Lecture Notes in Intelligent Transportation and Infrastructure
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Technological and Industrial Applications Associated with Intelligent Logistics

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Lecture Notes in Intelligent Transportation and Infrastructure

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Introduction

This book is a novel, innovative, and adequate source of information that compiles interdisciplinary perspectives about diverse issues related to Intelligent Logistics in Industry 4.0 including Artificial Intelligent applications associated with Logistics 4.0 on different ways about Intelligent Optimization, Industrial Applications on real world, Social applications and Technology applications each one with a different perspective about the correct solution of this kind of methodologies. This book is a collective effort to introduce new ideas and paradigms from a variety of perspectives using innovative techniques related to Bioinspired Algorithms, metaheuristics, and methodologies associated with Logistics 4.0. An innovative and specialized book on optimization considers different aspects to realize this "Intelligent Optimization" and tries to improve with innovative techniques and methodologies different daily aspects of our lives, in each one of them it is possible to understand the necessity to improve scenarios, distances, time, costs, spaces, and a plethora of features associated with the modern life (labor associated with organize, kept, and delivery of goods, materials, people, life issues, or products).

We received manuscripts from renowned researchers from all around the world associated with Theoretical foundations of Intelligent Logistics to understand many paradigms on different Optimization implementation kinds. In addition, we received many manuscripts with expertise on improving optimization related to Logistics 4.0 of deliveries associated with products and services, Optimization of different elements in the time and location, Social Applications to enjoy our life of a better way to improve the life in a Smart City, and finally, Technologies Applications of diverse ways to increase our Life Quality. The book starts with a part entitled Industrial Logistics featuring seven chapters on the theoretical and mathematical ideas related to the correct implementation of a diverse range of Intelligent Logistics optimization algorithms and Logistics 4.0 applications in real world. The first chapter of this section is "Determining and Applying Productive, Environmental and Economical Indicators and Indexes to a Cyber Physical System for Greening Process of Supply Chain" which aboard that a company that transports goods to supply customers usually needs to plan the routes that the fleet must follow, since transportation means a high percentage of the value added to

products outside their store using a model called pret-a-porter. Therefore, it causes them to go back to it once a product in their mobile store runs out since the customer is waiting for them at the store. The chapter "The Difficulties and Complications of Children When Going to a Zoo and Should Interact with the Colors of the Information in It: An Approach Based on the Use of a Humanoid NAO Robot in an Application for "Smart Cities"", determines as in nowadays that the health industry utilizes critical machines to treat and diagnose illness in patients. In a large majority of hospitals that treat patients with color blindness, especially children, mobile applications are beginning to be used to improve the quality of life of these patients in environments that require information associated with safety colors or the level of extinction of a species, such as in zoos; then, they choose to have many components of their critical machines stored inside a warehouse in the hospital. The chapter "Optimization of Route Planning for the Package Delivery Problem Using Fuzzy Clustering" is explains that nowadays, warehouse operations, specifically order picking process, are receiving close attention of researches due to the need of companies in minimizing operational costs. Finally, the last chapter in this part is "State of the Art for the Creation of a Methodology for the Proper Location of Urban Truck Stops on Route 2A" which determines that in these times, the human factor is key to improve order preparation processes—which is why it is necessary to determine a correct bus stop-. For example, in a Smart City associated with a line of replacement processes for different pieces of equipment or devices—which must be purchased in a specialized store-, it is necessary to find the best bus route in each case to minimize the time consumed, and that this does not affect the continuity of the assembly in small workshops specialized in automotive parts.

The third part is named Humanitarian Logistics, featuring five chapters related to different comparatives of Humanitarian Logistics and Intelligent Logistics Models in the search to improve resources in diverse aspects of companies and to improve our lives. The first chapter of this section is "Financial Analysis Over the Smartest Companies" and in this research chapter is focused the problem of the distribution of escape routes in a public space. The chapter "Simulating Crowd Movements During Emergency Fire Situations: Mexico City Airport Simulation Case" details as in several societies of emerging economies, increasingly large community linked to the scalability and adjustment of components to resolve a problem of Humanitarian Logistics. In the research chapter "Modular Framework for Crowd Simulation "Menge" from a Production Warehouse Simulation Perspective", many industrial sectors use 3D components design customization to improve aspects of competitiveness. In the chapter "Mobile Application for the Detection of COVID19 Suspicious Cases in Mexico Using an Intelligent Model of Virtual Patients". In hospitals with an excessive number of patients and the decrease of medical services associated with other diseases, we propose the use of an intelligent model of virtual patients that allows students of health sciences to practice in an adequate and valid way the detection of various symptoms that affect the health of the population in a

Smart City. The next chapter "Humanitarian Logistics for the Optimal and Timely Evacuation in High Buildings Within a Smart City Using an Adaptive Metaheuristic Context" explains about the analysis concerning the accommodation of safe escapes in a building inside a structure for their respective distribution, verifying the option of finding the correct stow model and accommodation of humanitarian logistics.

