

STUDENT VERSION

Dicey Population Modeling

Brian Winkel
SIMIODE
Cornwall NY USA

STATEMENT

We are going to simulate death and immigration using dice. We will use 12 sided (dodecahedron) and 20 sided (icosahedron) dice, found in gaming stores and in educational supply stores (1). Your team will select a rule for death and note the parameters of your simulation, run the simulation, and build a mathematical model, estimate your parameters and compare to your original rule and immigration rate, and then compare your model to your data in Activity 1. In Activity 2 you will pass along your data ONLY for another team to build a model, determine your rule, estimate the parameters of your population, and compare their model to your data.

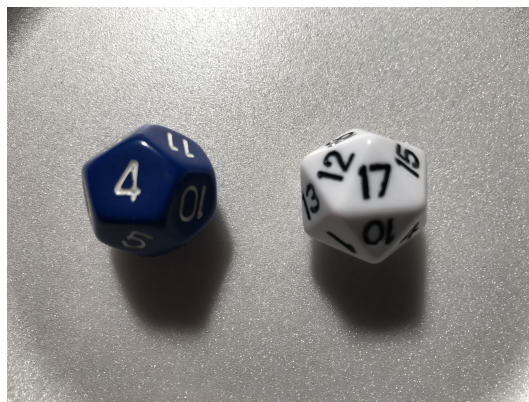


Figure 1. Two different dice used in the population modeling; 12 sided (dodecahedron) on the left and 20 sided (icosahedron) on the right. These are examples of Platonic solids [1].

Here is the basic idea and we leave it up to you to decide your rules for death and numbers.

Suppose we have a bag of 25 of the 12 sided dodecahedral dice. Determine a rule for death which you will apply to the dice you will toss into a plate. See examples in Table 1.

Rule for Death	Probability of Death
Even number facing up	$\frac{6}{12} = \frac{1}{2}$
Multiple of 4 facing up	$\frac{3}{12} = \frac{1}{3}$
Number greater than 8 facing up	$\frac{8}{12} = \frac{2}{3}$

Table 1. Different rules for death (left hand column) and resulting probability of death (right hand column) using dodecahedron (12 sided) dice.

Follow these Steps below. You can use Table 2 to record your data for each Step or Generation. Also record your data in Table 4, for you will be passing this data on to another team for modeling, parameter estimation, and model verification.

1. Start at Generation 0 with, say, 20 of the 12 sided dodecahedral dice in a cup. Place remaining dice in a second excess dice cup.
2. Toss the dice in the cup (gently) onto a paper plate or a surface which will contain them so you do not have them going all over the place and on the floor.
3. Observe the numbers facing up. Establish a rule for death. We give some examples in Table 1. Remove all those who have died because of your death rule back into a second excess dice cup.
4. Then immigrate a fixed number of dice to the population (take them from your second excess cup), say you immigrate $m = 5$ dice into the population, and place them in the original cup. **WARNING:** For this simulation always use this same number of immigrants.
5. Record the number of dice in the cup on Table 2 and in Table 4 on the sheet at the end of this document and mark this as the “next” Generation, i.e. if you have just tossed your dice and immigrated dice from Generation n then record this number as the number of dice at generation $n + 1$.
6. Toss the dice in the cup (from Generation $n + 1$) onto the paper plate and go to Step (3) above. Continue this until you see some pattern you can report in your generations of dice.

REMEMBER: At each Generation follow this sequence: toss, identify dead, remove dead, immigrate, and then count for next Generation.

Activity 0: Data pregenerated

In the data sheet Table 3, found in the Appendix, we use an initial population of 20 dodecahedral dice with a death rule of our own and an immigration rate of our own choice. You can see these at the bottom of the table in the tiny font if you want. **BUT DO NOT LOOK THERE!** However, we want you to use this data to try your skills at determining our death rule and our immigration number at each generation, as well as verify your model when compared to the data, so even if you peek we expect you to do all the work!.

Modeling Death and Immigration of dice	
Iteration	# dice at start of iteration
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Table 2. Modeling death and immigration of dice for your modeling.



Figure 2. Plate with 25 dodecahedral dice.

Activity 1: Model building and comparing with data

Form a mathematical model of your Generation tossing of icosahedral dice and use the data in Table 3 to estimate parameters in your model. Then compare your model prediction to the actual data.

Activity 2: Pass Along

In the data sheet Table 4, place the same data from your Table 2. Then fill out the information with your team name, as simulation team, and pass it along to another team for them to model, estimate parameters, and compare their model with the data you generated. The receiving team should also be able to see your initial condition. Their task is to determine your death rule and estimate your immigration level in a defensible and reproducible manner.

REFERENCES

- [1] Wikipedia contributors. 2019. Platonic solid. In *Wikipedia, The Free Encyclopedia*. Accessed on 23 February 2019. https://en.wikipedia.org/w/index.php?title=Platonic_solid&oldid=881081530.

APPENDIX

Modeling Death and Immigration of dice	
Iteration	# dice at start of iteration
0	20
1	16
2	13
3	9
4	13
5	12
6	10
7	13
8	13
9	14
10	15
11	14
12	13
13	13
14	15
15	11
16	11
17	11
18	13
19	16
20	17
21	14
22	13
23	10
24	12

Table 3. Simulation in which you need to determine the death rule and the immigration level.

Death Rule: If die face turns up 6 or less that die dies and we immigrate 6 dice at each generation.

Modeling Death and Immigration of dice	
Iteration	# dice at start of iteration
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Table 4. Modeling death and immigration of dice.

Team Conducting Simulation Membership

Team Conducting Analysis Membership

Model:

Parameters Obtained:

Evidence: