

POLISH PARASITOLOGICAL SOCIETY

ANNALS OF PARASITOLOGY

volume 70 · supplement 1 · 2024



eISSN 2300-6706

Session: Symposium [SY1] Artificial intelligence and digital health: multidisciplinary examination of potential applications in geospatial analysis

Geospatial Health: development of a maturing scientific journal 2006 – 2023

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Abstract

Geospatial Health is an international, peer-reviewed scientific journal produced by the International Society of Geospatial Health. The journal covers all aspects of geographical information system (GIS) applications, remote sensing and other spatial analytic tools focusing on human and veterinary health.

Our study illustrates how the interdisciplinary domain of Geospatial Health has evolved over time by analysing the published content of the journal for the period 2006 – 2023.

A systematic bibliometric analysis was conducted based upon all (review) articles and editorials published in Geospatial Health. To capture key research topics, methods & techniques, geographic areas studied, and temporal development, our analysis proceeds through three stages: (1) high-frequency keywords identification, (2) co-occurrence analysis that identifies how high-frequency keywords are related, and (3) cluster analysis that identifies groups of interlinked keywords. Impact analysis based on citation counts is included.

Original research papers represent the largest publication category, followed by editorials, and review papers. Three quarters of the publications focus on human health, the rest is on veterinary applications. Geographic focus was initially largely on Africa and Asia. This remained up to around 2020 after which a strong decline in African studies, and a major increase of Asian studies is observed. Initially, focus was on schistosomiasis and malaria, but the scope widened to 35+ different diseases, injuries and risk factors. Over time there is growing attention for non-communicable disease such as cancer and obesity. Spatial and statistical analytical techniques used are diverse and exhibit increasing sophistication over time.

Scaling up the analysis to include related journals is straightforward. This would enable a solid understanding of the temporal development of the scientific discipline Geospatial Health as a whole.

Keywords: geospatial health, bibliometric analysis

OS – oral session

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Development of an automated system to recognize and count parasitic elements of veterinary and medical relevance

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Abstract

The development of new (semi-)automated system for the diagnosis in parasitology offers potential solutions to overcome gaps and limitations (i.e. human errors and time for analysis) of Faecal Egg Count (FEC) techniques in veterinary and human fields.

For this reason, from a collaboration among Dept. of Veterinary Medicine and Animal Production, Dept. of Electrical Engineering and Information Technology and a company of Mechanical Engineering a new automated system for diagnosis of helminth eggs in animals and humans was developed the Kubic FLOTAC Microscope (KFM). The KFM is a compact, low-cost digital microscope that combines the high sensitivity, accuracy and precision of the Mini-FLOTAC/FLOTAC techniques with a reliable system based on Artificial Intelligence (AI) predictive model, that after capturing high resolution pictures, is able to recognize and count the parasitic elements in the analysed samples. This system can be remotely controlled via software by smartphone, tablet or PC, and via internet it is possible to transfer the captured pictures to other laboratories, that could be very useful to create a network or to support operators directly in the field. A dataset with more than 5,000 objects for each analysed parasite was used. The acquired images are first segmented into background and objects, which can be either impurities or pseudo-parasites with the main goal of being able to characterize the parasite species and to automatically count eggs. The AI system is able to recognize the 90.0% of the parasitic elements analysed. Therefore, the KFM is a promising automated system for a rapid and accurate assessment of FEC to improve the diagnosis of parasitic infections in veterinary and human fields.

This study was supported by EU funding within the NextGenerationEU-MUR PNRR Extended Partnership initiative on Future Artificial Intelligence Research (Project no. PE00000013, FAIR)

Keywords: Artificial Intelligence, Digital microscope, Kubic FLOTAC microscope, Faecal Egg Count

OS – oral session

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Geospatial tools and digital health for sustainable strategies to control cystic echinococcosis in endemic areas

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Abstract

Cystic echinococcosis (CE), caused by the larval stage of the cestode *Echinococcus granulosus*, is one of the most widespread zoonoses in Mediterranean countries. In this area, the traditional actions taken to control CE are still inefficient, because surveillance and treatment strategies fail to reach inaccessible grazing areas (accessible to stray canids) and are usually designed for wide geographical areas without considering that the prevalence of CE can differ widely in different locations of the same region. The aim of this study is to show the potential of geographical information systems (GIS)-based innovative tools to support control strategies against cystic echinococcosis in highly endemic areas. The use of GPS devices makes it possible to track the movements of animals (sheep and dogs) and identify the most frequented locations within the grazing areas. Furthermore, the application of anthelmintic baits (laced with praziquantel) using unmanned aerial vehicles (UAVs) allows the development of treatment strategies specifically designed for capillary and automatic distribution of anthelmintics in the study areas, minimizing waste of time and resources. Other innovative devices to implement the control of CE include camera traps to continuously monitor the stray canids for praziquantel-laced baits.

These innovative tools and technologies have been successfully used to control CE in southern Italy as part of the International Echino-Safe-Med project.

