Welcome

LTL: RoboTrain

Greetings!

This survey asks about the meaning of LTL formulas and their translation to and from English.

By consenting to the survey, you acknowledge the following:

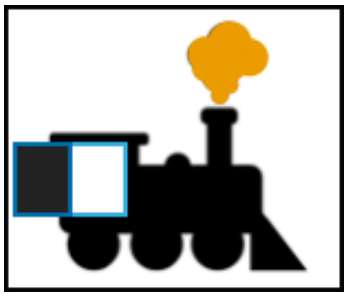
- your anonymized responses may appear in a public dataset
- you consent to a zoom recording while completing the survey
- your participation is voluntary

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

In total, the survey has three parts:

1. Match traces and formulas
2. Translate formulas to English
3. Translate English to formulas

The questions ask about the state of a robot-driven train over time. This RoboTrain has three components, each of which can be ON or OFF at any point in time: the engine, the door, and the headlight. For example, below is a picture of a RoboTrain with the engine on, the door open, and the headlight off:

 = { Engine and DoorOpen and not Light }

Traces true-false

Part 1 of 3: Match traces and formulas

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

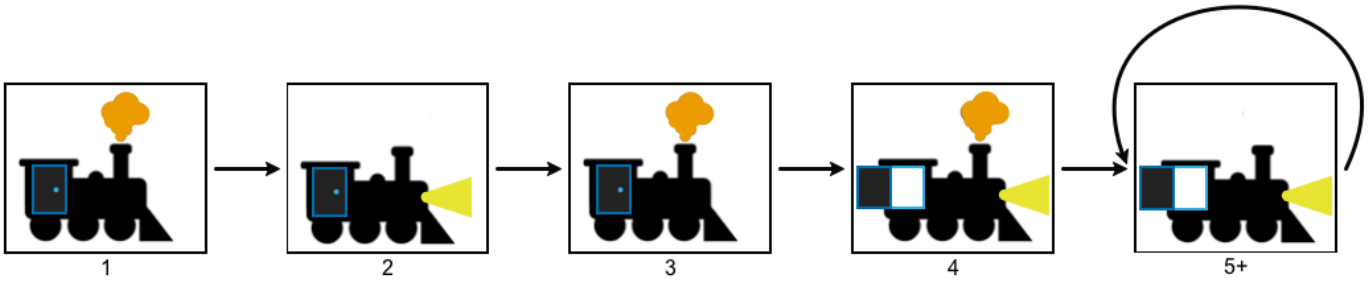
A trace is an infinite sequence of states. We represent traces as five states of the RoboTrain in which the final state repeats forever.

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

Example Question: Is the formula

```
always ( Engine or Light )
```

satisfied by this trace?



Example Answer: Yes, because either the engine (smoke) or the headlight is on in each state.

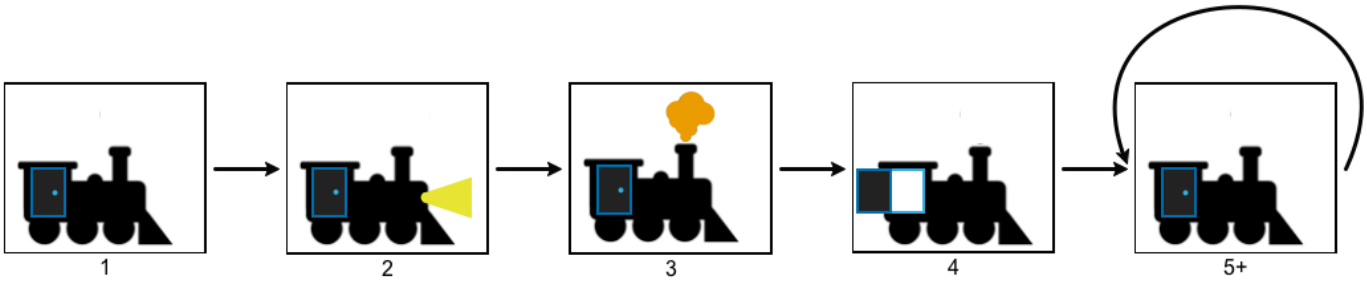
Does the example make sense to you?*

- ○ Yes
- ○ [ ] No (please explain)

Example Question: Is the formula

```
eventually ( Engine and DoorOpen )
```

satisfied this trace?



