King Saud University
College of Computer & Information Science
CSC111 – Lab10
Arrays – II –
All Sections

Instructions

Web-CAT submission URL:
http://10.131.240.28:8080/Web-CAT/WebObjects/Web-CAT.woa/wa/assignments/eclipse

Objectives:

- To know how to define and create an array.
- To know how to pass array to method and return array from method.
- To know how to create object with arrays as attributes
- To know how to add elements to arrays
- To know how to search arrays
- To know how to find max element in an array

Lab Exercise 1 (Lab Homework) – Expected Time: 2 hours

Part 1 (read/write array values)

Write a program **`CourseManager1`** that reads and prints scores of students in a course. The scores are double numbers between 0 and 100.

- Your program should start by reading the number of the students taking the course.
- Then it reads and stores the scores in an array. If a score is invalid then your program should store 0.
- After that it prints the scores.

Sample Run

```
Enter number of students: 4 ↲
Please enter students' scores: 100 -30 75 90 ↲
The score -30.0 you entered is wrong. Program will store score 0.
The scores are: 100.0 0.0 75.0 90.0
```

Complete following pseudo code

```
import java.util.Scanner;
public class CourseManager1 {
	public static void main(String[] args)
	{
		Scanner input = new Scanner(System.in);
		System.out.print("Enter number of students: ");
		/* read the number of students ( array size) */

		while (/* array size less than 1*/numOfStudents < 1){
			System.out.print("Number of students is invalid. Enter
number of students: ");
			/* read array size  again */

		}
		/* define and declare the array ( double) */

		System.out.print("Please enter students' scores: ");
		//read the array score
		for (int i = 0; i < scores.length; i++){

			//read the array score
```

```
                    if (score >= 0 && score <= 100){
                          scores[i] = score;
                    }
                    else {
                          System.out.println("The score " + score + " you
entered is wrong. Program will store score 0.");
                    }
             }
             System.out.print("The scores are: ");


             /*write a code to output the contents of the array (print the
array score*/
             System.out.println();
       }// end of main method

}// end of CourseManager1 class
```

At this point, submit your program to WebCAT.

Part 2 (copy array, pass array as parameter, return array as result)

Modify the previous program such that after reading the scores, your program computes the letter grades and store them in an array of type **`char`**.

- Write a static method `scoreToGrade` that
    - takes the **scores** array as parameter,
    - creates the **grades** array,
    - fill **grades** array up with letter grades (A: 90-100, B: 80-89, C: 70-79, D: 60-69, F: 0-59) then return it.

  Use the rules of KSU to convert a score into a letter grade.
- Prints each score along with the letter grade using format *score/letter_grade*.

Name your new program **`CourseManager2`**.

Sample Run

```
Enter number of students: 5 ↲
Please enter students' scores: 100 40 79 89 90 ↲
The scores/grades are: 100.0/A 40.0/F 79.0/C 89.0/B 90.0/A
```

Complete following pseudo code

```
import java.util.Scanner;
public class CourseManager2 {
	public static void main(String[] args) {
		Scanner input = new Scanner(System.in);
		System.out.print("Enter number of students: ");
		// read the number of students ( array size)
		while (/* array size less than 1*/){
			System.out.print("Number of students is invalid. Enter
number of students: ");
			/* read array size  again */

		}
/* define and declare the  scores array ( double) */

		System.out.print("Please enter students' scores: ");

		for (int i = 0; i < scores.length; i++){

			/*read score and store it in the array */

		}
		/* define and declare the  grades array ( char) */
		char[] grades = scoreToGrade(scores);
		System.out.print("The scores/grades are: ");
		for (int i = 0; i < scores.length; i++){
			System.out.print(scores[i] + "/" + grades[i] + " ");
			/* prints each score along with the letter grade using
format scores[i] + "/" + grades[i] + " " */

		}
		System.out.println();
	}

	/* Precondition: all scores in the array are between 0 and 100
	 create scoreToGrade method */
	public static char[] scoreToGrade(double[] scores){
		char[] grades = new char[scores.length];
		for (int i = 0; i < scores.length; i++){
			if (scores[i] >= 90)

			/*if score >=90 store A in grade

			if score > 80 store B in grade

			if score > 70 store C in grade */
			else if (scores[i] >= 60)
				grades[i] = 'D';
```

```
                    /*if score > 60 store D in grade */
                    else
                          /* store F */
                          grades[i] = 'F';
             }

             return grades;
      }

}
```

At this point, submit your program to WebCAT.

