Knowledge Discovery in a Stock Data using Moving Averages
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ABSTRACT
Association rules mining algorithms can be used to discover all item associations (or rules) in a dataset. Majority voting is adopted as classification technique and on the basis of voting pattern, the consequent is chosen. The moving averaging is applied on the obtained consequents to identify the emerging pattern. Four moving averages on the basis of Fibonacci sequence are applied. It has been observed that number of trades is more in lower range of moving averages as compared to higher range and a longer days averaging has not been yielding good returns. It has been observed that the accuracy level is higher in case of smaller duration whereas the error rate is on the higher side in case of longer period averages.

Table 1 . List of stocks

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Code</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S1</td>
<td>ABB</td>
</tr>
<tr>
<td>2</td>
<td>S2</td>
<td>ACC</td>
</tr>
<tr>
<td>3</td>
<td>S3</td>
<td>BHEL</td>
</tr>
<tr>
<td>4</td>
<td>S4</td>
<td>BPCL</td>
</tr>
<tr>
<td>5</td>
<td>S5</td>
<td>CIPLA</td>
</tr>
<tr>
<td>6</td>
<td>S6</td>
<td>GRASIM</td>
</tr>
<tr>
<td>7</td>
<td>S7</td>
<td>HDFC</td>
</tr>
<tr>
<td>8</td>
<td>S8</td>
<td>HDFC BANK</td>
</tr>
<tr>
<td>9</td>
<td>S9</td>
<td>HLL</td>
</tr>
<tr>
<td>10</td>
<td>S10</td>
<td>ITC</td>
</tr>
<tr>
<td>11</td>
<td>S11</td>
<td>INFOSYS</td>
</tr>
<tr>
<td>12</td>
<td>S12</td>
<td>L&amp;T</td>
</tr>
<tr>
<td>13</td>
<td>S13</td>
<td>M&amp;M</td>
</tr>
<tr>
<td>14</td>
<td>S14</td>
<td>ONGC</td>
</tr>
<tr>
<td>15</td>
<td>S15</td>
<td>RANBAXY</td>
</tr>
<tr>
<td>16</td>
<td>S16</td>
<td>RELCAP</td>
</tr>
<tr>
<td>17</td>
<td>S17</td>
<td>RELIANCE</td>
</tr>
<tr>
<td>18</td>
<td>S18</td>
<td>SAIL</td>
</tr>
<tr>
<td>19</td>
<td>S19</td>
<td>SBI</td>
</tr>
<tr>
<td>20</td>
<td>S20</td>
<td>SIEMENS</td>
</tr>
<tr>
<td>21</td>
<td>S21</td>
<td>SUNPHARMA</td>
</tr>
<tr>
<td>22</td>
<td>S22</td>
<td>TATAMOTOR</td>
</tr>
<tr>
<td>23</td>
<td>S23</td>
<td>TATASTEEL</td>
</tr>
<tr>
<td>24</td>
<td>S24</td>
<td>UNITECH</td>
</tr>
<tr>
<td>25</td>
<td>S25</td>
<td>WIPRO</td>
</tr>
</tbody>
</table>

After that intra stock mining is conducted on that consequent for the next year and its trend is to be determined. Intra-stock pattern mining concerns with the discovery of repetitive temporal association patterns for the stock itself across a time span of few trading days [11]. Technical analysis tools are discussed and Moving Average technique is adopted to decide what type of action is required in case of reversal in the existing pattern. A combination of these two techniques is presented and the obtained results are discussed. The NSE data of eight years from year 2001-2008 is used and 25 stocks of different sectors have been chosen for the study.

Majority Voting
Majority Voting [15] is used to determine the effectiveness of the mined rules and on the basis of this approach the consequent is chosen and its accuracy is determined. The
occurrences (voting) of each consequent is computed using the instances of the same and then they are categorized as per their votes and the consequent obtaining highest votes is declared as the selected consequent on which intra stock mining is to be conducted. The thirteen tables of association rules are generated. There are ten rules in Table 1 and according to the majority approach the classification result should be “S5”. It is because total votes for “S5” is $84 + 119 + 88 + 111 + 92 + 86 = 580$, total vote for “S8” is $84 + 114 = 198$ and total votes for $S21$ is $84 + 91 = 175$. So as per majority approach S5 would be treated as winning consequent. Further this approach need not to be adopted if there is clearly shown highest number of occurrences of the same consequent in different rules. In case of a tie the total votes are required to be counted. Because of limited space one table is shown with all association rules with a minimum specified confidence. Maximum 10 association rules are taken for the study with minimum support value. In some cases more rules are generated while in some cases, few rules are generated but for the sake of clarity, maximum 10 rules are considered.

