
Contactless Fingerprint Recognition Based on Machine Learning and Neural Network

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Abstract

Fingerprints are something which is greatly examined biometry features. Particularly, based only through contact fingerprints identification systems are leading because of their powerfully built, flexibility, and wide research in the particular domain. But these type of systems has some issues like hygiene, and detector degradation because of the regular physical touch. In this project, we present a process for creating an amazing system of identification of fingerprints that catches ridges images through a space utilising a picture detector within proper conditions. That caught ridges pictures were moved forward to get global and local components. Particularly, (CNN) is developed in order to remove worldwide components through provided ridges image.

Keywords

Contactless Fingerprint, Biometrics, Convolutional Neural Network, Deep Learning, Deep Hashing, Machine learning

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Introduction

Challenges of identification based verification system and the latest technologies are applying. One of those technologies are biometrics which has found as the most suitable technology for authentication and recognizing individuals very quick and very safe using the new different from others ridges features^[1]. These, ridges are majorly and popularly used ridges features. The ridges image contains patterns of lines, ups and downs present on the fingertip. Identify of an individual through matching the fingerprint way which is an old method^[2]. Fingerprint identification is carryout in two paths. The first is verification of the fingerprints and the second is identification of fingerprints. The verification process includes, matching the person's fingerprint within the arrangement which is kept in the directory to check whether the user was authentic^[3]. And these all happens with the help of the biometry structure which execute the tone matched for the person including database. Alternatively, the verification process includes the person's fingerprints is compared with the impressions of fingerprint which is stored in the database to get the individual's identity. Therefore, as compared to the verification process, the identification process is expensive as computationally mainly for numerous databases^[4].

Developing a biometry structure through the visual using and infrared images based on five characteristics and they are hand geometry, palm print, palmar knuckle print, palm vein, and finger vein for verification^[5].

Literature Survey

Deep Learning

Deep learning is introduced by latest region of machine learning and this is regressively performed to find solution which has a great opportunity for artificial intelligence and machine learning. It has been discovered as great composition in infinite-dimensional data hence it's applied to various areas of the scientific technology, government and business^[6].

Deep learning is regressively solved, it is applied to image recognition tasks and it is the example in the region of object verification and classification by implementing a CNN for object verification. They have the ability to decrease the error rate to half. The neural network is implemented and triggered the speed advertisement of deep learning^[7]. The depth of the convolutional network has decreased the area of all the filters that was utilized for complication. The important contribution was the complete assessment of networks for larger depth using filters, which created a captivating progress over the organization^[8].

The architecture of CNN is intense and vast by presenting a CNN described as inception. A specific personification of the design is called as GoogleNet. He et al. A very deep convolutional neural network design named as ResNet. The originality of ResNet sites just in designing a deep network but also in the implementation for the remaining design to reframe various layers because learning remaining structures through the recommendation of layer inputs, in place of learning non recommended structures.

For further improvement of the execution in image and speech verification, deep learning has implemented most assuring outputs of different types of tasks in natural language recognition^[9].

Deep Hashing

Many hashing techniques have already suggested to permit systematic estimated nearer neighbor search because of less area and measure complication. Those typical hashing techniques will be divided in

data-independent or data dependent methods^[10]. An extensive study of hashing methods is represented. Starting investigations on hashing were mostly concentrated on data-independent techniques, as locality sensitive hashing. LSH techniques bring about hashing through using a lot of projections. Although, LSH techniques commands remarkable part of the storage because they need lengthy codes to obtain an adequate presentation^[11].

To know about the compact binary codes, data-dependent hashing techniques are presented in the composition. Data-dependent techniques achieve similarity-preserving hashing techniques from a sequence. Data-dependent hashing techniques have been classified to unsupervised or supervised^[12]. These techniques have attained using handmade attributes for understanding hash techniques. But, the handmade attributes don't conserve the semiology data resemblance of the similar pairs and random variation in actual data. That led to the increment of deep hashing methods were deep neural networks encode non-linear hash functions. This causes a productive end-to-end understanding of attribute presentation and hash coding^[13].

System Analysis

Existing System

The existing system includes adopting methods and they are divided into two types of learning, initially it enumerates all the hash codes from the pairwise similarity matrix and secondly it instructs the deep neural network to fix in the hash codes which was started initially^[14]. The existing system is invented by Lai et al. At the same time it catches middle image characters and instructs hash function in combined learning method. The mentioned hashing function enables a divide-and-encode module that divide all the characters of image that retrieved from the deep network into the numerous blocks and each block is encoded in a single bit. Liu et al represents a model named as deep hashing which understands the hash code by one after the other^[2].

Proposed System

Discharge of biometric arrangement to opponent forms a significant warning to the safety and peace of the person and it has to be done because if the opponent acquires the approach to biometric database, the person can easily acquire the reserved biometric knowledge of the performer^[16]. In order to reduce the privacy and safety risks in the biometry utilization, safe biometry designs have evolved to permit verification without the need of the recommended biometric impression to be reserved in the original form at access control device. The secured biometric arrangement comprises of the biometric cryptosystems, secure sketch and fuzzy commitment and transformation based methods^[2].

Secure Multimodal Biometrics

Secured biometry frameworks have increased a lot to involve various types of biometry impressions of a person. Fingerprint and face impressions are joined together to create an only binary string and then that joined string is used as input to the secured sketch schemes.

System Requirements

Hardware Requirements:

- System : i3 IV or Above.
- Hard Disk : 40 GB.
- Ram : 4 GB.

Software Requirements:

- Operating System: Windows 8 or Above
- Coding Language: Python 3.7

System Design

UML Diagrams

The full form of UML is Unified Modelling Language. This is a multipurpose modelling language of object oriented software engineering. It was invented by the Object Management Group.

Main aim here is to make similar languages for making the object oriented computer software model. It is made up of two elements.

