10
구이(GUI) 및
이벤트 구동 프로그래밍

구이 (Graphical User Interface)

- 사용자 인터페이스
  - 프로그램과 사람을 연결짓는 것
- 그래픽 사용자 인터페이스
  - 문자가 아닌 보다 비주얼한 것들을 사용하여 사용자가 편리하게 사용하도록 하는 것
- AWT/Swing
  - Java에서 제공하는 기본 구이 프레임워크
  - java.awt, javax.swing 패키지

이벤트 구동 프로그래밍 (Event-Driven Programming)

- 이벤트: 불시에 일어나는 사건
  - 예, 마우스 움직였다, 버튼이 눌렸다, 키보드가 눌렸다,메뉴 아이템이 선택되었다
- 이벤트 구동 프로그램
  - 이벤트 발생과 처리로 제어하는 프로그램
- 이벤트 처리기 (event-handler or event-listener)
  - 이벤트를 처리하는 프로세스
  - 일반적으로, 이벤트를 여러 번 처리하여 정보를 축적하였다가 결과를 보여주는 형태
- Java에서는 액션 이벤트 (action event), 액션 리스너 (action listner)라고 부른다.

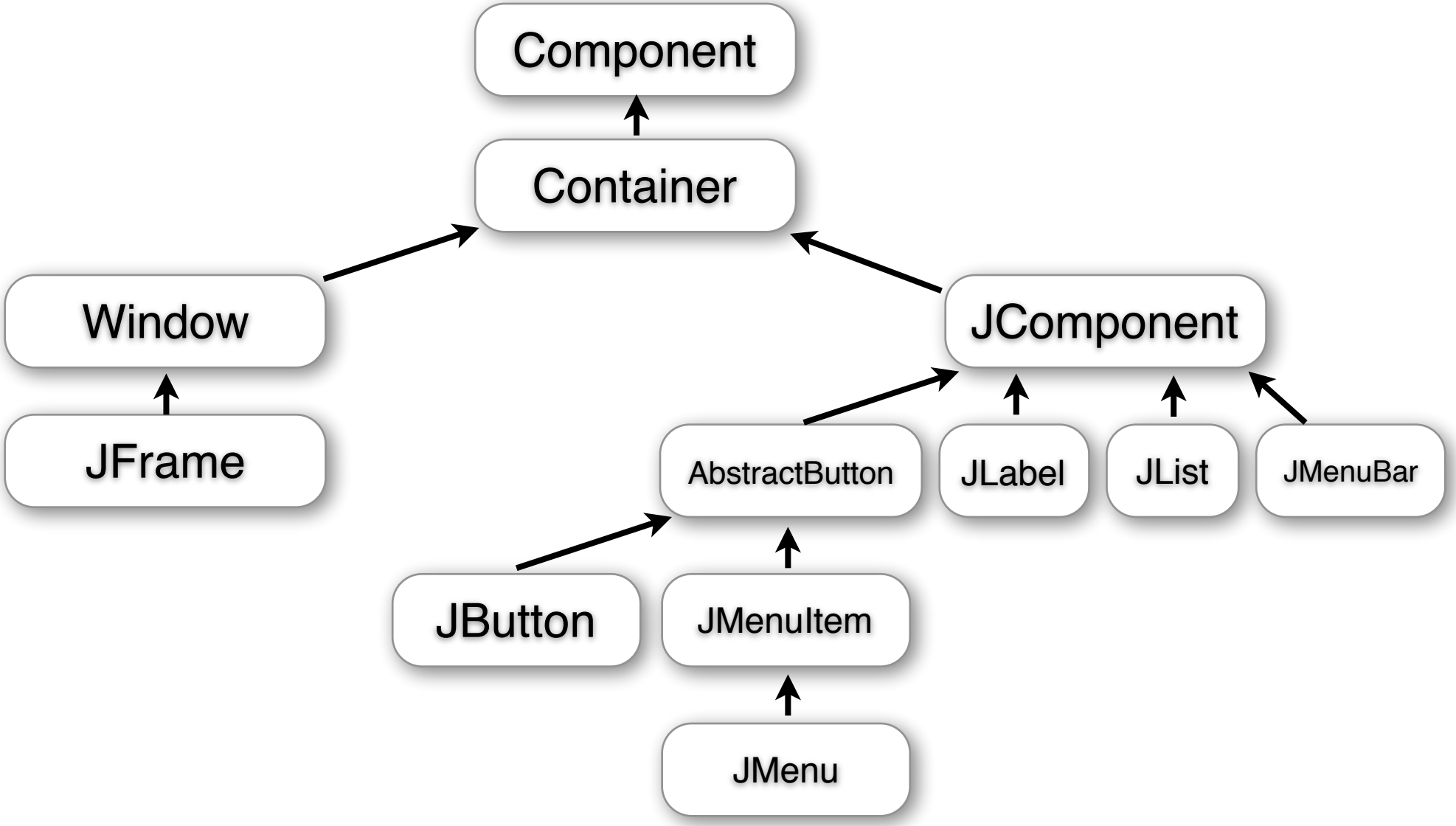
Java AWT/Swing에서의 용어들

- 컴퍼넌트 (component)
  - 화면에서 크기와 위치가 있고 이벤트가 발생하는 객체
  - 예, 라벨(label), 텍스트(text component), 단추(button), 리스트(list)
- 컨테이너 (container): 컴퍼넌트 여러 개를 담을 수 있는 컴퍼넌트
- 패널 (panel): 표준 컨테이너
- 윈도우 (window), 맨 위의 컨테이너
  - 바로 화면에 보여주는 컨테이너
  - 패널을 담은 컨테이너
- 프레임 (frame): 윈도우에 제목과 메뉴가 달린 것
- 대화창 (dialog): 임시 윈도우
- 메뉴바 (menu bar): 메뉴가 있어서 선택할 수 있는 것, 프레임에 달려 있음

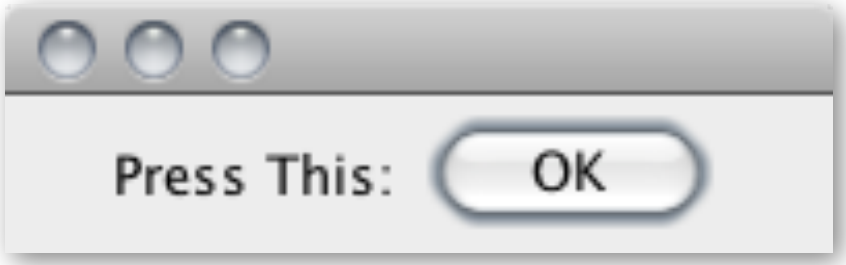
레이아웃 (Layout)

- 컨테이너가 가지고 있는 여러 컴퍼넌트를 어떻게 배열할 것이냐에 대한 정책
- 레이아웃 관리자(layout manager)가 관리
- 예
  - 순서대로 (flow): 차례대로 나열
  - 경계 (border): 동서남북, 가운데 등으로 위치 지정
  - 그리드 (grid): 행렬모양으로

AWT/Swing 클래스 구조도



단순 예제, 단추



방법

- JFrame을 상속받아 나만의 프레임을 만든다.
- 라벨 "Press This"를 만든다.
- 단추 "OK"를 만든다.
- 레이아웃을 “순서대로”로 설정한다.
- 라벨을 프레임 컨테이너에 추가한다.
- 단추를 프레임 컨테이너에 추가한다.
- 보여준다.

구현

```
import java.awt.*;
import javax.swing.*;

public class ButtonFrame extends JFrame {
    public ButtonFrame() {
        JLabel label = new JLabel("Press This:");
        JButton button = new JButton("OK");
        Container c = getContentPane();
        c.setLayout(new FlowLayout());
        c.add(label);
        c.add(button);
        setSize(200, 60);
        setVisible(true);
    }
    public static void main(String[] args) {
    new ButtonFrame();
  }
}
```

단추를 눌러 봐야 아무 소용 없죠

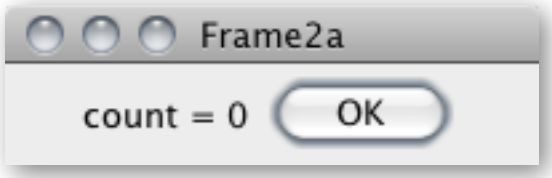
- 단추 눌림 이벤트가 발생했을 때 무슨 일을 할 지 등록해 두어야 합니다.
- 다음 인터페이스를 만족하는 처리기를 구현

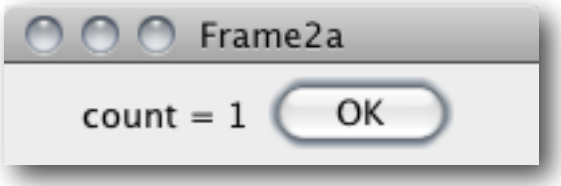
```
public interface ActionListener {
    public void actionPerformed(ActionEvent e);
}
```

- 단추에 등록해야 합니다.

예제, 셈하기

- 단추를 누를 때 마다 1씩 증가하는 창을 만드세요.





모델: 카운터

```
public class Counter {
    private int count;
    public Counter(int start) {
    count = start;
  }
    public void increment() {
    count++;
  }
    public int countOf() {
    return count;
  }
}
```

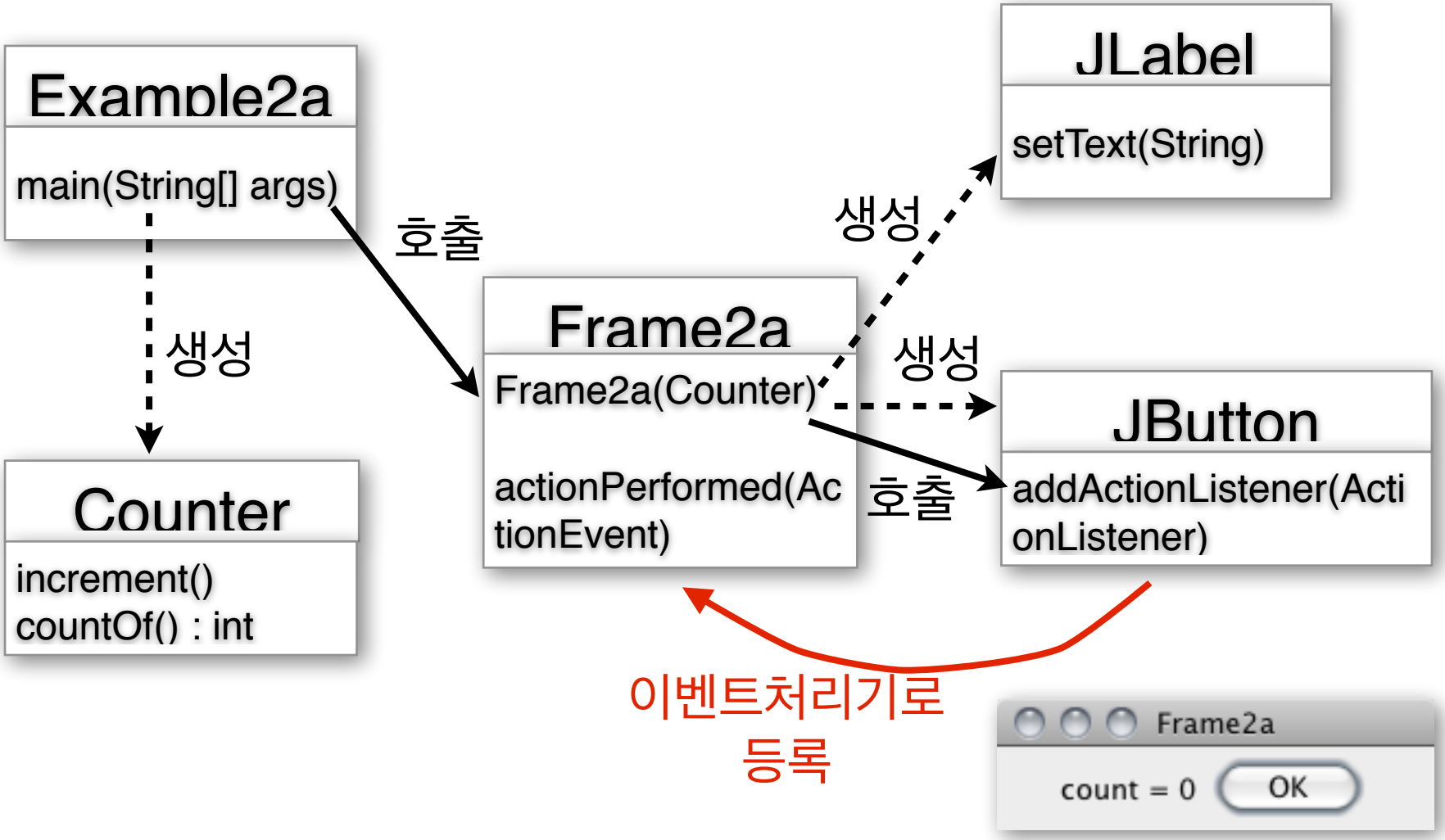
이벤트 처리기와 프레임 동시 구현

```
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

class Frame2a extends JFrame implements ActionListener {
     private Counter count;
     private JLabel label = new JLabel("count = 0");
     public Frame2a(Counter c) {
          count = c;
          Container cp = getContentPane();
          cp.setLayout(new FlowLayout());
          JButton button = new JButton("OK");
          cp.add(label); cp.add(button);
          button.addActionListener(this); // 이 객체를 단추의 이벤트 처리기로 등록
          setTitle("Frame2a"); setSize(200, 60);
          setVisible(true);
     }
     public void actionPerformed(ActionEvent e) {
          count.increment();
          label.setText("count = " + count.countOf());
     }
}
```

