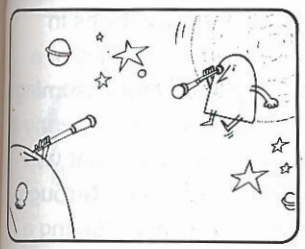
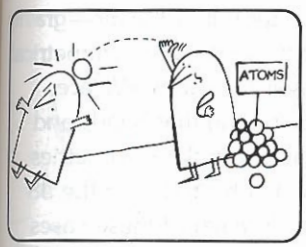
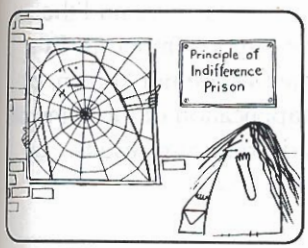
The Principle of Indifference



Is there life on Titan, the largest moon of Saturn?



Will there be an atomic war?



If you answer questions like these by saying that yes and no are equally probable, you are foolishly applying what is called the "principle of indifference." Careless use of this principle has caught many mathematicians, scientists, and even great philosophers in webs of absurdity.

The "principle of insufficient reason," which the economist John Maynard Keynes renamed the "principle of indifference" in his famous *Treatise on Probability,* can be stated as follows: If we have no good reasons for supposing something to be true or false, we assign even odds to the probability of each truth value.

The principle has had a long and notorious history, with applications in such diverse fields as science, ethics, statistics, economics, philosophy, and psychic research. If not properly used, it leads to absurd paradoxes and outright logical contradictions. The French astronomer and mathematician Laplace once used the principle as a basis for calculating that the probability of the sun rising tomorrow is 1,826,214 to 1!

Let's see how contradictions arise if the principle is carelessly applied to our questions about Titan and atomic war. What is the probability there is some form of life on Titan? We apply the principle of indifference and answer 1/2. What is the probability of *no* simple plant life on Titan? Again, we answer 1/2. Of no one-celled animal life? Again, 1/2. What is the probability there is neither simple plant life nor simple animal life on Titan? By the laws of probability we must multiply 1/2 by 1/2 and answer 1/4. This means that the probability of *some* form of life on Titan has now risen to $1 - 1/4 = 3/4$, contradicting our former estimate of 1/2.

What is the probability of an atomic war before the year 2000? By the principle of indifference we reply 1/2. What is the probability of no atom bomb dropped on the United States? Answer: 1/2. Of no atom bomb on Russia? Answer: 1/2. Of no atom bomb on France? Answer: 1/2. If we apply this reasoning to ten different countries, the probability of no atom bomb falling on any of them is the tenth power of 1/2, or 1/1024. Subtracting this from 1 gives us the probability that an atom bomb will fall on one of the ten countries—a probability of 1023/1024.

From Martin Garner's GOTCHA

From Bayes Nets and Consistent Joint Distributions point of view the lesson here is that you can avoid the inconsistency if you avoided asking the question "how likely is life on Titan"--and only asked the specific questions (which will then give a pretty high probability for life on Titan).