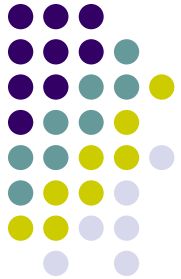
# Java 100/105/200

Object oriented programming

Project management and entities

# OO DEVELOPMENT

# Project stages



- Analysis
  - Understanding and communicating scope
  - High-level models
  - Business language
- Design
  - Understanding how to accomplish goals
  - More detailed models
  - Technical language
- Development
- Maintenance

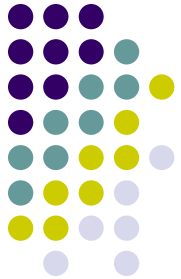
# Traditional analysis

- Collect needs to define scope
- Organize needs by categories
- **Process** decomposition
  - Identify process flows
  - Break large processes into smaller
  - Break processes into tasks
- Define **data entity** structure to support tasks
- Move to design/development

# OO analysis

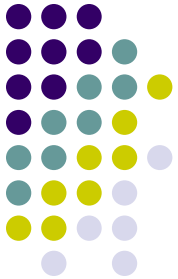
- Collect needs to define scope
- Organize needs by categories
- **Process flow decomposition (use cases)**
  - Identify process flows
  - Break high-level processes into smaller
- Define **data entities** in processes
  - Break processes into tasks
  - Add detail to data entities
- Move to design/development

# OO advantages



- Easier to maintain
- Modules organized by entity (important data)
- Better architecture

# OO entities



- A entity/class has two parts
- Data parts grouped together by entity
  - Date **of sale**
  - Price **of sale**
  - Seller **of sale**
  - Buyer **of sale**
- Processes grouped together by entity
  - **Print** address card of **student**
  - **List students** addresses by state
  - **Find student** by ID

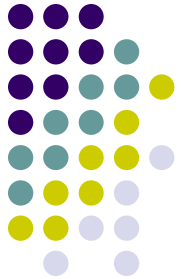
# OO entities

- Business entities can encapsulate real-world data in four major categories
  - **Physical**–a person, place, thing
  - **Role**–information/permissions for tasks
  - **Event**–a time bounded/related occurrence
  - **Reference**–look-up table data or constants
- Design entities are abstractions to manage other entities
  - see Peter Coad –Java Design

The object data structure

# CLASSES & OBJECTS

# A relational data structure



- A relational database
  - is defined by a **table** (the schema)
  - divided into **fields**
  - assigned a data type
  - has data created in **rows**
  - is uniquely defined by a primary key
  - can tie to other rows by storing a foreign key
  - sometimes has a **stored procedure** that operates on a table of data

# An object data structure

- A object
  - is defined by a **class** (the schema)
  - divided into **fields** or instance variables
  - assigned a data type
  - has data created in **objects**
  - is uniquely defined internally
  - can tie to other objects by storing a reference
  - sometimes has a **method** that operates on a class of data

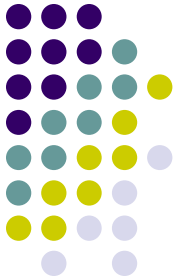
# Relational vs. OO

- Program entities = database = spreadsheet
- Class = table schema = Excel tab
- Object = row of data
- Instance = object
- Instantiate = create
- Instance variable = field which holds data
- Member = field or method in class

# Defining the class (schema)

- Usually nested in a package
- Starts with an access modifier (none, **protected**, **public**)
- Uses the keyword **class**
- Ends with a class name which uses identifier rules
  - style convention is using a Capital letter first
- A code block follows

# Class data structure

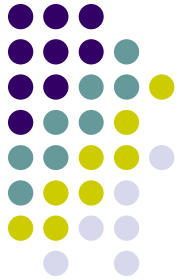


- An instance variable (field) has
- an access modifier –usually **private**
- a data type
- a variable name

# Data analysis

- The purposes for having an object use an instance variable are to
- **Remember** an association to another object
- **Track** the state of a piece of data or object
- Use to generate a **report** in the future

# Class as a data type

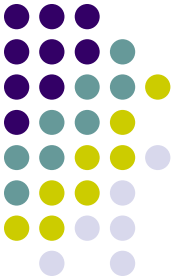


- The name of a class can be a data type
- Aggregation (composition)
  - using a complex structure of a class as a field in another class
  - just like making a foreign key to primary key relationship
  - parent/child relationship

# Constructors

- The only way to create an object
- Like adding a row to a table
- Uses the class name as a method name
- Default constructors are provided by default and can be publicly called
  - new Person( );

# Reference → object



- A reference has a datatype
- **Car** c
- An object has a datatype
- new **Car**( )
- When the object is created, it must be assigned to a reference for reuse.
- **Car** c ← new **Car**( );
- The datatypes must be compatible
- **Car** c = new **Car**( );

