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**“INTERNSHIP”
(18CSI85)**

REPORT ON

**“FRUIT CLASSIFICATION USING MACHINE LEARNING WITH
PYTHON”**

Submitted in partial fulfillment for the requirements for the Award of Degree of

**BACHELOR OF ENGINEERING
IN
INFORMATION SCIENCE AND ENGINEERING
BY**

**AVINASH KUMAR SINGH
1EP19IS012**

UNDER THE GUIDANCE OF

Prof. Teena KB
Asst Professor
Dept. of ISE, EPCET



Department of Information Science and Engineering

Approved by AICTE New Delhi| Affiliated to VTU, Belagavi
Virgo Nagar, Bengaluru-560049

2022-23



(Affiliated to Visvesvaraya Technological University, Belgavi)

Bangalore-560049

DEPARTMENT OF INFORMATION SCIENCE & ENGINEERING

CERTIFICATE

This is to certify that the **Internship** entitled “**FRUIT CLASSIFICATION USING MACHINE LEARNING WITH PYTHON**” is a bonafied work carried out by **Mr. AVINASH KUMAR SINGH**, bearing **USN 1EP19ISO12** in partial fulfillment for the award of **Bachelor of Engineering in Information Science and Engineering** under **Visvesvaraya Technological University, Belagavi** during the year **2022-23**. It is certified that all the corrections/suggestions indicated in the Internal Assessment have been incorporated in the report and submitted in the department library. This Internship report has been approved as it satisfies the academic requirements in respect of Internship (18CSI85) prescribed for the award of the said degree.

GUIDE
Prof. Teena KB
Asst Professor

HOD
Dr. Lingaraju G M
EPCET

PRINCIPAL
Dr. Yogesh G S
EPCET

Examiners

Name of the Examiners

Signature with date

1.

2.

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Name: AVINASH KUMAR SINGH

USN: 1EP19IS012



REG NO: AAN8688

PraLoTech Solutions LLP

PraLoTech Solutions Certifies

AVINASH KUMAR SINGH [1EP19IS012]

For successfully completing

Training and Internship Programme Conducted for a
Period of 2 Months between **6th February 2023** to **20th April 2023**

We take the pleasure in recognizing the achievement

With the award of

“Internship Certificate”

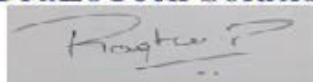
In

“MACHINE LEARNING WITH PYTHON AND OPENCV”

Given on the **20th** day of **April 2023**

PraLoTech

For PraLoTech Solutions LLP


Director

Project Manager

PraLoTech Solutions LLP

ABSTRACT

The machine learning field, which can be briefly defined as enabling computers make successful predictions using past experiences, has exhibited an impressive development recently with the help of the rapid increase in the storage capacity and processing power of computers. Machine learning is closely related to computational statistics, which focuses on making predictions using computers. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Having a system that classifies different types of fruits and identifies the quality of fruits will be of a value in various areas especially in an area of mass production of fruits' products. This project presents a novel system that differentiates between four fruits types and identifies the decayed ones from the fresh. The algorithms used are based on the color and the texture features of the fruits' images. The algorithms extract the RGB values and the first statistical order and second statistical of the Gray Level Co-occurrence Matrix (GLCM) values. To segregate between the fruits' types, 'apple' 'mandarin' 'orange' 'lemon', and Weighted K-Nearest Neighbors algorithms are applied. The accuracy percentages of each are 96.3%, 93.8%, 25%, 83.8%, 90%, and 95% respectively.

INDEX

SL NO.	TITLE	PAGE NO.
1	About The Company	1-11
2	Theoretical Background	12-27
3	Introduction on Project Work	28-29
4	SRS and Implementation	30-33
5	Results/Snapshots	34-35
	Conclusion	36
	References	37

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
1.1	Organization Structure	10
2.1	ML and TP Flows	14
2.2	Data Preprocessing	17
2.3	Labelled Dataset	18
2.4	Supervised Learning	19
2.5	Unsupervised Learning	21
2.6	Reinforcement Learning	22
3.1	Architecture	29
5.1	Results/Snapshots	34-35

LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
2.1	Reinforcement and Supervised Learning	23
2.2	Matrix in ML	25

CHAPTER 1

ABOUT THE COMPANY

1.1 Brief history of the Organization

With the active participation of its multi-disciplinary Assignment Execution Team, Pralotech Solutions has emerged as a leader in the ITES in India and has established itself in the field of software development, data processing, data conversion, digital printing, Digitization, System integration, smart card personalization, IT facility management and other IT enabled services. Pralotech Solutions LLP, incorporated in end of 2018, is a professionally managed, rapidly growing, multifaceted Information technology company. The company is actively involved in developing automation and e-Governance solutions for Transport, Social Security, Citizen Identity, Education, Public Distribution System, Retail Management and a host of other application areas.

Pralotech Solutions is a leading System integrator in India providing complete turnkey solutions on BOO & BOOT basis including facility management services, Smart Cards applications, Document Management System (DMS), Work Flow Management and Manpower Deployment.

Pralotech Solutions has successfully completed many e-governance projects for the various departments of Govt. of Karnataka and has won accolades for its superior service delivery, timely execution of projects and the quality of the deliverables. PRALOTECH SOLUTIONS is being trusted by many clients who are looking for reliable and quality services for their business. PRALOTECH SOLUTIONS is currently operating and managing in Bangalore and giving services to e-commerce business services.

Pralotech Solutions adopted project team and dedicated organization structure. In project based organization, the project manager's directors have a high level of power to oversee and control the project assets. The project manager in this structure has downright power over the project and can secure assets expected to fulfill project targets from inside then again outside the parent organization, subject just to the extension, quality, furthermore, budget constraints are identified in the project.

In the project based structure, staff is particularly relegated to the project and report specifically to the project manager. The project manager is in charge of the execution evaluation and vocation movement of all undertaking colleagues while on the project. This prompts expanded project faithfulness. Complete line power over undertaking endeavors bears the project manager solid undertaking controls and brought together lines of correspondence. This prompts quick response time and enhanced responsiveness. In addition, project work forces are held on a restrictive instead of shared or low maintenance premise. Project teams create an in number feeling of task recognizable proof and possession, with profound faithfulness efforts to the project and a decent comprehension of the way of project's exercises, mission, or objectives.

1.2 Overall Organization Structure

Pralotech Solutions is completely dedicated to the success of our customers and does not permit external forces to diminish our focus and commitment. To achieve the highest level of customer satisfaction, we follow basic principles to deliver solutions with impact.

1.2.1 Vision:

Vision Statement: “To be the pioneer in e-commerce solutions by building and implementing robust and future proof systems which are efficient, transparent and accountable.”

1.2.2 Our Values:

The core values which lay the foundation for Pralotech Solutions are:

- **Honesty & Integrity:** Pralotech Solutions individual and business relationships are governed by the highest standards of honesty and integrity. People at all levels adhere to the code of conduct and the highest standards of business ethics, as they believe in conducting their business with uncompromising integrity.
- **Respect & Dignity:** Pralotech Solutions respects its customers, recognize that they have different needs and continuously strive towards satisfying those needs by improving the quality of its solutions and services. It trusts and respect its people and recognize their contributions to Pralotech Solutions.

