

Deliverable #2

SE 3A04: Software Design II – Large System Design

Tutorial Number: T03

Group Number: G09

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1 Introduction

1.1 Purpose

The primary purpose of this document is to offer a clear, technical roadmap of the *PolyCare* application for stakeholders, developers, and anyone involved in the design and implementation process. Individuals reading this document should already be familiar with the background details from Software Requirements Specification (SRS), which introduced our project goals, functional and non-functional requirements, and sample use cases. Here, we expand upon that foundation, providing a structured guide to our system's internal organization and high-level design decisions.

1.2 System Description

PolyCare is an Android-based mobile health application aimed at helping women determine the likelihood Polycystic Ovary Syndrome (PCOS). Drawing from three experts—a symptom-focused large language model, a blood test analyzer, and an ultrasound image analysis model— *PolyCare* calculates an overall PCOS likelihood. The system then presents a streamlined interface for reviewing results, storing information, and securely sharing data with trusted third parties (e.g., family physicians or health insurance representatives).

In this deliverable, we emphasize the system's logical structure by exploring its architectural choices, subsystem design, and inter-class relationships. By detailing the system at a deeper technical level, we ensure that future

development remains coherent, scalable, and aligned with the system's initial requirements as stated in the SRS.

1.3 Overview

Section 2 (Analysis Class Diagram) presents a class diagram depicting the main classes, their relationships, and primary attributes/methods based on our requirements. Followed by Section 3 (Architectural Design) which explains the overall architecture chosen for the *PolyCare* system, including design rationale, a structural architecture diagram, and the breakdown of subsystems. Design alternatives that were considered but ultimately discarded are briefly discussed as well. Lastly, Section 4 (CRC Cards) provides Class Responsibility Collaboration (CRC) cards for each identified class, clarifying how responsibilities are distributed and how classes collaborate to achieve the desired functionality.

2 Analysis Class Diagram



Figure 1. Analysis Class Diagram

3 Architectural Design

3.1 System Architecture

The app will be based on data centered blackboard architectural pattern. The partitions of the complete blackboard system will be as follows:

- 1) The blackboard sub-system: this will be used to store hypotheses. For example, one hypothesis will be: if a patient who is a female and has T levels that are greater than 70 ng/dL, levels of glucose greater than 5.6 mmol/L, and high levels of bile salts, the patient has an increased likelihood of having PCOS.
- 2) The knowledge sources: the symptom chat agent, the blood test result submission form and the ultrasound image analyzer.
- 3) The controller: This will be responsible for calculating the likelihood of having PCOS based on the information provided by the knowledge sources, as well as using the blackboard subsystem stored data.

To obtain some necessary information to verify user identity, the system will be communicating with the relevant official government organizations to cross check validity of their credentials.

This architectural pattern was chosen since the communication taking place is between the active agent and a passive data store. After successful communication, the active portion of the whole system will have obtained the necessary credentials to complete verification. It then moves onto our initial requirements, for the three experts. For the blood test result knowledge source, a valid blood test to determine PCOS likelihood is required. Similarly, the patient must also have a valid ultrasound result for the ultrasound knowledge source to determine if the patient may have PCOS. Finally, a requirement of the symptom chat agent is for the patient to have at least one symptom of PCOS, such as irregular periods, so that the knowledge source can determine a likelihood.

