Module Interface Specification for Software Engineering

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1 Revision History

Date	Version	Notes
Date January 17th	1.0	

2 Symbols, Abbreviations and Acronyms

See SRS Documentation at [https://github.com/OKKM-insights/OKKM.insights/tree/main/docs/SRS—SS]

Contents

3 Introduction

The following document details the Module Interface Specifications for OrbitWatch, a crowd-sourced datalabelling platform which aims to improve the process of extracting information from satelite images.

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found at https://github.com/OKKM-insights/OKKM.insights/

4 Notation

The structure of the MIS for modules comes from Hoffman and Strooper (1995), with the addition that template modules have been adapted from Ghezzi et al. (2003). The mathematical notation comes from Chapter 3 of Hoffman and Strooper (1995). For instance, the symbol := is used for a multiple assignment statement and conditional rules follow the form $(c_1 \Rightarrow r_1|c_2 \Rightarrow r_2|...|c_n \Rightarrow r_n)$.

The following table summarizes the primitive data types used by Software Engineering.

Data Type	Notation	Description
character	char	a single symbol or digit
integer	$\mathbb{Z}$	a number without a fractional component in (-∞, ∞)
natural number	$\mathbb{N}$	a number without a fractional component in [1, ∞)
real	$\mathbb{R}$	any number in (-∞, ∞)
date	Date	provides a specific date and time

The specification of Software Engineering uses some derived data types: sequences, strings, and tuples. Sequences are lists filled with elements of the same data type. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. In addition, Software Engineering uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

System Components

MLModel

Represents a machine learning model, identified by attributes such as:

- **model_name**

- **model_path**
- **model_type**
- Metadata about the model (e.g., training parameters, architecture)

ModelTrainingRun

Captures the details of a model's training process, including:

- **training_data_path**
- Evaluation metrics
- Parameters used during training

ModelEvaluationRun

Represents the evaluation process for a model, containing:

- **evaluation_data_path**
- Evaluation metrics (e.g., precision, recall)

ModelDeployment

Tracks the deployment details of a machine learning model, such as:

- **deployment_environment** (e.g., Production, Staging)
- **deployment_date**

Account

Describes user accounts in the system with attributes like:

- **username**
- **email**
- **account_type** (e.g., Client, Labeler, Admin)
- Security-related fields such as **password_hash** and **last_login**

AccountModification

Maintains a log of changes made to user accounts, tracking:

- **field_modified**
- **old_value**
- **new_value**

LoginAttempt

Records login attempts for security purposes, including:

- **username**
- **attempt_time**
- Whether the attempt was successful

Project

Defines a labeling or analysis project, identified by:

- **project_name**
- **description**
- Associated metadata

User

Represents individuals (e.g., labelers, managers) working within the system, including:

- **username**
- **role**

ProjectAssignment

Tracks which users are assigned to specific projects, identified by:

- **project_id**
- **user_id**

SatelliteImage

Represents images (e.g., satellite imagery) linked to specific projects, with attributes like:

- **image_path**
- **acquisition_date**

LabelingTask

Encapsulates a labeling activity, defined by:

- **status**
- **start_time**
- **end_time**
- The user assigned to the task

Report

Represents generated reports for projects, with fields like:

- **report_data**
- **generation_date**
- The user who generated the report

ServiceRequest

Tracks requests for services such as image acquisition or data processing, with attributes like:

- **request_type**
- **status**

Image

Represents standalone images within the system, identified by:

- **image_path**
- **upload_date**

Labeller

Represents individuals performing labeling tasks, identified by:

- **labeller_name**

Object

Represents specific objects detected in an image, with attributes like:

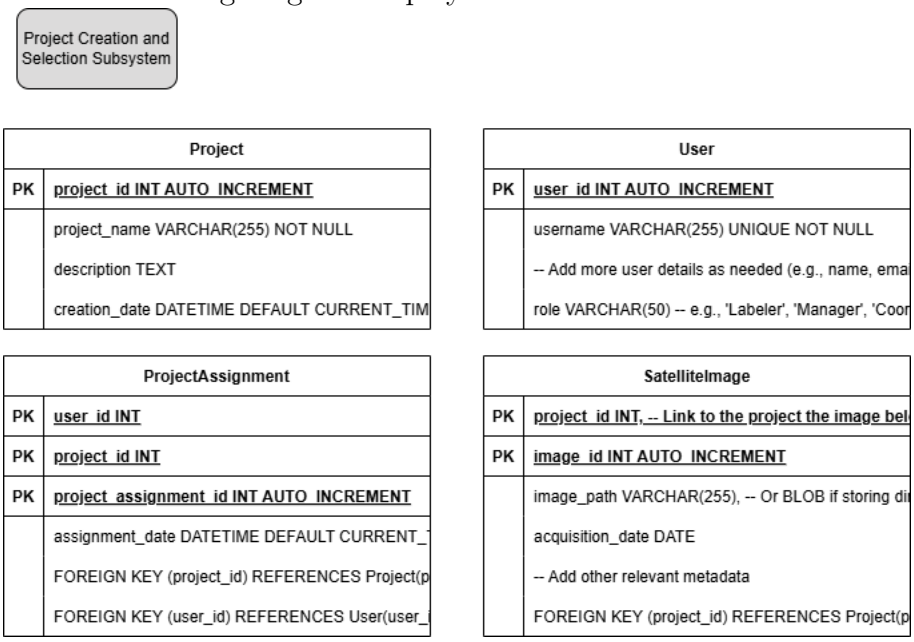
- **bounding_box_coordinates**
- **object_type**

Label

Represents annotations made by a labeller, linking to specific objects in an image and storing information like:

- **label_text**
- **timestamp**
- **labeller_id**

The following diagram display additional details on the relationship between datatypes



LabelingTask	
PK	image_id INT
PK	project_id INT
PK	labeling_task_id INT AUTO_INCREMENT
	assigned_to INT, -- User assigned to this task
	status VARCHAR(50) DEFAULT 'Pending', -- e.g., 'Pe
	start_time DATETIME
	end_time DATETIME
	FOREIGN KEY (project_id) REFERENCES Project(p
	FOREIGN KEY (image_id) REFERENCES SatelliteIn
	FOREIGN KEY (assigned_to) REFERENCES User(u

Report	
PK	project_id INT
PK	report_id INT AUTO_INCREMENT
	generated_by INT, -- User who generated the report
	generation_date DATETIME DEFAULT CURRENT_T
	report_data TEXT, -- Or a link to a file if large
	FOREIGN KEY (project_id) REFERENCES Project(p
	FOREIGN KEY (generated_by) REFERENCES User

ServiceRequest	
PK	project_id INT
PK	request_id INT AUTO_INCREMENT
	requested_by INT
	request_date DATETIME DEFAULT CURRENT_TIME
	request_type VARCHAR(255), -- e.g., 'Image Acquisit
	status VARCHAR(50) DEFAULT 'Pending'
	FOREIGN KEY (project_id) REFERENCES Project(p
	FOREIGN KEY (requested_by) REFERENCES User

Computer Vision Model Creation Subsystem

MLModel	
PK	model_id INT AUTO_INCREMENT
	model_name VARCHAR(255) NOT NULL
	model_path VARCHAR(255), -- Path to the model file
	model_type VARCHAR(255), -- e.g., 'Classification', '
	creation_date DATETIME DEFAULT CURRENT_TIM
	last_modified DATETIME
	description TEXT
	version VARCHAR(50), -- Versioning of the model
	metadata JSON -- Store model metadata like training

ModelTrainingRun	
PK	model_id INT
PK	training_run_id INT AUTO_INCREMENT
	start_time DATETIME
	end_time DATETIME
	training_data_path VARCHAR(255), -- Path to the tra
	evaluation_metrics JSON, -- Store evaluation metrics
	training_parameters JSON, -- Store training paramete
	FOREIGN KEY (model_id) REFERENCES MLModel

ModelEvaluationRun	
PK	model_id INT
PK	evaluation_run_id INT AUTO_INCREMENT
	start_time DATETIME
	end_time DATETIME
	evaluation_data_path VARCHAR(255), -- Path to the
	evaluation_metrics JSON, -- Store evaluation metrics
	FOREIGN KEY (model_id) REFERENCES MLModel

ModelDeployment	
PK	model_id INT
PK	deployment_id INT AUTO_INCREMENT
	deployment_date DATETIME DEFAULT CURRENT_
	deployment_environment VARCHAR(255), -- e.g., 'Pr
	deployed_by INT, -- User who deployed the model
	FOREIGN KEY (model_id) REFERENCES MLModel
	-- Add foreign key reference to user table if needed

Client/ Labeller Management Susbsystem

Account	
PK	account_id INT AUTO_INCREMENT
	username VARCHAR(255) UNIQUE NOT NULL
	password_hash VARCHAR(255) NOT NULL, -- Store
	email VARCHAR(255) UNIQUE
	full_name VARCHAR(255)
	account_type VARCHAR(50) CHECK (account_type
	creation_date DATETIME DEFAULT CURRENT_TIM
	last_login DATETIME
	-- Add other account-related fields as needed (e.g., a

