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Talking Climate Change via Social Media: Communication, Engagement and Behaviour

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ABSTRACT

While individual behaviour change is considered a central strategy to mitigate climate change, public engagement is still limited. Aiming to raise awareness, and to promote behaviour change, governments and organisations are conducting multiple pro-environmental campaigns, particularly via social media. However, to the best of our knowledge, these campaigns are neither based on, nor do they take advantage of, the existing theories and studies of behaviour change, to better target and inform users. In this paper we propose an approach for analysing user behaviour towards climate change based on the 5 Doors Theory of behaviour change [19]. Our approach automatically identifies five behavioural stages in which users are based on their social media contributions. This approach has been applied to analyse the online behaviour of participants of the Earth Hour 2015 and COP21 Twitter movements. Results of our analysis are used to provide guidelines on how to improve communication via these campaigns.

Categories and Subject Descriptors

Human-centered computing [**Social networking sites**]:

Keywords

Behaviour Analysis, Social Media, Climate Change

1. INTRODUCTION

In recent years, there has been growing international acceptance that climate change poses a serious threat to human well-being and ecological stability[1][24], and govern-ments have been urged to respond to the challenge of mitigating climate change. An example of this response is the latest agreement reached in the United Nations Climate Change Conference (COP21), held in Paris, France, in December 2015.

However, the responsibility of climate change not only lies on governments and industries, but also on each of us as citizens of the planet. A recent eurostat report[2] shows that households constitute 19% of greenhouse emissions, the third highest value after the energy sector (27%) and industry (26%), and more than either agriculture (12%) or transport (11%). However, despite the clear implications of individual and household consumption on climate change, and the urgent need for a societal response to the problem, public engagement is currently limited [24]. Many people do not appreciate the correlation between their individual behaviour and its global impact, underestimating their power to influence climate change [22].

Several campaigns and initiatives have emerged in the last few years with the aim of involving individuals closely in the solution to this problem.[3] One of the core mediums they use to communicate with the public worldwide are social platforms, such as Twitter and Facebook.

Parallel to the generation of these initiatives and campaigns, multiple theories have emerged from psychology and social sciences that aim to investigate what are the motivations that drive people to get involved and change their own behaviour, and how these behavioural changes happen; in particular in the context of energy saving and climate change. However, it is unclear how all these theories can be applied to practical settings, particularly social media campaigns, to help organisations improve their communication strategies. It is often difficult to understand how these campaigns are received by the public, especially when the amount of traffic generated on social media around them is so vast (more than 2 billion Twitter impressions and nearly 8 million digital interactions were reported for the Earth Hour 2015 campaign[4]). Manual analysis is impractical, and

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[1] http://ec.europa.eu/clima/change/consequences/index_en.htm

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[2] http://ec.europa.eu/eurostat/news/themes-in-the-spotlight/cop21

[3] http://www.theguardian.com/global-development-professionals-network/2013/nov/15/top-10-climate-change-campaigns

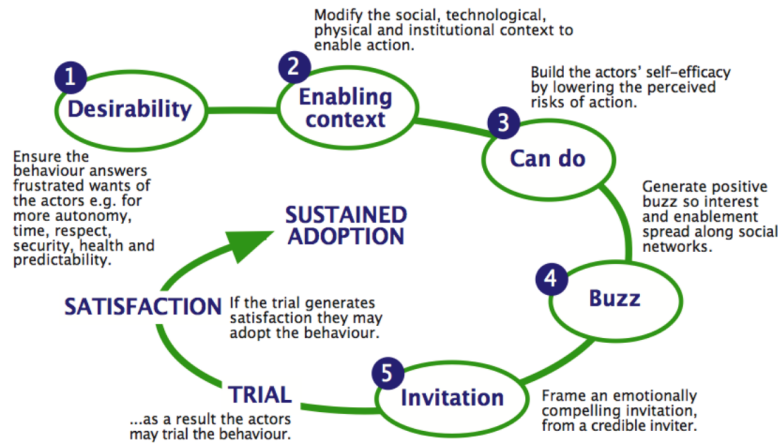[4] https://www.earthhour.org/sites/default/files/

Figure 1: 5 Doors theory of behaviour change

thus automated techniques need to be used; however, it is not clear exactly how this data should be analysed and how we can gain useful insights that can ultimately be used to improve not only communication but actually effect behavioural change. Simple statistical analysis of outreach is insufficient to gain proper insight; we need to understand also the semantics of messages so that we can better correlate social communication with environmental behaviour, i.e. not just whether people responded to a tweet, but *how* they responded. To bridge this gap, our work investigates two main research questions:

1. *How can we translate theories of behaviour change into computational methods to enable the automatic identification of behaviour?* We propose an approach based on Natural Language Processing (NLP) and Machine Learning (ML) that automatically identifies the different behavioural stages in which users are at, by analysing large amounts of user-generated content from social media. We follow in our approach the behavioural stages identified by Robinson [19] in his 5 Doors Theory of behaviour change.

2. *How can the combination of theoretical perspectives and the automatic identification of behaviour help us to develop effective social media communication strategies for enabling behaviour change?* We combine the learnings from different theories towards awareness, engagement and behaviour with the learnings acquired after analysing online behaviour from two large-scale social media movements, and translate these into a set of social media campaign recommendations.

