

Bibliography

- [ACD 90] R. Alur, C. Courcoubetis, D. Dill. *Model Checking for Real-Time Systems*, Proceedings of the Fifth IEEE Symposium on Logic in Computer Science, pp. 414–425, 1990.
- [Ack 62] W. Ackermann. *Solvable Cases of the Decision Problem*. Studies in Logic and the Foundations of Mathematics, North-Holland, Amsterdam, 1962.
- [Ada 83] *The Programming Language Ada, Reference Manual*. Lecture Notes in Computer Science Vol. 155, Springer, Berlin, 1983.
- [AFH 91] R. Alur, T. Feder, T.A. Henzinger. *The Benefits of Relaxing Punctuality*, to appear in Proceedings of the Tenth ACM Symposium on Principles of Distributed Computing, 1991.
- [AH 89] R. Alur, T.A. Henzinger. *A Really Temporal Logic*, Proceedings of the Thirtieth Symposium on the Foundations of Computer Science, pp. 164–169, 1989.
- [AH 90] R. Alur, T.A. Henzinger. *Real-time Logics: Complexity and Expressiveness*, Proceedings of the Fifth IEEE Symposium on Logic in Computer Science, pp. 390–401, 1990.
- [BC 85] G. Berry, L. Cosserat. *The ESTEREL Synchronous Programming Language and its Mathematical Semantics*, pp. 389–448 in Proceedings of a *Seminar on Concurrency*, Carnegie Mellon University, Pittsburgh, July 1984, Lecture Notes in Computer Science Vol. 197, Springer, Berlin, 1985.
- [Ben 83] J.F.A.K. van Benthem. *The Logic of Time*. Reidel, Dordrecht, 1983 (second edition 1991).

- [Ben 84] J.F.A.K. van Benthem. *Correspondence Theory*, in [GG 84], pp. 167–247.
- [Ben 85] J.F.A.K. van Benthem. *Modal Logic and Classical Logic*. Bibliopolis, Naples, 1985.
- [Ben 89] J.F.A.K. van Benthem, *private correspondence*, 1989.
- [BH 81] A. Bernstein, P.K. Harter, Jr. *Proving Real-Time Properties of Programs with Temporal Logic*, Proceedings of the Eighth ACM Symposium on Operating System Principles, pp. 1–11, 1981.
- [BK 85a] H. Barringer, R. Kuiper. *Hierarchical Development of Concurrent Systems in a Temporal Logic Framework*, pp. 35–61 in Proceedings of a *Seminar on Concurrency*, Carnegie Mellon University, Pittsburgh, July 1984, Lecture Notes in Computer Science Vol. 197, Springer, Berlin, 1985.
- [BK 85b] H. Barringer, R. Kuiper. *Towards the Hierarchical, Temporal Logic Specification of Concurrent Systems*, in [DHJR 85], pp. 156–183.
- [BKP 84] H. Barringer, R. Kuiper, A. Pnueli. *Now You May Compose Temporal Logic Specifications*, Proceedings of the Sixteenth ACM Symposium on the Theory of Computing, pp. 51–63, 1984.
- [BKP 86] H. Barringer, R. Kuiper, A. Pnueli. *A Really Abstract Concurrent Model and its Temporal Logic*, Proceedings of the Thirteenth ACM Symposium on the Principles of Programming Languages, pp. 173–183, 1986.
- [Bla 89] P. Blackburn. *Nominal Tense Logic*. Centre for Cognitive Science, University of Edinburgh, 1989.
- [Bla 90] P. Blackburn. *Nominal Tense Logic and Other Sorted Intensional Frameworks*, Ph.D. Thesis, University of Edinburgh, 1990.
- [Bur 84] J.P. Burgess. *Basic Tense Logic*, in [GG 84], pp. 89–133.
- [CHILL 80] *CHILL Recommendation Z.200 (CHILL Language Definition)*. C.C.I.T.T. Study Group XI, 1980.

