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NON-LINEAR MACHINE LEARNING CLASSIFICATION FOR TRIGGERING Co-ORIDNATED MULTIPOINT IN 5G HETEROGENOUS NETWORKS

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ABSTRACT

The downlink coordinated multipoint performance will be increased by using scheduling algorithms. These scheduling algorithms compared were support vector machine (SVM) linear, SVM- Radial Basis Function (SVM RBF), SVM-Sigmoid, Deep Neural Networks (DNN) and Convolutional Neural Networks (CNN). To verify this performance metrics based on speed were compared in results. Out rated CNN relives the best triggering composition for 5G radio networks that enhances the performance characteristic of the system

1.1 INTRODUCTION

In 5G networks CoMP transmission and reception wide range of techniques to enable the dynamic coordination in multiple geographical network topologies from one to other not it increases the power system performance in case of throughput and minimizes the delay with effective utilization is also and hence is the servicing quality to provide users effectively.

It is a difficult task to maintain in a condition of distance increment but this made possible by accessing LTE advanced systems which will increase system to high Data rates by maintaining the user equipment's near by the base station this will access the little amount of power that will be generated by the base stations and make an easy transmission of the signal through OFDM systems

The challenging task in LTE systems to sustain the signal even in low power situation when the strength of the strength of the signal was very much low from the base station especially in conditions of cell edges. But this is too much effective when the user equipment is nearer to PlayStation by considering neighboring notes.

In LTE advanced CoMP geographically, nodes were separated but this requires a close coordination between each node. Dynamical co-ordinate scheduling scheme helps in transmission as a joint processing

uski the received signals will also use this dynamic coordinating scheduling algorithm

this helps the cell it rains or minimizes the cell at interference by increasing the strength of neighboring nodes.

1.2 EXISTING SCHEME

We use the SVM classifier [9] in the implementation of this algorithm. We define the learning features in a matrix X as listed in Table I. These features are collected from all the UEs in the CoMP cooperating set during the time duration of TCoMP. This duration cannot exceed either the channel coherence time or the radio frame duration measured in transmit time intervals (TTIs). From the CSI in NR [10], we choose a linearly mapped

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version of the signal to noise and interference ratio (CSI-SINR) and CSI reference symbol received power (CSI-RSRP) as x1 and x2 respectively. This linearly mapped version of the NR CSI-SINR resembles what LTE/LTE-A calls the channel quality indicator (CQI) [11] and shall be the name we use here, as shown in Fig. 2. We observe the transport block error rate (BLER), computed at the receiving UE, to create the supervisory signal labels y for our machine learning algorithm.

1.3 PROPOSING SCHEME

In 5G networks CoMP transmission a wide range of receiving techniques exists to enable the dynamic coordination multipoint in multiple geographical network topologies for connection between one to other node. But this process increases the power in system and decays performance in case of throughput and maximizes the delay with effective utilization and hence machine learning approaches considered for improving the quality of services to provide users effective signal without droppings in both downlink/uplink scenarios. These algorithms were clearly explained below with all exceptions and limitations to trace the better algorithm for CoMP- Scheduling. The necessity of comparing 3 different self learning supervisory algorithms and here SVM classifiers for the CoMP scheduling models and have not compared with non-linear SVM approaches. Therefore, this make us to implement more conditions and not limit linear cases only.

1.4 LITERATURE SERVEY

Transmission (CoMP) is a DL/UL approach for improving framework limit and mobile facet client throughput. As of now, there are two distinct methodologies for CoMP (Figure 1). One technique utilizes self-sufficient, decentralized control and an engineering with self-sustaining Nodes. The subsequent methodology utilizes incorporated manage and an engineering dependent on Remote Radio Equipment (RRE).

In the technique with self-sufficient eNB design, CoMP is performed through motioning between Nodes. This system can use inheritance cells, but the drawbacks comprise flagging deferral and one-of-a-kind overheads.

In the second one method that coordinates RRE, the eNB can unify and manage each unmarried radio asset by transmitting baseband records straightforwardly between the eNB and RRE on optical fiber associations. There is small flagging deferral or one-of-a-kind overheads right now, intra-cell radio asset manipulate is usually easy. In any case, optical strands may additionally require noteworthy CAPEX, and the focal eNB should have the option to address higher burdens as indicated by the quantity of RRE. In this manner, the two methodologies are becoming looked at for LTE-Advanced.

