Swing to SWT and Back: Patterns for API Migration by Wrapping

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Outline

Outline

1 - API Migration

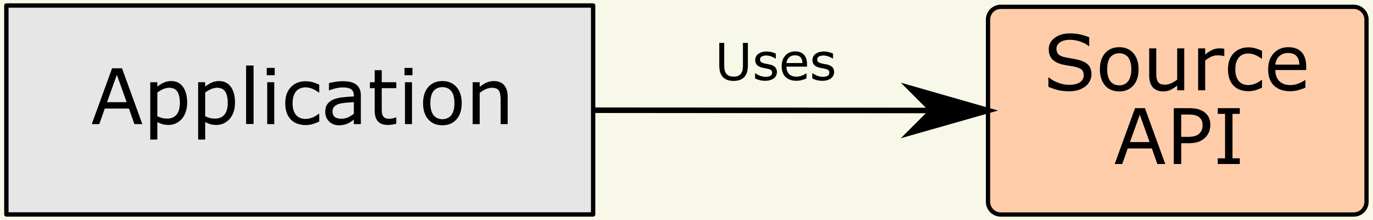
2 - Study Design

3 - Study Results

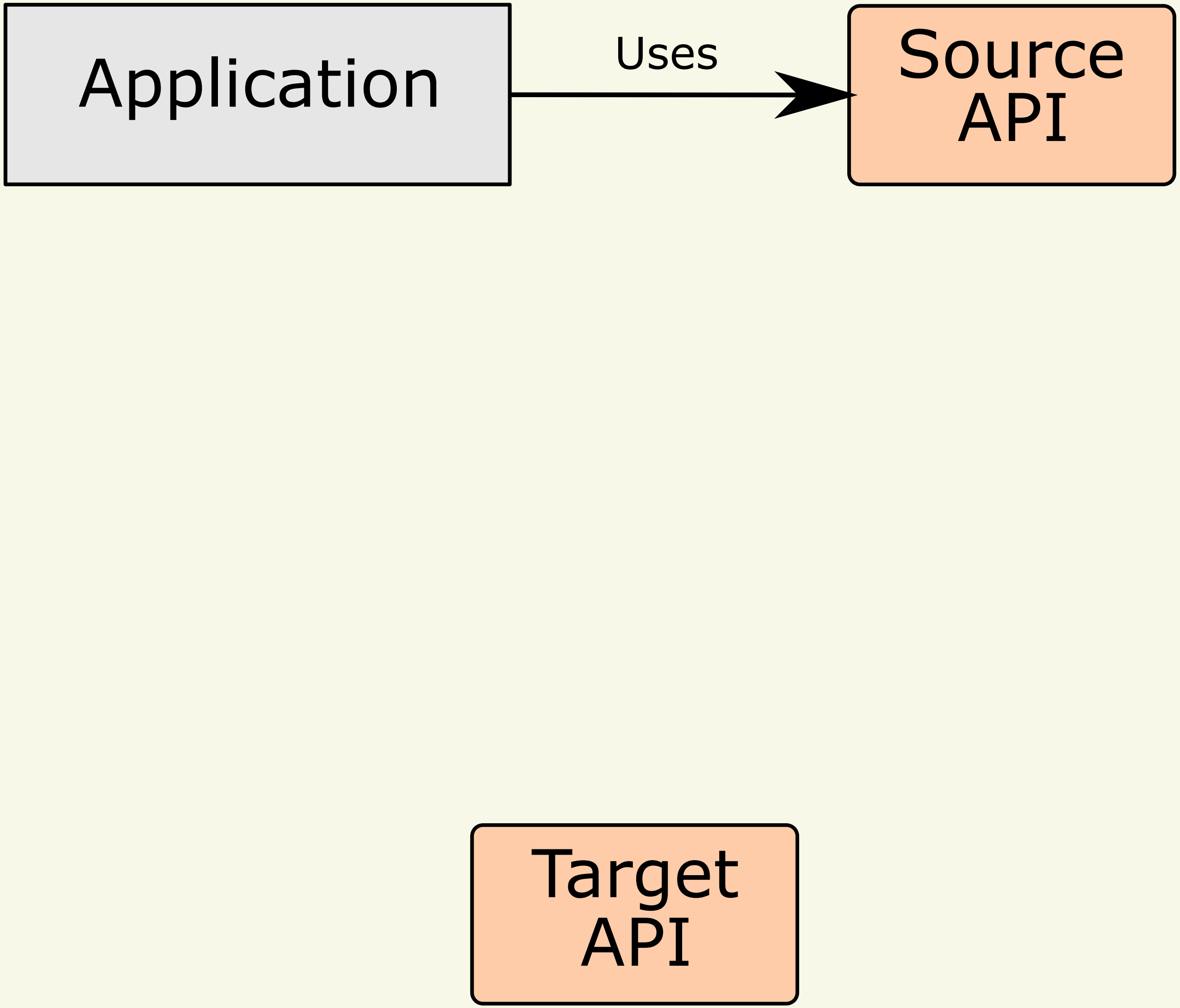
4 - Conclusion and Future Work

1 - API Migration

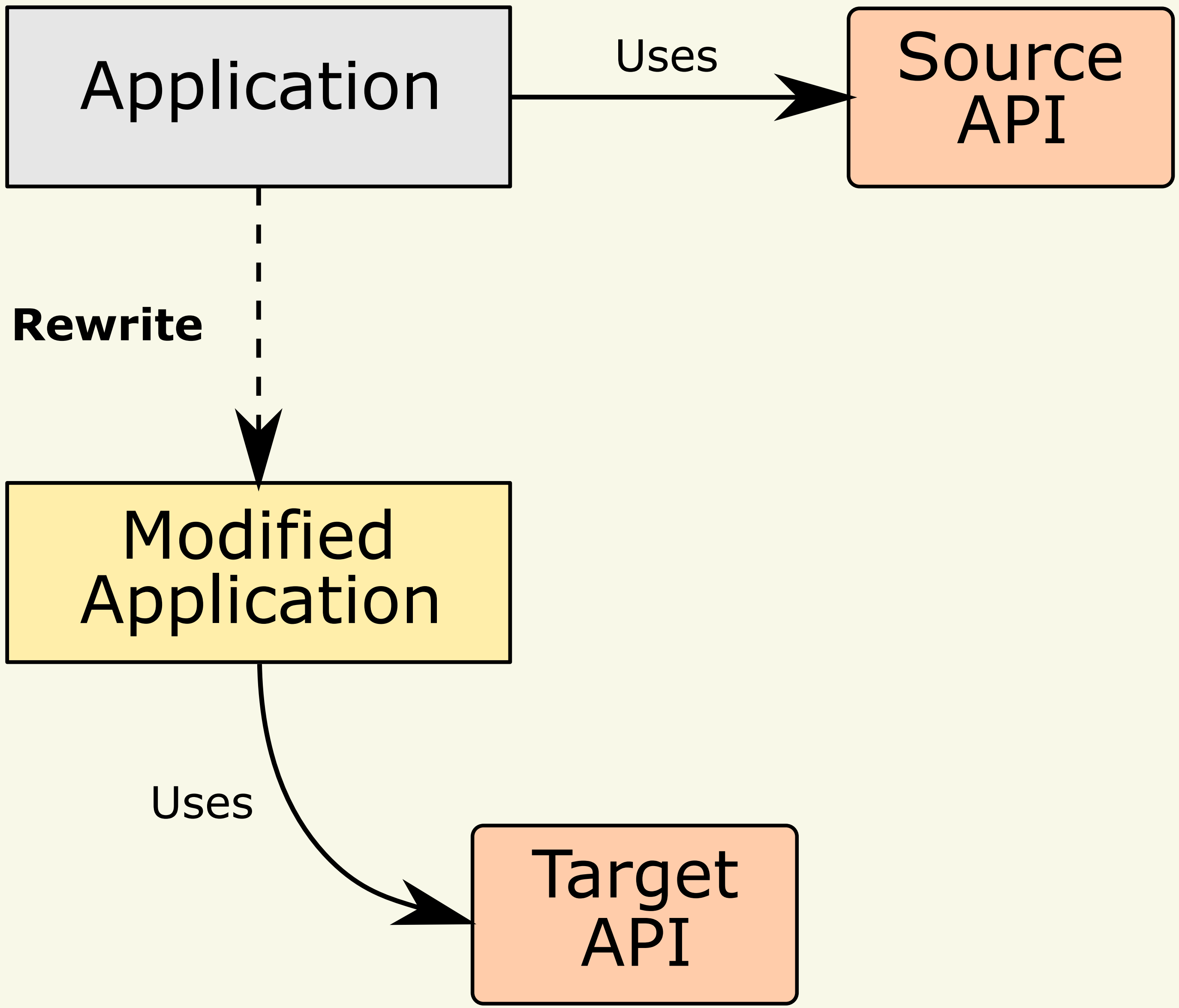
API Migration



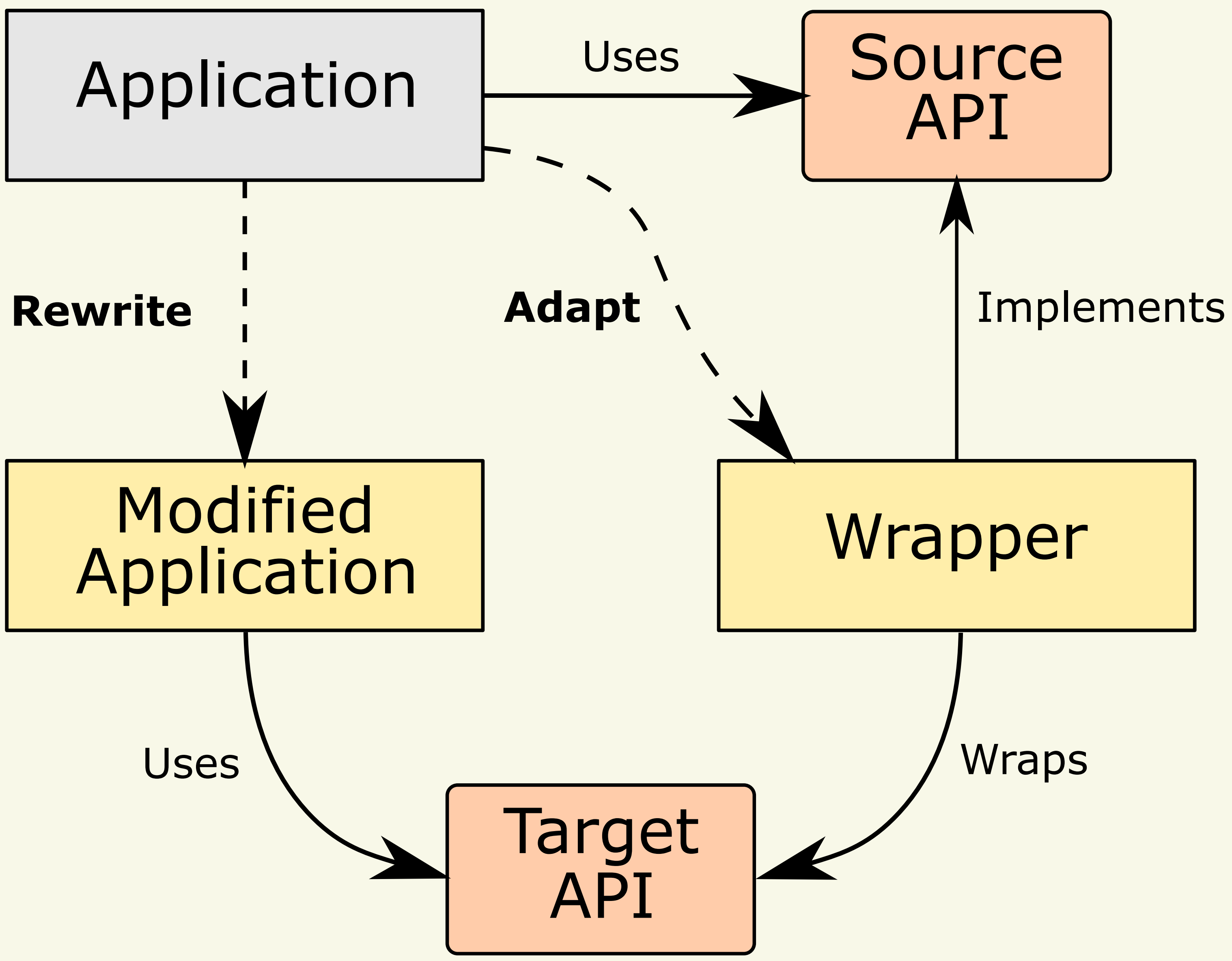
API Migration



API Migration

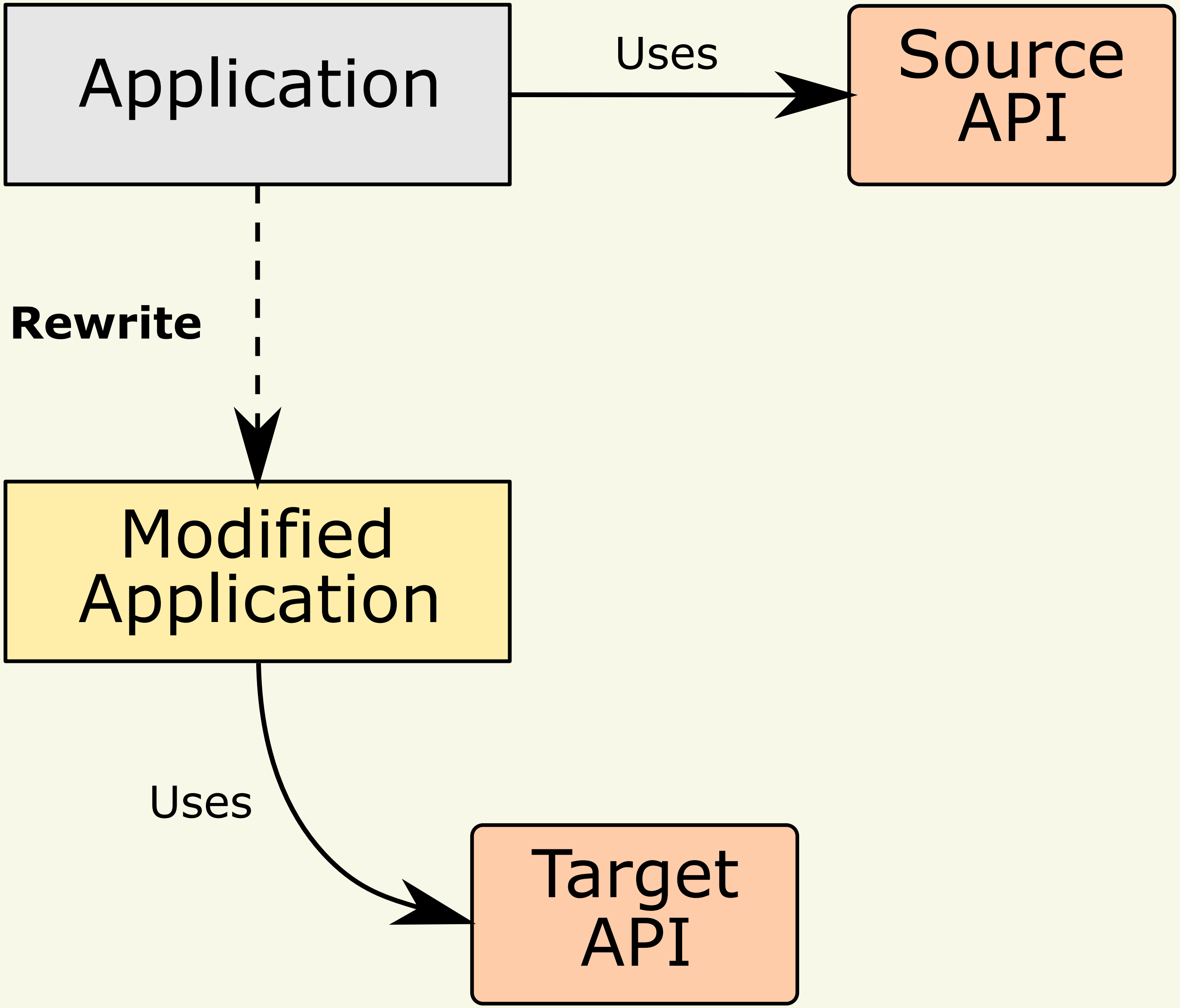


API Migration

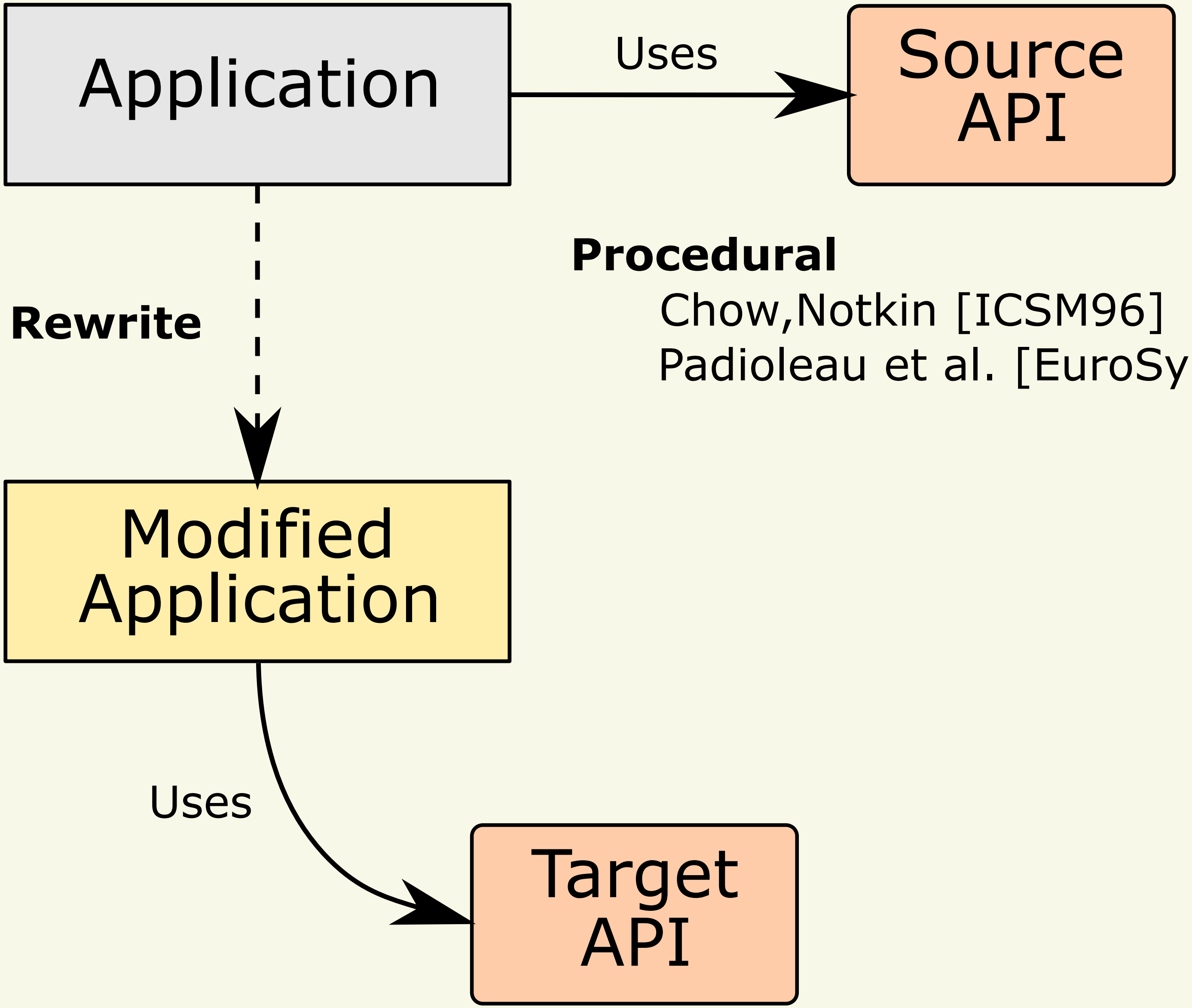


Related Work

API Migration



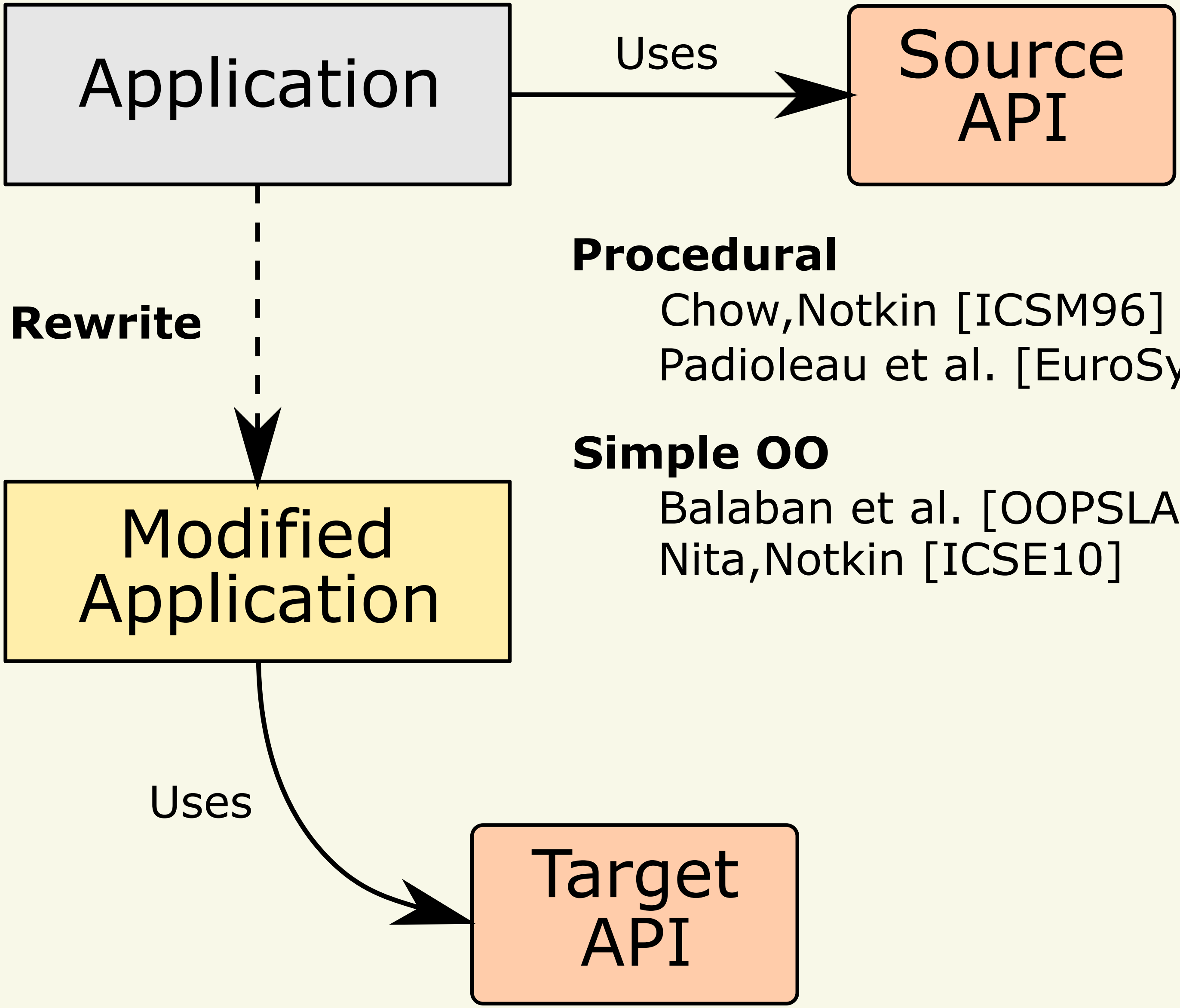
API Migration



Procedural

Chow,Notkin [ICSM96]
Padioleau et al. [EuroSys08]

