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Introduction to Computing II (ITI 1121)
Midterm Examination

Instructor: Marcel Turcotte

February 2011, duration: 2 hours

Identification

Student name: ____

Student number: ____________________ Signature: ______________________________

Instructions

1. This is a closed book examination;
2. No calculators or other aids are permitted;
3. Write comments and assumptions to get partial marks;
4. Beware, poor hand writing can affect grades;
5. **Do not remove the staple holding the examination pages together**
6. Write your answers in the space provided. Use the back of pages if necessary. You may **not** hand in additional pages.

Marking scheme

Question	Maximum	Result
1	15	
2	32	
3	23	
Total	**70**	

Question 1: (15 marks)

For this question, n items are stored into k boxes. Given the weight of the items (**weights**) and their box assignment (**map**), in Java, write a static method that calculates the weight difference between the heaviest and the lightest box.

- There are n items, numbered $0, 1 \ldots n-1$.
- There are k boxes, numbered $0, 1 \ldots k-1$.
- The formal parameter **weights** designates an array of size n of integers where **weights**[**i**] is the weight of the **i**th item. Hence, **weights**[**0**] is the weight of item 0, **weights**[**1**] is the weight of item 1, etc.
- The formal parameter **map** designates an array of size n of integers such that **map**[**i**] is the number of the box where item **i** is stored. Hence, **map**[**0**] indicates the box number of item 0, **map**[**1**] indicates the box number of item 1, etc.

```
public static int getWeightDifference( int[] weights, int[] map, int k ) {











}
```

If the above method is declared in the class **Q1**, the program below would display 70.

```
int[] weights = { 10, 50, 30, 10, 40, 20, 10, 10 };
int[] map     = {  2,  0,  1,  0,  0,  1,  2,  2 };
System.out.println( Q1.getWeightDifference( weights, map, 3 ) );
```

You can assume that **weights** and **map** are not **null**, and the content of both arrays is valid.

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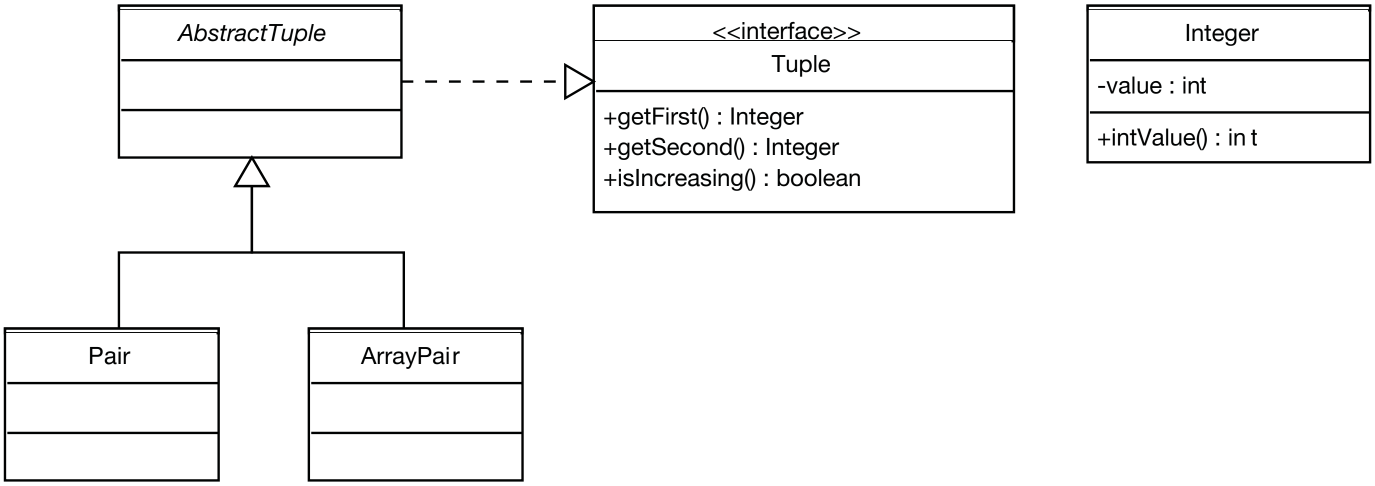
Question 2: (32 marks)

A tuple holds two **Integer** numbers (objects of the class **Integer**). All the tuples have a method **getFirst**, as well as a method **getSecond**, returning a reference to the first, and second, number of the tuple, respectively. A tuple has a method **isIncreasing** that returns **true** if the first element is smaller than the second element, and **false** otherwise.



