Core Java

"this" reference

- "this" is implicit reference variable that is available in every non-static method of class which is used to store reference of current/calling instance.
- Whenever any non-static method is called on any object, that object is internally passed to the method and internally collected in implicit "this" parameter.
- "this" is constant within method i.e. it cannot be assigned to another object or null within the method.
- Using "this" inside method (to access members) is optional. However, it is good practice for readability.
- In a few cases using "this" is necessary.
    - Unhide non-static fields from local fields.

    ```
    double height; // "height" field
    void setHeight(double height) { // "height" parameter
        height = height; // ???
    }
    ```

    - Constructor chaining
    - Access instance of outer object.

null reference

- In Java, local variables must be initialized before use; otherwise it raise compiler error.

    ```
    int a;
    a++; // compiler error
    Human obj;
    obj.walk(); // compiler error
    ```

- In Java, reference can be initialized to null (if any specific object is not yet available). However reference must be initialized to appropriate object before its use; otherwise it will raise NullPointerException at runtime.

    ```
    Human h = null; // reference initialized to null
    h = new Human(); // reference initialized to the object
    h.walk(); // invoke the method on the object
    ```

    ```
    Human h = null;
    h.walk(); // NullPointerException
    ```

Constructor chaining

- Constructor chaining is executing a constructor of the class from another constructor (of the same class).

```
Human(int age, double height, double weight) {
    this.age = age;
    this.height = height;
    this.weight = weight;
}
Human() {
    this(0, 1.6, 3.3);
    // ...
}
```

- Constructor chaining (if done) must be on the very first line of the constructor.

OOP concepts

Abstraction

- Abstraction is getting essential details of the system.
- Abstraction change as per perspective of the user.
- Abstraction represents outer view of the system.
- Abstraction is based on interface/public methods of the class.

Encapsulation

- Combining information/state and complex logic/operations so that it will be easier to use is called as Encapsulation.
- Fields and methods are bound in a class so that user can create object and invoke methods (without looking into complex implementations).
- Encapsulation represents inner view of the system.
- Encapsulation and abstraction are complementary to each other.

Information hiding

- Members of class not intended to be visible outside the class can be restricted using access modifiers/specifiers.
- The "private" members can be accessed only within the class; while "public" members are accessible in as well as outside the class.
- Usually fields (data) are "private" and methods (operations) are "public".

Packages

- Packages makes Java code modular. It does better organization of the code.

- Package is a container that is used to group logically related classes, interfaces, enums, and other packages.

- Package helps developer:
  - To group functionally related types together.
  - To avoid naming clashing/collision/conflict/ambiguity in source code.
  - To control the access to types.
  - To make easier to lookup classes in Java source code/docs.
- Java has many built-in packages.
  - java.lang * --> Integer, System, String, ...
  - java.util --> Scanner, ArrayList, Date, ...
  - java.io --> FileInputStream, FileOutputStream, ...
  - java.sql --> Connection, Statement, ResultSet, ...
  - java.util.function --> Predicate, Consumer, ...
  - javax.servlet.http --> HttpServlet, ...
- Package Syntax
  - To define a type inside package, it is mandatory write package declaration statement inside .java file.
  - Package declaration statement must be first statement in .java file.
  - Types inside package called as packaged types; while others (in default package) are unpackaged types.
  - Any type can be member of single package only.
- It is standard practice to have multi-level packages (instead of single level). Typically package name is module name, dept/project name, website name in reverse order.

```java
package com.sunbeaminfo.modular.corejava;
```

```java
package com.sunbeaminfo.dac;
```

- Packages can be used to avoid name clashing. In other words, two packages can have classes/types with same name.

```java
package com.sunbeam.tree;

class Node {
    // ...
}

public class Tree {
    // ...
}
```

