

# Complete Survey Instrument (S2 - Anti-Patterns and Program Repair)

This document is the complete survey instrument for S1, the survey focusing on declarative policies, which we refer to as the “Patterns” survey in the data. We separate the main sections of the survey using **bold headings**, add other details about the survey using *italics*, and list answer choices in bulleted lists.

## Section 1 - Background questions on smart home devices

The following 2 questions help us understand more about your experiences with smart home devices.

1. For each of the following categories, tell us if you **have used** and/or **have heard of** the device. If you own or have set up a device not listed here, you can use the box at the bottom to describe the device.

Note that in the questions below, when we say "smart features", we mean you have used the internet or smart phone features on the device. For instance, if you have a smart lightbulb, but you only use the physical light switch and never connect your phone to it, select "I have **used** one of these, but **not the smart features**". On the other hand, if you stream shows on your smart TV, select "I have **used smart features** on one of these".

*Categories include: Voice Assistant (e.g., Google Home, Amazon Echo, Siri); Doorbell Camera; Smart Lock; Smart TV; Smart Lightbulb or Lightswitch; Smart Smoke or CO Detector; Smart Lawn Mower or Sprinkler; Internet-Connected Security Camera; Internet-Connected Baby Monitor; Smart Thermostat or AC; Smart Vacuum or Mop; and Other internet-connected device, not listed here [free-response]*

- I have **used smart features** on one of these
- I have **used** one of these, but **not the smart features**
- I have **heard of these**, but **never used one**
- I have **never heard of these**

2. For each of the following categories, tell us if you **own** and/or have **set up** the device. If you own or have set up a device not listed here, you can use the box at the bottom to describe the device.

Note that in the questions below, when we say "set up", we mean you have connected the device to the internet or a smart phone so that you (or another person) can use the smart features on the device. For instance, if you have a smart lightbulb, but you only use the physical light switch and never connect your phone to it, select "I **own** one of these, but **have not set it up**". On the other hand, if a family member asked you to set up their smart TV for streaming, select "I do **not own** one of these but I **have set one up**".

*Categories are the same as the ones listed above, excluding those the participant responded "I have never heard of these" plus Other internet-connected device, not listed here [free-response]*

- I **own** and have **set up** one of
- I **own** one of these, but have **not set it up**
- I **do not own** one of these but I **have set one up**
- I **do not own**, nor have I set up one of these

## Section 2 - Warm-up exercises introducing TAP rules

Platforms like [IFTTT](#), Samsung [SmartThings](#), Apple [HomeKit](#), or [openHAB](#) allow people to automate behaviors and connect their smart home devices so they interact in new ways. Automations from these platforms are often in an "if-then" format, like "IF I leave home THEN turn off my lights".

Some devices also have built-in automation settings, like schedules for smart thermostats or turning on/off your smart lights based on your location.

These automation platforms and built-in automations are collectively called **home automations**.

3. Let's look at an example of a home automation. **This question is just for practice. Your answer will not affect the results of our study.**

Suppose you live somewhere cold. A few days a week you commute to your office. On days you are at home, you like to control the heat manually to save energy. On days you go into the office, you like to keep the heat off as much as possible. But if you leave it off the whole time you're gone, it is uncomfortably cold by the time you return from work.

You want to set up a home automation which will turn on your heat **automatically** so that when you get home from work, the house will already be comfortable. Please select the home automation below that would **best fit your needs**.

- IF user leaves work THEN turn on heat.
- IF user arrives at home THEN turn on heat.
- IF the time is 5PM THEN turn on heat.

- a. *If the participant selects "IF user leaves work THEN turn on heat" display...*

**Correct!** The home automation "IF user leaves work THEN turn on heat" will automatically turn your heat on when you leave work, so by the time you get home your house will be warm.

- b. *If the participant selects "If user arrives at home THEN turn on heat" display...*

**This isn't the best home automation for this situation.** The home automation "IF user arrives at home THEN turn on heat" will turn the heat on whenever you get home. This means, the house will not have time to heat up before you get there and your heat will turn on other times as well (like when you run a quick errand).

A better choice for this situation would be "IF user leaves work THEN turn on heat".

