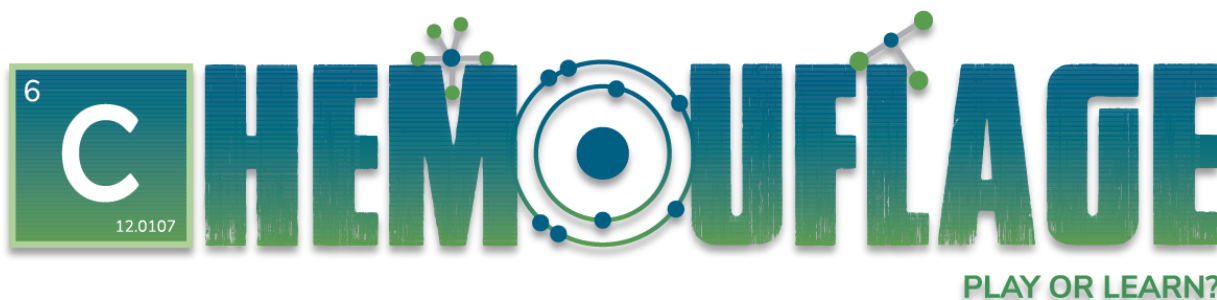




Institute of Information Technology

University of Dhaka



Software Requirements Specification and Analysis

Software Project Lab - II [SE-505]

**Submitted By**

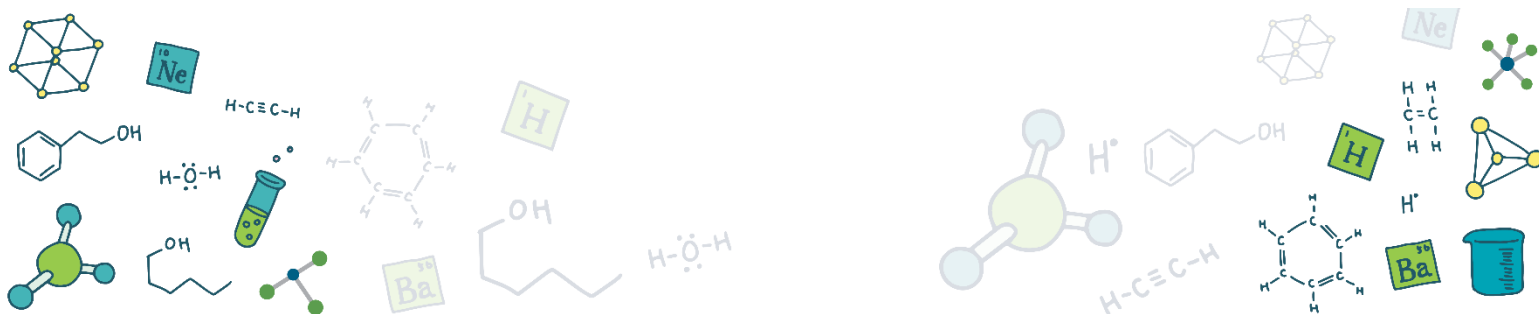
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10<sup>th</sup> March, 2022

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**Supervisor's Approval:**



09/03/2022

# **1. INTRODUCTION**

This chapter is a part of our software requirement specification for the project “Chemouflage”. In this chapter we will focus on the intended audience for this project.

## **1.1. PURPOSE**

The document thoroughly describes the Software Requirement Analysis of our Android application “Chemouflage”. It contains the functional, non-functional and the supporting requirements and establishes a requirement’s baseline for the development of the system. The requirements contained in the SRS are independent, uniquely numbered and organized by topics. This SRS serves as an official means of communicating user requirements to the developer and providing a common reference point for both the developer team and the stakeholder community. The SRS will evolve over time as users and developers work together to validate, clarify and expand its contents.

## **1.2. INTENDED AUDIENCE**

This SRS report is intended for several audiences. We discussed with all the possible stakeholders and developed this SRS that gives a clear guideline and documentation to -

- The users and admin will use this SRS to verify that the developer team has created a product that is acceptable to the customer.

- The project managers of the developer team will use this SRS to plan milestones and a delivery date, and ensure that the developing team is on track during development of the system.
- The designers will use this SRS as a basis for creating the system's design. The designers will continually refer back to this SRS to ensure that the system they are designing will fulfill the customer's needs.
- The developers will use this SRS as a basis for developing the system's functionality.
- The developers will link the requirements defined in this SRS to the software they create to ensure that they have created a software that will fulfill all of the customer's documented requirements.
- The testers will use this SRS to derive test plans and test cases for each documented requirement. When portions of the software are complete, the testers will run their tests on that software to ensure that the software fulfills the requirements documented in this SRS.
- The testers will again run their tests on the entire system when it is complete and ensure that all requirements documented in this SRS have been fulfilled.

### **1.3. CONCLUSION**

The analysis helped us figure out the stakeholders and requirements systematically. Moreover, it helped us to focus on the users who will be using our analysis. The document will be helpful to each and every stakeholder of the software to understand, relate and ensure convenient usage of the software. Developers and testers will have some clear ideas of what to do and development

will be smoother. More and more communication between the stakeholders and developers will help evolve the software and enhance it further.

## **2. INCEPTION OF CHEMOUFLAGE**

In this chapter, the inception part of the SRS is discussed briefly:

### **2.1. INTRODUCTION**

Chemouflage is a chemistry based android application. The objective of the application is to teach the fundamental basics of chemistry (such as atomic and compound structures, compound forming) to the students in an interactive way. The application is intended specially for school and college students using gamification method for fun learning. For this we will show the structures in a 3-Dimensional way and in Augmented Reality.

### **2.2. INCEPTION OF THE PROJECT**

The project begins with the inception (a task that defines the scope and nature of the problem to be solved). In order to make this phase effective we took the following steps:

- Establishing a basic understanding of the problem
- Identifying the clients of the solution
- Identifying the stakeholders of the solution
- The nature of the solution that is desired



- Establishing preliminary communication and collaboration between the stakeholders and the software team

### 2.2.1. Establishing a Basic Understanding of the Problem

Nowadays, students find it boring to only read books for studying. In Chemistry, they can't visualize the structures while reading the book. They can't understand the bonds of a compound or the complete structure of an atom. So, we have thought of making an application which will be more of a game than a typical learning app with visualizing and interacting with atom and compounds.

### 2.2.2. Identifying the Clients of the Solution

Secondary and higher secondary level students can be identified as a client of our project.

### 2.2.3. Identifying the Stakeholders of the Solution

Stakeholder refers to any person or group who will be affected directly or indirectly by the system. Stakeholders include end-users who interact with the system and everyone else in an organization who may be affected by its installation. The stakeholders of our solution are mainly Teachers as they can also use the application to teach the students more easily.

#### 2.2.4. The Nature of the Solution that is Desired

After communicating with the client and stakeholders, we identified the basic desires of them that the software should offer. The basic desires that the client and the stakeholders stated were as follows-

- Developing an Android application which will contain the 3D structures of the atoms and compounds.
- Enable the users to interact with the elements in an augmented and gamified way
- Make and experiment atom and compounds on their own.

#### 2.2.5. Establishing Preliminary Communication

We evaluated the problem with our proper solution and established a communication between the stakeholders and the software developer team. After doing a survey and getting feedback from the students, we proposed the solution which is feasible to be implemented by the dev team, we started the SRS of the project with the communicated schemes.

### **3. ELICITATION OF CHEMOUFLAGE**

After discussing the Inception phase, we need to focus on the Elicitation phase. So this chapter specifies the Elicitation phase.

#### **3.1. INTRODUCTION**

Requirements Elicitation is a part of requirements engineering that is the practice of gathering requirements from the stakeholders. We have faced many difficulties, like understanding the problems, making questions for the stakeholders, limited communication with stakeholders due to shortage of time and volatility of the stakeholders. Though it is not easy to gather requirements within a very short time, we have surpassed these problems in an organized and systematic manner.

#### **3.2. ELICITING REQUIREMENTS**

In order to encourage a collaborative, team-oriented approach to requirements gathering, stakeholders work together to identify the problem, propose elements of the solution, negotiate different approaches, and specify a preliminary set of solution requirements. In our elicitation phase, we completed the following tasks –

- Collaborative Requirements Gathering
- Quality Function Deployment
- Usage Scenarios

### 3.2.1. Collaborative Requirements Gathering

We have conducted meeting with many students and did surveys in the Inception phase. Besides, we have met with 1 teacher. These meetings created an indecisive state for us to elicit the requirements. These meetings helped us to identify the problem, propose elements of the solution, negotiate different approaches, and specify a preliminary set of solution requirements.

### 3.2.2. Quality Function Deployment

*Quality Function Deployment (QFD) is a structured approach of defining customer needs or requirements and translating them into specific plans to produce products to meet those needs. The “voice of the customer” is the term to describe these stated and unstated customer needs or requirements.*

#### 3.2.2.1. Normal Requirements

Normal requirements reflect objectives and goals stated for a product or system during meetings with the customer. Those are the basic requirements that fulfills client satisfaction. The Normal requirements we came up with are the following:

- Interactive and user-friendly interface so that the students get interested to use the application
- Smartphone based application
- Chapter wise interactive learning
- Augmented Reality based learning
- Following the curriculum of NCTB Book
- Quiz system for evaluation

### 3.2.2.2. Expected Requirements

These requirements are so obvious that the customer need not explicitly state them. Their absence can create significant dissatisfaction. The expected requirements of our system are given below:

- Authentication System
- Scope for further extension
- Maintain users accounts and related details
- Offline learning for enabling more students to learn from it

### 3.2.2.3. Exciting Requirements

These requirements are beyond the user's expectations. Following are the exciting requirements of our system:

- Gamification Methodology based learning
- Interaction of Augmented Reality based learning
- Interactive compound building by adding elements
- Memorizing technique

### 3.2.3. Usage Scenario

Chemouflage is a chemistry based android application that helps the user to understand chemistry in an interactive way. This application simulates the fundamental basics of chemistry, using 3D structure and augmented reality for visualizing the atoms and compounds.

#### 1. Account Management

Any user can enter the application either by sign up, login or guest mode.

**Sign Up:** A user can create an account to enter into the system. He/she needs to provide the following common information in order to create an account:

1. Username
2. Email Address
3. Password

A user can create only one account with the same email address.

**Log In:** A user can log into the system by providing email address/username and password. The system should authorize the user to log into the application.

**Recover Password:** If a user forgets the password, he/she will be given a new password through the email address.

**Update Account:** A user can update the username or password of the account.

**Guest Mode:** If any user wishes to enter the system without an authentication, he/she can enter using the guest mode. He/she will have limited access to the application.

## 2. Features

There will be four chapters for learning the basics of chemistry.

1. Building an Atom
2. Periodic Table of Elements
3. Chemical Bonding
4. AR Learning
5. Quiz

The students will learn these topics one by one and can test their learning by giving quizzes.

### Building an Atom

A user can build an atom by adding particles (protons, neutrons and electrons) in the 3D model. See the dynamic changes of [ Atomic mass, atomic number, charge] the model. So, user can see the output while understanding the laws, structure formation and electron configuration of an atom. Also learn when ionization energy or electron affinity occurs.

### Periodic Table

Here a user can view the whole periodic table of 118 elements., where he/she can choose any element and go to its detail section.

- There will be a list of physical and chemical properties, such as, electron configuration, atomic mass, ionization energy, electron affinity.

- Along with that, the user can see the 3D structure of the elements according to Rutherford and Bohr's theorem.

## Chemical Bonding

A user can view any compound, see its bond formation and 3D structure in different model (Structural model, ball and stick model)

- There will be a predefined set of compounds for simulation. The user can see the list and choose any compound from it, such as NaCl, H<sub>2</sub>O, CH<sub>4</sub>. He/she can view, rotate and scale the compound to see in different models.
- User can make a compound by combining the cation and anion for understanding valency. There will be two types of Ions.
  1. The list of Cations, e.g. (Na<sup>+</sup>, Mg<sup>+</sup>, Ca<sup>2+</sup>)
  2. The list of Anions (Cl<sup>-</sup>, O<sup>2-</sup>, F<sup>-</sup>)

A user can select a cation from Cations list and an anion from the Anions list. If those together form a compound, system will identify it and show the 3D modeling of the compound. By this, a user can learn from experimenting through games.

## AR (Augmented Reality) Learning

In the **AR book feature**, users can see the structures of elements and compounds in augmented reality mode.

- After entering this option, the user can select an atom or compound. In the atom section, user can hold the device over an image of a periodic table



element. The system will detect the image and show the 3-D model of compounds.

In the **AR interaction feature**, users can make compounds in augmented reality mode.

- Any user can simulate the chemical bonding in Augmented Reality mode. User can use marker image of the elements, place them side by side for forming a compound. For example, a user has two marker images, one is of Sodium (Na) and the other is of Chlorine (Cl). The user can place these two images closely, then the compound Sodium Chloride (NaCl) can be visualized in the space.

## Quiz

Quiz is only available for the users who are logged in. There will be a quiz feature in every chapter for practicing. Here the player will be given short questions related to the topics. After answering the question users can immediately get the feedback of their learning and make it effective. After every quiz, the user will get points and unlock the next chapter if the desired score is achieved.

## **4. REQUIREMENTS MODELING**

The requirements model, actually a set of models—is the first technical representation of a system. Requirements modeling uses a combination of text and diagrammatic forms to depict requirements in a way that is relatively easy to understand, and more important, straightforward to review for correctness, completeness, and consistency.

### **4.1. SCENARIO BASED MODELING**

This chapter describes the Scenario Based Model for “Chemouflage”.

#### **4.1.1. Introduction**

Although the success of a computer-based system or product is measured in many ways, user satisfaction resides at the top of the list. If we understand how end users (and other actors) want to interact with a system, the software team will be better able to properly characterize requirements and build meaningful analysis and design models. Hence, requirements modeling with UML begins with the creation of scenarios in the form of use cases, activity diagrams, and swimlane diagrams.

### 4.1.2. Use Case Diagram

A **use case** is a list of actions or event steps typically defining the interactions between a role (actor) and a system to achieve a goal. The actor can be a human or other external system. In this modelling, **use case diagram** is a graphical depiction of a user's possible interactions with a system. A use case diagram shows various use cases and different types of users the system has and will often be accompanied by other types of diagrams as well. Use case diagrams are a blueprint for the system. Due to their simplistic nature, use case diagrams can be a good communication tool for stakeholders. The drawings attempt to mimic the real world and provide a view for the stakeholder to understand how the system is going to be designed. Use case diagrams consist of actors, use cases and their relationships. The diagram is used to model the system/subsystem of an application. A single use case diagram captures a particular functionality of a system.

#### Primary Actor

Primary actors interact to achieve required system function and derive the intended benefit from the system. They work directly and frequently with the software.

#### Secondary Actor

Secondary actors support the system so that primary actors can do their work. They either produce or consume information.

**Level: 0**

**Name:** Chemouflage

**Primary Actor:** User, System

**Secondary Actor:** Phone Storage, Firebase, Vuforia Database

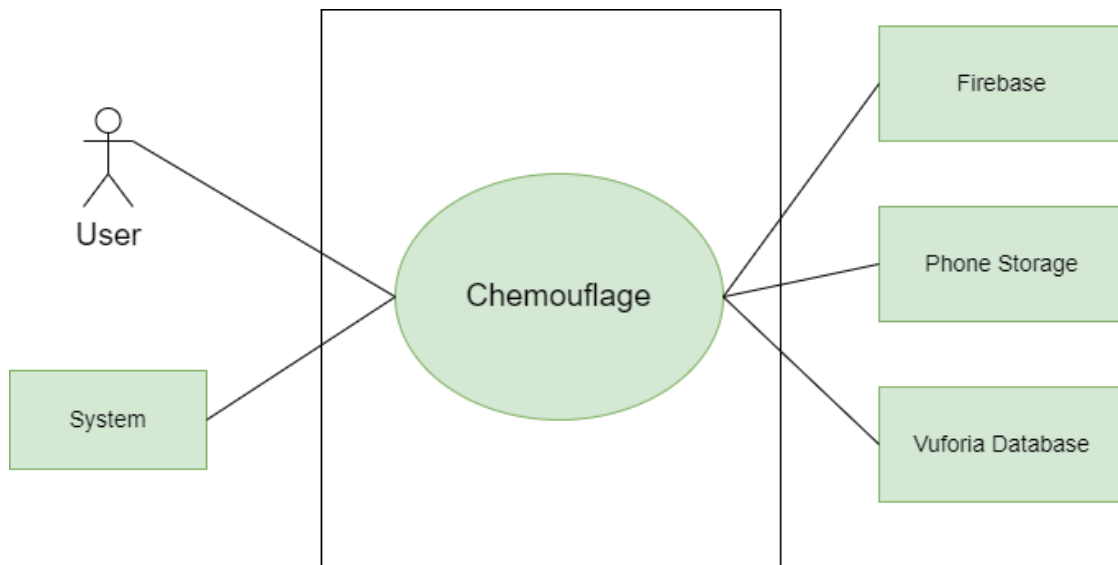


Figure 1: **Chemouflage**

## Level: 1

**Name:** Chemouflage (Detailed)

**Primary Actor:** User, System

**Secondary Actor:** Phone Storage, Firebase, Vuforia Database

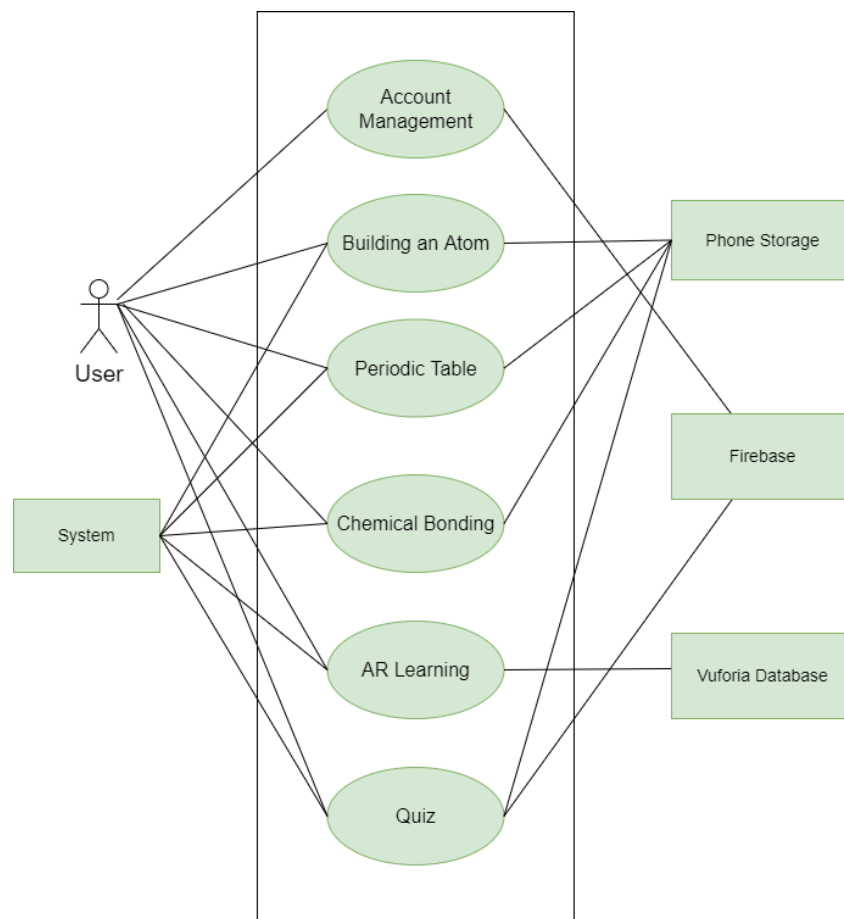


Figure 2: Chemouflage (Detailed)

## Description of Use Case Diagram Level 1:

From this level all the subsystem of the proposed main system and connectivity of those subsystem through actors has been explicit. From this level interaction between actors and subsystem will be clearer.

