



TURING MACHINE PROJECT

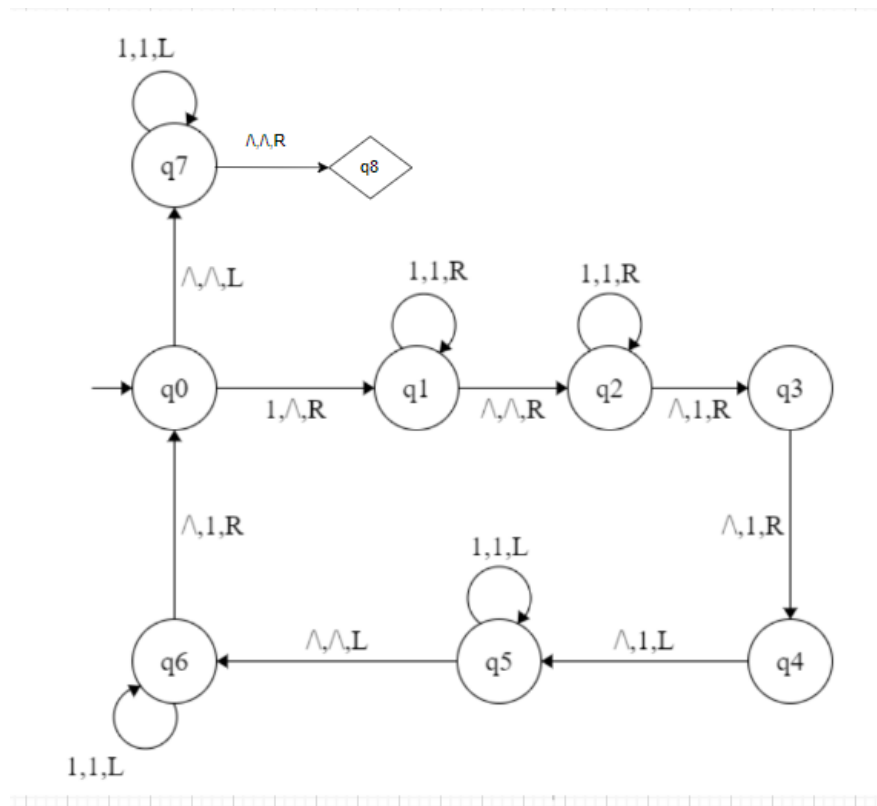
Patryk Zboch



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Graph for turing machine



Formal definition on proposed graph

States = {q0, q1, q2, q3, q4, q5, q6, q7, q8}

Start state = {q0}

Symbols = {1, /}

Action table :


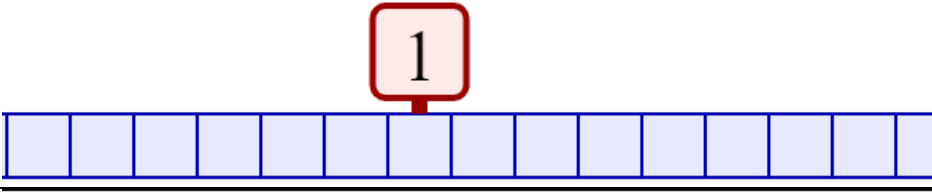
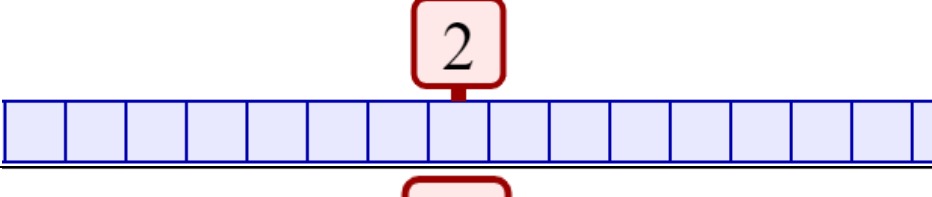
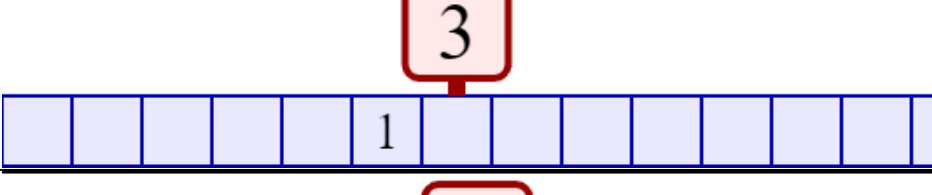
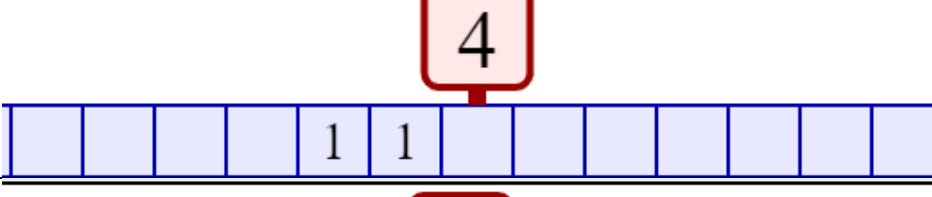
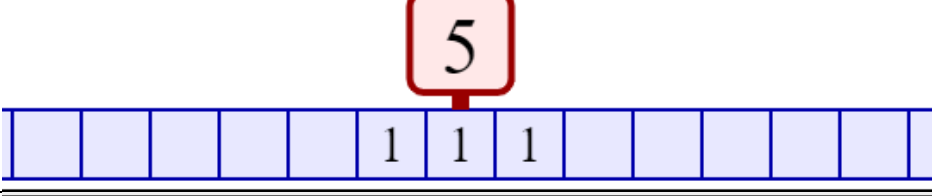
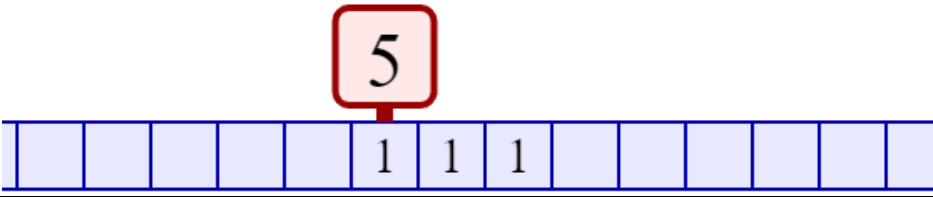
Current state:	q ₀		q ₁		q ₂		q ₃	q ₄	q ₅		q ₆		q ₇	
Current Symbol:	1	/	1	/	1	/	/	/	1	/	1	/	1	/
New State:	q ₁	q ₇	q ₁	q ₂	q ₂	q ₃	q ₄	q ₅	q ₅	q ₆	q ₆	q ₀	q ₇	q ₈
New Symbol:	/	/	1	/	1	1	1	1	1	/	1	1	1	/
Move:	R	L	R	R	R	R	R	L	L	L	L	R	L	R


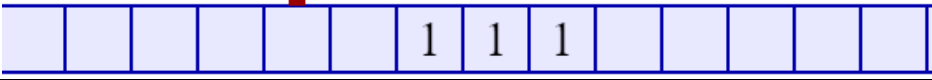

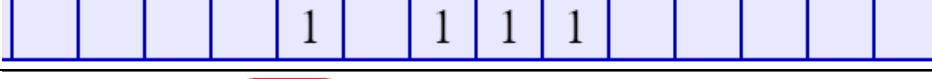
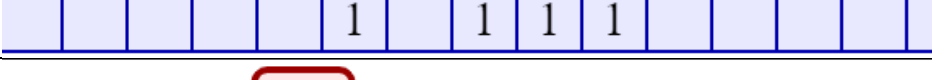

Turing Machine Description

Start of at state q_0 , when we encounter a 1 we mark it with \wedge symbol, move right and switch to state q_1 . This is done so we make sure that for every 1 in our input number we get three after the space. Then loop through the remaining 1's in the input whilst remaining in state q_1 . Once we reach an empty space, we leave it as it is, move right and switch to state q_2 (this space will separate our input and our output). If we encounter a 1, leave it as it is, move to the right and remain in state q_2 (this is to loop through the 1's after the blank). Once we encounter a blank space we now know that we can start adding more 1's to the tape. Change the blank space to 1, move right and switch to state q_3 . If we get a blank space, change it to 1, move right and switch to state q_4 . If we get a blank space, change it to 1, move left and switch to state q_5 . States $q_3 \rightarrow q_4 \rightarrow q_5$ effectively make sure that for every 1 in our input we have three 1's in the output. In state q_5 loop through the 1's that we already have and keep moving left. Once we encounter the blank space separating the input and output, we leave it as it is, move left and switch to state q_6 . In state q_6 we loop through the 1's in our input and keep moving left. Once we encounter the previously marked 1 with a \wedge , change the \wedge back to 1, move right (to the next 1 in our input) and switch back to state q_0 . This repeats the process until all of our 1's in our input are processed. Once they are processed we need to move back to the start of the input number. If there is a blank space at q_0 we are at the space between our input and output number, leave the space as it is, move left and switch to state q_7 . In state q_7 we loop through the 1's and keep moving left until we reach the end of our input number. When we reach the blank space leave as it is, move right and switch to state q_8 (the final state).


