Curriculum Vitae: Esko Ukkonen

Esko Ukkonen
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Personal data

Full name: Esko Juhani Ukkonen.
Born on January 26th, 1950, in Savonlinna, Finland.
Citizen of Finland. Married, two grown–up children.

Academic Degrees

Ph.D. (computer science): University of Helsinki, 1978. (PhD Thesis accepted Nov 24, 1977.)
Phil.Lic. (computer science): University of Helsinki, 1976.
M.Sc. (mathematics): University of Helsinki, 1973.

Employment

Present positions:

Professor of Computer Science, University of Helsinki, 1985–.

Director of National Center–of–Excellence in Algorithmic Data Analysis of the Academy of Finland, 2002 –.

Chairman of the Department of Computer Science, Univ of Helsinki, 2010—.

Docent of Theory of Computing, Helsinki University of Technology, 1989–.

Earlier positions:

Research Director of the Basic Research Unit of the Helsinki Institute of Information Technology (HIIT/BRU), 2004 – 2008.

Academy Professor, Academy of Finland, 1999–2004 (5 year term).

Chairman of the Department of Computer Science, Univ of Helsinki, 1998–99.

Associate Professor of Computer Science, University of Helsinki, 1981–1985.

Junior Research Fellow, Academy of Finland, 1980–1981.

Docent (Computer Science), University of Helsinki, 1979–1981.

Assistant Professor (yliassistentti) of Computer Science, University of Helsinki, 1978–1981.

Assistant, instructor and research associate, University of Helsinki, 1973–1978.

Visiting positions

Universität Bielefeld, Technische Fakultät, Oct – Nov 1994.
Universität Freiburg, Institut für Informatik, Aug 1990 – Aug 1991 (Humboldt Research Grant).
University of California at Berkeley, Computer Science Division, Jan 1981 – Jan 1982.

SCIENTIFIC ACTIVITIES

Research projects (external funding)

- *Algorithmic Data Analysis* (National Center–of–Excellence of the Academy of Finland), 2008–2013.

- *ESO (European Southern Observatory) collaboration project* (Ministry of Education, Helsinki), 2008–2010.
- *REGULATORY GENOMICS* (EU STREP), 2004–2008.
- *Yeast Systems Biology* (TEKES, Neobio program), 2004–2006.
- *BIOSAPIENS* (EU Network of Excellence), 2004–2009.
- *From Data to Knowledge* (National Center–of–Excellence of the Academy of Finland), 2002–2007.
- *Integrated Computational Methods for Genomic, Proteomic and Metabolic Modeling* (Academy of Finland, the MaDaMe program), 2000–2003.
- *A global molecular approach in the study of microbial stress* (Academy of Finland, the Life2000 program), 2000–2003.
- *Pattern matching and machine learning – algorithms and biocomputing applications* (Academy of Finland), 2000–2002, 2003–2004.
- *Structure, assembly and dynamics of biological macromolecule complexes* (Academy of Finland), 2000–2002.
- *SEMEX* (Nokia Research Center), 1999.
- *Algorithmic methods in biocomputing and data–analysis* (Academy of Finland), 1999.
- *Combining expert knowledge and observed data in hydrological modeling and optimization* (Academy of Finland), 1998–99.
- *Neural and Computational Learning* (ESPRIT Working Group 8556 'NeuroCOLT', a joint project with 10 European research groups), 1994–97; 'NeuroCOLT II' 1998–2002.
- *Machine learning and combinatorial pattern matching – theory, algorithms and applications* (Research Contract with the Academy of Finland), 1994 – 1998.
- *Combinatorial Pattern Matching* (a subproject in the research consortium *From Data to Knowledge* funded by the Academy of Finland and the University of Helsinki), 1996 – 2001.
- *Machine learning methods in hydrological modelling and optimization*, (Academy of Finland, UNESCO's IHP Programme, a joint project with the Finnish Environment Institute), 1994 – 1997.
- *Efficient algorithms and data structures* (Academy of Finland, a joint project with the Universities of Helsinki, Turku, Tampere and Joensuu), 1992–1996.
- *Low–level machine learning* (Research Contract with the Academy of Finland), 1987–91.
- *Logic programming languages and their implementations* (Academy of Finland, Technology Development Centre), 1985–89.
- *Algorithms and complexity* (Academy of Finland, Aaltonen Foundation), 1983–1986.
- *Software for nucleotide sequence analysis* (Academy of Finland, Foundation for Industrial Fermentation Research), 1982–1985.
- *Development and analysis of algorithms for programming language implementation* (Academy of Finland), 1979–1981.