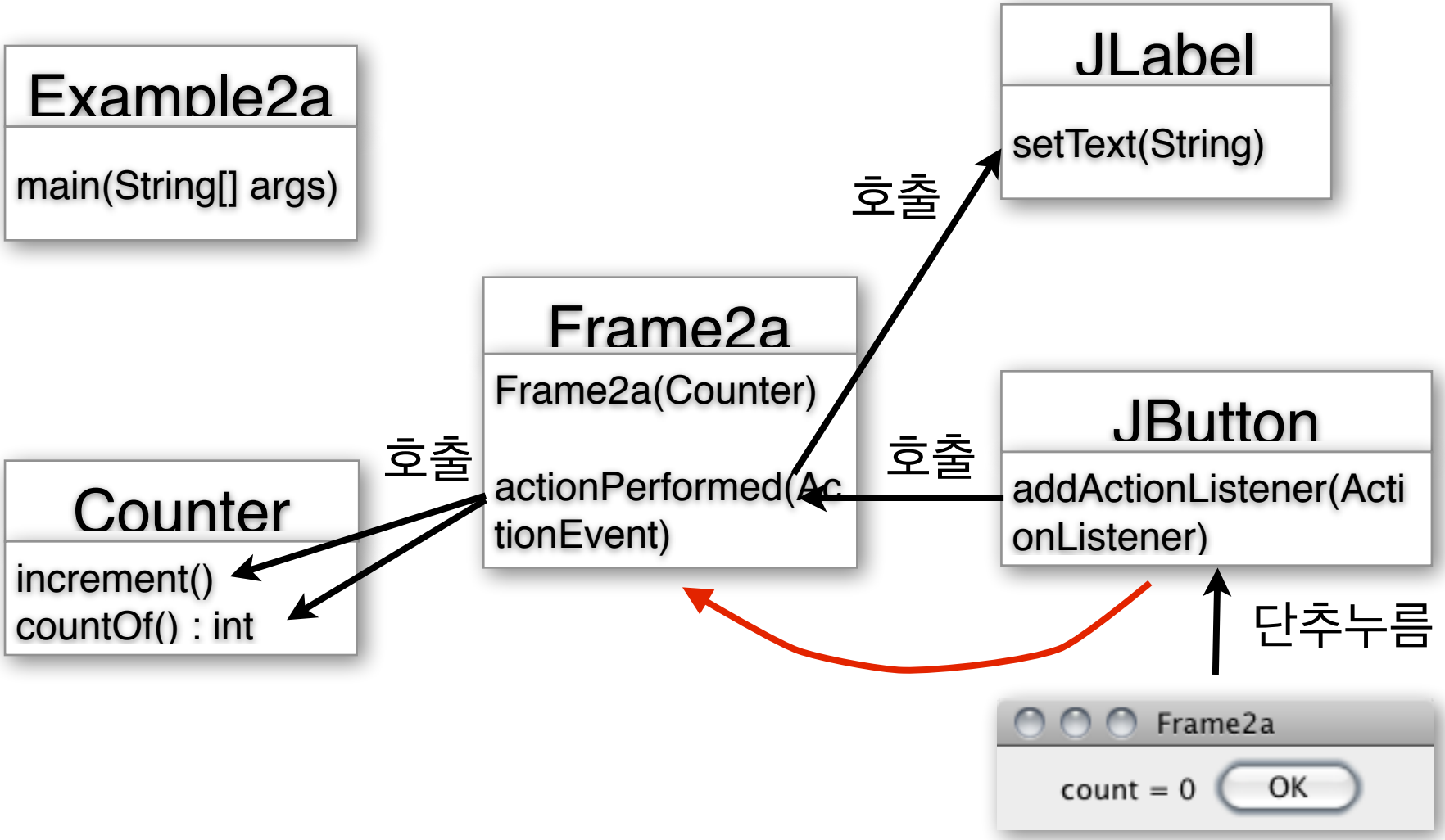
구동 코드

```
public class Example2a {
    public static void main(String[] args) {
        Counter model = new Counter(0);
        Frame2a view = new Frame2a(model);
    }
}
```

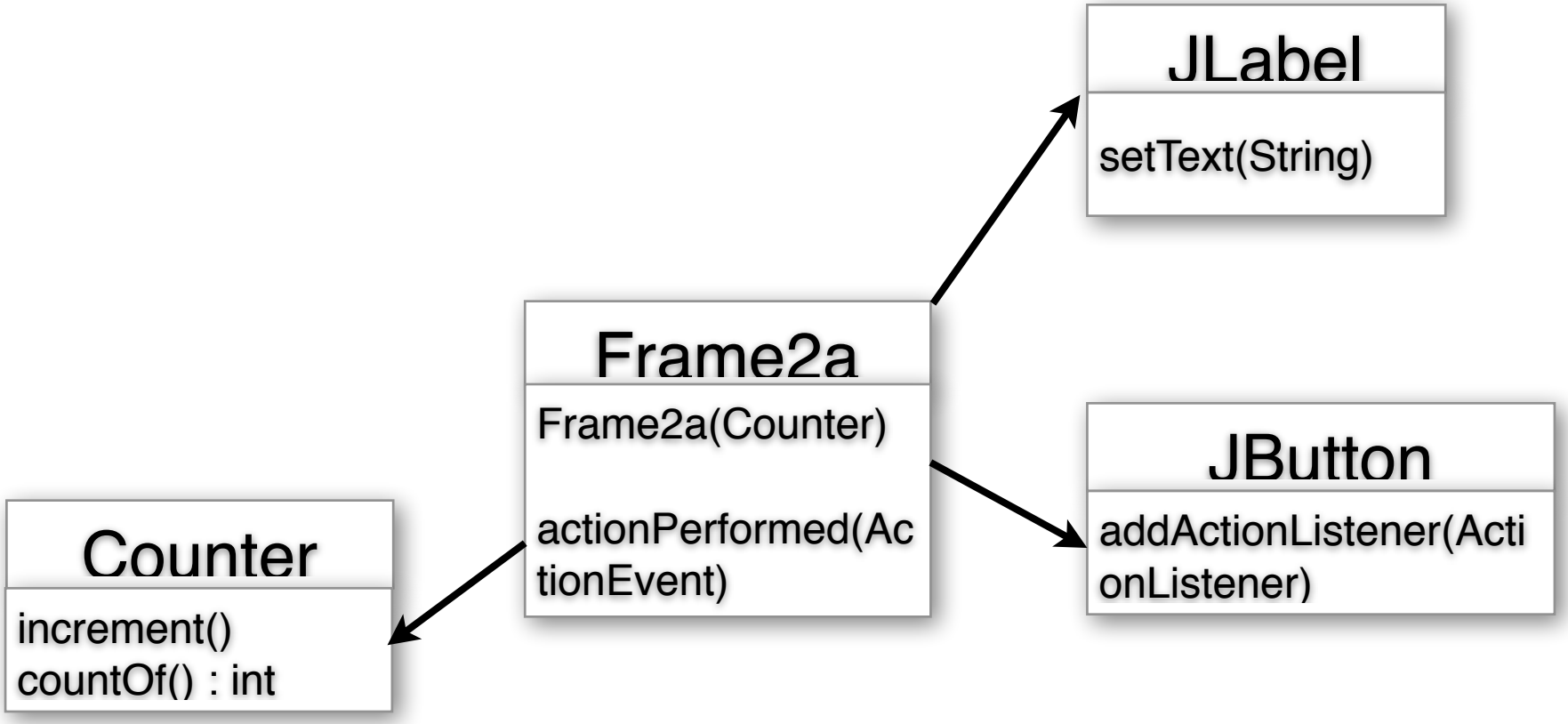
실행 구조: 시작


Example2a
main(String[] args)
생성
Counter
increment()
countOf() : int
호출
Frame2a
Frame2a(Counter)
actionPerformed(Ac
tionEvent)
생성
JLabel
setText(String)
생성
JButton
addActionListener(Acti
onListener)
호출
이벤트처리기로
등록
Frame2a
count = 0
OK

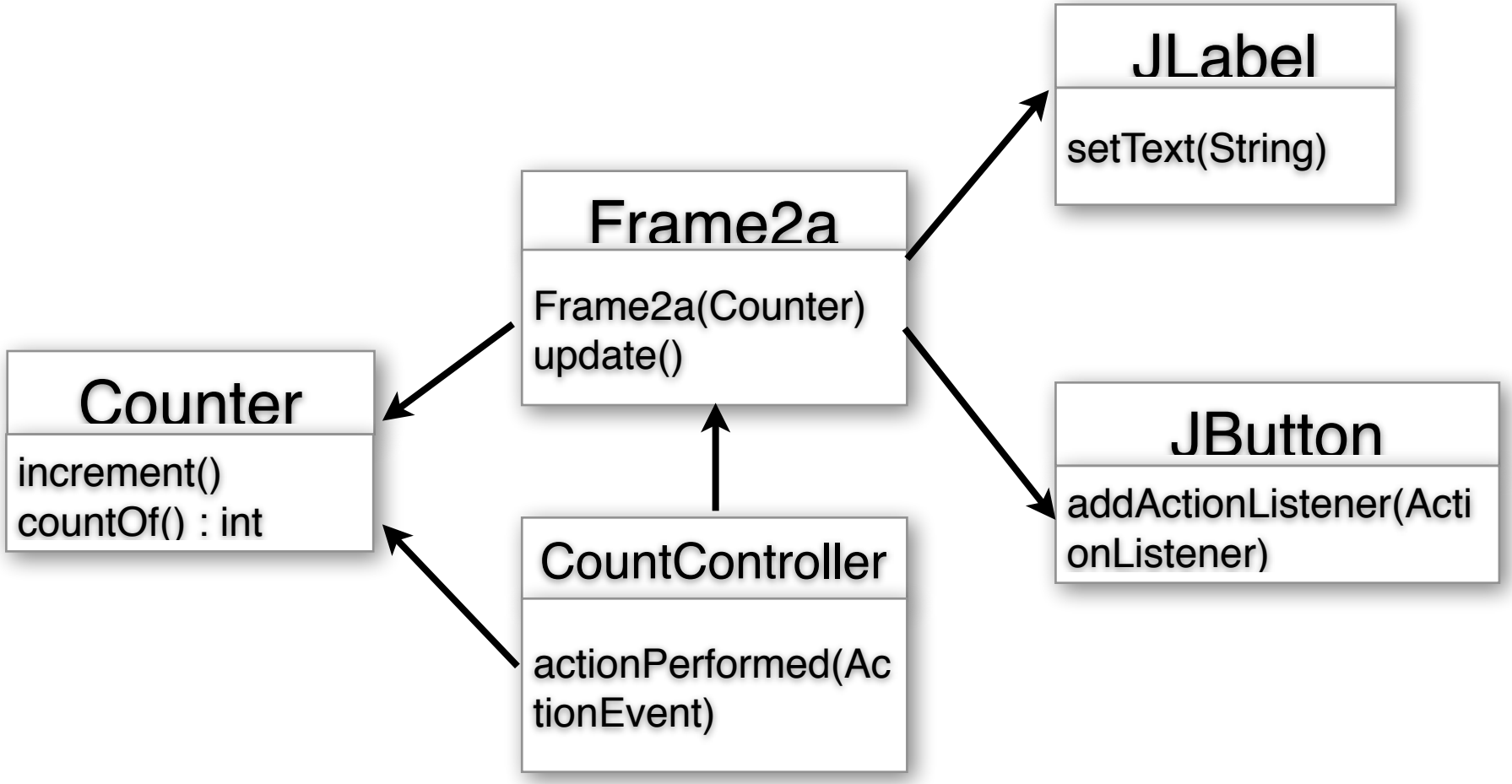
실행 구조: 단추 누름


Example2a
main(String[] args)
JLabel
setText(String)
호출
Frame2a
Frame2a(Counter)
actionPerformed(Ac
tionEvent)
호출
JButton
addActionListener(Acti
onListener)
호출
Counter
increment()
countOf() : int
단추누름
Frame2a
count = 0
OK

