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# Unexpected Economic Consequence of Cloud Computing: A Boost to Algorithmic Creativity

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**Abstract** While theoreticians have been designing more and more efficient algorithms, in the past, practitioners were not very interested in this activity: if a company already owns computers that provide computations in required time, there is nothing to gain by using faster algorithms. We show the situation has drastically changed with the transition to cloud computing: many companies have not yet realized this, but with the transition to cloud computing, any algorithmic speed up leads to immediate financial gain. This also has serious consequences for the whole computing profession: there is a need for professionals better trained in subtle aspects of algorithmics.

## 1 Algorithms can be made more efficient

It is well known than many algorithms that we traditionally use are not the most efficient ones. This was a big revelation in the 20th century, when it turned out that not only the traditional algorithms for such exotic things as Fourier transform were not the most efficient ones, but also traditional algorithms for multiplying matrices – and even for multiplying numbers – are far from efficient; see, e.g., [2].

## 2 Theoreticians win prizes, but practitioners are not impressed

Researchers still actively work on designing new more and more efficient algorithms. These new algorithms win research prizes and academic acclaim, but in most cases, these developments do not attract much interest from the practitioners. As a result,

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while there is a lot of effort for speeding general algorithms – efforts supported by national funding agencies – there is very little effort in speeding specialized algorithms intended for geo-, bio-, engineering, and other applications.

## 3 Why, in the past, practitioners were not interested

In the recent past, this lack of interest was mostly caused by the fact that we were still operating under Moore's Law, according to which computer speed doubled every two years or so. So why invest in speeding up the algorithm by 20% if in two years, we will get a 100% increase for free?

## 4 Practitioners are still not very interested

Nowadays, Moore's Law is over, but practitioners are still not very interested. The main reason for this is that – with the exception of a few time-critical situations when computation time is important – what would a company gain by having a faster algorithm? This company most probably already has computer hardware allowing it to perform all the computations it needs within the required time – so there will be no financial gain if these computations are performed faster.

## 5 But what happens with the transition to cloud computing?

The above arguments work well when the company owns its computers, However, largely, a large portion of computations is done in the cloud – i.e., on computers owned by a cloud service (to which the company pays for these computations); see, e.g., [1].

What we plan to show is that this drastically changes the situation: many companies may not have realized that, but now it has become financially beneficial to support algorithmic creativity.

## 6 How a company pays for cloud computing a reminder

With cloud computing, a company only pays for the actual computations. This fact is the main reason why cloud computing is economically beneficial for companies. For example, a chain of stores does not need to buy additional computers to cover spikes in purchase processing needs during the Christmas season – additional computers that

will be mostly idle at other times. Instead, it can only pay for additional computations during this season – and do not spend any money at other times.

## 7 This leads to a boost in algorithmic creativity

Now that the company payment is directly proportional to computation time, any decrease in computation time leads to immediate financial savings. For example, if a company spends 3 million dollars a year on cloud computing services, and its computer specialists manage to make its algorithms 20% faster, the company immediately saves 600 000 dollars – not an insignificant amount.

With this in mind, it has become financially beneficial to try to speed up existing algorithms – i.e., to boost algorithmic creativity. Many companies haven not yet recognized this – and this paper is one of the ways to convince them – but the financial logic is clear: the more algorithmic creativity, the larger the company's profit.

## 8 How this will affect education of computing professionals

As of now, most companies are not interested in computational efficiency, so they hire people who can code – without requiring that these folks are familiar with all the techniques used in making algorithms faster. The resulting demand leads to the emphasis on basic skills when teaching computing professionals.

As more and more companies will realize that algorithmic creativity is profitable, there will be a larger need for professionals who are more skilled in algorithmics – and the resulting demand will definitely change the way computer professional are educated.

This phenomenon will also boost the corresponding theory – and modify it since companies will be interested in actual computation time, the corresponding problems will switch from optimizing approximate characteristics like number of elementary computational steps to more sophisticated characteristic that will provide a better approximation to the actual computation time.

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## References

1. D. Comer, *The Cloud Computing Book: The Future of Computing Explained*, CRC Press, Boca Raton, Florida, 2021.
2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, MIT Press, Cambridge, Massachusetts, 2022.