A propos du centre ou de la direction fonctionnelle

The Inria Lille - Nord Europe Research Centre was founded in 2008 and employs a staff of 360, including 300 scientists working in sixteen research teams. Recognised for its outstanding contribution to the socio-economic development of the Hauts-de-France region, the Inria Lille - Nord Europe Research Centre undertakes research in the field of computer science in collaboration with a range of academic, institutional and industrial partners.

The strategy of the Centre is to develop an internationally renowned centre of excellence with a significant impact on the City of Lille and its surrounding area. It works to achieve this by pursuing a range of ambitious research projects in such fields of computer science as the intelligence of data and adaptive software systems. Building on the synergies between research and industry, Inria is a major contributor to skills and technology transfer in the field of computer science.

Contexte et atouts du poste

The INOCS team aims to develop new models, algorithmic techniques and implementations for optimization problems with complex structure (CS). More precisely, we consider that an optimization problem presents a CS when for example it involves some hierarchical leader-follower structure (bilevel optimization). Luce Brotcorne is specialist in bilevel optimization with a particular expertise to solve bilevel problems, while Bernard Fortz has also a strong experience in decomposition methods that will be at the core of algorithms developed in the project.

A post doctoral position is available in the Incos team for the topic "Services Pricing for cloud computing".

Mission confiée

— Research scope —

Cloud computing is offering a variety of services to end users like the management and storage of data, the processing of jobs or the access to platforms on demand. More precisely, cloud computing can be defined as "a large-scale distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted, virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet." The service level agreement (SLA) is the contract between the service provider and the customers. It defines the services that the provider will furnish. The quality of service (QoS) represents the capacity of the service provider to respect the SLA subscribed by the clients. Focusing on the "Platform as a service" or the Infrastructure as a service" context, the QoS can be deteriorated if the delay of processing increases. This occurs when the amount of resources required by the users are not sufficient to satisfy the demand. To solve this problem the cloud provider can either reduce the maximum resources consumption of users in the SLA or invest in additional servers or define incentives like the price to smooth out the demand over time. This last solution is under study in this project.

When defining the service prices, the cloud service provider objectives are to increase the benefits while insuring a good quality of service. Three pricing strategies can be identified in the literature [3]:

i) value-based pricing, based on the demand of users,
ii) cost-based pricing, based on the costs for the service provider,
iii) market-based pricing considering both aspect, like auction model for example.

Unfortunately, these "pay-per-use fixed pricing" charging users for what they consume can't be used to limit the peak periods of usage by the users. In order to reach this objective, prices need to vary over time and accordingly to the amount of resources required.

To intrinsically integrate the decisions of the cloud users maximizing their utility into the decision making process of the cloud service provider the cloud service pricing problem (CSPP) can be modeled as a bilevel optimization problem.

Bilevel Programming is a fairly recent branch of optimization that deals with programs whose constraints embed an auxiliary optimization problem (ILP, [5]). More precisely bilevel problems involve two decision makers (a leader and a follower) interacting sequentially and hierarchically. In our context the leader is the cloud operator defining a pricing strategy taking explicitly into account the reactions of the users. For the CSPP the objective of the leader is to maximize the revenue (profit - costs) and decrease the peaks while the objective of the users is to minimize their cost and they delay.

Bilevel programming problems, being generally difficult to solve due to their non-convexity and non-differentiability, the structure of the problem will be exploited to define efficient solution methods. For example when the optimization problem is convex for fixed leader decisions, it can be replaced by its KKT conditions leading to a single level optimization problem.

— Research objective —

The goal of the post-doc is to study the properties of bilevel bilinear programs for the SEPP and develop efficient solution methods. Numerical results should be studied and discussed. This field of research is very innovative and promising in an industrial context.

— References —

[1] I. Foster, Y. Zhao, I. Raicu and S. Lu, "Cloud Computing and Grid Computing 360-Degree..."
The overall research activities can be summarized as follows:

- Keep updated with the state-of-the-art and inform the INOCS team about relevant publications.
- Define new bilevel models for the service cloud pricing problems.
- Design efficient algorithms to solve the problem.
- Test the algorithms on randomly generated instances and possibly real-life instances.
- Present the results in international conferences and write a scientific publication.

### Compétences

Candidates should hold a PhD Thesis in Operations research, mathematics, computer science, or similar fields and should ideally have a solid background in discrete optimization, integer programming, decomposition techniques. Computer science skills in algorithmic and C/C++ development are also welcome.

Knowledge of French is not required, but good communication skills and a solid knowledge of English are essential.

### Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Access to vocational training
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

### Rémunération

Gross monthly salary (before taxes): 2653 €