights.

6.5 Real Time Collaboration

Real time collaboration is one of the most important features of this IDE. This feature was implemented to provide various users with the ability to modify the same file at the same time and also view the changes made by others in real time. This feature is implemented by automatic saving of files and retrieval of their contents at regular intervals.
When a user opens the file that he has access to, the contents of that file are retrieved from the database tables and are displayed to the user. If some other user who has access to the same file opens it, the contents of the file are displayed to him as well. So, multiple users who open same file at the same time will have their own copies of the actual contents of the file.

Now, when any user makes changes to the file the modified content is retrieved from the text area. This is then stored into the database table again. The server then reflects the modified content to all the users in their text areas. This entire process uses AJAX technology in order to refresh just the part of the entire page with the modified contents. This entire process is initiated by the client and the client pulls the new contents of the files.

6.6 Deleting and Removing the Projects from the List

There are two versions of delete options that are provided to the users. One is actual delete option and the other is called remove from list. The users who have 'all access' to certain projects can delete those projects completely.
When those users press the delete button, the project details are removed from the table and also the details of access rights of different users for that project are also removed from the tables. The delete option is provided only to those users who have all the access rights for that particular project.
The other variant called remove from the list is an option that is given to all the users who have access to a particular project irrespective of whether the access right granted to them is 'read only' or 'all access'. When the user clicks this option, the access right of the user for that project is deleted. So, the project name will not appear in the list of projects that the user can see. But, the actual project and other user's access rights are retained in the database tables.
This means that the other users will still have access to the project. Also, if the user who removed the project from his list wants to get access to the project again, then some other user who currently has access to that project will have to share it with him again. Also, if the user who removes the project from his list was the only user with access to that project, then a warning is displayed to the user and then, the access rights of that user for the project and also the project are removed from the tables.

6.7 Downloading Files

The users who have 'all access' to a particular file can only download that file. The one's with 'read only' access are not permitted to download the files. The users have to select the file they want to download. They can also specify the format in which they want the file to be downloaded.
For example, the users may want the file to be downloaded with a .txt extension. The users should then specify that extension. If no extension is provided, by default, the files will be stored on the local machines with the .java extension.
After the user selects the file and specifies the extension, the name of the file on the cloud and the contents of the file are retrieved. Then, a new file is created in the user's local machine at the location he specified to save the downloaded file. The file is given the name and the extension that was retrieved initially. The retrieved contents of the file are written into the new file on the local machine. After this process completes, the user can view the file on his machine. This downloading process is shown in Fig 14.

6.8 Integrated Forums

This IDE integrates forums for all the users who are faced with various problems during implementation of their programs or those who have queries related to various technical topics. The forums can be accessed by all the users of the IDE after logging into it as shown in Fig 15.
Any user is allowed to ask questions or answer them. Only the user who puts forth the question can delete or modify it. Similarly, when users post answers corresponding to particular question, only the users who are the owner of the answers can delete or modify them as shown in Fig 16.

6.9 Integrated Blogs

Another feature that the IDE provides is that of integrated technical blogs. All users after login, can also avail this integrated blogs facility. They can use this to write about various new technologies, how to best approach a type of problem, algorithms, etc. All the users will be able to view the posts

from every other user but only the creator of the post is given the rights to modify or delete it as shown in Fig 18.

VII. EXPERIMENTAL RESULTS

As the IDE is provided as a service, the users need to have Internet connection to access it. The users have to type the correct URL and the home page will be displayed to the users as shown in Fig 3.

