Surfing versus Drilling for knowledge in science: When should you use your computer? When should you use your brain?

Author(s):
Hünenberger, Philippe; Renn, Oliver

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Around 1660, the French scientist and philosopher Blaise Pascal wrote a beautiful text (reproduced as an addendum to this editorial) about the position of humans, stuck somewhere between two infinities: the infinitely large and the infinitely small. For mathematicians, the same double-infinities situation occurs in the ensemble of real numbers: however small the interval between two distinct numbers, it still contains an infinity of other ones; and however large a finite number, it is still surpassed in size by an infinity of larger ones. Somewhat similarly, the Gödel theorem shows that beyond a certain complexity, it is impossible to enumerate systematically all the theorems of an axiomatic system from within this system; i.e., the knowledge of any complex system cannot become complete unless you transcend its own limitations.

Although Pascal invented the first "arithmetic machines", ancestors of computers, he was probably far from envisioning the "digital world" we live in. The 21st century technologies, and in particular the internet, bring both infinities directly into our life – even into our pockets – as a permanent invite to search, process, and spread new information. But are we equipped mentally and socially to deal with the double-infinity in such an immediate and permanent proximity?

There is only so much earth you can shovel in a day. If you dig deep, you dig narrow. If you dig wide, you dig shallow. Diving into the infinitely small, i.e., “drilling”, makes sense when the nuggets are hidden deep below the ground. It is a time-consuming and often lonely activity, that brings depth, quality, and insight. Dissolving into the infinitely large, i.e., “surfing”, makes sense when the nuggets are widely spread just under the grass. It is a comparatively faster and easier activity, that brings overview, throughput and interactivity, but also a risk of information overflow.

The drilling vs. surfing duality can be interpreted in a variety of ways, e.g., researching a topic thoroughly vs. exploratively, thinking analytically vs. synthetically, relying on analog vs. digital technologies, or using your brain vs. your computer. These perspectives are not necessarily entirely equivalent. For example, one may argue that thorough vs. explorative work and analytical vs. synthetic thinking apply all the same to both mental (e.g., solving a scientific problem) and computational (e.g., searching the internet for information) activities.

A key ability of good students, teachers, academic or industry researchers, and software developers has always been to find the right balance between drilling and surfing. Undoubtedly, the digital-liberal orientation of our modern society is strongly influencing our ability to switch between the two lenses of these bifocal glasses. Even the way we read has dramatically changed. The printed book, permanent and finite, is (was?) definitely an invitation to drill. The web, fluctuating and open, is certainly more of an invitation to surf. And the growing pressure on scientists and research institutions to justify their “usefulness” on a continuous basis is yet another incentive to short-term surfing for immediate exposure, as opposed to long-term drilling for deeper achievements.

On the one hand, the digital-liberal era provides scientists with an unprecedented power in terms of sources (databases and search engines), processing (machine learning and artificial intelligence), analytics (visualization and aggregation), reach (electronic publishing and media), and interactions (social networks and collaborative software). On the other hand, these amazing new extensions to the human brain may create handicaps for which they work as prostheses (substitution of brain-learning by bookmarking, reduced exposure to challenging/contradicting information, overweighting of quantity over quality, enhancement of short-termism and superficiality). As was the case for all technology leaps in the past, the balance between risk and gain will depend on how wisely we use these technologies, i.e., to which extent we – as humans and as scientists – actively manage to remain their masters, or passively drift to become their victims.

For this second Special Issue of Infozine, we have invited students, teachers, researchers, and software developers to share their opinions about one or the other aspect of this broad topic: how to balance drilling (for depth) vs. surfing (for breadth) in scientific learning, teaching, research, and software design – and how the modern digital-liberal system affects our ability to strike this balance. This special issue is meant to provide a wide and unbiased spectrum of possible viewpoints on the topic, helping readers to define lucidly their own position and information use behavior.

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Addendum: Blaise Pascal: Les deux infinis – The two infinities

Let man then contemplate the whole of nature in her full and lofty majesty, let him turn his gaze away from the lowly objects around him; let him see the dazzling light set like an eternal lamp to light up the universe, let him see the earth as a mere speck compared to the vast orbit described by this star, and let him marvel at finding this vast orbit itself to be no more than the tiniest point compared to that described by the stars revolving in the firmament. But if our eyes stop there, let our imagination proceed further; it will grow weary of conceiving things before nature tires of proceeding further; it will grow weary of continuing them. The whole visible world is only an imperceptible dot in nature's ample bosom. No idea comes near it; it is no good inflating our conceptions beyond imaginable space, we only bring forth atoms compared to the reality of things. Nature is an infinite sphere whose center is everywhere and the circumference nowhere. In the end, the greatest palpable sign of the omnipotence of God is that our imagination loses itself in thinking about it.

Let man, returning to himself, consider what he is in comparison to what exists; let him regard himself lost, and from his little dungeon, in which he finds himself lodged, I mean in the universe, let him take the earth, its realms, its cities, its houses and himself at their proper value. What is man in the infinite?

But, to offer him another prodigy equally astounding, let him look into the tiniest thing he knows. Let a mote show him in its minute body incomparably more minute parts, legs with joints, veins in its legs, blood in the veins, humors in the blood, drops in the humors, vapors in the drops: let him divide these things still further until he has exhausted his powers of imagination, and let the last thing he comes down to now be the subject of our discourse. He will perhaps think that this is the ultimate of minuteness in nature.

