

## TWA Output Proof of Concept;

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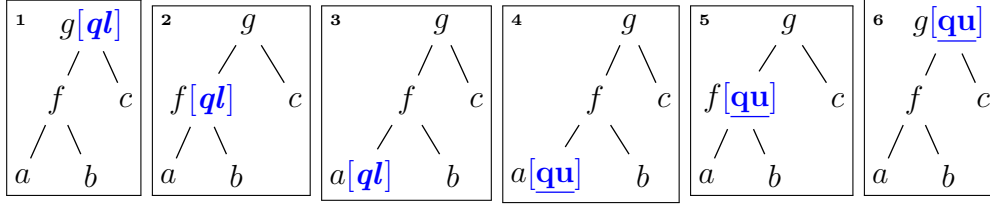
Generated on 2011-02-07 15:39:10 (GMT)

```
TWA [] = {
  alphas = #6{a/0, b/0, c/0, f/2, g/2, h/2}
  states = #2{ql, qu}
  inits = #1{ql}
  finals = #1{qu}
  rules = #14{(a ql @) -> (* qu), (a ql <) -> (* qu), (a
    qu <) -> (! qu), (b qu <) -> (! qu), (c qu <) ->
    (! qu), (f ql @) -> (< ql), (f ql <) -> (< ql), (f
    qu <) -> (! qu), (g ql @) -> (< ql), (g ql <) -> (<
    ql), (g qu <) -> (! qu), (h ql @) -> (< ql), (h ql
    <) -> (< ql), (h qu <) -> (! qu)}
}
```

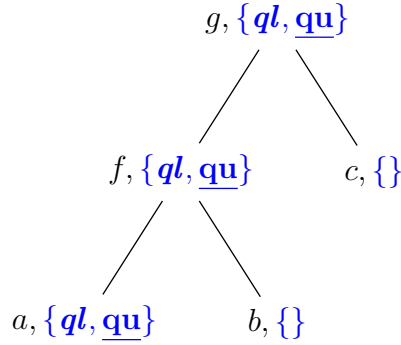
## 1 Deterministic run

ACCEPTING

$(ql, \varepsilon) \rightarrow (ql, 0) \rightarrow (ql, 0.0) \rightarrow (\underline{qu}, 0.0) \rightarrow (\underline{qu}, 0) \rightarrow (\underline{qu}, \varepsilon)$



## 2 Nondeterministic power run



## 3 Transformations into BUTA

Note: Post-processing BUTA Cleanup is deactivated.

### 3.1 Classical loop-based transformation

```

States/Loops correspondance table
0 --> [a,@,#3{(q1,q1), (q1,qu), (qu,qu)}]
1 --> [a,<,#3{(q1,q1), (q1,qu), (qu,qu)}]
2 --> [a,>,#2{(q1,q1), (qu,qu)}]
3 --> [b,@,#2{(q1,q1), (qu,qu)}]
4 --> [b,<,#2{(q1,q1), (qu,qu)}]
5 --> [b,>,#2{(q1,q1), (qu,qu)}]
6 --> [c,@,#2{(q1,q1), (qu,qu)}]
7 --> [c,<,#2{(q1,q1), (qu,qu)}]
8 --> [c,>,#2{(q1,q1), (qu,qu)}]
9 --> [f,@,#3{(q1,q1), (q1,qu), (qu,qu)}]
10 --> [f,@,#2{(q1,q1), (qu,qu)}]
11 --> [f,<,#3{(q1,q1), (q1,qu), (qu,qu)}]
12 --> [f,<,#2{(q1,q1), (qu,qu)}]
13 --> [f,>,#2{(q1,q1), (qu,qu)}]