AccountModification	
PK	account_id INT
PK	modification_id INT AUTO_INCREMENT
	modified_by INT, -- User who made the modification (
	modification_date DATETIME DEFAULT CURRENT_
	field_modified VARCHAR(255), -- e.g., 'email', 'full_na
	old_value TEXT
	new_value TEXT
	FOREIGN KEY (account_id) REFERENCES Account
	FOREIGN KEY (modified_by) REFERENCES Accou

LoginAttempt	
PK	attempt_id INT AUTO_INCREMENT
	username VARCHAR(255)
	attempt_time DATETIME DEFAULT CURRENT_TIME
	successful BOOLEAN
	ip_address VARCHAR(45) -- For tracking location of

Label Collection and Aggregation Subsystem

Image	
PK	image_id INT AUTO_INCREMENT
	image_data BLOB, -- Or VARCHAR for file paths if st
	image_path VARCHAR(255)
	upload_date DATETIME

Labeller	
PK	labeller_id INT AUTO_INCREMENT
	labeller_name VARCHAR(255)

Object	
PK	image_id INT
PK	object_id INT AUTO_INCREMENT
	bounding_box_coordinates VARCHAR(255), -- Store
	object_type VARCHAR(255)
	FOREIGN KEY (image_id) REFERENCES Image(ima

Label	
PK	labeller_id INT
PK	object_id INT
PK	image_id INT
PK	label_id INT AUTO_INCREMENT
	label_text VARCHAR(255)
	timestamp DATETIME
	FOREIGN KEY (image_id) REFERENCES Image(image_id)
	FOREIGN KEY (object_id) REFERENCES Object(object_id)
	FOREIGN KEY (labeller_id) REFERENCES Labeller(labeller_id)

5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.

Level 1	Level 2
Hardware-Hiding Module	

Table 1: Module Hierarchy

Level 1	Level 2
	Account Creation Interface
	Account Database
	Account Update Interface
	Login Interface
Behaviour-Hiding	Access Token
Module	Labeler
	Client
	User
	Satellite Image Request Interface
	Satellite Image Request
	Project Creation Interface
	Project
	Service Request Failure Interface
	Image Upload Interface
	Report Interface
	Report
	Project Selection Interface
	Labeling Interface
	Image
	Label Server
	Label Database Connector
	Label Database
	ImageObject Database Connector
	ImageObject Database
	Labeller Database Connector
	Labeller Database
	Object Extraction Manager
	Image Service Manager
	ModelCreation (Abstract Class)
	CNNModelCreation
	OtherModelCreation
	ModelManager
	MLModelDatabase

Table 2: Module Hierarchy

Level 1	Level 2
	Account Creation Controller
	Account Database Connector
	Account Update Controller
	Authentication Controller
Software Decision Module	Satellite Image Request Controller
	Project Creation Controller
	Report Controller
	Project Selection Controller
	Labeling Controller
	Label Confidence Service
	Object Extraction Service
	Image Prior Analyzer
	Labeller Expertise Calculator
	Image Mask Service
	Image Selection Service
	ModelComparision Evaluation
	CrossValidation Evaluation
	ModelTrainingService
	ModelEvaluationService

Table 3: Module Hierarchy

6 MIS of Account Creation Interface

6.1 Module

Account Creation Interface

6.2 Uses

Account Creation Controller 20

6.3 Syntax

6.3.1 Exported Constants

None

6.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	Enum[labeler, client]	-	-
submitForm	list[(string, string)]	-	-

6.4 Semantics

6.4.1 State Variables

None

6.4.2 Environment Variables

win: 2D sequence of coloured pixels

6.4.3 Assumptions

None

6.4.4 Access Routine Semantics

renderPage(userType):

- transition: win := Modify window so that it shows a registration form that asks for the necessary information depending on if the user is a labeler or client.

submitForm(formData):

- transition: Passes the submitted form data to the Account Creation Controller for validation and processing.

6.4.5 Local Functions

None

7 MIS of Account Database Connector

7.1 Module

Account Database Connector

7.2 Uses

Account Database 13

7.3 Syntax

7.3.1 Exported Constants

None

7.3.2 Exported Access Programs

Name	In	Out	Exceptions
insertUser	User	-	-
retrieveUser	string	User	-
updateUser	User	-	-
userExists	string	boolean	-
makeDBConnection	credentials		-

7.4 Semantics

7.4.1 State Variables

None

7.4.2 Environment Variables

databaseConnection: connection to relational database

7.4.3 Assumptions

None

7.4.4 Access Routine Semantics

insertUser(user):

- transition: Request to insert user into database through databaseConection.

retrieveUser(email):

- output:

$$\begin{cases} \text{User where User.email} == \text{email}, & \text{if userExists(email)} \\ \text{null}, & \text{otherwise} \end{cases}$$

updateUser(user):

- transition:

$$\begin{cases} \text{Request to update user in database}, & \text{if userExists(user.email)} \\ \text{Do nothing} & \text{otherwise} \end{cases}$$

userExists(email):

- output: out :=

$$\exists\, \text{User} \in \text{Database}\, \text{s.t.}\, \text{User.email} == \text{email}$$

makeDBConnection(credentials):

- transition: databaseConnection := connection is established with database if credentials are correct

7.4.5 Local Functions

None

8 MIS of Account Database

8.1 Module

Account Database

8.2 Uses

None

8.3 Syntax

8.3.1 Exported Constants

None

8.3.2 Exported Access Programs

Name	In	Out	Exceptions
insertUser	User	-	-
retrieveUser	string	User	-
updateUser	User	-	-
userExists	string	boolean	-

8.4 Semantics

8.4.1 State Variables

None

8.4.2 Environment Variables

databaseConnection: connection to Application

8.4.3 Assumptions

None

8.4.4 Access Routine Semantics

insertUser(user):

- transition: Insert user into database.

retrieveUser(email):

- output:
$$\begin{cases} \text{User where User.email} == \text{email}, & \text{if userExists(email)} \\ \text{null}, & \text{otherwise} \end{cases}$$

updateUser(user):

- transition:
$$\begin{cases} \text{Update user in database}, & \text{if userExists(user.email)} \\ \text{Do nothing} & \text{otherwise} \end{cases}$$

userExists(email):

- output: out :=
$$\exists\, \text{User} \in \text{Database}\, \text{s.t.}\, \text{User.email} == \text{email}$$

8.4.5 Local Functions

None

9 MIS of Account Update Interface

9.1 Module

Account Update Interface

9.2 Uses

Account Update Controller 21

9.3 Syntax

9.3.1 Exported Constants

None

9.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	User	-	-
submitForm	list[(string, string)]	-	-

9.4 Semantics

9.4.1 State Variables

None

9.4.2 Environment Variables

win: 2D sequence of coloured pixels

9.4.3 Assumptions

None

9.4.4 Access Routine Semantics

renderPage(userInfo):

- transition: win := Modify window so that it shows a form with the current user's information. This information can be changed by the user.

submitForm(formData):

- transition: Passes the submitted changes to the Account Update Controller for validation and processing.

9.4.5 Local Functions

None

10 MIS of Login Interface

10.1 Module

Login Interface

10.2 Uses

Authentication Controller 22

10.3 Syntax

10.3.1 Exported Constants

None

10.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
submitForm	list[(string, string)]	-	-

10.4 Semantics

10.4.1 State Variables

None

10.4.2 Environment Variables

win: 2D sequence of coloured pixels

10.4.3 Assumptions

None

10.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows a login form.

submitForm(formData):

- transition: Passes the submitted credentials to the Authentication Controller for validation.

10.4.5 Local Functions

None

11 MIS of Access Token

11.1 Module

Access Token

11.2 Uses

None

11.3 Syntax

11.3.1 Exported Constants

None

11.3.2 Exported Access Programs

Name	In	Out	Exceptions
isExpired	-	boolean	-
renew	-	-	-

11.4 Semantics

11.4.1 State Variables

- tokenValue: string
- expirationTime: Date
- userID: string

11.4.2 Environment Variables

None

11.4.3 Assumptions

None

11.4.4 Access Routine Semantics

isExpired():

- output: out := currentTime > expirationTime

renew():

- transition: expirationTime := expirationTime + 5 hours

11.4.5 Local Functions

None

12 MIS of Account Creation Interface

12.1 Module

Account Creation Interface

12.2 Uses

Account Creation Controller 20

12.3 Syntax

12.3.1 Exported Constants

None

12.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	Enum[labeler, client]	-	-
submitForm	list[(string, string)]	-	-

12.4 Semantics

12.4.1 State Variables

None

12.4.2 Environment Variables

win: 2D sequence of coloured pixels

12.4.3 Assumptions

None

12.4.4 Access Routine Semantics

renderPage(userType):

- transition: win := Modify window so that it shows a registration form that asks for the necessary information depending on if the user is a labeler or client.

submitForm(formData):

- transition: Passes the submitted form data to the Account Creation Controller for validation and processing.

