CSE216 – Programming Abstractions
Recitation 4

Objectives:

- Understand parameter passing in Java and Python
- Revise C pointers
- A glance at Java generics.

Download CSE216Rec4.zip.

Modes of passing parameters:

1. **Pass by value:** Make a copy of the parameter. The most common strategy is the call-by-value evaluation, sometimes also called pass-by-value. This strategy is used in C and C++, for example. In call-by-value, the argument expression is evaluated, and the result of this evaluation is bound to the corresponding variable in the function. So, if the expression is a variable, a local copy of its value will be used, i.e. the variable in the caller's scope will be unchanged when the function returns.

2. **Pass by reference:** Allows the function to change the parameter. In call-by-reference evaluation, which is also known as pass-by-reference, a function gets an implicit reference to the argument, rather than a copy of its value. As a consequence, the function can modify the argument, i.e. the value of the variable in the caller's scope can be changed. The advantage of call-by-reference consists in the advantage of greater time- and space-efficiency, because arguments do not need to be copied. On the other hand this harbours the disadvantage that variables can be "accidentally" changed in a function call. So special care has to be taken to "protect" the values, which shouldn't be changed.

3. **Pass by sharing:** requires parameter to be a reference itself.

    - Makes copy of reference that initially refers to the same object.
    - Within subroutine, value of the object can be changed.
    - However, identity of the object cannot be changed.
    - E.g., User defined Java Objects.

Argument passing in Java

1. Java uses call-by-value for variables of built-in type (all of which are values). See example: PassByValue.java

2. Call-by-sharing for variables of user-defined class types (all of which are references). See example: VehicleProcessor.java

C Pointers

In C, you can create a special variable that stores the address (rather than the value). This variable is called pointer variable or simply a pointer.

Creating a pointer variable

```
data_type* pointer_variable_name;
```

E.g.: `int* p;`

Above statement defines, p as pointer variable of type int.

Reference operator (&) and Dereference operator (*)

& is called reference operator. It gives you the address of a variable. Likewise, there is another operator that gets you the value from the address, it is called a dereference operator *.

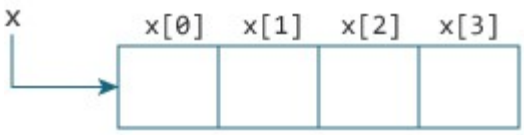
Note: The * sign when declaring a pointer is not a dereference operator. It is just a similar notation that creates a pointer.

See example: cpointers.c

Relationship between Arrays and Pointers

Consider an array:

int x[4];



x and &x[0] both contains the same address. Hence, &x[0] is equivalent to x. And, x[0] is equivalent to *x. Similarly,

- &x[1] is equivalent to x+1 and x[1] is equivalent to *(x+1).
- &x[2] is equivalent to x+2 and x[2] is equivalent to *(x+2).
- ...
- Basically, &x[i] is equivalent to x+i and x[i] is equivalent to *(x+i).

See example: carraypointers.c

Reading: Read the Pointer variables tutorial at https://www.ntu.edu.sg/home/ehchua/programming/cpp/cp4_PointerReference.html.

Pass by value example: see passbyval.c

Pass by reference example: see passbyref.c

Exercise: Write a C program to calculate arithmetic mean of an array using array pointers.

Java Generics

Java Generic methods and generic classes enable programmers to specify, with a single method declaration, a set of related methods, or with a single class declaration, a set of related types, respectively.

Generics also provide compile-time type safety that allows programmers to catch invalid types at compile time. When defining a function, we don't need to give all the types. When we invoke the class or function we specify the type. This is called parametric polymorphism.

Example: Comparable interface

By default, a user defined class is not comparable. That is, its objects can't be compared. To make an object comparable, the class must implement the Comparable interface. The Comparable interface has a single method called compareTo() that you need to implement in order to define how an object compares with the supplied object -

```
public interface Comparable<T> {
     public int compareTo(T o);
}
```

When you define the compareTo() method in your classes, you need to make sure that the return value of this method is -

- negative, if this object is less than the supplied object.
- zero, if this object is equal to the supplied object.
- positive, if this object is greater than the supplied object.

Many predefined Java classes like String, Date, LocalDate, LocalDateTime etc implement the Comparable interface to define the ordering of their instances.

Exercise: Study the Employee class which implements Comparable interface as well as ComparableExample class for illustration. You will use this example to solve the following problem:

Suppose there is a class named Product with the following attributes:

`String productCategory`

`int productCost, and`

`String productName.`

Consider a scenario where you have an arraylist of objects of type Product. Write a Java code that uses `java.util.Collections#sort` to sort Product arraylist as follows:

- items will be sorted by `productCost` first,
- if there are multiple items with the same `productCost`, then those will be sorted alphabetically by `productCategory` next, and
- if there are items in the same category and have the same cost, then they will be sorted alphabetically by the `productName` finally.

Submission

Submit the following on the blackboard:

- C program to calculate arithmetic mean of an array using array pointers.
- Product class that implements comparable interface.
- An example for sorting products as per criteria explained in above section.

To be studied at a later date:

Argument passing in Python[1]

Integer variables: The parameter inside of the function remains a reference to the arguments variable, as long as the parameter is not changed. As soon as a new value will be assigned to it, Python creates a separate local variable.

List variables: List variables behave like integer variables unless they are modified within a function. This results in the side effect of modifying list outside the function. A function is said to have a side effect if, in addition to producing a value, it modifies the caller's environment in other ways. For example, a function might modify a global or static variable, modify one of its arguments, raise an exception, write data to a display or file and so on. The unwanted side effect can be avoided by passing a copy of list to the function.

Tuple variables: Tuple variables are immutable and they cannot be modified within a function. Trying to assign another values to tuple within a function does not have any effect outside the function. If you pass immutable arguments like integers, strings or tuples to a function, the passing acts like call-by-value. The object reference is passed to the function parameters. They can't be changed within the function, because they can't be changed at all, i.e. they are immutable.

Variable length of parameters: The asterisk "*" is used in Python to define a variable number of arguments. The asterisk character has to precede a variable identifier in the parameter list.

See program **parameterpassing.py**.

[1] Reference: Passing Arguments, https://www.python-course.eu/passing_arguments.php.

Exercise: Write a Python program to calculate arithmetic mean of a list or tuple using variable number of arguments.