CHAPTER – 4

Application based Performance Testing

4. Application based Performance Testing
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4.1 Introduction

A key part of any mobile phone specification is its operating frequency bands. In today’s era we are surrounded by many buzzing technologies like GPS, Wi-Fi, Bluetooth, GSM, 3GPP, CDMA, 4G LTE and many technologies that are based on Radio signals at distinct frequencies, different types of modulation techniques and concepts. We are using all these
techniques in our regular life in day-to-day basis. Some researchers had also made efforts to maintain bridge between two or more technologies to boost up internet speed.

More often time simulation will not give exact idea of interference problem. But the real world problem may differ than simulation predefine situation. Many GPS receiver company has found interfering by other radio signal in real world. [1] For the real world collection of data here we had considered that mobile devices are the best real world data collecting tools in which especially android and IPhone mobile’s application are convenient, faster way to collect data from real world GPS, Wi-Fi, Bluetooth, GSM, CDMA, 4G LTE signal data and SNR data just because all radio signal receiver are built in smart phone. By collecting all the device data from different cell of mobile towers, with WI-FI signal strength, GPS signal strength as raw data of our measurement. The data collection process is voluntary and if like to give feedback to our collection then simply install and just wait for 5 minutes hard in between our application collecting. After collecting all the data from selected population we can measure it in Data mining tools like weka by which we can measure some sort of classifications and clusters.

<table>
<thead>
<tr>
<th>INDIA’s carrier frequency band</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2G</td>
<td>GSM 900,GSM 1800</td>
</tr>
<tr>
<td>3G</td>
<td>UMTS 900,UMTS 2100</td>
</tr>
<tr>
<td>4G</td>
<td>LTE 850 (5), LTE 1800 (3), LTE 2100 (1),LTE 2300 (40),LTE 2500(41)</td>
</tr>
</tbody>
</table>

The entire data collection period is significantly shortened; most of data are collected within 3-4 days. But we can make best insight, classification and clustering by taking regular basis input from various mobiles in which it is already installed. The goal is to quantitatively access all the application measuring the relationship between the signal-to-noise ratio (SNR) and the bit error rate of the all the technologies and mobile devices signal receiver. A cell phone and or cell data device is a radio. Radio’s operate on signal strength and signal quality, these are both measured in decibels (dBm). Decibels are expressed as a negative number, like -70 dBm. The closer the number is to 0, the stronger the signal. For example, -70 dBm is a stronger signal than -90 dBm.

<table>
<thead>
<tr>
<th>RSSI</th>
<th>Signal Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;70 dBm</td>
<td>Excellent</td>
</tr>
<tr>
<td>-70 dBm &lt;= -85 dBm</td>
<td>Good</td>
</tr>
<tr>
<td>-86 &lt;= to -100 dBm</td>
<td>Poor</td>
</tr>
<tr>
<td>-100 dBm</td>
<td>No Signal</td>
</tr>
</tbody>
</table>

Table 4.1 Classification of Received Signal Strength

4.2 Row Data Collection Procedures with android app
For row data collection we have developed one android and Iphone application based on angular js through which we can collect the signal data by just installing and make it open for just 3-5 seconds, it will collect and submit to our server. So it is very easy to collect, no need to give more detail instruction to user for data collection. So data collection without user inference could give better data then user manual entry.

4.2.1 Download & run Mobile app from paly store


After Downloading and installing the following main screen will appear and after permission of user all GPS, WI-FI, mobile GSM, 4G sent to the webserver and it will fill the database.

![Signal Measurement](Image)

Figure 4.1 Client application transferring the data to the server

After filling the database we can see the area from where data is coming by latitude and longitude received from user mobile. In following figure we can see google map balloon from we were got the data.

