Object Fundamentals Part Two

Kenneth M. Anderson
University of Colorado, Boulder

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Lecture Goals

- Continue our tour of the basic concepts, terminology, and notations for object-oriented analysis, design, and programming
  - Some material for this lecture is drawn from Head First Java by Sierra & Bates, © O'Reilly, 2003

Overview

- Objects
- Classes
  - Relationships
    - Inheritance
    - Association
    - Aggregation/ Composition
    - Qualification
    - Interfaces

Objects (I)

- OO Techniques view software systems as being composed of objects
- Objects have
  - state (aka attributes)
  - behavior (aka methods or services)
- We would like objects to be
  - highly cohesive
    - have a single purpose; make use of all features
  - loosely coupled
    - be dependent on only a few other classes

Objects (II)

- Objects interact by sending messages to one another
  - A message is a request by object A to have object B perform a particular task
    - When the task is complete, B may pass a value back to A
    - Note: sometimes A == B
      - that is, an object can send a message to itself

Objects (III)

- In response to a message, an object may
  - update its internal state
  - retrieve a value from its internal state
  - create a new object (or set of objects)
  - delegate part or all of the task to some other object
- As a result, objects can be viewed as members of various object networks
  - Objects in an object network (collaboration) work together to perform a task for their host application

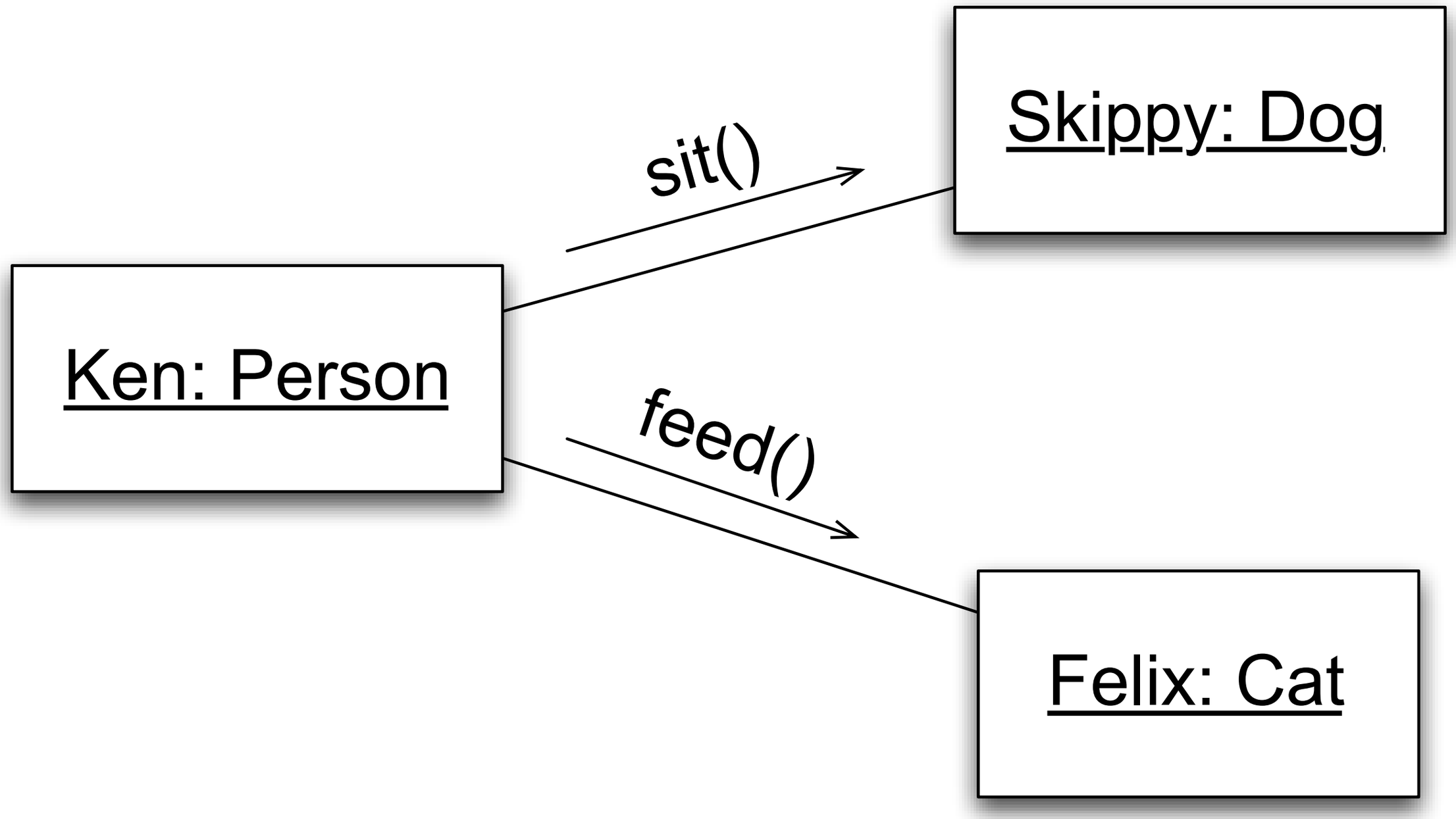
Objects (IV)

