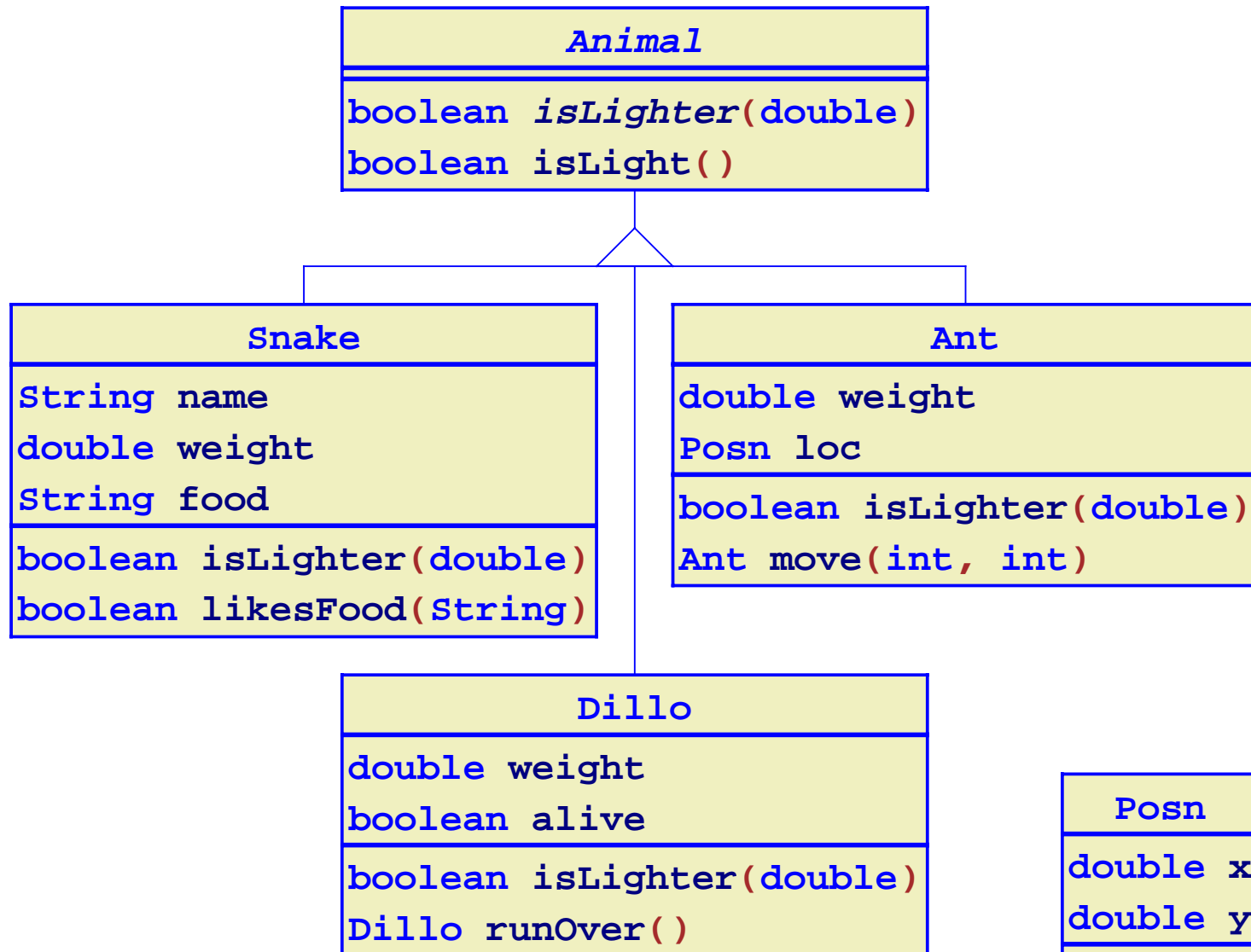


➤ **Class Diagrams**

- **Nesting Variants to Refine Contracts**
- **Common Functionality in Abstract Classes**
- **Nesting without Abstract**

Animal Classes

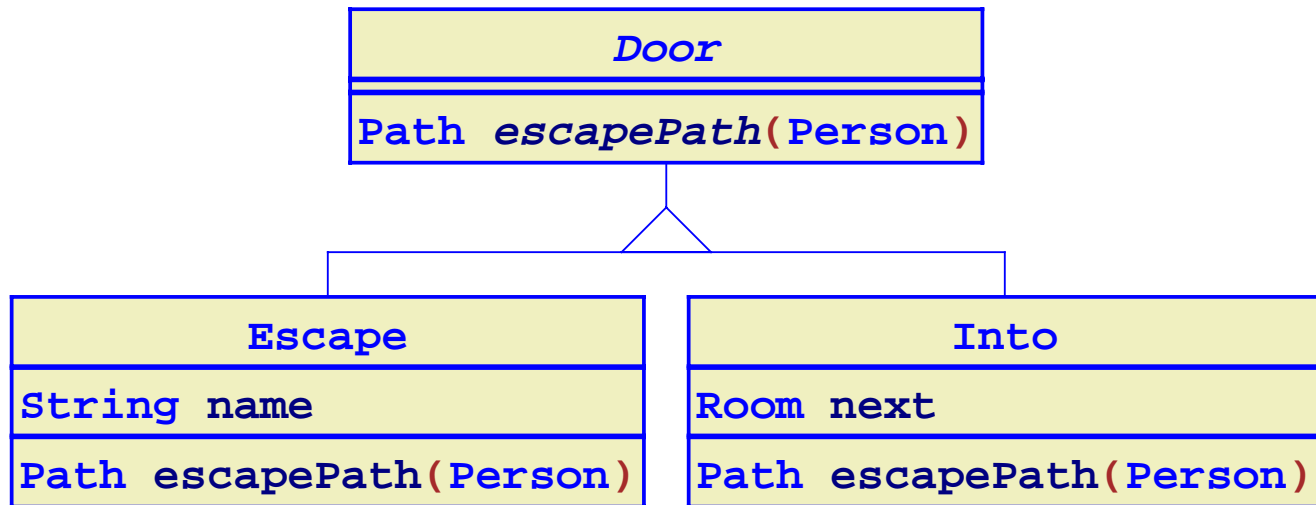


Some Maze Classes

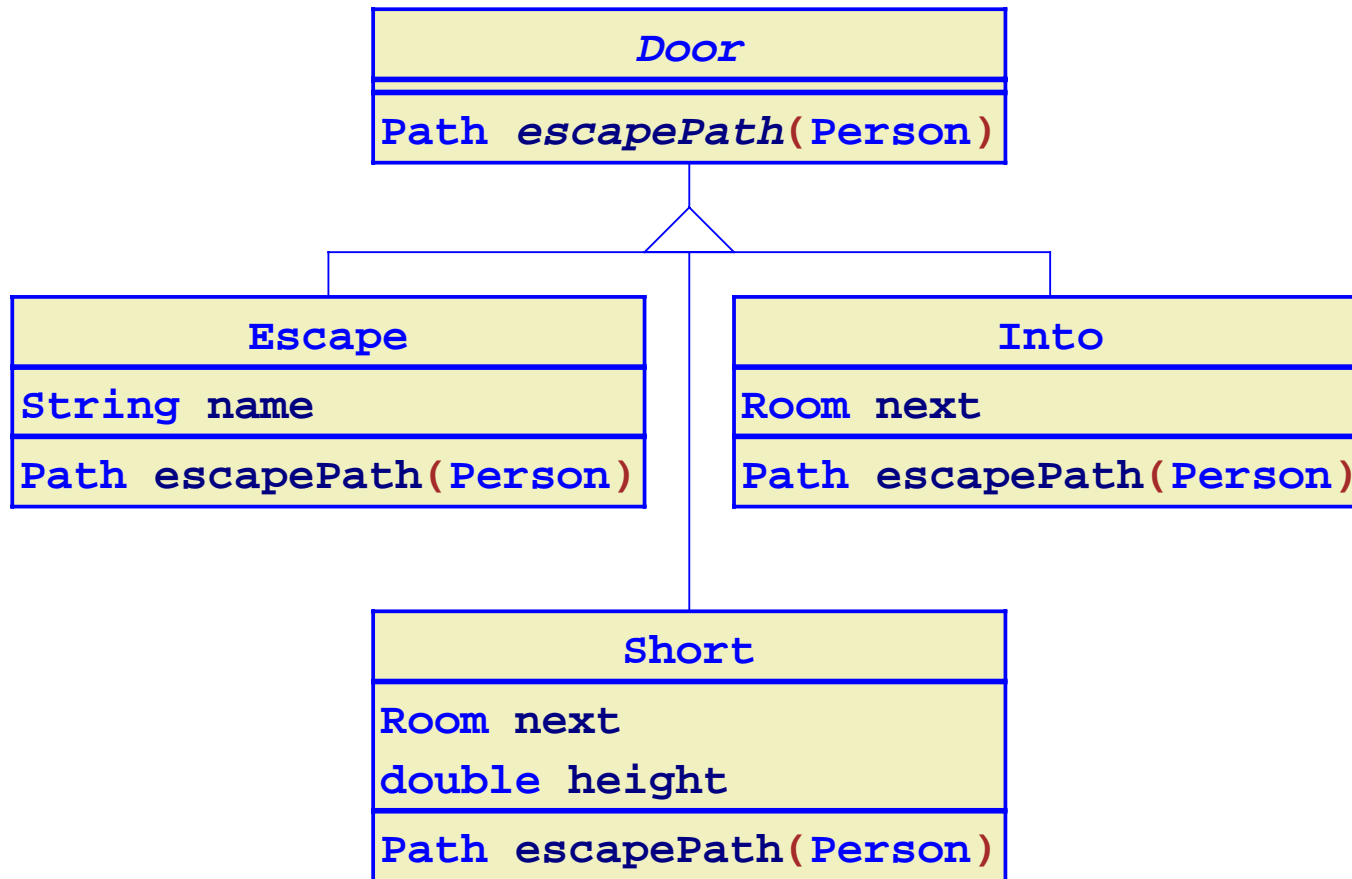
Room
Door left
Door right
Path escapePath(Person)

