Paper Assessment: Supporting Mental Model Accuracy in Trigger-Action Programming

1. Problems addressed in the paper
    - Inconsistencies in interpreting the behavior of trigger-action programs.
    - Errors made in creating programs.
2. Examples of TAP rules.
    - If “12:00p.m” then “send mail”.
    - If “sleep duration below 7.5 hours” then “turn on coffee maker”.
3. What are the mental model ambiguities (with specific examples)?
   The researchers in the paper
   The example cited in the paper is “If I am sleeping, turn the stereo off”
   The “if I am sleeping” is the ambiguous part as the system will not understand how to interpret it, if it should perform it instantly or implement the rule at any point during the sleep. If it waits then portion of time it waits for, will be a violation of the rule.
4. Case Studies:
   Study 1:
        - Aim: The main purpose of this study was how the users interpreted the different types of triggers and actions. The idea behind this was to present the same IFTTT rules to the users and try and see how they understand it. Both event and state triggers were provided for the study.
        - Number of people: 60
        - Method: They had split the study into five part to examine the various aspects of TAP.
            - When Actions will happen: In this part of the study the participants were given either single or multiple triggers an were supposed to answer when the action will occur. For event triggers the participants were supposed to answer an exact time frame for when the event take place and for state triggers they were supposed to answer if the action will take place any time the state is true. They were also quizzed on various combinations of state and event triggers. There were a total of 9 questions and the participants were given an option of saying the event doesn’t occur at all or write down a free-response answer.
            - When actions will happen: This is similar to the first part but here the participants are given a set of rules and were asked when the action will end or for how long will the action sustain. They could either say it never ends or give a free response answer.
            - Open ended questions: This part of the study was created to gauge the participants understanding of the rules. They conducted this phase by by asking the participants to differentiate between the different triggers by wording the rules differently. This was also done to understand how the participants usually like to phrase their rules.
            - Additional open ended questions: These question were asked to get the participants opinions on the questions asked in the previous rounds of

this study. They wanted to find out that some examples of rules provided in the previous would exist or not. They also wanted to find out which events the participants feel should be treated as state. The final question they asked was if a rule "If the time is between 3:00 -4:00pm,then turn the lights on" was provided to them then would the light turn off automatically at 4 or another rule should be provided

- Demographic question: these question were asked mainly to collect the background information on the participants.

Results: The expectations by the users on various triggers were different depending on the type of trigger given. If it was a single trigger then the majority of the participants said it would start immediately if it was an event trigger but for a state trigger only 36.7% agreed if it would start immediately. However if there were two event triggers or state triggers then the people differed in their view as there was no clear majority for an answer and it was further explained in the free-response answer that people felt that it depended on the predictability of the trigger. If there was a combination of a state and event trigger then the majority view was that the action would when the event occurs as long as the state is true.

For multiple events the majority was of the view that the action would take place as long as the the actions took place simultaneously. Since the liklihood of two events occuring together is highly unlikely therfore one participtant suggested that ther should be a time associated with the rule. People were divided when it came to multiple state triggers.

The last question asked in study was to see for how long would the rule sustain.Around 56% said the light would still be on after 4:00. So the participants felt the light would not turn off just because the state goes false.

Study 2:

- Aim: To investigate whether program creation mitigates the ambiguities observed in the first study by using TAP interface.
- Number of People: 42
- Method:
  - This study had 5 program creation on TAP interface and 5 multiple choice questions.
  - None of the program creation questions were framed with"if" and "that" , example: "You want to be notified via email, should a person to be detected in the house while everyone's at work (9:00 am - 5:00 pm every day)"
  - 5 programming question are
    - You want the lights to turn on at 6:00PM every day
    - You want to be notified, via email, should a person be detected

in the house while everyone at work
        - Your work starts at 9:00am. On days when you get to work on time , you want to send an email to yourself saying “I got to work on time!”
        - You want the thermostat to be off as much as possible, unless the temperature outside is below 40 degrees in which case the thermostat should be set to 72 degrees
        - You want a pot of coffee to be brewed when its below 40 degrees outside but only before 10:00 AM everyday.
    - 5 Mutliple choice questions are
        - If the time is 6:00PM, then turn the light on
        - if I arrive at home and the time is between 6 - 11pm, then turn the light on
        - if the doorbell rings and the time is 3 PM, then unlock the front door for 10 seconds
        - if it is snowing, then turn the thermostat to 75 degrees F
        - If the time is between 7AM and 10 AM and the outside temperature is below 40 degrees then brew a pot of coffee
    - Multiple choice question were asked after the programing creation, and users were not allowed to change answer answered to previous questions

- Results:
    - For Q2: 24% said light would turn ON any time between 6 -11 PM and 19% said that the lights would turn ON at 6PM . This shows that they are still not sure.
    - For Q3: 36% said that they would use the rule, 31% said they would modify the rule by specifying the range as 3 -3:01. Only 13% said they would not use the rule
    - For Q4: 79% said that thermostat would be set as soon as it started snowing where 21% said thermostat would be set anytime it is snowing. To this question fairly large number of people got it correct
    - For Q5: 62% said that brewer would start at 7:00 AM while 36% said that brewer would start anytime between 7- 10 am. Again fairly large population got it right.
    - Many expected to for state to revert back automatically after being set.

Observing the results from both study suggests that program creation does not help the user to mitigate the mental model ambiguity.