AZO DYE DEGRADING BACTERIA ISOLATED FROM COW DUNG IN TRICHY DISTRICT, TAMILNADU, SOUTH INDIA

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ABSTRACT

Dye degrading efficiency of bacteria isolated from Cow dung in Trichy District. Four different bacterial strains Enterobacter sp., Klebsiella sp., Serratia sp., and Bacillus sp. were isolated. The dye degrading efficiency was ranging between 24.03% to 61.52%. As the days of incubation were increasing from 1 to 7 days the degradation efficiency was also increasing to a greater extent. When compared to all the bacterial isolates Bacillus sp. is a highly promising agent, which could act as an efficient dye degrader. Because, from the first day onwards, the degradation was high (34.10%), and after that, at every day incubation the degradation was increasing profoundly. 46.31%, 54.26% and to a maximum of 98.44% at the end of 7 days. Almost hundred % of degradation was effected by this isolate. The entire cell Supernatants also showed equal dye degrading ability. FT –IR, HPLC results confirmed that, the complex, toxic azo dyes are degraded in to simple, non toxic compounds. Due to the removal or the complete degradation the environment is protected from Azo dyes.

Key Words: Bacteria, Azo dye, Degradation, FT –IR and HPLC

INTRODUCTION

Synthetic dyes are colouring agents mainly used in textile industries which generate a huge amount of wastewater in the process of dyeing. Different dyes used in textile industry usually have a synthetic origin and complex aromatic molecular structures which make them more stable and more difficult to be biodegraded. Due to their ease of manufacturing methodology, azo dye statement for almost 82% of annual production of commercial dyes all over the world. Dyes are coloring pigment that imparts color to the
substrate when they are in solution form. Dyes are derived synthetically from raw materials like hydrocarbons, benzene, toluene, naphthalene and anthracene using coal tar obtained from distillation of coal. Both organic and inorganic materials are needed to make dyes and intermediates (Patovirta et al., 2003). The raw material sequence for making dye is petroleum to hydrocarbons to intermediates to dyes. Textile dyes effluents have toxic effect on the germination rates and biomass concentration of several plant species which play many important ecological functions such as providing the habitat for wildlife: protecting soil from erosion and providing bulk of organic matter that is significant to soil fertility. The toxicity of effluent is because of the presence of dye or its degraded products which are mutagenic or carcinogenic. Therefore, the treatment of industrial effluents contaminated with dye becomes necessary prior to their final discharged to the environment (Elisangela et al., 2009). Biological processes provide an alternative to existing technologies because they are more cost-effective, environmentally friendly, and do not produce large quantities of sludge. Biodegradation by microorganisms is a promising approach for treating dyes contained in wastes. The effectiveness of decolorization depends on the adaptability and the activity of selected microbes. In the present study was to investigate degradation of Azo dye by bacteria isolated from cow dung.

Materials and Methods

Sample Collection

Fresh Cow dung was collected from Kuzhumani, Trichy district, Tamilnadu, South India. The sample was collected with sterilized spatula and kept in sterile polyethylene bags. The samples were transported to the laboratory in an icebox and processed within 6hrs of collection.

Isolation of Bacteria

Nutrient agar medium was prepared and autoclaved. Then the medium was poured into sterile petri plates. The collected cow dung sample was diluted up to $10^{-6}$ and 0.1 ml of the diluted samples was spread over the agar plates. The plate was incubated at 37°C for 24 Hrs. After incubation the colonies was purified by using streak plate method then the bacterial cultures were stored at 4°C for further investigation (Teo et al., 2011).

Characterization of bacteria

Selected individual colonies from nutrient agar were subjected to microscopic
observations of gram staining, motility test and biochemical tests (indole, MR-VP, Citrate utilization, Urea production, Triple sugar iron and oxidase test) for further identification (Shrivastava and Mishra, 2011).

Collection of Dye

The dye sample was graded and supplied by the dealers of global dyes, Tiruppur, Tamilnadu, and South India. Azo dye used in this study is reactive 2B (λm= 5m).

Bacterial inoculum preparation

All the isolates cultures were inoculated in Nutrient broth and incubated for 24 hrs. 18 – 24 hrs fresh cultures were used. Fresh cultures were prepared for every time (Chang and Lin, 2001).

Dye decolorization (Waghmode et al., 2011a)

Dye decolorization were carried out in 500 ml flask containing 250ppm of azo dyes in 250 ml of C-limited Czapek-Dox broth. The pH was adjusted to 7.3± 0.2 using sodium hydroxide and hydrochloric acid solution. Then, the flasks were autoclaved at 121°C for 15minutes. The autoclaved flasks were inoculated with 1ml of all the bacterial inoculums separately. The flasks were kept in a mechanical shaker at room temperature for 7-15 days. Samples were drawn at 24 hrs intervals for observation. 10ml of the dyes solution was filtered and centrifuged at 5000rpm for 20minutes. Decolorization was assessed by measuring absorbance of the supernatant with the help of UV spectrophotometer at wavelength maxima (m) of respective dye (580nm).

Assay on the dye degrading Efficiency of supernatants:

From 24 Hrs broth cultures, the supernatant was collected by the following procedure. 10ml of the culture was centrifuged at 10000 rpm for 30 minutes. The supernatant was collected separately, pellet was discarded. The supernatants of all the cultures were utilized separately for the dye degradation analysis (Waghmode et al., 2011a).

FT-IR spectral analysis

The samples were dried and grinded with KBr pellets and analyzed on a Shimadzu FT-IR Affinity model in the diffuse reflectance mode operating at a resolution of 4cm−1 (Vaijayanthi et al., 2012).
HPLC ANALYSIS

Reverse phase HPLC (Cyberlab, USA) analysis was carried out in a C 18 Column (250 mm X 4.6 mm) version (Lake Forest, CA, USA) equipped with a C18 guard column. The compounds were eluted with an isocratic elution of Acetonitrile vs water at the flow rate of 1 mL/min & absorbance recorded at 680nm (Baiocchi et al., 2002).

RESULT AND DISCUSSION

In the present study cow dung sample was collected from Trichy district, Tamilnadu, South India. A total of 4 different bacterial isolates were isolated from the cow dung sample of Trichy district, and they were characterized based on the morphological, biochemical and cultural properties. Morphologically, all the isolates were rod shaped and 3 is motile and one is non motile bacteria. Among the 4 isolates 3 isolates were identified as Gram negative and one identified as Gram positive bacteria. Biochemically, indole was positive by 3 isolates and 1 isolate is negative followed by citrate utilization. Whereas, the results of other biochemical tests were varied between the isolates. Among 4 bacteria, each one isolate was belonged to Enterobacter sp., Klebsiella sp., Serratia sp. and Bacillus sp. (Table-1). Earlier studies, Shunyao et al., 2017 was identified E2-degradating bacterium E2S was isolated from the activated sludge of a STP in Nanjing, China. E2S is rod shaped with a size of 0.5 µm × 1.8 µm and lacks a flagellum. The analysis of the physiological and biochemical characteristics of E2S show that it is gram negative; it lacks the ability to produce indol or H2S, hydrolyze starch, use sodium citrate, decompose glucose to produce pyruvate, or hydrolyze gelatin. By contrast, the glucose fermentation, nitrate reductase and methyl red test were positive. Similarly, Sharma et al.,(2009), Waghmode et al.,2012 stated that the decolorization of textile dye waste water is a major aspect of research, to solve the problem of environmental pollution.

