Classification of Technological Approaches to the Revival of the Dead

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Abstract. Death seems to be a permanent event, but there is no actual proof of its irreversibility. Here we list all known ways to resurrect the dead that do not contradict our current scientific understanding of the world. While no method is currently possible, many of those listed here may become feasible with future technological development, and it may even be possible to act now to increase their probability. The most well-known approach to technological resurrection is cryonics. Another method is indirect mind uploading, or digital immortality, namely the preservation of data about a person to allow for future reconstruction by powerful AI. More speculative paths to immortality include combinations of future superintelligence on a galactic scale, which could use simulation to resurrect all possible people, and new physical laws, which may include time travel or obtaining information from the past. Acausal trade with parallel worlds could help combine random resurrection and reconstruction based on known data without loss of share of worlds where I exist (known as an existence measure). Quantum immortality could help to increase the probability of success for cryonics and digital immortality. There are many possible approaches to technological resurrection, thus if large-scale future technological development occurs, some form of resurrection seems plausible.

Keywords: resurrection – immortality – superintelligence – mind uploading – quantum immortality – cryonics

Highlights:

- Resurrection is the reconstruction of a personality based on information.
- The problem of personal identity will be solved in the future.
- If large-scale future technological development occurs, some form of resurrection of the dead is inevitable.
- The main player in this resurrection will be powerful AI.
- A combination of random mind generation and acausal trade between parallel worlds in the multiverse allows resurrection of all the dead without loss of “measure”.

1. Introduction

1.1. Overview

The topic of returning the dead to live is a somewhat taboo area for scientific inquiry. But if we take a rationalistic approach to the human mind and assume that "mind" is just information, then recreating of this mind – which we call here "technological resurrection" – becomes a tractable and quantifiable task of reconstruction of the same information. Even if the human mind has some parts which are more than information, like qualia and continuity, some forms of technological resurrection may still be possible. (When we speak about information, we understand it here in the sense of the computer science: as programs or data, which could be completely presented as 0 and 1, and copied without loss. This is in line with the functionalism view on the human mind, where mental processes are some form of computation. Whether this is actually true, is a subject of philosophical uncertainty which will be addressed in section 1.2.)

Many notions of technological resurrection have long histories, and most have been explored independently. For a long time, the idea of resurrection was the sole province of

religion, and has been one of its most attractive parts, especially in Christianity. Fedorov suggested resurrection via collecting the atoms of the dead (Fedorov, 1903). Ettinger and many others have explored cryonics as an instrument for future resurrection (Ettinger & Rostand, 1965). Rothblatt (Rothblatt, 2012) wrote, and Kurzweil spoke in his interview (Berman, 2011), about digital immortality based on computer reconstruction of a person based on her informational traces, and Almond suggested the use of a quantum random generator to fill the gaps in such a resurrection (Almond, 2006). Almond also coined the term "AI assisted indirect mind uploading" for digital immortality. Jones wrote a book about hypothetical quantum archeology, capable of retrieving a dead mind and sending it into the future (Jones, 2017). Bostrom wrote about future superintelligence which will create extensive past simulations, thus creating copies of people from the past and effectively resurrecting them (Bostrom, 2003). Tipler suggested that infinitely powerful superintelligence at the end of the Universe could resurrect everybody by a brute force just by simulating all possible humans (Tipler, 1997). Steinhart analyzed multiple naturalist and digital theories of resurrection (Steinhart, 2015).

The goal in this article is to create a full list of all known methods of technological resurrection and estimate their feasibility, as well as what needs to be done now in order to eventually achieve immortality. We will not explore the questions of the need for resurrection, which directly follow from the idea of badness of death (Bavelaar, 2016), nor will we look into the social implications of the possible resurrection process.

We will list resurrection methods starting with the most technologically simple, and thus closest in time to us, progressing to the more remote, hypothetical, or partial solutions. The findings are presented in graphical form in Fig. 1.

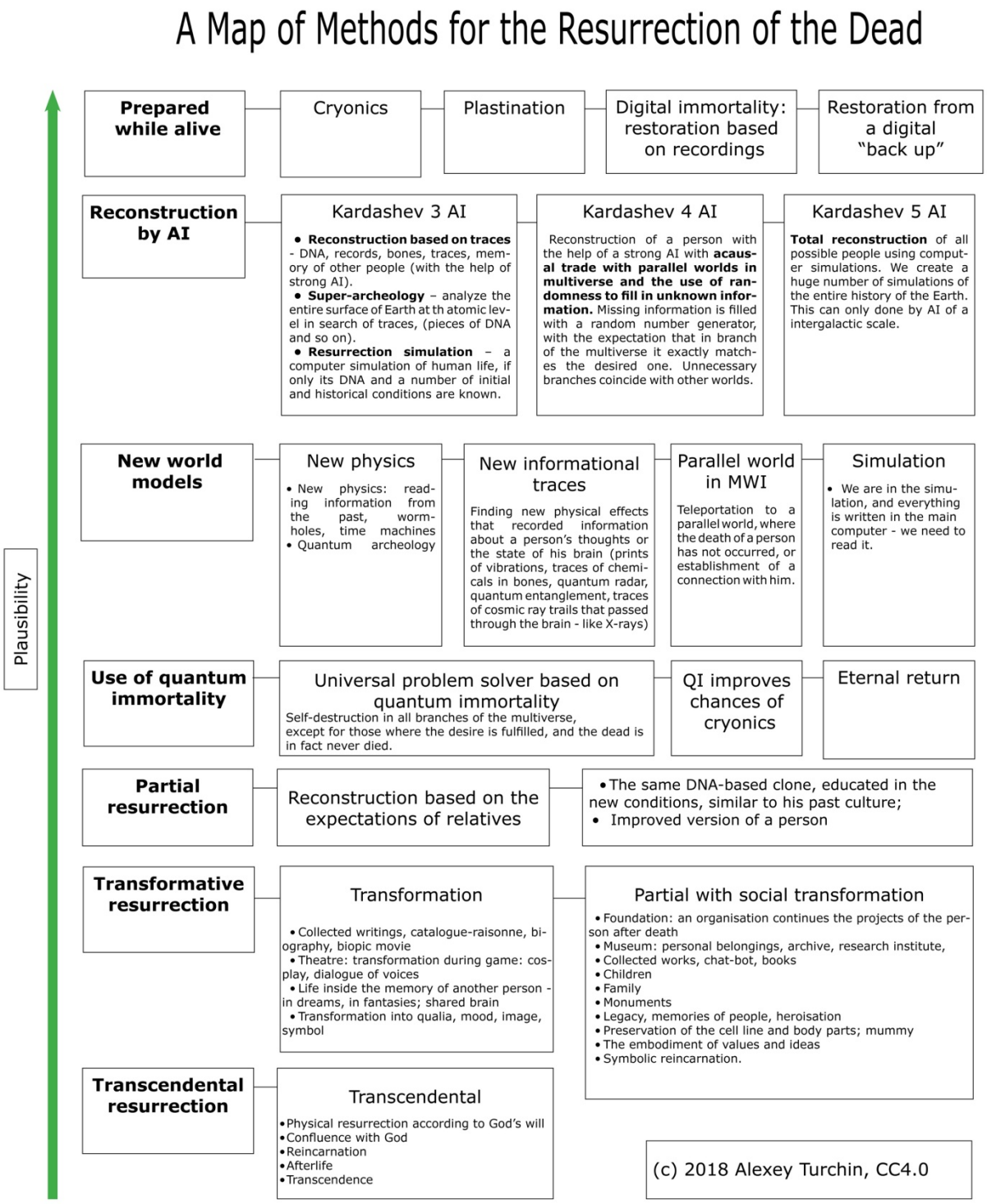

Figure 1. Overview of all ideas about resurrection

2. Death, identity, and immortality

2.1. The definition of death depends on the current level of medical technology

Death, from the medical point of view, is the moment at which the attempts to save a life become futile. However, such a definition is somewhat circular, as the life-