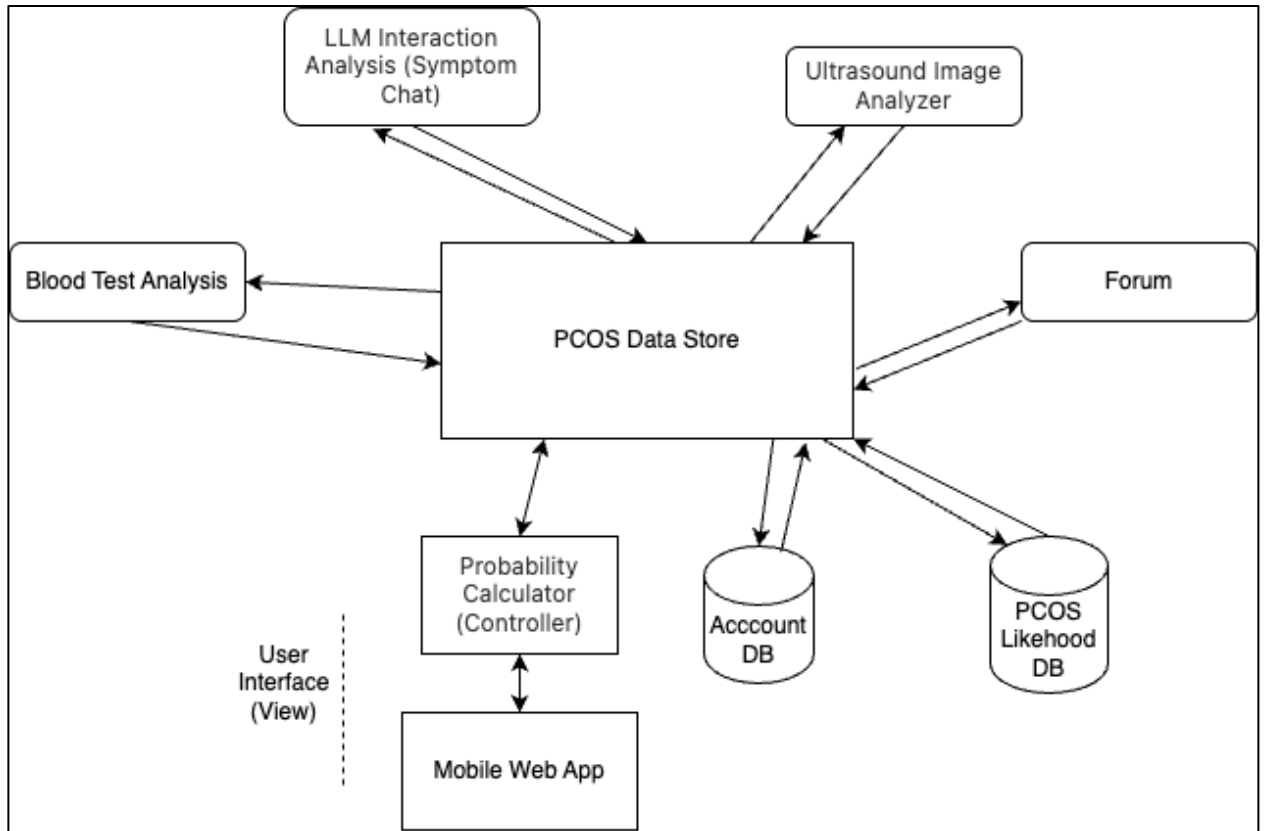


Figure 2. System Architecture

The repository (data centred architecture) architecture was considered initially as it comes under the same umbrella as blackboard. However, due to the uncertain nature of the solution that the system aims to produce, characteristics of a blackboard architecture are implied. Most importantly, each knowledge source agent determines an “answer” from a set of specific patient-provided information to be combined with “answers” from other agents to return the final verdict.

However, in repository, there is only an exchange of information taking place between the agents and the central data source. In this case, the three knowledge sources work independently to provide their *optimal* answer for PCOS likelihood.

The batch-sequential architecture was considered to be another feasible architecture. Data inputted by the patient could be transferred in a batch-sequential manner where each transformer would be the three agents and the forum. However, the nature of the application does not support this form of data processing. There are three different input formats: images, numerical values and conversational text. A separate transformer would be needed to process a specific data type and output a result based on said data. For example, the output of the ultrasound image analyzer would be a PCOS likelihood probability, which would then be inputted into the following transformer. The next transformer would be expecting a specific type of data (such as blood test results), therefore the results of the previous

transformer would not be compatible. It would be more productive to store the output in a common data store so that each subcomponent would not need to transfer unnecessary data between each other.