Dye degrading efficiency of bacteria was assayed against dye. At every 24 Hrs intervals sample was derived and analyzed spectrophotometrically. The dye degrading efficiency was ranging between 24.03% to 61.52%. As the days of incubation were increasing from 1 to 7 days the degradation efficiency was also increasing to a greater extent. The bacterial isolates Bacillus sp., 78.44% (Table-2) followed by Serratia sp., 65.11%, (Table-3) Klebsiella sp., 62.9% (Table-4) and Enterobacter (61.52%). When compared to all the bacterial isolates Bacillus sp is a highly promising agent, which could act as an efficient dye degrader. Because, from the first day onwards, the degradation was high (34.10%), and after
that, at every day incubation the degradation was increasing profoundly. i.e 46.31%, 54.26%. To a maximum of 78.44% at the end of 7 days (Table-5). Previously, Aldoury et al., (2014) reported that when plicatilis was cultured in malt extract medium containing 50mg/L RB 19, the percentage decolorization increased over time, reaching a peak of 99% decolorization after 15 days of incubation. similarly, Elisangela et al., 2009 studied that pleurotus sp. it is capable of efficient decolorization of a wide range of chemically different dyes. In this study the dye degradation which could be available in the supernatant was also subjected for the degradation of dye. All the supernatants showed good results similar to that of whole bacterial cells the result was given in fig-1. Bacillus sp., is a dominant isolates of dye degradation when compared to other isolates so, it was selected for FT-IR and HPLC analysis. Many authours reported the similar result such as Chen et al., 2005; Modi et al., 2010; Phugare et al., 2011 and Lade et al., 2015).

FTIR spectrum of control and samples obtained after decolourization of both dyes showed various peaks. A new peak at 1384 cm⁻¹ represented –N=N- stretching vibration. The C− H deformation showed at 1112 cm⁻¹. The peak at 1384 cm⁻¹ showed N-H stretching vibration. The significant change in the FTIR spectrum of metabolites compared to control spectrum suggest the biotransformation of complex dyes present in the mixture into simpleform. The FTIR spectrum of control Dye 6 displays peak at 3449 for intramolecular hydrogen bonding and O-H stretching. Peaks in the control dye spectrum represented symmetric stretching at 1384 cm⁻¹and asymmetric stretching at 1114 cm⁻¹for C−N. C−N stretching at 1637 cm⁻¹represented nature of aromatic amine group present in parent dye; 3449 cm⁻¹and 2075 cm⁻¹represented the presence of free NH group of parent dye. whereas peak at 1637 cm⁻¹represented −N=NH- stretching of azo group. In degraded extracted metabolites, a new peak at 435 cm⁻¹represented C−H deformation of alicyclic CH2 whereas a peak at 685 cm⁻¹was observed for substituted anilines (Fig.2 &3). Zhou (2002), reported that, the sample treated with both E. cloacae and H. alvei obtained a new peak with 2.61 RT along with 2 other peaks with similar RT as those observed in case of two previously mentioned treatments. Comparison between the polarities of the samples showed that the control and H. alvei treated samples have the peak with shortest RT 1.98. From the retention times, it can be concluded that the control has the highest polarity. Polarity refers to the number of functional groups in the dye Zhou H, (2002). Highest retention time of 2.6 and thus the lowest polarity was obtained by the sample treated with the two bacterial isolates. All the treated samples showed peaks almost similar to that of control. But the peak with RT 2.94 did not appear in any of the treated samples.
In this present study HPLC analysis of control azo dye and *Bacillus* sp degraded sample of dye were depicted in Fig 4&5. The absorption spectra of the samples obtained at 680 nm are presented in figures 7 & 8. The HPLC elution profile of the Azo dye (Control) showed 5 peaks with retention time (RT) of 1.98, 2.18, 2.37, 2.59 and 2.94 minutes. The elution profile obtained for the bacteria treated samples significantly differed from the control in terms of number, height of peaks obtained and RT. The HPLC profile of azo dye treated with bacterial isolate *Bacillus Sp* showed 3 peaks with RT 1.98, 2.18 & 2.39. Kalyani et al., 2008 reported the HPLC analysis of control dye showed the presence of one major peak at retention time of 2.702 min and three minor peaks at retention times of 2.125, 2.801, and 3.394 min (Figure 3(a)). After the dye decolorization process, the disappearance of peaks as seen in case of the control and the formation of completely different three major peaks at retention times of 2.521, 3.241, and 3.564 min and two minor peaks at retention time of 3.123 and 3.910 min were observed.

**Conclusion**

To conclude, the complex chemical azo dyes could be degraded by the whole cell, and supernatant of *Bacillus sp* isolated from Cow dung. Similarly, instead of using hazardous, time consuming and costly chemicals, we could protect our environment from dyes by using these types of natural bacterial isolates and their supernatant.

**REFERENCE**


**Table:1 Characterizations of cow dung bacteria**

<table>
<thead>
<tr>
<th>Name of the test</th>
<th>Enterobacter</th>
<th>Klebsiella</th>
<th>Serratia</th>
<th>Bacillus sp</th>
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<tbody>
<tr>
<td>Gram staining</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
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<td>Shape</td>
<td>Rods</td>
<td>Rods</td>
<td>Rods</td>
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<tr>
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<td>-</td>
<td>+</td>
<td>+</td>
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<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Methyl red</td>
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<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Voges proskaur</td>
<td>-</td>
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<td>+</td>
<td>-</td>
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<td>Citrate utilization</td>
<td>-</td>
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<td>+</td>
<td>-</td>
</tr>
<tr>
<td>TSI (H2 S)</td>
<td>Acidic</td>
<td>-</td>
<td>-</td>
<td>acidic</td>
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<tr>
<td>Oxidase</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
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<tr>
<td>Urease</td>
<td>+</td>
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### Table-2 Dye Degrading Efficiency of *Enterobacter* sp.

