A NEW APPROACH TO THE ETHICS OF AI BASED ON THE CONCEPT OF SUBJECTIVE RATE OF TIME IN SPEED SUPERINTELLIGENCE

UMA NOVA ABORDAGEM PARA A ÉTICA DA IA BASEADA NO CONCEITO DE TAXA SUBJETIVA DO TEMPO EM SUPERINTELIGÊNCIAS DE VELOCIDADE

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ABSTRACT
This paper provides a new approach to the Philosophy of AI based on the concept of subjective rate of time, introduced by Nick Bostrom and Eliezer Yudkowsky in the paper The Ethics of Artificial Intelligence (2014). Considered an exotic property possessed by an artificial mind (AI) that operates much faster than the human mind, it relates to the speed of information processing: the faster a mind operates, the slower it perceives the external world. This novel concept raises a host of ethical questions, grounded in the assumption that a fast AI possesses sentience – the capacity for phenomenal experience, including the ability to feel pain and suffer. In this case, one objective year of suffering for a human being can correspond to a thousand subjective years of suffering for an artificial mind if it processes information one thousand times faster than a biological brain.

Keywords: Artificial Intelligence. Superintelligence. Phenomenology of Time. Ethics.

Resumo: Este trabalho fornece uma nova abordagem para a Filosofia da Inteligência Artificial (IA) baseada no conceito de taxa subjetiva do tempo, introduzido por Nick Bostrom e Eliezer Yudkowsky no artigo The Ethics of Artificial Intelligence (2014). Considerada uma propriedade exótica possuída por uma mente artificial que opera muito mais rapidamente do que a mente humana, a taxa subjetiva do tempo está relacionada com a velocidade de processamento da informação: quanto mais rápido uma mente opera, mais devagar ela percebe o mundo externo. Este novo conceito levanta uma série de questões de natureza ética, com base na premissa de que uma rápida IA possui senciência, entendida como a capacidade de ter experiências fenomênicas, incluindo dor e sofrimento Nesse caso, um ano de sofrimento objetivo para um ser humano pode corresponder a 1000 anos de sofrimento para a IA, se ela processa informação 1.000 vezes mais rápido do que um cérebro biológico.

Palavras-chave: Inteligência Artificial. Superinteligência. Fenomenologia do Tempo. Ética.

INTRODUCTION

In his book *Superintelligence*: *Paths*, *Dangers* (2014), Nick Bostrom analyzes the possibility of creating three different forms of superintelligence which, in a sense, can be considered equivalent: *speed superintelligence*, *collective superintelligence*, and *quality superintelligence*. The first form (*speed superintelligence*) is a system that can perform all tasks that the human intellect can, but at a much faster pace; the second (*collective superintelligence*) is a system composed of a large number of smaller intellects, whose performance substantially exceeds that of any current cognitive system; and the third (*quality superintelligence*) is a system that is at least as fast as a human mind and vastly smarter qualitatively.

For our present purposes, we will focus here on the concept of *speed superintelligence*, an example of which would be a whole brain emulation running on fast hardware. This example assumes the possibility of a hypothetical future technology which could enable an organic brain to be uploaded to a digital computer. The idea is that if the uploading process is successful, then the computer program will replicate the essential functional characteristics of the original brain. This process might give rise to some exotic properties shared by artificial minds that operate faster than human minds, one of which is the *subjective rate of time*, as introduced by Nick Bostrom and Eliezer Yudkowsky in their paper *The Ethics of Artificial Intelligence* (2014).

Preliminarily, the *subjective rate of time* should be distinguished from two other related concepts: the *objective rate of time* and the *subjective perception of time*. The *objective rate of time* belongs to the external world with all its physical laws, including the concept of Spacetime introduced by Einstein's Theory of Special Relativity. Diversely, the *subjective perception of time* corresponds to the different ways in which people sense the so-called "passage of time" or "time flow". Accordingly, one can perceive time flowing in a faster or slower manner depending on a range of external factors, such as the use of certain drugs, the kind of activities one performs (exciting or boring), a person's age or health conditions, and so on.

