Supplementary Materials:
Understanding Trigger-Action Programs Through Novel Visualizations of Program Differences

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1 Codebase and Data

Our codebase and user study data with analysis are available at:
`https://github.com/UChicagoSUPERgroup/tapdiff`.

2 Additional Figures

Figure 1: Example of the "split diff" view on Github, which inspired the visual design of our *Text-Diff* interface. Found at `https://github.com/octocat/git-consortium/commit/6b9b40ef57b03d5c48ac5ca96ce80dade0949350?branch=6b9b40ef57b03d5c48ac5ca96ce80dade0949350&diff=split`.

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3   Regression Tables

Table 1: Our parsimonious Poisson regression model of the number of tasks a participant **answered correctly**. Higher numbers indicate that more tasks were answered correctly. For categorical independent variables, we indicate the baseline category.

Factor	Baseline	Coefficient	SE	t	p
(Intercept)	–	0.249	0.383	0.650	.516
UI: *Text-Diff*	*Rules*	-0.011	0.200	-0.054	.957
UI: *Outcome-Diff: Flowcharts*	*Rules*	0.399	0.180	2.215	**.027**
UI: *Outcome-Diff: Questions*	*Rules*	0.581	0.174	3.342	**<.001**
UI: *Property-Diff*	*Rules*	0.096	0.184	0.523	.601
Number of tutorial questions correct	(Continuous)	0.222	0.140	1.587	.112

Table 2: Our parsimonious Poisson regression model of the number of tasks for which a participant **used the program button** (looked at the rules themselves). Higher numbers indicate viewing the programs in more tasks.

Factor	Baseline	Coefficient	SE	t	p
(Intercept)	–	1.468	0.555	2.643	**.008**
UI: *Text-Diff*	*Rules*	-0.064	0.272	-0.235	.815
UI: *Outcome-Diff: Flowcharts*	*Rules*	-0.304	0.289	-1.054	.292
UI: *Outcome-Diff: Questions*	*Rules*	-0.046	0.270	-0.169	.866
UI: *Property-Diff*	*Rules*	0.653	0.225	2.897	**.004**
Number of tutorial questions correct	(Continuous)	-0.315	0.179	-1.763	.078
Gender: Man	Woman	-0.468	0.174	-2.693	**.007**
Gender: Non-binary	Woman	0.326	0.407	0.801	.423
Education: Some college, no degree	High School	-0.117	0.272	-0.431	.666
Education: College degree	High school	0.060	0.231	0.261	.794
Education: Graduate degree	High school	-0.649	0.329	-1.973	**.049**

Table 3: Our parsimonious linear regression model of participants' **confidence ratings** summed across the six tasks. We collected confidence ratings for each task on a Likert scale from 1 ("strongly agree") to 7 ("strongly disagree"). Thus, smaller numbers for the dependent variable indicate greater confidence, whereas larger numbers indicate less confidence.

Factor	Baseline	Coefficient	SE	t	p
(Intercept)	–	13.940	0.763	18.279	**<.001**
Age Range: 18–24	25–34	2.184	1.117	1.955	.053
Age Range: 35+	25–34	2.280	1.214	1.878	.063
Gender: Man	Woman	-1.944	0.954	-2.039	**.044**
Gender: Non-binary	Woman	-2.672	3.516	-0.760	.449

Table 4: Our parsimonious linear regression model of participants' **perception that the task was demanding** summed across the six tasks. We collected ratings for each task on a Likert scale from 1 ("strongly agree") to 7 ("strongly disagree"). Thus, smaller numbers for the dependent variable indicate that the participant found the task more demanding, whereas larger numbers indicate that they found it less demanding.

Factor	Baseline	Coefficient	SE	t	p
(Intercept)	–	3.056	5.080	0.602	.549
UI: *Text-Diff*	*Rules*	3.029	2.162	1.400	.165
UI: *Outcome-Diff: Flowcharts*	*Rules*	2.046	2.264	0.903	.369
UI: *Outcome-Diff: Questions*	*Rules*	7.457	2.468	3.022	**.003**
UI: *Property-Diff*	*Rules*	3.329	2.246	1.482	.142
Number of tutorial questions correct	(Continuous)	4.684	1.651	2.837	**.006**
Gender: Man	Woman	4.433	1.531	2.896	**.005**
Gender: Non-binary	Woman	3.432	5.301	0.647	.519
Education: Some college, no degree	High School	-6.300	2.429	-2.594	**.011**
Education: College degree	High school	-4.012	2.093	-1.917	.058
Education: Graduate degree	High school	-2.079	2.533	-0.821	.414
Taken CS class: Yes	No	2.272	1.531	1.484	.141
Familiar with IFTTT: Yes	No	6.286	2.212	2.842	**.006**
Own IoT devices: No	Yes	2.856	1.633	1.749	.084

