# Java Interfaces

- Interfaces declare *features(i.e. methods)* but provide *no* implementation
- classes that implement an interface *must* provide an implementation for each feature
- Interfaces can inherit from another interface
  - at most one superinterface
- A Java class can implement more than one interface
  - Java inherits(extends) from at most one type, but can implement more than one interface.

# Java Interfaces (cont)

- Printable defines 3 methods
- Displayable inherits from Printable and adds some more method signatures
- A class that implements Displayable will have to provide an implementation for all 6 methods.

```
 interface Printable {
   public String printInstVar();

   public String showInfo();

   public String printWithSpaces();
 }
```

```
interface Displayable extends
   Printable {
  public String display();

  public String refresh();

  public void displayColor(Color c);
}
```

# Java Interfaces (cont)

- keyword `implements` followed by a list of one or more comma separated interface names
- Method signatures must match
  - same modifiers
  - same method names
  - same number of arguments
  - corresponding argument types.

```
public class Circle implements
    Displayable {
 private int radius;
 public String printInstVar(){
  System.out.println(“Radius “
                         +radius);
 }
 public String showInfo(){
  System.out.println(“ I am a
     Triangle with radius “
     + radius);
 }
 public String printWithSpaces(){
 ...
 }
 public String display(){
 ...
 }
 public String refresh(){
 ...
 }
 public void displayColor(Color c){
 ...
 }
}
```

# Types Revisited

- In Java each interface defines a type. Interface extension and implementation as *subtype* relationships
- A subtype relation in Java is:
  - *if class* $C_1$ *extends class* $C_2$ *then* $C_1$ *is a subtype of* $C_2$
  - *if interface* $I_1$ *extends I then I is a subtype of I*
  - *if class C implements interface I then C is a subtype of I*
  - *for every interface I, I is a subtype of Object*
  - *for every type T , T[ ] is a subtype of Object*
  - *if* $T_1$ *is a subtype of* $T_2$ *then* $T_1$*[ ] is a subtype of* $T_2$*[ ]*

# Types of Circle

- Circle is a subtype of
  - Object
  - Displayable
  - Printable

```
public class Circle implements
   Displayable {
 private int radius;
 public String printInstVar(){
  System.out.println(“Radius “
                       +radius);
 }
 public String showInfo(){
  System.out.println(“ I am a
   Triangle with radius “+ radius);
 }
 public String printWithSpaces(){
 ...
 }
 public String display(){
 ...
 }
 public String refresh(){
 ...
 }
 public void displayColor(Color c){
 ...
 }
}
```

# Inheritance and its forms

- Combination
  - child class inherits features from more than one parent
    - Java does not *directly* support this last form, although we can simulate it (more on this next time)