Person
String dest
double height
boolean isDest(String)
boolean isShorter(double)

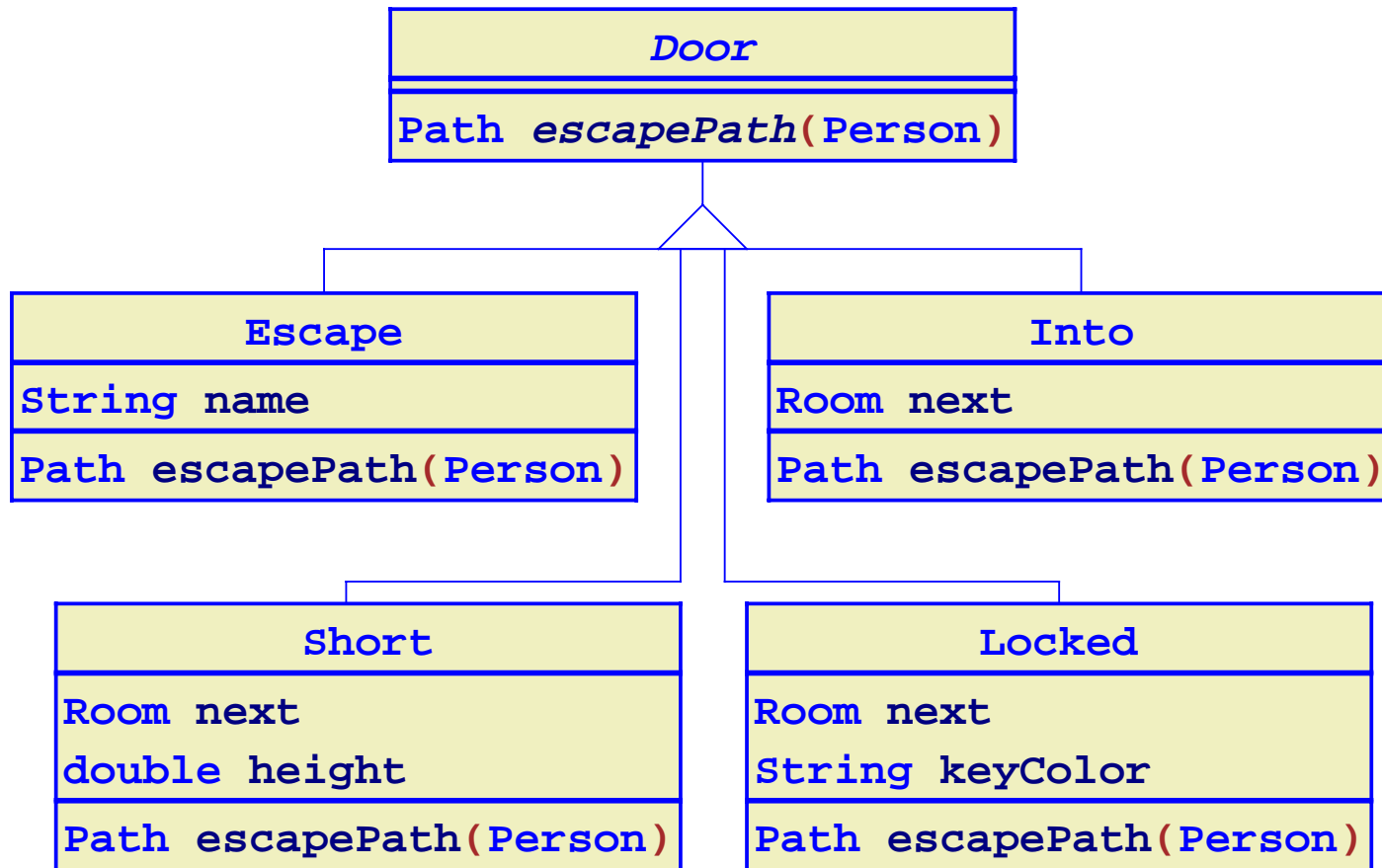
Door Classes



Door Classes

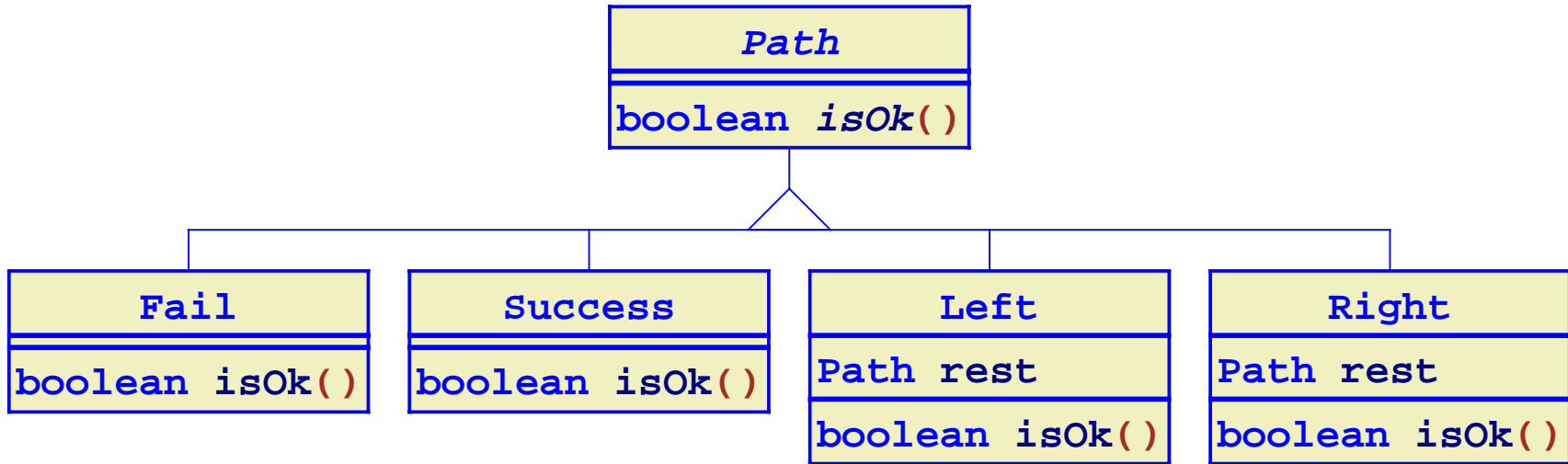


Door Classes

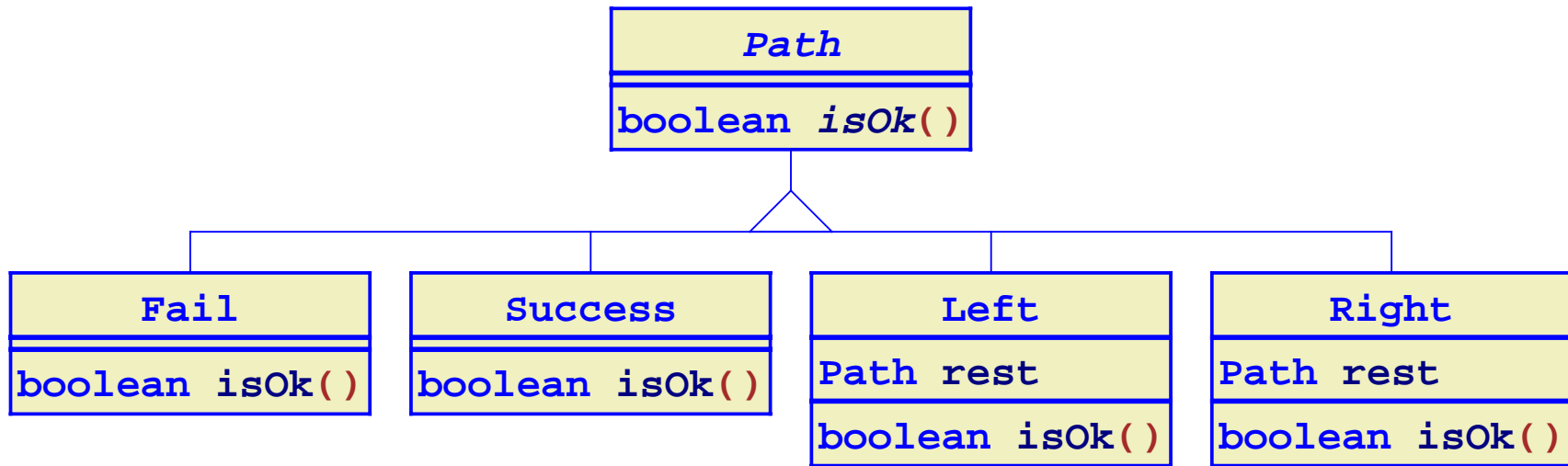


- **Class Diagrams**
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Path Classes



