Please refer to Associate Teams call for projects: http://en.inria.fr/research/international-mobility/associate-teams/call-for-projects

Submit your proposal online before 2011 September 30th on https://international-programs.inria.fr

Name of the project: BANANAS

A. DETAILED PROJECT DESCRIPTION

A1 Description of the research project - *2 pages maximum.*

- *Describe the scientific objectives of the project and the method used*
- *Describe how, what and to what extent you intend to advance this research*

New industrial problems require more and more complex models and involve more and more variables and data. Several aspects have to be taken into account such as: temporal scheduling, uncertainty leading to several scenarios, or the fact that the variables are of different types (numerical variables, symbolic variables, Boolean variables, etc.). For instance, the recent ROADEF challenge on large-scale energy management with varied constraints is an interesting example of such a complex problem. Only experts are able to devise efficient algorithms for solving such problems, most of the time by using decomposition techniques and combination of heuristics and solvers. In fact, while formerly the complexity of problem solving was mainly related to the dimensions of the search space, we are now faced to complex models that include complex constraints (which even may be difficult to formalize) and that require complex and heterogeneous solving technologies. Therefore, there is a need for new solving tools, made available to engineers, and easily (or even automatically) configurable for a specific problem.

In this project we focus on such complex industrial applications related to Chile. More specifically, we want to focus on the models issued from problems such as mining problem, electric generators, and water distribution. We hope this first phase will attract some industries or government institutions in order to focus on applied research with real data; we also hope this will encourage some industrial partners to participate, and this will reinforce our relationships with some companies such as ESVAL, a water distribution company.

Note also that parts of this project are integrated in the future activities of CIRIC in Chile, and that the results about autonomous search will be helpful for the CIRIC.

By tackling problems related to Chilean industry and development, we hope to attract young researchers. Indeed, the Chilean economy is strongly related with the mine industry; water is a scarce resource missing in some parts of Chile; in summer water needs to be saved in almost all parts of Chile. These problems are interesting for young researchers who aim at being involved in the development of Chile and of its industrial companies. A bilateral project is also since allows young scientists to visit foreign institutions.

During the last decades, impressive improvements have been achieved to solve complex combinatorial optimization problems, issued from real world applications, and which involve more and more data and constraints. In order to tackle large scale instances and intricate problem structures, sophisticated solving techniques have been developed, combined, hybridized to provide efficient solvers. Combinatorial problems are often modeled as constraint satisfaction problems (e.g., [A03]) or constraint optimization problems, which consist of a set of variables, a set of possible values for these variables, and a set of constraints to be satisfied.

A common idea to get more efficient and robust solving algorithms consists in combining several resolution paradigms in order to take advantage of their respective assets (see, for example, [JG01], [FLL02], [MHGRA+09] or [BB95]). Such combinations are now well recognized and they have been more and more studied and investigated during the last years by several communities, including the constraint programming community. Considering that very efficient constraint solvers are currently available, the challenge is to make them cooperate in order to:

- get better solution, either in terms of solution quality (a better optimum closer to the global optimum can be reached by combining various optimization systems) or in terms of types of solutions, e.g., when there are numerous solutions, provide a solution that better suits the user (i.e., for the mining problem, provide a solution closer to the solution given by mine experts),
- improve solving efficiency and solving time,
- tackle and solve more problem classes, e.g., solve hybrid problems (with different types of domains for variables and different types of constraints) that could not be solved by a unique solver,
- solve distributed problems (distributed either naturally or for some security and confidentiality reasons),
- and/or reuse (parts of) solvers to reduce implementation costs.

However, solvers or hybridization of solvers become more and more complex: the user must select or design various solving and hybridization strategies and tune numerous parameters, either related to the solvers or to the hybridization strategy. Moreover, it is well-known that a priori decisions concerning strategies and parameters are difficult since strategies and parameters effects are rather unpredictable and may change during resolution.

