

# Paolo Terenziani

## PERSONAL DATA

Paolo Terenziani was born in Torino on 4.7.1963.

## BIO AND EDUCATION

On 3/7/1987 he got the Master degree in Computer Science at the University of Turin with 110/110 and laude. On 28/5/1993 he got the PhD in Computer Science at the University of Turin and Milan. Since 2000, he is full professor at Dipartimento di Scienze ed Innovazione Tecnologica, Università degli Studi del Piemonte Orientale Amedeo Avogadro, in Alessandria. He is also research associate with Dipartimento di Informatica of the University of Turin, and adjunct professor with the Griffith University, Brisbane, Australia.

The research activity of Paolo Terenziani has begun in 1987 and it concerns mainly the field of Artificial Intelligence, and specifically the areas of computational linguistics, design of ontologies and formalisms for knowledge representation and automatic reasoning (with particular attention to representation and reasoning with temporal constraints), the field of databases and medical informatics. Regarding these research topics Paolo Terenziani has published over 150 papers in peer-reviewed international journals, books derived from conference proceedings, conference proceedings and workshops. Regarding the area of knowledge representation, Paolo Terenziani has concentrated his attention on modelling time, causality and temporal periodicity. Regarding the area of temporal constraints, the main results he has obtained concern the development of LaTeR, an integrated approach for treating qualitative and quantitative temporal constraints, granting efficiency in performance in query answering, and design of representation formalisms and of algorithms for reasoning with repeated and/or periodic events. Recently, he has also achieved innovative results in the areas of time series retrieval and of process mining. Regarding the area of temporal databases, Paolo Terenziani has proposed some extensions of classical data models and relational algebra for dealing with (i) temporal constraints among tuples, and (ii) periodic events, (iii) instantaneous events, (iv) versioning and proposal vetting. In collaboration with R.T. Snodgrass, one of the “founding fathers” of the area of temporal databases, recently he devised an extension of classic relation model in order to deal with phenomena concerning telic and atelic events. Paolo Terenziani has been Chair of the Temporal Database Track of TIME'12 (Leicester, GB, September 2012). Since 1997, Paolo Terenziani collaborates with Azienda Ospedaliero-Universitaria San Giovanni Battista of Torino with GLARE project, for developing a prototype of a domain-independent software system for acquisition, representation and execution of clinical guidelines. The scientific quality and prominence in international scientific research community of GLARE project are attested by the relevant number of published scientific papers regarding the project. In particular, since 1998, over 30 papers has been published in peer-reviewed international scientific journals and conference proceedings of Medical Informatics and Artificial Intelligence (e.g., AIIMJ, AMIA, AIME, Medinfo, GIN). Paolo Terenziani, the scientific coordinator of the project, has been invited to be a member of the Program Committee of several international conferences and workshops regarding medical informatics and/or clinical guidelines (among the main conferences, CGP'04, AIME'05, 07, 09, 13,15 the ECAI'06 workshop on clinical guidelines,

ProHealth'07, 08, 10, 11, 12,13, KR4HC'09, 10, 11, 12,13, ProHealth+KR4HC'14,15, Medinfo'13), has held invited talks in Medical Informatics Conferences and Workshops, and is part of the Editorial Board of the Open Medical Informatics Journal and of the International Journal of Knowledge-Based Organizations. Since 2015 he is in the board of AIME (Artificial Intelligence in Medicine Europe). The GLARE project is part of Openclinical, a larger international project for the development and dissemination of medical informatics, and in particular of computer-supported clinical guidelines. GLARE makes use of advanced techniques of databases and of artificial intelligence, being the main application domain used by Paolo Terenziani for applying the results of his scientific research. In particular, among similar approaches in literature, GLARE stands out for the advanced support for helping physicians in decision-making activities, for the advanced treatment of temporal phenomena and for verification of acquired clinical guidelines by means of model-checking techniques. Recently, GLARE has been extended to deal with comorbidities. META-GLARE, a meta-system for the semi-automatic development of systems coping with computerized clinical guidelines, is currently under development, as an evolution of the GLARE project.

Thanks to his research activity, Paolo Terenziani has received several national and international awards. He is an “expert” for the European Community, and has been a reviewer of EC projects in Medical Informatics.