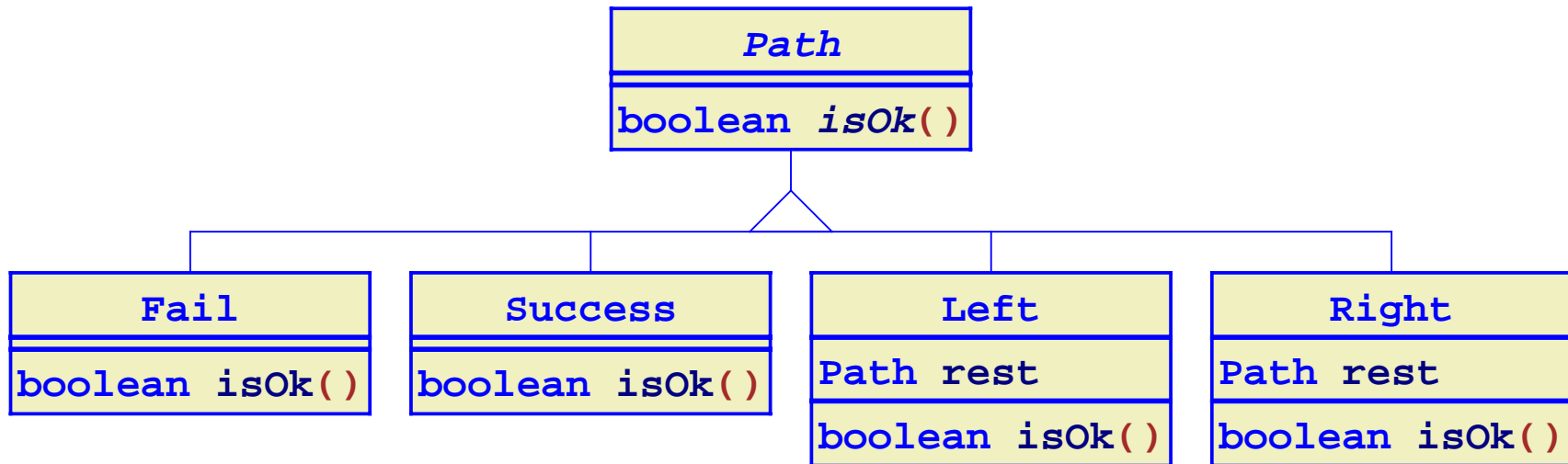
Path Classes



No escape:

```
new Fail()
```

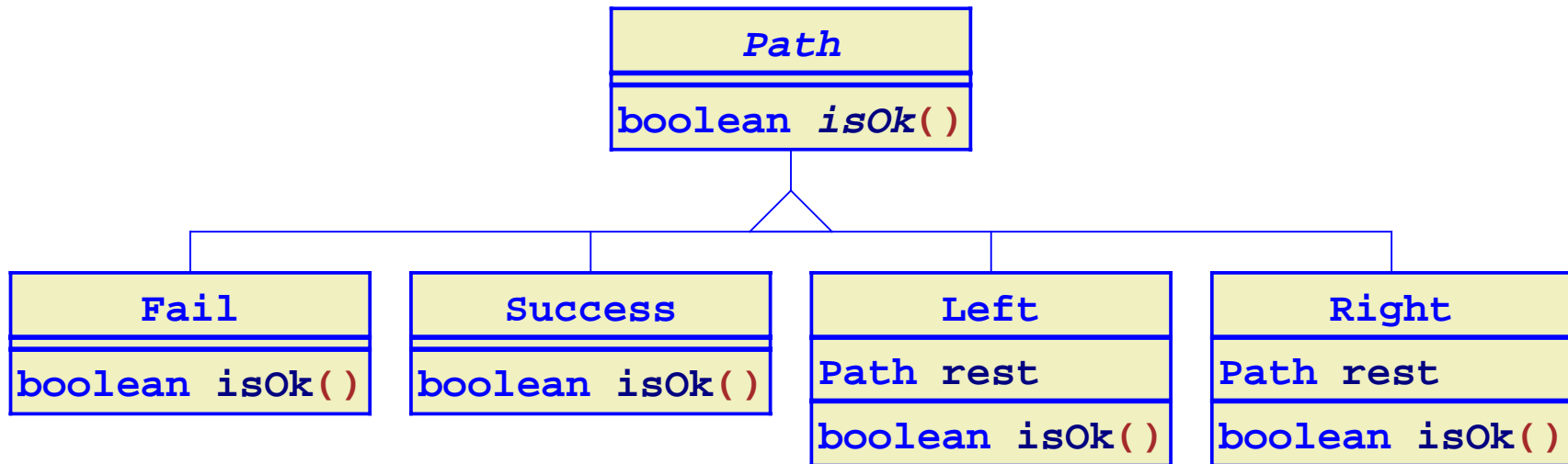
Path Classes



Door is an immediate escape:

```
new Success()
```

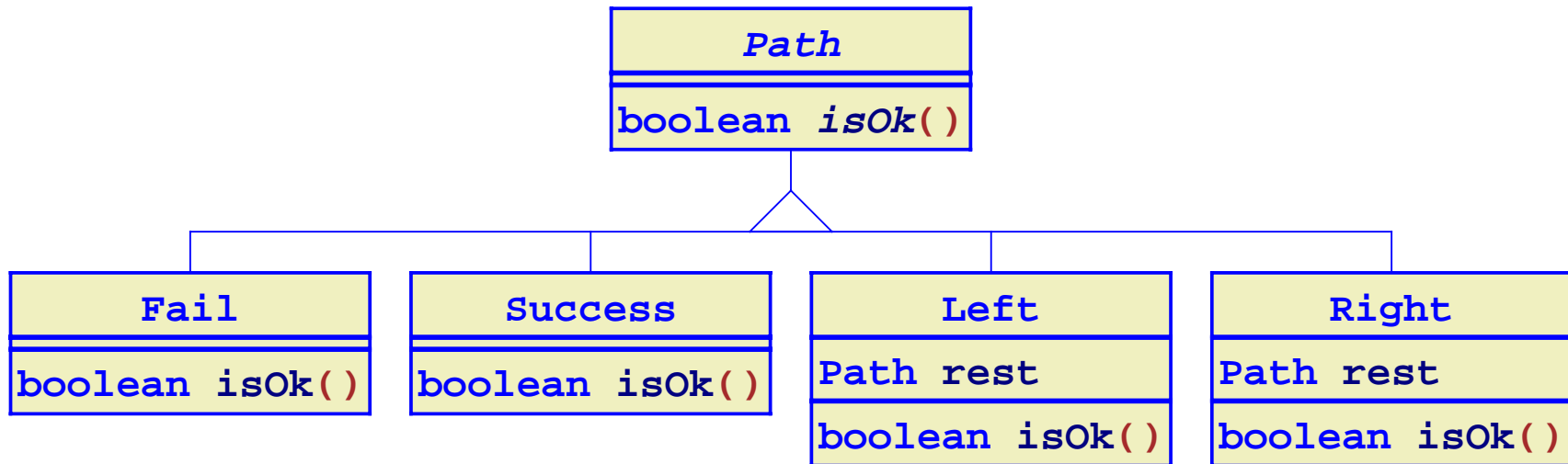
Path Classes



Turn left, then right, then you're there:

```
new Left(new Right(new Success()))
```