<table>
<thead>
<tr>
<th>Days of Incubation</th>
<th>Control(OD)</th>
<th>OD (590 nm)</th>
<th>Degradation Efficiency (%)</th>
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<tr>
<td>1</td>
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<td>3</td>
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<tr>
<td>4</td>
<td>1.29</td>
<td>0.83</td>
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<td>5</td>
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<tr>
<td>7</td>
<td>1.29</td>
<td>0.59</td>
<td>61.52</td>
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</table>

### Table-3 Dye Degrading Efficiency of *Klebsiella pneumoniae*

<table>
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<th>OD (590 nm)</th>
<th>Degradation Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1.29</td>
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<td>2</td>
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<td>7</td>
<td>1.29</td>
<td>0.56</td>
<td>62.90</td>
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### Table-4 Dye Degrading Efficiency of *Serratia* sp.,

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<th>Days of Incubation</th>
<th>Control(OD)</th>
<th>OD (590 nm)</th>
<th>Degradation Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.29</td>
<td>0.88</td>
<td>33.09</td>
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<tr>
<td>2</td>
<td>1.29</td>
<td>0.83</td>
<td>35.56</td>
</tr>
<tr>
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<td>0.79</td>
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<td>5</td>
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<td>7</td>
<td>1.29</td>
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Table-5 Dye Degrading Efficiency of Bacillus sp

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<th>Days of Incubation</th>
<th>Control OD (590nm)</th>
<th>Degradation efficiency(%)</th>
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<td>1.29</td>
<td>0.99</td>
</tr>
<tr>
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<td>1.29</td>
<td>0.93</td>
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<td>3</td>
<td>1.29</td>
<td>0.82</td>
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<tr>
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<tr>
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<td>1.29</td>
<td>0.61</td>
</tr>
<tr>
<td>7</td>
<td>1.29</td>
<td>0.53</td>
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</table>

Fig-1 Dye degradation of bacterial supernatant

Fig-2a FTIR analysis of dye (control)

Fig-2b FTIR Analysis of Azo dye degradation by Bacillus sp.
Fig-3a HPLC chromatogram of Azo dye (Control)

Fig-3b HPLC chromatogram of Azo dye degraded by the *Bacillus* Sp.
AN EMPIRICAL STUDY ON FACTORS THAT INFLUENCES THE MARKETING OF PINE APPLES IN VAZHAKULAM-KERALA

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Dhanalakshmi Srinivasan College of Arts and Science for Women, Perambalur.

ABSTRACT:

Agriculture is the back bone of Indian economy, and no designing for economic process can be fruitful while not the event of the agricultural sector. Pineapple is that the marvelous tropical fruit having exceptional appetisingness, vivacious tropical flavor and large health advantages. Pineapple exhibits increasing demand worldwide, over the years. During this article the man of science needs to seek out out the assorted factor that influences the promoting of pine apple in Vazhakulam space, Kerala. Vazhakulam in Ernakulam district is extremely renowned for pineapple cultivation. Primary knowledge was collected by the man of science with the assistance of structured form administered to farmers’ victimisation interview schedule. A sample of one hundred forty farmers was elect from the pineapple farmers’ association members in Vazhakulam, Manjalur panchayath. Victimisation applied mathematics package for scientific discipline (SPSS) the subsequent check were administered one. Factor Analysis and a pair of. Dependability check. Supported the check results a number of the relevant findings were derived which will be important and relevant to the pineapple growers to plug their product.

Key Words: Market, Pineapple & promoting

Introduction:

India could be a country of peasants, and agricultural provides sustenance to over 2 third of Indian population. Agriculture is the back bone of Indian economy and no designing for economic process will be fruitful while not the event of the agricultural sector. This sector in India assumes special importance within the context of the population explosion, and it's needed that agricultural designing ought to be therefore devised that agricultural productivity ought to keep step with the growing population. Pineapple is that the marvelous tropical fruit having exceptional appetisingness, vivacious tropical flavor and large health advantages. Pineapple exhibits increasing demand worldwide, over the years. The worldwide trade is around five hundredth as contemporary fruit half-hour as canned product and 2 hundredth juice concentrate. during this article the man of science needs to seek out out the assorted
factors that influences the promoting of pineapple in Vazhakulam space, Kerala. Vazhakulam in Ernakulam district is extremely renowned for pineapple cultivation. Pineapple has been commercially fully grown in Vazhakulam space for over fifty years for its glorious fruit for contemporary consumption.

**Review of Literature**

Dr. P. Anandaraj and Dr. V. Chinniah in their study on the promoting issues of mango growers in Madurai District, Tamil Nadu” (2011) found that, the extremely volatile worth pattern, lack of storage facilities, non-handiness of agricultural labours now {and then|every now and then} the primitive strategies of mango cultivation and the stranglehold of the center man area unit a number of the disabling road blocks featured by the mango entrepreneurs devouring of a gradual progress. there's an imperative got to came upon economical market data network, in order that farmers will get timely and adequate market connected data, which is able to facilitate them to urge higher worth for the mango. Dr. D. Seetha and Dr. B. Shivaraj had studied “Production and promoting of fruits and vegetables in Karnataka” (2006) states that, there's a necessity to develop an economical transport system for fast procural and distribution turn out. A processed system will be used for this purpose. Production designing is important in order that there's matching of offerand demand. This incorporate dissemination of promoting data to farmers. C.P. Godara and S.R. Bhonde in their study on “Market arrivals and worth trend of necessary fruits at Azadpur Mandi, Delhi” (2006) the study of seasonal fluctuation in arrivals and costs reveals that arrivals of most of the fruits were higher within the season and lower within the lean season. The correlation between arrivals and costs were discovered and it had been found that each one fruits area unit negatively related. Once arrival of fruits will increase, costs weakened and vice-versa. Prof. (Dr) P.K. Dutta had studied “Agricultural rural promoting in India” (2011). In his study he found that major issues that have an effect on agricultural rural promoting area unit underneath developed individuals and underneath developed markets, lack of correct physical communication facilities, inadequate media coverage for rural communication, multiple languages and Dialects and market organisation & workers. In his study he suggests that for storage facilities the govt. ought to rely on personal agencies to store food grains. Rural markets would like a lot of range of go downs and ancillary platforms for packing places, market workplace liquid body substance data cell, bank and post workplace. Dr. Shivsankar K and Dr. Basavaraj Banakar had studied “Agribusiness management in Karnataka: a case analysis of dry chillies and its products” all the chosen markets the turn outs incurred the value in promoting of the produce solely on sorting. Hence, most of the farmers
oversubscribed their turn out to the native traders within the village level solely. An appraisal of elements of promoting price clearly discovered that the value on packing fashioned the foremost important constituent of total cost incurred by farmers particularly in dry chillies within the study space. Dr.N.Kathiravel had studied “Satisfaction level of farmers towards production and promoting of agricultural products” in his study he steered that the scale of the farm holdings incorporates a direct impact on the output of agricultural. Sub divisions and fragmentation of the farms resulting in uneconomical holdings lead to lower output. Necessary steps ought to be taken to consolidate the little holdings of the farmers to create the agricultural holding a lot of economic in order that it'll increase the output. The uneconomical holding could also be born-again into economic holdings through corporative farming. The National Commission on Agriculture outlined Agricultural promoting because the method that starts with a choice to provide vendible farm commodities and it involves all aspects of market structure or system each practical, institutional supported technology and academic thought as well as pre and post harvest operation, grading, storage, transportation and distribution.

