Welcome

LTL Instrument

Greetings!

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

This survey was designed by researchers at Brown University. Be advised that your anonymized responses may appear in a public dataset. For more information, contact benjamin.l.greenman@gmail.com

This survey has three parts:

1. Match traces and formulas (11 questions)
2. Describe formulas in English (6 questions)
3. Translate English to formulas (5 questions)

The formulas use four LTL operators:

- G ~ always
- F ~ eventually
- U ~ until (the strong version, not the weak until W)
- X ~ next

and four propositional connectives:

- && ~ and
- || ~ or
- => ~ implies
- ! ~ not

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

Background Questions

Have you taken a course on formal methods or verification?*

- Yes
- No
- Other (explain below)

Is there anything we should know about your prior coursework?

Do you have experience with LTL?*

- Yes
- No
- Other (explain below)

Briefly describe your experience with LTL.*

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 operators:

- G ~ always
- F ~ eventually
- U ~ strong until
- X ~ next

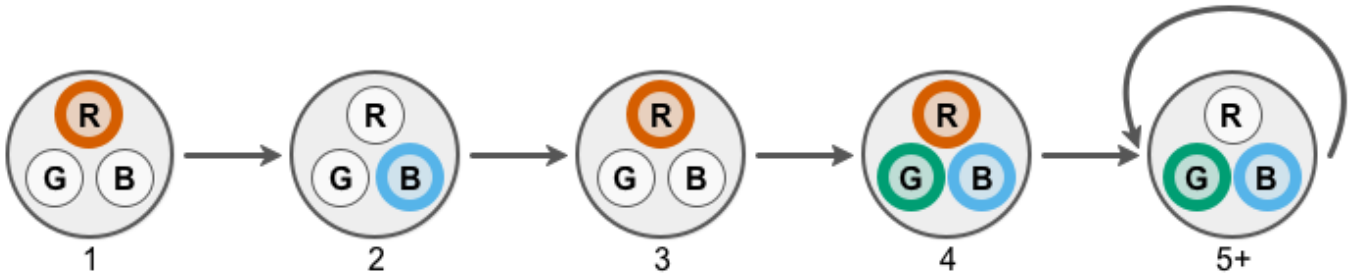
A trace is an infinite sequence of states. We represent traces as five states of the panel, arranged left-to-right as earliest-to-latest in time. The final state repeats forever.

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

Example Question: Is the formula

```
G(Red || Blue)
```

satisfied by this trace?



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

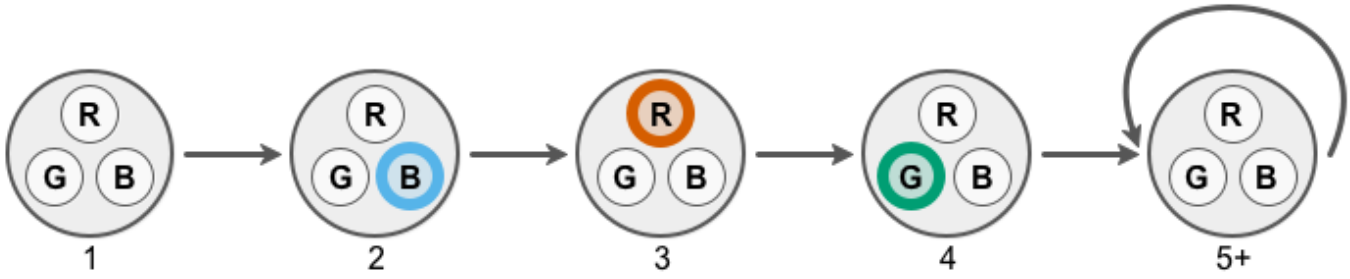
Do the **Example Question** and **Example Answer** make sense to you?*

- ○ Yes
- ○ [ ] No (please explain)

Example Question: Is the formula

```
F(Red && Green)
```

satisfied by this trace?



