Automated Motivational Agent Framework for a Greener Lifestyle Behavior Change

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Abstract:
Every person is aware of ecological issues. Hence, consciously, ecological issues are already objects of the mind. What is lacking is the behavioral preference for activities and practices that would lead to an ecologically-sustainable behavior. Hence, intervention may be needed to stir things up with a drop of behavioral insights – to really turn the tide. This study aims to develop a framework that can be used in designing chatbots as a tool and a space for discussion for the diffusion and generation of practical ideas and knowledge for a greener lifestyle behavior change. We utilized a theory-based behavior change agent framework and motivation techniques to guide our structured intervention. To validate the technical feasibility of the framework's design principles, theoretical underpinnings, and procedures, a functionality review of chatbot development platforms was conducted. The features provided by Artificial Intelligence Markup Language (AIML) language proved that it is possible to develop a chatbot as a tool to bring about behavioral change. We contribute a valuable framework that can be adopted in the design of conversational agents equipped and trained with behavioral science perspectives to help effectively address the challenges presented by climate change and declining natural resource availability.

I. INTRODUCTION

Our lifestyle represents a sum of actions, habits and behaviors. The resource-intensive lifestyle of people has been known as the leading cause of environmental depletion that needs transformation towards a more sustainable lifestyle[1]. Many if not most of the present threats to our environment are caused by humans and therefore can be addressed at the scale of human behavior[2]. This had prompted a new form of green consuming where people buying and using decisions should need to consider hidden information like the amount of carbon footprint [3] which accounts for carbon-dioxide emission during its production [4][5], food miles by verifying the place of origin, etc. Manning stressed that human behavior triggers almost every environmental harm, as manifested in the air and water contamination,

climate change and damages to biodiversity[6]. While relevant activities and even legislation that are designed to transform consumption patterns to green behaviors, consumers still continue to engage in purchase behaviors that are not at all good for the environment in both short and long run.

Substantial technological developments continue to transpire and offer possibilities for integration to other domains like behavioral sciences. This intersection underlies the integration of intelligent technologies that are changing the landscape of communication and social behaviors [7]. Previous researches have primarily used traditional methods to encourage behavior change interventions. However, there have been notable efforts to provide these interventions via modern technologies, such as text messaging [8] and social media[9]. Young et al., in their study, implemented interventions with

messages using social media (Facebook) pages to inspire customers to interact for managing food waste, which yields significant self-reported food waste management actions[10].

Inspired by a deep concern to the sustainability of natural resources, this study takes an important step towards exploring conversation technologies using chatbots to behaviorally influence the preferential consciousness of people towards a greener lifestyle.

With the foregoing, the study hereby proposes a new way of looking at the environmental issues from the lens of behavior change. Acknowledging the linkages between behavioral sciences and technology is particularly relevant in designing innovative responses to the growing threats to the issues.

The potential of using chatbots in this continuum can be acclaimed from its ability to utilize Natural Language Processing (NLP). Hence, chatbots can be used to make inferences about peoples' perceptions, which can be tapped to create online pathways toward greener activities and practices through personalized intervention, an approach that does not require costly implementation considering the human resources like availability of expert practitioners in the domain. Just like humans, a bot needs proper design to accomplish the intended role. Hence, the exclusive focus of this study is to develop an automated motivational agent framework that can be adopted in the design of chatbots as behavioral change agent. As such, it is considered necessary to equip the bot's knowledge base with skills and know-how from a range of disciplines and techniques from behavioral sciences.

II. MATERIALS AND METHODS

A review of a new and growing set of insights that can aid us in designing solutions was conducted in order to identify key intervention strategies which can be aligned for the purpose of the study.

This study postulates that motivating lifestyle is a behavioral challenge and therefore needs behaviorally-informed solutions. Hence, a review of intervention strategies from the behavioral science domain was conducted.

The way the strategies are presented in the behavior change process can be guided by one or more behavioral change theories or models which are richly available in the behavioral science domain. To implement the strategies in a conversation setting, the study followed the trans-theoretical model where relevant strategies and tasks are grouped and presented in the appropriate stages of change. To understand the consumers' status-quo and willingness to change, interviewing techniques were reviewed to allow open conversation with the respondents.

A new framework which was grounded from the relevant theories reviewed from multiple disciplines was developed to guide the intended behavioral change agent to accomplish its goal.

