M8(c)- Inversion of Control

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Image source: https://www.goodfreephotos.com/albums/animals/mammals/red-squirrel-climbing-up-a-tree.jpg

Recap

- Be able to Use Callback to achieve decoupling
- Be able to use the Observer design pattern effectively;
- Event Handling in GUI applications
- Understand the concept of an application framework;
- Understand the Model-View-Controller Decomposition;
- Be able to use the Visitor Design Pattern effectively;
- Be able to determine when to used different design patterns effectively.

Objective

- Be able to Use Callback to achieve decoupling
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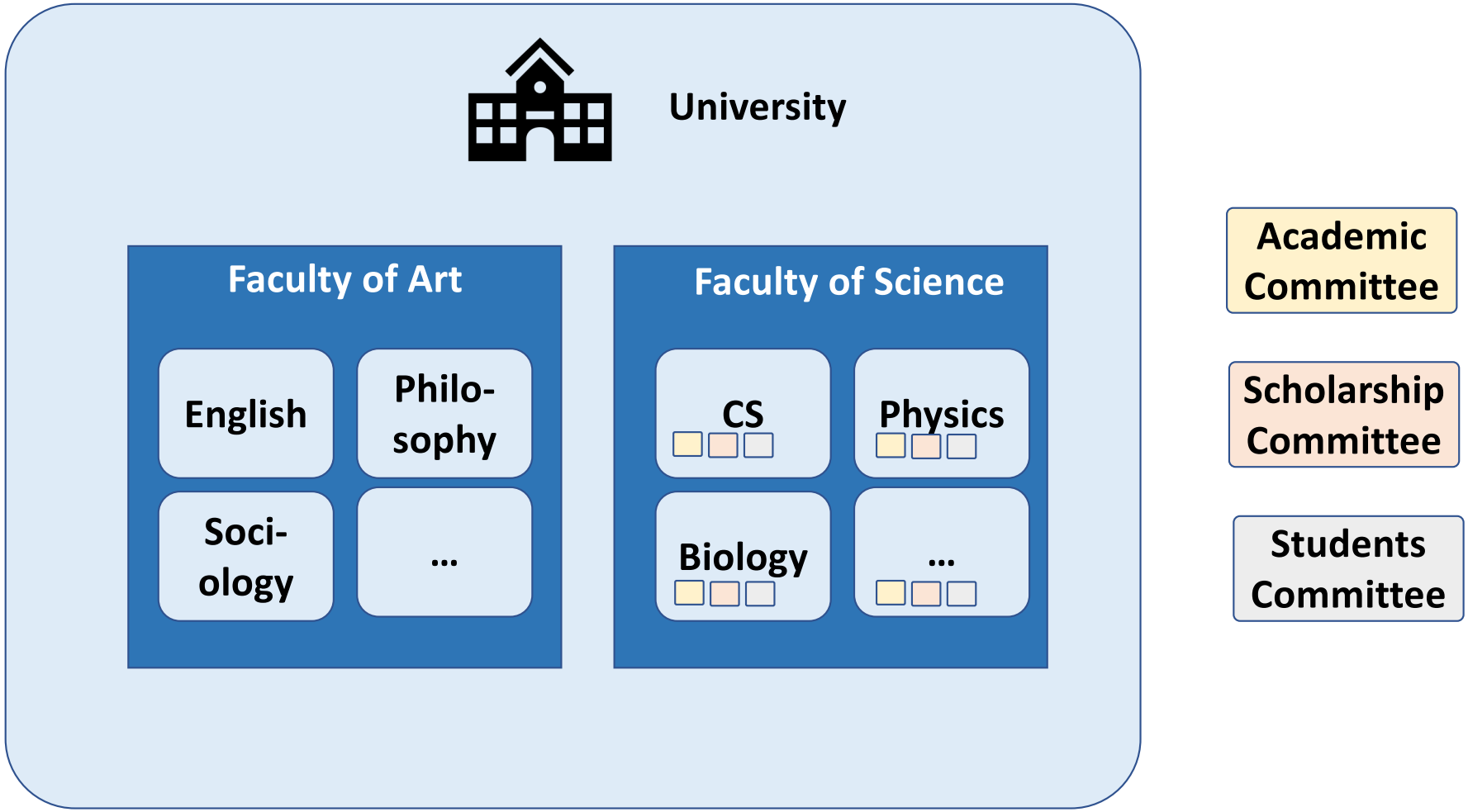
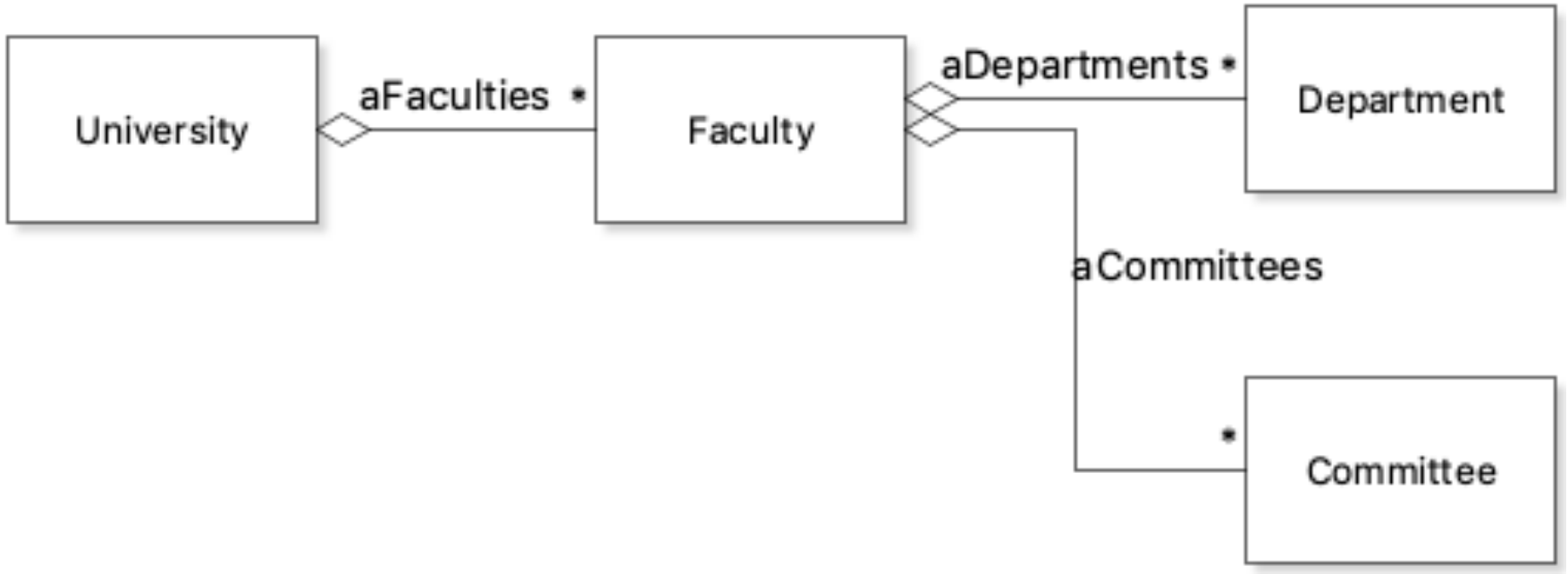

University
Faculty of Art
English
Philo-
sophy
Soci-
ology
...
Faculty of Science
CS
Physics
Biology
...
Academic
Committee
Scholarship
Committee
Students
Committee