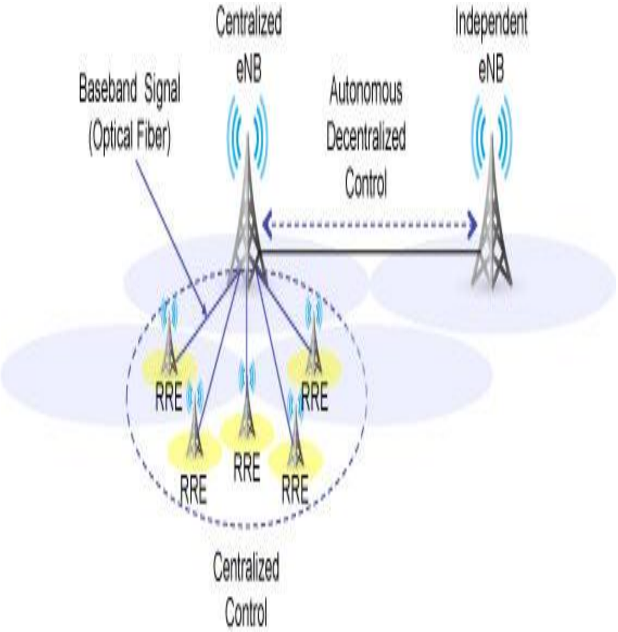

Figure 1.1: Centralized/Autonomous Decentralized Control

Fundamentally, 5G LTE-A CoMP, Coordinated Multipoint falls into two extensive classifications:

- Joint getting ready: Joint coping with occurs where there is coordination between specific substances - base stations - that are at the same time transmitting or attending to or from UEs.

- Coordinated booking or beamforming: This often alluded to as CS/CB (facilitated planning/composed beamforming) is a type of coordination where a UE is transmitting with a solitary transmission or gathering point - base station. Anyway, the correspondence is made with a change of control among some facilitated materials.
- To accomplish both of these modes, notably factor by factor grievance is needed at the divert properties in a short manner with the purpose that the progressions can be made. The other prerequisite is for extraordinarily near coordination among the Nodes to inspire the blend of records or quick changing of the cells.
- The techniques utilized for facilitated multipoint, CoMP are altogether one-of-a-kind for the uplink and downlink. This outcomes from the way that the Nodes are in a device, associated with special Nodes, even though the handsets or UEs are singular components.
- The downlink LTE CoMP requires dynamic coordination among a few geologically remoted Nodes transmitting to the UE. The organizations of composed multipoint can be partitioned for the downlink:
- Joint getting ready plans for transmitting inside the downlink: Using this factor of LTE CoMP, facts is transmitted to the UE all of the whilst from various Nodes. The factor is to enhance the gotten signal exceptional and quality. It may likewise have the point of efficiently losing impedance from transmissions which are expected for special UEs.
- This sort of facilitated multipoint places a popularity onto the backhaul set up in light of the fact that the records to be transmitted to the UE ought to be despatched to each eNB with the intention to transmit it to the UE. This can also successfully twofold or considerably boom the degree of records inside the system subordinate upon what number of Nodes will send the information. What's more, joint making ready records ought to be despatched among all Nodes engaged with the CoMP territory.
- Coordinated planning and moreover beamforming: Using this idea, records to a solitary UE is transmitted from one eNB. The making plans picks just as any shafts are composed to manipulate the impedance that might be created.
- The upside of this methodology is that the requirements for coordination over the backhaul set up are drastically reduced for 2 motives:
- UE statistics shouldn't be transmitted from numerous Nodes, and therefore just ought to be coordinated to one eNB.
- Only making plans alternatives and subtleties of bars need to be composed among severa Nodes.
- Downlink CoMP moreover has two methodologies viable for LTE-Advanced: Coordinated Scheduling/Beamforming (CS/CB) (Figure 2), and Joint Processing (Figure three).

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- In CS/CB, transmission to a solitary UE is completed by means of the serving mobile, further as in non-CoMP transmission. Be that as it could, the planning of transmissions is Step by Step prepared between the cells, along with any beamforming usefulness. In that way, the impedance among diverse transmissions may be managed and dwindled. On a essential level, plan enhancement might be founded on the association of clients being served, so the transmitter pillars are advanced to lessen obstruction with other neighbouring customers while expanding the served customers' signal first-class.
- In Joint Processing, the Joint Transmission plot transmits records to a solitary UE on the equal time from various transmission focuses. The multi-factor transmissions will be facilitated as a solitary transmitter with severa reception apparatuses which are geologically isolated. This plan offers probable higher gains contrasted with CS/CB, yet additionally puts a excessive flagging overhead on the backhaul arrange.

