

MR2277561 (2007j:68083) 68Q45 (68Q42)

Bordihn, Henning (D-PTDM-II); **Fernau, Henning** (D-TRR-I);

Holzer, Markus (D-MUTU-IIG); **Manca, Vincenzo** (I-PISA-IF); **Martín-Vide, Carlos**

Iterated sequential transducers as language generating devices. (English summary)

Theoret. Comput. Sci. **369** (2006), no. 1-3, 67–81.

A finite-state sequential transducer T whose output alphabet coincides with the input alphabet can be iterated and used as a language generating device: each iteration corresponds to a rewriting step. The authors restrict their model to those derivations where only in the last step does an accepting state of T play its significant role. This contrasts with existing models, cited by the authors, as well as with the reviewer's approach [*Theoret. Comput. Sci.* **81** (1991), no. 2, Algorithms Automat. Complexity Games, 269–288; [MR1107716 \(92f:68094\)](#)] where in each iteration an accepting state should be reached.

The family of languages obtained by (deterministic) T 's with at most n states is denoted by IFT_n (DIFT_n , respectively). The authors investigate the closure properties of these language families, show that the hierarchy $\{\text{IFT}_n\}_{n \geq 1}$ collapses at level 4 (since IFT_4 equals the family of recursively enumerable languages), and establish some equalities and (proper) inclusions between these families and members from the Chomsky and from the Lindenmayer hierarchy. Whether the hierarchy $\{\text{DIFT}_n\}_{n \geq 1}$ collapses at some level is still an open problem.

Reviewed by *Peter R. J. Asveld*

References

1. P.R.J. Asveld, On controlled iterated gsm mappings and related operations, *Rev. Roumaine Math. Pures Appl.* 25 (1980) 136–145. [MR0577022 \(81j:68083\)](#)
2. J.M. Autebert, J. Gabarró, Iterated gsm's and co-cfl, *Acta Inform.* 26 (1989) 749–769. [MR1021789 \(91c:68066\)](#)
3. H. Bordihn, H. Fernau, On the degree of parallelism, Manuscript, 2005, accepted at *Descriptive Complexity of Formal Systems*, Como, Italy, 2005.
4. H. Bordihn, H. Fernau, M. Holzer, On iterated sequential transducers, in: C. Martín-Vide, V. Mitrana (Eds.), *Grammars and Automata for String Processing: From Mathematics and Computer Science to Biology, and Back*, Taylor and Francis, London, 2003, pp. 121–130. [MR2036021](#)
5. D. van Dalen, A note on some systems of Lindenmayer, *Math. Systems Theory* 5 (1979) 128–140. [MR0341935 \(49 #6681\)](#)
6. J. Dassow, H. Jürgensen, W. Rülling, Information transmission in IL systems, *Internat. J. Comput. Math.* 37 (1990) 1–19.
7. V. Geffert, Normal forms for phrase structure grammars, *RAIRO Inform. Théor. Appl.* 25 (1991) 473–496. [MR1144010 \(92m:68062\)](#)
8. L. Haines, Representation theorems for context-sensitive languages, *Notices Amer. Math. Soc.*