In fourth part, which is named E-commerce, Marketing and Mobile Application of Logistics Including Human Factor, are described five chapters related to technologies associated with Intelligent Logistics and Logistics 4.0. The first chapter of this part is "Using Machine Learning to Predict Online Buying Behaviour, Wholesale and Fashion Marketing at Zara, an Analysis Including Z Generation" which presents a problem solved by social modeling, associated with the adequate choice of colors to issues and their distribution in a Fashion Market using a range of 64 colors to specify different features related to the principal attributes of an issue adequate to represent the symbolic capital of a modern society. In the chapter "Analysis of Mental Fatigue Under Delivery Pressure and Considering Creativity and Precision to Organize and Distribute a Diorama to Represent Social Issues Based on Cultural Algorithms" details how mental fatigue is a decisive aspect in the creation of collectible issues, especially in a growing collecting community—mainly from emerging economies—which collects and buys "dioramas and click toys among others", that is, scalable and adjustable collectibles composed of many pieces; this type of paper toys and dioramas have been used for educational purposes. In the chapter "Medicine Inventory Control System Through Fuzzy Logic and Genetic Algorithms: Applied to a Biopharmaceutical" is described a novel research focused on the main economic activities in a Smart City; in another chapter named "Technical Analysis of Shipments in an Automotive Company to Forecast Sales Volumes" is proposed the implementation of an order picking algorithm for the optimization of the packing and distribution of car component products. Finally, in this section is presented "Distributed Programming Applied for the Optimization of Hydraulic Networks Through a Web Application", which proposes new ideas related to web applications by means of an Advanced Selection of systems, which is fundamental for the operational improvement and logistics global supply chain.

And finally, in the part entitled Diverse Kind of Logistics in Amalgamed Application Domains grouped nine different chapters related to solutions derived of specific aspects which try to improve daily activities on Optimization with real applications to amalgamed social topics. In the chapter "What is the Best Location of a Smart Airport in Juarez, Mexico?" is described, as the latter includes, customizing the user interface, as well as the way the system retrieves and processes cases afterward to distribute original products in a novel supply chain and its respective Intelligent Logistics. The purpose of the chapter "Colombian Coffee Price Forecast via LSTM Neural Networks" is to propose a conceptual order picking model to increase the commercialization of coffee in Colombia, through the sequential analysis of activities such as distribution in the warehouse, preparation,

packing of orders, and the issuance of orders to final customers. The next chapter "Some Pragmatic Prevention's Guidelines Regarding SARS-CoV-2 and COVID-19 in Latin-America Inspired by Mixed Machine Learning Techniques and Artificial Mathematical Intelligence. Case Study: Colombia" details that due to the worldwide strengthening of the health sector, it presents itself as a challenge for the companies that comprise it to immerse themselves in processes of continuous improvement that contribute to increasing the satisfaction of the needs of its customers, as well as achieving a better positioning in the market. In the chapter "A Drone System for Detecting, Classifying and Monitoring Solid Wastes Using Computer Vision Techniques in the Context of a Smart Cities Logistics Systems" is proposed that the freshness, flavor, good presentation, and nutritional value of fruits and vegetables diminish as time passes until the food begins to lose them completely. That is why the correct implementation of supply chains is a subject of great interest for companies dedicated to the rotation of food marketing. The next chapter "Geo-Referenced Correlation for a Fire in a Smart City Urban Forest Using Hybrid Drone Data and Satellite Images" determines that the purpose of this research is to understand a Multivariable optimization associated with the path of a group of vehicles integrated in an Ecological Community and determine the optimal route involve speed, storage, and travel resources including time of charge for determining the cost-benefit linked to safety in case of a disaster as a wildfire at a Natural Park in a Smart City and considering that most of the drivers in such an ecological community own an electric car, which is coupled with a travel plan associated with the electric power charging point in a Smart City. In the chapter "Evaluation of Drones for Inspection and Control in Industry 4.0" is analyzed that Internet sales have increased exponentially in the last decade. Much of the internet sales are of physical products in urban areas that require product delivery transportation with a tight delivery lead time using drones for this purpose. And finally, in the chapter "Uncertain Analysis Based on Milk-Runs Systems Using Bayesian Networks" is a important considering that one of the most common operations in warehouses of package delivery companies (e.g., UPS or FedEx) is to pack the products in trucks in order to locally deliver them to the customers. The products are generally packed in rectangular-shaped boxes of different dimensions; in addition in the chapter "Implementation of an Intelligent Visual Recognition System for the Proper Classification of Solid Waste Using a Mobile Application in a Smart City" explains a model of ecological support to groutier people with shady hair linked to Greenpeace—which allows a better identification of solid waste and its correct and adequate separation, using a smart mobile application for recycling within the Z generation—to improve the lives of citizens in their environment within a smart city. The last chapter of this part is "Logistics on the Designing of an Electronic Colorblindness Application for Early Colorblindness Detection in Children by Using a Modified Ishihara Test", which describes the social inclusion with colorblindness.

