

A Study of Nature of Mushrooms with Machine Learning and Data Mining Technique

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Abstract

Mushrooms are an important part of the natural ecosystem and are widely used in food, medicine, and various industrial applications. However, different mushroom species possess distinct characteristics, and some are edible while others are poisonous or harmful to human health. Therefore, the accurate identification and classification of mushrooms is essential for ensuring food safety and supporting biological research. Traditional mushroom identification methods generally depend on expert knowledge, physical observation, and laboratory analysis, which may be time-consuming and challenging when dealing with a large number of species.

This study focuses on analyzing the nature and characteristics of mushrooms using Machine Learning (ML) and Data Mining techniques. The proposed approach involves collecting and preprocessing mushroom-related datasets containing attributes such as cap shape, cap color, odor, gill characteristics, stalk features, habitat, and other morphological properties. Data mining techniques are applied to discover meaningful patterns, relationships, and hidden information within the dataset.

Introduction

Traditional ethno medicine uses theories, beliefs, and experiences unique to its people and culture to inform its knowledge, practises, and abilities for maintaining health. It has a long history of societal acceptance and is purely based on the knowledge amassed over time by herbalists, which is useful not only for the preservation of cultural tradition but also for the development of drugs for the present and the future. Across a variety of contexts and cultures, we can observe the fuzziness of the connections between food and medicine (Heinrich, 2016) [1]. The saying "let food be your medicine, let medicine be your food" is credited to Hippocrates, the father of medicine (480–377 BC), and it refers to the influence of food on human health.

Ethno medicine

For the majority of the people in rural areas, medicinal plants are frequently the only readily available alternative to conventional medication; in fact, traditional herbal therapy is the most popular treatment for common illnesses. In India, household treatments for common ills include herbal infusions, decoctions, and tinctures, which are typically referred to as "elderly formulations." Herbal remedies are made from a range of plant elements, such as leaves, stems, roots, and bark, and they are primarily used to cure minor or persistent illnesses [4]. The majority of them are readily accessible in the area. As a result, how people perceive the environmental accessibility of resources will vary depending on the culture of each society, and when people define the uses, they are conveying the ideas and categories

unique to their own culture. Global ethnobiological studies, including traditional ethnobotany and ethnomedicine, have shown that the general public is becoming more aware of herbal medicine.

Ethnomycology and its Importance

The traditional usage of fungus by humans is known as ethno mycology ('ethno' denoting people and 'mycology' denoting the study of fungi). The earliest accounts of ethno mycology appeared within the century and evolved from ethno biology (the study of how individuals interact with the biota and the environment) and ethno botany (the study of plants' cultural uses). It also overlapping with social science-based subjects like anthropology (the study of humankind) and ethnography (the collection of empirical data on human society and culture). More helpful mushroom species than poisonous ones are made more well-known thanks to ethno mycology, which also sheds light on their sociological effects on human behaviour and reveals their traditional uses. This field was created as a result of people's insatiable and constant drive to advance their knowledge of food, medicine, civilization, and culture (De Kesel and Degreef, 2007) [5].

India has an enormous emporium of ethno medicinal and folktale wealth. Indian ethnic groups also hold excellent ethno mycological knowledge (Purkayastha and Chandra, 1985) [7]. Charaka Samhita refers the old medical text used mushrooms as food and medication.(3000 ± 500 BC). The discipline of ethno mycology is said to have begun with the work of Wasson (1968) the American ethno mycologists [7].

