Curriculum Vitae: Esko Ukkonen

Esko Ukkonen
Professor of Computer Science and Vice-Dean (research) of the Faculty of Science
Department of Computer Science
P.O.Box 68 (Gustav Hällströmin katu 2b)
FIN–00014 University of Helsinki, Finland
Tel.: +358 294151280, fax.: +358 294151120, email: Esko.Ukkonen@cs.helsinki.fi
Home page: www.cs.helsinki.fi/u/ukkonen/

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.

Present employment and positions

Professor of Computer Science, University of Helsinki, 1985–.
Vice-Dean of Research of the Faculty of Science, Univ of Helsinki, 2014—.
Docent of Theory of Computing, Helsinki University of Technology / Aalto University, 1989–.

Earlier positions

Director of National Center–of–Excellence in Algorithmic Data Analysis of the Academy of Finland, 2002–13.
Head of the Department of Computer Science, Univ of Helsinki, 2010–13.
Research Director of the Basic Research Unit of the Helsinki Institute for Information Technology (HIIT/BRU), 2004 – 2008.
Academy Professor, Academy of Finland, 1999–2004 (5 year term).
Head 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.

Administrative and organizational service

- Chair of the computer science panel of the national Publication Forum Project (ranking of scientific publication channels), 2010 – present.
- Member of the national Research Council for Natural Sciences and Engineering of the Academy of Finland, 2012 – present.
- 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, 1983–84 and 1998-99 and from 2010.
- 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 2009–14; Board of the Helsinki Area Master's Programme in Biotechnology 2003–; University Collegium 2007–13; Board of the IT Center 2014–; Scientific Council 2014–;).
- 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.

SCIENTIFIC ACTIVITIES

Publications

About 210 publications including more than 160 original papers in international journals and conference proceedings with refereeing procedure, and several articles in Finnish media popularizing computer science.

Research projects (external funding)

- *Systems Biology of Colorectal Cancer* (SYSCOL) (EU STREP), 2010-2015.
- *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

IEEE International Conference on Bioinformatics and Biomedicine (BIBM 2014, Belfast); Combinatorial Pattern Matching (CPM 2014, Moscow); 20th Symposium on String Processing and Information Retrieval (SPIRE 2013, Jerusalem); IEEE International Conference on Bioinformatics and Biomedicine (BIBM 2013, Shanghai); 19th Symposium on String Processing and Information Retrieval (SPIRE 2012, Cartagena de Indias, Colombia); 19th International Conference on Intelligent Systems for Molecular Biology (ISMB/ECCB 2011, Wien); 6th International Conference on Language and Automata Theory and Applications (LATA 2012, A Coruña, Spain); 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, Languages, 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 Information Theory*, *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/panel member of university RAEs and academic educational programs

Swedish National Agency for Higher Education; Akkreditierungsagentur ASIIN / TU München; Royal Institute of Technology, Stockholm; INRIA (panel chairman, Paris 2013).

External expert to review applicants of 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 (three 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).

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).
- University of Pisa (A special lecture series of 20 hours for PhD students; October 2009).
- Structure Discovery in Biology: Motifs, Networks and Phylogenies (Dagstuhl, June 2010).
- Cold Spring Harbor Asia Conference on Computational Biology (Suzhou, China, Sept 2010).
- BioRegSig2011 (Vienna, July 2011).
- Fifth International Moscow Conference on Computational Molecular Biology and Bioinformatics (MCCMB'11, Moscow, July 2011).
- Algorithmique, combinatoire du texte et applications en bio-informatique (SeqBio2011, Lille, December 2011).
- 37th International Symposium Mathematical Foundations of Computer Science (MFCS 2012, Bratislava, Slovakia).

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.
- Margus Lukk: *Construction of a global map of human gene expression – the process, tools and analysis*, 2010.
- Esa Pitkänen: *Computational methods for reconstruction and analysis of genome–scale metabolic networks*, 2010 (with J. Rousu).

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, Kirsti Laurila 2011;
- Universidad Carlos III de Madrid, Spain: Aurora Torrente 2007;
- Aalto University / Helsinki University of Technology: Leena Salmela 2009, Kalle Karhu 2013.

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.
Silver Medal of the University of Helsinki 2010.
First Honorary Member of Bioinformatiikan seura ry.

Other

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

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.

62. E. Ohlebusch & E. Ukkonen: On the equivalence problem for E–pattern languages (Extended Abstract). In: W. Penczek and A. Szalas (eds.), *Proc. MFCS 96. Lecture Notes in Computer Science* 1113, pp. 457–468, Springer 1996.

63. M. Huttunen, E. Ukkonen & B. Vehviläinen: Neural networks as a part of watershed–model in ice–reduction of discharge observations. *Proc. Nordic Hydrological Conference 1996*, Vol. 1, pp. 286–293. NHP-report no 40, Icelandic Hydrological Committee, Reykjavik 1996.

64. A. Brazma, E. Ukkonen & J. Vilo: Discovering unbounded unions of regular pattern languages from positive examples. In: T. Asano, Y. Igarashi, H. Nagamochi, S. Miyano & S. Suri (eds.), *Proc. Seventh International Symposium on Algorithms and Computation (ISAAC'96), Lecture Notes in Computer Science* 1178, pp. 95–104, Springer 1996.

65. M. Huttunen, B. Vehviläinen & E. Ukkonen: Coding a conceptual model into a neural network in modeling ice–correction. In: C. H. Dagli, M. Akay, C. L. P. Chen, B. R. Fernandez & J. Ghosh (eds.), *Proc. of the Artificial Neural Networks in Engineering (ANNIE'96) Conference. Intelligent Engineering Systems Through Artificial Neural Networks, Vol.* 6, pp. 1001 – 1006, ASME Press, New York 1996.

