Principles of Software Construction: Objects, Design, and Concurrency

Libraries and Frameworks

(Design for large-scale reuse)

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Administrivia

Midterm is next Thursday, we will release sample questions this week.

HW5:

- Decoupling game from god cards
  - Specific requirement: base game must not depend on god cards
  - General expectation: keep coupling low (*something* in the back end will have to select & set up god cards)
  - Think: What patterns can you use?
- Picking god cards
  - Should be a way to play without god cards
  - Should be a way to assign them – doesn't have to exactly follow Santorini rules (but it's nice!), random is OK.

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, …

* Effective Java items 26, 29, 30, and 31

Where Does That Get Us?

	Small scale: One/few objects	*Mid scale:* Many objects	*Large scale:* Subsystems
Design for understanding change/ext. reuse robustness ...	Subtype Polymorphism ✓ Information Hiding, Contracts ✓ Immutability ✓ Types ✓ Unit Testing ✓	Domain Analysis ✓ Inheritance & Del. ✓ Responsibility Assignment, Design Patterns, Antipattern ✓ Promises/ Reactive P. ✓ Integration Testing ✓	GUI vs Core ✓ **Frameworks and Libraries**, APIs Module systems, microservices ✓ (Testing for) Robustness CI ✓, DevOps, Teams

Reuse and variation: Family of development tools

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
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
°C 50 40 30 20 10 0 -10 -20 -30
°F 120 100 80 60 40 20 0 -20

