**USCOTS 2017 (Hildreth and Green)--Worksheet**

**This Little Piggy . . .**

adapted from Hancock et al. (2010)

We have received a request from the board game company, Porker Brothers©, to develop rules for their new game. It’s similar to a dice game but instead of dice, players roll a plastic pig. They want players to get different amounts of points depending on how the pig lands. They also want to assign points in a way that most players will think is fair. Our assignment is to determine how many points to assign to each type of landing. There are six types of landing:

|  |
| --- |
| **Position** |
| **Dot Up** | **Dot Down** | **Trotter** | **Razorback** | **Snouter** | **Leaning Jowler** |
|  |  |  |  |  |  |

Table adapted with permission from Kern (2006).

* *Dot Up:* Pig lies on its left side
* *Dot Down:* Pig lies on its right side
* *Trotter:* Pig stands on all fours
* *Razorback:* Pig lies on its spine, with feet skyward
* *Snouter:* Pig balances on front two legs and snout
* *Leaning Jowler:* Pig balances on front left leg, snout and left ear

Porker Brothers© wants to include the rule that the first player to 100 points wins.

1. What are important considerations in determining how many points to assign to each position?
2. Collecting whatever information you need, assign points to each of the 6 types of landing.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Position** | **Dot Up** | **Dot Down** | **Trotter** | **Razorback** | **Snouter** | **Leaning Jowler** |
| **Times Rolled** |  |  |  |  |  |  |
| **Probability** |  |  |  |  |  |  |
| **Points** |  |  |  |  |  |  |

1. Play the game using the points you assigned to each position in question 2. How many rolls did it take for a person to reach 100 points? Based on the considerations you used to assign points, do you think that your point assignment is reasonable? Why or why not?
2. How many turns do you think it would typically take for someone to win the game? Do you think the game we just played took more or less rounds than usual?

**USCOTS 2017 (Hildreth and Green)—R Code**

#function for one game

pig.rolls.fun <- function(du, dd, tr, rb, sn, lj) {

 pts <- rbind(c(du, dd, tr, rb, sn, lj))

 pig.probs <- rbind(c(0.302,0.349,0.088,0.224,0.03,0.0061))

 exp.value <- pts %\*% t(pig.probs)

 exp.rolls <- 100/exp.value

 max.rolls <- exp.rolls\*3

 rolls <- rmultinom(n=max.rolls,size=1,prob=pig.probs)

 pts.per.roll <- pts%\*%rolls

 cumsum.rolls <- cumsum(pts.per.roll)

 cumsum.100 <- cumsum.rolls-100

 rolls.to.100 <- order(cumsum.rolls)[cumsum.100 == min(cumsum.100[cumsum.100>=0])]

 rolls.to.100 <- rolls.to.100[1]

 return(rolls.to.100)

}

#function for multiple games

pigrolls.manygames <- function(du, dd, tr, rb, sn, lj, n.games=1000) {

 game.rolls <-replicate(n.games, pig.rolls.fun(du=du, dd=dd, tr=tr, rb=rb, sn=sn, lj=lj))

 m.title <- paste("1000 games ( points=", paste(du,",",dd,",",tr,",",rb,",",sn,",",lj), ")")

 hist(game.rolls, nclass=30, col="lightblue", main=m.title, xlab="Number of rolls to reach 100 points")

}

#run this code to obtain empirical sampling distribution

pigrolls.manygames(6.5,5,12.5,5,20,20)

**USCOTS 2017 (Hildreth and Green)—References**

Feldman, L. and Morgan, F. (2003). The pedagogy and probability of the dice game HOG. *Journal of Statistics Education*, 11(2). [online: <http://www.amstat.org/publications/jse/v11n2/feldman.html>].

Gorman, M.F. (2012). Analytics, pedagogy and the Pass the Pigs game. *INFORMS Transactions on Education*, 13(10), 54—64.

Hancock, S., Noll, J., Simpson, S., and Weinberg, A. (2010), November 23. This little piggy teaches probability. In CAUSEweb.org Activity Webinar Series. [online: <https://www.causeweb.org/webinar/activity/2010-11>].

Hildreth, L.A. and Green, J.L. (2016). Using pig die and simulation to explore probability and expected values. *Teaching Statistics*, 38(2), 67—71.

Johnson, R.W. (2008). A simple ‘Pig’ game. *Teaching Statistics*, 30(1), 14-16.

Neller, T.W. and Presser, C.G.M. (2004). Optimal play of the dice game Pig. *The UMAP Journal*, 25(1), 25—47.

Neller, T.W., Presser, C.G.M., Russel, I. and Markov, Z. (2006). Pedagogical possibilities for the dice game Pig. *Journal of Computing Sciences in Colleges*, 21(6), 149—161.

Shi, Y. (2000). The game PIG: Making decisions based on mathematical thinking. *Teaching Mathematics and Its Applications*, 19(1), 30—34.

Tijms, H. (2007). Dice games and stochastic dynamic programming. *Morfismos*, 11(1), 1—14.

**Possible places to buy pig dice**

Winning Moves (manufacturer of Pass the Pigs)

Math ‘n’ Stuff (http://mathnificent.com/Math-N-StuffStore)--in the search box type in piglet and you will be directed to the page for the pig dice. This is where we bought our pig dice.