Applications of Intelligent Systems in Tourism: Relevant Methods

Raúl A. Sánchez-Ancajima[1*], Miguel Jiménez-Carrión[2], Flabio Gutierrez[3],
Adriel O. Hermenegildo-Alfaro[4], Miguel A. Saavedra-López[5], Ronald M. Hernández[6] and
Luis Reynaldo Exebio Moya[7]

[1*]Senior Lecturer, Universidad Nacional de Tumbes, Tumbes, Perú. rsanchez@untumbes.edu.pe
ORCID: https://orcid.org/0000-0003-3341-7382

[2]Senior Lecturer, Universidad Nacional de Piura, Piura, Perú. mjimenezc@unp.edu.pe
ORCID: https://orcid.org/0000-0001-9632-5085

[3]Profesor, Universidad Nacional de Piura, Piura, Perú. flabio@unp.edu.pe
ORCID: https://orcid.org/0000-0003-0372-3864

[4]Associate Professor, Universidad Nacional de Tumbes, Tumbes, Perú.
ahermenegildoa@untumbes.edu.pe
ORCID: https://orcid.org/0000-0001-5436-9696

[5]Lecturer, Universidad Nacional de Tumbes, Tumbes, Perú.
Universidad Continental, Cusco, Perú. saavedralopezmiguel@gmail.com
ORCID: https://orcid.org/0000-0003-4913-933X

[6]Professor, Universidad Privada Norbert Wiener, Lima, Perú. ronald.hernandez@outlook.com.pe
ORCID: https://orcid.org/0000-0003-1263-2454

[7]Professor, Universidad Científica del Sur, Lima, Perú. lexebio@cientifica.edu.pe
ORCID: https://orcid.org/0000-0001-5381-0339

Abstract

This article presents a literature review of Intelligent Systems applications in Tourism in different parts of the world. The review focuses on the most relevant methods in free and paid databases, in English and Spanish. Most of the works deal with methodologies based on artificial intelligence, such as expert systems, fuzzy logic, machine learning, data mining, neural networks, genetic algorithms. In the review, several characteristics of the systems have been taken into account, such as, knowledge base, actors in the operation of the system, types of tourists, usefulness or not in space and time. According to the review it was found that most of the researches are deterministic models, the most used methodology in tourism are the expert systems based on rules, observing an emerging innovation in metaheuristics, mainly genetic algorithms and intelligent systems with knowledge base based on optimization methods for route choice or optimal visit plan. It is expected that this work serves to give a general perspective on the application of intelligent systems in the area of tourism, as well as a work that consolidates background for work in this area of research.

*Corresponding author: Senior Lecturer, Universidad Nacional de Tumbes, Tumbes, Perú.

1 Introduction

The tourism sector is a sector of vital importance in the world economy, it economically sustains millions of people, generates one in ten jobs, for example, in Europe, it generates 27 million jobs, in 2019 it accounted for 7% of world trade (Guterres, A., 2020). The World Tourism Organization (UNTWO) (UNTWO, 2018), states that in 2018 the tourism sector contributed 2% to the world's GDP. In addition, the tourism sector helps to promote other economic sectors such as the hotel sector, transportation, gastronomy, leisure and entertainment sector, souvenir production industry, textile sector etc. Therefore, the development of intelligent systems that help tourists and companies in decision making is under constant research.

Intelligent systems are successfully applied to solve problems in different areas of science, particularly in the tourism sector, expert systems to simulate or mimic the decision making of tourism experts, fuzzy systems to create tourism systems that take into account the imprecision that can occur in parameters and variables, case-based reasoning systems to make decisions based on successfully solved cases in the tourism sector, semantic web to find relevant tourism knowledge on the internet, intelligent agents to help create systems where many individuals participate in tourism-related decisions, machine learning, data mining and biga data to find important knowledge in the vast amount of data coming from tourists and metaheuristics to find optimal routes for the movement of vehicles that transport tourists.

The proposed article reviews various intelligent systems applied in tourism, with the aim of showing an overview of their application in the area of tourism as well as consolidating background for future work. Accordingly, the criteria to be taken into account are: methodology, genetic algorithm and knowledge base, in the argumentation section you can read the theoretical aspect of it, then in the results section the applications of intelligent systems and genetic algorithms in tourism are shown and finally the conclusions section.

