Recent Advances in Computer Science

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Abstract–**The paper reviews the different research performed on varied fields of computer science technology. The first section covers the general idea of computer networks and how wireless computer networks is an integral part of internet of things. The different methods of deep learning with applications of text and data analysis, video surveillance systems and image detection are covered in the next section.**

***Index Terms*—IOT, RFID, CPS, SDN, Blockchain, , semantic analysis, text mining, SDLC, ReLU, ConvNets, extraction, deep learning, neural network, code caching**

I. Computer Networks - Dr. El Ocla

Computer Network is commonly defined as the interconnection of different systems to share information. It basically has two parts: Data communication and Networks. A simple data communication system component includes a sender, a medium and the receiver which are governed by a protocol. The message is sent via a signal which can be a digital or analog. There are various techniques to enhance the signal strength.

The two main protocols used are TCP/IP and UDP. TCP/IP (Transmission Control Protocol/Internet Protocol) provides applications a way to deliver ordered data packets over the network. Whereas the UDP (User Datagram Protocol) is used by the apps to deliver the data packets faster. While, TCP might be slower than UDP, it is reliable as it guarantees the delivery of data to the destination.

Wireless And Mobile Networks

Random Access is one such taxonomy wherein at each instance, transmission of data is regulated by set of protocols. No station is assigned control over the other. Transmission depends on the state of the medium (idle or busy). Comparing various random-access methods – ALOHA, CSMA/CD, CSMA/CA – The ALOHA method was introduced initially but had a major drawback of the collision. CSMA/CD (Carrier Sense Multiple Access/Collision Detection) worked on the principle of "sense before transmit" which mean that if the station receives other transmissions while it is still transmitting, collision is detected and thus transmission time is saved. CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance) was introduced to offset the drawback of the previous method wherein the receiving signal and sent signal has little energy and when there is a collision, the detected energy almost is negligible.

MANET(Mobile Adhoc Network) are a set of mobile nodes connected wirelessly without having a fixed network. Even though they require less human intervention to configure, they have less reliability, efficiency, security. Therefore, the MANET's are easy targets for masquerading attacks. Entity distinctness and identity uniqueness are the two things compromised by malicious nodes [1]. These mobile nodes donot have permanent power supply, thereby relying on batteries. Nodes keep changing their positions thereby exhausting the batteries. There is a protocol proposed in order to reduce the energy consumption [2].

Network Restoration in Wireless Sensor Network for Next-Generation Applications, an IEEE journal paper investigates the concept of wireless sensor networks. The paper enforces on optimizing the network resource utilizations and protecting the network against failures. The resource optimization is done by exploiting the feature of the WSN, i.e., the they remain in active state even when one or more active elements have failed. The other is achieved by using the p-cycle-based restoration solutions providing better recovery speeds and mesh like efficiencies.

Similarly, a paper, **Energy Efficient Multipath Routing Protocol for Mobile Ad-hoc Network Using the Fitness Function**, proposes a protocol called AOMDV with a fitness function (FF-AOMDV) to find a best path from source to destination node so as to reduce the energy consumption in multipath routing. The mobile wireless network operations are to be supported by MANETS through incorporation of routing functionality into mobile nodes. Multihop, dynamic or sometimes random topologies are used which probable would consist of wireless links that are bandwidth contained. In the proposed model, when RREQ is transmitted, source node will contain 3 types of information: Energy level of every network's each node. Every route's distance. Energy consumed while every route is discovered. Route with the highest energy level and less distance will be referred to as the optimal route. Finding multiple routes between source and destination is carried out by the route discovery and route maintenance. Link-disjoint, node disjoint and non disjoint nodes are identified by multiple path routing protocols [3] [4]. Nodes and links can be common in non disjoint routes [5].

In the paper: **Masquerading Attacks Detection in Mobile Ad hoc Networks**, a system to detect masquerading attacks without using fixed anchor nodes or air monitors has been proposed. As the wireless ad-hoc nature are easy targets for such attacks because of their lack of centralized identity management and broadcast nature, a model based on statistically significant testing which takes into the consideration the signal strength fluctuation has been developed. The tests conducted

on Samsung Galaxy based smart phones with the proposed schemes show 90% true positives. As preinstalled architecture is not required for this network, they are cheaper and can be used in disaster scenarios like earthquakes, floods and rescue operations. It is suggested that for future, the concept of IoT and 5G would allow for a heterogenous environment.

With advancements in wireless technology, and various research conducted in wireless technology, the computer networks have evolved into wireless communication network which is covered in the next section.

II. Wireless Communication Networks - Dr. Fadlullah

Wireless communication is categorised between one hop and multi hops. One hop transmission wireless communication includes Bluetooth, cellular networks etc. While the multihop wireless communication include WSNs, IoT, MANETs etc. There are two types of routing protocols used: Reactive (Finds a route dynamically) and Proactive (Routes are calculated before it is required) routing. There was a brief discussion about sensor networks being insecure. There are issues like jamming and collision in the physical and link layers. While the networking and routing layers suffer from issues such as Sinkhole Sybil and wormhole, the transport layer suffers from flooding. To counter these issues, there are various methods such as Secure routing via cryptography, anomaly detection using statistical approach, and secure data gathering.

Sensor networks are combination of tiny sensors with communication function to measure temperature, position etc. There are various issues in wireless sensor network. Routing protocol is divided into heterogeneous, homogeneous and hybrid WSN architectures. Main concern being the security as it is very prone to attacks and hacks.

