# Welcome

LTL

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

There are three parts:

1. Match traces and formulas (8 questions)
2. Translate formulas to English (2 questions)
3. Translate English to formulas (2 questions)

The questions ask about the state of a robot-driven locomotive (RoboLoc) over time. The RoboLoc has three components, each of which can be ON or OFF at any point: the engine, the door, and the headlight. In the image below, the engine is on, the door is open, and the headlight is off:
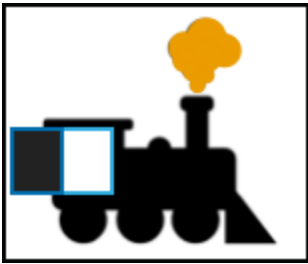
 `= (Engine /\ DoorOpen /\ not Light)`

The RoboLoc is a discrete system, not a hybrid system.

Traces true-false

Part 1 of 3: Match traces and formulas

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

A trace is an infinite sequence of states. We represent traces as five states of the RoboLoc 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

```
G(Engine \/ Light)
```

satisfied by this trace?
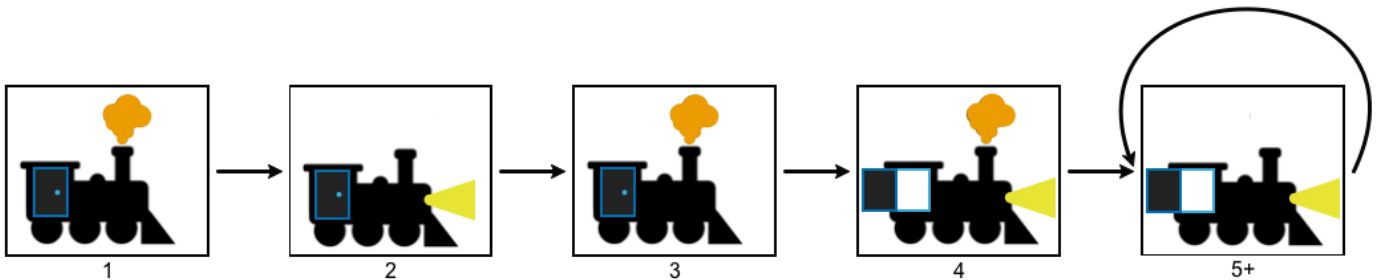
Example Answer: Yes, because either the engine (smoke) or the headlight is on in each state.
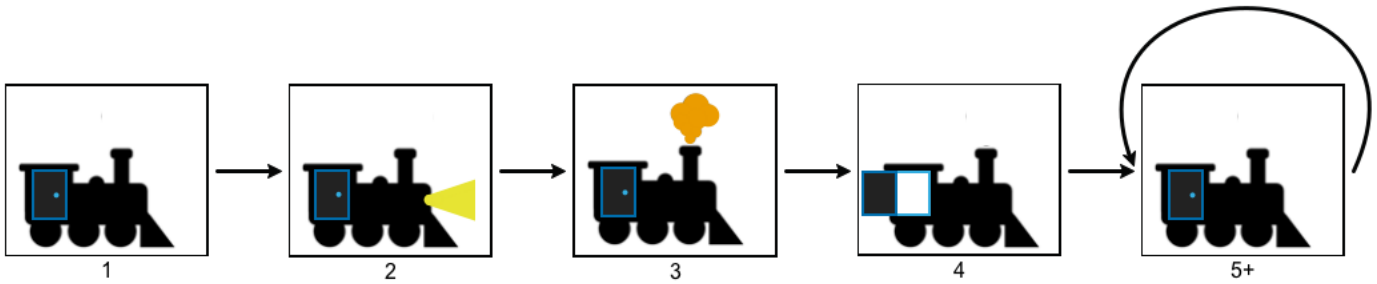
Does the example make sense to you?*

○ Yes

○ [   ] No (please explain)

Example Question: Is the formula

```
F(Engine /\ DoorOpen)
```

satisfied this trace?

