# Arrays
# and
# Collections ( Array List and Maps)

# Objectives

- After you have read and studied this chapter, you should be able to
  - Manipulate a collection of data values, using an array.
  - Declare and use an array of primitive data types in writing a program.
  - Declare and use an array of objects in writing a program
  - Define a method that accepts an array as its parameter and a method that returns an array
  - Describe how a two-dimensional array is implemented as an array of arrays
  - Manipulate a collection of objects, using lists and maps

# Array Basics

- An array is a collection of data values.
- If your program needs to deal with 100 integers, 500 Account objects, 365 real numbers, etc., you will use an array.
- In Java, an array is an indexed collection of data values of the same type.

# Arrays of Primitive Data Types

- Array Declaration

```
<data type> [ ] <variable>          //variation 1
<data type>   <variable>[ ]         //variation 2
```

- Array Creation

```
<variable>  = new <data type> [ <size> ]
```

- Example

Variation 1

```
double[ ] rainfall;
rainfall
    = new double[12];
```

Variation 2

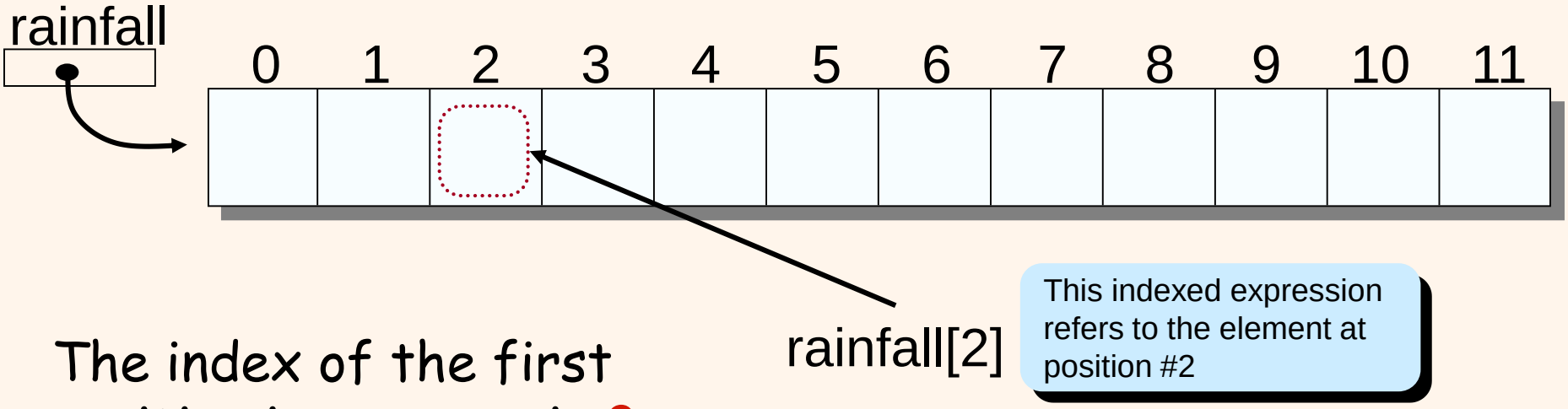
```
double rainfall [ ];
rainfall
    = new double[12];
```

An array is like an object!

# Accessing Individual Elements

- Individual elements in an array accessed with the indexed expression.

```
double[] rainfall = new double[12];
```




The index of the first position in an array is 0.

# Array Processing – Sample1

```
Scanner scanner = new Scanner(System.in);
double[] rainfall = new double[12];

double   annualAverage,
         sum = 0.0;

for (int i = 0; i < rainfall.length; i++) {

    System.out.print("Rainfall for month " + (i+1));
    rainfall[i] = scanner.nextDouble( );
    sum += rainfall[i];
}

annualAverage = sum / rainfall.length;
```

The public constant length returns the capacity of an array.

# Array Processing – Sample 2

```
Scanner scanner = new Scanner(System.in);
double[] rainfall = new double[12];
String[] monthName = new String[12];
monthName[0] = "January";
monthName[1] = "February";
…
double   annualAverage, sum = 0.0;

for (int i = 0; i < rainfall.length; i++) {
    System.out.print("Rainfall for " + monthName[i] + ": ");
    rainfall[i] = scanner.nextDouble();
    sum += rainfall[i];
}
annualAverage = sum / rainfall.length;
```

The same pattern for the remaining ten months.

The actual month name instead of a number.

