

# BINUS University

<b>Academic Career:</b> <i>Undergraduate / <del>Master</del> / <del>Doctoral</del> *)</i>		<b>Class Program:</b> <i><del>International</del>/Regular/<del>Smart Program</del>/Global Class*)</i>	
<input type="checkbox"/> Mid Exam <input checked="" type="checkbox"/> Final Exam <input type="checkbox"/> Short Term Exam <input type="checkbox"/> Others Exam : _____		Term : <del>Odd</del> /Even/ <del>Short</del> *)	
<input checked="" type="checkbox"/> Kemanggisan <input checked="" type="checkbox"/> Alam Sutera <input type="checkbox"/> Bekasi <input type="checkbox"/> Senayan <input type="checkbox"/> Bandung <input type="checkbox"/> Malang		Academic Year : 2019 / 2020	
Faculty / Dept. : School of Computer Science		Deadline	Day / Date : Monday / Jun 29 <sup>th</sup> , 2020 Time : 13:00 - 16:20
Code - Course : COMP6048 – Data Structures		Class : All Classes	
Lecturer : Team		Exam Type : Online	
*) <i>Strikethrough the unnecessary items</i>			
<b><i>The penalty for CHEATING is DROP OUT!!!</i></b>			

**The total duration of this exam is 200 minutes, including downloading the questions and uploading the answers. Please use the time provided wisely.**

**THIS EXAM SHOULD BE SOLVED BY THOSE WHO HAS EVEN NIM (NIM GENAP)**

**NOTE:**

1. There are **2 parts** in this exam, Essay and Case.
2. For essay problem:
  - a. You are required to solve it using by ***handwritten on a paper***
  - b. Subsequently, your essay answers ***should be converted in 1 pdf file*** using this format: ***nim.pdf***
  - c. The lecturers won't accept any answers using word processing application in order to prevent copy-paste answers in a last minute
3. For case problem:
  - a. ***The submission code is in .cpp file*** and using this format: ***nim.cpp***
4. All your answers ***either essay (nim.pdf) or case (nim.cpp) should be zipped and submitted through <https://exam.apps.binus.ac.id/>***. Other than that, the submission won't be accepted for any reasons. ***(Note : Please zip both files using this format: nim.zip)***
5. The exam will be **marked as 0** if any **plagiarism is found** or if you solve **A WRONG PROBLEM SET** (We have a problem set both for **NIM GENAP** and **NIM GANJIL**).

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## I. Essay (60%)

### 1. [15%] Red Black Tree

- a. [7.5%] By using the existing tree in Figure 1, please insert nodes **Q, U, T, R, S** subsequently!

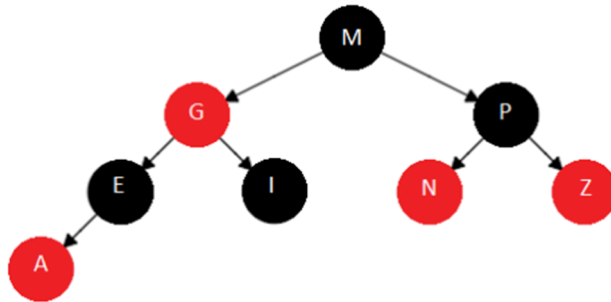


Figure 1 Red Black Tree 1

- b. [7.5%] By using the existing tree in Figure 2, please delete nodes **G, E, P, A, Z** subsequently!

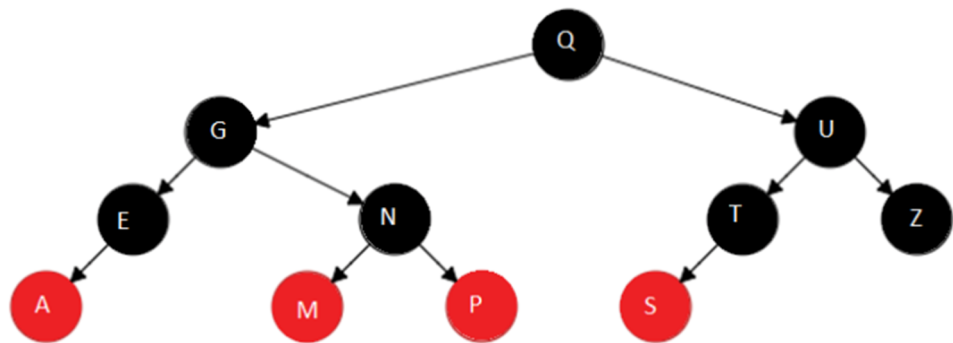


Figure 2 Red Black Tree 2

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2. [15%] Transform the undirected graph below into **Minimum Spanning Tree using Kruskal's Algorithm**. Please answer this question by **using the provided simulation table!**