Table 5: Our parsimonious linear regression model of participants' **perception that the interface was helpful in completing the task** summed across the six tasks. We collected helpfulness ratings for each task on a Likert scale from 1 ("strongly agree") to 7 ("strongly disagree"). Thus, smaller numbers for the dependent variable indicate that participants found the interface more helpful, whereas larger numbers indicate that they found it less helpful.

Factor	Baseline	Coefficient	SE	t	p
(Intercept)	–	7.629	3.366	2.266	**.026**
Number of tutorial questions correct	(Continuous)	1.891	1.199	1.578	.118
Held CS-related job: Yes	No	2.879	1.189	2.421	**.017**
Own IoT devices: No	Yes	4.586	1.140	4.024	**<.001**

4   Survey Instrument

Introduction: In this study, we will give you a computer **interface** to help you understand **if-this-then-that** rules and how they affect **smart devices**. We will explain them below.

A **smart home** is a home with **smart devices**, which are Internet- connected appliances like lights, refrigerators, or door locks. This means you can do things like telling your smart windows to automatically close when it rains, or your lights to change colors when someone enters the room.

One way to tell smart devices what to do is by writing **rules**, which are in the form of: **"IF [an event happens] THEN [have the smart home do something]"** or **"IF [an event happens] WHILE [a state is true] THEN [have the smart home do something]"**.

For the purpose of this study, **a program is the collection of the <u>rules</u> that the smart home follows**.

Example #1:   The smart home home should close the living room window at the *exact instant* when the weather starts raining.

- Rule: **IF** it starts raining **THEN** close the living room window.

Example #2:   The smart home should carry out the rule in Example #1 *only* when both Alice and Bobbie are at home at night.

- Rule: **IF** it starts raining **WHILE** it is nighttime **AND** Alice is at home **AND** Bobbie is at home **THEN** close the living room window.

- *(In any other instances, e.g. when it's day time or when Alice is not at home, the smart home will **<u>not</u>** automatically close the living room window when it starts raining.)*

Tutorial: <tutorial:interface>

Main Part Instructions: You are now ready to complete the 6 tasks in the main part of the study. Each task describes a problem that Alice is facing with her smart home, and **you will help Alice solve these problems**. This smart home has various Internet-connected appliances, such as a refrigerator and a door lock. They can be automated with rules like we described earlier.

For each task, we will describe the task to you and give you a link to an interface. Then:

1. Please **left click** on the link to open a new tab in your web browser and complete the task **as quickly as you can**. **If you find yourself spending more than 5 minutes on a single task, please answer with your best guess and move on**.

2. After you complete the task there, **return to this tab** to answer a few survey questions that ask you to reflect on your experiences with the interface.

3. You will then proceed to the next task.

Note that completing the survey requires that you use that interface to complete the tasks, in addition to answering questions here in this Qualtrics tab. **You will not be paid for the study unless you also use the interface we provide to complete the assigned tasks!**

Before starting, please note:

1. For each task, **if a behavior is not mentioned in the task description, you <u>do not</u> have to consider this behavior in your response.** For example: if Alice wants to her smart fridge door to automatically unlock when a guest comes into the kitchen, the correct program *does not* have to lock the fridge door when the guest leaves the kitchen.

2. **The tasks are separate:** instructions for one task will <u>not</u> apply to other tasks.

3. There are **no other rules** automating the home **other than those in the programs we provide**.

4. Assume that all smart devices and sensors are **working as expected**. For example, if the program says to turn on the TV (and there are no rules that tell it to stay off), the TV <u>will</u> turn on.

Main Part: <Repeat the following part for x=1...6>

Task x of 6: Please **left click** on the link below to open a new tab and complete the task. The link will lead you to the interface showing or comparing the programs.

Once you've completed this task in the other tab, please **continue with the survey here. If you spend more than 5 minutes on the task, please complete the task with your best guess and move on.**

Click here to open the interface and complete the task!

