G54SOD (Spring 2018)

Workshop 01
Introduction to AnyLogic + Java

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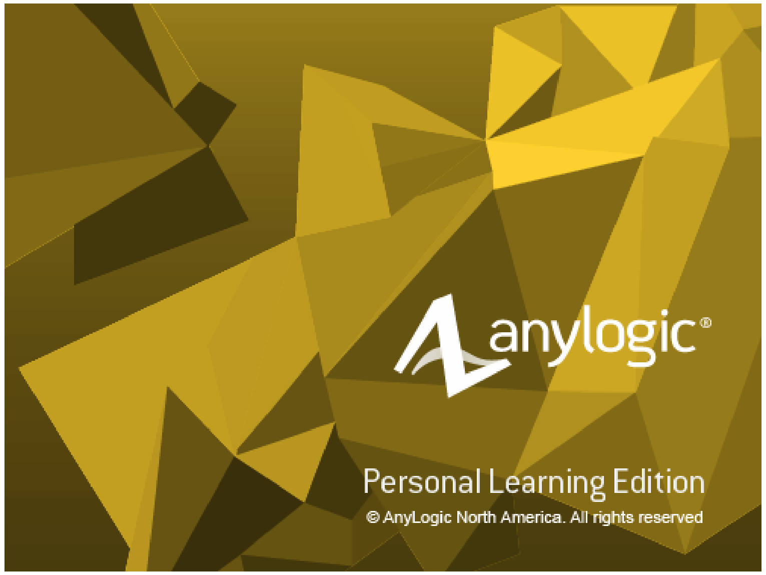
AnyLogic

- We use AnyLogic 8.1.0 PLE
  - In AnyLogic you are not writing the full code of Java classes from the beginning to the end; instead you are entering pieces of code and expressions in numerous small edit boxes in the properties of various model elements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Personal Learning Edition
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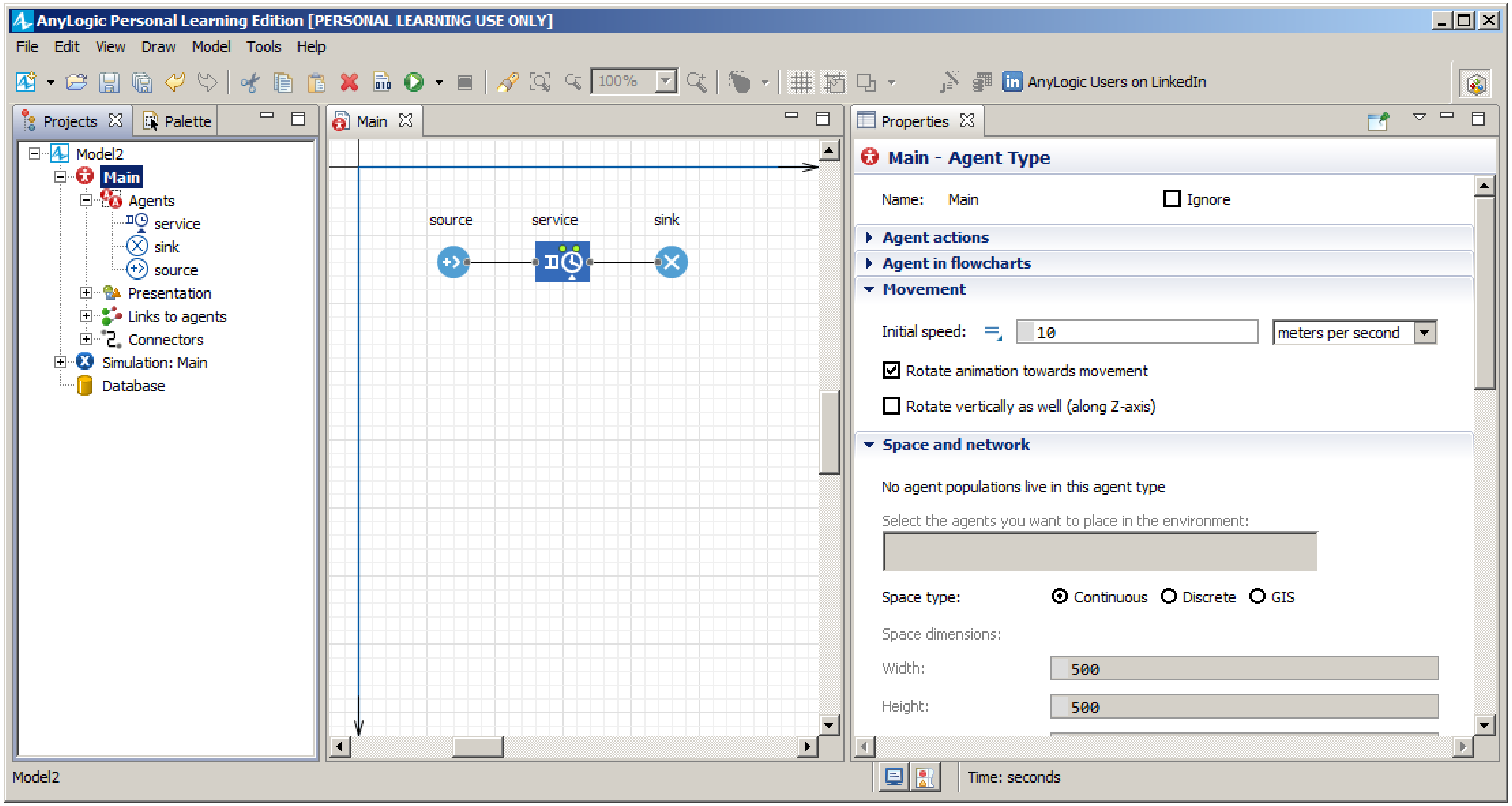
AnyLogic IDE



Main - Agent Type

Name: Main ☐ Ignore

Agent actions

Agent in flowcharts

Movement

Initial speed: 10 meters per second

☑ Rotate animation towards movement

☐ Rotate vertically as well (along Z-axis)

Space and network

No agent populations live in this agent type

Select the agents you want to place in the environment:

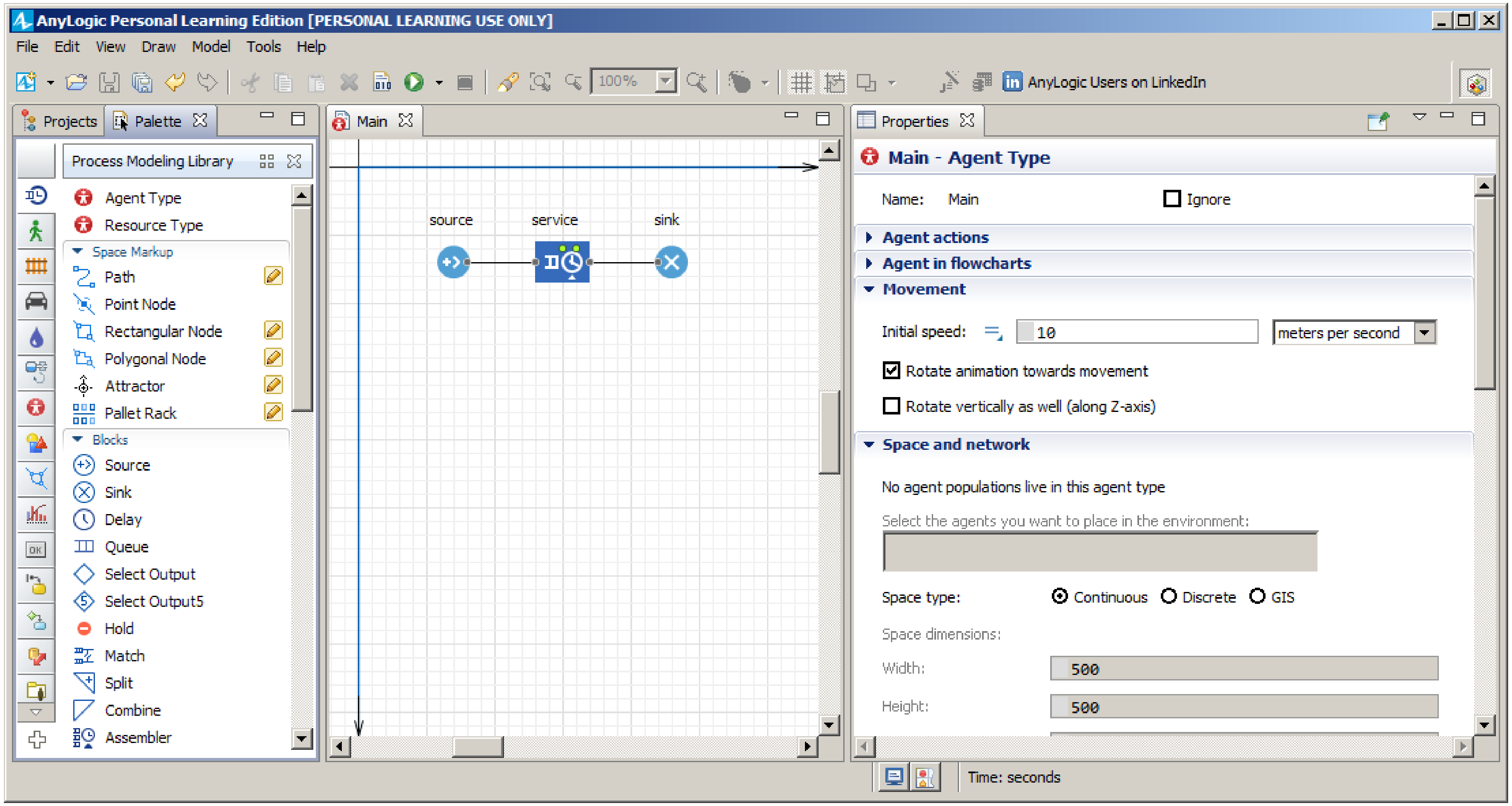
Space type: [✓ Continuous] Discrete GIS

Space dimensions:

Width: 500

Height: 500

AnyLogic IDE



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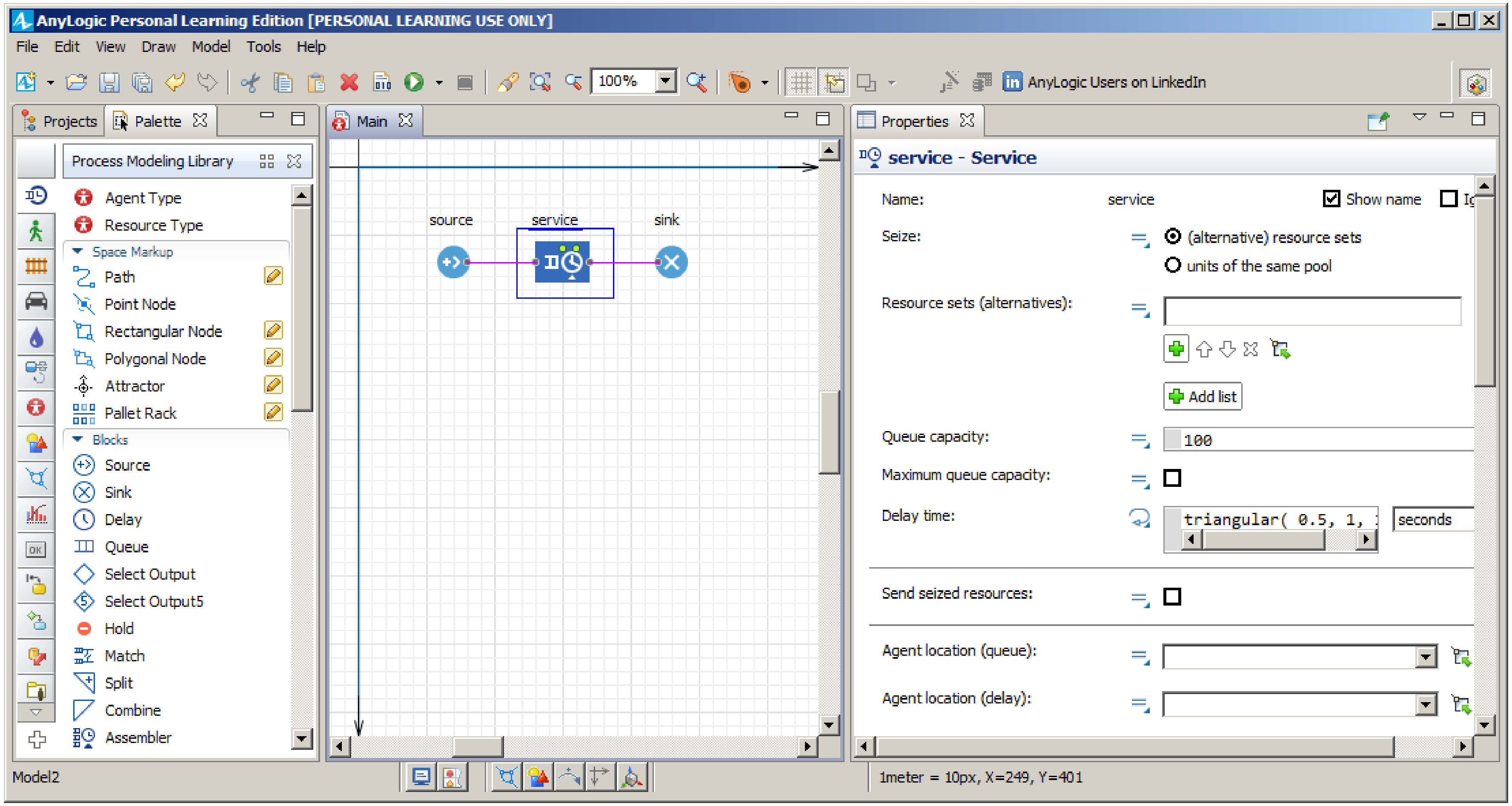


service - Service

Name: service ☑ Show name ☐ Ig

Seize: [● (alternative) resource sets] ○ units of the same pool

Resource sets (alternatives):

Add list

Queue capacity: 100

Maximum queue capacity: ☐

Delay time: triangular(0.5, 1, seconds

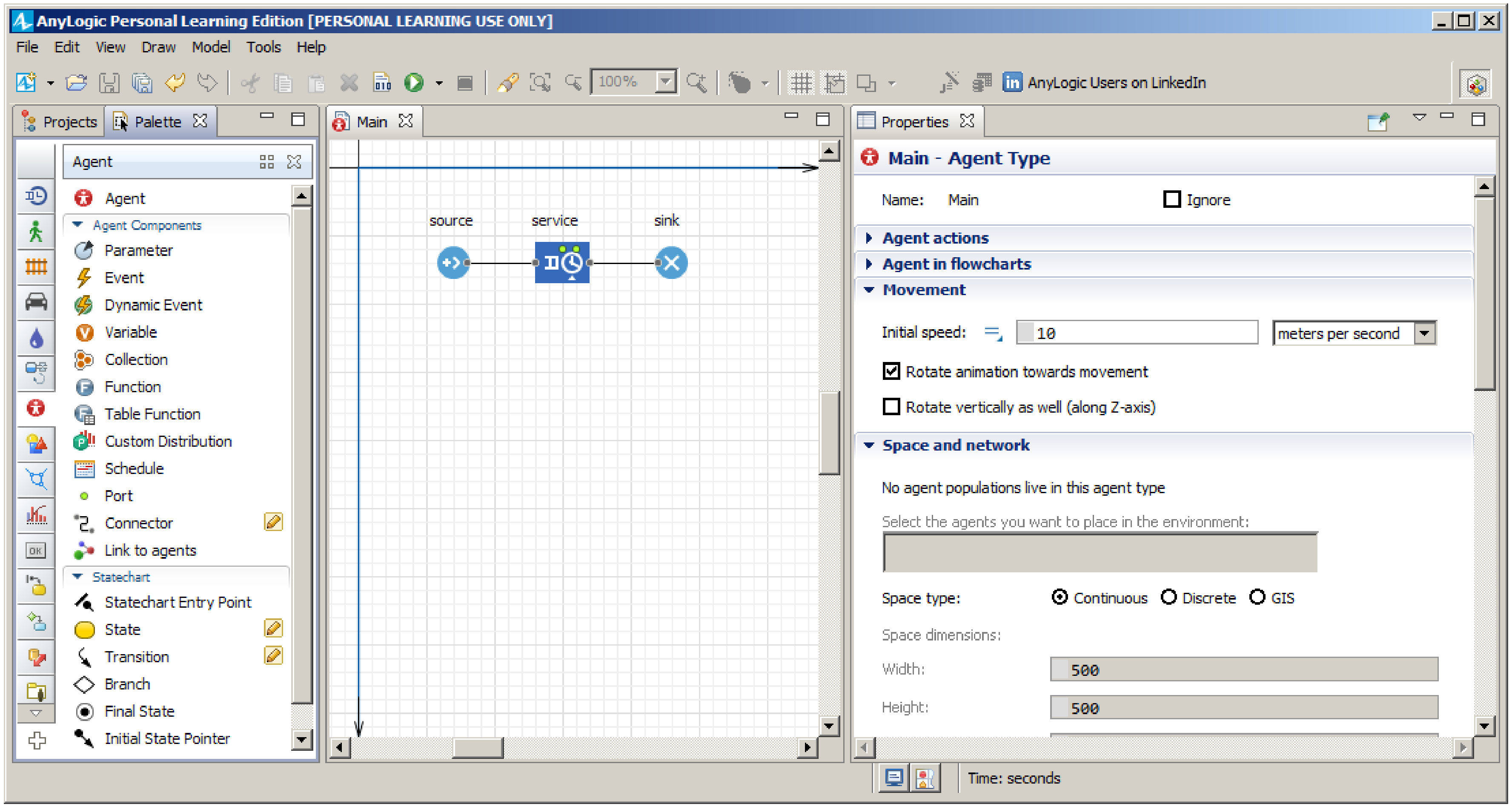
Send seized resources: ☐

Agent location (queue):

Agent location (delay):

1meter = 10px, X=249, Y=401

AnyLogic IDE



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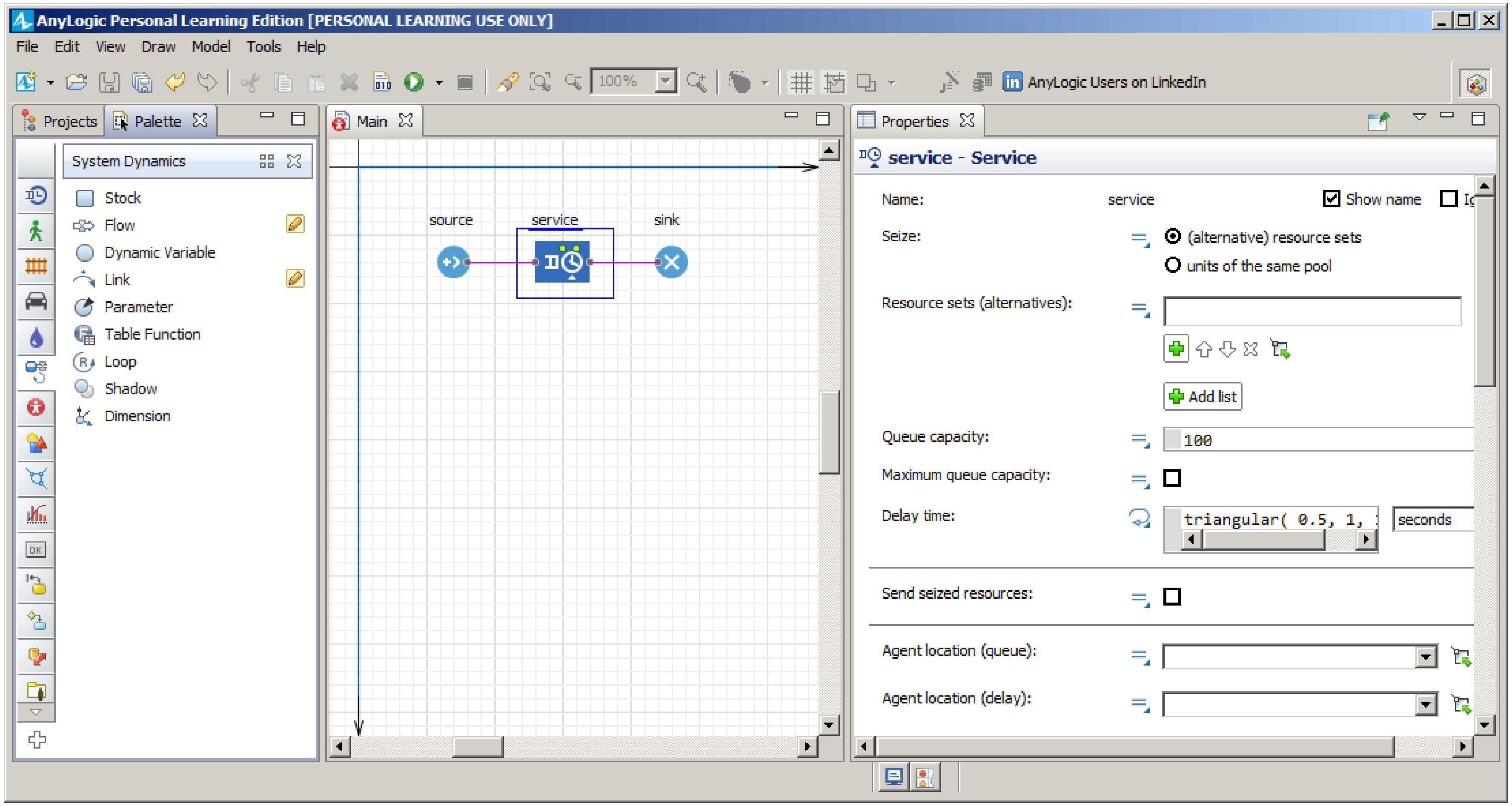

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Send seized resources: ☐

Agent location (queue):

Agent location (delay):

