Curriculum Vitæ

Heikel BATNINI

French nationality, born 1976, Nov. 14th, 1 child

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Education

Since 2002	**PhD** in Computer Science	*University of Nice*
2001 - 2002	**D.E.A.** in Computer Science (w/ honors, ranked 1st/19)	*University of Nice*
2000 - 2001	**Master's degree** in Computer Science (w/ honors, ranked 5th/69)	*University of Nice*
1999 - 2000	**Bachelor's degree** in Computer Science	*University of Nice*
1996 - 1999	**Bachelor's degree** in Mathematics	*University of Nice*

Skills

- *Areas of expertise* : **Constraint programming**, **interval analysis**, **numerical optimization**
- *Operating Systems* : Linux, Windows, MacOs
- *Programming Languages* : C, C++, Java, Scheme, Maple, Mupad, Scilab, Bigloo, Pascal, Perl, Ada, Tcl/Tk, Shell, HTML, SQL, UML
- *Other skills* : Computational geometry, algebraic methods, grid computing, network programming, concurrent programming, algorithmic, artificial intelligence, complexity, langage theory, automata theory, graph theory, logic, data bases, cryptology, compilation, object oriented design, software engineering, computer vision, 3D engines
- *Languages spoken :* French (native), English (good), Spanish and Arab (some notions).

Professional Experience

Since Oct. 2002 — **PhD in Computer Science** — *University of Nice*
(Defense in November 2005) — *COPRIN Project*
Director : Michel Rueher — *I.3.S./I.N.R.I.A./CERTIS*
Title : Global Constraints for Numerical Constraint Satisfaction Problems.
Keywords : Constraint programming, interval analysis, search techniques, consistency techniques, global constraints, distance constraints (applications in robotics, molecular biochemistry)

Jan. 2002 - Sept. 2002 — **Research internship** — *University of Nice*
(D.E.A. of Computer Science)* — *COPRIN Project*
Director : Michel Rueher, Claude Michel — *I.3.S./I.N.R.I.A./CERTIS*
Title : Global Constraints for Solving Euclidean Distance Constraints.
Keywords : Constraint programming, interval analysis, search techniques, consistency techniques, global constraints, distance constraints (applications in robotics, molecular biochemistry)

* Diplômes d'Études Approfondies, equivalent to the last year of MSc

Avr. 2001 - Sept. 2001 **Research internship** *NARVAL/SUMARE Project*
(within my Master's degree of Computer Science) *I.3.S./University of Nice*
Advisor : Maria Joao Rendas, Stefan Rolfes and Jean-Pierre Folcher.
Title : Automatic mosaïc creation from ocean floor images.
Keywords : Computer vision

Nov. 2000 - Mar. 2001 **Engineer internship** *NARVAL/SUMARE Project*
Advisor : Maria Joao Rendas, Stefan Rolfes and Jean-Pierre Folcher. *I.3.S./University of Nice*
Title : Development of a GUI for the guidance of a submarine robot.
Keywords : Computer vision

Teaching

Oct. 2002 - Sept. 2005 **Computer Science Teacher** *Computer Science Department, University of Nice*

- *Topics* : Algorithmic and programming in Java (65h), Advanced algorithmic (99h), Languages and Automata (26h), Operating Systems (26h), Data Bases (24h), Image processing (19h).
- *Miscellaneous* : Involved in the preparation of practical courses material and examining questions. Responsible of the practical course of Algorithmic for the 2nd year of BSc (2002-2004). Director of 4 BSc end year projects (2005) and member of the evaluation commitee (2004 and 2005).

Oct. 2001 - Sept. 2002 **Computer Science Lecturer** *Computer Science Department, University of Nice*

- *Topics* : Algorithmic and programming in Java (96h), Advanced algorithmic (48h), responsible of the practical courses (Scheme).

Miscellaneous

Part-time Jobs (full finance of my studies) :

Jan. 1999 - Sept. 2000	**Mathematics Teacher** (Home study courses)	*Acadomia*
Mar. 2000 - Jun. 2000	**Cashier assistant**	*Auchan supermarket*
Jul. 1996 - Avr. 2000	**Pizza Deliverer/Receptionist/Pizzaïolo/Manager**	*Mister Pizza*

Research

Since Oct. 2002 **PhD Thesis** *University of Nice*
Director : Michel Rueher *COPRIN Project*
Title : Global Constraints for Numerical Constraint Satisfaction Problems. *I.3.S./I.N.R.I.A./CERTIS*
Expected graduation date : November 2005

The main part of our works concerns systems of distance equations and inequations. Such distance constraints can be defined as follows:

$$\sum_{k=1}^{k=p} (x_{ik} - x_{jk})^2 = \delta_{ij}^2$$

where x_{ik} is the k-th coordinate of the point P_i in the euclidian space of dimension p, and δ_{ij} is a positive real value. More generally, this value can be given by an interval: $\delta_{ij} \in [\underline{\delta_{ij}}, \overline{\delta_{ij}}]$, where $\underline{\delta_{ij}}$ (resp. $\overline{\delta_{ij}}$) stands for the minimal (resp. maximal) euclidian distance between P_i and P_j. Finding all the roots of such systems is NP-complete. These constraints are widely used in many applications ranging from robot kinematics to chemistry. One branch of computational molecular biology study the automation of structure determination for instance for drug design. The problem of molecular conformation is equivalent to finding the forward kinematics of robots, which is crucial for optimal design. Several computer assisted design softwares uses a representation by geometric constraints and particularly distance constraints. Classical methods for solving numerical constraints are based on local consistencies like 2B-consistency or Box-consistency. The drawback of these methods comes from the fact that constraints are handled independently and in a blind way i.e., local consistencies do not take advantage of the specific semantic properties of distance constraints. In the purpose of distance constraints solving, we explored 3 different approaches : introduction of redundant constraints, a global pruning method and a specific splitting strategy :

- *Introduction of Redundant Constraints* : In [7], we used a algorithm based on Floyd's shortest path algorithm to compute intervals for the missing distances; the bounds of these intervals satisfy distance triangular inequalities. Then, we introduced additional points (barycenter of triangles) to reinforce the pruning achieved by local consistencies.