- 16 (1969) 527. [MR0405939 \(53 #9731\)](#)
9. G.T. Herman, Computing ability of a developmental model for filamentous organisms, *J. Theoret. Biol.* 25 (1969) 421–435. [MR0274220 \(42 #9095\)](#)
 10. G.T. Herman, G. Rozenberg, *Developmental Systems and Languages*, North-Holland, Amsterdam, 1975. [MR0495247 \(58 #13968\)](#)
 11. J.E. Hopcroft, J.D. Ullman, *Introduction to Automata Theory, Languages, and Computation*, Addison-Wesley, Reading, MA, 1979. [MR0645539 \(83j:68002\)](#)
 12. P. Jančar et al., On restarting automata with rewriting, in: Gh. Păun, A. Salomaa (Eds.), *New Trends in Formal Languages*, Lecture Notes in Computer Science, Vol. 1218, Springer, Berlin, 1997, pp. 119–136. [MR1605213 \(98j:68112\)](#)
 13. S. Kobayashi, Iterated transductions and efficient learning from positive data: a unifying view, in: A.L. Oliveira (Ed.), *Grammatical Inference: Algorithms and Applications*, 5th ICGI 2000, Lecture Notes in Computer Science/Lecture Notes in Artificial Intelligence, Vol. 1891, Springer, Berlin, 2000, pp. 157–170.
 14. M. Latteux, D. Simplot, A. Terlutte, Iterated length-preserving rational transductions, in: L. Brim, J. Gruska, J. Zlatuška (Eds.), *Mathematical Foundations of Computer Science, MFCS'98*, Lecture Notes in Computer Science, Vol. 1450, Springer, Berlin, 1998, pp. 286–295. [MR1684072](#)
 15. V. Manca, On the generative power of iterated transduction, in: M. Ito, Gh. Păun, S. Yu (Eds.), *Words, Semigroups, and Transductions*, World Scientific Publisher, New Jersey, 2001, pp. 315–327. [MR1914768 \(2003f:68076\)](#)
 16. V. Manca, C. Martín-Vide, Gh. Păun, New computing paradigms suggested by DNA computing: computing by carving, *Biosystems* 52 (1999) 47–54.
 17. V. Manca, C. Martín-Vide, Gh. Păun, Iterated gsm-mappings: a collapsing hierarchy, in: J. Karhumäki et al. (Eds.), *Jewels are Forever*, Springer, Berlin, 1999, pp. 182–193, Extended version as Technical Report TUCS-TR-206, Turku Centre for Computer Science, Finland, see

<

<http://www.tucs.fi/publications/techreports/TR206.html>

>

- . [MR1719061 \(2000h:68123\)](#)
18. Gh. Păun, On the iteration of gsm mappings, *Rev. Roumaine Math. Pures Appl.* 23 (1978) 921–937. [MR0521211 \(58 #25146\)](#)
 19. Gh. Păun, Classes of iterated gsm's suggested by suspicious communication questions, *Rev. Roumaine Linguistique, Cah. ling. th. appl.* XXIV (1987) 139–144.
 20. Gh. Păun, The complexity of language translation by gsm's, *Rev. Roumaine Linguistique, Cah. ling. th. appl.* XXV (1988) 49–58.
 21. K.S. Rajasethupathy, R.K. Shyamasundar, Programmed 0L-systems, *Inform. Sci.* 20 (1980) 137–150. [MR0560198 \(80k:68063\)](#)
 22. B. Rován, A framework for studying grammars, in: J. Gruska, M. Chytil (Eds.), *Proc. of MFCS'81*, Lecture Notes in Computer Science, Vol. 118, Springer, Berlin, 1981, pp. 473–482. [MR0652779 \(83e:68118\)](#)

23. G. Rozenberg, A.K. Salomaa, *The Mathematical Theory of L Systems*, Academic Press, New York, 1980. [MR0561711 \(82g:68053\)](#)
24. W. Rülling, *Informationsübertragung in L-Systemen*, Dissertation, TH Darmstadt, Germany, 1983.
25. C.E. Shannon, A universal Turing machine with two internal states, in: C. Shannon, J. McCarthy (Eds.), *Automata Studies*, *Annals of Mathematical Studies*, Vol. 34, Princeton University Press, 1956, pp. 157–165. [MR0079548 \(18,103e\)](#)
26. D. Simplot, A. Terlutte, Closure under union and composition of iterated rational transductions, *RAIRO Inform. théor. Appl./Theoret. Inform. Appl.* 34 (2000) 183–212. [MR1796268 \(2001j:68075\)](#)
27. H. Takahashi, The maximum invariant set of an automaton system, *Inform. and Control* 32 (1976) 307–354. [MR0426962 \(54 #14893\)](#)
28. P.M.B. Vitányi, *Lindenmayer systems: structure, languages, and growth functions*, Technical Report 96, Mathematisch Centrum, Amsterdam. 1980. [MR0596583 \(82e:68054\)](#)
29. R. Vollmar, *Algorithmen in Zellularautomaten, Leitfäden der angewandten Mathematik und Mechanik*, Vol. 48, Teubner, Stuttgart, 1979. [MR0528756 \(83k:68047\)](#)
30. D. Wood, Iterated α -NGSM maps and Γ systems, *Inform. and Control* 32 (1976) 1–26. [MR0416130 \(54 #4206\)](#)

Note: This list reflects references listed in the original paper as accurately as possible with no attempt to correct errors.

© Copyright American Mathematical Society 2007