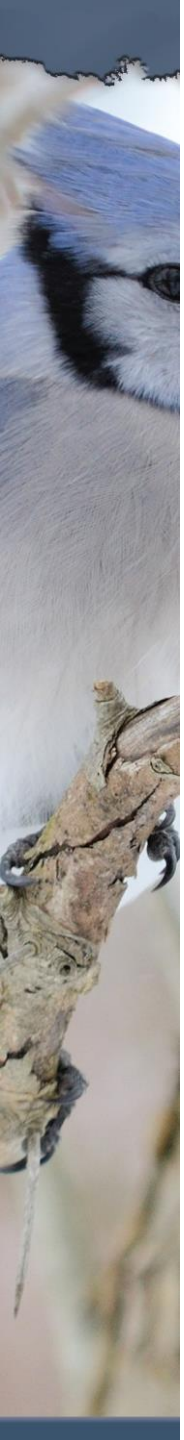
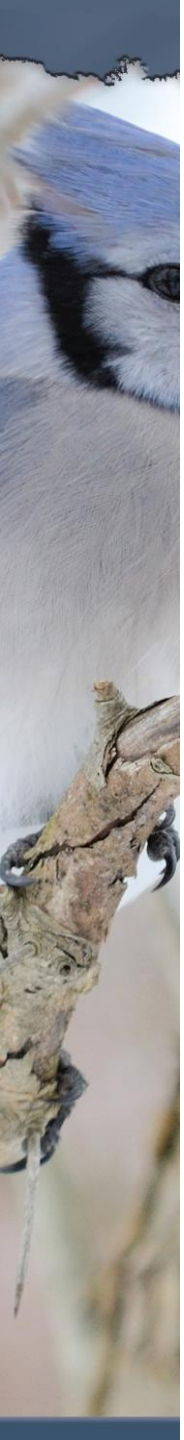


Understanding class and object definitions

Looking inside classes and exploring source code

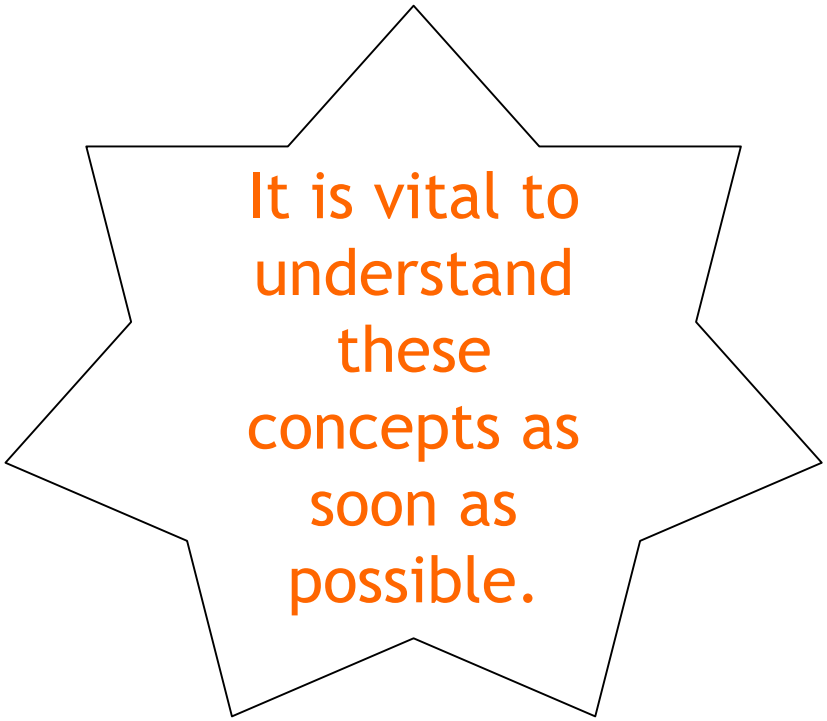


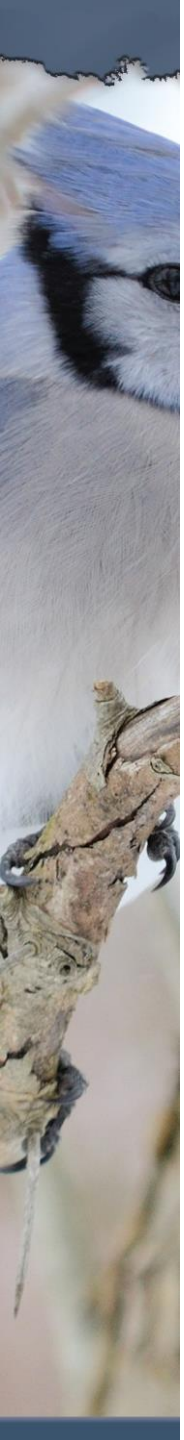
Classes and objects

- Fundamental to much of the early parts of this course
- Class: category or type of ‘thing’ (Like a template or blueprint)
- Object: belongs to a particular class and has individual characteristics
- Explore through BlueJ …

Fundamental concepts

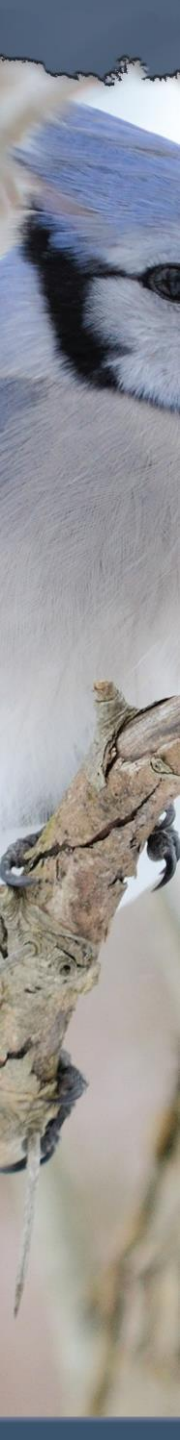
- object
- class
- method
- parameter
- data type





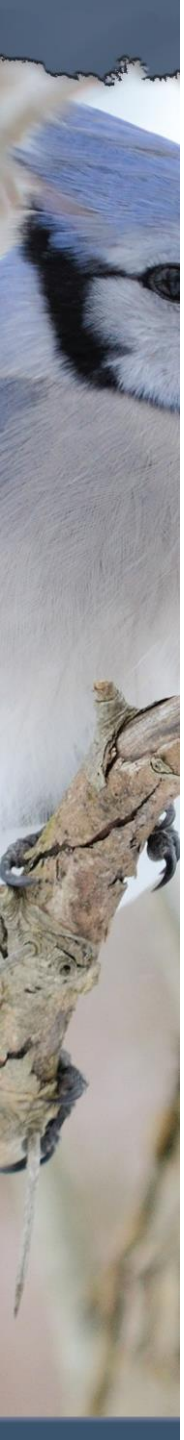
Classes and Objects

- Classes (noun)
  - Represents *ALL generic objects* of a similar kind or type
  - e.g. Car
- Objects (proper noun)
  - Represents *ONE specific thing* from the real world or some problem domain
  - e.g. THAT red car in the garage or YOUR green car in the parking lot



Methods and Parameters

- Methods (verbs)
  - Objects have operations which can be invoked on a specific object
  - e.g. *drive* the red car
- Parameters (adverbs)
  - Additional necessary information may be passed to the method to help with its execution
  - e.g. drive the red car *for 10 miles*



Other observations

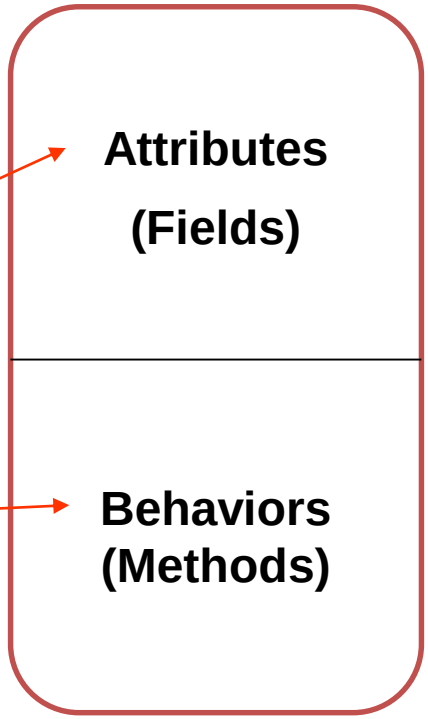
- Many distinct *instances* can be created from a single class
- An object has *attributes* that are values stored in *fields*
- The CLASS defines what FIELDS an object has
- But each OBJECT stores its own set of VALUES (the *state* of the object)

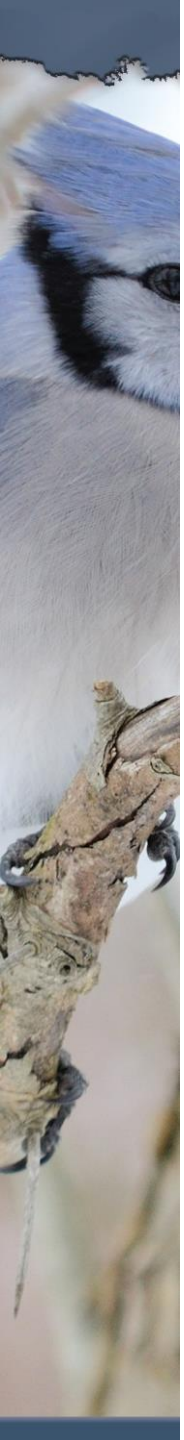
Definitions summary

Class

- A blueprint for objects of a particular type
- Defines the structure (number, types) of the attributes
- Defines available behaviors of its objects

