# A Guided Tour through Interval Temporal Logics
# Mid- and Long-Term Research Agenda

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# Mid-term research agenda - 1

- extending the expressiveness classification result for the family of HS fragments to other classes of linear orders, e.g., the classes of finite, discrete, and dense linear orders

The set of inter-definability equations for the class of all linear orders does not apply if the non-strict semantics is considered. For instance, $\langle A \rangle$ (resp., $\langle \overline{A} \rangle$) can be defined in $\overline{\mathrm{B}}\mathrm{E}$ (resp., $\mathrm{B}\overline{\mathrm{E}}$).

Moreover, if the semantics is restricted to specific classes of linear orders, completeness of the set of equations is no longer guaranteed.

For instance, in discrete linear orders, $\langle A \rangle$ can be defined in $\overline{\mathrm{B}}\mathrm{E}$: $\langle A \rangle p \equiv \varphi(p) \vee \langle E \rangle \varphi(p)$, where $\varphi(p)$ is a shorthand for $[E]\bot \wedge \langle \overline{B} \rangle ([E][E]\bot \wedge \langle E \rangle (p \vee \langle \overline{B} \rangle p))$; likewise, $\langle \overline{A} \rangle$ is definable in $\mathrm{B}\overline{\mathrm{E}}$.

As another example, in dense linear orders, $\langle L \rangle$ can be defined in DO: $\langle L \rangle p \equiv \langle O \rangle (\langle O \rangle \top \wedge [O](\langle O \rangle p \vee \langle D \rangle p \vee \langle D \rangle \langle O \rangle p))$; likewise, $\langle \overline{L} \rangle$ is definable in $\mathrm{D}\overline{\mathrm{O}}$.

# Mid-term research agenda - 2

- obtaining a complete classification of the family of HS fragments with respect to decidability/undecidability of their satisfiability problem (more than 90% of HS fragments have already been classified, but the remaining cases are expected to be among the most difficult to settle)

Recent results:

D. Bresolin, D. Della Monica, A. Montanari, P. Sala, and G. Sciavicco, *Interval Temporal Logics over Finite Linear Orders: the Complete Picture*, ECAI 2012

D. Bresolin, D. Della Monica, A. Montanari, P. Sala, and G. Sciavicco, *Interval Temporal Logics over Strongly Discrete Linear Orders: the Complete Picture*, GandALF 2012

(Still) open issues: D over the class of all linear orders.

# Mid-term research agenda - 3

- extending the study of metric variants of interval logics (we already did it for $A\overline{A}$ over finite linear orders, natural numbers, and integers) to other HS fragments and over other metrizable linear orders, notably that of rational numbers

D. Bresolin, D. Della Monica, V. Goranko, A. Montanari, and G. Sciavicco, *Metric Propositional Neighborhood Logics on Natural Numbers*, Software and Systems Modeling, accepted for publication, January 2011

D. Bresolin, A. Montanari, P. Sala, and G. Sciavicco, *An Optimal Decision Procedure for MPNL over the Integers*, GandALF 2011

# Long-term research agenda

- interval temporal logics and regular languages of finite and infinite words
- quest for automaton-based techniques for proving decidability of interval temporal logics;
- development of methods and algorithms for model-checking in finite and finitely presentable infinite interval structures, such as ultimately periodic ones;
- identification and development of major applications of interval temporal logics. Besides system specification, verification, and synthesis, planning and plan validation (to represent and to reason about actions/events with duration, accomplishments, and interval constraints), temporal databases (to deal with temporal aggregation), and natural language processing (to model features like progressive tenses)

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