

Welcome

This assignment will test your ability to translate between Electrum formulas and English descriptions of formulas.

All formulas and descriptions use a template that models a control panel with lights on it. The template is printed below and available at this link:

<https://gist.github.com/bennn/3560a21e73c36c33e53bdd3ce29ada19>

For example, the following formula and description match:

- `formula`: `always { Red in Panel.lit and Green not in Panel.lit }`
- `description`: "The Red light is always lit and the Green light is never lit."

```
#lang forge
option problem_type temporal

// ONLY CHANGE THE VALUE OF THE myFormula PREDICATE!

// There is a control panel with lights on it. Each light has a
// different color, and over time some may be switched on or of
abstract sig Color {}
one sig Red, Green, Blue extends Color {}
one sig Panel { var lit: set Color }

pred myFormula {
  // WRITE YOUR FORMULA HERE and then run this file to test
  // if your formula parses.
  // - You may use: always, after, eventually, and until
  // - You may NOT use: releases, ', before, historically,
  // E.g.:
```

```
always { eventually { Red in Panel.lit and Green not in Panel
}

test expect {
  // This is always true!
  // We're just checking that your formula is syntactically v
  doNotChange: {myFormula or not myFormula} is sat
}
```

The goal of this exercise is to learn how you **think about** temporal formulas.

You will receive **full credit** for honest, professional attempts. There is no added credit for being correct.

Ground rules:

- **Do** save a copy of the template and use it to validate the syntax of your formulas.
- You **may** use the operators: `always`, `eventually`, `after`, and `until`
- You **may not** use the operators: `releases`, `'`, `before`, and `historically`
- **Do not** use Forge to view example traces or otherwise test the meaning of your answers
- **Do not** discuss the survey with other students

Contact Tim and Ben G. if you run into issues:

`tbnelson@gmail.com`, `benjaminlgreenman@gmail.com`

This survey has 3 parts and should take no more than 2 hours.

We recommend that you **take breaks** between the major parts.

Overview:

1. Convert formulas to descriptions
2. Convert descriptions to formulas
3. Determine whether a trace satisfies a formula

Required questions are marked with a star (*).

Enter your anonymous Gradescope gmail address to begin

LTL to English

Describe the following Electrum formulas in English.

Aim for short, illustrative sentences. For example:

- formula: `always { Blue not in Panel.lit }`
- English: "The Blue light is never on."

For reference, the Forge template is here:

<https://gist.github.com/bennn/3560a21e73c36c33e53bdd3ce29ada19>

Red in Panel.lit implies

```
after {  
  after {  
    after { Red in Panel.lit } } }  
}
```

English description*

On a 1 to 5 scale, how confident are you that your description matches the formula?*

- 1 (Not Confident)
- 2
- 3 (Somewhat Confident)
- 4
- 5 (Highly Confident)

(optional) If you can think of a "near miss" English description that illustrates a misconception that a learner might have about the formula, write it below.

```
after {  
  after {  
    eventually {  
      after { Red in Panel.lit } } } }
```

English description*

On a 1 to 5 scale, how confident are you that your description matches the formula?*

- 1 (Not Confident)
- 2
- 3 (Somewhat Confident)
- 4
- 5 (Highly Confident)

(optional) If you can think of a "near miss" English description that illustrates a misconception that a learner might have about the formula, write it below.

```
eventually { Red in Panel.lit } implies  
  always { Blue in Panel.lit }
```

English description*

On a 1 to 5 scale, how confident are you that your description matches the formula?*

- 1 (Not Confident)
- 2
- 3 (Somewhat Confident)
- 4
- 5 (Highly Confident)

(optional) If you can think of a "near miss" English description that illustrates a misconception that a learner might have about the formula, write it below.

```
{ Red in Panel.lit until Blue in Panel.lit }  
and  
always { Red in Panel.lit }
```

English description*

On a 1 to 5 scale, how confident are you that your description matches the formula?*

- 1 (Not Confident)
- 2
- 3 (Somewhat Confident)
- 4

5 (Highly Confident)

(optional) If you can think of a "near miss" English description that illustrates a misconception that a learner might have about the formula, write it below.

```
always {  
  Red in Panel.lit implies {  
    after { Red not in Panel.lit }  
    and  
    after {  
      after {  
        Red in Panel.lit } } } }  
}
```

English description*

On a 1 to 5 scale, how confident are you that your description matches the formula?*

- 1 (Not Confident)
- 2
- 3 (Somewhat Confident)
- 4
- 5 (Highly Confident)

(optional) If you can think of a "near miss" English description that illustrates a misconception that a learner might have about the formula, write it below.

(optional) Write a new Electrum formula that demonstrates a behavior that is interesting, tricky, surprising, or different than someone might expect.

Use [the Forge template](#) to check that your formula is syntactically correct.

Try to keep the formula as small as possible to illustrate your idea.

(optional) Please explain what you think is interesting about the formula you have written.

Break 1

Consider taking a short break before moving on to the next part.

English to LTL

Convert the English descriptions below into Electrum formulas, or write "inexpressible" if you believe that Electrum cannot express the idea.

Please explain your answers in the "Explanation" boxes.

Please use [the Forge template](#) to check that your formulas are syntactically correct.

"Whenever the Red light is on, it turns off in the next state and on again in the state after that."

Electrum formula*

On a 1 to 5 scale, how confident are you that your formula captures the English description?*

- 1 (Not Confident)
- 2
- 3 (Somewhat Confident)
- 4
- 5 (Highly Confident)

(optional) If you can think of a "near miss" Electrum formula that illustrates a misconception that a learner might have about the English description, write it below.

