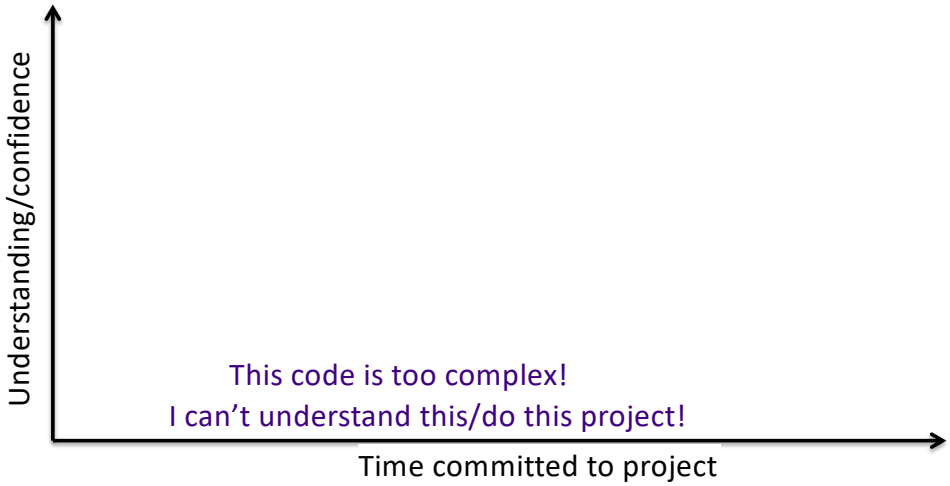
Objectives

- Picasso Design
- Reflection
- GUIs in Java
  - Anonymous inner classes

1

Typical Trajectory of Projects



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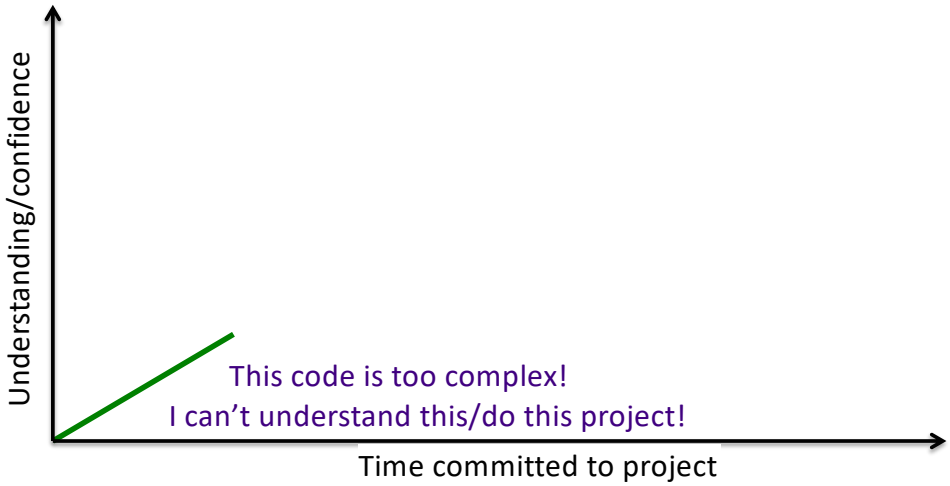
Typical Trajectory of Projects



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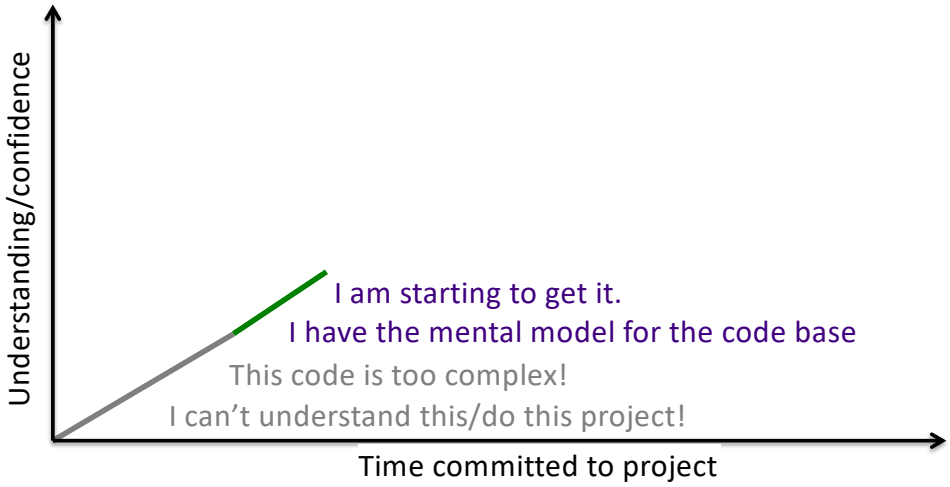
Typical Trajectory of Projects



