Computing Fibonacci numbers on a Turing Machine

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Abstract. A Turing machine that computes Fibonacci numbers is described.

1   Preface

The program computes a Fibonacci number.

A number n is represented by n 1-s.
Sample :
5 is represented as 1 1 1 1 1
3 is represented as 1 1 1

Input : number n
Sample (n = 7) :
1 1 1 1 1 1 1

Output : Fibonacci-n
Sample (Fibonacci-7) :
1 1 1 1 1 1 1 1 1 1 1 1 1

2 Alphabets of States and Symbols

Here are alphabets of states and symbols.

State alphabet

Initial state: q_0;

Halting state: q_f;

Internal states: q_{101}, q_{102}, q_{103}, q_{104}, q_{105}, q_{106}, q_{107}, q_{108}, q_{109}, q_{201}, q_{202}, q_{203}, q_{204}, q_{301}, q_{302}, q_{303}, q_{304}, q_{305}, q_{306}, q_{307}, q_{308}, q_{309}, q_{310}, q_{311}, q_{401}, q_{402}, q_{403}, q_{404}, q_{501}, q_{502}, q_{503}, q_{601}, q_{602}, q_{603}, q_{604}, q_{701}, q_{702}, q_{703}, q_{704}, q_{801}, q_{802}, q_{803}, q_{804}, q_{805}, q_{806}, q_{807}, q_{808}, q_{809}.

Symbol alphabet

Empty symbols alphabet: b;

Input alphabet: 1;

Internal alphabet: x, $*$.

3 Transition Table

The table contains 100 rules.

$Rule_{No}$	$State_{cur}$	$Symbol_{cur}$	$State_{next}$	$Symbol_{next}$	$Head_{move}$
0	q_0	1	q_{101}	x	R
1	q_{101}	1	q_{101}	1	R
2	q_{101}	b	q_{102}	1	R
3	q_{102}	b	q_{103}	$*$	R
4	q_{103}	b	q_{104}	1	R
5	q_{104}	b	q_{601}	$*$	L
6	q_{105}	b	q_{106}	1	L
7	q_{106}	$*$	q_{701}	$*$	L
8	q_{107}	$*$	q_{108}	$*$	L
9	q_{107}	1	q_{107}	1	L
10	q_{108}	$*$	q_{109}	$*$	N
11	q_{108}	1	q_{108}	1	L
12	q_{109}	$*$	q_{109}	$*$	R
13	q_{109}	1	q_{109}	1	R
14	q_{109}	b	q_{201}	$*$	N
15	q_{201}	$*$	q_{202}	$*$	L
16	q_{201}	1	q_{201}	1	L
17	q_{202}	$*$	q_{203}	$*$	R
18	q_{202}	1	q_{202}	1	L
19	q_{202}	b	q_{203}	b	R
20	q_{203}	$*$	q_{301}	$*$	N
21	q_{203}	1	q_{204}	b	R
22	q_{204}	$*$	q_{204}	$*$	R
23	q_{204}	1	q_{204}	1	R
24	q_{204}	b	q_{201}	1	L
25	q_{301}	$*$	q_{302}	$*$	L
26	q_{302}	$*$	q_{303}	$*$	L
27	q_{302}	b	q_{302}	b	L
28	q_{303}	$*$	q_{304}	$*$	R
29	q_{303}	1	q_{303}	1	L
30	q_{303}	b	q_{304}	b	R
31	q_{304}	$*$	q_{308}	b	N
32	q_{304}	1	q_{305}	b	R
33	q_{305}	$*$	q_{306}	$*$	R
34	q_{305}	1	q_{305}	1	R
35	q_{306}	$*$	q_{307}	$*$	L
36	q_{306}	1	q_{307}	1	L
37	q_{306}	b	q_{306}	b	R
38	q_{307}	b	q_{302}	1	L
39	q_{308}	1	q_{309}	1	L