**Objectives:**

To find out the assorted factors that influences the promoting of pine apple in Vazhakulam Area, Kerala.

**Methodology:**

The study is a descriptive one. Primary data was collected by the researcher with the help of structured questionnaire administered to farmers using interview schedule. A sample of 140 farmers was selected from the pineapple farmers’ association members in Vazhakulam, Manjalur panchayath. Fifteen questionnaires were distributed for the purpose of pre-testing the questionnaire's contents a complete questionnaire was developed based on the comments collected during the pre-testing period. Type of sampling method used was convenience sampling. Using statistical package for social science (SPSS) the following test were administered 1. Factor Analysis and 2. Reliability test.

**Reliability Statistics:**

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
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</thead>
<tbody>
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<td>.654</td>
<td>22</td>
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</tbody>
</table>
An examination had been made from the reliability of the data to check whether random error causing inconsistency and in turn lower reliability is at a manageable level or not, by running reliability test. From table 1 it is clear that the values of coefficient Alpha (Cronbach’s Alpha) have been obtained, the minimum value of coefficient Alpha obtained was .654. This shows data has satisfactory internal consistency reliability.

**Factor Analysis:**

The individual statements of a study on the factors that influences the marketing of pine apples was examined using factor analysis based on 20 individual statements and their reliability of the samples collected was tested for internal consistency of the grouping of the items.

**Table 2: KMO and Bartlett's Test**

<table>
<thead>
<tr>
<th>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</th>
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<tbody>
<tr>
<td>Bartlett's Test of Sphericity</td>
<td>Approx. Chi-Square</td>
</tr>
<tr>
<td></td>
<td>df</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
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</tbody>
</table>

KMO measure of sampling adequacy is an index to examine the appropriateness of factor analysis. High values between 0.5 and 1.0 indicate factor analysis is appropriate. Values below 0.5 imply that factor analysis may not be appropriate. From the above table it is seen that Kaiser – Meyer – Olkin measure of sampling adequacy index is **0.601** and hence the factor analysis is appropriate for the given data set. Bartlett’s Test of Sphericity is used to examine the hypothesis that the variables are uncorrelated. It is based on chi-Square transformation of the determinant of correlation matrix. A large value of the test statistic will favor the rejection of the null hypothesis. In turn this would indicate that factor analysis is appropriate. Bartlett’s test of Sphericity Chi-square statistics is 895.121, that shows the 20 statements are correlated and hence as inferred in KMO, factor analysis is appropriate for the given data set.
Table 3: Total Variance Explained

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<th>Component</th>
<th>Initial Eigen values</th>
<th>Extraction Sums of Squared Loadings</th>
<th>Rotation Sums of Squared Loadings</th>
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<td>Total</td>
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<td>Cumulative %</td>
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<td>7.522</td>
<td>51.670</td>
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<tr>
<td>6</td>
<td>1.082</td>
<td>5.409</td>
<td>63.792</td>
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<td>.946</td>
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<tr>
<td>9</td>
<td>.831</td>
<td>4.154</td>
<td>76.844</td>
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<td>10</td>
<td>.779</td>
<td>3.896</td>
<td>80.739</td>
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<tr>
<td>11</td>
<td>.674</td>
<td>3.372</td>
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</tr>
<tr>
<td>12</td>
<td>.616</td>
<td>3.080</td>
<td>87.191</td>
</tr>
<tr>
<td>13</td>
<td>.505</td>
<td>2.515</td>
<td>89.704</td>
</tr>
<tr>
<td>14</td>
<td>.456</td>
<td>2.279</td>
<td>91.983</td>
</tr>
<tr>
<td>15</td>
<td>.440</td>
<td>2.202</td>
<td>94.185</td>
</tr>
<tr>
<td>16</td>
<td>.375</td>
<td>1.628</td>
<td>95.808</td>
</tr>
<tr>
<td>17</td>
<td>.276</td>
<td>1.379</td>
<td>97.187</td>
</tr>
<tr>
<td>18</td>
<td>.260</td>
<td>1.302</td>
<td>98.489</td>
</tr>
<tr>
<td>19</td>
<td>.174</td>
<td>.872</td>
<td>99.361</td>
</tr>
<tr>
<td>20</td>
<td>.128</td>
<td>.639</td>
<td>100.000</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.

Eigen Value represents the total variance explained by each factor. Percentage of the total variance attributed to each factor. One of the popular methods used in Exploratory Factor Analysis is Principal Component Analysis, Where the total variance in the data is considered to determine the minimum number of factors that will account for maximum variance of data.
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 11 iterations.

Interpretation of factors is facilitated by identifying the statements that have large loadings in the same factor. The factor can be interpreted in terms of the statement that loads high on it. The factors that influences the marketing of pine apples comprises of 20 individual Statements. Out of 20 factors, 6 individual factors influences more, the factors are:
1. Fluctuation in price
2. Transportation cost
3. Shortage of labor to market the product
4. Lack of information about marketing of pine apple
5. Commission charges
6. No proper storage facility

