ICT within limits compared with fisheries within limits

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Abstract

We advocate to step outside the computer science box, and look at other domains that have courageously tried to work within limits. One such domain is fisheries, and the courageous endeavour to force it within limits is the European *common fishery policy*.

1 Introduction

Optimizing is a keyword of many CS researches, from silicon where cramming more electronic gates per surface unit is a never-ending game (less silicon per gate sounds good), to algorithmic where fiddling with complexity is the game. It is even so true that as early as 1974 [1], Donald Knuth found it necessary to warn against "premature optimization"!

Recently, Bol et al. [2] have shown how per-unit optimizations promoted by ICT researchers of different sub-domains are systematically counter-balanced by an increasing commercial diffusion of ICT systems. In short, reading Moore's law (the number of gates per surface unit of an integrated circuit doubles every two years) as an exponential diminishing impact law (the material required to manufacture a gate is divided by two every two years) is always defeated by market laws that augment the number of units at a faster rate than technology evolution improves efficiency. Is this inescapable?

A very different domain tends to say no, it is not inescapable. The fatal race between local optimisations and market laws can be escaped. This domain is *fisheries*.

2 Fishery policy in Europe

Europe has an explicit *common fishery policy* (CFP [3]) since 1979. It may look very complex, but in fact it obeys a few simple principles. It is interesting to try to transpose them into the ICT domain. We do not mean CFP is ideal. We only mean it is a good starting point for a thought experiment.

- First, Europe recognises that there are environmental issues related to fisheries. It started with overfishing, but progressively other issues have been integrated, such as pollution. Does this transposes to the ICT domain? Probably yes, with CO_2-eq as first issue, water, energy and rare materials for more sophisticated analysts.

- Second, Europe takes total control of CFP in place of member countries. Nothing like this exists for ICT. Politic powers may express concerns, but they assume that markets will do the job. For instance, the European directive on e-wastes (WEEE) was barred several times on the ground that it biased market.

- Third, Europe defines *total allowable catches* (TAC), that is an *a priori* global limit on fish captures. This was made possible by imposing strict accounting rules on boats, in fish-markets, etc. To express a TAC-like limit in the ICT domain, whichever first concern is adopted, will necessitate similar accounting rules. A huge difference between fisheries and ICT appears: the scale and complexity of the system. We think that we should not over-exagerate this obstacle. The WEEE directive [4] gives an example of regulating a few macroscopic operators instead of the millions microscopic end-users. Note that Paris Agreement [5] also states global limits on something, but it lacks the bureaucratic engineering that would transform them into actions.

- Fourth, Europe recognised latter that limiting TAC is not enough. It added a control on *fishing effort* in the CFP, and soon recognised that the *fleet capacity* should be reduced. Who ever speaks of limiting ICT capacities [6]? How does Europe measure fleet capacity? As simply as in gross tonnage and kilowatt-hours. Europe did not invent new units. It only reused classical units of the trade. What could that be in the ICT domain? Mass and electrical power seem to be good candidates. Mass is a good proxy of the impact on raw material, and power is a good proxy for energy and we think it is also a good proxy of cooling effort (including water). Mass could be expressed in kg Sb-eq to take care of the different scarcities of different materials (Sb is the chemical symbol for antimony, and kg Sb-eq is the standard unit for raw material depletion).

- Last, but not least, CFP is under permanent scrutiny by scientists. This helps to not lose the goal from sight. Counter-examples abound. For instance, transport policy that multiplies large electric vehicles has completely lost from sight the goal of abating CO_2-eq emissions.

We believe an important aspect of this story is the trial-and-error process. CFP exists since 1979. It adjusted itself permanently to new inputs. Not only did it adapt parameters like, say, fish net dimensions, but also it adapted its structure, e.g., when introducing and formalizing the concept of fleet capacity. In short, the regulators did not wait to have the good solution to apply it.

A related aspect is that each new development of CFP prompted new enquiries. For instance, the obligation of declaring all catches prompted researches on undeclared catches. It also prompted researches on by-catches, or non-targeted catches (e.g., juveniles, or dolphins). This shows that CFP did not sign the end of research on improving fisheries. In fact, CFP only reoriented research.

Another aspect is that CFP is already a long story, and that it did not yield visible results before a long time. For instance, Europe recognised in 2002 that 88 % of stocks was still over-fished.

3 CFP-like policies for reducing impacts of ICT

The first three point above are universal. They apply to every activity domain. They represent the global attitude that every regional power should have if it wanted to control anything.

We have seen that a first step is to have an agreement on the evaluation of the situation. Scientific and popularisation literature, laws (e.g., WEEE, RENE [7] and AGEC [8] in France) and regulations seem to reveal a basic level of awareness. The first step includes also to choose a concern. CO_2-eq is often considered as *the* concern, but it is notoriously difficult to evaluate. But do we have the choice? International agreements are all expressed in CO_2-eq. One must enforce a CO_2-eq accounting, and it is beneficial for all activities. So, the TAC of ICT will be *total GHG emissions*.

CFP has waited about 15 years to recognise that measuring catches is not enough, and to introduce the concept of *fleet capacity*. We need not wait so long because we already know that there are other important impacts, like raw material and water depletion. Thus, we believe that an ICT policy should include a control of mass and power of ICT equipments. One can imagine such regulations as assigning mass and power caps to ICT equipments according to market sector. For instance, one could say that private computers weigh less than a kilogram (possibly Sb-eq), and consume less that 10 watts. Note that in another domain, one could say that a private car is less than 800 kg and less than 5 kW.

4 Research and CFP-like policy for ICT

Is there room for research and innovation in such a corseted ICT domain? We believe yes (others do too, ex. [9]), but it is for a large part science undone, or even science unthought of. We mentioned the necessary scrutiny of CFP by experts, and we believe it will be so for all applications of similar policies.

Capping mass and power will certainly stimulate research and innovation. Mainstream CS is really not good at that because there is always some means to buy one more machine, or a bigger one. Even its most strongly established algorithmic subdomain, asymptotic complexity analysis, measures impacts with unit-less cost functions. Asymptotic complexity is mainly used to compare time and memory consumption, but interesting proposals have been done for measuring energy [10]. However, comparing energy consumption modulo a multiplicative constant is vain when one is confronted with physical limits.

There is a niche that already knows to play with strong physical constraints, dimension, mass or power caps. It is the domain of embedded systems. Its most spectacular incarnations are spatial systems like artificial satellites or planet rovers. Very intimate applications are pace-makers or audio-aids. CS research in CFP-like times will probably look more like present research on embedded systems, but on a vastly wider scale. Datacenters or the Internet [6] could be its objects of interest.

5 Conclusion

CS specialists are used to improve in the abstract. In this world there is no physical units, only asymptotic behaviours modulo multiplicative and additive constants. It is time to explore as a routine non-asymptotic behaviours inside concrete a priori limits. It already exists in important economic domains, but it is not in the mainstream education and research tracks of computer science. It is time to take computing in the limits seriously at all levels, including research to understand what it really means.

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