Welcome

LTL

This survey asks about LTL formulas and their translation to English sentences.

By consenting to the survey, you acknowledge the following:

- your anonymized responses may appear in a public dataset
- you are at least 18 years old
- your participation is voluntary

You may opt out at any time by exiting the survey and leaving it unfinished. We will discard unfinished responses after 1 week.

In total, the survey has three parts:

1. Match traces and formulas (4 questions)
2. Translate formulas to English (3 questions)
3. Translate English to formulas (2 questions)

The formulas use English words instead of the traditional one-letter operators:

- always = G
- eventually = F
- until = U (strong until, not weak until)
- after = X

The questions ask about the state of an instrument panel over time. The panel has three colors: Red, Green, and Blue. For example, below is a picture of one panel state in which Red and Blue are on and Green is off.

Traces true-false

Part 1 of 3: Match traces and formulas

The following questions ask whether a trace of the panel satisfies an LTL formula.

Recall our LTL syntax:

- always = G
- eventually = F
- until = U (strong until, not weak until)
- after = X

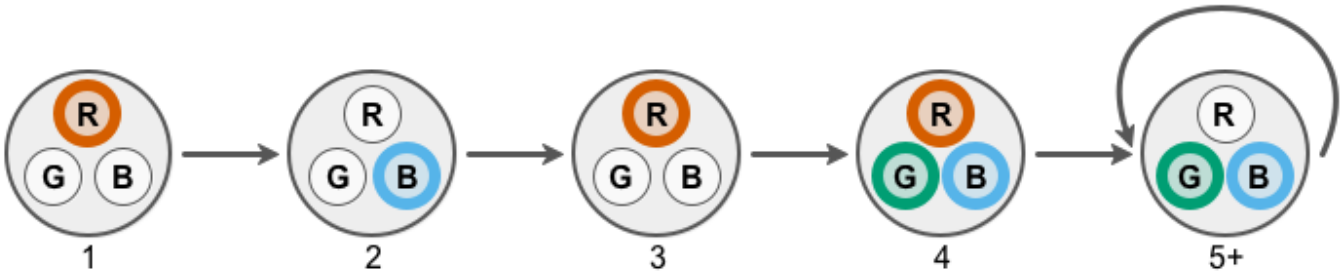
A trace is an infinite sequence of states. We represent traces as five states of the panel in which the final state repeats forever.

We first give two **Examples** to illustrate the questions and the style of answers that we are expecting.

Example Question: Is the formula

```
always ( Red or Blue )
```

satisfied by this trace?



Example Answer: Yes, because either Red or Blue is on in each state.

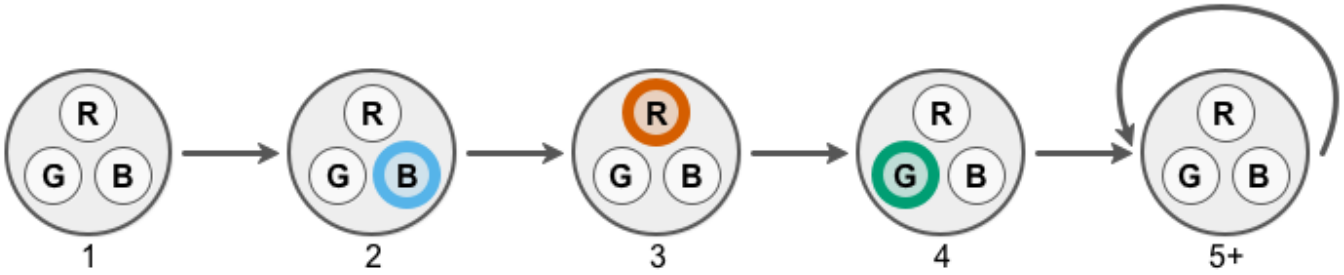
Does the example make sense to you?*

- ○ Yes
- ○ [ ] No (please explain)

Example Question: Is the formula

```
eventually ( Red and Green )
```

satisfied this trace?



Example Answer: No, because there is no state in which Red and Green are both on.

