

Automation of Animal Classification using Deep Learning

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Abstract - A real-world animal biometric system which detects and describes animal life in image and video is an emerging subject in machine vision. These systems provide computer vision approaches for the classification of animals. A novel method for animal face classification based on one of the popular convolutional neural network (CNN) features. We are using CNN in this project which can automatically extract features, learn and classify them. The proposed method can also be used in other areas of image classification and object recognition. The experimental results show that automatic feature extraction in CNN is better compared to other simple feature extraction techniques (both local- and appearance-based features). It shows that the proposed technique have a positive effect on classification accuracy.

Key Words: Animal classes, CNN, Decision making.

1. INTRODUCTION

Animal recognition and classification is an important area which has not been discussed rapidly. Animal classification which relies on the problem of distinguishing images of different animal species is an easy task for humans, but evidence suggests that even in simple cases like cats and dogs, it is difficult to distinguish them automatically. Animals have flexible structure that could self-mask and usually they appear in complex scene. Also, as all objects, they may appear under different illumination conditions, viewpoints and scales. There are attempts to apply recognition methods on images of animals but the specific problem of animal categorization has recently attracted limited interest. Many existing methods showing promising results for human face recognition cannot properly represent the diversity of animal classes with complex intraclass variability and interclass similarity. There are several kinds of approaches for solving this problem with each one having its advantages and disadvantages. The first approach constructs complex features which represents and discriminates sample images better but creating such a feature is complicated and it is problem dependent. The second approach combines the extracted features from different methods and concatenates them to build a more powerful feature vector. Increasing the size of feature space causes increased problem computation cost. Instead of using complex representation, the information is consolidated from different classifiers and a decision is made according to it. This method is known as score-level fusion. Observing wild animals in their natural environments is an important task in ecology. The fast growth of human population and the

endless pursuit of economic development are making over exploitation of natural resources, causing rapid and novel and substantial changes to Earth's ecosystems. An increasing area of land surface has been transformed by human action, altering wildlife population, habitat and behavior. More seriously, many wild species on Earth have been driven to extinction and many species are introduced into new areas where they can disturb both natural and human systems. Monitoring wild animals, therefore, is essential as it provides researchers evidences to help make conservation and management decisions to maintain diverse, balanced and sustainable ecosystems in the face of those changes, Various modern technologies have been developed for wild animal monitoring, including radio tracking, wireless sensor network tracking, satellite and global positioning system (GPS) tracking, and monitoring by motion sensitive camera traps. Motion-triggered remote cameras or "camera traps" are an increasingly popular tool for wildlife monitoring, due to their novel features equipped, wider commercial availability, and the ease of deployment and operation. For instance, a typical covert camera model is capable of not only capturing high definition images in both day and night, but also collecting information of time, temperature and moon phase integrated in image data. In addition, flexible camera settings allow tracking animals secretly and continuously.

Once being fully charged, a camera can snap thousands of consecutive images, providing a large volume of data. These specifications make camera traps a powerful tool for ecologists as they can document every aspect of wildlife. Visual data, if can be captured is a rich source of information that provide scientists evidences to answer ecology related scientific questions such as: what are the spatial distributions of rare animals, which species are being threatened and need protection such as bandicoot, which cohort of pest species such as fox and rabbit, need to be controlled; they are examples of key questions to understand animal population, ecological relationships and population dynamics. To this end, a recently widely used approach by ecologists is to set up several camera traps in the wild to collect image data of wild animals in their natural habitat. The overwhelming amounts of data from camera traps highlight the need for image processing automation. From data analysis and machine learning point of views, there are some immediate techniques to make wildlife identification automated classifier with manual object bounding on hand-crafted features, convolutional neural network (CNN) model with automatic object detection, or fine-tuning CNN models inheriting model weights pretrained on a very large scale

dataset such as the ImageNet. These approaches addressed the problem of automating wildlife and demonstrated promisingly empirical results. However, two primary challenges which holds back the feasibility of an automated wildlife monitoring application in practice, are still remaining. The first obstacle is that, to obtain applicable image classification accuracy, an enormous amount of manual preprocessing is still required to input images for detecting and bounding animal objects. The second limitation is poor performance obtained by wildlife monitoring system, in spite of complete automation it requires much more improvements for practical application. The concepts that inspired us to choose this research are:

In [3], The authors described that biometric ear recognition has recently gained a considerable degree of attention, it remains difficult to use currently available ear databases because most of them are constrained. Here, we introduce a novel architecture called ScoreNet for unconstrained ear recognition. The ScoreNet architecture combines a modality pool with a fusion learning approach based on deep cascade score-level fusion (DCSLF). Hand-crafted and deep learning methods can be used together under the ScoreNet architecture. The proposed method represents the first automated fusion learning (AutoFL) approach and is also compatible with parallel processing. We evaluated ScoreNet using the Unconstrained Ear Recognition Challenge Database (UERC), which is widely considered to be the most difficult database for evaluating ear recognition developed to date, and found that ScoreNet outperformed all other previously reported methods and achieved state-of-the-art accuracy.

In [8], this paper presents a method to do a fast score-level fusion between multibiometric data. The method uses optimization and training to generate the total score of multibiometric system. This score will depend on as many constants as the multibiometric type of data. These constants will be estimated solving an optimization problem built in such a way that the resulting linear combination between these constants and the scores makes it possible to discriminate between genuine and impostor.

In [1], Paper describes the information of multiple biometric modalities are fused at a single level, for example, score level or feature level. The recognition accuracy of a multimodal biometric system may not be improved by carrying fusion at a single level, since one matcher may provide a performance lower than that provided by other matchers. In view of this, we propose a new fusion scheme, referred to as the matcher performance-based (MPb) fusion scheme, in which the fusion is carried out at two levels, feature level and score level, to improve the overall recognition accuracy. We first consider the performance of the individual matchers in order to find out which of the modalities should be used for fusion at the feature level. Then, the selected modalities are fused at this level by utilizing their encoded features. Next, we fuse the score

obtained from the feature-level fusion with that of the modality for which the performance is the highest. In order to carry out this fusion, a new normalization technique, referred to as the overlap extrema-variation-based anchored min-max (OEVBAMM) normalization technique, is also proposed. By considering three modalities, namely fingerprint, palmprint and earprint, the performance of the proposed fusion scheme as well as that of the single level fusion scheme, both with various normalization and weighting techniques are evaluated in terms of a number of metrics. It is shown that the multi-biometric system based on the proposed fusion scheme provides the best performance when it employs the new normalization technique and the confidence-based weighting (CBW) method.

In [9], Attribute-Based Signatures (ABS), a versatile primitive that allows a party to sign a message with fine-grained control over identifying information. In ABS, a signer, who possesses a set of attributes from the authority, can sign a message with a predicate that is satisfied by his attributes. The signature reveals no more than the fact that a single user with some set of attributes satisfying the predicate has attested to the message. In particular, the signature hides the attributes used to satisfy the predicate and any identifying information about the signer (that could link multiple signatures as being from the same signer). Furthermore, users cannot collude to pool their attributes together. We give a general framework for constructing ABS schemes, then show several practical instantiations based on groups with bilinear pairing operations, under standard assumptions. We describe several practical problems that motivated this work, and how ABS can be used to solve them.

In [10], Attribute-based signature (ABS) enables users to sign messages over attributes without revealing any information other than the fact that they have attested to the messages. However, heavy computational cost is required during signing in existing work of ABS, which grows linearly with the size of the predicate formula. As a result, this presents a significant challenge for resource-constrained devices (such as mobile devices or RFID tags) to perform such heavy computations independently. Aiming at tackling the challenge above, we first propose and formalize a new paradigm called Outsourced ABS, i.e., OABS, in which the computational overhead at user side is greatly reduced through outsourcing intensive computations to an untrusted signing-cloud service provider (S-CSP). Furthermore, we apply this novel paradigm to existing ABS schemes to reduce the complexity. As a result, we present two concrete OABS schemes: i) in the first OABS scheme, the number of exponentiations involving in signing is reduced from $O(d)$ to $O(1)$ (nearly three), where d is the upper bound of threshold value defined in the predicate; ii) our second scheme is built on Herranz et al.'s construction with constant-size signatures. The number of exponentiations in signing is reduced from $O(d^2)$ to $O(d)$ and the communication

overhead is $O(1)$. Security analysis demonstrates that both OABS schemes are secure in terms of the unforgeability and attribute-signer privacy definitions specified in the proposed security model. Finally, to allow for high efficiency and flexibility, we discuss extensions of OABS and show how to achieve accountability as well.

