Digital networks, knowledge and political biases in their understanding and use[1]

Giuseppe Longo[2], Lorenzo Seno[3]

Abstract

Current Internet technologies are the result of an original assemblage of old and new technologies, whose networking interaction produces novelties. An analysis of some key aspects of this technological blend may help to understand the emergence of unpredictable features and their effects on human communities. Yet, these phenomena are not uniquely determined by the technological infrastructure but also depend on the underlying social and economical trends. Often, unsound claims and promises bias the role of the Internet and artificially canalize its aims and potentialities towards a decreasing diversity of human experiences. Moreover, the digital world is often used as an "image" for physical or biological phenomena, or even as an intrinsic structure of knowledge or reality. Its use, instead, in an interactive and constructive way may enhance human activities and increase knowledge by sound practices. The role of "information" is crucial in this context. This notion is identified, in physics, with "negentropy" (or negative entropy): a close analysis of the current ideas of entropy, negentropy and "anti-entropy" will help to clarify and focus on the general phenomenon also concerning human activities. In particular, the abstract discussion may clarify the polymorphic meaning and the actual role of information.

Keywords. Technological assemblages, discrete data types, one-dimensional coding, stereotypes, diversity, abuses in Big Data, entropy, negentropy, anti-entropy.

More Keywords and Themes :

A modified semiotics, dualism, one-dimensional coding, measurement, exact data, following the rule, term rewriting systems. How increasing concentration of wealth and power changes the networks; the possible "distributed" alternatives; elaboration of information vs construction of sense; averaging out; stereotypes (bibliometrics vs access to knowledge); expression or repression of minority thinking.

1. Emerging Qualities

1.1. The origin of the Internet and the transition from the old to the new Economy

The Internet is probably the most important "innovation" in the aftermath of WW2. It contributed in a decisive way to the large scale diffusion of new technologies and products such as computers and smartphones.

It comes from the demilitarization of ARPANET, the state-funded military computer communication network developed in USA at the end of the 60's. In the 70's many

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2 Centre Cavaillès, CNRS et École Normale Supérieure, Paris, and Department of Integrative Physiology and Pathobiology, Tufts University School of Medicine, Boston, http://www.di.ens.fr/users/longo .

3 Former intrepreneur, Microelectronics R&D Corporate manager, Informatics Faculty, Dept. of Economics at the University Roma 3, Musical signal processing teacher at the L'Aquila Conservatory, Italy.

institutions and companies developed similar networks: NFS[4], NASA, and DOE[5] , as well as DEC[6] and HP[7]. In Europe, in the 80's, CERN developed its own network, and the same happened in Asia. These networks shared the same "technology" adopting the TCP-IP protocol, intrinsically "decentralized", which allowed the subsequent interconnection of these different networks into one, the "Inter-net". In France, in the '80s there was the Minitel (Vidéotex), a network delivering some services, including selling, but founded on a different architecture of protocols. In the '90s it was replaced by Internet.

Then came the World-Wide Web (WWW) – i.e. what regular users see, where Internet is behind the scenes. TCP-IP allows several overlying protocols at the same time, in order to accomplish different tasks: exchange of emails and text or vocal messages, download of files, broadcast of sounds, movies, and the diffusion of hypertexts (linked web pages) and so on. A multi-modal, universal network was built up.

This "innovation" was a typical outcome of the "military fallout" mechanism, which dominated the so called "Old economy" until the '70s: state-funded Research and Development (R&D) made in the military industry, capable of introducing new ("innovative") devices on the grounds of new technologies coming from basic research. When some of these technologies became obsolete, it was "demilitarized" and made available ("fall out") to the mass-market. It is for example the case of nuclear fission energy, which derived from the demilitarization of the Atomic Bomb-related technologies; of transistor and micro-chip (microelectronics), which are the foundation of digital technologies.

Starting from the '70s, the Thaw made military technological advancement less crucial, so state-funding of the military industry declined. A new innovation mechanism was introduced: the so called "New economy", strictly tied to the "financialization" (or "globalization", or "neoliberalism", i.e. the current state of affairs) – a process extensively state-funded (from R&D to including marketing) in turn strictly tied to the main feature of those days: a long-standing growth of new, fresh, expanding markets, based on entirely new ("innovative") products (computers, digital devices, mobile phones, smart phones, CD, DVD, and so on).[8] Those times are now over, all these markets being almost "saturated", "mature" markets, i.e. mainly "replacement markets".[9]

This transition is generally referred to also as "financialization", interpreted as "the rise of the power of "finance" – stock exchange, Big Banks, and so on – which prevails over the "real economy" (industrial production).

As a matter of fact, this process nevertheless pertains to both the "financial" sector as well as to "real economy", strictly intertwined. The reader should consult *Reclaiming the State*[10] for a comprehensive analysis of these topics from a social, economical, and political standpoint.

Although the Internet is an outcome of the Old Economy, its subsequent history is strictly intertwined with the "New economy". On one hand, since it is a network that connects computers, its success strictly depends on the large diffusion of computers in homes,

4 National Science Foundation (USA).
5 Department of Energy (USA).
6 Digital Equipment Corporation (USA).
7 Hewlett-Packard (USA).
8 For a more detailed discussion of this topic, see **"Why the development engine broke down"** I IEA Nantes, February 2014. Available here for free download: http://www.acustica.org/publicat.htm#2014 p. 25.
9 For a more thorough investigation on the Old to New Economy transition, see Lorenzo Seno, **"Why the development engine broke down"** I IEA Nantes, February 2014. Available here for free download: http://www.acustica.org/publicat.htm#2014, p. 25.
10 William Mitchell & Thomas Fazi, **"Reclaiming the State"** Pluto Press, London, 2017 ISBN 978 1 7868 0149 [3, 6, 7, 0, 4]. Available here: https://www.plutobooks.com/9780745337326/reclaiming-the-state/

which started in the '90s. On the other hand, it has greatly helped the diffusion of computers, because in order to access WWW services, you need to own a computer, or later a similar device, such as nowadays' smartphones.

1.2. The Internet, the New economy and "cycle inversions"

In the XIX century, in order to describe the main implication of the transition from the "Ancien Régime" to the "Capitalist mode of production" (aka "modernity"), Karl Marx writes about an "inversion of the cycle": from "Commodity-Money-Commodity" (C-M-C) to "Money-Commodity-Money" (M-C-M). This implies a further "inversion" between Means and Purposes: before modernity, Money was a *means* to exchange Commodities, which was the *purpose* of the action – exchange by money as a replacement of barter. After modernity, Money became the *purpose* of the exchange, thus Commodities became the *means* for that. The aim is then Capital accumulation, by means of the progressive accumulation of "surplus value".