By investigating these research questions, we provide the following contributions:

1. A summary and analysis of a wide range of theories around awareness, engagement and behaviour change currently existing in the social science literature;

2. The development of a behaviour analysis approach able to identify users' behavioural stages based on their social media contributions;

3. A list of recommendations to enhance social media campaign communication based on the combination of theoretical perspectives and the analysis of two large-scale social media environmental movements.

The following sections are structured as follows: Section 2 describes the scenarios, or social media movements, analysed in the context of this research. Section 3 describes a compendium of different theories of awareness, engagement and behaviour change. Section 4 shows our proposed approach to automatically identify different stages of behaviour towards climate change based on the users' social media contributions. Section 5 describes our experiments to categorise users into behavioural stages using the analysis tools. Section 6 discusses our recommendations for social media environmental campaigns based on our study of the literature and the result of our analyses, while Section 7 concludes.

2. USE CASE SCENARIOS

We analyse behaviour in the context of two of the largest, more recent, movements for climate change reflected in social media: Earth Hour 2015 (EH2015) and the 2015 United Nations Climate Change Conference (COP21).

Earth Hour (EH)[5] is a large-scale campaign launched by the World Wide Fund For Nature (WWF) every year to raise awareness about environmental issues. The event aims to encourage individuals, communities, households and businesses to turn off their lights for one hour, from 8:30 to 9:30 p.m. on a specified evening towards the end of March, as a symbol for their commitment to the planet. It started as a lights-off event in Sydney, Australia in 2007. Since then it has grown to engage more than 172 countries worldwide.[6] Today, Earth Hour engages a massive mainstream community on a broad range of environmental issues. The one-hour event continues to remain the key driver of the now larger movement. WWF's Earth Hour is a unique opportunity to understand user engagement and behaviour towards climate change, and the possibilities to facilitate more sustainable behaviours.

Earth-Hour-2015-Global-Stats-Report.pdf

[5]https://www.earthhour.org/

[6]https://www.earthhour.org/sites/default/files/Earth-Hour-2015-Global-Stats-Report.pdf

COP21 is the 2015 United Nations Climate Change Conference. This conference was held in Paris, France, from 30 November to 12 December 2015. The conference negotiated the Paris Agreement, a global agreement on the reduction of climate change, the text of which represented a consensus of the representatives of the 196 parties attending it. COP21 is part of a series of periodic meetings, that began at the Rio Earth Summit in 1992, where the highest world authorities debate thresholds between socio-economic development and carbon emission reduction, and try to produce consensual plans to control the impact of climate change. Multiple organisations, including WWF, launched social media campaigns around COP21, generating a large world-wide social media reaction. This movement is a reflection of society's pressure on governments to commit to the agreements and to make better environmental choices.

3. AWARENESS ENGAGEMENT AND BEHAVIOUR CHANGE

As mentioned in the introduction, people typically do not understand the correlation between their individual behaviour and its global impact, thus underestimating their power to influence climate change. Particularly, the lack of self-efficacy is one of the reasons that prevent people to take part in the climate change battle [22]. The impact of individual behaviour on the global scenario is not obvious, and people usually underestimate their power to change reality.

Understanding the mechanisms that govern behaviour with regard to energy use, and fostering changes towards conservation, has been a topic of investigation in the domain of social and environmental psychology [1], in computing technology [13], and in interactive design [14]. Understanding behaviour and its change in general is also widely discussed in marketing and advertising, particularly by using social media [4][23][19][2][11].

In this section, we first take a look at theoretical studies to get insights on which communication strategies have been proposed to influence people's behaviour in favour of a product or idea. We dissect the more general studies, and then focus on studies about behavioural change. As a result of the analysis of these theories, we propose a set of strategies that can be used to promote awareness, engagement and behaviour change using social media as a medium.

3.1 Awareness and Engagement

The first issue a campaign needs to consider is awareness, i.e., how to make users aware of the topic, in our case climate change, and aware of their own behaviour towards the topic. One of the key recommendations proposed by Ariely [2] is that the user not only needs to be aware of the subject, but they also need to be aware of the various options to act. To have impact, the first thing a campaign needs is *to have a clear story to tell, with a very concrete action connected to it*. This is particularly complex in the case of campaigns towards climate change, since it is a very broad subject that represents many different smaller stories, connected to multiple behavioural actions. Campaigners should therefore be able to break down those stories and actions for the public.

In addition to the previous recommendations, Berger [4] highlights the need for "word of mouth", i.e. the need for social transmission, or social influence, to spread the message and increase awareness. Berger and his colleagues anal-

ysed several viral campaigns and concluded that to make a campaign "engaging" it should follow the six principles of contagiousness, or STEPPS: *Social currency* (people share things that make them look good); *Triggers* (it is part of the users' everyday life, and on top of their minds); *Emotional resonance* (when users care about something, they share it with others); *Public* (the idea or product is built to show and built to grow); *Practical value* (people like to share practical or helpful information); and *Storytelling* (people tend to share stories, not information). Climate change campaigners should therefore focus on creating *innovative useful messages with an emotional undertone and a memorable story line*.