2 Argumentation

Intelligent Systems and Genetic Algorithms: Intelligent systems are systems capable of solving complex and multidisciplinary problems in an automatic way giving support to the decisions of an expert, i.e. they are mainly high-tech machines that can perceive and respond to their environment, it is a machine with an attached device connected to the internet, which can collect and analyze information, as well as communicate with other devices (Shyamapada Mukherjee, 2022). In relation to experts these are traditionally humans however currently with the advancement of technology we already have expert systems that are either software or machines that give effective assistance to users thus we have metaheuristics which for decades have seen a rapid growth in computing power and as computers have become faster, these metaheuristic techniques have become increasingly popular for solving difficult combinatorial problems. The intelligent system is unreal, which is built from reasoning, learning, problem solving, perception and linguistic intelligence (see Figure 1), in that sense, reasoning is a series of procedures that allow us to make judgments, decisions and predictions; learning is the process of gaining information or skill through study, practice, teaching or experience; problem solving is the process of perceiving and attempting to arrive at the desired solution from a circumstance by following a path that is hindered by known or unknown obstacles; perception is the process of collecting, interpreting, selecting, and organizing sensory data; and linguistic intelligence is the faculty of using,

understanding, speaking, and writing oral and written language (Shyamapada Mukherjee, 2022). Figure 2 shows some of the most common forms of intelligent systems in the framework of a brief overview of various system architectures with an intelligent system (Shyamapada Mukherjee, 2022).
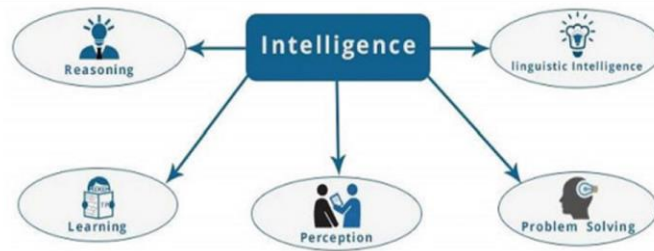

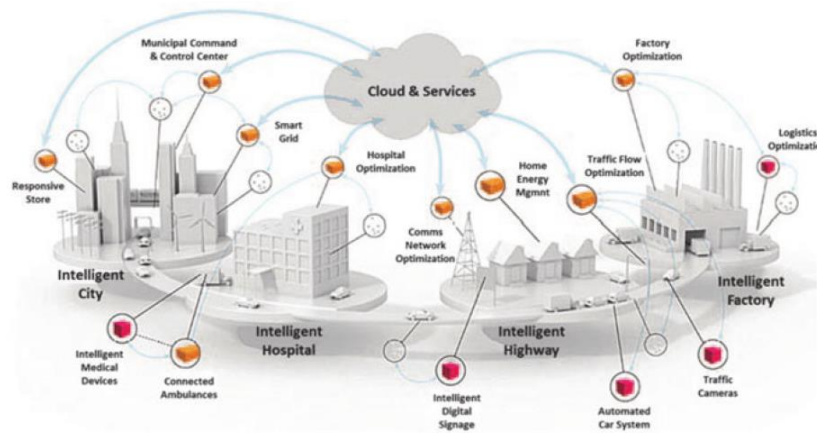Figure 1: Elements of Intelligence. (Shyamapada Mukherjee, 2022)

Figure 2: Intelligent System Framework. (Shyamapada Mukherjee, 2022)

A solution approach based on intelligent systems is related to tourism because on the one hand it integrates the experience of human experts in tourism when translated into an expert system based on rules and on the other hand the metaheuristics of Genetic Algorithms when it assists the expert system and returns the optimal route of tourists after selecting their preferred places to visit. Therefore, evolutionary methods such as evolutionary programming, evolutionary strategies and genetic algorithms (GA) are the most used for these cases because they have the advantage of applying in highly complex models that are difficult to solve with conventional mathematical methodologies, because they can evaluate infinite optimal solutions (Pattnaik, S. B., 1998) (Tom, V.M., 2003) (Agrawal, J., 2004) (Bastidas, 2010) Likewise, the design of a genetic algorithm begins with the design of the chromosome, which is the initial stage of the algorithm and is characterized because much of the inventiveness of the design of a genetic algorithm rests on this stage, specifically on how to design the chromosome that will represent each individual, a chromosome that will implicitly contain the constraints of the problem (Jiménez-Carrión, (2018).