There is a major increase in the data being sensed and used. Due to this and also the higher response required for IOT delivery network, high speed transmission has emerged as an important issue [6]. The conventional fixed channel assignment is ineffective because of high dynamic traffic load. To improve this situation, SDN-IoT was proposed. Discussing this issue and trying to resolve the problem, the paper **"An Intelligent Traffic Load Prediction Based Adaptive Channel Assignment Algorithm in SDN-IoT: A Deep Learning Approach"** proposes a deep learning algorithm to forecast future traffic load and congestion in the network. An algorithm, DLPOCA (Deep Learning based Partially Channel Assignment Algorithm) is introduced next to allocate channels to all the links in the SDN-IoT network. Finally, to prevent congestion, TP-DLPOCA (novel intelligent channel assignment algorithm) based on POCA (Partially Overlapping Channel Assignment) is proposed.

Software defined network is an approach to management of dynamic and efficient networking configurations so as to make the network performance more efficient. Software Defined networking is a technique used in IoT which involves heterogenous resources and structures [7]. Devices sense, collect and transmit data to the gateway after integration through switches. With ever increasing number of devices, leading to increase in traffic and congestion, there has to be multiple channels assigned to balance the load [8] [9] [10]. According to few research papers, Partially overlapping channel (POC) is suggested to be a better solution to decrease interference and improve network throughput [11] [12] [13].

As the current IoT is more dynamic, assigned channels need to be frequently changed to adapt to the changing network traffic. To resolve the drawbacks of the previous paper [14], in which ACPOCA was proposed, this paper proposes a deep learning based, intelligent POC assignment algorithm assigned to SDN. With the control paradigm of SDN being centralised, channel states need not be exchanged by the respective switches. Network's signalling overhead is reduced because of the centralised controller. Also, with deep learning introduced, the channel assignment can be achieved in single iteration. This reduces the suspension time.

The algorithm predicts the traffic and achieves a better accuracy. Three different load prediction algorithms are designed for different control systems (centralised SDN control system, semi centralised and distributed control system). After testing, it is concluded that the accuracy for SDN is better than the other two models. Also, the throughput and the delay in SDN-IoT is better than the conventional methods.

The deep learning based traffic load predictor is designed in three parts – the conventional network where the switch has the information and transmits data in distributed manner, also known as distributed control system. Mixed control system has a central communicator set up with minimal computation ability. In each switch, the relayed traffic from other switches and integrated traffic flow from sensing data is comprised to form the traffic load sequence.

Each load traffic load prediction model (Central control based Traffic load Prediction (CTP), Semi-Central control, Traffic load Prediction(S-CTP), and Distributed control Traffic load Prediction (DTP) has 4 phases of prediction processes, namely :

- Data collection phase
- Training phase
- Prediction and accuracy calculation phase
- Online training phase

The paper proposes a channel algorithm to resolves issues of the existing conventional channel assignment where partially over lapping channels are assigned to each link by using an anti coordination game. To make it even more simpler, this algorithm is split into 2: one being DLPOCA and the other TP-DLPOCA enhancing the performance. The redundant signalling increases due to the redundant convergence time.

The rapid growth of gathering data and the quick response requirement of IoT has led to high speed transmission. In order to get high speed transmission, suitable channels need to be assigned. It is concluded that the conventional fixed channel assignment algorithms aren't suitable because of their high dynamic traffic loads. The proposed algorithm and model can avoid congestion and assign suitable channels to wireless channels of SDN-Iot. Wireless communication networks play

an important part in internet of things as the technology to be connected to the application or the device needs security and wireless networking.

IOT (Internet of Things) can be defined as a stack of various technologies, standards and applications which allows the gathering of data in some sorts, communicating and powering different applications.

III. Optimizing the Internet of Things - Dr. Choudhury

IOT is a system of interconnected devices with unique identifiers that can transmit data over a network without human interaction. The seminar began with brief explanations of related technologies such as RFID, D2D Communication, Cellular Automata and Sensors. RFID (Radio frequency Identifiers) is a technology that introduced the concept of reading digital data encoded on tags using radio waves. D2D (Device to Device communication) represents the concept of direct communication between mobile devices that provides interoperability between public networks. A wireless sensor network mainly consists of sensor nodes and sinks that collect information about the environment they are setup in and transmit the collected data to a central location. Computations performed on inputs by shifting through various states is called automation and the abstract models that facilitate this action are called automatons. Software defined network is an approach to management of dynamic and efficient networking configurations so as to make the network performance more efficient.

Paper "**Degree Based Balanced Clustering for Large Scale Software Defined Networks"** discusses about SDN and proposes a novel controller placement algorithm to cluster the SDNs in polynomial time complexity. Having an optimal number of controllers in a Software defined network is called as the controller placement problem. CPP increases the throughput thereby decreasing the latencies. There have been many solutions to counteract the CPP problem, but none have had solutions that can simultaneously optimise more than one parameter.

Heavy traffic at the controller coupled with large network causes issues like scalability, inefficiency [15]. A proposal to use multiple controllers was implemented which lead to CPP [16]. Placing the optimal number of controllers at the appropriate positions and assigning them switches carefully was a solution implemented for CPP [17]. With many proposals being made in the recent years, one proposal: Lange et al. proposed POCO (Pareto based Optimal Controller placement) a solution which represents CPP as combinatorial optimisation problem [18] [19] that iterates various possible combinations to improve its computational complexity while risking its operational costs.

This paper proposes to place minimum number of controllers to minimize:

- Flow setup latency
- Route Synchronisation Latency and
- Load of controller.