- c. *If the participant selects "IF the time is 5PM THEN turn on heat" display...*

**This isn't the best home automation for this situation.** The home automation "IF the time is 5PM THEN turn on heat" will turn the heat on every day at 5PM, even if you never left for work.

A better choice for this situation would be "IF user leaves work THEN turn on heat".

4. Let's look at another example of a home automation. **This question is just for practice. Your answer will not affect the results of our study.**

You're in the same situation as above, but after a few weeks you realized that some days are too warm for your heater. You want to **update** your home automation so that the heater still turns on automatically, but **only when** the temperature outside is below 45F.

Please select the home automation below that would **best fit your needs**.

- IF user leaves work WHILE temperature outside < 45F THEN turn on heat.
- IF user leaves work WHILE temperature outside > 45F THEN turn on heat.

- a. *If the participant selects "IF user leaves work WHILE temperature outside < 45F THEN turn on heat." display...*

**Correct!** The home automation "IF user leaves work WHILE temperature outside < 45F THEN turn on heat" will automatically turn your heat on when you leave work, but only when the temperature outside is below 45F. If the temperature outside is 45F or higher when you leave work, your heater will not turn on.

- b. *If the participant selects "IF user leaves work WHILE temperature outside > 45F THEN turn on heat." display...*

**This isn't the best home automation for this situation.** The home automation "IF user leaves work WHILE temperature outside > 45F THEN turn on heat" will turn the heat on when you leave work, but only when the temperature is above 45F. This home automation will prevent the heater from turning on when it is below 45F, and since you don't want the heater to turn on when it is too warm, this isn't the best choice.

A better choice for this situation would be "IF user leaves work WHILE temperature outside <45F THEN turn on heat".

### **Section 3 - Background questions on home automation**

5. Have you ever tried to use home automations with your own smart home devices? (Please select "yes" even if you tried to set up home automations without success.)

*Allows multiple answers*

- Yes, using a platform (like IFTTT, SmartThings, or openHAB)
- Yes, using built-in settings like schedules or based on my location
- No

6. Which of the following reasons stop you from using more smart home devices than you currently do? (either installing more home automations with your current devices, buying more devices, or using more features on your current devices)

*Reasons include: Learning to use a new device/feature/home automation is too difficult; Cost is too high; Not interesting to me; Privacy and/or security concerns; Other (please describe below)*  
*[free-response]*

- This is not a factor
- This is somewhat a factor
- This is definitely a factor

## Section 4 - Home automation goals

7. Below, we organize home automation goals into broad categories.

Please select from the choices below to tell us **how important these goal categories are to you**.

*Goal categories include: Comfort and convenience (e.g., "I want my A/C to turn on when it is hotter than 76F"); Home security (e.g., "I want my door to be locked whenever I am away from home"); Home safety (e.g., "I want to receive a notification if my CO detector goes off");*

*Understanding failures (e.g., "Whenever my security camera turns off, I want to know why it happened"); Privacy (e.g., "I don't want people to know I am out of town by looking at my house"); To demonstrate that you are not a bot, please click "I don't care about goals like this"; Just for fun (e.g., "I want to be notified whenever the international space station passes over my house")*

- Goals like this are very important to me
- Goals like this are somewhat important to me
- Goals like this are only a little important to me
- I don't care about goals like this

## Section 5 - Task intro (anti-patterns)

Suppose you had access to a website that could warn you about potentially dangerous patterns in your home automations. We want to know what kind of patterns would be most helpful for this tool to look for.

In the following, we will ask questions about such a tool that looks for patterns in home automations. In each of the following questions, we will describe a pattern to you with a few examples. We want to know whether you understand the pattern, if the pattern we describe is something you think is desirable or undesirable, and whether you would want help from a tool to look for the pattern in your home automations.

## Section 6 - Main survey task 1 (anti-patterns)

*Participants receive 2 of the following questions (random). Half of the participants are asked to identify the example of the anti-pattern before they are asked about their perception of the anti-pattern. The other half are asked to identify the example of the anti-pattern after being asked about their perception. Anti-patterns, descriptions, and choices given to the participant are shown at the end of this section.*

Pattern task *CurrentLoopNumber* of 2.

