SLUGS

SLUGS: SmalL bUt Complete GROne Synthesizer

- Slugs is a stand-alone reactive synthesis tool for generalized reactivity(1) synthesis.
- Free, open source and available at: https://github.com/VerifiableRobotics/slugs

Using SLUGS

Step 1: Model the 2-player game in .structuredslugs format

Step 2: Convert the file to .slugsin using: slugs/tools/Struc../compiler.py
$ python slugs/tools/Struc../compiler.py [filename].structuredslugs

Step 3: Run slugs with .slugsin file as input and the option you need
$ slugs [filename.slugsin] --explicitStrategy --jsonOutput > [output_filename]

The Structured Slugs Language

Variable Definitions:

```
[INPUT]
a
b:0...10

[OUTPUT]
c:2...8
d
```

Safety Formula G (...):

```
[ENV_TRANS]
a -> (a' <-> ! a)
b' = b + 1

[SYS_TRANS]
d -> (c' = 3)
```

Initial conditions:

```
[ENV_INIT]
! a
b = 1

[SYS_INIT]
d
c = 4
```

Conjunction of Liveness Formulas G F (...):

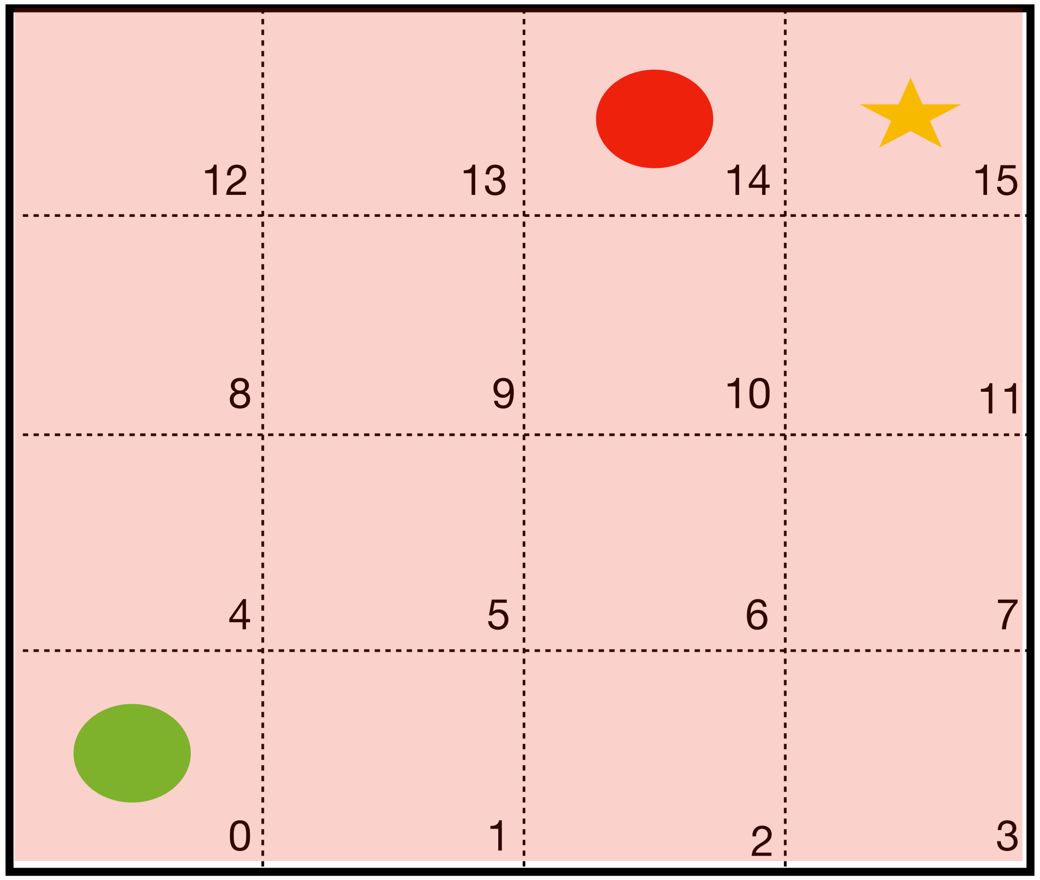
```
[ENV_LIVENESS]
! a | (b = 3)

[SYS_LIVENESS]
d
c = 2
```

SLUGS Example

Model all the allowed transitions of the agent and the obstacle in LTL

```
[ENV_TRANS]
o_state = 0 -> (o_state' = 1) | (o_state' = 4) | (o_state' = 0)
o_state = 4 -> (o_state' = 1) | (o_state' = 8) | (o_state' = 4) | (o_state' = 5)
.
.
a_state = 0 -> (a_state' = 1) | (a_state' = 4) | (a_state' = 0)
a_state = 4 -> (a_state' = 1) | (a_state' = 8) | (a_state' = 4) | (a_state' = 5)
```



The agent must reach the starred location and never crashes into the moving obstacle.