It is important to state that the chapters were selected following a rigorous analysis done by the book editors, and each chapter was double or triple-blind peer-reviewed by at least two experts in the area. This would not have been possible

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Analysis of Mental Fatigue Under Delivery Pressure and Considering Creativity and Precision to Organize and Distribute a Diorama to Represent Social Issues Based on Cultural Algorithms

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Abstract Mental fatigue is characterized by excessive work under pressure, which occurs when creativity, precision and organization of the material produced are required. Considering a case study, the behavior of a group of people in a scenario similar to the one that occurs in Industry 4.0 considering people of generation Z was analyzed by means of a metaheuristic. This case of study attempts to explain this innovative representation and location of societies. The creation of a diorama and, therefore, the correct arrangement of issues in it represents a manufacturing model that implies precision, creativity, and optimization of space, all considering the restriction of time and the representation of the symbolic capital of the issues in a physical space. This research aims to reveal and blur how we adapt to quality standards during work involve several tasks under pressure. In addition, this research addresses a problem in the literature on social modeling associated with the selection of adequate locations in decoration to make the correct distribution of a diorama of imaginary groups of societies to specify the relationships between them, associated with their main attributes to represent symbolic capital of each one. The case study presented deals with the diversity of cultural patterns described in Memory Alpha. We use several main attributes and a range of diverse adequate locations. The purpose of this research is to apply the computational solution of cultural algorithms to solve the problem and later represent the diorama distribution decoration. Memory Alpha is organized by 1,287 societies -Memory Alpha repository-, which shows that the pairing of social themes allows a correct selection of adequate locations.

Keywords Analysis of mental fatigue · Cultural algorithms · Social modeling · Multi-combinatorial problem · Pattern recognition

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1 Introduction

In this research, we focused our attention on a practical problem from literature related to societies modeling, which is the selection of visual representation including adequate locations and design of features associated with their symbolic capital, in this case, using a diorama which allows include the position that keeps relationships between societies these to focus on design decoration distribution diorama. Our proposed solution uses a hybridization of two techniques: adequate location graph (for representation) and cultural algorithms (to define the distribution and social relationship among them), subsequently represent the adequate location graph in a diorama. As it is described in [1, 2], cultural algorithm agents can only select from a limited repository of adequate locations and forms. For this research, we use the societies described in [3], which is a repository of information about artificial societies [4] that are divided into four quadrants. The selection of each attribute and its visual representation involves the skill evaluation of several individuals from diverse quadrants. The social networking representation requires the development of similarity measures that allow establishing locations in dioramas to carry out a comprehensive analysis of behavioral changes in societies [5]. In addition, we establish an index to measure the workload and mental fatigue associated with the development of the diorama and the times established for it.

2 Cultural Algorithms

Cultural Algorithms (CAs) were developed by Reynolds [6, 7] as a complement to the metaphor used by evolutionary algorithms, which had focused on the concepts of genetics and natural evolution. CAs are based on the theories of anthropologists, sociologists, and archaeologists, who have tried to model the evolution as a process of cultural evolution [8]. The belief space characterizes the CAs of other evolutionary algorithms; it is used to store the knowledge acquired from previous generations. The information in this space must be accessible to any individual who may use it to change their behavior and their respective proposed solution. To join the belief space and the population is necessary to establish a communication protocol, which dictates rules of the type of information to be exchanged between the spaces. This protocol defines the acceptance and influence functions. The acceptance function is responsible for accepting the information or experience that the individuals have obtained in the current generation and bring it to belief space. On the other hand, the influence function is responsible for "influence" like variation operator of individuals (such as crossover and mutation in the case of genetic algorithms). This means that this function has a type of pressure on individuals resulting from the application of variation operators to approach the desirable behavior and away from the undesirable, according to the information stored in the belief space.

