CSCI 232:
Data Structures and Algorithms

Java Review

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Spring 2025

Announcements

- **No lab tomorrow**

- **Quizzes-** You **must** attend the lab that you are registered for
  → If you can’t make it to your lab section, talk to reese beforehand

- Fill out the course questionnaire

We are going to write a program where a user can keep track of their online shopping cart.

Users can add items, remove items, search for items, get the total price of cart, and apply coupons to items

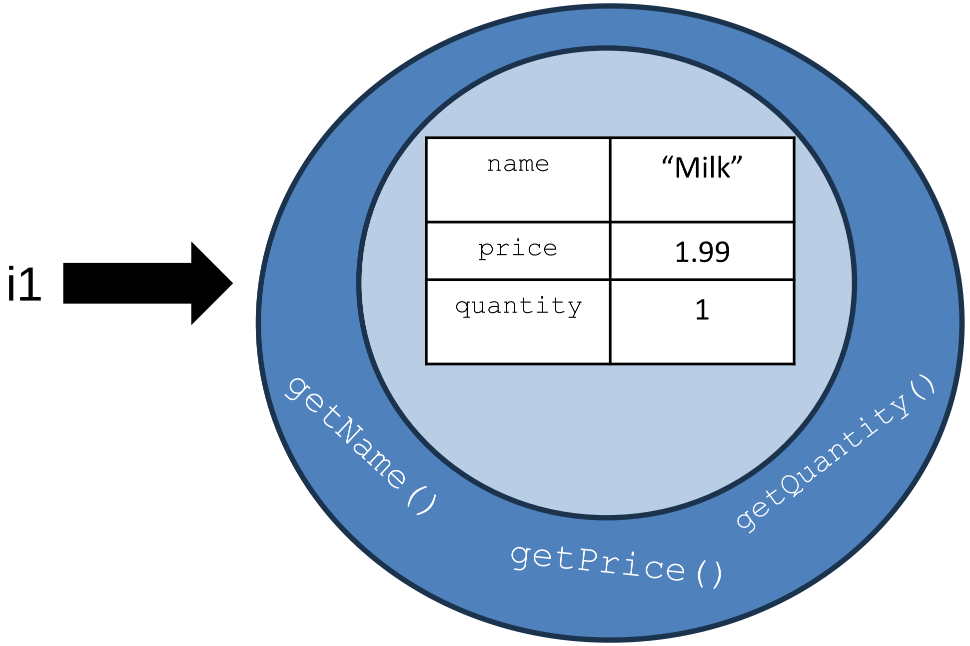
```java
public class Item {


    private String name;
    private double price;
    private int quantity;

    public Item(String n, double p, int q) {
        this.name = n;
        this.price = p;
        this.quantity = q;
    }

    public String getName() {
        return this.name;
    }

    public double getPrice() {
        return this.price;
    }

    public int getQuantity() {
        return this.quantity;
    }
}
```

Java Class: Blueprint for an object (i.e. a “thing”)

- Instance Field/Attributes
- Methods

```java
Item i1 = new Item("Milk", 1.99, 1);
Item i2 = new Item("Eggs", 3.99, 2);

System.out.println(i1.getName());
System.out.println(i2.getQuantity());
```



