Optional

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ITERATR LEARNING

Outline of module

1. The problem with null
2. How Optional improves upon null
3. How to use Optional in your code
4. Data Modelling Approaches
5. Practical: refactoring to remove nulls

The problem with null

NullPointerException

Raise your hand if you’ve come across this before:

Exception in thread "main" `java.lang.NullPointerException`

Person/Car/Insurance data model

```
public class Person {
    private Car car;
    public Car getCar() { return car; }
}

public class Car {
    private Insurance insurance;
    public Insurance getInsurance() { return insurance; }
}

public class Insurance {
    private String name;
    public String getName() { return name; }
}
```

Car Insurance Name

What's possibly problematic with the following code?

```
public String getCarInsuranceName(Person person) {
    return person.getCar().getInsurance().getName();
}
```

Defensive checking (1)

```
public String getCarInsuranceName(Person person) {
  if (person != null) {
    Car car = person.getCar();
    if (car != null) {
      Insurance insurance = car.getInsurance();
        if (insurance != null) {
          return insurance.getName();
        }
      }
    }
  return "Unknown";
}
```

Defensive checking (2)

```
public String getCarInsuranceName(Person person) {
    if (person == null) {
        return "Unknown";
    }
    Car car = person.getCar();
    if (car == null) {
        return "Unknown";
    }
    Insurance insurance = car.getInsurance();
    if (insurance == null) {
        return "Unknown";
    }
    return insurance.getName();
}
```

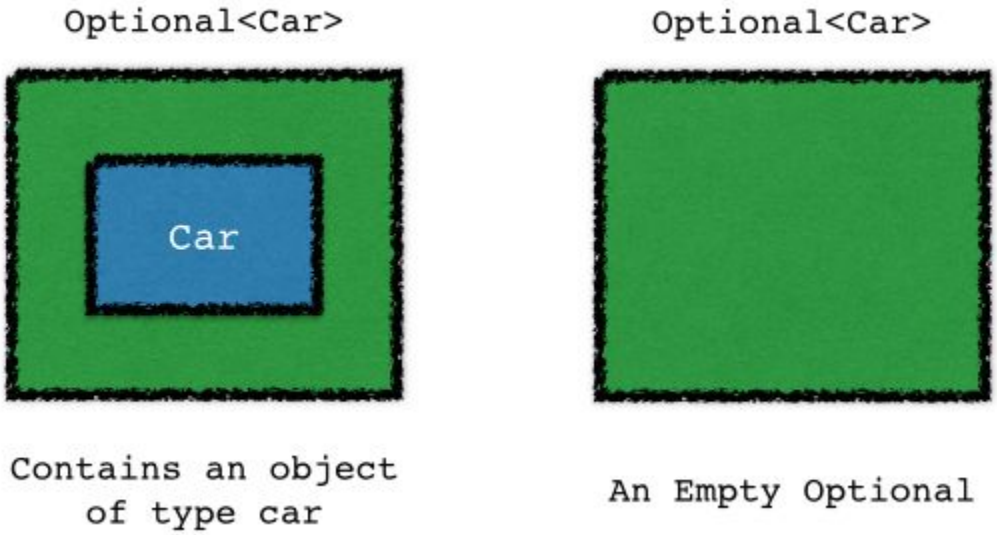
Problems with null

1. Error-prone checking
2. Verbose checking
3. No useful semantic meaning

How Optional improves upon null

Optional in a nutshell

- Java 8 introduces a new class **java.util.Optional<T>**
- Optional encapsulates an optional value
- You can view Optional as a single-value container that either contains a value or doesn't



Updating our model

```
public class Person {
  private Optional<Car> car;
  public Optional<Car> getCar() { return car; }
}

public class Car {
  private Optional<Insurance> insurance;
  public Optional<Insurance> getInsurance() {
    return insurance;
  }
}

public class Insurance {
  private String name;
  public String getName() { return name; }
}
```

Benefits

- More comprehensible model where it’s immediately understandable whether to expect an optional value
  - better maintainability

- You need to actively unwrap an Optional to deal with the absence of a value
  - fewer errors

How to use Optional in your code

Creating Optional objects

```
Optional<Car> optCar = Optional.empty();

Optional<Car> optCar = Optional.of(car);

Optional<Car> optCar = Optional.ofNullable(car);
```

Do something if a value is present (1)