Table 2. Single consequent with majority voting for year 2001 support = .16

<table>
<thead>
<tr>
<th>Rules</th>
<th>Association Rules</th>
<th>Confidence</th>
<th>Instances</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>s12, s25 -&gt; s16</td>
<td>.88</td>
<td>43</td>
</tr>
<tr>
<td>2</td>
<td>s6, s11 -&gt; s16</td>
<td>.88</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>s11, s16 -&gt; s25</td>
<td>.84</td>
<td>49</td>
</tr>
<tr>
<td>4</td>
<td>s6, s25 -&gt; s16</td>
<td>.83</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>s6, s16 -&gt; s25</td>
<td>.81</td>
<td>44</td>
</tr>
<tr>
<td>6</td>
<td>s12, s16 -&gt; s25</td>
<td>.80</td>
<td>43</td>
</tr>
<tr>
<td>7</td>
<td>s23, s25 -&gt; s16</td>
<td>.80</td>
<td>44</td>
</tr>
<tr>
<td>8</td>
<td>s16, s23 -&gt; s25</td>
<td>.80</td>
<td>45</td>
</tr>
<tr>
<td>9</td>
<td>s6, s25 -&gt; s11</td>
<td>.75</td>
<td>42</td>
</tr>
<tr>
<td>10</td>
<td>s17 -&gt; s16</td>
<td>.73</td>
<td>49</td>
</tr>
</tbody>
</table>

Table 3 Voting pattern of consequents 2001

<table>
<thead>
<tr>
<th>Consequent</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S11</td>
<td>1</td>
</tr>
<tr>
<td>S16</td>
<td>5</td>
</tr>
<tr>
<td>S25</td>
<td>4</td>
</tr>
</tbody>
</table>

With the use of Majority Voting the voting pattern of the consequents is presented in Table 3 to Table 10. On that basis such eight tables having the list of consequent obtained using majority voting are generated. All the consequents with their voting pattern are presented in the separate tables for each year.

Table 4. Voting pattern of consequents for the year 2002

<table>
<thead>
<tr>
<th>Consequent</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5</td>
<td>6</td>
</tr>
<tr>
<td>S8</td>
<td>2</td>
</tr>
<tr>
<td>S21</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5. Voting pattern of consequents for the year 2003

<table>
<thead>
<tr>
<th>Consequent</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S18</td>
<td>5</td>
</tr>
<tr>
<td>S22</td>
<td>1</td>
</tr>
<tr>
<td>S23</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 6. Voting pattern of consequents for the year 2004

<table>
<thead>
<tr>
<th>Consequent</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S10</td>
<td>3</td>
</tr>
<tr>
<td>S18</td>
<td>3</td>
</tr>
<tr>
<td>S22</td>
<td>2</td>
</tr>
<tr>
<td>S23</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 7. Voting pattern of consequents for the year 2005

<table>
<thead>
<tr>
<th>Consequent</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S6</td>
<td>6</td>
</tr>
<tr>
<td>S10</td>
<td>2</td>
</tr>
<tr>
<td>S21</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 8 Voting pattern of consequents for the year 2006

<table>
<thead>
<tr>
<th>Consequent</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>2</td>
</tr>
<tr>
<td>S16</td>
<td>1</td>
</tr>
<tr>
<td>S18</td>
<td>2</td>
</tr>
<tr>
<td>S20</td>
<td>1</td>
</tr>
<tr>
<td>S21</td>
<td>2</td>
</tr>
<tr>
<td>S23</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 9 Voting pattern of consequents for the year 2007

<table>
<thead>
<tr>
<th>Consequent</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3</td>
<td>2</td>
</tr>
<tr>
<td>S12</td>
<td>1</td>
</tr>
<tr>
<td>S16</td>
<td>3</td>
</tr>
<tr>
<td>S18</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 10. Voting pattern of consequents for the year 2008

<table>
<thead>
<tr>
<th>Consequent</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3</td>
<td>1</td>
</tr>
<tr>
<td>S12</td>
<td>3</td>
</tr>
<tr>
<td>S16</td>
<td>4</td>
</tr>
<tr>
<td>S17</td>
<td>1</td>
</tr>
<tr>
<td>S24</td>
<td>4</td>
</tr>
</tbody>
</table>

A consolidated table is prepared of all the eight years on the basis of majority voting and the consequent was decided and presented in Table 11.

