

A Step Towards Modeling and Destabilizing Human Trafficking Networks Using Machine Learning Methods

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Abstract

Human trafficking is a multi-dimensional problem for which we have incomplete data, limited knowledge of the exploiters, and no understanding of the dynamics of the process. It is a problem that requires a larger, more complete database, understanding of key actors and their interactions in a dynamic environment. These methods exist in the areas of Data Mining, Machine Learning, Network Analysis, and Multi-agent systems. Using these methods, it is possible to create a model which is unique to detecting and preventing human trafficking. These methods can give applicable and successful solutions for different components of the problem of human trafficking. The goal is to build an intelligent system to enable collaboration and analysis, to identify and profile victims, traffickers, buyers, and exploiters, to predict human trafficking patterns, and to disrupt and destabilize human trafficking networks.

In this paper, I will outline how some of these methods may be able to help analyze and model the dynamic phenomenon of human trafficking. The purpose is to see whether, using intelligent systems and appropriate collaboration and analysis tools, optimized intervention strategies can be created to profile victims and traffickers as well as impact, dissolve, and disrupt the human trafficking network in such a way that the network is unable to recover.

Introduction

Human trafficking can be viewed as modern day slavery. Human trafficking is the third largest source of profit for global organized crime, after drugs and arms. It is also one of the fastest growing crimes. According to the UN, 700,000 women, children and men end up in human trafficking every year. US Department of State estimates that approximately 80 percent of the victims are women and girls. According to the International Labor Organization, forced labor makes profits of US\$32 billion a year. About half of this is made in industrialized countries and about one-third is made in Asia.

Although human trafficking is a very serious problem, until recently there was no precise definition for it, which made it even more difficult to understand the problem. The

UN Protocol to Prevent, Suppress and Punish Trafficking in Persons, especially Women and Children, defines human trafficking as (UN 2000),

The recruitment, transportation, transfer, harbouring or receipt of persons, by means of the threat or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of power or of a position of vulnerability or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purpose of exploitation. Exploitation shall include, at a minimum, the exploitation of the prostitution of others or other forms of sexual exploitation, forced labour or services, slavery or practices similar to slavery, servitude or the removal of organs.

Knowledge about the structure and the dynamics of human trafficking networks is important for investigation, development and implementation of effective strategies to attack the problem and destabilize trafficking networks. It is crucial to understand the conditions necessary for trafficking to exist and for it to be maintained. However, the heterogeneous and complex nature of the phenomenon of human trafficking, i.e. involvement of a large number players and many geographical locations, has only made the problem worse and therefore difficult to understand. This complexity makes it extremely difficult to model and predict human trafficking patterns and design effective policies.

Some of the challenges to end human trafficking can be summarized as follows.

Lack of comprehensive data and reluctance to share data:

- There is no reliable data on the distribution of victims, traffickers, buyers, and exploiters;
- Much of the available data is not shared.

Lack of a visual representation:

- There is no representation of trafficking routes, migration flow, monetary flow, etc. from origin, transit, and destination regions;
- There is no map that ties in the social, economic, or political drivers of the problem with its location.

Lack of complete knowledge:

- There is no globally common understanding of the problem;
- There are too many actors whose roles and importance is unclear;
- There is no study on the demand side of the problem - no understanding of who the traffickers and the buyers are.

Complexity of the problem:

- The nature of the problem is heterogeneous and complex due to many actors and many interactions.

Dynamic evolution of the problem:

- The system's behavior changes in time and we do not understand how.

Lack of Awareness:

- Many victims and potential victims are unaware of the dangers of trafficking and the ways in which they can be deceived or pushed into exploitative labor.

Lack of relevant policies and capacity to respond:

- There is no knowledge of how the problem changes over time, hence designing relevant policies and measuring impact and effectiveness of policies is difficult.

In 2006, NY times published an article about a human trafficking case in New York. Thirty-one people were found to be linked to a trafficking ring and were arrested.

Recruiters who worked for the trafficking ring would go to Korea in search of women who wanted to come to the United States and either supply them with false documents to travel to the country or smuggled them across United States borders with Mexico or Canada, officials said. Once delivered to a brothel, managers would typically take away their identification and travel documents (Vasquez, 2006).

The information for the case came from an investigation of a brothel in Queens. During the Queens investigation, the officials obtained "court-authorized wiretap of a cell phone used by Tae Hoon Kim, a Flushing-based middleman and transporter. That wire-tap led to the discovery of a network of Korean-owned brothels".