1. A meta model
2. A Notation model

It is possible to add more method forms in the future.

Use Case Diagram

This diagram in the UML is the part of behavioural illustration described and invented through a use case investigation. The motive here is to represent a visual survey through the performance on condition of the organisation regarding the performer, their target and dependency among use cases. Main motive of the use case diagram is to showcase how the functions of systems are performed by the performers and also the characters of performers in the system can be portrayed.

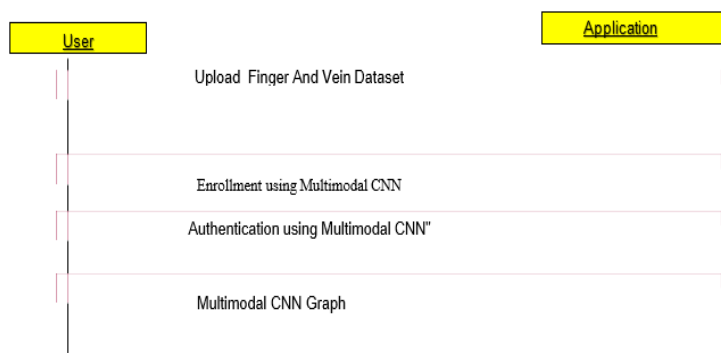


Figure 1. Use Case Diagram

Class Diagram

In the unified modelling language a class diagram is a type of static structure diagram which enumerates the design of the system by viewing the system's classes, attributes, operations, methods and the connection between the classes. This illustrates the class which carries all the information. It explains which class contains information.

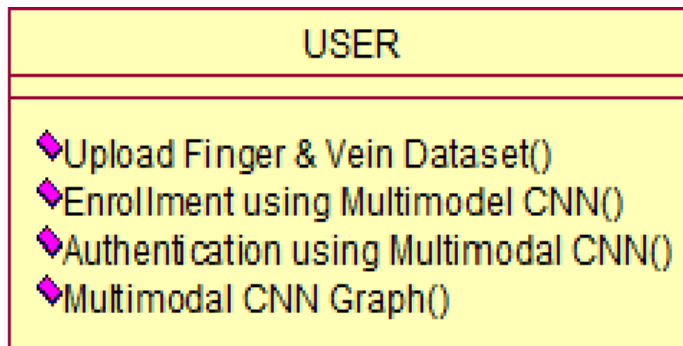


Figure 2. Class Diagram

Identifiers in Python



Figure 3. Identifiers in Python

Python data types

In UML, (Unified Modelling Language) a sequence diagram is a type of interaction diagram that possess the order in which the processor is operated and how it is done. The message sequence chart is used in

the construction of the sequence diagram. The Sequence diagrams are also known as timing diagrams, event diagrams and event scenarios.

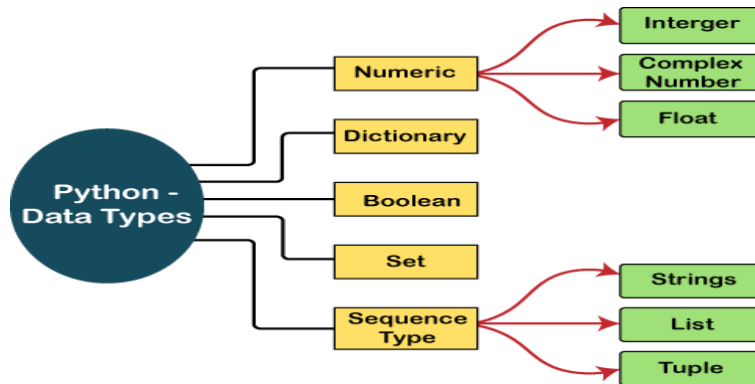


Figure 4. Python data types

Implementation

Modules

Deep Features Extraction: The use of deep features extraction module is to read finger and vein images and then pull out pixels from both images and after extracting convert these pixels into binary to generate a feature vector.

Cancellable Module: The use of cancellable module is to select random bits from each image after that this randomly selected bits will be input to VGG19 CNN model. CNN will use FUSION layer to mix both finger and vein features to generate raw features.

Enrolment: Using this module VGG19 CNN model get trained on fusion features and then build a training model. This training model can be applied on test images to authenticate users.

Authentication: Using this module application take two images as input (finger and vein) and then extract features from images and then apply VGG19 to predict and authenticate users.

Multimodal CNN Graph: To train VGG we took 20 iterations or epoch and using this module we will plot accuracy and loss graph of VGG at each epoch/iterations.

Software Environment

What is Python

Python is a universally useful decipherable, intuitive, object-oriented, high-level programming language. Python contains thousands of library files to help develop any application in a fast development way. Many companies use python as their main programming language because of its flexibility and ease of code, and there is plenty of help and community to make the app better day by day.

Installation Work

The installation work of python 3.6 and with it the installation of Pycharm IDE is shown in the following set of steps which needs to be followed to get the final execution environments.

The version you need depends on your project end goal. This project is coded in python language and requires python 2.7 version. MCDungeon project with python 3.6 version cannot run. If you're working with projects like MCDungeon, most of these projects use python 2.7. If your goal is to get some project that ends with a ".py" extension, then you will need the python 2.7 version for it.

Furthermore, if you want to learn python, we recommend installing both versions side by side in your system (which you can do with zero risk). This will lead you to work with the newest version of the python language. Comparing the two versions together, we'll defer to the python project wiki where you can read their differences. If you are sure, you can download a particular version of python 2 or python 3. You should download both versions and do the same.

Installing Python

Step 1) Need to download the python software from online provided by the concerned web site and correct version downloading must be done. This is the first step of installing python. It includes downloading the python software from online provided by the concerned website. The correct version of python downloading must be done.

Variable: It is name given to the memory location where value is stored. Variable=value

Identifiers: These are the names which are given to the memory block to identify.

