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Short Article

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Exploring the Integration of Machine Learning Models in Programming Languages on GitHub: Impact on Compatibility to Address Them

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Abstract
GitHub repositories are often used for collaborative development, allowing multiple developers to work on the same codebase and contribute their changes. Each repository is typically associated with a specific project, and it can contain everything from code files to documentation, bug reports, and feature requests. Depending on the context, it can contain files, directories, other resources related to a project, and it is often associated with a particular programming language. By default, GitHub automatically detects the primary programming language used in a repository based on the file extensions and content within the repository. However, this detection is not true all the time; there are some potential issues to consider. One of these problems is that the detected language may not accurately reflect the actual programming languages used in the project, especially if the project utilizes multiple programming languages or has undergone language migrations. In this study, we apply an alternative technology to resolve problems with classifying the programming language of a GitHub repository by analysing file extensions and identifying all programming languages used in the project. We also determine the appropriate primary programming language for the repository. This paper investigates how this technology can address the issues surrounding GitHub's automatic detection of a repository's primary programming language and how it can provide information on all the programming languages used in a project.

Keywords: GitHub Projects (GP), File Extension (FE), Programming Language (PL), Machine Learning (ML)

1. Introduction

Accounting is a complex subject that involves managing the finances of a business or organization. Information technologies have greatly transformed the way businesses manage their accounting by allowing for automation of many tasks. GitHub projects related to accounting often utilize programming languages to automate accounting tasks such as data entry, billing, and expense management. These projects may also use visualization tools to present data in a clear and concise manner. GitHub projects related to accounting can help businesses improve their efficiency and make more informed financial decisions.

In addition, compatibility issues on GitHub can occur when code written in one programming language or framework is incompatible with another language or framework. These issues can arise when different versions of a programming language or library are used, or when code written for one operating system is run on a different operating system. To resolve compatibility issues, developers may need to update their code to use compatible versions of programming languages or libraries, or they may need to make changes to the code to ensure that it works correctly on different operating systems. Additionally, checking the issues page of the repository in question, searching for similar issues in other repositories, and consulting the documentation for the language or library in question can also help to resolve compatibility issues.

There are numerous types of programming language difficulties on GitHub. Others may be due to conflicts with other libraries or frameworks, while some may be the result of grammatical errors or programming issues. Users might also experience performance problems or compatibility issues when a project's code is incompatible with specific platforms or operating systems or problems with the version of their programming language. Finding suitable solutions to these issues is crucial. Some options include looking for answers on developer forums or enlisting the assistance of more seasoned developers.

In this work, a file extension approach (EF) for defining GitHub project domains in programming languages was presented. The file extensions of every project folder will be sorted, and percentages for each extension will be computed. The project in question will then be removed with the PL flag set to null, and its dominant language will be determined by the language with the highest proportion (does not contain any part of the software). This study also led us to search for a connection between the EF approach and Compatibility Issues (CI), which arise when a project's code is incompatible with particular platforms or operating systems. Using this technique, we recovered over 200 deposits from GitHub. Before starting, the dataset content needs to be organized.

Important companies like Azure, Google, AWS, and Microsoft use GitHub as the finest storage solution for open-source projects. Every day, a large number of projects are registered on GitHub with the ultimate goal of making them feasible for further usage and easing project cloning. The complexity of the programming languages employed on this open-source platform can be seen and explored on GitHub. Several million programming languages, including Python, Java, C++, etc., are included in the latter. In essence, the original concept of GitHub is to classify existing projects according to their programming languages (PL). For DevOps engineers, this approach can make it simple to recycle source code, clone projects, detect, and install apps. On the software development site GitHub, users can use Git to store, share, and collaborate on software projects. The source code of a project can be changed, and users of the Git version control system can track those changes.

GitHub supports a wide range of programming languages, including C, C++, Python, Java, JavaScript, PHP, Ruby, C, Swift, Go, Shell, TypeScript, and many more. Users can establish repositories to store their code in addition to using collaborative tools to work on team projects. Developers can use GitHub to host open-source projects, as well as to look for worthwhile projects to join. A web-based platform for hosting and working on software projects is called GitHub. Users can collaborate on projects, log changes to their code, and share their work with others. The ability to manage versions, support for teamwork and communication, and a massive user base are just a few of GitHub's important features.

GitHub enables businesses to utilize them all in one location. Researchers now have the chance to explore a wide range of software engineering issues on a big dataset thanks to the accessible tools and datasets existing on the GitHub ecosystem. Although GitHub indicates the language of each project, after compiling the results, we see that it is standard practice to employ many programming languages in closely related open-source projects (OSP). I began to wonder how GitHub determines the language to use for each project as a result of this.

Depending on the kind of project and the interests of the engineers working on it, many programming languages may be employed on GitHub. On GitHub, languages including JavaScript, Python, Java, and C++ are frequently used. To identify projects created in a particular programming language, users can search for repositories on GitHub by language. GitHub offers users tools to manage their projects and work with others in addition to hosting code. This covers tools for team collaboration, project management, and issue tracking.

GitHub ranking is generated by Linguist, a library used on the site to detect languages used in public and private repositories, excluding forks. However, it should be noted that the ranking is relative in that if a language does not exist on GitHub, it will never be part of the ranking, regardless of its popularity outside the collaboration site. At a high level, GitHub is a website and cloud service that helps developers store and manage their code, as well as track and monitor changes to it. To understand exactly what GitHub is, you need to know two related principles:

- Version Control
- Git

Version control helps developers track and manage changes to the code in a software project. As a software project grows, version control becomes essential. Take WordPress...

At this point, WordPress is a fairly large project. If a core developer wanted to work on a specific part of the WordPress codebase, it would not be safe or efficient to have them modify the "official" source code directly. Instead, version control allows developers to work safely through branches and merges. With branching, a developer duplicates a portion of the source code (called the repository). The developer can then safely make changes to that part of the code without affecting the rest of the project. Then, once the developer has successfully made his or her portion of the code work, he or she can merge that code with the main source code to make it official. All these changes are then tracked and can be undone if necessary. Git is a specific open-source version control system created by Linus Torvalds in 2005. Specifically, Git is a distributed version control system, which means that the entire code base and history are available on each developer's computer, allowing for easy branching and merging.

GitHub's collaborative design also includes social networking features such as wikis, feeds, and followers. Companies and individuals host their codes on the platform for open-source and closed projects. In addition to being cloud storage for code, users can also browse and download public repositories and make contributions such as feature requests and code reviews. The service also offers a self-managed version of its services and features for businesses and organizations called GitHub Enterprise. You can install it on company hardware or on a cloud service.

As shown in Figure 1, GitHub integrates well with third-party applications and custom tools to create your projects and automate your workflow. It also has an integration of workflow tools. GitHub applications, which have granular APIs and built-in webhooks, give developers more control over what they build. They are accessible from a dedicated market, where you can search for everything your project needs in multiple categories. Even more interesting, the codes of all these tools that make it possible to quickly create an application are on GitHub, available to all. However, developers find multiple difficulties in installing a GitHub project application for multiple reasons (Show Figure 2).

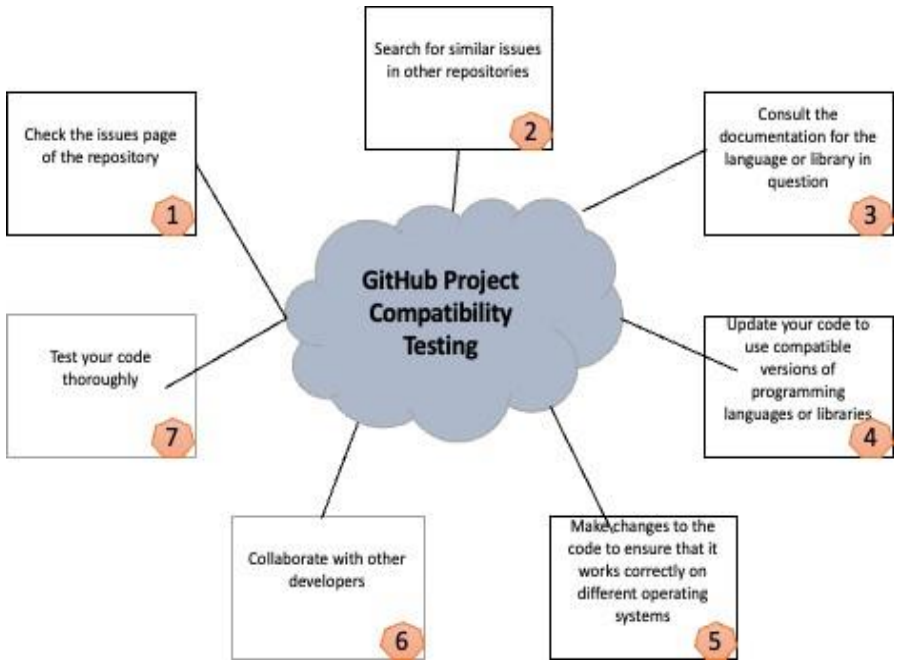

Search for similar issues in other repositories
2
Check the issues page of the repository
1
Consult the documentation for the language or library in question
3
GitHub Project Compatibility Testing
Test your code thoroughly
7
Update your code to use compatible versions of programming languages or libraries
4
Collaborate with other developers
6
Make changes to the code to ensure that it works correctly on different operating systems
5

