Reconciling Hot and Cold Cognition in Persuasive Technologies

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Abstract. This paper is concerned with the study of persuasion through a synthesis of cold, or rationally driven, and hot, or emotionally driven, cognitive reasoning. We present a computational framework for persuasion that is based on two principles: (a) argumentation captures the natural form of human reasoning; and (b) persuasion of individual users can only be effective if it also takes into account emotional arguments. We propose a general architecture for persuasive systems that is based on a unified argumentation theory for cold and hot reasoning. The architecture allows a full spectrum on the relative strength of cold and hot arguments for taking decisions and for persuasively supporting these decisions. This enables us to design experiments to empirically calibrate the architecture, to measure the interaction between hot and cold cognition/reasoning in artificial cognitive systems and to compare this with human behavior. Importantly, we can study how hot and cold cognition can mitigate each others weaknesses in decision making and persuasiveness.

1 INTRODUCTION

Aristotle defined three persuasion methodologies, namely, *ethos* (appeal to authority/honesty), *pathos* (appeal to emotions), and *logos* (appeal to logic). Gorgias, the philosopher of rhetoric, turned persuasion into a "science" by learning to use skillful arguments to support a position (a thesis) or indeed to support the opposite position (the anti-thesis) as the case may require. From these ancient works on persuasion, one sees the importance of considering and playing with the emotions of the people - hot reasoning/cognition - but also addressing their rational reasoning - cold reasoning/cognition - in order to produce a persuasive effect on them. Persuasion is most effective when people are "seduced" through their *pathos* and *reason* into a decision.

This paper is concerned with the study of computational persuasion through a synthesis of theory and methods from Artificial Intelligence and Cognitive Psychology. We aim to develop experimental artificial systems, whose foundation rests on a synthesis of cold, or rationally driven, and hot, or emotionally driven, reasoning and through which we can carry out empirical psychological experiments to examine various aspects of persuasion. The purpose is both to draw from Cognitive Science in building and refining these systems but also to use these systems to help us understand aspects of persuasion and in particular those aspects that would make these systems naturally effective cognitive assistants to human users.

For example, consider a scenario where a user is depressed and he may be reluctant to take his needed daily walk outside in the park. A persuasive system based on cold cognition would lead to the decision to take a walk at the usual time, supported by arguments grounded on the physiological and medical needs of the user. Hot cognition under the emotional state of depression, will support arguments to stay indoors and carry on watching TV.

What is a good decision for the user? To encourage him to go for a walk or to let him calm down, thus missing the walk? Furthermore, which decision can be best supported in the sense that it will have a better chance to be persuasive to the user at the current situation? In other words, what matters is not only the (objective) quality of the decision but also the ability of the system to find and present arguments to the user that would be persuasive. It is this concern of convincing the user that would help a persuasive system find a useful middle ground between the independent cold and hot decisions. The challenge is: (a) to be able to take into consideration both sides of cold and hot cognition; and (b) to be able to find decisions that are persuasively supported.

Persuasive technologies—technologies that are designed to influence the behavior of users [9]—are widely deployed in everyday interactive systems. Popular examples include persuasive technologies that augment and personalize the care of patients [8], motivate healthier life styles [5], encourage social interaction [23], promote safe driving behavior [3], promote global peace [15], and many more.

Research in persuasive technologies has shown that individuals differ in their susceptibility to persuasion—how individuals respond to certain persuasive strategies [14]. An important challenge for designing effective persuasive technologies is to understand users and their unique personal characteristics in order to choose the *"best-fit" persuasive strategy* to approach each individual. The idea is to take a particular decision and personalize the delivery by taking into consideration the users' unique characteristics and context of use [13]. However, which characteristics are considered important in order to make persuasive technologies effective through personalization and adaptation?

Researchers and practitioners have exposed the importance of emotional persuasion; effective persuasive technology should not only appeal to the users' practical needs but also to their emotional self. Research works have studied the role of emotions in the design of persuasive strategies; [19] examined the interplay between emotional and non-emotional strategies, [1] investigated whether emotions affect users' trust towards persuasive technology, [7] suggested that persuasion can be more successful when strategies are framed with emotional overtones that match the emotional state of the user.

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2 UNIFYING COLD AND HOT COGNITION THROUGH ARGUMENTATION

Guided by work in Cognitive Psychology (and Philosophy to some extent), we present a computational framework for persuasion technologies that is based on two principles: (a) argumentation captures the natural form of human reasoning; and (b) persuasion of individual users can only be effective if it also takes into account emotional arguments. Persuasion is critically affected by emotional considerations, depending on the general emotional character of a user, on his emotional stability (or emotion regulation) and on his current emotional state, that come to play along with cold arguments based solely on rationality. In addition, bearing in mind that individual differences in cognitive processing affect the way individuals control their emotions, e.g. people with high working memory capacity control their emotions more naturally than those with a more limited working memory capacity [22], such individual human characteristics are also considered for the delivery of a more refined persuasion strategy.