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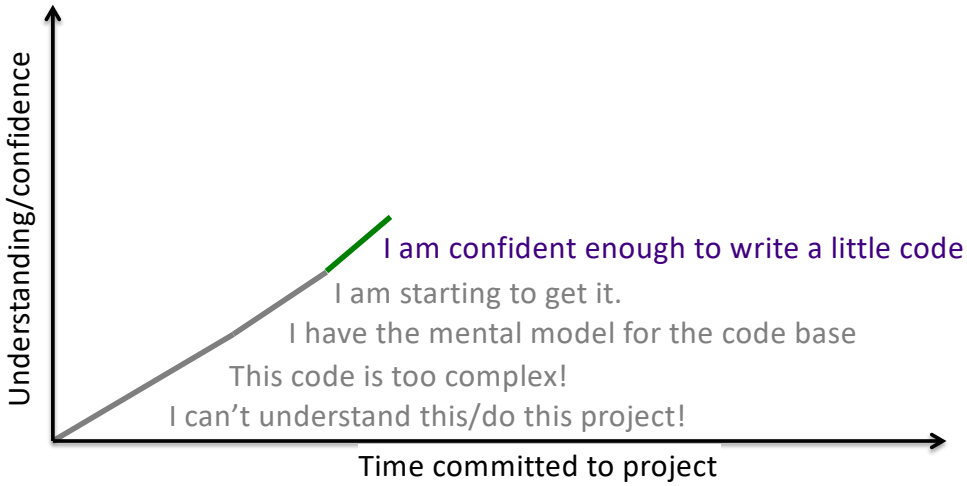
Typical Trajectory of Projects



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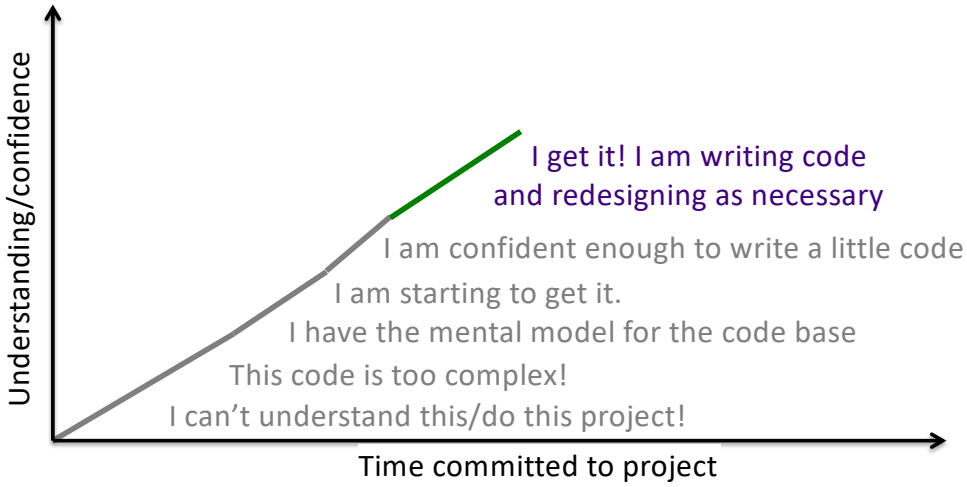
Typical Trajectory of Projects



