PLANT SPECIES IDENTIFICATION USING LEAF IMAGE

A WORKING PROJECT REPORT

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Introduction

1.1 Introduction

Many researches have proposed techniques for content-based image retrieval using image features such as color, shape, texture, and spatial relationship. Nevertheless, if images contain similar color or texture, shape-based image retrieval is more effective than other approaches. For instance, leaves of most plants are green or brown; but the leaf shapes are distinctive and thus can be used for identification. So, the shape of plant leaf is one of the most important features for characterizing various plant species. Shape-based image retrieval is composed, like typical content-based image retrieval, of two main steps. The first one is to represent shapes in such a way that it is invariant to translation, rotation, scale, and viewing angle changes. The other step is shape matching that determines how similar shapes are to a given query image. Ingeneral, there are two basic approaches for shape representation: by contours and by regions. The former describes a region of interest using its external characteristics, while the latter represents a region of interest using its internal characteristics. Examples of region based shape representation are octrees, quadtrees, skeletons and morphology decomposition. Polygonal approximation, chain code, geometric primitives, parametric curves, Fourier descriptors and Hough transform are contour based shape representation methods.

1.2 INTRODUCTION TO ML AND AI

Machine learning (**ML**) is the study of computer algorithms that improve automatically through experience. It is seen as a part of artificial intelligence. Machine learning algorithms build a model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks.

A subset of machine learning is closely related to computational statistics, which focuses on making predictions using computers; but not all machine learning is statistical learning. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a related field of study, focusing on exploratory data analysis through unsupervised learning. In its application across business problems, machine learning is also referred to as predictive analytics.

Machine learning involves computers discovering how they can perform tasks without being explicitly programmed to do so. It involves computers learning from data provided so that they

carry out certain tasks. For simple tasks assigned to computers, it is possible to program algorithms telling the machine how to execute all steps required to solve the problem at hand; on the computer's part, no learning is needed. For more advanced tasks, it can be challenging for a human to manually create the needed algorithms. In practice, it can turn out to be more effective to help the machine develop its own algorithm, rather than having human programmers specify every needed step.

Artificial intelligence (**AI**) is intelligence demonstrated by machines, unlike the **natural intelligence** displayed by humans and animals, which involves consciousness and emotionality. The distinction between the former and the latter categories is often revealed by the acronym chosen. 'Strong' AI is usually labelled as AGI (Artificial General Intelligence) while attempts to emulate 'natural' intelligence have been called ABI (Artificial Biological Intelligence). Leading AI textbooks define the field as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals. Colloquially, the term "artificial intelligence" is often used to describe machines (or computers) that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem solving".

As machines become increasingly capable, tasks considered to require "intelligence" are often removed from the definition of AI, a phenomenon known as the AI effect. A quip in Tesler's Theorem says "AI is whatever hasn't been done yet." For instance, optical character recognition is frequently excluded from things considered to be AI, having become a routine technology. Modern machine capabilities generally classified as AI include successfully understanding human speech, competing at the highest level in strategic game systems (such as chess and Go), autonomously operating cars, intelligent routing in content delivery networks, and military simulations.

1.3 BENEFITS OF ML AND AI

Simplifies Product Marketing and Assists in Accurate Sales Forecasts

ML helps enterprises in multiple ways to promote their products better and make accurate sales forecasts. ML offers huge advantages to sales and marketing sector, with the major ones being -

- Massive Data Consumption from Unlimited Sources

  ML virtually consumes unlimited amount of comprehensive data. The consumed data can then be used to constantly review and modify your sales and marketing strategies based on the customer behavioral patterns. Once your model is trained, it will be able to identify highly relevant variables. Consequently, you will be able to get focused data feeds by foregoing long and complicated integrations.

- Rapid Analysis Prediction and Processing

The rate at which ML consumes data and identifies relevant data makes it possible for you to take appropriate actions at the right time. For instance, ML will optimize the best subsequent offer for your customer. Consequently, the customer will be able to see the right offer at a given point of time, without you actually investing time to plan and make the right ad visible for your customers.