Before

```
if(insurance != null) {
  System.out.println(insurance.getName());
}
```

After

```
Optional<Insurance> optInsurance = car.getInsurance();

optInsurance.ifPresent(insurance ->
      System.out.println(insurance.getName()));
```

Do something if a value is present (2)

```
if(optInsurance.isPresent()) {
  System.out.println(optInsurance.get());
}
```

- **get** throws a NoSuchElementException if no value contained in the Optional object (null doesn't propagate)

- Combining **isPresent** and **get** is not recommended
  - nested checks
  - have to work with exceptions to handle default values/actions

- We explore more idiomatic alternatives using map and flatMap soon

Default values or actions

```
Stream<Player> players = Stream.of(ronaldo, messi,
    rooney);
Optional<Player> optFirstPenalty =
     players.filter(p -> p.getConfidence() > 90)
            .findAny();
```

Default value

```
Player p = optFirstPenalty.orElse(terry);
```

Default action

```
Player p = optFirstPenalty.orElseThrow(
              SurrenderGameException::new);
```

Extracting values from Optionals with map

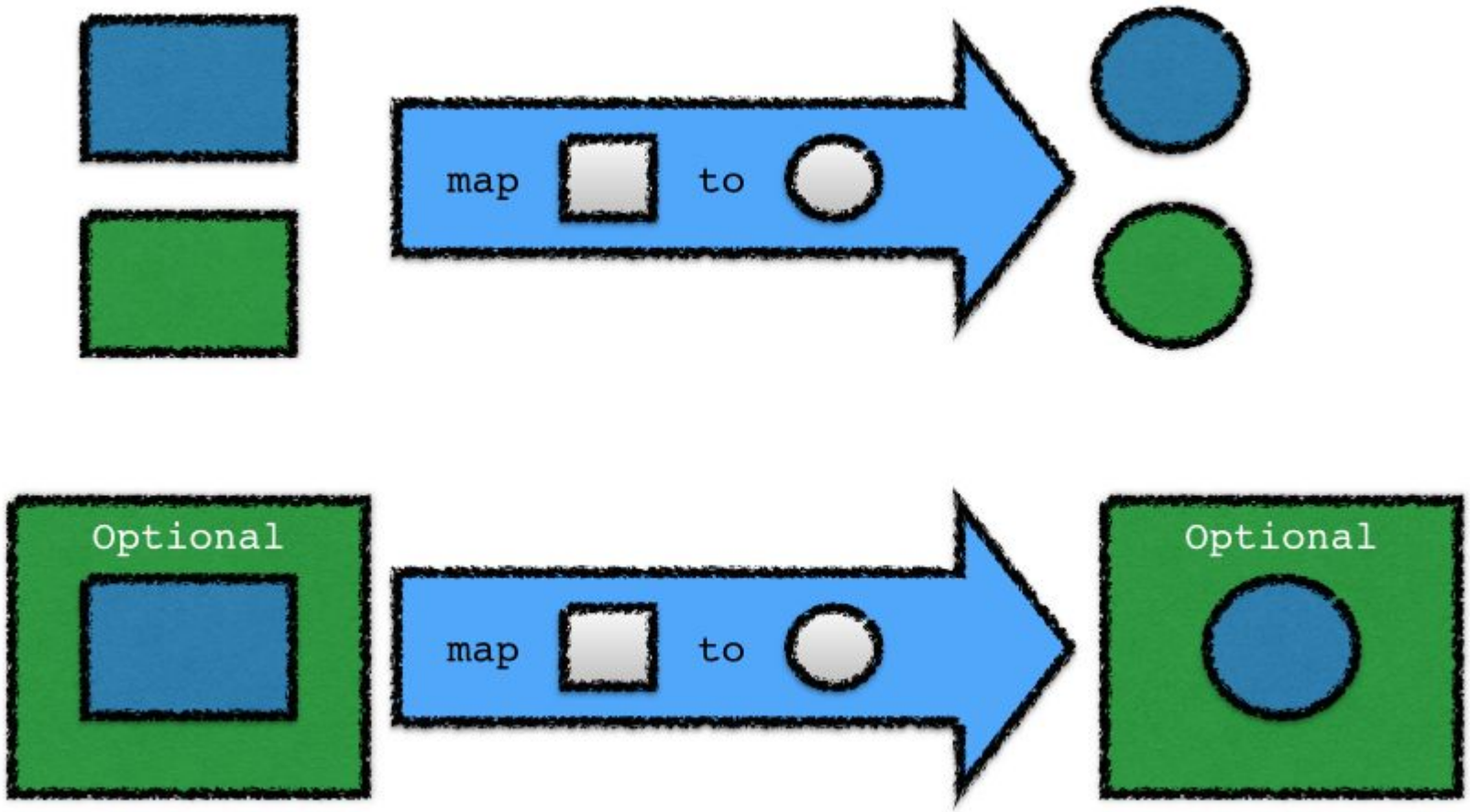
Before:

```
String name = null;
if(insurance != null) {
    name = insurance.getName();
}
```