Java Objects: **Instances** of classes.
Program entities

```
public void addItem(String name, double price, int quantity) {
        Item item = new Item(name, price, quantity);
        Item[] tempArray = new Item[this.shoppingCart.length + 1];
        for(int i = 0; i < this.shoppingCart.length; i++) {
                tempArray[i] = shoppingCart[i];
        }
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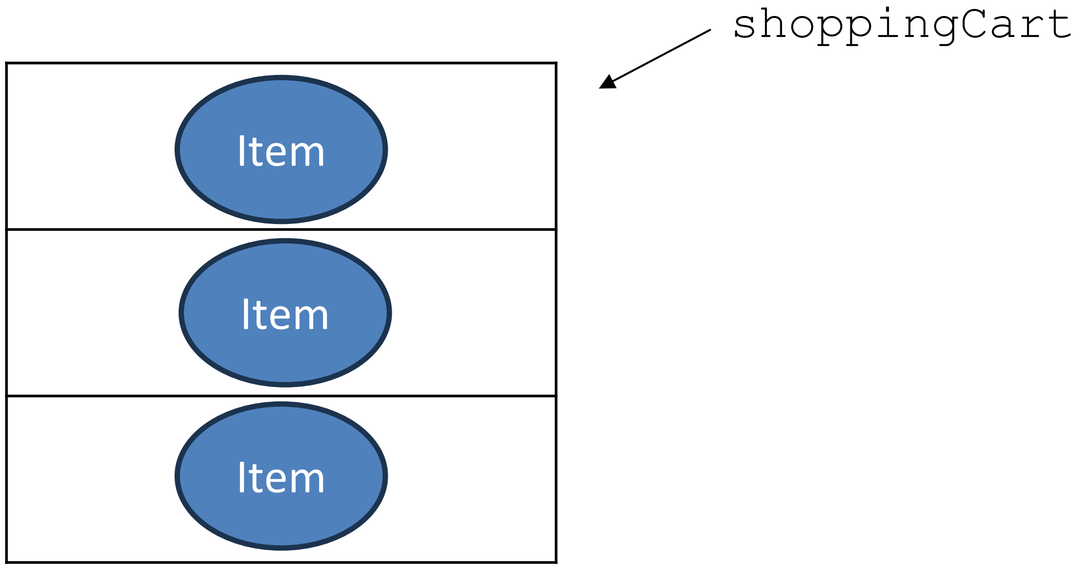

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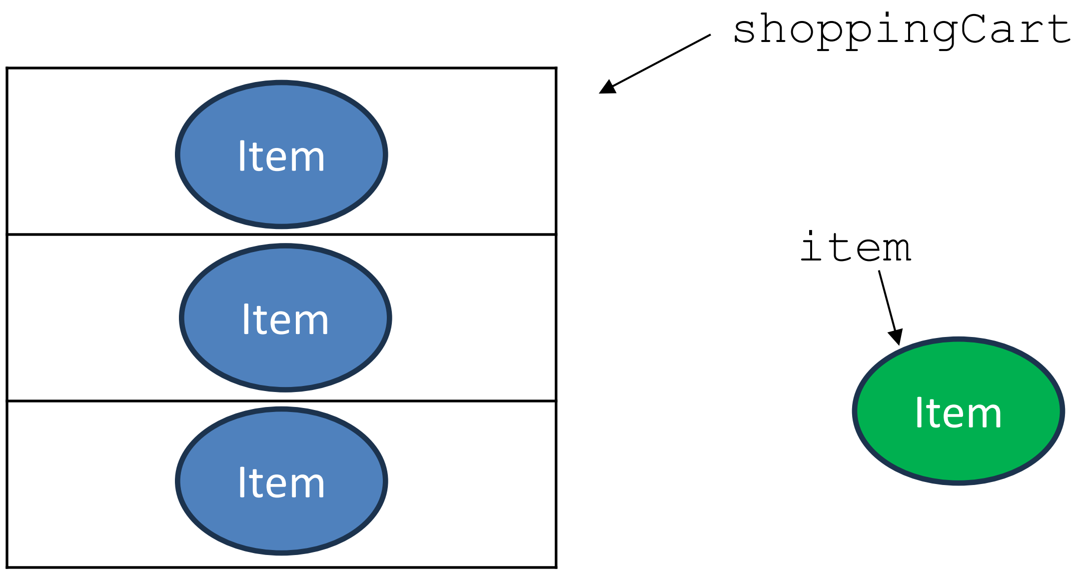

