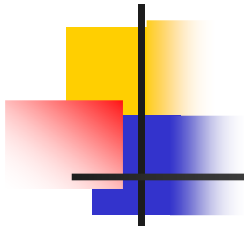
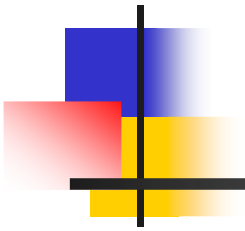
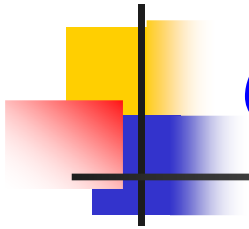


# Lecture3 – OOP concepts in Java

- Object Oriented Programming in Java
  - Review
    - Concept of class/object
      - Constructors
  - Inheritance
  - Data encapsulation
  - Polymorphism
- Overloaded Functions

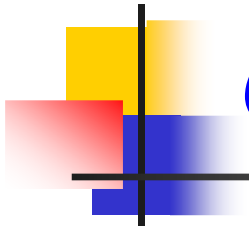
# Review: Class, objects, constructors





# Class and objects

- class – the basic unit of OOP in Java
- A class typically corresponds to some meaningful entity.
- class has both data and methods.
- Attributes and methods are members of a class
- An instance of a class is an object.
- A class uses methods to interact with other classes/functions.



# Class and objects … contd.

- Classes may have both
  - Data attributes
    - Can be of basic or user defined data types.
    - Need to be initialized – typically done in a constructor
  - Methods, Functions
    - Functions that are part of classes
    - Typically interfaces to interact with other classes and functions.
    - Provide APIs to external world to access and manipulate data attributes.

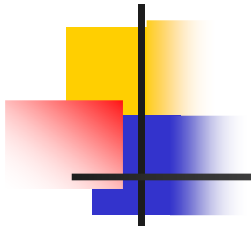
# Constructor and destructor … contd.

## Constructor

- A function with the same name as the class
- Called when an object is created
- A class can have more than one constructor

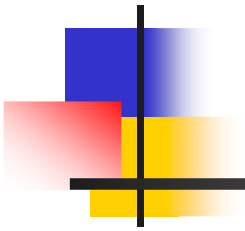
## Destructor

- There is NO destructor in Java, equivalent to C++ destructor
- In C++
  - Destructor: A function with the name ~classname( )
  - Called when the object goes out of scope, or deleted.
- In Java, closest equivalent is finalize( ) function
  - Used to clean up system resources
    - E.g. close open files, open sockets
    - Clear screen for GUI/graphics objects.
  - Called by system garbage collectors and other resource cleanup functions.

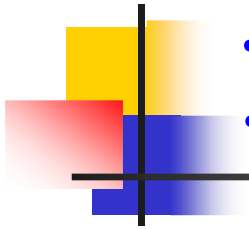


# A simple "account" example

```
public class Account
{
  private  int user_SSN;                                  // attribute (data)
  private  int accountNumber;                             // attribute (data)
  public   void withdrawMoney (int amount) { .. } ;       // method
  public   void depositMoney (int amount)   { .. };       // method
  public   void computeInterest( )          { .. };       // method

  public Account() { }                                    // Constructor
  public static void main (String args[ ])                // main function
    {
       Account a = new Account( );                        // Create a new object
       System.out.println ("In account main");
    }
};
```

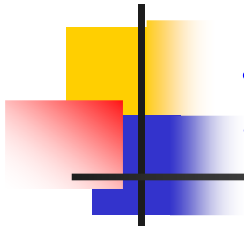


# Inheritance



# Inheritance

- Let's take the account example
- There can be many types of accounts
  - Checking, saving, money market, IRA, etc.
- All accounts may have
  - Some common members.
    - Account number, user SSN, etc.
  - Some class specific members.
    - Checks cleared, investment options, etc.
- Method implementation may be
  - Same in different classes
  - Different in different classes.



# Inheritance – base class & derived class

- Base class or parent class

```
class account
{
    private int user_SSN;
    private int accountNumber;
    public account ( ) { .. }
    public void deposit (int amount)    { …  }
    public void withdraw (int amount) { …  }
};
```

- Derived class or child class

```
class checkingAccount  extends account     // checkingAccount is
{                                          // derived from account
    private int lastCheckCleared;          // not present in account
    public  void showAllChecksCleared( ) { } // not present in account
};
```

# Inheritance – base class and derived classes

- Base Class

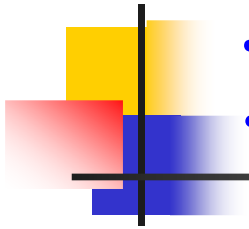
```
class account
{
   private int user_SSN;
   private int accountNumber;
   public  account ( ) { … } // code
   public  void deposit (int amt)
    {
      // code
    }
   public  void withdraw (int amt)
    {
      // code
    }
};
```

- Derived (or child) class-1

```
class checkingAccount extends account
{
     private int lastCheckCleared;
     public checkingAccount ( ) { … };
     public void showChecksCleared ( ) { //code
      }
};
```

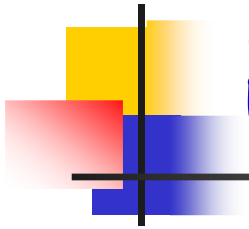
- Derived (or child) class-2

```
class IRA_account extends account
{
     public IRA_Account ( ) { … };
     public void buyFund (int fund_ID)  {
     //code
      }
     public void sellFund (int fund_ID)  {
     //code
      }
};
```



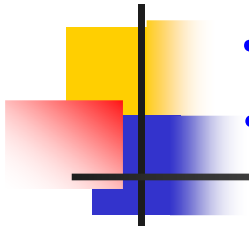
# Inheritance – continued.