Finding the most suitable algorithm and its correct setting for solving a given problem has already been investigated many years ago [Ric76] as the *algorithm selection problem*. From these seminal works, new trends have been explored [SM08]. Focusing on constraint optimization problems, an *Autonomous Search* [HMS11a] system offers the ability to advantageously modify its internal components when exposed to changing external forces and opportunities. Internal components correspond to the various algorithms involved in the search process - heuristics, inference mechanisms, etc. External forces correspond to some evolving information collected during this search process - search landscape analysis (quality, diversity, entropy, etc.), external knowledge (prediction models, rules, etc.), etc. This information can be either directly extracted from the problem or indirectly computed through the perceived efficiency of algorithm's components. Examples of collected information include the size of the search space (exact or estimated), the number of sub-problems, etc. Computed information includes the discriminating degree of heuristics, the pruning capacity of inference techniques, etc. Information can also refer to the computational environment, which can often vary, e.g., number of CPU cores.

The main challenges of the project are thus:

- to automate selection and cooperation of basic solving components by using machine learning techniques (i.e., inspired by portfolios algorithms)
- to automate tuning of parameters of the resulting solvers, including the cooperation parameters (without the need of an expert user who cannot tune (hybrid) solvers when parameters are too numerous)
- to control and adapt solvers during the solving process by changing parameter values, solver components, and (cooperation) strategies.

A2	**Expected project outcomes and scientific value** - *2 pages maximum*

- *Project's characteristics, advancement beyond the state-of-the-art*
- *General orientation of the project (basic research – applied research with or without the participation of industry)*
- *Project's contribution to fostering young researchers*

Project Background

Our application domains are strongly related to Chilean industry and development: we are interested in Electric generator problems (at UTFSM); we have some contacts with the Chilean water provider ESVAL (at Valparaíso) on Water distribution problem; and the Associate Team includes a partner (CMM) who is focused on optimization problems occurring in the mining industry. For example, a crucial problem in the mining industry is to determine the optimal sequence of extraction of virtual blocks in which the mine has been structured for exploitation. A Chilean mine, typically can be constituted by more than 1 million blocks: from an Optimization point of view, the sequencing models for this structure are very complex. In fact, these are combinatorial linear models, having a huge number of variables, which means that the exact resolution by standard optimization techniques is very frequently inefficient. In general terms, the medium and long term planning is extremely simplified, because of the difficulties in finding optimal solutions for the complex mathematical problems that appear, mainly those representing the sequence of exploitation. Two main concepts have to be considered: the optimality of the sequence of extraction and the robustness of the solution. This last aspect is very relevant, due to the variability of prices, minerals grades estimations and other sources of uncertainty, and it deals with a very active field of research in mathematical optimization nowadays. The search for the best sequence of exploitation is our main objective.

With respect to solvers, our background material consists of:

- Solvers of the CMM (different types of solvers derived from mathematical tools such as combinatorial optimization, heuristics strategies, and optimal control)
- The autonomous solvers developed in Angers, based on evolutionary and local search algorithms
- The adaptive and hybrid CP solver and some problem specific metaheuristic solvers developed by UTFSM
- The SMT solvers from Nancy

Expected improvements of the state of the art

Until now, a solver cooperation is often specified in an ad-hoc way as a fixed cooperation of given solvers in order to solve efficiently one given class of problems. In that case, the solver is neither flexible nor extendable nor re-usable. To avoid these drawbacks, a more recent idea consists in adopting a glass-box approach by specifying solver cooperation via a set of solvers and a strategy language. However, with respect to the No Free Lunch theorems for optimization [WM97], there probably does not exist a universal strategy that is the most efficient for all possible problems. As a counterpart of the solver+strategy approach, an expert is required to tune the cooperation strategy in order to get an efficient solving of the problem at hand. Moreover this approach does not consider adaptive or autonomous cooperation strategy that could adapt or change during the solving process.

The motivation of this project is thus to investigate the following problems in order to design an autonomous cooperative solver system:

- Offline tuning of cooperation strategies: Automated design of cooperation strategies adapted to the problem or class of problems at hand
- Online tuning: Control and adaptation of cooperation strategies during the solving process

The expected gains in terms of solving problems are:

- Cooperation strategies adapted to the problem to be solved,
- Cooperation strategies that evolve during solving,
- And subsequently, improvement of the solving process in terms of: quality of solutions, efficiency of the process, and increase of the number of problems that can be tackled.

This project could be related to existing approaches (such as the following ones) but our originality is to focus on solver cooperation:

- Hyperheuristics [BHK+09]: building new heuristics from basic heuristics. This technique addresses mainly finer grain level of heuristics and is not focused on cooperation and mixed problems.
- Portfolios based solvers (see e.g., [XHHLB08]): portfolio techniques mainly aim at choosing a single solver and cannot be really considered as solver cooperation.