To validate the technical feasibility of the framework's design principles, theoretical underpinnings and procedures, a functionality review of chatbot development platforms was conducted.

III. RESULTS AND DISCUSSION

In this study, we focused on finding significant intervention strategies from the behavioral science perspectives to transform people toward a greener lifestyle, explore behavioral theories and motivation techniques to guide the fundamental design of a change agent, integrate these findings to develop a new behavior change agent framework and finally, find a suitable chatbot development platform to implement the new framework. The findings for these research questions are discussed in the following.

A. Review of Intervention Strategies from the behavioral science domain

To motivate people and spur behavior change, we draw from a collection of strategies and techniques grounded in science yet applicable to real-world conservation challenges. We adopted selected strategies from "The Behavior Change For Nature: A Behavioral Science Toolkit for Practitioners"

provided by Rare and The Behavioural Insights Team [2]. The toolkit provides guidelines which are essential for a new wave of behaviorally-informed interventions in conservation. The toolkit shares findings from behavioral science and propose strategies for conservation which are grouped into three categories that capture the main drivers of behavior change, 1) motivate the change, by harnessing positive emotions, behaviorally-informed incentives, personalized and humanize messages, and cognitive biases; 2) socialize the change, leveraging the deeply social nature of our behavior, which can be achieved by highlighting the desirable norm and cases of success or good behavior; and 3) ease the change, by removing hassle, helping people plan, and building supporting environments.

Our motivation to change may be in conflict with our desires for pleasure, wealth, security, comfort, happiness, self-expression and so on [2]. Hence this may become the barriers to the intended change and can be the subject to be addressed in order to elicit change. As proposed by Rare in their toolkit, it would be necessary to use positive messaging with emotions like pride, self-efficacy, joy and gratitude to encourage change without inviting defensiveness. The use of negative emotions like guilt, disgust or fear may just cause a backfire [2].

Humans are extremely social creatures. As such, beliefs and behaviors tend to be socially communicable [2]. For instance, people may be inclined to act in conformance with what is believed to be good by the community, a normative behavior. Hence, it could be a strategy to promote the desirable norm or practices by highlighting the increasing prevalence of the desired behavior.

To ease the change, it is necessary to make the desired behavior more convenient and easier to do. This could be done by promoting appealing substitutes to undesirable behaviors and at the same time, provide premediated strategies for overcoming likely barriers [2].

B. Behavioral Theories and Motivation Techniques

If climate change is driven by human behavior, then by using the deep understanding of decision-making theories offered by behavioral sciences, we can, therefore, design a new framework to shift greener lifestyle to achieve sustainability.

A theory-based model that can easily be used in practice, is the Trans-Theoretical Model (TTM) proposed by Prochaska and Diclemente [11]. The model had been used successfully in several studies, Carbonara explored the possibility to increase the intake of fruit and vegetables and decrease the consumption of unhealthy snacks through a mobile application [12], de Vries et al., assessed the possibility of using crowdsourcing as a method to design the motivational messages which are grounded on TTM [13] and many others.

The TTM conceptualizes behavioral change as a transition through five stages. At the pre-contemplation (PC) stage, the individual is presumed to be not ready or not intending to take action. At the contemplation (C) stage, individuals are contemplating that a change may be needed. At the preparation (P) stage, individuals start to form specific actions. The action (A) is the stage where the behavior change takes place. The last stage is the maintenance (M) where the individual need stimulus control to prevent relapse. According to this theory, each stage of change requires different information needs and approaches to advance to the next stage. Though it is predictable that the individual linearly advances to the following stage, individuals may also drop back or jump over stages. Abrash recommends a constellation of tasks for each stage of change [14]. For instance, from PC to C, consciousness-raising activities may be utilized to educate the individual. Other tasks may be needed like dramatic relief activity to allow expressing negative and positive emotions with respect to the intended behavior change, an environmental re-evaluation may also be necessary by considering the influence on others, and social liberation by allowing individuals to engage in the behavior change by

providing options and resources. Whereas, during C to P, self-re-evaluation is used, recognizing that the behavioral change is vital to personal identity, happiness, success and/ or values. During the P to A, self-liberation is used to provide a steady commitment to change. Counter conditioning may also be needed in this stage to provide new ways of acting or thinking for old behaviors. And finally, during the A to M, reinforcement management may be used to increasing rewards for new behaviors and decreasing rewards for old behaviors.