The *AntiPatternName* pattern:

*Description*

8. Please select the example of automations with the "*AntiPatternName*" pattern. (Exactly 1 will fit the pattern.) *Participants are*
- *Participants are given 4 programs to pick from, summarized below*

9. How difficult do you think it is to understand what the "*AntiPatternName*" pattern is, as a concept?

*Participants are asked about all of the following perspectives: I find understanding AntiPatternName to be...; Technical people would find understanding AntiPatternName to be...; Most people would find understanding AntiPatternName to be...; Finding AntiPatternName in my home automations would be...*

- Very easy
- Easy
- Neither easy nor difficult
- Difficult
- Very difficult

10. How often would people have the "*AntiPatternName*" pattern in their home automations? How often would people **want** to have the "*AntiPatternName*" pattern in their home automations?

*Participants are asked about all of the following perspectives: I think my home automations would have AntiPatternName...; I would **want** AntiPatternName in my home automations...; I would want to **avoid***

*AntiPatternName in my home automations...; I think other people would want AntiPatternName in their home automations...*

- Always
- Sometimes
- Rarely
- Never

11. Would people want help from a tool to find the "AntiPatternName" pattern in their home automations?

*Participants are asked about all of the following perspectives: I would **need** help finding AntiPatternName in my home automations...; I would **want** help finding AntiPatternName in my home automations...; I would use a tool if it looked for AntiPatternName...; It would be annoying if the tool looked for AntiPatternName...*

- Definitely
- Probably
- Probably Not
- Definitely Not

*Anti-Patterns in this section include:*

*Name:* Different Triggers, Same Behavior

*Description:* This pattern looks for automations which are triggered by different events, but lead to the same action. For instance, "IF light turns on THEN turn on A/C" and "IF light turns off THEN turn on A/C" have different triggers (light turns on vs light turns off) and the same action (turn on A/C).

*Programs to pick from:*

- "IF user arrives at home THEN lock door" and "IF user leaves home THEN lock door"
- "IF temperature > 78F THEN turn on A/C" and "IF temperature < 73F THEN turn off A/C"
- "IF motion is detected THEN turn on security camera" and "IF the time is 6AM THEN turn off security camera"
- "IF email is received THEN turn on light" and "IF user leaves work THEN turn off light"

*Name:* Same Except No Condition



*Description:* Some automations include a WHILE condition, like "IF window opened WHILE it is raining THEN close window". This pattern looks for automations that are identical except that one has the WHILE condition and the other one doesn't. For instance, the automation "IF light turns on THEN turn on A/C" is the same as the automation "IF light turns on WHILE it is raining THEN turn on A/C" except that it doesn't have the WHILE condition.

*Programs to pick from:*

- "IF it begins raining THEN close window" and "IF window is opened WHILE it is raining THEN close window"
- "IF temperature > 70 THEN turn on A/C" and "IF temperature < 73 THEN turn off A/C"
- "IF the time is 7AM THEN post a new tweet" and "IF I post a new status on Facebook THEN post a new tweet"
- "IF email is received THEN turn on light" and "IF user leaves work THEN turn off light"

*Name:* Same Triggers, Different Behavior & Conditions

*Description:* Some automations include a WHILE condition, like "IF window opened WHILE A/C on THEN close window". This pattern looks for situations where two automations are triggered by the same event and one automation has a WHILE condition and the other automation turns off the WHILE condition. For instance, "IF light turns on WHILE A/C is off THEN turn off light" and "IF light turns on THEN turn on A/C" are triggered by the same event and the first automation has a WHILE condition. Meanwhile, the second automation turns off the WHILE condition of the first.

*Programs to pick from:*

- "IF the temperature is > 74F WHILE the A/C is off THEN turn on A/C" and "IF the temperature is > 72F THEN turn on A/C"
- "IF it begins raining WHILE the window is open THEN close the window" and "IF the temperature outside is > 85F THEN close the window"
- "IF email is received THEN turn on light" and "IF user leaves work THEN turn off light"
- "IF it begins raining THEN set light color to blue" and "IF it becomes sunny THEN set light color to yellow"

*Name:* Chains with Opposite Behaviors

*Description:* This pattern looks for automations which trigger other automations (i.e. form "Chains") and have different behaviors. For instance, "IF A/C turns on WHILE light is on THEN turn off A/C" triggers the automation "IF light turns on THEN turn on A/C" and the automations have opposite behaviors.

