

Técnicas de los Sistemas Inteligentes

Práctica 2: Planificación Clásica



**UNIVERSIDAD
DE GRANADA**

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Fecha: 22/05/2018
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1. Ejercicio 1

1.1 Principales decisiones en el diseño del dominio.

1.1.1 Apartado a)

Para representar en el dominio los objetos del mundo, se han definido los siguientes tipos:

- **locatable:** elementos “físicamente” localizables en las zonas.
 - **item:** objetos, no se han definido subtipos de objetos porque el problema todavía no lo requiere.
 - **actor:**
 - **player:** jugadores (los agentes que realizan las acciones)
 - **character:** personajes a los que entregar objetos
- **zone:** zonas del mapeado
- **orientation:** que orientaciones tendremos en cuenta (en nuestro caso, norte, sur, este y oeste)

1.1.2 Apartado b)

Se han definido predicados para poder representar el estado del mundo: conexión de una zona con otra con una orientación, que orientación tiene un jugador actualmente, en que zona se encuentra cierto “locatable”, si un actor (jugador o personaje) tiene un objeto concreto y si un actor tiene la mano vacía.

1.1.2 Apartado c)

Para **girar al jugador**, se ha utilizado la sentencia **when** de manera que el jugador pasa a estar orientado a una dirección concreta dependiendo del giro y de su orientación anterior. Por ejemplo, si está mirando al norte y gira a la izquierda, estará ahora orientado al oeste.

Para **coger un objeto** de una determinada zona, el jugador tiene que estar situado en ella y tener la mano vacía. El efecto de la acción es que el jugador tiene ese objeto, deja de tener la mano vacía y el objeto ya no está en dicha zona.

Para **dejar un objeto** en una zona, el jugador debe estar en dicha zona y tener la mano ocupada, en cuyo caso el objeto pasa a encontrarse en esta zona, el jugador deja de poseer el objeto concreto y también pasa a tener la mano vacía.

Para **entregar un objeto** a un personaje en una determinada zona, el jugador debe tener un objeto, tener la mano ocupada y estar en dicha zona. Como efecto, el personaje pasa a tener dicho objeto, deja de tener la mano vacía, y el jugador pasa a tener la mano vacía y deja de poseer el objeto. **Nota:** como el enunciado no dice nada, se ha supuesto que se puede entregar más de un objeto al mismo personaje.

1.2 Problemas utilizados.





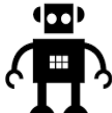



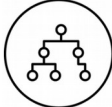


Se ha planteado un problema con 25 zonas en las que aparecen los 5 personajes y al menos 5 objetos. El objetivo de los problemas consiste en conseguir que **todos los personajes tengan un objeto**.

1.2.1 Problema 1

1.2.1.1 Características

- 25 zonas (conectadas a modo de “matriz”)
- 5 personajes distintos
- 5 objetos

1.2.1.2 Representación gráfica

				
				
		 (NORTH)		
				
				

1.2.1.3 Plan obtenido.

ff: found legal plan as follows

```
step    0: TURN-RIGHT PLAYER1
        1: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
        2: TAKE-ITEM PLAYER1 GOLD ZONE3_4
        3: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
        4: TURN-RIGHT PLAYER1
        5: TURN-RIGHT PLAYER1
        6: DELIVER-ITEM PLAYER1 GOLD PROFESSOR ZONE3_5
        7: GO PLAYER1 ZONE3_5 ZONE3_4 WEST
        8: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
        9: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
       10: GO PLAYER1 ZONE3_2 ZONE3_1 WEST
       11: TURN-RIGHT PLAYER1
       12: GO PLAYER1 ZONE3_1 ZONE2_1 NORTH
       13: GO PLAYER1 ZONE2_1 ZONE1_1 NORTH
       14: TURN-RIGHT PLAYER1
       15: GO PLAYER1 ZONE1_1 ZONE1_2 EAST
       16: TURN-RIGHT PLAYER1
       17: GO PLAYER1 ZONE1_2 ZONE2_2 SOUTH
       18: TURN-RIGHT PLAYER1
       19: TAKE-ITEM PLAYER1 ROSE ZONE2_2
       20: GO PLAYER1 ZONE2_2 ZONE2_1 WEST
       21: TURN-RIGHT PLAYER1
       22: GO PLAYER1 ZONE2_1 ZONE1_1 NORTH
       23: TURN-RIGHT PLAYER1
       24: TURN-RIGHT PLAYER1
       25: DELIVER-ITEM PLAYER1 ROSE PRINCESS ZONE1_1
       26: GO PLAYER1 ZONE1_1 ZONE2_1 SOUTH
       27: GO PLAYER1 ZONE2_1 ZONE3_1 SOUTH
       28: GO PLAYER1 ZONE3_1 ZONE4_1 SOUTH
       29: GO PLAYER1 ZONE4_1 ZONE5_1 SOUTH
       30: TURN-LEFT PLAYER1
       31: GO PLAYER1 ZONE5_1 ZONE5_2 EAST
       32: GO PLAYER1 ZONE5_2 ZONE5_3 EAST
       33: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
       34: TURN-LEFT PLAYER1
       35: TAKE-ITEM PLAYER1 OSCAR ZONE5_4
       36: GO PLAYER1 ZONE5_4 ZONE4_4 NORTH
       37: GO PLAYER1 ZONE4_4 ZONE3_4 NORTH
       38: GO PLAYER1 ZONE3_4 ZONE2_4 NORTH
       39: TURN-LEFT PLAYER1
       40: DELIVER-ITEM PLAYER1 OSCAR LEONARDO ZONE2_4
       41: GO PLAYER1 ZONE2_4 ZONE2_3 WEST
       42: GO PLAYER1 ZONE2_3 ZONE2_2 WEST
       43: TURN-LEFT PLAYER1
       44: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
       45: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
       46: TURN-LEFT PLAYER1
       47: GO PLAYER1 ZONE4_2 ZONE4_3 EAST
       48: GO PLAYER1 ZONE4_3 ZONE4_4 EAST
       49: GO PLAYER1 ZONE4_4 ZONE4_5 EAST
       50: TURN-RIGHT PLAYER1
       51: TURN-RIGHT PLAYER1
```

```
52: TAKE-ITEM PLAYER1 ALGORITHM ZONE4_5
53: GO PLAYER1 ZONE4_5 ZONE4_4 WEST
54: GO PLAYER1 ZONE4_4 ZONE4_3 WEST
55: GO PLAYER1 ZONE4_3 ZONE4_2 WEST
56: TURN-RIGHT PLAYER1
57: DELIVER-ITEM PLAYER1 ALGORITHM WITCH ZONE4_2
58: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
59: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
60: GO PLAYER1 ZONE2_2 ZONE1_2 NORTH
61: TURN-RIGHT PLAYER1
62: GO PLAYER1 ZONE1_2 ZONE1_3 EAST
63: GO PLAYER1 ZONE1_3 ZONE1_4 EAST
64: GO PLAYER1 ZONE1_4 ZONE1_5 EAST
65: TURN-RIGHT PLAYER1
66: TAKE-ITEM PLAYER1 APPLE ZONE1_5
67: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH
68: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
69: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH
70: GO PLAYER1 ZONE4_5 ZONE5_5 SOUTH
71: TURN-RIGHT PLAYER1
72: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
73: GO PLAYER1 ZONE5_4 ZONE5_3 WEST
74: DELIVER-ITEM PLAYER1 APPLE PRINCE ZONE5_3
```





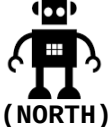









```
time spent:    0.00 seconds instantiating 957 easy, 0 hard action templates
              0.00 seconds reachability analysis, yielding 201 facts and 357
actions
              0.00 seconds creating final representation with 196 relevant
facts, 0 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              0.01 seconds searching, evaluating 817 states, to a max depth of
16
              0.01 seconds total time
```

1.2.2 Problema 2

1.2.2.1 Características

- 25 zonas (conectadas a modo de “matriz”)
- 5 personajes distintos
- 8 objetos

1.2.2.2 Representación gráfica

1.2.2.3 Plan obtenido.

ff: found legal plan as follows

```

step    0: TURN-LEFT PLAYER1
        1: TURN-LEFT PLAYER1
        2: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
        3: TAKE-ITEM PLAYER1 OSCAR ZONE3_2
        4: TURN-RIGHT PLAYER1
        5: GO PLAYER1 ZONE3_2 ZONE3_1 WEST
        6: TURN-RIGHT PLAYER1
        7: TURN-RIGHT PLAYER1
        8: TURN-RIGHT PLAYER1
        9: GO PLAYER1 ZONE3_1 ZONE4_1 SOUTH
       10: TURN-LEFT PLAYER1
       11: DELIVER-ITEM PLAYER1 OSCAR LEONARDO ZONE4_1
       12: TAKE-ITEM PLAYER1 GOLD2 ZONE4_1
       13: TURN-RIGHT PLAYER1
       14: GO PLAYER1 ZONE4_1 ZONE5_1 SOUTH
       15: TURN-LEFT PLAYER1
       16: GO PLAYER1 ZONE5_1 ZONE5_2 EAST
  
```

```
17: GO PLAYER1 ZONE5_2 ZONE5_3 EAST
18: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
19: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
20: TURN-RIGHT PLAYER1
21: TURN-RIGHT PLAYER1
22: TURN-RIGHT PLAYER1
23: DELIVER-ITEM PLAYER1 GOLD2 PROFESSOR ZONE5_5
24: GO PLAYER1 ZONE5_5 ZONE4_5 NORTH
25: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
26: TURN-LEFT PLAYER1
27: TAKE-ITEM PLAYER1 ALGORITHM2 ZONE3_5
28: GO PLAYER1 ZONE3_5 ZONE3_4 WEST
29: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
30: TURN-RIGHT PLAYER1
31: DELIVER-ITEM PLAYER1 ALGORITHM2 PRINCESS ZONE3_3
32: GO PLAYER1 ZONE3_3 ZONE2_3 NORTH
33: GO PLAYER1 ZONE2_3 ZONE1_3 NORTH
34: TURN-RIGHT PLAYER1
35: GO PLAYER1 ZONE1_3 ZONE1_4 EAST
36: TURN-RIGHT PLAYER1
37: GO PLAYER1 ZONE1_4 ZONE2_4 SOUTH
38: TURN-RIGHT PLAYER1
39: TURN-RIGHT PLAYER1
40: TAKE-ITEM PLAYER1 ROSE ZONE2_4
41: GO PLAYER1 ZONE2_4 ZONE1_4 NORTH
42: TURN-LEFT PLAYER1
43: DELIVER-ITEM PLAYER1 ROSE WITCH ZONE1_4
44: GO PLAYER1 ZONE1_4 ZONE1_3 WEST
45: GO PLAYER1 ZONE1_3 ZONE1_2 WEST
46: GO PLAYER1 ZONE1_2 ZONE1_1 WEST
47: TURN-RIGHT PLAYER1
48: TURN-RIGHT PLAYER1
49: TAKE-ITEM PLAYER1 APPLE1 ZONE1_1
50: GO PLAYER1 ZONE1_1 ZONE1_2 EAST
51: DELIVER-ITEM PLAYER1 APPLE1 PRINCE ZONE1_2
```

```
time spent:    0.00 seconds instantiating 1482 easy, 0 hard action templates
              0.00 seconds reachability analysis, yielding 294 facts and 522
actions
              0.00 seconds creating final representation with 289 relevant
facts, 0 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              0.01 seconds searching, evaluating 259 states, to a max depth of
5
              0.01 seconds total time
```

2. Ejercicio 2

2.1 Principales decisiones en el diseño del dominio.

2.1.1 Apartado a)

Para considerar que la acción de desplazamiento entre zonas tiene un coste, definimos una función que nos dirá la distancia entre dos zonas y una función que nos dirá el total recorrido por un jugador.

Cuando el jugador tome la acción de ir de una zona a otra, incrementaremos dicha distancia total en una cantidad igual a la coste de ir entre dichas zonas.

2.2 Problemas utilizados.





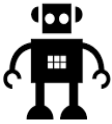



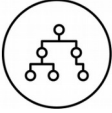


Se han planteado problemas con estructura similar a los anteriores, pero definiendo las distancias entre zonas, el coste total inicial del jugador (cero) y que uno de los objetivos debe ser que el coste total recorrido sea menor a cierto número.

2.2.1 Problema 1

2.2.1.1 Características

- Nuevo objetivo: coste total del recorrido ≤ 475
- Las distancias entre zonas son 5, 10, 15 o 20.

2.2.1.2 Representación gráfica

				
				
		 (NORTH)		
				
				

2.2.1.3 Plan obtenido.

ff: found legal plan as follows

```

step    0: TURN-RIGHT PLAYER1
        1: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
        2: TAKE-ITEM PLAYER1 GOLD ZONE3_4
        3: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
        4: TURN-RIGHT PLAYER1
        5: DELIVER-ITEM PLAYER1 GOLD PROFESSOR ZONE3_5
        6: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH
        7: GO PLAYER1 ZONE4_5 ZONE5_5 SOUTH
        8: TURN-RIGHT PLAYER1
        9: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
       10: TAKE-ITEM PLAYER1 OSCAR ZONE5_4
       11: GO PLAYER1 ZONE5_4 ZONE5_3 WEST
       12: TURN-RIGHT PLAYER1
       13: DELIVER-ITEM PLAYER1 OSCAR PRINCE ZONE5_3
       14: GO PLAYER1 ZONE5_3 ZONE4_3 NORTH
       15: GO PLAYER1 ZONE4_3 ZONE3_3 NORTH
       16: GO PLAYER1 ZONE3_3 ZONE2_3 NORTH
       17: TURN-LEFT PLAYER1
       18: GO PLAYER1 ZONE2_3 ZONE2_2 WEST
  
```

```
19: TAKE-ITEM PLAYER1 ROSE ZONE2_2
20: GO PLAYER1 ZONE2_2 ZONE2_1 WEST
21: TURN-RIGHT PLAYER1
22: GO PLAYER1 ZONE2_1 ZONE1_1 NORTH
23: TURN-RIGHT PLAYER1
24: DELIVER-ITEM PLAYER1 ROSE PRINCESS ZONE1_1
25: GO PLAYER1 ZONE1_1 ZONE1_2 EAST
26: GO PLAYER1 ZONE1_2 ZONE1_3 EAST
27: GO PLAYER1 ZONE1_3 ZONE1_4 EAST
28: GO PLAYER1 ZONE1_4 ZONE1_5 EAST
29: TAKE-ITEM PLAYER1 APPLE ZONE1_5
30: TURN-RIGHT PLAYER1
31: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH
32: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
33: TURN-RIGHT PLAYER1
34: GO PLAYER1 ZONE3_5 ZONE3_4 WEST
35: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
36: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
37: TURN-LEFT PLAYER1
38: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
39: TURN-LEFT PLAYER1
40: DELIVER-ITEM PLAYER1 APPLE WITCH ZONE4_2
41: GO PLAYER1 ZONE4_2 ZONE4_3 EAST
42: GO PLAYER1 ZONE4_3 ZONE4_4 EAST
43: GO PLAYER1 ZONE4_4 ZONE4_5 EAST
44: TURN-LEFT PLAYER1
45: TAKE-ITEM PLAYER1 ALGORITHM ZONE4_5
46: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
47: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
48: TURN-LEFT PLAYER1
49: GO PLAYER1 ZONE2_5 ZONE2_4 WEST
50: DELIVER-ITEM PLAYER1 ALGORITHM LEONARDO ZONE2_4
```





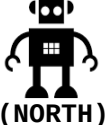







```
time spent:    0.00 seconds instantiating 957 easy, 0 hard action templates
              0.00 seconds reachability analysis, yielding 201 facts and 357
actions
              0.00 seconds creating final representation with 196 relevant
facts, 2 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              2.79 seconds searching, evaluating 52838 states, to a max depth
of 16
              2.79 seconds total time
```

2.2.2. Problema 2.

2.2.2.1 Características

- Nuevo objetivo: coste total del recorrido ≤ 475
- Las distancias entre zonas son 5, 10, 15 o 20.