- [CK 73] C.C. Chang, H.J. Keisler. *Model Theory*, Studies in Logic and the Foundation of Mathematics Vol. 73, North-Holland, Amsterdam, 1973.
- [Coc 84] N.B. Cocchiarella. *Philosophical Perspectives on Quantification in Tense and Modal Logic*, in [GG 84], pp. 309–353.
- [DHJR 85] T. Denvir, W. Harwood, M. Jackson, M. Ray. *The Analysis of Concurrent Systems*. Proceedings of a Tutorial and Workshop, Cambridge University, September 1983, Lecture Notes in Computer Science Vol. 207, Springer, Berlin, 1985.
- [Gab 81] D. Gabbay. *Expressive Functional Completeness in Tense Logic*, pp. 91–117 in U. Mönnich (ed.) *Aspects of Philosophical Logic*, Reidel, Dordrecht, 1981.
- [Gar 84] J.W. Garson. *Quantification in Modal Logic*, in [GG 84], pp. 249–307.
- [GG 84] D. Gabbay, F. Guenther (eds.). *Handbook of Philosophical Logic, Vol. II*. Reidel, Dordrecht, 1984.
- [GG 89] G. Gargov, V. Goranko. *Modal Logic with Names I*. Linguistic Modelling Laboratory, CICT, Bulgarian Academy of Sciences, Sofia, Bulgaria, and Section of Logic, Faculty of Mathematics and Computer Science, Sofia University, Bulgaria, 1989.
- [GMM 89] C. Ghezzi, D. Mandrioli, A. Morzenti. *TRIO: A Logic Language for Executable Specifications of Real-Time Systems*. Report 89-006, Dipartimento di Elettronica, Politecnico di Milano, 1989.
- [Gol 82] R. Goldblatt. *Axiomatizing the Logic of Computer Programming*. Lecture Notes in Computer Science Vol. 130, Springer, Berlin, 1982.
- [Gor 88] V. Goranko. *Modal Definability in Enriched Languages*. Section of Logic, Faculty of Mathematics, Sofia University, Bulgaria, 1988, also appeared in Notre Dame Journal of Formal Logic, Volume 31, Number 1, pp. 81–105, 1990.

- [GPSS 80] D. Gabbay, A. Pnueli, S. Shelah, J. Stavi. *On the Temporal Analysis of Fairness*, Proceedings of the Seventh ACM Symposium on the Principles of Programming Languages, pp. 163–173, 1980.
- [Hai 80] B.T. Hailpern. *Verifying Concurrent Processes Using Temporal Logic*. Ph.D. Thesis, Stanford University, 1980.
- [Har 84] D. Harel. *Dynamic Logic*, in [GG 84], pp. 497–604.
- [Har 87] D. Harel. *Statecharts: A Visual Formalism for Complex Systems*, Science of Computer Programming **8**, pp. 231–274, 1987.
- [Hen 91] T.A. Henzinger. *The Temporal Specification and Verification of Real-Time Systems*. Ph.D. Thesis, Department of Computer Science, Stanford University, 1991.
- [HLP 90] E. Harel, O. Lichtenstein, A. Pnueli. *Explicit Clock Temporal Logic*, Proceedings of the Fifth IEEE Symposium on Logic in Computer Science, pp. 402–413, 1990.
- [HMP 91] T.A. Henzinger, Z. Manna, A. Pnueli. *Temporal Proof Methodologies for Real-time Systems*, Proceedings of the Eighteenth ACM Symposium on the Principles of Programming Languages, 1991.
- [HO 83] B.T. Hailpern, S.S. Owicki. *Modular Verification of Computer Communication Protocols*, IEEE Transactions on Communications, Vol. COM-31, No. 1, pp. 56–68, 1983.
- [Hoo 91] J. Hooman. *Specification and Compositional Verification of Real-Time Systems*, Ph.D. Thesis, Eindhoven University of Technology, 1991.
- [Hui 91] C. Huizing. *Semantics of Reactive Systems: Comparison and Full Abstraction*, Ph.D. Thesis, Eindhoven University of Technology, 1991.
- [HW 89] J. Hooman, J. Widom. *A Temporal-Logic Based Compositional Proof System for Real-Time Message Passing*, Proceedings of the Conference on Parallel Architectures and Languages Europe (PARLE) '89, Eindhoven, 12–16 June 1989, Lecture Notes

- in Computer Science Vol. 366, pp. 424–441, Springer, Berlin, 1989.
- [JG 88] M. Joseph, A. Goswami. *Formal Description of Real-Time Systems: A Review*. Research Report RR129, Department of Computer Science, University of Warwick, 1988.
- [JM 86] F. Jahanian, A.K. Mok. *Safety Analysis of Timing Properties in Real-Time Systems*, IEEE Transactions on Software Engineering 12, pp. 890–904, 1986.
- [JM 87] F. Jahanian, A.K. Mok. *A Graph-Theoretic Approach for Timing Analysis and its Implementation*, IEEE Transactions on Computers, Vol. C-36, No. 8, pp. 961–975, 1987.
- [Jon 87] B. Jonsson. *Compositional Verification of Distributed Systems*. Ph.D. Thesis, Department of Computer Systems, Uppsala University, 1987.
- [Kam 68] J.A.W. Kamp. *Tense Logic and the Theory of Linear Order*. Ph.D. Thesis, University of California, Los Angeles, 1968.
- [KKZ 87] R. Koymans, R. Kuiper, E. Zijlstra. *Specifying Message Passing and Real-Time Systems with Real-Time Temporal Logic*, Proceedings of the Fourth ESPRIT Conference, pp. 311–324, North-Holland, Amsterdam, 1987.
- [KKZ 88] R. Koymans, R. Kuiper, E. Zijlstra. *Paradigms for Real-Time Systems*, Proceedings of a Symposium on Formal Techniques in Real-Time and Fault-Tolerant Systems (ed. M. Joseph), University of Warwick, 22–23 September 1988, Lecture Notes in Computer Science Vol. 331, pp. 159–174, Springer, Berlin, 1988.
- [KKZ 89] R. Koymans, R. Kuiper, E. Zijlstra. *Specification Specified*, chapter 1 of R. Kuiper, *Combining Linear Time Temporal Logic Descriptions of Concurrent Computations*, Ph.D. Thesis, Eindhoven University of Technology, 1989.
- [Koy 87] R. Koymans. *Specifying Message Passing Systems Requires Extending Temporal Logic*, Proceedings of the Sixth ACM Symposium on Principles of Distributed Computing, pp. 191–204,