Figure 1: GitHub Projects Compatibility Test Scope and Focus

1. Check the issues page of the repository: Look for similar issues that have been reported and resolved by other users.
2. Search for similar issues in other repositories: This can help you understand how other developers have resolved compatibility issues in the past.
3. Consult the documentation for the language or library in question: The documentation may contain information about known compatibility issues and how to resolve them.
4. Update your code to use compatible versions of programming languages or libraries: This is often the easiest and most effective way to resolve compatibility issues.
5. Make changes to the code to ensure that it works correctly on different operating systems: This may involve using conditional statements or other techniques to ensure that the code runs correctly on different platforms.
6. Use a virtual machine or containerization technology: This can help to isolate the environment in which your code runs, making it less likely that compatibility issues will arise.
7. Collaborate with other developers: Reach out to other developers who have experience with the language or library in question and ask for their help in resolving compatibility issues.
8. Test your code thoroughly: Before you release your code, make sure to test it on different operating systems, browsers, and devices to ensure that it is compatible.

In this test, the software or application developed is examined to see if it and the projects are compatible with one another and with earlier iterations of the project. It is possible to manually test the compatibility of projects on GitHub or to use automated tools, as was already mentioned. This operation's process consists of four steps. Assure yourself that the testing environments and platforms have already been identified before moving forward with the process.

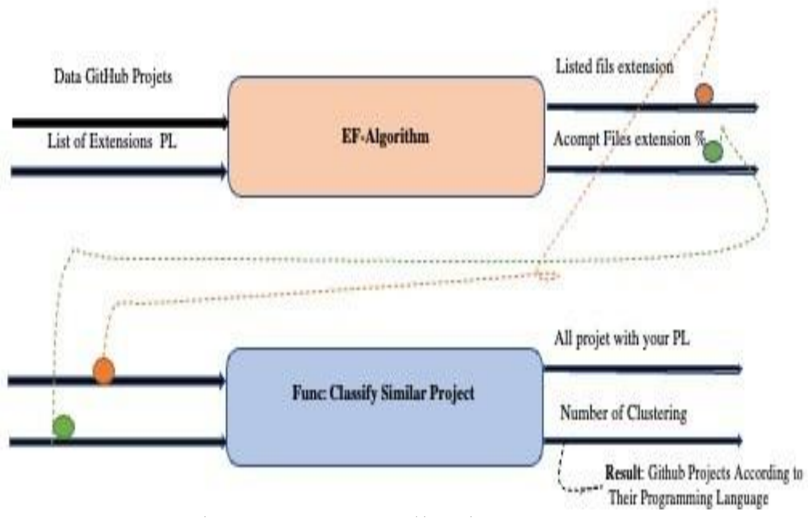


Figure 2: Requirements Generalization Process

This image shows a set of files with different extensions (".java", ".py", ".mp3", etc). A classification algorithm is used to group the files into different categories based on their extension. For example, the ".java" files are grouped into the "Java" category, the ".py" files are grouped into the "Python" category, and the ".mp3" files are grouped into the "audio" category.

The project title does not always provide the program type index to be used.

The algorithm can be trained on a dataset of labelled files to learn to predict the category of a file based on its extension. Once trained, it can be used to classify new files based on their extension.

This image is a simplified representation of classifying files by their extension, and the details of the implementation may vary depending on the data and the algorithm used. If you are interested in implementing this approach, I would recommend consulting a machine-learning expert or doing further research on the topic.

This new framework has been successfully applied to a real database containing more than a hundred projects with various extensions. The results obtained After that, we use the FE of each PL, then extension-based segmentation to find the most used language. Finally, we use techniques to analyse GitHub projects. In this article, we will further detail this new method and we will describe and explain the obtained results.

When you have a set of unlabelled data, it's very likely that you'll be using some kind of unsupervised learning algorithm. So, we choose K-means clustering because it is the most commonly used clustering algorithm. It's a centroid-based algorithm and the simplest unsupervised learning algorithm. This algorithm tries to minimize the variance of data points within a cluster. It's also how most people are introduced to unsupervised machine learning. K-means is best used on smaller data sets because it iterates over all of the data points. That means it'll take more time to classify data points if there are a large amount of them in the data set. Since this is how we implement the method EF to k-means clusters and facilitate the use of the application GitHub.

There are several ways to categorize GitHub projects by programming language. One of the most popular methods is to use GitHub's search functionality to look for projects using keywords associated with various programming languages. For instance, you can search for Python-based projects by using keywords like "Python," "Django," or "Flask." Additionally, there are tools like GitHub Trends that allow you to view the trends of the most well-liked projects according to programming languages. There are also third-party services like GitHub Language Statistics, which allows you to view the language statistics for all of GitHub's open-source projects. There are visualization tools available that will allow you to see the trends of programming languages used on GitHub. Additionally, data analysis tools exist that can be used to extract information about GitHub projects based on the programming language they use. GitHub projects can be efficiently imitated through the site's fork process or through a Git clone-push sequence and improve the quality of GitHub project samples that are utilized to conduct empirical software engineering studies [1]. This work surveys the recent attempts, both from the machine learning and operations research communities, at leveraging machine learning to solve combinatorial optimization problems [1].

Given the hard nature of these problems, state-of-the-art algorithms rely on handcrafted heuristics for making decisions that are otherwise too expensive to compute or mathematically not well-defined. In recent years, the development of machine learning has led to augmentations of automated tools that classify or extract information in GitHub [2]. The research works on classification in GitHub have been still in the passage of development, primarily engrossed in the submitting, reviewing, and evaluation process. To recommend experts for the development of AI and machine learning to classify the content of GitHub. Although different classification in GitHub, for example in M Golzadeh propose an automated classification model to detect bots, Bots are frequently utilized in GitHub projects to automate iterative activities that are part of the relegated software development process [3]. As a case study J. Manuel Perez-Verdejo proposes a TF-IDF algorithm to identify quality-attributes-related knowledge on such user feedback [4]. There are numerous different issues that could arise when managing a programming project on GitHub.

Some such examples include:
• Conflicts during branch fusion occur when many people make changes to the same file at the same time, and the changes become incompatible after the branches are combined.
• Compatibility issues occur when a project's code is incompatible with specific platforms or operating systems.
• Performance issues occur when a project's code takes too long to run or consumes too many system resources.
• Security issues arise when a project's source code contains flaws that malicious individuals could use against it. Problems with compatibility can occur when a project's code has been developed and tested on a certain platform or operating system but does not work correctly on other platforms or operating systems. These issues could be brought about by variations in the system libraries, software versions, or hardware settings.

There are several methods for fixing compatibility issues: testing the code across a wide range of platforms and operating systems to find compatibility issues Making the code compatible with the targeted platforms or operating systems by using compatibility libraries or tools Utilizing platform detection techniques to modify the code according to the platform or operating system that it runs on. Utilize container and virtualization technologies to isolate the code and its dependencies from platform differences. It's crucial to remember that compatibility issues can sometimes be resolved by working with the open-source community, submitting pull requests with fixes, and talking to contributors.

In the context of GitHub, compatibility refers to the ability of a project to work seamlessly with other projects, platforms, and technologies. A compatible project is one that can be integrated with other projects, run on different platforms, and be used in conjunction with other tools and technologies without any issues.