*Programs to pick from:*

- "IF temperature < 74F THEN turn off A/C" and "IF temperature > 78F THEN turn on A/C"
- "IF it begins raining THEN set light color to blue" and "IF it becomes sunny THEN set light color to yellow"
- "IF I post a new Facebook status THEN post a new tweet" and "IF I post a new tweet THEN post a new Facebook status"
- "IF it begins raining WHILE the window is open THEN close the window" and "IF temperature < 75F and temperature > 50F THEN open window"

*Name:* Chain

*Description:* This pattern looks for automations which may trigger other automations (i.e. form "Chains"). For instance, the automations "IF light turns on THEN turn on A/C" and "IF A/C turns on THEN turn off light" create a chain.

*Programs to pick from:*

- "IF temperature > 78F THEN turn on A/C" and "IF temperature < 73F THEN turn off A/C"
- "IF it begins raining THEN close window" and "IF window is opened WHILE it is raining THEN close window"
- "IF email is received THEN turn on light" and "IF user leaves work THEN turn off light"
- "IF it begins raining THEN set light color to blue" and "IF it becomes sunny THEN set light color to yellow"

*Name:* Different Triggers, Different Behaviors

*Description:* This pattern looks for automations with different triggers and different behaviors. For instance, the automations "IF the time is 6AM THEN turn on my light" and "IF it is raining THEN close window" have different triggers and different behaviors.

*Programs to pick from:*

- "IF it begins raining THEN set light color to blue" and "IF it becomes sunny THEN set light color to yellow"

- “IF it begins raining WHILE the window is open THEN close the window” and “IF the temperature outside is > 85F THEN close the window”
- “IF the time is 7AM THEN post a new tweet” and “IF I post a new status on Facebook THEN post a new tweet”
- “IF temperature > 74F THEN turn on A/C” and “IF temperature > 78F THEN turn on A/C”

*Participants receive 2 of the following questions (random). The difference between this set of questions and the above is that participants are asked to identify two examples of the anti-pattern here, but only one above.*

Pattern task *CurrentLoopNumber* of 2.

The *AntiPatternName* pattern:

*Description*

12. Please select the example of automations with the “*AntiPatternName*” pattern. (Exactly 1 will fit the pattern.) *Participants are*
  - *Participants are given 4 programs to pick from, summarized below*
13. Please select the example of automations with the “*AntiPatternName*” pattern. (Exactly 1 will fit the pattern.) *Participants are*
  - *Participants are given 4 programs to pick from, summarized below*
14. How difficult do you think it is to understand what the “*AntiPatternName*” pattern is, as a concept?  
*Participants are asked about all of the following perspectives: I find understanding AntiPatternName to be...; Technical people would find understanding AntiPatternName to be...; Most people would find understanding AntiPatternName to be...; Finding AntiPatternName in my home automations would be...*
  - Very easy
  - Easy
  - Neither easy nor difficult
  - Difficult

- Very difficult

15. How often would people have the "*AntiPatternName*" pattern in their home automations? How often would people **want** to have the "*AntiPatternName*" pattern in their home automations?

*Participants are asked about all of the following perspectives: I think my home automations would have AntiPatternName...; I would **want** AntiPatternName in my home automations...; I would want to **avoid** AntiPatternName in my home automations...; I think other people would want AntiPatternName in their home automations...*

- Always
- Sometimes
- Rarely
- Never

16. Would people want help from a tool to find the "*AntiPatternName*" pattern in their home automations?

*Participants are asked about all of the following perspectives: I would **need** help finding AntiPatternName in my home automations...; I would **want** help finding AntiPatternName in my home automations...; I would use a tool if it looked for AntiPatternName...; It would be annoying if the tool looked for AntiPatternName...*

- Definitely
- Probably
- Probably Not
- Definitely Not

*Anti-Patterns in this section include:*

*Name:* Loops

*Description:* Triggering any automation in the loop will cause another automation to be triggered, which then causes the first automation to trigger again, leading to a loop. For instance, "IF light turns on THEN turn on A/C" and "IF A/C turns on THEN turn on light" create a loop.

