How to survive forever?

In the following, I am going to present some mathematical background and two different strategies to live eternally[1]. We are going to say that a subject "survives" as long as it stays in a given state. "Survival" in this broad sense can be applied to living creatures, machines, nations, companies or information (e.g. the data "survived" because I had a backup copy).

From a mathematical point of view, survival is a matter of probability. A subject survives any time period n (say, a year) with a specific probability $0 \leq p_n \leq 1$. Thus, the probability P_n to survive all years till year n can be calculated by

$$P_n = \prod_{j=1}^{n} p_j$$

Unfortunately, $P_\infty = 0$ unless p_j is always 1. The only way to circumvent this mathematical insight is an increasing p over time, that is, every year the subject has a higher probability to survive. Eventually, p_∞ must be one for P_∞ to be greater than zero. For example:

$$\begin{aligned} P_n &= \prod_{j=1}^{n} p^{(\frac{1}{j^2})} \\ &= p^{1+\frac{1}{4}+\frac{1}{9}+\frac{1}{16}+\cdots+\frac{1}{n^2}} \\ &= p^{\frac{\pi^2}{6}} > 0 \text{ as } n \longrightarrow \infty \end{aligned}$$

This gives an upper bound on P_n. In this case, if $p_1 = 0.8$, the probability to survive infinitely is ≈ 0.69.

Now, one strategy to increase the survival property is **replication**. Of course, this won't save *The Mona Lisa* but maybe important data sitting on a hard drive. A possible replication strategy would be to copy the data every year on a new hard drive so that in year n, there exists n copies (supposing crashed hard drives get replaced). Let's define q_n as the possibility for all hard drives to fail in year n (as opposed to p_n - the probability of the data to survive year n). Thus, $q_1 = (1 - p_1)$ and $q_{n>1} = q_1^n$. The larger n, the more q_n approaches zero and q_n is exactly zero for $n = \infty$.

However, if $q_\infty = 0$ it follows that $p_\infty = 1$ (if the probability of all hard drives failing at the same time is zero, the probability of the data to survive is 1). Adding only one copy per year is actually a sufficient growth rate to assure that $P_\infty > 0$. Note that this neither means that the data will *always* survive nor that *all* hard drives are intact. It just tells us that this is a sufficient effort to *allow* for survival.

A weak point in this argumentation is the assumption that the survivals/deaths of the copies are uncorrelated. This is a very strong limitation because it is nearly impossible to setup such a scenario. For example, if all hard drives are located on the same planet, their destinies may be interweaved: an asteroid might destroy the whole planet. On the other hand, Life on Earth deploys this strategy quite successfully. If we consider every living thing as a copy (of "something that lives"), we can see that their individual probabilities are relatively unrelated. The more the copies diverge, the higher the probability of some of them to survive a specific

[1] Most ideas mentioned here have been stolen shamelessly from David A. Eubanks's paper *Survival Strategies*, obtainable here.

situation (in fact, some bacteria might very well survive a galactic crash).

The second strategy to survive eternally is **prediction**. If an individual could get better and better at predicting its environment, it does in fact nothing else than increasing its probability to survive. At least, if the subjects takes appropriate actions.

Such a subject would need to put a lot of effort into observing and experimenting. It is not hard to see the strong environment's influence on the success of the subject. If external circumstances vary too quickly, the individual might not be able to raise its yearly survival probabilities quickly enough. It greatly depends on a "smoothly changing" environment.

The prediction strategy has a very interesting property, namely the problem of self-prediction. The individual is itself part of the environment. As the individual seeks to model its environment, it would also need to model its own behavior. This is necessary because the subject could create for itself the circumstances of its death. But this creates a paradox: In order to predict its own behavior it would need to be more complex than itself.

This problem might be illustrated by the following pragmatic consideration. A subject aiming to live forever must have the possibility to replace its inner parts. In theory, the subject could modify everything about itself. By consequence, it could very well modify itself in the way that it doesn't want to live eternally (or even live anymore). Biological organism have a deeply integrated wish to survive. But a subject smart enough to predict the future would also be able to circumvent any deeply integrated maxim. In fact, in order to prevent itself from doing so, it would need to anticipate all environmental changes that could lead to suicidal modification. But this simulation would require to simulate its own changes in the future, which in turn leads to an ever-growing simulation complexity.

If the decisions made by the subject can be expressed as a program for a Turing machine, this is actually a halting problem. No algorithm can be applied to determine whether general self-modifying subjects will eventually kill themselves or not. In contrast, this might be possible for specific subjects. A subject would need to undertake research in this field of study to minimize suicidal modifications by better understanding its own behavior.

Both strategies may provide eternal survival. Implementing the replication strategy is easier, though. Survival through prediction is much more dependent on environmental influence including the subject itself.

Two consequences can be drawn from this: Strive to constantly improve your attention on things in your life you care about. And never store your backup copies in the same house!