Does the example make sense to you?*

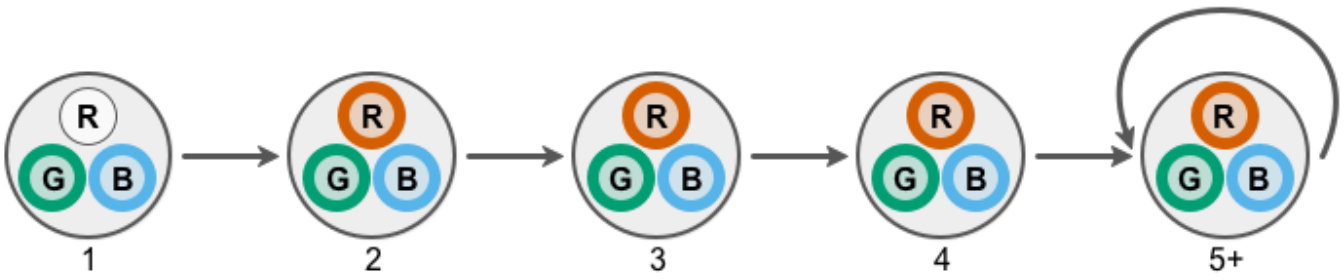
- ○ Yes
- ○ [ ] No (please explain)

The actual task begins now.

