Alfonso Emilio Gerevini
Curriculum Vitae

(with focus on activities in Artificial Intelligence)

June 2019

Highlights: Alfonso Emilio Gerevini has been an active researcher in Artificial Intelligence (AI) since 1988. His main research achievements are in the fields of AI Planning, Temporal and Spatial Reasoning, Knowledge-based Systems and Applied Machine Learning. The contributions that he gave to these fields are variegated and range from new algorithms and theoretical results of different kind, to experimental analyses, implemented systems and innovative applications of AI techniques. He also developed several software tools for efficient automated reasoning and planning, such as the well-known competition-awarded planner LPG, that has been widely used by academic and industrial researchers. He published 130 peer-reviewed research papers in AI (many of which in top scientific journal and conference proceeding) and he received five international awards for some of the AI planning systems that he developed with his research team, as well as an *Influential Paper Award* from the ICAPS conference. He has served the International AI Community and the Italian AI society (AI*IA) in various ways (e.g. Associate Editor of AIJ, EB member of AIJ and of JAIR, Program Chair of ICAPS-2009, Chair of AI*IA-2010, organizer-chair of an International Planning Competition, organizer of 2 International summer schools, PC/SPC member of 68 International Conferences, developer of the standard planning language PDDL3.0). He has also taught university courses in AI for the last 20 years, and for the last few years he has been involved in some industrial projects using AI.
Since June 2019 he is Fellow of the European Association for Artificial Intelligence (EurAI).

CONTACT INFORMATION

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CURRENT POSITION

Since 2005 he is full professor of Information Processing Systems at the Department of Information Engineering of the University of Brescia (*UniBrescia*) in Italy, where his research and teaching activities are in the area of Artificial Intelligence. At UniBrescia he is:

- Director of the PhD Program in Information Engineering (since 2016).
- Head of a research group in AI currently of nine members (3 professors, 1 researcher and 5 PhD students).
- Head of the "Robotics and Intelligence Systems" Lab (since 2017).
- Head of UniBrescia Unit of the National Lab "Artificial Intelligence and Intelligence Systems", CINI.
- Appointed professor for teaching courses "Intelligenza Artificiale" (since 1998) and "Machine Learning and Data Mining" (since 2015).

EURAI FELLOWSHIP

Since June 2019 he is fellow of *EurAI* - The European Association for Artificial Intelligence. The EurAI Fellows Program recognises annually European AI researchers who have made exceptional contributions to the field, and honors only a very small percentage of the total membership of the 29 EurAI member societies (up to a maximum of 3%).

OTHER ACADEMIC & RESEARCH APPOINTMENTS

- 1988-1995: Researcher at Istituto per la Ricerca Scientifica e Tecnologica (IRST) – currently Fondazione Bruno Kessler (FBK) – Trento, Italy.
- 1992-2002: Visiting researcher at University of Rochester, USA, for several periods (about 2 years total).
- 1995-1998: Assistant professor at UniBrescia.
- 1998-2005: Associate professor at UniBrescia.
- 1997 & 2003: Visiting professor at the University of Freiburg (Germany) twice for about six months.
- 2001 & 2008: Visiting professor at University of Cyprus and Australian Nation University, short periods.
- 2010-2017: Director of the PhD Program in Computer Science and Control Systems at UniBrescia.
- 2013-2015: President of the Bachelor and Master Engineering degree studies in Computer Science and Engineering at UniBrescia.
- 2017-2019: Invited expert evaluator for EU projects FET OPEN RIA.
- Member of the Italian Association for Artificial Intelligence (AI*IA) for several years.

COLLABORATION WITH IBM RESEARCH

He collaborated with scientists of IBM Research centers obtaining results that are described in 5 scientific articles published in Artificial Intelligence Journal (the top journal in AI) and in the Proceedings of the IJCAI and ICAPS conferences (two top conferences in AI). He has also been collaborating through a Joint Study Agreement (no. D1463119) between IBM and the University of Brescia that started in 2014 and had 6 amendments to extend it. Under this agreement some students from the University of Brescia did their Master theses at IBM Research (Ireland) under a joint supervision. Currently the research collaboration is still very active.

