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https://www.cs.umd.edu/~gihan/resources/cmsc132/

CMSC132: Week 02, Lab 1

2025-Feb-03, Gihan

Outline

- Project 01
  - Submissions
  - Test types – Public, release, private
  - Coding style
- Inheritance (Recap from Week 01, Lab 2)
- ArrayList
  - Initialization, add, get, set, remove, clear, iterations
- 2D Arrays
  - Initialization, ragged, iterations

Additional resources Brian, Angelyn

CMSC132: Week 02, Lab 2

2025-Feb-05, Gihan

Outline

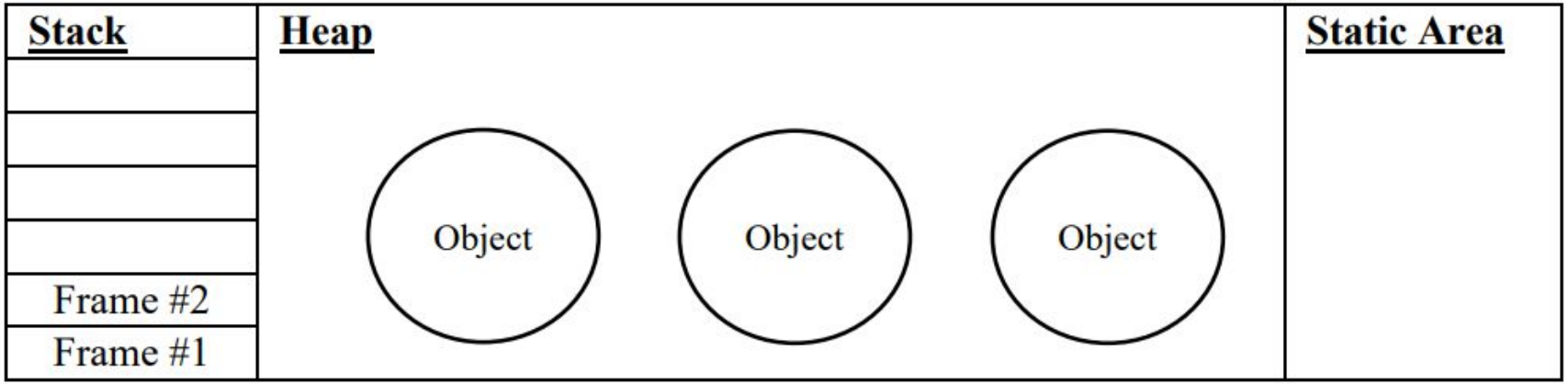
- Check – are you fine with submitting the Project 1?
- Doubts check – lecture material.
- Debugger
  - Breakpoints
  - Views
  - Step into, step over, step return
  - Colors for public, private, static, instance variables.
- Debugging instead of print()!
  - Checking the value of variables, arrays, and ArrayLists.