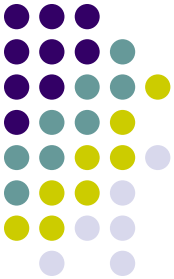
# Basic steps of object use

- **Declare** a variable reference (holds an object)
  - uses the class name as data type
  - **Person me;**
- **Create** the object (an empty container)
  - uses keyword **new** and a constructor method
  - **me = new Person( );**
  - **Person me = new Person( );**
- **Initialize** the fields in the object
  - direct access fields by **object.field**
  - **me.name = “Doug”;**

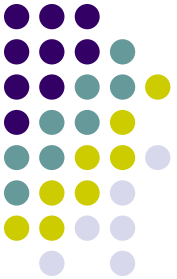
# Exercise

- Create a **Dog** class with a few fields
- Create a **Person** class with a few fields
- Aggregation
  - Add a owner field to the **Dog** class
  - Initialize the fields of the Dog
  - Print the data from the fields

# Many references, no object



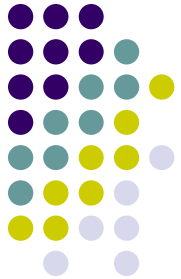
- An object can have multiple references
  - Dog fido, rover, max, spot;
  - fido= new Dog( );
  - rover = fido;
  - max = fido;
- References don’t point to other references
- A reference can point and object or to no object
  - System.out.println(spot)
  - fido= null;



# Exercise

- Share an object between two references
- Null one of the object references
- Create a new object for the null reference
- Print out field data to confirm what is happening.

# Garbage collection

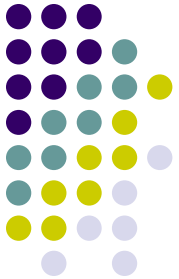


- Objects without reference are removed from active memory.
- A background thread is constantly looking for candidates for GC.
- You can’t control GC.

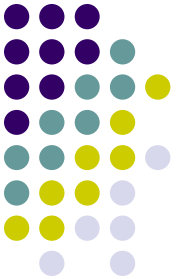
# Class data structure - static

- keyword applied to field
- does not copy value to all objects, keeps one copy accessible via the class name
  - Data can change! - updateable
- One value for all Dog objects
  - static Person veterinarian
  - static double officeVisitRate
  - static String kennelName
- Reference
  - Dog.veterinarian, Dog.officeVisitRate, Dog.kennelName

# static or instance?



- **A class to hold the data** –the data field
  - **HouseLoan**-Prime rate as of today.
  - **BondFilm**-The person who plays James Bond in a 007 film.
  - **Employee**-Your salary
  - **MileageMeasurement**-The distance between Omaha and KC
  - **Person**-Social security number
  - **KidsGreenRide**-The minimum height for riding a type of kid's ride at Worlds of Fun
  - **Meal**-Total calories



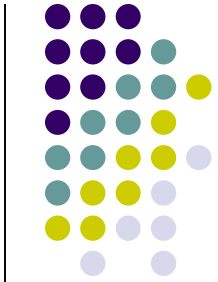
# Exercise

- Create a static field for a Dog or Person

Simple data structure for multiple values or references

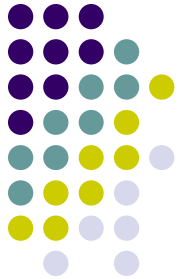
# ARRAYS

# The array (object)



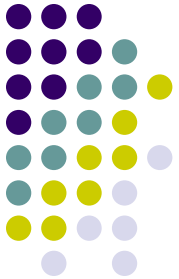
- An object that hold multiple values/references of any one data type.
- Built in to the language so it’s fast
- Fixed length (will not expand)

# Declaring arrays



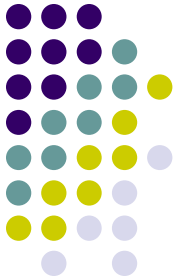
- Square bracket set follows data type
  - String[ ]
  - int[ ]
  - Dog[ ]
- Identifier follows data type
  - String[ ] roster
  - int[ ] scorebook
  - Dog[ ] kennel

# Creating arrays



- Size must be declared when an array is created.
  - String[ ] roster = new String[5];
  - int[ ] scorebook = new int[25];
  - Dog[ ] kennel = new Dog[15];
- Or use initialization (see later)

# Initializing arrays

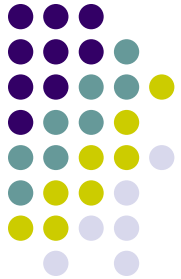


- Zero based counting
  - roster[0] = “Doug”;
  - scorebook[24] = 97;
  - kennel[1] = new Dog( );
- All values not initialized will have
  - Null if a reference
  - Zero or false if a value