Table 4: Rotated component matrix

<table>
<thead>
<tr>
<th></th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
<th>Component 4</th>
<th>Component 5</th>
<th>Component 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluctuation in Price</td>
<td>.030</td>
<td>.062</td>
<td>.786</td>
<td>-.144</td>
<td>.204</td>
<td>.113</td>
</tr>
<tr>
<td>Middle man assistance</td>
<td>-.055</td>
<td>-.138</td>
<td>.703</td>
<td>.042</td>
<td>-.082</td>
<td>.107</td>
</tr>
<tr>
<td>No standard price system</td>
<td>.220</td>
<td>-.075</td>
<td>.659</td>
<td>.149</td>
<td>-.268</td>
<td>.022</td>
</tr>
<tr>
<td>Extra charges</td>
<td>.057</td>
<td>.033</td>
<td>.666</td>
<td>.212</td>
<td>-.451</td>
<td>-.248</td>
</tr>
<tr>
<td>Government provide subsidies</td>
<td>.383</td>
<td>.328</td>
<td>.344</td>
<td>-.108</td>
<td>.539</td>
<td>-.104</td>
</tr>
<tr>
<td>Information about financial assistance</td>
<td>.569</td>
<td>.559</td>
<td>.071</td>
<td>.180</td>
<td>-.050</td>
<td>-.045</td>
</tr>
<tr>
<td>Price differences in markets</td>
<td>.546</td>
<td>.439</td>
<td>-.051</td>
<td>.072</td>
<td>-.130</td>
<td>.210</td>
</tr>
<tr>
<td>Transportation facility</td>
<td>.281</td>
<td>.355</td>
<td>-.088</td>
<td>-.313</td>
<td>.275</td>
<td>.483</td>
</tr>
<tr>
<td>Transportation cost higher than expected</td>
<td>.833</td>
<td>.109</td>
<td>.177</td>
<td>.018</td>
<td>-.045</td>
<td>.027</td>
</tr>
<tr>
<td>Interest rate for borrowed fund</td>
<td>.620</td>
<td>.046</td>
<td>-.070</td>
<td>.254</td>
<td>.172</td>
<td>.024</td>
</tr>
<tr>
<td>Lack of performance by government</td>
<td>-.050</td>
<td>.779</td>
<td>-.099</td>
<td>.180</td>
<td>.054</td>
<td>-.032</td>
</tr>
<tr>
<td>Shortage of labor to market</td>
<td>.138</td>
<td>.831</td>
<td>-.066</td>
<td>.070</td>
<td>.148</td>
<td>-.011</td>
</tr>
<tr>
<td>Lack of information about marketing of pine apple</td>
<td>-.003</td>
<td>.126</td>
<td>-.104</td>
<td>.152</td>
<td>.768</td>
<td>.159</td>
</tr>
<tr>
<td>Lack of information about variety of Pine apples</td>
<td>.672</td>
<td>-.083</td>
<td>.082</td>
<td>.074</td>
<td>.177</td>
<td>.186</td>
</tr>
<tr>
<td>Difficult to get loan</td>
<td>.135</td>
<td>.370</td>
<td>.243</td>
<td>.389</td>
<td>-.050</td>
<td>.353</td>
</tr>
<tr>
<td>Seasonal</td>
<td>.413</td>
<td>.056</td>
<td>.018</td>
<td>.479</td>
<td>.364</td>
<td>.257</td>
</tr>
<tr>
<td>Storage Facility</td>
<td>.123</td>
<td>-.101</td>
<td>.115</td>
<td>.172</td>
<td>.126</td>
<td>.841</td>
</tr>
<tr>
<td>Commission charges</td>
<td>.330</td>
<td>.111</td>
<td>-.131</td>
<td>.763</td>
<td>.141</td>
<td>-.071</td>
</tr>
<tr>
<td>Advance money</td>
<td>.002</td>
<td>.292</td>
<td>.176</td>
<td>.721</td>
<td>.076</td>
<td>.120</td>
</tr>
<tr>
<td>Interest from unorganized sector</td>
<td>.182</td>
<td>-.236</td>
<td>.128</td>
<td>.366</td>
<td>.478</td>
<td>.241</td>
</tr>
</tbody>
</table>

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Conclusion:

Pineapple has remained the top most fruit in India ever since ancient days. It is delicious and luscious table fruit for the Indians. To meet ever growing demand of the pineapple, a large area of the Indian soil should be used for pineapple cultivation. The pineapple cultivation provides employment opportunities to many people, and also helps the pineapple growers of improving their economic status. In this context, the present study is highly unique in nature and the findings of the study would prove to be quite helpful to many people, including the government departments, for further research as well as for formulating the future plans for various policies. It was an attempt to study and make some recommendation to solve current marketing problems pineapple farmers. The lack of storage facilities, inadequate government assistance, high commission charge collected by the intermediaries, non availability of packing materials are some of the crippling roadblocks faced by the pineapple entrepreneurs desirous of a steady progress.

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ANALYSIS OF DISTRIBUTED MULTIAGENT SYSTEM WITH JADE PLATFORM

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ABSTRACT

Agent- oriented software engineering (AOSE) is quickly emerging in response to urgent needs in both software engineering and agent-based computing. From past few years there is an improvement in Multi agent System. Many problems of distributed System are solved via multi agent system .The main aim of this work is to implement distributed multi agent system using JADE platform. This system should permit the parameterization of the characteristics of each agent running on the system in order to simulate a place for buying and selling. In this work a scenario is created to simulate a place where multiple buyer and seller negotiate the purchase and sale of certain product to implement distributed multi agent system. The trading of the products will take into account numerous attributes such as price, delivery time, quality factor of the merchandise. Consist of an automation process between the buyer and potential sellers.

Keywords: Distributed MAS, AOSE, JADE, Software, Multiagent, FIP

INTRODUCTION

A new software engineering paradigm Agent-Oriented Software Engineering (AOSE) is aroused to apply finest practice in the development of complex Multi-Agent Systems (MAS) mainly by focusing on the use of agents, and organizations of agents as the main abstractions. All the software development lifecycle required to develop a family of products where the derivation of concrete products is made systematically and rapidly are covered by field of Software Product Lines (SPL).

A growing number of computer systems are being viewed in terms of autonomous agents. Agents are being espoused as a novel theoretical model of computation that more closely reflects current computing reality than Turing Machines [1]. Agents are being advocated as a next generation model for engineering complex, distributed systems [2, 3]. In order to bring together the component AI sub disciplines that are essential to design and build intelligent entities [4, 5] agents are also used as an overarching framework. Yet despite this
deep interest, a number of fundamental questions about the nature and the use of the agent-oriented approach remain unanswered.

Existing results in MAS research facilitate a developer to construct MAS easier than before. Among others, there are tools that can produce entire MAS from a specification, libraries of components that deal with concrete MAS issues (distributed planning, reasoning, learning), and theories that describe MAS behavior and properties. Knowing all of them needs a great effort. The specified task has been assisted but it is difficult to give an overall view of what software, theories, and methodologies exist, and how they are applied to MAS development.

A Multi-agent system is a system that consists of numerous agents that interact with each other. These Interactions are frequently handled by messages that are sent between the agents. These agents replicate intelligence by using methodical, procedural, functional or algorithmic search, for finding and processing approaches. Each of the agents can have diverse goals and behaviors, which together combine to a dynamic system.

Multi Agent Systems (MAS) are suitable and powerful tools adopted to model and simulate different types of complex systems [6][7][8]. They are mostly used because they enable intuitive modeling and rapid simulation of complex situations. To deal with realistic complex systems, large scale agent-based simulations are often required. However, considering the large number of the simulated entities and their complex behaviors, scalability becomes a challenging problem for such simulation environments. Distributed infrastructure such as clusters, grids and clouds are powerful computational environments that can be efficiently used to run large-scale agent-based simulations. However, the existing literature does not provide an overall study about the existing solution for distributing a given MAS. The main challenge, for MAS designers and developers is how to select the appropriate partitioning mechanism for a given MAS. There is no generic approach for guiding the designers and developers to select an appropriate approach for partitioning a given agent-based system. Therefore, in this work, we present a generic conceptual framework JADE for: 1) Analyzing existing partitioning methods and 2) It can also be used as a basis while designing a distributed architecture of new MAS based on relevant criteria. The major reason for this selection was the fact that JADE is one of the best modern agent environments. The selection of this platform for the implementation of the Multi-agent system was based on some advantages and criteria. JADE uses Java and each agent is run in a separate thread, which is faster than usual Java threads. JADE is updated frequently and has a large
development crew and community. JADE works on any platform that supports a Java Virtual Machine, or JVM. It has an excellent GUI with a lot of valuable features and tools. It supports multiple communication and transport protocols, such as socket, RMI and IIOP Communication.

