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The Fourth Revolution

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Oversimplifying, science has two fundamental ways of changing our understanding: one extrovert, or about the world, and the other introvert, or about ourselves. Three scientific revolutions have had great impact both extrovertly and introvertly. In changing our understanding of the external world they also modified our internal conception of who we are. After Copernicus, the heliocentric cosmology displaced the Earth and hence humanity from the centre of the universe. Darwin showed that all species of life have evolved over time from common ancestors through natural selection, thus displacing humanity from the centre of the biological kingdom. And following Freud, we acknowledge nowadays that the mind is also unconscious and subject to the defence mechanism of repression. So we are not immobile, at the centre of the universe (Copernican revolution), we are not unnaturally separate and diverse from the rest of the animal kingdom (Darwinian revolution), and we are very far from being purely rational minds entirely transparent to ourselves (Freudian revolution).

Freud was the first to interpret these three revolutions as part of a single process of reassessment of human nature, and his perspective was blatantly self-serving. But replace Freud with neuroscience, and the framework is still useful to explain our intuition that something profound and very significant has recently happened to our self-understanding. Since the fifties, computer science and ICTs have exercised both an extrovert and an introvert influence, fundamentally changing not only our interactions with the world, but also our essential views about who we are. In many respects, we no longer interpret ourselves as standalone entities, but rather as interconnected informational organisms or *infORGs*, sharing with biological, artificial and hybrid agents and engineered artefacts a global environment, ultimately made of information, the *infosphere*. This is the environment constituted by all informational processes, services and entities, thus including informational entities as well, their properties, interactions, and mutual relations.

The digital revolution is therefore best understood as a fourth revolution, in the long process of dislocation and reassessment of our fundamental nature and role in the universe. Today, it is modifying our everyday perspective on ourselves and on the ultimate nature of reality, that is, our metaphysics, from a materialist to an informational one. Objects and processes are seen as de-physicalised, in the sense that they tend to be treated as support-

independent (consider a music file). They are typified, in the sense that an instance of an object (my copy of a music file) is as good as its type (the music file of which my copy is an instance). And they are assumed to be perfectly clonable by default, in the sense that my copy and your original become interchangeable. Less stress on the physical nature of objects and processes means that the right of use is perceived to be at least as important as the right to ownership. Finally, the criterion for existence – what it means for something to exist – is no longer being actually immutable (the Greeks thought that only that which does not change can be said to exist fully), or being potentially subject to perception (modern philosophy insisted on something being perceivable by the five senses in order to qualify as existing), but being potentially subject to interaction. To be is to be interactable, even if the interaction is only virtual.

All this is part of a deeper metaphysical drift caused by the fourth revolution. During the last decade or so, we have become accustomed to conceiving our life online as a mixture between an evolutionary adaptation of humans to a digital environment, and a form of post-modern, neo-colonization of that environment by us. Yet the digital revolution is as much changing our world as it is creating new realities. The threshold between *here* (analogue, carbon-based, off-line) and *there* (digital, silicon-based, online) is fast becoming blurred, but this is as much to the advantage of the latter as it is of the former.

The digital is spilling over into the analogue and merging with it. This increasing informatization of artefacts, identities and of whole (social) environments and life activities suggests that soon it will be difficult to understand what life was like in pre-digital times and, in the near future, the very distinction between online and offline will disappear. At present, older generations still consider cyberspace as something one logs-in to and logs-out from. Our view of the world (our metaphysics) is still modern or Newtonian: it is made of "dead" cars, buildings, furniture, clothes, fridges, which are non-interactive, irresponsive and incapable of communicating, learning, or recording. But in advanced information societies, what we still experience as the world offline is bound to become a fully interactive and more responsive environment of wireless, pervasive, distributed, *a2a* (anything to anything) information processes, that work *a4a* (anywhere for anytime), in real time, possibly independently of us. As a consequence, we shall be living in an infosphere that will become increasingly synchronized (time), delocalised (space) and correlated (interactions). We shall be increasingly "onlife".

Cloud computing is the most recent episode in this fourth revolution. Historically, it represents the coming of age of the Turing machines invented more than half a century ago. Today, we are gradually accepting the fact that computers are their best friends. They do not need us, we should not be in the loop, and cloud computing is the first, graceful step out of it. Conceptually, this means decoupling the intelligent invention, discovery and design of information from the algorithmic and physical substratum that make them possible. This sort of *unmanned computing* enables digital resources to be monitored and managed more efficiently and cost-effectively because independently of their users and consumers, who have better things to worry about. The more we live and interact in the infosphere the less necessary and reasonable it becomes to own physical chunks of it. The intellectual consequences of this *e-migration* are significant. In an increasingly informed society, it will become progressively less credible for someone to claim ignorance when confronted by easily predictable events and hardly ignorable facts. Common knowledge, which occurs when everybody not only knows something but also knows that everybody knows that everybody knows... that particular something, will grow exponentially, further undermining the right to ignore. As for the value of information, the cloud will magnify the huge waves of deflation already caused by projects like Wikipedia or Google books: shared information is information that nobody wants to pay to acquire. And because cloud computing will make problems concerning the availability of information obsolete, it will also reinforce the importance of the juicer model: increasingly, *factual* information (knowing that such and such is the case) will become valuable only insofar as it can be fruitfully squeezed between more and more powerful forms of *practical know-how*, which is required to manage and interact with it, and ever more refined levels of *theoretical knowledge* indispensable to understand and make intelligent use of it. Note, however, that because computers are semantically-inapt, clouds will be really helpful only on the practical side of management. So the boundless *availability* of information will reveal and exacerbate what has always been the real issues, which are entirely semantic: *accessibility, usefulness* and *fruitfulness*. Knowledge requires skilful and intelligent fluency in the technical languages in which information is encoded, and in the future such languages will continue to become progressively more complex and in high demand. The good news is that cloud computing will foster new forms of robust forms of intellectual concurrency, understood as the focusing of multi-intelligence systems on the same issues in order to tackle them. Competitive collaboration will be

essential in order to turn the handles of the gigantic information squeezers we shall build in the future.

In terms of security, we will be able to insure *our* data because we will not physically possess them. This might seem paradoxical, but it is obvious that, although data may be invaluable and irreplaceable, they are also perfectly clonable at a negligible cost, contrary to physical objects. So a simple and reliable way to know whether some data have been really lost is to posses those data physically. Now, cloud computing decouples physical possession from user's ownership, so providers/possessors and users/owners will be able to trust each other and agree on data insurances. Having digital resources collected together may be risky, but it will also multiply the opportunities for C2C ("cloud to cloud") interactions: the more data, applications and services will coexist in the same environment the easier and more likely it will become to take advantage of smart solutions, feedback procedures, patterns mining and so forth. Intracloud computing will flourish and it will put increasing pressure on human-computer interfaces. Telepresence or presence in the infosphere is a matter of levels of availability, accessibility and interaction, so some of the great innovations in ICT will take place on the frontiers of the clouds, there where users and computers meet.

Finally, but not less importantly, cloud computing is part of a macroscopic, digital revolution, which poses unprecedented ethical issues. These will require an *e-nvironmental* approach capable of treating as authentic and genuine all forms of existence and behaviour, even those based on synthetic and engineered artefacts. The challenge will be to reconcile our roles as both inforgs within nature, and stewards of nature. The good news is that this is a challenge we can meet.