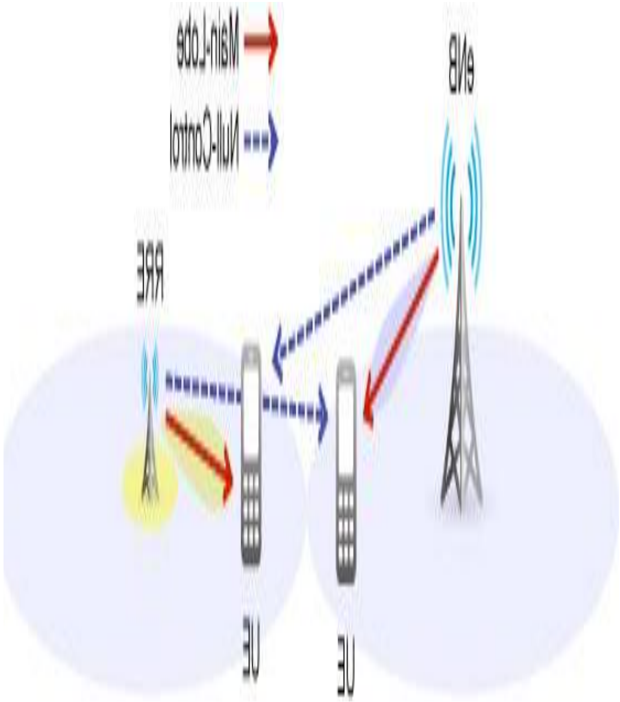

Figure 1.2: Downlink CoMP 1

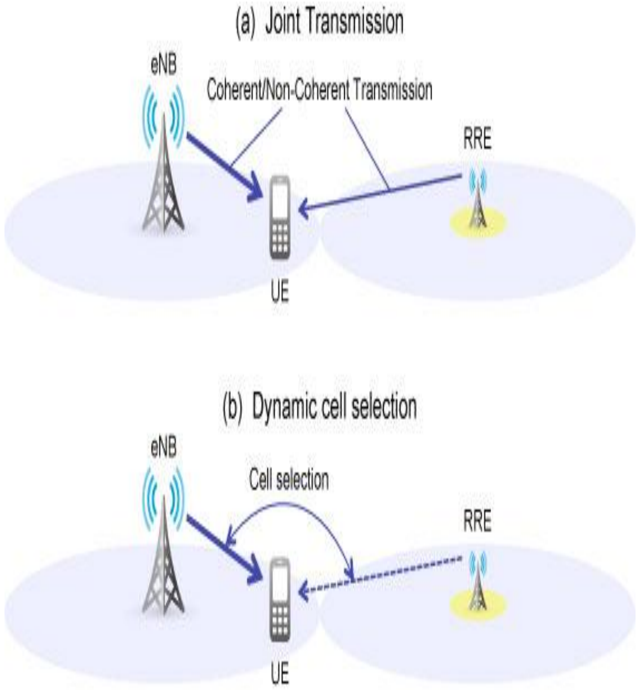

Figure 1.3: Downlink CoMP 2

Reference	Applied Scheduling Scheme	Pros	Cons
[1]	SVM, Proportional Fair	Through put was enhanced with	Error percentage with respect to

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		error percentage of 18%	system
[2]	DNN, Proportional Fair	Through put was enhanced with error percentage of 15%	But not effective iterative cost function
[4]	Affinity Propagation, Round Robin	Fair index was good	Limited non iterative conditions but dynamic for the first round
[7]	Static, Proportional Fair, Round Robin	Through put was enhanced with error percentage of 35%	Limited for Static
[9]	Static, Round Robin	-	Limited for static

Table 1.1: Survey on scheduling algorithms

In LTE-Advanced focus is on higher capacity: The driving force to further develop LTE towards LTE–Advanced - LTE Release10 was to provide higher bitrates in a cost-efficient way and, at the same time, completely fulfil the requirements set by ITU for IMT Advanced, also referred to as 4G.

- Increased peak data rate, DL 3 Gbps, UL 1.5 Gbps
- Higher spectral efficiency, from a maximum of 16bps/Hz in R8 to 30 bps/Hz in R10
- Increased number of simultaneously active subscribers

1.5 Carrier Aggregation

The most straightforward way to increase capacity is to add more bandwidth. Since it is important to keep backward compatibility with R8 and R9 mobiles the increase in bandwidth in LTE-Advanced is provided through aggregation of R8/R9 carriers. Carrier aggregation can be used for both FDD and TDD. Each aggregated carrier is referred to as a component carrier. The component carrier can have a bandwidth of 1.4, 3, 5, 10, 15 or 20 MHz and a maximum of five component carriers can be aggregated. Hence the maximum bandwidth is 100 MHz. The number of aggregated carriers can be different in DL and UL, however the number of UL component carriers is never larger than the number of DL component carriers. The individual component carriers can also be of different bandwidths, see figure 1.