```

```

14 --> [g,@,#3{(q1,q1), (q1,qu), (qu,qu)}]
15 --> [g,@,#2{(q1,q1), (qu,qu)}]
16 --> [g,<,#3{(q1,q1), (q1,qu), (qu,qu)}]
17 --> [g,<,#2{(q1,q1), (qu,qu)}]
18 --> [g,>,#2{(q1,q1), (qu,qu)}]
19 --> [h,@,#3{(q1,q1), (q1,qu), (qu,qu)}]
20 --> [h,@,#2{(q1,q1), (qu,qu)}]
21 --> [h,<,#3{(q1,q1), (q1,qu), (qu,qu)}]
22 --> [h,<,#2{(q1,q1), (qu,qu)}]
23 --> [h,>,#2{(q1,q1), (qu,qu)}]

```

```

TAGED 'fromTWA-Sigma' [1986] = {
  alphab = #6{a/0, b/0, c/0, f/2, g/2, h/2}
  states = #24{0, 1, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19,
    2, 20, 21, 22, 23, 3, 4, 5, 6, 7, 8, 9}
  final = #4{0, 14, 19, 9}
  rules = #495{a()->0, a()->1, a()->2, b()->3, b()->4, b()
    ->5,
c()->6, c()->7, c()->8, f(1, 13)->11, f(1, 13)->13,
f(1, 13)->9, f(1, 18)->11, f(1, 18)->13, f(1, 18)->9,
f(1, 2)->11, f(1, 2)->13, f(1, 2)->9, f(1, 23)->11,
f(1, 23)->13, f(1, 23)->9, f(1, 5)->11, f(1, 5)->13,
f(1, 5)->9, f(1, 8)->11, f(1, 8)->13, f(1, 8)->9,
f(11, 13)->11, f(11, 13)->13, f(11, 13)->9, f(11,
18)->11, f(11, 18)->13, f(11, 18)->9, f(11, 2)->11,
f(11, 2)->13, f(11, 2)->9, f(11, 23)->11, f(11, 23)->13,
f(11, 23)->9, f(11, 5)->11, f(11, 5)->13, f(11, 5)->9,
f(11, 8)->11, f(11, 8)->13, f(11, 8)->9, f(12, 13)->10,
f(12, 13)->12, f(12, 13)->13, f(12, 18)->10, f(12,
18)->12, f(12, 18)->13, f(12, 2)->10, f(12, 2)->12,
f(12, 2)->13, f(12, 23)->10, f(12, 23)->12, f(12,
23)->13, f(12, 5)->10, f(12, 5)->12, f(12, 5)->13,
f(12, 8)->10, f(12, 8)->12, f(12, 8)->13, f(16, 13)->11,
f(16, 13)->13, f(16, 13)->9, f(16, 18)->11, f(16,
18)->13, f(16, 18)->9, f(16, 2)->11, f(16, 2)->13,
f(16, 2)->9, f(16, 23)->11, f(16, 23)->13, f(16, 23)->9,
f(16, 5)->11, f(16, 5)->13, f(16, 5)->9, f(16, 8)->11,
f(16, 8)->13, f(16, 8)->9, f(17, 13)->10, f(17, 13)->12,
f(17, 13)->13, f(17, 18)->10, f(17, 18)->12, f(17,
18)->13, f(17, 2)->10, f(17, 2)->12, f(17, 2)->13,
f(17, 23)->10, f(17, 23)->12, f(17, 23)->13, f(17,
5)->10, f(17, 5)->12, f(17, 5)->13, f(17, 8)->10,