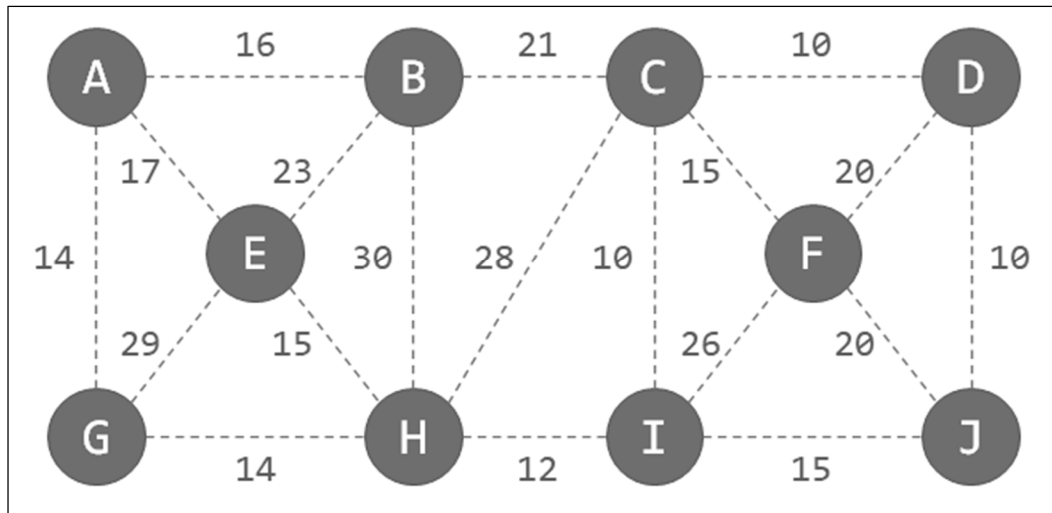


Figure 3 Undirected Graph

Table 1 Simulation Table

Adjacency List (SORTED)	Track	Visited

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3. [15%] Which one of the statements is **true** about **Red Black Tree**? Please **elaborate your answer by giving comments for each statement given.**
- a. Red Black Tree will not have any kind of 3-nodes chain
  - b. Every path from a node (including root) to any of its leaves (NULL) has the same number of black nodes which means the leaves always at the same height
  - c. Height (h) of the longest path in red black tree can have a maximum height of two times plus one ( $2h+1$ ) from the shortest path
  - d. The path from the root to the descendant nearest leaf has at least one black node and one red node
4. [15%] Which one of the statements is **true**? Please **elaborate your answer by giving comments for each statement given.**
- a. The Red Black Trees are more balanced compared to AVL Trees
  - b. AVL Tree is suitable for applications that require a lot of insert and delete processes compare to Red Black Tree
  - c. Inserting a set of number in AVL Tree and Red Black Tree will not produce the same tree shape
  - d. Red Black Tree has slower searching process than AVL Tree

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## II. Case (40%)

### BeeAero Database System

BeeAero is a NASA-like agency in BeeCountry. They catalogue many planets and asteroids in this **UNIVERSE**. Now, they decided to develop their own database system using **AVL TREE**. This database does not need any interface, and all the input/output operations are done via **CONSOLE**. There are several requirements in developing this database, and you've been tasked to develop it. The following are the requirements of this prototype database:

#### 1. GENERAL GUIDELINES

- You must use **AVL Tree**. No other tree is allowed.
- This database must support 4 major queries:
  - i. INSERT NEW PLANET/ASTEROID
  - ii. DELETE PLANET/ASTEROID
  - iii. FIND SIMILAR PLANET/ASTEROID
  - iv. SHOW PLANETS/ASTEROIDS
- For **simplicity**, the database will record only **thermal temperature** of the planet/asteroid and the **planet/asteroid name**.
- In this BeeCountry universe, it's confirmed that **no planet/asteroid has the same thermal temperature**. Therefore, you can safely assume that each planet/asteroid is unique in terms of **thermal temperature**.
- The database will store the information in **ASCENDING ORDER** based on the **thermal temperature**.
- If you **can't output anything**, then **don't output anything!**

#### 2. INSERT NEW PLANET/ASTEROID Queries

- This command will be used to insert a new planet/asteroid into the database.
- The thermal temperature of a planet/asteroid is in the range of  $-2^{31}$  to  $2^{31}-1$ .
- The planet/asteroid name is in lowercase, has no whitespaces, and it will be between 1 to 30 characters.
- The command form will be as follow:

```
1 <<thermal-temperature>> <<planet-name>>
```

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For example, if there's a planet named "kepler" with thermal temperature of -215 (Celsius), then the insert command will be:

1 -215 kepler

- After this command, please output the number of planet/asteroid that **has larger thermal temperature than the current added**.
- If the temperature **already exists** in the database, you can **ignore the command**, but still output the number of planet/asteroid that **has larger thermal temperature than the current added**.

### 3. DELETE PLANET/ASTEROID

- Sometimes, planet / asteroid is destroyed via natural process. Thus, we need to update the database.
- This command will be used to delete a planet/asteroid from the database.
- This command will delete a planet/asteroid based on its thermal-temperature.
- The command form will be as follow:  

asdas
- If you can find the planet/asteroid with the given thermal temperature, then the planet/asteroid will be deleted from database. Otherwise, nothing happened.
- After this command, please output **the number of planet/asteroid exists in the database**.