2.2.2.2 Representación gráfica

2.2.2.3 Plan obtenido.

ff: found legal plan as follows

```

step    0: TAKE-ITEM PLAYER1 ALGORITHM1 ZONE3_3
        1: TURN-RIGHT PLAYER1
        2: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
        3: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
        4: TURN-RIGHT PLAYER1
        5: DELIVER-ITEM PLAYER1 ALGORITHM1 PROFESSOR ZONE3_5
    
```

```
6: TAKE-ITEM PLAYER1 ALGORITHM2 ZONE3_5
7: TURN-RIGHT PLAYER1
8: GO PLAYER1 ZONE3_5 ZONE3_4 WEST
9: TURN-RIGHT PLAYER1
10: GO PLAYER1 ZONE3_4 ZONE2_4 NORTH
11: TURN-LEFT PLAYER1
12: DELIVER-ITEM PLAYER1 ALGORITHM2 LEONARDO ZONE2_4
13: TAKE-ITEM PLAYER1 ROSE ZONE2_4
14: GO PLAYER1 ZONE2_4 ZONE2_3 WEST
15: TURN-LEFT PLAYER1
16: GO PLAYER1 ZONE2_3 ZONE3_3 SOUTH
17: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
18: GO PLAYER1 ZONE4_3 ZONE5_3 SOUTH
19: TURN-RIGHT PLAYER1
20: DELIVER-ITEM PLAYER1 ROSE PRINCE ZONE5_3
21: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
22: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
23: TAKE-ITEM PLAYER1 APPLE2 ZONE5_1
24: TURN-RIGHT PLAYER1
25: GO PLAYER1 ZONE5_1 ZONE4_1 NORTH
26: GO PLAYER1 ZONE4_1 ZONE3_1 NORTH
27: GO PLAYER1 ZONE3_1 ZONE2_1 NORTH
28: GO PLAYER1 ZONE2_1 ZONE1_1 NORTH
29: TURN-RIGHT PLAYER1
30: DELIVER-ITEM PLAYER1 APPLE2 PRINCESS ZONE1_1
31: TAKE-ITEM PLAYER1 APPLE1 ZONE1_1
32: GO PLAYER1 ZONE1_1 ZONE1_2 EAST
33: TURN-RIGHT PLAYER1
34: GO PLAYER1 ZONE1_2 ZONE2_2 SOUTH
35: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
36: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
37: DELIVER-ITEM PLAYER1 APPLE1 WITCH ZONE4_2
```

```
time spent:    0.00 seconds instantiating 1482 easy, 0 hard action templates
              0.00 seconds reachability analysis, yielding 294 facts and 522
actions
              0.00 seconds creating final representation with 289 relevant
facts, 2 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              0.77 seconds searching, evaluating 42864 states, to a max depth
of 22
              0.77 seconds total time
```

3. Ejercicio 3

3.1 Principales decisiones en el diseño del dominio.

Ahora existen nuevas zonas y nuevos tipos de objeto, por lo que se han definido nuevos tipos derivados para ello de la siguiente manera:

- **zone:**
 - `passable_zone`: zonas transitables
 - `special_zones`: zonas que necesitan algún requisito especial para pasar (bosque y agua)
 - `normal_zones`: zonas sin requisitos especiales para pasar (piedra y arena)
 - `impassable_zone`: zonas intransitables (precipicio)
- **items:**
 - `special_item`: objetos especiales que no son entregables.
 - `zapatilla`: para pasar por bosques
 - `bikini`: para pasar por zonas de agua
 - `deliverable_item`: objetos que se pueden entregar a personajes

Esto podría haberse hecho mediante predicados que, a la hora de definir el problema, nos digan el tipo de zona o de objeto. Intenté hacerlo de las dos formas y esta me parece la más “lógica” o “natural”, ya que si un objeto es de cierto tipo, lo más intuitivo es declarar un tipo como tal. Además, en el problema será mucho más cómodo declarar los objetos, no como con los predicados, que habría que poner uno por cada zona/objeto.

Para la mochila, se han definido nuevos predicados que nos dicen si la está vacía o si tiene algún objeto en concreto (similar a lo que ocurría con la mano).

Además, dado que los nuevos objetos especiales **no son entregables**, en la acción de entregar un objeto a un personaje, el tipo de objeto debe ser “deliverable-item”, para que el jugador no intente entregar unas zapatillas o un bikini.

3.1.1 Apartado a)

Para poder movernos a una zona de bosque, he declarado una nueva acción **ir**. Es igual que la acción de ir de una zona a otra, salvo que el parámetro de la zona a la que va el jugador es de tipo “bosque”, y se añade un nuevo parámetro de item de tipo “zapatilla” que, como nueva precondition, el jugador debe tener en la mano o en la mochila.

Se ha procedido de forma similar con la acción para ir a zonas de agua.

También se ha cambiado, en la acción de ir de una zona a otra, que los tipos de los parámetros “zona de origen” y “zona de destino” sean de tipo “passable zone”, para que el planificador ni se plantee ir a zonas intransitables.

3.1.2 Apartado b)

Para meter objetos en la mochila, se ha declarado una nueva acción. Como precondiciones, el jugador debe tener el objeto en la mano, no tener la mano vacía y la mochila debe estar vacía. Como efectos, el jugador tendrá la mano vacía, no tendrá el objeto concreto en la mano, el objeto estará en la mochila y la mochila dejará de estar vacía.

Para sacar objetos de la mochila, se ha declarado otra acción. Como precondiciones, el jugador debe tener el objeto en la mochila, tener la mochila llena y tener la mano vacía. Como efectos, el jugador deja de tener el objeto en la mochila, la mochila pasa a estar vacía, tiene el objeto concreto en la mano y la mano no está vacía.

3.2 Problemas utilizados.

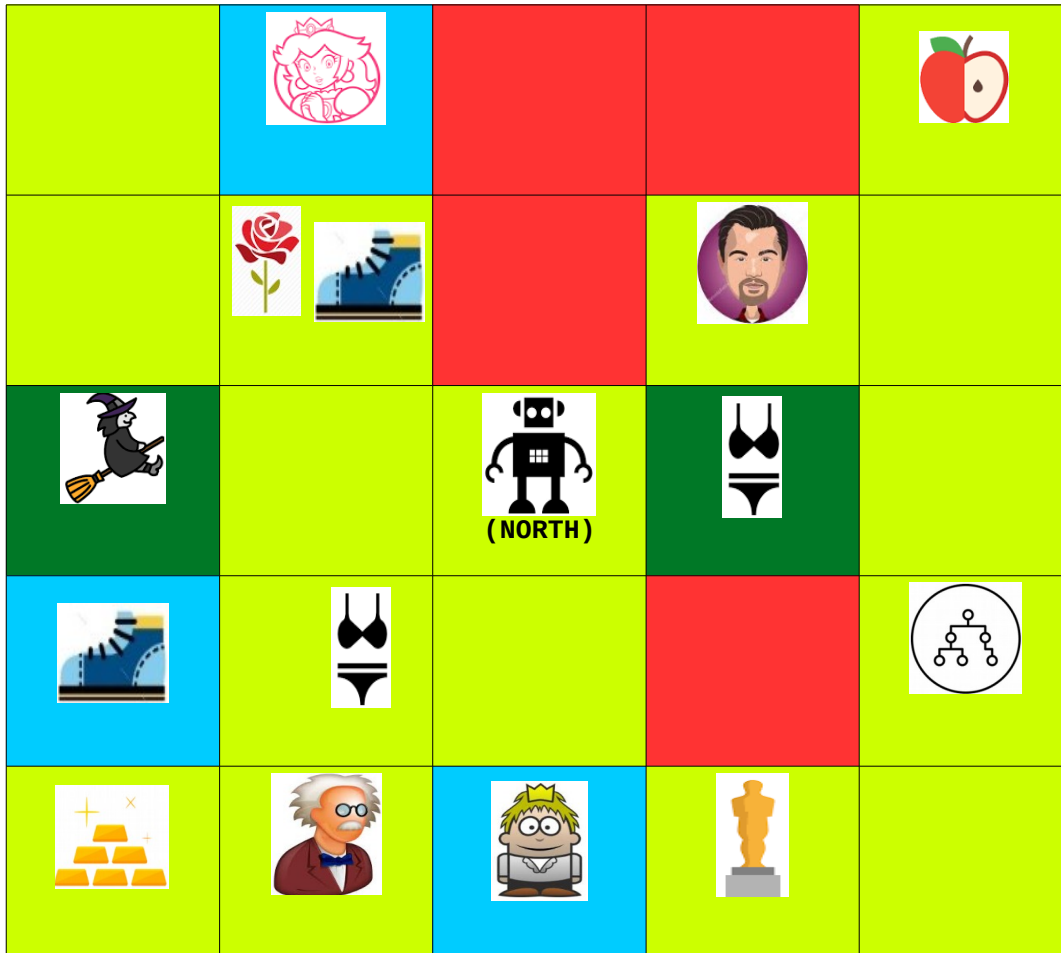
Se han planteado problemas con la misma estructura que anteriormente, pero definiendo tipos de zonas y al menos un bikini en una zona de bosque y una zapatilla en una zona de agua. El **objetivo** común es que todos los personajes tengan un objeto.

3.2.1 Problema 1

3.2.1.1 Características

- Nuevas zonas:
 - Rojo: precipicio.
 - Verde: transitable (piedra o arena)
 - Azul: Agua
 - Verde oscuro: Bosque
- Nuevos objetos: Zapatillas y bikinis
- 5 objetos entregables

3.2.1.2 Representación gráfica



3.2.1.3 Plan obtenido.

ff: found legal plan as follows

```

step    0: TURN-LEFT PLAYER1
        1: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
        2: TURN-RIGHT PLAYER1
        3: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
        4: TAKE-ITEM-HAND PLAYER1 ZAPATILLA1 ZONE2_2
        5: PUT-IN-BAG PLAYER1 ZAPATILLA1
        6: TURN-RIGHT PLAYER1
        7: TURN-RIGHT PLAYER1
        8: TAKE-ITEM-HAND PLAYER1 ROSE ZONE2_2
        9: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
       10: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
       11: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
       12: TURN-RIGHT PLAYER1
       13: TURN-RIGHT PLAYER1
       14: GO PLAYER1 ZONE5_2 ZONE4_2 NORTH
    
```

15: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
16: TURN-LEFT PLAYER1
17: GO PLAYER1 ZONE3_2 ZONE3_1 WEST ZAPATILLA1
18: TURN-LEFT PLAYER1
19: TURN-LEFT PLAYER1
20: DELIVER-ITEM PLAYER1 ROSE WITCH ZONE3_1
21: GO PLAYER1 ZONE3_1 ZONE3_2 EAST
22: TURN-RIGHT PLAYER1
23: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
24: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
25: TURN-RIGHT PLAYER1
26: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
27: TURN-RIGHT PLAYER1
28: TURN-RIGHT PLAYER1
29: TAKE-ITEM-HAND PLAYER1 GOLD ZONE5_1
30: GO PLAYER1 ZONE5_1 ZONE5_2 EAST
31: DELIVER-ITEM PLAYER1 GOLD PROFESSOR ZONE5_2
32: TURN-LEFT PLAYER1
33: GO PLAYER1 ZONE5_2 ZONE4_2 NORTH
34: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
35: TURN-RIGHT PLAYER1
36: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
37: GO PLAYER1 ZONE3_3 ZONE3_4 EAST ZAPATILLA1
38: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
39: TURN-RIGHT PLAYER1
40: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH
41: TURN-RIGHT PLAYER1
42: TURN-RIGHT PLAYER1
43: TAKE-ITEM-HAND PLAYER1 ALGORITHM ZONE4_5
44: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
45: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
46: TURN-LEFT PLAYER1
47: GO PLAYER1 ZONE2_5 ZONE2_4 WEST
48: DELIVER-ITEM PLAYER1 ALGORITHM LEONARDO ZONE2_4
49: TURN-LEFT PLAYER1
50: GO PLAYER1 ZONE2_4 ZONE3_4 SOUTH ZAPATILLA1
51: TURN-RIGHT PLAYER1
52: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
53: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
54: TURN-RIGHT PLAYER1
55: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
56: TURN-RIGHT PLAYER1
57: TURN-RIGHT PLAYER1
58: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
59: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
60: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
61: TURN-LEFT PLAYER1
62: TURN-LEFT PLAYER1
63: GO PLAYER1 ZONE5_2 ZONE4_2 NORTH
64: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
65: TURN-RIGHT PLAYER1
66: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
67: GO PLAYER1 ZONE3_3 ZONE3_4 EAST ZAPATILLA1
68: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
69: TURN-LEFT PLAYER1
70: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH

```
71: GO PLAYER1 ZONE2_5 ZONE1_5 NORTH
72: TURN-RIGHT PLAYER1
73: TURN-RIGHT PLAYER1
74: TAKE-ITEM-HAND PLAYER1 APPLE ZONE1_5
75: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH
76: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
77: TURN-RIGHT PLAYER1
78: GO PLAYER1 ZONE3_5 ZONE3_4 WEST ZAPATILLA1
79: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
80: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
81: TURN-LEFT PLAYER1
82: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
83: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
84: TURN-LEFT PLAYER1
85: TURN-LEFT PLAYER1
86: GO PLAYER1 ZONE5_2 ZONE4_2 NORTH
87: LEAVE-HAND-ITEM PLAYER1 APPLE ZONE4_2
88: TAKE-BAG-ITEM PLAYER1 ZAPATILLA1
89: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE4_2
90: TAKE-ITEM-HAND PLAYER1 BIKINI1 ZONE4_2
91: PUT-IN-BAG PLAYER1 BIKINI1
92: TAKE-ITEM-HAND PLAYER1 APPLE ZONE4_2
93: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
94: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
95: GO PLAYER1 ZONE2_2 ZONE1_2 NORTH BIKINI1
96: TURN-RIGHT PLAYER1
97: TURN-RIGHT PLAYER1
98: DELIVER-ITEM PLAYER1 APPLE PRINCESS ZONE1_2
99: GO PLAYER1 ZONE1_2 ZONE2_2 SOUTH
100: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
101: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
102: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
103: TURN-LEFT PLAYER1
104: GO PLAYER1 ZONE5_2 ZONE5_3 EAST BIKINI1
105: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
106: TURN-RIGHT PLAYER1
107: TURN-RIGHT PLAYER1
108: TAKE-ITEM-HAND PLAYER1 OSCAR ZONE5_4
109: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI1
110: DELIVER-ITEM PLAYER1 OSCAR PRINCE ZONE5_3
```