The modern switch from the Old to the New economy brings on further "cycle inversions". The first is the cycle of accumulation: in order to create an enterprise one needs Capital. The purpose of such an enterprise is to sell its products to customers in order to make profit (margin), thus to progressively accumulated Capital.

The New Economy provides instead a new mechanism: Capital (enterprise value) can improve by itself, via increases of stock value. What any enterprise sells are thus its own shares to "customers" (i.e. Stock exchange), whose price is based on the expectations share value growth itself, more than on the enterprise's profit growth. Shares thus become a commodity. Profit is of course again involved, becoming however a *means*, not a *purpose*. By buying and selling shares at the appropriate moment the owner makes a capital gain well above dividends. Nowadays finance tools allow capital gains also when shares slump, so that the trader of the new economy can say "a good trader always makes money, no matters if market surges or slumps. What matters is that it moves". Profit role become thus to be a vow of future share value improvements. This is synthesized in the theory "Maximise Shareholders Value" (MSV) as the paramount strategy of any enterprise[11]. This may be largely independent from increased productivity or technological progress. Money is made out of fluctuations, erasing any role of "trends"[12].

One of the main tools to line up the different sectors of the economy to MSV were the Stock Options[13], by which the Companies boards payouts are strictly tied to the company itself share values raise. This brought to the practice of "buy-back", i.e. where a company pushes up its own shares price by buying them itself. Cash is thus subtracted from investment – mainly in Research, a risky and long term business. This novelty, a result of "deregulation", badly affected technological advancement. Only short term areas – thus "visible" to the stock exchange such as Marketing, Advertising, or Development at best – are attractive for investment. This is the so called "short-termism", a hallmark of the New Economy.

Its not completely new: about this "disentanglement" between value and profit, the role of promises and the truth of the trader maxim, you can find many episodes in the transcript of a '90s documentary[14], particularly in what the Narrator says about Jesse Livermore's

11 See Lorenzo Seno, **"Why the development engine broke down**", I IEA Nantes, February 2014. Available here for free download: http://www.acustica.org/publicat.htm#2014 p. 19

12 See Bouleau N., **Wall Street ne connais pas la tribu borellienne**, Spartacus, Paris, 2017.

13https://www.optionsplaybook.com/options-introduction/stock-option-history/

14 Transcript of the '90s documentary "The crash of 1929". English and Italian text available here: http://documentazione.altervista.org/The_Crash_of_1929.html. Documentary here: https://www.youtube.com/watch?v=7EPTCm9RVRM and here: http://documentazione.altervista.org/crash29.html

wife, in October 29th. You can also encounter similar features during the various "bubbles" in the history of "modernity" and even before – for example the "Tulip mania" during the XVII century, or the South Sea Company bubble in the XVIII century[15]. In current financial events it is easy to find many examples of a similar "disentanglement".

During the eve of the "Dot com bubble", in 1994, Intel – the sole supplier of the star of the CPUs (the heart of any computer), Pentium – got in trouble: it was Intel's *annus horribilis*. One of the commentaries explaining Intel's problems was: "Margins matter less than volumes"[16].

In a more recent news (October 2017) there was a sudden five-fold increase in stock quotations due to a change in a company name: "Bubble Watch: 'On-line Plc' Changes Name To 'On-line Blockchain Plc' And Share Price Skyrocketed 394%"[17].

The same phenomenon may be observed in the financial situation of a couple of Big Internet Corporations – Facebook and Twitter.

As to income, Facebook is doing very well: its net income has grown from 32 Million US$ in 2012 to 10,2 Billion US$ in 2016, about 320 times higher, an excellent result.[18]

As to a shareholders value evaluation, Facebook performance is excellent as well: the share price has grown from about 21 US$ in 2012 to about 180 US$ in 2017[19], about 8,6 times. As expected: share values rise together with income (thus margins).

Lets now make the same analysis concerning Twitter.

Under income evaluation, Twitter is doing very badly: the net income has gone down from -79,4 Million US$ in 2012 to -456,87 Million US$ in 2017. The minus sign makes these "incomes" actually a loss. These losses – accumulating for five years in a row – have increased by a factor of about 6.

The impact on the shareholders value is of course negative, but not as much as expected[20] for a Company which is – from an "old styled" standpoint – close to bankrupt: Twitter's share has gone down from 45 US$ to 21 US$ in 2017, a slump only of a factor about 2[21].

Despite this, Twitter is always there, and "analysts" are wondering about targeting it as an investment[22].

Thus, there is a "disentanglement" between economic and financial performance: they are weakly or not correlated at all, depending on extra-economics circumstances.

1.3. Internet features compared to traditional networks

The Internet is of course not the first communication network in the history: Telex was introduced during the XIX century and so was the fax (Telex network based). Then the telephone (beginning of XX century) and the radio came (1920s). The Internet is nevertheless very different from these media of communication not only on the grounds of

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15 More details in **"Why the development engine broke down"**, I IEA Nantes, February 2014. Available here for free download: http://www.acustica.org/publicat.htm#2014 p. 13.

16 See **"Why the development engine broke down"**, I IEA Nantes, February 2014. Available here for free download: http://www.acustica.org/publicat.htm#2014 p.12.

17 https://www.silverdoctors.com/headlines/world-news/stock-market-bubble-watch-on-line-plc-renames-to-on-line-bitcoin-plc-and-share-price-skyrockets-394/.

18 https://www.marketwatch.com/investing/stock/fb/financials.

19 http://www.nasdaq.com/symbol/fb/historical.

20 There is a deep asymmetry between losses and gains: gains can last forever, losses only for a limited time, after which bankruptcy arrives.

21 http://www.nasdaq.com/symbol/twtr/historical.

22 https://secure.marketwatch.com/investing/stock/TWTR/financials

its extensive diffusion, but because it allows diverse ways of use, an original sum of all previous and new modalities. It allows peer-to-peer modality, and one-to-many modality. It also allows for a “broadcast” modality (by means of streaming), while remaining essentially an “on demand” medium. When you switch on your TV set, you have only to choose a channel, then you get what is broadcast to you and to everyone else. The Internet user cannot simply switch on his computer and listen to or watch something on the screen. He has to decide and search for something he needs, likes, or wants.

The on-demand modality is not a novelty, as both telex and telephone are intrinsically “on demand” media, but they are confined to the peer-to-peer modality, and to oral or written communication. An attempt to use the telephone network to spread music as early as the beginning of 1900 quickly failed[23]. Even the traditional TV, when the Satellite arrived, adopted the “on demand” modality (mainly for movies), considered attractive from a marketing point of view, yet the modality remained “one to many”.