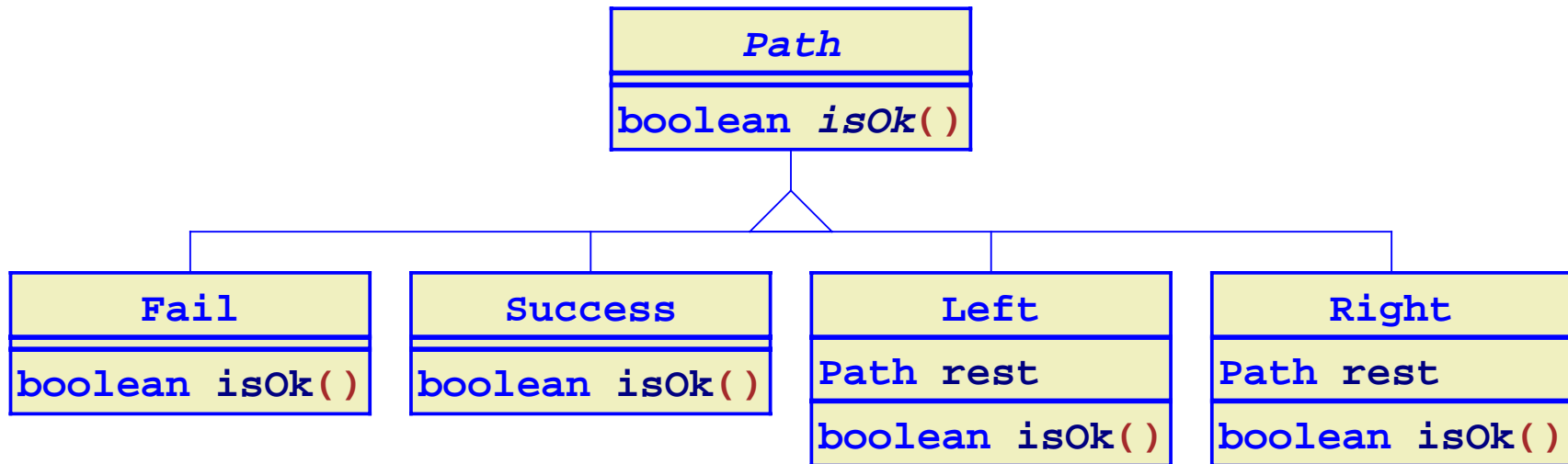
Path Classes



What's this?

```
new Left(new Right(new Fail()))
```

Path Classes



What's this?

```
new Left(new Right(new Fail()))
```

We'd prefer to ensure that `Left` and `Right` to extend only successful paths

Paths Reconsidered

Our current definition:

- A path is either
 - failure
 - immediate success
 - left followed by a path
 - right followed by a path

Paths Reconsidered

Our current definition:

- A path is either
 - failure
 - immediate success
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A better definition:

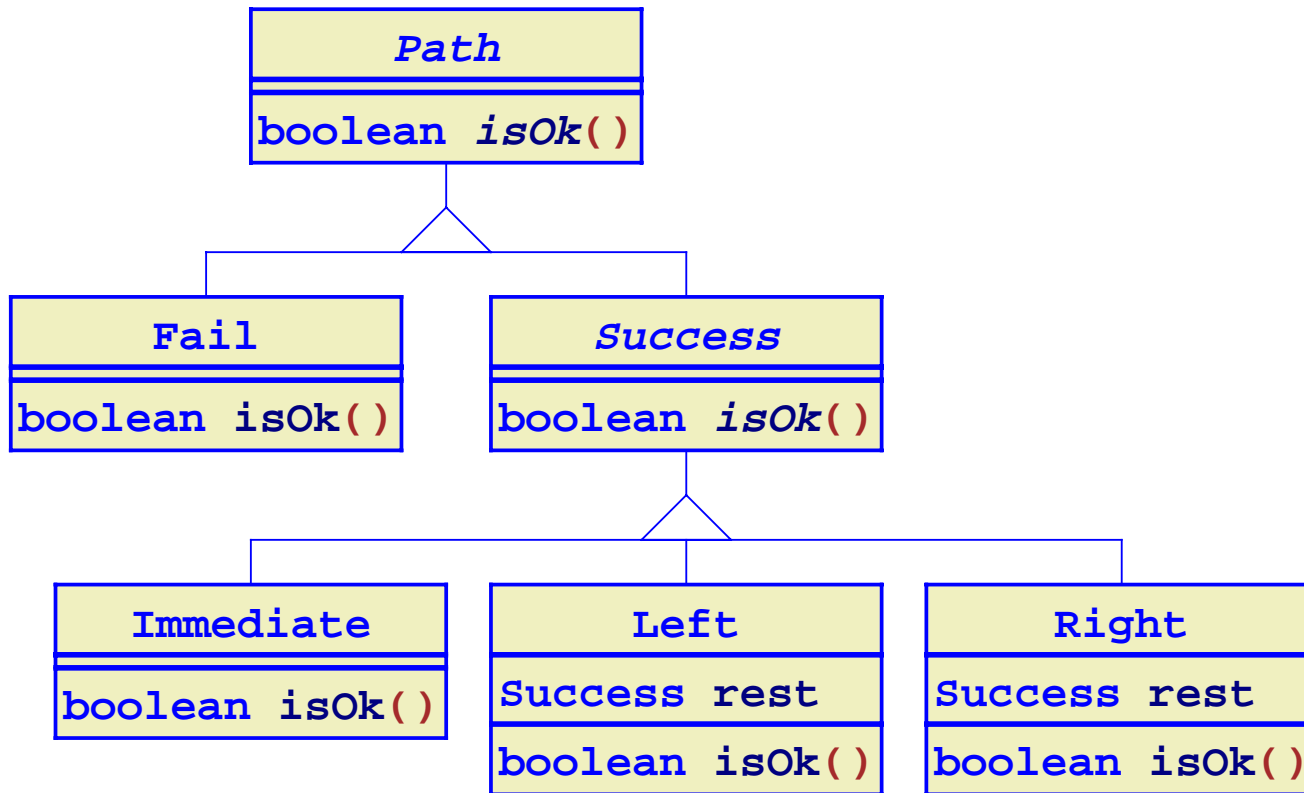
- A path is either
 - failure
 - success
- A success is either
 - immediate
 - left followed by success
 - right followed by success

Nested Variants

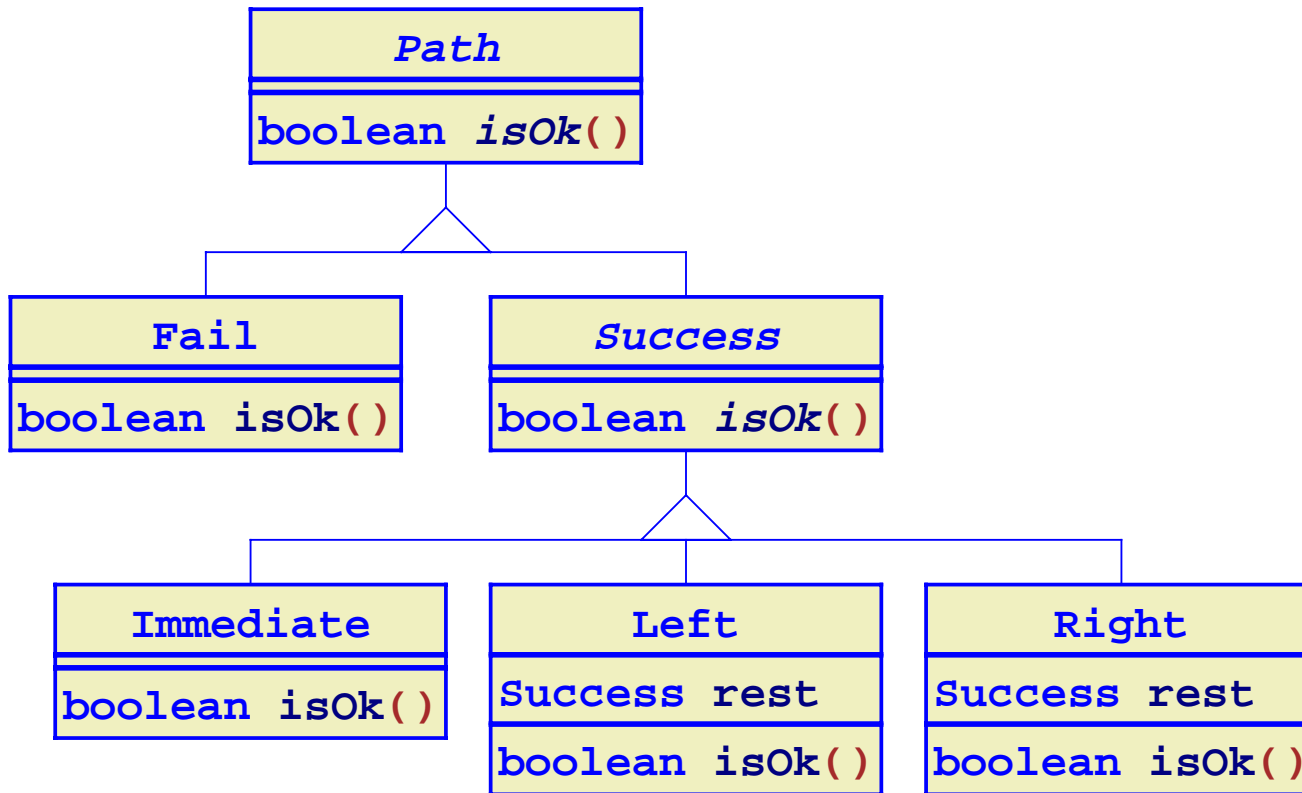
- A path is either
 - failure
 - success
- A success is either
 - immediate
 - left followed by success
 - right followed by success