Table 11 the consequent with majority voting is presented below in a table

<table>
<thead>
<tr>
<th>Year</th>
<th>Consequent</th>
<th>Total Instances</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>S16</td>
<td>223</td>
<td>.16</td>
</tr>
<tr>
<td>2002</td>
<td>S5</td>
<td>578</td>
<td>.18</td>
</tr>
<tr>
<td>2003</td>
<td>S18</td>
<td>186</td>
<td>.18</td>
</tr>
<tr>
<td>2004</td>
<td>S18</td>
<td>134</td>
<td>.18</td>
</tr>
<tr>
<td>2005</td>
<td>S6</td>
<td>265</td>
<td>.17</td>
</tr>
<tr>
<td>2006</td>
<td>S23</td>
<td>123</td>
<td>.16</td>
</tr>
<tr>
<td>2007</td>
<td>S18</td>
<td>164</td>
<td>.17</td>
</tr>
<tr>
<td>2008</td>
<td>S24</td>
<td>164</td>
<td>.33</td>
</tr>
</tbody>
</table>

Moving Averages

A moving average is a trend following device. Its purpose is to identify that a new trend has begun or that an old trend has ended or reversed [13]. Its purpose is to track the progress of the trend. The moving average is a follower, not a leader. The moving average follows a market and conveys that a trend has begun, but only after the fact. Moving averages is one of the most popular and easy to use indicators available to the technical analyst [10, 12]. MA method enable the construction of a computerized algorithm for the application of the method, and the indications of buy or sells signals. Because past price data is used to form moving averages, they are considered lagging, or trend following, indicators. A moving average has been an average of observations from several consecutive time periods. To compute a moving average sequence, we compute successive averages of a given number of consecutive observations. The objective underlying the MA method is to smooth out seasonal variation in the data. The method involved a comparison of the most recent market price with the long MA of the price. If the current price is higher than the long MA, a long position (BUY) should be adopted, and conversely, if the current price is lower than the MA, a short position (SELL) could be adopted.

Exponential Moving Average (EMA)

Exponential moving averages (also called exponentially weighted moving averages) apply weighting factors which decrease exponentially. EMAs reduce the lag by applying more weight to recent prices relative to older prices. The shorter the EMAs period, the more weight would be applied to the most recent price. Shorter moving averages would be more sensitive
and generate more signals. However, there would also be an increase in the number of false signals and whipsaws. Longer moving averages would move slower and generate fewer signals. These signals would likely prove to be more reliable, but they also might come late. Because moving averages followed the trend, they work best when a security is trending and are ineffective when a security move in a trading range. A simple visual assessment of the price chart could determine what a security exhibited. Now different Fibonacci days strategies EMAs was studied in the further study.

**Characteristics Of Trend**

There were three ways to identify the direction of the trend with moving averages: direction, location and crossovers. The first trend identification technique used the direction of the moving average to determine the trend [9]. If the moving average was rising, the trend was considered UP. If the moving average was declining, the trend was considered DOWN. The direction of a moving average could be determined simply by looking at a plot of the moving average or by applying an indicator to the moving average. In either case, we would not want to act on every subtle change, but rather look at general directional movement and changes.

**Experimental Results**

Four combination of Fibonacci days are used as ema8-21, ema13-34, ema 21-55 and ema 34-89. The following charts have been presented using these four different Moving Average strategies as ema 8-21, ema13-34, ema 21-55 and ema 34-89 for each consequent for each year and the crossover details of that consequent was tabulated.

![Fig 1 s16 chart with ema8-21](image1)

![Fig. 2 s16 chart with ema13-34](image2)

![Fig. 3 s16 chart with ema21-55](image3)

![Fig. 4 s16 chart with ema34-89](image4)