Editorships

- Editor–in–Chief of the *Nordic Journal of Computing*, 1993–present.

- Member of the Board of Editors of the *Journal of Universal Computer Science* (Springer–Verlag), 1999–.
- Associate Editor of the *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, 2004–.

Memberships in scientific program committees of international conferences:
18th International Conference on Intelligent Systems for Molecular Biology (ISMB 2010, Boston); 4th International Conference on Language and Automata Theory and Applications (LATA 2010, Trier); Combinatorial Pattern Matching (CPM'09, Lille *Co–chairman of the program committee*) 2009; 17th International Conference on Intelligent Systems for Molecular Biology (ISMB 2009, Stockholm *Co–chairman of area program committee*); European Computer Science Summit (ECSS 2008, Zuerich); International Symposium on Bioinformatics Research and Applications (ISBRA 2008, Atlanta); Eight Workshop on Algorithms in Bioinformatics (WABI 2008, Karlsruhe); Symposium on String Processing and Information Retrieval (SPIRE'2008, Melbourne); European Conference on Computational Biology (ECCB 2008, Cagliari); 11th International Conference on Computational Molecular Biology (RECOMB 2007, Berkeley); International Symposium on Bioinformatics Research and Applications (ISBRA 2007, Atlanta); 10th International Conference on Computational Molecular Biology (RECOMB 2006, Venice); Combinatorial Pattern Matching (CPM'06, Barcelona) 2006; 13th International Conference on Intelligent Systems for Molecular Biology (ISMB 2005, Detroit); Fifth Workshop on Algorithms in Bioinformatics (WABI 2005, Mallorca, Spain); The 16th International Conference on Algorithmic Learning Theory (ALT 2005, Singapore); Fourth Workshop on Algorithms in Bioinformatics (WABI 2004, Bergen); Seventh International Colloquium on Grammatical Inference (ICGI-2004, Athens); Symposium on String Processing and Information Retrieval (SPIRE'2004, Padova); European Conference on Computational Biology (ECCB 2003, Paris); Fundamentals of Computation Theory (FCT'03, Malmö); First European Conference on Computational Biology (ECCB 2002, Saarbrücken); Sixth International Colloquium on Grammatical Inference (ICGI-2002, Amsterdam); Bioinformatics 2001 (Skövde, Sweden); Symposium on String Processing and Information Retrieval (SPIRE'2001, Laguna de San Rafael, Chile) 2001; Fundamentals of Computation Theory (FCT'01, Riga) 2001; Fifth International Colloquium on Grammatical Inference (ICGI-2000, Lisbon) 2000; Combinatorial Pattern Matching (CPM'00, Montreal) 2000; Scandinavian Workshop on Algorithm Theory (SWAT'00, Bergen) 2000; Second International Conference on on Discovery Science (DS'99, Tokyo) 1999; Symposium on String Processing and Information Retrieval (SPIRE'99, Cancun) 1999; Third Workshop on Algorithm Engineering (WAE'99, London), 1999; First International Conference on Discovery Science (DS'98, Fukuoka) 1998; Algorithmic Learning Theory (ALT'98, Otzenhausen) 1998; Combinatorial Pattern Matching (CPM'97, Aarhus) 1997; Fourth South American Workshop on String Processing (WSP'97, Valparaiso, Chile) 1997; International Colloquium on Automata, Languages and Programming (ICALP'97, Bologna) 1997; Combinatorial Pattern Matching (CPM'95, Helsinki; *Chairman of the Program Committee*) 1995; Fourth Symposium on Programming Languages and Software Tools (Visegrad) 1995; Algorithmic Learning Theory (ALT'94, Leipzig) 1994; Combinatorial Pattern Matching (CPM'94, Asilomar, Calif.) 1994; Scandinavian Workshop on Algorithm Theory (SWAT'94, Aarhus) 1994; Fourth Workshop on Algorithmic Learning Theory (ALT'93, Tokyo) 1993; First European Symposium on Algorithms (ESA'93, Bonn) 1993; Combinatorial Pattern Matching (CPM'92, Tucson) 1992; Scandinavian Workshop on Algorithm Theory (SWAT'92, Helsinki; *Chairman of the Program Committee*) 1992; Algorithmic Learning Theory (ALT'90, Tokyo) 1990; Workshop on Algorithms and Data Structures (WADS'89, Ottawa) 1989; Finnish–Hungarian Workshop on Programming Languages and Software Tools (Szeged) 1989; International Colloquium on Automata, Lan-

