Final (Attributes/Parameters)

Variable	Method	Class
Constant	No overriding	No inheritance

Initialisation

1) Default-Values ↓
2) Attribute Assignments
3) Initialisation block
4) Constructor

Default Values

Type	Default	Type	Default
boolean	false	char	'\u0000'
byte	0	short	0
int	0	long	0L
float	0.0f	double	0.0d

Types

Type	Size (bit)	From	To
byte	8	**−128**	**127**
short	16	**−32'768**	**32'767**
char	16	UTF-16 chars	
int	32	-2^{31}	$2^{31}-1$
long	64	-2^{63}	$2^{63}-1$
float	32	$\pm 1.4 \cdot 10^{-45}$	$\pm 3.4 \cdot 10^{38}$
double	64	$\pm 4.9 \cdot 10^{-324}$	$\pm 1.7 \cdot 10^{308}$

```
// short * int         ⇒ int
// float + int        ⇒ float
// int / double       ⇒ double
// int + long * float ⇒ float
// 0.0 / 0.f          ⇒ NaN

long l = 1L;
long ll = 0b1l;
float f = 0.0f;
double d = 0.0d;

12 == '.'; // implicit int/char conversion
0.1 + 0.1 != 0.2; // true
5/2 == 2;  // true, int div truncates to 0
NaN == NaN; // false
Integer.MAX_VALUE + 1 == Integer.MIN_VALUE;
1 / 0.0 == Double.POSITIVE_INFINITY; // true

var ints = new ArrayList<Integer>();
int[] jnts = new int[69];

if (obj instanceof ArrayList<Integer>)
  ((ArrayList<Integer>)obj).add(2);

public List<String> method(
  BiFunction<Integer, String, List<String>> fn) {
  return fn.apply(5, "FooBar");
}
```

Implicit casting

No information loss `int→float`, to larger type `int→long`
Sub→Super is implicit, Super→Sub ClassCastException

```
// explicit casting
float f = (float) 1;
// type conversion
Integer.parseInt("2");
Float.parseFloat("2.0");
```

Variable args

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

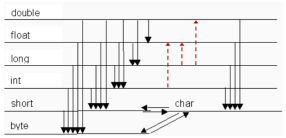
Misc

```
int[] intarr = new int[] {1, 2, 3, 4, 5};
int[] sub = Arrays.copyOfRange(intarr, 1, 3); // 2,3

var intlist = new ArrayList<Integer>();
intarr.length;
intlist.size();

// Multiply first to not lose precision
int percent = (int)((filled * 100) / capacity);

obj.clone();

Double.POSITIVE_INFINITY; // exists

Math.min(x, y);
Math.max(x, y);
```

Rekapitulation: Primitive Datentypen

Konversionen

explizit
implizit (mit evtl. Genauigkeitsverlust)
Sonstige Richtungen implizit



Equality

```
s.equals(sOther);           // Strings / Objects
Arrays.equals(a1, a2);      // arrays
Arrays.deepEquals(a1, a2);  // nested arrays

class Student extends Person {
  @Override
  public boolean equals(Object obj) {
    if (obj == null) return false;
    if (getClass() != obj.getClass()) return false;
    if (!super.equals(obj)) return false;
    Student other = (Student) obj;
    return getNumber() == other.getNumber();
  }
}
```

Strings

```
String multiline = """
  Hello, "world"
""";
"a:b:c".split(":",2).length == 2; // true
String str = Integer.toString(123456789);
str.length();                     // 9
str.charAt(1);                    // 2
str.toUpperCase();
str.toLowerCase();
str.trim();
str.substring(1, 3);              // 2,3
```

String pooling

```
String first = "hello", second = "hello";
System.out.println(first == second);      // true

String third = new String("hello");
String fourth = new String("hello");
System.out.println(third == fourth);      // false
System.out.println(third.equals(fourth)); // true

String a = "A", b = "B", ab = "AB";
System.out.println(a + b == ab);          // false

final String d = "D", e = "E", de = "DE";
System.out.println(d + e == de);          // true
```

Visibility

public	all classes
protected	package + sub-classes
private	only self
(none)	all classes in same package

