Principles of Software Construction: Objects, Design, and Concurrency

Libraries and Frameworks

(Design for large-scale reuse)

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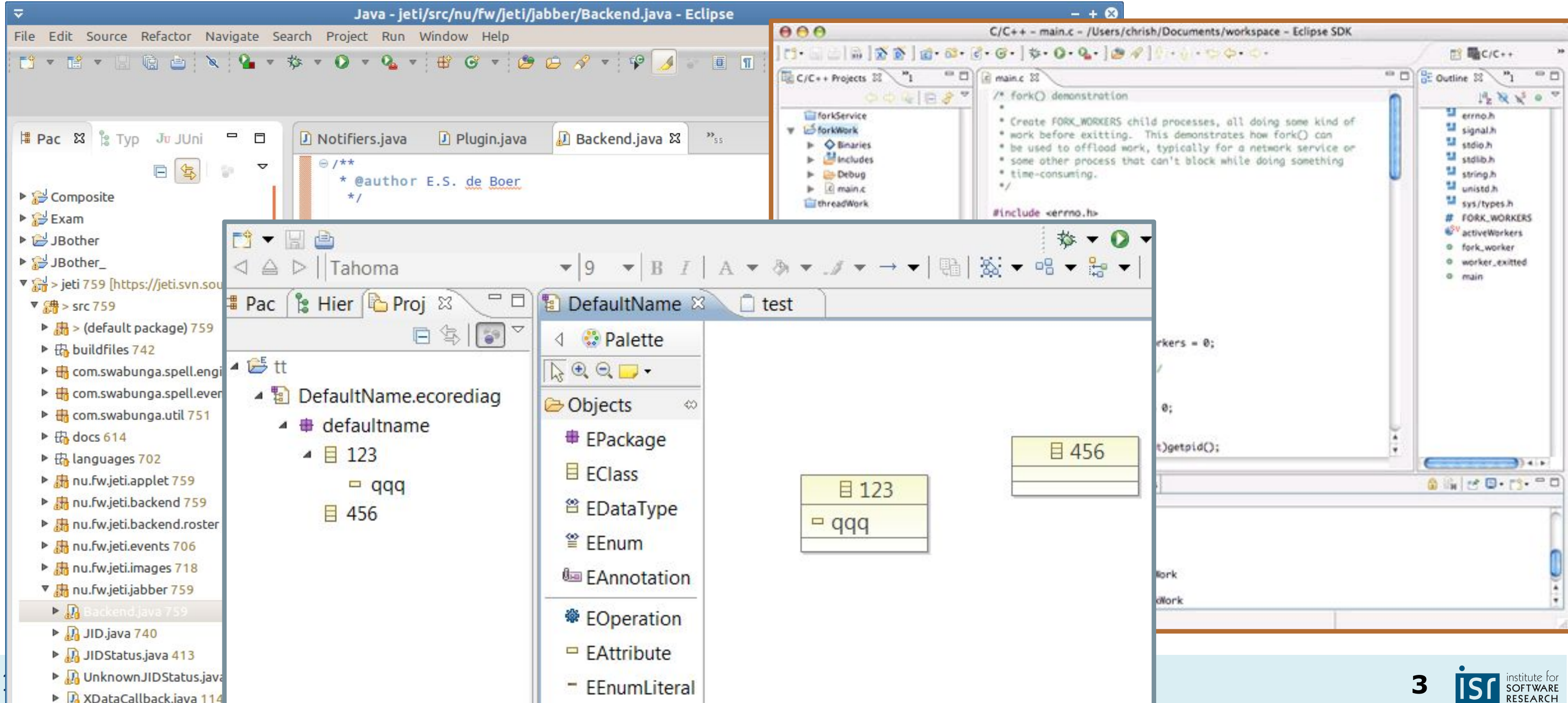
Learning goals for today

- Describe example well-known example frameworks
- Know key terminology related to frameworks
- Know common design patterns in different types of frameworks
- Discuss differences in design trade-offs for libraries vs. frameworks
- Analyze a problem domain to define commonalities and extension points (cold spots and hot spots)
- Analyze trade-offs in the use vs. reuse dilemma
- Know common framework implementation choices

Reuse and variation: Family of development tools

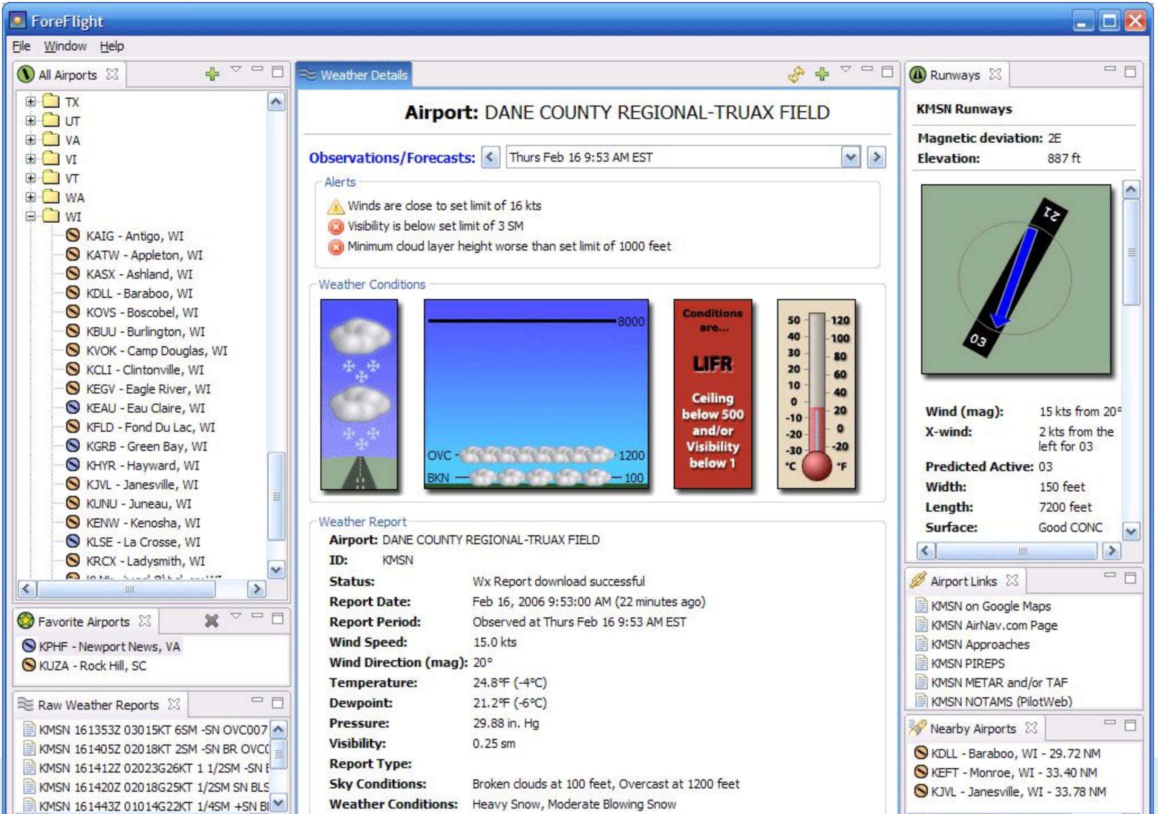


```
/**
 * @author E.S. de Boer
 */
```

```
/* fork() demonstration
 *
 * Create FORK_WORKERS child processes, all doing some kind of
 * work before exitting.  This demonstrates how fork() can
 * be used to offload work, typically for a network service or
 * some other process that can't block while doing something
 * time-consuming.
 */

#include <errno.h>
```

Reuse and variation:
Eclipse Rich Client Platform



ForeFlight

File Window Help

All Airports

- TX
- UT
- VA
- VI
- VT
- WA
- WI
  - KAIG - Antigo, WI
  - KATW - Appleton, WI
  - KASX - Ashland, WI
  - KDLL - Baraboo, WI
  - KOVS - Boscobel, WI
  - KBUU - Burlington, WI
  - KVOK - Camp Douglas, WI
  - KCLI - Clintonville, WI
  - KEGV - Eagle River, WI
  - KEAU - Eau Claire, WI
  - KFLD - Fond Du Lac, WI
  - KGRB - Green Bay, WI
  - KHYR - Hayward, WI
  - KJVL - Janesville, WI
  - KUNU - Juneau, WI
  - KENW - Kenosha, WI
  - KLSE - La Crosse, WI
  - KRCX - Ladysmith, WI

Favorite Airports

- KPHF - Newport News, VA
- KUZA - Rock Hill, SC

Raw Weather Reports

```
KMSN 161353Z 03015KT 6SM -SN OVC007
KMSN 161405Z 02018KT 2SM -SN BR OVC(
KMSN 161412Z 02023G26KT 1 1/2SM -SN E
KMSN 161420Z 02018G25KT 1/2SM SN BLS
KMSN 161443Z 01014G22KT 1/4SM +SN BI
```

Weather Details

Airport: DANE COUNTY REGIONAL-TRUAX FIELD

Observations/Forecasts: Thurs Feb 16 9:53 AM EST

Alerts

- Winds are close to set limit of 16 kts
- Visibility is below set limit of 3 SM
- Minimum cloud layer height worse than set limit of 1000 feet

