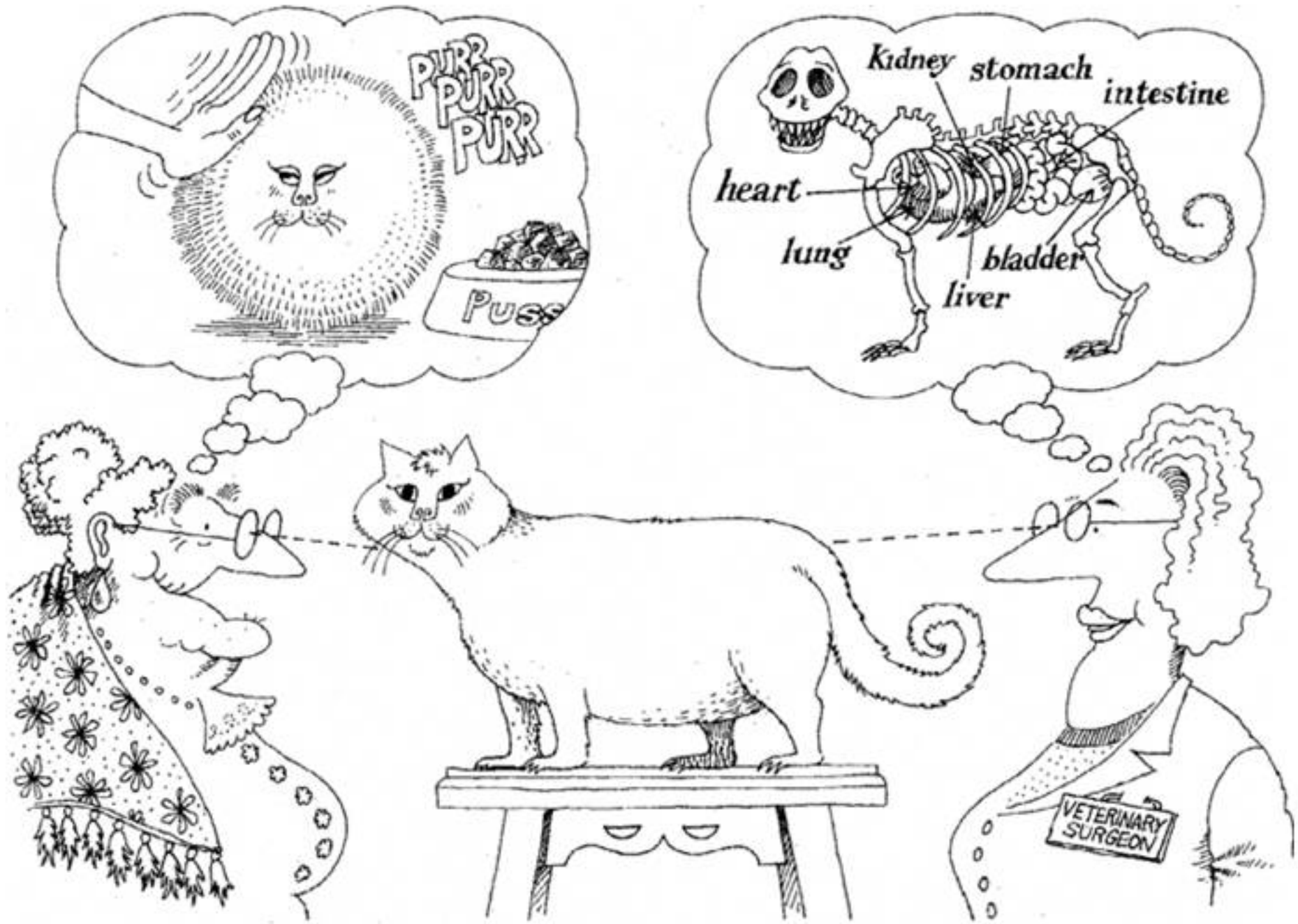
Common Modeling Techniques

- A well-defined class **is loosely coupled** (few entry points) and **highly cohesive** (all members work toward a common functionality).

- Ask yourself "Am I trying to show *what* the class does or *how* it does it". That will tell you at what level of abstraction to model the class.

- In the *requirements* and *specification* phase you are interested in "what". In the *design* phase you are interested in "how".