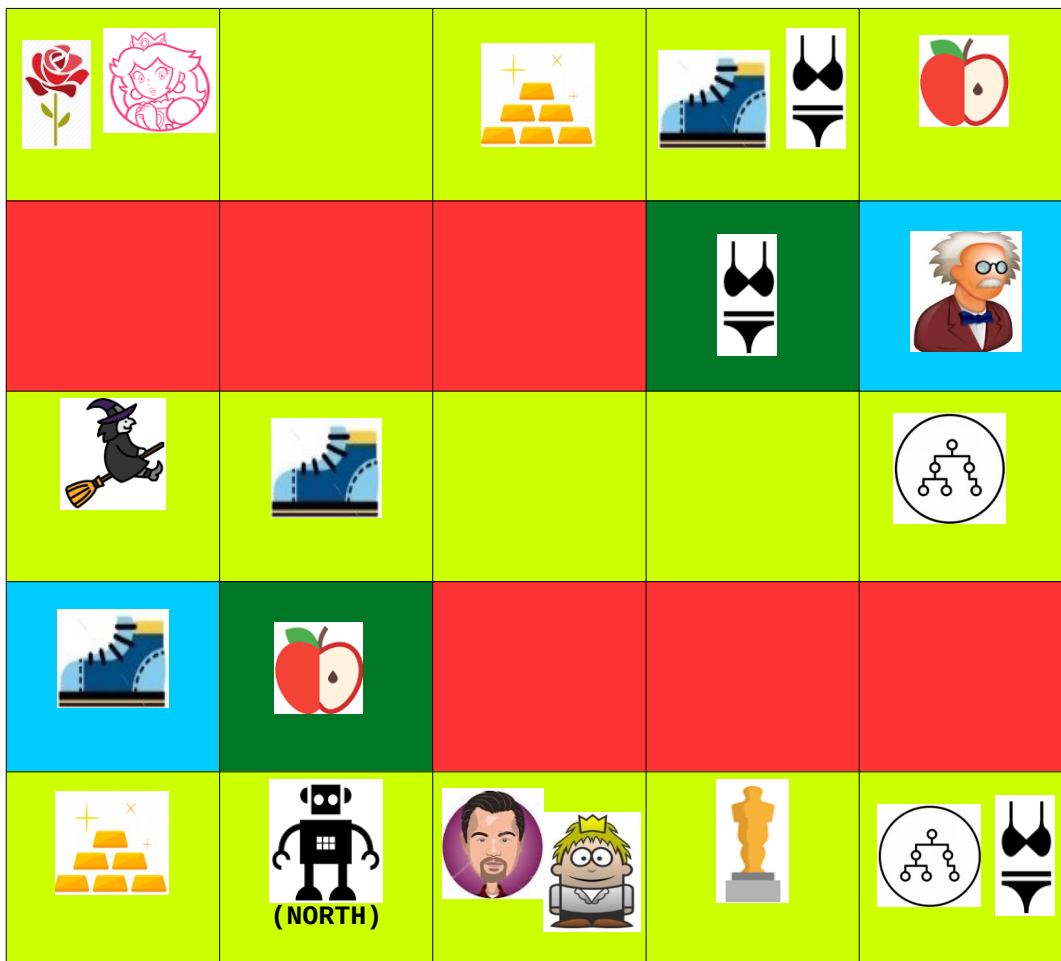
```
time spent:    0.00 seconds instantiating 965 easy, 56 hard action templates
              0.00 seconds reachability analysis, yielding 276 facts and 521
actions
              0.01 seconds creating final representation with 271 relevant
facts, 1 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              64.41 seconds searching, evaluating 1255147 states, to a max depth
of 99
              64.42 seconds total time
```

3.2.2 Problema 2

3.2.2.1 Características

- Nuevas zonas:
 - Rojo: precipicio.
 - Verde: transitable (piedra o arena)
 - Azul: Agua
 - Verde oscuro: Bosque
- Nuevos objetos: Zapatillas y bikinis
- 8 objetos entregables.
- **Objetivo extra:** Coste total del camino recorrido ≤ 300

3.2.2.2 Representación gráfica



3.2.2.3 Plan obtenido.

ff: found legal plan as follows

```
step    0: TURN-RIGHT PLAYER1
        1: GO PLAYER1 ZONE5_2 ZONE5_3 EAST
        2: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
        3: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
        4: TAKE-ITEM-HAND PLAYER1 BIKINI2 ZONE5_5
        5: PUT-IN-BAG PLAYER1 BIKINI2
        6: TURN-LEFT PLAYER1
        7: TURN-LEFT PLAYER1
        8: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
        9: TAKE-ITEM-HAND PLAYER1 OSCAR ZONE5_4
       10: GO PLAYER1 ZONE5_4 ZONE5_3 WEST
       11: DELIVER-ITEM PLAYER1 OSCAR LEONARDO ZONE5_3
       12: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
       13: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
       14: TAKE-ITEM-HAND PLAYER1 GOLD2 ZONE5_1
       15: TURN-RIGHT PLAYER1
       16: GO PLAYER1 ZONE5_1 ZONE4_1 NORTH BIKINI2
       17: GO PLAYER1 ZONE4_1 ZONE3_1 NORTH
       18: TURN-RIGHT PLAYER1
       19: DELIVER-ITEM PLAYER1 GOLD2 WITCH ZONE3_1
       20: GO PLAYER1 ZONE3_1 ZONE3_2 EAST
       21: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
       22: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
       23: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
       24: TAKE-ITEM-HAND PLAYER1 ALGORITHM1 ZONE3_5
       25: TURN-LEFT PLAYER1
       26: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH BIKINI2
       27: DELIVER-ITEM PLAYER1 ALGORITHM1 PROFESSOR ZONE2_5
       28: GO PLAYER1 ZONE2_5 ZONE1_5 NORTH
       29: TURN-LEFT PLAYER1
       30: GO PLAYER1 ZONE1_5 ZONE1_4 WEST
       31: GO PLAYER1 ZONE1_4 ZONE1_3 WEST
       32: TAKE-ITEM-HAND PLAYER1 GOLD1 ZONE1_3
       33: GO PLAYER1 ZONE1_3 ZONE1_2 WEST
       34: GO PLAYER1 ZONE1_2 ZONE1_1 WEST
       35: TURN-LEFT PLAYER1
       36: TURN-LEFT PLAYER1
       37: DELIVER-ITEM PLAYER1 GOLD1 PRINCESS ZONE1_1
       38: GO PLAYER1 ZONE1_1 ZONE1_2 EAST
       39: GO PLAYER1 ZONE1_2 ZONE1_3 EAST
       40: GO PLAYER1 ZONE1_3 ZONE1_4 EAST
       41: TAKE-ITEM-HAND PLAYER1 ZAPATILLA3 ZONE1_4
       42: GO PLAYER1 ZONE1_4 ZONE1_5 EAST
       43: TURN-RIGHT PLAYER1
       44: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH BIKINI2
       45: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
       46: TURN-RIGHT PLAYER1
       47: GO PLAYER1 ZONE3_5 ZONE3_4 WEST
       48: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
       49: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
       50: TURN-LEFT PLAYER1
       51: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH ZAPATILLA3
```

```
52: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA3 ZONE4_2
53: TAKE-ITEM-HAND PLAYER1 APPLE2 ZONE4_2
54: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
55: TURN-LEFT PLAYER1
56: GO PLAYER1 ZONE5_2 ZONE5_3 EAST
57: DELIVER-ITEM PLAYER1 APPLE2 PRINCE ZONE5_3
```

```
time spent:    0.00 seconds instantiating 1354 easy, 72 hard action templates
              0.00 seconds reachability analysis, yielding 376 facts and 706
actions
              0.00 seconds creating final representation with 371 relevant
facts, 2 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              9.13 seconds searching, evaluating 258314 states, to a max depth
of 18
              9.13 seconds total time
```

4. Ejercicio 4

4.1 Principales decisiones en el diseño del dominio.

4.1.1 Apartado a)

Para poder representar los puntos otorgados al entregar cierto tipo de objeto se han definido funciones del tipo “points-(tipo-de-objeto) ?c – character”. Para representar el total de puntos del jugador, se ha definido una función “total-points”.

Además, se han definido predicados para determinar el tipo del objeto. Se ha decidido así en vez de declarar 5 sub-tipos de objeto dentro de “deliverable-item” porque de la segunda manera habría que duplicar 5 veces la acción de “entregar objeto a personaje” (una por cada tipo de objeto), aunque esta manera sea la más natural.

Gracias a estos predicados, podemos mantener esta acción como una sola y modificar los efectos con la sentencia **when**. Si el objeto es determinado tipo y se entrega a un personaje concreto, se sumará la puntuación adecuada a la puntuación total gracias a esta sentencia.

4.2 Problemas utilizados.

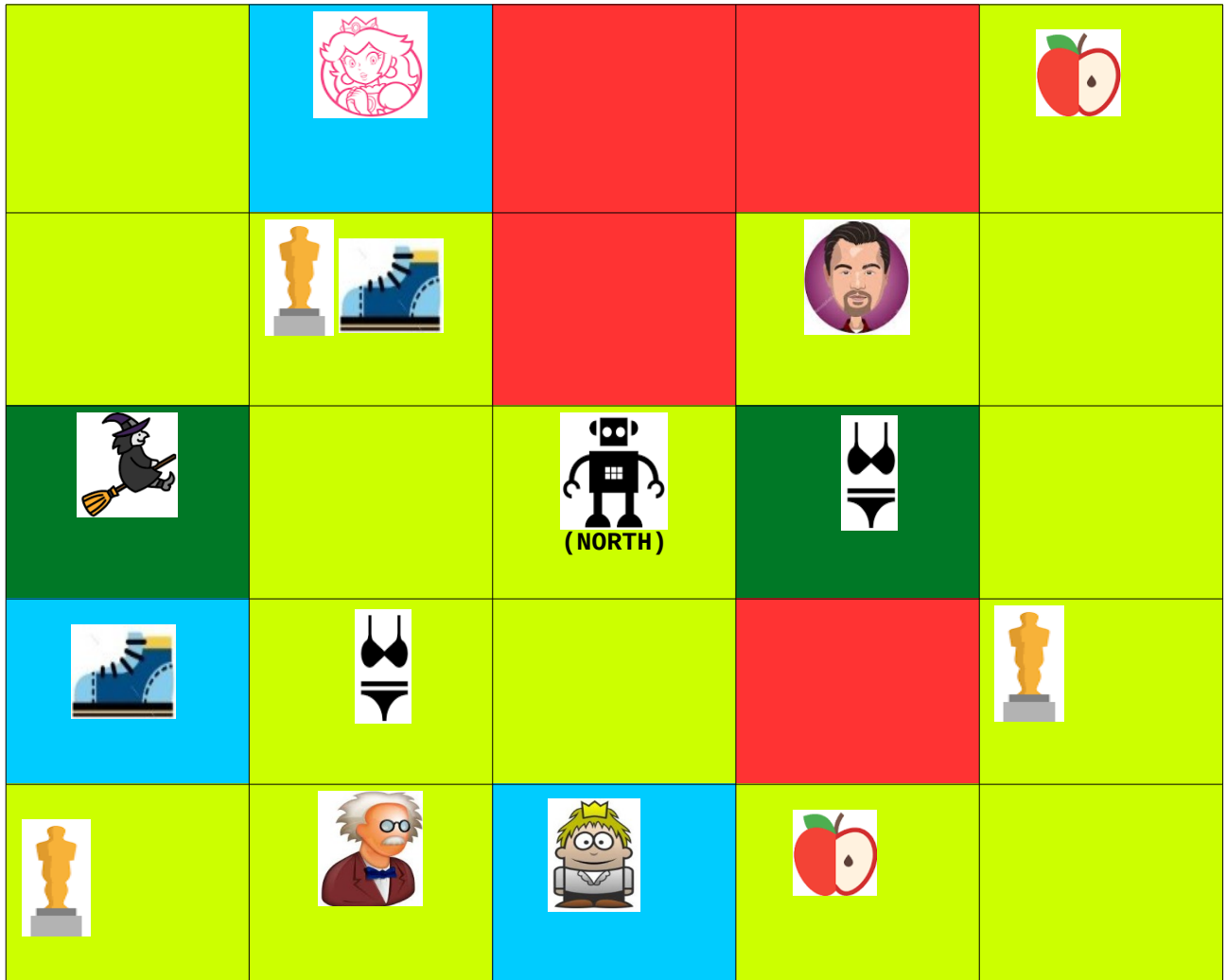
Los problemas planteados son similares a los anteriores, pero esta vez el **objetivo** será alcanzar cierta cantidad de puntos. Además, se ha definido en el problema la tabla de puntos que aparece en el enunciado, con ayuda de las funciones descritas anteriormente.

4.2.1 Problema 1

4.2.1.1 Características

- 3 objetos de tipo oscar
- 2 objetos de tipo manzana
- **Objetivo:** alcanzar al menos 50 puntos.

4.2.1.2 Representación gráfica



4.2.1.3 Plan obtenido.

ff: found legal plan as follows

```

step    0: TURN-LEFT PLAYER1
        1: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
        2: TURN-RIGHT PLAYER1
        3: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
        4: TURN-RIGHT PLAYER1
        5: TAKE-ITEM-HAND PLAYER1 ZAPATILLA1 ZONE2_2
        6: PUT-IN-BAG PLAYER1 ZAPATILLA1
        7: TURN-RIGHT PLAYER1
        8: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
        9: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
       10: TAKE-ITEM-HAND PLAYER1 BIKINI1 ZONE4_2
    
```

11: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
12: TURN-RIGHT PLAYER1
13: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
14: TURN-RIGHT PLAYER1
15: LEAVE-HAND-ITEM PLAYER1 BIKINI1 ZONE5_1
16: TURN-RIGHT PLAYER1
17: TAKE-ITEM-HAND PLAYER1 OSCAR3 ZONE5_1
18: GO PLAYER1 ZONE5_1 ZONE5_2 EAST
19: TURN-LEFT PLAYER1
20: GO PLAYER1 ZONE5_2 ZONE4_2 NORTH
21: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
22: TURN-RIGHT PLAYER1
23: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
24: GO PLAYER1 ZONE3_3 ZONE3_4 EAST ZAPATILLA1
25: TURN-LEFT PLAYER1
26: GO PLAYER1 ZONE3_4 ZONE2_4 NORTH
27: DELIVER-ITEM PLAYER1 OSCAR3 LEONARDO ZONE2_4
28: TURN-RIGHT PLAYER1
29: GO PLAYER1 ZONE2_4 ZONE2_5 EAST
30: TURN-RIGHT PLAYER1
31: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
32: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH
33: TURN-RIGHT PLAYER1
34: TURN-RIGHT PLAYER1
35: TAKE-ITEM-HAND PLAYER1 OSCAR1 ZONE4_5
36: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
37: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
38: TURN-LEFT PLAYER1
39: GO PLAYER1 ZONE2_5 ZONE2_4 WEST
40: DELIVER-ITEM PLAYER1 OSCAR1 LEONARDO ZONE2_4
41: TURN-LEFT PLAYER1
42: TURN-LEFT PLAYER1
43: GO PLAYER1 ZONE2_4 ZONE2_5 EAST
44: TURN-LEFT PLAYER1
45: GO PLAYER1 ZONE2_5 ZONE1_5 NORTH
46: TURN-RIGHT PLAYER1
47: TURN-RIGHT PLAYER1
48: TAKE-ITEM-HAND PLAYER1 APPLE1 ZONE1_5
49: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH
50: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
51: TURN-RIGHT PLAYER1
52: GO PLAYER1 ZONE3_5 ZONE3_4 WEST ZAPATILLA1
53: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
54: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
55: GO PLAYER1 ZONE3_2 ZONE3_1 WEST ZAPATILLA1
56: DELIVER-ITEM PLAYER1 APPLE1 WITCH ZONE3_1
57: TURN-RIGHT PLAYER1
58: GO PLAYER1 ZONE3_1 ZONE2_1 NORTH
59: TURN-RIGHT PLAYER1
60: GO PLAYER1 ZONE2_1 ZONE2_2 EAST
61: TURN-RIGHT PLAYER1
62: TAKE-ITEM-HAND PLAYER1 OSCAR2 ZONE2_2
63: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
64: TURN-LEFT PLAYER1
65: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
66: GO PLAYER1 ZONE3_3 ZONE3_4 EAST ZAPATILLA1

```
67: TURN-LEFT PLAYER1
68: GO PLAYER1 ZONE3_4 ZONE2_4 NORTH
69: DELIVER-ITEM PLAYER1 OSCAR2 LEONARDO ZONE2_4
70: TURN-RIGHT PLAYER1
71: GO PLAYER1 ZONE2_4 ZONE2_5 EAST
72: TURN-RIGHT PLAYER1
73: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
74: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH
75: GO PLAYER1 ZONE4_5 ZONE5_5 SOUTH
76: TURN-RIGHT PLAYER1
77: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
78: TURN-RIGHT PLAYER1
79: TURN-RIGHT PLAYER1
80: TAKE-ITEM-HAND PLAYER1 APPLE2 ZONE5_4
81: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
82: TURN-LEFT PLAYER1
83: GO PLAYER1 ZONE5_5 ZONE4_5 NORTH
84: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
85: TURN-LEFT PLAYER1
86: GO PLAYER1 ZONE3_5 ZONE3_4 WEST ZAPATILLA1
87: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
88: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
89: GO PLAYER1 ZONE3_2 ZONE3_1 WEST ZAPATILLA1
90: DELIVER-ITEM PLAYER1 APPLE2 WITCH ZONE3_1
```