# Array Processing – Sample 3

- Compute the average rainfall for each quarter.

```
//assume rainfall is declared and initialized properly

double[] quarterAverage = new double[4];

for (int i = 0; i < 4; i++) {
    sum = 0;
    for (int j = 0; j < 3; j++) {
                                          //compute the sum of
        sum += rainfall[3*i + j];         //one quarter
    }
    quarterAverage[i] = sum / 3.0;    //Quarter (i+1) average
}
```

# Array Initialization

- Like other data types, it is possible to declare and initialize an array at the same time.

```
int[] number = { 2, 4, 6, 8 };

double[] samplingData = { 2.443, 8.99, 12.3, 45.009, 18.2,
                          9.00, 3.123, 22.084, 18.08 };

String[] monthName = { "January", "February", "March",
                       "April", "May", "June", "July",
                       "August", "September", "October",
                       "November", "December"  };
```

```
number.length ⟶ 4
samplingData.length ⟶ 9
monthName.length ⟶ 12
```

# Variable-size Declaration

- In Java, we are not limited to fixed-size array declaration.
- The following code prompts the user for the size of an array and declares an array of designated size:

```
Scanner scanner = new Scanner(System.in);
int size;
int[] number;

System.out.print("Size of an array:"));
size= scanner.nextInt( );

number = new int[size];
```

# The For-Each Loop

- This new for loop is available from Java 5.0
- The for-each loop simplifies the processing of elements in a collection
- Here we show examples of processing elements in an array

```
int sum = 0;

for (int i = 0; i < number.length; i++) {
     sum = sum + number[i];
}
```

standard for loop

```
int sum = 0;

for (int value : number) {
     sum = sum + value;
}
```

for-each loop

# For-Each: Key Points to Remember

- A for-each loop supports read access only. The elements cannot be changed.
- A single for-each loop allows access to a single array only, i.e., you cannot access multiple arrays with a single for-each loop.
- A for-each loop iterates over every element of a collection from the first to the last element. You cannot skip elements or iterate backward.

# Two-Dimensional Arrays

- Two-dimensional arrays are useful in representing tabular information.

**Distance Table (in miles)**

| | Los Angeles | San Francisco | San Jose | San Diego | Monterey |
|---|---|---|---|---|---|
| Los Angeles | — | 600 | 500 | 150 | 450 |
| San Francisco | 600 | — | 100 | 750 | 150 |
| San Jose | 500 | 100 | — | 650 | 50 |
| San Diego | 150 | 750 | 650 | — | 600 |
| Monterey | 450 | 150 | 50 | 600 | — |

**Multiplication Table**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **2** | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| **3** | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 |
| **4** | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
| **5** | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 |
| **6** | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 |
| **7** | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 |
| **8** | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 |
| **9** | 9 | 18 | 27 | 36 | 45 | 54 | 63 | 72 | 81 |

**Tuition Table**

| | Day Students | Boarding Students |
|---|---|---|
| Grades 1 – 6 | $ 6,000.00 | $ 18,000.00 |
| Grades 7 – 8 | $ 9,000.00 | $ 21,000.00 |
| Grades 9 – 12 | $ 12,500.00 | $ 24,500.00 |

# Declaring and Creating a 2-D Array

## Declaration

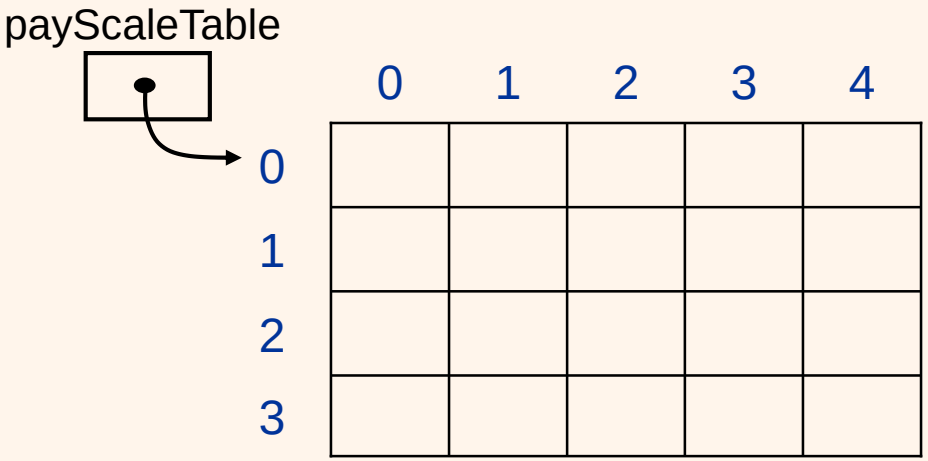
```
<data type> [][] <variable>     //variation 1
<data type>   <variable>[][]    //variation 2
```

