A Real TI-83 Craps Simulation Teaches Beginning Probability

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October 31, 2022

Abstract

Simple craps, a Vegas casino game, is easily modeled using a TI-83's programming, list, and statistics features. Roll two dice. If the coming out roll, as it is called is 2, 3, or 12, the player immediately loses. If a 7 or 11 is rolled, they immediately win. If any of the remaining totals are rolled, if the player rolls that number before rolling a 7, they win, not they lose. A program can be initialized with a bank roll and a standard, non-changing bet. Using the list feature 999, the maximum size of a list, rolls can be stored in a built-in list. A bar chart for the distribution of numbers is easily generated and confirms the calculated probabilities. The code to mimic the game is straightforward. The user repeatedly plays the game until the stake is 0, an inevitability given say a stake of \$100 and a bet of \$5. This certainty instills the truth: it's a loser's game.

Introduction

I admit it. I probably lost about \$1000 in twenty years or so gambling, playing *craps* at Vegas casinos. I know I made a living card counting at the Holiday Casino for a few weeks in the 1980s. Low stakes. I bring this all up because subsequent to these exploits, I became a mathematics teacher and someone who absolutely despises the idea of gambling, most especially the casinos, but also poker, the lottery, and really all other forms of bells and whistles enticing people to be really mathematically foolish.

I try during a probability and statistics courses to instill this anti-gambling sentiment amongst my students. I say things like the dice have no feelings, no memory. They, unlike people, can't be moved by a sense of fairness or an emotional need to reciprocate attention with attention and, maybe, acquiescing to entreaties. They are inanimate objects, after-all. Casino operators exploit this innate generalization from our typical interactions with humans that do cave with pressure to our incorrect, silly feeling that dice should be like humans and give a little with emotive displays: blowing the dice, cursing them, begging them to *come on*.

I always feel like it is wasted breath. But recently, while thinking about presenting probability in a course, I lighted on attempting to teach the subject by making a TI-83 (84) program that simulates a *craps* game. I coded awkwardly at first and then it struck me: I could, maybe, fill a list with hundreds of rolls and, rather than one at time doing rolls, just reference this pre-existing list. It can be done. The implication: all the remonstrating, appeals to the dice are totally insane. It's like arguing with a brick wall or pounding your head against it. Unrelated to anything! The list is a forgone reality, an immovable script – granted some impertinent variance.

What I'm going to present to my latest P&S class, I'll present here. Maybe it will purge the world of all forms of gambling. Note: the weather and pandemics are dangerous crap tables, wishing them away is proving disasterous to our species. Perhaps a good start towards not playing games with such is to stop playing games at casinos. Can academic courses perform that trick?

Two Dice

Two dice are really a perfect way to introduce the *fundamental counting principle*. There are $6 \times 6 = 36$ combinations of two dice, as Table 1 shows. It is also pretty, IMHO.

```
VAR NAME: INITCRAP

999→dim(L1)
randInt(1,6,999)+randInt(1,6,999)→L1
0→X:100→S:5→B
```

Figure 1: Caption for craps-init-craps

Next, we can roll these two dice 999 times and store the totals in a list.

	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

Table 1: A random variable is given by the sum of two dice: the top row and left column die are summed in interior cells.

Figure 1 shows the code to do this. It is part of the INITCRAP program. In this same routine we set our stake or bankroll to \$100, that's the variable S and our non-changeable bet to \$5, that's B. The variable X is initialized to 0 and will be referenced in a later program.

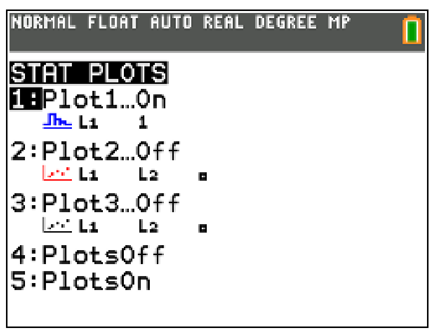

Figure 2: Turn STAT PLOT number 1 on.

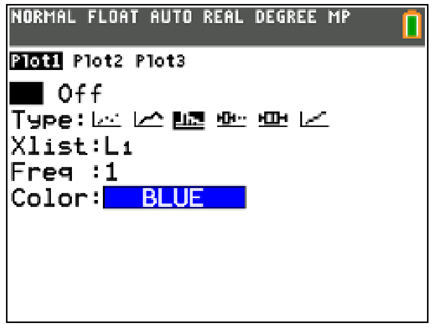

Figure 3: Choose the histogram option, third from left.

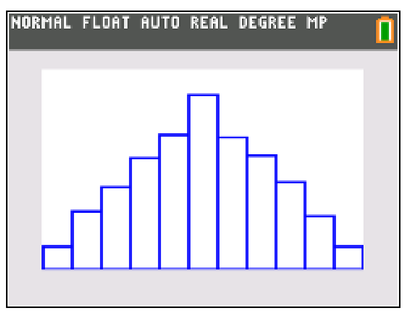

Figure 4: This histogram depicts the number of rolls for each of the $2, \ldots, 12$ sum of two dice.