- UML notation
  - Objects are drawn as rectangles with their names and types underlined
    - <u>Ken : Person</u>
  - The name of an object is optional. What is required is to list the object's type
    - <u>: Person</u>
  - Note: the colon is not optional. It's another clue that you are talking about an object, not a class

Objects (V)

- Objects that know about each other have lines drawn between them
  - This connection has many names, the three most common are
    - object reference
    - reference
    - link
  - Messages are sent across links
    - Links are instances of associations (see below)

Objects (Example)



Classes (I)

- A class is a blueprint for an object
  - The blueprint specifies the attributes (aka instance variables) and methods of the class
    - attributes are things an object of that class knows
    - methods are things an object of that class does
  - An object is instantiated (created) from the description provided by its class
    - Thus, objects are often called instances

Classes (II)

- An object of a class has its own values for the attributes of its class
  - For instance, two objects of the `Person` class can have different values for the `name` attribute
- In general, each object shares the implementation of a class's methods and thus behave similarly
  - When a class is defined, its developer provides an implementation for each of its methods
  - Thus, object `A` and `B` of type `Person` each share the same implementation of the `sleep()` method

Classes (III)

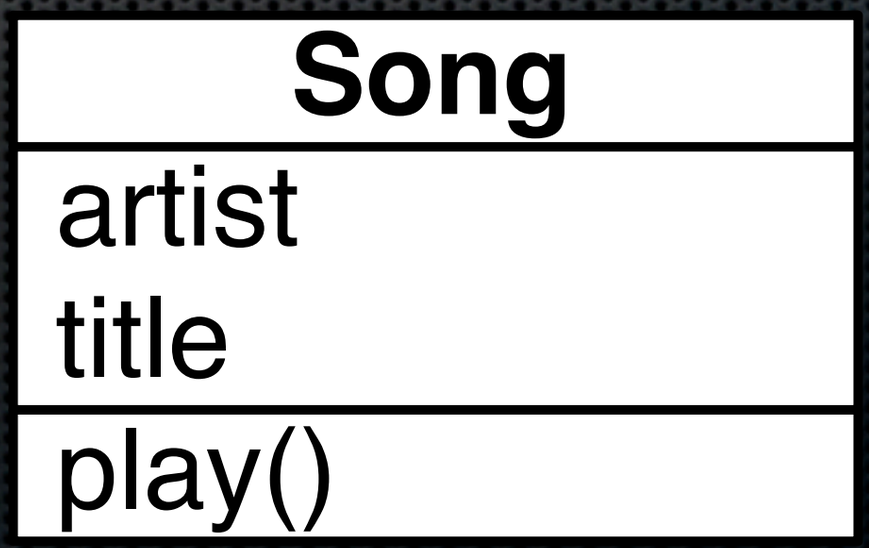
- Classes can define “class wide” (aka static) attributes and methods
  - A static attribute is shared among a class’s objects
  - A static method does not have to be accessed via an object; you invoke static methods directly on a class
  - We will see uses for static attributes and methods throughout the semester

Classes by Analogy

- Address Book
  - Each card in an address book is an “instance” or “object” of the `AddressBookCard` class
    - Each card has the same blank fields (attributes)
    - You can do similar things to each card
      - each card has the same set of methods
  - The number of cards in the book is an example of a static attribute; sorting the cards alphabetically is an example of a static method

