DOCUMENT SUBMISSION SYSTEM

Software Design and Research Report

Software Engineering Project Group 28

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0.2	29/04/2022	Adrian Sim Huan Tze	Introduction and Document Overview are added.
0.3	03/05/2022	Jun Wee Tan	Complete and revised Section 2: Problem analysis Section 2.1: System Goals and objectives
0.4	05/05/2022	Adrian Sim Huan Tze	• Provided description for Detailed Design with Justification. • UML Class Diagram is added. • UML Sequence Diagrams of Login and Submission are added.
0.5	06/05/2022	Adrian Sim Huan Tze	Completed Model-View-Controller Design Pattern.
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DOCUMENT SIGN OFF

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1 Introduction

The Software Design document is a paper that provides detailed documentation on the design of the proposed prototype, *Document Submission System,* to aid in software development. The system shall support text-based analysis on the submission. The system is able to perform text extraction from the report and thus, generate five MCQ questions for the student to complete the submission. Web search against the assignment help portal can be carried out by the system to look for identical submissions. The system is capable of summarizing the report submitted with analysis result that includes reference summary, sentiment analysis, word count and frequency count, etc. The prototype is designed to have a backend MySQL server to support data storage. All application data is to be kept permanently in the persistent storage and the system provides an admin interface for data management.

The main idea to be addressed in this document would be the software architecture adopted in the design and describing how the software should be built. Contained by the document are graphical documentation of the software design of the project including class diagrams, high-level architectural diagram, use case diagrams, collaboration models, software design pattern and other supporting requirement information.

Apart from software design, there is also a research report embedded in this document. Various research is to be carried out by the team to develop certain technology that are requested by the client to satisfy the functional requirements of the system. Relevant technologies include Google NLP (text analysis tool), PDF-based text extraction, sentiment analysis and AWS EC2, S3 and RDS cloud services.

This software design and research report document serves as a proof of concept for the use of system building that delivers a base level of functionality to determine if the project is feasible to implement these technologies. It is basically focused on the design of critical components of the system. There will be no code implementation covered in this document.

1.1 Overview

The purpose of this document is to provide a comprehensive description of the system design in a graphical way to deliver an understanding of what is to be built and how it is planned to build. The document ensures that the software developers are on the same page of the software design before proceeding with the implementation and it also serves as a blueprint for communicating ideas. The target readers and audiences of this document are the client (Caslon Chua) and the software developer team. The proposed solution in this paper describes a functional document submission system with backend server database. The scope of the analysis mainly reviews object-design adopted by the system and incorporates problem analysis, high-level system architecture, design patterns, design heuristics as well as detailed design (class diagram).

1.2 Definitions, Acronyms and Abbreviations

MySQL	Open-source relational database management system.
PDF	Portable Document Format
EC2	Amazon Elastic Computing Cloud
AWS	Amazon Web Services
RDS	Amazon Relational Database Service
MCQ	Multiple Choice Question
OOD	Object-Oriented Design
NLP	Natural Language Processing
FAQ	Frequently Asked Questions
AMI	Amazon Machine Image
UML	Unified Modelling Language

2 Problem Analysis

This software design document will analyse the requirement of the document submission system stated in the Software Requirement Specification. All the functional and quality requirements will be discussed and analysed to produce design solutions for software. The requirement in SRS reveals all the essential functionalities that the document submission system needs to achieve business goals and every use case scenario.

2.1 System Goals and Objectives

Software Requirements Specification shows a list of functionalities that the system needs to perform to meet the use cases carried out in the acceptance criteria.

- Accept PDF submission from student
- Perform text extraction from submitted document
- Perform web search against assignment help or code repository website
- Generate MCQ questions from document submitted for student
- Analyze submitted document from student
- Record the information of:
    - The admin / convenor
    - The student
    - The student’s document submission
    - The multiple-choice questions generated from the submitted document
    - The student’s selected answers for the multiple-choice questions
    - The analysis results:
        - All extracted keywords from document
        - Extraction of 'references' section of document (if any)
        - Top 5 web search results link from the extracted keywords of the document (reference summary)
        - Sentiment analysis results
- Produce analysis report from document submitted, which contain:
    - MCQ question and results
    - Analysis results (stated above)
- Deliver student MCQ summary report to the convenor by sending daily email notification

2.2 Assumptions

A1. Only written documents and reports are submitted (research reports, literature reviews, and other essay-like documents).

A2. Only .PDF document file extensions are accepted and submitted to system.

A3. Codes, spreadsheets, slides, images, videos, and zipped files are not being submitted.

A4. Each analysis report and the multiple-choice questions generated is for exactly one document, one student and directed to one selected convenor.

A5. All users (students) will have a unique id, name, and email address.

A6. A user (student) can only submit 1 document at a time for analysis and multiple-choice question generation.

A7. A user (student) will only be able to answer the MCQ questions after they have submitted their document.

A8. A daily summary of student's MCQ question and result will be sent to respective convenor via email notification.

A9. Convenors will only receive the student's MCQ summary that have written down their email correctly.

3 High–Level System Architecture and Alternatives

3.1 System Architecture

3.1.1 Component-and-connector view

Figure 1 below presents the high-level design of the document submission system:

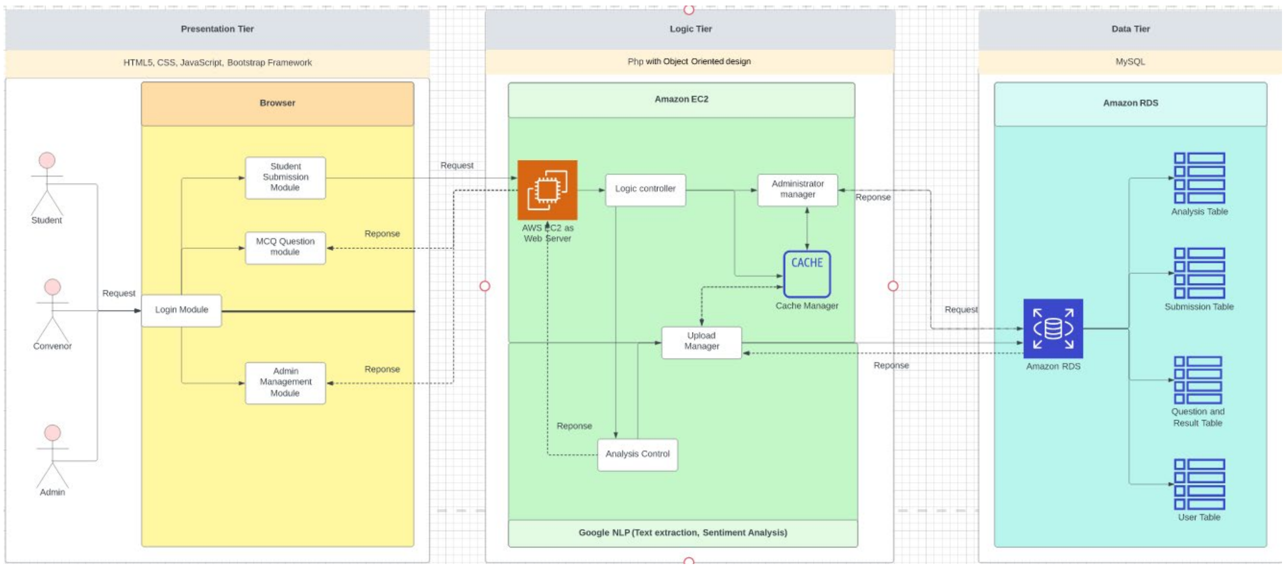


Figure 1 Component-and-connector view of architecture

The design is presented in a component and connector, arranged in a tiered architecture consisting of 3 tiers: the **presentation tier** dashboard accessed by the data administrator and students via the login module. It is important to specify that in this instance the unit convenors will have access to submissions like the data administrator as they are both considered as the role of admins in this context; the only difference would be that the convenor will only be able to access all information related to their corresponding unit, whereas the data administrator would have complete access to all records in the database. The dashboard will then allow the students to interact with the login module of the presentation tier, where they would be able to login to the system and submit documents in the student submissions module.

Furthermore, once the student submits the document, the MCQ module will be available for them to answer the questions provided and submit. The admin component will interact such that it can access the submissions in the admin management module, where the records will be available according to the type of admin the individual is (i.e., convenor or data administrator). The admin will have the privilege to access every analysis report and the questions generated for each submission by each student would be available for viewing and changes. The data administrator in the admin component is allowed to access and maintain the data-store, where management access will be provided in the logic layer.

The **logic tier** allows data sent by the presentation layer to be received by the analysis control component via the logic controller component: the logic controller component is responsible for the validation of data submitted in PHP. The administrator manager component allows the data administrator to request access for the maintenance of the database components. The upload manager component has the functionality of ensuring that successful uploading of information is made when analysis control component has conducted analysis and found analytical information that would need to be stored in the database. Finally, the cache manager that is connected to the web server is responsible for caching user data arriving from web server in the instance where the total amount of requests or updates exceed the throughput of the database. All the components detailed will be located within the Amazon EC2 instance.

The analysis control component consists of a machine-learning model with natural language capabilities to extract, conduct writing style analysis and summarize the content in a submitted document, where then onwards it would proceed to generate MCQs for the students to answer and the convenors to check with the utilization of Google NLP combined with other Python-related libraries; this analysed information would be passed to the database located in the data layer. The analysis control component will be the only component to exist outside of the Amazon EC2 instance from the logic tier; instead, the information would be handled via Google NLP.

The **data tier** consists of the database component which is connected to the cache manager, administrator manager and analysis control components. The database consists of connections to the analysis, questions, submit and user tables where queries can be passed from the database component to retrieve data corresponding to each query, which will be presented in a visual manner in the dashboard component for the student and admin components to view and utilize for their tasks. These components also allow the storage of new information pertaining to a new submission.

3.1.2 Deployment View

The figure 2 below is a diagrammatical representation of the document submission system from a deployment perspective:

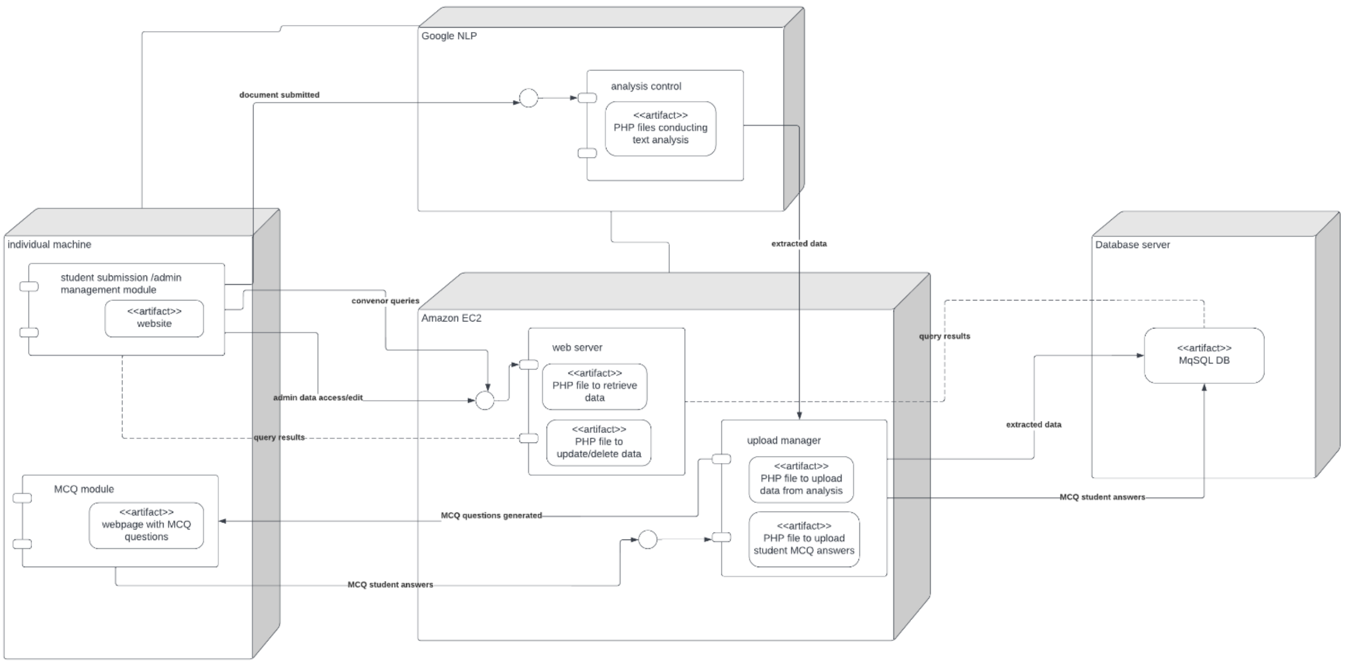


Figure 2 Deployment view of the solution

The student will be able to upload files to the submission system, which will be compiled and submitted via the student submission component that will be home page of the developed website that the student can access with an internet-connected device. There onwards it will be passed to the analysis control component under Google NLP where the document content will be extracted for text analysis. The text analysis will include the following:

1. A reference summary extraction from the document submitted by the student(if a list of references is available)
2. Keywords and key phrases identified in the document
3. MCQs generated with answers
4. Web search results from the title of the document with the result headings and their corresponding links

Once the text analysis is completed, all information will be passed to the upload manager component which will handle uploading all information provided onto their corresponding tables for safe storage. The uploaded manager will also simultaneously pass MCQ questions generated will be presented for the student in the MCQ module for the student to answer, and also store the questions with the actual correct answers. Once the questions are answered by the student, they will submit them again, which will be passed back to the upload manager for storing student answers in the database.

