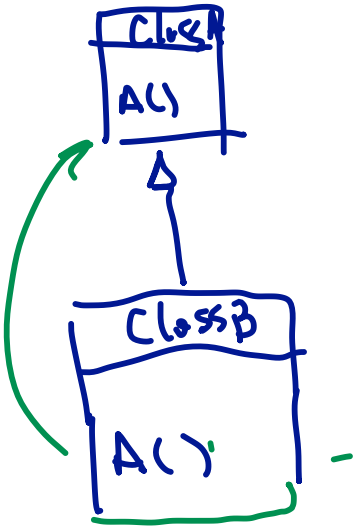
inheritance
polymorphism
encapsulation

overloading ✓ in the same class many methods with same name but different signature

Overriding → Canceling the inherited method signature is same (interface)



@Override
public void A(){

Accessibility of Overridden Methods

An overriding method must provide at least as much access as the overridden method in the parent class. ✓

```
public class Employee {
    //... other fields and methods
    public String getDetails() { ... }
}
```

public

```
public class Manager extends Employee {
    //... other fields and methods
    private String getDetails() { //... }  // Compile time error
}
```

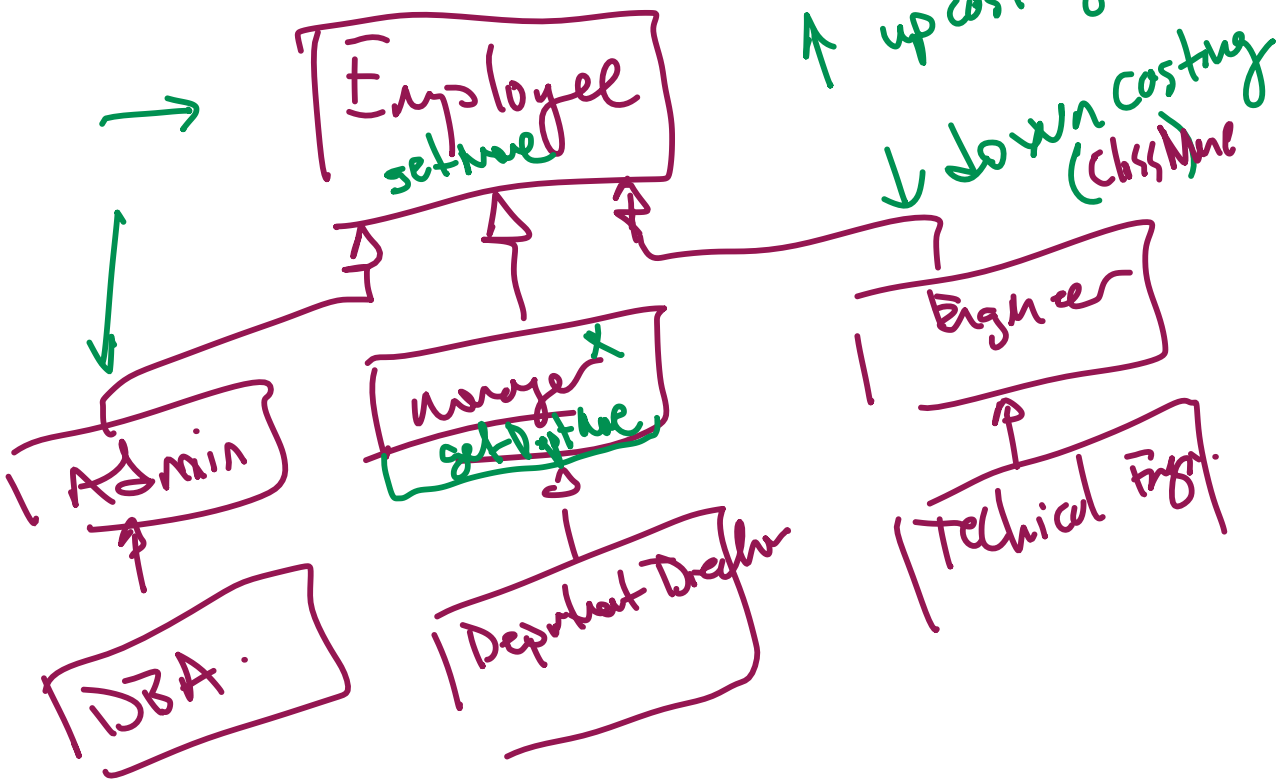
Applying Polymorphism

Suppose that you are asked to create a new class that calculates a stock grant for employees based on their salary and their role (manager, engineer, or admin):

```
1 public class EmployeeStockPlan {
2    public int grantStock (Manager m) {
3       // perform a calculation for a Manager
4    }
5    public int grantStock (Engineer e) {
6       // perform a calculation for an Engineer
7    }
8    public int grantStock (Admin a) {
9       // perform a calculation for an Admin
10   }
11   //... one method per employee type
12}
```

not very object-oriented!

future maintenance



Applying Polymorphism

A good practice is to pass parameters and write methods that use the most generic form of your object as possible.

```
public class EmployeeStockPlan {
   public int grantStock (Employee e) {
      // perform a calculation based on Employee data
   }
}
```

upcasting

```
// In the application class
EmployeeStockPlan esp = new EmployeeStockPlan ();
Manager m = new Manager ();
int stocksGranted = grantStock (m);
...
```

Dep. Director d = new DD();

