VU VRIJE UNIVERSITEIT AMSTERDAM

SOD Assignment1
AI Research Service Regarding the Effect of Classical Music on Mental Illness

---

Service Oriented Design 2022

Group: 09
Member names: (Tianhao Xu, Ruijia Lei, Zhining Bai, Boyuan Xiao)
Emails: (t4.xu@student.vu.nl/r.lei@student.vu.nl/
z.bai@student.vu.nl/b.xiao@student.vu.nl)
VUnetIDs: (txu900, rli520, zbi350, bxo200)
Master program and Track: Computer Science - BDE, IWT

October 28, 2022

Contents

Change Log

Number	Name	Feedback	Description
1.	Section 2.1: Ambiguous naming	"The word discrimination is often used as negative meaning"	We deleted the word "discrimination" and used "identification" to replace it.
2.	Section 4.1: Inconsistent naming of involved participants	"It should be the same as the Participants part"	We changed the participants' names.
3.	Section 4.1: Data Model	"Can't find the identity service, check relation"	We changed the structure of the data model.
4.	Section 4.2: Inconsistent naming of services	"Ensure the consistence of service names if they are same. e.g. identity service"	We changed the service names in the diagrams.
5.	Section 4.5: Context Model	"End-users cannot use the services directly without a SBA. Therefore, they should not be involved directly in the context model."	We updated the services and changed the participants in the diagram.
6.	The title and corresponding content	"The word 'Classic' should be 'Classical' which is more appropriate"	We changed all the corresponding words in the full text.
7.	Section 1.2: Participants	None	We included more participants in this section.
8.	The title and corresponding content	"Consider better FR name"	We renamed "AI Study Toolkit" to "AI Study Assistance".
9.	Section 1.1: Usage Scenarios	"No strong link to digital heritage"	We rewrited that part to present a strong connection with digital heritage.
10.	Business service behavior: AI Study Assistance	None	We fixed some mistake in the business service behavior of "AI Study Assistance".
11.	Quality Requirements: Performance	"Be more precise with numbers. How will you measure this?"	We updated some descriptions and ideas of QR-2.

12.	Section 4.3: Wrong name of Involved Participants	"Inconsistent name of Involved Participants"	We changed Healthcare Provider to Mental-health Service Provider, and Researchers to Medical Researcher.
13.	Section 4.4: Wrong name of Involved Participants	"Inconsistent name of Involved Participants"	We changed Healthcare Provider to Mental-health Service Provider, and Researchers to Medical Researcher.
14.	Section 4.3: Wrong color of User	None	We changed red color to white color of the user.
15.	Section 4.3: Inappropriate description of Scalability	"Which service? maybe our services"	We modified the description of Scalability.
16.	Section 5: Design Space	"Selection of design concern seems relevant and realized in BS. However, the mapping is not clear."	We enriched the mapping relationships in the Concerns.
17.	Section 4.3: Treatment - Service Behavior	"Don't use "will ... " in diagram for services"	We modified the description of services in the flow chart.

Responsibility

Section	Team Member
Section 1: Business Domain	Boyuan Xiao
Section 2: Functional Requirements	Boyuan Xiao
Section 3: Quality Requirements	Ruijia Lei
Section 4: Business Services	Tianhao Xu
Section 5: Design Space	Zhining Bai
Section 6: Sustainability Strategies	Tianhao Xu
Section 7: Software Decomposition of Business Services	Boyuan Xiao
Section 8: Participant's Service Inventory Identification	Ruijia Lei
Section 9: Service Contract Identification	Tianhao Xu
Section 10: Business Service Network	Zhining Bai
Section 11: Design View	Ruijia Lei

1 Business Domain

Mental illnesses, also called mental health disorders, are one of the most harmful and wide-range diseases well known to the world. A recent report by the World Health Organization denotes that there are nearly 1 billion people suffering from such illnesses in 2019. And this number is even boosted during the COVID pandemic in the past two years. On the path of seeking treatment methods for mental illnesses, Dr. Miranda Yeoh [1] and other medical researches have proved that positive effects can be dealt to patients with certain mental illnesses, such as depression, schizophrenia and more, with the help of classical music. Based on this finding and the existence of the tremendous cultural heritage data, we would like to introduce an AI-based research model concerning how classical music can affect on treatment of certain mental illnesses, as our Service Oriented Design project. The service mainly benefits two types of people, medical researchers, and patients. For medical researchers, the service provides insights into how classical music effect mental illness patients. What's more, they can further continue their research with the help of AI. On the patient side, a playlist of classical music, aiming at the treatment of their mental illness, will be given by the default AI model. Along with that, an IoT device will also be provided to monitor their physical sign to adjust and refine both the playlist and their private AI model.

1.1 Usage Scenarios

As depicted above, the main purpose of the service is to offer assistance to not only patients with mental illness but also medical researchers to study how classical music impacts the treatment of mental illness with the help of AI. None of this could be done without the assistance of digital cultural heritage. Because the correctness of the prediction by the AI is ensured by the digital culture heritage.

Upon the first access, the user shall identify themselves as a researcher or patient. Patients have access to AI-Based Diagnosis and Personalized Recommendations and Treatment. In the recommendation process, an IoT device and a list of helpful music, which is generated by the default AI model in the system will be provided to the patient. Meanwhile, the IoT device helps monitor the feedback of patients when they are listening to the music on the list. The collected feedback data, along with the heritage data of classical music can be used to adjust the default AI model and generate different private AI models for each patient. The private model, in turn, refines the music playlist for the patient. Hence, patients gain better help for their condition. Also, data captured by IoT devices can be shared to medical researchers anonymously with the consent of patient. Furthermore, the IoT device can also immediately play music or call emergency services when it monitors a spike in a patient's physical signs. As for the medical researchers, the service offers Identification with Scientific Help and AI Study Assistance. After specifying the name of the illness that the researcher wants to study, a list of classical music, which can positively affect mental illnesses treatment based on the current literature database, will be given. With the shared data of patients, the heritage data of classical music, and a beginner-friendly UI interface, medical researchers without an AI study background can build their own AI models concerning the specific illness that they are interested in.

1.2 Participants

Participants of this service can be divided into 2 types: Stakeholders and End Users. Stakeholders mainly consist of Mental-health Service Provider, Audio Resource Provider, Literature Resource Provider, and IoT Device Provider. Audio Resource Provider specifically provides digital heritage

data of classical music for other services. As for the End Users, Patients and Medical Researchers form the majority of End Users. Business interactions between these participants are depicted in Figure 1. A detailed description of each participant can be found in Table 3.

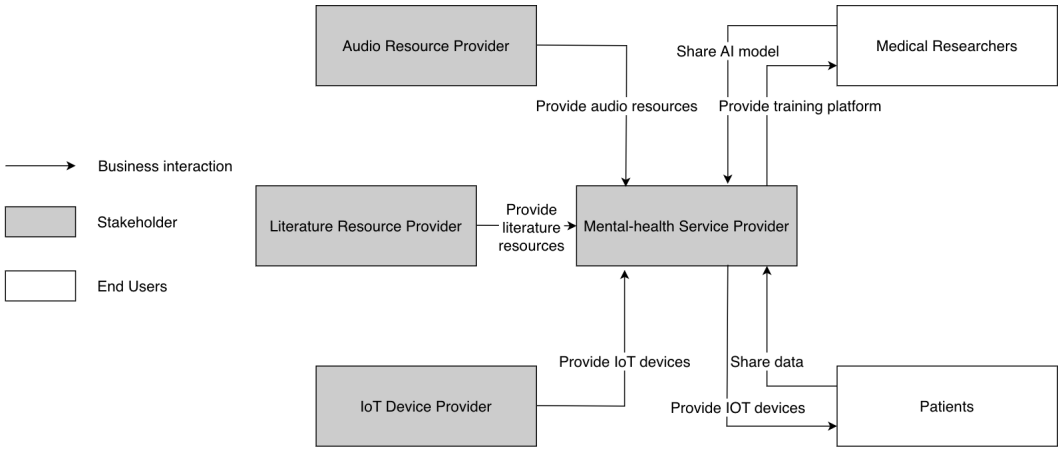


Figure 1: Business domain model

Table 3: List of participants in detail

Participants	Role	Description
Mental-health Service Provider	Service provider and Consumer	The Mental-health Service Provider provides software functions. Besides that, all the data would also be stored in the Mental-health Service Provider, including data shared by the patient, and the AI model generated by End Users. Meanwhile, the patients interact with the services of Mental-heal Service Provider for better treatment. For medical researchers, the patient-shared data will be available for AI training purpose.
Medical Researchers	End User	Medical Researchers use the software function given by the Mental-health Service Provider. Namely, the AI training platform.
Patients	End User	Patients receive classical music recommendations from the Mental-health Service Provider. Along with that, patients can interact with the IoT device to refine their private AI model as well. Finally, if the patient consent, the data collected by the device can be shared with the Mental-health Service Provider anonymously.

Audio Resource Provider	Service provider	The Audio Resource Provider provides audio resources, in our case, classical music, and the heritage data of classical music for services of the Mental-health Service Provider.
Literature Resource Provider	Service provider	The Literature Resource Provider provides literature resources for services of the Mental-health Service Provider.
IoT Device Provider	Service provider	The IoT Device Provider provides IoT devices for services of the Mental-health Service Provider.

2 Functional Requirements

In this section, four main functional requirements of the services are presented. They are derived from the wishes of stakeholders and follow the business domain usage scenarios. Each functional requirement (FR) has a unique identifier, a more detailed description of the requirement, and a rationale for the inclusion of the requirement.

2.1 Identification with Scientific Help

Field	Description
Unique ID	FR1 - Identification with Scientific Help
Short Name	Identification with Scientific Help
Functional Description	This functionality is able to retrieve and review existing literature in the fields of psychology, sociology, music therapy and medicine in a global database of scientific papers, text processing and extraction of key information to generate a preliminary report on the association between classical music therapy and pathology, together with a list of corresponding music. Firstly it will check if the user has an account or not, if not, the user has to register. We will differentiate the user's login options into researcher and general user, based on which we will push the pre-generated research report to the researcher for subsequent scientific research or to produce a primary music list, and to the general user based on the inner engine, who will first be asked to fill in basic information, personal preferences and complete a psychologically relevant selection, and then push the primary music list with multiple categories to the user. The initial personalized music list is then recommended to the user for listening.
Motivation	It often takes a lot of time for researchers to search and read about classical music to find out what works for a particular psychological state (e.g. mania, depression) and illness, and providing pre-generated literature compilation reports can save researchers time and increase efficiency. In order to broaden the target group of the service, the average user may only want to relax or heal through music and does not have professional knowledge of classical, so we do not put pressure on the user to choose music or require them to have professional knowledge, and we make preliminary music recommendations.

2.2 Diagnosis and Recommendations

Field	Description
Unique ID	FR2 - Diagnosis and Recommendations
Short Name	Diagnosis and Recommendations
Functional Description	This functionality uses voice analysis technology, motion sensors and other IoT devices to acquire user data and automatically diagnose the user's mental problems with AI, and provides personalized music recommendations to the user based on the diagnostic results. Generally speaking, psychological problems are difficult to quantify, but several studies have now shown that observing characteristics such as a patient's activity, calls, text messages, and speech patterns can diagnose some common mental problems. Therefore, GPS, acceleration sensors, phone calls and text message records in a user's phone will collect a lot of information about their mental condition. When a user's mental problem is detected, this functionality uses FR1 to obtain classical music that is beneficial for that mental problem. Then, based on information such as the user's age, gender, nationality, ethnicity, the user preferences, and using sociological and psychological science theories, the AI algorithm compiles a 20-minute playlist of soothing classical music for the user in seconds.
Motivation	Mental health issues may develop gradually in some persons with impaired mental health, such as those who have depression or PTSD (post-traumatic stress disorder), making emotional problems difficult to completely manifest in daily life or even to notice by the patients themselves. Studies have been done to identify early indicators of mental illness by observing characteristics such as patients' activities, calls, texts, and speaking patterns. The effectiveness of such silent detection is better than patient self-reporting of mental health issues.

2.3 Treatment

Field	Description
Unique ID	FR3 - Treatment
Short Name	Treatment
Functional Description	An IoT device worn on the wrist, such as a heart rate monitor, assesses the physiological impact of the music on the patient while they listen to a customized playlist recommended by the program. If the listener doesn't react as predicted, our digital player alters the playlist's songs to better fit the patient's musical tastes using AI and machine learning components. The running order of the playlist is intended to lower levels of stress chemicals like cortisol and heart rate while increasing levels of the neurotransmitters dopamine and oxytocin, which are known to induce relaxation. Additionally, the user data produced throughout the process is shared concurrently with our researchers.
Motivation	Through the process of treatment, people can find the most suitable playlist for them. Music prescriptions would be beneficial to patients to greatly reduce their medication costs. Based on the digital reports, researchers can get deep research on their prediction model fine-tuning and study work.