Example Answer: No, because there is no state in which the engine is on and the door is open.

Does the example make sense to you?*

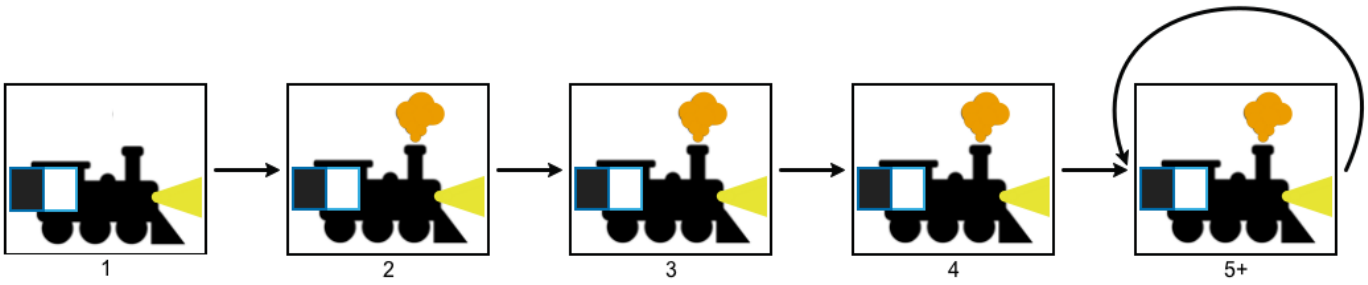
- ○ Yes
- ○ No (please explain)

The actual task begins now.

Q. Is the formula

`Engine`

satisfied by this trace?*



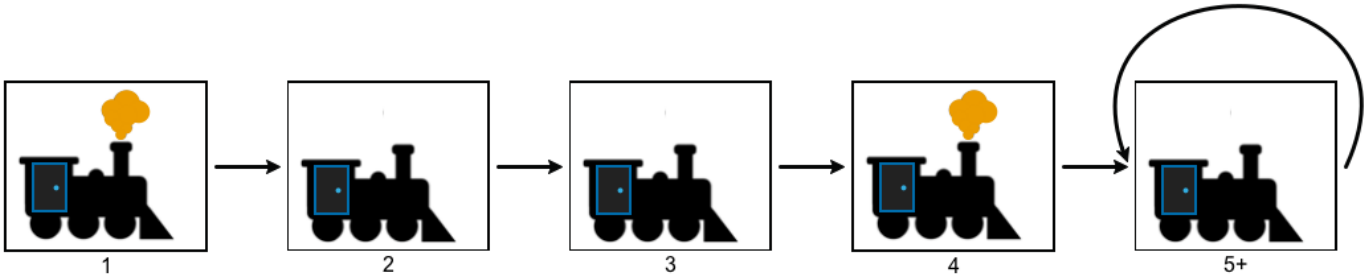
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

```
next_state (
  next_state (
    next_state ( Engine ) ) )
```