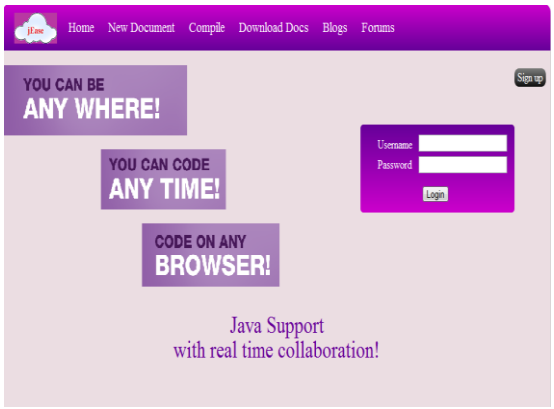


Fig 3. Home Page

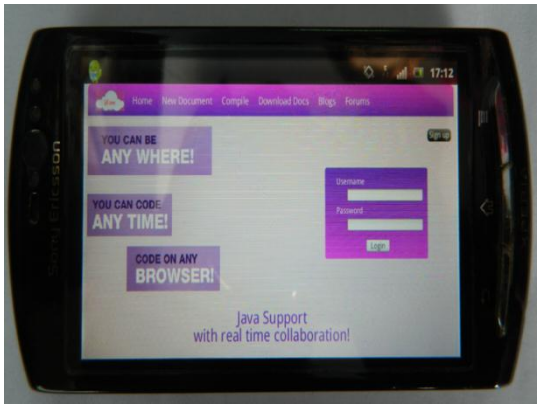


Fig 4. Home Page accessible through a mobile phone

This IDE is accessible from all devices that have Internet access such as smart phones, laptops, desktops, etc. The Fig 4 shows that this Browser Based IDE can be accessed from a mobile phone with Internet connection.

7.1 Registration and Login

The users can register themselves by providing the details like username, password, etc as shown in Fig 5.

7.2 Users Home Page

After successful login, the user will be redirected to a page called the 'user home page' shown in Fig 6.

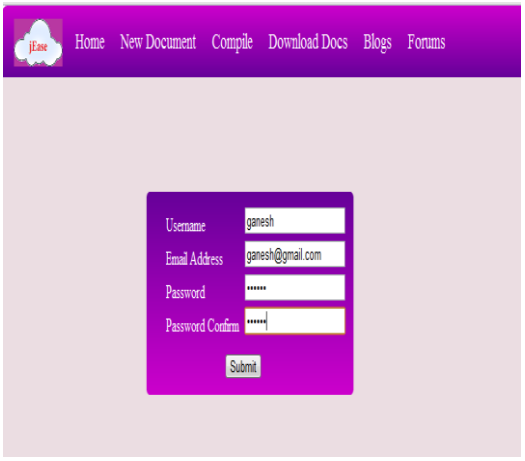


Fig 5 New User Registration Page

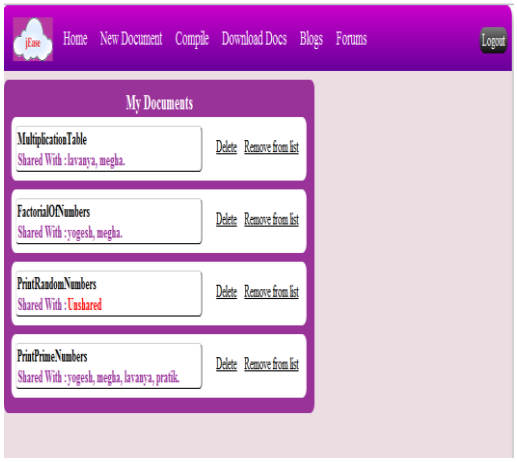


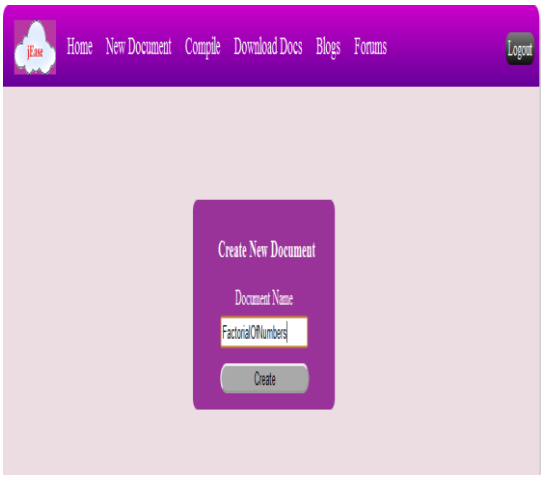
Fig 6 User Home Page (After Login)

7.3 Creation of New Files

The users can create new files by clicking on the appropriate button. The user is asked to provide the name of the file at the time of creation as shown in Fig 7.

