

# Examination 1

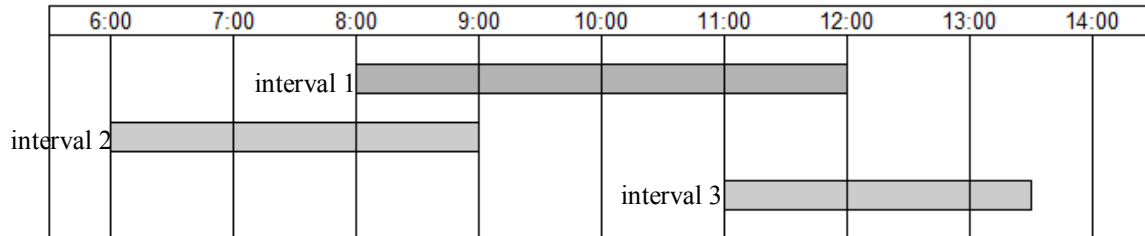
## – "Manage time for tasks !" –

### Introduction

We cannot do different tasks at the same time.

To manage time for our tasks, we use a "schedule chart" such as the following.

Figure 1: An example of **schedule chart**



### Outline of this examination

**Write programs which check "intervals" to make a proper schedule chart.**

### What is "interval" ?

"Interval" is a time range of each task.

It shows what time each task will start/end and how long it will take.

(e.g.) "Figure 1" has three "intervals" such as [08:00,12:00], [06:00,09:00], [11:00,13:30]. )

In this examination, "interval" is defined as following;

#### <Definition of "interval">

- "Interval" has a "start time" and an "end time"
- "Start time" and "end time" have only hour and minute
  - You do not have to consider other information such as year, month, date or second
- The earliest time is "00:00", the latest time is "24:00"
- "24:00" is not equal to "00:00" on the same day but equal to "00:00" on the next day
- The "start time" must be earlier than, or the same as the "end time"
- The "start time" and "end time" are included within "interval" (in mathematics, it's called "closed interval")

(e.g.) [08:00,09:00] and [09:00,10:00] are overlapped because both include "09:00".

- You can assume that the given parameters are valid.

Therefore, no invalid interval will be generated in our scoring system.

\* "Interval class" represents "interval". ( See List 3)

\* You should use attached code skeleton.

**\* Any classes or functions in the skeleton must not be changed.**

(name, variable number, parameters and return value)

\* You can add new classes and/or functions if you need.

\* Time should be printed in HH:mm format.

## Problem 1

Multiple “**intervals**” are to be given as tasks.

Calculate the maximum number of overlapped “**intervals**” at the same time .

## <Implementation>

Implement the method "**getMaxIntervalOverlapCount**" in the class "**Problem1**".

**int Problem1#getMaxIntervalOverlapCount(List<Interval> intervals)**

## <Specifications>

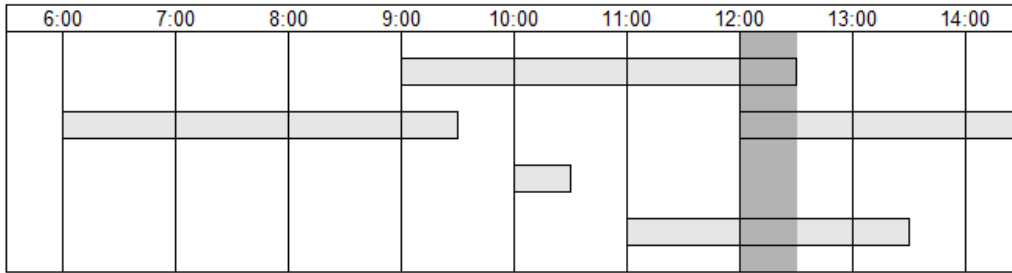
- Return 0 if the argument is null or an empty list.
- The argument (a list of “**intervals**”) must not contain null.

## <Examples>

In Figure 1, two “**intervals**” are overlapped at most.  $\Rightarrow$  Return “2” for this case.

In Figure 2, three “**intervals**” are overlapped at most.  $\Rightarrow$ Return “3” for this case.