satisfied by this trace?*



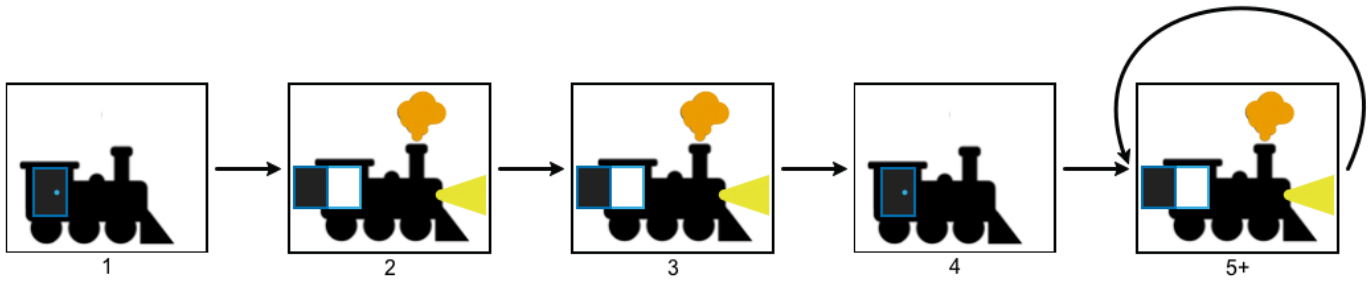
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

```
always (
  Engine implies
    next_state (
      next_state (
        next_state ( Engine ) ) ) )
```

satisfied by this trace?*



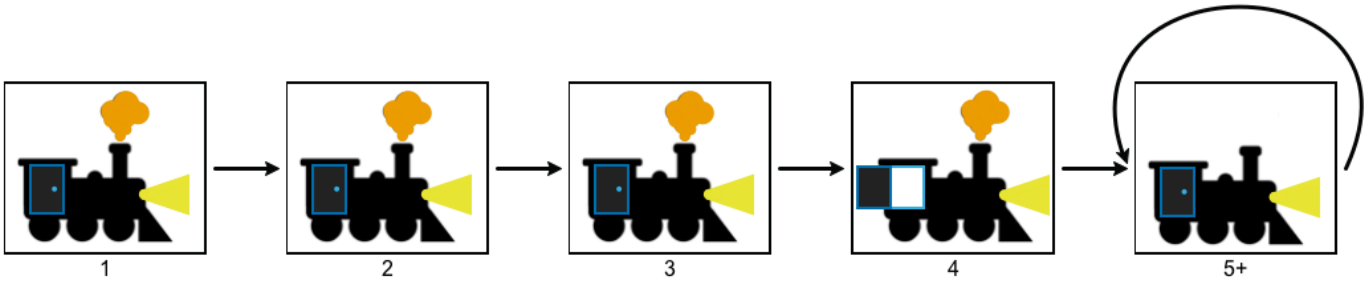
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

```
( next_state ( Engine ) )
until
( next_state ( DoorOpen ) )
```

satisfied by this trace?*



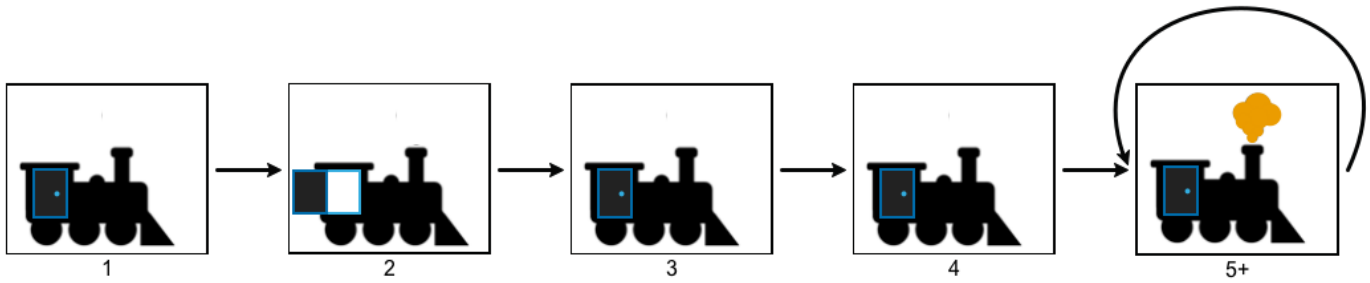
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

```
{ eventually ( Engine ) }
and
{ eventually ( DoorOpen ) }
```