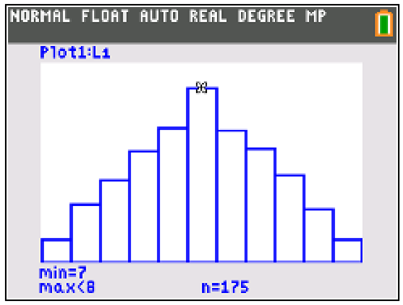

Figure 5: The number of seven rolls is 175, about as predict by theoretical probability.

Just because it is as good a time as any to show L_1, the list with these 999 rolls of our two dice, we will give a histogram, as they are called for the totals. This is done by a 2nd F1 key, Figure 2 and choosing the image as shown in Figure 3. When the graph key is pressed, F5, a histogram is created, Figure 4. Using the trace, F3 key we find that 175 of the 999 dice tosses resulted in a 7, Figure 5. Looking back at Table 1, the theoretical probability of a 7 is $6/36 = 1/6$, the number of ways of getting a 7 divided by the total number of possible combinations. So we predict $(1/6)999 = 166.5$ and we got 175, close enough. This gives, I suggest, the essence of probability: theoretical calculations and empirical results that mirror them. One can go deeper and predict confidence intervals for how many sevens there will be in 999 tosses, but lets move on to playing craps.

The Game

With horror consider that in a live casino all sorts of commotion and emotions are generated for a list made by a simple TI-84 calculator in a few seconds. Granted our game doesn't allow for changing your bets with streaks (imagined), but none-the-less one can read the ticker tape L_1 and interpret it. Figure 6 shows a few rolls. The first roll is an 8, so you have a number and you do get another 8 before you get a 7, so you win the first bet. At $L_1(8)$, the first roll after the second 8, you roll a 2 and that's a loss. Then a 6 which is your new number, etc...

The rules given of the game are given in the *abstract* of this article.. Figure 7 shows the code that simulates a single crap game. Repeatedly hitting enter,

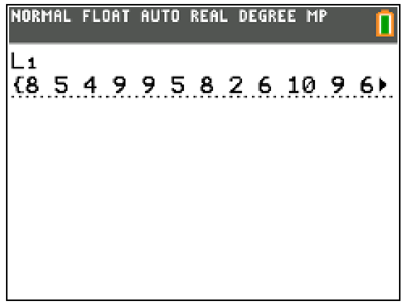

Figure 6: First few rolls of the dice indicate a win and a loss.

after initialising with INITCRAP, results in successive games being played. Figure 8 shows the 9th roll resulting in a loss; a seven was rolled before the player's number, a 6.

VAR NAME: CRAPS

```
X+1→X
L1(X)→C
If C=7 or C=11
Then
S+B→S:Disp C,S,X
Else
If C=2 or C=3 or C=12
Then
S-B→S:Disp C,S,X
Else
13→R:Disp "NUMBER IS",C
End
Repeat R=7 or R=C
X+1→X
L1(X)→R:Disp R
End
If R=7
Then
S-B→S:Disp R,S,X
Else
If R=C
Then
S+B→S:Disp R,S,X
End
```

Figure 7: Code for simulating the game of craps.

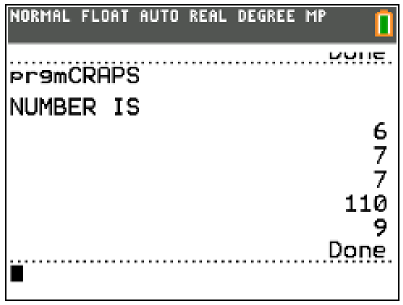

Figure 8: The user just hits enter to repeatedly run the code for simulating the game of craps.

Gambler's Ruin

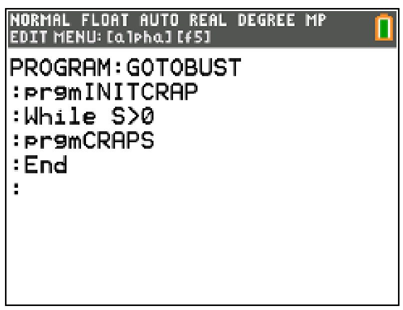

Figure 9: Code that allows the game to be played until S, the player's bankroll is exhausted.

Figure 9 gives a while loop that plays the game till $S \geq 0$ is false, no stake is left. Given 999 tosses of the dice with the stake of \$100 and the standard bet of \$5, it is inevitable that the 999 tosses will not be reached. Figure 10 shows that upon the 755 roll of the dice S has dropped to -5; the player's shirt is lost.

Welcome to Las Vegas.

Conclusion

For me there is something stark and horrible about this simulation. I am hopeful that students who make this code and run this simulation we'll go

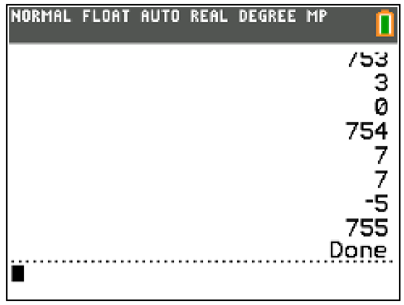

Figure 10: After 755 rolls the inevitable occurs: $S < 0$.

away with complete certainty that the game of *craps* is a boring, stupid endeavor that has no point what-so-ever. Maybe some generalization might then occur (texts like [1] updated) to reveal that playing fast and loose with climate change and pandemics, praying that things get better, just like blowing on dice is a pointless endeavor. Science and mathematics are needed.

References

[1] Blitzer, R. (2022). *Thinking Mathematically*. 9th Edition. New York: Pearson.