guages, and Programming (ICALP'88, Tampere) 1988; Symposium on Theoretical Aspects of Computing (STACS'86, Paris) 1986.

Referee in several international conferences and in the following journals: *Algorithmica*, *Journal of the ACM*, *Communications of the ACM*, *ACM Transactions on Information Systems*, *Acta Informatica*, *ACM Computing Surveys*, *Theoretical Computer Science*, *SIAM Journal of Computing*, *Information Processing Letters*, *Information and Computation*, *Mathematical Systems Theory*, *Discrete Applied Mathematics*, *Science of Computer Programming*, *IEEE Transactions on Computing*, *IEEE Transactions on Knowledge and Data Engineering*, *IEEE Transactions on Systems, Man, and Cybernetics*, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *Journal of Computer and System Sciences*, *Journal of Complexity*, *Journal of Discrete Algorithms*, *Biological Cybernetics*, *BIT*, *Bioinformatics*, *PLoS Computational Biology*, *BMC Bioinformatics*.

Reviewer of research proposals: European Commission (Brussels); European Science Foundation (Strasbourg); NSF National Science Foundation (Washington D.C.); NSERC Natural Sciences and Engineering Research Council of Canada (Ottawa); Netherlands Organization for Scientific Research (NWO); TFR Swedish Research Council for Engineering Sciences (Stockholm); Norges Forskningsrad (Oslo); Estonian Higher Education Accreditation Centre (Tallinn); DFG Deutsche Forschungsgemeinschaft (Bonn); GIF German–Israeli Foundation for Scientific Research & Development (Jerusalem); Academy of Finland (Helsinki).

Reviewer of academic educational programs: Swedish National Agency for Higher Education; Akkreditierungsagentur ASIIN (Duesseldorf).

Reviewer for professorships in Finland (Abo Academy University, University of Tampere, University of Kuopio); Sweden (Chalmers University of Technology, Lund University, Royal Institute of Technology (three times), Luleå University (two times)); Norway (University of Bergen (two times)); Estonia (University of Tartu); Germany (several cases); U.S.A (University of Colorado at Boulder, University of California (Davis and San Diego), University of Georgia, University of Utah).

Administrative and organizational service

- Director of National Center-of-Excellence granted by the Academy of Finland (two 6 year terms: *Algorithmic Data Analysis* 2008–2013, *From Data to Knowledge* 2002–2007).
- Society for Bioinformatics in the Nordic Countries, member of the Board, 2000–2003.
- Helsinki Institute of Information Technology, member of the Board, 2000–2004.
- Chairman of the Department of Computer Science, University of Helsinki, 1998–99 and 1983–84.
- Director of *Graduate School in Computational Biology, Bioinformatics, and Biometry* 1998–2002. The school, funded by the Ministry of Education, is jointly organized by the Universities of Helsinki, Turku, and Tampere, and by the Finnish Centre for Scientific Computing.
- Chairman of the Board of the Finnish Society of Computer Science 1999–2000; vice–chairman 1996–98; member of the board 1982–83.
- Member of several administrative boards and committees at the University of Helsinki since 1979 (e. g., Board of the Department of Computer Science; Information Management Steering Committee of the University 1996–2000; Delegation of the Open University 1996–99; Chairman of the Board of the Rolf Nevanlinna Institute 1998–2003; Board of the Institute of Biotechnology: member 2002–2009, chairman 2009–; Board of the Helsinki Area Master's Programme in Biotechnology 2003–).