In [11], paper describes that e-Healthcare promises to be the next big wave in healthcare. It offers all the advantages and benefits imaginable by both the patient and the user. However, current e-Healthcare systems are not yet fully developed and mature, and thus lack the degree of confidentiality, integrity, privacy and user trust necessary to be widely implemented. Two primary aspects of any operational healthcare enterprise are the quality of healthcare services and patient trust over the healthcare enterprise. Trust is intertwined with issues like confidentiality, integrity, accountability, authenticity, identity and data management, to name a few. Privacy remains one of the biggest obstacles to ensuring the success of e-Healthcare solutions in winning patient trust as it indirectly covers most security concerns. Addressing privacy concerns requires addressing security issues like access control, authentication, non-repudiation, and accountability, without which end to end privacy cannot be ensured. Achieving privacy from the point of data collection in wireless sensor networks (WSN), to incorporating the internet of things (IoT), to communication links, to data storage and access, is a huge undertaking and requires extensive work. Privacy requirements are further compounded by the fact that the data handled in an enterprise is of an extremely personal and private nature, and its mismanagement, either intentionally or unintentionally, could seriously hurt both the patient and the future prospects of an e-Healthcare enterprise. Research carried out in order to address privacy concerns is not homogenous in nature. It focuses on the failure of certain parts of the e-Healthcare enterprise to fully address all aspects of privacy. In the middle of this ongoing research and implementation, a gradual shift has occurred, moving e-Healthcare enterprise controls away from an organizational level towards the level of patients. This is intended to give patients more control and authority over decision making regarding their PHI/EHR. A lot of work and effort is necessary in order to better assess the feasibility of this major shift in e-Healthcare enterprises. Existing research can be naturally divided on the basis of techniques used. These include data anonymization/ pseudonymization and access control mechanisms primarily for stored data privacy. This, however, results in giving a back seat to certain privacy requirements (accountability, integrity, non-repudiation, identity management). This paper reviews research carried out in this regard and explores whether this research offers any possible solutions to either patient privacy requirements for e-Healthcare or possibilities for addressing the (technical as well as psychological) privacy concerns of the users.

In [12], paper describes that Social Media Health Networks provide a promising paradigm to attract patients to share and communicate their personal health status with other online patients, and consult healthcare services from online caregivers with social networks. Social Media Health Networks transform healthcare services from time-consuming offline hospital-centered paradigm to the convenient and efficient online paradigm through Internet, which can expand the traditional healthcare services and shorten the information gap between patients and caregivers. However, how to build the trust between patients and caregivers raises a challenging issue due to the openness of the social networks; meanwhile, the personal privacy may be disclosed when sharing personal health information with other patients and caregivers. In this paper, we propose a personalized and trusted healthcare service approach to enable trusted and privacy-preserving healthcare services in social media health networks, which can improve the trustiness between patients and caregivers through authentic ratings toward caregivers and guarantee the patients' privacy. Specifically, we employ the collaborative filtering model to seek appropriate personalized caregivers, bloom filter to extract and map the personal healthcare symptoms, and inner product to compute the similarity between patients for finding patients with similar health symptoms in a privacy-preserving way. Meanwhile, to guarantee authentic ratings and reviews toward caregivers, we develop a sybil attack detection scheme to find patients' fake ratings and reviews using different pseudonyms. Security analysis shows that our proposed approach can preserve the privacy of patients and prevent sybil attacks. Performance evaluation demonstrates that our approach can achieve prominent performance improvement, in terms of personalized caregivers finding and sybil attack resistance.

In [13], paper describes that, Based on the wireless sensor networks many applications are developed where more usage at military, medical fields. All this leads to exposure of the network against various threats from the outside. The network security from external attacks considered as one of the most important studies of today. This study examined the effects of security limits the wireless network WSN, typical attacks of certain species, and provided security over the years for a wide range of emotions to detect attacks and to protect wireless network.

2. METHOD SPECIFICATION

A system architecture diagram is used to show the relationship between different components. Usually they are created for systems which include both hardware and software and these are represented using diagram to show the interaction between them. A novel method is proposed for animal face classification based on one of the popular convolutional neural network (CNN) features. We are using CNN, a method which can automatically extract features, learn and classify them. CNNs relatively does little pre-

processing compared to other image classification algorithms. This means that the network learns the filters which were hand-engineered in previous traditional algorithms. This independence from prior knowledge and human effort in feature design is a major advantage in image classification.

