BRAIN STATION 23

Hackathon

CHEMOUFLAGE

PLAY OR LEARN?

TEAM NAME

TEAM GGWP

TEAM MEMBERS

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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 o f compounds for simulation. The user can see the list and choose any compound from it, such as NaCl, H_2O, CH_4 . 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^+, Mg^+, Ca^{2+})
    2. The list of Anions (Cl^-, O^{2-}, F^-)

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.

Use Case Diagram

Level: 0

Name: Chemouflage

Primary Actor: User, System

Secondary Actor: Phone Storage, Firebase, Vuforia Database

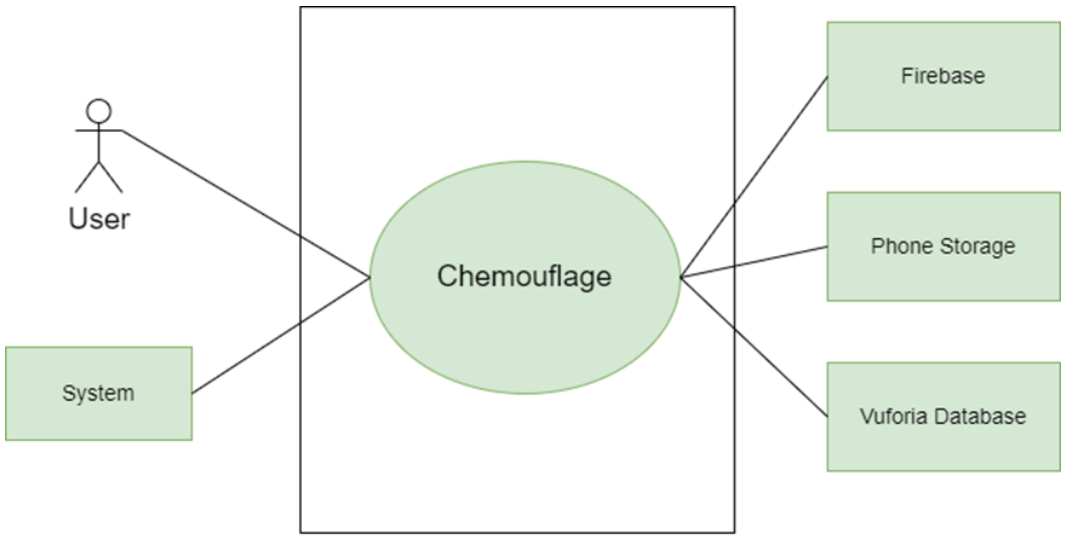


Figure 1: **Chemouflage**

Level: 1

Name: Chemouflage (Detailed)

Primary Actor: User, System

Secondary Actor: Phone Storage, Firebase, Vuforia Database

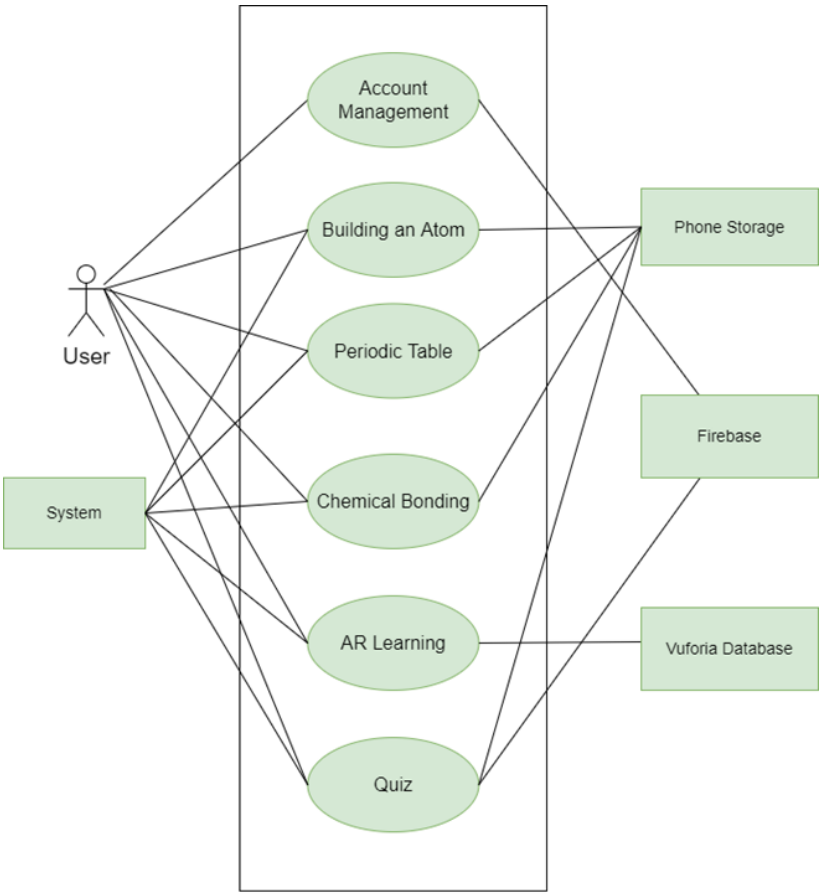


Figure 2: **Chemouflage (Detailed)**

Description of Use Case Diagram Level 1:

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

Here, the whole system is divided into six subsystems and Firebase, vuforia 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 to fully explore 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

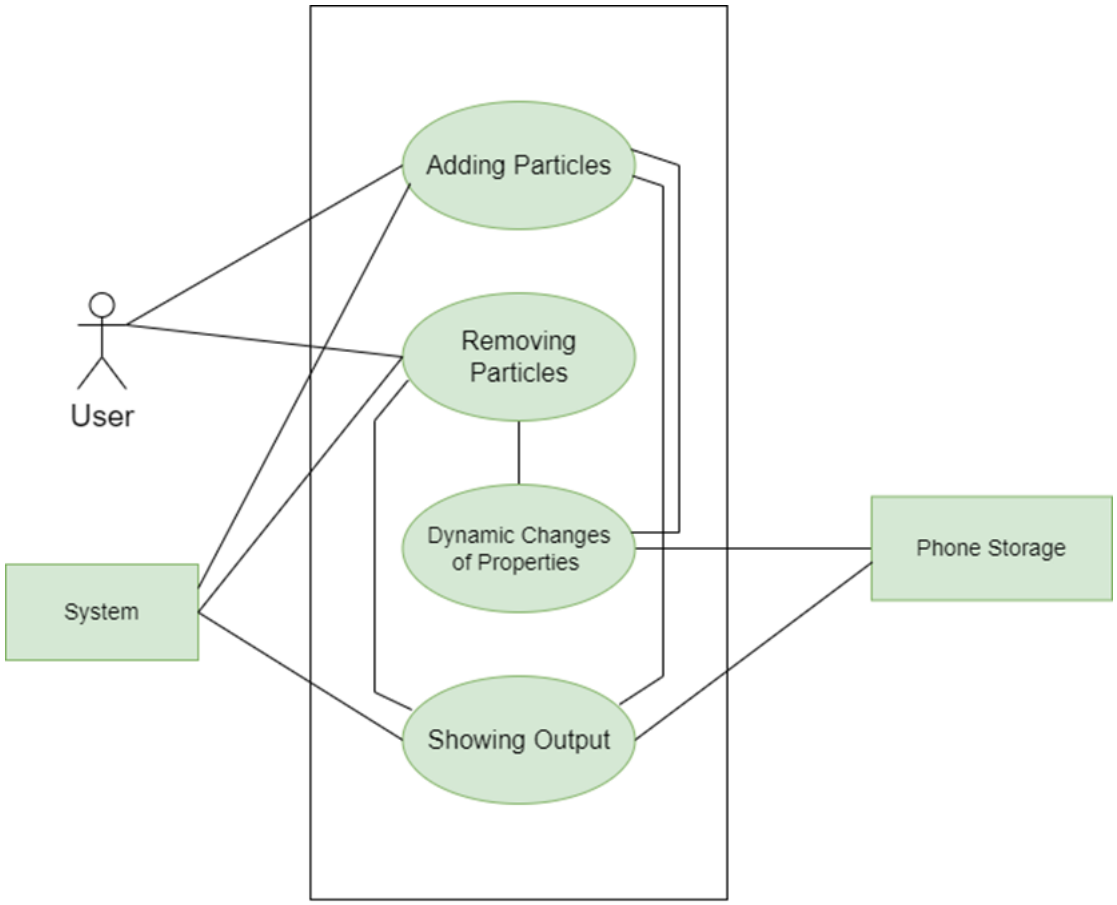


Figure 4: **Building an Atom**

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 particles, 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