66. A. Brazma, E. Ukkonen, J. Vilo & K. Valtonen: Data mining for regulatory elements in yeast genome. In: Terry Gaasterland et al. (eds.), *Proc. Fifth International Conference on Intelligent Systems for Molecular Biology (ISMB'97)*, pp. 65–74, AAAI Press (Menlo Park) 1997.

67. A. Brazma, J. Vilo & E. Ukkonen: Finding transcription factor binding site combinations in the yeast genome (extended abstract). In: *Computer Science and Biology: Proc. German Conference on Bioinformatics (GCB'97)*, pp. 57–59. MIPS Munich Information Center for Protein Sequences 1997.

68. E. Ohlebusch & E. Ukkonen: On the equivalence problem for E–pattern languages. *Theoretical Computer Science* 186 (1997), 231–248.

69. M. Huttunen, B. Vehviläinen & E. Ukkonen: Neural networks in the ice–correction of discharge observations. *Nordic Hydrology* 28 (1997), 283–296.

70. M. Huttunen, E. Ukkonen & B. Vehviläinen: Using trainable computing networks in the optimization of lake regulation. *Proc. Fourth International Conference on Neural Information Processing and Intelligent Information Systems (ICONIP'97)*, pp. 975–978, Springer 1997.

71. A. Brazma, I. Jonassen, J. Vilo & E. Ukkonen: Pattern discovery in biosciences. In: *Grammatical Inference: 4th International Colloquium (ICGI'98), Lecture Notes in Atrificial Intelligence* 1433, pp. 257–270, Springer 1998.

72. K. Fredriksson & E. Ukkonen: A rotation invariant filter for two–dimensional string matching. In: M. Farach–Colton (ed.) *Proc. Combinatorial Pattern Matching (CPM'98), Lecture Notes in Computer Science* 1448, pp. 118–125, Springer 1998.

73. K. Lemström, A. Haapaniemi & E. Ukkonen: Retrieving music – to index or not to index. *Multimedia 98, the 6th ACM International Multimedia Conference*, pp. 64–65, Exeter: Intellect 1998.

74. K. Korpimies & E. Ukkonen: Term weighting in query–based document clustering (extended abstract). *Proc. Advances in Databases and Information Systems (ADBIS'98), Lecture Notes in Computer Science* 1475, pp. 151–153, Springer 1998.

75. K. Korpimies & E. Ukkonen: Searching for general documents. *Proc. International Conf. on Flexible Query Answering Systems (FQAS'98). Lecture Notes in Computer Science* 1495, pp. 203–214, Springer 1998.

76. G. Grahne, R. Hakli, M. Nykänen & E. Ukkonen: AQL: An alignment based language for querying string databases. *Proc. Ninth Int. Conf. on Management of Data (COMAD'98)*, pp. 235–251, McGraw–Hill 1998.

77. H. Haario, P. Vuorela, M. Nyman, E. Ukkonen, H. J. Vuorela & K. Outinen: Optimization of selectivity in high–performance liquid chromatography using desiderability functions and mixture designs according to PRISMA. *European Journal of Pharmaceutical Sciences* 6 (1998), 197–205.

78. A. Brazma, I. Jonassen, J. Vilo & E. Ukkonen: Predicting gene regulatory elements in silico on a genomic scale. *Genome Research* 8 (1998), 1202–1215.

79. R. Hakli, M. Nykänen, H. Tamm & E. Ukkonen: Implementing a declarative string query language with string restructuring. *Proc. Practical Aspects of Declarative Languages (PADL'99), Lecture Notes in Computer Science* 1551, pp. 179–195, Springer 1999.

80. M. Nykänen & E. Ukkonen: Finding paths with the right cost. In: *Proc. 16th Ann. Symposium on Theoretical Aspects of Computer Science (STACS'99), Lecture Notes in Computer Science* 1563, pp. 345–355, Springer 1999.

81. G. Grahne, M. Nykänen & E. Ukkonen: Reasoning about strings in databases. *Journal of Computer and System Sciences* 59 (1999), 116–162.

82. K. Fredriksson & E. Ukkonen: Combinatorial methods for approximate image matching under translations and rotations. *Pattern Recognition Letters* 20 (1999), 1249–1258.

83. J. Kärkkäinen & E. Ukkonen: Two- and higher–dimensional pattern matching in optimal expected time. *SIAM J. on Computing* 29 (1999), 571–589.

84. K. Lemström & E. Ukkonen: Including interval encoding into edit distance based music comparison and retrieval. In: *Proc. of the AISB'2000 Symposium on Creative & Cultural Aspects and Applications of AI & Cognitive Science*, pp. 53–60, University of Birmingham, 2000.

85. M. Huttunen, E. Ukkonen & B. Vehviläinen: Using trainable computing networks in the control of a physical system. *Preprints of the Second AMS Conference on Artificial Intelligence*, pp. 60–64, American Meteorological Society 2000.

86. J. Kärkkäinen, G. Navarro & E. Ukkonen: Approximate string matching over Ziv–Lempel compressed text. In: R. Giancarlo & D. Sankoff (ed.) *Proc. Combinatorial Pattern Matching (CPM'00), Lecture Notes in Computer Science* 1848, pp. 195–209, Springer 2000.

87. K. Fredriksson, G. Navarro & E. Ukkonen: An index for two dimensional string matching allowing rotations. In: J. van Leeuwen et al. (eds.) *Theoretical Computer Science (IFIP TCS 2000), Lecture Notes in Computer Science* 1872, pp. 59–75, Springer 2000.