For the task that you just completed, please indicate how much you agree or disagree with the following statements:

I am **confident** that my answer is correct: ◯ Strongly agree; ◯ Agree; ◯ Somewhat agree; ◯ Neither agree nor disagree; ◯ Somewhat disagree; ◯ Disagree; ◯ Strongly disagree.

I found the task **mentally demanding**: ◯ Strongly agree; ◯ Agree; ◯ Somewhat agree; ◯ Neither agree nor disagree; ◯ Somewhat disagree; ◯ Disagree; ◯ Strongly disagree.

I found the interface **helpful** in completing the task. ◯ Strongly agree; ◯ Agree; ◯ Somewhat agree; ◯ Neither agree nor disagree; ◯ Somewhat disagree; ◯ Disagree; ◯ Strongly disagree.

For 2 minutes, please explain your thought process and how you arrived at your answer for this task, with as many details as you can.

How did the design of the interface help or hinder your ability to answer the question?

Reflection Questions: Nice job! You have completed the 6 tasks. Now, **please spend 3 minutes to describe how you used the interface to complete the tasks**.

We would like you to be **specific** in describing what you did and the order of what you did. To show you the level of details we're looking for, here is how we would describe the process of accepting a friend request on Facebook (on a desktop web browser):

> First, I would look at the top right corner to see if there was a red number on the Friend Request icon (or the "icon with two people on it" if I didn't know its name). If there was a red number, then I would click on the icon and look at the person's name. If the person was someone I wanted to have as a Facebook friend, then I would click on "Confirm".

Which parts of the interface did you find the **most helpful**?

Which parts of the interface did you find the **least helpful**?

Which parts of the interface did you find the **most confusing**?

The interface had this button on the left side (show the "Programs" button picture), which allowed you to see the programs by themselves. **In completing the tasks, did you rely mostly on the programs that you got by clicking on this button, on the interface in the middle of the screen, or both?** ◯ The **Programs** (from clicking on this **button**); ◯ The **interface** in the middle of the screen; ◯ **Both**. Why?

General Evaluation: On this page, we will show you 10 statements. Please indicate how much you agree or disagree with each statement based on your experience with the interface you used to analyze the programs. We refer to the interface as "the system" in these questions.

I think that I would like to use this system frequently: ◯ Strongly agree; ◯ Agree; ◯ Somewhat agree; ◯ Neither agree nor disagree; ◯ Somewhat disagree; ◯ Disagree; ◯ Strongly disagree.

I found the system unnecessarily complex: ◯ Strongly agree; ◯ Agree; ◯ Somewhat agree; ◯ Neither agree nor disagree; ◯ Somewhat disagree; ◯ Disagree; ◯ Strongly disagree.

I thought the system was easy to use: ◯ Strongly agree; ◯ Agree; ◯ Somewhat agree; ◯ Neither agree nor disagree; ◯ Somewhat disagree; ◯ Disagree; ◯ Strongly disagree.

I think that I would need the support of a technical person to be able to use this system: ◯ Strongly agree; ◯ Agree; ◯ Somewhat agree; ◯ Neither agree nor disagree; ◯ Somewhat disagree; ◯ Disagree; ◯ Strongly disagree.

I found the various functions in this system: ◯ Strongly agree; ◯ Agree; ◯ Somewhat agree; ◯ Neither agree nor disagree; ◯ Somewhat disagree; ◯ Disagree; ◯ Strongly disagree.

Demographics: Almost done! We will finish the survey with a few questions about your demographics.

What is your age? ◯ 18-24; ◯ 25-34; ◯ 35-44; ◯ 45-54; ◯ 55-64; ◯ 65-74; ◯ 75 or older; ◯ I prefer not to answer.

What is your gender? ◯ Woman; ◯ Man; ◯ Non-binary; ◯ I prefer to self-describe; ◯ I prefer not to answer.

Please select the highest level of education you have completed: ◯ Less than high school; ◯ High school graduate; ◯ Some college, no degree; ◯ 2 year college degree; ◯ 4 year college degree; ◯ Master's or professional degree; ◯

Doctorate; ◯ I prefer not to answer.

Are you majoring in, hold a degree in, or have held a job in any of the following fields: computer science, computer engineering, information technology, or a related field? ◯ Yes; ◯ No; ◯ I prefer not to answer.