To translate this into Java, a variant of the abstract class `Path` must itself be an abstract class with variants

Revised Path Classes

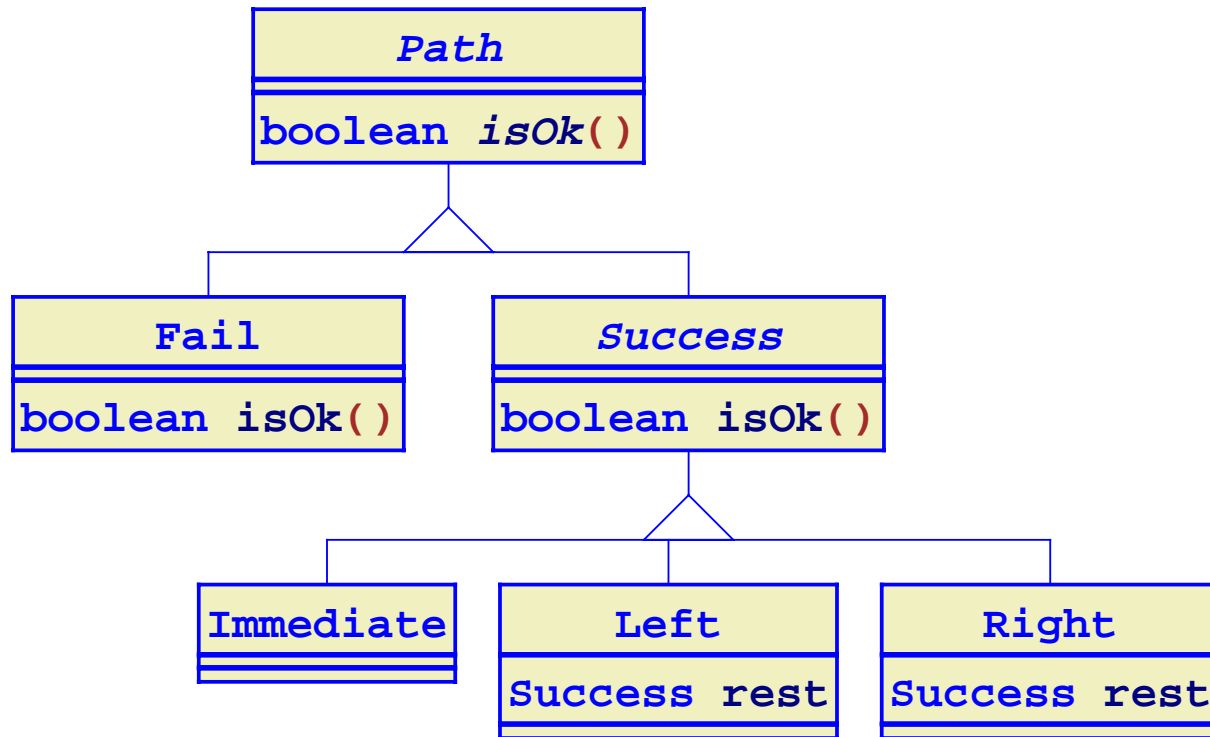


Revised Path Classes



For the **Success** classes, the `isOk` method always returns **true**, so we can simplify...

Revised Path Classes



Revised Path Class Code

```
abstract class Path {
    abstract boolean isOk();
}

class Fail extends Path {
    Fail() { }
    boolean isOk() { return false; }
}

abstract class Success extends Path {
    boolean isOk() { return true; }
}

class Immediate extends Success {
    Immediate() { }
}

class Right extends Success {
    Success rest;
    Right(Success rest) { this.rest = rest; }
}

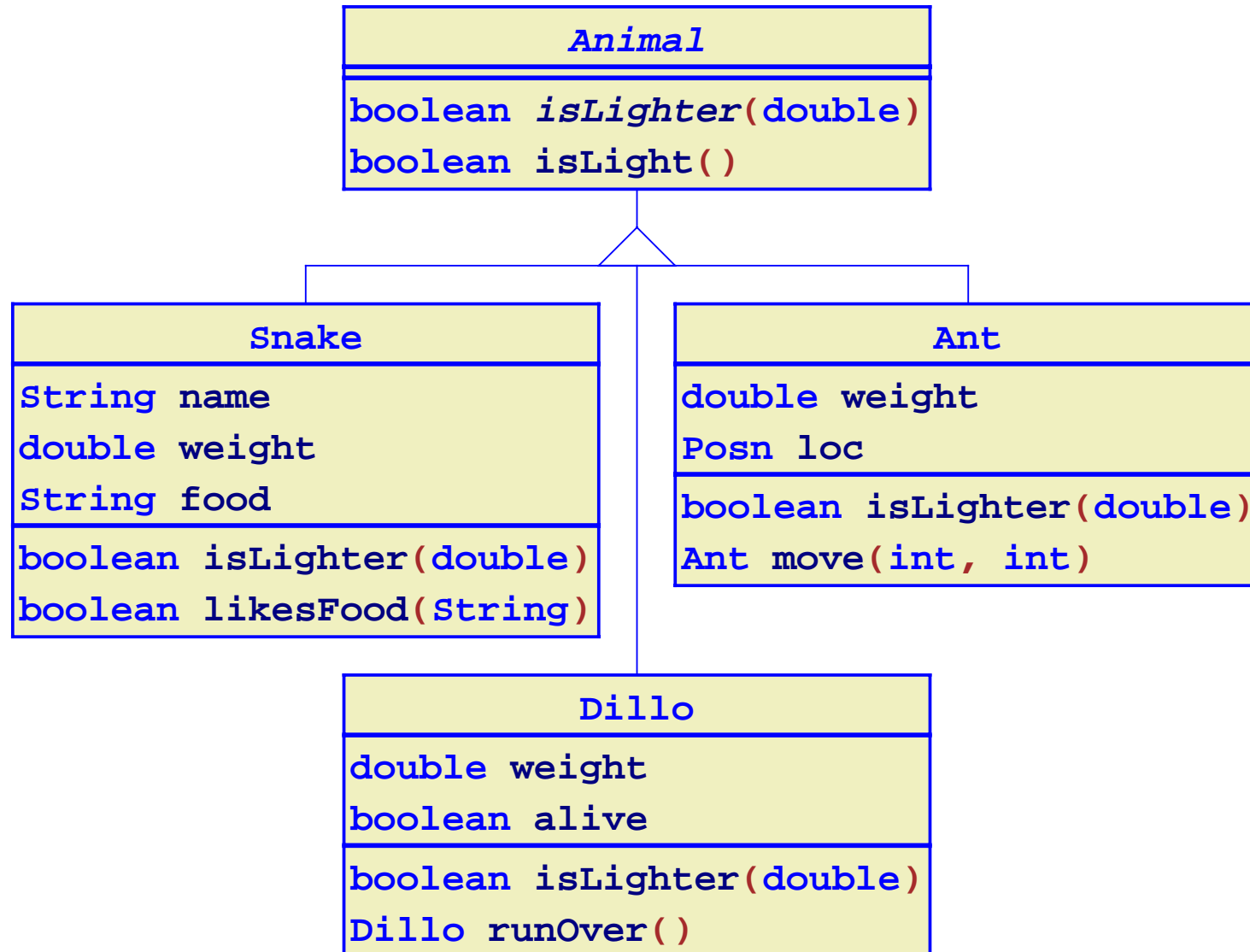
class Left extends Success {
    Success rest;
    Left(Success rest) { this.rest = rest; }
}
```

[Copy](#)