On the other hand and in the same vein, during the last fifty years, the traveling salesman problem (TSP) is considered one of the most important topics for exploring optimization problems in operations research, mainly due to its purer formulation nature, focused on some of the most important applications related to practical, occupations, such as, for example, in some areas of industrial planning, cargo logistics, vehicle routing and machine configuration as mentioned by Júnior and Guimarães (Júnior, A.N., 2019) reported by Jiménez-Carrión (Jiménez-Carrión, 2020).

Knowledge base of an Intelligent System: In an intelligent system there are two subsystems that cannot be missing, the knowledge base and the inference engine, The construction of the knowledge base is crucial, whatever method or technique is used, the inference engine of the intelligent system uses the knowledge base as input to make a decision, if the knowledge collected is good the system will make good decisions, on the contrary if the knowledge is poor it will make bad decisions (Martinsanz, 2006).

In rule-based expert systems the knowledge base contains logical rules that represent the expert's knowledge; in probabilistic expert systems the knowledge base is formed by probability distributions obtained from databases; while in fuzzy intelligent systems the knowledge base is formed by fuzzy rules that contain the expert's experience and knowledge including the imprecision that occurs in the problem to be solved (Castillo, E., 2012); on the other hand, in case-based reasoning systems, the knowledge base contains successfully solved cases (Pal, S.K., 2004), in intelligent agents and the semantic web the knowledge base is formed by ontologies that represent the relationships, knowledge and experience of the subject to be solved (Mas, A., 2005). Currently, with the advance of machine learning, data mining and big data, knowledge bases can be obtained from databases.

There are different methodologies to develop each type of intelligent system, for expert systems the methodology of Durkin (Durkin, J., 1998), CommonKads Methodology (Schreiber (Schreiber, A.T., 2000)), in case-based reasoning the methodology of Aamodt & Plaza (Aamodt, A., 1994) and in data mining the CRISP-DM methodology can be used.

Whatever methodology is used for the development of the intelligent system, in all of them the construction of the knowledge base is a fundamental part (Wirth, R., 2000). For example, Jadrná Monike & Macak Tomas (Jadrná, M.A., 2018) in work focus on the use of a fuzzy rule-based system for the area of tourism, specifically, the optimization of production for companies operating in the tourism industry.

3   Results

Applications of Intelligent Systems in Tourism: The identification of tourist resources and attractions is an important element to promote tourism in a given city or geographical area, recommendation systems are currently being applied in many different domains, including tourism. Borrás Moreno (Borràs, J., 2014) in their research, performs an exhaustive and thorough search of intelligent systems in Tourism in Artificial Intelligence journals and conferences since 2008, highlighting the functionalities offered by these systems and the use of Artificial Intelligence techniques. Tourism and economics have an important relationship when the accuracy of tourism demand is required for the development and implementation of actions and strategies to optimize resources and utilities, in that sense, Yu Huixia (Yu, H., 2021), proposes a system that has a combination of neural networks and FPGA convolutional to establish a neural network for tourism demand forecasting, the modeling methodology introduces a significant prediction accuracy of artificial intelligence methods versus traditional statistical methods. Gretzel (Gretzel, U., (2011) and Loureiro et al. (Loureiro, S.M., 2020), in their research makes a citation network analysis and text mining techniques to achieve a full text analysis of 56 journal articles and 325 conference proceedings related to virtual reality and augmented reality in the context of tourism and provides an overview of the network of studies in tourism in addition makes a discussion over time highlighting the important aspects and studies emerging from this literature. Information on databases in tourism and hospitality research are limited, however, Li Law Xie and Wang (Li, X., 2021) present a review of important research in tourism forecasting and show in their results that time series and econometric forecasting models are still dominant and that artificial intelligence methods are still being developed, further stating that combined internet data and forecasting models will help to further improve forecast accuracy in future research. The tourism potential in different cities is an important

data when wanting to establish development policies, Leyva Eddy (Leyva, E.S., 2014) proposes a formula to calculate the index of tourism potential based on Fuzzy Logic methodology that allows a treatment to the subjectivity inherent in the evaluation criteria of tourism potential also compares it with other methodologies conceiving a model that provides experts with a ductile tool in the art of tourism potential evaluation.

