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SIMIODE
A SYSTEMIC INITIATIVE FOR MODELING INVESTIGATIONS & OPPORTUNITIES WITH DIFFERENTIAL EQUATIONS

STUDENT VERSION
TOSSING

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Abstract: We offer students simulation experience or data from a simulation and ask them to model the simulation using several approaches, to include exponential decay fit, difference equation, and differential equation.

SCENARIO DESCRIPTION

The mathematics lesson uses forty 10-sided dice. Working in groups, students first roll the dice. They remove all dice that land showing a 1 on top and record the number. They then repeat the process, continuing to record the number of dice remaining after each roll until no dice remain.

Sets of 10-sided dice may be purchased in gaming and education offerings either in stores or on-line. However, if there is no convenient way to conduct this simulation then we offer in Table 1 a result from such an experimental run. We also offer a plot of this data in Figure 1.

a) Build a reasoned model for $R(n)$, the number of dice remaining after n tosses, where $R(0) = 40$. State your assumptions clearly and show how they are used in the model building process. Finally, compare your model predictions with the data.

b) Build a reasoned model with a difference equation for $R(n)$, the number of dice remaining after n tosses, where $R(0) = 40$. State your assumptions clearly and show how they are used in the model building process. Solve the model to produce a predicting function, $R(n)$. Finally, compare your model predictions with the data.

c) Build a reasoned model for a differential equation for $R(t)$, the number of dice remaining after t tosses, where we make a toss every minute - so t is time in minutes or generation of toss and $R(0) = 40$. State your assumptions clearly and show how they are used in the model building process. Solve the model to produce a predicting function, $R(t)$. Finally, compare your model predictions with the data.

Iteration	Dice Alive	Iteration	Dice Alive	Iteration	Dice Alive
0	40	15	8	30	3
1	35	16	8	31	2
2	30	17	6	32	2
3	28	18	5	33	2
4	26	19	5	34	2
5	24	20	5	35	2
6	19	21	5	36	1
7	18	22	4	37	1
8	17	23	4	38	1
9	14	24	4	39	1
10	12	25	4	40	0
11	10	26	4		
12	10	27	3		
13	9	28	3		
14	8	29	3		

Table 1. Results of simulation in which forty 10-sided dice are tossed and at each iteration when a 1 lands on top the die is removed at that iteration. The simulation is conducted until there are no more dice remaining.

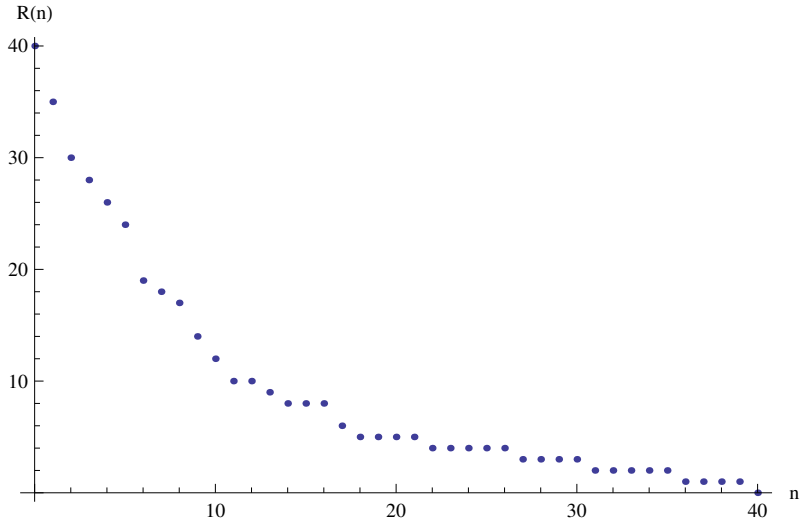

Figure 1. Plot of the data from Table 1 in which n is the iteration and $R(n)$ is the number of remaining die.