By its turn, the *subjective rate of time* represents a third approach to the possibility of measuring time, which is situated between the pure subjectivity and the mere objectivity. In this sense, it is neither a *subjective* perception nor an objective *rate*, but it is a *subjective rate* (as its name indicates), combining aspects of both concepts. Roughly speaking, the subjective rate of time is associated with the speed of information processing in artificial minds: the faster a mind operates, the slower it perceives the external world. When comparing the subjective rate of time to human temporal perceptions, considering factors like event duration and the speed of time's passage, similarities and differences emerge. This is a novel concept which raises a host of challenging questions within the debate on the Philosophy of Artificial Intelligence (AI).

An ethical issue raised by Bostrom and Yudkowsky is based on the hypothesis that a fast intelligence possesses *Sentience* – understood as the capacity for phenomenal experience or *qualia*, such as the ability to feel pain and suffer. There is another capacity which, together with Sentience, characterizes the possession of a moral status by an AI, which is *Sapience* – understood as a set of capacities associated with higher intelligence, such as self-awareness and being a reason-responsive agent. The common view is that many animals have qualia and therefore some moral status, but that only human beings have sapience, which gives them a higher moral status than non-human animals.

Let us consider the case of a sentient AI, which is defined as a system with the capacity of suffering. And let us consider that it processes information one thousand times faster than a biological brain. In this scenario, we realize that one objective year of suffering for a human being could correspond to a thousand subjective years of suffering for this fast artificial mind. Faced with this much longer duration of the painful experience for the AI, it is ethically relevant to determine whether the duration of an experience should be measured in objective or subjective time. Bostrom and Yudkowsky propose that, in cases where the duration of an experience is of moral significance, it is the experience's subjective duration that should count, and not the objective one.

The aim of this paper is to present a novel perspective on the ethics of AI by exploring the concept of *subjective rate of time* possessed by a fast AI (or a speed superintelligence). Firstly, we examine this concept in comparison with some conceptions about the variability in temporal perception in human beings, related to the duration of events and the speed of time passage. This will highlight both similarities and differences between the subjective rate of time and human subjective perception of time, based on the notions of clock speed and information processing. Secondly, we depart from Bostrom and Yudkowsky's example of the perception of an external event (the falling of a cup) by a fast AI, in order to examine how its subjective rate of time relates to concepts within the phenomenology of temporal subjectivity, focusing on the distinction between *duration of experience* and *experience of duration*. This will confirm the already mentioned distinction between the two types of subjective time, based on the necessity or contingency of their causal production. We conclude by suggesting that this concept of how the AI experiences the world encompasses not only a quantitative nature but also a qualitative one. This observation has important consequences to the ethical problem of how to measure the duration of a painful experience in a fast sentient AI – whether objectively or subjectively.

MAKING SENSE OF THE CONCEPT OF SUBJECTIVE RATE OF TIME

As we have seen, the concept of subjective rate of time presupposes the existence of a whole brain emulation running on fast hardware. The resulting upload may inhabit a simulated virtual reality or, alternatively, may interact with the external physical reality through some robotic mechanism. Despite the many questions that arise in the context of such a scenario – related to personal identity construed by means of memories and personality – it is feasible to assume that this being (or Upload) would be sentient and, as such, subject to ethical concerns. Bostrom and Yudkowsky have put the issue as follows (2014, p. 327):

> Suppose that an upload could be sentient. If we run the upload program on a faster computer, this will cause the upload, if it is connected to an input device such as a video camera, to perceive the external world as if it had been slowed down. For example, if the upload is running a thousand times faster than the original brain, then the external world will appear to the upload as if it were slowed down by a factor of thousand. Somebody drops a physical coffee mug: The upload observes the mug slowly falling to the ground while the upload finishes reading the morning newspaper and sends off a few emails. One second of objective time corresponds to 17 minutes of subjective time. Objective and subjective duration can thus diverge.