- Interpret Past Customer Behaviors

  ML will let you analyze the data related to past behaviors or outcomes and interpret them. Therefore, based on the new and different data you will be able make better predictions of customer behaviors.

2. Facilitates Accurate Medical Predictions and Diagnoses

   In healthcare industry, ML helps in easy identification of high-risk patients, make near perfect diagnoses, recommend best possible medicines, and predict readmissions. These are predominantly based on the available datasets of anonymous patient records as well as the symptoms exhibited by them. Near accurate diagnoses and better medicine recommendations will facilitate faster patient recovery without the need for extraneous medications. In this way, ML makes it possible to improve patient health at minimal costs in the medical sector.

3. Simplifies Time-Intensive Documentation in Data Entry

   Data duplication and inaccuracy are the major issues confronted by organizations wanting to automate their data entry process. Well, this situation can be significantly improved by predictive modeling and machine learning algorithms. With this, machines can perform time-intensive data entry tasks, leaving your skilled resources free to focus on other value-adding duties.

4. Improves Precision of Financial Rules and Models

   ML also has a significant impact on the finance sector. Some of the common machine learning benefits in Finance include portfolio management, algorithmic trading, loan underwriting and most importantly fraud detection. In addition, according to a report on ‘The Future of Underwriting’ published by Ernst and Young, ML facilitates continual data assessments for detecting and analyzing anomalies and nuances. This helps in improving the precision of financial models and rules.

5. Easy Spam Detection

   Spam detection was one of the earliest problems solved by ML. Few years ago email providers made use of rule-based techniques to filter out spam. However, with the advent of ML, spam filters are making new rules using brain-like neural networks to eliminate spam

mails. The neural networks recognize phishing messages and junk mail by evaluating the rules across a huge network of computers.

6. Increases the Efficiency of Predictive Maintenance in the Manufacturing Industry

   Manufacturing firms have corrective as well as preventive maintenance practices in place. However, these are often costly and inefficient. This is exactly where ML can be of great help. ML helps in the creation of highly efficient predictive maintenance plans. Following such predictive maintenance plans will minimize the chances of unexpected failures, thereby reducing unnecessary preventive maintenance activities.

7. Better Customer Segmentation and Accurate Lifetime Value Prediction

   Customer segmentation and lifetime value prediction are the major challenges faced by marketers today. Sales and marketing units will have enormous amounts of relevant data sourced from various channels, such as lead data, website visitors and email campaigns. However, accurate predictions for incentives and individual marketing offers can be easily achieved with ML. Savvy marketers now use ML to eliminate guess work associated with data-driven marketing. For instance, using the data representing the behavioral pattern of a particular set of users during a trial period will help businesses in predicting the probability of conversion to paid version. Such a model triggers customer interventions to better engage the customers in the trial and also persuade customers to convert early.

8. Recommending the Right Product

   Product recommendation is an important aspect of any sales and marketing strategy including upselling and cross-selling. ML models will analyze the purchase history of a customer and based on that they identify those products from your product inventory in which a customer is interested in. The algorithm will identify hidden patterns among the items and will then group similar products into clusters. This process is known as unsupervised learning, which is a specific type of ML algorithm. Such a model will enable businesses to make better product recommendations for their customers, thereby motivating product purchase. In this way, unsupervised learning helps in creating a superior product-based recommendation system.

CIVR ’10, July 5-7, Xi’an China

1.4 APPLICATION OF ML AND AI

1. Chatbots:

Artificial intelligence continues to be a hot topic in the technology space as well as increasing its inception into other realms such as healthcare, business, and gaming. AI-powered chatbots in enterprises will also see an influx of people get more comfortable with how AI can actually benefit businesses versus, say, take away their jobs. From an analytical standpoint, AI can be incorporated into interfaces to change how they receive and understand data.