Here, the whole system is divided into six subsystem and Firebase, vufoia database is the outside system in this proposed system.

## Level: 1.1

**Name:** Account Management

**Primary Actor:** User

**Secondary Actor:** Firebase

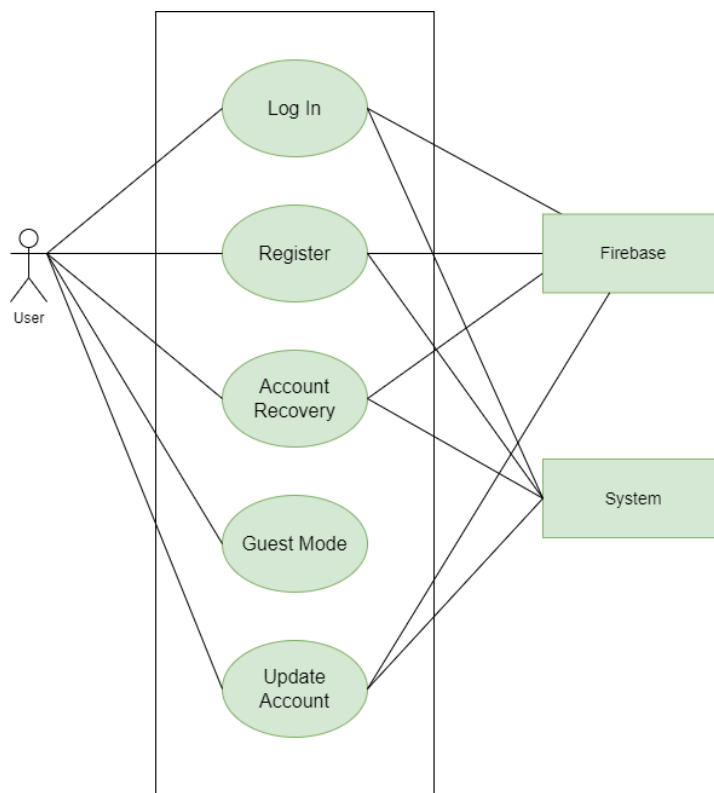


Figure 3: **Account Management**

## Description of Use Case Diagram Level 1.1:

1. **Log In:** Any user has to log into his/her account for fully exploring the application. The credentials entered by him/her will be matched with the ones stored in the firebase.

2. **Register:** A user can enjoy the application along with the quiz if he/she is a registered user. One has to only enter the username, email and password for registration.
3. **Account Recovery:** Any user can recover the forgotten password, an email will be sent for recovery.
4. **Guest Mode:** If any user doesn't want to register, still he/she can get access to the application with limited features.
5. **Update Account:** Any user can update username or password in the application.

### Action and Reply:

**Action:** User provides credentials.

**Reply:** System will check the validity of the given credentials. For valid information system will allow users to create an account and log into the account.

**Action:** User provides invalid credentials. (i.e. common username)

**Reply:** System will show an error message and allow to try again.

**Action:** User requests for account recovery.

**Reply:** System will send an email to the users account for setting a new password.

**Action:** The user provides personal and login credentials for the update.

**Reply:** System will check the validity of the given credentials and after validation updates the given info.

## Level: 1.2

**Name:** Building an Atom

**Primary Actor:** User, System

**Secondary Actor:** Phone Storage

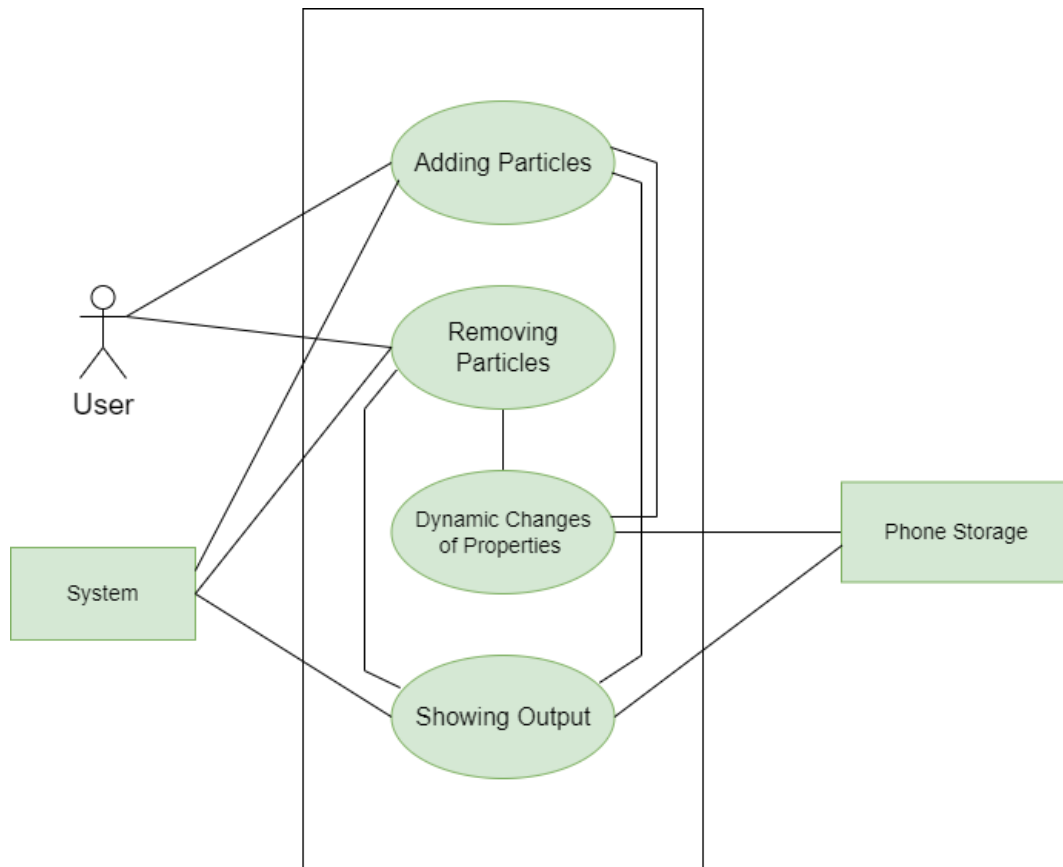


Figure 4: **Building an Atom**

### Description of Use Case Diagram Level 1.2:

1. **Adding Particles:** User can drag and drop proton, neutron and electron to make an atom.



2. **Removing Particles:** User can remove any existing particle if he/she wants to change the atom.
3. **Dynamic Changes of Properties:** While adding or removing the particles, the changed properties will be shown to user. (e.g., Adding proton changes the atomic number)
4. **Showing Output:** The resultant output of model of the atom will be continuously shown to the user.

### Action and Reply:

**Action:** Users can add particle, remove particles.

**Reply:** System will change the properties according to the atomic structure accordingly. System will update the atomic mass, proton, electron, neutron structure dynamically.

**Action:** Users can make a complete atomic model.

**Reply:** System will populate the model structure with details.

### Level: 1.3

**Name:** Periodic Table

**Primary Actor:** User, System

**Secondary Actor:** Phone Storage

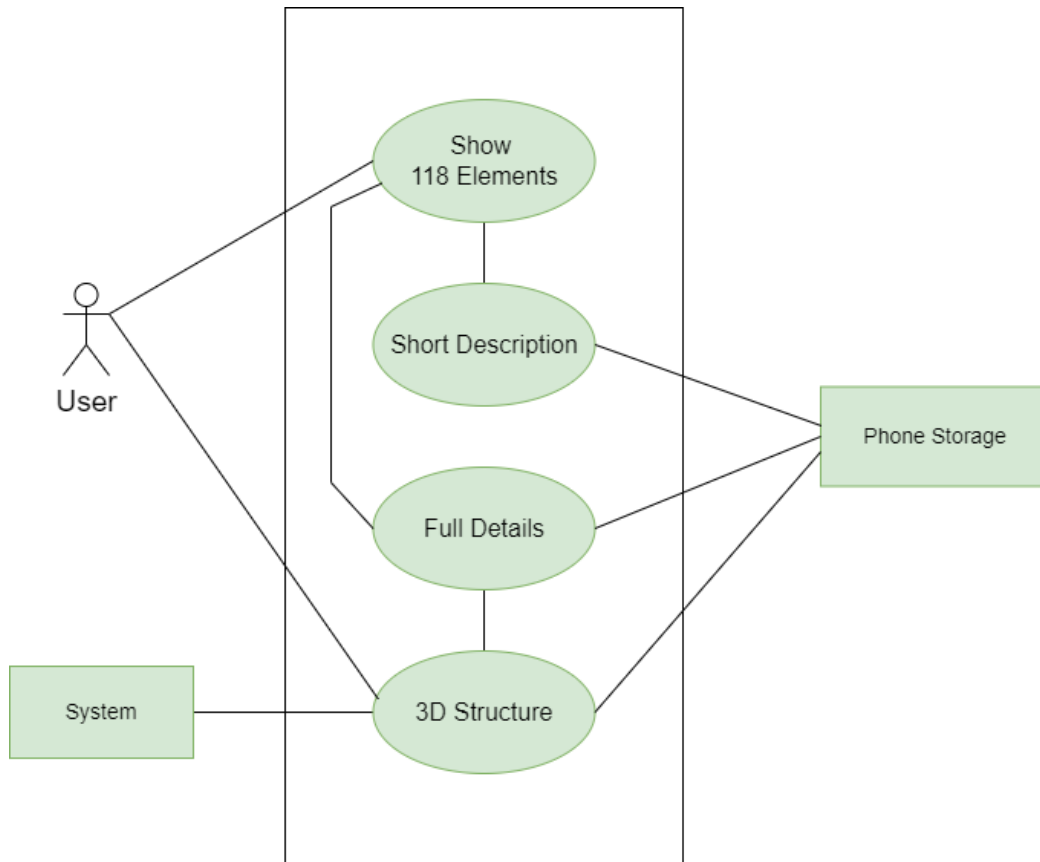


Figure 5: **Periodic Table**

### Description of Use Case Diagram Level 1.3:

1. **Show 118 Elements:** User can see the full periodic table with the symbol of the elements.

2. **Short Description:** User can see some of the basic information about the selected element.
3. **Full Details:** User can see details, including physical, chemical, thermodynamic properties of his/her desired element.
4. **3D structure:** User can also visualize the structure of the element with the help of 3D model.

### Action and Reply:

**Action:** User can see the 118 elements of periodic table. User clicks one of elements.

**Reply:** System will show the properties of the elements, short description.

**Action:** User long presses the structures.

**Reply:** System will populate the model structure with detail information.

## Level: 1.4

**Name:** Chemical Bonding

**Primary Actor:** User, System

**Secondary Actor:** Phone Storage

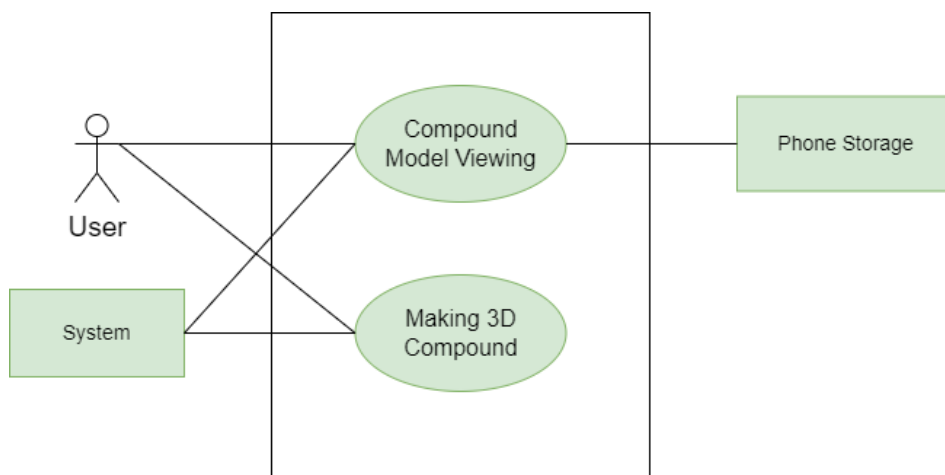


Figure 6: **Chemical Bonding**

### Description of Use Case Diagram Level 1.4:

1. **Compound Model Viewing:** User can view the model of any compound.
2. **Making 3D Compound:** User can make his/her desired compound by adding cations/anions.

### Action and Reply:

**Action:** Users can view the compounds selectively.

**Reply:** System will show the compound structure, angles and other properties.

### Level: 1.4.1

**Name:** Compound Model Viewing

**Primary Actor:** User, System

**Secondary Actor:** Phone Storage

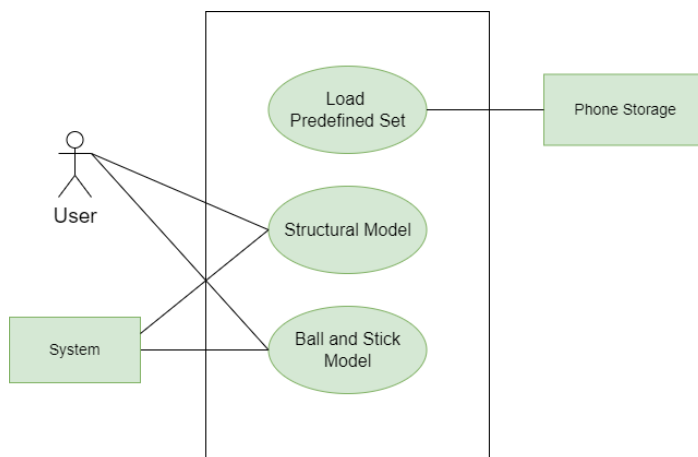


Figure 7: Compound Model Viewing

### Description of Use Case Diagram Level 1.4.1:

1. **Load Predefined Set:** There will be a predefined set of compounds for viewing, user can select from them.
2. **Structural Model:** User can see the structural model for every compound.
3. **Ball and Stick Model:** User can see the 3d structure of any compound through this type of model.

### Action and Reply:

**Action:** Users can view the loaded predefined set of compounds.

**Reply:** System will show details of any selected compound.

**Action:** Users can view, interact with the model.

**Reply:** System will show the ball and stick model, structural model behavior.

## Level: 1.4.2

**Name:** Making 3D Compound

**Primary Actor:** User, System

**Secondary Actor:** Phone Storage

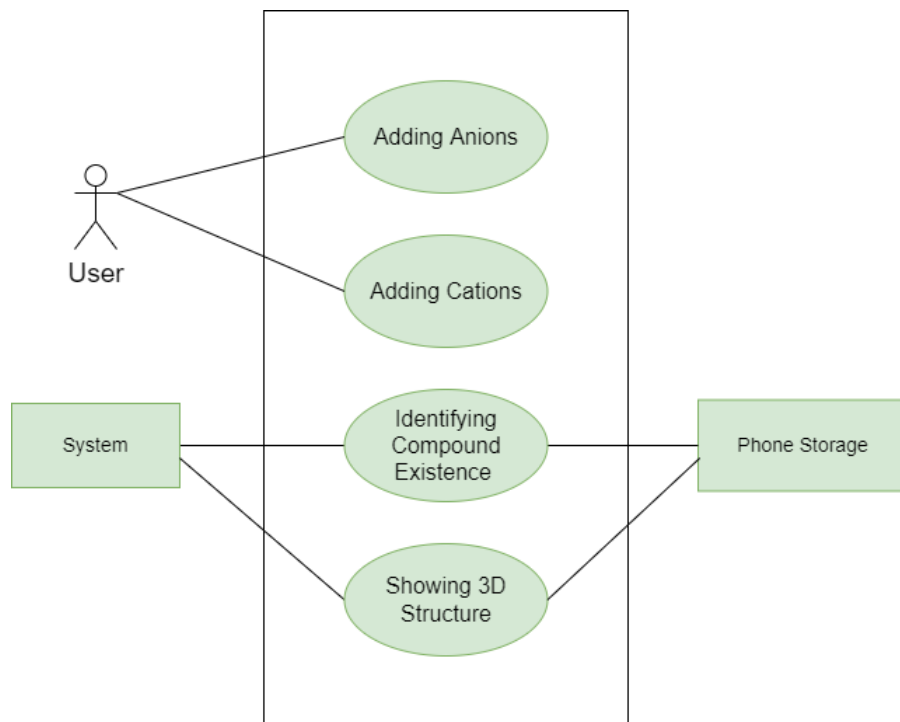


Figure 8: **Making 3D Compound**

### Description of Use Case Diagram Level 1.4.2:

1. **Adding Anions:** User can add anions from the anions list.
2. **Adding Cations:** User can add cations from the cations list.
3. **Identifying Compound Existence:** If any compound exists, user can view it.
4. **Showing 3D structure:** After the compound is formed, user can view the structure.