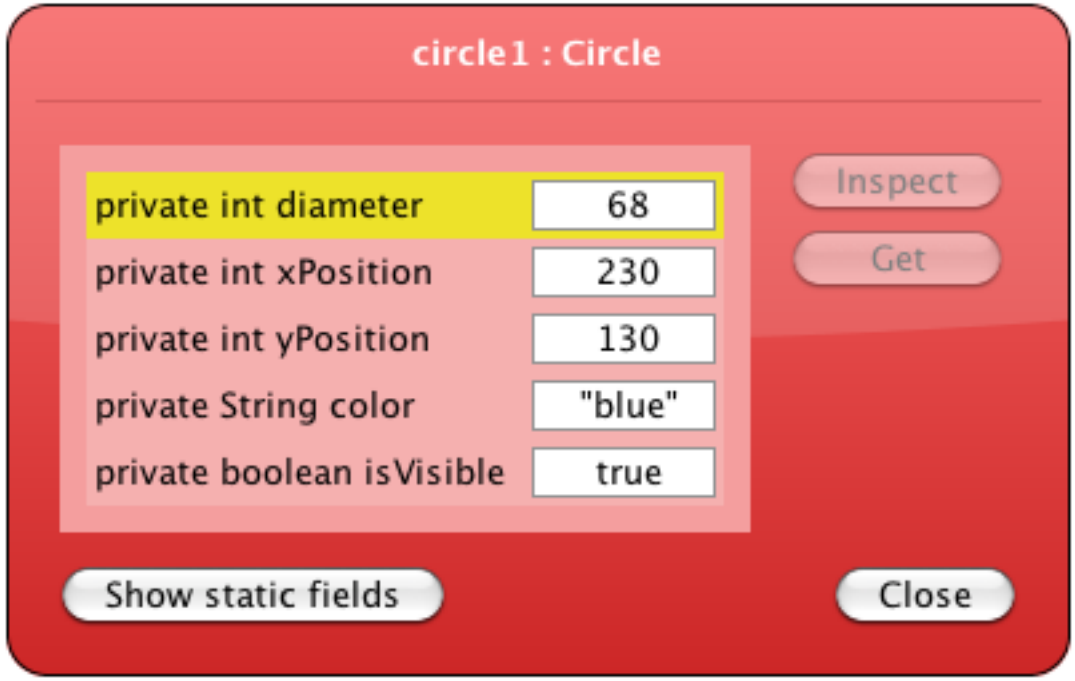
Object



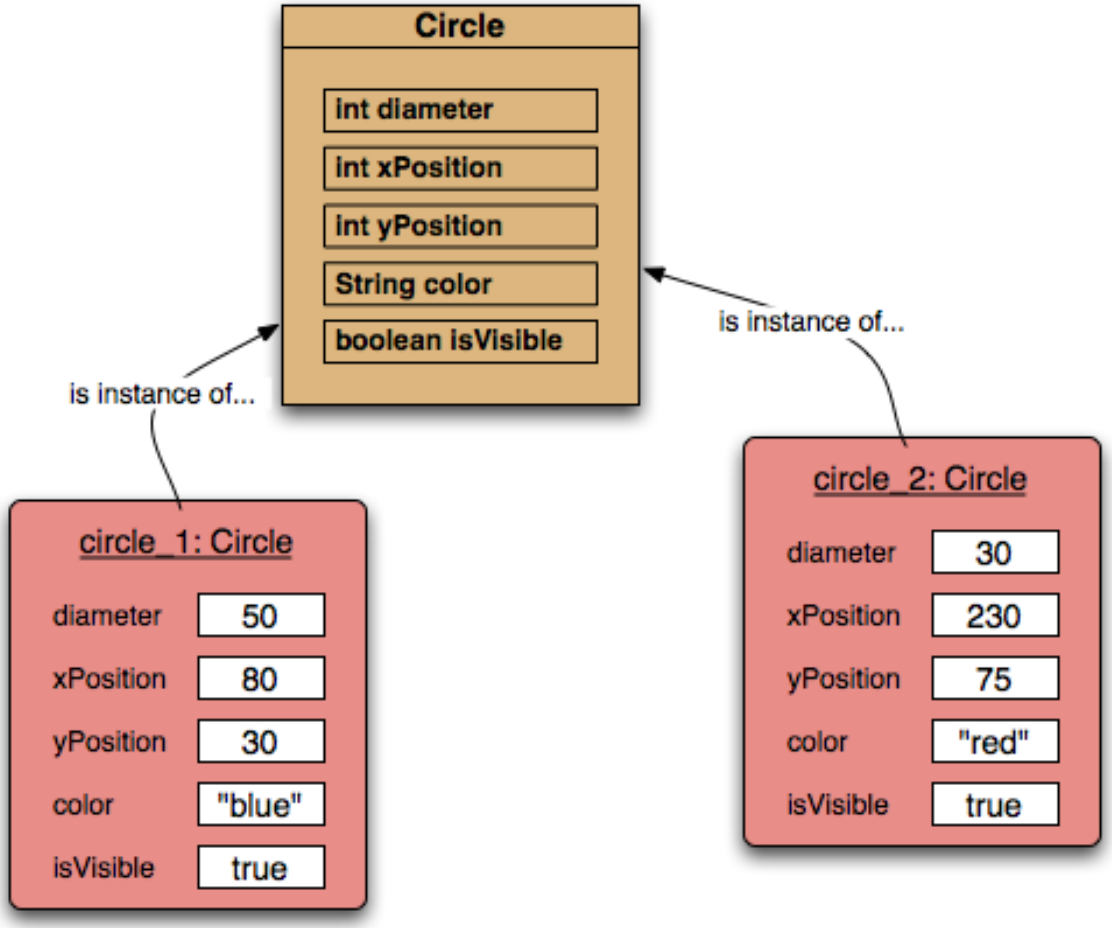


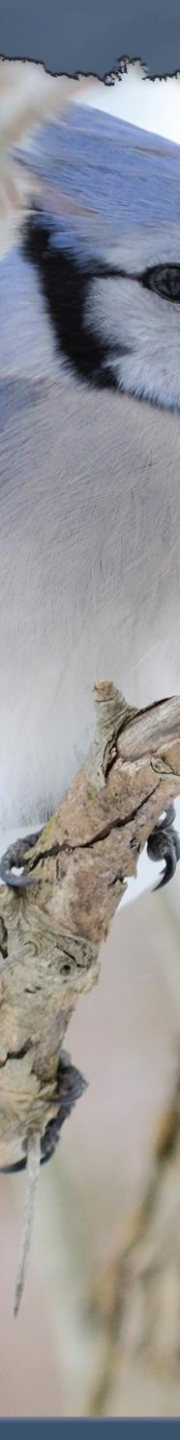
Demo of figures project

State



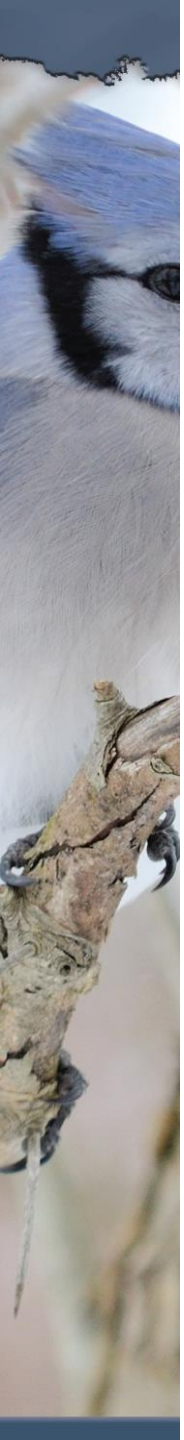
Two circle objects





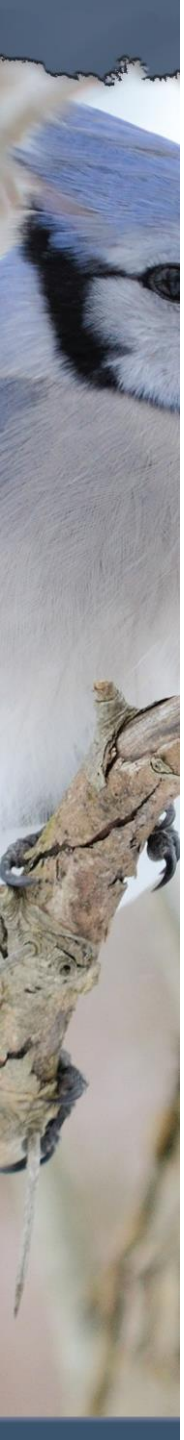
Source code

- Each class has its own JAVA source code associated with it that defines its details (attributes and methods)
- The source code is written to obey the rules of a particular programming language (i.e. JAVA)
- We will explore this in detail in the next chapter