## Creation

```
<variable>  = new <data type> [ <size1> ][ <size2> ]
```

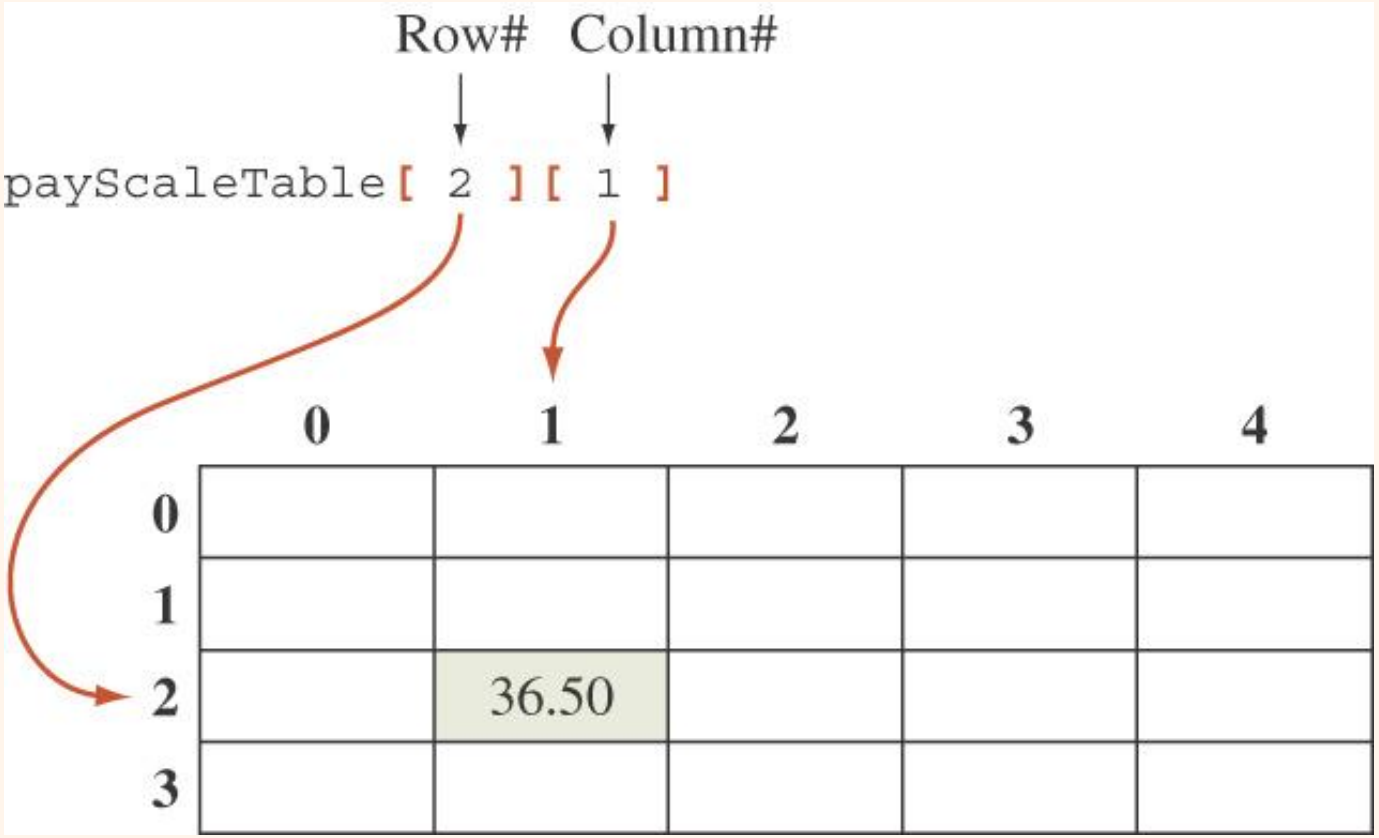
## Example

```
double[][] payScaleTable;
payScaleTable
    = new double[4][5];
```



# Accessing an Element

- An element in a two-dimensional array is accessed by its row and column index.



# Sample 2-D Array Processing

- Find the average of each row.

```
double[ ] average = { 0.0, 0.0, 0.0, 0.0 };

for (int i = 0; i < payScaleTable.length; i++) {

    for (int j = 0; j < payScaleTable[i].length; j++) {

        average[i] += payScaleTable[i][j];
    }

    average[i] = average[i] / payScaleTable[i].length;
}
```

# Java Implementation of 2-D Arrays

- The sample array creation

```
payScaleTable = new double[4][5];
```

is really a shorthand for

```
payScaleTable = new double [4][ ];

payScaleTable[0] = new double [5];
payScaleTable[1] = new double [5];
payScaleTable[2] = new double [5];
payScaleTable[3] = new double [5];
```

# Collection Classes: Lists and Maps

- The **java.util** standard package contains different types of classes for maintaining a collection of objects.
- These classes are collectively referred to as the *Java Collection Framework (JCF).*
- JCF includes classes that maintain collections of objects as sets, lists, or maps.

# List Methods

- Here are five of the 25 list methods:

| |
|---|
| `boolean add ( E o )` |
| Adds an object o to the list |
| `void clear ( )` |
| Clears this list, i.e., make the list empty |
| `E get ( int idx )` |
| Returns the element at position idx |
| `boolean remove ( int idx )` |
| Removes the element at position idx |
| `int size ( )` |
| Returns the number of elements in the list |

E is a generic class.
Replace E with a concrete class.

# Using Lists

- To use a list in a program, we must create an instance of a class that implements the List interface.
- Two classes that implement the **List** interface:
  - **ArrayList**
  - **LinkedList**

- The **ArrayList** class uses an array to manage data.
- The **LinkedList** class uses a technique called *linked-node representation*.