"The Red light is on in exactly one state, but not necessarily the first state."

Electrum formula*

On a 1 to 5 scale, how confident are you that your formula captures the English description?*

- 1 (Not Confident)

- 2
- 3 (Somewhat Confident)
- 4
- 5 (Highly Confident)

(optional) If you can think of a "near miss" Electrum formula that illustrates a misconception that a learner might have about the English description, write it below.

"The Red light cannot stay lit for three states in a row."

Electrum formula*

On a 1 to 5 scale, how confident are you that your formula captures the English description?*

- 1 (Not Confident)
- 2
- 3 (Somewhat Confident)
- 4
- 5 (Highly Confident)

(optional) If you can think of a "near miss" Electrum formula that illustrates a misconception that a learner might have about the English description, write it below.

"Whenever the Red light is on, the Blue light will turn on at some point."

Electrum formula*

On a 1 to 5 scale, how confident are you that your formula captures the English description?*

- 1 (Not Confident)
- 2
- 3 (Somewhat Confident)
- 4
- 5 (Highly Confident)

(optional) If you can think of a "near miss" Electrum formula that illustrates a misconception that a learner might have about the English description, write it below.

"The Red light is lit for a finite number of steps, and then never again becomes lit."

Electrum formula*

On a 1 to 5 scale, how confident are you that your formula captures the English description?*

- 1 (Not Confident)
- 2

3 (Somewhat Confident)

4

5 (Highly Confident)

(optional) If you can think of a "near miss" Electrum formula that illustrates a misconception that a learner might have about the English description, write it below.

(optional) Write a new English statement that is interesting, tricky, or surprising to express as an Electrum formula.

Try to keep it short --- 1 or 2 sentences.

Please state your description in terms of [the Forge template](#) (colors, Panel, and so on).

(optional) Please explain what you think is interesting about the description you have written.

Block 5

Consider taking a short break before moving on to the final part.

Traces true-false

Recall that Electrum formulas are statements about traces (sequences of states). A non-trivial formula is satisfied by some traces, but not all.

The following questions present a formula and ask whether it is satisfied by a specific trace. For each, choose Yes or No and briefly explain which part(s) of the trace motivated your answer.

Notation for states and traces:

- $\{\}$ is the empty state, where all lights are off
- $\{RGB\}$ is the state where all lights are on
- in $\{G\}$ only the Green light is lit
- ... and so on, for other combinations of R , G and B
- $\{\} \{\} \{\} \{R\} \{\}$ is a trace in which the Red light is lit in the fourth state, and all lights are off at other times
- all traces below show exactly five states; you can assume the final state repeats forever

Template:

<https://gist.github.com/bennn/3560a21e73c36c33e53bdd3ce29ada19>

Example Q/A:

Q. Is the formula

`eventually { Blue in Panel.lit }`

satisfied by trace $\{\} \{RG\} \{RG\} \{RG\} \{G\}$?

A. No

Why? Because the Blue light never turns on --- neither in the first four states nor in the final lasso state.

Q. Is the formula

`Red in Panel.lit`

satisfied by the trace $\{GB\} \{RGB\} \{RGB\} \{RGB\} \{RGB\}$?*

Yes

No

What about the trace made you give that answer?*

Q. Is the formula

```
after {  
  after {  
    after { Red in Panel.lit } } }  
satisfied by the trace {R} {} {} {R} {} ?*
```

Yes

No

What about the trace made you give that answer?*

Q. Is the formula

```
always {  
  Red in Panel.lit implies  
  after {  
    after {  
      after { Red in Panel.lit } } } }  
satisfied by the trace {} {RGB} {RGB} {} {RGB} ?*
```

Yes

No

What about the trace made you give that answer?*

Q. Is the formula R

```
after { Red in Panel.lit } until  
after { Green in Panel.lit }
```

satisfied by the trace {RB} {RB} {RB} {RGB} {B} ?*

- Yes
 No

What about the trace made you give that answer?*

Q. Is the formula

```
eventually { Red in Panel.lit }  
and  
eventually { Green in Panel.lit }
```

satisfied by the trace {} {G} {} {} {R} ?*

- Yes
 No

What about the trace made you give that answer?*

Q. Is the formula

```
after {  
  after {  
    eventually { Red in Panel.lit } } }  
}
```

satisfied by the trace {RGB} {RGB} {RGB} {RGB} {RGB} ?*

- Yes
 No

What about the trace made you give that answer?*

Q. Is the formula

Red in Panel.lit until Blue in Panel.lit
satisfied by the trace {R} {R} {R} {R} {R} ?*

- Yes
 No

What about the trace made you give that answer?*

Q. Is the formula

eventually { always { Red in Panel.lit } }
satisfied by the trace {} {RGB} {} {RGB} {} ?*

- Yes
 No

What about the trace made you give that answer?*

Q. Is the formula

always { Red in Panel.lit implies

Green in Panel.lit }
satisfied by the trace {} {} {} {} {} ?*

- Yes
 No

What about the trace made you give that answer?*

(optional) Write a new Electrum formula and a 5-state trace to demonstrate a behavior that is interesting, tricky, surprising, or different than someone might expect.

Say whether the trace satisfies the formula, and explain why the question is interesting.

Please use [the Forge template](#) to check the syntax of your formula.

For reference, the 5-state trace with all lights always on is:

{RGB} {RGB} {RGB} {RGB} {RGB}

Formula

Trace

(optional) Is your formula satisfied by your trace?

- Yes
 No

(optional) Please explain what you think is interesting about your formula and trace.



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