2.4 AI Study Assistance

Field	Description
Unique ID	FR4 - AI Study Assistance
Short Name	AI Assistance
Functional Description	The AI Assistance aims to bring the benefits of AI studying to medical researchers who study mental illness. The researchers can use the shared data by anonymous patients or the data collected by themselves as training data to train a duplicate of the default model to generate their own model. With this model, researchers are able to gain insights from the perspective of AI, then further study the connection between classical music and mental illness treatment. On the other hand, the study result, namely the AI model, can be shared between different researchers and patients. In order to simplify the process of tuning an AI model, the Interactive service presents a clean and simple UI. Additionally, it will translate the simple user input into lower-level machine learning activities, which enables researchers who don't have any machine learning background to benefit from AI.
Motivation	By means of AI, researchers are enabled to be inspired and gain insights into how can classical music positively affect patients. Another further benefit would be solving the problem of data shortage for a researcher by anonymously sharing data. An open platform for researchers to share their self-tuned AI model would be of great help for research as well.

3 Quality Requirements

In this section, the quality requirements of the services are presented. Relevant quality requirements are chosen based on their importance to the adoption rate of the envisaged business services. Each quality requirement (QR) has a unique identifier, a more detailed description of the requirement and a rationale for the inclusion of the requirement.

3.1 Privacy

Field	Description
Unique ID	QR1 - Privacy
Short Name	Privacy
Description	Privacy relates to the extent to which the service protects information and data, and users have the right to set different levels of privacy protection so that individuals or other services have the level of data access appropriate to the type and level of their authorisation. Of course, data captured by IoT devices can only be uploaded to the server for subsequent functions if the user has authorised it, and our services require strong restrictions on access to existing data of all kinds and special privacy protection mechanisms and encryption.
Rationale	The main business services are strongly linked to the access, transmission, query and use of user data. Data is extremely sensitive and a breach can result in serious consequences such as reputational damage, financial loss, identity theft, fraud, telephone harassment, intimidation and discrimination. Good privacy protection measures are necessary for healthcare-related services to ensure the personal interests of users and the proper functioning of business services, as well as to increase user credibility and user loyalty.

3.2 Performance

Field	Description
Unique ID	QR2 - Performance
Short Name	Performance
Description	Performance is essential to the quality of our services, with fewer hardware resources to support faster speed and more functionality. For a pleasant user experience, user personal data and IoT monitoring data must be delivered to the back-end computing centre as soon as possible, this process needs to be completed at the millisecond level, and then using machine learning models and AI algorithms to generate the data or a classical music list for the users within seconds.
Rationale	Good performance ensures the parallelism of our four services, and efficient data transfer. Our services, such as literature traversal, providing valid results for users and researchers, etc. all require excellent computational analysis and operational performance.

3.3 Scalability

Field	Description
Unique ID	QR3 - Scalability
Short Name	Scalability
Description	For the scalability, the design of entity services must be compatible with a huge memory space. To gain a better scalability, entity services should grow dynamically.
Rationale	Since this project offers service to two types of user. Both the number of users and the amount of data for each user can huge. The user data includes the data captured by IoT device, AI models generated by each user and researcher. In order to provide a better experience, entity services should hold a storage that is big enough for a large amount of user data.

3.4 Reliability

Field	Description
Unique ID	QR4 - Reliability
Short Name	Reliability
Description	Our services must be accurate in the prediction and diagnosis. As users' IoT data increase and researchers train the models, the prediction and diagnostic models would be at least 98% accurate.
Rationale	Most importantly, reliability guarantees the research's accuracy. Based on it, researchers can get further study on how classical music affects users. If the accuracy of our predictions is low, the service becomes unusable. At the same time, low reliability may increase the workload and financial costs of subsequent service maintenance, as well as irreparable waste. Additionally, reliability increases user trust. This will help to extend the life of the service.

4 Business Services

The following section will present our four business services directly mapped from the functional requirements presented in Section 2.

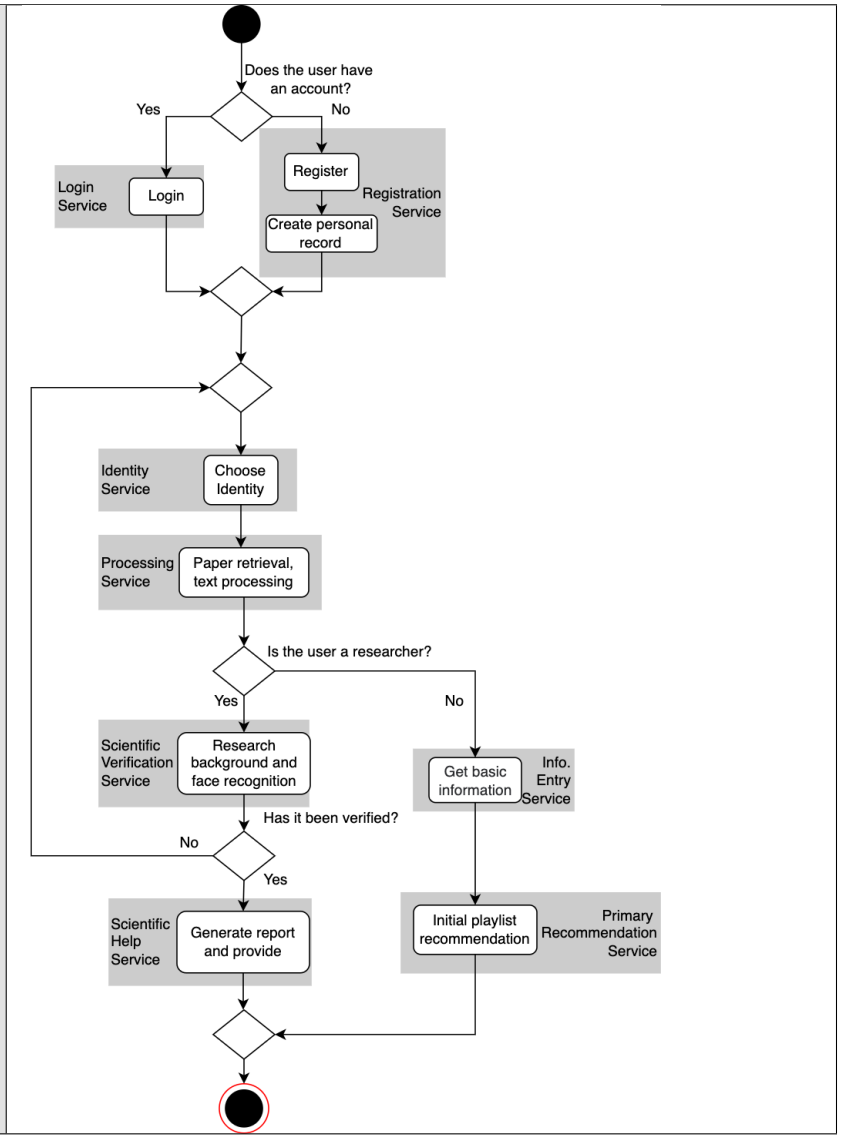
For each business service, we present the involved participants and a detailed operational description. In addition to this the service behaviour is presented as an activity diagram which identifies the service candidates and service operation candidates.

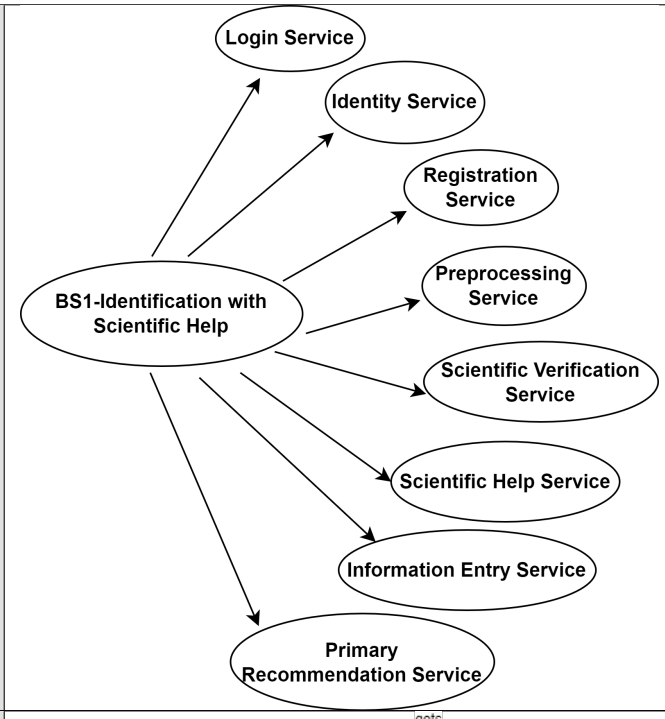
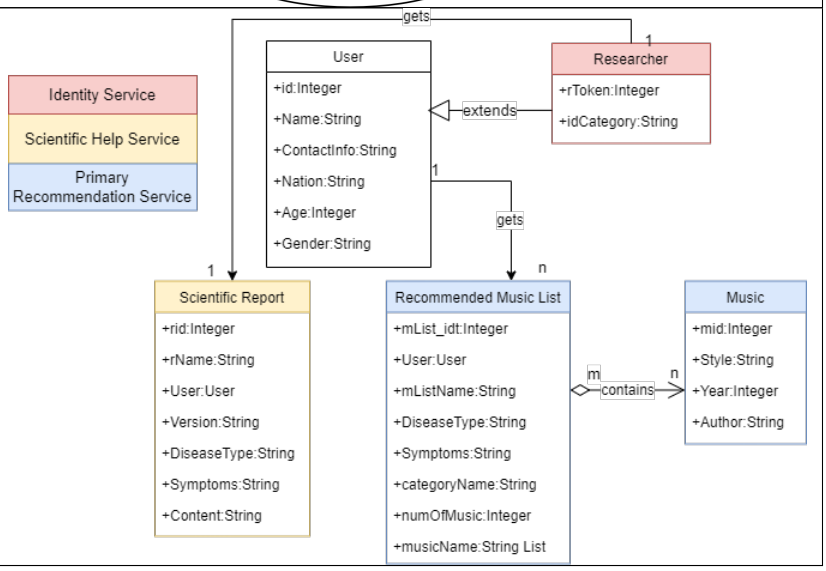
Furthermore, the service candidates decomposition is then presented using use case diagrams. Finally, a data model depicting which service candidates' instantiate or use which classes is presented. All of the service candidates from the four business services are provided in a context model at the

conclusion of this section. The latter also presents the business interactions that stakeholders have with our service candidates.