```

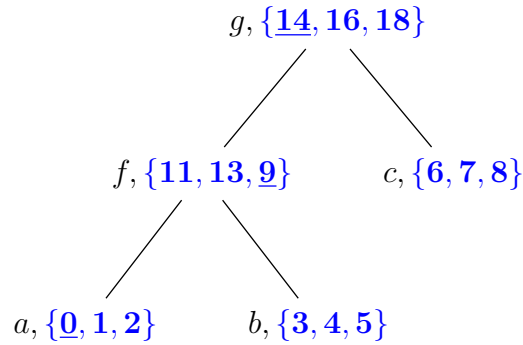
$f(17, 8) \rightarrow 12$ ,  $f(17, 8) \rightarrow 13$ ,  $f(21, 13) \rightarrow 11$ ,  $f(21, 13) \rightarrow 13$ ,  
 $f(21, 13) \rightarrow 9$ ,  $f(21, 18) \rightarrow 11$ ,  $f(21, 18) \rightarrow 13$ ,  $f(21,$   
 $18) \rightarrow 9$ ,  $f(21, 2) \rightarrow 11$ ,  $f(21, 2) \rightarrow 13$ ,  $f(21, 2) \rightarrow 9$ ,  $f(21,$   
 $23) \rightarrow 11$ ,  $f(21, 23) \rightarrow 13$ ,  $f(21, 23) \rightarrow 9$ ,  $f(21, 5) \rightarrow 11$ ,  
 $f(21, 5) \rightarrow 13$ ,  $f(21, 5) \rightarrow 9$ ,  $f(21, 8) \rightarrow 11$ ,  $f(21, 8) \rightarrow 13$ ,  
 $f(21, 8) \rightarrow 9$ ,  $f(22, 13) \rightarrow 10$ ,  $f(22, 13) \rightarrow 12$ ,  $f(22, 13) \rightarrow 13$ ,  
 $f(22, 18) \rightarrow 10$ ,  $f(22, 18) \rightarrow 12$ ,  $f(22, 18) \rightarrow 13$ ,  $f(22,$   
 $2) \rightarrow 10$ ,  $f(22, 2) \rightarrow 12$ ,  $f(22, 2) \rightarrow 13$ ,  $f(22, 23) \rightarrow 10$ ,  
 $f(22, 23) \rightarrow 12$ ,  $f(22, 23) \rightarrow 13$ ,  $f(22, 5) \rightarrow 10$ ,  $f(22,$   
 $5) \rightarrow 12$ ,  $f(22, 5) \rightarrow 13$ ,  $f(22, 8) \rightarrow 10$ ,  $f(22, 8) \rightarrow 12$ ,  
 $f(22, 8) \rightarrow 13$ ,  $f(4, 13) \rightarrow 10$ ,  $f(4, 13) \rightarrow 12$ ,  $f(4, 13) \rightarrow 13$ ,  
 $f(4, 18) \rightarrow 10$ ,  $f(4, 18) \rightarrow 12$ ,  $f(4, 18) \rightarrow 13$ ,  $f(4, 2) \rightarrow 10$ ,  
 $f(4, 2) \rightarrow 12$ ,  $f(4, 2) \rightarrow 13$ ,  $f(4, 23) \rightarrow 10$ ,  $f(4, 23) \rightarrow 12$ ,  
 $f(4, 23) \rightarrow 13$ ,  $f(4, 5) \rightarrow 10$ ,  $f(4, 5) \rightarrow 12$ ,  $f(4, 5) \rightarrow 13$ ,  
 $f(4, 8) \rightarrow 10$ ,  $f(4, 8) \rightarrow 12$ ,  $f(4, 8) \rightarrow 13$ ,  $f(7, 13) \rightarrow 10$ ,  
 $f(7, 13) \rightarrow 12$ ,  $f(7, 13) \rightarrow 13$ ,  $f(7, 18) \rightarrow 10$ ,  $f(7, 18) \rightarrow 12$ ,  
 $f(7, 18) \rightarrow 13$ ,  $f(7, 2) \rightarrow 10$ ,  $f(7, 2) \rightarrow 12$ ,  $f(7, 2) \rightarrow 13$ ,  
 $f(7, 23) \rightarrow 10$ ,  $f(7, 23) \rightarrow 12$ ,  $f(7, 23) \rightarrow 13$ ,  $f(7, 5) \rightarrow 10$ ,  
 $f(7, 5) \rightarrow 12$ ,  $f(7, 5) \rightarrow 13$ ,  $f(7, 8) \rightarrow 10$ ,  $f(7, 8) \rightarrow 12$ ,  
 $f(7, 8) \rightarrow 13$ ,  $g(1, 13) \rightarrow 14$ ,  $g(1, 13) \rightarrow 16$ ,  $g(1, 13) \rightarrow 18$ ,  
 $g(1, 18) \rightarrow 14$ ,  $g(1, 18) \rightarrow 16$ ,  $g(1, 18) \rightarrow 18$ ,  $g(1, 2) \rightarrow 14$ ,  