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```

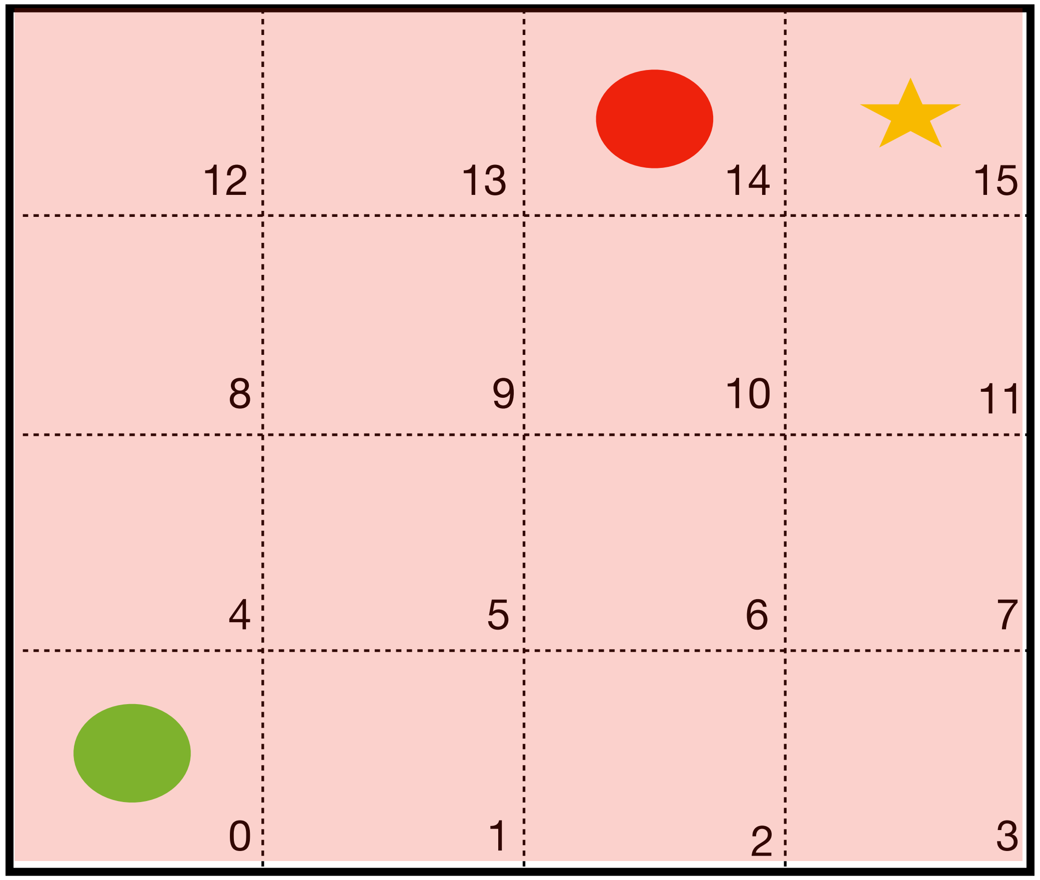
Encode the properties as either safety or liveness LTL specifications

the agent must visit locations 15 and 0 infinitely often

```
[SYS_LIVENESS]
a_state = 15
a_state = 0
```

the agent and obstacle must never crash

```
[SYS_TRANS]
o_state != a_state
o_state' != a_state
o_state != a_state'
```