University
aFaculties
*
Faculty
aDepartments
*
Department
aCommittees
*
Committee

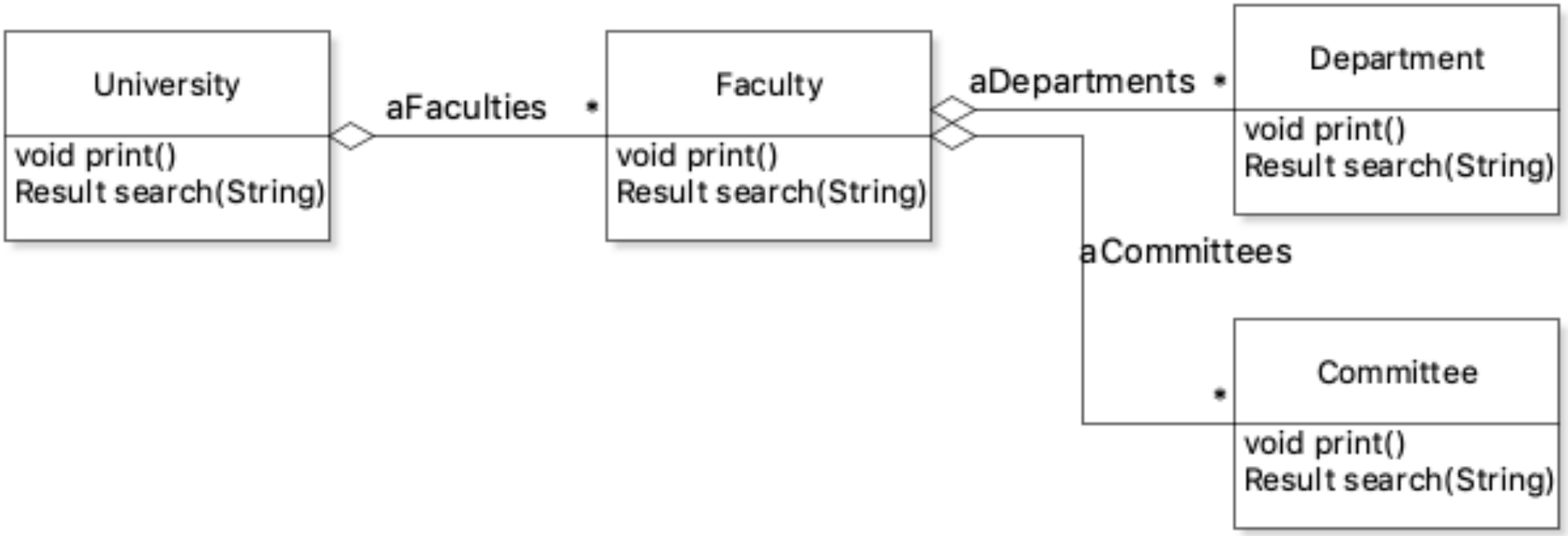
Add functionalities to aggregate

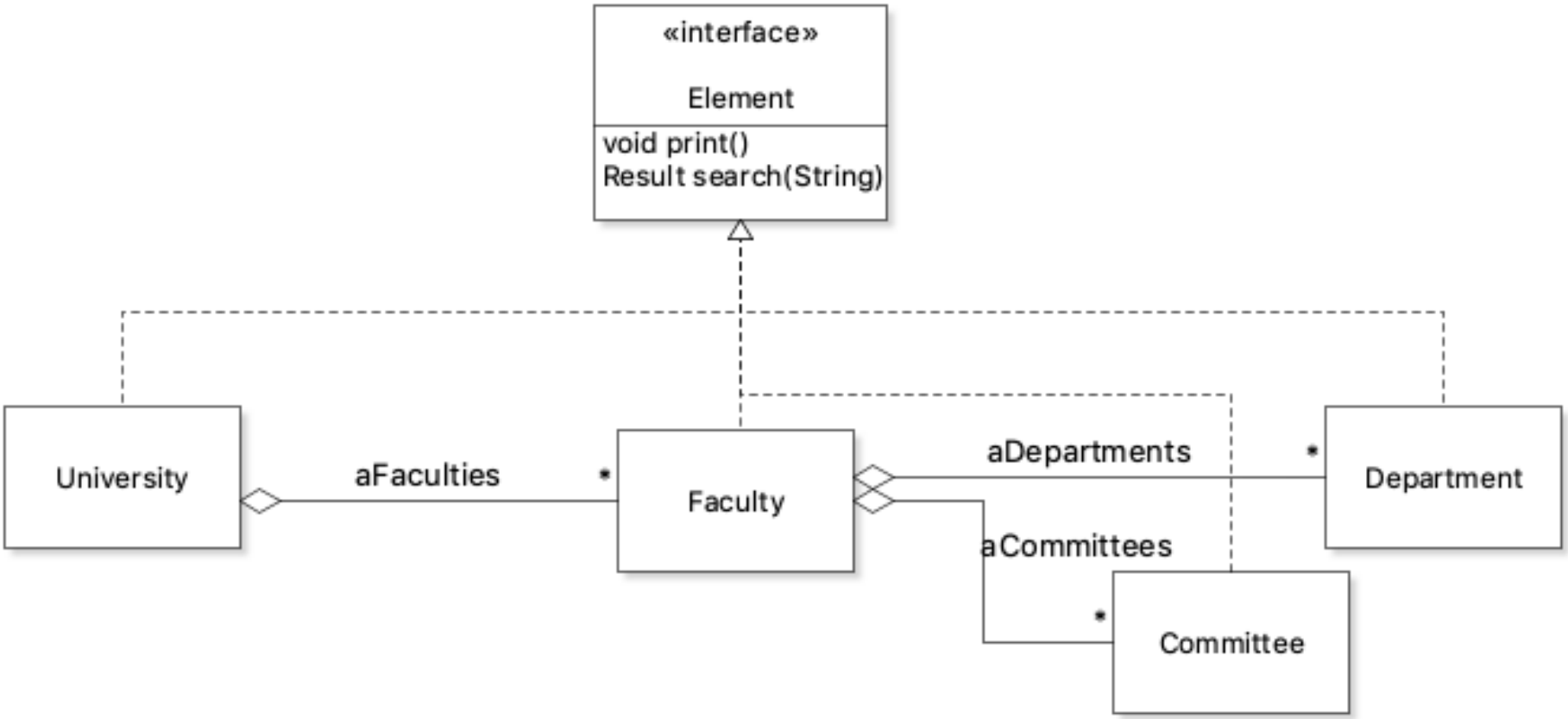
Print annual report for every organizations in university