For this question there is an interface named **Tuple**, an abstract class named **AbstractTuple**, and two concrete implementations, called **Pair** and **ArrayPair**. Their complete description can be found on the next pages. An object of the class **Integer** has a method **intValue** that returns the value of the object as an **int**. The execution of the statements below produces the following output: `7 is less than 17`.

```
Integer n1, n2, n3;

n1 = new Integer( 7 );
n2 = new Integer( 17 );
n3 = new Integer( 2 );

Tuple t1, t2;

t1 = new Pair( n1, n2 );
t2 = new ArrayPair( n2, n3 );

if ( t1.isIncreasing() ) {
    System.out.println( t1.getFirst() + " is less than " + t1.getSecond() );
}

if ( t2.isIncreasing() ) {
    System.out.println( t2.getFirst() + " is less than " + t2.getSecond() );
}
```

Make sure to include the constructors and access methods that are necessary for the execution of the above statements.

A. Implement the interface **Tuple**. The interface declares 3 methods. There are two access methods, named **getFirst** and **getSecond**, and both return a reference of type **Integer**. Finally, the interface also declares a method called **isIncreasing** that returns a **boolean** value. (6 marks)

B. Write the abstract class named **AbstractTuple**, which implements the interface **Tuple**. The class **AbstractTuple** has a concrete implementation of the method **isIncreasing**, which returns **true** if the first element of the tuple is less than the second element, and **false** otherwise. (8 marks)

C. Write a concrete implementation of the class **AbstractTuple** called **Pair**. The implementation has two instance variables that are references to the first and second element of this tuple. Add all the necessary constructors and access methods. (8 marks)

D. Write a concrete implementation of the class **AbstractTuple** called **ArrayPair**. The implementation uses an array of size 2 to store references to the first and second element of this tuple. Add all the necessary constructors and access methods. (10 marks)

Question 3: (23 marks)

A. Following the guidelines presented in class, as well as the lecture notes, draw the memory diagrams for all the objects and all the local variables of the method **Q3.test** following the execution of the statement “**line = new Line(origin, new Point(11, 21)**)”.

```
public class Point {
    private int x = 0;
    private int y = 0;
    public Point( int x, int y ) {
        this.x = x;
        y = y;
    }
}

public class Line {
    private Point a;
    private Point b;
    public Line( Point a, Point b ) {
        this.a = a;
        this.b = b;
    }
}

public class Q3 {
    public static void test() {
        int zero;
        Point origin;
        Line line;
        zero = 0;
        origin = new Point( zero, 0 );
        line = new Line( origin, new Point( 11, 21 ) );
        // Here!
    }
}
```

Answer:

B. The class **DynamicArrayStack** implements the interface **Stack** using the dynamic array technique presented in class. This allows a data structure (here a stack) to increase its physical size according to the needs of the application.

For the partial implementation of the class **DynamicArrayStack** below, implement the method void **trimToSize()** that reduces the physical size of the stack to the maximum of minCapacity and its logical size.

```java
public class DynamicArrayStack<E> implements Stack<E> {

        // The minimum physical size of the stack

        private final int minCapacity;

        // A default value for the increment that is used to increase
        // the capacity of the stack

        private static final int DEFAULT_INCREMENT = 25;

        // Each time the stack becomes full, a larger array is created,
        // increment is the number of cells to add to the size of the
        // previous array in order to obtain the size of the new array.

        private final int increment;

        // A reference to an array that holds the elements of the stack

        private E[] elems;

        // An instance variable that keeps track of the position of the
        // top element of the stack within the array. For an empty
        // stack the value is -1.

        private int top = -1;

        // Implement the method void trimToSize() that reduces the
        // physical size of the stack to the maximum of minCapacity and its
        // logical size.

        public void trimToSize() {






        }
}
```

