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An Overview of Mind Uploading

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Abstract: *Mind uploading is an ongoing area of active research, bringing together ideas from neuroscience, computer science, engineering, and philosophy. Realistically, mind uploading likely lies many decades in the future, but the short-term offers the possibility of advanced neural prostheses that may benefit us. Mind uploading is the conceptual futuristic technology of transferring human minds tocomputer hardware using whole-brain emulation process. In this research work, we have discuss the brief review of the technological prospectsfor mind uploading, a range of philosophical and ethical aspects of the technology. We have also summarizes various issues for mind uploading. There are many technologies are working on these issues will be summarize. These include questions about whether uploads will have consciousness and whether uploading willpreserve personal identity, as well as what impact on society a working uploading technology is likelyto have and whether these impacts are desirable. The issue of whether we ought to move forwardstowards uploading technology remains as unclear as ever.*

Keywords: *Mind Uploading, Whole brain simulation,*

I. Introduction

Mind uploading is an ongoing area of active research, bringing together ideas from neuroscience, computer science, engineering, and philosophy.

Realistically, mind uploading likely lies many decades in the future, but the short-term offers the possibility of advanced neural prostheses that may benefit us.

Mind uploading is a popular term for a process by which the mind, a collection of memories, personality, and attributes of a specific individual, is transferred from its original biological brain to an artificial computational substrate. Alternative terms for mind uploading have appeared in fiction and non-fiction, such as mind transfer, mind downloading, off-loading, side-loading, and several others. They all refer to the same general concept of "transferring" the mind to a different substrate.

Once it is possible to move a mind from one substrate to another, it is then called a substrate-independent mind (SIM). The concept of SIM is inspired by the idea of designing software that can run on multiple computers with different hardware without needing to be rewritten. For example, Java's design principle "write once, run everywhere" makes it a platform independent system. In this context, substrate is a term referring to a generalized concept of any computational platform that is capable of universal computation.

We take the materialist position that the human mind is solely generated by the brain and is a function of neural states. Additionally, we assume that the neural states are computational processes and devices capable of universal computing are sufficient to generate the same kind of computational processes found in a brain.

Whole brain emulation (WBE), mind upload or brain upload (sometimes called "mind copying" or "mind transfer") is the hypothetical futuristic process of scanning the mental state (including long-term memory and "self") of a particular brain substrate and copying it to a computer. The computer could then run a simulation model of the brain's information processing, such that it responds in essentially the same way as the original brain and experiences having a conscious mind. The brain will have the state of the mind living person, it's not clear it will update the information as per the human with reference to the psychological aspects.[1][2][3]

Mind uploading may potentially be accomplished by either of two methods: Copy-and-transfer or gradual replacement of neurons. In the case of the former method, mind uploading would be achieved by scanning and mapping the salient features of a biological brain, and then by copying, transferring, and storing that information state into a computer system or another computational device. The biological brain may not survive the copying process. The simulated mind could be within a virtual reality or simulated world, supported by an anatomic 3D body simulation model. Alternatively the simulated mind could reside in a computer that is inside (or connected to) a (not necessarily humanoid) robot or a biological body.[4]

Among some futurists and within the transhumanist movement, mind uploading is treated as an important proposed life extension technology. Some believe mind uploading is humanity's current best option for preserving the identity of the species, as opposed to cryonics. Another aim of mind uploading is to provide a permanent backup to our "mind-file", to enable interstellar space travels, and a means for human culture to

survive a global disaster by making a functional copy of a human society in a Matrioshka brain, i.e. a computing device that consumes all energy from a star. Whole brain emulation is discussed by some futurists as a "logical endpoint"[4] of the topical computational neuroscience and neuroinformatics fields, both about brain simulation for medical research purposes. It is discussed in artificial intelligence research publications as an approach to strong AI. Computer-based intelligence such as an upload could think much faster than a biological human even if it were no more intelligent. A large-scale society of uploads might, according to futurists, give rise to a technological singularity, meaning a sudden time constant decrease in the exponential development of technology.[5] Mind uploading is a central conceptual feature of numerous science fiction novels and films.