Example Answer: No, because there is no state in which the engine is on and the door is open.
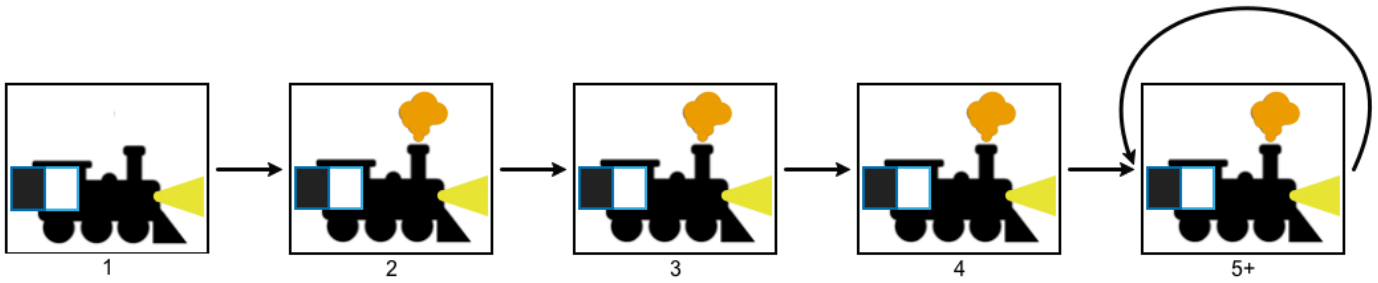
Does the example make sense to you?*

○ Yes

○ [   ] No (please explain)
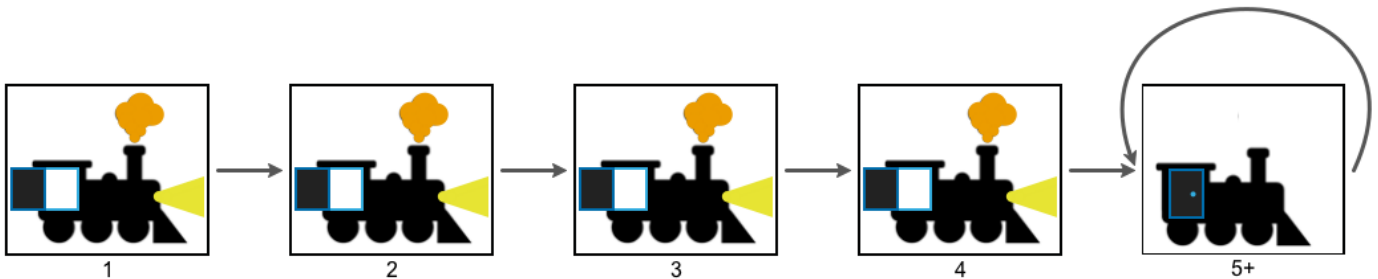
The actual task begins now.

Q. Is the formula

    Engine

satisfied by this trace?*

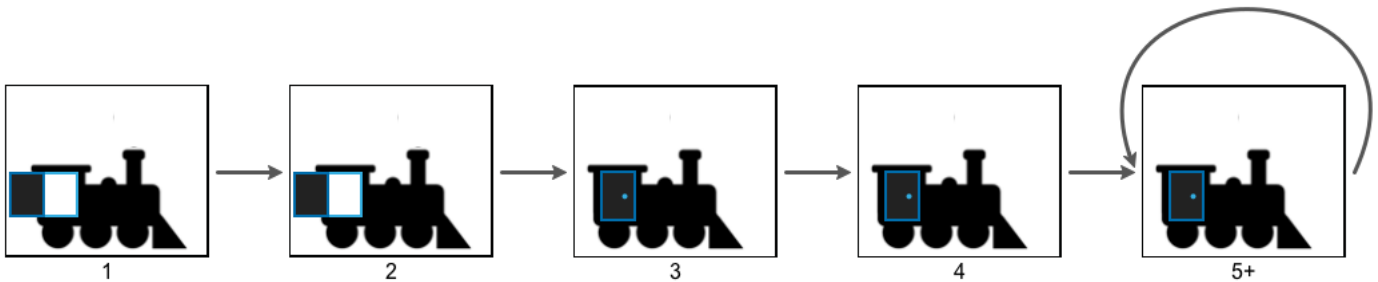○ Yes

○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

Engine

satisfied by this trace?*

○ Yes

○ No

(Optional) Feel free to explain your reasoning

```
[                                                                    ]
[                                                                    ]
[                                                                    ]
[                                                                    ]
[                                                                    ]
```

Q. Is the formula

```
    not G(DoorOpen)
```

satisfied by this trace?*

○ Yes

○ No

(Optional) Feel free to explain your reasoning

[text box]

