PREPARACIÓN PARA EL EXAMEN 1
(solución)

1. Consider the following two processes, A and B, to be run concurrently in a shared memory (all variables are shared between the two processes).

PROCESS A:
1 $x := 2x$;
2 $x := 2x$;

PROCESS B:
1 $x := 1$;
2 $x := x + 1$;

Assume that load (read) and store (write) of the single shared register x are atomic, x is initialized to 0, and x must be loaded into a register before being incremented. What are all the possible values for x after both processes have terminated?

Use, como el modelo del incremento de una variable x en Promela, la secuencia de dos asignaciones: `temp = x; x = temp + 1`.

Solución:

```
$ cat -n p1.pml | expand
    1  byte x = 0
    2
    3  active proctype A() {
    4      byte t
    5
    6      t = x
    7      x = 2*t
    8      t = x
    9      x = 2*t
   10  }
   11
   12  active proctype B() {
   13      byte t
   14
   15      x = 1
   16      t = x
   17      x = t + 1
   18  }
   19
   20  init {
   21      _nr_pr == 1
   22      assert(x == 100)
   23  }
```

Construimos el analizador, verificamos el modelo solicitando todos los errores y guardamos el resultado en el archivo p1.pan_result

```
$ spin -run -e p1.pml | expand > p1.pan_result
```

Revisamos los resultados:

$ cat p1.pan_result | expand
pan:1: invalid end state (at depth 6)
pan: wrote p1.pml1.trail
pan: wrote p1.pml2.trail
pan: wrote p1.pml3.trail
pan: wrote p1.pml4.trail
pan: wrote p1.pml5.trail
pan: wrote p1.pml6.trail
pan: wrote p1.pml7.trail
pan: wrote p1.pml8.trail
pan: wrote p1.pml9.trail
pan: wrote p1.pml10.trail
pan: wrote p1.pml11.trail
pan: wrote p1.pml12.trail
pan: wrote p1.pml13.trail
pan: wrote p1.pml14.trail

(Spin Version 6.4.6 -- 2 December 2016)
        + Partial Order Reduction

Full statespace search for:
        never claim   - (none specified)
        assertion violations   +
        cycle checks   - (disabled by -DSAFETY)
        invalid end states   +

State-vector 28 byte, depth reached 7, errors: 14
        74 states, stored
        15 states, matched
        89 transitions (= stored+matched)
        0 atomic steps
hash conflicts: 0 (resolved)

Stats on memory usage (in Megabytes):
    0.004   equivalent memory usage for states (stored*(State-vector + overhead))
    0.292   actual memory usage for states
  128.000   memory used for hash table (-w24)
    0.534   memory used for DFS stack (-m10000)
  128.730   total actual memory usage

unreached in proctype A
        (0 of 5 states)
unreached in proctype B
        (0 of 4 states)
unreached in init
        p1.pml:22, state 2, "assert((x==100))"
        p1.pml:23, state 3, "-end-"
        (2 of 3 states)

pan: elapsed time 0 seconds

Tenemos 14 archivos *trail*. Los veremos todos juntos en un archivo:

$ > p1.all_errors; for i in {1..14}; do spin -t$i p1.pml | expand >>p1.all_errors; done

Filtraremos del archivo p1.all_errors las líneas que contienen el nombre de la variable x:

```
$ cat p1.all_errors | expand | grep x > p1.final_values
```

y revisamos los valores finales:

```
$ cat p1.final_values | expand
                x = 8
                x = 4
                x = 2
                x = 6
                x = 4
                x = 3
                x = 5
                x = 0
                x = 2
                x = 2
                x = 0
                x = 1
                x = 2
                x = 3
```

Entonces, los valores finales posibles de la variable x son: 0..6, 8.