Proposed Algorithm

The network is considered to be a bidirectional graph G = (S,L) where S is the set of nodes, representing the set of switches, and L is edge representing the connectivity between switches. The graph is clustered into multiple subnetworks which are disjoint set of switches. Each sub network must have a switch of its own, and all the switches of the network must fall into a sub network, where there is only one controller for every sub network The proposed methodology maintains few assumptions:

- The transmission delay is maintained to be identical and negligible.
- There is a fixed load imposed on each switch
- Controller can replace a switch alone and also, cannot be placed at different locations.
- The propagation, processing and queueing delay of each switch is the same. inorder to simplify the objective of minimizing the flow-setup latency, balance the load of each controller

Degree based Balanced clustering, an algorithm to implement the above has been proposed in this paper. This proposed algorithm has the network divided into k-clusters, with each cluster being assigned one controller and also, obtaining the minimum latency by getting the min. value of k. This algorithm makes sure that there is not one controller with extra load and also there is a minimum distance between the node and cluster heads. For maximum number of nodes to be received with minimum delay, there should be highest connectivity between a cluster head and all the switches of its cluster.Graph theory dictates that every link increments the degree of a couple of switches by one simultaneously. Inter cluster head distance is the measure of a certain distance between cluster heads. With every increase of Threshold Cluster head distance, number of nodes in the cluster increases:

$$Boundary = Boundary * (AvgDeg–1)eq \qquad (1)$$

Where AvgDeg measures the average node degree of the network, boundary indicates the number of the nodes situated at the periphery of the cluster. With nodes sorted in descending order of node degree, a cluster head is selected only if it is at a threshold distance away from the selected cluster heads.

The controller selection is done by the process of summation of the component latencies. There is a weight variable introduced so that the dominance of inter cluster latency isnt on overall latency.

The function to find the optimum k is by calculating the average setup latency of all possible switch pairs.

This process and algorithm is tested on a simulated C++ environment by taking number of nodes, and connections as inputs. With all tests and simulations completed, the results of the proposed algorithm reveal that it outperforms the previous solutions by forming clusters because they are more balanced in terms of load per controller.

The DBC algorithm proposed has nodes sorted based on the descending value of its node degree initially. The first

cluster node is the node with highest degree. The cluster head is selected from the remaining nodes only if it is at a threshold distance away from the selected cluster head. Taking the scatterness of the selected nodes into account, the threshold distance is multiplied with degree ratio. The density of node and degree of the node are proportional. If it is low, the threshold cluster separation gradually increases to include more nodes. If cluster heads arent selected by this method, only its degree is used to select, ignoring the distance from other clusters.

A controller selection function that comprises a switch's intra cluster distance and also its inter cluster distance. A weight variable is introduced to provide dynamic selection of cluster to control the dominance.

Having a background at internet of things and wireless computer networks, the idea of deploying and monitoring Iot enabled system is a challenge which is covered in the next section.

IV. Deployment and Monitoring of Self-Oriented IoT-Aided Systems - Dr. Ebrahimi

Wireless networks are computer networks which aren't connected by any physical cable. There is a transfer or data to and from the device without any physical connection. This concept of wireless connection is used by Internet of things. IoT is the interconnection of computing devices via internet, enabling them to transfer data without a wired connection.

Sometimes the data transferred would be unnecessary and in a huge quantity. To reduce this, the concept of compressed sensing was introduced. This is a signal processing technique to efficiently receive and transform the signal so that it can be inputted correctly. An unmanned vehicle that is capable of flying and gathering the information/performing the required task is an unmanned aerial vehicle. Wireless sensor networks are the group of sensors that are connected to each other, communicate with each other wirelessly to collect data from the neighbouring environment.

The paper **"UAV-Aided Projection Based Compressive Data Gathering in Wireless Sensor Networks"** propose the use of UAVs to collect data in areas which are hard to reach, from devices which are extremely energy constrained and which exist in large numbers. A data gathering technique called compressive data gathering is used wherein the data coming from large sensor nodes are aggregated to few cluster heads (projection nodes) in order to reduce the energy consumption and also increase the network lifetime. A sink node is used to which the data is transmitted to from the various UAVs to avoid the long range transmissions. [20]

In many scenarios where IoT is used, sensor nodes measure and send collected data either directly or through multiple hops to a central unit for its processing. UAVs are an efficient and scalable method to collect data from sensor nodes in dense environment. [21] [22]

The wireless channel quality, the data rate is boosted and overall energy consumption is reduced because the trajectory of the UAV can be controlled. Collective data gathering is a technique used wherein few encoded sums are received by sink nodes which can be useful in recovering from the original data as long as the reading can be transformed into orthogonal domain instead of the normal method of receiving the readings from all the sensors. [23] [24]

The data gathered by the sensors can be recovered at the sink by receiving parse projections. [25] Each gathered data is collected and transferred to the CH. This data is then collected by the UAVs and transferred to the sink node. So instead of sending each sensors reading to the cluster head in multiple hops, the data is aggregated and transmitted to the CH. [26]

Few assumptions made are as follows: density of nodes and transmit power capability per node is high enough to have a connected graph, each sensor node has a data reading x which is sent to a sink node.

A UAV is used to navigate over the region so that data can be collected from the sensors and transmitted to the sink. To have a balance in the tradeoff between reducing the UAV trajectory and reducing the energy utilisation, sensor network is divided into multiple clusters where each sensor nodes has a cluster head. The CH acts as a device which gathers data from all the nodes in its cluster and transmits it to the UAV that is sent, which then aggregates the data and transmits it to the sink node. Along with the characteristics of the UAV and nodes, the environment plays a major role in determining the characteristic of the channel. [27]

Another assumption made is that the UAV flies over the required CHs at a low altitude with a fixed transmission power and high bit rate, with a suitable velocity to have enough contact time with CH to collect the aggregated data. A mixed liner integer program is formulated in order to separate the clusters into equally distributed clusters with one CH per cluster atleast. The objective is to generate forward trees to collect data at CHs with minimum transmission power and also reducing the UAV trajectory to traverse all CHs from starting to destination sink node.