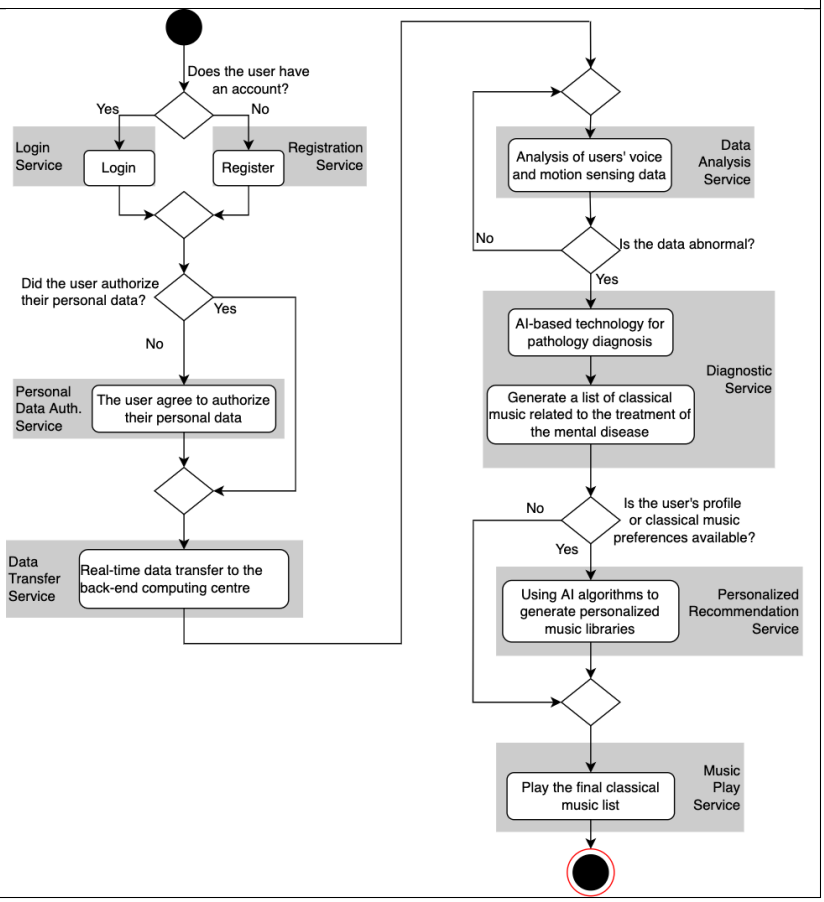
4.1 Identification with Scientific Help

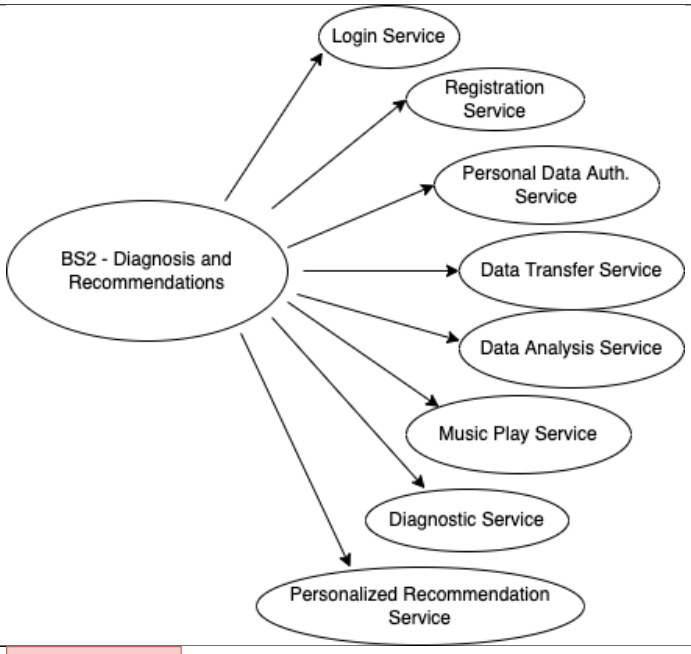
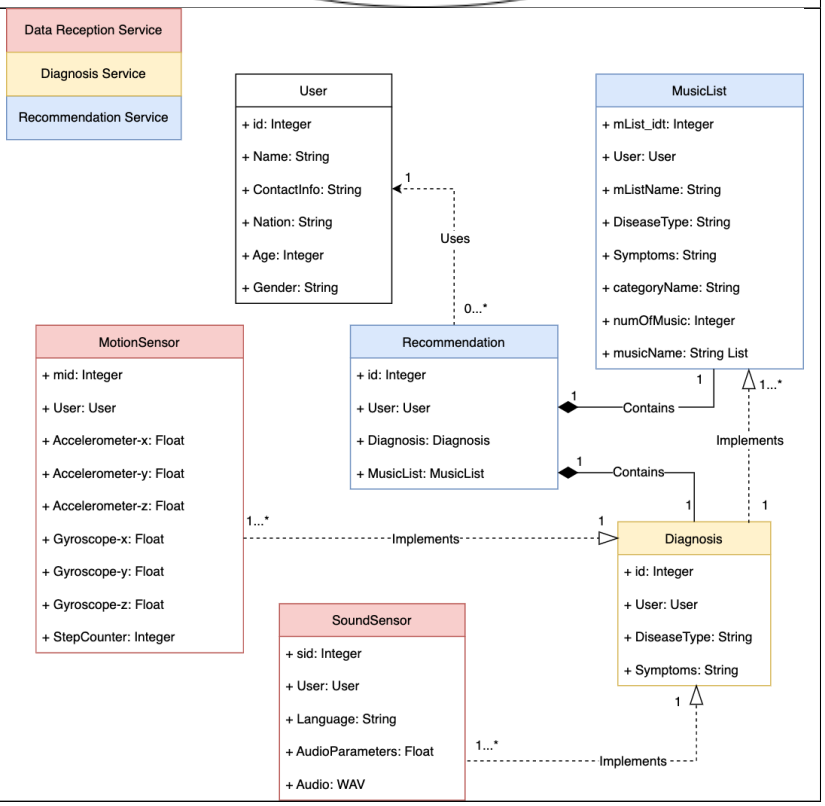
Field	Description
Unique ID	BS1-Identification with Scientific Help
Short Name	Identification with Scientific Help
Involved Participants	Medical Researcher and Patient
Detailed Operational Description	Initially, the user needs to log in through the interface and at the login stage, it is determined whether the user is already registered, if not they will be directed to register first. The user will then choose whether to log in as a researcher or as a regular user. If they choose to be a researcher, then they will need to undergo background verification and face recognition, and once they have passed this, they will be given access to the scientific report from the inner literature review and text processing by the engine. If a user choose to be a general user, he will be asked to fill in some basic information and then a primary playlist covering different categories will be recommended.

Service Behavior	

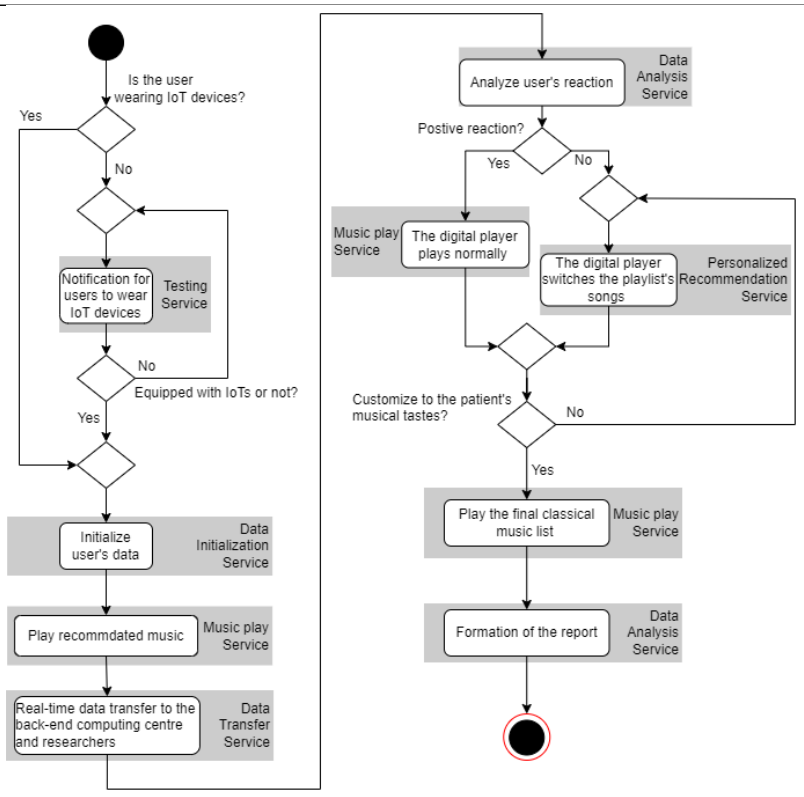
Service Candidates Decomposition	
Data Model	

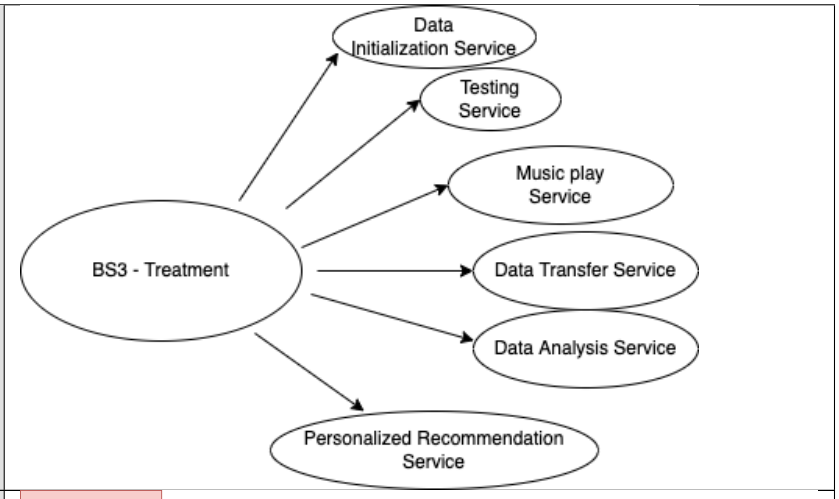
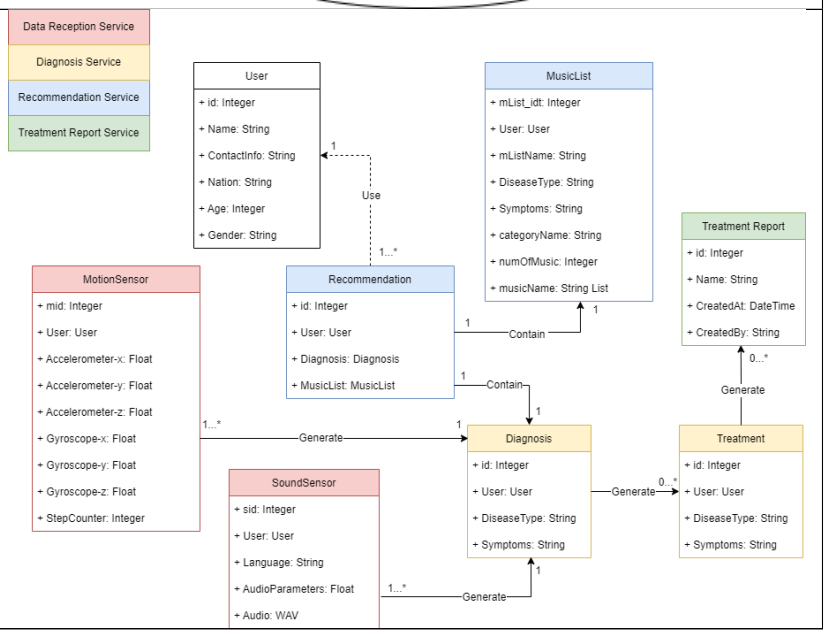
4.2 Diagnosis and Recommendations

Field	Description
Unique ID	BS2-Diagnosis and Recommendations
Short Name	Diagnosis and Recommendations
Involved Participants	Patient
Detailed Operational Description	First, users are able to log in or register if they do not have an account, and then users need to agree to authorize their personal data, such as voice data, movement data, etc., which will be monitored and sent offline to the computing center for analysis. If the monitored data is abnormal, a preliminary diagnosis of psychological problems is made by artificial intelligence and machine learning algorithms. The diagnosis is next fed into BS-1, which gets some classical music from the relevant literature that is beneficial for that mental problem. If that user has a personal list of preferred classical music, the AI algorithm is used to customize a library more suitable for that user, based on the user's preferences and the music list given by BS-1.
Service Behavior	

Service Candidates Decomposition	
Data Model	

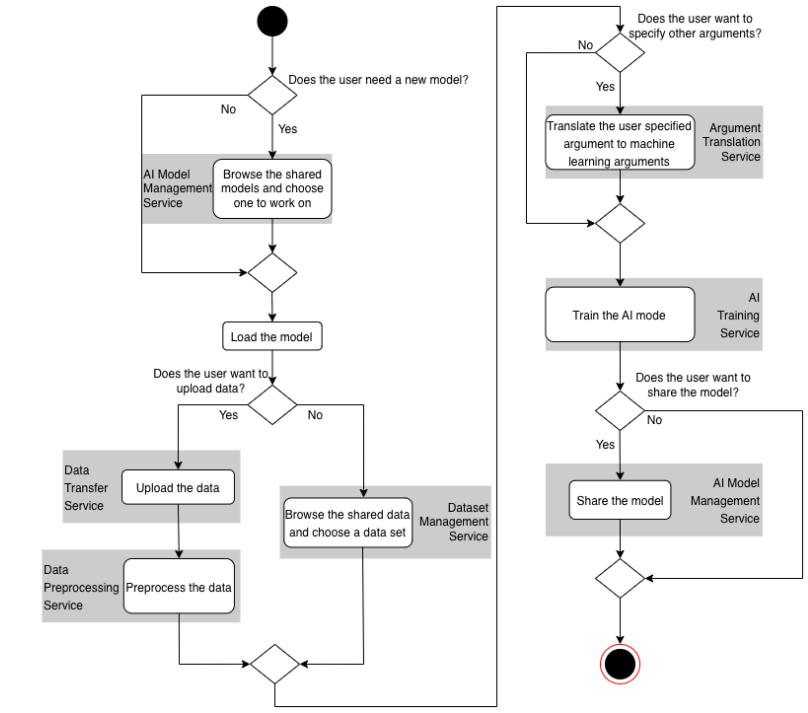
4.3 Treatment

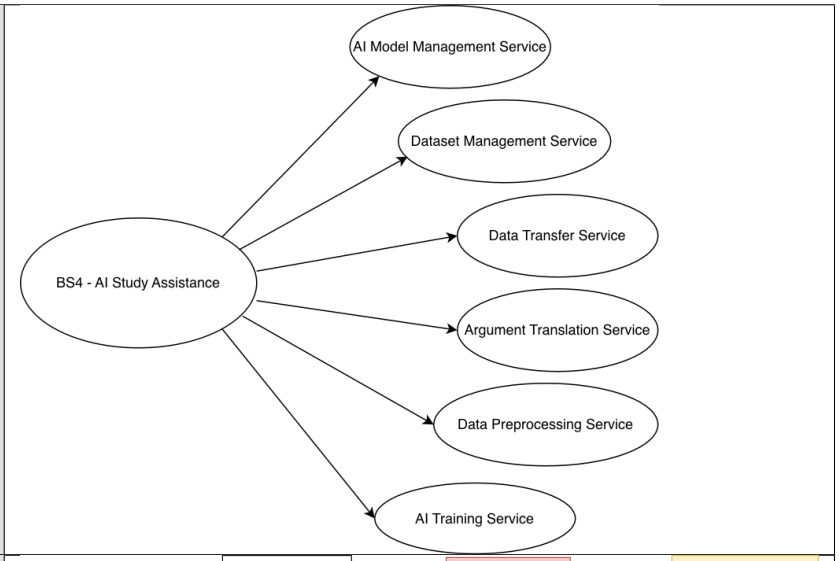
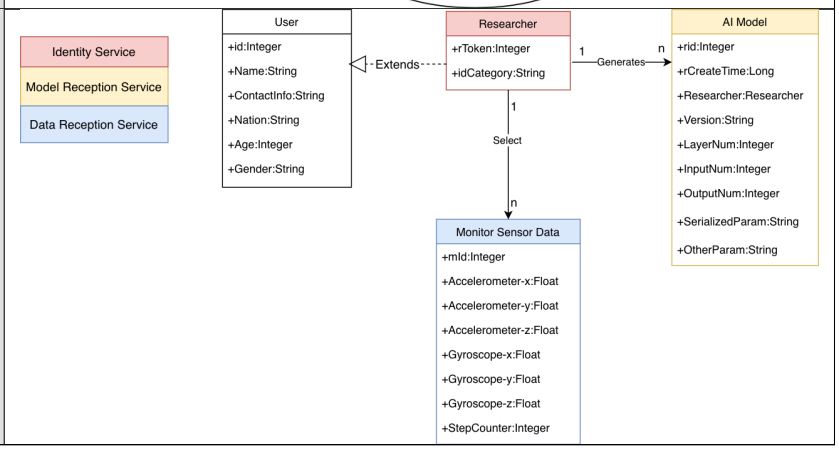
Field	Description
Unique ID	BS3 - Treatment
Short Name	Treatment
Involved Participants	Medical Researcher , Mental-health Service Provider, Patient
Detailed Operational Description	A personalized playlist of music selected specifically for the user is played first throughout the therapy. The user will be detected whether the IoT device is being worn correctly. The IoT gadget on the wrist then detects the physiological effects of each song on the user and synchronizes it constantly with the Computing Analysis Centre. The digital player will play normally if the user exhibits the appropriate favorable response. If not, the digital player switches the playlist's songs around until it is completely customized to the patient's musical tastes. Through the Computing Analysis Centre, the researcher also monitors the user's state all the time. At the conclusion of the treatment procedure, the Computing Analysis Centre would send a comprehensive report with all the data collected to the researcher.
Service Behavior	