satisfied by this trace?*



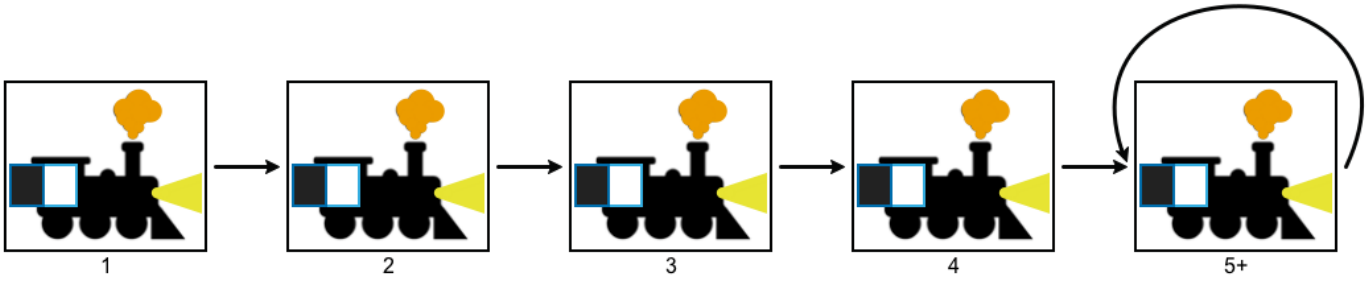
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

```
next_state (
  next_state (
    eventually ( Engine ) ) )
```

satisfied by this trace?*



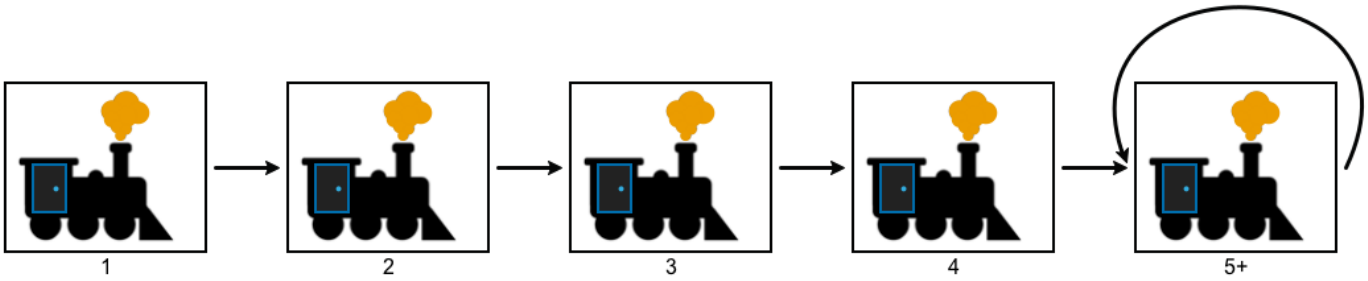
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

`( Engine ) until ( Light )`

satisfied by this trace?*



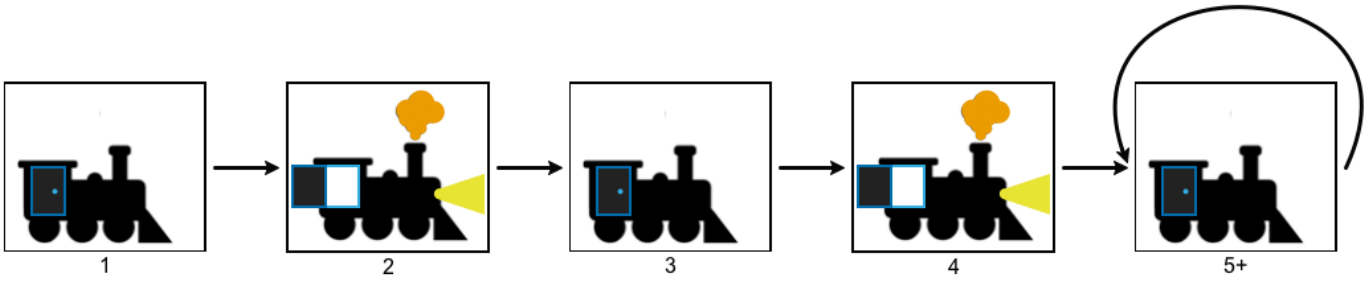
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

```
eventually ( always ( Engine ) )
```

