Fighting wildfires with AI-powered insights

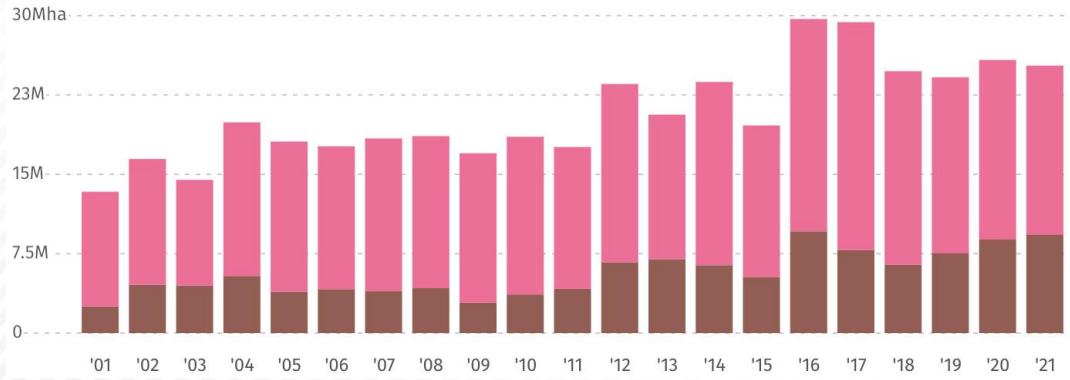
Helen li
lilun@caict.ac.cn

Content

Development Status

Natural governance is of great significance in protecting the natural environment, maintaining ecological balance and promoting sustainable development.

◆ From 2001 to 2021, **the total reduction of tree cover caused by fire** in the world was **119 Mha**. During this period, the year with the largest reduction of tree cover due to fire was 2016, **with 9.61Mha reduction due to fire** - accounting for **32%** of the total reduction of tree cover in that year.

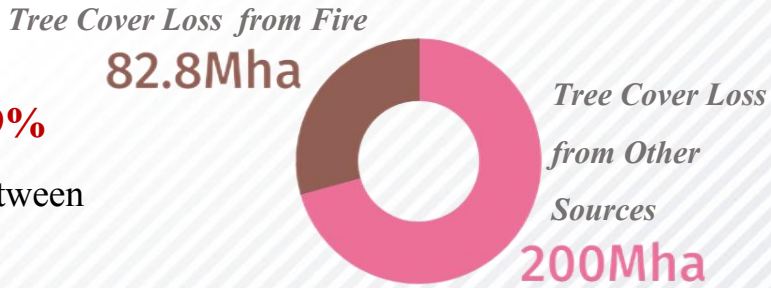


◆ From 2010 to 2021, **Russia** had the highest rate of tree cover loss due to fires with an average of **3.19Mha** lost per year.

1	Russia	3.19Mha
2	Canada	1.39Mha
3	Brazil	660kha
4	United States	530kha
5	Australia	416kha

Russia

Fires were responsible for **29%** of tree cover loss globally between 2010 and 2021.



Development Status

In 2016 the U.S. released Artificial Intelligence Research and Development Strategic Plan, which proposed advancing the use of **AI in Disaster Management**.

2016

The new AI disaster management technologies currently being used and studied also include the Internet of Things (LOT), nanotechnology, biotechnology, quantum computing and robotics.

2019

The **Upgrading of Hardware Equipment** supports deep learning, machine learning algorithm, data feature extraction and other AI core technologies, which have been widely used in fire control and early warning.

2020

The fire control is becoming mature and **Platform-based**, the original AI technology will further create the Super Artificial Intelligence.

2021

Development Status

Introduction to the scope and importance of AI applications in fire scenarios

Fire Prevention

The analysis of historical data and simulated fire scenarios can help identify potential fire risks and provide appropriate recommendations and early warning measures.

Fire Control

By using sensors, cameras and machine learning technology, the fire scene can be monitored and controlled in real time, such as the application of intelligent fire extinguishers, automatic fire doors and other equipment.

Fire Alarm

The fire alarm system can use artificial intelligence to improve the accuracy of fire alarms, for example, by identifying the source of fire in the monitoring screen to trigger the fire alarm system to avoid false alarms and missed alarms.

Fire Rescue

Artificial intelligence can play a role in fire rescue, such as rescue through intelligent robots, the use of machine learning technology to help firefighters determine the fire scene situation.

