CS-0445

Algorithms and Data Structures - 1

Fall 2023

INTRODUCTION

Marina Barsky
mbarsky@pitt.edu
people.cs.pitt.edu/~mbarsky/cs0445

Lecture Handouts

- These handouts are intended for use by students in CS0445 at the University of Pittsburgh and **no one else**
- These notes are provided free of charge and may not be utilized in any other shape or form

- Sources:
  - Lecture notes developed by *Prof. John Ramirez* and *Prof. Sherif Khattab*
  - Data Structures and Abstractions with Java, 2nd, 3rd and 4th and 5th Editions by Frank Carrano (and Timothy Henry)
  - Your instructor

The course is about

- Data structures
- Algorithms
- Java

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What is a Data Structure?

- Each program works on data: takes input data and produces output data
- There are sophisticated ways to structure data in memory – and that can make your program more efficient

The choice of a suitable data structure can make all the difference between a working and a failing program

Example: Most Frequent Word

Many Data Structures exist

- Simple: ***arrays, linked lists, stacks, queues***
- More intricate - but still very useful: ***heaps***, ***search trees***, ***hash tables***
- Advanced - ***Bloom filters***, ***union-find*** …

- Why do we need so many?
- Because different data structures support different sets of operations and are good for different types of tasks.

We need to know what exists and what it is good for

- We will discuss the pros and cons of each data structure for a particular task
- The fewer operations the data structure supports - the faster these operations will be

The skill: think about the operations that you **need** for solving a problem

Choose the best data structure - the one that supports only required operations, and not more.

Four levels of Data Structure Proficiency

- Level 0: **ignorance**
- Level 1: **cocktail party awareness**
- Level 2: **solid literacy**: know which data structures are appropriate for which types of tasks and comfortable using them

We aim here →

- Level 3: **hardcore** programmers and computer scientists: understand the internals of existing and implement new data structures

The course is about

- Data structures
- ➢Algorithms
- Java

Why algorithms?

- *Algorithm* is a sequence of steps that converts input data into a desired output
- We will get familiar with algorithms for the most fundamental computational tasks: searching and sorting
- We will study the basics of *Algorithm Analysis* and learn how to compare the performance of different algorithms
- That will give us a tool for comparing performance of different data structures for the same task

The course is about

- Data structures
- Algorithms
- ➢Java

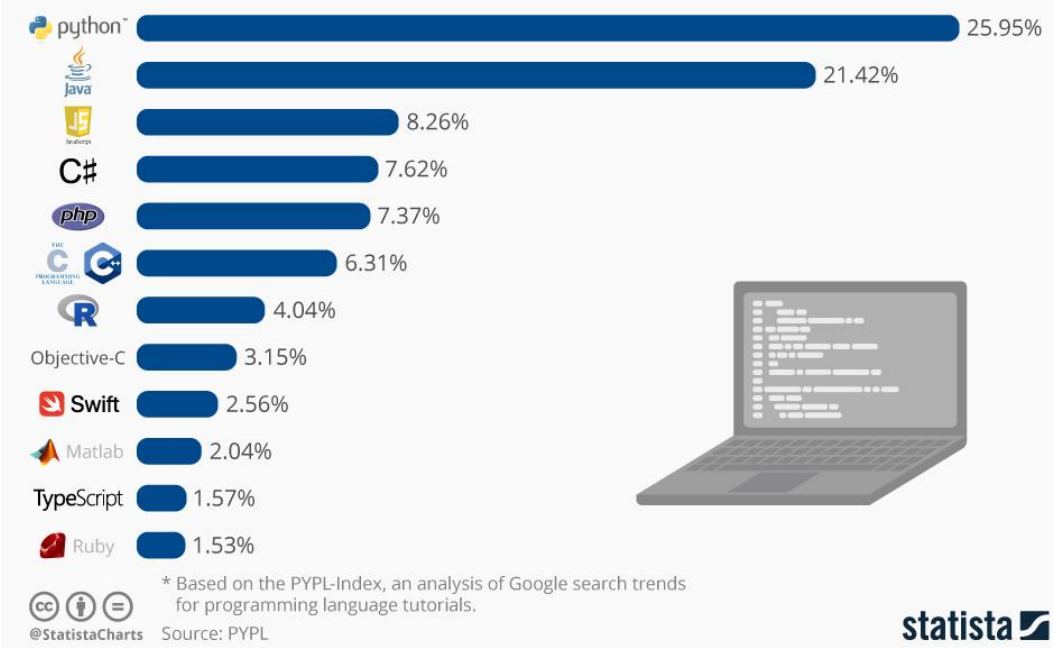
Why Java?