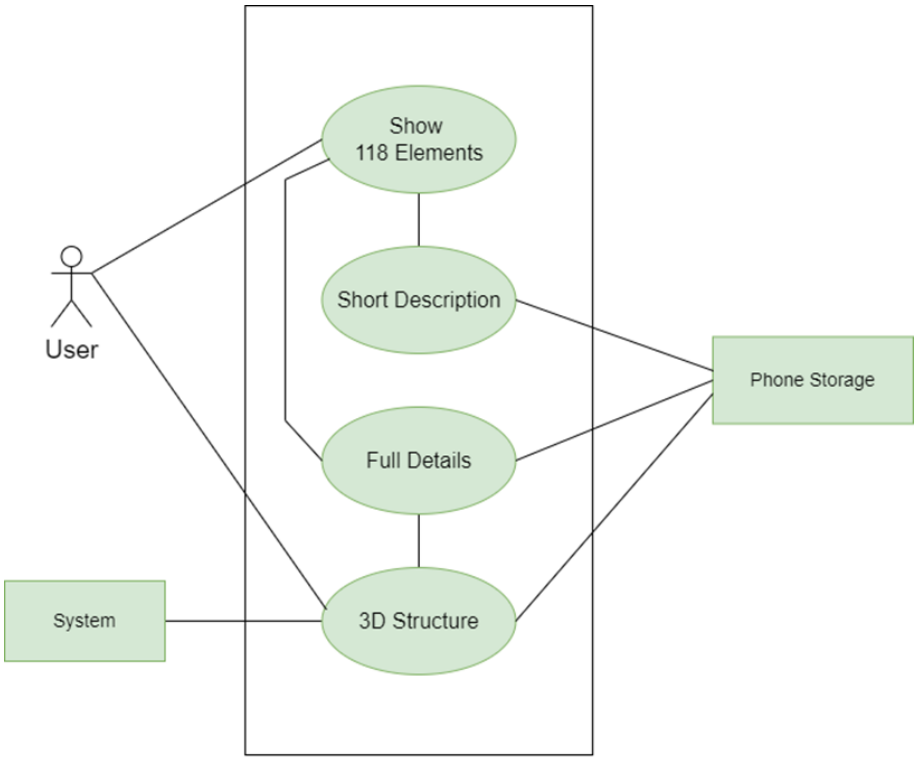


Figure 5: **Periodic Table**

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

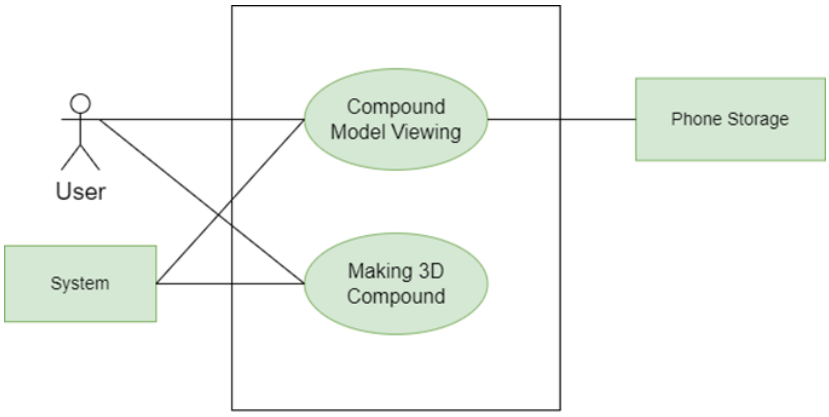


Figure 6: **Chemical Bonding**

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

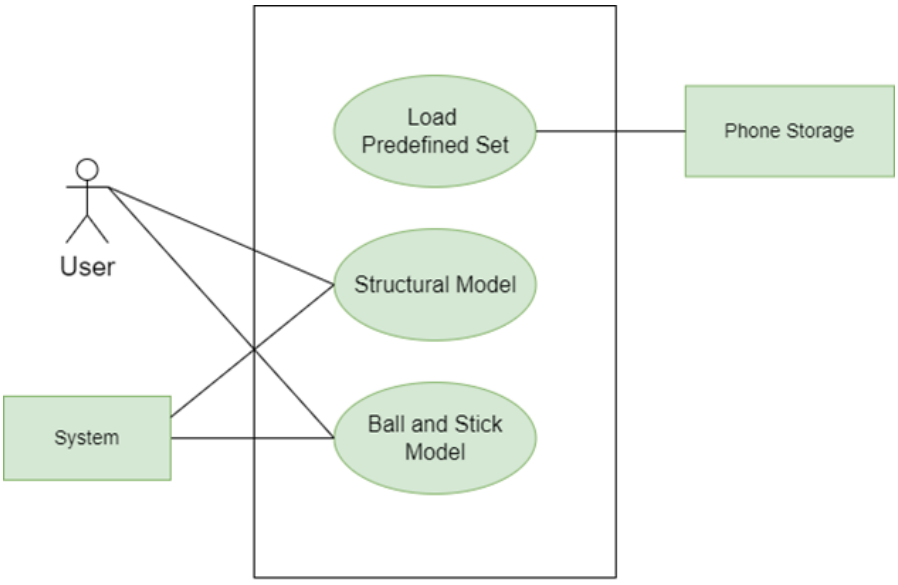


Figure 7: **Compound Model Viewing**

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

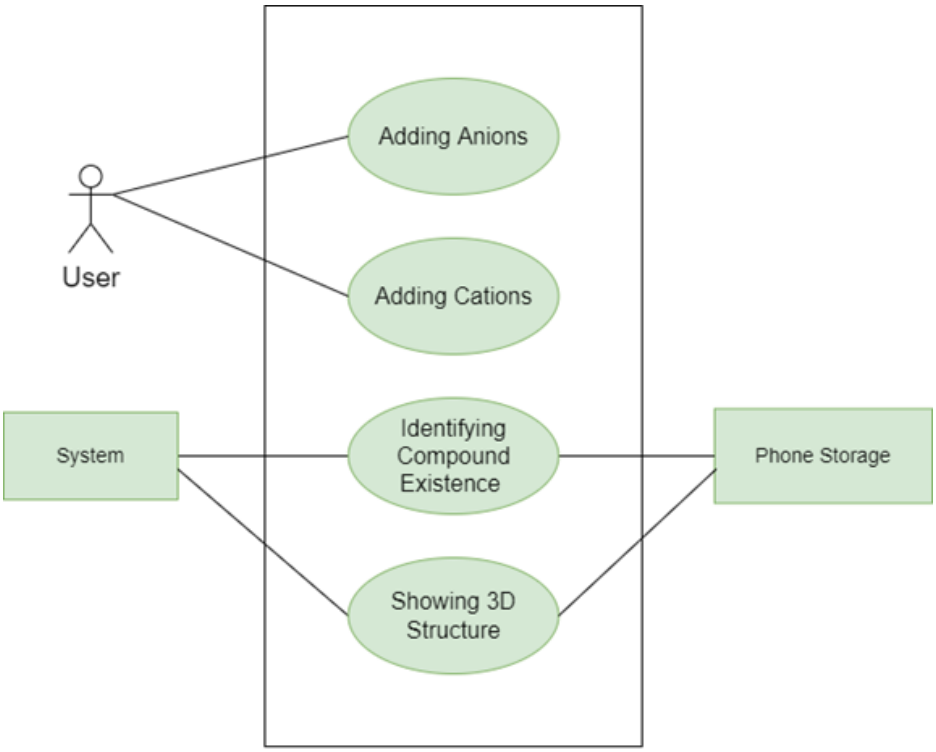


Figure 8: **Making 3D Compound**

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

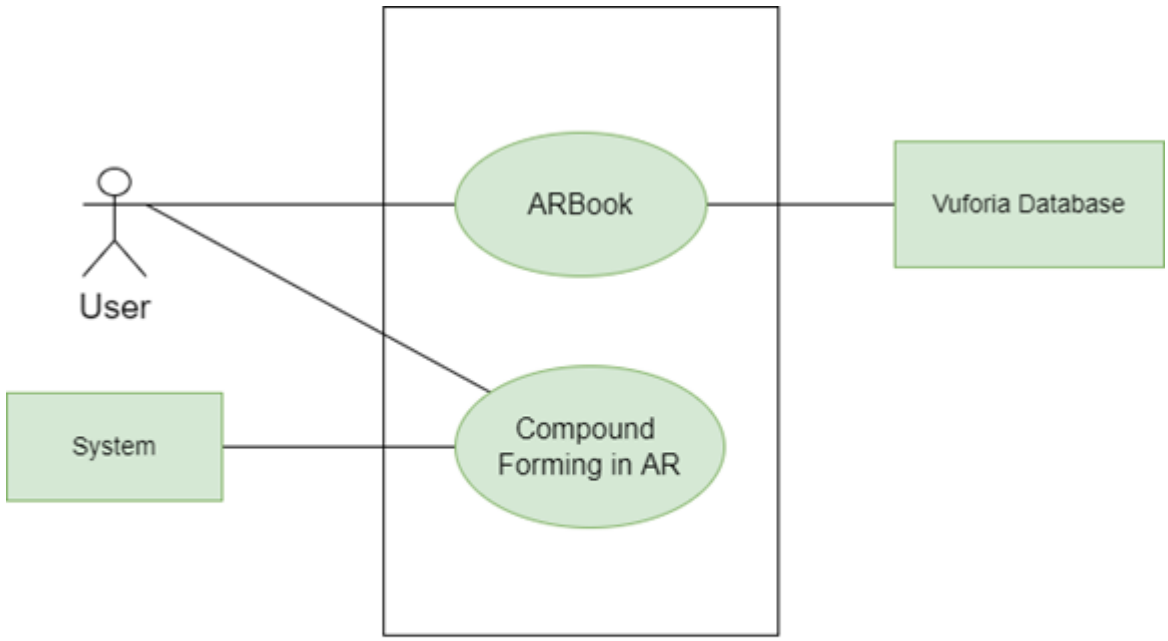


Figure 9 : **AR Learning**

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

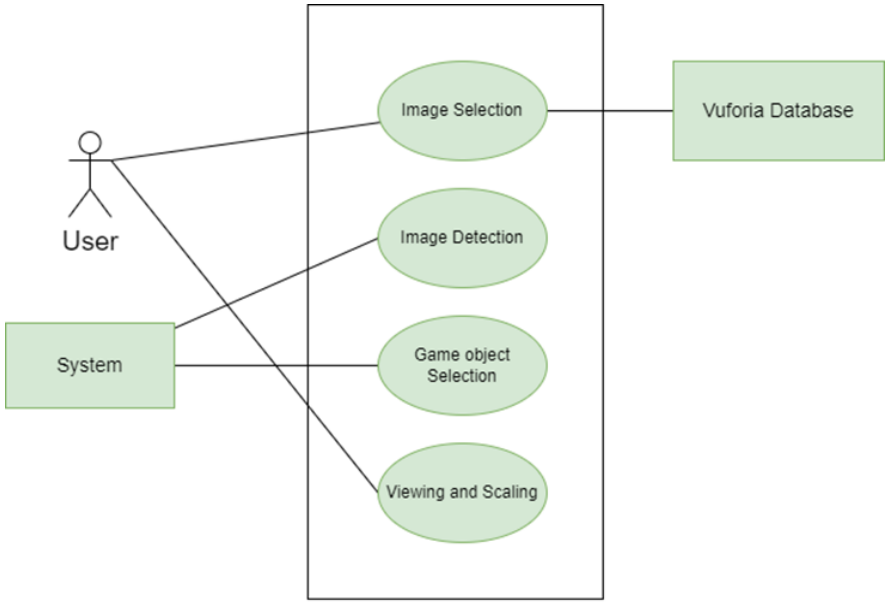


Figure 10 : **AR Book**

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 take 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