Example:

- variable name
- class name
- object name
- function name

Rules of Identifier:

- identifier should not be a keyword, But True,False,None can be taken as values.
- Identifiers should not start with numerals.
- Identifiers should not contain any special symbols in it.
- Identifiers can start with alphabets.
- Identifiers can start with alphanumeric.
- Identifiers should not contain any space.
- Identifiers can be upto 32 characters.

Data Type: Type of the value stored inside in memory block. Why to use: To perform a task we should have to know what type of value we should take. Two types:

- Single valued data type: single values are store in memory block. Single value assign to single variable.
- Multi valued data type: multi value store in memory block. Only one value we can assign.

Single valued data type:

- Integer : These are numericals. It should not contain decimal pointer floating values. Number can be positive or negative.
- Float : These are numericals. It should contain decimal pointer floating values. Number can be positive or negative.
- Complex: These are the numbers combination of real part and imaginary part.
- Boolean: To represent logical value. True and False. It contain value True and False as values. These are the single value data types whose values are already defined 1 and 0 which comes under integer.

Multi value data type or collection.

- String: It is sequence of characters which are inclosed between single quotes and double quotes or triple quotes.
- List: It is a collection of homogenous or heterogenous data types or data items. List values should be enclosed between square brace[] and values separated by comas(,).
- Tuple: It is a collection of homogenous or heterogenous data types or data items. List values should be enclosed between open paranthesis() and values separated by comas(,). It is immutable object. It is faster than list. It is static memory allocation. It support indexing.
- Set: It is a collection of homogenous and heterogenous data types or data items. It's values are enclosed between {} and values are separated by commas(,). It is mutable object. Index is not possible in set.
- Dictionary: It is a collection of key value pair. Whenever we want to store the data in the form of key value pair we should have to go for dictionary.

Python Is having many built-in Data Types. The below figure shows the python data types.



Figure 5. Python.links.Download

Slicing: The process of extracting sequence of elements or data from given collection between the limits. Slicing can be applied for those data types who supports indexing concept.

Type casting: The process of conversion of one data type to the another data type. Single value to single data type: The source type is single value data type and destination type is single value data types. Int:

here source type is integer data type and destination types are other single value datatypes. Float: here source type is float data type and destination types are all other single value datatypes.

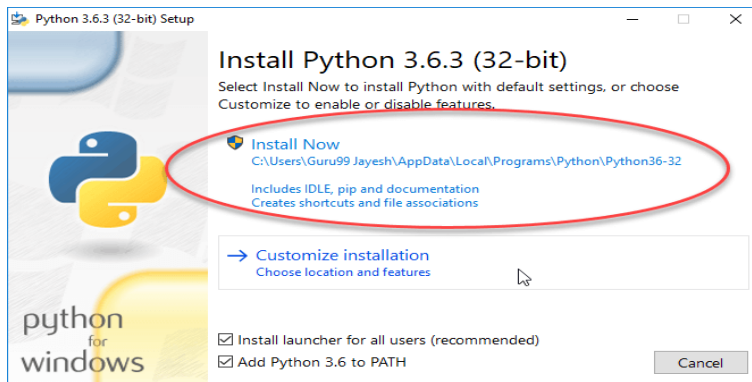


Figure 6. Installing_Python

Step 2) Then the installation process needs to be started by selecting the following option.

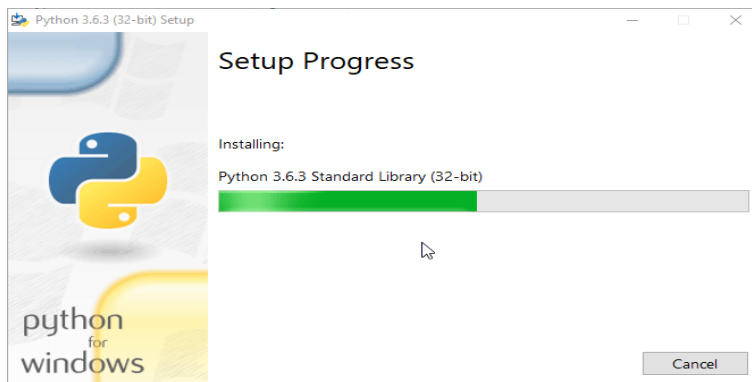


Figure 7. Installation_Process

Step 3) Python installation process is started now.

Step 4) Needs to wait till the installation process is done and then cancel button needs to be pressed.

Step 5) Here you see a different version of python along with the operating system.

Installing Pycharm

Step 1) Next Pycharm IDE installation needs to be done, depending on the version needed for your computer correct ide must be downloaded.

Step 2) After downloading the IDE installation process needs to be started as shown in the following diagram.