Service Candidates Decomposition	
Data Model	

4.4 AI Study Assistance

Field	Description
Unique ID	BS4 - AI Study Assistance
Short Name	AI Assistance
Involved Participants	Medical Researcher , Mental-health Service Provider

Detailed Operational Description	When accessed, the user needs to choose an AI model to work on. This can be either the default model integrated to the service or one of the shared models from another user or the model previously saved by the user. When determining the input data for training, the user can upload data collected by themselves or browse the database that contains the data shared from the patient's IoT device. For user-uploaded data, the data processing service will automatically do the pre-processing so that they can be properly fed to the model. After finalizing the input data, some optional training arguments can be assigned by the user. However, this step is not mandatory. When the training procedure is over, the user decides whether to save or share this model.
Service Behavior	

Service Candidates Decomposition	
Data Model	

4.5 Context Model

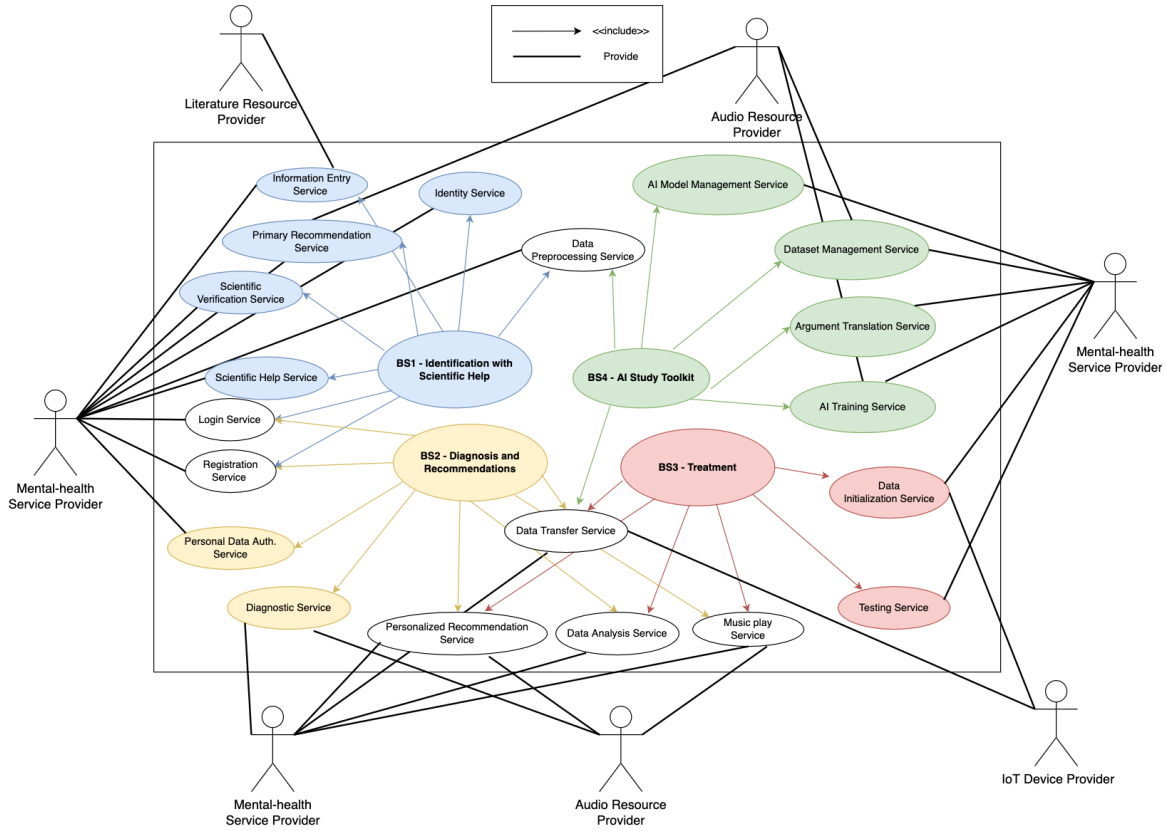


Figure 2: Model context for service candidates.

5 Design Space

In this section we will present the two main designs concerns we have detected in our project. The first concern is based on our business domain and the second one is related to a green sustainability strategy. We use the QOC (Question - Option - Criteria) notation and the AK design-space modeling template (AK-SPAM) to describe both issues.

We offer three options for every issue and explain each one. Each option is evaluated based on our quality requirements presented in Section 3. It is crucial to note that, with regard to our second concern, we also evaluate our quality requirements in light of sustainability and the environment.

At last, we conclude by presenting a graphic for each concern that summarizes the QOC analysis for that concern.

5.1 Concern 1

Concern 1 (Identifier:Description)		**Con#1**: How to ensure the availability of user behavior tracking data and IoT monitoring device data?
Ranking Criteria (Identifier:Name)		**Cr#1**: Privacy **Cr#2**: Performance **Cr#3**: Scalability **Cr#4**: Reliability
Option 1	Identifier:Name	**Con#1-Opt#1**: Data Authorization and Protection
	Description	Users' personal data is very sensitive, so in order to ensure the legality of the use of the data, we need to ensure that the user is aware of the data we obtain and agrees to authorize us to perform analysis and calculations, which are carried out in BS2, BS3 and BS4.
	Status	Decided
	Relationships	Subsumes
	Evaluation	**Cr#1**: Privacy is **supported** by this option directly, the data authorization operation constrains and manages the data backend, ensuring the customer's right to know the use of their own data and safeguarding for private data processing. **Cr#2**: Data authorization does not affect the performance of the services, so Opt#1 is **neutral** to Cr#2. **Cr#3**: Data authorization does not affect the scalability of the services, so Opt#2 is **neutral** to Cr#3. **Cr#4**: The data transmitted in the service will be authenticated, guaranteeing the legitimate origin of the data, so data authorization **supports** Cr#4-Reliability.
	Rationale of decision	Although Data Authorization and Protection rarely supports Cr#2 and Cr#3, it has great support for privacy and reliability, ensuring the privacy and legitimacy of sensitive data and avoiding the risk of data leakage. Therefore, we decided to accept this option.
Option 2	Identifier:Name	**Con#1-Opt#2**: Offline Data Transfer
	Description	In our services, tracking data and IoT device data are generally multiple data sets combined by time series. We need to ensure uninterrupted data transmission to obtain continuous data and ensure data reliability in BS2. Hence data transmission offline is also one of the issues to be considered.
	Status	Decided

	Relationships	Is related to
	Evaluation	**Cr#1**: This option is not related to the data protection and privacy, so it is **neutral** to Cr#1. **Cr#2**: The offline transmission of data ensures the authenticity and analyzability of the data source, which can make the analysis results more accurate, so this option **supports** the Cr#2-performance very well. **Cr#3**: Large amounts of offline transfer data can take up a lot of storage space, showing the importance of scalability of the software, so this option **supports** Scalability. **Cr#4**: This option guarantees the integrity of the data and greatly **supports** Cr#4-Reliability.
	Rationale of decision	Offline data transfer allows tracking data regardless of whether the recipient client is online or not, reducing the latency of processing data in the background, so we decided to accept this option.
Option 3	Identifier:Name	**Con#1-Opt#3**: Standard Diary
	Description	Due to the randomness of the tracking data and the large amount of redundant invalid data, we can provide a data upload template for the user to upload a requested speech, walking motion sensing data etc. to the backend in a period (e.g. one week).
	Status	Rejected
	Relationships	None
	Evaluation	**Cr#1**: As this option allows users to upload their own data, privacy is well **supported**. **Cr#2**: The data obtained with this option is more standard and better suited to the algorithms and data analysis models allowed and therefore also **supports** Cr#2. **Cr#3**: Standard Diary is **neutral** to this criteria due to the small scale data transfer. **Cr#4**: This option **contradicts** the reliability of the data, as users uploading the data themselves defeats the original purpose of tracking real-time user behaviour, and is not reliable compared to tracking data.
	Rationale of decision	Although Standard Diaries can reduce random data and improve the efficiency of our computational models, this does not contribute to the user experience of our services, therefore we reject the option.

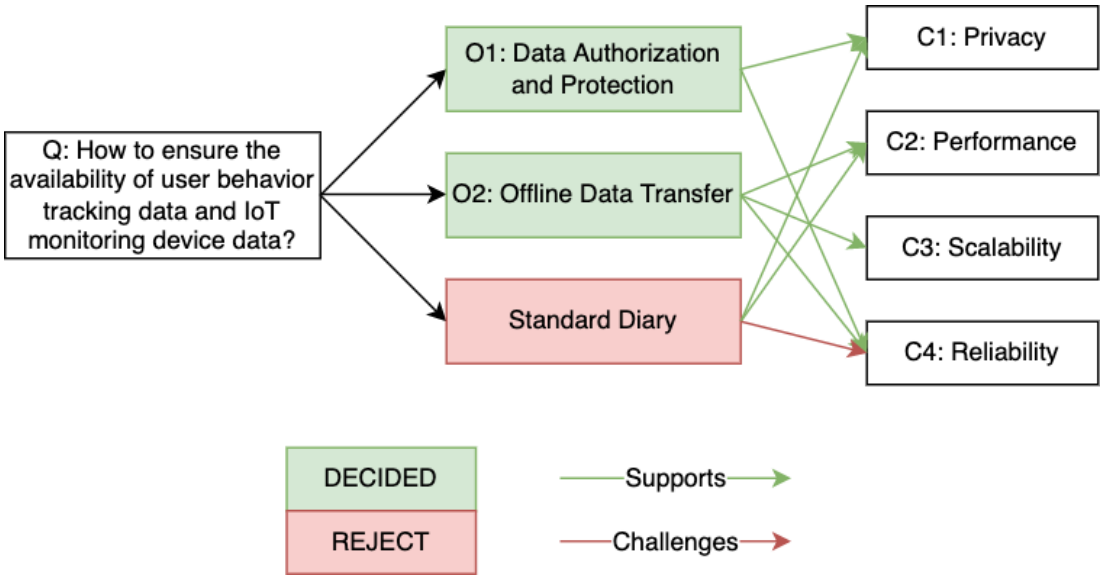


Figure 3: QOC notation of Con#1: Data Authorization & Protection and Offline Data Transfer were accepted. Option 1 maps to the BS2 and BS3, and option 2 maps to the service candidate BS2.

5.2 Concern 2

Concern 2 (Identifier:Description)		**Con#1**: How can we make reduction of users's ecological footprint?
Ranking Criteria (Identifier:Name)		**Cr#1**: Reliability **Cr#2**: Privacy **Cr#3**: Performance **Cr#4**: Scalability
Option 1	Identifier:Name	**Con#2-Opt#1**: No-Drug Treatment
	Description	Classical music helps the patient's health concerns, such as hormonal imbalance and irregular heartbeat within BS3(Data Transfer Service). Some of the side effects of the medicine are replaced by classical music. The issue of incorrect medical waste and supply management in hospitals and clinics has been resolved.
	Status	Decided
	Relationships	none

	Evaluation	**Cr#1**: No-Drug Treatment is **neural** to the reliability. This requires the stability of the inner AI model, when it is modified by technicians the accuracy and classification function may have fluctuations. **Cr#2**: No-Drug Treatment is **positively affected** since all of the generated data from IoTs and original stored data will not go through intermediaries. The collected data is authorized by users and it prevents abuse and leakage. **Cr#3**: Users may request the service at the same time which will create concurrency problems, so No-Drug Treatment will **negatively affect** the performance. **Cr#4**: Scalability will be **supported** since there are more demand from users when they are equipped with IoT devices which will replace some in-person diagnosis.
	Rationale of decision	Although No-Drug treatment sometimes violates Cr#3, other critetias are positively supported. Therefore, we decided to accept this option.
Option 2	Identifier:Name	**Con#2-Opt#2**: Effective Music
	Description	We have advanced AI model for applying better experience for users according to personal condition. Personalised recommendations are made through inner models to form an exclusive playlist suitable for the patient, with different parts having different therapeutic effects on mental illness.
	Status	Decided
	Relationships	none
	Evaluation	**Cr#1**: It is **neutral** to the reliability of the service. This due to although Opt#2 may rarely collapse due to the cloud computing server, it is a standalone service, it will not cause the entire basic service to collapse. **Cr#2**: Effective Music will **impact Cr#2 positively**. Since the extra monitored data is from our own IoT devices without any intermediaries, and the data access rights are permitted by users themselves. **Cr#3**: Cr#3 will be **negatively affected** by it. Since AI models often need strong computing capability and the time cost grows as the collected data grows. **Cr#4**: Effective Music is **positive** for Cr#1 since it requires the system to utilize its computation ability when user has demand of AI recommendation.