- **Terms Spirit & Camaraderie:** Pralotech Solutions believes that focus on Team Work is its competitive advantage. Teams act as catalysts for successful achievement of the organizational goals. Individuals are encouraged to interact with all levels of management, freely share their ideas and suggestions and work together as a cohesive unit.
- **Openness & Transparency:** Pralotech Solutions has an open and transparent culture. Openness facilitates informed decisions, shared understanding and builds an environment of trust in the organization.
- **Empowerment:** Pralotech Solutions employs high caliber people who take responsibility for their actions and exercise good judgment in an environment of mutual trust. Pralotech Solutions seeks to retain its entrepreneurial spirit and minimize bureaucracy.
- **Core Values:** When we take on your project, we take the stewardship of the project with you in the director's seat. As stewards of your project, we consider ourselves successful not when we deliver your final product but when the product meets your business objectives.
- **Integrity:** Honesty in how we deal with our clients, each other and with the world.
- **Candor:** Be open and upfront in all our conversations. Keep clients updated on the real situation. Deal with situations early; avoid last minute surprises.
- **Service:** Seek to empower and enable our clients. Consider ourselves successful not when we deliver our client's final product but when the product is launched and meets success.
- **Kindness:** Go the extra mile. Speak the truth with grace. Deliver more than is expected or promised.
- **Competence:** Benchmark with the best in the business. Try new and better things Never rest on laurels. Move out of comfort zones. Keep suggesting new things. Seek to know more.
- **Growth:** Success is a journey, not a destination. Seek to multiply/increase what we have - wealth, skills, influence, and our client's business.

1.2.3 Our Goal:

Our company objectives as follows:

- To promote a profitable and sustainable business activity that meets the customer's needs.
- To increase the company's market share
- To gain the competitive edge
- To increase the company's role in relations to social responsibility
- To provide excellent customer service

1.2.4 Mission:

“To enable its customers to achieve total e-commerce through innovative solutions using the cutting edge technologies and to provide world class IT and ITES services at affordable costs to the customers with fast turnaround time and to continually improve the service delivery at the client service center's managed by us.”

Over the next few years our goal is to harness our talents and skills by permeating our company further with process-centered management. In this way, once a customer's project enters our quality oriented process, it will exit as a quality product.

We will also strive to add to our knowledge and enhance our skills by creating a learning environment that includes providing internal technology seminars, attending conferences and seminars, building a knowledge library and encouraging learning in every way. Our in-house Intranet portal makes sure that knowledge is shared within the organization.

With our beliefs, the future can only look promising as we continue to build our team with the best Indian talent and mould them into our quality-oriented culture. We will find our niche in a competitive world by excelling at what we do, following our guiding principles and most importantly, listening to the needs of our customers, to complete within deadline period is also our mission.

Contact Information

Company Name : Pralotech Solutions LLP
Development &
Data Processing Centre : #1 Silicon Plaza, Near Usha Dental clinic, subhashnagar, T
C Palya, K R Puram, Bangalore-560049
General Phone No : 9611431872, 9164884137
Company Email : info@pralotech.com , pralotechsolutions@gmail.com
Website : www.pralotech.com
Contact Person : Mr. Lohith.C
(lohith@pralotech.com)

1.3 The Products and the Services Offered by Organization

Company offer the key products and services you would expect from a leading Microsoft Gold and Oracle partner including Web, Software Development and Mobile application, Integration, Consultancy and Support Services.

What sets us aside is our focus, vision and capability to deliver. We are highly accredited, come highly recommended and invest heavily in both product development and our first class consultants.

Pralotech Solutions LLP is one of India most well-known and well-trusted solution provider. Today, Pralotech Solutions stands as a source of reliable and innovative products that enhance the quality of costumer's professional and personal lives.

Its employees in all the branches are active in the areas of production, software development, Implementation, system integration, and training.

Why PraloTech?

With a client list spanning nearly in all industries, and colleges, Pralotech Solutions product solutions have benefited customers of many different sizes, from non-profit organizations to companies.

By acquaintance with Pralotech Solutions, you'll have access to current IT research, tools, templates, and step-by-step action plans for completing Key projects. You'll also be provided full access to our research archives and knowledge base.

1.3.1 Corporate Philosophy

- **Quality Policy:** "Pralotech Solutions is committed to provide world class Information Technology Enabled Services (ITES) to its customers with high accuracy, unmatched quality and fast turnaround time".
- **Security Policy:** "Pralotech Solutions understands that the trust of the client in it depends on how well it keeps their personal, business and accounts information secure. PRALOTECH SOLUTIONS follows international standards set under Information Security Management System (ISMS) policy guidelines."

1.4 Number of People Working in the Organization

Pralotech Solutions employs more than 50 professionals with various skill set and professional competence. Have different project execution teams for different application areas in Information Technology Industry. The Human Resources available with Pralotech Solutions, their qualification and technical skills are depicted below.

Human capital is our most important asset. A qualified and highly specialized team with multi-disciplinary approach forms the technical core at Six Axis. This repository of talented and committed software developers has a proven track record to ensure success in IT solution implementation. With skills ranging from business process re-engineering to application development, Pralotech Solutions technical team seeks to constantly enhance and expand its technical knowledge. Capturing knowledge through procedures and processes is the premise on which the entire organization works. Pralotech Solutions resource base consists of IIT engineers (three including the Directors), management graduates, masters in computer applications and domain experts from various fields.

Pralotech Solutions have improved the quality of communication and satisfied customers. We have earned their respect by providing excellent products and services. In addition, we are

flexible with services and financial structures for contracts aiming for mutually beneficial relationships with our customers.

Our customers are dynamic and diverse and include Large Corporate Offices, Universities, Educational Institutions, Factories, etc.

1.5 Financial Details

PRALOTECH SOLUTIONS provides flexible investment solutions, such as leasing, financing, utility programs and asset management services, for customers to enable the creation of unique technology deployment models and acquisition of complete IT solutions, including hardware, software and services from PRALOTECH SOLUTIONS and others.

Providing flexible services and capabilities that support the entire IT lifecycle, partners with customers globally to help build investment strategies that enhance their business agility and support their business transformation. PRALOTECH SOLUTIONS offers a wide selection of investment solution capabilities for large enterprise customers and channel partners, along with an array of financial options to SMBs, educational and governmental entities.

Corporate Investments Corporate Investments includes PRALOTECH SOLUTIONS Labs and certain cloud-related business incubation projects among others. Sales, Marketing and Distribution We manage our business and report our financial results based on the business segments described above.

1.5.1 Growth Record

Since its inception and with initial small steps, Pralotech Solutions is now progressing by leaps and bounds. It has grown from a small venture to a medium scale enterprise with a strong 80+ workforce, our rate of more than 100%. The company is executing some of the prestigious projects and has earned a very respectable name in the Indian IT and e-commerce industry.

1.5.2 Partnership

Our innovative and highly integrated approach means customers benefit from working with specialists. Our continuous strive to be a technology leader in the industry means that our clients directly benefit from the huge expertise that our people possess.

We strive to be at the forefront of technology that enables us to provide you with highly effective and optimized solutions to all your problems.

Clients like to have a single point-of-contact for their solutions, and expect a complete solution from the vendor, which is not possible unless there are partnerships and alliances within and outside the company.

