DFS & Intro to GUIs

Lecture 22

CS211 – Fall 2005

Graph Overview

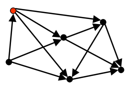
- Graph Definitions
  - Directed graph (digraph)
  - Undirected graph
  - Directed acyclic graph (dag)
  - Paths & cycles
- Graph Properties
  - Graph coloring
  - Planarity
  - Bipartite graphs
- Graph Implementations
  - Adjacency matrix
  - Adjacency lists
- Graph Searching
  - Breadth First Search (BFS)
  - *Depth First Search (DFS)*
- Graph Algorithms
  - Single-source shortest paths (Dijkstra's Algorithm)
  - Minimum spanning tree (MST)
    - Prim's Algorithm
    - *Kruskal's Algorithm*

Depth-First Search

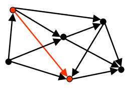
- Follow edges depth-first starting from an arbitrary vertex s, using a *Stack* to remember where you came from
- When you encounter a vertex previously visited, or there are no outgoing edges, retreat and try another path
- Eventually visit all vertices reachable from s
- If there are still unvisited vertices, repeat

Easy to see this takes O(m) time

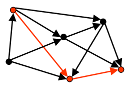
Depth-First Search



Depth-First Search



Depth-First Search



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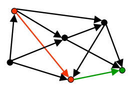
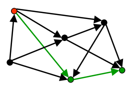


Depth-First Search



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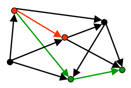

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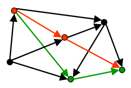

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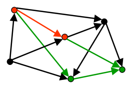

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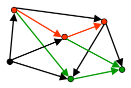

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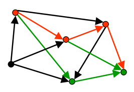

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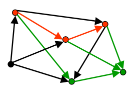

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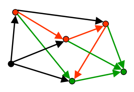

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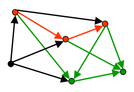

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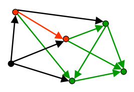

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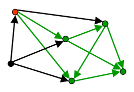

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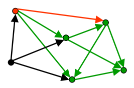

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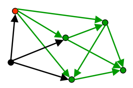

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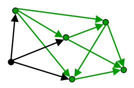

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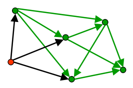

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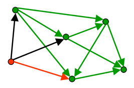

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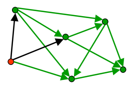

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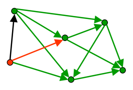

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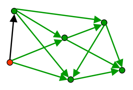

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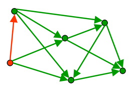

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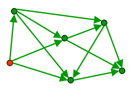

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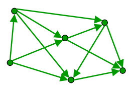

DFS Notes

- Same as BFS, except we use a Stack instead of a Queue to determine which edge to explore next
- Can also implement DFS recursively
  - The Stack is represented implicitly via the Stack-Frames created by the recursive calls

- Initially, vertices are unmarked

```
for all vertices v {
    if (v is marked) continue;
    recursiveDFS(v);
}

recursiveDFS (s) {
    Mark s:
    for (each v adj to s) {
        if (v is marked) continue;
        recursiveDFS(v);
    }
}
```

GUI Motivation

- Interacting with a program
  - Program Driven
    - Statements execute in sequential, predetermined order
    - Typically use keyboard or file I/O
  - Event Driven
    - Program waits for user input to activate certain statements
    - Typically use a GUI (Graphical User Interface)
- Design...Which to pick?
  - Program called by another program?
  - Program used at command line?
  - Program interacts often with user?
  - Program used in window environment?
- How does Java do GUIs?

Java Foundation Classes

- Java Foundation Classes
  - Classes for building GUIs
  - Major components
    - Swing
    - Pluggable look-and-feel support
    - Accessibility API
    - Java 2D API
    - Drag-and-drop Support
    - Internationalization
- Our main focus: Swing
  - Building blocks of GUIs
    - Windows & components
    - User interactions
  - Built upon something called the AWT (Abstract Window Toolkit)
- What are the other things....?

Other Aspects of the JFC

- Pluggable look-and-feel Support
  - Controls look-and-feel for particular windowing environment
  - E.g., Windows, Motif
- Accessibility API
  - Supports assistive technologies such as screen readers and Braille
- Java 2D
  - Drawing
  - Includes rectangles, lines, circles, images, ...
- Drag-and-drop:
  - Support for drag and drop between Java application and a native application
- Internationalization
  - Support for other languages

Brief Example

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

public class Intro extends JFrame {
    private int count;
    private JButton b = new JButton("Push Me!");
    private JLabel label = new JLabel(generateLabel());

    public static void main(String[] args) {
        JFrame f = new Intro();
        f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        f.setSize(200,100);
        f.setVisible(true);
    }

    public Intro() {
        setLayout(new FlowLayout(FlowLayout.LEFT) );
        add(b);
        add(label);
        b.addActionListener( new ActionListener() {
            public void actionPerformed(ActionEvent e) {
                count++;
                label.setText(generateLabel());
            }
        } );
    }