 $g(1, 2) \rightarrow 16$ ,  $g(1, 2) \rightarrow 18$ ,  $g(1, 23) \rightarrow 14$ ,  $g(1, 23) \rightarrow 16$ ,  
 $g(1, 23) \rightarrow 18$ ,  $g(1, 5) \rightarrow 14$ ,  $g(1, 5) \rightarrow 16$ ,  $g(1, 5) \rightarrow 18$ ,  
 $g(1, 8) \rightarrow 14$ ,  $g(1, 8) \rightarrow 16$ ,  $g(1, 8) \rightarrow 18$ ,  $g(11, 13) \rightarrow 14$ ,  
 $g(11, 13) \rightarrow 16$ ,  $g(11, 13) \rightarrow 18$ ,  $g(11, 18) \rightarrow 14$ ,  $g(11,$   
 $18) \rightarrow 16$ ,  $g(11, 18) \rightarrow 18$ ,  $g(11, 2) \rightarrow 14$ ,  $g(11, 2) \rightarrow 16$ ,  
 $g(11, 2) \rightarrow 18$ ,  $g(11, 23) \rightarrow 14$ ,  $g(11, 23) \rightarrow 16$ ,  $g(11,$   
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 $g(11, 8) \rightarrow 14$ ,  $g(11, 8) \rightarrow 16$ ,  $g(11, 8) \rightarrow 18$ ,  $g(12, 13) \rightarrow 15$ ,  
 $g(12, 13) \rightarrow 17$ ,  $g(12, 13) \rightarrow 18$ ,  $g(12, 18) \rightarrow 15$ ,  $g(12,$   
 $18) \rightarrow 17$ ,  $g(12, 18) \rightarrow 18$ ,  $g(12, 2) \rightarrow 15$ ,  $g(12, 2) \rightarrow 17$ ,  
 $g(12, 2) \rightarrow 18$ ,  $g(12, 23) \rightarrow 15$ ,  $g(12, 23) \rightarrow 17$ ,  $g(12,$   
 $23) \rightarrow 18$ ,  $g(12, 5) \rightarrow 15$ ,  $g(12, 5) \rightarrow 17$ ,  $g(12, 5) \rightarrow 18$ ,  
 $g(12, 8) \rightarrow 15$ ,  $g(12, 8) \rightarrow 17$ ,  $g(12, 8) \rightarrow 18$ ,  $g(16, 13) \rightarrow 14$ ,  
 $g(16, 13) \rightarrow 16$ ,  $g(16, 13) \rightarrow 18$ ,  $g(16, 18) \rightarrow 14$ ,  $g(16,$   
 $18) \rightarrow 16$ ,  $g(16, 18) \rightarrow 18$ ,  $g(16, 2) \rightarrow 14$ ,  $g(16, 2) \rightarrow 16$ ,  
 $g(16, 2) \rightarrow 18$ ,  $g(16, 23) \rightarrow 14$ ,  $g(16, 23) \rightarrow 16$ ,  $g(16,$   
 $23) \rightarrow 18$ ,  $g(16, 5) \rightarrow 14$ ,  $g(16, 5) \rightarrow 16$ ,  $g(16, 5) \rightarrow 18$ ,  
 $g(16, 8) \rightarrow 14$ ,  $g(16, 8) \rightarrow 16$ ,  $g(16, 8) \rightarrow 18$ ,  $g(17, 13) \rightarrow 15$ ,  
 $g(17, 13) \rightarrow 17$ ,  $g(17, 13) \rightarrow 18$ ,  $g(17, 18) \rightarrow 15$ ,  $g(17,$   
 $18) \rightarrow 17$ ,  $g(17, 18) \rightarrow 18$ ,  $g(17, 2) \rightarrow 15$ ,  $g(17, 2) \rightarrow 17$ ,  
 $g(17, 2) \rightarrow 18$ ,  $g(17, 23) \rightarrow 15$ ,  $g(17, 23) \rightarrow 17$ ,  $g(17,$   
 $23) \rightarrow 18$ ,  $g(17, 5) \rightarrow 15$ ,  $g(17, 5) \rightarrow 17$ ,  $g(17, 5) \rightarrow 18$ ,