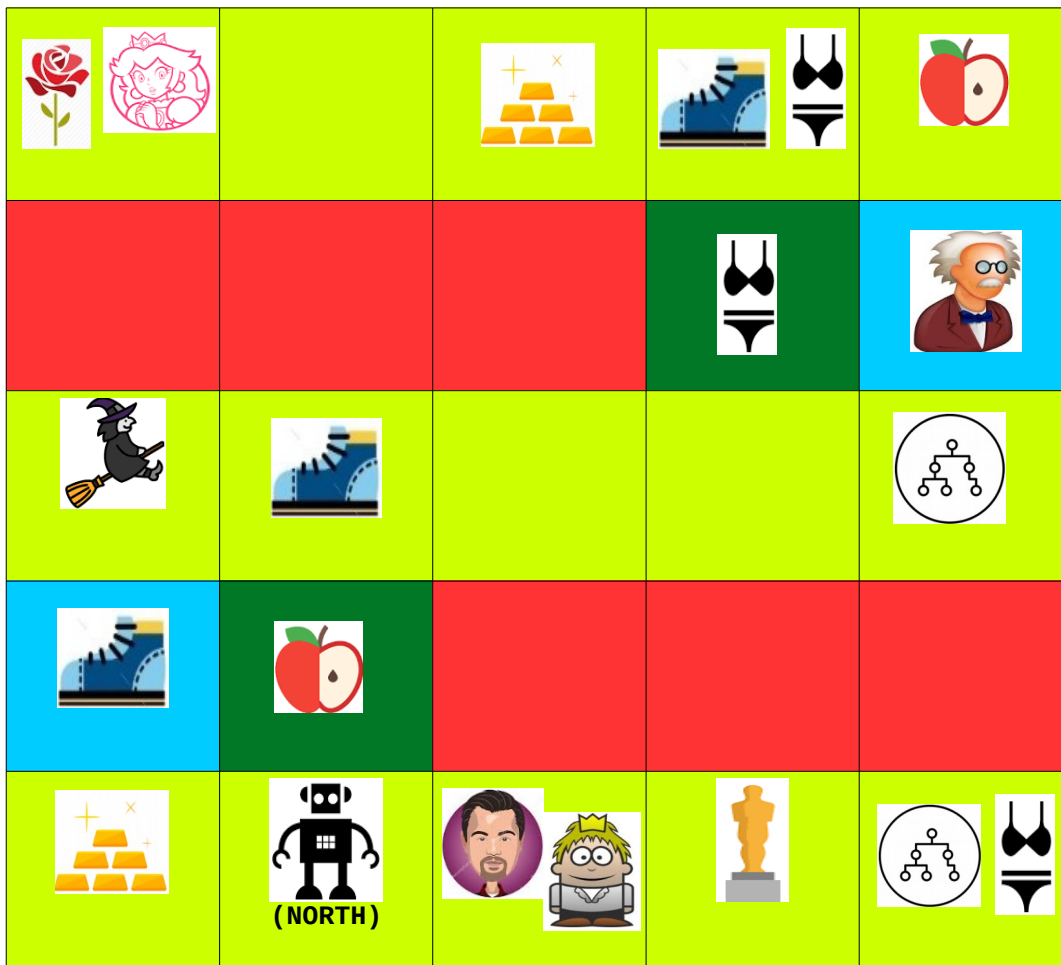
```
time spent:    0.00 seconds instantiating 965 easy, 56 hard action templates
              0.00 seconds reachability analysis, yielding 276 facts and 521
actions
              0.00 seconds creating final representation with 271 relevant
facts, 2 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              0.05 seconds searching, evaluating 3135 states, to a max depth of
21
              0.05 seconds total time
```

4.2.2 Problema 2

4.2.2.1 Características

- 8 objetos entregables.
- **Objetivo:** Alcanzar al menos 65 puntos.
- **Objetivo extra:** Coste total del camino recorrido ≤ 500

4.2.2.2 Representación gráfica



4.2.2.3 Plan obtenido.

ff: found legal plan as follows

```

step    0: TURN-LEFT PLAYER1
        1: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
        2: TURN-RIGHT PLAYER1
        3: TURN-RIGHT PLAYER1
        4: TAKE-ITEM-HAND PLAYER1 GOLD2 ZONE5_1
        5: GO PLAYER1 ZONE5_1 ZONE5_2 EAST
        6: GO PLAYER1 ZONE5_2 ZONE5_3 EAST
        7: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
        8: TURN-RIGHT PLAYER1
        9: TURN-RIGHT PLAYER1
       10: PUT-IN-BAG PLAYER1 GOLD2
       11: TAKE-ITEM-HAND PLAYER1 OSCAR ZONE5_4
       12: GO PLAYER1 ZONE5_4 ZONE5_3 WEST
       13: DELIVER-ITEM PLAYER1 OSCAR LEONARDO ZONE5_3
       14: TAKE-BAG-ITEM PLAYER1 GOLD2
    
```

```
15: DELIVER-ITEM PLAYER1 GOLD2 PRINCE ZONE5_3
16: TURN-RIGHT PLAYER1
17: TURN-RIGHT PLAYER1
18: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
19: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
20: TURN-RIGHT PLAYER1
21: TURN-RIGHT PLAYER1
22: TAKE-ITEM-HAND PLAYER1 BIKINI2 ZONE5_5
23: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
24: PUT-IN-BAG PLAYER1 BIKINI2
25: GO PLAYER1 ZONE5_4 ZONE5_3 WEST
26: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
27: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
28: TURN-RIGHT PLAYER1
29: GO PLAYER1 ZONE5_1 ZONE4_1 NORTH BIKINI2
30: TAKE-ITEM-HAND PLAYER1 ZAPATILLA2 ZONE4_1
31: TURN-RIGHT PLAYER1
32: GO PLAYER1 ZONE4_1 ZONE4_2 EAST ZAPATILLA2
33: TURN-LEFT PLAYER1
34: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA2 ZONE4_2
35: TAKE-ITEM-HAND PLAYER1 APPLE2 ZONE4_2
36: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
37: TURN-LEFT PLAYER1
38: GO PLAYER1 ZONE3_2 ZONE3_1 WEST
39: DELIVER-ITEM PLAYER1 APPLE2 WITCH ZONE3_1
40: TURN-LEFT PLAYER1
41: TURN-LEFT PLAYER1
42: GO PLAYER1 ZONE3_1 ZONE3_2 EAST
43: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
44: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
45: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
46: TURN-LEFT PLAYER1
47: TAKE-ITEM-HAND PLAYER1 ALGORITHM1 ZONE3_5
48: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH BIKINI2
49: DELIVER-ITEM PLAYER1 ALGORITHM1 PROFESSOR ZONE2_5
50: GO PLAYER1 ZONE2_5 ZONE1_5 NORTH
51: TURN-LEFT PLAYER1
52: GO PLAYER1 ZONE1_5 ZONE1_4 WEST
53: GO PLAYER1 ZONE1_4 ZONE1_3 WEST
54: GO PLAYER1 ZONE1_3 ZONE1_2 WEST
55: GO PLAYER1 ZONE1_2 ZONE1_1 WEST
56: TAKE-ITEM-HAND PLAYER1 ROSE ZONE1_1
57: DELIVER-ITEM PLAYER1 ROSE PRINCESS ZONE1_1
58: TURN-RIGHT PLAYER1
59: TURN-RIGHT PLAYER1
60: GO PLAYER1 ZONE1_1 ZONE1_2 EAST
61: GO PLAYER1 ZONE1_2 ZONE1_3 EAST
62: TAKE-ITEM-HAND PLAYER1 GOLD1 ZONE1_3
63: GO PLAYER1 ZONE1_3 ZONE1_4 EAST
64: GO PLAYER1 ZONE1_4 ZONE1_5 EAST
65: TURN-RIGHT PLAYER1
66: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH BIKINI2
67: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
68: TURN-RIGHT PLAYER1
69: GO PLAYER1 ZONE3_5 ZONE3_4 WEST
70: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
```

```

71: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
72: GO PLAYER1 ZONE3_2 ZONE3_1 WEST
73: TURN-LEFT PLAYER1
74: GO PLAYER1 ZONE3_1 ZONE4_1 SOUTH BIKINI2
75: GO PLAYER1 ZONE4_1 ZONE5_1 SOUTH
76: TURN-LEFT PLAYER1
77: GO PLAYER1 ZONE5_1 ZONE5_2 EAST
78: GO PLAYER1 ZONE5_2 ZONE5_3 EAST
79: DELIVER-ITEM PLAYER1 GOLD1 PRINCE ZONE5_3
80: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
81: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
82: TURN-RIGHT PLAYER1
83: TAKE-ITEM-HAND PLAYER1 ALGORITHM2 ZONE5_5
84: TURN-RIGHT PLAYER1
85: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
86: GO PLAYER1 ZONE5_4 ZONE5_3 WEST
87: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
88: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
89: TURN-RIGHT PLAYER1
90: GO PLAYER1 ZONE5_1 ZONE4_1 NORTH BIKINI2
91: GO PLAYER1 ZONE4_1 ZONE3_1 NORTH
92: TURN-RIGHT PLAYER1
93: GO PLAYER1 ZONE3_1 ZONE3_2 EAST
94: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
95: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
96: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
97: TURN-LEFT PLAYER1
98: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH BIKINI2
99: DELIVER-ITEM PLAYER1 ALGORITHM2 PROFESSOR ZONE2_5

```

```

time spent:    0.00 seconds instantiating 1354 easy, 72 hard action templates
              0.00 seconds reachability analysis, yielding 376 facts and 706
actions
              0.00 seconds creating final representation with 371 relevant
facts, 3 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              1.91 seconds searching, evaluating 105811 states, to a max depth
of 40
              1.91 seconds total time

```

5. Ejercicio 5

5.1 Principales decisiones en el diseño del dominio.

5.1.1 Apartado a)

Se han introducido nuevas funciones para declarar que un personaje puede tener un número máximo de objetos (max-items) y tiene un cierto número de objetos en posesión (total-items).

Se ha modificado la acción de entregar un objeto. Se ha añadido una nueva precondition que dice que el número de objetos en posesión de un personaje debe ser menor al número máximo de objetos que puede tener. Se ha añadido un efecto a esta acción en el que se incrementa en uno el número total de items que posee el personaje.

Además, antes se había declarado el tipo “**actor**”, y dentro de él estaban los personajes y los jugadores. Este tipo tenía sentido para poder reutilizar el predicado de “mano-vacía”, ya que podíamos representar que un jugador o un personaje tenían algún item en posesión de esta manera.

No es que sea incorrecto mantener el tipo actor, pero ha dejado de tener sentido, ya que ahora tenemos una función que nos dice el número de objetos que tiene cierto personaje, luego ya no necesitamos el predicado “mano-vacía” para los personajes.

Así que los personajes y jugadores han dejado de tener algo en común, por lo que se ha eliminado el tipo actor, y los jugadores y personajes pasan a ser de tipo **locatable**.

5.2 Problemas utilizados.

Los problemas planteados son similares a los anteriores, pero esta vez el **objetivo** será alcanzar cierta cantidad de puntos. Además, se ha definido en el problema la tabla de puntos que aparece en el enunciado, con ayuda de las funciones descritas anteriormente.