*Programs to pick from (first question):*

- "IF I post a new Facebook status THEN post a new tweet" and "IF I post a new tweet THEN post a new Facebook status"
- "IF new calendar event created THEN add reminder" and "IF new reminder added THEN send notification"
- "IF motion is detected THEN turn on security camera" and "IF the time is 6AM THEN turn off security camera"
- "IF email is received THEN turn on light" and "IF user leaves work THEN turn off light"

*Programs to pick from (second question):*

- "IF temperature > 70F WHILE A/C is off THEN turn on A/C" and "IF temperature < 73F WHILE A/C is on THEN turn off A/C"
- "IF the time is 7AM THEN begin brewing coffee" and "IF user arrives at home THEN begin brewing coffee"
- "IF user leaves home THEN turn on porch light" and "IF user arrives at home THEN unlock door"
- "IF presence detected WHILE user is not at home THEN turn on security camera" and "IF presence detected THEN turn on security camera"

*Name:* Opposite Behaviors

*Description:* This pattern looks for automations which might trigger at the same time and result in opposite behaviors. For instance, "IF light turns on THEN turn on A/C" and "IF light turns on THEN turn off A/C" are triggered by the same event (light turning on) and result in opposite behaviors (turn on A/C vs turn off A/C).

*Programs to pick from (first question):*

- "IF motion is detected THEN turn on security camera" and "IF the time is 6AM THEN turn off security camera"
- "IF it begins raining THEN set light color to blue" and "IF it becomes sunny THEN set light color to yellow"
- "IF the time is 7AM THEN begin brewing coffee" and "IF user arrives at home THEN begin brewing coffee"
- "IF someone I follow tags me THEN re-tweet their post" and "IF I post a new status on Facebook THEN post a new tweet"

*Programs to pick from (second question):*

- "IF temperature > 70 THEN turn on A/C" and "IF temperature < 73 THEN turn off A/C"
- "IF the time is 7AM THEN begin brewing coffee" and "IF user arrives at home THEN begin brewing coffee"

- “IF presence detected WHILE user is not at home THEN turn on security camera” and “IF presence detected THEN turn on security camera”
- “IF user leaves home THEN turn on porch light” and “IF user arrives at home THEN unlock door”

*Name:* Same Behaviors

*Description:* This pattern looks for situations where multiple automations trigger the same behavior. For instance, "IF light turns on THEN turn on A/C" and "IF light turns off THEN turn on A/C" are result in the same behavior (turn on A/C).

*Programs to pick from (first question):*

- "IF temperature >74F THEN turn on A/C" and "IF humidity >80% THEN turn on A/C"
- "IF email is received THEN turn on light" and "IF user leaves work THEN turn off light"
- "IF the time is 7AM THEN post a status on Facebook" and "IF I post a new status on Facebook THEN post a new tweet"
- "IF new calendar event created THEN add reminder" and "IF new reminder added THEN send notification"

*Programs to pick from (second question):*

- "IF it begins raining THEN close window" and "IF window is opened WHILE it is raining THEN close window"
- "IF motion is detected THEN turn on security camera" and "IF the time is 6AM THEN turn off security camera"
- "IF I post a new Facebook status THEN post a new tweet" and "IF I post a new tweet THEN post a new Facebook status"
- "IF an email is received THEN flash lights" and "IF new reminder added THEN send notification"

*Name:* Un-Paired Automations

*Description:* Some automations form pairs (one automation might turn a device "on", while another turns it "off"). This pattern looks for situations where an automation is installed without a matching pair. For instance, "IF light turns on THEN turn on A/C" is installed without an automation that includes "THEN turn off A/C".