Packages

p1.sub won't be automatically imported in p1.
Package name collisions: first gets imported.

```
package p1;
public class A { }
```

```
package p1.sub;
public class E { }
```

```
package p2;
import p1.sub.E;
public class C {
  E e = new E();
}
```

```
package p1; // public class A { }
package p2; // public class A { }

// OK
import p1.A;
import p2.*;

// reference to A is ambiguous
import p1.*;
import p2.*;

// sin, PI
import static java.lang.Math.*;
```

Modules

```
// ./foo/module-info.java
module foo.bar.baz {
  exports com.my.package.foo;
}

// ./main/module-info.java
module main.module {
  requires com.my.package.foo;
}
```

Enums

```
public enum Weekday {
  MONDAY(true),
  TUESDAY(true),
  WEDNESDAY(true),
  THURSDAY(true),
  FRIDAY(true),
  SATURDAY(false),
  SUNDAY(false);

  private boolean workDay;

  Weekday(boolean workDay) { // private constructor
    this.workDay = workDay;
  }
  public boolean isWorkDay() {
    return workDay;
  }
}

switch (wd) {
  case MONDAY:
  case TUESDAY:
    System.out.println("First two");
    break;
  default:
    System.out.println("Rest");
}
```

Switch

```
switch (x) {
  case 'a':
    System.out.println("1");
    break;
  default:
    System.out.println("2");
}

int y = switch (x) {
  case 'a' -> 1;
  default -> 2;
}
```

Overloading

Methods with same names but different parameters
Gets statically chosen by compiler

```
void print(int i, double j) { }    // 1
void print(double i, int j) { }    // 2
void print(double i, double j) { } // 3

print(1.0, 2.0);        // 3
print(1,2);// error: reference to print is ambiguous
print(1.0, 2);          // 2
print(2.0, (double) 2); // 3
```

Overriding

Methods with same names and signatures
Dynamically chosen (Dynamic dispatch / Virtual call)
Error: Cannot override the final method…
Error: Cannot be subclass of final class…

```
class Fruit {
  void eat(Fruit f) { System.out.println("1"); }
}
class Apple extends Fruit {
  void eat(Fruit f) { System.out.println("2"); }
  void eat(Apple a) { System.out.println("3"); }
}

Apple a = new Apple();
Fruit fa = new Apple();
Fruit f = new Fruit();

a.eat(fa);            // 2
a.eat(a);             // 3
fa.eat(a);            // 2
fa.eat(fa);           // 2
f.eat(fa);            // 1
f.eat(a);             // 1
((Fruit) a).eat(fa);  // 3
((Apple) fa).eat(a);  // 2
((Apple) f).eat(a);   // ClassCastException
```

Hiding

```
super.description == ((Vehicle)this).description
super.super // doesn't exist, use v
((SuperSuperClass)this).variable
```

Abstract classes

```
public abstract class Vehicle {
  private int speed;
  public abstract void drive();
  public void accelerate(int acc) {
    this.speed += acc;
  }
}
public class Car extends Vehicle {
  @Override
  public void drive() { }
  @Override
  public void accelerate (int acc) { }
}
```

Interfaces default methods

```
interface Vehicle {
  default void printModel() {
     System.out.println("Undefined vehicle model");
  }
}
```

Interfaces

Cannot have Attributes

```
interface RoadV {
  int MAX_SPEED = 120;
  void drive();
}
interface WaterV {
  int MAX_SPEED = 80;
  void drive();
}
class AmphibianMobile implements RoadV, WaterV {
  @Override // because ambiguous
  public void drive() {
    println(RoadV.MAX_SPEED); // MAX_SPEED ambiguous
  }
}

interface RoadV { String getModel(); }
interface WaterV { int getModel(); }
// Error, because of different return types
class AmphibianMobile implements RoadV, WaterV { }
```

Anonymous Classes

```
var v = new RoadV() {
    @Override
    public void drive() {
      System.out.println("Anon");
    }
}
```

Inheritance

```
public class Vehicle {
   private int speed;
   public Vehicle(int speed) {
     this.speed = speed;
   }
}
public class Car extends Vehicle {
   private int doors;
   public Car(int speed, int doors) {
      super(speed);
      this.doors = doors;
   }
}
Car c     = new Car(); // Points to Car
Vehicle v = new Car(); // Points to Car
Object o  = new Car(); // Points to Car
// ^static      ^dynamic
Car c = (Car) new Vehicle(); // ClassCastException
```