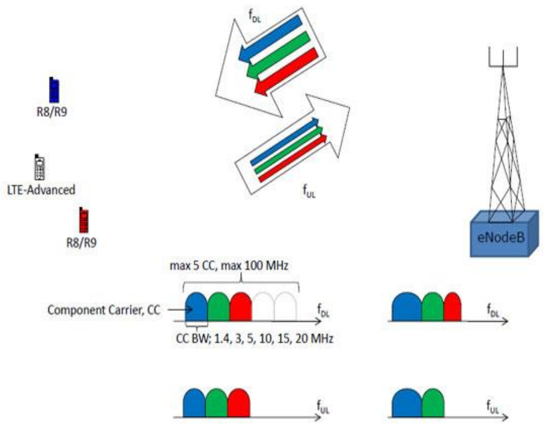

Figure 1.4. Carrier Aggregation – FDD The R10 UE can be allocated resources DL and UL on up to five Component Carriers (CC). The R8/R9 UEs can be allocated resources on any ONE of the CCs. The CCs can be of different bandwidths.

For practical reasons different carrier aggregation configurations – specified by e.g., combinations of E-UTRA operating band and the number of component carriers - are introduced in steps. In R10 there are two

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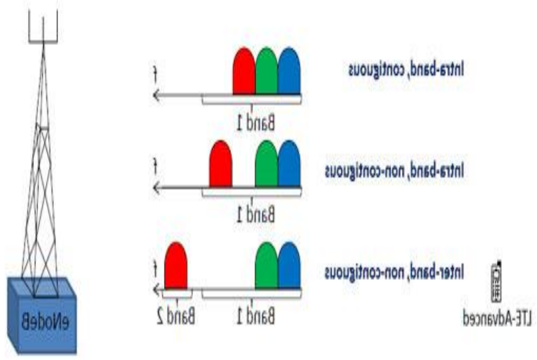
component carriers in the DL and only one in the UL (hence no carrier aggregation in the UL), in R11 there are two component carriers DL and one or two component carriers in the UL when carrier aggregation is used. The easiest way to arrange aggregation is to use contiguous component carriers within the same operating frequency band (as defined for LTE), so called intra-band contiguous. This might not always be possible, due to frequency allocation scenarios. For non-contiguous allocation it could either be intra-band, i.e. the component carriers belong to the same operating frequency band, but are separated by a frequency gap, or it could be inter-band, in which case the component carriers belong to different operating frequency bands, see figure 2.



1.5 Carrier Aggregation – Intra- and inter-band alternatives

When carrier aggregation is used there is a number of serving cells, one for each component carrier. The coverage of the serving cells may differ – due to e.g., component carrier frequencies. The RRC connection is handled by one cell, the Primary serving cell, served by the Primary component carrier (DL and UL PCC). The other component carriers are all referred to as Secondary component carrier (DL and possibly UL SCC), serving the Secondary serving cells. In the inter-band CA example shown in figure 3, carrier aggregation on all three component carriers are only possible for the black UE, the white UE is not within the coverage area of the red component carrier.

Improved performance at cell edges, e.g. for DL 2x2 MIMO at least 2.40 bps/Hz/cell.

The main new functionalities introduced in LTE-Advanced are Carrier Aggregation (CA), enhanced use of multi-antenna techniques and support for Relay Nodes (RN).

1.7 METHODOLOGY

The LTE-A simulator worked to enhance the throughput in this research paper was comprised with the following simulator block diagram in figure 4:

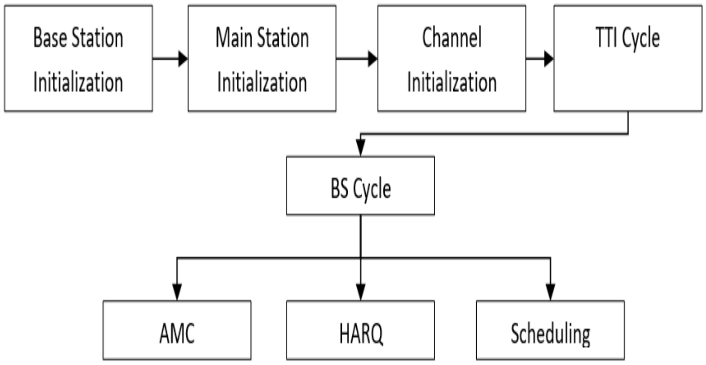


Figure 1.6: Block diagram for simulator

From figure 3.1, it is identifying that a stage of Channel state initialization and based on the cyclic conditions the third stage AMC (Adaptive Modulation and coding), HARQ (Hybrid Automatic Repeat Request), Scheduling strategy.