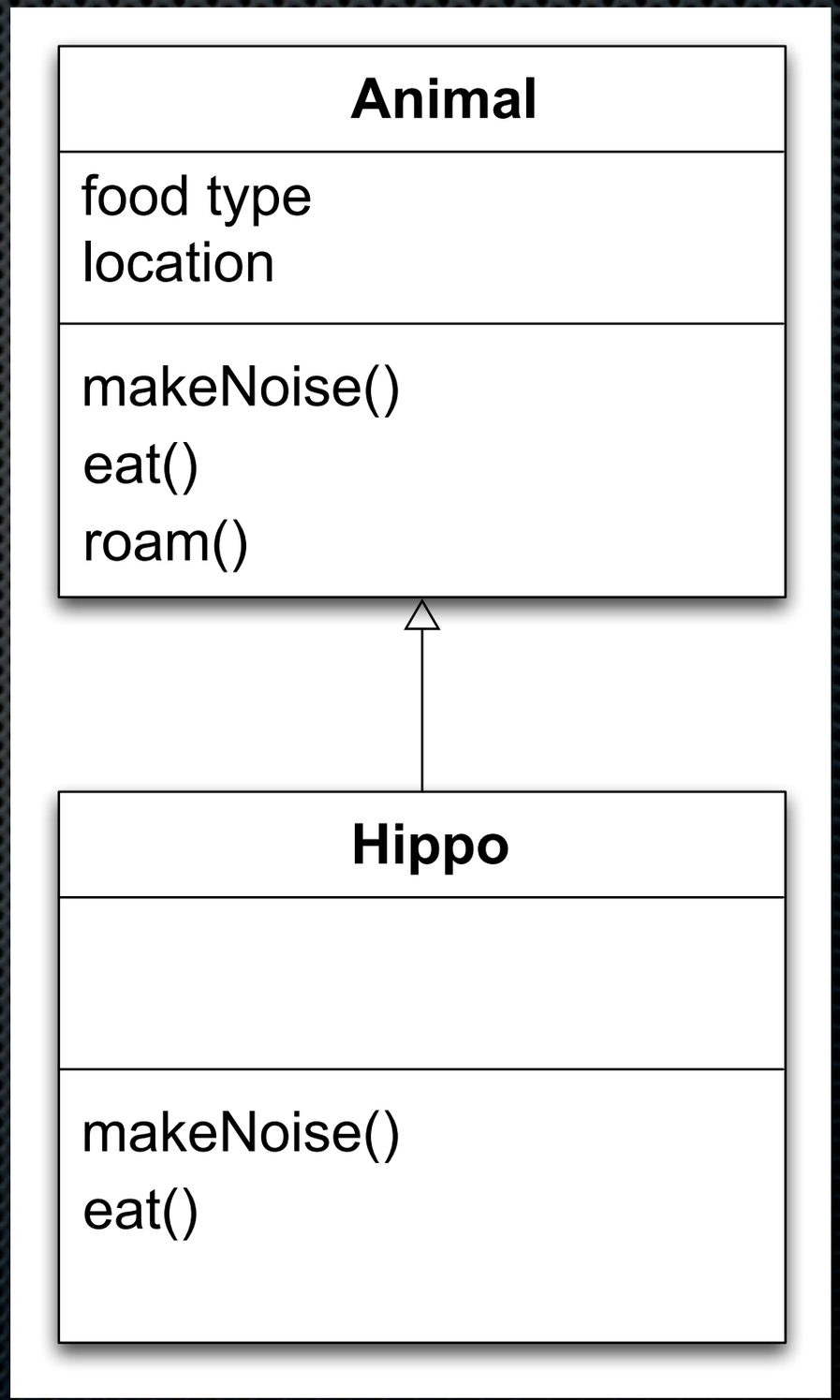
Classes (IV)

- UML Notation
  - Classes appear as rectangles with multiple parts
    - The first part contains its name (defines a type)
    - The second part contains the class's attributes
    - The third part contains the class's methods