The Internet is instead intrinsically “multi-modal”, and this is mainly the reason of its huge social, cultural and political impact. In short, it allows peer-to-peer, one-to-many, many-to-many communication, as well as oral, graphics, music, movie … all modalities of communication. Moreover, all these modalities are available to anyone: everyone can publish anything for a restricted set of friends, or for everyone all around the world, even for free. There are plenty of providers who give you the capability to build your site for free.

These features have allowed the “transfer” of functions of traditional media (newspapers, TV, Radio) to the WWW, as well as the “invention” of new ones, such as (personal) blogs, on-line encyclopedias, fully on-demand streaming, newsgroups …

The nature of the Internet nevertheless shuffles the deck: traditional media are “centralized” and easily controlled “from above”, while on the Internet anyone is potentially able to communicate anything to a general audience. This led to the birth of whistleblowers, either as single persons or as communities like Wikileaks – a circumstance, even today, able to infuriate the “establishment”.

The “on-demand” nature of the Internet nevertheless means that search engines have a huge importance, because the Internet does nothing if you don’t take the lead and search for something. This quickly led to oligopolies (Google, Amazon, and so on …) which were able to create a fresh new market: that of marketing data. This introduces a new “inversion”: users become a commodity. And what a commodity!

Google is a search engine, but its main (remunerated) job is to track your activities on the WWW in order to collect statistics. These are used to set up an efficient, targeted and personalized advertising. For this, Google’s customers – the advertisers – will pay large amounts of money. This is the origin of “Big Data”. So, what Google sells to its customers is *you*.

In short, Google is mainly an advertising and marketing Data seller: the search engine is a *means*, not a *purpose,* another one of those “inversions”, so clearly understood by Marx.

Also Amazon, despite appearances, is a search engine you can use to find the merchandise you need. It is not a shop – you buy nothing from it, since you buy from shops, the shops are Amazon’s customers, and they pay Amazon for supplying them with customers. Again, Amazon's merchandise is *you*.

This “inversion” is not new, nor tied specifically to the Internet or WWW. It was formerly adopted by the classical media, such as newspapers and TV chains. It was explicitly

23 It was the Telharmonium, by Thaddeus Cahill, USA: https://en.wikipedia.org/wiki/Telharmonium

disclosed in 2004 by a French TV “Patron”, Patrick Le Lay, in an interview who made a splash all around France[24]:

“Patrick Le Lay, TF1 CEO, interviewed together many others in a book whose title is “Managers in front of the change” (Éditions du Huitième Jour), shows his views about TV: «TF1’s job consists of helping for instance Coca-Cola in selling its products»; he then added: «In order to be sensitive to advertisement, the viewer’s brain has to be receptive. All our TV broadcasts have the target to make him/her receptive : i.e amusing, chilling out the viewer, in order to prepare him/her between two advertising. We are selling to Coca-Cola the human brain’s available time.»”

1.4. Internet as a countermeasure: communities

Governments and Security Agencies can “control” from the top at least in part the activities of Internet users, or forbid access to some resources. This is also not a novelty: government agencies and the judiciary have always been able to read private mail, to record phone calls, to shut down TV, radio channels, newspapers and so on. Wrongdoers can crack your site, your email account, PC, smartphone and the like. Again, this is not new: wrongdoers were able to open your lock-box even without damaging the lock, to steal your mail, even to listen private conversations at your home using special remote focusing microphones, installing a wiretap, or using laser-based devices to remotely detect the vibrations of your windows.

The same features of the Internet allow however a flourishing of alternatives, opposing those intrusive features: search engines that do not track user activities[25], “private navigation modalities[26]” up to the TOR network and browser that hides your WWW navigation from everything and everyone[27], even to security governmental Agencies. Emails and voice conversations can be encrypted by means of a public key algorithm[28]. Files can be encrypted using hardly crackable algorithms such as AES 256 bit, and so on.

So, in addition to the classic media, on the Internet anyone can publish his own blog; a small community can set-up a news and commentary website to counter mainstream news, propose different views in aesthetics, politics, economics, philosophy, science, technology, and so on. Newsgroups provided to large, worldwide communities a way to lead discussions, exchange news and information.

Internet allows countermeasures which were absent in previous media, a completely new phenomenon: to build up from small to huge communities, whose “glue” is represented by a broad range of motivations: common interests, friendliness, taste, aims, culture, professionalism, financial motivations, and so on. The “medium” is the Internet, without which all that would have been impossible.

Of course, this allows[29] also bad behaviors: f.i. terrorism and scams (phishing, cracking). However, opponents communities can easily spread information about the wrongdoing, broadcast advice and warnings.

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24 This was AFP 09/07/2004. Here reported by Libération: http://www.liberation.fr/medias/2004/07/10/patrick-le-lay-decerveleur_486069

25 DuckDuckGo, Startpage, Ixquick, Disconnect, Privatoria (VPN who conceal your IP).

26 Nowadays allowed by any web navigator as Firefox, Chrome, Chromium, Opera, Safari, and so on.

27 Your Internet Provider can detect you when you are connected to a TOR router, but none can see what and where you are exchanging information. The final target, the web server, f.i, will see the IP address of the last TOR node, but it will ignore your own IP address. More here: https://www.torproject.org/ https://www.torproject.org/about/overview.html.en .

28 F.i. PGP: https://en.wikipedia.org/wiki/Pretty_Good_Privacy; here a tutorial: http://pitt.edu/%7Epoole/PGP.htm

29 Despite what classical media believe, “allow” isn’t a synonym of “cause”.

One of the most relevant Internet communities is the “Open source” one, which appeared long before today’s trendy “social networks”. A community which largely contributed to the development and improvement of the Internet, WWW and the digital market in a broad sense. It would never have existed – at least in the present form and extension – without the Internet.

Open Source brings to the Internet itself the software it needs, which is both open and free (both in the sense of “freedom”, and as in “free beer”). Linux and its hundreds of different “distributions” comes from it: it is an Operating System which is nowadays installed in nearly all web servers all around the world, and even in the huge majority of Internet routers. It has recently started to spread to the end users, competing with products from corporations such as Microsoft and Apple.

This is a huge, worldwide community of highly professional developers, none of whom suffer from the decline of professionalism and from the lowering of the quality of products which is currently affecting industry, mainly – but not exclusively – in the digital and software fields. It is of course in principle possible that a governmental Security Agency, or other group could infiltrate such a community, but it is hardly possible that such a break-in could escape from the scrutiny and monitoring of this huge community. So, the widespread feature and huge dimension of the Internet acts as a countermeasure. Also this is not new: it is impossible, and has always been impossible, to contain or tap large numbers of people, for trivial reasons. On the contrary, the large numbers of people interconnected helps the “masses” to find a way to counteract any attempt to put them under control. A feature that Internet has not inherited from previous, traditional communication media, or that goes well beyond previous existing features.