Weather Conditions

8000
OVC
1200
BKN
100
Conditions are...
LIFR
Ceiling below 500 and/or Visibility below 1
50 40 30 20 10 0 -10 -20 -30 °C
120 100 80 60 40 20 0 -20 °F

Weather Report

Airport: DANE COUNTY REGIONAL-TRUAX FIELD
ID: KMSN
Status: Wx Report download successful
Report Date: Feb 16, 2006 9:53:00 AM (22 minutes ago)
Report Period: Observed at Thurs Feb 16 9:53 AM EST
Wind Speed: 15.0 kts
Wind Direction (mag): 20°
Temperature: 24.8°F (-4°C)
Dewpoint: 21.2°F (-6°C)
Pressure: 29.88 in. Hg
Visibility: 0.25 sm
Report Type:
Sky Conditions: Broken clouds at 100 feet, Overcast at 1200 feet
Weather Conditions: Heavy Snow, Moderate Blowing Snow

Runways

KMSN Runways

Magnetic deviation: 2E
Elevation: 887 ft

Wind (mag): 15 kts from 20°
X-wind: 2 kts from the left for 03
Predicted Active: 03
Width: 150 feet
Length: 7200 feet
Surface: Good CONC

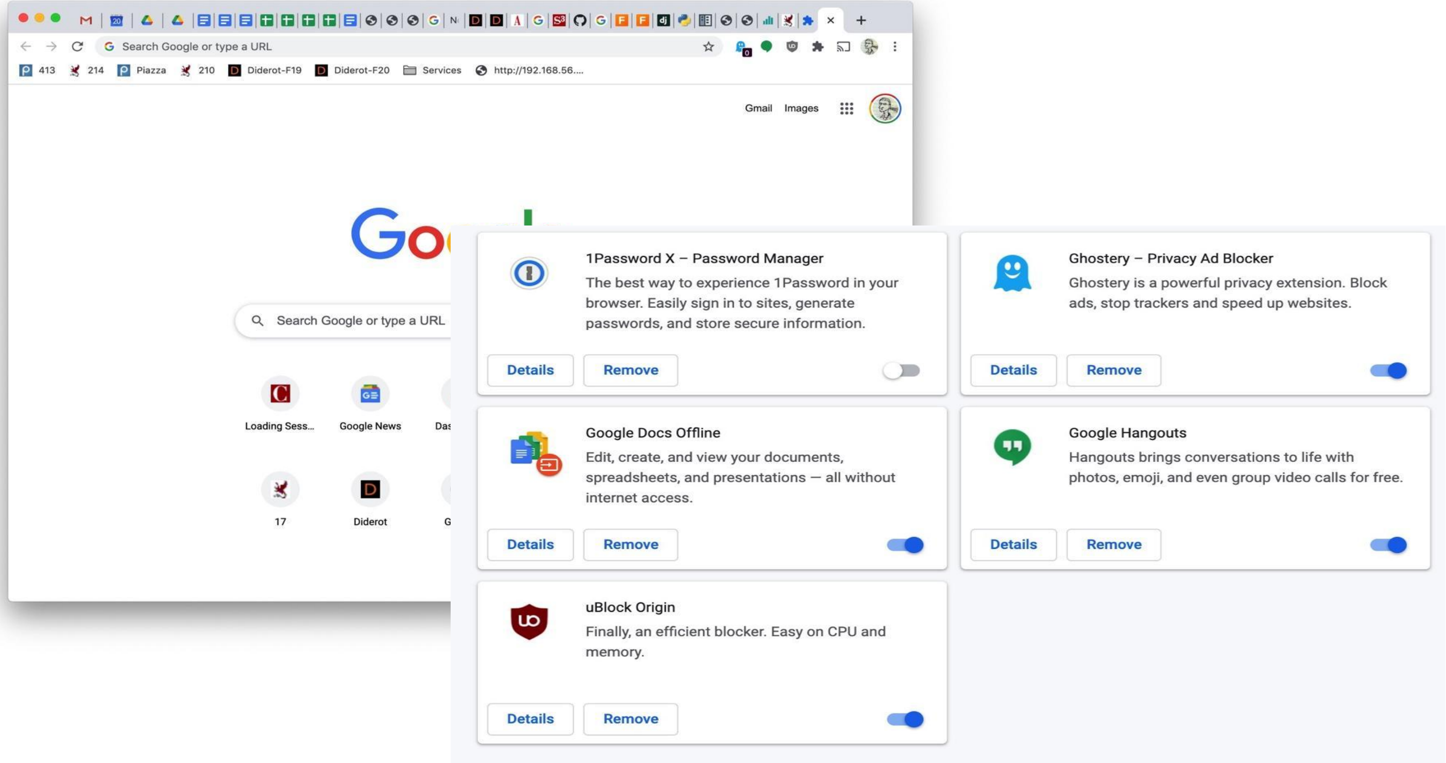
Airport Links

- KMSN on Google Maps
- KMSN AirNav.com Page
- KMSN Approaches
- KMSN PIREPS
- KMSN METAR and/or TAF
- KMSN NOTAMS (PilotWeb)

Nearby Airports

- KDLL - Baraboo, WI - 29.72 NM
- KEFT - Monroe, WI - 33.40 NM
- KJVL - Janesville, WI - 33.78 NM

Reuse and variation:
Web browser extensions



1Password X – Password Manager

The best way to experience 1Password in your browser. Easily sign in to sites, generate passwords, and store secure information.

Details Remove

Ghostery – Privacy Ad Blocker

Ghostery is a powerful privacy extension. Block ads, stop trackers and speed up websites.

Details Remove

Google Docs Offline

Edit, create, and view your documents, spreadsheets, and presentations — all without internet access.

Details Remove

Google Hangouts

Hangouts brings conversations to life with photos, emoji, and even group video calls for free.

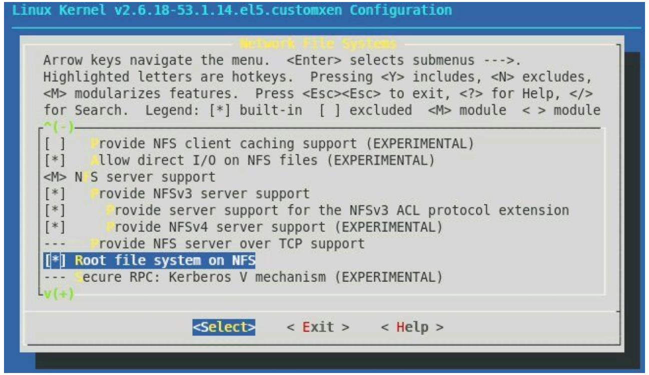
Details Remove

uBlock Origin

Finally, an efficient blocker. Easy on CPU and memory.

Details Remove

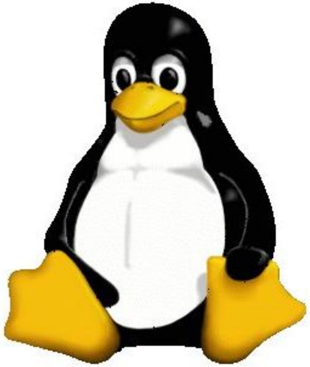
Reuse and variation: Flavors of Linux



```
Linux Kernel v2.6.18-53.1.14.el5.customxen Configuration

                     Network File Systems
 Arrow keys navigate the menu.  <Enter> selects submenus --->.
 Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
 <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </>
 for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < > module
^(-)
 [ ]   Provide NFS client caching support (EXPERIMENTAL)
 [*]   Allow direct I/O on NFS files (EXPERIMENTAL)
 <M> NFS server support
 [*]   Provide NFSv3 server support
 [*]     Provide server support for the NFSv3 ACL protocol extension
 [*]     Provide NFSv4 server support (EXPERIMENTAL)
 ---   Provide NFS server over TCP support
 [*] Root file system on NFS
 --- Secure RPC: Kerberos V mechanism (EXPERIMENTAL)
v(+)

          <Select>    < Exit >    < Help >
```



Reuse and variation: Product lines

Earlier in this course: **Class-level** reuse

Language mechanisms supporting reuse

- Inheritance
- Subtype polymorphism (dynamic dispatch)
- Parametric polymorphism (generics)

Design principles supporting reuse

- Small interfaces
- Information hiding
- Low coupling
- High cohesion

Design patterns supporting reuse

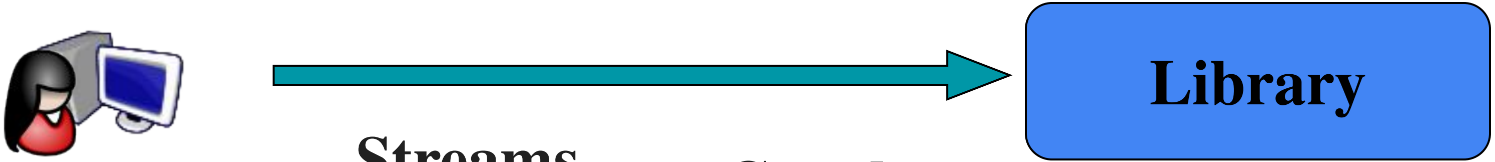
- Template method, decorator, strategy, composite, adapter, …

Today: Reuse **at scale**

- Examples, terminology
- Whitebox and blackbox frameworks
- Design considerations
- Implementation details
  - Responsibility for running the framework
  - Loading plugins