Substantial mainstream research in related areas is being conducted in animal brain mapping and simulation, development of faster supercomputers, virtual reality, brain–computer interfaces, connectomics and information extraction from dynamically functioning brains.[6] According to supporters, many of the tools and ideas needed to achieve mind uploading already exist or are currently under active development; however, they will admit that others are, as yet, very speculative, but still in the realm of engineering possibility. Neuroscientist Randal Koene has formed a nonprofit organization called Carbon Copies to promote mind uploading research.;

Figure 1:A cyborg short for "cybernetic organism", is a being with both organic and biomechatronic body parts.[1](Source Wiki)

II. Overview

The human brain contains, on average, about 86 billion nerve cells called neurons, each individually linked to other neurons by way of connectors called axons and dendrites. Signals at the junctures (synapses) of these connections are transmitted by the release and detection of chemicals known as neurotransmitters. The established neuroscientific consensus is that the human mind is largely an emergent property of the information processing of this neural network.[a1]

Neuroscientists have stated that important functions performed by the mind, such as learning, memory, and consciousness, are due to purely physical and electrochemical processes in the brain and are governed by applicable laws. For example, Christof Koch and Giulio Tononi wrote in IEEE Spectrum:

Consciousness is part of the natural world. It depends, we believe, only on mathematics and logic and on the imperfectly known laws of physics, chemistry, and biology; it does not arise from some magical or otherworldly quality.[7]

The concept of mind uploading is based on this mechanistic view of the mind, and denies the vitalist view of human life and consciousness.[citation needed]

Eminent computer scientists and neuroscientists have predicted that specially programmed[clarification needed] computers will be capable of thought and even attain consciousness, including Koch and Tononi,[7] Douglas Hofstadter,[8] Jeff Hawkins,[8] Marvin Minsky,[9] Randal A. Koene, and Rodolfo Llinás.[10]

However, even though uploading is dependent upon such a general capability, it is conceptually distinct from general forms of AI in that it results from dynamic reanimation of information derived from a specific human mind so that the mind retains a sense of historical identity (other forms are possible but would compromise or eliminate the life-extension feature generally associated with uploading). The transferred and reanimated information would become a form of artificial intelligence, sometimes called an infomorph or "noömorph".[12]

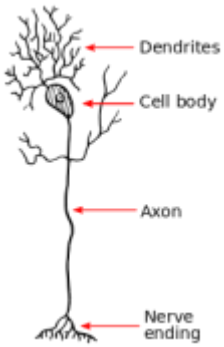

Figure 2: Neuron Anatomical model

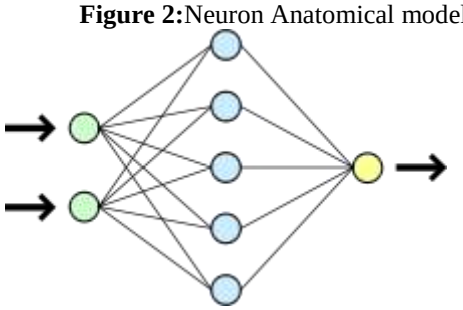

Figure 3: Artificial Neural Network

III. Theoretical Benefits And Applications

A) Immortality or backup

In theory, if the information and processes of the mind can be disassociated from the biological body, they are no longer tied to the individual limits and lifespan of that body. Furthermore, information within a brain could be partly or wholly copied or transferred to one or more other substrates (including digital storage or another brain), thereby – from a purely mechanistic perspective – reducing or eliminating "mortality risk" of such information. This general proposal was discussed in 1971 by biogerontologist George M. Martin of the University of Washington[12]