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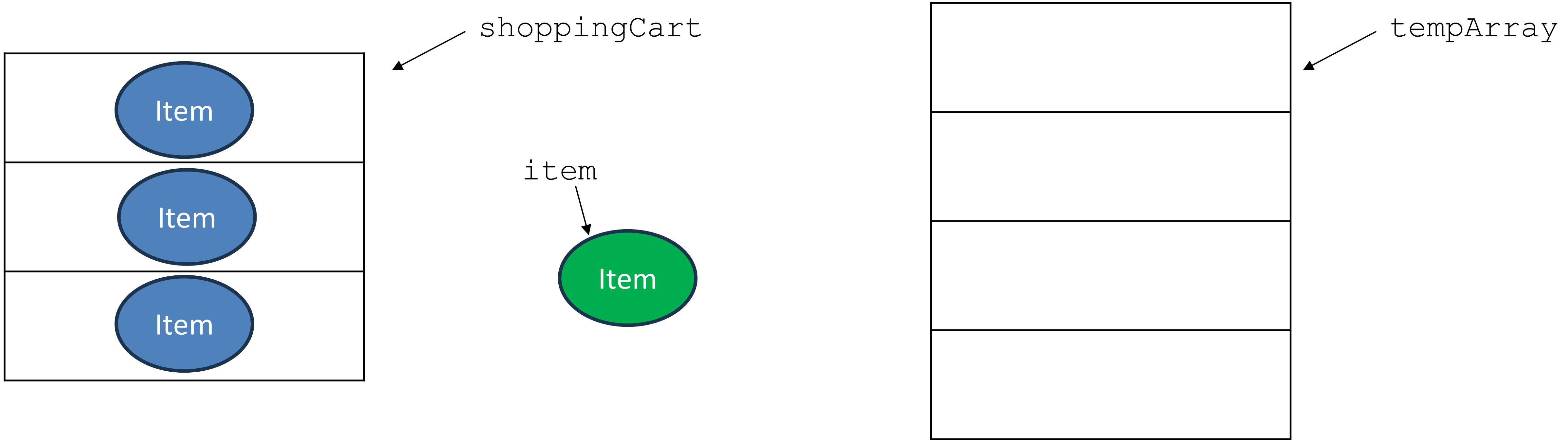

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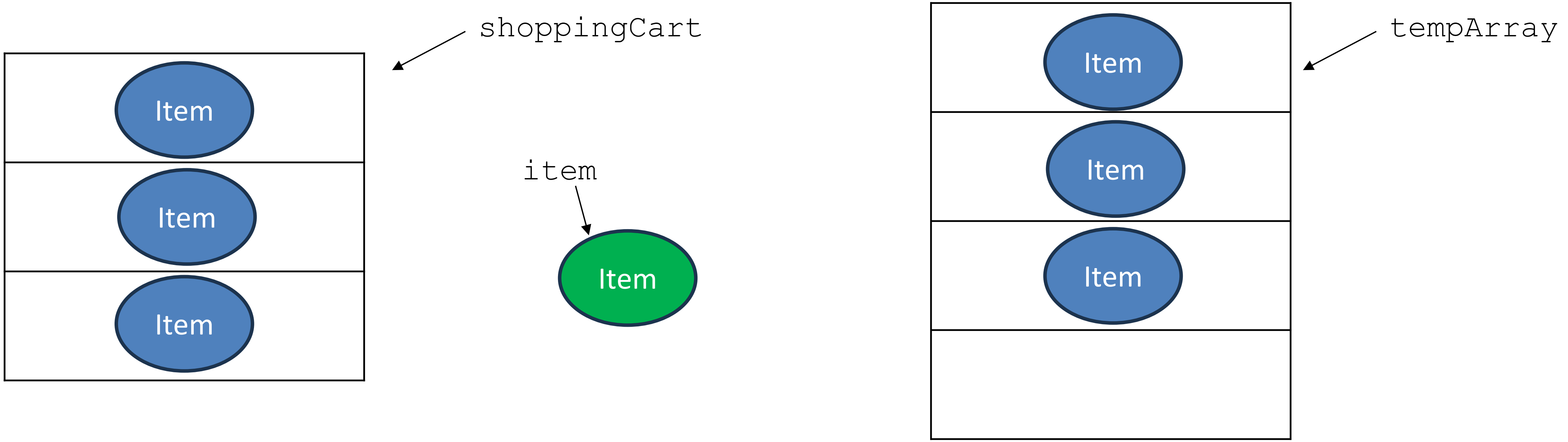

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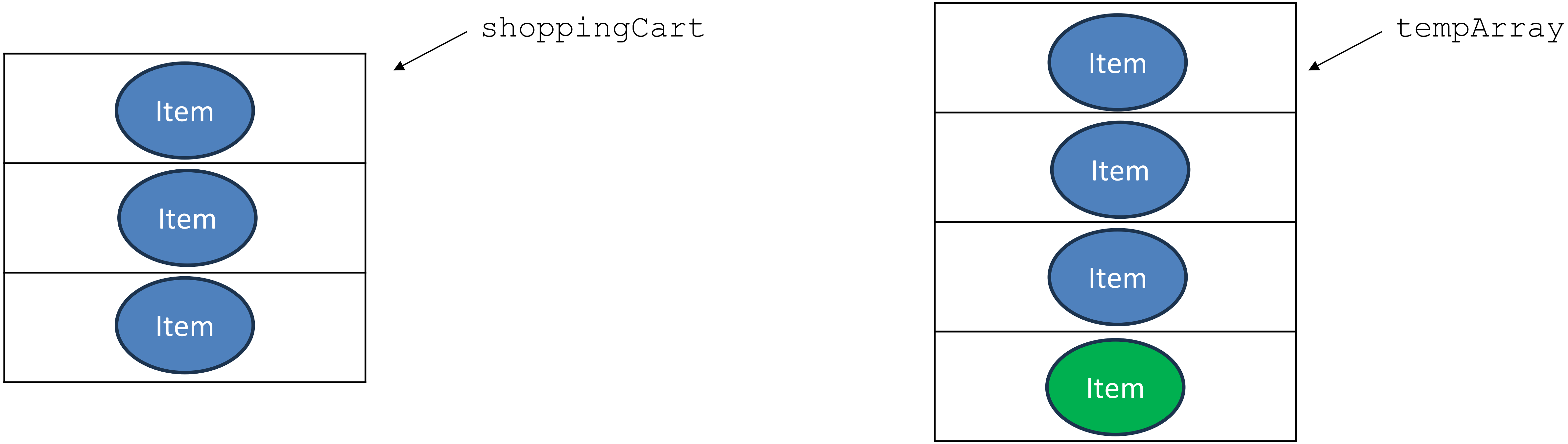

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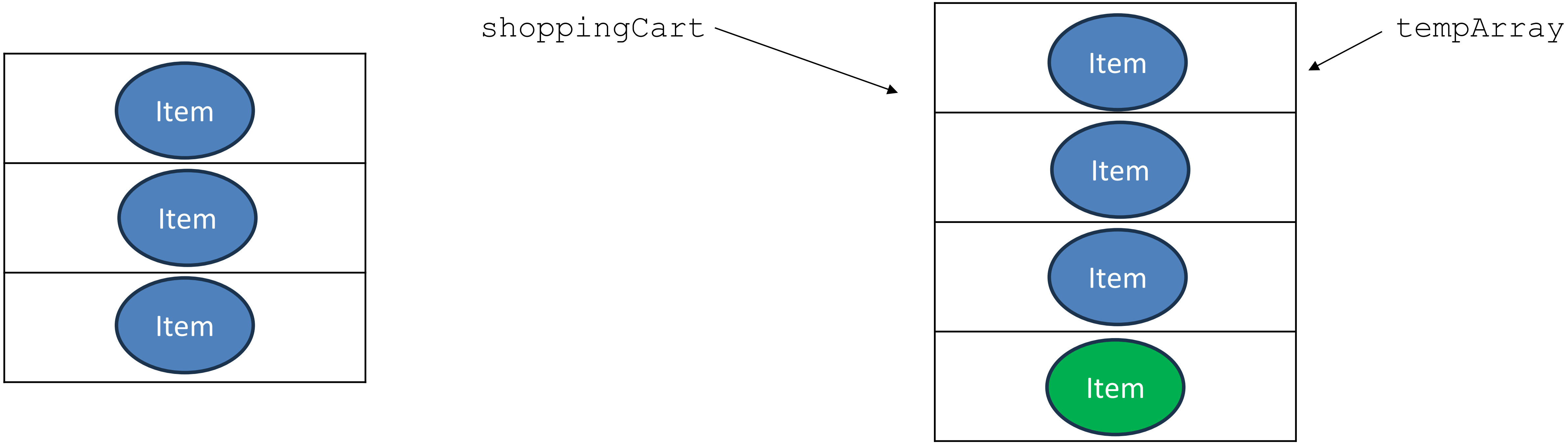

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Running time?

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Running time: Number of operations required to complete algorithm

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Big O Notation: Upper bound on asymptotic growth. I.e. Worst case upper bound of a function

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Running time: Number of operations required to complete algorithm

Big O Notation: Upper bound on asymptotic growth. I.e. Worst case upper bound of a function

Big O Notation measures the number of steps needed to complete an algorithm under the worst-case scenario