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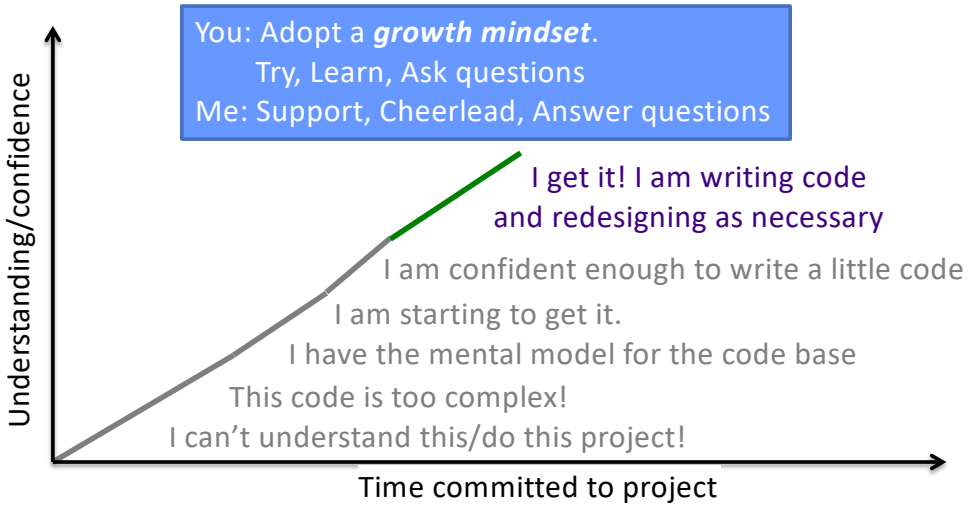
Our Responsibilities



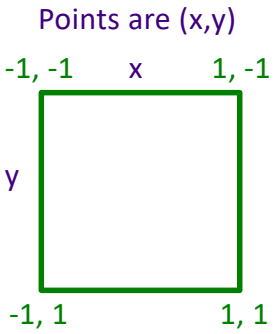
Review

- What is the goal of the Picasso project?
- When you click the Evaluate button in the given version of Picasso, it generates the image for `floor(y)`
  - Explain why the generated image looks like this:
    - Include the constraints/rules of Picasso

- How does an interpreter interpret a programming language?
- What should we think about during design and analysis of a project?
  - What are best practices?
- How should we learn a code base?

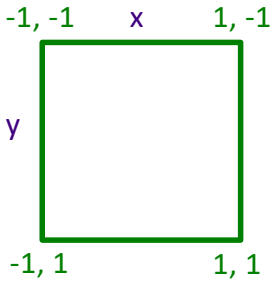
Review: Picasso Project Overview

- Goal: Generate images from expressions
- Every pixel at position (x,y) gets assigned a color, computed from its x and y coordinate and the given expression
  - Range for x and y is [-1, 1]
- Colors are represented as RGB [red, green, blue] values
  - Component's range [-1, 1]
  - Black is [-1,-1,-1]
  - Red is [1,-1,-1]
  - Yellow is [1, 1,-1]

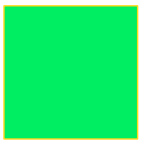


Review: Generating Images from Expressions

- ***Expressions*** at a specific (x,y) point/pixel evaluate to *RGB colors* [r,g,b]
  - `pixels[x][y] = expression.evaluate(x, y)`
- **x** evaluates to RGB color [x, x, x]
- In top right corner,
  - x evaluates to [1, 1, 1]
  - y evaluates to [-1, -1, -1]



Review: Generated Expressions



[-1, 1, -1]