### 4. FIND SIMILAR PLANET/ASTEROID

- This command will be used by BeeAero to search for other planet/asteroid that has **"similar" thermal temperature**.
- Here, "similar" means the **absolute difference** between the asked thermal-temperature with all planets is the **smallest**. If there are more than 1 such planets, you need to output the planet/asteroid that has **the largest temperature** among such planets/asteroids (you can see the simulation below for this case).
- The "asked thermal temperature" is in the range of  $-2^{31}$  to  $2^{31}-1$ .

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- The command form will be as follow:

3 <<asked-thermal-temperature>>

For example, if all planets/asteroids data in the database shown using in-order traversal are as follow:

<b>1000</b> proxima	<b>1500</b> mars	<b>2500</b> venus	<b>3500</b> earth	<b>3900</b> jupiter	<b>6400</b> uranus	<b>79850</b> saturn	<b>150350</b> neptune
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Then below are the output for each input command given:

INPUT	OUTPUT	EXPLANATION
3 12000	6400 uranus	There are two planets/asteroids thermal temperature "similar" to 12000: 6400 uranus and 79850 saturn. The smallest difference with thermal temperature 12000 is "6400 uranus".
3 1500	1500 mars	mars thermal temperature is the same with the given thermal temperature.
3 3000	3500 earth	There are two planets/asteroids that has the smallest difference – both with 500 degree Celsius differences -- (venus, and earth). We will choose the planet with <b>the larger temperature</b> .
3 100000	79850 saturn	There are two planets/asteroids that has "similar" thermal temperature to 100000: 79850 saturn and 150350 neptune. The smallest difference with 100000 is 79850 saturn.
3 1000000	150350 neptune	There is only one planet/asteroid that has "similar" thermal temperature to 1000000: 150350 neptune.

- This command output the thermal-temperature and the name of the planet/asteroid in a single line separated by spaces like the example above.

#### 5. SHOW PLANETS/ASTEROIDS

- This command will be used to **show up to 10 planets/asteroids between certain input range**.

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- The command form will be as follow:

**4 <<from>> <<to>>**

For example, if all planets/asteroids data in the database shown using in-order traversal are as follow:

<b>1000</b> proxima	<b>1500</b> mars	<b>2500</b> venus	.....	<b>3900</b> jupiter	<b>6400</b> uranus	<b>79850</b> saturn	<b>150350</b> neptune
<b>1</b>	<b>2</b>	<b>3</b>	.....	<b>97</b>	<b>98</b>	<b>99</b>	<b>100</b>

Then below are the output for each input command given:

INPUT	OUTPUT	EXPLANATION
4 1 2	1: 1000 proxima 2: 1500 mars	The data in the rank between 1 and 2 will be shown.
4 97 106	97: 3900 jupiter 98: 6400 uranus 99: 79850 saturn 100: neptune	Because the last data is in the position 100, therefore only data in rank 97 up to 100 will be shown

- The “from” and “to” is in the range of **1** to **2<sup>31</sup>-1**.

## 6. Application usage

- The 1<sup>st</sup> line in the input file will be an integer N (  $1 \leq N \leq 250000$  ), the number of input command to be executed.
- Then, it will be followed by N command that consists of the command number and its parameter. The sample of the input are as follow:

INPUT	OUTPUT	EXPLANATION
10	0	
1 1500 mars	1	
1 1000 proxima	0	
1 2500 venus	1000 proxima	
3 1000	0	
1 3900 jupiter	3	
2 1500	1: 1000 proxima	
4 1 10	2: 2500 venus	
3 5000	3: 3900 jupiter	
2 1200	3900 jupiter	
1 1000 centaur	3	
	2	

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**Explanation**

The first line of output is “0”, because after you insert to the database the thermal-temperature 1500, there’s no planet that has thermal-temperature larger than 1500.

The second line of output is “1”, because after you insert to the database the thermal-temperature 1000, there’s 1 planet that has thermal-temperature larger than 1000.

The third line of output is a “0”, because after you insert to the database the thermal-temperature 2500, there’s no planet that has thermal-temperature larger than 2500.

The fourth line of output is “1000 proxima”, because when you “FIND SIMILAR” the thermal-temperature of 1000, the planet “proxima” temperature is **the same** with the given thermal-temperature. Thus, the difference is 0 (which is the smallest).

The fifth line of output is “0”, because after you insert to the database the thermal-temperature of 3900, there’s no planets that has thermal-temperature larger than 3900.

The sixth line of output is “3”, because after you delete the thermal-temperature 1500 (which belong to planet “mars”), there’re 3 planets/asteroids exists in the database.

The seventh line until the ninth line of output are the planet in rank 1 to 3.

The tenth line of output is “3900 jupiter”, because when you “FIND SIMILAR” the thermal-temperature of 5000, the planet “jupiter” temperature is the smallest differences with the given thermal-temperature.

The eleventh line of output is 3, because after you try to delete the thermal-temperature 1200 (which belong to **no planet**), there still 3 planets/asteroids exists in the database. Note that **no planets/asteroids** are deleted. It’s because **no planet has the thermal-temperature of 1200**.

The last line of output is “2”, because there’re 2 planet that has thermal-temperature larger than 1000. Also, this command get “ignored” because in the database, there already exists “1000 proxima”.

-- Good Luck --

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