MAIN RESEARCH AREAS

His research activities are mainly in Artificial Intelligence, and particularly in the following fields:

Automated planning; temporal and spatial reasoning; knowledge representation; software tools for automated reasoning and planning; applied machine learning; data and text mining; intelligent decision support systems; natural language processing and conversational agents; AI for mobile robotics and autonomous systems.

His research contributions in these fields are variegated and range from new algorithms and theoretical results of different kind, to experimental analyses, implemented systems and innovative applications of AI techniques.

He is interested in applying AI techniques to develop innovative applications is several areas, including: medicine and health care; predictive maintenance and intelligent manufacturing for Industry 4.0; video games; autonomous mobile vehicles; virtual assistants for customer services; decision support systems in finance; AI for security; AI for e-learning.

SERVICE FOR SCIENTIFIC JOURNALS

- 2012-2016: Associate Editor of *Artificial Intelligence* (Elsevier).
- 2009-2011: Editorial board member of *Artificial Intelligence* (Elsevier).
- 2000-2003: Editorial board member of *Journal of Artificial Intelligence Research* (AI Access Foundation, AAAI Press).
- 2011-2015: Editorial board member of *Intelligenza Artificiale*, the International journal of the AI*IA (IOS Press).
- 2014: CoEditor of the special issue on Automated Planning & Scheduling of *Intelligenza Artificiale* (IOS Press), Vol. 8(1).

He also reviewed papers for many scientific journals, including:

Artificial Intelligence Journal, Journal of ACM, Journal of Artificial Intelligence Research, Journal of Logic and Computation, Information Sciences, IEEE Transactions on Systems, Man and Cybernetics, IEEE Transactions on Knowledge and Data Engineering, Constraints, Computational Intelligence, AI Communications, Annals of Mathematics and Artificial Intelligence, Information Processing Letters, Discrete Mathematics & Theoretical Computer Science, Knowledge and Information Systems.

SERVICE FOR CONFERENCES, WORKSHOPS AND SCHOOLS

- 2010: Chair of the 11th Symposium on Artificial Intelligence of the Italian Association for Artificial Intelligence (AI*IA-2010).
- 2010: CoChair of the 4th Italian Workshop on Planning and Scheduling.
- 2010: CoChair of the 28th Workshop of the UK Planning and Scheduling Special Interest Group.
- 2009: Program CoChair of the 19th International Conference on Automated Planning and Scheduling (ICAPS-2009).
- 2006: CoChair of the ICAPS Workshop on Preferences and Soft Constraints in Planning (ICAPS-2006).
- 2000: CoChair and organizer of the 1st International Summer School in AI Planning, Cyprus. This school, whose organization was supported by generous funds from the European Union (PLANET Project), was the first of a successfully series in the context of the International Conference on Automatic Planning and Scheduling (ICAPS). The school speakers were: H. Geffner, M. Ghallab, S. Kambhampati, D. Long, B. Nebel, D. Nau, P. Traverso.
- 1992: CoChair of the International workshop on Representing and Reasoning about Temporal Information, Bolzano, Italy.
- 1992: Co-organizer (chair O. Stock) of the International School on Temporal Reasoning, Bolzano, Italy. The school speakers included J. Allen, J. van Benthem, D. Mc Dermott, E. Sandewall, A. Galton.