The slump in product quality comes from the “financialization” of the economy and depends on various reasons, which do not affect the Open source world, intrinsically extraneous to finance. Since nowadays the stock exchange is the customer of actual enterprises, merchandise and services become a means and not a purpose. Thus, the product quality loses importance, as well as the professionalism of workers at different levels, since most jobs are temporary and precarious. Professionalism requires continuity, time, and direct learning and training by more experienced workers. In the USA amid Universities[30] there exists an initiative called HCD (Human Centered Design)[31] as a reaction to this loss of quality “by design”. There is also a debate on this issue, and some[32] criticize this approach considering it as inadequate, and propose the ACD (Activity Centered Design). In one of these texts[33] one can read: “The plethora of bad designs in the world would seem to be excellent demonstrations of the perils of ignoring the people for whom the design is intended. Human-centered design was developed to overcome the poor design of software products.”

Following current media usage, “innovation” means “introduction in the mass-market of a product already existing at a smaller market scale, or of a new product based on already developed technologies”. For example, the mobile phones were available since long ago at a small-scale, for a very high price, for very big companies’ private networks. It was then rolled out in the large-scale, low-cost market starting by the end of the ‘50s[34]. Or the smartphone in the '90s, which is the result of the fusion of a couple of existing products into one: a digital mobile phone and a PDA (“Personal Digital Assistant), which was more or less a smartphone minus the phone. Innovation is thus more a matter of the “D” (in the R&D acronym) and “M” (Marketing), after which comes the “S” (Sell).

30 As Virginia Tech: http://hcd.icat.vt.edu/, for instance.
31 https://en.wikipedia.org/wiki/Human-centered_design.
32 http://www.jnd.org/dn.mss/human-centered.html.
33 http://www.jnd.org/dn.mss/human-centered.html.
34 MTA (Mobile Telephone system A), Ericsson (https://en.wikipedia.org/wiki/MTD_(mobile_network)#MTA)

Financialization provided nevertheless a path to “sell” also the research activity, but in a different way: all in the attempt to sustain stock prices. It helped to multiply – by means of advertising – hugely spread promises all around the world concerning new, incoming innovations, supposedly available in a few years[35]. In this way, it can be understood the emphasis of the newspapers and media reports about the promise of “incoming” innovations on the future market, such as Google Glass (which today seems to have disappeared), “self-driving Cars”, Artificial Intelligence (today’s “deep learning”) applications for everything, including robotics and medicine. It is worth noting here that these topics are not new at all: manufacturing robotics started in 1973 with the foundation of FIAT COMAU[36], in order to develop and produce the RoboGate, the robotic assembly line for cars, installed in 1978 at FIAT Rivalta and Cassino factory in order to produce the Fiat Ritmo[37]. Also “adaptive systems” are not a novelty, as a network approach to AI. In the 1950s Frank Rosenblatt invented the Perceptron[38], an adaptive algorithm simulating a neural network which was implemented in a big computer capable of recognizing different objects shown on a stage. By adding several layers to the originally two dimensional networks, the architecture is considered “deep” (three dimensions are indeed required for “depth”). Some more mathematics is actually needed, but also the “optimality methods” used for network modeling in continua go back to classical gradient’s techniques widely used in mathematical physics since the XIX century. Of course, this goes well beyond classical and purely logico-deductive AI, since the new AI is based on a model of learning in adaptive networks instead of preprogrammed deductions. Yet, on one side, many forget the promises made by classical AI, from the ‘50s to the ‘90s: a robot able to be an indistinguishable imitation of a human (cf. the search for an implementation of Turing’s Imitation Game). On the other side, the new network computing is, so far, mostly implemented on discrete-state machines, with little analysis of discrete-continua mathematical challenges (e.g., shadowing theorems[39]) or little attention to the issue of “correctness” of implementation[40], a well analyzed issue in digital control machines, such as airplanes and flight control softwares.

What is now happening is a deluge of promises, in many fields, even in Research and Academic circles. A recent book[41] (unfortunately only in French) *Pourquoi tant de Promesses?* (“Why such a lot of promises?”) deals with and criticizes the new trend of huge funding of grandiose research projects whose scientific foundations are weak.

All these projects are tied in some way to the maintenance of stock exchange value, mainly of big digital corporations.

This is accomplished by a mechanism similar to “stock options”: i.e. the tying-up of phantasmagorical proposals to stakeholders’ evaluations of the market’s dynamics. Corporations can ask for well paid expertise, so that members of academic or research circles become less prone to adopt a critical stance. Or they can use a typical lure: revolving doors. This means that at the end or in the midst of your academic or political career, a “grateful” company will give you a good servicing contract[42].

Any criticism to the academic circles involved *in* and *by* these mechanisms of subtle and silent corruption – even if correct by itself – is worthless if not extended to the whole,

35 Robotics, Artificial intelligence, Big data, and so on.
36 https://en.wikipedia.org/wiki/Comau#Formation.
37 https://en.wikipedia.org/wiki/Alfa_Romeo_Cassino_Plant#History.
38 https://en.wikipedia.org/wiki/Perceptron.
39 Pilyugin S.. **Shadowing in dynamical systems**, Springer, 1999.
40 Sifakis J.. System Design Automation: Challenges and Limitations, *in* **Proceedings of the IEEE,** vol. 103, num. 11, p. 2093-2103, 2015.
41 “Sciences et technologies emergentes: Pourquoi tant de promesses,” sous la directions de Marc Audétat, Hermann, 2015 ISBN 978 2 7056 9106 6.
42 A typical stance of Goldman Sachs towards the “Brussels bubble”.

general, mechanism. It is always possible to resist, but the solution cannot be found inside the circle: it is mainly a political issue.

Of course, the Internet can also be used to spread promises to users. In this process, promises operate as advertising. Of what? Of shares. Users are thus sold to advertisers, as we mentioned above: moreover, there are websites and companies which allow small traders to operate in the stock exchange market, in analogy with the brokers of the ‘20s: anyone may become or *believe* themselves to be an effective trader, gaining from the pure growth of share values, independently of any knowledge of the underlying “fundamentals”. The Internet takes on the role of the old ticker during the '20s, in a more effective way, the difference being the number of people involved and the media used to communicate and act: in the '20s it was the telephone, today it is the Internet.

