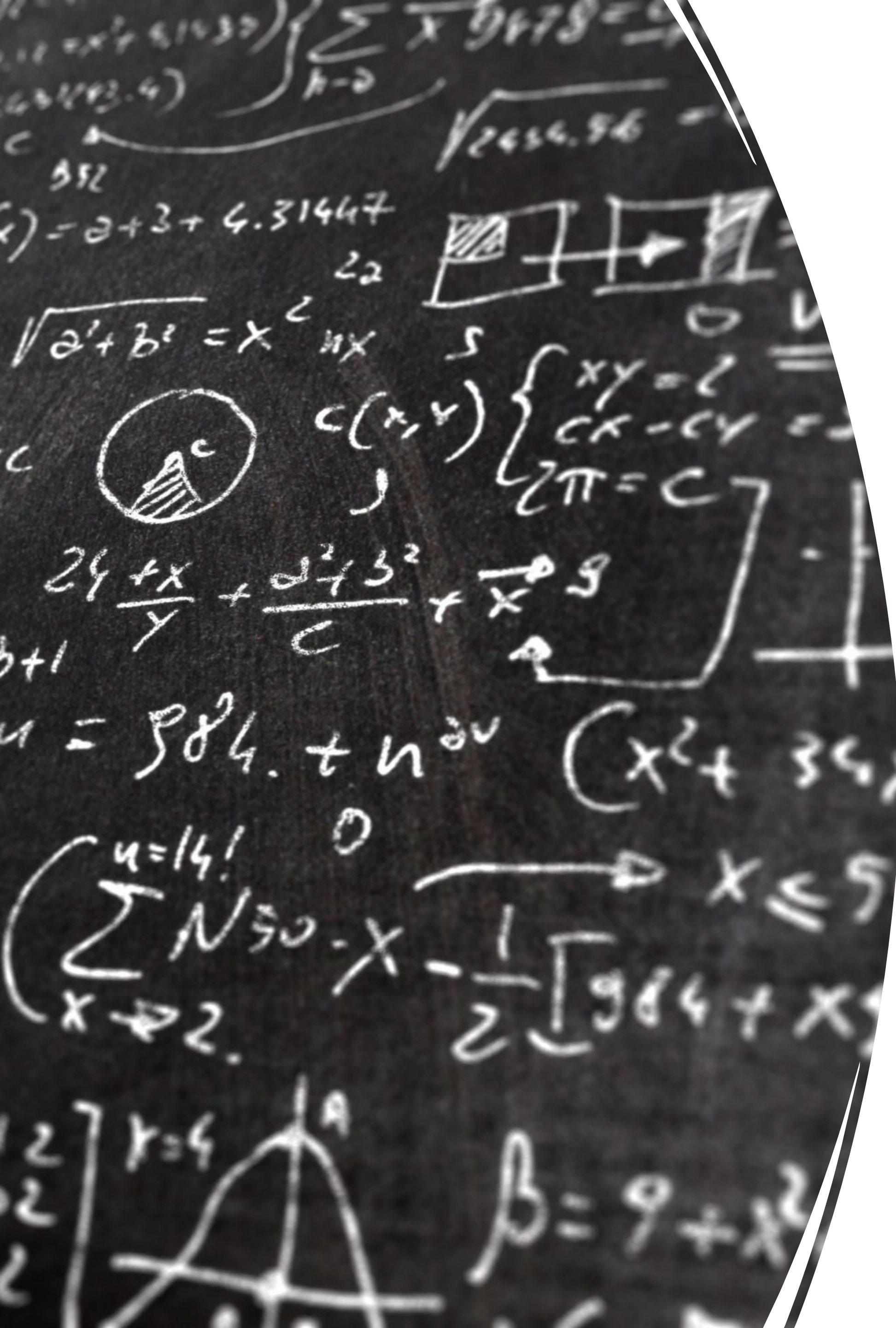

CS 113 – Computer Science I

Lecture 21 – Data Structures – Hashmaps & Exceptions

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12/01/2022

Announcements

- Assignment 10
  - Due Thursday 12/01
  - tonight
- Assignment 11
  - Due Thursday 12/08
  - Optional/extra credit
- Code jam this week in lab

Key Concept review

primitive data type vs objects

8 primitive data types in java: https://docs.oracle.com/javase/tutorial/java/nutsandbolts/datatypes.html

We've covered:

ints, floats, doubles, booleans, chars

Didn't cover:

bits, shorts, longs

Primitive data types

8 primitive data types in java:
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We’ve covered:

ints, floats, doubles, booleans, chars

Didn’t cover:

bits, shorts, longs

Strings

Strings are not primitives, they are …

they are objects!