API Migration



Procedural

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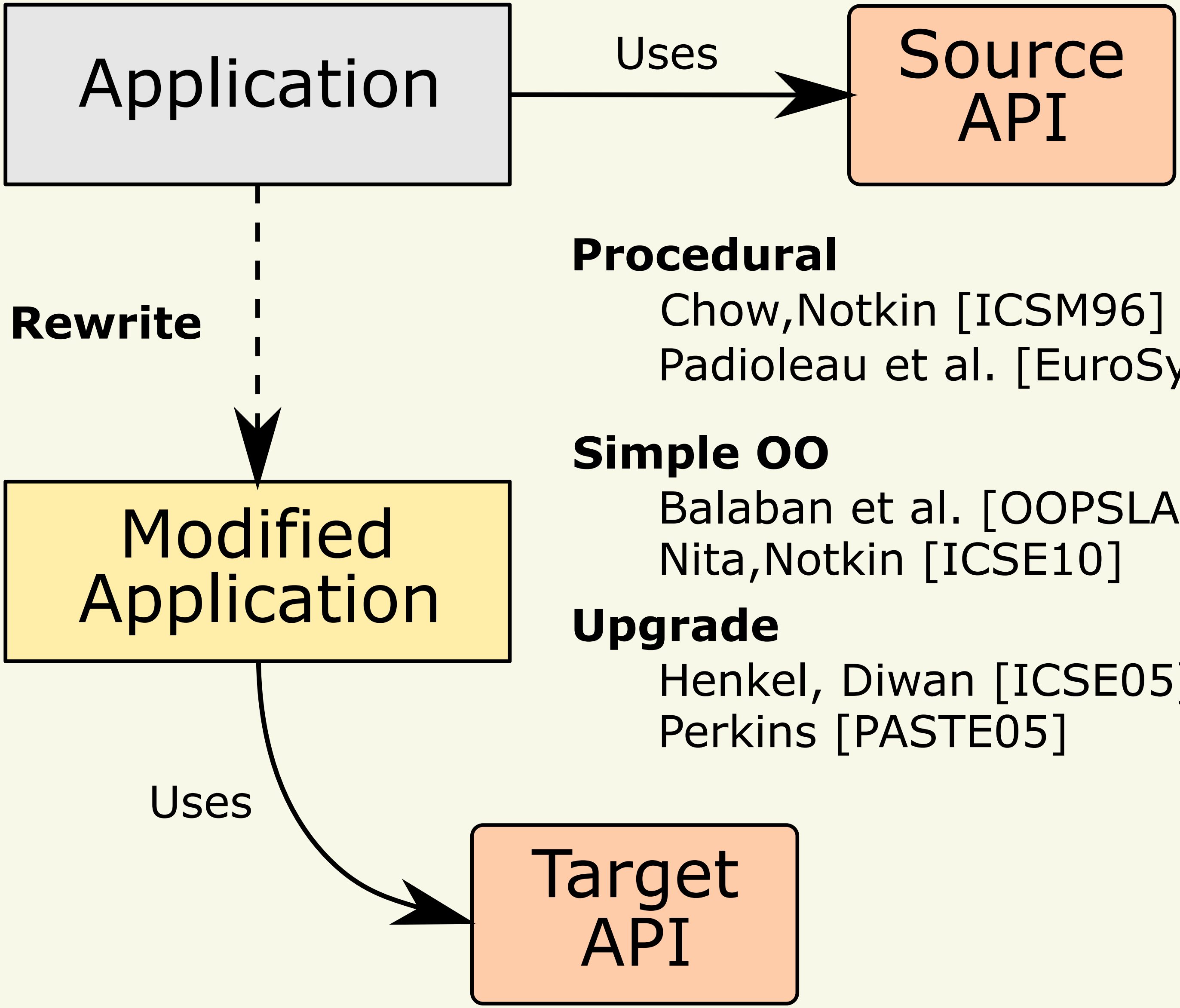
Simple OO

Balaban et al. [OOPSLA05]
Nita,Notkin [ICSE10]

API Migration



Application

Uses

Source API

Rewrite

Modified Application

Uses

Target API

Procedural

Chow,Notkin [ICSM96]
Padioleau et al. [EuroSys08]

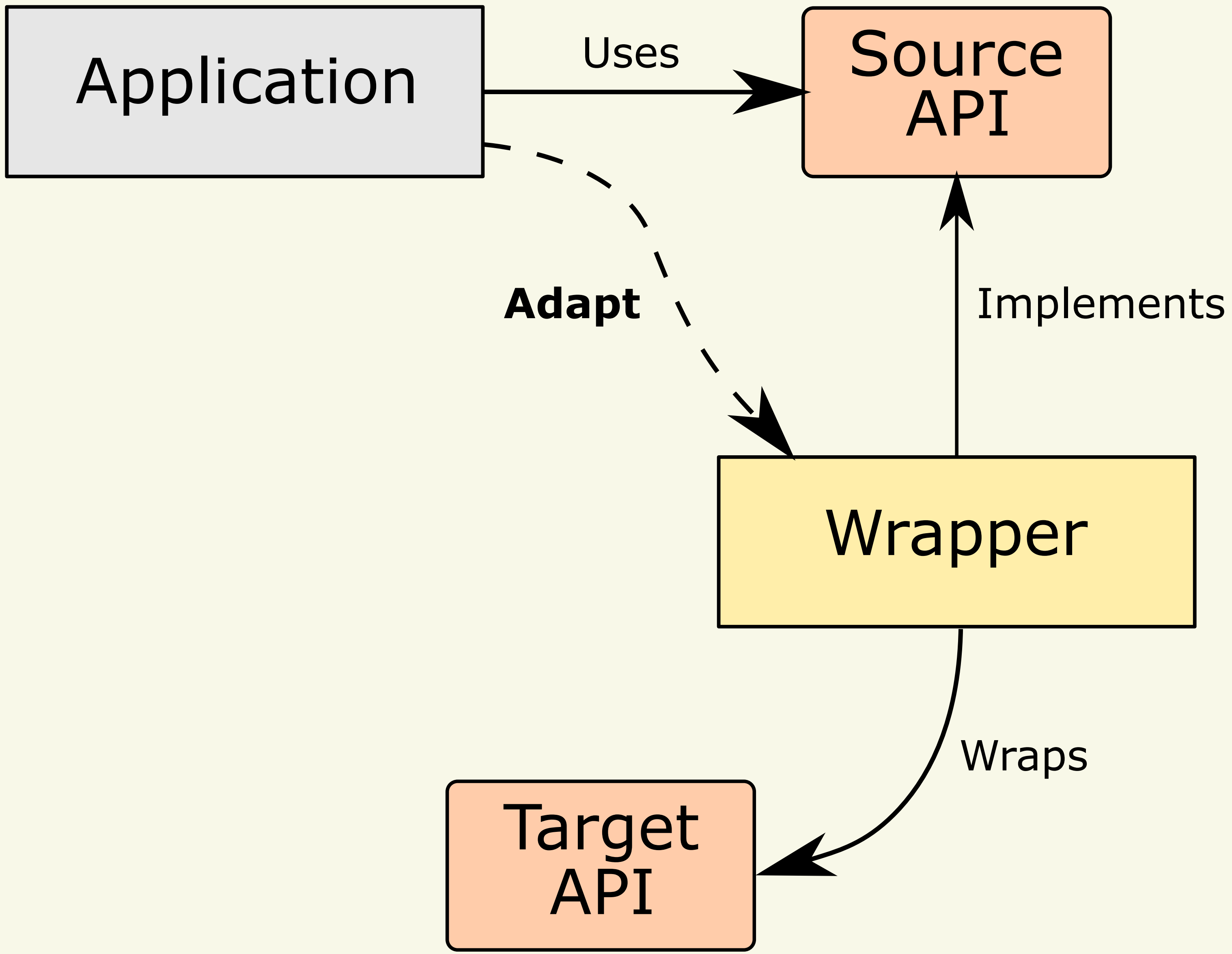
Simple OO

Balaban et al. [OOPSLA05]
Nita,Notkin [ICSE10]

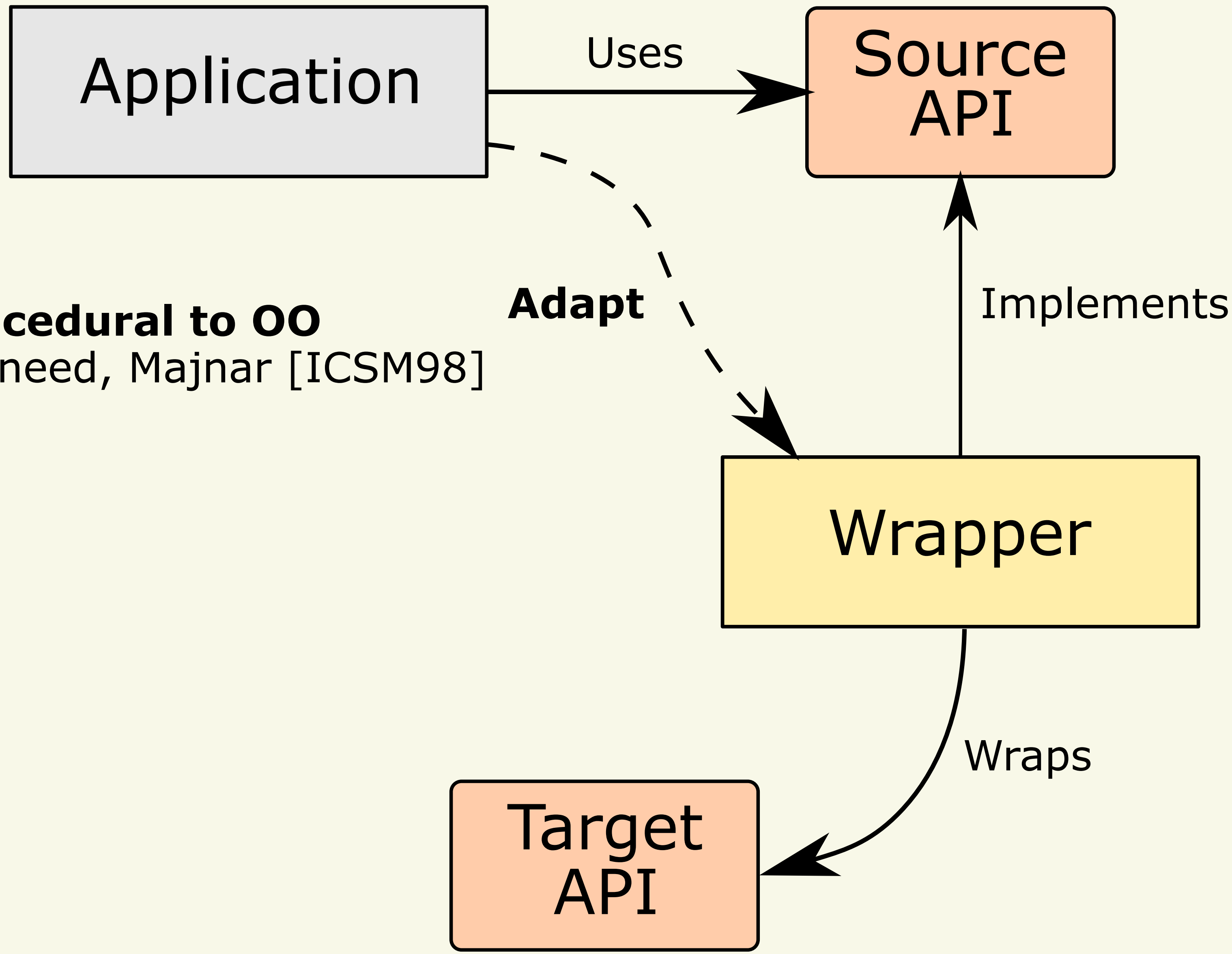
Upgrade

Henkel, Diwan [ICSE05]
Perkins [PASTE05]

API Migration

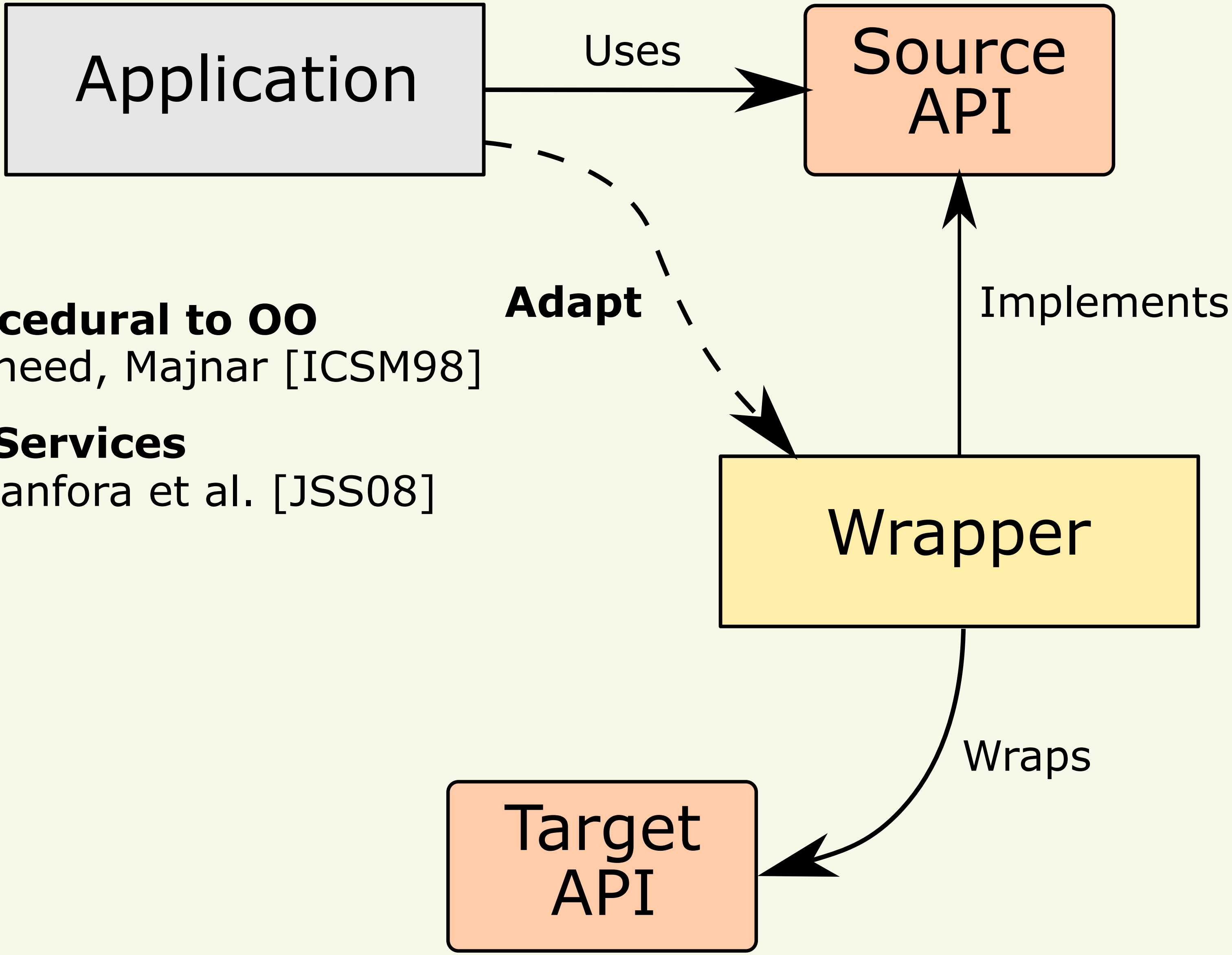


API Migration



Procedural to OO
Sneed, Majnar [ICSM98]

API Migration



Procedural to OO
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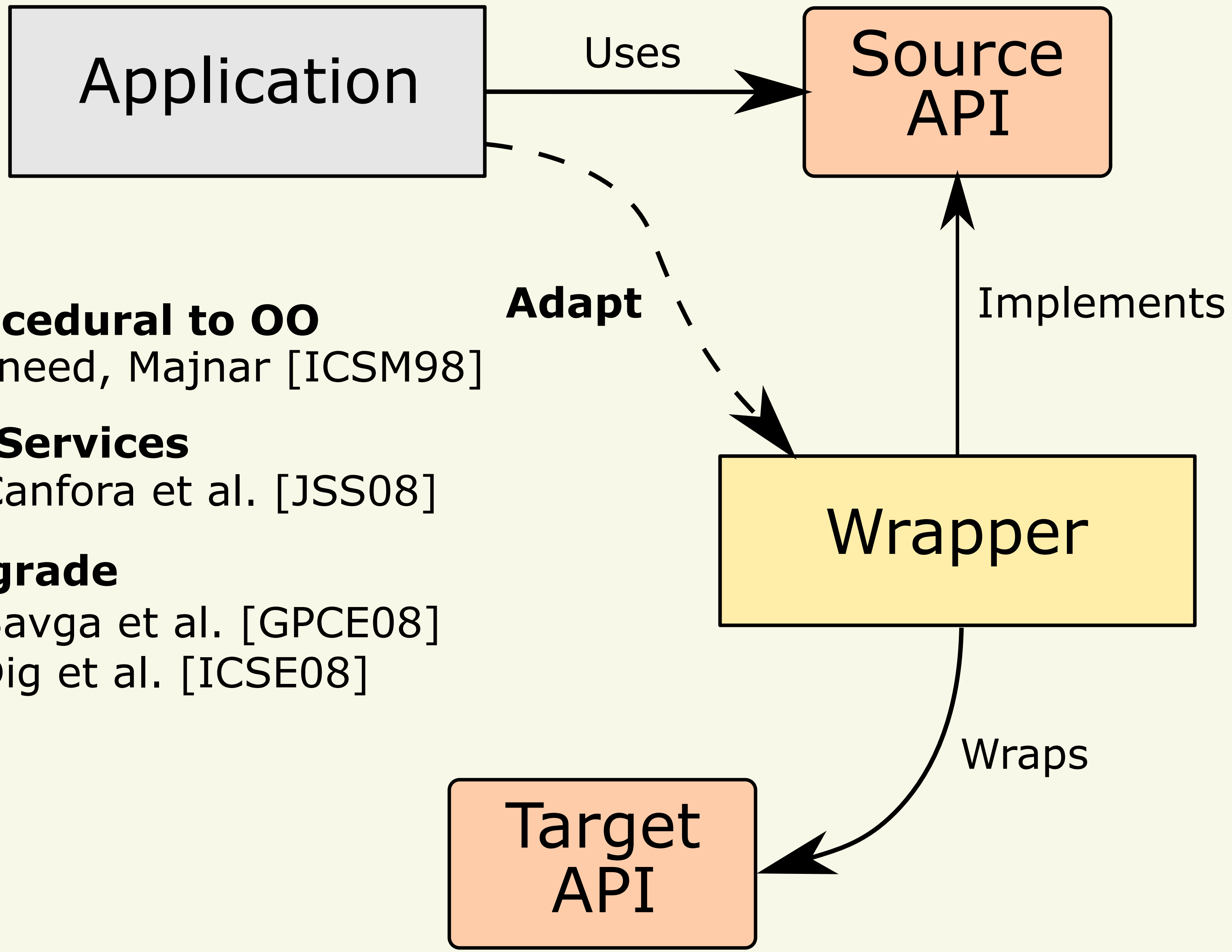
To Services
Canfora et al. [JSS08]

API Migration



Procedural to OO
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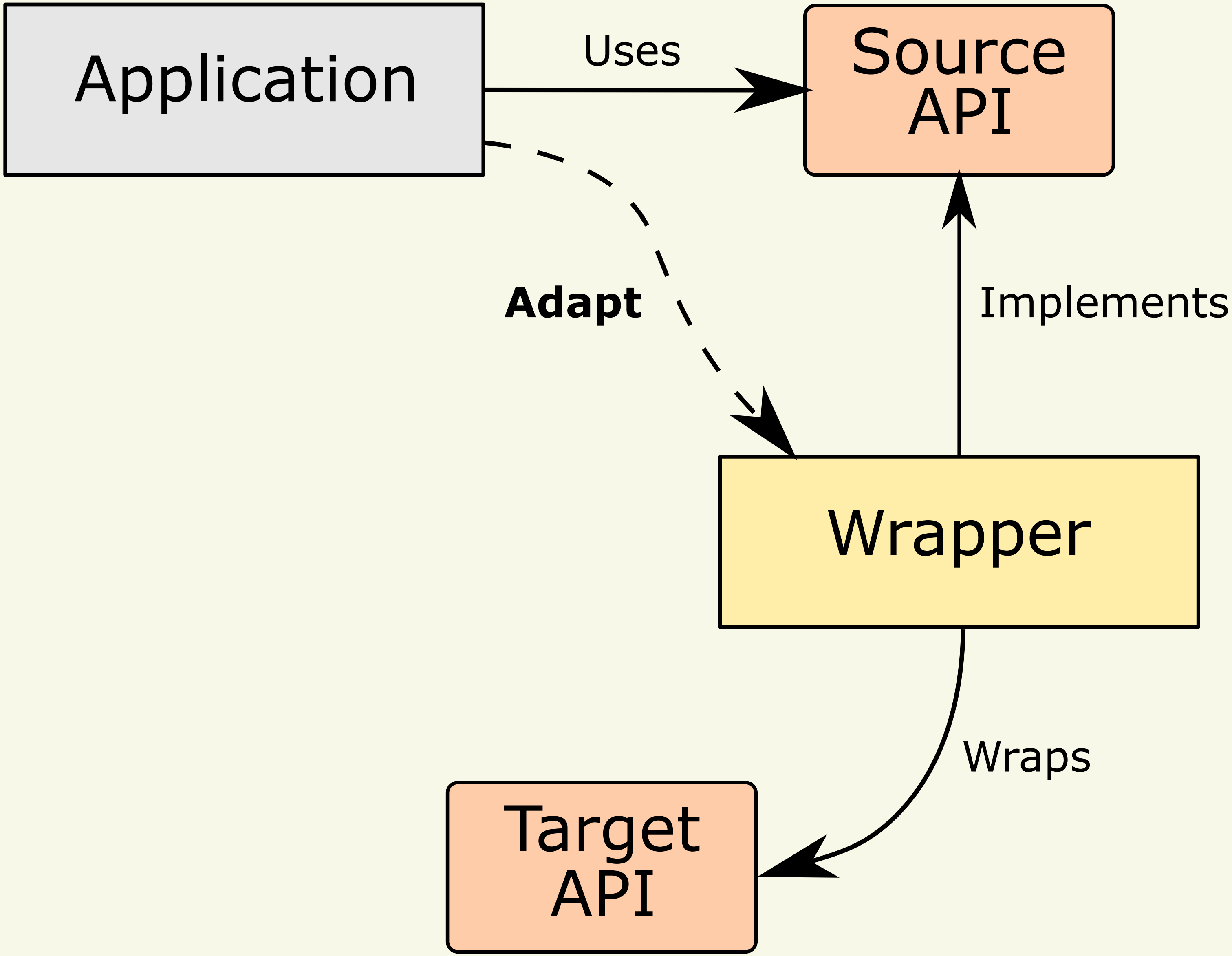
Şavga et al. [GPCE08]
Dig et al. [ICSE08]

API Migration



Limitations (Motivations)

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Simple APIs

Limitations (Motivations)

Simple APIs

No Deep Inheritance Hierarchies

Limitations (Motivations)

Simple APIs

No Deep Inheritance Hierarchies

Simple Mappings

2 - Study Design

Research Questions

Research Questions

1. What are the **design challenges** faced by developers when implementing wrapping layers around OO APIs?

Research Questions

1. What are the **design challenges** faced by developers when implementing wrapping layers around OO APIs?
2. What are the **solutions** employed in practice?