To motivate an individual's decision to change, Miller and Rollnick developed the Motivational Interviewing (MI) technique, an evidence-based treatment methodology that enables to train people about different kinds of behavioral changes [15]. MI is a powerful client-centered, goal-directed

counselling method, particularly when the goal is to improve intrinsic motivation [16]. MI assumes that humans are willing to change but often have conflicting thoughts about the change [17]. MI is grounded on 4 principles which are: (1) express empathy which allows the client to express openly about their behaviors and beliefs, (2) develop discrepancy by recognizing inconsistencies, (3) roll with resistance by recognizing that it is normal to have conflicting thoughts, and (4) support self-efficacy by expressing optimism [18]. The study conducted by Klonek et al. confirmed that MI lessens the adverse effects, both the social and cognitive level of threats in conversations about environmental behavior change [19]. Furthermore, Tomlin et al, in their Learners Manual, outlined MI's basic interaction strategies [20]. Performing MI sessions requires counselors to build and put into use four core interviewing skills that form the acronym OARS: asking Open questions, Affirming, Reflecting, and Summarizing [16] [15]. In order to elicit the client's point of view, open-ended questioning is recommended. Affirmation is also an essential strategy to communicate an understanding of empathy for the client's struggles. Reflective listening serves as a directive strategy to guide clients towards the intended change. By providing

summaries based on what the client has stated in the previous dialogues, discrepancies can be discovered.

During the dialogue, the counselor usually uses change talk to the client to positively influence the intended change. Change Talk (change positive) indicates that clients are considering the possibility of change. Sustain Talk (change negative) indicates there is a resistance and may need further strategies usually responses with "do not" or "don't". These talks can be classified into 4 types, Desire, Ability, Reason, and Need (DARN). An expression of desire may be perceived when the client uses phrases like "I Want", "I wish", "I would like", "I would enjoy" and the like. The client's expression of the capability of change can be perceived when the client uses the phrases "I can", "I could", "I am able", "It is possible for me". Reasons are the rationale or basis for making the target behavior change and can also be perceived when the client use statements like "If I reduce my meat consumption, then my carbon footprint will be lowered". A need or necessity, urgency or requirement to change are usually statements that do not include specific reason, for instance, "I need", "I must", "I have to", "I've got to", "I can't keep".

C. The New Behavior Change Agent Framework

Fig. 1 shows the new Automated Motivational Agent Framework. The chatbot (bot) acts as a conversation agent which was tasked to motivate a respondent to a greener lifestyle behavior. The bot's knowledge base (KB) draws its intelligence from multiple domains – Motivational Interviewing principles, environment and ecosystem knowledge and Behavior Science theories, motivation techniques and strategies. The bot's conversation pattern was organized to follow the stages of change from the TTM (Pre-contemplation to Maintenance. At each stage, TTM processes of change (tasks) were used as applicable, together with appropriate strategies. Following the rules and patterns in the KB, the bot uses motivational interviewing principles to motivate an individual's decision to change toward greener lifestyle.
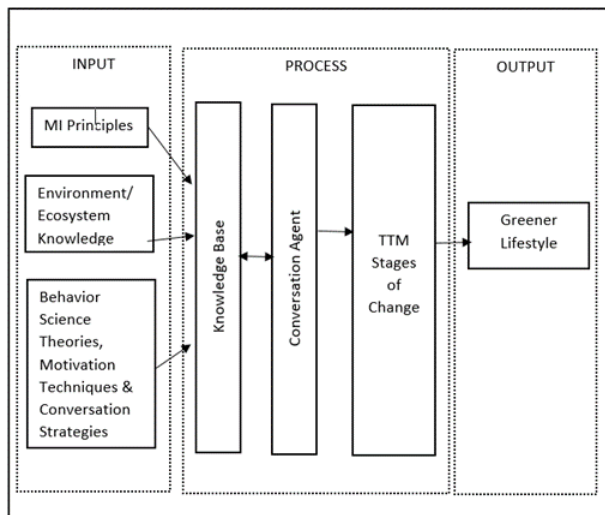
Fig. 1. Automated Motivational Agent Framework

