The Improbability Scale

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(Dated: March 30, 2005)

Abstract

The Improbability Scale (IS) is proposed as a way of communicating to the general public the improbability (and by implication, the probability) of events predicted as the result of scientific research. Through the use of the Improbability Scale, the public will be able to evaluate more easily the relative risks of predicted events and draw proper conclusions when asked to support governmental and public policy decisions arising from that research.

PACS numbers: 01.75.+m
I. INTRODUCTION

Many aspects of life as a responsible citizen in society involve having an understanding of the probability of one type of event in comparison to others. Yet event probabilities are often expressed using unfamiliar or varied terminology (i.e., negative exponents, such as $10^{-4}$ or $10^{-5}$, one part in a thousand, etc.) with the result that, for the ordinary person, the comparison of event probabilities and the drawing of valid conclusions are made more difficult.

II. PROPOSED REMEDY

As a remedy for this, I propose the Improbability Scale, or $IS$, defined as:

$$IS = - \log_{10}(p)$$

where $p$ is the probability of the event.

$IS$ takes on the value of 0 for absolutely certain events and proceeds upwards for events with greater and greater improbability. Table I lists some events and their $IS$ values.

| Event                                                                 | IS   |
|-----------------------------------------------------------------------|------|
| Rolling a 7 on the next roll of a pair of dice [1]                    | 0.8  |
| Space Shuttle major failure on next launch - current experience [2]   | 2.3  |
| One’s birthday occurring tomorrow within a given year [3]            | 2.6  |
| Space Shuttle major failure on next launch - near term goal [2]       | 4.0  |
| Being struck by lightning within a given year [4]                    | 5.4  |
| Drawing a royal flush on the next deal of five cards [5]             | 5.8  |
| Space shuttle major failure on next launch - eventual goal [2]       | 6.0  |
| Winning the jackpot in the next Powerball Lottery [6]                | 8.1  |
| A core-collapse Supernova occurring within a given year close         |      |
| enough to Earth (8 parsecs) to cause significant biological effects  | 8.8  |

Table I
Some Events and their $IS$ values
Because Improbability Scale values are typically small numbers between 0 and 10, they are easily remembered—particularly in the case of personally meaningful events. The public can use the IS values for such events to “customize” its understanding of the Improbability Scale. When a new or less familiar event is presented, the public can use the event’s IS value to put its improbability into proper perspective and, by implication, to draw conclusions about the event’s probability as well.

III. EXAMPLES OF THE UTILITY OF THE IMPROBABILITY SCALE

A standout example of how the Improbability Scale could have served better to communicate the risks of a technological endeavor may be found in an October 2000 speech [2] on the topic of NASA in the 21st Century given by then NASA Administrator Daniel Goldin. The speech was given to a Laboratory audience at the Applied Physics Laboratory Colloquium [8] of The Johns Hopkins University and was also reported on Space.com by Leonard David to a readership more characteristic of the interested general public. There, Goldin is reported as saying:

“We want to take the probability of a major failure of today’s space shuttle from one part in 200 to one part in 10,000, and eventually to one part in 1,000,000 with about the same reliability of today’s commercial aircraft.”

No doubt for the experienced Laboratory audience the implications of a risk assessment of “one part in 200” were well understood. For the interested general public with little or no context in which to place that assessment, the same is not clear.

However, with context provided by the Improbability Scale and a knowledge of the IS for familiar events, such as that for certainty equaling 0 and that for tomorrow being one’s birthday equaling 2.6, the public would have almost certainly understood the implications of a risk assessment that stated:

“On the Improbability Scale, a major failure of today’s Space Shuttle has a rank of 2.3.”

Another example of the utility of the Improbability Scale relates to the IS for several independent events occurring together. The IS for the combined occurrence is the sum of
the IS values for the individual events. This simple combination rule makes it easy for the general public to use its knowledge of the IS values for familiar events to understand the improbability of a new or less familiar event.

Knowing that the IS for one’s birthday occurring tomorrow within a given year is 2.6 and that the IS for being struck by lightning within a given year is 5.4, one has an immediate understanding of just how improbable an IS 8.0 event is—namely, it is as improbable as getting struck by lightning on one’s birthday. One can then apply that understanding to even mundane matters, such as when one learns that winning the Powerball Lottery jackpot on the next drawing [6] has an IS of 8.1.

IV. CONCLUSION

I suggest that researchers quote the Improbability Scale values when writing for the general public. Widespread adoption of this way of characterizing events will enhance the public’s understanding of the predictions of science and help in obtaining the public’s support for actions related to those predictions in, for example, such cases as natural disasters and technological failures.

V. ACKNOWLEDGEMENTS

I am grateful to Robert Cousins, Department of Physics and Astronomy, UCLA for a number of discussions. I thank Mariano Zimmler, Division of Engineering and Applied Sciences, Harvard University for a careful reading of the manuscript. Fermilab is operated under DOE contract DE-AC02-76CH03000.
VI. REFERENCES

[1] The probability of rolling two die and having the total come out to be seven is 6/36 for which the IS is computed to be 0.8.

[2] Daniel Goldin, as reported by Leonard David, Space.com, October 11, 2000, http://www.space.com/business/technology/business/goldin_tsunami_001011.html

[3] The probability within the calendar year of today being one's birthday is 1/365 or 1/366 depending on whether the year is a leap year or not. To two significant figures, the IS is 2.6.

[4] According to the National Lightning Safety Institute, the number of lightning strike victims in the US per year on average is 1000. Taking the US population at 280,000,000, one finds that the odds of being a victim are 1 in 280,000. From this, one computes the IS to be 5.4. See: http://www.lightningsafety.com/nlsi_pls/probability.html

[5] The probability of drawing a royal flush is computed as 4C1/52C5 or 0.0000015 from which the IS is computed to be 5.8.

[6] See Powerball Game Information, http://www.wilottery.com/lottogames/pballinfo.asp

[7] N. Gehrels, C. M. Laird, C. H. Jackman, J. K. Cannizzo, B. J. Mattson, and W. Chen, “Ozone Depletion From Nearby Supernovae,” ApJ 585, 1169 (2003) [arXiv:astro-ph/0211361].

[8] The Johns Hopkins University Applied Physics Laboratory Colloquium began in 1947. Held weekly, it is one of the longest standing technical and scientific lecture series in the Washington/Baltimore area. See: http://www.jhuapl.edu/colloquium/