Applying Polymorphism

Adding a method to `Employee` allows `EmployeeStockPlan` to use polymorphism to calculate stock.

```
public class Employee {
    protected int calculateStock() { return 10; }
}
```

```
public class Manager extends Employee {
    public int calculateStock() { return 20; }
}
```

```
public class EmployeeStockPlan {
    private float stockMultiplier;    // Calculated elsewhere
    public int grantStock (Employee e) {
        return (int)(stockMultipier * e.calculateStock());
    }
}
```


Using the `instanceof` Keyword

The Java language provides the `instanceof` keyword to determine an object's class type at run time.

```
1 public class EmployeeRequisition {
2     public boolean canHireEmployee(Employee e) {
3         if (e instanceof Manager) {
4             return true;
5         } else {
6             return false;
7         }
8     }
9 }
```

Casting Object References

In order to access a method in a subclass passed as an generic argument, you must cast the reference to the class that will satisfy the compiler:

```
1 public void modifyDeptForManager (Employee e, String dept) {
2     if (e instanceof Manager) {
3         Manager m = (Manager) e;
4         m.setDeptName (dept);
5     }
6 }
```

Without the cast to `Manager`, the `setDeptName` method would not compile.

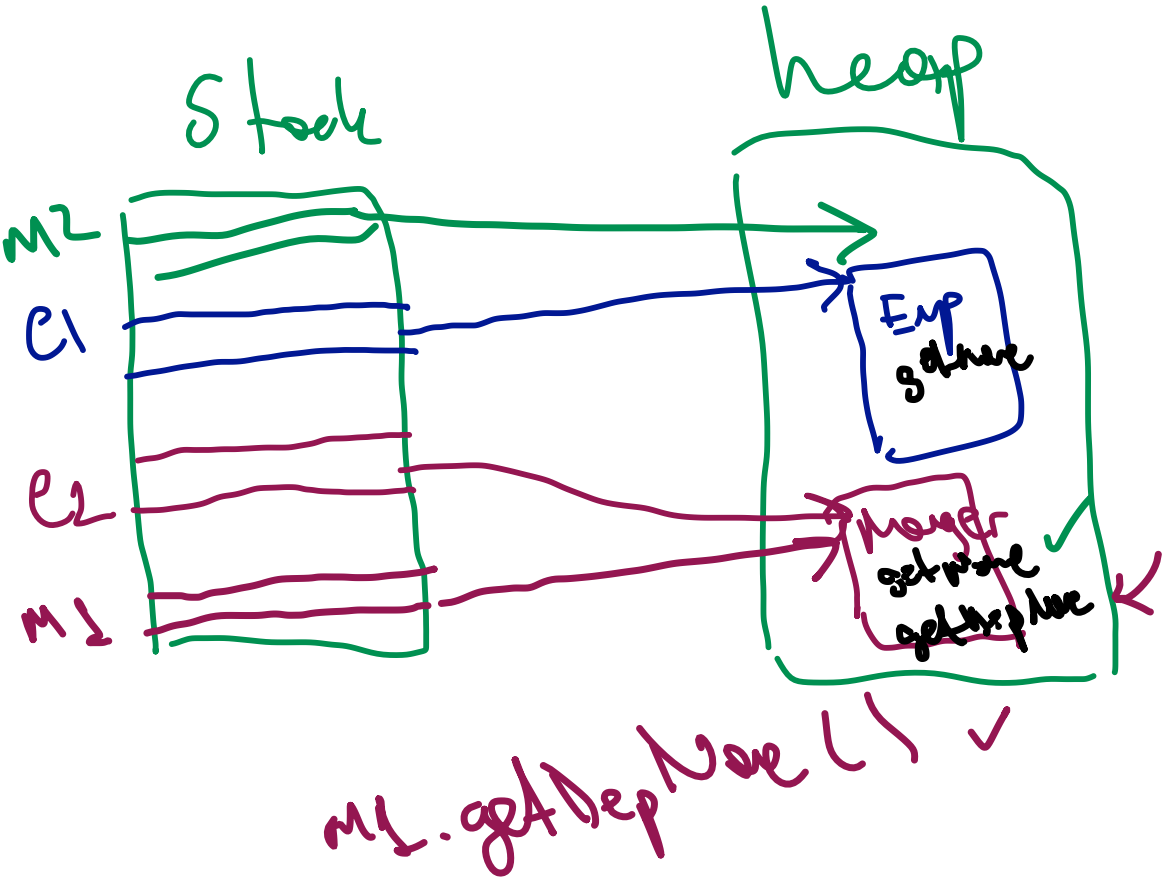
✓✗ Employee e1 = new Employee(); ✓

✓ Employee e2 = new Manager(); ✓

Costing

(*) Manager m1 = (Manager) e2; ✓ ✓

Manager m2 = (manager) e1; ✗ ✗

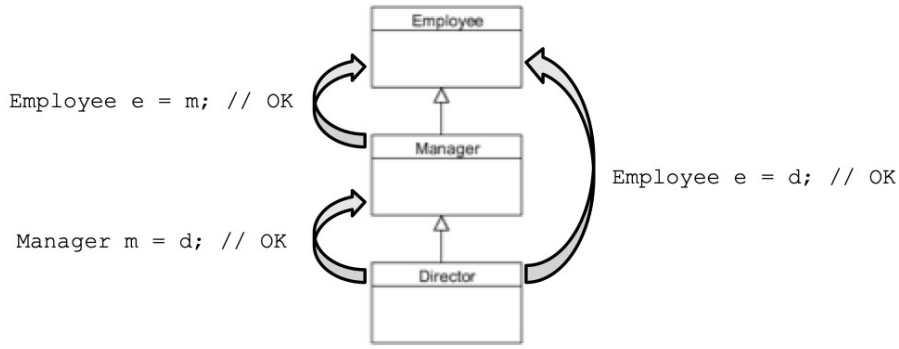


m1.getDeptName(); ✓

Casting Rules

Upward casts are always permitted and do not require a cast operator.

```
Director d = new Director();
Manager m = new Manager();
```