## Action and Reply:

**Action:** Users can add cation from cation list, anion from anion list.

**Reply:** System will validate the correctness of building compounds according to the rules.

**Action:** Users want to build compounds.

**Reply:** System identify the compound existence and show the suggestions of it.

## Level: 1.5

**Name:** AR Learning

**Primary Actor:** User, System

**Secondary Actor:** Vuforia Database

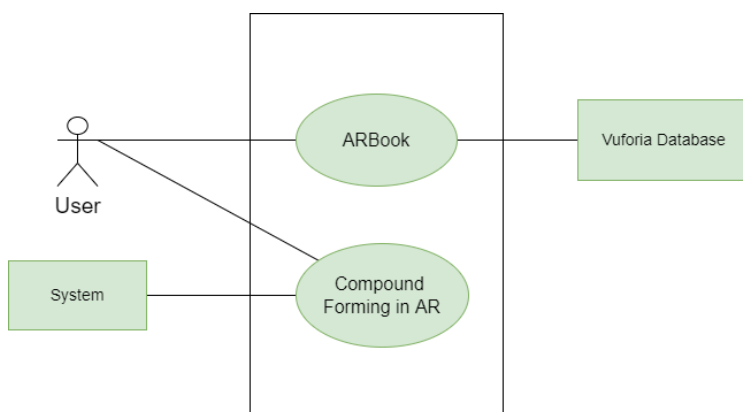


Figure 9 : AR Learning

## Description of Use Case Diagram Level 1.5:

1. **AR Book:** User can learn about the elements through augmented reality book feature.

2. **Compound Forming in AR:** User can add multiple elements to form compound in AR.

### Action and Reply:

**Action:** User enters the Augmented reality learning part.

**Reply:** System will show the two chapters corresponding to the reply. One is AR book and the other is AR object interaction.

### Level: 1.5.1

**Name:** AR Book

**Primary Actor:** User, System

**Secondary Actor:** Vuforia Database

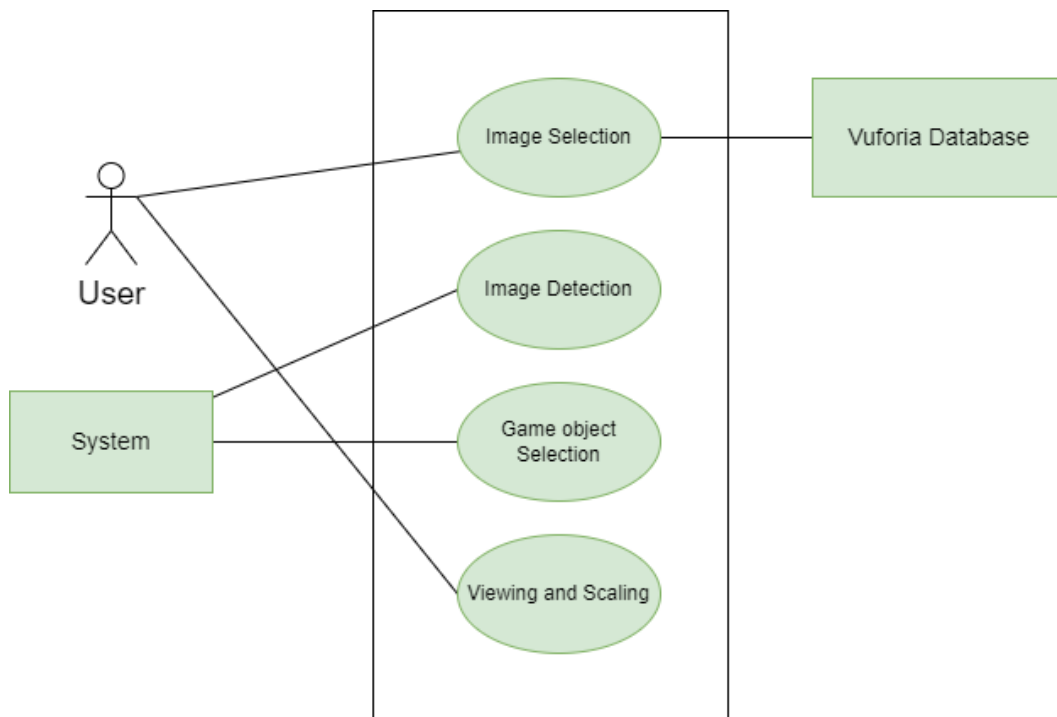


Figure 10 : **AR Book**



### Description of Use Case Diagram Level 1.5.1:

1. **Image Selection:** User puts camera on top of any marker image for viewing model in AR.
2. **Image Detection:** The system detects the image from Vuforia image track database.
3. **Game Object Selection:** The system then gets the required game object of the corresponding image.
4. **Viewing and Scaling:** User can view, scale and rotate the 3D model.

### Action and Reply:

**Action:** Users takes a card and put the target image.

**Reply:** System will validate the targeted image with vuforia database and show the augmented structure of elements accordingly.

**Action:** Users want to rotate the structures.

**Reply:** System will allow using joystick movement component.

**Action:** Users want to scale the structures.

**Reply:** System will allow using slider movement component.

## Level: 1.5.2

**Name:** Compound Forming in AR

**Primary Actor:** User, System

**Secondary Actor:** Vuforia Database

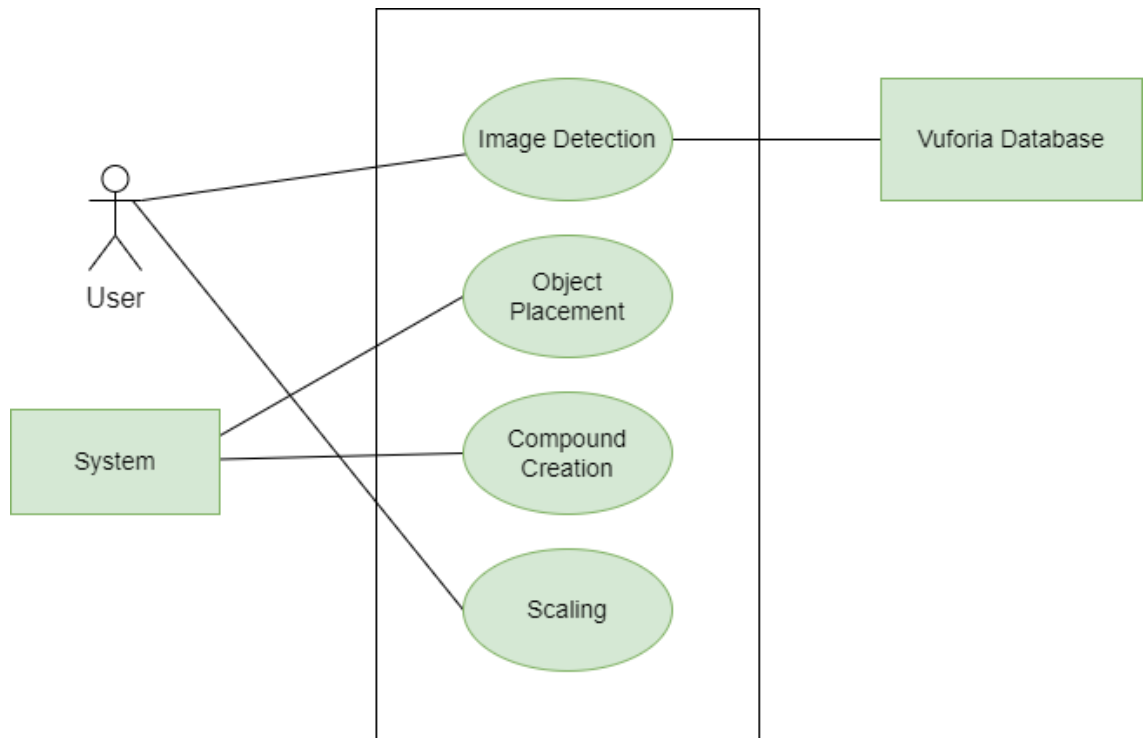


Figure 11 : **Compound Forming in AR**

### Description of Use Case Diagram Level 1.5.2:

1. **Image Detection:** The system detects the image which the user selects.
2. **Object Placement:** System places the object on top of the selected image.
3. **Compound Creation:** Compound is created after the objects are placed.
4. **Scaling:** User can now view, scale the compound for a better understanding.

## Action and Reply:

**Action:** User takes multiple cards and put the target images

**Reply:** System will validate the targeted image with vuforia database and show the augmented structure of elements accordingly.

**Action:** User brings the cards.

**Reply:** System will validate the request and form chemical compounds according to the rule of chemistry.

## Level: 1.6

**Name:** Quiz

**Primary Actor:** User, System

**Secondary Actor:** Firebase

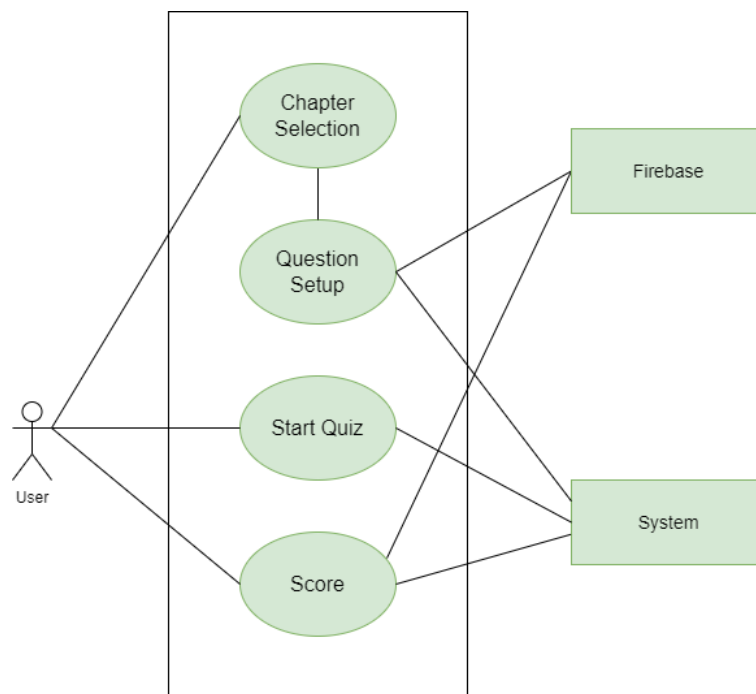


Figure 12: Quiz

## Description of Use Case Diagram Level 1.6:

1. **Chapter Selection:** System checks the eligibility of user who want to give exam.  
If a user has enough points he/she can enter into the exam section. User can select any desired chapter to give the quiz.
2. **Question Setup:** System sets the question that are stored in firebase database.
3. **Start Quiz:** User can start the quiz and answer within the given time.
4. **Score:** User will get marks for right answers. After giving exams he/she will get some points that will be needed for next quiz.

## Action and Reply:

**Action:** User selects the quiz

**Reply:** System will validate the request according to the point score.

**Action:** User enters the quiz section of a particular chapter.

**Reply:** System requests the firebase to populate the question.

**Action:** User answers the question.

**Reply:** System calculates the score and store the score to the firebase.

### 4.1.3. Activity Diagram

Activity diagram is an important behavioral diagram in UML diagram to describe dynamic aspects of the system. Activity diagram is essentially an advanced version of flow chart that models the flow from one activity to another activity.

#### Level: 1

**Name:** Chemouflage

**Reference:** Use Case Diagram Level – 1

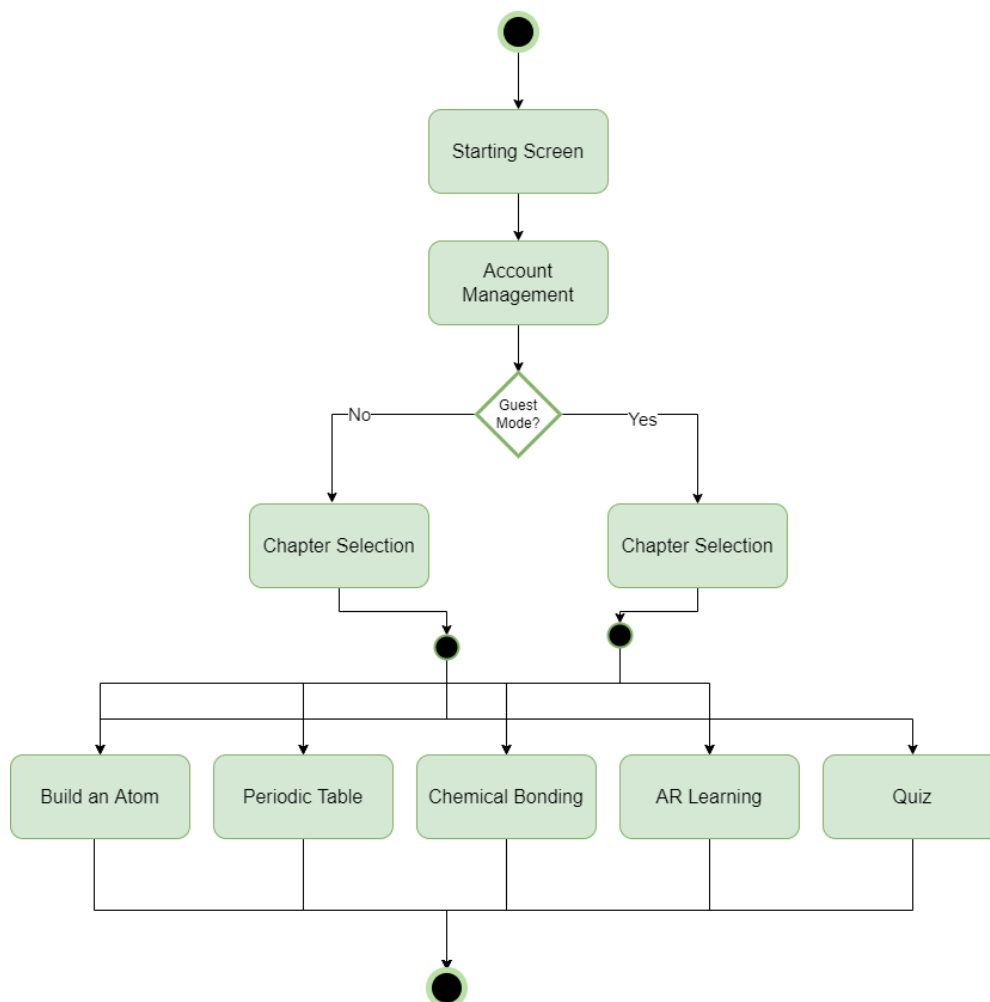


Figure 13: Chemouflage (Activity Level - 1)

## Level: 1.1

**Name:** Account Management

**Reference:** Use Case Diagram Level – 1.1

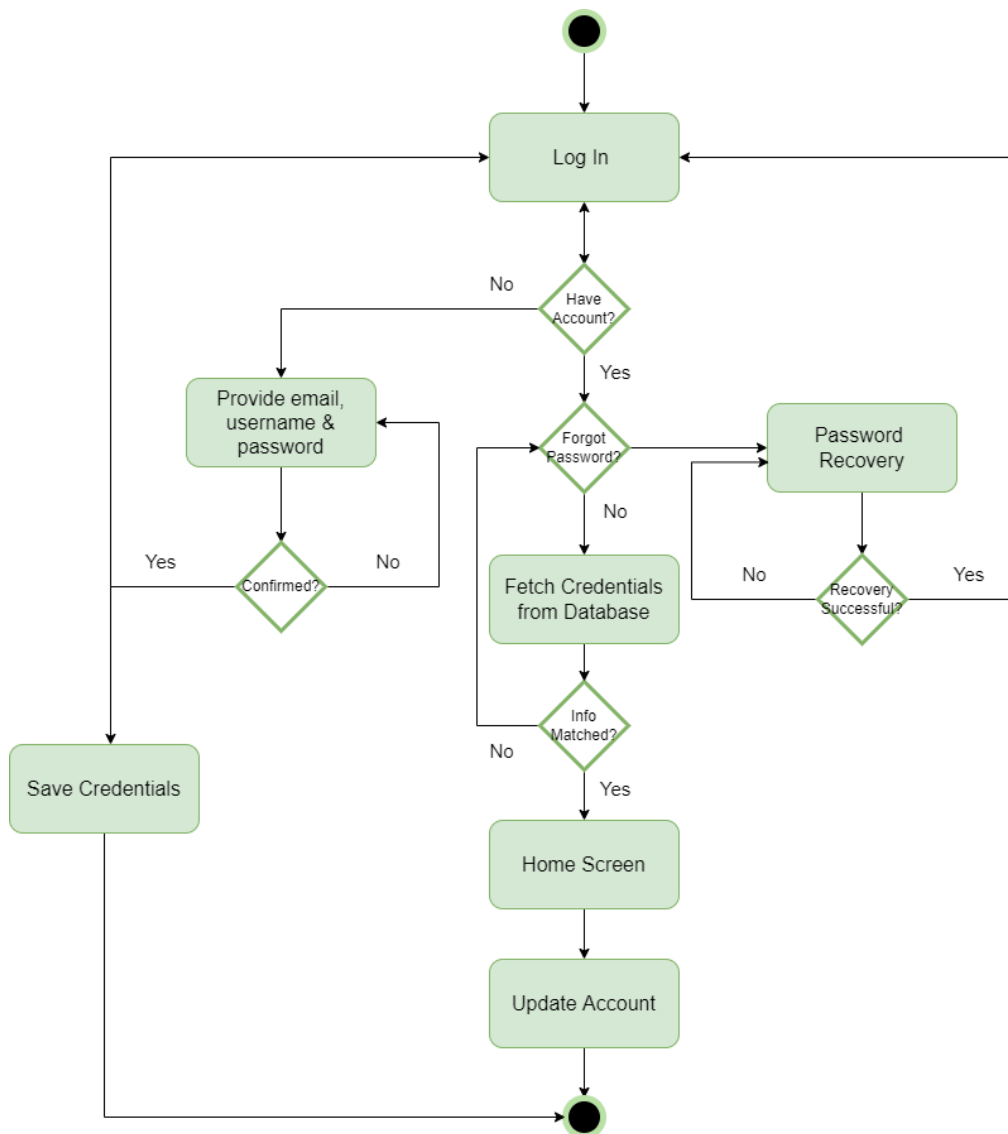


Figure 14: Account Management (Activity Level - 1.1)