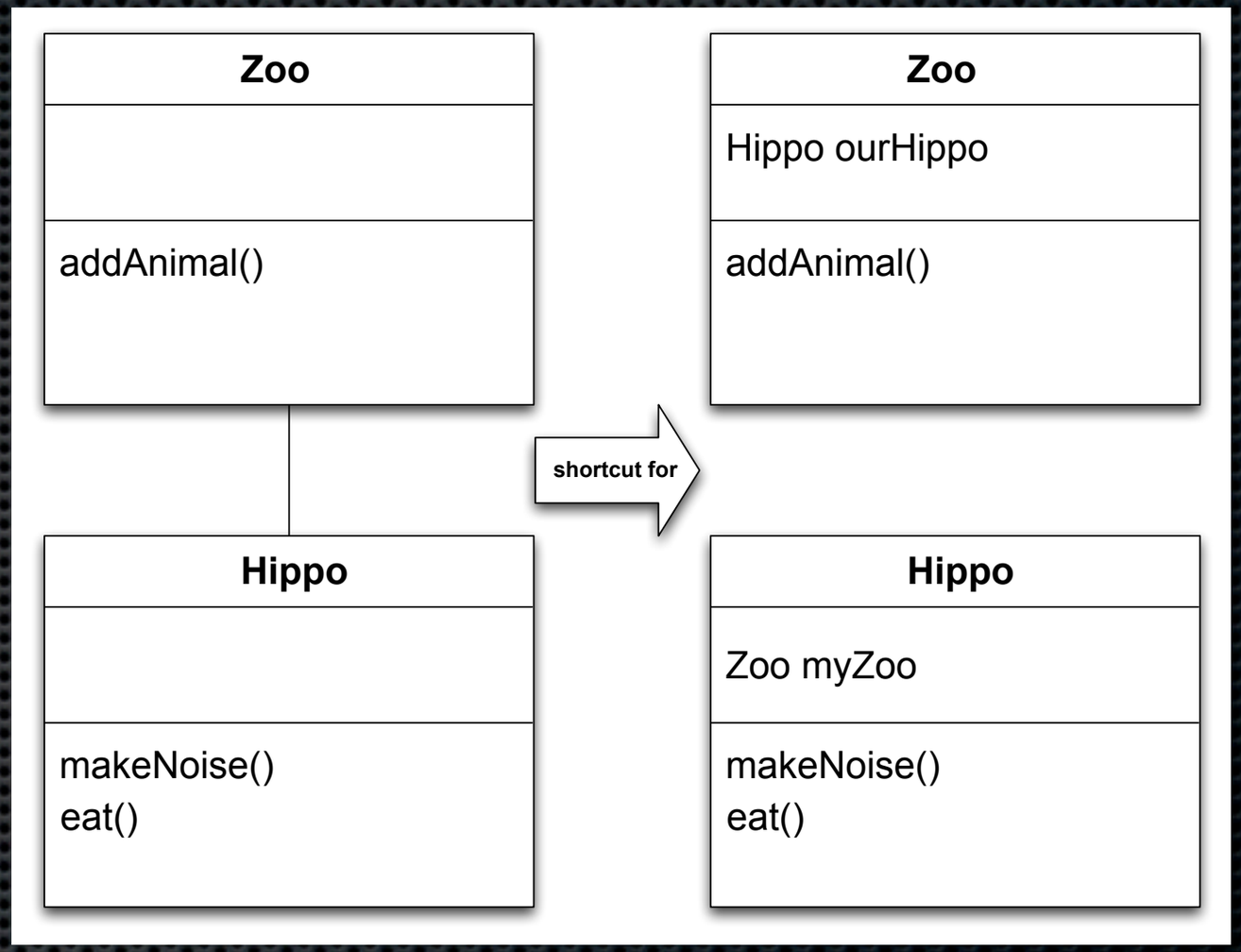
Relationships: Inheritance

- Classes can be related in various ways
  - One class can extend another (aka inheritance)
    - notation: an open triangle points to the superclass
  - As we learned last time, the subclass can add behaviors or override existing ones