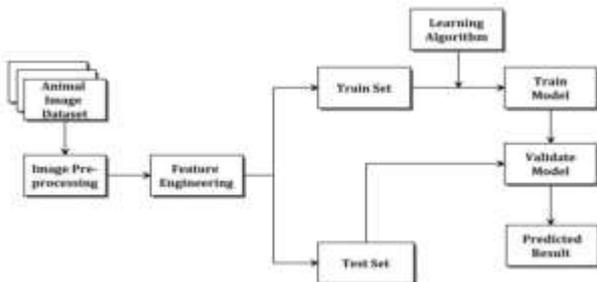


Fig -2.1: Model Architecture
Source: adilmoujahid.com

As shown in the above Fig 2.1, the following figure demonstrates the architecture of this model.

3. CONCEPT DETAILS

This model is built by using Convolutional neural network. Convolutional neural networks (CNN) are a special architecture of artificial neural networks, proposed by Yann LeCun in 1988. CNN uses some of the features of the visual cortex. Now that the pre-processing is done, neural network can be implemented. It will produce 3 convolution layers with 2 x 2 max-pooling. Artificial neural networks are one of the main tools used in machine learning. As the name suggests, they are brain-inspired systems which are intended to replicate the way that we humans learn. Neural networks consist of input and output layers and a hidden layer consisting of units that transform the input into something that the output layer can use in most cases. They are excellent tools for finding patterns which are far too complex for a human programmer to extract and teach the machine to recognize. While neural networks have been around since the 1940s, it is only in the last several decades where they have become a major part of artificial intelligence. This is due to the arrival of a technique called "back propagation," which allows networks to adjust their hidden layers of neurons in situations where the output does not match from what the creator is expecting — like a network designed to recognize dogs, which misidentifies a cat, for example.

In [2] the authors Tilo Burghardt, Janko Calic presented an algorithm for detecting and tracking animal faces from the videos which use Haar-features and adaboost classifiers, this was tested on lion faces.

In [4], authors Alexander Loos and Andrea Ernst presented and evaluated a unified image-based automated

face identification of captive and free living chimpanzees in uncontrolled free environments.

Another important advance has been the arrival of neural networks in deep learning, in which different layers of a multilayer network extract different features until it can recognize what it's expecting. Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze. It can then be used to provide projections given new situations of interest and answer "what if" questions.

- **Adaptive learning:** An ability to learn how to do tasks based on the data given for training or basic experience.
- **Real Time Operation:** ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured and has a lot of demand, which take advantage of this capability of this feature.
- **Fault Tolerance via Redundant Information Coding:** Partial destruction of a network leads to the decline in performance. Some network capabilities may be retained even with major network damage. The fig: 3.1 shows the basic structure of Neural Networks. Max-pooling is a technique used to reduce the dimensions of an image by taking the maximum pixel value of a grid. This also helps reduce over fitting and makes the model more generic. Next, 2 fully connected layers is added. Since the input of fully connected layers should be two dimensional and the output of convolution layer should be four dimensional.

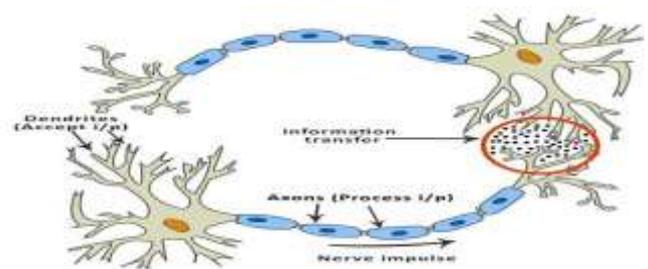


Fig -3.1: Basic Structure of neural networks

Source: medium.com

So, a flattening layer is needed between them. At the very end of the fully connected layers is a layer called softmax layer.