In recent decades, intelligent tourism recommendation systems are showing great importance in the sector, Liang Hon (Liang, H.Y., 2021) in his research combines big data technology to build a personalized recommendation system for tourism based on real travel recommendation needs and verifies the system in combination with experimental research arguing that a high practical effect is obtained. The sustainable development of Tourism over time is also addressed by researchers through predictive models or intelligent systems, Seminar Vasquez (Seminario Vásquez, R.G., 2021) designed a model that allows determining policies and strategies with a sustainable approach to tourism development in the Department of Piura, Peru, It is a non-experimental research and shows the importance of system dynamics in the sense that it provides a vision of the interrelation of variables or interest groups in tourism, as well as their impact on the environment and their projection over time for the sustainable and sustainable development of tourism. On the other hand, recommender systems (RS) are gaining immense popularity with the wider adaptation to deal with the problem of information overload in various application domains such as e-commerce, entertainment, e-tourism, etc., Logesh et al. (Logesh, R., 2019) propose a personalized (RS) induced by activity and behavior as a hybrid approach to predict POI recommendations, the RS help traveling users because it provides an effective list of POIs as recommendations, further as an extension, they have designed a new group recommendation model to meet the requirements of the user group by exploiting the relationships between them and their experimental results show the improved performance of the proposed hybrid recommendation approach over the standalone approach and hybrid benchmark approaches. The improvement of smart tourism is steady over time, Jia Du (Du, J., 2021) proposes to improve the effect of smart tourism a common big data technology through improving algorithms to improve the intuitive effect of big data, constructs big data visualization technology and realizes real-time online visualizations of tourism data, his results show that the constructed big data-based smart tourism information system satisfies the actual tourism information needs and user experience needs. Tourist assistance systems have their advantages and disadvantages, Mikhailov (Михайлов, C.A., 2019), in his research develops the architecture of a system with details for its implementation and developed a method for generating tourist ratings for places of interest in the region, on the basis of which the author conducted experiments, obtaining as main results a description of a method that allows generating information about a tourist region from specialized open sources.

Tourism and economy are inevitably related for example Mendonça, Vítor & Cunha Carlos (Mendonca, V.J., 2021) state that the economic sector of tourism has gained significant weight in the economy of many countries, highlighting the importance of this sector in Portugal, however, the inconsistency and seasonality of demand makes companies linked to the sector face difficulties in terms of planning and management of resources allocated to the activity. It is very frequent that there are periods with economic losses caused by a small and insufficient volume of demand to support the costs of the activity, in this sense his article proposes a system that, based on the intelligent analysis of data, allows a hotel chain to segment customers and enhance exclusive offers in order to minimize fluctuations and gaps in demand in hotels located in thermal spas.

Chérrez-Bahamonde, R.C., 2021 et al., found that the results of the consulted research coincide in indicating that tourism plays an increasingly important role in the global economy. Fernandez, N.A,

2022 et al., in their work to develop the system used the methodology of Nicolás Kemper. Tourism experts from the provinces participated in the development of the knowledge base.

Genetic Algorithms in tourism as a method of optimization: Holland (Holland, J.H., 1992) in this line, for example, for the problem of how to better capture the attention of tourists and explore the combination of keywords, the researcher Sun (Sun, S., 2023) in his study proposes a methodology based on the selection of features in two stages: comparison of selection methods and obtaining a subset of features suitable for a forecasting model, this based on a genetic algorithm obtaining better results compared to the benchmarks considered in his study. On the other hand, in the business area; the problem of identifying optimal target markets using tourism demand expenditure is exposed as a novel concept in the tourism literature in the study by Cazorla (Cazorla-Artiles, J.M., 2023), in which the latent tourism demand between each origin-destination pair is quantified through the distinction by type of tourism and seasonality. The study is based on a fractional regression model. Accurate tourism demand forecasting systems are fundamental in tourism planning, in that sense artificial neural networks are gaining relevance in forecasting problems so Hong et al. (Hong, W.C., 2011) present a support vector regression(SVR) model with chaotic genetic algorithm (CGA), for forecasting tourism demand, they propose a solution to the increasing complexity and as it is known that at larger scale of tourism demands problems genetic algorithms (GA) often face premature convergence problems, slowly reaching the global optimal solution or trapping in a local optimum.

