The Intellectualized Disposal System of Cognitive Domain's Confrontation

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Abstract—In recent years, the confrontational behavior in cognitive domain have gradually developed from fragmented and local behavior such as guided propaganda and agitation to widely influencing global confrontational behavior. The impact of confrontational behaviors act in cognitive domain is even worse. Vicious cognitive domain events occurred in our society are more frequent these years. Problems created by cognitive domain's confrontation are worthy to explore and research from the perspective of artificial intelligence and system science. In view of this, we try to build an intellectualized disposal system to give a solution for these problems. The main work is as follows: (1)We build the framework required for the disposal of cognitive domain's confrontation based on the OODA loop and confrontational strategy theory. We analyze the characteristics and methods of cognitive domain's confrontation from actual cases. (2)We construct an intelligent solution to the problems of cognitive domain confrontation hierarchically, and analyze its engineering feasibility based on existing artificial intelligence methods such as natural language processing. (3)We presents the design of the Intellectualized Disposal System of Cognitive Domain's Confrontation(IDSoCDC), which is introduced in this paper.

Keywords—Cognitive Domain's confrontation; Cognitive warfare; Cognitive confrontation; Natural language processing.

I. INTRODUCTION

Cognitive domain refers to the domain and scope that human being's Cognitive activities involved in as cognitive subjects. Before modern research method and systematic opinion of cognitive science, the understanding of cognitive domain is limited by basic cognitive and logic ideas and methods. As an objective domain that involves but is much wider than the realm of cognitive science and communication science such as public opinion, official propaganda and normal social cognition, it has earned its unique research value and concern, incorporating the applicable criteria that follow.

Joint research teams from the Defense Advanced Research Projects Agency (DARPA) have included cognitive domain's confrontation as part of the theoretical research of unrestricted warfare and global warfare [1]. The main opinion of cognitive domain's confrontation is to disturb the steady situation, and to redirect the natural evolutionary of the cognitive domain. Different methods such as disinformation delivery, propagation confusion and communication distortion are considered and partially practiced at the warfare of Midwest and East Europe since 2010s.

By combining the research results in different fields such as cognitive science, communication, computing science, as a confrontational behavior toward cognitive domain of target 's social cognition, cognitive domain's confrontation has quietly become a new form of confrontation which is completely differ to the confrontation occurs in the physical domain and the information domain. In September 2019, DARPA identify the social systems' cognitive domain, which is known as cognitive domain, as an important realm of concern by the Defense Science and Technology Office of DARPA for the first time [2].

This paper attempts to combine the existing relevant research, to design an intellectualized disposal system of cognitive domain's confrontation, in order to solve the disposal problems created by cognitive domain's confrontation.

II. RELATED WORK

Cognitive domain's confrontation is a new form of confrontation with cognitive domain as the main confrontation field. It aims at directly affect the subjective cognition of social subjects, thereby affecting their emotions, motivations, judgments and behaviors. It uses social media network as the infrastructure, open source intelligence's disguise and deception as the core method. The only goal of cognitive domain confrontation is to guide and shape the people's subjective cognition which constitutes the cognitive domain [3].

Confrontational behavior is usually manifested as cognitive domain behavior with malicious intent. It mainly uses misleading communication, inflammatory communication, misinformation dissemination and other means to achieve the goal of induction, instigation, and deception of cognitive subjects [4]. Cognitive domain events are usually caused by social issues, emergencies or some misinformation, and gradually produce adverse cognitive effects among subjects in the process of communication [5].

In a confrontation event, the advantage is often depended on the OODA cycle efficiency of both sides [6]. The advance side with better turnover rate and cost-effectiveness ratio in each link of OODA cycle can often complete more confrontational behaviors per unit time.

According to the above research, aiming at the basic needs and behavioral characteristics of cognitive domain confrontation, this paper attempts to combine the existing relevant research, tries to propose a basic design of an intellectualized disposal system optimized in cognitive domain's confrontation on the understanding of existing theories and methods. It tries to give a basic solution to the problems created by cognitive domain's confrontation.

III. FUNCTIONS OF THE SYSTEM

Based on the investigation of several different cases that are considered as confrontational behaviors detected these years [7][8][9][10], it can be concluded that the priority of cognitive domain's confrontation problems at this phase is mainly the immediate and efficient response to cognitive domain events.