Part 3

Since we are doing object oriented programming, a better design is to declare and use arrays as attributes of the class **CourseManager**. This means that we will avoid passing/return arrays to/from methods.

Rewrite previous program using object oriented programming methodology as following:

- Define the two arrays `scores` and `grades` as attributes of the class **`CourseManager3`**.
- Change the method `scoreToGrade` such that:
  - It becomes an instance method.
  - It does not receive or return anything.
- Add a methods `readScores` to create the `scores` array and read its values.
- Add a methods `printGrades` to print the `scores` and `grades` arrays as done in previous program.

Create a program **`TestCourseManager3`** that does exactly the same as previous program but using an instance of class **`CourseManager3`**.

Sample Run

```
Enter number of students: 5 ↵
Please enter students' scores: 100 40 79 89 90 ↵
The scores/grades are: 100.0/A 40.0/F 79.0/C 89.0/B 90.0/A
```

Complete following pseudo code

```
import java.util.Scanner;

class CourseManager3 {


	/*declare an array scores ( double)
	declare an array score (char) */


	/*create a method readScores() */
	public void readScores()
	 {
		Scanner input = new Scanner(System.in);
		System.out.print("Enter number of students: ");
		int numOfStudents = input.nextInt();
		while (/* array size less than 1*/)
		 {
			System.out.print("Number of students is invalid. Enter
number of students: ");
			//READ numOfStudents  AGAIN
		  }

		scores = new double[numOfStudents];
		System.out.print("Please enter students' scores: ");
		for (int i = 0; i < scores.length; i++)
		 {
			double score = input.nextDouble();

		/* print a message ""The score " + score + you entered is wrong.
Program will store score 0." if you entered a wrong score. */



		}
	   }

	/* Precondition: all scores in the array are between 0 and 100 */
	public void scoreToGrade() {
		/*create a method scoreToGrade with return type void */

		/* define array grades with type char */
		for (int i = 0; i < scores.length; i++) {

			/*if score >=90 store A in grade */
			else if (scores[i] >= 80)
				grades[i] = 'B';
			/*if score > 80 store B in grade

			if score > 70 store C in grade
```

```
                        if score > 60 store D in grade */
                        else
                                grades[i] = 'F';
                        /* store F */
                }
        }

        public void printGrades(){
                /*create a method printGrades with return type void */

                }
                System.out.println();
        }
}
 /*create a class TestCourseManager3 */

public class TestCourseManager3 {

        public static void main(String[] args) {
                CourseManager3 cm = new CourseManager3();
                /*create an object cm of Class CourseManager3 and call
readScores, scoreToGrade and printGrades  */


        }

}
```

At this point, submit your program to WebCAT.

Part 4

Modify previous program by adding two methods to class **`CourseManager4`** that will compute the average score of the course. Methods are:

- `sumScores` which computes and returns the sum of scores in `scores` array. This method is an *internal helper method* and it should be `private`. It will be used by the next method `average`.
- `average` which computes and returns the average of scores in `scores` array using `sumScores` as an *internal helper method*.

Now write the main program to do the same as previous one in addition to printing the scores average. Name your program **`TestCourseManager4`**.

Sample Run

```
Enter number of students: 5 ↲
Please enter students' scores: 100 40 79 89 90 ↲
The scores/grades are: 100.0/A 40.0/F 79.0/C 89.0/B 90.0/A
Average = 79.6
```

Complete following pseudo code

```
import java.util.Scanner;

class CourseManager4 {
	/*declare an array scores ( double)
	declare an array score (char) */

	public void readScores()
	 {
		Scanner input = new Scanner(System.in);
		System.out.print("Enter number of students: ");
		int numOfStudents = input.nextInt();
		while ((/* array size less than 1*/))
		 {
			System.out
					.print("Number of students is invalid. Enter
number of students: ");
			numOfStudents = input.nextInt();
		}
		scores = new double[numOfStudents];
		System.out.print("Please enter students' scores: ");
		for (int i = 0; i < scores.length; i++) {
				/* print a message ""The score " + score + you
entered is wrong. Program will store score 0." if you entered a wrong score.
*/
		}
	}

	// Precondition: scores is not null and all scores in the array are
between 0 and 100
	public void scoreToGrade() {
		grades = new char[scores.length];
		for (int i = 0; i < scores.length; i++) {
			/*if score >=90 store A in grade */
			else if (scores[i] >= 80)
				grades[i] = 'B';
			/*if score > 80 store B in grade

			if score > 70 store C in grade

			if score > 60 store D in grade */
			else
				grades[i] = 'F';
			/* store F */
```

```
            }
        }

        /* Precondition: scores and grades are not null
CREATE A printGrades method. */
        public void printGrades()
        {
        }

/*create a method sum() with return type double which should return sum of all
the elements of an array scores[] */
        private double sum()
        {

        }

        // Precondition: scores is not null
        /*create a method average which has return type double ( formula sum() /
scores.length) */
        public double average(){

        }
}

public class TestCourseManager4 {
        public static void main(String[] args) {
                CourseManager4 cm = new CourseManager4();
                /*create an object cm of Class CourseManager4 and call
readScores, scoreToGrade, printGrades and average  */

        }

}
```

