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TECHNOLOGICAL SINGULARITY IN THE AGE OF SURPRISE FACING COMPLEXITY

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Abstract

The existing repertoires of the definitions, perspectives and models of Technological Singularity (TS) show that there are only few studies elaborated from the complex, trans-disciplinary perspective, whereas the interdisciplinary or multidisciplinary ones are various. Moreover, those studies are expressions of individual, not collective, complex, networked minds. This is why a real advancement regarding the study of TS is possible only under the following conditions: we need studies made from the complexity perspective, but also studies elaborated by collective (networked), complex minds.

Keywords: interdisciplinary, complexity brake, collective, network, complex minds

1. Introduction and two hypotheses

Among the researchers interested in the effects and consequently in the philosophical dimensions of the so called *disruptive technologies* [1], which are characteristic for our *Age of Surprise* [R. Cohen, *The Age of Surprise. Predicting the Future of Technology*, Forbes, December 18, 2013, http://www.forbes.com/ sites/reuvencohen/2013/12/18/the-age-of-surprise-predicting-the-future-of-technology/, http://www.kurzweilai.net/welcome-to-2035-the-age-of-surprise, http://www.youtube.com/watch?v=9Xpu2QqLnHY], there is a consensus that Technological Singularity (TS) is one of the most controversial, problematic and challenging concepts [http://theratchet.ca/ redefining-the-singularity]. The term disruptive technologies is used here to describe a technology that is intrinsically disruptive So, our focus is on those technologies that are intrinsically disruptive by their broad effects (economic, social, etc.) as it is the case with Artificial Intelligence, Nanotechnology, Genetic Engineering, etc.

It was Vernor Vinge who introduced the term TS (in the January 1983 issue of *Omni* journal) "in a way that was specifically tied to the creation of intelligent machines". "We will soon create intelligences greater than our own. When this happens, human history will have reached a kind of singularity, an intellectual transition as impenetrable as the knotted space-time at the centre of a black hole, and the world will pass far beyond our understanding." [Nikola

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Danaylov (Socrates), *17 Definitions of the Technological Singularity*, Singularity Weblog, August 22, 2012, http://www.singularityweblog.com/17-definitions-of-the-technological-singularity/; *When Vernor Vinge Coined the Technological Singularity*, http://www.singularityweblog.com/when-vernor-vinge-coined-the-technological-singularity/] So, *grosso modo*, TS represents a theoretical future period in time when super-intelligence emerges through technological means, far beyond our understanding.

Because it has been – from its very beginning – controversial, problematic and challenging, the term TS is covering several competing and colliding sets of concepts [2] and is working on many levels [*The advanced apes* on Hubski – a thoughtful web, http://hubski.com/pub?id=81165].

This may be the reason why the attempts of counting and classifying the concepts of TS were not only difficult, but also deeply related to some very different assumptions – philosophical or not – regarding the technology itself. Moreover, the existing definitions of TS seem to be the consequence of the "long-standing debate in the Philosophy of science which seeks to establish whether scientific theories and developments are accepted mainly because of successful novel predictions or perhaps for their successful accommodations of already known facts" [3].

Considering these existing taxonomical efforts, our first hypothesis is the following: most of the current perspectives on Singularity are unable to actually deal with complexity.

Consequently, our second hypothesis is the following: this is why there are so many difficulties, uncertainties and so much haziness regarding the full and appropriate understanding of TS.

2. Methodology

Let us state – as this is one of our ground assumptions – that the existing repertoires of the definitions of the TS are not only remarkable ones, due to the multitude of included definitions and perspectives, but ones inviting for further reflections, too [4].

We shall start with Anders Sandberg's repertoire of the definitions of TS. He presents 9 definitions in a "brief list of meanings of the term 'technological singularity' found in the literature and some of their proponents" [2]:

- *Accelerating change* as technological growth is exponential/super-exponential, and linked to economic growth and social change [5, 6];
- *Self improving technology* as better technology allows its faster development [7, http://flakenstein.net/lib/flake-singularity.pdf];
- *Intelligence explosion* as smarter systems can improve themselves in a strong feedback loop [8; http://webdocs.cs.ualberta.ca/~sutton/ Good65ultraintelligent.pdf; E.S. Yudkowsky, *Three major singularity schools*, 2007, http://yudkowsky.net/singularity/schools];
- *Emergence of super-intelligence* [http://singinst.org/overview/ whatisthesingularity];

- *Prediction horizon* as the "rapid change or the emergence of superhuman intelligence makes the future impossible to predict from our current limited knowledge and experience" [9];
- *Phase transition* as TS could be "a shift to new forms of organization" or "the emergence of a new meta-system level" [10, 11];
- *Complexity disaster* as "increasing complexity and interconnectedness causes increasing payoffs, but increases instability" and as "eventually this produces a crisis, beyond which point the dynamics must be different" [12, 13];
- *Inflexion point* as "the large-scale growth of technology or the economy follows a logistic growth curve", in which "the singularity represents the inflexion point where change shifts from acceleration to deceleration" [14];
- *Infinite progress* as "the rate of progress in some domain tends to infinity".