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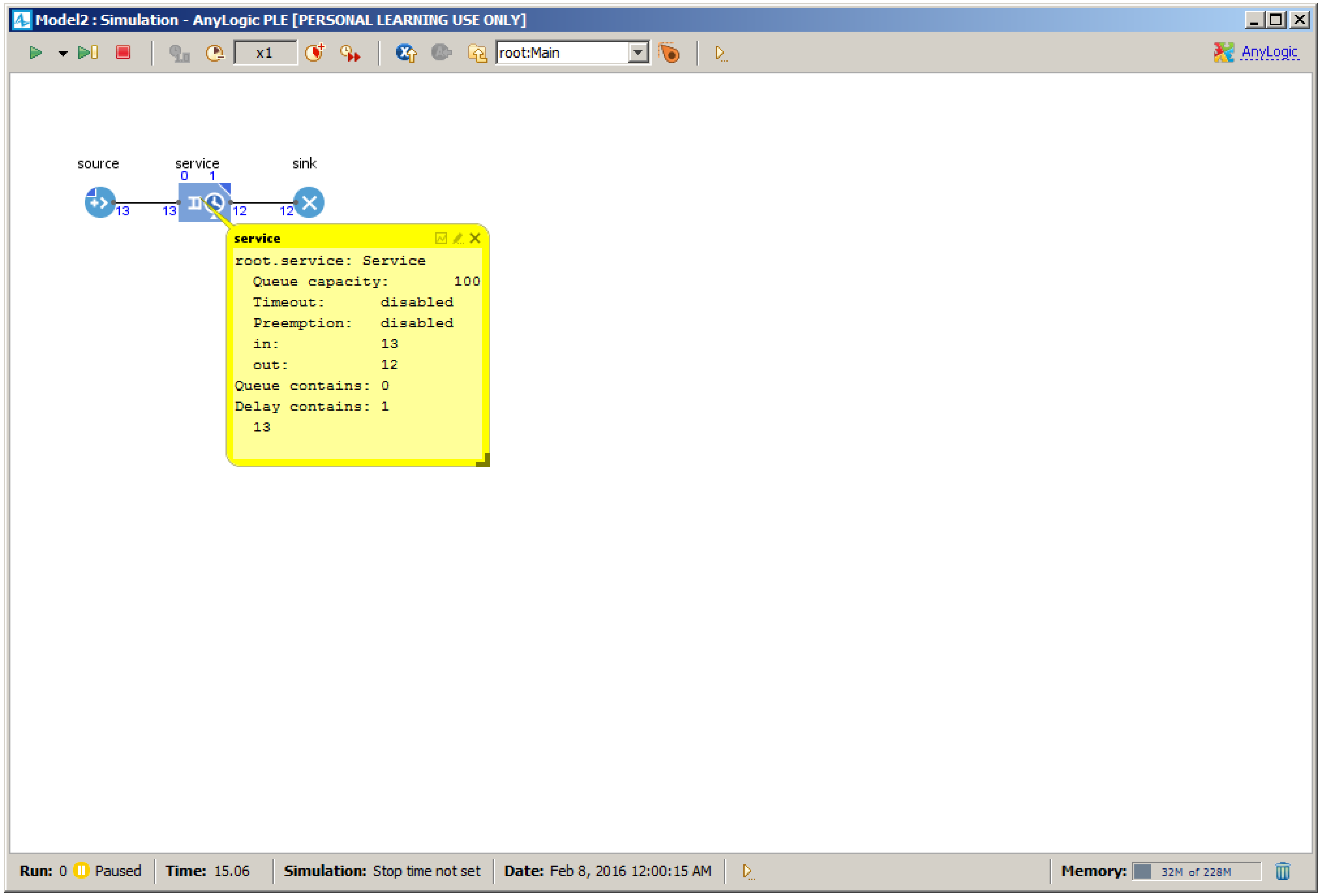
Things to Remember

- Important things
  - F1: Help
  - Ctrl-Space: Code completion support
  - Ctrl-Enter: Perform refactoring (replace name occurrences)
  - Make sure you select the correct model when pressing "Run"
  - Make sure you set up model time units correctly in the "Model"
  - Use the "magic lightbulb" ...

- Since AnyLogic 7 …
  - Everything is called "Agent" (entities, resources, agents, …)
  - PLE version limits number of entities per simulation run to 50,000

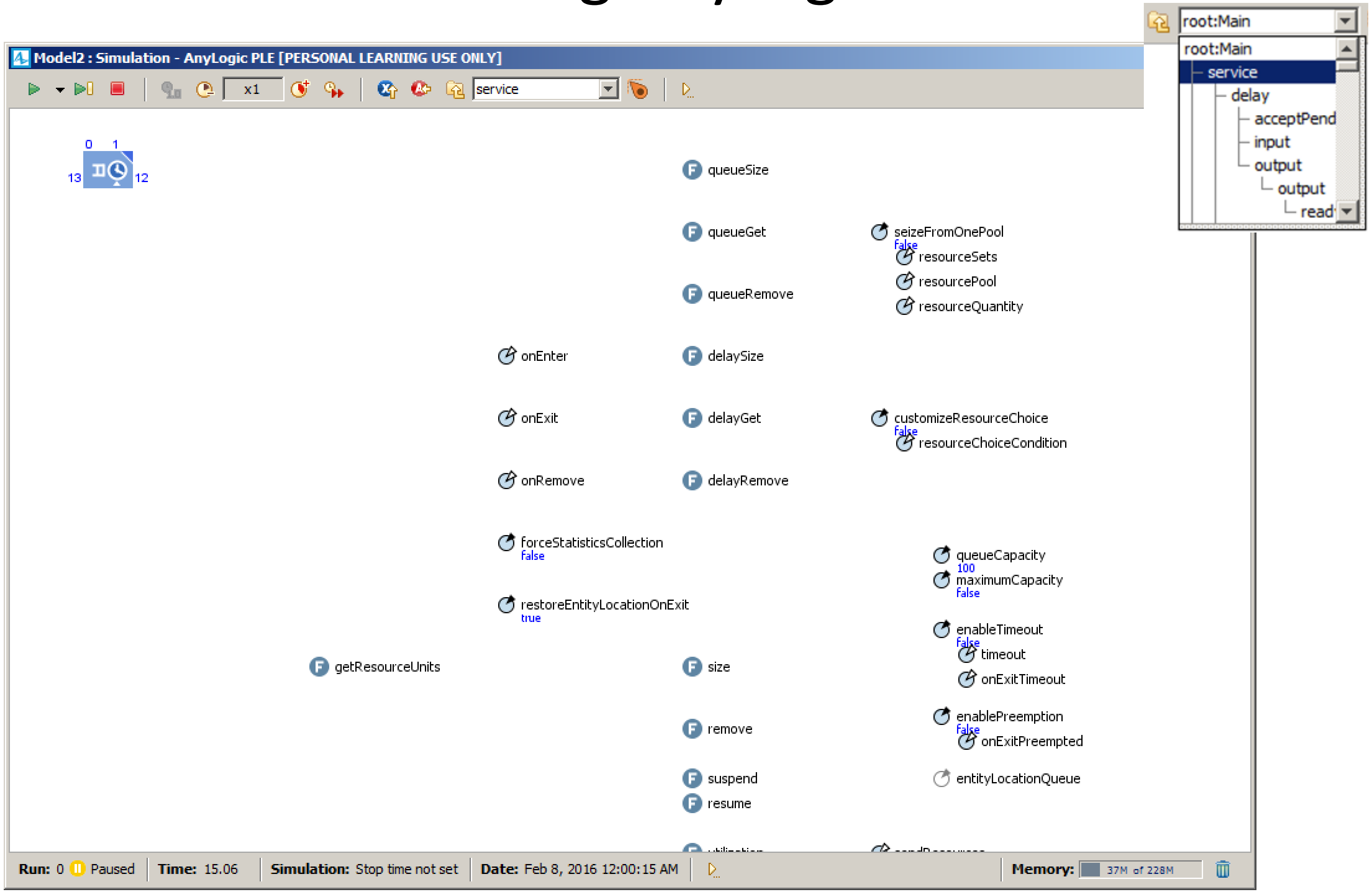
Running AnyLogic


Model2 : Simulation - AnyLogic PLE [PERSONAL LEARNING USE ONLY]
x1
root:Main
AnyLogic
source
service
sink
0
1
13
13
12
12
Run: 0
Paused
Time: 15.06
Simulation: Stop time not set
Date: Feb 8, 2016 12:00:15 AM
Memory:
32M of 228M

service

```
root.service: Service
  Queue capacity:        100
  Timeout:       disabled
  Preemption:    disabled
  in:            13
  out:           12
Queue contains: 0
Delay contains: 1
  13
```

Running AnyLogic


Model2 : Simulation - AnyLogic PLE [PERSONAL LEARNING USE ONLY]

seizeFromOnePool false
resourceSets
resourcePool
resourceQuantity
customizeResourceChoice false
resourceChoiceCondition
forceStatisticsCollection false
restoreEntityLocationOnExit true
queueCapacity 100
maximumCapacity false
enableTimeout false
timeout
onExitTimeout
enablePreemption false
onExitPreempted
entityLocationQueue

Run: 0 Paused | Time: 15.06 | Simulation: Stop time not set | Date: Feb 8, 2016 12:00:15 AM | Memory: 37M of 228M

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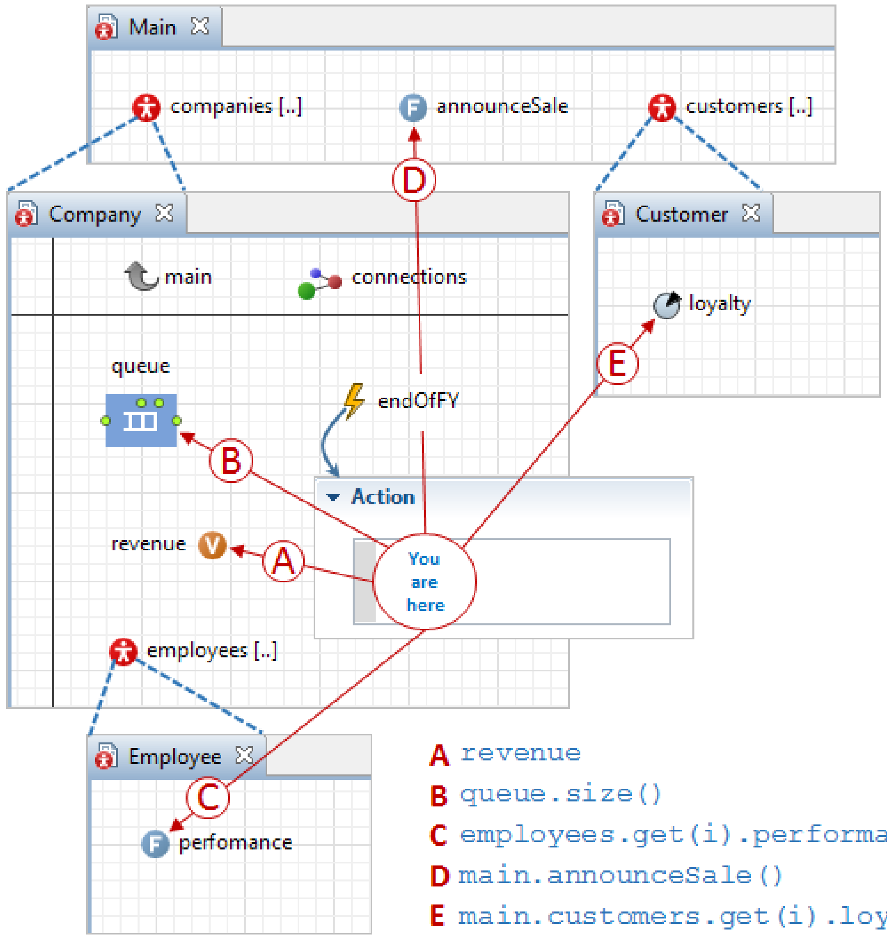
Where am I and how do I get to…?



