



Scientific Singularity Studies

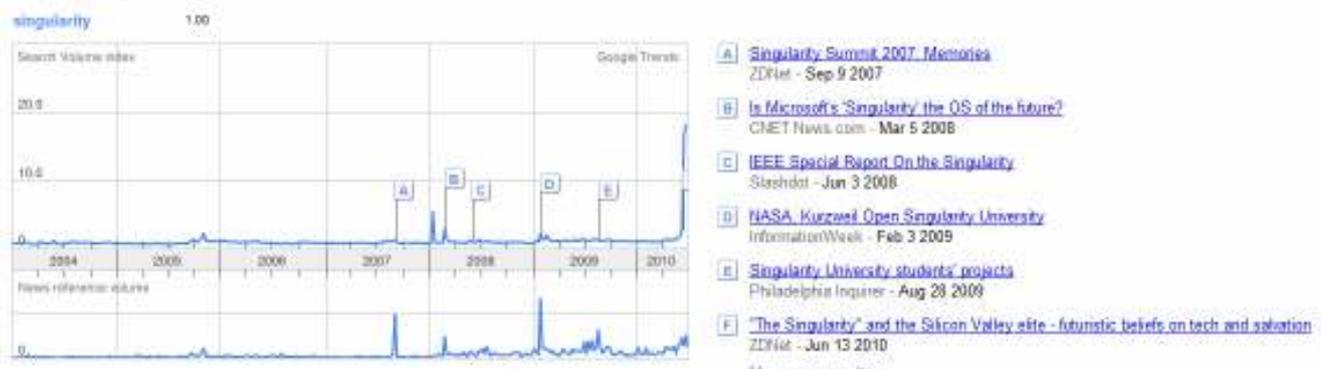
Project Proposal by Dr. Miriam Leis

Note: This is still just an idea!

The project is envisioned as a collaborative work under the (formal) project management of Miriam Leis and is not planned to be directly related to EFP, but insights and results may be shared at EFP. This is still an idea and financial and other issues need to be worked out, but your ideas, input, proposals, funding ideas and requests for participation can be sent to: leis.miriam@gmail.com.

Introduction to “Singularity Studies”

Especially since the release of Raymond Kurzweil’s movie “Transcendent Man”¹ (2009) and the movie “The Singularity is Near”² released in 2010 as well as feature articles in IEEE (2008)³, the New York Times (2010)⁴ and popular magazines and the founding of the “Singularity University”, the concept of the so-called “technological singularity” (Vinge, 1993 / Kurzweil 1999; 2005; 2009; 2010) is more and more entering public perception and debates. It has also been an inconclusively debated topic at the 2010 conference of the World Futurist Society⁵. Looking at google-trends there has been a steep increase in google search requests on the term “singularity” in 2010.



Although there already exist vivid discussions on the internet and among intellectuals if a so-called “technological singularity” (S^{\wedge}) may ever happen, there does not yet exist a clear and common definition of the concept, even among futurist circles. However, certain elements are central to all definitions (for more detailed information refer to the annex II)⁶:

- The assumption of accelerating (or sufficiently fast) technological progress;
- The assumption that the resulting societal and economic changes will at some point become so fast that they will be incomprehensible to what is currently considered as a “normal human”;
- Sufficiently reliable predictions about the future will become increasingly difficult for increasingly smaller time scales due to fast changes and new possibilities;
- The singularity will bring about profound und unprecedented changes for humanity

Further, the singularity is generally regarded as a generalisation of “Moore’s Law” that refers to the exponential growth of many parameters in ICT and is often considered to be the result of

¹ <http://www.transcendentman.com/>

² <http://www.singularity.com/themovie/index.php>

³ <http://spectrum.ieee.org/biomedical/ethics/signs-of-the-singularity>

⁴ <http://www.nytimes.com/2010/06/13/business/13sing.html>

⁵ <http://twitter.com/#search?q=%23wf10>

⁶ <http://www.kurzweilai.net/the-law-of-accelerating-returns> and <http://ieet.org/index.php/tpwiki/Singularity/>



advances in Artificial Intelligence (self-improving AI) as well as converging technologies (NBIC)⁷ and may even lead to a “posthuman” future (cf. annex II).