5.2.1 Problema 1

5.2.1.1 Características

- 3 oscars, 2 manzanas, 1 algoritmo y 5 rosas.
- Máximo de objetos:
 - Princesa: 2


```
3: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
4: TURN-LEFT PLAYER1
5: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
6: TURN-RIGHT PLAYER1
7: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
8: TURN-RIGHT PLAYER1
9: GO PLAYER1 ZONE4_3 ZONE4_2 WEST
10: TURN-LEFT PLAYER1
11: TAKE-ITEM-HAND PLAYER1 BIKINI1 ZONE4_2
12: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
13: TURN-LEFT PLAYER1
14: GO PLAYER1 ZONE5_2 ZONE5_3 EAST BIKINI1
15: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
16: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
17: TURN-RIGHT PLAYER1
18: PUT-IN-BAG PLAYER1 BIKINI1
19: TURN-RIGHT PLAYER1
20: TAKE-ITEM-HAND PLAYER1 ALGORITHM ZONE5_5
21: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
22: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI1
23: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
24: TURN-RIGHT PLAYER1
25: TURN-RIGHT PLAYER1
26: LEAVE-HAND-ITEM PLAYER1 ALGORITHM ZONE5_2
27: GO PLAYER1 ZONE5_2 ZONE5_3 EAST BIKINI1
28: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
29: TURN-RIGHT PLAYER1
30: TURN-RIGHT PLAYER1
31: TAKE-ITEM-HAND PLAYER1 APPLE2 ZONE5_4
32: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI1
33: DELIVER-ITEM PLAYER1 APPLE2 PRINCE ZONE5_3
34: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
35: TURN-RIGHT PLAYER1
36: TURN-RIGHT PLAYER1
37: TAKE-ITEM-HAND PLAYER1 ALGORITHM ZONE5_2
38: GO PLAYER1 ZONE5_2 ZONE5_3 EAST BIKINI1
39: TURN-RIGHT PLAYER1
40: TURN-RIGHT PLAYER1
41: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
42: LEAVE-HAND-ITEM PLAYER1 ALGORITHM ZONE5_2
43: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
44: TURN-RIGHT PLAYER1
45: GO PLAYER1 ZONE5_1 ZONE4_1 NORTH BIKINI1
46: TURN-RIGHT PLAYER1
47: TAKE-ITEM-HAND PLAYER1 ROSE5 ZONE4_1
48: GO PLAYER1 ZONE4_1 ZONE4_2 EAST
49: TURN-RIGHT PLAYER1
50: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
51: TURN-RIGHT PLAYER1
52: DELIVER-ITEM PLAYER1 ROSE5 PROFESSOR ZONE5_2
53: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
54: TURN-RIGHT PLAYER1
55: TURN-RIGHT PLAYER1
56: TAKE-ITEM-HAND PLAYER1 OSCAR3 ZONE5_1
57: GO PLAYER1 ZONE5_1 ZONE5_2 EAST
58: DELIVER-ITEM PLAYER1 OSCAR3 PROFESSOR ZONE5_2
```

```
59: TAKE-ITEM-HAND PLAYER1 ALGORITHM ZONE5_2
60: GO PLAYER1 ZONE5_2 ZONE5_3 EAST BIKINI1
61: DELIVER-ITEM PLAYER1 ALGORITHM PRINCE ZONE5_3
62: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
63: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
64: TURN-LEFT PLAYER1
65: GO PLAYER1 ZONE5_5 ZONE4_5 NORTH
66: TAKE-ITEM-HAND PLAYER1 OSCAR1 ZONE4_5
67: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
68: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
69: TURN-LEFT PLAYER1
70: GO PLAYER1 ZONE2_5 ZONE2_4 WEST
71: DELIVER-ITEM PLAYER1 OSCAR1 LEONARDO ZONE2_4
72: TURN-RIGHT PLAYER1
73: TURN-RIGHT PLAYER1
74: TAKE-ITEM-HAND PLAYER1 ROSE3 ZONE2_4
75: GO PLAYER1 ZONE2_4 ZONE2_5 EAST
76: TURN-RIGHT PLAYER1
77: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
78: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH
79: GO PLAYER1 ZONE4_5 ZONE5_5 SOUTH
80: TURN-RIGHT PLAYER1
81: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
82: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI1
83: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
84: TURN-RIGHT PLAYER1
85: GO PLAYER1 ZONE5_2 ZONE4_2 NORTH
86: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
87: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
88: GO PLAYER1 ZONE2_2 ZONE1_2 NORTH BIKINI1
89: DELIVER-ITEM PLAYER1 ROSE3 PRINCESS ZONE1_2
90: TURN-LEFT PLAYER1
91: GO PLAYER1 ZONE1_2 ZONE1_1 WEST
92: TURN-LEFT PLAYER1
93: TURN-LEFT PLAYER1
94: TAKE-ITEM-HAND PLAYER1 ROSE1 ZONE1_1
95: GO PLAYER1 ZONE1_1 ZONE1_2 EAST BIKINI1
96: DELIVER-ITEM PLAYER1 ROSE1 PRINCESS ZONE1_2
97: TURN-RIGHT PLAYER1
98: GO PLAYER1 ZONE1_2 ZONE2_2 SOUTH
99: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
100: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
101: TURN-RIGHT PLAYER1
102: GO PLAYER1 ZONE4_2 ZONE4_1 WEST BIKINI1
103: TURN-LEFT PLAYER1
104: GO PLAYER1 ZONE4_1 ZONE5_1 SOUTH
105: TURN-LEFT PLAYER1
106: TAKE-ITEM-HAND PLAYER1 ROSE4 ZONE5_1
107: GO PLAYER1 ZONE5_1 ZONE5_2 EAST
108: DELIVER-ITEM PLAYER1 ROSE4 PROFESSOR ZONE5_2
109: GO PLAYER1 ZONE5_2 ZONE5_3 EAST BIKINI1
110: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
111: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
112: TURN-LEFT PLAYER1
113: GO PLAYER1 ZONE5_5 ZONE4_5 NORTH
114: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
```

```
115: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
116: GO PLAYER1 ZONE2_5 ZONE1_5 NORTH
117: TURN-RIGHT PLAYER1
118: TURN-RIGHT PLAYER1
119: TAKE-ITEM-HAND PLAYER1 APPLE1 ZONE1_5
120: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH
121: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
122: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH
123: GO PLAYER1 ZONE4_5 ZONE5_5 SOUTH
124: TURN-RIGHT PLAYER1
125: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
126: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI1
127: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
128: GO PLAYER1 ZONE5_2 ZONE5_1 WEST
129: TURN-RIGHT PLAYER1
130: GO PLAYER1 ZONE5_1 ZONE4_1 NORTH BIKINI1
131: LEAVE-HAND-ITEM PLAYER1 APPLE1 ZONE4_1
132: TAKE-BAG-ITEM PLAYER1 BIKINI1
133: LEAVE-HAND-ITEM PLAYER1 BIKINI1 ZONE4_1
134: TAKE-ITEM-HAND PLAYER1 ZAPATILLA2 ZONE4_1
135: PUT-IN-BAG PLAYER1 ZAPATILLA2
136: TAKE-ITEM-HAND PLAYER1 APPLE1 ZONE4_1
137: GO PLAYER1 ZONE4_1 ZONE3_1 NORTH ZAPATILLA2
138: DELIVER-ITEM PLAYER1 APPLE1 WITCH ZONE3_1
```

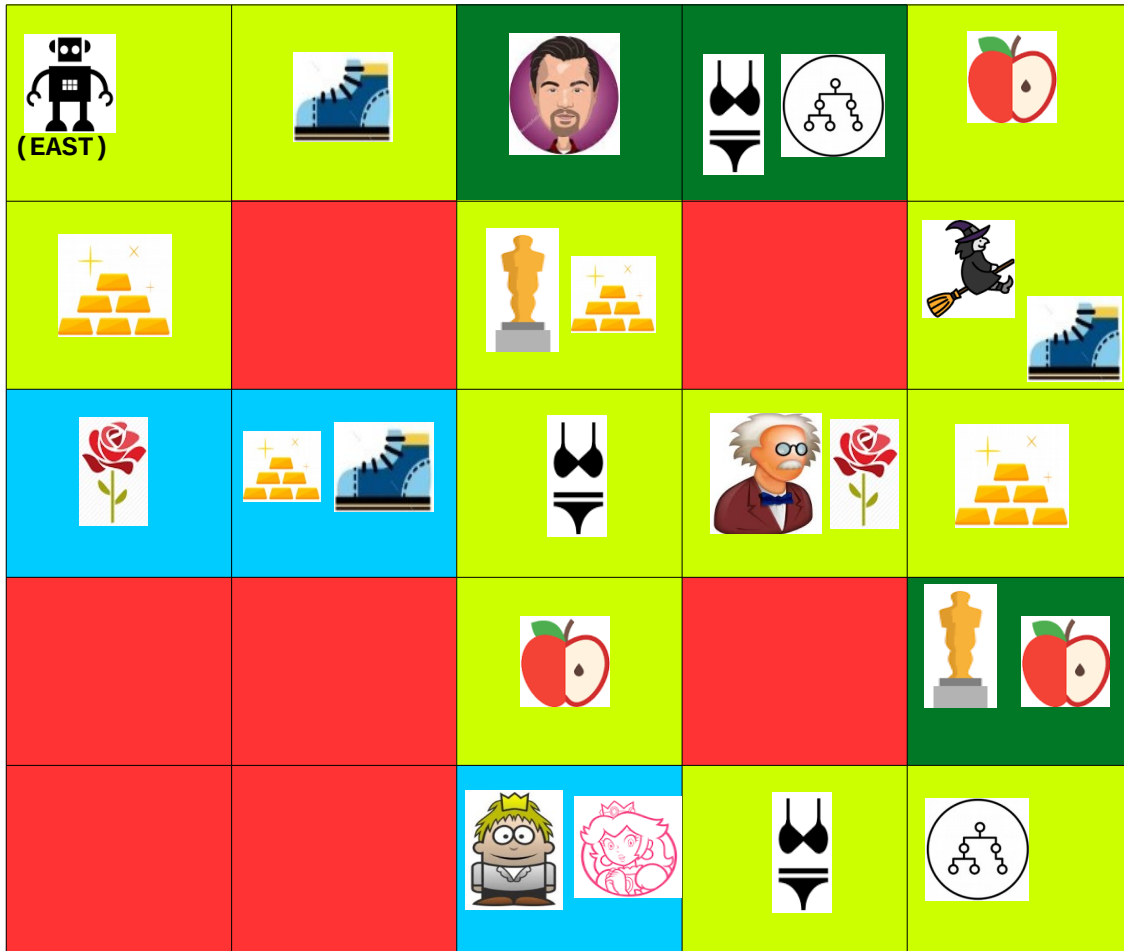
```
time spent:    0.00 seconds instantiating 1859 easy, 56 hard action templates
              0.00 seconds reachability analysis, yielding 379 facts and 815
actions
              0.00 seconds creating final representation with 374 relevant
facts, 12 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              13.53 seconds searching, evaluating 532891 states, to a max depth
of 107
              13.53 seconds total time
```

5.2.2 Problema 2

5.2.2.1 Características

- 2 oscars, 3 manzanas, 2 algoritmo, 2 rosas y 4 de oro.
- Máximo de objetos:
 - Princesa: 3
 - Príncipe: 2
 - Leonardo: 4
 - Bruja: 5
 - Profesor: 1
- **Objetivo:** alcanzar al menos 93 puntos, que la bruja tenga exactamente 5 objetos, que leonardo tenga exactamente 3 objetos y que la princesa tenga al menos 1 objeto.

5.2.2.2 Representación gráfica



5.2.2.3 Plan obtenido.

ff: found legal plan as follows

```

step    0: GO PLAYER1 ZONE1_1 ZONE1_2 EAST
        1: TAKE-ITEM-HAND PLAYER1 ZAPATILLA1 ZONE1_2
        2: PUT-IN-BAG PLAYER1 ZAPATILLA1
        3: GO PLAYER1 ZONE1_2 ZONE1_3 EAST ZAPATILLA1
        4: TURN-RIGHT PLAYER1
        5: GO PLAYER1 ZONE1_3 ZONE2_3 SOUTH
        6: TURN-LEFT PLAYER1
        7: TURN-LEFT PLAYER1
        8: TAKE-ITEM-HAND PLAYER1 GOLD2 ZONE2_3
        9: GO PLAYER1 ZONE2_3 ZONE1_3 NORTH ZAPATILLA1
       10: TURN-LEFT PLAYER1
       11: DELIVER-ITEM PLAYER1 GOLD2 LEONARDO ZONE1_3
       12: TURN-LEFT PLAYER1
       13: GO PLAYER1 ZONE1_3 ZONE2_3 SOUTH
    
```

14: TURN-LEFT PLAYER1
15: TURN-LEFT PLAYER1
16: TAKE-ITEM-HAND PLAYER1 OSCAR1 ZONE2_3
17: GO PLAYER1 ZONE2_3 ZONE1_3 NORTH ZAPATILLA1
18: TURN-RIGHT PLAYER1
19: LEAVE-HAND-ITEM PLAYER1 OSCAR1 ZONE1_3
20: GO PLAYER1 ZONE1_3 ZONE1_4 EAST ZAPATILLA1
21: TAKE-ITEM-HAND PLAYER1 ALGORITHM1 ZONE1_4
22: TURN-RIGHT PLAYER1
23: TURN-RIGHT PLAYER1
24: GO PLAYER1 ZONE1_4 ZONE1_3 WEST ZAPATILLA1
25: DELIVER-ITEM PLAYER1 ALGORITHM1 LEONARDO ZONE1_3
26: TURN-LEFT PLAYER1
27: TAKE-ITEM-HAND PLAYER1 OSCAR1 ZONE1_3
28: TURN-LEFT PLAYER1
29: DELIVER-ITEM PLAYER1 OSCAR1 LEONARDO ZONE1_3
30: GO PLAYER1 ZONE1_3 ZONE1_4 EAST ZAPATILLA1
31: GO PLAYER1 ZONE1_4 ZONE1_5 EAST
32: TAKE-ITEM-HAND PLAYER1 APPLE1 ZONE1_5
33: TURN-RIGHT PLAYER1
34: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH
35: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
36: LEAVE-HAND-ITEM PLAYER1 APPLE1 ZONE3_5
37: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH ZAPATILLA1
38: TURN-RIGHT PLAYER1
39: TURN-RIGHT PLAYER1
40: TAKE-ITEM-HAND PLAYER1 APPLE3 ZONE4_5
41: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
42: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
43: TURN-RIGHT PLAYER1
44: TURN-RIGHT PLAYER1
45: LEAVE-HAND-ITEM PLAYER1 APPLE3 ZONE2_5
46: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
47: TURN-RIGHT PLAYER1
48: TURN-RIGHT PLAYER1
49: TAKE-ITEM-HAND PLAYER1 GOLD3 ZONE3_5
50: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
51: TURN-RIGHT PLAYER1
52: TURN-RIGHT PLAYER1
53: DELIVER-ITEM PLAYER1 GOLD3 WITCH ZONE2_5
54: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
55: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH ZAPATILLA1
56: TURN-RIGHT PLAYER1
57: TURN-RIGHT PLAYER1
58: TAKE-ITEM-HAND PLAYER1 OSCAR2 ZONE4_5
59: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
60: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
61: TURN-RIGHT PLAYER1
62: TURN-RIGHT PLAYER1
63: DELIVER-ITEM PLAYER1 OSCAR2 WITCH ZONE2_5
64: TAKE-ITEM-HAND PLAYER1 APPLE3 ZONE2_5
65: DELIVER-ITEM PLAYER1 APPLE3 WITCH ZONE2_5
66: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
67: TURN-RIGHT PLAYER1
68: TURN-RIGHT PLAYER1
69: TAKE-ITEM-HAND PLAYER1 APPLE1 ZONE3_5

```
70: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
71: TURN-RIGHT PLAYER1
72: TURN-RIGHT PLAYER1
73: DELIVER-ITEM PLAYER1 APPLE1 WITCH ZONE2_5
74: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
75: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH ZAPATILLA1
76: GO PLAYER1 ZONE4_5 ZONE5_5 SOUTH
77: TURN-RIGHT PLAYER1
78: TURN-RIGHT PLAYER1
79: TAKE-ITEM-HAND PLAYER1 ALGORITHM1 ZONE5_5
80: GO PLAYER1 ZONE5_5 ZONE4_5 NORTH ZAPATILLA1
81: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
82: TURN-LEFT PLAYER1
83: GO PLAYER1 ZONE3_5 ZONE3_4 WEST
84: DELIVER-ITEM PLAYER1 ALGORITHM1 PROFESSOR ZONE3_4
85: TURN-LEFT PLAYER1
86: TURN-LEFT PLAYER1
87: TAKE-ITEM-HAND PLAYER1 ROSE1 ZONE3_4
88: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
89: TURN-RIGHT PLAYER1
90: GO PLAYER1 ZONE3_5 ZONE4_5 SOUTH ZAPATILLA1
91: GO PLAYER1 ZONE4_5 ZONE5_5 SOUTH
92: TURN-RIGHT PLAYER1
93: LEAVE-HAND-ITEM PLAYER1 ROSE1 ZONE5_5
94: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
95: TAKE-ITEM-HAND PLAYER1 BIKINI3 ZONE5_4
96: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI3
97: LEAVE-HAND-ITEM PLAYER1 BIKINI3 ZONE5_3
98: TURN-RIGHT PLAYER1
99: GO PLAYER1 ZONE5_3 ZONE4_3 NORTH
100: TAKE-ITEM-HAND PLAYER1 APPLE2 ZONE4_3
101: GO PLAYER1 ZONE4_3 ZONE3_3 NORTH
102: TURN-RIGHT PLAYER1
103: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
104: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
105: TURN-LEFT PLAYER1
106: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
107: DELIVER-ITEM PLAYER1 APPLE2 WITCH ZONE2_5
108: GO PLAYER1 ZONE2_5 ZONE1_5 NORTH
109: TURN-LEFT PLAYER1
110: GO PLAYER1 ZONE1_5 ZONE1_4 WEST ZAPATILLA1
111: TAKE-ITEM-HAND PLAYER1 BIKINI1 ZONE1_4
112: GO PLAYER1 ZONE1_4 ZONE1_3 WEST ZAPATILLA1
113: TURN-LEFT PLAYER1
114: GO PLAYER1 ZONE1_3 ZONE2_3 SOUTH
115: GO PLAYER1 ZONE2_3 ZONE3_3 SOUTH
116: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
117: GO PLAYER1 ZONE4_3 ZONE5_3 SOUTH BIKINI1
118: TURN-LEFT PLAYER1
119: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
120: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
121: TURN-RIGHT PLAYER1
122: TURN-RIGHT PLAYER1
123: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
124: TURN-RIGHT PLAYER1
125: TURN-RIGHT PLAYER1
```

