

Module Interface Specification for Software Engineering

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1 Revision History

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2 Symbols, Abbreviations and Acronyms

See SRS Documentation at [\[give url —SS\]](#)

[\[Also add any additional symbols, abbreviations or acronyms —SS\]](#)

Contents

1	Revision History	i
2	Symbols, Abbreviations and Acronyms	ii
3	Introduction	1
4	Notation	1
5	Module Decomposition	1
6	MIS of the User data module	3
6.1	Module	3
6.2	Uses	3
6.3	Syntax	3
6.3.1	Exported Constants	3
6.3.2	Exported Access Programs	3
6.4	Semantics	3
6.4.1	State Variables	3
6.4.2	Environment Variables	3
6.4.3	Assumptions	4
6.4.4	Access Routine Semantics	4
6.4.5	Local Functions	6
7	MIS of Info Profile data module	6
7.1	Module	6
7.2	Uses	6
7.3	Syntax	6
7.3.1	Exported Constants	6
7.3.2	Exported Access Programs	6
7.4	Semantics	7
7.4.1	State Variables	7
7.4.2	Environment Variables	7
7.4.3	Assumptions	7
7.4.4	Access Routine Semantics	7
7.4.5	Local Functions	8
8	MIS of Trial data module	9
8.1	Module	9
8.2	Uses	9
8.3	Syntax	9
8.3.1	Exported Constants	9
8.3.2	Exported Access Programs	9

8.4	Semantics	9
8.4.1	State Variables	9
8.4.2	Environment Variables	9
8.4.3	Assumptions	9
8.4.4	Access Routine Semantics	9
8.4.5	Local Functions	10
9	MIS of the Fetch Trials Modules	11
9.1	Module	11
9.2	Uses	11
9.3	Syntax	11
9.3.1	Exported Constants	11
9.3.2	Exported Access Programs	11
9.4	Semantics	11
9.4.1	State Variables	11
9.4.2	Environment Variables	11
9.4.3	Assumptions	11
9.4.4	Access Routine Semantics	12
9.4.5	Local Functions	12
10	MIS of the Trial Filtering Module	12
10.1	Module	12
10.2	Uses	12
10.3	Syntax	12
10.3.1	Exported Constants	12
10.3.2	Exported Access Programs	13
10.4	Semantics	13
10.4.1	State Variables	13
10.4.2	Environment Variables	13
10.4.3	Assumptions	13
10.4.4	Access Routine Semantics	13
10.4.5	Local Functions	14
11	MIS of the Registration Module	15
11.1	Module	15
11.2	Uses	15
11.3	Syntax	15
11.3.1	Exported Constants	15
11.3.2	Exported Access Programs	15
11.4	Semantics	15
11.4.1	State Variables	15
11.4.2	Environment Variables	15
11.4.3	Assumptions	15

11.4.4	Access Routine Semantics	15
11.4.5	Local Functions	16
12	MIS of the Login Module	16
12.1	Module	16
12.2	Uses	16
12.3	Syntax	16
12.3.1	Exported Constants	16
12.3.2	Exported Access Programs	16
12.4	Semantics	16
12.4.1	State Variables	16
12.4.2	Environment Variables	16
12.4.3	Assumptions	16
12.4.4	Access Routine Semantics	16
12.4.5	Local Functions	17
13	MIS of the Email Template Module	17
13.1	Module	17
13.2	Uses	17
13.3	Syntax	17
13.3.1	Exported Constants	17
13.3.2	Exported Access Programs	17
13.4	Semantics	17
13.4.1	State Variables	17
13.4.2	Environment Variables	17
13.4.3	Assumptions	17
13.4.4	Access Routine Semantics	17
13.4.5	Local Functions	18
14	MIS of the Email Notification Module	18
14.1	Module	18
14.2	Uses	18
14.3	Syntax	18
14.3.1	Exported Constants	18
14.3.2	Exported Access Programs	18
14.4	Semantics	18
14.4.1	State Variables	18
14.4.2	Environment Variables	18
14.4.3	Assumptions	18
14.4.4	Access Routine Semantics	18
14.4.5	Local Functions	19