saving attempts are futile because the person is dead, and he is dead because resuscitation attempts are futile. This ambiguity results in constant changes of the understanding of death, as medical technology advances, and people can be revived after longer periods of "clinical death".

To escape this ambiguity, the conception of "informational-theoretical death" (ITD) has been suggested (Merkle, 1992). ITD is the moment in time when information about the personality is irreversibly destroyed and thus no future technologies could be used to extract the information from the remains of the brain. However, as we will see in the next sections, there are hypothetical technologies which could overcome even complete destruction of the physical brain and still be able to regain the same information as it was in the mind. But is the sameness of the information enough?

2.2. Identity problem as a core to the resurrection

The problem of "personal identity" is known to be notoriously difficult. A deep analysis of the problem is outside the scope of this article, but some overview is needed.

Several publications claim that the identity problem will make mind uploading difficult (Pigliucci, 2014; Swan & Howard, 2012), and most people share this view. In-depth analysis of the mind uploading theory and its problems is presented in (Wiley, 2014). There are two types of personal identity:

- *informational identity* which is the measure of similarity between two minds.

- *observer identity* which answers the question: will my exact copy be me, or not?

2.3. Non-informational identity carrier as a backdoor to immortality

While informational identity is rather straightforward and measurable, the question of the observer identity is still dividing philosophers: some think that my copy will be me, and others think my copy never will be me.

The belief in the existence of the observer identity—the idea that "my copy is not me"—implies that informational identity is not enough for "real" identity, and that some form of *non-informational identity carrier* (NIIC) is needed. This NIIC could either be a "soul" or "continuity of consciousness," but these things are currently unmeasurable. Thus, their existence (or lack thereof) is purely based on belief for now. In other words, we can't measure observer identity.

Even if NIIC exists, it is not an obstacle to resurrection, but a possible instrument. For example, if a causal continuity is needed for NIIC, it could be preserved separately from the human brain inside some continuous physical process. This process can continue indefinitely—some candles are still preserving fire from the Hiroshima explosion (Kishikami, 2010).

In other words, if NIIC exists, then "normal" human death may not be a final death, as NIIC could survive it, like the concept of a soul surviving death.

The problem of the nature of the human observer identity could be solved by future human science, or by superintelligent AI, but for now it cannot be definitively answered. This means that we should try to preserve as much identity-related things as possible, and not reject any approaches to life extension and resurrection, even if they contradict our intuition about identity, as our understanding of identity could change later.

2.4. Necessary conditions for a technological resurrection:

Technological resurrection has several required conditions:

1. Advanced forms of science will evolve, especially in the form of nanotechnology and AI. Existence of universal superhuman AI seems very helpful for the revival of the dead, but if it turns to be impossible, large volumes of scientific work could be done by human scientists, such as the development of nanotechnology or coding pas simulations. More about these in the next subsection 2.5.
2. These new technologies will not cause a global catastrophe: the same supertechnologies which could help in the revival of the dead could be sources of possible global risks (Bostrom, 2014; Freitas, 2000).
3. Our descendants will have an interest in the resurrection of the dead, and thus resolve all related ethical and legal questions in favor of resurrection. Some utilitarians have suggested that the creation of a new people who are more adapted to life and less prone to suffering will be a greater moral good than the resurrection of the dead.
4. Another source of uncertainty is philosophical, as we still don't fully understand the nature of consciousness and personal identity. If personal identity is very fragile, and is based on continuity of consciousness or some fragile quantum effects—as was suggested by some scientists (Penrose & Gardner, 2002)—when return to life will be only partial. The nature of qualia is currently unsolved (Chalmers, 1996), and here we assume that the same subjective experience will appear if the same computational processes as in the person's brain are recreated, even on a different computational substrate, that is, on a computer.
5. General difficulty of predicting the future blurs our confidence in more technologically advanced resurrection methods, which are also much less explored in existing literature; thus, the discussion about them becomes more vague.

The more technologically advanced methods of resurrection are more likely to work, but the worlds where it could happen are themselves less probable, because of the uncertainties listed above. Thus, cryonics has the biggest chance of working as it is based on the smallest number of assumptions about the nature of the mind and about future technologies; indirect mind uploading (also known as digital immortality or reconstruction based on traces) is the next, and everything else is more hypothetical.

2.5. Expected future technological progress as a basis for resurrection hopes

Technological resurrection will become possible only if significant technological progress occurs. Such progress should happen in the following spheres:

1) *Artificial intelligence.* It is assumed by some that progress in AI will reach a point where AI will be capable of self-improvement, and thus will increase its own power by many orders of magnitude, thus becoming superintelligent (Bostrom, 2014; Yampolskiy, 2014; Yudkowsky 2008), or even if superintelligence is not possible, it is reasonable to expect much larger capabilities to manipulate data in the future, which will fuel technological progress, may be in the form of some AI services (Drexler, 2018) or human uploads (R Hanson, 2016). It was suggested that superintelligent AI will start space exploration, colonizing the solar system and creating computers called *Jupiter brains* (Sandberg, 1999) or *Matrjoshka brains* (Bradbury, 2001) with an estimated power of 10^{50} flops. This type of AI could be called "Kardashev 2 AI", based on the Kardashev scale of extraterrestrial civilizations (Kardashev, 1985), as it will use the energy of the whole Solar system. It was suggested that one of the most obvious strategies for advanced AI is to start space colonization via von Neumann probes, which could be done at speeds close to the speed of light (Armstrong & Sandberg, 2013; Bostrom, 2003; Hanson, 1998). It will probably later become a galactic-size AI, equivalent to a Kardashev 3 civilization, and finally reach the size of the visible universe, at which point it will probably exist until it reaches the *Omega point*, where it will perform an infinite number of calculations. Each Kardashev level of AI means total calculation power growth of at least 20 orders of magnitude: 10 orders because of the growth in size, and 10 orders because of the longer time required for calculation compared to the time of existence of the AI's previous level. Superintelligent AI will also enable progress in the other technologies listed below.

2) *Nanotechnology.* It is assumed that in the future, atom-level precession nanotech will appear and enable body repair, as well as reading of data from human remains and from frozen brains, and creation of exact copies of the objects (Drexler, 1986).