A mathematical formula was developed to solve the joint optimisation problem which included clustering, CH selection, forwarding trees construction, and UAV trajectory planning. The problem is decomposed into multiple disjoint subproblems and generate optimised solution with lesser complexity. Based on less complex algorithms, a heuristic method is proposed to scale up the solutions in a dense sensor network scenario. The results provided demonstrated efficiency and superiority of proposed methods with insightful comparisons between optimal and suboptimal approaches.

With advent rise in technology and machine learning gaining a lot of attention, our next section focuses on deep learning and its various applications.

V. Deep Learning - Dr. Yang

Deep learning is an artificial intelligence function that processes data and creates patterns similar to how the human brains work to make decisions. It is a subset of machine learning that is capable of learning from unstructured and structured data. Differing from machine learning, deep learning uses

hierarchical level of artificial neural networks to carry out the required tasks. These hierarchical structures allow machines to process data with a non linear approach.

The network is differentiated along various types of learning : supervised learning, augmented supervised learning, semi-supervised learning, reinforcement learning and unsupervised learning.

"Deep Learning", A reference paper published by Yann LeCun, Yoshua Bengio and Geoffrey Hinton states that deep learning allows computational models with multiple processing layers to get the knowledge of representing data with multiple level of abstraction. This technology controls and powers many aspects of life: from web searches to recommendations on things to view online/purchase and many various websites [28].

It can be used to classify objects as images, text, convert speech to text. Machines that are fed with raw data and automatically detects or classifies a representation are referred to as representation learning. An image is taken in the form of an array of pixelated values and represents the presence or absences at particular orientations. The other layer detects edges regardless of small variations in the edge positions [29]. Collecting a large dataset of images each having its own label with its category will come under supervised learning. While training an algorithm, model is shown images and it produces output in forms of vector of scores. Each category needs to have the highest scores possible which doesn't happen before training. Then an objective function is computed that helps measure the error between output and desired pattern. Weights are added to reduce the weights [30].

A gradient vector is computed by the model for each to adjust the weights used. This is followed by the weight vector being adjusted in the opposite side of the vector. A process called stochastic gradient descent is used which consist of having the input vector shown a few examples computing the output and the errors, having the average gradient of each example computed [31] [32]. If the weighted sum is above a particular threshold, input is classified as belonging to a particular category. Shallow classifiers require a good extractor. This is because of the selectivity-invariance dilemma.

Unsupervised learning is a type of self organised learning to find the previously unrecognised pattern without the pre existing labels. It allows modelling of probability densities of other inputs. Cluster analysis and principal component are the two main approaches used in this learning. Anomalous data points that do not fit into either groups of data could be found out using unsupervised learning. Even though it can perform complex tasks, the learning can be unpredictable in some cases.

Stochastic Gradient descent can be used to train multi layer architecture. The gradient of the objective along with its input can be worked backward from the gradient with respect to the output. This backpropagation module can be implemented repeatedly to propagate gradients to all modules. Once this is done, gradients can computed with respect to each weights.

Traversing from one layer to the other, weighted sums of inputs are calculated and results are passed through a non linear function. Rectified linear unit (ReLU) is a simple half wave rectifier f(z) = max(z,0). ReLU trains with multiple layers without unsupervised pretraining [33]. Local minima are not a problem with large networks. The analysis show saddle points with a few downward curving, with almost all of them having similar objective functions.

Convolutional neural networks are neural networks designed to process data that come in form of multiple arrays. Local connections, shared weights, pooling and use of many layers are the four main ideas of convNets. The architecture of the convolutional neural networks is dual layered: convolutional layers and pooling layers.

Each unit is connected via a local patch in the feature map of previous layer through set of weights called a filter bank. ReLU is then provided with the result of this weighted sum [34] [35]. Local group of arrays have high correlation in larger data such as images. Local statistics are invariant to locations.

While training RNNs is problematic because of the back-propogated gradients either growing or shrinking at each time step, it is a very powerful dynamic system. With advancements in technology, RNNs have been found to be very useful in predicting the next character in the text or next word in the sentence and many more complex tasks [35].

With Artificial Neural Networks, there are issues with naively trained DNNs, namely computation time and overfitting.

Due to added layers of abstraction, there are dependancies in the training data. Pruning, weight decay can be applied in order to solve the problem of overfitting.

DNNs considers many training parameters to help itself become efficient such as number of layers and number of units per layer, learning rate and initial weights.

Human vision being an active process that sequentially samples the optic array in a task specific way using small high resolution surround. Future progress will be in the area of machines working with RNNs and ConvNets which use reinforcement learning to decide where and what to look. Natural language understanding is another key area in which deep learning can make an substantial impact [28].

VI. Segmentation: From Conventional Methods to Deep Learning - Dr. Akilan

Segmentation is defined as the process of splitting into many parts. Image segmentation is a type of segmentation wherein an image is split into areas that relate to certain objects. Foreground segmentation is defined as the process of extracting an object from the foreground of an image with a relatively still background. Video foreground segmentation is the process of extracting a distinct object from multiple frames of continuous moving objects.

Difference between an semantic and instance segmentation is that the each object pixel is clustered for semantic and each distinct object is clustered and labelled for instance segmentation.

There are a lot of issues with video foreground segmentation, namely: illumination changes, dynamic background, random variations. There is a technique called BGS that helps with the issues, called BGS Algorithm. It is segregated into 5 different parts: sample based, probabilistic, subspace, codebook based and deep learning [36].