Deciding on the right set of abstractions for a given domain is the central problem in object-oriented design



- Abstraction focuses on the essential characteristics of some object, relative to the perspective of the viewer

- Abelson and Sussman call this behavior / implementation division an abstraction barrier achieved by applying the *principle of least commitment*, *through which the interface of an* object provides its essential behavior, and nothing more

- Booch describes an additional principle that he calls the *principle of least astonishment*, *through which* an abstraction captures the entire behavior of some object, no more and no less, and offers no surprises or side effects that go beyond the scope of the abstraction.

Automated Teller Machine (ATM) Case Study

System Concept

Develop software so that customers can access a bank's computer and carry out their own financial transactions without the mediation of a bank employee

How to find new system concept?

- Add functionality to an existing system
- Automate a manual process
- Combine functionality from different systems
- Look for analogies in other problem domains and see if they have useful ides
- Travel to other countries and observe their business practices
- An entirely new idea comes to mind

- Who is the application for?
- What problem will it solve?
- Where will it be used?
- When is it needed
- Why is it needed?
- How will it work?

Design the software to support a computerized banking network including both human cashiers and ATMs to be shared by a consortium of banks. Each bank provides its own computer to maintain its own accounts and process transactions against them. Cashier stations are owned by individual banks and communicate directly with their own bank's computers. Human cashiers enter account and transaction data.

ATMs communicate with a central computer that clears transactions with the appropriate banks. An ATM accepts a cash card, interacts with the user, communicates with the central systems to carry out the transaction, dispenses cash, and prints receipts.

The system requires appropriate recordkeeping and security provisions. The system must handle concurrent accesses to the same account correctly.

The banks will provide their own software for their own computers; you are to design the software for the ATMs and the network. The cost of the shared system will be apportioned to the banks according to the number of customers with cash cards.