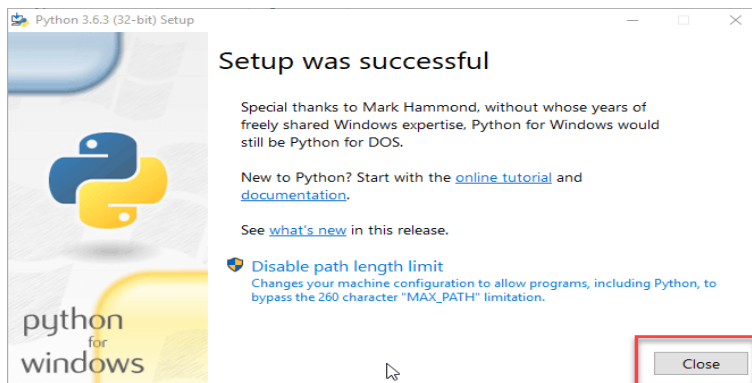


Figure 8. Successfully installed

Files					
Version	Operating System	Description	MD5 Sum	File Size	GPU
clipped source tarball	Source release		6d111671e35b2db4aef701a0118f0f9e	23017683	38G
K7 compressed source tarball	Source release		d334e4a6d097011c1c1e4d5e36d4003	17133432	38G
macOS 64-bit/32-bit installer	Mac OS X	for Mac OS X 10.6 and later	6x20b4a75d3d9f1a442c4a6ce0b6	34958436	38G
macOS 64-bit installer	Mac OS X	for OS X 10.9 and later	3d4d05c38227a457738f4e4536d40f	28892845	38G
Windows help file	Windows		463999573a2c3682ac36cad6b4771d2	8131762	38G
Windows x86-x64 embeddeddata zip file	Windows	for AMD64/EM64T/x64	9b050c9b4f6c3d4b4b4b3118a4e1725a2	7584391	38G
Windows x86-x64 executable installer	Windows	for AMD64/EM64T/x64	4702b4d4a0716b0b3043a583e3d5400	26880368	38G
Windows x86-x64 web-based installer	Windows	for AMD64/EM64T/x64	20c31c00b0d075a0b32a30d31d4b4d2	1362904	38G
Windows x86 embeddeddata zip file	Windows		9f4b30b138b42879b4b412307413b00	6743826	38G
Windows x86 executable installer	Windows		33c1602942a54446a3d9431476394788	25883848	38G
Windows x86 web-based installer	Windows		2b670c5c5d1170f2c310f83a571d87f	1324606	38G

Figure 9. Python version files with operating system

Step 3) Click the next to proceed further.

Step 4) Select the option depending on the requirements, as for our requirements we keep everything default.

Step 5) Choose the JetBrains option for the list of option given.

Step 6) Installation is started and we must wait till the installation is completed.

Step 7) After the installation process, there will be a screen showing that PyCharm is installed.

Step 8) Then after clicking the finish button PyCharm IDE is started.

What is Machine Learning

Machine learning is one of the areas of AI (artificial intelligence). Machine learning has the capacity to understand and upgrade from the without directly being programmed by any person. That learns from trained examples and improve accordingly.

Download PyCharm

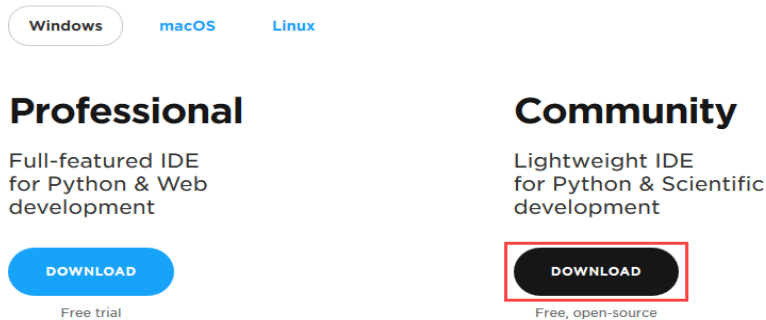


Figure 10. Pycharm_Download_screen

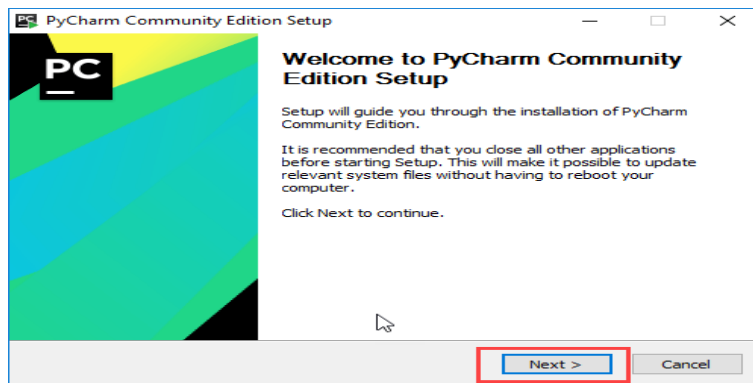


Figure 11. Starting_Pycharm_Installation

Need for Machine Learning

Right now humans are the greatest brilliant and modern people on the globes so that it can view, asses and find solution for difficult situations. Whereas, AI is now in the beginning stage and have not exceed human intellect in many ways. Then why we need to learn the machine learning? The most permissible cause of performing this is to take proper decisions, which is based on data with proper planning.

In the past few days, companies are charging highly in latest technologies such as AI (Artificial Intelligence), ML (Machine Learning) and DL (Deep Learning) to achieve all salient points through data for the execution of various real-life challenges and find solution for the situations. It can be called as data-driven decisions performed through machines, specifically to brutalize the procedure. Those data-driven decisions have been utilized, in place of utilizing programing technique within problems that cannot be performed fundamentally. But we cannot do this without the intelligence of human beings, but the other feature is to find solution for real-life problems along with the organization at greater scale. This is the reason machine learning needs to rise.