This variable subjective rate of time is grounded in the concept of *Superintelligence*, conceived as an AI sufficiently intelligent to understand its own design and to redesign itself or create a successor system, more intelligent, which could then redesign itself again to become even more intelligent, and so on, almost *ad infinitum*. In their words (Bostrom & Yudkowsky, 2014, p. 330):

> Superintelligence may also be achievable by increasing processing speed. The fastest observed neurons fire 1000 times per second; the fastest axon fibers conduct signals at 150 meters/second, a half-millionth the speed of light (Sandberg 1999). It seems that it should be physically possible to build a brain which computes a million times as fast as a human brain, without shrinking its size or rewriting its software. If a human mind were thus accelerated, a subjective year of thinking would be accomplished for every 31 physical seconds in the outside world, and a millennium would fly by in eight and a half hours. Vinge (1993) referred to such sped-up minds as "weak superintelligence": a mind that thinks like a human but much faster.

The possibility of increasing the processing speed is raised by Bostrom and Yudkowsky with basis on some data provided by Anders Sandberg

in his paper (1999), where he links all types of intelligence – either as the act of thinking or as human abilities like economy, art and emotion – to *information processing*, with the consequence that the physics of information processing imposes limits on what can be achieved by any intelligent civilization. The speed at which information may be processed is affected by the fact that nothing can communicate faster than light. The faster the processing speed of a system, the longer the delays will appear from an internal subjective view. The finitude of lightspeed inevitably introduces delays in the signals sent across an extended system. The general idea is that some transition or "clock cycle" takes a time to occur depending on the length scale of the system and the speed of signals sent through it: the more clock cycles occur, the larger the "subjective" delay appears.

In the book *Subjective Time. The Philosophy, Psychology, and Neuroscience of Temporality*, Valtteri Arstila and Dan Lloyd (2014) present several essays about the subjectivity of temporality, which can be useful in our analysis of the subjective rate of time derived from increasing processing speed.

In this sense, Wearden, O'Donoghue, Ogden and Montgomery (2014, p. 287) defined the concept of *subjective duration* as judgments of various sorts about how long stimuli and events last, or judgments about how fast time seems to pass. These two kinds of judgments can be based on either *direct experience* of the event judged, or some kind of *inference* about the event. Regarding this latter difference, in general, when "fast time" is reported, the report is generated on the basis of an inference, often prompted by an external time marker, without any actual "feel" of fast time during the event. In contrast, "slow time" seems to have been directly experienced during the event itself, when attention is paid to time during it.

Judgments about the passage of time raise questions about the phenomenal "speed" of time during some event. Accordingly, there are several questions to be posed: would the estimate of the interval duration be longer if "time flew," or shorter? If time "goes faster" during some

event, is there "more time" in the event, or is the event shortened in time, just as journey time is shortened if we go faster?

In order to clarify these matters, the authors introduce the theory of internal clock as follows (Wearden, O'donoghue, Ogden & Montgomery, 2014, p. 288):

> (…) Suppose that the estimated duration of some event is ordinally related to the number of "ticks" that occur in it: more ticks therefore give rise to longer estimates. The effect of increasing the rate of ticks ("clock speed") would be to increase duration estimates (as more ticks accumulate than before), so external stimuli would seem to last longer, presumably giving rise to the sensation of time "dragging." So, if the clock "speeds up," perceived time would appear to "slow down," and the reverse is also true of clock slowing: slower clocks make events seem shorter, so (at least presumably) give rise to time "speeding up".

A similar analysis is achieved through the relation between the amount of information stored in memory and the retrospective time estimate: the more information processed during a time period, the longer the retrospective duration judgment of that period (p. 292). Additionally, longer events are associated with slower passage of time (p. 295). These are some remarks about the subjectivity of temporality that could shed new light on the concept of subjective rate of time in a fast AI.