Terminology: Libraries

- Library: A set of classes and methods that provide reusable functionality



Library

Streams

Graphs

I/O

Math

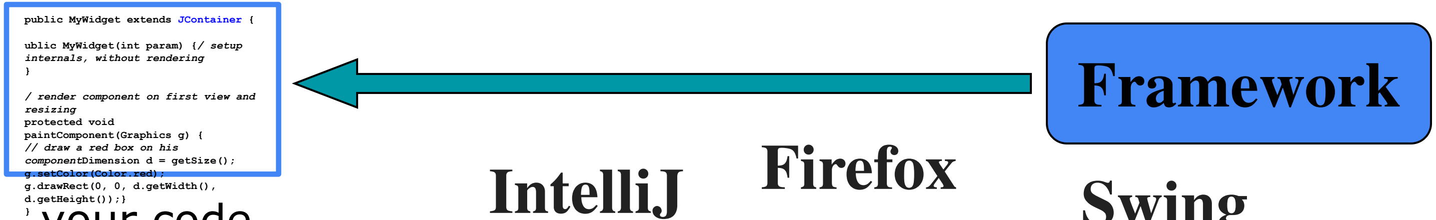
Swing

Collections

CLI Parsing

Terminology: Frameworks

- Framework: Reusable skeleton code that can be customized into an application
- Framework calls back into client code
    - The Hollywood principle: “Don’t call us. W



```
public MyWidget extends JContainer {

ublic MyWidget(int param) {/ setup
internals, without rendering
}

/ render component on first view and
resizing
protected void
paintComponent(Graphics g) {
// draw a red box on his
componentDimension d = getSize();
g.setColor(Color.red);
g.drawRect(0, 0, d.getWidth(),
d.getHeight());}
}
```

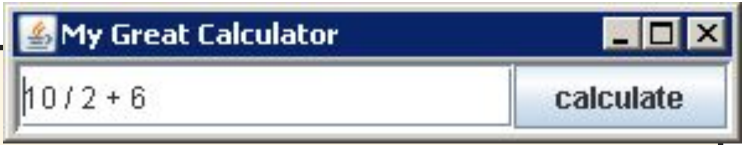
your code

Framework

IntelliJ   Firefox   Swing

Express   NanoHttpd   Spring

A calculator example (without a framework)

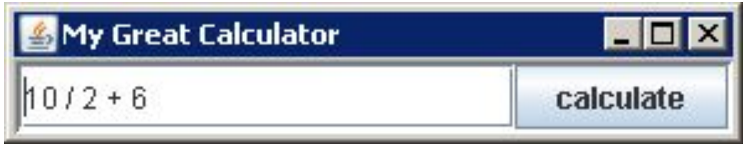


10 / 2 + 6

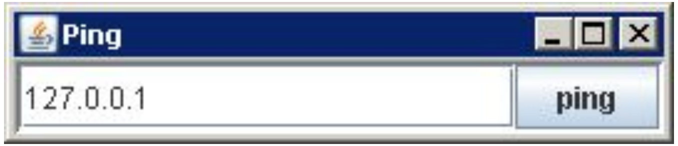
```
public class Calc extends JFrame {
  private JTextField textField;
  public Calc() {
      JPanel contentPane = new JPanel(new BorderLayout());
      contentPane.setBorder(new BevelBorder(BevelBorder.LOWERED));
      JButton button = new JButton();
      button.setText("calculate");
      contentPane.add(button, BorderLayout.EAST);
      textField = new JTextField("");
      textField.setText("10 / 2 + 6");
      textField.setPreferredSize(new Dimension(200, 20));
      contentPane.add(textfield, BorderLayout.WEST);
      button.addActionListener(/* calculation code */);
      this.setContentPane(contentPane);
      this.pack();
      this.setLocation(100, 100);
      this.setTitle("My Great Calculator");
      ...
  }
}
```

A simple example framework

- Consider a family of programs consisting of a button and text field only:



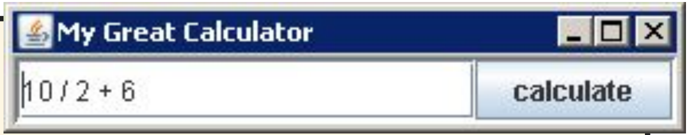
10 / 2 + 6



127.0.0.1

- What source code might be shared?

A calculator example (without a framework)



10 / 2 + 6

```
public class Calc extends JFrame {
  private JTextField textField;
  public Calc() {
      JPanel contentPane = new JPanel(new BorderLayout());
      contentPane.setBorder(new BevelBorder(BevelBorder.LOWERED));
      JButton button = new JButton();
      button.setText("calculate");
      contentPane.add(button, BorderLayout.EAST);
      textField = new JTextField("");
      textField.setText("10 / 2 + 6");
      textField.setPreferredSize(new Dimension(200, 20));
      contentPane.add(textfield, BorderLayout.WEST);
      button.addActionListener(/* calculation code */);
      this.setContentPane(contentPane);
      this.pack();
      this.setLocation(100, 100);
      this.setTitle("My Great Calculator");
```

A simple example framework

```
public abstract class Application extends JFrame {
  protected String getApplicationTitle() { return ""; }
  protected String getButtonText() { return ""; }
  protected String getInitialText() { return ""; }
  protected void buttonClicked() { }
  private JTextField textField;
  public Application() {
      JPanel contentPane = new JPanel(new BorderLayout());
      contentPane.setBorder(new BevelBorder(BevelBorder.LOWERED));
      JButton button = new JButton();
      button.setText(getButtonText());
      contentPane.add(button, BorderLayout.EAST);
      textField = new JTextField("");
      textField.setText(getInitialText());
      textField.setPreferredSize(new Dimension(200, 20));
      contentPane.add(textField, BorderLayout.WEST);
      button.addActionListener((e) -> { buttonClicked(); });
      this.setContentPane(contentPane);
      this.pack();
```

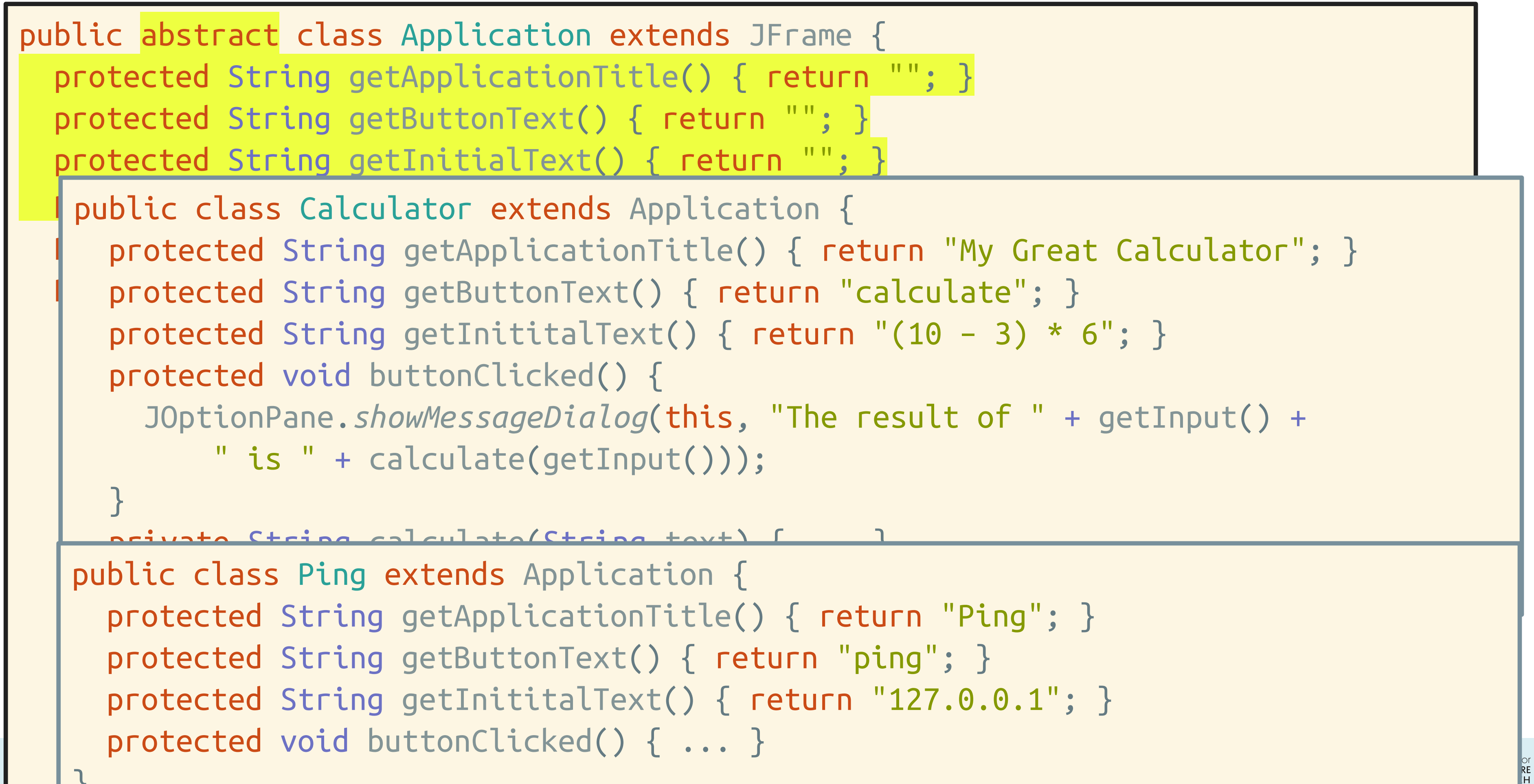
Using the example framework

```java
public abstract class Application extends JFrame {
  protected String getApplicationTitle() { return ""; }
  protected String getButtonText() { return ""; }
  protected String getInitialText() { return ""; }
```

```java
public class Calculator extends Application {
  protected String getApplicationTitle() { return "My Great Calculator"; }
  protected String getButtonText() { return "calculate"; }
  protected String getInititalText() { return "(10 - 3) * 6"; }
  protected void buttonClicked() {
    JOptionPane.showMessageDialog(this, "The result of " + getInput() +
        " is " + calculate(getInput()));
  }
  private String calculate(String text) { ... }
}
```

```java
    textField.setPreferredSize(new Dimension(200, 20));
    contentPane.add(textField, BorderLayout.WEST);
    button.addActionListener((e) -> { buttonClicked(); });
    this.setContentPane(contentPane);
    this.pack();
```