Pralotech Solutions fosters partnerships with companies with whom a value proposition can be offered to clients.

One of the key benefits that you receive by partnering with Pralotech Solutions is increased project completion certainty, project transparency, renewed customer confidence and credibility from our unparalleled track record, mature processes and quality recognition and customer endorsement.

1.5.3 Experience Certainty

True certainty of success comes from working with a partner you trust to provide the insight, support and expertise that will propel your business forward. Experiencing certainty with Pralotech Solutions means you can count on results, partnership and leadership. When you work with us, your long-term success is our motivation. This is why we can offer you the ability to meet every challenge and the ability to capitalize on every opportunity. That's the power of certainty. And it is our promise to every client.

1.5.4 Overall Turnover or Operational Cost of Organization

For most of our products, we have existing alternate sources of supply or such alternate sources of supply are readily available. However, we do rely on sole sources for laser printer engines, LaserJet supplies, certain customized parts and parts for products with short life cycles (although some of these sources have operations in multiple locations in the event of a

disruption). We are dependent upon Intel and AMD as suppliers of x86 processors and Microsoft for various software products; however, we believe that disruptions with these suppliers would result in industry-wide dislocations and therefore would not disproportionately disadvantage us relative to our competitors.

See “Risk Factors—we depend on third-party suppliers, and our financial results could suffer if we fail to manage suppliers properly,” in Item 1A, which is incorporated herein by reference. Like other participants in the IT industry, we ordinarily acquire materials and components through a combination of blanket and scheduled purchase orders to support our demand requirements for periods averaging 90 to 120 days. From time to time, we may experience significant price volatility or supply constraints for certain components that are not available from multiple sources.

Frequently, we are able to obtain scarce components for somewhat higher prices on the open market, which may have an impact on our gross margin but does not generally disrupt production. We also may acquire component inventory in anticipation of supply constraints or enter into longer-term pricing commitments with vendors to improve the priority, price and availability of supply. See “Risk Factors—we depend on third-party suppliers, and our financial results could suffer if we fail to manage suppliers properly,” in Item 1A, which is incorporated herein by reference. Research and Development Innovation is a key element of our culture. Our development efforts are focused on designing and developing products, services and solutions that anticipate customers’ changing needs and desires, and emerging technological trends.

Our efforts also are focused on identifying the areas where we believe we can make a unique contribution and the areas where partnering with other leading technology companies will leverage our cost structure and maximize our customers’ experiences. PRALOTECH SOLUTIONS together with the various research and development groups within our business segments, are responsible for our research and development efforts. We anticipate that we will continue to have significant research and development expenditures in the future to support the design and development of innovative, high-quality products and services to maintain and enhance our competitive position. For a discussion of risks attendant to our research and development activities, see “Risk Factors— If we cannot successfully execute on our strategy and continue to develop, manufacture and market products, services and solutions that meet

customer requirements for innovation and quality, our revenue and gross margin may suffer,” in Item 1A, which is incorporated herein by reference.

1.6 Organization Structure of the Company

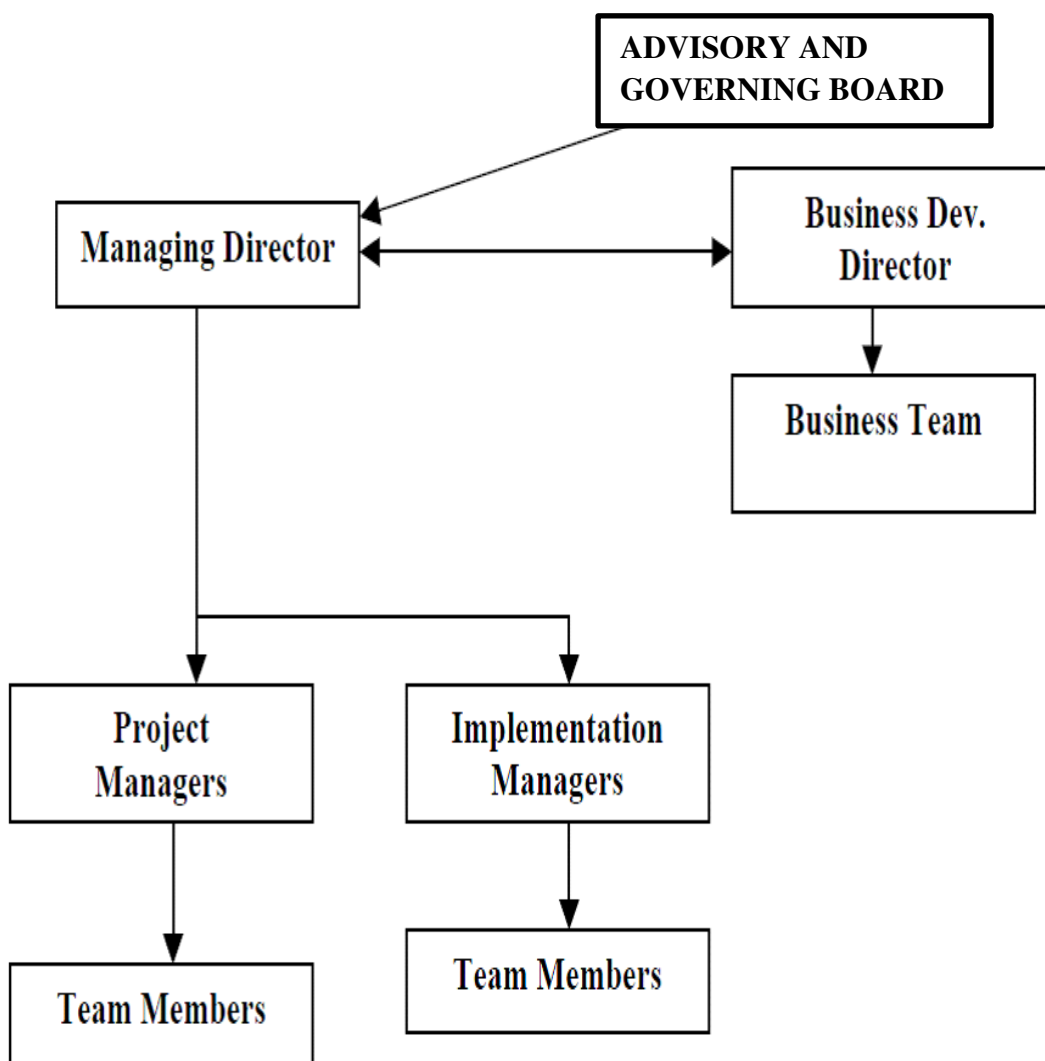


Fig. 1.1 Organization Structure

1.6.1 Current Research and Development

- The current R & D efforts are primarily aimed at the following segments in the healthcare industry:

- Developing a system for integrating medical schools with major hospitals for knowledge gathering, sharing and learning
- Developing a Clinical Decision Support System to aid doctors in difficult to diagnose cases using Artificial Intelligence and Probabilistic Techniques.