For example, a project may be compatible with different operating systems, such as Windows, macOS, and Linux, or with different web browsers, such as Chrome, Firefox, and Safari. A project may also be compatible with different programming languages, databases, and other technologies.

Having a compatible project is important for several reasons. It enables users to integrate the project into their existing workflow, use it with other tools and technologies they already have, and collaborate with others who may be using different platforms and technologies.

To ensure compatibility, projects may need to follow certain standards, use certain APIs, and adhere to certain protocols. Additionally, they may need to be tested and validated on different platforms and configurations to ensure that they work as expected.

In the context of open-source projects hosted on GitHub, compatibility is an important consideration for both contributors and users of the project. By working together to ensure compatibility, contributors and users can help to ensure that the project remains useful and relevant and that it continues to grow and evolve over time.

1.1. Related Work

1.1.1. Compatibilite

Compatibility Problems Numerous issues have been linked to Android fragmentation [5,6]. While Pathak et al. have shown that the frequent Android OS upgrades have been the cause of a significant portion of user complaints regarding energy issues, Liu et al. have discovered that Android performance bugs could only be spotted while testing some specific devices and Android platforms [7]. Nayebi et al. discovered in a usability study from 2012 that the various display resolutions of devices present design and implementation challenges for Android apps, creating significant compatibility concerns [8]. Our study, which focuses on API-related compatibility issues, is complementary to several related initiatives. FicFinder is the work that comes closest to ours in terms of fixing API-induced compatibility problems. Recently, Wei et al. suggested this tool for Android developers [9].

However, their work differs from ours in a number of ways:
1. Due to human construction, the database (i.e., API-context pairs) used by FicFinder to highlight compatibility issues is tiny and is likely to produce a significant number of false negatives (i.e., missing real compatibility issues). Our approach to CiD is based on an API lifetime model that is constructed automatically and methodically by mining changes between various versions of the Android framework.
2. API compatibility issues, including both forward and backward compatibility, are the main focus of our effort. FicFinder model's other device-specific concerns by mining issue reports.

1.1.2. GitHub Repositorie

We classify related work into tables. We introduce the most related works to ours. Following the illustrative scheme of the generalization process of our work, Figure 3 shows that in GitHub. For manual tests, it is a person, an experienced tester, who will navigate the GitHub project [10]. We use the file extensions of each programming language. Unlike the automated test, the manual test allows you to test or find the GitHub project language of the file extension that contains the application code, in which case, we can say that the project is the developer of this language. EF is considered to categorize the projects in GitHub, and used by software developers and programmers as a source code or script file type. A source code file is a human-readable text file that contains a collection of statements or declarations in any of many computer programming languages (e.g. BASIC, PASCAL, DELPHI, C, C++, C charp, COBOL, etc.).

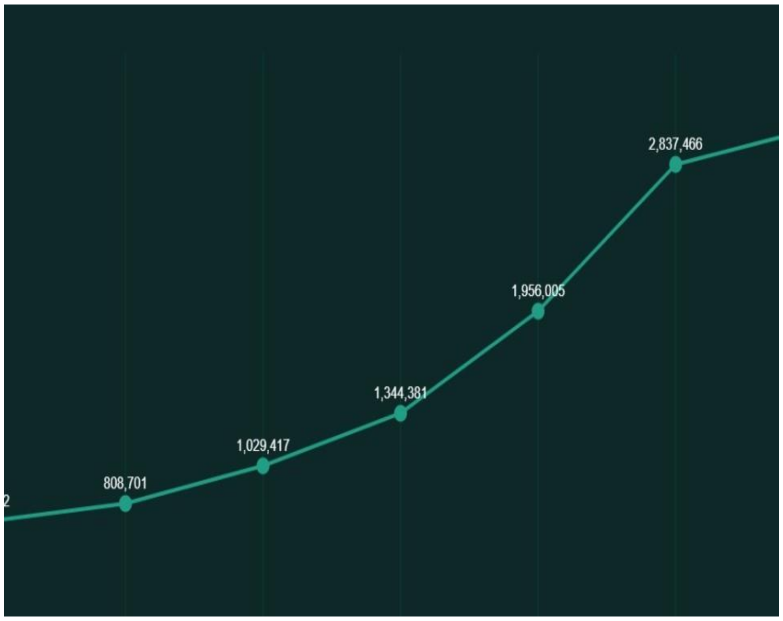


Figure 3: In 2022, the number of first-time contributors to open-source projects is on the rise.

- In a single project, you can find multiple folders where files are just for description. Thus, the developer takes the time to select the code files to use in each project.
- For companies and our case study. There are thousands of clone projects in GitHub so it is necessary to develop an intelligent method to classify projects by this programming language.
- Clustering all projects has a similar programming language.

On the other hand, GitHub notes that in its open-source community, projects built from code and toolchains shared by others are growing. Thus, the performance of developers at work would be likely to increase by 87% when code reuse is easy and does not introduce friction.

In Table 1 all of the researchers used linguists to understand the types of programming language. Linguist takes the list of languages it knows from languages. yml and uses a number of methods to try to determine the language used by each file, and the overall repository breakdown. Linguist starts by going through all the files in a repository and excludes all files that it determines to be binary data, vendor code, generated code, documentation, or are defined as data (e.g. SQL) or prose (e.g. Markdown) languages, whilst considering any overrides. If an explicit language override has been used, that language is used for the matching files. The language of each remaining file is then determined using the following strategies, in order, with each step either identifying the precise language or reducing the number of likely languages passed down to the next strategy: Vim or Emacs mode line, commonly used filename, shell shebang, file extension, XML header, man page section, heuristics, naive Bayesian classification.

Years	**Authors**	**Method**	**Subject**
2014 [11]	F Tomassetti, M Tor	Polyglot-ism (Linguist)	How many languages are used in each software project, Relations between different languages in similar to GitHub Project
2015 [12]	P Mayer, A Bauer	process of random	Number and type of languages found and the relative sizes of the languages.
2014 [13]	B Ray, D Posnett	Polyglot-ism (Linguist)	Presented a large-scale study of language type related to software quality. Characterized the GitHub projects by their complexity and the variance along multiple dimensions of language, language type, usage domain, amount of code, sizes of commits, and the various characteristics of the many issue types.

2019 [14]	PH merlin, A Stefik	Polyglot prog (Linguist)	Described a pilot experiment on the impact of code-switching on software development productivity, Findings in linguistic research suggest that there is a time cost to switching between natural languages.
2021 [15]	Wen li, Na Meng	SPC and EVC (Linguist)	Estimating the functionality domain of each project through topic modeling, followed by studying the statistical correlation between these domains and language selection.
2022 [16]	H.yang, W.Li	Analyzing multilingual	O the prospects of language-agnostic dynamic analysis of multilingual code.

Table 1: A Comparative Research Study Used to Classify Projects on GitHub with the Programming Language

The result of this analysis of the Linguist method is used to produce the language stats bar which displays the language percentages for the files in the repository. The percentages are calculated based on the bytes of code for each language as reported by the List Languages API.

"Linguistics is the scientific study of language. It involves the analysis of language form, language meaning, and language in context. Linguists traditionally analyse human language by observing an interplay between sound and meaning."

Linguist is a Ruby library so you will need a recent version of Ruby installed. There are known problems with the macOS/Xcode-supplied version of Ruby that cause problems installing some of the dependencies. Accordingly, we highly recommend you install a version of Ruby using Homebrew, rbenv, rvm, ruby-build, asdf, or other packaging systems, before attempting to install Linguist and the dependencies.

In addition, Yu Zhang proposes the HIGITCLASS framework to classify of GitHub Repositories [17]. Similarly, Song Yu proposes a supervised classification model attached to the supervised topics model and Naive Bayes classifier to make the Pull Requests (PRs) appear in GitHub to be classified automatically [18]. Enayet, A., in shows a classification system for GitHub issue comments using both sentence-level and word-level embedding models to leverage information from the SwDA dataset [19].

FEs User an extension language is a programming language interpreter offered by an application program so that users can write macros or even full-fledged programs to extend the original application [20,21]. Extension languages have a C interface (it is usually C, but it could be any other compiled language), and can be given access to the C data structures. Likewise, there are C routines to access the extension language data structures [22]. File extensions are very important for the proper identification of programs that can open and display the correct information with regard to a file [23].