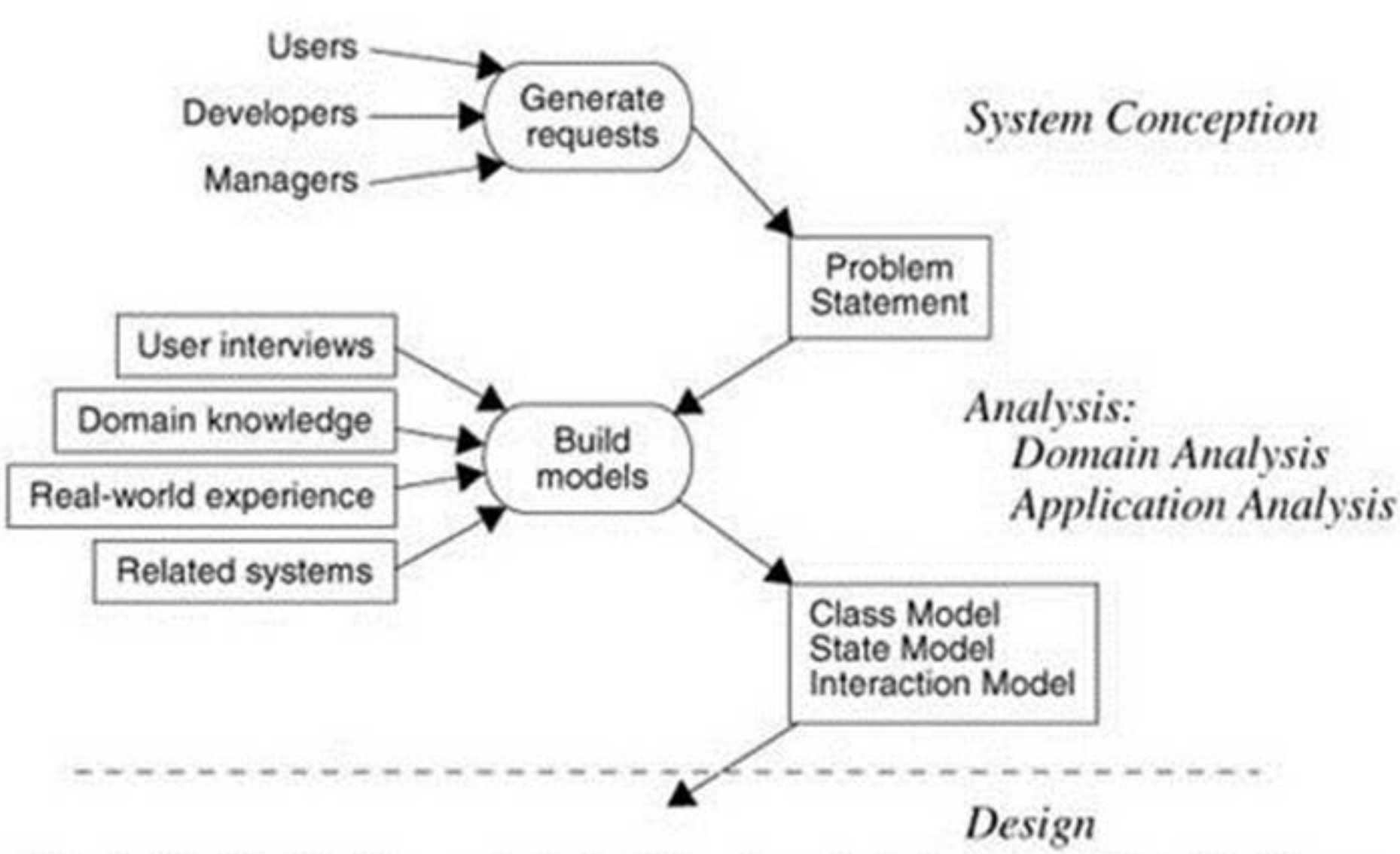


Figure 12.1 Overview of analysis. The problem statement should not be taken as immutable, but rather as a basis for refining the requirements.

- All three models are not equally important
- Problems concerning reactive control and timing (user interfaces, process control) have important state models
- Problems containing significant computation have important interaction models

Domain Class Model

- Find classes
- Prepare a data dictionary
- Find associations
- Find attributes of objects and links
- Organize and simplify classes using inheritance
- Verify that access paths exist for likely queries
- Iterate and refine model
- Reconsider the level of abstraction
- Group classes into packages

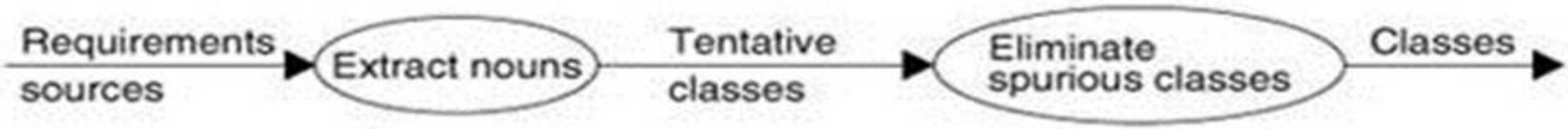


Figure 12.2 Finding classes. You can find many classes by considering nouns.