```java
public int linearSearch(int[] array, int target) {
	for(int i = 0; i < array.length; i++) {
		if(array[i] == target){
			return i;
		}
	}
	return -1;
}
```

To calculate the running time, we add up the running time of each operation

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public int linearSearch(int[] array, int target) {
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Worst case scenario, this for loop will need run **n** times

O(n) **Let n = array.length**

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Primitive operation – operation that takes constant time (independent of size of the input)

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In Big O notation:

- We can drop non dominant factors
- We can drop multiplicative constants (coefficients)

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To calculate the running time, we add up the running time of each operation

Primitive operation – operation that takes constant time (independent of size of the input)

Total running time: O(n) where n = | array |

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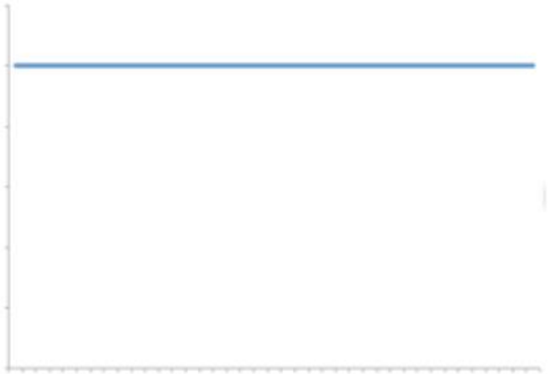
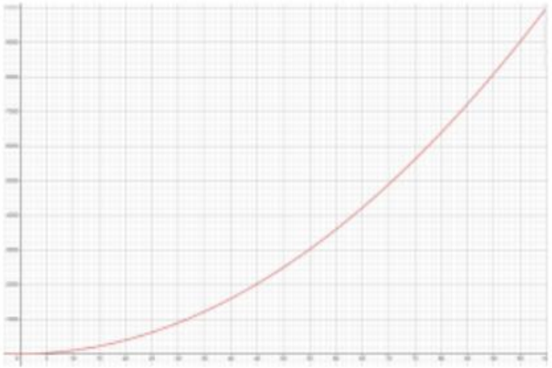
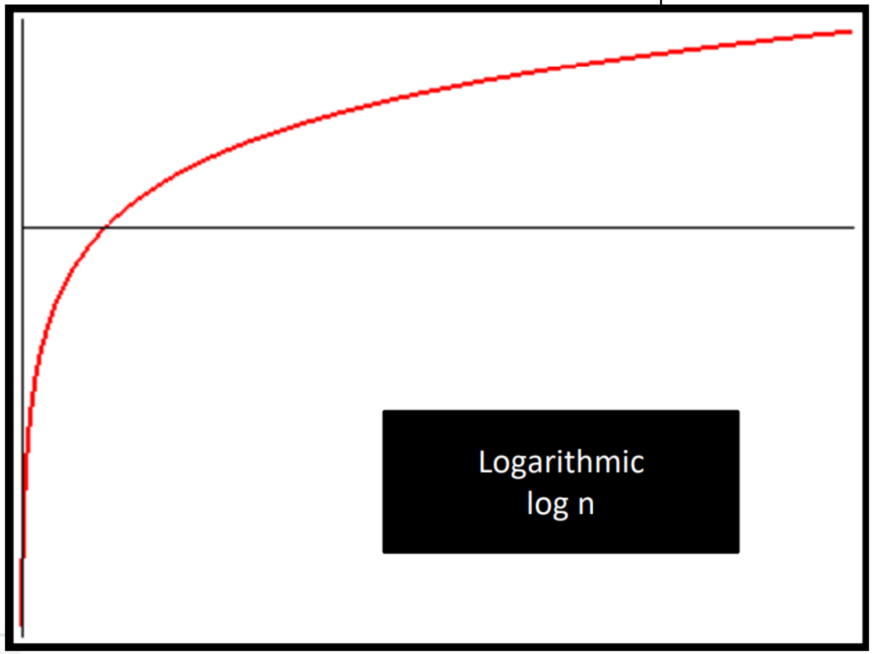
```
{