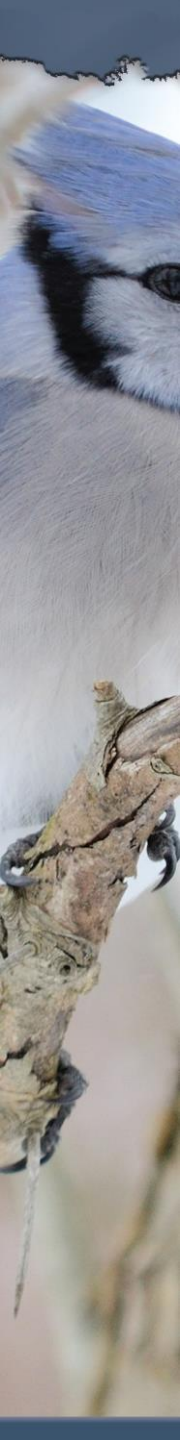
Return values

- All the methods in the *figures* project have **`void`** return types
- But methods may return a result via a return value that is not **`void`**
- Such methods will have a specific non-**`void`** return data type
- More on this in the next chapter



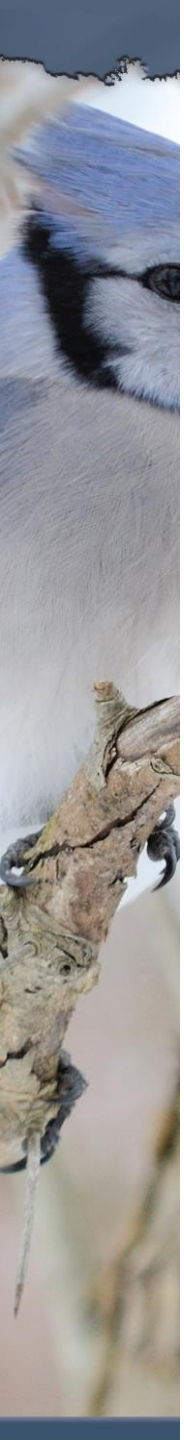
Main concepts to be covered in the rest

- fields
- constructors
- methods
- parameters
- assignment statements



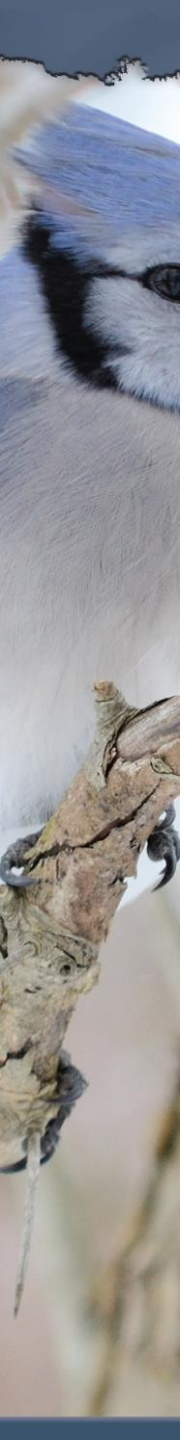
Ticket machines

Demo of
naïve-ticket-machine



Ticket machines – an external view

- Exploring the behavior of a typical ticket machine using *naive-ticket-machine* project that supplies tickets of a fixed price
  - How is that price determined?
  - How does a machine keep track of the money that is entered so far?
  - How does a machine keep track of the total amount of money collected?
  - How is ‘money’ entered into a machine?
  - How does the machine issue the ticket?



Ticket machines – an internal view

- Interacting with an object gives us clues about its behavior
- Looking inside allows us to determine how that behavior is provided or implemented
- All Java classes have a similar-looking internal view

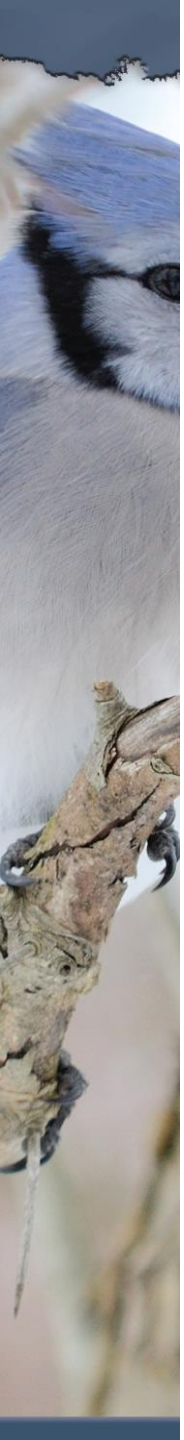
Basic class structure

```
public class TicketMachine
{
    Inner part omitted
}
```

The outer wrapper of TicketMachine

```
public class ClassName
{
    Fields

    Constructors

    Methods
}
```

The inner contents of a class



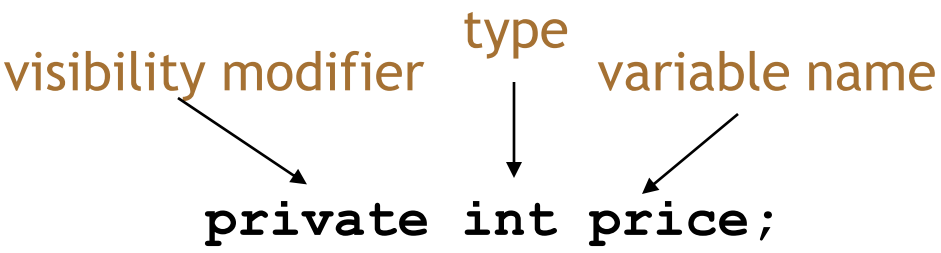
Keywords

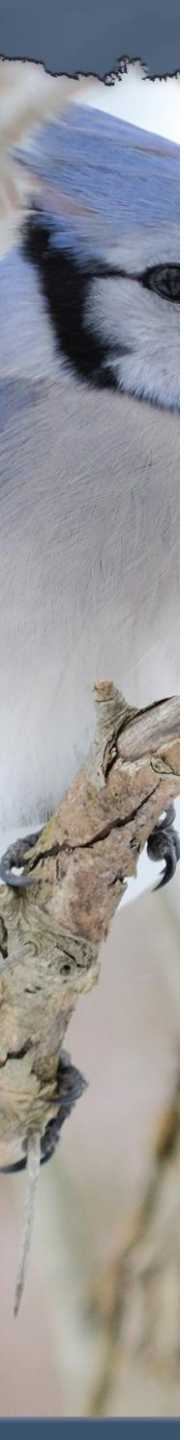
- Words with a special meaning in the language:
  - `public`
  - `class`
  - `private`
  - `int`
- Also known as *reserved words*
- Always entirely lower-case

Fields

- Fields store *values* for an object
- They are also known as *instance variables*
- Fields define the *state* of an object
- Use *Inspect* in BlueJ to view the state
- Some values change often
- Some change rarely (or not at all)

```
public class TicketMachine
{
    private int price;
    private int balance;
    private int total;

    Further details omitted.
}
```





Visibility

- Private members
  - Can be accessed only by instances of same class
  - Provide concrete implementation / representation
- Public members
  - Can be accessed by any object
  - Provide abstract view (client-side)
- Protected members
  - Can be accessed by instances of the same class and its subclasses

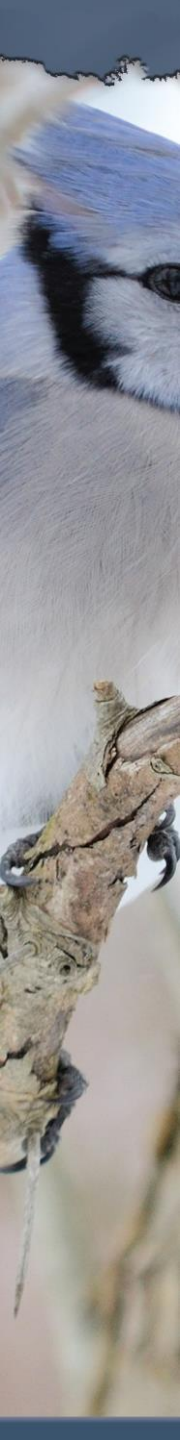
Declaration with an access modifier

- Each class declaration that begins with the access modifier public must be stored in a file that has **exactly the same name** as the class and ends with the **.java** file-name extension.

Constructors

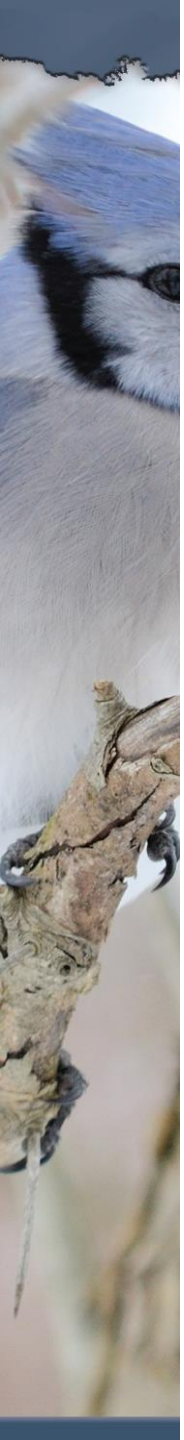
```
public TicketMachine(int cost)
{
    price = cost;
    balance = 0;
    total = 0;
}
```

- Initialize an object
- Have the same name as their class
- Close association with the fields:
  - Initial values stored into the fields
  - Parameter values often used for these



Constructors (cont.)

