

Source File: ~/4301/10/lab10.(C|CPP|cpp|c++|cc|cxx|cp)
Input: Under control of main function
Output: Under control of main function
Value: 3

For $\Sigma = \{a, b, 0, 1, =, \sqcup\}$, construct a Turing machine for the following:

$$\left\{ \begin{array}{l} (x =, x = ans) \mid x \in \{a, b\}^*, \\ ans = \begin{cases} 1, & \text{if } x \text{ has twice as many } a\text{'s as } b\text{'s, and} \\ 0, & \text{otherwise} \end{cases} \end{array} \right\}$$

This assignment will use the same header file and sample main function used for Lab 09. A sample execution sequence is shown in Figure 1. To use the Makefile as distributed in class, add a target of `lab10` to `targets2srcfiles`.

Additional notes:

- As each input line is read in, the main function creates the initial tape contents as follows: ten blanks followed by the original input line followed by more blanks.
- The halt state is 0 and the start state is 1.

```

1  newuser@csunix ~> cd 4301
2  newuser@csunix ~/4301> ./getlab.ksh 10
3  * Checking to see if a folder exists for Lab 10. . .No
4  * Creating a folder for Lab 10
5  * Checking to see if Lab 10 has sample input and output files. . .Yes
6  * Copying input and output files for Lab 10
7  from folder /usr/local/4301/data/10 to folder ./10
8  * Checking to see if /usr/local/4301/src/lab10main.C exists. . .Yes
9  * Copying file /usr/local/4301/src/lab10main.C to folder ./10
10 * Checking to see if /usr/local/4301/include/lab10.h exists. . .No
11 * Copying file /usr/local/4301/src/Makefile to folder ./10
12 * Adding a target of lab10 to targets2srcfiles
13 * Touching file ./10/lab10.cpp
14 * Edit file ./10/lab10.cpp in Notepad++
15 newuser@csunix ~/4301> cd 10
16 newuser@csunix ~/4301/10> ls
17 01.dat      01.out      Makefile    lab10.cpp   lab10main.C
18 newuser@csunix ~/4301/10> make lab10
19 g++ -g -Wall -std=c++11 -c lab10main.C -I/usr/local/4301/include -I.
20 g++ -g -Wall -std=c++11 -c lab10.cpp -I/usr/local/4301/include -I.
21 g++ -o lab10 lab10main.o lab10.o -L/usr/local/4301/lib -lm
22 newuser@csunix ~/4301/10> cat 01.dat
23 =
24 a=
25 b=
26 aa=
27 ab=
28 ba=
29 bb=
30 aaa=

```

Figure 1. Commands to Compile, Link, & Run Lab 10 (Part 1 of 5)

```
31 aab=
32 aba=
33 abb=
34 baa=
35 bab=
36 bba=
37 bbb=
38 aaba=
39 aabb=
40 abab=
41 babb=
42 bbba=
43 aaaab=
44 aabab=
45 baaaa=
46 aaaabb=
47 aaabab=
48 aaabba=
49 aabaab=
50 aababa=
51 aabbaa=
52 abaaab=
53 abaaba=
54 ababaa=
55 abbaaa=
56 baaaaab=
57 baaaba=
58 baabaa=
59 babaaa=
60 bbaaaa=
61 aaabbbb=
62 baaabaab=
63 bbaaaaab=
64 bbbaaaaa=
65 aaaaaabbbb=
66 aaaabbbbb=
67 bbbbaaaaa=
68 newuser@csunix ~/4301/10> cat 01.dat | ./lab10
69 Your Name
70 CS 4301
71 Lab 10
72 {(x=, x=ans) | x is in {a,b}* and
73     ans = 1 if x has twice as many a's as b's, and
74     ans = 0 otherwise}
75
76 Input:  =
77 Output:      =1
78
```

Figure 1. Commands to Compile, Link, & Run Lab 10 (Part 2 of 5)

```
79 Input: a=
80 Output:      a=0
81
82 Input: b=
83 Output:      b=0
84
85 Input: aa=
86 Output:      aa=0
87
88 Input: ab=
89 Output:      ab=0
90
91 Input: ba=
92 Output:      ba=0
93
94 Input: bb=
95 Output:      bb=0
96
97 Input: aaa=
98 Output:      aaa=0
99
100 Input: aab=
101 Output:      aab=1
102
103 Input: aba=
104 Output:      aba=1
105
106 Input: abb=
107 Output:      abb=0
108
109 Input: baa=
110 Output:      baa=1
111
112 Input: bab=
113 Output:      bab=0
114
115 Input: bba=
116 Output:      bba=0
117
118 Input: bbb=
119 Output:      bbb=0
120
121 Input: aaba=
122 Output:      aaba=0
123
124 Input: aabb=
125 Output:      aabb=0
126
```

Figure 1. Commands to Compile, Link, & Run Lab 10 (Part 3 of 5)

```
127 Input: abab=
128 Output:      abab=0
129
130 Input: babb=
131 Output:      babb=0
132
133 Input: bbba=
134 Output:      bbba=0
135
136 Input: aaaab=
137 Output:      aaaab=0
138
139 Input: aabab=
140 Output:      aabab=0
141
142 Input: baaaa=
143 Output:      baaaa=0
144
145 Input: aaaabb=
146 Output:      aaaabb=1
147
148 Input: aaabab=
149 Output:      aaabab=1
150
151 Input: aaabba=
152 Output:      aaabba=1
153
154 Input: aabaab=
155 Output:      aabaab=1
156
157 Input: aababa=
158 Output:      aababa=1
159
160 Input: aabbaa=
161 Output:      aabbaa=1
162
163 Input: abaaab=
164 Output:      abaaab=1
165
166 Input: abaaba=
167 Output:      abaaba=1
168
169 Input: ababaa=
170 Output:      ababaa=1
171
172 Input: abbaaa=
173 Output:      abbaaa=1
174
```

Figure 1. Commands to Compile, Link, & Run Lab 10 (Part 4 of 5)

```
175 Input: baaaab=
176 Output:          baaaab=1
177
178 Input: baaaba=
179 Output:          baaaba=1
180
181 Input: baabaa=
182 Output:          baabaa=1
183
184 Input: babaaa=
185 Output:          babaaa=1
186
187 Input: bbaaaa=
188 Output:          bbaaaa=1
189
190 Input: aaabbbb=
191 Output:          aaabbbb=0
192
193 Input: baaabaab=
194 Output:          baaabaab=0
195
196 Input: bbaaaaab=
197 Output:          bbaaaaab=0
198
199 Input: bbbaaaaa=
200 Output:          bbbaaaaa=0
201
202 Input: aaaaaabbbb=
203 Output:          aaaaaabbbb=0
204
205 Input: aaaabbbbb=
206 Output:          aaaabbbbb=0
207
208 Input: bbbbaaaaa=
209 Output:          bbbbaaaaa=0
210
211 newuser@csunix ~/4301/10> cat 01.dat | ./lab10 > my.out
212 newuser@csunix ~/4301/10> diff 01.out my.out
213 newuser@csunix ~/4301/10>
```

Figure 1. Commands to Compile, Link, & Run Lab 10 (Part 5 of 5)