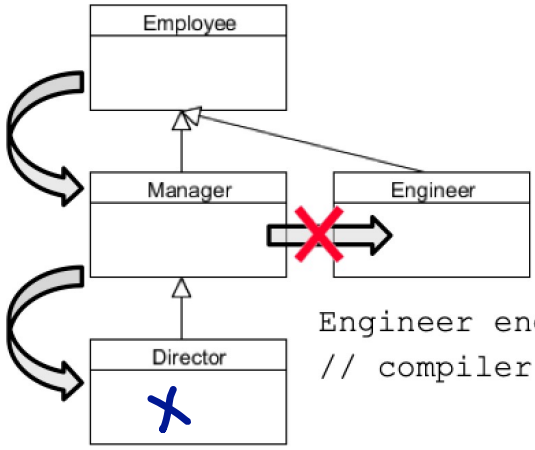
Casting Rules

For downward casts, the compiler must be satisfied that the cast is at least possible.

```
Employee e = new Manager();
Manager m = new Manager();
```

```
Manager m = (Manager)e;
// Would also work if
// e was a Director obj
```

```
Director d = (Director)m;
// fails at run time
```




```
Engineer eng = (Engineer)m;
// compiler error
```

Overriding Object methods

One of the advantages of single inheritance is that every class has a parent object by default. The root class of every Java class is `java.lang.Object`.

- You do not have to declare that your class extends `Object`. The compiler does that for you.

```
public class Employee { //... }
```

is equivalent to:

```
public class Employee extends Object { //... }
```

- The root class contains several non-final methods, but there are three that are important to consider overriding:
  - `toString`, `equals`, and `hashCode`

`Object toString` Method

The `toString` method is called to return the string value of an object. For example, using the method `println`:

```
Employee e = new Employee (101, "Jim Kern", ...)
System.out.println (e);
```

- String concatenation operations also invoke `toString`:

```
String s = "Employee: " + e;
```

- You can use `toString` to provide instance information:

```
public String toString () {
    return "Employee id:   " + empId + "\n"
           "Employee name:" + name;
}
```

- This is a better approach to getting details about your class than creating your own `getDetails` method.

Object equals Method

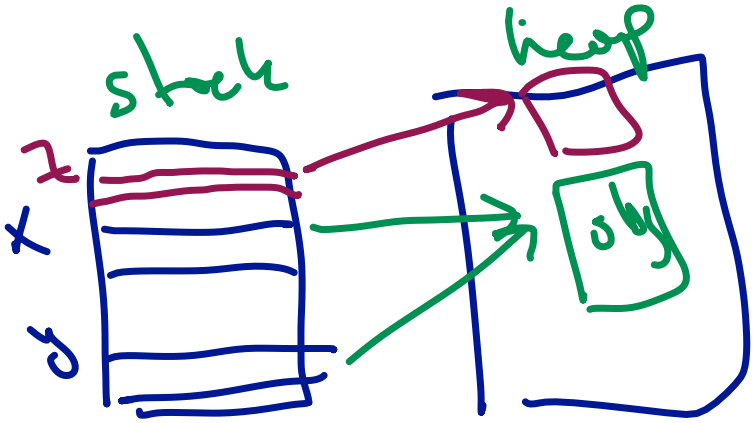
The `Object equals` method compares only object references.

- If there are two objects x and y in any class, x is equal to y if and only if x and y refer to the same object.
- Example:

```
Employee x = new Employee (1,"Sue","111-11-1111",10.0);
Employee y = x;
x.equals (y); // true
Employee z = new Employee (1,"Sue","111-11-1111",10.0);
x.equals (z); // false!
```

- Because what we really want is to test the contents of the Employee object, we need to override the `equals` method:

```
public boolean equals (Object o) { ... }
```

Overriding `equals` in `Employee`

An example of overriding the `equals` method in the `Employee` class compares every field for equality:

```
1 public boolean equals (Object o) {
2     boolean result = false;
3     if ((o != null) && (o instanceof Employee)) {
4         Employee e = (Employee)o;
5         if ((e.empId == this.empId) &&
6             (e.name.equals(this.name)) &&
7             (e.ssn.equals(this.ssn)) &&
8             (e.salary == this.salary)) {
9                result = true;
10         }
11     }
12     return result;
13 }
```

Overriding `Object` `hashCode`

The general contract for `Object` states that if two objects are considered equal (using the `equals` method), then integer hashcode returned for the two objects should also be equal.