He served as Program Committee member of many International conferences and symposia in AI, including:

IJCAI-1999, IJCAI-2001, IJCAI-2005, IJCAI-2007, IJCAI-2009, AAAI-2005, AAAI-2007, AAAI-2008, AAAI-2010, AAAI-2012, AAAI-2015, AAAI-2016, AIPS-2000, AIPS-2002, ICAPS-2003, ICAPS-2004, ICAPS-2005, ICAPS-2006, ICAPS-2007, ICAPS-2008, ICAPS-2010, ICAPS-2011, ICAPS-2012, ICAPS-2014, ICAPS-2015, ICAPS-2016, ICAPS-2017, ICAPS-2018, ICAPS-2019, ECAI-2000, ECAI-2012, ECAI-2014, ECAI-2018, AIA-2004, AIA-2005, ECP-2001, TIME-2001, TIME-2002, TIME-2003, TIME-2004, TIME-2009, ICAI-2001, CinC-2015, AI*IA-1993, AI*IA-1995, AI*IA-2003, AI*IA-2004, AI*IA-2011, AI*IA-2013, AI*IA-2018, KR-2014, SoCS-2017, SoCS-2017, SoCS-2018, IASTED-2004, CP-2002, CP-2007.

Moreover, he has been Senior Program Committee member of:

IJCAI-2011, ICAPS-2013, IJCAI-2013, IJCAI-2015, IJCAI-2016, IJCAI-2017, IJCAI-2018, IJCAI-2019, AAAI-2002, AAAI-2013, AAAI-2019.

He was also part of the organization teams of several AI workshops and Doctoral Consortium programs.

SERVICE FOR THE INTERNATIONAL PLANNING COMPETITION (PART OF ICAPS)

- In 2006 he organized and chaired the deterministic part of the *Fifth International Planning Competition (IPC-5)*, held in the context of the International Conference on Automated Planning and Scheduling (ICAPS-2006). As part of IPC-5, he designed (with D. Long) version 3.0 of the standard planning language PDDL, and, together with the IPC-5 organization team, he evaluated several planning systems using a set of new (publicly available) benchmarks that he developed with the IPC-5 organizers.
- From 2007 he was member of the International Planning Competition Council (IPCC) for few years.

AWARDS

The International Conference on Automated Planning and Scheduling (ICAPS) gave him 6 awards:

- 2002: award from the 6th International Conference on AI Planning and Scheduling (now ICAPS) for the best-performing fully-automated *planner LPG*, that won the *3rd International Planning Competition* (AIPS-2002, Toulouse, France). A very short description of LPG is given in the summary of the main research results at the end of the document.
- 2004: award from the 14th International Conference on Automated Planning and Scheduling for the high performance of *planner LPG-TD* demonstrated at the *4th International Planning Competition* (ICAPS-2004, Whistler Canada). LPG-TD is a substantial extension of LPG to support language PDDL2.2.
- 2008: two awards from the 18th International Conference on Automated Planning and Scheduling for *Planners PbPs* and *PbPq* that won the learning track (speed and quality) of the *6th International Planning Competition* (ICAPS-2008 Sydney, Australia). These systems, where PbP stands for "Portfolio-based Planner", use particular techniques for statistically comparing the performance of different planners on configuration problem instances and scheduling the selected planners.
- 2011: award from the 21st International Conference on Automated Planning and Scheduling for *Planner a PbP2q* that won the learning track of the *7th International Planning Competition* (ICAPS-2011 Freiburg, Germany). PbP2q is an extension of PbPq improving its performance.
- 2019*: Influential Paper Award* from the International Conference on Automated Planning and Scheduling (ICAPS) for the paper "LPG: A Planner Based on Local Search for Planning Graphs with Action Costs", Alfonso Gerevini and Ivan Serina, in Proccedings of the Sixth International Conference on Artificial Intelligence Planning Systems, 2002, AAAI Press.

The techniques in these awarded planners are described in several papers published in the Proceedings of IJCAI-AAAI-ECAI-ICAPS conferences and in some journals such as AIJ, JAIR and others.