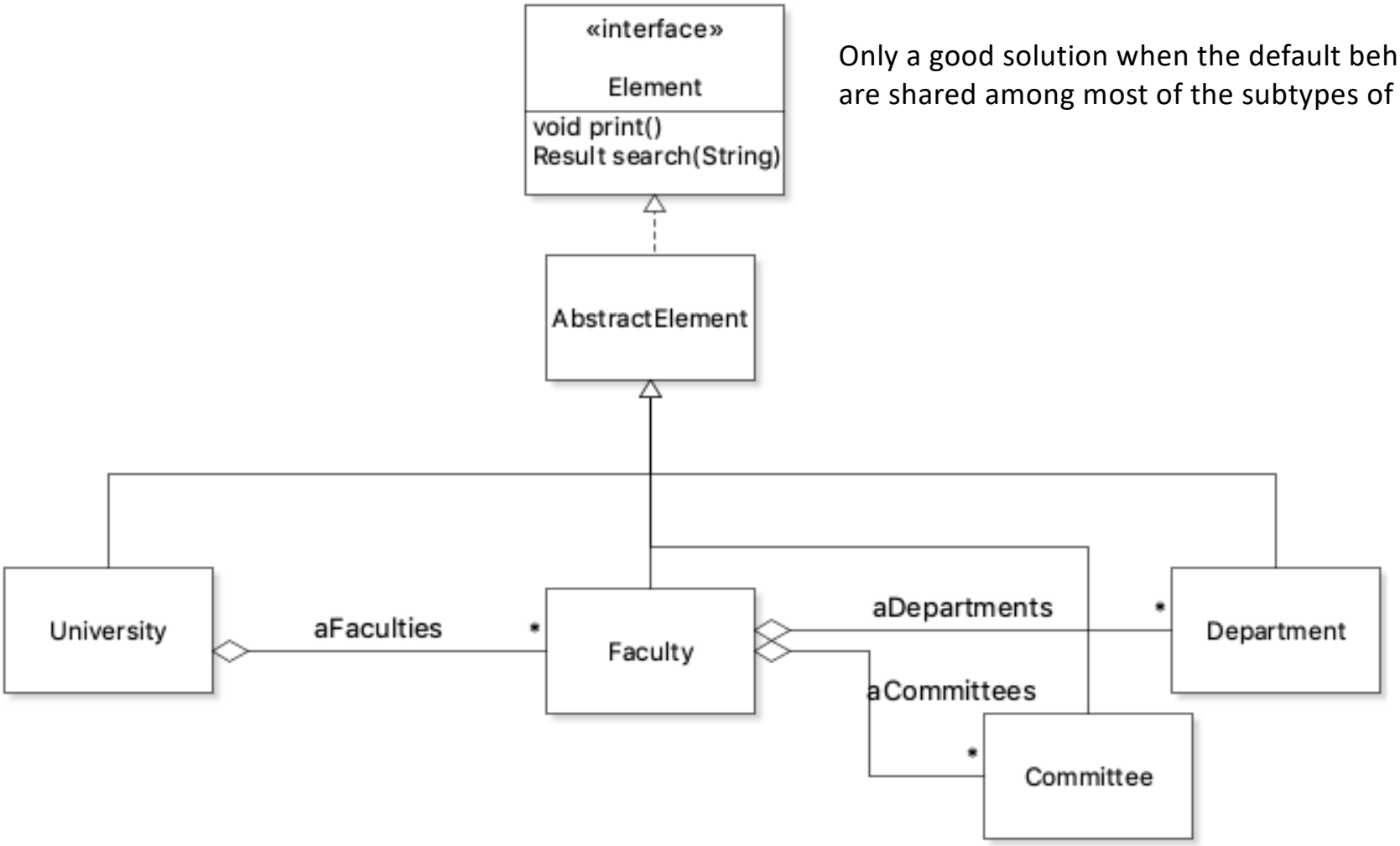
Search if one person belongs to any organization in university

… …

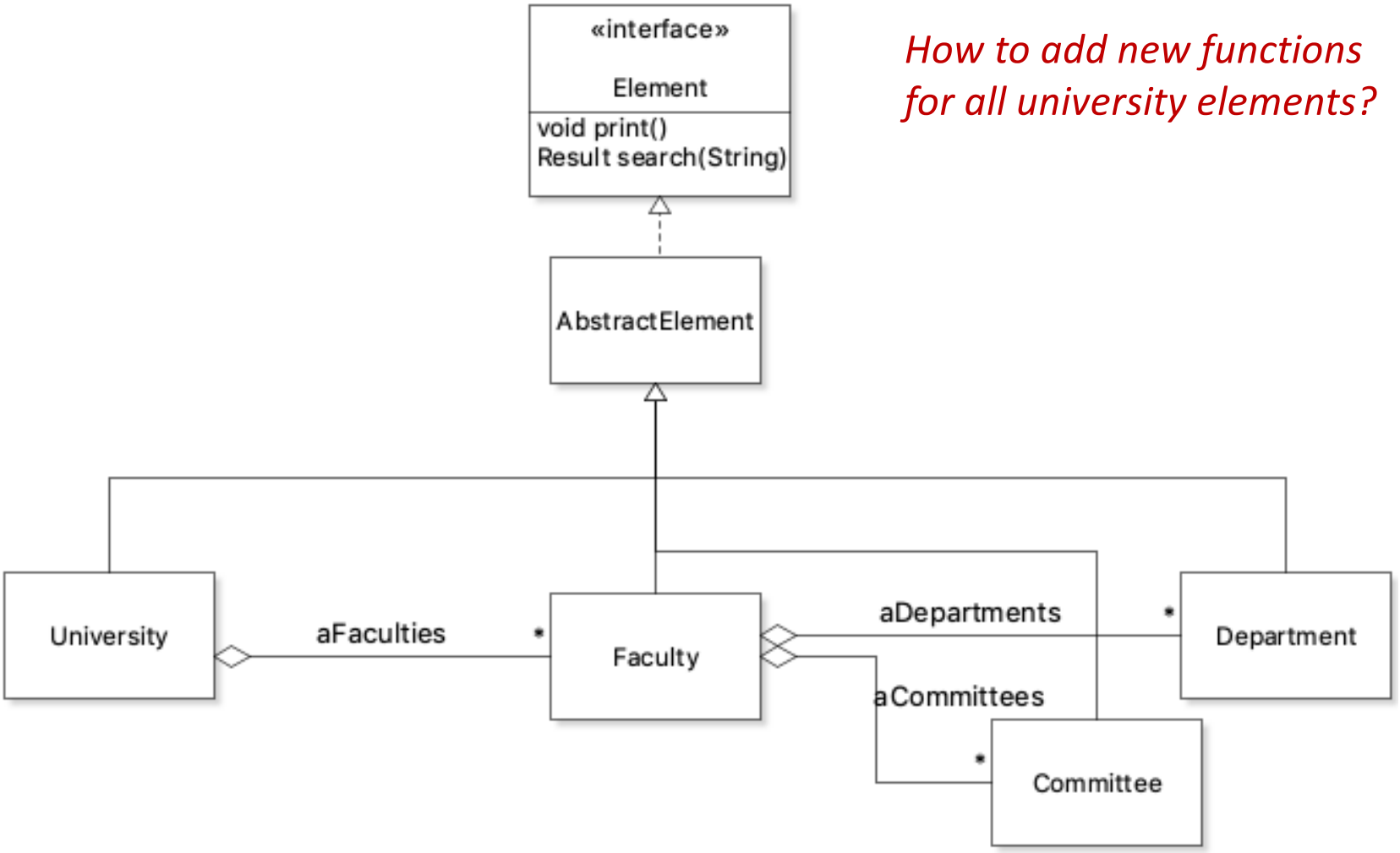
All requires traverse all the elements in University,
and process them (potentially differently)


University
void print()
Result search(String)
aFaculties
*
Faculty
void print()
Result search(String)
aDepartments
*
Department
void print()
Result search(String)
aCommittees
*
Committee
void print()
Result search(String)