It has to be taken into account that advertising can be administered also in a way that is not perceived as such, but as regular information[43]. This was quite a regular and well paid practice for traditional media, even in the good old days of the “paper-press”[44]: though the general audience was – and still is – not well aware of it.

Many of the grandiose articles, texts, and even “scientific papers” are in some way “advertorials”. Also this phenomenon is not specifically related to the Internet or WWW. On the contrary, the Internet allows communities all around the world to have the capability to debunk these “truths” which are supported by the mainstream media. This makes “steamship owners” furious for their loss of the monopoly of “fake news”. Thus, they are spending a lot of energy in a vain attempt to re-establish control over the Internet – a task for which there are significant obstacles, not least the main feature of Internet: its size. As always, it is a hard task to put under control a huge number of people, and Internet use is 2 Billion people worldwide, today.

For these reasons the Internet has attracted political movements who have in their horizon some form of “direct democracy”, as a replacement or as a complement of representative democracy. The actual implementation of this move at different scales, in a society, is today’s challenge.

2. Interlude

In Part 1, we examined the basic historical dynamics and some of the main features of today’s WWW. It should follow from this that there is a peculiar tension between potentialities and actualities, in particular concerning the human and social consequences of these new technologies. Information is a new commodity or asset that structures the web; it is both a means and a purpose, yet it is not always used to increase human knowledge or quality of life. On the contrary, there are increasingly strong tendencies to transform the new availability of “information”, as bits traveling everywhere and as immense databases, into forms of dispersion of human cohesion. It is also used to channel and normalize exchange, to flatten diversity and reduce democracy; abuses of Big Data[45] and Bibliometrics[46] are relevant examples of these phenomena. As mentioned above, the opposite is also possible: it is possible to oppose these trends, on and by the Internet

43 This is also not new: it is (called) “advertorial” (in English and Spanish); or “publicité rédactionnelle”, “publi-reportage” (in French); or “pubblicità redazionale” (in Italian); or “redaktionelle Werbung” (in German).

44 Look at the term “paint the tape” in Transcript of the ‘90s documentary **“The crash of 1929”** English and Italian text available here: http://documentazione.altervista.org/The_Crash_of_1929.html. Documentary here: https://www.youtube.com/watch?v=7EPTCm9RVRM and here: http://documentazione.altervista.org/crash29.html

45 Calude C., Longo G., “The Deluge of Spurious Correlations in Big Data”. *In* **Found. of Science**, 1-18, March, 2016.

46 Longo G. “Science, Problem Solving and Bibliometrics”. *In* **Use and Abuse of Bibliometrics**, Wim Blockmans et al. (eds), Portland Press, 2014.

itself, or by various sorts of computers' webs, and increase instead meaningful and diverse human exchange as well as the quantity and quality of human organization and solidarities. In view of the classical identification of information to “negentropy” (or negative entropy), this may be analyzed in some abstract but effective terms. A close analysis of the notions of entropy, negentropy and “anti-entropy” (below) may then help to clarify and focus on the general phenomenon. In particular, the abstract discussion may clarify the polymorphic meaning and role of information, a largely abused term in today’s world.

3. Entropy, negentropy and anti-entropy in biological organisms and human-ecosystemic relations

In several writings, Bernard Stiegler focuses on the “entropic” effects of contemporary economic and social trends, to which he opposes the need for a “negentropic” activity. In this section, we first revisit and then propose some refinement of these concepts. This will help us to at a possible interpretation and use of these notions in our frame: the analysis of networks of various nature.

The origin of this use of terms from thermodynamics in economics and social activities goes back to the early work by Nicolas Georgescu-Roegen[47], to which Stiegler often refers.

It is well-known that classical “equilibrium economics” is inspired by classical dynamics, that is by the Newtonian-Hamiltonian frame of systems evolving at equilibrium, such as the planetary system[48]. Georgescu-Roegen instead focused on the thermodynamic effects of energy transformation proper to human activities, beginning with industrial ones. As a matter of fact, in thermodynamics, any transformation of energy produces some form of energy dissipation that is strictly irreversible (frictions, at least, are unavoidable). In a closed system, this phenomenon irreversibly decreases the energy available for work (Gibbs’ free energy). Georgescu-Roegen’s concerns pioneered the contemporary attention to the ecosystemic consequences of the use (and abuse) of natural resources. The incoming flow of solar energy, the only renewable source of energy on Earth, may not be sufficient or not sufficiently usable to compensate the energy downgrading of other sources and, thus, entropy production. Typically, its transformation into available work for human activities, e.g. under the form of electric power, technically implies entropy production, as with all these sorts of transformations – including the construction of the machines performing the transformation.

Georgescu-Roegen stresses that biological evolution also transforms energy, at each reproduction and metabolic cycle, and, by this, it produces entropy. Yet, evolution also opposes entropy, locally, by producing “organized entities”, such as biological organisms – this, of course, has an energetic cost. This peculiar use of energy, thus, and related energy dissipation, has a local negentropic effect. He then sees human evolution as the last part of this process, characterized by an evolution of “exosomatic” features to be added to biological novelty creation. That is, on “top of” and “externally to” (“exo”) the formation of organisms due to biological evolution, humans produce(d) tools, from the simplest polished stone to the computer, as extensions of our biological bodies (“soma”) and organs, including our brains. Thus, in Georgescu-Roegen’s view, life – i.e. both ontogenesis and phylogenesis – produces entropy by transforming energy, but it also increases its opposite, negentropy in his terminology, as somatic and exosomatic organization. The challenge is exactly in maintaining a sufficiently high negentropic activity

47 **Analytical Economics**, Harvard U. Press, 1966; **The Entropy Law and the Economic Process**, Harvard U. Press, 1971.

48 Walras L., **Économique et mécanique**, Bulletin de la Société Vaudoise de Sci. Naturelles, Vol. 45, p.313-325, 1909.

to compensate for the loss of organization due to entropy production, at least at the level of human exo-somatization and, in our concern, human social or network activities. Computer networks may be seen as the most recent form of exosomatic organization. However, they also happen to produce forms of disruption of social organization (entropy production) to be compensated, in this perspective, by an opposite and conscious use of their potentialities for a richer organization of human activities. Below, we will use and go beyond the notion of negentropy by drawing on a biologically sound notion, anti-entropy, which may help to refine the analysis.

Finally, following physics, Georgescu-Roegen soundly distinguishes between a reversible time *t* of equilibrium systems (mathematically, planets may equivalently go backwards: just change time *t* to *-t* in Newton's equations, where *t* appears squared) and a thermodynamic time *T*. The latter is strictly irreversible and includes the irreversible time of biological and human evolution. He considers *T* as the appropriate time for discussing also the historical dynamics of the economy. This may be also refined, as the biologically irreversible time of evolution is more appropriately analyzed as a further observable time, to be added to the irreversible time of thermodynamics[49].