Relationships: Association

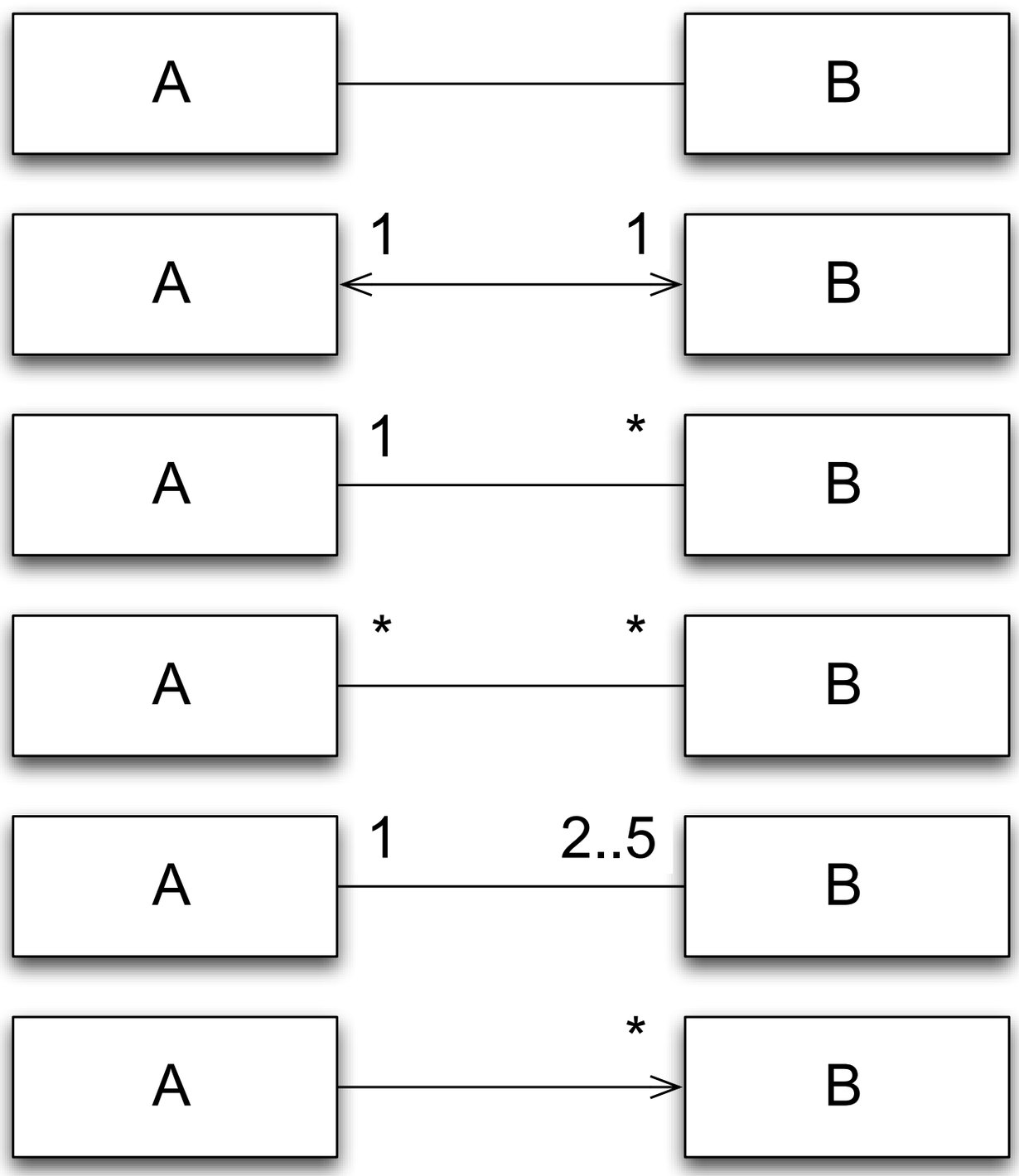
- One class can reference another (aka association)
  - notation: straight line
- This notation is a graphical shorthand that one or both classes contain an attribute whose type is the other class



Multiplicity

- Associations can indicate the number of instances involved in the relationship
  - this is known as multiplicity
- An association with no markings is “one to one”
- An association can also indicate directionality
- Examples on next slide

Multiplicity Examples



One B with each A; one A with each B

Same as above

Zero or more Bs with each A; one A with each B

Zero or more Bs with each A; ditto As with each B

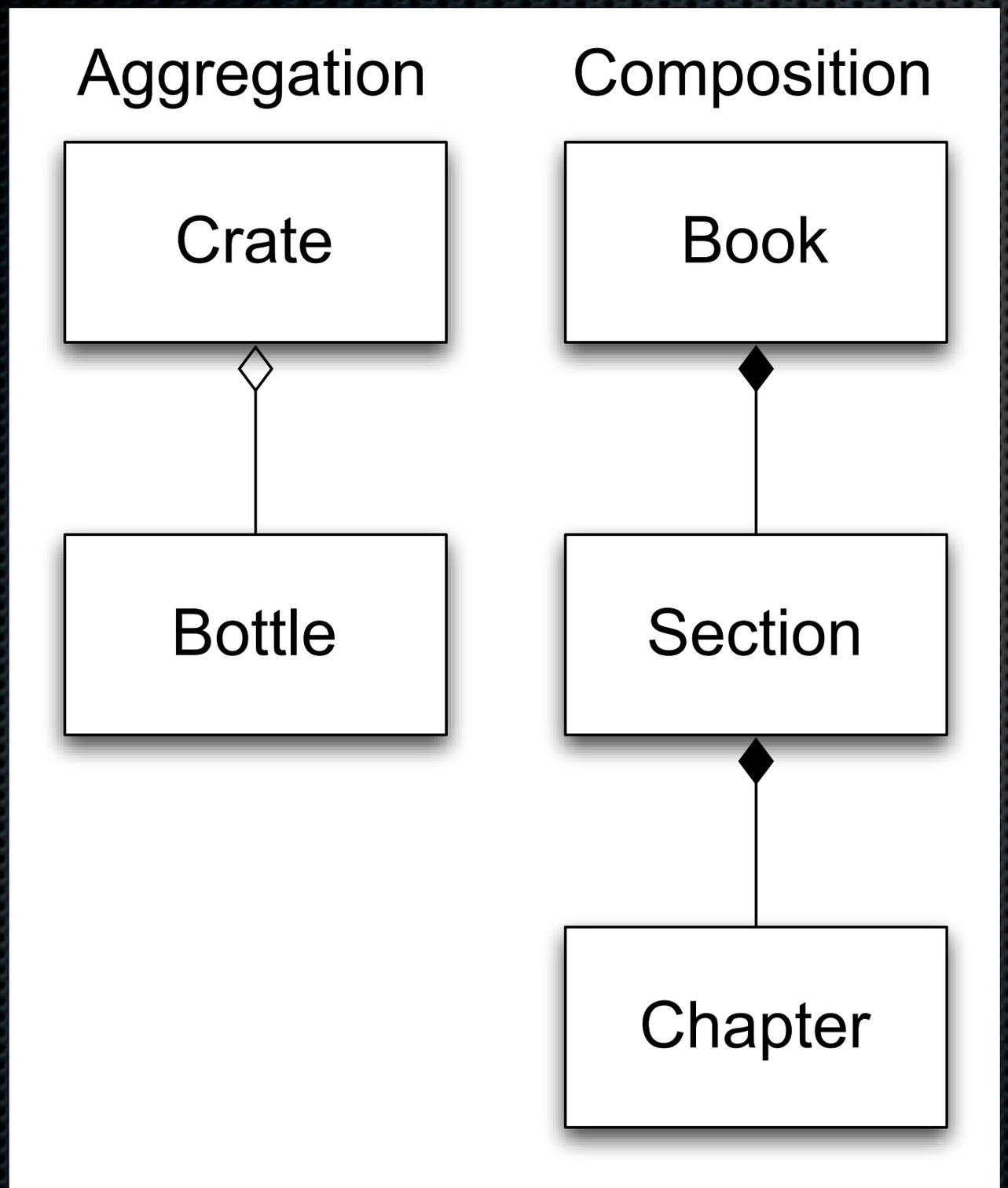
Two to Five Bs with each A; one A with each B