Figure 1 shows the interaction between the belief space and population space. The population space has been worked in the same way that evolutionary algorithms, i.e., the population consists of a set of individuals where each has an independent feature set for others; it is possible to determine their suitability (fitness). Over time, such individuals could be replaced by some of their descendants, obtained from a set of operators applied to the population. In the literature about CAs, this space is defined based on an evolutionary algorithm that has operators of mutation and selection. Adding information from the problem domain knowledge to the evolutionary stage, this algorithm must worry about the interaction of both spaces. The interaction between the two spaces makes the CA more complex than a traditional evolutionary algorithm. Algorithm 1 shows a CAs.

Algorithm 1. Cultural Algorithm

```
Begin
  t=0;
  Initialize POP(t); // Initialization of population
  Initialize BLF(t); // Initialization of believing space
  Evaluate POP(t);
  While (Do not condition of term t=t+1)
    Vote (BLF (t), Accept (POP(t)))) ;
    Adjust (BLF (t));
    Evolve (POP(t), Influence (BLF(t)));
    t = t +1;
    Select POP(t) from POP(t-1);
  End While
End
```

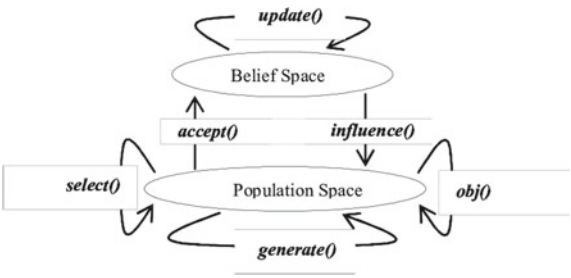

Fig. 1 Components and functions in a cultural algorithm

3 Selection of Relationships in a Workforce to Determine Mental Fatigue

A social network is a theoretical construct useful to study social relationships. As it is mentioned in [9], the diorama and the graphs are used to represent social networks. The representation of a social network can consist of one or more graphs where these graphs conceptualize the network. Social modeling is a combinatorial problem that can be solved with CA, determining a specific solution according to the different perspectives of the population space (see Eq. 1). The main reason for using this innovative algorithm is the potential to describe different application domains with uncertainty solutions in random situations such as classification of languages, architecture, transportation, race competitions, logistics, mental fatigue, and many different aspects and algorithmic problems such as:

- Cooperative Interactive Based on Dynamic Knowledge and Alliance to find the solution in a Diorama.
- Multi-population Cooperative belief space.
- Cooperative interactive information to adopt knowledge migration.

$$\beta = \sum_{i}^{n} abs\left[corr\left(W_i Attribute_i^A, W_i Attribute_i^B\right)\right] \tag{1}$$

where:

β	Index associated with creativity and mental fatigue.
W_i	Vector of weights that represent the importance of attribute *i*.
A, B	They represent the societies whose similarity we want to compare.
$Attribute_i$	Vector of the attributes for each society.
$corr$	Correlation de Pearson.
abs	Absolute values from relative data.

A graph is an abstract representation of a set of objects where some pairs of the objects are connected by links. For this work, each object in the graph represents one society, and the link represents the relationship between societies. In the CA to measure the similarity between societies from Memory Alpha, the Pearson correlation function is used. This measure allows us to relate each society to the others; also, to organize the societies in clusters (64 adequate locations). We have a weight for each attribute, which represents the importance of one attribute to compare among two societies. It means that the sum of the weighted attribute correlation between two societies gives the measure of similarity, as it is shown in Fig. 2. The greater the correlation increase, the stronger the relationship between societies. If the correlation value is less than a threshold of 0.1, we assume an empty relationship between the societies (zero value); the vector of weights and attributes are described. The correct location selection is used (1) only in the societies that have the same adequate location.

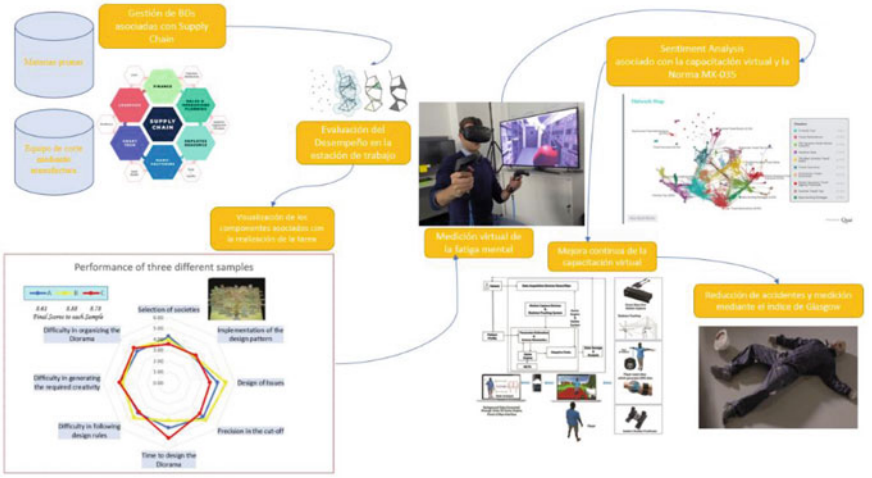

Fig. 2 Conceptual diagram detailed diverse aspects to determine mental fatigue in a workforce produce issues in a Diorama and its social representation

Therefore, each agent in the CA has the links between societies and their adequate locations, where Eq. (1) is used as a fitness function.