+ 1];
```

Constant



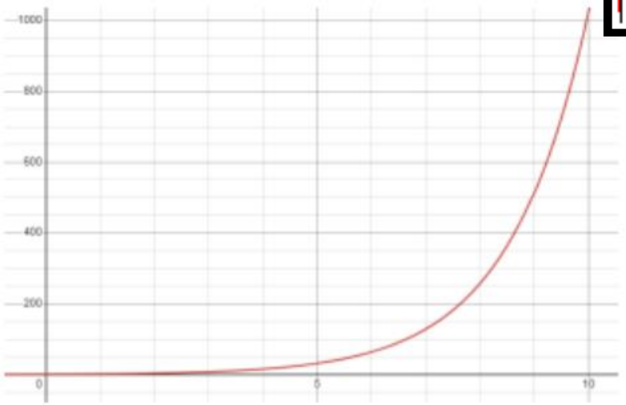
Quadratic





Linear

Exponential



```
function computeDistanceBetweenCaves():

        for each cave in all_caves i;
                for each cave in all_caves j;
                        compute_distance(i, j)
```

	C1	C2	C3	...	C9
C1	/	D(1,2)	D(1,3)	...	D(1,9)
C2	D(2,1)	/	D(2,3)	...	D(2,9)
C3	D(3,1)	D(3,2)	/	...	D(3,9)
...	...	...	...	...	....
C9	D(9,1)	D(9,2)	D(9,3)	...	/

```
function computeDistanceBetweenCaves():

