Topic5: Structural Modeling

-Introduction to structural modeling

-class diagram model

-object diagram model

-collaboration diagram model

-Exercises

5.1 Structural modeling

- representing structural aspects of any object oriented system i.e. either
  - underlying static elements representing static stable generic structure of system or
  - structural arrangements of elements during behavior

5.2 class diagram

- shows underlying building blocks (classes, interfaces, and collaborations) of any object oriented system

class diagram components

- 1 Classes
- 2 Relationships
  - association
  - generalization
  - composition
  - aggregation
- 3 Class attributes
- 4 Class operations

Note

- Classes and relationships shown in the diagram depend on whether for analysis or design purpose i.e.
- Two types:
  1. domain or conceptual class diagram
     - class diagram modeling analysis requirements
     - Class and attribute names reflect concepts in the problem domain
     - Sometimes there are no class operations
     - Relationships shown are generalization and association only

2– design class diagram
  – class diagrams modeling design requirements
  –Class and attribute names reflect concepts in the solution domain
  –class operations and attributes reflect implementation details
  –Relationships shown are realization, dependency, as additional to generalization and association

5.3 Drawing class diagram

– find and name classes i.e. nouns or noun phrases
– identify attributes if any i.e. properties of classes
– identify operations if any i.e. verbs or verb phrases
– identify relationships i.e. connections between classes that imply interactions
– draw class diagram by representing each component with their respective notations

Example1

The goal is to process different types of credit applications at a bank. The credit applications include those for home equity loans, home mortgage loans, auto loans, and credit cards. From the bank's perspective therefore, the customers are home owners, home buyers, auto buyers, and credit card applicants. To process any type of loan or credit card application, the bank needs to check the applicant's credit history, based on a report from the credit bureau. For the first two types of

loans, the bank summons assessor to assess the property value before making a decision. Develop a class model for the following scenario.

1.Analysis

Main class name	Specialized classes	Main class Associated to
applicant (customer)	property buyer applicant, credit card applicant	1.loan, 2.credit report,3.credit card
credit report		applicant
loan	Home equity loan, mortgage loan, auto loan	applicant
Credit card		applicant
property	Home, automobile	loan
assessor		property