CMSC132: Week 03, Lab 1

2025-Feb-10, Gihan

Outline

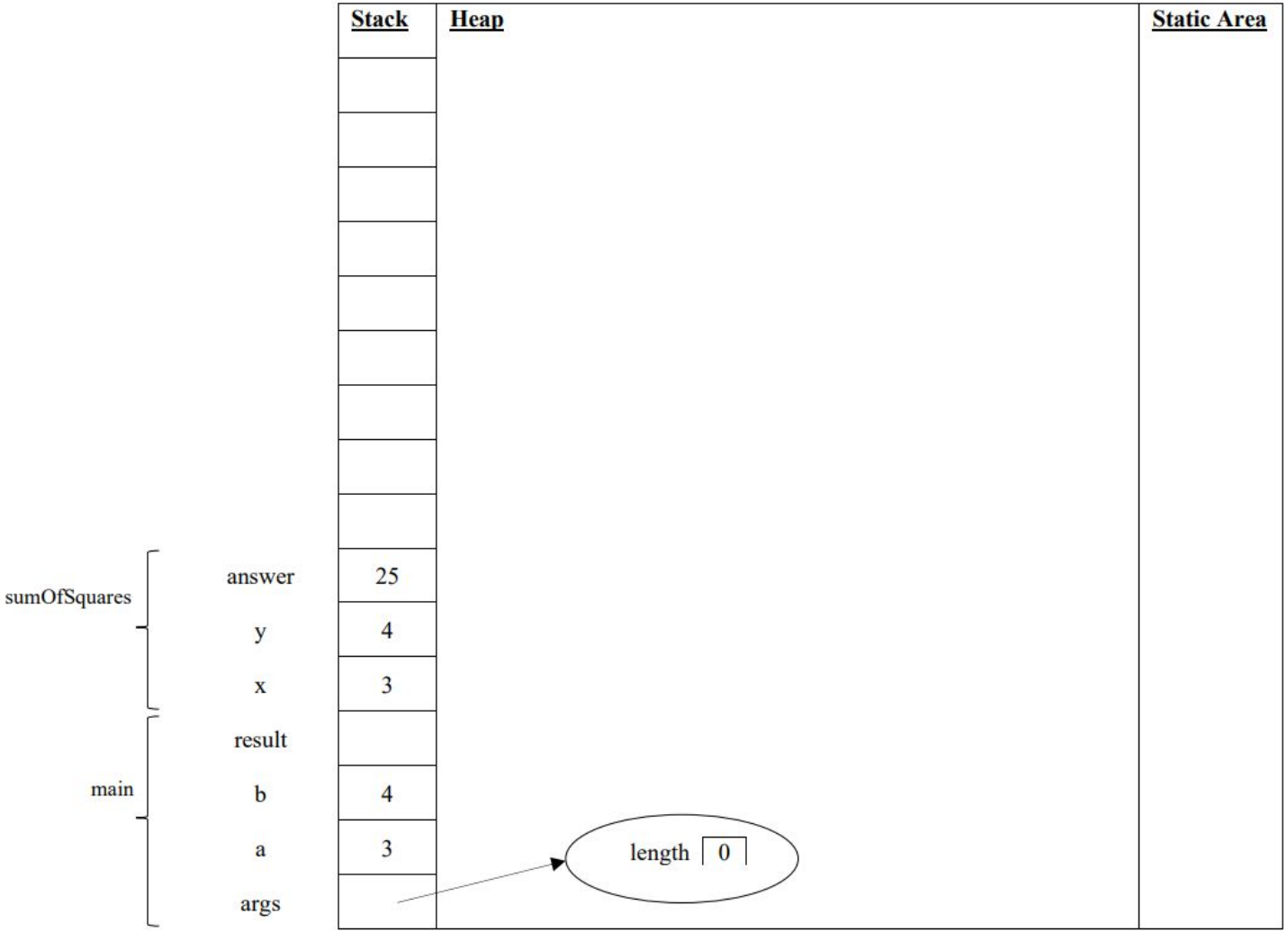
- How is Proj 1 going?
- Java assert
- JUnit
  - assertTure, assertEquals, assertFalse
  - E.g. AuxMath, Zip archive
- Memory maps
  - Stack, heap, static, code
-


Stack
Frame #2
Frame #1
Heap
Object
Object
Object
Static Area

Example #1 (Static Methods)

Draw a memory map for the following program at the point ir

```
public class Driver {
   public static int sumOfSquares(int x, int y) {
      int answer;

      answer = x * x + y * y;

      /* HERE */
      return answer;
   }

   public static void main(String[] args) {
      int a = 3, b = 4, result;

      result = sumOfSquares(a, b);
      System.out.println("Answer: " + result);
   }
}
```