3) *Biology of the human brain.* Obviously, a better understanding of what is actually going on in the human brain is needed, and a combination of nanotech and AI will provide better instruments to look into the brain.

4) *Philosophy of mind.* This is needed to better-understand the nature of personal identity, which will have a large practical impact on the kind of data that should be preserved.

5) *Space-time physics.* New discoveries in the field of space-time physics are not a prerequisite for resurrection technologies, but they can significantly help. They may make time travel possible, reading data from the past, or perhaps travel to parallel worlds. However, this can't be taken for granted, as we can't predict future discoveries of unknown physical laws.

3. Methods of resurrection requiring preparation now

In this section, we will review methods of resurrection for which a living person will need to prepare.

3.1. Cryonics

Cryonics is the practice of preserving the human body after death at cold temperatures until new technologies appear, as cold temperatures are known to slow down chemical processes. At temperatures near that of liquid nitrogen (-196 C) biological tissue could be preserved for millions of years (Merkle, 1992). Human embryos have been successfully preserved for up to 24 years (Barr, 2017), but preservation of the whole body is difficult because of the water-ice problem; freezing damages cell membranes. To prevent this, various technologies of vitrification—the process in which water is cooled without creating crystal structures—are used, which include adding cryoprotectors to the blood vessels of the dead person to prevent ice formation. However, these compounds may be cytotoxic. Thus, contemporary cryonics is close to chemical fixation.

At first it was expected that frozen tissues would be controllably thawed in the future and returned back to life, but now this seems less likely because of the amount of damage they suffer in the freezing process (Rothblatt, 2007). Even so, if NIIC is somehow connected with the "sameness" of atoms, which is highly doubtful, classical cryonics will preserve such an identity.

For resurrection after cryopreservation, an extensive restoration process should be performed on the cryopreserved brain in order to repair all damage. One potential method is the use of nanorobots, which will be able to penetrate the brain and fix damage at a cellular level. Another option is to use the cryopreserved brain only as a source of information about the human mind. In that case, the mind will be scanned and information from it uploaded into a computer. But in that case NIIC supposedly connected with the brain would be lost, which may discourage some people.

There are several possible approaches to informational scanning:

- *Brain slicing* and photography. This approach is already in use now for brain research.
- *Non-invasive tomography.* A frozen brain could be photographed by X-rays from multiple angles, and its internal structure reconstructed by powerful computer algorithms.
- *Use of atomically precise manufacturing* to disassemble the brain slice by slice, and later scan the slices.

Cryonics could greatly benefit if cryothanasia (Minerva & Sandberg, 2017) was legal. Cryothanasia is euthanasia combined with cryopreservation.

Cryonics will need advanced data crunching capabilities, which may be not an agential superintelligence, but could still be regarded as some form of instrumental AI, which is needed to perform brain scans or control repairing nanorobots.

3.2. Chemical fixation, plastination, and slicing

3.2.1. Chemical fixation

As we have seen above, cryonics already uses some type of chemical fixation, and it is expected that the brain will be sliced for scanning in the future. Thus, cryonics becomes only one of several instruments of data preservation. The next logical step is to move directly to chemical fixation (called plastination if polymers are used) and/or brain slicing immediately after death.

The Brain Preservation Foundation recently awarded a prize for "Aldehyde-Stabilized Cryopreservation" (Brain Preservation Foundation, 2018); however, the procedure still requires cryopreservation. The latter formed a startup, *Netcome*, with the aim of preserving brains via a combination of chemical preservation and cooling for a price of 10,000 USD. However, their initial business plan was not clear and they received bad press (Letzter, 2018). Another competitor for the prize suggested a non-cryogenic solution of high quality (Mikula, 2016).

There are several types of chemical fixations, each with their own price, and which cause varying levels of damage to the brain. The simplest and cheapest is soaking the brain in formalin or alcohol. Oregon Cryonics offers this service at a price of $ 1,000, which is much cheaper than the price of cryonics. But the company is very small.

There are two advantages of plastination:

- Legal – A brain is not treated like a body in most jurisdictions, but as a tissue sample. Tissue samples have been donated for scientific research since the 19th century, and thus the plastination of a brain avoids many of the legal difficulties of cryonics.
- Logistical – A plastinated brain could be preserved for a long time without any human attention, as constant addition of liquid nitrogen is not needed. In addition, there is no risk of additional damage due to cold cracks, liquid oxygen accumulation, or crystal formation. The brain could be preserved in a home or buried in a time capsule. Cryogenic vessels are potentially more dangerous and should not be kept in homes.

In addition, simple chemical fixation is cheaper and more accepted by society and, therefore, has better legal protection: there are about 100 repositories of brain samples where people donate their brains for research. A lot of human brains were chemically preserved for scientific research from the 19th century onwards, typically using formalin. Unfortunately, these types of chemicals seem to damage the brain's structures such as the connectome and synapses. Full body perfusion with fixatives requires advanced professionals and equipment and may also take a longer time; thus, it can't be done for everybody, especially in the case of unexpected death. But brain removal and placement in a fixing solution could be done in almost every morgue with the price of ingredients starting from only a few dollars.

3.2.2. Preservation of the brain slices

Lenin's brain was sliced after his death for future study and in hope of future resurrection. The resulting 34 000 slices are (probably) still preserved in the Brain Institute in Moscow, inside what was the "Brain Pantheon" of Soviet leaders (Neumeyer, 2014).

Slicing is damaging to the brain, but it also helps quickly deliver fixatives to the cells without the use of the patient's circulation system. Currently, slices of brain tissues 1 mm thick could be successfully preserved via diffusion of fixative chemicals (Gwern, 2017).

Thus, by combining slicing and cheap chemical fixation, brain tissue preservation that is cheaper and better than chemical fixation without slicing could be achieved. Very thin diamond knifes are needed, or brain-penetrating needles.

3.3. Digital immortality based on indirect mind uploading via traces

"Digital immortality" has two meanings. One is *direct mind uploading*, which would require a computer connection to the brain of a living person, and is not a resurrection technology *per se*. Another is *indirect mind uploading* (Almond, 2003), or reconstruction of the personality based on her informational footprint in life (Rothblatt, 2012).

For such a reconstruction to become possible, powerful AI will be needed. Constant growth of information technologies gives us the opportunity to cheaply record a lot of personal data, including constant audio and video, and all of our behavior in the internet. But this is only passive recording.

DI also includes the idea of active recording, which is the conscious act of self-description similar to the *Confessions* by Rousseau (1782). It also includes running tests on oneself, recording memories, the practice of active imagination during EEG sessions, dream recordings, etc. (Volpicelli, 2016). A protocol for digital immortality could consist of passive constant recording and active self-description.

Regardless of the exact protocol, collecting all of these data could easily require tens of terabytes of storage, and one also needs to preserve it for the long term. There are several methods for such preservation, including the Internet Archive; undergrounds vaults with eternal disks, like M-disks; and preservation on the Moon, as will soon be provided by organizations like Arch Mission.