Mushrooms

The majority of mushroom species are saprophytes. By destroying dead organic matter like wood, leaves, needles, and manure, they purify the environment. Wood and plant waste are transformed into soft, fibrous, or crumbly material by mushrooms. The process releases a lot of water. Wild edible plants like *Agaricus* and *Amanita* are found in pastures and other grassy regions. Fungi that create symbiotic partnerships with other species benefit both parties. Mycorrhizae are symbiotic relationships between mushrooms and tree roots that typically grow on the forest floor. The mycelium of the fungus creates a covering that covers the outermost fine roots. Numerous mycorrhizal fungi are host-specific, meaning they can only flourish on particular tree species. Many of the important edible species that are foraged in the wild, such as cantherelles, russula, boletus, etc., are among the macrofungi that often produce ectomycorrhiza (Mohan, 2014) [9]. The mycorrhizal association aids in the exchange of nutrients between the mycorrhizal fungus and the tree. As a byproduct of photosynthesis, the tree provides the fungus with sugar, and in exchange, the fungus provides the tree with other nutrients like nitrogen and phosphorus, which it absorbs via its hyphae from the tiniest soil pores. Additionally, mycorrhizae can shield trees from the harmful impacts of pollution. The fungi store heavy metals that the tree may absorb and deposit in the fungus' fruiting body. The trees that have mycorrhizal associations exhibit enhanced tolerance to various stress conditions, making them less prone to frost and gaining more protection from soil-borne pathogenic microbes.

Among fungi, parasitic mushrooms are the most lethal. They multiply on active trees and other plants, stealing their nutrients and slowly killing their hosts. A parasite continues to break down the organic matter after the host plant dies, turning the situation into a saprophytic one. Examples of this group include polypores and shelf fungus, which grow on the sides of trees and feed on the living wood (Deacon, 2006).

Diversity of Wild Mushrooms

Mushrooms are unique in its diversity. They grow well in some particular environmental conditions and are found in many parts of the world (Smith, 1963) [10]. In order to produce detectable fruiting body they require combination of conditions together with geographic location, elevation, temperature, humidity, light and surrounding flora. Even though fungi are extremely diverse they are often transient and cryptic. Approximately 850 species of mushrooms were recorded from India, (Deshmukh, 2004) of which 283 species were reported to be edible [11].

The macro fungal flora in the Western Ghats is incredibly diverse and abundant. The most macrofungi are typically found in moist-deciduous and semi-evergreen forests, which are followed by evergreen and Shola forests. Distinct mushroom communities are supported by each forest environment, and their occurrence is mostly dependent on physiological parameters, microclimate, and human perturbations.

Habitat and Season of Mushrooms

During the rainy season, mushrooms can be seen growing on manure piles and in damp areas with lots of humus. Mushrooms flourish everywhere under the warm and humid climate. They possess a wide substrate range most are saprophytic some are parasitic and few are highly specific such as the dung fungi and ectomycorrhizal forms. Mushrooms can be found growing in open areas, lawns, trees, primary and secondary forests, lowlands and highlands. Although mushrooms can be found anytime in the year, they appear generally in monsoons seasons after relatively dry periods of several weeks. If the right amount of food and humidity are provided, they can readily be produced in the local environment. Prolonged vegetative growth during the rainy season, without a preceding dry period does not lead to fruiting. Mushrooms fruit in succession, headed by small *Agaricus* with slower growing *Polyporus* at the end (Corner, 1981) [11].

Ecology of Mushrooms

Fungi had different methods for living since they lack chlorophyll. They exist as saprotrophs, parasites and symbionts. Symbiotic fungi play a critical role in ecosystem management. In grassland and forest ecosystems they are equally vital as they are an indispensable link in the food web as decomposers and pathogens. Being heterotrophy they are involved in decomposition, nutrient cycling, nutrients transport and are indispensable for achieving sustainable development.

They also serve the plant kingdom by mutualistic association. By extending the absorptive area of the root system, mycorrhizae increase plant uptake of nutrients, in particular phosphorus in exchange, the host plant provides carbohydrates and a place to live. Ectomycorrhiza plays an important role to increase nodulation and nitrogen fixing ability as well as growth regulators like Indole Acetic Acid (IAA) for plant growth. The *Termitomyces* species degrade cellulose and hemicellulose and have a great impact on carbon cycling in tropical ecosystems. Mushrooms are good biofertilizers as they preserve the health of the soil, reduce environmental harm, and utilise less chemicals in agriculture.