88. J. Vilo, A. Brazma, I. Jonassen, A. Robinson & E. Ukkonen: Mining for putative regulatory elements in the yeast genome using gene expression data. In: *Proc. Eighth International Conference on Intelligent Systems for Molecular Biology (ISMB-2000)*, pp. 384–394, AAAI Press 2000.

89. T. Kivioja, J. Ravantti, A. Verkhovsky, E. Ukkonen & D. Bamford: Local average intensity–based method for identifying spherical particles in electron micrographs. *J. Structural Biology* 131 (2000), 126–134.

90. K. Fredriksson & E. Ukkonen: Combinatorial methods for approximate pattern matching under rotations and translations in 3D arrays. In: *Proc. 7th International Symposium on String Processing and Information Retrieval (SPIRE 2000)*, pp. 96–104, IEEE Computer Society 2000.

91. E. Ukkonen: Toward complete genome data mining in computational biology. In: *Proc. 7th Scandinavian Workshop on Algorithm Theory (SWAT 2000), Lecture Notes in Computer Science* 1851, pp. 20–21, Springer 2000.

92. V. Mäkinen, G. Navarro & E. Ukkonen: Approximate matching of run–length compressed strings. In: *Proc. 12th Annual Symposium on Combinatorial Pattern Matching (CPM 2001), Lecture Notes in Computer Science* 2089, pp. 31–49, Springer 2001.

93. K. Fredriksson & E. Ukkonen: Faster template matching without FFT. In: *Proc. 2001 International Conference on Image Processing (ICIP 2001)*, pp. 678–681, IEEE Signal Processing Society 2001.

94. T. Mielikäinen & E. Ukkonen: The complexity of matroid–greedoid intersection. In: *Proc. Fundamentals of Computation Theory (subsection Efficient Algorithms WEA 2001), Lecture Notes in Computer Science* 2138, pp. 535–539, Springer 2001.

95. K. Fredriksson, G. Navarro & E. Ukkonen: Faster than FFT: Rotation invariant combinatorial template matching. In: S.G. Pandalai (ed), *Recent Research Developments in Pattern Recognition*, Vol. 3 (2002), pp. 75–112, Transworld Research Network 2002.

96. M. Nykänen & E. Ukkonen: The exact path length problem. *Journal of Algorithms* 42 (2002), 41–53.

97. A. Amir, G. M. Landau & E. Ukkonen: Online time stamped text indexing. *Information Processing Letters* 82, 5 (2002), 253–259.

98. K. Fredriksson, G. Navarro & E. Ukkonen: Optimal exact and fast approximate two dimensional pattern matching allowing rotations. In: *Proc. 13th Annual Symposium on Combinatorial Pattern Matching (CPM 2002), Lecture Notes in Computer Science* 2373, pp. 235–248, Springer 2002.

99. V. Mäkinen & E. Ukkonen: Local similarity based point–pattern matching. In: *Proc. 13th Annual Symposium on Combinatorial Pattern Matching (CPM 2002), Lecture Notes in Computer Science* 2373, pp. 115–132, Springer 2002.

100. T. Kivioja, M. Arvas, K. Kataja, M. Penttilä, H. Söderlund & E. Ukkonen: Assigning probes into a small number of pools separable by electrophoresis. In: *Proc. Tenth International Conference on Intelligent Systems for Molecular Biology (ISMB-2002)*, *Bioinformatics* 18, Suppl 1 (2002), S199–S206.

101. K. Palin, E. Ukkonen, A. Brazma & Jaak Vilo: Correlating gene promoters and expression in gene disruption experiments. In: *Proc. European Conference on Computational Biology (ECCB-2002)*, *Bioinformatics* 18, Suppl 2 (2002), S172–S180.

102. E. Ukkonen: Finding founder sequences from a set of recombinants. In: *Algorithms in Bioinformatics (WABI-2002), Lecture Notes in Computer Science* 2452, pp. 277-286, Springer 2002.

103. G. Grahne, R. Hakli, M. Nykänen, H. Tamm & E. Ukkonen: Design and implementation of a string database query language. *Information Systems* 28 (2003), 347–369.

104. M. Koivisto, M. Perola, T. Varilo, W. Hennah, J. Ekelund, M. Lukk, L. Peltonen, E. Ukkonen & H. Mannila: An MDL method for finding haplotype blocks and for estimating the strength of haplotype block boundaries. In: *Pacific Symposium on Biocomputing 2003*, pp. 502–513, World Scientific 2003.

105. V. Mäkinen, G. Navarro & E. Ukkonen: Approximate matching of run–length compressed strings. *Algorithmica* 35 (2003), 347–369.

106. J. Rousu, A. Rantanen, H. Maaheimo, E. Pitkänen, K. Saarela & E. Ukkonen: A method for estimating metabolic fluxes from incomplete isotopomer information. In: *Computational Methods in Systems Biology (CMBS 2003), Lecture Notes in Computer Science* 2602, pp. 88–103, Springer 2003.

107. V. Mäkinen, G. Navarro & E. Ukkonen: Algorithms for transposition invariant string matching. In: *20th Ann. Symp. on Theoretical Aspects of Computer Science (STACS 2003), Lecture Notes in Computer Science* 2607, pp. 191–202, Springer 2003.

108. H. Tamm & E. Ukkonen: Bideterministic automata and minimal representations of regular languages. In: *Eighth Int. Conf. on Implementation and Application of Automata (CIAA 2003), Lecture Notes in Computer Science* 2759, pp. 61–71, Springer 2003.