There is a separate question about how future AI will reconstruct personality based on this data: one approach is to predict future behavior based on behavior data, just as GPT-3 predicts the continuation of any text, and the other is to fully simulate the life history of a person.

3.4. Sideloading: calibrating a computer self-model while a person is still alive

The idea of "sideloading" is that the model of the brain is created while the modeled brain is still alive and the interaction used to calibrate the model's behavior. The model

is started from some blank human mind model, which is then calibrated to mimic the original. This concept was first explored in the novel *Zendegi* (Egan, 2011). Sideloading is currently impossible, but it may become possible in a few years when chat bots and robotic brains advance further. Some have already tried to sideload their dying parents via chatbots (Alestig, 2018).

We could also introduce the idea of "reverse sideloading" where a human biological clone of a person is programmed to have the same mind as the original person. It could be done via education or perhaps nanoprobes, which translate information from a computer to the biological body—that is why we call it "reverse".

3.5. Restoration from the digital back-up and "evacuation" of consciousness at the moment of death

We don't yet know how to directly create a digital backup of the human mind, but one idea to reach direct uploading is gradual growth of neural implants based on nanotechnology (Urban, 2017), or of genetically modified neurons. If nanorobots—which could gradually replace neurons of the brains, or connect to them to read their state—were created, they could survive biological death and "evacuate" consciousness from the brain, by sending data about last states of mind to the outside computer.

3.6. Live preservation of small pieces of brain tissue

There have been suggestions that the claustrum (Reardon, 2017), hypothalamus, or even a single neuron is the neural correlate of consciousness (Argonov, 2012). If only a small part of the brain is responsible for consciousness, then only that part should be preserved. A small piece of the brain tissue could be extracted from the dead brain and be preserved alive by implantation into other organism or by feeding it a liquid solution. Such a preserved part will carry only a small portion of a person's memories, but the whole personal identity. Thus, NIIC consisting of physical continuity of consciousness will be preserved.

Probably not only consciousness-related parts of the brain, but also parts which carry biographical and other types memory should be preserved. As the full mechanisms of memory are not currently known, we could only speculate that some parts of brain, like the hypothalamus, may have larger "memory content."

HeLa cell lines continue to be alive for more than 70 years, but it is unlikely that it will be possible to preserve even a small piece the brain tissue alive for so long. Smaller pieces of tissue could potentially be successfully cryopreserved in the same way human embryos are; such small objects can be frozen so quickly that no ice crystals form.

There are no known experiments that have succeeded at keeping parts of the human brain alive after the death of the rest of the body. The brain of a guinea pig was preserved alive for several days perfused with oxygenated fluid (Mühlethaler, Curtis, Walton, & Llinas, 1993). Separate rat cortical neurons have survived *in vitro* for 15 days (Ruardij, Goedbloed, & Rutten, 2003).

4. Reconstruction by superintelligent AI

4.1. AI is necessary for resurrection

AI is the key to almost all methods of resurrection, but each level of AI will provide its own instruments for resurrection. The importance of AI to the process also means that almost all resurrection technologies lead to the same end point: uploading into a computer.

However, this may not be the last step, as information about a mind may be "downloaded" into a new biological body via advanced nanotech or biotech. Thus, if biological neurons are required for experiencing qualia, they could be recreated and calibrated in the almost the same way as they were in the original mind. A resurrected person will have conscious experiences; whether she would have the same NIIC is not clear, but it seems likely that there will be ways to ensure it.

4.2. Kardashev 1 level of global AI: resurrection of cryopatients and uploading of plastinated brains

As soon as the first superintelligent AI appears which will likely coincide with the creation of advanced nanotechnology (Yudkowsky 2008), it will be able to return cryopatients to life, as well as scan and upload plastinated brains. But this AI's power may not be enough for proper digital immortal reconstruction as its implementation would require many computations, and modeling of the past. This stage will be relatively short and may take only a few years. Bostrom suggested that such superintelligent AI could become a singleton, capable of controlling the whole Earth and thus its capabilities will be equal to a Kardashev 1 level civilization (Kardashev, 1985).

4.3. Kardashev 2 level AI: Jupiterian brains powered by Dyson spheres—digital immortality resurrections via simulation

After an AI starts space travelling, it will quickly grow toward the Kardashev 2 level, that is stellar civilization. The AI will explore the solar system, and could start to build "small" astro-engineering objects (Bradbury, 2001), which it could use for much more powerful computing. It will probably also start to send von Neumann probes to other stars and even other galaxies (Armstrong & Sandberg, 2013). The AI should quickly start "archeology" on Earth, as much of the remaining information will be decaying and should be collected as soon as possible.

At this level, AI uses a large part of the energy of the Sun (probably collected by a Dyson sphere) to power enormous calculation engines. One hypothetical example is a so-called Jupiterian brain: a whole planet converted into a computer via some form of nanotechnology (Sandberg, 1999) or Matrioshka brain, which is a Dyson sphere using the whole star energy for computations (Bradbury, 2001). However, construction of a Dyson sphere in the solar system should not affect the Earth, as it will be a place where data about most people who have lived is preserved.

On this level, reconstruction of most individuals who properly collected digital immortality information becomes possible. However, only a few people currently collect

data for digital immortality in the most effective way. As a result, AI will only be able to resurrect those who lived just prior to its creation and "enjoyed" ubiquitous surveillance and a large Internet footprint.

For the resurrection of the dead, such Kardashev 2 AI could use "*resurrection-simulation*": a simulation of the whole history of humankind based on all available traces, which uses these data as reference points to calibrate the simulation. It could deliver a good result for people who lived recently, including those who died in the 21st century, but as uncertainty about the past grows exponentially due to data decay and the absence of "big data" in the past, there will be a point in time before which such a resurrection simulation will be insufficient.

The main idea of a resurrection-simulation is that if one takes the DNA of a past person and subjects it to the same developmental conditions, as well as correcting the development based on some known outcomes, it is possible to create a model of a past person which is very close to the original. DNA samples of most people who lived in the past centuries could be extracted via global archeology.

4.4. Kardashev 3 level or galactic-scale AI: acausal deals with a parallel world for resurrection of partly-preserved people

The use of von Neumann probes (self-replicating robotic starships) will allow future AI to colonize the Milky Way galaxy in about 100,000 to 1 million years, depending on the speed of the probes (Armstrong & Sandberg, 2013). The galaxy has around 100 billion stars, whose energy could be used for calculations by creating enormous galaxy-sized populations of Dyson spheres (Zackrisson, Calissendorff, Asadi, & Nyholm, 2015). This will provide colossal, but not infinite amounts of computation power, which could be used to reconstruct the past in the ways which will be described below.

4.4.1. Resurrection via quantum random generator

Almond suggested the following idea about resurrection of all people who ever lived: the use of a quantum random generator, which creates a random mind within a computer (Almond, 2006). If the many-worlds interpretation of quantum mechanics is true, all possible minds will appear in separate timelines starting from the moment of random mind creation, which will mean resurrection of everyone from his own point of view. However, this approach will not help an outside observer, who wants to resurrect a relative, for instance, as the observer would see only a random mind. This could be called *immortality-for-self* (more on this below). This approach is computationally simple as it requires just one mind simulation.