Using the example framework again

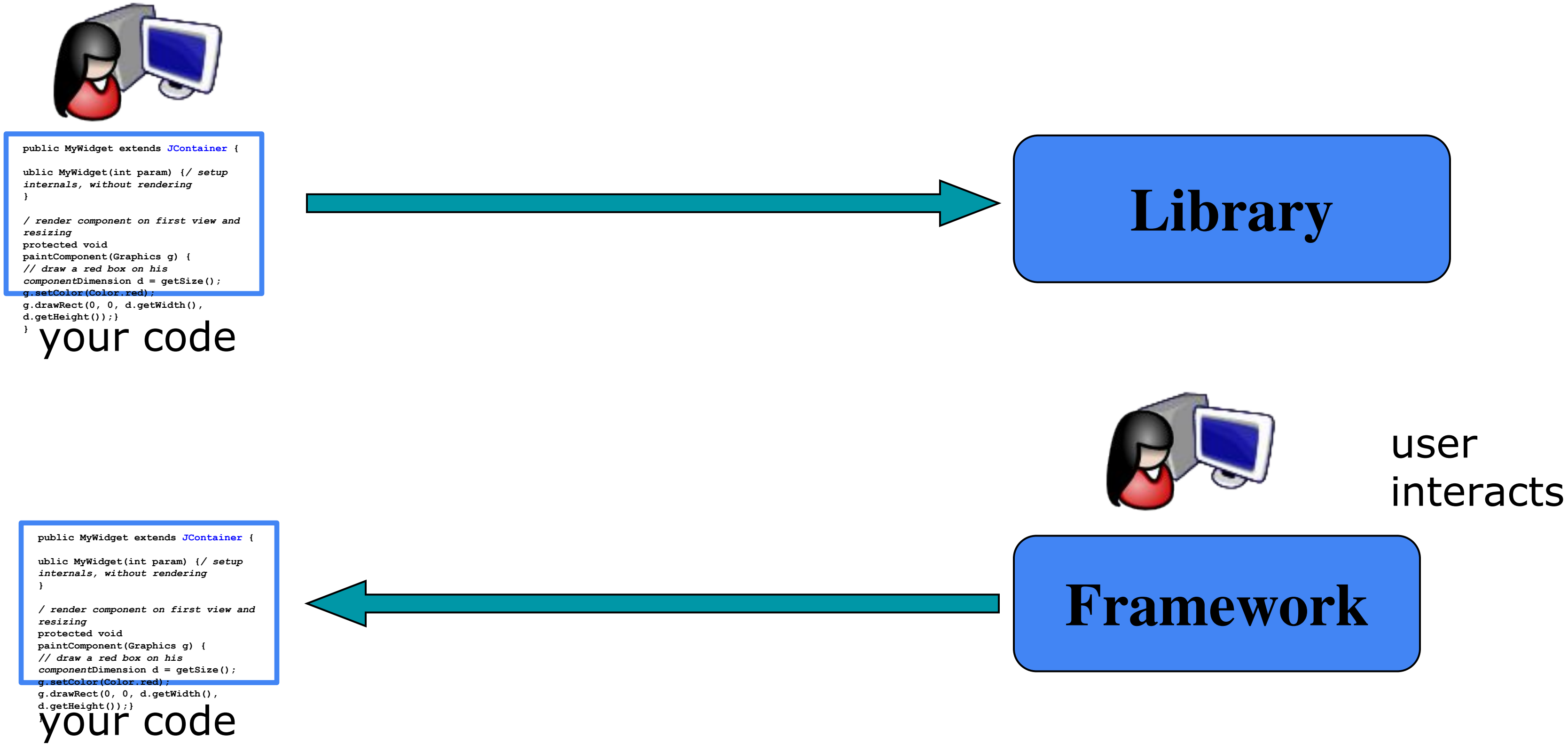


```
public abstract class Application extends JFrame {
  protected String getApplicationTitle() { return ""; }
  protected String getButtonText() { return ""; }
  protected String getInitialText() { return ""; }
```

```
public class Calculator extends Application {
  protected String getApplicationTitle() { return "My Great Calculator"; }
  protected String getButtonText() { return "calculate"; }
  protected String getInititalText() { return "(10 - 3) * 6"; }
  protected void buttonClicked() {
    JOptionPane.showMessageDialog(this, "The result of " + getInput() +
        " is " + calculate(getInput()));
  }
  private String calculate(String text) { ... }
```

```
public class Ping extends Application {
  protected String getApplicationTitle() { return "Ping"; }
  protected String getButtonText() { return "ping"; }
  protected String getInititalText() { return "127.0.0.1"; }
  protected void buttonClicked() { ... }
}
```

General distinction: Library vs. framework



```
public MyWidget extends JContainer {

ublic MyWidget(int param) {/ setup
internals, without rendering
}

/ render component on first view and
resizing
protected void
paintComponent(Graphics g) {
// draw a red box on his
componentDimension d = getSize();
g.setColor(Color.red);
g.drawRect(0, 0, d.getWidth(),
d.getHeight());}
}
```

your code

Library

```
public MyWidget extends JContainer {

ublic MyWidget(int param) {/ setup
internals, without rendering
}

/ render component on first view and
resizing
protected void
paintComponent(Graphics g) {
// draw a red box on his
componentDimension d = getSize();
g.setColor(Color.red);
g.drawRect(0, 0, d.getWidth(),
d.getHeight());}
```

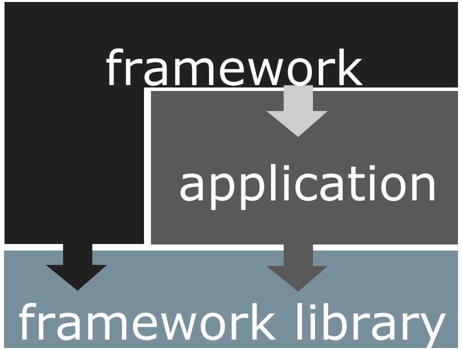
your code

user interacts

Framework

Libraries and frameworks in practice

- Defines key abstractions and their interfaces
- Defines object interactions & invariants
- Defines flow of control
- Provides architectural guidance
- Provides defaults



credit: Erich Gamma

Framework or library?

- IntelliJ / VSCode
- Java Collections / Node Streams

Framework or library?

- IntelliJ / VSCode
- Java Collections / Node Streams
- Command line parser
- Express/NanoHttpd
- Handlebars (the template library used in HW4)

- On a piece of paper:
  1. Describe the software (<= one sentence)
  2. Describe one way the software is like a library.
  3. Describe one way the software is like a framework.

Is Santorini a Framework?