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

21
03

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

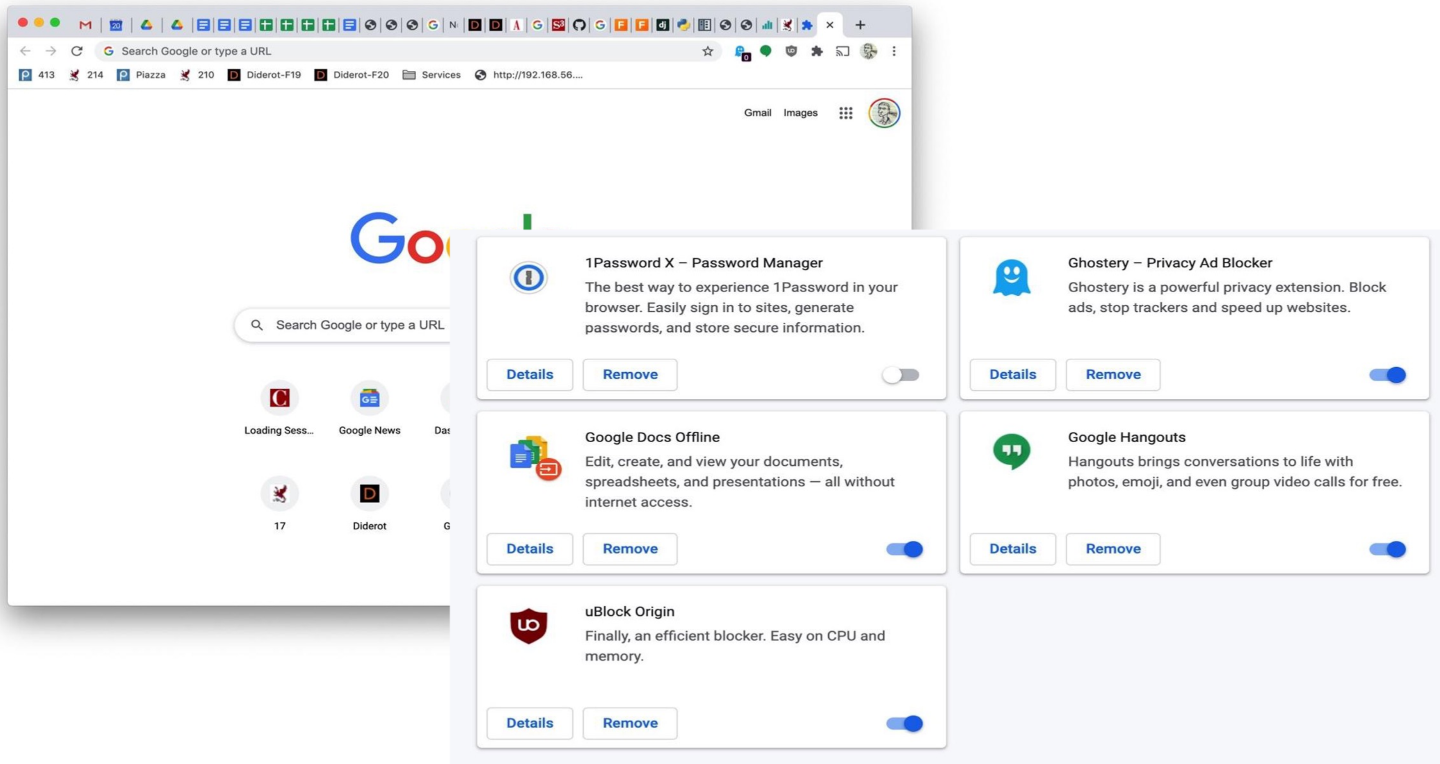
Airport Links

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

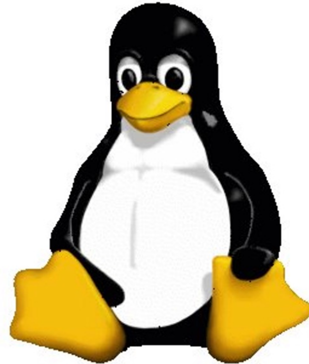


Reuse and variation: Flavors of Linux

```
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 >
```



S3D

Reuse and variation: Product lines

Today: Reuse **at scale**

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

Today: Reuse **at scale**

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

Terminology: Library

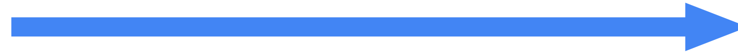
- *Library*: A set of classes and methods that provide reusable functionality
- Client calls library; library executes and returns data
- Client controls
  - Program structure
  - Control flow

```java
public MyWidget extends JContainer {

  public 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 component
    Dimension d = getSize();
    g.setColor(Color.red);
    g.drawRect(0, 0, d.getWidth(), d.getHeight());
  }
}
```

your code



Library

- E.g.: Math, Collections, I/O, command line 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. We’ll call you.”
- Framework controls
  - Program structure
  - Control flow

```
public MyWidget extends JContainer {

  public 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 component
    Dimension d = getSize();
    g.setColor(Color.red);
    g.drawRect(0, 0, d.getWidth(), d.getHeight());
  }
}
```

your code

Library

- E.g.: VSCode, Firefox, IntelliJ, NanoHttpd, Express, Android, React?

A calculator example (without a framework)

```
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:

- What source code might be shared?

A calculator example (without a framework)

```
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");
      ...
  }
}
```

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A simple example framework

```java
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();
      this.setLocation(100, 100);
      this.setTitle(getApplicationTitle());
      ...
  }
```

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);
```

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"; }
```

General distinction: Library vs. framework

user
interacts

```
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

user
interacts

```
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());                    }
}
```

Framework

your code

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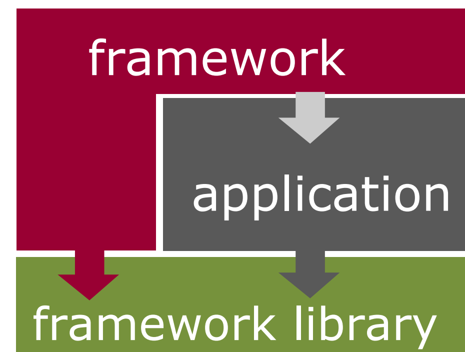
Libraries and frameworks in practice

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



credit: Erich Gamma

slido

Express/NanoHttpd: Framework or Library? (include rationale, andrewID)

ⓘ Start presenting to display the poll results on this slide.

slido

Handlebars: Framework, or Library? (include rationale, andrewID)

ⓘ Start presenting to display the poll results on this slide.

Is Santorini a Framework?