Zero or more Bs with each A; B knows nothing about A

Relationships: whole-part

- Associations can also convey semantic information about themselves
  - In particular, aggregations indicate that one object contains a set of other objects
    - think of it as a whole-part relationship between
      - a class representing a group of components
      - a class representing the components
  - Notation: aggregation is indicated with a white diamond attached to the class playing the former role

Example: Aggregation



Composition will be defined on the next slide

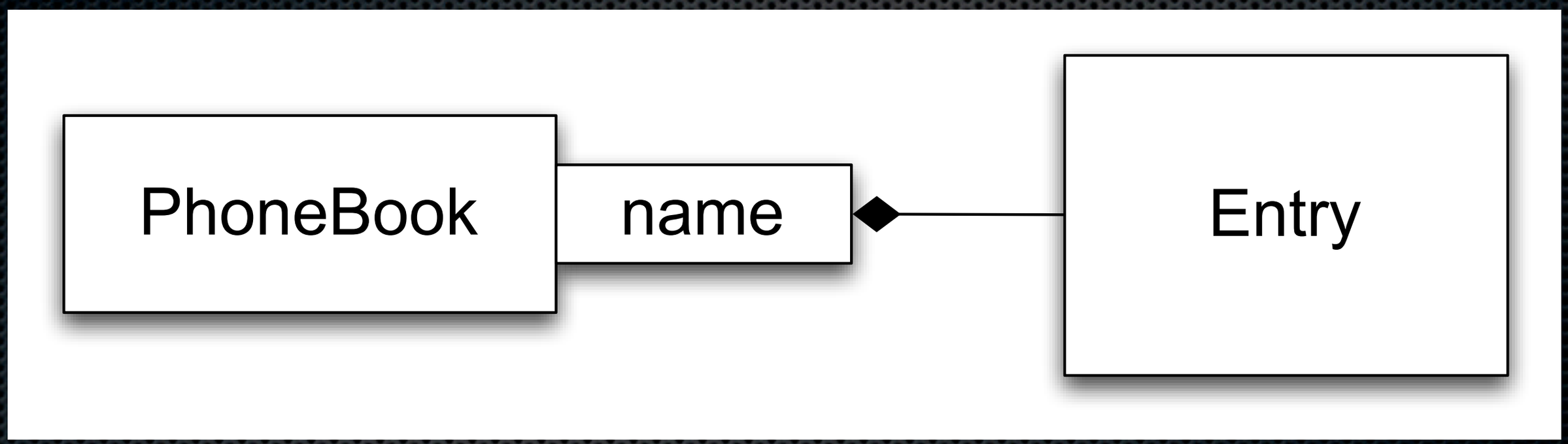
Semantics of Aggregation

- Aggregation relationships are transitive
  - if A contains B an B contains C, then A contains C
- Aggregation relationships are asymmetric
  - If A contains B, then B does not contain A
- A variant of aggregation is composition which adds the property of existence dependency
  - if A composes B, then if A is deleted, B is deleted
- Composition relationships are shown with a black diamond attached to the composing class

