



Big data and artificial intelligence in earth science: recent progress and future advancements

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Earth science informatics has experienced significant growth in recent decades due to advancements in computational efficiency and processing power. The fourth industrial revolution has had a major impact on the environment, making earth science informatics crucial for detecting and predicting changes in the ecosystem and understanding the interactions between the land, ocean, and climate system. To tackle these challenges, data-driven approaches such as big data analytics and artificial intelligence (AI) are being utilized with increasing frequency. Big data analytics and AI allow researchers to analyse and acquire insights more efficiently, making predictions with observed data more effective. AI algorithms learn patterns from input and output data to establish a relationship and create a training model. The optimization of AI algorithms can improve the efficiency of earth science data computation even with complex datasets, uncovering hidden relationships and correlations between data sources. This Special Issue aims to bring together some of the leading experts in the field to share their latest research findings, as well as their perspectives on the future of Big data analytics and AI. Each of the fourteen articles published in this Special Issue has been rigorously peer-reviewed to ensure that they meet the highest standards of quality and scientific rigour. We are pleased to present the following highlights of these carefully selected contributions.

In the paper titled “Molecular Scale of Network Structure and Water Absorption of Soil Moisture Gel” (Jiang 2022), the soil moisture hydrogel was taken as the research object. Firstly, NaOH and acrylic acid were used as the main raw material to dissolve it into ethylene glycol. Then, the pH value was adjusted by different acids. After adjustment, the pH value was 7 after dialysis. Finally, acrylic acid nanoparticle hydrogel was obtained after ultrasonic treatment. Then, the network structure and molecular scale were observed by an Internet of things microscope. The aged gum for 8 h was injected into the hydrogel at a rate of 0.05 mL/min. The results showed that nanoparticle hydrogel showed natural expansion under the electron microscope of the Internet of things.

In the paper titled “Impact of the Evolution of Plateau Lake Landscape Pattern on Ecosystem Service Value in the Pearl River Basin-A Case Study of Yilong Lake Basin in Yunnan Province, China” (Ma et al. 2022), the landscape types of the Yilong Lake Basin in 1990, 1995, 2000, 2005, 2010, 2015, and 2018 were presented and discussed, focusing on the impact of landscape pattern type changes and its effect on ecosystem services values (ESV). The comprehensive analysis shows that the implementation of management measures such as ecological protection and governance of Yilong Lake surface mountain are needed to increase the landscape types variability and the total ESV.

In the paper titled “Design and Application of An Ontology to Identify Crop Areas and Improve Land Use” (Riaño et al. 2022), the authors presented the development of an ontology in the agricultural domain to facilitate the identification of cultivation areas and improve land use, relating the basic concepts for an effective crop development according to the specifications and recommendations proposed in Colombian government documentation, using the so-called Methontology methodology. The results of the relationship between the data defined from the documentation and the historical data of crops previously planted showed a high percentage of assertiveness for the recommendation of areas.

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In particular, in the case of the recommendation of crops, the percentage of assertiveness could be improved.

In the paper titled “Analysis of Accumulation Mechanism of Guantao Formation in Matouying Uplift of Jidong Oil field and its Exploration Inspiration” (Wang et al. 2022), the determination of oil sources and the correct understanding of the transport system were the keys to the reservoir understanding of the Guantao Formation in Matouying Uplift, as well as to the establishment of the reservoir model and the prediction of favourable oil and gas development areas. It provided the enlightenment for the exploration of reservoir outside sources in peripheral convex, and although oil and gas displays have been seen during single-well drilling, no large-scale reservoirs have been discovered until the industrial flow of oil. The results presented in this work provided evidence of future exploration trends and potential areas in the uplift around the Nazione and Npu sag.

In the paper titled “The Effect of Mulching Films on the Temporal and Spatial Distribution of Soil Water in Semiarid Hilly Area” (He et al. 2022), the changes in soil moisture under different plastic films and the impacts of different types of plastic films on local water retention were studied. The results showed that the soil moisture content was minimal in the 5 cm soil layer on any given day and that the white film led to greater soil moisture content than the other treatments within a depth of 1 m with a higher outcome. The soil water content at a depth of 10 m in the white film treatment was significantly higher than that in the other two treatments from October 2017 to May 2019. Film mulching not only increased the soil water content but also increased the water storage and moisture conservation in areas planted with jujube.

In the paper titled “Sustainable and Adaptable Measures to Address Climate Change in China: A Strategic Analysis in Urban Planning” (Yang 2022), the authors looked at the built environment and how it will adapt to rising climate change impacts, as well as the restrictions and potential for controlling such consequences for human sustainability. The research focused on a selected case study in China, which showed that constraints and opportunities to reduce the impacts of climate change exist across social, political, and economic indicators. The authors also stressed that China has implemented a series of strategies for combating climate change, including technological innovation, energy transition, enhancement of education, and public awareness as well as legal controls.