- 1987, updated version appeared in Proceedings of a Colloquium on Temporal Logic in Specification, University of Manchester, April 1987, Lecture Notes in Computer Science Vol. 398, pp. 213–223, Springer, Berlin, 1989.
- [Koy 89] R. Koymans. *Specifying Message Passing and Time-Critical Systems with Temporal Logic*, Ph.D. Thesis, Eindhoven University of Technology, 1989.
- [Koy 90] R. Koymans. *Specifying Real-Time Properties with Metric Temporal Logic*, Journal of Real-Time Systems, Volume 2, Number 4, pp. 255–299, Kluwer Academic Publishers, 1990.
- [KP 87] S. Katz, D. Peled. *Interleaving Set Temporal Logic*, Proceedings of the Sixth ACM Symposium on Principles of Distributed Computing, pp. 178–190, 1987.
- [KR 85] R. Koymans, W.-P. de Roever. *Examples of a Real-Time Temporal Logic Specification*, in [DHJR 85], pp. 231–251.
- [KSRGA 85] R. Koymans, R.K. Shyamasundar, W.-P. de Roever, R. Gerth, S. Arun-Kumar. *Compositional Semantics for Real-Time Distributed Computing*, Proceedings of the Workshop on Logics of Programs '85, Lecture Notes in Computer Science Vol. 193, pp. 167–189, Springer, Berlin, 1985, extended version appeared in Information and Computation, Volume 79, Number 3, pp. 210–256, Academic Press, December 1988.
- [KVR 83] R. Koymans, J. Vytupil, W.-P. de Roever. *Real-Time Programming and Asynchronous Message Passing*, Proceedings of the Second ACM Symposium on Principles of Distributed Computing, pp. 187–197, 1983.
- [Lam 83a] L. Lamport. *What Good is Temporal Logic?*, Proceedings of Information Processing (IFIP) '83 (editor R. Mason), pp. 657–668, North-Holland, Amsterdam, 1983.
- [Lam 83b] L. Lamport. *Specifying Concurrent Program Modules*, ACM Transactions on Programming Languages and Systems (TOPLAS), Volume 5, Number 2, pp. 190–223, 1983.
- [Lam 85] L. Lamport. *STL/SERC Problems*, in [DHJR 85], pp. 252–270.

- [Lew 90] H. Lewis. *A Logic of Concrete Time Intervals*, Proceedings of the Fifth IEEE Symposium on Logic in Computer Science, pp. 380–389, 1990.
- [LPZ 85] O. Lichtenstein, A. Pnueli, L. Zuck. *The Glory of The Past*, Proceedings of the Workshop on Logics of Programs '85, Lecture Notes in Computer Science Vol. 193, pp. 196–218, Springer, Berlin, 1985.
- [MCS 82] J. Misra, K.M. Chandy, T. Smith. *Proving Safety and Liveness of Communicating Processes, with Examples*, Proceedings of the First ACM Symposium on Principles of Distributed Computing, 1982.
- [MM 84] B. Moszkowski, Z. Manna. *Reasoning in Interval Temporal Logic*, Proceedings of AMC/NSF/ONR Workshop on Logics of Programs, Lecture Notes in Computer Science Vol. 164, pp. 371–383, Springer, Berlin, 1984.
- [Mos 83] B. Moszkowski. *Reasoning about Digital Circuits*. Ph.D. Thesis, Department of Computer Science, Stanford University, 1983.
- [Mos 86] B. Moszkowski. *Executing Temporal Logic Programs*. Cambridge University Press, 1986.
- [MP 82] Z. Manna, A. Pnueli. *Verification of Concurrent Programs: The Temporal Framework*, pp. 215–273 in R. Boyer, J. Moore (eds.) *The Correctness Problem in Computer Science*, International Lecture Series in Computer Science, Academic Press, London, 1982.
- [MP 83a] Z. Manna, A. Pnueli. *How to Cook a Temporal Proof System for your Pet Language*, Proceedings of the Tenth ACM Symposium on the Principles of Programming Languages, pp. 141–154, 1983.
- [MP 83b] Z. Manna, A. Pnueli. *Verification of Concurrent Programs: A Temporal Proof System*, pp. 163–255 in J. de Bakker, J. van Leeuwen (eds.) *Foundations of Computer Science IV*, Mathematical Center Tracts Vol. 159, CWI, Amsterdam, 1983.