More terms

- *API*: Application Programming Interface, the interface of a library or framework
- *Client*: The code that uses an API
- *Plugin*: Client code that customizes a framework
- *Extension point*: A place where a framework supports extension with a plugin

More terms

- *Protocol*: The expected sequence of interactions between the API and the client
- *Callback*: A plugin method that the framework will call to access customized functionality
- *Lifecycle method*: A callback method that gets called in a sequence according to the protocol and the state of the plugin

WHITE-BOX VS BLACK-BOX* FRAMEWORKS

* old terms, not aware of common replacements; maybe Inheritance-Based vs Delegation-Based Frameworks

Whitebox (inheritance-based) frameworks

- Extension via subclassing and overriding methods
- Common design pattern(s):
    - Template method
- Subclass has main method but gives control to framework

Blackbox (delegation-based) frameworks

- Extension via implementing a plugin interface
- Common design pattern(s):
    - Strategy
    - Command
    - Observer
- Plugin-loading mechanism loads plugins and gives control to the framework

Is this a whitebox or blackbox framework?

```java
public abstract class Application extends JFrame {
  protected String getApplicationTitle() { return ""; }
  protected String getButtonText() { return ""; }
  protected String getInitialText() { return ""; }
```

```java
public class Calculator extends Application {
  protected String getApplicationTitle() { return "My Great Calculator"; }
  protected String getButtonText() { return "calculate"; }
  protected String getInititalText() { return "(10 - 3) * 6"; }
  protected void buttonClicked() {
    JOptionPane.showMessageDialog(this, "The result of " + getInput() +
        " is " + calculate(getInput()));
  }
```

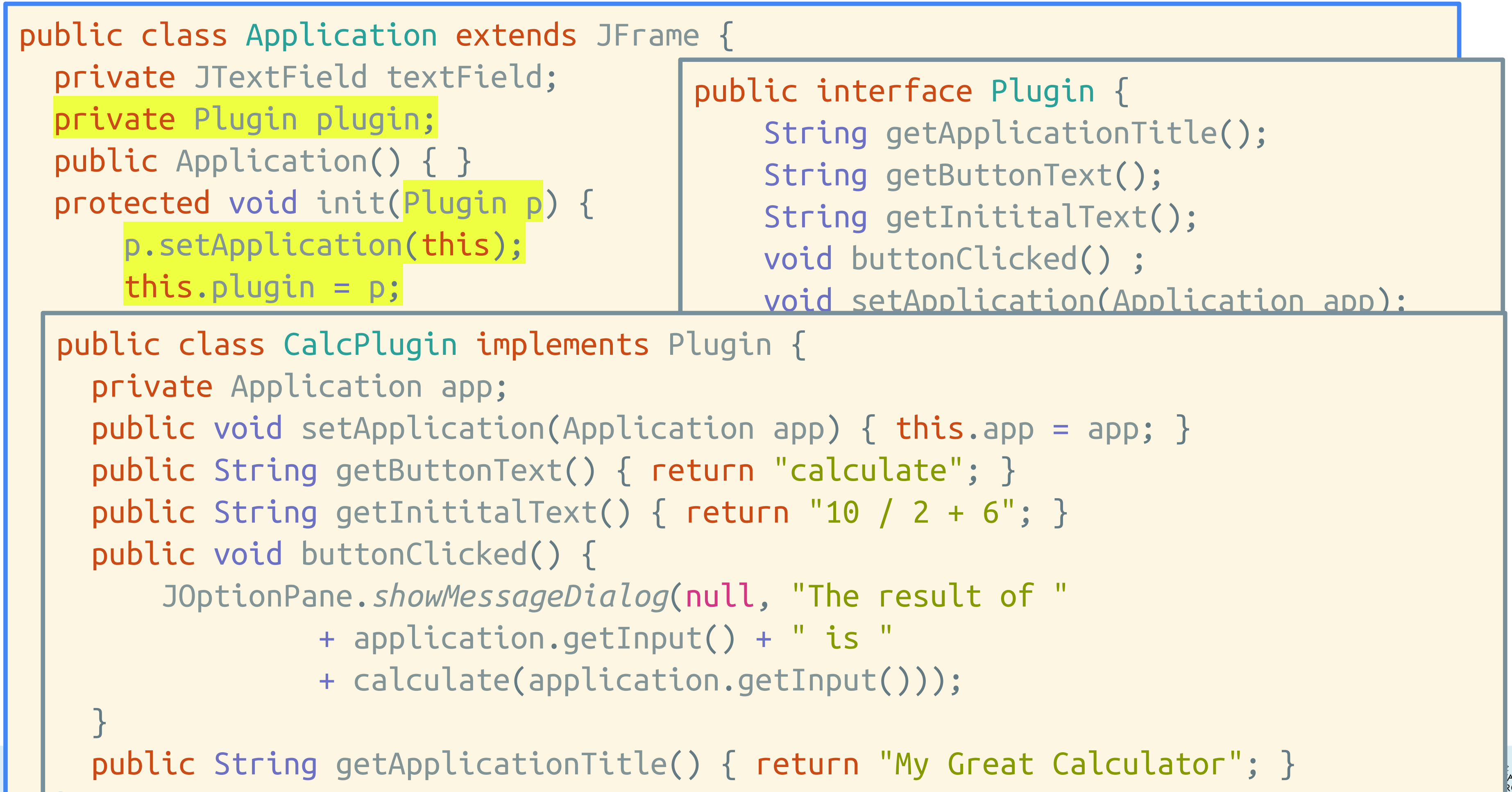
```java
public class Ping extends Application {
  protected String getApplicationTitle() { return "Ping"; }
  protected String getButtonText() { return "ping"; }
  protected String getInititalText() { return "127.0.0.1"; }
  protected void buttonClicked() { ... }
}
```

An example blackbox framework

```
public class Application extends JFrame {
  private JTextField textField;
  private Plugin plugin;
  public Application() { }
  protected void init(Plugin p) {
      p.setApplication(this);
      this.plugin = p;
      JPanel contentPane = new JPanel(
      contentPane.setBorder(new BevelBorder(BevelBorder.LOWERED));
      JButton button = new JButton();
      button.setText(plugin != null ? plugin.getButtonText() : "ok");
      contentPane.add(button, BorderLayout.EAST);
      textField = new JTextField("");
      if (plugin != null) textField.setText(plugin.getInititalText());
      textField.setPreferredSize(new Dimension(200, 20));
      contentPane.add(textField, BorderLayout.WEST);
      if (plugin != null)
          button.addActionListener((e) -> { plugin.buttonClicked(); } );
      this.setContentPane(contentPane);
```

```
public interface Plugin {
    String getApplicationTitle();
    String getButtonText();
    String getInititalText();
    void buttonClicked() ;
    void setApplication(Application app);
}
```

An example blackbox framework



```
public class Application extends JFrame {
  private JTextField textField;
  private Plugin plugin;
  public Application() { }
  protected void init(Plugin p) {
      p.setApplication(this);
      this.plugin = p;
```

```
public interface Plugin {
    String getApplicationTitle();
    String getButtonText();
    String getInititalText();
    void buttonClicked() ;
    void setApplication(Application app);
```

```
public class CalcPlugin implements Plugin {
  private Application app;
  public void setApplication(Application app) { this.app = app; }
  public String getButtonText() { return "calculate"; }
  public String getInititalText() { return "10 / 2 + 6"; }
  public void buttonClicked() {
      JOptionPane.showMessageDialog(null, "The result of "
              + application.getInput() + " is "
              + calculate(application.getInput()));
  }
  public String getApplicationTitle() { return "My Great Calculator"; }
```

An aside: Plugins could be reusable too…

```
public class Application extends JFrame implements InputProvider {
  private JTextField textField;
  private Plugin plugin;
  public Application() { }
  protected void init(Plugin p) {
      p.setApplication(this);
      this.plugin = p;
      JPanel contentPane = new JPa
```

```
public interface Plugin {
    String getApplicationTitle();
    String getButtonText();
    String getInititalText();
    void buttonClicked() ;
    void setApplication(InputProvider app);
```

```
public class CalcPlugin implements Plugin {
  private InputProvider app;
  public void setApplication(InputProvider app) {
  public String getButtonText() { return "calculate"; }
  public String getInititalText() { return "10 / 2 + 6"; }
  public void buttonClicked() {
      JOptionPane.showMessageDialog(null, "The result of "
              + application.getInput() + " is "
              + calculate(application.getInput()));
  }
  public String getApplicationTitle() { return "My Great Calculator"; }
```

```
public interface InputProvider {
    String getInput();
}
```