- Member of the Steering Committee of the Scandinavian Workshops on Algorithm Theory (SWAT), 1991–present.
- Co-chairman of the international program committee of the Sixth Annual Symposium on Combinatorial Pattern Matching (CPM'95, July 1995, Helsinki).
- Chairman of the international program and organization committees of the Third Scandinavian Workshop on Algorithm Theory (SWAT'92, July 1992, Helsinki).
- Member of the Finnish–Estonian Joint Committee on Informatics, 1988–1994.
- Director of the National Finnish Doctoral Programme in Computer Science, 1988–1990.
- Organizing Committee for SWAT 90 (Bergen, Norway) 1990.
- Organizing Committee for Workshop on Algorithms for Molecular Genetics (Bethesda, U.S.A.) 1988.
- Chairman of the organizing committee for the Finnish Artificial Intelligence Symposium STeP–88 (Helsinki) 1988.

Invited tutorials and talks in international conferences

- Workshop on Algorithms for Molecular Genetics (Bethesda, May 1988).
- First Symposium on Combinatorial Pattern Matching (A tutorial of 4 hours; Paris, July 1990).
- Efficient Algorithms (Oberwolfach, August 1991).
- Data Structures (Dagstuhl, March 1992).
- Data Structures (Dagstuhl, March 1994).
- Italian–Israeli Workshop on Algorithmic Aspects of Molecular Biology (Padova, Dec 1994).
- Fourth South American Workshop on String Processing (Valparaiso, November 1997).
- Workshop on Data Mining and Bioinformatics (European Bioinformatics Institute, Hinxton, U.K., March 1998).
- Scandinavian Workshop on Algorithm Theory (Bergen, July 2000).
- University of Padova (A special guest lecture series of 8 hours; June 2001.)
- NWO/IOP–Genomics Winterschool on Mathematics and Biology (A minicourse of 4 hours; Wageningen, The Netherlands, Dec 2001).
- Computational Biology (Dagstuhl, Nov 2002).
- Fourteenth Seminar: Algorithmics and Combinatorics in Biology (Univ. Claude Bernard, Lyon, April 2–4, 2003).
- Fifteenth Int. School 'Algorithmics for data mining and pattern discovery' (Lipari, July 2003).
- Workshop on Combinatorics, Algorithms and Applications (Ubatuba, Brazil, September 2003).
- Seventh International Conference on Discovery Science / 15th International Conference on Algorithmic Learning Theory (DS 2004 / ALT 2004, Padova).
- 16th Annual Symposium Combinatorial Pattern Matching (CPM 2005, Jeju, Korea).
- Erice School "The Analysis of Patterns" (4 hours of lectures; Erice, Italy, Nov 2005).
- Workshop "Algorithms in Bioinformatics" (J.-V. Poncelet Laboratory, Moscow July 2006).
- SBF Meeting COMPARATIVE GENOMICS (St Andrews, June 2008).
- ESF symposium "The Computational Challenges of The Next Generation DNA Sequencing" (Uppsala, January 2009).
- 5th International Symposium on Bioinformatics Research and Applications (ISBRA 2009, Ft. Lauderdale, Fl, USA).

PhD Dissertations supervised

- Heikki Mannila: *Instance complexity for sorting and NP–complete problems*, 1985.
- Pekka Orponen: *The structure of polynomial complexity cores*, 1986.
- Niklas Holsti: *Script editing for recovery and reversal in textual user interfaces*, 1989.