<table>
<thead>
<tr>
<th>Sr NO.</th>
<th>Features</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>provider</td>
<td>Mobile network provider like reliance, idea, vodafone</td>
</tr>
<tr>
<td>2</td>
<td>type</td>
<td>Signal type like gsm, lte</td>
</tr>
<tr>
<td>3</td>
<td>timestamp</td>
<td>Current time stamp of device</td>
</tr>
<tr>
<td>4</td>
<td>cdmaDbm</td>
<td>Cdma type signal power</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>No.</th>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Cdma ECIO</td>
<td>Energy to Interference ratio 0 to -6 Excellent indicate excellent, -7 to -10 good indicate, -11 to -20 Fair to poor indication.</td>
</tr>
<tr>
<td>6</td>
<td>Cdma evdo (Evolution Data Only/Evolution Data Optimized, is a 3G mobile broadband)</td>
<td>EVDO SNR is the Signal to Noise Ratio, which is another representation of the quality of the signal in the presence of interference</td>
</tr>
<tr>
<td>7</td>
<td>gsmBitErrorRate</td>
<td>Give bit error rate when gsm signal</td>
</tr>
<tr>
<td>8</td>
<td>gsmSignalStrength</td>
<td>Gsm signal strength</td>
</tr>
<tr>
<td>9</td>
<td>isGSM</td>
<td>If gsm type then it will true</td>
</tr>
<tr>
<td>10</td>
<td>Latitude</td>
<td>Latitude of UE</td>
</tr>
<tr>
<td>11</td>
<td>Longitude</td>
<td>Longitude of UE</td>
</tr>
<tr>
<td>12</td>
<td>Manufacturer</td>
<td>Mobile manufacturer</td>
</tr>
<tr>
<td>13</td>
<td>Platform</td>
<td>OS in Mobile</td>
</tr>
<tr>
<td>14</td>
<td>Model</td>
<td>Mobile Model</td>
</tr>
<tr>
<td>15</td>
<td>Uuid</td>
<td>Unique id</td>
</tr>
<tr>
<td>16</td>
<td>version</td>
<td>Android os version</td>
</tr>
<tr>
<td>17</td>
<td>carrierName</td>
<td>Mobile network provider</td>
</tr>
<tr>
<td>18</td>
<td>countryCode</td>
<td>Like india, uk</td>
</tr>
<tr>
<td>19</td>
<td>deviceId</td>
<td>Device unique id</td>
</tr>
<tr>
<td>20</td>
<td>networkType</td>
<td>Type of network</td>
</tr>
<tr>
<td>21</td>
<td>phone Type</td>
<td>Type of cellphone</td>
</tr>
<tr>
<td>22</td>
<td>Simstatus</td>
<td>No represent status 5 active</td>
</tr>
<tr>
<td>23</td>
<td>SNR</td>
<td>Signal to noise ratio</td>
</tr>
</tbody>
</table>

Table 4.2 Different Types of Row Data from User Device

**4.2.2 View all Ballons of Mobile location from admind side**
Figure 4.2 Received Mobile Signal’s Data on Google Maps

Figure 4.3 In admin panel we can also find the balloon wise detailing
Figure 4.4: Find all the row data of signals on Dashboard data in grid

<table>
<thead>
<tr>
<th>network</th>
<th>signal_type</th>
<th>timestamp</th>
<th>latitude</th>
<th>longitude</th>
<th>model</th>
<th>signal_strength</th>
<th>signal_quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jio4g</td>
<td>GPRS</td>
<td>2012-01-01</td>
<td>31.24</td>
<td>120.65</td>
<td>A70</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>Jio4g</td>
<td>LTE</td>
<td>2012-01-02</td>
<td>31.24</td>
<td>120.65</td>
<td>E70</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Jio4g</td>
<td>3G</td>
<td>2012-01-03</td>
<td>31.24</td>
<td>120.65</td>
<td>C70</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 4.3 Sample Datasheet of Row Data of Jio4g from Database

4.2.3 Classification of Row Data

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Figure 4.5 Classification of total android mobile from which get the data manufacturer wise

Figure 4.6 Classification total mobile operator company from which we gather data company name wise

Figure 4.7 signal comparison combo chart of gsmBiterrorrate, gsmSignal strength, evdoSnr, evdoECIO, cdmaECIO, ebdDbm
4.3 Visualize & Measurement of Data

4.3.1 Carrier Provider Base Measurement

In this section we are going to visualize the carrier provider base signal to noise ratio and bit error rate value with respect to latitude, longitude, and manufacture wise.