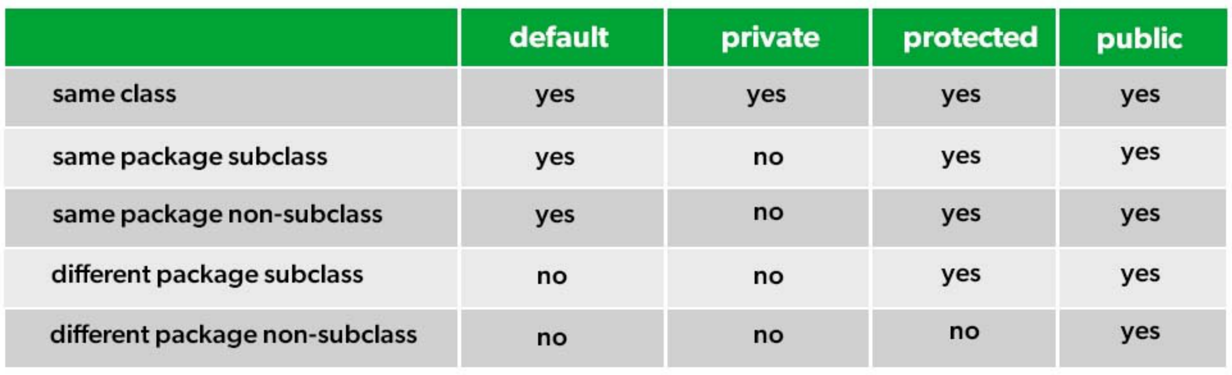
```java
package com.sunbeam.list;

class Node {
    // ...
}

public class List {
    // ...
}
```

Access modifiers (for types)

- default: When no specifier is mentioned.
    - The types are accessible in current package only.
- public: When "public" specifier is mentioned.
    - The types are accessible in current package as well as outside the package (using import).

Access modifiers (for type members)

- private: When "private" specifier is mentioned before the member field/method.
    - The members are accessible in current class (member OR this.member).
- default: When no specifier is mentioned before the member field/method.
    - The members are accessible in current class (member OR this.member).
    - The members are accessible in all classes in same package (obj.member OR ClassName.member).
- protected: When "protected" specifier is mentioned before the member field/method.
    - The members are accessible in current class (member OR this.member).
    - The members are accessible in all classes in same package including its sub-classes (super.member, obj.member OR ClassName.member).
    - The members are accessible in sub classes outside the package including its sub-classes (super.member).
- public: When "public" specifier is mentioned before the member field/method.
    - The members are accessible in current class (member OR this.member).
    - The members are accessible in all other classes (super.member, obj.member OR ClassName.member).
- Scopes
    - private (lowest)
    - default
    - protected
    - public (highest)



	default	private	protected	public
same class	yes	yes	yes	yes
same package subclass	yes	no	yes	yes
same package non-subclass	yes	no	yes	yes
different package subclass	no	no	yes	yes
different package non-subclass	no	no	no	yes

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Array

- Array is collection of similar data elements. Each element is accessible using indexes (0 to n-1).
- In Java, array is non-primitive/reference type i.e. its object is created using new operator (on heap).
- Array size is fixed - given while creating array object. It cannot be modified later.
- Java array object holds its length and data elements.
- The array of primitive type holds values (0 if uninitialized) and array of non-primitive type holds references (null if uninitialized).
- Array of primitive types

```
int[] arr1 = new int[5];

int[] arr2 = new int[5] { 11, 22, 33 };
// error

int[] arr3 = new int[] { 11, 22, 33, 44, 55 };

int[] arr4 = { 11, 22, 33, 44 };
```

- Array of non-primitive types

```
Human[] arr5 = new Human[5];

Human[] arr6 = new Human[] {h1, h2, h3};
// h1, h2, h3 are Human references

Human[] arr7 = new Human[] {
    new Human(...),
    new Human(...),
    new Human(...)
};
```

- In Java, checking array bounds is responsibility of JVM. When invalid index is accessed, ArrayIndexOutOfBoundsException is thrown.
- Array types are
  - 1-D array
  - 2-D/Multi-dimensional array
  - Ragged array

1-D array

```java
int[] arr = new int[5];

int[] arr = new int[4] { 10, 20, 30, 40 };
// error

int[] arr = new int[] { 11, 22, 33, 44, 55 };

int[] arr = { 11, 22, 33, 44 };

Human[] arr = new Human[5];

Human[] arr = new Human[] {h1, h2, h3};
```

- Individual element is accesses as `arr[i]`.

