A Short Review of the Application of Machine Learning Methods in Smart Airports

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Abstract. Machine learning has influenced the modern transportation in many aspects, such as it could help construct ‘smart airports’ along with big data. Many researchers have discussed a lot of relevant topics in this area. This paper gives a relevant short review, indicating that there are mainly 4 issues which are under the concept of machine learning in the construction of smart airports in recent times. The issues are flight delays, airport environment, operation management of airport, safety of airport. The researches of the 4 issues have become the mainstream for the studies on smart airports.

Keywords. Machine learning, Smart airport

1. Main issues in SMART airports
Machine learning, as a key technology in artificial intelligence, bring the society deep revolution. Correspondingly, the concept of smart airport has once again entered the public review due to the airport security, operation efficiency, and environmental protection. All of these issues were previously unexpected or impossible to achieve, but now it becomes possible to build smart airports with massive data and information.

This article reviewed the latest papers which relate to machine learning application in smart airports, in order to find the key issues, discussed how machine learning is used to solve the four issues: flight delays, airport environment, operation management of airport, safety of airport, and predict the roadway of smart airports development in future.

2. Main application of machine learning on SMART airport

2.1. Flight delays analysis
Bojia Ye [1] By exploring supervised learning methods, this article predicted aggregate flight departure delays in airports, it process individual flight data and meteorological information to obtain four types of airport-related aggregate characteristics for prediction modeling. It has 4 supervised learning methods: multiple linear regression, a support vector machine, extremely randomized trees and LightGBM, these 4 methods are investigated to improve the predictability and accuracy of the model. This article compare this 4 modeling, using operational data from March 2017 to February
2018 for the Nanjing Lukou International Airport in China. The results show that the LightGBM model provides the best result.

Miguel et al. [2] explore a machine learning method to evaluate the influence of strategic IATA guidelines-compliant flight schedules on the on-time performance at an airport. It proposes classification algorithms to predict whether flights scheduled in the strategic phase are subject to arrival/departure delays and cancellations during execution times. By using the obtained flight delay and cancellation data, it proposes a general methodology to rank the strategic schedules by comparing the related flight delay and cancellation predictions. This article provides a means to assess strategic schedules based on their predisposition on flight delays and cancellations. The paper address for the assessment of strategic flight schedules is associated with the potential flight delays and cancellations.

Robert et al. [3] By using data mining, archived weather and airport performance data at ten climatologically and geographically different airports are analyzed. It establishes relationships between environmental variable inputs and airport efficiency. By using different statistical modeling methods within an overarching data mining protocol and the developed models, it discovered some meaningful relationships. Furthermore, a selected model was deployed to use real-time predictive weather information to estimate airport efficiency. This article employs SAS® Enterprise MinerTM data mining and modeling software to train and assess decision tree, neural network.

2.2. Airport environment analysis

Yong Tian proposed a new framework which were combined the standard assessment procedure and machine learning methods for fast and accurate prediction of air quality in airports.

Xunge Zhang et al. [4] This article proposes machine learning algorithms to design a prediction solution on water consumption in airport.

2.3. Operation management of airport analysis

Zhao Jiaming [5] proposed a deep reinforcement learning based AGAP (DRL-AGAP). With the rapid development of air transportation in recent years, airport operations have attracted a lot of attention. Among them, airport gate assignment problem (AGAP, Airport Gate Assignment Problem) has become a research hotspot. However, the real-time AGAP algorithm is still an open issue. In this study, Simulation results show that the performance of the proposed DRL-AGAP algorithm is close to that of pre-assignment obtained by the Gurobi optimization solver. Meanwhile, the real-time assignment ability is ensured by the proposed DRL-AGAP algorithm due to the dynamic modeling and lower complexity.

Moisés [6] in his master paper concerns case of bus services in the airport zone, It assess a model which basing on the available resources and the expected desirable service, its purpose is to get the optimum performance of the system. By using machine learning, it found patterns in the model that are far away or can be drawn to the optimum. In that way, driver behavior such as; acceleration profile, fuel consumption, eco-friendly habits, etc. could be assessed with the purpose of attempting to change it.