The codebook based technique stores colour, intensity and temporal features into memory. Principal Component Analysis or Eigen space is used in subspace based approach. In sample based approach, k samples are tested with similar pixel from the whole list of samples taken. There is another technique: GMM based approach where randomisation and probability distribution is used. [37]

Disadvantages of a conventional method is that it needs higher processing time, it has no mechanism to tackle moving shadows and also the number of parameters for GMM must be initialised [38].

There are two parts of CNN: Feature extractors, wherein data is traversed through multiple convolutional layers just to extract multiple features and then the densely connected layers, [39] the classifiers.

In the paper **"Video Foreground Extraction Using Multi-View Receptive Field and Encoder–Decoder DCNN for Traffic and Surveillance Applications"**, a FG extraction model is introduced and the proposed model uses a heterogenous set of convolutions to store scale-invariant FG object representations. Experiments were conducted with few conditions:

- training is done with random state initialisation
- transfered parameters are used for model fine tuning
- single frame is configured with RGB color space
- configuration with two gray scale frames
- poorly annotated GTs are used for training
- an unknown data set is used for testing

This technique is introduced to handle spatial and temporal correlations between foreground and background objects of the scene and also overcome the poorly dilineated borders of FG regions. Multi-view Receptive Field Encoder- Decoder Convolutional Neural Network called MvRF-CNN harnesses multiple views of convolutional kernels with residual features fusions. Two input configurations are used: a 3 channel single frame and a 3 channel double frame with two consecutive grey scales attached with eachother at the BG. It has been shown that background subtraction and foreground segmentation are effective schemes to get rid of the above said issues. [36]- [47]

The proposed method is three fold:

- Application Side: Traffic monitoring and surveillence is used to reduce the congestion. Encode-Decode model is utilised.
- Architectural Side: The proposed model is multi view receptive field with convolutional neural networks. This allows conditional-invariant objects to be learnt and also highly delineated FG masks from heuristic to DNN based techniques.
- Experimental Side: The model is sequence specific pixel level labels of FG objects. The ablation investigation is conducted to show the importance of multi view receptive field

The proposed MvRF-CNN inherits the following properties from U-Net:

- Models input layer is configured in such a way as to capture spatio-temporal agents
- The multi view receptive field fusions in early, mid and late stages so that the object size variations can be handled.
- 2D convolutional is used to carry out subsampling process to address the segmentation accuracy issues of the U-net [48].

The transpose convolution are used to perform up sampling process while maintaining connectivity pattern. Zeros are inserted between each neuron in receptive field of input.

Adam optimiser is used to train so that the binary cross entropy is reduced.

Interclass domain transfer is introduced so as to improve networks generalisation calibre. Weights are used to initialise fresh model so that target domain remain updated.

A dataset specific global threshold and an otsu based dynamic segmentation model is applied to transform the salient map generated by the model to a binary one.

Network optimisation can be used to enhance the method. Decisions on hyper parameter, depth and types of levels will remain an emperical process. Tensor RT API can be followed in the future for high performance model.

One other application of machine learning is block chain and data analysis using text which is covered in the next section.

VII. Blockchain and Text Analysis - Dr. Srivastava and Dr. Mago

A blockchain is a time stamped series of immutable records of data managed by a cluster of systems not owned by a single person. Converting unstructured text data into something meaningful for semantic, syntactical and sentimental analysis to support fact based decision making is called as Text analysis.

The block chain seminar started off with the basics: block chain is nothing but packages that contain digital and unchangeable stored data called blocks. These blocks are in the form of a linear chain. Each chain consist of transactional data which is cryptographically hashed. Block chain consist of four essential parts: Encryption, Replication, Integrity and Mining.

There are two types of block chains: Public block chain which is also called as permissionless ledgers allows anyone to contribute in the ledger while everyone has a copy of it. And, in Permissioned ledgers called Private block chains, only a limited number of participants are allowed to have the distributed identical copies of the ledger.

There is also centralised and distributed block chains. Using block chain in any technology has its benefits, such as : intermediaries are eradicated, its simple to use, transactions can be verified easily, decentralised and secure.

Smart Contracts are computer protocols intended to verify the performance of a contract, which can maintain its own state and control its own assets. These are irreversible, and if tried to be changed, would become visible to everyone. There was this example of a smart alarm "Dapp". It works with every participating person setting a time before which they wake everyday, and if they fail to do so, a certain amount is deducted from their account. 90% of the money accumulated is redistributed among the people who woke up before the declared time.

Autonomous decentralised peer to peer telemetry, a concept which is being worked on by Samsung and IBM together uses block chain technology as a backbone of IoT based devices. Devices will use block chain to serve as a public ledger so that devices would no longer need a central hub to have communication between them.

A simple use of block chain is in drug traceability, wherein every drug manufactured will have an unique code which will be hashed and its information will be stored in a block chain. The origin will be checked when it is transferred from the manufacturer to wholesaler then to the pharmacist and then finally to the consumer, with all this information also being stored in block chain, avoiding any counterfeit drugs.

"Identifying and allocating resources during out of hospital cardiac arrest" is a paper about solving the situation of helping out a person suffering from out of hospital cardiac arrest by having an access to nearby automated external defibrillator (AED). Multiple factors are considered to determine the optimal combination of the user and the AED, such as the distance between the user and the AED, the battery level of the user, the functioning capacity of the AED etc.

The heart stops beating due to some issue in the internal electrical system of the heart [49]. The proposed method is a two step process wherein first, the alert is sent to everyone nearby, and then a selected few are alerted based on few constraints to go and help based on availability of the user and AED nearby [50]- [52].