What happens if we print an object?

We see the location in memory?

Why does the following print:

```
String name = “adam”;
System.out.println(name);
```

Answer: The String class has a toString() method!

Recursion

What is the sum of the following numbers?

[10, 20, 30, 50, 300, 543, 553, 654, 7654, 7654, 34, 25, 673, 6753]

How would you solve this?

Recursion

What is the sum of the following numbers?

[10, 20, 30, 50, 300, 543, 553, 654, 7654, 7654, 34, 25, 673, 6753]

Approach 1 (iterative):

- keep track of a running sum
- add each number to the sum

How many computations/steps do you have to do?

atleast 14 – keep track, add every number

Recursion

What is the sum of the following numbers?

[10, 20, 30, 50, 300, 543, 553, 654, 7654, 7654, 34, 25, 673, 6753]

Approach 2 – lazy!:

- keep track of one number
- ask my friend to sum the rest of the numbers
- add the answer from my friend to the number I kept track of

How many computations/steps do you have to do?

1 or 2 – keep track, add once

ArrayList

- Convenient when we don’t know the size we need at the start
- Best for storing sequences/list of data
- When we run out of space, the array list resizes itself
- Adding elements to the end is generally fast (so long as we don’t need to resize)
- Removing elements or inserting in the middle can be slow (need to shift elements)

Hashmap

Stores <key, value> pairs

Examples: associate a name to age

Examples: associate a studentId to a grade

Fast lookup, add, and remove by key

Does not preserve the ordering of data

Keys should be unique

Hashmap

https://docs.oracle.com/javase/8/docs/api/java/util/HashMap.html

```
public static void main(String[] args) {
    HashMap<String, String> map = new HashMap<String, String>();
    map.put("dog", "woof");
    map.put("cow", "moo");
    map.put("cat", "meow");
    map.put("bird", "chirp");
    System.out.println(map.get("dog"));

    for (String key : map.keySet()) {
        System.out.printf("What does the %s say? %s\n", key, map.get(key));
    }

    bool test = map.containsKey("turkey");
    System.out.println(test);

    map.remove("cat");
}
```

Hashmap – adding to hashmap

```
public static void main(String[] args) {
    HashMap<String, String> map = new HashMap<String, String>();
    map.put("dog", "woof");
    map.put("cow", "moo");
    map.put("cat", "meow");
    map.put("bird", "chirp");
    System.out.println(map.get("dog"));

    for (String key : map.keySet()) {
        System.out.printf("What does the %s say? %s\n", key, map.get(key));
    }

    bool test = map.containsKey("turkey");
    System.out.println(test);

    map.remove("cat");
}
```

Hashmap – accessing from hashmap

```
public static void main(String[] args) {
    HashMap<String, String> map = new HashMap<String, String>();
    map.put("dog", "woof");
    map.put("cow", "moo");
    map.put("cat", "meow");
    map.put("bird", "chirp");
    System.out.println(map.get("dog"));

    for (String key : map.keySet()) {
        System.out.printf("What does the %s say? %s\n", key, map.get(key));
    }

    bool test = map.containsKey("turkey");
    System.out.println(test);

    map.remove("cat");
}
```

Hashmap – iterating through hashmap

```
public static void main(String[] args) {
    HashMap<String, String> map = new HashMap<String, String>();
    map.put("dog", "woof");
    map.put("cow", "moo");
    map.put("cat", "meow");
    map.put("bird", "chirp");
    System.out.println(map.get("dog"));

    for (String key : map.keySet()) {
        System.out.printf("What does the %s say? %s\n", key, map.get(key));
    }

    bool test = map.containsKey("turkey");
    System.out.println(test);

    map.remove("cat");
}
```

