From Individual to Collective Attention – Models and Dynamics

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VISION

In media-rich living spaces (like cities of the future, urban and rural living residencies, virtual societies, etc.), where thousands of people are overflooded with signals and messages at all levels of perception and modalities (visual, auditory, tactile, olfactory) while engaging -actively or passively- in the mechanisms of social life and society, the (i) *dynamics of individual attention* and the (ii) *emergence of collective attention* appear to be among the most demanding challenges of the information society. It is of high interest to understand how spontaneous, local, individual attention to novel information items occurs, propagates and eventually fades among large populations.

Some two decades of pervasive and ubiquitous computing research have clearly revealed [1], that out of the many indicative design factors for modern ICT, human attention is the first source of perception, consequently als awareness towards information and other individuals. As such, human attention represents the primary concern in the design and operation of pervasive, socio-technical systems [2].

Over the last decades, attention research has succeeded in identifying several attention types as well as physiological mechanisms and neural processes and revealing its relation to memory, learning, decision making and perception [3] [4]. In the history of attentional research many different attentional mechanisms have been discovered and according descriptive models have been developed. Usually, these models adequately describe single or several aspects of attention, e.g. the ambiguity of single- and multi-tasking capability, whereas a general, overall theory of attention is still missing.

APPROACH

We favor a synthesis driven research approach, combining (i) existing theory and its assessment, with (ii) insights from analysing large data sets collected from operational socio-technical systems (mobile communications networks, TV and broadcast networks, road traffic and transportation networks, social networks on the WWW, Internet of Things networks, etc.)

Synthesis of Attention Models The first step towards human attention models as the underpinning design, deployment, operational and evolutionary principles of *Socio-Technical Systems* is to understand, and in further to have reliable models on how individuals perceive (i) reality, (ii) other individuals, and the (iii) collective behaviour of human societies. Crucial towards collective attention is to understand from observations of the attention of individuals the potential impact to collective behaviour. A possible approach is to start with established attention models developed in cognitive and social sciences (*Theory Driven Models*, TDMs), and to try to validate them with datasets drawn from real world settings (e.g. using the research methods of the Computational Social Sciences like Reality Mining and the analysis of Big Data). The empirical support for TDMs will then related to findings gathered from empirical observations (Data Driven Models, DDMs). The synthesis of the two respective model categories (TDMs and DDMs) will thus represents the foundational grounds for formal models of individual and collective attention, combining the rich body of cognitive models from neuroscience and artificial intelligence, with evidence from the symbiosis of real world societies and real world ICTs.

Synthesis of Information Diffusion Models The process of the emergence of collective attention is steered by the way how information is shared in societies. Understanding the ways of imformation diffusion has attracted research in many, even complementary fields (social network analysis, epidemology, anthropology, social psychology, organizational theory, network science). Most of the analysis techniques, and thus most of the existing theories for information diffusion have been developed in sociology, mathematics, statistics and recently in computational social sciences and network science. Again, to relate this pure theory driven models (TDMs), with findings from exposing huge socio-technical system data sets (mobile communications data, traffic mobility patterns, smart meter readings, public display frequency and attention counts, etc.) to advanced mining techniques (DDMs) will unveil the underpinning support of information diffusion to the raise and fade of collective attention in societies.

IMPACT

More than two decades of pervasive and ubiquitous computing research have brought the vision where the “computer” is no a single device or a network of devices, but rather the entirety of all services originating in a digital world (i.e. a globe-spanning, dynamic, complex infrastructure), which are perceived through the physical world (i.e. technology rich spaces and objects of everyday use).

In this emerging symbiosis of the digital and the physical world, human attention is the most crucial, yet least understood, but fundamental underpinning of a flourishing human computer confluence.

The development thus of a (i) body of formal methods and computational models for attention, together with the respective (ii) design principles, (iii) operational principles, and (iv) evolutionary dynamics represents the foundational underpinning of a novel, "human-friendly" ICTs - as future generation ICTs apparently will have to be grounded on (i) individual socio-cognitive capacities (attention, perception, expectation, belief, meaning, trust, experience, forgiving and empathy) and (ii) collective social capacities (social adaptiveness, social self-organization, collective consensus) [5].

REFERENCES

[1] A. Ferscha: "20 Years Past Weiser: What's Next?", IEEE Pervasive Computing, Vol. 11, No. 1, pp. 52-61, 2012.

[2] D. Garlan, D.P. Siewiorek, A. Smailagic, P. Steenkiste: "Project Aura: toward distraction-free pervasive computing", IEEE Pervasive Computing, Vol 1, No 2, pp 21-31. Apr-Jun 2002.

[3] C. D. Wickens and J. S. McCarley. Applied attention theory. CRC Press, Boca Raton, 2008.

[4] S. Masmoudi, D.-Y. Dai, A. Naceur: "Attention, representation, and human performance : integration of cognition, emotion, and motivation", New York : Psychology Press, 2012.

[5] P. Lukowicz, A. Pentland, A. Ferscha: "From Context Awareness to Socially Aware Computing", IEEE Pervasive Computing, Vol. 11, No. 1, pp. 32-41, 2012.