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

Do the **Example Question** and **Example Answer** make sense to you?*

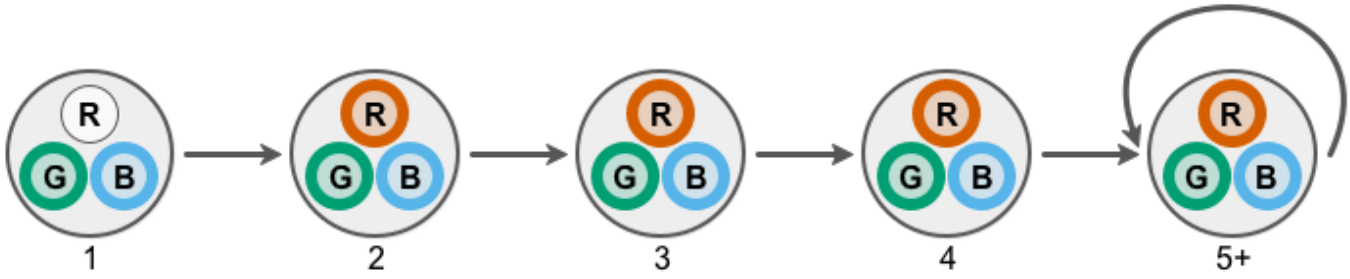
- ○ Yes
- ○ [ ] No (please explain)

The actual task begins now.

Q. Is the formula

`G(X(Red))`

satisfied by this trace?*



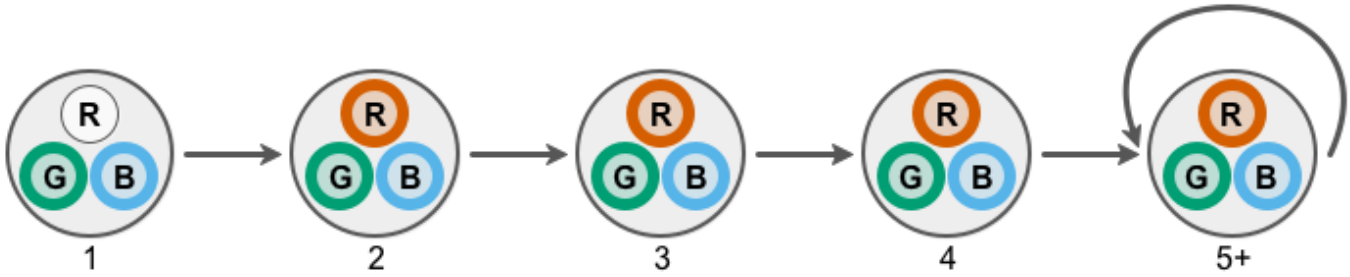
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`Red`