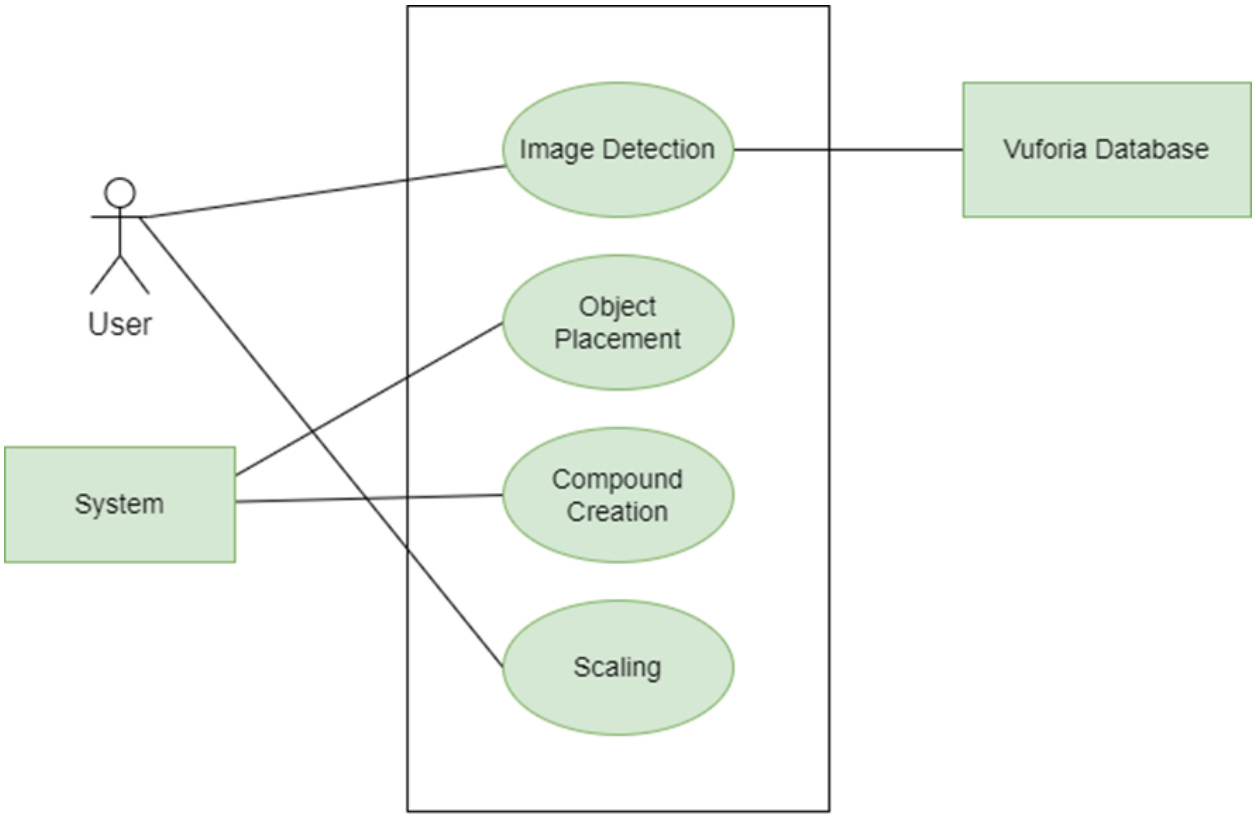


Figure 11 : **Compound Forming in AR**

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

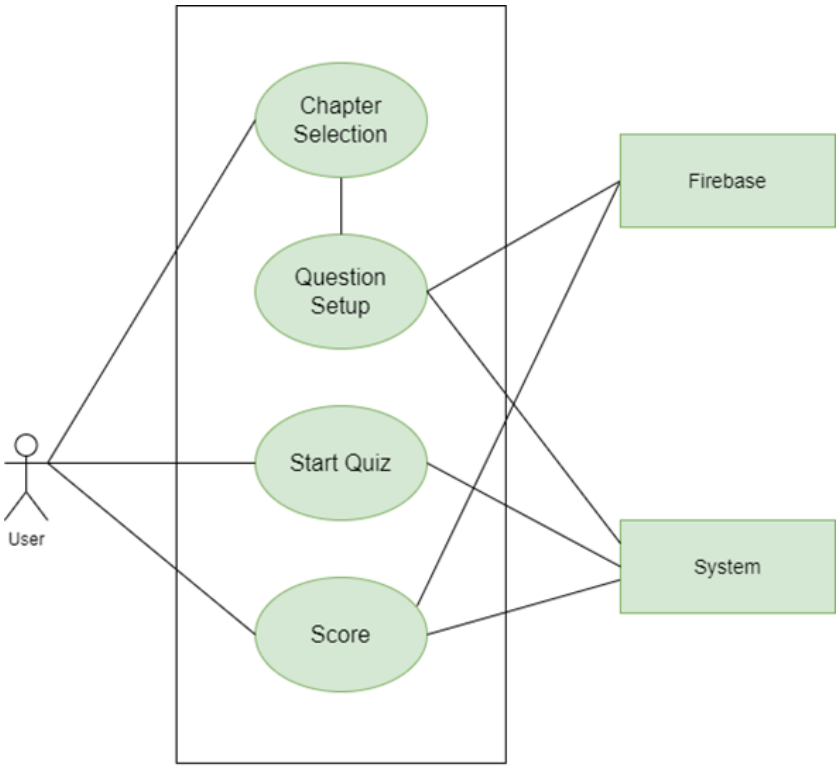


Figure 12: **Quiz**

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 stores the score to the firebase.