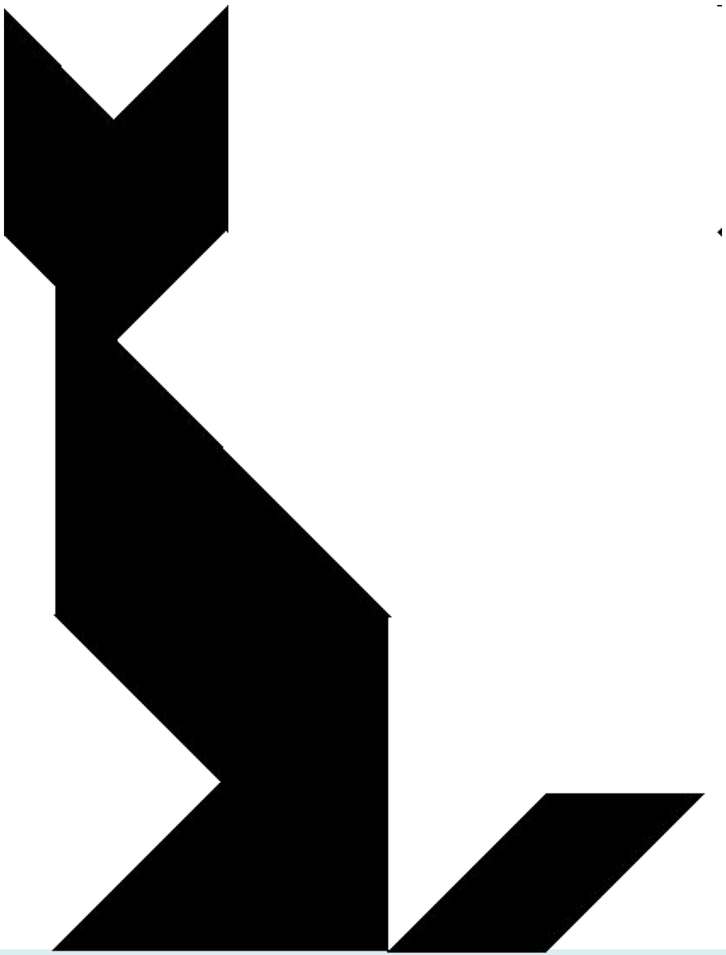
Framework summary

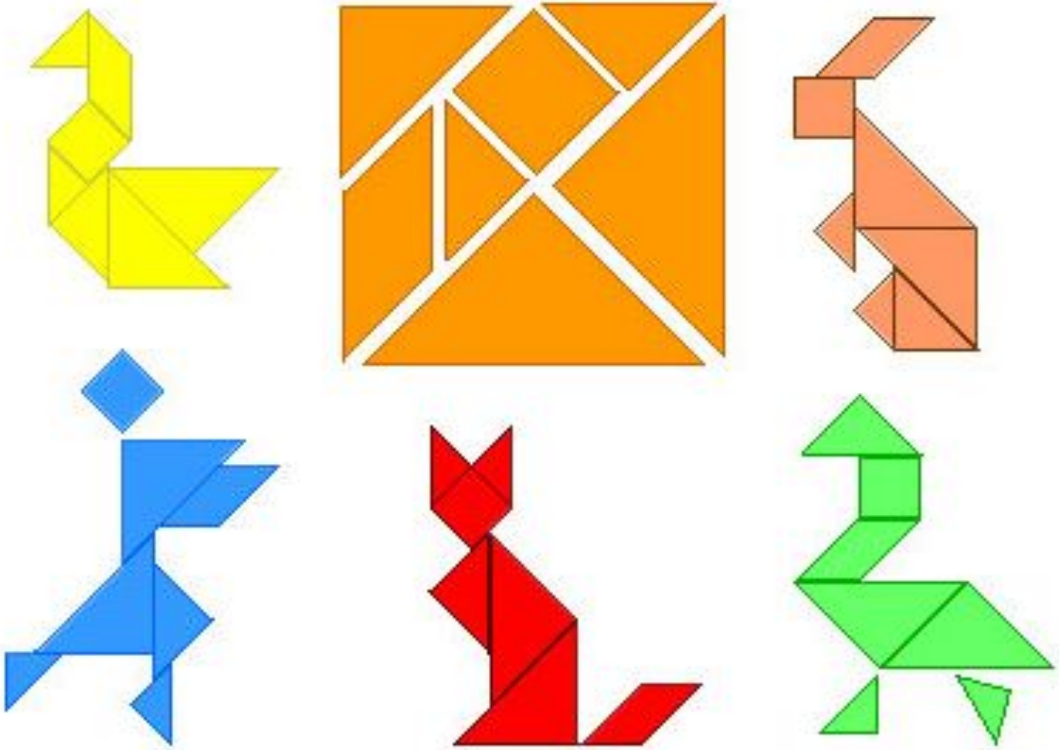
- Whitebox frameworks use subclassing
    - Allows extension of every nonprivate method
    - Need to understand implementation of superclass
    - Only one extension at a time
    - Compiled together
    - Often so-called developer frameworks
- Blackbox frameworks use composition
    - Allows extension of functionality exposed in interface
    - Only need to understand the interface
    - Multiple plugins
    - Often provides more modularity
    - Separate deployment possible (.jar, .dll, …)
    - Often so-called end-user frameworks, platforms

Framework design considerations

- Once designed there is little opportunity for change
- Key decision: Separating common parts from variable parts
  - What problems do you want to solve?
- Possible problems:
  - Too few extension points: Limited to a narrow class of users
  - Too many extension points: Hard to learn, slow
  - Too generic: Little reuse value

USE VS REUSE: DOMAIN ENGINEERING





(one modularization: tangrams)

The use vs. reuse dilemma

- Large rich components are very useful, but rarely fit a specific need
- Small or extremely generic components often fit a specific need, but provide little benefit

“maximizing reuse minimizes use”

C. Szyperski

Domain engineering

- Understand users/customers in your domain: What might they need? What extensions are likely?
- Collect example applications before designing a framework
- Make a conscious decision what to support *(scoping)*
- e.g., the Eclipse policy:
  - Plugin interfaces are internal at first
    - Unsupported, may change
  - Public stable extension points created when there are at least two distinct customers

The cost of changing a framework

```
public class Application extends JFrame {
          private JTextField textfield;
          private Plugin plugin;
          public Application(Plugin p) { this.plugin=p; p.setApplication(this); init(); }
          protected void init() {
               JPanel contentPane = new JPanel(new BorderLayou
               contentPane.setBorder(new BevelBorder(BevelBord
               JButton button = new JButton();
               if (plugin != null)
                    button.setText(plugin.getButtonText());
               else
                    butto
               contentPane
               textfield =
               if (plugin
                    textf
```

```
public interface Plugin {
    String getApplicationTitle();
    String getButtonText();
    String getInititalText();
    void buttonClicked() ;
    void setApplication(Application app);
}
```

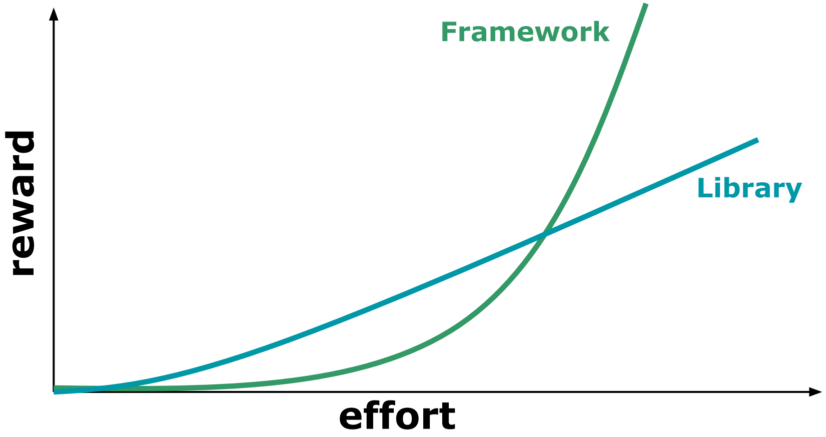
```
public class CalcPlugin implements
     private Application application;
     public void setApplication(Application app) { this.application = app; }
     public String getButtonText() { return "calculate"; }
     public String getInititalText() { return "10 / 2 + 6"; }
     public void buttonClicked() {
                                           l, "The result of "
                                           () + " is "
                                           n.getText())); }
                                           ) { return "My Great Calculator"; }
```

```
class CalcStarter { public static void main(String[] args) {
          new Application(new CalcPlugin()).setVisible(true); }}
```

Consider adding an extra method.
Many changes require changes to *all* plugins.

Learning a framework

- Documentation
- Tutorials, wizards, and examples
- Communities, email lists and forums
- Other client applications and plugins



Typical framework design and implementation

Define your domain

- Identify potential common parts and variable parts

Design and write sample plugins/applications

Factor out & implement common parts as framework

Provide plugin interface & callback mechanisms for variable parts

- Use well-known design principles and patterns where appropriate…

Get lots of feedback, and iterate

FRAMEWORK MECHANICS

Running a framework

- Some frameworks are runnable by themselves
  - e.g. Eclipse, VSCode, IntelliJ
- Other frameworks must be extended to be run
  - MapReduce, Swing, JUnit, NanoHttpd, Express

Methods to load plugins

Client writes main function, creates a plugin object, and passes it to framework

> (see blackbox example above)

Framework has main function, client passes name of plugin as a command line argument or environment variable

> (see next slide)

Framework looks in a magic location

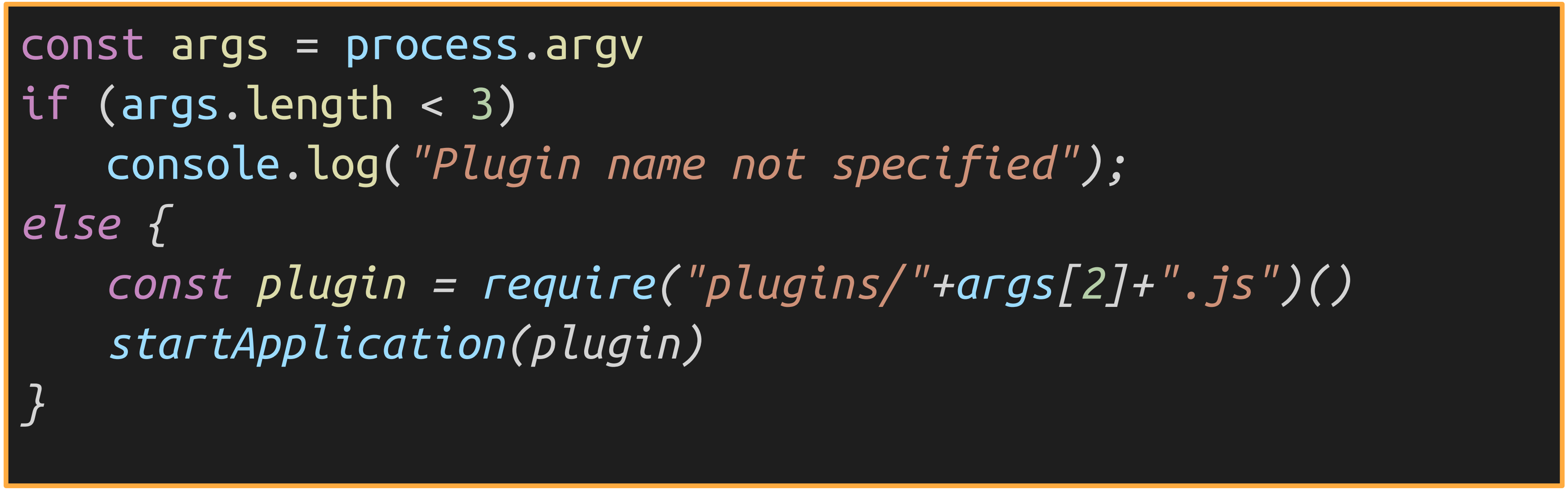
> Config files or .jar/.js files in a plugins/ directory are automatically loaded and processed