2.class diagram
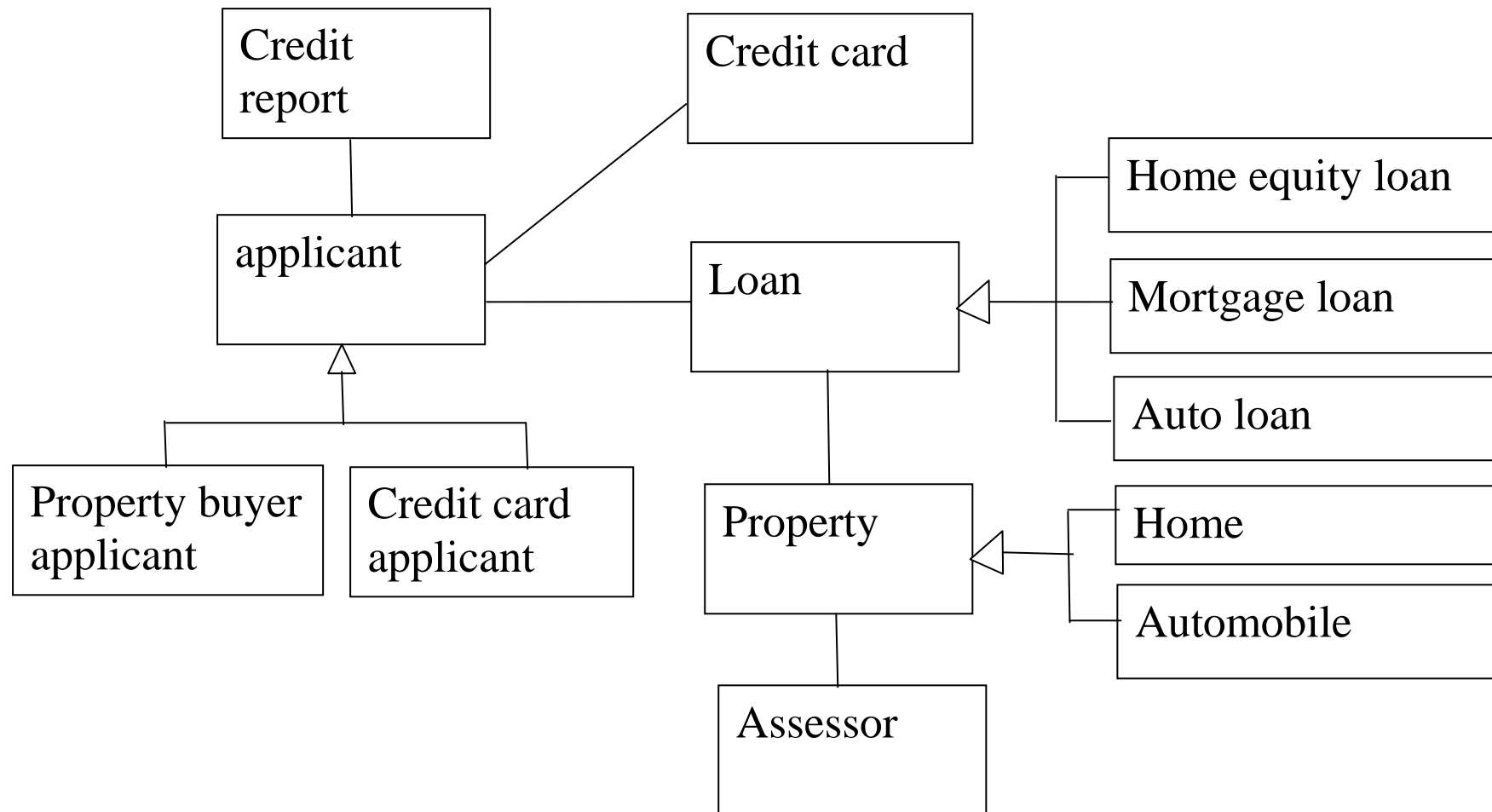
Assignment

John is an enthusiastic gardener who earns money by doing gardening work for his neighbors. John buys the materials (fertilizer, mulch, pesticide) that he needs, and charges his customers for both labor and materials. Some customers make appointments when they want work done and pay when John completes the Work. Some customers set up a schedule (usually weekly) for regular work and pay when John sends them a monthly invoice for work done during the month.

Exercise

A small Library Database System has been planned to be developed. The small Library Database System will be used by the Biology Department of a local college to track the borrowing of books and other forms of media, such as video tapes, and software. A secretary will operate the system and will be responsible for checking out books to students and faculty members.

Draw class diagram for this system.

5.4 Object diagram

- Models the instances of things described by a class diagram.
- Modeling object structures involves taking a snapshot of the application by showing a set of objects and their interrelationships at a given moment in time.
- Each object has an optional name and set of classes it is an instance of, also values for attributes of these classes.

5.5 Drawing Object diagram

1) identify the function/behaviour of interest that results from interaction of classes, interfaces and other artifacts

2) for each function/behaviour, identify the artifacts that participate in the collaboration as well as their relationships

3) consider one scenario that invokes the function/behaviour, freeze the scenario and render each participating object

4) expose the state and attribute values of each object, as necessary to understand the scenario

