1 Overview

Important: please read
This assignment is intended to help you become familiar with:

- Event-B symbols,
- using Rodin,
- creating projects and machines,
- entering information into the bodies of machines

This should help you become familiar with a number of functions of the Rodin toolkit. The marked up machines are appended to this specification. They are presented in the ISO characters used in the toolkit; some of those characters must be entered using ASCII representations.

Please see bonus requirement.

2 Requirement

A specification of machine CoffeeClub, context Members, and machine Membership, as discussed in the lectures, is required. You must carry out the actions described in the following section.

3 What you have to do

Please read and follow the instructions carefully.

1. Create a new development directory You can call it what you want, but for the purposes of this specification, it will be called CoffeeClub.

2. Run Rodin toolkit and create or load a workspace.

3. Use the Event-B explorer to create a project called CoffeeClub.
4. Within the CoffeeClub project create the machine CoffeeClub.

5. Fix any errors and check the proof obligations in Event-B explorer.

6. Create the context Members and the machine Membership.

7. Please note that, where appropriate, the listing of refined events is shown with status extended.

8. Export (File menu) a zip archive of the CoffeeClub project.

9. Submit assignment as above.

3.1 Requirements

The following is an abbreviated set of requirements.

REQ1 money bank for storing finite, non-negative funds
REQ2 an operation for adding money to the money bank
REQ3 an operation for removing money from the money bank.
REQ4 a facility for members to join the coffee club;
   each member has a distinct membership id
REQ5 members have an account that cannot go into debt;
REQ6 an operation that enables a member to add money to their account;
REQ7 money added to a members account is also added to the club money bank;
REQ8 an operation that sets the price for a cup of coffee;
REQ9 an operation that enables a member to buy a cup of coffee;
   the member’s account is reduced by the cost of a cup of coffee.
4 CoffeeClub Machine

MACHINE CoffeeClub

VARIABLES
piggybank  REQ1

INVARIANTS
inv1: piggybank ∈ ℤ REQ1: piggybank must be non-negative

EVENTS

Initialisation ≜

THEN
act1: piggybank := 0 initialise piggybank to satisfy inv1
END

FeedBank ≜

ANY
amount
WHERE
gd1: amount ∈ N1
THEN
act1: piggybank := piggybank + amount
END

RobBank ≜

ANY
amount
WHERE
gd1: amount ∈ N1
gd2: amount ≤ piggybank  There must be enough in the piggybank
THEN
act1: piggybank := piggybank − amount
END

END
4.1 Context Members

**CONTEXTMembers**

**SETS**

MEMBER

**AXIOMS**

\[ \text{axm1: } \text{finite}(\text{MEMBER}) \quad \text{REQ3: a finite set of members} \]

END

4.2 MemberShip Machine (Refinement)

**MACHINE** MemberShip

**Requirements:**

REQ4, REQ5, REQ6, REQ7, REQ8, REQ9

**REFINES**

CoffeeClub

**SEES**

Members

**VARIABLES**

piggybank

members \quad \text{REQ4: the set of current members}

accounts \quad \text{REQ5: the member accounts}

coffeeprice \quad \text{REQ8: the price of a cup of coffee}

**INVARIANTS**

\[ \text{inv1: } \text{piggybank} \in \mathbb{N} \]

\[ \text{inv2: } \text{members} \subseteq \text{MEMBER} \quad \text{REQ4: each member has unique id} \]

\[ \text{inv3: } \text{accounts} \in \text{members} \rightarrow \mathbb{N} \quad \text{REQ5: each member has an account} \]

\[ \text{inv4: } \text{coffeeprice} \in \mathbb{N} \quad \text{REQ8: any price other than free!} \]

**EVENTS**

**Initialisation : extended \equiv**

**THEN**

act2: \quad \text{members} := \varnothing \quad \text{empty set of members}

act3: \quad \text{accounts} := \varnothing \quad \text{empty set of accounts}

act4: \quad \text{coffeeprice} := \mathbb{N} \quad \text{initial coffee price set to arbitrary non-zero value}

END

**SetPrice \equiv**

**REQ8**

**ANY**

amount

**WHERE**
\[
\begin{align*}
\text{grd1:} & \quad \text{amount } \in N_1 \\
\text{THEN} \\
\text{act1:} & \quad \text{coffeeprice } := \text{amount} \\
\text{END}
\end{align*}
\]

\textbf{NewMember} \equiv \text{REQ4, REQ5}

\textbf{ANY}
\textbf{member}
\textbf{WHERE}
\textbf{grd1:} \quad \text{member } \in\text{ MEMBER} \setminus \text{members} \quad \text{choose a unique member id}
\textbf{THEN}
\textbf{act1:} \quad \text{members } := \text{members } \cup \{\text{member}\}
\textbf{act2:} \quad \text{accounts} (\text{member}) := 0
\textbf{END}

\textbf{Contribute} \equiv

\textbf{REFINES}
\textbf{FeedBank}
\textbf{ANY}
\textbf{amount}
\textbf{member}
\textbf{WHERE}
\textbf{grd1:} \quad \text{amount } \in N_1 \\
\textbf{grd2:} \quad \text{member } \in \text{members}
\textbf{THEN}
\textbf{act1:} \quad \text{piggybank } := \text{piggybank } + \text{amount} \\
\textbf{act2:} \quad \text{accounts} (\text{member}) := \text{accounts} (\text{member}) + \text{amount}
\textbf{END}

\textbf{BuyCoffee} \equiv \text{REQ9}

\textbf{ANY}
\textbf{member}
\textbf{WHERE}
\textbf{grd1:} \quad \text{member } \in \text{members} \\
\textbf{grd2:} \quad \text{accounts} (\text{member}) \geq \text{coffeeprice}
\textbf{THEN}
\textbf{act1:} \quad \text{accounts} (\text{member}) := \text{accounts} (\text{member}) - \text{coffeeprice}
\textbf{END}

\textbf{FeedBank : extended} \equiv

\textbf{REFINES}
\textbf{FeedBank}
\textbf{ANY}
\textbf{WHERE}
THEN
END

RobBank : extended ⊑

REFINES
  RobBank
ANY

WHERE
THEN
END

END