4 Adequate Location Selection Based on Visual Representation

From the point of view of agents, this combinatorial optimization problem is very complex, since the best location of an individual representing a society with respect to the other representatives is unknown. In the algorithm proposed for cultural change, individuals in the belief space (beliefscape) through their best paradigm (BestParadigm), are set to zero to represent the fact that culture increases the number of expectations associated with the location of a society with respect for others, encouraging behavior associated with the best paradigm (BestParadigm). For this, we selected 1244 societies described in [3] and characterized their social behavior based on eight attributes: emotional control, ability to fight, intelligence, agility, force, resistance, social leadership, and speed. These characteristics make it possible to describe both society and the individual. When the comparison between societies is analyzed, the main factors are associated with the most representative adequate locations like a country with the adequate locations of its national flag in a scenario.

5 Multiple Matching to Determinate and Evaluate the Selection on a Location in a Diorama

The multiple matching is a series of seven evaluations according to different combinations of adequate locations and wardrobe over 50 runs in different scenarios. The bidding process for the final selection of one wardrobe to each issue is done when different features are analyzed. In the interest of proportional development, individuals from all quadrants should be represented in the diorama based on the interest generated in each one. In the evaluation phase, preference will be given to the topics with the most sociocultural similarities; 47 topics will be selected to compete in these comparisons. Each issue agrees and will contract to participate in exactly seven of these evaluations. Issues must rank their preference of tournaments once the final list of multiple matching is evaluated, and the algorithm evaluates these. The hybrid algorithm reserves the right to assign societies to evaluate their wardrobe according to organizational needs and societies for each comparison and assign the societies list before the cycle begins. Each evaluation will have until 120 societies playing over a schedule of seventeen runs. In view of an objective of harmonization by part of a hybrid algorithm, it will be programmed to meet the comparative time of different similarities using a round of multiple matching analyses and based on the gender assigned to an issue, as it is shown in Fig. 3. The societies that qualify for selection in a diorama will be chosen on the following prioritized basis. For the first cycle of similarity, all societies in Memory Alpha (i.e., Aenar, Ha'Dara, or Ventu Societies) and similarity matches will be invited to participate in different comparators. Given the organization of each society, these matches in each round in the algorithm. All these societies will be asked to commit their participation in the evaluation of each series. If any of these societies decline to participate in the series, the algorithm may nominate one society to replace it, and this society must be ranked among the best societies on Memory Alpha. Based on an average calculation to two decimal places, in the rating list of the comparator series before the start of the cycle, twenty qualified will be selected (excluding the seven societies that will compare the matches). If societies have the same average rating, the number of similarities played (rating period) will

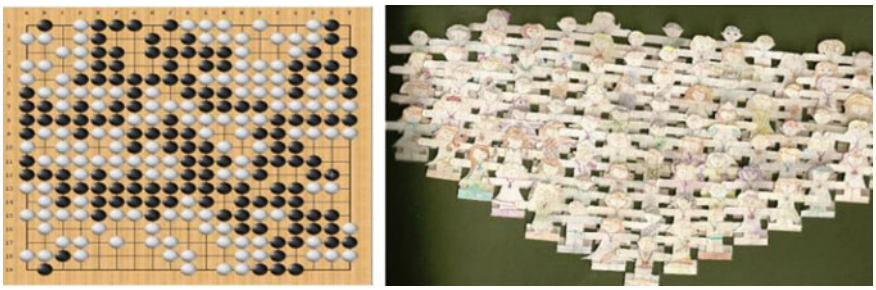

Fig. 3 Comparative model for assigning locations in a diorama, the black dots represent lass issues and the white dots represent lad issues and the adequate clustering

be used to determine ranking. To ensure active participation in the future, a minimum of 25 games is being recommended in the four rating lists, including and prior to the rating list. If any society does not accept to play in the multiple matching series, the selection process using the average rating plus the number of games played in the rating period will be adopted until the number of qualifiers required for the multiple matching series is completed. Using this technique of comparative and classification is possible to organize un adequate ranking based on all possible possibilities to participate in the final issues accommodation.