4.3.1.1 Jio (4g)
Figure 4.9 visualize JIO specific data instance for analysis in weka.

From the figure 4.9 we can easily analyse that jio carrier having 1842 instances with 7 attributes gsmBiterrorrate, gsmSignalStrength, latitude, longitude, manufacturer, model, SNR.
Figure 4.10 visualize Signal strength of jio respect to latitude as (X) & longitude (Y)

From Figure 4.10 we can conclude that the most of the jio data were collected from 69.294 to 78.439 latitude and 17.391 to 30.657 longitude. From Figure we can visualize the strength of signal. Blue colour indicate low power signal strength and brown colour indicate the high power signal strength.
Figure 4.11 visualize gsmBiterrorrate of jio respect to latitude as (X) & longitude (Y)

From Figure 4.11 we can conclude that the most of the jio data were collected from 69.294 to 78.439 latitude and 17.391 to 30.657 longitude. From Figure we can visualize the GSM Bit error rate. Blue colour indicate low Bit Error rate and brown colour indicate the high Bit Error rate.
Figure 4.12 visualize Signal to Noise Ratio (SNR) of jio respect to latitude as (X) & longitude (Y).

From Figure 4.12 we can conclude that the most of the jio data were collected from 69.294 to 78.439 latitude and 17.391 to 30.657 longitude. From Figure we can visualize the GPS Signal to Noise ratio (SNR). Blue colour indicate low SNR and brown colour indicate the high SNR.
Figure 4.13 visualize Mobile Models which are using jio carrier respect to latitude as (X) & longitude (Y).

From Figure 4.13 we can conclude that the most of the jio data were collected from 69.294 to 78.439 latitude and 17.391 to 30.657 longitude. From Figure 4.13 we can visualize the model's signal records.
From Figure 4.14 we can conclude that gsm bit error rate is high on specific manufacturer like Samsung was having whether signal strength high or low. Other manufacturer also having bit error rate high like xiamoi, vivo, Letv, Lenovo.

*
Figure 4.15 visualization Signal to Noise ratio of jio respect to manufacturer as (X) & Signal Strength(Y)

From Figure 4.15 we can conclude that SNR is high on specific manufacturer like Samsung was having when signal strength low but SNR was very low when signal strength was high. Other manufacturer also having bit error rate high like xiamoi, vivo, Letv, Lenovo.*
Figure 4.16 visualize BER of jio respect to Model as (X) & Signal Strength (Y)

From Figure 4.16 we can conclude that Bit error rate was high on specific model like SM-G9, SM-J2, Lenovo, was having when signal strength low but Bit error rate was very low when signal strength was high with one exception found that SM-G9 was highest signal strength with high bit error rate. Other model also having bit error rate high like Ms-li, SM-J2, Letv, Lenovo.
4.3.1.2 Idea

From the figure 4.17 we can easily analyse that IDEA carrier having 1576 instances with 7 attributes gsmBiterrorrate, gsmSignalStrength, latitude, longitude, manufacturer, model, SNR.
Figure 4.18 visualize Signal Strength of idea respect to latitude as (X) & longitude as (Y).

From Figure 4.18 we can conclude that the most of the IDEA data were collected from 18.646 to 23.264 latitude and 69.609 to 82.78 longitude. From Figure we can visualize the strength of signal. Blue colour indicate low power signal strength and brown colour indicate the high power signal strength.
From Figure 4.19 we can conclude that the most of the IDEA data were collected from 18.646 to 23.164 latitude and 69.609 to 82.78 longitude. From Figure we can visualize the GSM Bit error rate. Blue colour indicate low Bit Error rate and brown colour indicate the high Bit Error rate.
Figure 4.2 visualize Different Mobile Model which are using idea as radio signal provider respect to latitude as (X) & longitude as(Y)

From Figure 4.20 we can conclude that the most of the IDEA data were collected from 18.646 to 23.164 69.609 latitude and to 82.78 longitude. From Figure we can visualize the Mobile models. Different colours code define different mobile such as blue color indicate Mi4i and Red colour define RedmiNote3. *
Figure 4.21 visualize SNR of idea as radio signal provider respect to latitude as (X) & longitude as (Y).