The admin management component will be accessible to convenors and data administrators; the convenor will be able to login to the dashboard and access submissions made by students that are involved with their corresponding unit. This will be done by navigating the website to access student submissions, which will result in a query to be executed that will return all relevant submissions made. By selecting a particular submission, it will trigger another query that would retrieve the relevant information regarding the submission. The retrieved information will then be added to form an analysis report via a PHP file that will be located in the web server. Along with the analysis report, the MCQ questions generated, including the student's answers and the actual answers are displayed in the admin management component.

The data administrator will get access to all data in the database for data to be updated and managed. The data administrator will also be able to access the data management component using an internet connected device. Once logged in, all information will be loaded to the admin interface where the data admin can edit or delete records in the database. This will be done by the corresponding PHP file applicable for the type of user logged in, which in this instance is the data administrator. The PHP file artifact will be located in the web server component of the Amazon EC2 instance.

3.2 Other Alternative Architectures Explored

3.2.1 Peer-to-Peer Architecture

The process below shows a high-level view of the document submission system arranged in a Peer-to-peer Architecture.

In the document submission system when a student logs into the system. The student establishes a connection to a workstation (node). The workstation will be responsible for collecting the documents and the MCQ answers from the student, send the generated questions to the student, and sends them all to the convenor (another node) via email. The requests that perform the actions mentioned above will be directly connected between the student's computer and the workstation.

However, the Peer-to-peer Architecture uses different computer system to store data. If many students submit their documents, then the storage and processing power needs to be upgraded more frequently when compared to having a centralised server. The student might also need to take longer time to send the documents and the MCQ answers, as well as receiving the MCQ questions as the connection bandwidth is limited on both ends of the node.

3.2.2 Event Driven Architecture

The process of the document submission system can be explained using the event driven architecture as follows.

In the document submission system when a student accesses the login to the system, a login event is published. Then the document submission system receives this event and accepts the login, if the credentials match. The student then makes a submission and uploads a document, which will publish a new upload event. A submission event is published when the student clicks on the 'submit' button after he/she finishes uploading the document/s. The student will then be required to answer the MCQ questions generated, which the system will publish an answer event. An event is triggered when the student answers each of five questions. Then 'submit' will complete submission process. After the student 'submit' the MCQ questions, they are sent to the convenor via email. Another email event is published in that instance.

However, development of the system from an event driven architecture is much more complex as event driven architectures backend does all the work to deliver the end user experience. Duplicates events may also occur in event driven environment, and this will result in increased work for error handling and trouble-shooting these errors.

4 Detailed Design (using Object Orientation or alternative)

4.1 The Detailed Design and Justification

The proposed design method of *Document Submission System* is **Object-Oriented Design (OOD)** which takes a **responsibility-driven** approach. The rationale behind the adoption of OOD in the system design is due to the strong encapsulation supported by OOD, thereby enhancing the reusability, maintainability, testability, and expendability of the software (Wirfs-Brock, R. and Wilkerson, B., 1989). Improving these software metrics can be achieved by managing the complexity of the software effectively. OOD method separates or decomposes the system based on the objects of the system to increase the modularity of the system and thus achieve *Weak Coupling and Strong Cohesion*. Each object in the system will follow the approach of **Responsibility-Driven Design (RDD)**. The main idea of this design focuses on assigning a certain role to each object in the system to evenly distribute the system intelligence. What are the responsibilities of this object? What information does this object share and who are the collaborators? (Wirfs-Brock, R. and Wilkerson, B., 1989) Behaviours are kept together with any relevant data in the individual object.

The system objectives outlined in 2.1 reveals a list of candidate classes that may be included into the system to perform those operations. Below shows all the required candidate classes:

- User – Parent class
- Unit
- Student – Child class
- StudentTable
- Admin – Child class
- Convenor – Child class
- Submission
- SubmissionTable
- Question
- QuestionTable
- Question List
- Analysis
- AnalysisTable
- Sentiment Analysis
- Database

All the candidate classes above will be tied with at least one collaborator and assigned with certain role to attain the system objectives. Overall, the system is designed to have a set of these interacting objects, each with at least one role. The high-level view of the object design is illustrated via a UML Class Diagram below.

Data storing will be managed by a database in the backend cloud server. Each of the classes act as a software component which encompasses a collection of data and relevant responsibilities, and they are tied together in an inter-dependency relationship to form the system. The classes will be the interface between the application and the database which governs the data flow.

In terms of the database schema, it is designed to normalize the database tables to third normal form without any data duplication, transitive dependency, and data anomalies. This is to simplify the data management and ensure referential integrity.

4.1.1 UML Class Diagram

Figure 3 below represents the UML class diagram for the document submission system to be implemented by group 28:

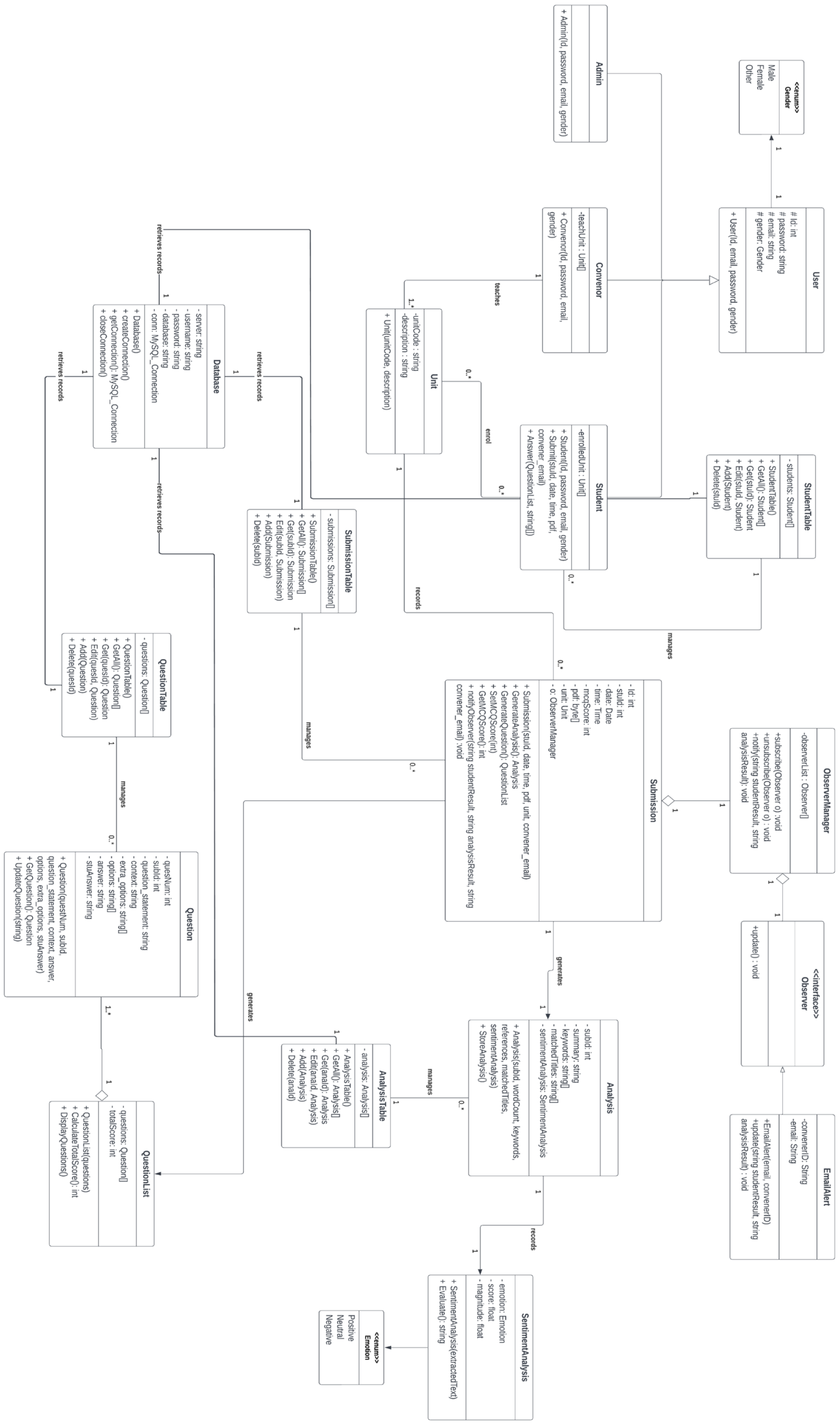


Figure 4 UML diagram for document submission system

For the **User** class diagram, it will act as the abstract base class that can be inherited to three concrete child classes which include **Admin**, **Convenor** and **Student** classes. **StudentTable**, **SubmissionTable**, **AnalysisTable** and **QuestionTable** act as an interface to retrieve records from the database. Their roles are similar to each other which modify, delete, add or view records. The key difference between them is that they are managing different types of data and performing different queries. The **Database** class is used to establish MySQL connection to the server to be used by these four classes.

The **Analysis** class will be responsible to perform and store the analysis result into analysis table. This information collected includes the results from the extracted keywords, top five web search result and sentiment results. The sentiment results are collected from sentiment analysis performed by **Sentiment** class. The metrics used to determine emotions are captured by an enumeration class called **Emotion**.

The generated question will be stored in **QuestionList** class. The **QuestionList** class is responsible to display question to student and calculate student's total score. Each generated question is represented by a **Question** class instance. This class is responsible to store data including question number, question statement, answer, student's answer etc. **ObserverManager** class will store the question list of multiple students that have the same convenor email. It also stores a list convenor that wants to subscribe system to get the latest notification. When schedule time is around, the **ObserverManager** class will send email and notify subscribed convenors.

The **Submission** class is used to record the submission attempt performed by the student. Each instance will store information such as Student ID, unit, date and time. Each student has many submissions, but one submission only belongs to a student.

4.1.2 Design Patterns

Model-View-Controller Pattern

MVC Design Pattern is applied in the development of Document Submission System. It is widely adopted in most of the software implementation as it practices the goals of '***separation of concerns***' and is very good in concern separation for user interaction. Since the system itself is performing a high abundance of data and handling lots of object interactions, MVC aids in separating user interaction from data processing and enables them to behave independently (Curry, E. and Grace, P., 2008). In other words, MVC decomposes the system intelligence and ease the complexity management which is beneficial to our system. The MVC proposes an effective method for viewing and varying data. It allows a model to have several views and controllers, which can be constructed and reworked independently of the model (Curry, E. and Grace, P., 2008).

There are three different components produced by decoupling data-processing logic, data access, data presentation and user interaction tasks to achieve independency. **Model**, **View** and **Controller**. Table 1 shows their individual responsibility and rule. Figure 4 illustrates the relationship between each MVC component.

Model	Model objects are responsible for storing, encapsulating and abstracting the data. There should not be any methods or application logic.
View	View components controls how the information from the model object is displayed to the user. View class design goes from the very basic to the very precise; generic view classes are supplied by the framework to present most kind of string, number, or image, while you are expected to implement very specific view objects designed for the application. Furthermore, view components also interpret and respond to user-initiated events including mouse click and keystrokes. Subsequent actions are instantiated in respond to the events that are passed to the controller object for execution. The event and resulting action are often very simple; clicking the mouse over a button object will send an action message to a controller.
Controller	Controller objects interacts and handles application actions from users. It merely serves as an intermediary between Model and View to facilitate the communication between them. Actions are usually invoked by view objects in response to user events.

Table 1: Model-View-Controller Components (Curry, E. and Grace, P., 2008)

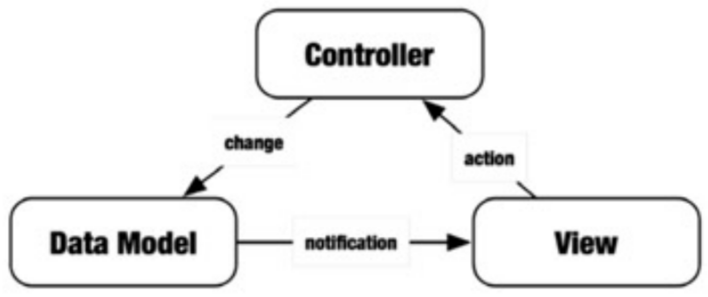


Figure 5: MVC Component Relationship (Bucanek, J n.d.)

Advantages of MVC Pattern in Software Quality

Modularity **-** The MVC Design Pattern is a good practice of computer science principles, separation of concern, and encapsulation. Applying the pattern enables the developers to identify the functional requirements of the document submission system and convert them into roles and compartmentalize those roles into distinct objects (Bucanek, J n.d.).

Interconnected functionalities like submitting assignment, answering questions are localized into containers with particular boundaries. When the interface to the class is well specified, it is less difficult to identify errors or analyse how the classes are affected when there are changes in the classes (Bucanek, J n.d.). Separating these components allows future modifications like replacing, subclassing and reusing classes without any impact on the other design components.

Flexibility **-** Model-View-Controller design pattern offers high flexibility. This is because MVC supports the features of effortlessly replacing view objects or use several view objects without worrying the cause of impact to the controller or data model. Any object (data model, controller, or view) is compatible with any functionally same object (Bucanek, J n.d.). Exchanging objects, or affixing multiple objects, does not disrupt the rest of the design. The mantra of MVC is to construct complicated applications by interlinking simple objects.

For instance, in the view object of QuestionList class, we can easily define multiple views of displaying the questions. The system is able to present the questions in different ways but yet still maintain the integrity of the data model.

Reuse **-** Reuse has a close association to flexibility. For instance, extracting the common abstractions of the classes allows the team to reuse the objects in other applications (if there is any) for some purposes. View and model components are the two most commonly reused objects (Bucanek, J n.d.).

Scalability **-** The Model-View-Controller design pattern has the effect of low coupling. MCV framework introduces low coupling among models, views or controllers which ease the modification. As MVC pattern separates the responsibilities, it is less complex to maintain for future development and modification. Thus, scalability increases.