- A constructor is a procedure for creating objects of the class.
- Keyword new requests memory from the system to store an object, then calls the corresponding class's constructor to initialize the object.
- A constructor often initializes an object's fields.
- Constructors do not have a return type (not even void) and they do not return a value.
- All constructors in a class have the same name — **the name of the class**.
- Constructors may take parameters.



Constructors (cont.)

- If a class has more than one constructor, they must have different numbers and/or types of parameters.
- Programmers often provide a "no-args" constructor that takes no parameters (a.k.a. *arguments*).
- If a programmer does not define any constructors, Java provides one default (no-args) constructor, which allocates memory and sets fields to the default values.

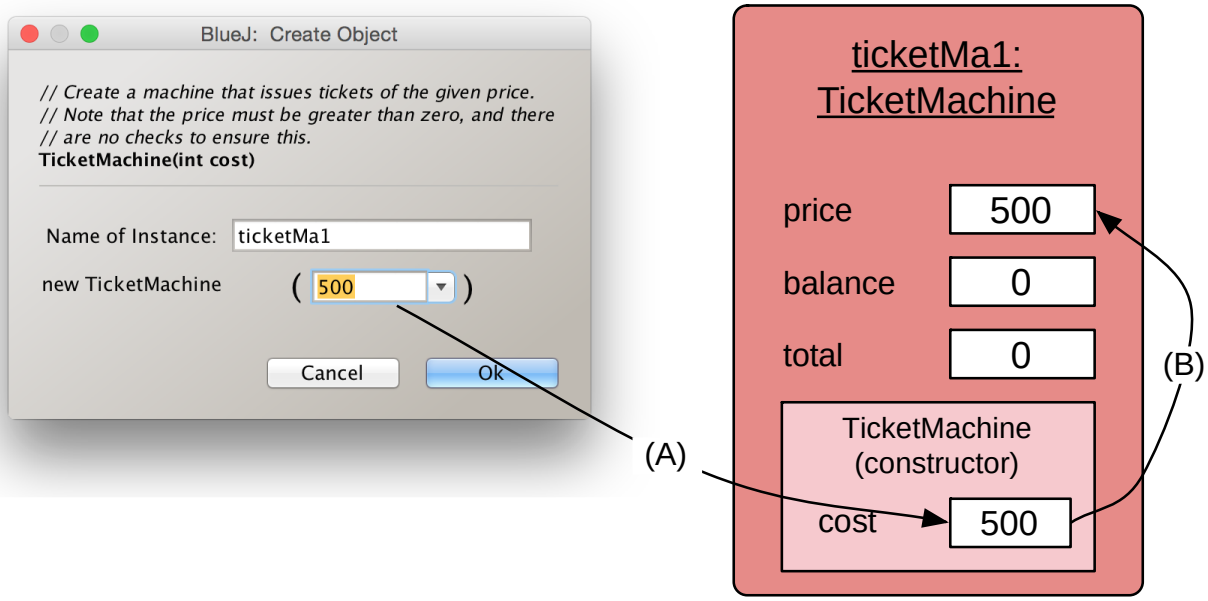
Constructors (cont.)

A nasty bug:

```
public class MyClass
 {
   ...
   // Constructor:
   public  void  MyClass (…)
   {
      ...
   }
   ...
```

Compiles fine, but the compiler thinks this is a method and uses **MyClass**'s default no-args constructor instead.

Passing data via parameters



Parameters **are another sort of variable**

Assignment

- Values may be stored into fields and other variables via assignment statements:

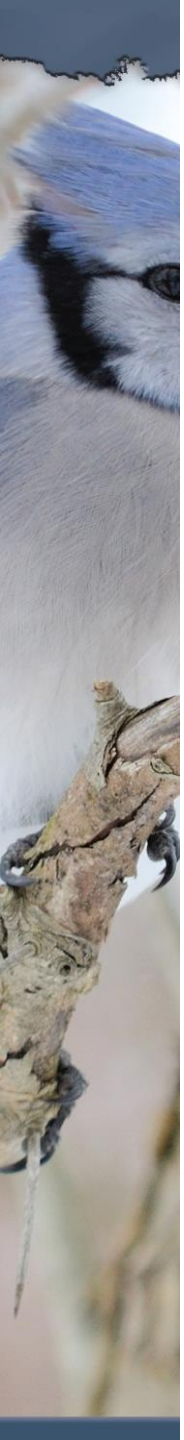
pattern

  - *variable* = *expression*;

example

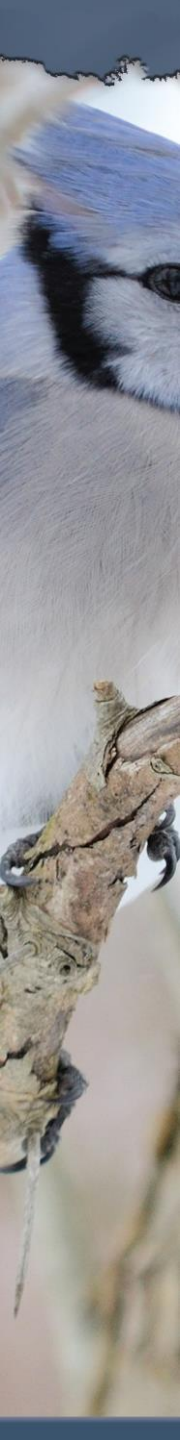
  - `balance = balance + amount;`

- A variable can store just one value, so any previous value is lost



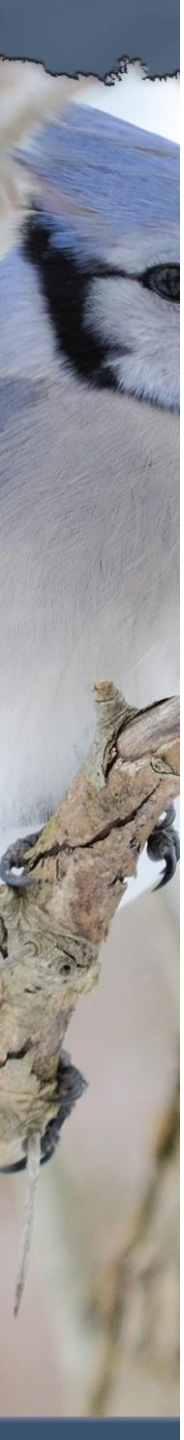
Choosing variable names

- There is a lot of freedom over choice of names … so use it wisely!
- Choose expressive names to make code easier to understand:
  - **`price`**, **`amount`**, **`name`**, **`age`**, etc.
- Avoid single-letter or cryptic names:
  - **`w`**, **`t5`**, **`xyz123`**



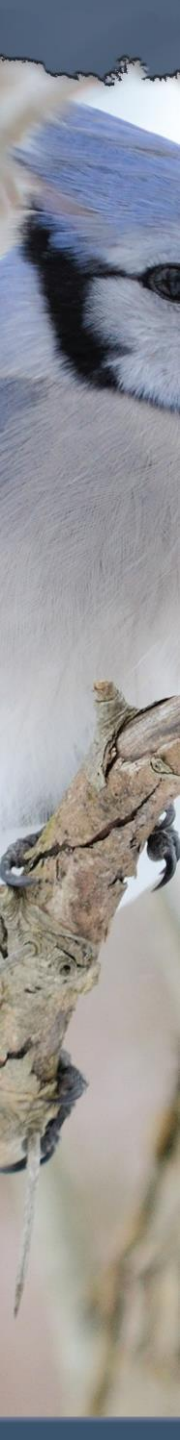
Next concepts to be covered

- String concatenation
- Methods
  - *accessors* and *mutators*
- Conditional statements
- Local variables
- Scope and lifetime



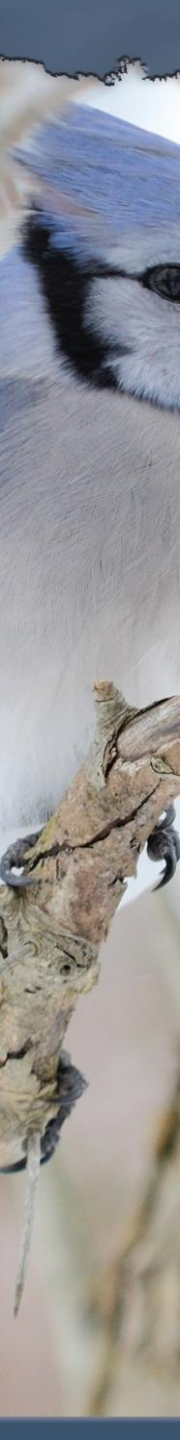
Methods

- Methods implement the *behavior* of objects
- Methods have a consistent structure comprised of a *header* and a *body*
- *Accessor methods* provide information about an object
- *Mutator methods* alter the state of an object
- Other sorts of methods accomplish a variety of tasks (e.g. Print methods)