INVITED TALKS

- University of Rochester, USA, 1992-1993-1994: two talks on "*Algorithms for Qualitative Temporal Reasoning"* and a talk on *"Complexity of Temporal Rreasoning with Disjointness Relations"*
- Bell Laboratories AT&T, USA, and University of Rochester, 1993: "*Efficient Temporal Reasoning through Timegraphs*"
- University of Padova, Italy, 1994: "*Complessità e Algoritmi Efficienti per il Ragionamento Temporale Qualitativo*"
- University of Torino, Italy, 1994: "*Complessità e Algoritmi di Ragionamento Temporale Qualitativo basato su Relazioni*"
- MITRE, Bedford Massachusetts, USA, 1995: "*Efficient Methods for Temporal Reasoning*"
- Rome Laboratory, Griffiss Air Force Base, USA, 1995: "*Efficient Methods for Temporal Reasoning*"
- Israeli-Italian Symposium on Artificial Intelligence, 1996, Venice, Italy: "*Reasoning about Time through Disjunctive Timegraphs*"
- University of Cyprus, 2002: "*Discovering State Constraints for Planning: DISCOPLAN*"
- Istituto per la Ricerca Scientifica e Tecnologica di Trento (IRST/FBK), Italy, 2004, "*Temporal Reasoning and Planning*"
- Schloss Dagstuhl, Leibniz Center for Informatics, Germany, 2005, Synthesis and Planning Workshop, and University of Cyprus, 2005: "*Automated Temporal Planning: An Approach based on Graphs, Temporal Constraints and Heuristic Search*"
- TIME-2007, 4th Int. Symposium on Temporal Representation and Reasoning, 2007, Alicante, Spain: "*Automated Planning in Temporal Domains: Some Recent Advances and Current Research Topics*"
- ICAPS-2006, 16th International Conference on Automated Planning & Scheduling, 2006, Cumbria, UK: "*The Deterministic Part of the 5th International Planning Competition*"
- University of Rochester, USA, 2010: "*Automated Planning in Temporal Domains: Some Recent Advances and Research Topics*" (extended and revised version of the talk given at TIME-2007)
- University of Rochester, USA, 2012: "*Fast Planning through Local Search and Action Graphs: LPG*"

- International Quality Network on Spatial Cognition, Universität Bremen, Albert-Ludwings-Universität Freiburg, Universität Hamburg, DAAD, Germany, 2003, invited talk on "*Qualitative Spatio-Temporal Reasoning*"
- Palazzolo Digital Festival, Palazzolo, Italy, 2016, plenary section talk: *"What is Artificial Intelligence? The past, present and future of AI*"
- University of Verona, Italy, 2016: "*Agent Planning Programs: A New Method to Design and Control Intelligent Agents Behaviour*".

RESEARCH COLLABORATORS

He carried out his research in collaboration with many AI researchers, including (randomly ordered):

James Allen and Lenhart Schubert (University of Rochester, USA), Rao Kambhampati (Arizona State University, USA), Dana Nau (University of Maryland, USA), Bernhard Nebel (University of Freiburg, Germany), Holger Hoos (Leiden University, Netherlands), Derek Long and Maria Fox (King's College London, UK), Hector Geffner (Universitat Pompeu Fabra, Spain), Minh Do (NASA Ames Research Center, USA), Adi Botea (IBM Research, Ireland), Biplav Srivastava (IBM T.J. Watson Research Center, USA), Jochen Renz and Patrik Haslum (Australian National University, Australia), Joerg Hoffmann (Saarland University, Germany), Yannis Dimopoulos (University of Cyprus), Daniel Harbor and Peter Stuckey (Monash University, Australia), Sebastian Sardina (RMIT University, Australia), Nir Lipovetzky (University of Melbourne, Australia), Ugur Kuter (SIFT, USA), Giuseppe de Giacomo (Sapienza University, Rome), Alberto Lavelli (FBK, Italy), Mauro Vallati (University of Huddersfield, UK), Tuan Anh Nguyen (Arizona State University, USA), Ivan Serina and Alessandro Saetti (UniBrescia, Italy), Chris Fawcett (University of British Columbia, Canada), and others.

INDUSTRIAL COLLABORATIONS

Especially since the last few years he has been collaborating, often as scientific advisor, with a number of companies and startups (e.g., Euroverde, Engineering, ELCO, AB Group, Dinema, BBS, ATS, Archon, AMPS-LLC) and a Hospital (Spedali Civili di Brescia) on the development of innovative applications involving AI techniques for predictive maintenance of production machines in manufacturing and energy cogeneration plants, information extraction from clinical reports, cardiological data quality, surveillance tasks, customer assistance through chatbots, decision support in finance, and planning for autonomous drones.