2. (Bridge Crossing Problem) Three people begin on the same side of a bridge. You must help them across to the other side. It is night. There is one flashlight. A maximum of two people can cross at a time. Any party who crosses, either one or two people, must have the flashlight to see. The flashlight must be walked back and forth, it cannot be thrown, etc. Each person walks at a different speed. A pair must walk together at the rate of the slower person's pace, based on this information: Person 0 takes $t_0 = 1$ minutes to cross, and the other persons take $t_1 = 2$ minutes, and $t_2 = 5$ minutes to cross, respectively.

```
$ cat bridge.pml

...

#define max(a,b) ((a>b) -> a : b)
#define N        3

byte a[N] = 0    /* crossing times of N persons */

active proctype Bridge() {
...
}
```

Construya el modelo en Promela para encuentrar todas las soluciones posibles.

Solución:

```
$ cat -n bridge3.pml | expand
     1  #define max(a,b) ((a>b) -> a : b)
     2  #define N         3
     3
     4  byte a[N] = 0       /* crossing times of N persons */
     5  bool c[N] = false  /* nobody crossed */
     6  byte t = 0          /* total time */
     7
     8  active proctype Bridge() {
     9      a[0] = 1; a[1] = 2; a[2] = 5
    10
    11      do
    12      ::  c[0]&&c[1]&&c[2] -> break     /* todos cruzaron */
    13      ::  else ->
    14            if
    15            ::  !c[0]&&!c[1] -> c[0]=true; c[1]=true    /* cruzan 0+1 */
    16                               t=t+max(a[0],a[1])
    17                               printf("0,1 -->\n")
    18            ::  !c[0]&&!c[2] -> c[0]=true; c[2]=true    /* cruzan 0+2 */
    19                               t=t+max(a[0],a[2])
    20                               printf("0,2 -->\n")
    21            ::  !c[1]&&!c[2] -> c[1]=true; c[2]=true    /* cruzan 1+2 */
    22                               t=t+max(a[1],a[2])
    23                               printf("1,2 -->\n")
    24            ::  c[0]&&(c[1]||c[2]) -> c[0]=false        /* regresa 0 */
    25                               t=t+a[0]
    26                               printf("    <-- 0\n")
    27            ::  c[1]&&(c[0]||c[2]) -> c[1]=false        /* regresa 1 */
    28                               t=t+a[1]
    29                               printf("    <-- 1\n")
    30            ::  c[2]&&(c[0]||c[1]) -> c[2]=false        /* regresa 2 */
```

```
31                                              t=t+a[2]
32                                              printf("     <-- 2\n")
33              fi
34         od
35
36         printf("total time = %d\n", t)
37         assert(t==0)
38  }
```

Construimos el analizador, verificamos el modelo solicitando todos los errores y guardamos el resultado en el archivo bridge3.pan_result

$ spin -run -e bridge3.pml | expand > bridge3.pan_result

Revisamos los resultados:

$ cat bridge3.pan_result | expand
```
pan:1: assertion violated (t==0) (at depth 22)
pan: wrote bridge3.pml1.trail
pan: wrote bridge3.pml2.trail
pan: wrote bridge3.pml3.trail

(Spin Version 6.4.6 -- 2 December 2016)
        + Partial Order Reduction

Full statespace search for:
        never claim             - (none specified)
        assertion violations    +
        cycle checks            - (disabled by -DSAFETY)
        invalid end states      +

State-vector 20 byte, depth reached 24, errors: 3
        92 states, stored
         3 states, matched
        95 transitions (= stored+matched)
         0 atomic steps
hash conflicts:         0 (resolved)

Stats on memory usage (in Megabytes):
    0.004       equivalent memory usage for states (stored*(State-vector + overhead))
    0.289       actual memory usage for states
  128.000       memory used for hash table (-w24)
    0.534       memory used for DFS stack (-m10000)
  128.730       total actual memory usage


unreached in proctype Bridge
        (0 of 41 states)

pan: elapsed time 0 seconds
```

Tenemos 3 archivos _trail_. Los veremos todos juntos en un archivo con la orden de una sola línea:

$ > bridge3.all_errors; for i in {1..3}; do spin -t$i bridge3.pml | expand >>bridge3.all_errors; done

Filtraremos del archivo bridge3.all_errors las líneas que contienen la palabra "total":

```
$ cat bridge3.all_errors | expand | grep total > bridge3.final_values
```

y revisamos los valores finales:

```
$ cat bridge3.final_values | expand
     total time = 8
     total time = 9
     total time = 15
```

Entonces, el tiempo mínimo de cruce es de 8 minutos.