- Jukka Paakki: *Paradigms for attribute–grammar–based language implementation*, 1991.
- Patrik Floreen: *Computational complexity problems in neural associative memories*, 1992 (joint supervision with P. Orponen).
- Jyrki Kivinen: *Problems in computational learning theory*, 1992.
- Petri Myllymäki: *Mapping Bayesian networks to stochastic neural networks: a foundation for hybrid bayesian–neural systems*, 1995 (with P. Orponen).
- Tapio Elomaa: *Tools and techniques for decision tree learning*, 1996.
- Henry Tirri: *Plausible prediction by Bayesian inference*, 1997.
- Matti Nykänen: *Querying string databases with modal logic*, 1997 (with G. Grahne).
- Erkki Sutinen: *Approximate pattern matching with the q–gram family*, 1998.
- Juha Kärkkäinen: *Repetition–based text indexes*, 1999.
- Kjell Lemström: *String Matching Techniques for Music Retrieval*, 2000.
- Juho Rousu: *Efficient Range Partitioning in Classification Learning*, 2001 (with T. Elomaa).
- Kimmo Fredriksson: *Rotation invariant template matching*, 2001.
- Jaak Vilo: *Pattern discovery from biosequences*, 2002.
- Veli Mäkinen: *Parametrized approximate string matching and local similarity based point–pattern matching*, 2003.
- Janne Ravantti: *Computational methods for reconstructing macromolecular complexes from cryo–electron microscopy images*, 2004.
- Teemu Kivioja: *Computational tools for a novel transcriptional profiling method*, 2004.
- Hellis Tamm: *On minimality and size reduction of one–tape and multitape finite automata*, 2005.
- Ari Rantanen: *Algorithms for 13C metabolic flux analysis*, 2006.
- Kimmo Palin: *Computational methods for locating and analyzing conserved gene regulatory DNA elements*, 2007.
- Ilkka Autio: *Modeling efficient classification as a process of confidence assessment and delegation*, 2008 (with T. Elomaa).
- Juha Makkonen: *Semantic classes in topic detection and tracking*, 2009 (with H. Ahonen–Myka).
- Pasi Rastas: *Computational techniques for haplotype inference and for local alignment significance*, 2009.

Opponent or External Reviewer in PhD Committees

- University of Pisa, Italy: Roberto Grossi;
- University of Bergen, Norway: Carsten Helgesen 1994;
- University of Turku, Finland: Timo Knuutila 1994, Tapio Salakoski 1997;
- University of Bielefeld, Germany: Stefan Kurtz 1995;
- University of Lund, Sweden: Stefan Nilsson 1996;
- ETH Zuerich, Switzerland: Fei Shi 1997;
- Norwegian University of Science and Technology, Trondheim: Eivind Coward 1998;
- University of Chile, Santiago: Gonzalo Navarro, 1998;
- KTH Stockholm, Sweden: Lars Ivansson, 2000;
- University of Saarbrücken, Germany: Stefan Burkhardt 2002;
- University of Tampere, Finland: Heikki Hyyrö 2003;
- Tampere Technical University, Finland: Jaco Geldenhuys 2006, Gergely Korodi 2006;
- Universidad Carlos III de Madrid, Spain: Aurora Torrente 2007;
- Helsinki University of Technology: Leena Salmela 2009.

Honours

Biotechnology Prize of 1996 (FIM 125000), awarded by the ALKO Group Ltd (Helsinki).

Knight, First Class, of the Order of the White Rose of Finland, Dec 6, 2000.
Finnish Academy of Science and Letters, member 2000–.
Science Prize of the City of Helsinki 2007.
Medix-prize (with Jussi Taipale's group) 2007.

Other

Honorary Supervisor ('Inspector') of the student fraternity 'Kymenlaakson Osakunta' of the University of Helsinki, 1995 – 2009.