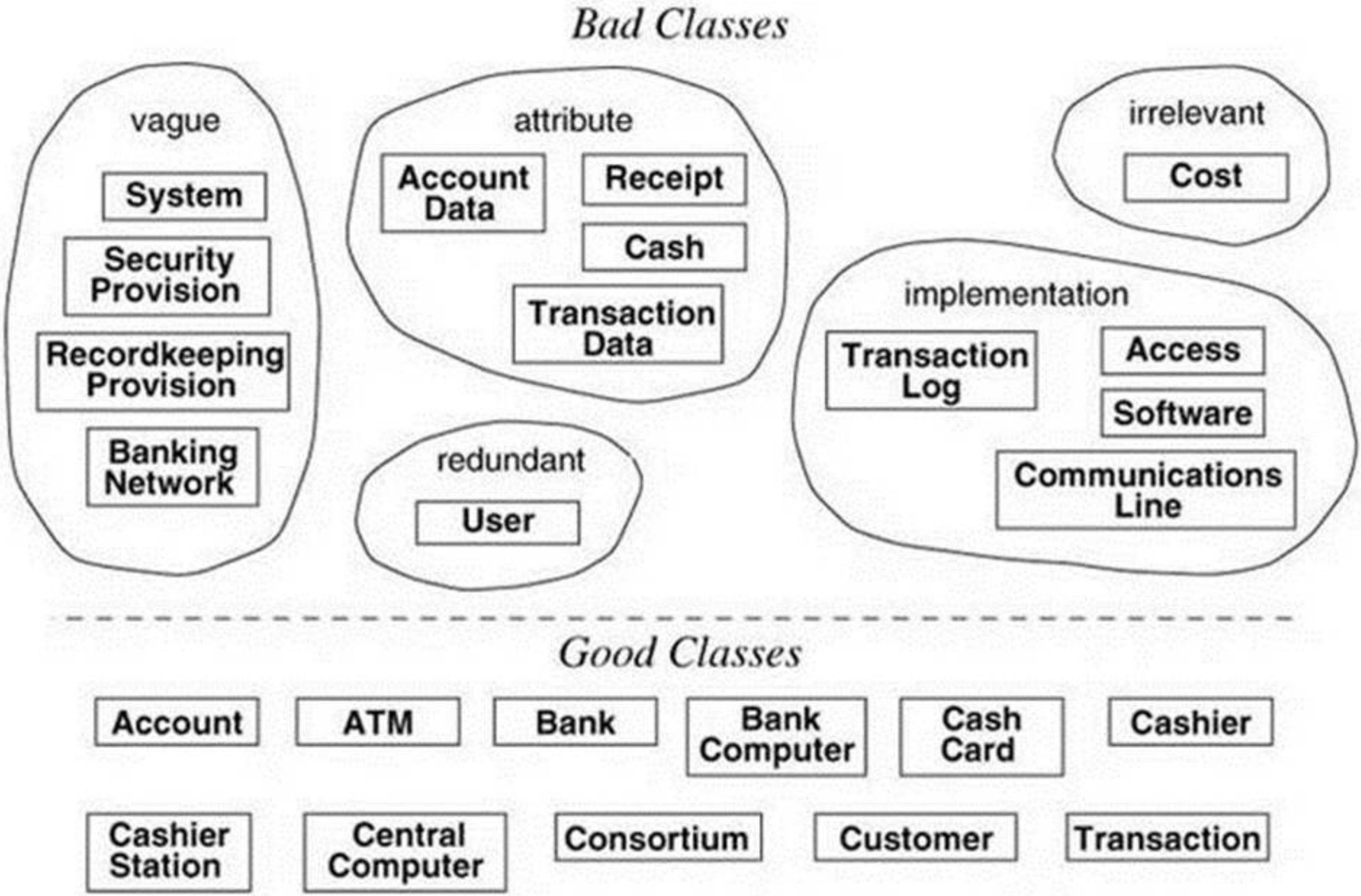


Figure 12.5 Eliminating unnecessary classes from ATM problem.

Preparing a data dictionary

Isolated words have too many interpretations

Write a paragraph describing each class

Account—a single account at a bank against which transactions can be applied. Accounts may be of various types, such as checking or savings. A customer can hold more than one account.

Verb phrases

Banking network includes cashier stations and ATMs
Consortium shares ATMs
Bank provides bank computer
Bank computer maintains accounts
Bank computer processes transaction against account
Bank owns cashier station
Cashier station communicates with bank computer
Cashier enters transaction for account
ATMs communicate with central computer about transaction
Central computer clears transaction with bank
ATM accepts cash card
ATM interacts with user
ATM dispenses cash
ATM prints receipts
System handles concurrent access
Banks provide software
Cost apportioned to banks

Implicit verb phrases

Consortium consists of banks
Bank holds account
Consortium owns central computer
System provides recordkeeping
System provides security
Customers have cash cards

Knowledge of problem domain

Cash card accesses accounts
Bank employs cashiers

Associations from ATM problem statement.

Discard unnecessary and incorrect associations

- Association between eliminated classes
- Irrelevant and implementation associations
- Actions
- Ternary associations
- Derived associations

Specify the semantics of associations as follows

- Misnamed associations
- Association end names
- Qualified associations
- Multiplicity

Identify missing associations

Identify aggregations

Verb phrases

Banking network includes cashier stations and ATMs	x
Consortium shares ATMs	
Bank provides bank computer	
Bank computer maintains accounts	
Bank computer processes transaction against account	
Bank owns cashier station	
Cashier station communicates with bank computer	
Cashier enters transaction for account	
ATMs communicate with central computer about transaction	
Central computer clears transaction with bank	x
ATM accepts cash card	x
ATM interacts with user	x
ATM dispenses cash	x
ATM prints receipts	x
System handles concurrent access	x
Banks provide software	x
Cost apportioned to banks	x

Implicit verb phrases

Consortium consists of banks	
Bank holds account	
Consortium owns central computer	
System provides recordkeeping	x
System provides security	x
Customers have cash cards	

Knowledge of problem domain

Cash card accesses accounts	
Bank employs cashiers	

Associations from ATM problem statement.