Method structure

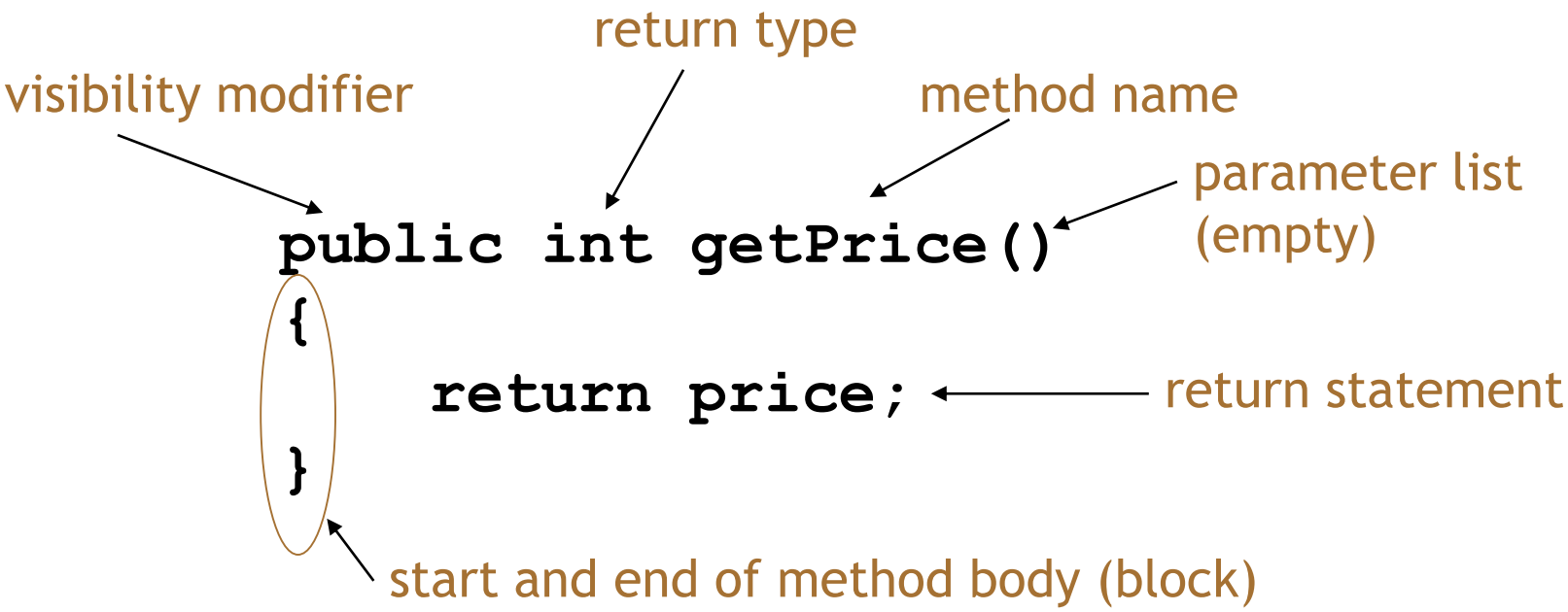
- The header provides the method's *signature*:
  - `public int getPrice()`
- The header tells us:
  - the *visibility* to objects of other classes (e.g. public, private or protected)
  - whether the method *returns a result*
  - the *name* of the method
  - whether the method takes *parameters*
- The body encloses the method's *statements* within curly braces { }

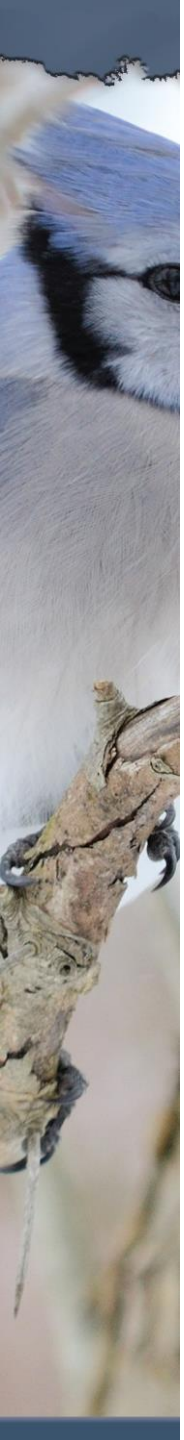


Method summary

- Methods implement all object behaviour
- A method has a name and a return type
  - The return-type may be **`void`**
  - A non-**`void`** return type means the method will return a value to its caller
- A method might take parameters
  - Parameters bring values in from outside for the method to use

Accessor (`get`) methods





Accessor methods

- An *accessor* method always has a return type that is not **`void`**
- An *accessor* method returns a value (*result*) of the type given in the header
- The method will contain a ***`return`*** statement to return the value
- NOTE: Returning is *not* printing!

Test

```
public class CokeMachine
{
   private price;

   public CokeMachine()
   {
      price = 300
   }

   public int getPrice
   {
      return Price;
   }
```

- What is wrong here?

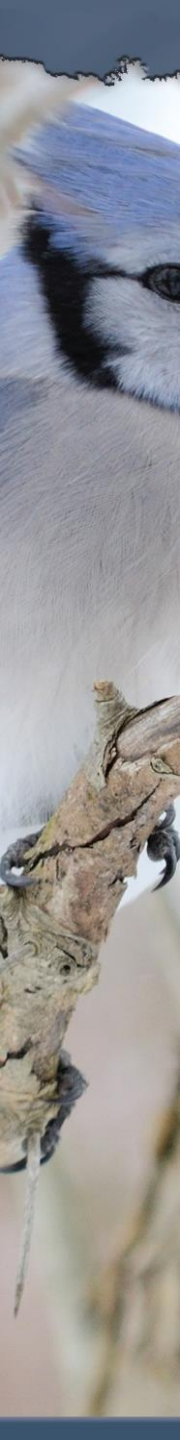
(there are five errors!)

Test

```
public class CokeMachine
{
   private int price;

   public CokeMachine()
   {
      price = 300;
   }

   public int getPrice()
   {
      return Price;
   }
}
```

- What is wrong here?

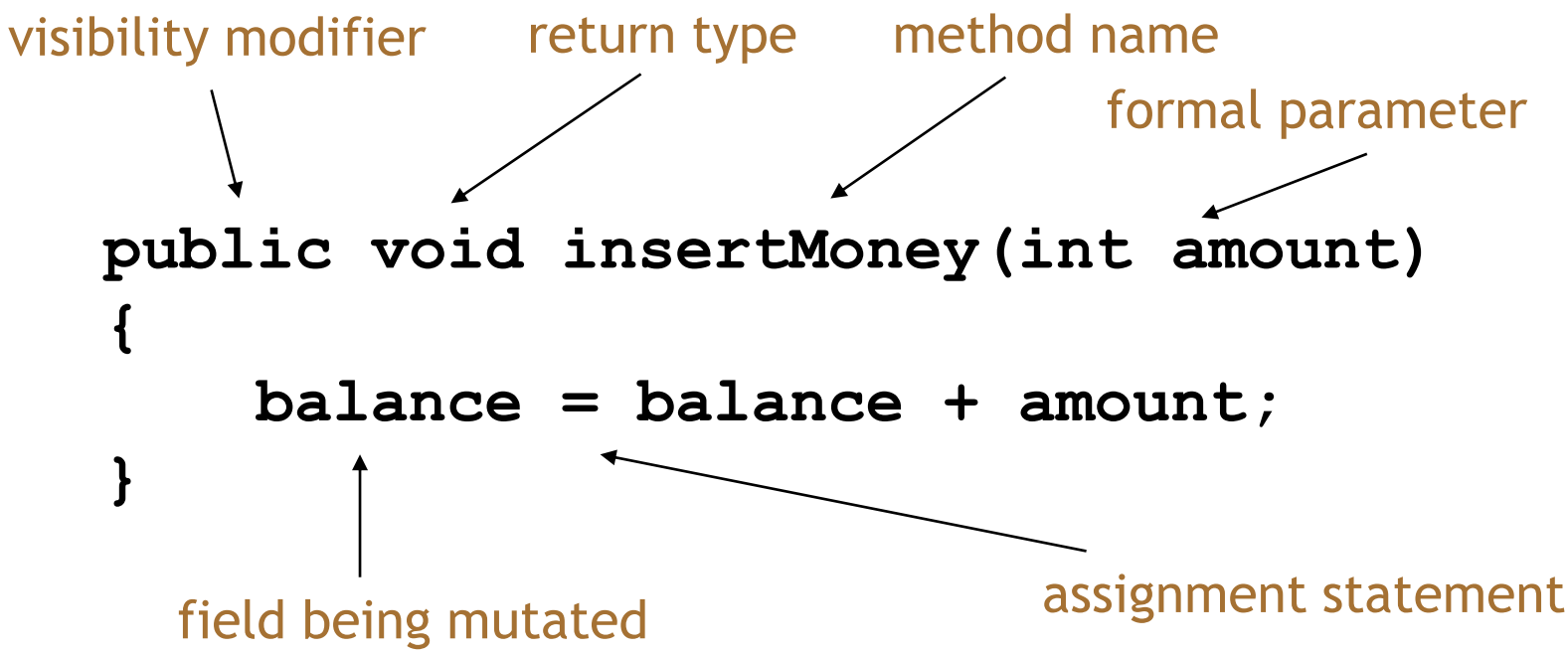
(there are five errors!)