1.2. Strategies GitHub Projects Dataset

In the following sections, we describe the data set in which we perform our analysis, as well as the lexical sentiment analysis approach we use.

1.2.1. Data Collection and Features

We gathered 100 repositories that were as close as possible to being fully written in Java due to the uncertainty of how Designite Java would perform. Another requirement we decided upon was that each repository contains at least 3000 lines of code for it to be considered. As mentioned in further sections, this was due to alleviating potential inconsistencies and ensuring that one particular smell would not be disproportionate to other smells. This particular minimum value was selected due to testing the tool with smaller repositories and discovering this value to be suitable and adequate for our sample size. Most repositories examined were libraries and frameworks repositories would also be thoroughly checked to ensure that no other languages would be scanned in by our chosen tool.

We collect one data Set of GitHub projects enveloped in different project domain languages their statistics are specified in Table 2.

Dataset	Input-projects	output-projects	Classes
Data 1	200	176	∓language ID
Data 2	500	400	∓language ID
Data 3	1000	853	∓language ID

Table 2: The Dataset Used in This Study is Organized as Shown

In this study, we produce a data Set using the topics projects GitHub and the others projects. Our dataset has 1000 projects extracted from GitHub. These 1000 projects are collected by selecting the top 1,000 projects sorted by classifying the file extension of each project. For our own use after the classification FE, we give projects a programming language specified (see Figure 3). Bao et al. dataset has 917 repositories, while our data Set has 1000 projects [15]. We found 30 projects with not no extension for the 11 top languages chosen shown in Figure 4.

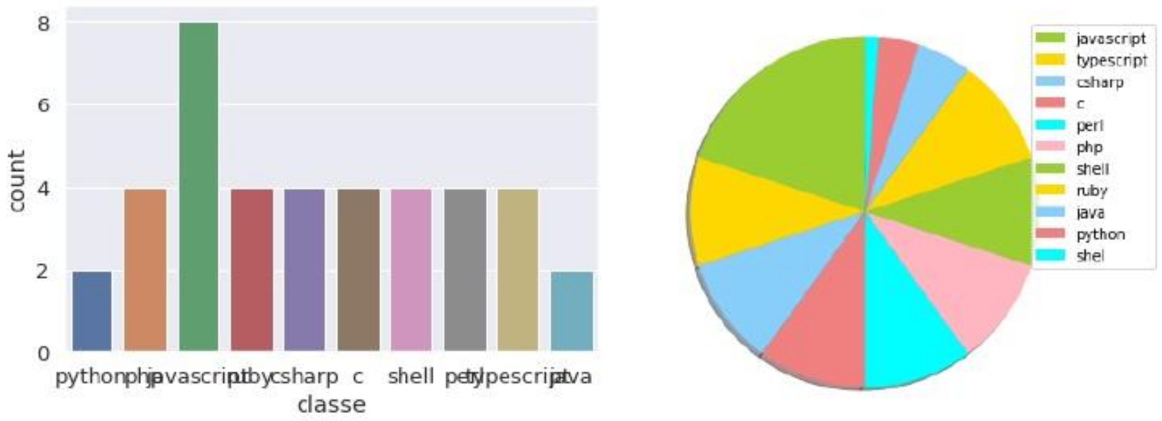


Figure 4: Top and Evolution of the Association Between the Main Selections of Programming Languages in GitHub until 2021

The proposed method aims to collect and interpret the data from GitHub projects related to files or documents originating from different geographical programming language like java, Python, JavaScript, etc.

The original values of the continuous features have very different scales. While modelling the data, some features tend to dominate others because of their higher range. Hence, to reduce the variance between the features and scale all of them to a certain range, standardization is used. Standardization expects the data to have a Gaussian distribution and as observed, the features of the data are close to the Gaussian distribution. Standard scaling centres the data points by subtracting them from the mean and scales by dividing them by the standard deviation. Thus, standardization is also referred to as 'centre scaling'. Equations 1, 2, and 3 are the equations for Mean, Standard deviation, and Standard Scaled values respectively.

We construct data containing 1000 projects with +2000 files. Figure 4 shows the organization of the futures when we categorized them as either file extension. For each observation, we extract +50 features related to the file project extension from GitHub. Figure 4 shows the association evolution for the programming language across the years. These +50 features are comprised of all of the extension features and the 10 top contributor features. We used GitHub to extract the top active language feature.

1.2.2. Language Detection Categorizing Extension Languages

Programming languages with file extensions in GitHub projects can be broadly categorized based on the type of language they are. Here is a brief overview of some of the most common programming languages you might encounter in a GitHub project:

- **Python:** Python is a high-level, interpreted language that is widely used for web development, scientific computing, data analysis, and more. It is known for its readability, ease of use, and vast library of modules. The file extension for Python is .py.
- **JavaScript:** JavaScript is a high-level, dynamic, and interpreted programming language that is primarily used for web development. It is used for creating interactive web applications, animations, and another client-side scripting. The file extension for JavaScript is .js.
- **Ruby:** Ruby is a dynamic, object-oriented, and interpreted programming language that is often used for web development, scripting, and system automation. It is known for its elegance and readability. The file extension for Ruby is .rb.
- **Java:** Java is a high-level, object-oriented, and class-based programming language that is widely used for developing enterprise applications, mobile applications, and other large-scale projects. The file extension for Java is .java.□C: C is a low-level, procedural programming language that is widely used for system programming, embedded systems, and other applications that require a high degree of control over the hardware. The file extension for C is .c.
- **C++:** C++ is an extension of the C programming language that adds object-oriented programming features. It is widely used for developing high-performance applications, such as games, scientific simulations, and other resource-intensive programs. The file extensions for C++ are .cpp and .cc.
- **C charp:** C charp is a modern, object-oriented, and type-safe programming language that is widely used for developing Windows desktop applications, games, and other applications. The file extension for C charp is .cs.
- **Swift:** Swift is a powerful, object-oriented, and type-safe programming language developed by Apple for developing iOS, macOS, and other Apple platforms. The file extension

for Swift is .swift.

- **Go:** Go is a statically typed, concurrent, and garbage-collected program- ming language developed by Google. It is widely used for developing scalable and high-performance systems and applications. The file extension for Go is .go.
- **TypeScript:** TypeScript is a statically typed superset of JavaScript that adds optional type annotations and other features to the language. It is widely used for developing large-scale and complex web applications. The file extension for TypeScript is .ts.

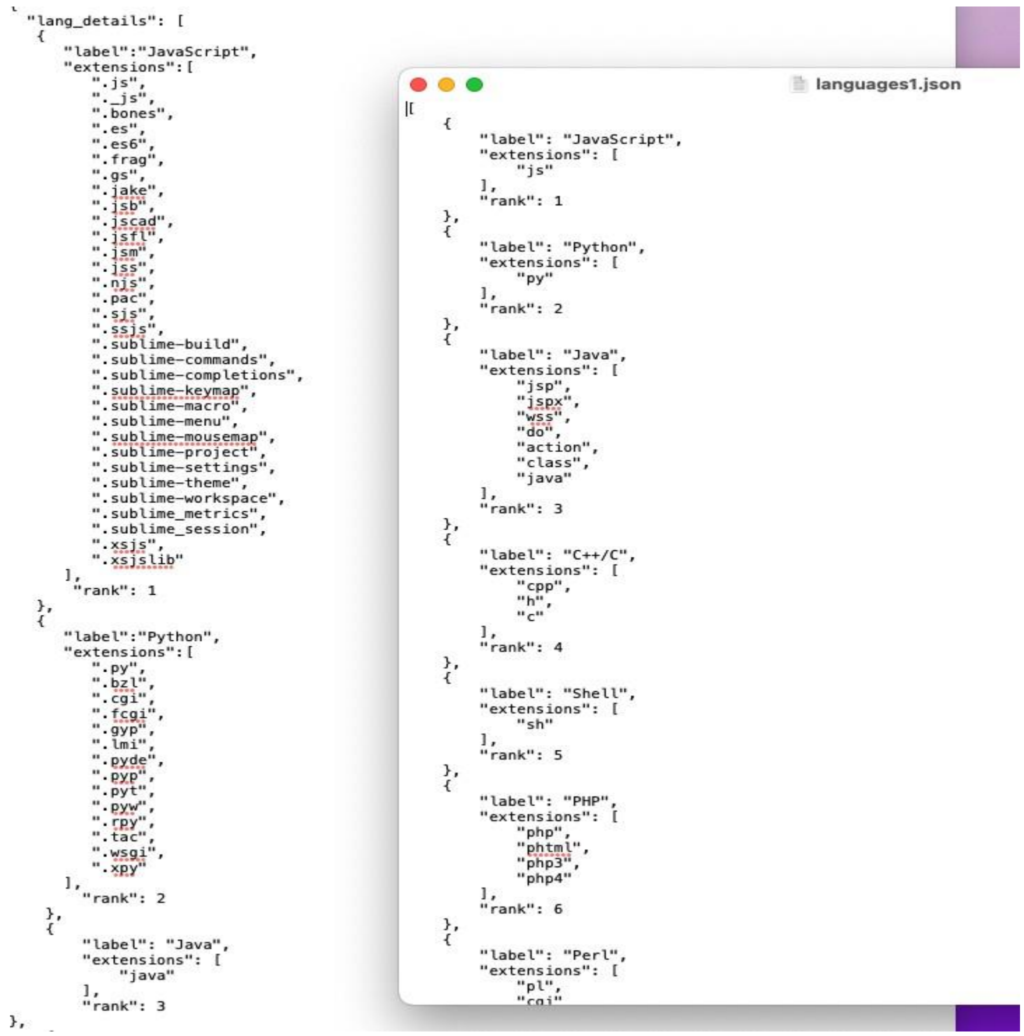
These are just a few examples of the programming languages you might encounter in a GitHub project. There are many other programming languages with different file extensions that may be used in a project, depending on the requirements and constraints of the project.