Vaynerchuk [23] emphasises the issue of differentiating each social medium when communicating a story, since different social media platforms are generally used for different needs and use different algorithms to promote content in the users' news feeds. It is therefore important for campaigners to *get familiar with the different social media platforms* where the campaign will be communicated.

Works like Campbell [6], Kazakova [15] and Cheong [7] have focused on analysing the characteristics of the climate change social media campaigns, including previous editions of EH, and the mechanisms used to engage with the public during these campaigns. The work of Fernandez [12] complements these by studying the effect of some of those mechanisms and their impact on public engagement. This study concludes that, in the context of these campaigns, *more engaging posts tend to be slightly longer (in the case of Twitter they use nearly all 140 characters available), are easier to read, have positive sentiment and have media items (original/funny photos linked to the message) associated to them*. Also, *symbolism needs to be focused around climate change related topics*. Superheroes, celebrities, and other types of symbols that are sometimes associated to these social media campaigns, create buzz but do not generate awareness or engagement towards climate change.

3.2 Behavioural Change

Environmental campaigns not only aim to raise awareness and create engagement, but ideally also to trigger behavioural changes, for instance by encouraging individuals to reduce their consumption of energy. Different scientific domains such as psychology, anthropology, sociology, and philosophy have put effort into understanding the forces that drive people's behaviour with protecting the natural environment [5], [8]. This "not emotionally neutral subject" [21] has been conceptualised as Behaviour Change Theory, a field of study that transcends environmental purposes, being also applied to health, education and dissemination of new products or concepts.

Behaviour Change Theory is mainly dominated by two complementary approaches: models of behaviour and theories of change. Models of behaviour can be applied to understand specific behaviour and identify factors of influence, mainly at the individual level [10]. Theories of change, on the other hand, explain the behavioural change process through social science lenses, being particularly helpful for developing interventions leading to a desired behaviour change. Theories are more generic, usually not taking into account contexts, perceptions and needs of a particular group of people [19].

By integrating a number of formal theories from psychol-

ogy and social sciences in terms of "what it takes for new practices or products to be adopted by groups of people", Robinson developed the 5 Doors theory [19]. This generic theory aggregates elements from Diffusion of Innovations [20] and the Self-Determination theory of motivation[7], among others. Instead of promoting changes to people's beliefs or attitudes, the 5 Doors theory focuses more on "enabling relationships between people and modifying technological and social contexts".

The theory consists of 5 conditions that must be present in a cycle of behaviour change (see Figure 1). It is important to highlight that when mapping this theory to analyse user behaviour, our interpretation is that each of these conditions maps to a different behavioural stage, our assumption being that users shape their social media messages differently according to the stage in which they are at:

- *Desirability*: For someone to adopt a new behaviour into their lives, they have to want it. People in this stage are motivated (desire) to reduce their frustrations, which can be about day-to-day inconveniences (e.g. high expense on their electricity bill), or about deeper personal frustrations (e.g. living in a less polluted environment to recover lost health);

- *Enabling context*: People in this stage are changing their environment to enable a new behaviour. That includes infrastructure, services, social norms, governance, knowledge – literally anything that could exert a positive or negative influence on a specific behaviour;

- *Can do*: People in this stage are already acting. This stage focuses on increasing the person's self-efficacy and lowering the perceived risks of change by building a set of tactics;

- *Positive buzz*: People in this stage communicate their experiences and success stories, which helps creating buzz and increasing other people's desires;

- *Invitation*: People in this stage invite and engage other people to their cause. Who issues the invitation is vital to engage others. A good inviter wins people's attention and commitment by authentically modelling the change in their own lives.

The 5 Doors theory correlates closely with empirically generated theories of behaviour, such as the one developed by Green Energy Options (GEO)[8] when conducting energy trials.[9] This model consists of five stages that refer to the level of awareness and involvement with a cause and the sort of tactics a sender should employ to nudge the user in the direction of change: (i) *Enrol*: establish means to generate / spread interest; (ii) *Educate*: help people understand/ gain confidence in their ability; (iii) *Engage*: facilitate to take action; (iv) *Encourage*: provide feedback and encouragement; and (v) *Expand*: provide opportunities to share and expand.

Since intervention strategies, or tactics to nudge the user in the direction of change, are generally different according to the stage in which the user is, it is important for campaigners to: (i) identify the different behavioural stages of

their audiences in order to generate more targeted strategies, and (ii) to make sure that a campaign is covering all possible stages so that all users find support to progress. A key contribution of this research is therefore directed towards providing computational methods able to automatically categorise users into different stages of behaviour based on their social media contributions (see Section 4).

3.3 Intervention Strategies

Intervention strategies are used when aiming to change behaviours. Multiple works in the literature have emerged in the last few years studying the effects of different intervention strategies, particularly with the goal of reducing energy use [1], [14]. While Abrahamse [1] analyses interventions from the social and environmental psychology perspective, Froehlich [14] focuses on how to design for eco-feedback within the human-computer interaction context. Based on [1] and [14], in this section we summarise a set of popular interventions that can be applied to social media campaigns.