3. The *frogs puzzle* (from `jspin-4-7/jspin-examples/frogs.pml`) La descripción se puede encontrar en:

http://www.hellam.net/maths2000/frogs.html

```
$ cat frogs.pml
/*
   Frogs puzzle:
     Seven stones
     Three male frogs at right facing left
     Three female frogs at left facing right
     F-> F-> F-> [EMPTY] <-M <-M <-M

   Frogs can move in the direction it is facing to an empty stone:
     That is adjacent
     That is reached by jumping over a frog on an adjacent stone

   Is there a sequence of moves that will exchange the positions
     of the male and female frogs?
   Solution: try to Verify/Safety []!success;
     when it fails the trail gives the set of moves.
   Local variables ":init:" and "at" can be excluded.
*/

#define STONES 7

/* Verify acceptance of []!success */
#define success (\
    (stones[0]==female) && \
    (stones[1]==female) && \
    (stones[2]==female) && \
    (stones[4]==male)   && \
    (stones[5]==male)   && \
    (stones[6]==male)      \
    )

mtype = { none, male, female }
mtype stones[STONES];

ltl { []!success }

proctype mF(byte at) {
end:do
    :: atomic {
            (at < STONES-1) &&
            (stones[at+1] == none) ->
                stones[at] = none;
                stones[at+1] = male;
                at = at + 1;
        }
    :: atomic {
            (at < STONES-2) &&
            (stones[at+1] != none) &&
            (stones[at+2] == none) ->
                stones[at] = none;
                stones[at+2] = male;
                at = at + 2;
        }
    od
```

```
}

proctype fF(byte at) {
end:do
    :: atomic {
            (at > 0) &&
            (stones[at-1] == none) ->
                stones[at] = none;
                stones[at-1] = female;
                at = at - 1;
        }
    :: atomic {
            (at > 1) &&
            (stones[at-1] != none) &&
            (stones[at-2] == none) ->
                stones[at] = none;
                stones[at-2] = female;
                at = at - 2;
        }
    od
}

init {
    atomic {
        stones[STONES/2] = none;
        byte I = 0;
        do
        :: I == STONES/2 -> break;
        :: else ->
            stones[I] = male;
            run mF(I);
            stones[STONES-I-1] = female;
            run fF(STONES-I-1);
            I++
        od
    }
}
```

Solución:

La solución es directa:

$ spin -run frogs.pml | expand > frogs.pan_result
warning: never claim + accept labels requires -a flag to fully verify

$ cat frogs.pan_result | expand
pan:1:   assertion   violated   !(!(!
(((((((((stones[0]==1)&&(stones[1]==1))&&(stones[2]==1))&&(stones[4]==2))&&(stones[5]==2)
)&&(stones[6]==2))))) (at depth 52)
pan: wrote frogs.pml.trail

(Spin Version 6.4.6 -- 2 December 2016)
Warning: Search not completed
        + Partial Order Reduction