## Level: 1.2

**Name:** Building an Atom

**Reference:** Use Case Diagram Level – 1.2

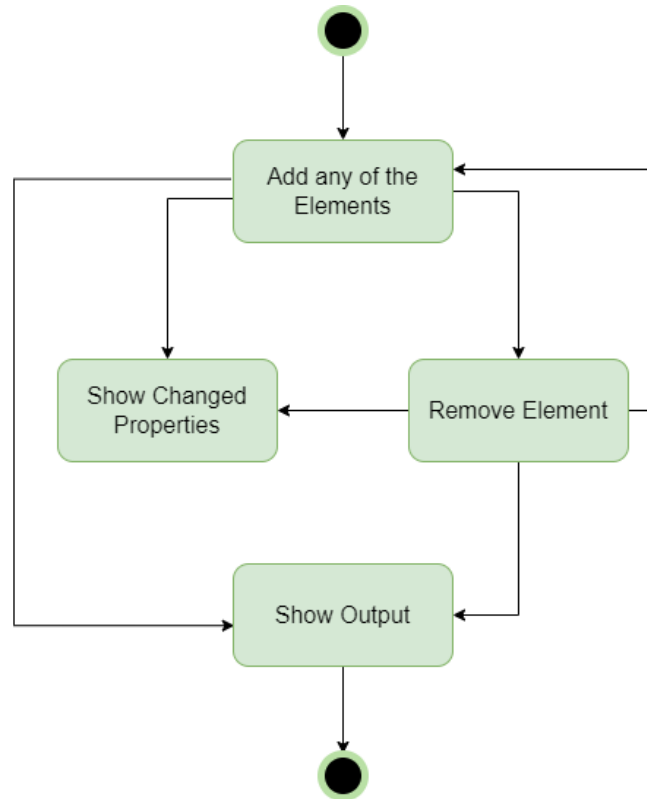


Figure 15: **Building an Atom (Activity Level - 1.2)**

### Level: 1.3

**Name:** Periodic Table

**Reference:** Use Case Diagram Level – 1.3

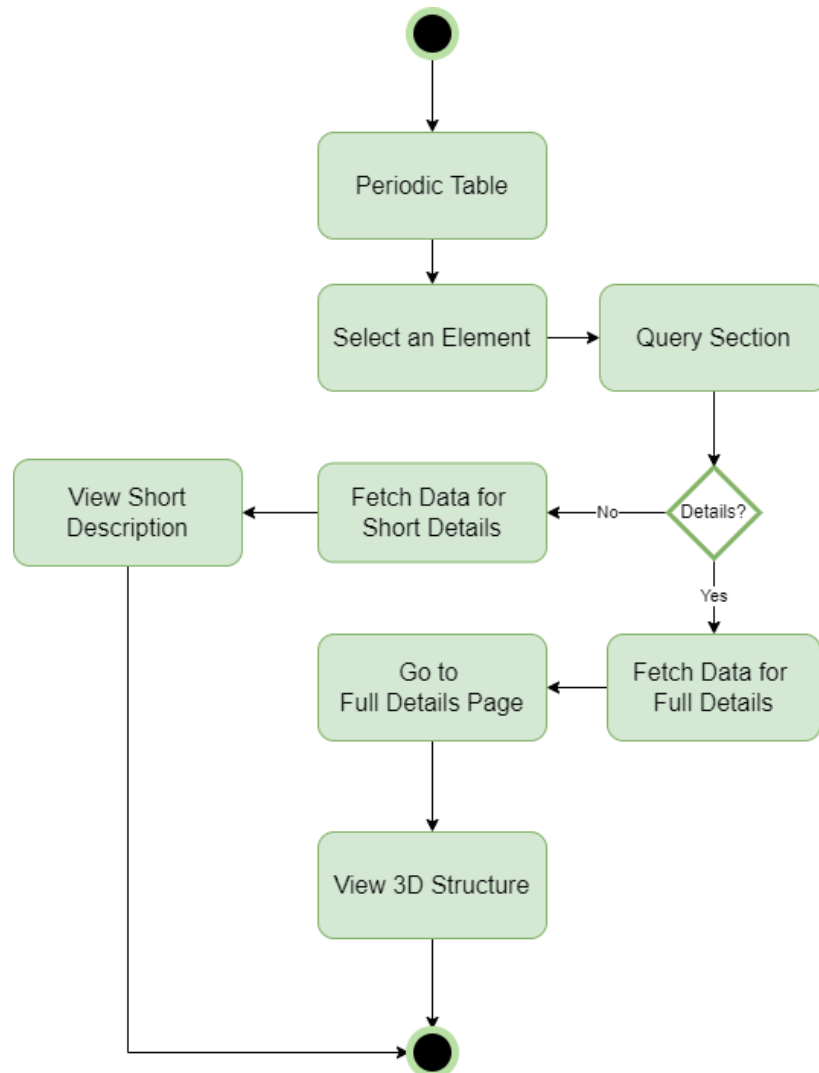


Figure 16: **Periodic Table (Activity Level - 1.3)**



## Level: 1.4

**Name:** Chemical Bonding

**Reference:** Use Case Diagram Level – 1.4

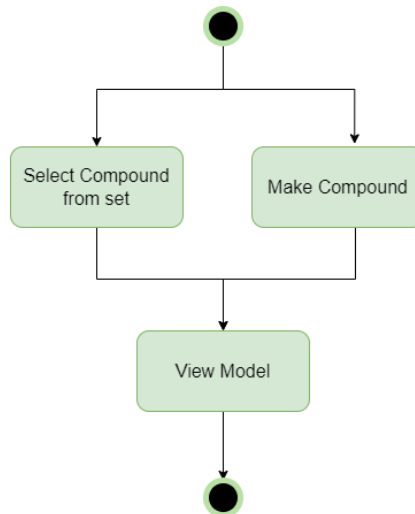


Figure 17: **Chemical Bonding (Use Case Level - 1.4)**

## Level: 1.4.1

**Name:** Compound Model Viewing

**Reference:** Use Case Diagram Level – 1.4.1

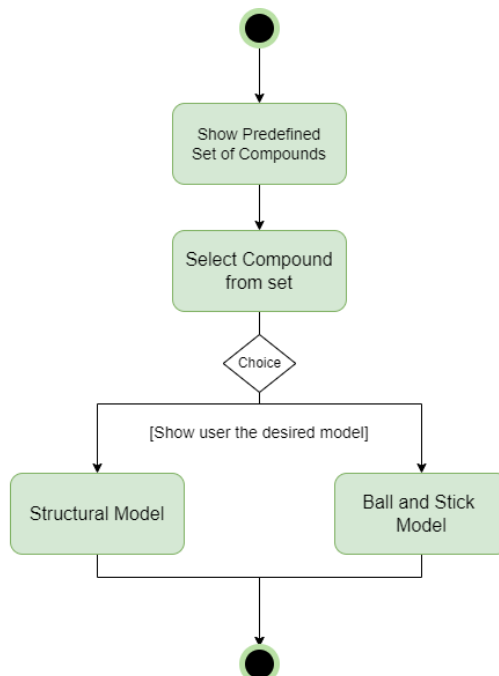


Figure 18: **Compound Model Viewing (Activity Level - 1.4.1)**

## Level: 1.4.2

**Name:** Making 3D Compound

**Reference:** Use Case Diagram Level – 1.4.2

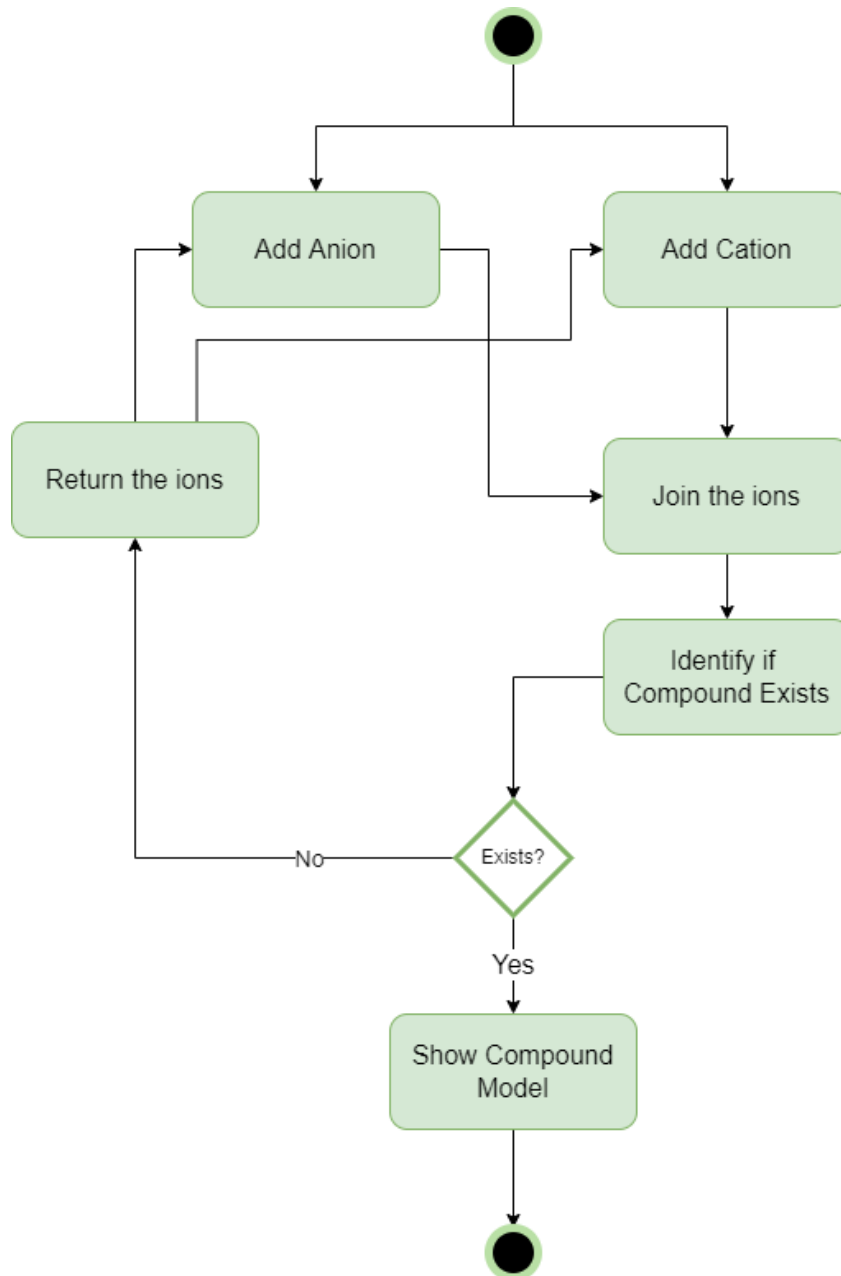


Figure 19: **Making 3D Compound (Use Case Level - 1.4.2)**

## Level: 1.5

**Name:** Chemouflage

**Reference:** Use Case Diagram Level – 1.5

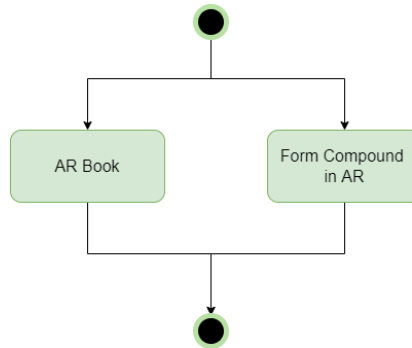


Figure 20: **AR Learning (Use Case Level - 1.4)**

## Level: 1.5.1

**Name:** AR Book

**Reference:** Use Case Diagram Level – 1.5.1

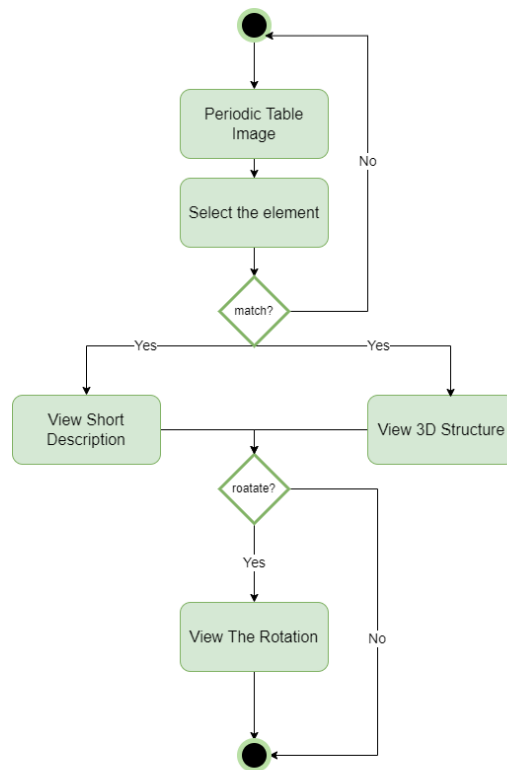


Figure 21: **AR Book (Activity Level - 1.5.1)**

## Level: 1.5.2

**Name:** Compound Forming in AR

**Reference:** Use Case Diagram Level – 1.5.2

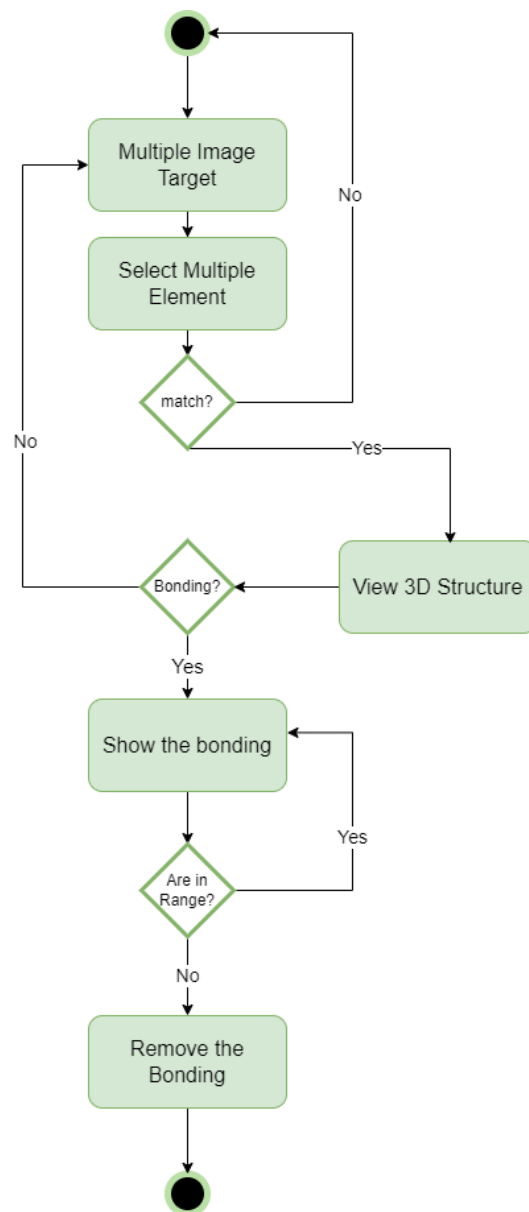


Figure 22: **Compound Forming in AR**  
(Use Case Level - 1.5.2)

## Level: 1.6

**Name:** Quiz

**Reference:** Use Case Diagram Level – 1.6

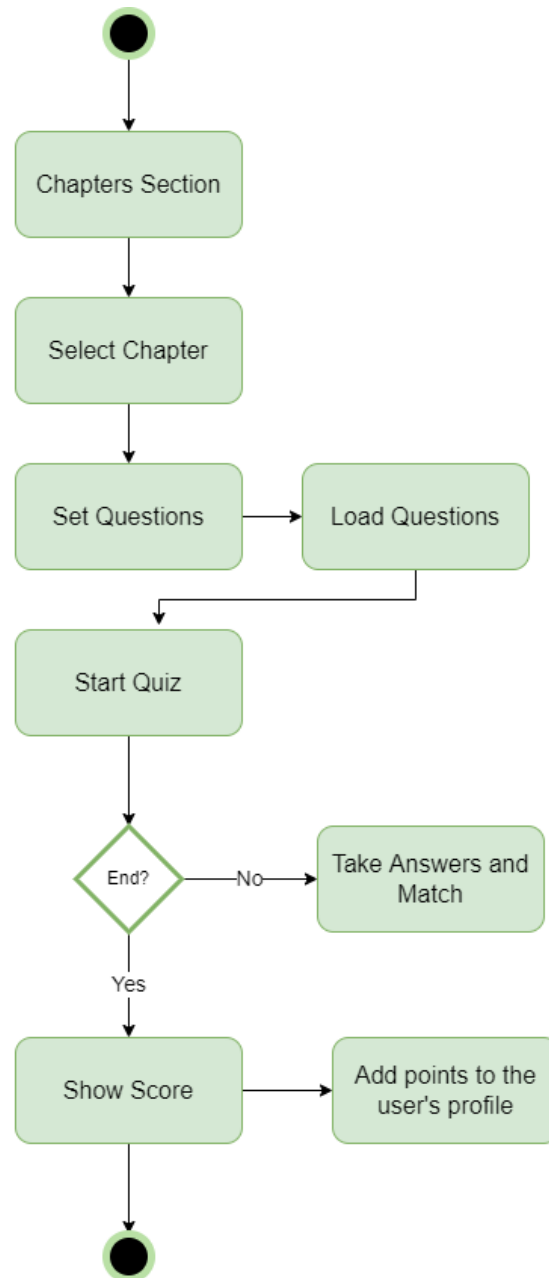


Figure 23: **Quiz (Activity Level - 1.6)**

## 4.1.4. Swimlane Diagram

A swimlane diagram is a type of flowchart. Like a flowchart, it diagrams a process from start to finish, but it also divides these steps into categories to help distinguish which departments or employees are responsible for each set of actions. It is based on the analogy of lanes in a pool, as it places process steps within the horizontal or vertical “swimlanes” of a particular department, work group or employee, thus ensuring clarity and accountability.