We propose a general architecture for persuasion systems that is based on a unified argumentation theory for cold and hot reasoning. Arguments are parameterized by needs, e.g. based on Maslow's hierarchy of needs [17], and emotions, e.g. based on HUMAINE's emotion annotation and representation language (EARL) [10]. Accordingly, the architecture allows a full spectrum on the relative strength of cold and hot arguments for taking decisions and for persuasively supporting these decisions. Decisions in argumentation are taken by building a case comprising of a set of arguments, S, that are dialectically acceptable in the sense that the arguments in S are able to defend against any counter-argument against S. Through this dialectical semantics of argumentation we aim to capture the processes of cold and hot reasoning that occur internally within the minds of people, when they are considering how to decide on a particular dilemma.

Argumentation can form a formal and computational foundation both for pure logical (deductive) reasoning but also for decision making amongst (conflicting) options under personal preferences that are also sensitive to the particular context in which we are taking the decision. Such personal preferences may be driven by utility needs and motivations or the high-level desires and emotional character of the person. Uniformly, argumentation can capture and integrate the whole spectrum of human reasoning from extreme rationality on one side to extreme emotions or pathos driven on the other side of the spectrum. Indeed, argumentation allows a description of human reasoning that escapes from a pure logical form giving higher flexibility in the process of decision making. For a review of the wider computational links between Argument and Cognition see [12] and [11]. More generally, the link between persuasion and argumentation is supported through several works in Cognitive Psychology, e.g. in [21, 20, 18].

The unified view of cold and hot cognition through argumentation helps to mitigate the dichotomy between these two forms of human reasoning and to bring them together to argue their case or possibly to unite in support of the same position in some decision cases. Figure 1 presents a framework that brings together the aforementioned aspects. The core of the framework is comprised of three main processes: *i)* the decision taking process that initially chooses a recommendation based on the needs of the user; *ii)* the persuasion taking process that aims to support the recommendation based on the emotional state of the user; and *iii)* the dialogue taking process that is responsible to deliver the persuasion strategy by considering the user's unique characteristics. All three processes are highly interrelated while setting up a persuasion strategy; from decision making to delivering the decision. In particular, decision making can critically depend on the persuasion degree of an option, determined by an evaluation on how convincing the arguments can be for the user. These three processes are driven by three models that surround them; what drives the decisions is on the one hand the high-level general characteristics of the user (i.e. emotions and needs), and on the other hand the situational input from the environment (that includes the user).

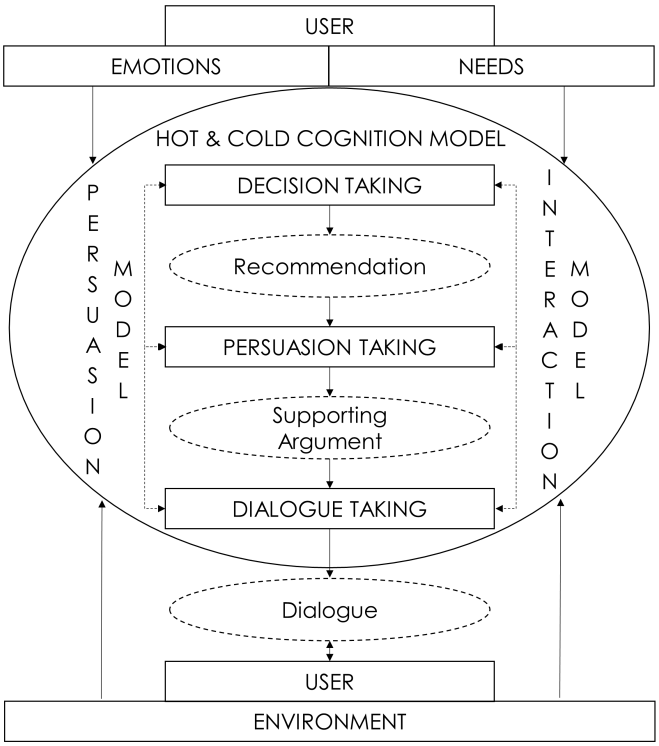

Figure 1. Framework for delivering persuasion strategies based on a hot and cold cognition model

3 COGNITIVE EXPERIMENTS FOR PERSUASION

A series of user studies are planned with the aim to best realize the proposed framework and empirically calibrate the architecture. We primarily aim: *i)* to study how cold and hot cognition interact and how they can mitigate each other's weaknesses in decision making; *ii)* investigate the interplay between decision making and persuasion taking towards effective persuasive argumentation; and *iii)* investigate the interplay between human factors, and cold/hot cognition arguments towards persuasion effectiveness.