- **Class Diagrams**
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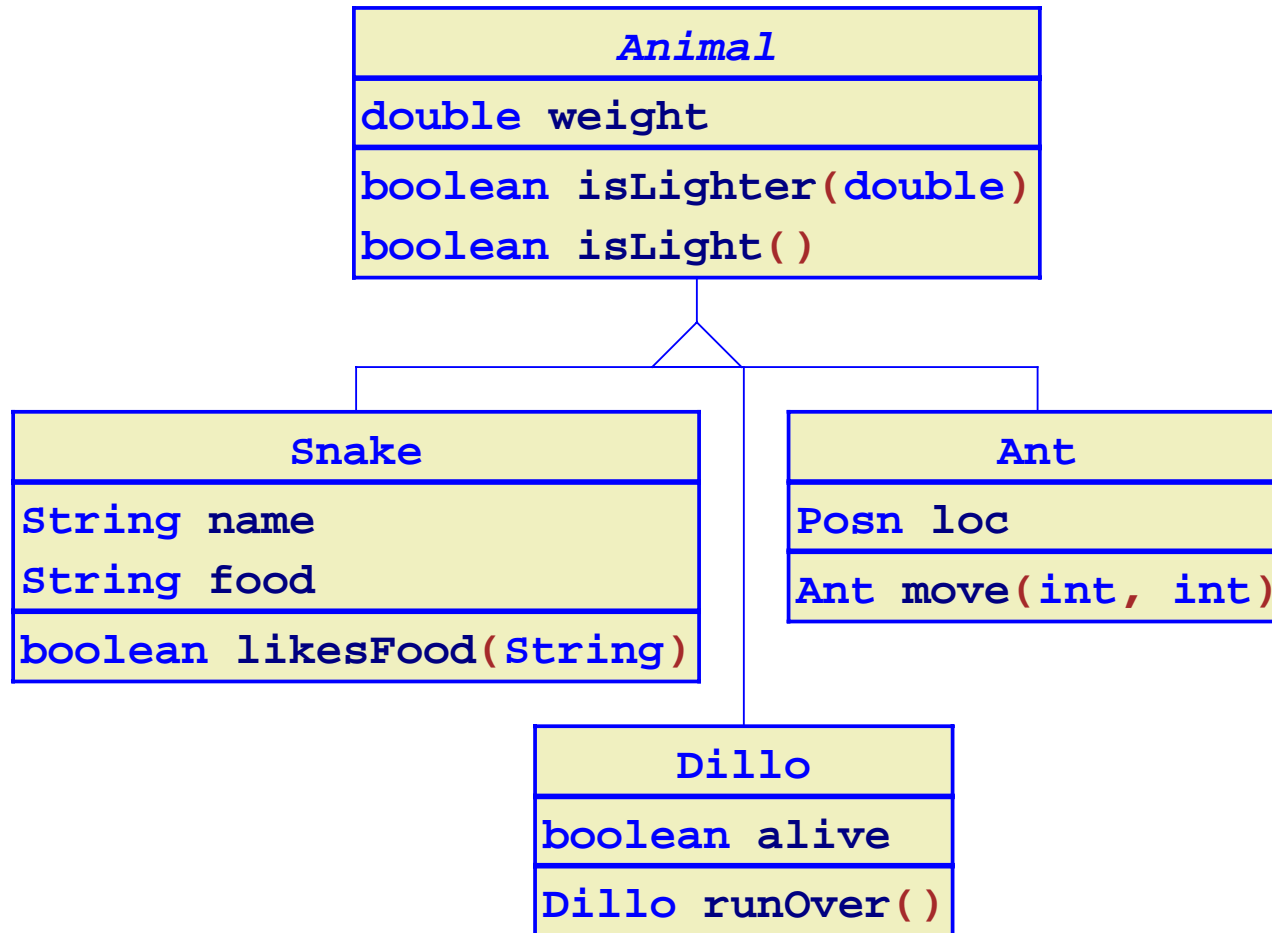
Common Animal Behavior

All animals have a **weight** field:



Common Animal Behavior

We can move the common field into the **Animal** class:



Fields in Abstract Classes

An abstract class with a field needs a constructor:

```
abstract class Animal {
    double weight;
    Animal(double weight) {
        this.weight = weight;
    }
    boolean isLighter(int n) {
        return this.weight < n;
    }
    boolean isLight() {
        return this.isLighter(10);
    }
}
```

[Copy](#)

Classes that extend a Class with Fields

Extensions of `Animal` must now supply the `super` class with its field:

```
class Snake extends Animal {
    String name;
    String food;
    Snake(String name, double weight, String food) {
        super(weight);
        this.name = name;
        this.food = food;
    }
    boolean likesFood(String s) {
        return this.food.equals(s);
    }
}
```

[Copy](#)

Classes that extend a Class with Fields

Extensions of `Animal` must now supply the `super` class with its field:

```
class Snake extends Animal {  
    String name;  
    String food;  
    Snake(String name, double weight, String food) {  
        super(weight);  
        this.name = name;  
        this.f  
    }  
    boolean  
    return  
}  
}
```

The `super` keyword in a constructor calls the extended class's constructor

[Copy](#)

Classes that extend a Class with Fields

Extensions of `Animal` must now supply the `super` class with its field:

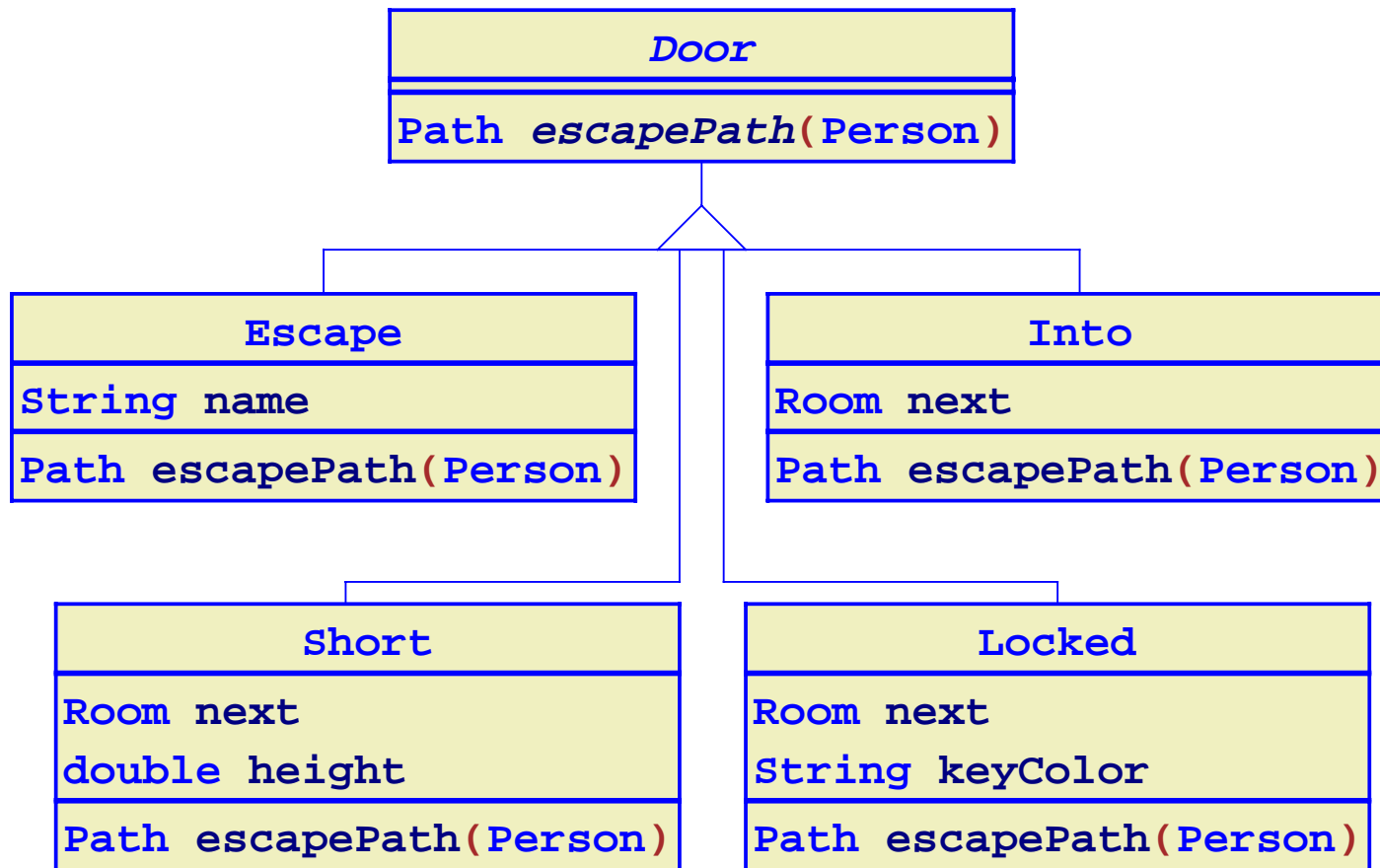
```
class Snake extends Animal {  
    String name;  
    String food;  
    Snake(String name, double weight, String food) {  
        super(weight);  
        this.name = name;  
        this.f  
    }  
    boolean  
    return  
}
```