### Level: 1.1

**Name:** Account Management

**Reference:** Use Case & Activity Diagram Level – 1.1

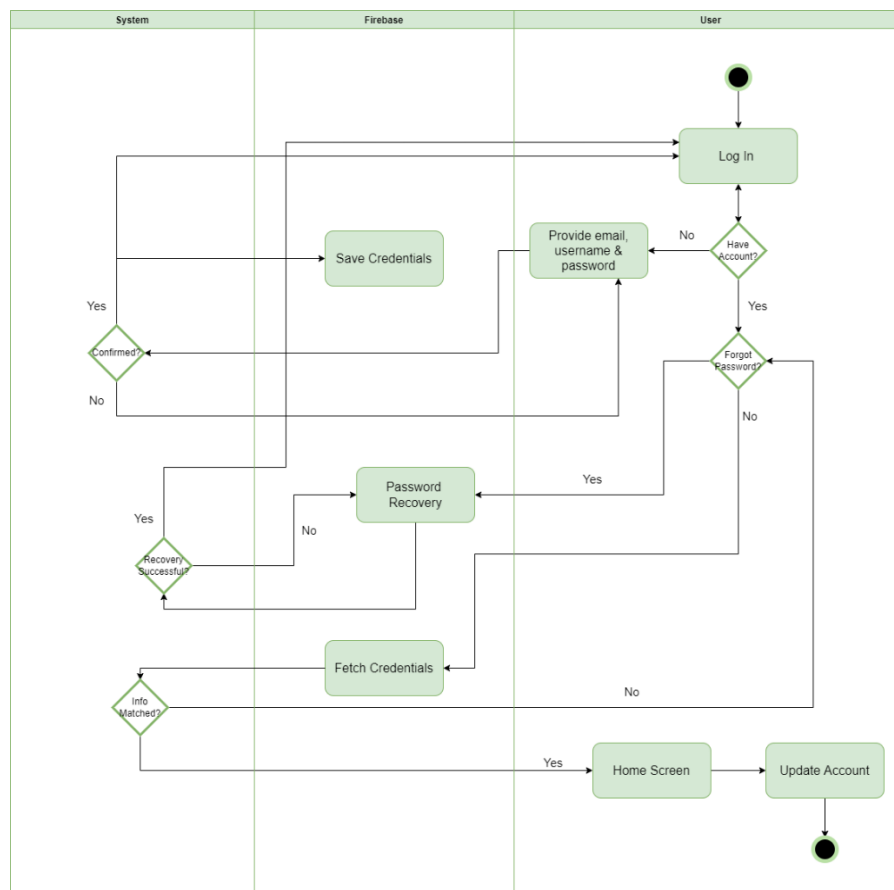


Figure 24: Account Management (Swimlane Level - 1.1)

## Level: 1.2

**Name:** Building an Atom

**Reference:** Use Case & Activity Diagram Level – 1.2

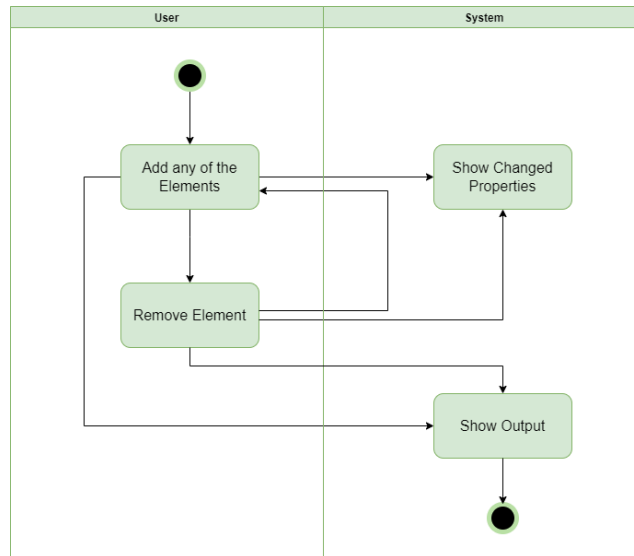


Figure 25: Building an Atom (Swimlane Level - 1.2)

## Level: 1.3

**Name:** Periodic Table

**Reference:** Use Case & Activity Diagram Level – 1.3

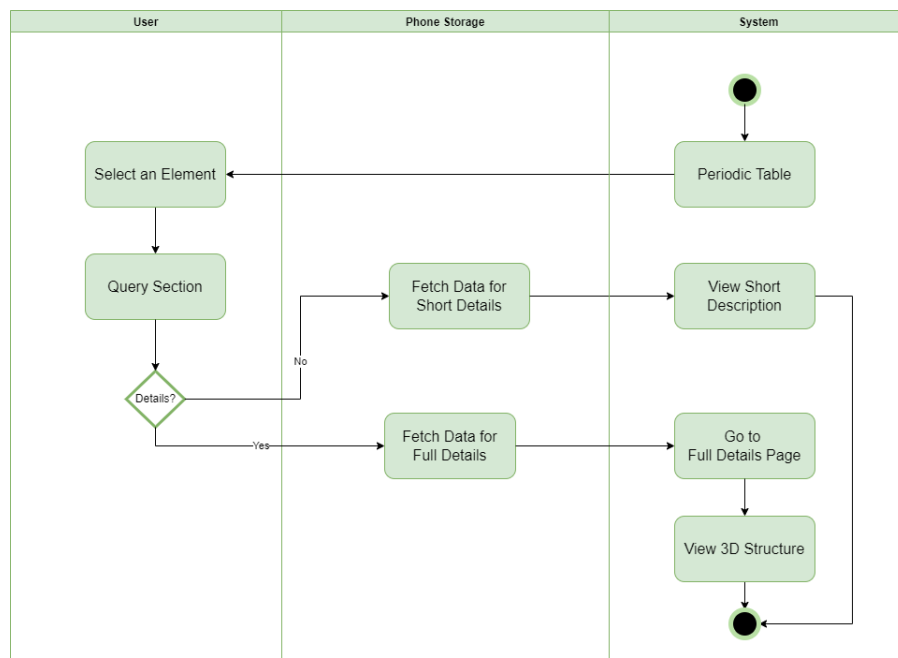


Figure 26: Periodic Table (Swimlane Level - 1.3)

## Level: 1.4

**Name:** Chemical Bonding

**Reference:** Use Case & Activity Diagram Level – 1.4

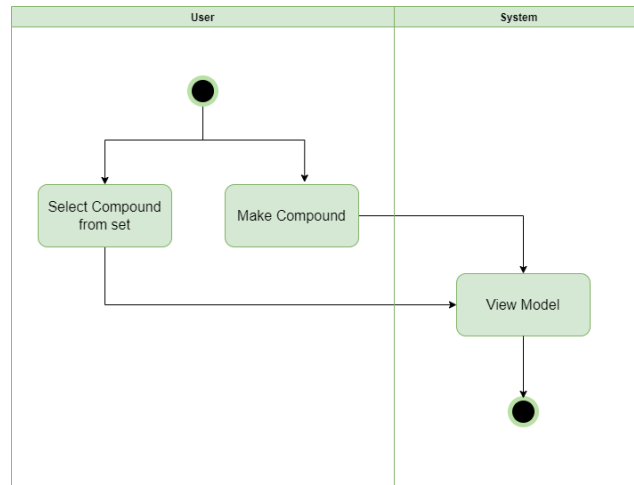


Figure 27: Chemical Bonding (Swimlane Level - 1.4)

## Level: 1.4.1

**Name:** Compound Model Viewing

**Reference:** Use Case & Activity Diagram Level – 1.4.1

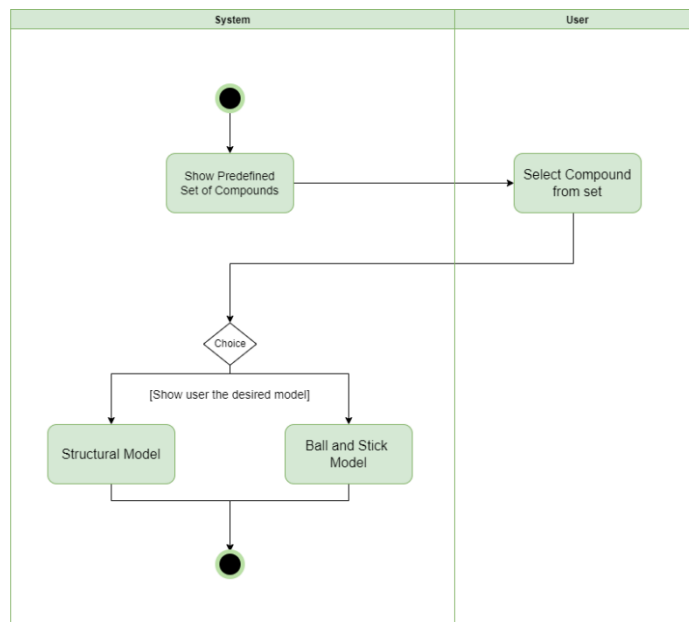


Figure 28: Compound Model Viewing (Swimlane Level - 1.4.1)



## Level: 1.4.2

**Name:** Making 3D Compound

**Reference:** Use Case & Activity Diagram Level – 1.4.2

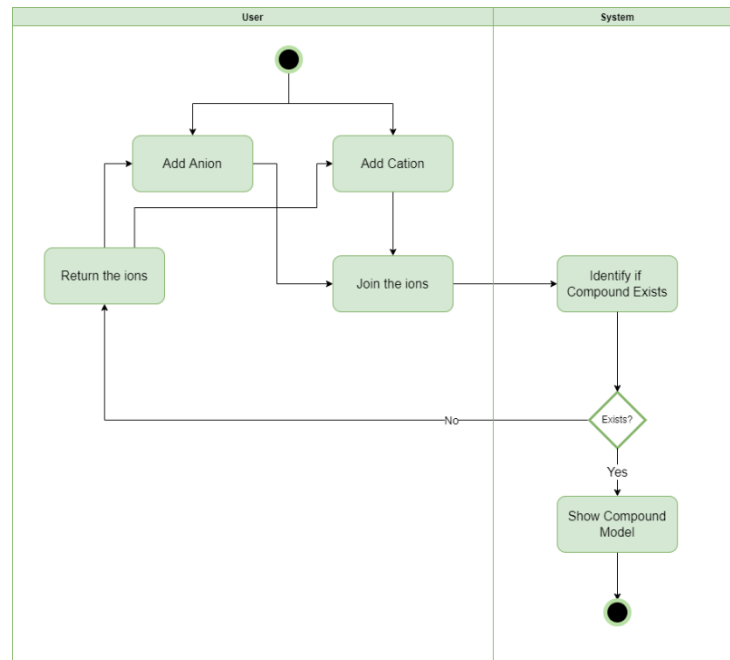


Figure 29: Making 3D Compound (Swimlane Level - 1.4.2)

## Level: 1.5

**Name:** Chemouflage

**Reference:** Use Case & Activity Diagram Level – 1.5

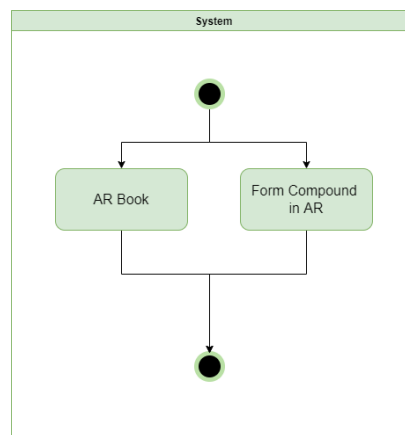


Figure 30: AR Learning (Swimlane Level - 1.5)

## Level: 1.5.1

Name: AR Book

Reference: Use Case & Activity Diagram Level – 1.5.1

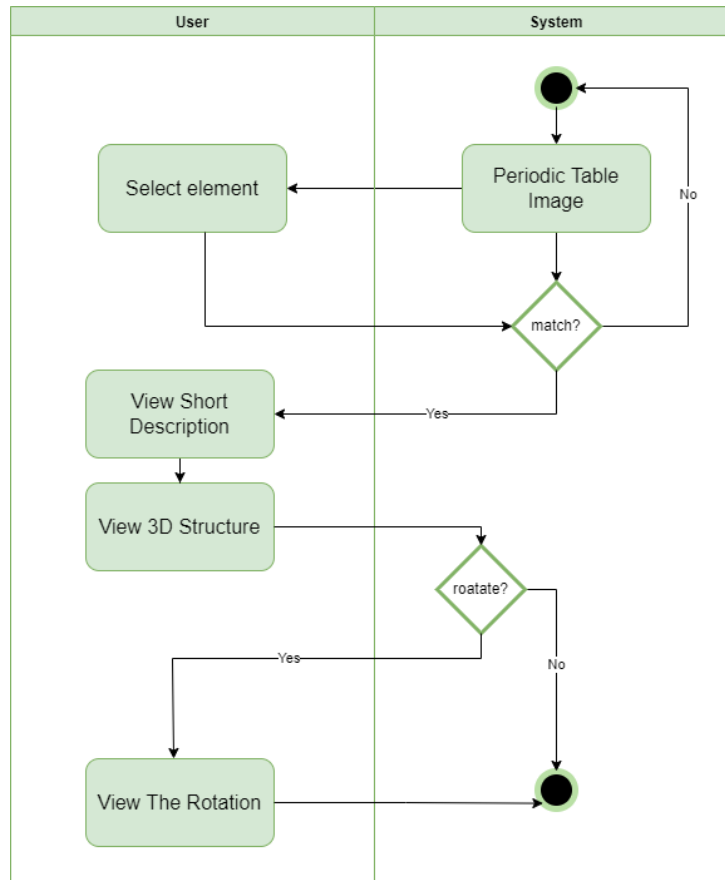


Figure 31: AR Book (Swimlane Level - 1.5.1)

## Level: 1.5.2

**Name:** Compound Forming in AR

**Reference:** Use Case & Activity Diagram Level – 1.5.2

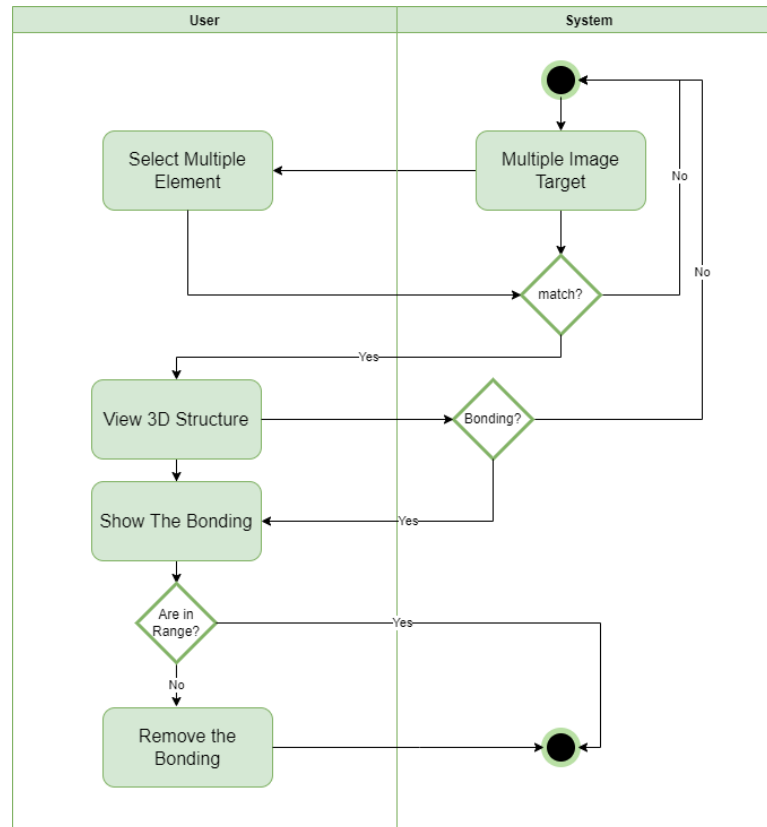


Figure 32: Compound Forming in AR (Swimlane Level - 1.5.2)

## Level: 1.6

**Name:** Quiz

**Reference:** Use Case & Activity Diagram Level – 1.6

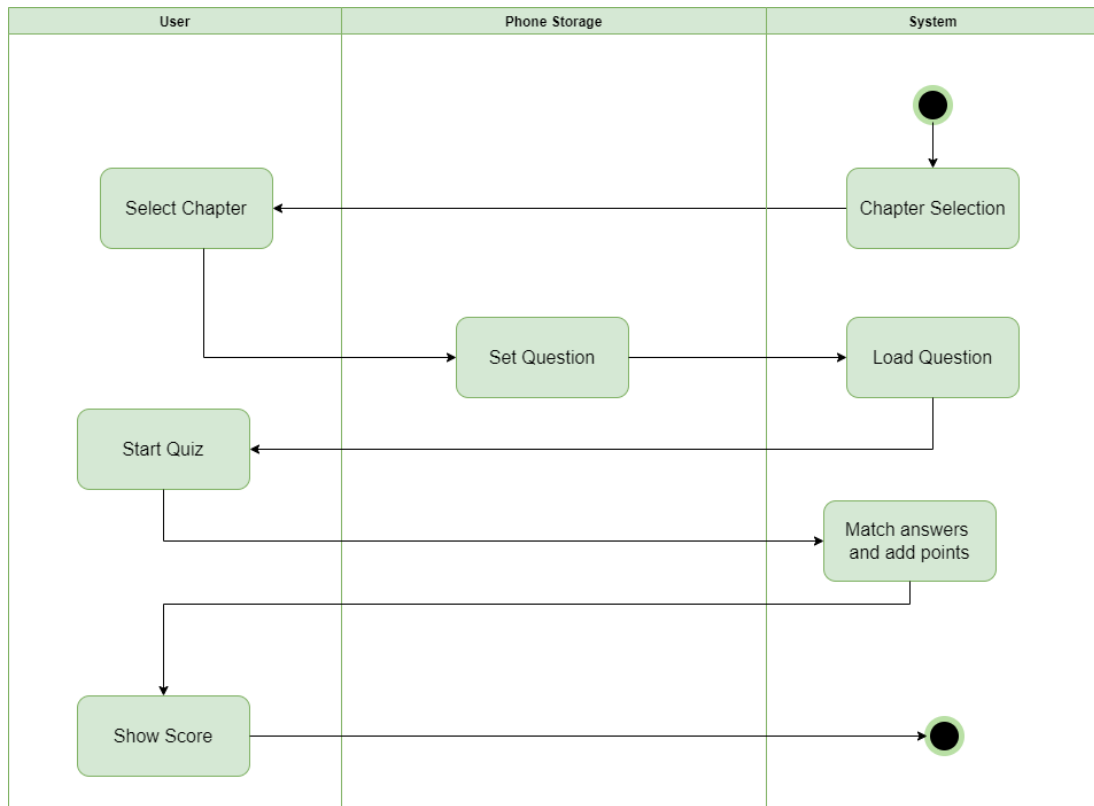


Figure 33: Quiz (Swimlane Level - 1.6)

## 4.2. DATA BASED MODELING

This chapter describes the Data Based Model for “Chemouflage”.