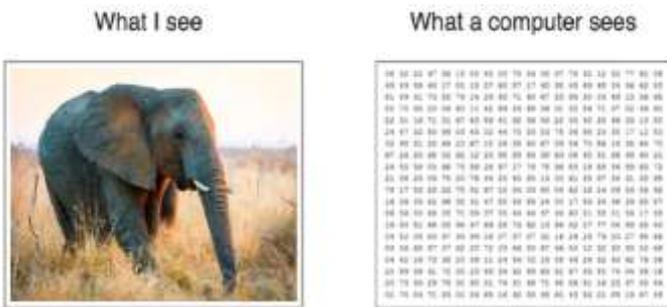


Fig -3.2: What a Computer Sees

Source: medium.com

Instead of an image, the computer sees an array of pixels. For example, if image size is 300x300, In this case, the size of the array would be 300x300x3. Where 300 is width, next 300 is height and 3 is RGB values. The computer is assigned a value from 0 to 255 to each of these numbers. This value describes the intensity of the pixel at each point. To solve this problem, the computer looks for the characteristics of the base level. In human understanding such characteristics are seen as, for example the trunk or large ears. For the computer, these characteristics are seen as, boundaries or curvatures. And then through the groups of convolutional layers, computer constructs more abstract concepts. In the above fig 3.2, the two images show us what a human eye and computer see when they are presented with an image. the image is passed through a series of convolutional, nonlinear, pooling and fully connected layers, and then the output is generated.

In [6], authors Bhalke D.G and Archana P have worked on multimodal biometrics which produces enhanced accuracy and least error rates like FAR and FRR. Based on the present situation regarding the quality of security and accuracy of biometrics, this can become a revolution in e-commerce industry which suffers a lot of security vulnerability these days in warehouse and as well as in the logistics department.

The Convolution layer is always the first. The image (matrix with pixel values) is entered into it. Imagine that the reading of the input matrix begins at the top left of image. Then the software selects a smaller matrix there, which is called a filter (or neuron, or core). And then the filter produces convolution, i.e. moves along the input image. The filter's work is to multiply its values by the original pixel values. All these multiplications are summed up. One number is obtained in the end. Since the filter has read the image only in the upper left corner, it moves further and further to the right by 1 unit performing a similar operation. After passing the filter across all positions, a matrix is obtained, but smaller than an input matrix.

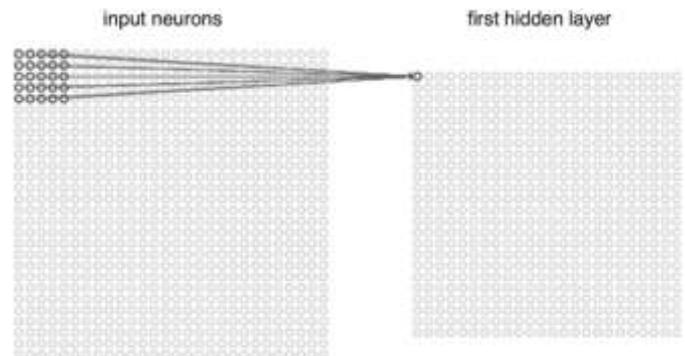


Fig -3.3 : Input neurons and hidden layer

Source: medium.com

This operation, from a human perspective, is analogous to identifying boundaries and simple colors on the image. But in order to recognize the properties of a higher level factor such as the trunk or large ears the whole network is needed. The network will consist of several convolutional networks mixed with nonlinear layers and pooling layers. When the image passes through one convolution layer, the output of the first layer becomes the input for the second layer. And this happens with every convolutional layer coming in order. The nonlinear layer is added after each convolution operation. It has an activation function, which brings nonlinear property. Without this property a network will not be sufficiently intense and will not be able to model the response variable.

The pooling layer follows the nonlinear layer. It works with width and height of the image and performs a down sampling operation on them. As a result the image volume is reduced. This means that if some features (as for example boundaries) have already been identified in the previous convolution operation, than a detailed image is no longer needed for further processing, and it is compressed to as less detailed pictures.

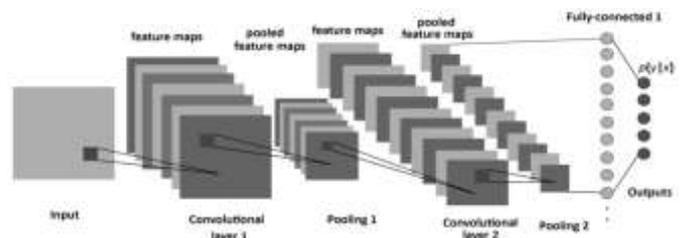


Fig -3.4: CNN in detail

Source: medium.com

After completion of series of convolutional layers, nonlinear layers and pooling layers, it is necessary to attach a fully connected layer. This layer takes the output from convolutional networks. Attaching a fully connected layer to the end of the network results in an N dimensional vector,

where N is the amount of classes from which the model selects the desired class. The above fig: 3.3 and Fig 3.4 describes various layers in CNN and its operations.