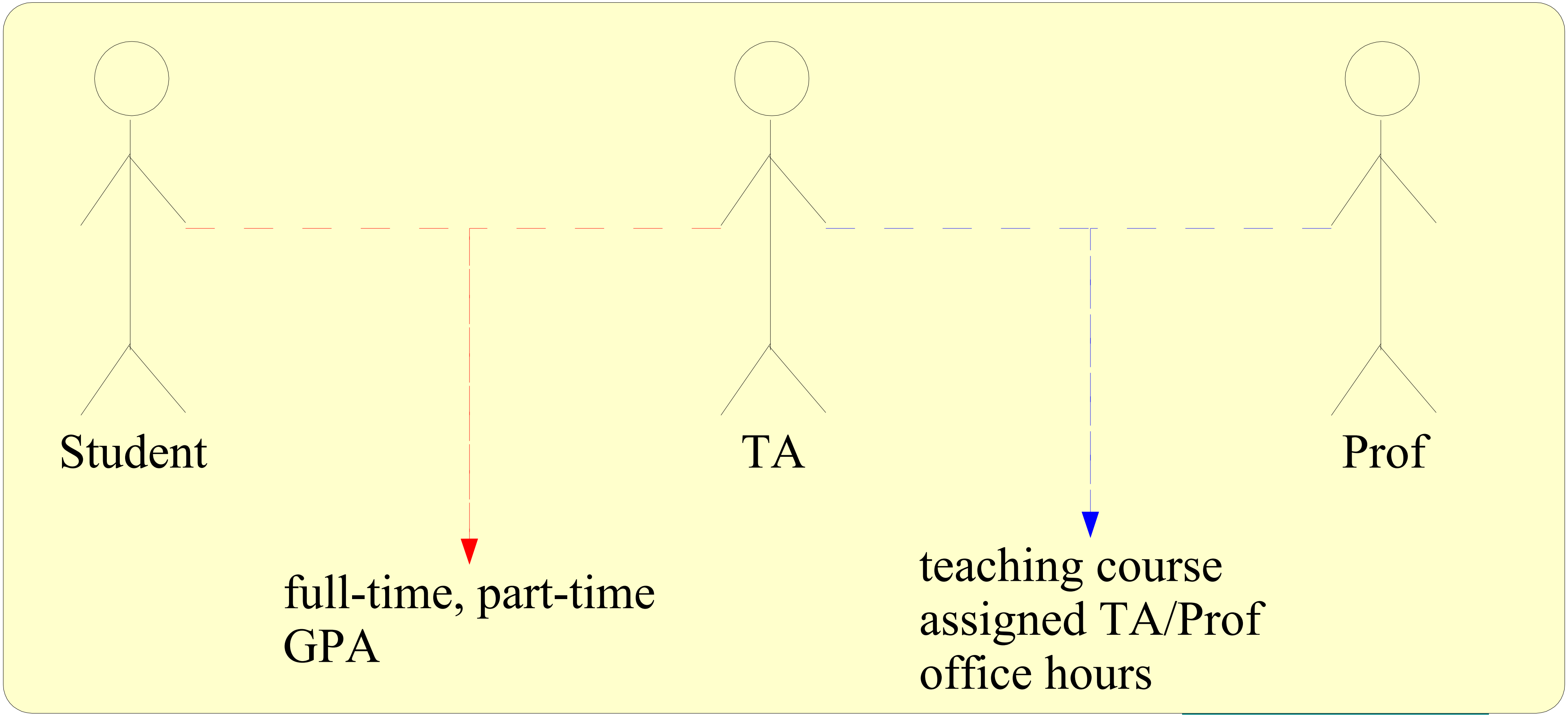
- Using interfaces a class can inherit features from more that one parent.
  - parents do not have to be in an direct inheritance relationship

# Students, TAs and Professors

- Modeling a department with
  - students
  - TA
  - professors
- Students
  - gpa, full-time or part-time, courses
- TA
  - is a student, office hours, course TAing for and professor
- Professors
  - office hours, teaching courses, TA for each one

# Students, TAs and Professors (cont)

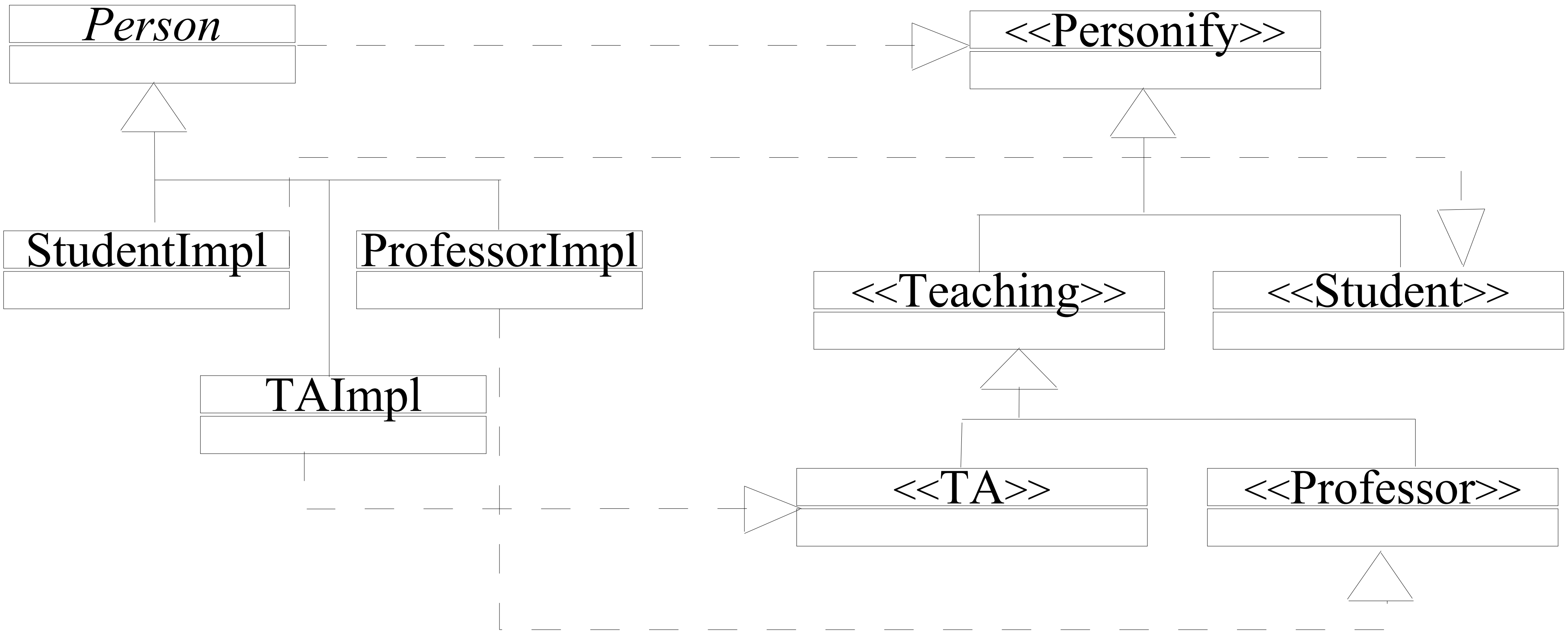
- The goal is not only to correctly implement but to also capture each concept separately.
  - design is equally important