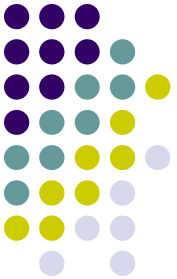
# Quick creation & initialization

- Multiple value creation & initialization
  - String[ ] roster = {“Doug”, “Dave”, “Teri”,null, null, null };
  - int[ ] scorebook = {96,93,83,86,79,96,82,88,0,0,0};
  - Dog[ ] kennel = {
    - new Dog( ),
    - new Dog( ), null
  - };
- Also known as array initializers

# Anonymous arrays



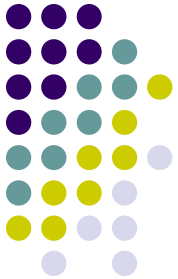
- Sometimes you don’t need to save the reference
  - public static void iNeedAnArray(int[ ] numbers){…}
  - iNeedAnArray(new int[ ] {1,2,3,4,5,6});
- Easier and clearer
  - int[ ] ints= {1,2,3,4,5,6};
  - iNeedAnArray(ints);



# Multi-dimensional arrays

- Array references can be stored in an array to make an array of arrays.
  - Egg[ ] eggCarton= new Egg[12];
  - eggCarton[0] = new Egg( );
  - Egg[ ] [ ] eggCrate= new Egg[30] [ ];
  - eggCrate[1] = eggCarton;
  - Egg[ ] [ ] [ ] eggTruck= new Egg[96] [ ] [ ] ;
  - eggTruck[2] = eggCrate;
- How many eggs are in the eggTruck?

# One field, no methods

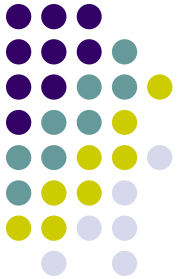


- Arrays don’t do much.
- Get the size of the array with
  - Dog[ ] kennel = new Dog[5];
  - kennel.length
- More static methods are found in Arrays
  - Arrays.sort(roster);
  - Arrays.toString(kennel);
  - Arrays.deepToString(eggTruck);

# java.util.Arrays

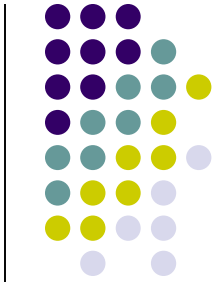
- Because there is no Array class, there is a utility class
- static methods
  - int **binarySearch**(array)
  - array **copyOf**(array), array **copyOfRange**(array)
  - **fill**(array, value)
  - **sort**(array), **sort**(array, from, to)

# Enhanced for loop



- foreach
- Traditional for loop
  - for (int i = 0; i< kennel.length; i++) {
  - kennel[ i ].bark( );
  - }
- All iteratable items, beginning to end
  - for (Dog dog: kennel) {
  - dog.bark( );
  - }

# The main( ) args array



- On the command prompt you run a program by typing
  - java package.Class
- If you add program arguments they follow:
  - java package.Class one too tree “fo wah”
- The …main(String[ ] args) {… parameter is initialized with the arguments

# Iterating over command line input (CommandLineArgs)

- **public static void main(String[ ] args) {**
- **for (String string: args)**
  **{**System.*out.*println(string)*;*
- }
- }

# Exercise (CommandLineArgs)

- Create a class that
- Uses a foreach loop to iterate over the main's args
- And prints out each one.

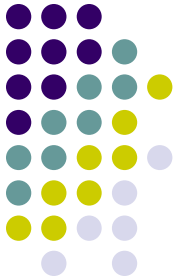
# Command line input -Eclipse

- After running a program, the run configuration is saved.
- Open up the run config that you want args for
- Add the program arguments

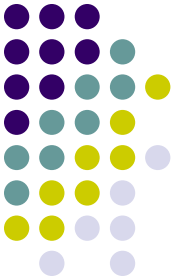
# Exercise (ArraysTest)

- Duplicate your CommandLineArgs class and
- Sort the args
- Print out the result
- Print out the Arrays.toString( ) of the args

# varargs



- last parameter, one datatype, like an array
- Old style
  - static void test(int[ ] numbers)
  - test(new int[ ] {1, 2, 3} );
- vararg style
  - static void test(int… numbers)
  - test(1, 2, 3)
  - test( )
  - static void test(String s, int… numbers)

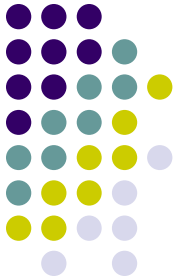


# printf

- printf(<formatted string>, args…)
- System.out.printf("I want a %s with %s and a %s.", "Corvette", "a sun roof", "set of new tires");
- System.out.printf(" My %d %s cost $%,.2f\n", 2016, "computer", 2442.32789);

Sending a message to an object

# INSTANCE METHODS



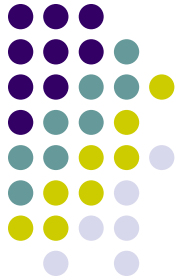
# Two class code sections

- One part of the class is data definition
- The other part is defining processes that use the data by default.
- like associating a stored procedure with a table
- Separate the two sections in your code by comments to see easier.