Anders Sandberg accepts the tri-partition of the definitions of TS as it was set by Nick Bostrom (Verticality, Super-intelligence, Unpredictability) [Nick Bostrom, *Singularity and predictability*, 1998 http://hanson.gmu.edu/vc.html# bostrom] and especially by Eliezer Yudkowski (Accelerating Change, Event Horizon, Intelligence Explosion) [http://yudkowsky.net/singularity/schools] – with a *parti pris* for the last one: "The three major groupings appear to be accelerating change, prediction horizon and intelligence explosion, leading to super-intelligence" [2].

At the same time, he notices that "in addition to the general meaning(s), the singularity might be local or global (evolution capability of an entity or small group, or broad evolution of the whole economy), fast or slow (occurring on computer timescales, hardware development timescales, human timescales, or historical timescales)" and "there is also confusion over whether the salient issue is the point/event-like character, the historical uniqueness, the nature of the overall process or the big historical trend" [2].

His focus is on the growth aspect, as "accelerating change, self-improving technology, intelligence explosions and the complexity disaster (and to some extent the inflexion point) - all involve the growth of the technological or cognitive capability" [2].

Continuing to examine the repertoires of TS, we will shortly refer to the anthology of Amnon H. Eden, James H. Moor, Johnny H. Søraker and Eric Steinhart. In the introductory chapter, they notice that the "accounts of a technological singularity – henceforth the singularity – appear to disagree on its causes and possible consequences, on timescale, and even on its nature: the emergence of machine intelligence or of post-humans? An event or a period? Is the technological singularity unique or have there been others? The absence of a consensus on basic questions casts doubt whether the notion of singularity is at all coherent." [4, p. 4]

Their taxonomy of TS definitions follows a grid using two dimensions/characteristics:

- *Acceleration* as "rate of growth in some quantity" such as: "computations per second per fixed dollar" [4, p. 4]; "economic measures of growth rate"

[15, 16]; "total output of goods and services" [17]; "energy rate density" [18]; "quantitative measures of physical, biological, social, cultural, and technological processes of evolution: milestones or 'paradigm shifts' whose timing demonstrates an accelerating pace of change" – biological evolution [19], developments in machine learning [20-22];

- *Discontinuity* as "an event that may take a few hours" [23]; such as epistemological discontinuities [Y. Hirshfeld, *A note on mathematical singularity and technological singularity*, 'The singularity hypothesis' blog entry, February 5, 2011, http://singularityhypothesis.blogspot.ro/2011/02/note-on-mathematical-singularity-and.html]; "a point of no return" [5, p. 256]; impossibility of humans to understand super-intelligence [24].

Let us notice that some of the definitions mentioned above are embedded in a third repertoire, proposed by Nikola Danaylov: *17 Definitions of the Technological Singularity.*

One has to notice that he is only presenting some of the most well-known definitions more or less related to it, without trying to filter them from a (meta-) theoretical perspective. He accepts the definitions/perspectives of: R. Thornton, editor of *the Primitive Expounder,* Samuel Butler – *Darwin among the Machines*, Alan Turing - *Intelligent Machinery: A Heretical Theory*, John von Neumann, I.J. Good, Vernor Vinge, Hans Moravec - *Mind Children*, Ted Kaczynski, Nick Bostrom - *How Long Before Super-intelligence*, Ray Kurzweil, Kevin Kelly, senior maverick and co-founder of *Wired Magazine,* Eliezer Yudkowsky, Michael Anissimov, John Smart - *Acceleration Watch*, James Martin, Sean Arnott and *Qwiki's Definition of the Technological Singularity.*

When reviewing the perspectives on TS, one should take into account several studies:

- Nick Bostrom's tri-partition – 'The singularity' has been used to mean different things by different authors, and sometimes by the same author on different occasions. There are at least three clearly distinct theoretical entities that might be referred to by this term: a point in time at which the speed of technological development becomes extremely high (Verticality); the creation of superhuman artificial intelligence (Super-intelligence); a point in time beyond which we can predict nothing, except maybe what we can deduce directly from Physics (unpredictability, aka 'prediction horizon') [http://hanson.gmu.edu/vc.html# bostrom].
- Eliezer S. Yudkowsky's tri-partition - "Singularity discussions seem to be splitting up into three major schools of thought: Accelerating Change, the Event Horizon, and the Intelligence Explosion." [http://yudkowsky.net/singularity/schools]

When considering the models of TS, one has to pay attention to Anders Sanberg's paper, as his focus is primarily on the growth aspect: Linear takeover, Logistic growth, Meta-system transition, Accelerated meta-system transition, Accelerating change (Economic input models, Endogenous growth models, Population-technology model, Law of Accelerating returns - Vinge/Moravec, Solomonof, Hamacher), City economics - Hanson [2].

For simplicity reasons, in the next section of this paper, we will consider only the definitions/perspectives/models focusing on the growth and discontinuity aspects.

3. Discussion

Springer's outstanding anthology on the *Singularity Hypothesis* also includes papers expressing concern and scepticism (pats III and IV).

Concern is based on studies from the following fields: Bioengineering of the Artificial Intelligence [25], Cognitive science and Neurobiology of intelligence [26], reverse engineering of the brain [27], and ethics of the post-humanity [28].

Scepticism is based on studies from the following fields: Artificial Intelligence (AI) [29], critics of the techno-economic growth [30], Neuroscience and AI [31], technological supernaturalism [32], rationalist critics of the AI [33], and Physics of the complexity studies [34].

There are a lot of other critiques of the TS that have not been presented in this paper.

The reason is, mainly, the following: what is important for this paper is to notice and agree with the idea that the studies defending, doubting or rejecting the TS are methodologically different, they are often multidisciplinary, sometimes interdisciplinary but almost never trans-disciplinary and they are deeply involved in the encounter and collision between the studies and findings from the area of Human and Social sciences and those from the area of 'hard' sciences.

Regarding the relation between *multidisciplinary, interdisciplinary* & *trans-disciplinary,* the *multidisciplinary* approaches means the association of scholars from various fields in order to provide multiple points of view regarding a particular subject or problem, while the methodologies of the individual disciplines remain more or less intact. The *interdisciplinar*y approach would involve some kind of methodological synthesis of the participating fields of research. *The interdisciplinary* is not necessarily defined based on the object of study, but rather through the adoption of various methods from one discipline to another. The aim of the *trans-disciplinary approach*, characterized by co-operation, is to achieve an overarching synthesis or a larger vision covering several fields [35]. So, multidisciplinary, interdisciplinary or trans-disciplinary approaches are linked to the levels of the interaction between the various disciplines.

The definitions and the perspective/models of the TS presented in this paper are expressions of the need for over passing the disciplinary borders of the theories behind some of nowadays intrinsic disruptive technologies such as AI, Robotics, Nanotechnology, Genetic engineering, Biotechnology towards studies that reach different levels of interaction between these disciplines – some of them already being multidisciplinary/interdisciplinary fields.

The three repertoires that have been shortly presented in this paper seem to confirm, *grosso modo*, such a difference between the *multidisciplinary*, *interdisciplinary* or *trans-disciplinary approaches*.

Secondly, when the multidisciplinary and/or interdisciplinary approaches are easily detectable in the philosophies of the studies behind the definitions of TS, the trans-disciplinary approaches [36], which are deeply related to the complexity studies – even having some good examples in the 3 repertoires [34], can still be better achieved, promoted and developed.

The reason is simple, as Liviu Nedelescu notices: "the world is still dominated by a mechanistic, cause and effect mindset with origins in the Industrial Revolution and the Newtonian scientific philosophy" [L. Nedelescu, *The rising toll of the (still) predominant mechanistic mindset in a complex world*, June 11 2013, Liviu's global perspectives from the inner mind ~ A blog dedicated to the pervasive implications of the perpetual tension between creativity and resistance to change, http://lnedelescu.wordpress.com/2013/06/11/the-insurmountable-toll-of-the-still-predominantly-mechanistic-mindset-in-a-complex-world/]. He adds the names of several researchers – from management, the theory of complexity, the systems theory or AI, who share the same opinion: David Snowden [37, 38], Harrison G. Pink [H.G. Punk, *Elegance and Enhancement*, March 4 2013, Gamasutra. The Art of Business and Making Games, http://www.gamasutra.com/blogs/HarrisonPink/20130403/189745/Elegance__Engagement.php], David K. Hurst [D.K. Hurst, *Organic and Mechanical Approaches to Complex Systems*, October 8 2013, http://www.davidkhurst.com/organic-and-mechanical-approaches-to-complex-systems/], James Martin [39; *Getting Empirical About Complexity in Templates*, https://coderwall.com/p/qdrt3g], Peter Checkland [40], Elizabeth McMillan [41].

