Data Structures + Algorithms

**Goal:** Many ways to solve a problem
- Learn about the most efficient ways
- Very often this involves the data structures + algorithms used.

Data Structures - what we use to store data
Algorithms - steps we use to solve problem.

① Searching - in a sorted list of size n, find the index of a number x.

**Linear Search**: Time: \( \Theta(n) \)

**Better: Binary Search**
- Like searching a phone book
- Start at middle element, compare element to \( x \),
- Continue searching either left or right of \( x \).

```
if y < x
    ① Search here
if y > x
    Search here
if y == x
    return i
```
Time? List of size \( n \): Check middle of list until:
- \( x \) found or 1 element left.

\[
\begin{array}{c}
\frac{n}{2} \\
\frac{n}{4} \\
\vdots \\
1
\end{array}
\] How many times can \( n \) be halved?
\[ \sim \log_2(n) \]

2) Sorting: List of \( n \) numbers between 0 and 10 (inclusive). Sort the list:

\[ \{9, 5, 1, 4, 7, 1, 3\} \]

Fastest general sorting algorithm \( \sim n \log n \).

Can we do better?

countArray

- Array of size \( n \) (countArray)
- Keep count of # of 0s, 1s, 2s, \ldots, 10s
- Scan and print from countArray

Time: \( \sim n + 11 \)
COURSE INFO

Java

Java has data types

(1) primitive data type - stores basic data
   - built into Java language.

int: 10, -5, 0 (-2 billion, 2 billion)
double: 5.63, -7.1, 10.0
char: 'a', 'A', '7', '8'
boolean: true, false

Each data type has: value (10, 5.63, 'a', true)
   - set of operations

ex: int operations: + - * / % = , < , > , <= , >= =

int x;
int y;
int x;
int y = 10;
int sum = x + y;

(Sample Code)
(2) object data type - stores advanced data

- "object-oriented programming"

- (a) built into Java (like primitive data)
- (b) built by programmer (later)

(a) ex. String "stores" sequence of characters

methods (operations) +, =, toUpperCase(), toLowerCase(), equals()

```
String a = "Hello"
String b = "hello"

String c = a.toLowerCase();

System.out.println(a.equals(b)); => false
System.out.println(c.equals(b)); => true
```

Sample code>

For primitive data, operations are basic
For objects, methods are more advanced

- Might be wondering: which methods can be performed?

class - defines (data values) + methods of an object

=> Java API for string class

Notice: methods have input, output.