5) show the links among these objects

Example2:Refer to Example1

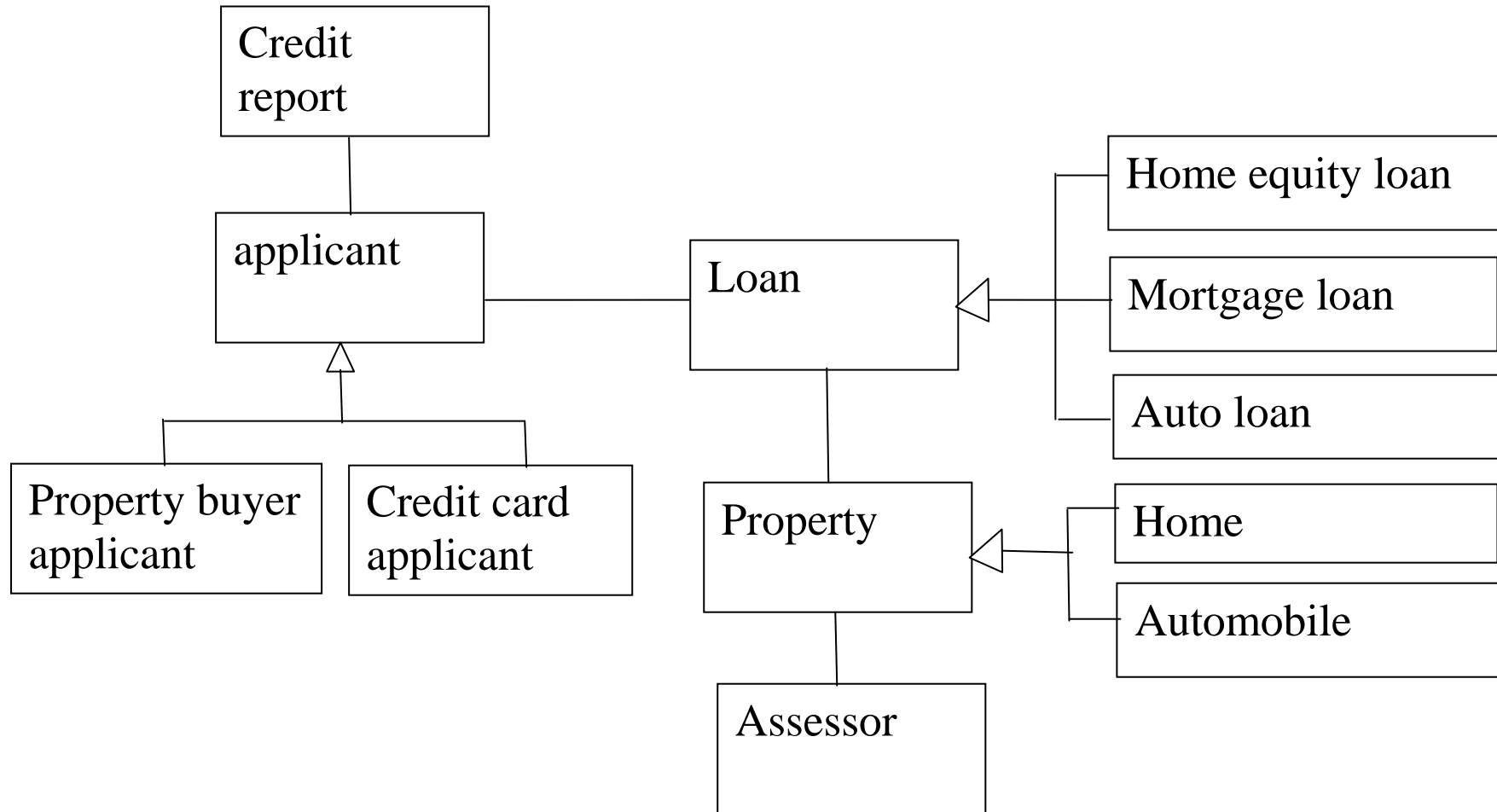Draw an object diagram for the process loan application use case

1.Analysis

a) behavior of interest: process loan application use case

b) classes in the interaction

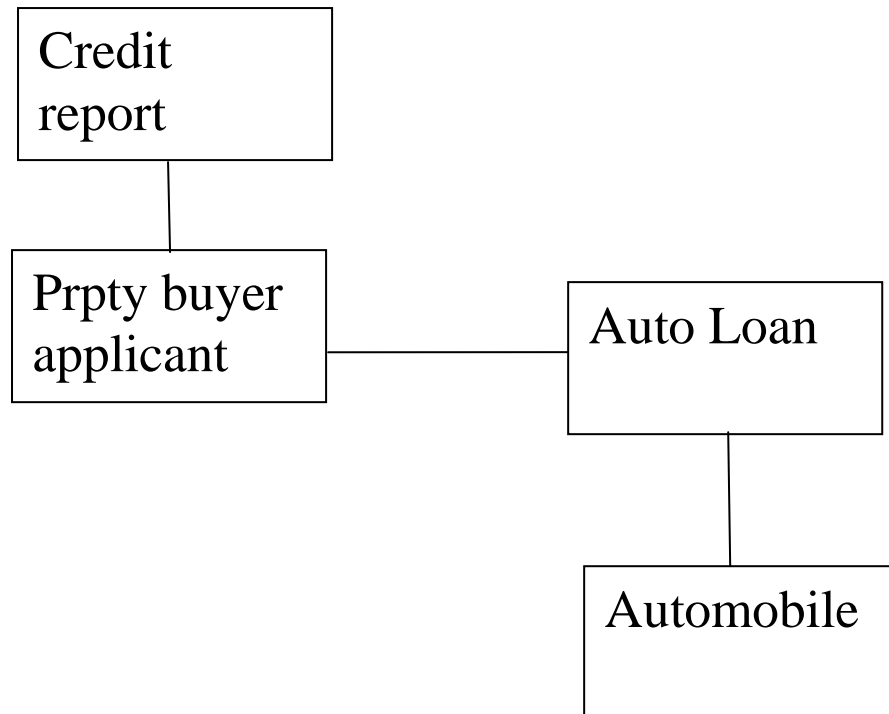| Main class name	Specialized classes	Main class Associated to
applicant (customer)	property buyer applicant, credit card applicant	1.loan, 2.credit report,3.credit card applicant
credit report		applicant
loan	Home equity loan, mortgage loan, auto loan	applicant