In GitHub, programming language extensions are used to identify the programming language used in a project and to highlight the specific syntax and constructs used in the code. This information is used by GitHub to highlight the code, display it in a consistent manner, and make it easier to read and understand.

The following (show Figure 5) is a list of common programming language extensions that can be found in GitHub projects:

- .py for Python
- .js for JavaScript
- .java for Java
- .rb for Ruby
- .c or .cpp for C or C++
- .go for Go
- .rs for Rust
- .hs for Haskell
- .scala for Scala
- .php for PHP

It's important to note that this is not an exhaustive list, and that there may be other extensions for other programming languages used in GitHub projects. Additionally, some projects may use multiple programming languages, and in such cases, multiple extensions may be used.



```
"lang_details": [
  {
     "label":"JavaScript",
     "extensions":[
        ".js",
        "._js",
        ".bones",
        ".es",
        ".es6",
        ".frag",
        ".gs",
        ".jake",
        ".jsb",
        ".jscad",
        ".jsfl",
        ".jsm",
        ".jss",
        ".njs",
        ".pac",
        ".sjs",
        ".ssjs",
        ".sublime-build",
        ".sublime-commands",
        ".sublime-completions",
        ".sublime-keymap",
        ".sublime-macro",
        ".sublime-menu",
        ".sublime-mousemap",
        ".sublime-project",
        ".sublime-settings",
        ".sublime-theme",
        ".sublime-workspace",
        ".sublime_metrics",
        ".sublime_session",
        ".xsjs",
        ".xsjslib"
     ],
      "rank": 1
  },
  {
     "label":"Python",
     "extensions":[
        ".py",
        ".bzl",
        ".cgi",
        ".fcgi",
        ".gyp",
        ".lmi",
        ".pyde",
        ".pyp",
        ".pyt",
        ".pyw",
        ".rpy",
        ".tac",
        ".wsgi",
        ".xpy"
     ],
       "rank": 2
   },
   {
       "label": "Java",
       "extensions": [
           "java"
       ],
       "rank": 3
},
```

languages1.json

```
[
    {
        "label": "JavaScript",
        "extensions": [
            "js"
        ],
        "rank": 1
    },
    {
        "label": "Python",
        "extensions": [
            "py"
        ],
        "rank": 2
    },
    {
        "label": "Java",
        "extensions": [
            "jsp",
            "jspx",
            "wss",
            "do",
            "action",
            "class",
            "java"
        ],
        "rank": 3
    },
    {
        "label": "C++/C",
        "extensions": [
            "cpp",
            "h",
            "c"
        ],
        "rank": 4
    },
    {
        "label": "Shell",
        "extensions": [
            "sh"
        ],
        "rank": 5
    },
    {
        "label": "PHP",
        "extensions": [
            "php",
            "phtml",
            "php3",
            "php4"
        ],
        "rank": 6
    },
    {
        "label": "Perl",
        "extensions": [
            "pl",
            "cgi"
```

Figure 5: Progression of Programming Language Extension: Expansion of JSON File Extension in the Programming World (A Graphical Overview, A Visual Analysis).

GitHub provides various tools to detect the programming language used in a project. You can view the primary language of a project by looking at the “Languages” section on the right-hand side of a project’s GitHub page. GitHub also provides a heat map that shows the distribution of code written in different languages within the project’s repository.

To measure the similarity between two programming languages, you can compare their syntax, features, libraries, and paradigms. There are several libraries and tools available to automatically measure the similarity between programming languages, but the results may vary depending on the methodology used.

In our study, the method EF gives all the nature of the programming language used in each project with the number of file languages.

1.3. Issues with GitHub's Programming Language

1.3.1. What is the impact of programming language choice on development speed and project success in GitHub?

RQ1 The choice of programming language can impact development speed, as some languages have different levels of expressiveness, libraries, and tools, which can make certain tasks faster or more convenient to accomplish in certain languages compared to others.

However, the impact on project success on GitHub is not solely determined by the programming language, as other factors such as team size, development processes, user needs, and specifications, budget, and project scope also play important roles. Ultimately, the most suitable language for a project is one that meets the project requirements and allows the development team to work efficiently and effectively.

1.3.2. How does the use of GitHub affect software development and bug tracking in projects?

RQ2 GitHub can significantly affect software development and bug tracking by providing:

• **Version Control:** GitHub provides a platform for version control using Git, which allows developers to track changes, collaborate on code, and manage merge conflicts efficiently.

• **Collaboration:** GitHub makes it easy for developers to work together on projects by providing a platform for code review, commenting, and bug tracking.

• **Bug Tracking:** GitHub offers built-in issue tracking, which allows developers to create, manage, and track bugs, enhancement requests, and other project tasks in one place.

• **Open-Source Community:** GitHub provides a large open-source community, allowing developers to easily contribute to and use existing code and tools.

By providing these features, GitHub can improve efficiency, transparency, and collaboration in software development and bug tracking, leading to better and faster development processes.

1.3.3. How does the community and collaboration around programming languages on GitHub impact their adoption and popularity?

RQ3 The community and collaboration around programming languages on GitHub can significantly impact their adoption and popularity by:

• **Providing Resources:** GitHub provides access to a vast collection of resources, including code samples, libraries, and tools, which can make it easier for developers to learn and use new programming languages.

• **Encouraging Collaboration:** GitHub makes it easy for developers to collaborate on projects and contribute to open-source libraries, which can foster the growth of a strong and supportive community around a programming language.

• **Highlighting Popular Languages:** GitHub’s popularity and widespread use make it a prime platform for measuring the popularity and adoption of different programming languages, as the number of repositories, contributors, and stars can be used as a proxy for a language’s popularity and user base.

• **Showcasing Real-World Use Cases:** GitHub provides a platform for developers to share their projects and solutions, allowing others to see the practical applications of a programming language and inspiring further adoption.

By providing these benefits, GitHub can play a significant role in shaping the popularity and adoption of programming languages and encouraging their growth.

1.3.4. How does GitHub handle compatibility issues between different programming languages and their libraries and frameworks?

RQ4 GitHub handles compatibility issues between different programming languages, libraries, and frameworks by:

• **Providing Version Control:** GitHub provides version control through Git, which allows developers to maintain multiple versions of their code and libraries and easily switch between them to resolve compatibility issues.

• **Documenting Dependencies:** GitHub allows developers to specify dependencies for their projects, including the version of the programming language, libraries, and frameworks required. This helps ensure compatibility and reduces the risk of errors and bugs.

•**Encouraging Collaboration:** GitHub provides a platform for collaboration, allowing developers to discuss and resolve compatibility issues with others and leverage the collective knowledge and expertise of the community.

• **Supporting Package Management:** GitHub integrates with popular package managers like npm, pip, and gems, which allow developers to easily manage and install dependencies, including libraries and frameworks, reducing compatibility issues.