The primary level of initialization was dependent on 3 sector cell model with antenna pattern. This sector scenario is 120-degree based 3 - directional antenna that enhances the systems cell edge throughput. But for this section transmission channel is most prior and was given with the standards of OFDM is Spatial Channel model which is expressed as below equation as the progression delivers this equation should be an answer for shadow fading, antenna gain array, base station based sub-path, power at n[th] path, direct path and the total path:

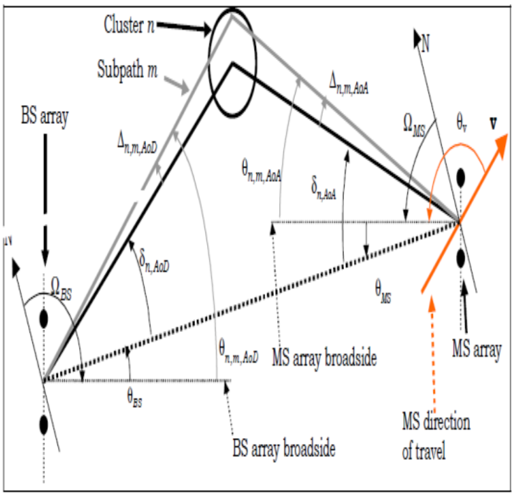


Figure 1.7: Principle of SCM channel

$$H_{u,s,n}(t) = \sqrt{\frac{P_n \sigma_{SF}}{M}}$$

$$* \sum_{m=1}^{M} \left(\begin{array}{c} \sqrt{G_{BS}(\theta_{n,m,AoD})} \exp\left(j\left[kd_s \sin(\theta_{n,m,AoD}) + \Phi_{n,m}\right]\right) * \\ \sqrt{G_{MS}(\theta_{n,m,AoA})} \exp\left(j\left[kd_u \sin(\theta_{n,m,AoA})\right]\right) * \\ \exp\left(j\left[k \cos(\theta_{n,m,AoA} - \theta_v) t\right]\right) \end{array} \right) \quad (1)$$

Here, $H_{u,s,n}(t)$ represent the channel , P_n is power at nth point, σ_{SF} is log normal for shadow fading effect, similarly $\theta_{n,m,AoD}, \theta_{n,m,AoA}$ and the gain at BS and MS is given with $G_{BS}(\theta_{n,m,AoD}), G_{MS}(\theta_{n,m,AoA})$ respectively.

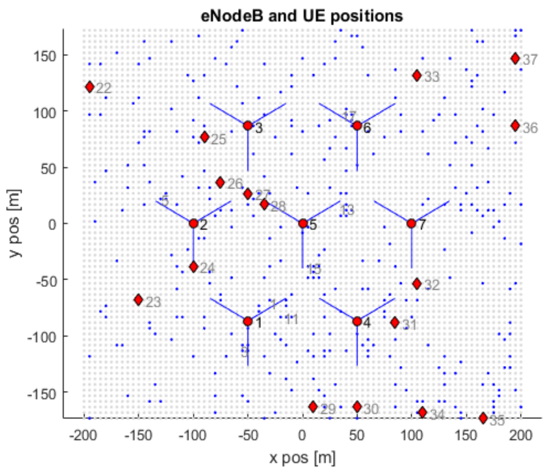


Figure 1.8: System Architecture

From the equation angle of arrival (AoA) and angle of departure (AoD) were completly shared at user side and the equation is completly dependent on omni directional antennas.

1.8 Adaptive Modulation and coding

After the channel transmitted the data bits now its turn to verify the data of channel state information from the information a database will generated along with uppdating the scheduling of CoMP factors.

In this section the channel state information was used as a prime aspect with SINR values and BLER values. To complete the database labels were generated with the help BLER values and the data values were operated by SINR values.

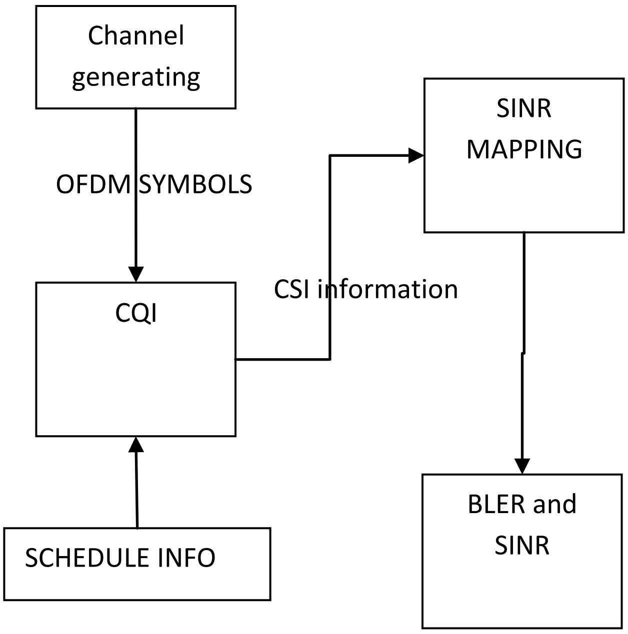


Figure 1.9: AMC block diagram

The operation was explained with the help of flow chart drawn below, which consists of channel generating OFDM symbols that states channel quality index with SINR mapping along scheduling information that results in BLER performance values and SINR information of the system. Here in this scenario Rayleigh fading based proportional sun fading channel considered for development. As [2] there will be multiple

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streams through the channel each user equipment (UE) will be given as

$$BLER' = 1 - \prod_{j=1}^{n} (1 - BLER_j) \quad (2)$$

Where BLER at stream j given by $BLER_j$ and every section of BLER(Block Error Rate) needs to cross the target point of H-ARQ to meet scheduling point update. As this research point works on 5G communication with OFDM SCM with ZF (Zero Forcing) channel equalization was performed. This limits LTEA systems CQI with updating TTI.