12.4.5 Local Functions

None

13 MIS of Account Database

13.1 Module

Account Database

13.2 Uses

Relational Database

13.3 Syntax

13.3.1 Exported Constants

None

13.3.2 Exported Access Programs

Name	In	Out	Exceptions
insertUser	User	-	-
retrieveUser	string	User	-
updateUser	User	-	-
userExists	string	boolean	-

13.4 Semantics

13.4.1 State Variables

None

13.4.2 Environment Variables

databaseConnection: connection to relational database

13.4.3 Assumptions

None

13.4.4 Access Routine Semantics

insertUser(user):

- transition: Insert user into database through databaseConection.

retrieveUser(email):

- output:
$$\begin{cases} \text{User where User.email} == \text{email}, & \text{if userExists(email)} \\ \text{null}, & \text{otherwise} \end{cases}$$

updateUser(user):

- transition:
$$\begin{cases} \text{Update user in database through databaseConection}, & \text{if userExists(user.email)} \\ \text{Do nothing} & \text{otherwise} \end{cases}$$

userExists(email):

- output: out :=
$$\exists\, \text{User} \in \text{Database}\, \text{s.t.}\, \text{User.email} = \text{email}$$

13.4.5 Local Functions

None

14 MIS of Account Update Interface

14.1 Module

Account Update Interface

14.2 Uses

Account Update Controller 21

14.3 Syntax

14.3.1 Exported Constants

None

14.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	User	-	-
submitForm	list[(string, string)]	-	-

14.4 Semantics

14.4.1 State Variables

None

14.4.2 Environment Variables

win: 2D sequence of coloured pixels

14.4.3 Assumptions

None

14.4.4 Access Routine Semantics

renderPage(userInfo):

- transition: win := Modify window so that it shows a form with the current user's information. This information can be changed by the user.

submitForm(formData):

- transition: Passes the submitted changes to the Account Update Controller for validation and processing.

14.4.5 Local Functions

None

15 MIS of Login Interface

15.1 Module

Login Interface

15.2 Uses

Authentication Controller 22

15.3 Syntax

15.3.1 Exported Constants

None

15.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
submitForm	list[(string, string)]	-	-

15.4 Semantics

15.4.1 State Variables

None

15.4.2 Environment Variables

win: 2D sequence of coloured pixels

15.4.3 Assumptions

None

15.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows a login form.

submitForm(formData):

- transition: Passes the submitted credentials to the Authentication Controller for validation.

15.4.5 Local Functions

None

16 MIS of Access Token

16.1 Module

Access Token

16.2 Uses

None

16.3 Syntax

16.3.1 Exported Constants

None

16.3.2 Exported Access Programs

Name	In	Out	Exceptions
isExpired	-	boolean	-
renew	-	-	-

16.4 Semantics

16.4.1 State Variables

- tokenValue: string
- expirationTime: Date
- userID: string

16.4.2 Environment Variables

None

16.4.3 Assumptions

None

16.4.4 Access Routine Semantics

isExpired():

- output: out := currentTime > expirationTime

renew():

- transition: expirationTime := expirationTime + 5 hours

16.4.5 Local Functions

None

17 MIS of Labeler

17.1 Module

Labeler

17.2 Uses

Extends User 19

17.3 Syntax

17.3.1 Exported Constants

None

17.3.2 Exported Access Programs

Name	In	Out	Exceptions
getFirstName	-	string	-
getLastName	-	string	-
getSkills	-	list[string]	-
getAvailability	-	int	-
setFirstName	string	-	-
setLastName	string	-	-
setSkills	list[string]	-	-
setAvailability	int	-	-

17.4 Semantics

17.4.1 State Variables

- firstName: string
- lastName: string
- skills: list[string]
- availability: int

17.4.2 Environment Variables

None

17.4.3 Assumptions

None

17.4.4 Access Routine Semantics

getFirstName():

- output: out := firstName

getLastName():

- output: out := lastName

getSkills():

- output: out := skills

getAvailability():

- output: out := availability

setFirstName(newfn):

- transition: firstName := newfn

setLastName(newln):

- transition: lastName := newln

setSkills(newSkills):

- transition: skills := newSkills

setAvailability(newAvail):

- transition: availability := newAvail

17.4.5 Local Functions

None

18 MIS of Client

18.1 Module

Client

18.2 Uses

Extends User 19

18.3 Syntax

18.3.1 Exported Constants

None

18.3.2 Exported Access Programs

Name	In	Out	Exceptions
getCompanyName	-	string	-
getIndustry	-	string	-
getTypicalProject	-	Image	-
setCompanyName	string	-	-
setIndustry	string	-	-
setTypicalProject	string	-	-

18.4 Semantics

18.4.1 State Variables

- companyName: string
- industry: string
- typicalProject: string

18.4.2 Environment Variables

None

18.4.3 Assumptions

None

18.4.4 Access Routine Semantics

getCompanyName():

- output: out := companyName

getIndustry():

- output: out := industry

getTypicalProject():

- output: out := typicalProject

setCompanyName(newcn):

- transition: companyName := newcn

setIndustry(newIndustry):

- transition: industry := newIndustry

setTypicalProject(newtp):

- transition: typicalProject := newtp

18.4.5 Local Functions

None

19 MIS of User

19.1 Module

User

19.2 Uses

None

19.3 Syntax

19.3.1 Exported Constants

None

19.3.2 Exported Access Programs

Name	In	Out	Exceptions
getEmail	-	string	-
getPassword	-	string	-
getProfilePic	-	Image	-
setEmail	string	-	-
setPassword	string	-	-
setProfilePic	string	-	-

19.4 Semantics

19.4.1 State Variables

- email: string

- password: string
- profilePic: image

19.4.2 Environment Variables

None

19.4.3 Assumptions

None

19.4.4 Access Routine Semantics

getEmail():

- output: out := email

getPassword():

- output: out := password

getProfilePic():

- output: out := profilePic

setEmail(newEmail):

- transition: email := newEmail

setPassword(newPassword):

- transition: password := newPassword

setProfilePic(newProfliePic):

- transition: profilePic := newProfilePic

19.4.5 Local Functions

None

20 MIS of Account Creation Controller

20.1 Module

Account Creation Controller

20.2 Uses

Account Creation Interface 12
Account Database 13
User 19
Labeler 17
Client 18

20.3 Syntax

20.3.1 Exported Constants

None

20.3.2 Exported Access Programs

Name	In	Out	Exceptions
validateForm	list[(string, string)], Enum[labeler, client]	boolean	-
createUser	list[(string, string)], Enum[labeler, client]	User	-
uploadUser	User	-	DatabaseException

20.4 Semantics

20.4.1 State Variables

None

20.4.2 Environment Variables

None

20.4.3 Assumptions

Assumes AccountDatabase is operational when calling uploadUser.

20.4.4 Access Routine Semantics

validateForm(formData, userType):

- output: out := hasRequiredFields(formData, userFields)∧isValidEmail(formData.email)∧

isValidPassword(formData.password)∧

$$\begin{cases} \text{hasRequiredFields}(\text{formData}, \text{labelerFields}), & \text{if userType} = \text{"labeler"} \\ \text{hasRequiredFields}(\text{formData}, \text{clientFields}), & \text{if userType} = \text{"client"} \\ \text{true}, & \text{otherwise} \end{cases}$$

Where:

$$\begin{aligned} \text{userFields} &= \{\text{email, password}\} \\ \text{labelerFields} &= \{\text{firstName, lastName, skills, availability}\} \\ \text{clientFields} &= \{\text{companyName, industry, typicalProject}\} \end{aligned}$$

createUser(formData, userType):

- output: out :=

$$\begin{cases} \text{Labeler}(\text{formData.email}, \text{formData.password}, \text{formData.firstName}, & \\ \text{formData.lastName}, \text{formData.skills}, \text{int}(\text{formData.availability})), & \text{if userType} = \text{"labeler"} \\ \text{Client}(\text{formData.email}, \text{formData.password}, \text{formData.companyName}, & \\ \text{formData.industry}, \text{formData.typicalProject}) & \text{if userType} = \text{"client"} \end{cases}$$

uploadUser(newUser):

- transition: Passes the User object to the AccountDatabase for storage.
- exception: Throws DatabaseException if storage fails.

20.4.5 Local Functions

- hasRequiredFields(data, fields) = $\forall$field $\in$ fields, (data[field] $\neq$ "")
- isValidEmail(email) = email $\in V \wedge$ email$\neg \in$ Registered Emails

  Let E represent the set of all email addresses, and let V represent the set of all valid email addresses. A valid email address conforms to the general pattern:

  V = ($\forall$ *email* $\in E$ | *email matches the pattern* [a-zA-Z0-9+_.-]+@[a-zA-Z0-9.-]+[a-zA-Z])

- isValidPassword(password) = (*password matches the pattern* (?=.*[a-z])(?=.*[A-Z])(?=.*[0-9])(?=.*[#$%&])[a-zA-Z0-9#$%&]{8,})

21 MIS of Account Update Controller

21.1 Module

Account Update Controller

21.2 Uses

Account Update Interface 14
Account Database 13
User 19

21.3 Syntax

21.3.1 Exported Constants

None

21.3.2 Exported Access Programs

Name	In	Out	Exceptions
validateForm	list[(string, string)]	boolean	-
getUser	string	-	-
requestUpdate	User	-	DatabaseException

21.4 Semantics

21.4.1 State Variables

- user: User

21.4.2 Environment Variables

None

21.4.3 Assumptions

Assumes AccountDatabase is operational when calling requestUpdate.