property	Home, automobile	loan
assessor		property

c) scenario in the behavior: property buyer to apply for an auto loan
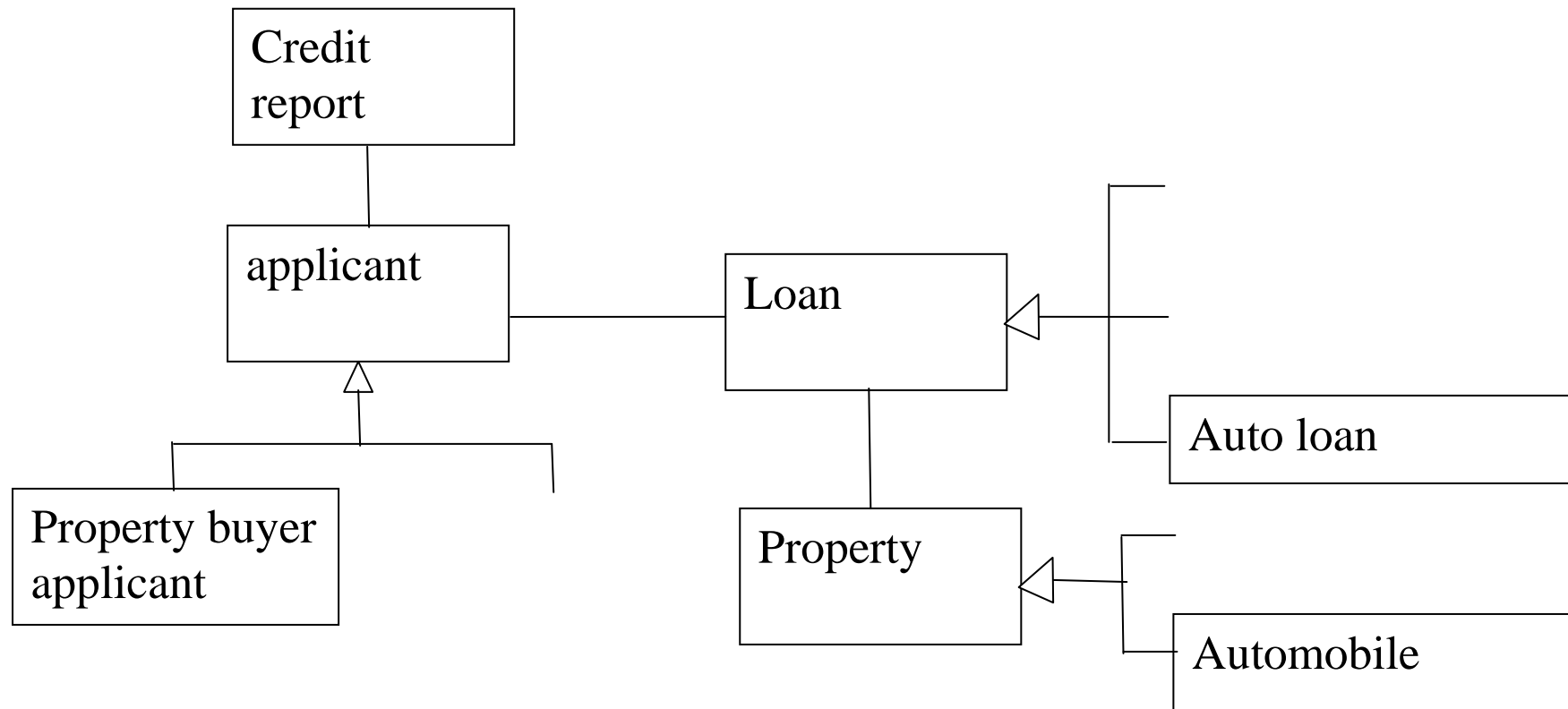
d) rendering relevant classes for the scenario

```
┌──────────────┐
│ Credit       │
│ report       │
└──────┬───────┘
       │
┌──────┴───────┐        ┌──────────────┐
│ Prpty buyer  │        │ Auto Loan    │
│ applicant    ├────────┤              │
└──────────────┘        └──────┬───────┘
                               │
                        ┌──────┴───────┐
                        │ Automobile   │
                        │              │
                        └──────────────┘
```