Development Status

Significant progress and results have been achieved in many areas, but some major issues and challenges remains

Data Quality and Quantity

Current fire data sets tend to be limited and of varying quality, which makes training and application of machine learning algorithms difficult.

Adaptability of Algorithms

Existing machine learning algorithms and artificial intelligence techniques may perform better in some fire scenarios, but may have problems in other scenarios, and how to improve the adaptability and pervasiveness of algorithms is an issue worth exploring.

Sensor Equipments

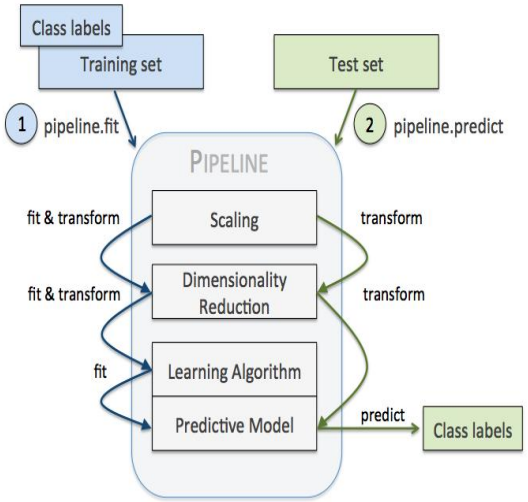
Although there are already some sensors and monitoring devices that can monitor fire conditions in real time, in fire scenarios, equipment damage, network interruptions, etc. may lead to interruptions in data collection, thus affecting the effectiveness and accuracy of the algorithms.

Explanation of Algorithms

Existing machine learning algorithms and artificial intelligence techniques may perform better in some fire scenarios, but may have problems in other scenarios, and how to improve the adaptability and pervasiveness of algorithms is an issue worth exploring.

Technical Progress

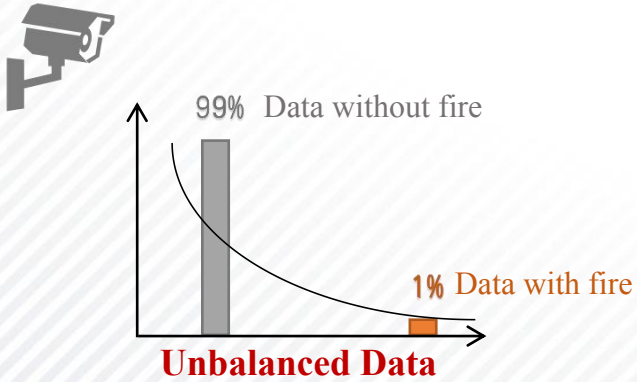
Resolving extreme class imbalance in fire situation data distribution requires the use of specialized techniques such as oversampling, undersampling, or the application of ensemble methods.



ML Pipeline

1. Data Preprocessing
2. Data Standardization
3. Dimension Reduction
4. Feature Selection Algorithm
5. Classification/Prediction

Data Distribution



Affect the learning effect and generalization ability of the model

Trained model may not be able to adapt well to the data in the actual application scenario

Addressing extreme class imbalance in fire situation data distribution

Resampling Techniques

Undersampling can delete some of the majority class samples, while oversampling duplicates some of the minority class samples or generates new ones.

Cost-sensitive Learning

Different costs to different types of samples in a dataset, to make the classifier more focused on correctly classifying samples with high error rates.

Ensemble Learning Techniques

By integrating the results of multiple classifiers, the generalization performance of the classifier can be improved, such as voting, Bagging, Boosting, etc.

Technical Progress

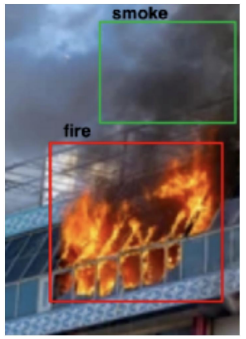
Deep learning algorithm, model optimization, data fusion and other artificial intelligence technologies realize more accurate identification and early warning of fire

Feature Selection

◆ From traditional data annotation to intelligent annotation based on machine learning