Observer Behavioural Patterns

The observer design pattern has been considered and applied in our document submission system project. The observer, also known as the event subscriber or listener, is responsible for listening and waiting for updated data. If the data changes, the observers will notify immediately. This pattern suggests adding a subscription mechanism that observers have the choice to either subscribe or unsubscribe to from a stream of the event (Refactoring.guru 2022).

The advantages of an observer design pattern are providing a loose coupling between objects and provide scalability. The observers can be added or removed without affecting other objects. Below is the design of observer patterns implemented in our UML class diagram:

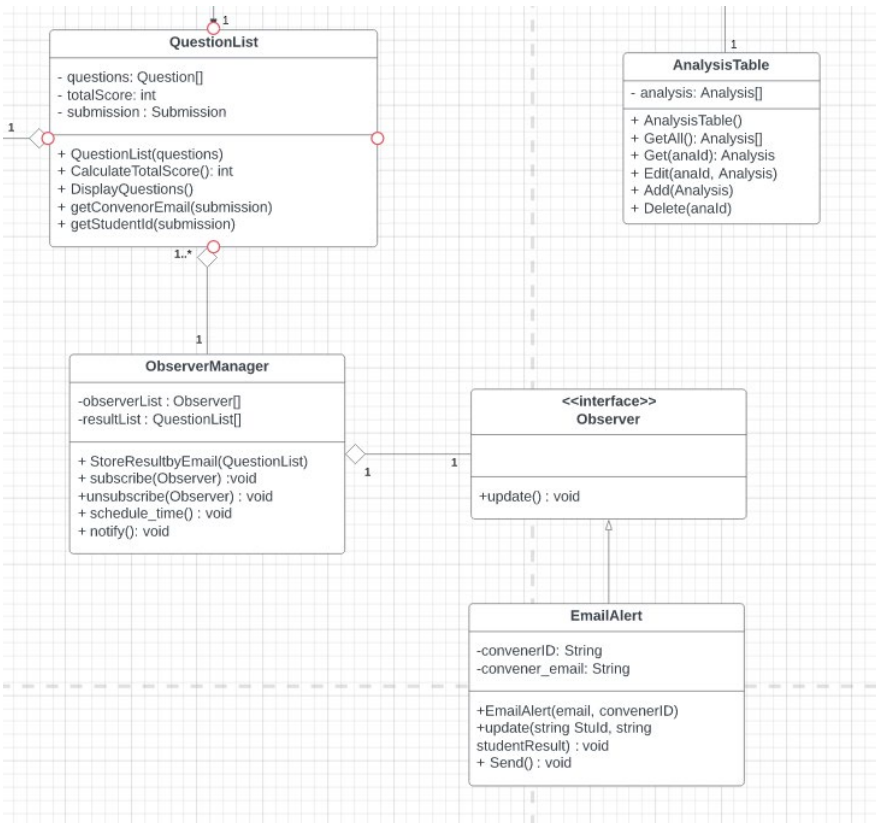


Figure 6 Observer patterns implemented

The ObserverManager will act as the **publisher of the student MCQ result to the convener.** The observer will serve as the base class that can derive types of observers. The derived class of observers will act as **subscribers of the observerManager (publisher).** The observerManager (publisher) can add many kinds of subscribe sub-class under the observer base class, such as phone calls and SMS. It provides scalability to the system.

ObeserverManager pseudocode:

```
//pseudocode
public class ObserverManager(){
    //store list of observer/convener that wants to receive email
    List<Observer> observerList = new List<Observer>();
    List<QuestionList> resultList =new List<QuestionList>();

    //add and remove the Observer(for now, is the convener that wants/do not want
to receive schedule email)
    public void subscribe(observer o){
        emailList.add(o);
    };
    public void unsubscribe(observer o){
        emailList.remove(o);
    };

    public void schedule_time(){
        DateTime nowTime = DateTime.Now;
        DateTime scheduledTime = new DateTime(nowTime.Year, nowTime.Month,
nowTime.Day, 9, 0, 0, 0); //every day 9am
        if (nowTime >= scheduledTime)
        {
            nofity();
        }
    };

    public void notify(){
        for each (observer o in observerList){
            for each (QuestionList r in resultList){
                if(o.convener_email =
resultList[r].QuestionList.submission.convener_email){
                    o.update(string resultList[r].QuestionList.submission.stuId,
string resultList[r].QuestionList.totalScore);
                }
            }
            }
        }
    };
};
};
```

Figure 7 observerManager pseudocode

The observerManager(Publisher) will have a list of observers (subscribers) that want to receive the student result. Whenever there is a new submission from the student, the observerManager will keep the student MCQ result in a list. An email will be composed by the end of the day (24 hours), with the student Id, student MCQ result send to convenor email (observer that have subscribed).

Observer and its sub-classes pseudocode:

```
//pseudocode
//base class
public abstract class Observer(){
    public abstract void update(){};
};

//derived class
public class Observer: EmailAlert
{
    private string email;
    private string convenerID;

    //constructor for creating convener that wants to receive schedule email
    public EmailAlert(email,convenerID){
        this.email = email;
        this.convenerID = convenerID;
    }

    //perform email sending function
    public override void update(string StuId, string studentResult){

        Console.WriteLine("Below is the schedule email for submission of student
with their result");
        //populate the email format and send
    };

};
```

Figure 8 observer and the pseudocode of its sub classes

When the **update** has been sent to the observer object, the update function will send an email query to the convenor with a list student Id and student result. Convenor can log in to the submission system web page to have a completely view of the student result report.

4.2 Design Verification

The proposed design solution is objectively verified by the following five non-trivial business use scenarios. Each of the scenario is illustrated using UML Sequence Diagram. In this section, these scenarios will demonstrate how the proposed solution handles them.

4.2.1 Student Login

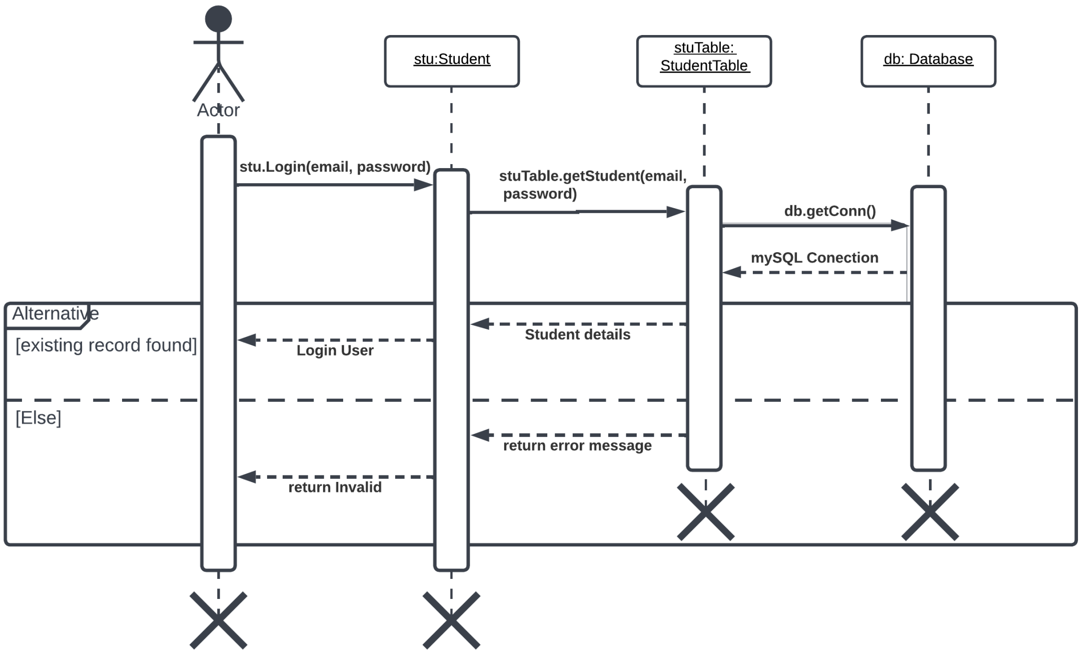


Figure 9 Sequence diagram for student login

After the user has entered the login credentials (email and password), the user will click on the Login button which invokes the Login method encapsulated in the Student class. The student class then calls the StudentTable class to perform SQL query to search for the existing record of the student. To achieve that, StudentTable class then calls Database class for MySQL connection to execute the query. Invalid login credentials will be returned to user if no existing record is found. Otherwise, the system will grant access to the student to access the system.

4.2.2 Student Submits an Assignment

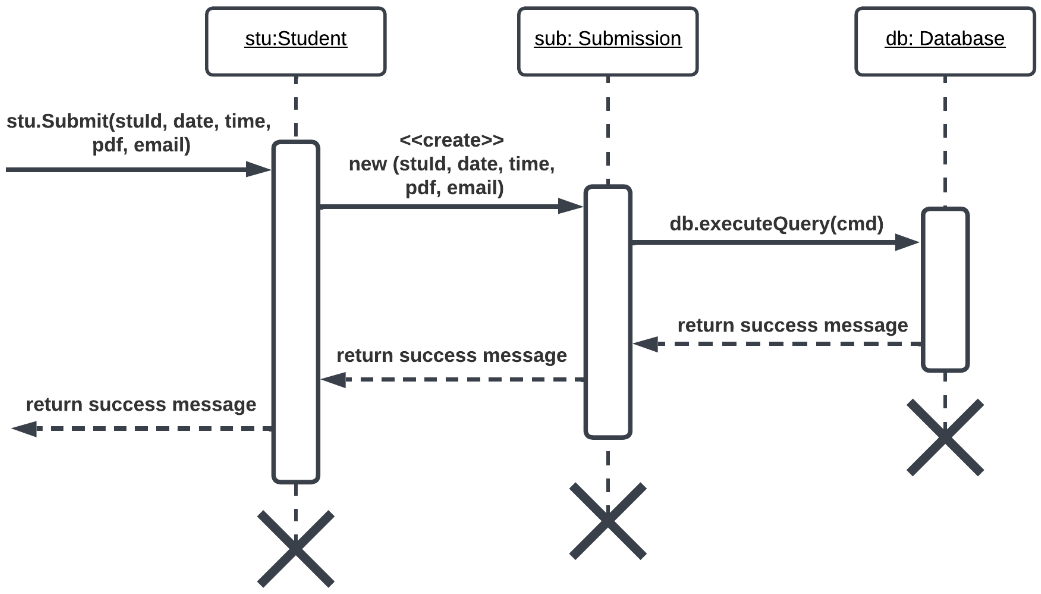
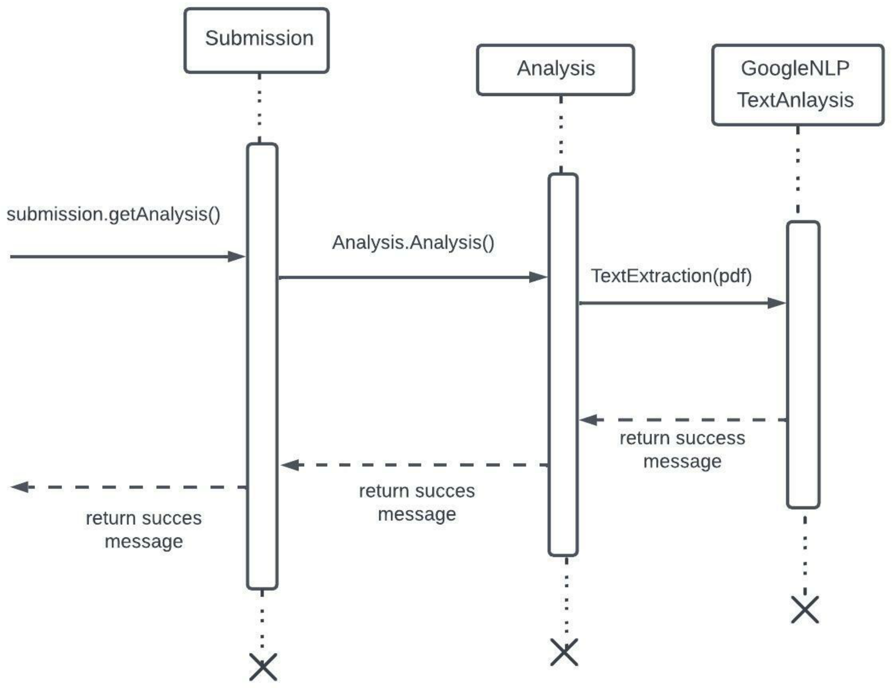


Figure 10 Sequence diagram for document submission

The caller calls the Student class to carry out the Submit method and passes in certain arguments which include student Id, pdf file and current date and time. A new submission object is created to store these data. The database class is then invoked to execute the insert query which stores the data from the submission object to the database. A return message will be returned by the database to the submission which passed it to the student.

4.2.3 Extract Text from PDF file



Once the document has been submitted for analysis, an Analysis object will be created through generateAnalysis(). This method will analysis the text through methods in Google NLP; Natural Language Processing. Once the text analysis has been completed, it will extract the keywords or phrases and it will be deemed a success if a “return success message” has appeared.