- *Information*: Providing information is a main intervention. However, it is also very important to consider the way the information is presented (whether it is simple to understand, easily remembered, attractive, and provided at the right place and time). Some strategies on how to make messages engaging in social media campaigns are summarised in Section 3.1.

- *Discussions*: Sometimes it is useful to encourage discussions and debates, and social media platforms provide the technical capabilities for such matters. Discussions can be triggered by raising questions or dilemmas, i.e. difficult choice questions confronting pro-environmental behaviour and personal values (e.g., cold showers or no internet for a week?).

- *Public Commitment*: A way of committing to a cause is to publicly pledge or promise to do something to change behaviour. Both the type of commitment, and the person or group to whom the commitment is made, are factors that impact behaviour. Campaigners should propose that users engage with pledges or other concrete actions, and make their commitment public.

- *Feedback*: Feedback about the users' actions, alone or in combination with other strategies, particularly advice, seems to be an effective intervention. Providing feedback, however, requires a higher dedication from campaigners, since it implies bi-directional dialogues where campaigners do not only act as broadcasters but also actively engage in conversations.

- *Social Feedback*: Social Feedback covers all types of social context for comparison and discussion among peers. It includes comparison of energy use across users and dialogue among individuals about their habits and behaviours towards the environment. To generate social feedback, campaigners should stimulate discussions and encourage users to share their experiences with others.

- *Goal-setting*: Setting goals is a motivational technique. Goals can be established by users or by third parties, but should be kept feasible. Campaigners should design and promote a set of feasible goals and encourage users adopt them.

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[7]https://en.wikipedia.org/wiki/Self-determination_theory
[8]http://store.greenenergyoptions.co.uk/
[9]http://www.decarbonet.eu/wp-content/uploads/sites/23/2014/10/D5-1_final.pdf

Table 1: Social Media environmental campaigns: recommendations to increase awareness

Behaviour Stage	Intervention Strategies
Desirability	Providing *Information* in an attractive way (see Section 3.1), and proposing *dilemmas* to trigger discussion about the extend of the problem and its impact are some of the interventions that can help users in this stage
Enabling Context	*Information*, *rewards* and *incentives* are important intervention strategies at this stage. Providing appropriate links to dedicated portals so that the user can learn about her options, as well as providing rewards and incentives can help motivating the user for change. Also having access to the personal experiences reported by other users via social platforms
Can Do	Helping the user to set realistic *goals* and promoting *public commitments* via social media (e.g., link to petitions to be signed) are some of the strategies to help users to drive their change further. In addition, providing frequent and focused *feedback* and challenge negative thoughts are also strategies to build self-efficacy
Buzz	Providing *feedback*, as well as *social feedback* (i.e., encourage the user to share their success stories, comment over them and help them to discuss their achievements with their peers) are some of the intervention strategies recommended at this stage
Invitation	*Promoting collaboration*, i.e., encourage the users to invite and collaborate with others to reach a bigger achievement

- *Collaboration*: Collaboration aims at aggregating efforts to reach a bigger achievement. It brings a set of individuals together to act towards a common goal. Establishing collaboration initiatives by local teams as part of a campaign, and encouraging users to get involved, are some actions to consider as part of this intervention.

- *Competition*: The effectiveness of competition has proved sometimes controversial in the studies performed by Froehlich [14] and Abrahamse [1], with some positive but not so evident results in terms of behavioural change. As with collaboration, games and competitions can be prepared as part of environmental campaigns.

- *Rewards*: Rewards provide extrinsic motivations, usually with the intent to promote a short-term behaviour change. Providing monetary rewards or other prizes are examples of actions that can be considered within the context of a campaign.

- *Incentives*: Incentives are an alternative to rewards, mostly aimed at starting and continuing behaviour. Acknowledgements of positive behaviour, and ensuring the users are having fun while engaging with the environment, are examples of possible incentives.

- *Personalisation*: Personalisation strategies are less common in the literature. Within the context of large social media campaigns, generic messages are provided rather than targeting specific individuals. In this work, we move a step forward in this direction by identifying different subgroups of users according to their behaviour expressed online (see Section 4).

These different intervention strategies can be used alone or combined to promote or influence a behaviour change. According to [19], people in different stages of behaviour change can be influenced by different incentives (or interventions). A summary of the intervention strategies that can be considered to encourage a behavioural change at each stage is presented in Table 3.2. This mapping builds on Robinson's theory [19] and on our previous analysis on the role of social media in the perceptions and behaviours towards climate change [18].

3.4 Barriers to Change

An additional element to consider when aiming to change users' behaviours are the *barriers to change*. Ariely and colleagues [3] identified four main barriers:

- *Friction*. Changing behaviour, however small, always meets resistance. When communicating via social media, the sender needs to reduce friction and resistance as much as possible by giving the user tips and advice.

- *The pain of acting now overshadows delayed benefits*. Climate change is often seen as a vague, abstract problem with far away consequences. Communication strategies need to highlight how a person's actions really matter.

- *People don't think about the benefits at the right time*. It is therefore important to work on communicating the benefits clearly and recurrently, rather than hoping people will later remember them.

- *People do not agree it is a good idea*. If people do not believe that climate change is real, then it is important to find other benefits to tie to the desired behaviour (e.g. prizes or monetary rewards). However, behaviour promoted by rewards does not tend to be long-lasting.