Mutator methods

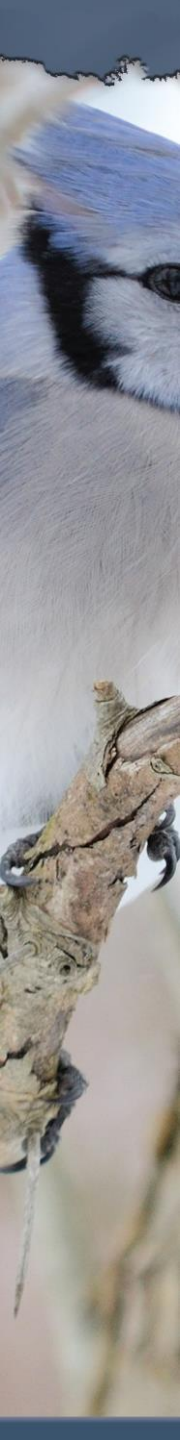
- Have a similar method structure: header and body
- Used to *mutate* (i.e. change) an object's state
- Achieved through changing the value of one or more fields
  - Typically contain one or more assignment statements
  - Often receive parameters

Mutator methods



Compound assignment operators (e.g. +=, -=, *=, /=)

```
balance += amount;
```



`set` mutator methods

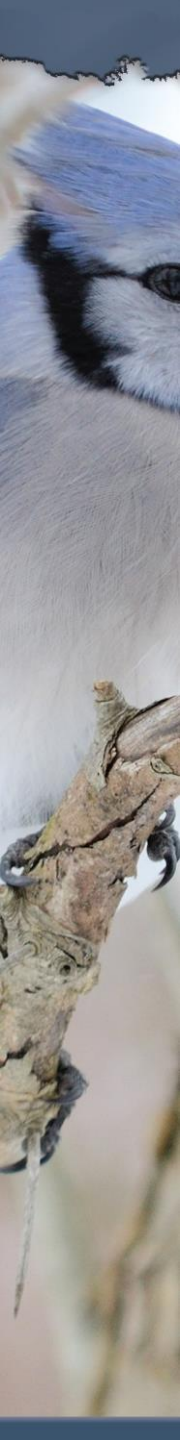
- Fields often have dedicated **`set`** mutator methods
- These have a simple, distinctive form:
  - **`void`** return type
  - method name related to the field name
  - single formal parameter with the same type as the type of the field
  - a single assignment statement

A typical `set` method

```
public void setDiscount(int amount)
{
    discount = amount;
}
```

We can easily infer that `discount` is a field of type `int`:

```
private int discount;
```



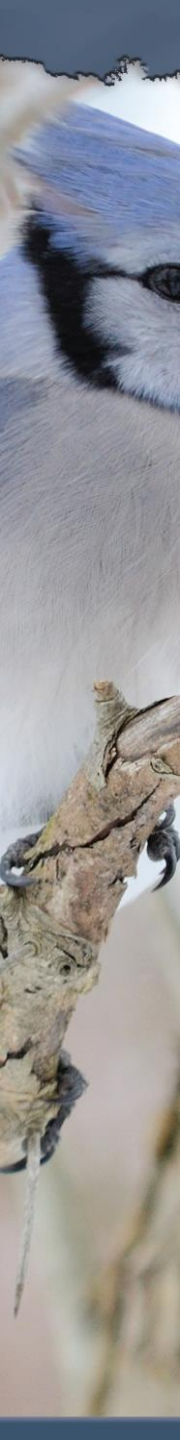
Protective mutators

- A set method does not have to always assign unconditionally to the field
- The parameter may be checked for validity and rejected if inappropriate
- Mutators thereby protect fields
- Mutators support *encapsulation*

String concatenation

- 4 + 5
  9
- "wind" + "ow"
  "window"
- "Result: " + 6
  "Result: 6"
- "# " + price + " cents"
  "# 500 cents"
- 4 + 5 + “window“ + 4 + 5
  “9window45"

→ overloading



Quiz

- System.out.println(5 + 6 + "hello");

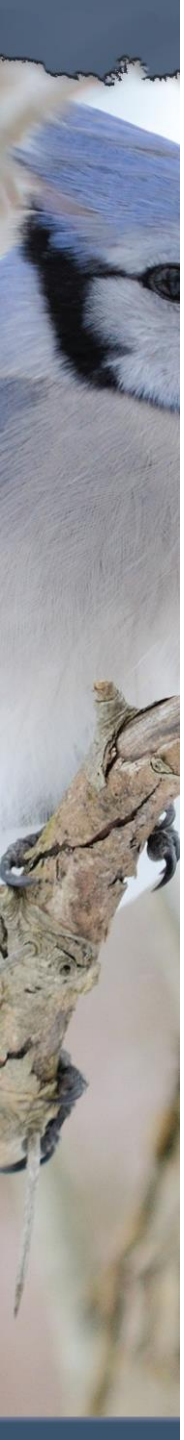
  11hello

- System.out.println("hello" + 5 + 6);

  hello56

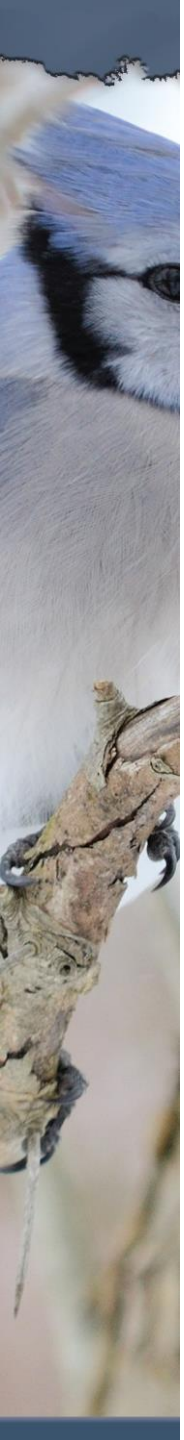
Printing from methods

```
public void printTicket()
{
    // Simulate the printing of a ticket.
    System.out.println("####################");
    System.out.println("# The BlueJ Line");
    System.out.println("# Ticket");
    System.out.println("# " + price + " cents.");
    System.out.println("####################");
    System.out.println();

    // Update the total collected with the balance.
    total = total + balance;

    // Clear the balance.
    balance = 0;
}
```



Reflecting on the ticket machines

- Their behavior is inadequate in several ways:
  - No checks on the amounts entered
  - No refunds
  - No checks for a sensible initialization
- How can we do better?
  - We need the ability to choose between different courses of action



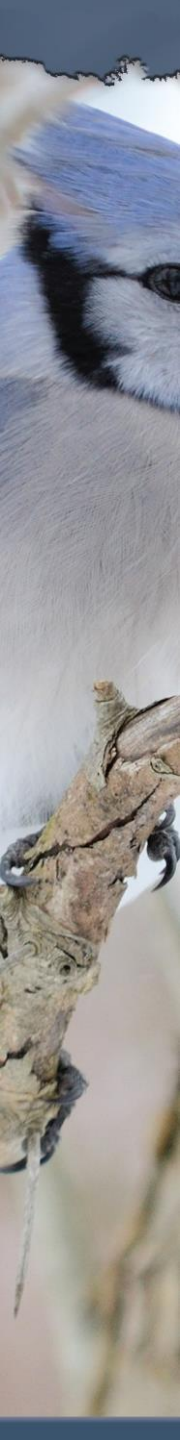
Making choices in everyday life

- If I have enough money left, then I will go out for a meal
- Otherwise, I will stay home and watch a movie

Making a choice in everyday life

```
if(I have enough money left)
{
    I will go out for a meal;
}
else
{
    I will stay home and watch a movie;
}
```

Making choices in Java



‘if’ keyword

boolean condition to be tested

actions if condition is true

```
if(perform some test)
{
    Do these statements if the test gave a true result
}
else
{
    Do these statements if the test gave a false result
}
```

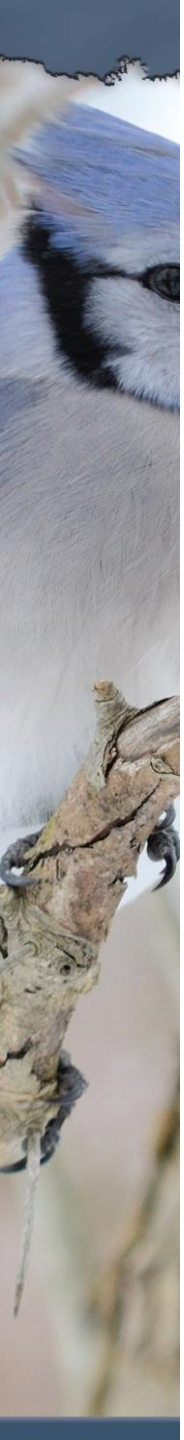
‘else’ keyword

actions if condition is false

Making a choice in the ticket machine

```
public void insertMoney(int amount)
{
    if(amount > 0)
    {
        balance = balance + amount;
    }
    else
    {
        System.out.println(
            "Use a positive amount: "
                + amount);
    }
}
```

conditional statement avoids an inappropriate action

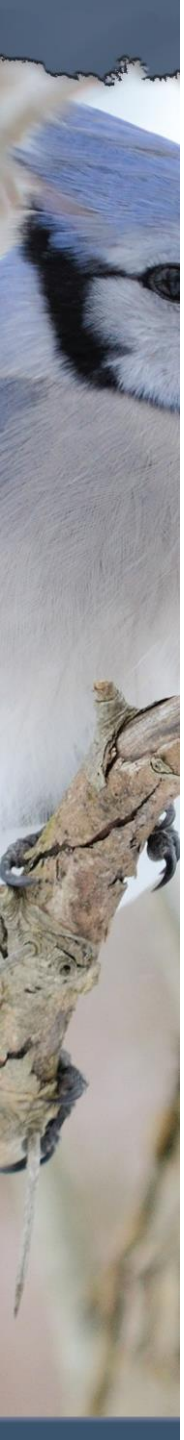


How do we write a method to ‘refund’ an excess balance?

