***Supporting Mental Model Accuracy in Trigger-Action Programming***

***Questions:***

1. What are the problems that the authors studied?
2. Provide a few examples of Trigger-Action rules.
3. What are mental model ambiguities?
4. Provide specific examples?

***Answers:***

1. The authors claim that the oversimplification of trigger-action rules makes it difficult to express complex programs. There have been extensions of IFTTT but they neglects a key distinction between different trigger types and action types. The authors study the differences through two user studies. One, which studies the uncertainties in interpreting the behavior of trigger-action programs and errors encountered while creating programs with desired behavior.

     2.   ***Examples of Trigger-action rules:*** It starts raining, someone tags the user in a picture, the user arrives at home, Nest thermostats, Belkin weMo switches or phillips Hue lightbulbs.

     3.   Considering the absence of trigger and the action types is the cause of ambiguity. In specific we have three possibility of confusion.

* Analyzing when the triggers will happen precisely.
* It’s unsure if the conjunction of events are very meaningful for people.
* People’s view about the constant actions might react automatically.

***Study 1****:*

***Program Interpretation***

***Purpose***: To describe the differentiation between trigger and action types the Amazon Mechanical Turk conducted a web based study.

**The study was divided into 5 parts:**

***Text Description***: ***Purpose***-The user should answer the multiple-choice question which consist of text description in order to interpret trigger action programs.

***Result:*** In overall studies, they decided to lessen the variance between the questions by using the reliable set of triggers and actions.

***When actions will occur: Purpose***- During the first part of study the users where given single and multiple triggers in order to know when the actions will occur. They were given 9 questions, in all the cases the action was assigned as “[X]”. The users where given multiple choice questions in order to know when the actions will occur. The questions with one event and one state trigger the actions were limited.

The questions with two event triggers the respondent where asked to say whether the action followed with the same time or with certain given time.

The questions with two state triggers the respondent could say whether the action **resulted** as

* true
* depends if it was already true or not
* or both the options.

***When actions will end:*** ***Purpose-*** In the second part of study the users were given certain rules in order to study the two issues, in the begin the users accepted that sustained actions ended up when paired with state triggers.

Secondly, the trigger associated in the rule leads to variety of expectations to know when the actions will end or not.

***Open ended questions***: ***Purpose-***The questions were designed in order to find the differences between the triggers and asked for their opinions. The questions were related to two event triggers, that occur at the same time, in another question they were asked to know the trigger should occur as state trigger or not.

**Demographic questions:** This part of study is about the respondent’s age, gender, level of prior programming experience and the level of previous experience using IFTTT.  After the study the result was formulated as a numerous page questionnaire using google forms, the participants were allowed to alter their answers by visiting the form again.

***Results from study 1***: ***Demographics***- There were around **60 respondents** to the survey, they had certain restrictions in which the workers would be obtained **“Master Worker”** by Amazon and who lived in US and the age should be between 21 to 68 years.

***Results:*** 32 reported no prior programming experience, 19 reported that had little knowledge about the programming, 9 said they programmed on regular basis, 54 respondents said they were not aware of IFTTT, 5 said they had heard about it and 1 said they have used it before.

***Findings:***

***Expectations about triggers depend on the specific triggers:*** Depending on the event the respondent had different expectations when the actions should be triggered. As well the user expectations varied between two different even triggers or two different state triggers.

* The participants agreed on the behavior for rules that have the combination of one event

trigger and one state trigger. On average of 85% of responses expressed that the rule should be activated when the event occurred as well when the state was true.

***Multiple event triggers are considered to be technically valid:*** The rule is “if it turns 10:00 am and the doorbell rings, do **[X]”**

* 7% responded the action would not occur
* 55% the rule should be activated if the events occurred simultaneously.
* The remaining should be activated when the event should be occurred within 1 or 5 minutes of the other.

***Expectations varied for multiple state triggers***: when asked “if it is raining between 3:00-4:00pm”

* 38% responded saying it could start any time if the state is true
* 30% said that rule rules will be started if both the rules became true
* Majority of them had no unique answer

***When sustained actions, end depends on the trigger***: According to the rules the participants agreed that depends on triggers.

***Study 2:***

***Program Creation:***

***Purpose:*** To examine whether the program reduce the ambiguities which was observed in the first study, they designed a TAP interface and conducted a second study.

***Interface design:***  Here the interface were designed for multiple triggers with different triggers and action types. These interfaces borrows the visual aspects of IFTTT for creating rules.

***Choice triggers and actions:*  The interface had a set of 5 trigger and 5 action categories**. The triggers and actions were generic smart home capabilities and did not specify any real-world products.

Few were supported with both the events and some of the ations could be made only with sustained actions and non-sustained actions or both.

***Multiple triggers:***  ***Purpose***: Since the IFTTT doesn’t support multiple trigger, implementing the design work was incorporated into the design work.

* The interface design had several iterations which starts from paper prototyping.
* In the next phase a digital prototype was implemented on the interface and collected informal feedback.

***Wording of triggers and actions:***  The icon and a name was provided for each trigger and action, it includes a textual name that define the trigger and action. These were selected to self-evident and to communicate the trigger and action type.

***Result from study 2:***

***Deployment:*** Prior to the beginning to the study, participants were given a short introduction about the smart home and some examples of their capabilities.

***Demographics:*** out of **42 participants**(20 to 66 years)  22 had no programming experience, 17 had little knowledge about the programming experience, 34 had no idea about IFTTT, 8 said they heard about it and none of them had used it before.

***Findings:***

***Multiple event triggers were used in practice:*** By considering the first rule to be incorrect because of the event triggers the respondent was on time by being at work early.

* A thematic issue provided a natural language can often be ambiguous.

***Event and state triggers were hard to reason about:*** Here the rules with the combination of both triggers were hard for the users to synthesize.

* Users had varied mental models for state triggers.
* The users are not sure about the state trigger. Majority of the participant have misunderstanding about the non-trivial problem.

The results from the study 1, shows that the most of the users expected state triggers to activate as soon as the states results true, if not the users will have a different interpretation.

***User disagreed on sustained actions and forgot to undo them:*** Here the multiple choice questions acknowledged that most of the participant thought that sustained actions would be undone automatically according to the trigger, i.e. depends on the state and event triggers.

**4.Specific Examples**:

* A user might want to receive notifications that the motion sensor in their home was activated while they are not at home.
* “it is between 3:00-5:00p” or “it is raining”
* “if I ‘am sleeping turn off the stereo off”
* “If the doorbell rings and it is between 3:00-5:00pm”, should activate when the doorbell rings, but only if it is between 3:00-5:00pm.