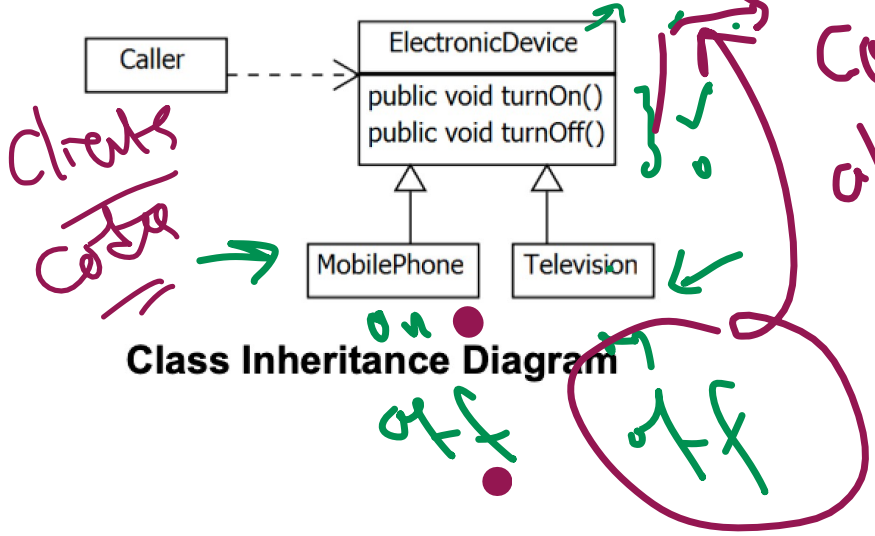
```
1 // Generated by NetBeans
2 public int hashCode() {
3     int hash = 7;
4     hash = 83 * hash + this.empId;
5     hash = 83 * hash + Objects.hashCode(this.name);
6     hash = 83 * hash + Objects.hashCode(this.ssn);
7     hash = 83 * hash +
8                (int)(Double.doubleToLongBits(this.salary) ^
9                (Double.doubleToLongBits(this.salary) >>> 32));
10    return hash;
11 }
```

5 Advanced Class Design

Modeling Business Problems with Classes

Inheritance (or subclassing) is an essential feature of the Java programming language. Inheritance provides code reuse through:

- Method inheritance: Subclasses avoid code duplication by inheriting method implementations.
- Generalization: Code that is designed to rely on the most generic type possible is easier to maintain.



Class Inheritance Diagram

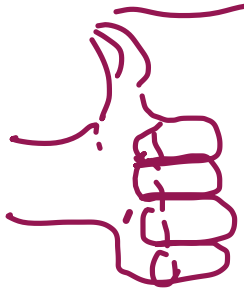
Enabling Generalization

Coding to a common base type allows for the introduction of new subclasses with little or no modification of any code that depends on the more generic base type.

```
ElectronicDevice dev = new Television();
dev.turnOn(); // all ElectronicDevices can be turned on
```

Always use the most generic reference type possible.

Rule of thumb



field declarations, arguments, return types

object

object

+ Design Principles

→ loosly coupled ⇒

Identifying the Need for Abstract Classes

Subclasses may not need to inherit a method implementation if the method is specialized.

```
public class Television extends ElectronicDevice {

    public void turnOn() {
        changeChannel(1);
        initializeScreen();
    }
    public void turnOff() {}

    public void changeChannel(int channel) {}
    public void initializeScreen() {}

}
```

Defining Abstract Classes

A class can be declared as abstract by using the `abstract` class-level modifier.

```
public abstract class ElectronicDevice { }
```

- An abstract class can be subclassed.

```
public class Television extends ElectronicDevice { }
```

- An abstract class cannot be instantiated.

```
ElectronicDevice dev = new ElectronicDevice(); // error
```

polymorphism, template method, class,

both codes, and abstract methods

Defining Abstract Methods

A method can be declared as abstract by using the `abstract` method-level modifier.

```
public abstract class ElectronicDevice {

   public abstract void turnOn();
   public abstract void turnOff();
}
```

No braces

An abstract method:

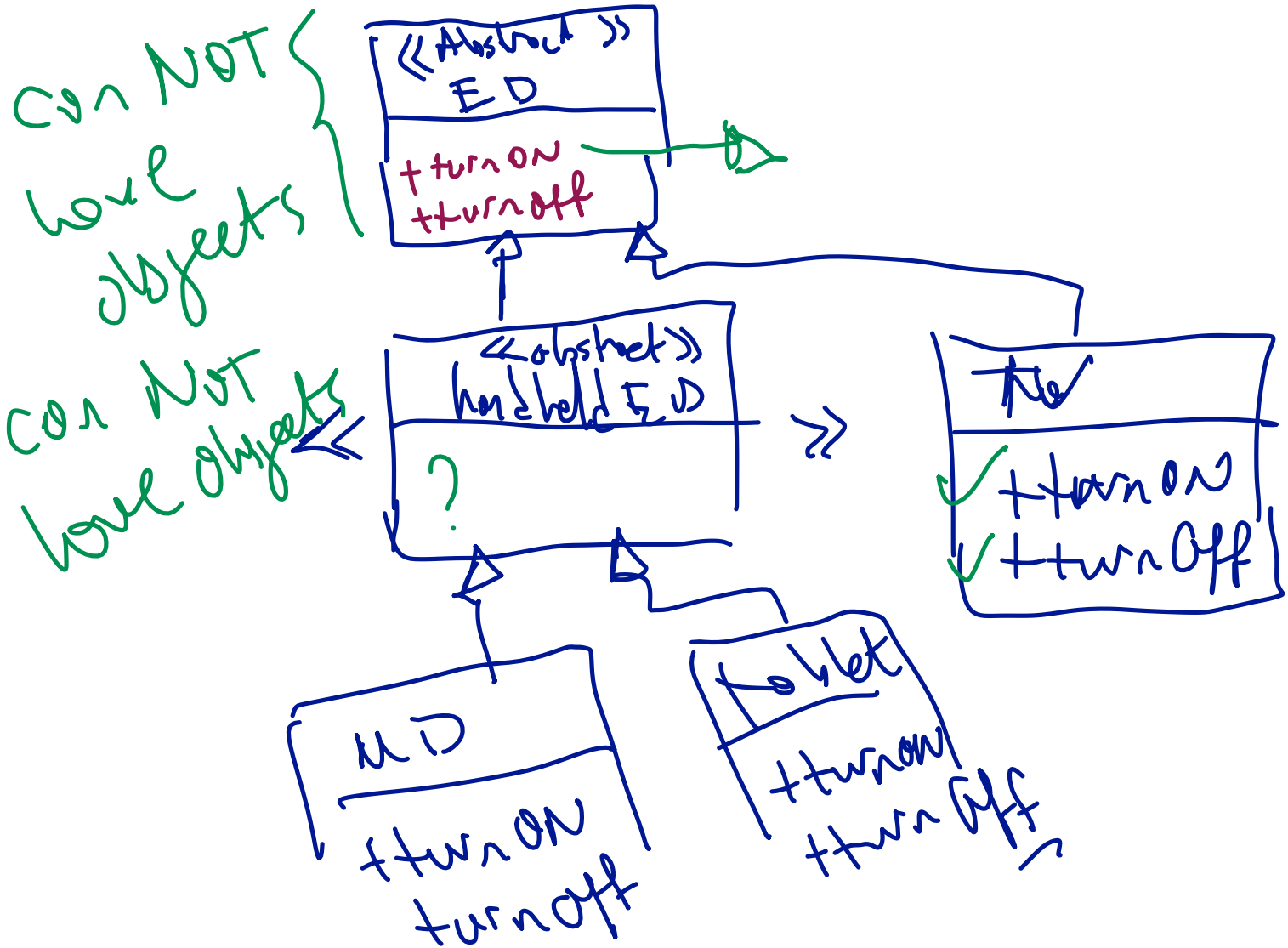
- Cannot have a method body
- Must be declared in an abstract class
- Is overridden in subclasses

Validating Abstract Classes

The following additional rules apply when you use abstract classes and methods:

- An abstract class may have any number of abstract and non-abstract methods.
- When inheriting from an abstract class, you must do either of the following:
  - Declare the child class as abstract.
  - Override all abstract methods inherited from the parent class. Failure to do so will result in a compile-time error.

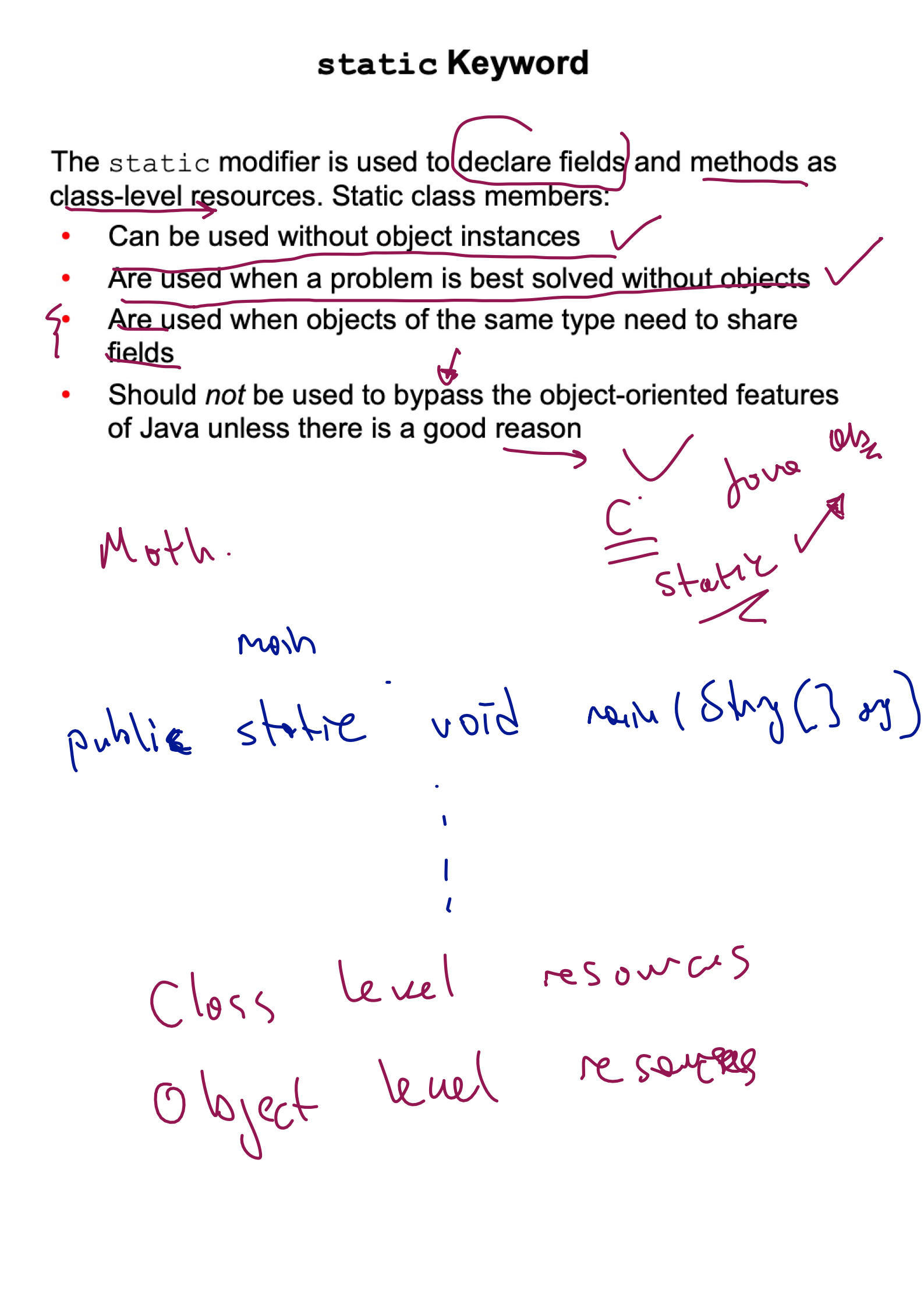
```
error: Television is not abstract and does not override
abstract method turnOn() in ElectronicDevice
```