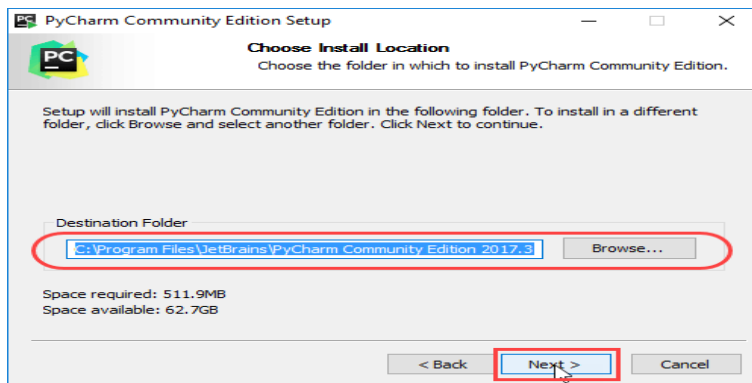


Figure 12. Choosing Location

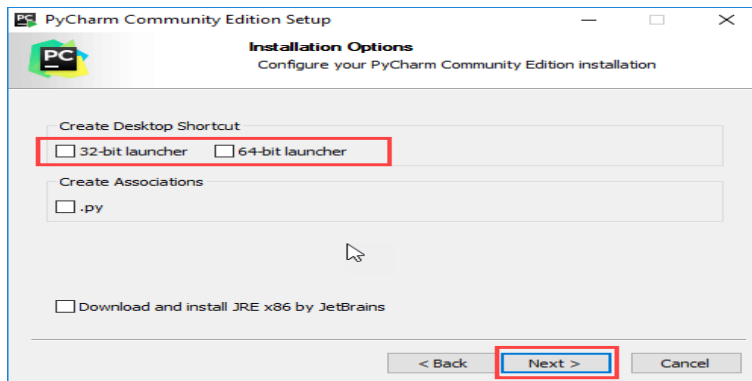


Figure 13. Choosing the bit of operating system

Challenges in Machines Learning

Although machine learning is quickly emerging, creating important steps with cyber security and independent cars, in this section of artificial intelligence completely has even now a lot of things to do. The purpose of this is that ML does not have the ability to perform the n number of challenges. There are various challenges in machine learning. There are also few limitations in understanding machine learning. Following are the challenges,

Quality of data – One of the major challenges of the ML algorithms is having high quality of data to perform tasks. Using the less data quality tends to various difficulties connected to the feature extraction and data preprocessing.

Time-Consuming task – Other challenges which are faced by the machine learning models is the utilization of time mainly for the data accession, characteristic removal and recruitment.

Lack of specialist persons – Right now the machine learning technology is right now in the initial stage and because of that the accessibility of the special resource is a very difficult task.

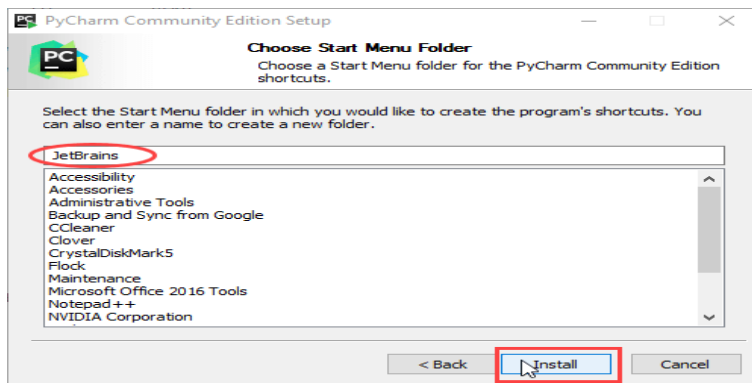


Figure 14. Version_choosing

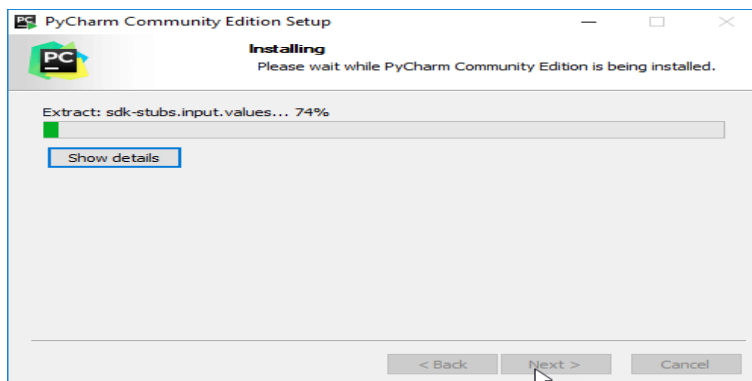


Figure 15. Installation_Process

No clear objective for formulating business problems – The ML technology is not advanced yet and for that reason there is no proper motive for business problems and lack of well objectified goals.

Issue of overfitting & underfitting – This model is either overfitting or underfitting and hence this can never be presented effectively for the difficulty that needs to be solved.

Curse of dimensionality – the curse of dimensionality is one more challenge machine learning model is facing. There are a lot of characteristics of the data points which can cause a lot of difficulties and disturbance.

Difficulty in deployment – Complications of machine learning model leads to various difficulties that is employed in today's world.

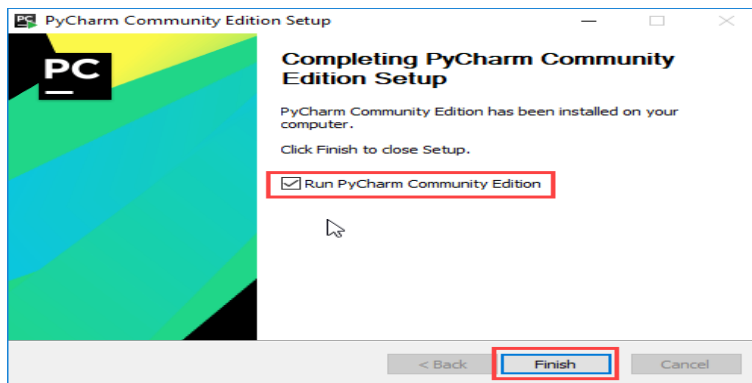


Figure 16. Installation Done

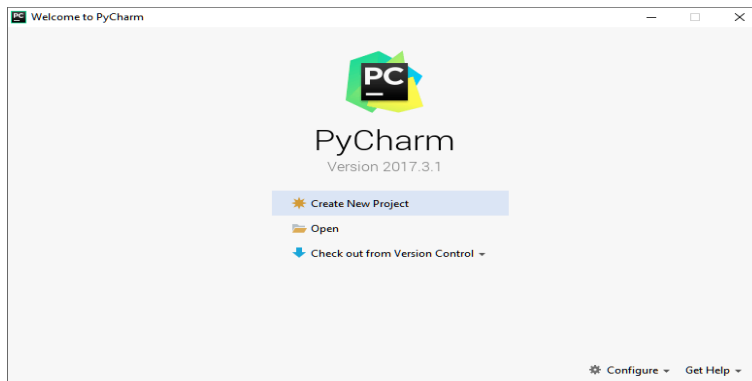


Figure 17. PyCharm IDE started

Applications of Machines Learning

Machine Learning is the most rapidly growing technology and according to researchers we are in the golden year of AI and ML. It is used to solve many real-world complex problems which cannot be solved with traditional approach. Following are some real-world applications of ML.