15 MIS of Patient Data Collection Form Module	19
15.1 Module	19
15.2 Uses	19
15.3 Syntax	20
15.3.1 Exported Constants	20
15.3.2 Exported Access Programs	20
15.4 Semantics	20
15.4.1 State Variables	20
15.4.2 Environment Variables	20
15.4.3 Assumptions	20
15.4.4 Access Routine Semantics	20
15.4.5 Local Functions	21
16 MIS of User Login Form Module	21
16.1 Module	21
16.2 Uses	21
16.3 Syntax	21
16.3.1 Exported Constants	21
16.3.2 Exported Access Programs	21
16.4 Semantics	21
16.4.1 State Variables	21
16.4.2 Environment Variables	21
16.4.3 Assumptions	22
16.4.4 Access Routine Semantics	22
16.4.5 Local Functions	22
17 MIS of User Profile Settings Module	22
17.1 Module	22
17.2 Uses	22
17.3 Syntax	22
17.3.1 Exported Constants	22
17.3.2 Exported Access Programs	22
17.4 Semantics	23
17.4.1 State Variables	23
17.4.2 Environment Variables	23
17.4.3 Assumptions	23
17.4.4 Access Routine Semantics	23
17.4.5 Local Functions	23
18 MIS of Trial Display Module	25
18.1 Module	25
18.2 Uses	26
18.3 Syntax	26

18.3.1	Exported Constants	26
18.3.2	Exported Access Programs	26
18.4	Semantics	26
18.4.1	State Variables	26
18.4.2	Environment Variables	26
18.4.3	Assumptions	26
18.4.4	Access Routine Semantics	26
18.4.5	Local Functions	27
19	Appendix	29

3 Introduction

The following document details the Module Interface Specifications for REACH, a web application used to improve patients' access to clinical trials and practitioners' access to potential participants. More specifically, it will provide the list of modules that have been decomposed from the Module Guide, each with their interface specification, detailing important characteristics such as the module's methods and state variables.

Complementary documents, such as the System Requirement Specifications and Module Guide can be found at <https://github.com/davimang/REACH>.

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 $(c_1 \Rightarrow r_1 | c_2 \Rightarrow r_2 | \dots | c_n \Rightarrow r_n)$.

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 $(-\infty, \infty)$
natural number	\mathbb{N}	a number without a fractional component in $[1, \infty)$
real	\mathbb{R}	any number in $(-\infty, \infty)$

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.

5 Module Decomposition

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

Level 1	Level 2
Hardware-Hiding	
Behaviour-Hiding	Input Parameters Output Format Output Verification Temperature ODEs Energy Equations Control Module Specification Parameters Module
Software Decision	Sequence Data Structure ODE Solver Plotting

Table 1: Module Hierarchy

6 MIS of the User data module

6.1 Module

User

6.2 Uses

PatientInfo, Trial

6.3 Syntax

6.3.1 Exported Constants

None

6.3.2 Exported Access Programs

Name	In	Out	Exceptions
getName	-	seq of char	-
setName	seq of char	-	EmptyName
getEmail	-	seq of char	-
setEmail	seq of char	-	InvalidEmail
getInfoProfiles	-	list of InfoProfile	-
getInfoProfile	integer	InfoProfile	InvalidInfoProfileId
addInfoProfile	InfoProfile	-	-
removeInfoProfile	integer	-	-
addTrial	Trial	-	-
removeTrial	integer	-	-
getTrials	-	list of Trial	-
getTrial	integer	Trial	InvalidTrialId

6.4 Semantics

6.4.1 State Variables

name: seq of char

email: seq of char

infoProfiles: list of PatientInfo

trials: list of Trial

6.4.2 Environment Variables

None

6.4.3 Assumptions

- Each InfoProfile has a unique id.
- Each Trial has a unique id.

6.4.4 Access Routine Semantics

getName():

- transition: N/A
- output: $\text{out} := \text{self.name}$
- exception: N/A

setName(newName: seq of char):

- transition: $\text{self.name} := \text{newName}$
- output: N/A
- exception: $\text{exc} := \text{length}(\text{newName}) == 0 \Rightarrow \text{EmptyName}$

getEmail():

- transition: N/A
- output: $\text{out} := \text{self.email}$
- exception: N/A

setEmail(newEmail: seq of char):

- transition: $\text{self.email} := \text{newEmail}$
- output: N/A
- exception: $\text{exc} := \text{isInvalidEmail}(\text{newEmail}) \Rightarrow \text{InvalidEmail}$

getInfoProfiles():

- transition: N/A
- output: $\text{out} := \text{self.infoProfiles}$
- exception: N/A

getInfoProfile(id: integer):