6 Experimentation

In order to be able similar, the most efficient arrangement of individuals in a social network is developed an atmosphere able to store the data of each one of the representing individuals of each society based on CA, with the purpose of distributing by an optimal form each one of the evaluated societies [2, 10]. The main experiment consisted of detailing each one of the 1244 communities in the CA, with 500 agents and 200 different believes in the belief space, one stop condition of 75 epochs; this allowed to generate the best selection of each quadrant and their possible location in a diorama, which was obtained after comparing the different cultural and social similarities from each community, and to evaluate with Multiple Matching Model each one of them as in [11]. The vector of weight used in the fitness function is $W_i = [0.6, 0.7, 0.8, 0.5, 0.6, 0.4, 0.9, 0.5, 0.4, 0.9, 0.6, 0.7]$, which represents the importance of diverse attributes: emotional control, ability to fight, intelligence, agility, force, resistance, social leadership, and speed -in another's-, in the same order, as the design of experiments proposes in [2]. The CA will select the adequate location and features of each society based on the similarity of attributes and determine a kind of society. The time related to building a diorama is shown in Fig. 4. We use multivariable analysis to determine creativity and mental fatigue in our three samples.

Each attribute is represented by a discrete value in a range from 0 to 5, where 0 means absence and 5 the highest value for the attribute. The design of the experiment consists of an orthogonal array test with interactions between the variables (the eight attributes mentioned in a range from 0 to 5). These variables are studied within an adequate location range (1 to 64 diverse positions in the diorama). An orthogonal array is L-N (2**8); in other words, 8 factors in N executions. The value of N is defined by the combination of the 8 possible values of the variables, also values in the adequate location range. Table 1 lists some possible scenarios result from combining the values of the attributes and the specific adequate location to represent this issue (society). The results permit us to analyze the effect of the variables on the adequate location selection in all the possible combinations of values, as was proposed in [2].

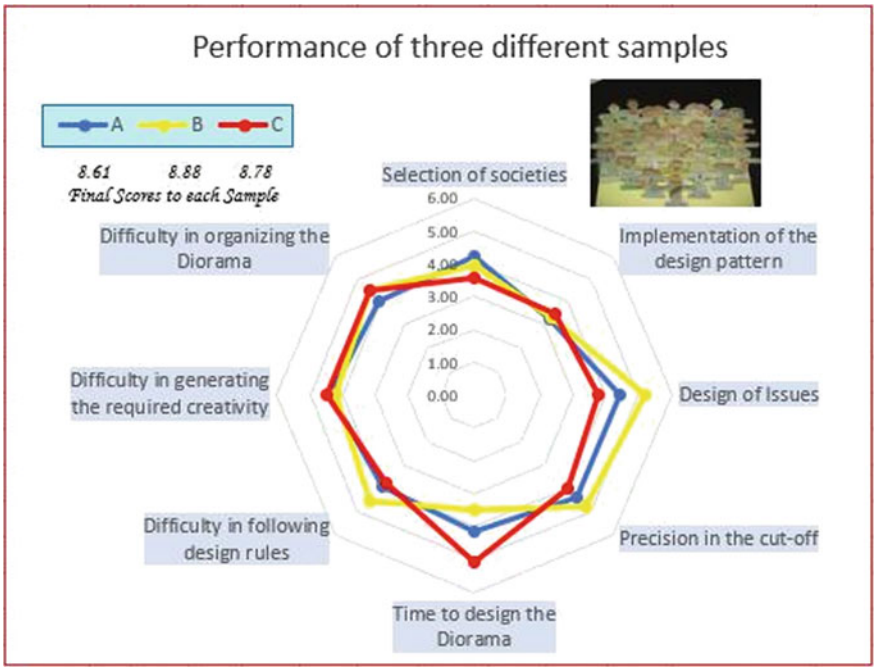

Fig. 4 Multivariable analysis of three samples analyzed to determine mental fatigue

With this orthogonal array test, we try to reorganize the different attributes and specify the best possibilities for adequate correct solutions (skills) in each society. The different attributes were used to identify the real possibilities of improving society in each and potential environment (see Fig. 5), and to specify the correlations with other societies.