I. RELATED WORK

Present a load management mechanism for distributed simulations of multi-agent systems. The cost of accessing the shared state in the distributed simulation is reduced by dynamically redistributing shared state variables based on the access pattern of the simulation model [14].

Present PDES-MAS, a distributed simulation engine for large scale multi-agent simulations. The system uses a space-time DSM approach to adaptively and dynamically divide the shared state of the MAS and addresses the issues of load balancing, synchronization and interest management in an integrated transparent manner [15].

Propose a reference model that specifies the usual launching and configuration infrastructure. The reference model is based on the ideas of agents and societies as constituting entities. For the reference model a FIPA-compliant service interface has been designed, which permits applications to be started on different hosts and possibly on different platforms [16].

Illustrate a detailed implementation of multi agents in an artificial stock market invoking the agent-based methodology on Java Agent Development (JADE) environment, a platform to extend multi-agent systems. The Extended Glosten and Milgrom Model, an agent based artificial stock market model, has been selected to depict the multi-agent environment model in JADE [17].

II. EXISTING METHODS

In this we analyze the existing relevant partitioning approaches that were devoted to be used in the case of MAS.

A. Cluster-based partitioning methods

The comparative study of the algorithm is based on three metrics which are Number of messages to measure the communication, CPU load and Number of migrations. Four
scenarios were defined in order to study the influence of the movement of agents as well as the situation. While the k-means algorithm shows more efficiency in a few scenarios, it becomes worse when agents are moving individually. Therefore clustering agents into partitions based on the position may not be effectual in the cases where agents are acting individually.

B. Grid-based partitioning methods

Partitioning the grid for parallel processing has three main goals:

- Make partitions with equal numbers of cells.
- Reduce the number of partition interfaces--i.e., decrease partition boundary surface area.
- Lessen the number of partition neighbors.

Balancing the partitions guarantees that each processor has an equal load and that the partitions will be ready to communicate at about the same time. Since communication between partitions can be a relatively time-consuming process, minimizing the number of interfaces can decrease the time associated with this data interchange. Minimizing the number of partition neighbors minimize the chances for network and routing contentions. In addition, minimizing partition neighbors is significant on machines where the cost of initiating message passing is expensive compared to the cost of sending longer messages. This is particularly true for workstations connected in a network.

An approach to distribute shared spatial environment in MAS consisting of considering the spatial environment as a grid that can be separated into multiple spatial regions. The formed region is allocated to diverse Logical Processes (LPs). A situated agent is hosted to the consequent LP. Grid-based clustering algorithm dedicated to partition and load-balance crowd simulations among multiple processors but it is less capable to balance the load during runtime.

III. PROPOSED FRAMEWORK

The proposed framework has been developed on a broadly used agent platform (JADE). JADE is a framework for developing multi-agent applications. It is provided as a FIPA (The Foundation for Intelligent Physical Agents)-compliant agent framework with a package to extend Java agents. JADE is fully implemented in Java and it is fully open-source,
it is FIPA compliant and runs on a variety of operating systems including Windows and Linux.

JADE is a middleware which facilitates the development of multi-agent systems under the standard FIPA for which intention it creates multiple containers for agents, each of them can run on one or more systems. Is understood that a set of containers constitutes a platform.

JADE offers an environment where JADE agents are executed, the Class Libraries to create agents using heritage and redefinition of behaviors and a graphical toolkit to monitoring and managing the platform of Intelligent Agent agents.

Agent is a computer program that acts for a user or other program in a relationship of agency. The term "agent" describes a software abstraction, an idea, or a concept, similar to OOP terms such as methods, functions, and objects. The concept of an agent offers a convenient and powerful way to illustrate a complex software entity that is capable of acting with a certain degree of autonomy in order to accomplish tasks on behalf of its host. But unlike objects, which are defined in provision of methods and attributes, an agent is defined in terms of its behavior.

By an agent-based system, we signify one in which the key abstraction used is that of an agent. Agent-based systems may contain a single agent [11], but arguably the greatest potential lies in the application of multiagent systems [12].

The following are the properties of agents:

**Autonomy**: agents encapsulate a few state and make decisions about what to do based on this state, without the direct involvement of humans or others;

**Reactivity**: agents are located in an environment, which are capable to perceive this environment and are capable to respond in a timely fashion to changes that occur in it;

**Pro-Activeness**: agents do not simply act in response to their environment, they are able to demonstrate goal-directed behavior by taking the initiative;

**Social Ability**: agents interact with other agents via some kind of agent-communication language [13], and normally have the ability to engage in social activities in order to achieve their goals.
The agent is a key element in the design of multi-agent systems. Ferber in [9], defines it as a physical or virtual entity that can act, perceive its environment and communicate with others, is autonomous and has skills to attain its goals and tendencies. Also, Wooldridge [10] presents the agent as an autonomous entity situated in some environment and having the following features: reactivity, proactivity and social ability. For Purely communicative MAS, in addition the common attributes such as, goals and internal state, the agents have more social abilities and they use direct contact to communicate and cooperate. Also, agent’s goal is a criterion that can be used to distribute agents into partitions.

**IV. DISTRIBUTED MULTIAGENT SYSTEM**

A multi-agent system is a computerized system composed of multiple interacting intelligent agents in an environment. Multi-agent systems can be used to crack problems that are difficult or impossible for an individual agent or a monolithic system to solve. Intelligence may comprise some methodic, functional, procedural approach, algorithmic search or reinforcement learning. Although there is significant overlap, a multi-agent system is not always the same as an agent-based model (ABM). The aim of an ABM is to search for explanatory insight into the collective behavior of agents obeying simple rules, typically in natural systems, rather than in solving specific practical or engineering problems. A Multi Agent System is more capable in retrieving, filtering, and globally coordinating information from the sources that are distributed spatially. A Multi agent system is a system which offers solutions in a situation like where expertise is temporally and spatially distributed. A Multi Agent System improves overall performance of the system, particularly in the field of reliability, computational efficiency, maintainability, flexibility, extensibility, responsiveness, robustness and reuse.