현재: 출력 뷰와 제어기가 합쳐져 있음



대안 1: 출력 뷰와 제어기 분리



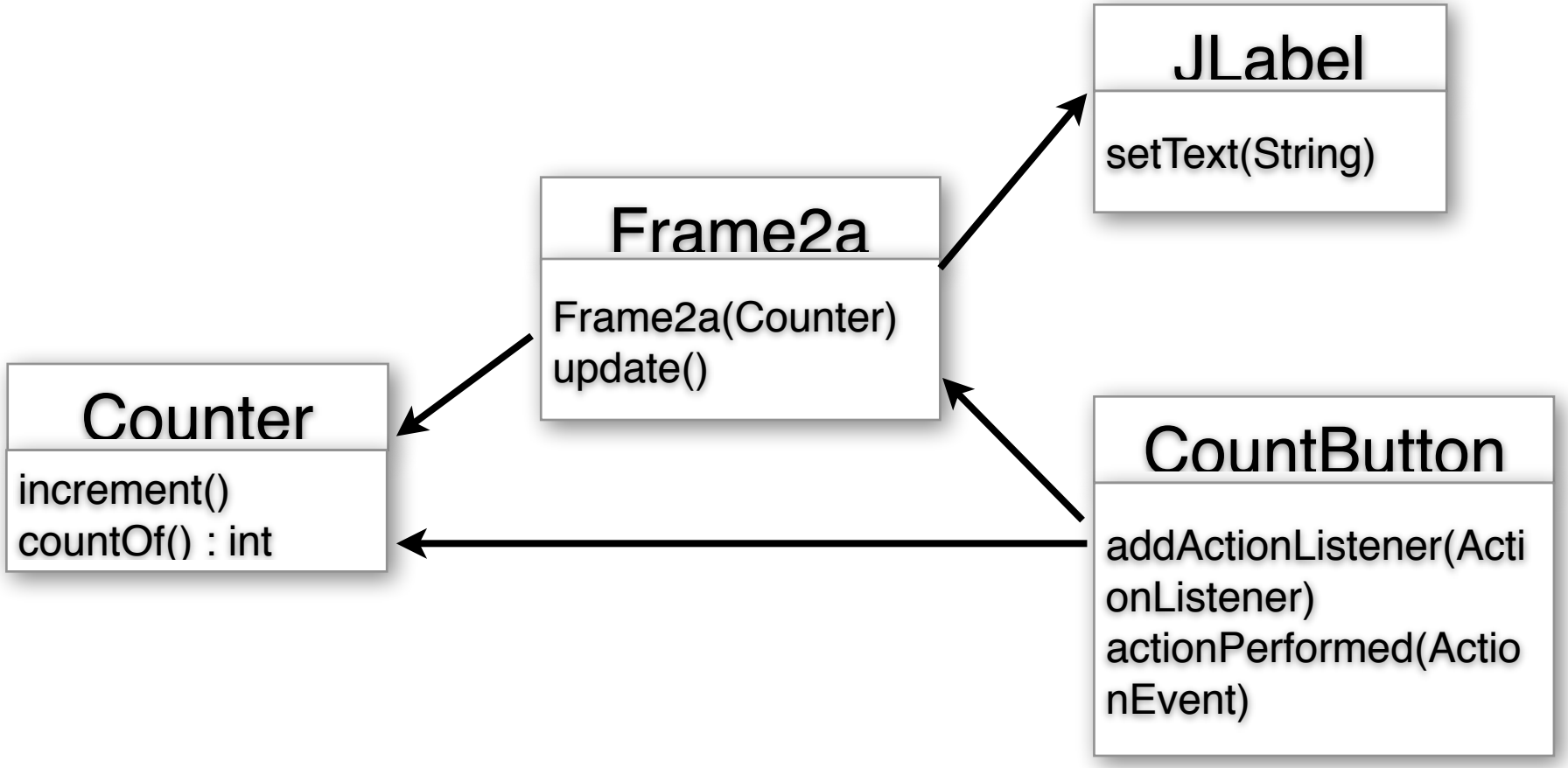
출력 뷰

```
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

class Frame2b extends JFrame {
     private Counter count;
     private JLabel label = new JLabel("count = 0");
     public Frame2b(Counter c) {
          count = c;
          Container cp = getContentPane();
          cp.setLayout(new FlowLayout());
          JButton button = new JButton("OK");
          cp.add(label); cp.add(button);
          button.addActionListener(new CountController(count,this));
          setTitle("Frame2b"); setSize(200, 60);
          setVisible(true);
     }
     public void update() {
     // 모델에 계산시키는 부분이 삭제
          label.setText("count = " + count.countOf());
     }
}
```

제어기

```
import java.awt.event.*;

public class CountController implements ActionListener {
    private Frame2b view;
    private Counter model;
    public CountController(Counter m, Frame2b v) {
        view = v; model = m;
    }
    public void actionPerformed(ActionEvent e) {
        model.increment();
        view.update();
    }
}
```

대안 2: 입력 뷰와 제어기를 함께



출력 뷰

```
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

class Frame2c extends JFrame {
     private Counter count;
     private JLabel label = new JLabel("count = 0");
     public Frame2b(Counter c) {
          count = c;
          Container cp = getContentPane();
          cp.setLayout(new FlowLayout());
          CountButton button = new CountButton("OK", count, this);
          cp.add(label); cp.add(button);
     // 단추의 이벤트 처리기 등록시키는 부분 삭제
          setTitle("Frame2c"); setSize(200, 60);
          setVisible(true);
     }
     public void update() {
          label.setText("count = " + count.countOf());
     }
}
```

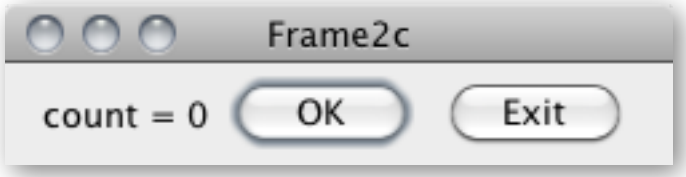
입력 뷰 + 제어기

```
import javax.swing.*; import java.awt.event.*;

public class CountButton extends JButton implements
ActionListener {
    private Frame2c view;
    private Counter model;
    public CountButton(String label, Counter m, Frame2c v) {
        super(label);
        view = v; model = m;
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        model.increment();
        view.update();
    }
}
```

여러 제어기

- 이벤트 구동 프로그램은 제어기가 여러 개 있을 수 있다.
  - 단추1을 눌렀을 때
  - 단추2를 눌렀을 때
  - 단추3을 눌렀을 때
- 그렇기 때문에 단추에 제어기를 장착하는 것이 유리한 경우가 많다.

예제, 종료 단추를 추가하라



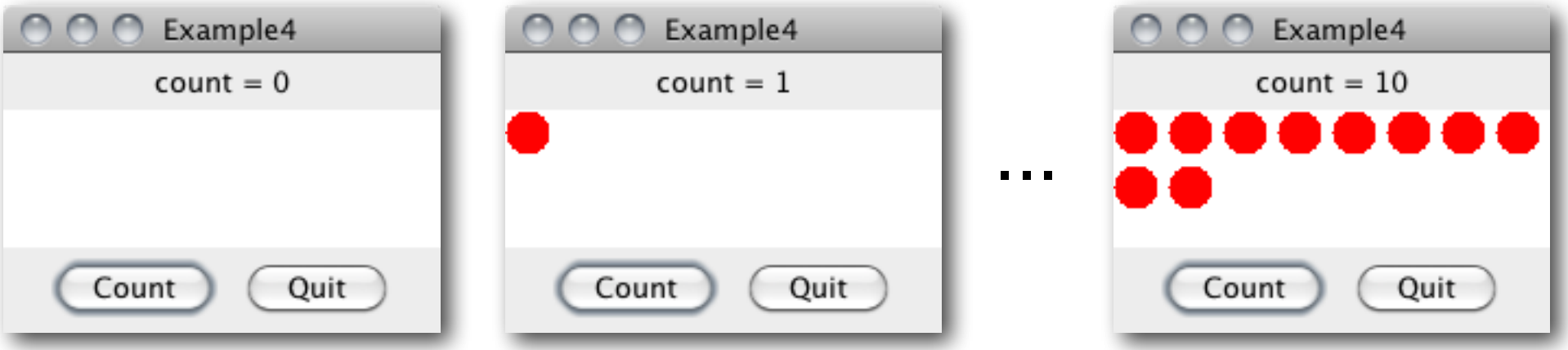
종료 단추

```
import java.awt.event.*; import javax.swing.*;

public class ExitButton extends JButton implements
ActionListener {
    public ExitButton(String label) {
        super(label);
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        System.exit(0);
    }
}
```

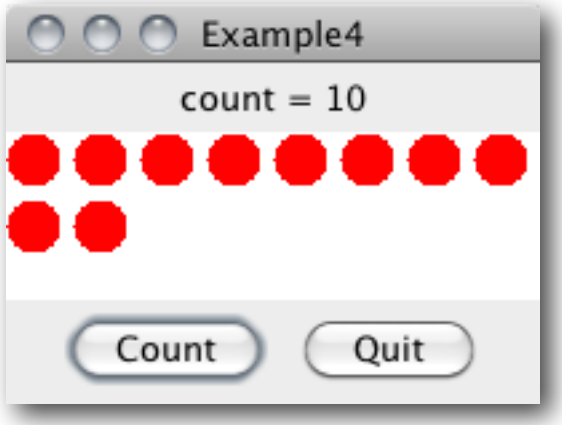
출력 뷰

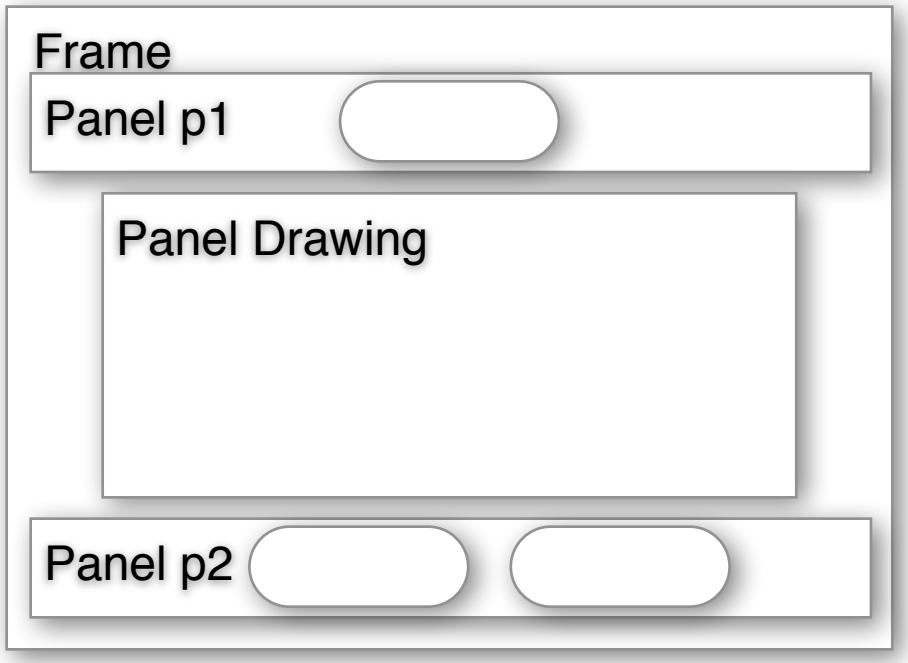
```
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

class Frame2c extends JFrame {
     private Counter count;
     private JLabel label = new JLabel("count = 0");
     public Frame2b(Counter c) {
          count = c;
          Container cp = getContentPane();
          cp.setLayout(new FlowLayout());
          cp.add(label);
          cp.add(new CountButton("OK",count,this));
          cp.add(new ExitButton("Exit"));
          setTitle("Frame2c"); setSize(200, 60);
          setVisible(true);
     }
     public void update() {
          label.setText("count = " + count.countOf());
     }
}
```

예제, 공 세기


Example4
count = 0
Count
Quit
Example4
count = 1
Count
Quit
...
Example4
count = 10
Count
Quit

경계 레이아웃 (BorderLayout)





p1 패널은 NORTH로 Frame에 붙이고,
Drawing 패널은 센터로
p2 패널은 SOUTH로 붙인다.

Count 버튼, Drawing, Label은 모두 Counter를 공유

Drawing

```
import java.awt.*; import javax.swing.*;

public class Drawing extends JPanel {
  private Counter count;
  public Drawing(Counter model) {
      count = model; setSize(200,80);
  }
  public void paintComponent(Graphics g) {
      g.setColor(Color.white);   // 바닥에 흰 칠하고
      g.fillRect(0,0,200,80);
      g.setColor(Color.red);
      int x=0, y=0;
      for(int i=0; i<count.countOf(); i++) { // 빨간 점을 그려준다.
          g.fillOval(x*25, y*25, 20, 20);
          x++; if(x>7) { x=0; y++; }
      }
  }
}
```

CountButton

```
import java.awt.*; import javax.swing.*; import java.awt.event.*;

public class CountButton extends JButton implements ActionListener {
    private Frame4 view;
    private Counter model;
    public CountButton(String label, Counter m, Frame4 v) {
        super(label);
        view = v; model = m;
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        model.increment();
        view.update();
    }
}
```

Frame

```
import java.awt.*; import javax.swing.*;

public class Frame4 extends JFrame {
    private Counter count;
    private JLabel lab = new JLabel("count = 0");
    private JPanel drawing;

    public void update() {
        lab.setText("count = " + count.countOf());
        drawing.repaint();
    }
```