Have you ever completed a class or completed a class-length online tutorial about computer programming? ◯ Yes; ◯ No; ◯ I prefer not to answer.

Have you ever done computer programming as part of a job or hobby? ◯ Yes; ◯ No; ◯ I prefer not to answer.

Have you previously used the website IFTTT ("If this, then that")? ◯ Yes; ◯ No; ◯ I'm not sure.

Do you, or any other member of your household, own any internet- connected home devices, including (but not limited to) a Nest Thermostat, Philips Hue lights, Samsung SmartThings, Roomba vacuum cleaner, Amazon Echo ("Alexa"), or Google Home? ◯ Yes; ◯ No; ◯ I'm not sure.

What internet-connected home devices do you or other members of your household own?

Final Comments: (Optional) Do you have any additional thoughts on any aspect of today's study?

5 Tasks

Task 1 (Straightforward)
Problem: In the past, Alice used the Original Program to automate her smart home. Now, she wants the smart home to do the **same things as before** (i.e. the same things as in the Original Program), except it should also automatically **turn off the faucet when she leaves the bathroom.**

Help Alice determine whether her goal can be achieved by **replacing** the Original Program with the Modified Program.

Original Program
> **IF** It becomes Nighttime **THEN** Turn HUE Lights On.
> **IF** It starts raining **WHILE** Bedroom Window is Open **THEN** Close Bedroom Window.
> **IF** It starts raining **WHILE** Living Room Window is Open **THEN** Close Living Room Window.
> **IF** It starts raining **WHILE** Bathroom Window is Open **THEN** Close Bathroom Window.

Modified Program
> **IF** It becomes Nighttime **THEN** Turn HUE Lights On.
> **IF** It starts raining **WHILE** Living Room Window is Open **THEN** Close Living Room Window.
> **IF** It starts raining **WHILE** Bedroom Window is Open **THEN** Close Bedroom Window.
> **IF** Alice Exits Bathroom **WHILE** Smart Faucet's water is running **THEN** Turn Off Smart Faucet's water.
> **IF** It starts raining **WHILE** Bathroom Window is Open **THEN** Close Bathroom Window.

Task 2 (Simple Logic)
Problem: In the past, Alice used the Original Program to automate her AC and save on electricity. Now, her brother **(Bobbie)** is temporarily staying with her, and **he complains that sometimes he can't use the AC when he is at home.**

Help Alice fix this issue by deciding **which** of Program #1 and Program #2, **if any**, will meet Alice's goal below:
Let anyone (Alice or Bobbie) who is home to use the AC freely, but keep the AC off when no one is home.

Original Program
> **IF** It starts raining **WHILE** Bedroom Window is Open **THEN** Close Bedroom Window.
> **IF** Alice Exits Home **WHILE** The AC is On **THEN** Turn Off the AC.
> **IF** Smart TV turns On **WHILE** Roomba is On **THEN** Turn Roomba Off.
> **IF** The AC turns On **WHILE** Alice is not at Home **THEN** Turn Off the AC.

Program #1
> **IF** It starts raining **WHILE** Bedroom Window is Open **THEN** Close Bedroom Window.
> **IF** The AC turns On **WHILE** Alice is not at Home **AND** Bobbie is not at Home **THEN** Turn Off the AC.
> **IF** Smart TV turns On **WHILE** Roomba is On **THEN** Turn Roomba Off.
> **IF** Bobbie Exits Home **WHILE** The AC is On **AND** Alice is not at Home **THEN** Turn Off the AC.
> **IF** Alice Exits Home **WHILE** The AC is On **AND** Bobbie is not at Home **THEN** Turn Off the AC.

Program #2
> **IF** It starts raining **WHILE** Bedroom Window is Open **THEN** Close Bedroom Window.
> **IF** Alice Exits Home **WHILE** The AC is On **THEN** Turn Off the AC.
> **IF** The AC turns On **WHILE** Alice is not at Home **AND** Bobbie is not at Home **THEN** Turn Off the AC.
> **IF** Smart TV turns On **WHILE** Roomba is On **THEN** Turn Roomba Off.
> **IF** Bobbie Exits Home **WHILE** The AC is On **THEN** Turn Off the AC.

Task 3 (Redundant Programs)
Problem: In the past, Alice used the Original Program to automate her home security system. It worked perfectly, but then a visiting friend modified it behind her back! Now Alice is not sure if the program still protects her home.