21.4.4 Access Routine Semantics

validateForm(formData):

- output: out := $\forall$data $\in$ formData, (data[1] $\neq$ "")

getUser(email):

- transition: user := AccountDatabase.retreiveUser(email)

requestUpdate(updatedUser):

- transition: Passes the updated User object to the AccountDatabase for modifications.
- exception: Throws DatabaseException if storage fails.

21.4.5 Local Functions

None

22 MIS of Authentication Controller

22.1 Module

Authentication Controller

22.2 Uses

Login Interface 36
Account Database 13
Access Token 16

22.3 Syntax

22.3.1 Exported Constants

None

22.3.2 Exported Access Programs

Name	In	Out	Exceptions
validCredentials	(string, string)	boolean	-
generateAccessToken	string	-	-

22.4 Semantics

22.4.1 State Variables

- token: AccessToken

22.4.2 Environment Variables

None

22.4.3 Assumptions

Assumes AccountDatabase is operational when calling validCredentials.

22.4.4 Access Routine Semantics

validCredentials(email, password):

- output: out := AccountDatabase.retreiveUser(email) $\neq$ null $\wedge$ AccountDatabase.retreiveUser(email).getPassword() == password

generateAccessToken(email):

- transition: token := AccessToken(email)

22.4.5 Local Functions

None

23 MIS of Satellite Image Request Interface

23.1 Module

Satellite Image Request Interface

23.2 Uses

Satellite Image Request Controller 24

23.3 Syntax

23.3.1 Exported Constants

None

23.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
submitForm	list[(string, string)]	-	-

23.4 Semantics

23.4.1 State Variables

None

23.4.2 Environment Variables

win: 2D sequence of coloured pixels

23.4.3 Assumptions

None

23.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows a form requesting information regarding an image request.

submitForm(formData):

- transition: Passes the submitted changes to the Satellite Image Request Controller for validation and processing.

23.4.5 Local Functions

None

24 MIS of Satellite Image Request Controller

24.1 Module

Satellite Image Request Controller

24.2 Uses

Satellite Image Request Interface 23
Satellite Image Request 25

24.3 Syntax

24.3.1 Exported Constants

None

24.3.2 Exported Access Programs

Name	In	Out	Exceptions
validateForm	list[(string, string)]	boolean	-
requestImages	SatelliteImageRequest	-	-

24.4 Semantics

24.4.1 State Variables

None

24.4.2 Environment Variables

None

24.4.3 Assumptions

None

24.4.4 Access Routine Semantics

validateForm(formData):

- output: out := $\forall$data $\in$ formData, (data[1] $\neq$ "")

requestImages(imgRequest):

- transition: Passes imgRequest to third party image provider to be processed.

24.4.5 Local Functions

- calculateCost(imgRequest): out := Use information given to calculate the cost of a request using third party rates

25 MIS of Satellite Image Request

25.1 Module

Satellite Image Request

25.2 Uses

None

25.3 Syntax

25.3.1 Exported Constants

None

25.3.2 Exported Access Programs

Name	In	Out	Exceptions
getLocation	-	(float, float)	-
getRadius	-	float	-
getDate	-	Date	-
setLocation	(float, float)	-	-
setRadius	float	-	-
setDate	Date	-	-

25.4 Semantics

25.4.1 State Variables

- locationX: float
- locationY: float
- radius: float
- date: Date

25.4.2 Environment Variables

None

25.4.3 Assumptions

None

25.4.4 Access Routine Semantics

getLocation():

- output: out := (locationX, locationY)

getRadius():

- output: out := radius

getDate():

- output: out := date

setLocation(x, y):

- transition: locationX, locationY := x, y

setRadius(newRadius):

- transition: radius := newRadius

setDate(newDate):

- transition: date := newDate

25.4.5 Local Functions

None

26 MIS of Project Creation Interface

26.1 Module

Project Creation Interface

26.2 Uses

Project Creation Controller 27

26.3 Syntax

26.3.1 Exported Constants

None

26.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
submitForm	list[(string, string)]	-	-

26.4 Semantics

26.4.1 State Variables

None

26.4.2 Environment Variables

win: 2D sequence of coloured pixels

26.4.3 Assumptions

None

26.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows a form requesting information regarding creating a new project.

submitForm(formData):

- transition: Passes the submitted changes to the Project Creation Controller for validation and processing.

26.4.5 Local Functions

None

27 MIS of Project Creation Controller

27.1 Module

Project Creation Controller

27.2 Uses

Project Creation Interface 26
Project 28

27.3 Syntax

27.3.1 Exported Constants

None

27.3.2 Exported Access Programs

Name	In	Out	Exceptions
validateForm	list[(string, string)]	boolean	-
createNewProject	list[(string, string)]	Project	-

27.4 Semantics

27.4.1 State Variables

None

27.4.2 Environment Variables

None

27.4.3 Assumptions

None

27.4.4 Access Routine Semantics

validateForm(formData):

- output: out := $\forall$data $\in$ formData, (data[1] $\neq$ "")

createNewProject(formData):

- output: out := Project(formData.name, formData.description, formData.labelClasses.split(), Date(formData.startDate), Date(formData.endDate))

27.4.5 Local Functions

- calculateEstimatedCost(project): out := Use information given to calculate the estimated cost of a project.

28 MIS of Project

28.1 Module

Project

28.2 Uses

None

28.3 Syntax

28.3.1 Exported Constants

None

28.3.2 Exported Access Programs

Name	In	Out	Exceptions
getProjectID	-	int	-
getName	-	string	-
getDescription	-	string	-
getLabelClasses	-	list[Enum[string]]	-
getTimePeriod	-	(Date, Date)	-
setName	string	-	-
setDescription	string	-	-
setLabelClasses	list[Enum[string]]	-	-
setTimePeriod	(Date, Date)	-	-

28.4 Semantics

28.4.1 State Variables

- projectID: int
- name: string
- description: string
- labelClasses: list[Enum[String]]
- startDate: Date
- endDate: Date

28.4.2 Environment Variables

None

28.4.3 Assumptions

None

28.4.4 Access Routine Semantics

getProjectID():

- output: out := projectID

getName():

- output: out := name

getDescription():

- output: out := description

getLabelClasses():

- output: out := labelClasses

getTimePeriod():

- output: out := (startDate, endDate)

setName(newName):

- transition: name := newName

setDescription(newDesc):

- transition: description := newDesc

setLabelClasses(newlc):

- transition: labelClasses := newlc

setTimePeriod(start, end):

- transition: startDate, endDate := start, end

28.4.5 Local Functions

None

29 MIS of Service Request Failure Interface

29.1 Module

Service Request Failure Interface

29.2 Uses

29.3 Syntax

29.3.1 Exported Constants

None

29.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayErrorInfo	-	-	-

29.4 Semantics

29.4.1 State Variables

None

29.4.2 Environment Variables

win: 2D sequence of coloured pixels

29.4.3 Assumptions

None

29.4.4 Access Routine Semantics

displayErrorInfo():

- transition: win := Modify window so that it shows a warning to the user that their request has failed.

29.4.5 Local Functions

None

30 MIS of Image Upload Interface

30.1 Module

Image Upload Interface

30.2 Uses

30.3 Syntax

30.3.1 Exported Constants

None

30.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayUploadImages		-	-

30.4 Semantics

30.4.1 State Variables

None

30.4.2 Environment Variables

win: 2D sequence of coloured pixels

30.4.3 Assumptions

None

30.4.4 Access Routine Semantics

displayUploadImages():

- transition: win := Modify window so that it allows users to upload images.

30.4.5 Local Functions

- validateImage(image): out :=

$$\text{image.extension} \in \{\text{svg}, \text{jpeg}, \text{png}\}$$

31 MIS of Report Interface

31.1 Module

Report Interface

31.2 Uses

Report Controller 32

31.3 Syntax

31.3.1 Exported Constants

None

31.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayStats	-	-	-

31.4 Semantics

31.4.1 State Variables

None

31.4.2 Environment Variables

win: 2D sequence of coloured pixels

31.4.3 Assumptions

None

31.4.4 Access Routine Semantics

displayStats():

- transition: win := Modify window so that it shows project specific statistics.

31.4.5 Local Functions

None

32 MIS of Report Controller

32.1 Module

Report Controller

32.2 Uses

Report Interface 31
Report 33

32.3 Syntax

32.3.1 Exported Constants

None

32.3.2 Exported Access Programs

Name	In	Out	Exceptions
getProjectStats	string	-	-
exportLabeledImages	-	-	-

32.4 Semantics

32.4.1 State Variables

- report: Report

32.4.2 Environment Variables

fm: External systems file manager

32.4.3 Assumptions

None

32.4.4 Access Routine Semantics

getProjectStats(projectID):

- transition: report := Report of statistics for project with projectID

exportLabeledImages():

- transition: fm := given labeled images to download to device.