$g(17, 8) \rightarrow 15, g(17, 8) \rightarrow 17, g(17, 8) \rightarrow 18, g(21, 13) \rightarrow 14,$   
 $g(21, 13) \rightarrow 16, g(21, 13) \rightarrow 18, g(21, 18) \rightarrow 14, g(21,$   
 $18) \rightarrow 16, g(21, 18) \rightarrow 18, g(21, 2) \rightarrow 14, g(21, 2) \rightarrow 16,$   
 $g(21, 2) \rightarrow 18, g(21, 23) \rightarrow 14, g(21, 23) \rightarrow 16, g(21,$   
 $23) \rightarrow 18, g(21, 5) \rightarrow 14, g(21, 5) \rightarrow 16, g(21, 5) \rightarrow 18,$   
 $g(21, 8) \rightarrow 14, g(21, 8) \rightarrow 16, g(21, 8) \rightarrow 18, g(22, 13) \rightarrow 15,$   
 $g(22, 13) \rightarrow 17, g(22, 13) \rightarrow 18, g(22, 18) \rightarrow 15, g(22,$   
 $18) \rightarrow 17, g(22, 18) \rightarrow 18, g(22, 2) \rightarrow 15, g(22, 2) \rightarrow 17,$   
 $g(22, 2) \rightarrow 18, g(22, 23) \rightarrow 15, g(22, 23) \rightarrow 17, g(22,$   
 $23) \rightarrow 18, g(22, 5) \rightarrow 15, g(22, 5) \rightarrow 17, g(22, 5) \rightarrow 18,$   
 $g(22, 8) \rightarrow 15, g(22, 8) \rightarrow 17, g(22, 8) \rightarrow 18, g(4, 13) \rightarrow 15,$   
 $g(4, 13) \rightarrow 17, g(4, 13) \rightarrow 18, g(4, 18) \rightarrow 15, g(4, 18) \rightarrow 17,$   
 $g(4, 18) \rightarrow 18, g(4, 2) \rightarrow 15, g(4, 2) \rightarrow 17, g(4, 2) \rightarrow 18,$   
 $g(4, 23) \rightarrow 15, g(4, 23) \rightarrow 17, g(4, 23) \rightarrow 18, g(4, 5) \rightarrow 15,$   
 $g(4, 5) \rightarrow 17, g(4, 5) \rightarrow 18, g(4, 8) \rightarrow 15, g(4, 8) \rightarrow 17,$   
 $g(4, 8) \rightarrow 18, g(7, 13) \rightarrow 15, g(7, 13) \rightarrow 17, g(7, 13) \rightarrow 18,$   
 $g(7, 18) \rightarrow 15, g(7, 18) \rightarrow 17, g(7, 18) \rightarrow 18, g(7, 2) \rightarrow 15,$   
 $g(7, 2) \rightarrow 17, g(7, 2) \rightarrow 18, g(7, 23) \rightarrow 15, g(7, 23) \rightarrow 17,$   
 $g(7, 23) \rightarrow 18, g(7, 5) \rightarrow 15, g(7, 5) \rightarrow 17, g(7, 5) \rightarrow 18,$   
 $g(7, 8) \rightarrow 15, g(7, 8) \rightarrow 17, g(7, 8) \rightarrow 18, h(1, 13) \rightarrow 19,$   
 $h(1, 13) \rightarrow 21, h(1, 13) \rightarrow 23, h(1, 18) \rightarrow 19, h(1, 18) \rightarrow 21,$   
 $h(1, 18) \rightarrow 23, h(1, 2) \rightarrow 19, h(1, 2) \rightarrow 21, h(1, 2) \rightarrow 23,$   
 $h(1, 23) \rightarrow 19, h(1, 23) \rightarrow 21, h(1, 23) \rightarrow 23, h(1, 5) \rightarrow 19,$   
 $h(1, 5) \rightarrow 21, h(1, 5) \rightarrow 23, h(1, 8) \rightarrow 19, h(1, 8) \rightarrow 21,$   
 $h(1, 8) \rightarrow 23, h(11, 13) \rightarrow 19, h(11, 13) \rightarrow 21, h(11, 13) \rightarrow 23,$   
 $h(11, 18) \rightarrow 19, h(11, 18) \rightarrow 21, h(11, 18) \rightarrow 23, h(11,$   
 $2) \rightarrow 19, h(11, 2) \rightarrow 21, h(11, 2) \rightarrow 23, h(11, 23) \rightarrow 19,$   