B) Space exploration

An "uploaded astronaut" could be used instead of a "live" astronaut in human spaceflight, avoiding the perils of zero gravity, the vacuum of space, and radiation to the human body. It would allow for the use of smaller spacecraft, such as the proposed StarChip, and it would enable virtually unlimited interstellar traveldistances.[13]

IV. Relevant Technologies And Techniques

The focus of mind uploading, in the case of copy-and-transfer, is on data acquisition, rather than data maintenance of the brain. A set of approaches known as loosely coupled off-loading (LCOL) may be used in the attempt to characterize and copy the mental contents of a brain.[14] The LCOL approach may take advantage of self-reports, life-logs and video recordings that can be analyzed by artificial intelligence. A bottom-up approach may focus on the specific resolution and morphology of neurons, the spike times of neurons, the times at which neurons produce action potential responses.

C) Scanning and mapping scale of an individual

When modelling and simulating the brain of a specific individual, a brain map or connectivity database showing the connections between the neurons must be extracted from an anatomic model of the brain. For whole brain simulation, this network map should show the connectivity of the whole nervous system, including the spinal cord, sensory receptors, and muscle cells. Destructive scanning of a small sample of tissue from a mouse brain including synaptic details is possible as of 2010.[19]

However, if short-term memory and working memory include prolonged or repeated firing of neurons, as well as intra-neural dynamic processes, the electrical and chemical signal state of the synapses and neurons may be hard to extract. The uploaded mind may then perceive a memory loss of the events and mental processes immediately before the time of brain scanning.[4]

A full brain map has been estimated to occupy less than 2 x 10^{16} bytes (20,000 TB) and would store the addresses of the connected neurons, the synapse type and the synapse "weight" for each of the brains' 10^{15} synapses.[4] However, the biological complexities of true brain function (e.g. the epigenetic states of neurons, protein components with multiple functional states, etc.) may preclude an accurate prediction of the volume of binary data required to faithfully represent a functioning human mind.

D) Serial sectioning

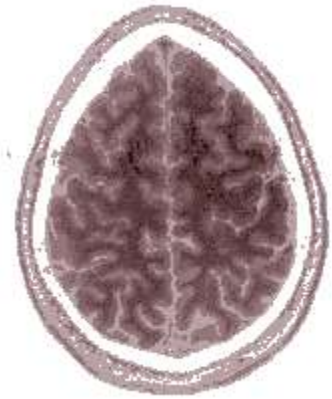

Figure 4: Serial sectioning of a brain

A possible method for mind uploading is serial sectioning, in which the brain tissue and perhaps other parts of the nervous system are frozen and then scanned and analyzed layer by layer, which for frozen samples at nano-scale requires a cryo-ultramicrotome, thus capturing the structure of the neurons and their interconnections.[20] The exposed surface of frozen nerve tissue would be scanned and recorded, and then the surface layer of tissue removed. While this would be a very slow and labor-intensive process, research is currently underway to automate the collection and microscopy of serial sections.[21] The scans would then be analyzed, and a model of the neural net recreated in the system that the mind was being uploaded into.

There are uncertainties with this approach using current microscopy techniques. If it is possible to replicate neuron function from its visible structure alone, then the resolution afforded by a scanning electron microscope would suffice for such a technique.[21]However, as the function of brain tissue is partially determined by molecular events (particularly at synapses, but also at otherplaces on the neuron's cell membrane), this may not suffice for capturing and simulating neuron functions. It may be possible to extend the techniques of serial sectioning and to capture the internal molecular makeup of neurons, through the use of sophisticated immunohistochemistry staining methods that could then be read via confocal laser scanning microscopy. However, as the physiological genesis of 'mind' is not currently known, this method may not be able to access all of the necessary biochemical information to recreate a human brain with sufficient fidelity.