`static` Keyword

The `static` modifier is used to declare fields and methods as class-level resources. Static class members:

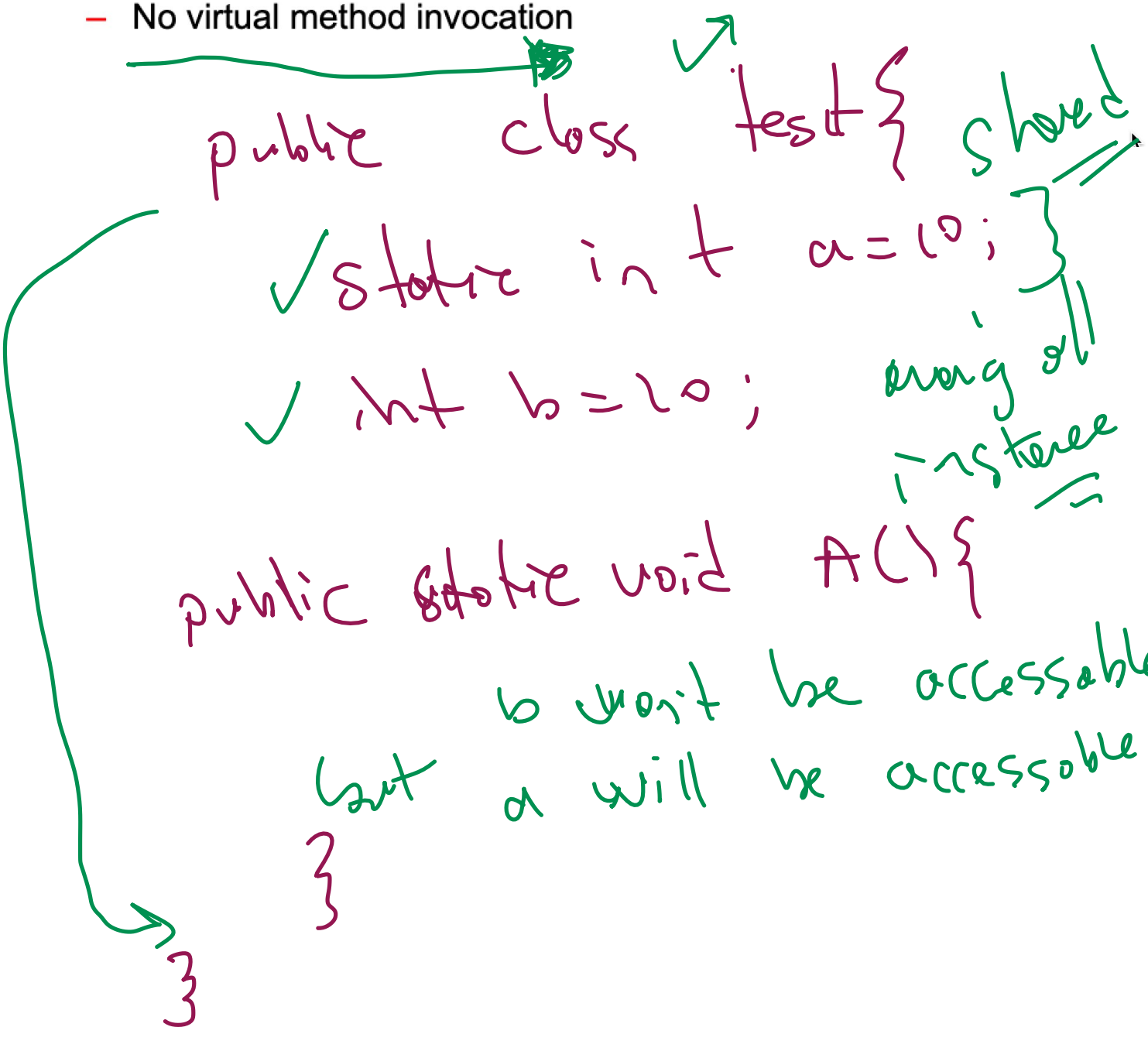
- Can be used without object instances
- Are used when a problem is best solved without objects
- Are used when objects of the same type need to share fields
- Should *not* be used to bypass the object-oriented features of Java unless there is a good reason