4. APPROACH

In Section 3.2, we highlighted our assumption that different users in different behavioural stages communicate differently. Our first task has therefore been to validate this assumption by conducting an online survey (Section 4.1).

Having acquired an understanding of how different behavioural stages are communicated, we developed an approach for automatically identifying the behavioural stage of users, based on three main steps: (i) a manual inspection of the user-generated content (in our case Twitter data) to identify how different behavioural stages are reflected in terms of linguistic patterns (Section 4.2); (ii) a feature engineering process, in which the previously identified linguistic patterns are transformed into numerical, categorical and semantic features, which can be automatically extracted and processed (Section 4.3); and (iii) the construction of supervised classification models which aim to categorise users into

Table 2: Examples of tweets reflecting the 5 different behavioural stages

Behavioural Stage	Examples of posts
Desirability	- Our buildings needs 40% of all energy consumed in Switzerland!
Enabling context	- I am considering walking or using public transport at least once a week.
Can do	- If you are not using it, turn it off!
Buzz	- I'm so proud when I remember to save energy and I know however small it's helping
Invitation	- Take 15 minutes out to think about what you do now and what you could do in the future. Read up on the subject and decide what our legacy will be.

Table 4: Linguistic Patterns per behavioural stage

Behavioural Stage	Linguistic Patterns
Desirability	- Negative sentiment (expressing personal frustration- anger/sadness) - URLs (generally associated with facts) - Questions (how can I? / what should I?)
Enabling context	- Neutral sentiment - Conditional sentences (if you do [..] then [...]) - Numeric facts [consumption/pollution] + URL
Can do	- Neutral sentiment - Orders and suggestions (I/we/you should/must...)
Buzz	- Positive sentiment (happiness / joy) - I/we + present tense) I am doing / we are doing
Invitation	- Positive sentiment (happy / cute) - [vocative] Friends, guys - Join me / tell us / with me

different behavioural stages based on the features extracted from their generated content (Section 4.4).

4.1 Social Media Reflection of Behaviour

To test our assumption that users at different behavioural stages communicate differently, we conducted an online survey between September and October 2014 targeting internet users in communities and workplaces. The survey received answers from 212 participants. A description of the elaborated questionnaire, the demographic characteristics of the users who completed it, and an analysis of the obtained answers can be found in [18]. For the purpose of this research, we focus on two main questions from it in which we ask users: (i) how they identify themselves within the five stages of behaviour; and (ii) to provide examples of messages they will post on Twitter. By performing this exercise, we gathered 161 examples of posts associated to a particular behavioural stage. Examples of the messages reported by the users are displayed in Table 2.

In addition to this set of examples, we annotated 100 tweets (a sample of 20 tweets per stage) randomly selected from our collected datasets (see Section 5.1). These tweets were annotated by two different researchers. Discussions were raised about those tweets where disagreements were found. If the disagreement could not be resolved, the tweet was marked as ambiguous and discarded. Examples of tweets annotated under each category are displayed in Table 3.

4.2 Manual Inspection of Linguistic Patterns

To identify the key distinctive features of tweets belonging to each behavioural stage, a manual inspection of the previously annotated tweets was performed by two Natural Language Processing (NLP) experts. During this process, a number of linguistic patterns were identified as potentially useful to help characterise the different behavioural stages. The list of identified patterns is given below:

- *Desirability*: Tweets categorised in this behavioural stage tend to express negative sentiment and emotions such as personal frustration, anger and sadness. They usually include URLs to express facts, and questions asking for help on how to solve their problem/frustration.

- *Enabling Context*: Tweets categorised under this behavioural stage tend to be expressed in a neutral sentiment and emotion. They generally provide facts about how to solve a certain problem; in particular numerical facts about amounts of waste, energy reduction, URLs pointing to information, and conditional sentences to indicate that, by performing certain actions, benefits can potentially be obtained.

- *Can do*: Tweets categorised under this behavioural stage tend to be expressed in a neutral sentiment and generally contain suggestions and orders directed to self and others (I/we/you should) (I/we/you must).

- Buzz: Tweets categorised under this behavioural stage tend to have positive sentiment and emotions of happiness and joy, since they generally talk about the user's success stories and about the actions they are already performing in their engagement towards climate change and sustainability.

- Invitation: Tweets categorised under this behavioural stage tend to have positive sentiment and emotions of happiness or cuteness, since they are focused about engaging others in a positive and funny way. The text generally contains vocative forms (friends, guys) calling others to join the cause.