4.4.2. Resurrection based on the expectations of peers

On the other side, it is possible to use the expectations of relatives as the only resurrection criteria. Any mind which complies with the expectations would suffice. This could be called *immortality-for-others*.

Immortality-for-self and *immortality-for-others* could be reached via separate technological procedures, both of which are much simpler then solving the problem of the full resurrection. Resurrection based on expectations is also rather computationally simple, as most expectations are simple descriptions of behavior, and something like generative-adversarial neural networks could be trained to satisfy a formalized set of expectations. There is also no problem of loss of information about the person, because if some of the expectations are lost, that means the task of resurrection is simplified.

Reconstruction based on expectations raises the ethical question of identity. For example, a parent would like to see *exactly* her child, but would not accept a child who simply looks exactly like hers. This problem will be addressed and partially solved in the next section.

4.4.3. Resurrection based on combining expectations, random noise, and acausal trade with parallel worlds

This section is more speculative, as it assumes the existence of some form of multiverse, where everything possible exists, thus individual civilizations could "trade" with each other by cross-resurrecting each other's dead. Such a multiverse may not be based on the many worlds interpretation of quantum mechanics (Deutsch, 2002), which itself is questionable, but on some other multiverse theories, or on an infinite universe, which may be based on cosmological inflation (Knobe, Olum, & Vilenkin, 2006; Tegmark, 2009).

The ideal method of resurrection would be a combination of the methods listed above: quantum randomness resurrection and resurrection based on expectations—in a way which does not increase the computational complexity of either task.

The idea is that future AI could use all sets of expectations and other available data to recreate the known portions of a personality and then use random quantum noise to fill in unknown portions.

Surprisingly, any personality created by the combination described above will be the resurrection of some personality that has existed, even if it didn't exist in our world! Any random person will be a resurrection of an actual person who lived in a parallel world. Such parallel worlds should exist, if we accept the many-worlds interpretation of quantum mechanics.

As a result, the so called "measure" of personal existence (which is a share of all possible worlds where one exists), will not decline after resurrection using quantum randomness. For example, we know that someone's name was John S—. His last name was either Smith or Simpson. We create a model of John S— and use a quantum generator to choose between either Smith or Simpson. In half of all future worlds we will get Smith, and in the other half we'll get Simpson. If the actual name was Smith, this means that the "measure" of Smith declines by half.

Some scientists think that the decline in measure should be counted as a lower level of existence, so the resurrection was not full (Mallah, 2009). In any real case of many random parameters relating to personality, it appears that the measure will decline by many orders of magnitude, because of the combinatorial explosion of possible

combinations of parameters. While the question of the “measure decline problem” for resurrection is debatable, it seems that it would be better if measure does not decline.

However, if we look closely on the setup of the experiment, we could find that there is no decline of measure. If we look at a broader picture of the multiverse, there is another possible world, where John S— was named Simpson, and this is the only difference. In that world, another AI will try to recreate John S—, also by using a quantum random generator to decide his full name, which will give “Simpson” only half of the time. However, if we combine both worlds, at the beginning we have one “Smith world” and one “Simpson world”, and at the end we have four worlds: two with a half measure of Simpson, and two with a half measure of Smith. Thus, the total measures of Smith and Simpson will not change.

While these worlds can’t communicate, they could know about each others’ existence through consideration of the general multiverse model, and use it for a type of cooperation called an “acausal deal”.

In other words, if an AI creates just one random quantum generator to model a human mind, it may expect that an astronomically large number of such generators are also created in other worlds. Even if the many-worlds interpretation (MWI) of quantum mechanics is not true, there are other ways in which the universe could be infinite and include many parallel worlds that would justify the use of randomness to fill gaps in the resurrected mind without fear that the original will never be resurrected.

The suggested combination of expectation and randomness is a computationally simple resurrection method. But to resurrect everyone, it must be applied many times, but the resulting people will be "from different worlds". Therefore, you need to model the entire past history.

4.5. Kardashev 4 and 5 level superintelligence: omega point

The Kardashev 4 level involves control of the entire visible Universe (10^{10} galaxies), and Kardashev 5 AI is assumed to be capable of acting on the scale of the multiverse. This definition of the multiverse could include the 10^{500} possible worlds of the string landscape, plus eternal inflation conditions near the Big Bang, plus Everett’s full multiverse (Tegmark, 2009). A Kardashev 6 level has also been suggested, which would exist outside space-time and be able create universes. It would be generally undistinguishable from God (Sicoe, 2014). Surely, there could be even higher levels which we can’t imagine based on our current knowledge, especially if the “mathematical universe” hypothesis (Tegmark, 2014) of world origin is true, or if multilevel nested simulations are possible (Torres, 2014).

It is currently unknown whether it is possible to escape the end of the observable universe (heat death or Big Rip), and even the way it will end is unknown, but there are many ideas about how such an escape could be possible (Dvorsky, 2015). If there is no escape, future AI will be limited to the observed universe, where it could still have astronomically large computations in the scenario of a heat death (Armstrong & Sandberg, 2013).

If the Universe ends with Big Crunch, that is a gravitational collapse—opposite to the Big Bang—it could still be used for practically infinite numbers of computations as was suggested by Tipler in his book "Physics of immortality" (Tipler, 1997). On this level, resurrection becomes possible even without much data about humanity, as very advanced AI, called "Omega" by Tipler, could utilize the energy of a collapsing universe for computations. Omega will run all possible past simulations of all human (and not-necessary human) histories. Tipler shows that the upper boundaries of all possible humans is 10^{10E70}. This is a very large number, and the computational power of one visible universe is not enough to reach it.

5. New world models

Approaches to resurrection depend on the world model. When people believed in animalistic spirits, they thought the dead would also turn into such spirits. When people believed in an omnipotent God, they expected it to create a special, separate world for souls to live in after death.

The possible types of resurrection listed above are based on an understanding of the world based on physics and biology at the start of the 21st century. They do not require any new fundamental discoveries about space, time, and consciousness, which may or may not be made in the future. While we can't count on future discoveries, we also can't exclude them; history has shown that many dramatic changes of the world model are possible.

5.1. New physical discoveries which may help humanity find new resurrection methods

5.1.1. Time travel: sending a nanorobot into the remote past to collect all data.

If there is, at some point, technology that allows travel back to the past, then our future descendants will be able to directly save people dying in the past by collecting their brains at the moment of death and replacing them with replicas. However, most currently existing ideas of time travel require some high-energy exotic matter, like wormholes the size of a large black hole, which would destroy everything around it. But if such time-travel is possible, a nanorobot could be sent back several billion years, where it could secretly replicate and sow nanotech within all living beings without affecting the course of history. At the moment of death, such nanorobots could be activated to collect the data about the brain and preserve it somewhere until its future resurrection; thus, there would be no need for forward time travel.