In 2009, eight people in NJ, who were involved in a sex trafficking ring, were arrested and charged (Santiago, 2009). The ringleader Brown and seven other people, including his mother, niece, and his high school girlfriend were involved in trafficking women, all of whom were

between ages 17 and 43. The women were from slum streets in Newark, Camden, Atlantic City, Elizabeth, and Philadelphia. Brown was doing this for approximately twenty years; he was arrested because eventually someone came forward and cooperated with the authorities. He recruited local "soldiers" to keep things under "control". Jersey City Police Chief said, "The arrest and subsequent indictment of Allen Brown is another example of the positive results achieved when law enforcement agencies join forces".

The two cases as well as the challenges listed above make the need for intelligent systems clear and obvious. We need intelligent systems that can facilitate collaboration and aid in analysis of the heterogeneous factors. Based on this, action can be taken to identify victims/traffickers/exploiters, to prevent key interactions (transactions, communication channels, etc.), to disrupt and destabilize human trafficking networks, and to assist in policy-making.

From the two cases above as well as research studies, it is clear that there is a need for a system that can help provide intelligent victims and traffickers identification methods. Identification methods and collaboration are crucial in order to combat and prevent human trafficking. Criminal data is collected by authorities and institutions while data on victims is collected by NGOs and service providers. The data is usually dispersed and not shared. Each collects data for its own local purpose and is fragmented, hence, no general or global trends are found. Even when data is compiled in one place, there are no learning algorithms used and hence important trends may be missing. Data mining and machine learning techniques can allow different agencies and organizations to share data and collaborate. Different types of data can help in providing a more complete picture of the entire process of human trafficking. Using these methods, key patterns can be identified, which could give important characteristics of victims and traffickers, thus helping officials in identifying them.

After the arrests of the eight people, investigators in the Brown case were trying to determine if the ring operated in additional locations. Knowing the connections of everyone in this case would help in determining if there exist other brothels run by Brown. In the other case, recruiters who worked with the brothels in New York frequently went back to Korea to recruit more women. They were relying on their connections in their networks - from locals in Korea to the brothel owners in New York. Additionally, because of Kim's connections, which were discovered using his cell phone, led to more arrests and exposed other actors in the trafficking network. It is clear from both examples that examining networks, such as social networks or communication networks, will provide critical information to combat trafficking. Network analysis can help to find associations among actors, as well as identify other types of connections such as communication channels, financial transactions, etc. Using these methods, the roles of key actors as well as the evolution of

trafficking networks over time can become clearer, thus allowing officials to design better intervention strategies.

Multi-agent systems can help to relate the heterogeneous local behavior of agents to the macro behavior of the larger system. Examining the interactions of victims, traffickers, and buyers in the system helps to determine which locations are most susceptible to becoming places of origin, transit, or destination. According to a report,

There is a great need for a human rights impact assessment tool to analyze and assess anti-trafficking laws, policies and measures". They say such a tool is need because "There is a lack of (technical) ability to analyze, make impact assessments and find solutions, especially in situations where the needs and interests of various sectors and communities; intersect each other and human rights issues are more complicated than what meets the eye (The Humanist Committee on Human Rights, 2007).

Impact and effectiveness of policies and intervention strategies can also be measured using multi-agent systems. Such an analysis can help NGOs, service providers, and policy makers because currently there is no other way to evaluate policy impact.

The role of intelligent collaboration and analysis systems is crucial for all researchers, agencies and organizations for fighting human trafficking.

Data Mining and Machine Learning

Data, and hence trends, can sometimes be hidden within a bulk of confusing information. A powerful and a necessary tool to prevent human trafficking is data mining with machine learning. It can automate the process of searching, discovering, and recognizing important features and patterns in databases. Data mining and machine-learning tools and techniques for extracting rules, clusters, and decision trees from the data can help to predict trafficking-related crimes as well as profile victims, traffickers, and exploiters. These can be used to detect unusual patterns, relevant to trafficking-related activities and crimes.

What is missing?

Human trafficking related activities are hidden. The problem is that one does not know when it will happen and how to identify signs and patterns until it is too late. As of now, data sharing doesn't happen very frequently and hence the solutions have been limited. Data mining is a natural way for different agencies to collaborate and share information in order to find patterns that we are currently unable to do so. These techniques may provide answers to questions such as when or where is trafficking most likely to take place, what are the characteristics of a trafficker or a buyer.

What is it?

Machine learning and data mining provides analytical methods for handling large amount of data. These techniques are about extracting rules from structured, semi-structured, or unstructured data and uncovering new patterns that may assist in understanding the process better. It is not about just collecting and storing data; it also includes collaboration, analysis and forecasting. Data mining uses a variety of techniques, including association, classification, clustering, and forecasting, to examine the data.