satisfied by this trace?*



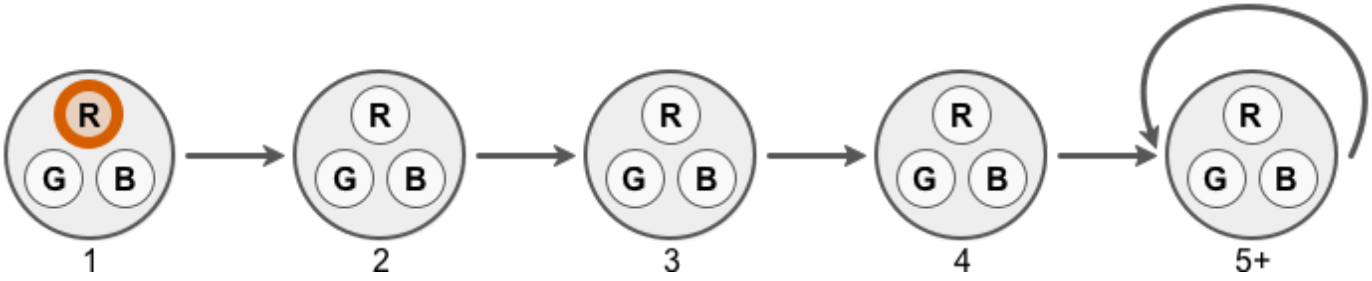
- Yes
- No

(Optional) Feel free to explain your reasoning

Q. Is the formula

```
F(Red)
```

satisfied by this trace?*



- Yes

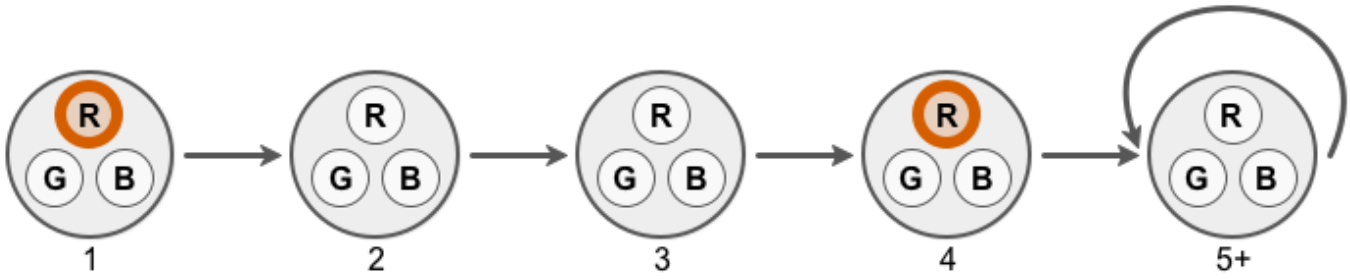
○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`X(X(X(Red)))`

satisfied by this trace?*



○ Yes

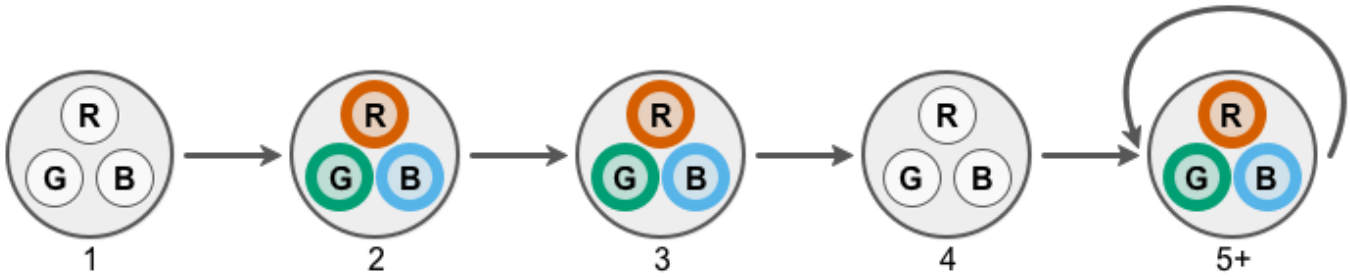
○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`G(Red => X(X(X(Red))))`

satisfied by this trace?*



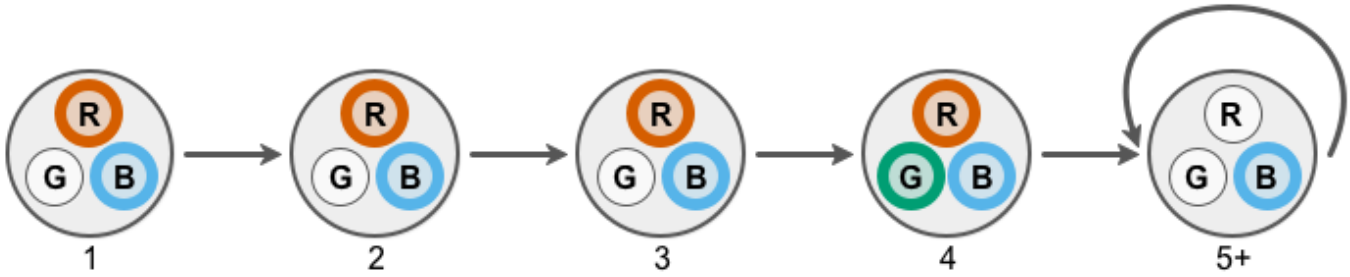
- Yes
- No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`Red U Green`