Help Alice decide whether the Modified Program still meets the same **goal** below as the Original Program, *even if the home behaves differently*:

The security camera is always recording the house when she is asleep, when the front door is unlocked, or both.

Original Program

    IF I Fall Asleep **WHILE** Front Door Lock is Unlocked **THEN** (Security Camera) start recording.

    IF Front Door Lock Unlocks **WHILE** Security Camera is not recording **AND** I am Asleep **THEN** (Security Camera) start recording.

    IF Security Camera starts recording **WHILE** I am Asleep **AND** Roomba is On **THEN** Turn Roomba Off.

    IF Security Camera stops recording **WHILE** I am Asleep **THEN** (Security Camera) start recording.

    IF I Fall Asleep **WHILE** Front Door Lock is Locked **AND** Security Camera is not recording **THEN** (Security Camera) start recording.

    IF Security Camera starts recording **WHILE** I am Awake **THEN** Turn Roomba Off.

    IF Security Camera stops recording **WHILE** Front Door Lock is Unlocked **AND** I am Awake **THEN** (Security Camera) start recording.

    IF Security Camera starts recording **WHILE** Front Door Lock is Locked **THEN** Turn Roomba Off.

    IF Security Camera stops recording **WHILE** I am Asleep **AND** Front Door Lock is Unlocked **THEN** (Security Camera) start recording.

    IF Front Door Lock Unlocks **THEN** (Security Camera) start recording.

Modified Program

    IF I Fall Asleep **WHILE** Front Door Lock is Unlocked **THEN** (Security Camera) start recording.

    IF Front Door Lock Unlocks **WHILE** Security Camera is not recording **AND** I am Asleep **THEN** (Security Camera) start recording.

    IF Security Camera starts recording **WHILE** I am Asleep **AND** Front Door Lock is Locked **THEN** Turn Roomba Off.

    IF Security Camera stops recording **WHILE** I am Asleep **THEN** (Security Camera) start recording.

    IF I Fall Asleep **WHILE** Front Door Lock is Locked **AND** Security Camera is not recording **THEN** (Security Camera) start recording.

    IF Security Camera stops recording **WHILE** I am Asleep **AND** Front Door Lock is Unlocked **THEN** (Security Camera) start recording.

    IF Front Door Lock Unlocks **WHILE** Security Camera is not recording **AND** I am Asleep **THEN** (Security Camera) start recording.

    IF Security Camera starts recording **WHILE** Front Door Lock is Unlocked **THEN** Turn Roomba Off.

    IF Security Camera stops recording **WHILE** I am Asleep **AND** Front Door Lock is Unlocked **THEN** (Security Camera) start recording.

    IF Security Camera starts recording **WHILE** I am Awake **THEN** Turn Roomba Off.

    IF Front Door Lock Unlocks **WHILE** I am Awake **THEN** (Security Camera) start recording.

    IF Front Door Lock Unlocks **WHILE** I am Asleep **THEN** (Security Camera) start recording.

Task 4 (Hidden Similarity)

Problem: In the past, Alice used the Original Program to automate her smart home for good air circulation. It worked perfectly, but her friend thinks she should replace this Original Program with either Program #1 or Program #2.

Help Alice decide **which** of Program #1 and Program #2, **if any**, will meet the same goal below as her Original Program *even if the home behaves differently*:

There is always one window open in the house, no more and no less. Any window (in the bathroom, bedroom, or living room) is fine.

*(**Note***: *As long as the smart home opens/closes some window (no matter which one) to make sure that exactly one window is open at the end, **it's okay if there are zero or two windows open temporarily.**)*

Original Program

    IF Bathroom Window Closes **WHILE** Bedroom Window is Closed **AND** Living Room Window is Closed **THEN** Open Bedroom Window.

IF Bedroom Window Closes **WHILE** Living Room Window is Closed **AND** Bathroom Window is Closed **THEN** Open Living Room Window.

IF Bathroom Window Opens **WHILE** Bedroom Window is Open **AND** Living Room Window is Closed **THEN** Close Bedroom Window.

IF Bedroom Window Opens **WHILE** Living Room Window is Open **AND** Bathroom Window is Closed **THEN** Close Living Room Window.

IF Living Room Window Opens **WHILE** Bathroom Window is Open **AND** Bedroom Window is Closed **THEN** Close Bathroom Window.