Frame

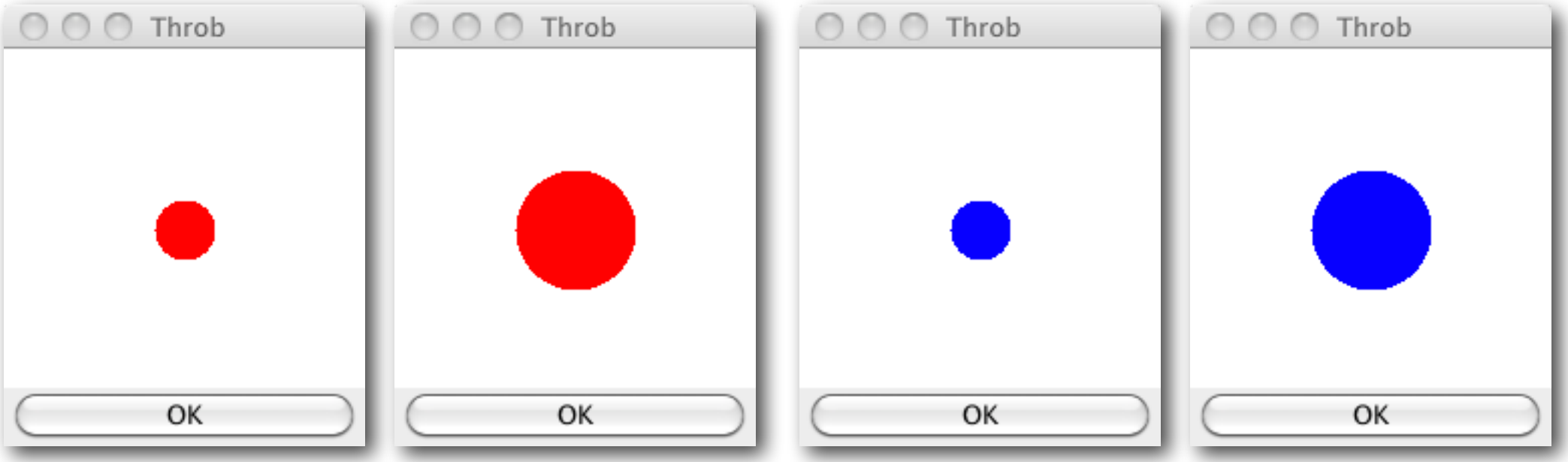
```
    public Frame4(Counter c, JPanel panel) {
        count = c; drawing = panel;
        Container cp = getContentPane();
        cp.setLayout(new BorderLayout());
        JPanel p1 = new JPanel(new FlowLayout());
        JPanel p2 = new JPanel(new FlowLayout());

        lab = new JLabel("count = " + count.countOf());
        p1.add(lab);

        p2.add(new CountButton("Count", count, this));
        p2.add(new ExitButton("Quit"));

        cp.add(p1, BorderLayout.NORTH);
        cp.add(drawing);
        cp.add(p2, BorderLayout.SOUTH);
        setTitle("Example4"); setSize(200,150); setVisible(true);
}}
```

구동 코드

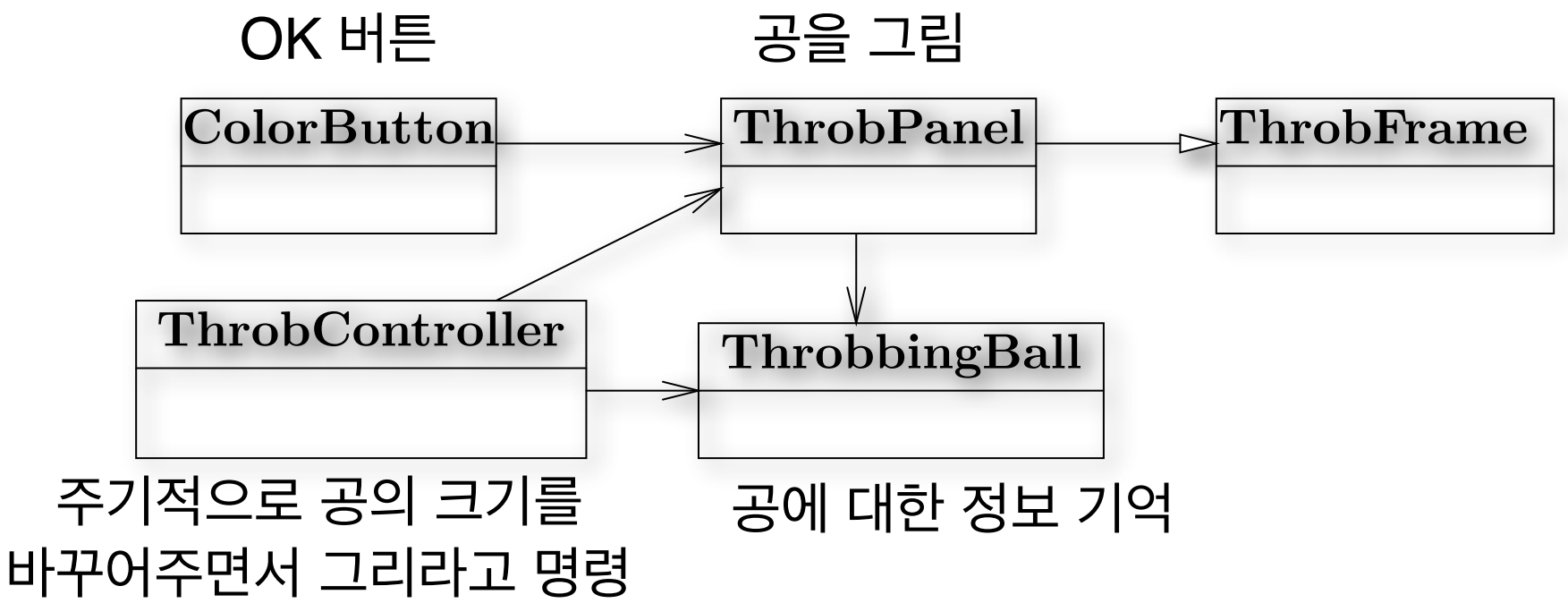
```
public class Example4 {
    public static void main(String[] args) {
        Counter model = new Counter(0);
        Drawing drawing = new Drawing(model);
        Frame4 view = new Frame4(model, drawing);
    }
}
```

예제, 숨쉬는 공, 색 변하는 공

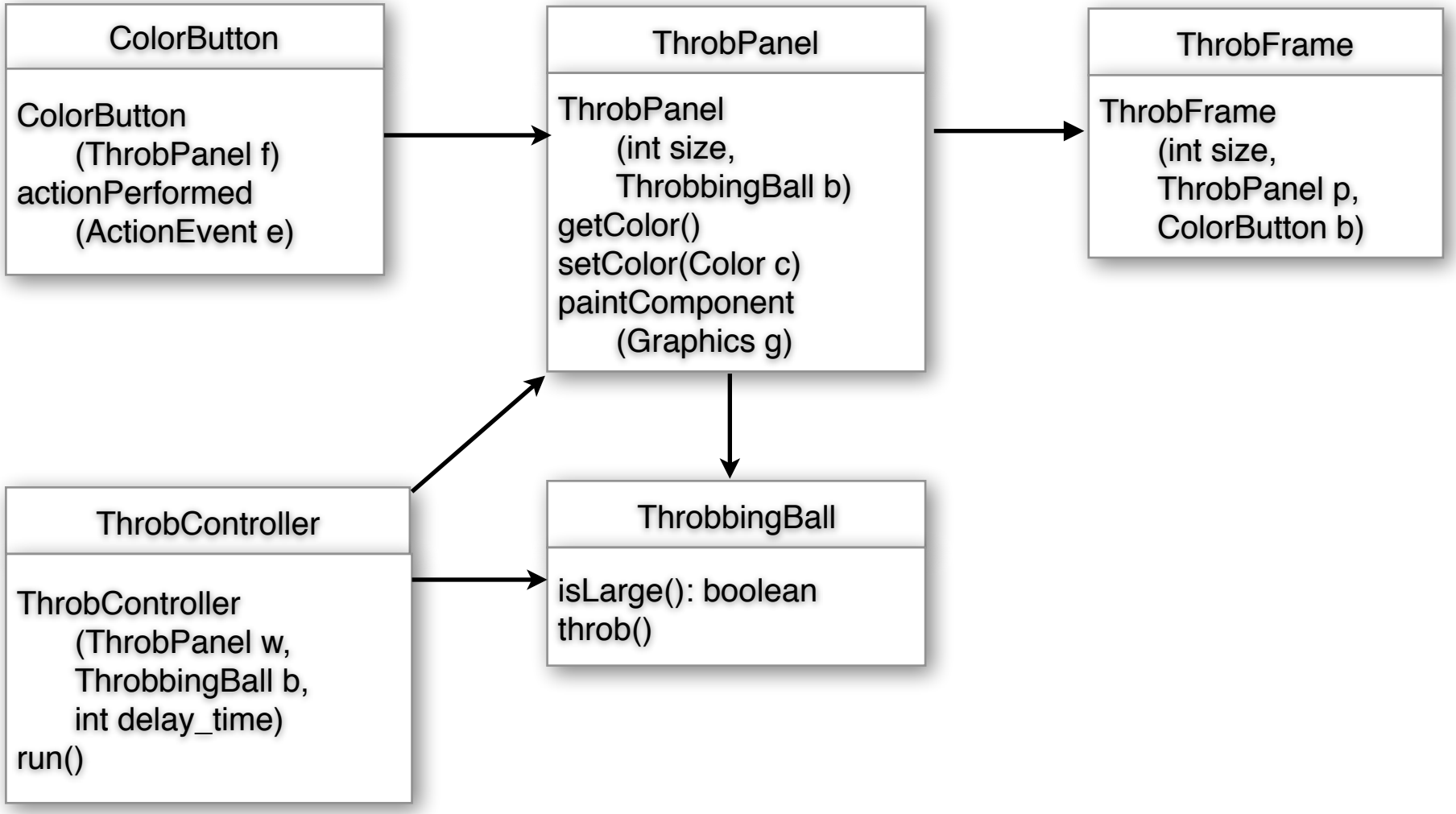
- 크기가 주기적으로 변하는 공을 그려보자.
- OK 단추를 그리면 색도 변하게 하자.



소프트웨어 구조


OK 버튼
공을 그림
ColorButton
ThrobPanel
ThrobFrame
ThrobController
ThrobbingBall
주기적으로 공의 크기를
바꾸어주면서 그리라고 명령
공에 대한 정보 기억

구체적인 소프트웨어 구조



ThrobbingBall

```
public class ThrobbingBall {
    private boolean is_large = true;
    public boolean isLarge() { return is_large; }
    public void throb() { is_large = !is_large; }
}
```

ThrobPanel

```
mport java.awt.*; import javax.swing.*;
public class ThrobPanel extends JPanel {
    private int panel_size, location, ball_size;
    private Color c = Color.red;
    private ThrobbingBall ball;
    public ThrobPanel(int size, ThrobbingBall b) {
        panel_size = size; location = size/2; ball_size = size/3; ball = b;
        setSize(size, size);
    }
    public Color getColor() { return c; }
    public void setColor(Color new_color) { c = new_color; }
    public void paintComponent(Graphics g) {
        g.setColor(Color.white); g.fillRect(0, 0, panel_size, panel_size);
        g.setColor(c);
        if (ball.isLarge())
        g.fillOval(location-ball_size/2,location-ball_size/2,ball_size,ball_size);
        else
        g.fillOval(location-ball_size/4,location-ball_size/4,ball_size/2,ball_size/2);
    }
}
```

ColorButton

```
import java.awt.*; import java.awt.event.*; import javax.swing.*;

public class ColorButton extends JButton implements ActionListener {
    private ThrobPanel view;
    public ColorButton(ThrobPanel f) {
        super("OK");
        view = f;
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        Color c = view.getColor();
        if(c==Color.red)
            view.setColor(Color.blue);
        else
            view.setColor(Color.red);
    }
}
```

ThrobFrame

```
import java.awt.*; import javax.swing.*;

public class ThrobFrame extends JFrame {
    public ThrobFrame(int size, ThrobPanel p, ColorButton b) {
        Container cp = getContentPane();
        cp.setLayout(new BorderLayout());
        cp.add(p, BorderLayout.CENTER);
        cp.add(b, BorderLayout.SOUTH);
        setTitle("Throb"); setSize(size, size+40);
    setVisible(true);
    }
}
```

ThrobController

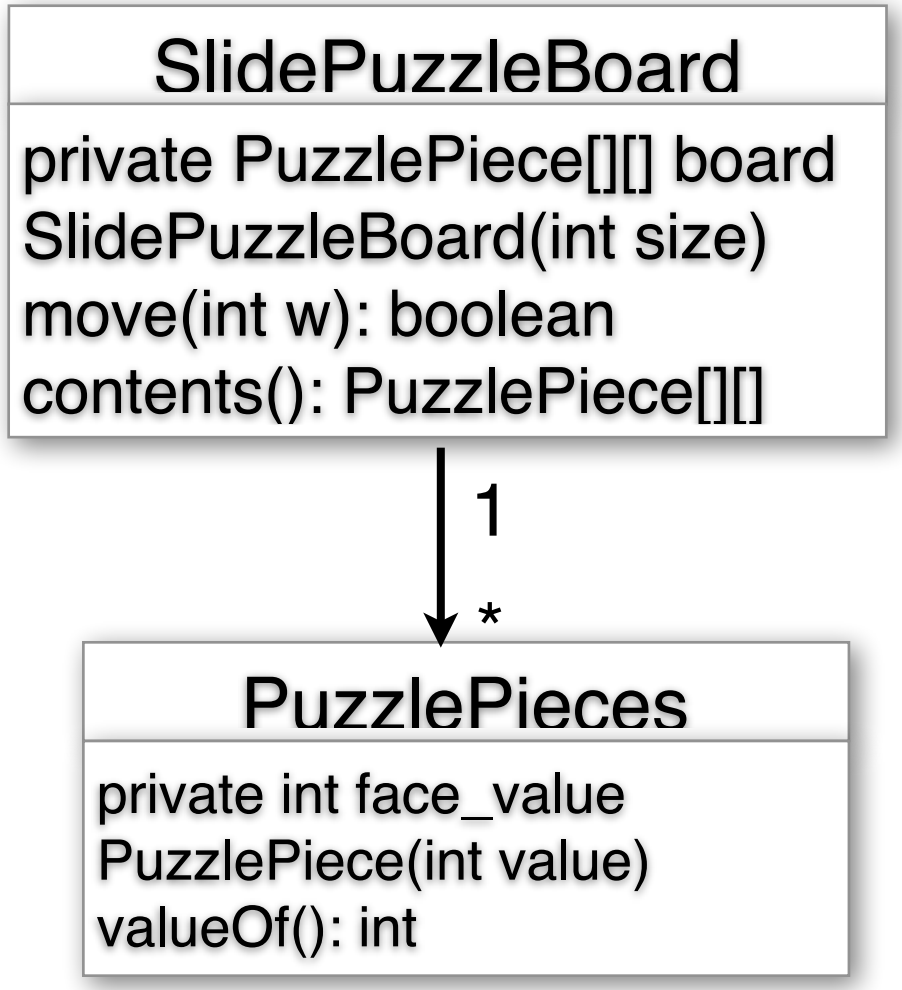
```
public class ThrobController {
    private ThrobPanel writer;
    private ThrobbingBall ball;
    private int time;

    public ThrobController(ThrobPanel w, ThrobbingBall b, int delay_time) {
        writer = w; ball = b; time = delay_time;
    }
    public void run() {
        while(true) {
            ball.throb();
            writer.repaint();
            delay();
        }
    }
    private void delay() {
        try { Thread.sleep(time); } catch (InterruptedException e) {}
    }
}
```