Waqar et al. [7] It is meaningful to predict accurately the taxi-out times of departures which is important for improving airport efficiency and takeoff time predictability. In this article, it applies machine learning methods to actual traffic data at Charlotte Douglas International Airport for taxi-out time prediction. Machine learning methods are applied to actual flight data, these methods including of linear regression, support vector machines, k-nearest neighbors, random forest, and neural networks model. The taxi-out time prediction results show that linear regression and random forest techniques are the most accurate prediction.

Ying Li [8] proposed using flexible mobile internet solution for air passenger in airport, by providing smart airport service terminal and internet to provide paper-free boarding passenger service, efficient check-in baggage services, personal airport navigation services, airport business services basing on passenger habit, flight delay due to special circumstances etc. It provide the dynamiting
information of flight, changing flight schedule in the internet, delay expance compensate, waiting entertainment etc. It also provide improve level of airport operation, efficiency, reducing energy consumption, It can act a big role in non-aviation business.

Yong Wang et al. [9] The design of the robot control system realizes the functions of networked query information, voice recognition preset response, obstacle avoidance and mobile by means of platform structure scheme based on wheeled mobile, which is a design of human-computer interaction system.

Qi Zhou [10] proposed using artificial intelligent to dealt with the problem of check-in baggage in airport, solving the waiting baggage phenomenon in airport. By using PFID and face recognition technology, the error rate of passenger baggage is lower than before.

Jinjun Du [11] It review the face recognition technology application on airport, It describe relevant information about safety, service, operation statistical, finding passenger etc. in airport.

Xuan Li [12] This article propose that Intelligent security is indispensable in smart airport, and intelligent video analysis is an important part to ensure the safety of smart airport.

2.4. Safety of airport analysis
Cornejo-Bueno By using machine learning methods, it addressed the prediction of low-visibility events at airports. by using of support-vector regression, neural networks (multi-layer perceptrons and extreme-learning machines) and Gaussian-process algorithms, the proposed model successfully predicts low-visibility events on the runway visual range area at the airport, it also propose a study of the atmospheric variables measured at a nearby tower which are related to low-visibility atmospheric conditions, because they are considered as the inputs of the different repressors. The results show that the proposed machine-learning algorithms can predict low-visibility events well. On the above analyzed algorithm, this article assert that the Gaussian process is the best algorithm obtaining over 98% of the correct classification rate in low-visibility events when the runway visual range is >1000m, and about 80% under this threshold.

Matthew (2016) et al. Duing to the limitations of machine vision geolocation in poor weather, it cannot be the only backup navigational technology. By using the weather-penetrating sensors. It could overcome this limitation. The article proposed machine vision is now capable and compact enough to pursue this purpose.

Fucheng Yin [14] According to the dynamic deformations of the pavement obtained from the ANN model, several parameters are defined to reflect the characteristics of the deformations of the surface layer and underground layers in the flexible pavement. In order to quantitatively reflect the contribution of the layer deformations in the total deformation of the flexible pavement, a parameter of deformation integration is introduced.

Jiankai Shen et al. [15] used Q—Learning algorithm to study the behavior of controller, introduced the prior probability path to join the conflict path set to be detected. The Agent has the ability to predict the future conflict and to optimize taxing time for the situation of regular conflict while respecting aircraft separation and airport capacities. The simulation results show that the controller Agent can solve the conflict effectively, which reflects the feasibility and superiority of this work.

Zhaohuan Zhan et al. [16] Existing methods for detection of objects on the surface of airports based on visual surveillance have problems such as large deviation of location and 10w accuracy of recognition. To solve these problems, a new method for detection of moving objects at airports is proposed.

Jin Hou et al. [17] A multiple feature combined convolutional network system based on deep learning is proposed in Aeronautical Communications. The experiment indicates that the proposed networks could be applied in real-time airport radio detection.