Full statespace search for:
        never claim   + (ltl_0)
        assertion violations   + (if within scope of claim)
        cycle checks   - (disabled by -DSAFETY)
        invalid end states   - (disabled by never claim)

```
State-vector 76 byte, depth reached 52, errors: 1
      42 states, stored
       8 states, matched
      50 transitions (= stored+matched)
      20 atomic steps
hash conflicts:          0 (resolved)

Stats on memory usage (in Megabytes):
    0.004        equivalent memory usage for states (stored*(State-vector + overhead))
    0.286        actual memory usage for states
  128.000        memory used for hash table (-w24)
    0.534        memory used for DFS stack (-m10000)
  128.730        total actual memory usage


pan: elapsed time 0 seconds
ltl  ltl_0:  []  (!  (((((((stones[0]==female))  &&  ((stones[1]==female)))  &&
((stones[2]==female)))  &&  ((stones[4]==male)))  &&  ((stones[5]==male)))  &&
((stones[6]==male))))
```

Despleguemos la ejecución de spin con el archivo *trail* generado filtrando solamente las
líneas que contienen la palabra "stones" y de estas quitemos todas las líneas que
contienen las palabras "spin", "frogs", "claim" y "ltl" grabándolas en el archivo
frogs.result:

**$ spin -t -p -g frogs.pml | grep stones | grep -v spin | grep -v frogs | grep -v claim
| grep -v ltl > frogs.result**

$ cat -n frogs.result | expand
```
     1                stones[0] = 0
     2                stones[1] = 0
     3                stones[2] = 0
     4                stones[3] = none
     5                stones[4] = 0
     6                stones[5] = 0
     7                stones[6] = 0
     8                stones[0] = 0
     9                stones[1] = 0
    10                stones[2] = 0
    11                stones[3] = none
    12                stones[4] = 0
    13                stones[5] = 0
    14                stones[6] = 0
    15                stones[0] = male
    16                stones[1] = 0
    17                stones[2] = 0
    18                stones[3] = none
    19                stones[4] = 0
    20                stones[5] = 0
    21                stones[6] = 0
    22                stones[0] = male
    23                stones[1] = 0
    24                stones[2] = 0
    25                stones[3] = none
    26                stones[4] = 0
    27                stones[5] = 0
    28                stones[6] = female
    29                stones[0] = male
    30                stones[1] = male
```

```
31                      stones[2] = 0
32                      stones[3] = none
33                      stones[4] = 0
34                      stones[5] = 0
35                      stones[6] = female
36                      stones[0] = male
37                      stones[1] = male
38                      stones[2] = 0
39                      stones[3] = none
40                      stones[4] = 0
41                      stones[5] = female
42                      stones[6] = female
43                      stones[0] = male
44                      stones[1] = male
45                      stones[2] = male
46                      stones[3] = none
47                      stones[4] = 0
48                      stones[5] = female
49                      stones[6] = female
50                      stones[0] = male
51                      stones[1] = male
52                      stones[2] = male
53                      stones[3] = none
54                      stones[4] = female
55                      stones[5] = female
56                      stones[6] = female
57                      stones[0] = male
58                      stones[1] = male
59                      stones[2] = male
60                      stones[3] = none
61                      stones[4] = none
62                      stones[5] = female
63                      stones[6] = female
64                      stones[0] = male
65                      stones[1] = male
66                      stones[2] = male
67                      stones[3] = female
68                      stones[4] = none
69                      stones[5] = female
70                      stones[6] = female
71                      stones[0] = male
72                      stones[1] = male
73                      stones[2] = male
74                      stones[3] = female
75                      stones[4] = none
76                      stones[5] = female
77                      stones[6] = female
78                      stones[0] = male
79                      stones[1] = male
80                      stones[2] = none
81                      stones[3] = female
82                      stones[4] = none
83                      stones[5] = female
84                      stones[6] = female
85                      stones[0] = male
86                      stones[1] = male
87                      stones[2] = none
88                      stones[3] = female
89                      stones[4] = male
90                      stones[5] = female
91                      stones[6] = female
92                      stones[0] = male
93                      stones[1] = male
```

```
94                    stones[2] = none
95                    stones[3] = female
96                    stones[4] = male
97                    stones[5] = female
98                    stones[6] = female
99                    stones[0] = male
100                   stones[1] = none
101                   stones[2] = none
102                   stones[3] = female
103                   stones[4] = male
104                   stones[5] = female
105                   stones[6] = female