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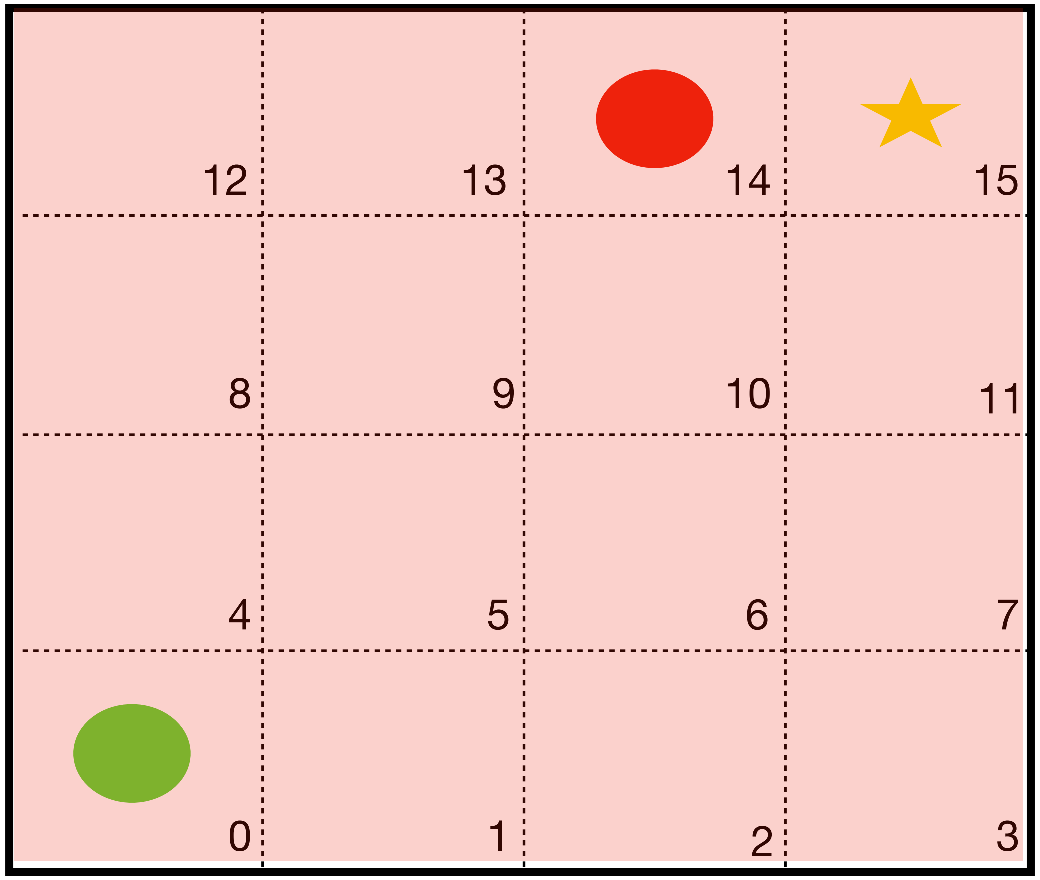
This problem is unrealizable



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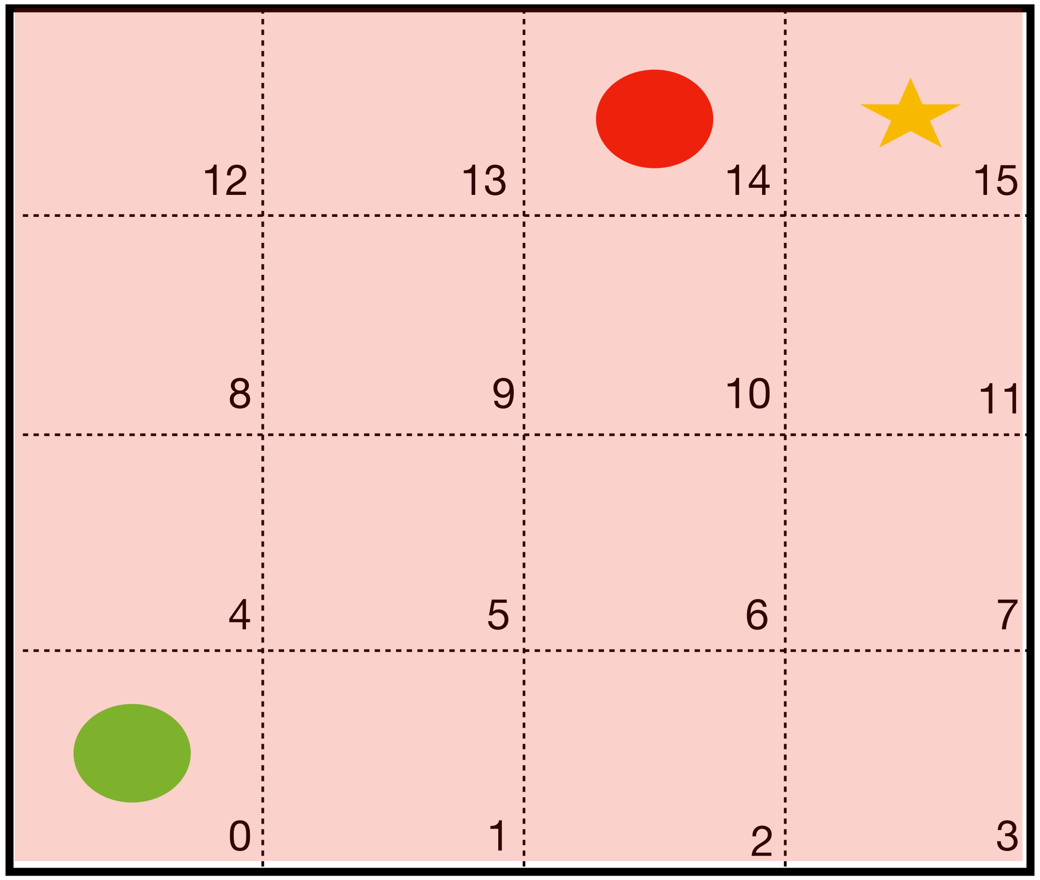
SLUGS Example