From Figure 4.21 we can conclude that the most of the IDEA data were collected from 18.646 to 23.264 latitude and 69.609 to 82.78 longitude. From Figure we can visualize the SNR. Blue colour indicate low power signal strength and brown colour indicate the high SNR. *
Figure 4.22 visualize GSM Bit error rate of idea as radio signal provider respect to Manufacturer as (X) & Signal Strength as (Y).

From 4.22 one can conclude that Samsung, oppo, vivo has highest bioterror rate then other manufacture when work with idea carrier. *
Figure 4.23 visualize GSM Bit error rate of idea as radio signal provider respect to Model as (X) & Signal Strength as(Y)

From 4.23 one can conclude that A37e, vivo160, sumsungJ710 mobile model has highest bioterror rate then other manufacture when work with idea carrier. *
4.3.1.3 Airtel

Figure 4.24 visualize Airtel specific data instance for analysis.

From the figure 4.24 we can easily analyse that Airtel carrier having 958 instances with 7 attributes gsmBiterrorrate, gsmSignalStrength, latitude, longitude, manufacturer, model, SNR.
Figure 4.25 visualize SNR of idea as radio signal provider respect to latitude as (X) & longitude as (Y)

From Figure 4.25 we can conclude that the most of the IDEA data were collected from 18.646 to 23.264 latitude and 69.609 to 82.78 longitude. From Figure we can visualize the SNR. Blue colour indicate low power signal strength and brown colour indicate the high SNR.
Figure 4.26 visualize GSM Bit error rate of Airtel respect to latitude as (X) & longitude as (Y)

From Figure 4.26 we can conclude that the most of the IDEA data were collected from 69.609 to 82.78 latitude and 70.080 to 88.372 longitude. From Figure we can visualize the GSM Bit error rate. Blue colour indicate low Bit Error rate and brown colour indicate the high Bit Error rate.
Figure 4.27 visualizes the signal strength of Airtel with respect to latitude (X) and longitude (Y).

From Figure 4.27, we can conclude that most of the Airtel data were collected from 12.996 to 31.399 latitude and 70.088 to 88.372 longitude. From the figure, we can visualize the strength of the signal. Blue color indicates a low power signal strength, and brown color indicates the high power signal strength.
Figure 4.28 visualize Mobile model who uses Airtel respect to latitude as (X) & longitude as (Y)

From figure 4.28 we can conclude number of records of mobiles which are using airtel carrier frequency from 12.996 to 31.399 latitude & from 70.088 to 88.732 longitude.
Figure 4.29 visualize Mobile model who uses Airtel respect to latitude as (X) & longitude as (Y)

From figure 4.29 we can conclude number of records of manufacturer of mobile which are using airtel carrier frequency from 12.996 to 31.399 latitude & from 70.088 to 88.732 longitude.
Figure 4.30 visualize GSM Bit error rate of Airtel as radio signal provider respect to mobile manufacturer as (X) & Signal Strength as(Y)

From 4.30 one can conclude that Samsung, Lenovo mobile model has highest bioterror rate then xiaomi, motorola manufacture when work with Airtel carrier. We cannot conclude oneplus, sony and oppos because we have not sufficient data to reach a conclusion. *)
4.3.1.4 Vodafone

From the figure 4.31 we can easily analyse that Vodafone carrier having 1120 instances with 7 attributes gsmBiterrorrate, gsmSignalStrength, latitude, longitude, manufacturer, model, SNR.
Figure 4.32 visualize Signal Strength of Vodafone respect to latitude as (X) & longitude as(Y)

From Figure 4.32 we can conclude that the most of the Vodafone data were collected from 3.13 to 29.015 latitude and 69.622 to 101.6882 longitude. From Figure we can visualize the strength of signal. Blue colour indicate low power signal strength and brown colour indicate the high power signal strength. *
Figure 4.33 visualize GSM Bit error rate of Vodafone as radio signal provider respect to latitude as (X) & longitude as (Y).

