

CISC 3667 - Game Design and Development
Homework 2: Randomness and Probability

Objective: Solve the following questions.

1. A die is rolled and a coin is tossed. Find the probability that the die shows an odd number and the coin shows a head.

2. Assume that you pick two cards from a deck of cards (without replacing the first card before you pick the second). What is the probability that both are number cards (i.e., numbers 2 -- 10, not J, Q, K, A)?

3. In the game of Tetris, there are seven shapes (called tetronimos) that descend during the game. The choice of which tetronimo to select next is random, but there is more than one way to implement this randomness.

Here are two possible random selection algorithms:

Random A: At every iteration, select a tetronimo at random from all seven possibilities

Random B: At the beginning of the game, make a “bag” of seven tetronimos, one of each shape. At every iteration, choose a tetronimo at random from the bag. After the tetronimo is used, it is discarded from the bag. At the end of seven iterations, create a new bag and proceed as above.

- a. Suppose you have just been given a certain tetronimo. What is the probability that the next piece will have the same shape, using the Random A strategy?

- b. Suppose you have just been given a certain tetronimo. What is the probability that the next piece will have the same shape, using the Random B strategy?

4. I'm working on a new tabletop RPG / strategy game / party game. It's pretty promising, but I'm in a little over my head with some of the math stuff. So I'm glad I just hired you on as a designer!

Okay, so think I have a new combat mechanic worked out, but I'm not sure. I need to know the following probabilities to be sure. Can you tell me the following? Make sure to show your work so I can explain it to our publishers later.

(I'll use this shorthand a lot, so just FYI: "2d6" means rolling two six-sided dice at once. So "4d10" means four ten-sided dice, and so on.)

- a. Rolling 2d4, what is the probability of rolling at least one 4?
 - b. Rolling 2d6, what is the probability of rolling at least one 6?
 - c. Rolling 2d6, what is the probability of getting both 5s?
5. I think we need to simplify our combat system.

I'm thinking it'll work like this:

First, the player rolls a d4, and if they roll a 4, then they roll a d6. If they roll a 6 on that, then they roll a d20.

If they rolled higher than 15 on that, then they win! I think all the rolling will be pretty exciting.

What percentage of the time will a player win?

6. The working title of our game is "The Six Trials of the Hero".

Right now, the core mechanic is pretty simple: the player rolls a D10 each turn, and they need to roll higher than the turn number to proceed.

So they need to roll a two or more on turn 1, three or more on turn 2, and so on, and if they get past all six trials, then they win the game and become a hero. But is it too hard, though?

What percentage of the time will a player win?

7. Mary is playing an adventure game. She is wandering around her game world, and she comes to a fork in the road. The fork has 3 choices. The left fork leads to the cave of the evil ogre, next to which is a medium-sized bag of money. The middle fork leads to a small bag of money. The right fork leads to a large bag of money, which is guarded by an angry dragon.

Mary's goal in the game is to collect as much money as she can, without getting killed by the evil ogre or the angry bunny. She knows that the evil ogre is lazy and that he sleeps 75% of the time (she can grab the money bag nearby when he is sleeping). She also knows that the angry dragon is full of energy and only sleeps 10% of the time. Mary needs to decide what to do; i.e., which fork to take.

The large bag of money is worth 10 points in the game; the medium bag is worth 5; the small is worth 1. Getting killed is worth -10 points (and if Mary goes near the ogre or the dragon when they are awake, she will definitely be killed).

- A. What is the expected value of going down the left path?
- B. What is the expected value of going down the middle path?
- C. What is the expected value of going down the right path?
- D. Which way should Mary go?