    private String generateLabel() {
        return "Count: "+count;
    }
}
```

GUI Statics vs. GUI Dynamics

- Statics:
  what's drawn on the screen
  - Components
    - E.g., buttons, labels, lists, sliders
  - Containers: components that contain other components
    - E.g., frames, panels, dialog boxes
  - Layout managers: control placement and sizing of components
- Dynamics:
  user interactions
  - Events
    - E.g., button-press, mouse-click, key-press
  - Listeners: an object that responds to an event
  - Helper classes
    - E.g., Graphics, Color, Font, FontMetrics, Dimension

Overview for Statics

- Determine which components you want
- Choose a top-level container in which to put the components
- Choose a layout manager to determine how components are arranged
- Place the components

AWT vs. Swing

- AWT
  - Initial GUI toolkit for Java
  - Provided a “Java” look and feel
  - Basic API: java.awt.*
- Swing
  - More recent (Java 1.2) GUI toolkit
  - Added functionality (new components)
  - Supports look and feel for various platforms (Windows, Motif, Mac)
  - Basic API: javax.swing.*
- Did Swing replaced AWT?
  - Not quite: both use the AWT event model

Components

- Components = what you see
  - Visual part of an interface
  - Represents something with position and size
  - Can be *painted* on screen and receive events
  - Buttons, labels, lists, sliders, etc.
- Examples (see next slide)

Component Examples

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

public class ComponentExamples extends JFrame {
    public static void main(String[] args) {
        ComponentExamples f = new ComponentExamples();
        f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        f.pack();
        f.setVisible(true);
    }

    public ComponentExamples() {
        setLayout( new FlowLayout(FlowLayout.LEFT) );
        add(new JButton("Button"));
        add(new JLabel("Label"));
        add(new JComboBox(new String[] { "A", "B","C" } ) );
        add(new JCheckBox("JCheckBox"));
        add(new JSlider(0,100));
        add(new JColorChooser());
    }
}
```

Containers

- A container is a *component* that
  - Can hold other components and
  - Has a layout manager
- Heavyweight vs. lightweight
  - A *heavyweight* component interacts directly with the host system
  - JWindow, JFrame, and JDialog are heavyweight
  - Except for these top-level containers, Swing components are almost all lightweight
    - JPanel is lightweight
- There are three basic *top-level* containers
  - JWindow: top-level window with no border
  - JFrame: top-level window with border and (optional) menu bar
  - JDialog: used for dialog windows
- The other important container
  - JPanel: used mostly to organize objects within other containers

Creating a Window

```
import javax.swing.*;

public class Basic1 {
    public static void main(String[] args) {

        // Create window:
        JFrame f = new JFrame("Basic Test!");

        // Set 500x500 pixels^2:
        f.setSize(500,500);

        // Show the window:
        f.setVisible(true);

        // Quit Java after closing the window:
        f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    }
}
```

Creating a Window using an Initialization Block

```
import javax.swing.*;

public class Basic2 {
    public static void main(String[] args) {
        new B2GUI();
    }
}

class B2GUI {
    {
    JFrame f = new JFrame("Basic Test2!");
    f.setSize(500,500);
    f.setVisible(true);
    f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    }
}
```

Creating a Window using a Constructor

```
import javax.swing.*;
public class Basic3 extends JFrame {

    public static void main(String[] args) {
        new Basic3();
    }

    public Basic3() {

        // Title window:
        setTitle("Basic Test!");

        // Set 500x500 pixels^2:
        setSize(500,500);

        // Show the window:
        setVisible(true);

        // Quit Java after closing the window:
        setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    }
}
```

Layout Managers

- A layout manager controls placement and sizing of components in a container
  - If you do not specify a layout manager, the container will use a default:
    - JPanel default = FlowLayout
    - JFrame default = BorderLayout
- Five common layout managers: BorderLayout, BoxLayout, FlowLayout, GridBagLayout, GridLayout
- General syntax
  container.setLayout(new LayoutMan( ))
- Examples:

  JPanel p1 = new JPanel(new BorderLayout( ));

  JPanel p2 = new JPanel( );
  p2.setLayout(new BorderLayout( ));

Some Example Layout Managers

- FlowLayout
  - Components placed from left to right in order added
  - When a row is filled, a new row is started
  - Lines can be centered, left-justified or right-justified (see FlowLayout constructor)
  - See also *BoxLayout*
- GridLayout
  - Components are placed in grid pattern (think array)
  - #rows, #columns defined by GridLayout constructor
  - Grid is filled left-to-right, then top-to-bottom
- BorderLayout:
  - Divides window into 5 areas: North, South, East, West, Center
- Adding components
  - FlowLayout and GridLayout use container.add(component)
  - BorderLayout uses container.add(component, index) where index is one of
    - BorderLayout.North
    - BorderLayout.South
    - BorderLayout.East
    - BorderLayout.West
    - BorderLayout.Center

More Layout Managers

- CardLayout
  - Tabbed index card look from Windows
- GridBagLayout
  - Most versatile, but complicated
- *Custom*
  - Can define your own layout manager
  - Best to try Java's layout managers first...
- *Null*
  - Implies no layout manager
  - Programmer must specify absolute locations
  - Provides great control, but can be dangerous to application because of platform dependency

FlowLayout Example

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

public class Statics1 {
    public static void main(String[] args) {
        new S1GUI();
    }
}

class S1GUI {

    private JFrame f;
    private Container c;

    public S1GUI() {
        f = new JFrame("Statics1");
        f.setSize(500,500);
        f.setLayout(new FlowLayout(FlowLayout.LEFT) );
        for (int b = 1; b < 9; b++)
            f.add(new JButton("Button "+b));
        f.setVisible(true);
        f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    }
}
```

Code Examples

- Basic1.java
  - Create a window
- Basic2.java
  - Create a window using an initialization block
- Basic3.java
  - Create a window using a constructor
- Calculator.java
  - Shows use of JOptionPane to produce standard dialogs
- ComponentExamples.java
  - Sample components
- Intro.java
  - Button & counter
- Statics1.java
  - FlowLayout example
- Statics2.java
  - GridLayout example