Incrementally add reasonable assumptions on the environment until it's realizable



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SLUGS Example

Incrementally add reasonable assumptions on the environment until it's realizable

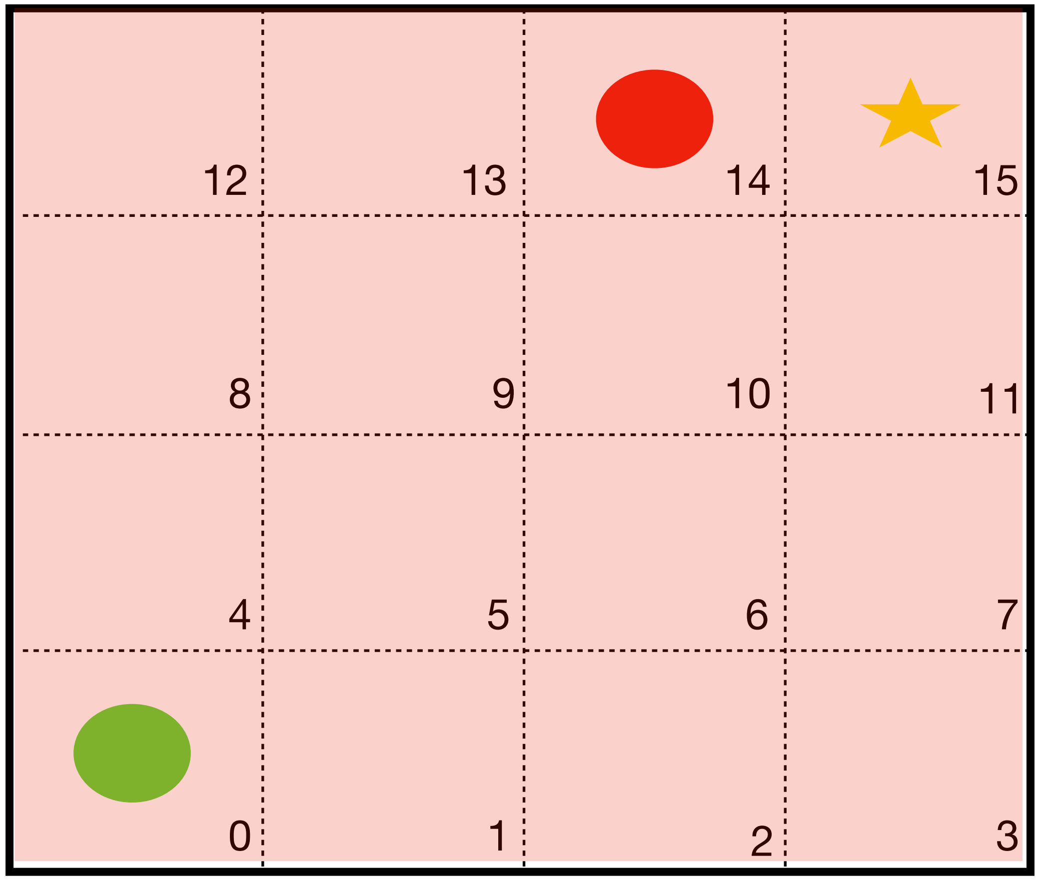
Example:

assume that the moving obstacles visits locations 0 and 15 infinitely often

$G\ (F\ (o\_state = 15) \wedge F\ (o\_state = 0))$

=

[ENV_LIVENESS]
o_state = 15
o_state = 0



Now we can synthesize a reactive controller for this problem

The agent must reach the starred location and never crashes into the moving obstacle.