E) Brain imaging

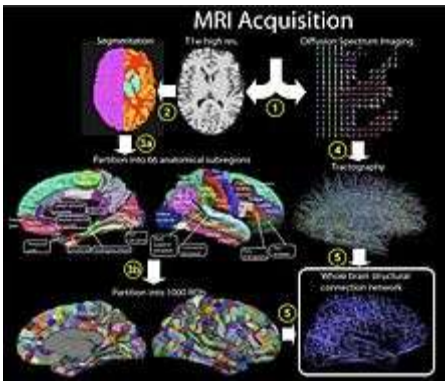

Figure 5: Process from MRI acquisition to whole brain structural network[22]

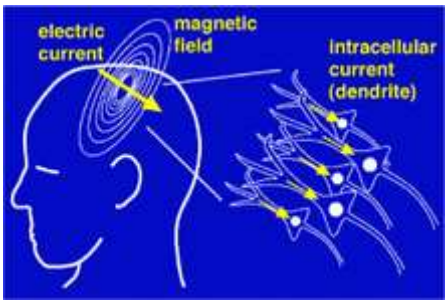

Figure 6: Magnetoencephalography

It may be possible to create functional 3D maps of the brain activity, using advanced neuroimaging technology, such as functional MRI (fMRI, for mapping change in blood flow), magnetoencephalography (MEG, for mapping of electrical currents), or combinations of multiple methods, to build a detailed three-dimensional model of the brain using non-invasive and non-destructive methods. Today, fMRI is often combined with MEG for creating functional maps of human cortex during more complex cognitive tasks, as the methods complement each other. Even though current imaging technology lacks the spatial resolution needed to gather the information needed for such a scan, important recent and future developments are predicted to substantially improve both spatial and temporal resolutions of existing technologies.[23]

F) Brain simulation

There is ongoing work in the field of brain simulation, including partial and whole simulations of some animals. For example, the C. elegans roundworm, Drosophila fruit fly, and mouse have all been simulated to various degrees.

The Blue Brain Project by the Brain and Mind Institute of the ÉcolePolytechniqueFédérale de Lausanne, Switzerland is an attempt to create a synthetic brain by reverse-engineering mammalian brain circuitry.

V. Uploading And Conciousness

Ordinary human beings are conscious. That is, there is something it is like to be us. We have conscious experiences with a subjective character: there is something it is like for us to see, to hear, to feel, and to think. These conscious experiences lie at the heart of our mental lives, and are a central part of what gives our lives meaning and value. If we lost the capacity for consciousness, then in an important sense, we would no longer exist. Before uploading, then, it is crucial to know whether the resulting upload will be conscious. If my only residue is an upload and the upload has no capacity for consciousness, then arguably I do not exist at all. And if there is a sense in which I exist, this sense at best involves a sort of zombified existence. Without consciousness, this would be a life of greatly diminished meaning and value. Can an upload be conscious? The issue is complicated by the fact that our understanding of consciousness is so poor. No-one knows just why or how brain processes give rise to consciousness. Neuroscience is gradually discovering various neural correlates of consciousness, but this research program largely takes the existence of consciousness for granted. There is nothing even approaching an orthodox theory of why there is consciousness in the first place. Correspondingly, there is nothing even approaching an orthodox theory of what sorts of systems can be conscious and what systems cannot be. One central problem is that consciousness seems to be a further fact about conscious systems, at least in the sense that knowledge of the physical structure of such a system does not tell one all about the conscious experiences of such a system.2 Complete knowledge of physical structure might tell one all about a system's objective behavior and its objective functioning, which is enough to tell whether the system is alive, and whether it is intelligent. But this sort of knowledge alone does not seem to answer all the questions about a system's subjective experience. A famous illustration here is Frank Jackson's case of Mary, the neuroscientist in a black-and-white room, who knows all about the physical processes associated with color but does not know what it is like to see red. If this is right, complete physical knowledge leaves open certain questions about the conscious experience of color. More broadly, a complete physical description of a system such as a mouse does not appear to tell us what it is like to be a mouse, and indeed whether there is anything it is like to be a mouse. Furthermore, we do not have a "consciousness meter" that can settle the matter directly. So given any system, biological or artificial, there will at least be a substantial and unobvious question about whether it is conscious, and about what sort of consciousness it has. Still, whether one thinks there are further facts about consciousness or not, one can at least raise the question of what sort of systems are conscious. Here philosophers divide into multiple camps. Biological theorists of consciousness hold that consciousness is essentially biological and that no nonbiological system can be conscious. Functionalist theorists of consciousness hold that what matters to