109. J. Kärkkäinen, G. Navarro & E. Ukkonen. Approximate String Matching on Ziv-Lempel Compressed Text. *Journal of Discrete Algorithms (JDA)* 1(3/4), (2003), 313–338.

110. Th. Schlitt, K. Palin, J. Rung, S. Diekmann, M. Lappe, E. Ukkonen & A. Brazma: From gene networks to gene function. *Genome Research* 13 (2003), 2568–2576.

111. E. Ukkonen, K. Lemström & V. Mäkinen: Geometric algorithms for transposition invariant content–based music retrieval. In: *Proc. Fourth Int. Conf. on Music Information Retrieval (ISMIR–2003)*, Johns Hopkins University, 2003, pp. 193–199.

112. T. Mielikäinen, J. Ravantti & E. Ukkonen: The computational complexity of orientation search in cryo–electron Microscopy. In: *Fourth Int. Conf. on Computational Science, Lecture Notes in Computer Science* 3036, pp. 231–238, Springer 2004.

113. H. Tamm, M. Nykänen & E. Ukkonen: Size reduction of multitape automata. Short paper in: *Ninth Int. Conf. on Implementation and Application of Automata (CIAA 2004), Lecture Notes in Computer Science* 3317, pp. 329–330, Springer 2004.

114. S. Burkhardt, K. Fredriksson, T. Ojamies, J. Ravantti & E. Ukkonen: Local approximate 3D matching of proteins in viral cryo–EM density maps. In: *Proc. Second Int. Symp. on 3D Data Processing, Visualization, and Transmission (3DPVT 2004)*, pp. 979–886, IEEE Computer Society 2004.

115. H. Tamm & E. Ukkonen: Bideterministic automata and minimal representations of regular languages. *Theoretical Computer Science* 328 (2004), 135–149.

116. T. Kivioja, M. Arvas, M. Saloheimo, M. Penttilä & E. Ukkonen: Optimization of cDNA-AFLP experiments using genomic sequence data. *Bioinformatics* 21 (2005), 2573–2579.

117. G. Navarro, V. Mäkinen & E. Ukkonen: Transposition invariant string matching. *J. Algorithms* 56 (2005), 124–153.

118. K. Fredriksson, G. Navarro & E. Ukkonen: Sequential and indexed two–dimensional combinatorial template matching allowing rotations. *Theoretical Computer Science* 347 (2005), 239–275.

119. A. Rantanen, T. Mielikäinen, J. Rousu & E. Ukkonen: Planning isotopomer measurements for estimation of metabolic fluxes. In: *Proc. German Conference on Bioinformatics (GCB 2005), Lecture Notes in Informatics* 71, pp. 177-191, GI 2005.

120. E. Pitkänen, A. Rantanen, J. Rousu & E. Ukkonen: Finding Feasible Pathways in Metabolic Networks. In: *Proc. Panhellenic Conference on Informatics 2005, Lecture Notes in Computer Science* 3746, pp. 123-133, Springer 2005.

121. I. Autio, J.C. Borras, I. Immonen, P. Jalli & E. Ukkonen: A voting margin approach for the detection of retinal microaneurysms. In: *Proc. IASTED Int. Conf. on Visualization, Imaging, and Image Processing (VIIP 2005)*, pp. 511-517, ACTA Press 2005.

122. P. Rastas, M. Koivisto, H. Mannila & Esko Ukkonen: A Hidden Markov Technique for Haplotype Reconstruction. In: *Algorithms in Bioinformatics (WABI-2005), Lecture Notes in Computer Science* 3692, pp. 140-151, Springer 2005.

123. H. Tamm, M. Nykänen & E. Ukkonen: Size reduction of multitape automata. In: *Tenth Int. Conf. on Implementation and Application of Automata (CIAA 2005), Lecture Notes in Computer Science* 3845, pp. 307–318, Springer 2006.

124. T. Mielikäinen & E. Ukkonen: The complexity of matroid–greedoid intersection and weighted greedoid maximization. *Discrete Applied Mathematics* 154 (2006), 684–691.

125. O. Hallikas, K. Palin, N. Sinjushina, R. Rautiainen, J. Partanen, E. Ukkonen & J. Taipale: Genome-wide prediction of mammalian enhancers based on analysis of transcription-factor binding affinity. *Cell* 124 (January 13, 2006), 47–59.

126. A. Rantanen, T. Mielikäinen, J. Rousu, H. Maaheimo & E. Ukkonen: Planning optimal measurements of isotopomer distributions for estimation of metabolic fluxes. *Bioinformatics* 22 (2006), 1198–1206.

127. H. Tamm, M. Nykänen & E. Ukkonen: On size reduction techniques for multitape automata. *Theoretical Computer Science* 363 (2006), 234–246.

128. A. Rantanen, H. Maaheimo, E. Pitkänen, J. Rousu & E. Ukkonen: Equivalence of metabolite fragments and flow analysis of isotopomer distributions for flux estimation. *Transactions on Computational Systems Biology VI, Lecture Notes in Bioinformatics* 4220 (2006), 198–220.

129. P. Parikka, E. Pitkänen, A. Rantanen, A. Åkerlund & E. Ukkonen: Pathway Assistant: a web portal for metabolic modelling. In: *Network Tools and Applications in Biology (NETTAB 2006)*, pp. 90–96, http://www.nettab.org 2006.

130. K. Palin, J. Taipale & E. Ukkonen: Locating potential enhancer elements by comparative genomics using the EEL software. *Nature Protocols* 1 (2006), 368–374.