1.6.2 New Technology Capability and Positions

The organization has a process in place, which addresses the issue of incorporating emerging technologies into the product design. The process is as follows:

- Core committee on new development evaluates and identifies new technology for the purpose of integration.
- The research and development department identifies the resource and people and formulates the process for working while setting key performance indicator.
- A thorough study of the new technology along the tools is made and documented.
- Estimates are made as to the impact of the new technology on the products developed by the company.
- Effort estimates are made for introducing the new technologies
- Client feedback is received about the efforts needed and the advantages of the new technology.
- The core committee takes a knowledgeable decision as to the advantages and efforts required and approve the introduction of the technology
- The affected personnel are trained in the new technologies
- The new technology is introduced and the product is enhanced
- The clients are informed about the enhancement and introduction of related documents are prepared for the changeover
- The clients are guided in implementing the new technologies

Being a technology driven company we are always exploring ways of enhancing our product capabilities and aim at providing the latest state-of-the-art products to our customers. We have incorporated the PDAs and the smart card already in the system. We are currently evaluating blue tooth capability and the Tablet PC relevance to the field.

CHAPTER 2

THEORETICAL BACKGROUND

Intelligence, as we know, is the ability to acquire and apply the knowledge. Knowledge is the information acquired through experience. Experience is the knowledge gained through exposure(training). Summing the terms up, we get **artificial intelligence** as the “copy of something natural (i.e., human beings) ‘WHO’ is capable of acquiring and applying the information it has gained through exposure.”

Intelligence is composed of:

- Reasoning
- Learning
- Problem Solving
- Perception
- Linguistic Intelligence

Many tools are used in AI, including versions of search and mathematical optimization, logic, methods based on probability and economics. The AI field draws upon computer science, mathematics, psychology, linguistics, philosophy, neuro-science, artificial psychology and many others.

2.1 Need for Artificial Intelligence

- To create expert systems which exhibit intelligent behavior with the capability to learn, demonstrate, explain and advice its users.
- Helping machines find solutions to complex problems like humans do and applying them as algorithms in a computer-friendly manner.

Applications of AI include **Natural Language Processing, Gaming, Speech Recognition, Vision Systems, Healthcare, Automotive** etc.

An AI system is composed of an agent and its environment. An agent (e.g., human or robot) is anything that can perceive its environment through sensors and acts upon that environment

through effectors. Intelligent agents must be able to set goals and achieve them. In classical planning problems, the agent can assume that it is the only system acting in the world, allowing the agent to be certain of the consequences of its actions. However, if the agent is not the only actor, then it requires that the agent can reason under uncertainty. This calls for an agent that cannot only assess its environment and make predictions but also evaluate its predictions and adapt based on its assessment. Natural language processing gives machines the ability to read and understand human language. Some straightforward applications of natural language processing include information retrieval, text mining, question answering and machine translation. Machine perception is the ability to use input from sensors (such as cameras, microphones, sensors etc.) to deduce aspects of the world. e.g., Computer Vision. Concepts such as game theory, decision theory, necessitate that an agent be able to detect and model human emotions.

Many times, students get confused between Machine Learning and Artificial Intelligence, but Machine learning, a fundamental concept of AI research since the field's inception, is the study of computer algorithms that improve automatically through experience. The mathematical analysis of machine learning algorithms and their performance is a branch of theoretical computer science known as a computational learning theory.

Stuart Shapiro divides AI research into three approaches, which he calls computational psychology, computational philosophy, and computer science. Computational psychology is used to make computer programs that mimic human behavior. Computational philosophy is used to develop an adaptive, free-flowing computer mind. Implementing computer science serves the goal of creating computers that can perform tasks that only people could previously accomplish.

AI has developed a large number of tools to solve the most difficult problems in computer science, like:

- Search and optimization
- Logic
- Probabilistic methods for uncertain reasoning
- Classifiers and statistical learning methods
- Neural networks

- Control theory
- Languages

2.2 Machine Learning

Machine Learning(ML) can be explained as automating and improving the learning process of computers based on their experiences without being actually programmed i.e. without any human assistance. The process starts with feeding good quality data and then training our machines(computers) by building machine learning models using the data and different algorithms. The choice of algorithms depends on what type of data do we have and what kind of task we are trying to automate.



Fig. 2.1 ML and TP Flows

Basic Difference in ML and Traditional Programming?

- **Traditional Programming:** We feed in DATA (Input) + PROGRAM (logic), run it on machine and get output.
- **Machine Learning:** We feed in DATA(Input) + Output, run it on machine during training and the machine creates its own program(logic), which can be evaluated while testing.

2.3 Classification of Machine Learning

Machine learning implementations are classified into three major categories, depending on the nature of the learning “signal” or “response” available to a learning system which are as follows:

1. **Supervised learning:** When an algorithm learns from example data and associated target responses that can consist of numeric values or string labels, such as classes or tags, in order to later predict the correct response when posed with new examples comes under the category of Supervised learning. This approach is indeed similar to human learning under the supervision of a teacher. The teacher provides good examples for the student to memorize, and the student then derives general rules from these specific examples.
2. **Unsupervised learning:** Whereas when an algorithm learns from plain examples without any associated response, leaving to the algorithm to determine the data patterns on its own. This type of algorithm tends to restructure the data into something else, such as new features that may represent a class or a new series of un-correlated values. They are quite useful in providing humans with insights into the meaning of data and new useful inputs to As a kind of learning, it resembles the methods humans use to figure out that certain objects or events are from the same class, such as by observing the degree of similarity between objects. Some recommendation systems that you find on the web in the form of marketing automation are based on this type of learning.
3. **Reinforcement learning:** When you present the algorithm with examples that lack labels, as in unsupervised learning. However, you can accompany an example with positive or negative feedback according to the solution the algorithm proposes comes under the category of Reinforcement learning, which is connected to applications for which the algorithm must make decisions (so the product is prescriptive, not just descriptive, as in unsupervised learning), and the decisions bear consequences. In the human world, it is just Errors help you learn because they have a penalty added (cost, loss of time, regret, pain, and so on), teaching you that a certain course of action is less likely to succeed than others. An interesting example of reinforcement learning occurs when computers learn to play In this case, an application presents the algorithm with examples of specific situations, such as having the gamer stuck in a maze while avoiding an enemy. The application lets the algorithm know the outcome of actions it takes, and learning occurs while trying to

avoid what it discovers to be dangerous and to pursue survival. You can have a look at how the company Google DeepMind has created a reinforcement learning program that plays old Atari's videogames. When watching the video, notice how the program is initially clumsy and unskilled but steadily improves with training until it becomes a champion.

4. **Semi-supervised learning:** where an incomplete training signal is given: a training set with some (often many) of the target outputs missing. There is a special case of this principle known as Transduction where the entire set of problem instances is known at learning time, except that part of the targets are missing.

2.4 Categorizing on the basis of required Output

Another categorization of machine learning tasks arises when one considers the desired output of a machine-learned system:

1. **Classification:** When inputs are divided into two or more classes, and the learner must produce a model that assigns unseen inputs to one or more (multi-label classification) of these classes. This is typically tackled in a supervised way. Spam filtering is an example of classification, where the inputs are email (or other) messages and the classes are “spam” and “not spam”.
2. **Regression:** Which is also a supervised problem, a case when the outputs are continuous rather than discrete.
3. **Clustering:** When a set of inputs is to be divided into groups. Unlike in classification, the groups are not known beforehand, making this typically an unsupervised task.