Confrontational behavior in cognitive domain is usually performed as behavior with malicious intent with characteristics. It always acts by misleading communication, inflammatory communication and misinformation dissemination. By deceiving, inciting and deceiving cognitive subjects, it will adversely affect the self-sustaining and natural evolution of cognitive domains.

Cognitive domain's confrontational behavior always acts in cognitive domain, a complex social system. Therefore, it is difficult to capture and prevent. With potentially malicious intent, it is hard to assess the scale and severity of its impact. Cognitive domain's confrontational behavior has a high degree of time-sensitivity and uncertainty, thus it is difficult to analysis the situation promptly.

There are also difficulties in real-time decision-making and early warning of cognitive domain's confrontational behavior. These difficulties make the OODA cycle of disposal cannot be completed efficiently and timely and then lose the advantage in the confrontation [11]. The basic process of OODA is shown in Figure 1.
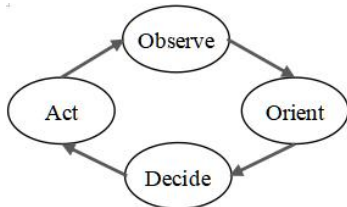

Fig. 1. The basic process of OODA.

In addition, on account of the actual situation of network infrastructure and the decentralized and universalized tendency of social media, there are still many challenges such as perception, decision-making and disposal execution in the cognitive domain confrontational behavior [12] .

Since then, the development of cognitive domain's confrontation has shown a systematic and automated trend. The intellectualized disposal system of cognitive domain's confrontation (IDSoCDC) should also have a corresponding architecture with feature like Intellectualized.

Therefore, based on the theory of OODA cycle, the tasks of IDSoCDC are divided into four phases. They are situation perception, situation analysis and assessment, decision-making

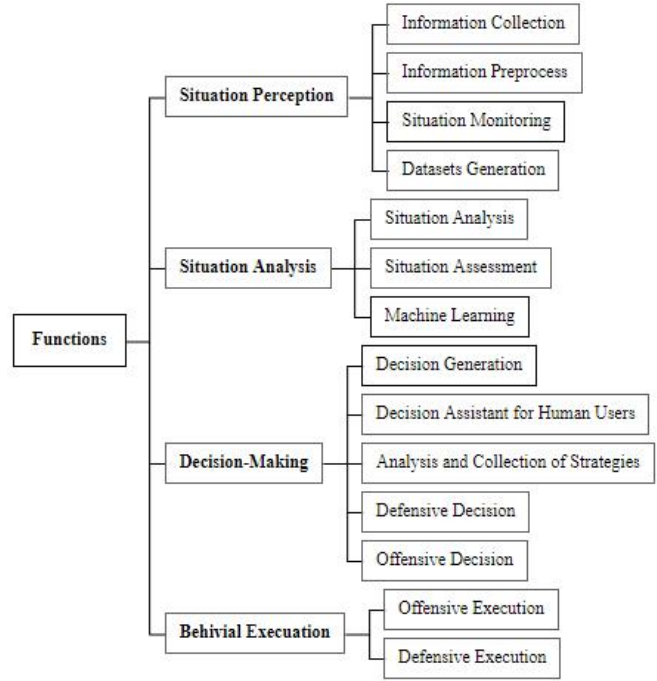and execution. The basic functions required for the IDSoCDC are shown in Figure 2.

Fig. 2. The basic functions required of the IDSoCDC.

A. Situation Perceptions

In terms of situation perception, the main tasks are information collection, information preprocessing, events detection and datasets' maintenance. When processing situation perception, the IDSoCDC should collect and summarize the basic information of the situation of the cognitive domain. In the preprocessing phase, IDSoCDC should capture the basic characteristics such as search index, browsing keywords, and key communicators of the events that occur in the cognitive domain.

The events detection monitor of the system monitors the characteristics of confrontational behaviors and events, and evokes latter parts of the system when these occur in the cognitive domain. It should be mainly based on the basic information collected by other phases. In addition, the information obtained in the situational perception phase needs to be collated and labeled as datasets, which is the basis of the training of machine learning models.

B. Situation Analysis and Assessment

The tasks of analyzing and assessing of the cognitive domain's situation are similar in cases like data sources and intelligent methods, so they are considered as one phase in the system. In the phase of situation analysis and assessment, the system needs to complete the macroscopic analysis of the situation of the cognitive domain and the concrete evaluation of indicators.