GUI for plugin management

An example plugin loader using Java Reflection

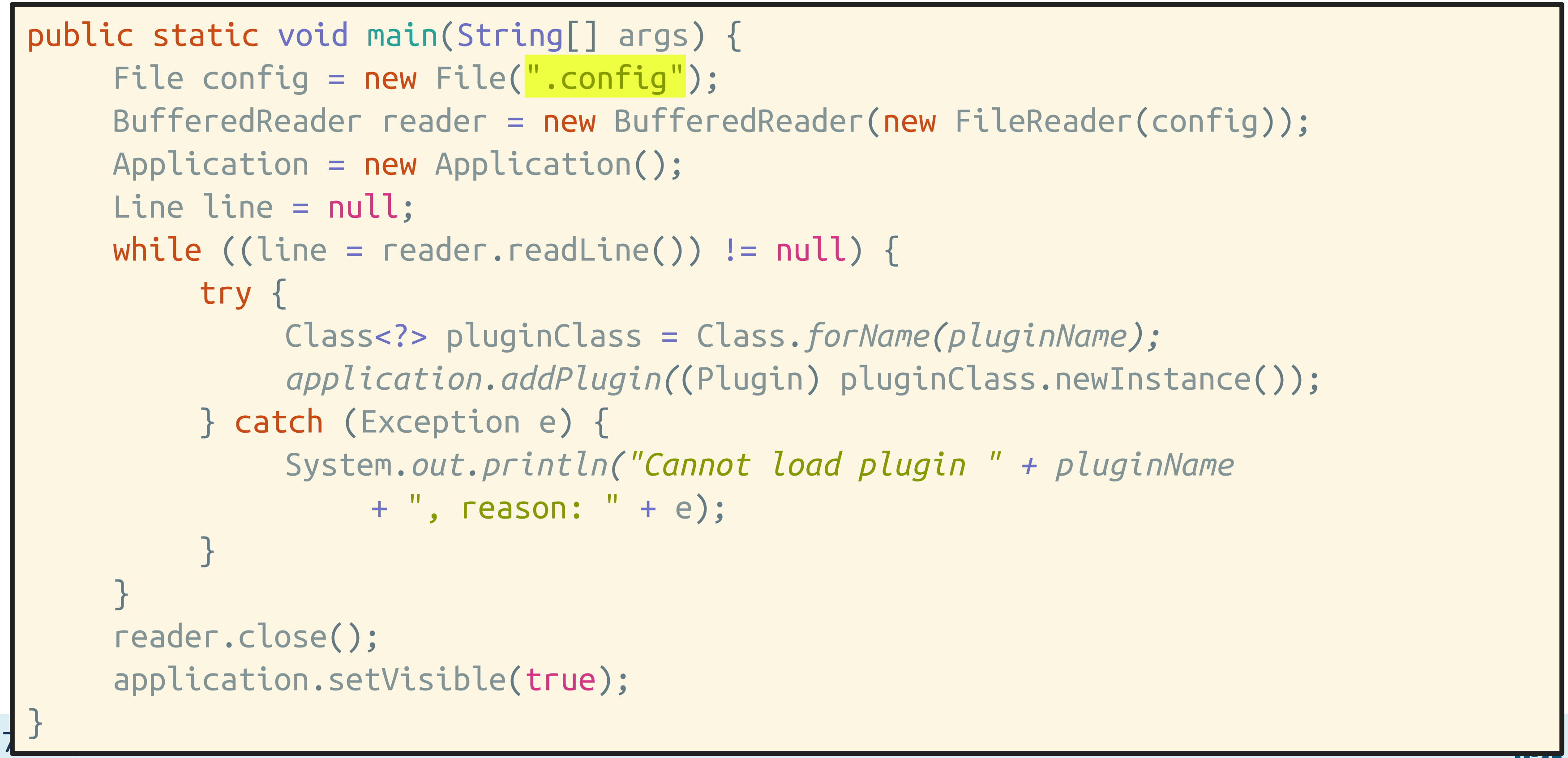
```
public static void main(String[] args) {
     if (args.length != 1)
          System.out.println("Plugin name not specified");
     else {
          String pluginName = args[0];
          try {
               Class<?> pluginClass = Class.forName(pluginName);
               new Application((Plugin) pluginClass.newInstance()).setVisible(true);
          } catch (Exception e) {
               System.out.println("Cannot load plugin " + pluginName
                    + ", reason: " + e);
          }
     }
}
```

An example plugin loader in Node.js



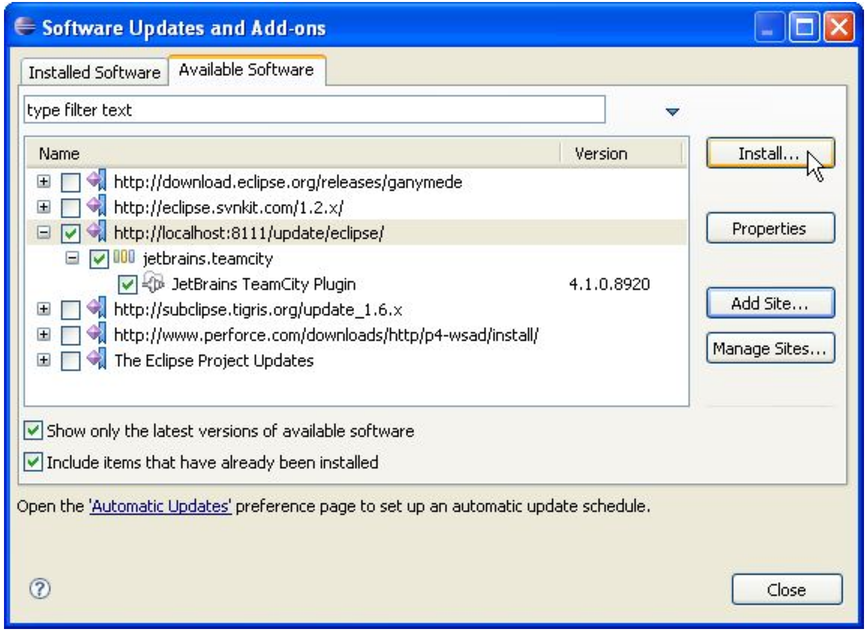
```
const args = process.argv
if (args.length < 3)
    console.log("Plugin name not specified");
else {
    const plugin = require("plugins/"+args[2]+".js")()
    startApplication(plugin)
}
```

Another plugin loader using Java Reflection



```java
public static void main(String[] args) {
    File config = new File(".config");
    BufferedReader reader = new BufferedReader(new FileReader(config));
    Application = new Application();
    Line line = null;
    while ((line = reader.readLine()) != null) {
        try {
            Class<?> pluginClass = Class.forName(pluginName);
            application.addPlugin((Plugin) pluginClass.newInstance());
        } catch (Exception e) {
            System.out.println("Cannot load plugin " + pluginName
                + ", reason: " + e);
        }
    }
    reader.close();
    application.setVisible(true);
}
```

GUI-based plugin management



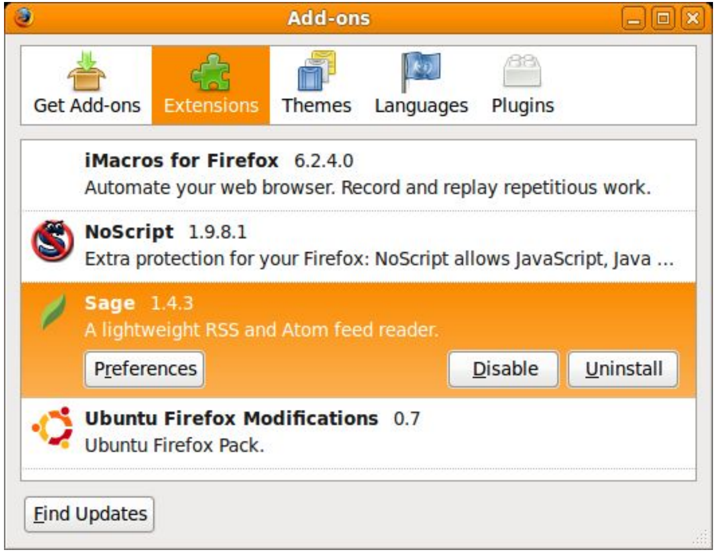
type filter text

Name	Version
⊞ □ http://download.eclipse.org/releases/ganymede	
⊞ □ http://eclipse.svnkit.com/1.2.x/	
⊟ ☑ http://localhost:8111/update/eclipse/	
⊟ ☑ jetbrains.teamcity	
☑ JetBrains TeamCity Plugin	4.1.0.8920
⊞ □ http://subclipse.tigris.org/update_1.6.x	
⊞ □ http://www.perforce.com/downloads/http/p4-wsad/install/	
⊞ □ The Eclipse Project Updates	

☑ Show only the latest versions of available software

☑ Include items that have already been installed

Open the 'Automatic Updates' preference page to set up an automatic update schedule.



iMacros for Firefox 6.2.4.0
Automate your web browser. Record and replay repetitious work.