2.5 Data Preprocessing for Machine learning in Python

- Pre-processing refers to the transformations applied to our data before feeding it to the algorithm.
- Data Preprocessing is a technique that is used to convert the raw data into a clean data set. In other words, whenever the data is gathered from different sources it is collected in raw format which is not feasible for the analysis.

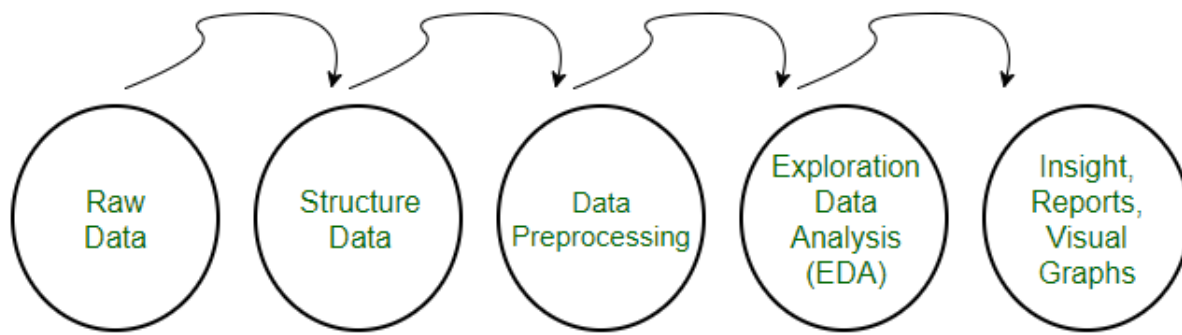


Fig. 2.2 Data Preprocessing

Need of Data Preprocessing

- For achieving better results from the applied model in Machine Learning projects the format of the data has to be in a proper manner. Some specified Machine Learning model needs information in a specified format, for example, Random Forest algorithm does not support null values, therefore to execute random forest algorithm null values have to be managed from the
- Another aspect is that data set should be formatted in such a way that more than one Machine Learning and Deep Learning algorithms are executed in one data set, and best out of them is chosen.

Three different data preprocessing techniques for machine learning

1. Rescale Data

- When our data is comprised of attributes with varying scales, many machine learning algorithms can benefit from rescaling the attributes to all have the same scale.
- This is useful for optimization algorithms in used in the core of machine learning algorithms like gradient descent.
- It is also useful for algorithms that weight inputs like regression and neural networks and algorithms that use distance measures like K-Nearest Neighbors.
- We can rescale your data using scikit-learn using the [MinMaxScaler](#) class.

2. Binarize Data (Make Binary)

- We can transform our data using a binary threshold. All values above the threshold are marked 1 and all equal to or below are marked as 0.
- This is called binarizing your data or threshold your data. It can be useful when you have probabilities that you want to make crisp values. It is also useful when feature engineering and you want to add new features that indicate something meaningful.
- We can create new binary attributes in Python using scikit-learn with the [Binarizer](#) class.

3. Standardize Data

- Standardization is a useful technique to transform attributes with a Gaussian distribution and differing means and standard deviations to a standard Gaussian distribution with a mean of 0 and a standard deviation of 1.
- We can standardize data using scikit-learn with the [StandardScaler](#) class.

2.6 Supervised Learning:

Supervised learning is when the model is getting trained on a labelled dataset. **Labelled** dataset is one which have both input and output parameters. In this type of learning both training and validation datasets are labelled as shown in the figures below.

User ID	Gender	Age	Salary	Purchased	Temperature	Pressure	Relative Humidity	Wind Direction	Wind Speed
15624510	Male	19	19000	0	10.69261758	986.882019	54.19337313	195.7150879	3.278597116
15810944	Male	35	20000	1	13.59184184	987.8729248	48.0648859	189.2951202	2.909167767
15668575	Female	26	43000	0	17.70494885	988.1119385	39.11965597	192.9273834	2.973036289
15603246	Female	27	57000	0	20.95430404	987.8500366	30.66273218	202.0752869	2.965289593
15804002	Male	19	76000	1	22.9278274	987.2833862	26.06723423	210.6589203	2.798230886
15728773	Male	27	58000	1	24.04233986	986.2907104	23.46918024	221.1188507	2.627005816
15598044	Female	27	84000	0	24.41475295	985.2338867	22.25082295	233.7911987	2.448749781
15694829	Female	32	150000	1	23.93361956	984.8914795	22.35178837	244.3504333	2.454271793
15600575	Male	25	33000	1	22.68800023	984.8461304	23.7538641	253.0864716	2.418341875
15727311	Female	35	65000	0	20.56425726	984.8380737	27.07867944	264.5071106	2.318677425
15570769	Female	26	80000	1	17.76400389	985.4262085	33.54900114	280.7827454	2.343950987
15606274	Female	26	52000	0	11.25680746	988.9386597	53.74139903	68.15406036	1.650191426
15746139	Male	20	86000	1	14.37810685	989.6819458	40.70884681	72.62069702	1.553469896
15704987	Male	32	18000	0	18.45114201	990.2960205	30.85038484	71.70604706	1.005017161
15628972	Male	18	82000	0	22.54895853	989.9562988	22.81738811	44.66042709	0.264133632
15697686	Male	29	80000	0	24.23155922	988.796875	19.74790765	318.3214111	0.329656571
15733883	Male	47	25000	1					

Fig. 2.3 Labelled Dataset

Both the above figures have labelled data set

- **Figure A:** It is a dataset of a shopping store which is useful in predicting whether a customer will purchase a particular product under consideration or not based on his/ her gender, age and salary.
- **Input:** Gender, Age, Salary
- **Output:** Purchased i.e. 0 or 1; 1 means yes the customer will purchase and 0 means that customer won't purchase it.
- **Figure B:** It is a Meteorological dataset which serves the purpose of predicting wind speed based on different parameters.
- **Input:** Dew Point, Temperature, Pressure, Relative Humidity, Wind Direction
- **Output:** Wind Speed

Training the system:

While training the model, data is usually split in the ratio of 80:20 i.e. 80% as training data and rest as testing data. In training data, we feed input as well as output for 80% data. The model learns from training data only. We use different machine learning algorithms (which we will discuss in detail in next articles) to build our model. By learning, it means that the model will learn from the training data. Once the model is ready then it is good to be tested. At the time of testing, input is fed from remaining 20% data which the model has never seen before, the model will predict some value and we will compare it with actual output and calculate the accuracy.

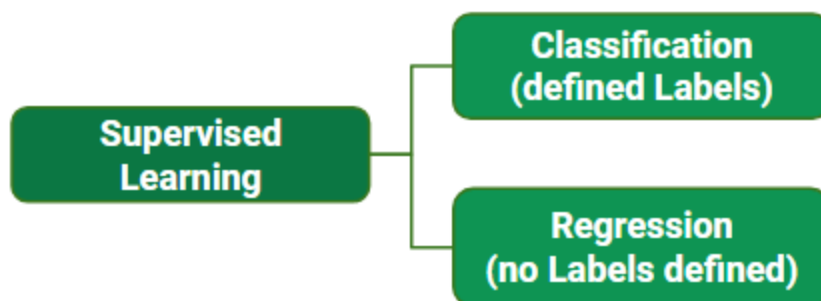


Fig. 2.4 Supervised Learning

Types of Supervised Learning:

1. **Classification:** It is a Supervised Learning task where output is having defined labels (discrete value). For example, in above Figure A, Output – Purchased has defined labels i.e. 0 or 1; 1 means the customer will purchase and 0 means that customer won't purchase. The goal here is to predict discrete values belonging to a particular class and evaluate on the basis of accuracy.
2. **Binary:** It can be either binary or multi class classification. In **binary** classification, model predicts either 0 or 1; yes, or no but in case of **multi class** classification, model predicts more than one class.