x

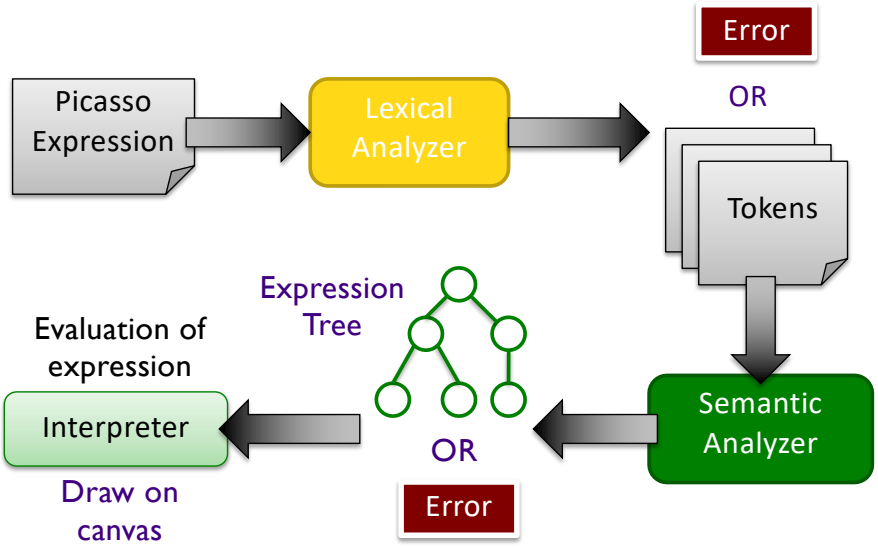
x*y

```
For all x:
    For all y:
        pixels[x][y] = expression.evaluate(x, y)
```


Review: Programming Language Design

- Must be unambiguous
  - Programming Language defines a ***syntax*** and ***semantics***
- Interpreting programming languages
  1. Parse program into tokens
  2. Verify that tokens are in a valid form
  3. Generate executable code
  4. Execute code

Review: Interpreting the Picasso Language

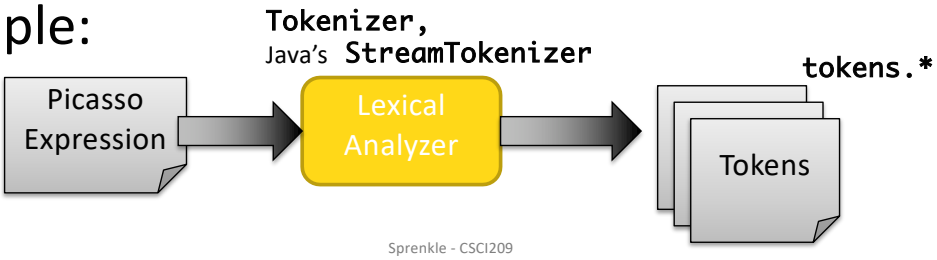


Understanding the Code

- How does the given code map to lexical analysis, semantic analysis, and evaluation components?
  - Look for packages, classes that map to these steps
- Suggestions:
  - Look for important words/terms from problem domain
  - Look for terms from design patterns
  - Put code in black boxes or group code together
- Task: Label the process picture with the associated packages/classes

Process of Understanding Code: Building Your Mental Model

- Look for important words/terms from problem domain
- Look for terms from design patterns
- Put code in black boxes or group code together
- Example:



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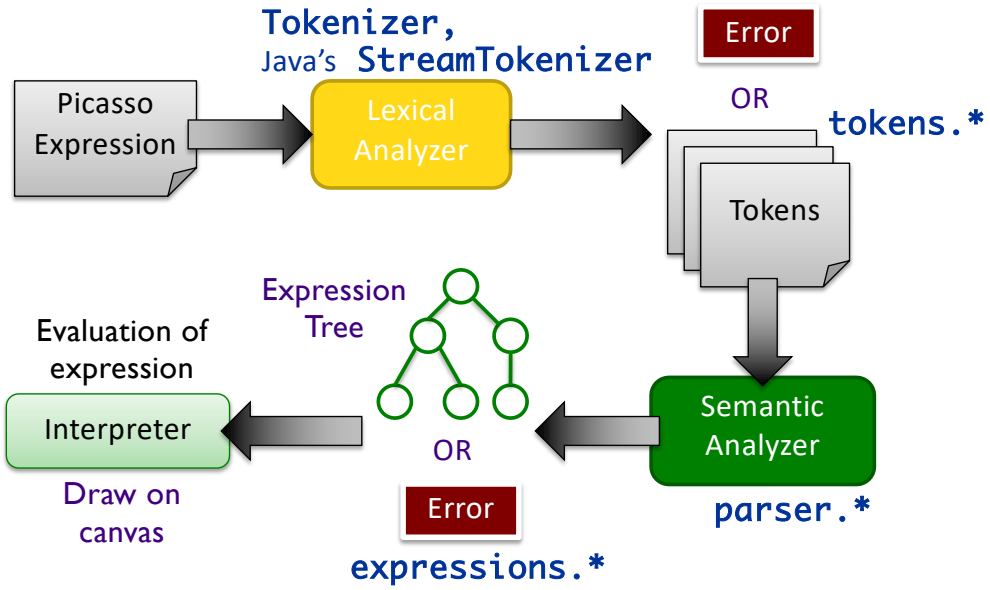
Interpreting the Picasso Language