7 Conclusions and Future Research

An interesting characteristic observed in this experiment was the diversity of the cultural patterns established by each community, which represents a unique and innovative form of adaptive behavior that solves a computational problem that does not attempt to group societies only with a factor associated with their external appearance. (The attributes of each society). The generated configurations can be metaphorically related to the knowledge of the behavior of the community with respect to an optimization problem (to select culturally until 47 similar societies, without being of the same quadrant of [2, 3]). The developed tool classified each of the societies belonging to each quadrant, with different costumes for societies that included linguistic and

Table 1 Orthogonal array test

Emotional control	Ability to fight	Intelligence	Agility	Force	Resistance	Social leadership	Speed	Negotiation level	Natural resources	Technology implementation	Adequate location
0	1	2	2	3	3	4	5	2	3	3	1
0	1	2	2	3	4	5	5	2	3	4	1
1	1	3	2	4	4	2	1	3	3	5	2
1	1	3	2	5	3	2	1	4	4	5	2
1	0	0	3	4	2	3	5	5	4	5	3

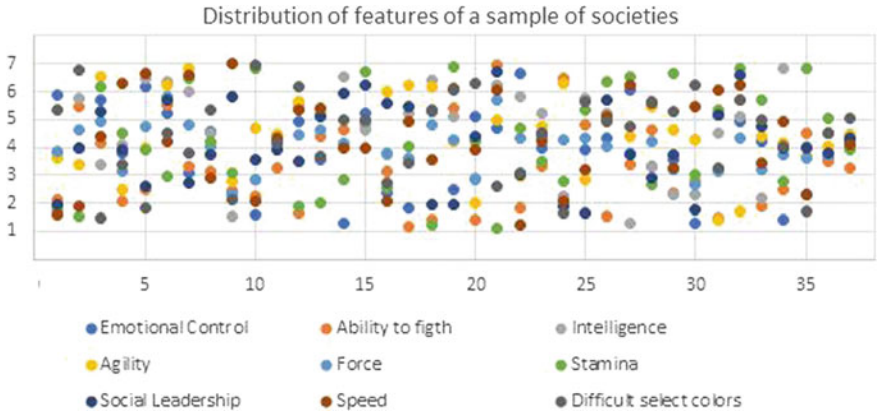

Fig. 5 Values after applying orthogonal array to evaluate the dataset associated with some features of 37 societies to organize in the Diorama

cultural identity. This permit identifies changes over time with respect to other societies (see Fig. 6). A decisive and extremely important aspect in order to correctly evaluate the final product developed in this case study was the proposal of an index to obtain the correlation between the aesthetics of the diorama and the time dedicated to it, considering the different restrictions needed to develop it.

Using CAs, we improved the understanding substantially to obtain the change of "best paradigm", because we appropriately classified the agent communities basing to us on an approach to the relationships that keeps their attributes. This allowed us to understand that the concept of "cooperative collaborative information" exists with

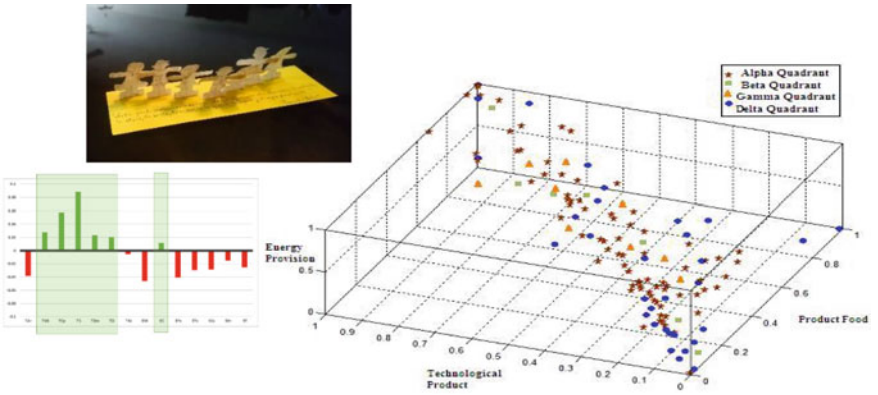

Fig. 6 Visual representation of societies analyzed according to the orthogonal array test and multivariable analysis of specific variables associated with mental fatigue

base in the determination of the function of acceptance on the part of the rest from the communities to the proposed location for the rest of others [2, 12].

Future Research

The analysis of the level and degree of cognitive knowledge of each community is an aspect that is desired to evaluate for future research. On the other hand, in order to understand the true similarities that different societies have based on the characteristics that make them cluster contributors and, in turn, allow them to keep their own identity, in [6] it shows that the small variations go beyond the characteristics phenotypic and are mainly associated with tastes and similar characteristics developed over time. The CAs can be used in the Evolutionary Robotic field, when the problem needs social interaction and decision, for example, in the training phase described in [7], and to organize a group of robots for collaborative tasks; also, could be used to distribute workgroups, social groups or social networking [9]. One future research using CAs is pattern recognition in a social database, for example fashion styling to determine criminal behaviors [13], as it is possible to see in Fig. 7. In addition, the CAs can help in the construction of the Neuromarketing and Cyberbullying model by determining and adjusting correctly the social behavior of a group of people over time and their particular way of changing their way of thinking.