106                   stones[0] = male
107                   stones[1] = none
108                   stones[2] = male
109                   stones[3] = female
110                   stones[4] = male
111                   stones[5] = female
112                   stones[6] = female
113                   stones[0] = male
114                   stones[1] = none
115                   stones[2] = male
116                   stones[3] = female
117                   stones[4] = male
118                   stones[5] = female
119                   stones[6] = female
120                   stones[0] = male
121                   stones[1] = none
122                   stones[2] = male
123                   stones[3] = none
124                   stones[4] = male
125                   stones[5] = female
126                   stones[6] = female
127                   stones[0] = male
128                   stones[1] = female
129                   stones[2] = male
130                   stones[3] = none
131                   stones[4] = male
132                   stones[5] = female
133                   stones[6] = female
134                   stones[0] = male
135                   stones[1] = female
136                   stones[2] = male
137                   stones[3] = none
138                   stones[4] = male
139                   stones[5] = female
140                   stones[6] = female
141                   stones[0] = male
142                   stones[1] = female
143                   stones[2] = male
144                   stones[3] = none
145                   stones[4] = male
146                   stones[5] = none
147                   stones[6] = female
148                   stones[0] = male
149                   stones[1] = female
150                   stones[2] = male
151                   stones[3] = female
152                   stones[4] = male
153                   stones[5] = none
154                   stones[6] = female
155                   stones[0] = male
156                   stones[1] = female
```

```
157                     stones[2] = male
158                     stones[3] = female
159                     stones[4] = male
160                     stones[5] = none
161                     stones[6] = female
162                     stones[0] = male
163                     stones[1] = female
164                     stones[2] = male
165                     stones[3] = female
166                     stones[4] = male
167                     stones[5] = none
168                     stones[6] = none
169                     stones[0] = male
170                     stones[1] = female
171                     stones[2] = male
172                     stones[3] = female
173                     stones[4] = male
174                     stones[5] = female
175                     stones[6] = none
176                     stones[0] = male
177                     stones[1] = female
178                     stones[2] = male
179                     stones[3] = female
180                     stones[4] = male
181                     stones[5] = female
182                     stones[6] = none
183                     stones[0] = male
184                     stones[1] = female
185                     stones[2] = male
186                     stones[3] = female
187                     stones[4] = none
188                     stones[5] = female
189                     stones[6] = none
190                     stones[0] = male
191                     stones[1] = female
192                     stones[2] = male
193                     stones[3] = female
194                     stones[4] = none
195                     stones[5] = female
196                     stones[6] = male
197                     stones[0] = male
198                     stones[1] = female
199                     stones[2] = male
200                     stones[3] = female
201                     stones[4] = none
202                     stones[5] = female
203                     stones[6] = male
204                     stones[0] = male
205                     stones[1] = female
206                     stones[2] = none
207                     stones[3] = female
208                     stones[4] = none
209                     stones[5] = female
210                     stones[6] = male
211                     stones[0] = male
212                     stones[1] = female
213                     stones[2] = none
214                     stones[3] = female
215                     stones[4] = male
216                     stones[5] = female
217                     stones[6] = male
218                     stones[0] = male
219                     stones[1] = female
```

```
220                    stones[2] = none
221                    stones[3] = female
222                    stones[4] = male
223                    stones[5] = female
224                    stones[6] = male
225                    stones[0] = none
226                    stones[1] = female
227                    stones[2] = none
228                    stones[3] = female
229                    stones[4] = male
230                    stones[5] = female
231                    stones[6] = male
232                    stones[0] = none
233                    stones[1] = female
234                    stones[2] = male
235                    stones[3] = female
236                    stones[4] = male
237                    stones[5] = female
238                    stones[6] = male
239                    stones[0] = none
240                    stones[1] = female
241                    stones[2] = male