*Programs to pick from (first question):*

- "IF it begins raining THEN close window" and "IF window is opened WHILE it is raining THEN close window"

- "IF motion is detected THEN turn on security camera" and "IF the time is 6AM THEN turn off security camera"
- "IF I post a new Facebook status THEN post a new tweet" and "IF I post a new tweet THEN post a new Facebook status"
- "IF email is received THEN turn on light" and "IF user leaves work THEN turn off light"

*Programs to pick from (second question):*

- "IF a presence is detected THEN turn on security camera" and "IF new reminder added THEN send notification"
- "IF someone I follow tags me THEN re-tweet their post" and "IF I post a new status on Facebook THEN post a new tweet"
- "IF new calendar event created THEN add reminder" and "IF new reminder added THEN send notification"
- "IF user leaves home THEN lock door" and "IF user arrives at home THEN unlock door"

*Name:* Extended Behavior

*Description:* This pattern looks for automations which do not account for behaviors that do not happen instantaneously, i.e., they are "extended" over a period of time. For instance, an automation which does not wait for the coffee pot to finish before brewing another pot.

*Programs to pick from (first question):*

- "IF the time is 7AM THEN begin brewing coffee" and "IF user arrives at home THEN begin brewing coffee"
- "IF presence detected WHILE user is not at home THEN turn on security camera" and "IF presence detected THEN turn on security camera"
- "IF it begins raining THEN close window" and "IF window is opened WHILE it is raining THEN close window"
- "IF user leaves home THEN turn on porch light" and "IF user arrives at home THEN unlock door"

*Programs to pick from (second question):*

- "IF email is received THEN turn on light sequence" and "IF user leaves work THEN turn off light"
- "IF someone I follow tags me THEN re-tweet their post" and "IF I post a new status on Facebook THEN post a new tweet"
- "IF presence detected WHILE user is not at home THEN turn on security camera" and "IF presence detected THEN turn on security camera"

- "IF email is received THEN turn on light" and "IF user leaves work THEN turn off light"

*Name:* Privacy

*Description:* This pattern looks for automations which may allow people to learn private things about you. For instance, if you want to keep your location private, then the automation "IF I leave home THEN post a public tweet" tells people something private about you.

*Programs to pick from (first question):*

- "IF user leaves home THEN turn on porch light" and "IF user arrives at home THEN unlock door"
- "IF it begins raining THEN set light color to blue" and "IF it becomes sunny THEN set light color to yellow"
- "IF a presence is detected THEN turn on security camera" and "IF new reminder added THEN send notification"
- "IF motion is detected THEN turn on security camera" and "IF the time is 6AM THEN turn off security camera"

*Programs to pick from (second question):*

- "IF the time is 7AM THEN post a new tweet" and "IF I post a new status on Facebook THEN post a new tweet"
- "IF temperature >74F THEN turn on A/C" and "IF humidity >80% THEN turn on A/C"
- "IF it begins raining THEN close window" and "IF window is opened WHILE it is raining THEN close window"
- "IF an email is received THEN send notification" and "IF new reminder added THEN send notification"

*Name:* Trust

*Description:* This pattern looks for automations which do things that require your trust. For instance, if you only want people you trust to unlock your door, the automation "IF presence detected THEN unlock door" gives your devices control over something which requires your trust.

*Programs to pick from (first question):*

- "IF someone I follow tags me THEN re-tweet their post" and "IF I post a new status on Facebook THEN post a new tweet"
- "IF the time is 7AM THEN post a new tweet" and "IF I post a new status on Facebook THEN post a new tweet"



- "IF it begins raining THEN close window" and "IF window is opened WHILE it is raining THEN close window"
- "IF the time is 7AM THEN begin brewing coffee" and "IF user arrives at home THEN begin brewing coffee"

*Programs to pick from (second question):*

- "IF an email is received THEN flash lights" and "IF new reminder added THEN send notification"
- "IF user leaves home THEN turn on porch light" and "IF user arrives at home THEN unlock door"
- "IF temperature >74F THEN turn on A/C" and "IF humidity >80% THEN turn on A/C"
- "IF new calendar event created THEN add reminder" and "IF new reminder added THEN send notification"

## Section 7 - Task intro (program repair)

Next, we are going to ask questions about what actions you would take if a tool reported possible problems with your home automations.