Q. Is the formula

    X(X(X(Engine)))

satisfied by this trace?*

○ Yes

○ No

(Optional) Feel free to explain your reasoning

```

```

Q. Is the formula

`F(G(Engine))`

satisfied by this trace?*

○ Yes

○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

   Engine U DoorOpen
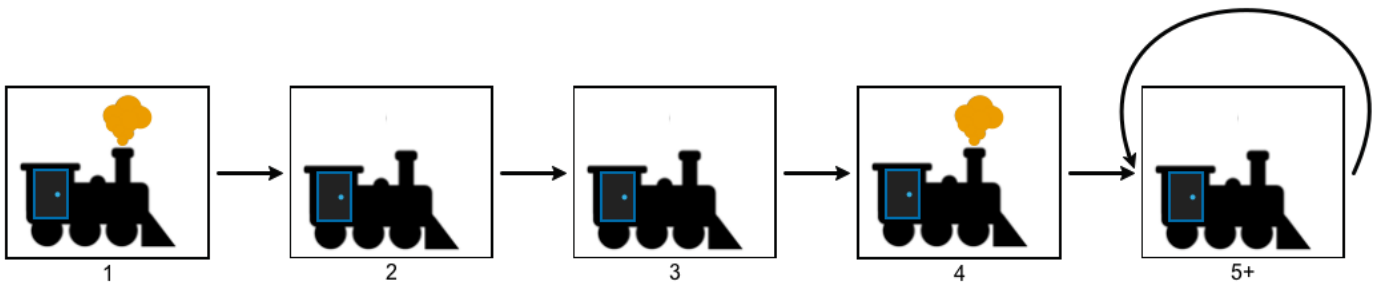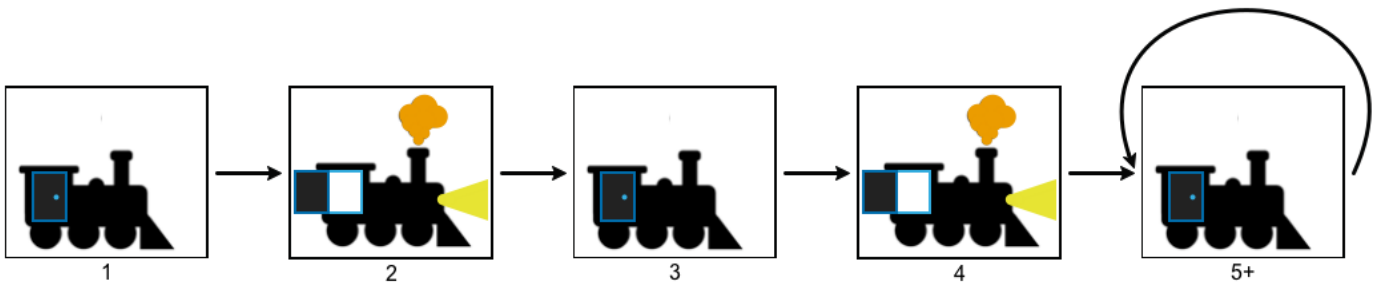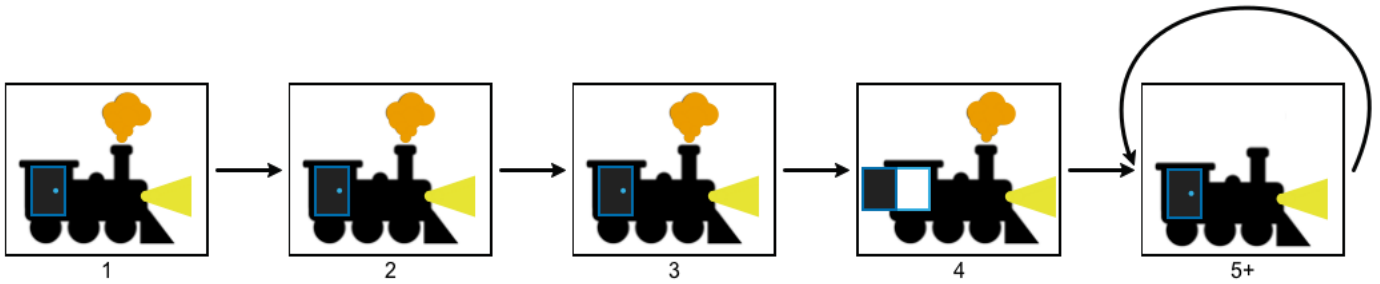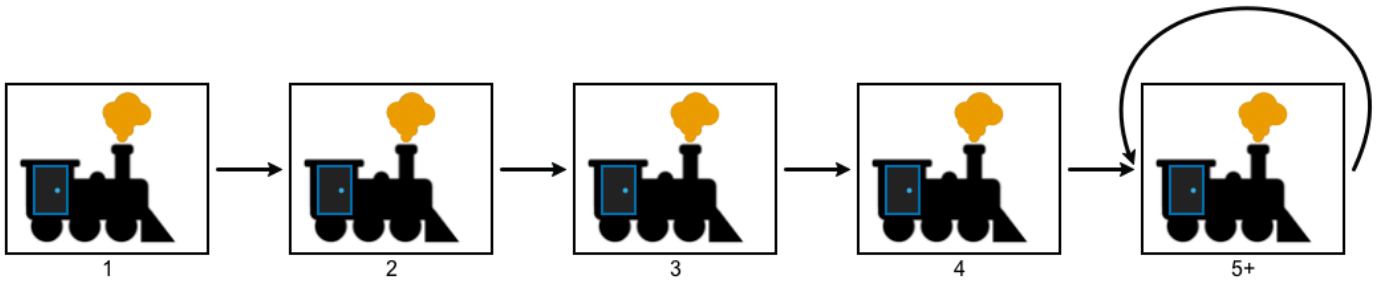
satisfied by this trace?*