Basic research vs. applied research?

The beginning of this project can be considered as basic research guided by some applications related to Chile. Indeed, we plan to investigate the required strategy language for cooperation and how to couple it with the offline and online mechanisms for tuning to make the cooperation system autonomous. This phase will thus consist in designing the system.
The next phase will be applied research: we plan to feed the system with the required components in order to solve efficiently the problems related to Chilean industry and development:

- Integration of the generic solvers
- Integration of the problem specific solvers
- Integration of knowledge, learning, and data required for the offline tuning of cooperation strategies with respect to the real problems
- Integration of knowledge, learning, and data required for the online tuning to adapt and change cooperation strategies during the solving of the real problems

The last phase will be totally dedicated to applications. It will consist in:

- improving the components of the system to solve more efficiently the considered problems,
- improving the quality of solutions by adjusting the solvers, and the online and offline tuning,
- and broadening of the problems. For example, current water distribution models only consider the distribution of a city or small region, but they do not consider supplying of the net from the reservoirs.

Impact:

- Existing collaboration with partners: the Associate Team would enable us to reinforce the collaboration between the teams in the CIRIC project at Valparaíso and Santiago.
- Collaboration with other INRIA projects. The partner at UTFSM has also collaborations with the INRIA projects CONTRAINTES (STIC AmSud Todas) and COPRIN (INRIA-CONICYT projects).

- Collaboration with other teams of the foreign partner institute: reinforce collaboration with CMM, collaboration with U. Valdivia, PUCV that are in close relation with UTFSM, and Angers for U. Valdivia.

Encouraging doctoral programs and collaborations through PhD thesis : during the last years, the senior members of the team have been involved in the supervision of PhD students in both countries, thus developing cooperative works and new collaborations. They have been reviewers for PhD students, both in Chile and France.

A3 Presentation of each organization and lead researcher credentials – *2 pages maximum*

Brief introduction of the two partner institutions / teams

- In France:
  - Cassis project-team (Christophe Ringeissen, Laurent Vigneron), and Olivier Perrin (professor, U. Nancy 2), Frédéric Saubion (professor, U. Angers) and the following students: Caner Candan, Giacomo di Tollo, Nadarajen Veerapen.
- In Chile:
  - UTFSM (CIRIC): Eric Monfroy, Maria-Cristina Riff, Elizabeth Montero, Carlos Castro, and the following students: Broderick Crawford, Daniela López.
  - CMM (CIRIC): Jorge Amaya, Nelson Morales, Pierre Nancel-Penard

France:

The CASSIS research group at INRIA Grand Est, headed by Michaël Rusinowitch, is internationally known for its work on formal methods, automated software verification and testing, with expertise in security protocols, distributed collaborative systems, constraint solving and automated deduction.
CASSIS is actively engaged in multiple national and international projects (e.g. over 10 national and 4 European projects started in the last 5 years). CASSIS research group has about 20 members located in Nancy and Besancon. The research group has a good track record of training and networking, mainly in educational and training programs for bachelor and master students.
CASSIS also coaches yearly around 4 students during their MSc thesis and in average 3 PhD students graduate every year in the group. CASSIS publishes around 30 papers per year in international journals and international conferences.
The French side involves also

- Olivier Perrin (professor, U. Nancy 2) for his expertise on Semantic Web Services, Service Oriented Architectures, and Web service composition.
- Frédéric Saubion (professor, U. Angers) for his expertise on optimization problems, metaheuristics and autonomous search.

Olivier Perrin and Frédéric Saubion are long-time collaborators of our previous joint projects with UTFSM.

Chile:

The Chilean side involves two partners :

UTFSM partner consists of computer scientists who have developed, since their PhDs done at

INRIA, an expertise on constraint solving, combinatorial optimization, metaheuristics and cooperation techniques. UTFSM has a long tradition of cooperations with INRIA, through bilateral INRIA-CONICYT projects and one INRIA Associate Team (VanaWeb, 2008-2010).

CMM partner consists of mathematicians interested in optimization problems appearing in the mining industry by using mathematical tools such as combinatorial optimization, heuristics strategies and optimal control.