The effective SINR will be given as below form, this is will be in active only if TTI is active else it will remain as same

$$SINR_{effec} = \frac{1}{\frac{1}{N}(SINR)} \quad (3)$$

1.9 HARQ and Scheduling

HARQ is the one that supports the sharing of data packets as rescheduling phrased in every point of section. At each particular point of time some resource blocks were assigned and some were not assigned. On every of TTI updating the resource blocks which are not assigned will arranged and pleases with next iteration. This also limited with time slot. This is clearly represent in the flow process, The rest updation of all values will be slotted with high throughput data in cell edge throughput along with updated parameter SINR and BLER.

This HARQ helps in calculating proportional fairness scheduler which is completly dependent on TTI. Therefore, the scheduling coefficient denoted as M and given by

$$M_i(t) = \frac{T_{current}(t)}{T^{\alpha}_{average}(t)} \quad (4)$$

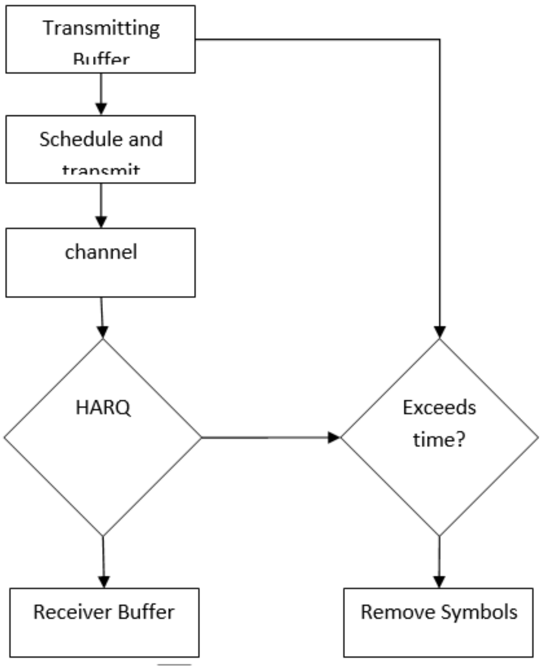

Figure 1.10: HARQ Scheduling flow chart

Algorithm 1: Support Vector Machine based DL CoMP improvement in heterogeneous networks

Inputs: Error Threshold, CQI [SINR, BLER], current triggering, UE report prior to scheduling generation.

Output: Triggering decision at TTI for UE

Step 1: For T = 1 to T_{sim} :

Step 2: Gather information from CQI i.e., SINR and BLER

Step 3: Get Labels based on BLER values

Step4: split data acquired as 70% for training and 30% for testing to perform K-Fold cross validation

Step 5: Train with SVM model using the split training data tune with the help of hyper parameters

Step 6: Classify the data with the help of test data. Calculate error rate

Step 7: if error_rate< error threshold then

Step 8: DL CoMP will be updated along with SINR value adjustment for Next TTI

Step 9: else

Step 10: Have continue with the same values presented in SINR and TTI DL-CoMP.
Step 11: end.
Step 12: end

Algorithm 2: Deep Learning based DL CoMP improvement in heterogeneous networks

Inputs: Error Threshold, CQI [SINR, BLER], current triggering, UE report prior to scheduling generation.

Output: Triggering decision at TTI for UE

Step 1: For T = 1 to T_{sim} :
Step 2: Gather information from CQI i.e., SINR and BLER
Step 3: Get Labels based on BLER values
Step 4: split data acquired as 70% for training and 30% for testing to perform K-Fold cross validation
Step 5: Train with DNN model using the split training data tune with the help of hyper parameters
Step 6: Classify the data with the help of test data. Calculate error rate
Step 7: if error_rate< error threshold then
Step 8: DL CoMP will be updated along with SINR value adjustment for Next TTI
Step 9: else
Step 10: Have continue with the same values presented in SINR and TTI DL-CoMP.
Step 11: end
Step 12: end

1.10 RESULTS

MATLAB based LTE-A Simulator was implemented with an average speed of v = 3.75 Kmph with below tabulated parameters. COMP triggering function was generated according to the ON and OFF conditions of COMP with scheduling algorithms results in better performance. In comparison the developing points CNN results as the best scheduling algorithm but the iterative cost function for regression make it away from consumption use. Apart from the cost function this is very easy to handle the point results the network best when compared with other algorithms.