By providing these features and integrations, GitHub helps developers manage compatibility issues between different programming languages, libraries, and frameworks, reducing the risk of errors and bugs and making it easier to develop and maintain software.

1.3.5. How does GitHub's version control system support and handle compatibility issues in multi-language projects?

RQ5 GitHub's version control system, Git, supports and handles compatibility issues in multi-language projects by:

• **Branching and Merging:** Git allows developers to work on separate branches and easily merge code changes, ensuring compatibility between different programming languages, libraries, and frameworks.

• **Tracking Changes:** Git provides a comprehensive history of all changes made to a project, allowing developers to see exactly what changes were made when they were made, and who made them. This makes it easier to identify and resolve compatibility issues.

• **Rollback Options:** Git provides the ability to revert to previous versions of code, allowing developers to easily undo changes that cause compatibility issues.

• **Conflict Resolution:** When multiple developers work on the same codebase, Git provides mechanisms for resolving conflicts that arise, including merging, rebasing, and resolving merge conflicts.

By providing these features, GitHub's version control system, Git, helps developers handle compatibility issues in multi-language projects and maintain a stable and reliable codebase.

1.3.6. How does the integration of machine learning models in programming languages on GitHub affect compatibility and scalability issues, and how are they addressed?

RQ6 The most common compatibility problems faced by developers using multiple programming languages in GitHub projects include:

• **Library Compatibility:** Different programming languages often have different libraries and tools, and these libraries may not be compatible with each other, causing compatibility issues.

• **Syntax Differences:** Different programming languages have different syntax and structures, making it difficult to integrate code written in different languages.

• **Data Exchange Format**: Different programming languages may use different data exchange formats, such as XML, JSON, or binary data, leading to compatibility issues. Performance: Machine-learning models can be computationally intensive, and integrating them into programming languages may affect the performance and scalability of the code.

• **Model Compatibility:** Different machine learning models may use different algorithms, data formats, and libraries, which can cause compatibility issues when integrating them into programming languages.

These compatibility problems are typically addressed by:

• **Converting Data:** Developers may use conversion tools or libraries to translate data between different formats and ensure compatibility.

• **Using Middleware:** Middleware can be used to provide a common interface between different programming languages and libraries, allowing them to interact and exchange data seamlessly.

• **Choosing Compatible Libraries:** Developers can choose libraries that are compatible with multiple programming languages, reducing compatibility issues.

• **Writing Glue Code:** Glue code can be written to integrate code written in different programming languages and ensure compatibility.

• **Choosing Optimized Libraries:** Developers can choose machine-learning libraries that are optimized for performance and compatibility with programming languages, reducing compatibility and scalability issues.

• **Testing and Profiling:** Developers can test and profile their code to identify performance bottlenecks and optimize the integration of machine learning models into programming languages.

• **Using Standardized Interfaces:** Developers can use standardized interfaces, such as APIs, to integrate machine-learning models into programming languages, reducing compatibility issues.

• **Encouraging Collaboration:** Developers can collaborate on projects and contribute to open-source libraries, encouraging the development of optimized and compatible machine-learning models for integration into programming languages.

By using these methods, developers can mitigate compatibility and scalability issues when integrating machine-learning models into programming languages on GitHub and ensure the stability and reliability of their code.

1.4. Software Compatibility

Software compatibility can refer to the capacity of two systems to work together without making any changes to support each other. Software Compatibility is the interoperability between any two software applications.

A variety of software can be used to assess project compatibility, including Microsoft Project is a well-known project planning tool that lets you manage each project's tasks, resources, and schedule as well as assess how well they work together in terms of both time and resources.

Trello: an online project management tool that can be used to assess the compatibility of projects by providing an overview of tasks and objectives, as well as real-time collaboration between Members of the team.

Asana is another online project management tool that enables users to plan, monitor, and organize tasks to achieve shared goals while assessing the compatibility of projects.

Basecamp is a web-based project management tool that may be used to assess compatibility across projects by centralizing interactions, tasks, and documentation for effective goal tracking.
In terms of project management software, it is crucial to pick the solution that best suits your requirements in terms of functionality, friendliness, and cost.

2. Methodology

GitHub is a popular platform for hosting and sharing software projects, including those that involve programming. You can find many projects on GitHub that use a specific programming language by searching for that language on the GitHub website. Here are a few examples of how you can search for projects on GitHub by programming language:

- Go to GitHub.com and use the search bar to search for a specific programming language, such as "JavaScript". You can also use the "Language" filter to narrow your search results to only show repositories written in a specific programming language.
- At the GitHub trending page for a specific programming language, which shows the most popular repositories written in that language.
- Look at the GitHub Explore page, which features curated collections of popular and trending repositories by language.
- Look at the GitHub leader board for a specific language, which shows the most active contributors for that language.

Here, we describe the languages and GitHub projects that we collected, and the analysis methods we used to answer our research question. To classify files with a specific extension, you could use a machine learning algorithm that is trained on a dataset of labeled files with various extensions. This algorithm would take in the file and its extension as input and would output a predicted class or category for the file.

For example, if you were classifying image files, the algorithm might take in a file with the extension ".jpg" and output the predicted class "image". If you were classifying audio files, the algorithm might take in a file with the extension ".mp3" and output the predicted class "audio".

There are many different machine-learning algorithms that can be used for classification, and the specific algorithm that would work best for your use case would depend on the details of your problem. Some popular algorithms for classification include support vector machines (SVMs), k-nearest neighbours (k-NN), and decision trees.

It's also important to note that classification is a complex topic and can be challenging to implement. If you were interested in using machine learning for classification, I would recommend consulting a machine-learning expert or doing further research on the topic.

To cluster similar projects on GitHub, you could first collect data on the projects you are interested in. This could include information about the languages used in the projects, the number of contributors, the number of stars and forks, and any other relevant data. In this research, we studied the domain of the GitHub Project with different areas (see Figure 1). The implementation of ML methods is shown in Figure 5. Involves training one method used to classify GitHub projects with a programming language, for this, we need a machine learning algorithm and a new method to classify the content extension files in each GitHub project. In this way, when using hierarchical clustering it is necessary to specify both the distance metric and the linkage criteria [24].

During the first phase of the study, we used a new method of quick filing and eliminated traditional tasks (read each shared project in GitHub) and read the contents of the project files file by file in order to know the language of the GitHub project. This method is based on the file extension, which means that this method can read a database containing thousands of projects. Then, indicates the percentage of uses of all programming extensions in each project. In addition, to marking the high percentage as the main language of the project.

We will give step by step:

- Prepare a database containing more than 200 projects downloaded from GitHub and prepare a JSON file containing all extensions of all programming languages.
- Start the EF-algo method.
- The percentage of results for each SQ type exists for each project. See Figure 6, this is a result of two projects then the master tests it for the whole base. The first project is a mix of programming languages, while the second is a Python project. Moreover, the result is a CSV file for the implementer in a clustering algorithm.

2.1. EF Method

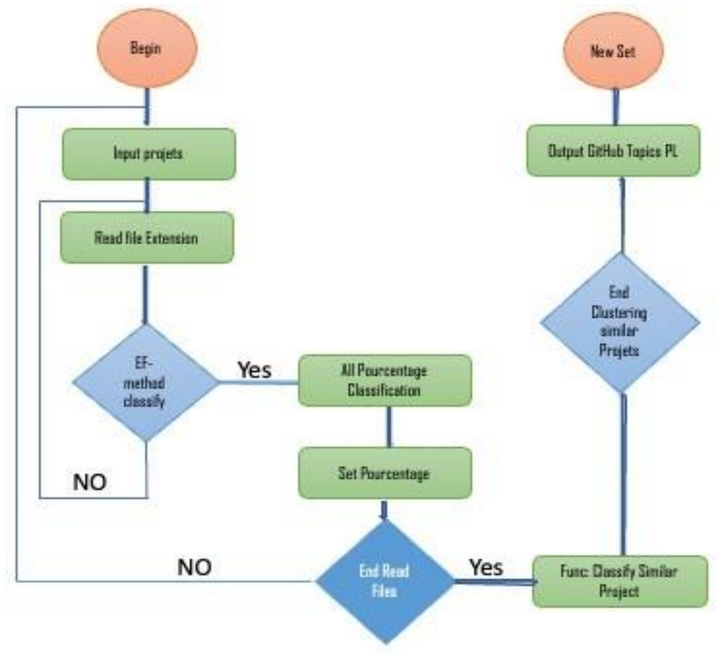


Figure 6: Methodology employed to identify the EF algorithm and the ML algorithm to classify project GitHub using the maximum of the extension file used. We added a graphical mark () to identify the challenges related to noisiness, which crosscut the categories of the GitHub project.