From Figure 4.33 we can conclude that the most of the Vodafone data were collected from 69.272 to 77.69 latitude and 12.080 to 23.372 longitude. From Figure we can visualize the GSM Bit error rate. Blue colour indicate low Bit Error rate and brown colour indicate the high Bit Error rate. Here we can conclude less gsm bit error rate.*
Figure 4.34 visualizes manufacturer who uses Vodafone with respect to latitude as (X) & longitude as (Y).

From Figure 4.34, we can conclude that the most of the Vodafone data were collected from 69.272 to 77.69 latitude and 12.080 to 23.372 longitude.
Figure 4.35 visualize SNR of Vodafone as radio signal provider respect to latitude as (X) & longitude as (Y).

From Figure 4.35 we can conclude that the most of the Vodafone data were collected from 69.272 to 77.69 latitude and 12.080 to 23.372 longitude. From Figure we can visualize the SNR. Blue colour indicate low power signal strength and brown colour indicate the high SNR.
Figure 4.36 visualize SNR of Vodafone as radio signal provider respect to mobile manufacturer as (X) & Signal Strength as(Y).

From 4.36 one can conclude that Samsung, Motorola mobile model has SNR then xiaomi, Lenovo, Sony, zuk manufacture when work with Airtel carrier. We cannot conclude oppo because we have not sufficient data to reach a conclusion. *
Figure 4.37 visualize GSM Bit error rate of Vodafone as radio signal provider respect to mobile manufacturer as (X) & Signal Strength as (Y)

From 4.37 one can conclude that Samsung, motorola mobile model has highest bioterror rate then xiaomi, Lenovo, Sony, zuk manufacture when work with Airtel carrier. We cannot conclude oppo because we have not sufficient data to reach a conclusion. *
Figure 4.38 visualize GSM Bit error rate of Vodafone as radio signal provider respect to mobile manufacturer as (X) & Signal Strength as(Y)

From 4.38 one can conclude that SM-J710, SM-G355, SM-N750, XT1706 mobile model has highest GSM Bit error rate then xiaomi, Remi35, RedmiNote , ZUKZ1 manufacture when work with Vodafone carrier. We cannot conclude LenovoP7 because we have not sufficient data to reach a conclusion. *
Figure 4.39 visualize SNR of Vodafone as radio signal provider respect to mobile manufacturer as (X) & Signal Strength as(Y)

From 4.39 one can conclude that Samsung, motorola mobile manufacturer has highest SNR then xiaomi, Lenovo, Sony, zuk manufacture when work with Vodafone carrier. We cannot conclude oppo because we have not sufficient data to reach a conclusion. *
4.3.2 Manufacturer Base Measurement

4.3.2.1 Lenovo

From Figure 4.40 we can visualize Lenovo’s different mobile models total collected 542 instance with 7 attributes like gsmbiterrorrate, signalstrength, latitude, longitude, model, carriername, SNR.*
Figure 4.4.1 visualize Lenovo’s different mobile models latitude and longitude.

From Figure 4.4.1 we can visualize Lenovo’s different mobile models like LenovoA7010a48, LenovoK50a40, LenovoA7000-a, LenovoP1ma40, LenovoS938t, LenovoP70-A, LenovoA7020a48 data are collected from 21.554 to 31.399 latitude and from 55.359 to 77.103 longitude. *
Figure 4.42 visualize Lenovo’s bit error rate different mobile models and Carrier Name.

From observing Figure 4.51 and 4.52 we can interpret Lenovo’s gsm bit error rate different mobile models data are with different carrier provider like ATADOCOMO, du, Jio4G, VodafoneIN, AIRCEL, AirTel and collected models data are collected from 21.554 to 31.399 latitude and from 55.359 to 77.103 longitude. Among the collected models LenovoK50a40 mobile model having more gsm bit error rate with most of carrier provider (Airtel, Vodafone, jio). *
From observing Figure 4.42 and 4.43 we can interpret Lenovo’s SNR different mobile models data are with different carrier provider like ATADOCOMO, du, Jio4G, VodafoneIN, AIRCEL, AirTel and collected models data are collected from 21.554 to 31.399 latitude and from 55.359 to 77.103 longitude. Among the collected models LenovoK50a40 mobile model having more SNR with most of carrier provider (Airtel, Vodafone, jio).
Figure 4.44 visualize Lenovo’s Signal Strength of different mobile models and Carrie Name.