Designing optimal travel routes for tourists is a crucial issue, so the time-windowed team orientation problem (toptw) is one of the approaches that can solve the tourist travel design problem, Shahrabi & Asadi (Shahrabi, J., 2013) and Heris et al. (Heris, F.S.M., 2022) design a multi objective model to determine optimal travel routes, and formulate a multiobjective genetic algorithm to solve the demand forecasting problem.

The problem of tourism demand forecasting is a guarantee to have an effective management from the point of view of government and tourism planning, so Sun (Sun, S., 2022) proposes an improved machine learning model that introduces valuable information by taking daily and weekly tourist arrivals resulting in significantly improved performance.

forecasting. Artificial intelligence (AI) has a lot of attention when it relates to tourism and hospitality (T&H) practices, for example Knani et al. (Knani, M., 2022) propose a bibliometric approach with the aim of examining current cutting-edge AI research in (T&H), they cite in their study 1035 manuscripts published between 1984 and 2021 in Scopus andWeb of Science, highlighting in the study networks of authors, affiliated institutions and countries, in addition to emerging topics such as experiences with service robots, the article concludes that there are future prospects and avenues for research in this area. In addition, with the development of neural network technology and genetic algorithms and especially the rapid growth of tourism revenue in China, Kan et al. (Kan, X., 2021) expound that there is a gradual emergence on the comprehensive evaluation of tourism resources and based on this they study the nervous system as a comprehensive network evaluation model based on multispecies evolutionary genetic algorithm and design the neural network as a system of tourism resources influence factors analysis, they argue that, the multispecies evolutionary genetic algorithm has the advantages of high practicability, good classification effect of variable proportion and good data integration. Public institutions and private companies responsible for tourism management have found genetic algorithms as an important alternative to optimize complete tourist tours for their customers, in light of this, Cao (Cao, S., 2022) presents a GA as a potential solution to the problem of how to visit a number of tourist destinations within a restricted area to quickly determine the shortest tourist route, first provides a simplified explanation of the improved GA, second analyzes the construction and solution of the model,

then with the improved GA determines the optimal travel route, to finally estimate the required number of days and arrangements to visit a variety of tourist attractions, concludes that the improved GA effectively applies to multi-path planning, assigning high practical value and justification to the research. There are also tourists who wish to make the routes by walking, but find a limitation of being unfamiliar with the target area, here Smirnov (Smirnov, 2021), proposes an algorithm that uses data on places of interest from Open Street Map and applies the modernized GA to construct routes, considering the creation of two route options: a route between two different points (if the tourist wants to reach a specific destination while seeing some places of interest on the way) and a circular route returning to the starting point in a specific time (e.g., if the tourist wants to walk around the hotel or a train station). In general and in summary, tourism has been, is and will continue to be an important factor as a driver of the economy in the world, so in recent years has continued with greater force its evolution having as an ally cloud computing, internet, wireless communication network, etc., allowing optimal route planning for the satisfaction of all tourists (Ka-Cheng, Choi., 2022) (Xiao, 2021) (Wang, Yapeng., 2021).

4   Conclusions

- In the group of researchers in the area of artificial intelligence, the interest in the application of intelligent systems in tourism has been growing in recent years and is increasing every year using hybrid methodologies.
- Although most of the works focus on intelligent systems in tourism, there are also works related to the importance of the tourism sector in the economy of society, as well as preserving and caring for the environment as a common good.
- Most of the studies are deterministic; few studies consider parameters with uncertainty, possibly because they are more complex to solve.
- Most of the works seek to satisfy the preferences of tourists and to optimize the time spent in each tourist site or city.