A `super` call must appear before the others statements

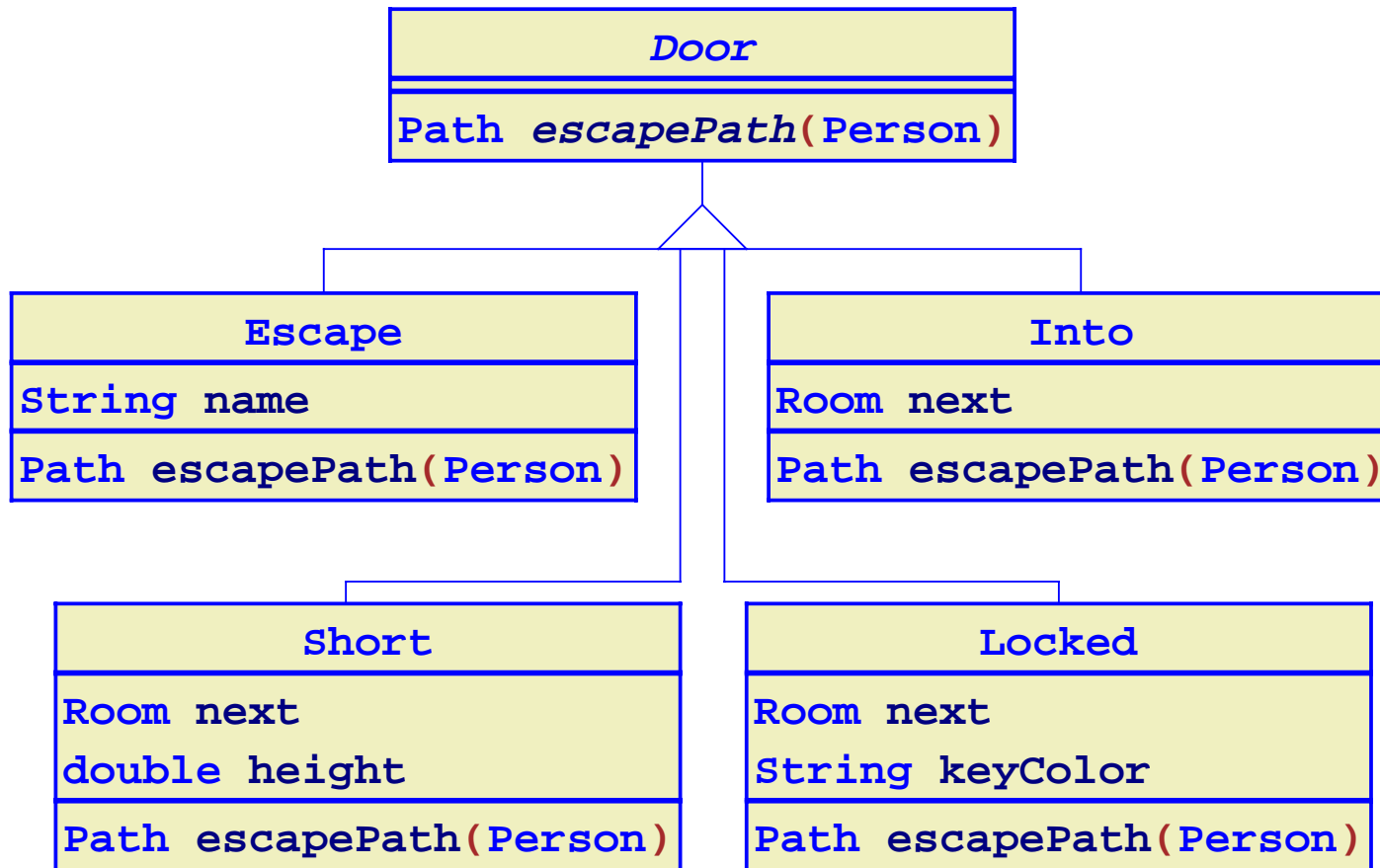
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More Common Features