I want to show him a new abyss. I want to depict to him not only the visible universe, but all the conceivable immensity of nature enclosed in this miniature atom. Let him see there an infinity of universes, each with its firmament, its planets, its earth, in the same proportion to the visible world, and on that earth, animals, and finallymites, in which he will find again the same results as in the first; and finding the same thing yet again in the others without end or respite, he will be lost in such wonders, as astounding in their minuteness as the others in their amplitude. For who will not marvel that our body, a moment ago imperceptible in a universe, itself imperceptible in the bosom of the whole, should now be a colossus, a world, or rather a whole, compared with the nothingness beyond our reach.

Anyone who considers himself in this way will be terrified at himself, and, seeing his mass as given by nature, supporting him between these two abysses of infinity and nothingness, will tremble at these marvels. I believe that with his curiosity changing into wonder he will be more disposed to contemplate them in silence than investigate them with presumption.

For, after all, what is man in nature? A nothing compared to the infinite, a whole compared to the nothing, a middle point between all and nothing, infinitely remote from an understanding of the extremes; the end of things and their principles are unattainably hidden from him in impenetrable secrecy. He is equally incapable of seeing the nothingness out of which he was drawn and the infinite in which he is engulfed.

Les deux infinis (French version)

Que l'homme contemple donc la nature entière dans sa haute et pleine majesté, qu'il éloigne sa vue des objets bas qui l'environnent. Qu'il regarde cette éclatante lumière, mise comme une lampe éternelle pour éclairer l'univers, que la terre lui paraisse comme un point au prix du vaste tour que cet astre décrit et qu'il s'énonce de ce que ce vaste tour lui-même n'est qu'une pointe très délicate à l'égard de celui que les astres qui roulent dans le firmament embrassent. Mais si notre vue s'arrête là, qu'à l'imagination passe outre; elle se lasserait plutôt de concevoir, que la nature de fournir. Tout ce monde visible n'est qu'un trait imperceptible dans l'ample sein de la nature. Nulle idée n'en approche. Nous avons beau enferer nos conceptions au-delà des espaces imaginables, nous n'enfantons que des atomes, au prix de la réalité des choses. C'est une sphère dont le centre est partout, la circonférence nulle part. Enfin, c'est le plus grand caractère sensible de la toute puissance de Dieu, que notre imagination se perde dans cette pensée.

Que l'homme, étant revenu à soi, considère ce qu'il est au prix de ce qui est; qu'il se regarde comme égaré dans ce canton détourné de la nature; et que de ce petit cachot où il se trouve logé, j'entends l'univers, il apprenne à estimer la terre, les royaumes, les villes et soi-même son juste prix. Qu'est-ce qu'un homme dans l'infini ?

Mais pour lui présenter un autre prodige aussi étonnant, qu'il recherche dans ce qu'il connaît les choses les plus délicates. Qu'un ciron lui offre dans la petite de son corps des parties incomparablement plus petites, des jambes avec des jointures, des veines dans ces jambes, des sangs dans ces veines, des humeurs dans ce sang, des gouttes dans ces humeurs, des vapeurs dans ces gouttes; que, divisant encore ces dernières choses, il épouse ses forces en ces conceptions, et que le dernier objet où il peut arriver soit maintenant celui de notre discours; il pensera peut-être que c'est là l'extréme petitesse de la nature.

Je veux lui faire voir là dedans un abîme nouveau. Je lui veux peindre non seulement l'univers visible, mais l'immensité qu'on peut concevoir de la nature, dans l'encercle de ce raccourci d'atome. Qu'il y voie une infinité d'univers, dont chacun a son firmament, ses planètes, sa terre, en la même proportion que le monde visible; dans cette terre, des animaux, et enfin des ciron, dans lesquels il retrouvera ce que les premiers ont donné; et trouvant encore dans les autres la même chose sans fin et sans repos, qu'il se perde dans ses merveilles, aussi étonnantes dans leur petitesse que les autres par leur étendue; car qui n'admiraera que notre corps, qui tantôt n'était pas perceptible dans l'univers, imperceptible lui-même dans le sein du tout, soit à présenter un colosse, un monde, ou plutôt un tout, à l'égard du néant où l'on ne peut arriver ?

Qui se conséderera de la sorte s'effrayera de soi-même, et, se conséderant soutenu dans la masse que la nature lui a donnée, entre ces deux abîmes de l'infini et du néant, il tremblera dans la vue de ces merveilles; et je crois que sa curiosité, se changeant en admiration, il sera plus disposé à les contempler en silence qu'à les rechercher avec présomption.

Car enfin qu'est-ce que l'homme dans la nature ? Un néant à l'égard de l'infini, un tout à l'égard du néant, un milieu entre rien et tout. Infinité éloigné de comprendre les extrêmes, la fin des choses et leur principe sont pour lui invinciblement cachés dans un secret impénétrable, également incapable de voir le néant d'où il est tiré, et l'infini où il est englouti.

The “Two infinities” has been published with the collection of Pensées (Thoughts)

Blaise Pascal (1623–1662) was a French mathematician, physicist, inventor, writer and Catholic theologian.