TABLE 5.1: 5G radio network parameters

Parameter	Value
Band Width	10MHz
Centre Frequency	2100MHz
Maximum Power for MACRO	46dBm
Maximum Power for Small Cell	37dBm
Maximum Stream numbers	2
Number of resource blocks	50

TABLE 2: Simulation Parameters

Parameter	Value
SINR TRIGGER	-3.dB
UE connections	182
Small cells count	17
Macro Base station count	21
Simulation Time	30 TTI
Error Threshold %	15%

Table 1.2: Downlink Throughput for various scheduling classification algorithms

Metric	Static	SVM-Linear	SVM-RBF	SVM-Sigmoid	DNN	CNN
Peak	2.84	3.52	4.72	4.92	5.08	5.20
Average	1.02	1.17	1.39	1.54	1.72	2.40
Edge	0.07	0.07	0.06	0.17	0.48	0.51

**Here all metrics were measured in Mbps.

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Table 1.3: Comparing Scheduling algorithms

Algorithm	BLER	Stream	CQI
SVM-LINEAR	3.25%	1.37ns	3
SVM-RBF	3.58%	1.45ns	3
SVM-SIGMOID	3.22%	1.36ns	3
DNN	2.58%	1.25ns	3
CNN	2.29%	1.24ns	3

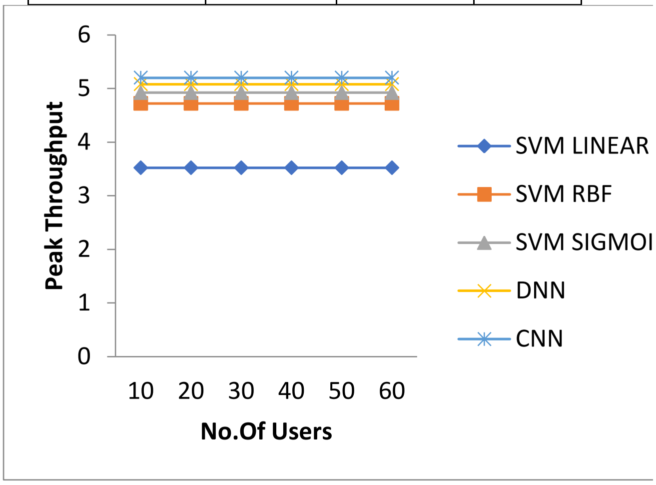


Figure 1.11: Peak Throughput for different scheduling algorithms

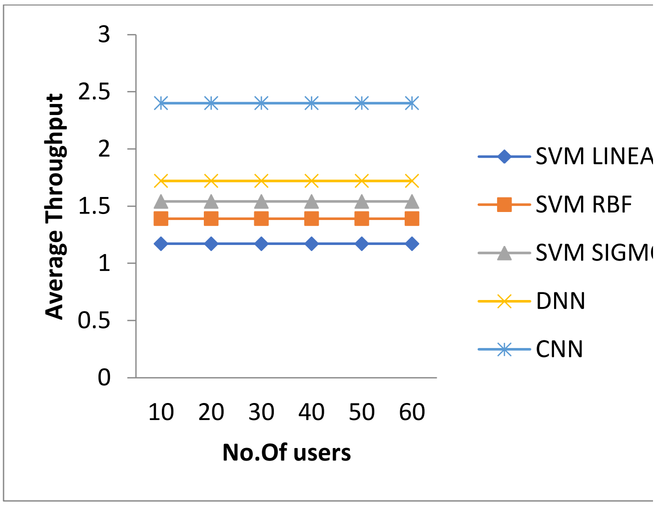


Figure 1.12: Average Throughput for different scheduling algorithms

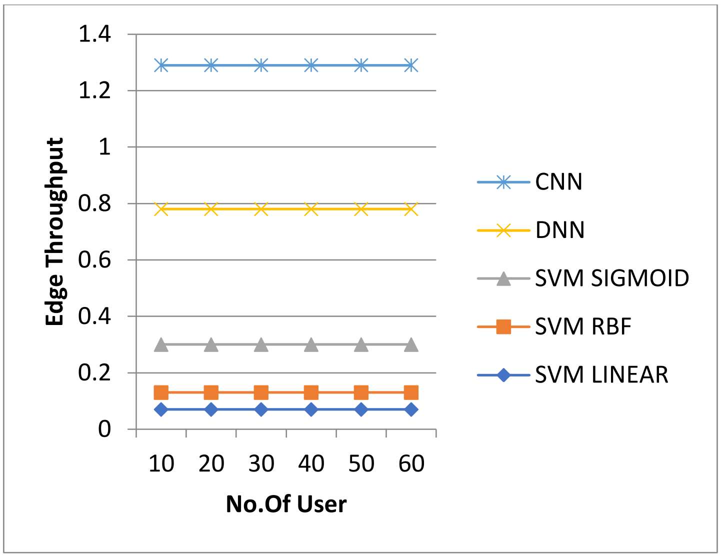


Figure 1.13: Cell Edge Throughput for different scheduling algorithms

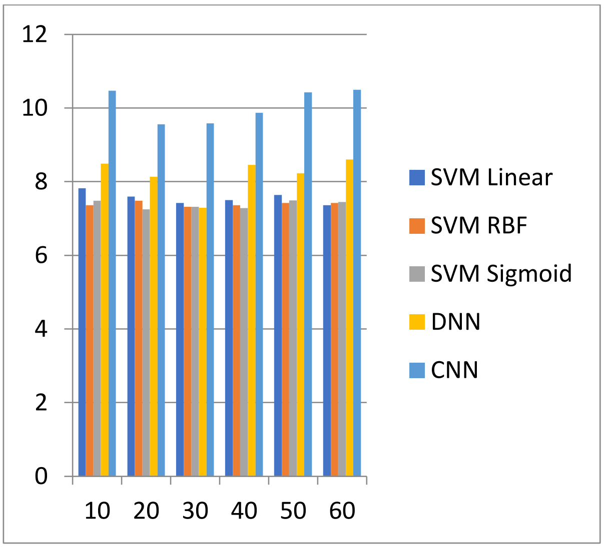
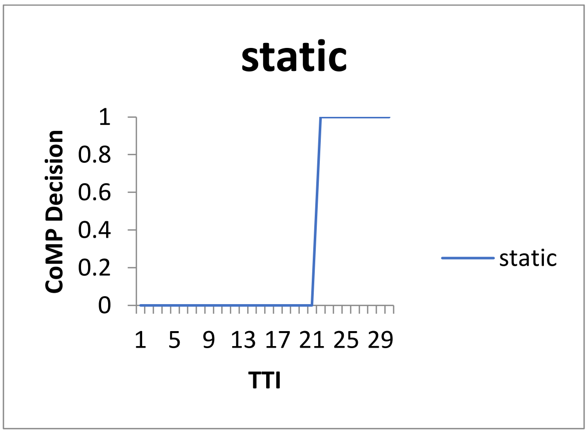