In the paper titled “Rainfall Erosion of Mountain Environment and People Flow Planning of Leshan Giant Buddha Site Based on Big Data GIS” (Zhu and Zhou 2022), the authors examined the route planning for tourists to the Leshan Giant Buddha scenic spot. Based on the availability of video surveillance equipment in the scenic spot, images and video data were collected, using another level

of co-Kejadian matrix theory to calculate the number of people in the scenic spot. The ARIMA model was adopted for investigating the time series, to eventually establish a model to change the fineness of the density data of the scenic spots. The simulation results highlighted that the estimation method proposed in this paper is consistent with the changing trend of tourist flow in scenic spots, and that it can be used for the visibility planning of tourist flow also in other areas.

In the paper titled “Automatic design optimization of landscape space based on improved genetic algorithm in tropical environment” (Yu 2022), the main research content was the automatic optimization design of landscape space based on genetic algorithms and urban climate map. Genetic algorithms on the Rhino Grasshopper software platform were here used to automatically find out the optimal layout of each module with different proportions and distributions and generate the optimal layout of the environment for a given volume ratio.

In the paper titled “Research on Garden Landscape Reconstruction Based on Geographic Information System Under the Background of Deep Learning” (Cui 2022), the authors adopted an improved GAN model based on an arbitration mechanism and developed a new scene of landscape reconstruction of a deep learning model applied to a geographic information system. The experimental results have shown that there is great potential to improve the efficiency of case analysis and drawing of designers.

In the paper titled “Method for Wavelet Denoising of Multi-Angle Prestack Seismic Data” (Renfei et al. 2022), the authors introduced the wavelet denoising of multi-angle (WDMA) method for prestack seismic data. Unlike the traditional method of directly stacking multi-angle gathers, the proposed WDMA method does not rely on the simple averaging of multi-angle prestack data, and when denoising the final result does not require averaging of direct stacking. Compared with soft threshold wavelet denoising or the traditional stacking method, the results reported in this paper demonstrated that the WDMA method can be implemented to obtain high-quality seismic data using fewer frames of angle gathers and can simultaneously perform denoising and stacking.

In the paper titled “Dynamic Process and Model Simulation of Soil Water Content During Citrus Growth Period” (Zhu et al. 2022), the change of soil water content in crop root systems was the basis for the designing of water-saving irrigation scheduling. To explore the dynamic changes in soil water content, the authors carried out long-term monitoring of the soil content at different depths in a typical citrus orchard. The results showed that, during the whole growth period of the citrus, the soil water content buried at 40 cm depth had the best correlation with that in the main active layer of the citrus root system (0–60 cm), between

which the correlation coefficient reached 0.988. Therefore, the depth of 40 cm could be used as the representative depth of soil water content monitoring.

In the paper titled “Scene Analysis of Landslide Geoscience and Characterization of Scene Evolution” (Zhang et al. 2022), the authors integrated the landslide’s disaster-pregnant environment and disaster information, by analysing the landslide geology scene to construct a multi-level scene model. The object features characterized the evolution process of landslides in terms of stratigraphic structure changes, surface changes, texture changes, shape characteristics, spectral characteristics, and colour characteristics. In this work, it was demonstrated that, through the cognition of landslide spatial scenes, one can understand better the influence mechanism of external events on landslide activities to predict the spatial and temporal characteristics of landslide activities.

The paper titled “Remote sensing data processing and analysis for the identification of geological entities” (Chi et al. 2022) proposed a ground object classification algorithm for polarized SAR images based on a fully convolutional network, which realized the geological classification function and overcomes the shortcomings of too long. The evaluation of DCNN-PSAR showed that the accuracy of the water area had a rising trend, and the growth rate was relatively fast in the early stage, changing from 0.14 to 0.6, while it was slower in the later stage. The authors pointed out that DCNN-PSAR achieved the highest quality of remote sensing data extraction.

In the paper titled “Process evaluation of soil treatment effect in Mu Us Sandy Land of Daji Khan in Northern Shaanxi Province based on fuzzy set” (Chen et al. 2022), the soil quality in the process of development and utilization of the Mu Us sandy land was evaluated based on Fuzzy sets for sustainable utilization of compound soil. Based on soil structure and soil fertility, sixteen evaluation indexes of soil quality in Mu Us sandy land were screened, and then, the evaluation index system of soil quality was constructed. The results showed that the dominant factor of this phenomenon was the comprehensive influence of soil fertility. Furthermore, the relationship between soil fertility and cultivated horizon in typical years was analysed one by one, and the specific factors affecting soil fertility were discussed.

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Declarations

Conflict of interest We have no Conflict of Interest to publish this SI.

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