Publications

About 190 publications including about 150 original papers in international journals and conference proceedings with refereeing procedure, and several articles in Finnish media popularizing computer science.

PUBLICATIONS : ESKO UKKONEN

Papers in refereed journals and proceedings:

1. E. Soisalon–Soininen & E. Ukkonen: A characterization of LL(k) languages. *Proc. ICALP 76*, Edinburgh University Press, Edinburgh 1976, pp. 20–30.
2. E. Ukkonen: Transformations to produce certain covering grammars. *Proc. MFCS 78*, *Lecture Notes in Computer Science* 64, 516–525, Springer 1978.
3. E. Ukkonen: An analysis of the effect of rounding errors on the flow of control in numerical processes. *BIT* 19 (1979), 116–133.
4. E. Ukkonen: The non–existence of some covering context-free grammars. *Information Processing Letters* 8 (1979), 187–192.
5. E. Soisalon–Soininen & E. Ukkonen: A method for transforming grammars into LL(k) form. *Acta Informatica* 12 (1979), 339–369.
6. E. Ukkonen: Remarks on the nonexistence of some covering grammars. *Proc. 4th GI Conf. on Theoretical Computer Science*, *Lecture Notes in Computer Science* 67, 298–309, Springer 1979.
7. E. Ukkonen: A modification of the LR(k) method for constructing compact bottom–up parsers. *Proc. ICALP 79*, *Lecture Notes in Computer Science* 71, 646–658, Springer 1979.
8. E. Ukkonen: A decision method for the equivalence of some non–real–time deterministic pushdown automata. *Proc. 12th Ann. ACM Symposium on Theory of Computing*, 29–38, ACM 1980.
9. K.–J. Räihä & E. Ukkonen: On the optimal assignment of attributes to passes in multi–pass attribute evaluators. *Proc. ICALP 80*, *Lecture Notes in Computer Science* 85, 500–511, Springer 1980.
10. K.–J. Räihä & E. Ukkonen: Balancing syntactic and semantic power in compiler specification. *Proc. IFIP Congress 80*, 65–70, North–Holland 1980.
11. E. Ukkonen: On the calculation of the effects of roundoff errors. *ACM Transactions on Mathematical Software* 7 (1981), 259–271.
12. K.–J. Räihä & E. Ukkonen: The shortest common supersequence problem over binary alphabet is NP–complete. *Theoretical Computer Science* 16 (1981), 187–198.
13. K.–J. Räihä & E. Ukkonen: Minimizing the number of evaluation passes for attribute grammars. *SIAM J. on Computing* 10 (1981), 772–786.
14. E. Ukkonen & E. Soisalon–Soininen: LALR(k) testing is PSPACE–complete. *Proc. 13th Ann. ACM Symposium on Theory of Computing*, 202–206, ACM 1981.
15. E. Ukkonen: On size bounds for deterministic parsers. *Proc. ICALP 81*, *Lecture Notes in Computer Science* 115, 218–228, Springer 1981.
16. E. Ukkonen: Structure preserving elimination of null productions from context–free grammars. *Theoretical Computer Science* 17 (1982), 43–54.
17. E. Ukkonen: The equivalence problem for some non–real–time deterministic pushdown automata. *Journal of the ACM* 29 (1982), 1166–1181.
18. S. Sippu, E. Soisalon–Soininen & E. Ukkonen: The complexity of LALR(k) testing. *Journal of the ACM* 30 (1983), 259–270.
19. E. Ukkonen: Two results on polynomial time truth–table reductions to sparse sets. *SIAM J. on Computing* 12 (1983), 580–587.

20. E. Ukkonen: Lower bounds on the size of deterministic parsers. *Journal of Computer and System Sciences* 26 (1983), 153–170.

21. E. Ukkonen: Exponential lower bounds for some NP–complete problems in restricted linear decision tree model. *BIT* 23 (1983), 181–192.

22. E. Ukkonen: On approximate string matching. *Proc. Foundations of Computation Theory 83*, *Lecture Notes in Computer Science* 158, 487–495, Springer 1983.