4.3 Feature Engineering

In order to automatically extract the linguistic features represented in the patterns described above, NLP tools (provided by GATE[10]) were used. These included basic linguistic pre-processing (such as part-of-speech tagging and verb chunking) [9] and more complex tasks such as opinion mining and emotion detection [17]. The features initially extracted were:

- Polarity: positive, negative, neutral

- Emotions

  - Positive (joy/surprise/good/happy/cheeky/cute)
  - Negative (anger/disgust/fear/sadness/bad/swearing)

Table 3: Examples of tweets reflecting the 5 different behavioural stages

Behavioural Stage	Examples of posts
Desirability	- It was sucha horrible storm today! Doesnt feel like the normal rain that we are used too isnt it?! Climate change? - Wondering what the grand bargain between the US and China on climate change is going to look like. Without one, we're all in deep trouble.
Enabling context	- Changing a light bulb. Fluorescent Lights last longer, use less energy, and save you money. - Cold air hand dryers utilise high air speed to dry hands quickly, helping to provide ongoing energy savings: http://t.co/8Ssq1aa6xs
Can do	- UN Campaign on Climate Change - sign the petition to Seal the Deal at Copenhagen http://www.sealthedeal2009.org#cop15 - Track your energy savings with this student-developed website #macewanu #yeggreen http://t.co/jckR9XAFKuhttp://t.co/2V2wEFkqg1
Buzz	- Filling my tires and saving one tank of gas per year! Climate Crisis Solution #06 - We thought we'd achieve10% energy savings thru efficiency.We were SO WRONG.It's 40% so far!
Invitation	- We hope you're all participating in Earth Hour tonight! It starts at 8:30!!! http://t.co/2VI8xxo2IA - I'm switching off for Earth Hour at 8.30pm on 28 March, will you join me? #EarthHourUK http://t.co/eitii1ojqW

- Directives

  - Obligate (you must do) - e.g., you must turn off the light

  - Imperative (do) - e.g., turn off the light!

  - Prohibitive or negative imperative (don't do) - e.g., do not turn off the light

  - Jussive or imperative in the 1st of 3rd person - e.g., go me!

  - Deliberative (shall/should we) - e.g., shall we turn off the light?

  - Indirect deliberative (I wonder if) - e.g., I wonder if we should turn off the light

  - Conditionals (if/then) - e.g., ,if you don't turn off the light your bill will increase

  - Questions (direct/indirect)

- URLs (yes/no) indicates if the message points to external information or not

We can clearly see how some of these linguistic modalities correlate with the behaviour model. For example, deliberatives are strongly associated with stage 1 (Desirability), while conditionals are often linked with stage 2 (Enable context) and jussives with stage 4 (Buzz or self-reporting). However, the boundaries between these stages are often quite fuzzy, and people's online behaviour will not always correlate exactly with a single stage. We should also note that not every occurrence of one of the linguistic patterns will reflect the correct stage: not every conditional sentence will necessarily reflect the "enabling context" stage, for example. We use these linguistic patterns only as a broad guideline to help with the categorisation. Furthermore, NLP tools are never 100% accurate, and this holds particularly for some of the harder tasks such as opinion mining and emotion detection. Performance varies greatly depending on the task: direct questions can be recognised at near 100% accuracy, but correct assignment of opinion polarity may only be around 70% accurate.

4.4 Behaviour Classification Model

Using the feature extractors, we process the 261 annotated posts, i.e. posts with associated behavioural stages (see Section 4.1), and use them to generate different classifiers. In particular, Naive Bayes, Support Vector Machines (SVM), and decision trees have been tested using 10-fold cross validation. The best performing classifier was the J48 decision tree, obtaining 71.2% accuracy. Decision trees discriminate the most distinctive attributes first and separate the population (in this case the set of posts) based on the identified distinctive features.

As we can see in Figure 2, the most discriminative feature is sentiment. If the sentiment of the post is negative, the classifier automatically categorises it as stage 1 (desirability). If the sentiment is neutral the classifier checks if the post contains a URL. Posts with neutral sentiment are classified as: stage 1 (desirability) if they do not contain a URL or stage 2 (enabling context) if a URL is present. Note that URLs are an indication of additional information, generally facts associated with the message. If the sentiment is positive, the classifier looks at the type of directive used. If the directive is conditional, deliberative or indirect deliberative, the post is classified as stage 2 (enabling context). If it is obligative or imperative the post is classified as stage 3 (can do). If there are no directives, or other kinds of directives, in the text, the classifier looks at emotions in order to discriminate. If the emotion is joy, the post is categorised as stage 5 (invitation); if the emotion is happy, good or surprise, the post is categorised as stage 4 (Buzz).

Our model provides an easily understandable set of rules to categorise posts into behavioural stages. To identify the behavioural stage of each user over time, we consider their contributions in a month period, and assign the user the most popular behaviour stage among their posts. If there is no majority class, or if the user did not post anything related to climate in that period, we consider them as "unclassified".

5. EXPERIMENTS

We describe here the experiments conducted to analyse the behaviour of the participants of the EH2015 and COP21 social media movements, following the proposed approach.
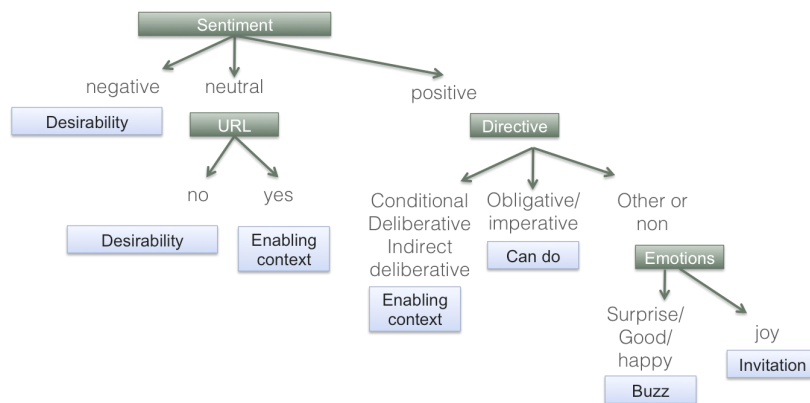
5.1 Data Collection