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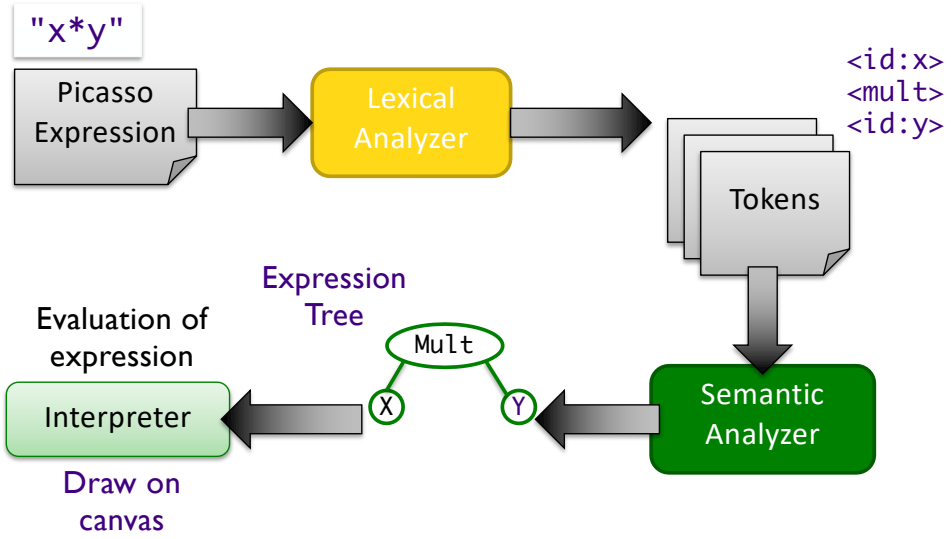
Process of Understanding Code: Building Your Mental Model

- Apply spiral model to understanding code
- Review problem specification (low-cost effort)
- Explore code at the top-level (low-cost effort)
  - Look at packages, class names
  - Don't take a deep-dive until you have the bigger picture

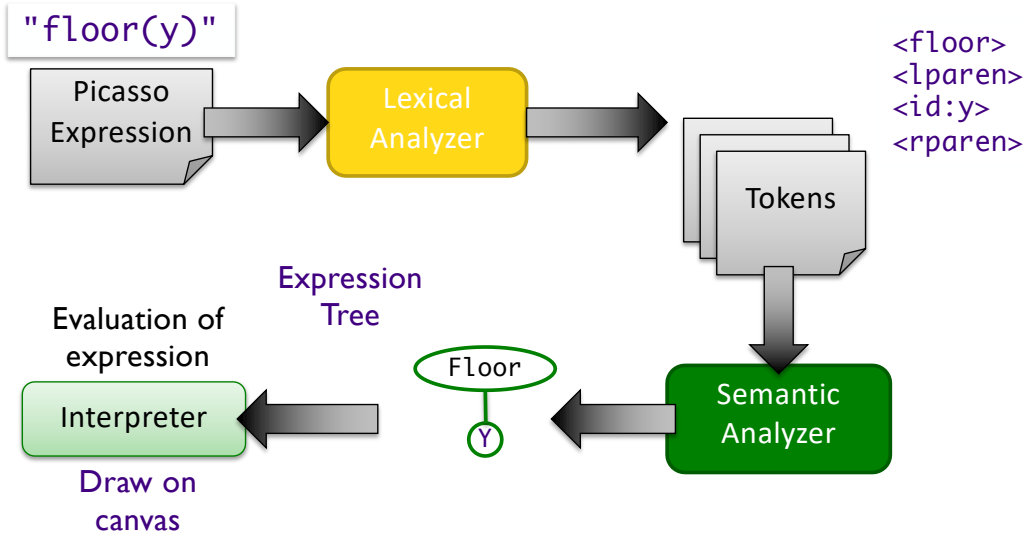
Process of Understanding Code: Building Your Mental Model

- After you have the big picture, look at most important classes
- Decide: Does this class merit a closer look? Or do I just need the big picture of what it does?
  - Lean towards the latter towards the beginning
- Iterate!
  - Grow your mental model
  - What a "closer look" means changes over time
    - Early: what methods does the class have? What classes does this object interact with?
    - Later: what do these methods do? How does this class interact with other objects?