- [MP 87] Z. Manna, A. Pnueli. *A Hierarchy of Temporal Properties*. Department of Computer Science, Stanford University, Report No. STAN-CS-87-1186, October 1987.
- [MP 89] Z. Manna, A. Pnueli. *The Anchored Version of the Temporal Framework*, pp. 201–284 in J.W. de Bakker, W.-P. de Roever, G. Rozenberg (eds.) *Linear Time, Branching Time and Partial Order in Logics and Models for Concurrency*, Lecture Notes in Computer Science Vol. 354, Springer, Berlin, 1989.
- [Ost 87] J.S. Ostroff. *Real-Time Computer Control of Discrete Event Systems Modelled by Extended State Machines: A Temporal Logic Approach*. Ph.D. Thesis, Department of Electrical Engineering, University of Toronto, 1987.
- [Ost 89] J.S. Ostroff. *Temporal Logic for Real-Time Systems*. Advanced Software Development Series, Research Studies Press Limited (marketed by John Wiley & Sons), England, 1989.
- [Pan 88] P.K. Pandya. *Compositional Verification of Distributed Programs*. Ph.D. Thesis, Tata Institute of Fundamental Research, Bombay, 1988.
- [Par 81] D. Park. *Concurrency and Automata on Infinite Sequences*, Proceedings of Fifth GI (Gesellschaft für Informatik) Conference, Lecture Notes in Computer Science Vol. 104, Springer, Berlin, 1981.
- [Pen 88] W. Penczek. *A Temporal Logic for Event Structures*, Fundamenta Informaticae XI, pp. 297–326, 1988.
- [PH 88] A. Pnueli, E. Harel. *Applications of Temporal Logic to the Specification of Real Time Systems*, Proceedings of a Symposium on Formal Techniques in Real-Time and Fault-Tolerant Systems (ed. M. Joseph), University of Warwick, 22–23 September 1988, Lecture Notes in Computer Science Vol. 331, pp. 84–98, Springer, Berlin, 1988.
- [Pnu 77] A. Pnueli. *The Temporal Logic of Programs*, Proceedings of the Eighteenth Symposium on the Foundations of Computer Science, pp. 46–57, 1977.

- [Pnu 86] A. Pnueli. *Applications of Temporal Logic to the Specification and Verification of Reactive Systems: A Survey of Current Trends*, pp. 510–584 in J.W. de Bakker, W.-P. de Roever, G. Rozenberg (eds.) *Current Trends in Concurrency*, Lecture Notes in Computer Science Vol. 224, Springer, Berlin, 1986.
- [Pri 67] A. Prior. *Past, Present and Future*. Oxford University Press, London, 1967.
- [PW 84] S. Pinter, P. Wolper. *A Temporal Logic for Reasoning about Partially Ordered Computations*, Proceedings of the Third ACM Symposium on Principles of Distributed Computing, pp. 28–37, 1984.
- [Rijk 89] M. de Rijke. *The Modal Theory of Inequality*. Master Thesis, Faculty of Mathematics and Computer Science, University of Amsterdam, 1989.
- [Rijk 90] M. de Rijke. *The Modal Theory of Inequality*, updated version of [Rijk 89], ITLI Prepublication Series LP-90-15, Institute for Language, Logic and Information, University of Amsterdam, 1990.
- [Sah 75] H. Sahlqvist. *Completeness and Correspondence in the First and Second Order Semantics for Modal Logic*, pp. 110–143 in S. Kanger (ed.) *Proceedings of the Third Scandinavian Logic Symposium*, North-Holland, Amsterdam, 1975.
- [SCFG 82] A.P. Sistla, E.M. Clarke, N. Francez, Y. Gurevich. *Can Message Buffers Be Characterized in Linear Temporal Logic?*, Proceedings of the First ACM Symposium on Principles of Distributed Computing, pp. 148–156, 1982.
- [SCFM 84] A.P. Sistla, E.M. Clarke, N. Francez, A.R. Meyer. *Can Message Buffers Be Axiomatized in Linear Temporal Logic?*, Information and Control, Volume 63, pp. 88–112, 1984.
- [Seg 70] K. Segerberg. *Modal Logics with Linear Alternative Relations*, Theoria, Volume 36, pp. 301–322, 1970.