Figure 2: Another example of **schedule chart**.



### <Examples of test>

The class “Problem1”, which you have created in this problem, is to be tested as following.

```
@Test
public void testProblem1Usage() {
    Problem1 p = new Problem1();

    // example: Figure 1
    Interval interval1 = new Interval("08:00", "12:00");
    Interval interval2 = new Interval("06:00", "09:00");
    Interval interval3 = new Interval("11:00", "13:30");
    List<Interval> figure1 = Arrays.asList(interval1, interval2, interval3);
    assertThat(p.getMaxIntervalOverlapCount(figure1), is(2));

    // example: Figure 2
    List<Interval> figure2 = Arrays.asList(new Interval("09:00", "12:30"),
        new Interval("06:00", "09:30"), new Interval("12:00", "14:30"),
        new Interval("10:00", "10:30"), new Interval("11:00", "13:30"));
    assertThat(p.getMaxIntervalOverlapCount(figure2), is(3));
}
```

## Problem 2

Multiple “**intervals**” are to be given as tasks.

Calculate the maximum work time (minutes) to assign to one worker.

## <Implementation>

Implement the method **"int Problem2#getMaxWorkingTime(List<Interval> intervals)"**.

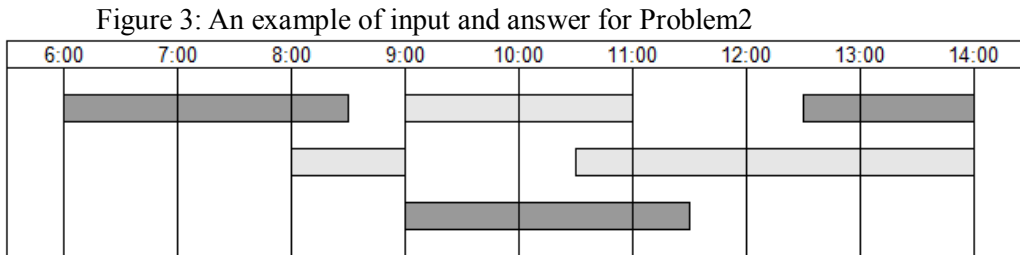
## <Specifications>

- Return the maximum time to work on a task when one worker takes it.
- Time assignment unit shall be based on tasks. (i.e. Task assignment shall be either to complete the whole task, or to do nothing for it.)
- The length of the interval, time required to complete the task, is calculated by subtracting "end time" from "start time". (e.g. If [12:00, 13:00] is given, the length of the task is 60 min.)
- Return 0 if the argument is null or an empty list.
- The argument (a list of “**intervals**”) must not contain null.
- The number of “**intervals**” must not exceed 10,000.

## <Examples>

In Figure 3 , work time is maximized when three tasks colored in dark grey, ["06:00", "08:30"], ["09:00", "11:30"], and ["12:30", "14:00"], are assigned.

Therefore, the answer is 390 (minutes).



# Program Codes

## Examination 1 : Skeleton and Interval Class

List 1: Problem 1 Skeleton Code.

```
package jp.co.wap.exam;

import java.util.List;

import jp.co.wap.exam.lib.Interval;

public class Problem1 {

    public int getMaxIntervalOverlapCount(List<Interval> intervals) {
        // TODO: Implement this method.
        return 0;
    }

}
```

List 2: Problem 2 Skeleton Code.

```
package jp.co.wap.exam;

import java.util.List;

import jp.co.wap.exam.lib.Interval;

public class Problem2 {

    public int getMaxWorkingTime(List<Interval> intervals) {
        // TODO: Implement this method.
        return 0;
    }

}
```