## Section 8 - Main survey task 2 (program repair)

*Participants are randomly assigned to one of three groups, which determines what they are shown in this section: (1) rule leading to error, (2) rule and state of home during error, (3) full trace leading to error. Participants answer the following for two of three scenarios. Goals, programs, and other information for each scenario are shown at the end of this section.*

Suppose you told a tool that your goal is **Goal**.

You have the following home automations installed: *Program*

*The group the participant is assigned to determines which of the following they are asked:*

- If they were assigned to the "rule only" group. Suppose the tool told you there was a problem with the following home automation: **ViolatingRule***
- If they were assigned to the "rule and state" group. If the tool told you there was a problem with the following home automation: **ViolatingRule** and it also tells you that the problem happens when **ViolatingState**.*

c. *If they were assigned to the “trace” group. If the tool told this was the sequence of events which led to the problem: SequenceOfEvents*

17. What problem is happening here?

- A home automation is missing
- A home automation is doing something I don't want
- Multiple home automations are interacting to do something I don't want
- I don't know
- Something else (please explain below) *[Free-response]*

18. What action would you take?

- Add another home automation
- Modify a home automation
- Delete a home automation
- Do nothing/I don't know
- Something else (please explain below) *[Free-response]*

a. *If the participant selected “Add another home automation”*

Which format would the new home automation take?

- If-then
- If-while-then

i. *If the participant selected “if-then”*

Please enter the missing fields in the “if-then” home automation, below. *[Drill-down]*

ii. *If the participant selected “if-while-then”*

Please enter the missing fields in the “if-while-then” home automation, below. *[Drill-down]*

b. *If the participant selected “Modify a home automation”*

Which home automation would you modify?

- *Participant selects from the rules in the program*

c. *If the participant selected “Delete a home automation”*

Which home automation would you delete?

- *Participant selects from the rules in the program*

*Everyone is shown the following attention-check question.*

Suppose you installed 3 home automations:

"IF the time is 7AM THEN unlock door"

"IF it begins raining THEN close the window"

"IF user leaves home THEN lock door"

**It is important that you read the instructions in this section. To show that you are not a bot, please select "Something else" and type "I am reading this".**

**19. Based on what you read above, what problem is happening here?**

- A home automation is missing
- A home automation is doing something I don't want
- Multiple home automations are interacting to do something I don't want
- I don't know
- Something else (please explain below) *[Free-response]*

*Scenarios in this section include:*

*Goal:* Whenever I am not at home, I want my door to be locked.

*Violating rule:* "IF the time is 7AM THEN unlock door"

*Violating state:* the time is 7AM

*Trace to violation:*

Initially, the time is 6AM, the user is at home, the door is unlocked, the temperature is 70F, and the A/C is off. Next, the time is 6:30AM and the user leaves home. An automation is triggered and the door is locked. Finally, the time is 7AM. An automation is triggered and the door is unlocked.

*Program:*

"IF the time is 7AM THEN unlock door"

"IF the user leaves home THEN lock door"

"IF the temperature is above 75 THEN turn on A/C"

"IF the temperature is below 68F THEN turn off the A/C"

*Goal:* I want my lights to blink only when smoke has been detected.

*Violating rule:* "IF new email received THEN blink lights"

*Violating state:* new email received

*Trace to violation:*

Initially, the time is 6AM, the user is at home, the door is unlocked, the lights are not blinking, and no smoke is detected. Next, the time is 6:30AM and an email is received. An automation is triggered and the lights begin blinking.

*Program:*

"IF smoke detected THEN blink lights"

"IF new email received THEN blink lights"

"IF the time is 7AM THEN unlock door"

"IF the user leaves home THEN lock door"

*Goal:* Temperature above 72 should never happen.

*Violating rule:* "IF window opened THEN turn off the A/C"

*Violating state:* window opened

*Trace to violation:*

Initially, the time is 10AM, the window is closed, the door is unlocked, the temperature is 70F, and the A/C is off. The temperature is rising. Next, the time is 10:30AM, the temperature is 71F, and the user opens the window. An automation is triggered and the A/C turns on. The temperature begins falling. An automation is triggered and the A/C is turned off. The temperature begins rising. The time is 11AM and the temperature is 72F. Finally, the time is 11:30AM and the temperature is 73F.