Subjects

Subjects

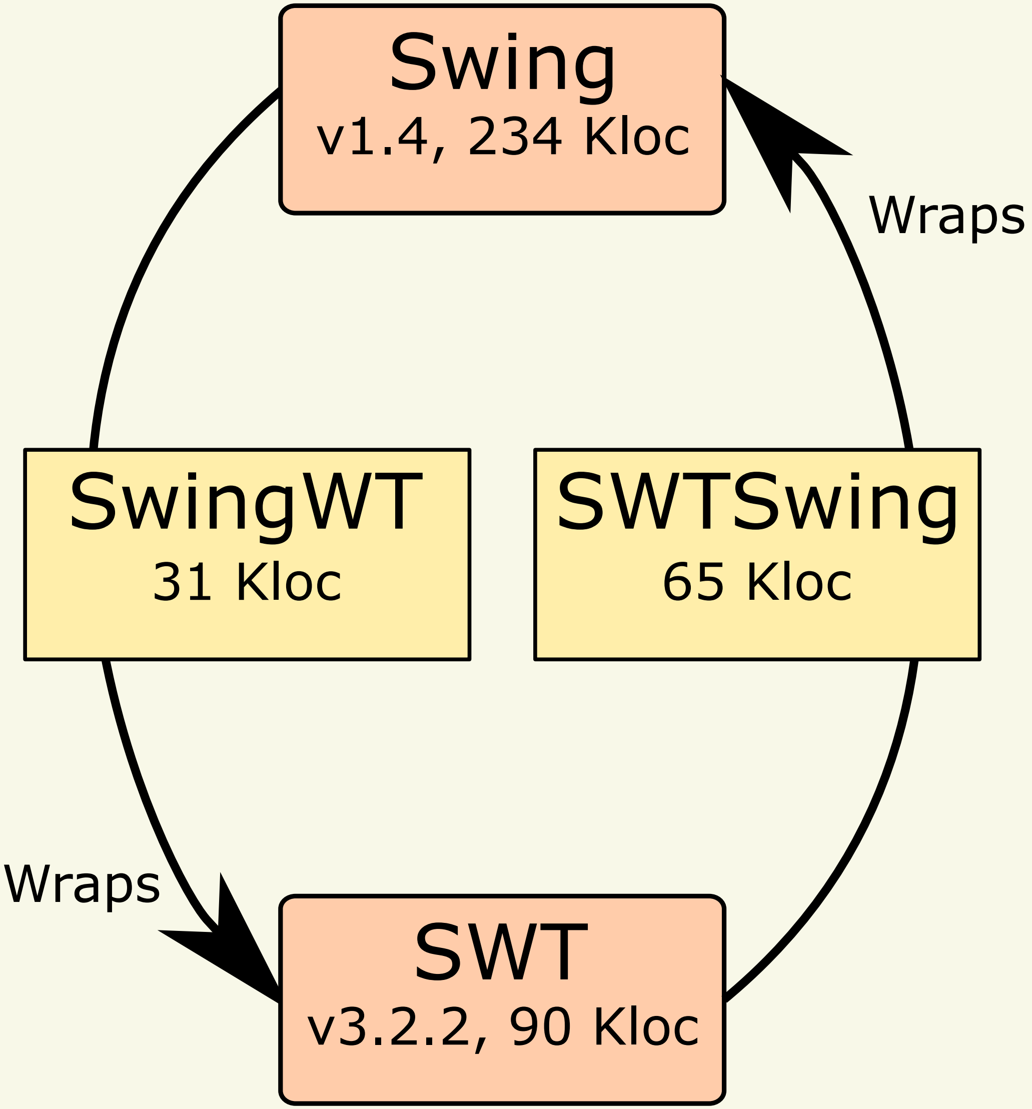
SwingWT

31 Kloc

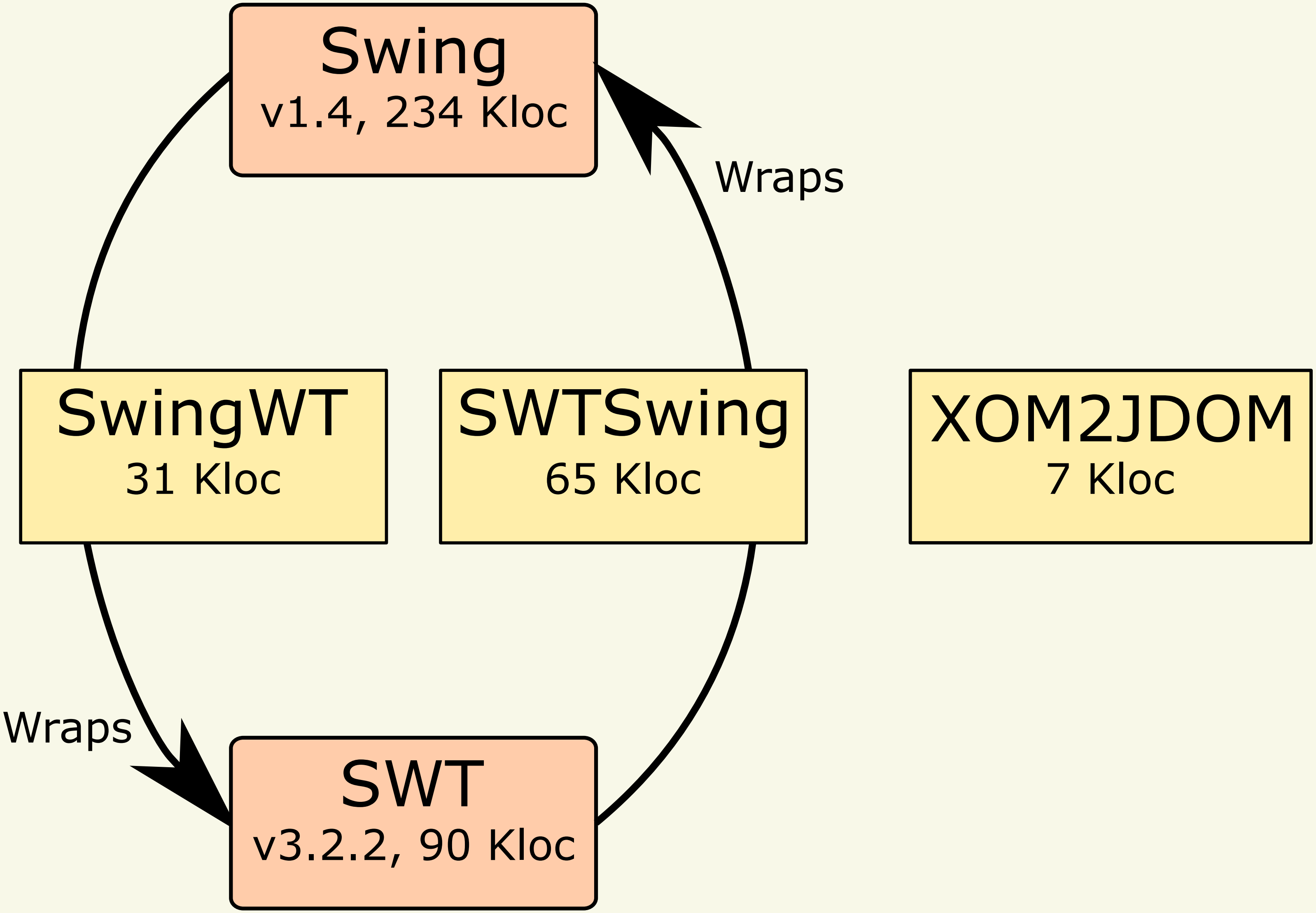
SWTSwing

65 Kloc

Subjects


Swing
v1.4, 234 Kloc
Wraps
SwingWT
31 Kloc
SWTSwing
65 Kloc
Wraps
SWT
v3.2.2, 90 Kloc

Subjects


Swing
v1.4, 234 Kloc
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XOM2JDOM
7 Kloc
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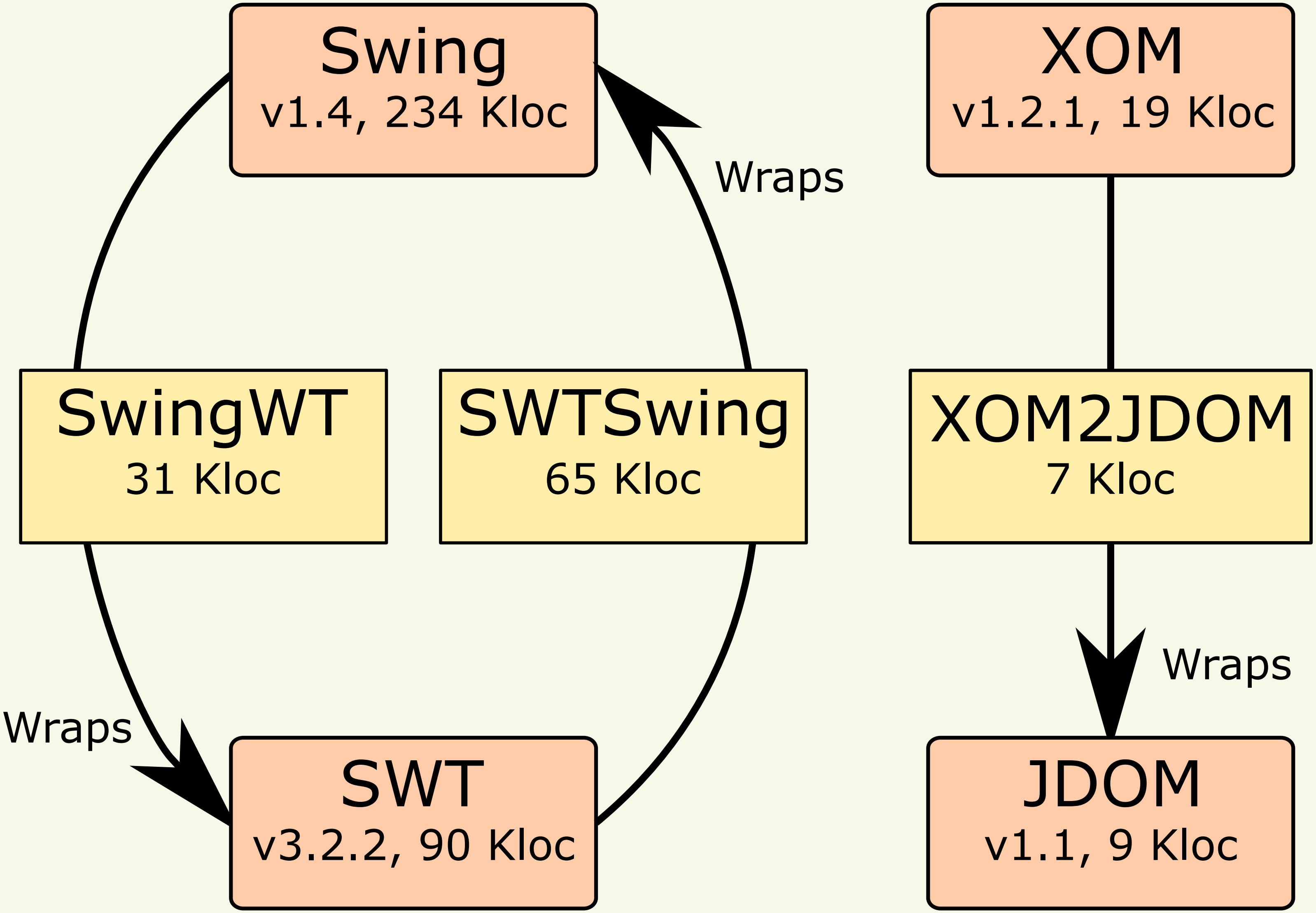
SWT
v3.2.2, 90 Kloc

Subjects



Swing
v1.4, 234 Kloc

XOM
v1.2.1, 19 Kloc

Wraps

SwingWT
31 Kloc

SWTSwing
65 Kloc

XOM2JDOM
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Wraps

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SWT
v3.2.2, 90 Kloc

JDOM
v1.1, 9 Kloc

Methodology

Methodology

1. **Uncover design challenges**

Methodology

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   Source Code

   Original Developers

   Type Correspondences

Methodology

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   - Original Developers
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    - Source Code
    - Original Developers
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2. **Understand solutions**
    - Source Code
    - Code Queries
    - Design Patterns

Methodology

1. **Uncover design challenges**

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   Design Patterns

3. **Measure presence of design patterns**

Methodology

1. **Uncover design challenges**

    Source Code

    Original Developers

    Type Correspondences

2. **Understand solutions**

    Source Code

    Code Queries

    Design Patterns

3. **Measure presence of design patterns**

    Metrics

3 - Study Results

API Wrapping Challenges
&
Design Patterns

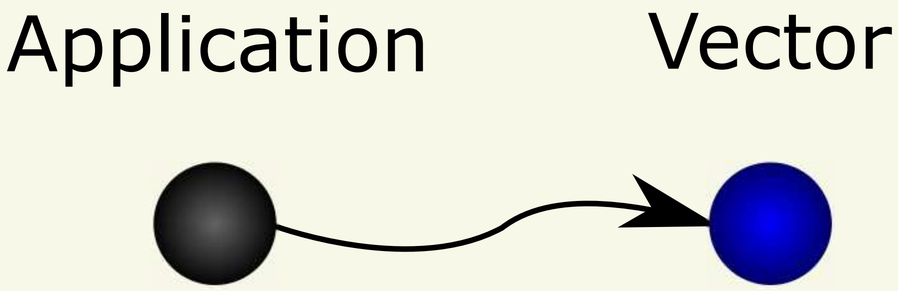
API Wrapping Challenges and Design Patterns

Challenge	Design Pattern
Non-trivial Mapping Multiplicities	Layered Adapter Stateful Adapter
Inversion of Control	Inverse Delegation
Correspondence of Object Identities	Wrapping Identity Map
Varying Creation and Wiring Protocols	Delayed Instantiation
Varying Type Hierarchies	

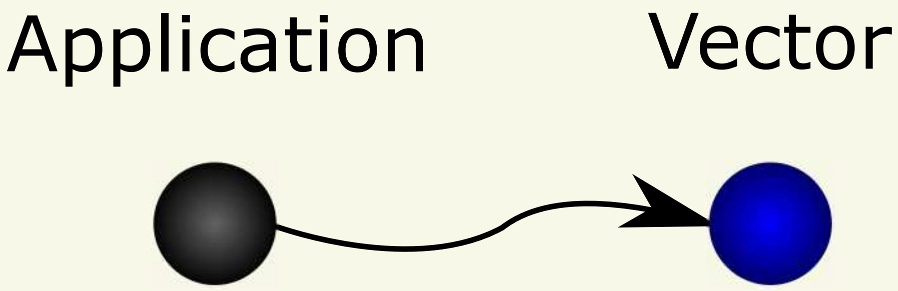
ADAPTER Pattern

Java Vectors to ArrayLists

Vector to ArrayList



Vector to ArrayList



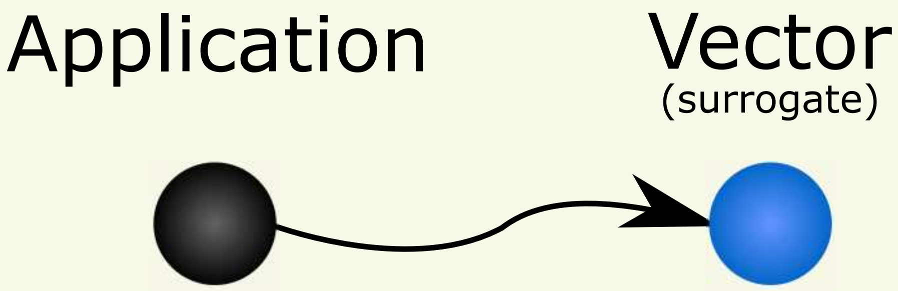
```
public class Vector ... {

    public Vector() {...}

    public void add(Object o) {...}

    public void setSize(int ns) {...}
    ...
}
```

Vector to ArrayList



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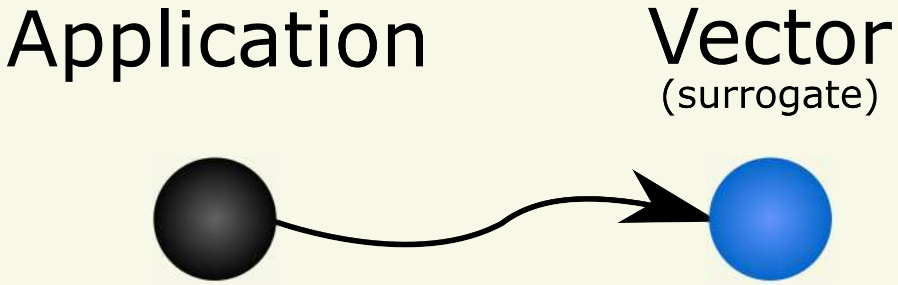

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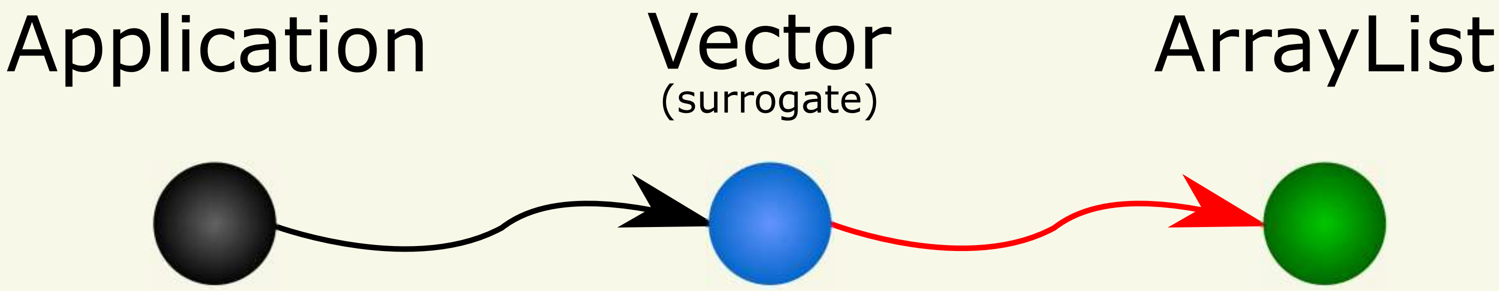

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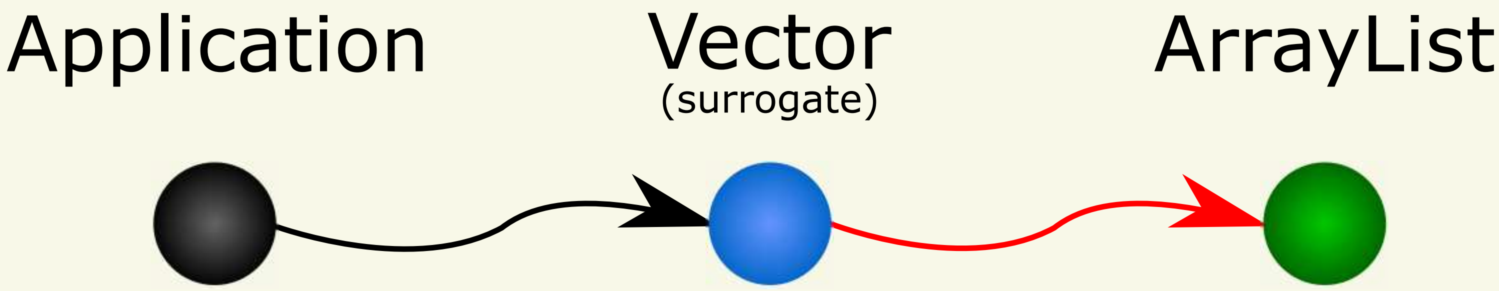
Vector to ArrayList



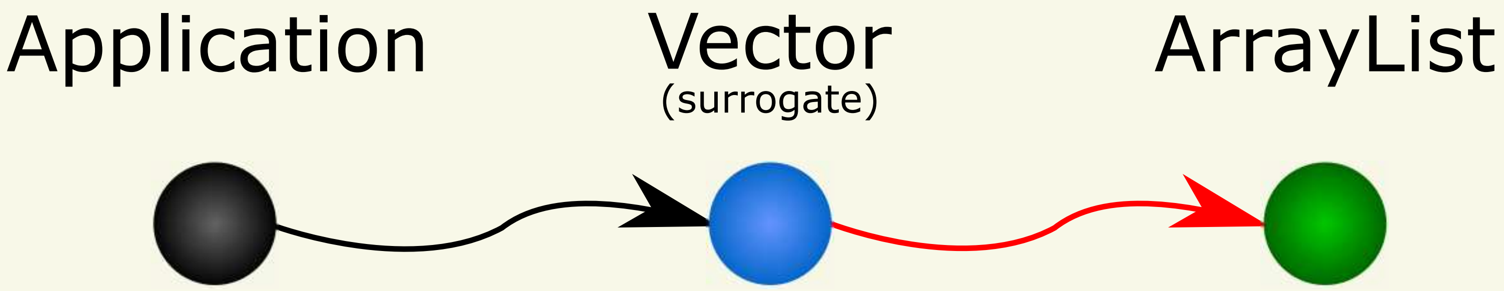
Application

Vector
(surrogate)

ArrayList

```
public class Vector ... {

    ArrayList adaptee;

    public Vector() {...}

    public void add(Object o) {...}

    public void setSize(int ns) {...}
    ...
}
```

Vector to ArrayList

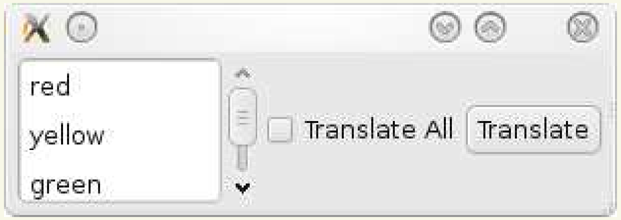


```
public class Vector ... {

  ArrayList adaptee;

  public Vector() { adaptee = new ArrayList(); }

  public void add(Object o) { adaptee.add(o); }

  public void setSize(int ns) {
    while(adaptee.size() < ns) adaptee.add(null);
    while(adaptee.size() > ns) adaptee.remove(ns);
  }
  ...
}
```