### 4.2.1. Introduction

Data modeling, sometimes also called information modeling, is the process of visually representing what data the application or system will use and how it will flow. The resulting diagram or other visual representation is meant to be designed in a way that is as easy to understand as possible. The fundamental elements that a data model needs to include and describe are the data objects, more frequently called "entities"; the attributes of those objects or entities; and the relationships between the objects or entities.

### 4.2.2. Data Object

A data object is a region of storage that contains a value or group of values. Each value can be accessed using its identifier or a more complex expression that refers to the object. In addition, each object has a unique data type. The data type of an object determines the storage allocation for that object and the interpretation of the values during subsequent access. It is also used in any type checking operations. Both the identifier and data type of an object are established in the object declaration.

#### 4.2.2.1. Data Objects Identification

Serial No	Noun	Problem/Solution Space	Attributes
1.	Chemouflage	p	
2.	Chemistry	p	
3.	User	s	10
4.	Android	p	
5.	Application	p	
6.	Structure	s	
7.	Augmented Reality	s	38
8.	Atom	s	6, 24, 26, 27, 35
9.	Compound	s	8, 24, 32, 33, 34
10.	Account	p	12, 13, 14
11.	Information	p	
12.	Username	s	
13.	Email Address	s	
14.	Password	s	
15.	System	s	
16.	Guest	p	
17.	Chapter	s	18, 19
18.	Periodic Table	s	6, 7, 8
19.	Quiz	s	17, 39, 40

20.	Particle	s	21, 22, 23
21.	Proton	s	
22.	Neutron	s	
23.	Electron	s	
24.	Model	s	6
25.	Output	s	8, 9, 20
26.	Ionization Energy	s	
27.	Electron Affinity	s	
28.	Element	s	8
29.	Element's Property	s	26, 27, 30, 31, 35
30.	Atomic Mass	s	
31.	Electron Configuration	s	
32.	Bond	s	
33.	Cation	s	
34.	Anion	s	
35.	Valency	s	
36.	AR Book	s	7
37.	Device	p	
38.	Image	s	
39.	Score	s	12
40.	Question	s	

## Selected Data Objects

- Atom
- Compound
- Account
- Periodic Table
- Quiz
- Particle
- Output
- Element's Property

## Analysis

As our application uses firebase and file system, we proceed to NoSQL database modeling. The above data objects are relatable to RDBMS, but in NoSQL all of them are not required. So we have eliminated some of them and added 3 new data objects, Quiz, Question\_Answer and Chapter to store the information.

## Final Data Objects

- Account
- Quiz
- Score
- Question\_Answer
- Chapter
- Element's Property



### 4.2.3. NoSQL Document Database

The application depends on an online database for storing user accounts and related quiz points. So we have used the above data objects for NoSQL Database modeling.

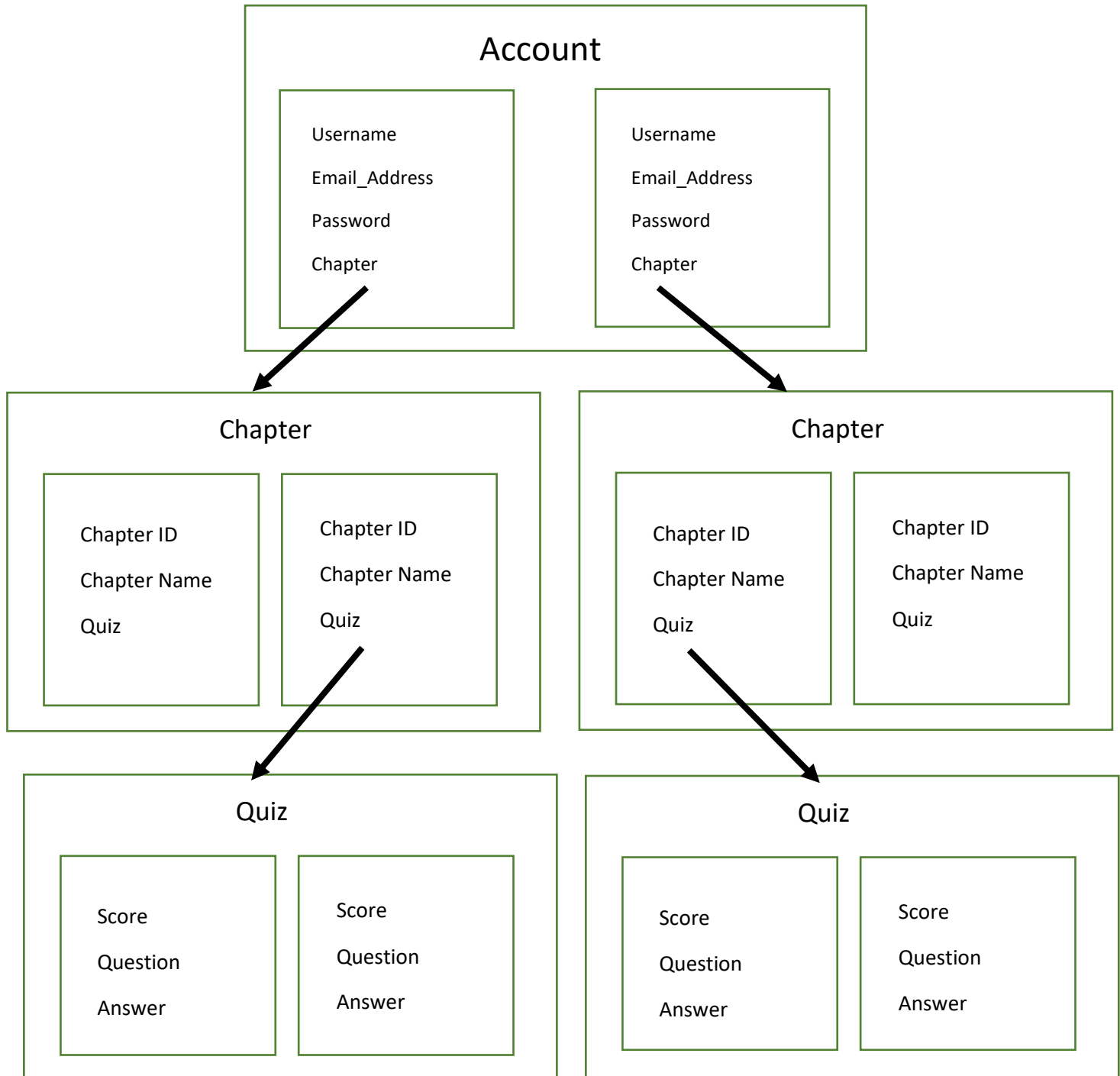


Figure 34: NoSQL Database of Chemouflage

#### 4.2.4. File System

As our application requires static details of 118 elements, we have decided to use file system over DBMS. We will store JSON files which contains the physical and chemical properties of the elements.

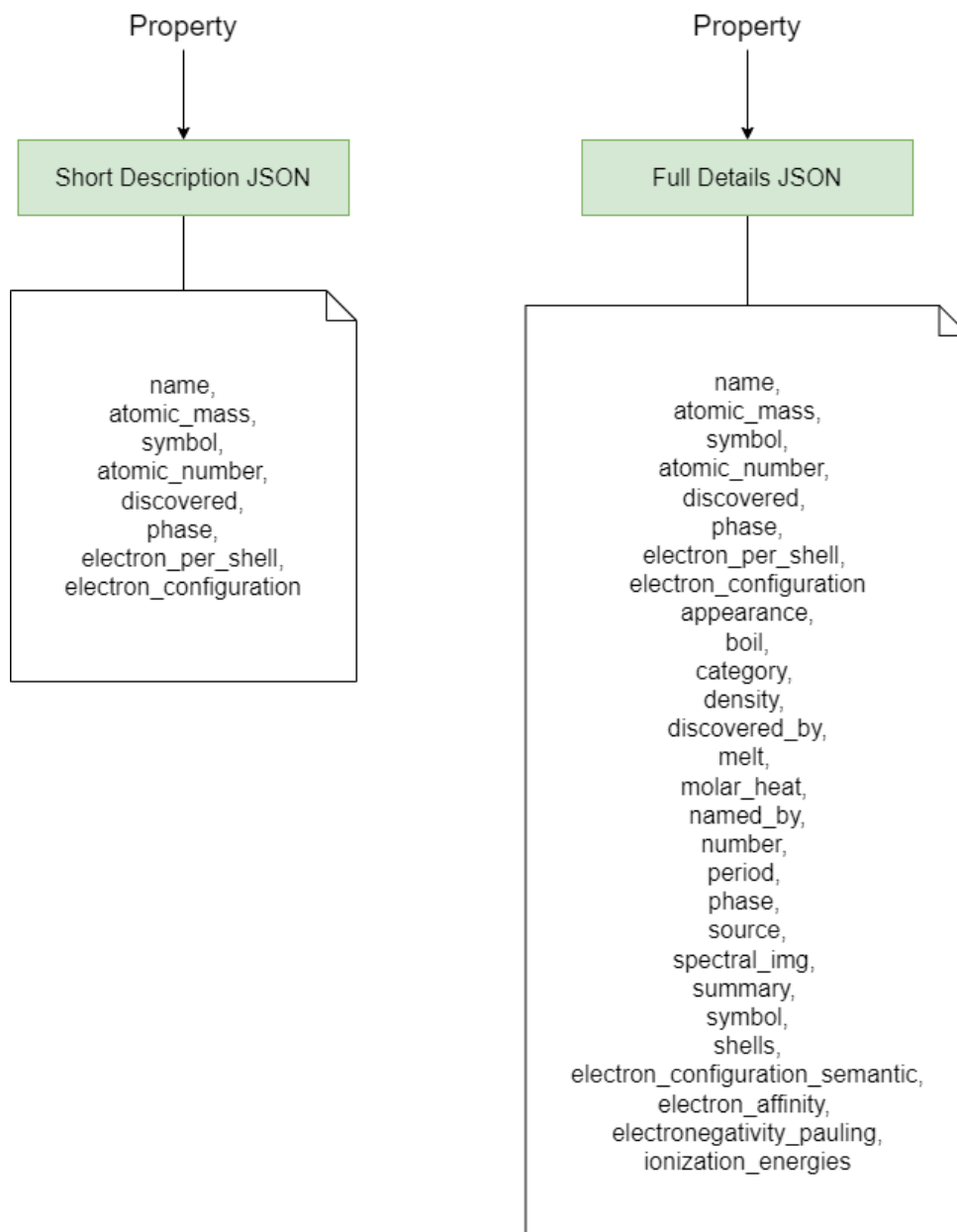


Figure 35: **File System for JSON Files**

## 4.3. CLASS BASED MODELING

This chapter describes the Class Based Model for “Chemouflage”.

### 4.3.1. Introduction

Class-based modeling represents the objects that the system will manipulate, the operations (also called methods or services) that will be applied to the objects to effect the manipulation, relationships (some hierarchical) between the objects, and the collaborations that occur between the classes that are defined. The elements of a class-based model include classes and objects, attributes, operations, class-responsibility-collaborator (CRC) models, collaboration diagrams, and packages.

### 4.3.2. List of Nouns in Chemouflage

Serial No	Noun	Serial No	Noun
1.	Chemouflage	21.	Proton
2.	Chemistry	22.	Neutron
3.	User	23.	Electron
4.	Android	24.	Model
5.	Application	25.	Output
6.	Structure	26.	Ionization Energy
7.	Augmented Reality	27.	Electron Affinity
8.	Atom	28.	Element
9.	Compound	29.	Property

10.	Account	30.	Atomic Mass
11.	Information	31.	Electron Configuration
12.	Username	32.	Bond
13.	Email Address	33.	Cation
14.	Password	34.	Anion
15.	System	35.	Valency
16.	Guest	36.	AR Book
17.	Chapter	37.	Device
18.	Periodic Table	38.	Image
19.	Quiz	39.	Score
20.	Particle	40.	Question

### 4.3.3. List of Verbs in Chemouflage

Serial No	Verb	Serial No	Verb
1.	Simulate	14.	Make Compound
2.	Visualize	15.	Rotate
3.	Sign Up	16.	Scale
4.	Login	17.	Combine
5.	Provide Information	18.	Hold Over Image
6.	Authorize User	19.	Place Closely
7.	Update Account	20.	Give Short Questions

8.	Recover Password	21.	Get Feedback
9.	Learn	22.	Get Points
10.	Give Quiz	23.	Unlock Chapter
11.	Build Atom	24.	Choose Element
12.	Add Particles	25.	View Detail
13.	See changes	26.	Choose Compound

#### 4.3.4. General Classification

Candidate classes are categorized based on the seven general classification. The analysis classes manifest themselves in one of the following ways:

1. External entities
2. Things
3. Events
4. Roles
5. Organizational units
6. Places
7. Structures

A candidate class is selected for special classification if it fulfills three or more characteristics.

Serial No	Solution Space Nouns	General Classification
1.	User	4, 5, 7
2.	Structure	2, 7
3.	Augmented Reality	2, 3, 5, 7
4.	Atom	2, 5, 7
5.	Compound	2, 5, 7
6.	Username	2
7.	Email Address	2
8.	Password	2
9.	System	5, 6, 7
10.	Chapter	2,6,7
11.	Periodic Table	2, 6, 7
12.	Quiz	2, 3, 7
13.	Particle	2
14.	Proton	2
15.	Neutron	2
16.	Electron	2
17.	Model	2, 7
18.	Output	2, 7
19.	Ionization Energy	2
20.	Electron Affinity	2
21.	Element	2, 7

22.	Atomic Property	2, 3, 7
23.	Atomic Mass	2
24.	Electron Configuration	2
25.	Bond	2
26.	Cation	2
27.	Anion	2
28.	Valency	2
29.	AR Book	2, 3, 7
30.	Image	1
31.	Score and Point	2
32.	Question	2, 7
33.	Firestore	1
34.	Periodic table of Elements	2,3,7
35.	Vuforia Database handler	1
36.	Property Of Elements	2,3,7
37.	AR Object Interaction	2,3,7

### Potential to be Classes

- User
- Player
- Account
- Atom
- Atomic Property
- Periodic Table

- Elements
- Property of Elements
- Compound
- Chapter
- Vuforia Database handler
- Firebase
- Augmented Reality Book
- AR Interaction
- System
- Image
- Score, Point
- Quiz

#### 4.3.5. Selection Criteria

The candidate classes are then selected as classes by six Selection Criteria:

1. Retain information
2. Needed services
3. Multiple attributes
4. Common attributes
5. Common operations
6. Essential requirements

A candidate class generally becomes a class when it fulfills around three characteristics.



Serial No	Noun	Selection Criteria
1.	User	1, 2, 3, 4, 5
2.	Atom	3, 4, 5
3.	Augmented Reality Book	1,2,3,4,5
4.	System	1, 2, 3, 4, 5
5.	Image	6
6.	Compound	1,2,3,4,5
7.	Chapter	1,2,3,4,5
8.	Atomic Property	1,2,3,4,5
9.	Element	1,2,3,4,5
10.	Property Of Element	1,2,3,4,5
11.	Vuforia database Handler	6
12.	Firebase	6
13.	Quiz	1,2,3,4,5
14.	Score and Points	1,2,3,4,5
15.	Player	1,2,3,4,5
16.	Account	1, 2, 3
17.	Periodic Table	1, 2, 3, 4, 5
18.	AR Book	1, 2, 3, 4, 5

## Analysis:

We merge two classes named 'Atomic property' and 'Property of element' as 'Property'. We also merge two classes of player and user class as their responsibilities are same. Besides, we handle two external classes for fetching data using API.

## Selected Classes

- User
- Account
- Chapter
- Atom
- Property
- Element
- Compound
- Periodic table
- Quiz
- Score and points
- Augmented Reality Book
- System
- Vuuforia Database
- Firebase
- AR object interaction

The above classes are divided into two groups, some are core classes, and others are supporting classes for the core classes to function properly.