Unsuccessful attempt

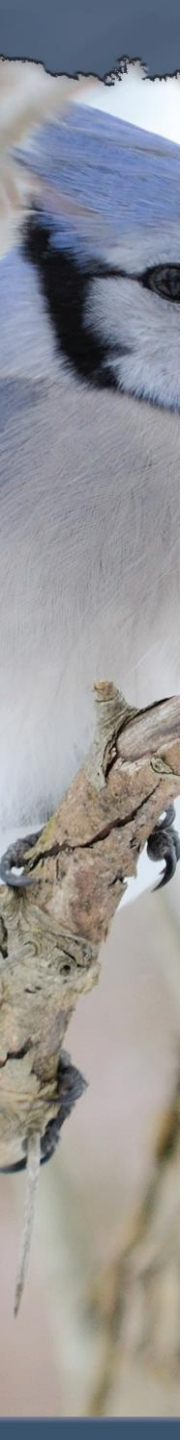
```
public int refundBalance()
{
    // Return the amount left
    return balance;

    // Clear the balance
    balance = 0;
}
```

It looks logical, but the language does not allow it.



Variables – a recap

- Fields are one sort of variable
  - They store values through the life of an object
  - They are accessible throughout the class
- Parameters are another sort of variable:
  - They receive values from outside the method
  - They help a method complete its task
  - Each call to the method receives a fresh set of values
  - Parameter values are short lived



Local variables

- Methods can define their own *local variables*:
  - Short lived just like parameters
  - But MUST be *declared* within the method first
  - Unlike parameters which receives external values, the method MUST *set* their values
  - Used for temporary calculation and storage
  - Exist only as long as method is being executed
  - ONLY accessible from within declared code block
  - ONLY defined within a particular *scope*
  - Storage and values will DISAPPEAR after the method call is completed
  - May NOT be accessed outside of the method

Local variables

A local variable

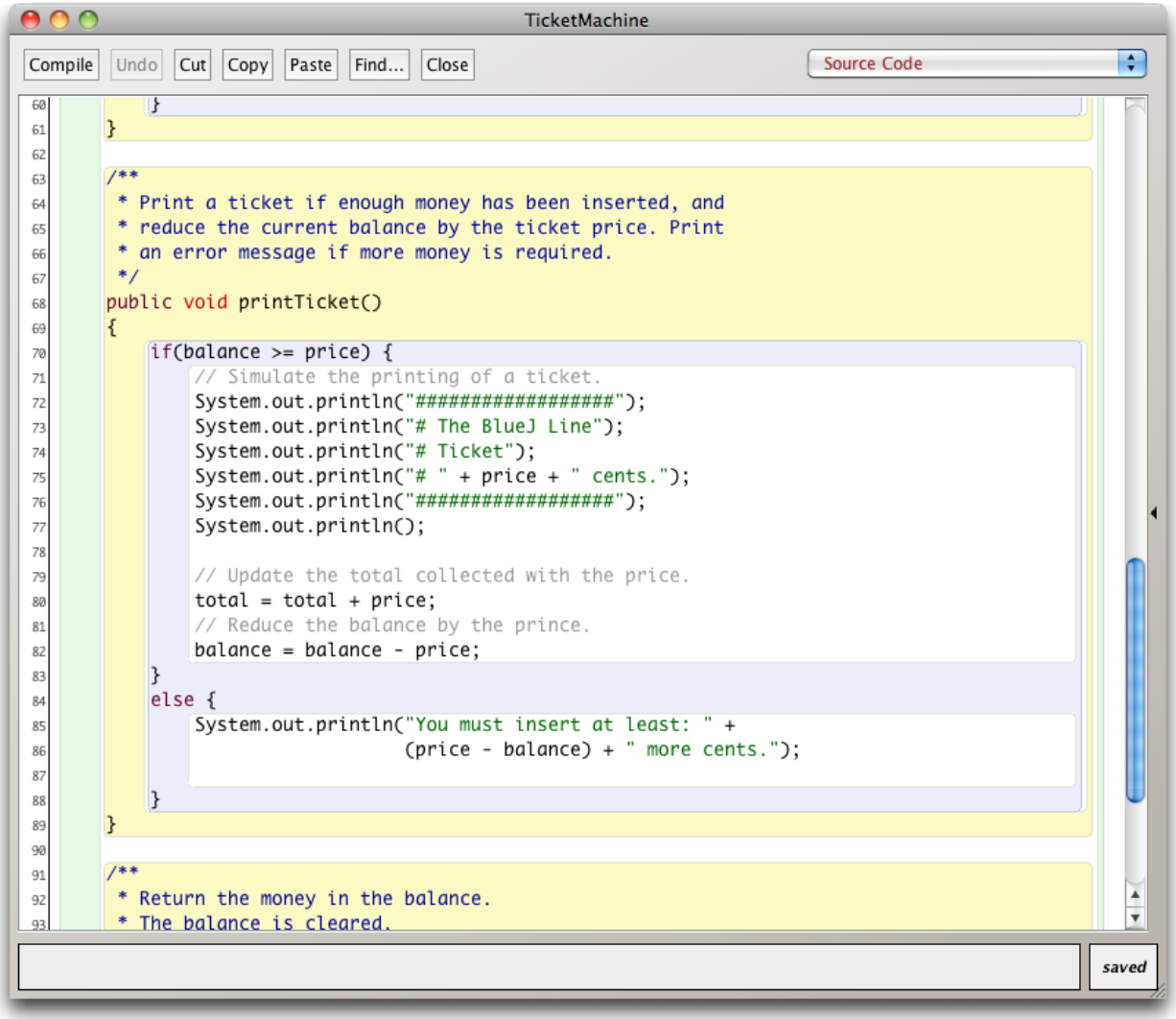
No visibility modifier

```
public int refundBalance()
{
    int amountToRefund;
    amountToRefund = balance;
    balance = 0;
    return amountToRefund;
}
```

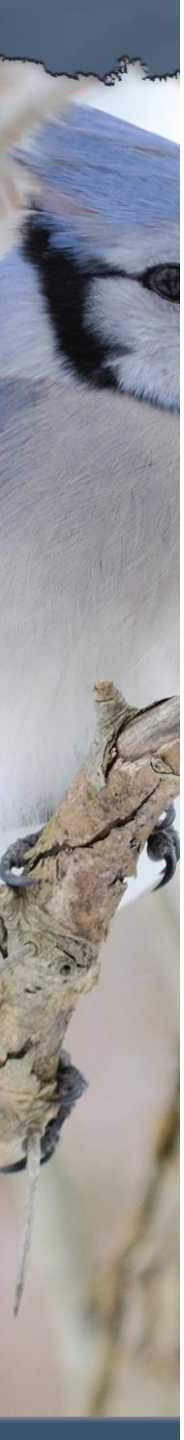
Replace declaration & assignment with:

```
int amountToRefund = balance;
```

Scope highlighting

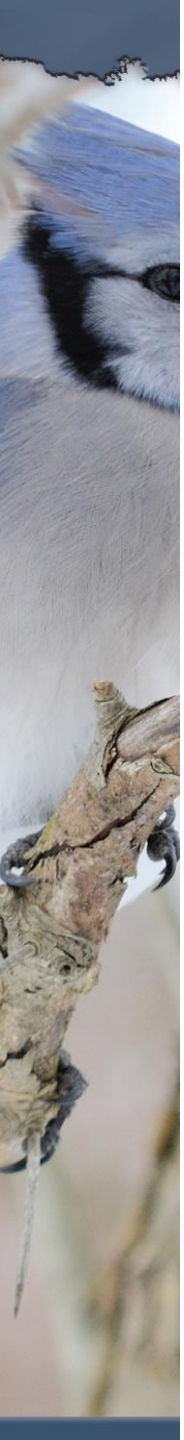



```
    }
}

/**
 * Print a ticket if enough money has been inserted, and
 * reduce the current balance by the ticket price. Print
 * an error message if more money is required.
 */
public void printTicket()
{
    if(balance >= price) {
        // Simulate the printing of a ticket.
        System.out.println("##################");
        System.out.println("# The BlueJ Line");
        System.out.println("# Ticket");
        System.out.println("# " + price + " cents.");
        System.out.println("##################");
        System.out.println();

        // Update the total collected with the price.
        total = total + price;
        // Reduce the balance by the prince.
        balance = balance - price;
    }
    else {
        System.out.println("You must insert at least: " +
                           (price - balance) + " more cents.");

    }
}

/**
 * Return the money in the balance.
 * The balance is cleared.
```