4.2.4 Report Analysis

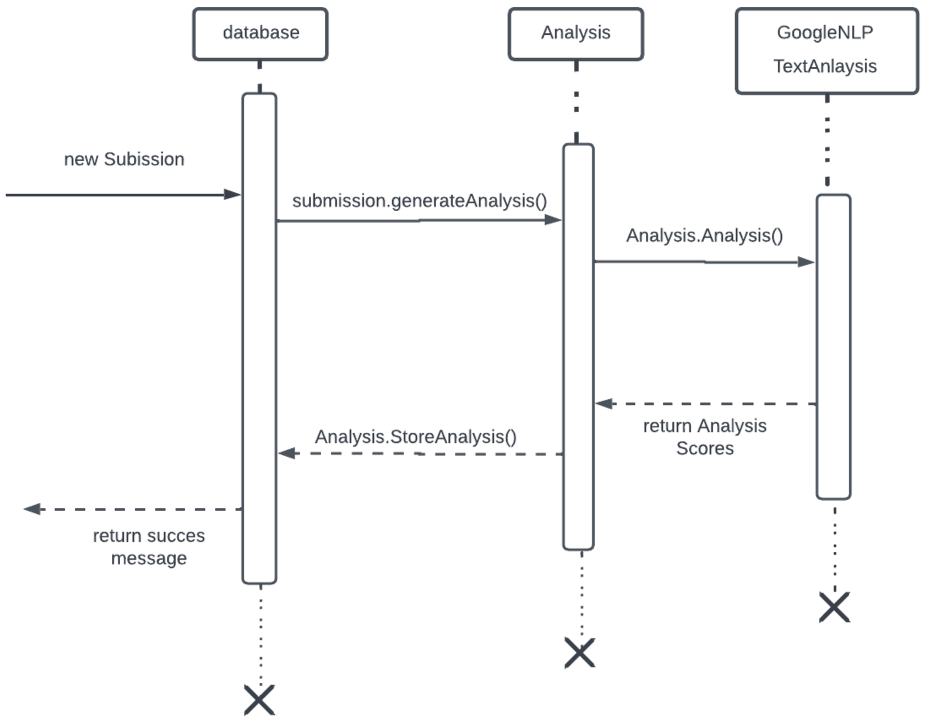


Figure 11 Sequence diagram for conducting report analysis

After a new submission is made by the student, the submission is stored in the database. Then the method generateAnalysis() is called to create a new Analysis object. The method Analysis is called to carry out the text analysis which is done using the methods in Google NLP. Several Analyses like syntax Analysis, Sentiment Analysis, Entity Analysis, Entity Sentiment Analysis and text Classification are carried out in this process. After the analysis is completed, Google NLP will return the scores of the Analyses performed. Then the method storeAnalysis() is called to store the scores in the database. After the scores are stored successfully, a success message will be returned.

4.2.5 Admin view Submissions from Database

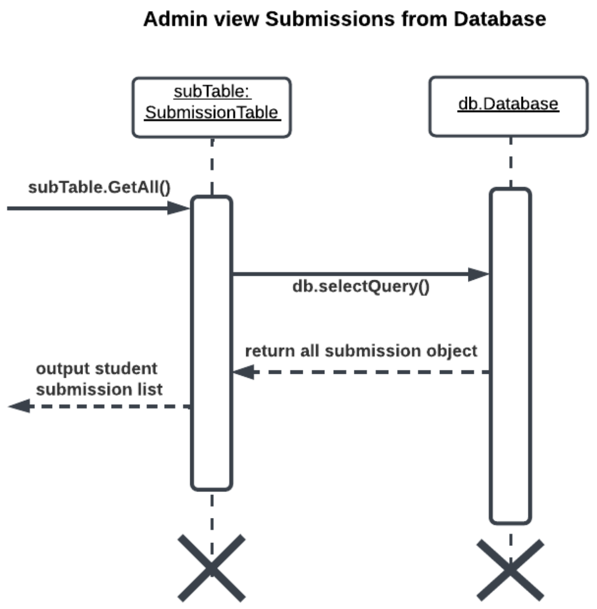

Admin view Submissions from Database
subTable: SubmissionTable
db.Database
subTable.GetAll()
db.selectQuery()
return all submission object
output student submission list

Figure 12 Sequence diagram for admin viewing submissions

When admin successfully login to document submission system webpage, they will be directed to students' submission page for checking total submission of students. The submission table object will perform GetAll() function to retrieve all students submission entries in the database to user interface as a list of table entries.

Besides, the filter for particular student Id and date will be done by front-end filter function, controlled by HTML. The student Id filter will get admin input for particular student Id whereas date filter will accept data input from admin. Admin have the freedom to provide input in both student Id and date filter. Below are the 4 scenario that will be examine by system:

- Admin provides Student Id and particular date – Filter by **certain** student submission in particular date
- Admin provides Student Id but did not provide particular date - Filter by **certain** student submission in **ALL** date
- Admin did not provide Student Id but provide particular date - Filter by **ALL** student submission in **particular** date
- Admin did not provide Student Id and particular date - Filter by **ALL** student submission in **ALL** date

5 Research and Investigations

5.1 Amazon Web Services

Document Submission System uses the cloud-computing Infrastructure-as-a-Service (IaaS) offered by AWS to host the application over the Internet. It serves as a platform built for accessing computing resources. These cloud applications comprise of huge data centres with powerful servers that host the web services and applications in the cloud. This amazing software platform offers convenience to the application user because anyone can access to the application as long as there is stable connection established and standard browser. This section discusses and reviews EC2, S3 and RDS.

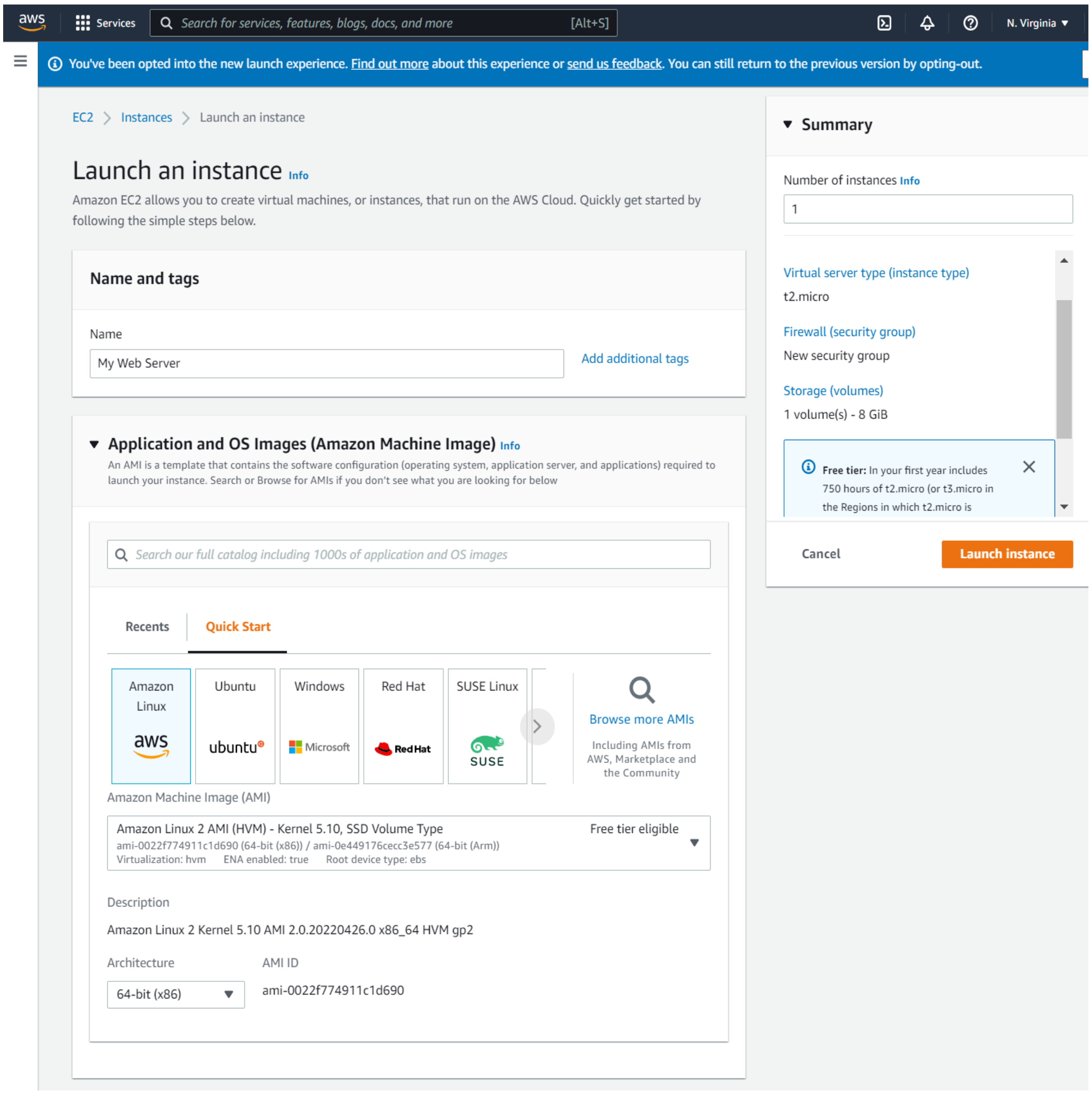
5.1.1 Elastic Compute Cloud (EC2)

Amazon Elastic Compute Cloud refers to one of the Amazon Web Services that supports resizable compute capacity in the cloud which enables developers to effortlessly web-scale the capacity of computing to suit the surfing demand. With the help of the AWS EC2 interface, the developers can adjust and configure the computing capacity with minimum friction. From the perspective of a software developer, there are various benefits offered by EC2 (Kulkarni, G., Sutar, R. and Gambhir, J., 2012).

- Lessens the time needed to boot new server instances in minutes
- Scaling capacity can be accomplished very quickly either vertically or horizontally
- Customize the capacity according to the requirements by altering the computing economics. The software developer only pays for capacity that is actually used.
- Developers are offered various necessary tools to develop failure resilient applications. These applications are then separated from common failure scenarios (Kulkarni, G., Sutar, R. and Gambhir, J., 2012)

Amazon EC2 offers a true computing virtual environment which enables developers to launch instances using AWS interfaces in a variety of operating systems such as Amazon Linux, Ubuntu, Windows Server, Red Hat Enterprise Linux, SUSE Linux Enterprise Server, Fedora, Debian, CentOS, Gentoo Linux, Oracle Linux, and FreeBSD. The launched instances can be loaded with custom application environment and configured network's access permissions. Before utilizing AWS EC2 services, there are a list of procedures needed to be followed and satisfied:

1. Choose a pre-configured, ***launch template image*** to be created and run instantly. For example, a launch template can contain the AMI (Amazon Machine Image) ID, instance type, and network settings that you typically use to launch instances. The AMI comprises of the applications, libraries, data and other connected configuration settings.


You've been opted into the new launch experience. Find out more about this experience or send us feedback. You can still return to the previous version by opting-out.

EC2 > Instances > Launch an instance

Launch an instance Info

Amazon EC2 allows you to create virtual machines, or instances, that run on the AWS Cloud. Quickly get started by following the simple steps below.

Name and tags

Name: My Web Server

Application and OS Images (Amazon Machine Image) Info

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. Search or Browse for AMIs if you don't see what you are looking for below

Amazon Machine Image (AMI)

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type — Free tier eligible
ami-0022f774911c1d690 (64-bit (x86)) / ami-0e449176cecc3e577 (64-bit (Arm))
Virtualization: hvm ENA enabled: true Root device type: ebs

Description: Amazon Linux 2 Kernel 5.10 AMI 2.0.20220426.0 x86_64 HVM gp2

Architecture: 64-bit (x86)

AMI ID: ami-0022f774911c1d690

Summary

Number of instances: 1

Virtual server type (instance type): t2.micro

Firewall (security group): New security group

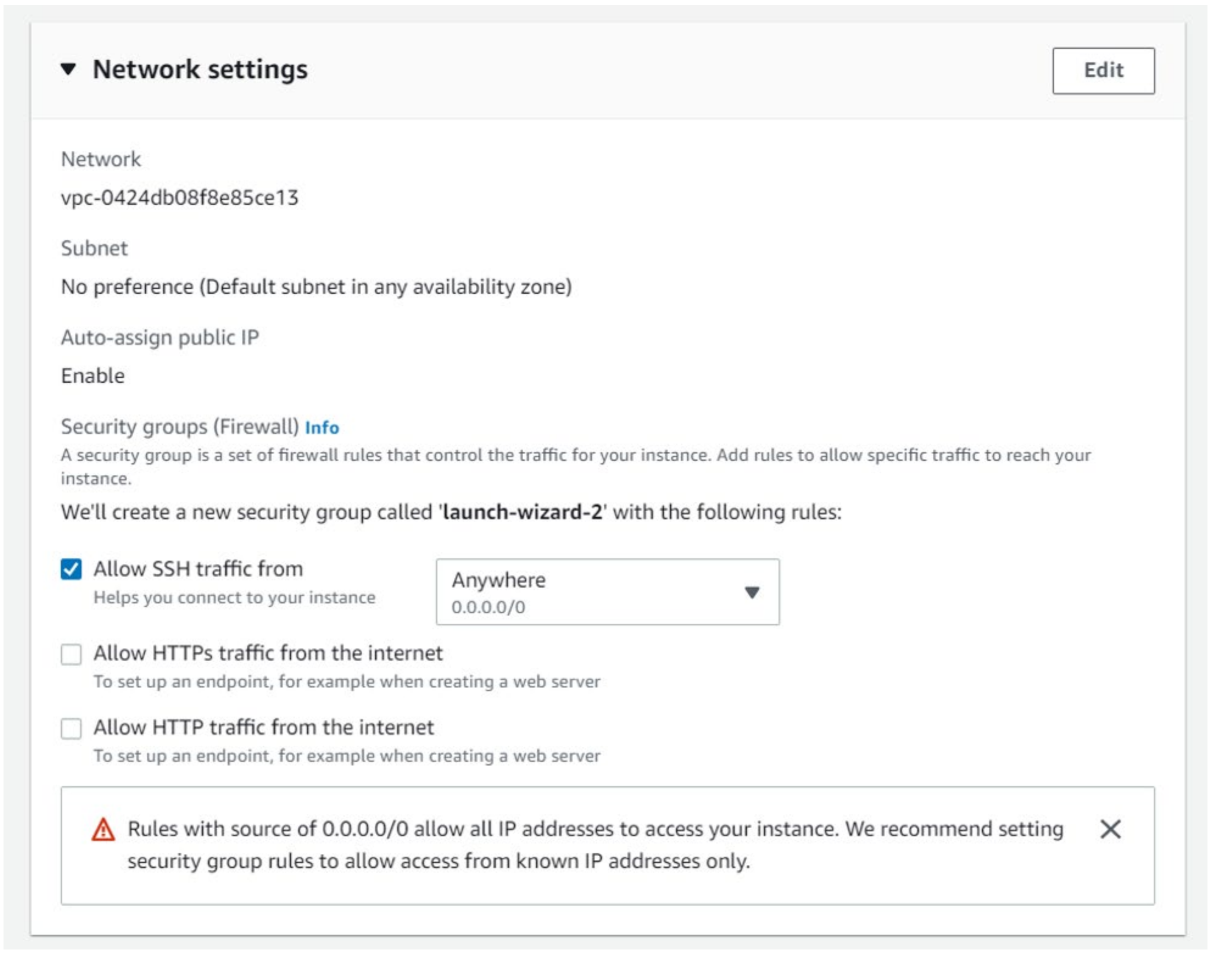
Storage (volumes): 1 volume(s) - 8 GiB

Free tier: In your first year includes 750 hours of t2.micro (or t3.micro in the Regions in which t2.micro is