<p>| Table 12: Crossover details of stock s16 for year 2002 |</p>
<table>
<thead>
<tr>
<th>ema</th>
<th>date</th>
<th>buy</th>
<th>date</th>
<th>sell</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-21</td>
<td>6.6.2002</td>
<td>51.80</td>
<td>15.5.2002</td>
<td>52.35</td>
</tr>
<tr>
<td>12.6.2002</td>
<td>51.80</td>
<td>19.7.2002</td>
<td>54.40</td>
<td></td>
</tr>
<tr>
<td>11.11.2002</td>
<td>46</td>
<td>15.7.2002</td>
<td>54.25</td>
<td></td>
</tr>
<tr>
<td>15.11.2002</td>
<td>46</td>
<td>31.12.2002</td>
<td>58.15</td>
<td></td>
</tr>
<tr>
<td>13-34</td>
<td>12.6.2002</td>
<td>51.80</td>
<td>19.7.2002</td>
<td>54.40</td>
</tr>
<tr>
<td>15.11.2002</td>
<td>46</td>
<td>19.7.2002</td>
<td>54.40</td>
<td></td>
</tr>
<tr>
<td>15.11.2002</td>
<td>46</td>
<td>31.12.2002</td>
<td>58.15</td>
<td></td>
</tr>
<tr>
<td>21-55</td>
<td>20.11.2002</td>
<td>49.45</td>
<td>25.7.2002</td>
<td>51.45</td>
</tr>
<tr>
<td>20.11.2002</td>
<td>49.45</td>
<td>31.12.2002</td>
<td>58.15</td>
<td></td>
</tr>
<tr>
<td>34-89</td>
<td>29.11.2002</td>
<td>53.60</td>
<td>31.12.2002</td>
<td>58.15</td>
</tr>
</tbody>
</table>

On the same pattern charts for all the six years Charts were used to determine the crossover of emas and accordingly six tables are presented below

<p>| Table 13. crossover details of stock s5 for year 2003 |</p>
<table>
<thead>
<tr>
<th>ema</th>
<th>date</th>
<th>buy</th>
<th>date</th>
<th>sell</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-21</td>
<td>30.5.2003</td>
<td>55</td>
<td>20.1.2003</td>
<td>69</td>
</tr>
<tr>
<td>30.5.2003</td>
<td>55</td>
<td>31.12.2003</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>13-34</td>
<td>4.6.2003</td>
<td>57</td>
<td>12.1.2003</td>
<td>69</td>
</tr>
</tbody>
</table>

<p>| Table 14. crossover details of stock s18 for the year 2004 |</p>
<table>
<thead>
<tr>
<th>ema</th>
<th>date</th>
<th>buy</th>
<th>date</th>
<th>sell</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-21</td>
<td>20.4.2004</td>
<td>37</td>
<td>21.1.2004</td>
<td>45</td>
</tr>
<tr>
<td>20.4.2004</td>
<td>37</td>
<td>30.4.2004</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>6.7.2004</td>
<td>30</td>
<td>30.4.2004</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>21-55</td>
<td>30.7.2004</td>
<td>40</td>
<td>13.2.2004</td>
<td>47</td>
</tr>
<tr>
<td>34-89</td>
<td>17.8.2004</td>
<td>42</td>
<td>15.3.2004</td>
<td>37</td>
</tr>
</tbody>
</table>

<p>| Table 15 crossover details of stock s6 for the year 2005 |</p>
<table>
<thead>
<tr>
<th>ema</th>
<th>date</th>
<th>buy</th>
<th>date</th>
<th>sell</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-21</td>
<td>18.1.2005</td>
<td>61</td>
<td>12.1.2005</td>
<td>56</td>
</tr>
<tr>
<td>18.1.2005</td>
<td>61</td>
<td>28.3.2005</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>12.7.2005</td>
<td>52</td>
<td>28.3.2005</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>12.7.2005</td>
<td>52</td>
<td>10.10.2005</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>13-34</td>
<td>20.7.2005</td>
<td>54</td>
<td>8.4.2005</td>
<td>64</td>
</tr>
<tr>
<td>20.7.2005</td>
<td>54</td>
<td>13.10.2005</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>21-55</td>
<td>3.8.2005</td>
<td>54</td>
<td>18.4.2005</td>
<td>54</td>
</tr>
<tr>
<td>34-89</td>
<td>9.8.2005</td>
<td>62</td>
<td>2.5.2005</td>
<td>54</td>
</tr>
</tbody>
</table>