# Instance methods

- Instance methods do not use the keyword **static**
- static methods are called class methods
- Called not by prefixing class name but by the object.
- me.printProfile( );
- The object becomes an argument to use in the method body.

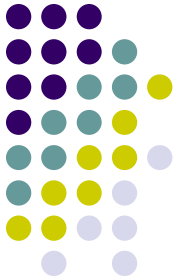
# Static vs instance



- Calls
  - Person.printName(aPerson);
  - aPerson.printName( );

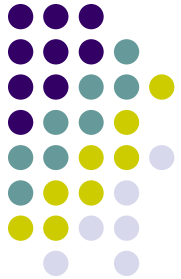
```
public static void printName(Person someone){
      System.out.println(someone.firstName+ "
"  + someone.lastName); }

public void printName( ) {
      System.out.println(firstName+ " " +
lastName); }
```

# this



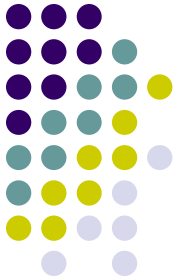
- The object that is being talked to must be created before
- Person me = new Person( );
- me.printProfile( );
- The method doesn't know the object being talked to so must use a proxy word –**this**
- public void printProfile( ) {
- System.out.println(this.name);
- }

# this



- The keyword this is often assumed and not written.
- Best practice: use this, always!

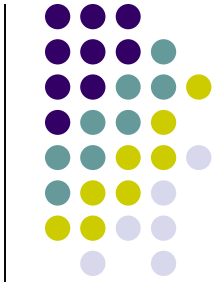
```
System.out.println(name);
System.out.println(this.name);
```



# Exercise

- Dog class
  - Create a bark( ) method
  - Create a bark(int howManyTimes) method
  - Create a getDataInOneString( ) method
- optional methods
  - goOutside( )
  - celebrateBirthday( )

# Reusability

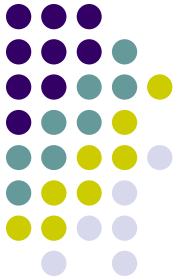


- If you copy and paste your code, you're doing something wrong.
- Either call the method
- Or extract a method and call it from all places
  - Eliminate bugs
  - Adds meaning

# Revisiting static

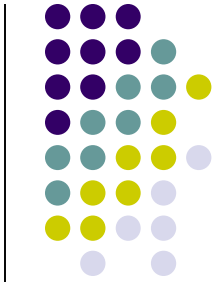
- Different for methods than fields
- Static methods
  - Can use static data or object arguments
  - Can't use **this**–no implicit object
- Use for grouping utility methods when the object could be anything
- Use instance methods when the object is very likely one data type

# Static blocks



- Static variables (no unique storage for each object) can be set
- When declared
- When ever any object feels like it
- Some static variables need to be declared before object is created
- And it takes code to run it (database connections)
- Use **static {**…init here… **}**

# Unchangeable variables



- Some variables should not be changed once set in the object.
- Locked field
- The keyword **final** prevents updates
  - final String SSN

# Constants

- A constant is unchanging therefore it uses the keyword **final**
- A constant only needs one copy for all objects of the class therefore it uses the keyword **static**.
- A constant identifier is usually put in all caps and uses an underscore as a word separator
  - public static final double PI = 3.141592653589793
  - public static final String SPECIES = "Canis lupus"

# final or not?

- **A class to hold the data** –the data

- **HouseLoan**-Prime rate as of today.
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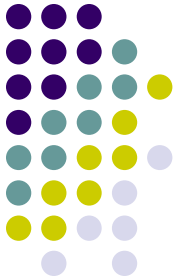
- **Person**-Social security number
- **KidsGreenRide-**The minimum height for riding a kid's ride at Worlds of Fun
- **Meal**-Total calories

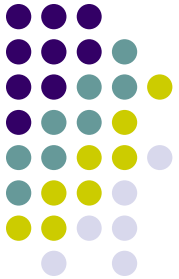
# Getters and setters

- Private data can not be accessed outside of the class code block.
- Public methods can be written to allow access to private data.
  - public <datatype> get<Field>( )
  - public void set<Field>(datatype field)
- Eliminate to restrict read/write access