Services
Search for services, features, blogs, docs, and more [Alt+S]
N. Virginia
Add additional tags
Search our full catalog including 1000s of application and OS images
Recents
Quick Start
Amazon Linux
Ubuntu
Windows
Red Hat
SUSE Linux
Browse more AMIs
Including AMIs from AWS, Marketplace and the Community
Cancel
Launch instance

Figure 13 Interface for launching an Amazon EC2 instance

2. Configure and setup the ***security and network access*** on the Amazon EC2 instance.



▼ **Network settings**

Network
vpc-0424db08f8e85ce13

Subnet
No preference (Default subnet in any availability zone)

Auto-assign public IP
Enable

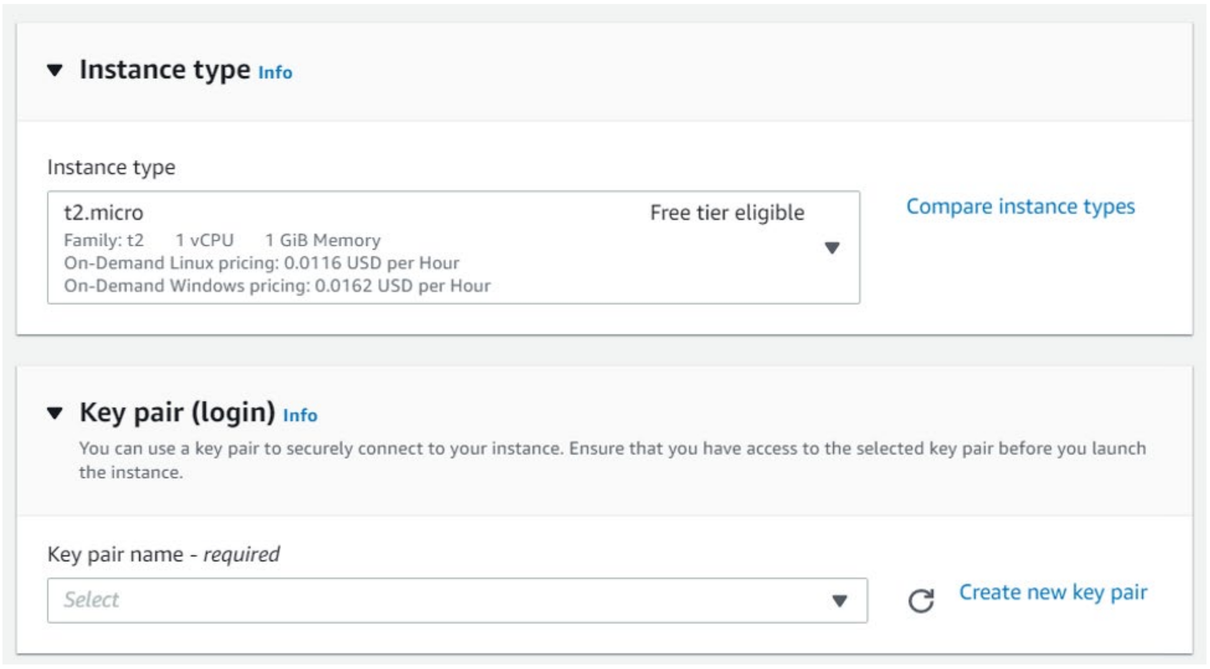
Security groups (Firewall) Info
A security group is a set of firewall rules that control the traffic for your instance. Add rules to allow specific traffic to reach your instance.
We'll create a new security group called '**launch-wizard-2**' with the following rules:

- [✓] Allow SSH traffic from — Anywhere 0.0.0.0/0
  Helps you connect to your instance
- [ ] Allow HTTPs traffic from the internet
  To set up an endpoint, for example when creating a web server
- [ ] Allow HTTP traffic from the internet
  To set up an endpoint, for example when creating a web server

⚠ Rules with source of 0.0.0.0/0 allow all IP addresses to access your instance. We recommend setting security group rules to allow access from known IP addresses only.

Figure 14 Configuration for Amazon EC2 instance

3. Select the type of instance, operating system needed. Start, terminate and monitor the launched instances needed with the help of web service APIs or other offered management tools.



Instance type

t2.micro — Free tier eligible
Family: t2 1 vCPU 1 GiB Memory
On-Demand Linux pricing: 0.0116 USD per Hour
On-Demand Windows pricing: 0.0162 USD per Hour

You can use a key pair to securely connect to your instance. Ensure that you have access to the selected key pair before you launch the instance.

Key pair name - *required*

Select

Figure 15 Instance type selection for Amazon EC2

4. Ascertain if the instance is intended to run in various locations by utilizing static IP endpoints or attach permanent block storage to the instances.
5. Pay for the resources that is actually consumed. Calculations are based on ***instance-hours*** or data transfer (Kulkarni, G., Sutar, R. and Gambhir, J., 2012).

5.1.2 Amazon S3 Storage Model

Amazon's Simple Storage Service (S3) provide cloud storage to store data which named as 'objects' and grouped in a container called 'buckets'. **This is explicitly beneficial to our prototype as it stores the project folder which are to be loaded by the EC2 instance later.**

To achieve the storage model, buckets have to be created initially prior to using it, each AWS user is able to create up to 100 buckets. The bucket names are global and only uniquely identified name is allowed in AWS to avoid name duplication. Every bucket can be configured to control the network access such as read/write permission (Garfinkel, S., 2007). Amazon states that S3 storage is designed to store huge objects and several tests have been conducted to verify that S3 storage offers high throughput dramatically on large objects than small objects due to high overhead per transaction (Garfinkel, S., 2007).

5.1.3 Amazon Pricing

The pricing for AWS EC2 is set at 10 cents/hour for each instance using rounded up fractional hours. Each running instance must be shut down with ***ec2-terminate-instances*** command to avoid additional charges.

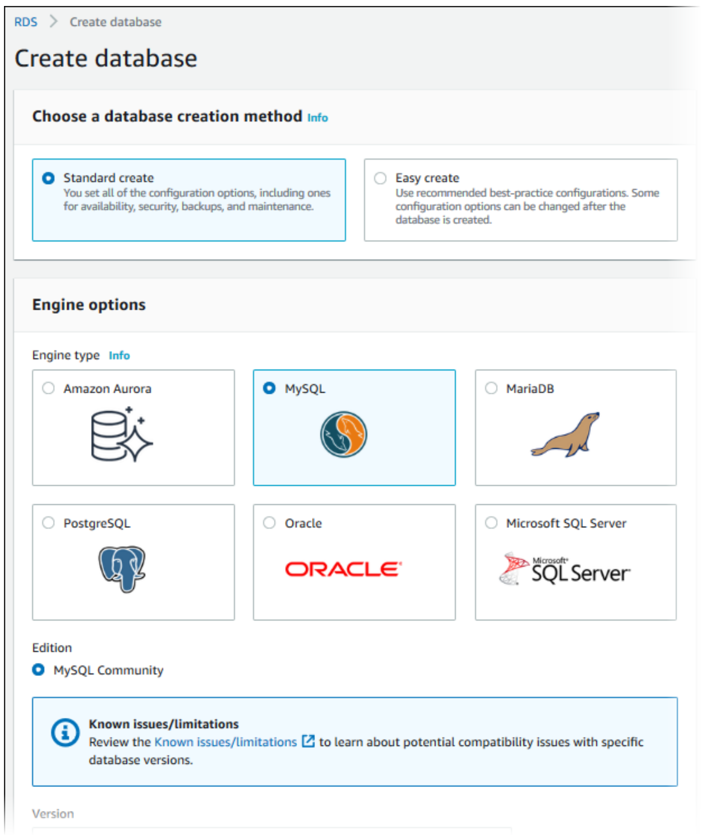
Crashed instance or instance that haven't reboot spontaneously will keep on acquiring charges (Garfinkel, S., 2007).

AWS S3 Storage is charged based on the size of data storage. It is charged on a flat basis of 15 cents/GB stored for one month. The data size will be worked out twice on a daily basis. Amazon has made a decision that starting from 1st of June 2007, 1 cent for each transaction fee will be charged for every 1000 PUT requests and 1 cent for every 10,000 GET requests (Garfinkel, S., 2007). Deleting requests do not incur any charges.

5.1.4 Relational Database System (RDS)

Amazon Relational Database Service (Amazon RDS) is a web service that helps users establish and run a relational database in the cloud. It delivers scalable and cost-effective storage for users while handling database management responsibilities (Jinesh. V, Sajee.M, 2014). It allows users to concentrate on the application and free up the stress of managing the database. Amazon RDS will automatically help users to secure the database including update patches and backup database.
In our project, we will use AWS Academy learner lab provided by Swinburne university to launch our Amazon RDS service. Below is the list of procedure to create a database (DB) instance:

1. Sign into AWS Academy Learner Lab and direct to AWS management console
2. Choose the Amazon RDS under AWS service panel
3. Choose the Database option to create (Our project will use MySQL as database engine)



Create database

Choose a database creation method Info

[✓ Standard create] You set all of the configuration options, including ones for availability, security, backups, and maintenance.

Easy create — Use recommended best-practice configurations. Some configuration options can be changed after the database is created.

Engine options

Engine type Info

Amazon Aurora | [✓ MySQL] | MariaDB | PostgreSQL | Oracle | Microsoft SQL Server

Edition

[✓ MySQL Community]

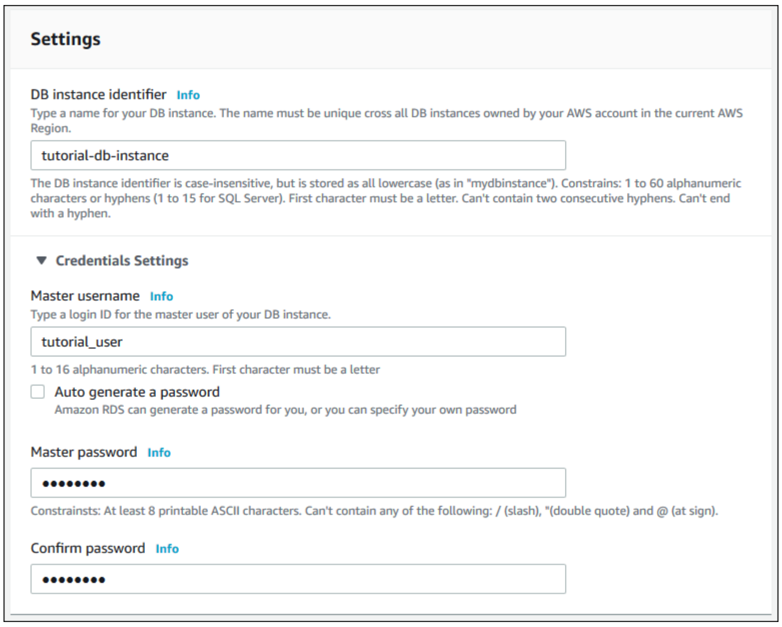
Known issues/limitations
Review the Known issues/limitations to learn about potential compatibility issues with specific database versions.

Version

Figure 16 Create database feature in Amazon EC2

Example of create database page (Amazon Web Service, 2022)

4. Choose the 'Free Tier' for database template
5. In setting section, set the values based on project needs



Settings

DB instance identifier Info
Type a name for your DB instance. The name must be unique cross all DB instances owned by your AWS account in the current AWS Region.

tutorial-db-instance

The DB instance identifier is case-insensitive, but is stored as all lowercase (as in "mydbinstance"). Constrains: 1 to 60 alphanumeric characters or hyphens (1 to 15 for SQL Server). First character must be a letter. Can't contain two consecutive hyphens. Can't end with a hyphen.

▼ Credentials Settings

Master username Info
Type a login ID for the master user of your DB instance.

tutorial_user

1 to 16 alphanumeric characters. First character must be a letter

☐ Auto generate a password
Amazon RDS can generate a password for you, or you can specify your own password

Master password Info

••••••••

Constrainsts: At least 8 printable ASCII characters. Can't contain any of the following: / (slash), "(double quote) and @ (at sign).