Sending just one nanorobot to the past seems to be a much more plausible idea if time travel becomes possible. Even if it requires some exotic matter, like supermassive black holes or the Big Bang itself, this would not be a problem, as such events have happened in the past, and a nanorobot from the past could replicate and then travel to the Earth via von Neumann probes.

However, a more serious problem is damage to the causal consistency of the time line, known as the "butterfly effect", and its extension, the "grandfather-killing paradox"

(Lewis, 1976). Even if a nanorobot tries to minimize its effects on the course of history, such effects will inevitably occur, and neither human civilization nor future AI might appear—or at least it might be completely different, and thus the point of collecting information about the past would vanish.

However, a trick similar to one described above (Section 4.4.3) could be implemented: acausal trade between parallel worlds. Humanity could send its nanorobot back in time, but collect information from nanorobots which were sent to the past by other civilizations in a parallel time line. Here the small changes in the past would play the role of a random quantum generator. Each nanorobot may be equipped with a program that tells it not to provide its information until the receiver civilization agrees that it will send its own nanorobot back, thus ensuring cooperation in this analogue of the prisoner's dilemma.

Another way to avoid timeline change is the idea that the loops in the timeline could form a strange attractor. From an observer's point of view, this would look like a stable timeline, unaffected by the butterfly effect. Loops in which there is no future effect that prevents the probe from being sent back—i.e., in which there is no grandfather-killing paradox—will become infinitely thicker than unstable loops. In other words, the measure of the loops in which time travel can't affect the future in a way that prevents the time probe from being sent back will be much higher.

The only thing we need from the past is information (plus NIIC, if any exists), and sending a nanorobot to the past is a method intended for information collection. However, it could potentially preserve some forms of NIIC, for example, if it preserves continuity of consciousness by secretly and continually uploading human minds just before death. If NIIC is the quantum state of a single neuron, it could also be preserved in some "quantum computer".

5.1.2. Reading information from the past

The ideal solution would involve receiving only information about the mind (and NIIC) from the past without sending any probes to the past; this seems less contradictory to the known laws of physics.

One idea which has been suggested for retrieving information from the past is so-called "quantum archeology." The idea is that some of the properties of quantum mechanics (QM) could be used to read data from the past. One such idea is based on "retrocausality" (Price, 2008), which is a timeless interpretation of quantum mechanics, where various non-locality paradoxes are explained by the supposed ability of quantum particles communicating backwards in time. However, the current understanding of QM doesn't allow the sending of any meaningful data via quantum teleportation, which only synchronizes random effects, like the spin of two particles in separate locations. Nevertheless, some clever experiments like non-explosive bomb testing (Elitzur & Vaidman, 1993)—not exactly this approach, but a similar one—may help us to read the data of the past.

5.1.3. Observation of the Earth from a remote distance

As the speed of light is finite and the universe is mostly empty, a hypothetical large telescope could be able to observe past events on Earth. However, to get to where the human past would be visible, superluminal travel and advanced astro-engineering would be necessary. Maybe some blackholes could be used as "mirrors", as some photons could travel around them.

5.1.4. New informational traces

Even reading information from the past is not needed if a new type of information trace is found.

Science constantly finds new ways to extract data about the past, like DNA from bones and the isotopic composition of hair samples which reveals what a person ate (Ungar & Sponheimer, 2011). Such traces may include subtle chemical changes, effects on atomic location inside solid objects in our surroundings, DNA and its epigenetic changes, as well as changes in unknown or hypothetical types of particles, like dark matter.

5.1.5. Parallel worlds in which the person is still alive

If the many-worlds interpretation of quantum mechanics is true (Deutsch, 2002; Higgo, 1998), then a person who died in our world didn't die in the same way in some other branch of the multiverse and could be still alive there. If it is impossible to go back in time, it may still be possible to communicate with other branches of the multiverse that have the same "timestamp" as ours and branched recently. We will not speculate here about how such communication could happen; it seems likely that it is not completely forbidden, as shown in experiments like bomb fuse testing (Elitzur & Vaidman, 1993), but that it differs extremely after branches become decoherent. Some theories explain quantum mechanics through such interactions (Hall, Deckert, & Wiseman, 2014).

Surely, it would be morally bad to "steal" a person from another branch where she is alive and happy. However, communicating with another branch may help to extract information about the personality which is not available in our branch, and may be possible via a communication method such as an "interdimensional telephone". However, it seems that this resurrection approach could be used for only a short time after a person's death, as people tend to die of aging, and the person of interest would soon be dead in almost all parallel timelines, probably before technology that can enable travel to other timelines could appear. But at least in one timeline she could be cryopreserved, maybe after some improbable chain of events, like falling through ice; this information could be used for her reconstruction in all timelines that are able to communicate with the information-preserving timeline.

5.1.6. Computing the past: No information is lost in the universe

On basic physical level, no information is ever lost in the universe: even black holes can't destroy it. It was suggested that future Omega could compute back what has

happened in the past and such act of computation, despite its reverse arrow of time will look like normal world from the inside.

5.2. Simulation

According to Bostrom, if future superintelligence is possible, we are likely to already be living in a computer simulation (Bostrom, 2003). If we live in a simulation, it runs on an enormous computer, which most likely has records of everything interesting which has happened in the simulation. If the ways to access such data could be found, the data could be extracted and used for resurrections—either by us, or by the owners of the simulation.

Maybe we are already located in the resurrection-simulation discussed above, whose only purpose is to relive past history and recreate all of the dead more or less accurately.

It is also possible that simulation is something akin a computer game for the beings living in the future civilization, and after the "death" here, they remember who they actually are and either return to their "world" or play a new game. If we are in a simulation, it is also likely that we are in a multilevel nested simulation (Torres, 2014). Data about all previous levels is probably stored at each level of such a simulation; thus, human personal data survives on many levels and could be restored in at least one of them.

5.3. Aliens

If extraterrestrial intelligence exists, either on other planets or in other dimensions, it or they could collect data about the Earth and even save people from death, if they are secretly present in the solar system. This is called the "Zoo hypothesis" (Ball, 1973). If aliens collect such data, they could provide us access to it after we contact them and thus help us to resurrect our dead. More about alien superintelligence can be found in Section 6.3.

6. Use of quantum immortality

6.1. Nature of quantum immortality

The main idea of quantum immortality (QI) is that our world is constantly splitting, according to Everett's MWI, and thus in a choice between life and death, there will be always at least one timeline in which I will not die (Almond, 2008b; Higgo, 1998). The idea is controversial, first, because it is not known if MWI is true, and second, many argue that surviving in a small probability timeline can't be counted as true immortality for two main reasons: firstly, the "measure" of existence will decay quickly, and thus from a decision theory point of view such timelines should be ignored, and secondly, even if one survives, such survival will be "bad" as it will be in a maximally damaged state of consciousness (Aranyosi, 2012). All of these objections are questionable for the reasons previously explored by Turchin (2018b).