FUNDED AI PROJECTS

A substantial part of his activities in AI has been carried out in the context of projects funded by NATO, EU, European Office of Aereospace Research and Development (EOARD), National Research Council (CNR), German Academic Research Exchange (DAAD), German Research Foundation (DFG), Italian Ministry of Education University and Research (MIUR), Regione Lombardia, Fondazione Bruno Kessler (FBK), Fondazione Malattie Infettive e Salute Internazionale (MISI), University of Brescia, and some private companies.

ACADEMIC TEACHING

At UniBrescia he has been teaching Artificial Intelligence for the Masters in "Computer Science and Engineering" and in "Telecommunications Engineering" as appointed professor of courses "Intelligenza Artificiale" (since 1998) and "Machine Learning & Data Mining" (since 2015). From 1998 to 2013 he was also appointed professor of some courses on Introduction to Computer Science and Programming for undergraduate students in mechanical and management engineering.

Moreover, at UniBrescia he organized several education initiatives in AI, such as collaborations with NASA, IBM Research, and Universities in UK and Canada to host Italian PhD and MSc students to work on AI projects. In this context, he developed a "Joint Study Agreement" contact between UniBrescia and IBM Research.

SUPERVISION OF YOUNG AI RESEARCHERS

He supervised a number of PhD students who did their theses in AI, including Ivan Serina (now associate professor at UniBrescia), Alessandro Saetti (now associate professor at UniBrescia), Mauro Vallati (now senior lecturer at University of Huddersfield), Andrea Bonisoli (now industry employee), Simone Magnolini (now post doc at FBK, Trento), and currently he is supervising five students. He also supervised the MEng/MSc theses in AI topics of many students.

BRIEF DESCRIPTION OF THE MAIN RESEARCH RESULTS

The most significant scientific results that he achieved are in Automated Planning, Temporal and Spatial Reasoning, and applied Machine Learning. The following is a very brief description of them.

- **AUTOMATED PLANNING**. During more than twenty years of research in AI Planning, he developed many techniques, algorithms, heuristics, languages, theoretical and experimental analyses for automated planning. This research work investigates many issues and approaches of (primarily model-based) AI planning, such as:

  Propositional planning, heuristic search for planning, planning as satisfiability and compilation approaches, learning for planning, configurable and portfolio-based planning, case-based planning, partial-order planning, multi-agent and distributed planning, planning with user preferences and soft goals, planning with state trajectory constraints and temporally extended goals, temporal and numeric planning, integrated scheduling and planning, hybrid (HTN+PDDL) planning, plan revision and adaptation, plan execution and monitoring, path planning, knowledge representation and engineering for planning, automatic domain analysis and state-invariants discovery, interactive planning and plan visualization, agent-behavior modeling through Planning Programs.

  Together with the research team that he led at UniBrescia, he developed several **efficient planning algorithms and systems**, most of which are distributed for research purposes. Five of these planners have been awarded at three International Competitions (*LPG, LPG-TD, PbPs, PbPq, PbP2*) organized by the International Conference on Automated Planning and Scheduling – see section "Awards" below.

  The **LPG planner** (http://lpg.unibs.it) is a very well-known and much used system in the planning community. It is supports **propositional, temporal and numeric planning with language PDDL2.2**, and it is based on a unique powerful and flexible approach using stochastic local search, graphs and integrated temporal/numerical reasoning techniques. LPG incorporates various algorithms, techniques and heuristics for fast *plan synthesis* from scratch, incremental *plan optimization*, *plan revision* (with techniques for optimizing plan similarity-diversity-stability relative to an input plan) and *interactive human-machine planning*.