Chatbots, in particular, are always on, delivering smart and flexible analytics through conversations on mobile devices using standard messaging tools and voice-activated interfaces. This dramatically reduces the time to collect data for all business users, thereby accelerating the pace of business and streamlines the way analysts use their time, preparing companies for the growing data needs of the near future.

2. Artificial Intelligence in eCommerce:

Artificial Intelligence technology provides a competitive edge to e-commerce businesses and is becoming readily available to companies of any size or budget. Leveraging machine learning, AI software automatically tags, organizes and visually searches content by labeling features of the image or video.

AI is enabling shoppers to discover associated products whether it is size, color, shape, or even brand. The visual capabilities AI is improving every year. By first obtaining visual cues from the uploaded imagery, the software can successfully assist the customer in finding the product they desire. Many e-commerce retailers are already becoming more sophisticated with their AI capabilities, and I only expect this to grow in the future.

3. AI to Improve Workplace Communication:

Current business communication is overloaded with content, channels, tools, and so-called solutions, depriving individuals (and companies) from hitting targets while also harming work-life balance. Artificial Intelligence will help businesses improve communication internally and externally by enabling individual personalization for each professional, allowing for enhanced focus and increased productivity.

With such AI personalization, each individual will be empowered thanks to an intelligent virtual assistant, helping take care of mundane or repeatable tasks, save time by understanding your needs and goals, as well as recommend next-best-action to take…as to utilize time much more efficiently, without requiring any extra effort. In the short to long run, business processes will improve, innovation will grow as employees will clear their tasks, and stress may decrease.

4. Human Resource Management:

AI and Machine learning are going to drastically and irrevocably change how HR and recruitment work in every company and this is going to be awesome. In fact, HR is likely to be one of the first areas of business that will benefit from AI for two simple reasons. Firstly there are tons of top quality data in HR, and secondly, HR is one part of any company that is both essential and yet feels the pressure of time.
If aspects of the recruiting and HR job can be automated, the HR workers can have the freedom to directly work with people in the business or potential hires, spending the quality human time necessary for a great HR department. It might seem paradoxical but the more Artificial Intelligence a company deploys in HR, the more 'Human' a company it can be.
Artificial Intelligence will essentially take out all of the "worst" elements of every HR professionals job (mundane screening, time-consuming paperwork, and annoying data entry) as well as deliver powerful tools and insights are a bonus to make their work better. HR's automatic generation of top quality data and the incredible benefits of AI make it one of the first places to experience the 4th industrial revolution.

5. AI in Healthcare:

In the year ahead, and particularly in the next five to ten years, artificial intelligence is going to have a big impact on the healthcare industry and the ways in which healthcare related companies utilize AI. Here is a short note from Dr. Jeff Dunn, CEO of Redivus Health. Redivus Health is a transformative mobile app used by healthcare providers to prevent medical errors by offering both clinical decision support during critical medical events as well as documenting those events electronically in real time.
AI presents opportunities for our application to take the data we have gathered from patients and be able to clinically innovate to improve patient outcomes to an even greater extent. AI improves reliability, predictability, and consistency with quality and patient safety. For us, AI, as applied to software, is used as a decision augmentation tool, but it should not have free reign without human interaction and guidance. While it can't replace doctors and nurses, it can make them more effective, efficient and happier on the job as it takes the cognitive burden off our providers – which increases confidence as well as reduces stress and anxiety.

6. Intelligent Cybersecurity:

In regard to cybersecurity, Artificial Intelligence is making great strides. Although AI is considered to be in its infancy in cybersecurity and cannot always effectively address all issues, it works successfully in data protection. AI allows companies to detect vulnerabilities or anomalous user behavior in such business applications as ERP or Financial systems.
A system of behavior anomalies analysis in computer systems resembles the world's most protected airport: when you are on the way to it, the security system has enough time to analyze your identity; you are examined by cameras and in case of any signs of danger, you are intercepted. Deep learning is empowered to see if a user has any suspicious activity. So, even if attackers have penetrated into a victim's system, they start taking actions that differ from the usual ones and as a result, they do not leave unnoticed and their damage is prevented.