Background of the Principal Investigators on both sides

France:

Christophe Ringeissen PhD in Computer Science from the University of Nancy (1993). Advisor: H. Kirchner. Habilitation in Computer Science from the University of Nancy (2009).
His research interests are: automated deduction, rewriting, constraint solving, combination methods, rule-based programming, constraint (logic) programming, and verification.
Researcher at INRIA since 1995. Member of the PROTHEO INRIA project: 1993-2005. Member of the CASSIS INRIA project-team since 2005.

Selected publications :

1. E. Monfroy and C. Ringeissen. An Open Automated Framework for Constraint Solver Extension: the SoleX Approach. Fundamenta Informaticae, 39(1-2):167-187, Jul 1999.

2. C. Castro, E. Monfroy, and C. Ringeissen. A Rule Language for Interaction. In Krzysztof R. Apt, François Fages, Francesca Rossi, Péter Szeredi, and József Váncza, editors, Recent Advances in Constraints, volume 3010 of Lecture Notes in Artificial Intelligence, pages 154-170. Springer-Verlag, May 2004.

3. E. Monfroy, O. Perrin, and C. Ringeissen. Dynamic Web Services Provisioning with Constraints. In Proc of 16th International Conference on Cooperative Information Systems, OTM Conferences, volume 5331 of LNCS, pages 26-43. Springer, Nov 2008.

Chile:

Eric Monfroy PhD in Computer Science from the University of Nancy (1996). Advisor: M. Rusinowitch. Habilitation in Computer Science from the University of Nantes (2002).
His research interests are: constraint solving, constraint reasoning, rule-based programming, autonomous search, coordination languages, and metaheuristics.
Researcher at UTFSM since 2004 (on leave from Professeur des Universités, Université de Nantes).

Selected publications:

1. E. Monfroy, F. Saubion, and T. Lambert, On Hybridization of Local Search and Constraint Propagation. Proceedings of the 20th International Conference on Logic Programming ICLP'2004, Lecture Notes in Computer Science 3132, Springer.

2. K.R. Apt and E. Monfroy, Constraint Programming viewed as Rule-based Programming, Journal of Theory and Practice of Logic Programming, 2001, 1(6):713-750.

3. L. Bordeaux and E. Monfroy, Beyond NP: Arc-consistency for Quantified Constraints, Proc. of the 8th Int. Conf. on Constraint Programming, Springer, Lecture Notes in Computer Science 2470, 2002.

4. Y. Hamadi, E. Monfroy, and F. Saubion, Hybrid Optimization (The 10 Years of CP-AI-OR), chapter "What is Autonomous Search?", Springer-Verlag, serie Optimization and its Applications, vol. 45, pp. 357-391, 2011.

Main publications of the participants related to the broad topic of the proposal (mark clearly the joint publications)

Publications on Mine Planning

1. Amaya J., L. Soto, R. Sanchez. Target Data Projection in Multivariate Visualization: an Application to Mine Planning. In: Computational Science and its Applications - ICCSA 2004-Pt 2. ***Lecture Notes in Computer Science, 0302-9743(3044): pp. 603 -612, 2004.***

2. Ferland, J., J. Amaya and M. S. Djuimo. Particle Swarm Procedure for the Capacitated Open Pit Mining Problem. ***Autonomous Robots and Agents, Studies in Computational Intelligence, Springer Verlag, 2007.***

3. Amaya, J., D. Espinoza, Goycoolea, M., E. Moreno, Th. Prévost. A scalable approach to optimal block scheduling. Proccedings: APCOM2009, ***Applications of Computers on Mining Industry, Vancouver, Canada, 2009.***

4. Alvarez, F., J. Amaya, A. Griewank and N. Strogies. A continuous framework for open pit mine planning. ***Mathematical Methods for Operations Research, Vol 73, pp 29-54, 2011.***

5. Guido Lagos, Daniel Espinoza, Eduardo Moreno and Jorge Amaya. Robust planning for an open-pit mining problem under ore-grade uncertainty. In: Proceedings LAGOS 2011–VI Latin-American Algorithms, Graphs and Optimization Symposium, ***Electronic Notes on Discrete Mathematics, Vol 37, pp 15-50, 2011***.