consciousness is not biological makeup but causal structure and causal role, so that a nonbiological system can be conscious as long as it is organized correctly. The philosophical issue between biological and functionalist theories is crucial to the practical question of whether or not we should upload. If biological theorists are correct, uploads cannot be conscious, so we cannot survive consciously in uploaded form. If functionalist theorists are correct, uploads almost certainly can be conscious, and this obstacle to uploading is removed. My own view is that functionalist theories are closer to the truth here. It is true that we have no idea how a nonbiological system, such as a silicon computational system, could be conscious. But the fact is that we also have no idea how a biological system, such as a neural system, could be conscious. The gap is just as wide in both cases. And we do not know of any principled differences between biological and nonbiological systems that suggest that the former can be conscious and the latter cannot. In the absence of such principled differences, I think the default attitude should be that both biological and nonbiological systems can be conscious. I think that this view can be supported by further reasoning. To examine the matter in more detail: Suppose that we can create a perfect upload of a brain inside a computer. For each neuron in the original brain, there is a computational element that duplicates its input/output behavior perfectly. The same goes for non-neural and subneural components of the brain, to the extent that these are relevant. The computational elements are connected to input and output devices (artificial eyes and ears, limbs and bodies), perhaps in an ordinary physical environment or perhaps in a virtual environment. On receiving a visual input, say, the upload goes through processing isomorphic to what goes on in the original brain. First artificial analogs of eyes and the optic nerve are activated, then computational analogs of lateral geniculate nucleus and the visual cortex, then analogs of later brain areas, ultimately resulting in a (physical or virtual) action analogous to one produced by the original brain. In this case we can say that the upload is a functional isomorph of the original brain. Of course it is a substantive claim that functional isomorphs are possible. If some elements of cognitive processing function in a noncomputable way, for example so that a neuron's input/output behavior cannot even be computationally simulated, then an algorithmic functional isomorph will be impossible. But if the components of cognitive functioning are themselves computable, then a functional isomorph is possible. Here I will assume that functional isomorphs are possible in order to ask whether they will be conscious. I think the best way to consider whether a functional isomorph will be conscious is to consider a gradual uploading process such as nanotransfer. Here we upload different components of the brain one by one, over time. This might involve gradual replacement of entire brain areas with computational circuits, or it might involve uploading neurons one at a time. The components might be replaced with silicon circuits in their original location, or with processes in a computer connected by some sort of transmission to a brain. It might take place over months or years, or over hours. If a gradual uploading process is executed correctly, each new component will perfectly emulate the component it replaces, and will interact with both biological and nonbiological components around it in just the same way that the previous component did. So the system will behave in exactly the same way that it would have without the uploading. In fact, if we assume that the system cannot see or hear the uploading, then the system need not notice that any uploading has taken place. Assuming that the original system said that it was conscious, so will the partially uploaded system. The same applies throughout a gradual uploading process, until we are left with a purely nonbiological system. What happens to consciousness during a gradual uploading process? There are three possibilities. It might suddenly disappear, with a transition from a fully complex conscious state to no consciousness when a single component is replaced. It might gradually fade out over more than one replacements, with the complexity of the system's conscious experience reducing via intermediate steps. Or it might stay present throughout. Sudden disappearance is the least plausible option. Given this scenario, we can move to a scenario in which we replace the key component by replacing ten or more subcomponents in turn, and then reiterate the question. Either new scenario will involve a gradual fading across a number of components, or a sudden disappearance. If the former, this option is reduced to the fading option. If the latter, we can reiterate. In the end we will either have gradual fading or sudden disappearance when a single tiny component (a neuron or a subneural element, say) is replaced. The latter seems extremely unlikely. Gradual fading also seems implausible. In this case there will be intermediate steps in which the system is conscious but its consciousness is partly faded, in that it is less complex than the original conscious state. Perhaps some element of consciousness will be gone (visual but not auditory experience, for example) or perhaps some distinctions in experience will be gone (colors reduced from a three-dimensional color space to black and white, for example). By hypothesis the system will be functioning and behaving the same way as ever, though, and will not show any signs of noticing the change. It is plausible that the system will not believe that anything has changed, despite a massive difference in its conscious state. This requires a conscious system that is deeply out of touch with its own conscious experience. We can imagine that at a certain point partial uploads become common, and that many people have had their brains partly replaced by silicon computational circuits. On the sudden disappearance view, there will be states of partial uploading such that any further change will cause consciousness to disappear, with no difference in behavior or organization. People in these states may have consciousness constantly flickering in and out, or at least might undergo total zombification with a tiny change.