2.2. Compatibility Project in GitHub Related to Programming Language

The "Compatibility" section of a project in GitHub is typically found in the project's documentation, or in the README file, and is used to provide information about the compatibility of the project with different operating systems, programming languages, and other technologies. This section can be very important for users who are interested in using the project and want to make sure that it will work with their existing infrastructure.

In this section, developers typically list the specific versions of operating systems, programming languages, and other technologies that their project is compatible with. They might also include information about any known issues or limitations and any additional steps that users need to take to get the project up and running.

It's worth noting that the compatibility information listed in the "Compatibility" section of a project is not always 100% accurate or up-to-date, so it's a good idea to double-check with the project's documentation and other sources before using the project in a production environment.
The "Compatibility" section of a project in GitHub can be used to provide information about the compatibility of the project with different methodologies. This section can be especially important for users who are interested in using the project for a specific methodology and want to make sure that it will work with their existing practices and processes.

In this section, developers typically list the specific methodologies that their project is compatible with, such as Agile, Waterfall, DevOps, etc. They might also include information about any known limitations or issues, and any additional steps that users need to take to ensure compatibility with their preferred methodology.

It's worth noting that compatibility with methodologies can depend on a number of factors, including the size and complexity of the project, the tools and technologies used, and the skills and experience of the development team. As a result, the information listed in the "Compatibility" section of a project is not always comprehensive or up-to-date, so it is a good idea to consult the project's documentation and other sources and to conduct your own testing, before using the project in a production environment.

3. Results

3.1. Result of FE Algorithm

In this case, there is a similar description for the setup of our methodology, in the first part, we should find the FE Algorithm which allows us to read and display all the files in the GitHub project. Then, it allows to classification of the files by their extensions and in the final state gives the number of files in percentages and gives the name of the most used extension. Figure 7 shows the results of simulation 3 comparing random forests successively to the result in Figure 6. We make the result in Table 1.

First, you can replace the detected language for your repository files using Linguist substitutions. In a few words: Each repository is labelled with the first language of the language statistics. Language statistics count the total file size for each detected programming or mark-up language. Sold files, documentation, and generated files are not counted. The language of each file is detected by the Linguist open-source project.

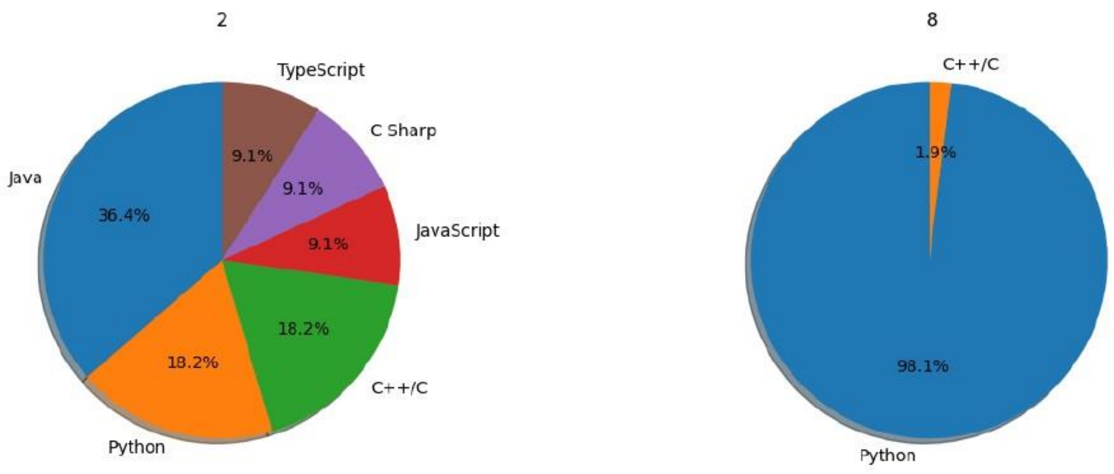
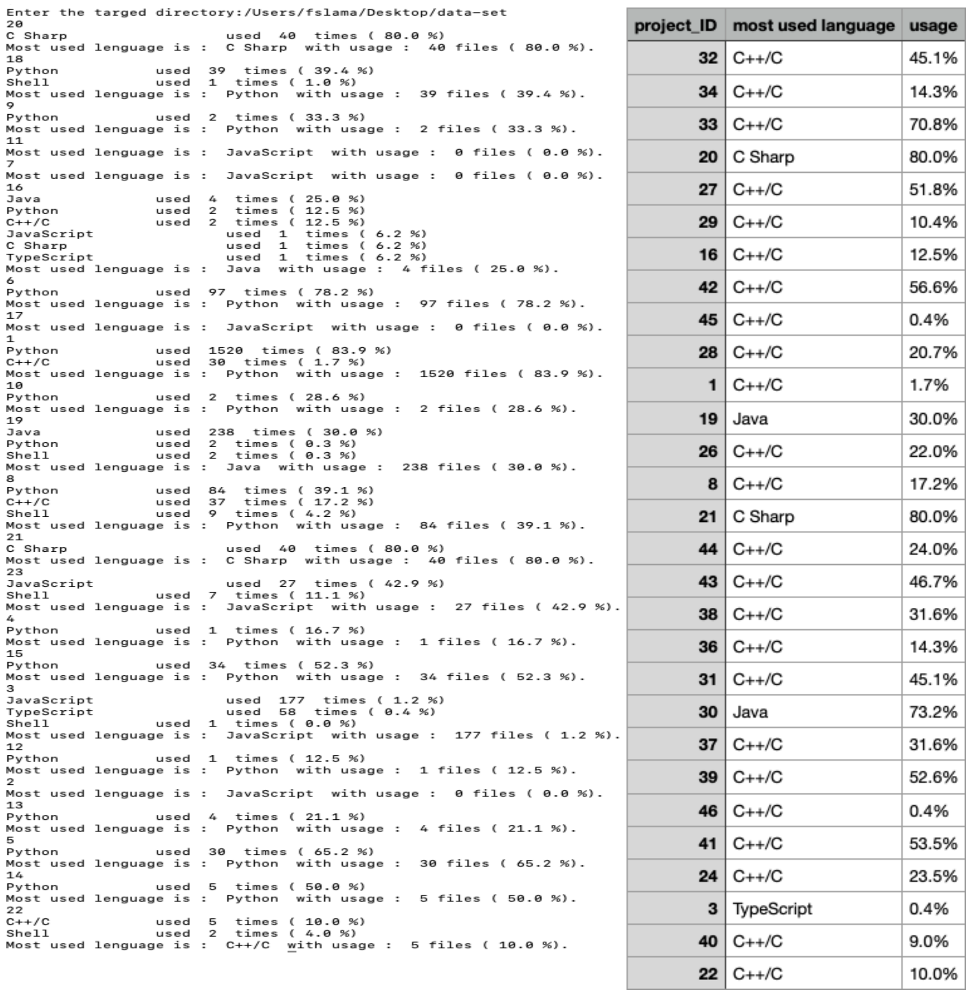