At this point, submit your program to WebCAT.

Small exercise: change method `average` to `averageScore` and create a new method `averageGrade` that returns the average letter grade based on the average score.

Part 6

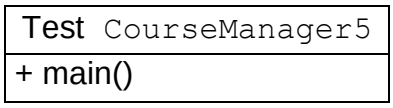
Common mistakes. If you have noticed, many methods in the class `CourseManager` has a comment `//precondition`. Why? Why `sumScores` does not have such comment? (Hint: think what will happen if the user of class `CourseManager` calls `printGrades` before `readScores`).

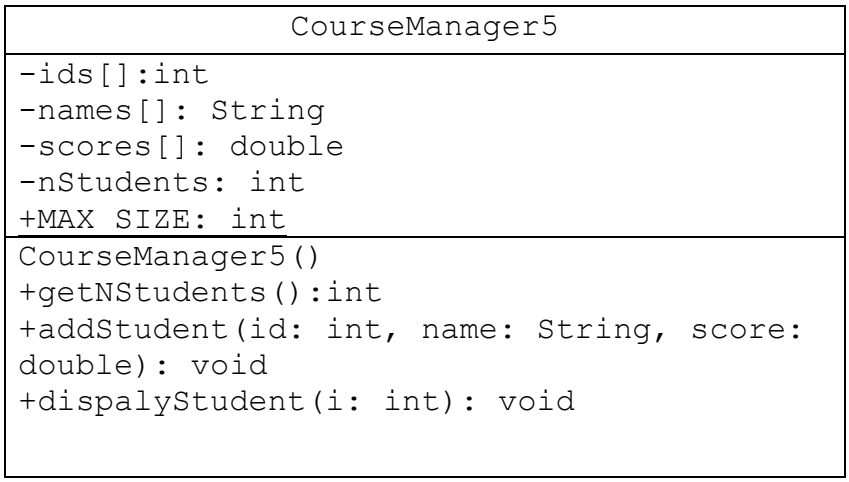
Lab Exercise 2 – Expected Time: 01:50 hours

In this exercise, we will make major changes to previous program to make it an interactive course manager.

Part 1 (add elements to array) – Expected Time: 50 min

Write a class **`CourseManager5`** that stores a list of students' IDs, names, and scores in a given class. The class allows the user to add a student, and display students' data. Here is the UML diagram:





As shown in the UML diagram, write the class **`CourseManager5`** that has the attributes: `ids`, `names`, `scores`, that represent the list of IDs, names, and scores of each student in the class, respectively. The attribute `nStudents` represents the current number of students in the list. *The maximum number of students in the class is 100*.

The methods are:

- `CourseManager5`: a constructor that initializes the attributes and creates the arrays each of size 100.
- `getNStudents` : returns the current number of students.

- `addStudent`: adds the student with the given data to the list. If course is full, it prints the error message: “ERROR: COURSE IS FULL” .
- `displayStudent`: displays all data of the student at index `i`.

Write a main class called **`TestCourseManager5`** with a `main` method that will do the following:

. It creates a `CourseManager5` object.

. Then, it adds 3 students by reading their IDs, names, and scores from the user.

. Then, it displays all students in class.