After:

```
Optional<Insurance> optInsurance =
          Optional.ofNullable(insurance);
Optional<String> name =
          optInsurance.map(Insurance::getName);
```

Understanding map



Chaining methods

How can we rewrite the following in a safe way?

```
public String getCarInsuranceName(Person person) {
    return person.getCar().getInsurance().getName();
}
```

First try

```
Optional<Person> optPerson = Optional.ofNullable(person);
Optional<String> name =
    optPerson.map(Person::getCar)
             .map(Car::getInsurance)
             .map(Insurance::getName);
```

Why it doesn't work?

```
Optional<People> optPerson = Optional.ofNullable(person);
Optional<String> name =
    optPeople.map(Person::getCar)
             .map(Car::getInsurance)
             .map(Insurance::getName);
```

returns Optional<Optional<Car>>

Invalid, the inner Optional object doesn't support the method getInsurance!

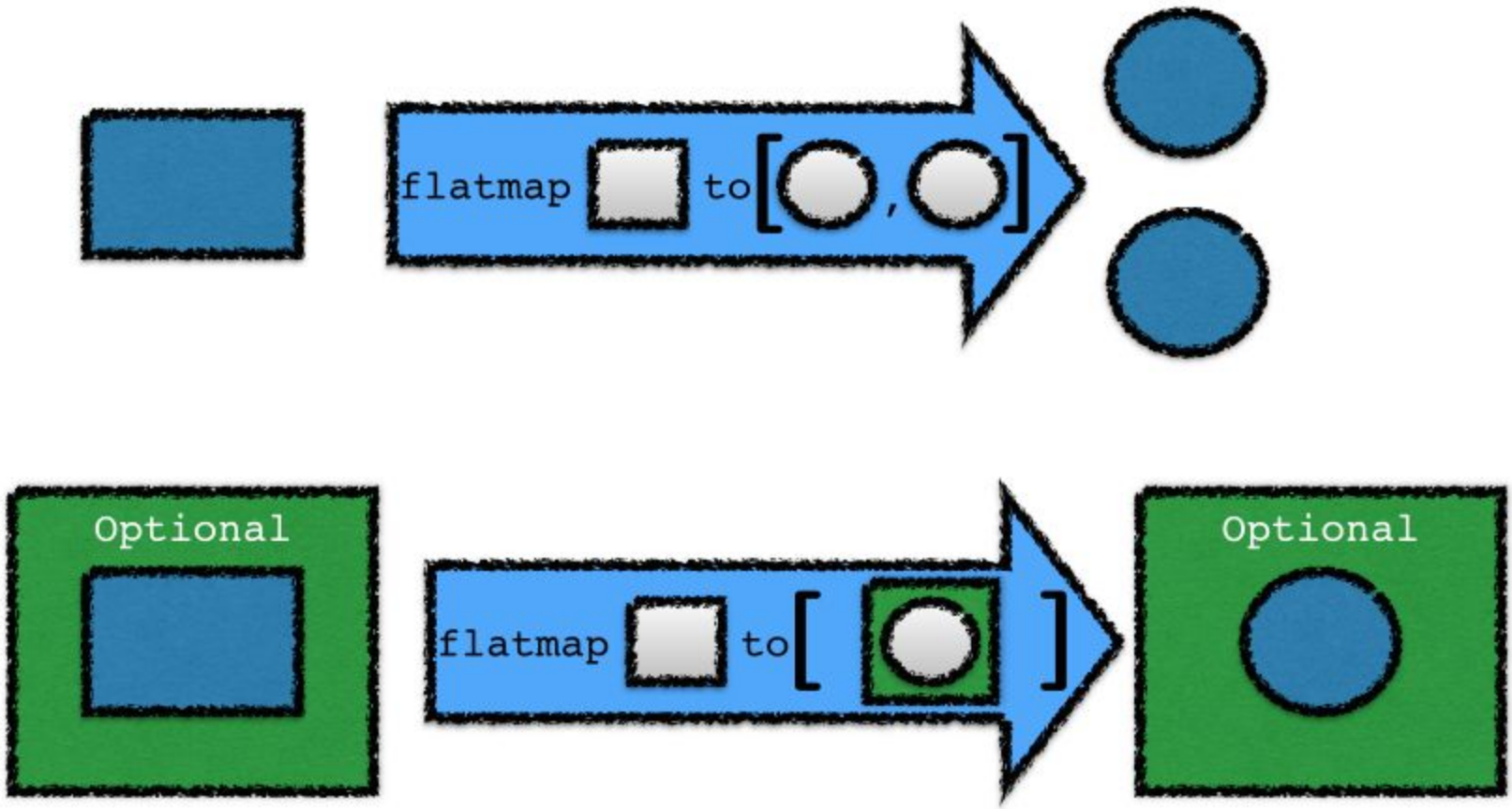
```
public class Person {
   private Optional<Car> car;
   public Optional<Car> getCar() { return car; }
}
```