Project plan proposal in brief and relevancy of the research

Whereas the “singularity” appears in some future scenarios and there is already a vivid discussion going on mainly on the internet about pros and cons and desirability, *there still seems to be insufficient scientific research being conducted around this concept*. Such a scientific study – the Scientific Singularity Studies” (S³) - would tackle issues like:

- “Singularity”: (Weak/early) signal, hype, social construct or something to be concerned about?
- Scientific research about the different concepts and definitions of the "singularity"
- Drafting a definition that needs to fulfil certain scientific criteria (with the input of relevant experts and stakeholders)
- Assessing the relation between forecasting (quantitative, economic/technological projections) and foresighting (focussing on societal influences) within this context
- What would be needed to arrive at a state that fits the proposed definition of "singularity"
- How can these states and changes associated with the “singularity” be measured? (e.g. what is it that is supposed to accelerate and/or change and how to measure it?)
- Weak signal scan for and “measurement” of relevant developments and counter-developments towards such a defined state

Some methods applied within a project could be:

- Scenario development in regard to different outcomes of (fast) technological development/acceleration or counter developments
- Evidence-based assessments and support for evidence-based decision-making
- Ethical, legal, societal assessment in relation to possible developments & policy options
- Expert discussions about pros and cons, sceptics and advocates
- Relation to policy making (innovation, risks, research etc.)
- Drafting a business concept around the issue (optional)
- Constant updates on the state of the research in line with occurring developments
- A website with a WIKI/glossar of related terms⁸
- A scanning database
- Expert discussions and possibly a conference
- Surveys
- Publications (papers, online, conferences)
- 3 to 5 participating researchers (or more)



Dr. Miriam Leis works as foresight researcher at TNO since May 2008, specialising in emerging technologies (e.g. NBIC, biomedical engineering, Human Enhancement Technologies (HET), advanced robotics and AI, synthetic biology), future issues (e.g. megatrends, weak signals, Grand Challenges), ELSI/ELSA of emerging technologies, vision assessment and foresight methodology.

She studied political sciences (with specialisation in biopolitics and international relations) and sociology (specialization: sociology of technology and scientific methodology) at University Konstanz (Germany) and got her PhD in sociology with an interdisciplinary thesis about non-industrial robots.

Specialties:

Analysis about societal implications of emerging technologies, ELSI-analysis, NBIC-convergence, future/foresight analysis and methodology, scenario studies, consulting, futurist (NBIC, HET, S³, h+) activities in futurist NGOs (Above this: formal university training in scientific methodology, statistics, game theory, qualitative and quantitative survey design, social network analysis).

⁷ For more information cf. Annex II

⁸ The IEET has a similar project, although with a slightly different objective: <http://ieet.org/index.php/tpwiki/>



Annex I: Draft Project Plan

The project is designed to be scalable and can be designed from being a small internal project to fill “indirect hours” to a large-scale undertaking aimed at becoming an internationally renowned institution dealing with the topic of scientific singularity studies. The infrastructure for both ambition levels (internal small project and international institution) exists or can be established.

The basic programme would include the following activities:

- Discussing in how far these activities could be integrated or done in cooperation with other activities and institutes with varying views on the topic;
- Scanning of relevant documents and media related to the topic of “technological singularity” and providing a document with summarizing the history, different view points, media representations, perceptions and the development of the topic;
- (Re)assessing the concept of “technological acceleration”;
- Developing a working definition of the concept of the “technological singularity” that satisfies scientific standards and contains elements that can be objectively observed and measured;
- Setting up a scanning/assessment methodology to assess the identified criteria;
- Archiving information about scientific and technological developments;
- Internal “get togethers” to discuss findings;
- Internal publications

On a medium-ambition level the following activities could be included:

- Scenario developments
- Expert consultations, workshops and conferences with external participants representing different opinions;
- Establishing networks with external partners representing different perspectives;
- Representation at conferences
- External publications

High ambition level:

- Establishment of a standing institution dealing with “singularity studies” which could also be re-formulated (e.g. emerging technology studies etc.) depending on the outcome of the previous research (i.e. if it the topic of “singularity” remains an issue or not after our initial research phase).

All activities are of use regardless of the “singularity” hypothesis being considered useful or not.