Interpreting the Picasso Language



Interpreting the Picasso Language



Understanding the Code: Lexical Analysis

- Process
  - `picasso.parser.Tokenizer`
  - `picasso.parser.tokens.TokenFactory`
- Output:
  - `picasso.parser.tokens.*`

Understanding the Code: Semantic Analysis

- Process
  - `picasso.parser.ExpressionTreeGenerator`
  - `picasso.parser.SemanticAnalyzer`
  - `picasso.parser.*Analyzer`
- Output
  - `picasso.parser.language.expressions.*`

Understanding the Code: Evaluation

- Process
  - picasso.parser.language.ExpressionTreeNode
- Output:
  - picasso.parser.language.expressions.RGBColor
- Displayed in PixMap on Canvas

Understanding the Code: Evaluation

- Key Parent class:

picasso.parser.language.ExpressionTreeNode

```
public abstract RGBColor evaluate(double x, double y);
```

- "Old" version of expressions:
  - ReferenceForExpressionEvaluations

Using Reflection in Java

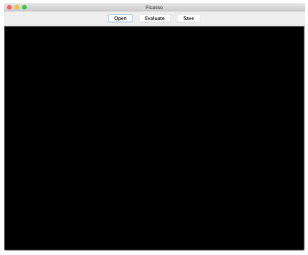
- *Reflection* allows us to create objects of a class using the *name* of the class
- Example adapted from MutantMaker:

```
public static void initMutantMaker() {
     mutants = new Mutant[numMutants];
     mutants[0] = new Wolverine();
     for (int i = 1; i < numMutants; i++) {
          Class<?> mutantClass;
          try {
               mutantClass = Class.forName("mutants.Mutant"+ i);
               mutants[i] = (Mutant)
                    mutantClass.getDeclaredConstructor().newInstance();
          } catch (Exception e) {
                    e.printStackTrace();
          }
     }
}
```


Using Reflection in Java

- Can create objects of a class through the *name* of the class
- Used in `SemanticAnalyzer`
  - Gets list of functions
    - Read from `conf/functions.conf`
  - Maps a token to the class responsible for parsing that type of token
  - When `SemanticAnalyzer` sees that token, calls the respective analyzer to parse
  - Example: `FloorToken` maps to the `FloorAnalyzer`
    - `FloorAnalyzer` pops the `Floor` token off the stack and then parses the (one) parameter for the *floor* function

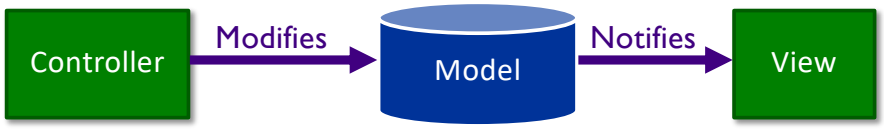
Understanding Code: A Top-Down Approach



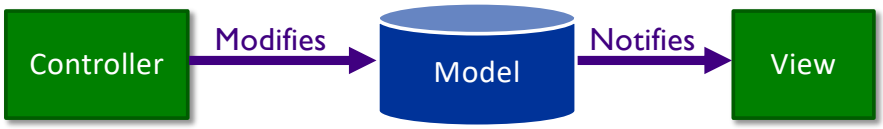
- Run program
- Start at `Main.java`
  - Follow calls to see how GUI is created
    - Breadth- or depth-first search
  - What classes make up the GUI?
- GUIs often follow the MVC design pattern
  - Identify the model, view-controller in Picasso

Model - Viewer - Controller (MVC)