7.4 Opening Existing Files

The names of the files are actually links to a new page where the file contents will be displayed and the user has to click on the name of the file in order to open it as displayed in Fig 8



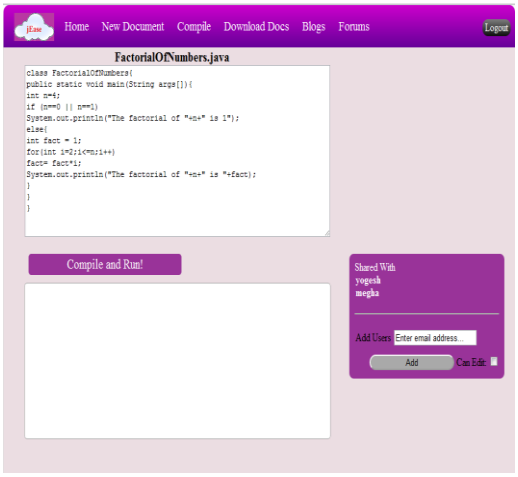


Fig 7 Create New Projects Page

Fig 8 Page upon opening of a file

7.5 Compilation and Execution

When the user hits the Compile and Run button, the source file is compiled using the Java compiler. If errors are present, they are displayed to the user as shown in Fig 9.

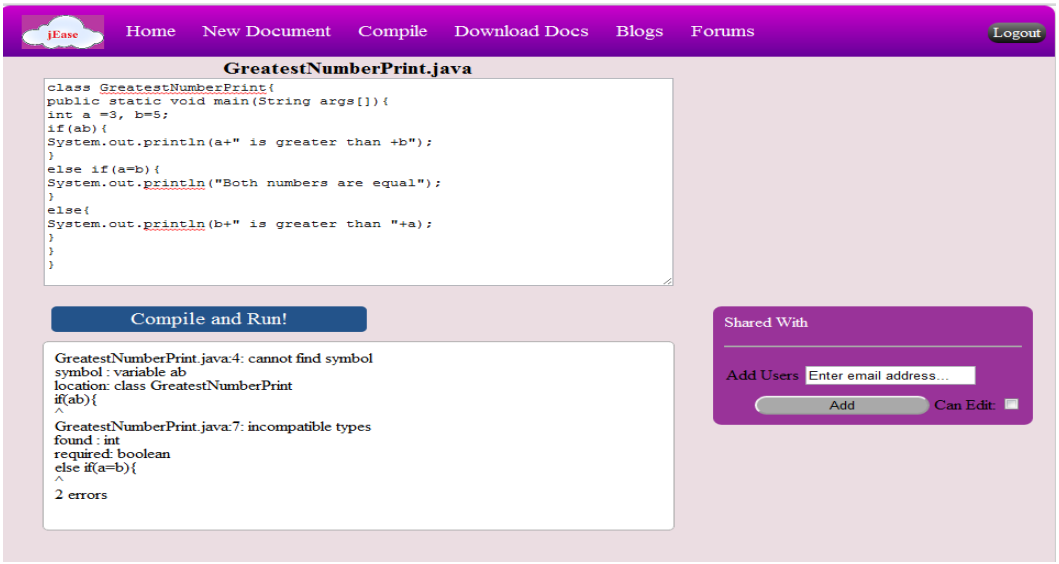


Fig 9 Compilation error displayed to the users

If there is no error, then the .class file is generated, this class file is run using the java command. The output is obtained and displayed to the user on his screen [12] as shown in Fig 10 and Fig 11.