![Figure1 Framework Architecture](image)
In our proposed method, there are three main types of agents, buyer, seller and JADE. Both seller and buyer agents have a type of product that trade as well as a minimum and maximum amount you are eager to transact. Also have an associated term delivery, and the buyer this is the maximum period for which the delivery will have to be satisfied in the case of the seller and the fastest time this can make the product obtainable. Finally there is another general attribute that represents the quality of the product transaction represented a scale of 1 (low) - 5 (very high). The seller will have a related product quality and buyer will require a minimum for this quality. This field can influence the decision of a buyer who can select a product of superior quality over price.

Sellers

The sellers register into the JADE with their unique name and their address. After registration they send the information about the products they contains into the JADE. They add and update the products into JADE. Whenever the buyers request for products the JADE agent verifies the sellers and connect the sellers to buyers. Here we take sellers as book sellers. The sellers add the book titles and the cost of books. The sellers connect to the buyers directly or indirectly whenever requires.

Figure 2 (a)

Figure 2 (b)
Progress window of Sellers for add and update the books

Buyers

The buyers send the request to the JADE agent for various products they require before that they want to register into JADE. Immediately the agent sends an automatic reply to the buyer after receiving the request from them. The agent reply contains the available products related to the request and the price of products. If the buyer satisfied with the price they can buy the products. Here we take buyers as book buyers. The book buyers request the books with titles. The buyers connect to the sellers directly or indirectly.

![Progress window of Sellers for add and update the books](image)

Figure3 Progress window of Buyers searching for books

JADE Agent

This agent collects information about the different transactions that are being made and who made them. Permits to correlate a reputation to buyers / sellers agents based on their historical fulfillment of contracts established. Jade DF - is a central register of entries linking agent’s services which are used for both actions. One for registration of new agents, registering your Agent ID and all relevant information to the product which they trade, another one for potential partners that have the product that you are looking at a purchase order from a buyer's agent. After receive the requests from the buyers it automatically starts searching the agents contains the requested books and send the reply message to the buyers regarding the agents.
Figure 4 Collecting information about the sellers contain the requested books

In this platforms used NetBeans, running on Windows7 respectively. These platforms have a development interface for very long Java, easy to use, simply add the jar file JADE so that you have an absolute and very powerful development environment JADE. All agents are recorded in the DF, allowing buyer’s agent’s seller’s agents to easily find the desired product. Buyer’s agents and sellers have minimum and maximum initial rates respectively.

V. DETAILS REGARDING IMPLEMENTATION

All agents are recorded in the Directory Facilitator (DF), allowing buyer’s agents, seller’s agents to easily find the desired product. DF keeps track of all advertised services offered by all the agents in the same Jade platform. After registered into JADE if the buyers send the request to JADE it automatically search the products required by the buyers and connect buyers to the respected sellers.

VI. RESULTS

The basic experience successfully concluded, it was potential to see the transaction in progress and all this iterative steps. The basic experience with JADE also concluded positively, where it can be seen that the JADE kept the transactions and reputations of the agents properly. The experience of burden had apparent success.

VII. CONCLUSION

In this work we introduced a framework called JADE for Multi-agent based simulations. Based on our frameworks base-GUI it allows the programmer to realize a domain specific end user application for Multi-Agent based simulations. Using the agent platform and implementing and testing the simulating technique through Java agent
development platform show how agent behave rationally, autonomously and automatically interact with each other to provide an optimal solution as well as reduction of domain complexity through distributed platforms. Agent coordination, competition, concession and negotiation with each other show an artificial intelligence environment. Very important conclusion is drawn from the full experiments about agent distribution. Because agents in the implemented system were representing the amount of work they were distributed.

VIII. REFERENCES


THE POST-COLONIAL IMPACT ON THE CHARACTERS IN GET READY FOR BATTLE

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INTRODUCTION:

Ruth Prawer Jhabvala is considered as one of the greatest contemporary novelist. She writes about the new rich middle class society, their culture, social values and practices in her novels. Both the novels chosen for the study deals with the rich middle class Punjabi family. In this chapter the researcher has analyzed the major characters with the key terminology of Post-Colonial Literature like hegemony, subalternity, and mimicry in the novel Get Ready for Battle.

PORTRAYAL OF THE PROTAGONIST:

In this novel Jhabvala has realistically depicted the obsession of individuals with money which plays a pivotal role in society and the codes of conduct that arise from the happenings in that society. She has written about the poor section, who are used and ill-treated by the richer upper class. She also portrays the greediness of the corrupted government officials who act as a link between these two sections of the society. Jhabvala has indirectly satirized them, because of their inability to serve the poor people. In this post-colonial society economy plays an important role. It decides the values and the class distinctions in the society. The people with money are considered as the ruling class and they dominate the poor sections of the society. The rich people use money to buy up everything and everyone like the tainted officials and the representatives of the poor for their own material benefits.

Jhabvala portrays the various groups of people in the Indian society with all its goodness and evilness like her other novels. She becomes a champion of social change in Get Ready for Battle where, certain cultural changes are not openly stated but the readers have to read between the lines to understand its meaning. Both the select novels revolve around the families and explain the complicated relationships which confuse, entertain and engage the readers with its clarity of thought and action. Even though Jhabvala’s narrative technique
presents the horrifying scenes in a harsh light; this is the only way she could present certain realistic truths to the reader.

**POSR-COLONIAL SALIENT FEATURES:**

The novel opens in a dramatic manner where a grand party takes place at the house of Gulzari Lal who is one of the richest businessmen in New Delhi. This party has been hosted by Gulzari Lal for an insignificant municipal engineer who will help him to succeed in one of his dirty tricks he would like to play on others. He loves to host parties like this and enjoys seeing people satisfied. The dinner was left to the care of Gulzari Lal’s mistress Kusum, who overlooked all the cooking and terrorized the servants of the house.

Kusum is the widow of an Army Major and has a married daughter. She has been in an illegal relationship with Gulzari Lal, for the past eight years. Though she was not living in the house, she takes care of everything and everybody in the house. She is a shrewd person, who knows how to get her work done. Even though no one questioned her authority in Gulzari Lal’s house and was accepted in the highest circles in Delhi, she still felt bad of her inferior status and determined to marry Gulzari Lal in order to enjoy a luxurious life. So she uses all kinds of ways to make Gulzari Lal divorce his wife Sara Devi from the beginning of the novel.

In this novel the dominance of the ruling class over the other classes is well portrayed by the character of Gulzari Lal. Gulzari Lal in the novel belongs to the vulgar rich class in the post-independence India. He uses his economic power to gain political support in order to attain his goals. At the opening of the novel, three parties are shown as interested in the evacuation of Bundi Basti, a slum area for construction purposes.

Sarla Devi’s estranged husband Gulzari Lal is interested in buying the land adjacent to it to build multi-storied residential flats and will do so only on the guarantee that the slum is cleared. In this he is aided by a corrupt government and a group of women from the small minority of the Delhi’s wealthy section, who in the name of social service are only abetting big business. The people of Bundi Basti are fearful at the prospect of being uprooted from an area that, though filthy and unhygienic, it is located at a convenient distance from where they work.