A `revenue`

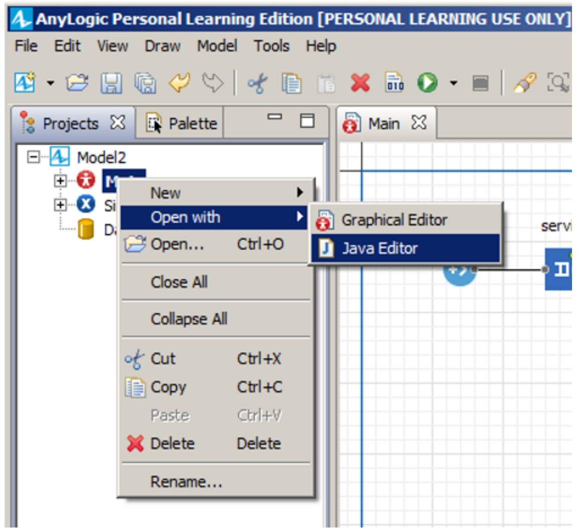
B `queue.size()`

C `employees.get(i).performance()`

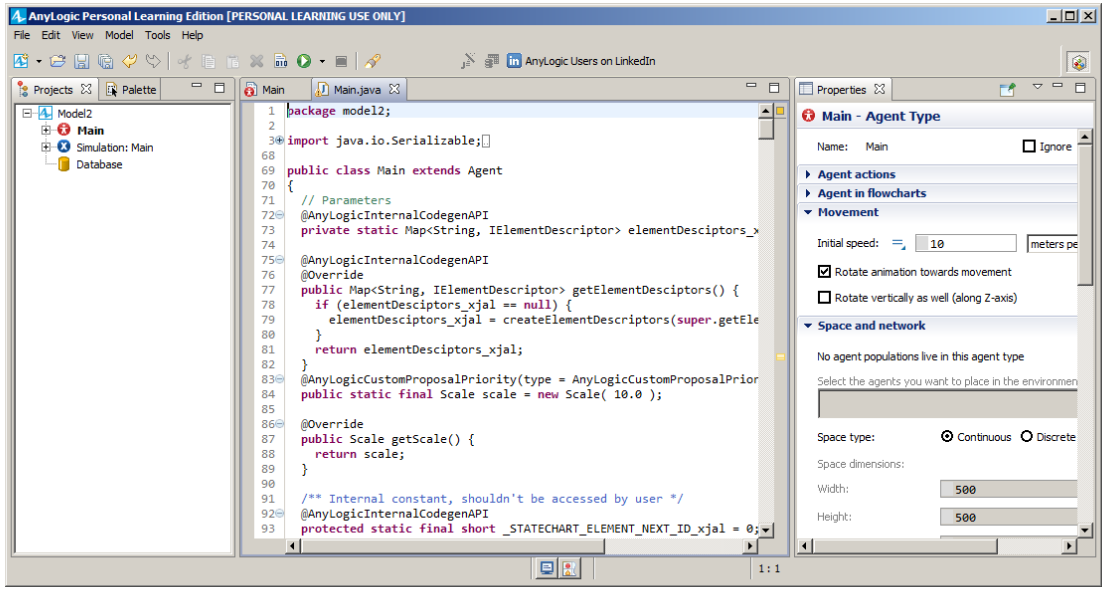
D `main.announceSale()`

E `main.customers.get(i).loyalty`

AnyLogic IDE



- Or press "Ctrl+J" to go to the point in the Java code that is associated with the current code snippet highlighted in the Properties window


AnyLogic Personal Learning Edition [PERSONAL LEARNING USE ONLY]
File Edit View Model Tools Help
AnyLogic Users on LinkedIn
Projects
Palette
Model2
Main
Simulation: Main
Database
Main
Main.java
Properties

```java
package model2;

import java.io.Serializable;

public class Main extends Agent
{
  // Parameters
  @AnyLogicInternalCodegenAPI
  private static Map<String, IElementDescriptor> elementDesciptors_x
  
  @AnyLogicInternalCodegenAPI
  @Override
  public Map<String, IElementDescriptor> getElementDesciptors() {
    if (elementDesciptors_xjal == null) {
      elementDesciptors_xjal = createElementDescriptors(super.getEle
    }
    return elementDesciptors_xjal;
  }
  @AnyLogicCustomProposalPriority(type = AnyLogicCustomProposalPrior
  public static final Scale scale = new Scale( 10.0 );

  @Override
  public Scale getScale() {
    return scale;
  }

  /** Internal constant, shouldn't be accessed by user */
  @AnyLogicInternalCodegenAPI
  protected static final short _STATECHART_ELEMENT_NEXT_ID_xjal = 0;
```

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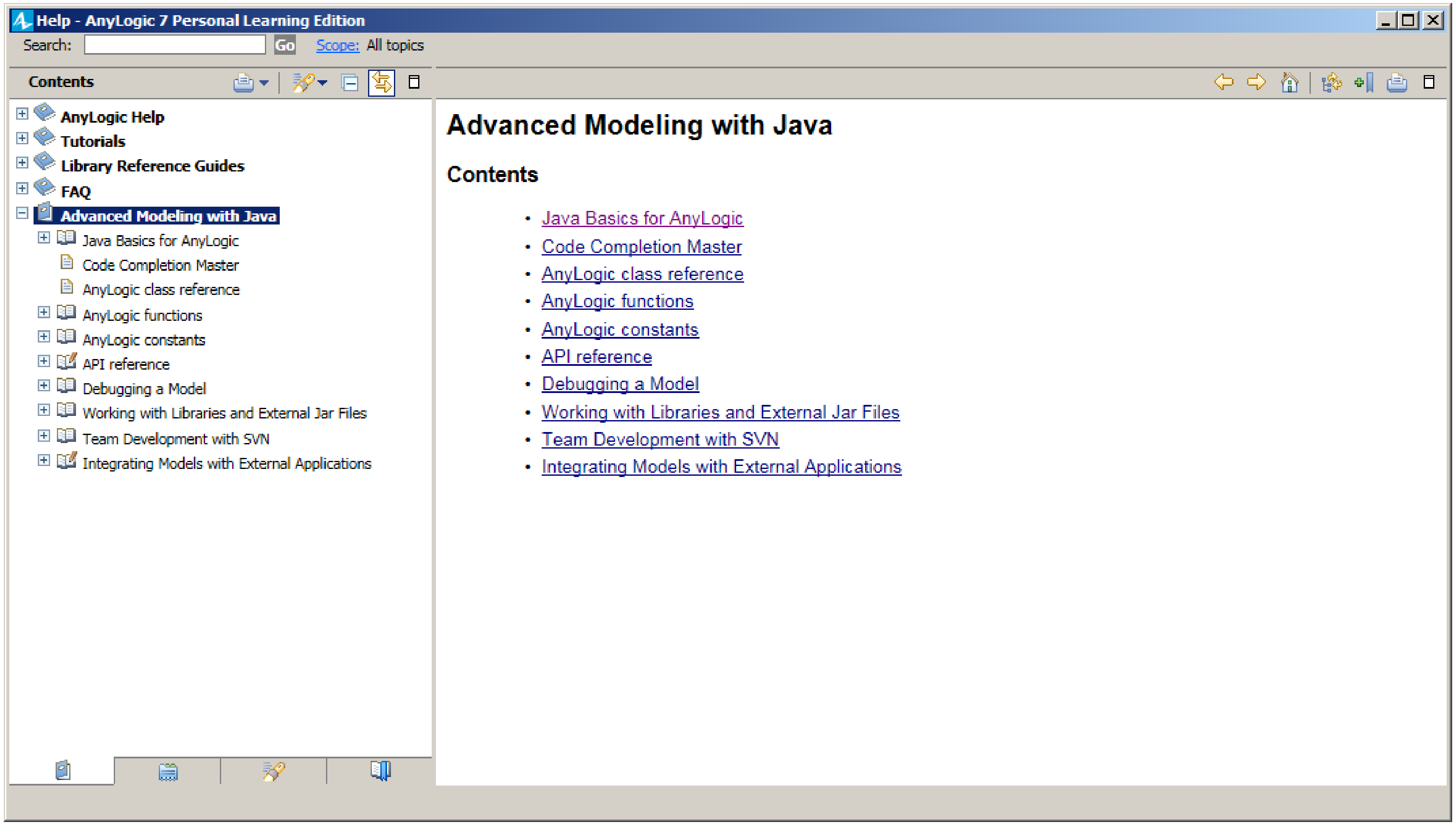
AnyLogic Help



Help - AnyLogic 7 Personal Learning Edition

Search: Go Scope: All topics

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  - AnyLogic constants
  - API reference
  - Debugging a Model
  - Working with Libraries and External Jar Files
  - Team Development with SVN
  - Integrating Models with External Applications

Advanced Modeling with Java

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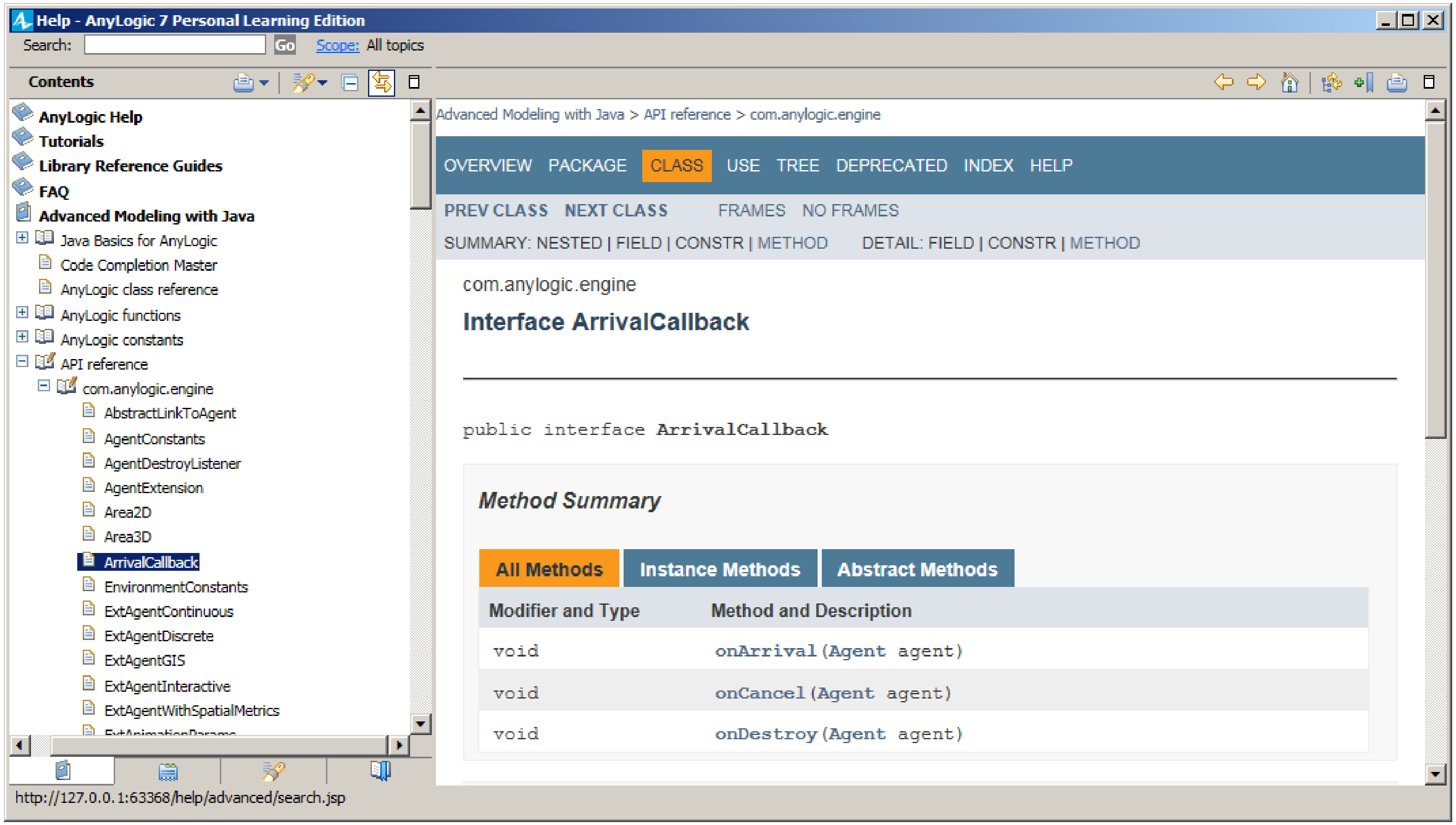
AnyLogic Help