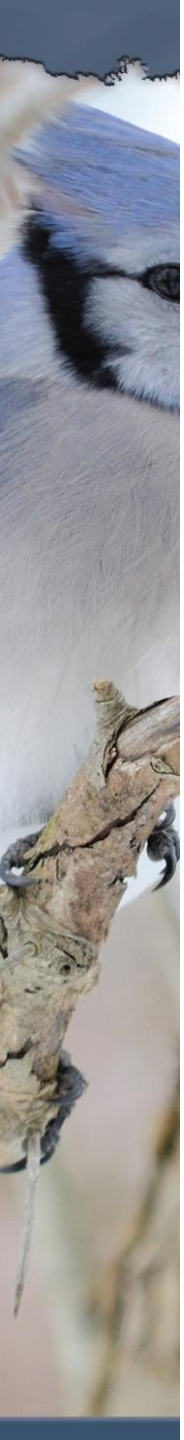
Scope and lifetime

- Each block defines a new scope
  - Class, method and statement
- Scopes may be nested:
  - statement block inside another block inside a method body inside a class body
- Scope is *static* (textual)
- Lifetime is *dynamic* (runtime)



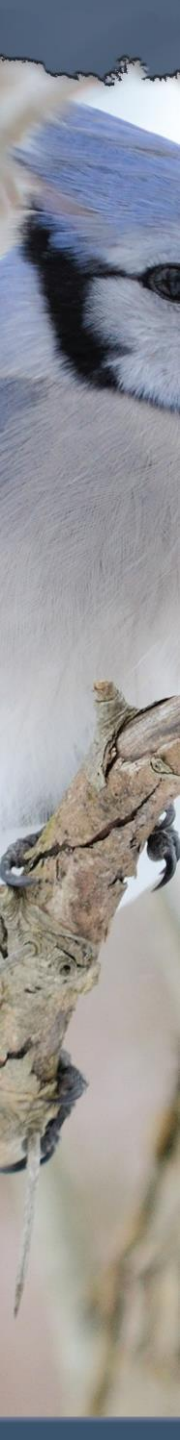
Scope and lifetime of variables

- Fields
  - Scope: the entire *class* in which it was defined
  - Lifetime: existence time of its containing object
- Parameters
  - Scope: *method/constructor* which it is declared
  - Lifetime: execution time of *method/constructor* in which it was declared/passed into
- Local variables
  - Scope: the *code block* in which it was declared
  - Lifetime: the execution time of the *code block* in which it was declared and initialized in



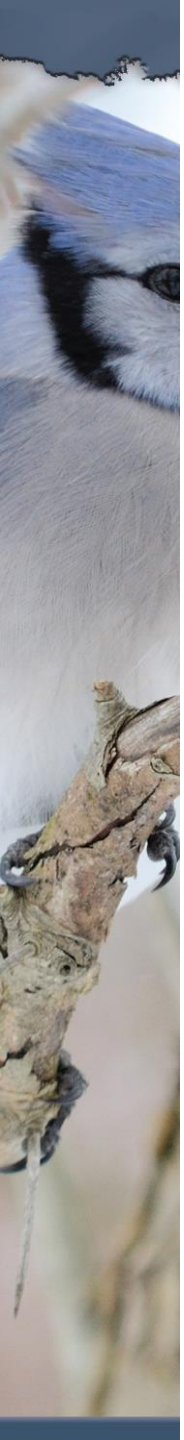
Review (1)

- Classes model concepts
- Source code realises those concepts
- Source code defines:
  - What objects can do (methods)
  - What data they store (attributes)
- Objects come into existence with pre-defined attribute values
- The methods determine what objects do with their data



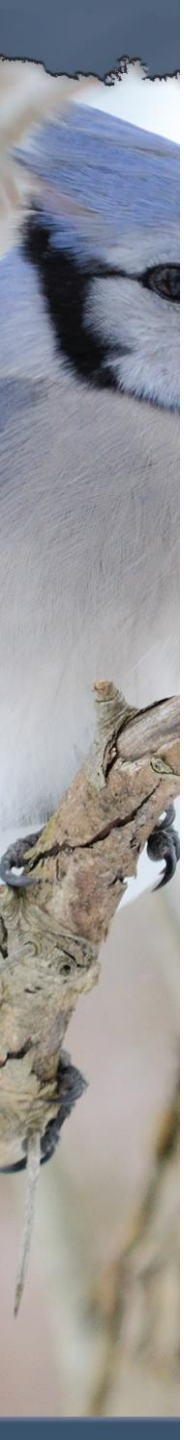
Review (2)

- When a method is called an object:
  - Alters its state, and/or
  - Uses its data to decide what to do
- Some methods take parameters that affect their actions
- Methods without parameters typically use their state to decide what to do
- Some methods return a value



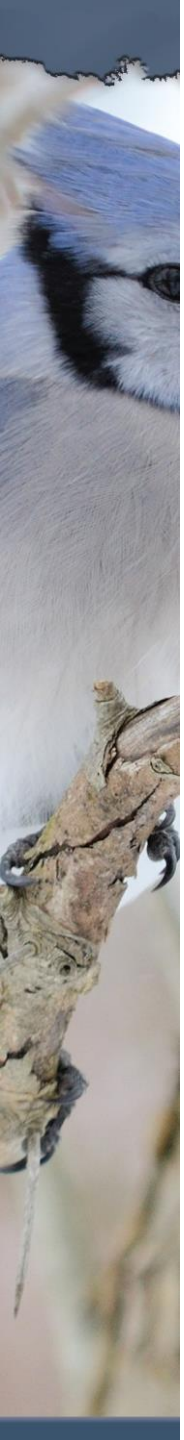
Review (3)

- Most programs contain multiple classes
- At runtime, objects interact with each other to realize the overall effect of the program



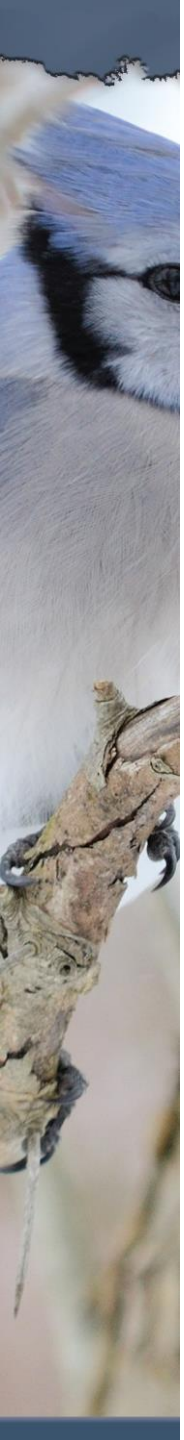
Review (4)

- Class bodies contain fields, constructors and methods
- Fields store values that determine an object's state
- Constructors initialize objects – particularly their fields
- Methods implement the behavior of objects



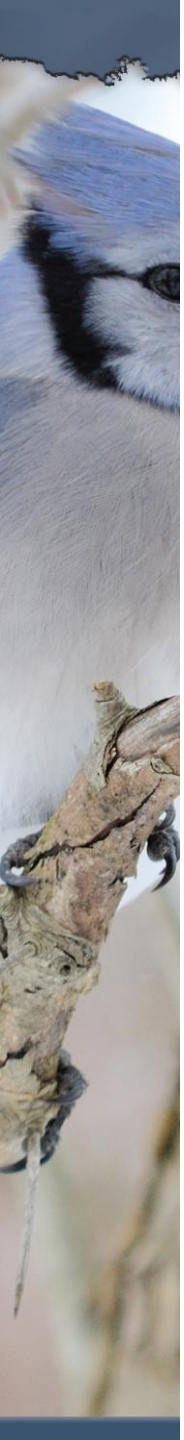
Review (5)

- Fields, parameters and local variables are all variables
- Fields persist for the lifetime of an object
- Local variables are used for short-lived temporary storage.
- Parameters are used to receive values into a constructor or method



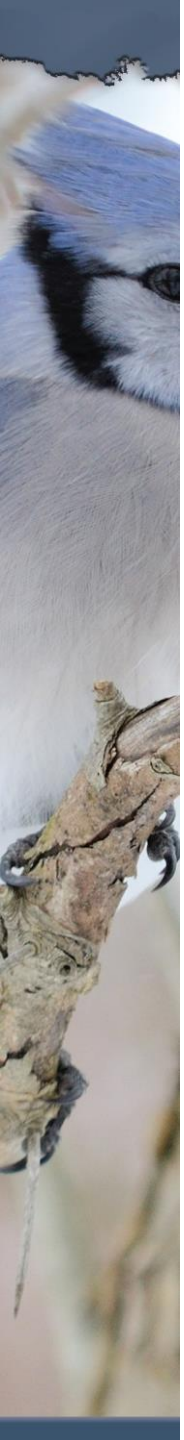
Review (6)

- Methods have a return type
- **`void`** methods do not return anything
- non-**`void`** methods always return a value
- non-**`void`** methods must have a return statement



Review (7)

- *Correct* behavior often requires objects to make decisions
- Objects can make decisions via conditional *if* statements
- A true-or-false test allows one of two alternative courses of actions to be taken



شعر امروز

عمریست که جان بنده بی‌خویشتن است
و انگشت‌نمای عالمی مرد و زن است

برخاستن از جان و جهان مشکل نیست
مشکل ز سر کوی تو برخاستن است