- transition: N/A

- output: $\text{out} := \{\exists i \in \text{self.infoProfiles} | i.id = id\} \Rightarrow i$
- exception: $\text{exc} := \neg\{\exists i \in \text{self.infoProfiles} | i.id = id\} \Rightarrow \text{InvalidInfoProfileId}$

addInfoProfile(newInfoProfile: InfoProfile):

- transition: $\text{self.infoProfiles} = \text{self.infoProfiles} + \text{newInfoProfile}$ (add the new infoprofile to the list of info profiles connected to the current user)
- output: N/A
- exception: N/A

removeInfoProfile(oldInfoProfile: InfoProfile):

- transition: $\text{self.infoProfiles} = \text{self.infoProfiles} - \text{oldInfoProfile}$ (remove the info profile passed to the method from the list of info profiles connected to the current user)
- output: N/A
- exception: N/A

getTrials():

- transition: N/A
- output: $\text{out} := \text{self.trials}$
- exception: N/A

getTrial(id: integer):

- transition: N/A
- output: $\text{out} := \{\exists i \in \text{self.trials} | i.id = id\} \Rightarrow i$
- exception: $\text{exc} := \neg\{\exists i \in \text{self.trials} | i.id = id\} \Rightarrow \text{InvalidTrialId}$

addTrial(newTrial: Trial):

- transition: $\text{self.trials} = \text{self.trials} + \text{newTrial}$ (same idea as add info profiles)
- output: N/A
- exception: N/A

removeTrial(oldTrial: Trial):

- transition: $\text{self.trials} = \text{self.trials} - \text{oldTrial}$ (same idea as remove info profiles)
- output: N/A
- exception: N/A

6.4.5 Local Functions

saveUser(user: User):

- transition: Saves the user to the database.
- output: N/A
- exception: N/A

loadUser(user: User):

- transition: Loads the user from the database.
- output: N/A
- exception: N/A

7 MIS of Info Profile data module

7.1 Module

InfoProfile

7.2 Uses

None

7.3 Syntax

7.3.1 Exported Constants

None

7.3.2 Exported Access Programs

Name	In	Out	Exceptions
getDOB	-	datetime	-
setDOB	datetime	-	-
getAddress	-	seq of char	-
setAddress	seq of char	-	-
getGender	-	seq of char	-
setGender	seq of char	-	-
getHealthDetails	-	map<seq of char: Any>	-
setHealthDetails	map<seq of char: Any>	-	-

7.4 Semantics

7.4.1 State Variables

dateOfBirth: datetime
address: seq of char
gender: seq of char
healthDetails: map<seq of char: Any>

7.4.2 Environment Variables

None

7.4.3 Assumptions

None

7.4.4 Access Routine Semantics

getDOB():

- transition: N/A
- output: out := self.dateOfBirth
- exception: N/A

setDOB(newDOB: datetime):

- transition: self.dateOfBirth = newDOB
- output: N/A
- exception: N/A

getAddress():

- transition: N/A
- output: out := self.address
- exception: N/A

setAddress(newAddress: seqOfChar):

- transition: self.address = newAddress
- output: N/A
- exception: N/A

getGender():

- transition: N/A
- output: out := self.gender
- exception: N/A

setGender(gender: seq of char):

- transition: self.gender = gender
- output: N/A
- exception: N/A

getHealthDetails():

- transition: N/A
- output: out := self.healthDetails
- exception: N/A

setHealthDetails(newHealthDetails: map<seq of char: Any>):

- transition: self.healthDetails = newHealthDetails
- output: N/A
- exception: N/A

7.4.5 Local Functions

saveInfoProfile(infoProfile: InfoProfile):

- transition: Saves the info profile to the database.
- output: N/A
- exception: N/A

loadInfoProfile(infoProfile: InfoProfile):

- transition: Loads the info profile from the database.
- output: N/A
- exception: N/A

8 MIS of Trial data module

8.1 Module

Trial

8.2 Uses

None

8.3 Syntax

8.3.1 Exported Constants

None

8.3.2 Exported Access Programs

Name	In	Out	Exceptions
getTitle	-	seq of char	-
getDescription	-	seq of char	-
getUrl	-	seq of char	-

8.4 Semantics

8.4.1 State Variables

title: seq of char

description: seq of char

url: seq of char

8.4.2 Environment Variables

None

8.4.3 Assumptions

- Trial details (title, description, url) will not need to be changed. Therefore no need for setter methods to update these values for a certain trial.