More terms

- ***API***: Application Programming Interface, the interface of a library or framework
  - Also used for the interface of a network service
- ***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

Today: Libraries and frameworks for reuse

- Terminology and examples
- **Whitebox and blackbox frameworks**
- Designing a framework
- Implementation details

WHITE-BOX VS BLACK-BOX* FRAMEWORKS

* outdated 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?

```
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()));
  }
```

```
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

```java
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);
```

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

S3D

Which version do you prefer? Why?

- Blackbox or whitebox?

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 "
              + app.getInput() + " is "
              + calculate(app.getInput()));
  }
  public String getApplicationTitle() { return "My Great Calculator"; }
```

An aside: Plugins could be reusable too…

```java
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;
```

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

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

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

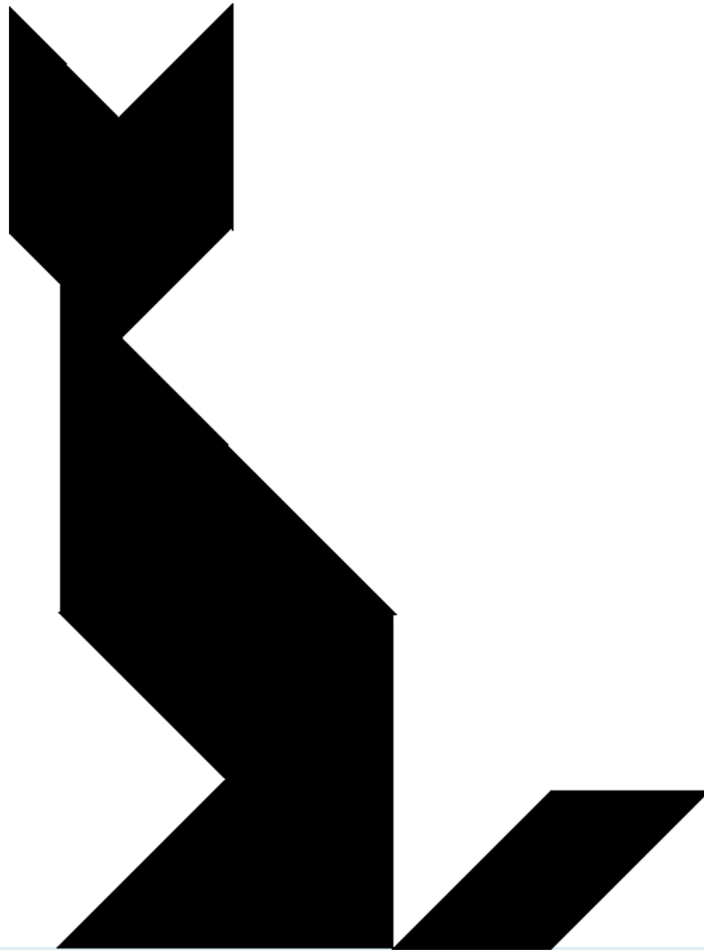
Frameworks summary

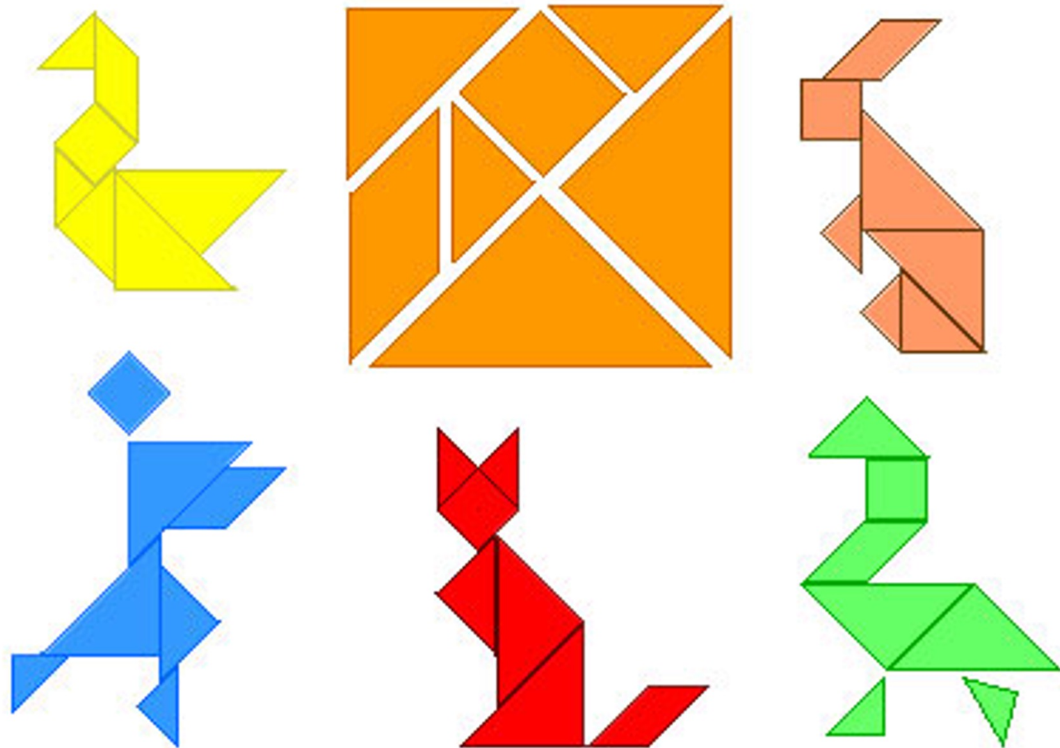
- Whitebox frameworks use subclassing
  - Allows extension of every nonprivate method
  - Need to understand implementation of superclass
  - Only one extension at a time
  - Easily supports recursive references (framework to plugin and vice versa)
  - Often so-called developer frameworks
- Blackbox frameworks use composition
  - Allows extension of functionality exposed in interface
  - Only need to understand the interface
  - Multiple plugins
  - Often provides more modularity
  - 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 to extend
    - Too generic: Little reuse value