Chaining methods with flatMap

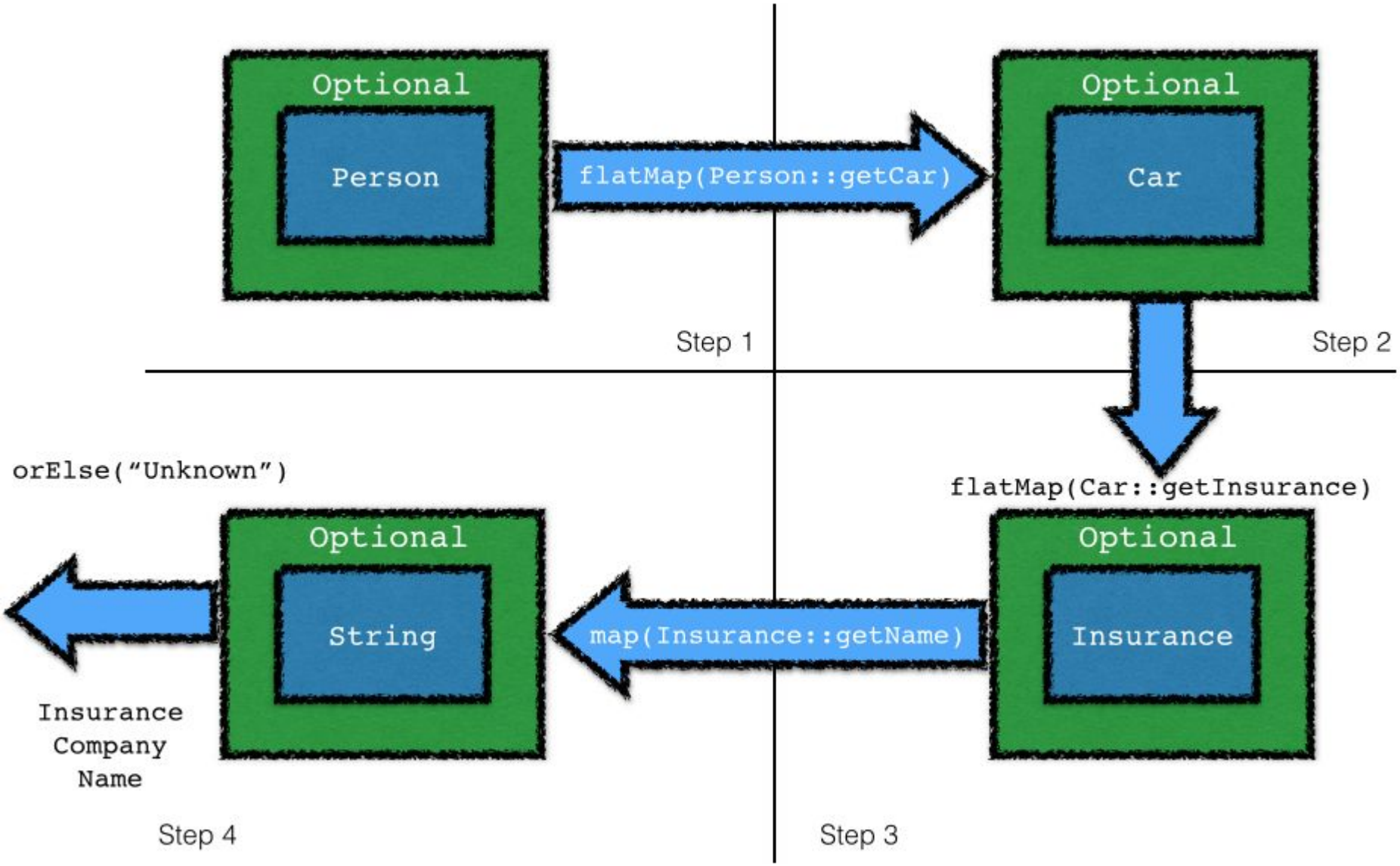
```
public String getCarInsuranceName(Person person) {
    return Optional.ofNullable(person)
                   .flatMap(Person::getCar)
                   .flatMap(Car::getInsurance)
                   .map(Insurance::getName)
                   .orElse("Unknown");
}
```

