International Journal of Advancements in Technology

Aiken and Chan, Int J Adv Technol 2015, 6:2
DOI: 10.4172/0976-4860.1000146

Research Article Open Access

Cyber Criminology: Algorithmic *vs.* Heuristical Approaches for Analysis within the Human Trafficking Domain

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Abstract

Advancing technologies afford new dimensionality to the modus operandi of cyber criminals, thereby – arguably - increasing the sophistication that is required for the investigation and profiling of criminal populations in the cyber context. Online classified adult advertising websites are leveraged to facilitate human trafficking. The problem of human trafficking is not confined geographically with more than 20 million victims of human trafficking around the world, it is an issue of global importance. The present study, inspired by the White House Tech. *vs.* Human Trafficking initiative, has shown that the velocity and sophistication of adaptation by cyber actors, who are disseminating images within the human trafficking domain, provide a discernible morphology. There is, therefore, a potential opportunity moving forward, for those involved in the White House Tech *vs.* Human Trafficking venue and the community of action-at-large, to actively collect, analyze, evaluate, and actuate upon the escalating body of publicly available Big Data and move towards Big Insights to facilitate more robust decision-making for directed interventions. The sophisticated nature of technology-facilitated human trafficking in cyberspace, continuous data creation, more intuitive software, surging cycles of adaptation, the macrotrending of online dynamism, increasing velocity, and the complexity and overall scale emphasizes the need for international collaborative information sharing, an interdisciplinary approach, activation of diverse skill sets, a heuristical as opposed to algorithmic perspective, and exploration of innovative structured scientific investigative methodologies.

Keywords: Human trafficking; Heuristics; Cyber criminals; Creativity; Big data big insight; Content-based visual querying; Data analysis

Introduction

"Trafficking in persons" or "human trafficking" are terms for activities involved when one person obtains or holds another person in compelled service. The U.S. Department of State Report [1] describes major forms of trafficking as forced labor, sex trafficking, bonded labor, debt bondage among migrant laborers, involuntary domestic servitude, forced child labor, child soldiers, and child sex trafficking.

Advancing technologies afford new dimensionality to the modus operandi of cyber criminals. It has been established that online classified adult advertising websites are leveraged to facilitate criminal human trafficking [2,3]. At the time of the study it was reported that during April 2013 the leading U.S. publisher of online prostitution advertising "published 67,800 online listings for escorts and body rubs – both considered euphemisms for prostitution – in 23 U.S. cities" [4]. The Washington Times reported that according to the National Center on Sexual Exploitation (NCSE) one website had become "the leading online site for prostitution and trafficking advertising, garnering over 80 percent of online prostitution advertising revenue," outlining that the website's adult ads "make up the foundation of a booming modern sex trafficking industry…it is a violent business that preys on the young and vulnerable, yet one that hides that reality behind a sense of normalcy created by sites" [5]. The sheer volume of online classified adult advertising and the ensuing potential human trafficking activity, as well as increasing technological sophistication of the cybercriminal population, necessitates a 'big data big insight' approach to the problem space.

The problem of human trafficking is not confined to a specific geographic locale; every region of the world is affected by trafficking, either as source, transit or destination countries [6]. With more than 20 million victims of human trafficking around the world, it is an issue of global importance that is subject to the forces of a dynamically evolving world in which the velocity, volume, and variety of methodologies and tools for manipulating images, as well as the associated search engine heuristics for filtering and/or ranking them, are ever-increasing. Accompanying this phenomenon, the rate of data creation in this domain far outpaces the mechanisms for data analysis - a central issue in an ever-growing number of domains that rely upon robust content-based visual querying [7] and other means of layered analysis.

There exist very useful applications in terms of generating unique forensic digital image signatures (the algorithmic generation of fingerprints based upon visual content as contrasted to fingerprints calculated by prototypical binary hash functions) that can be compared to signatures of other images to find matches, However, if the image has been adjusted substantively (in the case of sophisticated cyber actors facilitating human trafficking), then this is problematic, for unless robust query expansion [8] methodologies (as opposed to techniques, such as Query-By-Example, which rely upon the potentially specious assumption that all the relevant topical images are congregated inside the target visual feature space (i.e. cluster hypothesis), reside within the same visual cluster, and/or are physically clustered near the query image) are utilized, results will be missed. Existing technologies would, therefore, be algorithmically functional, but heuristically compromised. In essence, the algorithms underpinning current analysis systems cannot keep pace with the cycles of adaptation (for the

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Received September 04, 2015; **Accepted** October 02, 2015; **Published** October 12, 2015

Citation: Aiken M, Chan S (2015) Cyber Criminology: Algorithmic *vs*. Heuristical Approaches for Analysis within the Human Trafficking Domain. Int J Adv Technol 6: 146. doi:10.4172/0976-4860.1000146

eluding of detection by prevailing investigative methodologies/tools) characterizing the online dynamisms of cyber actors within the human trafficking space.