Arrays

2-D/Multi-dimensional array

```java
double[][] arr = new double[2][3];

double[][] arr = new double[][]{ { 1.1, 2.2, 3.3 }, { 4.4, 5.5, 6.6 } };

double[][] arr = { { 1.1, 2.2, 3.3 }, { 4.4, 5.5, 6.6 } };
```

- Internally 2-D arrays are array of 1-D arrays. "arr" is array of 2 elements, in which each element is 1-D array of 3 doubles.
- Individual element is accesses as `arr[i][j]`.

Ragged array

- Ragged array is array of 1-D arrays. Each 1-D array in the ragged array may have different length.

  ```java
  int[][] arr = new int[4][];
  arr[0] = new int[] { 11 };
  arr[1] = new int[] { 22, 33 };
  ```

```
arr[2] = new int[] { 44, 55, 66 };
arr[3] = new int[] { 77, 88, 99, 110 };
for(int i=0; i<arr.length; i++) {
    for(int j=0; j<arr[i].length; j++) {
        System.out.print(arr[i][j] + ", ");
    }
}
```

Variable Arity Method

- Methods with variable number of arguments. These arguments are represented by ... and internally collected into an array.

```
public static int sum(int... arr) {
    int total = 0;
    for(int num: arr)
        total = total + num;
    return total;
}
public static void main(String[] args) {
    int result1 = sum(10, 20);
    System.out.println("Result: " + result1);
    int result2 = sum(11, 22, 33);
    System.out.println("Result: " + result2);
}
```

- If method argument is `Object... args`, it can take variable arguments of any type.
- Pre-defined methods with variable number of arguments.
  - PrintStream class: PrintStream printf(String format, Object... args);
  - String class: static String format(String format, Object... args);

Method overloading

- Methods with same name and different arguments in same scope - Method overloading.
- Arguments must differ in one of the follows
  - Count

    ```
    static int multiply(int a, int b) {
        return a * b;
    }
    static int multiply(int a, int b, int c) {
        return a * b * c;
    }
    ```

  - Type

```
static int square(int x) {
    return x * x;
}
static double square(double x) {
    return x * x;
}
```

- Order

```
static double divide(int a, double b) {
    return a / b;
}
static double divide(double a, int b) {
    return a / b;
}
```

- Constructors have same name (as of class name) and different arguments. This is referred as "Constructor overloading".
- Note that return type is NOT considered in method overloading. Following code cause error.

```
static int divide(int a, int b) {
    return a / b;
}
static double divide(int a, int b) {
    return (double)a / b;
}
```

```
int result1 = divide(22, 7);
double result2 = divide(22, 7);
// collecting return value is not mandetory
divide(22, 7);
```

Method arguments

- In Java, primitive values are passed by value and objects are passed by reference.
- Pass by reference -- Stores address of the object. Changes done in called method are available in calling method.

```
public static void testMethod(Human h) {
    h.setHeight(5.7);
}
public static void main(String[] args) {
    Human obj = new Human(40, 76.5, 5.5);
```

```
        obj.display();  // age=40, weight=76.5, height=5.5
        testMethod(obj);
        obj.display();  // age=40, weight=76.5, height=5.7
    }
```

- Pass by value -- Creates copy of the variable. Changes done in called method are not available in calling method.

```
    public static void swap(int x, int y) {
        int t = x;
        x = y;
        y = t;
    }
    public static void main(String[] args) {
        int num1 = 11, num2 = 22;
        System.out.printf("num1=%d, num2=%d\n", num1, num2);
        swap(num1, num2);
        System.out.printf("num1=%d, num2=%d\n", num1, num2);
    }
```

- Pass by reference for value/primitive types can be simulated using array.

Command line arguments

- Additional data/information passed to the program while executing it from command line -- Command line arguments.

```
terminal> java pkg.Program Arg1 Arg2 Arg3
```

- These arguments are accessible in Java application as arguments to main().

```
package pkg;
class Program {
    public static void main(String[] args) {
        // ... args[0] = Arg1, args[1] = Arg2, args[2] = Arg3
    }
}
```