Swimlane Diagram

Level: 1.1

Name: Account Management

Reference: Use Case Level – 1.1

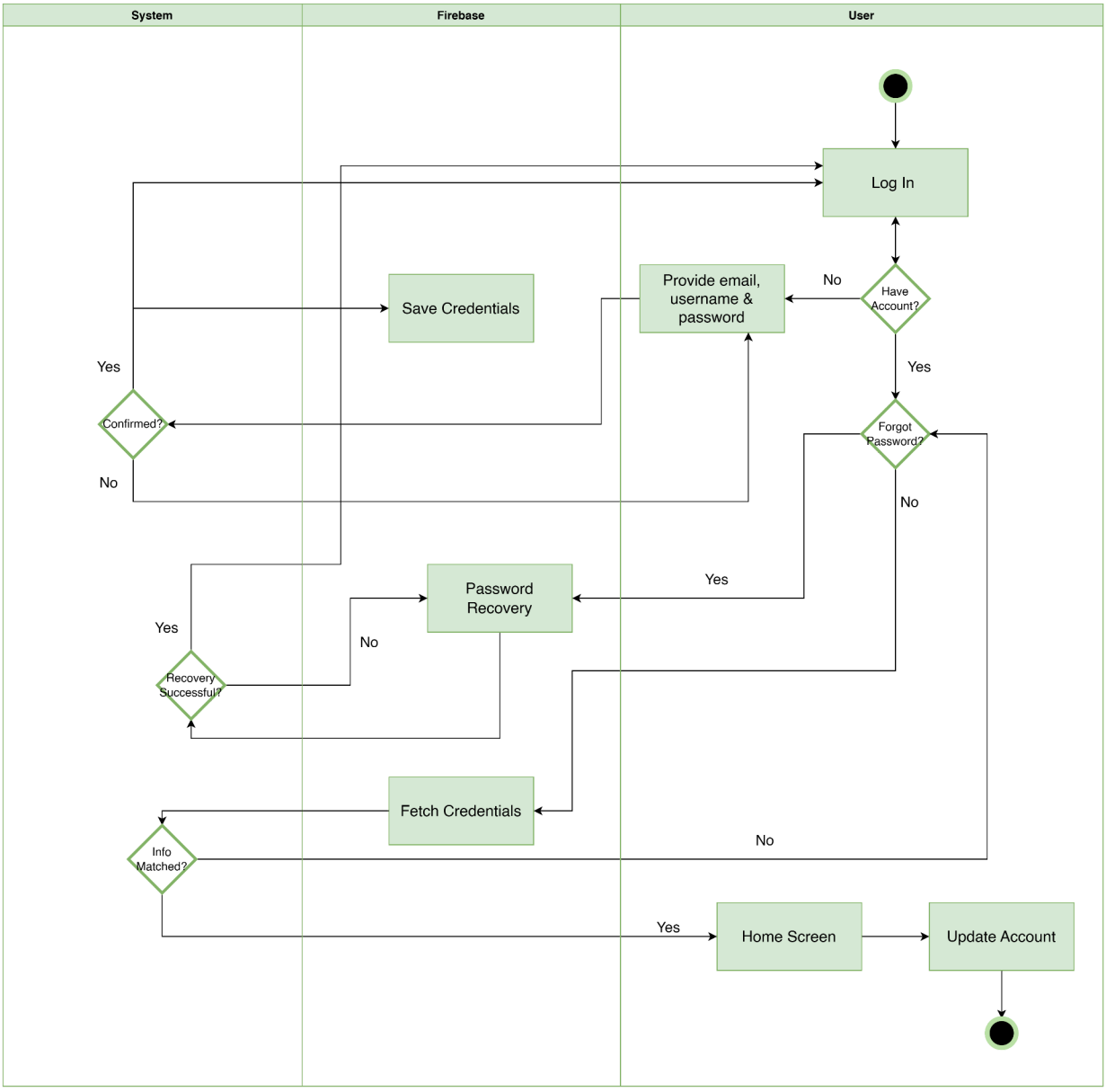


Figure 24: **Account Management (Swimlane Level - 1.1)**

Level: 1.2

Name: Building an Atom

Reference: Use Case & Activity Diagram Level – 1.2

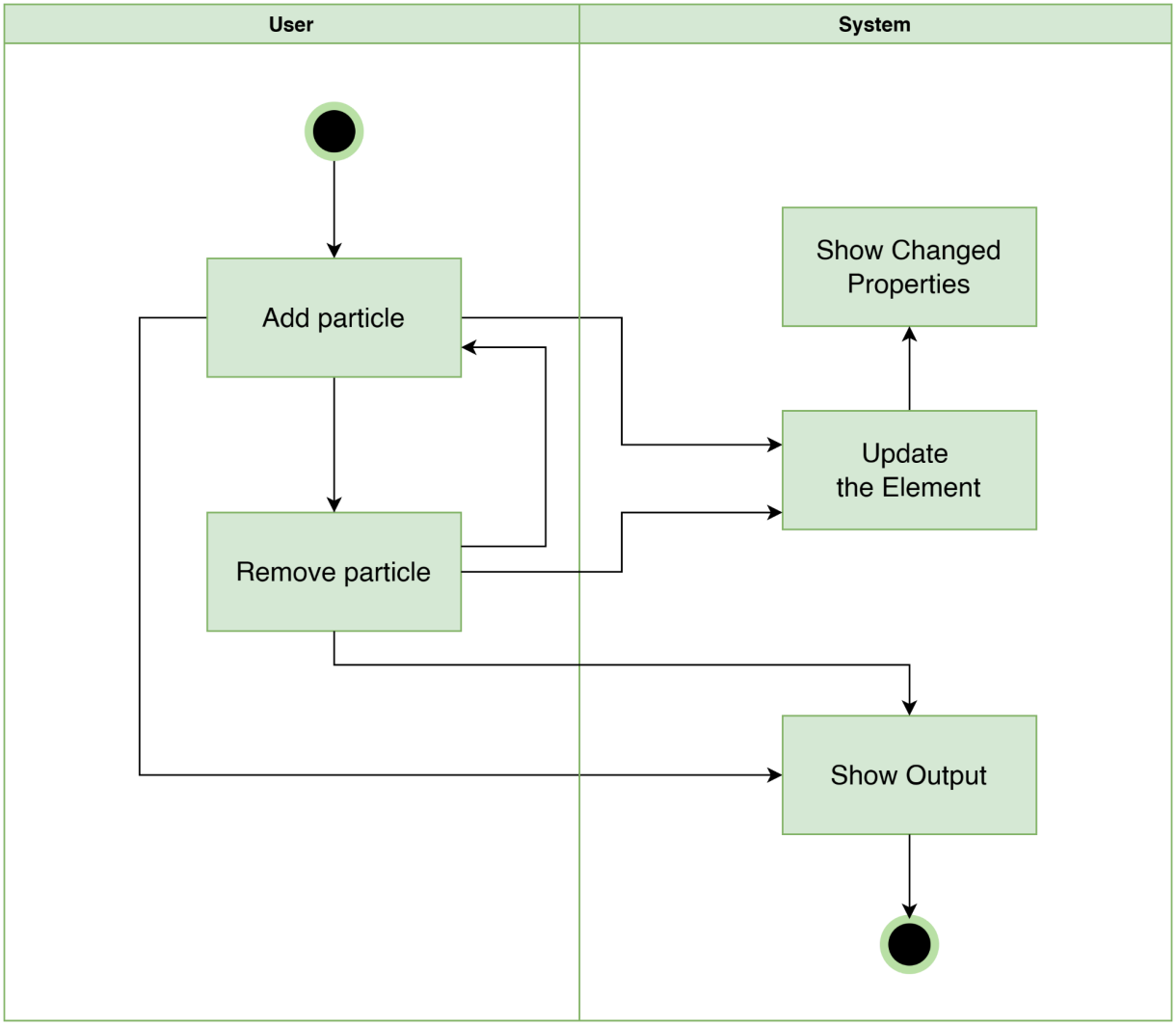


Figure 25: **Building an Atom (Swimlane Level - 1.2)**

Level: 1.3

Name: Periodic Table

Reference: Use Case Level – 1.3

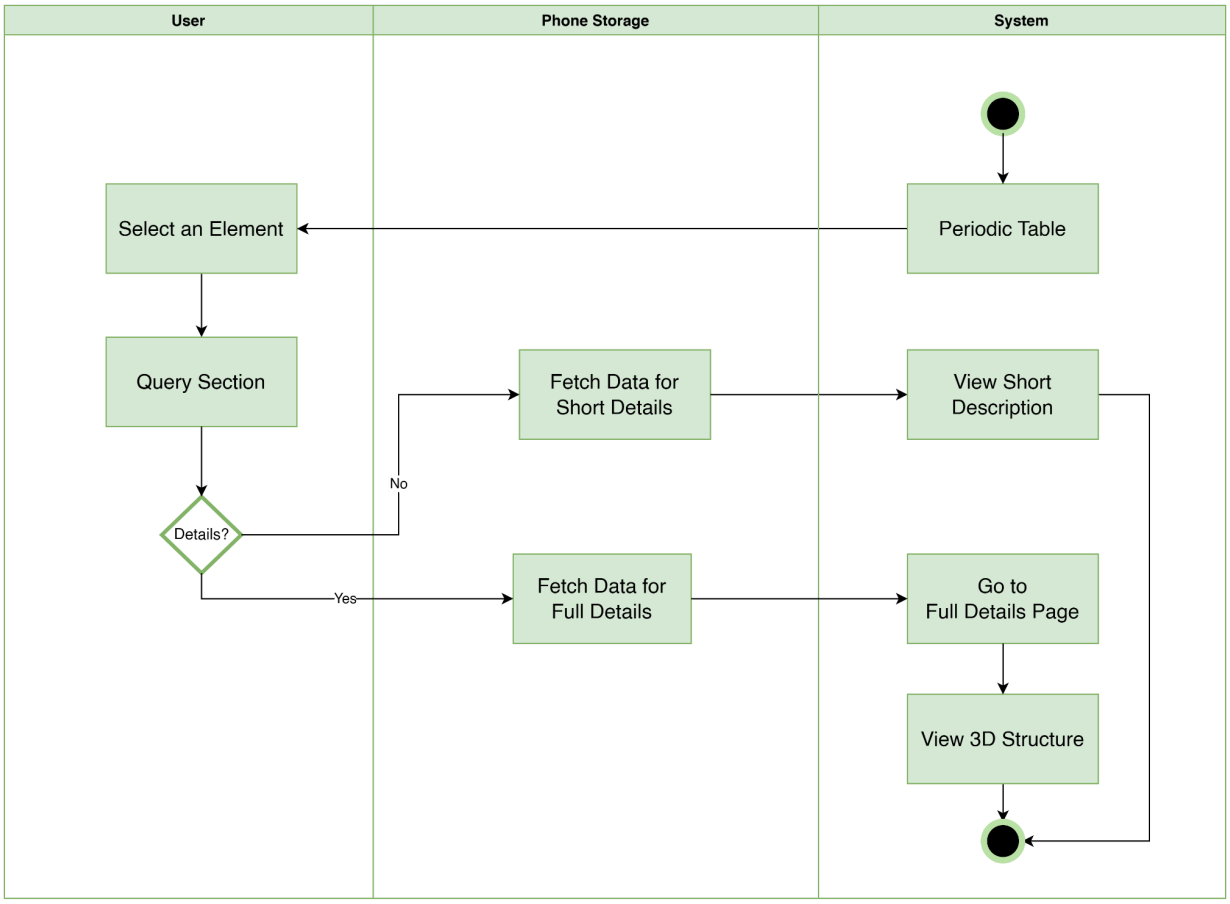


Figure 26: **Periodic Table (Swimlane Level - 1.3)**

Level: 1.4

Name: Chemical Bonding

Reference: Use Case Level – 1.4

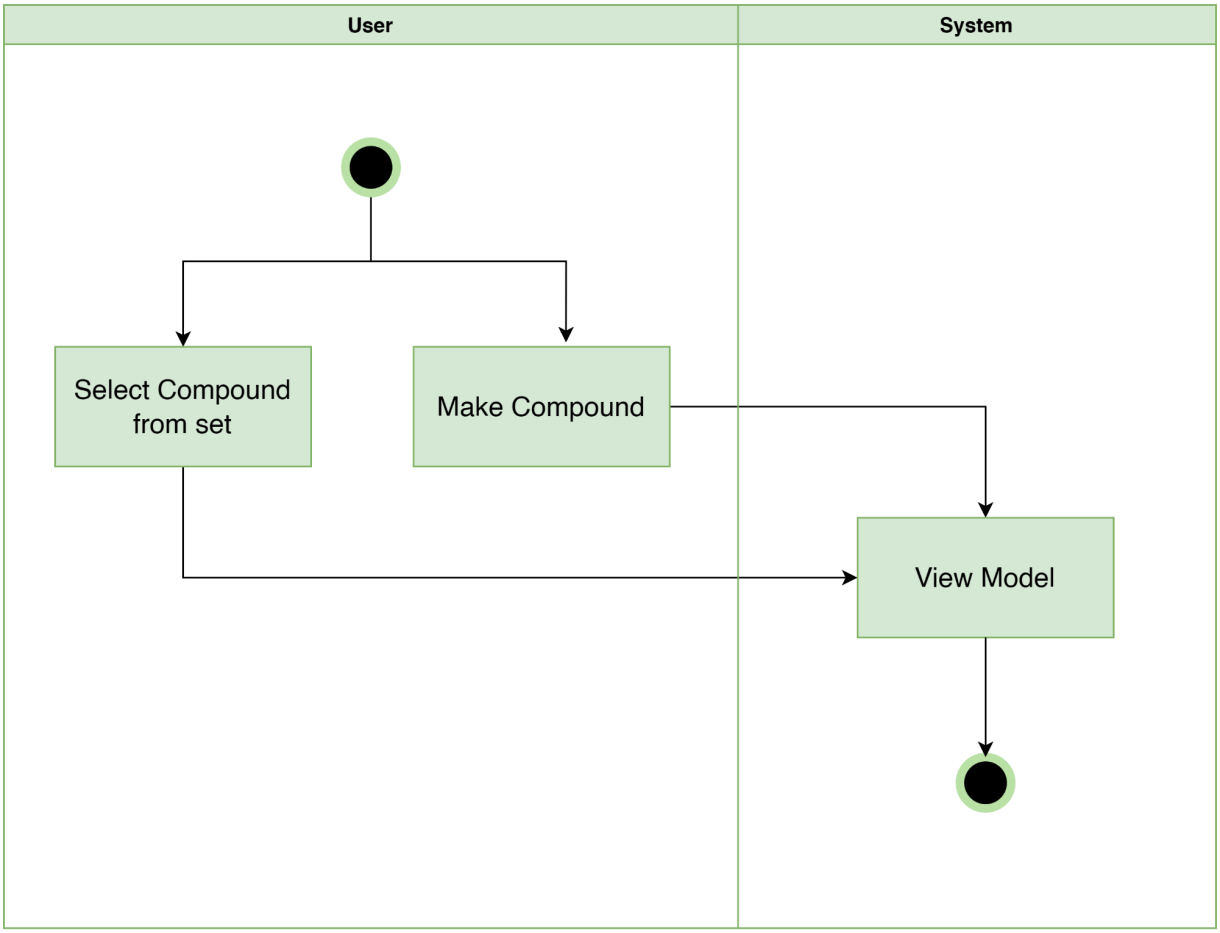


Figure 27: **Chemical Bonding (Swimlane Level - 1.4)**

Level: 1.4.1

Name: Compound Model Viewing

Reference: Use Case Level – 1.4.1

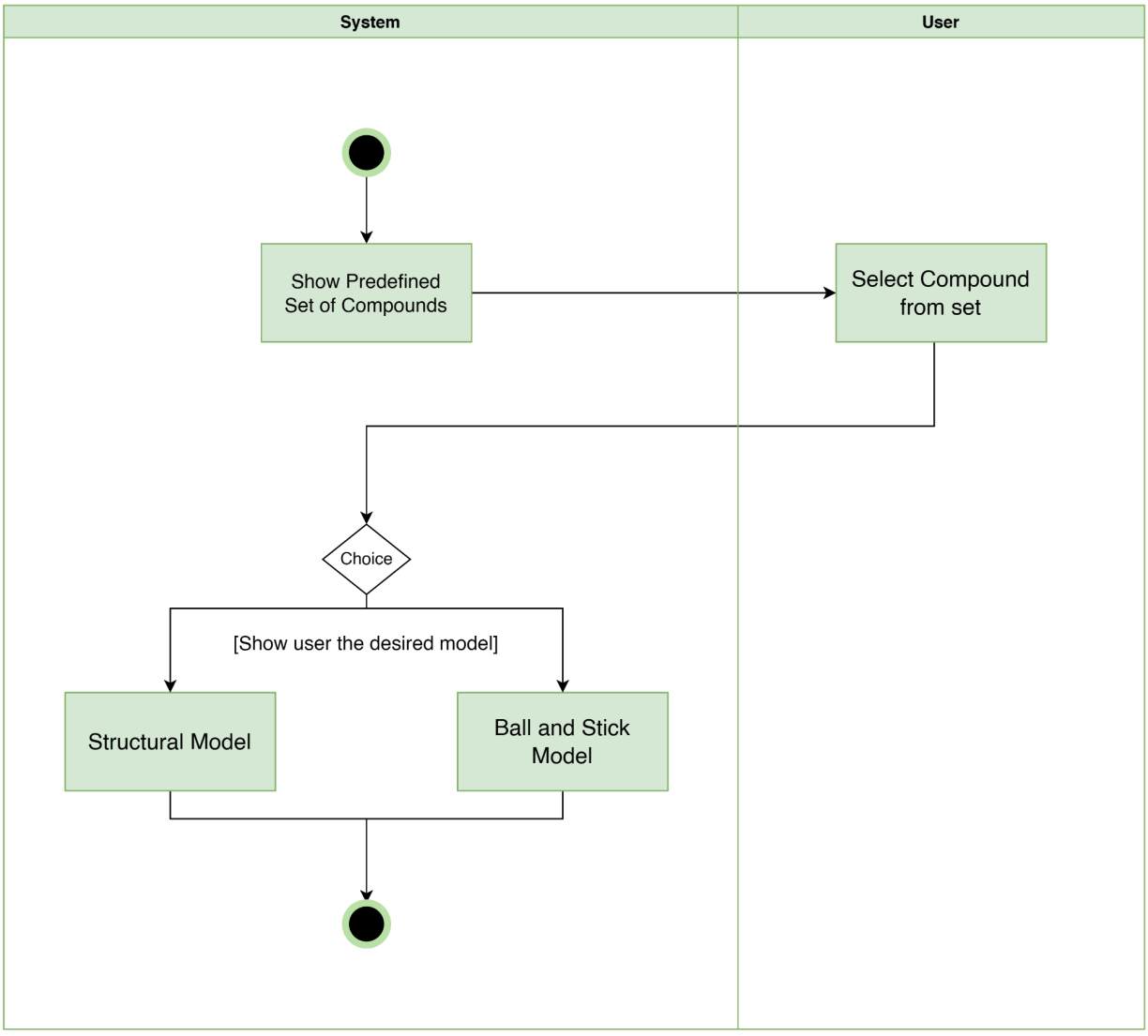


Figure 28: **Compound Model Viewing (Swimlane Level - 1.4.1)**

Level: 1.4.2

Name: Making 3D Compound

Reference: Use Case Level – 1.4.2