# Students, TAs and Professors (cont)

- Doing this only with Classes and inheritance
  - TA  to inherit from Student and Prof,
    - impossible in Java
  - Can make Prof and Student inherit from TA
    - exposes unused methods inside Prof and TA
  - Use inheritance for construction
    - keep inside TA an instance of Student and Prof
      - lose substitutability (less flexible design)
- Let's try interfaces
  - define a interface for each role( TA, Prof, Student) that enforces each role's features

# Students, TAs and Professors (cont)



# Students, TAs and Professors (cont)

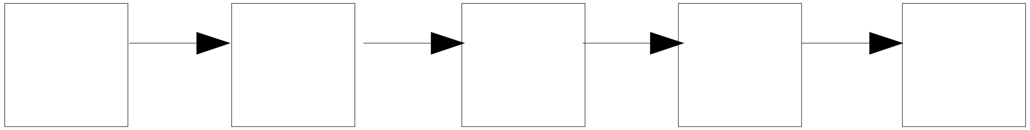
- Declare a type *Personify* as a Java interface type holding features shared by all
- Declare an abstract class *Person* that implements these common features
- For each role, define a corresponding interface
  - abstract away common behavior (i.e. *Teaching*)
- Create implementation classes for each of the roles
  - a student *implements* the Student Interface
  - a TA *implements* the TA Interface
  - a Professor *implements* the Professor Interface
- Check the source code on the class web page.

# Dynamic Data Structures

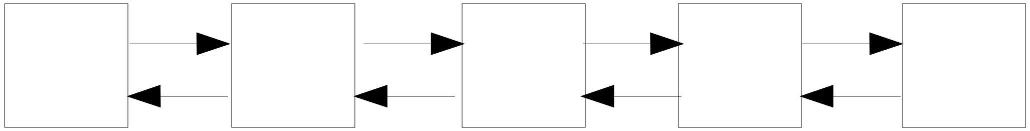
- Data Structures that have the ability to dynamically alter some of their properties like
  - e.g. size
- Some examples
  - LinkedList, Queues, Trees, HashTables
  - standard implementations are available in the standard Java library classes. Most of them under *java.util*
- We will examine some of these

# LinkedList

- a collection of locations with references from one cell to the next
- SingleLinkedList



DoublyLinkedList



# LinkedList (Java)

- Rich set of operations
  - add
    - at a specific index, begging, end
  - size
  - remove
    - an Object, first, last, at a specific index
- Return methods give you back an instance of type *Object*