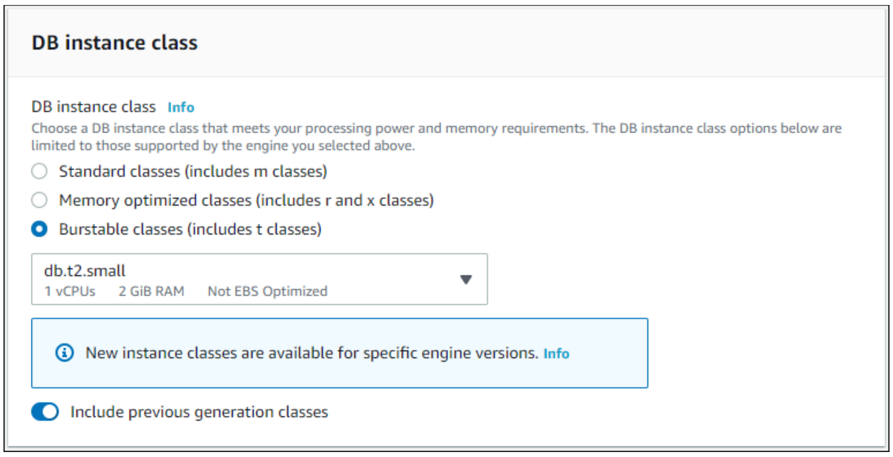
Confirm password Info

••••••••

Figure 17 Example of setting option in create database page (Amazon Web Service, 2022)

a. DB instance identifier is the unique name for database
b. Master username is the admin name for managing this database

6. After finishing the settings, user will have to choose DB instance size. Our project will adopt **db.t2.micro** instance size which have 1vCPU and 1 GiB RAM, to coordinate to our project needs.



DB instance class

DB instance class Info
Choose a DB instance class that meets your processing power and memory requirements. The DB instance class options below are limited to those supported by the engine you selected above.

○ Standard classes (includes m classes)
○ Memory optimized classes (includes r and x classes)
● Burstable classes (includes t classes)

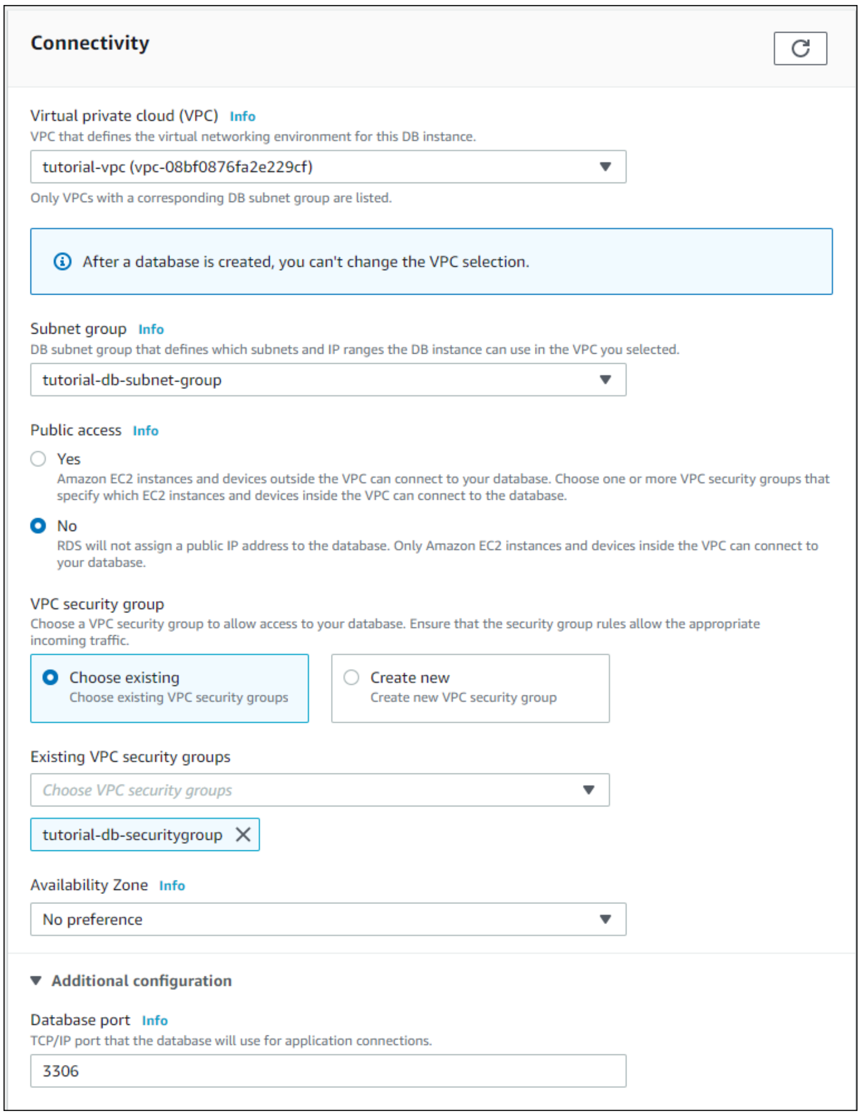
db.t2.small
1 vCPUs 2 GiB RAM Not EBS Optimized

New instance classes are available for specific engine versions. Info

Include previous generation classes

Figure 18 Example of DB instance size in create database page (Amazon Web Service, 2022)

7. Use the default value set in this Storage and Availability & durability sections
8. Heading to connectivity section, set the network value based on the project.



Connectivity

Virtual private cloud (VPC) Info
VPC that defines the virtual networking environment for this DB instance.
tutorial-vpc (vpc-08bf0876fa2e229cf)
Only VPCs with a corresponding DB subnet group are listed.

After a database is created, you can't change the VPC selection.

Subnet group Info
DB subnet group that defines which subnets and IP ranges the DB instance can use in the VPC you selected.
tutorial-db-subnet-group

Public access Info
- Yes
  Amazon EC2 instances and devices outside the VPC can connect to your database. Choose one or more VPC security groups that specify which EC2 instances and devices inside the VPC can connect to the database.
- [✓ No]
  RDS will not assign a public IP address to the database. Only Amazon EC2 instances and devices inside the VPC can connect to your database.

VPC security group
Choose a VPC security group to allow access to your database. Ensure that the security group rules allow the appropriate incoming traffic.
- [✓ Choose existing] Choose existing VPC security groups
- Create new — Create new VPC security group

Existing VPC security groups
Choose VPC security groups
tutorial-db-securitygroup

Availability Zone Info
No preference

Additional configuration

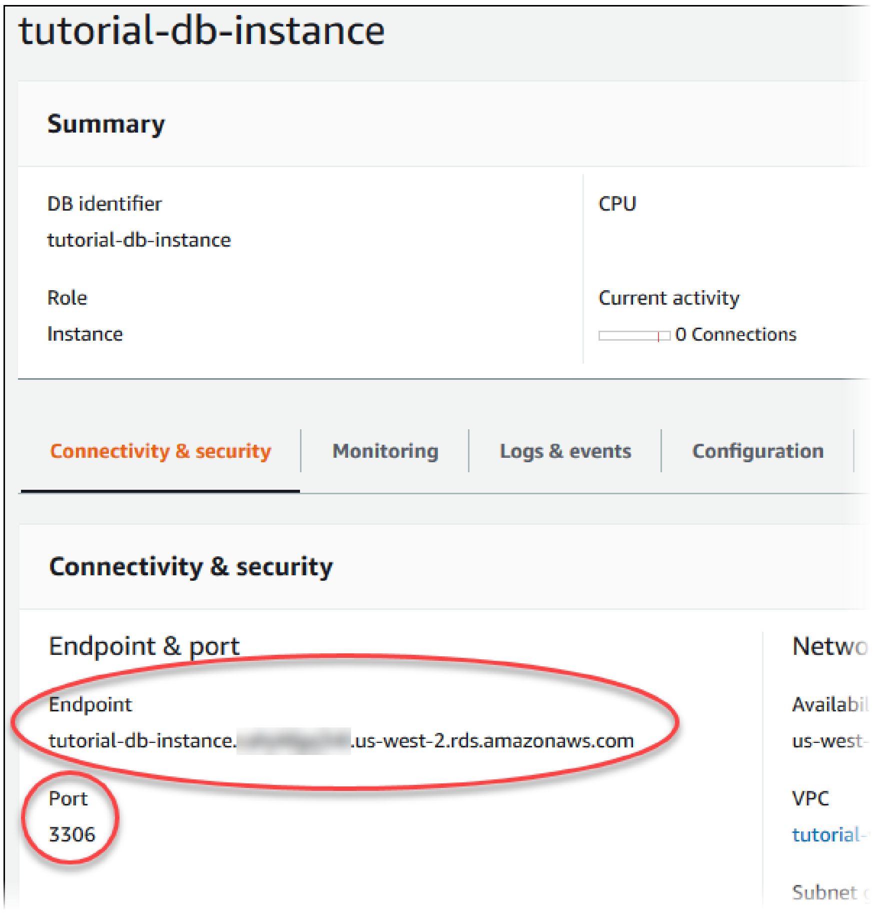
Database port Info
TCP/IP port that the database will use for application connections.
3306

Figure 19 Example of connectivity setting in create database page (Amazon Web Service, 2022)

a. Virtual Private Cloud (VPC) – choose the default VPC/ VPC that are same as EC2 instance
   i. Additional Connectivity configuration
      1. Subnet group – Choose default
      2. Public accessible – Choose **No** for not assign public IP address to RDS instance. Only EC2 instance or device inside the VPC can connect to database.
   ii. VPC security group – Choose the existing security group that have created in EC2 instance.
   iii. Availability Zone – Choose No preference
   iv. Database Port – Make sure use the default database port value 3306

9. Go to Database authentication after finishing the connectivity setting.
10. Enable Password authentication in database.
11. Keep all the setup by default in Additional configuration section.
12. Review all the setting and click Create Database once complete.

13. After successfully setup the database, view and copy the Endpoint and Port of the DB instance (both information is for connecting web server EC2 to database)



tutorial-db-instance

Summary

DB identifier
tutorial-db-instance

Role
Instance

CPU

Current activity
0 Connections

Connectivity & security

Endpoint & port

Endpoint
tutorial-db-instance.[redacted].us-west-2.rds.amazonaws.com

Port
3306

Netwo

Availabil
us-west-

VPC
tutorial-

Subnet

Figure 20 Example of Endpoint and Port information (Amazon Web Service, 2022)

14. Go back to EC2 instance and set Inbound rules for database port (3306)

5.2 Text Analysis Tool

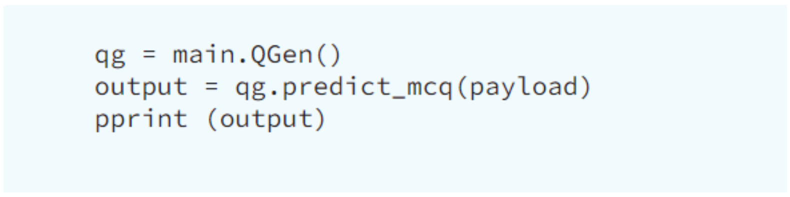
5.2.1 Generate Question

The relevance of question generation to this context is a software requirement where the software solution is expected to generate five MCQ questions including answers from the text extracted. The generation of questions and answers is expected to be conducted using NLP. Although the main text analysis tool used is Google NLP, the research conducted concluded that there is no efficient way to generate questions with answers. Therefore, another library or tool would have to be utilized in order to generate questions and answers.

According to the extended research conducted, a library named "Questgen.ai" which can generate questions via NLP algorithms (Kandi X-RAY Questgen.ai Summary, 2022). It currently supports the following types of questions and capabilities:

1. MCQs
2. Boolean questions ("Yes" or "no")
3. Question answering
4. Question paraphrasing
5. General FAQs

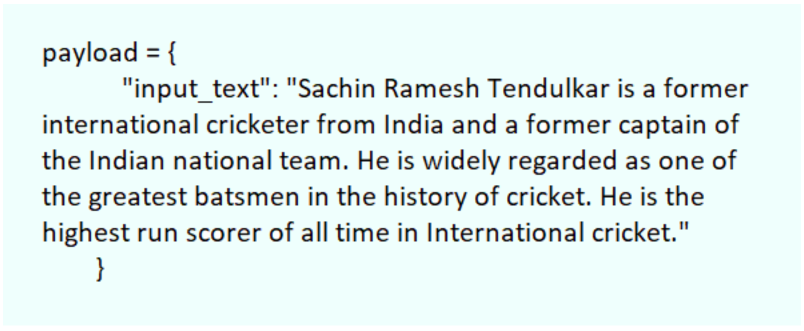
However, for our software requirement fulfilment, point number 1 will only be used; prior to question generation, the "Sense2vec" Python package would need to be downloaded and extracted to generate the MCQs. Once this is accomplished, the MCQs can be generated in Python using the Questgen.ai library as follows:



```
qg = main.QGen()
output = qg.predict_mcq(payload)
pprint (output)
```