How can it help?

A data mining system with a machine learning component would be an attempt to provide part of the intelligence that can help officials, researchers, organizations, and policy makers collaborate and understand problem better. With the help of experts in data mining and machine learning field, one of the most challenging parts can be attacked - neural networks, decision-trees, machine learning algorithms can be used to help discover potential trafficking related events *across* different distributed databases and detect kidnapping, abuse, runaway teens, drug arrests, prostitution, terrorism, pornography, as well as other crimes associated with human trafficking.

Forecasting would help provide answers to questions such as, "Is trafficking likely to occur in a community or place X?" This can help organizations provide suitable services and resources to a given community. Data mining can also help in creating and analyzing profiles of victims, traffickers, and other actors from any given area. It can also look at other trafficking-related activities and crimes to identify unusual events that may be linked to trafficking.

After going through the whole process from data selection to analysis, again with the help of experts, tools from data visualization can be used to visualize the results of the analysis. For example, maps of trafficking hot spot locations or high activities areas would provide help in identifying crime patterns and recurrences trafficking-related activities.

Network Analysis

The basis of network analysis is that individual nodes are connected by fairly complex yet understandable relationships that form networks. Human trafficking organizations and processes are well-suited to study using network analysis since they consist of networks of individuals and groups that span states, countries as well as economic status, and form around specific social ideologies and processes.

What is missing?

Traffickers' and exploiters' network is generally consciously constructed with secrecy in mind; hence the

configuration may be such that the damage to the network as a whole will be minimized, even if a link is affected. This means many ties stay hidden because of the need for covertness and hence analysts and officials would have incomplete knowledge without network analysis. Knowledge about the structure of a human trafficking network, from beginning of the process to the end, is extremely important and is missing.

What is it?

Social networks are basically nodes of individuals, groups, organizations, and other such systems that are connected by various aspects of human relationships and interactions that depend on: values, beliefs, ideas, and ideologies; social contacts and capital; friendship; conflict; monetary exchanges; information exchanges; group participation in any event or ritual; etc. The central characteristic of network analysis is its focus on the structure of relationships and interactions.

How can it help?

Network analysis can contribute to the solution via the ability to identify the hidden dynamics inside the traffickers' community. It can be used to measure relationships in trafficking networks, and to identify central structures (individuals, groups, paths, etc.) that facilitate or block flow (monetary, knowledge, communication, trafficking, etc.).

This tool can provide answers to some of the following questions:

- Removal of which node, i.e. individual, group, etc., would change the network structure significantly?
- Which nodes are unlikely to be affected if the network changes?
- Which nodes and paths can propagate flow (such as information) most rapidly? How can this flow be impeded or accelerated? (This information may be helpful in raising awareness of trafficking for those at risk of being trafficked)
- How does the economic (and political, personal, social) factors of the victims and the community shape the structure of the network?
- How can the victim's social network be enlarged? How does this affect the victim's probability of escaping the situation?
- How do risk and the need for secrecy (for traffickers) and security shape the structure of the network?
- Who is likely to be an extremely important person (node) in the network? Why is this node so important?
- Which nodes are highly/less connected?
- What are the position roles in the network? What is the structure, i.e. subgroups, triads, etc.?
- How efficient is the network?
- How can the network be disrupted and destabilized? (Law agencies can use this data to

design policies and intervention strategies. Destabilization can mean several things from minimizing monetary flow for traffickers, making the network less adaptable, etc.)

- What does the network look like after some period of time? (This can help in studying long term effects of policies, etc.)

Networks can be destabilized by studying position roles, structure cohesion, centrality, and dynamics of the system. In the long term, to plan policies and interventions, it is necessary to be able to predict the rise and fall of various criminal networks that play a key role in recruitment practices. For example, suppose a victim gives a name of one of his/her trafficker, then carrying out communication network analysis of the trafficker using his phone number and numbers he has called, duration of the calls, and sequence of the calls etc., may provide a network structure which might reveal new connections and new actors. Along with the information from the database, this information can be extremely useful in determining who the key players are by examining which individuals have the most links to others in the network.

Dynamic network analysis can be used to study how the system adapts to disturbances caused by specific interventions, i.e. to study whether or not the system will revert back to its original state or reorganize into a new system.