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$Rule_{No}$	$State_{cur}$	$Symbol_{cur}$	$State_{next}$	$Symbol_{next}$	$Head_{move}$
40	q_{308}	b	q_{308}	b	R
41	q_{309}	b	q_{310}	$*$	L
42	q_{310}	$*$	q_{311}	$*$	R
43	q_{310}	b	q_{310}	1	L
44	q_{311}	$*$	q_{501}	$*$	R
45	q_{311}	1	q_{311}	1	R
46	q_{401}	$*$	q_{402}	$*$	L
47	q_{401}	1	q_{401}	1	L
48	q_{402}	$*$	q_{403}	$*$	L
49	q_{402}	1	q_{402}	1	L
50	q_{403}	$*$	q_{403}	$*$	L
51	q_{403}	1	q_{404}	$*$	L
52	q_{404}	$*$	q_{404}	$*$	R
53	q_{404}	1	q_{404}	1	R
54	q_{404}	b	q_{201}	$*$	N
55	q_{404}	x	q_{801}	x	N
56	q_{501}	$*$	q_{502}	1	N
57	q_{501}	1	q_{501}	1	R
58	q_{502}	1	q_{502}	1	R
59	q_{502}	b	q_{503}	b	L
60	q_{503}	1	q_{401}	b	L
61	q_{601}	$*$	q_{602}	$*$	L
62	q_{601}	1	q_{601}	1	L
63	q_{602}	1	q_{603}	$*$	L
64	q_{603}	1	q_{604}	1	R
65	q_{603}	x	q_{801}	x	N
66	q_{604}	$*$	q_{604}	$*$	R
67	q_{604}	1	q_{604}	1	R
68	q_{604}	b	q_{105}	b	N
69	q_{701}	$*$	q_{702}	$*$	L
70	q_{701}	1	q_{701}	1	L
71	q_{702}	$*$	q_{702}	$*$	L
72	q_{702}	1	q_{703}	$*$	L
73	q_{703}	1	q_{704}	1	R
74	q_{703}	x	q_{801}	x	N
75	q_{704}	$*$	q_{704}	$*$	R
76	q_{704}	1	q_{704}	1	R
77	q_{704}	b	q_{107}	b	L
78	q_{801}	$*$	q_{801}	$*$	R
79	q_{801}	1	q_{801}	1	R

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$Rule_{No}$	$State_{cur}$	$Symbol_{cur}$	$State_{next}$	$Symbol_{next}$	$Head_{move}$
80	q_{801}	b	q_{802}	b	L
81	q_{801}	x	q_{801}	x	R
82	q_{802}	$*$	q_{808}	b	L
83	q_{802}	1	q_{808}	1	L
84	q_{803}	$*$	q_{803}	$*$	L
85	q_{803}	1	q_{803}	$*$	L
86	q_{803}	x	q_{804}	x	R
87	q_{804}	$*$	q_{804}	$*$	R
88	q_{804}	1	q_{805}	$*$	L
89	q_{804}	b	q_{809}	b	N
90	q_{805}	$*$	q_{805}	$*$	L
91	q_{805}	1	q_{806}	1	R
92	q_{805}	x	q_{806}	$*$	N
93	q_{806}	$*$	q_{807}	1	R
94	q_{807}	$*$	q_{804}	$*$	R
95	q_{808}	$*$	q_{803}	$*$	L
96	q_{808}	1	q_{808}	1	L
97	q_{809}	$*$	q_{809}	b	L
98	q_{809}	1	q_f	1	N
99	q_{809}	b	q_{809}	b	L

4   Testing the Machine

C++ Simulator of a Turing machine has been used to compute several Fibonacci numbers. The simulator can be downloaded at

- `http://sourceforge.net/projects/turing-machine`
- `http://alexvn.freeservers.com/s1/turing.html`

Raw logs can be seen at `http://groups.google.com/groups?th=1e653c4ef60faa44`