Static Methods

Static methods are methods that can be called even if the class they are declared in has not been instantiated. Static methods:

- Are called class methods
- Are useful for APIs that are not object oriented.
  - `java.lang.Math` contains many static methods
- Are commonly used in place of constructors to perform tasks related to object initialization
- Cannot access non-static members within the same class
- Can be hidden in subclasses but not overridden
  - No virtual method invocation



Implementing Static Methods

```
public class StaticErrorClass {
    private int x;

    public static void staticMethod() {
        x = 1; // compile error
        instanceMethod(); // compile error
    }

    public void instanceMethod() {
        x = 2;
    }
}
```

Calling Static Methods

```
double d = Math.random();
StaticUtilityClass.printMessage();
StaticUtilityClass uc = new StaticUtilityClass();
uc.printMessage(); // works but misleading
sameClassMethod();
```

When calling static methods, you should:

- Qualify the location of the method with a class name if the method is located in a different class than the caller
  - Not required for methods within the same class
- Avoid using an object reference to call a static method

Static Variables

Static variables are variables that can be accessed even if the class they are declared in has not been instantiated. Static variables are:

- Called class variables
- Limited to a single copy per JVM
- Useful for containing shared data
  - Static methods store data in static variables.
  - All object instances share a single copy of any static variables.
- Initialized when the containing class is first loaded

Before executing main methods, all class. with static fields and methods are loaded to the JVM

main(...)

↔ Math.sqrt(5)

Defining Static Variables

```
public class StaticCounter {
    private static int counter = 0;

    public StaticCounter() {
        counter++;
    }

    public static int getCount() {
        return counter;
    }
}
```

Only one copy in memory

Using Static Variables

```
double p = Math.PI;
```

```
new StaticCounter();
new StaticCounter();
System.out.println("count: " + StaticCounter.getCount());
```

When accessing static variables, you should:

- Qualify the location of the variable with a class name if the variable is located in a different class than the caller
  - Not required for variables within the same class
- Avoid using an object reference to access a static variable

Static Imports

A static import statement makes the static members of a class available under their simple name.

- Given either of the following lines:

```
import static java.lang.Math.random;
import static java.lang.Math.*;
```

- Calling the `Math.random()` method can be written as:

```
public class StaticImport {
    public static void main(String[] args) {
        double d = random();
    }
}
```

Final Methods

A method can be declared `final`. Final methods may not be overridden.

```
public class MethodParentClass {
    public final void printMessage() {
        System.out.println("This is a final method");
    }
}
```

```
public class MethodChildClass extends MethodParentClass {
    // compile-time error
    public void printMessage() {
        System.out.println("Cannot override method");
    }
}
```

final in front of
+ class = can not have subclasses
+ method = can not be overriden
+ field = constant

Final Classes

A class can be declared `final`. Final classes may not be extended.

```
public final class FinalParentClass { }
```

```
// compile-time error
public class ChildClass extends FinalParentClass { }
```

Final Variables

The `final` modifier can be applied to variables. Final variables may not change their values after they are initialized. Final variables can be:

- Class fields
  - Final fields with compile-time constant expressions are constant variables.
  - Static can be combined with final to create an always-available, never-changing variable.
- Method parameters
- Local variables

Note: Final references must always reference the same object, but the contents of that object may be modified.

Declaring Final Variables

```
public class VariableExampleClass {
    private final int field;
    private final int forgottenField;
    private final Date date = new Date();
    public static final int JAVA_CONSTANT = 10;

    public VariableExampleClass() {
        field = 100;
        // compile-time error - forgottenField
        // not initialized
    }

    public void changeValues(final int param) {
        param = 1; // compile-time error
        date.setTime(0); // allowed
        date = new Date(); // compile-time error
        final int localVar;
        localVar = 42;
        localVar = 43; // compile-time error
    }
}
```

When to Avoid Constants

`public static final` variables can be very useful, but there is a particular usage pattern you should avoid. Constants may provide a false sense of input validation or value range checking.

- Consider a method that should receive only one of three possible values:

```
Computer comp = new Computer();
comp.setState(Computer.POWER_SUSPEND);
```

This is an `int` constant that equals `2`.

- The following lines of code still compile:

```
Computer comp = new Computer();
comp.setState(42);
```

Typesafe Enumerations

Java 5 added a typesafe enum to the language. Enums:

- Are created using a variation of a Java class
- Provide a compile time range check

```
public enum PowerState {
    OFF,
    ON,
    SUSPEND;
}
```

These are references to the only three `PowerState` objects that can exist.

An enum can be used in the following way:

```
Computer comp = new Computer();
comp.setState(PowerState.SUSPEND);
```

This method takes a `PowerState` reference .