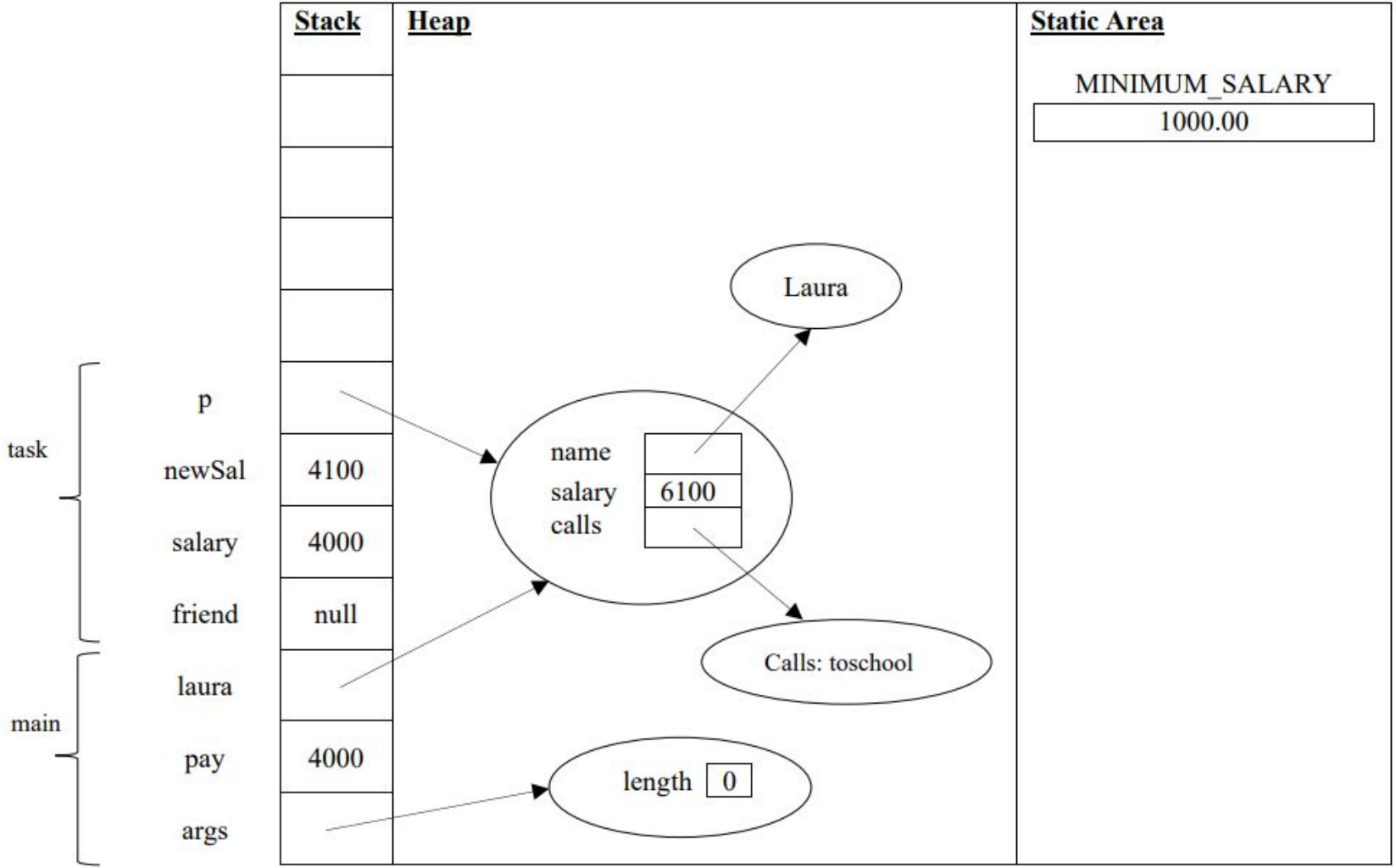

Stack
Heap
Static Area
sumOfSquares
answer
25
y
4
x
3
main
result
b
4
a
3
length
0
args

Example #2 (Methods/Objects)

Draw a memory map for the following program at the point in the program execution indicated by the comment **/*HERE*/**.

```
public class Person {
   public static double MINIMUM_SALARY = 1000.00;
   private String name;
   private double salary;
   private StringBuffer calls;

   public Person(String name, double salary) {
      this.name = name;
      this.salary = salary;
      calls = new StringBuffer("Calls: ");
   }

   public Person(String name) {
      this(name, MINIMUM_SALARY);
   }

   public Person increaseSalary(double delta) {
      salary += delta;

      /* Returning reference to current object */
      return this;
   }

   public void addCall(String newCall) {
      calls.append(newCall);
   }

   public String toString() {
      return name + ", $" + salary + ", " + calls;
   }
}
```

```
public class Driver {

   public static void task(Person friend, double salary) {
      double newSal = salary + 100;
      Person p = friend;

      p.increaseSalary(newSal);
      friend.addCall("toschool");
      friend = null;

      /* HERE */
   }

   public static void main(String[] args) {
      double pay = 4000;

      Person laura = new Person("Laura", 2000);
      task(laura, pay);
      System.out.println(laura);
   }
}
```


Stack
Heap
Static Area
MINIMUM_SALARY
1000.00
Laura
task
p
newSal
4100
salary
4000
friend
null
name
salary
6100
calls
Calls: toschool
main
laura
pay
4000
length
0
args

Sample Memory Maps

Please use the format described by the examples below when asked to draw memory maps / diagrams. Each example below covers typical diagrams we will ask you to draw. Regarding the diagrams:

1. When asking to draw a map, we need to set a stop point, so you can draw the contents of the stack, heap, and static area up to that point in the execution (otherwise the stack would be empty as the program would have finished execution). We will represent that stop point with the comment /* **HERE** */.
2. When drawing an object, we draw the instance variables associated with the object. For arrays, we draw the length property and a row of entries representing the array entries.
3. For non-static methods, the "this" current object reference will be drawn as the first entry in the stack (it can be seen as an implicit parameter).
4. Although the name "static method" may imply that static methods live in the static area, that is not the case. The code for both static and non-static methods resides in the code area. Both static and non-static methods use the stack for execution. The only difference between static and non-static methods, is that a static method does not require an object in order to be executed.
5. Any entry in the stack that has not been assigned a value will be left blank.
6. You should draw variables in the stack as you encounter them during code execution. This will allow you to verify your work easily.
7. You will see that **args** is always the first entry in the **main** method's frame. The **args** parameter represents command line arguments. We will not provide any command line arguments in our examples, so we will always draw **args** as a reference to an array of length 0. You will get points for drawing this **args** entry.
8. For simplicity, loop variables defined inside of a loop (e.g., for (int i = 0 …)) will not be drawn unless the /* HERE */ marker is within the scope of the variable.
10. We will use the following symbol to represent a stack frame.

CMSC132: Week 04, Lab 1

17-Feb-2025,Gihan

- Project 2 questions
- Snow day content
  - Comparator, Comparable
  - Lists
    - Vector
    - ArrayList
    - Stack

CMSC132: Week 05, Lab 1

24-Feb-2025,Gihan

Outline

- Proj 1, Proj 2
- How is project 3 going?
- Tying some loose ends from last week.
  - Difference between **final** and immutable.
  - Exceptions (Checked and unchecked)
  - Autoboxing and unboxing
- Enhanced switch
- Enums
- Annotations
- Varargs

Checked and unchecked Exceptions

Examples of Checked Exceptions:

- `IOException`
- `SQLException`
- `FileNotFoundException`
- `InterruptedException`

Examples of Unchecked Exceptions:

- `NullPointerException`
- `ArrayIndexOutOfBoundsException`
- `ArithmeticException`
- `IllegalArgumentException`

Autoboxing and Unboxing

```java
public class AutoboxingExample {
    public static void main(String[] args) {
        int primitiveInt = 10;
        Integer wrapperInt = primitiveInt;  // Autoboxing
        System.out.println(wrapperInt);  // Output: 10
    }
}
```

```java
public class UnboxingExample {
    public static void main(String[] args) {
        Integer wrapperInt = 20;
        int primitiveInt = wrapperInt;  // Unboxing
        System.out.println(primitiveInt);  // Output: 20
    }
}
```

Autoboxing and Unboxing continued

- Autoboxing in ArrayList
- Unboxing in primitive operations

Considerations

	Autoboxing	Unboxing
Memory usage?	Increase	Decreases
Equality checks?	Method calls	==
Null initialization?	Null	0
	Slow	Fast

Other presentation and code

- Enhanced switch
- Enums
- Annotations
- Varargs

CMSC132: Week 05, Lab 2

26-Feb-2025,Gihan

CMSC132: Week 07, Lab 1

10-Mar-2025,Gihan

Outline

- Project 3
- Search
  - Linear
  - Binary
- Sort
  - Bubble
  - Selection

CMSC132: Week 07, Lab 2

12-Mar-2025,Gihan

Outline

- Recap : LinkedList
- Java Collections Framework
  - LinkedList<E>
  - Deque<E>
  - Iterator<E>
  - ListIterator<E>

CMSC132: Week 08, Lab 1

24-Mar-2025,Gihan

Outline

- How is Project 5 going?
- Week 7>>> LListRecursion >>>
  - **delete()**
  - **findMax()**
- Insertion sort
- Cloning
  - Copy constructor?
  - Cloneable interface
  - clone()
    - Deep/shallow?

CMSC132: Week 08, Lab 2

26-Mar-2025,Gihan

Outline

- Clone – code
- Kahoot
- Wildcards
- Functional interfaces

Wildcard Usage Summary

Wildcard Type	Can Accept	Can Read	Can Write
`?` (Unbounded)	Any type (`List<?>`)	✅ as `Object`	🚫 Cannot add (except `null`)
`? extends Type` (Upper Bounded)	`Type` or any subclass	✅ as `Type`	🚫 Cannot add (except `null`)
`? super Type` (Lower Bounded)	`Type` or any superclass	🚫 Only as `Object`	✅ Can add `Type` and its subtypes

---

When to Use Which Wildcard?