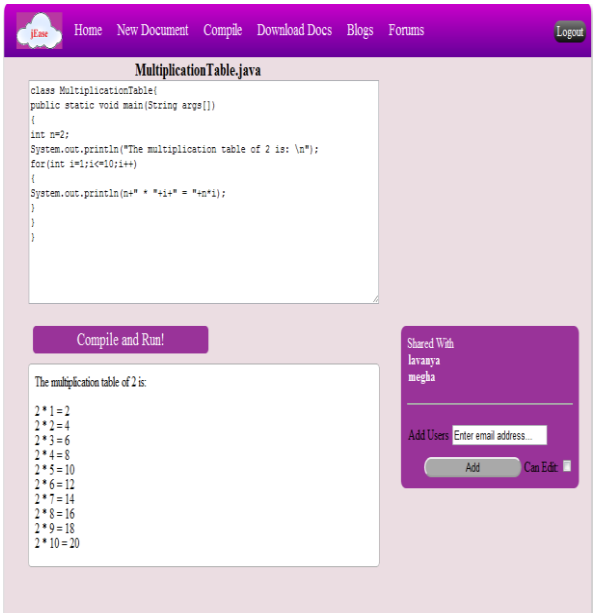


Fig 10. Compilation and execution output

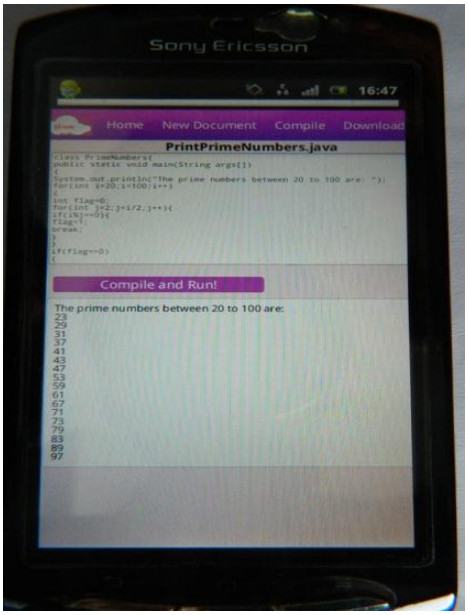


Fig 11. Compilation and execution of results through a mobile phone

7.6 Real Time Collaboration

Real time collaboration provides various users with the ability to modify the same file at the same time and also view the changes made by others in real time.

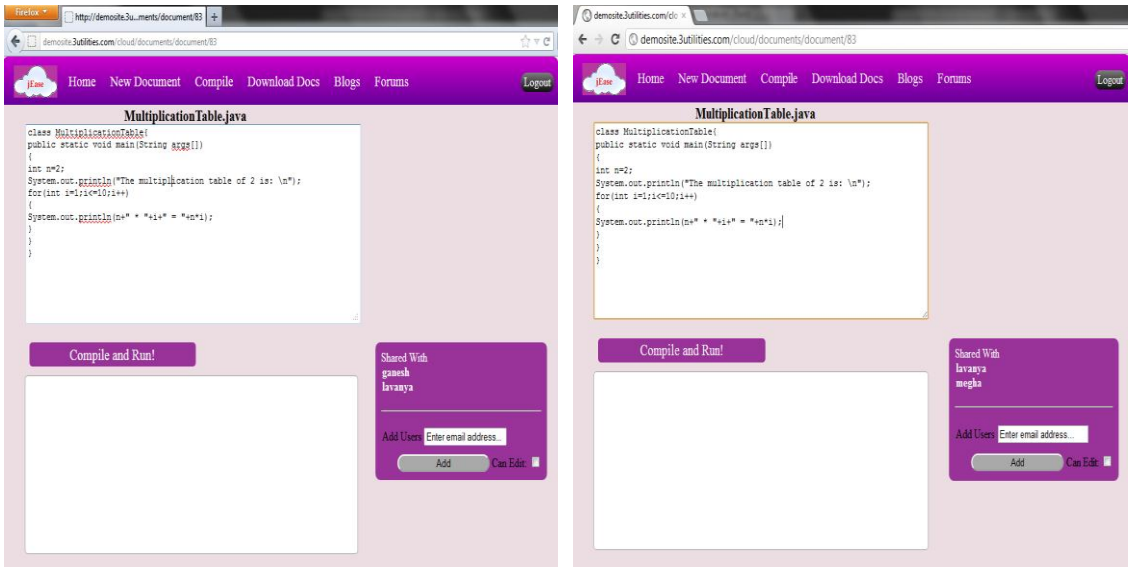


Fig 12 Real Time Collaboration by different users using different browsers (Mozilla Firefox and Google Chrome)