Thirdly, the history of Science is full of such attempts to reduce the richness of the facts, phenomena, entities and beings to a Mendelevium type of table. This is the Faustian knowledge management philosophy assumed by the Wizard Apprentice.

It is a sign of a deep belief in the *power of the taxonomy*, which is an effect of the so called presupposition of the 'generic (= linear and fully predictable) universality' [42, 43] – one of the best expressions of a mechanistic perspective on the world, but still an inconsistent use of the generalized induction method – claiming that we could fully reverse a deduction using only the generalizing method, often through strait abduction, in an attempt to rebuild the so called unity of the unbroken original mirror of the human knowledge using its fragments.

Fourthly, as Paul G Allen and Mark Greaves notice [P.G. Allen and M. Greaves, *The Singularity Isn't Near*, MIT Technology Review, 12 October, 2011, http://www.technologyreview.com/view/425733/paul-allen-the-singularity-isnt-near/#.TpXwCd6ImU9], in order to correctly understand the TS, we need to be aware of the complexity brake: "as we go deeper and deeper in our understanding of the natural systems, we typically find that we require more and more specialized knowledge in order to characterize them, and we are forced to continuously expand our scientific theories in more and more complex ways.

Understanding the detailed mechanisms of human cognition is a task that is subject to this complexity brake".

4. Conclusions

When studying the TS, "the amazing intricacy of human cognition should serve as caution for those who claim that the singularity is close. Without having a scientifically deep understanding of the cognition, we cannot create the software that could spark the singularity. Rather than the ever-accelerating advancement predicted by Kurzweil, we believe that progress towards this understanding is fundamentally slowed by the complexity brake." [http://www.technologyreview.com/view/425733/paul-allen-the-singularity-isnt-near/#.TpXwCd6ImU9] Moreover, the "AI researchers are only just beginning to theorize about how to effectively model the complex phenomena that give human cognition its unique flexibility: uncertainty, contextual sensitivity, rules of thumb, self-reflection, and the flashes of insight that are essential to higher-level thought" [http://www.technologyreview.com/view/425733/paul-allen-the-singularity-isnt-near/#.TpXwCd6ImU9]. Higher level thought is simply a complex thought.

This is precisely why *most of the current perspectives on Singularity are unable to really deal with the complexity* and *why they are facing so many difficulties, uncertainties and so much haziness in the full and appropriate understanding of the TS*.

On the other hand, the deterministic and nonlinear interactions of the individual human minds working together in a networked project or in a social network based project, offer the ground explanation for a type of reasoning that is not linear, but complex, as *CrowdForge*, EteRNA experiments (for example) proved [R. Tushar, *Carnegie Mellon Researchers Find Crowds Can Write as Well as Individuals*, The Chronicle of Higher Education, February 3, 2011, http://chronicle.com/blogs/wiredcampus/carnegie-mellon-researchers-find-crowds-can-write-as-well-as-individuals/29440; R. Wiseman, *The Public, Playing a Molecule-Building Game, Outperforms Scientists*, The Chronicle of Higher Education, August 12, 2011, http://chronicle.com/blogs/wiredcampus/the-public-playing-a-molecule-building-game-outperforms-scientists/32835; J.R. Young, *Crowd Science Reaches New Heights*, The Chronicle of Higher Education, May 28, 2010, http://chronicle.com/article/The-Rise-of-Crowd-Science/65707/].

This is why, even considering the power of computation or the complex computation, the management/braking of the complexity seems to be more accessible and feasible when it regards the fact that the results of citizen science (crowd science, networked science)/wisdom of the crowd/networked science are boldly expressing the power of the human mind to collectively overpass the power of computation of our 'smartest' machines just because the machine (=AI), being created using a linear reasoning, cannot deal with the complexity.

So, in order to better understand the TS, we need not only studies made from the complexity perspective, but also studies made by collective (networked) complex minds.

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