131. E. Kääriäinen, P. Nummela, J. Soikkeli, M. Yin, M. Lukk, T. Jahkola, S. Virolainen, A. Ora, E. Ukkonen, O. Saksela, & E. Hölttä: Switch to an invasive growth phase in melanoma is associated with tenascin-C, fibronectin, and procollagen-I forming specific channel structures for invasion. *Journal of Pathology* 210 (2006), 181–191.

132. C. Pizzi, P. Rastas & E. Ukkonen: Fast search algorithms for position specific scoring matrices. In: *Bioinformatics Research and Development (BIRD 2007), Lecture Notes in Computer Science* 4414, pp. 239–250, Springer 2007.

133. P. Rastas & E. Ukkonen: Haplotype inference via hierarchical genotype parsing. In: *Algorithms in Bioinformatics (WABI 2007), Lecture Notes in Computer Science* 4645, pp. 85–97, Springer 2007.

134. E. Ukkonen: Structural analysis of gapped motifs of a string. In: *Proc. MFCS 2007, Lecture Notes in Computer Science* 4708, pp. 681–690, Springer 2007.

135. J. Soikkeli, M. Lukk, P. Nummela, S. Virolainen, T. Jahkola, R. Katainen, L. Harju, E. Ukkonen, O. Saksela & E. Hölttä: Systematic search for the best gene expression markers for melanoma micrometastasis detection. *J Pathol.* 213,2 (2007), 180–189.

136. A. Rantanen, J. Rousu, P. Jouhten, N. Zamboni, H. Maaheimo & E. Ukkonen: An analytic and systematic framework for estimating metabolic flux ratios from 13C tracer experiments. *BMC Bioinformatics* 9:266 (2008).

137. E. Pitkänen, A. Akerlund, A. Rantanen, P. Jouhten & E. Ukkonen: ReMatch: a web-based tool to construct, store and share stoichiometric metabolic models with carbon maps for metabolic flux analysis. *Journal of Integrative Bioinformatics* 5, 2 (2008), 102.

138. E. Pitkänen, A. Rantanen, J. Rousu & E. Ukkonen: A Computational Method for Reconstructing Gapless Metabolic Networks. In: *Bioinformatics Research and Development (BIRD 2008), Communications in Computer and Information Science* 13, pp. 288-302, Springer 2008.

139. R. Giegerich, A. Brazma, I. Jonassen, E. Ukkonen & M. Vingron: The BREW workshop series: a stimulating experience in PhD education. *Briefings in Bioinformatics* 9, 3 (2008), 250-253.

140. C. Pizzi & E. Ukkonen: Fast profile matching algorithms – a survey. *Theoretical Computer Science* 395 (2008), 137–157.

141. M. Vingron, A. Brazma, R. Coulson, J. van Helden, T. Manke, K. Palin, O. Sand & E. Ukkonen: Integrating sequence, evolution and functional genomics in regulatory genomics. *Genome Biology* 2009, 10:202 (8 pages).

142. E. Ukkonen: Maximal and minimal representations of gapped and non–gapped motifs of a string. *Theoretical Computer Science* 410 (2009), 4341–4349.

143. F. Nicolas, V. Mäkinen & E. Ukkonen: Efficient construction of maximal and minimal representations of motifs of a string. *Theoretical Computer Science*, 410 (2009), 2999–3005.

144. S. Tuupanen, M. Turunen, R. Lehtonen, O. Hallikas, S. Vanharanta, T. Kivioja, M. Björklund, Gonghong Wei, Jian Yan, I. Niittymäki, J.-P. Mecklin, H. Järvinen, A. Ristimäki, M. Di-Bernardo, P. East, L. Carvajal-Carmona, R. S. Houlston, I. Tomlinson, K. Palin, E. Ukkonen, A. Karhu, J. Taipale & L. A. Aaltonen: The common colorectal cancer predisposition SNP rs6983267 at chromosome 8q24 confers potential to enhanced Wnt signaling. *Nature Genetics* 41, 3 (Aug 2009), 885–890.

145. J. Korhonen, P. Martinmaki, C. Pizzi, P. Rastas & E. Ukkonen: MOODS: fast search for position weight matrix matches in DNA sequences. *Bioinformatics* 25, 23 (2009), 3181–3182.

146. M. Michael, F. Nicolas & E. Ukkonen: On the complexity of finding gapped motifs. *Journal of Discrete Algorithms* 8 (2010), 131–142.

147. T. Vesala, S. Launiainen, P. Kolari, J. Pumpanen, S. Sevanto, P. Hari, E. Nikinmaa, P. Kaski, H. Mannila, E. Ukkonen, S. Piao & P. Ciais: Autumn temperature and carbon balance of a boreal Scots pine forest in Southern Finland. *Biogeosciences* 7 (2010), 163–176.

148. A. Jolma, T. Kivioja, J. Toivonen, L. Cheng, G. Wei, M. Enge, M. Taipale, J.M. Vaquerizas, J. Yan, M.J. Sillanpää, M. Bonke, K. Palin, S. Talukder, T.R. Hughes, N.M. Luscombe, E. Ukkonen & J. Taipale: Multiplexed massively parallel SELEX for characterization of human transcription factor binding specificities. *Genome Research* 20, 6 (June 2010), 861–873.

149. E. Pitkänen, J. Rousu & E. Ukkonen: Computational methods for metabolic reconstruction. *Current Opinion in Biotechnology* 21, 1 (2010), 70–77.

