CS363 Fall 2015 -- Midterm review page

To prepare for this midterm you should:
• review the lectures from class
• reread the labs (or possibly redo!)
• answer the questions below
• ask questions in class Tuesday 10/13 (for any of the following that are unclear)

Disclaimers: Not all exam questions will come from the following. Not all these questions will appear on the exam.

Sample Questions:
1. How can good programming habits reduce cognitive overhead? Give three examples.
2. Why might metacognition be helpful in programming?
3. What are models used for?
4. What is a simulation?
5. What are simulations used for?
6. What are three types of simulation?
7. Is time continuous or discrete (i.e. quantized)? What would constitute evidence of your answer?
8. Time, in simulations (as in the real world), is sometimes slippery. How does time move in a discrete time simulation? In a differential equation simulation?
9. In a discrete time simulation, what is a typical time step?
10. In the context of simulation, what is the difference between verification and validation? Give an example.
11. Assuming you have written a simulation that clearly does not work like the real system, how can you tell if the problem is with the mapping from the real system to the model or from the model to the simulation?
12. When is the mapping from the real system to the model not many-to-one?
13. Why are all models imperfect?
14. What, according to Chris Langton, is the central insight of Zen?
15. In the context of predictive modeling what does quasimorphic mean?
16. What is \( h(T(s)) - \tau(h(s)) \) called? Why doesn’t it need to be zero?

17. How is a model derived from a real system?

18. How is a simulation created from a model?

19. What are the Lotka-Volterra equations?

20. In the LV equations, what are the state variables? What is the transition function?

21. Given initial values for \( H \) and \( P \), select values for \( a, b, \alpha, \) and \( \beta \) that will be a fixed point? Say \( H=100, P=100, \) and for simplicity choose \( a=b=1. \)

22. Sketch a phase space diagram for a run of an LV simulation starting fairly close to that fixed point.

23. Why would you advise a person writing a simulation of a pendulum to use polar coordinates?

24. Draw a Booch diagram for your pendulum simulation.

25. Write the Pendulum:step() method, where the only force is gravity. Be sure to update both theta and vTheta. Does it matter if you permute the order of the assignment statements? Why?

26. Write pseudocode for the Controller:step() method where there is both gravity and magnetism.

27. Imagine you have a working pendulum simulation. The pendulum swings, looking very much like a real pendulum, for as long as you let it run (including overnight). Now you add another pendulum and magnetic repulsion between them -- and you turn the gravity off. You have been careful, and once you remove the obvious bugs, it seems to work fine; but, if you leave it running overnight, in the morning the pendula always go crazy. Someone proposes that it is an inherent flaw due to the temporal distortion of the modeling technique. Explain what they mean. Draw a picture illustrating the problem. How could you fix it?

28. Why is it useful to add GUI controls to a simulation (use the Pendula simulation as an example)?

29. Why do experienced programmers write prototypes (er, skillful experienced programmers)?

30. Why do skilled programmers write little bits of test code before trying to incorporate untested changes into substantial pieces of code?

31. What are the three software engineering principles presented in class? What does each mean? Give an example (and a counterexample, er... negative example) of each.
32. If you write a loop in the actionPerformed method of a Button that does animation (by creating a series of Images and repainting for each (with suitable delay); why doesn’t it work?

33. How do you create a new Thread in Java? How do you start it running?

34. When does a Thread, thus created, terminate?

35. Assume you saw a classmate struggling to get their pendulum to even display a single pendulum, and on closer inspection discovered that each time they made a change and recompiled, they were running hundreds of steps and not displaying anything. What advice would you give them?

36. Here’s some prototype code for Pendulum:paint(Graphics) -- Point2D.Double is simply a pair of doubles:

```java
private Point2D.Double where(Pendulum thePend) {
    int x = PendulaFrame.pivotX + (int) (length * Math.cos(thePend.theta));
    int y = PendulaFrame.pivotY - (int) (length * Math.sin(thePend.theta));
    return new Point2D.Double(x, y);
}

public void paint(Graphics g) {
    Point2D.Double whereAmI = where(this);
    int x = (int) whereAmI.getX();
    int y = (int) whereAmI.getY();

    g.drawLine(PendulaFrame.pivotX, PendulaFrame.pivotY, x, y);
}
```

The only problem is that gravity is pointed to the right (since the coder decided to go with Java’s idea that 0 (and 2π) is to the right of the origin. What changes must you make to this code so that it displays with gravity pointed down (i.e. rotate the output by π/2 clockwise)?

37. (continuing from previous) Assuming your Pendulum class has an Image variable named myImage, and that it has been correctly set to the image you wish to display at the end of the stick drawn above; write a line of code to display it (in the correct orientation), centered on the stick.

38. Here’s the method NetBeans writes when you add a mouse pressed event to a Frame. Write code to create a new Pendulum with pivot as above, and far end where they clicked. Assume there is a Controller:addPendulum(Pendulum) method, and a Pendulum constructor (public Pendulum(int l, double theta)).

```java
private void formMousePressed(java.awt.event.MouseEvent evt) {
    // Code to create and add a new Pendulum
}
```
39. After adding a second Pendulum, even though you have correctly implemented the repulsive force between the two pendula, any time they are moving at all quickly towards each other, they go right through each other. What is going wrong? What are two techniques to solve this problem?

40. Why do you have to calculate the forces between all the Pendulums before you send step() to (and thus change the position of) any of them?

41. Write differential equations for a snowball Earth simulation.

42. What is Monte Carlo simulation?

43. What is the law of large numbers?

44. What’s the connection between them (i.e. Monte Carlo simulation, and the law of large numbers)?

45. How many fixed points does an LV model have?

46. Why might it be difficult to find them (without doing arithmetic)?

47. Could you use Monte Carlo simulation to validate your LV model? Explain how.

48. What is the leaky toilet metaphor for neural synchrony?

49. Oregon's DOT is considering adding lanes to I-5 to relieve congestion. But, perhaps if drivers behaved differently, traffic could be reduced without that gigabuck expense. Write pseudocode for a traffic simulator that might convince ODOT to spend money on education instead of concrete.
50. What does this print? Why?

```java
public class SuperProblems {

    public static void main(String[] args) {
        //new Child();
        new GrandChild();
    }

    private static class GrandChild extends Child {

        public GrandChild() {
            foo("before !");
            list[0] = '!';
            foo("after !");
        }
    }

    abstract class Parent {
        abstract void foo(String gazortinplatz);
        Parent() {
            foo("in the Parent constructor"); // null?!
        }
    }

    class Child extends Parent {

        char[] list = {'a', 'b', 'c', 'b', 'a'};

        Child() {
            super();
            foo("after super()");
        }

        void foo(String s) {
            System.out.println("s=" + s + " list=" + pretty(list));
        }

        private String pretty(char[] list) {
            if (list==null) {
                return "whoa! it's null!";
            }
            String returnMe="";
            for (char ch: list) {
                returnMe += ch;
            }
            return returnMe;
        }
    }
}
```