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      - AgentExtension
      - Area2D
      - Area3D
      - ArrivalCallback
      - EnvironmentConstants
      - ExtAgentContinuous
      - ExtAgentDiscrete
      - ExtAgentGIS
      - ExtAgentInteractive
      - ExtAgentWithSpatialMetrics

http://127.0.0.1:63368/help/advanced/search.jsp

Advanced Modeling with Java > API reference > com.anylogic.engine

OVERVIEW PACKAGE CLASS USE TREE DEPRECATED INDEX HELP

PREV CLASS NEXT CLASS FRAMES NO FRAMES

SUMMARY: NESTED | FIELD | CONSTR | METHOD DETAIL: FIELD | CONSTR | METHOD

com.anylogic.engine

Interface ArrivalCallback

```
public interface ArrivalCallback
```

Method Summary

All Methods | Instance Methods | Abstract Methods

Modifier and Type	Method and Description
`void`	`onArrival(Agent agent)`
`void`	`onCancel(Agent agent)`
`void`	`onDestroy(Agent agent)`

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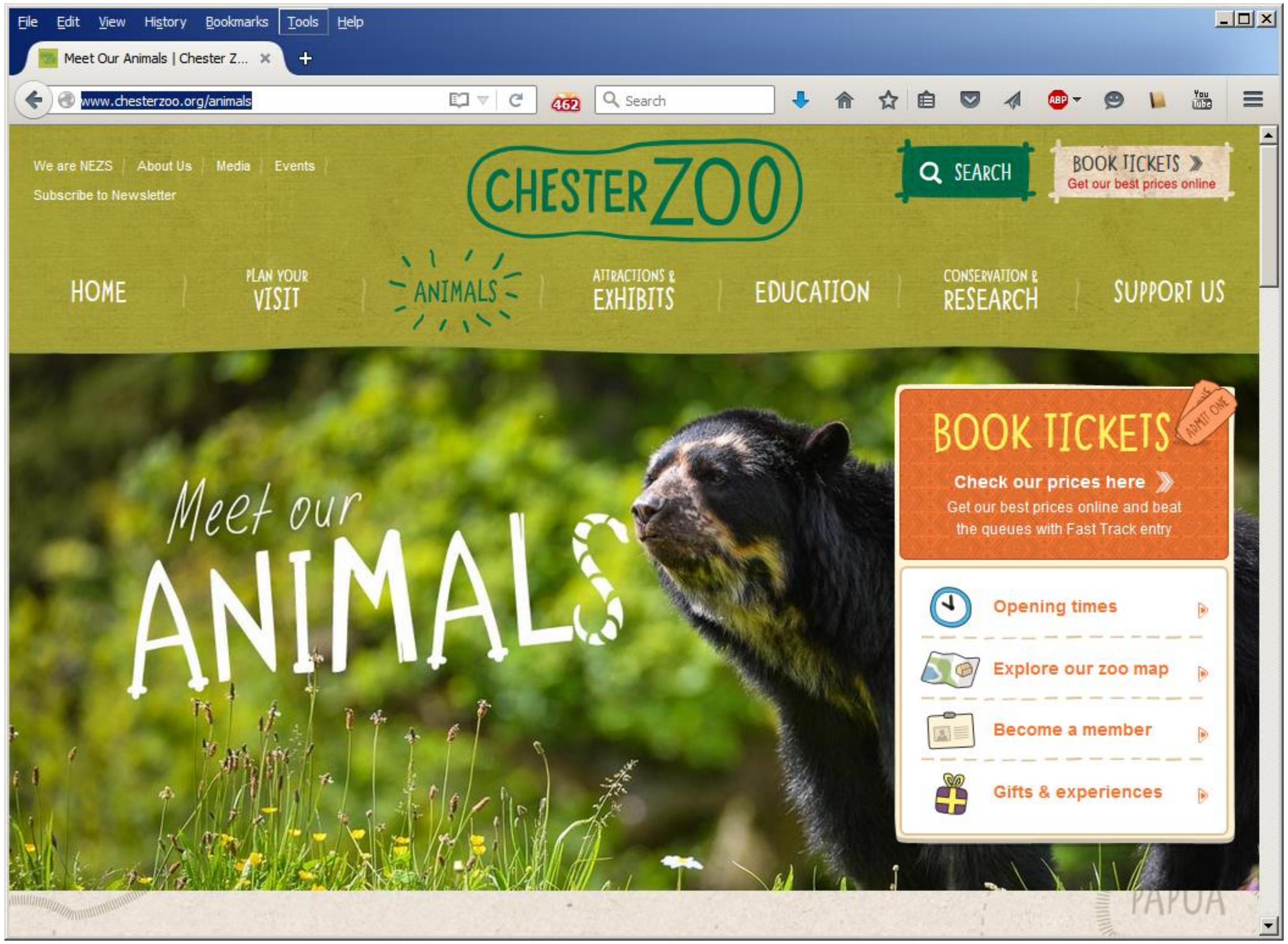
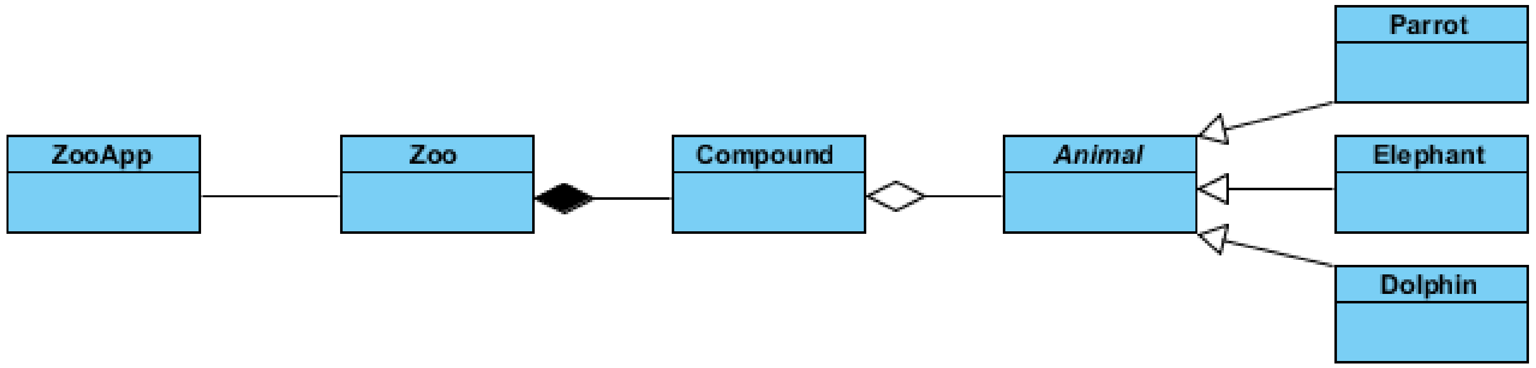
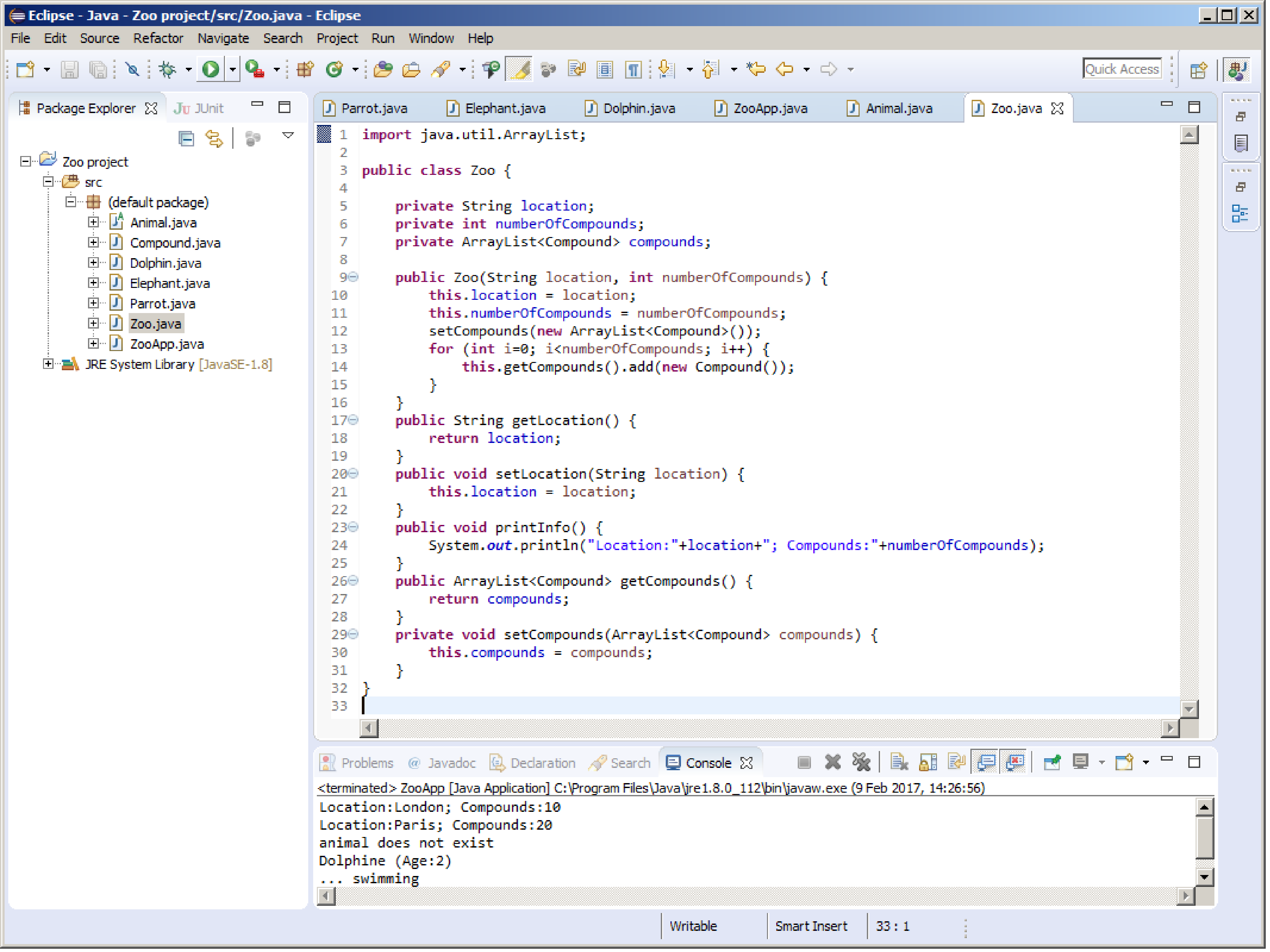
Objects and Java in 15 Minutes