구동 코드

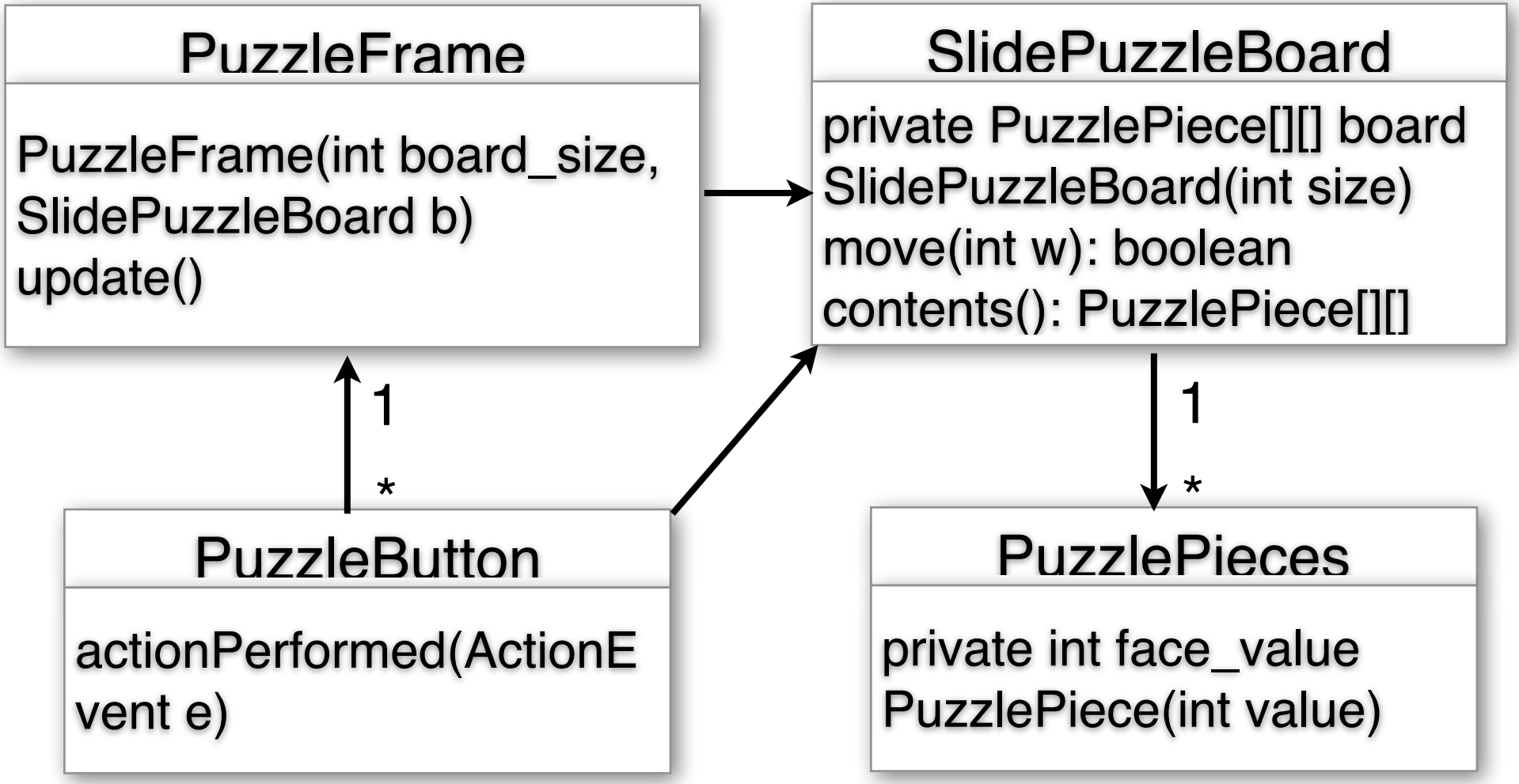
```
public class StartThrob {
  public static void main(String[] a) {
      int frame_size = 180;
      int pause_time = 200;
      ThrobbingBall b = new ThrobbingBall();
      ThrobPanel p = new ThrobPanel(frame_size, b);
      ThrobFrame f = new ThrobFrame(frame_size, p, new ColorButton(p));
      new ThrobController(p, b, pause_time).run();
  }
}
```

예제, 퍼즐판 그리기


PuzzleFrame
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1


SlidePuzzleBoard
private PuzzlePiece[][] board
SlidePuzzleBoard(int size)
move(int w): boolean
contents(): PuzzlePiece[][]
1
*
PuzzlePieces
private int face_value
PuzzlePiece(int value)
valueOf(): int

출력 뷰, 제어기 추가


PuzzleFrame
PuzzleFrame(int board_size, SlidePuzzleBoard b)
update()
SlidePuzzleBoard
private PuzzlePiece[][] board
SlidePuzzleBoard(int size)
move(int w): boolean
contents(): PuzzlePiece[][]
1
*
1
*
PuzzleButton
actionPerformed(ActionEvent e)
PuzzlePieces
private int face_value
PuzzlePiece(int value)

PuzzleButton

```
import javax.swing.*; import java.awt.event.*;

public class PuzzleButton extends JButton implements ActionListener {
    private SlidePuzzleBoard puzzle;
    private PuzzleFrame view;

    public PuzzleButton(SlidePuzzleBoard p, PuzzleFrame v) {
        puzzle = p; view = v;
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent evt) {
        String s = getText();
        if(!s.equals("")) {
            boolean ok = puzzle.move(new Integer(s).intValue());
            if(ok) view.update();
        }
    }
}
```

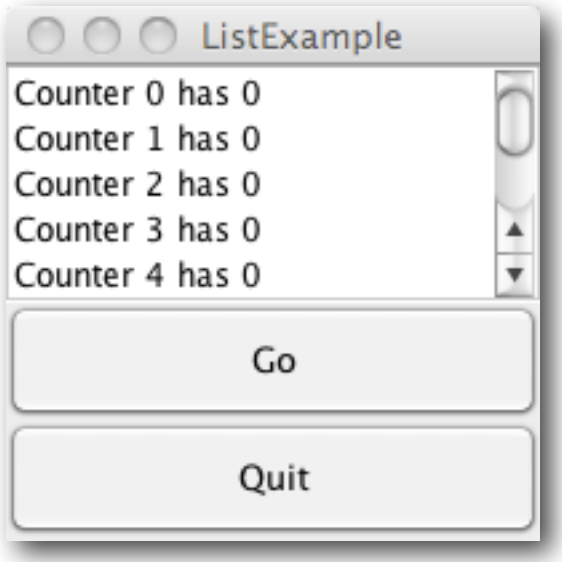
PuzzleFrame

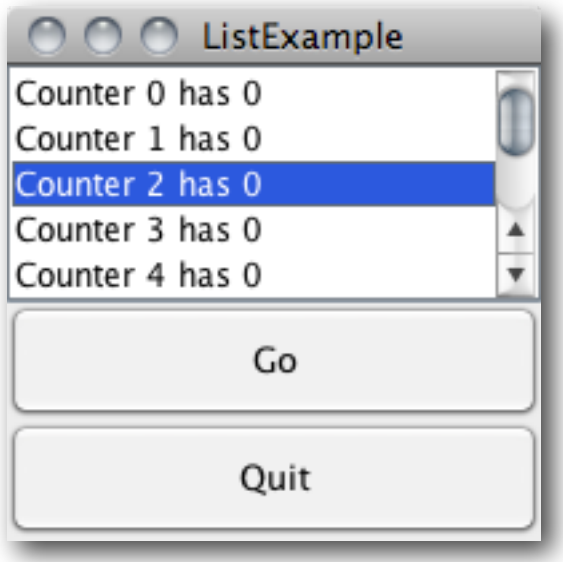
```
public class PuzzleFrame extends JFrame {
    private SlidePuzzleBoard board;
    private int size, button_size = 60;
    private PuzzleButton[][] button;

    public PuzzleFrame(int board_size, SlidePuzzleBoard b) {
        size = board_size; board = b;
        button = new PuzzleButton[size][size];
        Container cp = getContentPane();
        cp.setLayout(new GridLayout(size, size));
        for (int i=0; i<size; i++) for(int j=0; j<size; j++) {
            button[i][j] = new PuzzleButton(board, this);
            cp.add(button[i][j]);
        }
        update();
        setTitle("PuzzleFrame");
        setSize(size * button_size + 10, size * button_size + 20);
        setVisible(true);
    }
```

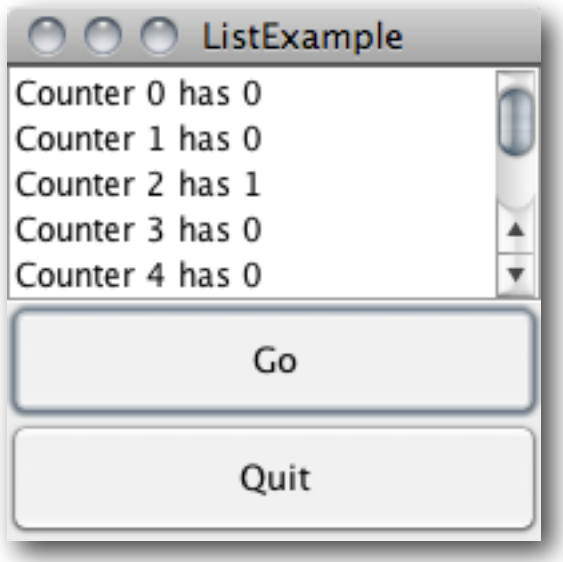
PuzzleFrame

```
    public void update() {
        PuzzlePiece[][] r = board.contents();
        for(int i=0; i<size; i++) for(int j=0; j<size; j++) {
            if (r[i][j]!=null) {
                button[i][j].setBackground(Color.white);
                button[i][j].setText("" + r[i][j].valueOf());
            }
            else {
                button[i][j].setBackground(Color.black);
                button[i][j].setText("");
            }
        }
    }
}
```

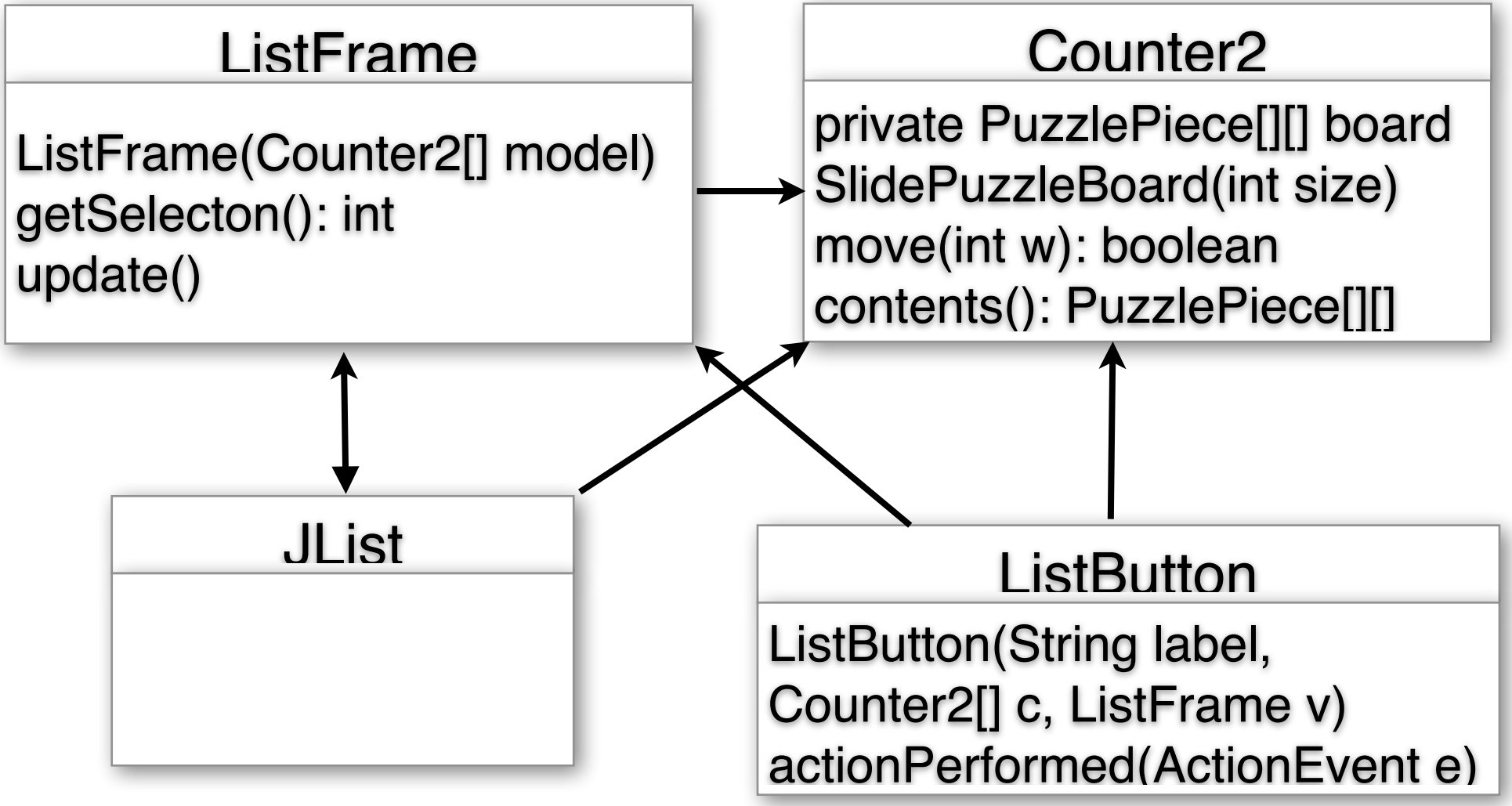
예제, 넘김 기능 있는 리스트 (Scrolling List)