  The many techniques developed for LPG system are described in 27 published papers; two of them currently have more 673 citations according to Google Scholar, and one of them has just won the ICAPS **Influential Paper Award 2019**. Many researchers from different universities, institutes and industries have used LPG, and a licensing agreement is under discussion with NASA. The website of LPG counts about 60K accesses and 2K software downloads by different users worldwide. The first version for LPG was distributed in 2002, and today LPG is still competitive in terms of planning performance with respect to the most recent planners, especially for temporal domains with PDDL "timed initial literals" (useful for, e.g., representing exogenous events).

  In the field of *Knowledge Representation and Engineering for Planning*, he developed:

  - The **Planning Language PDDL3.0** (with D. Long), that extends the standard domain representation language for model-based planning PDDL to support preferences over problem goals and soft/hard state-trajectory constraints (also called temporally extended goals) expressed by (metric) Linear Temporal Logic. PDDL3.0 was the language of the 5th International Planning Competition, and it has become a standard language for researchers working on planning with preferences and state-

trajectory constraints. According to Google Scholar, currently the papers describing PDDL3.0 have 800 citations.

- Several algorithms, techniques and tools for the **automatic analysis of planning domains**, such as the *DISCOPLAN* system (with L. Schubert), one the first and most successful systems for inferring *state invariants*, which are useful in planning for various purposes. DISCOPLAN is cited by many researchers in the field, and it contributed to the growth of interest in this important research topic. Over the years various other systems have been proposed, some of them using and developing quite similar ideas, such as DISCOPLAN's hypothesis-and-test paradigm. DISCOPLAN is the invariant inference system that supports the largest set of types of invariants for propositional domains with conditional effects.
- A new paradigm called **Agent Planning Programs** for modeling agents' behavior, that combines automated planning with agent-oriented programming, and consists of particular finite-state automata organizing networks of agents' goals in deterministic or non-deterministic planning domains (with G. De Giacomo, F. Patrizi, S. Sardina, A. Saetti). In particular he developed some planning-based techniques for addressing the problem of *realizing an agent planning program*.
- A **framework combining HTN-based and domain-independent planning** that is implemented in the *Duet Hybrid Planner* (with D. Nau, U. Kuter, and A. Saetti) integrating planners SHOP2 and LPG. The framework allows the user to specify procedural domain knowledge through HTNs combined with goals, and to exploit it in a general PDDL planner achieving significantly better performance.
- New **techniques for case-based planning**, and in particular some algorithms for effective plan retrieval and knowledge maintenance policies for the plan database (with I. Serina and A. Saetti).
- A system, called *InLPG*, for **interactive planning** supporting plan visualization and inspection, user requests of plan modification, user-adjusted heuristics, search inspection/monitoring (with A. Saetti).

In the field of *Heuristic Search for Planning*, he developed **some heuristics and search pruning techniques** for partial-order causal-link planning (with L. Schubert), forward planning (with H. Geffner, J. Hoffmann and others), and non-directional planning local search planning (with I. Serina, A. Saetti). Most of these techniques led to significant performance improvements in propositional planning, metric-temporal planning, and planning with soft goals.

In the field of *Multi Agent Planning,* he extended Brafman and Domshlak's MA-STRIPS model to address the agents' privacy preserving problem during planning by introducing the use of a **communication graph constraining the agents' information exchange** during planning (with A. Bonisoli, A. Saetti, I. Serina). Recently he has also developed **distributed variants of some centralized planning algorithms**, in particular of Iterative Width Search and Best-First Width Search (with G. Bazzotti, A. Saetti, I. Serina, N. Lipovetzky). The resulting multi-agent algorithms provide a good compromise of computational efficiency and privacy preserving, since very little information is exchanged among agents during planning.

In the field of *Configurable Planning Systems*, he developed **several automatic configuration techniques and systems** for generating portfolio planners, selecting effective learned macro actions, and setting the parameter values of a parameterized planning algorithm (with C. Fawcett, H. Hoos, A. Saetti, and others). In particular he introduced **a statistical approach for portfolio planner configuration** that is the base of the three competition-awarded planners PbPs, PbPq and PbP2 (with A. Saetti and M. Vallati).