Figure 2: Behaviour classification model

The first step to perform these experiments has been to collect data for the two social media movements, EH2015 and COP21. We monitored both events on Twitter by collecting tweets containing particular hashtags, such as #EH15, #earthhour, #changeclimatechange, etc. in the case of EH2015, or #COP21, #COP21Paris, #parisclimatetalks, etc. in the case of COP21. We used the Twitter IDs of the participants of these event to generate a second collection and gather historical tweets from their timeliness. Up to 3,200 posts were collected from each individual, which is the maximum allowed by the Twitter API. This provides information for up to several years for some users. The rationale behind the selection of these users is that they are already engaged with the environment, demonstrated by their participating and tweeting about these campaigns. Our dataset for EH2015 contains 56,531,349 posts from 20,847 users; the one for COP21 contains 48,751,220 posts from 17,127 users.

5.2   Data Filtering

We collected 3,200 posts from the timelines of each of the users who participated in the social media movements. Naturally, these users post about environmental issues, but they also post about their jobs, hobbies, personal experiences, and so on. To identify which of the content produced by the users relates to their environmental behaviour we used the Term Extraction tool ClimaTerm[11] developed in the context of this research and documented in [17]. ClimaTerm automatically identifies instances of environmental terms in text. Some of these are found directly in ontologies such as GEMET, Reegle and DBpedia, while others are found (using linguistic techniques) as variants of such terms (e.g. alternative labels, or hyponyms of known terms) [17]. Using these annotations helps us to identify, from the timeline of each individual user, which of their posts are related to climate change and sustainability. 750,538 posts were identified as climate-related by the ClimaTerm tool in the EH2015 dataset, and 422,211 in the case of COP21.

5.3   Behaviour Analysis

We have made use of the filtered tweets to categorise users in different behavioural stages over time. In particular, we take into account monthly behaviour before, during and after the days in which EH2015 and COP21 were celebrated.

[11]http://services.gate.ac.uk/decarbonet/term-recognition/

We focused on the analysis of these particular months, since being aware of the users' behavioural categorisation during these time periods may enable campaigners to use more targeted messages and interventions. The results of our behaviour analysis study are presented in Figure 3, for EH2015, and Figure 4, for COP21. These images display the percentage of users classified under each behavioural stage in the months around the campaigns as well as the users that are not categorised. Users are not categorised either because they did not produce any post related to environmental issues in the analysed month, or because our approach could not distinguish a clear stage for the user based on their generated content. The number of users in each stage for both datasets is reported in Table 5.3. Note that COP21 is a very recent event and post campaign data for January was not available at the time of analysis.

As we can see from both figures, there is a significant peak of activity around the time of the campaigns that decays later on. During the time of the campaigns, users produce more content related to environmental issues and it is therefore possible to classify them in different behavioural stages. Out of this time window, a higher percentage of users go uncategorised, mainly because they have not produced any content around environmental issues. In general, what we observe from both campaigns is that the highest percentage of users are in the Desirability stage. The second most popular stage is Can do. This indicates that users are either at the stage where they want to change their behaviour, or at the stage where they are already acting. We can also observe that, while not many users fall in the invitation stage, this changes during the campaigns, where there is a higher percentage of users who try to engage others. These users generally correspond to environmental organisations such as WWF. There are also not many users that fall in the Buzz stage (i.e., not many users communicating their achievements, although this also tends to change and increase during and after the campaigns). On the other hand, the percentage of users at the enabling context state is generally stable. What do these results teach us, and how can we use these learnings for further campaign improvements? We summarise the results of studying behaviour in these two campaigns and our previous learnings from our literature review in three additional recommendations:

- Our results show that most of the social media participants are at the desirability stage. There is some-
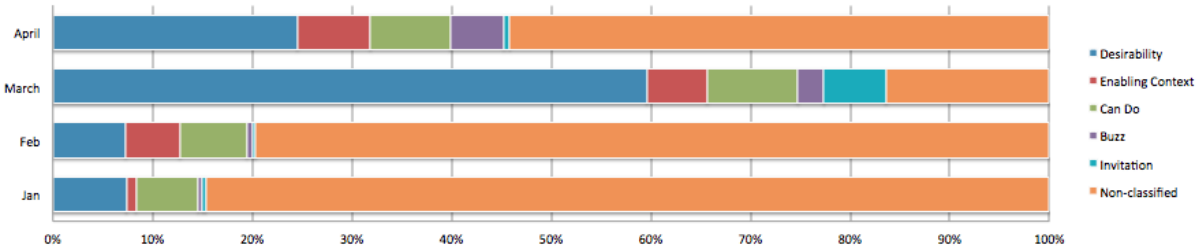
Figure 3: EH2015 - Number of users associated with each behavioural category
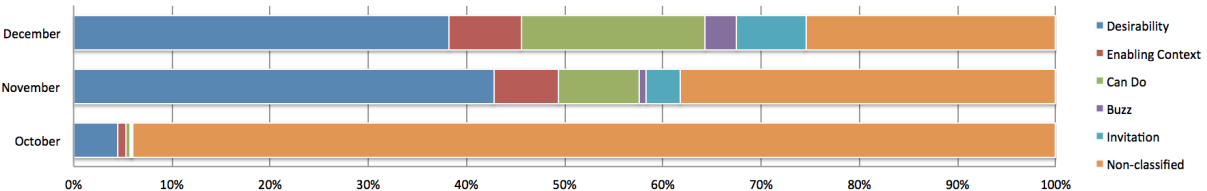