The point here is that one should not identify the economy with the thermodynamics law of physics, nor biological and economical evolution. Georgescu-Roegen first proposed a change of perspective from classical approaches in economy, grounded on classical mechanics, by enriching the conceptual tools with the use of ideas from thermodynamics. This may help to move away from absurd theories of economic equilibria, where planetary systems with no friction would provide the mathematical reference for agents with perfect knowledge acting on the basis of subject independent representations of value[50]. Similarly, in no way is the theory of evolution to be considered a sufficient frame for an economic theory: human symbolic activities go well beyond biological evolutionary interactions, they add further observables to say the least. Yet, part of the conceptual tools for the analysis of the historicity of organisms may provide the *preliminary guidelines* for some understanding of the historicity of economic phenomena, no more, no less[51]. The work still remains to be done to understand (and work with) the specificity of economics, as a proper theory of human exchange and interaction, along the history of diverse human communicating communities.

3.1. Negentropy as information and its limits

As mentioned above, following early ideas by Georgescu-Roegen, Stiegler extensively developed the idea that a form of dispersion or dis-aggregation of human organizations is largely due to novel forms of power structure, where the Internet plays a major role. The so called "civil society", in its manifold aspects of social and political aggregation and expression, as well our integrated relation to the ecosystem, are heavily modified by these new forms of interaction. The dismantlement of local aggregations (active social groups, coordinated activities of all sorts, from neighborhood solidarities to Trade Unions) that is proper to (neo-)liberal society, may be soundly compared, by a legitimate metaphor, to a form of "energy dispersal". In an imaginary society just composed of "individuals" interacting towards a mythical equilibrium, humans bump into each other as (classical) particles, one-by-one, in the pure state of gas molecules. Thus, by continuing the analogy

49 Longo, G. "How Future Depends on Past Histories and Rare Events in Systems of Life", **Foundations of Science,** pp. 1-32, 2017.

50 In a letter to L. Walras, Henri Poincaré, a major mathematician of the time, lists all the problems of this unsound transfer of the mathematics of equilibrium systems to economy, see at the end of https://www.taieb.net/auteurs/Walras/mech_gf.pdf

51 Felin T., S. Kauffman, R. Koppl, G. Longo. Economic Opportunity and Evolution: Beyond Bounded Rationality and Phase Space. In "**Strategic Entrepreneurship Journal**", vol. 8, issue 4: 269–282, 2014. Koppl R., S. Kauffman, G. Longo, T. Felin. Economy for a Creative World. Target article "**Journal of Institutional Economics**", Vol. 11, Issue 01, pp 1 - 31, March 2015.

above, they diffuse energy and therefore decrease energy available for work, in the broadest sense.

In physics, negentropy is opposed to this energy dispersal in principle, simply by its sign. That is, since Shannon, or, more precisely, Brillouin[52], the amount of transmitted information has been considered and described by the same formula as Boltzmann's entropy, but with the opposite sign, a "-". In other words, modulo a sign, entropy happens to be given by the same formula, $\sum_i p_i \cdot \log(p_i)$ used by Shannon to quantify information in terms of the probabilities of the occurrence of a (meaningless) symbol in a message. Thus Brillouin and his followers identified negentropy with information. This is a sound decision that we maintain here, but we have two criticisms. The second will provide a further specification.

First the identity of mathematical formulas does not force an identical interpretation (modulo a sign, i.e. a *+1* or *-1* as a coefficient). For example, Schrödinger equation for Quantum Mechanics is a "wave function", i.e. it is identical to a diffusion equation for a wave, modulo a complex number, $i=\sqrt{-1}$, as a coefficient. Yet, the quantum state it describes has nothing to do with fluid dynamics or water waves: it is interpreted in a radically different way. As always, the physical context and the theoretical frame yield the interpretation of a mathematical formula.

Let's maintain this interpretation of negentropy (as identical to information) as much as it makes sense: entropy, i.e. the dissipation of energy (as decreasing availability of energy for work, Gibbs free energy, or increasing entropy), is analogous to the dispersal or decrease of information, thus it may be understood as its opposite by a "-". In particular, in a society where social structures are minimized and where civil society is increasingly de-structured, it may be sound to say that "there is a loss of information" or "entropy increases". So, Shannon's formula, with the opposite sign of Boltzmann's entropy, or the concept associated to it, may be informally used to refer to both phenomena, that is to "information = negentropy" or the amount of "information in an organized society", following Georgescu-Roegen's and Stiegler's proposal. Note then that, when summed up, an equal amount of entropy and negentropy (as negative entropy) give 0, by definition: they are given in the same dimension and they are, mathematically, the opposite of one another.

However, and this is our second point, "organization" is not the same as information and this sets some limits on the use of negentropy for our analysis. Typically, a sequence of 0s and 1s may contain a lot of information, by a one-dimensional encoding, but, we will show, it may contain little "organization" if the latter is also considered as a spatial or geometric notion. A major advantage of both Shannon's theory of *transmission* of information and of Turing's theory of *elaboration* of information is that they are insensitive to the Cartesian dimensions of space, up to a minor cost of coding. That is, *discrete* information (i.e. encoded by isolated numbers or points), or any discrete type of data, may be equivalently displayed in one, two, three or more space dimensions and then (isomorphically) encoded by sequences of integer numbers, thus in one dimension. This process does not change the amount of transmitted or elaborated information, nor its mathematical invariant properties. Therefore Turing could write his Universal Machine as a sequence of instructions like any other Turing Machine, while acting on and simulating any Turing Machine: they may all be encoded as sequences of integer numbers. This turned out to be fundamental in order to later invent Operating Systems and Compilers written in the same (encodable) language, all in one dimension (they are all sequences of 0s and 1s, at the

52 Brillouin, L. **Science and Information Theory**. Academic Press, New York, 1956.

level of the machine language). In other words, both Shannon's and Turing's notions of information are fully expressed in a one-dimensional space. And this is crucial to them, that is, it is a fundamental mathematical invariant property of their theories.

Instead, both the physical and the biological notions of organization go well beyond coding by sequences. For example, a self-organized system, in physics, is better described by its *geometric* structure, in general in three dimensions: a flame, a hurricane, a Bénard cycle … only make physical sense in three dimensions and this is crucial/fundamental. Typically, diffusion equations, including heat equations, describe radically different phenomena in one, two, or three dimensions (and heat diffuses very differently in one, two or three dimensions).