<p>| Table16 crossover details of stock s6 for the year 2006 |</p>
<table>
<thead>
<tr>
<th>EMA</th>
<th>date</th>
<th>buy</th>
<th>date</th>
<th>sell</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-21</td>
<td>21.1.2006</td>
<td>1375</td>
<td>15.5.2006</td>
<td>2125</td>
</tr>
<tr>
<td>29.6.2006</td>
<td>1835</td>
<td>15.5.2006</td>
<td>2125</td>
<td></td>
</tr>
<tr>
<td>29.6.2006</td>
<td>1835</td>
<td>29.12.2006</td>
<td>2997</td>
<td></td>
</tr>
<tr>
<td>13-34</td>
<td>21.1.2006</td>
<td>1375</td>
<td>19.5.2006</td>
<td>1925</td>
</tr>
<tr>
<td>9.7.2006</td>
<td>1901</td>
<td>19.5.2006</td>
<td>1925</td>
<td></td>
</tr>
<tr>
<td>9.7.2006</td>
<td>1901</td>
<td>29.12.2006</td>
<td>2997</td>
<td></td>
</tr>
<tr>
<td>21-55</td>
<td>24.7.2006</td>
<td>1907</td>
<td>30.5.2006</td>
<td>1876</td>
</tr>
<tr>
<td>24.7.2006</td>
<td>1907</td>
<td>29.12.2006</td>
<td>2797</td>
<td></td>
</tr>
</tbody>
</table>
In this approach the return is found to be positive for all the years except in one in which it is found to be on a negative side, but still it is on a much lower side. Further with ema34-89 the return is having negative value for two years Fig. 5, but those values found to be on a higher side, thus indicating, that perspective is to be avoided.

So a longer days averaging has not been yielding good returns. So in both the approaches the ema34-89 strategy is found to be not a better strategy and such a longer days averaging approach might be avoided.

The performance metric such as accuracy and error rate is defined as follows

Accuracy = Number of correct predictions / Total number of predictions

Error rate = Number of wrong predictions / Total number of predictions

The accuracy and error rate for each ema strategy and for Moving Averages approach was evaluated and presented below in table 20. It has been observed the accuracy level was higher in case of smaller duration whereas the error rate is on the higher side in case of longer day average.

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### Table 17. Crossover details of stock s23 for the year 2007

<table>
<thead>
<tr>
<th>ema</th>
<th>date</th>
<th>buy date</th>
<th>sell date</th>
</tr>
</thead>
<tbody>
<tr>
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<td>438</td>
<td>1.8.2007</td>
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<td>9.11.2007</td>
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<td>3.9.2007</td>
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<td>3.9.2007</td>
<td>691</td>
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<td>10.4.2007</td>
<td>495</td>
<td>21.8.2007</td>
</tr>
<tr>
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<td>31.8.2007</td>
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<td>21.8.2007</td>
</tr>
<tr>
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<td>31.8.2007</td>
<td>690</td>
<td>31.12.2007</td>
</tr>
<tr>
<td>34-89</td>
<td>17.4.2007</td>
<td>528</td>
<td>31.12.2007</td>
</tr>
</tbody>
</table>

### Table 18. Crossover details of stock s18 for the year 2008

<table>
<thead>
<tr>
<th>ema</th>
<th>date</th>
<th>buy date</th>
<th>sell date</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-21</td>
<td>21.2.2008</td>
<td>236</td>
<td>8.1.2008</td>
</tr>
<tr>
<td></td>
<td>21.2.2008</td>
<td>236</td>
<td>12.3.2008</td>
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<tr>
<td></td>
<td>1.8.2008</td>
<td>144</td>
<td>10.9.2008</td>
</tr>
<tr>
<td></td>
<td>30.12.2008</td>
<td>79</td>
<td>10.9.2008</td>
</tr>
<tr>
<td>13-34</td>
<td>27.2.2008</td>
<td>243</td>
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<td>243</td>
<td>12.3.2008</td>
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<td>8.8.2008</td>
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<td>12.3.2008</td>
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<td>8.8.2008</td>
<td>146</td>
<td>12.9.2008</td>
</tr>
<tr>
<td></td>
<td>34-89</td>
<td>4.3.2008</td>
<td>229</td>
</tr>
<tr>
<td></td>
<td>4.3.2008</td>
<td>229</td>
<td>31.12.2008</td>
</tr>
</tbody>
</table>

Four moving averages as ema8-21, ema13-34, ema21-55 and ema34-89 are applied. It has been observed that number of trades is more in lower range of moving average as compared to higher range. Now evaluating the patterns for different stocks using different emas, return is being evaluated as once buy call is initiated, it would be terminated after another SELL signal and then it has to wait for another BUY signal. Consolidated returns with all different EMAs are presented in Table 19.

