Introduction

Did you ever feel like you've experienced a streak of misfortune so unlikely, that the likelihood of your next attempt being successful has increased?
In the case of statistically independent events, this believe is incorrect and an example of the gambler's fallacy.

History

One of the first descriptions of the gambler's fallacy can be found in Pierre Simon Laplace's "A Philosophical Essay on Probabilities" in 1796. In said essay, Laplace describes that expecting fathers which desired to have a son, would grow worried, when the children born in the timeframe leading up to their childs birth were predominantly male, because they were under the impression that this lowered the chance of their child being male.

The most famous real-life example of the gambler's fallacy occurred in a game of roulette on the 18th of august 1913 at the Monte Carlo Casino, which gave the gambler's fallacy it's alternate name "Monte Carlo fallacy". In said game, the ball happened to land in black 26 times in a row. Since roulette tables feature 37 spaces, 18 red and 18 black, the odds of this streak, given the roulette table is fair, can be calculated as $(\frac{18}{37})^{26}$ or about 1 in 137 million. Due to the gambler's fallacy many present mistakenly believed, during the streak and after, that red was due and lost money betting on it.

Gambler's Fallacy

The gambler's fallacy is the mistaken belief, that an event is more likely to happen, because it has happened less often than deemed probable in the past. For example one may feel as though the next coin toss should show tails, after throwing mostly heads 9 times out of the 10 last throws.

Reasons for the fallacy

The fallacy is often attributed to the false belief, that smaller sets of events should represent the distribution of larger sets of events, also known as "The Law of Small Numbers". Though the events of a growing set of trials will eventually approach a distribution similar to the probabilities of said events, the subsets needn't resemble the same distribution.

Another pitfall that leads into the gambler's fallacy is the incorrect calculation or misinterpretation of probabilities. For example if one throws 4 Heads

in a row, they may consider that throwing 5 times Heads is a low probability event with a 1 in 32 chance. Throwing 4 heads and 1 tails over 5 trials has a 5 in 32 chance. Because the first case is less likely, they may decide to bet on tails, however since the 4 heads lie in the past, they are no longer relevant for the calculation of future probabilities since there is now a 100% chance that this streak happened. Thus the chance of throwing Heads is 50%, just like throwing Tails.

The fallacy is also believed to be caused by the just-world hypothesis, because of which people believe that probability is a self correcting process. In reality however, trials are allowed to have very improbable outcomes, they are just less likely.

Possible Resolutions

Educating someone on the gambler's fallacy is not enough to squash all occurrences of the fallacy, thus different techniques are necessary.
To mitigate the effects of the fallacy one may try to perceive every future event as the start of a new sequence of events, thus eliminating the mistaken belief, in a run dependency into the past.

Reverse Position

The gambler's fallacy only applies to statistically independent trials of events of which the probabilities of each outcome are known. If we aren't sure whether the given probabilities are correct, for example if a coin is fair or not, it is rational to change the expected outcome according based upon the outcomes observed in the past.
As seen in the second multiple choice question one may no longer believe that a dice is fair, if an extremely unlikely event is observed.
The plot illustrates how an observed streak may influence our certainty in the fairness of an experiment.

Related Fallacies

Type Two gambler's fallacy

In some literature the gambler's fallacy as described above is called "gambler's fallacy type one". Gambler's fallacy type two happens when one observes a sequence of events to detect a favourable outcome, but underestimates the amount of observations necessary to find a bias. In the case of highly random events,

it takes a impractical or even impossible amount of time to discern a positive bias.

Retrospective gambler's fallacy

When one witnesses a low-probability event, they may draw the conclusion that this event must be one in a series of more likely events. For example, someone entering a room at the moment in which someone rolls 2 Sixes with 2 dies, they may have the impression that the person rolling the dies must have been doing so multiple times.
Whether this implies that philosophical arguments, like the existence of multiple universes based on the unlikelihood of our universe, are a fallacy, is still topic of philosophical debate.

Hot-Hand Fallacy

When one is under the impression, that they are "on a roll" or "have the hot hand", they believe that their odds of continuing their streak of positive events is more likely, which can be argued to be the inverse of the gambler's fallacy in which the gambler often believes that a streak must be broken instead of continued.

Sources and Further Readings

`https://effectiviology.com/gamblers-fallacy/`
`https://statistikguru.de/lexikon/spielerfehlschluss.html`

`https://en.m.wikipedia.org/wiki/Gambler%27s_fallacy`

(Laplace, 1796) (Marko Kovic, 2019)

References

Laplace, P. S. (1796). A philosophical essay on probabilities. , 184.
Marko Kovic, S. K. (2019). The gambler's fallacy fallacy (fallacy). *Journal of Risk Research*, *22*, 291+.