7. Artificial Intelligence in Logistics and Supply Chain:

When combined with customer data and analytics, physical artificial intelligence removes friction from the customer experience. Artificial intelligence empowers businesses to act on consumer data to drive improvements throughout many areas of supply chain operations. Mobile technology and the "Uberization" of things have made consumers hungry for AI. Consumers demand shorter delivery waits from retailers and retailers will expect the same from manufacturers and distribution centers. Autonomous trucks and robotic picking systems allow supply chains to make fulfillment seven days a week. Within the next five years, the shipping term "business days" will become obsolete as consumers expect delivery on nights and weekends.

8. Sports betting Industry:

In its article Sports trading and AI: Taking the human out of sports betting, Gambling Insider argues that, "Just as more scientific analysis of sport is changing how coaches, trainers, and clubs play their respective games, greater analysis of sporting events is helping odds making database operators evaluate the potential permutations of each sporting event, increasing the accuracy of that respective odd and thereby making the subsequent odds determination easier."
Human traders cannot compete with artificial intelligence when it comes to analyzing huge volume of data. With AI we can perform analysis of the vast volume of sporting analysis data available to maximize our accuracy when it comes to predicting future outcomes. This proves especially fruitful in today's expansive betting market, where a large number of games and bet types are offered to an increasingly insatiable betting public.

9. Streamlined Manufacturing with AI:

For most customers when it comes to AI or Machine Learning, the magic happens when vast amounts of data can be streamed at milliseconds from the machine and process data of various databases. This provides actionable insights that can help these customers reduce non-productive downtime, predict failures or build a "golden batch" that can be benchmarked across all production lines.
An example is a global adhesive manufacturing customer that is pulling data from their lab systems where the raw material is brought in and tested for quality. Data is also being pulled from what is called their "cooking process" where, based on dynamic conditions, AI and Machine Learning make real time recommendations about which materials to inject at what time to ensure continuity of the process. This helps the manufacturer keep a continual "golden batch" manufacturing of their products, improving yield and customer satisfaction.

10. Casino/Hotels/Integrated Resorts:

AI can help hotels/casinos discover customer segments that they may not realize were there. Which customers want to be near the pool, which ones need three morning papers before they can tackle the day. Armed with this kind of information, hotels can understand what matters the most to its guests at the individual level, enabling them to anticipate their guest's needs before even the guests are aware of them.
Even more, hotels can understand key characteristics of their most profitable customers and recognize the next important ones when he or she happens to login onto the hotel's online reservation system. The use of deep neural networks and image classifiers can analyze and parse images, which can enable hotel marketers to monitor the images that provide the highest booking conversion rate through each channel. AI can also be used to compute dynamic clusters of guests to create fluid segmentation in real-time.

11. Retail:

Shopping online creates rich data footprints regarding the individual preferences, spending habits and preferred channels of individual consumers. Feeding these digital breadcrumbs into an AI-engine helps bring curated shopping journeys to mass audiences. Automated bots can create lifelike, seamless customer service experiences, addressing the consumer on their purchase history and known preferences.
On the marketing side, AI may deliver that extra dash of relevancy programmatic advertising has been waiting for all these years. On the consumer side, AI helps create individualized display ads that website visitors want to see, while on the accounting side, "the bots handle invoicing and payment for these transactions, giving marketers more time to focus on the big picture. With AI, predictive customer service and marketing could be just around the corner.

2.2 SYSTEM REQUIREMENTS

2.2.1 PYTHON

Python is an interpreted, high-level and general-purpose programming language. Python's design philosophy emphasizes code readability with its notable use of significant indentation. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

Python is dynamically-typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly, procedural), object-oriented and functional programming. Python is often described as a "batteries included" language due to its comprehensive standard library.