Figure 21 Question generation using Questgen.ai library

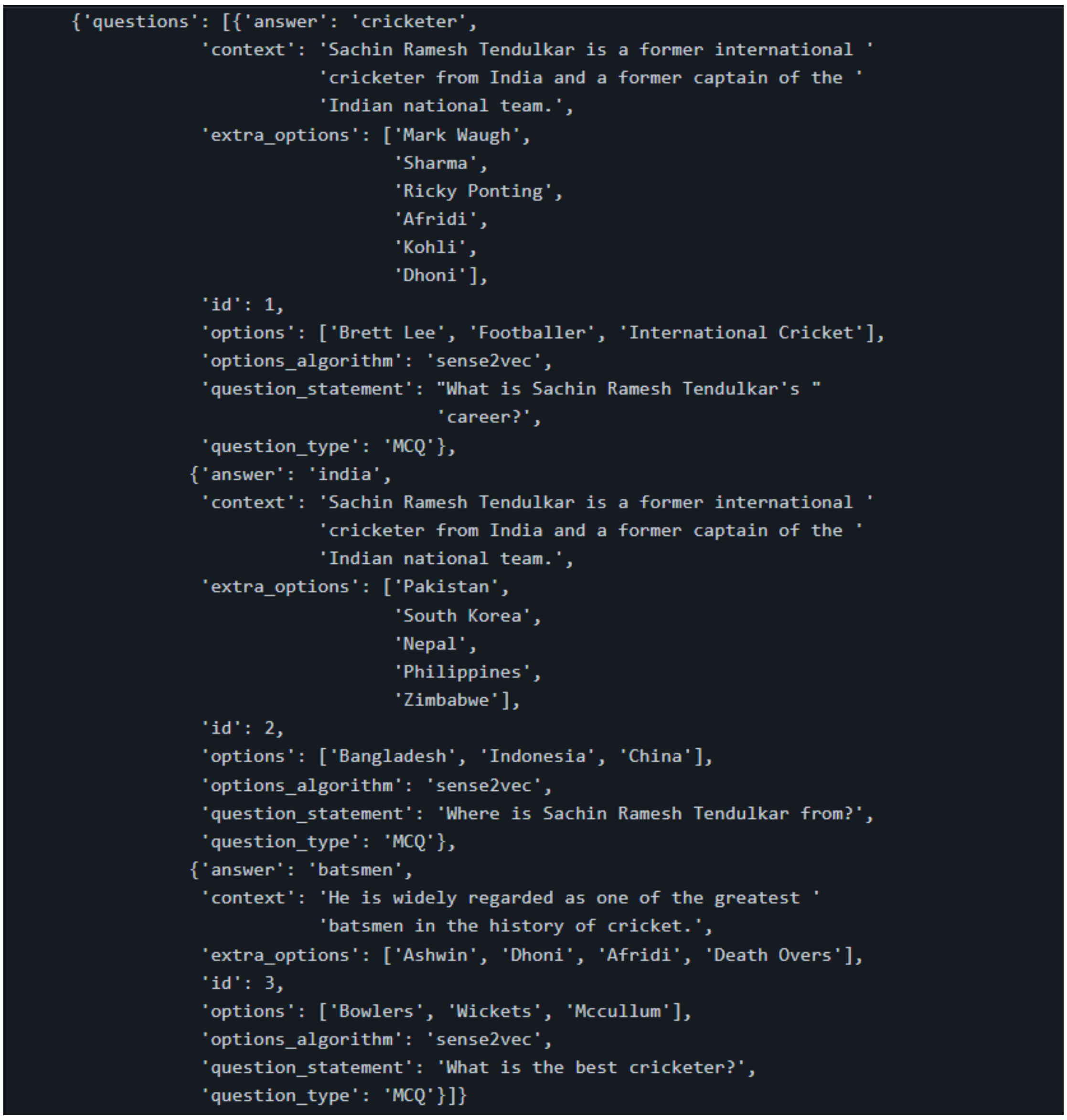
The payload in this context would be the text extracted from the document where it will be passed to "predict_mcq" method to generate the MCQs. To be more precise, figure below shows an example payload which can be run be used as an argument for the question prediction method:



```
payload = {
        "input_text": "Sachin Ramesh Tendulkar is a former
international cricketer from India and a former captain of
the Indian national team. He is widely regarded as one of
the greatest batsmen in the history of cricket. He is the
highest run scorer of all time in International cricket."
    }
```

Figure 22 Example payload (Goutham Golla, 2022)

An example of the output with the above payload is presented below in figure 22:



```
{'questions': [{'answer': 'cricketer',
                'context': 'Sachin Ramesh Tendulkar is a former international '
                           'cricketer from India and a former captain of the '
                           'Indian national team.',
                'extra_options': ['Mark Waugh',
                                  'Sharma',
                                  'Ricky Ponting',
                                  'Afridi',
                                  'Kohli',
                                  'Dhoni'],
                'id': 1,
                'options': ['Brett Lee', 'Footballer', 'International Cricket'],
                'options_algorithm': 'sense2vec',
                'question_statement': "What is Sachin Ramesh Tendulkar's "
                                      'career?',
                'question_type': 'MCQ'},
               {'answer': 'india',
                'context': 'Sachin Ramesh Tendulkar is a former international '
                           'cricketer from India and a former captain of the '
                           'Indian national team.',
                'extra_options': ['Pakistan',
                                  'South Korea',
                                  'Nepal',
                                  'Philippines',
                                  'Zimbabwe'],
                'id': 2,
                'options': ['Bangladesh', 'Indonesia', 'China'],
                'options_algorithm': 'sense2vec',
                'question_statement': 'Where is Sachin Ramesh Tendulkar from?',
                'question_type': 'MCQ'},
               {'answer': 'batsmen',
                'context': 'He is widely regarded as one of the greatest '
                           'batsmen in the history of cricket.',
                'extra_options': ['Ashwin', 'Dhoni', 'Afridi', 'Death Overs'],
                'id': 3,
                'options': ['Bowlers', 'Wickets', 'Mccullum'],
                'options_algorithm': 'sense2vec',
                'question_statement': 'What is the best cricketer?',
                'question_type': 'MCQ'}]}
```

Figure 23 Example output based on the example payload (Goutham Golla, 2022))

According to figure 3, there are 3 MCQs generated from the given input payload, which would be the text extracted from the diagram. For each MCQ generated, four elements would be presented: the answer element shows the answer to the MCQ, the context shows the statement from where the question was derived from, the options show the other options for the user to select that are generated, the options algorithm shows the algorithm used to generate the other options and finally the id element gives the question number. If these results are generated successfully, these elements can be used to present the MCQ questions to the student for them to answer and submit via the dashboard component.

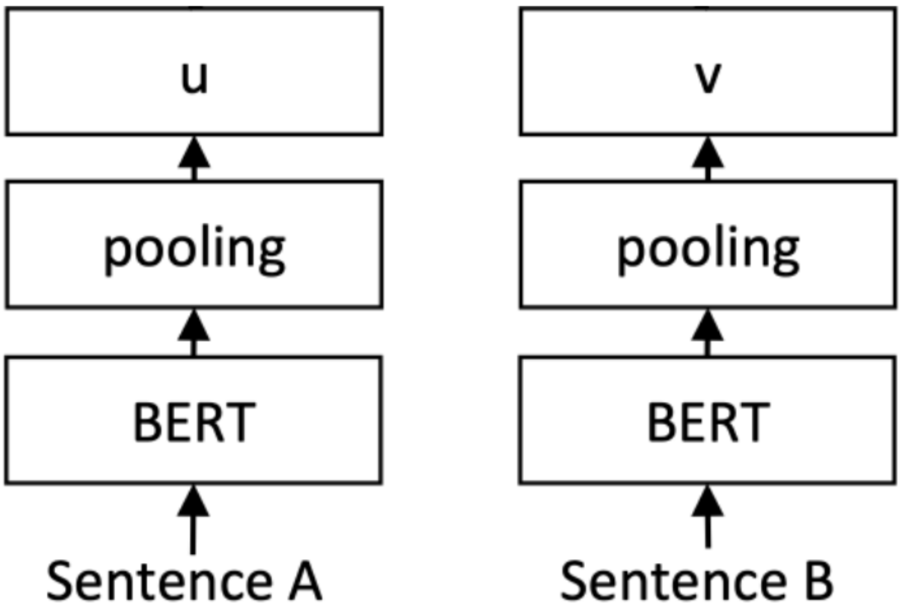
5.2.2 Extract sentence/Keyword

Keyword extraction is an automated method which extracts key information from pieces of text by looking for certain words or phrases.

There are various methods to extracting keywords which are:

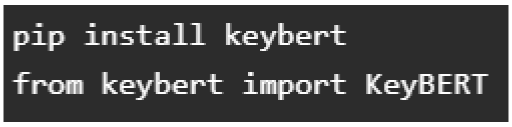
- **KeyBert –** A relatively simple "keyword extraction method" which takes advantage of the "SBERT embeddings" to find keywords and phrases from a document and comparing it to another similar document.

  Essentially, how it works is that it will first embed a document generated using the sentence-BERT model. Afterwards, the embedded words will be extracted for N-gram phrases, a continuous sequence of words within a document.



  Example of sentence-BERT Model (Viktor Karlsson 2020)

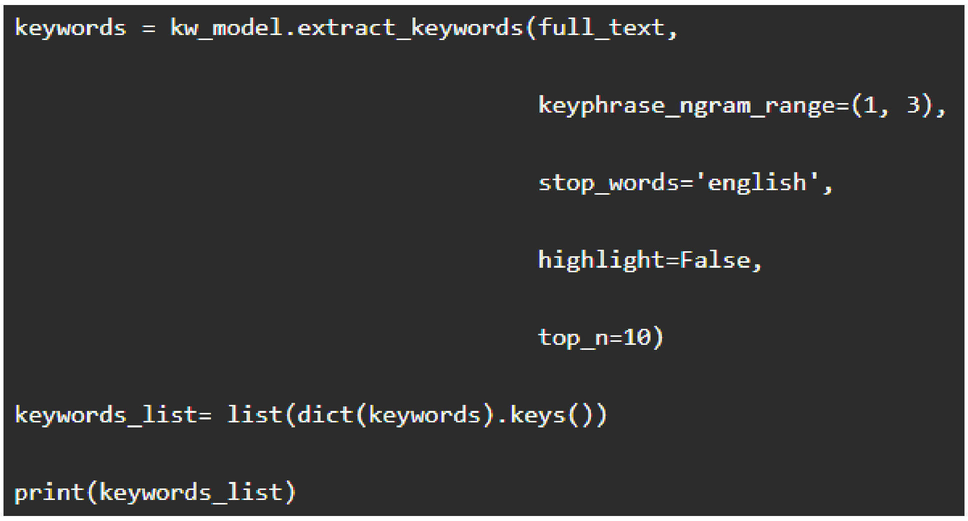
  To install KeyBert, users must use the example below.



```
pip install keybert
from keybert import KeyBERT
```

Figure example of KeyBert (Ali Mansour, 2022))

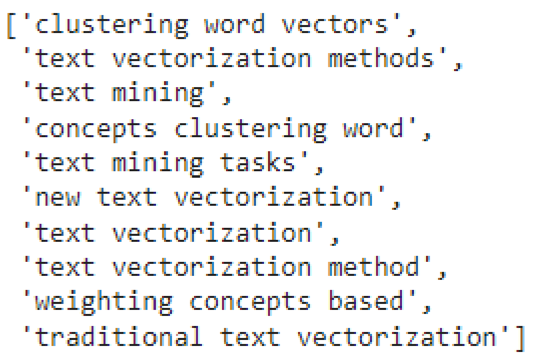
After installing KeyBert, write down the functionality for extracting keywords using several parameters such as the text, number of words or phrases, number of keywords to be found and highlighting the keyword as shown the figure below.



```
keywords = kw_model.extract_keywords(full_text,

                                     keyphrase_ngram_range=(1, 3),

                                     stop_words='english',

                                     highlight=False,

                                     top_n=10)

keywords_list= list(dict(keywords).keys())

print(keywords_list)
```

Figure example of KeyBert (Ali Mansour, 2022))

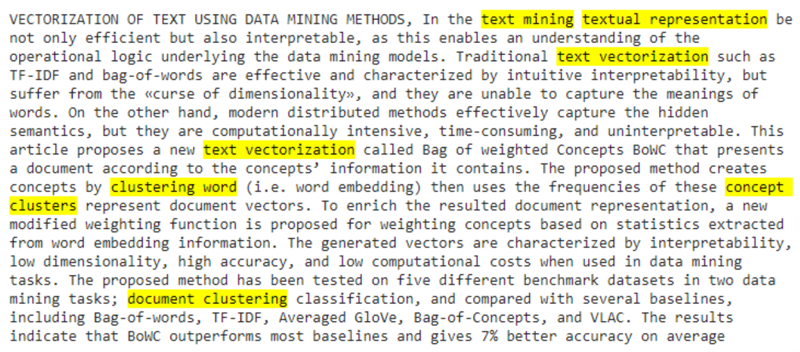
Once it has been completed, KeyBert will show the N-gram range results as shown below.



```
['clustering word vectors',
 'text vectorization methods',
 'text mining',
 'concepts clustering word',
 'text mining tasks',
 'new text vectorization',
 'text vectorization',
 'text vectorization method',
 'weighting concepts based',
 'traditional text vectorization']
```

Figure example of KeyBert N-gram results (Ali Mansour, 2022))

Furthermore, if highlight function is set to true, we can see words that are highlighted.