- *A Global Filtering Algorithm* : In [3], we introduced a global filtering algorithm for handling systems of distance relations. This new method, named *QuadDist*, is derived from *Quad*, a global filtering algorithm for handling systems of quadratic equations and inequations. *Quad* computes a tight linear relaxation of the terms of the quadratic equations and uses the simplex algorithm to reduce the domains of the variables. We proposed a new linear approximation for handling distance relations. The key point of this new method is that the approximations are not generated for each quadratic terms but for each distance constraint. Thus, *QuadDist* defines a tighter approximation than *Quad* without the need to generate any additional variables. Experimental results proved that *QuadDist* outperforms *Quad* on systems of distance constraints.

- *A Specific Search Algorithm* : In [4,5,6], we proposed a strategy, named SDD(Semantic Domain Decomposition), for choosing splitting points in the domains of the variables. These choices are defined by the monotonicity and convexity properties of the distance constraints and by the distribution of the local solutions in the space. Experimental results show that this heuristic improves the performances of the classical branching algorithm.

More recently, this specific search algorithm was extended for handling more general CSPs. In [1,2], we proposed a new splitting strategy for branch and bound algorithms based on consistency techniques :

- *A Search Strategy for Consistency Techniques* : Classical methods for solving numerical CSPs are based on a branch and prune algorithm, a dichotomic enumeration process interleaved with a consistency filtering algorithm. In many interval solvers, the pruning step is based on local consistencies (Hull-Consistency, Box-consistency) or partial consistencies (kB-consistencies, Bound-consistency). The associated pruning algorithms compute numerous data required to identify gaps within some domains, *i.e.* inconsistent intervals strictly included in the domain. However, these gaps are only used to compute the smallest approximation of the box enclosing all the solutions. In [6,7], we introduced a search strategy, named MindTheGaps, that takes advantage of the gaps identified during the filtering process. Gaps are collected with a negligible overhead, and are used to select the splitting direction as well as to define relevant cutting points within the domain. Splitting the domain by removing such gaps definitely reduces the search space. It also helps to discard some redundant solutions and helps the search algorithm to isolate different solutions. First experimental results shows that MindTheGaps significantly improves performances of the search process.

References :

[1] H. Batnini, C. Michel, M.Rueher. *MindTheGaps : A New Splitting Strategy for Consistency Techniques.* To appear in Proceedings of CP'05. 11th International Conference on Principles and Practice of Constraint Programming. October 2005. Barcelona. Spain.

[2] H. Batnini, M.Rueher. *Une Stratégie de Recherche Basée sur la Topologie des CSPs continus.* Actes JFPC'05. 1st French Conference on Constraint Programming. June 2005. Lens. France.

[3] H. Batnini, M.Rueher. *QuadDist: Filtrage Global pour les Contraintes de Distance* Actes JNPC'04. 10th French conference on NP-complete problems solving. June 2004. Angers. France.

[4] H. Batnini, M.Rueher. Décomposition sémantique pour la résolution de systèmes d'équations de distances. JEDAI. Electronic Journal of Artifical Intelligence. Special track JNPC 2003.

[5] H. Batnini, M.Rueher. *Semantic Decomposition for Solving Distance Constraints.* Proceedings of CP'03. 9th International Conference on Principles and Practice of Constraint Programming. September 2003. Kinsale, Co. Cork, Ireland.

[6] H. Batnini, M.Rueher. *Filtrage Local par Décomposition de CSP Continus* Proceedings of JNPC'03. 9th French conference on NP-complete problems solving. June 2003. Amiens. France.

[7] H. Batnini. *Introduction of Redundant Constraints for Solving Systems of Distance Equations* Journal of the university of Saärbrück Sept, 2002. CALCULEMUS Autumn School 2002 in Pisa.

Participations (Talks) :

- JFPC 2005. 1ères Journées Francophones de Programmation par Contraintes. Lens. Juin 2005. Session technique.
  http://www.cril.univ-artois.fr/JFPC05
- JNPC 2004. 10e Journées Nationales pour la résolution de Problèmes NP-complets. Angers. Juin 2004. Session commune JNPC/JFPLC.
  http://www.info.univ-angers.fr/jnpc2004
- CP 2003. 9th International Conference on Principles and Practice of Constraint Programming. Kinsale, County Cork, Ireland. Septembre 2003. Doctoral Programme.
  http://www.cs.ucc.ie/cp2003
- JNPC 2003. 9e Journées Nationales pour la résolution de Problèmes NP-complets. Amiens. Juin 2003. Session technique.
  http://www.laria.u-picardie.fr/JNPC2003/
- EJC 2003 du GdR ALP. Marne-la-vallée. Avril 2003. Exposés des jeunes chercheurs.
  http://www-igm.univ-mlv.fr/ ejc2003
- CALCULEMUS Autumn School. Pise. Septembre 2002. Student poster session.
  http://www.eurice.de/calculemus/autumn-school/getting_started.html