Example: Gmail classifies mails in more than one classes like social, promotions, updates, forum.

3. **Regression :** It is a Supervised Learning task where output is having continuous value. Example in above Figure B, Output – Wind Speed is not having any discrete value but is continuous in the particular range. The goal here is to predict a value as much closer to actual output value as our model can and then evaluation is done by calculating error value. The smaller the error the greater the accuracy of our regression model.

Example of Supervised Learning Algorithms:

- Linear Regression
- Nearest Neighbor
- Gaussian Naive Bayes
- Decision Trees
- Support Vector Machine (SVM)
- Random Forest

2.7 Unsupervised learning

Unsupervised learning is the training of machine using information that is neither classified nor labeled and allowing the algorithm to act on that information without guidance. Here the task of machine is to group unsorted information according to similarities, patterns and differences without any prior training of data.

Unlike supervised learning, no teacher is provided that means no training will be given to the machine. Therefore machine is restricted to find the hidden structure in unlabeled data by ourself.

For Instance, suppose it is given an image having both dogs and cats which have not seen ever.



Fig. 2.5 Unsupervised Learning

Thus the machine has no idea about the features of dogs and cat so we can't categorize it in dogs and cats. But it can categorize them according to their similarities, patterns, and differences i.e., we can easily categorize the above picture into two parts. First may contain all pics having **dogs** in it and second part may contain all pics having **cats** in it. Here you didn't learn anything before, means no training data or examples.

Unsupervised learning classified into two categories of algorithms:

- **Clustering:** A clustering problem is where you want to discover the inherent groupings in the data, such as grouping customers by purchasing behavior.
- **Association:** An association rule learning problem is where you want to discover rules that describe large portions of your data, such as people that buy X also tend to buy Y.

2.8 Reinforcement Learning

Reinforcement learning is an area of Machine Learning. It is about taking suitable action to maximize reward in a particular situation. It is employed by various software and machines to find the best possible behavior or path it should take in a specific situation. Reinforcement learning differs from the supervised learning in a way that in supervised learning the training data has the answer key with it so the model is trained with the correct answer itself whereas in reinforcement learning, there is no answer but the reinforcement agent decides what to do to perform the given task. In the absence of training dataset, it is bound to learn from its experience.

Example : The problem is as follows: We have an agent and a reward, with many hurdles in between. The agent is supposed to find the best possible path to reach the reward. The following problem explains the problem more easily.

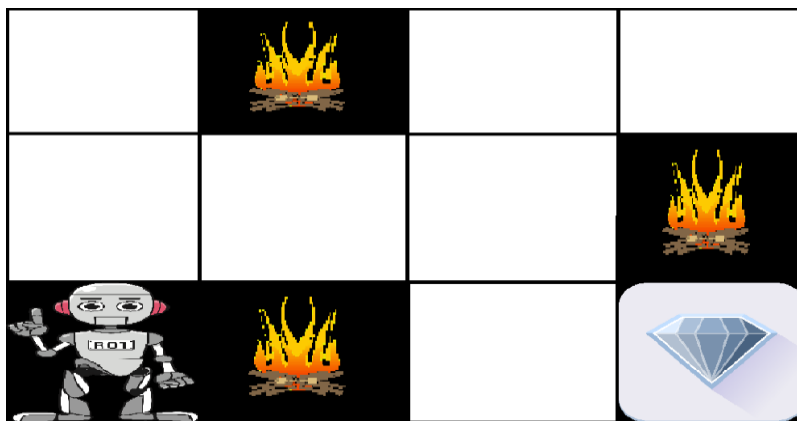


Fig. 2.6 Reinforcement Learning

The above image shows robot, diamond and fire. The goal of the robot is to get the reward that is the diamond and avoid the hurdles that is fire. The robot learns by trying all the possible paths and then choosing the path which gives him the reward with the least hurdles. Each right step will give the robot a reward and each wrong step will subtract the reward of the robot. The total reward will be calculated when it reaches the final reward that is the diamond.

Main points in Reinforcement learning –

- Input: The input should be an initial state from which the model will start

- Output: There are many possible output as there are variety of solution to a particular problem
- Training: The training is based upon the input, the model will return a state and the user will decide to reward or punish the model based on its output.
- The model keeps continue to learn.
- The best solution is decided based on the maximum reward.

Difference between Reinforcement learning and Supervised learning:

Table No. 2.1 Reinforcement Learning and Supervised learning

REINFORCEMENT LEARNING	SUPERVISED LEARNING
Reinforcement learning is all about making decisions sequentially. In simple words we can say that the output depends on the state of the current input and the next input depends on the output of the previous input	In Supervised learning the decision is made on the initial input or the input given at the start
In Reinforcement learning decision is dependent, So we give labels to sequences of dependent decisions	Supervised learning the decisions are independent of each other so labels are given to each decision.
Example: Chess game	Example: Object recognition

Types of Reinforcement: There are two types of Reinforcement:

1. Positive

Positive Reinforcement is defined as when an event, occurs due to a particular behavior, increases the strength and the frequency of the behavior. In other words, it has a positive effect on the behavior.

Advantages of reinforcement learning are:

- Maximizes Performance
- Sustain Change for a long period of time

Disadvantages of reinforcement learning:

- Too much Reinforcement can lead to overload of states which can diminish the results

2. Negative –

Negative Reinforcement is defined as strengthening of a behavior because a negative condition is stopped or avoided.

Advantages of reinforcement learning:

- Increases Behavior
- Provide defiance to minimum standard of performance

Disadvantages of reinforcement learning:

- It Only provides enough to meet up the minimum behavior

2.9 Confusion Matrix in Machine Learning

In the field of machine learning and specifically the problem of statistical classification, a confusion matrix, also known as an error matrix.

A confusion matrix is a table that is often used to describe the performance of a classification model (or “classifier”) on a set of test data for which the true values are known. It allows the visualization.

It allows easy identification of confusion between classes e.g. one class is commonly mislabeled as the other. Most performance measures are computed from the confusion matrix.

Confusion Matrix:

A confusion matrix is a summary of prediction results on a classification problem. The number of correct and incorrect predictions are summarized with count values and broken down by each class. This is the key to the confusion matrix.

The confusion matrix shows the ways in which your classification model is confused when it predictions.

It gives us insight not only into the errors being made by a classifier but more importantly the types of errors that are being made.