### List 3: Interval Class Code.

```
package jp.co.wap.exam.lib;

import java.util.regex.Matcher;
import java.util.regex.Pattern;

/**
 * This class represents interval.
 * YOU MUST NOT MODIFY THIS CLASS. (Use this as it is)
 * You do not have to submit this class. (Interval class is to be provided in our scoring system.)
 */
public class Interval {

    /**
     * It represents Time of Hour and Minute.
     */
    private static class Time {
        final int hour;
        final int minute;

        public Time(int hour, int minute) {
            this.hour = hour;
            this.minute = minute;
        }
        @Override
        public String toString() {
            return String.format("%02d:%02d", hour, minute);
        }
        @Override
        public int hashCode() {
            return toString().hashCode();
        }
        @Override
        public boolean equals(Object obj) {
            if (!(obj instanceof Time)) {
                return false;
            }
            Time other = (Time) obj;
            return (this.hour == other.hour && this.minute == other.minute);
        }
    }

    /** Initial point of interval. */
    private final Time begin;
```

```

/** Terminal point of interval. */
private final Time end;

/** Create interval from begin time (string) and end time (string). */
public Interval(String begin, String end) {
    this.begin = toTime(begin);
    this.end = toTime(end);
}

/** Convert time format (string) to Time structure. */
private static Time toTime(String timeFormatString) {
    Pattern p = Pattern.compile("(\\d?\\d):([0-5]\\d)");
    Matcher m = p.matcher(timeFormatString);
    if (!m.find()) {
        throw new IllegalArgumentException("invalid time format.");
    }
    int hour = Integer.parseInt(m.group(1));
    int minute = Integer.parseInt(m.group(2));

    return new Time(hour, minute);
}

/** Get interval begin string.*/
public String getBegin() {
    return this.begin.toString();
}

/** Get interval end string. */
public String getEnd() {
    return this.end.toString();
}

/** Get interval begin hour. */
public int getBeginHour() {
    return this.begin.hour;
}

/** Get interval begin minute. */
public int getBeginMinute() {
    return this.begin.minute;
}

/** Get interval end hour. */
public int getEndHour() {
    return this.end.hour;
}

/** Get interval end minute. */
public int getEndMinute() {
    return this.end.minute;
}

/**
 * Get total time (minute) from "00:00" to initial point of interval.
 * For example, it returns 150 when initial point of interval is "02:30".
 */
public int getBeginMinuteUnit() {
    return getBeginHour() * 60 + getBeginMinute();
}

/**
 * Get total time (minute) from "00:00" to terminal point of interval.
 * For example, it returns 1440 when terminal point of interval is "24:00".
 */

```

```

    public int getEndMinuteUnit() {
        return getEndHour() * 60 + getEndMinute();
    }
    /**
     * Get total time on interval.
     * That is, it returns getEndMinuteUnit() minus getBeginMinuteUnit().
     */
    public int getIntervalMinute() {
        return getEndMinuteUnit() - getBeginMinuteUnit();
    }
    @Override
    public int hashCode() {
        return toString().hashCode();
    }
    @Override
    public boolean equals(Object obj) {
        if (!(obj instanceof Interval)) {
            return false;
        }
        Interval other = (Interval) obj;
        return (this.begin.equals(other.begin) && this.end.equals(other.end));
    }
    @Override
    public String toString() {
        return String.format("[%s-%s]", begin, end);
    }
}

```

## Examination 2 : Implement This Skeleton Code

package jp.co.wap.exam;

```
/**
 * The Queue class represents an immutable first-in-first-out (FIFO) queue of objects.
 * @param <E>
 */
public class PersistentQueue<E> {
    /**
     * requires default constructor.
     */
    public PersistentQueue() {
        // TODO: implement if necessary
    }

    /**
     * Returns the queue that adds an item into the tail of this queue without modifying this queue.
     * <pre>
     * e.g.
     * When this queue represents the queue (2, 1, 2, 2, 6) and we enqueue the value 4 into this queue,
     * this method returns a new queue (2, 1, 2, 2, 6, 4)
     * and this object still represents the queue (2, 1, 2, 2, 6) .
     * </pre>
     * If the element e is null, throws IllegalArgumentException.
     * @param e
     * @return
     * @throws IllegalArgumentException
     */
    public PersistentQueue<E> enqueue(E e) {
        // TODO: implement this method
        return null;
    }

    /**
     * Returns the queue that removes the object at the head of this queue without modifying this queue.
     * <pre>
     * e.g.
     * When this queue represents the queue (7, 1, 3, 3, 5, 1) ,
     * this method returns a new queue (1, 3, 3, 5, 1)
     * and this object still represents the queue (7, 1, 3, 3, 5, 1) .
     * </pre>
     * If this queue is empty, throws java.util.NoSuchElementException.
     * @return
     * @throws java.util.NoSuchElementException
     */
    public PersistentQueue<E> dequeue() {
        // TODO: implement this method
        return null;
    }

    /**
     * Looks at the object which is the head of this queue without removing it from the queue.
     * <pre>
     * e.g.
     * When this queue represents the queue (7, 1, 3, 3, 5, 1),
     * this method returns 7 and this object still represents the queue (7, 1, 3, 3, 5, 1)
     * </pre>
     * If the queue is empty, throws java.util.NoSuchElementException.
     * @return
     * @throws java.util.NoSuchElementException
     */
    public E peek() {
        // TODO: implement this method
        return null;
    }

    /**
     * Returns the number of objects in this queue.
     * @return
     */
    public int size() {
        // TODO: implement this method
        return 0;
    }
}
```