satisfied by this trace?*



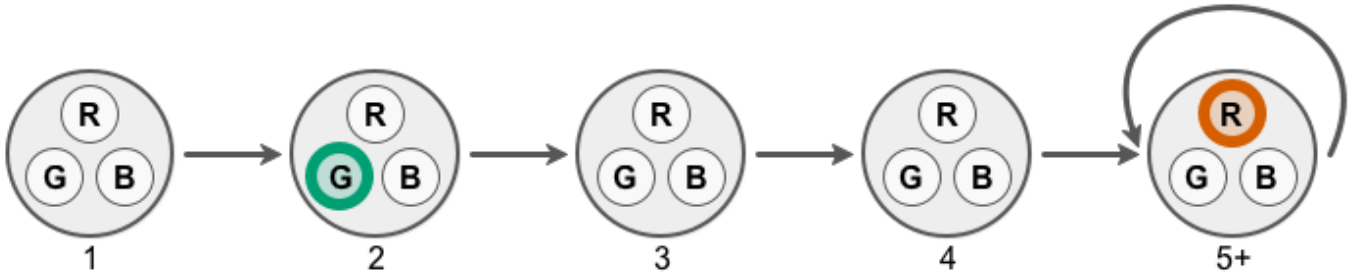
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`F(Red) && F(Green)`

satisfied by this trace?*



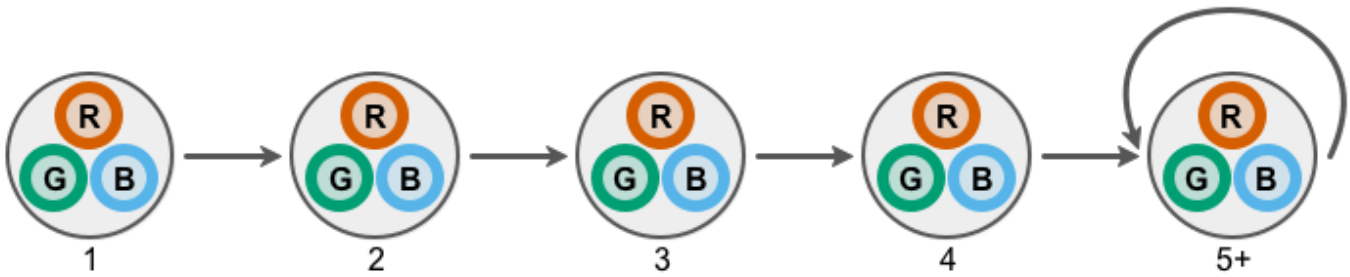
- Yes
- No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`X(X(F(Red)))`

satisfied by this trace?*



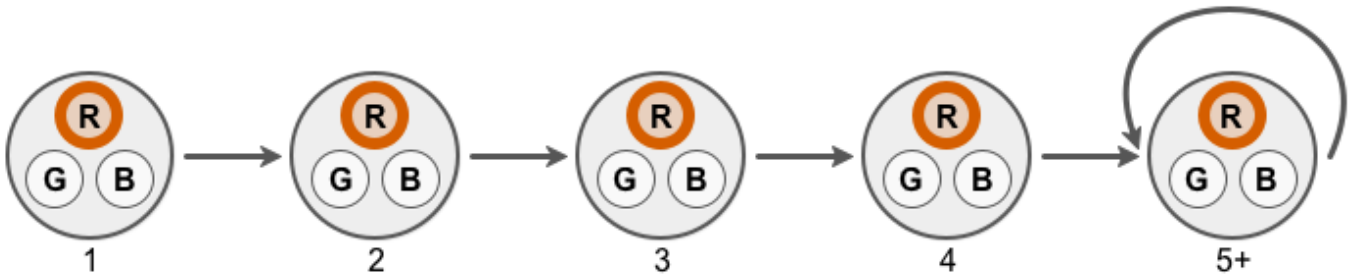
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`Red U Blue`