150. E. Ukkonen: Geometric Point Pattern Matching in the Knuth-Morris-Pratt Way. *Journal of Universal Computer Science* 16, 14 (2010), 1902–1911.

151. M. Lukk, M. Kapushesky, J. Nikkilä, H. Parkinson, A. Goncalves, W. Huber, E. Ukkonen & Alvis Brazma: A global map of human gene expression. *Nature Biotechnology* 28, 4 (April 2010), 322–324.

152. Gong-Hong Wei, Gwenael Badis, Michael F Berger, Teemu Kivioja, Kimmo Palin, Martin Enge, Martin Bonke, Arttu Jolma, Markku Varjosalo, Andrew R Gehrke, Jian Yan, Shaheynoor Talukder, Mikko Turunen, Mikko Taipale, Hendrik G Stunnenberg, Esko Ukkonen, Timothy R Hughes, Martha L Bulyk and Jussi Taipale: Genome-wide analysis of ETS-family DNA-binding *in vitro* and *in vivo*. *The EMBO Journal* 29 (2010), 2147–2160.

153. C. Pizzi, P. Rastas & E. Ukkonen: Finding significant matches of position weight matrices in linear time. *IEEE/ACM Transactions on Computational Biology and Bioinformatics* 8, 1 (2011), 69–79.

154. A. Apostolico, C. Pizzi & E. Ukkonen: Efficient Algorithms for the Discovery of Gapped Factors. *Algorithms for Molecular Biology* 6:5 (2011), 10 pages.

155. L. Salmela, V. Mäkinen, N. Välimäki, J. Ylinen & E. Ukkonen: Fast scaffolding with small independent mixed integer programs. *Bioinformatics* 27, 23 (2011), 3259–3265.

156. O. Solin, E. Ukkonen & L. Haikala: Mining the UKIDSS GPS: star formation and embedded clusters. *Astronomy & Astrophysics* 542, A3 (2012).

157. A. Jolma, Jian Yan, T. Whitington, J. Toivonen, K.R. Nitta, P. Rastas, E. Morgunova, M. Enge, M. Taipale, Gonghong Wei, K. Palin, J.M. Vaquerizas, R. Vincentelli, N.M. Luscombe, T.R. Hughes, P. Lemaire, E. Ukkonen, T. Kivioja & J. Taipale: Dna-binding specifities of human transcription factors. *Cell* 152, 1-2 (2013), 327–339.

158. E. Giaquinta, S. Grabowski & E. Ukkonen: Fast matching of transcription factor motifs using generalized position weight matrix models. *Journal of Computational Biology* 20, 9 (2013), 621-630.

159. E. Giaquinta, K. Fredriksson, S. Grabowski & E. Ukkonen: Motif matching using gapped patterns. In: *24th International Workshop on Combinatorial Algorithms (IWOCA 2013), Lecture Notes in Computer Science* 8288, pp. 448–452, Springer 2013.

160. O. Solin, E. Ukkonen & L. Haikala: Mining the VVV: star formation and embedded clusters. *Astronomy & Astrophysics* 562, A115 (2014).

161. V. Ahola, R. Lehtonen, P. Somervuo, L. Salmela, P. Koskinen, P. Rastas, N. Vlimki, L. Paulin, J. Kvist, N. Wahlberg, J. Tanskanen, E. Hornett, L. Ferguson, Shiqi Luo, Zijuan Cao, M. de Jong, A. Duplouy, O.-P. Smolander, H. Vogel, R. McCoy, Kui Qian, Swee Chong Wong, Qin Zhang, F. Ahmad, J. Haukka, A. Joshi, J. Salojrvi, C. Wheat, E. Grosse-Wilde, D. Hughes, R. Katainen, E. Pitknen, J. Ylinen, R. Waterhouse, M. Turunen, A. Vhrautio, S. Ojanen, A. Schulman, Minna Taipale, D. Lawson, E. Ukkonen, V. Mkinen, M. Goldsmith, L. Holm, P. Auvinen, M. Frilander & I. Hanski: The Glanville fritillary genome retains an ancient karyotype and reveals selective chromosomal fusions in Lepidoptera. *Nature Communications*, accepted for publication.

162. E. Giaquinta, K. Fredriksson, S. Grabowski, A.I. Tomescu & E. Ukkonen: Motif matching using gapped patterns. *Theoretical Computer Science*, accepted for publication.

Invited book chapters:

163. E. Ukkonen, L. Lemström & V. Mäkinen: Sweepline the music! Invited paper in: *Computer Science in Perspective. Essays Dedicated to Thomas Ottmann. Lecture Notes in Computer Science* 2598, pp. 330–342, Springer 2003.

164. M. Koivisto, P. Rastas & E. Ukkonen: Recombination systems. In: *Theory is Forever. Essays Dedicated to Arto Salomaa. Lecture Notes in Computer Science* 3113, pp. 159–169, Springer 2004.

165. M. Koivisto, T. Kivioja, H. Mannila, P. Rastas & E. Ukkonen: Hidden Markov modelling techniques for haplotype analysis. In: *Algorithmic Learning Theory (ALT 2004), Lecture Notes in Computer Science* 3244, pp. 37–52, Springer 2004.

166. M. Koivisto, P. Rastas, H. Mannila & E. Ukkonen: Phasing genotypes using a hidden Markov model. In: I. Mandiou & A. Zelikovsky (eds.), *Bioinformatics Algorithms: Techniques and Applications*, pp. 355–372, Wiley Book Series on Bioinformatics, Wiley 2008.

167. J. Kärkkäinen & E. Ukkonen: Multidimensional string matching. In: Ming-Yang Kao (ed.), *Encyclopedia of Algorithms*, pp. 559–561, Springer 2008.