- [Seg 71] K. Segerberg. *An Essay in Classical Modal Logic*. Filosofika Studier **13**, Department of Philosophy, University of Uppsala, 1971.
- [SM 82] R.L. Schwartz, P.M. Melliar-Smith. *From State Machines to Temporal Logic: Specification Methods for Protocol Standards*, IEEE Transactions on Communications Vol. COM-30, No. 12, pp. 2486–2496, 1982.
- [SMV 83] R.L. Schwartz, P.M. Melliar-Smith, F.H. Vogt. *An Interval Logic for Higher-Level Temporal Reasoning*, Proceedings of the Second ACM Symposium on Principles of Distributed Computing, pp. 173–186, 1983.
- [SS 82] R.D. Schlichting, F.B. Schneider. *Using Message Passing for Distributed Programming: Proof Rules and Disciplines*, Proceedings of the First ACM Symposium on Principles of Distributed Computing, 1982, also appeared in ACM Transactions on Programming Languages and Systems (TOPLAS), Volume 6, Number 3, pp. 402–431, July 1984.
- [Sta 79] J. Stavi. *Functional Completeness Over the Rationals*. Unpublished, Bar-Ilan University, Ramat-Gan, Israel, 1979.
- [Sti 87] C. Stirling. *Comparing Linear and Branching Time Temporal Logics*. ECS-LFCS-87-24, Laboratory for Foundations of Computer Science, Department of Computer Science, University of Edinburgh, April 1987.
- [Tar 69] A. Tarski. *What is Elementary Geometry?*, pp. 164–175 in J. Hintikka (ed.) *The Philosophy of Mathematics*, Oxford University Press, London, 1969.
- [Tho 86] W. Thomas. *Safety- and Liveness-Properties in Propositional Temporal Logic: Characterizations and Decidability*. Schriften zur Informatik und Angewandten Mathematik, Bericht Nr. 116, Rheinisch-Westfälische Technische Hochschule Aachen, April 1986.
- [Wol 86] P. Wolper. *Expressing Interesting Properties of Programs in Propositional Temporal Logic*, Proceedings of the Thirteenth

ACM Symposium on the Principles of Programming Languages, pp. 184–193, 1986.

- [ZRE 85] J. Zwiers, W.-P. de Roever, P. van Emde Boas. *Compositionality and Concurrent Networks: Soundness and Completeness of a Proofsystem*, Proceedings of the Twelfth International Colloquium on Automata, Languages and Programming, Lecture Notes in Computer Science Vol. 194, pp. 509–519, Springer, Berlin, 1985.
- [Zwi 88] J. Zwiers. *Compositionality, Concurrency and Partial Correctness: Proof Theories for Networks of Processes, and their Connection*. Ph.D. Thesis, Eindhoven University of Technology, 1988, also appeared as Lecture Notes in Computer Science Vol. 321, Springer, Berlin, 1989.

Index

- \perp , 14
- \top , 14
- A**, 41
- D**, 41
- $\overline{\mathbf{D}}$, 41
- \mathbf{D}_δ , 108
- E**, 41
- \mathbf{E}_δ , 108
- F**, 14
- \mathbf{F}_δ , 108
- $\mathbf{F}_{<\delta}$, 109
- $\mathbf{F}_{\leq\delta}$, 132
- G**, 14
- \mathbf{G}_δ , 108
- $\mathbf{G}_{<\delta}$, 109
- $\mathbf{G}_{>\delta}$, 132
- H**, 14
- \mathbf{H}_δ , 108
- J**, 119
- L**, 14
- \mathbf{L}^R , 40
- $\dot{\mathbf{L}}^R$, 40
- \mathbf{L}_δ , 108
- M**, 14
- \mathbf{M}^R , 40
- $\dot{\mathbf{M}}^R$, 40
- \mathbf{M}_δ , 108
- P**, 14
- $\dot{\mathbf{P}}$, 78
- \mathbf{P}_δ , 108
- $\mathbf{P}_{<\delta}$, 109
- $\mathbf{P}_{>\delta}$, 136
- U**, 45
- X**, 35
- Y**, 35
- \square , 35
- \diamond , 35
- $\diamond_{<\delta}$, 125
- since**, 32
- $\widehat{\mathbf{since}}$, 33
- \mathbf{since}_δ , 109
- since**, 119
- $\mathbf{since}_{>\delta}$, 126
- unless**, 78
- until**, 32
- $\widehat{\mathbf{until}}$, 32
- \mathbf{until}_δ , 109
- $\mathbf{until}_{<\delta}$, 125
- $\text{PML}(R_1, \dots, R_n)$, 40
- \prec , 106
- abstract interface, 7
- action, 8
- alternative relation, 14
- anchored temporal logic, 36
- basic liveness assumption, 68, 79
- black box representation, 9
- branching time temporal logic, 34
- categoricity, 23, 48
- causality, 8

- compositionality, 10
- computation, 34
- conformity, 10
- Consistency Theorem, 28

- data element, 8
- data-independence, 76
- decidability, 31
- disjoint union of frames, 19
- distance function, 105
- Distribution axiom schema, 27
- dual, 14

- environment, 7
- environment assumption, 82
- event, 8
- execution, 34, 103
- expressive completeness, 32
- extended event, 8
- extended zigzag connection, 42

- FIFO ordering, 70, 80
- filtrated model, 18
- filtration, 18
- finite model property, 18
- finite speed assumption, 68, 80
- first-order temporal logic, 33, 36
- frame, 14
- frame-complete, 31
- frequency, 101

- generated subframe, 19
- generated submodel, 17
- Generation Theorem, 17
- global equivalence, 24
- global variables, 33, 37