8.4.4 Access Routine Semantics

getTitle():

- transition: N/A

- output: `out := self.title`
- exception: N/A

`getDescription():`

- transition: N/A
- output: `out := self.description`
- exception: N/A

`getUrl():`

- transition: N/A
- output: `out := self.url`
- exception: N/A

8.4.5 Local Functions

`saveTrial(trial: Trial):`

- transition: Saves the trial to the database.
- output: N/A
- exception: N/A

`loadTrial(trial: Trial):`

- transition: Loads the trial from the database.
- output: N/A
- exception: N/A

9 MIS of the Fetch Trials Modules

9.1 Module

TrialFetcher

9.2 Uses

Trial

9.3 Syntax

9.3.1 Exported Constants

None

9.3.2 Exported Access Programs

Name	In	Out	Exceptions
getTrials	seq. of String, integer, String	DataFrame	MissingParameter, InvalidAge, InvalidAddress
getLocator	-	geocoder	-
setLocator	geocoder	-	-

9.4 Semantics

9.4.1 State Variables

locator: geocoder

9.4.2 Environment Variables

None

9.4.3 Assumptions

- Each Trial has a unique id.
- The trial API will always be accessible.

9.4.4 Access Routine Semantics

getTrials(conditions: sequence of String, age: int, address: String):

- transition: None
- output: $\text{out} := \text{DataFrame}$ populated with trials from the ClinicalTrials.gov API
- exception: $\text{exc} := (\text{age} \notin (0, 120] \rightarrow \text{InvalidAge}) \vee (\neg \text{checkAddress}(\text{address}) \rightarrow \text{InvalidAddress}) \vee ((\exists x.x \in \text{parameters} : x = \varepsilon) \rightarrow \text{MissingParameter})$

9.4.5 Local Functions

convertTrialsToDataFrame(rawData: csv):

- transition: None
- output: $\text{out} := \text{rawData}$ formatted as a DataFrame
- exception: None

checkAddress(address: String):

- transition: None
- output: $\text{out} := \text{True}$
- exception: $\text{exc} := (\text{geopy.geolocator}(\text{address}) = \text{exception} \rightarrow \text{False})$

10 MIS of the Trial Filtering Module

10.1 Module

TrialFilterer

10.2 Uses

Trial

10.3 Syntax

10.3.1 Exported Constants

None

10.3.2 Exported Access Programs

Name	In	Out	Exceptions
exportTrials	-	json	-
fetchTrials	seq. of String, integer, String	-	-
getLocator	-	geocoder	-
setLocator	geocoder	-	-

10.4 Semantics

10.4.1 State Variables

locator: geocoder

trials: DataFrame

10.4.2 Environment Variables

None

10.4.3 Assumptions

- Each Trial has a unique id.
- Exceptions are caught downstream by the TrialFetcher module

10.4.4 Access Routine Semantics

fetchTrials(conditions: sequence of String, age: int, address: String):

- transition: self.trials populated with trials via TrialFilterer module
- output: None
- exception: None

exportTrials():

- transition: None
- output: out:= self.trials as json
- exception: None

getLocator():

- transition: None

- output: $\text{out} := \text{self.locator}$
- exception: None

setLocator(loc: geocoder):

- transition: $\text{self.locator} = \text{loc}$
- output: None
- exception: None

10.4.5 Local Functions

cleanAge(stringAge: String):

- transition: None
- output: $\text{out} := (\text{inMonths} \rightarrow \text{int}(\text{stringAge})/12) \rightarrow \text{int}(\text{stringAge})$
- exception: $\text{exc} := \text{stringAge} \notin \mathbb{R} \rightarrow \text{InvalidAge}$

geodesicDistance(address: geocode, trialLocation: geocode):

- transition: None
- output: $\text{out} := \arccos(\sin(\text{address.latitude}) \cdot \sin(\text{trialLocation.latitude}) + \cos(\text{address.latitude}) \cdot \cos(\text{trialLocation.latitude}) \cdot \cos(\text{trialLocation.longitude} - \text{address.longitude})) \cdot 6371000$
- exception: None

calculateDistance():

- transition: $\text{self.trials}[\text{distance}] \mapsto \text{geodesicDistance}(\text{address}, \text{self.trials}[\text{trialLocation}])$
- output: None
- exception: None

convertToJSON(df: DataFrame):

- transition: None
- output: $\text{df} \rightarrow \text{json}(\text{df})$
- exception: None