○ Yes

○ No

(Optional) Feel free to explain your reasoning

Q. Is the formula

   `Engine U Light`
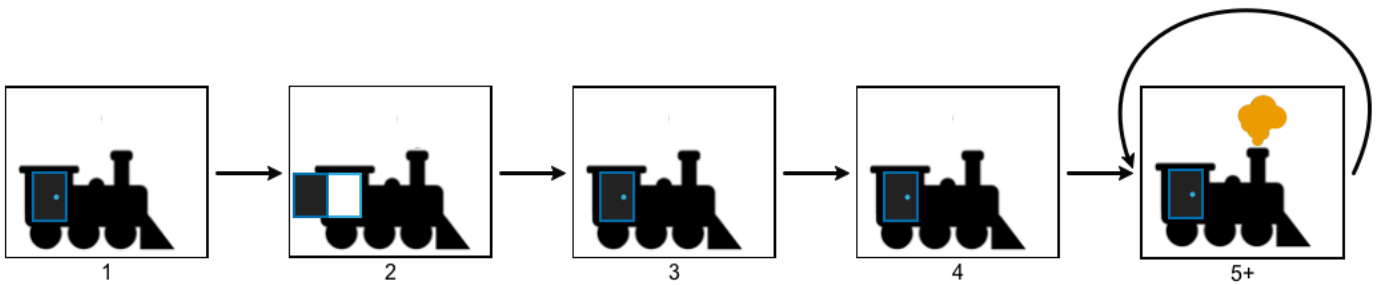
satisfied by this trace?*

○ Yes

○ No

(Optional) Feel free to explain your reasoning

```
┌────────────────────────────────────────────────────────────────┐
│                                                                │
│                                                                │
│                                                                │
│                                                                │
│                                                                │
│                                                              ╱╱│
└────────────────────────────────────────────────────────────────┘
```

Q. Is the formula

    `F(Engine) /\ F(DoorOpen)`

satisfied by this trace?*

○ Yes

○ No

(Optional) Feel free to explain your reasoning

```



```

Q. Is the formula

    `G(Engine ==> Light)`

satisfied by this trace?*

○ Yes

○ No
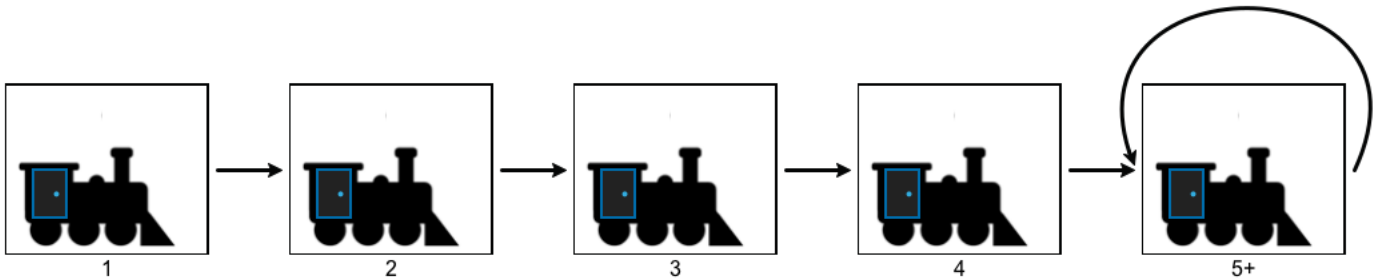
(Optional) Feel free to explain your reasoning

[ ]

LTL to English

Part 2 of 3: Translate formulas to English

Translate the following formulas to English sentences.

If you have do not know how to translate a formula, 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:

```
G(Engine ==> X(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)

The actual task begins now.

```
X(X(F(X(Engine))))
```

[   ]

(Optional) Feel free to explain your reasoning

```
F(Engine) ==> G(Light)
```

(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.

- 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.

As a reminder, here are the LTL connectives and RoboLoc variables:

- `G F X U`
- `/\ \/ ==> not`
- `Engine DoorOpen Light`

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:

```
G(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

[text box]

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

[text box]

(Optional) Feel free to explain your reasoning

[text box]

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