3.2 Subsystems

The *PolyCare* application will have four main distinct subsystems that represent its key functionalities. These subsystems include the following: Account Management Service, Symptom and Result Upload System, PCOS Likelihood Calculation Service, and Result Viewer Service.

The Account Management Service subsystem is responsible for providing users with the option to create an account, log into/log out of their account, update their account, delete their account, and perform any necessary account searches. The Account Management Service subsystem will have a dependency relationship to the user information entity alongside having a unidirectional relationship with the Account DB entity to extract relevant data. Additionally, this subsystem will communicate with the Symptom and Result Upload subsystem, allowing users to access their uploaded documents from the Account Management Service subsystem.

The Symptom and Result Upload subsystem will allow users to input their symptoms, enter their blood test results, and upload ultrasound images. This subsystem allows the users to interactively exchange information with the application. The Symptom and Result Upload System will specifically allow users to discuss any relevant PCOS symptoms they are experiencing. Additionally, this subsystem will allow users to enter relevant and correct data from the results of their blood test and ultrasound. This subsystem will communicate with the Account Management Service subsystem, to allow users to update or access their symptoms and uploaded information. This subsystem will also communicate with the PCOS Likelihood Calculation Service subsystem to calculate the probability of PCOS.

The PCOS Likelihood Calculation Service subsystem will ultimately calculate the partial and overall likelihoods of PCOS from their discussed symptoms, the analysis of biomarkers in the blood test results, and the analysis of the ultrasound images. This subsystem will share information with the PCOS Likelihood DB entity to store relevant PCOS probability calculations, as well as interact with the Result Viewer Service subsystem, so that users are able to access their Probability Calculations from the Result Viewer Service subsystem.

The Result Viewer Service subsystem will allow users to view their PCOS likelihood, view recommendations to see a physician and any possible lifestyle changes, save their results, and export them. This subsystem will interact with the PCOS Likelihood Calculation Service subsystem to present accurate and user-friendly insights.

4 Class Responsibility Collaboration (CRC) Cards

Class Name: Account Management Service (Controller)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Communicates with Update Account - Communicates with Delete Account - Communicates with Create Account - Communicates with Login To Account - Interacts with User Info instances through the Account DB 	<ul style="list-style-type: none"> - Update Account - Delete Account - Create Account - Login To Account - User Info - Account DB

Class Name: Create Account (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Select the type of user - Check the validity of health card/MINC/ONE ID - Verify that the user's provided information (name, birthday) matches government registered details - Check if the account already exists - Set a loginID - Set a password - Create a User Info instance through the Account Management Service <p>Accepting Privacy Policy:</p> <ul style="list-style-type: none"> - Add/update privacy policy - Add/update terms and conditions - User can accept terms and conditions - User can accept privacy policy 	<ul style="list-style-type: none"> - Account Management Service

Class Name: Update Account (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Edit profile information fields in User Info instance through the Account Management Service - Set new values for any changed fields <p>Forgot Password Process:</p> <ul style="list-style-type: none"> - Get and verify entered password (old) - Get new password - Check if old passwords entered match the one saved in the database - Set new password <p>Forgot loginID Process:</p> <ul style="list-style-type: none"> - Get entered email - Check if email exists in database - Send loginID to email 	<ul style="list-style-type: none"> - Account Management Service

Class Name: Login To Account (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Triggers "Forgot Password" process in Update Account through Account Management Service - Triggers "Forgot loginID" process in Update Account through Account Management Service - Enables user to login to their account 	<ul style="list-style-type: none"> - Account Management Service

Class Name: Delete Account (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Delete loginID - Delete password - Delete corresponding Account DB User Info instance through the Account Management Service 	<ul style="list-style-type: none"> - Account Management Service

Class Name: Account Search (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Get 'name' from 'search' field - Verify user credentials (health card number OR MINC OR ONE ID) - Search account DB for matching 'name' - Get all users with matching names - Display matching results or 'no results' 	<ul style="list-style-type: none"> - Account Management Service