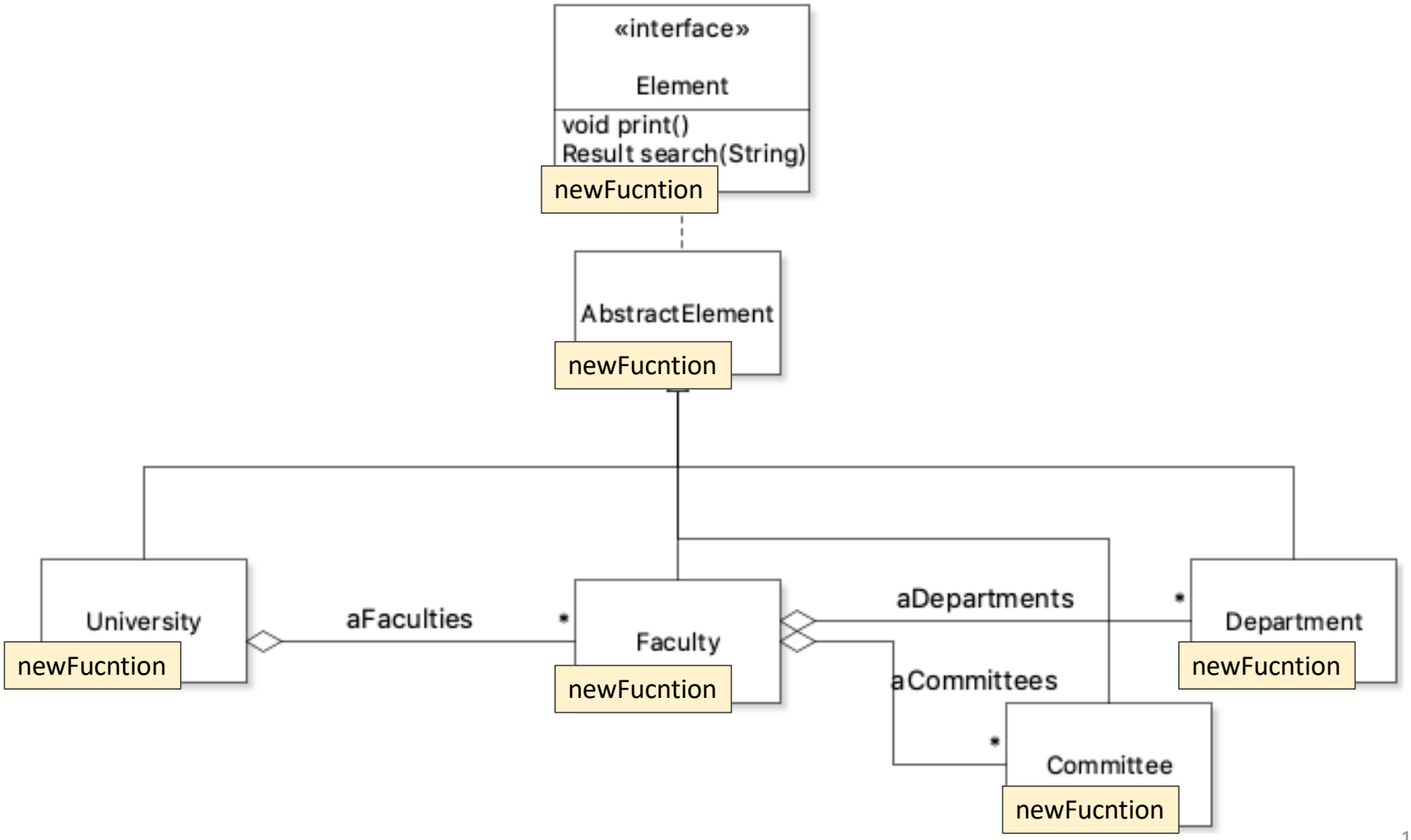

«interface»
Element
void print()
Result search(String)
University
aFaculties
*
Faculty
aDepartments
*
Department
aCommittees
*
Committee



Only a good solution when the default behaviors are shared among most of the subtypes of element.



How to add new functions for all university elements?

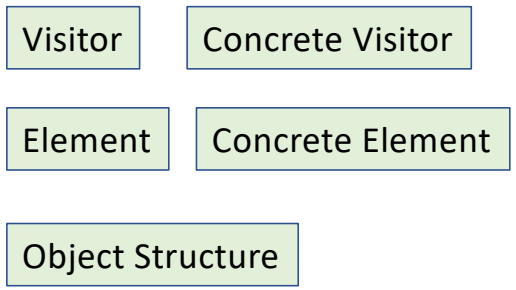

«interface»
Element
void print()
Result search(String)
newFucntion
AbstractElement
newFucntion
University
newFucntion
aFaculties
*
Faculty
newFucntion
aDepartments
*
Department
newFucntion
aCommittees
*
Committee
newFucntion

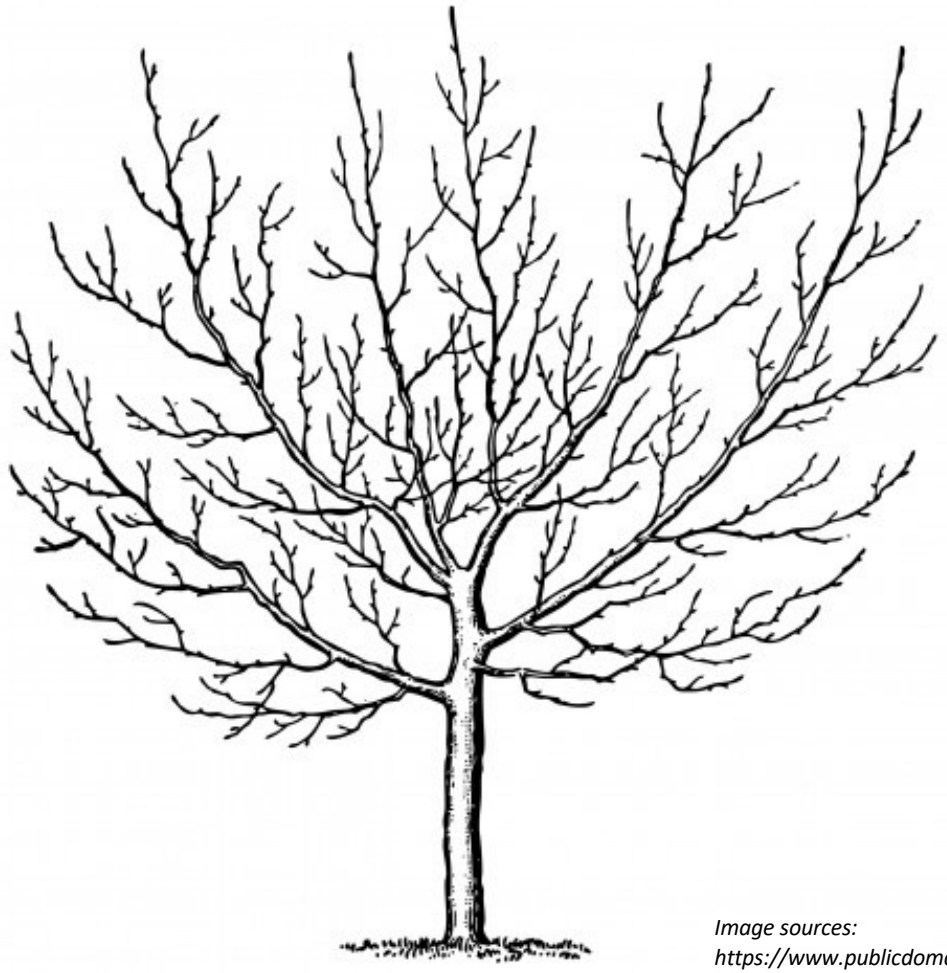
Visitor

- Intent:

Represent an operation to be performed on the elements of an object structure. Visitor lets you define a new operation without changing the classes of the elements on which it operates.