From observing Figure 4.42 and 4.44 we can interpret Lenovo’s Signal strength different mobile models data are with different carrier provider like ATADOCOMO, du, Jio4G, VodafoneIN, AIRCEL, AirTel and collected models data are collected from 21.554 to 31.399 latitude and from 55.359 to 77.103 longitude. We can conclude that Jio & Vodafone having most power full signal strength in LenovoK50a40 & LenvoA7000-a. *

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4.3.2.2 Motorola

From Figure 4.45 we can visualize Motorola’s different mobile models total collected 699 instance with 7 attributes like gsmbiterrorrate, signalstrength, latitude, longitude, model, carriername, SNR.
From Figure 4.46 we can visualize Motorola’s different mobile models [MotoG4, Nexus6, MotoG3, XT1706] data are collected from 3.13 to 13.015 latitude and from 69.622 to 101.6882 longitude. *
Figure 4.47 visualize Motorola’s bit error rate different mobile models and Carrie Name.

From observing Figure 4.46 and 4.47 we can interpret Motorola’s bit error rate different mobile models data are with different carrier provider like [IDEA, Reliance, airtel, TATADOCOMO, Jio4G, VodafoneIN] and collected models data are collected from 3.13 to 13.015 latitude and from 69.622 to 101.6882 longitude. Very negligible gsm bit error found in Motorola mobile with most of observable carrier provider. *
Figure 4.48 visualize Motorola’s SNR of different mobile models and Carrier Name.

From observing Figure 4.47 and 4.48 we can interpret Motorola’s SNR different mobile models data are with different carrier provider like [IDEA, Reliance, airtel, TATADOCOMO, Jio4G, VodafoneIN] and collected models data are collected from 3.13 to 13.015 latitude and from 69.622 to 101.6882 longitude. Very low SNR (means interference chance are high) found in Motorola mobile with most of observable carrier provider but motoG series 3 & 4 having low SNR means interference chance are high) issue with IDEA, Reliance ,Airtel. *
Figure 4.49 visualize Motorola’s Signal Strength of different mobile models and Carrier Name.

From observing Figure 4.48 and 4.49 we can interpret Motorola’s SNR different mobile models data are with different carrier provider like [IDEA, Reliance, airtel, TATADOCOMO, Jio4G, VodafoneIN] and collected models data are collected from 3.13 to 13.015 latitude and from 69.622 to 101.6882 longitude. Very Strong signal power found from most of carrier frequency provider Moto G4 & G3 having not good signal strength at Idea, Airtel.
4.3.2.3 Samsung

Figure 4.50 visualize Samsung’s different mobile models instance.

From Figure 4.50 we can visualize Samsung’s different mobile models total collected 1559 instance with 7 attributes like gsmbiterrorate, signalstrength, latitude, longitude, model, carriername, SNR.
Figure 4.51 visualize Samsung’s different mobile models latitude and longitude.

From observing Figure 4.51 and 4.52 we can interpret Samsung’s gsm bit error rate different mobile model’s [GT-S7262, GT-I9060, SM-J710F, SM-G928G, SM-J700F, SM-A500G, GT-I8552, SM-G550FY, GT-I9500, SM-G7102, GT-I9060I, SM-N750, GT-P3100, SM-J200G, SM-G355H ] data are with different carrier provider [ Telenor, TATADOCOMO, Jio4G, Vodafone IN , Idea, BSNLMOBILE, airtel] and collected from 17.391 to 30.657 latitude and from 69.272 to 78.439 longitude. We can conclude from observation that SM-A500G, SM-J200G,SM-G928G having more bit error rate with JIO. & SMJ710 model having high bit error rate with vodafone, idea. *
Figure 4.53 visualize Xiomi’s SNR of different mobile models and Carrie Name.

