## Library Management System

### System Requirements

The library management system manages book loans in a library as well as requests for books. The library has a certain stock of books that may be borrowed by users. The stock of books may be modified as books are added or retired. The library may hold several copies of the same book so each individual copy must be monitored by the system. The system should maintain information about a book such as ISBN, title, author and publication date.

The system should maintain a record of registered users who are allowed to borrow books as well as a record of which user a book is on loan to. When a book is borrowed, it will be given a return date. To encourage users to return books on time, the library operates a system of points. Users earn points when they return books on time and lose points for every day that a book is overdue. Users may renew a book they have borrowed – this extends the return date but does not earn them additional points. The maximum number of books that users are allowed to borrow depends on the number of points they have accumulated (up to a maximum of 20 books per users).

If all copies of a book are on loan, then a user may put in a request for a book. When a copy of a requested book is returned, it will be held in reserve for 1 week for the requesting user. Another user who already has a reserved book on loan cannot renew their loan if there is an outstanding request on the book.

### Tasks for you to complete:

1. Create a class diagram for the system showing the required sets and relationships between sets. This will help you specify appropriate Event-B sets, etc.
2. Construct an Event-B model of the library system. This should include appropriate sets, constants axioms, variables, invariants and events. The Event-B model should include sufficient events to model the following library procedures:
   1. Register a new user in the library and remove a library user
   2. Add and remove books to and from the library
   3. Borrow, return or renew a book
   4. Request a book and collect a requested book when available

A procedure may require more than one event to deal with different cases, for example, one event for returning a book in the case that it has not been requested by another user and another event for the case where it has. For each event, specify clearly in English the conditions under which the event is valid. Ensure that these conditions are also expressed as part of the event guards. Ensure that each event maintains all invariants and justify this informally in your report.

You should check your Event-B model using the Rodin tool.

1. Add a search facility to the specification of the library system.