168. V. Mäkinen & E. Ukkonen: Point pattern matching. In: Ming-Yang Kao (ed.), *Encyclopedia of Algorithms*, pp. 657–659, Springer 2008.

169. R. Coulson, T. Manke, K. Palin, H. Roider, O. Sand, J. van Helden, E. Ukkonen, M. Vingron & A. Brazma: From gene expression profiling to gene regulation. In: D. Frishman & A. Valencia (eds.), *Modern Genome Annotation*, pp. 105–119 (Chapter 2.3), Springer 2009.

Edited publications:

170. *Proceedings of the Winter School on Theoretical Computer Science* (January 3–6, 1984, Lammi, Finland), R.J.R. Back, H. Mannila, K.–J. Räihä & E. Ukkonen (eds.), 327 pages, Finnish Society of Information Processing Science 1984.

171. *STEP–88 (Proceedings of the Finnish Artificial Intelligence Symposium)* (August 15–18, 1988, Helsinki), M. Mäkelä, S. Linnainmaa & E. Ukkonen (eds.), 812 pages, Finnish Artificial Intellicence Society 1988.

172. *Algorithm Theory – SWAT'92, Proceedings of the Third Scandinavian Workshop on Algorithm Theory* (Helsinki, Finland, July 1992), O. Nurmi & E. Ukkonen (eds.), *Lecture Notes in Computer Science, Vol. 621*, 434 pages, Springer 1992.

173. *Combinatorial Pattern Matching – CPM 95, Proceedings of the Sixth Annual Symposium* (Espoo, Finland, July 1995), Zvi Galil & Esko Ukkonen (eds.), *Lecture Notes in Computer Science, Vol. 937*, 409 pages, Springer 1995.

174. *Nordic Journal of Computing*, Volumes 1 – 10, altogether about 4500 pages in 40 issues (some of them edited by guest editors, however), 1994 – 2003.

175. *Combinatorial Pattern Matching – CPM 2009, Proceedings of the 20th Annual Symposium* (Lille, France, June 22–24, 2009), Gregory Kucherov & Esko Ukkonen (eds.), *Lecture Notes in Computer Science, Vol. 5577*, 370 pages, Springer 2009.

176. *Algorithmic Learning Theory – ALT 2011, Proceedings of the 22nd International Conference* (Espoo, Finland, October 2011), Jyrki Kivinen, Csaba Szepesvari, Esko Ukkonen & Thomas Zeugmann (eds.), *Lecture Notes in Artificial Intelligence, Vol. 6925*, 453 pages, Springer 2011.

Technical papers in domestic series:

177. E. Ukkonen: On the effect of rounding errors on the flow of control in numerical processes, (Ph.D. Thesis). Report A–1977–7, Department of Computer Science, University of Helsinki, 1977.

178. K.–J. Räihä & J. Sajaniemi & E. Ukkonen: Ohjelmointikielten määrittelyn ja toteutuksen englantilais-suomalainen sanasto – English–Finnish Vocabulary of the Definition and Implementation of Programming Languages. Report A–1977–2, Department of Computer Science, University of Helsinki, 1977.

179. S. Linnainmaa, H. Lokki, E. Ukkonen & I. Verkamo: Algol Elastic, a programming language for analyzing numerical stability, and its implementation. Report A–1978–3, Department of Computer Science, University of Helsinki, 1978.

180. E. Ukkonen: Notes on grammatical covering by context-free grammars in normal forms. Report C–1979–37, Department of Computer Science, University of Helsinki, 1979.

181. E. Ukkonen: On a technique for proving lower bounds in the linear decision tree model. Report C–1982–66, Department of Computer Science, University of Helsinki, 1982.

182. E. Ukkonen: A lower bound technique with applications to the knapsack problem. *Proc. of the Winter School on Theoretical Computer Science*, 303–314. Finnish Society of Information Processing Science, 1984.

183. J. Tarhio & E. Ukkonen: On the preprocessing algorithm for Boyer–Moore string matching. Report C–1984–86, Department of Computer Science, University of Helsinki, 1984.

184. T. Karvi, H. Mannila & E. Ukkonen: Inferring mode declarations for Prolog programs. *Second Finnish Summer School on Theoretical Computer Science*, 47–59. Report A 38, University of Turku, Department of Mathematical Sciences, 1985.

185. P. Kilpeläinen, H. Mannila, J. Riivari & E. Ukkonen: Design principles of Helsinki Prolog programming environment. *STeP–86 (Finish Artificial Intelligence Symposium Papers: Methodology)*, 25–31. Finnish Society of Information Processing Science, 1986.

186. P. Kilpeläinen, H. Mannila, J. Riivari, A. Suorsa, M. Tiainen & E. Ukkonen: Helsinki Prolog Language – Reference Manual. Report A–1987–1, Department of Computer Science, University of Helsinki, 1987.

187. —: Helsinki Prolog System (HPS) – System Overview. Report A–1987–3, Department of Computer Science, University of Helsinki, 1987.

188. —: Helsinki Prolog System – User Guide. Report A–1987–2, Department of Computer Science, University of Helsinki, 1987.

189. H. Mannila & E. Ukkonen: Space–time optimal algorithms for the set union problem with backtracking. Report C–1987–80, Department of Computer Science, University of Helsinki, 1987.

190. P. Myllymäki, M. Rantamäki & E. Ukkonen: Some variations of the back–propagation algorithm for neural networks. *Proc. STeP–88*, Vol. 2, 602–610. Finnish Artificial Intelligence Society, 1988.