Table No. 2.2 Matrix in ML

	<i>Class 1 Predicted</i>	<i>Class 2 Predicted</i>
Class 1 Actual	TP	FN
Class 2 Actual	FP	TN

Here,

- Class 1: Positive
- Class 2: Negative

Definition of the Terms:

- Positive (P): Observation is positive (for example: is an apple).
- Negative (N): Observation is not positive (for example: is not an apple).
- True Positive (TP): Observation is positive, and is predicted to be positive.
- False Negative (FN): Observation is positive, but is predicted negative.
- True Negative (TN): Observation is negative, and is predicted to be negative.
- False Positive (FP): Observation is negative, but is predicted positive.

Classification Rate/Accuracy:

Classification Rate or Accuracy is given by the relation:

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

However, there are problems with accuracy. It assumes equal costs for both kinds of errors. A 99% accuracy can be excellent, good, mediocre, poor or terrible depending upon the problem.

Recall:

Recall can be defined as the ratio of the total number of correctly classified positive examples divide to the total number of positive examples. High Recall indicates the class is correctly recognized (small number of FN).

Recall is given by the relation:

$$\text{Recall} = \frac{TP}{TP + FN}$$

Precision:

To get the value of precision we divide the total number of correctly classified positive examples by the total number of predicted positive examples. High Precision indicates an example labeled as positive is indeed positive (small number of FP).

Precision is given by the relation:

$$\text{Precision} = \frac{TP}{TP + FP}$$

High recall, low precision: This means that most of the positive examples are correctly recognized (low FN) but there are a lot of false positives.

Low recall, high precision: This shows that we miss a lot of positive examples (high FN) but those we predict as positive are indeed positive (low FP)

F-measure:

Since we have two measures (Precision and Recall) it helps to have a measurement that represents both of them. We calculate an F-measure which uses Harmonic Mean in place of Arithmetic Mean as it punishes the extreme values more.

The F-Measure will always be nearer to the smaller value of Precision or Recall.

$$F - measure = \frac{2 * Recall * Precision}{Recall + Precision}$$

CHAPTER 3

INTRODUCTION ON PROJECT WORK

3.1 Introduction

Machine Learning is the process of analyzing, extracting and predicting the meaningful information from huge data to extract some pattern. This process is used by companies to turn the raw data of their customer to useful information. The process of Data Mining includes first selection of data followed by preprocessing of data and then transforming the data to get patterns which can then be used to predict useful insights. Preprocessing includes finding outliers and detecting missing values whereas transformation finds the correlation between objects.

Research has been done in the area of image processing and classifying fruits and vegetables to support work in the domains of agriculture automation and robotic fruit harvesting. Harvesting, for example, involves steps like identifying the ripped fruit and vegetable to collect, separating between different types and recognizing infected or decayed ones to isolate. Developing a system that differentiates between the fruits and vegetables types and their quality adds to this area. Another scenario where the classifications of fruits and vegetables will be of use is the supermarket. Some of the barcode labels of the products are partially damaged as a results the products' prices cannot be known. This delays the process of paying at the cashier. Customers have to wait till an employer goes and checks the price of the product on the shelf. A system that takes a picture of the product and identifies the product and consequently tell the price can solve this problem. This can as well support visually impaired and blind people to pick up the right fruits and the vegetables and know the cost of each.

3.2 Existing System

The existing work locating red and green apples in a single image. On-tree situations of contrasting red and green apple on a tree. The combined three features color, shape, and size to increase the accuracy. Also classified 6 types of fruits red apple, green banana, green guava, green melon, orange, and watermelon based on color, shape and size features and used a k-NN classifier. The accuracy researched 95%.

3.3 Proposed System

This work presents a new system that initially categorizes four types of fruits namely 'apple' 'mandarin' 'orange' 'lemon'. For each type, it recognizes the decayed fruits from the fresh. The algorithms make the differentiations based on the color and texture. The classification of the fruits' types is done with the K-Nearest Neighbors algorithms are applied to separate ones. The accuracy of classifier is reported.

Advantages

The proposed classification algorithm has More Accuracy.

3.4 Architecture

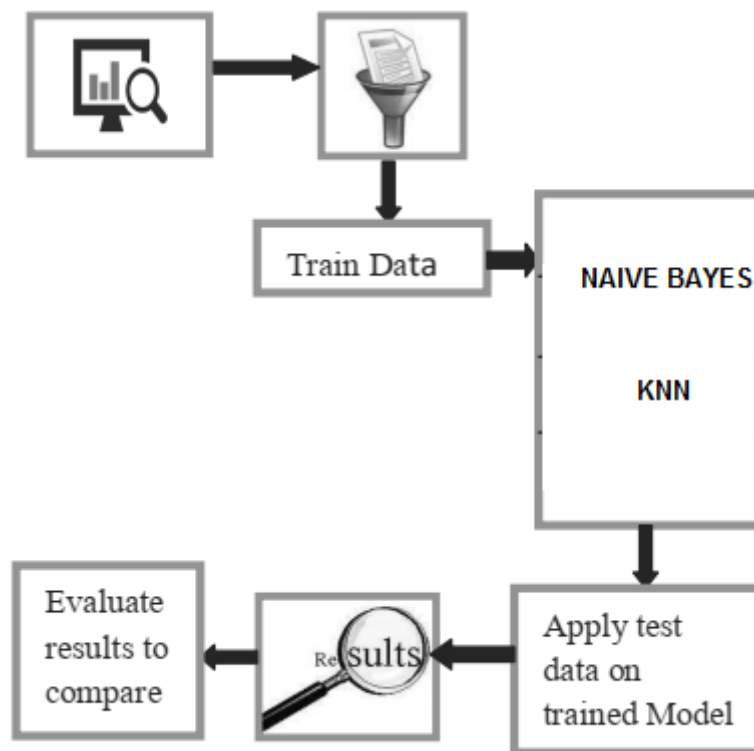


Fig. 3.1 Architecture

CHAPTER 4

SRS & IMPLEMENTATION

4.1 System Requirements

Hardware Requirements

Processors	:	Intel I3 2.2 Ghz
RAM	:	4 GB.
Storage	:	100 GB.
Monitor	:	15”
Keyboard	:	Standard 102 keys

Software (Tools & Technologies) Requirements

Coding	:	Python
Platform	:	python 3.7
Tool	:	Spyder
OS	:	Windows 7

4.2 Implementation

Main.py

```
#%matplotlib inline

import pandas as pd

from pandas.plotting import scatter_matrix

import matplotlib.pyplot as plt

from sklearn.model_selection import train_test_split

#fruits = pd.read_table('fruit_data_with_colors.txt')

fruits = pd.read_csv("fruit_data_with_colors.txt", header=0, delimiter="\t", quoting=3)

fruits.head()


print(fruits.shape)


fruits_unique = dict(zip(fruits.fruit_label.unique(),fruits.fruit_name.unique()))

print(fruits_unique)


print(fruits['fruit_name'].unique())


print(fruits.groupby('fruit_name').size())


import seaborn as sns

sns.countplot(fruits['fruit_name'],label="Count")

plt.show()
```

```
X = fruits[['mass', 'width','height','color_score']]
```

```
y = fruits['fruit_label']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=0)
```

```
print(X_train)
```

```
print("\n")
```

```
print(y_train)
```

```
print("\n")
```

```
print(X_test)
```

```
print("\n")
```

```
print(y_test)
```

```
from mpl_toolkits.mplot3d import Axes3D
```

```
fig = plt.figure()
```

```
ax = fig.add_subplot(111,projection = '3d')
```

```
ax.scatter(X_train['width'], X_train['height'],X_train['color_score'], c=y_train ,marker =  
'o',s=100)
```

```
ax.set_xlabel('width')
```

```
ax.set_ylabel('height')
```

```
ax.set_zlabel('color_score')
```

```
plt.show()
```

```
from sklearn.neighbors import KNeighborsClassifier
```

```
knn = KNeighborsClassifier(n_neighbors = 1)
```



```
knn.fit(X_train, y_train)
```

```
KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',  
                     metric_params=None, n_jobs=None, n_neighbors=1, p=2,  
                     weights='uniform')
```

```
knn.score(X_test, y_test)
```