- Participants:





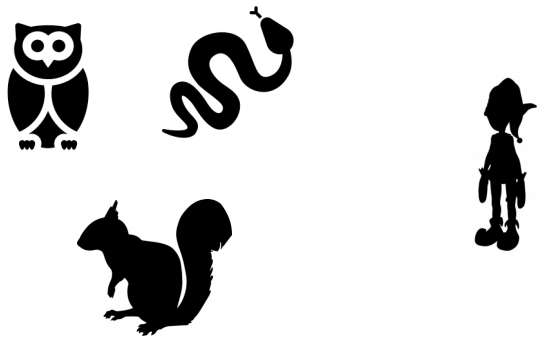


Image sources:
https://www.publicdomainpictures.net/pictures/100000/nahled/tree-1409250600Al7.jpg
https://www.publicdomainpictures.net/pictures/140000/nahled/black-elf.jpg
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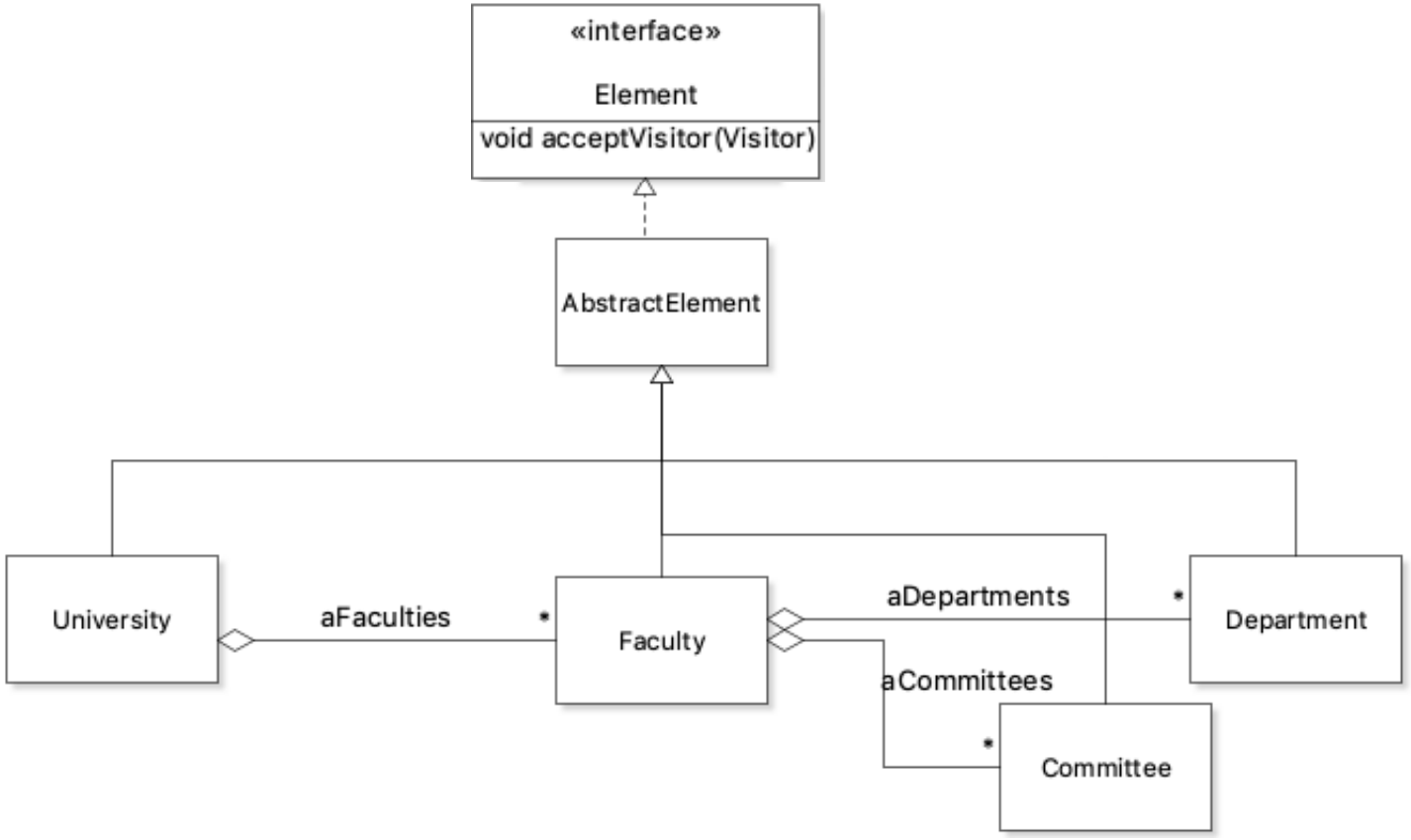
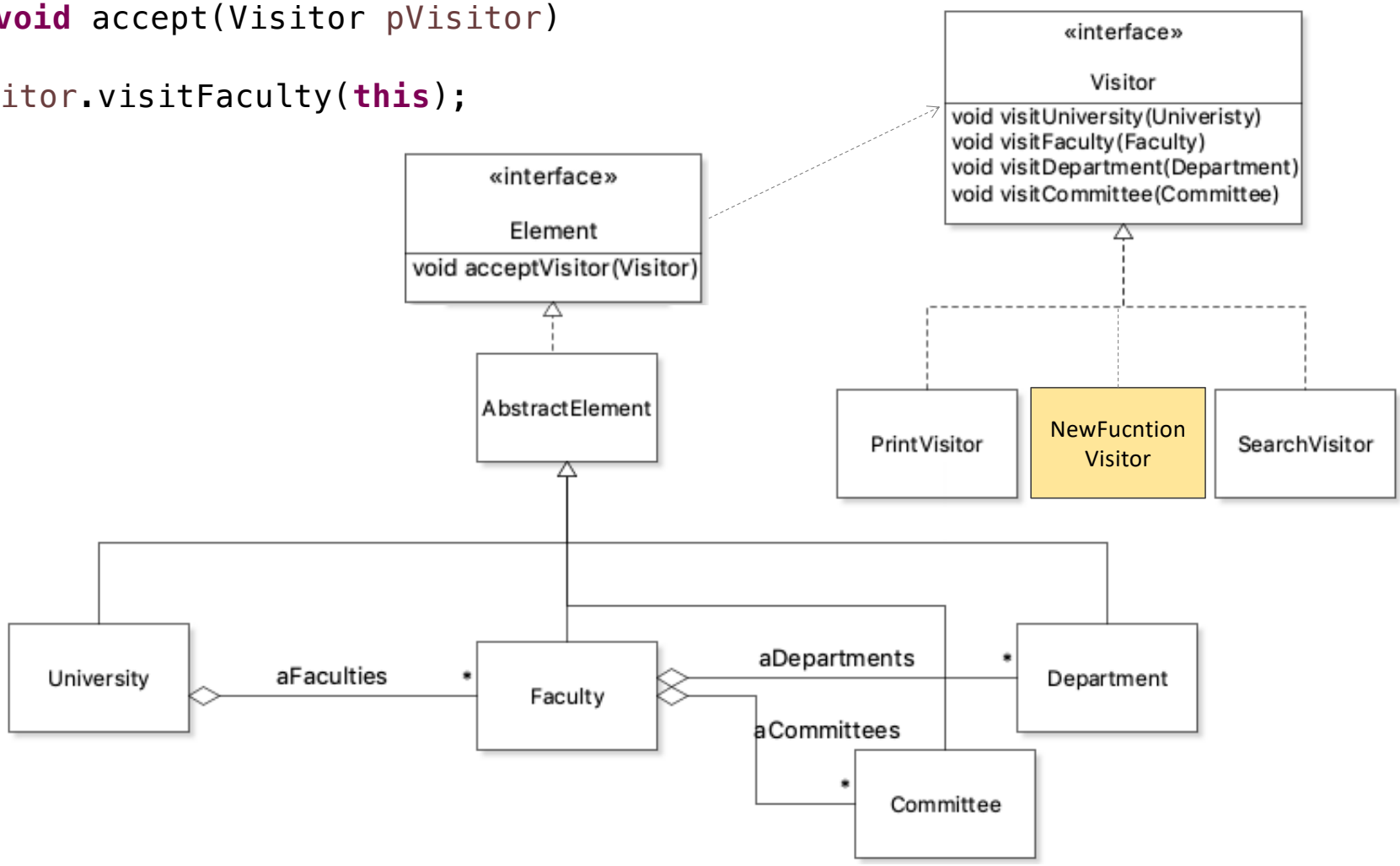
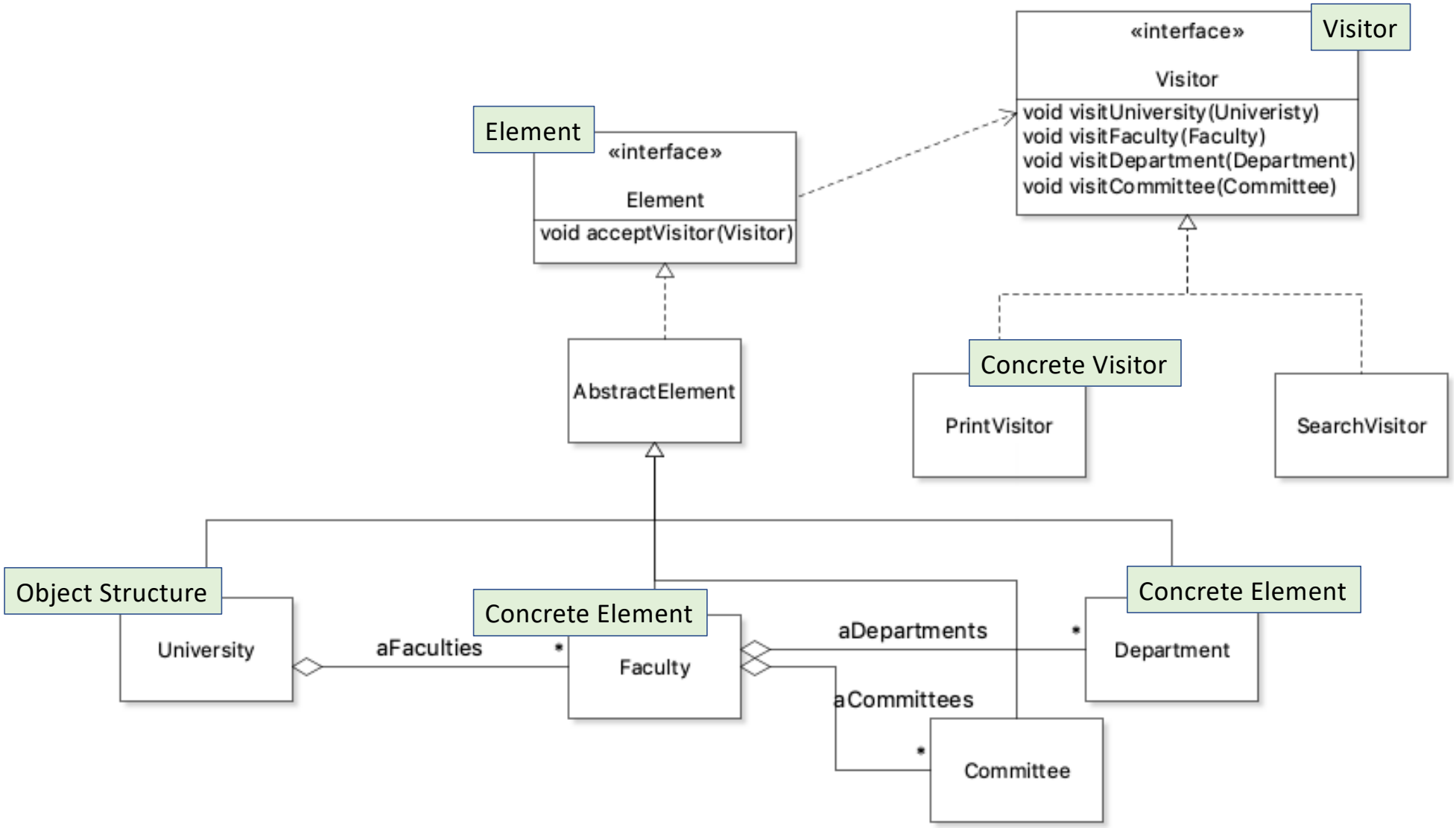
```java
@Override
public void accept(Visitor pVisitor)
{
    // Use callback functions from pVisitor
}
```