Hashmap – searching in a hashmap

```
public static void main(String[] args) {
    HashMap<String, String> map = new HashMap<String, String>();
    map.put("dog", "woof");
    map.put("cow", "moo");
    map.put("cat", "meow");
    map.put("bird", "chirp");
    System.out.println(map.get("dog"));

    for (String key : map.keySet()) {
        System.out.printf("What does the %s say? %s\n", key, map.get(key));
    }

    boolean test = map.containsKey("turkey");
    System.out.println(test);

    map.remove("cat");
}
```

Visualizing Hashmaps

```
public static void main(String[] args) {
    HashMap<String, String> map = new HashMap<String, String>();
    map.put("dog", "woof");
    map.put("cow", "moo");
    map.put("cat", "meow");
    map.put("bird", "chirp");
    System.out.println(map.get("dog"));

    for (String key : map.keySet()) {
        System.out.printf("What does the %s say? %s\n", key, map.get(key));
    }

    bool test = map.containsKey("turkey");
    System.out.println(test);

    map.remove("cat");
}
```

Exercise

Write a program, LetterCount.java, that counts the number of times each character appears in a given string.

```
$ java LetterCount
Please enter a word: lol
l: 2
o: 1

$ java LetterCount
Please enter a word: abba
a: 2
b: 2
```

Exercise

Write a program, Cake.java, that implements a Cake class that stores a cake name and cost. In main(), read in a CSV file of cakes into an ArrayList and sort them from least expensive to most expensive.

```
$ java-introcs Cake cakes.txt
Red velvet cake: $2.0
Chocolate cake: $3.5
Strawberry cake: $4.5
Cheesecake: $6.99
```