	Rationale of decision	Effective Music service increase the effectiveness of the impact from classical music and it is something like the personalized service, it also supports Cr#2 and Cr#4 so it is accepted
Option 3	Identifier:Name	**Con#2-Opt#3**: Digitalize Reports
	Description	Researchers and patients receive medical reports and notifications digitally via mobile phones and computers in BS3. Communication with researchers and patients is through email.
	Status	Decided
	Relationships	none
	Evaluation	**Cr#1**: Digitize Reports is **positive** for reliability since all data used inside the digital report and the report itself comes directly from inner AI model and connected with authorised data. **Cr#2**: Digitize Reports **positively** obey the privacy of our services as they will only be pushed since the user's identity is verified and the user is permitted, reports themselves will also be encrypted and stored safer than physical reports which avoids the leakage and misuse. **Cr#3**: This option is **neutral** in terms of performance because there may be a large number of digital reports which will impact the performance of services. **Cr#4**: This option **positively impact** the scalability due to a large number of personalized reports that can be generated according to their own specific condition and the system will scale up by load-balance and respond in time .
	Rationale of decision	This option has been decided since it supports three of our criterias and the rest is a neutral one.

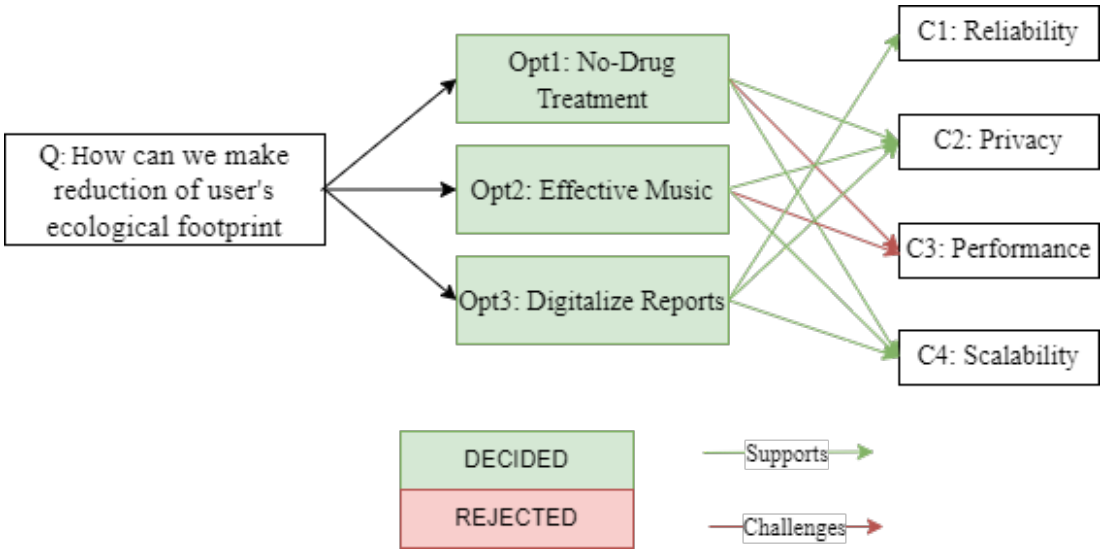
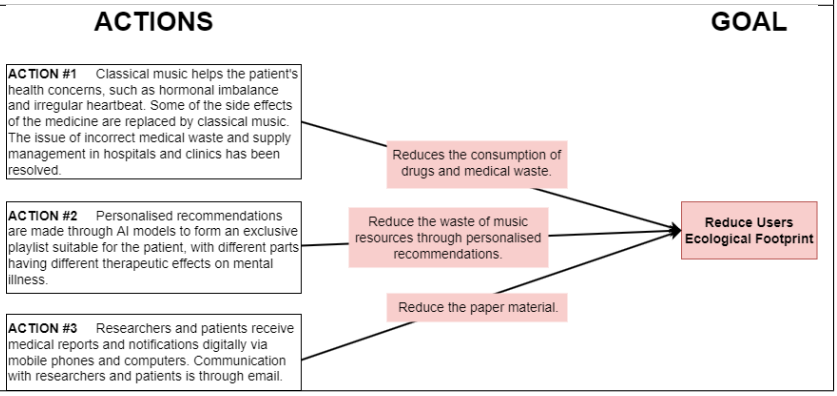


Figure 4: QOC notation of Con#2: All the options were accepted. Option 1 maps to the Business Service BS3. Option 2 maps to the service candidate "Personalized Recommendation Service". Finally, option 3 maps to the candidates "Scientific Help Service" of BS1 and "Data Analysis Service" of BS3

6 Sustainability Strategies

We outline our project's sustainability strategy in this part. For an enterprise's long-term growth and environmental preservation, a sustainable development plan is extremely valuable. We should take the sustainability of the services into account when maintaining services, in addition to the quality standards. Here, we outline our sustainability objective. Additionally, we will define sustainability strategies as initiatives that must be included in our service design in order to accomplish that objective.

Field	Description
Unique ID	SS1-Reduce Users Ecological Footprint
Short Name	Reduce Users Ecological Footprint
Description	As a sustainability strategy, this purpose is to reduce the ecological footprint of users. This environmental purpose is linked to Con#2 in Section 5: "How can we make reduction of users's ecological footprint?"
Action #1	**Description:** No-Drug Treatment: Classical music helps the patient's health concerns, such as hormonal imbalance and irregular heartbeat. Some of the side effects of the medicine are replaced by classical music. The issue of incorrect medical waste and supply management in hospitals and clinics has been resolved. The effect: Reduces the consumption of drugs and medical waste.
Action #2	**Description:** Effective Music: Personalised recommendations are made through AI models to form an exclusive playlist suitable for the patient, with different parts having different therapeutic effects on mental illness. The effect: Reduce the abuse and waste of music resources through personalized recommendations.
Action #3	**Description:** Digitalize Reports: Researchers and patients receive medical reports and notifications digitally via mobile phones and computers. Communication with researchers and patients is through email. The effect: Reduce the paper material.
Type of Strategy	Service Awareness
Relevance for Business Domain	Through sustainable services, the ecological footprint of the user is significantly reduced. Patients can effectively reduce their healthcare expenditures. At the same time, the hospital or clinic can reduce its expenditure on medication and the discharge of medical waste. Additionally, the implementation of sustainable strategies in the design ensures the longevity of the service.
Diagram	

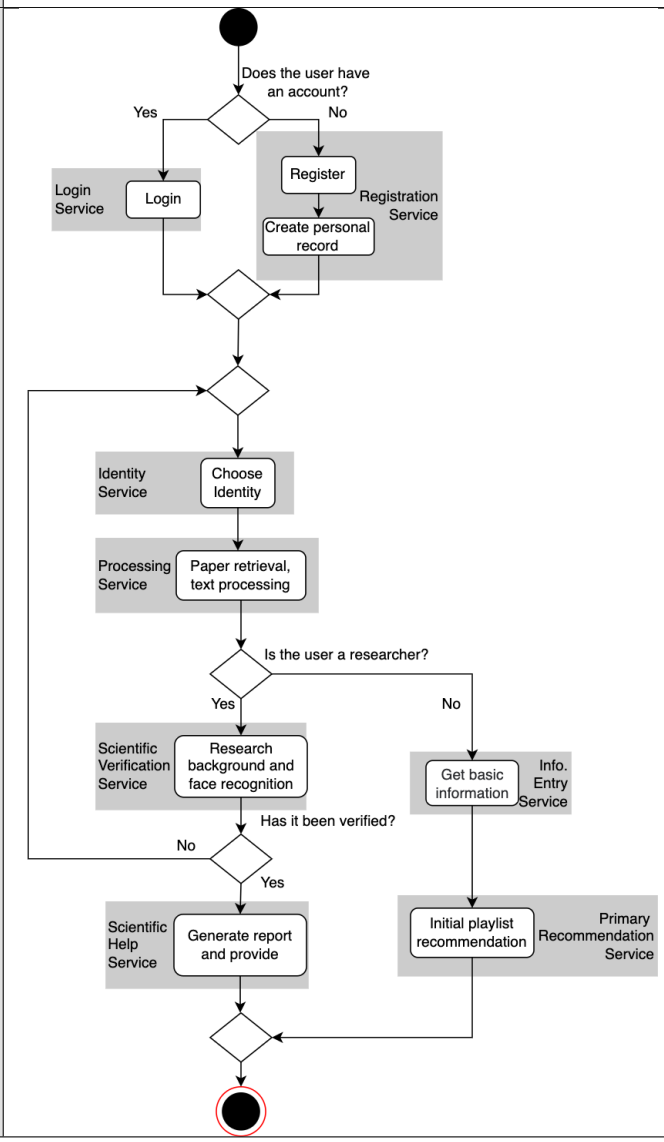
7 Software Decomposition of Business Services

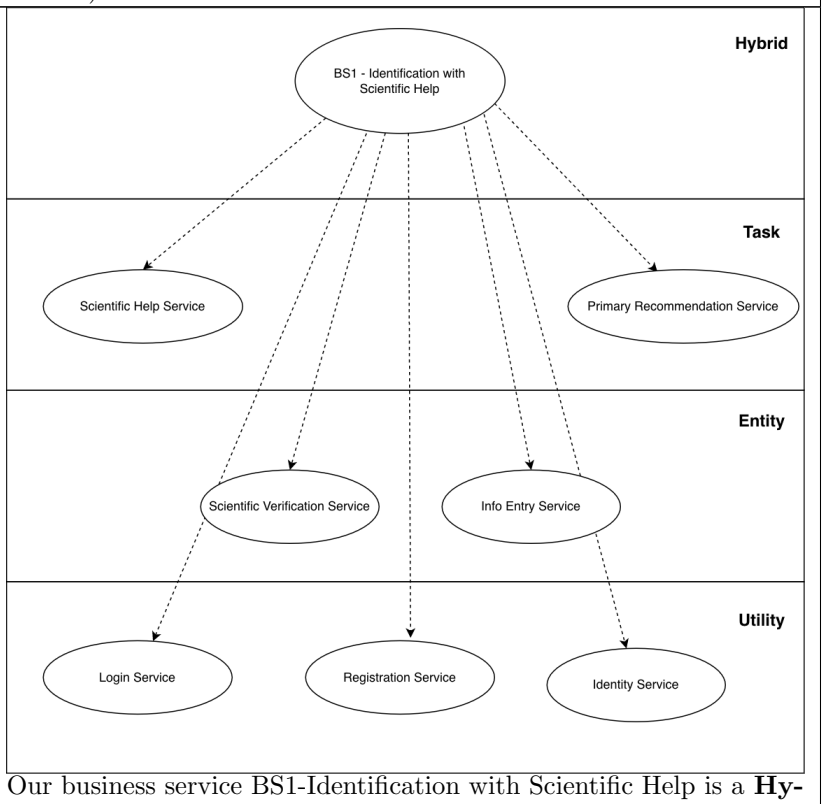
The following section presents the business services shown in section 4 as a list of candidate services. This decomposition is based on the perspective of the digital heritage service provider, i.e. the provider of the business service. Each business service decomposition shows its software service candidates as well as a diagram that classifies the type of decomposed service candidate as a hybrid, task, entity, or utility. In addition to this, each diagram is given a description and the service candidates are given a unique ID. In the table 10, we summarise the services involved and corresponding short codes.