23. H. Peltola, H. Söderlund, J. Tarhio & E. Ukkonen: Algorithms for some string matching problems arising in molecular genetics. *Proc. IFIP Congress 83*, 59–64, Elsevier 1983.

24. H. Mannila & E. Ukkonen: A simple linear–time algorithm for in situ merging. *Information Processing Letters* 18 (1984), 203–208.

25. H. Peltola, H. Söderlund & E. Ukkonen: SEQAID: A DNA sequence assembling program based on a mathematical model. *Nucleic Acids Research* 12 (1984), 307–321.

26. P. Vataja & E. Ukkonen: Finding temporary terms in Prolog programs. *Proc. Int. Conf. on Fifth Generation Computer Systems 1984*, 275–282, ICOT (Tokyo) 1984.

27. E. Ukkonen: Finding approximate patterns in strings. *J. Algorithms* 6 (1985), 132–137.

28. E. Ukkonen: Upper bounds on the size of deterministic parsers. *Information Processing Letters* 20 (1985), 99–103.

29. E. Ukkonen: Algorithms for approximate string matching. *Information and Control* 64 (1985), 100–118.

30. H. Peltola, H. Söderlund & E. Ukkonen: Algorithms for the search of amino acid patterns in nucleic acid sequences. *Nucleic Acids Research* 14 (1986), 99–107.

31. H. Mannila & E. Ukkonen: On the complexity of unification sequences. *Proc. Third Int. Conf. on Logic Programming*, *Lecture Notes in Computer Science* 225, 122–133, Springer 1986.

32. H. Mannila & E. Ukkonen: The set union problem with backtracking. *Proc. ICALP 86*, *Lecture Notes in Computer Science* 226, 236–243, Springer 1986.

33. J. Tarhio & E. Ukkonen: A greedy algorithm for constructing shortest common superstrings. *Proc. MFCS 86*, *Lecture Notes in Computer Science* 233, 602–610, Springer 1986.

34. H. Mannila & E. Ukkonen: Timestamped term representation for implementing Prolog. *Proc. IEEE Symp. on Logic Programming 1986*, 159–167.

35. H. Mannila & E. Ukkonen: Flow analysis of Prolog programs. *Proc. IEEE Symp. on Logic Programming 1987*, 205–214.

36. J. Tarhio & E. Ukkonen: A greedy approximation algorithm for constructing shortest common superstrings. *Theoretical Computer Science* 57 (1988), 131–145.

37. H. Mannila & E. Ukkonen: Time parameter and arbitrary deunions in the set union problem. *Proc. SWAT 88*, *Lecture Notes in Computer Science* 318, 34–42, Springer 1988.

38. P. Kilpeläinen, H. Mannila, J. Riivari & E. Ukkonen: Prolog in Ada: an Implementation and an Embedding. *Proc. AIDA 89*, 96–107, George Mason University 1989.

39. E. Ukkonen: A linear time algorithm for finding approximate shortest common superstrings. *Algorithmica* 5 (1990), 313–323.

40. H. Mannila & E. Ukkonen: Unifications, deunifications, and their complexity. *BIT* 30 (1990), 599–619.

41. J. Tarhio & E. Ukkonen: Boyer–Moore approach to approximate string matching. *Proc. SWAT 90*, *Lecture Notes in Computer Science* 447, 348–359, Springer 1990.

42. P. Jokinen & E. Ukkonen: Two algorithms for approximate string matching in static texts. *Proc. MFCS 91. Lecture Notes in Computer Science* 520, 240–248, Springer 1991.

43. E. Ukkonen: Approximate string–matching with q–grams and maximal matches. *Theoretical Computer Science* 92 (1992), 191–211.

44. J. Kivinen, H. Mannila & E. Ukkonen: Learning hierarchical rule sets. *Proc. Fifth Annual ACM Workshop on Computational Learning Theory*, 37–44, ACM Press 1992.