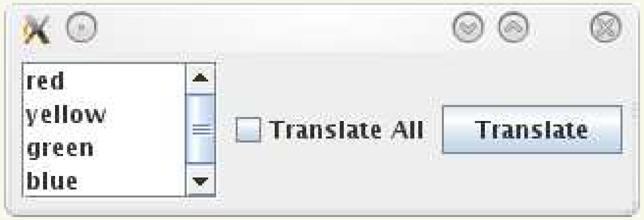
Sample GUI Application

Sample GUI Application

SWT

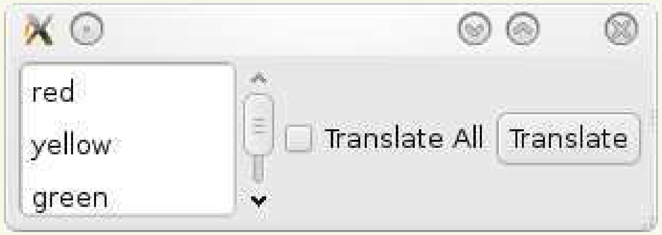


Swing

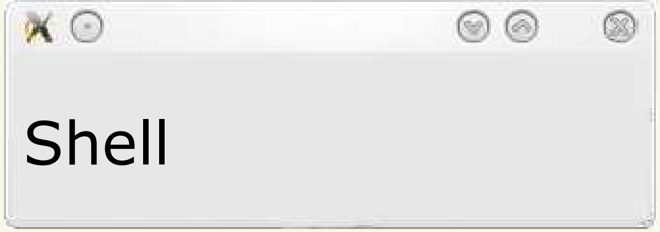


SWT GUI

SWT GUI

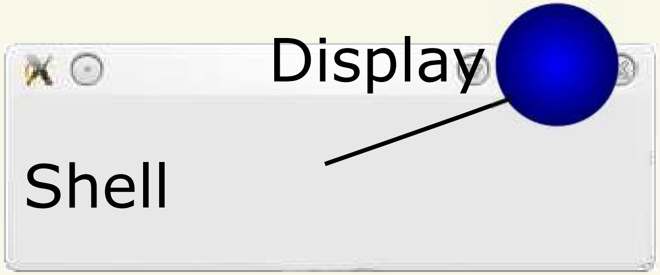


SWT GUI

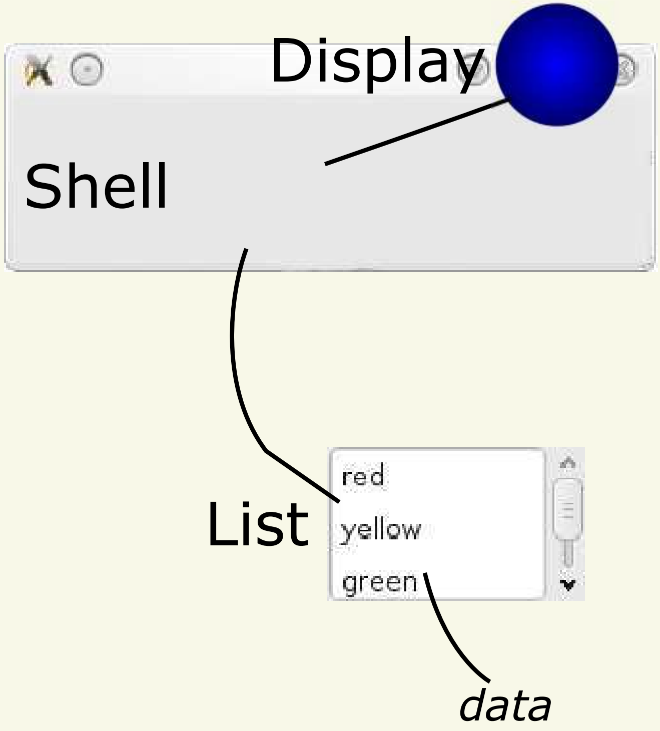


Shell

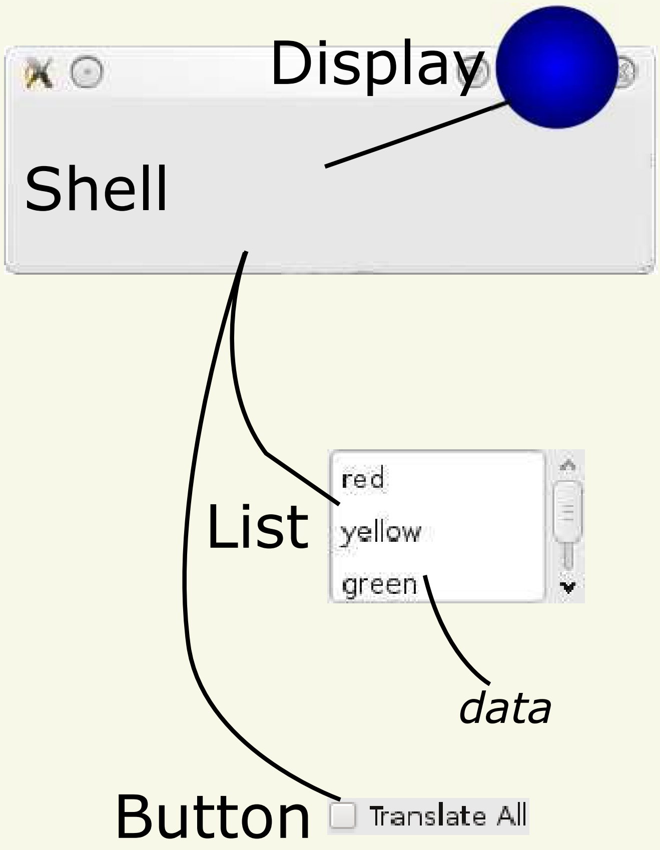
SWT GUI



SWT GUI



SWT GUI



Display

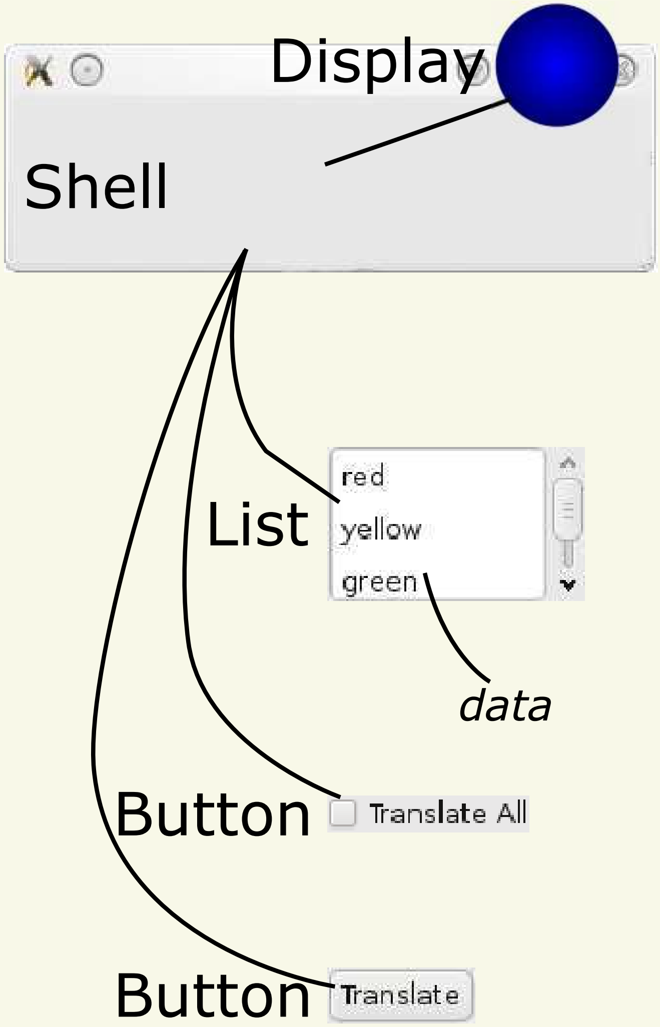
Shell

List

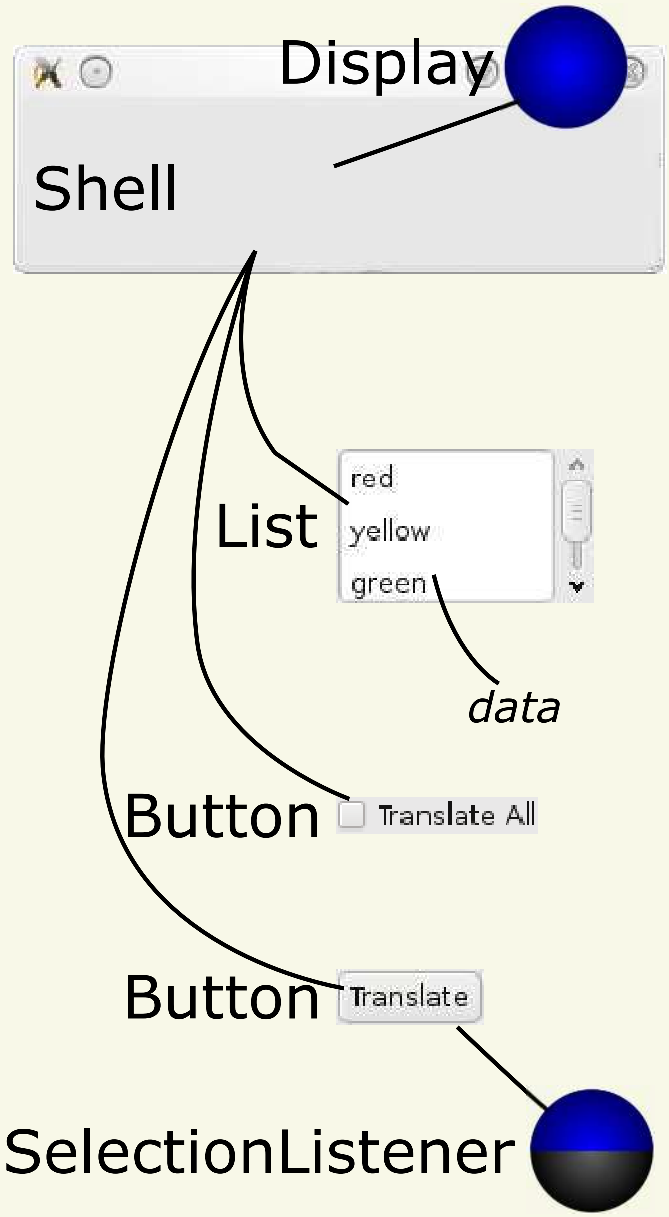
data

Button

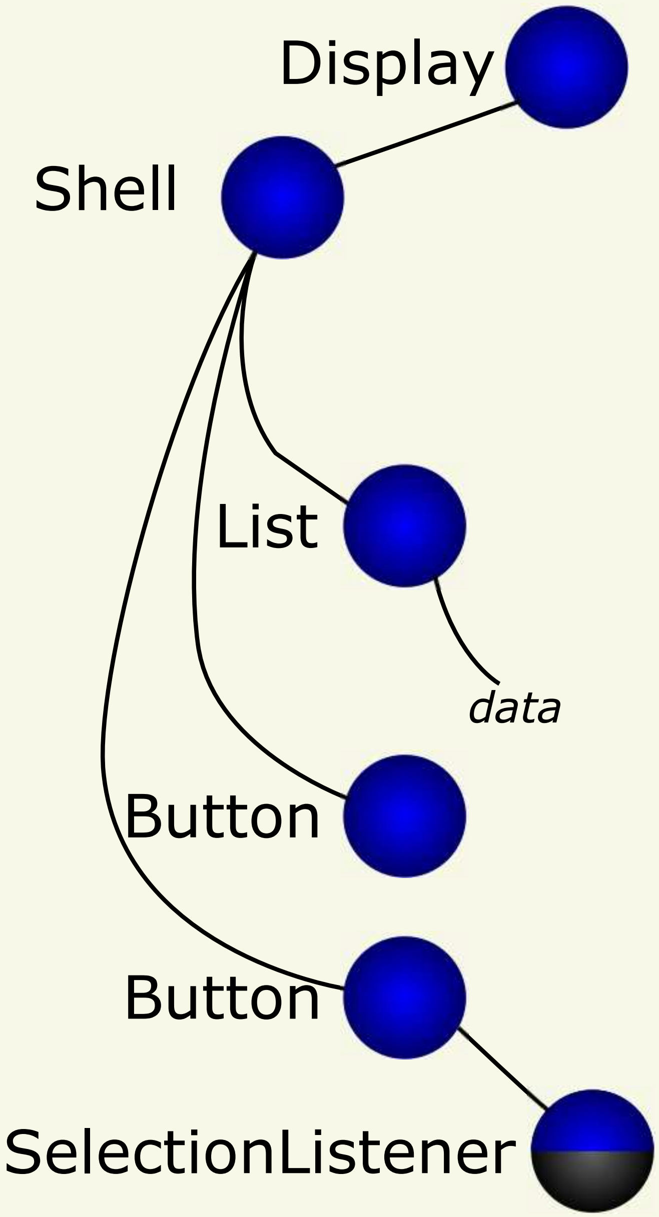
SWT GUI


Display
Shell
List
red
yellow
green
data
Button
Translate All
Button
Translate

SWT GUI

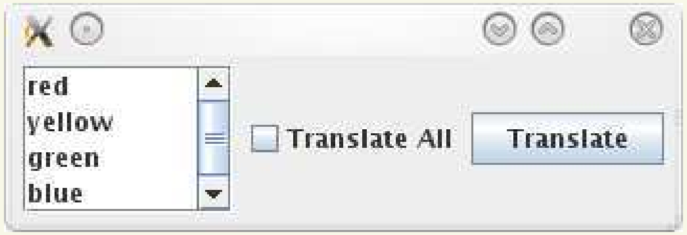

Display
Shell
List
red
yellow
green
data
Button
□ Translate All
Button
Translate
SelectionListener

SWT GUI

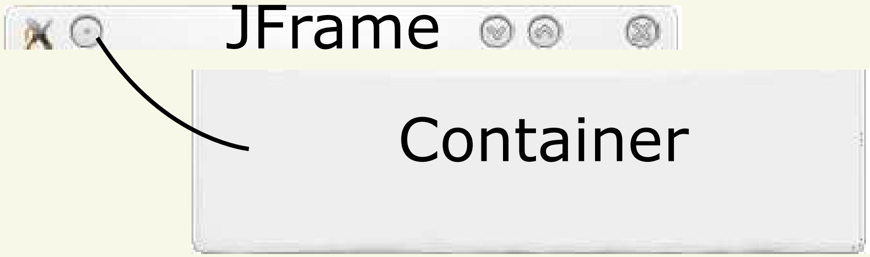


Swing GUI

Swing GUI



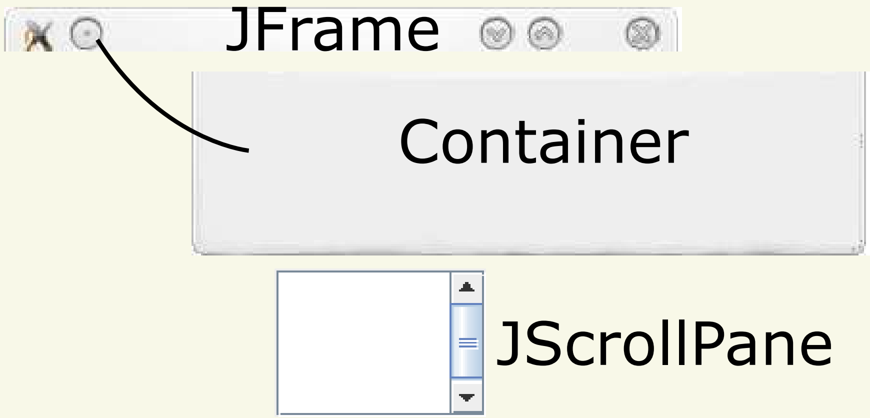
Swing GUI



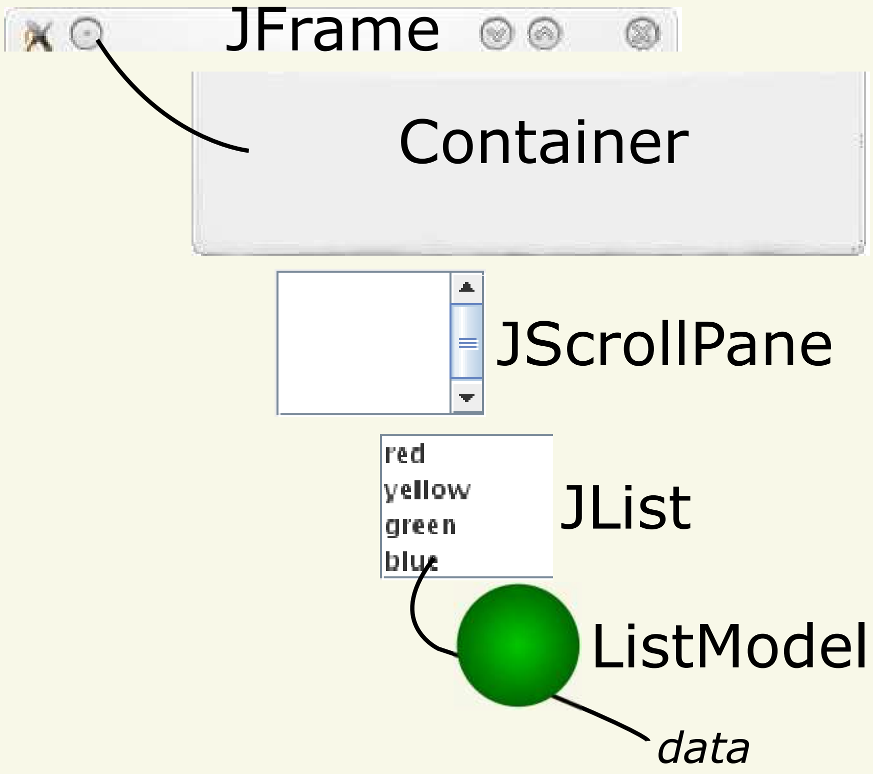
JFrame

Container

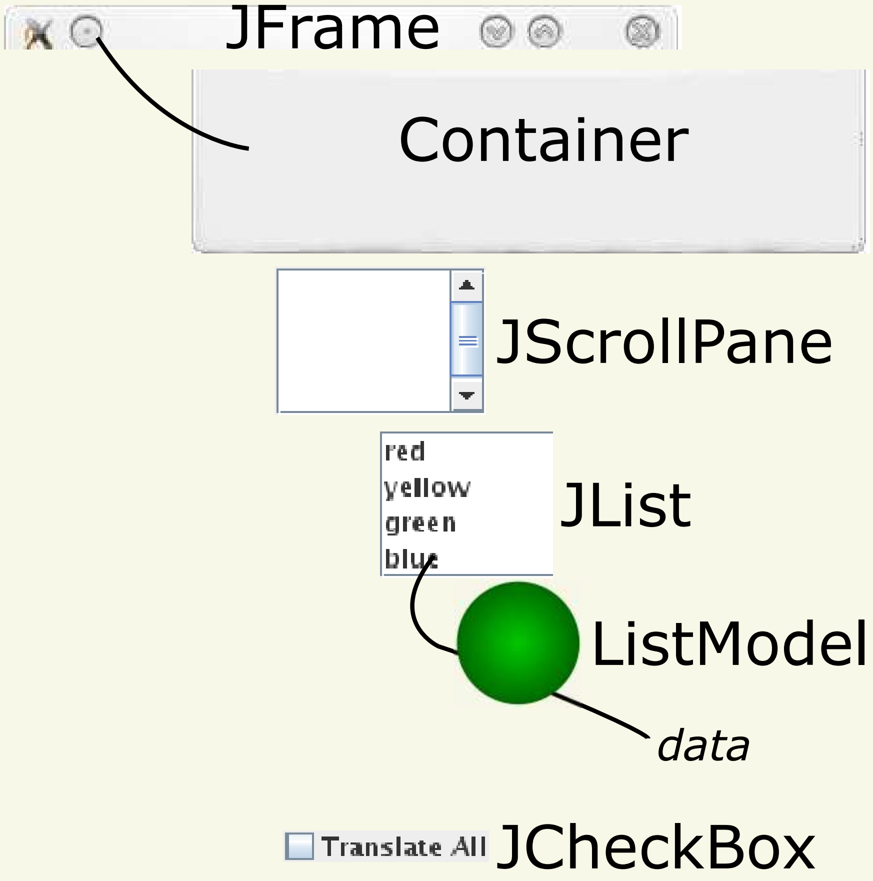
Swing GUI



Swing GUI


JFrame
Container
JScrollPane
red
yellow
green
blue
JList
ListModel
data

Swing GUI



JFrame

Container

JScrollPane

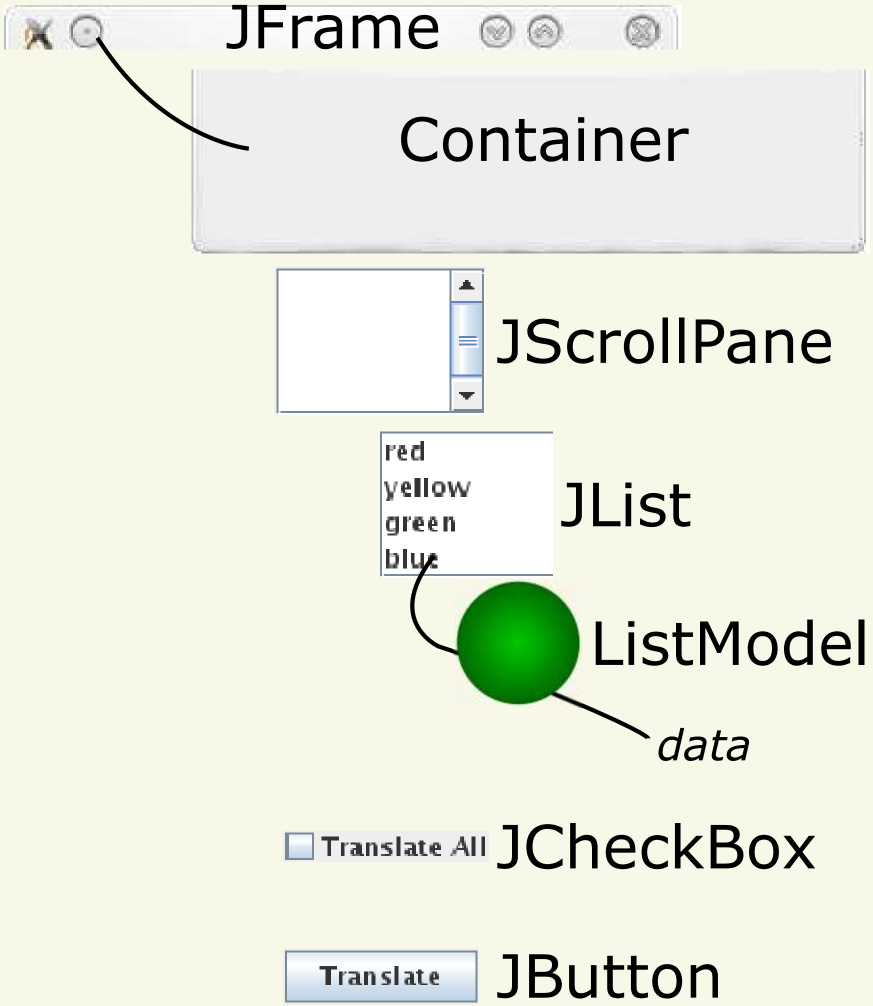
JList

ListModel

data

JCheckBox

Swing GUI



JFrame

Container

JScrollPane

JList

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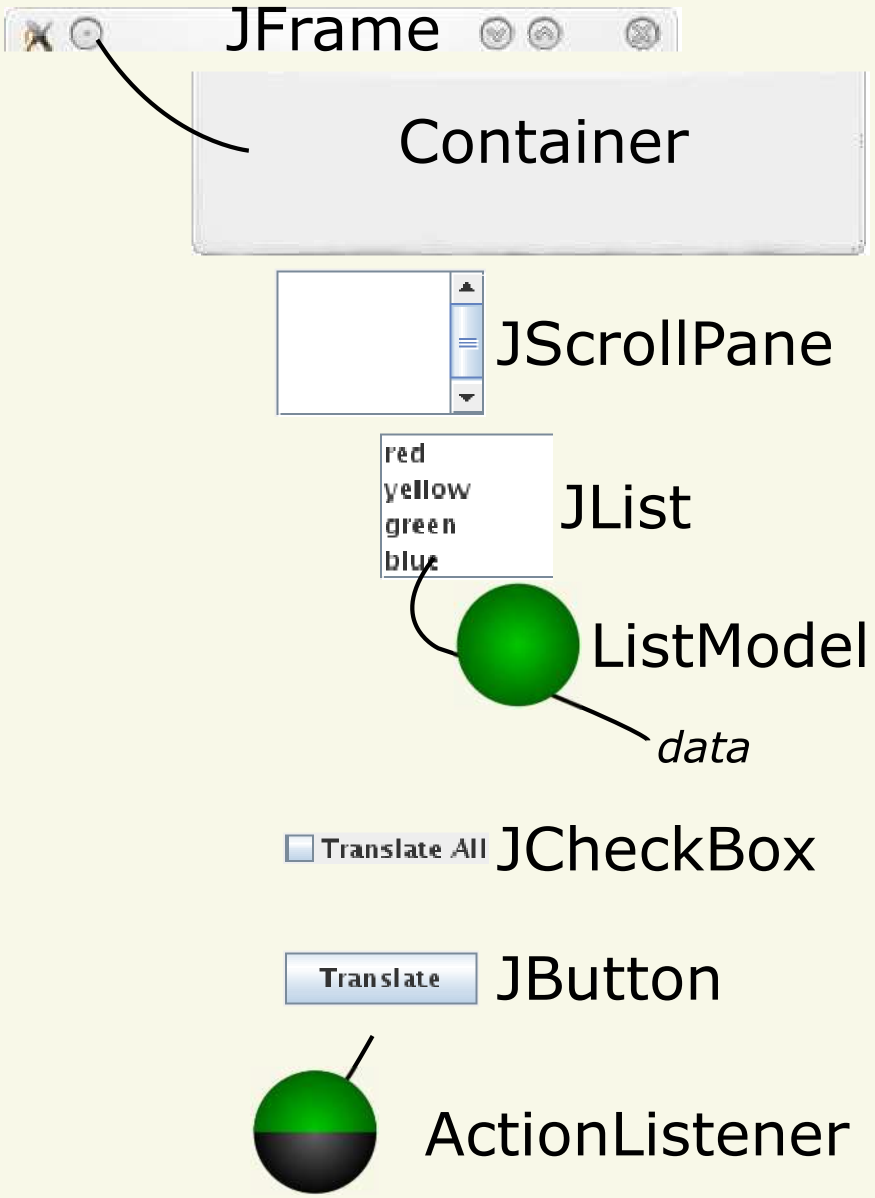
JCheckBox