Figure 4: COP21 - Number of users associated with each behavioural category

thing they want to change but they do not know how. A big part of a campaign's effort should therefore be concentrated on providing messages with very concrete suggestions on climate change actions. These messages should also be innovative, useful, and about day to day activities to maximise the STEPPS criteria [4].

- There are very few users in the invitation stage, and most of them are organisations. However, as stated by Robinson [19], for an invitation to be effective, it is vital who issues the invitation. Ideal inviters are those who have embraced change in their own lives and can serve as role models. It is our recommendation to identify these really engaged individuals and community leaders and involve them more closely in the campaigns, invite them to share their stories, and provide feedback, so that they can inspire others.

- Communication in our collected data generally functions as broadcasting, or one-way communication, from the organisations to the public. However, frequent and focused feedback is an intervention strategy that can help build self-efficacy and nudge the users in the can do and buzz stages in the direction of change. Our recommendation for campaigners is therefore to dedicate efforts towards engaging in discussions and providing direct feedback to users.

6. DISCUSSION

Engaging people with climate change by using social media as a medium not only requires the understanding of how social media communication can drive engagement and behaviour change, but also requires the understanding of the needs and situations of the users so that more targeted strategies can be selected to drive such change.

In this work, we have investigated how the combination of theories and computational models can help us to identify and categorise the behaviour of users towards the environment and to select more targeted communication and intervention strategies. This work has provided us with many useful insights. In this section we highlight some limitations of this study and multiple directions for future work.

Social media behaviour is not exactly the same as behaviour in the physical world. People do not report everything they do and how they do it via social media. While the results of our conducted questionnaire (see Section 4.1) indicate an association between behavioural stages and different types of communication, our learnings about users' behaviour from their generated content may be a partial reflection of the reality. Previous studies indicate that variances may exist between self-reported behaviour and objective, or real behaviour [16], since people tend to report themselves as being more environmentally friendly than they are.

Our classifier was trained with a small subset of tweets because of the cost of obtaining labelled data. Classification accuracy (71.2%) may therefore improve by using more training data. Adding some extra linguistic features, such as the recognition of numeric facts or expressions of need, could also potentially help to enhance classification accuracy. We are currently working on extending the GATE NLP tools to extract additional features that can provide a more complete characterisation of the data.

To analyse behaviour, we have considered a unique time-window of one month for all users. However, different users post at different paces. Our future work includes studying the impact of users' post rate for a more fine-grained categorisation of behaviour.

Our analysis of the COP21 and EH2015 movements does not distinguish between different types of social media profiles (organisations vs. individuals), but we are currently working on the construction of an author categorisation tool able to differentiate Twitter accounts as individuals vs. organisations. A preliminary analysis over the EH2015 data shows that 76% of the analysed accounts belong to individuals, which means that although some organisations were included in this study, the number of individuals is notably higher and we would not expect significantly different results were we to remove tweets originating from organisations.

Our classifier has been trained on Twitter data, which has a maximum of 140 characters per post. The length of the text may therefore determine the number of directives or emotions that emerge from one unique post. While our proposed analysis approach is generic and can be applied to analyse data from any given social media platform, our

Table 5: Behaviour Analysis results

EH2015	Desirability	Enabling Context	Can Do	Buzz	Invitation	Non-classified
Jan	1536	201	1307	91	58	17,654
Feb	1521	1138	1401	132	54	16,601
March	12432	1259	1891	550	1300	3,415
April	5114	1530	1671	1121	123	11,288
COP21	Desirability	Enabling Context	Can Do	Buzz	Invitation	Non-classified
October	765	141	76	23	14	16,108
November	7321	1138	1401	132	587	6,548
December	6543	1259	3211	550	1198	4,366

classifier is Twitter-specific and may need to be re-trained to work with longer texts.

7. CONCLUSIONS

Pursuing awareness and changes in behaviour, governments and organisations are constantly conducting pro environmental campaigns. However, little knowledge has been built around connecting social media and its potential to boost behaviour change. Following this goal, we have presented in this paper: (i) a deep state of the art analysis on the different theoretical perspectives towards increasing awareness, engagement and behaviour change; (ii) a computational analysis approach, inspired by the 5 Doors Theory [19], to automatically identify users' behavioural stages, and its use for analysing two of the largest and more recent environmental social media movements (EH2015 and COP21); and (iii) the combination of the lessons learned from theories and data analysis to provide a series of recommendations on how to enhance social media campaign communication.

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