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CS162, Lab #2
Jan 18, 2015

CS162 Lab 4

There really wasn't much design to this week's lab. The derived LoadedDice class was very simple, and the statistics computations are also pretty straightforward. I stored the numbers returned by rollTwoDice in an array, then used the C++ library routine std::sort() to sort that array in place. It was then trivial to calculate the median and the mode.

Summary

The loaded dice behave as expected, once I reviewed some math and adjusted my idea of what to expect. Although the analysis below only discusses 6-sided dice (for simplicity) I did similar testing with 8- and 20-sided dice in my program.

Statistics

Since I'm not very good at math I initially expected the distribution of values for rolling two fair dice to be evenly distributed (as it is for one fair die). Turns out this is not the case. I did some internet research on the expected values for die rolls; here are the sites I found most useful:

Statistics of Dice Throw, discusses the math behind rolling two 6-sided dice
AnyDice, simulates any number of any sided dice and graphs the results

Fair Dice

Using AnyDice I was able to confirm that my fair dice are behaving correctly, eg, the mode (most commonly occurring number) for two six-sided dice is 7, and the average and median are ~7 also (when the number of rolls is high enough; 100 rolls was a little too low, I used 500 rolls). Here is my program's output for six-sided dice:

```
Fair dice results:
       average = 6.978
       median = 7
       modes: 7

Loaded dice results:
       average = 9.516
       median = 10
       modes: 12
```

Loaded Dice

The mode, the most common roll for the loaded dice, is 12. This is expected since the program returns 12 27.1% of the time (25% of the time because of cheating, plus (2.8 * .75) randomly). By contrast the number 7 is returned 12.5% of the time (.167 * .75). These probabilities are from Statistics of Dice throw.

For two six-sided loaded dice, the distribution should be close to the "Predicted" table below. "Close to" because, other than for 12, I haven't taken the loadedness into account; numbers such as 10 and 11, which often have a 6 in them, will occur more often.

Predicted - approximate

value	predicted likelihood	
2	0.021	
3	0.042	
4	0.062	
5	0.083	
6	0.104	
7	0.125	will occur slightly more often
8	0.104	will occur slightly more often
9	0.083	will occur more often
10	0.062	will occur much more often
11	0.042	will occur much more often
12	0.271	

Actual observed (500 rolls)

value	observed frequency
2	0.008
3	0.004
4	0.014
5	0.016
6	0.032
7	0.140
8	0.116
9	0.122
10	0.116
11	0.102
12	0.330

That's all the analysis I'm going to do for now, since our writeup isn't meant to be exhaustive.