JButton

Swing GUI



JFrame

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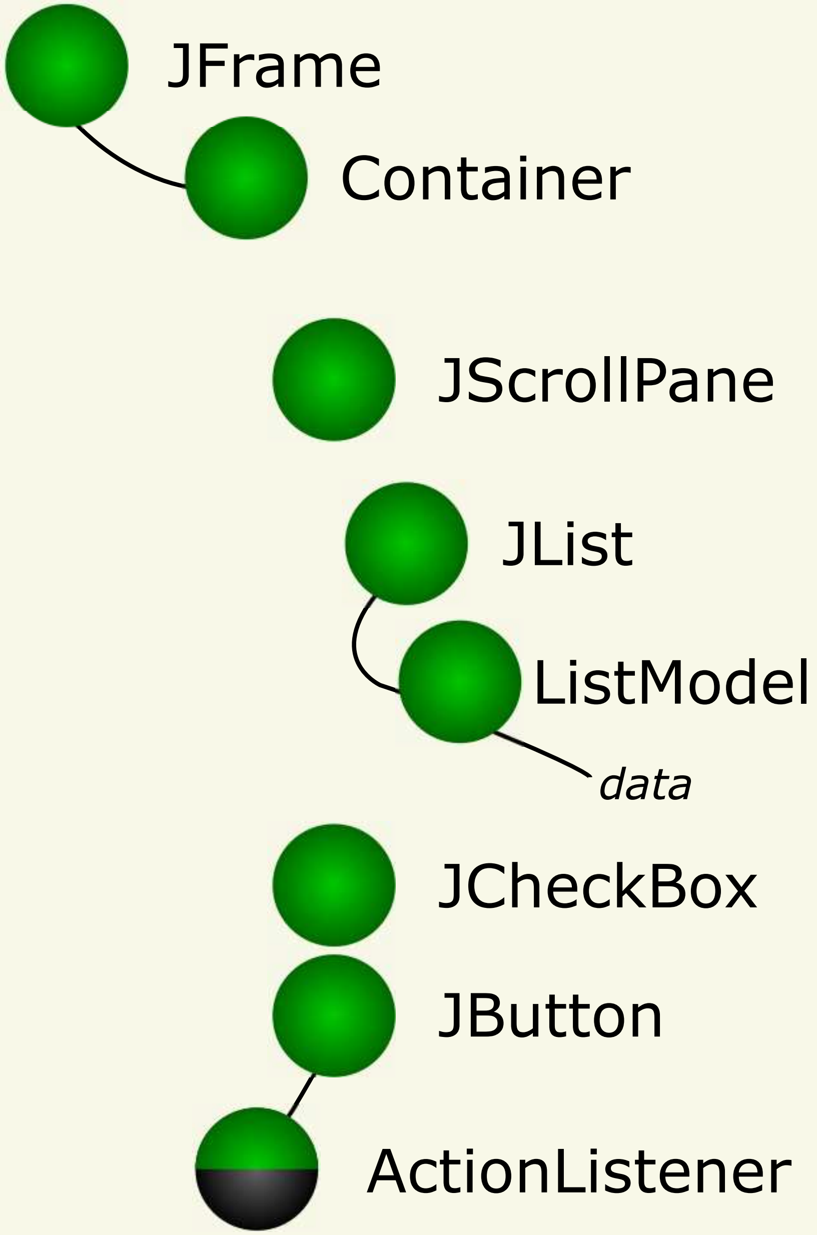
ActionListener

Swing GUI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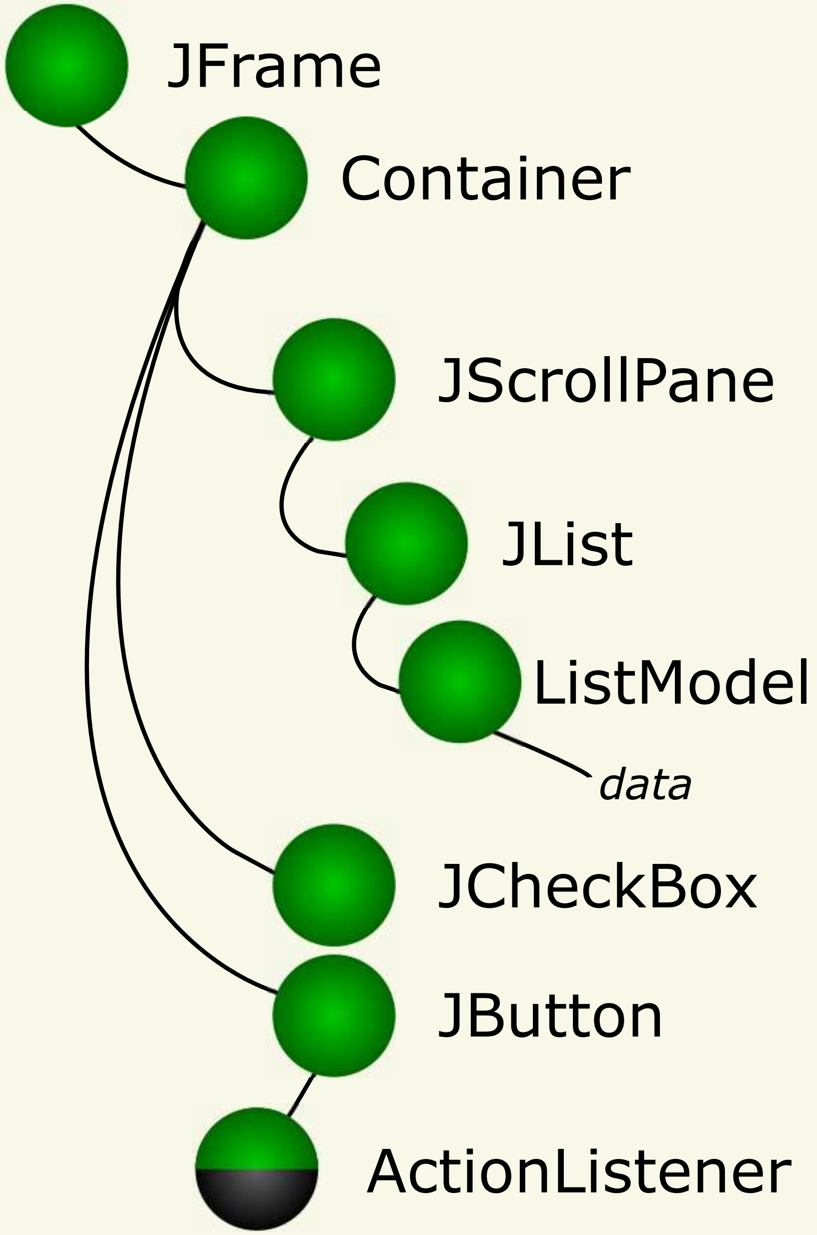
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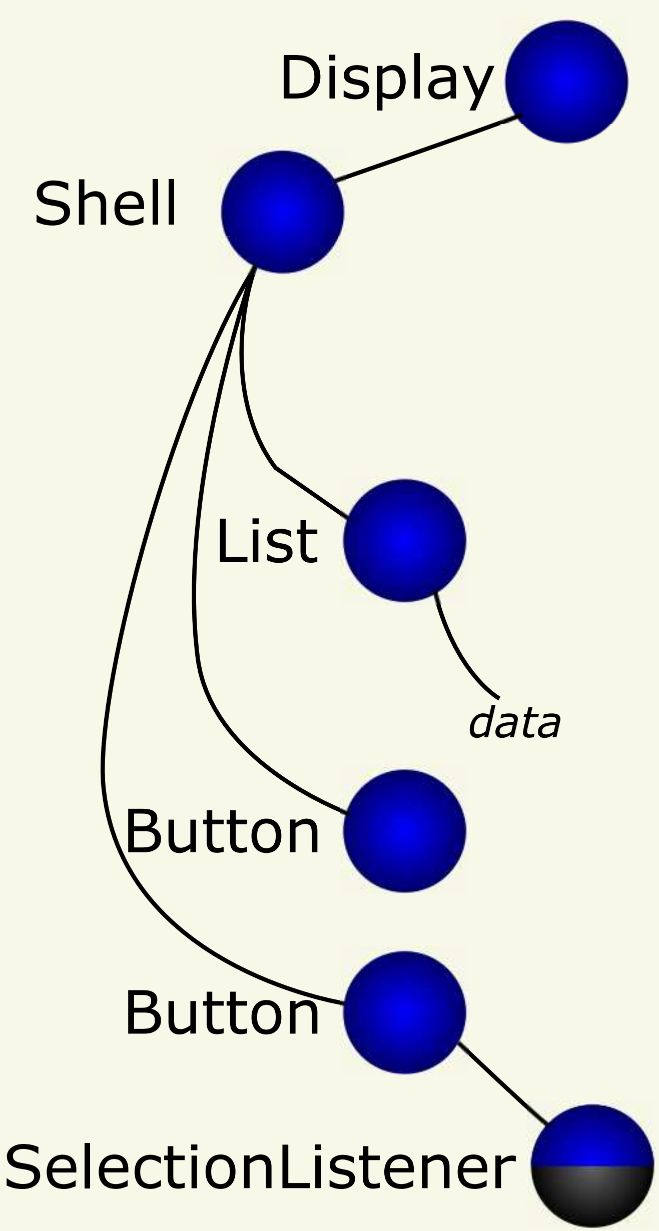
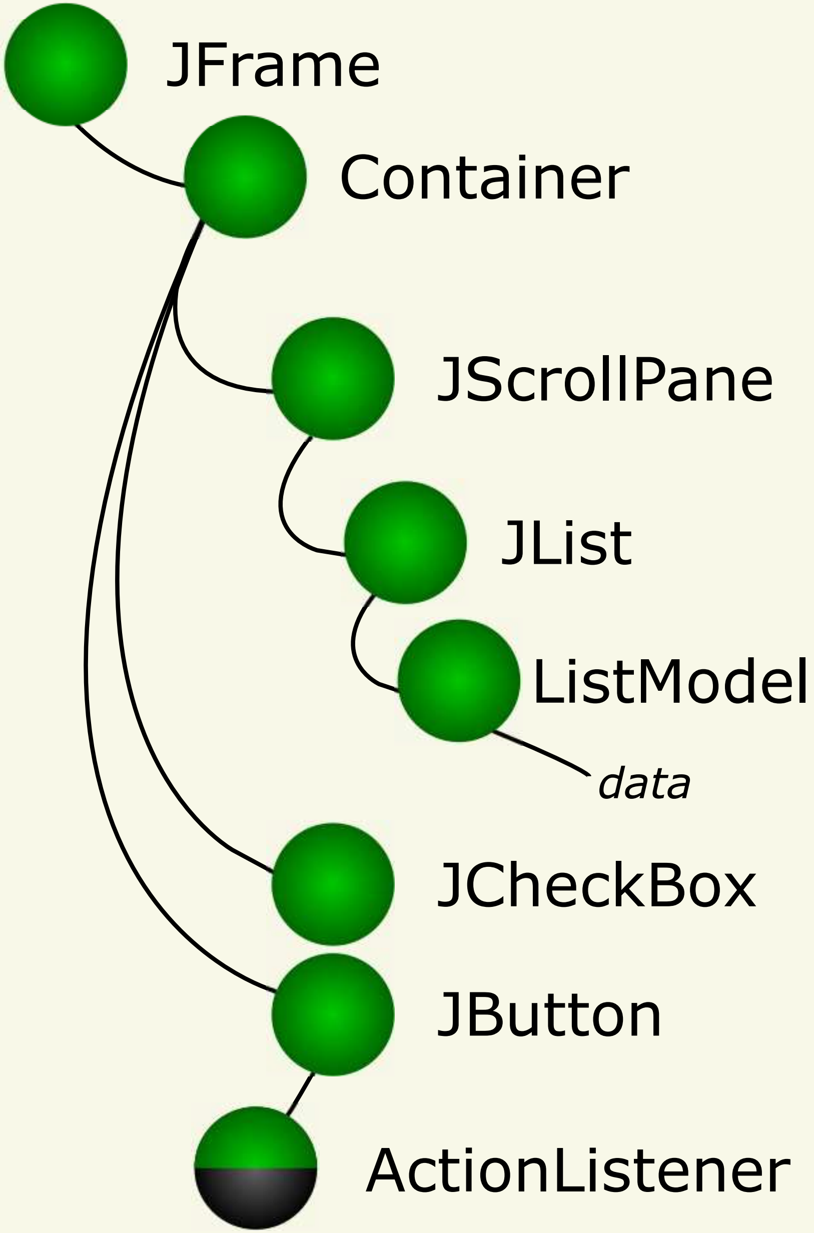
Mapping SWT to Swing

SWT to Swing


Display
Shell
List
data
Button
Button
SelectionListener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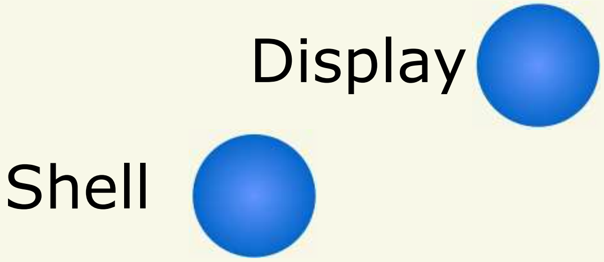
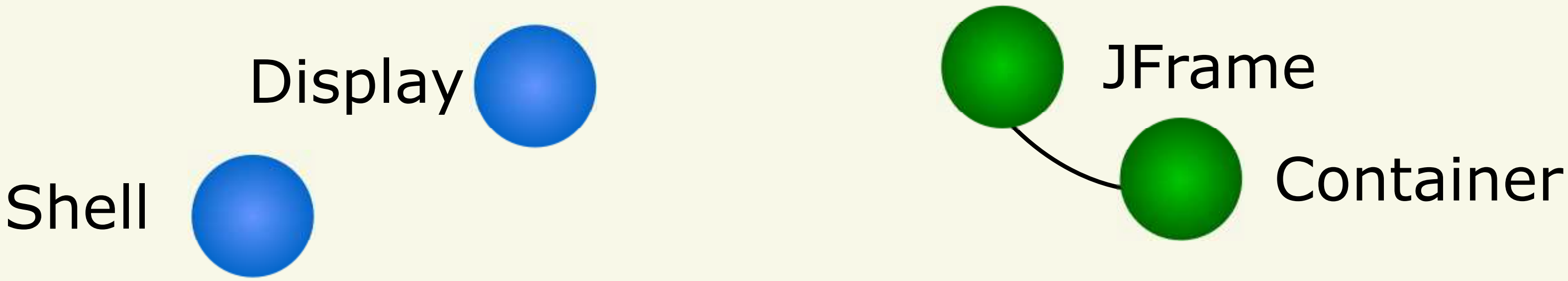


Display

Shell

SWT to Swing



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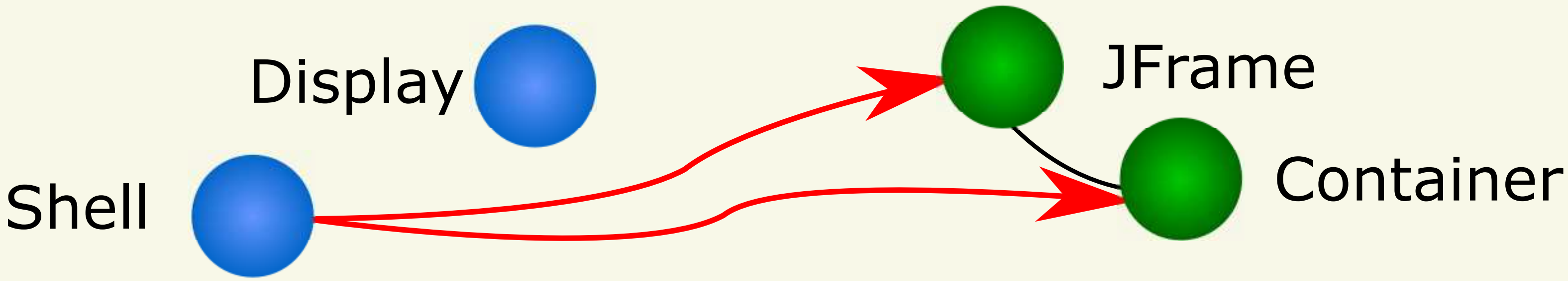

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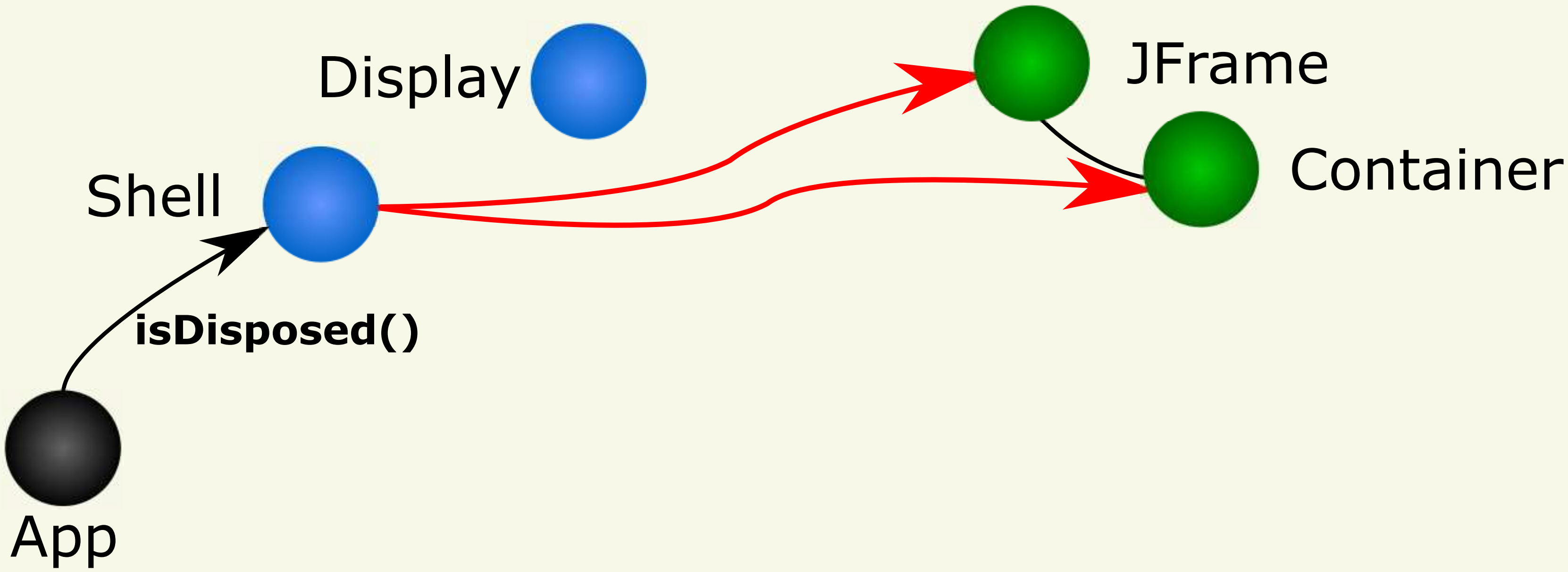

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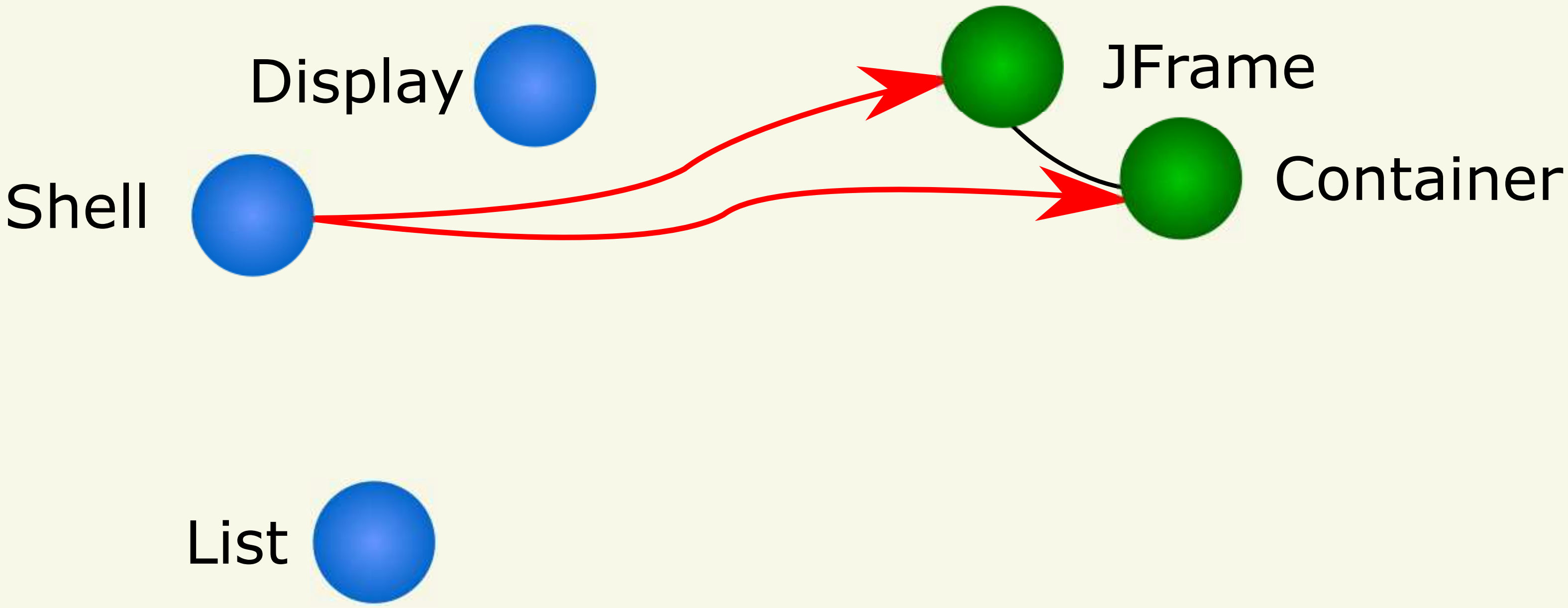