Figure 7: Overview of File Extension Classification De Deux Projects GitHub Different



```
Enter the targed directory:/Users/fslama/Desktop/data-set
20
C Sharp                         used  40  times ( 80.0 %)
Most used lenguage is :  C Sharp  with usage :  40 files ( 80.0 %).
18
Python              used  39  times ( 39.4 %)
Shell               used  1  times ( 1.0 %)
Most used lenguage is :  Python  with usage :  39 files ( 39.4 %).
9
Python              used  2  times ( 33.3 %)
Most used lenguage is :  Python  with usage :  2 files ( 33.3 %).
11
Most used lenguage is :  JavaScript  with usage :  0 files ( 0.0 %).
7
Most used lenguage is :  JavaScript  with usage :  0 files ( 0.0 %).
16
Java                used  4  times ( 25.0 %)
Python              used  2  times ( 12.5 %)
C++/C               used  2  times ( 12.5 %)
JavaScript                      used  1  times ( 6.2 %)
C Sharp                         used  1  times ( 6.2 %)
TypeScript                      used  1  times ( 6.2 %)
Most used lenguage is :  Java  with usage :  4 files ( 25.0 %).
6
Python              used  97  times ( 78.2 %)
Most used lenguage is :  Python  with usage :  97 files ( 78.2 %).
17
Most used lenguage is :  JavaScript  with usage :  0 files ( 0.0 %).
1
Python              used  1520  times ( 83.9 %)
C++/C               used  30  times ( 1.7 %)
Most used lenguage is :  Python  with usage :  1520 files ( 83.9 %).
10
Python              used  2  times ( 28.6 %)
Most used lenguage is :  Python  with usage :  2 files ( 28.6 %).
19
Java                used  238  times ( 30.0 %)
Python              used  2  times ( 0.3 %)
Shell               used  2  times ( 0.3 %)
Most used lenguage is :  Java  with usage :  238 files ( 30.0 %).
8
Python              used  84  times ( 39.1 %)
C++/C               used  37  times ( 17.2 %)
Shell               used  9  times ( 4.2 %)
Most used lenguage is :  Python  with usage :  84 files ( 39.1 %).
21
C Sharp                         used  40  times ( 80.0 %)
Most used lenguage is :  C Sharp  with usage :  40 files ( 80.0 %).
23
JavaScript                      used  27  times ( 42.9 %)
Shell               used  7  times ( 11.1 %)
Most used lenguage is :  JavaScript  with usage :  27 files ( 42.9 %).
4
Python              used  1  times ( 16.7 %)
Most used lenguage is :  Python  with usage :  1 files ( 16.7 %).
15
Python              used  34  times ( 52.3 %)
Most used lenguage is :  Python  with usage :  34 files ( 52.3 %).
3
JavaScript                      used  177  times ( 1.2 %)
TypeScript                      used  58  times ( 0.4 %)
Shell               used  1  times ( 0.0 %)
Most used lenguage is :  JavaScript  with usage :  177 files ( 1.2 %).
12
Python              used  1  times ( 12.5 %)
Most used lenguage is :  Python  with usage :  1 files ( 12.5 %).
2
Most used lenguage is :  JavaScript  with usage :  0 files ( 0.0 %).
13
Python              used  4  times ( 21.1 %)
Most used lenguage is :  Python  with usage :  4 files ( 21.1 %).
5
Python              used  30  times ( 65.2 %)
Most used lenguage is :  Python  with usage :  30 files ( 65.2 %).
14
Python              used  5  times ( 50.0 %)
Most used lenguage is :  Python  with usage :  5 files ( 50.0 %).
22
C++/C               used  5  times ( 10.0 %)
Shell               used  2  times ( 4.0 %)
Most used lenguage is :  C++/C  with usage :  5 files ( 10.0 %).
```

project_ID	most used language	usage
32	C++/C	45.1%
34	C++/C	14.3%
33	C++/C	70.8%
20	C Sharp	80.0%
27	C++/C	51.8%
29	C++/C	10.4%
16	C++/C	12.5%
42	C++/C	56.6%
45	C++/C	0.4%
28	C++/C	20.7%
1	C++/C	1.7%
19	Java	30.0%
26	C++/C	22.0%
8	C++/C	17.2%
21	C Sharp	80.0%
44	C++/C	24.0%
43	C++/C	46.7%
38	C++/C	31.6%
36	C++/C	14.3%
31	C++/C	45.1%
30	Java	73.2%
37	C++/C	31.6%
39	C++/C	52.6%
46	C++/C	0.4%
41	C++/C	53.5%
24	C++/C	23.5%
3	TypeScript	0.4%
40	C++/C	9.0%
22	C++/C	10.0%

Figure 8: Correspondence between the EF Algorithm and the ML Algorithm to Classify Project GitHub using the Maximum of the Extension File Used: Distribution of projects by Programming Domain

Shows Figure 1 the first test result. Part 1 gives all possible results even as files that do not have programming but in the second stage, these files were deleted for easy grouping of projects that have the same programming language. For example, we notice project use numbers 7, 11, 2, and 17 are all null. While one removed the output of our new base. EF classification of our method and we will display the results of my main database which contains more than 100 projects. Then proceed to the second step and group with function.

3.2. Solution Compatibility Issues in GitHub

The programming language's compatibility relates to how well a project's code source and the programming language being used are compatible. This means that the code must be consistent with the programming language's used syntax, libraries, and tools.

For instance, if a project is developed using the programming language Python, it is crucial to ensure that the code is compatible with the various versions of Python and that the necessary libraries are installed on the users' computers. Additionally, if a project is developed using a certain framework, it is crucial to ensure that the code is compatible with the most recent versions of the framework.

To ensure that the project runs consistently and error-free across various operating systems and platforms, it is crucial to consider the compatibility related to the programming language. Using the test and validation tools offered by GitHub, contributors can also confirm and validate the project's compatibility.

A GitHub project's compatibility issues can be solved using a variety of methods. Here are a few examples:
• Testing the code on a variety of platforms and operating systems will help you find any compatibility issues. This can be accomplished by running tests using test automation tools across many platforms and configurations.
• Use libraries or compatibility tools to make the code compliant with the targeted exploitation platforms or operating systems. For instance, by managing the differences between operating system versions by using compatibility libraries.
• Making use of platform detection techniques to modify the code depending on the platform or operating system

We have proposed two types of classification techniques here. We applied these three techniques on sets of identical GitHub projects and different sets of projects. On this basis, shows the Correspondence between the EF classification and the K-Means Clustering algorithm of the project GitHub.
• Utilize platform detection techniques to modify the code according to the platform or operating system that it runs on. This could be accomplished by using conditional instructions to check the platform or operating system the program is running on.
• Utilize container and virtualization technologies to isolate the code and its dependencies from platform differences. This can be accomplished by using tools like Virtual Box or Docker to build reproducible development environments. It's vital to remember that these treatments can be combined for increased effectiveness. To ensure that other developers can understand and apply the solutions used to solve compatibility issues, documentation of these solutions is also crucial.

4. Discussions and Conclusion

GitHub is a software development platform that houses open-source and free software projects. GitHub projects are compatible with a wide range of programming languages, making it a great place to find projects to use and contribute to.

The programming language used by the project must be understood in order to implement a GitHub project. It could involve popular programming languages like Python, Java, C++, JavaScript, Ruby, PHP, or other less well-known programming languages.

After determining the programming language used by the GitHub project, you can download and run the project's source code on your personal computer. Install the development tools necessary for the programming language, such as the compiler, interpreter, or necessary libraries, in order to accomplish this.
It is often advised to read the README or instructions file for the GitHub project since it contains crucial information on how to configure and run the project. You can also check the problems and merge requests (pull requests) to see if any known issues or updates are currently being made.

In terms of compatibility, GitHub is compatible with the majority of programming languages used in the software development industry. This includes both well-known programming languages like Python, Java, C++, JavaScript, Ruby, and PHP as well as less well-known ones like Rust, Swift, Kotlin, etc.

It's crucial to remember that GitHub is not just for open-source and free software projects. Additionally, private projects may be hosted on GitHub using subscription fees. In this case, the compatibility will depend on the programming language used for the private project.

The use and success of GitHub projects depend critically on the programming language's compatibility with them. In general, GitHub projects are compatible with a wide range of programming languages, making it a great place to find projects to use and contribute to.

It's crucial to keep in mind that each GitHub project has certain requirements for programming languages and development tools. Therefore, before using or contributing to the project, it is crucial to fully understand the programming language used by it as well as the tools required to execute it.

Developers should be aware of the programming languages that GitHub is responsible for managing and selecting projects that match their interests and level of expertise. The popularity of the programming language must also be taken into consideration by developers as it may affect the accessibility of online resources and documentation.

In general, GitHub is compatible with the majority of programming languages used in the software development industry. This includes both well-known programming languages like Python, Java, C++, JavaScript, Ruby, and PHP as well as less well-known ones like Rust, Swift, Kotlin, etc. Additionally, GitHub is compatible with a wide range of development tools, including database management systems, web development frameworks, version control tools, etc.

For developers and software users alike, the GitHub project's compatibility with the programming language is ultimately a crucial factor. For software developers and users alike, the GitHub projects provide a wide range of possibilities and potentially invaluable information and resources.

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