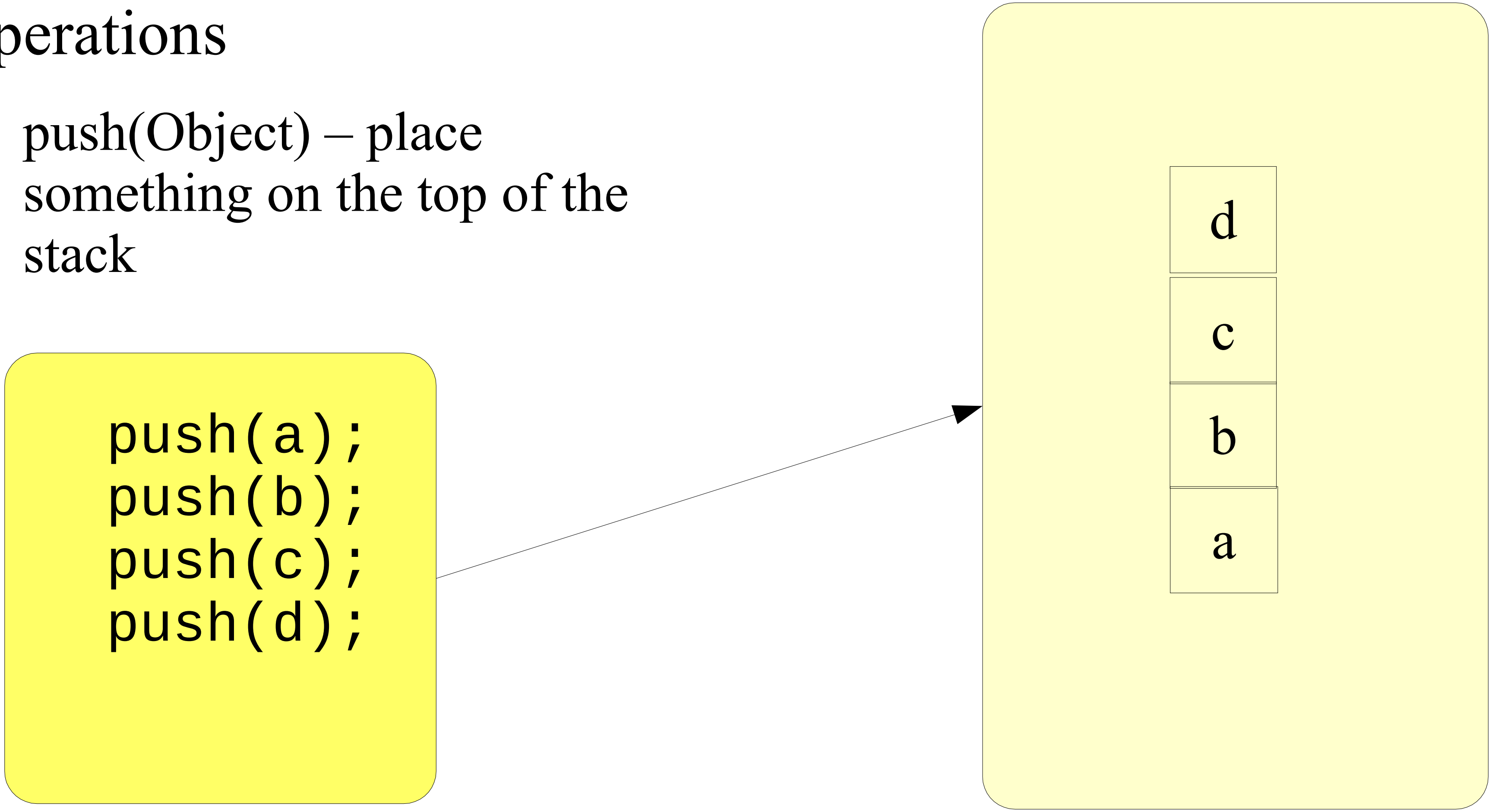
# LinkedList (Java) and Iterators

- Java provides a convenient way to go through an list, an iterator
- *iterator()* - returns an instance of an iterator initialized to point to the first element of the list.
- iterators can *alter* the underlying list elements !

```
LinkedList myList = new LinkedList();
  myList.add("The");
  myList.add("quick");
  myList.add("brown");
  myList.add("fox");
  Iterator it = myList.iterator();
  while(it.hasNext()){
   System.out.print((String)it.next());
   System.out.print(" ");
  }
  System.out.println("!");
```