IF Living Room Window Closes **WHILE** Bathroom Window is Closed **AND** Bedroom Window is Closed **THEN** Open Living Room Window.

IF Bathroom Window Opens **WHILE** Bedroom Window is Closed **AND** Living Room Window is Open **THEN** Close Living Room Window.

IF Bedroom Window Opens **WHILE** Living Room Window is Closed **AND** Bathroom Window is Open **THEN** Close Bathroom Window.

IF Living Room Window Opens **WHILE** Bedroom Window is Open **AND** Bathroom Window is Closed **THEN** Close Bedroom Window.

Program #1

IF Bathroom Window Closes **WHILE** Bedroom Window is Closed **AND** Living Room Window is Closed **THEN** Open Bedroom Window.

IF Bedroom Window Closes **WHILE** Living Room Window is Closed **AND** Bathroom Window is Closed **THEN** Open Living Room Window.

IF Bathroom Window Opens **WHILE** Bedroom Window is Open **AND** Living Room Window is Closed **THEN** Close Bedroom Window.

IF Bedroom Window Opens **WHILE** Living Room Window is Open **AND** Bathroom Window is Closed **THEN** Close Living Room Window.

IF Living Room Window Opens **WHILE** Bathroom Window is Open **AND** Bedroom Window is Closed **THEN** Close Bathroom Window.

IF Living Room Window Closes **WHILE** Bathroom Window is Closed **AND** Bathroom Window is Closed **THEN** Open Living Room Window.

Program #2

IF Bathroom Window Closes **WHILE** Bedroom Window is Closed **AND** Living Room Window is Closed **THEN** Open Bedroom Window.

IF Bedroom Window Closes **WHILE** Living Room Window is Closed **AND** Bathroom Window is Closed **THEN** Open Living Room Window.

IF Living Room Window Closes **WHILE** Bathroom Window is Closed **THEN** Open Bathroom Window.

IF Living Room Window Opens **WHILE** Bathroom Window is Closed **AND** Bedroom Window is Open **THEN** Close Bedroom Window.

IF Bathroom Window Opens **WHILE** Living Room Window is Open **AND** Bedroom Window is Closed **THEN** Close Living Room Window.

IF Bedroom Window Opens **WHILE** Living Room Window is Closed **AND** Bathroom Window is Open **THEN** Close Bedroom Window.

IF Bathroom Window Opens **WHILE** Bedroom Window is Open **AND** Living Room Window is Closed **THEN** Close Bedroom Window.

IF Bedroom Window Opens **WHILE** Living Room Window is Open **AND** Bathroom Window is Closed **THEN** Close Living Room Window.

IF Living Room Window Opens **WHILE** Bathroom Window is Open **AND** Bedroom Window is Closed **THEN** Close Bathroom Window.

Task 5 (27 Variants)
Problem: When Alice is watching TV with both the Roomba on and the living room window open, the combination of noise from the Roomba and the outside drowns out the TV. There are 27 programs that lets the smart home avoid this situation, each by closing the window or turning off the Roomba. **However, Alice prefers fresh air over having**

the Roomba clean the floor.

Help Alice find **all** programs out of the 27 ("Programs #1", "Program #2", etc.) that meet the goal below:
Never interrupt the TV. If there is combined noise from the living room window open and the Roomba on, prioritize the fresh air from the open window.

Program #1
    IF Smart TV turns On **WHILE** Roomba is On **AND** Living Room Window is Open **THEN** Close Living Room Window.
    IF Living Room Window Opens **WHILE** Roomba is On **AND** Smart TV is On **THEN** Close Living Room Window.
    IF Roomba turns On **WHILE** Smart TV is On **AND** Living Room Window is Open **THEN** Close Living Room Window.

The other 26 programs have almost identical rules, with the only differences being different permutations of "then Close Living Room Window", "then Turn Roomba Off", and "then Turn Smart TV Off".

Task 6 (Abstraction)
Problem: Alice tried using the Original Program to help her smart home save energy. Unfortunately, **this program didn't always do what she hoped for.** Her friend suggests that she replaces this program with either Program #1 or Program #2 instead.