Sedgewick and Wayne, page 465

Exceptions

An **exception** is a disruptive event that occurs while a program is running

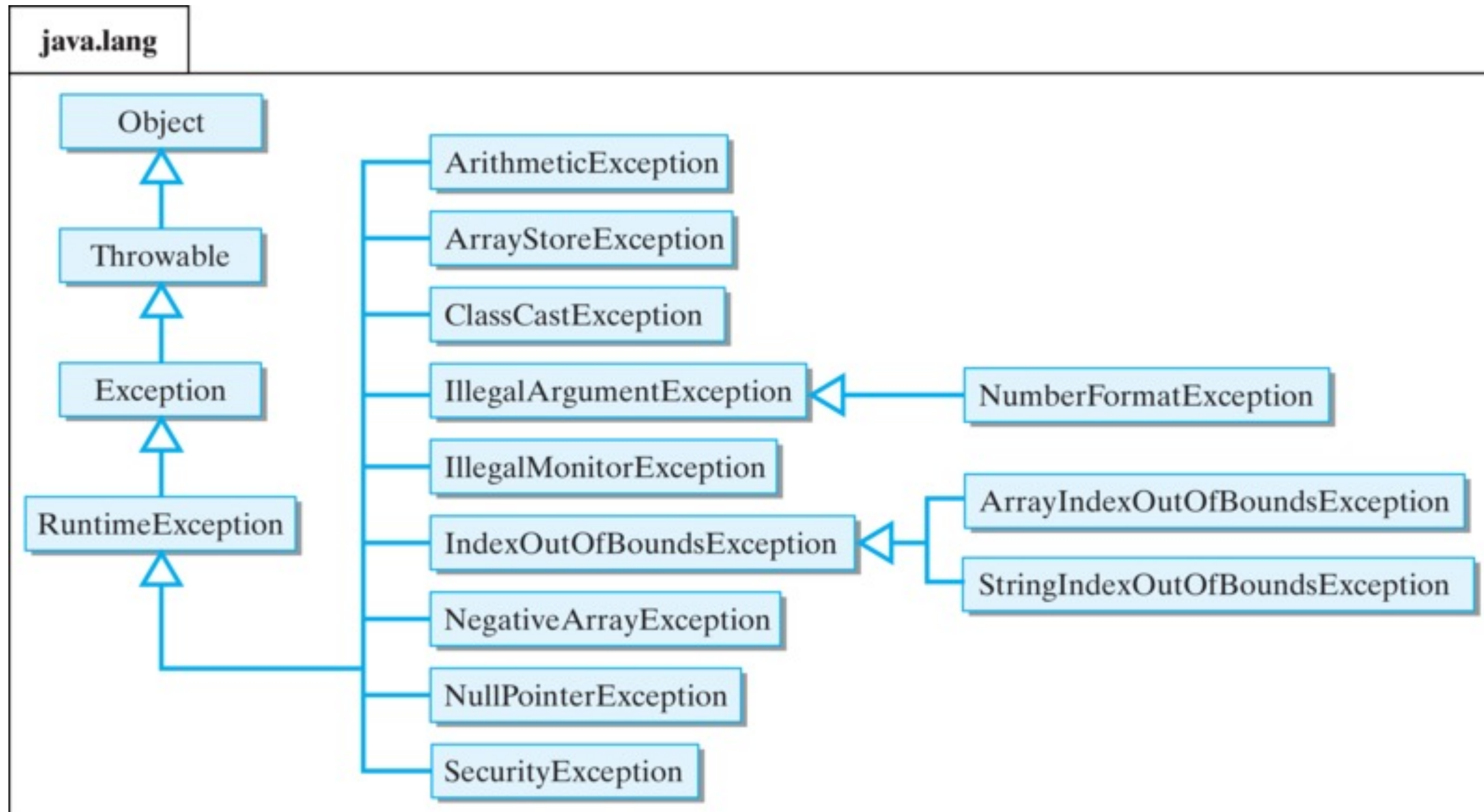
typically indicates a *runtime error*

Examples: IndexOutOfBoundsException, NumberFormatException

When an error occurs, we **throw** the exception. Any function that is currently on the stack can **catch** the exception.

- Functions that do not catch the exception are aborted
- If no one catches the exception, the program terminates and prints the exception to the console

Exceptions are objects



Throwing an exception

```
public static void bar() {
  throw new RuntimeException("An error happened in bar()");
}
```

Catching an exception

```
try {
  bar();
}
catch (RuntimeException e) {
  System.out.println("An exception occured: "+e.getMessage());
  e.printStackTrace();
}
```

Draw the stack diagram

```
public static void bar() {
  throw new RuntimeException(“ERROR");
}

public static void foo() {
  try {
    bar();
  }
  catch (RuntimeException e) {
    System.out.println(“Exception: "+e.getMessage());
    e.printStackTrace();
  }
  System.out.println("Hello!");
}

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

Exercise: Write a program that catches an ArrayOutOfBoundsError

Exceptions: best practices

- A production-level application should never throw and uncaught exception
  - e.g. the user should never encounter an exception.
  - thrown exceptions are bugs

- Throwing an exception is meant to help the developer
  - Serious mistakes that will derail further execution of the program
  - Errors related to undefined behaviors typically throw exceptions
    - divide by zero
    - adding vectors with mis-matches sizes
    - out of array bounds

Exceptions: best practices

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

    int value = 0;
    boolean valid = false;
    while (!valid) {
      System.out.print("Enter an integer: ");
      String input = System.console().readLine();
      try {
        value = Integer.parseInt(input);
        valid = true;
      }
      catch (RuntimeException e) {
        System.out.println("Sorry, this value is invalid");
      }
    }

    System.out.println("You entered "+value);
  }
}
```

NO

Exceptions are slow and should not be used for routine error checking

- For example, checking whether a user input an integer

Exceptions: Trace this program

```
int value = 0;
boolean valid = false;
while (!valid) {
  System.out.print("Enter an integer: ");
  String input = System.console().readLine();
  try {
    value = Integer.parseInt(input);
    valid = true;
  }
  catch (RuntimeException e) {
    System.out.println(“ERROR");
  }
}

System.out.println("You entered "+value);
```