References

[1]   Guterres, A. (2020). Tourism was devastated by COVID-19 and must be rebuilt in a more planet-friendly way. *Economic Affairs. United Nations (UN), 2020*, 1-15.
[2]   UNTWO. (2018). Traveling is an upward trend and the figures support it. World Tourism Organization (UNTWO).
[3]   Shyamapada Mukherjee, Naresh Babu Muppalaneni, Sukriti Bhattacharya, Ashok Kumar Pradhan (2022). Intelligent Systems for Social Good. Springer Singapore.
[4]   Pattnaik, S.B., Mohan, S., & Tom, V.M. (1998). Urban bus transit route network design using genetic algorithm. *Journal of transportation engineering, 124*(4), 368-375.
[5]   Tom, V.M., & Mohan, S. (2003). Transit route network design using frequency coded genetic algorithm. *Journal of transportation engineering, 129*(2), 186-195.
[6]   Agrawal, J., & Mathew, T.V. (2004). Transit route network design using parallel genetic algorithm. *Journal of Computing in Civil Engineering, 18*(3), 248-256.
[7]   Bastidas, Marlon J, Bermúdez, Raúl F, Jaramillo, Gloria P, & Chejne, Farid. (2010). Thermoeconomic and Environmental Optimization using Multi-Objective Genetic Algorithms. *Información tecnológica, 21*(4), 35-44.
[8]   Jiménez-Carrión, Miguel. (2018). Simple Genetic Algorithm to solve the Job Shop Scheduling Problem. *Información tecnológica, 29*(5), 299-314.

[9]   Júnior, A.N., & Guimarães, L.R. (2019). A greedy randomized adaptive search procedure
        application to solve the travelling salesman problem. *International Journal of Industrial
        Engineering and Management, 10*(3), 238-242.

[10]   Jiménez-Carrión, Miguel, Sánchez-Candela, Luis, Keewong-Zapata, Roxani, & Bazán, José.
        (2020). Optimization of routes for the intervention of oil wells. *Información tecnológica, 31*(4),
        71-84.

[11]   Martinsanz, G.P., & Peñas, M.S. (2005). *Inteligencia artificial e ingeniería del conocimiento*.
        Ra-Ma.

[12]   Castillo, E., Gutierrez, J.M., & Hadi, A.S. (2012). *Expert systems and probabilistic network
        models*. Springer Science & Business Media.

[13]   Pal, S.K., & Shiu, S.C. (2004). *Foundations of soft case-based reasoning*. John Wiley & Sons.

[14]   Mas, A. (2005). Software agents and multi-agent systems: Concepts, architectures and
        applications.

[15]   Durkin, J., & Durkin, J. (1998). *Expert systems: design and development*. Prentice Hall PTR.

[16]   Schreiber, A.T., Schreiber, G., Akkermans, H., Anjewierden, A., Shadbolt, N., de Hoog, R., &
        Wielinga, B. (2000). *Knowledge engineering and management: the Common KADS
        methodology*. MIT press.

[17]   Aamodt, A., & Plaza, E. (1994). Case-based reasoning: Foundational issues, methodological
        variations, and system approaches. *AI communications, 7*(1), 39-59.

[18]   Wirth, R., & Hipp, J. (2000). CRISP-DM: Towards a standard process model for data mining.
        *In Proceedings of the 4th international conference on the practical applications of knowledge
        discovery and data mining*, 1, 29-39.

[19]   Jadrná, M., & Macák, T. (2018). Optimisation of a travel agency´s product portfolio using a
        fuzzy rule-based system. *Scientific papers of the University of Pardubice. Series D, Faculty of
        Economics and Administration*.

[20]   Borràs, J., Moreno, A., & Valls, A. (2014). Intelligent tourism recommender systems: A survey.
        Expert systems with applications, 41(16), 7370-7389.

[21]   Yu, H. (2021). Development of tourism resources based on fpga microprocessor and
        convolutional neural network. *Microprocessors and Microsystems, 82*.

[22]   Gretzel, U. (2011). Intelligent systems in tourism: A social science perspective. *Annals of
        tourism research, 38*(3), 757-779.

[23]   Loureiro, S.M., Guerreiro, J., & Ali, F. (2020). 20 years of research on virtual reality and
        augmented reality in tourism context: A text-mining approach. *Tourism management, 77*.

[24]   Li, X., Law, R., Xie G., & Wang, S. (2021). Review of tourism forecasting research with internet
        data. *Tourism Management, 83*.

[25]   Leyva, E.S. (2014). Proyección del Modelo FUZZY-SECTUR para evaluar el potencial turístico
        de un territorio/Proposal of the FUZZY-SECTUR model to evaluate the tourist potential of a
        territory. *Retos Turísticos, 13*(3).

[26]   Liang, H. (2021). Intelligent Tourism Personalized Recommendation Based on Multi-Fusion of
        Clustering Algorithms. *Advances in Multimedia*, *2021*, 1-11.