Sophisticated cyber actors facilitating human trafficking are altering images at high velocity- reducing identifiable clutter theorized as *Clutter Hypothesis* compensating for the under saturation of cyan tones/oversaturation of other tones by digital cameras, presenting flesh tones that better resonate with target demographics, and enhancing image features (e.g. removing blemishes, wrinkles, contours, etc.). Hence, given that the creation and refinement of algorithms will consistently remain one or more steps behind the adaptations by those cyber actors facilitating human trafficking, an emphasis is placed upon those more difficult to obviate analysis heuristics. Artificial phenomenon, such as *Spontaneous Somatype Transmogrification* (Endomorph -> Mesomorph -> Ectomorph), *Anachronistic Wrinkle Geography* (Under Eyes, Side of Eyes, Forehead, Hands) and *Snakelet Development* [9] (manipulated age reversal), altered facial feature ratios and patterns (e.g. Duchenne smile), clothing mesh distortions, et al. can also be considered. After all, those human trafficking cyber actors cannot escape the longitudinal corpus of digital images, which have been cached, propagated, and preserved, via venues, such as the Internet Archive's Way Back Machine, The White House Office for Science and Technology and the Council on Women and Girls convened a workshop "Tech. *vs* Trafficking" in July 2012. Experience and creativity [10] were key participation prerequisites. Along this vein, cognitive scientists and theories of creativity describe innovative thinking as fluid [11]; regarding creativity, [12] asserts that "unlike algorithms, heuristic paths might not have a clearly defined goal and do not unfold in a straightforward manner." This notion is echoed by [13], who describes scientific creativity as "constrained stochastic behavior." Furthermore, [14] considered the heuristic nature of tasks as part of the creative process.

Flow research has emphasized dynamic systems [15] and is an important construct regarding capturing creative experience. Arguably, flow, fluid, stochastic and dynamic constitute a heuristical approach to innovative scientific problem solving for effective creative outcomes [16] and is particularly apt given the complexity, scale, and dynamic nature of technology-facilitated human trafficking. Concerning the present human trafficking research study, paucity apropos primary data (i.e. sparse data paradigms) was addressed by an innovative solution. Digital preservation initiatives (e.g. the Wayback Machine) provide a rich corpus for longitudinal research and can be considered as inherently Privacy by Design (PbD) [17]. The Wayback Machine is an offering of the Internet Archive working to prevent the Internet offerings of historical significance and other "born-digital" materials from disappearing. Collaborating with institutions including the Library of Congress and the Smithsonian, Wayback is working to preserve a record for generations to come, and more than 432 billion web pages have been archived from 1996 to 2015.

Aim

The aim of this study was to test advanced dynamic robust query expansion methodologies in the analysis of online classified escort advertisements. Algorithmic versus heuristical approaches for analysis were considered. This study was undertaken with a view to establishing the existence of detectable morphologies that might illuminate the problem of technology-facilitated human trafficking, and specifically the actions of sophisticated cyber actors, who facilitate human trafficking in online environments. An inter-disciplinary approach was conceptualized in order to combine human and machine heuristics, and in doing so, endeavor to leverage scientific creativity. It was anticipated that findings might be obtained that may otherwise have been missed by established technologies.

Method

An outcome of the White House Combatting Human Trafficking Initiative was the development of a domain-specific methodology that is, relating - via network/relationship science - isomorphic heuristical problem-solving experiences for the illumination of discernible morphologies, which segues to lower ambiguity and an enhanced observational space. The present study was comprised of analysis of 510 days of data from adult classified websites archived, via the Way Back Machine, from 2009 to 2013, in excess of 10,000 images. The sophistication of digital image cyber actors is increasing rapidly, as sophisticated software tools become less expensive and more intuitive to use. A degrade-perturb-observe methodology was employed to distinguish the most sophisticated digital image actors (by way of velocity, volume, and variety) from the most simplistic digital image actors, and a hermeneutic examination of the transitions between states (sophistication and cardinal number) over a period of time revealed certain morphologies.

Results

Initial findings indicate that the velocity and sophistication of adaptation by cyber actors, who are promulgating images for the human traffic domain, provide a detectable morphology- an extrapolation of Locard's exchange principle "every contact leaves a trace," particularly as pertains to cyber contexts [18,19]. Compressed cycles of adaptation, by which the cyber practitioner can adapt to the prevailing search engine optimization heuristics for topical quality images that are responsive to the queries of both the central tendency convergence as well as various target demographics, are indicative of the current state of proficiency and sophistication. The research involves content-based visual querying methodologies. Using advanced dynamic robust query expansion methodologies, results were obtained that would have been missed by other prevailing techniques.

This research illustrates the move away from desktop level datasets towards the spirit of an "N= (all)" [20] Big Data paradigm. As the methodological impetus moves from limited subsets to more robust sets, so too does the corpus expand for the problems that can creatively be solved, well beyond the human trafficking space, within other isomorphic arenas.

Conclusions

There is, therefore, the potential for continuing to conceptualize innovative methodologies and reactive complex heuristic systems that will actively collect, analyze, evaluate and actuate upon the burgeoning corpus of publicly available Big Data and move towards Big Insights [21] so as to facilitate more robust decision-making for directed interventions; indeed, the implications of this research approach may extend far beyond the problems posed by human trafficking, extending into the realm of tackling other technology-facilitated digitally exploitative crimes, such as generation and distribution of indecent images of minors.

Fundamentally, by combining human with machine heuristics, this paper articulates the heuristical sense making amplification for the illumination of the complex sector of human trafficking. Flow, fluid, stochastic and dynamic - in terms of analytic approach - conjoined with the gamut ranging from the heuristics of collaborative human insight to the heuristics of robust machine decision engineering,

collectively serve as a springboard for the Lickliderian symbiosis of man and machine in scientific exploration and investigation of cyber-criminal activity.

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