Python was created in the late 1980s, and first released in 1991, by Guido van Rossum as a successor to the ABC programming language. Python 2.0, released in 2000, introduced new features, such as list comprehensions, and a garbage collection system with reference counting, and was discontinued with version 2.7 in 2020. Python 3.0, released in 2008, was a major revision of the language that is not completely backward-compatible and much Python 2 code

does not run unmodified on Python 3. With Python 2's end-of-life (and pip having dropped support in 2021), only Python 3.6.x[1] and later are supported, with older versions still supporting e.g. Windows 7 (and old installers not restricted to 64-bit Windows).

Python interpreters are supported for mainstream operating systems and available for a few more (and in the past supported many more). A global community of programmers develops and maintains CPython, a free and open-source reference implementation. A non-profit organization, the Python Software Foundation, manages and directs resources for Python and CPython development.

As of January 2021, Python ranks third in TIOBE's index of most popular programming languages, behind C and Java, having previously gained second place and their award for the most popularity gain for 2020.

CHAPTER 2

PROPOSED MODEL

2.1 PLANT SPECIES IDENTIFICATION USING LEAF IMAGE

Plant recognition or classification has a broad application prospective in agriculture and medicine [1-4]. Plant leaf classification finds application in botany and in tea, cotton and other industries. Plants are vitally important for environmental protection [5]. However, it is an important and difficult task to recognize plant species on earth. Many of them carry significant information for the development of human society. So it is very necessary to set up a database for plant. The first step is to teach a computer how to classify plants. Plants are basically identified based on flowers, fruits, and leaf [2, 6, 4]. However, fruits and flowers are three dimensional objects and increases complexity. Plant identification based on flowers and fruits require morphological features such as number of stamens in flower and number of ovaries in fruits. Identifying plants using flowers and fruits are very time consuming task.Leaves also play an important role in plant identification. Moreover, leaves can be easily found and collected everywhere at all seasons; while flowers can only be obtained at blooming season.Shape of plant leaves is one of the most important features for characterizing various plants visually. Plant leaves have two-dimensional nature and thus they are most suitable for machine

processing. Before classification can be done on basis of leaf, some pre-processing is needed and most important step prior classification is feature extraction. For classification, different methods are available, namely, kNearest Neighbor (KNN),Probabilistic Neural Network (PNN) and Genetic algorithm (GA).

2.2.2 TRANSFER LEARNING

Transfer learning (TL) is a research problem in machine learning (ML) that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem. For example, knowledge gained while learning to recognize cars could apply when trying to recognize trucks. This area of research bears some relation to the long history of psychological literature on transfer of learning, although formal ties between the two fields are limited. From the practical standpoint, reusing or transferring information from previously learned tasks for the learning of new tasks has the potential to significantly improve the sample efficiency of a reinforcement learning agent.

2.2.3 TENSOR FLOW

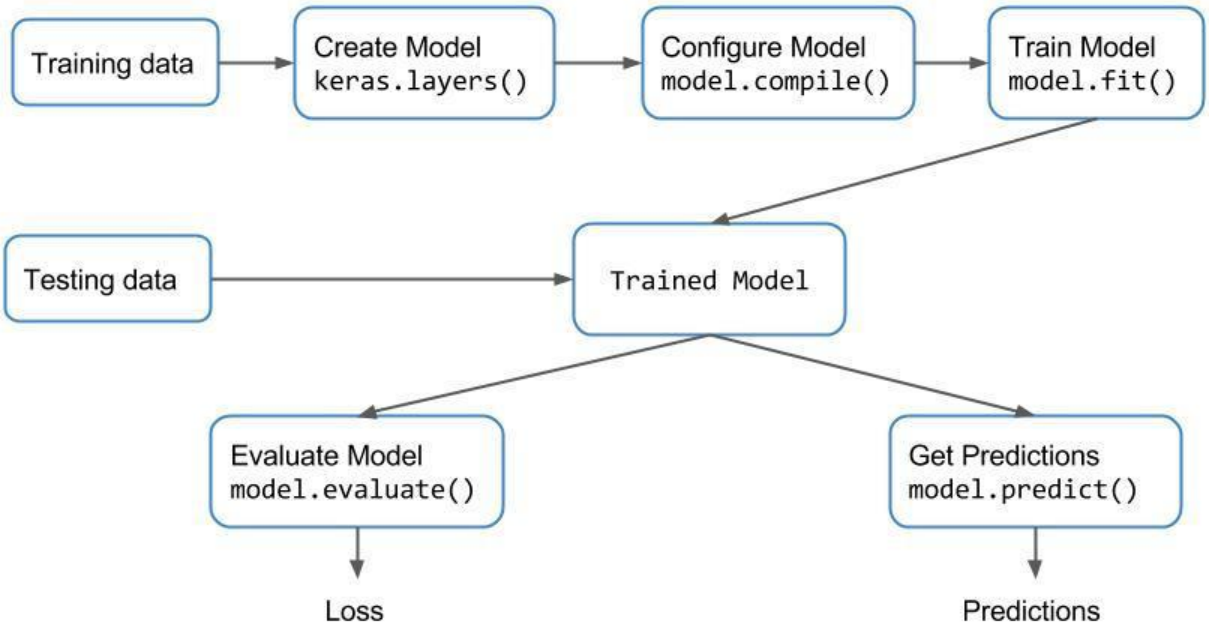
TensorFlow is an end-to-end open source platform for machine learning. TensorFlow is a rich system for managing all aspects of a machine learning system; however, this class focuses on using a particular TensorFlow API to develop and train machine learning models. See the TensorFlow documentation for complete details on the broader TensorFlow system.