242                    stones[3] = female
243                    stones[4] = male
244                    stones[5] = female
245                    stones[6] = male
246                    stones[0] = none
247                    stones[1] = none
248                    stones[2] = male
249                    stones[3] = female
250                    stones[4] = male
251                    stones[5] = female
252                    stones[6] = male
253                    stones[0] = female
254                    stones[1] = none
255                    stones[2] = male
256                    stones[3] = female
257                    stones[4] = male
258                    stones[5] = female
259                    stones[6] = male
260                    stones[0] = female
261                    stones[1] = none
262                    stones[2] = male
263                    stones[3] = female
264                    stones[4] = male
265                    stones[5] = female
266                    stones[6] = male
267                    stones[0] = female
268                    stones[1] = none
269                    stones[2] = male
270                    stones[3] = none
271                    stones[4] = male
272                    stones[5] = female
273                    stones[6] = male
274                    stones[0] = female
275                    stones[1] = female
276                    stones[2] = male
277                    stones[3] = none
278                    stones[4] = male
279                    stones[5] = female
280                    stones[6] = male
281                    stones[0] = female
282                    stones[1] = female
```

```
283                    stones[2] = male
284                    stones[3] = none
285                    stones[4] = male
286                    stones[5] = female
287                    stones[6] = male
288                    stones[0] = female
289                    stones[1] = female
290                    stones[2] = male
291                    stones[3] = none
292                    stones[4] = male
293                    stones[5] = none
294                    stones[6] = male
295                    stones[0] = female
296                    stones[1] = female
297                    stones[2] = male
298                    stones[3] = female
299                    stones[4] = male
300                    stones[5] = none
301                    stones[6] = male
302                    stones[0] = female
303                    stones[1] = female
304                    stones[2] = male
305                    stones[3] = female
306                    stones[4] = male
307                    stones[5] = none
308                    stones[6] = male
309                    stones[0] = female
310                    stones[1] = female
311                    stones[2] = male
312                    stones[3] = female
313                    stones[4] = none
314                    stones[5] = none
315                    stones[6] = male
316                    stones[0] = female
317                    stones[1] = female
318                    stones[2] = male
319                    stones[3] = female
320                    stones[4] = none
321                    stones[5] = male
322                    stones[6] = male
323                    stones[0] = female
324                    stones[1] = female
325                    stones[2] = male
326                    stones[3] = female
327                    stones[4] = none
328                    stones[5] = male
329                    stones[6] = male
330                    stones[0] = female
331                    stones[1] = female
332                    stones[2] = none
333                    stones[3] = female
334                    stones[4] = none
335                    stones[5] = male
336                    stones[6] = male
337                    stones[0] = female
338                    stones[1] = female
339                    stones[2] = none
340                    stones[3] = female
341                    stones[4] = male
342                    stones[5] = male
343                    stones[6] = male
344                    stones[0] = female
345                    stones[1] = female
```

```
346                    stones[2] = none
347                    stones[3] = female
348                    stones[4] = male
349                    stones[5] = male
350                    stones[6] = male
351                    stones[0] = female
352                    stones[1] = female
353                    stones[2] = none
354                    stones[3] = none
355                    stones[4] = male
356                    stones[5] = male
357                    stones[6] = male
358                    stones[0] = female
359                    stones[1] = female
360                    stones[2] = female
361                    stones[3] = none
362                    stones[4] = male
363                    stones[5] = male
364                    stones[6] = male
365                    stones[0] = female
366                    stones[1] = female
367                    stones[2] = female
368                    stones[3] = none
369                    stones[4] = male
370                    stones[5] = male
371                    stones[6] = male
372                    stones[0] = female
373                    stones[1] = female
374                    stones[2] = female
375                    stones[3] = none
376                    stones[4] = male
377                    stones[5] = male
378                    stones[6] = male
```