Joint Publications on Constraint Solving

[CMR04] Carlos Castro, Eric Monfroy, and Christophe Ringeissen. A rule language for interaction. In K.R. Apt, F. Fages, F. Rossi, P. Szeredi, and J. Vencza, editors, Proceedings of Recent Advances in Constraints, Joint ERCIM/CoLogNET International Workshop on Constraint Solving and Constraint Logic Programming (CSCLP 2003), number 3010 in Lecture Notes in Computer Science, pages 154-170, Budapest, Hungary, 2004. Springer.

[HMS08a] Y. Hamadi, E. Monfroy, and F. Saubion, editors. Special Issue on Autonomous Search, volume 4 of Constraint Programming Letters, 2008.

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[HMS11c] Y. Hamadi, E. Monfroy, and F. Saubion. Hybrid Optimization (The 10 Years of CP-AI-OR), volume 45 of Optimization and its Applications, chapter What is Autonomous Search?, pages 357-391. Springer-Verlag, van Hentenryck P. and Milano, M. edition, 2011.

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21st International Conference, ICLP 2005, volume 3668 of Lecture Notes in Computer Science, pages 421-423, Sitges, Spain, October 2 - 5 2005. Springer. poster paper.
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A4	**History of the collaboration between the teams -** *1 page maximum*

- *Existing activities correlated with the main objective of the project,*
- *Necessity and significance of this collaboration*
- *Added value of this project for each partner*

The project is the continuation of a well-established collaboration:

Carlos Castro, Eric Monfroy, Olivier Perrin, Christophe Ringeissen, Laurent Vigneron did their PhDs at CRIN-INRIA (Nancy) in the 90's, and share a common research interest on constraint and rule technologies. When Carlos Castro came back to Chile, we started collaboration on constraints, rules, and strategies. A major side-effect of this collaboration is that Eric Monfroy, who was professor at Nantes, has moved to Valparaíso, to work with Carlos Castro at UTFSM. Our collaboration has been successively supported by different INRIA-CONICYT projects, namely COCARS, VANANAA and CoreWeb. In the last years, the collaboration has been extended to French colleagues working on hybrid and adaptive methods (Frédéric Saubion, prof. U. Angers). More recently, the partners were involved in the Associate team VanaWeb (2008-10) whose focus was on composition problems for the Web via hybrid constraint solving. The partners from Angers and UTFSM Valparaíso are also involved in the STIC AmSud project TODAS coordinated by P. Deransart on Trace-Guided Autonomous Solvers. They are also involved in an Ecos-Sud Project between Angers, UTFSM Valparaiso and the university of Valdivia.

We are associated to the project of building an INRIA Lab in Chile (CIRIC centre of excellence). We are involved in the line ``Models and software for high impact industries", and more precisely in the sub-line ``Models and Algorithms" (head of the subline: Jorge Amaya), in which we find partners from Santiago (CMM, DCC, Delphos Lab), Valparaíso (UTFSM) and INRIA. The goal is to develop new mathematical models and tool support for the mining industry, by using integer programming, metaheuristics, constraint programming... The proposed Associate Team consists in developing new autonomous cooperative solvers that could be of practical interest for the mining industry. It is the opportunity to start a multidisciplinary project between mathematicians and computer scientists on optimization problems occurring in this industry. Clearly, this application domain should be considered as challenging for the solving techniques we want to address within the Associate Team.

Added value of this project for the CASSIS group:

This project is a good opportunity to start working on the possible interactions between SMT solvers and Autonomous Search. On the one hand, SMT solvers are nowadays also used to Optimization Problems. On the other hand, it is interesting to study how to boost SMT solvers with incomplete local search methods by using the AS approach investigated here.

A5 Scientific work program

Duration of the project : 3 years

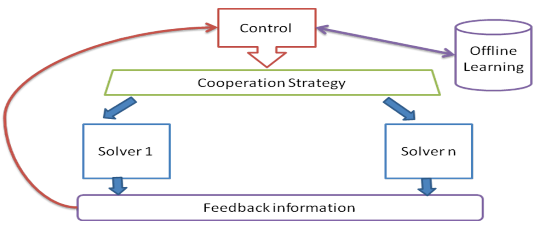
Work Program

- *Describe the scientific tasks planned for the duration of the project*
- *Explain how these tasks are distributed among the participating teams*

We consider 3 main research directions in this project, and each direction is split into tasks:

- **Direction 1**: considering instances of solvers, i.e., solvers as **black boxes (**e.g., cp_ac3_ff is a constraint propagation based solver, which reduces the search space with an ac3 filtering algorithm and performs a first fail enumeration)
  Tasks :
  - Identifications of the abstract architecture of a cooperation strategy
    - Solvers are components of a strategy
    - Operators apply one/several solver at each step of the running strategy
    - …
  - Learning for off-line design of the cooperation strategy (tuning of strategy); use of automated tuning techniques and machine learning techniques
  - Observation of the cooperative solving process required for evaluating the strategies; design of a general control process that manages the learning process and the update of the cooperation strategies; see figure below.
  - Update (change of solvers, change of cooperation operators) of the running cooperative strategy based on the work it has achieved; this update is performed online thanks to the control mechanism.
  - A service based system for autonomous solver cooperation considering instances of solvers (i.e., considering solvers as black boxes)

General scheme

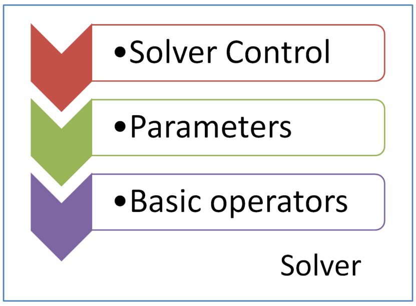


- **Direction 2**: considering solvers as independent autonomous search systems, and thus considering their components and parameters are also managed in the cooperation strategies: more parameters/components have to be considered than in Direction 1 (see figure below). Solvers are kinds of **toolbox**, and their components are instances of components (e.g., cp(ac3,ff) or cp(ac4,ff) in which cp a constraint propagation based solver, ac3 (and ac4) are filtering/reduction components, and ff is a first fail enumeration strategy)
  - Identifications of the abstract architecture
    - Solver components
    - Solver parameters
    - Solver operators

- Cooperation operators

The architecture should be able to manage cooperation strategies as high level parameters and solvers' parameters as low level parameters. The cooperation scheme may consist in information shared at the solvers' parameters level.

- Learning for off-line design of the cooperation strategy and cooperating solvers Two levels of parameters will be considered: cooperation parameters and solvers' parameters. The tuning has to take into account a larger parameters space and to detect suitable interaction of correlations.
- Observation of the cooperation strategies and of the cooperative solvers
- Update (change of solver components, change of solver parameters, change of solver operators, change of cooperation operators) of the running cooperative strategy and cooperating solvers based on the work it has done; this online control is thus generalized to solvers' internal parameters; there should be an interaction between general control and solver control (see figure below)
- A service based system for autonomous solver cooperation of concrete solvers (i.e., solvers are not yet instantiated; they become instantiated when "tuned" in the cooperation strategy).



A more complex and parameterized solvers

- **Direction 3**: considering solvers as abstraction of solvers describing interaction of their components. Components are not yet instantiated. Solvers are patterns/**abstract composition** of services (not instances) (e.g., CP(Prop,Enum) where Prop and Enum are services such that Prop is at least of the filtering strength of ac3, Enum is a first fail enumeration strategy: a possible automated instantiation is then: cp(ac3,ff) or cp(ac4,ff) are possible candidates, depending on the service instances that satisfies the constraints)
  - Learning for off-line design of the cooperation strategy and cooperating abstract solvers
  - Observation of the cooperation strategies and of the cooperative solvers services instances.
  - Update (change of service instances implementing solver and cooperation operators, change of service parameters) of the running composition implementing the solver cooperation
  - A service based system for autonomous solver cooperation of abstract solvers. This phase will use our work on instantiation of abstract service compositions using constraints [MPR08].

After a while, these 3 directions can be followed in parallel: for example, after the description of the cooperation operators, Direction 1 and Direction 2 can be conducted independently. The research directions are not disjoint: for example, the learning of the cooperation strategy operators can be used in the 3 directions.

We are confident that Direction 1 will succeed: indeed, it will consist in lifting the mechanism of

Autonomous Search for a solver at the level of a solver cooperation: solver components become solvers, operator become strategy operators, etc.

In Direction 2, the numerous parameters and components issued from the solvers and their cooperation will drastically increase the size of the search space of the problem (search space defined by the Cartesian product of the values of the parameters and the possible composition of the components). We suppose we will need techniques for automated parameters tuning (e.g., racing techniques, ILSParam or Revac), where clever methods are used to visit and consider only some elements of the search space of parameters and components.

