Today’s topics

Java Applications
Simulation

Upcoming
Software Engineering (Chapter 7)

Reading
Great Ideas, Chapters 6

What does it mean to be human?

- Tool User?
  - Some animals use tools

- Speech?
  - Some animals (whales?) seem to communicate by sound

- Do simulations?
  - Many things we do could be called simulations
    - Drawing a diagram of something to build
    - Using a map to give directions
    - Moveable furniture cutouts on a floor plan

Computer Simulation

- As suggested before, can simulate without computer
- Computer greatly extends the domain
  - Nowadays almost everything built is simulated first
- What are some of the things made possible by computer simulation?
- Early efforts:
  - Fancy camera lenses among first beneficiaries
  - Efficient paths for space ships
  - Population projections in relation to birth control policies
- Let’s use the computer to find solution to simple problem

Dog Lot Fence

- Optimize:
  - I.e., give your dog the biggest lot in the face of constraints
  - Build lot against side of house
  - Fixed length roll of fencing (and posts)
  - Rectangular layout

\[
\text{Length of fence is } 2x + y
\]

- Use program to try different values of $x$ and $y$
  - Better than actually trying different layouts!!
Fence

public class Fence extends java.applet.Applet implements ActionListener
{
    TextField mInstruct;
    Label lLength;
    DoubleField gLength;
    Button bSimulate, bDisplay;
    TextArea mResults;
    int k;
    public void init() {
        lLength = new Label("Length");
        mInstruct = new TextField(70);
        mInstruct.setText("Enter length of fence, the press Simulate or Display");
        gLength = new DoubleField(10);
        bSimulate = new Button("Simulate");
        bDisplay = new Button("Display");
        mResults = new TextArea(25,60);
        bSimulate.addActionListener(this);
        bDisplay.addActionListener(this);
        add(mInstruct);
        add(lLength);
        add(gLength);
        add(bSimulate);
        add(bDisplay);
        add(mResults);
    }
    public void actionPerformed(ActionEvent event) {
        Object cause = event.getSource();
        double fenceLength;
        if (cause == bSimulate) {
            fenceLength = gLength.getDouble();
            fenceTable(fenceLength);
        }
        if (cause == bDisplay) {
            fenceLength = gLength.getDouble();
            fencePlot(fenceLength);
        }
    }
}
Fence.2

void fenceTable(double fenceLength) {
    double area, x, y;
    x = 0.0;
    y = fenceLength - 2.0 * x;
    mResults.setText("Fence Optimization Table
");
    while (y >= 0.0) {
        area = x * y;
        mResults.append("x = " + x + " y = " + y +  
                        " area = " + area + "\n");
        x = x + 1.0;
        y = fenceLength - 2.0 * x;
    }
}
Fence.3

void fencePlot(double fenceLength) {
    double area, x, y;
    x = 0.0;
    y = fenceLength - 2.0 * x;
    mResults.setText("Fence Optimization Plot\n");
    while (y >= 0.0) {
        area = x * y;
        mResults.append(x + "\t" + plotString(area) + "\n");
        x = x + 1.0;
        y = fenceLength - 2.0 * x;
    }
    String plotString(double area) {
        String s = ""
        while (area > 0) {
            s = s + "*";
            area = area - 5.0;
        }
        return s;
    }
}
Fence.4
Fence Optimization

- Output makes it clear how fence should be arranged
  - Not necessarily intuitive (make simulation useful)
  - There are other tricks (non computer) to get answer
- Note we eyeballed the output to get answer
  - Could have had computer pick the maximum area
  - Could you sketch that program out?
- Let’s use slightly different approach; answer not obvious
  - Fix area
  - Minimize amount of fencing used
  - Change scenario a bit
    - Build into corner
    - Put in a tree!

Fence with Tree

- Program a bit more complicated
  - Will not go over details
  - However, intuitive methods not likely to work
  - Must use program to get right answer
  - Program is on-line

Pitfalls in Automatic Methods

- Optimization problems seem straightforward enough
  - Not always the case
- May involve many variables
  - Exhaustively checking all possible values may take too long
  - Need to intelligently look for optimal solution
  - However, can have local maxima or minima
  - Can lead to wrong answer
- Sometimes optimal Solution is computationally out of reach
  - Will come back to that theme at end of semester

Simulation in Microelectronics

- Modern microchips too complicated to be build without simulation
  - It take computers to build computers (recursion?)
- One chip takes tens of thousands of dollar to make
  - Additional ones are almost free
  - One error and it's useless
- Each much too complex to check by hand
  - Modern chips have millions of transistors
- Every aspect of the process is simulated
  - Logic
  - Layout
  - Circuit characteristics
  - Fabrication Process
Other Popular Simulation Targets

- **Games that are Simulations**
  - SimCity
  - Flight Simulator
  - Often serious simulation tools make good games

- **Graphics**
  - Many movies now use computer graphics
  - More and more are entirely graphics
    - Not voices, though!
  - UNC Computer Science Walk-through

- **Virtual Reality**
  - Headsets
  - Caves

- **Drug Design**
  - and the list goes one . . .