Class Name: Symptom and Result Upload System (Controller)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Use LLM API to determine likelihood of PCOS by user input of their symptoms - Analyze blood test results for PCOS biomarkers - Analyze ultrasound images for PCOS cysts - Relate uploads to User Info instance 	<ul style="list-style-type: none"> - Enter Blood Test Results - Discuss Symptoms - Upload Ultrasound Images - User Info (D2 Feedback Change: this was missing in the original, so we added it in here)

Class Name: Enter Blood Test Results (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Knows the Symptom and Result Upload System Controller - Handles user blood test results - Depends on User Info entity 	<ul style="list-style-type: none"> - Symptom and Result Upload System

Class Name: Discuss Symptoms (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Communicates with Symptom and Result Upload System - Handles click-event "Symptom Chat Agent" 	<ul style="list-style-type: none"> - Symptom and Result Upload System

Class Name: Upload Ultrasound Images (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Knows the Symptom and Result Upload System Controller - Handles user ultrasound image processing and analyzing - Depends on User Info entity 	<ul style="list-style-type: none"> - Symptom and Result Upload System

Class Name: PCOS Likelihood Calculation Service (Controller)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Redirects information from Symptom and Result Upload System to the Calculate Likelihood (Symptoms, Blood Test, Ultrasound) controllers. - Requests and receives calculated PCOS likelihood from Calculate Likelihood (Symptoms) - Requests and receives calculated PCOS likelihood from Calculate Likelihood (Blood Test) - Requests and receives calculated PCOS likelihood from Calculate Likelihood (Ultrasound) - Redirects previous three calculations to Calculate Likelihood (Overall) and receives calculated overall likelihood. - Redirects calculations to Results Viewer Service - Redirects calculated likelihoods to be stored in PCOS Likelihood DB, as well as retrieves them. 	<ul style="list-style-type: none"> - PCOS Likelihood DB - PCOS Likelihood Calculation - Results Viewer Service - Symptom and Result Upload System - Calculate Likelihood (Symptoms) - Calculate Likelihood (Blood Test) - Calculate Likelihood (Ultrasound) - Calculate Likelihood (Overall) <p>(D2 Feedback Change: Initially, had all Calculate Likelihoods as one single bullet, split them up into individual bullets as mentioned in the feedback)</p>

Class Name: Calculate Likelihood (Symptoms) (Controller)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Receives symptom information from PCOS Likelihood Calculation Service - Calculates PCOS likelihood from user's symptom chat 	<ul style="list-style-type: none"> - PCOS Likelihood Calculation Service

Class Name: Calculate Likelihood (Blood Test) (Controller)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Receives blood test information from the PCOS Likelihood Calculation Service - Calculates PCOS likelihood from the user's blood test 	<ul style="list-style-type: none"> - PCOS Likelihood Calculation Service

Class Name: Calculate Likelihood (Ultrasound) (Controller)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Receives ultrasound information from the PCOS Likelihood Calculation Service - Calculates PCOS likelihood from the user's ultrasound 	<ul style="list-style-type: none"> - PCOS Likelihood Calculation Service

Class Name: Calculate Likelihood (Overall) (Controller)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Receives symptom, blood test, and ultrasound likelihoods from PCOS Likelihood Calculation Service - Calculates overall PCOS likelihood from the three other likelihoods - Relays the result back to the PCOS Likelihood Calculation Service 	<ul style="list-style-type: none"> - PCOS Likelihood Calculation Service

Class Name: PCOS Likelihood Database (Entity)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Stores instances of PCOS Likelihood Calculation for record keeping - Provides retrieval of instances by PCOS Likelihood Calculation Service 	<ul style="list-style-type: none"> - PCOS Likelihood Calculation Service - PCOS Likelihood Calculation

Class Name: PCOS Likelihood Calculation (Entity)

Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Contains calculated likelihood (symptoms) result percentage - Contains calculated likelihood (blood test) result percentage - Contains calculated likelihood (ultrasound) result percentage - Contains calculated likelihood (overall) result percentage 	<ul style="list-style-type: none"> - PCOS Likelihood Calculation Service - PCOS Likelihood DB