TensorFlow APIs are arranged hierarchically, with the high-level APIs built on the low-level APIs. Machine learning researchers use the low-level APIs to create and explore new machine learning algorithms. In this class, you will use a high-level API named tf. keras to define and train machine learning models and to make predictions. tf. keras is the TensorFlow variant of the open-source Keras API.

2.2.4 KERAS

Keras is an open-source software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow library.

Up until version 2.3 Keras supported multiple backends, including TensorFlow, Microsoft Cognitive Toolkit, Theano, and PlaidML. As of version 2.4, only TensorFlow is supported. Designed to enable fast experimentation with deep neural networks, it focuses on being user-friendly, modular, and extensible. It was developed as part of the research effort of project ONEIROS (Open-ended Neuro-Electronic Intelligent Robot Operating System), and its primary author and maintainer is François Chollet, a Google engineer. Chollet also is the author of the XCeption deep neural network model.



2.2.5 IMAGENET

The **ImageNet** project is a large visual database designed for use in visual object recognition software research. More than 14 million images have been hand-annotated by the project to indicate what objects are pictured and in at least one million of the images, bounding boxes are also provided. ImageNet contains more than 20,000 categories with a typical category, such as "balloon" or "strawberry", consisting of several hundred images. The database of annotations of third-party image URLs is freely available directly from ImageNet, though the actual images are not owned by ImageNet. Since 2010, the ImageNet project runs an annual software contest, the ImageNet Large Scale Visual Recognition Challenge (ILSVRC), where software program compete to correctly classify and detect objects and scenes. The challenge uses a "trimmed" list of one thousand non-overlapping classes.

2.2.6 RESNET50

ResNet-50 is a convolutional neural network that is 50 layers deep. You can load a pretrained version of the network trained on more than a million images from the ImageNet database . The pretrained network can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals. As a result, the network has learned rich feature representations for a wide range of images. The network has an image input size of 224-by-224. For more pretrained networks in MATLAB®, see Pretrained Deep Neural Networks.

2.2.7 FLASK, HTML, CSS

Flask is a micro web framework written in Python. It is classified as a microframework because it does not require particular tools or libraries.[2] It has no database abstraction layer, form validation, or any other components where pre-existing third-party libraries provide common functions. However, Flask supports extensions that can add application features as if they were implemented in Flask itself. Extensions exist for object-relational mappers, form validation, upload handling, various open authentication technologies and several common framework related tools.

Hypertext Markup Language (**HTML**) is the standard markup language for documents designed to be displayed in a web browser. It can be assisted by technologies such as Cascading Style Sheets (CSS) and scripting languages such as JavaScript.