Turing Machine: File Configuration TM5

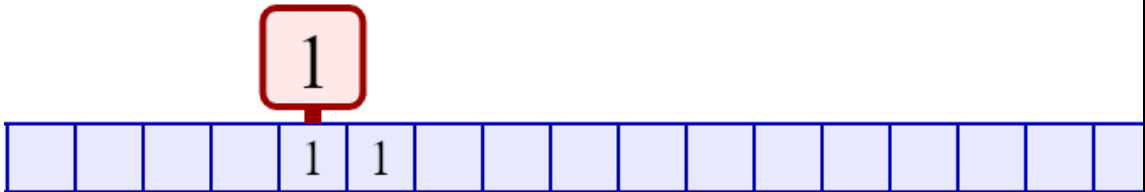


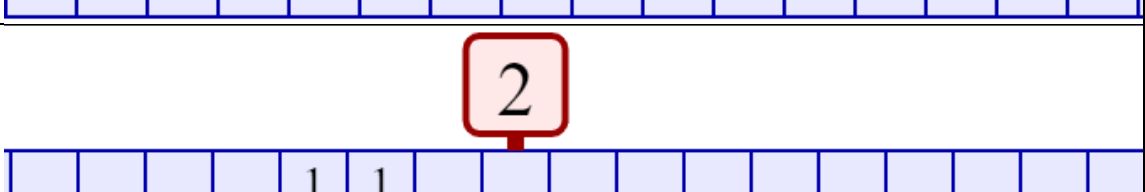

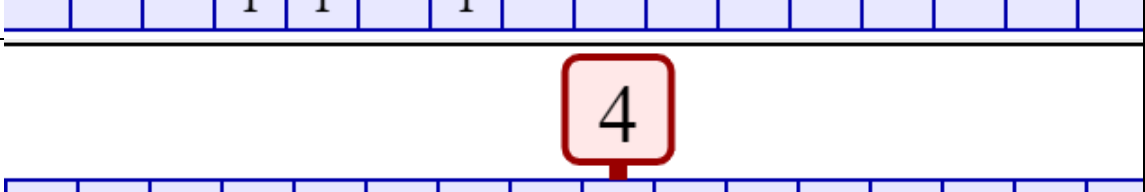
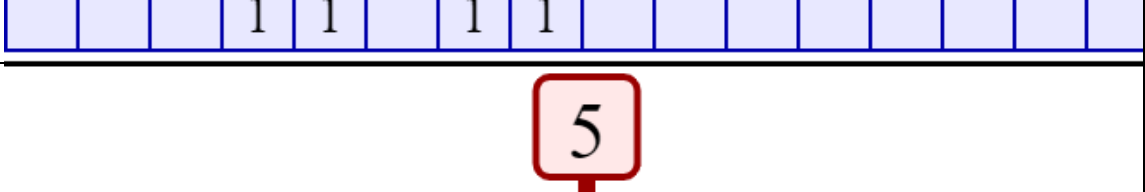
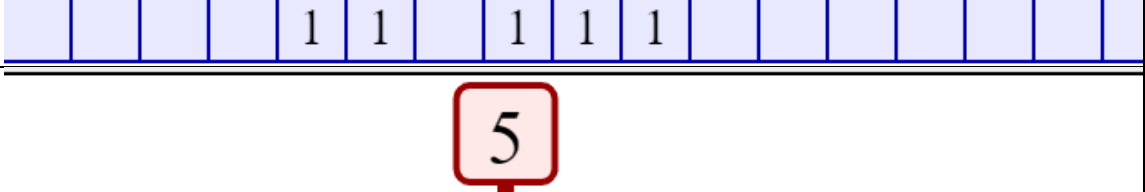
a) **Input 1**

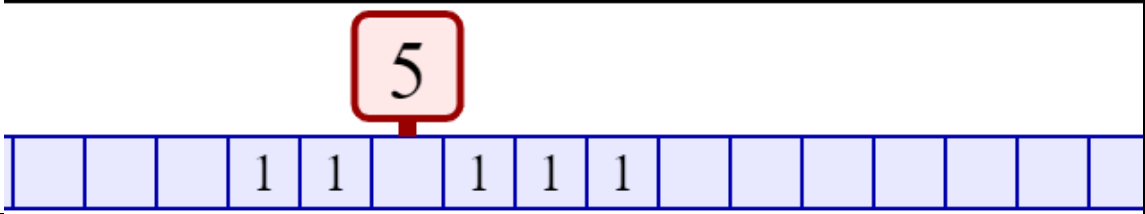
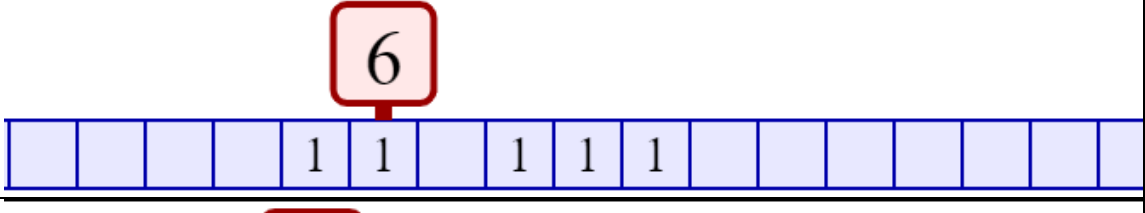
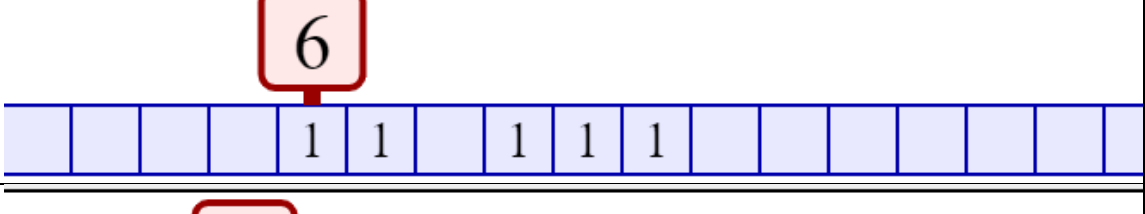
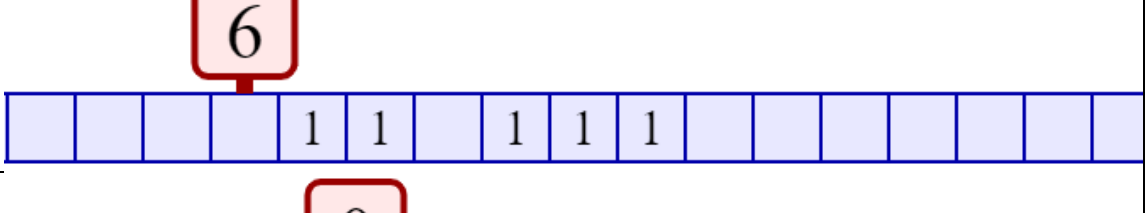
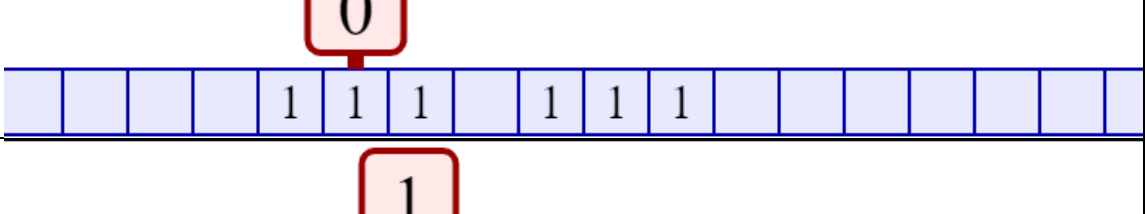
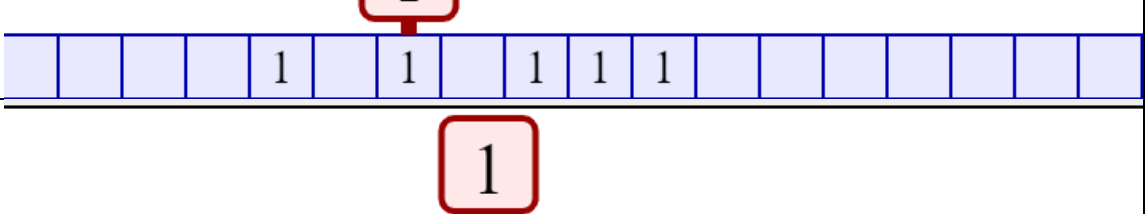
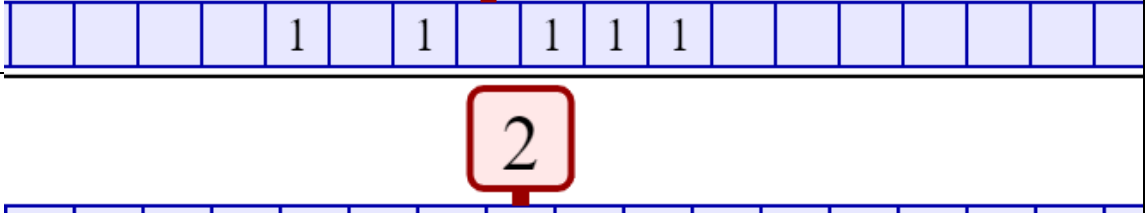
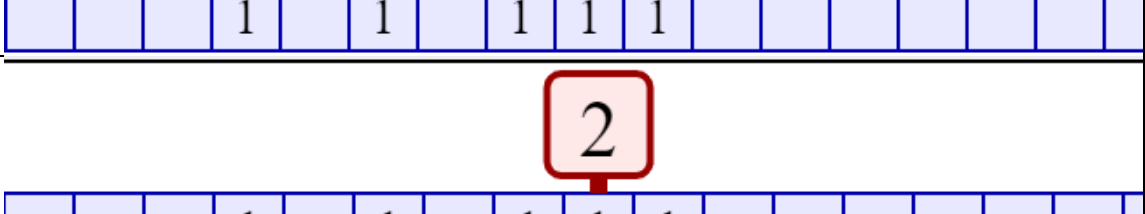
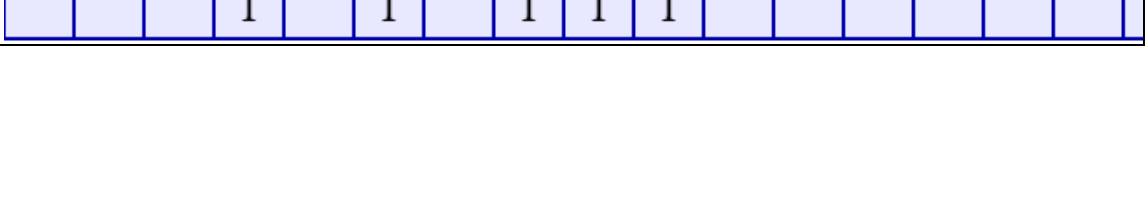
Computation configuration	Tape Configurations	Current State	Pointer Location
Config = (M1,T1,0)		State q0	0
Config = (M1,T1,1)		State q1	1
Config = (M1,T1,2)		State q2	2
Config = (M1,T1,3)		State q3	3
Config = (M1,T1,4)		State q4	4
Config = (M1,T1,5)		State q5	3
Config = (M1,T1,6)		State q5	2