  O(n)  for each cave in all_caves i;
        O(n-1) for each cave in all_caves j;
               O(1) compute_distance(i, j)
```

	C1	C2	C3	…	C9
C1	/	D(1,2)	D(1,3)	…	D(1,9)
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C3	D(3,1)	D(3,2)	/	…	D(3,9)
…	…	…	…	…	….
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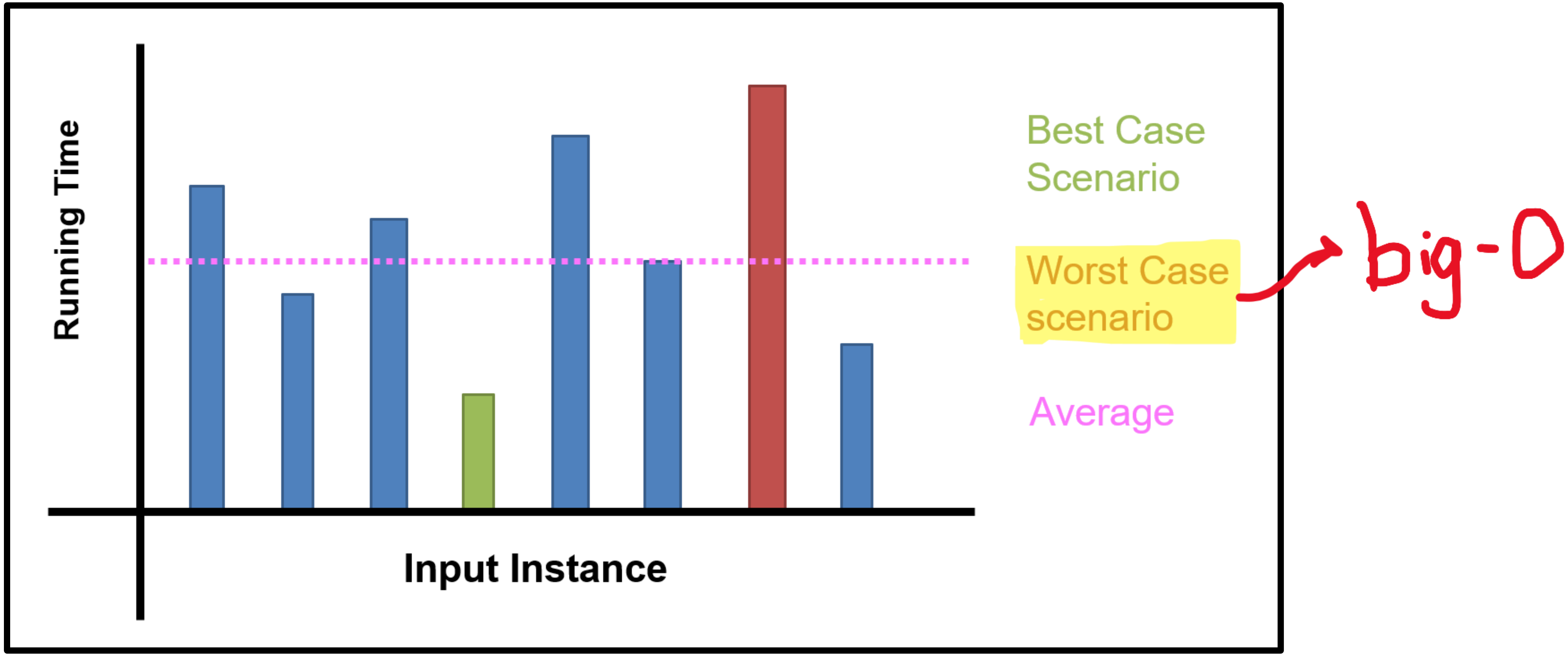
Total running time = O(n) * (O(n) * O(1))

O(n^2) **Where n = # of caves**



In computer science (and this class in particular), we will be focusing on stating running time in terms of **worst-case scenario**

Big O Formal Definition

Let $f(n)$ and $g(n)$ be functions mapping positive integers to positive real numbers

$f(n)$ is $\mathbf{O}(g(n))$ if there is a real constant $c > 0$ and an integer constant $n_0 \geq 1$ such that

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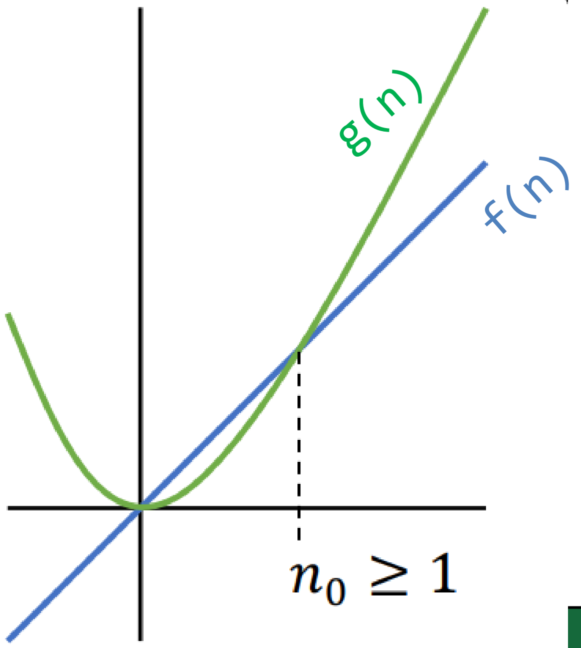

$$\forall n \geq 1, n^2 \geq n$$
$$\Rightarrow n \in O(n^2)$$

O -notation provides an upper bound on some function $f(n)$

Which would you rather have?

Given a problem of size *n*

Algorithm **A** runs in $O(n^2)$ time.

Algorithm **B** runs in $O(n)$ time.

Which would you rather have?

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Algorithm **A** runs in $n^2 \in O(n^2)$ time.

Algorithm **B** runs in $n + 10^{25} \in O(n)$ time.

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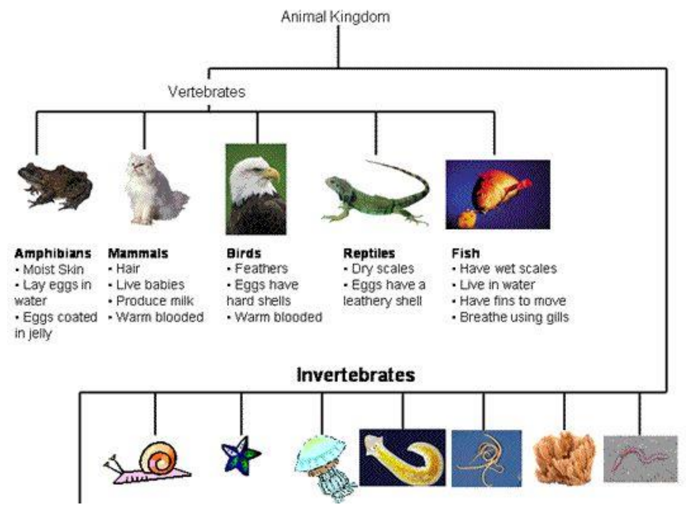
Big-O is a helpful way to broadly describe the running time of different programs, but it isn't perfect



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Total running time: O(n) + O(n)

O(2n)

O(n) where n = shoppingCart.length

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Takeaway: Adding to a full array takes O(n) time