- A common **design pattern** for GUIs
- Loosely coupled
  - Model: application data
  - View: graphical representation
  - Controller: input processing

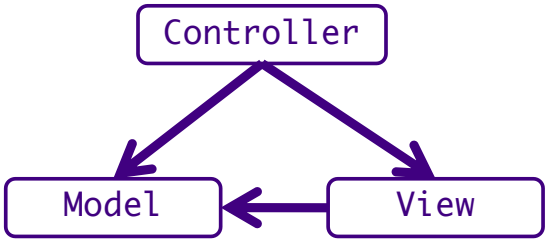


Model-Viewer-Controller

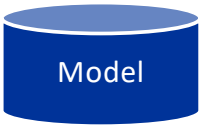


- Can have multiple viewers and controllers
- Goal: modify one component without affecting others

Direct associations

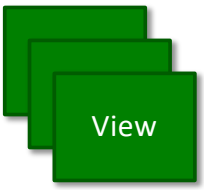


Model



- Represents application state
- Responsible for managing application state
- Purely **functional**
  - Nothing about how view presented to user

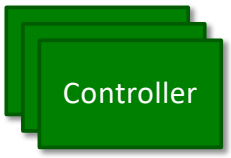
Multiple Views



- Provides graphical components for model
  - Look & Feel of the application
- User manipulates view
  - Informs **controller** of change

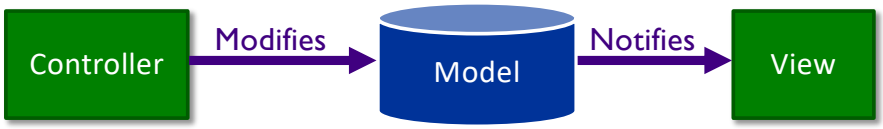
- Example of multiple views: spreadsheet data
  - Rows/columns in spreadsheet
  - Pie chart, bar chart, …

Controller(s)



- Handles user input
- Update **model** as user interacts with **view**
  - Call model's methods (often mutators)
  - Makes decisions about behavior of model based on UI
- Views are associated with controllers

Discussion: Map MVC to Goblin Game



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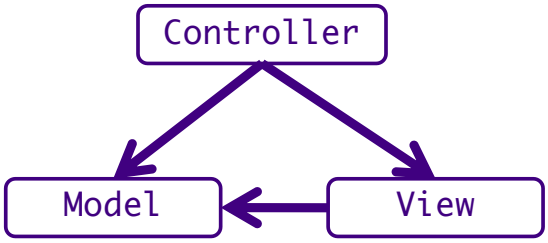
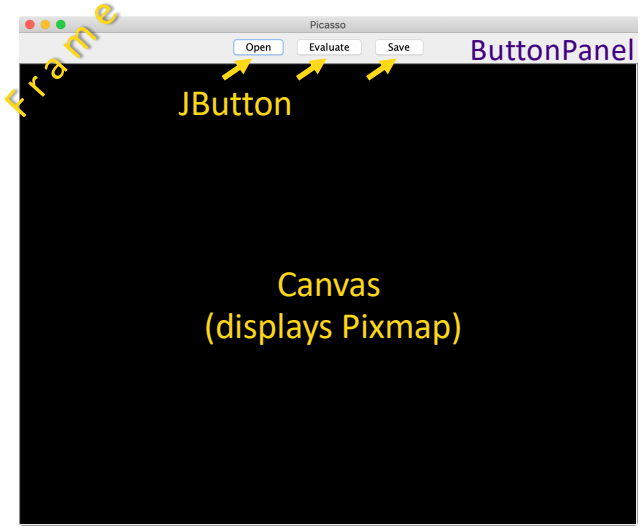


Picasso GUI



Picasso's GUI uses classes from two main Java packages:

- Abstract Windowing Toolkit: `java.awt`
- Swing: `javax.swing`

Understanding GUI Code

- In `ButtonPanel.java`, buttons are associated with a command or action

```
private Canvas myView;
…
public void add(String buttonText, final Command<Pixmap> action) {
    JButton button = new JButton(buttonText);
    button.addActionListener(new ActionListener() {
        public void actionPerformed(ActionEvent e) {
            action.execute(myView.getPixmap());
            myView.refresh();
        }
    });
    add(button);
}
```


