

JaguarCode: A Web-Based Object-Oriented Programming Environment with Static and Dynamic Visualization

Structure

- System demo
- Motivation
- Related work
- JaguarCode
 - System overview
 - Implementation
 - Static and dynamic visualization
 - Initial evaluation
 - Benefits and contributions
- Future work
- Collaborative research areas

Motivation

- Java programming language
 - Complex and difficulty due to the underlying object-oriented concepts and principles
- Programming environments
 - A single aspect of structural or functional behavior
- Difficulties of installing, setting up, modifying
 - JDK, IDEs, plug-ins, system environments

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Java Programming IDEs

- Standard IDEs
 - NetBeans
 - Eclipse
- Educational programming IDEs with visual notation
 - BlueJ
 - Jeliot 3 (stand alone or BlueJ plug in)
 - jGRASP
 - CoffeeDregs (stand alone or NetBeans plug in)
 - JIVE (Eclipse plug in)

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- Java SE
- Java EE
- Java ME
- Java SE Support
- Java SE Advanced & Suite
- Java Embedded
- Java DB
- Web Tier
- Java Card
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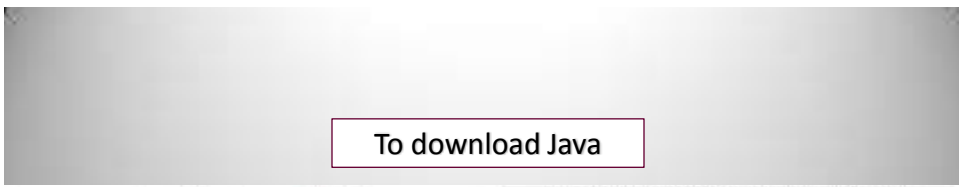
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IDE Language: English Platform: Windows

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<input checked="" type="checkbox"/> Java FX	•					•
<input checked="" type="checkbox"/> Java EE		•				•
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Windows x86	317.35 MB	jdk-8u121-nb-8_2-windows-i586.exe
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- License
- Java SE 8 Readme
- NB 8.2 3rd Party Readme
- Installation Instructions
- Java SE Release Notes

To download Eclipse for Java Developer

The screenshot shows the Eclipse IDE website for Java Developers. At the top, there is a navigation bar with the Eclipse logo, a search bar, and a 'DOWNLOAD' button. Below the navigation bar, there is a breadcrumb trail: HOME / DOWNLOADS / PACKAGES / ECLIPSE IDE FOR JAVA DEVELOPERS. The main content area is titled 'Eclipse IDE for Java Developers' and includes a 'Package Description' section. The description states: 'The essential tools for any Java developer, including a Java IDE, a CVS client, Git client, XML Editor, Mylyn, Maven integration and WindowBuilder'. It also lists the included packages: Code Recommenders Developer Tools, Eclipse Git Team Provider, Eclipse Java Development Tools, Maven integration for Eclipse, Mylyn Task List, WindowBuilder Core, and Eclipse XML, Editors and Tools. On the right side, there are 'Download Links' for Windows 32-bit, Windows 64-bit, Mac OS X (Cocoa) 32-bit, Mac OS X (Cocoa) 64-bit, Linux 32-bit, and Linux 64-bit. The download statistics show 1,044,994 downloads and a 'Checksums...' link.

BlueJ

The screenshot shows the BlueJ IDE interface. On the left, there is a 'Project: PolyShape' window displaying a class diagram. The diagram shows an abstract class 'Shape' with subclasses 'Sphere' and 'Cylinder'. There is also a class 'Ball' that inherits from 'Sphere' and 'Cylinder'. On the right, there is a 'Class Edit: Tools: Options' window showing the source code for the 'Shape' class. The code is as follows:

```

abstract public class Shape
{
    private String shapeName;

    public Shape (String name)
    {
        shapeName = name;
    }

    public abstract double area();

    public String toString()
    {
        return shapeName;
    }
}

```

At the bottom of the code editor, there is a status bar that says 'No changes need to be saved' and a 'Save' button.