Xin Niu et al. [18] studied deep learning techniques for airport and flight recognition. To achieve real—time performance for such recognition with “large region and small targets”, a cascade framework of deep networks has been proposed.
3. Conclusions and prediction

The airport is an integrated sophisticated body which includes multi-function, multi-person, multi-frustrations. It can be divided into lobby, departure lounge, working area, flight area etc. Each part has its own requirement such as service requirement, operation requirement, safety requirement, environmental requirement etc. Meanwhile with diversity of multi-person, vehicles and devices etc, which create a big challenge to coordinate these thing smoothly. So it should use big data and intelligent technology to manage the complexity in airport, however, It is not easy to manage airport in smart ways, which will lead to some problems such as safety problems, energy consumption problems.

It’s imperative to apply more machine learning to improve the level of smart airport, although, it might be a long road to go.

4. Reference

[1] Ye B J, Liu B, Tian Y and Wan L L 2020 A Methodology for Predicting Aggregate Flight Departure Delays in Airports Based on Supervised Learning Sustainability 12 p 2749, doi:10.3390/su12072749

[2] Miguel L, Mihaela M, Simon P, Alan M 2020 Assessing strategic flight schedules at an airport using machine learning-based flight delay and cancellation predictions Journal of Air Transport Management 82 p 101737

[3] Robert W M 2018 Prediction of Airport Arrival Rates Using Data Mining Methods Embry-Riddle Aeronautical University. oai:commons.erau.edu:edt-1418

[4] Zhang X G, Zhang X X, Xu Y C 2019 Machine learning logarithm to design a prediction solution on water consumption in airport Journal of urban construction theory research (9) pp 105-106

[5] Zhao J M 2020 Airport gate assignment problem with deep reinforcement learning HIGH TECHNOLOGY LETTERS 26(1) pp 102-107

[6] Moisés O C 2015 Escola dEnginyeria Analysis of airport telematic data using data mining and machine learning Universitat Autònoma de Barcelona Diposit Digital de Documents de la UAB. oai:ddd.uab.cat:146892

[7] Waqar M, Yoon C 2016 Jung and Hanbong Lee Taxi-Out Time Prediction for Departures at Charlotte Airport Using Machine Learning Techniques NASA Technical Reports Server oai:casi.ntrs.nasa.gov:20180002162

[8] Ying L 2015 Applied research review on internet+airport Computer & Telecommunication (10) pp 70-71, 76

[9] Wang Y, Wang X, Zhu X, et al. 2019 Design and research of airport service robot control system Design, research & analysis (1) pp 25-31

[10] Zhou Q, Sun C J, Zhan R X et al. 2019 artificial intelligent to dealt with the problem of check-in baggage in airport Chinese new technology and new product (7) pp 3-5

[11] Du J J 2018 face recognition technology application on airport China science & technology overview (5) pp 22-23

[12] Li X 2019 The applications of intelligent video analysis in smart Airport China computer & communication (12) pp 132-133

[13] Matthew S, Andrew J M, Chester D, Glenn W 2016 Machine Vision for Airport Runway Identification NASA Technical Reports Server oai:casi.ntrs.nasa.gov:20160007027

[14] Yin F C 2014 Artificial intelligence methods for analyzing deformation and craking pattern of airport pavement Harbin Institute of Technology

[15] Shen J K, Shen T G Q 2018 Learning applied to airport taxiway dynamic programming Journal of civil aviation flight university of China (3) pp 5-9

[16] Zhang Z H, Han S C, Li W, Li L S 2019 A target detection method of moving objects at airport based on stereo flow and deep learning Journal of traffic information and safety 037 p 001

[17] Jin H, Lv Z L, Xu M, Wu P J, Liu Y L, Yu X, Chen Z 2019 Combined neural networks based on deep learning for signal detection in aeronautical communications Journal of southwest jiaotong university (054) p 004
[18] Niu X, Dou Y, Zhang P, Chao Y 2016 Airport and flight recognition on optical remote sensing data by deep learning *Big data research* (002) p 005