191. P. Kilpeläinen, H. Mannila, J. Riivari, A. Suorsa, M. Tiainen & E. Ukkonen: An overview of Helsinki Prolog system. *Proc. STeP–88*, Vol. 2, 662–669. Finnish Artificial Intelligence Society, 1988.

192. R. Kankkunen, H. Mannila, M. Rantamaki & E. Ukkonen: Experience in inductive inference of a hyphenation algorithm for Finnish. *Proc. STeP–90*, 183–193. Finnish Artificial Intelligence Society, 1990.

193. J. Kärkkäinen & E. Ukkonen: Two dimensional pattern matching by static sampling. In: M. Penttonen (ed.), *Proc. Seventh Finnish Symp. on Computer Science*, Report A–1994–1, University of Joensuu, Department of Computer Science, 1994, pp. 79–90.

194. A. Brazma, E. Ukkonen & J. Vilo: Finding a good collection of patterns covering a set of sequences. Report C–1995–60, Department of Computer Science, University of Helsinki, 1995.

195. A. Brazma, I. Jonassen, I. Eidhammer & E. Ukkonen: Relation patterns and their automatic discovery in biosequences. REPORT NO 135 (March 1996), Department of Informatics, University of Bergen, 1996.

Writings in Finnish popularizing Computer Science:

196. K.–J. Räihä, J. Sajaniemi & E. Ukkonen: Paikallismuuttujasta laskennan vaativuuteen (From 'local variable' to 'computational complexity'). *Atk:n tietosanomat* 3/1978, 4–5.

197. E. Ukkonen: Teoreettisen tietojenkäsittelytieteen tutkimuksesta (On the Research of Theoretical Computer Science). *Korkeakoulujen atk–uutiset* 4/1985, 7–8.

198. E. Ukkonen: Logiikkaohjelmointi ja Prolog – perusideoita ja kehitysnäkymiä (Logic Programming and Prolog – Basic Ideas and Future Prospects). *Proc. BLANKO'86 Meeting* (Oct. 1986, Oulu, Finland), 8 pages.

199. E. Ukkonen: Ohjelmoinnin tulevaisuus (Future of Programming). *Dimensio* 5/1988, 20-21.

200. E. Ukkonen: Al–Khwarizmin perintö – Mitä on algoritmitutkimus? (The inheritance of Al–Khwarizmi – What is Algorithmics?) In: *Tietokone Suomessa 30 vuotta (Thirty Years of Computers in Finland)*, 33–48, Acta Universitatis Tamperensis, ser B vol 34, University of Tampere, 1990.

201. E. Ukkonen: Tietokoneet rynnistävät. *Tiede 2000* 8/1990, 28–32.

202. J. Kivinen, H. Mannila & E. Ukkonen: Sääntöjoukkojen oppiminen esimerkeistä (Learning rule sets from examples). *Tietojenkäsittelytiede* 3/1992, 31–35.

203. P. Jokinen, E. Sutinen & E. Ukkonen: Likimääräinen hahmonetsintä merkkijonoista (Approximate pattern matching in strings). *Tietojenkäsittelytiede* 3/1992, 35-39.

204. E. Ukkonen: Tietojenkäsittelytiede (Computer Science). In: E. Hyvönen, I. Karanta, M. Syrjänen (eds.), *Tekoälyn ensyklopedia (Finnish Encyclopedia of Artificial Intelligence)*, pp. 27–37, Gaudeamus, Helsinki 1993.

205. E. Ukkonen: Teoreettinen teoria ja käytännöllinen teoria (Theoretical theory and practical theory). *Tietojenkäsittelytiede* June 1998, 5.

206. E. Ukkonen: Tietojenkäsittelytieteen saavutusten kymmenen kärjessä. (Top ten of the achievments of Computer Science). *Tietojenkäsittelytiede* December 1999, 20–22.

207. E. Ukkonen: Bioinformatiikka – tietokoneet elämän ohjelman jäljillä. (Bioinformatics – using computers to trace the program of life). *Kemia* 8/2000, 629–631.
Reprinted in E. Hyvönen (ed.): *Inhimillinen kone – konemainen ihminen (Human machine – machine–like man)*, pp. 70–80, Helsinki University Press 2001.

208. E. Ukkonen: Metakääntäjistä Linuxiin ja bioinformatiikkaan – kolme vuosikymmentä tietojenkäsittelytiedettä yliopistossa. (From metacompilers to Linux and bioinformatics – three decades of Computer Science at the university). In: *Työvälineitä tietoyhteiskuntaan – SMFL:n 40–vuotisjuhlakirja*, pp. 22–36, Suomen Matemaatikko-, Fyysikko- ja Tietojenkäsittelytieteilijäliitto ry 2001.

209. E. Ukkonen: FDK–huippuyksikkö – tietoa datasta. (The FDK Center-of-Excellence – knowledge from data). *Tietojenkäsittelytiede* December 2001, 21–23.

210. E. Ukkonen: Mihin algoritmeja tarvitaan? (What are algorithms needed for?). *Tieteessä tapahtuu* 7, 2003, 19–22.

211. E. Ukkonen: Bioinformatiikan kutsu. (Bioinformatics calling). In: *Tietojenkäsittelytieteen päivät 2006*, Raport B-2006-3, pp. 3–5, Department of Computer Science, University of Helsinki, 2006.

212. E. Ukkonen: Tila ja tulevaisuus – pysähtyneisyydestä uuteen vauhtiin. (Current state and future prospects - From stagnation back to the swing). *Tietojenkäsittelytiede* July 2010, 4–6.

July 2014