- Important points to note:
  - Derived classes have access to public members of base classes in this example.
  - Derived classes can have their own members.
    - E.g. showLastCheckCleared( ), buyFund( ), sellFund( ), etc.
    - Members of one derived class are not accessible to another.



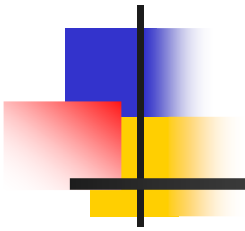
# Examples

- Valid usage in an external function
  - Account acct = new Account ( );
  - checkingAccount ca = new checkingAccount ( );
  - acct.deposit (700);
  - acct.withdraw (300);
  - checkingAccount.deposit (1000);
  - checkingAccount.withdraw (600);
- Invalid usage in an external function
  - acct.user_SSN = 1234; // Can't access user_SSN
  - acct.accountNumber = 567;

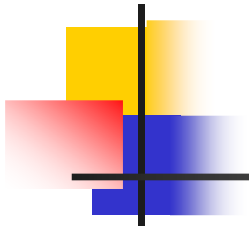


# Inheritance … Object class

- In Java Object is the base class for every Java class.
- Object is a built-in class.
- Defines useful functions.
  - hashCode
  - toString
  - equals
  - notify, etc.



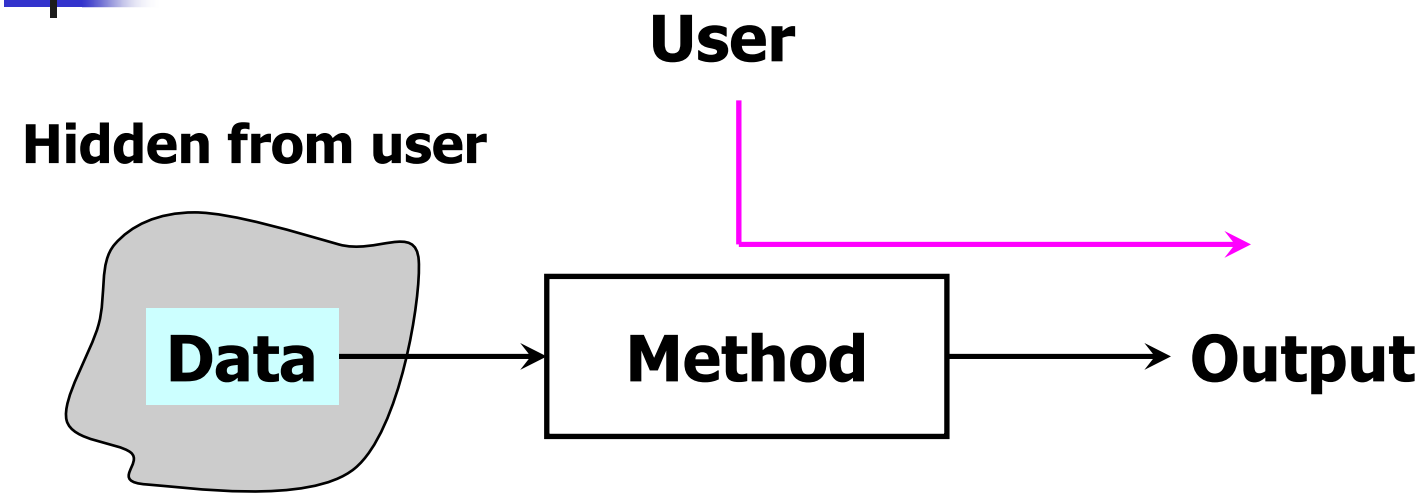
# Data encapsulation - review



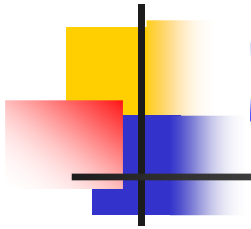
# Data encapsulation

- Hide the data from other classes
- Need to know what methods are implemented
- Not how they are implemented
- Provide interfaces (APIs) to access data
- E.g. To compute interest in a bank an user
  - Needs to know what function to call
  - NOT how the function is implemented

# Data encapsulation … contd.




- Methods act on data to provide output.
- User needs to see only method, not data.
- User should not be affected by
  - Implementation details of methods.
  - Changes in implementation of methods.