32.4.5 Local Functions

None

33 MIS of Report

33.1 Module

Report

33.2 Uses

None

33.3 Syntax

33.3.1 Exported Constants

None

33.3.2 Exported Access Programs

Name	In	Out	Exceptions
getLabeledImages	-	list[Image]	-
getReviewedImages	-	list[Image]	-
getEndDate	-	Date	-
getTotalLabelers	-	int	-
getAccuracy	-	int	-
getClassCount	-	list[(string, int)]	-

33.4 Semantics

33.4.1 State Variables

- labeledImages: list[Image]
- reviewedImages: list[Image]
- endDate: Date
- totalLabelers: int
- accuracyOfLabelers: int
- classCount: list[(string, int)]

33.4.2 Environment Variables

None

33.4.3 Assumptions

None

33.4.4 Access Routine Semantics

getLabeledImages():

- output: out := labeledImages

getReviewedImages():

- output: out := reviewedImages

getEndDate():

- output: out := endDate

getTotalLabelers():

- output: out := totalLabelers

getAccuracyOfLabelers():

- output: out := accuracyOfLabelers

getClassCount():

- output: out := classCount

33.4.5 Local Functions

None

34 MIS of Project Selection Interface

34.1 Module

Project Selection Interface

34.2 Uses

Project Selection Controller 35

34.3 Syntax

34.3.1 Exported Constants

None

34.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayActiveProjects	-	-	-

34.4 Semantics

34.4.1 State Variables

None

34.4.2 Environment Variables

win: 2D sequence of coloured pixels

34.4.3 Assumptions

None

34.4.4 Access Routine Semantics

displayActiveProjects():

- transition: win := Modify window so that it shows all active projects and a small description of each.

34.4.5 Local Functions

None

35 MIS of Project Selection Controller

35.1 Module

Project Selection Controller

35.2 Uses

Project Selection Interface 34
Project 28

35.3 Syntax

35.3.1 Exported Constants

None

35.3.2 Exported Access Programs

Name	In	Out	Exceptions
getActiveProjects	-	-	-
selectProject	Project	-	-

35.4 Semantics

35.4.1 State Variables

- activeProjects: list[Project]

35.4.2 Environment Variables

win: 2D sequence of coloured pixels

35.4.3 Assumptions

None

35.4.4 Access Routine Semantics

getActiveProjects():

- transition: activeProjects := All projects marked as active in the project database

selectProject(project):

- transition: win := redirects users to labeling interface of that project

35.4.5 Local Functions

None

36 MIS of Labeling Interface

36.1 Module

Labeling Interface

36.2 Uses

Labeling Controller 37
Image 38

36.3 Syntax

36.3.1 Exported Constants

None

36.3.2 Exported Access Programs

Name	In	Out	Exceptions
renderPage	-	-	-
displayImage	Image	-	-
skipImage	-	-	-
selectLabelClass	-	-	-

36.4 Semantics

36.4.1 State Variables

- projectImages: list[Image]
- currImage: int
- currLabelClass: Enum[string]

36.4.2 Environment Variables

win: 2D sequence of coloured pixels

36.4.3 Assumptions

None

36.4.4 Access Routine Semantics

renderPage():

- transition: win := Modify window so that it shows labeling tools along with a picture to label.

displayImage(img):

- transition: win := Modify window so that the picture it is showing is img.

skipImage():

- transition: currentImage := (currentImage + 1) % projectImages.length
  win := Modify window so that the picture it is showing is projectImages[currentImage].

selectLabelClass():

- transition: currLabelClass := the label class the user has selected on win.

36.4.5 Local Functions

None

37 MIS of Labeling Controller

37.1 Module

Labeling Controller

37.2 Uses

Labeling Interface 36
Label **??**

37.3 Syntax

37.3.1 Exported Constants

None

37.3.2 Exported Access Programs

Name	In	Out	Exceptions
getProjectImages	string	-	-
addLabel	Label	-	-
removeLabel	string	-	-
submitLabels	list[Label]	-	-

37.4 Semantics

37.4.1 State Variables

- labels: list[Label]

37.4.2 Environment Variables

None

37.4.3 Assumptions

None

37.4.4 Access Routine Semantics

getProjectImages(projectID):

- output: out := All images from project with projectID

addLabel(lbl):

- transition: labels := labels $\cup$ {lbl}

removeLabel(lblID):

- transition: labels := $\{\ell \in \text{labels} \mid \ell.\text{id} \neq \text{lblID}\}$

submitLabels(lbls):

- transition: labels are sent to be added to the Label Database

37.4.5 Local Functions

None

38 MIS of Image

38.1 Module

Image

38.2 Uses

None

38.3 Syntax

38.3.1 Exported Constants

None

38.3.2 Exported Access Programs

Name	In	Out	Exceptions
getProjectID	-	int	-
getImageID	-	int	-
getDimensions	-	(float, float)	-
getImageData	-	binary	-

38.4 Semantics

38.4.1 State Variables

- projectID: int
- imageID: int
- width: float
- height: float
- imageData: binary

38.4.2 Environment Variables

None

38.4.3 Assumptions

None

38.4.4 Access Routine Semantics

getProjectID():

- output: out := projectID

getImageID():

- output: out := imageID

getDimensions():

- output: out := (width, height)

getImageData():

- output: out := imageData

38.4.5 Local Functions

None

39 MIS of Label Server

39.1 Module

Label Server

39.2 Uses

Labeling Controller 37
Label **??**
Label Database Connector 40

39.3 Syntax

39.3.1 Exported Constants

None

39.3.2 Exported Access Programs

Name	In	Out	Exceptions
acceptLabel	Label	-	ValueError, ConnectionError

39.4 Semantics

39.4.1 State Variables

None

39.4.2 Environment Variables

LabelDatabaseConnector

39.4.3 Assumptions

Label Objects are given to the label server in JSON format. Exceptions will be thrown based on failure to match this standard.

39.4.4 Access Routine Semantics

acceptLabel(object o):

- transition: Transition occurs in LabelDatabaseConnector

- output: Standard HTTP response codes
- exception: Let L be the set of valid Labels. Throw ValueError if $\neg(o \in \mathrm{L})$
  Throw ConnectionError if ConnectionError is raised by LabelDatabaseConnector

39.4.5 Local Functions

JSONLabeltoLabel: converts a JSON object into a Label object.

40 MIS of Label Database Connector

40.1 Module

Label Database Connector

40.2 Uses

Label Database 41
Label **??**

40.3 Syntax

40.3.1 Exported Constants

None

40.3.2 Exported Access Programs

Name	In	Out	Exceptions
pushLabel	Label	-	ValueError, ConnectionError
makeDB Connection	Label	-	ConnectionError
getLabels	String	list[Label]	ValueError, ConnectionError

40.4 Semantics

40.4.1 State Variables

None

40.4.2 Environment Variables

None

40.4.3 Assumptions

40.4.4 Access Routine Semantics

pushLabel(Label l):

- transition: Transition occurs in LabelDatabase
- exception: Let L be the set of valid Labels. Throw ValueError if $\neg(l \in \mathrm{L})$
  Throw ConnectionError if ConnectionError is raised by makeDBConnection

makeDBConnection():

- transition: If sucessful, connection occurs
- exception: Throw ConnectionError if connection is not accepted by LabelDatabase

getLabels(String q):

- output: list of labels satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw ValueError if $\neg(q \in \mathrm{Q})$
  Throw ConnectionError if ConnectionError is raised by makeDBConnection

40.4.5 Local Functions

None

41 MIS of Label Database

41.1 Module

Label Database

41.2 Uses

None

41.3 Syntax

41.3.1 Exported Constants

None

41.3.2 Exported Access Programs

Name	In	Out	Exceptions
pushLabel	Label	-	ValueError
makeDB Connection	Label	-	ConnectionError
getLabels	String	list[Label]	ValueError

41.4 Semantics

41.4.1 State Variables

labels: labels stored in the database users: list of authenticated users

41.4.2 Environment Variables

None

41.4.3 Assumptions

41.4.4 Access Routine Semantics

pushLabel(Label l):

- transition: labels := labels $\cup\, l$
- exception: Let L be the set of valid Labels. Throw ValueError if $\neg(l \in \text{L})$ Throw ConnectionError if $\neg$(requestor $\in$ users)

makeDBConnection(credentials):

- transition: if credentials are valid, users := users $\cup$ *credentials.user*
- exception: Throw ConnectionError if credentials are not valid

getLabels(String q):

- output: list of labels satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw ValueError if $\neg(q \in \text{Q})$ Throw ConnectionError if $\neg$(requestor $\in$ users)

41.4.5 Local Functions

None

42 MIS of ImageObject Database Connector

42.1 Module

ImageObject Database Connector

42.2 Uses

ImageObject Database 43
ImageObject **??**

42.3 Syntax

42.3.1 Exported Constants

None

42.3.2 Exported Access Programs

Name	In	Out	Exceptions
push Image Object	ImageObject	-	ValueError, ConnectionError
makeDB Connection	ImageObject	-	ConnectionError
get Image Objects	String	list[ImageObject]	ValueError, ConnectionError