The mobiles battery level, users walking speed, if any help provided by the user, battery level of AED, expiry date of AED, self test status of AED are all the factors that decide which user to seek response from and which route to use to assist the patient. The proposed system works well in optimising and resource allocation by finding the functional AED reducing the time for the OHCA patient to get treated.

"Syntactic, Semantic and Sentiment Analysis: The Joint Effect on Automated Essay Evaluation" proposes a system or a model wherein the grading of any essay is done by the system using neural networks. Along with the rule based grammar, surface level coherence check, semantic, syntactic and the sentimental check of the essay is performed.

23 features are used in order to get the essay checked. Fewer features are helpful because it reduces redundancies and the performance is based on just the actual feature required. The features were extracted from the essay to select the most influential features of the predictive model. Natural language processing tool kit, a python based platform is used to extract the language based data. The total count of various features were used to understand [53] [54] the syntactic structure of the essay, namely Unique part of speech used, misspelled words, existential there, superlative adjectives, repetitive words etc. Semantic attributes provide meaning and purpose of language is to provide meaning from one to another [55].

Quadratic weighted kappa (QWK) was used to evaluate the performance of cases. Regression problem was used to treat score prediction and supervised learning was used for it. Support vector machine, random forest generator, three layer neural network are the prediction models used to propose this system.

"Challenging the Boundaries of Unsupervised Learning for Semantic Similarity" proposes a corpora based statistics in a standardized semantic similarity algorithm. The proposed method follows edge based approach using a lexical database to calculate the semantic similarity between words. The method to calculate semantic similarity between two sentences is divided: maximising the similarity and bound the similarity.

A tree like structure are used to compute similarity using predefined word hierarchy consisting of words, meaning and its relationship [56]. Tokenizer and part of speech technique is used to determine the words for comparison. This is helpful in filtering the sentences and tagging the words to POS [57]. The value of global dependency variable is incremented to keep track of syntactical differences. Detecting various objects from a video and analysing them is another application of machine learning that uses pattern recognition and is covered in the Video Surveillence section.

VIII. Responsive Video Surveillance System - Dr. Du

The lecture began by introducing the concept of intelligent video monitoring. It is the concept of setting up video cameras in each locality to observe an area. These videos are saved by having it connected to a recording device. These videos that are captured, are used by the court as evidence. When a certain event occurs, an alarm is triggered and required people are informed using the alarm. Cameras are connected to a digital video recorder along with many other sensors. The DVR is the interconnected in a network with workstation, interface and a smartphone may be to help identify distinct movements. Various techniques used in this include, background modelling, feature extraction, object recognition, motion estimation and object tracking.

Background modelling can be used when the background is stable or moving or completely busy. With its efficiencies, there are multiple difficulties which include: gradual or sudden change in lighting, cameras vibration and background having a motion. Although it has these difficulties, it is used by different techniques namely: average frame, Bayesian, mixture of gaussian and codebook.

"Object detection and deep learning: A review" is a review paper that provides a brief introduction of origins of deep learning and also Convolutional neural networks.

Understanding and estimating each object in the image along with classifying different images is called object detection [58]. Object detection involves different sub tasks such as face detection, pedestrian detection and skeleton detection [59] [60] [61]. Traditional object detection can be differentiated into three main components:

- **Informative region selection**: The image should be scanned completely because the objects can be in different portions of the image and also the aspect ratio varies accordingly. As it scans the entire image, it becomes expensive and creates many redundant windows.
- **Feature extraction**:Visual features which provide a semantic and robust representation, is extracted to recognise different objects.
- **Classification**: A classifier is required to differentiate the target object from everyother and so as to have a more visual recognition. Although SVM, AdaBoost are good choices, DPM (Deformable part based model is flexible as it combines deformation cost and objects to handle major issues [62] [63] [64].

CNN is split into multiple layers called feature maps. The 3d matrix of different color frequencies are the input of a feature. Different transformation such as filtering and pooling can be performed on feature [65] [66] [67]. A non linear function is used to obtain final responses after the filtering operation complexes filter matrix with values of receptive field of complex neuron.

With an interleave between convolution and pooling, an initial feature hierarchy is fine tuned by supervised manner wherein fully connected layers are added to adapt to different visual tasks. For each output neuron, different activation functions are are added to get a specific conditional probability.

The advantages of CNN over other methods are as follows:

- Hierarchical feature representation and hidden factors of input data can be differentiated through multi level non linear mappings.
- A deeper architectural model provided increased expressive capabilities.

Eventhough there are multiple advantages of CNN, there are few disadvantages which include:

- CNN requires a fixed size input image leading to the computation of of whole CNN which involves a lot of time.
- Training a RCNN is complex involving multiple steps like Cnovolutional network is fine tuned, then the softmax classifier is replaced by SVMs and then finally bounding box regressors are trained.
- Training is expensive and also involves a lot of time.

Differing from RCNN, SPPnet uses the feature maps of convolutional layer 5 again to project fixed length feature vectors. This concept of reusability is possible because of less strength required and also relationship between their spatial positions. Spatial pyramid pooling layer is the layer after the final convolutional layer.

The drawbacks of SPPnet include: similar multi stage pipeling that is used by RCNN which increases storage. Also, the convolutional layers before the SPP layer cannot be modified with fine tuning algorithm. Therefore, accuracy decreases.

Multitask learning makes use of representation for multiple correlated tasks from the same input [68] [69].

Multi scale Representation combines activations from multiple layers with skip layer connections to provide semantic information of different spatial resolutions. Contextual modelling exploits features around RoIs of different support regions and resolutions which inturn improves the detection performance.