### Analysis Class:

- User
- Account
- Chapter
- Atom
- Property
- Element
- Compound
- Periodic table
- Quiz
- Score and points
- AR Book
- AR Object Interaction
- Firebase

### Environmental Class:

- System
- Vuforia Database
- ImageTracker

### 4.3.6. Attribute and Method Identification

Class Name	Attribute	Method
Account	-email -password +username	+login() +create_account() -recover_password() +verify_info() +update_account() +provide_credentials() +getPassword() -setPassword()
User	+whichPage -userInput +quizHistory +scoreboard	+loginSignUp +selectElement() +play() +selectChapter() +viewProperty() +view3Dstructure() +rotate() +scale() +giveQuiz() +viewScore()
Chapter	-chaptersList -locked_unlocked	+buildAnAtom() +periodicTable() +chemBond()

		+AR() +goToQuiz()
Atom	+element -protons -neutrons -electrons -scale -position	-getElement() +showStructure() +updateOutput() +getElementProperty() -getParticleCount()
Property	+atomicNumber +atomicMass +charge	+structuralProperty() +physicalProperty() +chemicalProperty() +sendProperty()
Element	-elementName -elementNumber -elementType -audioSource -colour	+showAtomModel() +changeColourAsType() +startAudio()
Compound	+elementList -compoundList +cationList +anionList -checkIfExists	+getElements() -getElementModels() -checkCompoundExistence() +showCompound() +returnElements() +showCations()

		+showAnions()
Periodic Table	-element -property	+selectElement() +seeProperty() +getElement() +seeDetails() +getProperty()
Quiz	-question -rightanswer -answer	+getQuestion() +setQuestion() +getAnswer() +setAnswer() +CheckrightAnswer()
Score and Points	-score -point	+addScore() +addPoint() +usePoint() +setPoint()
ARBook	-ImageTarget -GameObject -Camera	+setCamera() +setTarget() +setObjectProperty() +setTransform() +setRigidbody() +setCollider() +distanceCalculation() +update()

AR Object Interaction	-ImageTarget -GameObject -Camera	+setCamera() +setTarget() +setObjectProperty() +setTransform() +setRigidbody() +setCollider() +distanceCalculation() +userRotate() +makeCompound() +update()
Firebase	-loginAuth	+confirmUser() +createUser() +updateUserInfo

### 4.3.7. Class Cards

Class: Account	
Responsibilities	Collaborators
Log In	User
Creating account by providing credentials	User, Firebase Database
Updating Account	User, Firebase Database
Recovering Password	User
Verifying Credentials	User, Firebase Database

Class: User	
Responsibilities	Collaborators
Get User Input	System
Log In or Create Account	Account
Get Current Page	System
Start Quiz	Quiz
View Score	Quiz, Score and Points
Select Chapter	Chapter



Class: Chapter	
Responsibilities	Collaborators
Build An Atom	User, Atom, Property, Element
Periodic Table	User, Atom, Property, Element
Chemical Bonding	User, Atom, Element, Compound
Augmented Reality	User, AR Object Interaction
Go to Quiz	Quiz, Score and Points

Class: Atom	
Responsibilities	Collaborators
Getting Current Element	Element, Property
Showing Structure	Element
Updating Output as User Input	Element
Getting Particles	
Updating Structure according to Distance	System, Compound, AR Object Interaction

Class: Property	
Responsibilities	Collaborators
Getting Structural Property	
Getting Physical Property	
Getting Chemical Property	
Send Properties	Element

Class: Element	
Responsibilities	Collaborators
Change Colour as Type	
Send Element Info	Atom, Compound, Periodic Table
Start Audio for Element	
Get Properties	Property

Class: Compound	
Responsibilities	Collaborators
Choose from Cation Anion List	
Check if Compound Exists	
Show or Break the Compound	
Show in AR Book	AR Object Interaction

Class: Periodic Table	
Responsibilities	Collaborators
Selecting Element	Element
Showing Properties	Element, Property
Showing Full Details	Property

Class: Quiz	
Responsibilities	Collaborators
Fetch Questions	Firebase
Set Questions	
Get Answer from User	User
Fetch Answers	Firebase
Check Answers	

Class: Score and Point	
Responsibilities	Collaborators
Adding Score	Firebase, System
Storing Score	Firebase, System
Update Score	Firebase
Adding Point	Firebase, System
Unlocking Another Chapter	System, Chapter

Class: AR Book	
Responsibilities	Collaborators
Detecting Atom of Elements	User, System, Atom
Simulate objects	System, Atom, Compound

Class: AR Object Interaction	
Responsibilities	Collaborators
Detecting Atom of Elements	User, System, Atom
Calculating Distance	System
Creating Compound	System, Atom, Compound
Removing Compound	System, Atom, Compound

Class: Firebase	
Responsibilities	Collaborators
Authenticating User	System
Verifying User	System
Adding User	
Saving Question	

## 4.3.8. CRC Diagram

ID: 1

Name: Chemouflage

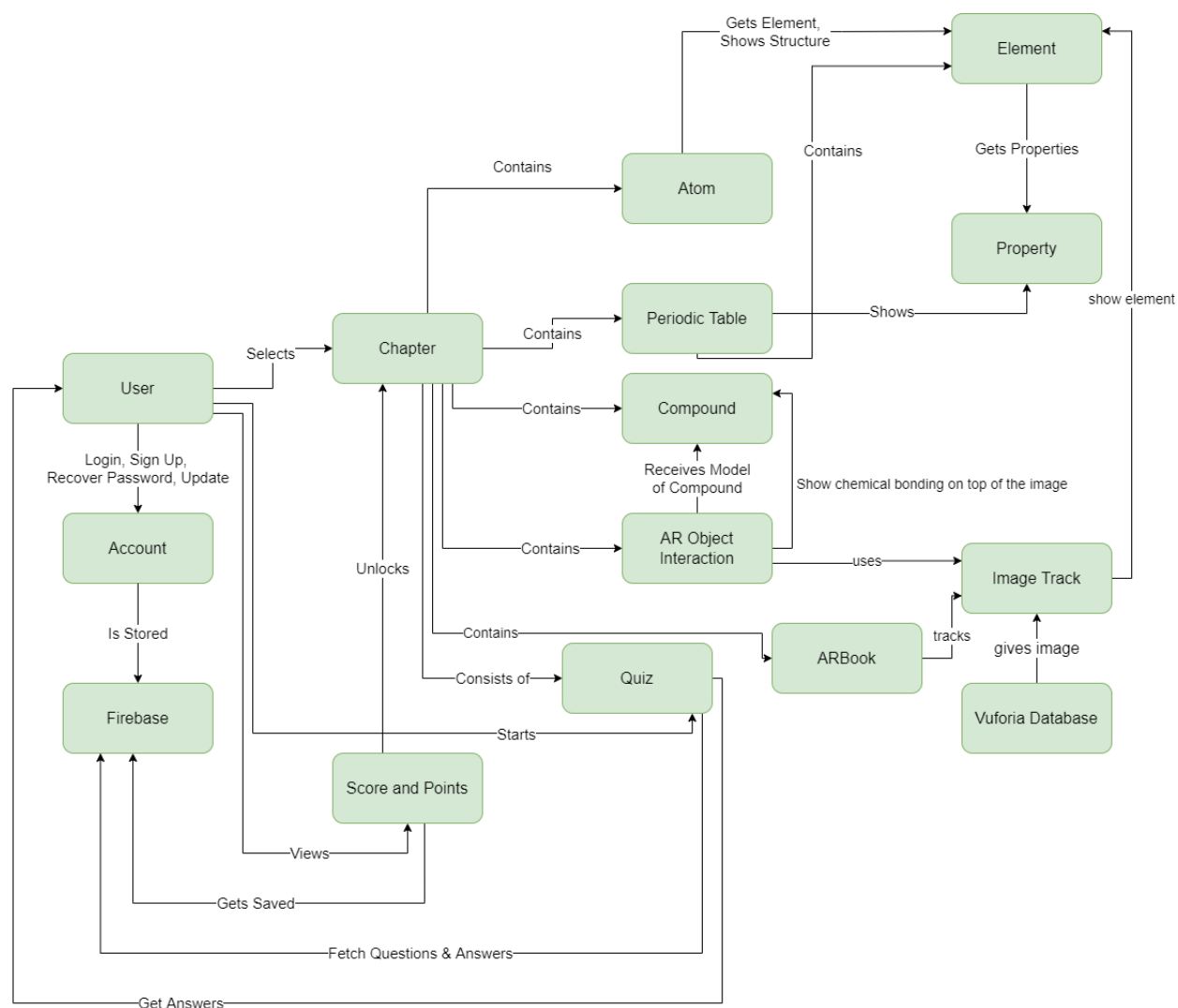


Figure 36: CRC Diagram for Whole System

## **4.4. BEHAVIORAL MODELING**

This chapter describes the Behavioral Model for “Chemouflage”.

### **4.4.1. Introduction**

The behavioral model indicates how software will respond to external events or stimuli. In the context of behavioral modeling, two different characterizations of states must be considered: (1) the state of each class as the system performs its function and (2) the state of the system as observed from the outside as the system performs its function.

### **4.4.2. State Transition**

One component of a behavioral model is a UML state diagram that represents active states for each class and the events (triggers) that cause changes between these active states.

#### 4.4.2.1. Event Table

SL. No.	Event	State Name	Initiator	Collaborator	Associated Method
1	Start App	Start_App	System	User	+launch()
2	Manage Account	Manage_Account	User	Account	
3	Will Create an account	Register	Account	Firebase	+createAccount() -verifyInfo() +notifyUser() -sendConfirmation()
4	Will provide information	Provide_Credentials	Account	System, Account	+getUserInfo()
5	Will Verify User's credentials	Verify	Account	Firebase	-sendConfirmation()
6	Send User to Login Page	Go_to_Login	Account	Firebase, User	+loginPage()

7	Take the User's Credentials	Check_Credentials	Account	Firebase	+checkCredentials()
8	Will login to system	Provide_username_password	User	System	-verifyInfo()
9	Will recover password	Recover_Password	User	Firebase	-passwordRecovery()
10	Will be updating user's information	Update_Profile	User	Firebase	+setUserName() +setEmailAddress() +setPassword()
11	Will log in as a guest	Log_In_AsA_Guest	User		+loginAsGuest()
12	Will go to Home Page	Launch_Home_Page	User	Chapter	+homePage()
13	Will Load Chapters	Load_Chapters	Chapter	Atom, element, compound, AR Interaction, Quiz	+loadChapters()



14	Go to Chapters	Go_to_Chapters	User	Chapter	+goChapter()
15	Will Load the Quizes of the Chapters	Load_Quizes	Chapter	Quiz	+loadQuiz()
16	Will Build an Atom	Building_an_atom	User	Atom, element	+createAtom() +removeStructure() +createElement() +addProton() +addNeutron() +addElectron()
17	Will interact with atom	Interacting_with_a tom	User	Atom,element	+addProton() +addNeutron() +addElectron() +removeProton() +removeElectron() +removeNeutron()
18	Will see the stability of an atom	Viewing_ stability_of_an_ atom	Atom	User, element	+seeStability() +seePropertyOfAtom()

19	Will see the dynamic changed properties	Viewing the dynamic changes of element	Atom	User, Element, Periodic table	+getProperty()
20	Will show the periodic table	Show_elements_of_periodic_table	Periodic Table	Element, User	+showPeriodicTable()
21	Select and View Element	Select_View_Element	User	Periodic Table, Atom	+selectElement()
22	Will fetch short description	Fetching short description of element	Property	JSON file (short), periodic table, element	+getShortProperty()
23	Will fetch full description of element	Fetching full description of element	Property	JSON file (details), periodic table, element	+getFullProperty()
24	Will see the 3D structure of elements	Creating 3D structure	Atom	System, element	+see3DModelOfElemets()

25	Will see the compound formation	Viewing compound	Compound	System, User	+see3DModelOfElemets()
26	Will scale, rotate compounds	Interact_with_compounds	User	System, compound	-rotate3DModel() -scale3DModel()
27	Will select cation, anion	Select_anion_cation	User	element, compound	+addCation() +addAnion() -createCompoundI() +checkCriteriaforFormingCompound()
28	Will see the bonds	See_chemical_bondings	User	element, compound	-createCompoundI() +createBondings()
29	Will view 3D model over an image	Viewing_3D_model_over_image	AR Book	User, Vuforia Database	+viewAtom()
30	Start AR Mode	Start_AR_mode	User	AR Object Interaction	+AR()
31	Will detect image	Detecting_marker_based_image	User	AR Object Interaction, Vuforia	+trackImage()

	target of atoms			Database,system	
32	Will detect multiple image target of atoms	Detecting_multiple_image	User	AR Object Interaction, VuforiaDatabase,system	+trackmultipleImage()
33	Will overlay atoms on top of the image target	overlaying atoms on top of the image target	AR Object Interaction	system	detectImage()
34	Will rotate, scale,move the atom	Interacting_atom_AR	User	system, AR Object Interaction	+rotate(), +transform(), +scale()
35	Will simulate chemical bonding	Simulating chemical bonding	AR Object Interaction		+simulate()
36	Will form compound	Forming compound	ARInteraction	Vuforia database	+formingCompound() +chemicalBonding()

37	Will update compound	Updating_compound	User	ARInteraction	+formingCompound() +chemicalBonding() +changeProperties()
38	Will verify user for taking exam	Verifying_user_for_taking_exam	User	system,Quiz	+verifyUser()
38	Will Start the Quiz	Start_Quiz	User	Quiz	+startQuiz()
40	Will set question	Setting question	Quiz	system,user,	+setQuestion()
41	Will check the answer	Checking the answer	system	user,quiz	+checkAnswer()
42	Store score and points	Storing score and points	firebase	User,quiz	+giveMarks() +storeMarks()
43	Will eligible for next quiz	eligible_for_next_quiz	User	Quiz,score and point	+score and points() +checkEligibility()

