PROBABILITY IN MULTIVERSE

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Abstract

Probability on itself is a hypothesis. It is defined as the chance of occurrence of an event out of the possible number of outcomes in a sample space. But things can slightly change if we take into account the concept of multiverse, as the existence of multiverse itself is probabilistic and the occurrence of an event and its outcomes can't be known and judged practically. Statistics is the most beloved child of mathematics, which has a lot of question everyday on various data. But here, it too may suffer difficulties as you don't even know specifically all the data.

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MULTIVERSE: DO THEY EXIST?

Before we go on further, we should think about why multiverse? Do they really exist? Isn't it just a fantasy in comics? But you know human is a race that works to make fantasies true. This universe is eternally inflating and many events are occurring infinite number of times. Quantum states represent space within horizon as beyond event horizon nothing can exist for an outside observer. Then what about the eternally inflating universe and the presence of multiverse in it? The answer lies in probability. The process of creation of all these bubble universes is probabilistic. In fact the existence of our own universe is probabilistic. These all are in quantum mechanical sense-occurs through quantum mechanical tunneling that has given rise various nuclear reactions in the space. Let's give simple example. Suppose you are driving a car up an inclined plane. If you don't give enough velocity, then the car will not reach the other side of the plane. But, if a quantum particle is rolled up a plane or a hill, then it can see the other side of the hill, and we can say it has "dug" through the potential hill. This states that starting from initially inflating space we can end up with multiple universes. Various researches have been done on this aspect and Carroll has stated the probability of existence of multiverse as 50%, whereas according to Polchinski it is slightly higher, 94%.

PROBABILITY OF AN EVENT

Suppose we want to calculate the probability of an event A in the sample space comprising of B.The general expression is

$$P(A) = \frac{N(A)}{N(B)}$$

But both A and B are infinite and you can't determine their exact number.So, let's think in some other way.

Suppose we toss a coin ad get "Heads" as an outcome. Then what are the rest probable universes observing the same outcome or different?

A coin, in any situation, if the event occurs properly, will always have two outcomes:"Heads" or "Tails". Let P(Head)=P(H).Then P(Tails)=1-P(H).

This is because in the universe A where the event is occurring, their total probability is 1,i.e. the probability of an event in that universe A should be 1.The third outcome of the universes with none of the desired outcomes comes in to the scenario when the universes are grouped as a part of the multiverse, and when doing so the probability of the universe A as a whole becomes less than 1.So at the point of the coin toss ,the universes are branching into three parts:"Heads as outcome", "Tails as outcome", "Undesired outcome". We can't be sure about the undesired outcomes, but we can say that the universe with "Heads as outcome" and "Tails as outcome" will be in the ratio P(H):P(T).

Now suppose there are N universes in total, out of which X universes will have "Heads" or "Tails" as outcome and the rest of N-X will have "undesired outcomes".

P(H)=1/a

P(T)=(a-1)/a

Number of outcomes (heads)=P(H)*X

Number of outcomes (tails)=(1-P(H))*X

The total number of outcomes will be 3^N(as seeing from the multiverse each universe can give 3 results).As stated earlier, we don't know anything about what these "undesired outcomes" can be, it is completely imaginary and on us . But there must be something happening for sure. We will assume the probability of these outcomes as,

$P(O) = \frac{(c+id(N-X))}{3\text{^}N}$,where c and d are parameters depending upon N and X.The real part on account of something is happening and the imaginary part is for what it is, "fantasy" or "imaginary".One thing should be kept in mind during this theory that X,i.e total number of universes with any of the desired outcomes must be a multiple of a. Because if not so, then the number of universe with heads or tails as an outcome will be a fraction and it is not possible. It can't be that a part of an universe is behaving differently from other. For example; we can't have 4.6 universes having heads and 3.4 having tails. It will mean that 0.6 of one universe is having a different behavior than the rest 0.4.So,in case if 'n' is not a multiple of 'a' then there must be some universe with absurd outcomes.

The expression of the probability might be

$$P = \frac{P(H) * X}{3^N} + \frac{\big(1 - P(H)\big) * X}{3^N} + \frac{c + id(N - X)}{3^N}$$

If we assume that the basic laws of probability holds in space then,

|P|=1

There will be two cases.

Case 1. N=X

$$\left|\frac{P(H) * X}{3^N} + \frac{(1 - P(H) * X}{3^N} + \frac{c}{3^N}\right| = 1$$

Therefore, $c = 3^X - X$

Case 2. N>X

$$\left|\frac{P(H) * X}{3^N} + \frac{(1 - P(H) * X}{3^N} + \frac{c + id(N - X)}{3^N}\right| = 1$$

(X+c/3^N)^2+ (d (N-X)/3^N)^2=1

Substituting c as $3^X - X$ we get,

$$d = \frac{\sqrt{3^{2N} - 3^{2X}}}{(N - X)}$$

One thing we should notice that c and d both are independent of a, i.e. they don't depend upon the probability of the occurrence of the event. They only depend on the number of universes. Now standing in this universe if we want to see the probability of occurrence of an event in a multiverse, it can be as:

P(H/U)->Conditional Probability of Head given multiverse exists

P(T/U)->Conditional Probability of Tails given multiverse exists

P(O/U)->Conditional Probability of 'undesired outcomes' given multiverse exists

So,

$$P(H \cap U)=P(U)*P(H/U)= \frac{P(U)*(P(H)*X)}{3^N}$$

$$P(T \cap U)=P(U)*P(T/U)= \frac{P(U)*(1-P(H))*X)}{3^N}$$

$$P(O \cap U)=P(U)*P(O/U)= \frac{P(U)*(c+id(N-X))}{3^N}$$

P(U) can be 0.5 or 0.94, depending on what we choose or accept.

CONCLUSION

The entire paper is based on various hypothesis, models and assumptions and is itself a hypothesis. We have often used the terms 'if' or 'might be' at places and is an mathematical approach of how we can give a trivial shape to events out there in space. Also the events here considered will have the same probability in which so ever situation they occur, like probability of obtaining heads will always be ½ or probability of getting a 3 on rolling a dice will always be 1/6 etc. But who knows what the reality is. It really doesn't matter whether probability bends to our will or whether we unconsciously create each moment around us. The reality is that our universe is a strange place. Why do we take ourselves so seriously when the universe can't be bothered to arrange itself in a coherent manner? The value of studying chance, probability, and wacky thought experiments about nature of reality is that they provide perspective of our place in the universe.

As Alan Guth has quoted "In an eternally inflating universe, anything that can happen, will happen, in fact it will happen an infinite number of times".

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