In [5], authors Dalila Cherifi, Fateh, Yacini and Nait-Ali have experimented on increasing the accuracy of the face recognition. This work is done on analysis and performance based on global methods like PCA, FLD and local methods like SIFT and LBP.

In [7], authors Zan Gao, Hai Zhen Xuan and Hua Zhang have worked on human face recognition using several angles of facial images. Their paper proves that having the images from several facial angles and using those images for identification, recognition and even in feature extraction produces more accuracy compared to using image consisting of just one angle.

4. DATA FLOW DIAGRAM

Data flow diagram (DFD) is a graphical representation of the flow of data through an information system, modeling its process aspects describes the first stage process of this project. An animal dataset is passed as an input and the system will perform the preprocess and extract the important features. Fig 4.1 describes first level of overall process.

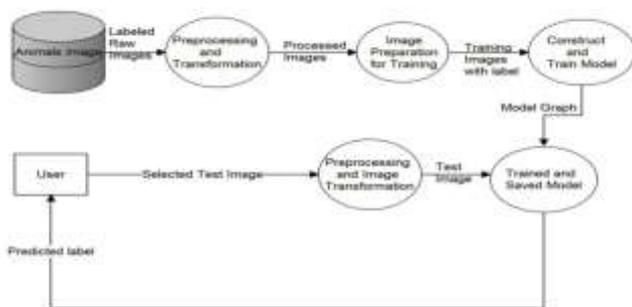


Fig -4.1: Overall Process

Source: mdpi.com

The dataset is passed and the system will do preprocessing and extract features and transforms them into content readable by the system. A training model is then constructed by using the training images with labels. A model graph is plotted and the model is saved by the system. Now for verification, the user evaluates the trained model with the test model to check the percentage of accuracy. This can be repeated with minor changes as per the requirements until the expected accuracy is achieved.

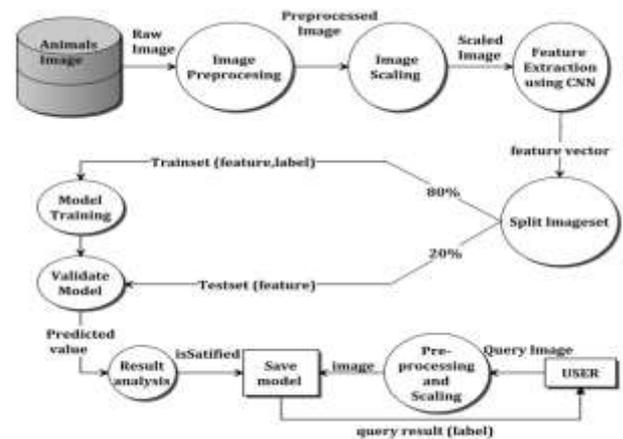


Fig: 4.2 - Stepwise Process

Source: mdpi.com

The above fig 4.2 describes the final stage of the process. Extracted features from level 1 are being passed and trained data as an input the system will classify the given animal is matched or not using CNN model. Fig 4.2 describes the internal working of model.

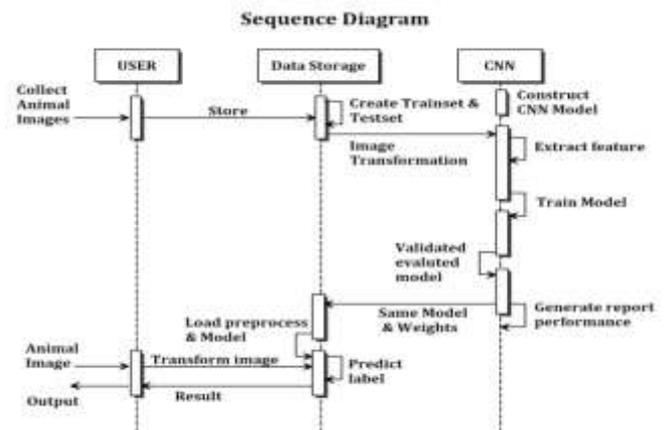


Fig -4.3: Sequence Diagram

Source: medium.com

The fig 4.3 describes the sequence diagram of the process. A sequence diagram simply represents interaction between objects in a sequential order, which is the order in which these interactions take place. The terms, event diagrams or event scenarios can be used for referring a sequence diagram. Sequence diagrams describe how and what order the objects in a system function.