More Inheritance

```
public class Qwer {
  public void print() {
    System.out.println("1");
  }
}
public class Asdf extends Qwer {
  @Override
  public void print() {
    System.out.println("2");
  }
  public void dostuff () { }
}

var x = new Asdf();
x.print();            // 2
((Qwer) x).print();   // 2
((Qwer) x).dostuff(); // cannot find symbol
```

Static Type: According to var declaration at compiletime
Dynamic Type: Type of the instance at runtime

Iterators

```
Iterator<String> it = stringList.iterator();
while (it.hasNext()) {
  String s = it.next();
  System.out.println(s);
}
```

Mutating Collection while iterating over it: ConcurrentModificationException

Exceptions

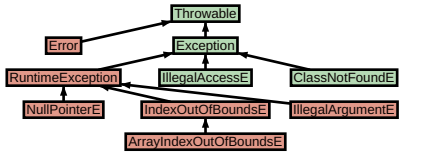
Error	Exception
Critical, don't handle	Runtime, handleable
OutOfMemoryError, StackOverflowError, AssertionError	IOException

Checked	Unchecked
Must be handled (or throws-declaration)	Not necessary
Checked by compiler	Compiler doesn't check
Exception, not RuntimeException	RuntimeException, Error

Child Exception gets caught in catch clause with parent class

```
void test() throws ExceptionA, ExceptionB {
  String c = clip("asdf");
  throw new ExceptionB("wack");
}
// finally ALWAYS executes, even on unhandled Exc.
try { test(); } catch (ExceptionA | ExceptionB e) {
} finally { }

try { ... } catch(NullPointerException e) {
  throw e; // ⟶leaves blocks⟶
} catch (Exception e) {
  // above e won't get caught!
}

1 / 0; // ArithmeticException div by zero
```

Unchecked Checked



Important stuff

- Hashing should be added to equals fn's for strict equality
- Check if `input == null`
- Check if `array.length == 0`
- `IllegalArgumentException("reason")`

IO

```
try (var fr = new FileReader("text.txt")) {
  int input = fr.read();
  while (input ⩾ 0) {
    if (input == ';') { /* do something */ }
    input = fr.read();
  }
}

try (FileWriter writer = new FileWriter("out.txt",
    StandardCharsets.UTF_8, true)) { // append
  writer.write("weeoo\n");
}

try {
  var input = new FileInputStream("text.txt");
  int i = input.read();
  while(i ≠ -1) {
     System.out.print((char)i);
     i = input.read();
  }
  input.close();
} catch (Exception e) { e.printStackTrace(); }

try (BufferedReader reader = new BufferedReader(
    new FileReader("text.txt",
      StandardCharsets.UTF_8))) {
  String line;
  while ((line = reader.readLine()) ≠ null) {
     System.out.println(line);
  }
}
```

Try with

```
try (var output = new FileOutputStream("f.txt")) {
  output.write("Hello".getBytes());
} catch (IOException e) {
  System.out.println("Error writing file.");
}
```

Serializing

```
class X implements Serializable { }
// Serializing
try (var stream = new ObjectOutputStream(
    new FileOutputStream("s.bin"))) {
  stream.writeObject(new X());
}
// Deserializing
try (var stream = new ObjectInputStream(
    new FileInputStream("s.bin"))) {
  X x = (X) stream.readObject();
}
```

Function

```
public interface Function<T, R> {
  R apply(T t);

  static <T> Function<T, T> identity();

  <V> Function <T, V> andThen(
    Function<? super R, ? extends V> after);

  <V> Function <V, R> compose(
    Function<? super V, ? extends T> before);
}
```

Predicate

```
public interface Predicate<T> {
  boolean test(T t);
}

static void removeAll(Collection<Person> collection,
    Predicate criterion) {
  var it = collection.iterator();
  while (it.hasNext())
    if (criterion.test(it.next()))
      it.remove();
}
```