Help Alice decide **which** of Program #1 and Program #2, **if any**, will meet Alice's goal below and solve the problem *even if it changes when the home turns on/off the devices*:
Never have all of these ON at the same time: AC, coffee pot, HUE lights, smart TV, speakers, and the Roomba (it has a rechargeable battery). *(**In other words**: one or more of these appliances should be off if the others are on, but Alice doesn't care which is off. It's also okay if they are all off.)*

Original Program
    IF Coffee Pot turns On **WHILE** It is Daytime **AND** The AC is On **AND** Coffee Pot is Off **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn HUE Lights Off.
    IF Coffee Pot turns On **WHILE** It is Nighttime **AND** The AC is On **AND** Coffee Pot is Off **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Roomba Off.
    IF HUE Lights turns On **WHILE** It is Daytime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is Off **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Coffee Pot Off.
    IF HUE Lights turns On **WHILE** It is Nighttime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is Off **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Roomba Off.
    IF Roomba turns On **WHILE** Alice is at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is Off **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Coffee Pot Off.
    IF Roomba turns On **WHILE** Alice is not at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is Off **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Smart TV Off.
    IF Smart TV turns On **WHILE** Alice is at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is Off **AND** Speakers is On **THEN** Turn Roomba Off.
    IF Smart TV turns On **WHILE** Alice is not at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is Off **AND** Smart TV is On **AND** Speakers is On **THEN** Turn HUE Lights Off.
    IF Speakers turns On **WHILE** Alice is at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is Off **THEN** Turn Smart TV Off.
    IF Speakers turns On **WHILE** Alice is not at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is Off **THEN** Turn Roomba Off.

Program #1
    IF The AC turns On **WHILE** Alice is at Home **AND** The AC is Off **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Roomba Off.

IF The AC turns On **WHILE** Alice is not at Home **AND** The AC is Off **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Coffee Pot Off.

IF Coffee Pot turns On **WHILE** Alice is at Home **AND** The AC is On **AND** Coffee Pot is Off **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Roomba Off.

IF Coffee Pot turns On **WHILE** Alice is not at Home **AND** The AC is On **AND** Coffee Pot is Off **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn HUE Lights Off.

IF HUE Lights turns On **WHILE** Alice is at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is Off **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Speakers Off.

IF HUE Lights turns On **WHILE** Alice is not at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is Off **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Smart TV Off.

IF Roomba turns On **WHILE** It is Daytime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is Off **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Off the AC.

IF Roomba turns On **WHILE** It is Nighttime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is Off **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Speakers Off.

IF Smart TV turns On **WHILE** It is Daytime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is Off **AND** Speakers is On **THEN** Turn Speakers Off.

IF Speakers turns On **WHILE** It is Daytime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is Off **THEN** Turn Roomba Off.

IF Speakers turns On **WHILE** It is Nighttime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is Off **THEN** Turn Coffee Pot Off.

IF Smart TV turns On **WHILE** It is Nighttime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is Off **AND** Speakers is On **THEN** Turn Coffee Pot Off.

Program #2

IF The AC turns On **WHILE** It is Daytime **AND** The AC is Off **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Roomba Off.

IF The AC turns On **WHILE** It is Nighttime **AND** The AC is Off **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Coffee Pot Off.

IF Coffee Pot turns On **WHILE** It is Daytime **AND** The AC is On **AND** Coffee Pot is Off **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn HUE Lights Off.

IF Coffee Pot turns On **WHILE** It is Nighttime **AND** The AC is On **AND** Coffee Pot is Off **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Roomba Off.

IF HUE Lights turns On **WHILE** It is Daytime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is Off **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Coffee Pot Off.

IF HUE Lights turns On **WHILE** It is Nighttime **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is Off **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Roomba Off.

IF Roomba turns On **WHILE** Alice is at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is Off **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Coffee Pot Off.

IF Roomba turns On **WHILE** Alice is not at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is Off **AND** Smart TV is On **AND** Speakers is On **THEN** Turn Smart TV Off.

IF Smart TV turns On **WHILE** Alice is at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is Off **AND** Speakers is On **THEN** Turn Roomba Off.

IF Smart TV turns On **WHILE** Alice is not at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is Off **AND** Smart TV is On **AND** Speakers is On **THEN** Turn HUE Lights Off.

IF Speakers turns On **WHILE** Alice is at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is Off **THEN** Turn Smart TV Off.

IF Speakers turns On **WHILE** Alice is not at Home **AND** The AC is On **AND** Coffee Pot is On **AND** HUE Lights is On **AND** Roomba is On **AND** Smart TV is On **AND** Speakers is Off **THEN** Turn Roomba Off.