42.4 Semantics

42.4.1 State Variables

None

42.4.2 Environment Variables

None

42.4.3 Assumptions

42.4.4 Access Routine Semantics

pushLabel(ImageObject l):

- transition: Transition occurs in ImageObjectDatabase
- exception: Let L be the set of valid ImageObjects. Throw ValueError if $\neg(l \in \mathrm{L})$ Throw ConnectionError if ConnectionError is raised by makeDBConnection

makeDBConnection():

- transition: If sucessful, connection occurs
- exception: Throw ConnectionError if connection is not accepted by ImageObject-Database

getLabels(String q):

- transition:
- output: list of ImageObjects satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw ValueError if $\neg(q \in \mathrm{Q})$ Throw ConnectionError if ConnectionError is raised by makeDBConnection

42.4.5 Local Functions

None

43 MIS of ImageObject Database

43.1 Module

ImageObject Database

43.2 Uses

None

43.3 Syntax

43.3.1 Exported Constants

None

43.3.2 Exported Access Programs

Name	In	Out	Exceptions
push Image Object	ImageObject	-	ValueError
makeDB Connection	ImageObject	-	ConnectionError
get Image Objects	String	list[ImageObject]	ValueError

43.4 Semantics

43.4.1 State Variables

ImageObjects: ImageObjects stored in the database users: list of authenticated users

43.4.2 Environment Variables

None

43.4.3 Assumptions

43.4.4 Access Routine Semantics

pushLabel(ImageObject l):

- transition: ImageObjects := ImageObjects $\cup\, l$
- exception: Let L be the set of valid ImageObjects. Throw ValueError if $\neg(l \in \text{L})$ Throw ConnectionError if $\neg$(requestor $\in$ users)

makeDBConnection(credentials):

- transition: if credentials are valid, users := users $\cup$ $credentials.user$
- exception: Throw ConnectionError if credentials are not valid

getLabels(String q):

- output: list of ImageObjects satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw ValueError if $\neg(q \in \text{Q})$ Throw ConnectionError if $\neg$(requestor $\in$ users)

43.4.5 Local Functions

None

=======

44 MIS of Labeller Database Connector

44.1 Module

Labeller Database Connector

44.2 Uses

Labeller Database **??**
ImageObject **??**

44.3 Syntax

44.3.1 Exported Constants

None

44.3.2 Exported Access Programs

Name	In	Out	Exceptions
push labeller	labeller	-	ValueError, ConnectionError
makeDB Connection	credentials	-	ConnectionError
get labeller	String	list[labeller]	ValueError, ConnectionError

44.4 Semantics

44.4.1 State Variables

None

44.4.2 Environment Variables

None

44.4.3 Assumptions

44.4.4 Access Routine Semantics

pushLabeller(Labeller o):

- transition: Transition occurs in LabellerDatabase
- exception: Let O be the set of valid Labellers. Throw ValueError if $\neg(o \in \mathrm{O})$
  Throw ConnectionError if ConnectionError is raised by makeDBConnection

makeDBConnection():

- transition: If sucessful, connection occurs
- exception: Throw ConnectionError if connection is not accepted by LabellerDatabase

getLabeller(String q):

- output: list of Labellers satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw ValueError if $\neg(q \in \mathrm{Q})$
  Throw ConnectionError if ConnectionError is raised by makeDBConnection

44.4.5 Local Functions

None

45 MIS of Labeller Database

45.1 Module

Labeller Database

45.2 Uses

None

45.3 Syntax

45.3.1 Exported Constants

None

45.3.2 Exported Access Programs

Name	In	Out	Exceptions
push Labeller	Labeller	-	ValueError
makeDB Connection	Credentials	-	ConnectionError
get Labeller	String	list[Labeller]	ValueError

45.4 Semantics

45.4.1 State Variables

Labellers: Labellers stored in the database users: list of authenticated users

45.4.2 Environment Variables

None

45.4.3 Assumptions

45.4.4 Access Routine Semantics

pushLabeller(Labeller o):

- transition: Labellers := Labellers $\cup$ o
- exception: Let O be the set of valid Labellers. Throw ValueError if $\neg(o \in \text{O})$ Throw ConnectionError if $\neg$(requestor $\in$ users)

makeDBConnection(credentials):

- transition: if credentials are valid, users := users $\cup$ $credentials.user$
- exception: Throw ConnectionError if credentials are not valid

getLabeller(String q):

- output: list of Labeller satisfying the provided query
- exception: Let Q be the set of valid Queries. Throw ValueError if $\neg(q \in \text{Q})$ Throw ConnectionError if $\neg$(requestor $\in$ users)

45.4.5 Local Functions

None

46 MIS of Object Extraction Manager

46.1 Module

Object Extraction Manager

46.2 Uses

ImageObject Database Connector 42
Label Database Connector 40
Labeller Database Connector 44
Image Prior Analyzer 49
Label Confidence Service 47
Object Extraction Service 48
Labeller Expertise Calculator 50

46.3 Syntax

46.3.1 Exported Constants

None

46.3.2 Exported Access Programs

Name	In	Out	Exceptions
getObjects	projectID	-	ValueError

46.4 Semantics

46.4.1 State Variables

None

46.4.2 Environment Variables

None

46.4.3 Assumptions

46.4.4 Access Routine Semantics

getObjects(ProjectID p):

- transition: Updates ImageObject database with identified objects & confidence and updates labeller expertise rating in labeller database

- exception: Let P be the set of assigned ProjectIDs. Throw ValueError if $\neg(p \in \mathrm{P})$

46.4.5 Local Functions

generate query:

47 MIS of Label Confidence Service

47.1 Module

Label Confidence Service

47.2 Uses

None

47.3 Syntax

47.3.1 Exported Constants

None

47.3.2 Exported Access Programs

Name	In	Out	Exceptions
getConfidence	list[label], list[labeller], list[ImageObject]	list[list[float]]	ValueError

47.4 Semantics

47.4.1 State Variables

None

47.4.2 Environment Variables

None

47.4.3 Assumptions

47.4.4 Access Routine Semantics

getConfidence(list[label] labels , list[labeller] labellers, list[ImageObject] imageobjects):

- output: return the confidence label of each extracted object
- exception: Let L be the set of valid Labels. Throw ValueError if ($\exists$label $\in$ labels| : $\neg$(label $\in$ L))
  Let X be the set of valid Labellers. Throw ValueError if ($\exists$labeller $\in$ labellers| : $\neg$(labeller $\in$ X))
  Let I be the set of valid ImageObjects. Throw ValueError if ($\exists$imageobject $\in$ imageobjects| :

$\neg$(imageobject $\in$ I))

47.4.5 Local Functions

48 MIS of Object Extraction Service

48.1 Module

Object Extraction Service

48.2 Uses

None

48.3 Syntax

48.3.1 Exported Constants

None

48.3.2 Exported Access Programs

Name	In	Out	Exceptions
getObjects	list[label], list[labeller], list[ImageObject], list[list[float]]	list[ImageObject]	ValueError

48.4 Semantics

48.4.1 State Variables

None

48.4.2 Environment Variables

None

48.4.3 Assumptions

48.4.4 Access Routine Semantics

getConfidence(list[label] labels, list[labeller] labellers, list[ImageObject] imageobjects, list[list[float]] confidence):

- output: returns a list of extracted image objects
- exception: Let L be the set of valid Labels. Throw ValueError if ($\exists$label $\in$ labels| : $\neg$(label $\in$ L))
  Let X be the set of valid Labellers. Throw ValueError if ($\exists$labeller $\in$ labellers| :

$\neg$(labeller $\in$ X))
Let I be the set of valid ImageObjects. Throw ValueError if ($\exists$imageobject $\in$ imageobjects| : $\neg$(imageobject $\in$ I))
Throw ValueError if ($\exists i, j | x =$ confidence[i][j] : $\neg(x \in \mathbb{R})$)

48.4.5 Local Functions

49 MIS of Image Prior Analyzer

49.1 Module

Image Prior Analyzer

49.2 Uses

None

49.3 Syntax

49.3.1 Exported Constants

None

49.3.2 Exported Access Programs

Name	In	Out	Exceptions
getPriors	list[image]	list[list[float]]	ValueError

49.4 Semantics

49.4.1 State Variables

None

49.4.2 Environment Variables

None

49.4.3 Assumptions

49.4.4 Access Routine Semantics

getPriors(list[image] Images):

- output: returns a list of priors for each pixel in the given images
- exception: Let I be the set of valid Images. Throw ValueError if ($\exists$image $\in$ images| : $\neg$(image $\in$ I))

49.4.5 Local Functions

50 MIS of Labeller Expertise Calculator

50.1 Module

Labeller Expertise Calculator

50.2 Uses

None

50.3 Syntax

50.3.1 Exported Constants

None

50.3.2 Exported Access Programs

Name	In	Out	Exceptions
getExpertise	list[label], list[labeller], list[ImageObject], list[list[float]]	list[dict[string, tuple[float, float]]]	ValueError