Relationships: Qualification

- An association can be qualified with information that indicates how objects on the other end of the association are found
  - This allows a designer to indicate that the association requires a query mechanism of some sort
  - e.g., an association between a phonebook and its entries might be qualified with a name, indicating that the name is required to locate a particular entry
  - Notation: a qualification is indicated with a rectangle attached to the end of an association indicating the attributes used in the query

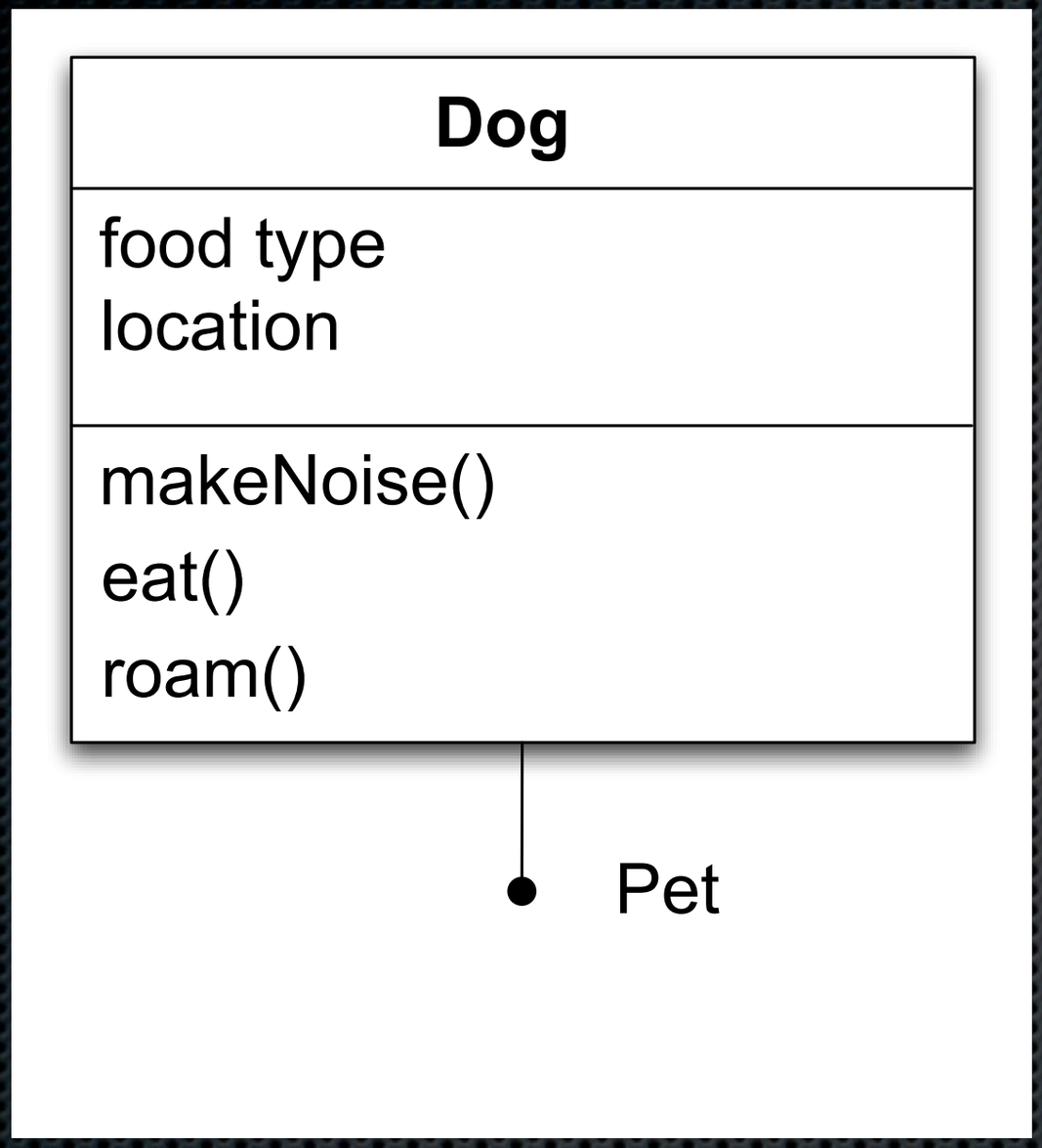
Qualification Example

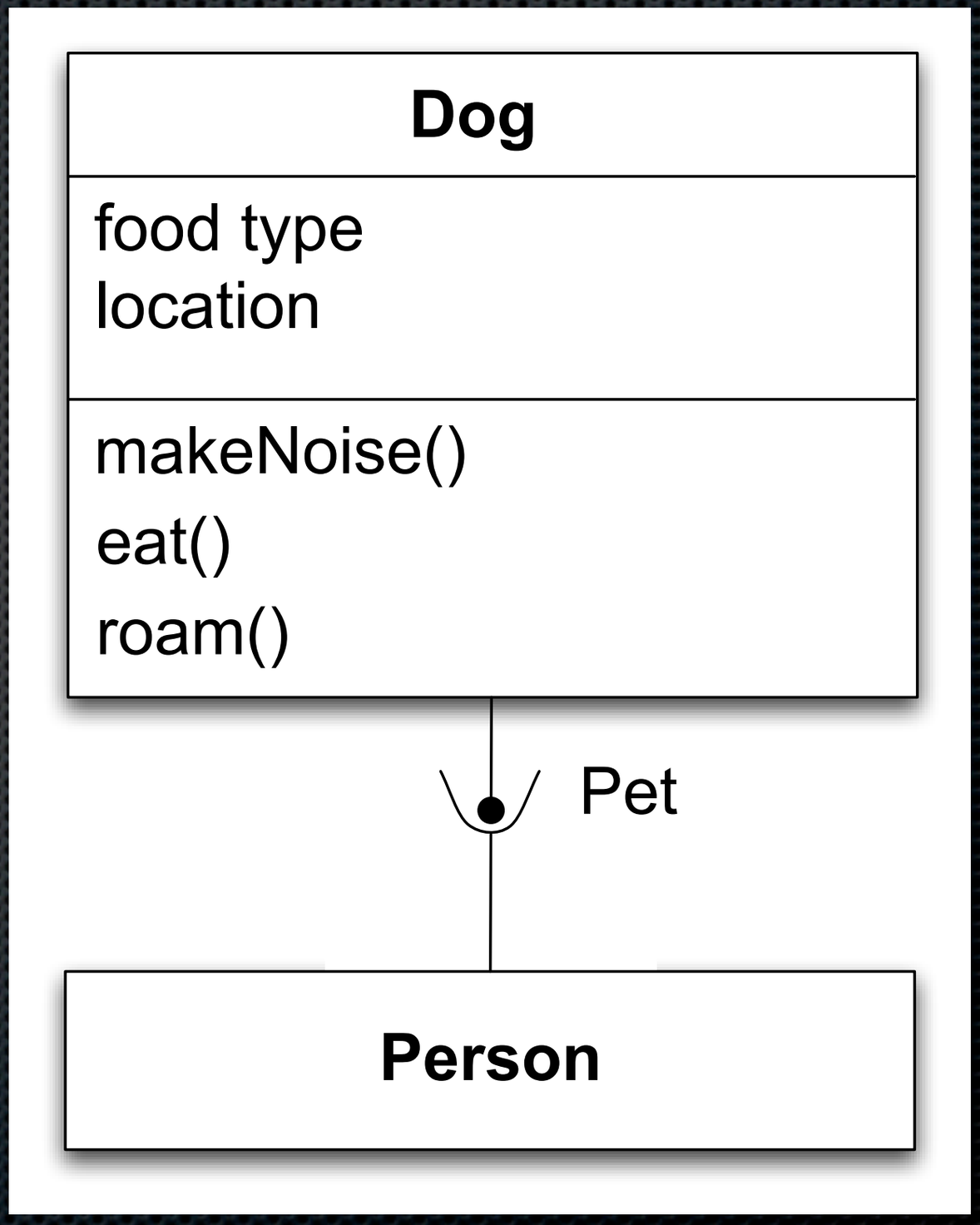


Relationships: Interfaces

- A class can indicate that it implements an interface
  - An interface is a type of class definition in which only method signatures are defined
- A class implementing an interface provides method bodies for each defined method signature
  - This allows a class to offer multiple types of services that are independent of its inheritance relationships
- Other classes can then access a class via an interface
  - This is indicated via a “ball and socket” notation

Example: Interfaces





Class Summary

- Classes are blue prints used to create objects
- Classes can participate in multiple relationship types
  - inheritance
  - association
    - associations have multiplicity
  - aggregation/composition
  - qualification
  - interfaces

Coming Up Next

- Lecture 4: Object Fundamentals, Part 3
- Lecture 5: Great Software
  - Read Chapter 1 of the OO A&D book