Fig. 2 shows the conceptual design of the Automated Motivational Agent that asks the user a predefined set of open-ended questions based on MI principles. The questions were structured in a predefined order based on the TTM stages of change. Questions were defined based on a behavioral change toolkit. For instance, the question "Does it make you feel proud to do something good for the environment?" is a strategy to leverage positive emotions. At the end of the conversation, the bot should summarize the answers to illustrate ambivalence and elicit reflection. This way, the desired behavior change actually comes from the respondent, it's not actually imposed by the bot.
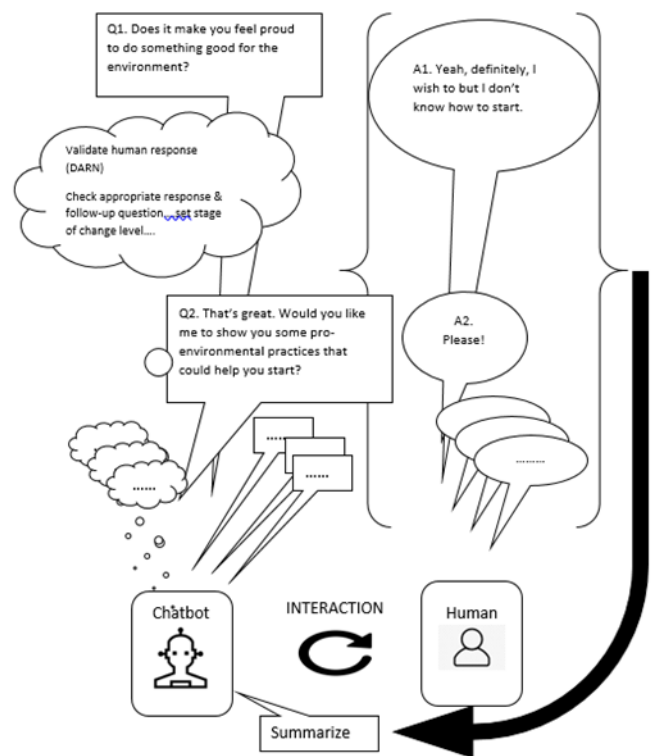

Fig. 2. Conceptual Design of the Automated Motivational Agent

D. Functionality review of chatbot development platform

This functionality review was conducted to assess and satisfy the technical requirements of the new framework illustrated in Fig. 3. The ideal technology should meet the following requirements: To be based on an open source platform; To be simple enough and easy to implement; To be able to provide features that allow the usage of natural language, such as dealing of ambiguous situations and context-based message analysis (pragmatic) to cater for open-ended question and answer; To have features to analyse responses to identify the respondent's desire, ability, reason, and need (DARN) for the intended behavior change; and to be able to categorize statements whether Sustain Talk of Change Talk to support the TTM stages of change.

After a few reviews on a variety of chatbot development platforms, we choose to focus on Artificial Intelligence Markup Language (AIML). AIML is the most-used open source chatbot language due to its simplicity, ease of implementation, portability to other platforms and

the availability of free AIML sets and is supported by a large community of developers. One of the development platforms that could be used to develop AIML based chatbots is the Pandorabots, an open-source chatbot platform which is based on the AIML scripting. AIML scripts created with Pandorabots is supported by various programming languages like Java, Node.js, Python, PHP, Ruby and Go.

The AIML language´s purpose is to make the task of dialog modelling easy, based on the stimulus-response approach in which the user enters a sentence (stimuli) and the chatbot makes an output (response) and that, it is a XML (eXtensible Markup Language) -based markup language [21] which makes it easy to implement. Fig. 2 shows the basic AIML architecture [22] . Stimuli were entered either through text or voice input, which is then pre-processed. Pattern matching takes place by searching the corresponding pattern from the KB. The dialogue units are called categories, and the set of all category tags define a unit of knowledge of the KB. Inside the category tags are pattern tags which define the possible user inputs, while the template tags set the bot's response. Listing 1 provides the scripting template using AIML.

Fig. 3. Architecture of AIML Engine (Jindal et al, 2015)

Listing 1.

```
<category>
<pattern></pattern>
<template></template>
</category>
```

To make the chatbot more effective in its conversational skills, we may want to make it responsive to a wide range of inputs from the respondent. In human conversation, there are always several ways of saying the same thing, alternate words, and phrases that we use to communicate the same ideas to each other. AIML can be programmed to efficiently look for an answer from different types of user input sentences through the use of <srai> tag. To simplify pattern matching, AIML uses symbolic reduction technique such that a complex grammar pattern is mapped into a set of simpler patterns with the <srai> tag [21], for instance, the question "WHAT IS X", where X represents any entity which can be denoted with a wildcard like "*". This question could be written in several ways, such as: "DO YOU KNOW WHAT X IS" and "TALK MORE ABOUT X".