소프트웨어 구조


ListFrame
ListFrame(Counter2[] model)
getSelecton(): int
update()
Counter2
private PuzzlePiece[][] board
SlidePuzzleBoard(int size)
move(int w): boolean
contents(): PuzzlePiece[][]
JList
ListButton
ListButton(String label,
Counter2[] c, ListFrame v)
actionPerformed(ActionEvent e)

Counter2

```
public class Counter2 {
    private int count, my_index;
    public Counter2(int start, int index) {
        count = start; my_index = index;
    }
    public void increment() { count++; }
    public int countOf() { return count; }
    public String toString() {
        return "Counter " + my_index + " has " + countOf();
    }
}
```

ListButton

```
import java.awt.event.*; import javax.swing.*;

public class ListButton extends JButton implements ActionListener {
    private Counter2[] counters;
    private ListFrame view;

    public ListButton(String label, Counter2[] c, ListFrame v) {
        super(label);
        counters = c; view = v;
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent evt) {
        int choice = view.getSelection();
        if(choice != -1) {
            counters[choice].increment();
            view.update();
        }
    }}
```

ListFrame

```
import java.awt.*; import javax.swing.*;
public class ListFrame extends JFrame {
     private Counter2[] counters;
     private JList items;
     public ListFrame(Counter2[] model) {
          counters = model;
          items = new JList(counters);
          JScrollPane sp = new JScrollPane(items);
          JPanel p = new JPanel(new GridLayout(2,1));
          p.add(new ListButton("Go", counters, this));
          p.add(new ExitButton("Quit"));
          Container cp = getContentPane();
          cp.setLayout(new GridLayout(2,1));
          cp.add(sp); cp.add(p);
          update();
          setTitle("ListExample"); setSize(200,200); setVisible(true);
     }
     public int getSelection() { return items.getSelectedIndex(); }
     public void update() { items.clearSelection(); }
}
```

JList의 더 많은 기능

- 선택될 때 무슨 일을 하고 싶다.
  - items.addListSelectionListener(ListSelectionListener);
    - valueChanged 메소드가 있어야 한다.
- 여러 개 선택 가능하게 하고 싶다.
  - items.setSelectionMode(ListSelectionModel.MULTIPLE_INTERVAL_SELECTION)
- 선택된 여러 개를 알고 싶다.
  - items.getSelectedIndices(): int[]

JTextField

- 사용자가 텍스트를 입력할 수 있는 칸
- input_text = new JTextField("초기값", 칸 수)
- input_text.getText(): 최종적으로 입력된 문자열
- input_text.setText("..."): 칸에 문자열를 바꿈

JTextArea

- JTextField와 같은 입력 칸이지만 크기가 큰 것

```
JTextArea text = new JTextArea("", 20, 40);
text.setLineWrap(true);
text.setFont(new Font("Courier", Font.PLAIN, 14));
JScrollPane sp = new JScrollPane(text);
```

JTextArea의 메소드들

- JTextComponent
  - getText(): String, setText(String)
  - getCaretPosition(): int, setCaretPosition(int), moveCaretPosition(int)
  - getSelectedText(): String, getSelectionStart(): int, getSelectionEnd(): int
  - cut(), copy(), paste()
  - isEditable(): boolean, setEditable(boolean)
- JTextArea
  - setFont(Font)
  - setLineWrap(boolean)
  - insert(String, int)
  - replaceRange(String, int, int)

JMenu & JMenuBar

```
JMenuBar mbar = new JMenuBar();
JMenu file = new JMenu("File");
mbar.add(file);
JMenu edit = new JMenu("Edit");
    edit.add(new JMenuItem("Cut"));
    edit.add(new JMenuItem("Copy"));
    edit.add(new JMenuItem("Paste"));
    edit.addSeparator();
    JMenu search = new JMenu("Search");
    ...
    edit.add(search);
mbar.add(edit);
setJMenuBar(mbar);
```

메뉴가 선택되었을 때 할 일은 단추의 경우와 같이 등록할 수 있다.

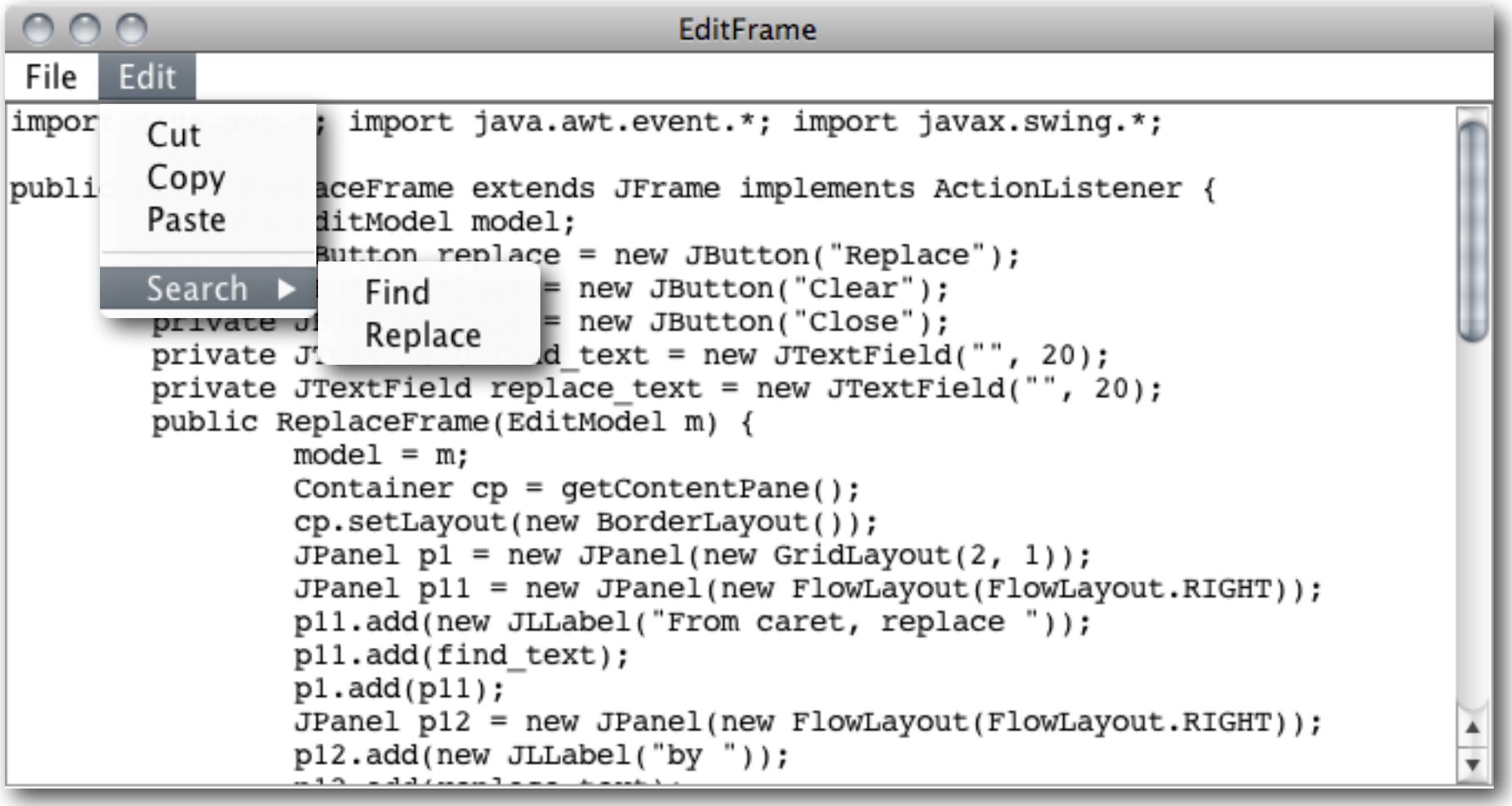
예제, 텍스트 편집기

EditFrame

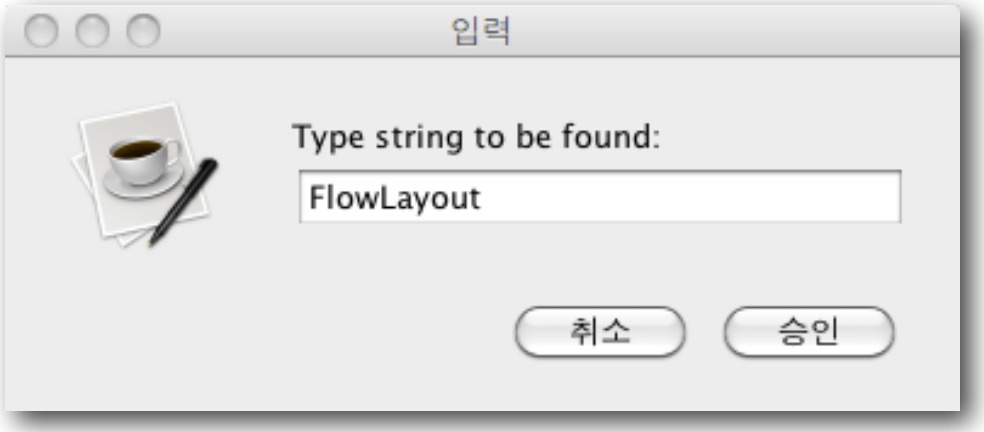
File Edit

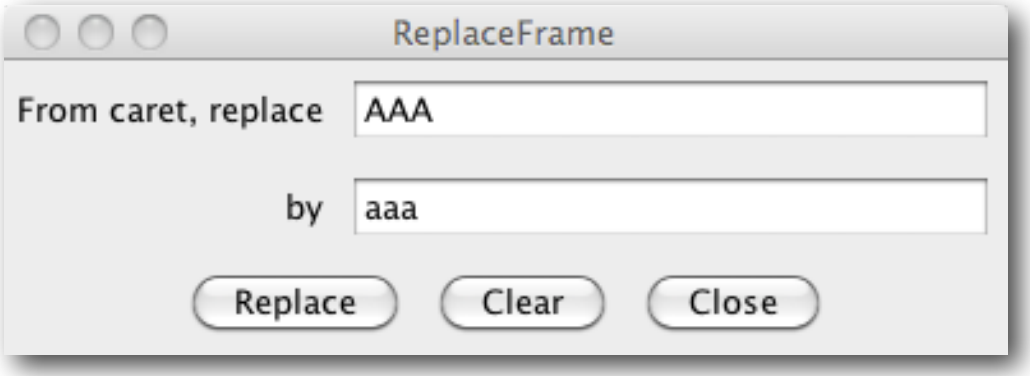
```
import java.awt.*; import java.awt.event.*; import javax.swing.*;

public class ReplaceFrame extends JFrame implements ActionListener {
        private EditModel model;
        private JButton replace = new JButton("Replace");
        private JButton clear = new JButton("Clear");
        private JButton close = new JButton("Close");
        private JTextField find_text = new JTextField("", 20);
        private JTextField replace_text = new JTextField("", 20);
        public ReplaceFrame(EditModel m) {
                model = m;
                Container cp = getContentPane();
                cp.setLayout(new BorderLayout());
                JPanel p1 = new JPanel(new GridLayout(2, 1));
                JPanel p11 = new JPanel(new FlowLayout(FlowLayout.RIGHT));
                p11.add(new JLLabel("From caret, replace "));
                p11.add(find_text);
                p1.add(p11);
                JPanel p12 = new JPanel(new FlowLayout(FlowLayout.RIGHT));
                p12.add(new JLLabel("by "));
```