7.7 Sharing Projects and Downloading Files

This IDE facilitates the users to share their files and projects with others. To share a project with other user, the email id of that user has to be specified and the project that is to be shared needs to be mentioned as shown in Fig 13. The users who have 'all access' to a particular file can only download that file as shown in Fig 14.

Fig 13 Share File option

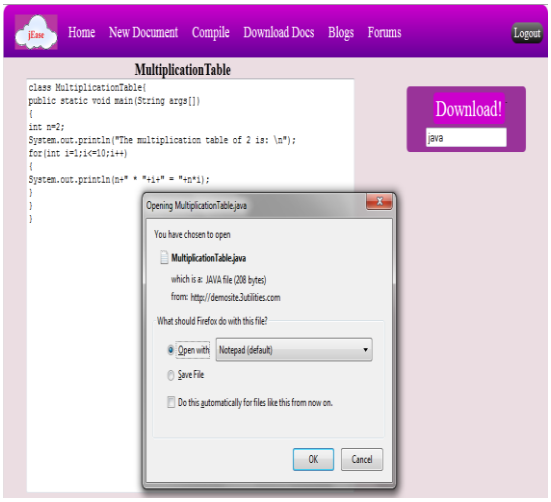


Fig 14 Download option for the users by specifying the extension

7.8 Integrated Forums and Blogs

The forums can be accessed by all the users of the IDE after logging into it as shown in Fig 15. Any user is allowed to ask questions or answer them as shown in Fig. 16.

Fig 15 Forums Home Page

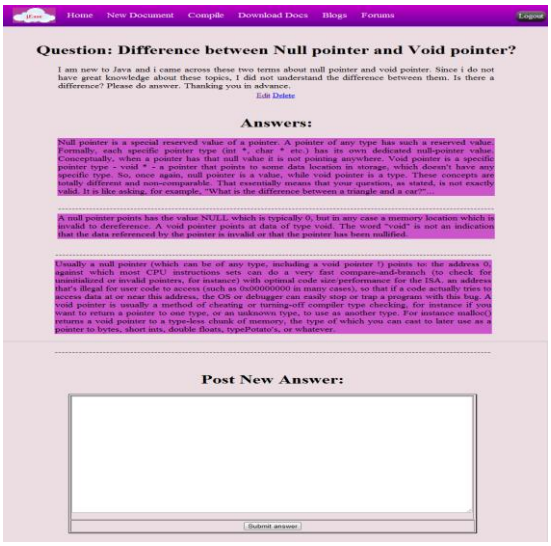


Fig 16 View the questions and answers in detail and also post new answers to that question.

Another feature that the IDE provides is that of integrated technical blogs as shown in Figs. 17 and 18. All users after login, can also avail this integrated blogs facility.

Fig 17 Blog Post titles Page

Fig 18 Opening blog post to view, edit or delete it.

VIII. CONCLUSION

This paper describes the implementation of browser based IDE to code in the cloud. The IDE is a software provided as a service and is mainly to write, compile and run Java language programs. The IDE also has integrated forum and blog facility and additional features of sharing, download and real time collaboration. This IDE eliminates the need to have software like JDK installed on the device that developers use for writing their Java programs. Also, it can be accessed from anywhere, anytime and with various devices like desktops, laptops and smart phones that have a web browser and an Internet connection.

IX. FUTURE SCOPE

The Browser Based IDE currently supports programming in Java language with additional feature of real time collaboration integrated forums and blogs. This IDE can be extended to support many more languages and features in the future like Support for advanced Java like J2EE ,Support for other programming languages like PHP, C#, etc ,Syntax Highlighting, Automatic code completion ,Code to UML diagram converter to understand legacy code and UML diagrams to code converter.

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