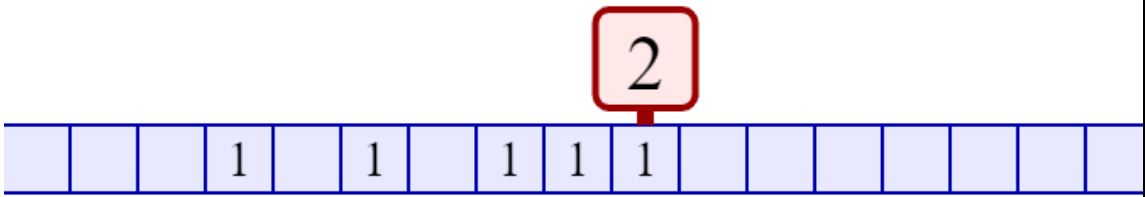
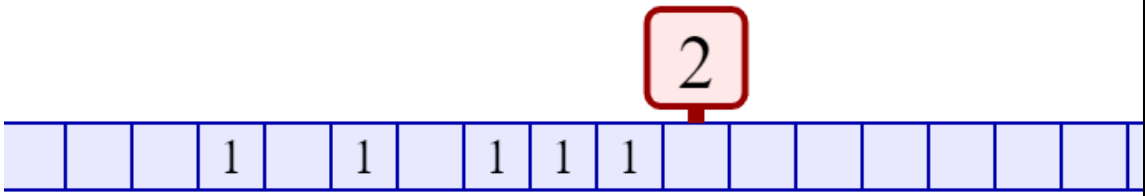
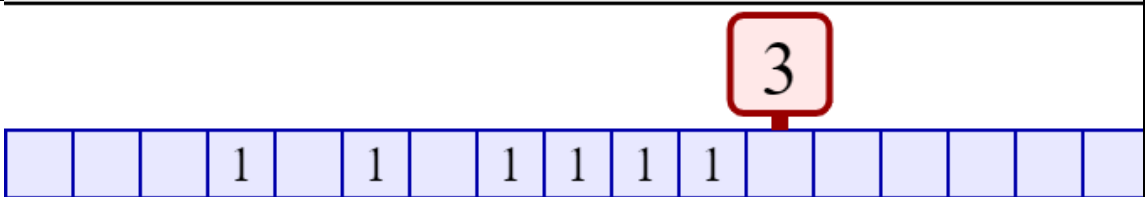
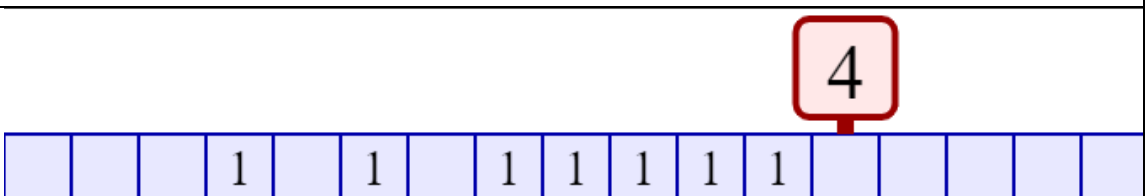
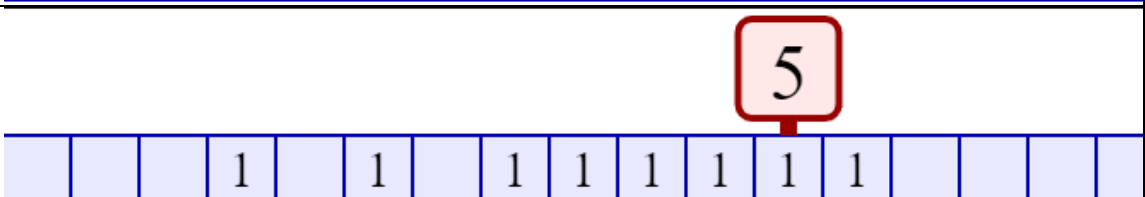