Q. Is the formula

`Red`

satisfied by this trace?*

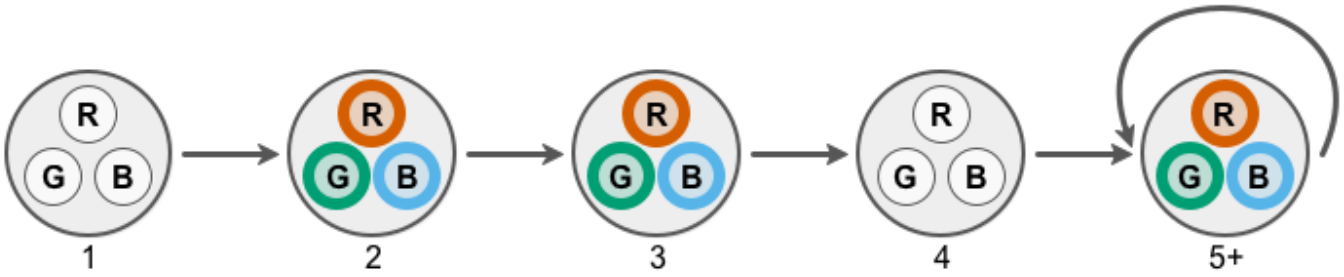


- ○ Yes
- ○ No

Q. Is the formula

```
always (
  Red implies
    after (
      after (
        after ( Red ) ) ) )
```

satisfied by this trace?*

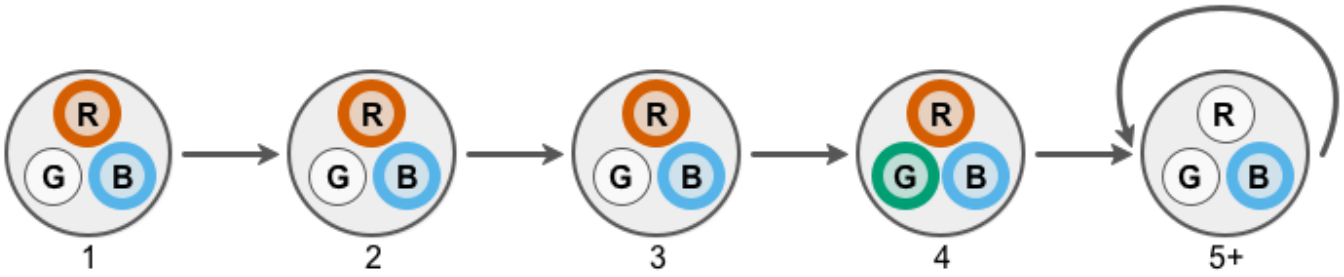


- ○ Yes
- ○ No

Q. Is the formula

```
( after ( Red ) )
until
( after ( Green ) )
```

satisfied by this trace?*

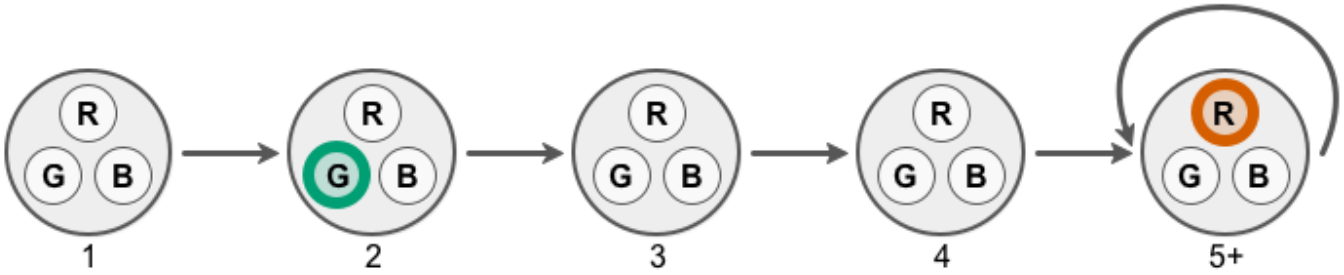


- ○ Yes
- ○ No

Q. Is the formula

```
{ eventually ( Red ) }
and
{ eventually ( Green ) }
```

satisfied by this trace?*

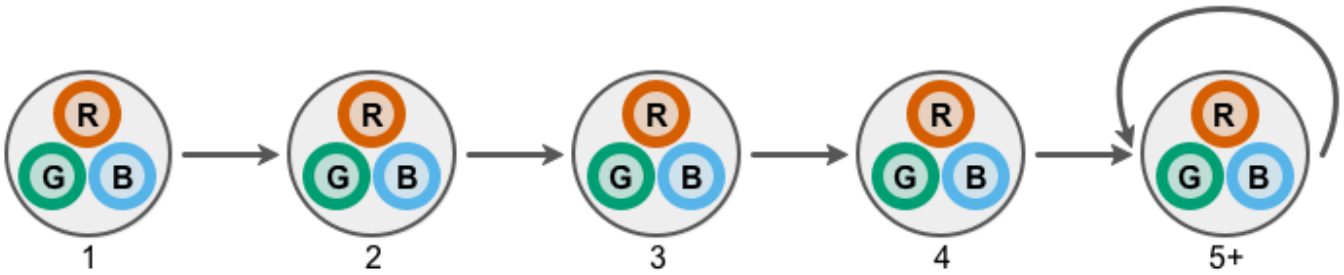


- ○ Yes
- ○ No

Q. Is the formula

```
after (
  after (
    eventually ( Red ) ) )
```

satisfied by this trace?*

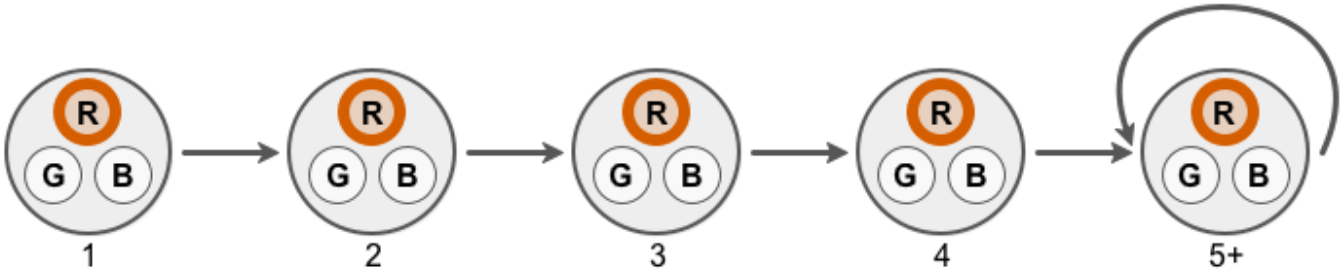


- ○ Yes
- ○ No

Q. Is the formula

```
( Red ) until ( Blue )
```

satisfied by this trace?*

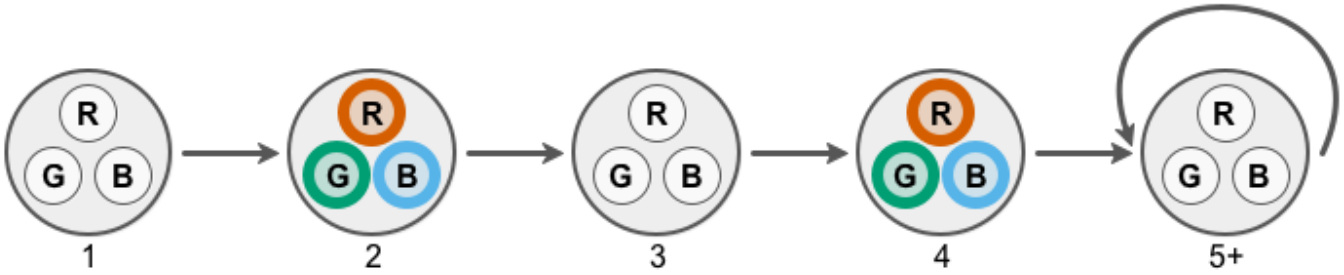


- ○ Yes
- ○ No

Q. Is the formula

`eventually ( always ( Red ) )`

satisfied by this trace?*

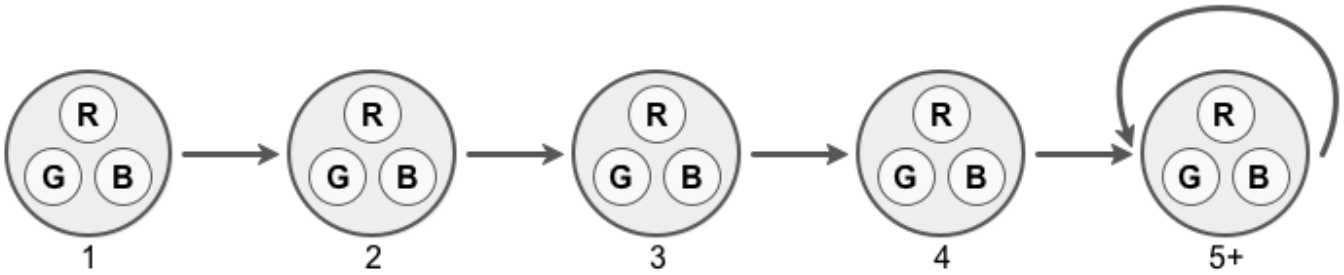


- ○ Yes
- ○ No

Q. Is the formula

`always ( Red implies Green )`

satisfied by this trace?*



- ○ Yes
- ○ No

LTL to English

Part 2 of 3: Translate formulas to English

Please translate the following formulas to English sentences.

Recall our LTL syntax:

- always = G
- eventually = F
- until = U (strong until, not weak until)
- after = X

If you have no idea how to translate a formula, feel free to write "I am lost" below.

We first show two **Examples** to illustrate the questions and the style of answers that we are expecting.

Example Question:

```
always ( Red implies
  after ( not Blue ) )
```

Example Answer: Whenever the Red light is on, the Blue light is off in the next state.

Does the example make sense to you?*

- ○ Yes
- ○ [ ] No (please explain)

Example Question:

```
( Red ) until ( not Red )
```

Example Answer: The Red light is on for zero or more states and then turns off.

Does the example make sense to you?*

- ○ Yes
- ○ No (please explain)

The actual task begins now.

```
Red implies
  after (
    after (
      after ( Red ) ) )
```

```
after (
  after (
```

```
    eventually (
      after ( Red ) ) ) )
```

```