How to Start Machine Learning?

Arthur Samuel discovered the term “Machine Learning” in 1959 and defined it as a “Field of study that gives computers the capability to learn without being explicitly programmed”.

This was the origination of machine learning. In today’s era, machine learning is right now the best profession choice. As stated by a machine learning engineer it is a great job for people hunting for jobs with best salaries. But still there are a lot of misconceptions that what actually machine learning is and how it is initiated to learn. Therefore this information provides the basics of machine learning and it



Figure 18. Machine Learning



Figure 19. Major challenges faced by machine learning professionals

also provides ways to go through and perform functions to finally become a hardcore machine learning engineer.

How to start learning ML, It is basic map that could be followed to finally become a crazy talented Machine Learning Engineer. If u want, anytime you are free to change the steps according to one's preference in order to reach the expected output.

Step 1 - Understanding the Prerequisites

If you are an expert, you can initiate machine learning easily and generally there are few prerequisites which has to be known that possess Linear Algebra, Multivariate Calculus, Statistics, and Python. If you are not aware of it no need to worry, you do not have to be perfect to learn this, you can just start practicing with only basic understanding of this.

(a) Learn Linear Algebra and Multivariate Calculus

Both Linear Algebra and Multivariate Calculus are prominent in Machine Learning. Although, the degree to which you require them completely depends on your part as a data scientist. If you are so much

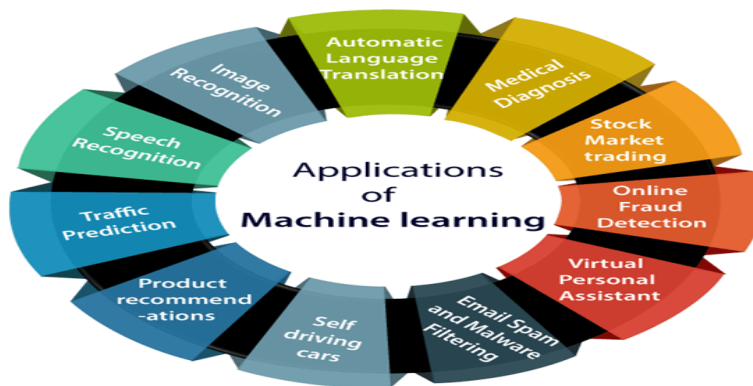


Figure 20. Applications of Machine learning

concentrated on the implementation of heavy machine learning, then there is no need to be completely concentrate on mathematics because there will be various amount of libraries available. But if you are interested in R&D in Machine Learning, then proficiency of Linear Algebra and Multivariate Calculus is very essential because you will be performing a lot of ML algorithms from beginning.

(b) Learn Statistics

Data performs a vital role in Machine Learning. By the way, almost half of your time as an ML expert will be performed In fact, around 80% of your time as an ML expert will be spent gathering and cleaning data. Statistics is an area that operates the collection, examination, and representation of data. Therefore u do not have to learn that. Some basic concepts in statistics that are important are Statistical Significance, Probability Distributions, Hypothesis Testing, Regression, etc. And, Bayesian Thinking is also a very prominent area of ML which trades with the different concepts like Conditional Probability, Priors, and Posteriors, Maximum Likelihood, etc.

(c) Learn Python

Few people tend to not practice Linear Algebra, Multivariate Calculus and Statistics and do not try to learn them as they come with various tests and errors. But Python is a part that one can clearly not skip. There are also other languages that can be applied for Machine Learning such a R, Scala, etc. Right now Python is one of the most famous languages for ML. Also, there are a lot of Python libraries that are particularly beneficial for Artificial Intelligence and Machine Learning such as Keras, TensorFlow, Scikit-learn, etc. So to learn ML completely, you need to learn python first for better understanding. One can do it by the help of different online resources available.

Step 2 – Learn Various ML Concepts

As we have performed all the prerequisites, it is the time to finally start learning ML. It will be great to initiate learning with the basics first and then slowly you can step forward to learn the difficult and complicated part. Some basic concepts of ML are:

(a) Terminologies of Machine Learning

- **Model** – It is particularly a representation which is obtained through data from the application of various machine learning algorithm. Model is also known as hypothesis.

- **Feature** - Feature is an independent assessable attribute of the data. Set of numerical characteristics could be efficiently explained by a feature vector. The feature vectors are lead to input for model. For instance, if vegetables have to be predicted, there can be many features such as smell, colour, taste, etc.
- **Target** – The target label is the amount that is defined by the model. As an example of a vegetable that was mentioned during feature section, label with every set of the input must be the name of the vegetable like cabbage, potato, cauliflower, etc.
- **Training** – The motive here is to provide all the features also the desired results, so that when the training is over, there will be a hypothesis which is expected to create latest data to any of the classifications that was performed.
- **Prediction** – If a model is prepared to perform, it can lead to different sets of input in correspondence it will prepare expected results.

(b) Types of Machine Learning

- **Supervised Learning** – Supervised machine learning learned through the experience to get data which is used for predicting future events. This method studies the training dataset to make prediction about the future results. After sufficient amount of training system produces accurate results for new data.
- **Unsupervised Learning** – Unsupervised machine learning algorithm is not trained on labelled or classified data. Unsupervised machine learning teaches the system on unlabelled data. This kind of system cannot figure out the correct output. It describes hidden structures by drawing conclusion from dataset using unlabelled data.
- **Semi-supervised Learning** – The semi-supervised machine learning occurs among supervised and unsupervised learning algorithm. It uses small amount of labelled and big amount of unlabelled data for training. It improves learning accuracy if they use this method considerable.
- **Reinforcement Learning** – Reinforcement machine learning interacts with the environment. It contains actions, rewards or error. Reinforcement learning works on trial-and-error search and rewards. These methods makes machine and software to maximize its performance by choosing certain conditions.