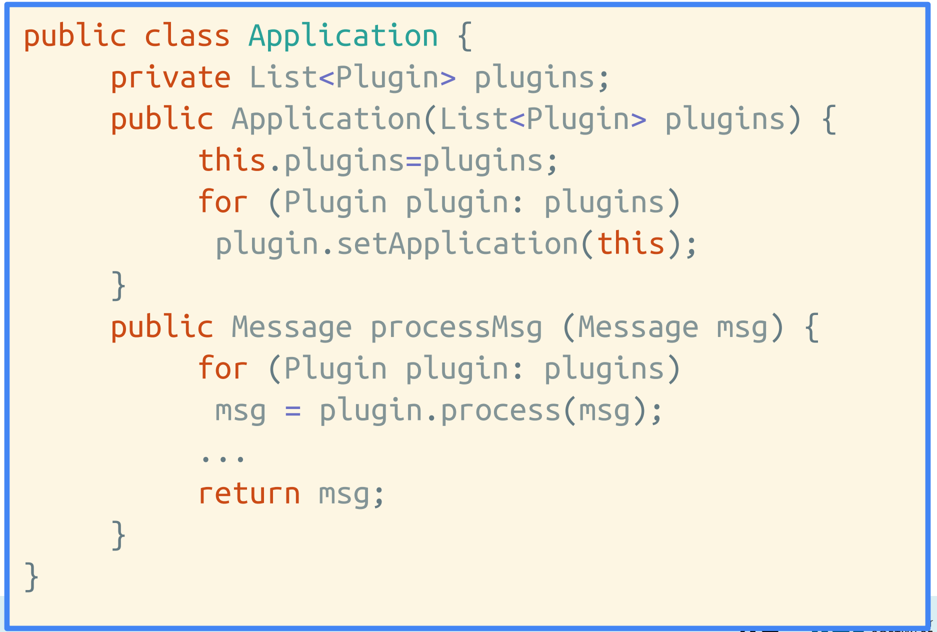
NoScript 1.9.8.1
Extra protection for your Firefox: NoScript allows JavaScript, Java ...

Sage 1.4.3
A lightweight RSS and Atom feed reader.

Ubuntu Firefox Modifications 0.7
Ubuntu Firefox Pack.

Supporting multiple plugins

- Observer design pattern is commonly used
- Load and initialize multiple plugins
- Plugins can register for events
- Multiple plugins can react to same events
- Different interfaces for different events possible



```
public class Application {
     private List<Plugin> plugins;
     public Application(List<Plugin> plugins) {
          this.plugins=plugins;
          for (Plugin plugin: plugins)
           plugin.setApplication(this);
     }
     public Message processMsg (Message msg) {
          for (Plugin plugin: plugins)
           msg = plugin.process(msg);
          ...
          return msg;
     }
}
```

Example: An Eclipse plugin

- A popular Java IDE
- More generally, a framework for tools that facilitate “building, deploying and managing software across the lifecycle.”
- Plugin framework based on OSGI standard
- Starting point: Manifest file
  - Plugin name
  - Activator class
  - Meta-data

```
Manifest-Version: 1.0
Bundle-ManifestVersion: 2
Bundle-Name: MyEditor Plug-in
Bundle-SymbolicName: MyEditor;
singleton:=true
Bundle-Version: 1.0.0
Bundle-Activator:
 myeditor.Activator
Require-Bundle:
 org.eclipse.ui,
 org.eclipse.core.runtime,
 org.eclipse.jface.text,
 org.eclipse.ui.editors
Bundle-ActivationPolicy: lazy
Bundle-RequiredExecutionEnvironment:
JavaSE-1.6
```

Example: An Eclipse plugin

- plugin.xml
  - Main configuration file
  - XML format
  - Lists extension points

- Editor extension
  - extension point: org.eclipse.ui.editors
  - file extension
  - icon used in corner of editor
  - class name
  - unique id
    - refer to this editor
    - other plugins can extend with new menu items, etc.!

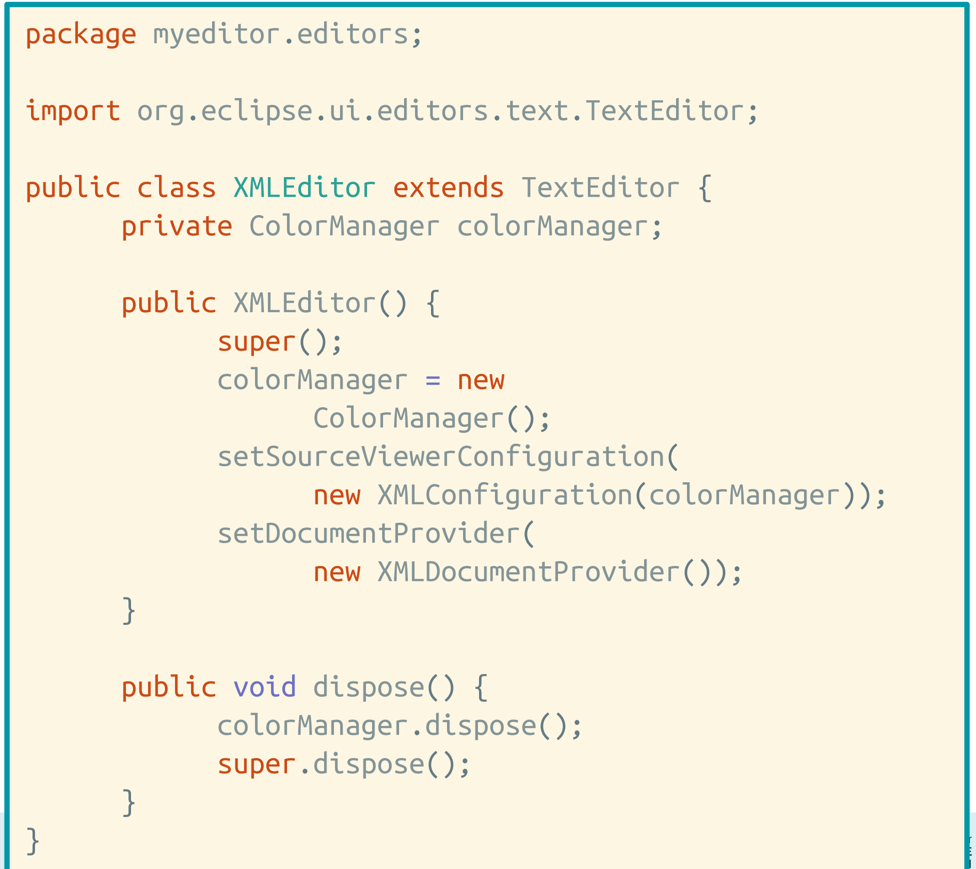
```
<?xml version="1.0" encoding="UTF-8"?>
<?eclipse version="3.2"?>
<plugin>

   <extension
         point="org.eclipse.ui.editors">
      <editor
               name="Sample XML Editor"
               extensions="xml"
               icon="icons/sample.gif“
contributorClass="org.eclipse.ui.texteditor.BasicText
EditorActionContributor"
            class="myeditor.editors.XMLEditor"
            id="myeditor.editors.XMLEditor">
      </editor>
   </extension>

</plugin>
```

Example: An Eclipse plugin

- At last, code!
- XMLEditor.java
  - Inherits TextEditor behavior
    - open, close, save, display, select, cut/copy/paste, search/replace, …
    - REALLY NICE not to have to implement this
    - But could have used ITextEditor interface if we wanted to
  - Extends with syntax highlighting
    - XMLDocumentProvider partitions into tags and comments
    - XMLConfiguration shows how to color partitions



```
package myeditor.editors;

import org.eclipse.ui.editors.text.TextEditor;

public class XMLEditor extends TextEditor {
	private ColorManager colorManager;

	public XMLEditor() {
		super();
		colorManager = new
			ColorManager();
		setSourceViewerConfiguration(
			new XMLConfiguration(colorManager));
		setDocumentProvider(
			new XMLDocumentProvider());
	}

	public void dispose() {
		colorManager.dispose();
		super.dispose();
	}
}
```

Example: A JUnit Plugin

```
public class SampleTest  {
      private List<String> emptyList;

      @Before
      public void setUp() {
          emptyList = new ArrayList<String>();
      }

      @After
      public void tearDown() {
          emptyList = null;
      }

      @Test
      public void testEmptyList() {
          assertEquals("Empty list should have 0 elements",
                       0, emptyList.size());
      }
}
```

Here the important plugin mechanism is Java annotations

Summary

- Reuse and variation essential
  - Libraries and frameworks
- Whitebox frameworks vs. blackbox frameworks
- Design for reuse with domain analysis
  - Find common and variable parts
  - Write client applications to find common parts