On the fading view, these people will be wandering around with a highly degraded consciousness, although they will be functioning as always and swearing that nothing has changed. In practice, both hypotheses will be difficult to take seriously. So I think that by far the most plausible hypothesis is that full consciousness will stay present throughout. On this view, all partial uploads will still be fully conscious, as long as the new elements are functional duplicates of the elements they replace. By gradually moving through fuller uploads, we can infer that even a full upload will be conscious. At the very least, it seems very likely that partial uploading will convince most people that uploading preserves consciousness. Once people are confronted with friends and family who have undergone limited partial uploading and are behaving normally, few people will seriously think that they lack consciousness. And gradual extensions to full uploading will convince most people that these systems are conscious at well. Of course it remains at least a logical possibility that this process will gradually or suddenly turn everyone into zombies. But once we are confronted with partial uploads, that hypothesis will seem akin to the hypothesis that people of different ethnicities or genders are zombies. If we accept that consciousness is present in functional isomorphs, should we also accept that isomorphs have qualitatively identical states of consciousness? This conclusion does not follow immediately. But I think that an extension of this reasoning (the "dancing qualia" argument in Chalmers 1996) strongly suggests such a conclusion. If this is right, we can say that consciousness is an organizational invariant: that is, systems with the same patterns of causal organization have the same states of consciousness, no matter whether that organization is implemented in neurons, in silicon, or in some other substrate. We know that some properties are not organizational invariants (being wet, say) while other properties are (being a computer, say). In general, if a property is not an organizational invariant, we should not expect it to be preserved in a computer simulation (a simulated rainstorm is not wet). But if a property is an organizational invariant, we should expect it to be preserved in a computer simulation (a simulated computer is a computer). So given that consciousness is an organizational invariant, we should expect a good enough computer simulation of a conscious system to be conscious, and to have the same sorts of conscious states as the original system. This is good news for those who are contemplating uploading. But there remains a further question.

Figure 7: The normalized frequency of the phrase "mind transfer" in books published in American English from 1940 to 2008. (Jean-Baptiste, 2010) The increase in frequency indicates a growing public interest in mind uploading and related concepts since 1940, and we expect this trend to continue as mind uploading becomes closer to reality.

VI. Conclusion

Yet, even if these philosophical questions are settled in favor of survival under uploading (or if theyare deemed ill-posed and therefore discarded), there still remains the difficult bioethics-like concernsdiscussed, as well as the weather uploading technology is likely to lead to a society worth wanting. Whatever knowledge we have on these issuesat present is highly tentative, and it is important that we put serious efforts into resolving them,rather than merely pressing ahead blindly with technology development. The future of humanity (orposthumanity) may be at stake.

On the other side, there are many grace for the human to preserve the knowledge forever. If we may think beyond of life period (as at most 100 year in this era). If really we can upload the machine, it may do the expriments beyond the possible life of single person.

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