- Use `?` **(Unbounded)** when you don't care about the specific type but just need to **iterate** or **print**.
- Use `? extends T` when you need to **read data** (e.g., process numbers).
- Use `? super T` when you need to **write data** (e.g., add numbers).

Step 1: Define a Functional Interface

```java
@FunctionalInterface
interface Greeting {
    void sayHello(String name);
}
```

✔ The `@FunctionalInterface` annotation ensures that only one abstract method is defined.

Step 2: Implementing with an Anonymous Class

Before Java 8, you would implement the interface using an **anonymous class** like this:

```java
public class AnonymousClassExample {
    public static void main(String[] args) {
        Greeting greeting = new Greeting() {
            @Override
            public void sayHello(String name) {
                System.out.println("Hello, " + name + "!");
            }
        };

        greeting.sayHello("Alice");
    }
}
```

✅ Works fine but involves **boilerplate code**.

Step 3: Implementing with a Lambda Expression (Java 8+)

Lambda expressions provide a more concise way to implement functional interfaces.

```java
public class LambdaExample {
    public static void main(String[] args) {
        Greeting greeting = (name) -> System.out.println("Hello, " + name + "!");

        greeting.sayHello("Bob");
    }
}
```

✔ **Shorter and cleaner** compared to an anonymous class.

CMSC132: Week 09, Lab 1

26-Mar-2025,Gihan

Outline

- Stability of Sorting Algorithms (from last week)
- How is project 5 going?
- 1:00PM - 1:30PM
  - You have to implement the following,
    - public static String mostFrequentWord(List<String> words)
    - public Set<T> removeInRange(boolean ordered, T lowerBound, T upperBound)
    - private Node removeInRangeAux(Node headAux, T lowerBound, T upperBound, Set<T> newSet)
- 1:30PM - 1:50OM
  - We will go through the solution

Stability of Sorting Algorithms

Sorting Algorithms	In - Place	Stable
Bubble Sort	Yes	Yes
Selection Sort	Yes	No
Insertion Sort	Yes	Yes
Quick Sort	Yes	No
Merge Sort	No (because it requires an extra array to merge the sorted subarrays)	Yes
Heap Sort	Yes	No