The analysis task is oriented to network and content which is the two basic elements of communication and concrete confrontational behavior occurs in cognitive domain. The analysis of content is based on authenticity and tendency. For

the network, the work focuses on the analysis of participants and propagation results. The task of assessment mainly evaluates indicators which show the severity and effectiveness of confrontational behavior and influence of behavior itself.

Due to machine learning models will be widely used in this phase, the design of the system needs to be centralized in implementation, training, and deployment to reduce costs and improve efficiency.

C. Decision-Making

The tasks in decision-making and execution phases are divided into offensive and defensive due to postures of confrontation. It is divided into two parts: offensive behavior and defensive behavior. Decisions come from decision-making sources such as cost-effectiveness game models, prefabricated strategies and expert systems. It provides the execution targets and plans the execution plan for the defensive behavior, and provides the basic intelligence of the projection content and method for the offensive behavior.

Due to the complexity and uncertainty of cognitive domain's confrontation, the possibility of human intervention cannot be ruled out. Thus, it is necessary to reserve human-machine friendly decision ports and interpretable situation reports for human user.

D. Execution

The execution phase is divided into two parts as offensive behavior and defensive behavior. The tasks are to eliminate the adverse effects of hostile offensive behavior and to launch targeted and efficient offensives against hostile targets. Therefore, it is necessary to consider the automatic generation of the dissemination content, as well as the specific delivery to the target by prefabricated means.

The purpose of defensive execution is to protect our cognitive domain from hostile confrontational behavior. Therefore, it is necessary to block the spread of adverse effects, block the source of behavior, and deal with the malicious propagators as soon as possible.

Moreover, according to the need to eliminate adverse effects by debunking and disseminating truth, as well as need

of simulating confrontation, the offensive execution of the system needs to be designed with same rules and standards as defensive execution.

E. Target Platform

Based on the consideration of project scale, computability and engineering problems [13], the current work in this paper focuses on social media platforms and online community platforms, which is the most active social platforms in the cognitive domain research, as target platforms.

As a concrete form of social system that is highly dependent on software engineering and computing hardware, social media platforms and online communities naturally have the characteristics of being collectible and computable. The data of these platforms is more user-friendly to technologies used in the research of cognitive domain such as data mining, social network structure analysis and other technologies. User-generated text content is the research object of emotional tendency analysis and ideological tendency and other methods. These factors are conducive to the development and advancement of following work.

IV. The Design of System

Based on the functional requirements, the system is designed with hierarchical structure for four layers and seven functional modules. The architecture of the system is shown in Figure 3. Constructing the intellectualized disposal system of cognitive domain's confrontation provides an efficient, reliable, and intelligent disposal framework for the problems caused by cognitive domains confrontation.

Based on the basic logic of confrontation and the OODA decision cycle theory, the hierarchical structure is divided into perception layer, analysis layer, decision layer and execution layer according to the source, usage and flow of intelligence.

More specifically, the seven functional modules include the situation perception module in the perception layer, the situation analysis, the situation assessment module, and the machine learning module in the analysis layer, the decision-making module in the decision layer and the offensive execution and the defensive execution module in the execution layer.
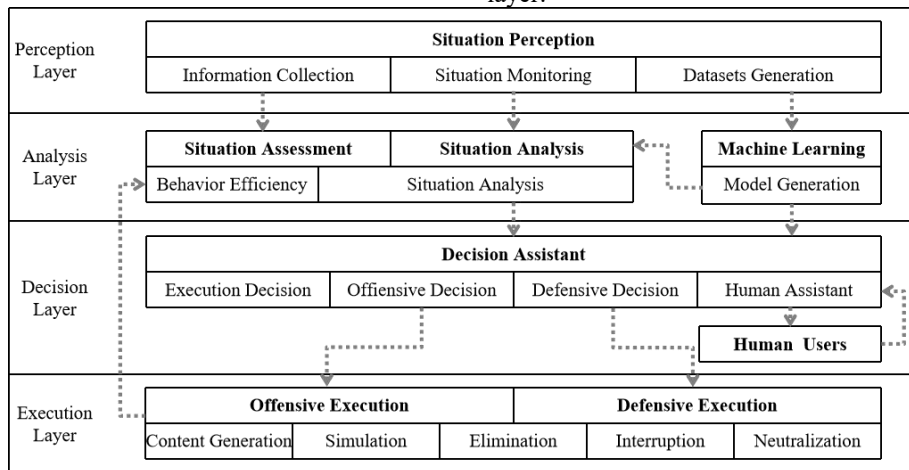

Fig. 3. The architecture of the intellectualized disposal system of cognitive domain's confrontation

A. Perception Layer

The main function of the perception layer is to collect, filter, and classify the information that describe current situation of the cognitive domain from concrete scenarios such as the network infrastructure of the cognitive domain.