Sample run

```
Please enter the ID, name, and score of student 0:
434000000 ↲
Ahmed ↲
95 ↲
Please enter the ID, name, and score of student 1:
433001234 ↲
Ali ↲
85 ↲
Please enter the ID, name, and score of student 2:
434005421 ↲
Fahad ↲
76 ↲
Students are:
434000000, Ahmed, 95.0
433001234, Ali, 85.0
434005421, Fahad, 76.0
```

Complete following pseudo code

```
class CourseManager5 {

   /* Declare the class data members as shown in the UML*/

       CourseManager5() {
          /* Write the constructor that initializes the attributes and creates the arrays each of size 100. here */
       }

       public /* method modifier*/ addStudent(/* parameters list */) {
```

```
        /* 1- check if nStudents is less than the maximum size to add a new student else
print the message:
         System.out.println("ERROR: COURSE IS FULL");*/

        /* 2- check if the student is not already in the list by using the methos
findStudentName
         if the student is not in the list, add the new student.
         if the student is already in the list print
         System.out.println("ERROR: STUDENT ALRAEDY THERE");

         */


        }

        public /* method modifier */ displayStudent(/* parameters list */) {

        /* print the id, name , and scores of the index i passed to the method */
    }

        public /* method modifier */ getNStudents() {


      /* retun nStudents */

    }
}


import java.util.Scanner;
public class TestCourseManager5 {
        public static void main(String[] args) {
           Scanner kb = new Scanner(System.in);

        /* creat a CourseManager5 object named c1*/


        /* use for loop to do the following 3 times:

        1- ask the user to enter student information ID, name, and score */
        //System.out.println("Please enter the ID, name, and score of a student: ");

        /* 2- use the scanner to get the id, name , and score */

        /* 3- add student using the method "addStudent" */



        /* display all students in class. */

           }
```

```
    }
  }
```

At this point, submit your program to WebCAT.

Part 2 (find elements in an array) – Expected Time: 30 min

Modify previous program by adding a method to find a student by name. Name your new class **`CourseManager6`**. Modify `addStudent` such that it uses the `findStudentByName` method to make sure the student is not added twice to class. Here is the UML diagram:

Test`CourseManager6`
+ main()

`CourseManager6`
-ids[]: int -names[]: String -scores[]: double -nStudents: int +MAX_SIZE: int
CourseManager6() +getNStudents():int +addStudent(id: int, name: String, score: double): void +findStudentByName(name: String) : int +dispalyStudent(i: int): void

As shown in the UML diagram, the new and modified methods are:

- `addStudent`: adds the student with the given data to the list. If course is full, it prints the error message: “ERROR: COURSE IS FULL”. If student is already added it prints the error message: “ERROR: STUDENT ALREADY ADDED”.
- `findStudentByName`: returns the index of the student whose name is `name`. If it is not found, -1 is returned.

Write a main class called **`TestCourseManager6`** with a `main` method that will do the following:

. It creates a `CourseManager6` object.

. Then, it adds a student by reading its ID, name, and score from the user.

. Then, it tries to add the same student again and prints a failure message.

. Then, it displays the students.

Sample run

```
Please enter the ID, name, and score of a student:
434001234 ↵
Ahmed ↵
65 ↵
Please enter the ID, name, and score of a student:
434001234 ↵
Ahmed ↵
65 ↵
ERROR: STUDENT ALRAEDY THERE
Students are:
434001234, Ahmed, 65.0
```

Complete following pseudo code

```
class CourseManager6 {

/* Declare the class data members as shown in the UML*/

        public CourseManager6() {
       /* Write the constructor that initializes the attributes and creates the arrays each of
size 100 nStudents should be initilized to 0. here */

       }

       public /* method type */ addStudent(/* parameters list */) {
          /* 1- check if nStudents is less than the maximum size to add a new student else
print the message:
           System.out.println("ERROR: COURSE IS FULL");*/

          /* 2- check if the student is not already in the list by using the methos
findStudentName
           if the student is not in the list, add the new student.
           if the student is already in the list print
```

```
            System.out.println("ERROR: STUDENT ALRAEDY THERE");

            */

        }

        public /* method type */ findStudentName(/* parameters list */) {

           /* 1- use for loop to check the student list */
           /* 2- check if the name in the array "names[]" is equal to the name passed to the
method
            if you find the name return the index number
            otherwise return -1 */


        }

        public /* method type */ displayStudent(/* parameters list */) {

       /* print the id, name , and scores of the index i passed to the method */

        }

        public /* method type */ getNStudents(/* parameters list */) {

       /* retun nStudents */

        }
}


import java.util.Scanner;
public class TestCourseManager6 {
        public static void main(String[] args) {
           Scanner kb = new Scanner(System.in);

       /* creat CourseManager6 object named c1 */


         /* ask the user to enter student information ID, name, and score */
           //System.out.println("Please enter the ID, name, and score of a student: ");

       /* use the scanner to get the id, name , and score */


       /* add student using the method "addStudent" */

       /* ask the user to enter another student information ID, name, and score */
       //System.out.println("Please enter the ID, name, and score of a student: ");
```

```
 /* add the student using the method "addStudent" */

//System.out.println("Students are: ");

/* print the student list using for loop and the methode displayStudents */

  }
}
```

At this point, submit your program to WebCAT.