---

### Table 19. Moving Averages returns

<table>
<thead>
<tr>
<th>year</th>
<th>ema8-21</th>
<th>ema13-34</th>
<th>ema21-55</th>
<th>ema34-89</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>32.93</td>
<td>32.93</td>
<td>21.21</td>
<td>16.92</td>
</tr>
<tr>
<td>2003</td>
<td>89.09</td>
<td>82.53</td>
<td>61.46</td>
<td>57.91</td>
</tr>
<tr>
<td>2004</td>
<td>51.25</td>
<td>107.80</td>
<td>56.35</td>
<td>49.00</td>
</tr>
<tr>
<td>2005</td>
<td>11.83</td>
<td>5.44</td>
<td>1.81</td>
<td>-14.23</td>
</tr>
<tr>
<td>2006</td>
<td>57.76</td>
<td>47.85</td>
<td>41.35</td>
<td>48.56</td>
</tr>
<tr>
<td>2007</td>
<td>21.60</td>
<td>38.85</td>
<td>22.45</td>
<td>75.54</td>
</tr>
<tr>
<td>2008</td>
<td>-5.44</td>
<td>-7.05</td>
<td>0.00</td>
<td>-64.62</td>
</tr>
</tbody>
</table>

---

Fig. 5 Chart of four emas

---

In this approach the return is found to be positive for all the years except in one in which it is found to be on a negative side, but still it is on a much lower side. Further with ema34-89 the return is having negative value for two years Fig. 5, but those values found to be on a higher side, thus indicating, that perspective is to be avoided.

So a longer days averaging has not been yielding good returns. So in both the approaches the ema34-89 strategy is found to be not a better strategy and such a longer days averaging approach might be avoided.

The performance metric such as accuracy and error rate is defined as follows

Accuracy = Number of correct predictions / Total number of predictions

Error rate = Number of wrong predictions / Total number of predictions

The accuracy and error rate for each ema strategy and for Moving Averages approach was evaluated and presented below in table 20. It has been observed the accuracy level was higher in case of smaller duration whereas the error rate is on the higher side in case of longer day average.

### Table 20. EMA comparison

<table>
<thead>
<tr>
<th></th>
<th>ema8-21</th>
<th>ema13-34</th>
<th>ema21-55</th>
<th>ema34-89</th>
</tr>
</thead>
<tbody>
<tr>
<td>accuracy rate</td>
<td>.63</td>
<td>.8</td>
<td>1</td>
<td>.71</td>
</tr>
<tr>
<td>error rate</td>
<td>.37</td>
<td>.2</td>
<td>0</td>
<td>.29</td>
</tr>
</tbody>
</table>

---

Fig. 6 Returns using four emas (Moving Averages)

---

Fig 7. Cumulative returns of different ema strategies

It has been shown that except in one year there was an overall positive return for each year. There is a negative return in one year but was still on much lower side. The returns is evaluated using all the four averages and it has been found that overall positive returns is obtained for different days moving strategies Fig. 6. There are variations in the terms of returns obtained and the highest return is achieved with ema13-34. It is also clearly reflected in the cumulative returns chart in fig. 7 which indicates that using ema13-34, the highest profitability was achieved.
Conclusion
It has been established that using majority approach on the generated rules one could plan their investment strategies, but it has not been giving a positive outlook for all the years, therefore only majority voting approach is not sufficient, some more indicators are required to be applied after having obtained a consequent using majority voting. Moving averages is a technical indicator which normally used to spot a trend. Normally it is very useful indicator when there is a change in the market trend either uptrend or downtrend. It is used to have a confirmation of a reversal of the trend. Moving averages can be an effective tool to identify and confirm the trend, identify support and resistance levels, and develop trading systems. However, traders and investors should learn to identify securities that are suitable for analysis with moving averages and how this analysis should be applied. Usually, an assessment can be made with a visual examination of the price chart, but sometimes it will require a more detailed approach. Four moving averages as ema8-21, ema13-34, ema21-55 and ema34-89 were applied. It has been observed that number of trades was more in lower range of moving average as compared to higher range. The return was found to be positive for all the years except in one year it found to be on a negative side, but still it is on a much lower side. Further with ema34-89 the return is having negative value for two years, but those values found to be on a higher side, thus indicating that perspective found to be avoided. Further a longer days averaging has not been yielding good returns. So in both the approaches the ema34-89 strategy is found to be not a better strategy and such a longer days averaging approach might be avoided. It has been observed that ema13-34, the highest profitability is achieved among the four emas.

References