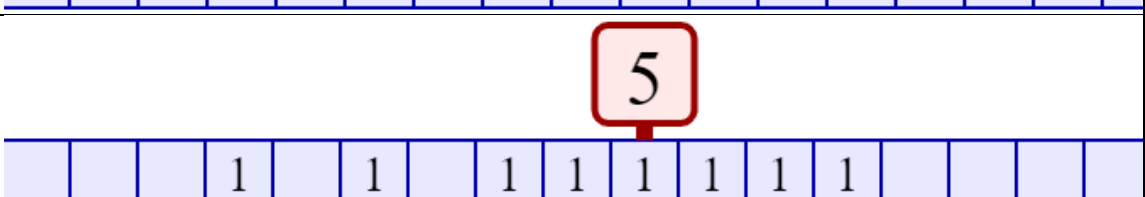
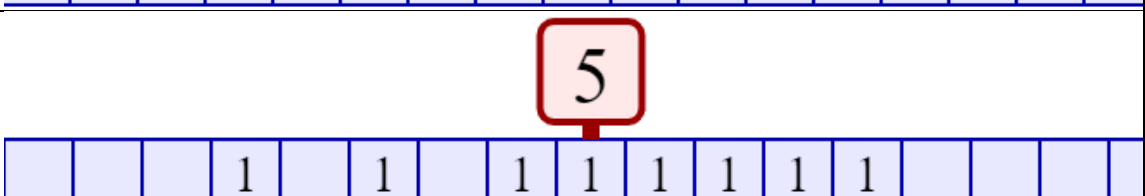
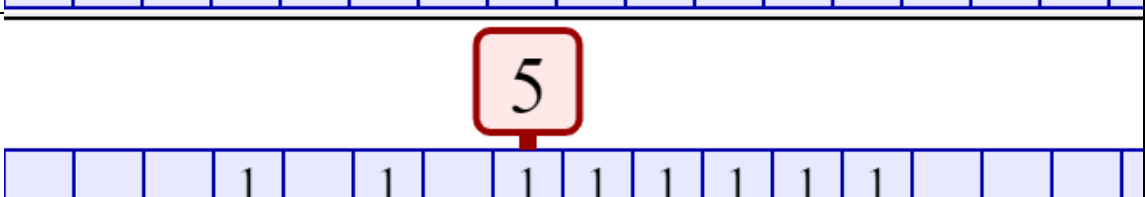
Config = (M1,T1,7)	<div>5</div> 	State q5	1
Config = (M1,T1,8)	<div>6</div> 	State q6	0
Config = (M1,T1,9)	<div>0</div> 	State q0	1
Config = (M1,T1,10)	<div>7</div> 	State q7	0
Config = (M1,T1,11)	<div>7</div> 	State q7	-1
Config = (M1,T1,12)	<div>8</div> 	State q8	0

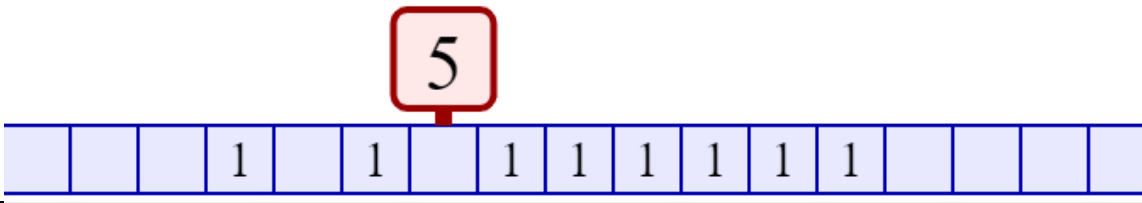
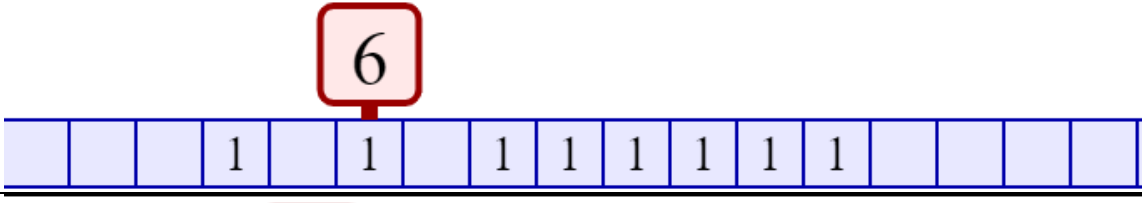
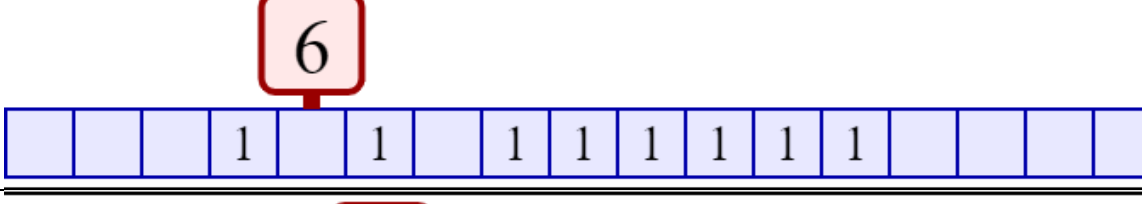
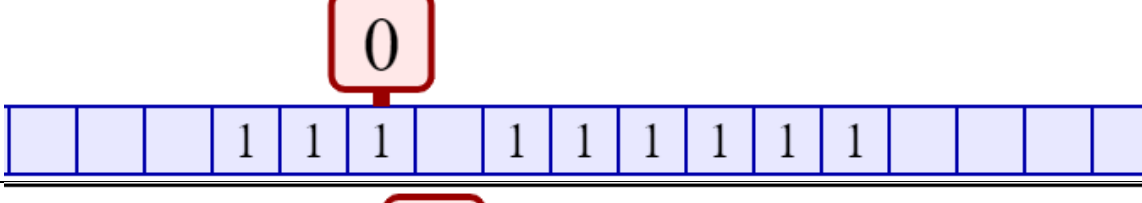
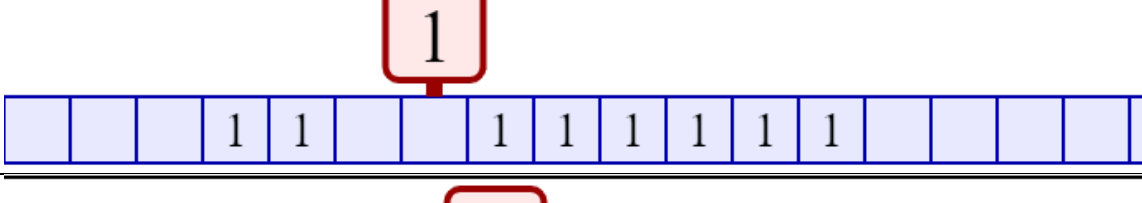
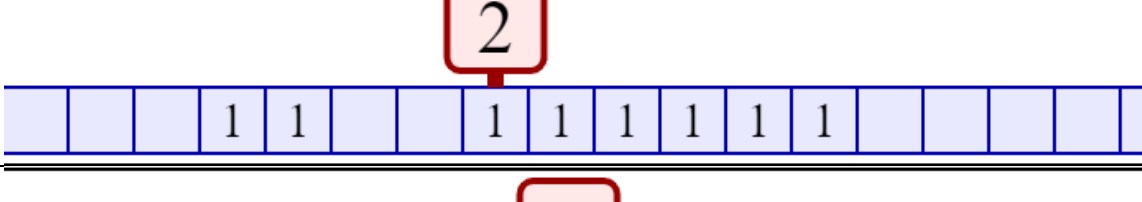
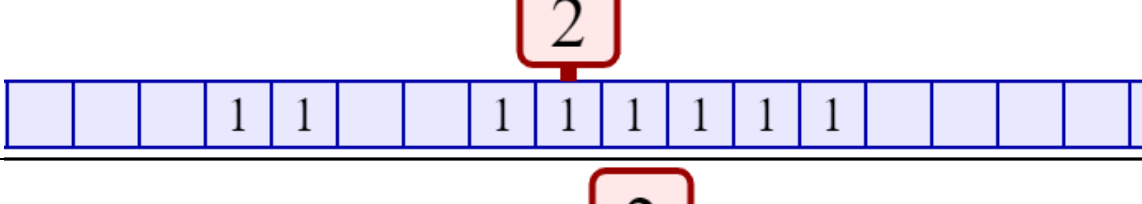
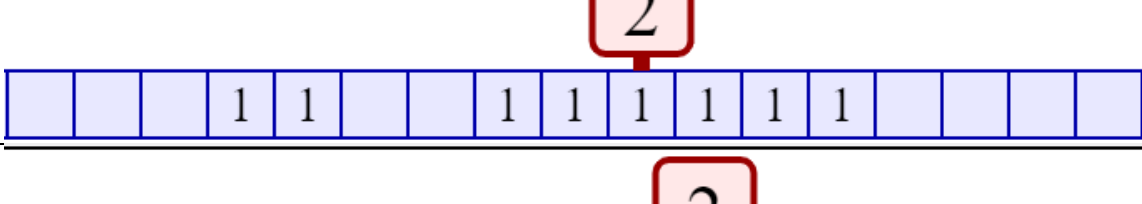
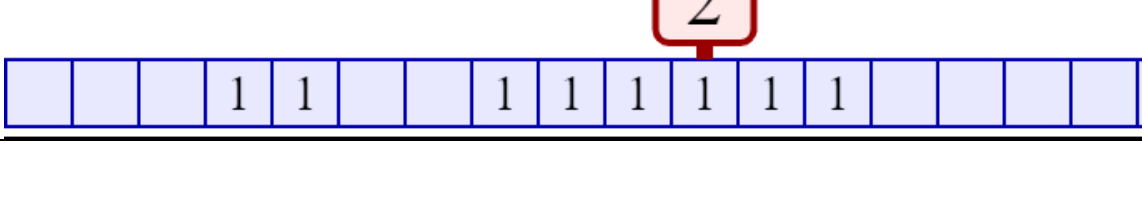
b) **Input 111**