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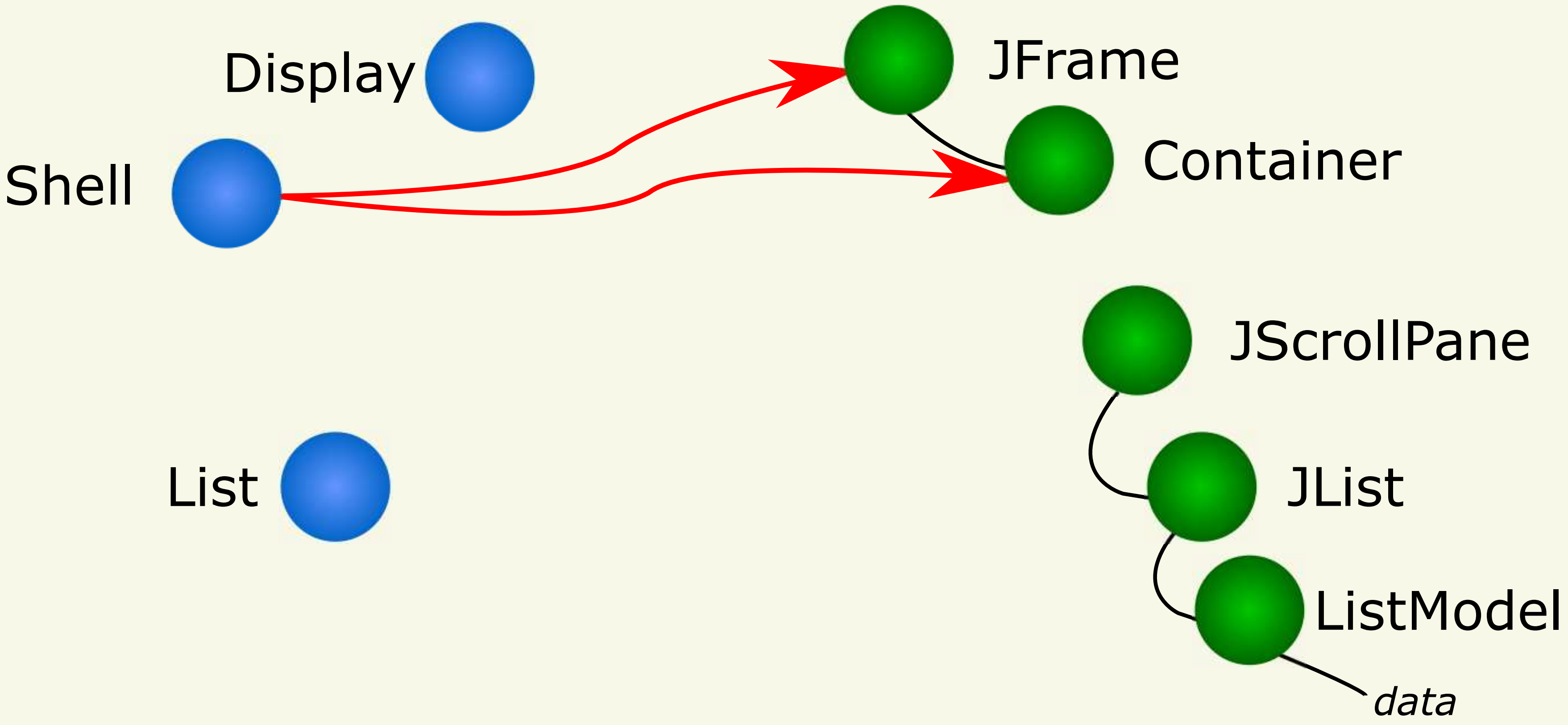
Display
Shell
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JFrame
Container
JScrollPane
JList
ListModel
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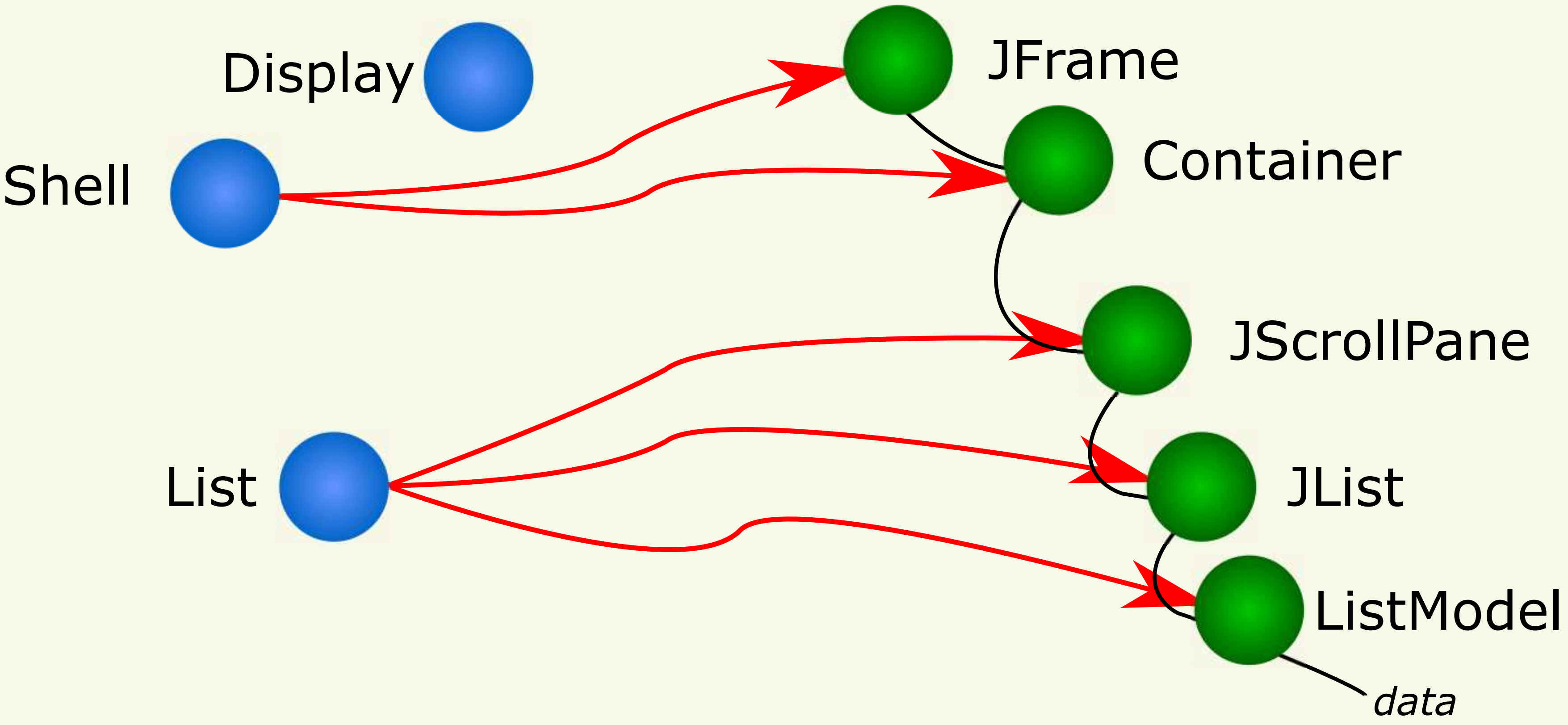
SWT to Swing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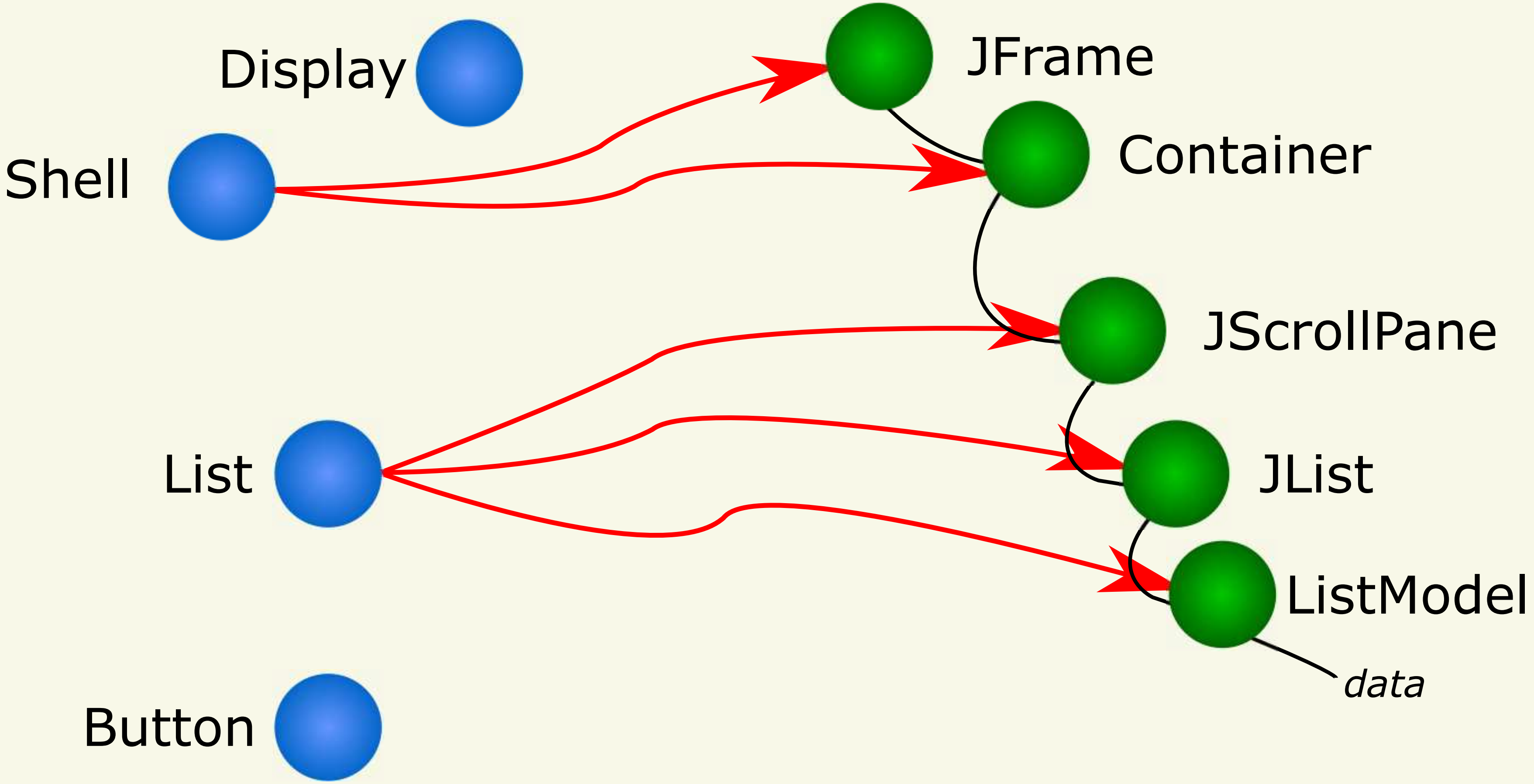
SWT to Swing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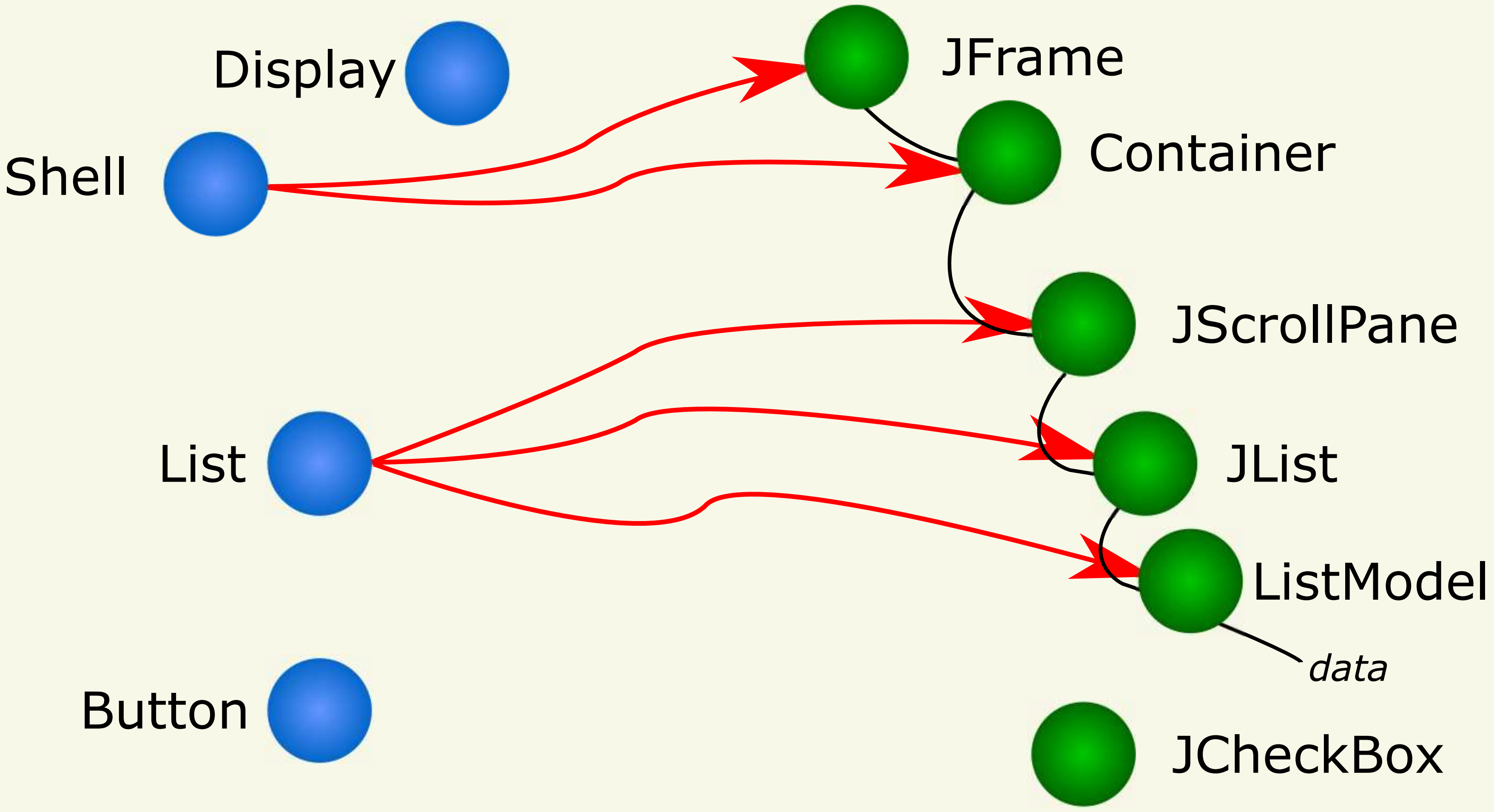
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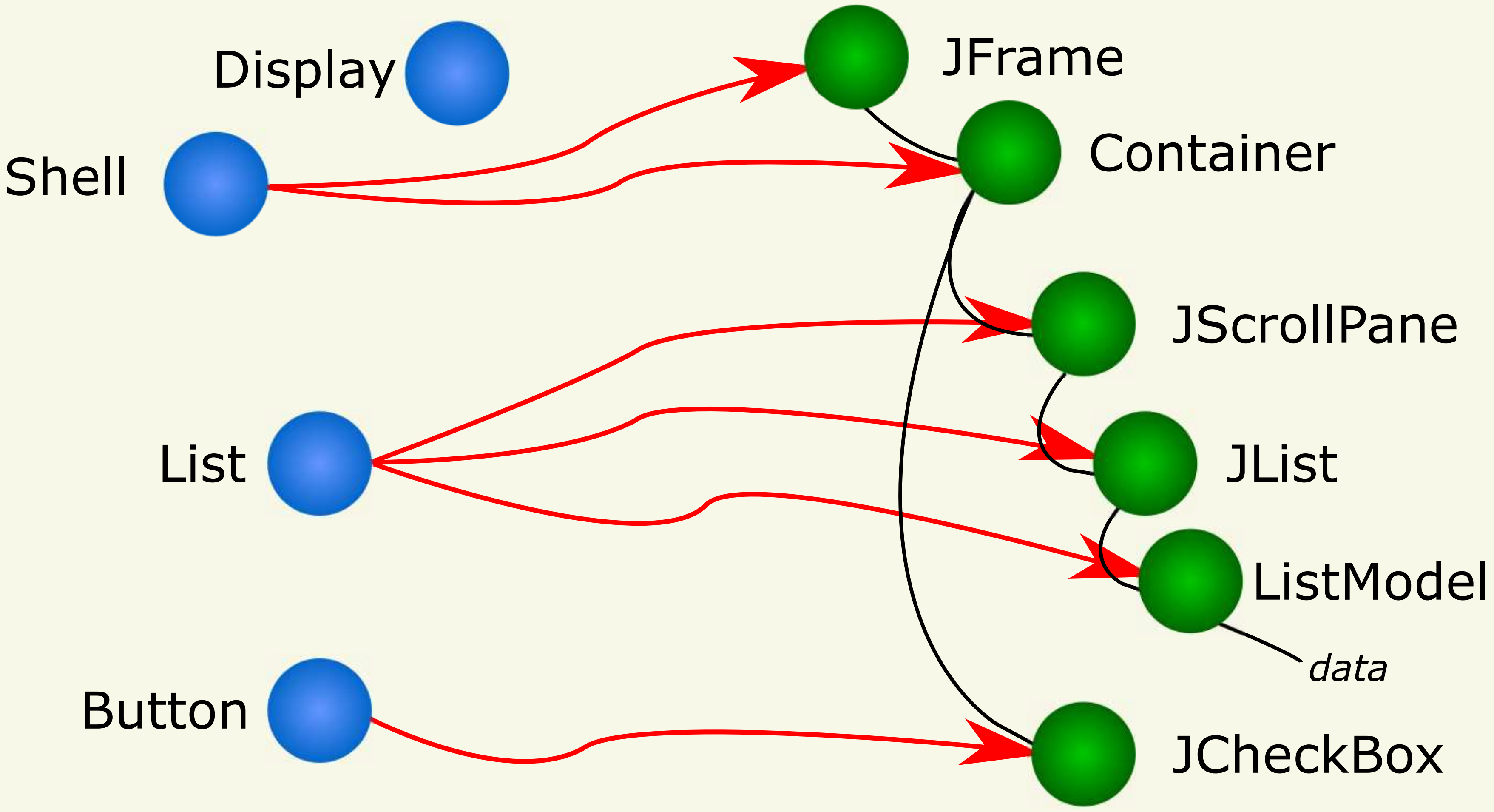
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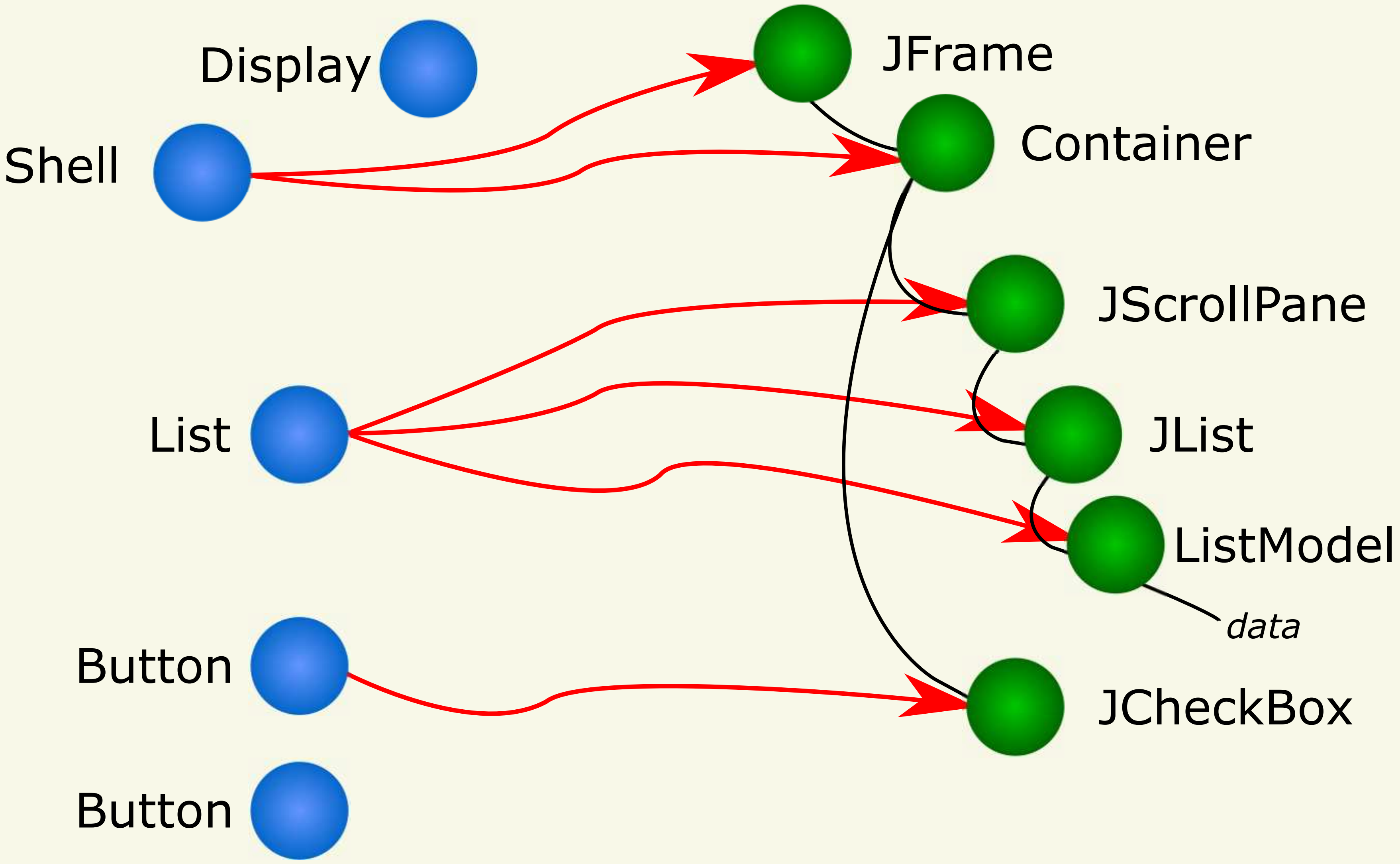
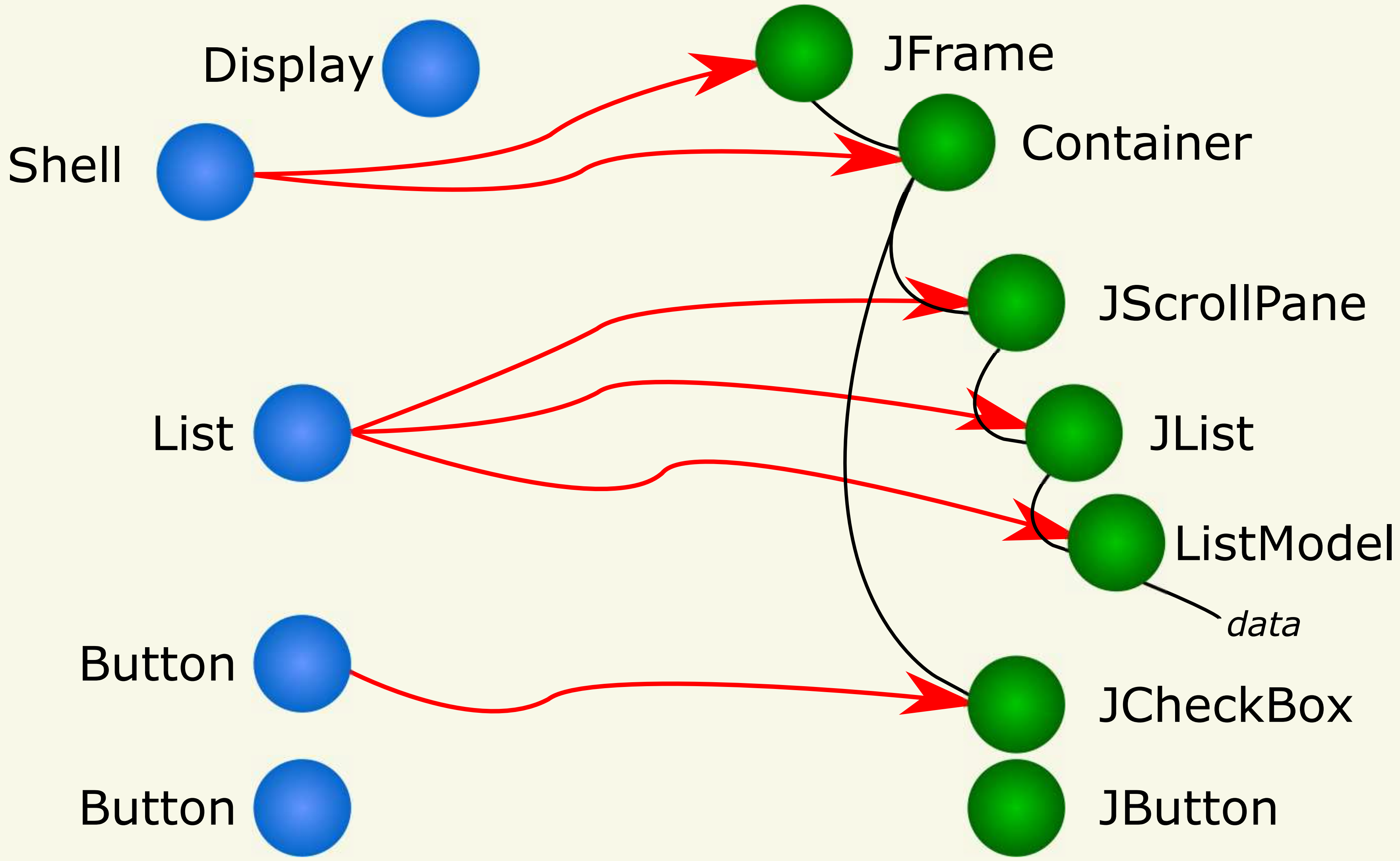
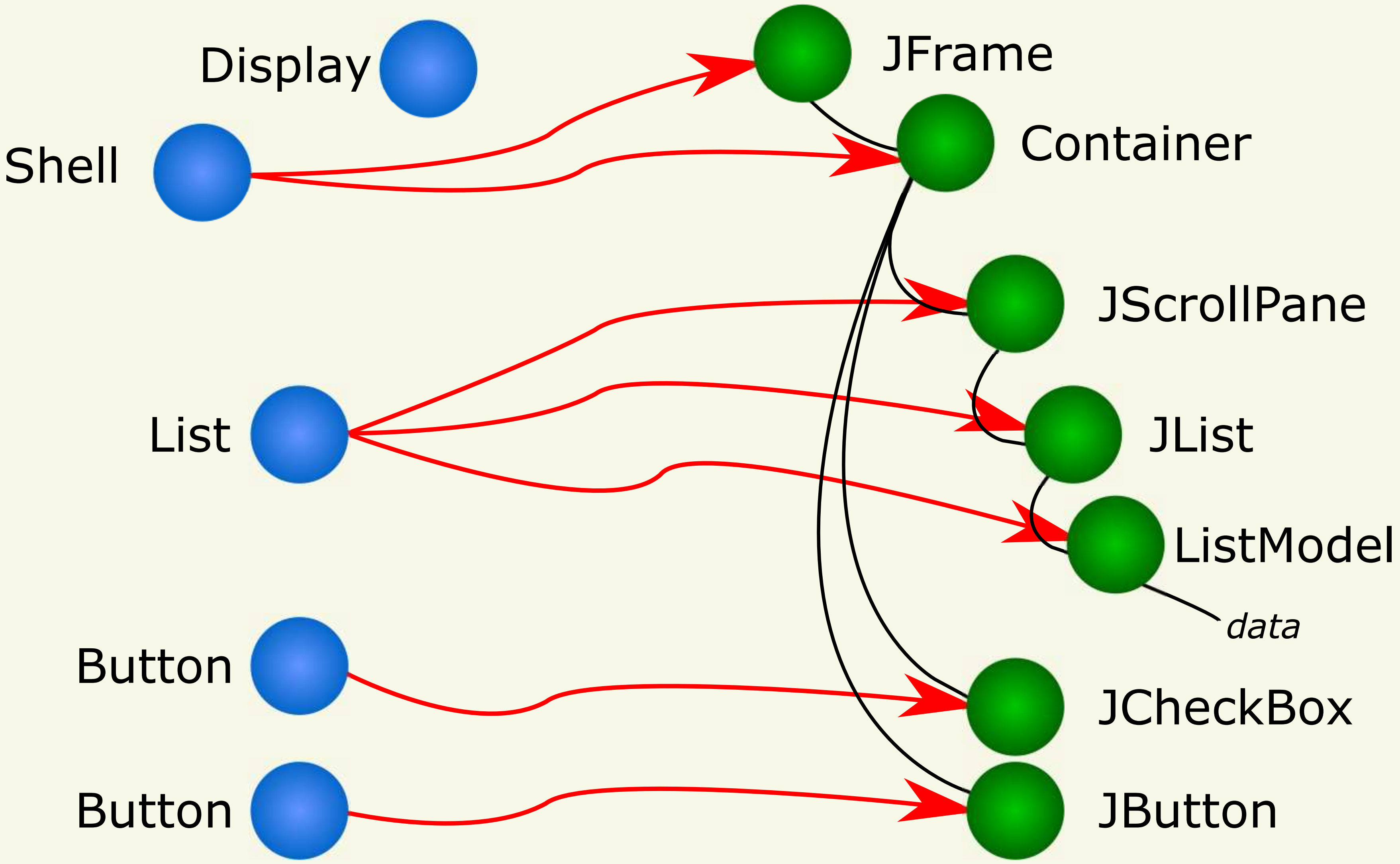
SWT to Swing