From observing Figure 4.53 and 4.52 we can interpret Samsung’s gsm bit error rate different mobile model’s [GT-S7262, GT-I9060, SM-J710F, SM-G928G, SM-J700F, SM-A500G, GT-I8552, SM-G550FY, GT-I9500, SM-G7102, GT-I9060I, SM-N750, GT-P3100, SM-J200G, SM-G355H ] data are with different carrier provider [ Telenor, TATADOCOMO, Jio4G, Vodafone IN , Idea, BSNLMOBILE, airtel] and collected from 17.391 to 30.657 latitude and from 69.272 to 78.439 longitude. We can conclude from observation that GT-I906,SM-J710F,SM-700,GT-I8852,SM-J200,SM-N750 having high SNR (low effect of interference) so Samsung mobile model having more SNR with any carrier provider.
Figure 4.54 visualize Samsung’s Signal Strength of different mobile models and Carrier Name.

From observing Figure 4.54 we can interpret Samsung’s Signal Strength of different mobile models [GT-S7262, GT-I9060, SM-J710F, SM-G928G, SM-J700F, SM-A500G, GT-I8552, SM-G550FY, GT-I9500, SM-G7102, GT-I9060I, SM-N750, GT-P3100, SM-J200G, SM-G355H ] with different carrier provider [ Telenor, TATADOCOMO, Jio4G, Vodafone IN , Idea, BSNLMOBILE, airtel]. Once can easily conclude that all Samsung model getting the high signal strength except GT-S7262 from Telenor, SM-A500g from Jio, Sm-G500 from BSNL. *
4.3.2.4 Xiomi

Figure 4.55 visualize Xiomi’s different mobile models total collected 2461 instance.

From Figure 4.55 we can visualize Xiomi’s different mobile models total collected 2461 instance with 7 attributes like gsmbiterrorrate, signalstrength, latitude, longitude, model, carriername, SNR.
Figure 4.56 visualize Xiomi’s different mobile models latitude and longitude.

From Figure 4.56 we can visualize Xiomi’s different mobile models data are collected most nearer to 23.164 latitude and 73 longitude.
Figure 4.57 visualize Xiomi’s bit error rate different mobile models and Carrie Name.

From observing Figure 4.56 and 4.57 we can interpret Xiomi’s gsm bit error rate different mobile models data are with different carrier provider and collected most nearer to 23.164 latitude and 73 longitude. At last we can conclude most of the model having average bit error rate or less than average.
From observing Figure 4.58 we can interpret Xiomi’s SNR of different mobile models with different carrier provider. One can observe from the data that BSNL, JIO, IDEA having more SNR with Mi4i mobile model of xiomi than other models of xiomi.
From observing Figure 4.58 we can interpret Xiomi’s Signal Strength of different mobile models with different carrier provider. Once can easily observe that Xiomi model getting the high signal strength at present from Jio4g preceding with bsnl, tatadocomo.

**4.4 Weka Datamining Tools File**

In today’s generation data mining is the activity by which one can easily estimate, find pattern, classify data, and find clustered from Dataset. Here we set our data into MySQL database then we export the data into the excel sheet (CSV) comma separated file from where we have to convert the file in arff file extension. After conversion we can apply the data into the Waikato Environment for Knowledge Analysis (WEKA) “arff” file format [7].

**4.4 Datamining algorithms**

**4.5.1 M5 RULE ALGORITHM:**

M5Rule creates a decision list for regression problems which is used to divide and to conquer. M5rules follow the step in which first create model and after that it makes the “best” leaf into a rule in each iteration of progress. The approach for generating rules from model trees, called M5-Rules. In its work flow a tree learner is apply to the full training dataset and a pruned tree is learned then, the best branch is made into a rule and the tree is discarded. Each and every instances must be covered by rule formation algorithm and removed unwanted from dataset. The above process continue recursively until the best branch for rules cannot get [14].

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The main problem in linear regression is that the attributes must be numeric so that the model obtained will also be numeric (simple equations in a dimension). As a solution to this problem, decision trees have been used in data mining for a long time as a learning technique, i.e. models are learned from data. A decision tree divides the attribute space into cluster (leaf of the tree). Each branch of the tree has a condition which reads as follows attribute ≤ value or attribute > value, that serves to make selections until a leaf is reached. Each leaf represents the average value of the instances covered by the leaf and each leaf is then turned into the rule.