default value if the resulting Optional is empty

Understanding flatMap (1)



Understanding flatMap (2)



Rejecting values with `filter`

Before

```
Insurance ins = car.getInsurance();
if(ins != null && "Sport_Insurance".equals(ins.getName())){
  System.out.println("This is an expensive insurance!");
}
```

After

```
optInsurance.filter(ins ->
        "Sport_Insurance".equals(ins.getName()))
            .ifPresent(ins ->
    System.out.println("This is an expensive insurance!"))
```

Java 9 - `Optional::stream`

```
Optional<Setting> lookupSettingByName(final String name)
```

Before

```
String homeDir = Stream.of("appHome", "user.home")
          .map(Setting::lookupSettingByName)
          .filter(Optional::isPresent)
          .map(Optional::get)
          .findFirst().get();
```

After

```
String homeDir = Stream.of("appHome", "user.home")
          .map(Setting::lookupSettingByName)
          .flatMap(Optional::stream)
          .findFirst().get();
```

Java 9 - `Optional::ifPresentOrElse`

```
Optional<Booking> lookupBooking(final String reference)
```

Before

```
Optional<Booking> booking = lookupBooking(reference);
if (booking.isPresent()) {
    Ui.displayCheckIn(booking.get());
} else {
    Ui.displayMissingBookingPage();
}
```

After

```
lookupBooking(reference)
    .ifPresentOrElse(
      Ui::displayCheckIn,
      Ui::displayMissingBookingPage);
```

Java 9 - `Optional::or`

```
Optional<Client> findClient(String id)
Optional<Client> lookupCompanyDetails(String id)
```

Before

```
Optional<Client> client = findClient(clientId);
if (!client.isPresent()) {
    client = lookupCompanyDetails(clientId);
}
```

After

```
Optional<Client> client
    = findClient(clientId)
        .or(() -> lookupCompanyDetails(clientId));
```

Unit testing with Optional

```
assertEquals(Optional.of(ferrari488), raoul.getCar());

assertEquals(Optional.empty(), richard.getCar());
```

Also: https://github.com/npathai/hamcrest-optional

```
assertThat(optional, hasValue(startsWith("CAMB")));
```

Optional in Fields

- Should it be used for fields, or just public methods?

- Pros
  - Explicit modelling
  - Null-safe access
  - Simple getters

- Cons
  - More indirection and GC overhead in Java 8
  - Not every library understands Optional yet
  - Some libraries require Serializable fields

Exercise

How would you rewrite the following code using an Optional object?

`com.java_8_training.problems.optional.RefactorToOptional1`

```
public int readDuration(Properties props, String name) {
   String value = props.getProperty(name);
   if (value != null) {
       int i = Integer.parseInt(value);
       if (i > 0) {
          return i;
       }
   }
   return 0;
}
```

make sure a property exists with the required name

try to convert the String property to a number

check the number is positive

return 0 if conversion failed

The End

Data Modelling Approaches

Updating our model

```
public class Person {
  private Optional<Car> car;
  public Optional<Car> getCar() { return car; }
}

public class Car {
  private Optional<Insurance> insurance;
  public Optional<Insurance> getInsurance() {
    return insurance;
  }
}

public class Insurance {
  private String name;
  public String getName() { return name; }
}
```

Left to right

- Pros
  - Conceptually simple
  - How to find insurance given an owner?
- Cons
  - Coupling of caller to a method call chain
  - How to find owner given a car?
  - How to find car given the insurance?