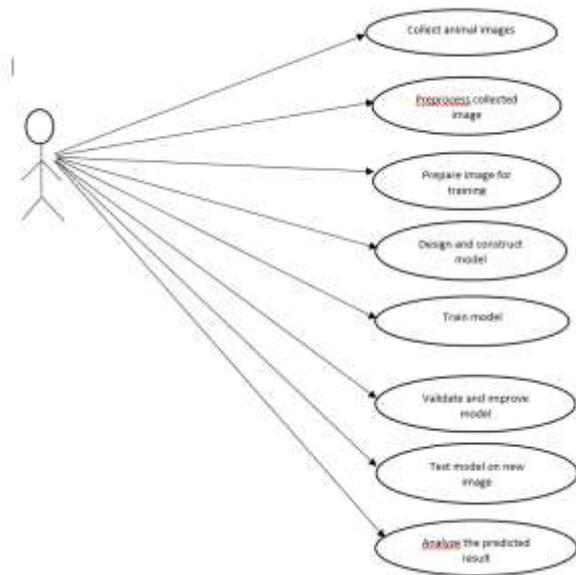


Fig -4.4: Use Case Diagram

Source: medium.com

The fig 4.4 illustrate the use-case diagram of the process. It will cover the details explanation of methodology that is being used to make this project complete and working well. Many findings from this field mainly generated into journal for others to take advantages and improve as upcoming studies. The method is used to achieve the objective of the project that will accomplish a perfect result. The below fig 4.5, is the SDLC life cycle of the process. In order to evaluate this project, the methodology based on System Development Life Cycle (SDLC), generally three major steps as shown in the below fig 4.6, which is planning, implementing and analysis.

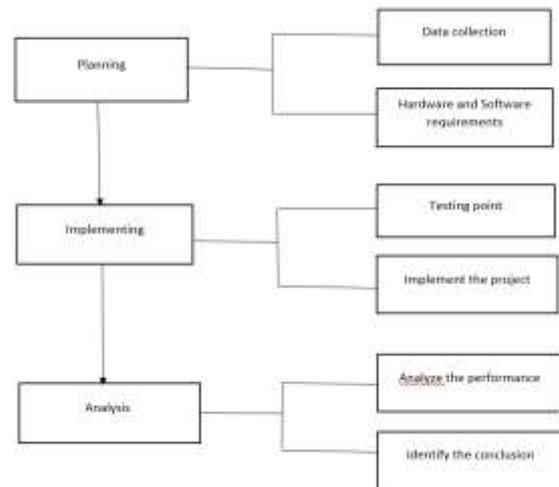


Fig -4.6 : Major Steps Followed

Source: medium.com

Machine learning needs two things to work: data and models. When acquiring the data, It must be made sure that there are enough features (aspect of data that can help for a prediction, like the surface of the house to predict its price) populated to train learning model correctly. In general, the more the data, the more the ability of making enough rows.

The primary data collected from the online sources remains in the raw form of statements, digits and qualitative terms. The raw data contains error, omissions and inconsistencies. It requires corrections after careful scrutinizing the completed questionnaires. The following steps are involved in processing the primary data. A huge volume of raw data is collected through field survey needs to be grouped for similar details of individual responses.

Data Preprocessing is a technique that is used to convert raw data into a clean data set. In other words, whenever the data is gathered from different sources it is congregated in a raw format which is not convenient for the analysis. Therefore, certain steps are executed to convert the data into a small and clean data set. This technique is performed before the execution of Iterative Analysis. These set of steps is known as Data Preprocessing. It includes -

- Data Cleaning
- Data Integration
- Data Transformation
- Data Reduction

Data Preprocessing is necessary because of the presence of unformatted real-world data. Mostly real-world data is composed of -

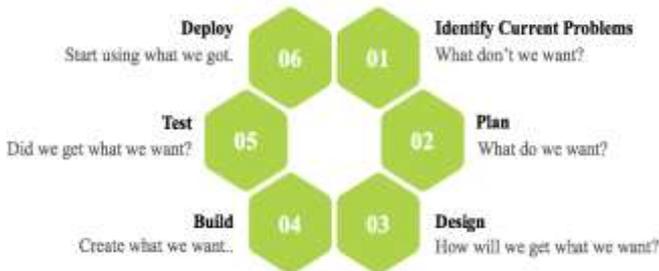


Fig -4.5: System Development Life Cycle

Source: workshop.readthedocs.io

- **Inaccurate data (missing data)** - There are many reasons for missing data such as data is not continuously collected, a mistake in data entry, technical problems with biometrics and much more.
- **The presence of noisy data (erroneous data and outliers)** - The reasons for the existence of noisy data could be a technological problem of gadget that gathers data, a human mistake during data entry and much more.