Annex II: Basic concepts and definitions of terms

Technological Singularity

Central to all definitions of the “technological singularity” that is commonly referred to by the following characteristics:

“The Singularity is a theorized future point of discontinuity when events will accelerate at such a pace that normal unaugmented humans will be unable to predict or even understand the rapid changes occurring in the world around them.”⁹,

This definition is agreed upon by most of the futurists who have coined the term around the 1990s. Questions, however remain if and how such a state as described above (in this sense the “singularity” is rather conceptualised as a scenario) may come to be realised. In this form the definition also raises methodological questions, i.e. what is meant by discontinuity, how to measure acceleration and has acceleration to be seen in relation to societal, economic and legal adaptability to new scientific and technological possibilities and in how far can one talk about the “predictability of the future” in the first place?

Above this, the hypothesis about the technological singularity is based on the assumption of exponential growth measured as outcome, change or progress within fixed time intervals. The concept is based on the so-called “Moore’s Law” that forecasts the doubling of specific ICT relevant parameters (e.g. number of transistors on an integrated circuit at fixed size and cost as well as related parameters like memory at constant costs or processing speed) approx. every two years. Such exponential growth patterns can also be seen within biological processes (cell division, biological replication, cf. “Malthusian” growth model), learning curves as well as financial investments (cf. Davidson 2002)¹⁰.

Thus there is an inherent property to exponential growth ($f(x) = 2^x$) curves which basically stay the same in shape and just vary in steepness depending on the definition of the intervals (e.g. one interval = 2 years, 4 years etc.). At some point, ultimately the curve inevitably becomes nearly vertical, which could be interpreted as “nearly infinite” growth (change or whatever denoted by the y-axis) within an extremely short time interval (x axis). This property is commonly referred to as the “singularity” and in mathematics refers to a point at which a function can not be defined; and in astrophysics/cosmology a singularity is defined in the context of black holes and “infinite” gravity and density.

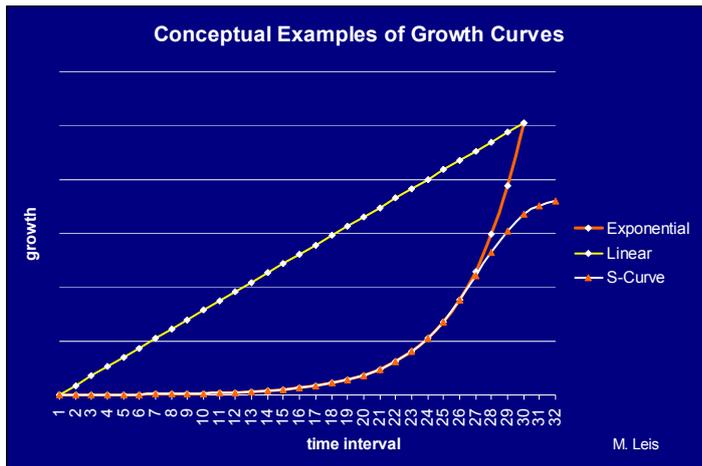
In contrast to linear growth, exponential growth shows the interesting property that not much change/growth happens for a long time until at some point a critical state is reached when the growth and acceleration takes visible effect.

Among others, one analytical issue might be to assess at which point the exponential growth development may reach a certain crucial state, i.e. where the “take-off” really takes effect. Another analytical question would be the assessment of exponential growth curves, so-called s-curves, overlapping s-curves and the relevancy of accelerating and de-accelerating phases for scientific and technological progress.

Last but not least the question remains if there can be observed an acceleration and “exponential growth” and if, about what and what does it mean.

⁹ <http://ieet.org/index.php/tpwiki/Singularity/>

¹⁰ <http://www.rgm.com/articles/davidson.html>



Conceptual example of different growth curves:

- Exponential
- Linear
- S-curve (starting as an exponential curve but flattening after some point (de-acceleration))

Although linear growth may yield the same result, its development may be perceived less sudden, surprising and dramatic. In regard to s-curves the point of what has been achieved prior to the flattening may be of relevance.

Other terms related to the “technological singularity”

NBIC Converging technologies

The convergence, i.e. the mutual influences of nano, bio, info and cogno sciences and technologies (NBIC) is assumed to contribute to the acceleration of scientific and technological progress in general and thus increases the probability for the potential realisation of a “technological singularity”.