Nutritional Values of Mushrooms

You can eat mushrooms since they are tasty and nutritious. Colour, texture, flavour, and taste all contribute to palatability, whereas scientific analysis determines nutritional value. You can eat edible mushrooms either fresh or cooked, and they have all three of the qualities that make good food: nutrition, flavour, and physiological functions. Mushrooms are low in fat but abundant in unsaturated fatty acids like gamma linoleic acid, low in calories, and cholesterol-free. They are also rich in proteins,

fibre, vitamins, minerals, and trace elements. Due to their distinct taste and flavour, which is mostly brought on by water-soluble flavouring elements including soluble sugars, organic acids, free amino acids, etc., mushrooms provide a wonderful food source and are frequently utilised as food flavouring ingredients. Additionally, they contain a variety of physiologically active compounds, including chemical compounds like terpenoids, steroids, and new phenols, β -D glucans, heteroglucans, chitinous substances, peptidoglucans, and proteoglucans (Chang and Lee, 2004) [10].

Medicinal Role of Mushrooms

There may be medical value in mushrooms. They can be thought of as a repository for biological chemicals and represent a substantial, largely unexplored source of potent novel pharmaceuticals. Many workers have studied the antibacterial, anti-fungal, antiviral, antioxidant, anti-inflammatory, anticancer, antitumour, cytotoxic, hypocholesteremic, anti-diabetic, anticoagulant and hepatic protective properties of mushrooms (Thatoi and Singdevsachan, 2014) [12].

Different Data Mining Tasks

Data mining encompasses a wide variety of activities, including, but not limited to, categorization, forecasting, analyzing time series, associating, grouping, and summarizing data. Every one of these jobs pertains to either the predictive or descriptive side of data mining. As a component of data mining, each of the aforementioned activities can be carried out by a data mining system, individually or in combination.

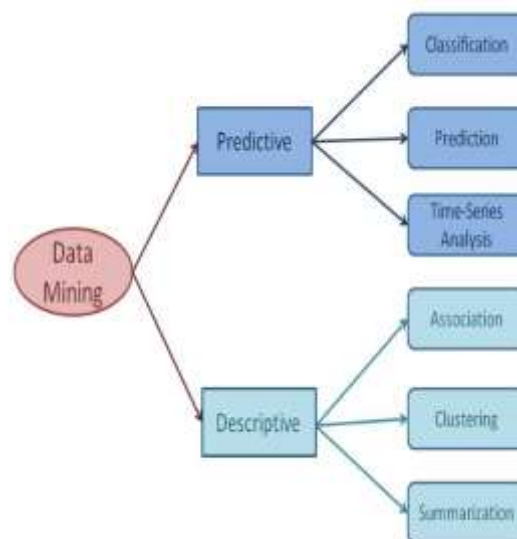


Figure 1.2: Data Mining Tasks

Predictive data mining tasks come up with a model from the given data set that is helpful in forecasting unknown or future values of another dataset of interest. A task of predictive data mining could be described as a medical practitioner attempting to diagnose an illness based on the patient's medical test findings.

The goal of descriptive data mining is typically to uncover data describing patterns and to derive new and meaningful information from the data set that is available. A task of descriptive data mining could be described as a store seeking to determine which products are commonly bought together.

Classification

The purpose of classification is to develop a model that can determine the category of an object based on the attributes of that object. It will be possible to access a collection of records, each of which will have its own individual set of characteristics. There will be a class attribute as one of the attributes, and the objective of the classification task will be to assign a class attribute to the new batch of records in the most accurate manner feasible.

Direct marketing is a method of lowering overall marketing expenses by focusing on a certain group of customers who are more likely to purchase new product. This method makes use of classification. It is conceivable, by using the data that is available, to determine which consumers have previously purchased comparable products and which customers have not done so. Therefore, the decision of "buy or don't purchase" serves as the class attribute in this instance. As soon as the class characteristic has been assigned, demographic and lifestyle information about consumers who have purchased similar products may be collected, and promotion mailings can be sent to those customers directly.

Making a Prediction

The purpose of the prediction exercise is to speculate on the likely values of missing or upcoming data. In order to make a prediction, you must first construct, on the basis of the information at hand, a model. You then put this model to use in determining what the future values of a new data set will be. For instance, a model can estimate an employee's salary by taking into account their level of education and professional experience in addition to other demographic data such as their place of residence, gender, and so on. Additionally, prediction analysis is utilized in a variety of fields, including medical diagnosis, the detection of fraud, and other applications.