11 MIS of the Registration Module

11.1 Module

Registration

11.2 Uses

User

11.3 Syntax

11.3.1 Exported Constants

None

11.3.2 Exported Access Programs

Name	In	Out	Exceptions
registerUser	String, String	Boolean	-

11.4 Semantics

11.4.1 State Variables

11.4.2 Environment Variables

11.4.3 Assumptions

None

11.4.4 Access Routine Semantics

registerUser(emailAddress: String, password: String):

- transition: None
- output: out := True if the Registration was successful, False otherwise
- exception: None

11.4.5 Local Functions

12 MIS of the Login Module

12.1 Module

Login

12.2 Uses

User

12.3 Syntax

12.3.1 Exported Constants

None

12.3.2 Exported Access Programs

Name	In	Out	Exceptions
loginUser	String, String	Boolean	-

12.4 Semantics

12.4.1 State Variables

12.4.2 Environment Variables

12.4.3 Assumptions

None

12.4.4 Access Routine Semantics

loginUser(emailAddress: String, password: String):

- transition: None
- output: out := True if the login was successful, False otherwise
- exception: None

12.4.5 Local Functions

13 MIS of the Email Template Module

13.1 Module

EmailTemplate

13.2 Uses

User, Trial

13.3 Syntax

13.3.1 Exported Constants

None

13.3.2 Exported Access Programs

Name	In	Out	Exceptions
createEmail	User, Trial	String	-

13.4 Semantics

13.4.1 State Variables

13.4.2 Environment Variables

13.4.3 Assumptions

13.4.4 Access Routine Semantics

createEmail(user: User, trial: Trial):

- transition: None
- output: out := email template personalized using User and Trial data
- exception: None

13.4.5 Local Functions

14 MIS of the Email Notification Module

14.1 Module

NotificationModule, User, PatientInfo, Trial

14.2 Uses

14.3 Syntax

14.3.1 Exported Constants

None

14.3.2 Exported Access Programs

Name	In	Out	Exceptions
sendEmail	String, String	-	DeliveryFailed
getAPIKey	-	String	-
setAPIKey	String	-	-

14.4 Semantics

14.4.1 State Variables

APIKey: String

14.4.2 Environment Variables

connection: API connection

14.4.3 Assumptions

- Emailer API is operational and accessible
- ClinicalTrial.gov API is operational and accessible

14.4.4 Access Routine Semantics

sendEmail(emailAddress: String, subject: String, body: String):

- transition: None
- output: out := email request sent through the emailing API

- exception: $\text{exc} := \text{emailer returns error code} \rightarrow \text{DeliveryFailed}$

getAPIKey():

- transition: None
- output: $\text{out} := \text{self.APIKey}$
- exception: None

setAPIKey(key: String):

- transition: $\text{self.APIKey} := \text{key}$
- output: None
- exception: None

14.4.5 Local Functions

findNewTrials():

- transition: None
- output: $\text{out} := \{ \text{trials} : \text{trial.postedDate} > \text{lastCheckedDate} \}$
- exception: None

matchUsersToNewTrials():

- transition: None
- output: $\text{out} := \{ \text{user} \times \text{trial} : \text{user.conditions} \subseteq \text{trial.conditions} \}$
- exception: None

15 MIS of Patient Data Collection Form Module

15.1 Module

PatientForm

15.2 Uses

InfoProfile, User

15.3 Syntax

15.3.1 Exported Constants

None

15.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayPatientForm	-	ReactComponent	-

15.4 Semantics

15.4.1 State Variables

patientForm: ReactComponent
name: String
dateOfBirth: String
address: String
gender: String
healthDetails: TS Object<String: Any>

15.4.2 Environment Variables

window
keyboard
mouse

15.4.3 Assumptions

None

15.4.4 Access Routine Semantics

displayPatientForm():

- transition: N/A
- output: out := self.patientForm
- exception: N/A

15.4.5 Local Functions

submitPatientDetails(newPatientDetails: TS Object<String: Any>):

- transition: self.healthDetails = newPatientDetails
- output: N/A
- exception: $exc := length(newPatientDetails) == 0 \Rightarrow InvalidDetails$

16 MIS of User Login Form Module

16.1 Module

LoginForm

16.2 Uses

Login

16.3 Syntax

16.3.1 Exported Constants

None

16.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayLoginForm	-	ReactComponent	-