The purpose of designing the perception layer is to preserve and perceive the macroscopic situation of the cognitive domain at a certain time, and to provide basic intelligence and information for each step of the subsequent OODA process done by other layers in the system. In addition, the information collected by the perception layer will provide the data for training the machine learning models of the analysis layer and decision layer.

1) Situation Perception

The module of situation perception is included in the perception layer. It is designed for the observation, detection and collection of cognitive domain's event information.

This module uses methods and tools such as rule crawling and content aggregation to directly capture basic information such as searching indexes, keywords and key nodes of social network related to the event for latter analysis and response. It judges the impact scale of the event based on the search and browsing index and the search correlation volume per 24 hours. Basic Information acquired by the situation perception module can also be used as language material for pre-training and generation for intelligent tools in other parts of the system. By organizing and labeling the collected information, it provides data sets for the machine learning module's development and training.

Otherwise, the situation perception module can collect and classify the basic information that circulating in the cognitive domain. It will support early warning of cognitive domain events and normalized situation monitoring. Continuous attention is paid in this module to the characteristics like self-sustaining and natural evolutionary. And it can modify and optimize the models and rules of the intellectualized parts of the system based on what the situation perception module acquired.

B. Analysis Layer

The purpose of the analysis layer is to analysis the basic data obtained by of the perception layer using automatized and intellectualized models and methods. Through intelligent tools such as natural language processing based on machine learning and public opinion ecological analysis tools, key representations and behavioral indicators in cognitive domain's confrontation are obtained to provide a basis for subsequent layers of the system [14]. A basic public opinion analysis method is to calculate indicators like Entropy Weight Method and Analytic Hierarchy Process (AHP) which is shown as formula (1). $M^{(e)}$ is the weight defined by AHP and $M^{(t)}$ is the information entropy of the information communicate in the cognitive domain. i is the number of the sample acquired by situation perception. M means the final weight which shows the influence of the sample.

$$M = \frac{M_i^{(e)} M_i^{(t)}}{\sum_{j=1}^{n} M_i^{(e)} M_i^{(t)}}; i = 1,2,..n \qquad (1)$$

Due to the characteristics of functionality and specific problems, the analysis layer has three modules: situation analysis, situation assessment and Machine Learning.

1) Situation Analysis

The situation analysis module is designed to abstract and refine the basic information of cognitive domain events acquired by the perception layer in order to obtain concrete characteristics for qualitative analysis such as keywords, emotional tendencies, ideological tendencies, and groups involved in cognitive domain events.

This module is used to give the direction of disposal by identifying and clarification the execution targets. It depends on natural language processing and knowledge expression tools such as text tendency analysis, misinformation detection, and knowledge graph, the basic information such as collected text, image and communication network is analyzed.

2) Situation Assessment

The situation assessment module analyzes the basic information such as communication network and communicator, and secondary analysis information such as emotional and ideological tendency that collected and made by other layers and modules.

This module is designed to obtain quantitative analysis indicators for the severity of events in the cognitive domain, the characteristics of the population involved in the event, and the transmission orientation of the event. Through the mathematical models and methods used in social science research, such as the ecological evaluation of public opinion, and the authenticity evaluation of key content, the basic data obtained by the perception layer is analyzed to assess the situation of cognitive domain.

Moreover, the situation assessment module evaluates the effectiveness of the disposal according to the evaluation principle after the disposal is completed.

3) Machine Learning

Modules of machine learning are designed to reduce development, deployment, and maintenance costs by integrating intelligent models. It is proved that neural network like BP neural network can be used to obtain the indicators of unexpected emergency of cognitice domain. And the network structure of multi-modal fake news detection acquires a well result by combining external knowledge and multi-modal feature extraction.

The machine learning module trains, adjusts, and tests intelligent tools based on machine learning models required in the system. This module uses datasets obtained by the perception layer to train and adjusts machine learning models such as text tendency analysis model, misinformation detection and information authenticity evaluation model, and behavioral intent evaluation model required by the situation analysis module and the situation assessment module. This is to provide

machine learning models that can be used for the intelligent tools in the analysis and decision layer.