In the field of *Path Planning*, he developed some efficient algorithms and data structures for the **Compressed Path Databases approach** (CPD), that are the state-of-the-art fastest method for computing shortest paths in 2D grid maps using limited memory (with A. Botea, D. Harabor, A. Saetti, M. Salvetti). Moreover, recently he developed CPD-based heuristics for **fast path finding in dynamic maps** (with M. Bono, D. Harabor, P. Stuckey).

In the field of *Planning as Satisfiability and Compilation Approaches*, he studied how to **exploit inferred invariants** and learned **macro actions in the SAT solver**. More recently he has also developed some

techniques for compiling **soft goals** and PDDL3.0 **soft trajectory constraints** into STRIPS with action costs (with F. Percassi), which allows many existing planners to support PDDL3 qualitative preferences without any change to them. He also developed a **compilation of classical propositional planning into Mixed-Integer Programming** (with Y. Dimopoulos).

In the field of *Plan Adaptation and Revision*, he proposed several techniques for offline and online (during execution) **synthesis of plans that repair an input invalid plan or optimize its quality**. In particular he developed some systems addressing the issues of (a) **fast adaptation** (with I. Serina), (b) **plan stability** of the new plan relative to the input plan (with M. Fox, D. Long, I., Serina), and of (c) **plan diversity** where the system provides the user a set of alternative different plans from which choosing the preferred solution (with T. A. Nguyen, M.B. Do, I. Serina, B. Srivastava, S. Kambhampati).

Selected journal papers [1]-[12] in the list below describe some of the results achieved in AI Planning. Additional relevant publications are included in the list of the selected conference papers.

- **TEMPORAL AND SPATIAL REASONING**. He developed new efficient algorithms and computational complexity analyses for constraint-based temporal and spatial reasoning. The main achieved results are:

  - The **Timegraph and Metagraph data structures and algorithms** for qualitative reasoning about time (primarily with L. Schubert and, more recently, with A. Saetti). These graph-based techniques are the core of the two fastest existing reasoning systems for the well-known Point Algebra (PA) and Simple Interval Algebra (SIA): *TimeGraph-II* and especially the newer *TimeGraph-III*. Moreover, an extension of the timegraph approach, called *Disjunctive Timegraph*, efficiently supports SIA and PA augmented with temporal disjointness constraints.

  - A collection of new efficient **dynamic algorithms for maintaining constraint properties** (satisfiability, solutions, minimality) of a knowledge based of qualitative temporal constraints over the Point Algebra and Nebel's ORD-Horn class of Allen's interval relations, when new constraints are incrementally added or retracted (relaxed). For the case of constraint relaxations, he also developed some fast, incremental algorithms for checking if an *in*consistent knowledge base becomes consistent when relaxing one or more constraints (with M. Bono). These algorithms reduce the theoretical complexity bound of using static algorithms or perform orders of magnitude faster than existing techniques.

  - Some (still state-of-the-art) algorithms for:
    i) computing the **minimal network for Point Algebra constraints** (he proved correctness of van Beek's algorithm, and he designed some efficient algorithms based on *Metagraph Closure*; this work is with L. Schubert and A. Saetti);
    ii) deciding the **satisfiability of a set of constraints over ORD-Horn** (this algorithm, called ORDHornSAT works especially well for sparse CSPs);
    iii) finding a **solution of a set of STP constraints extended with inequalities** (with M. Cristani).

  - Computational complexity analyses and new algorithms for **combining some constraint calculi**, such as the *Bipath-consistency algorithm* (with J. Renz) for reasoning with topological and size constraints between spatial regions, and a framework for combining Allen's temporal relations and the topological relations of the RCC-5/8 calculi between spatial regions (with B. Nebel);

  - A computational complexity study and some algorithms for **reasoning about point-based temporal disjointness** (with L. Schubert).

  Selected journal papers [13]-[18] in the list below describe some of the results achieved in Temporal/Spatial Reasoning. Additional relevant publications are included in the list of the selected conference papers.