 $h(11, 23) \rightarrow 21, h(11, 23) \rightarrow 23, h(11, 5) \rightarrow 19, h(11,$   
 $5) \rightarrow 21, h(11, 5) \rightarrow 23, h(11, 8) \rightarrow 19, h(11, 8) \rightarrow 21,$   
 $h(11, 8) \rightarrow 23, h(12, 13) \rightarrow 20, h(12, 13) \rightarrow 22, h(12,$   
 $13) \rightarrow 23, h(12, 18) \rightarrow 20, h(12, 18) \rightarrow 22, h(12, 18) \rightarrow 23,$   
 $h(12, 2) \rightarrow 20, h(12, 2) \rightarrow 22, h(12, 2) \rightarrow 23, h(12, 23) \rightarrow 20,$   
 $h(12, 23) \rightarrow 22, h(12, 23) \rightarrow 23, h(12, 5) \rightarrow 20, h(12,$   
 $5) \rightarrow 22, h(12, 5) \rightarrow 23, h(12, 8) \rightarrow 20, h(12, 8) \rightarrow 22,$   
 $h(12, 8) \rightarrow 23, h(16, 13) \rightarrow 19, h(16, 13) \rightarrow 21, h(16,$   
 $13) \rightarrow 23, h(16, 18) \rightarrow 19, h(16, 18) \rightarrow 21, h(16, 18) \rightarrow 23,$   
 $h(16, 2) \rightarrow 19, h(16, 2) \rightarrow 21, h(16, 2) \rightarrow 23, h(16, 23) \rightarrow 19,$   
 $h(16, 23) \rightarrow 21, h(16, 23) \rightarrow 23, h(16, 5) \rightarrow 19, h(16,$   
 $5) \rightarrow 21, h(16, 5) \rightarrow 23, h(16, 8) \rightarrow 19, h(16, 8) \rightarrow 21,$   
 $h(16, 8) \rightarrow 23, h(17, 13) \rightarrow 20, h(17, 13) \rightarrow 22, h(17,$   
 $13) \rightarrow 23, h(17, 18) \rightarrow 20, h(17, 18) \rightarrow 22, h(17, 18) \rightarrow 23,$   
 $h(17, 2) \rightarrow 20, h(17, 2) \rightarrow 22, h(17, 2) \rightarrow 23, h(17, 23) \rightarrow 20,$   
 $h(17, 23) \rightarrow 22, h(17, 23) \rightarrow 23, h(17, 5) \rightarrow 20, h(17,$

```

5)->22, h(17, 5)->23, h(17, 8)->20, h(17, 8)->22,
h(17, 8)->23, h(21, 13)->19, h(21, 13)->21, h(21,
13)->23, h(21, 18)->19, h(21, 18)->21, h(21, 18)->23,
h(21, 2)->19, h(21, 2)->21, h(21, 2)->23, h(21, 23)->19,
h(21, 23)->21, h(21, 23)->23, h(21, 5)->19, h(21,
5)->21, h(21, 5)->23, h(21, 8)->19, h(21, 8)->21,
h(21, 8)->23, h(22, 13)->20, h(22, 13)->22, h(22,
13)->23, h(22, 18)->20, h(22, 18)->22, h(22, 18)->23,
h(22, 2)->20, h(22, 2)->22, h(22, 2)->23, h(22, 23)->20,
h(22, 23)->22, h(22, 23)->23, h(22, 5)->20, h(22,
5)->22, h(22, 5)->23, h(22, 8)->20, h(22, 8)->22,
h(22, 8)->23, h(4, 13)->20, h(4, 13)->22, h(4, 13)->23,
h(4, 18)->20, h(4, 18)->22, h(4, 18)->23, h(4, 2)->20,
h(4, 2)->22, h(4, 2)->23, h(4, 23)->20, h(4, 23)->22,
h(4, 23)->23, h(4, 5)->20, h(4, 5)->22, h(4, 5)->23,
h(4, 8)->20, h(4, 8)->22, h(4, 8)->23, h(7, 13)->20,
h(7, 13)->22, h(7, 13)->23, h(7, 18)->20, h(7, 18)->22,
h(7, 18)->23, h(7, 2)->20, h(7, 2)->22, h(7, 2)->23,
h(7, 23)->20, h(7, 23)->22, h(7, 23)->23, h(7, 5)->20,
h(7, 5)->22, h(7, 5)->23, h(7, 8)->20, h(7, 8)->22,
h(7, 8)->23}
==rel = #0{}
<>rel = #0{}
}