Coding in one dimension misses what matters most: the geometric structure of natural phenomena. Information and its modern elaboration and transmission are our inventions, since the invention of the most striking form of one dimensional writing: the alphabet. This discrete, linear coding of the song of spoken language was later fully encoded by integer numbers by Gödel (1931) and Turing (1936)[53]. Again, any discrete structure in any finite space dimension, i.e. made out of isolated numbers or signs, may be equivalently encoded in just one dimension, at a minor "cost", with no loss of its mathematical invariant properties. In contrast to this, in continua, there is no way to bijectively encode several dimensions in just one, without losing the notion of *continuous transformation*, at the core of any dynamical analysis. In short, one may say that *geometric* means or implies "sensitive to coding and dimensions". Now, "organization" (physical, biological …) is at least a spatial, geometrical notion. This is incompatible with the core property of both Turing's and Shannon's theory: that is, the fact that they may be completely and soundly described over discrete sequences of numbers, in one dimension – a very convenient feature for the purposes of those theories is a major limit for the understanding of physical, biological, and human forms of organization. Negentropy, as strictly linked to information in current approaches, is thus insufficient, as such, for a sound analysis of the dynamics of life. More motivations for a change of "observable" will be given in the next sub-section.

3.2. Anti-entropy as biological organization

With these motivations in mind, in[54], we proposed a different notion in order to describe biological complexity as a component of biological organization, both in phylogenesis and ontogenesis (see[55] for a simplified and broader presentation). The idea is to develop a geometric (topological) analysis of organization in terms of "anti-entropy", which differs from the common use of "negative entropy" – in particular it belongs to a different dimension.

It is correct to say that, in biology, both the formation and maintenance of organization, as a permanent reconstruction of the organism's coherent structure, go in the opposite direction of entropy increase, as stressed above. That is, they are opposed to entropy by absorbing and using energy from the ecosystem. This is also emphasized by Schrödinger in the second part of his 1944 book ("What is life?"). He considers the local decrease of entropy by the construction of biological "order from order", which he also informally calls "negative entropy", several years before the use of these words by Shannon and Brillouin. However, in a footnote, Schrödinger explains that by negative entropy he refers to Gibbs'

53 The Morse code, or even the Kabala, may be considered predecessors of Gödel's idea, but Gödel added the encoding (the writing of) the formal meta-theory of Arithmetic into Arithmetic itself. This idea was later borrowed by Turing to invent a machine working over any other machine, a meta-machine, his Universal Turing Machine, that originated our operating systems and compilers, as we recalled, all encoded as a sequence of digits.

54 Bailly F., Longo G. Biological organization and anti-entropy. **J. Biological Syst.,** 17(1):63–96, 2009.

55 Longo G., Montévil M.. **Perspectives on Organisms: Biological Time, Symmetries and Singularities.** Springer, 2014.

free energy, that is to the available energy for work, and he does not mention “information”. Louis Brillouin[56] only later introduced the equivalence, negentropy = information, mentioned in the previous sub-section.

In our approach, anti-entropy is mathematically presented as a new observable, as it is not just entropy with a negative sign, possibly annihilating each other. Thus, it has a different physical dimension and it may be used for an abstract (mathematical) evaluation (measure) of biological (anatomical) organization or complexity. As a matter of fact, entropy and anti-entropy are produced simultaneously in an organism: the transformation of energy, typically by metabolism, thus the production of entropy, coexists and is actually essential to the formation and maintenance of organization. Yet, entropy and anti-entropy do not give 0 when summed up in the same quantity: biological organization coexists, in a normal adult organism, and it is not decreased by energy transformation, thus by entropy production, see[57] for details.

A purely conceptual analogy may be given with *anti-matter* in Quantum Physics: this is a new observable, relative to new particles, whose properties (charge, energy) have the opposite sign to the corresponding matter (particle). Along this wild analogy, matter and antimatter, when summed up, never give 0, but a new energy state: the double energy production as gamma rays, which is generated when they encounter in a (mathematically pointwise!) singularity. Analogously, entropy and anti-entropy coexist in an organism, whose biological state is also a “singularity”, a rather peculiar one: an extended interval of criticality (see the notion of “extended critical state” in[58]).

In short, anti-entropy schematically formalizes biological “organization”, at least as structural, thus geometric organization. To this purpose, as explained in the introduction of[59], sect. 1.4.4., we present “two biological principles (existence and maintenance of anti-entropy), in addition to the thermodynamic ones. These principles are (mathematically) compatible with the classical thermodynamic ones, but do not need to have meaning with regard to inert matter. The idea is that anti-entropy represents the key property of an organism, even a unicellular one, to be describable by several levels of organization (also a eukaryotic cell possesses organelles, say), regulating, integrating each other — they are parts that functionally integrate into a whole, and that the whole regulates. This corresponds to the formation and maintenance of a global coherence structure, in correspondence to its extended criticality: organization increases, along embryogenesis typically, and is maintained, by contrasting the ongoing entropy production due to all irreversible processes.”

In[60], we applied the notion of anti-entropy to the analysis of the complexification of life during evolution proposed in[61], as a purely random effect in an asymmetric diffusion of the biomass. The idea is to quantify some structural properties of organisms. Under some reasonable measures, a eukaryotic cell is more “complex” than a bacterium (e.g. it contains a nucleus, organelles, mitochondria … that one may count); a metazoan, with its numerous differentiated tissues, is in principle more “complex” than a cell. So, by counting also cells' differentiation and tissues, “cell networks in mammals are more complex that in early triploblast (which have three tissues layers) and these have more complex networks of all sorts than diploblasts (like jellyfish, a very ancient animal).” There is no qualitative

56 La Science et la Théorie de l’Information, Paris 1959.
57 Longo G., Montévil M.. **Perspectives on Organisms: Biological Time, Symmetries and Singularities.** Springer, 2014.
58 Longo G., Montévil M.. **Perspectives on Organisms: Biological Time, Symmetries and Singularities.** Springer, 2014.
59 Longo G., Montévil M.. **Perspectives on Organisms: Biological Time, Symmetries and Singularities.** Springer, 2014.
60 Bailly F., Longo G. Biological organization and anti-entropy. **J. Biological Syst.,** 17(1):63–96, 2009.
61 Gould, S.J., **Full House**. Three Rivers Press, New York, 1996.

judgment here, but just an attempted quantitative measurement of a change that spanned biological evolution. This is a global and *on average*, non-linear increase and it can be quantified by counting tissue differentiations, networks and more, as hinted by Gould and more precisely developed in the work quoted above by Bailly, Longo and Montévil. In short, by a very schematic approach to the purely structural complexity of an organism, we measured:

- topological forms and structures, i.e. number of connected components (muscles are each a different connected component of the muscular system), fractal dimensions (a mammal, say, has a more complex fractal lung than a frog's lung, which is a sort of balloon with little or no fractality);

- the relational structures supporting, but not identified with, biological functions (cellular and neuronal networks, other interaction networks), measured by counting, for example, the number of nodes and connections in cell networks, including neural nets …

Without going into further details, as other observables are taken into account in this approach, it should be clear that this understanding of the notion of anti-entropy is strictly geometrical (topological) and, thus, spatial: dimensions are crucial and key topological properties are lost by any encoding in one dimension. Many of the observables above make sense only in topological continua – that is, they *cannot* be mathematically given as isolated, well separated points, i.e. in discrete structures, without losing what matters, the intended mathematical *continuous* transformations that preserve their properties. This is life (and physics also): they are *not* just information, which is always mathematically encodable in one dimension, as it is the case in both Turing's and Shannon's sense and for good reasons[62]. It is, at least, *geometric* and implies *organization in space*.