Enum Usage

Enum references can be statically imported.

```
import static com.example.PowerState.*;

public class Computer extends ElectronicDevice {
    private PowerState powerState = OFF;
    //...
}
```

`PowerState.OFF`

Enums can be used as the expression in a switch statement.

```
public void setState(PowerState state) {
    switch(state) {
        case OFF:
        //...
    }
}
```

Complex Enums

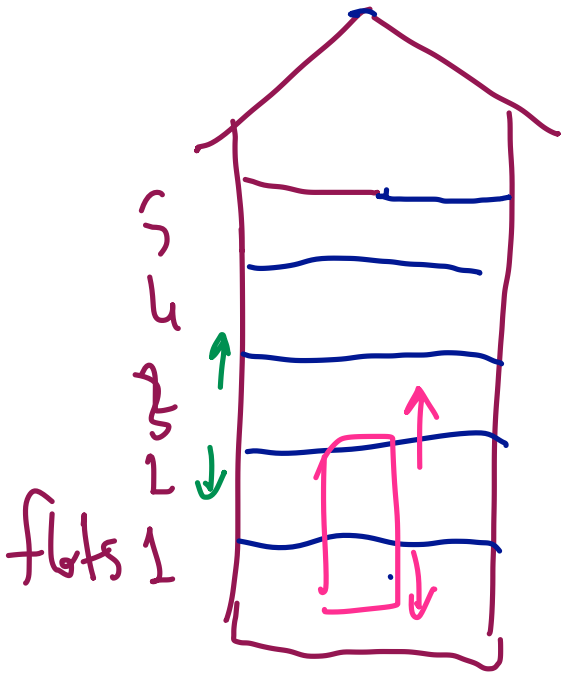
Enums can have fields, methods, and private constructors.

```
public enum PowerState {
    OFF("The power is off"),
    ON("The usage power is high"),
    SUSPEND("The power usage is low");

    private String description;
    private PowerState(String d) {
        description = d;
    }
    public String getDescription() {
        return description;
    }
}
```

Call a `PowerState` constructor to initialize the `public static final OFF` reference.

The constructor may not be `public` or `protected`.



⊕ Simulate an elevator

has capacity of number

~~Apartment~~

⊕ Max flat number

⊕ min flat number

⊕ Apartment has. elevator(s)

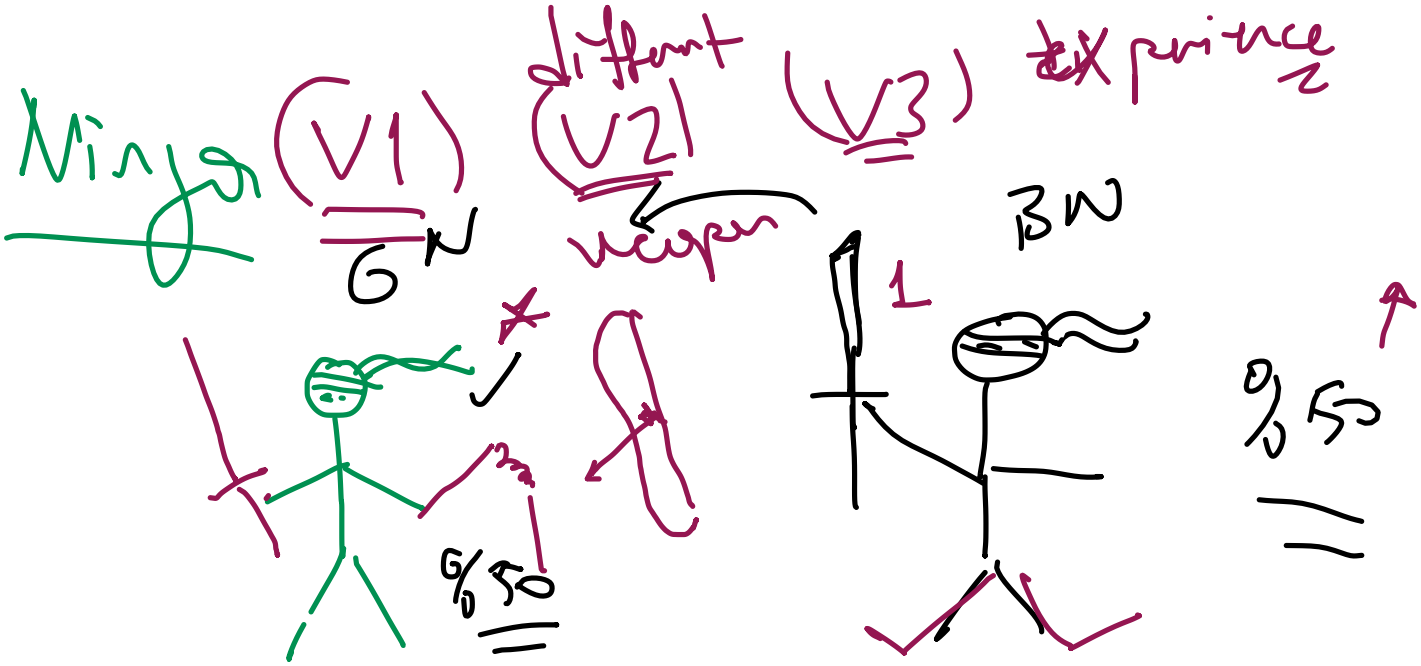
⊕ Elevator When it is moving It becomes busy

⊕ Elevator keep track of the flat they are in.

⊕ Elevator can move up or down

⊕ Elevator keeps track of ± of passenger

Ninja (V1) different (V2) experience (V3)



* Every ninja has an attact point starts 1
* Every ninja has an heath point starts 10
* Every ninja can attack %50
* Every ninja can defend %50 (block the successful attack)
* Each successfull attack if not not blocked will decrease health point of defender as attack points of attacker

(A) Ninja can either attack or defend at a time.

(A) → They are attacking and defending in order

→ Roll a dice with 100 face for each ninja

bigger value of dice will attack the other will defend

If they have same dice rolled they roll again.