#### UNIVERSITY CAREER

2000-	Full Professor, Università del Piemonte Orientale
1998-2000	Adjunct Professor, Università del Piemonte Orientale
1992-1998	Researcher, Università di Torino

#### UNIVERSITY POSITIONS

2008-2011	Vice-director of the Department of Computer Science, Alessandria, Università del Piemonte Orientale
2000-2003	President of the <i>Consiglio di Corso di Laurea</i> in Computer Science, Alessandria, Università del Piemonte Orientale

#### SCIENTIFIC POSITIONS

2016-	Member of the the Directory Board of Società Scientifica Italiana di Informatica Biomedica
2014-	Member of the board of Artificial Intelligence in Medicine Europe
2014-	Member of the Directory Board of CEIMS

#### MAIN FIELDS OF INTEREST

1. Temporal Databases
2. Artificial Intelligence: temporal reasoning
3. Artificial Intelligence: knowledge representation

4. Process Mining
5. Information Retrieval
6. Medical Informatics

## CURRENT ISSUES OF RESEARCH

### 1. **“Temporal indeterminacy, repeated and/or periodic events, and further evolutions of temporal databases” .**

Temporal databases support an appropriate and theoretically-grounded treatment of the problems arising from the introduction of the temporal dimension in the relational model. Although the research in the area has started more than 30 years ago, and has achieved many outstanding results, several research open problems still persist. Paolo Terenziani is currently facing some of them, including (i) the treatment of temporal indeterminacy (i.e., of situations in which the temporal pieces of information associated with data are not precise), (ii) the treatment of “now-related” facts, (iii) the treatment of repeated and/or periodic facts. The treatment of proposal vetting, and the treatment of the telic/atelic distinction. Paolo Terenziani has faced all such issues through an homogeneous methodology, consisting of the following steps: semantic analysis, development of new relational models, development of relational algebrae coping with them, formal analysis of the properties of models and algebrae, and, when appropriate, implementation and experimental evaluation. The main recent publications he has achieved in this context are:

1. Terenziani P (2016). “Irregular Indeterminate Repeated Facts in Temporal Relational Databases”. IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, to appear.
2. Khatri V, Ram S, Snodgrass R T, Terenziani P (2014). Capturing Telic/Atelic Temporal Data Semantics: Generalizing Conventional Conceptual Models. IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, vol. 26, p. 528-548, ISSN: 1041-4347, doi: 10.1109/TKDE.2012.74
3. Terenziani Paolo, Stantic Bela, Bottrighi Alessio, Sattar Abdul (2013). An intensional approach for periodic data in relational databases. JOURNAL OF INTELLIGENT INFORMATION SYSTEMS, vol. 41, p. 151-186, ISSN: 0925-9902, doi: 10.1007/s10844-013-0240-0
4. Terenziani P (2013). Coping with Events in Temporal Relational Databases. IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, vol. 25, p. 1181-1185, ISSN: 1041-4347, doi: 10.1100/TKDE.2011.265
5. Anselma L, Bottrighi A, Montani S, Terenziani P (2013). Extending BCDM to Cope with Proposals and Evaluations of Updates . IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, vol. 25, p. 556-570, ISSN: 1041-4347, doi: 10.1109/TKDE.2011.170
6. Anselma Luca, Stantic Bela, Terenziani Paolo, Sattar Abdul (2013). Querying now-relative data. JOURNAL OF INTELLIGENT INFORMATION SYSTEMS, vol. 41, p. 285-311, ISSN: 0925-9902, doi: 10.1007/s10844-013-0245-8
7. Anselma A, Terenziani P, Snodgrass RT (2013). Valid-Time Indeterminacy in Temporal Relational Databases: Semantics and Representations. IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, vol. 25, p. 2880-2894, ISSN: 1041-4347

2. **“Medical decision support systems based on clinical guidelines”**. Clinical guidelines represent the best procedures to treat diseases, as pointed out by the evidence-based medicine. The adoption of computer-based tools to manage clinical guidelines is the basis for the definition of highly qualified decision support systems, that provide physicians with appropriate evidence-based recommendations. Since 1997, Paolo Terenziani collaborates with Azienda Ospedaliero-Universitaria San Giovanni Battista of Torino within the GLARE project, for developing a prototype of a domain-independent software system for the acquisition, representation and execution of clinical guidelines. Among similar approaches in literature, GLARE stands out for the advanced support for helping physicians in decision-making activities, for the advanced treatment of temporal phenomena and for the verification of acquired clinical guidelines by means of model-checking techniques. Recently, GLARE has been extended to deal with comorbidities. META-GLARE, a meta-system for the semi-automatic development of systems coping with computerized clinical guidelines, is currently under development, as an evolution of the GLARE project. The main recent publications that Paolo Terenziani has achieved in this context are:

1. Piovesan Luca, Molino Gianpaolo, Terenziani Paolo (2014). An ontological knowledge and multiple abstraction level decision support system in healthcare. *DECISION ANALYTICS*, vol. 1, ISSN: 2193-8636, doi: 10.1186/2193-8636-1-8
2. Bottrighi A, Molino G, Montani S, Terenziani P, Torchio M (2013). Supporting a distributed execution of clinical guidelines. *COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE*, vol. 112, p. 200-210, ISSN: 0169-2607

3. **“Process mining ed information retrieval on process logs and time series”**. In many application area, the processes being executed and the temporal evolutions of data are recorded, in the form of (process) logs or time series. In such a context, Paolo Terenziani is currently facing two main topics: the retrieval of series or process traces, and the mining of process models from the logs. In both such contexts, he is focusing his research activity on the development of techniques to operate at multiple level of abstractions, and to achieve efficiency through the identification and use of proper indexing structures. The main recent publications that Paolo Terenziani has achieved in this context are:

1. Bottrighi A., Canensi L., Leonardi G., Montani S., Terenziani P. (2016). Trace Retrieval for Business Process Operational Support. *EXPERT SYSTEMS WITH APPLICATIONS*, vol. 55, p. 212-221, ISSN: 0957-4174.
2. ALESSIO BOTTRIGHI, GIORGIO LEONARDI, STEFANIA MONTANI, LUIGI PORTINALE, PAOLO TEREZIANI (2015). A time series retrieval tool for sub-series matching. *APPLIED INTELLIGENCE*, vol. 43, p. 132-149, ISSN: 0924-669X, doi: 10.1007/s10489-014-0628-8.
3. Montani S, Leonardi, Bottrighi A, Portinale L, Terenziani P (2013). Supporting Flexible, Efficient and User-Interpretable Retrieval of Similar Time Series. *IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING*, vol. 25, p. 677-689, ISSN: 1041-4347, doi: 10.1109/TKDE.2011.264

## CURRENT FUNDED PROJECTS

PROGRAMME	FUNDED PROJECT
Supported by FIL-ONLUS	“Sviluppo di metodologie informatiche finalizzate alla raccolta e alla gestione di dati derivanti da studi clinici promossi dalla Fondazione Italiana Linfomi ONLUS” The project aims at developing software tools to collect and analyse clinical trials.

## TOP FIVE PAPERS

1. Anselma A, Terenziani P, Snodgrass RT (2013). Valid-Time Indeterminacy in Temporal Relational Databases: Semantics and Representations. IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, vol. 25, p. 2880-2894, ISSN: 1041-4347
2. TEREZIANI P, SNODGRASS R T (2004). Reconciling Point-based and Interval-based Semantics in Temporal Relational Databases: A Proper Treatment of the Telic/Atelic Distinction. IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, vol. 16, p. 540-551, ISSN: 1041-4347, doi: 10.1109/TKDE.2004.1277816
3. TEREZIANI P (2003). Symbolic User-defined Periodicity in Temporal Relational Databases. IEEE TRANSACTIONS ON KNOWLEDGE AND DATA ENGINEERING, vol. 15, p. 489-509, ISSN: 1041-4347, doi: 10.1109/TKDE.2003.1185847
4. Terenziani P, Molino G., Torchio M. (2001). A modular approach for representing and executing clinical guidelines. ARTIFICIAL INTELLIGENCE IN MEDICINE, vol. 23, p. 249-276, ISSN: 0933-3657
5. Brusoni V, Console L, Terenziani P (1995). On the Computational Complexity of Querying Bounds on Differences Constraints. ARTIFICIAL INTELLIGENCE, vol. 74, p. 367-379 , ISSN: 0004-3702, doi: 10.1016/0004-3702(95)00008-3

## AWARDS

1. “Distinguished Paper” Award, American Medical Informatics Conference, Chicago, 2012 (su piu’ di 1000 sottomissioni), con il lavoro: “Exceptions Handling within GLARE Clinical Guideline Framework”
2. “Best Paper Award” congresso TIME 2000, 7-9 Luglio 2000, Cape Breton, Canada, con il lavoro: “Representing and reasoning with temporal constraints in multimedia presentations”
3. "Premio Intelligenza Artificiale" bandito dall'Associazione Italiana per l'Intelligenza Artificiale, 1998.

## FURTHER INFORMATION

Paolo Teenziani is the editor of the Proceedings of 17th International Symposium on Temporal Representation and Reasoning, Mark Reynolds, Paolo Terenziani, Ben Moszkowski (Eds.), IEEE Press.