Time-Series Analysis

A time series is a succession of events in which the outcome of the next event is dependent on the outcome of one or more of the events that came before it. Time series are a reflection of the process that is being measured, and the behaviour of a process can be influenced by a number of different factors. Methods for analyzing time-series data are included in time series analysis. The goal of these methods is to identify relevant patterns, trends, rules, and statistics in the data. Time series analysis has a number of important applications, one of which is the forecast of the stock market.

Association

The term "association" refers to the process of determining the connections or links between a group of things. The relationships between objects can be determined by their associations. The management of commodities, the design of advertisements and catalogues, as well as direct marketing all make use of association analysis. A store is able to determine the products that its consumers typically purchase together, as well as the customers who show the most interest in the promotion of similar kinds of products. If a retailer discovers that beer and nappies are typically purchased together, he may decide to offer nappies on sale in order to encourage customers to buy more alcohol.

Clustering

The purpose of clustering is to determine which data objects are comparable to one another and group them together. It is possible to determine the degree of resemblance based on a variety of criteria, such

as purchasing patterns, levels of reactivity to particular activities, geographical regions, and so on. An insurance firm, for instance, can categorize its clients according to factors such as age, residence, income, and so on. This information about the groups will be beneficial in better understanding the clients and, as a result, in providing better services that are more personalized.

Summarization

The data are simplified and generalized when you summarize them. A smaller collection of data that provides aggregated information of the data is produced as a result of a set of relevant data being summarized, which results in a smaller set. For instance, the shopping that a consumer does can be summed up in terms of the overall number of products, the total amount spent, the deals that were used, and so on. This kind of summarized information at a high level might be helpful for sales teams or customer relationship teams when conducting in-depth analyses of customer behavior and purchasing patterns. The same set of data can be summarized using a variety of various levels of abstraction and perspectives.

Predictive Data Mining

Knowledge discovery is useful in a wide variety of contexts, including the fields of finance and retail, as well as the telecommunications industry, intrusion detection, and medical diagnostics. The process of building and testing models to anticipate outcomes is at the heart of predictive data mining, which helps facilitate the discovery of new knowledge. The process of predictive mining is broken down into the steps shown in figure 1.3. In the beginning, the dataset is constructed by utilizing the database or the information from the transcript file. After that, the dataset is preprocessed in order to get rid of any missing values and zeros. After that, the data is interpreted and examined, and then the prediction is created [23].

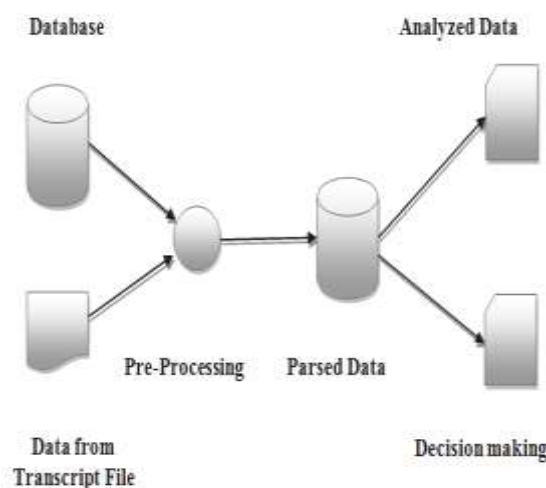


Figure 1.3: Predictive data mining

As a result of an increase in the amount of data that is accessible within medical applications, the significance of a decision making system has also increased. The diagnosis of diseases based on external symptoms and internal examination has traditionally been accomplished through the application of highly developed laboratory and imaging tools. The diagnosis of an illness required a significant

investment of both time and labour. To providing patients with clinical treatment that is both high in quality and cost-effective is a significant issue for the organizations that deliver health care.

As a direct result of this, there is an increasing demand for analyses of huge healthcare datasets, which will allow for the automatic extraction of information pertaining to the disease as well as decision making. This is a very essential application, especially in the case of serious disorders like diabetes, cancer, and heart disease [24]. In clinical research, predictive data mining refers to the process of training and testing models in order to make predictions about the health of patients. In order to build up a substantial amount of data, the information is compiled from the day-to-day, normal examinations performed by medical specialists. When developing models, one must take into account both the dynamic and temporal aspects of the data that is accessible from the clinical side (Bellazziet al 2012).

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