Verb phrases

Consortium shares ATMs
Bank provides bank computer
Bank computer maintains accounts
X Bank computer processes transaction against account
Bank owns cashier station
Cashier station communicates with bank computer
Cashier enters transaction for account
X ATMs communicate with central computer about transaction

Central computer communicates with bank computer

Bank Computer communicates with cashier station +

Cashier station processes transactions + transaction concerns accounts

ATMs communicate with central computer + Transactions are entered on ATM

Implicit verb phrases

Consortium consists of banks
Bank holds account
Consortium owns central computer

Customers have cash cards

Knowledge of problem domain

Cash card accesses accounts
Bank employs cashiers

Associations from ATM problem statement.

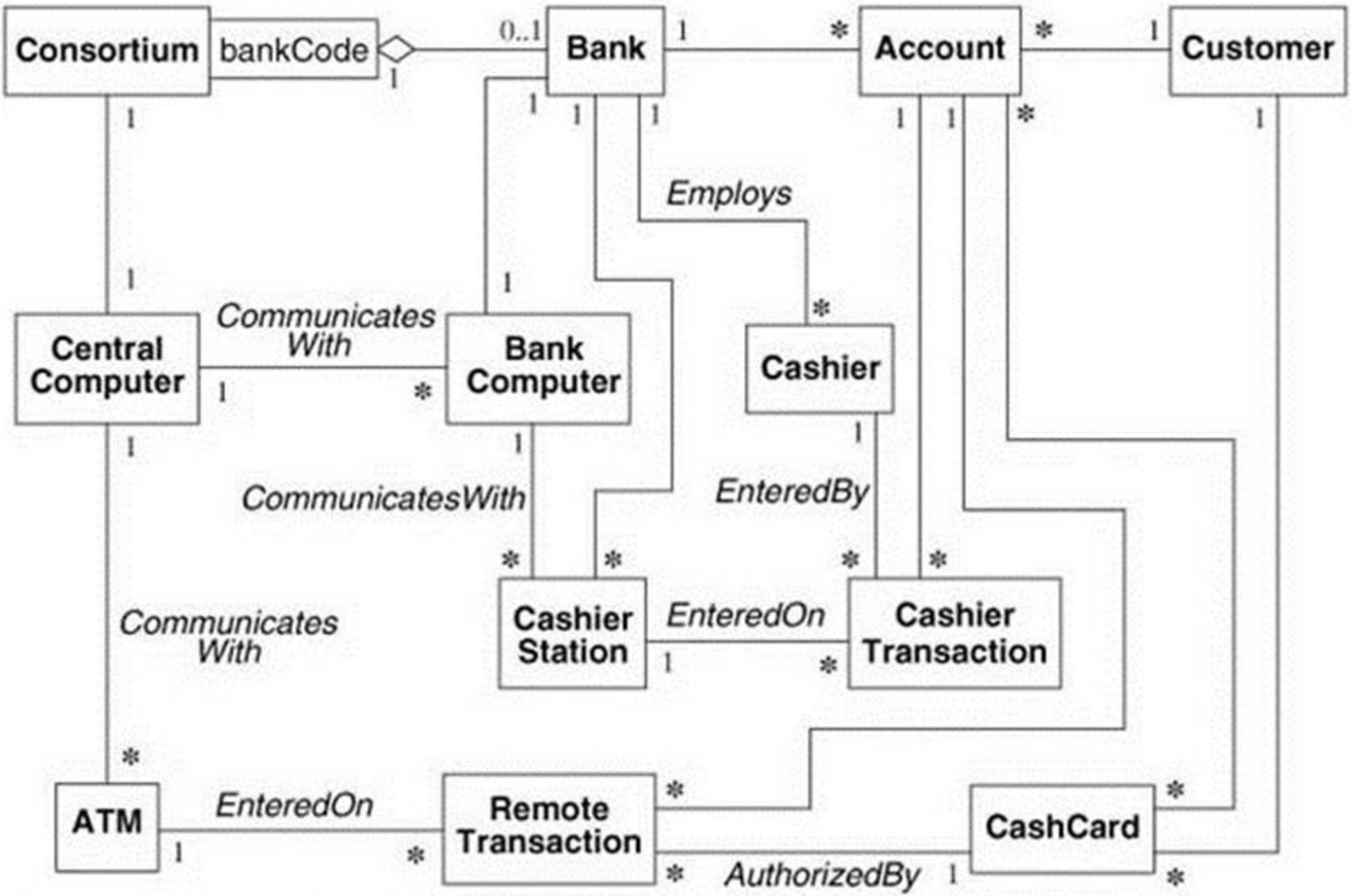


Figure 12.9 Initial class diagram for ATM system.