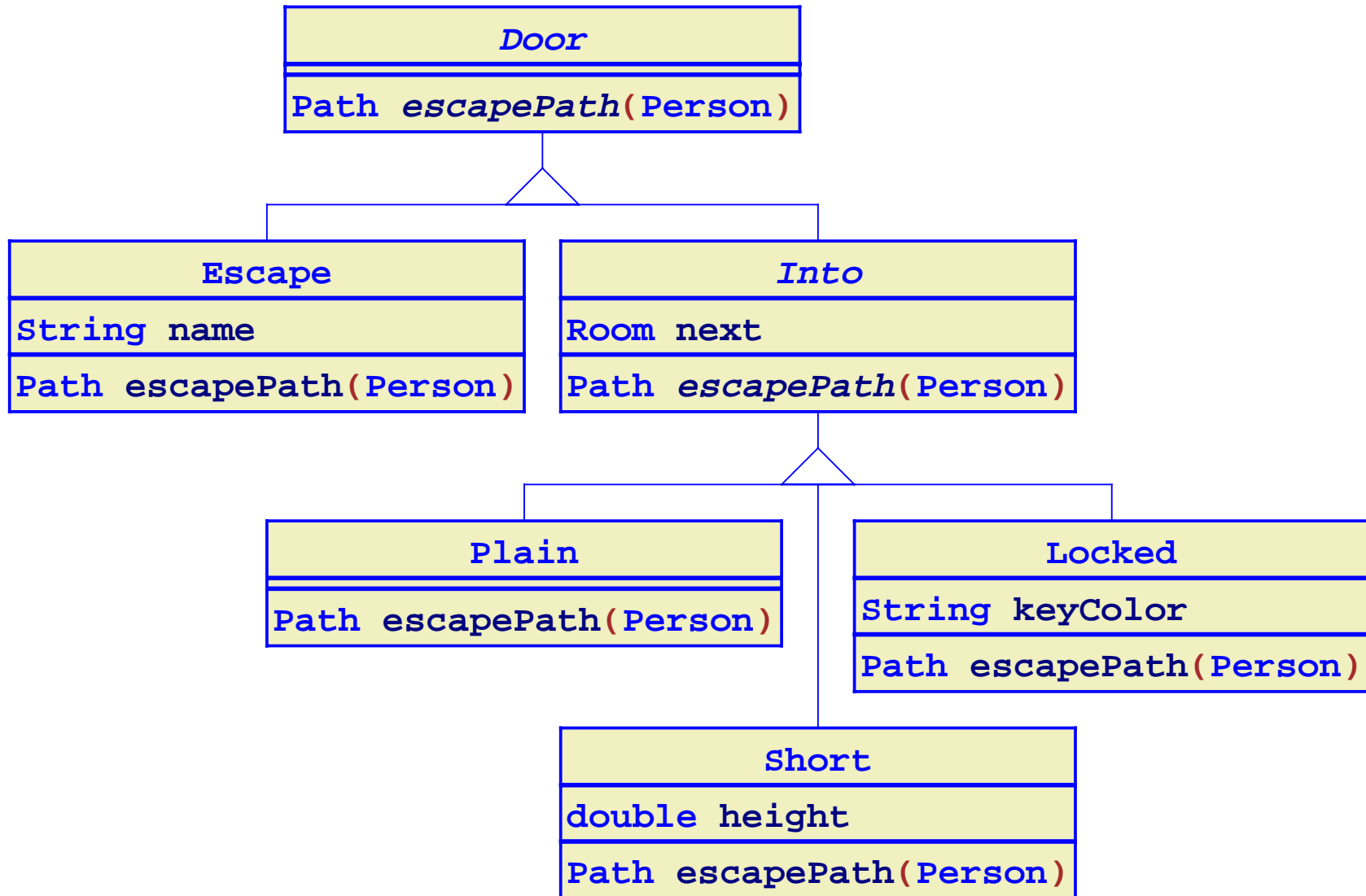


More Common Features

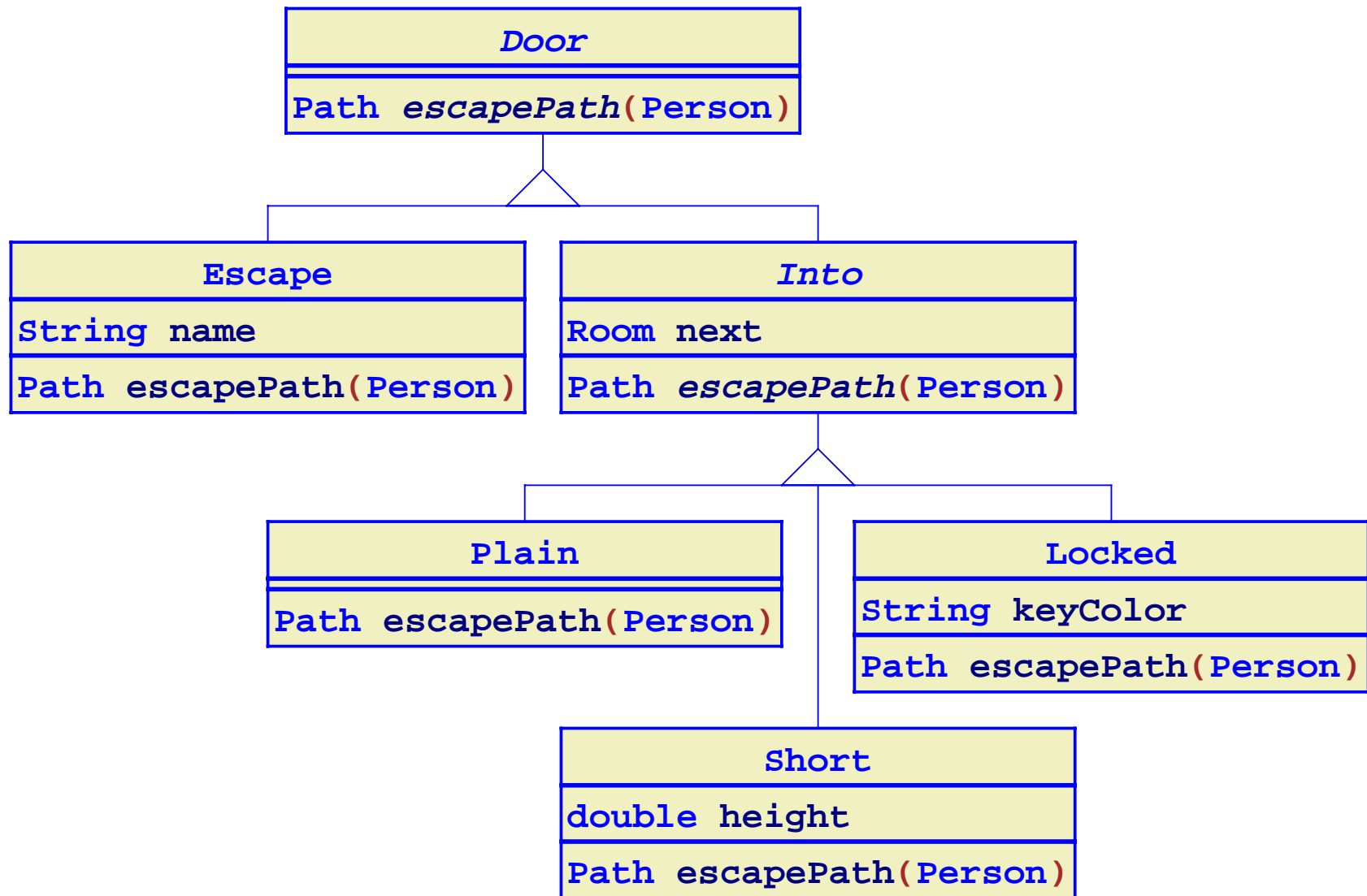


Most new kinds of door will have a **next** field, like **Into**

Doors



Doors



The `escapePath` method isn't always the same, but the `this.next.escapePath(p)` part is always the same...

Method Parts in Abstract Classes

```
abstract class Into extends Door {  
    Room next;  
    Into(Room next) {  
        this.next = next;  
    }  
    Path escapePath(Person p) {  
        return this.next.escapePath(p);  
    }  
}
```

[Copy](#)

Note that `escapePath` is not abstract

Chaining to a Super Method

```
class Short extends Into {
    double height;
    Short(Room next, double height) {
        super(next);
        this.height = height;
    }
    Path escapePath(Person p) {
        if (p.height <= this.height)
            return super.escapePath(p);
        else
            return new Fail();
    }
}
```

[Copy](#)

Chaining to a Super Method

```
class Short extends Into {
    double height;
    Short(Room next, double height) {
        super(next);
        this.height = height;
    }
    Path escapePath(Person p) {
        if (p.height <= this.height)
            return super.escapePath(p);
        else
            return new Fail();
    }
}
```

[Copy](#)

The `escapePath` in `Short` *overrides* the method in `Into`

Chaining to a Super Method

```
class Short extends Into {  
    double height;  
    Short(Room next, double height) {
```

Using the `super` keyword in `super.escapePath` means to call the extended class's method

```
        if (p.height < this.height)  
            return super.escapePath(p);  
        else  
            return new Fail();  
    }  
}
```

[Copy](#)

The `escapePath` in `Short` *overrides* the method in `Into`

Chaining to a Super Method

```
class Short extends Into {
    double height;
    Short(Room next, double height) {
        super(next);
        this.height = height;
    }
    Path escapePath(Person p) {
        if (p.height <= this.height)
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        else
            return new Fail();
    }
}
```

[Copy](#)

The `escapePath` in `Short` *overrides* the method in `Into`

Plain Door

```
class Plain extends Into {  
    Plain(Room next) {  
        super(next);  
    }  
    Path escapePath(Person p) {  
        return super.escapePath(p);  
    }  
}
```

Plain Door

```
class Plain extends Into {  
    Plain(Room next) {  
        super(next);  
    }  
    Path escapePath(Person p) {  
        return super.escapePath(p);  
    }  
}
```

The overriding `escapePath` merely chains to `super`, so it isn't needed

Plain Door

```
class Plain extends Into {  
    Plain(Room next) {  
        super(next);  
    }  
}
```

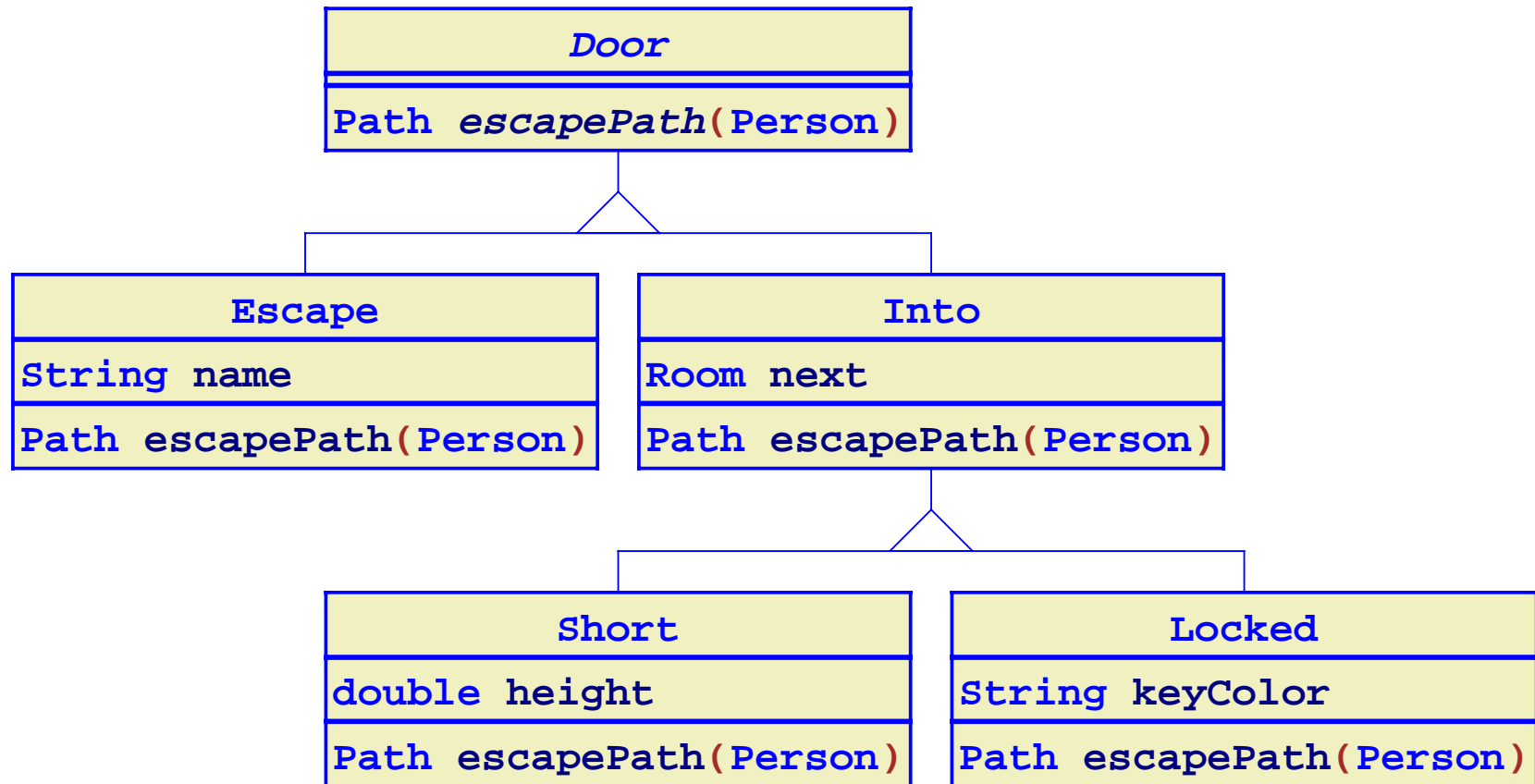
The overriding `escapePath` merely chains to `super`, so it isn't needed

Plain Door

```
class Plain extends Into {  
    Plain(Room next) {  
        super(next);  
    }  
}
```

The overriding `escapePath` merely chains to `super`, so it isn't needed
In fact, we can do away with the `Plain` class completely, and just make `Into` non-abstract

Doors Revised



Summary

- An **abstract class** can extend an **abstract class**
- An **abstract class** can declare fields
- A **class** can extend a **class**
- Use **super(...)** when the extended class has a constructor
- Use **super.method(...)** to chain to an overridden method