Visual salient detection aims to highlight most dominant object regions in an image. Various local and global features are extracted from pixels to learn local feature contrast. TD saliency prunes points that are unlikely to to be parts of objects.

With many advancements in detection techniques, there are still many issues such as small object detection in COCO dataset and in face detection task as well. Following methods will be able to improve localisation accuracy

- Multi task joint optimisation and multi modal information fusion
- Scale adaption
- Spatial correlation and contextual modelling
- Cascade network
- Unsupervised and weakly supervised learning

IX. Cyber Physical Systems with Domain Specific Language - Dr. Mohammed

A cyber physical system(CPS) is an integrated process of computation along with a proper networking structure. It is a mechanism that is controlled by computer based algorithms and connected with the internet. CPS is an extension of embedded system and therefore has a better support for hybrid and heterogenous models, networking and interoperability [70]. CPS's development is a multi disciplinary process, an approach which is time consuming and also difficult. Therefore, high level architecture is used [71].

To assist in designing a CPS, a Domain specific language tool support had to be introduced which includes: interactive model description with input and computation of possible operation modes of subsystems. Also, checks of adherence to requirements and finding pareto optimal designs. The DSL designed is a combination of multiple system designs and allows to build virtual prototypes of CPSs without actually constructing an cosimulation [71].

A computer system with a greater functionality embedded in a larger system is called as an embedded system [72] [73]. Most of the common devices used ranging from digital watches to complex systems are all embedded systems [74] [75]. Due to safety issues that can caused by an embedded systems, multiple approaches have been introduced that include safety and performance evaluation as a part of its design process. A DSL is used to model service oriented system after which model is automatically transformed into timed automata

to compute absolute latency bounds and probabilistic timed automata which can compute latency distributions for each service [76] [77]. Both the approaches yield a DSL that leads to: solutions being expressed in idiom and abstraction level of problem owner and relevant stakeholders, validation at domain level, new language transformation and evolution

"Designing Cyber-Physical Systems with aDSL: a Domain-Specific Language and Tool Support" proposes an system of system approach for CPSs where embedded systems network and monitor the control processes [78]. This architecture is important for composability and OS programming language which is required for flexibility and efficiency of the sensor. The tool that is provided supports a) interact input validation b) checking the design optimality c) understandable designs d) computation of possible operations

Cyber physical system is a realtime, intelligent and distributed controlled or monitored by computer based algorithms. They are driven by

- wireless communication devices
- abundant internet bandwidth
- increased energy availability
- low cost, low power, high capacity and small form computing devices
- small, low cost and increased capacity sensors [79]

CPS and IoT share similar architecture while providing more coordination between physical and computational elements. Link between computational and physical elements is emphasised. CPS includes aspects of cloud and cognitive computing [80] [81].

Three different measures of interoperability are : the interoperability ladder distinguishes between technical and syntactic operability. The level data, processes and enterprise is addressed by the ATHENA integration framework [82]. Also, LCIM extended covers conceptual interoperability with levels none, technical etc.

A service oriented architecture is used to enable networking and communication via open standards. It provides flexibility and also constructs SoS architecture.

Existing approaches addressed the safety and performances of CPSs however they lack some DSL based advantages : reasoning solutions to problems and transformations into multiple language for evaluation.

A. Modelling a CPS using an IDE

The system design is interactively created using the eclipse integrated development environment (IDE). The IDE shows feedback to the code being typed. Four levels of feedback is defined so as to not overload the system designer with too much information. Syntax: standard eclipse functionality Concepts: takes care of having the right names and validation being done for every system references Cycles: to detect cycles introduced by system references Guidance: Designs that depict the requirement

Only those messages are shown for which the lower messages are not shown. aDSL generates a visualisation for the model structure once the valid model is generated.

An operation space is imposed by requirements to have a maxima or minima.

aDSL is modelled as interoperability limits and make fully operated design space exploration possible via different points in the model. In the future, the requirements of how an aDSL is validated and elicited could be provided. Furthermore, aDSL algorithm is extended under the hood to verify more properties of a CPS.

"Rapid Construction of Co-simulations of Cyber-Physical Systems in HLA using a DSL" proposes a technique by which this can be reduced.

A connection library is developed for simulators which offer methods to control attribute values and time in simulators and are focused on reusability. The domain specific language for the configuration of the co simulation is used. From the specifications such as objects, attributes and connections, the code is generated. The system specification in the DSL together with the models of subsystem is sufficient to start the cosimulation of the system.

In C2WT project, different type of models were connected by the means of an HLA runtime. This concentrates on co simulation of tools for wind tunnel application. As atleast one modelling tool wasn't a fit for the approach and therefore C2WT wasn't used. SimGE is another tool that is creating model based cosimulation federation and is capable of generating federate code.

In HLA, every federate follows its own timing behaviour. It can either be time regulating, constrained both or neither one of them. A time regulating federate is capable of sending time stamped messages, while a time constrained federate can receive them. There is a lookahead time that represents a time period during which a federate isn't sent any updates. There is always a timestamp attached with the current time on it when it is sent. The RTI grants time advance requests when all the timestamps have been received from everyother federate.

Control software is developed by using parallel object oriented specification language. POOSL is a formal language allowing modelling of complex software including timing aspects. It allows simulation and debugging process of models. Its IDE is attached as a plug in in eclipse.

To connect to the POOSL model simulation to HLA cosimulation, a C++ library was developed which can be connected to debugging socket of Rotalumis. This library implements a simulator wrapper that supports time control and attribute management. This also can be used for RTI by wrapping it in federate implementation according to the HLA standard.