Case Study: Zoo Management



Case Study: Zoo Management





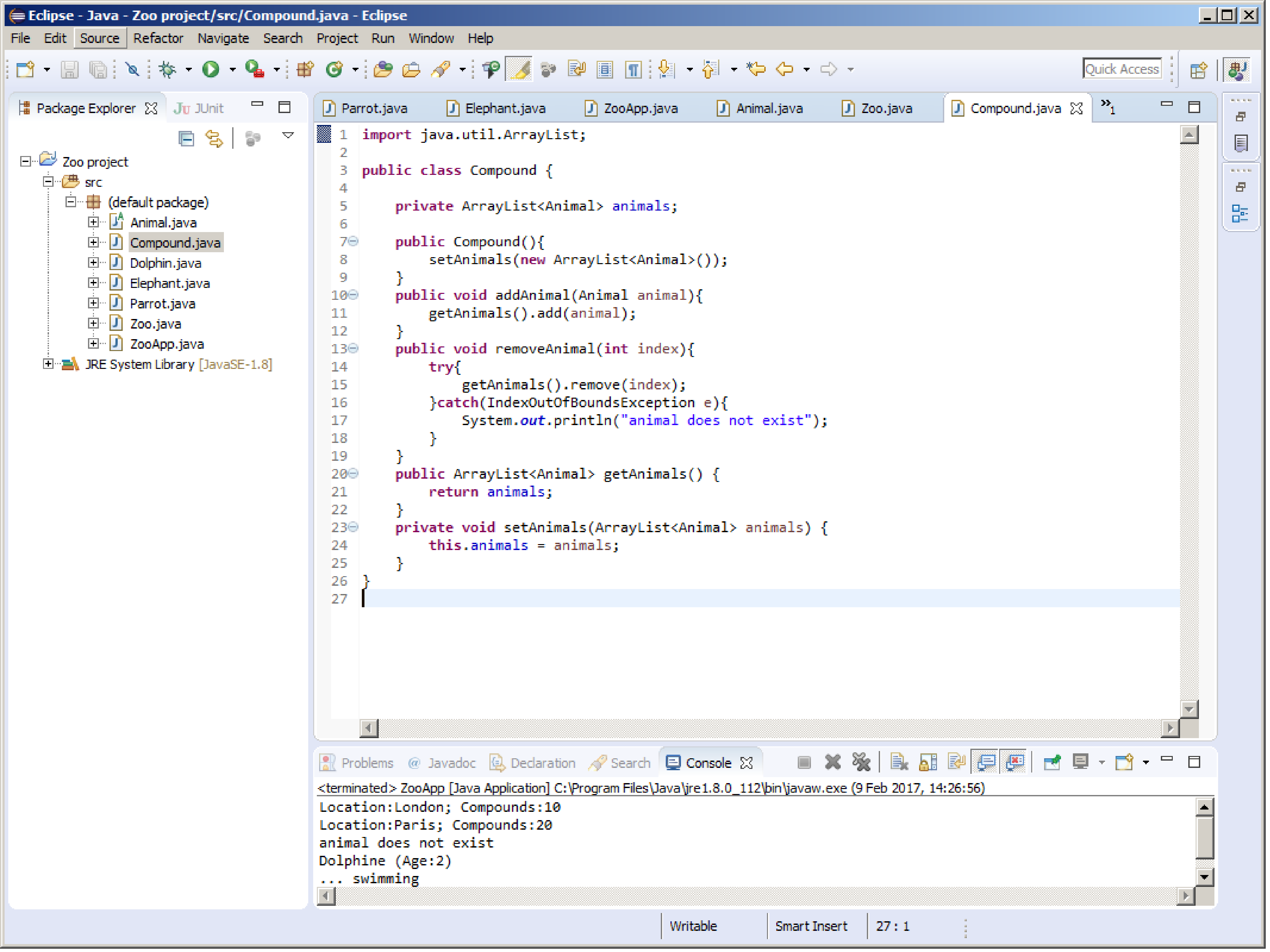
```java
import java.util.ArrayList;

public class Zoo {

    private String location;
    private int numberOfCompounds;
    private ArrayList<Compound> compounds;

    public Zoo(String location, int numberOfCompounds) {
        this.location = location;
        this.numberOfCompounds = numberOfCompounds;
        setCompounds(new ArrayList<Compound>());
        for (int i=0; i<numberOfCompounds; i++) {
            this.getCompounds().add(new Compound());
        }
    }
    public String getLocation() {
        return location;
    }
    public void setLocation(String location) {
        this.location = location;
    }
    public void printInfo() {
        System.out.println("Location:"+location+"; Compounds:"+numberOfCompounds);
    }
    public ArrayList<Compound> getCompounds() {
        return compounds;
    }
    private void setCompounds(ArrayList<Compound> compounds) {
        this.compounds = compounds;
    }
}
```

```
<terminated> ZooApp [Java Application] C:\Program Files\Java\jre1.8.0_112\bin\javaw.exe (9 Feb 2017, 14:26:56)
Location:London; Compounds:10
Location:Paris; Compounds:20
animal does not exist
Dolphine (Age:2)
... swimming
```



```java
import java.util.ArrayList;

public class Compound {

    private ArrayList<Animal> animals;

    public Compound(){
        setAnimals(new ArrayList<Animal>());
    }
    public void addAnimal(Animal animal){
        getAnimals().add(animal);
    }
    public void removeAnimal(int index){
        try{
            getAnimals().remove(index);
        }catch(IndexOutOfBoundsException e){
            System.out.println("animal does not exist");
        }
    }
    public ArrayList<Animal> getAnimals() {
        return animals;
    }
    private void setAnimals(ArrayList<Animal> animals) {
        this.animals = animals;
    }
}

```

```
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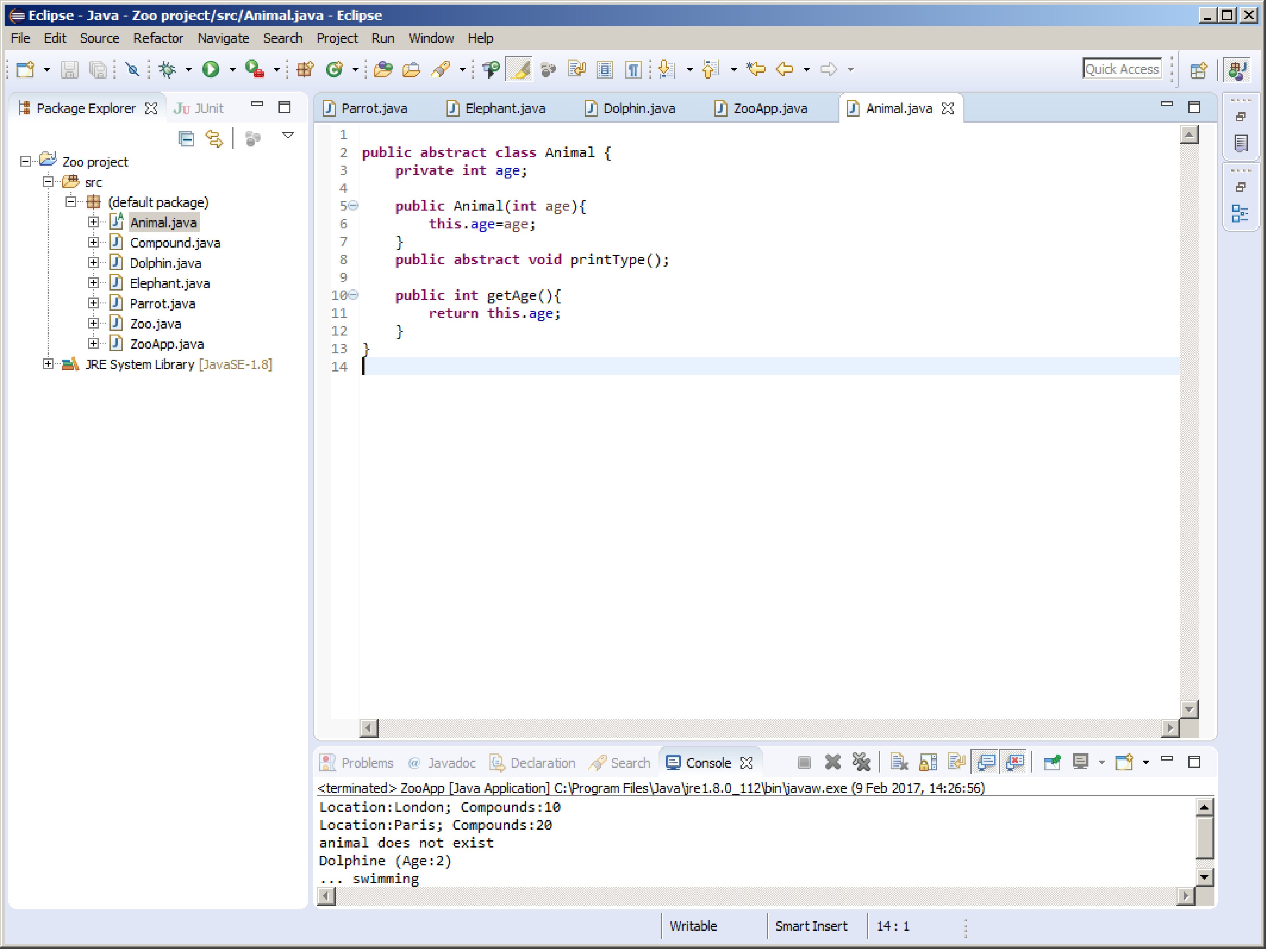

```java

public abstract class Animal {
    private int age;

    public Animal(int age){
        this.age=age;
    }
    public abstract void printType();

    public int getAge(){
        return this.age;
    }
}

```

```
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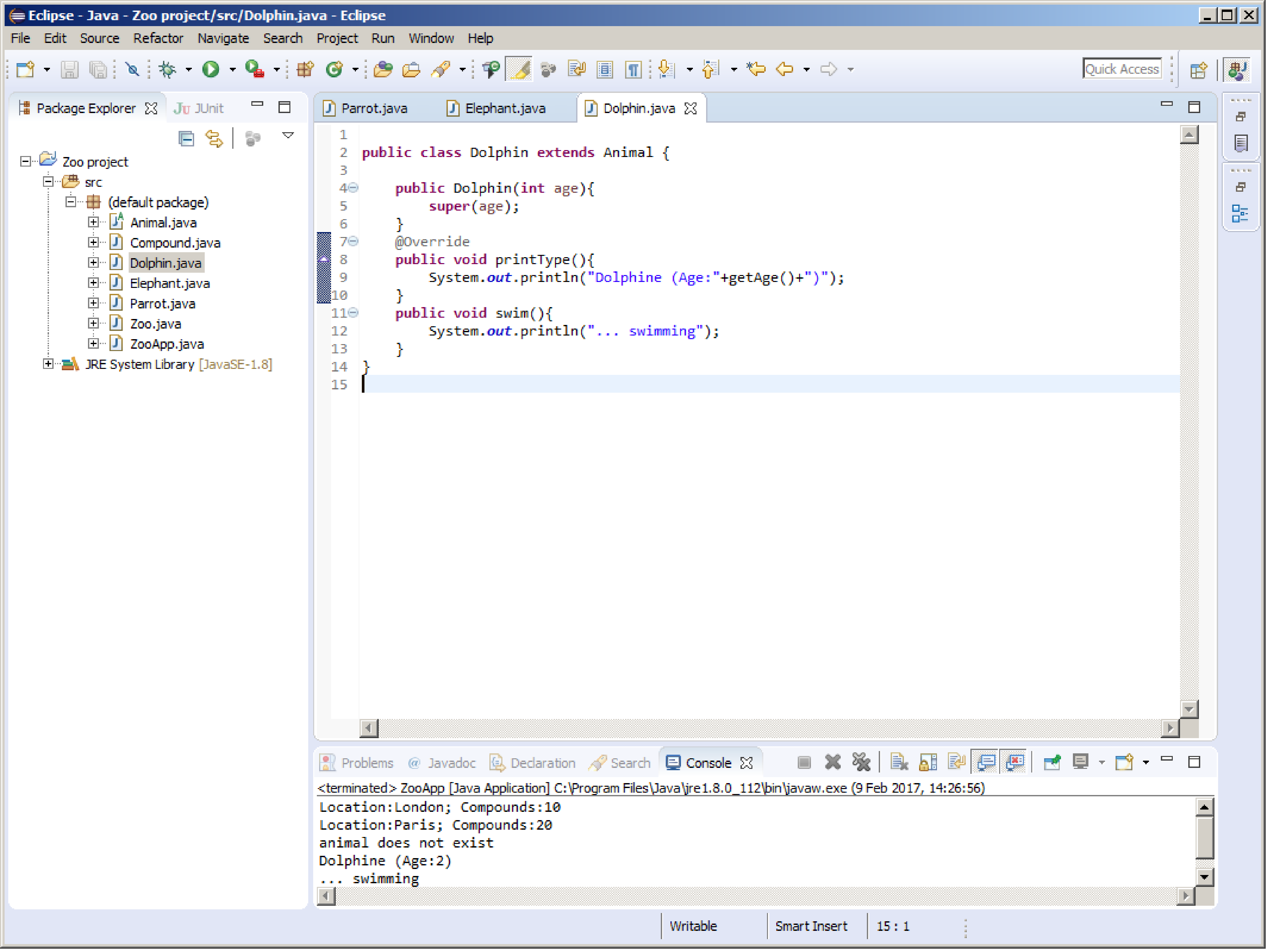

```java

public class Dolphin extends Animal {

    public Dolphin(int age){
        super(age);
    }
    @Override
    public void printType(){
        System.out.println("Dolphine (Age:"+getAge()+")");
    }
    public void swim(){
        System.out.println("... swimming");
    }
}