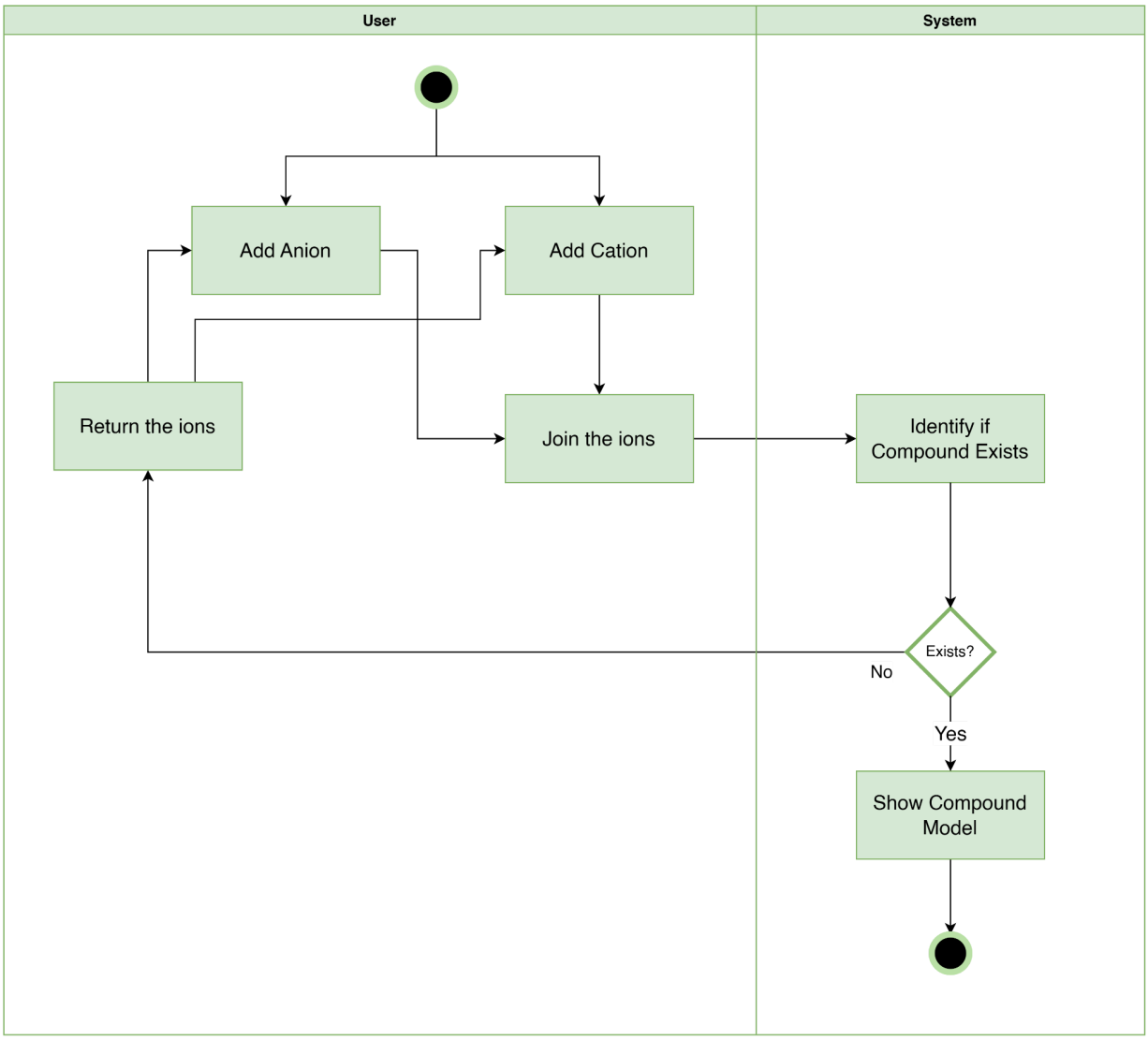


Figure 29: **Making 3D Compound (Swimlane Level - 1.4.2)**

Level: 1.5

Name: AR Learning

Reference: Use Case Level – 1.5

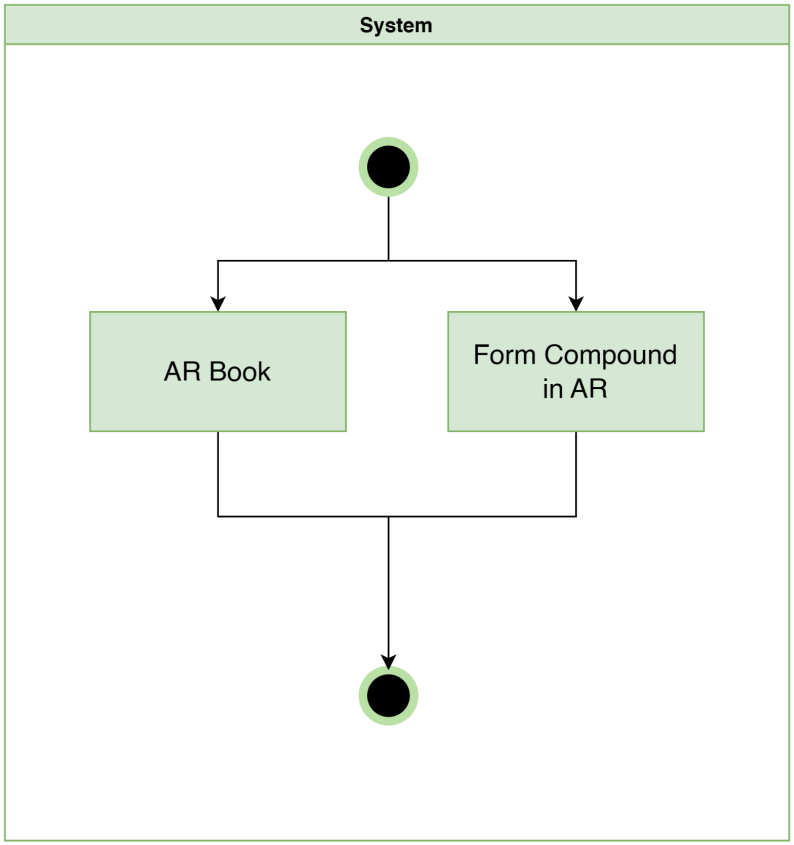


Figure 30: **AR Learning (Swimlane Level - 1.5)**

Level: 1.5.1

Name: AR Book

Reference: Use Case Level – 1.5.1

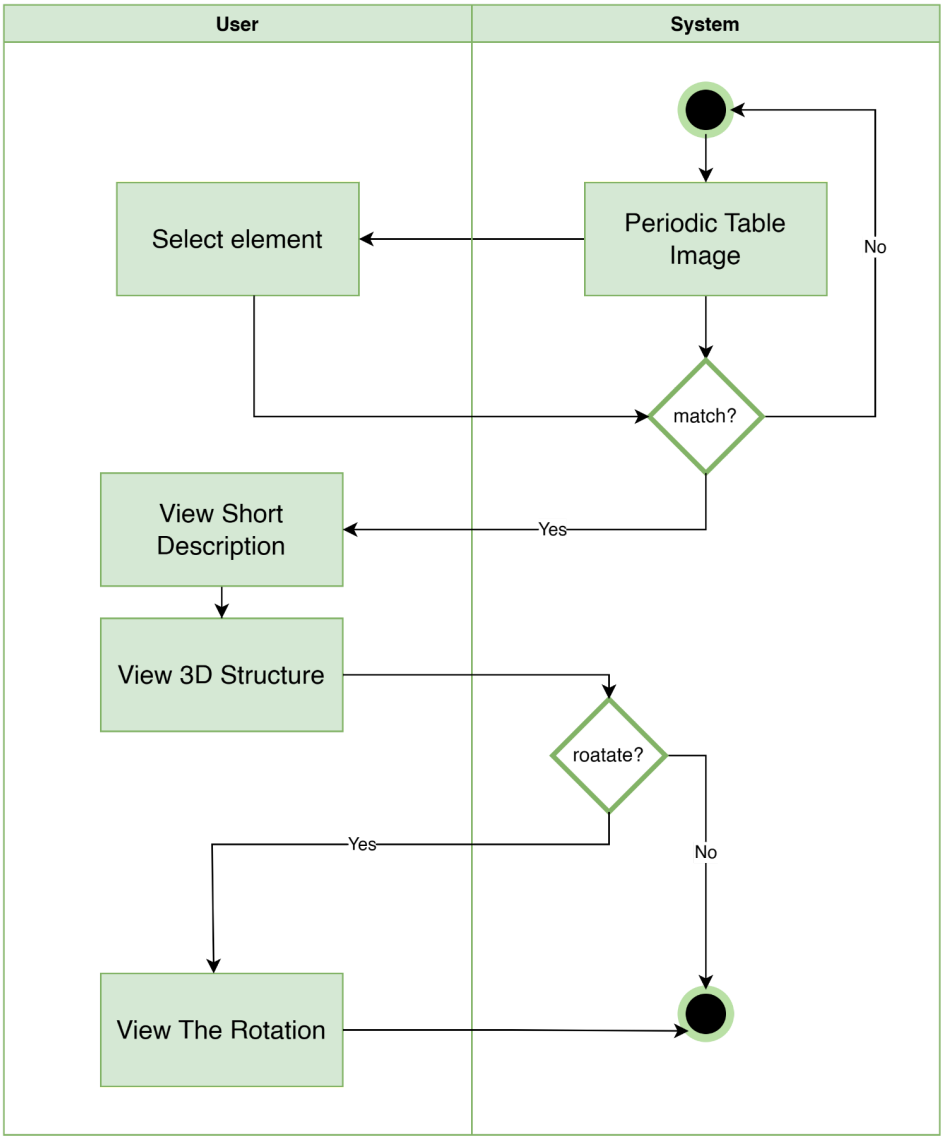


Figure 31: **AR Book (Swimlane Level - 1.5.1)**

Level: 1.5.2

Name: Compound Forming in AR

Reference: Use Case Level – 1.5.2

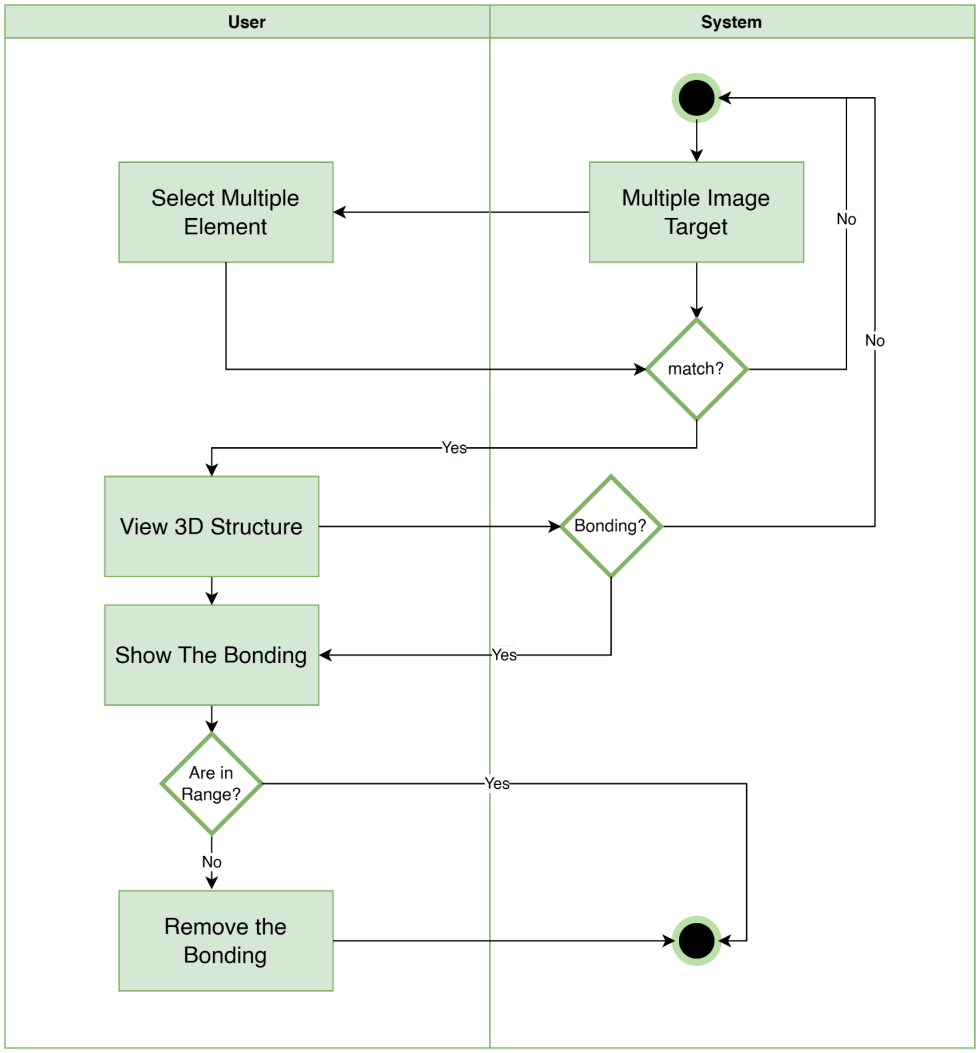


Figure 32: **Compound Forming in AR (Swimlane Level - 1.5.2)**

Level: 1.6

Name: Quiz

Reference: Use Case Level – 1.6

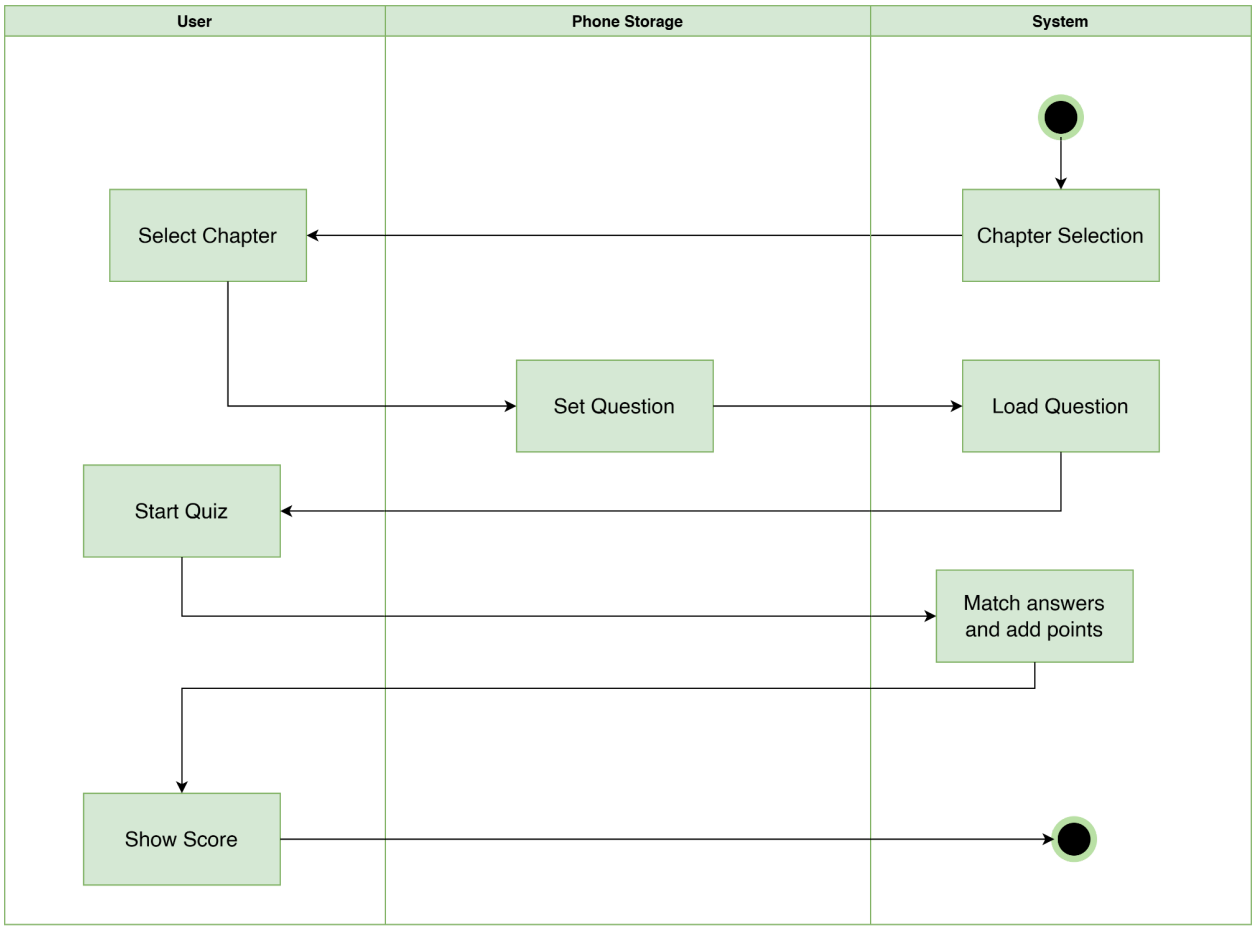


Figure 33: **Quiz (Swimlane Level - 1.6)**

Application Architecture Diagram

The system uses the MVVM (Model - View - ViewModel) architecture. This architecture is currently acceptable in the industry for development of android applications that are heavily UI intensive and require less database modifications. The view-model acts as a mediator between the UI and the database.