One of the common methods for generating rules from the trees is M5 algorithm. The M5 builds regression trees whose leaves are composed of multivariate linear models, and the nodes of the tree are chosen over the attribute that maximizes the expected error reduction as a function of the standard deviation of output parameter (Dolado et al., 2007) [15]. There are two main rule algorithm types: the association rule, and the classification rule. Rule algorithms are commonly used in data mining application for several reasons (Nagabhushana, 2006):

◆ It produces clear and understandable results.
◆ It supports undirected data mining (data mining of extremely large data sets).
◆ It works on variable length data (no need for summarization).
◆ The computation, it uses is the simple one.

The M5 constructs the tree in three steps:

1. Generates a regression tree using the training data, and calculates a linear model for each node of the tree generated.
2. Tries to simplify the regression tree deleting the nodes of the linear models whose attributes do not increase the error.
3. Reduces the size of the tree without reducing the accuracy [16].

4.5.2 Gaussian processes

To learn in kernel machines Gaussian processes (GPs) gives a principled, practical and probabilistic approach and over the past decades, GPs have received increased attention while talking about machine-learning community [17].

By using Gaussian Processes, this process develops an active mining mechanism for uncovering spatial aggregates from only a sparse set of samples which are targeted. This process gives unifying framework for developing surrogate models using sparse data, reasoning related to uncertainty of estimation at non sampled points and for closing the loop between collection of data and mining of data through representing the objective criteria. Using entropy-based functionalities defined over spatial aggregates, our mechanism optimises sample selection despite traditional approach of sampling to reduce estimated variance [7, 18].

The new development in machine learning and data mining is the actual use of Gaussian processes, even though their origins are traced to spatial statistics and also for kriging i.e. the practice of modelling. In comparison to global approximation techniques like least- square fitting, GPs are considered as local approximation techniques, which are similar to nearest-
neighbour procedures. And in comparison to function approximation technique that are placed in the form of function, GP modelling techniques are placed on the covariance underlying structure of the data.

4.6 Datamining evaluation and results

Weka tools Classify 59 rows with 7 attribute evdoDbm, evdoEcio, evdoSnr, gsmBitErrorrate, gsmSignalStrength, Carriername (BSNL3G), SNR

=== Run information ===

Scheme: weka.classifiers.rules.M5Rules -M 4.0
Relation: whatever
Instances: 59
Attributes: 7
evdoDbm
evdoEcio
evdoSnr
gsmBitErrorRate
gsmSignalStrength
carrierName

SNR
Test mode: split 66.0% train, remainder test

=== Classifier model (full training set) ===

M5 pruned model rules
(using smoothed linear models):
Number of Rules : 2

Rule: 1
IF
      gsmSignalStrength > 5
THEN
gsmBitErrorRate = 
0.9821 * gsmSignalStrength 
+ 46.7508 [38/38.373%]

Rule: 2

gsmBitErrorRate = 
+ 1 [21]

Time taken to build model: 0.02 seconds

=== Evaluation on test split ===

Time taken to test model on test split: 0 seconds

=== Summary ===

Correlation coefficient                  0.9943
Mean absolute error                     3.2421
Root mean squared error                  5.0781
Relative absolute error                 10.4391 %
Root relative squared error             15.9249 %
Total Number of Instances               20

Likewise we can create “4G Jio” file to calculate regression and M5Rules to get idea out this data. We can also generate the file of “Lenovo mobile” Model data and check same classifier on it and deduce some pattern on real time data [6].
*NOTES*

By the test we are not favouring any mobile operator company or manufacture because it’s purely data collection based mining and data may vary by external effect and time. One cannot simply justified by one sample time data to the which one having best SNR and BER. It is the test is conducted for only SNR & BER measurement in real device while using 4g, GSM, Wi-Fi & GPS.

**Conclusion**

By this research we can identify mobile devices manufacturer problem or Mobile operator to improve the overall performance. On above data mining we can give how the bit error rate and signal strength makes conditional change. This also helps in future to develop intelligent mobile communication system. From the observation of we can conclude mobile operator having highest signal strength and lower also. We can also come up to the conclusion that Mobile model having high BER and low SNR so became inference situation. If SNR is low ratio than interference presence at there so need better solution.

**References**