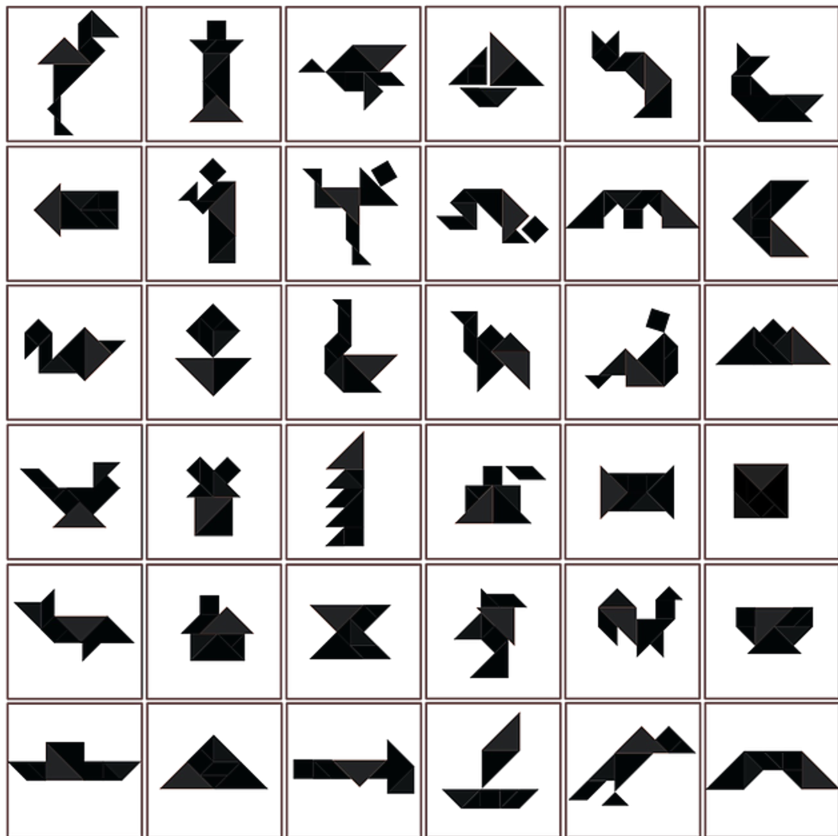
USE VS REUSE: DOMAIN ENGINEERING

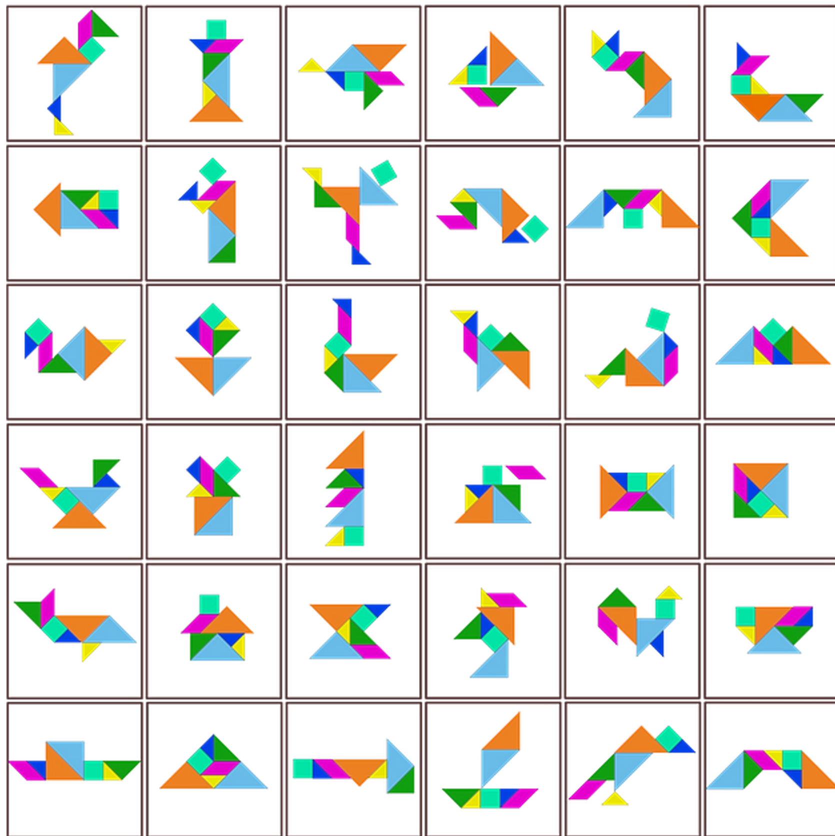




(one modularization: tangrams)

Tangrams





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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

Discussion question

- How would you redesign your Santorini program to make it into a framework?

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.setA
        protected void init() {
                JPanel contentPane = new JPanel(new Borde
                contentPane.setBorder(new BevelBorder(Bev
                JButton button = new JButton();
                if (plugin != null)
                        button.setText(plugin.getButto
                else

                conte
                textf
                if (p

                textf
                this.
```

```
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() {
     JOptionPane.showMessageDialog(null, "The result of "
                                        etInput() + " is "
                                        lication.getText())); }