50.4 Semantics

50.4.1 State Variables

None

50.4.2 Environment Variables

None

50.4.3 Assumptions

50.4.4 Access Routine Semantics

getObjects(list[label] labels, list[labeller] labellers, list[ImageObject] imageobjects):

- output: return the weighed success rate for each class a labeler has contributed to
- exception: Let L be the set of valid Labels. Throw ValueError if ($\exists$label $\in$ labels| : $\neg$(label $\in$ L))
  Let X be the set of valid Labellers. Throw ValueError if ($\exists$labeller $\in$ labellers| : $\neg$(labeller $\in$ X))

Let I be the set of valid ImageObjects. Throw ValueError if ($\exists$imageobject $\in$ imageobjects$|$: $\neg$(imageobject $\in$ I))
Throw ValueError if ($\exists i, j | x =$ confidence[i][j] : $\neg(x \in \mathbb{R})$)

50.4.5 Local Functions

51 MIS of Image Service Manager

51.1 Module

Image Service Manager

51.2 Uses

ImageObject Database Connector 42
Labeller Database Connector 44
Image Mask Service52
Image Selection Engine **??**

51.3 Syntax

51.3.1 Exported Constants

None

51.3.2 Exported Access Programs

Name	In	Out	Exceptions
getNextImages	labellerID, projectID, int	List[Image]	ValueError

51.4 Semantics

51.4.1 State Variables

None

51.4.2 Environment Variables

None

51.4.3 Assumptions

51.4.4 Access Routine Semantics

getNextImages(LabellerID l, ProjectID p, int n):

- output: return the next n images based on which are mose relevant
- exception: Let P be the set of assigned ProjectIDs. Throw ValueError if $\neg(p \in \mathrm{P})$
  Let L be the set of assigned LabellerIDs. Throw ValueError if $\neg(l \in \mathrm{L})$
  Throw ValueError if $\neg(n \in \mathbb{N})$

51.4.5 Local Functions

52 MIS of Image Mask Service

52.1 Module

Image Mask Service

52.2 Uses

None

52.3 Syntax

52.3.1 Exported Constants

None

52.3.2 Exported Access Programs

Name	In	Out	Exceptions
getImageMask	Image	Image	ValueError

52.4 Semantics

52.4.1 State Variables

None

52.4.2 Environment Variables

None

52.4.3 Assumptions

52.4.4 Access Routine Semantics

getImageMask(Image i):

- output: returns a modified image to improve the labeller's efficiency or accuracy
- exception: Let I be the set of valid Images. Throw ValueError if $\neg(i \in \mathrm{I})$

52.4.5 Local Functions

53 MIS of Image Selection Service

53.1 Module

Image Selection Service

53.2 Uses

53.3 Syntax

53.3.1 Exported Constants

None

53.3.2 Exported Access Programs

Name	In	Out	Exceptions
getNextImages	List[Image], List[ImageObjects], Labeller	List[Image]	ValueError

53.4 Semantics

53.4.1 State Variables

None

53.4.2 Environment Variables

None

53.4.3 Assumptions

53.4.4 Access Routine Semantics

getNextImages(List[Image] Images, List[ImageObjects] ImageObjects, Labeller labeller):

- output: return the next n images based on which are mose relevant
- exception: Let L be the set of valid Labellers. Throw ValueError if ($\neg$(labeller $\in$ L))
  Let X be the set of valid Images. Throw ValueError if ($\exists$Image $\in$ Images$|$: $\neg$(Image $\in$ X))
  Let I be the set of valid ImageObjects. Throw ValueError if ($\exists$imageobject $\in$ imageobjects$|$: $\neg$(imageobject $\in$ I))

53.4.5 Local Functions

None

54 MIS of ModelComparisonEvaluation

54.1 6.1 Module

Name: ModelComparisonEvaluation

54.2 6.2 Uses

- `TestDataset` (Holds test samples and true labels)
- `EvaluationResult` (Stores metrics from an evaluation)

54.3 6.3 Syntax

54.3.1 6.3.1 Exported Constants

None

54.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`evaluateModel`	`String modelId, TestDataset testData`	`EvaluationResult`	ModelNotFoundError, ValueError

54.4 6.4 Semantics

54.4.1 6.4.1 State Variables

- `comparisonMetrics`: Map<String, Float> (Stores metric-name to numeric value)
- `benchmarkModelId`: String (ID of the benchmark model)

54.4.2 6.4.2 Environment Variables

None

54.4.3 6.4.3 Assumptions

- The `modelId` provided must exist in the system.
- `testData` must be valid and non-empty.

54.4.4 6.4.4 Access Routine Semantics

`evaluateModel(modelId, testData)`:

- **transition**: Updates `comparisonMetrics` by comparing the given model with the benchmark.
- **output**: Returns an `EvaluationResult` with metrics (e.g., accuracy, precision).
- **exception**:
  - `ModelNotFoundError` if `modelId` does not exist.
  - `ValueError` if `testData` is invalid.

54.4.5 6.4.5 Local Functions

None

55 MIS of CrossValidationEvaluation

55.1 6.1 Module

Name: CrossValidationEvaluation

55.2 6.2 Uses

- `TestDataset`
- `EvaluationResult`

55.3 6.3 Syntax

55.3.1 6.3.1 Exported Constants

None

55.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`evaluateModel`	`String modelId`, `TestDataset testData`	`EvaluationResult`	ModelNotFoundError, ValueError

55.4 6.4 Semantics

55.4.1 6.4.1 State Variables

- `kFolds`: Integer
- `ValidationMetrics`: Map<String, Float> (Aggregated cross-validation metrics)

55.4.2 6.4.2 Environment Variables

None

55.4.3 6.4.3 Assumptions

- `kFolds` ≥ 2.
- `testData` is large enough for multiple folds.

55.4.4 6.4.4 Access Routine Semantics

`evaluateModel(modelId, testData)`:

- **transition**: Runs cross-validation and updates `ValidationMetrics`.
- **output**: An `EvaluationResult` (e.g., average accuracy).
- **exception**:
  - `ModelNotFoundError` if the model does not exist.
  - `ValueError` if `testData` is invalid or too small.

55.4.5 6.4.5 Local Functions

None

56 MIS of ModelTrainingService

56.1 6.1 Module

Name: ModelTrainingService

56.2 6.2 Uses

- `TrainingParams`
- `TrainingData`
- `ModelConfig`
- `TrainingResult`

56.3 6.3 Syntax

56.3.1 6.3.1 Exported Constants

None

56.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`trainModel`	`TrainingData data, ModelConfig modelConfig`	`TrainingResult`	ValueError, ResourceUnavailableError
`stopTraining`	`String modelId`	`void`	ModelNotFoundError

56.4 6.4 Semantics

56.4.1 6.4.1 State Variables

- `trainingParameters`: TrainingParams
- `trainingStatus`: String ("Not Started", "In Progress", "Completed", etc.)

56.4.2 6.4.2 Environment Variables

None

56.4.3 6.4.3 Assumptions

- System has enough resources (GPU, memory) to train the model.

56.4.4 6.4.4 Access Routine Semantics

`trainModel(data, modelConfig)`:

- **transition**: Sets `trainingStatus` to "In Progress" and, upon completion, "Completed".
- **output**: Returns a `TrainingResult` with metrics (loss, accuracy, etc.).
- **exception**:
  - `ValueError` if data or modelConfig is invalid.
  - `ResourceUnavailableError` if required resources are not available.

`stopTraining(modelId)`:

- **transition**: If the model is training, changes status to "Stopped" or "Cancelled".
- **exception**:
  - `ModelNotFoundError` if the model does not exist or is not training.

56.4.5 6.4.5 Local Functions

None

57 MIS of ModelEvaluationService

57.1 6.1 Module

Name: ModelEvaluationService

57.2 6.2 Uses

- `TestDataset`
- `EvaluationResult`

57.3 6.3 Syntax

57.3.1 6.3.1 Exported Constants

None

57.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`evaluateModel`	`String modelId, TestDataset testData`	`EvaluationResult`	ModelNotFoundError, ValueError
`fetchEvaluationMetrics`	`String modelId`	`Map<String,Float>`	ModelNotFoundError

57.4 6.4 Semantics

57.4.1 6.4.1 State Variables

- `evaluationMetrics`: Map<String, Float>
- `valuationStatus`: String (“Pending”, “In Progress”, “Completed”)

57.4.2 6.4.2 Environment Variables

None

57.4.3 6.4.3 Assumptions

- The `modelId` references a trained model.

57.4.4 6.4.4 Access Routine Semantics

`evaluateModel(modelId, testData):`

- **transition**: Sets `valuationStatus` to "In Progress" and updates `evaluationMetrics`.
- **output**: An `EvaluationResult` (accuracy, loss, etc.).
- **exception**:
  - `ModelNotFoundError` if modelId is invalid.
  - `ValueError` if testData is invalid or empty.

`fetchEvaluationMetrics(modelId):`

- **output**: Returns the `evaluationMetrics` for the model.
- **exception**:
  - `ModelNotFoundError` if the modelId does not exist or no metrics are found.