*Program:*

"IF the time is 7AM THEN unlock door"

"IF window opened THEN turn off the A/C"

"IF the temperature is below 68F THEN turn off the A/C"

"IF the temperature is 71F THEN turn on the A/C"

## **Section 9 - Main survey task 3 (program completion)**

*Participants are assigned to the same group as the previous section, which determines what they are shown in this section: (1) a rule is missing, (2) a rule is missing and state of home when the rule is needed, (3) full trace leading to the state of the home when the rule is needed. All participants are given the same two scenarios. Goals, programs, and other information for each scenario are shown at the end of this section.*

Suppose you told a tool that your goal is **Goal**.

You have the following home automations installed: *Program*

*The group the participant is assigned to determines which of the following they are asked:*

- d. *If they were assigned to the “rule only” group. If the tool told you there was a missing home automation, what home automation would you add?*
- e. *If they were assigned to the “rule and state” group. If the tool told you there was a problem with the following home automation: *ViolatingRule* and it also tells you that the problem happens when *ViolatingState*.*
- f. *If they were assigned to the “trace” group. If the tool told this was the sequence of events which led to the problem: *SequenceOfEvents**

20. Would you like to add a home automation in the "if-then" or the "if-while-then" format?

- If-then
- If-while-then

i. *If the participant selected “if-then”*

Please enter the missing fields in the “if-then” home automation, below. *[Drill-down]*

ii. *If the participant selected “if-while-then”*

Please enter the missing fields in the “if-while-then” home automation, below. *[Drill-down]*

*Scenarios in this section include:*

*Goal:* the window should never be open while it is raining

*Violating rule:* "IF the time is 7AM THEN unlock door"

*Violating state:* user opens window and it is raining

*Trace to violation:*

Initially, the temperature is 70F, the window is open, and it is not raining. Next, it begins raining. An automation is triggered, closing the window. Finally, the user opens the window.

*Program:*

"IF the user leaves home THEN lock door"

"IF it begins raining THEN close window"

"IF temp > 75 WHILE it is not raining THEN open window"

"IF temp > 75 WHILE it is raining THEN turn on A/C"

*Goal:* the temperature should never be above 75F for more than 1 hour

*Violating rule:* "IF new email received THEN blink lights"

*Violating state:* the temperature increases above 75F

*Trace to violation:*

Initially, the time is 10AM, the temperature is 75F, the window is open, and it is not raining. The temperature is rising. Next, the time is 10:30AM and the temperature is 76F. Next, the time is 11AM and the temperature is 77F. Finally, the time is 11:30AM and the temperature is 78F.

*Program:*

"IF it begins raining THEN close window"

"IF the user leaves home THEN lock door"

"IF smoke detected THEN blink lights"

"IF the time is 7AM THEN unlock door"

## Section 10 - Demographics

The last part of the survey will ask demographic questions. You will have a chance to give us feedback at the end.

21. What is your age?

- 18-20
- 21-25
- 26-30
- 31-35
- 36-40
- 41-45
- 46 or older

22. What is your gender?

- Male
- Female
- Non-binary
- Prefer not to answer

- Prefer to self-describe *[Free-response]*

23. What is the highest level of education that you have completed?

- Less than high school
- High school or GED
- Some college, no degree
- Associates or 2-year degree
- Bachelors or 4-year degree
- Graduate degree (Masters, PhD, professional, medicine, etc)
- Other *[Free-response]*
- Prefer not to answer

24. Are you employed in, majoring in, or do you hold a degree in a computing field (e.g. computer science, computer engineering, information technology)?

If your employment status has been affected by the COVID-19 pandemic, select the answer which best describes your situation before the pandemic.

- Yes
- No

25. Can we release your (anonymous) responses as part of a public research dataset? This would allow the information you provided here to be used by other researchers.

Releasing your responses is optional and will not affect whether you are paid for participating.

- Yes
- No

26. Is there any other feedback you'd like to give us?  
*[Free-response]*