Table 10: Service Short Codes

Services	*Service Short Codes*
Login Service	ss-01-loginService
Identity Service	ss-02-identityService
Registration Service	ss-03-registrationService
Preprocessing Service	ss-04-preprocessingService
Scientific Verification Service	ss-05-scientificVerificationService
Scientific Help Service	ss-06-scientificHelpService
Information Entry Service	ss-07-informationEntryService
Primary Recommendation Service	ss-08-primaryRecommendationService
Personal Data Auth. Service	ss-09-personalDataAuthService
Data Transfer Service	ss-10-dataTransferService
Data Analysis Service	ss-11-dataAnalysisService
Music Play Service	ss-12-musicPlayService
Diagnostic Service	ss-13-diagnosticService
Personalized Recommendation Service	ss-14-personalizedRecommendationService
Data Initialization Service	ss-15-dataInitialzaionService
TestingService	ss-16-TestingService
Argument Translation Service	ss-17-argumentTranslationService
Data Preprocessing Service	ss-18-dataPreprocessingService
AI Training Service	ss-19-aiTrainingService
Dataset Management Service	ss-20-datasetManagementService
AI Model Management Service	ss-21-aiModelManagementService

7.1 Identification with Scientific help

Field	Description
Unique ID	BS1-Identification with Scientific Help
Short Name	Identification with Scientific Help
Business Service Behavior	

Software Service Candidates	Login Service (ss-01-loginService) Identity Service (ss-02-identityService) Registration Service (ss-03-registrationService) Preprocessing Service (ss-04-preprocessingService) Scientific Verification Service (ss-05-scientificVerificationService) Scientific Help Service (ss-06-scientificHelpService) Information Entry Service (ss-07-informationEntryService) Primary Recommendation Service (ss-08-primaryRecommendation-Service)
Diagram	 Our business service BS1-Identification with Scientific Help is a **Hybrid** service since it is composed of different functional services. Primary Recommendation Service and Scientific Help Service are categorized as **Task** services since they are the core and ultimate functionalities in the business service. Scientific Verification Service and Info Entry Service are considered as **Entity** services since they perform the procedural functionalities and contain important data operation in the BS2. Login Service, Registration Service and Identity Service are considered to be the **Utility** services, as they are independent of the business service and can be reused in other business services.

7.2 Diagnosis and Recommendation

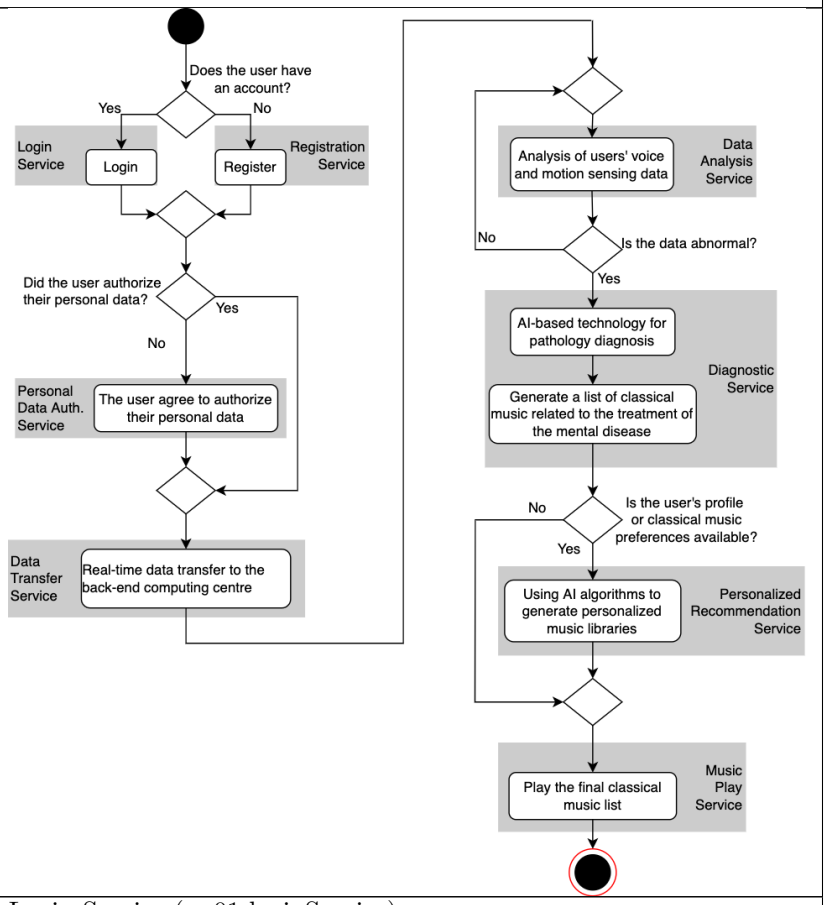
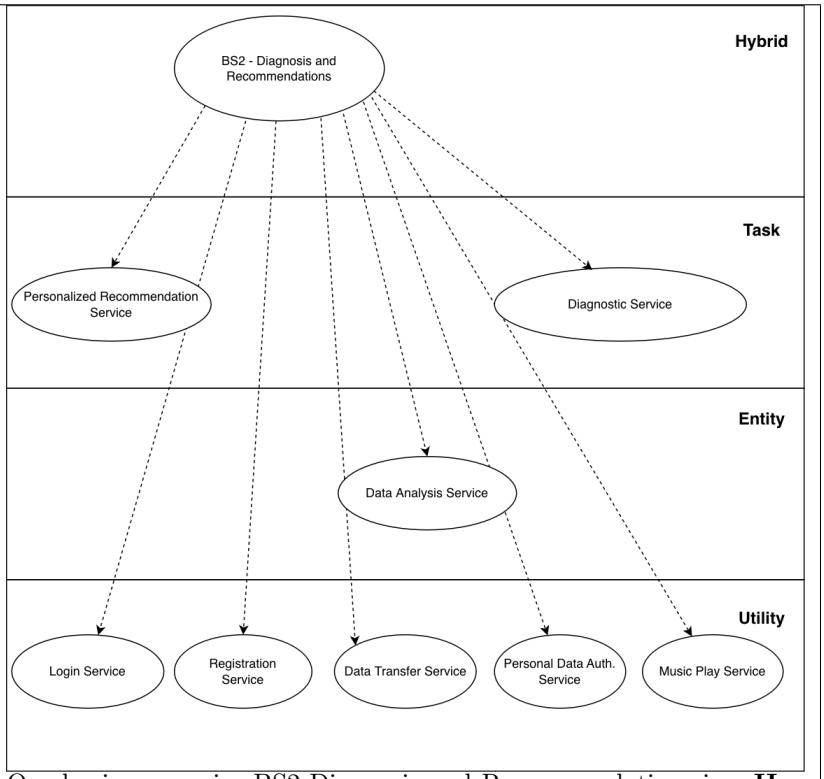
Field	Description
Unique ID	BS2-Diagnosis and Recommendations
Short Name	Diagnosis and Recommendations
Business Service Behavior	
Software Service Candidates	Login Service (ss-01-loginService) Registration Service (ss-03-registrationService) Personal Data Auth. Service (ss-09-personalDataAuthService) Data Transfer Service (ss-10-dataTransferService) Data Analysis Service (ss-11-dataAnalysisService) Music Play Service (ss-12-musicPlayService) Diagnostic Service (ss-13-diagnosticService) Personalized Recommendation Service (ss-14-personalizedRecommendationService)

Diagram	 Our business service BS2-Diagnosis and Recommendations is a **Hybrid** service since it is composed of services of different types. Personalized Recommendation Service and Diagnosis Service are considered as **Task** services since they are core functionalities in the business service. Data Analysis Service is considered as a **Entity** service since it performs the CRUD operation in the BS2. Data Transfer Service, Login Service, Registration Service and Personal Data Authorization Service are considered to be the **Utility** services, as they are independent of the business service and can be reused in other business services.

7.3 Treatment

Field	Description
Unique ID	BS3-Treatment
Short Name	Treatment

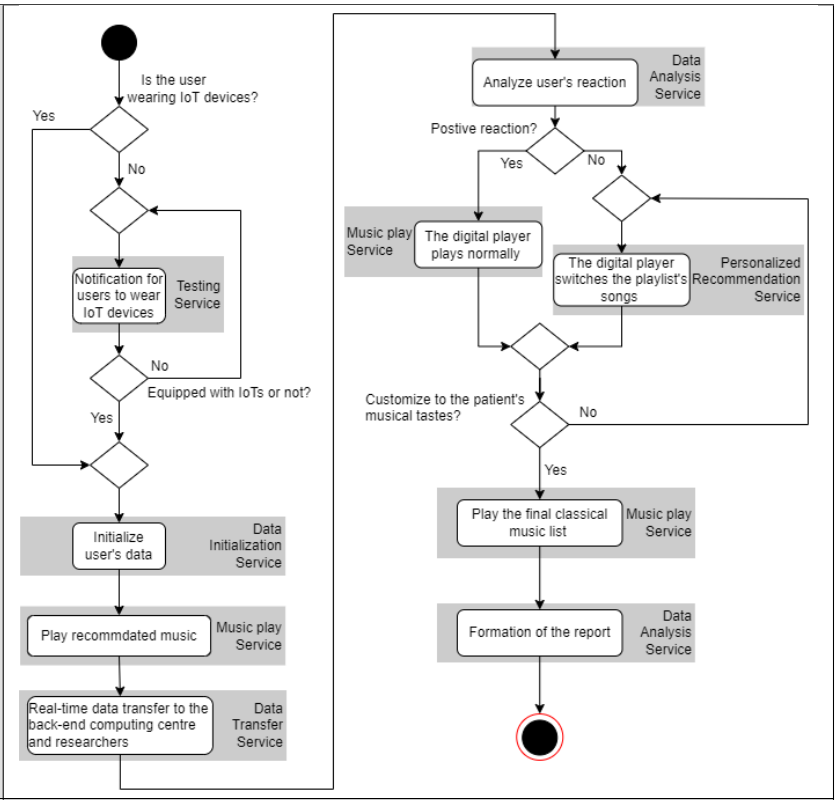
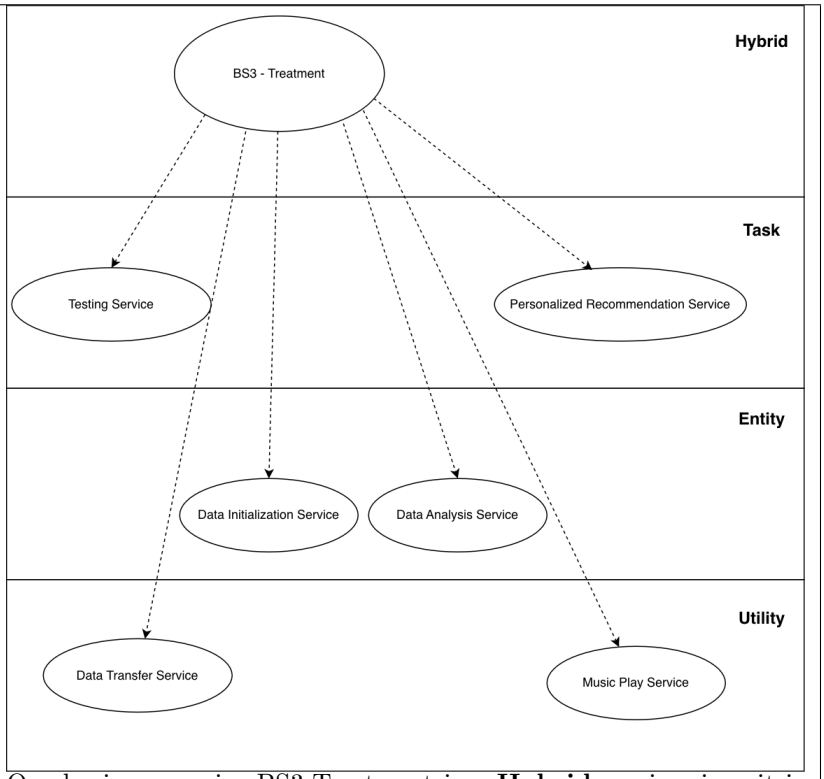
Business Service Behavior	
Software Service Candidates	Testing Service (ss-16-TestingService) Personalized Recommendation Service (ss-14-personalizedRecommendationService) Personal Data Auth. Service (ss-09-personalDataAuthService) Data Transfer Service (ss-10-dataTransferService) Data Analysis Service (ss-11-dataAnalysisService) Data Initialization Service (ss-15-dataInitialzaionService) Music Play Service (ss-12-musicPlayService)

Diagram	 Our business service BS3-Treatment is a **Hybrid** service since it is composed of services of different types. Treatment is considered as a **Task** service since it is core functionality in the business service. Data Initialization Service and Data Analysis Service are considered as **Entity** services since they provide access to data in the BS3. Data Transfer Service and Music Play Service are considered to be the **Utility** services, as they are independent of the business service and can be reused in other business services.