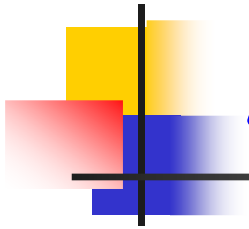


# Data encapsulation … contd.

- Not all data needs to be hidden
  - It is fine to give direct access to some data.
- Not all methods need to be given access
  - Some methods may be hidden – for internal use by classes

⇒ Data and methods both need access restrictions.

- How can data/methods be hidden?
  - By using access modifiers.
- Different access modifiers:
  - public – accessible to every class, function
  - private – accessible only to class
  - protected – accessible to class package and subclass
  - No modifier – accessible only to class and package

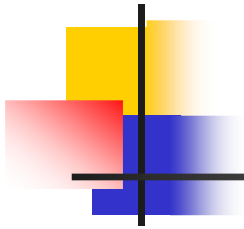


# Access modifiers

| Modifier | class | package | subclass | Other classess |
|---|---|---|---|---|
| public | Yes | Yes | Yes | Yes |
| protected | Yes | Yes | Yes | No |
| No modifier | Yes | Yes | No | No |
| private | Yes | No | No | No |

Source: Oracle.com

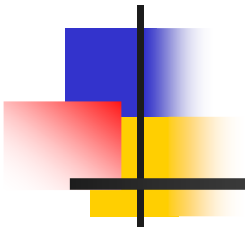
# Data encapsulation in account example



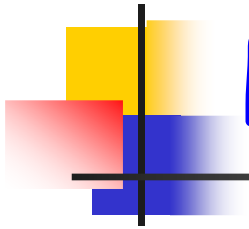
In an object of account

- user_ssn and accountNumber are declared private
  - Accessible only to account and nothing else.
  - Methods are public
    - Anyone can access them.

```
public class Account
{
  private  int user_SSN;                          // Accessible only to Account
  private  int accountNumber;                     // Accessible only to Account
  public   Account ( ) { .. }                          // Accessible to all
  public   void withdrawMoney (int amount) { .. } ; // Accessible to all
  public   void depositMoney (int amount)   { .. };  // Accessible to all
  public   void computeInterest( )          { .. };  // Accessible to all
 ...
};
```

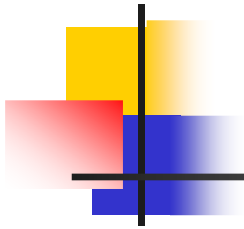


# Polymorphism



# Polymorphism

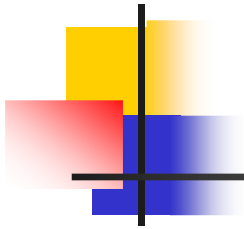
- Poly – many, Morphism – ability to take many forms
  - Ability of objects to behave differently
  - Achieved by using different implementations of the same function in different classes.
  - Parent class defines and implements a function in one way.
  - Child classes can override the function.



# Polymorphism

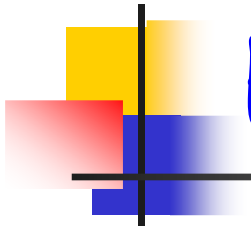
```
public class Account
{
    public Account() { }

    public void showAccountType  ( )
    {
        System.out.println ("Account");
    }

    public static void main (String args[ ])
    {
       Account a  = new Account();
       Account ca = new CheckingAccount( );
       Account sa = new SavingsAccount( );
       a.showAccountType( );  //Account
       ca.showAccountType( ); //CheckingAccount
       sa.showAccountType( ); //SavingsAccount
    }
};
```

```
class CheckingAccount extends Account
{
    public CheckingAccount() { }

    public void showAccountType  ( )
    {
       System.out.println ("CheckingAccount");
    }
};

class SavingsAccount extends Account
{
    public SavingsAccount( ) { }

    public void showAccountType  ( )
    {
        System.out.println ("SavingsAccount");
    }
};
```



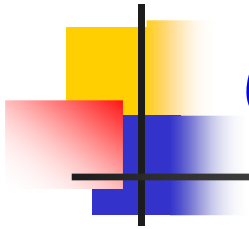
# Polymorphism … contd.

- In the previous example
  - a, ca and sa are defined of type Account
  - But they each executed a different showAccountType function.
    - a executed the function in class Account
    - ca executed the function in class CheckingAccount
    - sa executed the function in class SavingsAccount.
  - Reason this is possible
    - Each object is created differently
    - a is created as Account, ca as CheckingAcocunt, sa as SavingsAccount
    - This is an example of late binding or runtime binding
    - At runtime, objects are bound to the correct type and the corresponding function is executed.



# Executing a member function

- In any class, when a member function is called,
  - The member function of the most specific class is executed.
- E.g. object o is created of type class c
- If a member function o.f( ) is called, function in c is executed, if it exists.
- Otherwise, the function f( ) in the closest parent in the hierarchy is executed.



# Overloaded functions

- A function with the same function name
  - With different arguments
    - Same number of arguments, but different types
    - Different number of arguments
- E.g.

```
class foo
{
   void overloadedFn(int a) {… };
   void overloadedFn(String s) {…};
   void overloadedFn( ) {…};
   void overloadedFn(int a, double b) {…};
}
```