satisfied by this trace?*



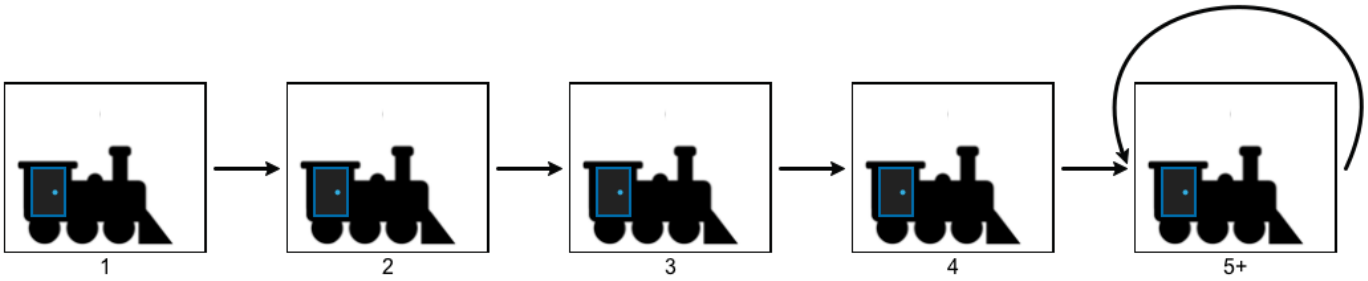
- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

```
always ( Engine implies Light )
```

satisfied by this trace?*



- ○ Yes
- ○ No

(Optional) Feel free to explain your reasoning

LTL to English

Part 2 of 3: Translate formulas to English

Please translate the following formulas to English sentences.

If you have no idea how to translate 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:

```
always ( Engine implies
  next_state ( not DoorOpen ) )
```

Example Answer: Whenever the engine is on, the door is closed in the next state.

Does the example make sense to you?*

- ○ Yes
- ○ [ ] No (please explain)

Example Question:

```
( Engine ) until ( not Engine )
```

Example Answer: The engine 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.

```
Engine implies
  next_state (
    next_state (
      next_state ( Engine ) ) )
```

(Optional) Feel free to explain your reasoning

```
next_state (
  next_state (
    eventually (
      next_state ( Engine ) ) ) )
```

(Optional) Feel free to explain your reasoning

```
{ eventually ( Engine ) } implies
  { always ( Light ) }
```

(Optional) Feel free to explain your reasoning

```
( ( Engine ) until ( Light ) )
and always ( Engine )
```

(Optional) Feel free to explain your reasoning

```
always (
  Engine implies (
    next_state ( not Engine )
    and
    next_state (
      next_state (
        Engine ) ) ) )
```

(Optional) Feel free to explain your reasoning

English to LTL

Part 3 of 3: Translate English to formulas

Please translate these English sentences to LTL formulas.

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

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

For reference, we have been using the following LTL operators:

- `always`
- `eventually`
- `next_state`
- `until`

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

Example Question: The door is never closed.

Example Answer:

```
always ( DoorOpen )
```

Does the example make sense to you?*

- ○ Yes
- ○ No (please explain)

The actual task begins now.

Whenever the engine 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 engine is on in exactly one state, but not necessarily the first state.

(Optional) Feel free to explain your reasoning

The engine cannot stay on for three states in a row.

(Optional) Feel free to explain your reasoning

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

(Optional) Feel free to explain your reasoning

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

(Optional) Feel free to explain your reasoning

Block 4

This is the final page. Click the right arrow (->) below to submit.