How to pass around functions?



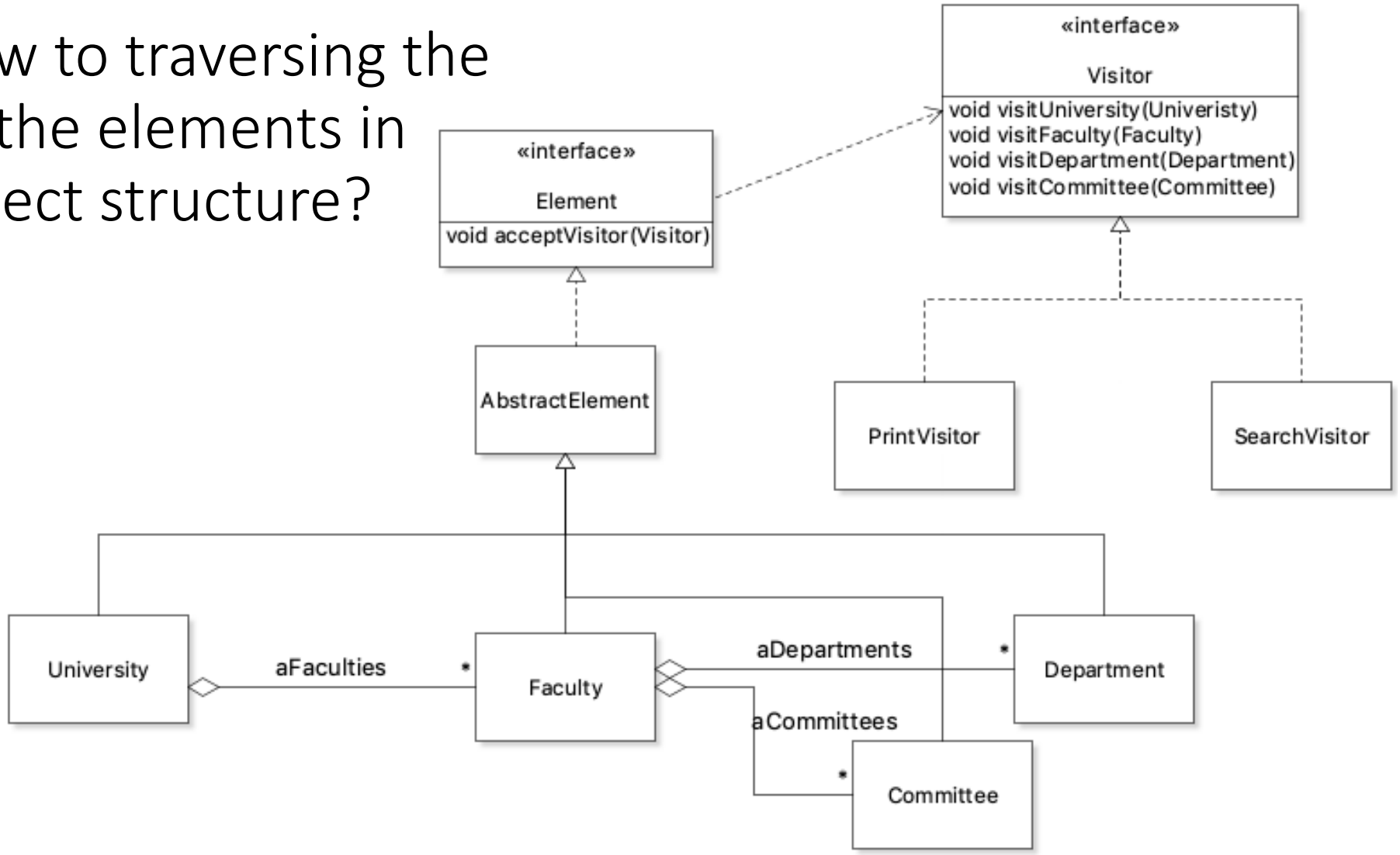
```java
@Override
public void accept(Visitor pVisitor)
{
    pVisitor.visitFaculty(this);
}
```