2.object diagram

```
┌─────────────┐
│ :Credit     │
│ report      │
└─────────────┘
       │
┌─────────────┐        ┌─────────────┐
│ :Prpty buyer│────────│ :Auto Loan  │
│ applicant   │        │             │
└─────────────┘        └─────────────┘
                              │
                       ┌─────────────┐
                       │ :Automobile │
                       │             │
                       └─────────────┘
```
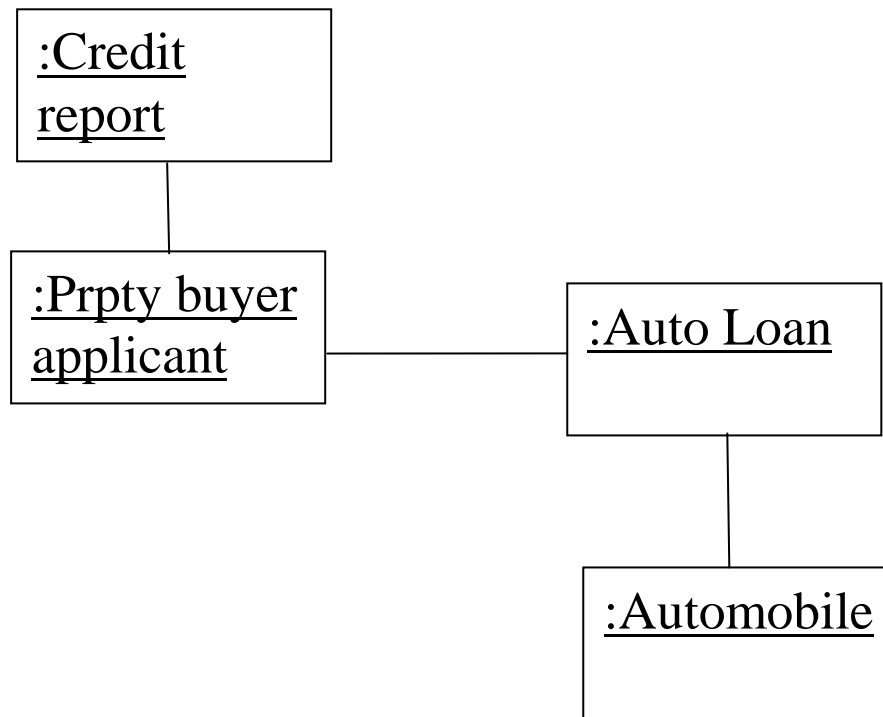
5.5 Collaboration diagram