CMSC132: Week 09, Lab 2

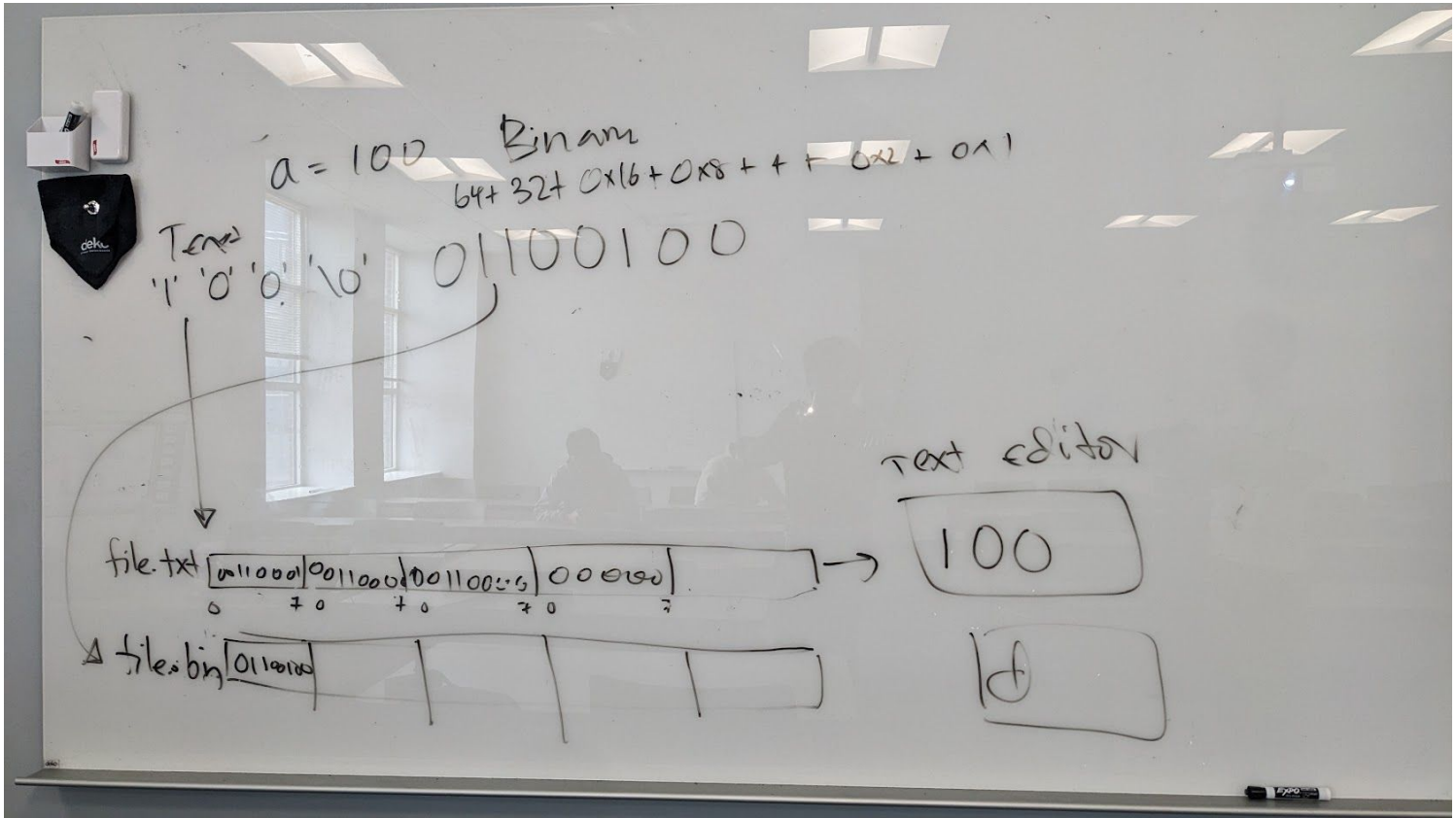
2-Apr-2025,Gihan

https://www.cs.umd.edu/~gihan/resources/cmsc132/

Outline

- Quick look at mostFrequentWord() from the previous class.
- Questions about Project 5? — (Deadline Thurs, 03-Apr-2025 11:30 pm)
  - DoublyLinkedList, Deque, Stack, Queue
- Binary Files
- Text Files
  - File
  - FileReader, BufferedReader
  - FileWriter, BufferedWriter
  - PrintWriter

Difference between binary files and text files



CMSC132: Week 10, Lab 1

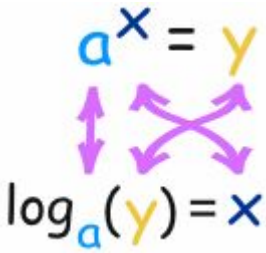
7-Apr-2025,Gihan

https://www.cs.umd.edu/~gihan/resources/cmsc132/

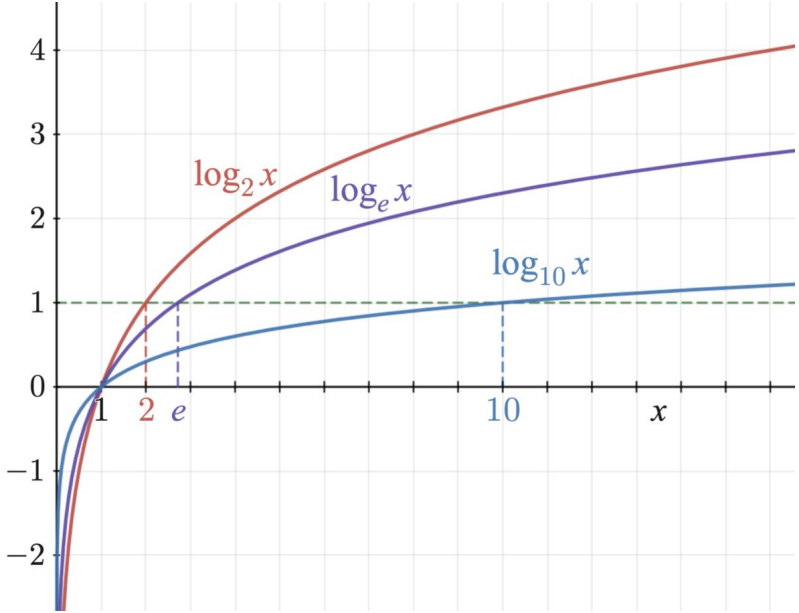
Outline

- How is Project 6 going?
- Logarithms (might be on the exam)
- Quiz 03

Logarithms



Logarithmic Properties	
Product Rule	$\log_a(xy) = \log_a x + \log_a y$
Quotient Rule	$\log_a\left(\frac{x}{y}\right) = \log_a x - \log_a y$
Power Rule	$\log_a x^p = p\log_a x$
Change of Base Rule	$\log_a x = \frac{\log_b x}{\log_b a}$
Equality Rule	If $\log_a x = \log_a y$ then $x = y$