126: LEAVE-HAND-ITEM PLAYER1 BIKINI1 ZONE5_4
127: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
128: TURN-RIGHT PLAYER1
129: TURN-RIGHT PLAYER1
130: TAKE-ITEM-HAND PLAYER1 ROSE1 ZONE5_5
131: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
132: LEAVE-HAND-ITEM PLAYER1 ROSE1 ZONE5_4
133: TAKE-ITEM-HAND PLAYER1 BIKINI1 ZONE5_4
134: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI1
135: TURN-RIGHT PLAYER1
136: TURN-RIGHT PLAYER1
137: LEAVE-HAND-ITEM PLAYER1 BIKINI1 ZONE5_3
138: TAKE-BAG-ITEM PLAYER1 ZAPATILLA1
139: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE5_3
140: TAKE-ITEM-HAND PLAYER1 BIKINI3 ZONE5_3
141: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
142: TURN-RIGHT PLAYER1
143: PUT-IN-BAG PLAYER1 BIKINI3
144: TURN-RIGHT PLAYER1
145: TAKE-ITEM-HAND PLAYER1 ROSE1 ZONE5_4
146: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI3
147: DELIVER-ITEM PLAYER1 ROSE1 PRINCESS ZONE5_3
148: TURN-RIGHT PLAYER1
149: GO PLAYER1 ZONE5_3 ZONE4_3 NORTH
150: GO PLAYER1 ZONE4_3 ZONE3_3 NORTH
151: TURN-LEFT PLAYER1
152: GO PLAYER1 ZONE3_3 ZONE3_2 WEST BIKINI3
153: TURN-RIGHT PLAYER1
154: TURN-RIGHT PLAYER1
155: TAKE-ITEM-HAND PLAYER1 GOLD4 ZONE3_2
156: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
157: TURN-RIGHT PLAYER1
158: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
159: GO PLAYER1 ZONE4_3 ZONE5_3 SOUTH BIKINI3
160: DELIVER-ITEM PLAYER1 GOLD4 PRINCE ZONE5_3
161: TURN-RIGHT PLAYER1
162: TURN-RIGHT PLAYER1
163: GO PLAYER1 ZONE5_3 ZONE4_3 NORTH
164: GO PLAYER1 ZONE4_3 ZONE3_3 NORTH
165: TURN-LEFT PLAYER1
166: GO PLAYER1 ZONE3_3 ZONE3_2 WEST BIKINI3
167: GO PLAYER1 ZONE3_2 ZONE3_1 WEST BIKINI3
168: TURN-RIGHT PLAYER1
169: GO PLAYER1 ZONE3_1 ZONE2_1 NORTH
170: TURN-RIGHT PLAYER1
171: TURN-RIGHT PLAYER1
172: TAKE-ITEM-HAND PLAYER1 GOLD1 ZONE2_1
173: GO PLAYER1 ZONE2_1 ZONE3_1 SOUTH BIKINI3
174: TURN-LEFT PLAYER1
175: GO PLAYER1 ZONE3_1 ZONE3_2 EAST BIKINI3
176: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
177: TURN-RIGHT PLAYER1
178: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
179: GO PLAYER1 ZONE4_3 ZONE5_3 SOUTH BIKINI3
180: DELIVER-ITEM PLAYER1 GOLD1 PRINCE ZONE5_3

Planificación clásica

```
time spent:    0.00 seconds instantiating 1921 easy, 78 hard action templates
              0.00 seconds reachability analysis, yielding 391 facts and 851
actions
              0.00 seconds creating final representation with 386 relevant
facts, 12 relevant fluents
              0.00 seconds computing LNF
              0.00 seconds building connectivity graph
              17.07 seconds searching, evaluating 480076 states, to a max depth
of 82
              17.07 seconds total time
```


6. Ejercicio 6

6.1 Principales decisiones en el diseño del dominio.

(el apartado “a” no tiene nada que ver con el dominio)

6.1.1 Apartado b)

Para poder tener más de un jugador, sólo tenemos que añadir un parámetro de tipo “jugador” predicados y funciones que tienen que ver con los jugadores: orientación, tener un objeto en la mochila, tener la mano vacía, tener la mochila vacía, tener cierto objeto en la mano, los puntos del jugador... Y también a todas las acciones: girar a izquierda y derecha, ir de una zona a otra, entregar un objeto, meter un objeto en la mochila, coger un objeto, etc.

6.2 Problemas utilizados.

Los problemas planteados son similares a los anteriores, pero esta vez el **objetivo** será que cada jugador alcance una cierta cantidad de puntos y además que la suma de los puntos de los jugadores supere una cierta cantidad.

6.2.1 Problema 1

6.2.1.1 Características

- 3 oscars, 2 manzanas, 1 algoritmo y 5 rosas.
- Máximo de objetos:
 - Princesa: 2
 - Príncipe: 3
 - Leonardo: 1
 - Bruja: 3
 - Profesor: 4
- 2 jugadores.
- **Objetivo:** Que el jugador 1 obtenga al menos 30 puntos, que el jugador 2 obtenga al menos 20 puntos y que entre los dos obtengan al menos 60 puntos

6.2.1.2 Representación gráfica



6.2.1.3 Plan obtenido.

ff: found legal plan as follows

```
step    0: GO PLAYER2 ZONE4_3 ZONE3_3 NORTH
        1: GO PLAYER1 ZONE2_1 ZONE1_1 NORTH
        2: TURN-RIGHT PLAYER1
        3: TURN-RIGHT PLAYER1
        4: TAKE-ITEM-HAND PLAYER1 ROSE1 ZONE1_1
        5: GO PLAYER1 ZONE1_1 ZONE2_1 SOUTH
        6: TURN-LEFT PLAYER1
        7: GO PLAYER1 ZONE2_1 ZONE2_2 EAST
        8: TURN-LEFT PLAYER1
        9: TURN-RIGHT PLAYER2
       10: TURN-LEFT PLAYER1
       11: PUT-IN-BAG PLAYER1 ROSE1
       12: TURN-RIGHT PLAYER2
       13: TAKE-BAG-ITEM PLAYER1 ROSE1
```

14: LEAVE-HAND-ITEM PLAYER1 ROSE1 ZONE2_2
15: TAKE-ITEM-HAND PLAYER1 ZAPATILLA1 ZONE2_2
16: PUT-IN-BAG PLAYER1 ZAPATILLA1
17: TURN-LEFT PLAYER1
18: TAKE-ITEM-HAND PLAYER1 ROSE1 ZONE2_2
19: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
20: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
21: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
22: TURN-RIGHT PLAYER2
23: GO PLAYER2 ZONE3_3 ZONE3_2 WEST
24: TURN-LEFT PLAYER2
25: GO PLAYER2 ZONE3_2 ZONE4_2 SOUTH
26: GO PLAYER2 ZONE4_2 ZONE5_2 SOUTH
27: TURN-RIGHT PLAYER1
28: TURN-RIGHT PLAYER2
29: TURN-RIGHT PLAYER2
30: GO PLAYER2 ZONE5_2 ZONE4_2 NORTH
31: TURN-RIGHT PLAYER1
32: GO PLAYER1 ZONE5_2 ZONE4_2 NORTH
33: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
34: TAKE-ITEM-HAND PLAYER2 BIKINI1 ZONE4_2
35: GO PLAYER2 ZONE4_2 ZONE3_2 NORTH
36: LEAVE-HAND-ITEM PLAYER2 BIKINI1 ZONE3_2
37: LEAVE-HAND-ITEM PLAYER1 ROSE1 ZONE3_2
38: TAKE-ITEM-HAND PLAYER2 BIKINI1 ZONE3_2
39: GO PLAYER2 ZONE3_2 ZONE2_2 NORTH
40: TAKE-BAG-ITEM PLAYER1 ZAPATILLA1
41: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE3_2
42: TAKE-ITEM-HAND PLAYER1 ROSE1 ZONE3_2
43: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
44: LEAVE-HAND-ITEM PLAYER2 BIKINI1 ZONE2_2
45: LEAVE-HAND-ITEM PLAYER1 ROSE1 ZONE2_2
46: TAKE-ITEM-HAND PLAYER1 BIKINI1 ZONE2_2
47: PUT-IN-BAG PLAYER1 BIKINI1
48: TAKE-ITEM-HAND PLAYER1 ROSE1 ZONE2_2
49: TURN-RIGHT PLAYER2
50: TURN-RIGHT PLAYER2
51: GO PLAYER1 ZONE2_2 ZONE1_2 NORTH BIKINI1
52: TAKE-ITEM-HAND PLAYER2 OSCAR2 ZONE2_2
53: GO PLAYER2 ZONE2_2 ZONE3_2 SOUTH
54: GO PLAYER2 ZONE3_2 ZONE4_2 SOUTH
55: GO PLAYER2 ZONE4_2 ZONE5_2 SOUTH
56: TURN-RIGHT PLAYER2
57: DELIVER-ITEM PLAYER2 OSCAR2 PROFESSOR ZONE5_2
58: GO PLAYER2 ZONE5_2 ZONE5_1 WEST
59: TURN-RIGHT PLAYER2
60: TURN-RIGHT PLAYER2
61: TAKE-ITEM-HAND PLAYER2 OSCAR3 ZONE5_1
62: PUT-IN-BAG PLAYER2 OSCAR3
63: TAKE-ITEM-HAND PLAYER2 ROSE4 ZONE5_1
64: GO PLAYER2 ZONE5_1 ZONE5_2 EAST
65: DELIVER-ITEM PLAYER2 ROSE4 PROFESSOR ZONE5_2
66: TAKE-BAG-ITEM PLAYER2 OSCAR3
67: DELIVER-ITEM PLAYER2 OSCAR3 PROFESSOR ZONE5_2
68: TURN-LEFT PLAYER2
69: GO PLAYER2 ZONE5_2 ZONE4_2 NORTH

```
70: GO PLAYER2 ZONE4_2 ZONE3_2 NORTH
71: TURN-RIGHT PLAYER2
72: TAKE-ITEM-HAND PLAYER2 ZAPATILLA1 ZONE3_2
73: GO PLAYER2 ZONE3_2 ZONE3_3 EAST
74: GO PLAYER2 ZONE3_3 ZONE3_4 EAST ZAPATILLA1
75: GO PLAYER2 ZONE3_4 ZONE3_5 EAST
76: TURN-RIGHT PLAYER2
77: GO PLAYER2 ZONE3_5 ZONE4_5 SOUTH
78: LEAVE-HAND-ITEM PLAYER2 ZAPATILLA1 ZONE4_5
79: TURN-RIGHT PLAYER2
80: TURN-RIGHT PLAYER2
81: TAKE-ITEM-HAND PLAYER2 OSCAR1 ZONE4_5
82: GO PLAYER2 ZONE4_5 ZONE3_5 NORTH
83: GO PLAYER2 ZONE3_5 ZONE2_5 NORTH
84: TURN-LEFT PLAYER2
85: GO PLAYER2 ZONE2_5 ZONE2_4 WEST
86: DELIVER-ITEM PLAYER2 OSCAR1 LEONARDO ZONE2_4
87: DELIVER-ITEM PLAYER1 ROSE1 PRINCESS ZONE1_2
88: TURN-RIGHT PLAYER1
89: TURN-RIGHT PLAYER1
90: GO PLAYER1 ZONE1_2 ZONE2_2 SOUTH
91: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
92: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
93: TURN-RIGHT PLAYER1
94: GO PLAYER1 ZONE4_2 ZONE4_1 WEST BIKINI1
95: TURN-LEFT PLAYER1
96: TURN-LEFT PLAYER1
97: TAKE-ITEM-HAND PLAYER1 ROSE5 ZONE4_1
98: GO PLAYER1 ZONE4_1 ZONE4_2 EAST
99: TURN-LEFT PLAYER1
100: GO PLAYER1 ZONE4_2 ZONE3_2 NORTH
101: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
102: GO PLAYER1 ZONE2_2 ZONE1_2 NORTH BIKINI1
103: DELIVER-ITEM PLAYER1 ROSE5 PRINCESS ZONE1_2
104: TURN-RIGHT PLAYER1
105: TURN-RIGHT PLAYER1
106: GO PLAYER1 ZONE1_2 ZONE2_2 SOUTH
107: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
108: GO PLAYER1 ZONE3_2 ZONE4_2 SOUTH
109: GO PLAYER1 ZONE4_2 ZONE5_2 SOUTH
110: TURN-LEFT PLAYER1
111: GO PLAYER1 ZONE5_2 ZONE5_3 EAST BIKINI1
112: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
113: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
114: TURN-RIGHT PLAYER1
115: TURN-RIGHT PLAYER1
116: TAKE-ITEM-HAND PLAYER1 ALGORITHM ZONE5_5
117: GO PLAYER1 ZONE5_5 ZONE5_4 WEST
118: GO PLAYER1 ZONE5_4 ZONE5_3 WEST BIKINI1
119: GO PLAYER1 ZONE5_3 ZONE5_2 WEST
120: DELIVER-ITEM PLAYER1 ALGORITHM PROFESSOR ZONE5_2
121: TURN-RIGHT PLAYER1
122: TURN-RIGHT PLAYER1
123: GO PLAYER1 ZONE5_2 ZONE5_3 EAST BIKINI1
124: GO PLAYER1 ZONE5_3 ZONE5_4 EAST
125: TURN-RIGHT PLAYER2
```

```
126: TURN-RIGHT PLAYER2
127: GO PLAYER2 ZONE2_4 ZONE2_5 EAST
128: TURN-RIGHT PLAYER2
129: TAKE-BAG-ITEM PLAYER1 BIKINI1
130: LEAVE-HAND-ITEM PLAYER1 BIKINI1 ZONE5_4
131: TAKE-ITEM-HAND PLAYER1 APPLE2 ZONE5_4
132: GO PLAYER1 ZONE5_4 ZONE5_5 EAST
133: TURN-LEFT PLAYER1
134: GO PLAYER1 ZONE5_5 ZONE4_5 NORTH
135: PUT-IN-BAG PLAYER1 APPLE2
136: TAKE-ITEM-HAND PLAYER1 ZAPATILLA1 ZONE4_5
137: GO PLAYER1 ZONE4_5 ZONE3_5 NORTH
138: TURN-LEFT PLAYER1
139: GO PLAYER1 ZONE3_5 ZONE3_4 WEST ZAPATILLA1
140: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
141: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
142: GO PLAYER1 ZONE3_2 ZONE3_1 WEST ZAPATILLA1
143: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE3_1
144: TAKE-BAG-ITEM PLAYER1 APPLE2
145: DELIVER-ITEM PLAYER1 APPLE2 WITCH ZONE3_1
```

```
time spent:    0.00 seconds instantiating 3718 easy, 112 hard action templates
              0.00 seconds reachability analysis, yielding 438 facts and 1630
actions
              0.00 seconds creating final representation with 433 relevant
facts, 15 relevant fluents
              0.02 seconds computing LNF
              0.00 seconds building connectivity graph
              135.86 seconds searching, evaluating 997936 states, to a max depth
of 25
              135.88 seconds total time
```

6.2.2 Problema 2

6.2.2.1 Características

- 2 oscars, 3 manzanas, 2 algoritmo, 2 rosas y 4 de oro.
- Máximo de objetos:
 - Princesa: 3
 - Príncipe: 2
 - Leonardo: 4
 - Bruja: 5
 - Profesor: 1
- 2 jugadores.
- **Objetivo:** Que el jugador 1 tenga al menos 25 puntos, que el jugador 2 tenga entre 20 y 40 puntos, y que entre los dos lleguen a, al menos, 70 puntos.