Display
Shell
List
Button
Button
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox

SWT to Swing


Display
Shell
List
Button
Button
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox
JButton

SWT to Swing


Display
Shell
List
Button
Button
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox
JButton

Non-trivial Mapping Multiplicities

Target Multiplicities

Name	Example
No Target	Display→ ∅
Single Target	Vector→ArrayList
Alternative Targets	Button→JButton | JCheckBox
Composite Targets	List→JList, ListModel

Target Multiplicities

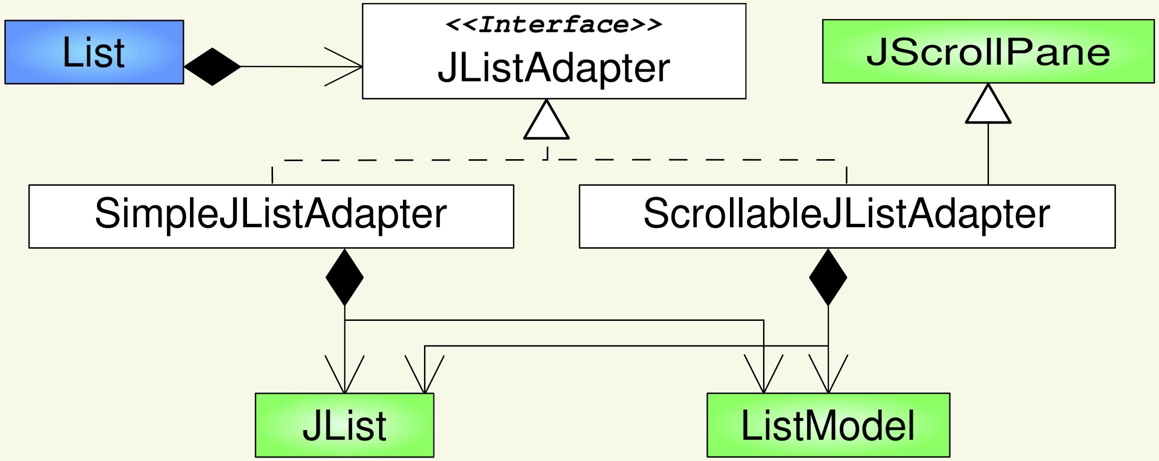
Name	Example
No Target	Display→ ∅
Single Target	Vector→ArrayList
Alternative Targets	Button→JButton $\mid$ JCheckBox
Composite Targets	List→JList, ListModel

Alternative and Composite

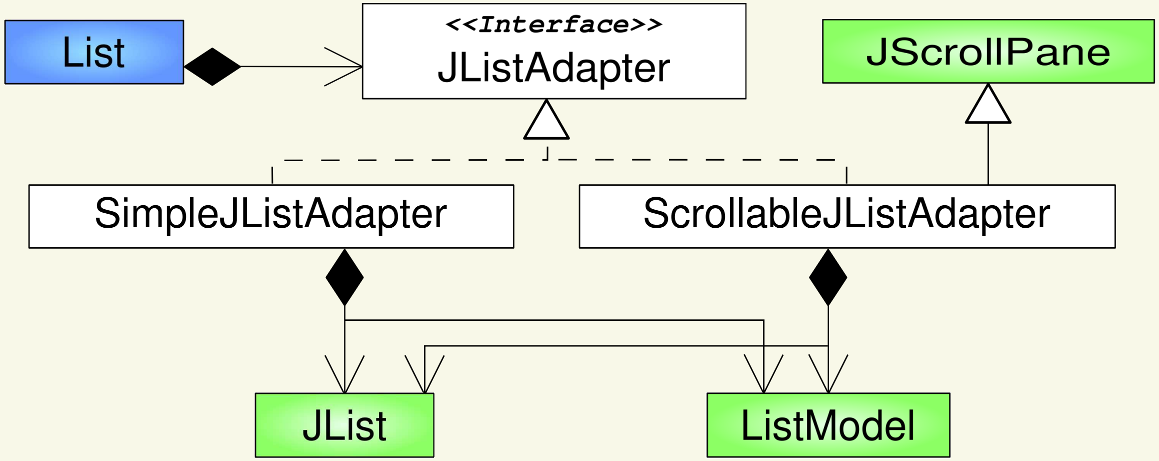
$$List \rightarrow (JList, ListModel)|(JList, ListModel, JScrollPane)$$

Layered Adapter

Layered Adapter



Layered Adapter

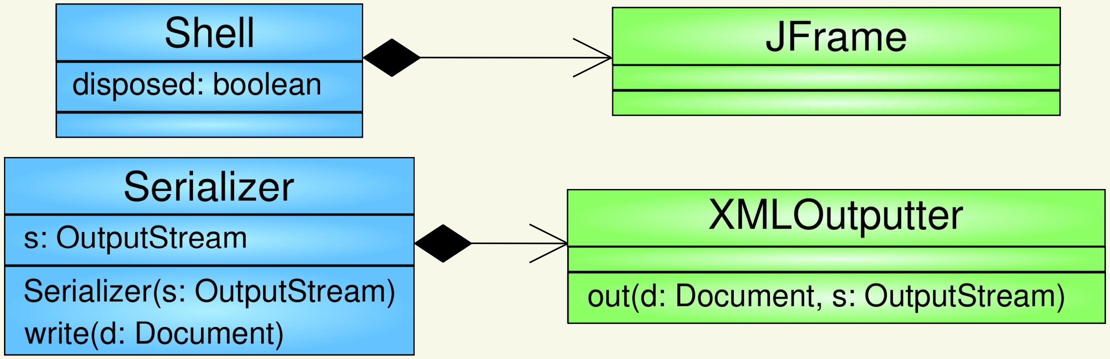


Alternative and Composite

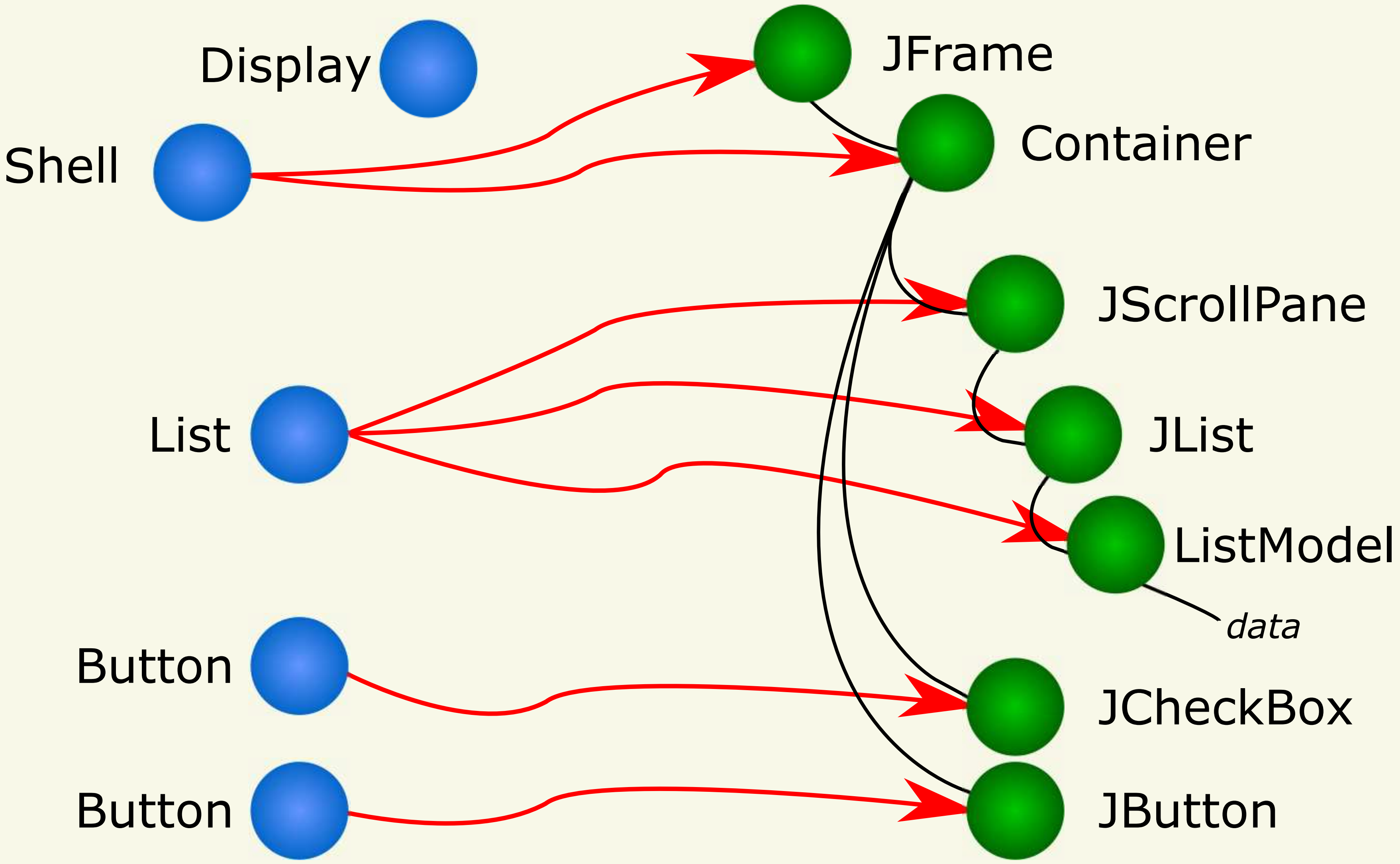
$$List \rightarrow (JList, ListModel) | (JList, ListModel, JScrollPane)$$

Stateful Adapter

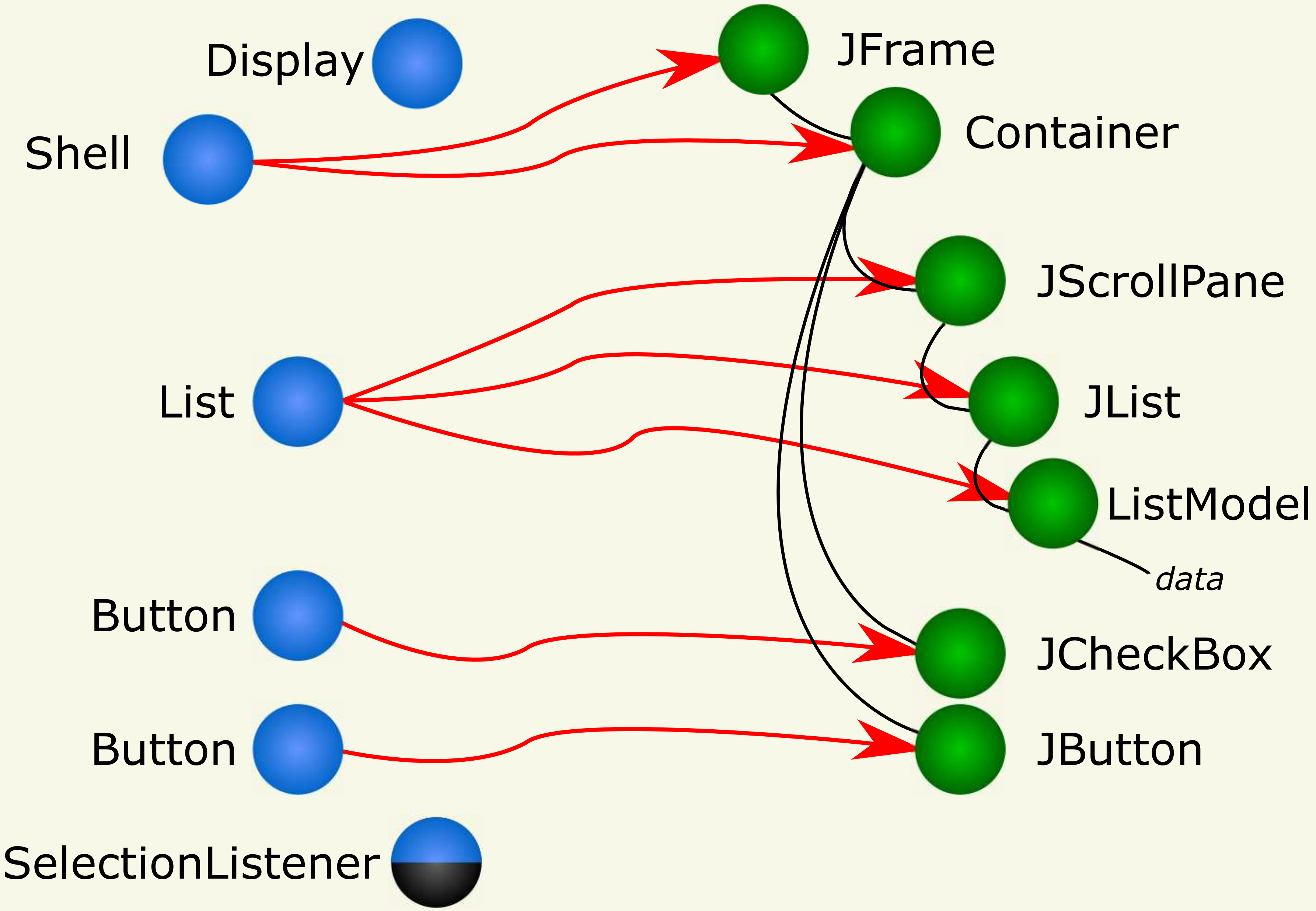
Stateful Adapter



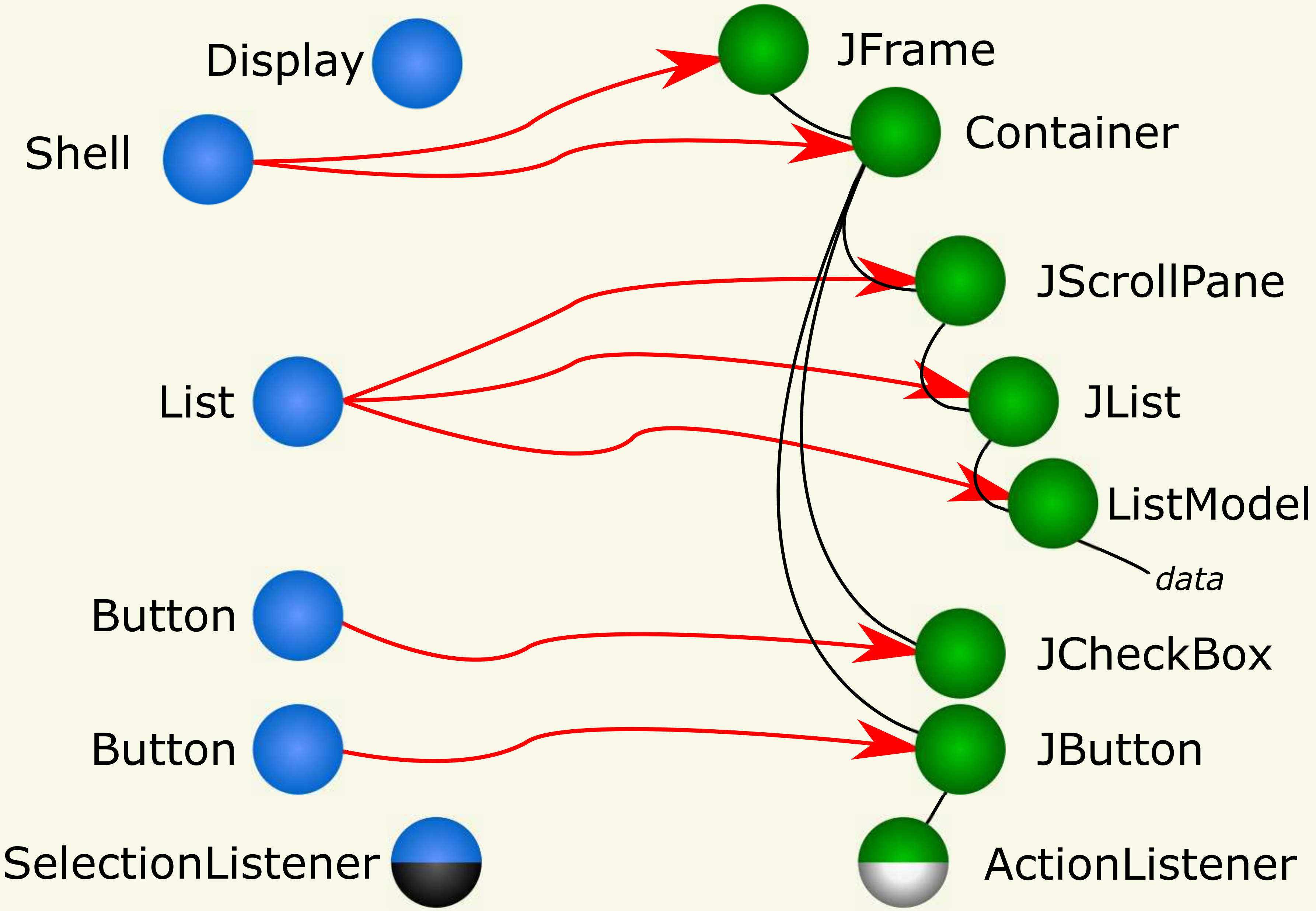
SWT to Swing


Display
Shell
List
Button
Button
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox
JButton