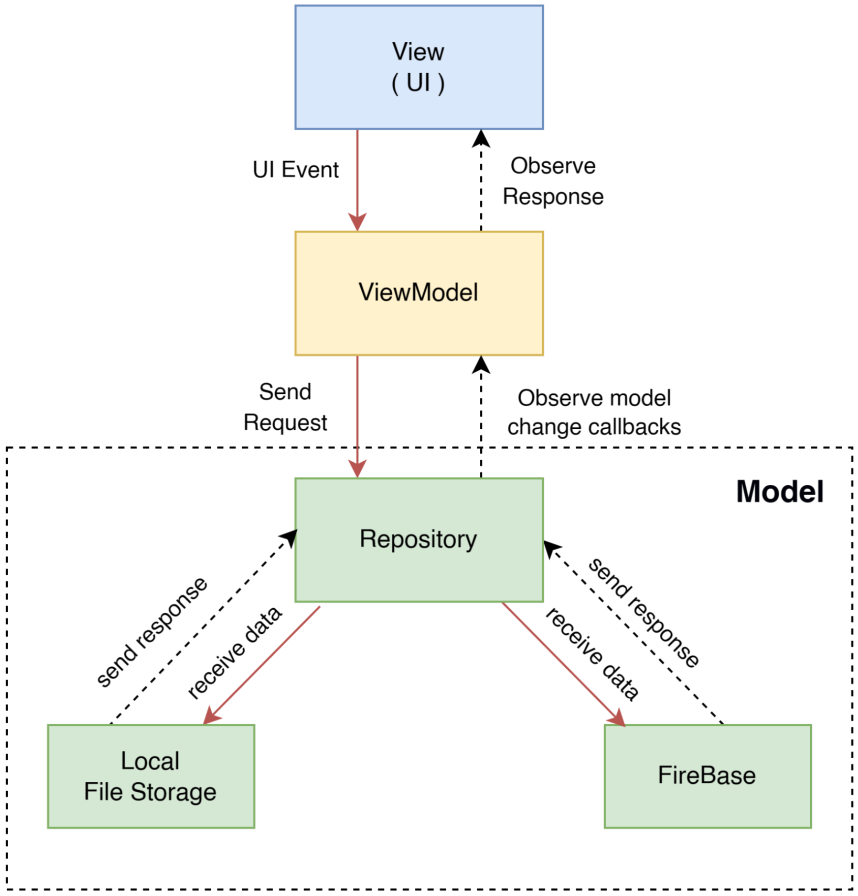


Figure 34: Application Architecture Diagram

NoSQL Document Database

The application depends on an online database for storing user accounts and related quiz points. We chose to use NoSQL in our project. NoSQL databaseshave

flexible data models, can scale horizontally, have incredibly fast queries, and are easy for developers to work with. Moreover, our application contains more read operations than write operations. And for such reasons, NoSQL seemed better for our project.

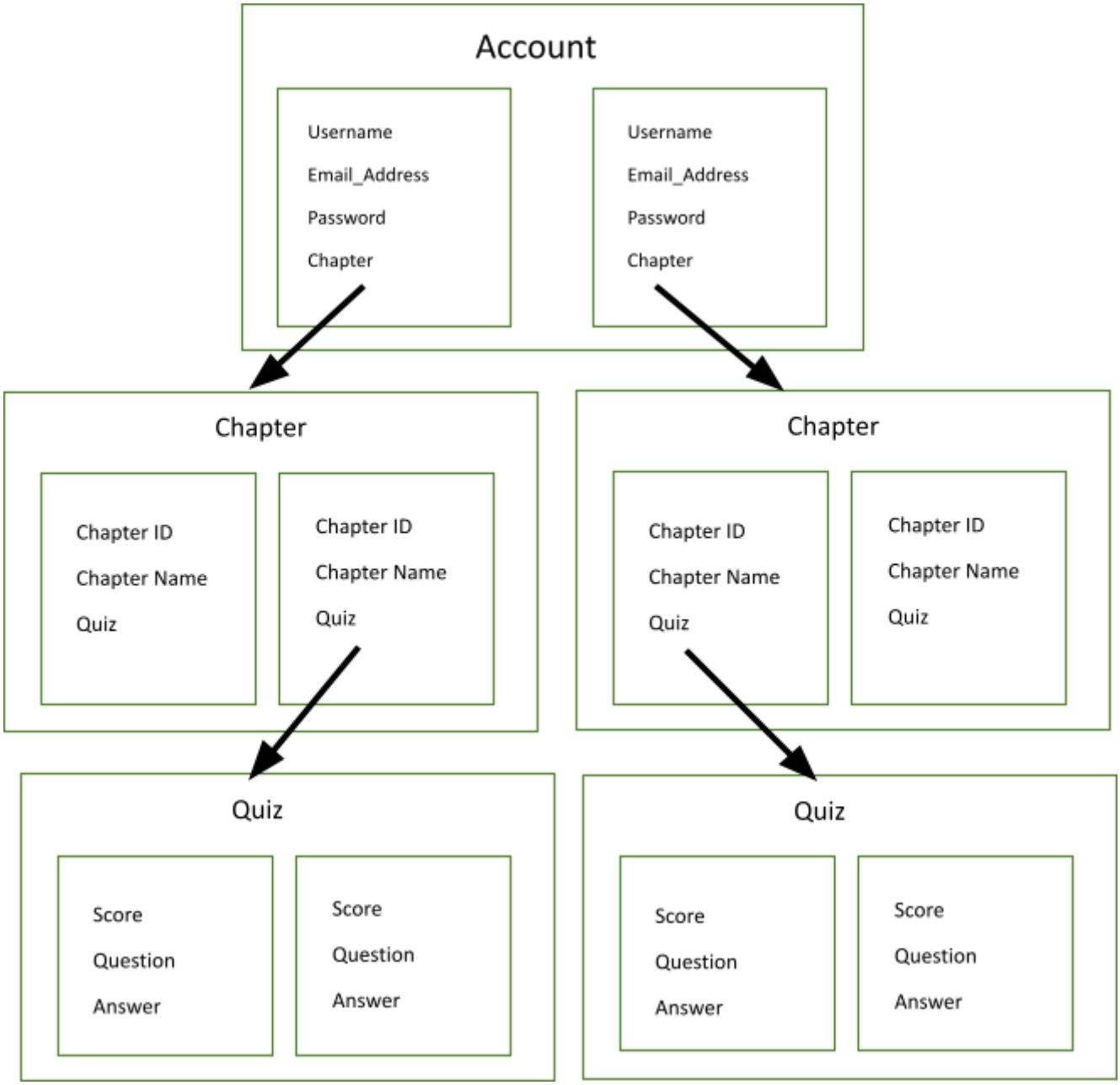


Figure 34: NoSQL Database of Chemouflage

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_atom	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() -createCompoundl() +checkCriteriaforFormingCompound()
28	Will see the bonds	See_chemical_bondings	User	element,compound	-createCompoundl() +createBondings()