Direction 3 will use the results of the VanaWeb project, a solver cooperation being seen as a special case of service composition. One of the main difficulties will be to express relations between parameters and components of solvers as constraints over services.

Case study: similar in the 3 directions (black boxes, AS systems, and solver abstractions)

- Problems: problems issued from the mining industry in Chile, e.g., the mining problem.
    - Identification of problems
    - Modelling of problems, definition of suitable modelling features
    - Portfolio of problems for learning cooperation strategies
- Solvers: solvers developed by the CMM, UTFSM, Angers, Nancy.
    - Identification of the architectures of the solvers (their components, their operators, their parameters)
- Cooperation strategies:
    - Identification of the required operators
- Evaluation using the developed platform

Distribution of the tasks among the participating teams:

- Identification of problems and their models: this task will mainly be achieved by the Chilean teams: mine industry (CMM and UTFSM), water distribution (UTFSM), electric generators (UTFSM).
- Solvers: every team has solvers of different types, and most of them will be used. An effort will be done to try to match the AS system of Angers.
- Solver cooperation language: this task will mainly be achieved by the Cassis team and UTFSM.
- Online and Offline learning: each team will work on these mechanisms with respect to their solvers. Moreover, a standard will be design in cooperation at the beginning of the project in order to homogenize the mechanisms.
- AS solver cooperation: this task will be designed by the collaboration of all the teams.
- Design of service oriented architecture and abstract mechanisms of Direction 3. This will mainly be done by CASSIS (plus Olivier Perrin) and UTFSM.
- Evaluations: this will mainly be achieved by the Chilean team with respect to the problems they will have focused on at the beginning of the project.

Outline how the partners will coordinate their joint activities and the specific part of each organization (e.g. workshops, website, videoconferencing, etc.)

We plan to organize a workshop in Chile on autonomous search and solver cooperation. Compared to the first workshop we organized in the context of the Associate Team VanaWeb in 2010, we want now to open the workshop to a larger audience, not restricted to the partners of the Associate Team.

Of course, we will maintain a website for the project. We plan to have videoconference meetings on a regular basis. Furthermore, we will use a version control system for our joint papers.

A6 Exchanges schedule for Year 1

Exchanges scheduled from France to the partner country (researchers' name, including students, and expected duration of stays)

- three 15 day visits of senior French researchers to Chile: Christophe Ringeissen and Frédéric Saubion, plus one participant to the workshop
- 1 month visits of French students to Chile: student of Frédéric Saubion (Nadarajen Veerapen or Caner Candan or Giacomo di Tollo)

Exchanges scheduled from the partner country to France (researchers' name, including students, and expected duration of stays)

- three 15 day visits of senior Chilean researchers to France: Eric Monfroy, Maria-Cristina Riff and one visitor from CMM
- two 1 month visits of Chilean students to France: Broderick Crawford (student of Eric Monfroy and Carlos Castro), and Daniela López (student of Maria-Cristina Riff)

A7 Additional information

External References

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B. PROJECT FUNDING

B1 Expected expenditures for Year 1

		Senior researcher	Postdoctoral fellow	PhD student	Intern	Other	Total
Visits of INRIA researchers to partners	Number of persons	3	0	1	0	0	4
	Estimated cost (€)	**7500**	**0**	**2500**	**0**	**0**	**10000**
Invitation of partner researchers to INRIA	Number of persons	3	0	2	1	0	6
	Estimated cost (€)	**7500**	**0**	**5000**	**4000**	**0**	**16500**

B2 Budget proposal for Year 1

Financial support request to INRIA* under the Associate Team program ** The maximum amount awarded by INRIA is 20000 € per year*	€ 20000
Expected financial and/or material contribution from the international partner to the project ➢ We expect UTFSM and CMM to sponsor the planned workshop (2000 euros). Part of the internal DGIP project budget (UTFSM) could be spent on the BANANAS project (1000 euros) ➢ We will try to fund an intern via the INRIA internship program and CASSIS project-team (4000 euros for the travel and the perdiem)	€ 7000
Other resources benefiting to the project ➢ *Please detail (contract, grant, etc.): …*	€
Total	€ 27000