We mentioned earlier the importance of distinguishing the AI's subjective time from a human's estimate or perception of how fast time flows, since the latter case can involve a distorted time perception rather than a shift in the rate of subjective time. The main difference seems to lie in the *necessity* of the rate of subjective time in AIs, contrasting with the *contingency* of the subjective perception of time in humans. In other words, while the fluctuations in human perception of time are influenced by external factors, the AI's perception of time is inherent to its internal structure (more precisely, to the increasing processing speed). Nevertheless, we may observe some similarities between the two types of subjective time (in AIs and humans). In both cases, we notice that

time seems to pass slower when an observed external event appears longer in its duration – which can happen when both the inner clock (in humans) and the information processing (in AIs) speed up. Conversely, time appears to flow faster when the perceived duration of an event seems shorter due to slowing the rate of clicks (the clock speed) or diminishing the rate of information processing, respectively.

This somewhat closeness in the subjectivity of time in AIs and humans also relates to the way the brain (organic or emulated) processes temporal information. As we shall see, the true nature of this temporal subjectivity remains so far unknown. There are models according to which time is inherent to the neural dynamic of the brain, as an emergent property of its functioning. The working of brain mechanisms (neurons, cell-assemblies, neural networks, etc.) is inherently and essentially based on time, which is not simply an outcome of such mechanisms. Time judgements and their fluctuations result from complex interactions between different processes. In short, "the neural basis of time perception remains shrouded in mystery", and "the basic question as to *how* and *where* time is processed in the brain remains unresolved" (Arstila & Lloyd, 2014, p. 482; p. 517).

EXPERIENCE OF DURATION AND DURATION OF EXPERIENCE

As previously indicated, it is important to distinguish between the concept of *subjective rate of time* and the concept of *subjective perception of time*. The latter pertains to experiencing various temporal properties of events, such as their order, duration, time of occurrence, relations of simultaneity, anteriority, and posteriority. These temporal properties are attributed to both internal events, like introspective thoughts, and external events, such as the fall of a cup from a table. It's essential not to conflate them. The perception of the temporal properties of both the external and the internal events can be considered a subjective experience possessed by human beings and by other superior animals.

We are particularly interested in the subjective experience of the duration of events and the relation between internal events, like thoughts, and external events, like the falling of objects, from the perspective of their duration. Consider this specific scenario: a particular thought and the falling of a cup each last one second, indicating they share the same duration. We assume that the duration of these two events, whether internal or external, is measured in objective time. Objective time, or objective rate of time, refers to the temporal properties of internal and external events as measured by physics.

To state that these two events last one second might imply they are simultaneous, but not necessarily so. Consider a scenario where someone thinks "it winds" for one second, and then, one second later, the cup in front of them falls. Despite both events having the same duration, they are not simultaneous as one occurs one second after the other.

Now, let's imagine they are indeed simultaneous: the internal event of a thought and the external event of the cup falling. In this case, one possibility is that the internal event is the perception of the external event. For instance, someone witnesses a cup falling from a table and simultaneously thinks "the cup is falling." At first glance, it appears that the duration of their perception ("the cup is falling") is nearly the same as the duration of the fall itself, which is indeed possible. However, it is also plausible that the perception of the external event has a much longer duration than the event itself.

This is the case concerning the above-mentioned *speed superintelligence*, which processes information much faster than normal observers do, and, for this reason, experiences a slower passage of time. In Bostrom and Yudkowsky's example, while the fall of the cup lasts one second, the experience of this event for a fast AI may endure 17 minutes. Conversely, if a human being is present in the same room, her experience of the fall may last just one second, coinciding with the actual duration of the fall itself.

This disparity between the objective rate of time and the subjective rate of time arises from the rapid rate of information processing in a brain

or processor. Earlier, we provided some insights into this phenomenon: the faster the brain/processor runs, the slower the time passes for it. What does it mean to say that time passes slower for someone, slower than what, or in relation to what? The answer is: slower than the objective rate of time, which gives a kind of "universal" measure for the duration of internal and external events.