This research was funded as part of the project “New sustainable tools and innovative actions to control cystic ECHINOCoccosis in sheep farms in the MEDiterranean area: improvement of diagnosis and SAFery in response to climatic changes - ECHINO-SAFE-MED”, supported by PRIMA (Partnership for research and innovation in the Mediterranean area).

Keywords: *Echinococcus granulosus*, geospatial tools, maps, drones, GPS

OS – oral session

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The importance of the urban environment for the sentiment during the COVID-19 pandemic

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Abstract

COVID-19 was one of the biggest public health problems in the world. It also had an impact on people's mental health, both as a direct result of the viral infection and because of the social and economic transformations largely caused by the decisions made to contain the global spread of the virus. In this context, it is essential to understand how COVID-19 measures affected sentiment in Portugal. For this, we used sentiment analysis utilizing a lexicon of sentiments and emotions, and data from the social network Twitter (actual X). Several studies have extracted significant information from Twitter databases over the years. Although individual and family circumstances, including age, income, marital status, economic situation, genetics, and subjective indicators of each person, have a significant impact on the subjective feelings of residents, environmental factors are also determining. Rapid urbanization has led to an increasing number of challenges, such as unhappiness, air pollution, irrational land use, traffic, and environmental degradation. However, the lockdown proved beneficial for the environment. Positive impacts were evident in large cities, where pollution levels decreased. Nevertheless, there were also adverse effects, including an increase in biomedical and plastic waste. Some of the measures adopted by Portugal during the lockdown were the mandatory adoption of remote work and the prohibition of movement between municipalities. These measures were responsible for increasing the time people spent indoors or in their neighborhood. Due to the potential of social media data, it sought to determine which aspects of the urban environment experience affected sentiment. For this, a machine-learning model was used along with an agnostic model, to increase the understanding of the factors in the urban environment that affected sentiment during the COVID-19 pandemic.

Keywords: sentiment analysis, twitter data, machine learning, Covid-19, agnostic model

OS – oral session

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Analysis of spatial determinants of community-acquired pneumonia incidence in Portugal mainland

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Abstract

Community-acquired pneumonia (CAP) is a common and serious infectious disease with various causative agents. Understanding the risk factors associated with different pathogens is crucial for effective treatment and management strategies. The incidence of CAP increases with age, with the highest rates seen in individuals over 65 years old. Environmental factors play a role in the development of CAP. Exposure to tobacco smoke, air pollution, and overcrowded living conditions increase the risk of acquiring pneumonia. Machine learning (ML) models, particularly the XGBoost algorithm, have shown effectiveness in predicting adverse outcomes in CAP patients, such as hospital admission and mortality. These models outperformed traditional clinical stratification tools, like the Pneumonia Severity Index (PSI), in terms of prediction accuracy. However, limitations of using ML for CAP diagnosis include the need for reliable and balanced datasets, potential biases in training data, and the black-box nature of artificial intelligence models. As such, we analyzed a set of more than 30 spatial determinants at a municipality level for Portugal mainland (chosen through bibliographic review) and after eliminating multicollinearity problems using Variance Inflation Factor (VIF) we tested Geographical Random Forest (GRF) which is a spatial extension of the random forest algorithm to address spatial heterogeneity in population modelling, Traditional RF, Support vector machines (SVM) and eXtreme Gradient Boosting (XGBoost). In the end, GRF performed better and we used explainable Artificial Intelligence (xAI), i.e., an agnostic model, for evaluating the importance of each variable, namely Triplot, that consider the hierarchical correlation structure of variables. Overall, a comprehensive understanding of the driving factors of CAP is essential for improving public health.

Keywords: Community-acquired pneumonia, Machine learning, explainable Artificial Intelligence, agnostic models

OS – oral session

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Machine learning and eXplainable Artificial Intelligence for the prevention of waterborne cryptosporidiosis and giardiasis

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Abstract

Cryptosporidium and *Giardia* are important parasitic protozoa due to their zoonotic potential and impact on human health, often causing waterborne outbreaks of disease. Several attempts have been made to investigate the association between the presence of those protozoa in waters with other biotic or abiotic factors, with inconclusive findings. The aim of this study was to develop an holistic approach leveraging Machine Learning (ML) and eXplainable Artificial Intelligence (xAI) techniques, to provide evidence related to the presence and prediction of *Cryptosporidium* and *Giardia* (oo) cysts in water samples. For this, we, initially, model the complex relationship between *Cryptosporidium* and *Giardia* (oo)cysts and a set of parasitological, microbiological, physicochemical, and meteorological parameters via a model-agnostic meta-learner algorithm. Based on this approach, a set of four well-known ML candidates were, evaluated in terms of their predictive capabilities. The best-performed algorithms were further examined through XAI techniques. Findings reveal that the Random Forest achieves the highest prediction performance when the objective is the prediction of both contamination and contamination intensity with *Cryptosporidium* oocysts in water samples, with meteorological/physicochemical and microbiological markers being informative, respectively. For the prediction of contamination with *Giardia*,