# Stack

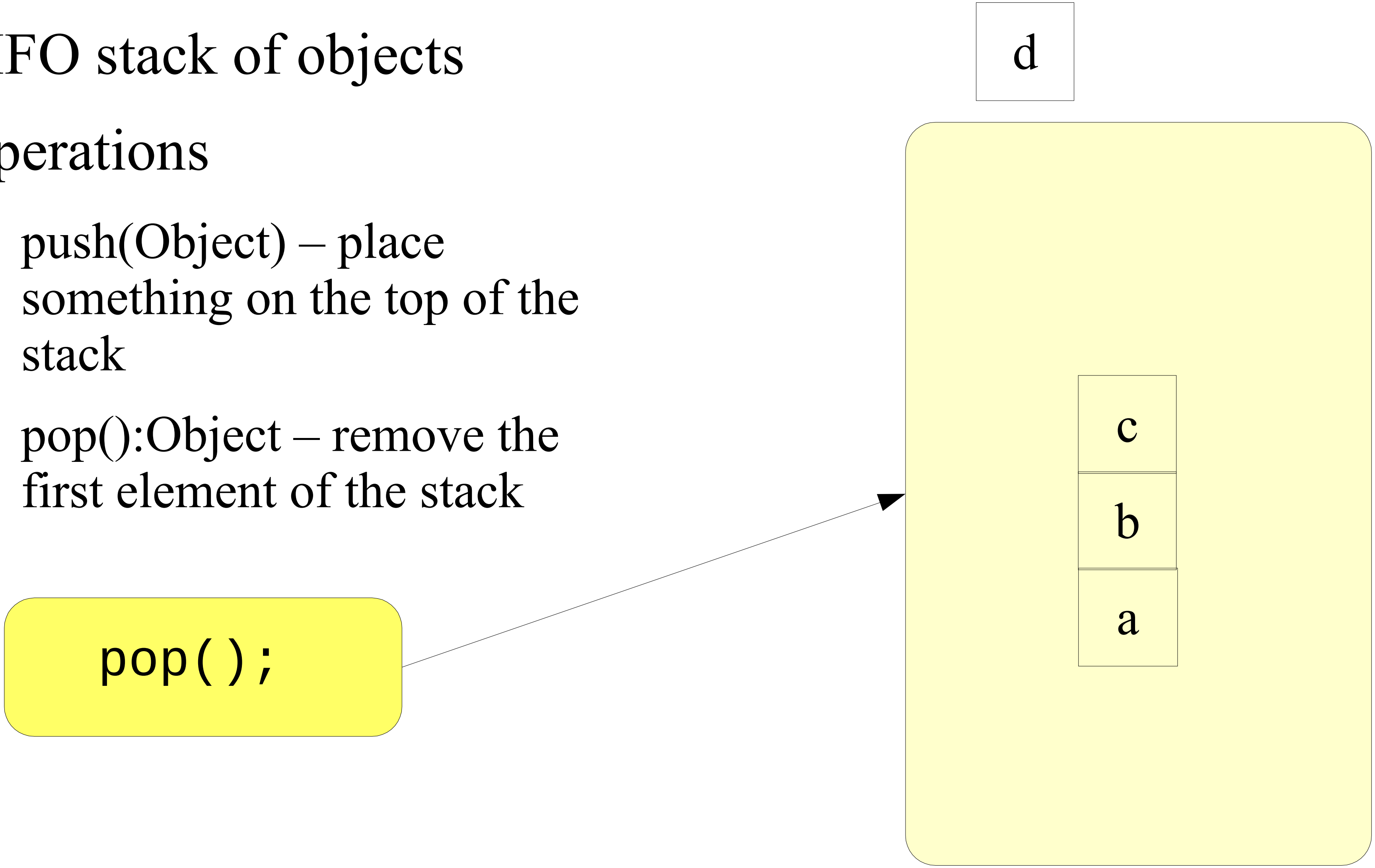
- LIFO stack of objects
- Operations
  - push(Object) – place something on the top of the stack



```
push(a);
push(b);
push(c);
push(d);
```