Initially, in order to test the appropriateness of our approach in integrating cold and hot cognition, we plan to carry out a series of experiments of the "delayed gratification type" so as to examine the sensitivity of our cognitive assistant systems with respect to the incremental dependence on hot emotional cognition, i.e. where the relative strength of emotionally based arguments is gradually increased.

An important challenge of the experiments is *ecological validity* which requires that the experimental design, procedure and setting of the study must approximate the real-life context that is under investigation [4]. In order to address ecological validity, we will design

a series of user studies in which real users will be performing real-life tasks in their natural environment (home, work, etc.).

For each study design, we will set the objectives of the persuasion strategy and measure whether the objectives were met based on a given decision making and persuasion strategy. In particular, we are interested to measure the *Persuasion Index* of how effective the systems were in persuading the users to adopt recommendations. Utilizing a parametric cognitive assistant whose operation will be varied from totally cold to totally hot decision and persuasion making, we will investigate the interaction effect between cold and hot decision making and user parameters, such as type of personal needs, current emotional state, emotion regulation, etc., towards effectiveness of the strategy. Figure 2 illustrates the experimental parameters that will indicate the interplay between user parameters and the level of integration of cold and hot cognition, towards the degree of persuasion effectiveness (*Persuasion Index*). In order to examine these effects, we will follow grounded experimental methods utilized for the design and evaluation of user-adaptive interactive systems [2], such as performing A-B evaluation methods by splitting the sample of the user study into different groups, in which Group A will receive specific feedback from the cognitive assistant (e.g. based on pure cold decision taking) *vs.* Group B that will receive different feedback (e.g. based on hot decision taking). This will allow us to investigate the interaction effects between various experimental parameters and the decision making (Figure 2), towards the effectiveness of the persuasion strategy. For modelling the user parameters, these experiments will use wearable technologies to monitor and analyze physiological signals (e.g. heart rate, heart rate variability) for the recognition of the emotional states of the users, and accredited psychometric instruments and questionnaires for the recognition of human cognitive factors such as emotion regulation [16], working memory capacity [6], etc. With the aim to support the quantitative measures and triangulate the results, we will obtain qualitative measures through user feedback on their perceptions regarding the interactions with the cognitive assistant, their behavior and the decisions they have taken based on the persuasive strategies.

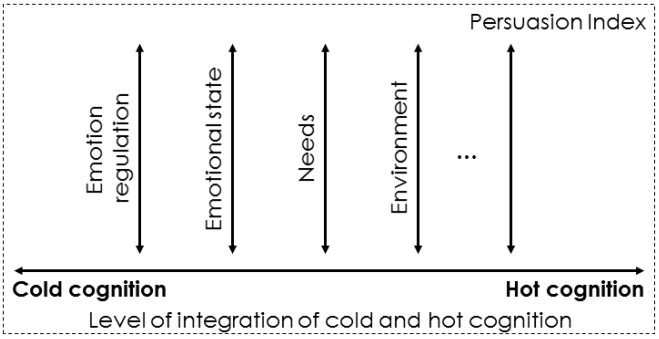

Figure 2. Experimental setup: Isolating a particular parameter (e.g. emotional state), we will split users into different groups according to their emotional states such as *stressed state* vs. *relaxed state*, and further provide various arguments to the users based on different levels of integration of cold and hot cognition. Accordingly, we will compare the persuasion effectiveness (measured through the Persuasion Index) between the different groups of users with the aim to investigate the interaction effects between the factor under investigation and the level of integration of cold and hot cognition arguments. Similarly, we will investigate other factors (e.g. emotion regulation, needs, environment, etc.) and their interactions with cold and hot arguments towards persuasion effectiveness

4 CONCLUSIONS

The aim of this work is to bring together theory and methods from Artificial Intelligence and Cognitive Psychology to study the interplay between cold and hot cognition in persuasion. Using computational argumentation theory as a theoretical basis for building cognitive assistants we aim to study the development of effective persuaders informed by systematic empirical psychological studies of evaluating the quality of decisions and degree of persuasion of these systems.

REFERENCES

[1] Wan Nooraishya Wan Ahmad and Nazlena Mohamad Ali, 'Investigation into trust and emotion in persuasive technology', *New Zealand Journal of Computer-Human Interaction*, **1**(1), (2016).