## Examination 2 : Code Sample

```
package jp.co.wap.exam;

import java.util.ArrayList;
import java.util.List;
import java.util.NoSuchElementException;

/**
 * The Queue class represents an immutable first-in-first-out (FIFO) queue of objects.
 * @param <E>
 */
public class PersistentQueue<E> {
    private List<E> queue;

    /**
     * requires default constructor.
     */
    public PersistentQueue() {
        // modify this constructor if necessary, but do not remove default constructor
        queue = new ArrayList<E>();
    }
    private PersistentQueue(List<E> queue) {
        // modify or remove this constructor if necessary
        this.queue = queue;
    }
    // add other constructors if necessary

    /**
     * Returns the queue that adds an item into the tail of this queue without modifying this queue.
     * <pre>
     * e.g.
     * When this queue represents the queue (2, 1, 2, 2, 6) and we enqueue the value 4 into this queue,
     * this method returns a new queue (2, 1, 2, 2, 6, 4)
     * and this object still represents the queue (2, 1, 2, 2, 6) .
     * </pre>
     * If the element e is null, throws IllegalArgumentException.
     * @param e
     * @return
     * @throws IllegalArgumentException
     */
    public PersistentQueue<E> enqueue(E e) {
        // TODO: make this method faster
        if (e == null) {
            throw new IllegalArgumentException();
        }
        List<E> clone = new ArrayList<E>(queue);
        clone.add(e);
        return new PersistentQueue<E>(clone);
    }
}
```

```

/**
 * Returns the queue that removes the object at the head of this queue without modifying this queue.
 * <pre>
 * e.g.
 * When this queue represents the queue (7, 1, 3, 3, 5, 1) ,
 * this method returns a new queue (1, 3, 3, 5, 1)
 * and this object still represents the queue (7, 1, 3, 3, 5, 1) .
 * </pre>
 * If this queue is empty, throws java.util.NoSuchElementException.
 * @return
 * @throws java.util.NoSuchElementException
 */

```

```

public PersistentQueue<E> dequeue() {
    // TODO: make this method faster
    if (queue.isEmpty()) {
        throw new NoSuchElementException();
    }
    List<E> clone = new ArrayList<E>(queue);
    clone.remove(0);
    return new PersistentQueue<E>(clone);
}

```

```

/**
 * Looks at the object which is the head of this queue without removing it from the queue.
 * <pre>
 * e.g.
 * When this queue represents the queue (7, 1, 3, 3, 5, 1),
 * this method returns 7 and this object still represents the queue (7, 1, 3, 3, 5, 1)
 * </pre>
 * If the queue is empty, throws java.util.NoSuchElementException.
 * @return
 * @throws java.util.NoSuchElementException
 */

```

```

public E peek() {
    // modify this method if needed
    if (queue.isEmpty()) {
        throw new NoSuchElementException();
    }
    return queue.get(0);
}

```

```

/**
 * Returns the number of objects in this queue.
 * @return
 */

```

```

public int size() {
    // modify this method if necessary
    return queue.size();
}

```

```

}

```