7.4 AI Study Assistance

Field	Description
Unique ID	BS4-AI Study Assistance
Short Name	AI Assistance

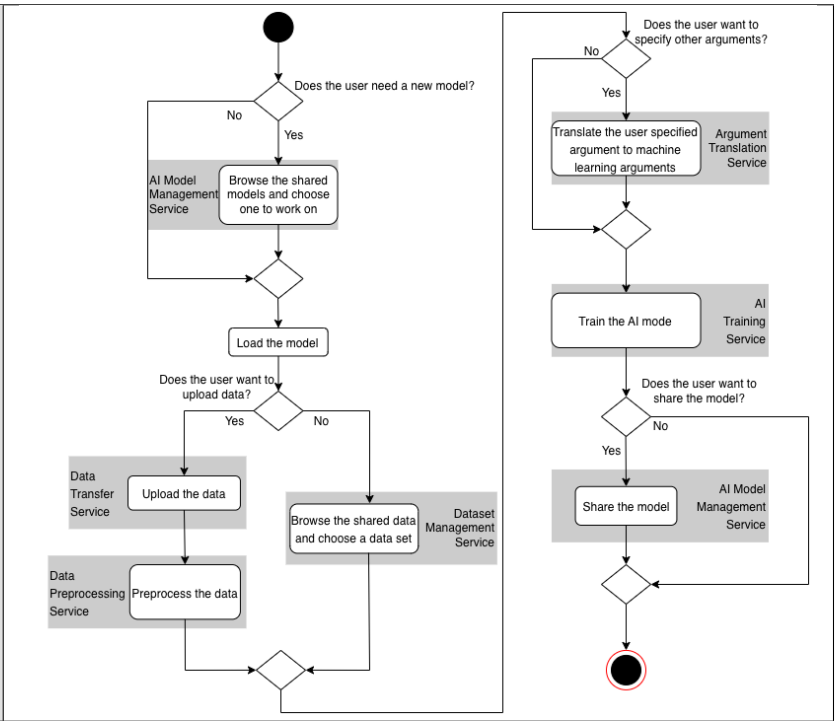
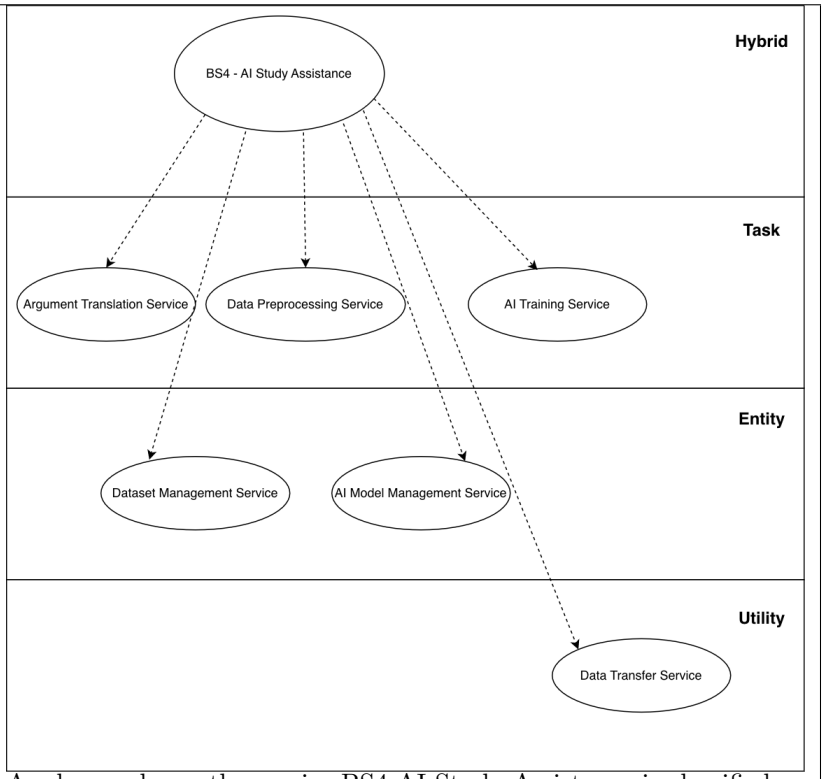
Business Service Behavior	
Software Service Candidates	Argument Translation Service (ss-17-argumentTranslationService) Data Preprocessing Service (ss-18-dataPreprocessingService) AI Training Service (ss-18-aiTrainingService) Dataset Management Service (ss-20-datasetManagementService) AI Model Management Service (ss-21-aiModelManagementService) Data Transfer Service (ss-10-dataTransferService)

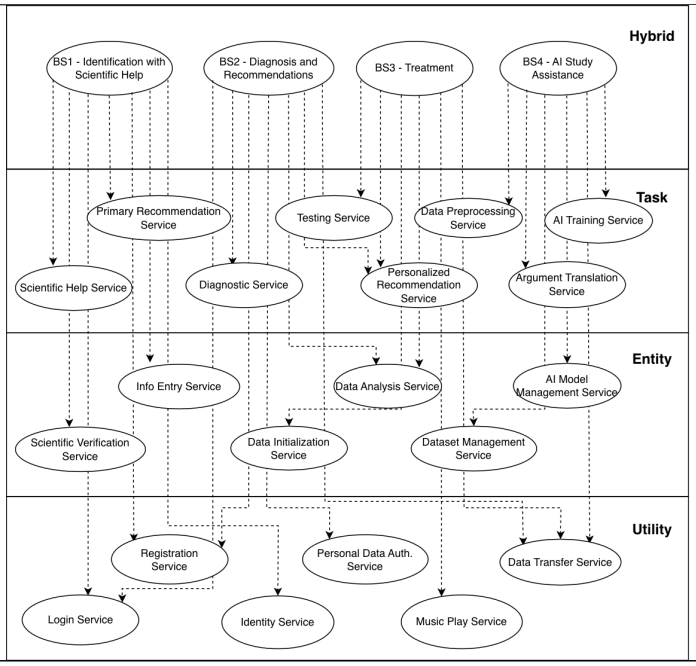
Diagram	 As shown above, the service BS4-AI Study Assistance is classified as **Hybrid** service for it has many different services as its component. Argument Translation Service, Data Preprocessing Service and AI Training Service are considered to be **Task** services since they execute different functionalities. Meanwhile, it has Dataset Management Service and AI Model Management as **Entity** services, which mainly offer access and manage data resources for other services. Finally, Data Transfer Service serves independently and provides generic functions. Therefore, it is known as a **Utility** service.

8 Participant's Service Inventory Identification

In this section, we describe the service inventories for each of the service providers (i.e. Mental-health Service Provider, Audio Resource Provider, Literature Resource Provider, IoT Device Providers), and taking into account the perspective of the participants, the services of each participant are classified on different service types (i.e. Hybrid, Task, Entity or Utility).

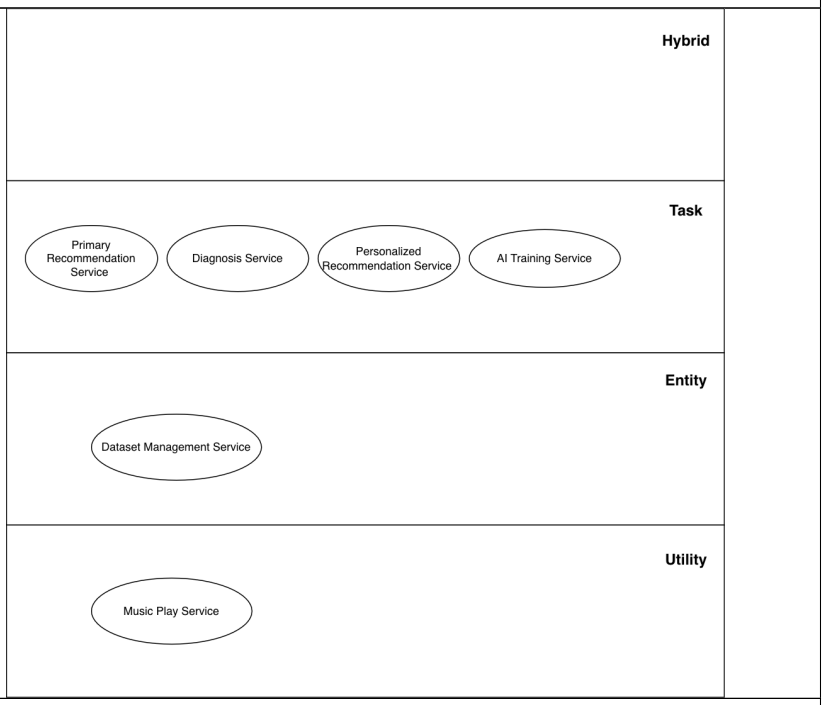
8.1 Mental-health Service Provider

Field	Description
ID	INV-01-Mental-healthServiceProvider
Name	Mental-health Service Provider Inventory
Participant	Mental-health Service Provider
Constituent Software Service Candidates	Login Service ss-01-loginService Identity Service ss-02-identityService Registration Service ss-03-registrationService Preprocessing Service ss-04-preprocessingService Scientific Verification Service ss-05-scientificVerificationService Scientific Help Service ss-06-scientificHelpService Information Entry Service ss-07-informationEntryService Primary Recommendation Service ss-08-primaryRecommendation-Service Personal Data Auth. Service ss-09-personalDataAuthService Data Transfer Service ss-10-dataTransferService Data Analysis Service ss-11-dataAnalysisService Music Play Service ss-12-musicPlayService Diagnostic Service ss-13-diagnosticService Personalized Recommendation Service ss-14-personalizedRecommen-dationService Data Initialization Service ss-15-dataInitialzaionService Testing Service ss-16-TestingService Argument Translation Service ss-17-argumentTranslationService Data Preprocessing Service ss-18-dataPreprocessingService AI Training Service ss-19-aiTrainingService Dataset Management Service ss-20-datasetManagementService AI Model Management Service ss-21-aiModelManagementService

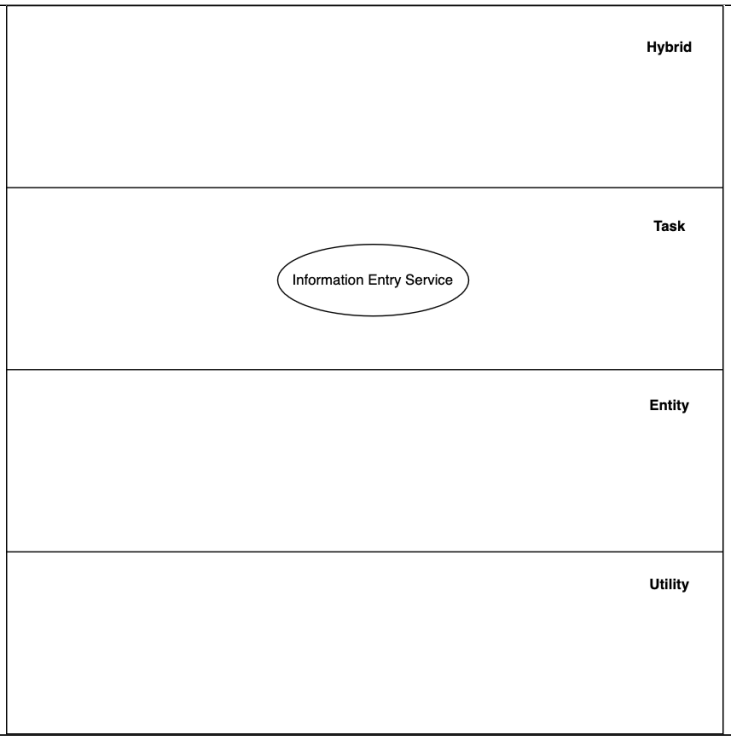
Diagram	
Diagram Description	As shown above, the inventory of the Mental-health Service Provider contains all 4 business services as hybrid services. On the other hand, Scientific Help Service, Primary Recommendation Service, Diagnostic Service, Testing Service, Personalized Recommendation Service, Data Preprocessing Service, Argument Translation Service and AI Training Service are core to the business of the Mental-health Service Provider. Hence, they are task services. Furthermore, entity service is consist of Scientific Verification Service, Information Entry Service, Data Initialization Service, Data Analysis Service, Dataset Management Service and AI Model Management Service. Finally, Login Service, Registration Service, Identity Service, Personal Data Auth. Service, Music Play Service and Data Transfer Service can operate independently. So they are considered utility services.

8.2 Audio Resource Provider

Field	Description
ID	INV-02-AudioResourceProvider
Name	Audio Resource Provider Inventory
Participant	Audio Resource Provider

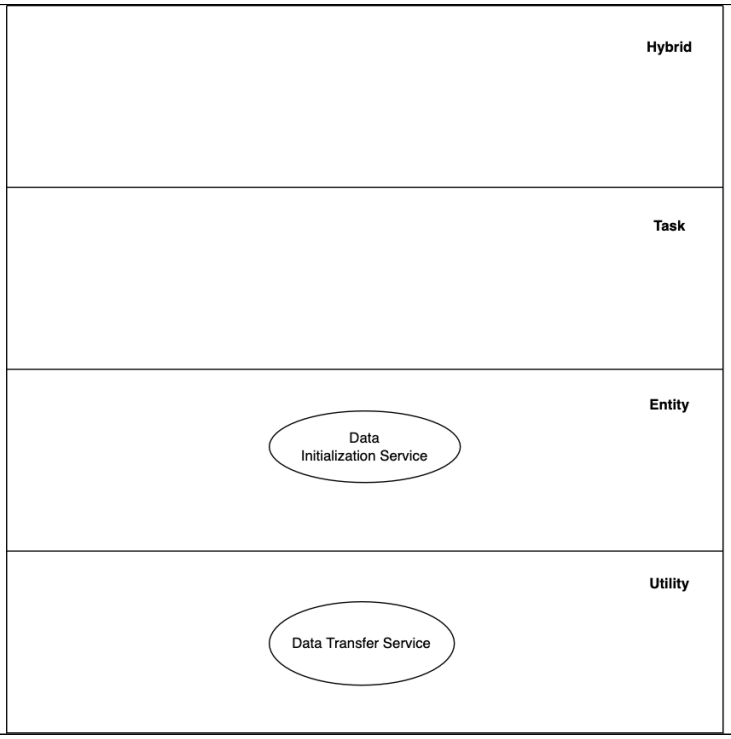
Constituent Software Service Candidates	Primary Recommendation Service (ss-08-primaryRecommendation-Service) Diagnostic Service (ss-13-diagnosticService) Music Play Service (ss-12-musicPlayService) Personalized Recommendation Service (ss-14-personalizedRecommendationService) AI Training Service (ss-19-aiTrainingService) Dataset Management Service (ss-20-datasetManagementService)
Diagram	
Diagram Description	From the perspective of the Audio Resource Provider, the task services are the Primary Recommendation Service, Diagnosis Service, Personalized Recommendation Service and AI Training Service. Because they are core to the business of the Audio Resource Provider. Meanwhile, it has the Dataset Management Service as an entity service. It is because the dataset also includes the digital heritage data of classical music. And the Music Play Service is considered a utility service.

