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A4_3 How Heroic is a Hero?

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Abstract
The d20 roleplaying system describes the average statistic for a heroic character as '12 or 13'. Generating a character's statistics is achieved by rolling four six-sided dice (4d6) and discarding the lowest value. The distribution of statistics that are generated by this method is illustrated. A comparison to the distribution of statistics generated by rolling three six-sided dice (3d6) is made, and the quoted average is confirmed to be accurate.

Introduction
The d20 system for roleplaying games (RPGs) used by Wizards of the Coast revolves around characters that have six basic statistics. Each other character attribute in the game relies on one (or more) of these six statistics. In the *Star Wars* variant of the system [1] the company claims, 'the most common ability scores for heroes are 12 and 13,' higher than the quoted average for an average citizen who is not a hero ('10 or 11').

There are three ways* to obtain the basic statistics for one's character in the *Star Wars* system. The most widely-used is that of rolling four six-sided dice, discarding the lowest value and then taking the sum of the remaining three values. For convenience, this will be referred to from this point on as 4d6-L, where 4d6 is an abbreviation for four six-sided dice and -L is an abbreviation for discarding the lowest.

Similar to rolling 3d6, this system provides a distribution of statistics between 3 and 18, as the lowest statistic is reached by rolling three values of 1 on the three undiscarded dice, whereas the highest statistic is reached by rolling three values of 6 on the three undiscarded dice. However, whereas rolling 3d6 will provide you with a distribution with a mean of 10.5 [2], the roll of 4d6-L will not. This paper aims to investigate how the distribution changes by going from 3d6 to 4d6-L.

Distribution Generation
In order to investigate the distribution (and therefore its mean), a set of possible statistics needed to be generated. Although the possibility of generating a random set of numbers and using those as dice values was considered, in fact, the distribution was generated by use of a program in C to generate the complete set of 1,296 possible values when rolling 4d6 and then using this to calculate the complete set of possible statistics s derived from 4d6-L.

The frequencies f of each statistic s are tabulated in Table 1 and then plotted as a bar chart which may be seen in Fig. 1, with the distribution for 3d6 overlaid as a red line.

s	f	s	f
3	1	11	148
4	4	12	167
5	10	13	172
6	21	14	160
7	38	15	131
8	62	16	94
9	91	17	54
10	122	18	21

Table 1: Frequency with which statistics arise using 4d6-L.

The distribution of the statistics that would be seen by using 3d6 was not generated in the same way as for 4d6-L. Instead, a normal distribution was used. The normal distribution gives a probability $p(x)$ for some variable x given that the expected value, or mean, of that variable is μ and the variance is σ^2 (where both numbers are real and the variance is positive). It is calculated by:

$$p(x) = \mathcal{N}(\mu,\, \sigma^2) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left\{-\frac{(x-\mu)^2}{2\sigma^2}\right\} \tag{1}$$

$$x = \mathcal{N}(10.5,\, 2.96). \tag{2}$$

where the values of the mean and standard deviation were found in [2].

Discussion
Looking at Table 1 and Fig. 1, it is easy to see that the statistics generated by the 4d6-L method are generally speaking higher than those that would be generated by rolling 3d6. The distribution in Fig. 1 can clearly be seen to skew to the right, and the modal statistic can be seen from Table 1 to be 13, higher than the value in the 3d6 case.

The mean is also different between the two distributions. Whereas the mean of the 3d6 distribution is

*The other two methods of generating a character's statistics are considered later in this paper.

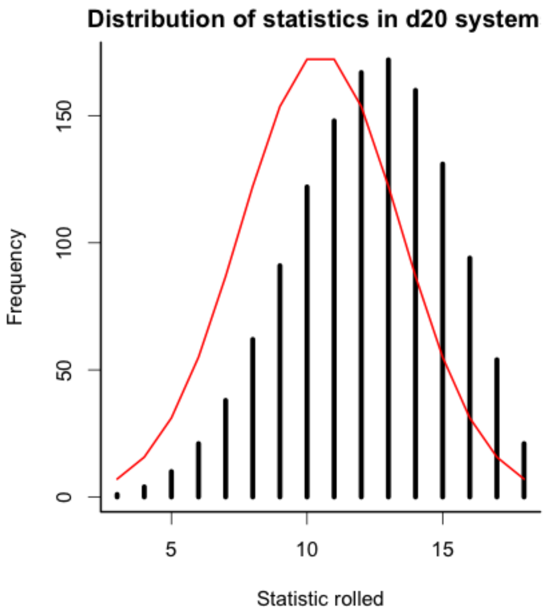

Fig. 1: Bar chart to illustrate the distribution of statistics using 4d6-L compared to the overlaid distribution of statistics using 3d6 (the red line).

10.5, the calculated mean of the 4d6-L distribution is 12.24, an increase of over 1.5.

As mentioned earlier, this is just one way of generating a character's statistics. The other two methods of obtaining one's character's statistics are: use the pre-generated six statistics in the book (the standard score package) or adopt a points-based system in which one is given 25 points to spend on increasing individual statistics (planned generation). Starting at a value of 8, one can purchase statistics. For values up to 14, the cost is the value minus 8 (so 9 is 1 point and 14 is 6 points), and after that the prices rise more steeply.

The standard score package is comprised of six statistics: 15, 14, 13, 12, 10 and 8. The sum of these numbers is 72, producing a mean statistic of 12. In planned generation, assuming the player spends no points on statistics above 14 (so, assuming maximum value-for-points), the sum of her statistics will be 73, producing a mean statistic of 12.17.†

Conclusion

The assertion that the average hero has a statistic of '12 or 13' is accurate. Although characters are more likely to get a 13 than a 12 in the 4d6-L method, their average score will be closer to 12 than 13.

In terms of which system is best for generating a character's statistics, assuming the player wants to maximise her statistics, she should choose the 4d6-L method, as it has the highest mean of the three methods. Planned generation is both more customisable and has a higher mean than the standard score package - however, this only remains true for statistics of 14 or less.

REFERENCES

[1] C. Perkins, O.K.C. Stephens and R. Thompson, *The Star Wars Roleplaying Game: Saga Edition Core Rulebook* (Wizards of the Coast, 2007), Chapter 1, p17.
[2] M.T. Hebner, *Index Funds: The 12-Step Program for Active Investors* (IFA Publishing, 2005), Step 3, p54.

†It is worth noting that the standard score package costs 25 points when generated using the planned generation rules. The reason that the two are different here is a statistic above 14 is present in the standard score package but ignored in the consideration of planned generation.