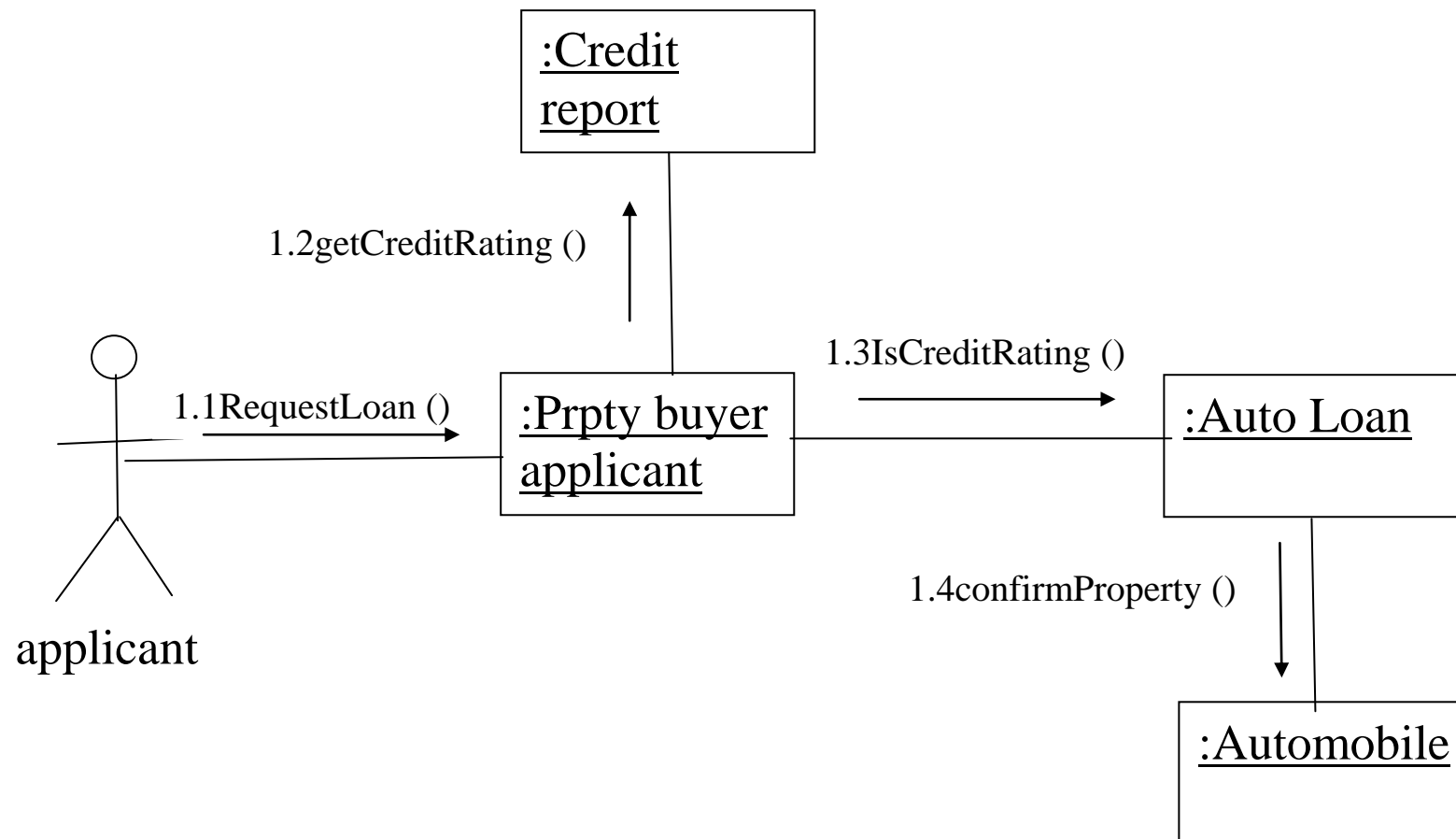- shows structural arrangement of interacting objects exchanging messages in order to realize a use case

collaboration diagram components

- 1 Collaboration objects – from object diagram
- 2 Collaboration messages – between objects
  - messages labeled with numbers
  - numbers indicate message level

5.6 Drawing collaboration diagram

- select one of the use cases in the use case diagram
- identify classes essential in realizing the use case guided by object diagram
- identify relationships i.e. connections between objects that imply interactions
- draw collaboration diagram by representing each component with their respective notations

Example3: Refer to Example2

:Credit
report

1.2getCreditRating ()

1.3IsCreditRating ()

1.1RequestLoan ()   :Prpty buyer
applicant

:Auto Loan

applicant

1.4confirmProperty ()

:Automobile

Next

Topic6: Behaviorial Modeling

Books and journals The library contains books and journals. It may have several copies of a given book. Some of the books are for short term loans only. All other books may be borrowed by any library member for three weeks. Members of the library can normally borrow up to six items at a time, but members of staff may borrow up to 12 items at one time. Only members of staff may borrow journals.

Borrowing The system must keep track of when books and journals are borrowed and returned, enforcing the rules described above.

An Example Sequence Diagram

☐ Consider what happens in the library scenario when a user wishes to borrow a copy of a book.

☐ The **library member** must first check that they are able to borrow a book (i.e., they have borrowing privileges, there exists at least one remaining copy of the book etc.).

☐ Then the **copy** object must be informed that the **library member** wishes to borrow the **copy** of the **book**..

☐ Finally the **copy** object must then tell the individual **book** object that it is out on loan and thus no longer available.