

# Complete Survey Instrument (S1 - Declarative Policies)

This document is the complete survey instrument for S1, the survey focusing on declarative policies, which we refer to as the “Properties” 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. Sometimes people have clear goals they want their home automation to **work together** to achieve (i.e. you might need multiple home automations for this goal). The goal "I want my windows to stay closed while it is raining" would require multiple home automations. One to close the window when it begins raining, and another to close the window if it is opened midway through the rainstorm.

Other times, people use home automation for **individual tasks**, which each have different goals (i.e. you would only need a single home automation for these goals). The goal "I want my door to lock when I leave home" would only require one home automation which locks the door when you leave home.

Yet other people might use home automations **without any goal** in mind.

- a. *If the participant indicated they have experience with TAP in Q5 display...*

Which of the following describes your goals for your home automation? If you have different goals for different types of home automation, you can select multiple options.

*Allows multiple answers*

- I have goals which some of my home automations **work together** to achieve
- I have **independent goals** which my home automations would achieve independently
- I have no specific goals in mind for some of my home automations

- b. *If the participant indicated they do not have experience with TAP in Q5 display...*

If you were to use home automation, which of the following would describe your goals for your home automation? If you think you

would have different goals for different types of home automation, you can select multiple options.

*Allows multiple answers*

- I would have goals which some of my home automations **work together** to achieve
- I would have **independent goals** which my home automations would achieve independently
- I would have no specific goals in mind for some of my home automations

8. Can you describe the goals you had in mind (if any) when you were answering the last question?

The goals can be general (e.g., "I want my home to be secure") or specific (e.g., "I want my door to be locked whenever I am away from home").

- *[Free-response]*

9. 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
10. Did you think of any other goal(s) which did not fit into the categories we identified, but would be important to you?
- Yes
  - No
- a. *If the participant responded "Yes"*
- How would you describe the goal(s)?
- *[Free-response]*

## Section 5 - Task intro (declarative policies)

The next section includes questions about **fixed goal formats** called **templates**. Templates are fill-in-the-blank statements, which you fill in with device behaviors or environmental states to describe a **goal that your home automations work together to achieve**.

For instance, you might have several home automations installed, and what you care about most is that your porch light stays on. Then, you could pick the: **I always want** \_\_\_\_ template and fill in "light on" using the drop downs to make the goal **I always want** light on.

## Section 6 - Main survey task 1 (template preferences)

*Half of participants are shown this task first. The other half are shown this task last. Participants receive 3 of the following questions (random), plus the attention-check question, which everyone receives.*

In this task, we want to know which goal formats are the **most natural** to use.

In the following questions, please select the option which best describes the goal, **in your opinion**. If none of the choices seem natural, please select the last option and briefly explain why.

11. Suppose your goal is... "I want my pets to be comfortable while I am at work. I read online that my pets likely prefer temperatures between 65F and 75F."



Pick the template which is most natural, in your opinion.

- **I always want** temperature < 75F **and** temperature > 65F.
- **I never want** temperature > 75F **or** temperature < 65F.
- Both of the following:  
Temperature > 75F **should never be active for more than 15** minutes.  
Temperature < 65F **should never be active for more than 15** minutes.
- Both of the following:  
Temperature > 75F **should never be active while** user is at work.  
Temperature < 65F **should never be active while** user is at work.
- None of the above seem natural to me. (Why?) [*Free-response*]

12. Suppose your goal is... "I have a lot of valuable books that I want to protect from damage. I want to keep the humidity in my house around 50-60%."

Pick the template which is most natural, in your opinion.

- **I always want** humidity > 50% **and** humidity < 60%.
- Both of the following:  
**I never want** humidity > 60%.  
**I never want** humidity < 50%.
- Humidity > 50% **and** humidity < 60% **should always be active.**
- Both of the following:  
Humidity < 50% **should never be active.**  
Humidity > 60% **should never be active.**
- None of the above seem natural to me. (Why?) [*Free-response*]

13. Suppose your goal is... "I want my light to blink to tell me when smoke is detected. If my light is blinking, I will assume it means that there is smoke."

Pick the template which is most natural, in your opinion.

- Both of the following:  
**Whenever** smoke detected, **make sure that** light is blinking.

**Whenever** light blinking, **make sure that** smoke is detected.

- **I want** light blinking **only when** smoke detected.
- Light blinking **should only happen when** smoke detected.
- Both of the following:  
Light blinking **and** no smoke detected **should never occur together**.  
Smoke detected **and** light not blinking **should never occur together**.
- None of the above seem natural to me. (Why?) [*Free-response*]

14. Suppose your goal is... "I want to make sure nobody is tampering with my security camera, so I want to know when it turns off. I also want to know when my local electric company tweets about power outages, in case that is the reason the camera turns off."

Pick the template which is most natural, in your opinion.

- Both of the following:  
**Whenever** camera turns off, **make sure that** notification is received.  
**Whenever** new tweet from electric company, **make sure that** notification is received.
- Both of the following:  
Camera off **and** no new notification **should never occur together**.  
New tweet from electric company **and** no new notification **should never occur together**.
- Notification is received **should always be active while** camera off **or** new tweet from electric company.
- All of the following:  
**Whenever** camera turns off **make sure that** notification is received.  
**Whenever** new tweet from electric company **make sure that** notification is received.  
Camera turns off **should never happen when** notifications volume turned off.
- None of the above seem natural to me. (Why?) [*Free-response*]

15. It is important that you read the instructions in this section. To demonstrate that you are not a bot, please click "None of the above" and type "I am reading this".