- Henkin Frame, 29
- Henkin Model, 29

- interface, 7
- interface specification, 8
- interleaving model, 102
- interval temporal logic, 35
- irreflexive operator, 32

- LIFO ordering, 70, 81
- Lindenbaum's Lemma, 28
- linear (time) temporal logic, 34
- local equivalence, 24
- local variables, 33, 37
- location, 120

- maximal parallelism model, 102
- method of substitutions, 25
- metric domain, 107
- metric operators, 108
- metric point structure, 106
- metric temporal logic, 100
- model, 14
- modularity, 10
- Modus Ponens, 14

- Necessitation rule, 27
- No Creation assumption, 67, 79
- no simultaneous input assumption, 68, 80
- no simultaneous output assumption, 68, 80

- perfectness assumption, 69, 80
- periodicity, 101
- periodicity requirements, 120
- point structure, 15
- polymodal logic, 40
- precedence relation, 15
- preservation results, 19, 20
- proof system D , 52
- proof system D_m , 57

- proof system D_t , 57
- proof system D_{lin} , 58
- proof system D_{rat} , 59
- proof system D_{int} , 59
- proof system K , 26
- proof system K_t , 30
- proof system M , 114
- propositional logic, 14

- quantitative temporal requirements, 101

- real-time temporal logic, 3
- refinement, 90, 97
- reflexive closure, 40
- response time, 101
- rule of substitution, 31

- Sahlqvist-form, 24, 50
- special structures, 23, 48
- state variable, 8
- stimulus-response mechanism, 101
- strict partial order, 15
- submodel, 17
- synchrony hypothesis, 108
- syntactical abstractness, 9
- system, 7
- system requirement, 82

- temporal distance function, 107
- temporal frame, 15
- time-out, 121
- Truth Lemma, 29
- truth-preserving operations, 16

- ultrafilter, 20
- ultrafilter extension, 20
- uniformity, 10
- unique identification assumption, 76,

Lecture Notes in Computer Science

For information about Vols. 1–579
please contact your bookseller or Springer-Verlag