Images from https://oercommons.org/ and Wikipedia

CMSC132: Week 10, Lab 2

9-Apr-2025,Gihan

https://www.cs.umd.edu/~gihan/resources/cmsc132/

Outline

- Did you prove the logarithm rules?
- How is Proj 6, HashTables going?
  - Chained hash tables, Open addressed hash tables, HashMaps, HashSets
- Java Input/Output - Binary Files

FileInputStream	FileOutputStream	
BufferedInputStream	BufferedOutputStream	
DataInputStream	DataOutputStream	

- Standard streams in JAVA
  - System.in, System.out, System.err
- (Prove the logarithm rules if time permits)

file.txt

"100" → String "100"

Integer.parseInt(

file.bin

Write

100 ← int

Read

System.in

JAV

File Output Stream

Hard Disk

System.

'a'

✓

×

1010 0111

5.67×10^7

output.dat

Character, Sys.in

random

b0.bin 0...16

Buffer

Buffered Output Stream

data.bin

12345

3.145

the

a

b

b_3

b_4 = d

CMSC132: Week 11, Lab 1

14-Apr-2025,Gihan

https://www.cs.umd.edu/~gihan/resources/cmsc132/

Outline

- How is Project 6 going?
- Quicksort
  - Divide and conquer – partitioning, subproblems
  - Time complexity
  - Memory complexity

Conceptual example

arr = [1 | 10 | 18 | 5 | 20 | 14 | 7 | 15] (l = 0, h = 7)

[1 | 10 | 5 | 14 | 7 | 18 | 20 | 15] (p)

less | more

arr = [1 | 10 | 5 | 14 | 7 | 15 | 20 | 18] (p1)

l = 0, h = 4, l = 6, h = 7

[15 | 7 | 10 | 14]

[1 | 5 | 7 | 14 | 10]

l, m

[1 | 5] [10 | 14]

l, p

15

[1 | 10 | 5 | 14 | 7] [18 | 20]

[1 | 5 | 7 | 10 | 14] [18 | 20]

easy to merge

qs(arr, 0, 7)

qs(arr, 0, 4) qs(arr, 6, 7)

qs(arr, 0, 1) qs(arr, 3, 4) qs(arr, 7, 7)

Example from sample code

9	3	7	6	2	8	5	1	10	4
0	1	2	3	4	5	6	7	8	9

1	2	3	4	9	8	5	7	10	6

qs(ar, 0, 9)

pivIdx = 3

qs(ar, 0, 2)

pivIdx = 0

~~qs(ar, 1~~

qs(ar, 1, 2)

pivIdx = 2

qs(ar, 1, 1)

qs(ar, 4, 9)

Complete at home...

CMSC132: Week 11, Lab 2

16-Apr-2025,Gihan

https://www.cs.umd.edu/~gihan/resources/cmsc132/

Outline

- How is the lectures going? Do you have any questions to discuss in this class?
- Recap – quick sort
- Merge sort - slides
- Merge sort - code