Part 3 (find max element in an array) – Expected Time: 30 min

Modify previous program by adding two methods to find the student with maximum score and compute the average score. Name your new class **`CourseManager7`** and add methods `findMaxScoreIndex` and `findAverageScore` to the class. Here is the UML diagram:

Test`CourseManager7`
+ main()

`CourseManager7`
-ids[]: int -names[]: String -scores[]: double -nStudents: int +MAX_SIZE: int
CourseManager7() +getNStudents():int +addStudent(id: int, name: String, score: double): void +findStudentByName(name: String) : int +dispalyStudent(i: int): void +findMaxScoreIndex() : int +findAverageScore(): double

As shown in the UML diagram, the new and modified methods are:

- `findMaxScoreIndex`: returns the index of a student whose score is the highest in the class.
- `findAverageScore`: returns the average score of the class.

Write a main class called **`TestCourseManager7`** with a `main` method that will do the following:

. It creates a `CourseManager7` object.
. Then, it adds 3 students by reading their IDs, names, and scores from the user.
. Then, it displays the average class scores.
. Then, it displays the student with the maximum score.

Sample run

```
Please enter the ID, name, and score of student 0:
433000111 ↵
Mohammad  ↵
60.0      ↵
Please enter the ID, name, and score of student 1:
433000222 ↵
Ahmad↵
100.0     ↵
Please enter the ID, name, and score of student 2:
433000333 ↵
Khalid    ↵
50.0      ↵
The class average = 70.0
The student with the highest score:
433000222, Ahmad, 100.0
```

Complete following pseudo code

```
class CourseManager7 {

    /* Declare the class data members as shown in the UML or copy from
CourseManager6 and paste here*/

        public CourseManager7() {
        /* Write the constructor that initializes the attributes and creates the arrays each of
size 100 nStudents should be initialized to 0.
```

```
        or copy from CourseManager6 and paste here*
        */

    }

    public /* method type */ addStudent(/* parameters list */) {

        /* 1- check if nStudents is less than the maximum size to add a new student else
print the message:
        System.out.println("ERROR: COURSE IS FULL");*/

        /* 2- check if the student is not already in the list by using the methos
findStudentName
        if the student is not in the list, add the new student.
        if the student is already in the list print
        System.out.println("ERROR: STUDENT ALRAEDY THERE");

        or copy from CourseManager6 and paste here*

        */


        }

        public /* method type */ findStudentName(/* parameters list */) {

        /* 1- use for loop to check the student list */
        /* 2- check if the name in the array "names[]" is equal to the name passed to the
method
        if you find the name return the index number
        Otherwise return -1

        or copy from CourseManager6 and paste here */
        }

        public /* method type */ findAverageScore(/* parameters list */) {
        /* 1- check if nStudents is grater than zero which means that the list is not empty

        if the list is empty return 0 */


        /* 2- use for loop to count the sum of all scores */



        /* 3- return  the average ==> sum/nStudents */


    }
```

```
        public /* method type */ findMaxScoreIndex(/* parameters list */) {

       /* create integer max = 0;

       /* 2- check if nStudents is grater than zero which means that the list is not empty

        if nStudents is equla to or less than 0  make max = -1 */


       /* 3- use for loop to compare the score of every student to the max score

          3.1- the max score should be initialized to be equal to the first element max = 0;

        the comparison should be like this if (score [i]>score[max]) => max = i; */

       /* 4- return max */

}

    public /* method type */ displayStudent(/* parameters list */) {

       /* print the id, name , and scores of the index i passed to the method */

    }

    public /* method type */ getNStudents(/* parameters list */) {

       /* return nStudents */
    }
}

import java.util.Scanner;
public class TestCourseManager7 {
        public static void main(String[] args) {
           Scanner kb = new Scanner(System.in);

            /* creat CourseManager7 object named c1 */

       /* use for loop to do the following 3 times:

       /* 1- ask the user to enter student information ID, name, and score */
       //System.out.println("Please enter the ID, name, and score of a student: ");

       /* 2- use the scanner to get the id, name , and score */

       /* 3- add student using the method "addStudent" */


       /* after the loop print the class average score */
       /* print the student information whos has the max score  using the method
displayStudent */
```

```
    }
}
```

At this point, submit your program to WebCAT.

Done…