To our surprise, by joint work with biologists Carlos Sonnenschien and Ana Soto, we could use the measurement of anti-entropy as a possible hallmark of cancer[63]. As a matter of fact, it seems that cancer is the only pathology where an increase of complexity, in our sense of anti-entropy (increasing fractal dimensions in lungs, intestine's villi ..., increasing topological numbers of lumina in ducts etc), goes together with a decreasing functionality of organs. In a sense, excessive structure may be dysfunctional: biological organisms are the result of an evolutionary constructed balance between *structural* organization (our anti-entropy) and functions. Overly nested complication, due to uncontrolled cell proliferation (cancer), typically, destroys the internal coherence, it kills *functional* organization: villi become excessively dense and nested, ducts' lumina split by uncontrolled cell proliferation etc. This is a minor observation, but, if we are right, in view of the relevance of the biological issue (cancer analysis), it may confirm the interest of the strictly geometric, thus not just "informational", in the traditional sense, notion of anti-entropy. It shows also how functionality, entropy, negentropy, anti-entropy etc are related in a complex way, far from any univocal terminology and flat transfer of terminology. In particular, thus, it is appropriate to depart from the informational myth and even terminology, in natural sciences. Elsewhere, we criticized at length the persistent a priori of the homunculus as information encoded by four letters in the sequence of nucleotides in DNA, see[64]. The

62 A remarkable new discipline, Geometry of Information, is being developed in abstract mathematics. Non obvious tools from analysis and algebraic geometry allow a very different approach to a notion of "geometric information", far from encodable in one dimension; it may be seen as an analysis of invariants (and variability) under complex geometric transformations, homotopies for example, see Barbaresco F., Mohammad-Djafari A. (Eds.), **Information, Entropy and Their Geometric Structures**, MDPI, Basel & Beijing , 2015.

63 Longo G., Montévil M., Sonnenschein C., Soto A. In Search of Principles for a Theory of Organisms, in **Journal of Biosciences**, Springer, pp. 955–968, 40(5), December, 2015.

64 Longo G., Miquel PA, Sonnenschein C., Soto A. Is Information a proper observable for biological organization? *In* **Progress in Biophysics and Molecular Biology**, Volume 109, Issue 3, pp. 108-114, August 2012, as well as Perret and Longo's paper in Soto, A., Longo, G & Noble, D, eds. ***From the century***

informational approach is at the core of the so called "central dogma of molecular biology", (Crick, 1958) and the idea of exact, stereospecific macro-molecular interactions (the key-lock paradigm), in particular as for cellular receptors. Besides the biological relevance of the geometric structure of DNA and proteins, the focus on information, in our opinion, is not helping in fighting cancer, in particular, as it diverted research towards the search for signals de-programming DNA, while many/most carcinogens seem now not to be mutagenic, see the references in[65] . Moreover, the informational approach has paid little attention to macro-molecular low affinities and low probabilities interactions that play a major role in endocrine disruptors[66]. It also justified the ecosystemic use of GMOs, the direct children of the central dogma: DNA is supposed to completely drive the plant in the ecosystem[67].

This is not a reason to exclude the interest of the notion of negentropy, per se, either as information or enriched by the new dimension of anti-entropy. In phenomena where space matters though, one needs to join it to an analysis of anti-entropy, or alike, as more proper to organization, at least in biology. This may be sound, most probably, also in social life, as this happens to be described in space, to say the least. Social communities are also a spatial matter, from the neighborhood proximity to the territorial nature of the modern State. But, of course, "meaning" in human interaction has a further dimension and meaningful production of sense is at the core of all our social activities.

4. Conclusion

The social and economic issues go well beyond the biological analysis: they are a matter of human history. In order to tackle this aspect, the challenge, possibly on the grounds of a sound or enriched terminology, is to jointly use, for example, the analysis of computer networks in the first part and the analysis of biological networks in the second. In biology, we hinted at cell networks as a component of complexity as anti-entropy in an organism. With some caution, this analysis may be extended to other structures of biological, ecosystemic or human interaction. Our approach may at least reduce abuses or misuses, like the flat reductions of socio-economic dynamics to theories of (economic) equilibria or to "everything is information". That is, some of the concepts we hinted to above may be transferred or used at least by analogies: local anti-entropic reinforcing of networks, based on specific forms of interaction, may enrich social complexity. This may oppose the neoliberal dispersion of unorganized individualities. Forms of organization may also diverge by "homology" (same roots, different functions) in diverse articulations and in other areas of activities. Their analysis may help in understanding what is happening and how to improve our new networking humanity.

***of the genome to the century of the organism: New theoretical approache*s**. Special issue, **Prog. Biophys. Mol. Biol.**, 122, Issue 1, Pages 1-82, 2016.

65 Longo G. The Biological Consequences of the Computational World: Mathematical Reflections on Cancer Biology, To appear in **Organisms. Journal of Biological Sciences,** 2018, see also Bertolaso M., Sterpetti F., Evidence amalgamation, plausibility, and cancer research, **Synthese,** to appear DOI 10.1007/s11229-017-1591-9, 2017.

66 Schug TT, Johnson AF, Birnbaum LS, Colborn T, Guillette LJ Jr, Crews DP, Collins T, Soto AM, Vom Saal FS, McLachlan JA, Sonnenschein C, Heindel JJ. Minireview: Endocrine Disruptors: Past Lessons and Future Directions. **Mol Endocrinol.** 2016 Aug;30(8):833-47. doi: 10.1210/me.2016-1096. Epub 2016 Jul 19.

67 Bizzarri M. **The New Alchemists: the risk of Genetic Modification** Wit Press (Boston), 2012. ISBN 978-1-84564-662-2.