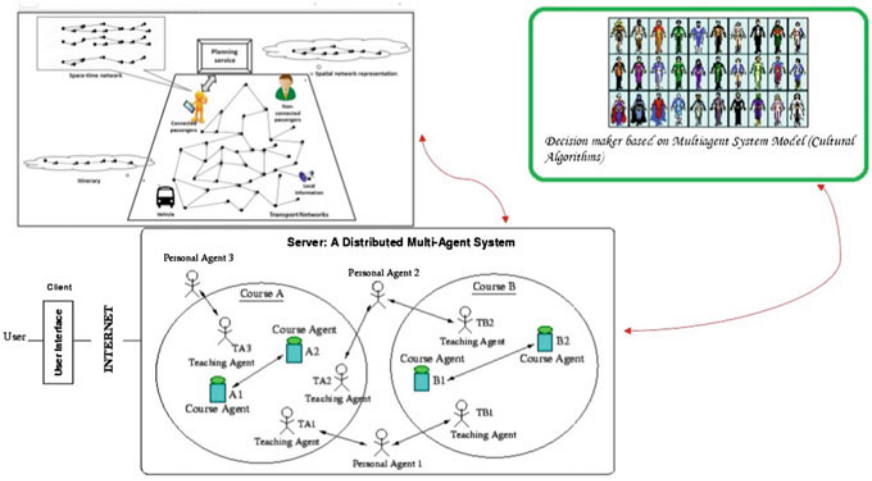

Fig. 7 Future enhancements to cultural algorithms include modeling a collaborative soul sense to make decisions considering future side effects

References

1. Reynolds RG (2018) Culture on the edge of chaos—cultural algorithms and the foundations of social intelligence. Springer. https://doi.org/10.1007/978-3-319-74171-0
2. Cruz-Álvarez V.R., Montes-Gonzalez F., Ochoa A., Palacios-Leyva R.E. (2012) Distribution and Selection of Adequate locations on a Diorama to Represent Social Issues Using Cultural Algorithms and Graph Adequate locationing. In: Omatu, S., De Paz Santana, J., González, S., Molina, J., Bernardos, A., Rodríguez, J. (eds.) Distributed Computing and Artificial Intelligence. Advances in Intelligent and Soft Computing, vol 151. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-28765-7_8
3. Zheng Y, Zhong B, Yang F (2018) When algorithms meet journalism: the user perception to automated news in a cross-cultural context. Comput Hum Behav 86:266–275. https://doi.org/10.1016/j.chb.2018.04.046
4. Guo YN, Zhang P, Cheng J, Wang C, Gong D (2018) Interval multi-objective quantum-inspired cultural algorithms. Neural Comput Appl 30(3):709–722. https://doi.org/10.1007/s00521-016-2572-5
5. Hué, T. et al.: The Emergence of Social Network Hierarchy Using Cultural Algorithms, VLDB'06, Seoul, Korea (2006)
6. Reynolds, R.G., Sverdlik, W.: Problem solving using cultural algorithms. In: International Conference on Evolutionary Computation. IEEE World Congress on Computational Intelligence, vol. 2, pp. 645–650. Orlando (1994). https://doi.org/10.1109/ICEC.1994.349983
7. Selvarajah K, Kobti Z, Kargar M (2020) Cultural algorithms for cluster hires in social networks. Proc. Comput. Sci. 170:514–521. https://doi.org/10.1016/j.procs.2020.03.117
8. Ponce J, Karahoca A (2009) Data Mining and Knowledge Discovery in Real Life Applications. IN-Tech, Vienna
9. Kobti Z, Reynolds RG, Kohler TA (2006) The emergence of social network hierarchy using cultural algorithms. Int J Artif Intell Tools 15(6):963–978. https://doi.org/10.1142/S0218213006003065
10. Song A, Niu C, Ding X, Xu X, Song Z (2019) Mental fatigue prediction model based on multimodal fusion. IEEE Access 7:177056–177062. https://doi.org/10.1109/ACCESS.2019.2941043
11. Herlambang MB, Taatgen NA, Cnossen F (2019) The role of motivation as a factor in mental fatigue. Hum Factors 61(7):1171–1185. https://doi.org/10.1177/0018720819828569
12. Ochoa A, Hernández A, Jons S, Montes F, Ponce J, Janacek L (2009) Dyoram's representation using a mosaic image. Int. J. Virtual Reality 8(3):1–4. https://doi.org/10.20870/IJVR.2009.8.3.2734
13. Li, F., Chen, C.-H., Xu, G., Khoo, L.P., Liu, Y.: Proactive mental fatigue detection of traffic control operators using bagged trees and gaze-bin analysis. Adv. Eng. Inform. **42**, 100987 (2019). https://doi.org/10.1016/j.aei.2019.100987