- Vol. 580: A. Pirotte, C. Delobel, G. Gottlob (Eds.), *Advances in Database Technology – EDBT '92. Proceedings.* XII, 551 pages. 1992.
- Vol. 581: J.-C. Raoult (Ed.), *CAAP '92. Proceedings.* VIII, 361 pages. 1992.
- Vol. 582: B. Krieg-Brückner (Ed.), *ESOP '92. Proceedings.* VIII, 491 pages. 1992.
- Vol. 583: I. Simon (Ed.), *LATIN '92. Proceedings.* IX, 545 pages. 1992.
- Vol. 584: R. E. Zippel (Ed.), *Computer Algebra and Parallelism. Proceedings, 1990.* IX, 114 pages. 1992.
- Vol. 585: F. Pichler, R. Moreno Díaz (Eds.), *Computer Aided System Theory – EUROCAST '91. Proceedings.* X, 761 pages. 1992.
- Vol. 586: A. Cheese, *Parallel Execution of Parlog.* IX, 184 pages. 1992.
- Vol. 587: R. Dale, E. Hovy, D. Rösner, O. Stock (Eds.), *Aspects of Automated Natural Language Generation. Proceedings, 1992.* VIII, 311 pages. 1992. (Subseries LNAI).
- Vol. 588: G. Sandini (Ed.), *Computer Vision – ECCV '92. Proceedings.* XV, 909 pages. 1992.
- Vol. 589: U. Banerjee, D. Gelernter, A. Nicolau, D. Padua (Eds.), *Languages and Compilers for Parallel Computing. Proceedings, 1991.* IX, 419 pages. 1992.
- Vol. 590: B. Fronhöfer, G. Wrightson (Eds.), *Parallelization in Inference Systems. Proceedings, 1990.* VIII, 372 pages. 1992. (Subseries LNAI).
- Vol. 591: H. P. Zima (Ed.), *Parallel Computation. Proceedings, 1991.* IX, 451 pages. 1992.
- Vol. 592: A. Voronkov (Ed.), *Logic Programming. Proceedings, 1991.* IX, 514 pages. 1992. (Subseries LNAI).
- Vol. 593: P. Loucopoulos (Ed.), *Advanced Information Systems Engineering. Proceedings.* XI, 650 pages. 1992.
- Vol. 594: B. Monien, Th. Ottmann (Eds.), *Data Structures and Efficient Algorithms.* VIII, 389 pages. 1992.
- Vol. 595: M. Levene, *The Nested Universal Relation Database Model.* X, 177 pages. 1992.
- Vol. 596: L.-H. Eriksson, L. Hallnäs, P. Schroeder-Heister (Eds.), *Extensions of Logic Programming. Proceedings, 1991.* VII, 369 pages. 1992. (Subseries LNAI).
- Vol. 597: H. W. Guesgen, J. Hertzberg, *A Perspective of Constraint-Based Reasoning.* VIII, 123 pages. 1992. (Subseries LNAD).
- Vol. 598: S. Brookes, M. Main, A. Melton, M. Mislove, D. Schmidt (Eds.), *Mathematical Foundations of Programming Semantics. Proceedings, 1991.* VIII, 506 pages. 1992.
- Vol. 599: Th. Wetter, K.-D. Althoff, J. Boose, B. R. Gaines, M. Linster, F. Schmalhofer (Eds.), *Current Developments in Knowledge Acquisition - EKAW '92. Proceedings.* XIII, 444 pages. 1992. (Subseries LNAI).
- Vol. 600: J. W. de Bakker, C. Huizing, W. P. de Roever, G. Rozenberg (Eds.), *Real-Time: Theory in Practice. Proceedings, 1991.* VIII, 723 pages. 1992.
- Vol. 601: D. Dolev, Z. Galil, M. Rodeh (Eds.), *Theory of Computing and Systems. Proceedings, 1992.* VIII, 220 pages. 1992.
- Vol. 602: I. Tomek (Ed.), *Computer Assisted Learning. Proceedings, 1992.* X, 615 pages. 1992.
- Vol. 603: J. van Katwijk (Ed.), *Ada: Moving Towards 2000. Proceedings, 1992.* VIII, 324 pages. 1992.
- Vol. 604: F. Belli, F.-J. Radermacher (Eds.), *Industrial and Engineering Applications of Artificial Intelligence and Expert Systems. Proceedings, 1992.* XV, 702 pages. 1992. (Subseries LNAI).
- Vol. 605: D. Etiemble, J.-C. Syre (Eds.), *PARLE '92. Parallel Architectures and Languages Europe. Proceedings, 1992.* XVII, 984 pages. 1992.
- Vol. 606: D. E. Knuth, *Axioms and Hulls.* IX, 109 pages. 1992.
- Vol. 607: D. Kapur (Ed.), *Automated Deduction – CADE-11. Proceedings, 1992.* XV, 793 pages. 1992. (Subseries LNAD).
- Vol. 608: C. Frasson, G. Gauthier, G. I. McCalla (Eds.), *Intelligent Tutoring Systems. Proceedings, 1992.* XIV, 686 pages. 1992.
- Vol. 609: G. Rozenberg (Ed.), *Advances in Petri Nets 1992.* VIII, 472 pages. 1992.
- Vol. 610: F. von Martial, *Coordinating Plans of Autonomous Agents.* XII, 246 pages. 1992. (Subseries LNAI).
- Vol. 611: M. P. Papazoglou, J. Zeleznikow (Eds.), *The Next Generation of Information Systems: From Data to Knowledge.* VIII, 310 pages. 1992. (Subseries LNAI).
- Vol. 612: M. Tokoro, O. Nierstrasz, P. Wegner (Eds.), *Object-Based Concurrent Computing. Proceedings, 1991.* X, 265 pages. 1992.
- Vol. 613: J. P. Myers, Jr., M. J. O'Donnell (Eds.), *Constructivity in Computer Science. Proceedings, 1991.* X, 247 pages. 1992.
- Vol. 614: R. G. Herrtwich (Ed.), *Network and Operating System Support for Digital Audio and Video. Proceedings, 1991.* XII, 403 pages. 1992.
- Vol. 615: O. Lehrmann Madsen (Ed.), *ECOOP '92. European Conference on Object Oriented Programming. Proceedings.* X, 426 pages. 1992.
- Vol. 616: K. Jensen (Ed.), *Application and Theory of Petri Nets 1992. Proceedings, 1992.* VIII, 398 pages. 1992.