16.4 Semantics

16.4.1 State Variables

loginForm: ReactComponent

emailAddress: String

password: String

16.4.2 Environment Variables

window

keyboard

mouse

16.4.3 Assumptions

None

16.4.4 Access Routine Semantics

displayLoginForm():

- transition: N/A
- output: `out := self.loginForm`
- exception: N/A

16.4.5 Local Functions

submitLoginDetails(newEmailAddress: String, newPassword: String):

- transition: `self.emailAddress, self.password = newEmailAddress, newPassword`
- output: N/A
- exception: *exc := length(newEmailAddress) == 0 \vee length(newPassword) == 0 \Rightarrow InvalidLoginDetails*

17 MIS of User Profile Settings Module

17.1 Module

ProfileSettings

17.2 Uses

User, InfoProfile, TrialFetcher, Trial

17.3 Syntax

17.3.1 Exported Constants

None

17.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayProfileSettings	-	ReactComponent	-

17.4 Semantics

17.4.1 State Variables

profileSettings: ReactComponent
name: String
email: String
savedTrials: list of Trial
dateOfBirth: String
address: String
gender: String
healthDetails: TS Object<String: Any>

17.4.2 Environment Variables

window
keyboard
mouse

17.4.3 Assumptions

None

17.4.4 Access Routine Semantics

displayProfileSettings():

- transition: N/A
- output: `out := self.profileSettings`
- exception: N/A

17.4.5 Local Functions

getName():

- transition: N/A
- output: `out := self.name`
- exception: N/A

setName(newName: String):

- transition: `self.name := newName`
- output: N/A

- exception: $exc := length(newName) == 0 \Rightarrow EmptyName$

getEmail():

- transition: N/A
- output: $out := self.email$
- exception: N/A

setEmail(newEmail: String):

- transition: $self.email := newEmail$
- output: N/A
- exception: $exc := length(newEmail) == 0 \Rightarrow InvalidEmail$

getSavedTrials():

- transition: N/A
- output: $out := self.trials$
- exception: N/A

removeTrial(oldTrial: Trial):

- transition: $self.trials = \forall t \in self.trials \mid t \neq oldTrial$
- output: N/A
- exception: N/A

getDOB():

- transition: N/A
- output: $out := self.dateOfBirth$
- exception: N/A

setDOB(newDOB: String):

- transition: $self.dateOfBirth = newDOB$
- output: N/A
- exception: $exc := length(newDOB) == 0 \Rightarrow EmptyDOB$

getAddress():

- transition: N/A
- output: $\text{out} := \text{self.address}$
- exception: N/A

setAddress(newAddress: String):

- transition: $\text{self.address} = \text{newAddress}$
- output: N/A
- exception: $\text{exc} := \text{length}(\text{newAddress}) == 0 \Rightarrow \text{EmptyAddress}$

getGender():

- transition: N/A
- output: $\text{out} := \text{self.gender}$
- exception: N/A

setGender(gender: String):

- transition: $\text{self.gender} = \text{gender}$
- output: N/A
- exception: $\text{exc} := \text{length}(\text{gender}) == 0 \Rightarrow \text{EmptyGender}$

getHealthDetails():

- transition: N/A
- output: $\text{out} := \text{self.healthDetails}$
- exception: N/A

setHealthDetails(newHealthDetails: TS Object<String: Any>):

- transition: $\text{self.healthDetails} = \text{newHealthDetails}$
- output: N/A
- exception: $\text{exc} := \text{length}(\text{newHealthDetails}) == 0 \Rightarrow \text{InvalidDetails}$

18 MIS of Trial Display Module

18.1 Module

TrialDisplay

18.2 Uses

TrialFetcher, Trial, InfoProfile

18.3 Syntax

18.3.1 Exported Constants

None

18.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayTrials	-	ReactComponent	-

18.4 Semantics

18.4.1 State Variables

trialsDisplay: ReactComponent

trials: list of Trial

conditions: seq of String

age: int

address: String

18.4.2 Environment Variables

window

keyboard

mouse

18.4.3 Assumptions

None

18.4.4 Access Routine Semantics

displayTrials(trials: list of Trial):

- transition: self.trials = trials
- output: out := self.trialsDisplay
- exception: N/A

18.4.5 Local Functions

getTrials():

- transition: N/A
- output: `out := TrialFetcher.getTrials(self.conditions, self.age, self.address)`
- exception: N/A

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>.

19 Appendix

[Extra information if required —SS]