```

<terminated> ZooApp [Java Application] C:\Program Files\Java\jre1.8.0_112\bin\javaw.exe (9 Feb 2017, 14:26:56)

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Location:London; Compounds:10
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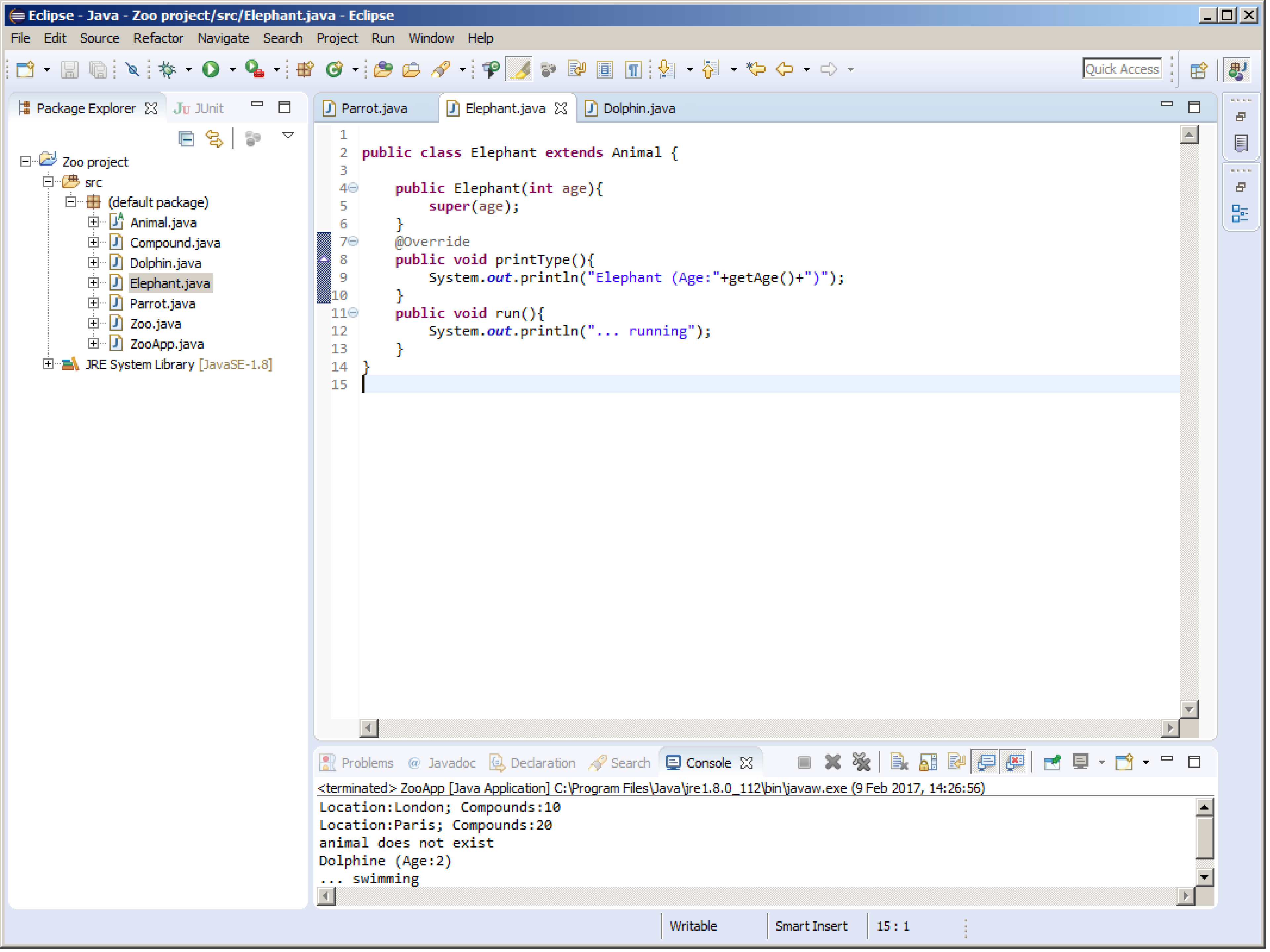

```java

public class Elephant extends Animal {

    public Elephant(int age){
        super(age);
    }
    @Override
    public void printType(){
        System.out.println("Elephant (Age:"+getAge()+")");
    }
    public void run(){
        System.out.println("... running");
    }
}

```

```
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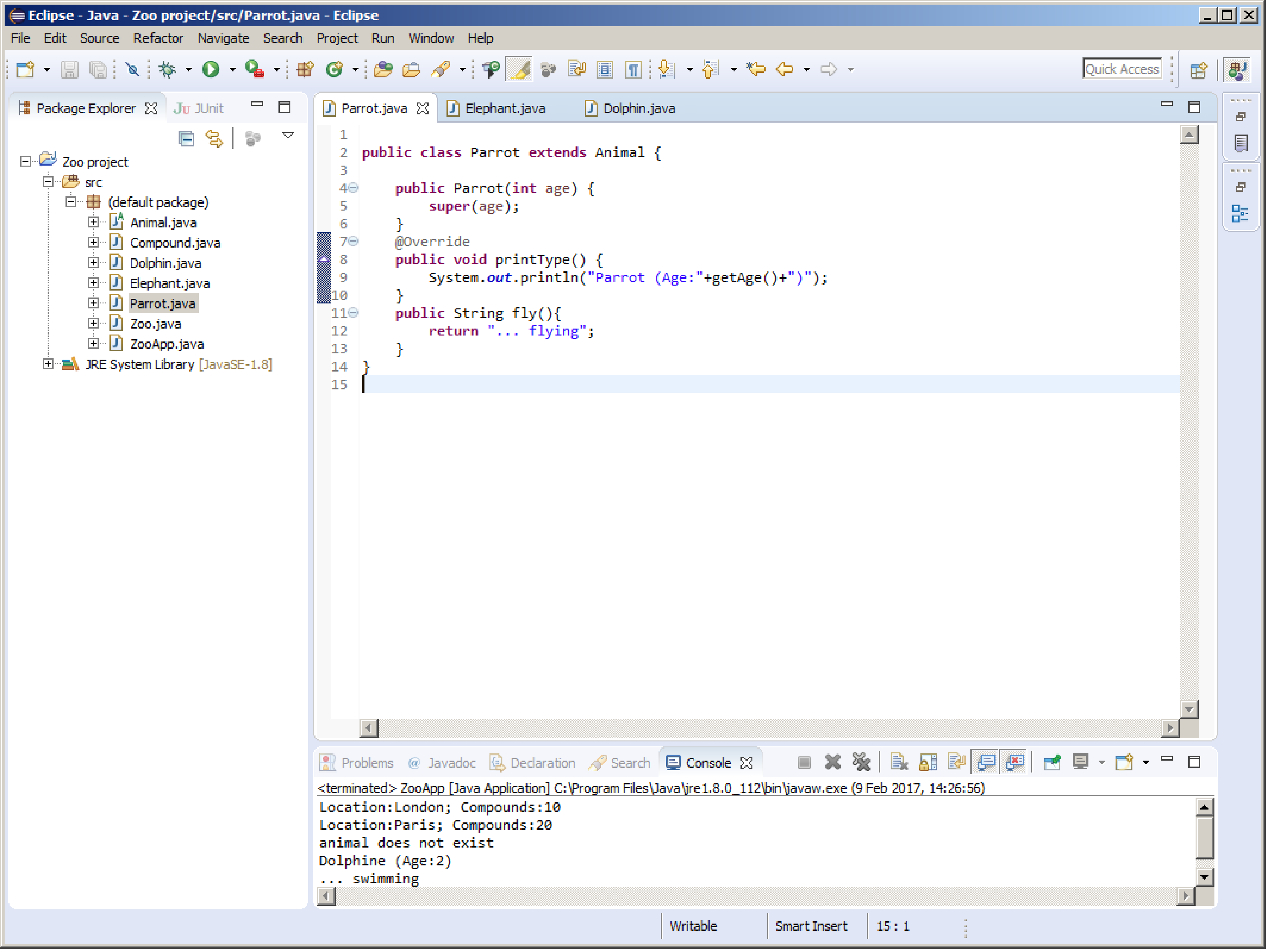

```java

public class Parrot extends Animal {

    public Parrot(int age) {
        super(age);
    }
    @Override
    public void printType() {
        System.out.println("Parrot (Age:"+getAge()+")");
    }
    public String fly(){
        return "... flying";
    }
}

```