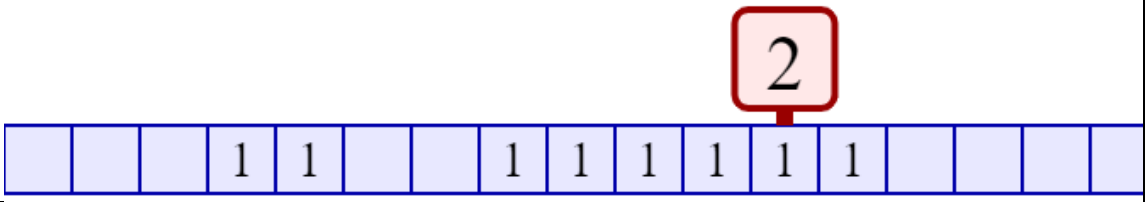
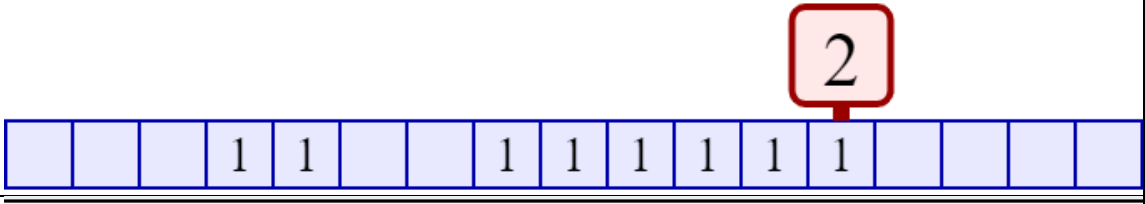
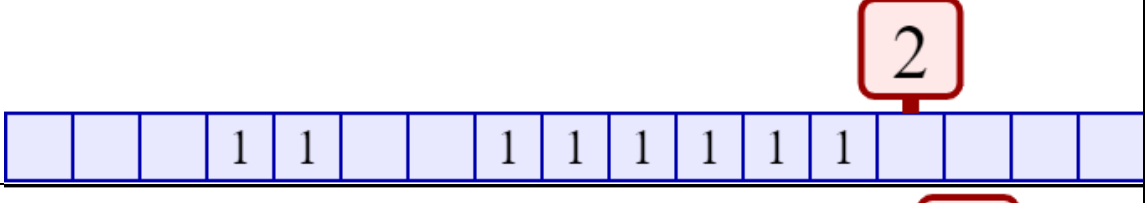
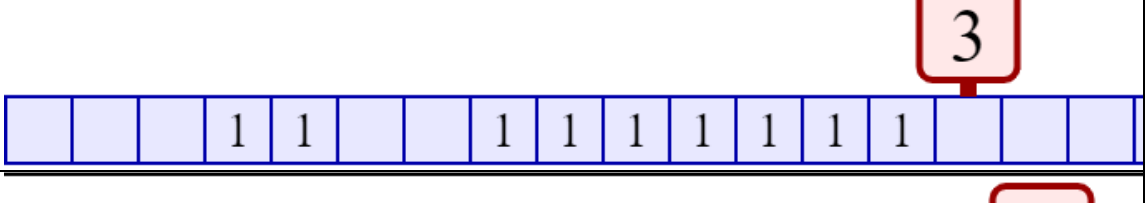
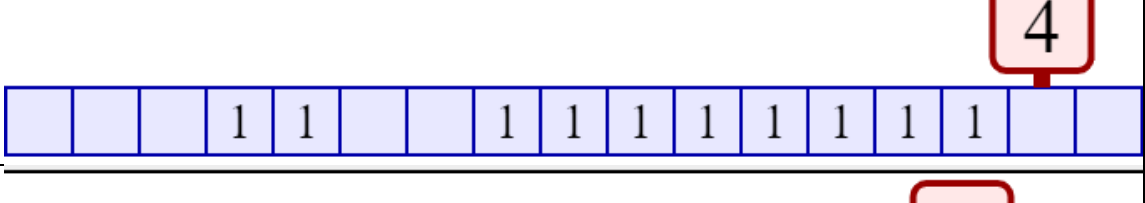
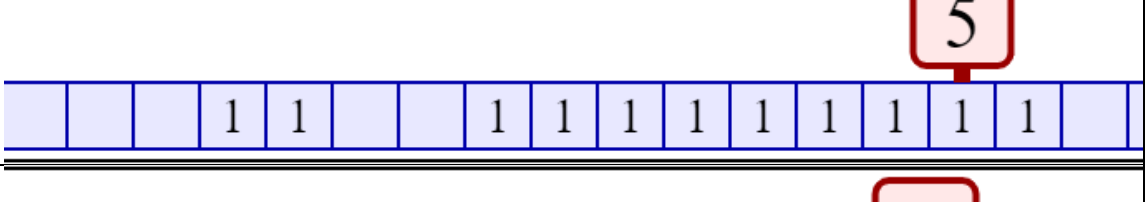
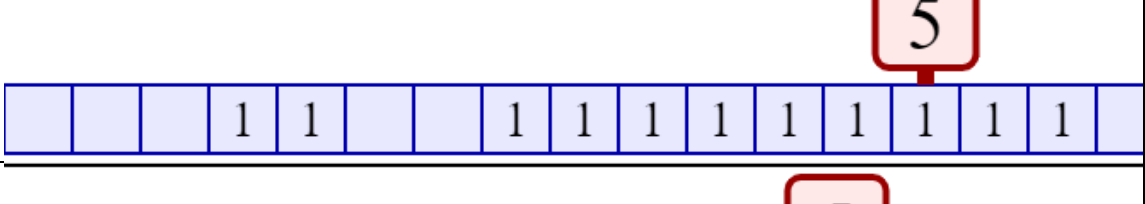
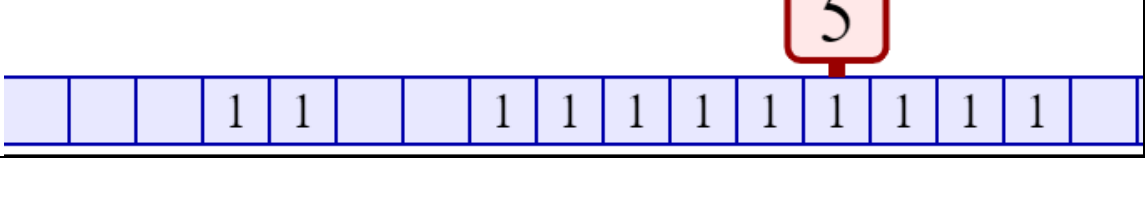
Computati on Configurati on	Tape Configurations	Current State	Pointer Location
Config = (M1,T1,0)	<div>0</div> 	State q0	0

Config = (M1,T1,1)		State q1	1
Config = (M1,T1,2)		State q1	2
Config = (M1,T1,3)		State q1	3
Config = (M1,T1,4)		State q2	4
Config = (M1,T1,5)		State q3	5
Config = (M1,T1,6)		State q4	6
Config = (M1,T1,7)		State q5	5
Config = (M1,T1,8)		State q5	4

Config = (M1,T1,9)		State q5	3
Config = (M1,T1,10)		State q6	2
Config = (M1,T1,11)		State q6	1
Config = (M1,T1,12)		State q6	0
Config = (M1,T1,13)		State q0	1
Config = (M1,T1,14)		State q1	2
Config = (M1,T1,15)		State q1	3
Config = (M1,T1,16)		State q2	4
Config = (M1,T1,17)		State q2	5

Config = (M1,T1,18)		State q2	6
Config = (M1,T1,19)		State q2	7
Config = (M1,T1,20)		State q3	8
Config = (M1,T1,21)		State q4	9
Config = (M1,T1,22)		State q5	8
Config = (M1,T1,23)		State q5	7
Config = (M1,T1,24)		State q5	6
Config = (M1,T1,25)		State q5	5
Config = (M1,T1,26)		State q5	4