6.2.2.2 Representación gráfica



6.2.2.3 Plan obtenido.

ff: found legal plan as follows

```

step    0: TURN-RIGHT PLAYER2
        1: GO PLAYER1 ZONE1_1 ZONE1_2 EAST
        2: TURN-LEFT PLAYER2
        3: TAKE-ITEM-HAND PLAYER1 ZAPATILLA1 ZONE1_2
        4: PUT-IN-BAG PLAYER1 ZAPATILLA1
        5: GO PLAYER2 ZONE4_3 ZONE3_3 NORTH
        6: TURN-LEFT PLAYER2
        7: TURN-LEFT PLAYER2
        8: TAKE-ITEM-HAND PLAYER2 BIKINI2 ZONE3_3
        9: PUT-IN-BAG PLAYER2 BIKINI2
       10: TURN-LEFT PLAYER2
       11: GO PLAYER1 ZONE1_2 ZONE1_3 EAST ZAPATILLA1
       12: GO PLAYER2 ZONE3_3 ZONE3_4 EAST
       13: TURN-RIGHT PLAYER1
       14: TURN-LEFT PLAYER2
    
```

```
15: TAKE-ITEM-HAND PLAYER2 ROSE1 ZONE3_4
16: GO PLAYER1 ZONE1_3 ZONE2_3 SOUTH
17: TURN-RIGHT PLAYER1
18: TURN-RIGHT PLAYER1
19: TURN-RIGHT PLAYER2
20: TAKE-ITEM-HAND PLAYER1 OSCAR1 ZONE2_3
21: GO PLAYER1 ZONE2_3 ZONE1_3 NORTH ZAPATILLA1
22: GO PLAYER2 ZONE3_4 ZONE3_5 EAST
23: TURN-LEFT PLAYER2
24: GO PLAYER2 ZONE3_5 ZONE2_5 NORTH
25: DELIVER-ITEM PLAYER2 ROSE1 WITCH ZONE2_5
26: GO PLAYER2 ZONE2_5 ZONE1_5 NORTH
27: TURN-RIGHT PLAYER2
28: TURN-RIGHT PLAYER2
29: TAKE-ITEM-HAND PLAYER2 APPLE1 ZONE1_5
30: GO PLAYER2 ZONE1_5 ZONE2_5 SOUTH
31: TURN-RIGHT PLAYER2
32: TURN-RIGHT PLAYER1
33: TURN-RIGHT PLAYER1
34: LEAVE-HAND-ITEM PLAYER1 OSCAR1 ZONE1_3
35: GO PLAYER1 ZONE1_3 ZONE2_3 SOUTH
36: TURN-RIGHT PLAYER1
37: TURN-RIGHT PLAYER1
38: TAKE-ITEM-HAND PLAYER1 GOLD2 ZONE2_3
39: GO PLAYER1 ZONE2_3 ZONE1_3 NORTH ZAPATILLA1
40: DELIVER-ITEM PLAYER1 GOLD2 LEONARDO ZONE1_3
41: TAKE-ITEM-HAND PLAYER1 OSCAR1 ZONE1_3
42: DELIVER-ITEM PLAYER1 OSCAR1 LEONARDO ZONE1_3
43: TURN-RIGHT PLAYER2
44: TURN-RIGHT PLAYER1
45: GO PLAYER1 ZONE1_3 ZONE1_4 EAST ZAPATILLA1
46: TAKE-ITEM-HAND PLAYER1 ALGORITHM1 ZONE1_4
47: GO PLAYER1 ZONE1_4 ZONE1_5 EAST
48: TURN-RIGHT PLAYER1
49: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH
50: GO PLAYER1 ZONE2_5 ZONE3_5 SOUTH
51: TURN-RIGHT PLAYER1
52: GO PLAYER1 ZONE3_5 ZONE3_4 WEST
53: DELIVER-ITEM PLAYER1 ALGORITHM1 PROFESSOR ZONE3_4
54: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
55: TURN-LEFT PLAYER1
56: DELIVER-ITEM PLAYER2 APPLE1 WITCH ZONE2_5
57: TURN-RIGHT PLAYER2
58: TURN-RIGHT PLAYER2
59: TAKE-ITEM-HAND PLAYER2 ZAPATILLA3 ZONE2_5
60: GO PLAYER2 ZONE2_5 ZONE3_5 SOUTH
61: GO PLAYER2 ZONE3_5 ZONE4_5 SOUTH ZAPATILLA3
62: TURN-RIGHT PLAYER2
63: TURN-RIGHT PLAYER2
64: LEAVE-HAND-ITEM PLAYER2 ZAPATILLA3 ZONE4_5
65: TAKE-ITEM-HAND PLAYER2 APPLE3 ZONE4_5
66: GO PLAYER2 ZONE4_5 ZONE3_5 NORTH
67: GO PLAYER2 ZONE3_5 ZONE2_5 NORTH
68: DELIVER-ITEM PLAYER2 APPLE3 WITCH ZONE2_5
69: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
70: TURN-RIGHT PLAYER1
```

```
71: TAKE-ITEM-HAND PLAYER1 APPLE2 ZONE4_3
72: TURN-RIGHT PLAYER1
73: GO PLAYER1 ZONE4_3 ZONE3_3 NORTH
74: TURN-RIGHT PLAYER1
75: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
76: GO PLAYER1 ZONE3_4 ZONE3_5 EAST
77: TURN-LEFT PLAYER1
78: GO PLAYER1 ZONE3_5 ZONE2_5 NORTH
79: DELIVER-ITEM PLAYER1 APPLE2 WITCH ZONE2_5
80: TURN-RIGHT PLAYER2
81: TURN-RIGHT PLAYER2
82: GO PLAYER2 ZONE2_5 ZONE3_5 SOUTH
83: TURN-RIGHT PLAYER2
84: TAKE-ITEM-HAND PLAYER2 GOLD3 ZONE3_5
85: GO PLAYER2 ZONE3_5 ZONE3_4 WEST
86: GO PLAYER2 ZONE3_4 ZONE3_3 WEST
87: TURN-LEFT PLAYER2
88: GO PLAYER2 ZONE3_3 ZONE4_3 SOUTH
89: GO PLAYER2 ZONE4_3 ZONE5_3 SOUTH BIKINI2
90: DELIVER-ITEM PLAYER2 GOLD3 PRINCE ZONE5_3
```

```
time spent:    0.01 seconds instantiating 3842 easy, 156 hard action templates
              0.00 seconds reachability analysis, yielding 453 facts and 1702
actions
              0.00 seconds creating final representation with 448 relevant
facts, 16 relevant fluents
              0.01 seconds computing LNF
              0.00 seconds building connectivity graph
              44.63 seconds searching, evaluating 357944 states, to a max depth
of 14
              44.65 seconds total time
```


7. Ejercicio 7

7.1 Principales decisiones en el diseño del dominio.

7.1.1 Apartado a)

Para definir a los nuevos tipos de robots, se han definido dos subtipos dentro del supertipo “player”:

- **character-interactive**: jugador que solo puede entregar objetos a personajes y solo recibe objetos de otro jugador. Como el enunciado no dice nada, supongo que sí que puede soltar objetos al suelo.
- **floor-interactive**: jugador que puede coger/soltar objetos del suelo y solo puede dárselos a otro jugador.

Ambos jugadores siguen teniendo mochila, pudiendo moverse, girar, etc.

Se ha modificado la acción de entregar objeto a personaje de manera que el parámetro que se refiere al jugador es de tipo “character-interactive”

Se han modificado las acciones de coger objeto del suelo y dejarlo de manera que el parámetro que se refiere al jugador es de tipo “floor-interactive”.

Se ha creado una nueva acción para que un jugador “floor-interactive” entregue un objeto a un jugador “character-interactive”. Para ello, el primero debe tener la mano ocupada y tener el objeto concreto en la mano, y el segundo debe tener la mano vacía y no tener el objeto en concreto en la mano. Además, los dos deben estar en la misma zona. Los efectos son los esperables, el segundo pasa a tener el objeto y el primero deja de tenerlo.

7.2 Problemas utilizados.

Los problemas planteados son similares a los anteriores, pero esta vez el **objetivo** será que el jugador que entrega objetos alcance una cierta cantidad de puntos.




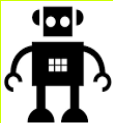










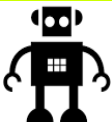






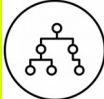
7.2.1 Problema 1

7.2.1.1 Características

- 3 oscars, 2 manzanas, 1 algoritmo y 5 rosas.

- Máximo de objetos:
 - Princesa: 2
 - Príncipe: 3
 - Leonardo: 1
 - Bruja: 3
 - Profesor: 4
- **Objetivo:** Que el jugador 1 obtenga al menos 30 puntos

7.2.1.2 Representación gráfica

				
 (P1 NORTH) (CHARACTER-INTERACTIVE)	 		 	
			 	
 		 (P2 NORTH) (FLOOR-INTERACTIVE)		
 				

7.2.1.3 Plan obtenido.

ff: found legal plan as follows

```
step    0: TURN-LEFT PLAYER2
        1: GO PLAYER2 ZONE4_3 ZONE4_2 WEST
        2: TURN-RIGHT PLAYER2
        3: TURN-RIGHT PLAYER1
        4: GO PLAYER1 ZONE2_1 ZONE2_2 EAST
        5: TURN-LEFT PLAYER1
        6: TAKE-ITEM-FLOOR PLAYER2 BIKINI1 ZONE4_2
        7: GO PLAYER2 ZONE4_2 ZONE3_2 NORTH
        8: GO PLAYER2 ZONE3_2 ZONE2_2 NORTH
        9: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 BIKINI1 ZONE2_2
       10: TAKE-ITEM-FLOOR PLAYER2 OSCAR2 ZONE2_2
       11: PUT-IN-BAG PLAYER1 BIKINI1
       12: TURN-LEFT PLAYER2
       13: GO PLAYER2 ZONE2_2 ZONE2_1 WEST
       14: TURN-RIGHT PLAYER2
       15: GO PLAYER2 ZONE2_1 ZONE1_1 NORTH
       16: GO PLAYER1 ZONE2_2 ZONE1_2 NORTH BIKINI1
       17: TURN-LEFT PLAYER1
       18: PUT-IN-BAG PLAYER2 OSCAR2
       19: TAKE-ITEM-FLOOR PLAYER2 ROSE1 ZONE1_1
       20: TAKE-BAG-ITEM PLAYER1 BIKINI1
       21: LEAVE-HAND-ITEM PLAYER1 BIKINI1 ZONE1_2
       22: GO PLAYER1 ZONE1_2 ZONE1_1 WEST
       23: TURN-RIGHT PLAYER2
       24: TURN-RIGHT PLAYER2
       25: GO PLAYER2 ZONE1_1 ZONE2_1 SOUTH
       26: TURN-LEFT PLAYER2
       27: GO PLAYER2 ZONE2_1 ZONE2_2 EAST
       28: LEAVE-HAND-ITEM PLAYER2 ROSE1 ZONE2_2
       29: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA1 ZONE2_2
       30: TURN-LEFT PLAYER1
       31: GO PLAYER1 ZONE1_1 ZONE2_1 SOUTH
       32: TURN-LEFT PLAYER1
       33: GO PLAYER1 ZONE2_1 ZONE2_2 EAST
       34: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ZAPATILLA1 ZONE2_2
       35: TAKE-BAG-ITEM PLAYER2 OSCAR2
       36: PUT-IN-BAG PLAYER1 ZAPATILLA1
       37: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 OSCAR2 ZONE2_2
       38: TURN-RIGHT PLAYER1
       39: GO PLAYER1 ZONE2_2 ZONE3_2 SOUTH
       40: TURN-LEFT PLAYER1
       41: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
       42: GO PLAYER1 ZONE3_3 ZONE3_4 EAST ZAPATILLA1
       43: TURN-LEFT PLAYER1
       44: GO PLAYER1 ZONE3_4 ZONE2_4 NORTH
       45: DELIVER-ITEM-TO-CHARACTER PLAYER1 OSCAR2 LEONARDO ZONE2_4
       46: TURN-RIGHT PLAYER1
       47: TURN-RIGHT PLAYER1
       48: TURN-RIGHT PLAYER2
       49: GO PLAYER2 ZONE2_2 ZONE3_2 SOUTH
       50: GO PLAYER1 ZONE2_4 ZONE3_4 SOUTH ZAPATILLA1
       51: TURN-RIGHT PLAYER1
```

```
52: TURN-LEFT PLAYER2
53: GO PLAYER2 ZONE3_2 ZONE3_3 EAST
54: TAKE-BAG-ITEM PLAYER1 ZAPATILLA1
55: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
56: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE3_3
57: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA1 ZONE3_3
58: GO PLAYER2 ZONE3_3 ZONE3_4 EAST ZAPATILLA1
59: TURN-LEFT PLAYER2
60: LEAVE-HAND-ITEM PLAYER2 ZAPATILLA1 ZONE3_4
61: TURN-LEFT PLAYER2
62: TAKE-ITEM-FLOOR PLAYER2 ROSE2 ZONE3_4
63: PUT-IN-BAG PLAYER2 ROSE2
64: TAKE-ITEM-FLOOR PLAYER2 BIKINI2 ZONE3_4
65: GO PLAYER2 ZONE3_4 ZONE3_3 WEST
66: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 BIKINI2 ZONE3_3
67: TAKE-BAG-ITEM PLAYER2 ROSE2
68: PUT-IN-BAG PLAYER1 BIKINI2
69: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ROSE2 ZONE3_3
70: GO PLAYER1 ZONE3_3 ZONE3_2 WEST
71: TURN-RIGHT PLAYER1
72: GO PLAYER1 ZONE3_2 ZONE2_2 NORTH
73: GO PLAYER1 ZONE2_2 ZONE1_2 NORTH BIKINI2
74: DELIVER-ITEM-TO-CHARACTER PLAYER1 ROSE2 PRINCESS ZONE1_2
75: TURN-RIGHT PLAYER1
76: TURN-RIGHT PLAYER1
77: GO PLAYER1 ZONE1_2 ZONE2_2 SOUTH
78: GO PLAYER2 ZONE3_3 ZONE3_2 WEST
79: TURN-RIGHT PLAYER2
80: TURN-RIGHT PLAYER1
81: TURN-RIGHT PLAYER1
82: GO PLAYER2 ZONE3_2 ZONE2_2 NORTH
83: TAKE-ITEM-FLOOR PLAYER2 ROSE1 ZONE2_2
84: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ROSE1 ZONE2_2
85: GO PLAYER1 ZONE2_2 ZONE1_2 NORTH BIKINI2
86: DELIVER-ITEM-TO-CHARACTER PLAYER1 ROSE1 PRINCESS ZONE1_2
```