## 4.4.2.2. State Transition Diagram

ID: 1

Name: Account

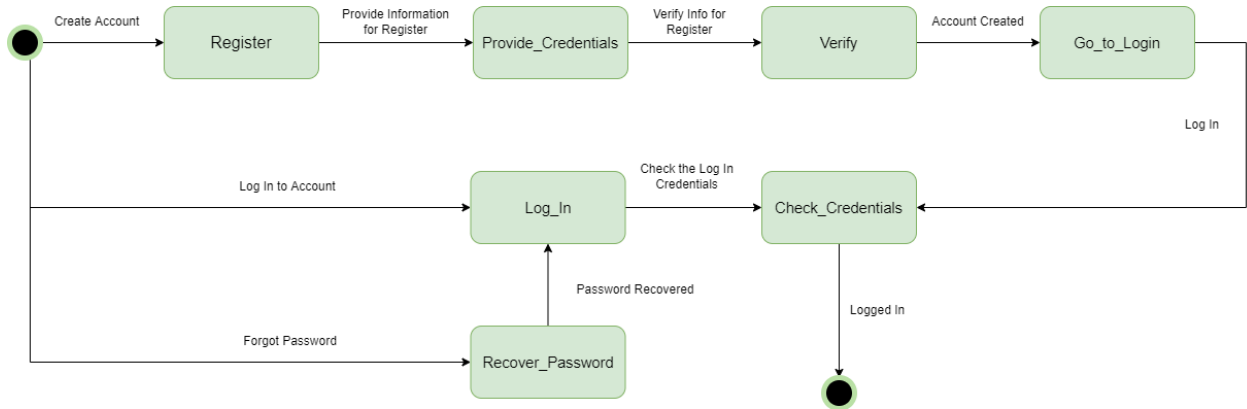


Figure 37: State Transition Diagram for Account Class

ID: 2

Name: User

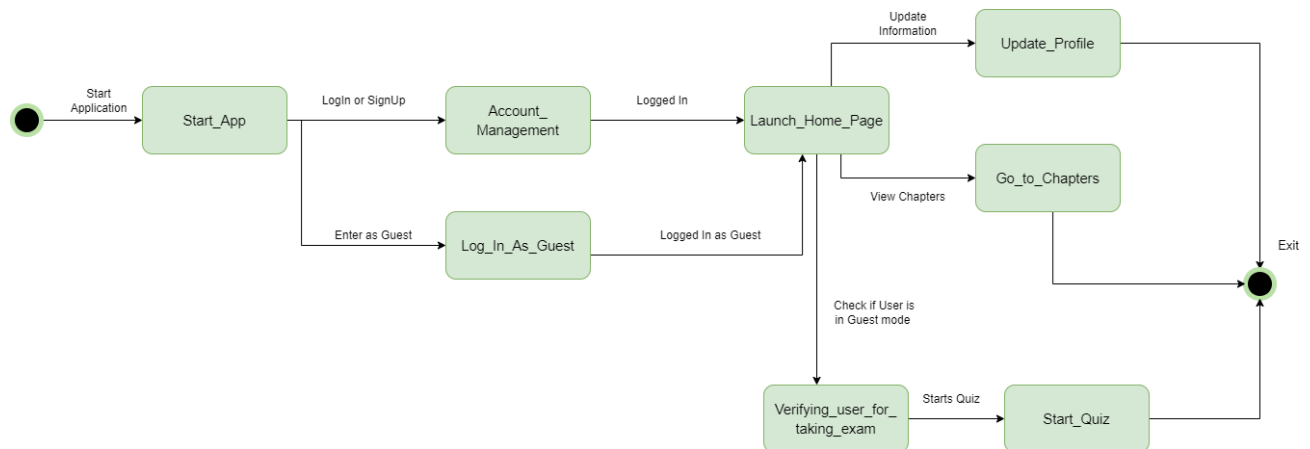


Figure 38: State Transition Diagram for User Class

ID: 3

Name: Chapter

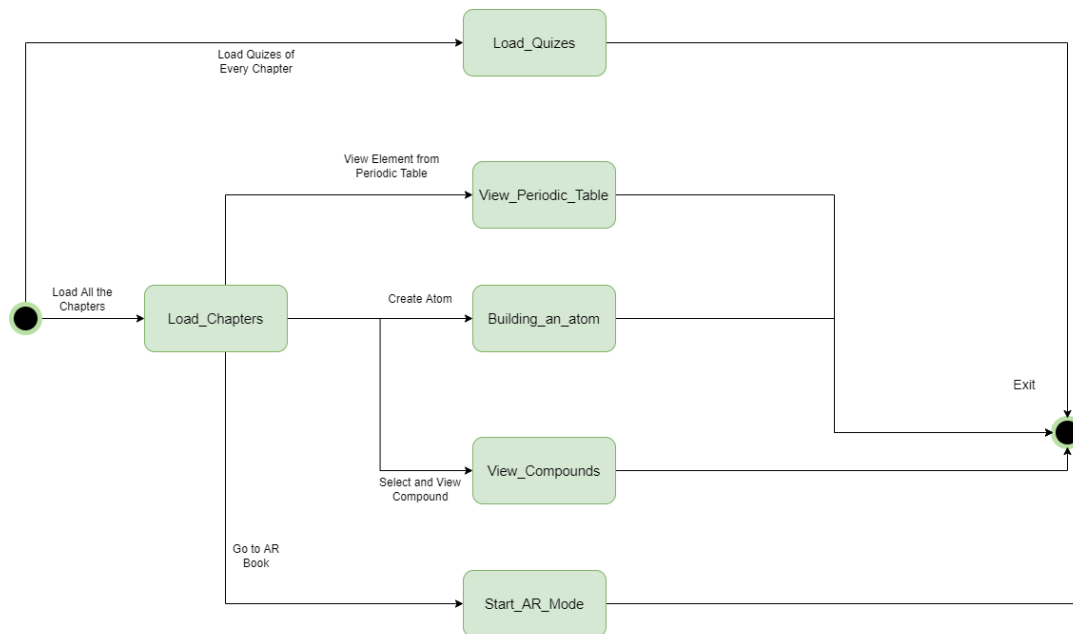


Figure 39: State Transition Diagram for Chapter Class

ID: 4

Name: Atom

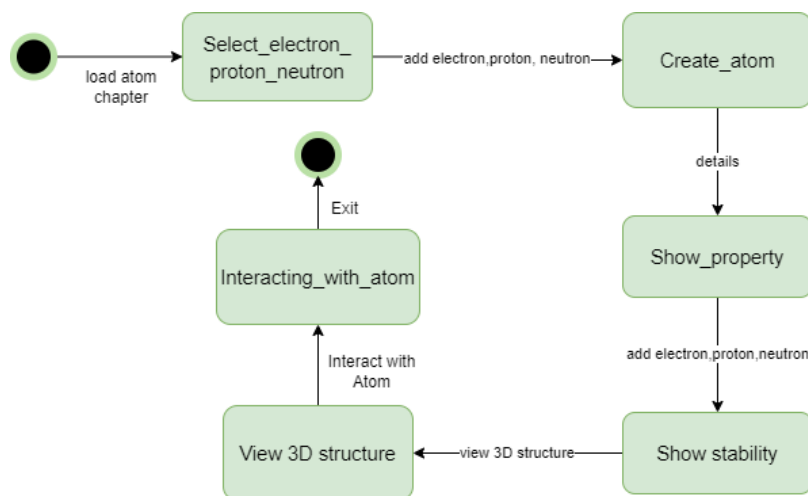


Figure 40: State Transition Diagram for Atom Class

**ID:** 5

**Name:** Property

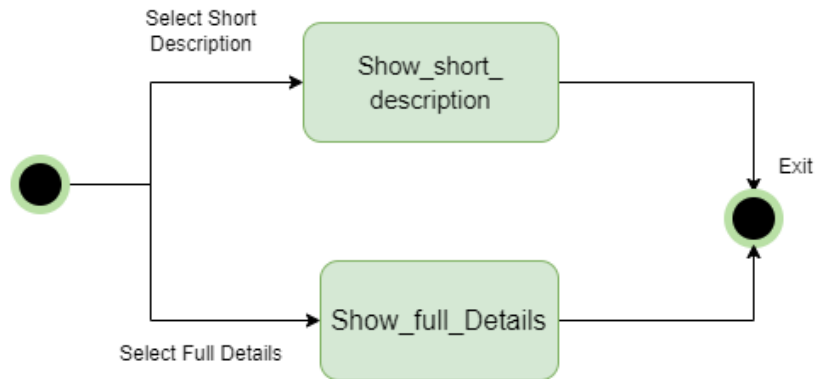


Figure 41: **State Transition Diagram for Property Class**

**ID:** 6

**Name:** Element

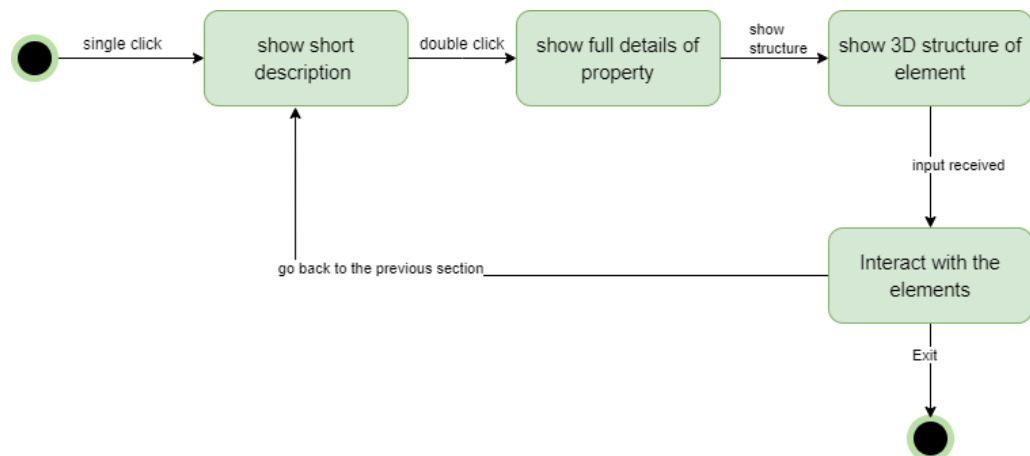


Figure 42: **State Transition Diagram for Element Class**



**ID:** 7

**Name:** Compound

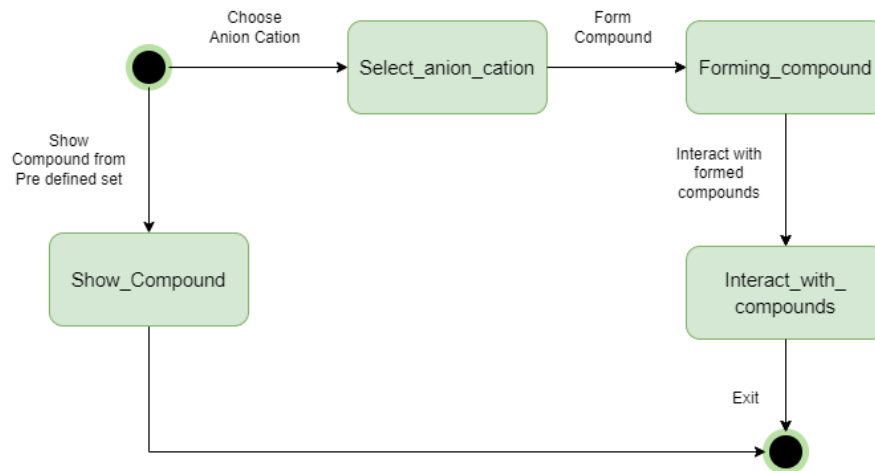


Figure 43: **State Transition Diagram for Compound Class**

**ID:** 8

**Name:** Periodic Table

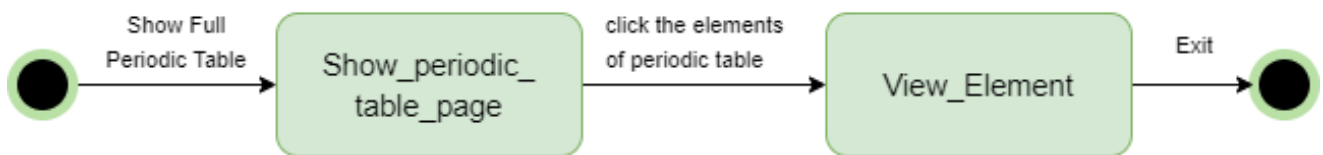


Figure 44: **State Transition Diagram for Periodic Table Class**

ID: 9

Name: Quiz

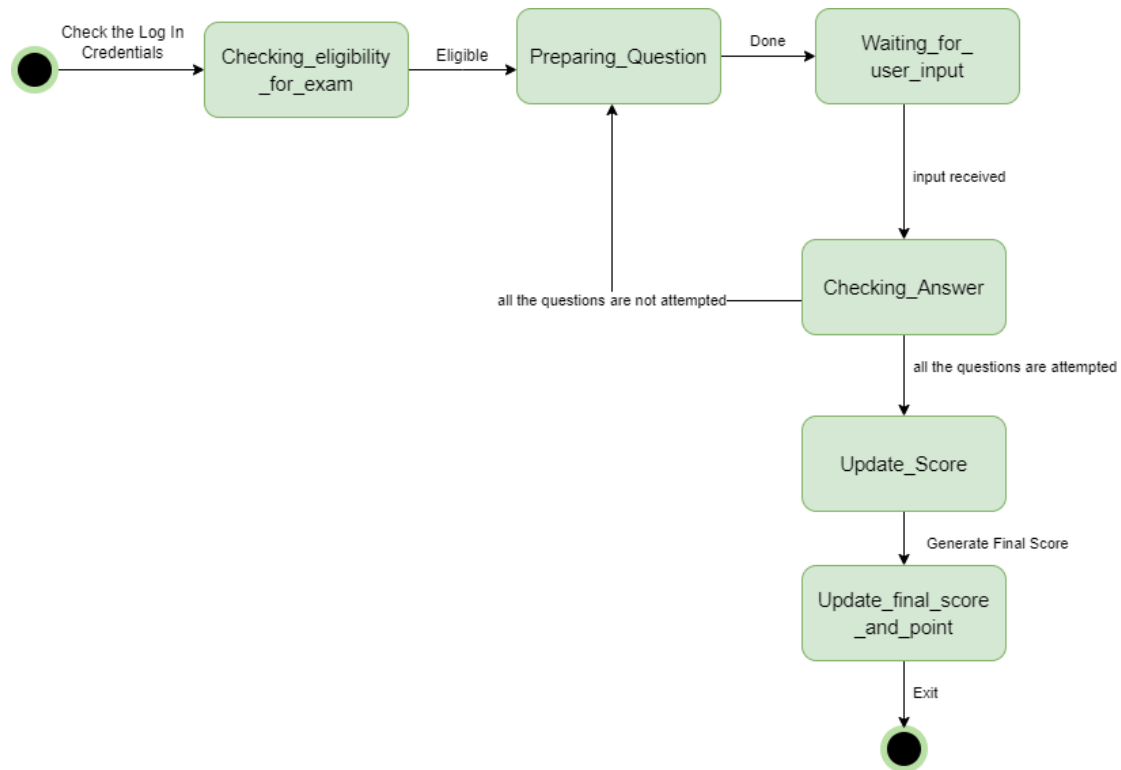


Figure 45: State Transition Diagram for Quiz Class

**ID:** 10

**Name:** Score and Point

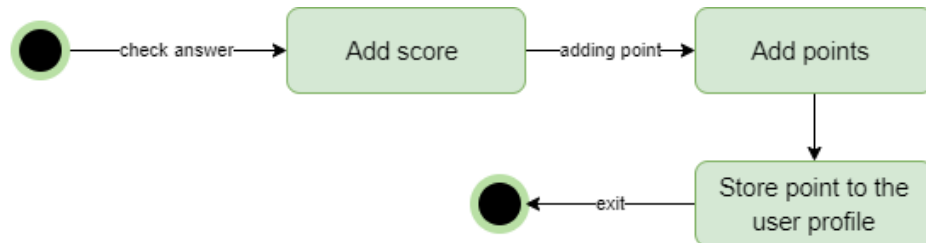


Figure 46: **State Transition Diagram for Score and Point Class**

**ID:** 11

**Name:** AR Book

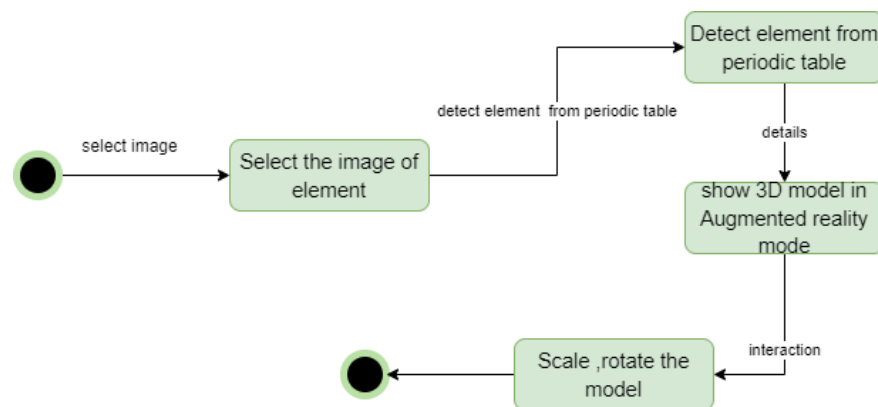


Figure 47: **State Transition Diagram for AR Book Class**

**ID:** 12

**Name:** AR Object Interaction

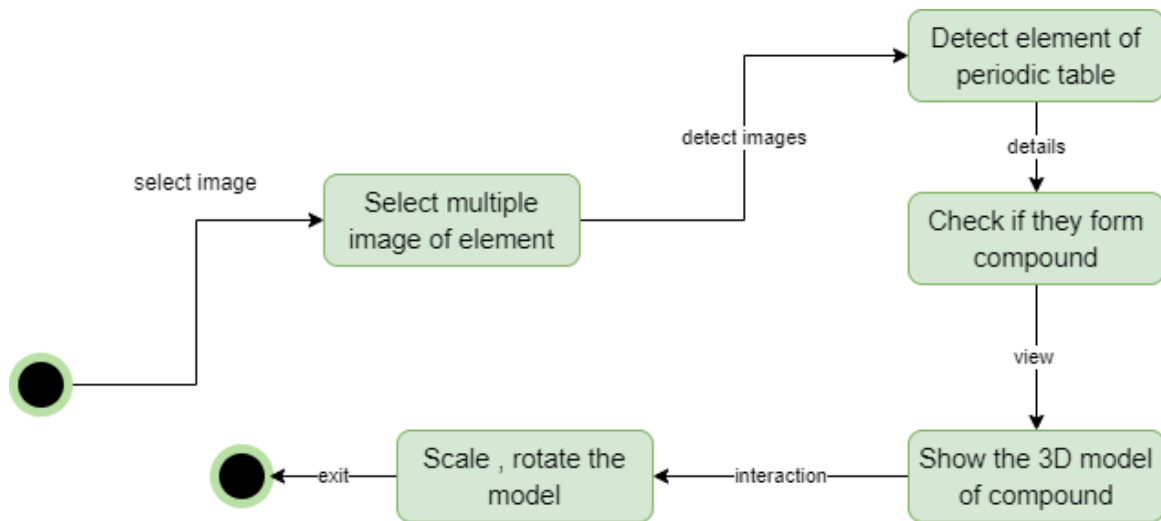


Figure 48: **State Transition Diagram for AR Object Interaction Class**

**ID:** 13

**Name:** Firebase

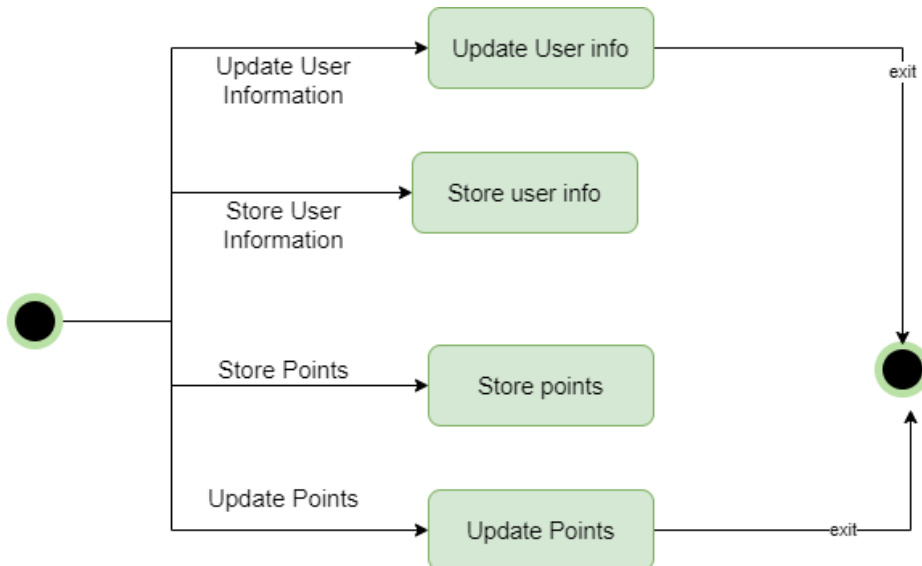


Figure 49: **State Transition Diagram for Firebase Class**

#### 4.4.2.3. Sequence Diagram

The second type of behavioral representation, called a sequence diagram in UML, is a representation of how events cause flow from one object to another as a function of time. In essence, the sequence diagram is a shorthand version of the use case. It represents key classes and the events that cause behavior to flow from class to class.

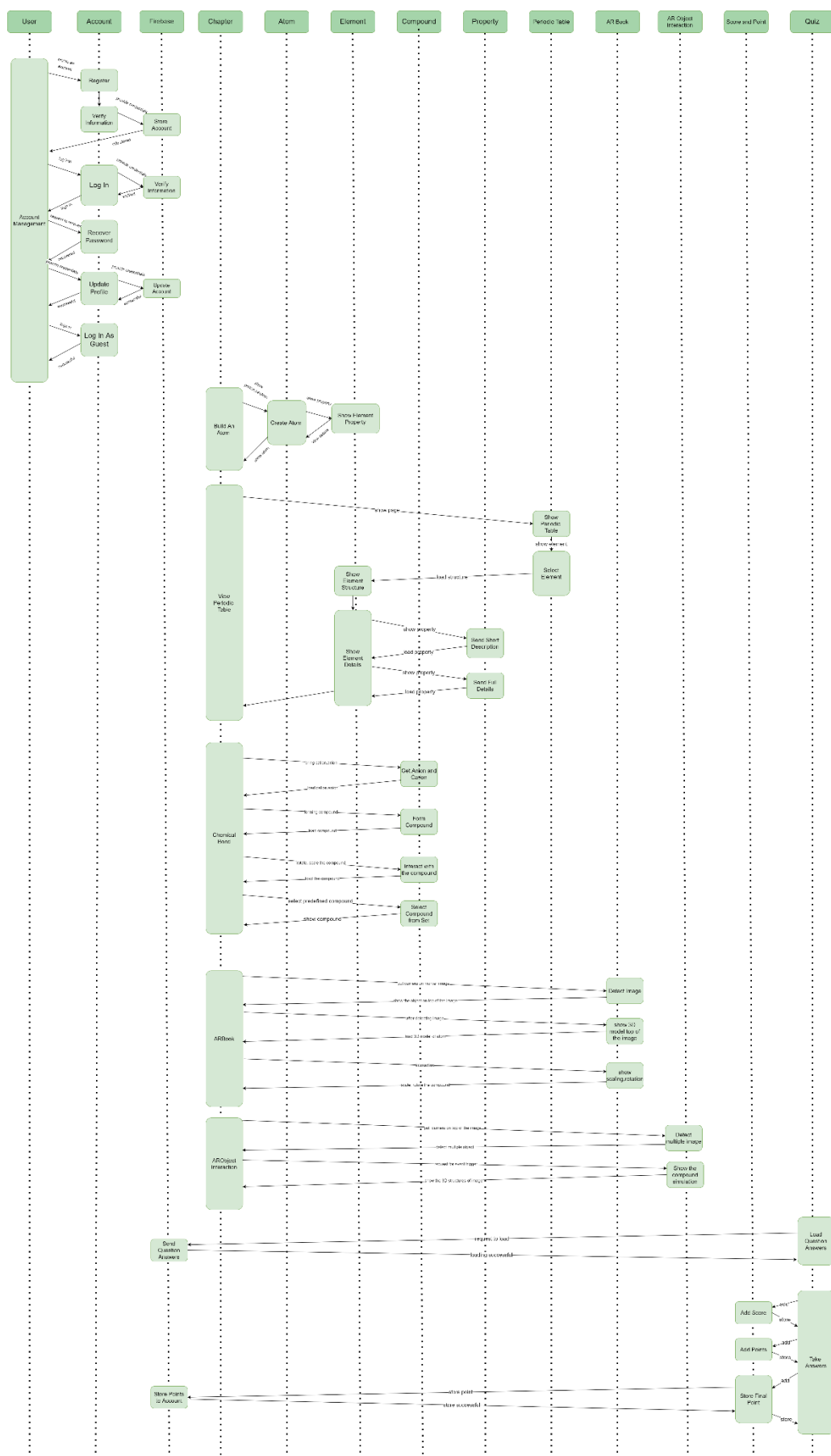


Figure 49: State Transition Diagram for Firebase Class

## Elaborated Figures of the Sequence Diagram