Jeliot 3: Stand Alone or BlueJ plug-in

```

1  public static void main (String[] args)
2  {
3      Rectangle deck = new Rectangle(20, 35);
4      Sphere bigBall = new Sphere(15);
5      Cylinder tank = new Cylinder(10, 30);
6
7      System.out.println (deck + " and its area is " +
8      System.out.println (bigBall + " and its area is "
9      System.out.println (tank + " and its area is "
10 }
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```

The graphical environment shows the following components:

- Method Area:** Contains the 'Main class' with variables 'String[] args', 'Rectangle deck', and 'Sphere bigBall'.
- Constant Area:** Labeled 'CONSTANTS'.
- Object of the class Rectangle:** A box containing 'String shapeName: Rectangle', 'double length: 20.0', and 'double width: 35.0'.
- int length: 0:** A variable box labeled 'EMPTY ARRAY'.

```

1  public class Main {
2
3
4
5      public static void main (String[] args)
6      {
7          Rectangle deck = new Rectangle(20, 35);
8          Sphere bigBall = new Sphere(15);
9          Cylinder tank = new Cylinder(10, 30);
10
11          System.out.println (deck + " and its area is " +
12          System.out.println (bigBall + " and its area is " +
13          System.out.println (tank + " and its area is " +
14      }
15

```

The Object Diagram shows the following objects:

- String:1
- Rectangle:1
- Sphere:1
- Cylinder:1

The Sequence Diagram shows the following interactions:

- Main:1 creates Rectangle:1 Shape:1.
- Main:1 creates Sphere:1 Shape:2.
- Main:1 creates Cylinder:1 Shape:3.