- **APPLIED MACHINE LEARNING**. Especially during the last years, he has also worked on applying machine learning techniques, mostly in collaboration with industries, to some real-world applications of *data analysis and predictive maintenance* (e.g., for Industry 4.0 applications), and *decision support in health care and medicine*. The most recent significant results concern a system based on machine learning and a hierarchical classification scheme for the **automatic classification of radiological reports**, that he developed with a team directed by him. He was also involved in applications of machine learning concerning data quality evaluation, conversational agents, and information extraction from textual documents.

  Another line of research is the use of *machine learning techniques to design efficient planning algorithms*. The main achieved results (with M. Vallati, A. Saetti , H. Hoos, and others) concern some new **techniques for predicting the solution cost** from the planning problem specification, the **automatic configuration of portfolio-based planners and of learned macro actions** (the *PbP* planners, and other static and dynamic portfolio planners), and the **automatic tuning of parameterized planning algorithms** for *generating efficient, domain-optimized planners* from a domain-independent planner (the *ParLPG planner*).

  Selected journal papers [19]-[20] in the list below describe a recent system for the automatic classification of radiology reports, and some techniques to predict and exploit bounds on the optimal solution length in the context of the planning as satisfiability approach.

PUBLISHED PAPERS

The results of his research in AI are described in 34 journal papers (including 9 in AIJ and 4 in JAIR), in the proceedings of many top International AI Conferences (including 6 IJCAI, 4 AAAI, 5 ECAI, 16 ICAPS, 4 CP, 1 KR), and in few book chapters. Overall, he has 130 peer-reviewed research papers in AI, an incomplete (e.g. without several workshop papers) list of which is available from DBLP: http://dblp.dagstuhl.de/pers/hd/g/Gerevini:Alfonso.

20 SELECTED JOURNAL PAPERS

Automated Planning

[J1] Alfonso E. Gerevini, Lenhart Schubert, "Discovering state constraints for planning with conditional effects in Discoplan (part I)", *Annals of Mathematics and Artificial Intelligence*, 2019, Springer, DOI 10.1007/s10472-019-09618-w, 2019 (printed version to appear).

[J2] Andrea Bonisoli, Alfonso E. Gerevini, Alessandro Saetti, Ivan Serina, A privacy-preserving model for multi-agent propositional planning, *Journal of Experimental and Theoretical Artificial Intelligence* Vol. 30(4), pp. 481-504, 2018.

[J3] Andrea F. Bocchese, Chris Fawcett, Mauro Vallati, Alfonso E. Gerevini, Holger H. Hoos, Performance robustness of AI planners in the 2014 International Planning Competition, *AI Communications*, 31(6), pp. 445-463, 2018.

[J4] Giuseppe De Giacomo, Alfonso E. Gerevini, Fabio Patrizi, Alessandro Saetti, Sebastian Sardina, Agent Planning Programs, *Artificial Intelligence*, Vol. 231, pp. 64-106, 2016.

[J5] Alfonso E. Gerevini, Alessandro Saetti, Mauro Vallati, Planning through automatic portfolio configuration: the PbP approach, *Journal of Artificial Intelligence Research (JAIR)*, Vol. 50, pp. 639-696, 2014.

[J6] Tuan A. Nguyen, Minh Binh Do, Alfonso E. Gerevini, Ivan Serina, Biplav Srivastava, Subbarao Kambhampati, Generating diverse plans to handle unknown and partially known user preferences, *Artificial Intelligence*, Vol. 190, pp. 1-31, 2012.

[J7] Alfonso E. Gerevini, Alessandro Saetti, Ivan Serina, Planning in domains with derived predicates through rule-action graphs and local search, *Annals Mathematics and Artificial Intelligence*, Vol. 62(3-4), pp. 259-298, 2011.

[J8] Alfonso E. Gerevini, Derek Long, Patrik Haslum, Alessandro Saetti, Yannis Dimopoulos, Deterministic planning in the fifth International planning competition: PDDL3 and experimental evaluation of the planners, *Artificial Intelligence*, Vol. 173, pp. 619-668, 2009.

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