Understanding GUI Code

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JButton's ActionListener says what to do when button is pressed

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            myView.refresh();
        }
    });
    add(button);
}
```

Defines an ***anonymous inner class*** and creates an object of that type.
Benefits: can access private data in class

Anonymous Inner Classes

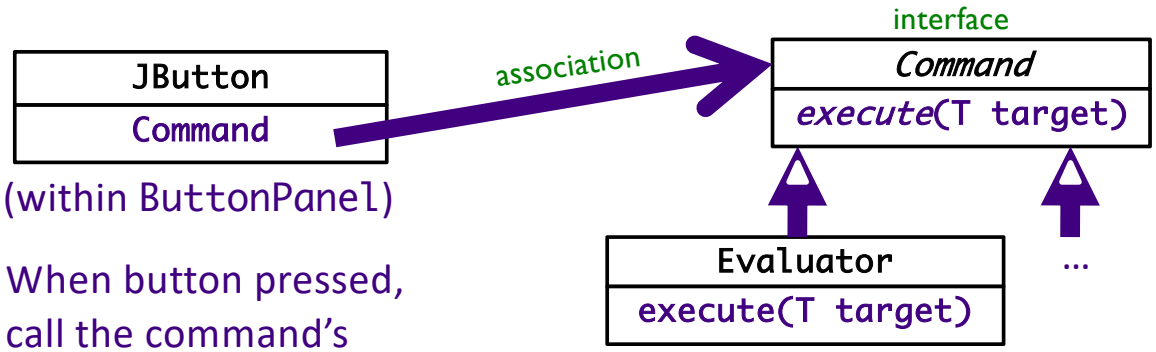
- Common way to write (certain) code
- No classname
  - Class is *anonymous*
- Extends a parent class or implements an interface

the parent class/interface

```
new ActionListener() {
        public void actionPerformed(ActionEvent e) {
            action.execute(myView.getPixmap());
            myView.refresh();
        }
    }
```

Method implementations

Picasso GUI: ButtonPanel



(within ButtonPanel)

When button pressed, call the command's execute method

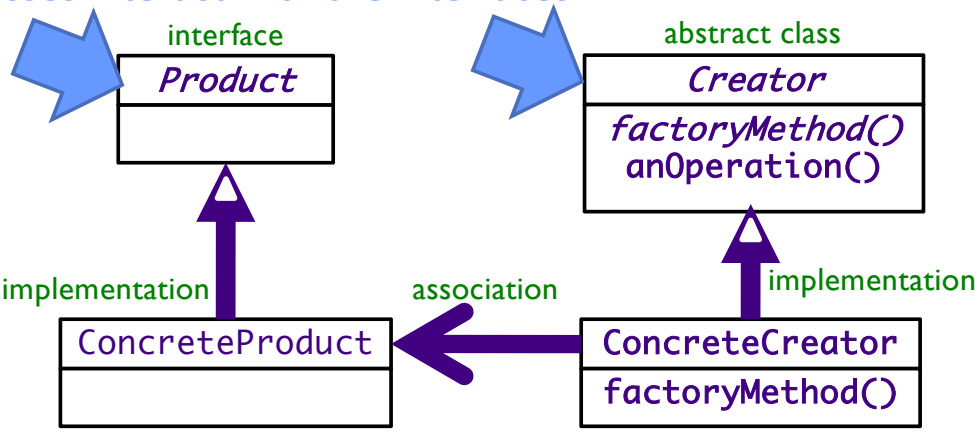
FACTORY DESIGN PATTERN

Design Pattern: **Factory Methods**

- Allows creating objects without specifying exact (concrete) class of created object
- Often used to refer to any method whose main purpose is creating objects
- How it works:
  1. Define a method for creating objects
  2. Child classes override method to specify the derived type of product that will be created

Factory Method Pattern

Client classes interact with the interfaces



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Dependency Inversion Principle

Depend upon Abstractions

"Inversion" from the way you think

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Understanding Picasso Code

- Start in `Evaluator` command's `execute` method

TODO

- Project Analysis due Friday before class