For example, despite being called "quantum immortality", the idea doesn't require any quantum effects, only the fact that the universe is infinitely large. This could be true in different ways (Tegmark, 2009). In an infinitely large universe there will be always copies of me in other supercivilizations which experiment with resurrection, so they will resurrect some being identical to me.

The existence of QI helps survival, but it is not resurrection. In this section, we will explore ideas relating to the use of QI as a method for amplification of other resurrection technologies. Resurrection using quantum generation of random minds, as discussed above, takes advantage of QI.

6.2. QI improves chances of cryonics

QI significantly increases the chances of successful resurrection via cryonics. If QI is true, the biggest share of timelines where I survive until 2100 include cryopreservation (Randall, 2004). For example, if, in the normal world, cryopreservation's chances are 0.1 per cent, and my chances to live until the year 2100 naturally is 1 in a million (here we exclude the effects of new life extension technologies and only look at the current human life expectancy distribution), it means that I have a 1000 times greater chance to survive to 2100 because of cryonics compared with my personal longevity.

Because of QI, the success probability of cryopreservation grows to 50 percent (our estimation that QI will work), in other words, 500 times. No matter how small the chances of the success of cryonics, QI increases them to the level of its own probability of success. In the case of QI, if you sign up for cryonics the multiverse will do the rest. Signing up for cryonics replaces the default outcome of the "bad immortality" of infinitely long aging, with a good "resurrection" outcome. However, if you want to ensure that your friends also survive, you will still need to invest in the quality and probability of the global success of cryotechnologies.

6.3. QI increases the chance that benevolent superintelligence will appear and invest in resurrection

The same way in which QI increases the chances of success with cryonics, it also increases the chances that there will be a timeline in which humanity will not go extinct, and, further, that humanity will create a benevolent superintelligence interested in the resurrection of the dead.

Not everybody agrees that benevolent superintelligence should resurrect the dead; for example, because it may create more "pure good" by creating happy people *de novo*—but we are interested in timelines in which AI has a subgoal to resurrect the dead.

Also, non-human superintelligence created by aliens in a causally disconnected part of the universe may create many different simulations of possible civilizations and randomly create one very similar to our civilization and thus "resurrect" people who lived on Earth. Given the infinite size of the universe, there will be infinitely many superintelligences, each creating many random past simulations of possible planets. Thus, it is likely that our planet and any particular person will be simulated, and moreover,

that there simulated the event of a particular person's resurrection after death will occur. This, however, requires a two-level simulation: super-superintelligence to simulate a superintelligence which resurrects the dead.

6.4. Universal problem solver based on the quantum immortality

There is also a controversial idea, which we do not endorse or recommend, that a quantum suicide experiment may be used to create something akin to a universal problem solver (Almond, 2008a). Imagine a machine which creates measure condition A, and if condition A is not met, it kills me: I will survive only in worlds where condition A is met. If we use A as a condition for person X's resurrection, then the observer will find himself only in the world in which person X is alive. This could obviously can go wrong in many ways, as the condition may be very improbable. In addition, if many people use this idea, the world would soon be empty.

A way to escape some of the difficulties of this "universal problem solver" was suggested by Yudkowsky in "Anthropic trilemma" (Yudkowsky, 2009). In this thought experiment, a large number of copies of an already uploaded mind is created, and all copies then play something like the quantum suicide experiment. At the end, even in worlds where the result of the game was negative, one copy remains. As a result, the subjective probabilities of the experimenter are skewed in the direction of the desired outcome, but for the outside viewer there is no loss of life.

6.5. Eternal return

According to Nietzsche, everything will happen again, if you wait for eternity (Nietzsche, 1883). According to Tipler, this effect is unlikely, based on the quantum cosmology of the 20th century (Tipler, 1980), but if universe is cyclic or if we account for the existence of other universes, "eternal return" (everyone who lived before will live again absolutely the same life) could theoretically occur, though it collapses into something like quantum immortality if we account for possible variation during each "run" of a human life. It might still be reasonable to consider this a form of resurrection, though.

Also, if one exists for an infinitely long period, one will encounter any possible other beings, including those, which are arbitrarily similar to the dead person. For example, if I exist for billion years, I could meet a person with exactly the same name and appearance as the one I loved, and this will be like eternal return from the outsider point of view.

7. Partial resurrection

7.1. "Resurrectors" and their goals

Partial resurrection is resurrection of only some aspects of a person. Resurrection is not its final goal *per se*; partial resurrection will happen according the goals of some perpetrator. This perpetrator is resurrecting the dead for some purpose, and that purpose

will affect the way in which resurrection is performed. There could be several "resurrection agents" or "resurrectors", of which we list the most prominent types:

1) *Friendly superintelligence* which seeks complete resurrection of everybody based on its understanding of "good."
2) *Future AI* resurrecting people from the past instrumentally, for example, to have a perfect simulation of its past.
3) *Relatives* who want their loved ones back. Such relatives may include parents, children, and lovers. They could have different levels of egocentrism connected with their desire for resurrection. Some relatives just want good for their loved ones, while others may want a person back as soon as possible because they want to communicate with that person and suffer personally without this type of communication. Probably most "lovers" will be this type of agent, and they may choose quicker but partial resurrection, as they are seeking to fill the hole in their own perception.
4) *The person himself,* when the person being resurrected is a stakeholder in his own resurrection, he is likely to be most interested in identity and less interested in exact traits, excluding those that are very valuable according to his own judgement. While he can't act as a resurrector, he could specify conditions for his future resurrection.

7.2. Information without identity

An egoistic resurrector may be more interested in the behavior of the deceased person than in her "true identity". The resurrector may use his own expectations as resurrection criteria, as discussed above in the section 4.4.2. In extreme cases, this may not be resurrection, but just a search for another person who could fill the gap. For example, a man could search a new girlfriend who he feels is similar to a previous one, but better.

7.3. Partial preservation of the information

There are several distinctive cases of partial informational resurrection, which are discussed in Section 8, as they are often a case of transformative resurrection:

- Reconstruction based on the expectations of the relatives.
- Reconstruction based on expected social function.
- Reconstruction of behavior but not internal states (e.g. chat-bots).
- Reconstruction with element randomness.

7.4. Identity without information

If anything like reincarnation is possible, it is an example of preserving identity without preserving information. A reincarnated person would be presumed to be the "same" even if there are no informational traces of his past life. Another example of

identity preservation without information would be a person with total amnesia who learns new things.

Identity could be theoretically preserved without information. For example, if a piece of brain tissue were extracted from a dying brain and kept alive, later growing into a new brain, it could be regarded as the same brain with continuity of electrical processes, despite the fact that it would have lost most of its memories.

8. Transformative resurrection

8.1. The main paradox of resurrection

The main paradox of resurrection is that, at first, we must collect many small pieces of data in order to create "the same" person, but as soon as we succeed we should immediately start to improve this person so she can adapt to her new life in the new world. As a result, most of the person's traits will be useless or even harmful. It seems that we could simplify the resurrection task if we resurrect a person who is already in an improved state.