# Getters and setters - uses



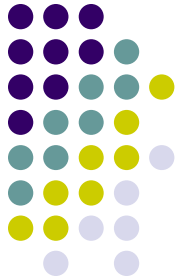
- Get
  - check authorization to get data
  - notify another object on access
  - transform output based on caller
  - null checks
- Set
  - validate data coming in and process
  - implement business rules here
  - record old data in case of reversal/veto
  - notify another object on change



# Getters and setters

- Your IDE will generate both for you
  - Eclipse: Source / Generate Getters and Setters…
  - Insertion point: after the last field of your class
  - Select all getters and setters
- Place in a separate section of the methods

# Calling getters and setters

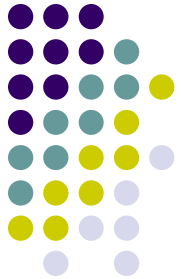


- Use getters and setters at all times
- even in the same class where private data is accessible.
  - me.setName(“Doug”)
  - String name = me.getName( );

# Exercises

- Add getters and setters to **Person** and **Dog**
- Access getters and setters
- initialize the pet and owner fields

# toString( )



- The toString( ) method converts the object data into a String when attempting to print it
  - System.out.println( fido.toString( ) );
  - System.out.println(fido);

# toString( ) – Eclipse

- Source / Generate toString( )…
- Select All (default)
- Insertion point: before method of your class
- Delete comments
- Leave @Override, even though it’s optional

# Exercise

- Generate toString( ) methods for **Person** and **Dog**
- Print out objects

# Common class tasks

- Always create
  - Data structure
  - Getters/setters
  - toString( )
  - Unique behavior (methods) if known
  - 2 constructors –no-args and all-args
- Optional
  - Static member (field or method)
  - Constants
  - equals( ), hashCode( ), compareTo( ) - sorting

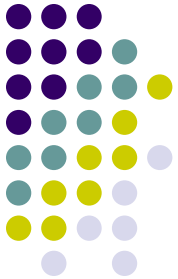
# Random numbers

- java.util.Random
  - Random generator = new Random( );
  - int i= generator.nextInt( );
  - number between 0 and maximum int
  - int i= generator.nextInt(100)
    - number between 0 and up to 100
  - double d = generator.nextDouble( );
    - number between 0 and 1.0
- Math.random( )
  - returns number between 0 and up to 1.0

# Payroll (200) - Requirements

- Trigger –print check for an employee id
- Flow
  - Look up employee by id
  - Create an employee
  - Create a check to record for later
  - Set up a layout for a check
  - Tell the check to print employee's amount
  - Look up the current wage
  - Calculate amount (wage * hours worked)
  - Print amount in layout

# Payroll (200) - classes



- Employee
  - **id, name, payGrade, hoursWorked**
  - *findById*(int)
- PayRate
  - constants
  - *findHourlyWageForPayGrade*(String)
- Check
  - **amount, checkLayout**
  - printForEmployee( Employee)

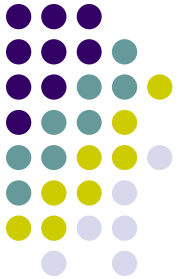
# Payroll (200) classes

- PrintLayout
  - **description**
  - *createCheckLayout*( )
- Comptroller
- main( )
  - with instructor: create an employee and print a check for the employee.
  - printCheckForEmployeeID(int)
- Create classes, method stubs, **fields**, gets/sets, toString( ) in a payroll package.

Initializing your data structures

# CONSTRUCTORS

# Purpose



- To provide convenient way of initializing objects
- To provide default values for any object
- To allow / disallow the creation of objects

# Default constructor

- The default constructor is always available if no other constructor has been written
- If you write it yourself, it looks like:
  - public Person( ) {
    - super();
  - }

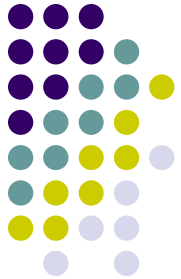
# Default constructor –IDE

- Press Ctrl-spacebar in the class code block
- Select the default constructor
- Constructors have the little C on the icon
- Delete the comment

# Exercises

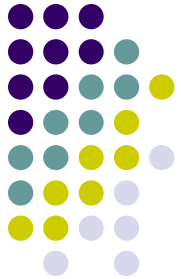
- Add a no-arg constructor to both a **Person** and **Dog** class
- Add a printInto say what class this is and “no-arg constructor”
- Add default data by the set methods in the constructors.
  - Should the Dog always create a default Person as its owner?
  - It’s not always the case that the Person should have a default Dog so we won’t do that.