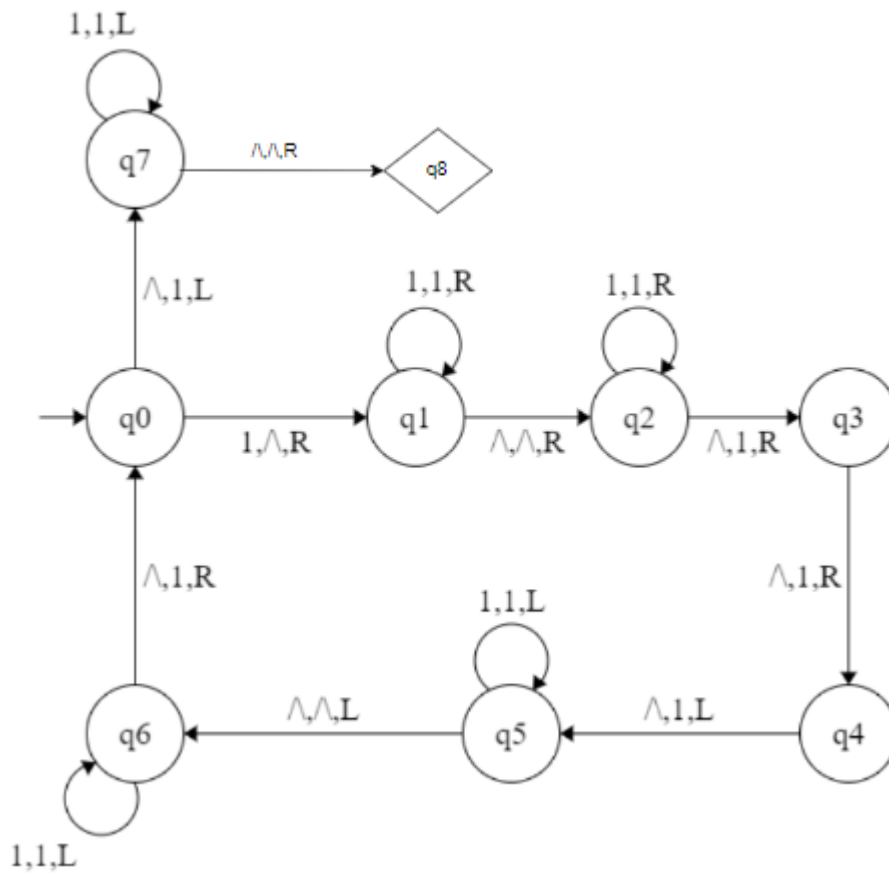
Config = (M1,T1,27)		State q5	3
Config = (M1,T1,28)		State q6	2
Config = (M1,T1,29)		State q6	1
Config = (M1,T1,30)		State q0	2
Config = (M1,T1,31)		State q1	3
Config = (M1,T1,32)		State q2	4
Config = (M1,T1,34)		State q2	5
Config = (M1,T1,35)		State q2	6
Config = (M1,T1,36)		State q2	7

Config = (M1,T1,37)		State q2	8
Config = (M1,T1,38)		State q2	9
Config = (M1,T1,39)		State q2	10
Config = (M1,T1,40)		State q3	11
Config = (M1,T1,41)		State q4	12
Config = (M1,T1,42)		State q5	11
Config = (M1,T1,43)		State q5	10
Config = (M1,T1,44)		State q5	9

Config = (M1,T1,45)	<div> <div>5</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div></div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q5	8
Config = (M1,T1,46)	<div> <div>5</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div></div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q5	7
Config = (M1,T1,47)	<div> <div>5</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div></div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q5	6
Config = (M1,T1,48)	<div> <div>5</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div></div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q5	5
Config = (M1,T1,49)	<div> <div>5</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div></div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q5	4
Config = (M1,T1,50)	<div> <div>5</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div></div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q5	3
Config = (M1,T1,51)	<div> <div>6</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div></div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q6	2
Config = (M1,T1,52)	<div> <div>0</div> <div> <div></div><div></div><div></div><div></div><div>1</div><div>1</div><div>1</div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q0	3
Config = (M1,T1,53)	<div> <div>7</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div>1</div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q7	2

Config = (M1,T1,54)	<div> <div>7</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div>1</div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q7	1
Config = (M1,T1,55)	<div> <div>7</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div>1</div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q7	0
Config = (M1,T1,56)	<div> <div>7</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div>1</div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q7	-1
Config = (M1,T1,57)	<div> <div>8</div> <div> <div></div><div></div><div></div><div>1</div><div>1</div><div>1</div><div></div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div>1</div><div></div> </div> </div>	State q8	0

Change to proposed graph





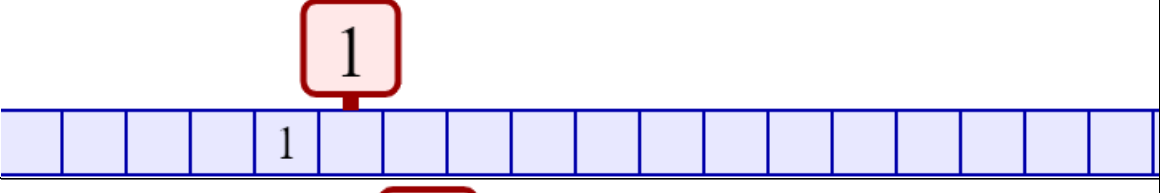
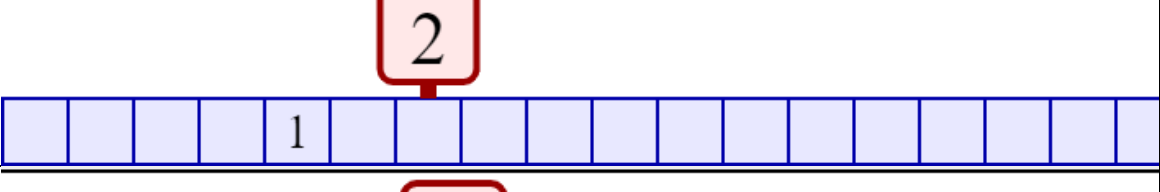
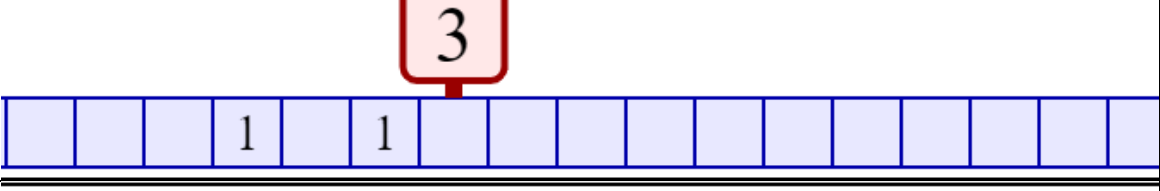
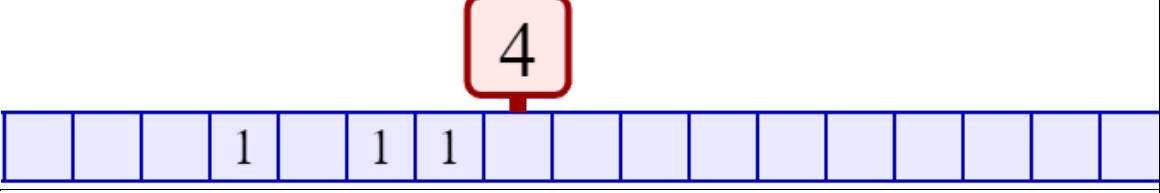
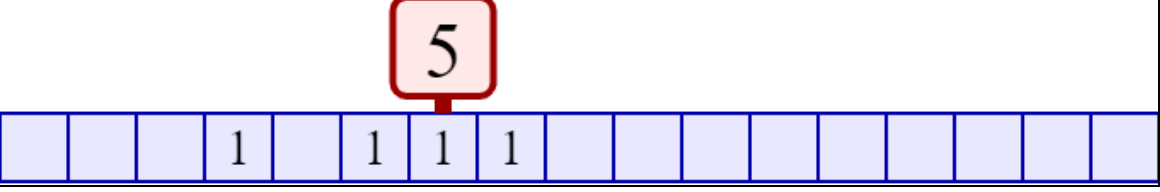
The minimal change I made to my old graph is changing the action between state q0 and q7. Before when we encountered a blank symbol in state q0, we simply left the space as it is and moved left, now we change that blank space to a 1. This can be shown below:

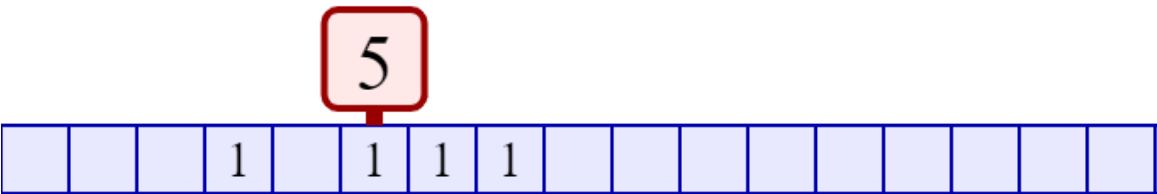
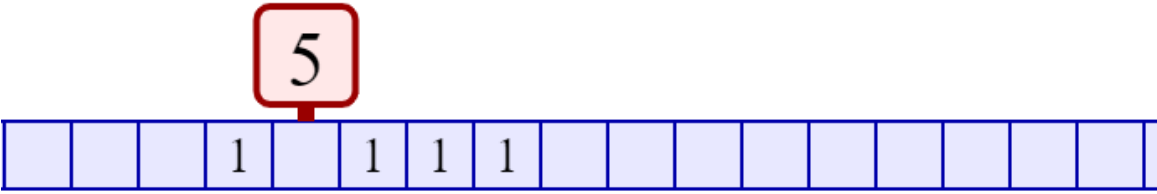
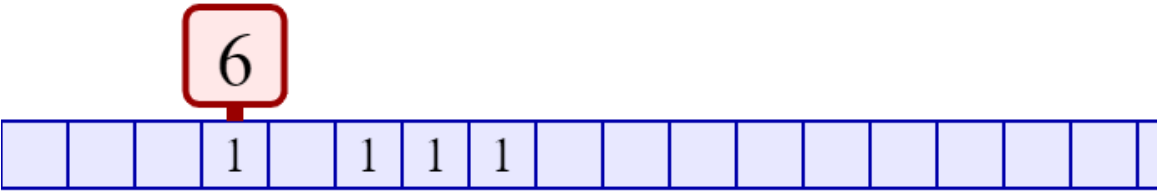
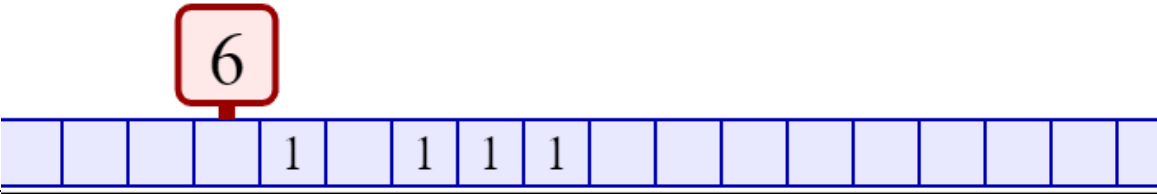
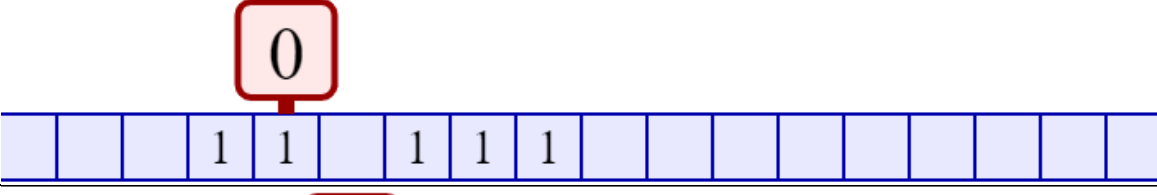
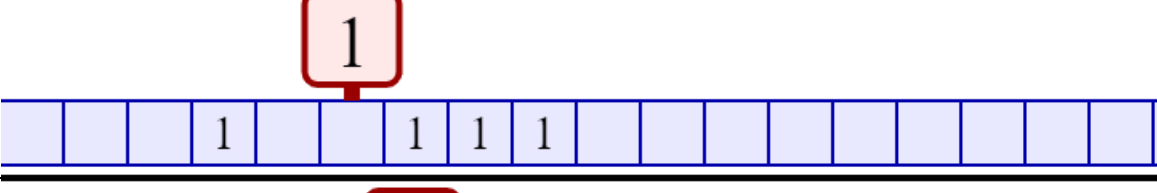
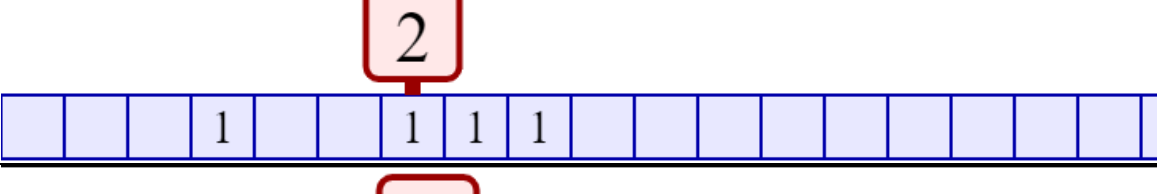
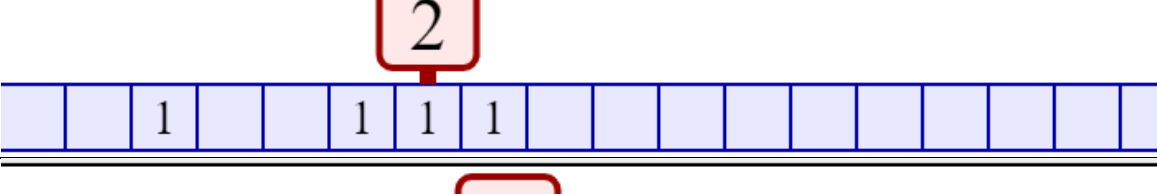
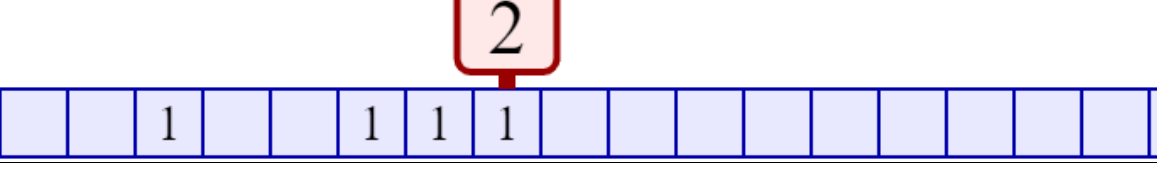
$$M_{ex}(q0, \Lambda) = (q7, \Lambda, L) \quad \text{to} \quad M_{ex}(q0, \Lambda) = (q7, 1, L)$$