Las líneas que nos interesan son:

```
 50                    stones[0] = male
 51                    stones[1] = male
 52                    stones[2] = male
 53                    stones[3] = none
 54                    stones[4] = female
 55                    stones[5] = female
 56                    stones[6] = female        M-> M-> M-> [EMPTY] <-F <-F <-F

 64                    stones[0] = male
 65                    stones[1] = male
 66                    stones[2] = male
 67                    stones[3] = female
 68                    stones[4] = none
 69                    stones[5] = female
 70                    stones[6] = female        M-> M-> M-> <-F [EMPTY] <-F <-F

 85                    stones[0] = male
 86                    stones[1] = male
 87                    stones[2] = none
 88                    stones[3] = female
 89                    stones[4] = male
 90                    stones[5] = female
 91                    stones[6] = female        M-> M-> [EMPTY] <-F M-> <-F <-F

106                    stones[0] = male
107                    stones[1] = none
```

```
108              stones[2] = male
109              stones[3] = female
110              stones[4] = male
111              stones[5] = female
112              stones[6] = female          M-> [EMPTY] M-> <-F M-> <-F <-F

127              stones[0] = male
128              stones[1] = female
129              stones[2] = male
130              stones[3] = none
131              stones[4] = male
132              stones[5] = female
133              stones[6] = female          M-> <-F M-> [EMPTY] M-> <-F <-F

148              stones[0] = male
149              stones[1] = female
150              stones[2] = male
151              stones[3] = female
152              stones[4] = male
153              stones[5] = none
154              stones[6] = female          M-> <-F M-> <-F M-> [EMPTY] <-F

169              stones[0] = male
170              stones[1] = female
171              stones[2] = male
172              stones[3] = female
173              stones[4] = male
174              stones[5] = female
175              stones[6] = none            M-> <-F M-> <-F M-> <-F [EMPTY]

190              stones[0] = male
191              stones[1] = female
192              stones[2] = male
193              stones[3] = female
194              stones[4] = none
195              stones[5] = female
196              stones[6] = male            M-> <-F M-> <-F [EMPTY] <-F M

211              stones[0] = male
212              stones[1] = female
213              stones[2] = none
214              stones[3] = female
215              stones[4] = male
216              stones[5] = female
217              stones[6] = male            M-> <-F [EMPTY] <-F M-> <-F M

232              stones[0] = none
233              stones[1] = female
234              stones[2] = male
235              stones[3] = female
236              stones[4] = male
237              stones[5] = female
238              stones[6] = male            [EMPTY] <-F M-> <-F M-> <-F M

253              stones[0] = female
254              stones[1] = none
255              stones[2] = male
256              stones[3] = female
257              stones[4] = male
258              stones[5] = female
259              stones[6] = male            F [EMPTY] M-> <-F M-> <-F M
```

```
274                 stones[0] = female
275                 stones[1] = female
276                 stones[2] = male
277                 stones[3] = none
278                 stones[4] = male
279                 stones[5] = female
280                 stones[6] = male              F F M-> [EMPTY] M-> <-F M

295                 stones[0] = female
296                 stones[1] = female
297                 stones[2] = male
298                 stones[3] = female
299                 stones[4] = male
300                 stones[5] = none
301                 stones[6] = male              F F M-> <-F M-> [EMPTY] M

316                 stones[0] = female
317                 stones[1] = female
318                 stones[2] = male
319                 stones[3] = female
320                 stones[4] = none
321                 stones[5] = male
322                 stones[6] = male              F F M-> <-F [EMPTY] M M

337                 stones[0] = female
338                 stones[1] = female
339                 stones[2] = none
340                 stones[3] = female
341                 stones[4] = male
342                 stones[5] = male
343                 stones[6] = male              F F [EMPTY] <-F M M M

358                 stones[0] = female
359                 stones[1] = female
360                 stones[2] = female
361                 stones[3] = none
362                 stones[4] = male
363                 stones[5] = male
364                 stones[6] = male              F F F [EMPTY] M M M
```

12 de octubre del 2017