- Simple typed language
- Fully Object-Oriented
- Takes care of memory with Garbage collector

- Contains multiple implementations of ready-to-use Data Structures
- We will learn which structures are available in the Java Developer Kit, so you won't waste time reinventing the wheel
- But we will also implement our own Data Structures from scratch

Why Java? Useful on its own

- High-level language – concentrate on a task not on the machine
- Building programs from interacting objects → large projects with short schedule: divide work into components
- Java is used to build long-lived, reliable, modifiable software



Course at a glance

- Java first:
  - Java's approach for designing new Data Types
  - Using features of language to design solutions
- Algorithms second:
  - Sorting and searching
  - Recursion
  - Analysis
- Basic structures
  - Arrays, Lists, Queues, Stacks
- Advanced structures
  - Hash tables

Course Mechanics

Where is everything!?

- Canvas: LINK
  - Announcements
  - Project submissions
  - Your grades

- WEBSITE
  - https://people.cs.pitt.edu/~mbarsky/cs-0445/
  - Links to (virtually) all course content
  - Organized by weeks

Textbooks

- Data Structures and Abstractions with Java, 5th Edition by Carrano and Henry, Pearson.

  The textbook is provided by the publisher via "inclusive access". "Inclusive access" is an agreement between Pitt and the textbook publishers that makes an e-copy of the text available to all students in the course via RedShelf in Canvas. Students are automatically billed for the e-copy of the text unless they opt out prior to the end of the add-drop period.

- A good Java reference book.

  You can reuse your textbook from CMPINF 0401:

  Starting Out with Java: Early Objects (5th Edition) by Tony Gaddis

There will be post-reading quizzes to help you access your understanding of the concepts

Help

- Discussion forum: Piazza
- Instructor office hours: Tu and Thu from 3:30 to 5:00 in my office
- Weekly recitations
- Emails (sparingly)

More details and links to support resources will be posted in the Course Syllabus: LINK

Grading

- 4 programming projects – 40 %
- Post-reading quizzes (open book, at home)– 10 %
- Class participation – 5 %
- Recitations (attendance only) – 5 %

- Exam 1 (closed-book, in class) – 20 %
- Exam 2 (closed-book, in class) – 20 %

Late submission policies

- 3 grace tokens: 3 days late with no penalty
  Must fill in the form before the due date
- When the grace is exhausted:
  Each late day: 20% penalty

Honor code

- The course grade is largely based on programming assignments, all must be your own work.
- We believe that you are here because you want to become a skillful Computer Scientist:

  Be honorable: do not copy solutions from each other

Punishments: zero grade, failing the course, suspension from the University (no jail time)

Your typical weekly workflow

- Before coming to class - **read** assigned sections of the book and answer questions
- Come to the **lecture**, listen, ask questions, and engage in at least 75% of weekly class activities
- Come to the **recitation** and finish the assigned exercise with the help of the TA (the recitations start the week of September 4)
- Work on a **programming project** (all the time) and submit your solution on the due date. (the first project will be assigned in week of September 11)

- Have fun!

Top Hat

- Both reading quizzes and class activities will be delivered using TopHat
- You need to register to the TopHat from the course canvas.

- Let’stry it right now