29	Will view 3D model over an image	Viewing_3D_model_over_image	AR Book	User,VuforiaDatabase	+viewAtom()
30	Start AR Mode	Start_AR_mode	User	AR Object Interaction	+AR()
31	Will detect image target of atoms	Detecting_marker_based_image	User	AR Object Interaction, Vuforia Database,system	+trackImage()
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	+startQquiz()
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()

State Transition Diagram

ID: 1

Name: Account

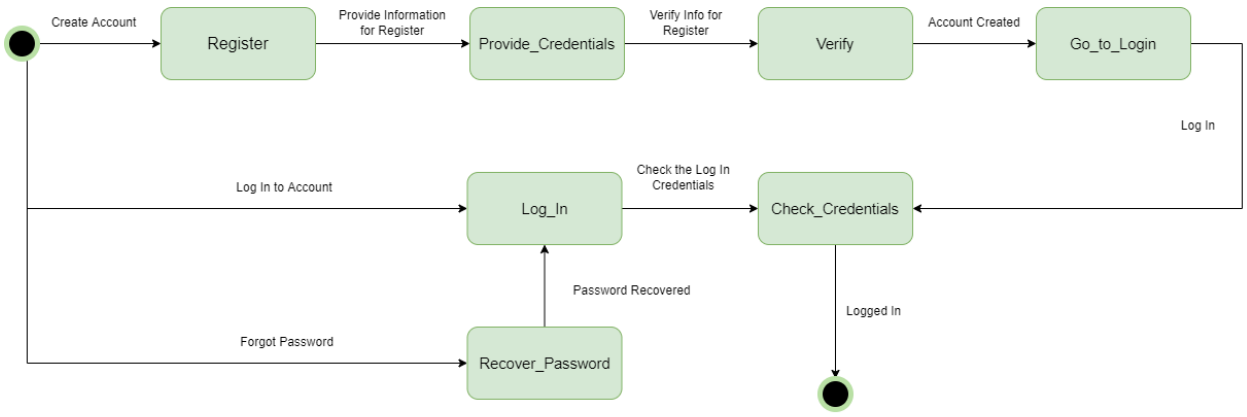


Figure 37: **State Transition Diagram for Account Class**

ID: 2

Name: User

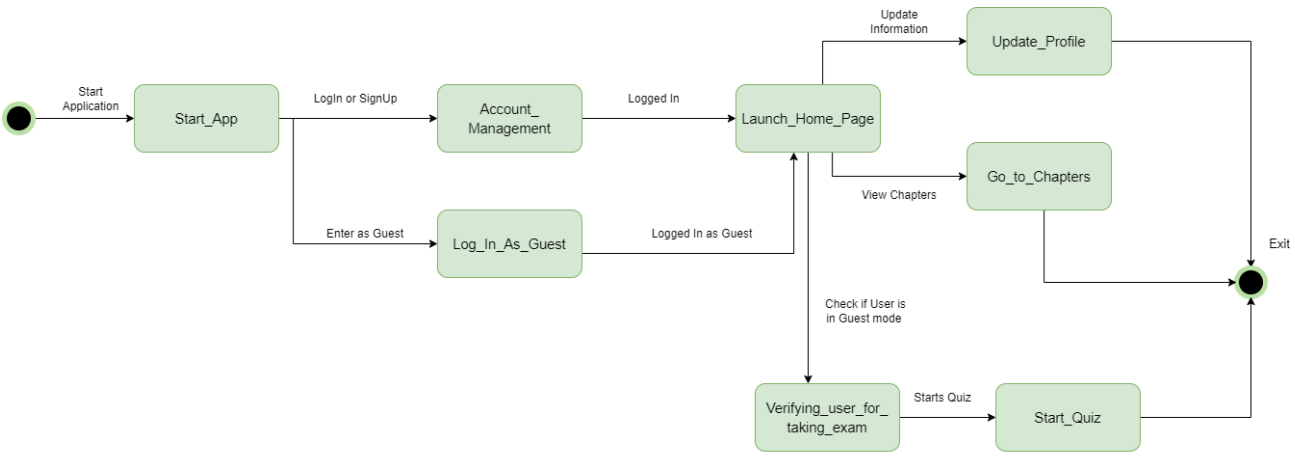


Figure 38: **State Transition Diagram for User Class**

ID: 3

Name: Chapter

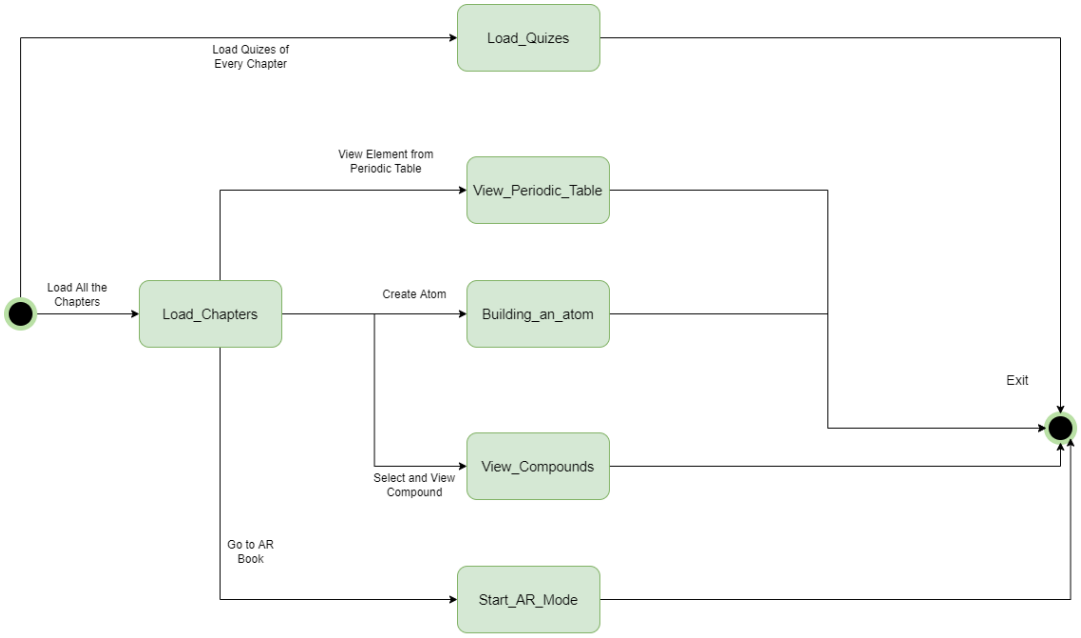


Figure 39: **State Transition Diagram for Chapter Class**

ID: 4

Name: Atom

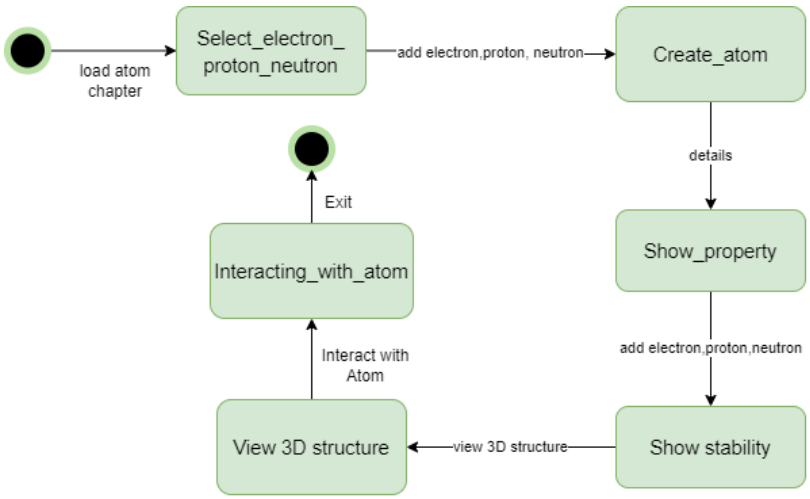


Figure 40: **State Transition Diagram for Atom Class**

ID: 5

Name: Property

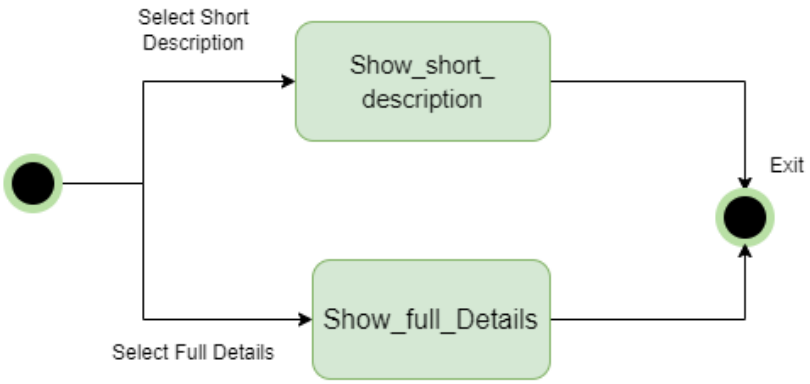


