

Binomial Distribution and Minecraft Speedrunning

Math Club

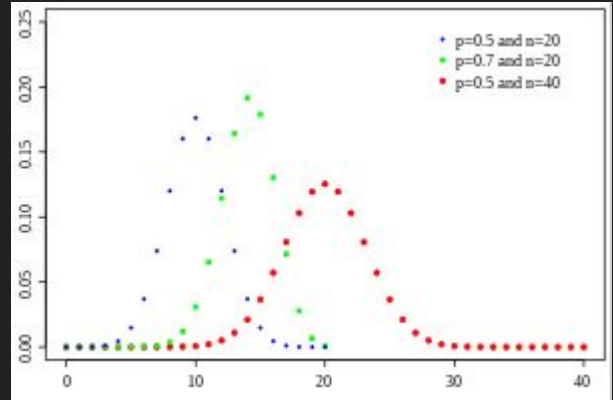
Combinations Formula

the number of ways selecting k things out of n things = $\binom{n}{k} = \frac{n!}{k!(n-k)!}$

Binomial Distribution

Consider flipping a coin that has a probability p for heads, then it has a probability $1-p$ for tails

Probability of getting k heads out of n flips $= P_k = \binom{n}{k} p^k (1-p)^{n-k}$



Background

Speedrunners try to beat a game as quickly as possible. For Minecraft as I will show soon there is an element of luck involved. Modern strategies exist to minimize this luck, however at the time of this speedrun controversy the strategy involved a lot of luck.

Minecraft speedrunner Dream was observed to be lucky, but not overtly lucky, instead a small boost in luck spread over a long time. Which is hard to see at first glance but we can compute with the binomial distribution the infeasibility of his odds.











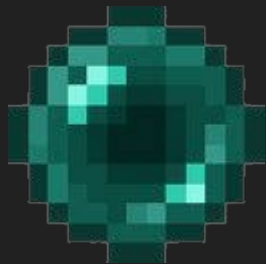
Computing

Probability of receiving an Ender pearls from a piglin barter in Minecraft 1.16.1 = $\frac{20}{423} \approx 4.73\%$

$$\text{Dream's observed barter "luck"} = \frac{42}{262} \approx 16.03\%$$

The probability of getting at least 42 ender pearl barter in 262 trials is calculated as follows:

$$\sum_{k=42}^{262} \binom{262}{k} \left(\frac{20}{423}\right)^k \left(1 - \frac{20}{423}\right)^{262-k} \approx 5.58 \times 10^{-12}$$



Computing

Probability of receiving a blaze rod drop from a blaze kill in Minecraft 1.16.1 = $\frac{1}{2} = 50\%$

Dream's observed blaze rod drop "luck" = $\frac{211}{305} \approx 69\%$

The probability of getting at least 211 blaze rod drops in 305 trials is calculated as follows:

$$\sum_{k=211}^{305} \binom{305}{k} \left(\frac{1}{2}\right)^k \left(1 - \frac{1}{2}\right)^{305-k} \approx 8.79 \times 10^{-12}$$



Probability

Since barter luck and blaze rod drop luck are independent in the code we can multiply them together and see

$$\text{Calculated probability} \approx 5.58 \times 10^{-12} \times 8.79 \times 10^{-12} \approx 4.97 \times 10^{-23} = \frac{1}{20120724346076460482560} \approx 1 \text{ in } 20 \text{ sextillion}$$

Final considerations, yes this is the correct probability. However this is a naive estimate and further statistics need to be done to make sure the probability wasn't calculated maliciously via methods like p-hacking.

Dream initially denied the allegations but after a drawn out back and forth he admitted that someone else put the feature in a mod he was using for recording without his knowledge.