Web browsers receive HTML documents from a web server or from local storage and render the documents into multimedia web pages. HTML describes the structure of a web page semantically and originally included cues for the appearance of the document.

HTML elements are the building blocks of HTML pages. With HTML constructs, images and other objects such as interactive forms may be embedded into the rendered page. HTML provides a means to create structured documents by denoting structural semantics for text such as headings, paragraphs, lists, links, quotes and other items. HTML elements are delineated by *tags*, written using angle brackets. Tags such as <**img** /> and <**input** /> directly introduce content into the page. Other tags such as <**p**> surround and provide information about document text and may include other tags as sub-elements. Browsers do not display the HTML tags, but use them to interpret the content of the page.

Cascading Style Sheets (**CSS**) is a style sheet language used for describing the presentation of a document written in a markup language such as HTML. CSS is a cornerstone technology of the World Wide Web, alongside HTML and JavaScript.

CSS is designed to enable the separation of presentation and content, including layout, colors, and fonts. This separation can improve content accessibility, provide more flexibility and control in the specification of presentation characteristics, enable multiple web pages to share formatting by specifying the relevant CSS in a separate .css file which reduces complexity and repetition in the structural content as well as enabling the .css file to be cached to improve the page load speed between the pages that share the file and its formatting.

2.2.8 CNN ALGORITHM

In deep learning, a **convolutional neural network** (**CNN**, or **ConvNet**) is a class of deep neural networks, most commonly applied to analyzing visual imagery. They are also known as **shift invariant** or **space invariant artificial neural networks** (**SIANN**), based on the shared-weight architecture of the convolution kernels that scan the hidden layers and translation invariance characteristics. They have applications in image and video

recognition, recommender systems, image classification, Image segmentation, medical image analysis, natural language processing, brain-computer interfaces, and financial time series.

CNNs are regularized versions of multilayer perceptrons. Multilayer perceptrons usually mean fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer. The "fully-connectedness" of these networks makes them prone to overfitting data. Typical ways of regularization include varying the weights as the loss function gets minimized while randomly trimming connectivity. CNNs take a different approach towards regularization: they take advantage of the hierarchical pattern in data and assemble patterns of increasing complexity using smaller and simpler patterns embossed in the filters. Therefore, on the scale of connectedness and complexity, CNNs are on the lower extreme.

2.2.9 NUMPY

NumPy (pronounced /ˈnʌmpaɪ/ (*NUM-py*) or sometimes (*NUM-pee*)) is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays. The ancestor of NumPy, Numeric, was originally created by Jim Hugunin with contributions from several other developers. In 2005, Travis Oliphant created NumPy by incorporating features of the competing Numarray into Numeric, with extensive modifications. NumPy is open-source software and has many contributors.

2.4 WORKING

PLANT SPECIES IDENTIFICATION USING LEAF IMAGE

- Collected dataset of three types of plant leaves and trained a model using transfer learning

1. Divided the data into 80: 20 in which 80% data is used for training model and 20% is used for testing the model.
2. Libraries like resnet50, sequential, globalaveragepooling2d, are imported
3. Complete data is divided into 3 classes ("apple", "blueberry", "tomato").
4. We have used pooling as average and activation function as softmax.
5. We have excluded top layer during the training.
6. We have used standard image size that is 224.

FOR TRAINING

7. We have all total images of 1200 x 3(number of classes) = 3600 images and that's why we take **batch_size** as 12.
   epoch=3600/12 =300

FOR TESTING

8. We have all total images of 300 x 3(number of classes) = 900 images and that's why we take **batch_size** as 3.
epoch=900/3 =300

9. We get prediction by following the piece of code :
model.predict(test_data)
We can save our model by following the piece of code :
model.save("keras_model.h5")

CONCLUSION

After the study of the project using python, transfer learning, tensorflow, keras, imagenet, resnet50, flask , html, css, cnn algorithm and numpy the objective is successfully achieved and the plant species is identified using leaf image successfully.

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