Multi-Agent System

Network analysis allows for global analysis, while multi-agent networks allows for micro-level analysis. Multi-agent models of adaptive agents established in social networks can be used to address issues of network destabilization by providing intervention strategies and policy guidance. Because of the complexity of the problem, due to local interactions, multi-agents modeling is well-suited to study human trafficking. Human trafficking processes and organizations display complex adaptive systems. Multi-agent network models, if based on known information about general or specific characteristics of groups (such as social networks), can suggest guidance and strategies about how to affect or protect an underlying group, i.e. those at risk of being trafficked or current victims.

Creating a multi-agent system that can mirror the dynamics of the human trafficking process and the decision-making of traffickers and victims helps not only to develop a deep understanding of the causes and the effects of the problem, but it can also help to simulate a wide range of scenarios and policies, thus allowing policy makers to determine effective policies over a range of scenarios.

What is missing?

Large proportion of conventional trafficking analysis involves examination of global patterns, i.e. at a macro level, to make predictions of the behavior at micro-levels. However, there is a gap between the observed global trafficking patterns and the micro level theories about the problem. Currently, there is no way to see what type of micro-level behavior gives rise to the global patterns we see in trafficking.

What is it?

Multi-agent systems provide a tool to test the consequences of our theoretical assumptions and policies regarding the problem by creating a system of actors and interactions between them based on our theories. The aim is to model this complex system. An agent is generally autonomous and can control its own actions based on a given set of rules and can interact intelligently with its environment. The system would be an intelligent adaptive system that is both constrained and driven by the networks in which it exists. This means a multi-agent network model can be used to assess the complex structure and investigate the adaptive evolutions to study emergent behavior, such as new types of vulnerabilities or risks that may arise as a result of micro-level interactions between agents.

Agents must have a reasoning system and learning ability, which means they must reason and decide to achieve a plan according to varying constraints. This will result in a different set of decisions by agents. Human trafficking involves multiple, conflicting interests and beliefs of traffickers and potential victims, hence we need appropriate decision analysis methods in order for agents to make better decisions. In order to do this, I will be studying various decision making methods that can be applied to multi-agents models. Using decision algorithms, it can become possible to predict the behavior of the agents and the dynamics of the system in various conditions and situations, even if we're lacking complete information of the system.

How can it help?

As noted earlier, human trafficking has many heterogeneous actors, hence via multi-agents models, we can relate the heterogeneous behavior of agents with different decision rules, actions, and situations to the macro behavior of the larger system. Examining the interactions of victims, traffickers, and buyers in the system helps to determine which locations are most susceptible to becoming places of origin, transit, or destination. With this information combined with relevant trafficking data and models, the probability of trafficking occurring (and being maintained) in various places as well as the probability of a person being trafficked can be estimated.

Using the literature on human trafficking, we can establish the factors that affect human trafficking and which must be included in the model. Social networks can then be used as a guide to code in social aspect and the

impact of the changes in these networks, on the process of trafficking, can be simulated. Using multi-agent systems, we can attempt to examine the emergent properties of the system to evaluate whether our micro-level theories are able to explain the global patterns of trafficking. It is clear that agent-based modeling will be an iterative process and this process will depend on the complexity of the model of trafficking and the availability of the relevant data for trafficking.

Trafficking networks are constructed on the principle of secrecy. Simulations can help understand which actions increase the risk of key actors being exposed and how this risk changes the dynamics of the system. For example, if the multi-agent systems possess self-organizing properties, i.e. a certain response to risk of exposure, then using the simulation we can determine when the system begins to organize and can plan to intervene. Given a structure, either from network analysis or from current theories, of trafficking organizations, multi-agent models can be used to study optimized intervention strategies to produce the best course of action to destabilize the system so that it is unable to recover.

Conclusion

Research has mostly divided data and information geographically, according to place of origin, places of transit, and place of destination, which means we might be missing key patterns that might exist across the spectrum of the whole process of human trafficking. Currently, it is almost impossible to study trends across databases; the problem is hidden and we cannot do much about it as of now. Data mining and machine learning would provide methods to do precisely this and hence cooperate and collaborate across various agencies and organizations to create a more complete picture of the problem. Network analysis and multi-agent systems can help to understand recruitment practices, transportation methods, and means of exploitation and to identify key processes by which connections are created, deleted, or changed some other way. These methods, I believe, can be extremely effective in attacking some of the most commonly encountered problems in the field of human trafficking. Using these methods, I hope to start with small training data to create a model which is unique to detecting and preventing human trafficking, and with the help of experts, even one that might be able to continuously adapt to new patterns. Finally, the results of the analysis can be used for policy planning, decision making, identifying needs of a community at risk of being trafficked, implementing intervention strategies, and planning victim assistance services.

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