[27]   Seminario Vásquez, R.G. (2021). Propuesta de Políticas y Estrategias para la Industria Turística
        Sustentable de Piura utilizando Dinámica de Sistemas. Piura: Graduate School Universidad
        Nacional de Piura.

[28]   Logesh, R., Subramaniyaswamy, V., Vijayakumar, V., & Li, X. (2019). Efficient user profiling
        based intelligent travel recommender system for individual and group of users. *Mobile Networks
        and Applications,* 1018-1033.

[29]   Hossain, M.S., Sultana, Z., Nahar, L., & Andersson, K. (2019). An intelligent system to
        diagnose chikungunya under uncertainty. Journal of Wireless Mobile Networks, Ubiquitous
        Computing, and Dependable Applications, 10(2), 37-54.

[30]   Du, J. (2021). Research on intelligent tourism information system based on data mining
        algorithm. *Mobile Information Systems*, *2021*, 1-10.

[31] Михайлов, С.А. (2019). Intelligent tourist assistance system: service-oriented architecture and implementation. *Journal Scientific and Technical Of Information Technologies, Mechanics and Optics, 121*(3), 499-507.

[32] Mendonca, V.J., Cunha, C.R., Correia, R.A., & Carvalho, A.M. (2021). Proposal for an IntelligentSystem to Stimulate the Demand for Thermal Tourism. *16th Iberian Conference on Information Systems and Technologies (CISTI),* 1-7.

[33] Chérrez-Bahamonde, R.C., López-Paredes, C.R., & Logroño-Naranjo, S.I. (2021). Tourism as a resource generating growth and economic development through statistical indicators. *Revista Científica FIPCAEC, 6*(1), 648-664.

[34] Fernandez, N.A., Gutierrez, F., Gómez, E.E., Ruiz, A.D., Tineo, J.P., & Segura, E.L. (2022). Expert System to Guide Users of the Tourist Corridor of the Provinces of Jaen, San Ignacio and Ucubamba in Cajamarca, Peru. *International Journal of Professional Business Review, 7*(2), 1-18.

[35] Holland, J.H. (1992). Genetic algorithms. *Scientific American, 267*(1), 66-73.

[36] Sun, S., Hu, M., Wang, S., & Zhang, C. (2023). How to capture tourists' search behavior in tourism forecasts? A two-stage feature selection approach. *Expert Systems with Applications, 213.*

[37] Cazorla-Artiles, J.M., & Eugenio-Martin, J.L. (2023). Optimal targeting of latent tourism demand segments. *Tourism Management, 95.*

[38] Hong, W.C., Dong, Y., Chen, L.Y., & Wei, S.Y. (2011). SVR with hybrid chaotic genetic algorithms for tourism demand forecasting. *Applied Soft Computing, 11*(2), 1881-1890.

[39] Shahrabi, J., Hadavandi, E., & Asadi, S. (2013). Developing a hybrid intelligent model for forecasting a problem: Case study of tourism demand time series. *Knowledge-Based Systems, 43,* 112-122.

[40] Heris, F.S.M., Ghannadpour, S.F., Bagheri, M., & Zandieh, F. (2022). A new accessibility-based team orienteering approach for urban tourism routes optimization (A RealLife Case). *Computers & Operations Research, 138.*

[41] Sun, S., Li, M., Wang, S., & Zhang, C. (2022). Multi-step ahead tourism demand forecasting: The perspective of the learning using privileged information paradigm. *Expert Systems with Applications, 210.*

[42] Knani, M., Echchakoui, S., & Ladhari, R. (2022). Artificial intelligence in tourism and hospitality: Bibliometric analysis and research agenda. *International Journal of Hospitality Management, 107.*

[43] Kan, X., & Li, L. (2021). Comprehensive evaluation of tourism resources based on multispecies evolutionary genetic algorithm-enabled neural networks. *Computational Intelligence and Neuroscience, 2021,* 1-11.

[44] Cao, S. (2022). An Optimal Round-Trip Route Planning Method for Tourism Based on Improved Genetic Algorithm. *Computational Intelligence and Neuroscience, 2022*, 1-18.