예제, 텍스트 편집기

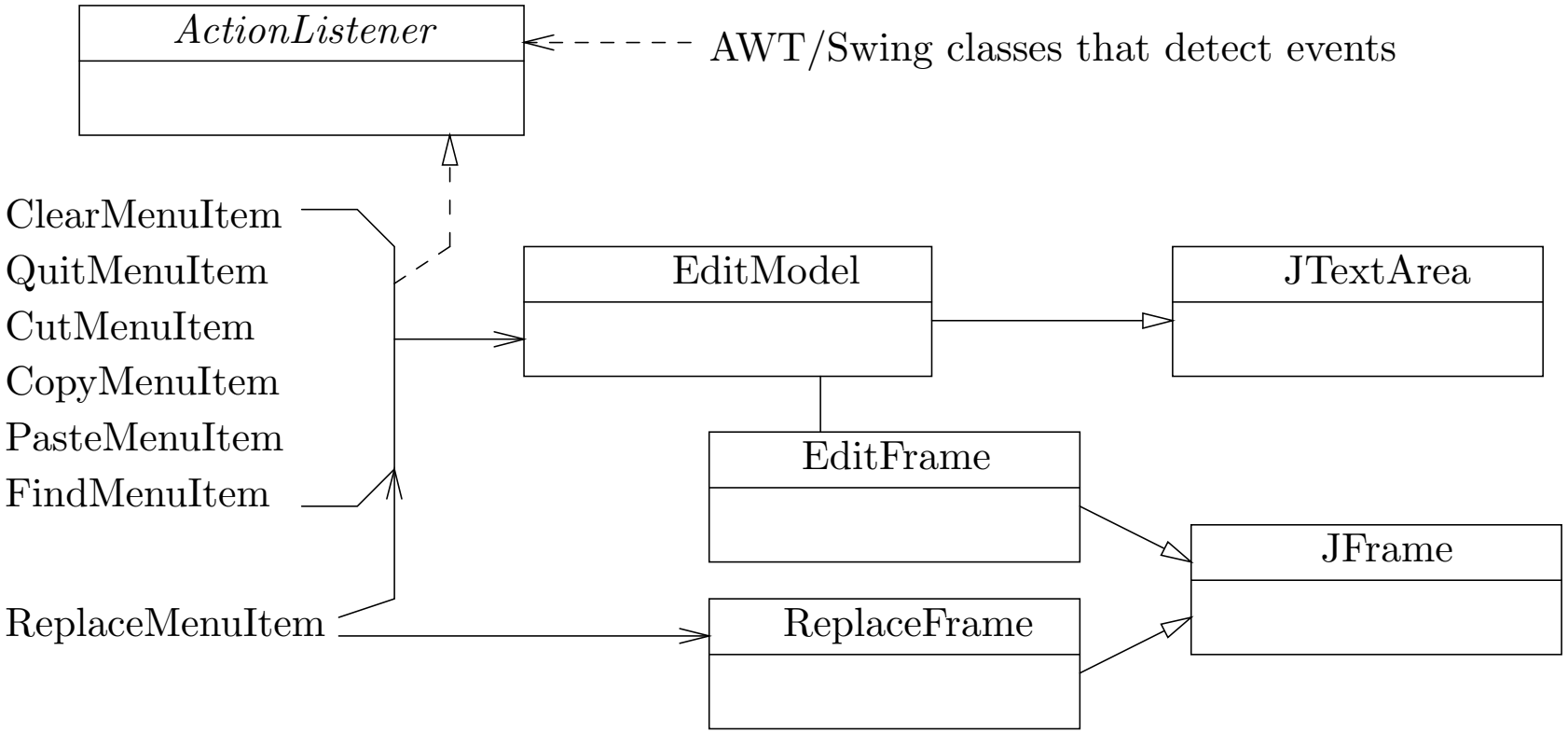

EditFrame
File
Edit
Cut
Copy
Paste
Search
Find
Replace
import java.awt.event.*; import javax.swing.*;
aceFrame extends JFrame implements ActionListener {
ditModel model;
= new JButton("Replace");
= new JButton("Clear");
= new JButton("Close");
d_text = new JTextField("", 20);
private JTextField replace_text = new JTextField("", 20);
public ReplaceFrame(EditModel m) {
model = m;
Container cp = getContentPane();
cp.setLayout(new BorderLayout());
JPanel p1 = new JPanel(new GridLayout(2, 1));
JPanel p11 = new JPanel(new FlowLayout(FlowLayout.RIGHT));
p11.add(new JLLabel("From caret, replace "));
p11.add(find_text);
p1.add(p11);
JPanel p12 = new JPanel(new FlowLayout(FlowLayout.RIGHT));
p12.add(new JLLabel("by "));

예제, 텍스트 편집기


입력
Type string to be found:
FlowLayout
취소
승인


ReplaceFrame
From caret, replace
AAA
by
aaa
Replace
Clear
Close

간략한 클래스 구조도


ActionListener
AWT/Swing classes that detect events
ClearMenuItem
QuitMenuItem
CutMenuItem
CopyMenuItem
PasteMenuItem
FindMenuItem
ReplaceMenuItem
EditModel
JTextArea
EditFrame
JFrame
ReplaceFrame

EditModel

```
import java.awt.*; import javax.swing.*;
public class EditModel extends JTextArea {
    public EditModel(String initial_text, int rows, int cols) {
        super(initial_text, rows, cols);
        setLineWrap(true); setFont(new Font("Courier", Font.PLAIN, 14));
    }
    public void clear() { setText(""); }
    private int find(String s, int position) {
        int index = getText().indexOf(s, position);
        if(index != -1) {
            setCaretPosition(index + s.length());
            moveCaretPosition(index);
        }
        return index;
    }
    public int findFromStart(String s) { return find(s, 0); }
    public int findFromCaret(String s) { return find(s, getCaretPosition()); }
}
```

QuitMenuItem

```
import javax.swing.*; import java.awt.event.*;

public class QuitMenuItem extends JMenuItem implements
ActionListener {
    public QuitMenuItem(String label) {
        super(label);
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        System.exit(0);
    }
}
```

추상클래스: EditorMenuItem

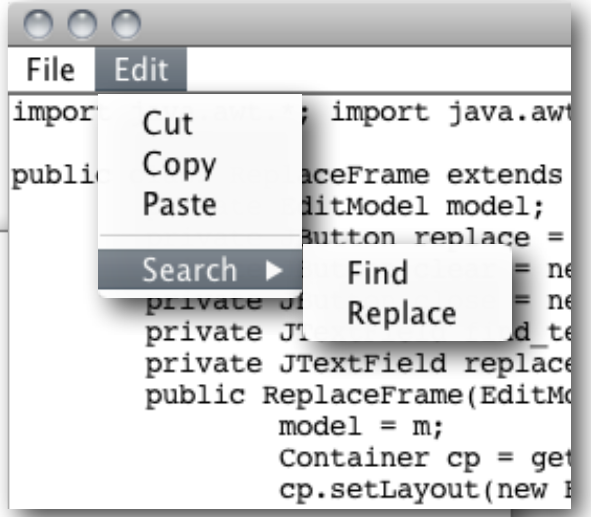
```
import javax.swing.*; import java.awt.event.*;

public abstract class EditorMenuItem extends JMenuItem
implements ActionListener {
    private EditModel buffer;
    public EditorMenuItem(String label, EditModel model) {
        super(label);
        buffer = model;
        addActionListener(this);
    }
    public EditModel myModel() { return buffer; }
    public abstract void actionPerformed(ActionEvent e);
}
```

ClearMenuItem

```
import java.awt.event.*;

public class ClearMenuItem extends EditorMenuItem {
    public ClearMenuItem(String label, EditModel model) {
        super(label, model);
    }
    public void actionPerformed(ActionEvent e) {
        myModel().clear();
    }
}
```

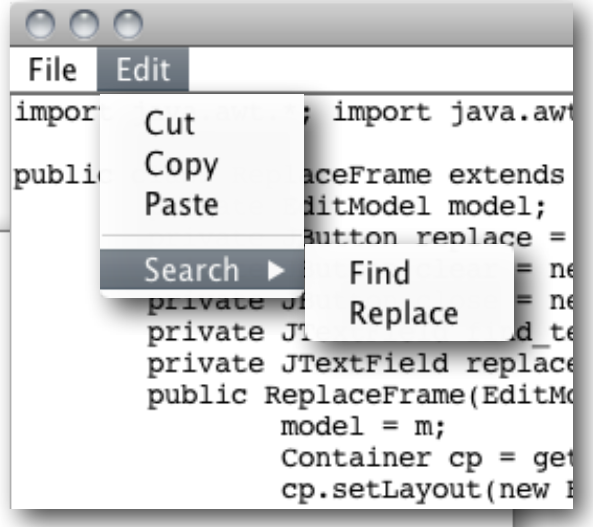
cut/copy/pasteMenuItem도 유사하게 구현 가능

EditFrame




```
import java.awt.*; import javax.swing.*;

public class EditFrame extends JFrame {
    private EditModel buffer = new EditModel("", 15, 50);
    public EditFrame() {
    //  ReplaceFrame second_frame = new ReplaceFrame(buffer);
        Container cp = getContentPane();
        cp.setLayout(new BorderLayout());
        JMenuBar mbar = new JMenuBar();
        JMenu file = new JMenu("File");
        file.add(new ClearMenuItem("New", buffer));
        file.add(new QuitMenuItem("Exit"));
        mbar.add(file);
        JMenu edit = new JMenu("Edit");
        edit.add(new CutMenuItem("Cut", buffer));
        edit.add(new CopyMenuItem("Copy", buffer));
        edit.add(new PasteMenuItem("Paste", buffer));
        edit.addSeparator();
```

ClearMenuItem




```
    //   JMenu search = new JMenu("Search");
    //   search.add(new FindMenuItem("Find", buffer));
    //   search.add(new ReplaceMenuItem("Replace",
    //                                  second_frame));
    //   edit.add(search);
    mbar.add(edit);
    setJMenuBar(mbar);
        JScrollPane sp = new JScrollPane(buffer);
        cp.add(sp, BorderLayout.CENTER);
        setTitle("EditFrame"); pack(); setVisible(true);
    }
    public static void main(String[] args) {
        new EditFrame();
    }
}
```

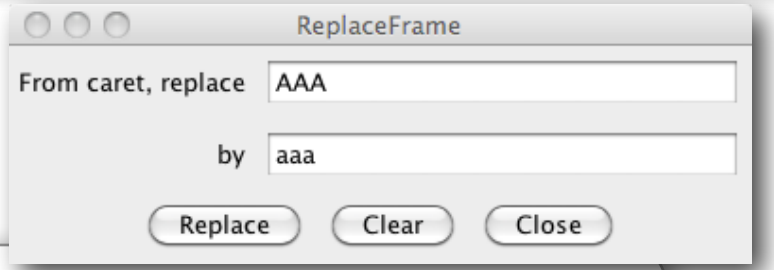
FindMenuItem

```
import java.awt.event.*; import javax.swing.*;

public class FindMenuItem extends EditorMenuItem {
    public FindMenuItem(String label, EditModel model) {
        super(label, model);
    }
    public void actionPerformed(ActionEvent e) {
        String s = JOptionPane.showInputDialog(this, "Type string to be found:");
        if(s != null) {
            if(myModel().findFromCaret(s) == -1) {
                int response = JOptionPane.showConfirmDialog(this,
          "String " + s + " not found. Restart search from beginning of
          buffer?");
                if(response == JOptionPane.YES_OPTION) {
                    if(myModel().findFromStart(s) == -1)
                        JOptionPane.showMessageDialog(this,
                "String " + s + " not found.");
                }
            }
        }}}
```

ReplaceMenuItem

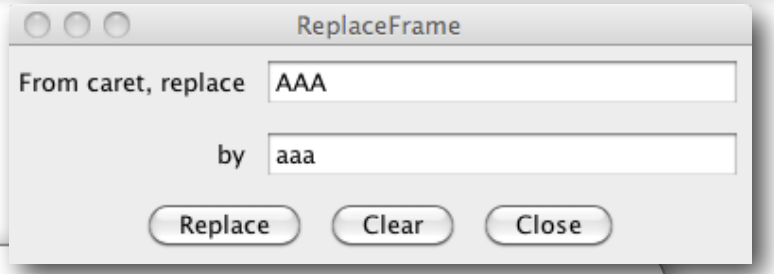
```
import java.awt.event.*; import javax.swing.*;

public class ReplaceMenuItem extends JMenuItem implements
ActionListener {
    private ReplaceFrame view;
    public ReplaceMenuItem(String label, ReplaceFrame v) {
        super(label);
        view = v;
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        view.setVisible(true);
    }
}
```

ReplaceFrame




```
import java.awt.*; import java.awt.event.*; import javax.swing.*;

public class ReplaceFrame extends JFrame implements ActionListener {
    private EditModel model;
    private JButton replace = new JButton("Replace");
    private JButton clear = new JButton("Clear");
    private JButton close = new JButton("Close");
    private JTextField find_text = new JTextField("", 20);
    private JTextField replace_text = new JTextField("", 20);
    public ReplaceFrame(EditModel m) {
        model = m;
        Container cp = getContentPane();
        cp.setLayout(new BorderLayout());
        JPanel p1 = new JPanel(new GridLayout(2, 1));
        JPanel p11 = new JPanel(new FlowLayout(FlowLayout.RIGHT));
        p11.add(new JLabel("From caret, replace "));
        p11.add(find_text);
        p1.add(p11);
```