C. Decision Layer

Relying on the preset disposal strategy, game model and the results from the analysis layer, the decision layer provides execution strategies and behavioral rules for the subsequent disposal process of the system. Besides, decision-makers provide decision support services for potential human user's intervention.

By putting the results from the analysis layer into strategies and models to acquire specific countermeasures, and provide human-friendly human-machine interface and feedback content for the need for human intervention. The decision layer obtains specific countermeasures by analyzing the results from the analysis layer with strategies models. It also provides human-friendly interfaces for the need for manual intervention.

The decision assistant module provides behavioral decisions based on the perception and analysis results from modules in other layers of the system. It provides the intelligence which is needed for subsequent disposal in execution layer and potential human intervention based on the game model in cognitive domain confrontation and basic cognitive domain governance rules.

This module generates the execution and resource strategy for disposing cognitive domain events by the pre-built model of cognitive domain's confrontation. The decision assistant module gives standardized, interpretable instructions for different agents and execution units in the execution layer. Moreover, as a supplement to the confrontational decision-making process, the decision assistant module records and learns the strategies and methods of offensive execution according to the analysis results of offensive behavior from the analysis layer.

D. Execution Layer

The execution layer performs concrete execution on cognitive domain events that have been identified and entered into the process of disposal. It can automatically processes elements such as key nodes in communication network, key information's circulation, and the source of confrontational behavior, in order to eliminate the adverse effects of hostile confrontational behavior in our cognitive domain or initiate confrontational behaviors in target cognitive domain.

This layer is designed to intellectualize and automate the executional operations in cognitive domain confrontation used to done manually, in order to reduce the cost and improve OODA cycle's efficiency to accumulate advantages in the confrontation. Furthermore, due to the need of simulation and test by launching offensive behavior in the system, the execution layer provides the ability to launch offensive behaviors if it's needed.

The execution layer is divided into two modules: defensive execution and offensive execution according to the posture of behavior.

1) Defensive Execution

The module of defensive execution performs defensive behaviors in the confrontation. It uses the governance methods of the cognitive domain to implement effective defense against hostile confrontation that has occurred. This module is designed to reduce the risk and potential hazards form the events by methods like neutralize key communication nodes and blocking the spread of misinformation.

It aims to reduce the scale of the influence and severity of the confrontational behavior through intelligent disposal of key propagation nodes, key information's circulation, hostile behavior sources and other elements of events occur in cognitive domain.

2) Offensive Execution

The offensive execution module performs offensive behavior in the confrontation. By performing offensive behaviors that contain intent, this module initiates offensive behaviors against the target cognitive domain and mitigates the adverse effects of hostile confrontational behaviors.

Based on the intelligent obtained by the analysis layer and the decision layer, the offensive execution module uses methods like text generation based on NLP to generate contents. These contents will be projected in target platform to disturb the self-sustaining and natural evolution of the target cognitive domain. Besides, the offensive execution module takes the role of an imaginary enemy in the system. It can test the system through the analysis and understanding of offensive behavior cases by simulating offensive behaviors.

E. Systematization

The systematic design allows the methods and functions used in cognitive domain's confrontation to be researched, developed and managed in a unified manner.

For the modules based on machine learning in the system, the quality, scale and diversity of the datasets provided for training and testing have a crucial influence on the training of machine learning models. In the design of IDSoCDC, the training and test datasets is divided into text datasets, communication structure datasets, and behavioral datasets according to the usage of models.

As a system that heavily relies on machine learning, the cases and datasets required for this work cannot be fully guaranteed presently. Future work will focus on the analysis of existing cognitive domain event cases and the labeling of datasets. Standardizing the data flowing through the system can reduce the development and deployment costs of each module.

V. CONCLUSION

Through the design of the system, it can be considered that the intelligent disposal to the problems created by cognitive domain's confrontation is practicable. At present, the concrete engineering of IDSoCDC is still in the exploratory stage.

However, it can be expected that with the development and application of IDSoCDC, the capabilities of perception, analysis decision and execution in cognitive domain can be highly improved. Moreover, early warning and preventive methods of confrontational behavior occurs in cognitive domain can be added in the system.

Based on the understand and research of cognitive domain's confrontation and theory of OODA cycle, this paper explains and designs the hierarchical structure and specific module division of the intellectualized disposal system of cognitive domain's confrontation.

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