57.4.5 6.4.5 Local Functions

None

58 MIS of ModelManager

58.1 6.1 Module

Name: ModelManager

58.2 6.2 Uses

- `ModelParameters`
- `MLModel`

58.3 6.3 Syntax

58.3.1 6.3.1 Exported Constants

None

58.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`createModel`	`ModelParameters params`	`void`	ValueError
`updateModelStatus`	`String modelId, String status`	`void`	ModelNotFoundError
`fetchModel`	`String modelId`	`MLModel`	ModelNotFoundError
`deleteModel`	`String modelId`	`void`	ModelNotFoundError

58.4 6.4 Semantics

58.4.1 6.4.1 State Variables

- `modelID`: String
- `status`: String ("Training", "Evaluating", "Completed", etc.)
- `createdAt`: Date
- `updatedAt`: Date

58.4.2 6.4.2 Environment Variables

None

58.4.3 6.4.3 Assumptions

- A unique `modelID` is generated upon creation.

58.4.4 6.4.4 Access Routine Semantics

`createModel(params):`

- **transition**: Instantiates a new `MLModel`, sets `modelID`, `createdAt`, `updatedAt`, `status` = "Created".
- **exception**:
  - `ValueError` if `params` are invalid.

`updateModelStatus(modelId, status):`

- **transition**: Updates `status` and `updatedAt` of the specified model.
- **exception**:
  - `ModelNotFoundError` if the modelId does not exist.

`fetchModel(modelId):`

- **output**: Returns the `MLModel` object.
- **exception**:
  - `ModelNotFoundError` if no model with modelId exists.

`deleteModel(modelId):`

- **transition**: Removes the model from storage.
- **exception**:
  - `ModelNotFoundError` if modelId is invalid.

58.4.5 6.4.5 Local Functions

None

59 MIS of ModelCreation (Abstract)

59.1 6.1 Module

Name: ModelCreation (Abstract Base Class)

59.2 6.2 Uses

- `ModelParameters`
- `MLModel`

59.3 6.3 Syntax

59.3.1 6.3.1 Exported Constants

None

59.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`createModel`	-	`MLModel`	NotImplementedError

59.4 6.4 Semantics

59.4.1 6.4.1 State Variables

- `modelType`: String
- `creationParams`: ModelParameters

59.4.2 6.4.2 Environment Variables

None

59.4.3 6.4.3 Assumptions

- Concrete subclasses must override the `createModel` method.

59.4.4 6.4.4 Access Routine Semantics

`createModel()`:

- **output**: A fully instantiated `MLModel`.
- **exception**:
  - `NotImplementedError` if called from the abstract class.

59.4.5 6.4.5 Local Functions

None

60 MIS of MLModelDatabase

60.1 6.1 Module

Name: MLModelDatabase

60.2 6.2 Uses

- `MLModel`

60.3 6.3 Syntax

60.3.1 6.3.1 Exported Constants

None

60.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`saveModel`	`MLModel model`	`void`	DatabaseError
`fetchModel`	`String modelId`	`MLModel`	ModelNotFoundError, DatabaseError
`deleteModel`	`String modelId`	`void`	ModelNotFoundError, DatabaseError
`updateModel`	`String modelId, Map<String, Any> updates`	`void`	ModelNotFoundError, DatabaseError

60.4 6.4 Semantics

60.4.1 6.4.1 State Variables

- `dbConnection`: Connection (Active DB connection)

60.4.2 6.4.2 Environment Variables

- External database system (accessed via `dbConnection`)

60.4.3 6.4.3 Assumptions

- `dbConnection` is valid and open.

60.4.4 6.4.4 Access Routine Semantics

`saveModel(model):`

- **transition**: Inserts or updates the model in the database.
- **exception**:
  - `DatabaseError` if insertion fails.

`fetchModel(modelId):`

- **output**: Returns the `MLModel` from the database.
- **exception**:
  - `ModelNotFoundError` if the modelId is not found.
  - `DatabaseError` if a DB error occurs.

`deleteModel(modelId):`

- **transition**: Removes the model record.
- **exception**:
  - `ModelNotFoundError` if modelId is not found.
  - `DatabaseError` on DB error.

`updateModel(modelId, updates):`

- **transition**: Updates the specified fields of the model in the database.
- **exception**:
  - `ModelNotFoundError` if modelId is not found.
  - `DatabaseError` if the update operation fails.

60.4.5 6.4.5 Local Functions

None

61 MIS of OtherModelCreation

61.1 6.1 Module

Name: OtherModelCreation

61.2 6.2 Uses

- `MLModel`
- `ModelCreation` (abstract base class)

61.3 6.3 Syntax

61.3.1 6.3.1 Exported Constants

None

61.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`createModel`	-	`MLModel`	ValueError

61.4 6.4 Semantics

61.4.1 6.4.1 State Variables

- `modelType`: String (e.g., "Decision Tree", "SVM")
- `hyperparameters`: Map<String, Any>

61.4.2 6.4.2 Environment Variables

None

61.4.3 6.4.3 Assumptions

- `hyperparameters` are valid for `modelType`.

61.4.4 6.4.4 Access Routine Semantics

`createModel()`:

- **output**: Returns an instantiated `MLModel` of `modelType`.
- **exception**:
  - `ValueError` if the `modelType`/`hyperparameters` combination is invalid.

61.4.5 6.4.5 Local Functions

None

62 MIS of CNNModelCreation

62.1 6.1 Module

Name: CNNModelCreation

62.2 6.2 Uses

- `ModelCreation` (abstract)
- `MLModel`

62.3 6.3 Syntax

62.3.1 6.3.1 Exported Constants

None

62.3.2 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
`createModel`	-	`MLModel`	ValueError

62.4 6.4 Semantics

62.4.1 6.4.1 State Variables

- `layers`: List<LayerConfig> (Defines structure of each CNN layer)
- `activatedFunctions`: List<String> (Activation functions for each layer)

62.4.2 6.4.2 Environment Variables

None

62.4.3 6.4.3 Assumptions

- The `layers` and `activatedFunctions` lists are valid and aligned.

62.4.4 6.4.4 Access Routine Semantics

`createModel()`:

- **output**: Instantiates a CNN `MLModel` with specified layers and activation functions.
- **exception**:
  - `ValueError` if `layers` or `activatedFunctions` are invalid or mismatched.

62.4.5 6.4.5 Local Functions

None

References

Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. *Fundamentals of Software Engineering*. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2003.

Daniel M. Hoffman and Paul A. Strooper. *Software Design, Automated Testing, and Maintenance: A Practical Approach*. International Thomson Computer Press, New York, NY, USA, 1995. URL http://citeseer.ist.psu.edu/428727.html.

63 Appendix

[Extra information if required —SS]

Appendix — Reflection

[Not required for CAS 741 projects —SS]

The information in this section will be used to evaluate the team members on the graduate attribute of Problem Analysis and Design.

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable? Everyone did a great job contributing their ideas and expertise to design each part of our application. We decided to use diagrams to express our designs before jumping into the documentation. This worked really well as it allowed everyone to have a better understanding of how our system would interact. When we had to specify our modules, a lot of the hard work was already complete due to have the diagrams.

2. What pain points did you experience during this deliverable, and how did you resolve them? A major pain point we faced was that a team member could no longer meet in person due to extraneous circumstances. This hindered our ability to effectively communicate as a team due to factors like time difference. To solve this, we rescheduled our meetings to a reasonable time for all members, and moved all meetings and communications online for the time being.

3. Which of your design decisions stemmed from speaking to your client(s) or a proxy (e.g. your peers, stakeholders, potential users)? For those that were not, why, and where did they come from? From talking to our supervisor, we determined that we would need our system to be able to pre-process images in an effective way so we took that into considering when designing the project creation subsystem. Also, our decision to have modules do standardized formatting stemmed from our usage of 3rd-party applications such as our image distributor. Due to the possibility of change, we knew that formatting outside information to a way our application could process it would be the best way to go about it. In general, for our other decisions we used the software principles we have learned through out our education including modularity, seperation of concern, and architecture that supports scalability.

4. While creating the design doc, what parts of your other documents (e.g. requirements, hazard analysis, etc), it any, needed to be changed, and why? When creating this design

document, we realized some functionality we want is not really specified much in the srs. For example, we have very little regarding the ai model part of our application. We also realized some of the requirements that we will not be able to focus on, such as the financial aspect of the app. We now must consider how to document what we need to in the srs, and possibly modify our vnv plan.

5. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO_ProbSolutions) One major focus would be to add in the financial capabilities like accepting payments for projects and distributing funds to users. Another thing would be to expand the platform to accept lots of different types of media, such as videos, instead of just images.

6. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select the documented design? We considered an approach where we would store all data as files on a server somewhere, however we decided that using a database would better fit our project due to the relation between the data and the usefulness of SQL statements. The downside of this approach is it requires more time to set up, but we believe the payoff is worth it. We also considered having one large system rather than many sub-systems. This would elimate alot of the communication and data transfer overhead. However, we believe that with this sub-system design, we have the ability to have or remove parts of the system much more easily. If we dont have time to get to a sub-system, our application can still function. (LO_Explores)