# An all-field constructor



- Will allow you to initialize all of the fields of the object at once
  - Shortcut: Source / Generate Constructor Using Fields…
- public Dog(String name, int age) {
  - this.name = name;
  - this.age= age;
- }

# Updating to use gets/sets

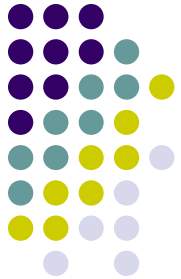


- Click on direct field access
- Hover on direct field access and select generate getters and setters or
- Shortcut: Refactor / Encapsulate Field / OK
- Do for each field

# Exercise

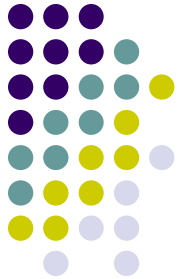
- Create the all-arg constructors in Dog and Person
- Add the println( ) to identify the constructor being run
- Test all-arg constructors
- Create a Person with a Dog

# Shadowing



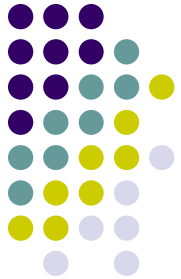
- When a variable uses the name of another variable and makes it unavailable
  - public Dog(String **name**, int **age**) {…
  - this.name = name
- Avoid shadowing, it's confusing
- Use prefix to help understanding
  - public Dog(String **_name**, int**_age**) {
  - name = _name;
- Even better, use this.setName(name)

# DRY in constructors

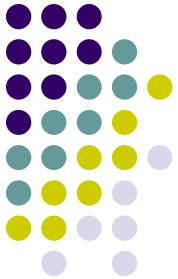


- All-arg constructor has all the logic we need.
- Have the no-arg constructor call the all-arg
- **this** has two uses: object proxy, constructor redirect in the same class.

# Exercise

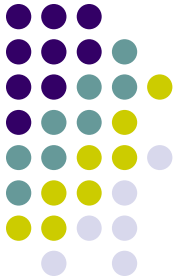


- Tie the no-arg and the all-arg constructors together in both Person and Dog
- Have the no-arg call the all-arg constructors
- Have any logic in the no-arg constructor move to the all-arg constructor



# Exercise (105/200)

- fields
  - **double firstNumber**
  - **double secondNumber**
- Instance methods (return a double)
  - calcSum( ), calcDifference( )
- common members
  - toString( ), gets/sets, constructors (no-arg, all-fields)
  - main( ) to test all methods with sysouts



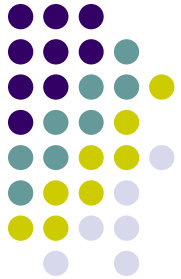
One class “is-a-special-type-of” another class

# INHERITANCE

# Inheritance

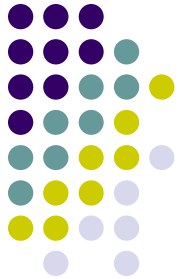
- a relationship between two classes based on wrapping behavior
- The goal is to use that shared behavior to achieve code reuse (polymorphism)
- Lets you use two objects with different datatypes as one type to reuse one method
- vs. an association
  - preferred when possible
  - combining objects into one entity

# Inheritance vs composition



- Aggregation and composition are stronger choices

# Demo

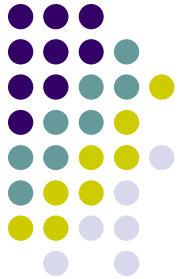


- Show shared behavior/fields through using aggregation
- Show direct access of shared behavior using delegate methods

# Motivation

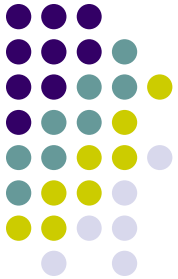
- Use inheritance when you need
  - to access a common method on many different data types
  - to write a method that accepts multiple data types based on what they do (there’s a better way)
  - Customize a class from another library

# Terminology



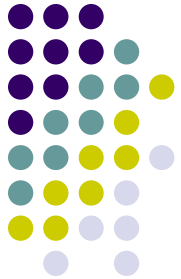
- Superclass
  - base class –generalized, shared behavior
- Subclass (subtype)
  - derived class –specialized, unique behavior
  - Say “a subclass is a special type of superclass”
- a Person is a special type of Object
- an Employee is a special type of Person
- a Teacher is a special type of Employee

# Implementation



- **Extends** keyword
  - RaceCar extends WheeledVehicle
  - HuntingDog extends Dog
  - TV extends RemoteControlledDevice
- apply the “is-a-special-type-of” test
  - a RaceCar is a special type of WheeledVehicle
  - a HuntingDog is a special type of Dog
  - a TV is a special type of RemoteControlledDevice

# Object class



- All classes inherit from Object
- Dog is a special type of Object
- Object has several useful methods
  - toString( )
  - equals( )
  - many others concerned with threads

# Behavior expansion

- A subclass is not a subset
- Sub means **specialized** not “a smaller part”
- Subclasses
  - have more functionality
  - have more fields they can store
  - are a way you can add your personalized touch to an existing class