{ eventually ( Red ) } implies
  { always ( Blue ) }
```

```
( ( Red ) until ( Blue ) )
and always ( Red )
```

```
always (
  Red implies (
    after ( not Red )
    and
    after (
      after (
        Red ) ) ) )
```

English to LTL

Part 3 of 3: Translate English to formulas

Please translate these English sentences to LTL formulas.

You may use **any** LTL syntax that you are comfortable with. As a reminder, we have been using the following aliases:

- always = G
- eventually = F
- until = U (strong until, not weak until)
- after = X

If you do not know how to express an idea in LTL, write "I am lost" below.

If you believe LTL cannot express a specification, write "inexpressible" and please explain.

We first show one **Example** to illustrate the questions and the style of answers that we are expecting.

Example Question: The Green light is never off.

Example Answer:

```
always ( Green )
```

Does the example make sense to you?*

- ○ Yes
- ○ No (please explain)

The actual task begins now.

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

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

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

Whenever the Red light is on, the Blue light will be on then or at some point in the future.

The Red light is on for zero or more states, and then turns off and remains off in the future.

Wrap-up

This is the LAST PAGE. Thank you for making it this far. :)

If you have any comments about your answers, or about this survey, please let us know.

What is your prior exposure to LTL? Select all that apply.

- [ ] I do research in formal methods, broadly
- [ ] I use LTL in my work
- [ ] My co-workers/labmates use LTL
- [ ] I took a course on formal methods
- [ ] I took a non-formal-methods course (on software, robotics, etc.) that discussed LTL
- [ ] I attended a talk that used LTL
- [ ] I read a research paper that used LTL
- [ ] I studied a tutorial on LTL
- [ ] None
- [ ] Other (explain below)

Which areas do you identify with? Select all that apply.

- [ ] Robotics
- [ ] AI / Machine Learning
- [ ] Formal methods / verification
- [ ] Other (please explain)

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