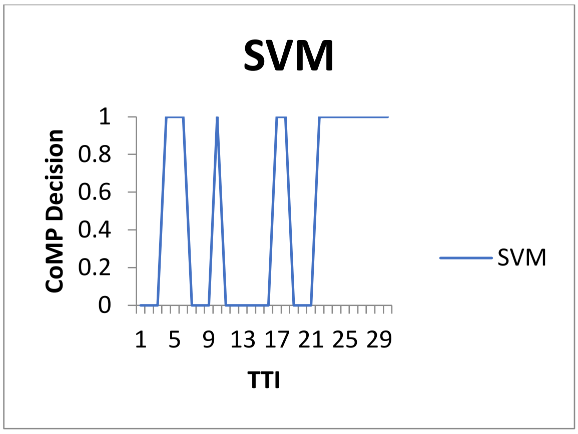


Figure 1.14: Overall Throughput for different scheduling algorithms





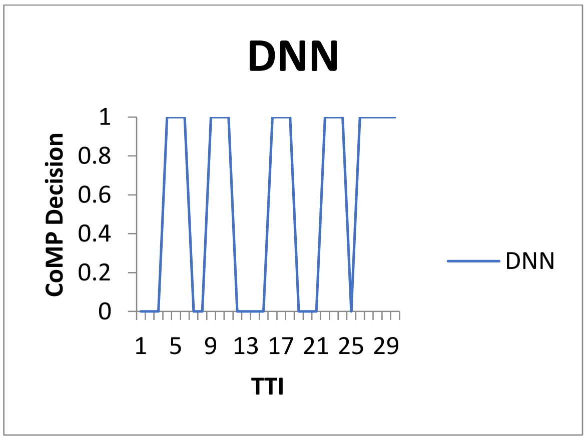


Figure 1.15: CoMP decision based on TTI iterations

From figure 13, 4 different dynamic CoMP decision modes operated by machine learning approaches namely SVM(Linear, RBF & Sigmoid), DNN and CNN. The CoMP decision was dynamically changing and result in efficient and effective throughput generation in all cases with relative speed varied from 2.1GHz to 3.75GHz. These resultant graphs were plotted in figures 9,10,11,12 and proved the effective CoMP decision made by CNN results in best throughputs i.e., Peak, Average, Cell and Overall compare with dynamic machine learning based scheduling techniques. These results showcase the better values for CNN with respect to SVM and DNN.

CONCLUSION

From [2] in this research paper a functional scheduling algorithm will results in better performance when compare with other schemes. As initially the data was considered from the network simulation and split to be trained and tested for the new BLER and SINR values along with TRIGGERING function detection. As per the paper DNN scheduling algorithm will result in best performance improvement.

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