# Inherited fields/methods

- No private fields/methods will be available in the subclass
- The subclass can access any method it knows about
- The subclass can access any method from any of its superclasses

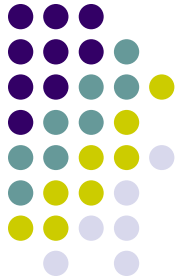
# Exercise

- Make sure to have a **Dog** class
  - print out object in the constructor
- Create a **HuntingDog** class with
  - an inheritance relationship to **Dog**
  - a hunt( ) method
  - a field for which game to hunt for
  - gets and sets
  - constructor with a default value for game to hunt

# Stopping inheritance

- Some class designers want to prevent you from subclassing their work
- The keyword final prevents this
  - public **final** class String { …
- String can not be subclassed

# Overriding

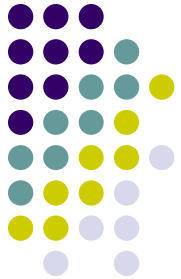


- Overriding is using the same method signature in the subclass as the superclass
- This “hides” the superclass call (not the behavior.
- @Override is a compiler check to make sure that the method really does match the superclass method.

# Overriding shortcuts

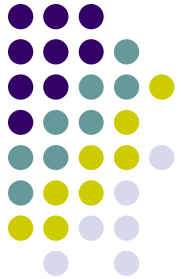
- Two methods
- Ctrl-spacebar in the class code block to get suggestions for overrides
- **Source menu**
  - Implement methods or interface will be used later.

# Stopping overriding



- Some method writers want to prevent you from overriding their work
- The keyword final prevents this also.
- public **final** void someMethod( ) { }
- Prevents polymorphic use to the subclass

# Accessing overridden methods



- Once you override a method, you should want to append to its behavior.
- Use super before the method name to access the superclass method of the same name.
  - super.toString( )

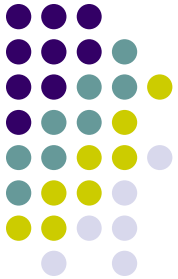
# Exercise

- Add the toString( ) method to the **HuntingDog**
- **Eclipse**: use the Generate toString()…
- select specialty
- select inherited methods / toString( )

# Abstract vs. concrete

- Concrete classes can make objects
- Abstract classes can not make objects
  - public abstract class Animal { }
- Used on a class when method signature is declared but has no code
  - public abstract void eat( );
- Abstract classes are used to guarantee that any related class has that behavior
- “a template class”

# Inheriting an abstract class



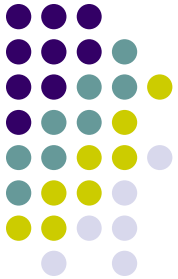
- Inheriting an abstract class forces you to implement the abstract methods
- Let the IDE implement the method for you:
- Eclipse -Ctrl-spacebar at start of line will override the method. Clicking the lightbulb also works.

```
public class Dog extends Animal {
      public void eat( ) {  }
}
```

# Constructors & inheritance

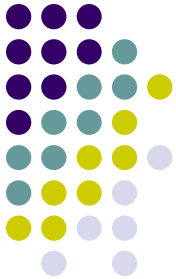
- Constructors are set up to achieve a division of labor based on the fields in their respective classes
- If a superclass has one field, it should only initialize that field in its constructor
- If a subclass also has one field, it should provide a constructor with two fields and passes the data to its superclass.

# Constructors & inheritance



- HuntingDog
  - hunt( ), toString( )
- Dog
  - bark( ), toString( )
- Animal
  - eat( )

# How to build an object



- Object
  - toString()
- new Object( )
- new Animal( )
- new Dog( )
- new HuntingDog( )

# Construction process

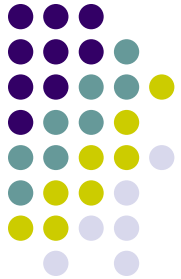
- **super**( ) calls the superclass no-argconstructor
- **super**( ) is a default call for the first statement of any constructor unless **this**( ) is called
- Object creation starts with an Object class constructor, then runs the subclass constructor, then the next subclass…

# Object layers

- The data for an object is initialized from the core outward to the last subclass
- The constructor call is for the last subclass so it must pass the data to the next superclass

```
public Subclass(datatype arg1, datatype arg2){
      super(arg1);
      this.arg2 = arg2
}
```

# Creating constructors with IDEs

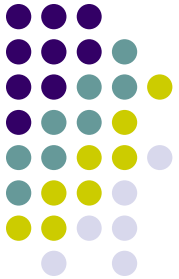


- Use Source / GenerateConstructor Using/With Fields
- Change the super constructor to invoke to the all-args