Comparable

```
public interface Comparable<T> {
  int compareTo(T obj);
}

var l = new ArrayList<Integer>(asList(3,2,4,5,1));
l.sort((a, b) → a > b ? 1 : -1); // ==
l.sort((a, b) → a - b);          // 1,2,3,4,5

class Person implements Comparable<Person> {
  private final String firstName, lastName;
  @Override
  public int compareTo(Person other) {
    int result = lastName.compareTo(other.lastName);
    if (result == 0)
      result = firstName.compareTo(other.firstName);
    return result;
  }

  static int compareByAge(Person a, Person b) {
    return Integer.compare(a.getAge(), b.getAge());
  }
}
List<Person> people = ...;
Collections.sort(people);
people.sort(Person::compareByAge);

class AgeComparator implements Comparator<Person> {
   @Override
   public int compare(Person a, Person b) {
     return Integer.compare(a.getAge(), b.getAge());
   }
}
Collections.sort(people, new AgeComparator());
people.sort(new AgeComparator());

people.sort(Comparator
  .comparing(Person::getAge)
  .thenComparing(Person::getFirstName)
  .reversed())
```

Collection

```
boolean add(E e);
boolean remove(Object o);
boolean equals(Object o);
int hashCode();
int size();
boolean isEmpty();
Object[] toArray();
void clear();
boolean contains(Object o);
boolean addAll(Collection<? extends E> c);
boolean containsAll(Collection<?> c);
boolean removeAll(Collection<?> c);
boolean retainAll(Collection<?> c);

Set<String> noDup = new HashSet<>();
```

Collection implementations

```
// List
int indexOf(Object o);
int lastIndexOf(Object o);
E get(int index);
subList(int from, int to);
void sort(Comparator<? super E> c);

// Stack
E peek();
E pop();
E push(E item);
boolean empty();
int search(Object o);

// Queue
E element();       // throws → peek();     doesn't
E remove();        // throws → poll();     doesn't
boolean add(E e); // throws → offer(E e); doesn't

// Set
// (I) SortedSet → (C) TreeSet
// (C) HashSet, (C) LinkedHashSet

// Map
// HashMap
boolean containsKey(Object key);
boolean containsValue(Object value);
Set<Map.Entry<K, V>>> entrySet();
V get(Object key);
V put(K key, V value);
V putIfAbsent(K key, V value);
V replace(K key, V value);
V remove(Object key);
V getOrDefault(Object key, V defaultValue);
Set<K> keySet();
Collection<V> values();
```

Lambdas

```
String pattern = readFromConsole();
//     vvv not final → Error
while (pattern.length() == 0)
  pattern = readFromConsole();
Utils.removeAll(people, p →
    p.getLastName().contains(pattern));
// local variable ... referenced from a lambda
expression must be final or effectively final

// Predicate      :: a → boolean
Predicate<Integer> isLarge = (v) → v > 69420;
// Function       :: a → b
Function<Integer, String> str = (v) → "" + v;
// Supplier       :: a
Supplier<String> hello = () → "Hello, World!";
// Consumer       :: a → void
Consumer<Integer> consoomer = (v) → log(v);
// UnaryOperator  :: a → a
UnaryOperator<Integer> more = (v) → v * v;
// BinaryOperator :: a → a → a
BinaryOperator<Integer> less = (a, b) → a - b;
```

Streams

```
import java.util.stream.*;

people
  .stream()
  .distinct()
  .filter(p → p.getAge() ⩾ 18)
  .skip(5)
  .limit(10)
  .map(p → p.getLastName())
  .sorted()
  .forEach(System.out::println);

people
  .stream()
  .reduce(0, (acc,cur) → acc + cur.getAge());

list.stream().mapToInt(Integer::intValue);
list.stream().mapToInt(Integer::parseInt);
```

Terminal operations:

```
min();
max();
average();
sum();
findAny();
findFirst();
forEach(Consumer);
count();
forEachOrdered(Consumer);
```

Collectors

```
// List
s.collect(Collectors.toList());
// TreeSet
s.collect(Collectors.toCollection(TreeSet::new));
// String
s.collect(Collectors.joining(", "));
// Integer
s.collect(Collectors.summingInt(Person::getAge));
// Map<String, Person>
s.collect(Collectors.groupingBy(Person::getCity));
// Map<String, Integer>
s.collect(Collectors.groupingBy(Person::getCity,
  Collectors.summingInt(Person::getSalary));
// Map<boolean, List<Person>>
s.collect(Collectors.partitioningBy(s →
  s.getAge() > 18))
```