Figure 41: **State Transition Diagram for Property Class**

ID: 6

Name: Element

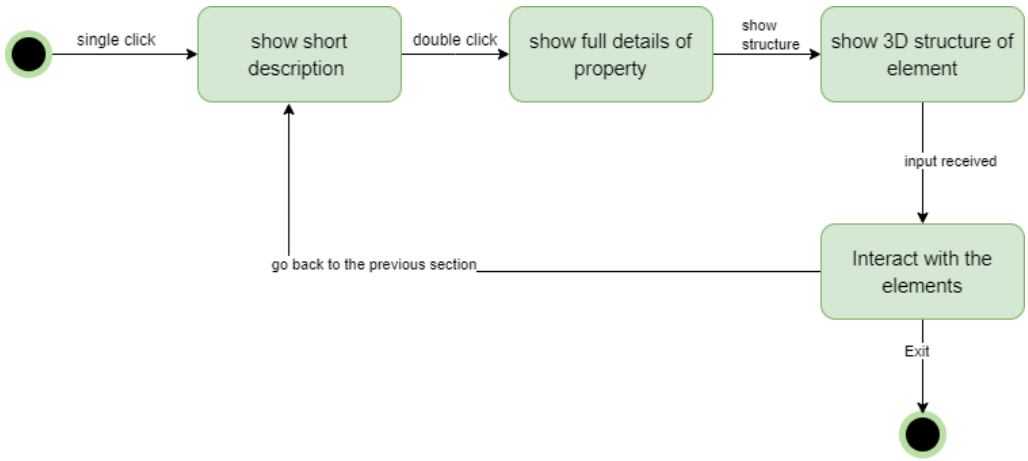


Figure 42: **State Transition Diagram for Element Class**

ID: 7

Name: Compound

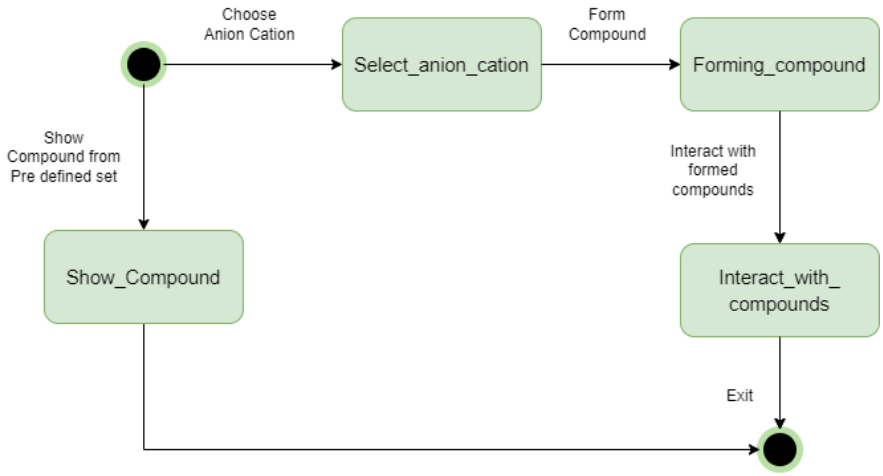


Figure 43: **State Transition Diagram for Compound Class**

ID: 8

Name: Periodic Table

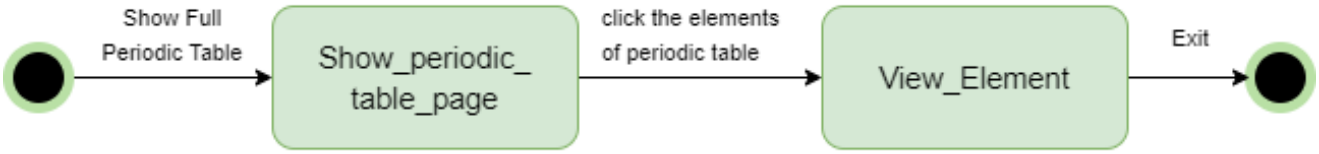
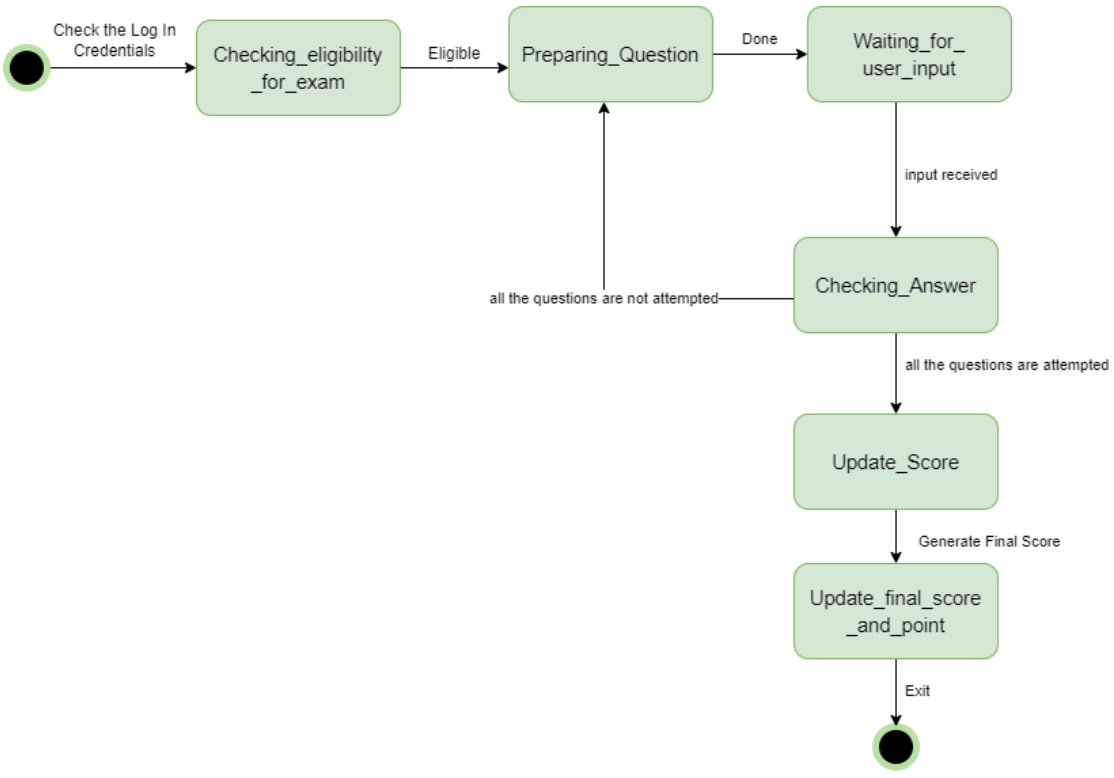


Figure 44: **State Transition Diagram for Periodic Table Class**

ID: 9

Name: Quiz



ID: 10

Name: Score and Point

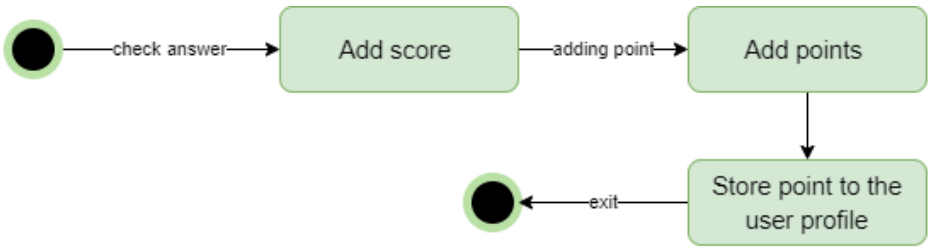


Figure 46: **State Transition Diagram for Score and Point Class**

ID: 11

Name: AR Book

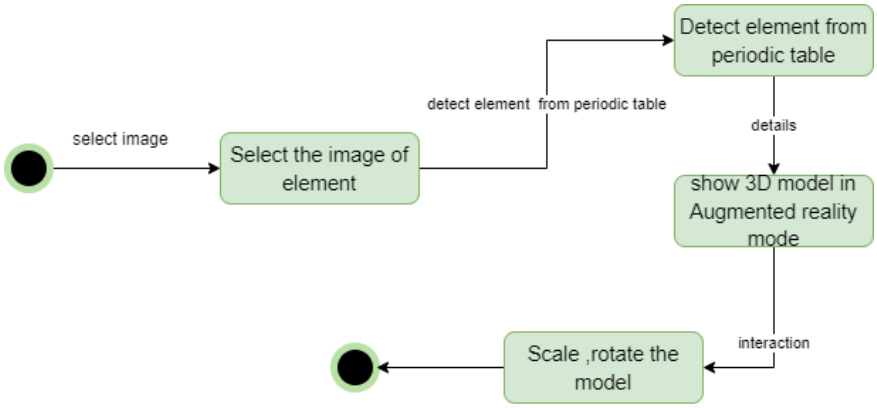


Figure 47: **State Transition Diagram for AR Book Class**

ID: 12

Name: AR Object Interaction

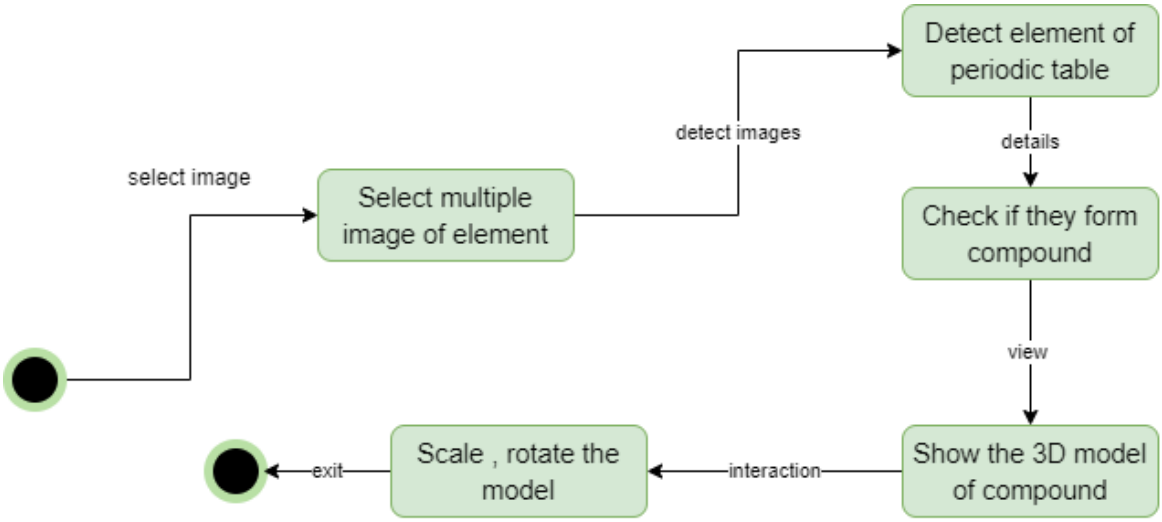


Figure 48: **State Transition Diagram for AR Object Interaction Class**

ID: 13

Name: Firebase

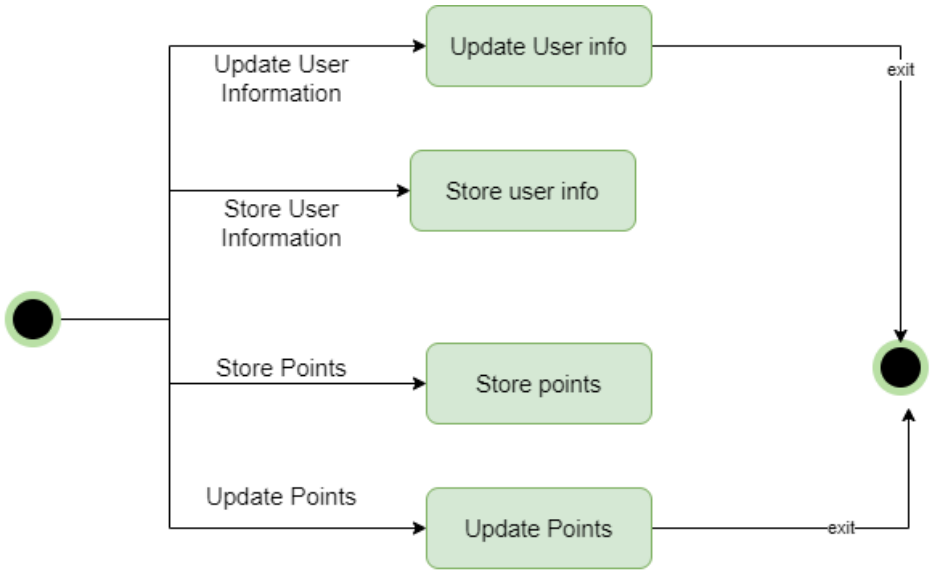


Figure 49: **State Transition Diagram for Firebase Class**