Visitor
«interface»
Visitor
void visitUniversity(Univeristy)
void visitFaculty(Faculty)
void visitDepartment(Department)
void visitCommittee(Committee)
Element
«interface»
Element
void acceptVisitor(Visitor)
AbstractElement
Concrete Visitor
PrintVisitor
SearchVisitor
Object Structure
University
aFaculties
*
Concrete Element
Faculty
aDepartments
*
Department
aCommittees
*
Committee
Concrete Element

What are the consequences when applying Visitor pattern?

How to traversing the all the elements in object structure?



Method1:

```
class University extends AbstractElement
{
    private final List<Faculty> aFaculties = new ArrayList<Faculty>();
    public University(String pName) { super(pName); }
    public void addFaculty(Faculty pFaculty) { aFaculties.add(pFaculty); }


    @Override
    public void accept(Visitor pVisitor)
    {
        pVisitor.visitUniversity(this);

        for( Faculty f : aFaculties )
        {
            f.accept(pVisitor);
        }
    }
}
```

← Traverse in the aggregate object structure.

Method1:

```
public class PrintVisitor implements Visitor
{
   @Override
   public void visitUniversity(University pUniversity)
   {

      // Printing operation for University

   }

   @Override
   public void visitFaculty(Faculty pFaculty)
   {

      // Printing operation for Faculty

   }

}
```

Method2:

```
class University extends AbstractElement
{
   private final List<Faculty> aFaculties = new ArrayList<Faculty>();
   public University(String pName) { super(pName); }
   public void addFaculty(Faculty pFaculty) { aFaculties.add(pFaculty); }
   public Iterator<Faculty> getFaculties()
      { return Collections.unmodifiableList(aFaculties).iterator(); }

   @Override
   public void accept(Visitor pVisitor)
   {
      pVisitor.visitUniversity(this);
   }
}
```

↑ But provide a traversal mechanism to its elements

← Not in the object structure.

Method2:

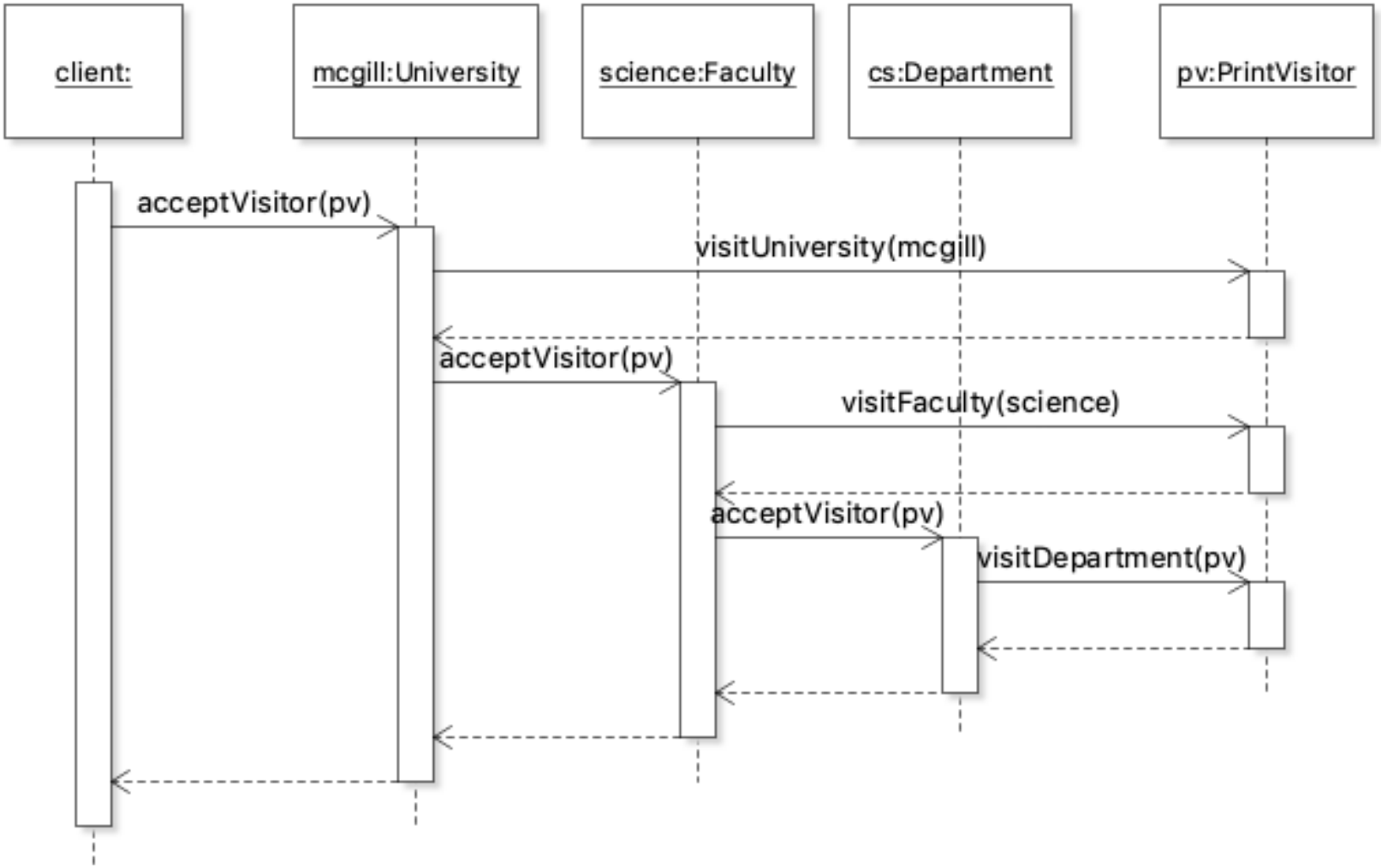
```
public class PrintVisitor implements Visitor
{


   @Override
   public void visitUniversity(University pUniversity)
   {
      // Printing operation for University
      for( Iterator<Faculty> i = pUniversity.getFaculties();
         i.hasNext(); )
         {
            i.next().accept(this);
         }
   }
}
```