```
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Location:London; Compounds:10
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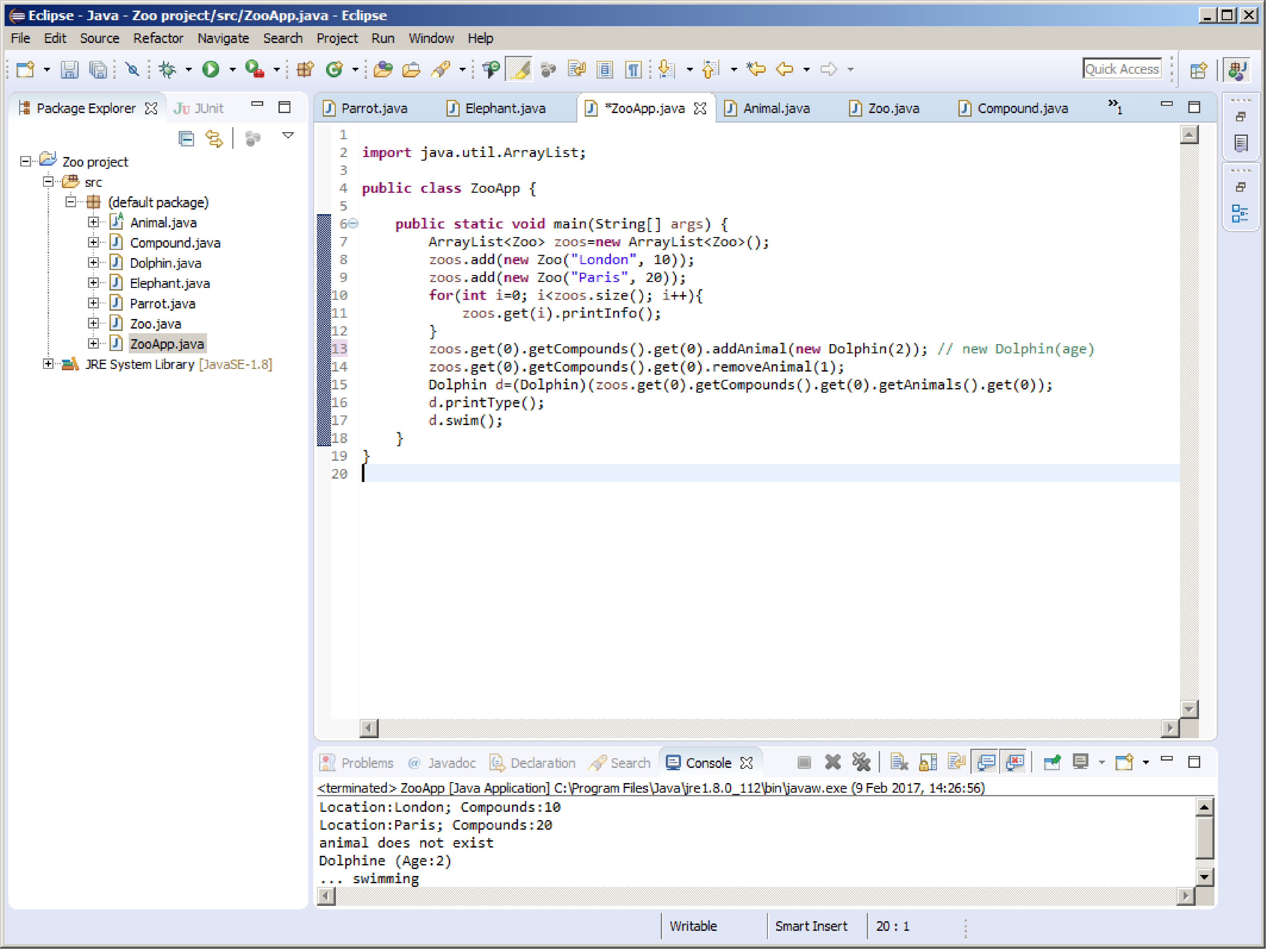

```java

import java.util.ArrayList;

public class ZooApp {

    public static void main(String[] args) {
        ArrayList<Zoo> zoos=new ArrayList<Zoo>();
        zoos.add(new Zoo("London", 10));
        zoos.add(new Zoo("Paris", 20));
        for(int i=0; i<zoos.size(); i++){
            zoos.get(i).printInfo();
        }
        zoos.get(0).getCompounds().get(0).addAnimal(new Dolphin(2)); // new Dolphin(age)
        zoos.get(0).getCompounds().get(0).removeAnimal(1);
        Dolphin d=(Dolphin)(zoos.get(0).getCompounds().get(0).getAnimals().get(0));
        d.printType();
        d.swim();
    }
}

```

```
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Location:London; Compounds:10
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animal does not exist
Dolphine (Age:2)
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```

Java Basics for AnyLogic

- General remarks
  - You do not have to learn full OO programming
    - You need to understand Java data types, expression, and statement syntax
  - Please note:
    - Java is case-sensitive: MyVar is different to myVar!
    - Spaces are not allowed in names: "My Var" is an illegal name!
    - Each statement has to be finished with ";": MyVar=150;
    - Each function has to have parenthesis: time(), add(a)
    - Mind integer division: 3/2=1, not 1.5
    - Boolean values are only true and false, you cannot use 1 and 0
    - Dot "." brings you "inside" the object: agent.event.restart()
    - Array elements have indexes from 0 to n-1

Java Basics for AnyLogic

- Primitive Types
  - double: Represents real numbers: 1.43, 3.6E18, -14.0
  - int: Represents integer numbers: 12, 16384, -5000
  - boolean: Represents Boolean (true/false) values

- Compound Types –Classes
  - String: Represents textual strings, e.g. "MSFT", "Hi there!", etc.
  - ArrayList; LinkedList: Represents collections of objects
  - HyperArray: Represents multi-dimensional array
  - …many others. See AnyLogic and Java Class References

Java Basics for AnyLogic

- Arithmetic operations
  - Notation: +; –; *; /; % (remainder)
  - In integer divisions, the fraction part is lost, e.g. 3/2=1, and 2/3=0
  - Multiplication operators have priority over addition operators
  - The "+" operator allows operands of type String

- Comparison operations
  - Notation: >; >=; <; <=; ==; !=

- Boolean operations
  - Notation: && (AND); || (OR); ! (NOT)

Java Basics for AnyLogic

- Conditional operator
  - Notation: condition ? value-if-true : value-if-false

- Assignments and shortcuts
  - Notation: =; +=; -=; *=; /=; %=; ++; -- (a+=b is the same as a=a+b)

- Please note:
  - Within most of operators, left-to-right precedence holds
  - Parentheses may be used to alter the precedence of operations

Java Basics for AnyLogic

- Method call
  - To call a method, type its name followed by parenthesis; if necessary, put parameters separated by commas within the parenthesis
    - Examples:
      - x=time(); moveTo(getX(),getY()+100); traceln("Population is increasing");

- Accessing object fields and methods
  - To access a field or method of a model element (statechart, timer, animation), use the model element name followed by dot "." followed by the field/method name
    - Examples:
      - statechart.fireEvent("go"); sum=sum+agents.get(i).x;

Java Basics for AnyLogic

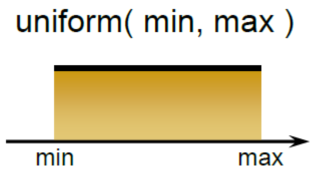
- Replicated objects are stored in a collection
  - Items are indexed from 0 to n-1
  - Getting the current size of the collection:
    - people.size()
  - Obtaining i-th item of the collection:
    - people.get(i)
  - Adding a new object to the collection:
    - add_people();
  - Removing an object from the collection:
    - remove_people(person);

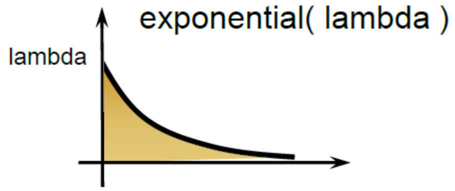
Java Basics for AnyLogic

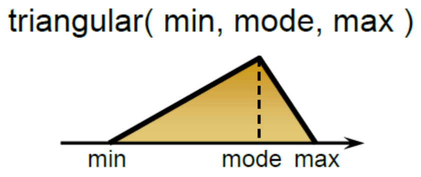
- Built-in Functions
  - System functions
    - time(); getOwner(); pause(); isStateActive(…); etc.
  - Mathematical functions
    - Basic: sqrt; sin; cos; tan; exp; log; round; zidz; xidz; etc.
    - Array: add; sub; mul; sum; avg; min; max; get; etc.
  - Special functions
    - Random numbers: uniform; exponential; bernoulli; beta; etc.
    - Time related: delay; etc.
  - And more…
    - See AnyLogic Class Reference

Java Basics for AnyLogic

- Probability Distributions
  - **Uniform:** Used to represent a random variable with constant likelihood of being in any small interval between min and max. Its density does not depend on the value of x.
  - **Exponential:** Used to represent the time between random occurrences. The unique property is history independence, i.e. it has the same set of probabilities when shifted in time.
  - **Triangular:** Used when no or little data is available to represent e.g. a process duration.







Java Basics for AnyLogic

- Common contextual variables that are used by code snippets
  - In statistics:
    - "item" indicates current agent
  - In "On Message Received" handler for agent:
    - "msg" indicates received message
  - In Dynamic properties of an Agent's replicated line property:
    - "index" indicates current person's index
  - In "Parameters" properties of Agent populations (used to set properties of agents within population):
    - "index" indicates the index of the current agent in the population

For more useful advice see Nathaniel Osgood's "AnyLogic and Java" presentation (url)

Tutorial: Object Oriented DES

- Laptop model: Considering different power states

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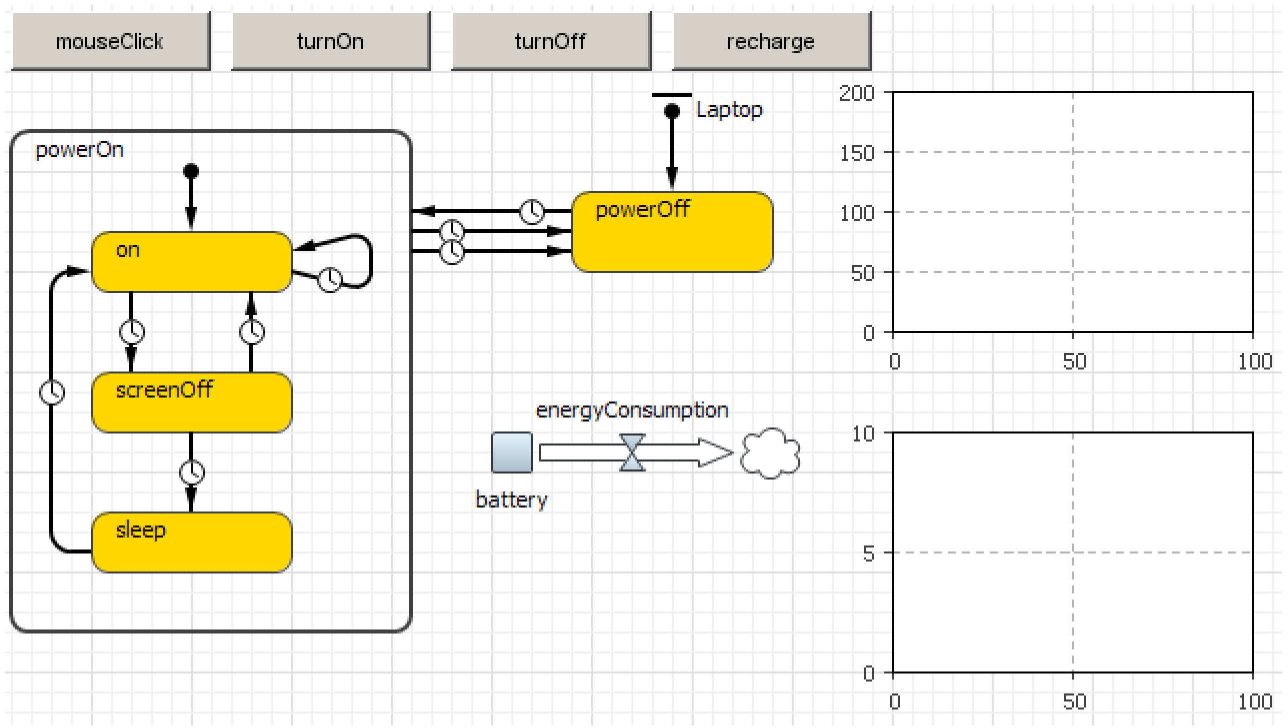

Questions