```



### 3.2 New overloop-based transformation

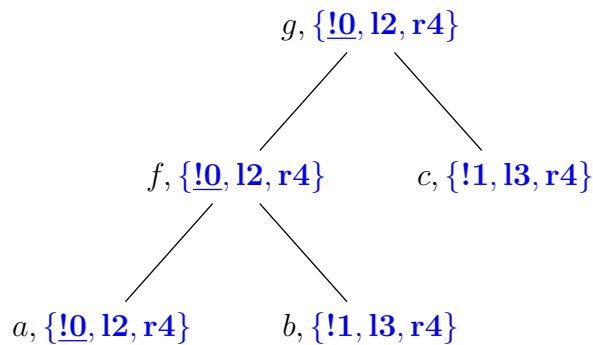
```

States/Loops correspondance table
!0 --> [@,#2{(q1,#), (qu,#)}]
!1 --> [@,#1{(qu,#)}]
!2 --> [<,#2{(q1,qu), (qu,qu)}]
!3 --> [<,#1{(qu,qu)}]

```

```
r4 --> [>, #0{}
```

```
TAGED 'fromTWA' [95] = {  
  alphab = #6{a/0, b/0, c/0, f/2, g/2, h/2}  
  states = #5{!0, !1, l2, l3, r4}  
  final = #1{!0}  
  rules = #27{a()->!0, a()->l2, a()->r4, b()->!1, b()->l3, b  
    ()->r4,  
  c()->!1, c()->l3, c()->r4, f(l2, r4)->!0, f(l2, r4)->l2,  
  f(l2, r4)->r4, f(l3, r4)->!1, f(l3, r4)->l3, f(l3,  
  r4)->r4, g(l2, r4)->!0, g(l2, r4)->l2, g(l2, r4)->r4,  
  g(l3, r4)->!1, g(l3, r4)->l3, g(l3, r4)->r4, h(l2,  
  r4)->!0, h(l2, r4)->l2, h(l2, r4)->r4, h(l3, r4)->!1,  
  h(l3, r4)->l3, h(l3, r4)->r4}  
  ==rel = #0{  
  <>rel = #0{  
}
```



## 4 Membership by overloops

Overloops of the TWA on the tree :

```
#2{(q1,#), (qu,#)}
```

## 5 Term in language

### 5.1 Loops

(as string)

a

7

(as tree representation)

a, (0)

## 5.2 Over-Loops

(as string)

a

(as tree representation)

a, (!0)

## 6 Over-Approximation

Found potential overloop @ #2{(q1,#), (qu,#)}

#0{}

#0{}

#0{}

Unknown