Machine Learning Methods

Machine learning algorithms is mainly classified into three types supervised, unsupervised or reinforcement learning. Each algorithm is having its own ability to learn from past data to explore into new data.

Supervised machine learning learned from the experience to get data which is used for predicting future events. This method studies the training dataset to make prediction about the future results. After sufficient amount of training system produces accurate results for new data. This algorithm compares its results against the required output to find errors. And to improve the model accordingly.

Unsupervised machine learning algorithm is not trained on labelled or classified data. Unsupervised machine learning teaches the system on unlabelled data. This kind of system cannot figure out the correct output. It describes hidden structures by drawing conclusion from dataset using unlabelled data.

Semi-supervised machine learning occurs in between supervised and unsupervised learning algorithm. It uses both small amount of labelled and big amount of unlabelled data for training. It improves learning accuracy if they use this method considerably.

Reinforcement machine learning interacts with the environment. It contains actions, rewards or error. Reinforcement learning works on trial-and-error search and rewards. This methods makes machine and software to maximize its performance by choosing certain conditions.

MACHINE LEARNING						
Supervised Learning		Unsupervised Learning		Deep Learning (semi-supervised)		
Regressors	Classifiers	Dimension Reducers	Clustering Methods	Unsupervised Pretrained Networks	Convolutional Neural Networks	Recurrent Neural Networks
Wireline log prediction Spatial interpolation Seismic inversion (with numeric labels)	Automatic facies prediction from wireline logs Seismic inversion (with categorical labels)	Compressing high-dimensional data Increasing signal-to-noise ratio in data	AVO class prediction Seismic inversion (uncalibrated)	Seismic denoising Seismic multiple removal Seismic migration	Seismic structural feature/fault detection Automatic facies prediction from borehole imagery	Microseismic analysis Sedimentary process modelling Earthquake prediction