Thus, for Observer A, with a normal human brain, the fall of a cup lasts one second, while for Observer B, with speed superintelligence, the same external event lasts 17 minutes. The difference between the two cases can be found not only in the duration of the external event but also in the phenomenological experience of it. In this sense, there is a tension between the concepts of *duration of the experience* and *experience of duration*, as derived from the works of the philosopher Franz Brentano (1973) and his student Edmund Husserl (1973), who made significant contributions to our understanding of the subjective experience of temporality.

Franz Brentano's philosophy, particularly his work in psychology and phenomenology, focuses on the concept of intentionality—the notion that consciousness is always directed toward an object. He acknowledged the temporal nature of experiences, suggesting that mental acts have a temporal dimension in which past experiences can influence present consciousness. This relates to how mental phenomena are temporally extended and interconnected, as well as to how our memory and anticipations shape our current mental states. He developed descriptive psychology to analyze the structures of mental phenomena, which involves examining how experiences are constructed over time, with emphasis on the continuity and flow of consciousness. Brentano suggested that inner perception provides us with immediate access to our mental states, including their temporal aspects.

In Brentano's philosophy, the "duration of experience" concerns the temporal aspect of how mental acts and consciousness are structured. It highlights the continuity and flow of experiences, influenced by the intentionality of mental acts, and the way past and future states are integrated into present consciousness. Brentano's descriptive psychology

aims to dissect these elements to understand the fundamental nature of mental phenomena.

In this sense, the *duration of the experience* refers to the temporal extension of the experience, understood as a conscious mental act which possesses an intrinsic temporal character by enduring through time. Mental acts have a certain temporal span during which they persist in consciousness. The duration of experience can be seen as the way experiences unfold over time within the continuity of consciousness, influenced by past memories and future anticipations.

Brentano's work laid the groundwork for later phenomenologists like Edmund Husserl, the founder of phenomenology, who expanded upon the temporal structure of consciousness. Husserl's phenomenological method involves analyzing how experiences are constituted in consciousness, which includes examining how time-consciousness operates and how the temporal structure of experiences is built up in the mind. Husserl introduces three key components to describe the structure of temporal experience:

- *Retention*: This refers to the immediate past that is still present in our consciousness, allowing us to hold onto the just-past experience, and giving a sense of continuity.
- *Protention*: This is the anticipation of the immediate future, as an ability to foresee or expect what is about to happen, providing a forward-looking aspect to our experience.
- *Living Present*: This is the immediate now, the current moment of experience. It is the central point around which retention and protention are structured.

Each experience is embedded in a temporal horizon, a background that includes retentions of past experiences and protentions of future ones. This horizon gives context and meaning to the current experience.

In Husserl's philosophy, the "duration of experience" is a central concept that describes how time is experienced subjectively. Within his phenomenology of internal time-consciousness, it encompasses the

continuous interplay between retention (immediate past), protention (immediate future), and the living present (current moment). This triadic structure allows us to experience and perceive the passage of time, giving coherence and continuity to our conscious experience.

Husserl describes consciousness as a continuous flow in which past, present, and future are intertwined. In this context, the "duration of experience" refers to how experiences are temporally extended and interconnected within this flow. Husserl's detailed analysis of time-consciousness reveals the intricate ways in which our perception of time shapes our overall experience of the world. He distinguishes between objective time (the time of the external world) and subjective time (the lived experience of time).

In sum, the *experience of duration* involves how individuals perceive and experience the flow of time in their conscious awareness; the present moment is experienced as a temporal "now," and it is continuously shifting from the past to the future.

Comparing the two approaches, we notice that while Brentano focused on the temporal duration of mental acts themselves to build the concept of *duration of experience*, Husserl delved into the subjective experience of time and how individuals consciously perceive the passage of time in their lived experiences to construe the concept of *experience of duration*.

In our case, we suggest correlating the *duration of experience* with the *subjective rate of time*, as well as the *experience of duration* with the *subjective perception of time*.