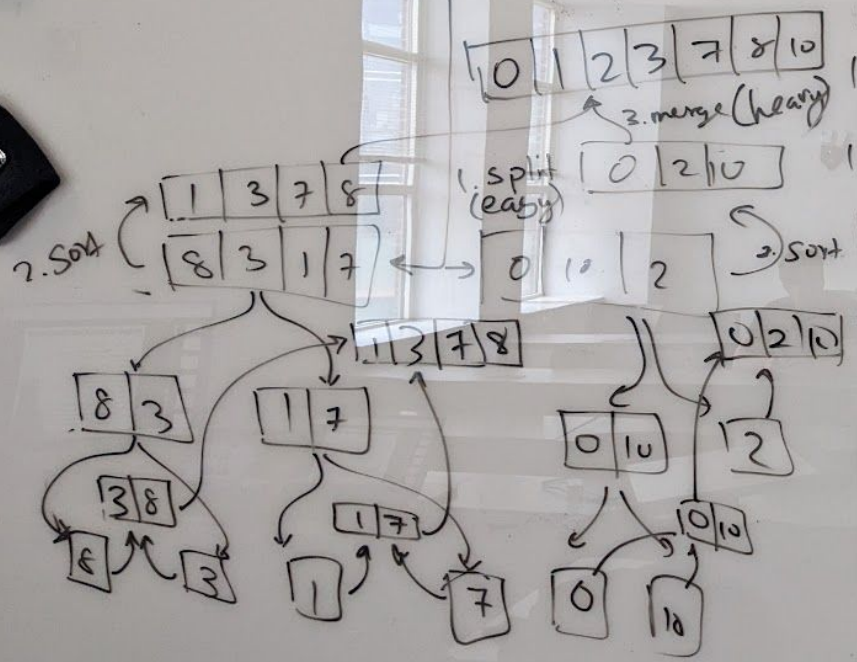
merge sort

0	1	2	3	4	5	6
8	3	1	7	0	10	2

1. split (easy)

2. sort

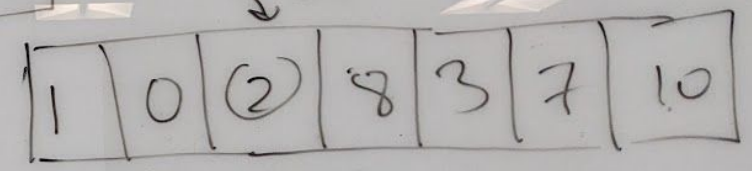
3. merge (heavy)



Quick sort

split (heavy)

merge easy



0. arr: 0 … n-1 len(arr) = n

1. n/2 n/2

2. n/4 n/4 n/4 n/4

k. $n/2^k$ $n/2^k$

1 1 1

k → m

$\log_2 n$

$2^m = n$

$\log_2(2^m) = \log_2 n$

$m \cancel{\log_2 2} = \log_2 n$

$m = \log_2 n$

		work
2	n/2	O(n)
4	n/4	O(n)
2^k	$n/2^k$	
n	1	O(n)

$O(n \log_2 n)$

Extra total				work
	0.	arr: 0 … n-1	len(arr) = n	
n	1.	extra: n; n/2; n/2	2 | n/2	O(n)
n	2.	extra: n/2; n/4; n/4; n/4; n/4	4 | n/4	O(n)
n	k.	extra: 2^{k-1} n/2; 2^k n/2^k; …	2^k | n/2^k	
		1 1 1	n | 1	O(n)

$k \to m$

$\log_2 n$

$2^m = n$

$\log_2(2^m) = \log_2 n$

$m \cancel{\log_2 2} = \log_2 n$

$m = \log_2 n$

$O(n \log_2 n)$

Extra total

0. arr:

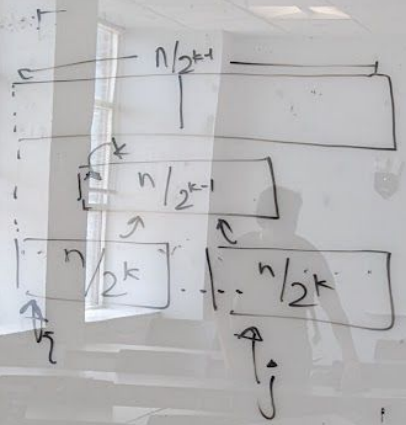
len(arr) = n

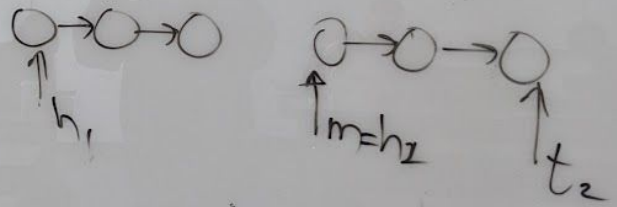
n 1.

n 2.

n

k.





k→m

$\log_2 n$

CMSC132: Week 11, Lab 2 (additional)

16-Apr-2025,Gihan

https://www.cs.umd.edu/~gihan/resources/cmsc132/

Outline

- Implementing mergesort and quicksort to work with Comparable data types.
- I am not going through this material in the discussion. Therefore, please watch the video on the following link:
  - https://www.cs.umd.edu/~gihan/resources/cmsc132/