$_{ m symbols}$													
10	Ma	\mathbf{Mi}_2											
9													
8	Ba												
7		Da											
6		Ma	\mathbf{Mi}_2										
5		Ba											
4		Mi_2	Ma	\mathbf{Mi}_2									
3				Ma	\mathbf{Mi}_1								
2							Yj		Ba	Ma		\mathbf{Mi}_2	
	2	3	4	5	6	7	8	9	10	11	12	13	states

Table 1: Turing machines simulating the 3x + 1 function: Ma = Margenstern [4, 5], Ba = Baiocchi [1], $Mi_1 = \text{Michel } [6]$, $Mi_2 = \text{Michel } [7]$. Da = Daniel [10]. Yj = Yijun Leng (this repo). In roman boldface, halting machines. Green: unary; Blue: base 2; Red: base 3;

This tex copy from [7], thanks! Preliminaries and background: see [7].

M_8	0	1
A	0LE	0RB
B	1LC	1RB
C	1LG	0LD
D	1RA	1LD
E	_	0RG
G	0RA	0RH
H	1LJ	1RH
J	1LG	1LJ

[—] means unreachable: any write, move and states is ok

References

- [1] C. Baiocchi, 3N+1, UTM e Tag-systems (Italian), Dipartimento di Matematica dell'Università "La Sapienza" di Roma 98/38, 1998.
- [2] C. Baiocchi and M. Margenstern, Cellular automata about the 3x+1 problem, in: Proc. LCCS'2001, Université Paris 12, 2001, 37–45, available on the website http://lacl.univ-paris12.fr/LCCS2001/.
- [3] J.C. Lagarias (Ed.), The Ultimate Challenge: The 3x+1 Problem, AMS, 2010.
- [4] M. Margenstern, Frontier between decidability and undecidability: a survey, Proc. MCU'98, Vol. 1, ISBN 2-9511539-2-9, 1998, 141–177.

- [5] M. Margenstern, Frontier between decidability and undecidability: a survey, *Theoret. Comput. Sci.* **231**, 2000, 217–251.
- [6] P. Michel, Busy beaver competition and Collatz-like problems, Arch. Math. Logic 32 (5), 1993, 351–367.
- [7] P. Michel, Simulation of the Collatz 3x+ 1 function by Turing machines. arXiv preprint arXiv:1409.7322. 2014 Sep 25.
- [8] P. Michel and M. Margenstern, Generalized 3x+1 functions and the theory of computation, in [3], 105-128.
- [9] D. Woods and T. Neary, The complexity of small universal Turing machines: a survey, *Theoret. Comput. Sci.* **410**, 2009, 443–450. Extended and updated in: http://arxiv/abs/1110.2230.