Updating our model

```
public class Insurance {
  private String name;
  private Car car;
  public String getName() { return name; }
  public Car getCar() { return car; }
}
public class Car {
  private Person owner;
  public Person getOwner() {
    return owner;
  }
}
public class Person {

}
```

Inverse

- Pros
  - Conceptually simple
  - No optional fields
  - How to find owner given a car?
  - How to find car given an insurance?
- Cons
  - How to find insurance given a car?
  - How to find insurance given an owner?

Updating our model

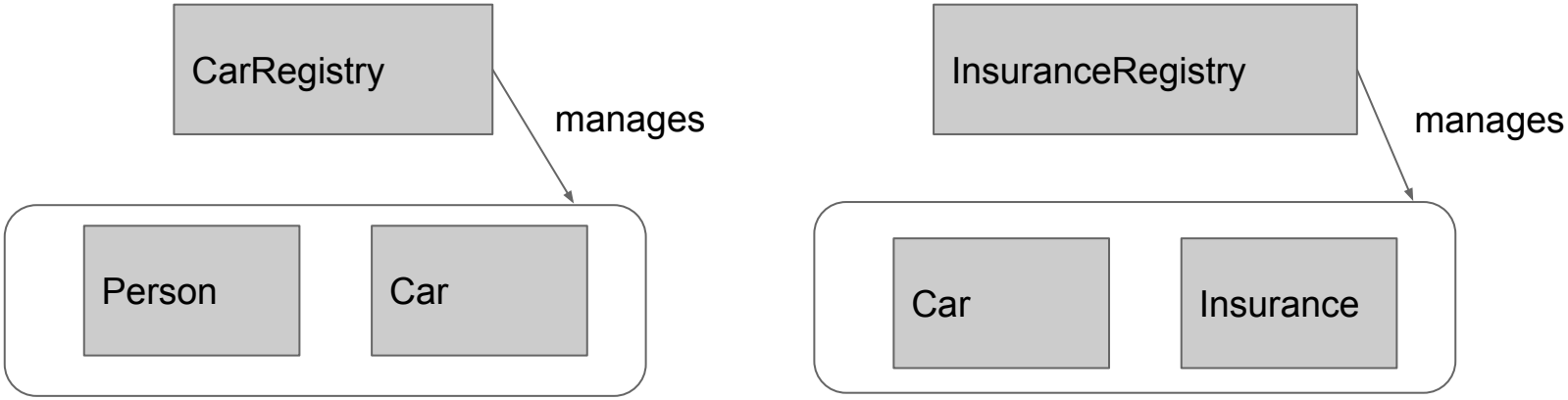
```
public class Car {
  private Person owner;
  private Optional<Insurance> insurance;
  public Person getOwner() { return owner; }
  public Optional<Insurance> getInsurance() {
  return insurance;
  }
}
public class Person { }

public class Insurance {
  private String name;
  public String getName() { return name; }
}
```

Split

- Pros
  - Conceptually simple
  - How to find owner given a car?
  - How to find insurance given a car?
- Cons
  - How to find insurance given an owner?
  - How to find car given an insurance?
  - How to find owner given an insurance?

Relationship managers



- Pros
  - Decouples Person, Car, Insurance
  - Extensible to many to many relationships
- Cons
  - More set up

Updating our model

```
public class CarRegistry {

    private Map<Person, Car> registry = new HashMap<>();

    public void addCarToRegistry(Person owner, Car car) {
        registry.put(owner, car);
    }

    public Optional<Car> findCarForPerson(Person owner) {
        return Optional.ofNullable(registry.get(owner));
    }
}
```

Updating our model

```
public String getCarInsuranceName(Person person) {
   return carRegistry.findCarForPerson(person)
                     .flatMap(insuranceRegistry::fetchInsuranceForCar)
                     .map(Insurance::getName)
                     .orElse("Unknown");
}
```

vs (previous)

```
public String getCarInsuranceName(Person person) {
    return Optional.ofNullable(person)
                   .flatMap(Person::getCar)
                   .flatMap(Car::getInsurance)
                   .map(Insurance::getName)
                   .orElse("Unknown");
}
```