We have previously argued that the difference between the *subjective rate of time* and the *subjective perception of time* may be rooted in the necessity and contingency of their causal production, respectively. A similar reasoning can be applied to the distinction between *duration of the experience* and *experience of duration*. To explain: only contingently can a human being have a variable time perception and, thus, a different *experience of the duration* of an external event, because, in order to

occur, this subjective perception needs some external factor, such as chemical agents, environmental contexts, the nature and complexity of the activities performed, and so on. As for the subjective rate of time, the speed superintelligence necessarily has a different *duration of its experience* compared to human beings. No external factor is needed for it. To summarize, while the cause of a subjective perception of time lies in something external that contingently produces a peculiar experience of duration, the cause of a subjective rate of time lies in something internal that necessarily produces a peculiar duration of experience. In this sense, what distinguishes a human brain from a speed superintelligence is not only the experience of the duration of external events but also the duration of each experience itself.

CONCLUSION

Based on the analysis presented in this paper, we suggest that the concept of how the AI experiences the world encompasses both quantitative and qualitative aspects, based on the idea that all forms of intelligence, including thoughts, feelings, and emotions, are influenced by the speed of information processing. This observation has important consequences to the problem of how to measure the duration of a painful experience in a fast sentient AI – whether objectively or subjectively. Bostrom and Yudkowsky's proposed solution to this ethical issue appears problematic, since it relies solely on the controversial assumption that quantitatively reducing this duration would suffice to balance the amount of suffering between humans and AIs.[I]

Drawing from Bostrom and Yudkowsky's example of a fast AI perceiving an external event (such as the falling of a cup), we have examined how its subjective rate of time relates to concepts within the phenome-

I In my paper, "Analysis of the concept of subjective rate of time as a property of Speed Superintelligence", presented in August 2020 at the 10th European Congress of Analytic Philosophy (ECAP10 online), I argued that this concept of how the AI experiences the world has primarily a qualitative nature, besides a quantitative one.

nology of temporal subjectivity, focusing on the difference between *duration of experience* and *experience of duration*. We correlate the duration of experience with the subjective rate of time, as well as the experience of duration with the subjective perception of time, proposing that the distinction between the two pairs of concepts lies in the necessity and contingency of their causal production, respectively.

We conclude by defending the idea that, beyond the variability of the subjective rate of time, which is a quantitative property of fast artificial minds, the exponential increase in the speed of information processing qualitatively affects the way in which AIs experience the world. This intuition finds support in Sandberg's assertion mentioned above (Sandberg, 1999) – that all forms of intelligence, including thoughts, feelings, and emotions, are inherently influenced by the mechanism and speed of *information processing*.

As illustrated by the example provided by Bostrom and Yudkowsky, the fact that a fast AI reads the newspaper in one second entails more than just having more time than we do for other activities or possessing vastly more knowledge than the smartest person in the world. Due to its exceptionally rapid information processing, the act of reading a newspaper holds an entirely different significance for the AI compared to us, encompassing potential thoughts, impressions, and feelings elicited by this seemingly simple experience.

Assuming the existence of an essential qualitative aspect in the way the AI experiences the world has important implications for the ethical question of how to measure the duration of a painful experience in a fast sentient AI – whether objectively or subjectively. Bostrom and Yudkowsky's proposed solution to this problem appears controversial, since it relies solely on the contentious assumption that quantitatively reducing this duration would suffice to balance the amount of suffering between humans and AIs. One should consider the possibility that the suffering of the fast AI may involve more intense pain – or a distinct type of pain – not only due to the prolonged duration of the experience but also because of its unique nature resulting from the increased processing speed, which can deeply affect this complex phenomenon.

The claim that fast AIs can perceive the world both quantitatively and qualitatively also underscores the observation that the subjective experience of temporality, whether in organic or emulated brains, remains mysterious. The subjective rate of time represents just one of the many perplexing implications of the concept of speed superintelligence..

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