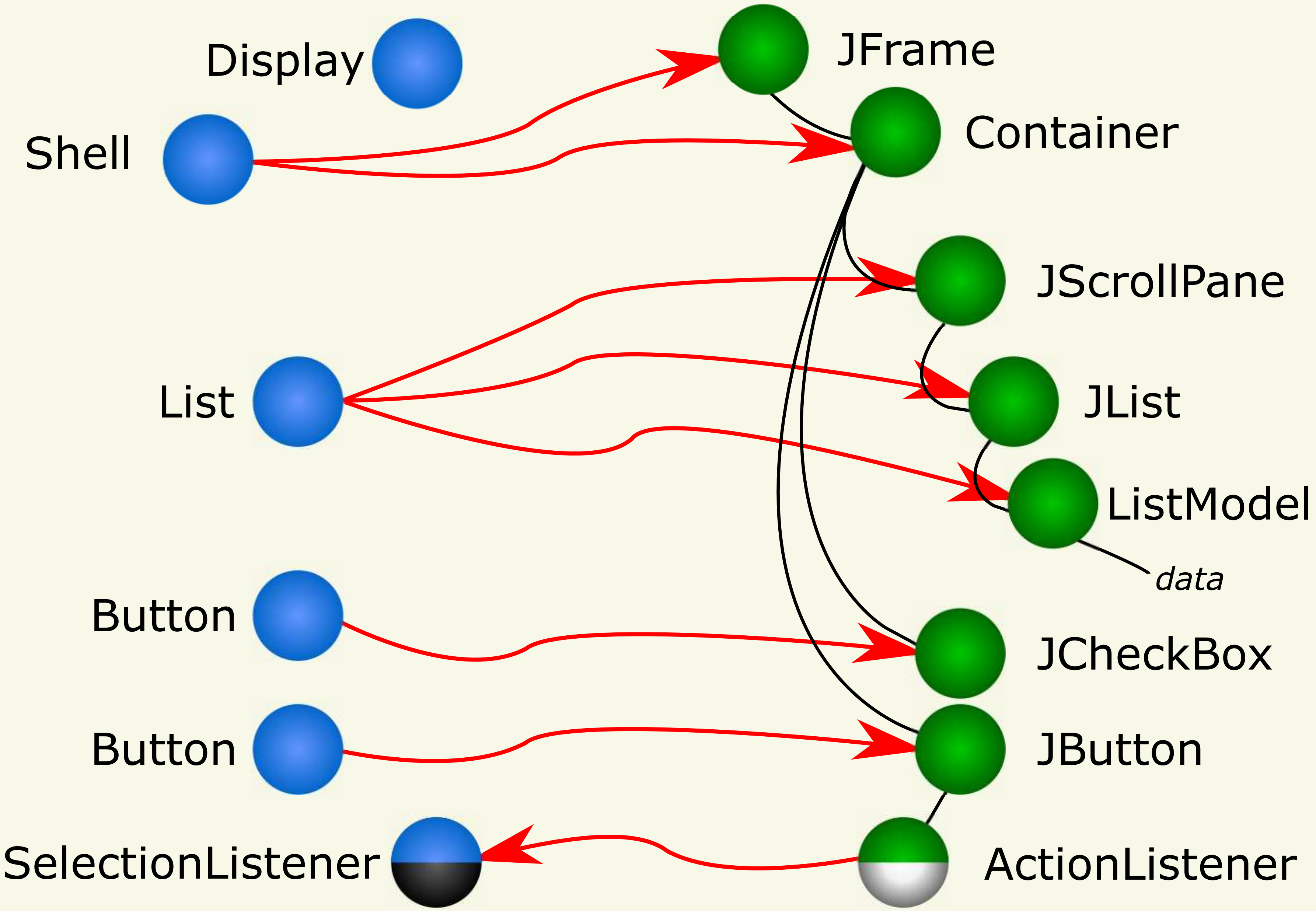
SWT to Swing


Display
Shell
List
Button
Button
SelectionListener
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox
JButton

SWT to Swing


Display
Shell
List
Button
Button
SelectionListener
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox
JButton
ActionListener

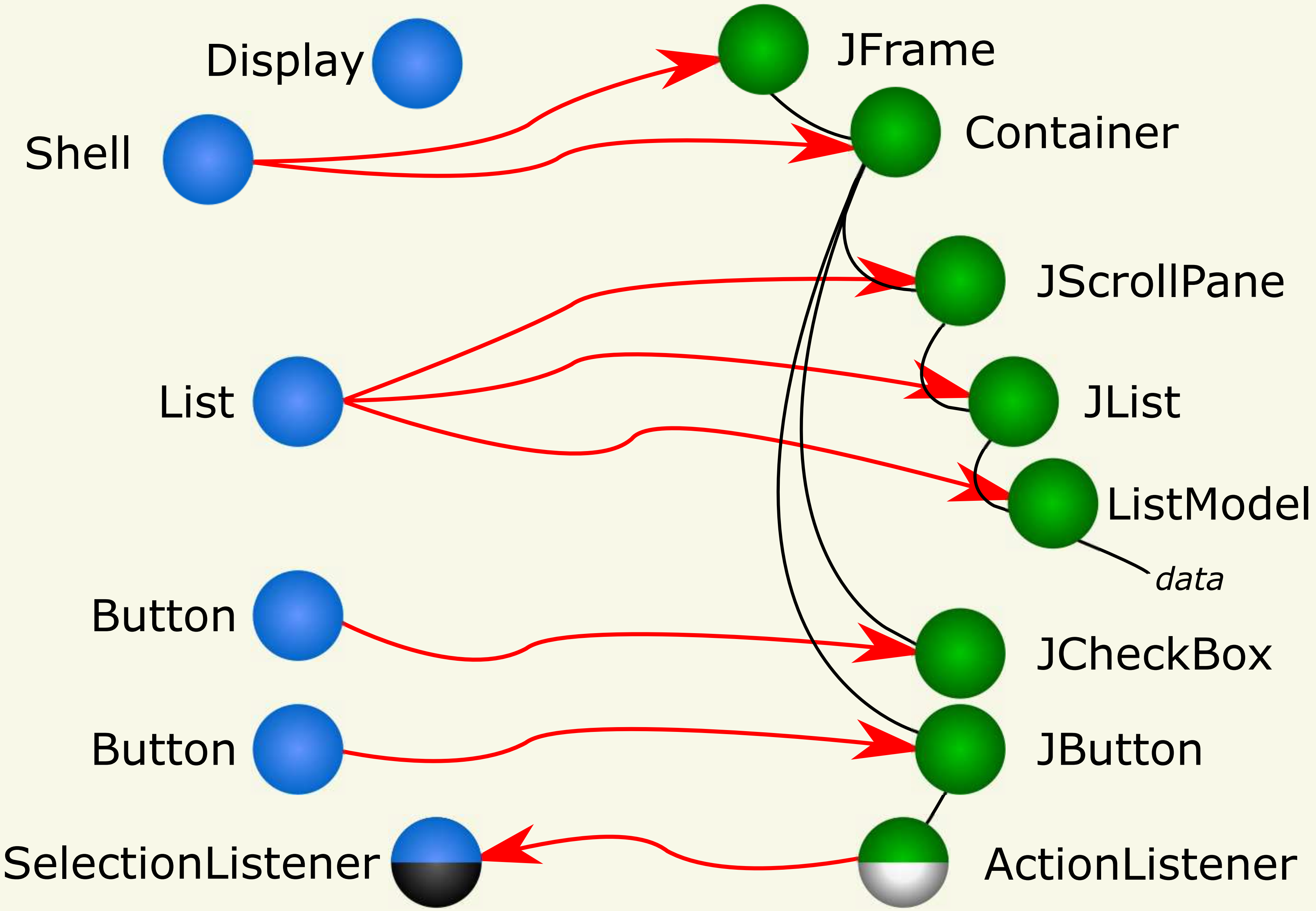
SWT to Swing


Display
Shell
List
Button
Button
SelectionListener
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox
JButton
ActionListener

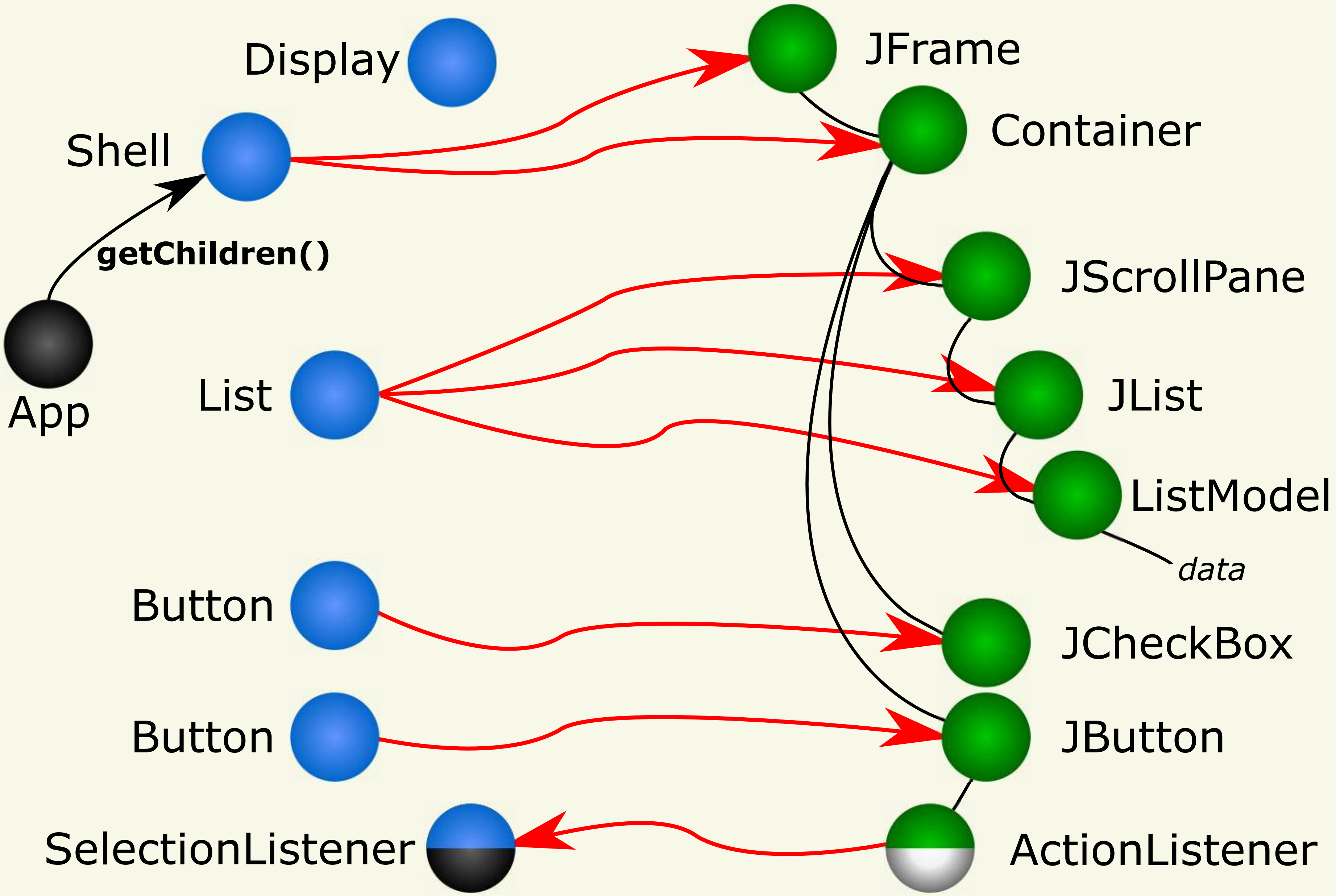
Inversion of Control

Inverse Delegation

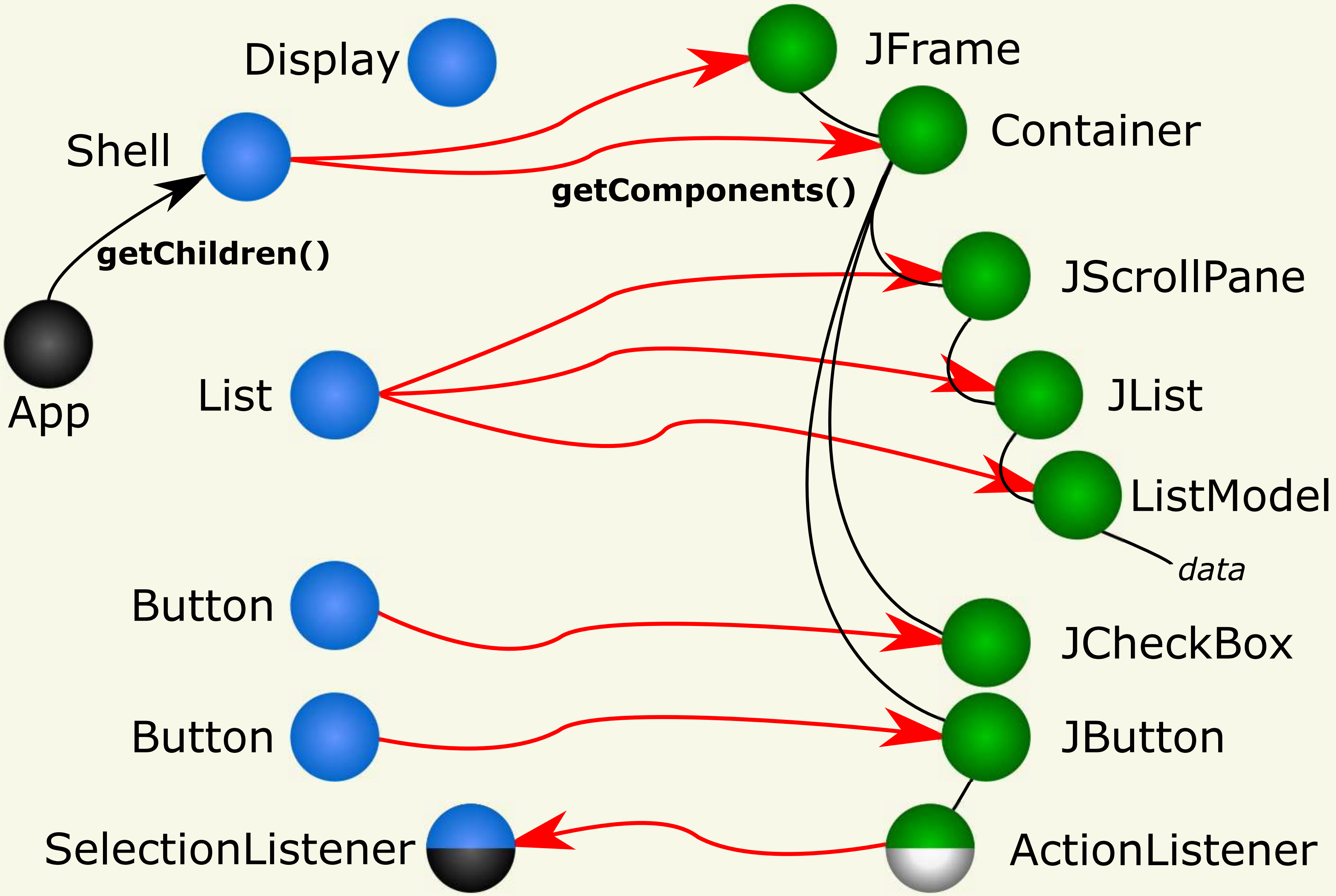
SWT to Swing


Display
Shell
List
Button
Button
SelectionListener
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox
JButton
ActionListener

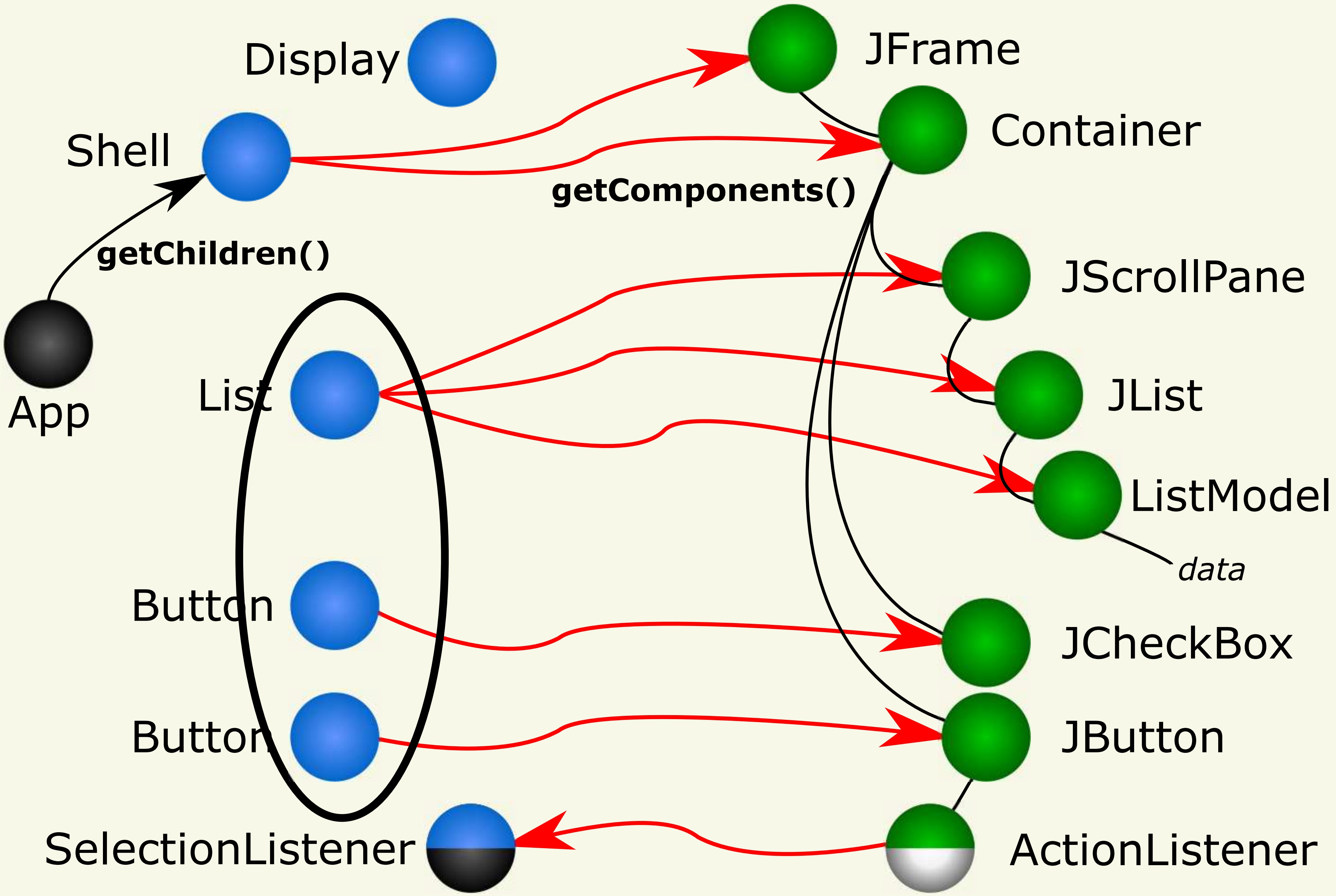
SWT to Swing


Display
Shell
getChildren()
App
List
Button
Button
SelectionListener
JFrame
Container
JScrollPane
JList
ListModel
data
JCheckBox
JButton
ActionListener

SWT to Swing

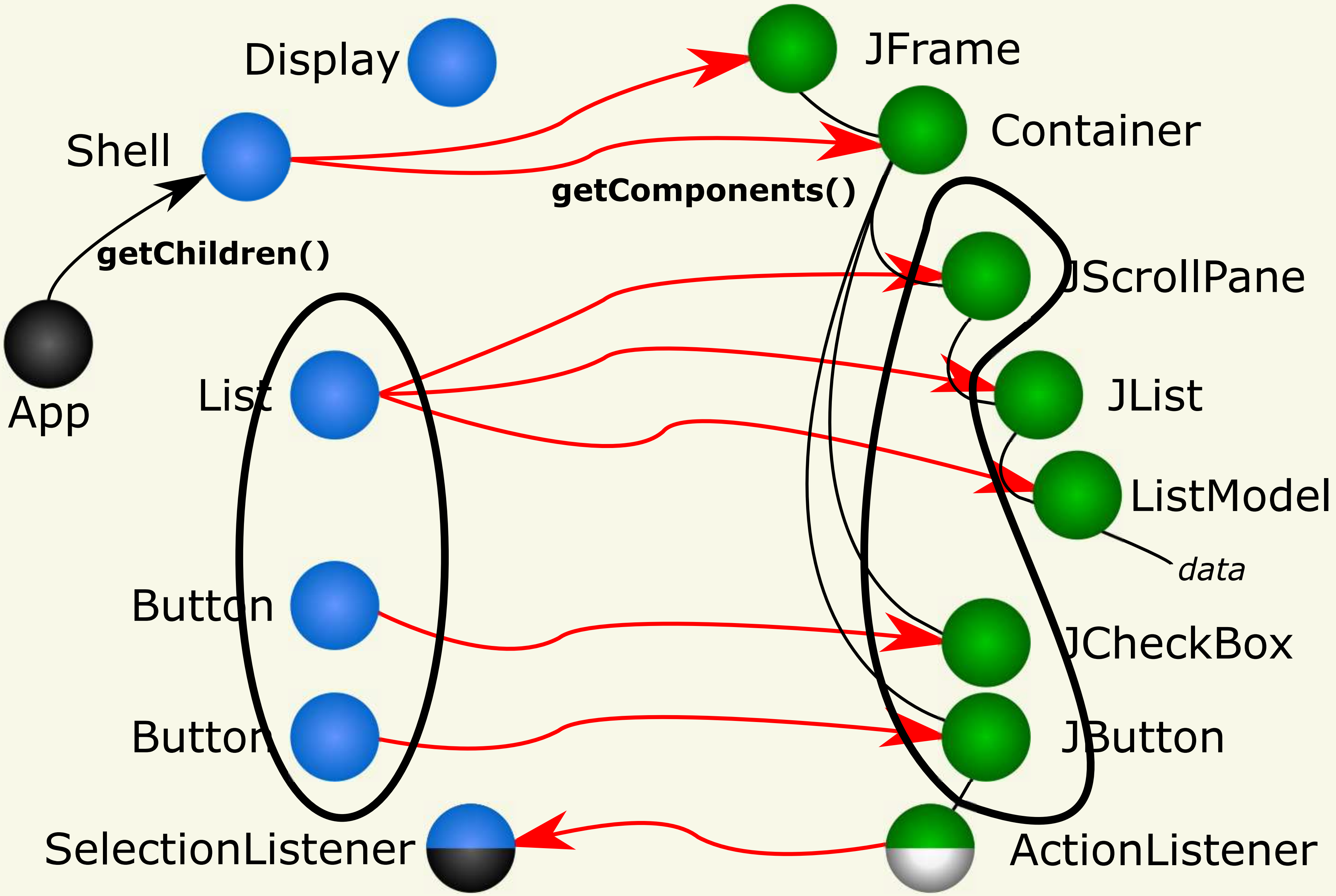

Display
Shell
getChildren()
App
List
Button
Button
SelectionListener
JFrame
Container
getComponents()
JScrollPane
JList
ListModel
data
JCheckBox
JButton
ActionListener

SWT to Swing



Display
JFrame
Shell
Container
getComponents()
getChildren()
JScrollPane
App
List
JList
ListModel
data
Button
JCheckBox
Button
JButton
SelectionListener
ActionListener

SWT to Swing


Display
Shell
getChildren()
App
List
Button
Button
SelectionListener
JFrame
Container
getComponents()
JScrollPane
JList
ListModel
data
JCheckBox
JButton
ActionListener

Correspondence of Object Identities

Wrapping Identity Map

Wrapper Metrics

Wrapper Metrics

Wrapper	SwingWT	SWTSwing	XOM2JDOM
Layered Adapters	64	54	1
Stateful Adapter	98	181	13
Inverse Delegation	20	59	1
Wrapping Identity Map	✔	✔	✔
Delayed Instantiation	✔	✘	✘

4 - Conclusion and Future Work

Conclusion

Conclusion

Challenges of OO API Migration by Wrapping in practice

Conclusion

Challenges of OO API Migration by Wrapping in practice

Solutions as design patterns

Future Work

Future Work

Validation of patterns in additional projects and domains

Future Work

Validation of patterns in additional projects and domains

DSL for API Migration

Questions?