Based on what you read above, pick the template which is most natural, in your opinion.

- I **always want** temperature < 75F **and** temperature > 65F.
- Light blinking **should only happen when** smoke detected.
- Notification is received **should always be active while** camera off **or** new tweet from electric company.
- None of the above seem natural to me. (Why?) *[Free-response]*

16. Suppose your goal is... "When I wake up in the morning, I want my smart light to tell me the forecast for the day. Yellow for sunny, blue for rain, purple for snow, white for cloudy."

Pick the template which is most natural, in your opinion.

- All of the following:  
**Whenever** forecast is sun, **make sure that** light is yellow.  
**Whenever** forecast is rain **make sure that** light is blue.  
**Whenever** forecast is snow, **make sure that** light is purple.  
**Whenever** forecast is cloudy, **make sure that** light is white.  
**Whenever** the time is 7AM, **make sure that** light is on.
- All of the following:  
**Whenever** forecast is sun, **make sure that** light is yellow.  
**Whenever** forecast is rain, **make sure that** light is blue.  
**Whenever** forecast is snow, **make sure that** light is purple.  
**Whenever** forecast is cloudy, **make sure that** light is white.  
Light on **should always happen within** 30 minutes **after** the time is 7AM.
- All of the following:  
Light is yellow **only when** forecast is sun.  
Light is blue **only when** forecast is rain.  
Light is purple **only when** forecast is snow.

Light is white **only when** forecast is cloudy.

Light is on **should happen within** 30 minutes **after** the time is 7AM.

- All of the following:

Light is yellow **only when** forecast is sun.

Light is blue **only when** forecast is rain.

Light is purple **only when** forecast is snow.

Light is white **only when** forecast is cloudy.

**Whenever** the time is 7AM, **make sure that** light is on.

- None of the above seem natural to me. (Why?) [*Free-response*]

## Section 7 - Main survey task 2 (template picking)

In this task, we want to know how difficult it is to pick a template to match a goal stated in plain English. We will give you a goal and you will pick the template format which **best matches the goal, in your opinion**. Note that more than one template may match the goal, just pick the one that you prefer.

17. Pick **one** template for the following goal: I want my lights to blink to tell me that smoke has been detected. If the lights are blinking, I will assume there is a fire, so I don't want them to blink for any other reason.

- I [always/never] want \_\_\_\_
- \_\_\_\_ only when \_\_\_\_
- Whenever \_\_\_\_ make sure that \_\_\_\_
- \_\_\_\_ and \_\_\_\_ should [always/never] occur together
- \_\_\_\_ should [always/never] be active
- \_\_\_\_ should [always/never] be active for more than \_\_\_\_ [minutes/hours]
- \_\_\_\_ should [always/never] be active while \_\_\_\_
- \_\_\_\_ should [only/never] happen when \_\_\_\_
- \_\_\_\_ should [always/never] happen within \_\_\_\_ [minutes/hours] after \_\_\_\_

18. Pick **one** template for the following goal: I have some automations to cause my lights to blink, but I am worried they might blink all night long

and disturb my neighbors while I am out of town. I want to know that when they blink, they never blink for more than half an hour.

- I [always/never] want \_\_\_\_
- \_\_\_\_ only when \_\_\_\_
- Whenever \_\_\_\_ make sure that \_\_\_\_
- \_\_\_\_ and \_\_\_\_ should [always/never] occur together
- \_\_\_\_ should [always/never] be active
- \_\_\_\_ should [always/never] be active for more than \_\_\_\_ [minutes/hours]
- \_\_\_\_ should [always/never] be active while \_\_\_\_
- \_\_\_\_ should [only/never] happen when \_\_\_\_
- \_\_\_\_ should [always/never] happen within \_\_\_\_ [minutes/hours] after \_\_\_\_

## Section 8 - Main survey task 3 (template filling)

19. Fill out the template(s) for the following goal: I want my windows to be closed while it is raining.

*Each participant is asked to fill out one of the following, selected randomly:*

- I [always/never] want \_\_\_\_
- \_\_\_\_ and \_\_\_\_ should [always/never] occur together
- \_\_\_\_ should [always/never] be active
- \_\_\_\_ should [always/never] be active while \_\_\_\_

20. Fill out the template(s) for the following goal: I am worried my baby will overheat at night. I read that they should sleep in rooms cooler than 73F.

*Each participant is asked to fill out one of the following, selected randomly:*

- Whenever \_\_\_\_ make sure that \_\_\_\_
- \_\_\_\_ and \_\_\_\_ should [always/never] occur together
- \_\_\_\_ should [always/never] be active
- \_\_\_\_ should [always/never] be active while \_\_\_\_

21. Fill out the template(s) for the following goal: My dryer is disrupting my Zoom meetings. I don't want it to run during business hours. My meetings are always finished by 5PM.

*Each participant is asked to fill out one of the following, selected randomly:*

- **Whenever \_\_\_\_ make sure that \_\_\_\_**
- **\_\_\_\_ should [always/never] be active while \_\_\_\_**
- **\_\_\_\_ should [only/never] happen when \_\_\_\_**
- **\_\_\_\_ should [always/never] happen within \_\_\_\_ [minutes/hours] after \_\_\_\_**

## **Section 9 - Demographics**

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

22. What is your age?

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

23. What is your gender?

- Male
- Female
- Non-binary
- Prefer not to answer
- Prefer to self-describe *[Free-response]*

24. 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

25. 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

26. 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

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