Class Name: Results Viewer Service (Controller)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Retrieves calculated likelihoods from PCOS Likelihood Calculation Service - Prepares PCOS likelihood information for Viewing PCOS Likelihood - Analyzes results and provides indication of whether to see a physician, presented by Physician Recommendation - Analyzes results and indicates the appropriate lifestyle recommendations to be presented by Lifestyle Recommendation - Communicates with Export Results - Communicates with Save Results 	<ul style="list-style-type: none"> - PCOS Likelihood Calculation Service - Viewing PCOS Likelihood - Physician Recommendation - Lifestyle Recommendation - Save Results - Export Results

Class Name: Viewing PCOS Likelihood (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Handles user requests to view their calculated PCOS Likelihood - Fetches the aggregated probability from the PCOS Likelihood Calculation Service through the Results Viewer Service - Displays the overall PCOS probability 	<ul style="list-style-type: none"> - Result Viewer Service

Class Name: Physician Recommendation (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Generates appropriate suggestion for a user to see a physician, through communication with the Results Viewer Service 	<ul style="list-style-type: none"> - Results Viewer Service

Class Name: Lifestyle Recommendation (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Generates appropriate lifestyle recommendations for the user, through communication with the Results Viewer Service 	<ul style="list-style-type: none"> - Results Viewer Service

Class Name: Save Results (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Notifies the user of success or failure in saving - Prompts the user for confirmation and handles any file path or naming details if needed - Calls the Result Viewer Service to retrieve results and generate a file (e.g., PDF, text). 	<ul style="list-style-type: none"> - Result Viewer Service

Class Name: Export Results (Boundary)	
Responsibility:	Collaborators:
<ul style="list-style-type: none"> - Retrieves the relevant final data from the Result Viewer Service and strips any sensitive identifiers - Handles the user's preferred method of export (e.g., via email, text message, or secure transfer) - Prepares the file/attachment for the chosen communication channel. - Alerts the user if export fails or if the user cancels midway - Interacts with external apps (e.g., email client) or a secure link to a physician/HIP 	<ul style="list-style-type: none"> - Result Viewer Service

A Division of Labour

Include a Division of Labour sheet which indicates the contributions of each team member. This sheet must be signed by all team members.

Beach, Jackson:

- Analysis Class Diagram (alongside Amal Hamid)
- CRC Card: PCOS Likelihood Calculation Service
- CRC Card: Calculate Likelihood (Symptoms)

- CRC Card: Calculate Likelihood (Overall)
- CRC Card: PCOS Likelihood Database
- CRC Card: PCOS Likelihood Calculation
- CRC Card: Results Viewer Service
- CRC Card: Physician Recommendation
- CRC Card: Lifestyle Recommendation
- Final document edits



Siddiqui, Maham:

- Adjusted business events from D1 for clarity
- Added assumptions necessary for system architecture functionality to D1
- System architecture (with Saad)
- CRC cards: Account management service, create account, update account, login to account, delete account, account search
- Final document edits



Hamid, Amal:

- Section 2: Analysis Class Diagram (alongside Jackson Beach)
- Section 3.2: Subsystems
- CRC Card: Calculate Likelihood (Blood Test)
- CRC Card: Calculate Likelihood (Ultrasound)
- CRC Card: Enter Blood Test Results
- CRC Card: Upload Ultrasound Images
- Final document edits



Salman, Saad:

- Feedback adjustment from D1
- System architecture (with Maham)
- CRC card: Discuss Symptoms

- CRC card: Symptom and Result Controller
- Overall document editing

A stylized, handwritten signature in black ink, featuring a large, looped initial 'Z' followed by a long, sweeping horizontal stroke.

Umer, Zayed:

- Introduction 1.1 (Purpose)
- Introduction 1.2 (System Description)
- Introduction 1.3 (Overview)
- CRC Card: Viewing PCOS Likelihood
- CRC Card: Save Results
- CRC Card: Export Results

A handwritten signature in black ink, appearing to read 'Zayed' with a stylized, cursive script.