5. EXPERIMENTS AND RESULT

In this work, a business intelligent model has been developed, to classify different animals, based on a specific business structure deal with Animal classification using a suitable deep learning technique. This model was evaluated by a scientific approach to measure accuracy. Convolutional Neural Network (CNN) is used to build the model. Several experiments have been carried out in order to show the performance of the proposed method and the other state-of-the-art methods. In the following subsections, the dataset description and experimental setup and results are presented.

5.1 Dataset

The CIFAR-10 dataset is used in this project. It is an online google dataset which is readily available. CIFAR-10 dataset consists of 32X32 color images with 10 classes. Each class consists of 6000 images. The dataset consists of even few low resolution images in it, which helps in making this experiment more efficient in classifying low resolution images and other images with lesser lighting and low quality as well.

5.2 Results

In all of the following experiments, the CIFAR-10 dataset is taken into a training set and test set is taken as a collection of images of the random animals with 32X32size resolution.

5.3 Model construction

The model is built by using Convolutional neural network. Convolutional neural networks (CNN) are a special architecture of artificial neural networks, proposed by Yann LeCun in 1988. CNN uses some features of the visual cortex. Now that the pre-processing phase is done, neural network can be implemented now. It is going to have 3 convolution layers with 2 x 2 max-pooling. Max-pooling is a technique used to reduce the dimensions of an image by taking the maximum pixel value of a grid. This also helps reduce over fitting and makes the model more generic. Next, add 2 fully connected layers. Since the input of fully connected layers should be two dimensional, and the output of convolution layer is four dimensional, a flattening layer is required

between them. At the very end of the fully connected layers is a softmax layer.

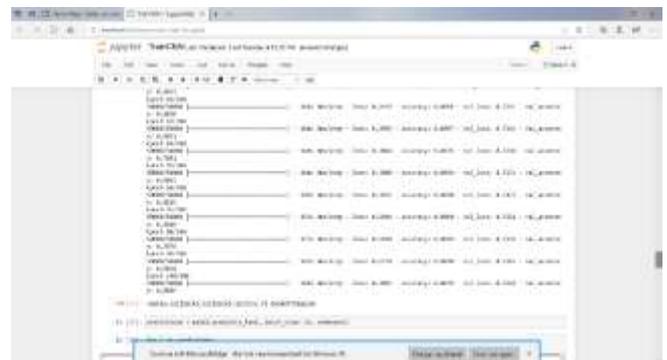


Fig -5.1: Execution of Code

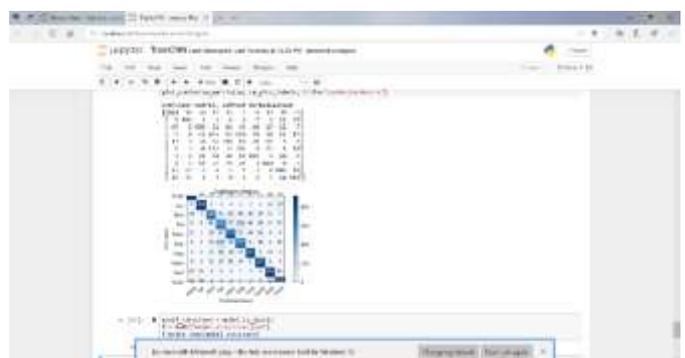


Fig -5.2: Constructing, Testing and Evaluating Experiment

5.5 Model testing and evaluation

Once the model has been trained, model testing can be carried out. During this phase a test set of data is loaded. This data set has never been seen by the model and therefore its true accuracy will be verified. Finally, the saved model is ready to be used in the real world. The name of this phase is called model evaluation. This means that the model can be used to evaluate new data. In the below fig 6.3, a tiny code has been used to show that the testing is done appropriately using the images in the desktop.



Fig - 6.3: Testing process

7. Conclusion and Future work

This system comes under deep learning which is advanced technique at present. CNN is more suitable for image processing especially in image classification. It concludes the experimental result what which is obtained from developed system is comparatively more accurate than many procedures followed before. Image recognition and prediction is a wide concept which is very deep. Deep learning concepts can be used in this subject to get efficient results. Concept like Convolutional neural networks(CNN) can be used, which is effective in obtaining results for image identification and classification.

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