Traverse in the visitor→

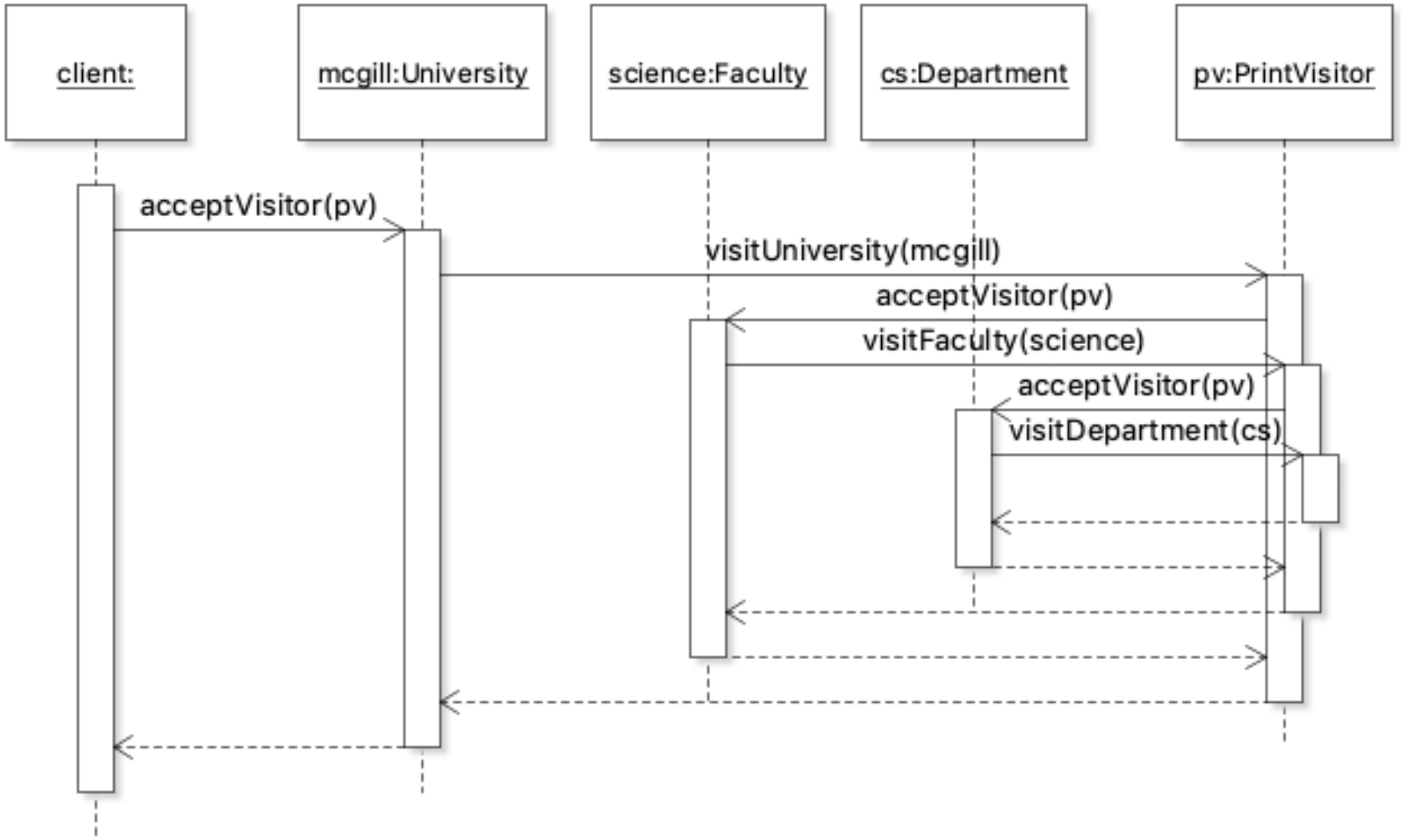
Activity2: Sequence Diagram for Visitor pattern

```
University mcGill = new University("McGill");
Faculty science = new Faculty("Science");
Department cs = new Department("Computer Science");

mcGill.addFaculty(science);
science.addDepartment(cs);

Visitor pv = new PrintVisitor();
mcGill.acceptVisitor(pv);
```

Traverse in the object structure



Sequence diagram for traversal in Visitor?


client:
mcgill:University
science:Faculty
cs:Department
pv:PrintVisitor
acceptVisitor(pv)
visitUniversity(mcgill)
acceptVisitor(pv)
visitFaculty(science)
acceptVisitor(pv)
visitDepartment(cs)

What is design pattern again?

- A standard solution to a common programming problem
- A technique for making code more flexible
- Shorthand for describing program design
- Vocabulary for communication & documentation

	Creational	Structural	Behavioral
Class	Factory Method	Adapter (class)	Integreter
			Template Method ✓
Object	Abstract Factory	Adapter (class)	Chain of Responsibility
	Builder	Bridge	Command ✓
	Prototype ✓	Composite ✓	Iterator ✓
	Singleton ✓	Decorator ✓	Mediator
		Flyweight ✓	Momento
		Façade	Observer ✓
		Proxy	State
			Strategy ✓
			Visitor ✓

Creational Patterns

- Creational Patterns control object creation
  - encapsulate knowledge about which concrete classes the system uses
  - hide how instances of concrete classes are created and combined.

Why not using the constructors?
Cannot return a subtype
Always create a new object

	Creational	Structural	Behavioral
Class	Factory Method	Adapter (class)	Interpreter
			Template Method ✓
Object	Abstract Factory	Adapter (object)	Chain of Responsibility
	Builder	Bridge	Command ✓
	Prototype ✓	Composite ✓	Iterator ✓
	Singleton ✓	Decorator ✓	Mediator
		Flyweight ✓	Momento
		Façade	Observer ✓
		Proxy	State
			Strategy ✓
			Visitor ✓

Structural Patterns

- Concerned with how classes and objects are composed to form larger structures.
- Patterns have distinct intention
- Structural object patterns can change the composition at run-time, which is impossible with static class composition.

	Creational	Structural	Behavioral
Class	Factory Method	Adapter (class)	Interpreter
			Template Method ✓
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	Prototype ✓	Composite ✓	Iterator ✓
	Singleton ✓	Decorator ✓	Mediator
		Flyweight ✓	Momento
		Façade	Observer ✓
		Proxy	State
			Strategy ✓
			Visitor ✓

Behavioral Patterns

- Concerned with algorithms and the assignment of responsibilities between objects.
- Describe not just patterns of objects or classes but also the patterns of communication between them.

Encapsulating Variation

- When an aspect of a program changes frequently, the behavioral patterns define an object that encapsulate that aspect:
  - A Strategy object encapsulates _____;
  - An iterator object encapsulates _____;
  - A command object encapsulates _____;
  - A visitor object encapsulates_____;

Passing around object

- Object is returned to the client and will be used at later time.
  - An iterator
  - A command
- Object is passed into the system as argument
  - A strategy
  - A visitor

Review Objectives of “Inversion of control”

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- Understand the concept of an application framework;
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