The Console output shows the following text:

```

<terminated> Main [Java Application] C:\Program Files\Java\jre1.8.0_71\bin\javaw.exe (Jun 4, 2016)
Rectangle of length 20.0 and width 35.0 and its area is 700.0
Sphere of radius 15.0 and its area is 2827.4333882308138 and its area is 2827.4333882308138
Cylinder of radius 10.0 height 30.0 and its area is 9424.77756076938

```

JIVE: Eclipse plug-in

Limitations of the Tools

- All require software and/or plug-in installation
- All require secondary storage device (flash drive) to carry on their project files
- Tools provide
 - No visual notation with only text code
 - Only visualize static structural information
 - Only visualize dynamic run time state

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Proposed Approach: JaguarCode

- Web-based
 - No software or plug-in installation required
 - No storage system needed
- Provide along with source code
 - Structural static visualization with UML class diagrams
 - Dynamic run time state of program execution
 - Synchronized

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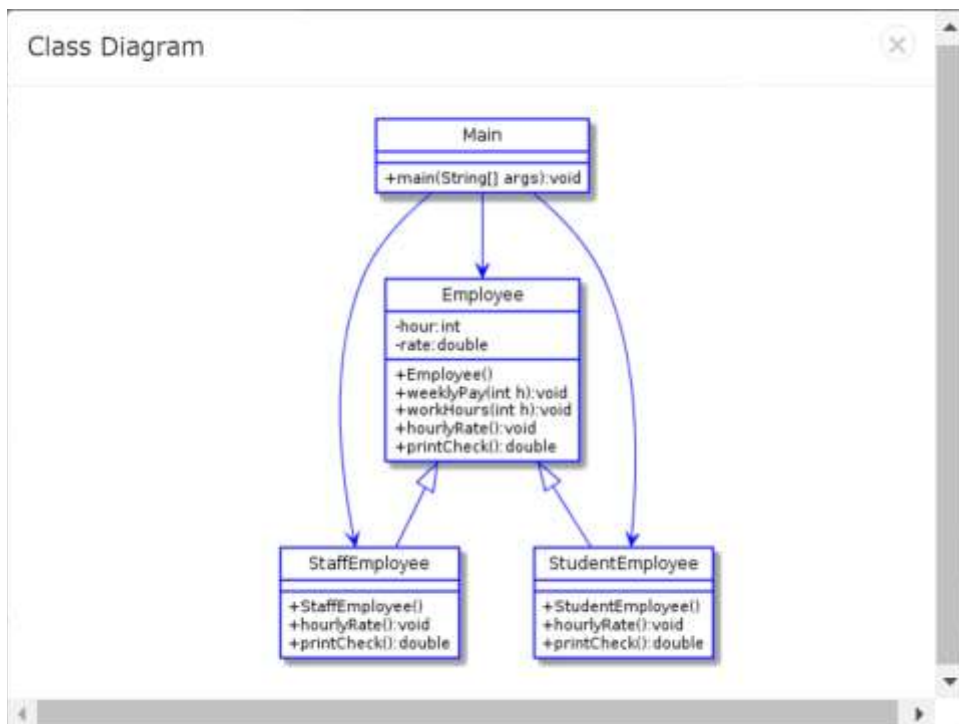
JaguarCode : All in One Window

The screenshot displays the JaguarCode IDE interface with three main sections:

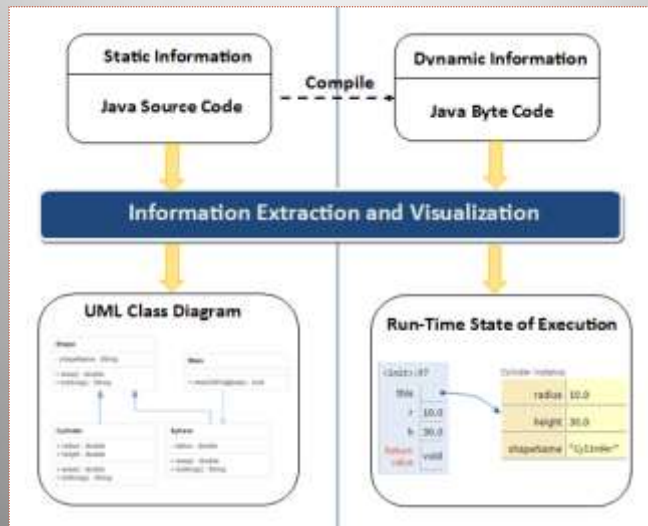
- Single UML:** A UML class diagram showing a `Main` class with a `+main(String[] args):void` method. It is connected to an `Employee` class, which is further connected to `StaffEmployee` and `StudentEmployee` classes.
- Editor Area:** A code editor showing the following Java code:


```

1: public class Main {
2:
3:     public static void main(String[] args){
4:
5:         Employee John = new Employee();
6:         John.weeklyPay(10);
7:         System.out.println("John's payment is " + John.printCheck()); //Prints 1
8:
9:         StudentEmployee Mary = new StudentEmployee();
10:        Mary.weeklyPay(15);
11:        System.out.println("Mary's payment is " + Mary.printCheck()); //Prints 2
12:
13:        StaffEmployee Henry = new StaffEmployee();
14:        Henry.weeklyPay(20);
15:        System.out.println("Henry's payment is " + Henry.printCheck()); //Prints 3
16:
17:    }
18:
19: }
```
- Run Time Status:** A runtime status window showing the execution of the code. It displays the state of objects:
 - `John` (Employee instance) with `hour: 10` and `rate: 10.0`.
 - `Mary` (StudentEmployee instance) with `hour: 15` and `rate: 0.0`.
 - `Henry` (StaffEmployee instance) with `hour: 20` and `rate: 0.0`.



JaguarCode: System Overview



JaguarCode: Development Environment

- AWS (Amazon Web Services) cloud computing platform
- On the back end server
 - Ubuntu operating system
 - Apache 2 HTTP server
 - MySQL 5 database server
 - Java 7 and 8
 - PhpMyAdmin
 - to handle the administration of the MySQL
 - to interact with its database
 - to manage user and project files

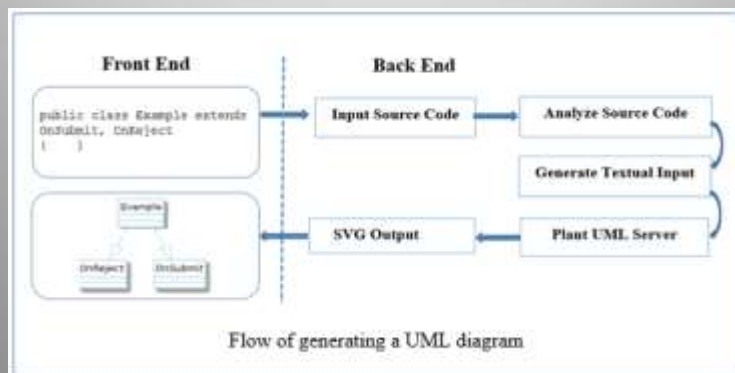
JaguarCode: Implementation

- Implemented with
 - A front end written in HTML5, CSS, JS, and jQuery
 - A back end written in PHP and Java
- For the editor
 - Ace, an embedded open-source code editor, is fully integrated
- For the static UML class diagram
 - Plant UML is customized and integrated
- For the dynamic run-time state visualization
 - Java Visualizer, created by David Pritchard, Will Gwozdz (https://cscircles.cemc.uwaterloo.ca/java_visualize/)
 - **Python Tutor**, created by Philip Guo (<http://www.pythontutor.com/>)

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UML Class Diagrams

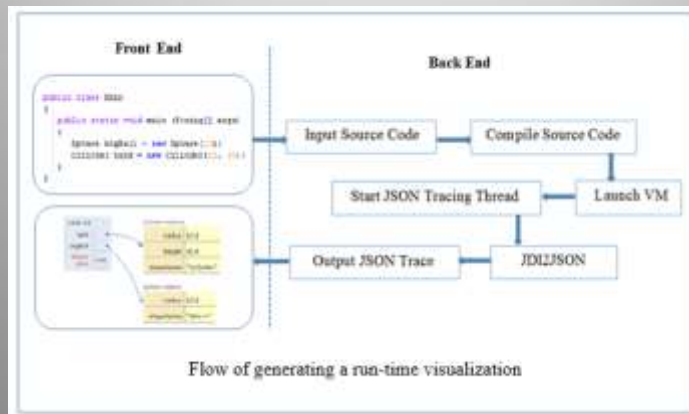
- Using Plant UML
 - Web-based open source visualization tool



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Run Time Visualization

- Use Java Visualizer
 - Web-based Java visualization tool



JaguarCode: Target Users

- Students
 - Learn how to program in Java
 - Learn how to design an OO system
- Instructors
 - Teach Java programming course
 - Design a OO system
- Professional developers
 - Can benefit in tracing their code for debugging

Results of Initial Experiments

- Quantitative evaluation
 - Measure learning effectiveness on student performance of OO programming tasks
 - Two aspects of visualizations
 - Experimental group consistently performed better than the controlled group
- Qualitative evaluation
 - Measure usability, comfortability, satisfaction from student feedback
 - Students were satisfied and comfortable with
 - two aspects of visualizations
 - its user friendly interface

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Experiments to be Conducted

- One
 - With students enrolled in CISA 4305 Java Programming course at TAMU-San Antonio
- Another
 - With students enrolled in CSEN 5322 Software Engineering course at TAMU-Kingsville
- And more...

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Benefits and Contributions

- Web-based
 - No software or plug-in installation
 - No setting up or modifying system environment variables
 - No storage system needed to keep and manage project files
 - Freed from concern about version changes of Java language, IDEs, OS
 - Programming patterns can be saved in log files for individualized mentoring
- Synchronized static and dynamic visualization
 - static structure of Java programs for OO design concepts
 - dynamic behavior of the programs for debugging purposes

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Future Work

- Provide
 - Object and sequence diagrams
 - Individual programming behavioral pattern
 - Mentoring/tutoring capability
 - Secure coding capability
- Support more languages: C, C++, Python
- Deploy everything with our own server on campus

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Collaborative Research Areas

- Shared resource and data with cloud computing
- Apps on a web platform
- Apps on a mobile platform (Android, iOS)
- Educational Data Mining
- Learning Analytics

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Acknowledgement

- TAMU-San Antonio
 - Dr. Jeong Yang, Assistant Professor of CS
- TAMU-Kingsville
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 - Sruth for Object and Sequence diagrams
 - Past graduate students
 - Madhusudan Srinivasan for sequence diagram
 - Sai Kiran for back end programming
 - Swetha Murthy for front end programming

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