# Stack (cont)

- LIFO stack of objects
- Operations
  - push(Object) – place something on the top of the stack
  - pop():Object – remove the first element of the stack



pop();

d

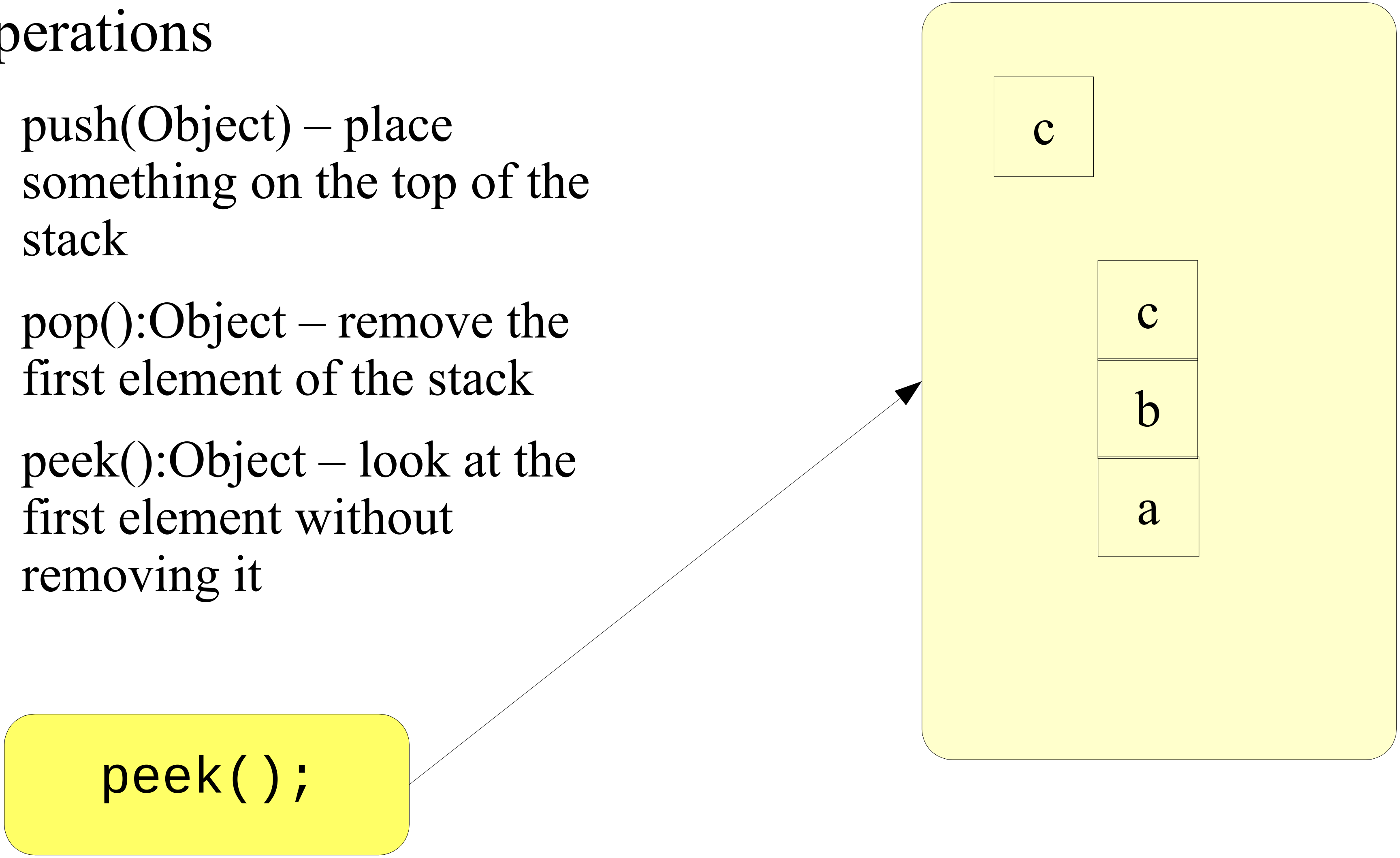
c

b

a

# Stack (cont)

- LIFO stack of objects
- Operations
  - push(Object) – place something on the top of the stack
  - pop():Object – remove the first element of the stack
  - peek():Object – look at the first element without removing it



```
peek();
```

# Stack (cont)

- LIFO stack of objects
- Operations
  - push(Object) – place something on the top of the stack
  - pop():Object – remove the first element of the stack
  - peek():Object – look at the first element without removing it
  - empty():boolean – check to see if the stack is empty