[45] Smirnov, E., & Kudinov, S. (2021). Using a Genetic Algorithm for Planning Interesting Tourist Routes in the City on the Basis of Open Street Map Data. *In IEEE Congress on Evolutionary Computation (CEC)*, 264-271.

[46] Ka-Cheng, Choi; Sha, Li; Chan-Tong, Lam; Angus, Wong; Philip, Lei; Benjamin, Ng & Ka-Meng, Siu. (2022). Genetic Algorithm for Tourism Route Planning Considering Time Constrains. *International Journal of Engineering Trends and Technology, 70*(3), 171-179.

[47] Xiao, S. (2022). Optimal Tourist Route Optimization Model Based on Cloud Data. In *The 2021 International Conference on Machine Learning and Big Data Analytics for IoT Security and Privacy, 2*, 479-486. Springer International Publishing.
Wang, Y., Lam, C.T., Choi, K.C., Ng, B., Siu, K.M., Lei, P., & Yang, X. (2021). An Open Tourism Mobile Platform with Personalized Route Planning and Voice Recognition. *In The 9th International Conference on Information Technology: IoT and Smart City*, 337-345.

Authors' Biography

Raúl A. Sánchez Ancajima obtained the degree of Licenciado in Mathematics from the Faculty of Sciences of the National University of Piura, Peru (2004). He obtained a Master's degree in Science with a major in Applied Mathematics from the National University of Piura, Peru (2011). Doctor in Mathematics from the National University of Trujillo, Peru (2021), with an internship at USP in Brazil. Senior Lecturer at the National University of Tumbes, Peru. My research interests are focused on Artificial Intelligence, Optimization Methods and Fractional Calculus.

Miguel Jiménez-Carrión Doctor in Industrial Engineering from the National University of Piura, Peru, 2013. He was the winner of a contest to mentor a participant with her thesis in Economic Engineering at the Universidad Nacional del Altiplano del Peru. He is currently a Senior Lecturer in the Operations Research Department of the Faculty of Industrial Engineering, and a RENACYT researcher; External Evaluator for CONCYTEC, and Innovate Peru. His research interests include Artificial Neural Networks, Genetic Algorithms, Fuzzy Logic, Fuzzy Controllers, Shape Recognition, Mathematical Modeling and Optimization.

Flabio Gutierrez I obtained my Bachelor's degree in Mathematics in 1991 at the National University of Trujillo (Peru), a Master's degree in Computer Science in 1997 at the University of Cantabria (Spain), I did doctoral studies in computer science at the Polytechnic University of Valencia (Spain) in 2013. In 2017 I obtained a PhD in Mathematics from the National University of Trujillo (Peru). I am currently a professor in the Department of Mathematics at the National University of Piura (Peru). My research area is artificial intelligence.

Adriel O. Hermenegildo Alfaro, He graduated with a degree in Tourism from the Faculty of Social Sciences of the National University of Trujillo, Peru (2001). He obtained the degree of Magister Scientiae in Ecotourism at the Universidad Nacional Agraria La Molina, Peru (2022). Associate Professor at the National University of Tumbes (UNTUMBES), Peru. His lines of research are focused on Tourism, Ecotourism, Adventure Tourism and Tourism Operation.

Miguel A. Saavedra-López, Doctor in Psychology from Universidad César Vallejo, Perú, 2023. Dean of the Regional Board of Directors of Tumbes - College of Psychologists of Peru (2020 - 2022). Qualified as a RENACYT researcher by the National Council of Science, Technology and Technological Innovation (CONCYTEC). Currently teaching at the National University of Tumbes and Continental University (Peru), director of the International Journal of Social Sciences. Interest in research related to mental health, artificial intelligence and scientific production.

Ronald M. Hernández, Bachelor's Degree in Psychology. Master in Education. Qualified researcher in RENACYT (Concytec). University professor. International assistant editor of the Educational Journal of Works Oriented to the XXI Century (Panama), Varela Journal(Cuba). Peer reviewer of scientific articles in national and international journals on topics of Psychology, Education and Medicine. Couator of the book Publishing in scientific journals. Has published scientific articles in international indexed journals in Scopus, Web of Science and SciELO.

Luis Reynaldo Exebio Moya, Doctor in Health; Master in Occupational Health. He is Deputy Director of the Lima East Metropolitan Health Network. He is a University Professor of "Research Methodology" at the Scientific University of the South