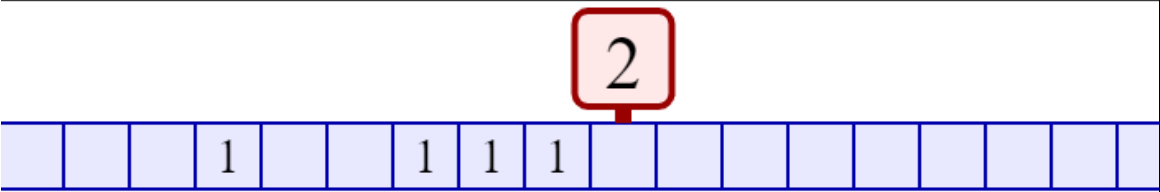
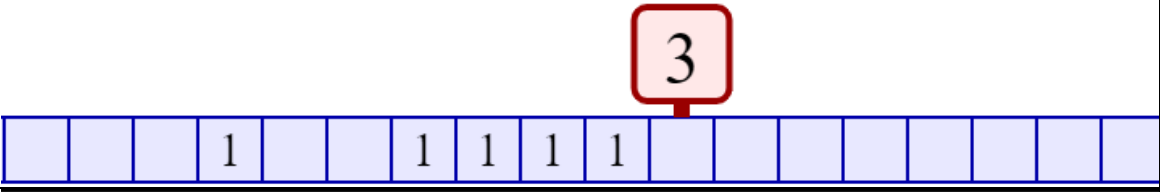
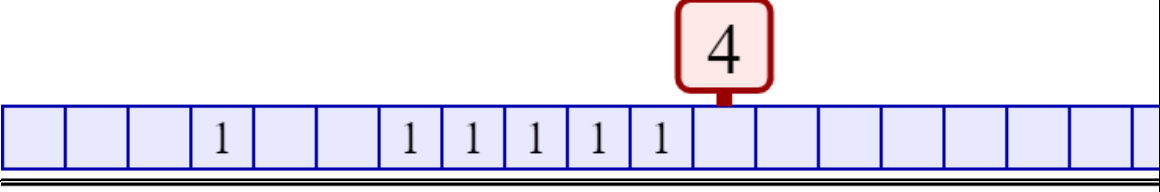
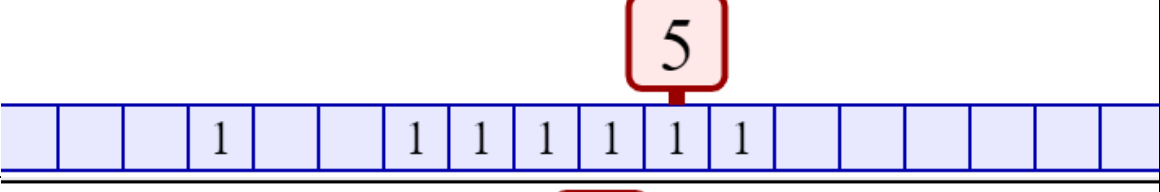
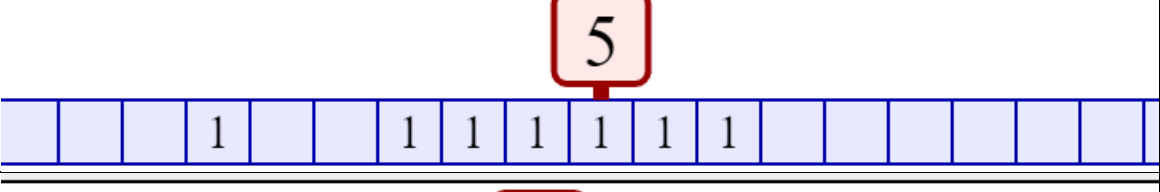
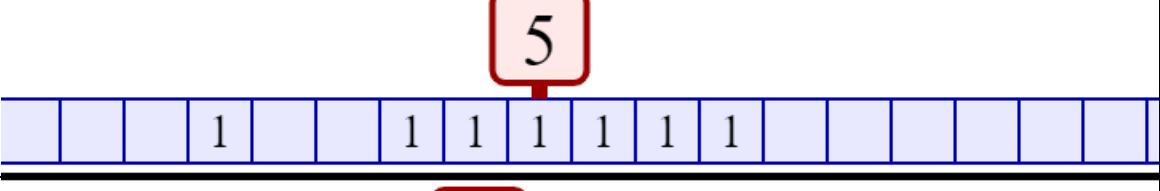
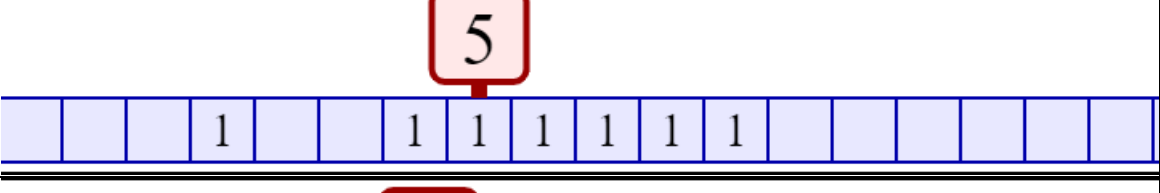
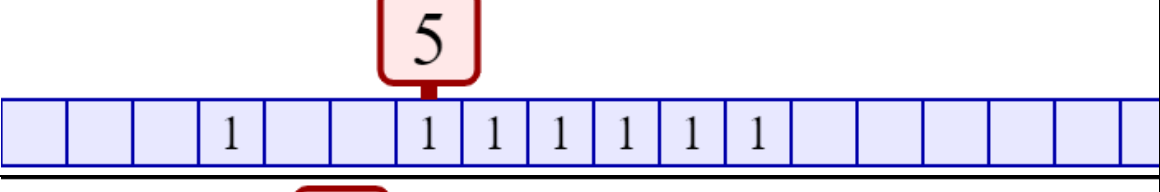
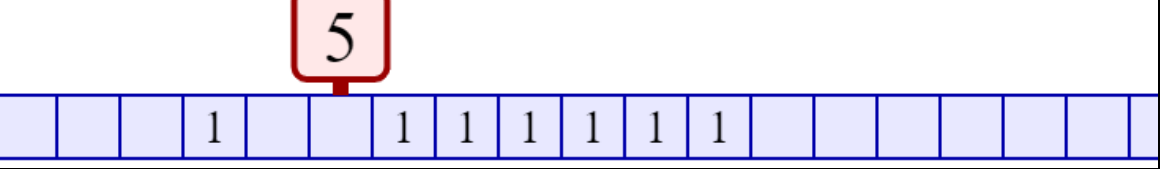
The change I made transforms the graph from the function $(n, 3n)$ to $4n + 1$ because before we had a space between the original input unary number e.g. 1 and the output number $(1 * 3)$ in unary representation, so we effectively had $1n$ (input) $\wedge 3n$ (output). Now since there is a 1 there instead of the space we have $1n 1 3n$ which simplifies to $4n + 1$ and in unary 11111. Hence making the new graph a function of $4n + 1$.



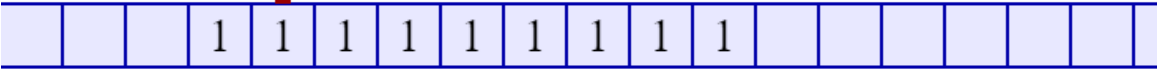
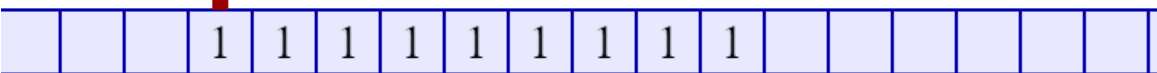
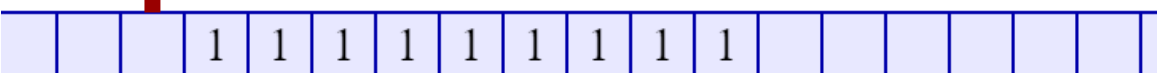
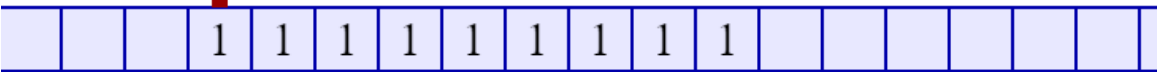
Turing Machine file configuration TM7.json

Input 11 :

Computation Configuration	Tape Configurations	Current State	Pointer Location
Config = (M1,T1,0)		State q0	0
Config = (M1,T1,1)		State q1	1
Config = (M1,T1,2)		State q1	2
Config = (M1,T1,3)		State q2	3
Config = (M1,T1,4)		State q3	4
Config = (M1,T1,5)		State q4	5
Config = (M1,T1,6)		State q5	4

Config = (M1,T1,7)		State q5	3
Config = (M1,T1,8)		State q5	2
Config = (M1,T1,9)		State q6	1
Config = (M1,T1,10)		State q6	0
Config = (M1,T1,11)		State q0	1
Config = (M1,T1,12)		State q1	2
Config = (M1,T1,13)		State q2	3
Config = (M1,T1,14)		State q2	4
Config = (M1,T1,15)		State q2	5

Config = (M1,T1,16)		State q2	6
Config = (M1,T1,17)		State q3	7
Config = (M1,T1,18)		State q4	8
Config = (M1,T1,19)		State q5	7
Config = (M1,T1,20)		State q5	6
Config = (M1,T1,21)		State q5	5
Config = (M1,T1,22)		State q5	4
Config = (M1,T1,23)		State q5	3
Config = (M1,T1,24)		State q5	2

Config = (M1,T1,25)	<div>6</div> 	State q6	1
Config = (M1,T1,26)	<div>0</div> 	State q0	2
Config = (M1,T1,27)	<div>7</div> 	State q7	1
Config = (M1,T1,28)	<div>7</div> 	State q7	0
Config = (M1,T1,29)	<div>7</div> 	State q7	-1
Config = (M1,T1,30)	<div>8</div> 	State q8	0