ReplaceFrame




```
        JPanel p12 = new JPanel(new FlowLayout(FlowLayout.RIGHT));
        p12.add(new JLabel("by "));
    p12.add(replace_text);
        p1.add(p12);
        cp.add(p1, BorderLayout.CENTER);
        JPanel p2 = new JPanel(new FlowLayout());
        p2.add(replace); p2.add(clear); p2.add(close);
        cp.add(p2, BorderLayout.SOUTH);
        replace.addActionListener(this);
        clear.addActionListener(this);
        close.addActionListener(this);
        setTitle("ReplaceFrame"); pack();
        setVisible(false);
    }
```

ReplaceFrame

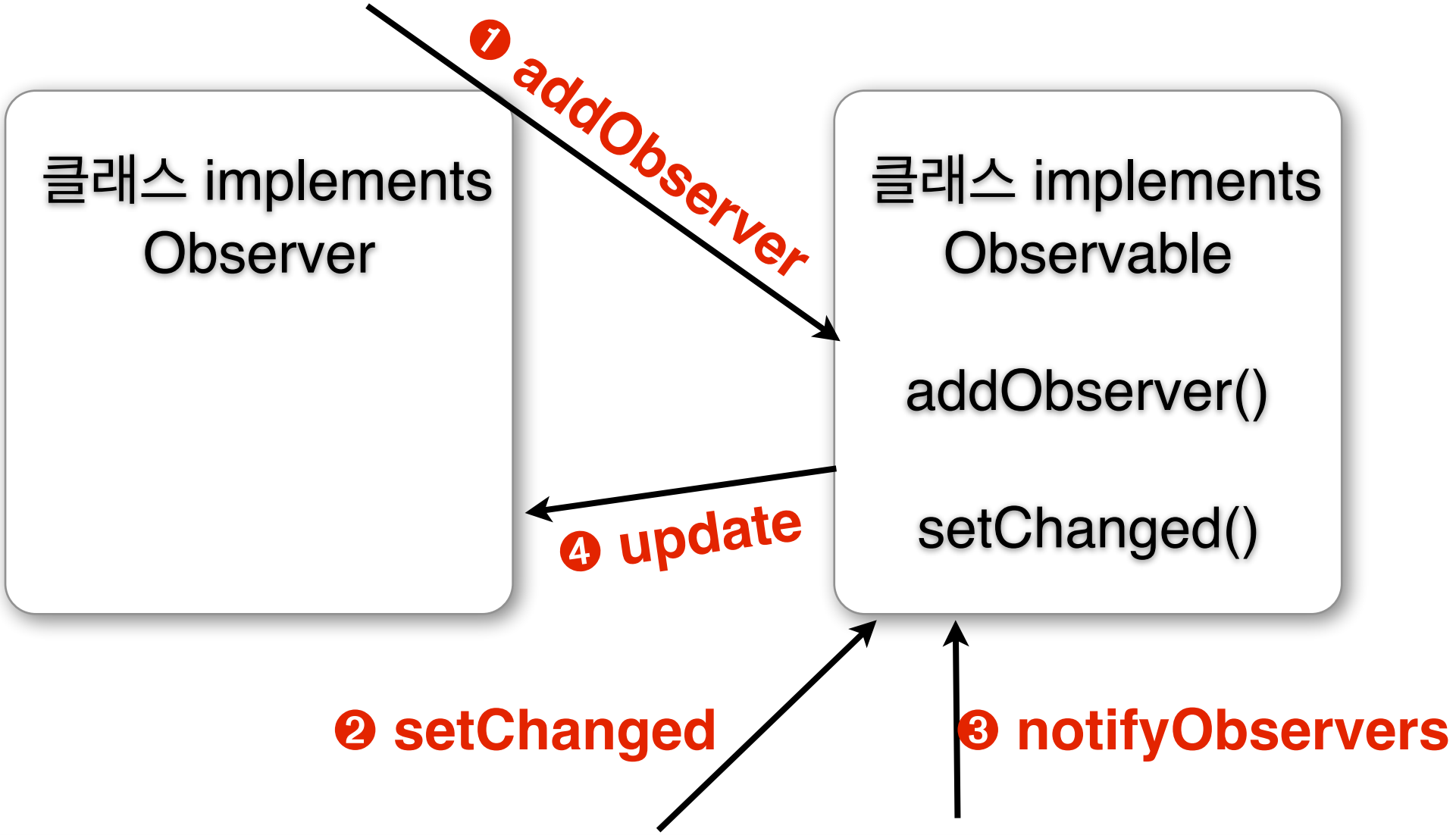
```
public void actionPerformed(ActionEvent e) {
    if(e.getSource() == close) {
        setVisible(false);
    }
    else if(e.getSource() == clear) {
        find_text.setText("");
        replace_text.setText("");
    }
    else if(e.getSource() == replace) {
        String find = find_text.getText();
        int location = model.findFromCaret(find);
        if(location == -1)
            JOptionPane.showMessageDialog(this,
  "String " + find + " not found.");
        else
            model.replaceRange(replace_text.getText(), location,
  location+find.length());
    }}}
```

단추 동작의 원리

- 단추는 관찰대상 객체이다.
  - 관찰자(listener object)들을 등록할 수 있다.
    - b.addActionListener(ob)
  - 단추가 눌리면 등록된 관찰자들에게 actionPerformed 메시지를 날린다.

- GUI 컴퍼넌트 뿐만 아니라 다른 객체도 관찰대상이 될 수 있다.
  - Observable을 구현하고
  - Observer(update 메소드)를 addObserver로 달아 주면 된다.

관찰대상과 관찰자


❶ addObserver
클래스 implements Observer
클래스 implements Observable
addObserver()
setChanged()
❹ update
❷ setChanged
❸ notifyObservers

예제, 자동출력 카운터

- 카운터가 증가할 때마다 화면에 출력해라.

```
public class Counter3 {
    private int count;
    public Counter3(int start)
        { count = start; }
    public int countOf()
        { return count; }
    public void increment() {
       count++;
       System.out.println("new count = " + countOf());
    }
}
```

MVC 구조 위배!

출력 뷰 분리!

어느 쪽부터 생성하지?

```
public class Counter3 {
   private int count;
   private PrintCount view;

   public Counter3(int start,
                   PrintCount v) {
      count = start;
      view = v;
   }
   public int countOf()
      { return count; }

   public void increment() {
      count++;
      view.update();
   }
}
```

```
public class PrintCount {
   private Counter3 counter;

   public PrintCount(Counter3 c)
      { counter = c; }

   public void update() {
      System.out.println(
        "new count = " +
        counter.countOf());
   }
}
```

Observable, Observer를 사용한 분리

```
public class Counter3 implements
Observable {
   private int count;

   public Counter3(int start)
      { count = start; }

   public int countOf()
      { return count; }

   public void increment() {
      count++;
      setChanged();
      notifyObservers();
   }
}
```

```
public class PrintCount
implements Observer {
   private Counter3 counter;

   public PrintCount(Counter3 c){
      counter = c;
      c.addObserver(this);
   }

   public void update() {
      System.out.println(
        "new count = " +
        counter.countOf());
   }
}
```

중요한 사실: Counter3는 PrintCount에 대해 아무 것도 알지 못한다!

예제, CountButton

```
import java.awt.*; import javax.swing.*; import java.awt.event.*;

public class CountButton extends JButton implements ActionListener {
    private Frame4 view;
    private Counter model;
    public CountButton(String label, Counter m, Frame4 v) {
        super(label);
        view = v; model = m;
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        model.increment();
        view.update();
    }
}
```

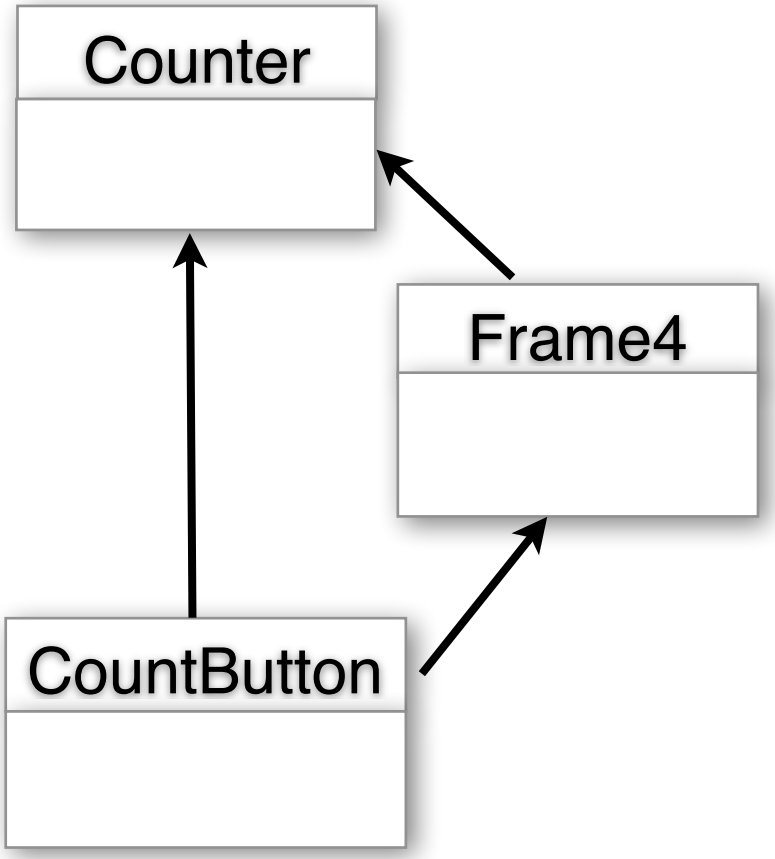
Observable, Observer를 사용한 분리

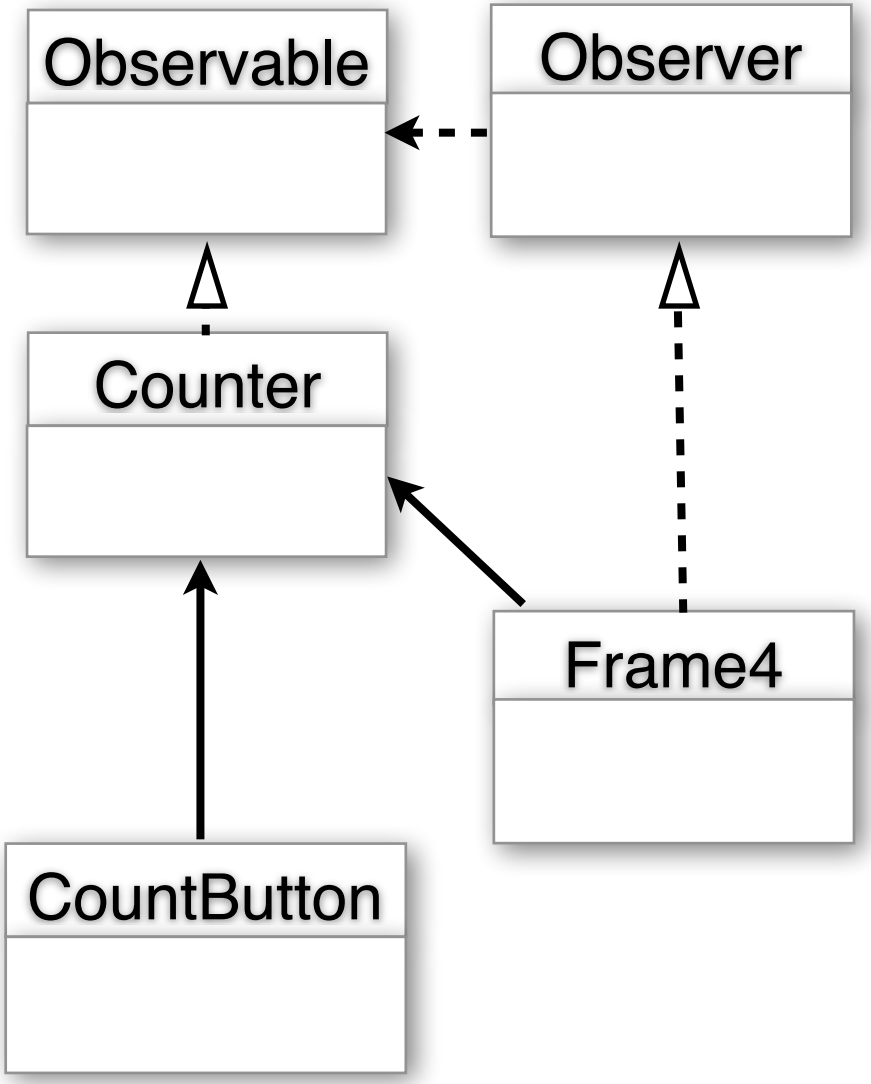
```
import java.awt.*; import javax.swing.*; import java.awt.event.*;

public class CountButton extends JButton implements ActionListener {
    private Frame4 view;
    private Counter3 model;
    public CountButton(String label, Counter3 m, Frame4 v) {
        super(label);
        view = v; model = m;
        addActionListener(this);
    }
    public void actionPerformed(ActionEvent e) {
        model.increment();
        view.update();
    }
}
```

Frame

```
import java.awt.*; import javax.swing.*;

public class Frame4 extends JFrame implements Observer {
    private Counter count;
    private JLabel lab = new JLabel("count = 0");
    private JPanel drawing;

    public void update() {
        lab.setText("count = " + count.countOf());
        drawing.repaint();
    }
    public Frame4(Counter c, JPanel panel) {
    c.addObserver(this);
    ...
}}
```

소프트웨어 구조의 변화


Counter
Frame4
CountButton


Observable
Observer
Counter
Frame4
CountButton