8.3 Literature Resource Provider

Field	Description
ID	INV-03-LiteratureResourceProvider
Name	Literature Resource Provider
Participant	Literature Resource Provider
Constituent Software Service Candidates	Information Entry Service (ss-07-informationEntryService)
Diagram	
Diagram Description	From the perspective of the Literature Resource Provider the Information Entry Service is a Task service since it is core to the business of this stakeholder.

8.4 IoT Device Providers

Field	Description
ID	INV-04-IoTDeviceProviders
Name	IoT Device Provider

Participant	IoT Device Provider, Patient
Constituent Software Service Candidates	Data Transfer Service (ss-10-dataTransferService) Data Initialization Service (ss-14-dataInitialzaionService)
Diagram	
Diagram Description	Data Initialization Service is considered as a Entity service that is in charge of CRUD operations, and Data Transfer Service is considered as a Utility service since it has utility functionality.

9 Service Contract Identification

This section identifies the service contracts needed to operate business services presented in section 4. Services contracts are identified using the service inventories presented in the previous section. Figure 5 depicts the identification process of the service contracts needed for our business services to operate. Finally, we present and describe each identified contract in detail using SoaML Service Contracts notation.

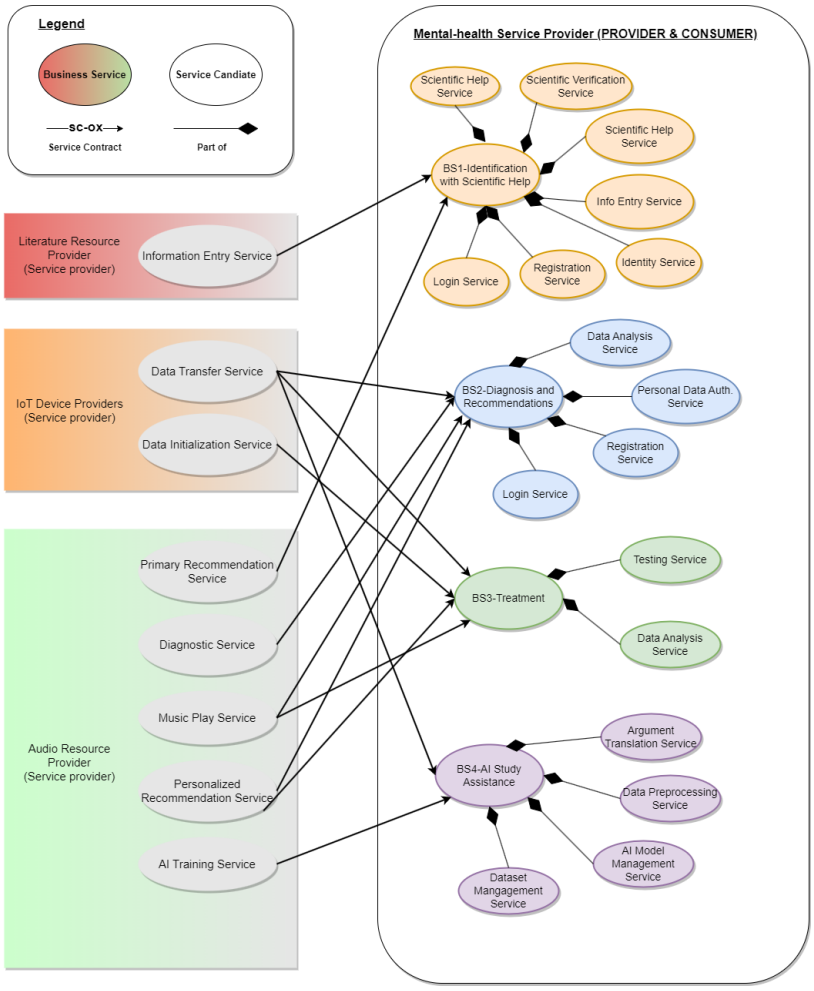
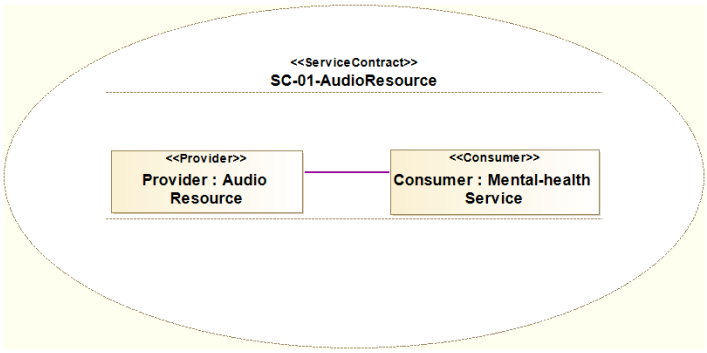
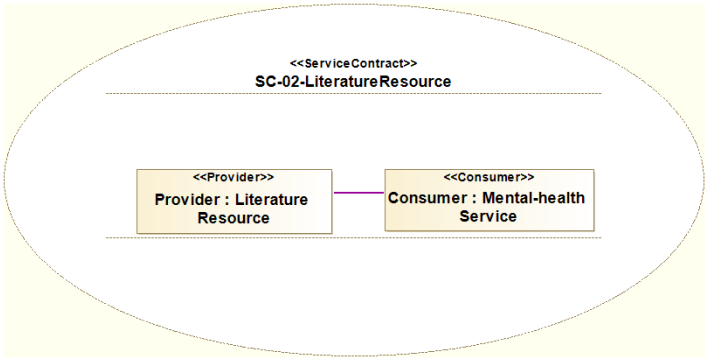


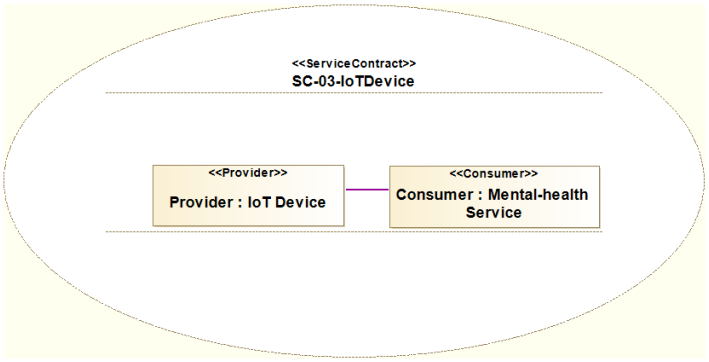
Figure 5: Service Contract Identification for our business services. Four service contracts are identified.

Field	Description
ID	SC-01-AudioResource
Name	Audio Resource
Participant	Audio Resource Provider Mental-health Service Provider

Service Structure Diagram	

Field	Description
ID	SC-02-LiteratureResource
Name	Literature Resource
Participant	Literature Resource Provider Mental-health Service Provider
Service Structure Diagram	

Field	Description
ID	SC-03-IoTDevice
Name	IoT Device
Participant	IoT Device Providers Mental-health Service Provider

Service Structure Diagram	

10 Business Service Network

The following section will use the service contracts described in the previous section to build a business service network as figure 6 presented as a Service Architecture Diagram using SoaML notation.

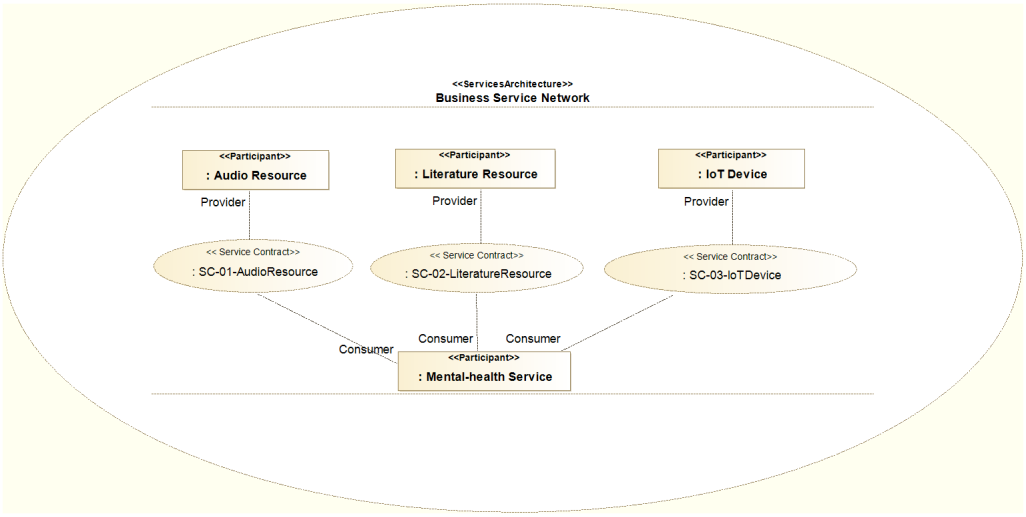
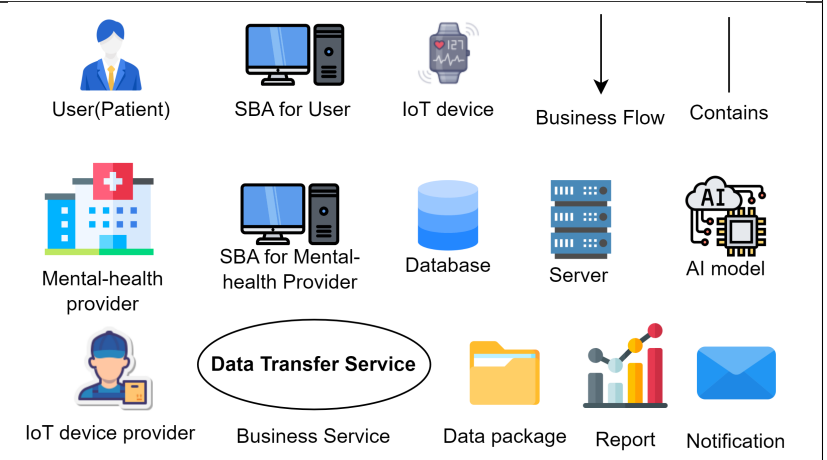
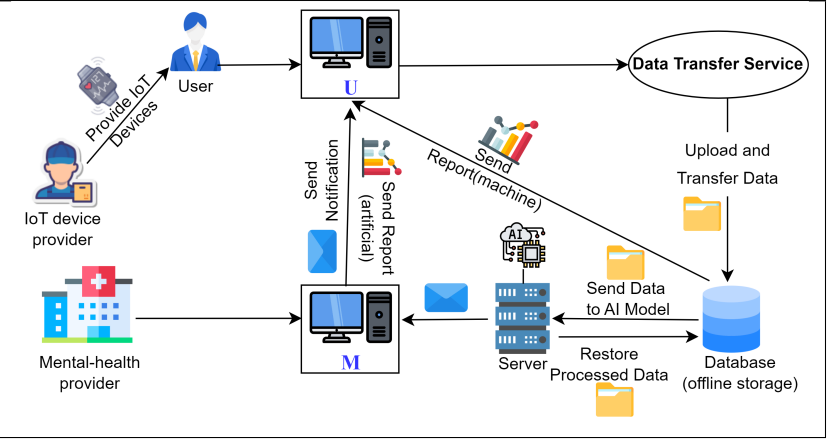


Figure 6: Business Service Network

11 Design View

In this section we describe a design view in detail illustrating the design solution of Opt#2:Offline Data Transfer mapped in our Con#1: "How to ensure the availability of user behavior tracking data and IoT monitoring device data?"

Field	Description
Viewpoint Name	VP01 - Offline Data Transfer
Viewpoint description	The goal of this viewpoint is to demonstrate how the data transfer service helps collect tremendous daily generated data by IoT devices, keeping the system efficient and reducing the latency of online merge and transfer when processing data in the background.
Design concern	Con#1: How to ensure the availability of user behavior tracking data and IoT monitoring device data?
Service Behavior	
Service Candidates Decomposition	

View description	There are three participants: User(Patient), IoT Device Provider, and the Mental-health Provider. Data Transfer service is the major related business service. The User and Mental-health provider interact with the services through two different SBAs. The IoT Device Provider provides IoT devices such as wearable heart rate and blood pressure monitoring watches to users, and each device generates a large amount of time-series data of affiliated health information which may significantly affect system efficiency. The data can be transferred and stored in the database offline and can be provided to the AI model in the server for calculation. Then the database can generate machine-generated reports and return them to the User, and the Mental-health Provider can also generate the periodic report and send notifications artificially to interact with the User's SBA. Therefore, the offline transfer makes the integrity of the user behavior tracking data and IoT monitoring device data and ensures the availability.

References

[1] Yeoh, Miranda. (2016). Effects of classical music and preferred music on mental health: an interview with Dr. Miranda Yeoh. Electronic Physician. 8. 10.19082/Music-Health.