Making Universal Reversible Turing Machines

Kenichi Morita

Hiroshima University, Higashi-Hiroshima, 739-8527, Japan

Abstract. Studies on universal Turing machines (UTM) have a long history, and various small UTMs have been given till now [2, 3, 10–12]. Here, we investigate the problem of constructing small UTMs under the constraint of *reversibility*, which is a property closely related to physical reversibility. Let URTM(m, n) denote an m-state n-symbol universal reversible Turing machine. So far, six kinds of small URTMs have been shown. They are URTM(10,8), URTM(13,7), URTM(15,6), URTM(17,5), URTM(24,4), and URTM(32,3) given in [4, 7–9]. All of them can simulate cyclic tag systems, which are universal string rewriting systems proposed by Cook [1]. Furthermore, by the methods of reducing the number of states or symbols [5, 7], URTM(3,36654), URTM(4,168), and URTM(138,2) are obtained, though their sizes are large. The reference [6] contains computer simulation results, and the description files of the URTMs. In this talk, we give a survey on these URTMs, and explain how they are designed. We also discuss open problems on URTMs.

References

1. Cook, M.: Universality in elementary cellular automata. Complex Syst. 15, 1–40 (2004)
2. Kudlek, M., Rogozhin, Y.: A universal Turing machine with 3 states and 9 symbols. In: Proc. DLT 2001, LNCS 2295. pp. 311–318 (2002)
3. Minsky, M.L.: Computation: Finite and Infinite Machines. Prentice-Hall, Englewood Cliffs, NJ (1967)
4. Morita, K.: Reversible computing and cellular automata — A survey. Theoret. Comput. Sci. 395, 101–131 (2008)
5. Morita, K.: Reversible Turing machines with a small number of states. In: Proc. NCMA 2014. pp. 179–190 (2014). Slide file: Hiroshima Univ. Institutional Repository, http://ir.lib.hiroshima-u.ac.jp/00036075
6. Morita, K.: Constructing small universal reversible Turing machines. Hiroshima Univ. Institutional Repository, http://ir.lib.hiroshima-u.ac.jp/00036736 (2015)
7. Morita, K.: Universal reversible Turing machines with a small number of tape symbols. Fundam. Inform. 138, 17–29 (2015)
8. Morita, K.: Two small universal reversible Turing machines. (submitted for publication)
9. Morita, K., Yamaguchi, Y.: A universal reversible Turing machine. In: Proc. MCU 2007, LNCS 4664. pp. 90–98 (2007)
10. Neary, T., Woods, D.: Four small universal Turing machines. Fundam. Inform. 91, 123–144 (2009)
11. Rogozhin, Y.: Small universal Turing machines. Theoret. Comput. Sci. 168, 215–240 (1996)
12. Woods, D., Neary, T.: The complexity of small universal Turing machines: a survey. Theoret. Comput. Sci. 410, 443–450 (2009)