                                        e() { return "My Great Calculator"; }
  }
```

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

The cost of changing a framework

Consider adding an extra method.
Requires changes to *all* plugins!

```
public class Application extends JFrame {
        private JTextField textfield;
        private Plugin plugin;
        public Application(Plugin p) { this.plugin=p; p.setA
        protected void init() {
                JPanel contentPane = new JPanel(new Borde
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                JButton button = new JButton();
                if (plugin != null)
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                conte
                textf
                if (p

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```

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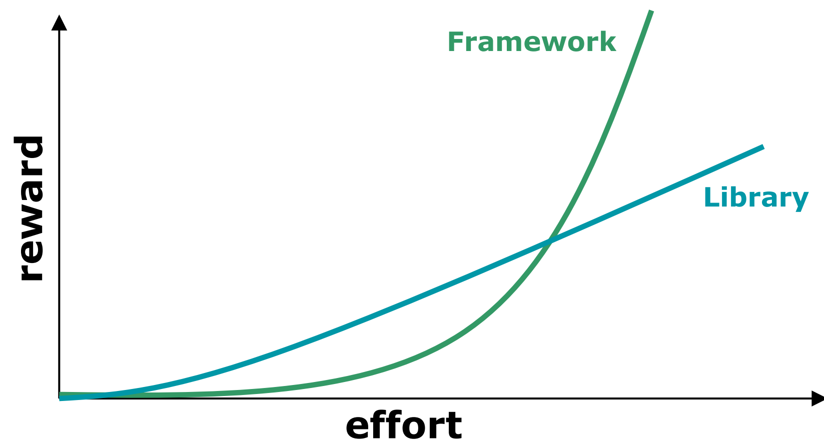
    String getApplicationTitle();
    String getButtonText();
    String getInititalText();
    void buttonClicked() ;
    void setApplication(Application app);
}
```