satisfied by this trace?*



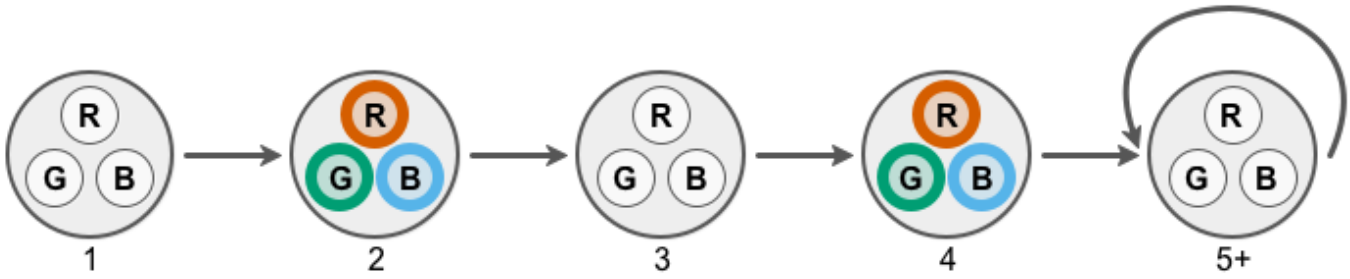
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`F(G(Red))`

satisfied by this trace?*



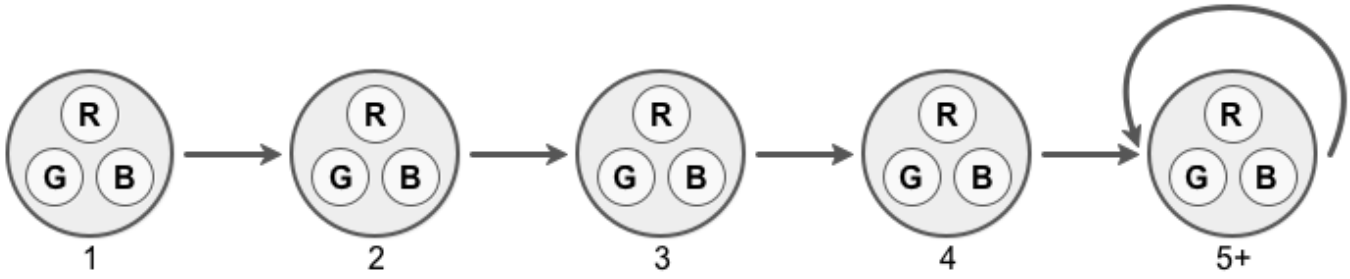
- Yes
- No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`F(Red => Green)`

satisfied by this trace?*



- Yes
- No

(Optional) Feel free to explain your reasoning

LTL to English

Part 2 of 3: Describe formulas in English

Describe the following formulas using English sentences.

Recall our LTL syntax:

- G ~ always
- F ~ eventually
- U ~ strong until
- X ~ next

If you have no idea how to describe a formula, write "I don't know" below.

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

Example Question:

```
G(Red => X(!Blue))
```

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

Do the **Example Question** and **Example Answer** make sense to you?*

- ○ Yes
- ○ [ ] No (please explain)

Example Question:

```
Red U !Red
```

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

Do the **Example Question** and **Example Answer** make sense to you?*

- ○ Yes
- ○ [ ] No (please explain)

The actual task begins now.

```
G(F(Red))
```

(Optional) Feel free to explain your reasoning

`Red => X(X(X(Red)))`

(Optional) Feel free to explain your reasoning

X(X(F(X(Red))))

(Optional) Feel free to explain your reasoning

F(Red) => G(Blue)

(Optional) Feel free to explain your reasoning

(Red U Blue) && G(Red)

(Optional) Feel free to explain your reasoning

```
G(Red => (X(!Red) && X(X(Red))))
```

(Optional) Feel free to explain your reasoning

English to LTL

Part 3 of 3: Translate English to formulas

Translate the following English sentences to LTL formulas.

As a reminder, we have been using the following atoms and connectives:

- Red, Green, Blue
- &&, ||, =>, !
- G ~ always
- F ~ eventually
- U ~ strong until
- X ~ next

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

If you do not know how to express an idea in LTL, write "I don't know" below.

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:

G(Green)

Do the **Example Question** and **Example Answer** 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.

(Optional) Feel free to explain your reasoning

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

(Optional) Feel free to explain your reasoning

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

(Optional) Feel free to explain your reasoning

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

(Optional) Feel free to explain your reasoning

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

(Optional) Feel free to explain your reasoning

Wrap up

Click the right arrow (->) below to submit.

On the next page, you will receive a PDF copy of your responses.