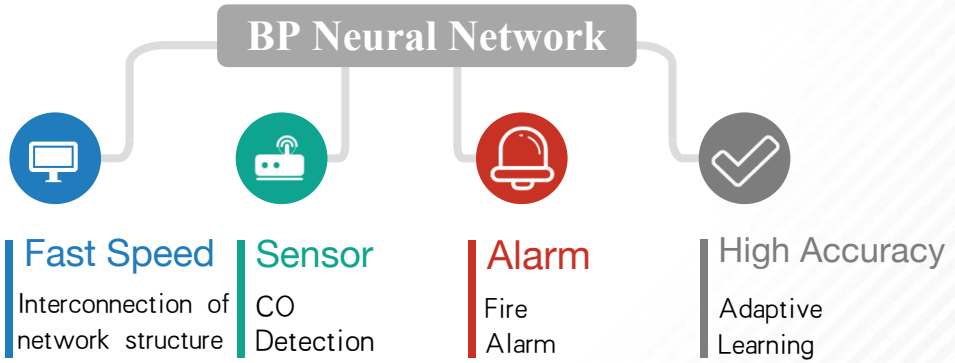
Expense Reduction

High Efficiency

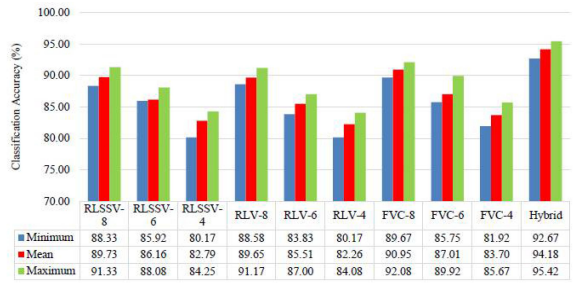


Computer Version

BP Neural Network Algorithm



◆ Deep learning led to more accurate and efficient fire detection and prediction, which can ultimately improve fire safety and response.



The case for AI in agricultural fire prevention is grounded on the accuracy and reliability of computer simulations in smoke movement analysis, risk assessment, and postfire analysis.

◆ The model combines multiple fire detection technologies, including smoke sensing, gas sensors, and infrared thermal imaging, and uses neural networks to fuse data and improve detection accuracy.

◆ In simulated experiments, joint detection of fire smoke was carried out in a cabin, resulting in improved accuracy compared to single detection modes.

Technical Progress

New paradigm of disaster management mainly rely on cloud computing, big data, blockchain and internet

Technology Convergence

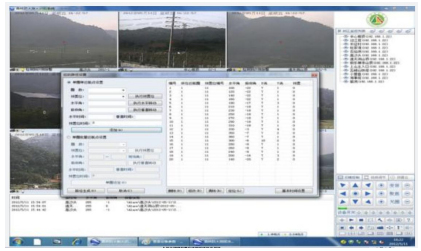
With the increasing size and complexity of the urban system, the risk of uncertainty also increases. Modern information and communication technology (ICT), ubiquitous sensors, the Internet of Things, advanced data science and crisis informatics and other new technologies have been more and more widely used in the field of disaster management.

Data-driven

Decision-making ability is the key element to improve disaster management ability. Intelligent Decision Support System (IDSS) is based on big data storage and machine learning analysis. It uses open application programming interface (API) and artificial intelligence algorithm to collect and process big data, helping to make faster and more accurate governance decisions.

Intelligent Forest Fire Prevention and Control System

Beijing, China



Visual Interface

Multi-sensor to obtain the field ecological parameters, which can transmit data in the forest with weak signal.

Weather ***Plant Parameters*** ***Sunshine*** ***Humidity***

11

Stable access to 11 types of forest climate data

24—hour

Uninterrupted fire detection and identification

10

10 satellites transmit data in real time

Conclusion

The application of AI in fire scenarios will be more intelligent, diversified and integrated.

Application Status and Development Trend of Artificial Intelligence in Fire Scenarios

At present, the application of artificial intelligence in fire scenarios mainly focuses on **Fire Detection, Fire Identification, Fire Prediction**, etc.

Among them, the **Deep Learning Model** has high accuracy and robustness in fire detection and recognition.

At the same time, the **Uneven Distribution of Data, Sample Label Noise** and other issues are also the focus of current research.

Suggestions for Further Research and Application in the Future

01 In combination with practical application scenarios, a **More Intelligent** decision support system

02 Explore the methods and technologies of **Multimodal Data Integration**, and explore the relationships and laws between different data.

03 Research and **Optimize the Training and Parameter Adjustment** methods of the model to adapt to different data distribution and sample label noise.

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