- Vol. 617: V. Mařík, O. Štěpánková, R. Trappl (Eds.), *Advanced Topics in Artificial Intelligence*. Proceedings, 1992. IX, 484 pages. 1992. (Subseries LNAI).
- Vol. 618: P. M. D. Gray, R. J. Lucas (Eds.), *Advanced Database Systems*. Proceedings, 1992. X, 260 pages. 1992.
- Vol. 619: D. Pearce, H. Wansing (Eds.), *Nonclassical Logics and Information*. Proceedings, 1990. VII, 171 pages. 1992. (Subseries LNAI).
- Vol. 620: A. Nerode, M. Taitslin (Eds.), *Logical Foundations of Computer Science – Tver '92*. Proceedings. IX, 514 pages. 1992.
- Vol. 621: O. Nurmi, E. Ukkonen (Eds.), *Algorithm Theory – SWAT '92*. Proceedings. VIII, 434 pages. 1992.
- Vol. 622: F. Schmalhofer, G. Strube, Th. Wetter (Eds.), *Contemporary Knowledge Engineering and Cognition*. Proceedings, 1991. XII, 258 pages. 1992. (Subseries LNAI).
- Vol. 623: W. Kuich (Ed.), *Automata, Languages and Programming*. Proceedings, 1992. XII, 721 pages. 1992.
- Vol. 624: A. Voronkov (Ed.), *Logic Programming and Automated Reasoning*. Proceedings, 1992. XIV, 509 pages. 1992. (Subseries LNAI).
- Vol. 625: W. Vogler, *Modular Construction and Partial Order Semantics of Petri Nets*. IX, 252 pages. 1992.
- Vol. 626: E. Börger, G. Jäger, H. Kleine Büning, M. M. Richter (Eds.), *Computer Science Logic*. Proceedings, 1991. VIII, 428 pages. 1992.
- Vol. 628: G. Vosselman, *Relational Matching*. IX, 190 pages. 1992.
- Vol. 629: I. M. Havel, V. Koubek (Eds.), *Mathematical Foundations of Computer Science 1992*. Proceedings. IX, 521 pages. 1992.
- Vol. 630: W. R. Cleaveland (Ed.), *CONCUR '92*. Proceedings. X, 580 pages. 1992.
- Vol. 631: M. Bruynooghe, M. Wirsing (Eds.), *Programming Language Implementation and Logic Programming*. Proceedings, 1992. XI, 492 pages. 1992.
- Vol. 632: H. Kirchner, G. Levi (Eds.), *Algebraic and Logic Programming*. Proceedings, 1992. IX, 457 pages. 1992.
- Vol. 633: D. Pearce, G. Wagner (Eds.), *Logics in AI*. Proceedings. VIII, 410 pages. 1992. (Subseries LNAI).
- Vol. 634: L. Bougé, M. Cosnard, Y. Robert, D. Trystram (Eds.), *Parallel Processing: CONPAR 92 – VAPP V*. Proceedings. XVII, 853 pages. 1992.
- Vol. 635: J. C. Derniame (Ed.), *Software Process Technology*. Proceedings, 1992. VIII, 253 pages. 1992.
- Vol. 636: G. Comyn, N. E. Fuchs, M. J. Ratcliffe (Eds.), *Logic Programming in Action*. Proceedings, 1992. X, 324 pages. 1992. (Subseries LNAI).
- Vol. 637: Y. Bekkers, J. Cohen (Eds.), *Memory Management*. Proceedings, 1992. XI, 525 pages. 1992.
- Vol. 639: A. U. Frank, I. Campari, U. Formentini (Eds.), *Theories and Methods of Spatio-Temporal Reasoning in Geographic Space*. Proceedings, 1992. XI, 431 pages. 1992.
- Vol. 640: C. Sledge (Ed.), *Software Engineering Education*. Proceedings, 1992. X, 451 pages. 1992.
- Vol. 641: U. Kastens, P. Pfahler (Eds.), *Compiler Construction*. Proceedings, 1992. VIII, 320 pages. 1992.
- Vol. 642: K. P. Jantke (Ed.), *Analogical and Inductive Inference*. Proceedings, 1992. VIII, 319 pages. 1992. (Subseries LNAI).
- Vol. 643: A. Habel, *Hyperedge Replacement: Grammars and Languages*. X, 214 pages. 1992.
- Vol. 644: A. Apostolico, M. Crochemore, Z. Galil, U. Manber (Eds.), *Combinatorial Pattern Matching*. Proceedings, 1992. X, 287 pages. 1992.
- Vol. 645: G. Pernul, A. M. Tjoa (Eds.), *Entity-Relationship Approach – ER '92*. Proceedings, 1992. XI, 439 pages. 1992.
- Vol. 646: J. Biskup, R. Hull (Eds.), *Database Theory – ICDDT '92*. Proceedings, 1992. IX, 449 pages. 1992.
- Vol. 647: A. Segall, S. Zaks (Eds.), *Distributed Algorithms*. X, 380 pages. 1992.
- Vol. 648: Y. Deswarte, G. Eizenberg, J.-J. Quisquater (Eds.), *Computer Security – ESORICS 92*. Proceedings. XI, 451 pages. 1992.
- Vol. 649: A. Pettorossi (Ed.), *Meta-Programming in Logic*. Proceedings, 1992. XII, 535 pages. 1992.
- Vol. 650: T. Ibaraki, Y. Inagaki, K. Iwama, T. Nishizeki, M. Yamashita (Eds.), *Algorithms and Computation*. Proceedings, 1992. XI, 510 pages. 1992.
- Vol. 651: R. Koymans, *Specifying Message Passing and Time-Critical Systems with Temporal Logic*. IX, 164 pages. 1992.
- Vol. 652: R. Shyamasundar (Ed.), *Foundations of Software Technology and Theoretical Computer Science*. Proceedings, 1992. XIII, 405 pages. 1992.
- Vol. 653: A. Bensoussan, J.-P. Verjus (Eds.), *Future Tendencies in Computer Science, Control and Applied Mathematics*. Proceedings, 1992. XV, 371 pages. 1992.
- Vol. 654: A. Nakamura, M. Nivat, A. Saoudi, P. S. P. Wang, K. Inoue (Eds.), *Parallel Image Analysis*. Proceedings, 1992. VIII, 312 pages. 1992.