C. Give the result that will be printed on the standard output when the following **main** method is executed.

```
public static void main( String[] args ) {

    Stack<Integer> s, t;

    s = new DynamicArrayStack<Integer>( 100 );

    for (int i=1; i<5; i++) {
        s.push( new Integer( i ) );
    }

    Integer x = null;

    if ( ! s.isEmpty() ) {
        x = s.pop();
    }

    t = new DynamicArrayStack<Integer>( 100 );

    while ( ! s.isEmpty() ) {
        t.push( s.pop() );
    }

    t.push( x );

    while ( ! t.isEmpty() ) {
        System.out.print( t.pop() );
        if ( ! t.isEmpty() ) {
        System.out.print( "," );
        }
    }
    System.out.println();

}
```

Answer:

D. If a subclass's constructor does not make an explicit call to a superclass's constructor:

(a) a run-time error will result

(b) a compile-time error will result

(c) the constructor will be called anyway

(d) the class will be implicitly declared as abstract

(e) none of the above

Answer:

E. All Java classes are subclasses of the ________________ class.

(a) String

(b) java.lang

(c) Java

(d) Class

(e) Object

Answer:

F. Consider the following line of code.

```
Comparable s = new String();
```

Which of the following statements is true about this line?

(a) It will result in a compile-time error.

(b) It will result in a run-time error.

(c) It will create a String object pointed to by a Comparable reference.

(d) Although it is perfectly valid Java, it should be avoided due to confusion.

(e) none of the above are true

Answer:

G. Give the result that will be printed on the standard output when the following **main** method is executed.

```
public class Ticket {
    private int nextSerialNumber = 100;
    private int serialNumber;
    public Ticket() {
        serialNumber = nextSerialNumber;
        nextSerialNumber = nextSerialNumber + 1;
    }
    public int getSerialNumber() {
        return serialNumber;
    }
    public static void main( String[] args ) {
        Ticket t1, t2, t3;
        t1 = new Ticket();
        t2 = new Ticket();
        t3 = new Ticket();
        System.out.print( t1.getSerialNumber() + "," );
        System.out.print( t2.getSerialNumber() + "," );
        System.out.println( t3.getSerialNumber() );
    }
}
```

```
Answer:
```

H. Give the result that will be printed on the standard output when the following **main** method is executed.

```
public class Ticket {
    private static int nextSerialNumber = 100;
    private static int serialNumber;
    public Ticket() {
        serialNumber = nextSerialNumber;
        nextSerialNumber = nextSerialNumber + 1;
    }
    public int getSerialNumber() {
        return serialNumber;
    }
    public static void main( String[] args ) {
        Ticket t1, t2, t3;
        t1 = new Ticket();
        t2 = new Ticket();
        t3 = new Ticket();
        System.out.print( t1.getSerialNumber() + "," );
        System.out.print( t2.getSerialNumber() + "," );
        System.out.println( t3.getSerialNumber() );
    }
}
```

```
Answer:
```

I. Give the result that will be printed on the standard output when the following **main** method is executed.

```
public class Ticket {
    private static int nextSerialNumber = 100;
    private int serialNumber;
    public Ticket() {
        serialNumber = nextSerialNumber;
        nextSerialNumber = nextSerialNumber + 1;
    }
    public int getSerialNumber() {
        return serialNumber;
    }
    public static void main( String[] args ) {
        Ticket t1, t2, t3;
        t1 = new Ticket();
        t2 = new Ticket();
        t3 = new Ticket();
        System.out.print( t1.getSerialNumber() + "," );
        System.out.print( t2.getSerialNumber() + "," );
        System.out.println( t3.getSerialNumber() );
    }
}
```

```
Answer:
```

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