```
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() {
     JOptionPane.showMessageDialog(null, "The result of "
                                        etInput() + " is "
                                        lication.getText())); }
                                        e() { return "My Great Calculator"; }
 }
```

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

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

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

    (see blackbox example above)

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

    (see next slide)

3. Framework looks in a magic location

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

4. GUI for plugin management

    E.g., web browser extensions

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);
          }
     }
}
```

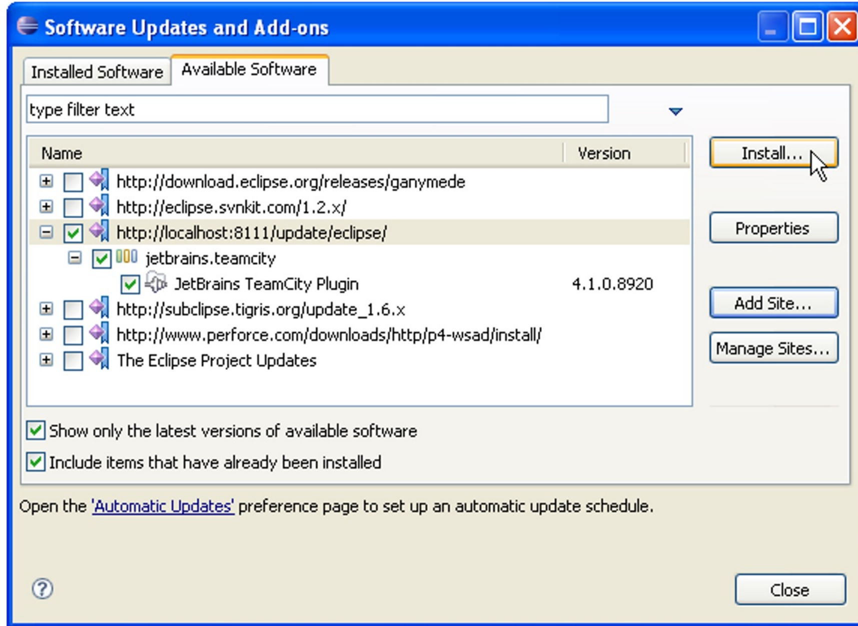
An example plugin loader in Node.js

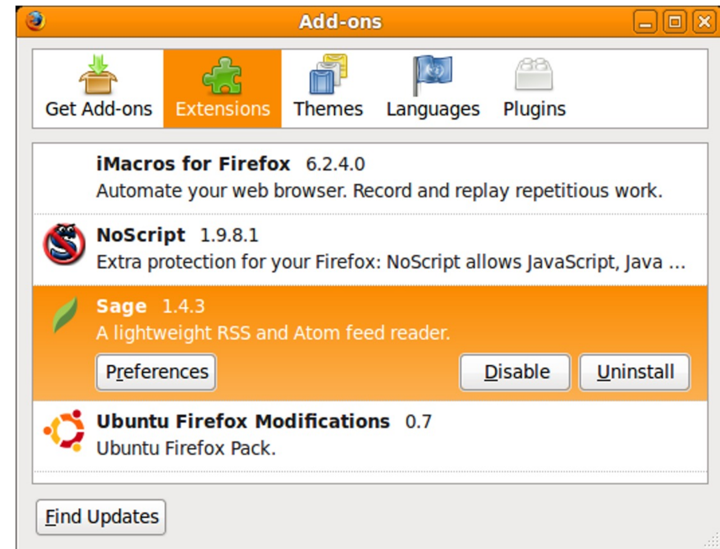
```
const args = process.argv
if (args.length < 3)
        console.log("Plugin name not specified");
else {
        const plugin = require("plugins/"+args[2]+".js")()
        startApplication(plugin)
}
```

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(line);
            application.addPlugin((Plugin) pluginClass.newInstance());
        } catch (Exception e) {
            System.out.println("Cannot load plugin " + line
                + ", reason: " + e);
        }
    }
    reader.close();
    application.setVisible(true);
}
```

GUI-based plugin management





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