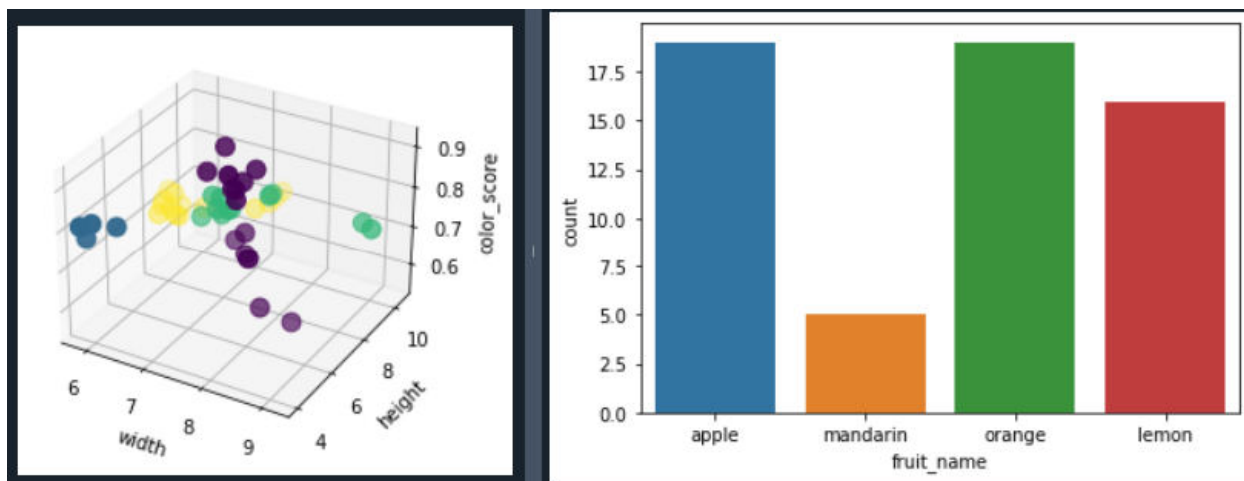
```
fruit_prediction = knn.predict([[155,6.43,9.5,1]])
```

```
print(fruits_unique[fruit_prediction[0]])
```

```
print(fruit_prediction[0])
```

CHAPTER 5

RESULTS/SNAPSHOTS



Name	Type	Size	Value
ax	axes._subplots.Axes3DSubplot	1	Axes3DSubplot object of matplotlib.axes._subplots module
fig	figure.Figure	1	Figure object of matplotlib.figure module
fruit_prediction	Array of int64	(1,)	[4]
fruits	DataFrame	(59, 7)	Column names: fruit_label, fruit_name, fruit_subtype, mass, width, hei ...
fruits_unique	dict	4	{1:'apple', 2:'mandarin', 3:'orange', 4:'lemon'}
knn	neighbors._classification.KNeighborsClassifier	1	KNeighborsClassifier object of sklearn...
score	float64	1	0.6
X	DataFrame	(59, 4)	Column names: mass, width, height, color_score
X_test	DataFrame	(15, 4)	Column names: mass, width, height, color_score
X_train	DataFrame	(44, 4)	Column names: mass, width, height, color_score
y	Series	(59,)	Series object of pandas.core.series module
y_test	Series	(15,)	Series object of pandas.core.series module
y_train	Series	(44,)	Series object of pandas.core.series module

	fruit_label	fruit_name	fruit_subtype	mass	width	height	color_score
1	apple	granny_smith	192	8.4	7.3	0.55	
1	apple	granny_smith	180	8.0	6.8	0.59	
1	apple	granny_smith	176	7.4	7.2	0.60	
2	mandarin	mandarin	86	6.2	4.7	0.80	
2	mandarin	mandarin	84	6.0	4.6	0.79	
2	mandarin	mandarin	80	5.8	4.3	0.77	
2	mandarin	mandarin	80	5.9	4.3	0.81	
2	mandarin	mandarin	76	5.8	4.0	0.81	
1	apple	braeburn	178	7.1	7.8	0.92	
1	apple	braeburn	172	7.4	7.0	0.89	
1	apple	braeburn	166	6.9	7.3	0.93	
1	apple	braeburn	172	7.1	7.6	0.92	
1	apple	braeburn	154	7.0	7.1	0.88	
1	apple	golden_delicious	164	7.3	7.7	0.70	
1	apple	golden_delicious	152	7.6	7.3	0.69	
1	apple	golden_delicious	156	7.7	7.1	0.69	
1	apple	golden_delicious	156	7.6	7.5	0.67	
1	apple	golden_delicious	168	7.5	7.6	0.73	
1	apple	cripps_pink	162	7.5	7.1	0.83	
1	apple	cripps_pink	162	7.4	7.2	0.85	
1	apple	cripps_pink	160	7.5	7.5	0.86	
1	apple	cripps_pink	156	7.4	7.4	0.84	
1	apple	cripps_pink	140	7.3	7.1	0.87	
1	apple	cripps_pink	170	7.6	7.9	0.88	
3	orange	spanish_jumbo	342	9.0	9.4	0.75	
3	orange	spanish_jumbo	356	9.2	9.2	0.75	
3	orange	spanish_jumbo	362	9.6	9.2	0.74	
3	orange	selected_seconds	204	7.5	9.2	0.77	
3	orange	selected_seconds	140	6.7	7.1	0.72	
3	orange	selected_seconds	160	7.0	7.4	0.81	
3	orange	selected_seconds	158	7.1	7.5	0.79	
3	orange	selected_seconds	210	7.8	8.0	0.82	
3	orange	selected_seconds	164	7.2	7.0	0.80	
3	orange	turkey_navel	190	7.5	8.1	0.74	
3	orange	turkey_navel	142	7.6	7.8	0.75	

Fig. 5.1 Result/Snapshots

CONCLUSION

This work presents a system that classifies four types of fruits namely 'apple' 'mandarin' 'orange' and 'lemon'. It as well separates between the fresh and decayed ones. The system has two phases and each follows these steps pre-processing, feature extraction, and classification. By implementing this system, we can say that Faster R- CNN is the quite fastest model and gives most accurate results. Accuracies for different categories of fruits lies between: Healthy apple = (60-75) %, Bad Apple = (60- 70) %, Healthy Pear = (85-99) %, Bad Pear = (80- 98) %, Healthy Banana = (80-97) %, Bad Banana = (70-80) %. Hence, this system can be very useful in automatic sorting machines where it can detect as well as classify the fruit and their defects. Therefore, it will help in ensuring the quality and richness of the fruit.

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