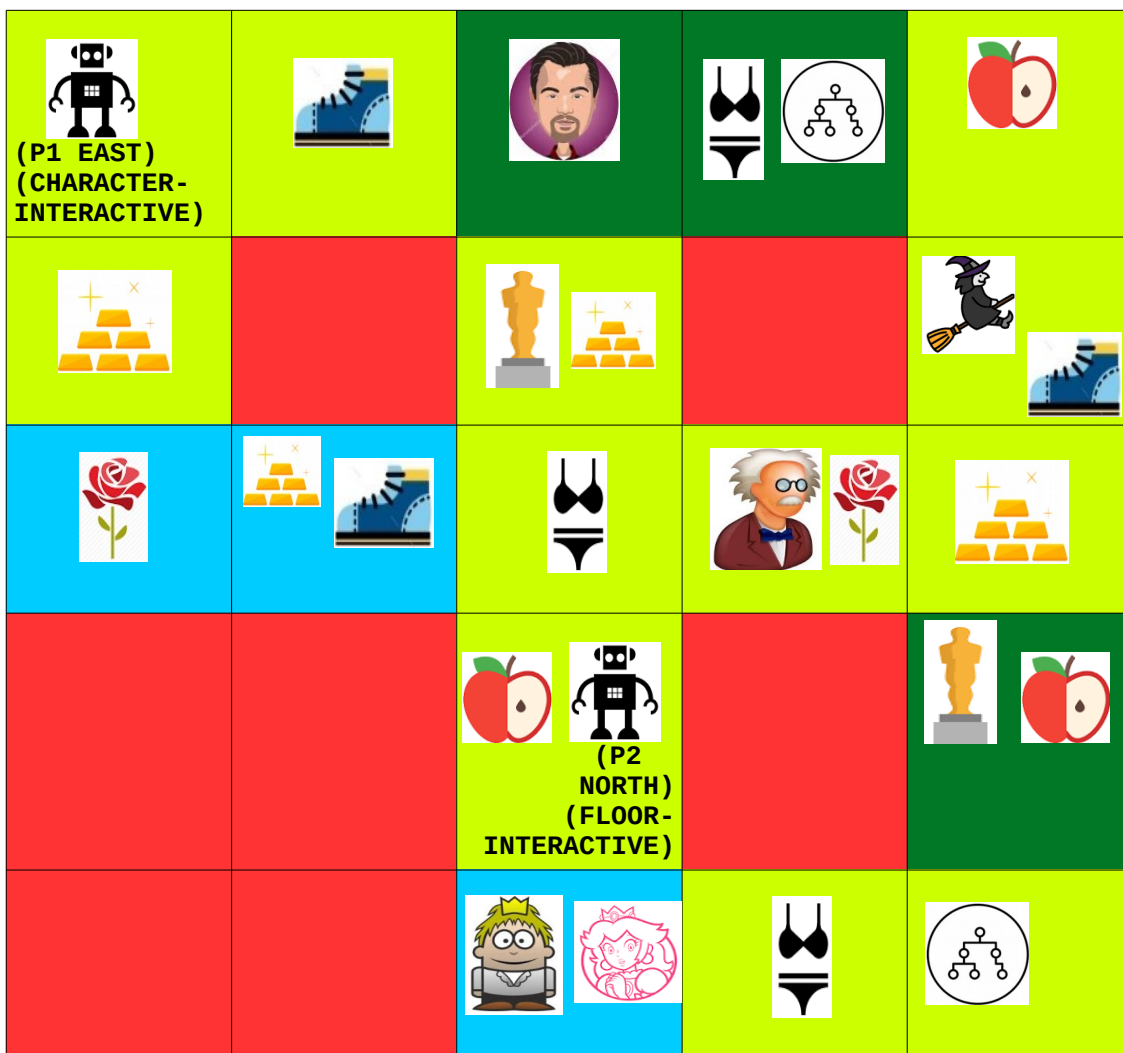
```
time spent:      0.01 seconds instantiating 2563 easy, 112 hard action templates
                0.00 seconds reachability analysis, yielding 468 facts and 1575
actions
                0.00 seconds creating final representation with 463 relevant
facts, 13 relevant fluents
                0.01 seconds computing LNF
                0.00 seconds building connectivity graph
                214.42 seconds searching, evaluating 1138173 states, to a max depth
of 29
                214.44 seconds total time
```

7.2.2 Problema 2

7.2.2.1 Características

- 2 oscars, 3 manzanas, 2 algoritmo, 2 rosas y 4 de oro.
- Máximo de objetos:
 - Princesa: 3
 - Príncipe: 2
 - Leonardo: 4
 - Bruja: 5
 - Profesor: 1
- 2 jugadores.
- **Objetivo:** Que el jugador 1 tenga al menos 30 puntos y todos los personajes obtengan al menos un objeto.

7.2.2.2 Representación gráfica



7.2.2.3 Plan obtenido.

ff: found legal plan as follows

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step    0: GO PLAYER2 ZONE4_3 ZONE3_3 NORTH
        1: TURN-RIGHT PLAYER1
        2: TURN-LEFT PLAYER2
        3: TAKE-ITEM-FLOOR PLAYER2 BIKINI2 ZONE3_3
        4: GO PLAYER2 ZONE3_3 ZONE3_2 WEST BIKINI2
        5: GO PLAYER2 ZONE3_2 ZONE3_1 WEST BIKINI2
        6: TURN-LEFT PLAYER2
        7: TURN-LEFT PLAYER2
        8: TURN-LEFT PLAYER2
        9: GO PLAYER2 ZONE3_1 ZONE2_1 NORTH
       10: GO PLAYER1 ZONE1_1 ZONE2_1 SOUTH
       11: TURN-LEFT PLAYER1
       12: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 BIKINI2 ZONE2_1
       13: GO PLAYER2 ZONE2_1 ZONE1_1 NORTH
       14: TURN-RIGHT PLAYER1
       15: GO PLAYER1 ZONE2_1 ZONE3_1 SOUTH BIKINI2
       16: TURN-LEFT PLAYER1
       17: TURN-RIGHT PLAYER2
       18: GO PLAYER1 ZONE3_1 ZONE3_2 EAST BIKINI2
       19: GO PLAYER2 ZONE1_1 ZONE1_2 EAST
       20: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA1 ZONE1_2
       21: GO PLAYER2 ZONE1_2 ZONE1_3 EAST ZAPATILLA1
       22: TURN-RIGHT PLAYER2
       23: GO PLAYER2 ZONE1_3 ZONE2_3 SOUTH
       24: GO PLAYER1 ZONE3_2 ZONE3_3 EAST
       25: GO PLAYER2 ZONE2_3 ZONE3_3 SOUTH
       26: GO PLAYER2 ZONE3_3 ZONE4_3 SOUTH
       27: TURN-RIGHT PLAYER1
       28: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
       29: TURN-RIGHT PLAYER1
       30: PUT-IN-BAG PLAYER1 BIKINI2
       31: TURN-RIGHT PLAYER1
       32: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ZAPATILLA1 ZONE4_3
       33: TAKE-ITEM-FLOOR PLAYER2 APPLE2 ZONE4_3
       34: GO PLAYER1 ZONE4_3 ZONE3_3 NORTH
       35: TURN-RIGHT PLAYER1
       36: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE3_3
       37: TURN-RIGHT PLAYER2
       38: TURN-RIGHT PLAYER2
       39: GO PLAYER2 ZONE4_3 ZONE3_3 NORTH
       40: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 APPLE2 ZONE3_3
       41: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA1 ZONE3_3
       42: GO PLAYER1 ZONE3_3 ZONE3_4 EAST
       43: TURN-RIGHT PLAYER2
       44: GO PLAYER2 ZONE3_3 ZONE3_4 EAST
       45: DELIVER-ITEM-TO-CHARACTER PLAYER1 APPLE2 PROFESSOR ZONE3_4
       46: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ZAPATILLA1 ZONE3_4
       47: GO PLAYER2 ZONE3_4 ZONE3_5 EAST
       48: TAKE-ITEM-FLOOR PLAYER2 GOLD3 ZONE3_5
       49: TURN-LEFT PLAYER1
       50: TURN-LEFT PLAYER1
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51: GO PLAYER1 ZONE3_4 ZONE3_3 WEST
52: TURN-RIGHT PLAYER1
53: TURN-RIGHT PLAYER1
54: TURN-RIGHT PLAYER1
55: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE3_3
56: TURN-LEFT PLAYER2
57: TURN-LEFT PLAYER2
58: GO PLAYER2 ZONE3_5 ZONE3_4 WEST
59: GO PLAYER2 ZONE3_4 ZONE3_3 WEST
60: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 GOLD3 ZONE3_3
61: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA1 ZONE3_3
62: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
63: GO PLAYER1 ZONE4_3 ZONE5_3 SOUTH BIKINI2
64: TURN-RIGHT PLAYER1
65: TURN-RIGHT PLAYER1
66: DELIVER-ITEM-TO-CHARACTER PLAYER1 GOLD3 PRINCE ZONE5_3
67: TURN-RIGHT PLAYER2
68: GO PLAYER1 ZONE5_3 ZONE4_3 NORTH
69: GO PLAYER1 ZONE4_3 ZONE3_3 NORTH
70: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ZAPATILLA1 ZONE3_3
71: TURN-RIGHT PLAYER1
72: TURN-RIGHT PLAYER1
73: GO PLAYER1 ZONE3_3 ZONE4_3 SOUTH
74: TURN-RIGHT PLAYER2
75: GO PLAYER2 ZONE3_3 ZONE3_4 EAST
76: TAKE-ITEM-FLOOR PLAYER2 ROSE1 ZONE3_4
77: GO PLAYER1 ZONE4_3 ZONE5_3 SOUTH BIKINI2
78: TURN-RIGHT PLAYER1
79: TURN-RIGHT PLAYER1
80: GO PLAYER1 ZONE5_3 ZONE4_3 NORTH
81: TURN-RIGHT PLAYER1
82: TURN-RIGHT PLAYER1
83: TURN-RIGHT PLAYER2
84: TURN-RIGHT PLAYER2
85: GO PLAYER2 ZONE3_4 ZONE3_3 WEST
86: TURN-LEFT PLAYER2
87: GO PLAYER2 ZONE3_3 ZONE4_3 SOUTH
88: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE4_3
89: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ROSE1 ZONE4_3
90: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA1 ZONE4_3
91: GO PLAYER1 ZONE4_3 ZONE5_3 SOUTH BIKINI2
92: TURN-RIGHT PLAYER1
93: TURN-RIGHT PLAYER1
94: DELIVER-ITEM-TO-CHARACTER PLAYER1 ROSE1 PRINCESS ZONE5_3
95: TURN-RIGHT PLAYER2
96: TURN-RIGHT PLAYER2
97: GO PLAYER2 ZONE4_3 ZONE3_3 NORTH
98: GO PLAYER1 ZONE5_3 ZONE4_3 NORTH
99: GO PLAYER2 ZONE3_3 ZONE2_3 NORTH
100: GO PLAYER1 ZONE4_3 ZONE3_3 NORTH
101: GO PLAYER1 ZONE3_3 ZONE2_3 NORTH
102: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ZAPATILLA1 ZONE2_3
103: TAKE-ITEM-FLOOR PLAYER2 GOLD2 ZONE2_3
104: GO PLAYER1 ZONE2_3 ZONE1_3 NORTH ZAPATILLA1
105: TURN-RIGHT PLAYER1
106: GO PLAYER1 ZONE1_3 ZONE1_4 EAST ZAPATILLA1

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107: GO PLAYER1 ZONE1_4 ZONE1_5 EAST
108: TURN-RIGHT PLAYER2
109: TURN-RIGHT PLAYER2
110: GO PLAYER2 ZONE2_3 ZONE3_3 SOUTH
111: TURN-LEFT PLAYER2
112: GO PLAYER2 ZONE3_3 ZONE3_4 EAST
113: GO PLAYER2 ZONE3_4 ZONE3_5 EAST
114: TURN-LEFT PLAYER2
115: GO PLAYER2 ZONE3_5 ZONE2_5 NORTH
116: TURN-RIGHT PLAYER1
117: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE1_5
118: GO PLAYER1 ZONE1_5 ZONE2_5 SOUTH
119: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 GOLD2 ZONE2_5
120: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA3 ZONE2_5
121: TURN-RIGHT PLAYER1
122: TURN-RIGHT PLAYER1
123: DELIVER-ITEM-TO-CHARACTER PLAYER1 GOLD2 WITCH ZONE2_5
124: GO PLAYER1 ZONE2_5 ZONE1_5 NORTH
125: TURN-LEFT PLAYER1
126: GO PLAYER2 ZONE2_5 ZONE1_5 NORTH
127: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ZAPATILLA3 ZONE1_5
128: TAKE-ITEM-FLOOR PLAYER2 APPLE1 ZONE1_5
129: GO PLAYER1 ZONE1_5 ZONE1_4 WEST ZAPATILLA3
130: PUT-IN-BAG PLAYER2 APPLE1
131: TURN-LEFT PLAYER2
132: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA1 ZONE1_5
133: GO PLAYER2 ZONE1_5 ZONE1_4 WEST ZAPATILLA1
134: LEAVE-HAND-ITEM PLAYER2 ZAPATILLA1 ZONE1_4
135: TAKE-ITEM-FLOOR PLAYER2 ALGORITHM1 ZONE1_4
136: GO PLAYER1 ZONE1_4 ZONE1_3 WEST ZAPATILLA3
137: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA3 ZONE1_3
138: LEAVE-HAND-ITEM PLAYER2 ALGORITHM1 ZONE1_4
139: TAKE-ITEM-FLOOR PLAYER2 ZAPATILLA1 ZONE1_4
140: GO PLAYER2 ZONE1_4 ZONE1_3 WEST ZAPATILLA1
141: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 ZAPATILLA1 ZONE1_3
142: TAKE-BAG-ITEM PLAYER2 APPLE1
143: LEAVE-HAND-ITEM PLAYER1 ZAPATILLA1 ZONE1_3
144: DELIVER-ITEM-TO-PLAYER PLAYER2 PLAYER1 APPLE1 ZONE1_3
145: DELIVER-ITEM-TO-CHARACTER PLAYER1 APPLE1 LEONARDO ZONE1_3
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time spent:    0.00 seconds instantiating 2672 easy, 156 hard action templates
              0.00 seconds reachability analysis, yielding 491 facts and 1642
actions
              0.01 seconds creating final representation with 484 relevant
facts, 13 relevant fluents
              0.00 seconds computing LNF
              0.01 seconds building connectivity graph
              162.68 seconds searching, evaluating 828977 states, to a max depth
of 16
              162.70 seconds total time
```