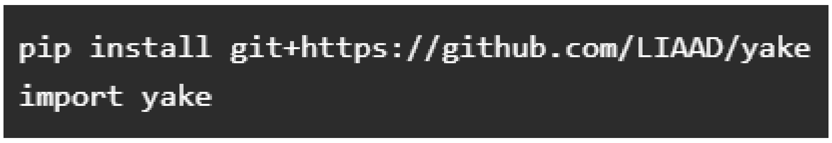


```
VECTORIZATION OF TEXT USING DATA MINING METHODS, In the text mining textual representation be
not only efficient but also interpretable, as this enables an understanding of the
operational logic underlying the data mining models. Traditional text vectorization such as
TF-IDF and bag-of-words are effective and characterized by intuitive interpretability, but
suffer from the «curse of dimensionality», and they are unable to capture the meanings of
words. On the other hand, modern distributed methods effectively capture the hidden
semantics, but they are computationally intensive, time-consuming, and uninterpretable. This
article proposes a new text vectorization called Bag of weighted Concepts BoWC that presents
a document according to the concepts' information it contains. The proposed method creates
concepts by clustering word (i.e. word embedding) then uses the frequencies of these concept
clusters represent document vectors. To enrich the resulted document representation, a new
modified weighting function is proposed for weighting concepts based on statistics extracted
from word embedding information. The generated vectors are characterized by interpretability,
low dimensionality, high accuracy, and low computational costs when used in data mining
tasks. The proposed method has been tested on five different benchmark datasets in two data
mining tasks; document clustering classification, and compared with several baselines,
including Bag-of-words, TF-IDF, Averaged GloVe, Bag-of-Concepts, and VLAC. The results
indicate that BoWC outperforms most baselines and gives 7% better accuracy on average
```

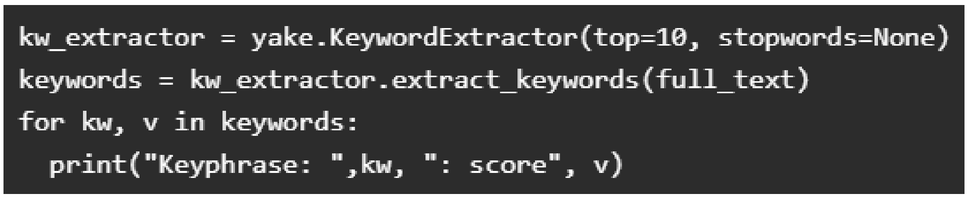
Figure example of KeyBert N-gram results with highlights (Ali Mansour, 2022))

❖ **YAKE! (Yet Another Keyword Extractor) –** Uses "text statistical features" which are extracted from single documents for the purpose of finding the most important words within the text. YAKE does not require to trained and

To install YAKE, users must write down the following code and then import it like below.



```
pip install git+https://github.com/LIAAD/yake
import yake
```

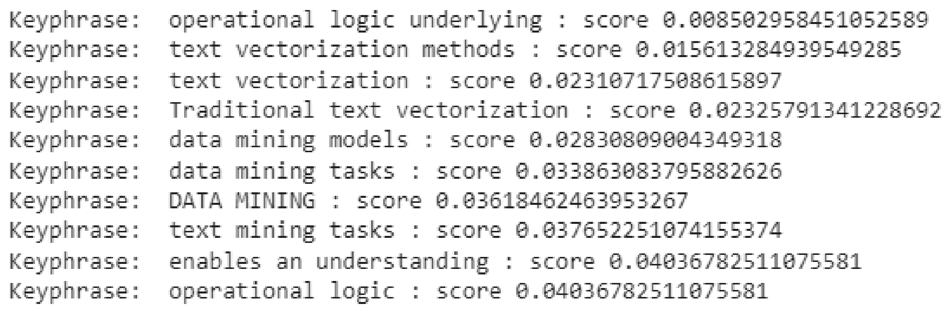


```
kw_extractor = yake.KeywordExtractor(top=10, stopwords=None)
keywords = kw_extractor.extract_keywords(full_text)
for kw, v in keywords:
  print("Keyphrase: ",kw, ": score", v)
```

Figure example of YAKE! (Ali Mansour, 2022))

Once YAKE has been imported, a "KeywordExtractor object" must be build. In the example above, the parameters used in this case are the numbers of words retrieved is set to 10; kw_extractor = yake.KeywordExtractor(**top=10,** stopwords=None) and a list of stop words will also pass.

Once that has been completed, using the **extract_keywords** function, it will return the keyword score depending on the length range from 1 to 3.



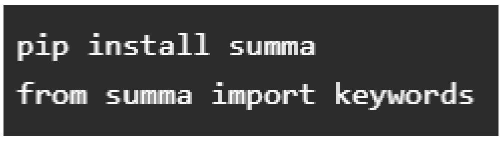
```
Keyphrase:  operational logic underlying : score 0.008502958451052589
Keyphrase:  text vectorization methods : score 0.015613284939549285
Keyphrase:  text vectorization : score 0.02310717508615897
Keyphrase:  Traditional text vectorization : score 0.02325791341228692
Keyphrase:  data mining models : score 0.02830809004349318
Keyphrase:  data mining tasks : score 0.03386308379582626
Keyphrase:  DATA MINING : score 0.03618462463953267
Keyphrase:  text mining tasks : score 0.03765225107415537 4
Keyphrase:  enables an understanding : score 0.04036782511075581
Keyphrase:  operational logic : score 0.04036782511075581
```

Figure Example of YAKE! Result output (Ali Mansour, 2022))

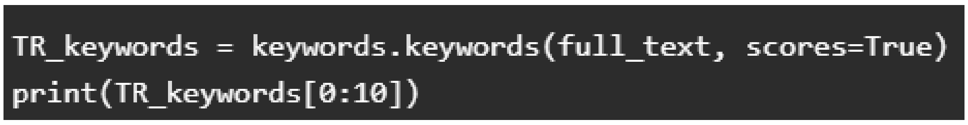
From this example, the most common used words "text mining", "data mining" and "text vectorization records".

❖ **TextRank –** "A graph-based ranking model for text processing" to find the most relevant words within the sentence as well as keywords in the text. Words are represented by a node and edges represent the relationship between words which are formed by "defining the co-occurrence of words".

To use TextRank, we must first install and import as usual like in the example below.



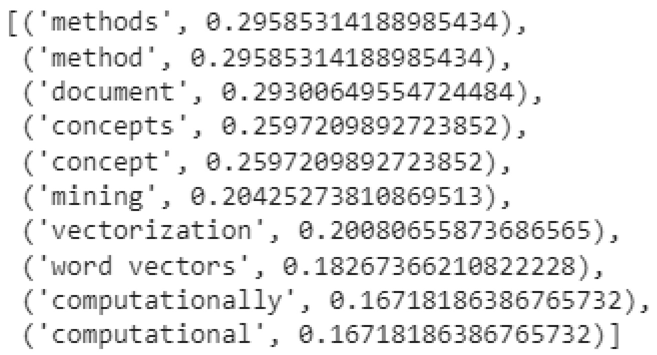
```
pip install summa
from summa import keywords
```



```
TR_keywords = keywords.keywords(full_text, scores=True)
print(TR_keywords[0:10])
```

Figure Example of TextRank (Ali Mansour, 2022))

Once the installation and importing has been complete, using the keyword functionality shown above, the text will show up and additionally, using the print function will also print the scores of each relevant word of the resulting keyword like in the figure below.

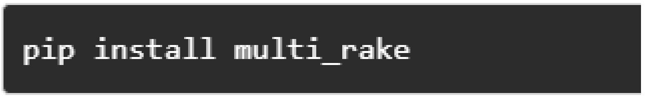


```
[('methods', 0.29585314188985434),
 ('method', 0.29585314188985434),
 ('document', 0.29300649554724484),
 ('concepts', 0.2597209892723852),
 ('concept', 0.2597209892723852),
 ('mining', 0.20425273810869513),
 ('vectorization', 0.20080655873686565),
 ('word vectors', 0.18267366210822228),
 ('computationally', 0.16718186386765732),
 ('computational', 0.16718186386765732)]
```

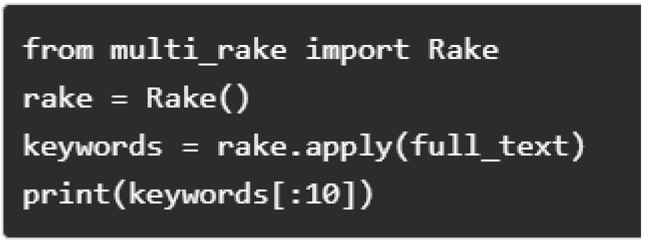
Figure Example of TextRank Result output (Ali Mansour, 2022))

- **Rake (Rapid Automatic Keyword Extraction) –** An extraction method which is effective for "multiple types of documents" with "specific grammatical conventions. Using Rake would be able to detect the most frequently used words or phrases in the written piece of text.

  For Rake to work, we must install and the package "multi_rake" and then import as shown below.



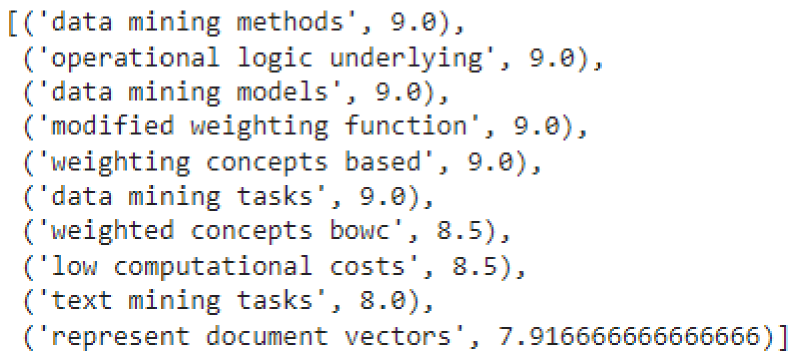
```
pip install multi_rake
```



```
from multi_rake import Rake
rake = Rake()
keywords = rake.apply(full_text)
print(keywords[:10])
```

Figure example of Rake (Ali Mansour, 2022))

Once we run the code, the most used words will show up and as shown in the example below, we can see that the most frequently used word is “text mining” and “data mining”.



```
[('data mining methods', 9.0),
 ('operational logic underlying', 9.0),
 ('data mining models', 9.0),
 ('modified weighting function', 9.0),
 ('weighting concepts based', 9.0),
 ('data mining tasks', 9.0),
 ('weighted concepts bowc', 8.5),
 ('low computational costs', 8.5),
 ('text mining tasks', 8.0),
 ('represent document vectors', 7.916666666666666)]
```

Figure Output of key phrases extracted from a document

The purpose of using a keyword extraction method is to describe what the written text is about by identifying the keywords or phrases within the document.

5.2.3 Perform Analysis and Send Result

The **Google Natural Language API** consists of 5 different services that can perform text analysis and shows the results for each type of analysis.

Syntax Analysis

In each sentence, Google Natural Language API can break down all the words with a rich set of linguistic information for each token. Basically, it finds the grammatical information of each word within the sentence, such as its type, gender, grammatical case, tense, and grammatical mood.

A	tag: DET
computer	tag: NOUN number: SINGULAR
once	tag: ADV
beat	tag: VERB mood: INDICATIVE tense: PAST
me	tag: PRON case: ACCUSATIVE number: SINGULAR person: FIRST
at	tag: ADP
chess	tag: NOUN number: SINGULAR
.	tag: PUNCT

Table 2 Syntax Analysis results provided by Google Natural Language API (Toptal Engineering, 2022).

Sentiment Analysis

Google's sentiment analysis can detect the emotions that are conveyed within a sentence given. The API returns 2 values, the score describes the positivity of the text, ranging from –1 (negative) to +1 (positive), with 0 being neutral. The magnitude measures how striking the emotion is being delivered. The more bombastic words included, the greater the magnitude.

Input sentence	Sentiment Results	Interpretation
"I go to school today for lunch."	Score: 0.0 Magnitude: 0.0	A completely neutral statement. Does not contain any emotion at all
"This meal is good."	Score: 0.7 Magnitude: 0.7	A positive sentiment, but not expressed very strongly
"This meal is very delicious. Whoever made this deserves a raise"	Score: 0.7 Magnitude: 2.3	A positive sentiment but expressed much stronger.
This meal is very delicious. But for some reason the ingredients are not very fresh.	Score: 0.0 Magnitude: 1.6	There are emotions expressed in this sentence based on the magnitude. However, the sentiment shows that they are mixed and not clearly positive or negative

Table 3: Sentiment Analysis results provided by Google Natural Language API (Toptal Engineering, 2022).

Entity Analysis

Google Natural Language API can also detect the entities that are present in each sentence such as a person, landmark or any object that can be seen and felt by humans. Some information in the form of a Wikipedia link and a salience score is generated based on the entity detected. The salience score is calculated based on the importance of the entity in the document, ranging from 0 being less salient, and 1 being highly salient.

"Robert DeNiro spoke to Martin Scorsese in Hollywood on Christmas Eve in December 2011"

Detected entity	Entity information
Robet De Niro	type : PERSON salience : 0.5869118 wikipedia_url : https://en.wikipedia.org/wiki/Robert_De_Niro
Hollywood	type : LOCATION salience : 0.17918482 wikipedia_url : https://en.wikipedia.org/wiki/Hollywood
Martin Scorsese	type : LOCATION salience : 0.17712952 wikipedia_url : https://en.wikipedia.org/wiki/Martin_Scorsese

Christmas Eve	type : PERSON salience : 0.056773853 wikipedia_url : https://en.wikipedia.org/wiki/Christmas
December 2011	type : DATE Year: 2011 Month: 12 salience : 0.0 wikipedia_url : -
2011	type : NUMBER salience : 0.0 wikipedia_url : -

Table 3: Entity Analysis results provided by Google Natural Language API (Toptal Engineering, 2022).

Entity Sentiment Analysis

Google Natural Language API can also combine both Sentiment Analysis and Entity Analysis to form Entity Sentiment Analysis. It will provide the salience score for the entity, magnitude, and score based on the sentence.

“The author is a horrible writer. The reader is very intelligent on the other hand”

Detected entity	Entity information
Author	Salience: 0.8773350715637207 Sentiment: magnitude: 1.899999976158142 score: -0.8999999761581421
Reader	Salience: 0.08653714507818222 Sentiment: magnitude: 0.8999999761581421 score: 0.8999999761581421

Table 4: Entity Sentiment Analysis results provided by Google Natural Language API (Toptal Engineering, 2022).

Text Classification

Google Natural API also provides a text classification model. It classifies the input documents into large sets of hierarchical categories, each of them has several sub-categories. A confidence score is given to determine how close the sentence belongs inside the category, the higher the relativity, the greater the confidence score.

“The D3500’s large 24.2 MP DX-format sensor captures richly detailed photos and Full HD movies—even when you shoot in low light. Combined with the rendering power of your NIKKOR lens, you can start creating artistic portraits with smooth background blur. With ease.”

Category	Confidence
Arts & Entertainment/Visual Art & Design/Photographic & Digital Arts	0.95
Hobbies & Leisure	0.94

Computers & Electronics/Consumer Electronics/Camera & Photo Equipment	0.85

Table 5: Text Classification results provided by Google Natural Language API (Toptal Engineering, 2022).

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7. Appendix

Client Research Report