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 110 researchers working in sixteen research teams. Recognised for its outstanding contribution to the socio-economic development of the Nord – Pas-de-Calais Region, the Inria Lille - Nord Europe Research Centre undertakes research in the field of computer science in collaboration with a range of academic, industrial and institutional 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

Research environment

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 it presents a hierarchical leader-follower structure or integrates different decisions variables. Diego Cattaruzza, Maxime Ogier and Frédéric Semet, members of INOCS team, are experts in the transport and production fields and have strong background in the design of exact heuristics to tackle complex problems from both the heuristic and exact perspective. Claudia Archetti from the Università degli Studi di Brescia will participate in the supervision of the thesis. She has large experience in the design of branch-and-price algorithm for routing problems. This PhD project focuses on the study of the class of integrated optimization problems (IOPs) where two sub-problems at the operational level are integrated. Problems are considered operational when they are carried out on a daily basis. Examples of operational problems are delivery or production planning.

Context of the project

More formally, an IOP can be modelled as a mathematical program with the following features. The decisions variables can be divided in two vectors: x and y representing the decisions to be taken in the two sub-problems. The constraints can be divided in three sets: (1) constraints involving only variables x, expressed as x X, (2) constraints involving only variables y, expressed as y Y and (3) constraints linking variables x and y, expressed as (x, y) Z. This last set of constraints represents the integration of the decision variables. The objective to optimize is modelled by a function h(x; y) involving the two vectors of variables.

Operations Research (OR) state of the art tools allow to eiently solve both routing and production problems when treated separately. When these problems are integrated, only very small size instances can be solved with state of art tools.

Scientific challenge

Mathematical models that define a complete IOP are too complex to be directly solved by state of the art commercial solvers. As a consequence, ad-hoc methods need to be designed to tackle IOP as a whole problem. The challenge of the thesis is to conceive and develop exact methods that efficiently scale up with the size of the instance. Exact methods for routing problems with time windows can solve to optimality instances with around 100 customers. When vehicles are allowed to perform several trips, state-of-the-art methods can solve instances with up to 50 customers. In this thesis we will design algorithms able to solve the same size instances but in a IOP context.

Applications

IOPs are present in real life and solving them efficiently will have a big impact in different contexts. In the following, we describe two real examples of IOPs, one in the production sector and another in the distribution sector. The first application is the just-in-time production. This is the case when the storage capacity after production is really limited, or for short lifespan products like perishable goods. Here, the operations consist in (1) a complex production schedule to be carried by operators in a production center 2) a delivery planning to be conducted by drivers to deliver the products to the clients. These two actions need to be deeply synchronized due to limited storage capacity and/or short lifespans. Moreover, the time window for delivery to clients is usually short making the delivery planning hardly constrained. As a consequence, solving production and distribution in cascade can easily bring to an infeasible solution. Therefore the two problems must be integrated, thus simultaneously solved.

The second case finds its application in the context of local supply chain. Here, different commodities have to be delivered from producers to final customers. Usually producers do not have the resources to deliver all customers or this is done at the detriment of their working time. More often, they may not produce enough quantity or all the commodities to satisfy the customer demands. As a consequence, the producers may gather together and adhere to a platform in charge of a) the collection of commodities from producers, b) consolidation of commodities at one of several central depots; c) delivery of commodities to customers. The problem that arises is a IOP that consists in the integration of two routing problems, one dedicated to the collection and another to the delivery. To efficiently optimize the whole system one has to consider the whole IOP since solving in cascade collection and delivery can result in sub-optimal solutions.

Mission confiée

Objectives of the thesis

• To study the design of algorithms to solve IOPs with complex structure.
• To compare exact methods and heuristic methods on IOPs instances.
• To contribute to the theoretical know-how in the field of OR.

Informations générales

• Type de contrat : CDI de la fonction publique
• Niveau de diplôme exigé : Bac + 5 ou équivalent
• Fonction : Doctorant

A propos d’Inria

Inria, l’institut national de recherche dédié aux sciences du numérique, promeut l’excellence scientifique et le transfert pour avoir le plus grand impact. Il emploie 2400 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3000 scientifiques pour relever les défis des sciences informatiques et mathématiques, souvent à l’interface d’autres disciplines. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 160 start-up. L’institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l’économie.

L’essentiel pour réussir

The candidate should hold a Master’s degree in operations research, mathematics, computer science, or similar fields.

The candidate should demonstrate coding skills in at least one language among C++, Java and Julia. Knowledge in branch-and-price algorithms and familiarity with the column generation paradigm will be a plus.

Consignes pour postuler

CV, application letter, one or more letters of recommendation and last school transcripts

Sécurité défense

Ce poste est susceptible d’être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L’autorisation d’accès à une zone est délivrée par le chef d’établissement, après avis ministériel favorable, tel que défini dans l’arrêté du 03 juillet 2012, relatif à la PPST Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l’annulation du recrutement.

Politique de recrutement :

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.

Attention: Les candidatures doivent être déposées en ligne sur le site Inria.
The main objective of the thesis directly follows from the challenge presented in the previous section, that is to conceive efficient mathematical models and exact methods in order to solve large scale instances. The use of the column generation paradigm could be investigated, by defining the notion of column, and the resulting extended formulation and pricing problem in the context of IOP.

**Principales activités**

Study the existing literature on exact methods for routing, scheduling and production problems.
Study the existing literature on the integration of operational problems.
Conceive and implement efficient exact methods for IOP.
Test the methods on benchmark instances and analyse the results.

**Related activités**

Present the work at national and international conferences.
A period as a visiting student in a foreign university may be possible.

**Compétences**

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) + Access to vocational training
- Social security coverage

**Rémunération**

1st and 2nd year: 1593.50€ Net monthly salary (after taxes)
3rd year: 1676.31€ Net monthly salary (after taxes)