45. E. Ukkonen: Constructing suffix trees on–line in linear time. *Information Processing 92, Vol. 1*, *IFIP Transactions A–12*, 484–492, Elsevier 1992.

46. J. Tarhio & E. Ukkonen: Approximate Boyer–Moore string matching. *SIAM J. Computing* 22 (1993), 243–260.

47. E. Ukkonen & D. Wood: Fast approximate string matching with suffix automata. *Algorithmica* 10 (1993), 353–364.

48. E. Ukkonen: Approximate string matching and the *q*–gram distance. In: R. Capocelli, A. De Santis & U. Vaccaro (eds.), *SEQUENCES* II – *Methods in Communication, Security, and Computer Science*, 300–312, Springer 1993.

49. E. Ukkonen: Approximate string–matching over suffix trees. In: A. Apostolico, M. Crochemore, Z. Galil & U. Manber (eds.), *CPM 93. Lecture Notes in Computer Science* 684, pp. 228–242, Springer 1993.

50. J. Kivinen, H. Mannila & E. Ukkonen: Learning rules with local exceptions. In: J. Shawe–Taylor & M. Anthony (eds.), *Computational Learning Theory: EuroCOLT'93*, pp. 35–46, Clarendon Press, Oxford 1994.

51. M. Nykänen & E. Ukkonen: Finding lowest common ancestors in arbitrarily directed trees. *Information Processing Letters* 50 (1994), 307–310.

52. J. Kärkkäinen & E. Ukkonen: Two and higher dimensional pattern matching in optimal expected time. *Fifth Annual ACM–SIAM Symposium on Discrete Algorithms (SODA 94)*, 1994, pp. 715–723.

53. T. Elomaa & E. Ukkonen: A geometric approach to feature selection. In: F. Bergadano & L. De Raedt (eds.), *Machine Learning: ECML–94*, *Lecture Notes in Artificial Intelligence* 784, pp. 351–354, Springer 1994.

54. J. Kivinen, H. Mannila, E. Ukkonen & J. Vilo: An algorithm for learning hierarchical classifiers. In: F. Bergadano & L. De Raedt (eds.), *Machine Learning: ECML–94*, *Lecture Notes in Artificial Intelligence* 784, pp. 375–378, Springer 1994.

55. G. Grahne, M. Nykänen & E. Ukkonen: Reasoning about strings in databases. *Proceedings of the Thirteenth ACM Symp. on Principles of Database Systems (PODS'94)*, 303–312, ACM 1994.

56. E. Ukkonen: On–line construction of suffix–trees. *Algorithmica* 14 (1995), 249–260.

57. P. Kilpeläinen, H. Mannila & E. Ukkonen: MDL learning of unions of simple pattern languages from positive examples. In: Paul Vitanyi (ed.), *Proc. EuroCOLT'95*, *Lecture Notes in Artificial Intelligence* 904, pp. 252–260, Springer 1995.

58. J. Kärkkäinen & E. Ukkonen: Sparse suffix trees. In: Jin-Yi Cai and Chak Kuen Wong (eds.), *Proc. COCOON'96*, *Lecture Notes in Computer Science* 1090, pp. 219–230, Springer 1996.

59. A. Brazma, I. Jonassen, E. Ukkonen & J. Vilo: Discovering patterns and subfamilies in biosequences. In: David J. States et al. (eds.), *Proc. Fourth International Conference on Intelligent Systems for Molecular Biology (ISMB'96)*, pp. 34–43, AAAI Press (Menlo Park) 1996.

60. P. Jokinen, J. Tarhio & E. Ukkonen: A comparison of approximate string matching algorithms. *Software – Practice and Experience* 26 (1996), 1439–1458.
61. J. Kärkkäinen & E. Ukkonen: Lempel–Ziv parsing and sublinear–size index structures for string matching. In: N. Ziviani, R. Baeza–Yates and K. Guimaraes (eds.), *Proc. Third South American Workshop on String Processing (WSP'96)*, *International Informatics Series 4*, pp. 141–155, Carleton University Press 1996.
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