# Exercise

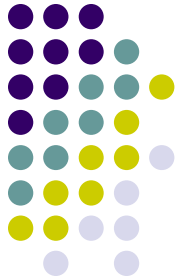
- Create the Dog / HuntingDog constructors
- chain the constructors
- no-arg or partial constructors call all-arg constructors
- all-arg constructors call superclass' all-arg constructors

# Superclass references



```
Object o1 = new Object( );
Object o2 = new Dog( );
Object o3 = new HuntingDog( );
Dog d = new HuntingDog( );
Object[ ] objects = {o1, o2, o3, d }
```

# Object layers

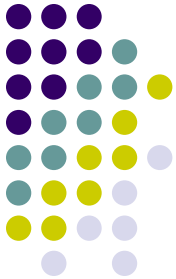


- **References to object layers**
- Object references only allow access (scope) to the layer and inner layers (supertypes) they point to.
- Overridden methods allow access to a method only if a method by that name is in scope.
- You can increase the scope by creating a reference to the outer layer data type (subtype) by casting the inner layer reference type.

# Casting references

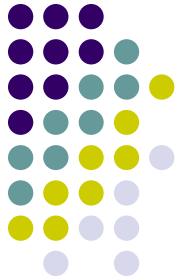
- Casting to a superclass is always OK
  - Object[ ] objects = {o1, o2, o3, d }
- You must confirm casting to a subclass
  - Dog d1 = (Dog) objects[1];
  - HuntingDog hd= (HuntingDog) objects[2];
- You only can cast to a data type in the object's layers.
  - Dog d2 = (Dog) objects[0];  //  not a Dog object

# Exercise (ReferenceTest)



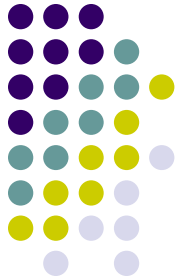
- Create a HuntingDog and an Object
- Put the objects into an array
- Print out both objects by array references
- Cast and use the array objects to
  - Animal
  - Dog
  - HuntingDog

# Polymorphism



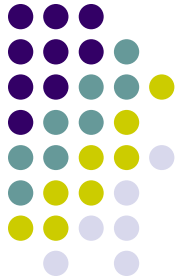
- Sending the same message to objects of different classes and getting different results.
  - anAnimal.toString( )
  - aDog.toString( )
  - aHuntingDog.toString( )
- Most often implemented by methods tied by overriding so we get useful results

# Polymorphic methods



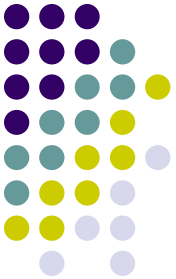
- Methods that use superclasses in parameter datatypes can be polymorphic
- Implement this code.

# Object oriented principles



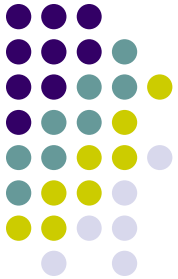
- Any OO language must support three major principles
- **Encapsulation**–the definition of the fields, the behavior, and the access to those members.
- **Inheritance**–the ability to relate two classes so that fields & behavior is shared
- **Polymorphism**–the ability to send the same message to objects of different classes and get different results.

# Vehicle exercise (100)



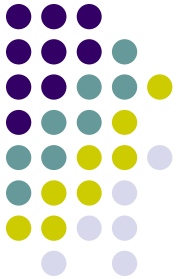
- Set up classes and methods for
  - Vehicle (abstract)
    - moveForward( ), abstract park( )
    - abstract turn( ) –turnRight( ) or turn(“right”)  ?
  - WheeledVehicle
    - brake( ), toString( )
  - FlyingVehicle
    - takeOff( ), land( ), toString( )
  - FloatingVehicle
    - ffloat( ), toString( )

# Vehicle exercise (100)



- Set up fields and constructors for
  - Vehicle (abstract)
    - driver, velocityMPS
  - WheeledVehicle
    - numberOfWheels
  - FlyingVehicle
    - flyingAltitude
  - FloatingVehicle
    - dockedAt

# Vehicle exercise (100)

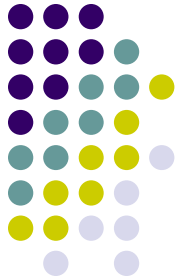


- Create a Valet class
- Inherit from Person (with a name field)
  - main ( )
- Create an array of vehicles
- Initialize them
- Move each forward then park the vehicle
  - parkVehicle( ) method
- Greet the driver by name, use the valet name also
- Tell them you will be parking their type of vehicle
  - getClassName().getName( )

# Issues

- FloatingVehicle
  - dive( )
- FlyingVehicle
  - dive( )
- Seaplane
  - wheeled, floating, flying
- Helicopter
  - doesn’t have all flying capabilities
  - rotor-based flying, wing-based flying ?

# Person/Org exercise (105/200)



- Person
- Organization
- Telephone
- Address
- Email