To deal with ambiguous situations and context-based message analysis (pragmatic) in order to infer the direction of the conversation, AIML offers the <that> and <topic> tags [21]. The <that> tag tells the system to analyse the

previous bot's statement so that the user's response needs to be contextualized relative to the bot's statement. The <topic> tag is used to organize subjects/topics that the bot will be able to discuss by grouping categories that deal with the same subject/ topic [21].

To allow the bot to adjust the conversation according to whether it identifies enthusiasm or discontent in the user's statements, we can recognize negative (ST) and positive (CT) stimuli by grouping together similar stimuli as reductions using <srai> tag. For example, the AIML script in Listing 2 may be written.

Listing 2.

```
<category> <pattem>DESIRE CT</pattem> <template>
You expressed POSITIVE DESIRE </template></category>

 <category><pattem>I  WISH* </pattem>  <template>
<srai>DESIRE CT</srai></template>
 </category>

 <category><pattem>I LIKE * </pattem>  <template>
<srai>DESIRE CT</srai></template>
 </category>

 <category><pattem>I  WOULD   LIKE  * </pattem>
<template>      <srai>DESIRE      CT</srai></template>
</category>

 <category><pattem>I  WOULD  ENJOY  * </pattem>
<template><srai>DESIRE           CT</srai></template>
</category>
```
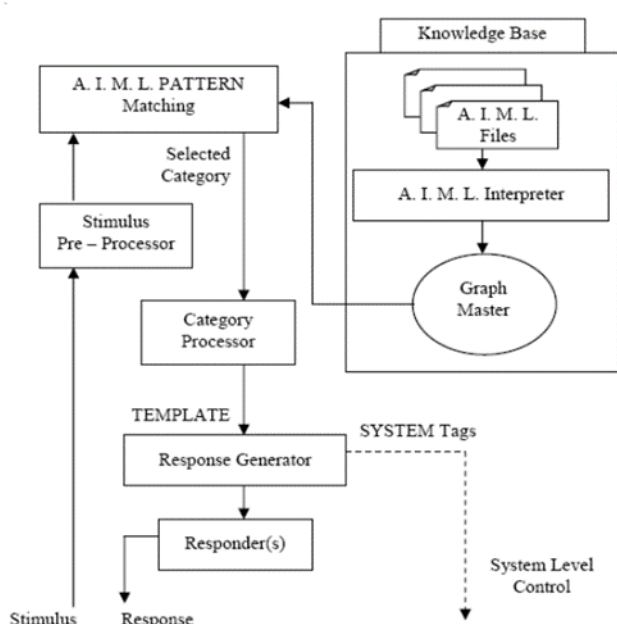
When the respondent's statement contains the sentence "I wish to buy local products", the bot goes through pattern matching to look for patterns like "I WISH *". The <srai> DESIRE CT</srai> tag directs the conversation to DESIRE CT (Desire Change Talk), hence corresponding bot's response was displayed using the <template> tag. Reductions to the same pattern were added ("I LIKE", "I WOULD LIKE") to also mean DESIRE CT using the <srai> tag. The script can be enhanced to set a memory variable to elevate the level to the appropriate stage of change in the TTM. This can be done using <set>, <get> and <condition> tags.

IV. CONCLUSION

The new behavior change agent framework which was developed in this study can be adapted in the design of conversational agents aimed at improving one's well-being through the adoption of greener lifestyle behavior to help effectively address the challenges presented by climate change and declining natural resource availability. Proven and effective models and strategies which are richly available in the domain of the behavioral sciences could be used to provide directions and guidelines to accomplish our task in the path to behavior change. The features provided by AIML platform also prove that it is possible to use chatbot as a tool to bring about behavioral change. The conceptual design provided should provide a clearer picture for the development of a working chatbot that was theoretically grounded to interact with humans to bring about behavior change.

However, due to the nature and context of the chatbot as a tool, which is dependent on the transcript of the conversation, measurement of behavior changes was solely dependent on self-reported rather than actual behavior change. We are looking forward to the development and deployment of a chatbot using the new framework to assess its possibility to influence behavioral change.

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