Figure 21. Machine Learning methods

Screenshots

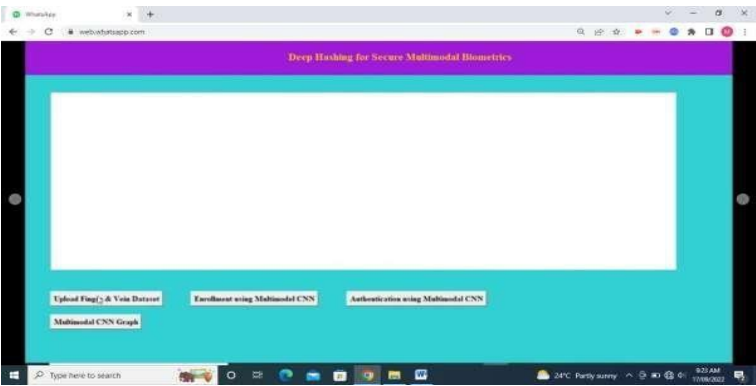


Figure 22. Deep Hashing for Secure Multimodal Biometrics interface

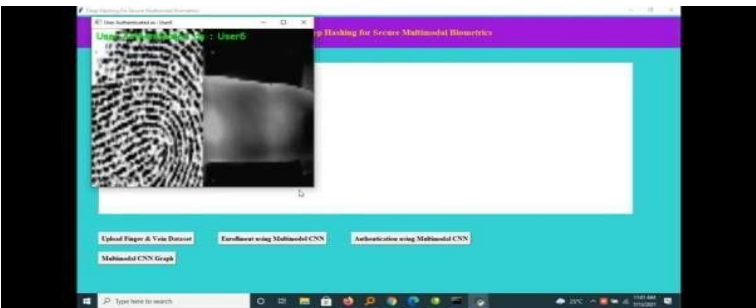


Figure 23. Uploaded fingerprint image

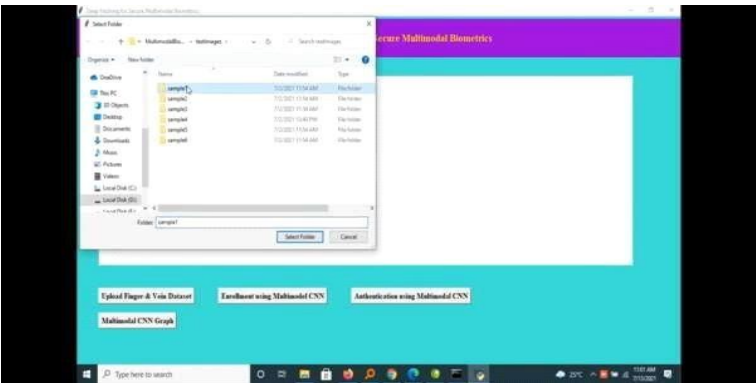


Figure 24. Multimodal biometric dataset loaded



Figure 25. Feature extraction process completed

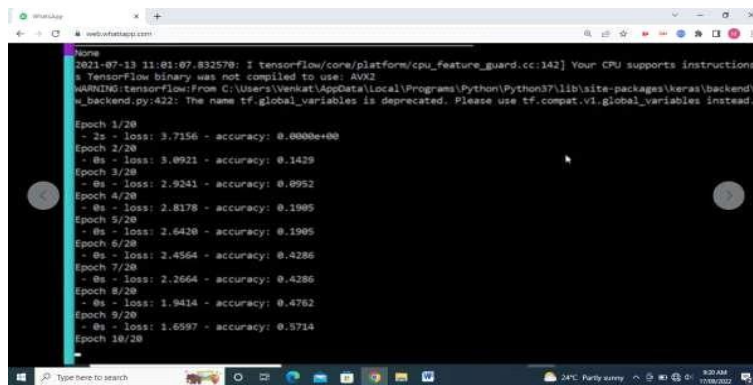


Figure 26. VGG training with accuracy result

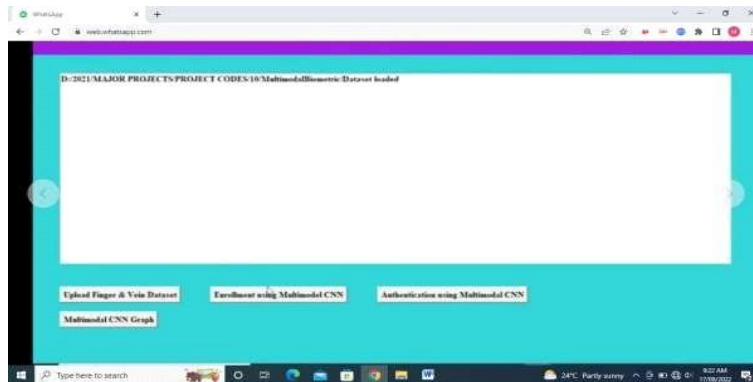


Figure 27. Training epochs and accuracy log

Conclusion

During the execution of this project, we have observed a lot of difficulties and problems with the functioning of contact based biometry system and developed a lot of opportunities of the contactless fingerprint recognition system. With this we have also created an excellent quality image processing and also characteristic extraction algorithms. Also the deep learning models could be utilized to increase the matching precision to the next level. Due to the development in the sensing technology and computation power, the contactless fingerprint model has a great amount of opportunity in the market. The outputs shows that the contactless fingerprint recognition systems have the ability to attain the matching precision, that other structures declare in the market. For the future part, we will be looking forward to execute our already developed model using a micro controller and GPU for quicker execution and then we will insert it on PCB (Printed Circuit Board). We will also use the image sensor and image capturing environment along with that. So, this is how the contactless fingerprint recognition model will have the ability of the standalone embedded device.

References

- [1] A. A. Moenssens, *Fingerprint Techniques*, 1st ed. Chilton Book Company, Philadelphia, 1971.
- [2] D. Maltoni, D. Maio, A. Jain, and S. Prabhakar, *Handbook of fingerprint recognition*, 2nd ed. Springer Science & Business Media, 2009.
- [3] A. Jain, L. Hong, and R. Bolle, "On-line fingerprint verification," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 19, no. 4, pp. 302–314, Apr. 1997.
- [4] V. Piuri and F. Scotti, "Fingerprint biometrics via low-cost sensors and webcams," in *2008 IEEE Second International Conference on Biometrics: Theory, Applications and Systems*, Sep. 2008, pp. 1–6.
- [5] R. D. Labati, A. Genovese, V. Piuri, and F. Scotti, "Contactless fingerprint recognition: A neural approach for perspective and rotation effects reduction," in *2013 IEEE Symposium on Computational Intelligence in Biometrics and Identity Management (CIBIM)*, April 2013, pp. 22–30.
- [6] B. Y. Hiew, A. B. J. Teoh, and D. C. L. Ngo, "Automatic digital camera based fingerprint image preprocessing," in *International Conference on Computer Graphics, Imaging and Visualisation (CGIV'06)*, July 2006, pp. 182–189.
- [7] B. Y. Hiew, A. B. J. Teoh, and Y. H. Pang, "Digital camera based fingerprint recognition," in *2007 IEEE International Conference on Telecommunications and Malaysia International Conference on Communications*, May 2007, pp. 676–681.
- [8] B. Hiew, A. B. Teoh, and D. C. Ngo, "Preprocessing of fingerprint images captured with a digital camera," in *2006 9th International Conference on Control, Automation, Robotics and Vision*, Dec 2006, pp. 1–6.
- [9] C. Lin and A. Kumar, "A cnn-based framework for comparison of contactless to contact-based fingerprints," *IEEE Transactions on Information Forensics and Security*, vol. 14, no. 3, pp. 662–676, March 2019.
- [10] G. K. O. Michael, T. Connie, and A. B. J. Teoh, "A contactless biometric system using multiple hand features," *Journal of Visual Communication and Image Representation*, vol. 23, no. 7, pp. 1068–1084, Oct. 2012.
- [11] A. Kumar, "Toward pose invariant and completely contactless finger knuckle recognition," *IEEE Transactions on Biometrics, Behavior, and Identity Science*, vol. 1, no. 3, pp. 201–209, July 2019.
- [12] F. Zhang, S. Xin, and J. Feng, "Combining global and minutia deep features for partial high-resolution fingerprint matching," *Pattern Recognition Letters*, vol. 119, pp. 139–147, 2019, deep Learning for Pattern Recognition. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S0167>.
- [13] E. Davies, *Computer and Machine Vision: Theory, Algorithms and Practicalities*, 4th ed. Academic Press, 2012.

- [14] C. I. Watson, M. D. Garriss, E. Tabassi, C. L. Wilson, R. M. McCabe, S. Janet, and K. Ko, "User's guide to NIST biometric image software (NBIS)," 2007.
- [15] T. Guo, J. Dong, H. Li, and Y. Gao, "Simple convolutional neural network on image classification," in 2017 IEEE 2nd International Conference on Big Data Analysis (ICBDA), March 2017, pp. 721–724.
- [16] N. Jmour, S. Zayen, and A. Abdelkrim, "Convolutional neural networks for image classification," in 2018 International Conference on Advanced Systems and Electric Technologies (IC_ASET), 2018, pp. 397–402.
- [17] Sharma, V. Jain, and A. Mishra, "An analysis of convolutional neural networks for image classification," *Procedia Computer Science*, vol. 132, pp. 377–384, 2018, International Conference on Computational Intelligence and Data Science. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S1877050918309335>.