8.2. Clones

The most obvious idea of the transformative resurrection is human cloning. Obviously, clones do not preserve identity and do not preserve personal memories, but they do preserve many important personal traits from the point of view of an outside observer. Moreover, clones could be adapted to the new surroundings of the future in the most natural way: by education.

In Houellebecq's novel "The possibility of an island", another option which combines cloning and digital immortality in the form of self-description is explored (Houellebecq, 2007). After a person's death, a clone of that person is created and educated based on the something like an autobiography of his original; the clone thus continues his line of thought. This approach to resurrection seems unlikely, as it assumes a technologically advanced and very stable society that lacks powerful AI.

A clone inside a very fine-tuned environment, almost a simulation of the past, could produce a human being very similar to the dead one. However, it seems to be ethically questionable to imprison a person in such an environment, similar to that shown in the movie "The Truman Show" (Weir, 1998).

Raising a clone in the same culture and speaking the same language but not isolated from the environment seems to be more ethical approach to this particular type of resurrection. Surely, a cloned person could be also cured from some diseases or could know the typical mistakes made by his progenitor as well as potential pitfalls from the past life. It would be example of even higher transformation but less preservation of the same "identity".

The existence of clones as twins is accepted as normal by society, but not considered anything close to resurrection, despite the fact that due to embryo freezing some genetic

twins could be of different ages (Telegraph, 2012), and even another one could be born after death of the first one.

8.3. Postmortem transformation into some other form

Another method of transformative resurrection is transformation into something which is not a person at all. Such transformation is mostly reasonable for immortality-for-others, but it could be relatively cheap and effective, and many forms already exist:

- Collecting and analyzing the person's works in ways that are useful for other people: collected writings, catalogue-raisonne, biography, biopic movie.
- One person simulating the other person: theatre, transformation during games, cosplay, psychotherapy techniques, e.g. the dialogue of voices (Stone & Stone, 2011).
- Life inside the memory of another person: in dreams, in fantasies; in a more advanced case, one could even share his brain's calculating power with a "subpersonality" modeled based on memories of the dead person.
- Symbolic transformation: transformation into qualia, mood, image, drawing; something simple and stable. Interestingly, if a person concentrates all his attention at the moment of death in one simple object, then the image of this object may work as a bridge for the continuity of identity, if identity is defined through the continuity of the mental states. It may sound esoteric, but it follows from the definition of identity as continuity, which is likely false.

8.4. Partial resurrection with social transformation

Social transformation is transformation of personality into some human organization which is not a human mind, but which could have goals, behavior, and values.

- *Foundation*s. Organizations that continue the projects of a person after he dies. There are several examples of successful foundations in the names of deceased artists, which own their collections, organize exhibitions of their work, and research their art. One example of a successful artist's foundation is Henry Moore's Foundation (Little, 2016). A good foundation can continue to work according to the dead person's will, promote his values, work on the catalogue of his art work and eventually participate in his resurrection. However, foundations are expensive and legally complex.
- *Museums*. Museums are buildings that house personal belongings, an archive, and could works as a research institute. Many famous people have founded personal museums, often in their own houses.
- *Chat-bots*. In the Apple app store, one can download "Roman Mazurenko", a memorial app based on the logs of an entrepreneur of that name who died in 2015 (Newton, 2015). Currently, such chat-bots mostly produce nonsense and may have only symbolic meaning.

- *Children*. Children often are claimed as some form of immortality. But not everybody would agree that he is the immortality of his parents, not to mention grandparents.
- *Family*. Some form of immortality can be achieved by identification with some large entity, most likely a family, company, or nation-state. Family can carry on traditions and have similar personal traits or even roles (Hellinger, 2001).
- *Monuments*. Creating dedicated personalized objects is an attempt to increase social memory about a person. Street statues subconsciously affect people; society does not forget a person who is still present in their surroundings.
- *Temples*. Most Christian temples are built around the relics of some saint and such reliquaries are dedicated to his name. A temple is the symbolic postmortem home of the person.
- *Legacy*. A person's legacy consists of other people's memories; it is often said that the dead will "live in our memories". However, memories are fragile and will die off in a few decades as their carriers also die. Such personal memories can potentially be transformed into institutionalized social memory or myth.
- *Relics*. Preservation of the cell line and body parts or a mummy. The Christian tradition of burial of whole skeletons is based on the belief that the actual body will be resurrected after Judgment Day. A skeleton could provide a lot of information for future reconstruction, including DNA, habits, and travel history.
- *Values*. The embodiment of values and ideas. Some people completely identify with their set of values, most likely connected with the ideology of some large project. If such a project continues, it is the most important form of immortality for them. This practice is institutionalized by giving the person's name to the institutions with which he was connected, or which represents his values, like research labs and battle ships.
- *Name* as symbolic reincarnation. There is a tradition in some countries to give children the names of dead relatives.

9. Transcendental resurrection

Here we list some ideas about resurrection which come from the religious philosophy, and which imply some ontological change in the status of the person, which in many cases can't be described in human language:

- Physical resurrection according to God's will
- Confluence with God
- Reincarnation
- Afterlife
- Transcendence

10 From resurrection to immortality

10.1. Resurrection timing

All other things being equal, it is better to be resurrected soon after death. The world will not have changed much, and the resurrected individual will be able to preserve his-her social connections and will have more opportunities to participate in future events. However, later resurrection may happen via more powerful AI and thus be of better quality.

10.2. Resurrection accuracy

NIIC implies that the new person is either "completely me" or "completely not-me", that is, only a binary type of relationship in identity. However, informational identity is more flexible, and there could be varying levels of accuracy in the resulting reconstruction of a person. It is tempting to say that less accurate reconstructions will dominate, but this is not necessarily so in a universe dominated by very powerful AIs and in an infinite universe where all possible reconstructions will appear.

10.3. Repeated resurrection means practical immortality

If a person could be repeatedly resurrected, it would mean she had a practical immortality. Such resurrections could be of two types: the person being repeatedly resurrected as a continuation of her first "interval of life", or such intervals could follow one another, so she would be resurrected based on the last "backup point". The second variant is more like real immortality, as in that case the person's memory will continue and increase with each resurrection.

In reality, future resurrection could have separate forms simultaneously, which interact with each other. For example, the ancient Parthenon is currently "resurrected" at least three times simultaneously: as an actual renovated building, as its copy in the National Greek Museum, and as original sculptures in the British Museum.

Conclusion

We have found that there are many differing ideas about technological resurrection. Some are practical and will not require much new scientific knowledge to implement, while others are more hypothetical. The sheer number of paths to resurrection means that at least one of them may work, and resurrection becomes possible.

However, humanity must survive multiple global catastrophic risks and create a friendly AI in order to make resurrection possible. If humanity has no future, there will either be no resurrection, or only resurrection by a hostile entity, like evil AI with a random goal (s-risk), or by curious aliens.

A person could take some practical steps now to increase the probability of his-her resurrection: sign a cryocontract, start to collect data for digital immortality as described in (Turchin, 2018) or at least express a desire to be resurrected in the future in the written form, hoping that future advanced AI will take such a desire into consideration.

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