The functional mock up interface (FMI) is a standard for model exchange and cosimulation. The standards specify interfaces to support the exchange of models and enable Functional mock up units. HLA is used to combine FMU into a coherent distributed simulation environment.

Loggers are usually used to save the state of the system when it is running. A logger library was developed in order to provide the same functionality of the cosimulator. This library can combined with OpenRTI to execute as a federate and

subscribe to all federates that it holds. An end time is required for the logger to stop recording the values.

The system designer can use the DSL to decompose things to subsystem, each with its own model. Each model has its own attribute. Also, the simulator types for each models and its connections can be specified in DSL. A fully working simulation of an RTI can be done by specifying the systems with each of its sub systems.

DSL is created to decrease the implementation effort of constructing the co-simulation and to automatically generate the code for it.

The DSL grammar is defined in XText using eclipse framework. An instance of DSL starts with definition of environments to generate for, such as RTI to use and also the external libraries. Number of federate classes are defined, each having a number of attributes. Each class has a pre defined step size to use during execution. The code is generated using Xtend, a dialect of JAVA. Xtext and Xtend are powerful tools for defining and performing custom DSL. The proposed method generates source files in an organised structural format, typically a directory wise consisting of two parts: actual federate, simulation and execution of the code.

The generated code includes a FOM XML containing HLA federation description, a CMake file, C++ simulation wrapper and a C++ file for federate implementation and also to contain federates main method. These sources include code for detection of other federates. Additional scripts are included in the other part. The scripts provide easier method to build and execute cosimulation. They also increase the flexibility of configuration and allow batch execution.

In future works, the automated unit tests for a model based model system design could be implemented. The method could be used for design and exploration in industrial context.

X. Code Caching Schemes - Dr. Wei

Code caching is an optimisation technique in a browser wherein buffer time of a frequently used website is reduced by caching the outcome of compilation and parsing. The traffic flow is very high in applications of internet. The fluctuating variability in the network during the peak traffic times leaves the off peak times underutilised. Caching allows this issue to be solved by transferring from peak to off peak using caching memories.

The network is considered is a mesh network with multiple users and a single server. When there is an off peak duration, each user is placed with some content. Each user then requests for a file randomly during peak traffic time. Satisfying various users requests, server sends the coded signal according to the cache each user has.

The quality of code caching scheme is calculated by the formula, K (1 minus M/N). The rate R must be as minimal as possible due to the same users and cache stored in M/N of a file. The server has no information if the user will ask for data once already given. Each user is given equal size for the cache and can request one file with equal probability.

The file is segregated and sent to the user because the user wouldn't know what file is required. In certain scenarios during the delivery phase, a small part of the file will be enough for the user to recover the requested file. The message sent must be ordered in such a way so as to recover the data from cache that the user requested easily.

Constructing a good PDA can be done using various mathematical methods such as coloring of bipatite graphs, combinatorial designs, hyper graphs, MDS codes, Linear spaces etc.

Dividing a file into F packets increases the computation complexity. To reduce the complexity, the paper **"Constructions of Coded Caching Schemes with Flexible Memory Size"**, proposes a different way to handle PDAs wherein there are 4 new classes developed for the newly created schemes out which two are to reduce the value of number of packets by increasing the transmission amount. The proposed method follows the scheme proposed by Maddah Ali and Niesen in [83]. This schemes follows two separate phases: Placement Phase wherein the file is divided into packets with every user having the access to the file.

Delivery Phase is the phase in which the user requests for a packet randomly by requesting it to the server. Once the server receives a request, it transmits the file with stipulated size to the user so that the user can find the file.

A concept called placement delivery array was introduced by Yan et al. [84] which encapsulated the characteristics of the placement and the delivery phase simultaneously.

Another paper, **"Coded Caching for Hierarchical Networks with a Different Number of Layers"** introduces a method based on cut set bound, three caching schemes and also characterise them, two schemes are combined and appropriate rates of code caching is availed. In a uncoded method, the content that is stored in the memory can only be accessed by the user [85]. If the content is not enough to fetch the file, the additional data is gathered from the mirror server or the origin server.

XI. Trends in Software Development - Dr. Fiaidhi

A Software is efficient only when it is flexible, scalable, free of error, manageable and secure. Software development is a process of specifying, collecting, designing, programming, debugging, documenting and testing. An IDE (Integrated Development Environment or also known as integrated design environment is a software application that provides comprehensive facilities to programmers for developing software.

Requirement gathering is the first step of a software development as in this step the developers meet the user that provides the requirements for the way the software needs to function or look. This is followed by a sequence of documenting – functional specification document, the technical specification documentation is continued while developing the code. This initially includes the architecture of the software. Once the basic of the documentation is completed, implementation and coding begins. While in the coding process, the design is enhanced based on the inputs and efficiency upon the testing

performed and feedbacks received. Usually, testing is carried out on the entire code with unit, sanity and regression testing performed as well.

IDE (Integrated development environment) is an application that provides a user with multiple functionalities to develop a software. Ideally a an IDE consists of interpreter, automation tools, editor and debugger.

There are various models of software development. Waterfall model has a linear sequential flow, wherein the development of any phase in the software development cycle can be done only if the previous one is completed. Spiral model combines elements of both design and prototyping. This model manages risks and develops the system in phases where as limits reusability due to high customisations.

Agile model is the latest model which brings a modern approach to software development. It is based on iterative and incremental development where development and requirements are met with dialogues and continuous interactions with the developing team and the input team.

XII. Conclusion

With an avid increase in research conducted around internet of things and machine learning, technology is quickly improving and expanding for the better. With the above mentioned research conducted on related topics such as wireless communication, IoT and machine learning, there is a better understanding on the current trends and also how the technology will boom in the future.

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