Nanotechnology (miniaturisation), biotechnology and neurotechnology (fusing ICT with the working and structures of biological brains in hard and software) contributes greatly to the further development of computing technologies and Artificial Intelligence (AI) and could possibly lead to self-improving AI. NBIC convergence could also lead to technologies that might profoundly impact properties of human nature by enabling possibilities like better cooperation between AI and human intelligence (ICT interfaces, semantic web, AI), extreme life extension, modification of biological properties to improve human health, survivability and abilities (Human Enhancement Technologies).

Artificial General Intelligence

Artificial General Intelligence (AGI) is a term being used for so-called “strong AI” that aims at designing machines to possess general properties of intelligence in contrast to only specific forms of intelligence as encountered in (most of) today’s robots and AI programs. The term is also often equated with AI that matches or exceeds human level intelligence, whereas the concept is still difficult to assess due to a lacking definition of “human intelligence” and its relevant properties. In contrast to human intelligence that is constrained by biological properties and is not expected to increase significantly on a natural basis, it is assumed that if an AI has reached a specific level of intelligence it may be able to improve itself autonomously and thus be able to far exceed human capabilities (e.g. due to its intrinsic capabilities of dealing with digital data and fast parallel processing).

Human Enhancement Technologies

Human Enhancement Technologies (HET) describe any kind of method based on science and applied technology that is aimed at increasing a healthy human individual’s “possibility space” of capabilities beyond the current status quo. It can aim at different dimensions of human existence like life span, survivability, intelligence, emotional/psychological capabilities, physical strength etc.

Posthuman

A “posthuman” is a hypothetical future being that either develops out of a fusion of human and artificial intelligence (e.g. advanced brain-computer interfacing, brain simulations/emulations or neurochips) or through the application of human enhancement technologies whose capabilities by far exceed that of current humans.



Annex III: Some Resources

Major Web Resources:

- Accelerating Future (blog): <http://www.acceleratingfuture.com/michael/blog/>
- Accelerating Studies Foundation (Institute): <http://www.accelerating.org/>
- Institute for Ethics and Emerging Technologies (Institute): <http://ieet.org/index.php/IEET/IEETblog>
- KurzweilAI.net (blog/institute): <http://www.kurzweilai.net/>
- Lifeboat Foundation (institute): <http://lifeboat.com/ex/main>
- Oxford Future of Humanity Institute (Institute): <http://www.fhi.ox.ac.uk/>
- Singularity & Futurism Documenting the Approaching Singularity (blog) <http://www.thepriceofrice.com/>
- Singularity Hub (blog): <http://singularityhub.com/>
- Singularity Institute of Artificial Intelligence (institute): <http://singinst.org/aboutus/>
- Singularity University (institute): <http://singularityu.org/overview/>

Collection of related news about scientific and technological developments:
<http://quemot.wordpress.com/tag/s/>

Recent discussions:

- Scientific American Blog (2010) Singularity Schtick: Hi-tech moguls and The New York Times may buy it, but you shouldn't (23.06.2010)
<http://www.scientificamerican.com/blog/post.cfm?id=singularity-schtick-hi-tech-moguls-2010-06-23>
- New York Times (2010) Merely Human? That's So Yesterday (June 11, 2010)
<http://www.nytimes.com/2010/06/13/business/13sing.html>
- IEEE Spectrum (2008) Signs of the Singularity (June, 2008)
<http://spectrum.ieee.org/biomedical/ethics/signs-of-the-singularity>

Movies:

Kurzweil, Ray (2009) Transcendent Man (<http://transcendentman.com/>)
Kurzweil, Ray (2010) The Singularity is Near (<http://www.singularity.com/themovie/index.php>)

Some prominent publications mentioning the concept of the singularity:

- Coenen, Cristopher (2007) Utopian Aspects of the Debate on Converging Technologies
<http://www.itas.fzk.de/deu/lit/epp/2007/coen07-pre01.pdf>
- ETAG (2006) Technology Assessment on Converging Technologies
<http://www.itas.fzk.de/eng/etag/document/beua06a.pdf>
- Kurzweil, Ray (2005) The Singularity Is Near: When Humans Transcend Biology
- Kurzweil, Ray (1999) The Age of Spiritual Machines
- Nordmann, Alfred (2009) Singular Simplicity
<http://spectrum.ieee.org/robotics/robotics-software/singular-simplicity/0>
- Vinge, Vernor (1993) The Coming Technological Singularity: How to Survive in the Post-Human Era (<http://www-rohan.sdsu.edu/faculty/vinge/misc/singularity.html>)