[2] Marios Belk, Christos Fidas, Panagiotis Germanakos, and George Samaras, 'Do human cognitive differences in information processing affect preference and performance of captcha?', *International Journal of Human-Computer Studies*, **84**, 1 – 18, (2015).

[3] Anne Bergmans and Suleman Shahid, *DriveRS: An In-Car Persuasive System for Making Driving Safe and Fun*, 469–472, Springer Berlin Heidelberg, Berlin, Heidelberg, 2012.

[4] Marilynn Brewer, 'Research design and issues of validity', in *Handbook of research methods in social and personality psychology*, eds., Harry Reis and Charles Judd, 3–16, Cambridge University Press, (2000).

[5] Sunny Consolvo, Kendra Markle, Kevin Patrick, and Kara Chanasyk, 'Designing for persuasion: Mobile services for health behavior change', in *Proceedings of the 4th International Conference on Persuasive Technology*, Persuasive '09, pp. 11:1–11:1, New York, NY, USA, (2009). ACM.

[6] Andreas Demetriou, George Spanoudis, and Michael Shayer, 'Developmental intelligence: From empirical to hidden constructs', *Intelligence*, **41**(5), 744 – 749, (2013).

[7] David DeSteno, Richard Petty, Derek Rucker, Duane Wegener, and Julia Braverman, 'Discrete emotions and persuasion: The role of emotion-induced expectancies', *Journal of Personality and Social Psychology*, **86**, 43–56, (2004).

[8] C. Elton, *'Laura' makes digital health coaching personal*, The Boston Globe, 2007.

[9] B. J. Fogg, 'Persuasive technology: Using computers to change what we think and do', *Ubiquity*, **2002**(December), (December 2002).

[10] HUMAINE. Emotion annotation and representation language, 2017.

[11] Antonis Kakas and Loizos Michael. Argument and cognition, 2016.

[12] Antonis Kakas and Loizos Michael, 'Cognitive systems: Argument and cognition', *IEEE Intelligent Informatics Bulletin*, **17**(1), 14–20, (2016).

[13] Maurits Kaptein, Boris De Ruyter, Panos Markopoulos, and Emile Aarts, 'Adaptive persuasive systems: A study of tailored persuasive text messages to reduce snacking', *ACM Trans. Interact. Intell. Syst.*, **2**(2), 10:1–10:25, (June 2012).

[14] Maurits Kaptein, Joyca Lacroix, and Privender Saini, 'Individual differences in persuadability in the health promotion domain', in *Proceedings of the 5th International Conference on Persuasive Technology*, PERSUASIVE'10, pp. 94–105, Berlin, Heidelberg, (2010). Springer-Verlag.

[15] Stanfords Persuasive Tech Lab. Peace innovation lab, 2017.

[16] Zacharias Lekkas, Nikos Tsianos, Panagiotis Germanakos, Constantinos Mourlas, and George Samaras, 'Emotional web-based design: the concepts of emotional experience and emotional expression', in *Proceedings of the IADIS international conference on interfaces and human computer interaction*, IHCI 2011, pp. 283–290. IADIS, (2011).

[17] Abraham Maslow, 'A theory of human motivation', *Psychological Review*, **50**(4), 370–396, (1943).

[18] H. Mercier and D. Sperber, 'Why do humans reason? arguments for an argumentative theory', *Behavioral and Brain Sciences*, **34**(2), 57–74, (2011).

[19] Maria Miceli, Fiorella de Rosis†, and Isabella Poggi, *Emotion in Persuasion from a Persuader's Perspective: A True Marriage Between Cognition and Affect*, 527–558, Springer Berlin Heidelberg, Berlin, Heidelberg, 2011.

[20] F. Paglieri, L. Bonelli, and S. Felletti (eds), *The Psychology of Argument: Cognitive Approaches to Argumentation and Persuasion*, Studies in Logic and Argumentation, College Publications, 2016.

[21] R. E. Petty, J.T. Cacioppo, and R. Goldman, 'Personal involvment as a determinant of argument-based persuasion', *Personality and Social Psychology*, **41**(5), 847–855, (1981).

[22] Brandon Schmeichel, R Volokhov, and Heath Demaree, 'Working memory capacity and the selfregulation of emotional expression and experiencen', *Journal of Personality and Social Psychology*, **95**(6), 1526–1540, (2008).

[23] John Paul Vargheese, Somayajulu Sripada, Judith Masthoff, and Nir Oren, 'Persuasive strategies for encouraging social interaction for older adults', *International Journal of HumanComputer Interaction*, **32**(3), 190–214, (2016).