Ruth Prawer Jhabvala brings out the failure of the country to provide basic necessities like food and shelter to the majority of people who are forced to live permanently on the edge.
of extermination through the portrayal of Bundi Basti. Increasing prices, lack of adequate housing, official corruption, and governmental indifference, shortage of public health facilities and denial of educational opportunities to those within the poverty line were indeed Ruth Prawer Jhabvala's characteristics of India in the post-colonial period. This clearly brings out the economic and political hegemony prevalent in the novel.

The post-colonial literature not only deals with the problems like hegemony, subalternity and oppression, but also about the evolution of the modern woman. The post-colonial period saw the emergence of the modern women who are able to break away from the shackles of the old tradition and lead an independent life. Sarla Devi in this novel can be taken as the best example of the modern independent women who has asserted her rights by leaving her husband’s house. She is a traditional woman with modern ideas.

Sarla Devi is the wife of Gulzari Lal and was born into a Kshatriya family of Punjab of the pre-partition India. In the past according to the tradition women from Kshatriya tribe were not allowed to go out except to do charity and carrying out religion. But Sarla Devi is against such conditions laid for women. She represents the modern woman with powerful and strong ideals to be fulfilled irrespective of the consequences.

Opposite to the character of Sarla Devi is the character of Kusum. Kusum is the widow of an army officer and she has an illegal relationship with Gulzari Lal for many years. She is a shrewd person who wants to attain power and wealth in the society through Gulzari Lal. Even though she never stays at his house, she has the entire control of his household and terrorizes the servants. Even Gulzari Lal’s son Vishnu and daughter-in-law Mala accept her place in the family.

Kusum was not satisfied with her position in the family. Even though she was accepted in the high class society, she still feels inferior of her status, so she wants to marry Gulzari Lal legally. So she forces Gulzari Lal to get divorce from his wife Sarla Devi. Being an opportunist, she tries to make the best of every situation in her favor so that she can achieve her ultimate goal of becoming Mrs. Gulzari Lal. In her pursuit of goals, she even befriends Sarla Devi and even goes to the extent of siding with her friend Mrs. Bhatnagar (another social worker), promising her to do something for the Bundi Busti people.

Mrs. Bhatnagar even approaches Sarla Devi’s brother Brij Mohan to win him to her side, as she knows that he is against divorce, which is quite natural that he who always cared
about wealth and did not want his sister to lose all her rights in Gulzari Lal’s property and break the link with that family forever. Kusum, who could change Gulzari Lal, does not take long in changing Brij Mohan’s views. She uses all her tactics and goes to the extent of telling him that she is also his sister and, once she is married, it will be once again like good old days.

In the end Brij Mohan gives in. Kusum is happy and is ready to marry Gulzari Lal. On the other hand Gulzari Lal who is leading a smooth life with Kusum as his mistress is quite content to live as it is and never thought of seeking legal divorce, not because he has any feeling for his wife, but because he is scared of society.

The change in Gulzari Lal’s attitude is perhaps symbolic of the changing attitude of modern Indian society. The question that is left unanswered, especially for a person who is not familiar with Indian society, is whether this change is accepted and practiced only among the affluent sections of Indian society, those who can suppress all the criticism with the help of their money or by all sections of Indian society. Perhaps it is difficult to answer this question, because the masses that live in the villages of India would neither welcome divorce nor widow remarriage. These new ideas and laws are only confined to a particular section of Indian society. Jhabvala is aware of this fact and makes it clear through Sarla Devi who tells her husband Gulzari Lal: “I know what you mean when you speak of society—you mean the people like yourself, who have houses and cars and go to clubs, for you, only these people are society, only they are human.” (GRFB, 39)

The subaltern theory introduced by Gayatri Spivak can be applied to the poor people of Bundi Busti in this novel. They all struggle to live in this harsh society where everything is determined by money and power. The people of Bundi Busti are very poor and live in very unhygienic conditions. They struggle even to get a meal a day. In this post-colonial society there prevails a huge difference between the two sections of the society. One has everything excessively, while the other has nothing. The party held at the beginning of the novel and the slum area can be taken as an example. The rich have so much that they are spent lavishly, while the poor starve. Jhabvala has portrayed a variety of scenes from slums and tenements to palatial interiors and moonlit gardens.

Jhabvala traces these materialistic tendencies through the character of Gulzari Lal as we find in the novel Get Ready for Battle in which Gulzari Lal depicts extreme materialism of rich, corrupt, bourgeoisie of contemporary India. The novelist deals with a number of
intrigues – sexual, familial and social and also the theme of marital dissonance in the upper middleclass and money minded urban society.

In this novel, the novelist not only criticizes the affluent sections of society for treating the poor badly, but also brings out the fact that the poor people themselves are responsible for their miserable condition.

CONCLUSION:

Before concluding the study of his novel it will not be inappropriate to go back to the main theme of the novel- the clash between the capitalists and the poor people in Indian society and those helpless social workers who genuinely work for the upliftment of the downtrodden and who want to leave no stone unturned to help them. In the end even though the social workers like Sarla Devi fails, she is not dejected and she strives forward tirelessly in order to achieve her goal.

In Get Ready for Battle Jhabvala portrays the predicament of the Indian society through the major characters of the novel. Gulzari Lal is a rich businessman around whom the entire novel is built. He is a greedy businessman who wants to earn more money and does not care about morality or the sufferings of the poor. He represents the new bourgeoisie class that emerged in the post-independent India. They have no morals values and imitate the western culture of which they don’t have much knowledge. As a result they are neither westerners nor Indians and cause cultural degradation in the society. However the younger generation still worries about the development of the Indian society. This group of youngsters are portrayed by Vishnu and his friends.

WORKS CITED:


(1, 2)*-rgα-Interior and (1, 2)*-rgα-Closure in Topological Spaces

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Abstract

In this paper, we introduce (1, 2)*-rgα-interior, (1, 2)*-rgα-closure and study some of its basic properties.

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1. Introduction

Levine[12] introduced generalized closed sets in general topology as a generalization of closed sets. This concept was found to be useful and many results in general topology were improved. Many researchers like Balachandran, Sundaram and Maki[3], Bhattacharyya and Lahiri[4], Arockiarani[1], Dunham[6], Gnanambal[7], Malghan[14], Palaniappan and Rao[15], Park and Park[16], Arya and Gupta[2] and Devi et al [5] have worked on generalized closed sets, their generalizations and related concepts in general topology. In this paper, the notion of (1, 2)*-rgα-interior is defined and some of its basic properties are studied. Also we introduce the concept of (1, 2)*-rgα-closure sets, and we obtain some related results. For any A ⊂ X, it is proved that the complement of (1, 2)*-rgα-interior of A is the (1, 2)*-rgα-closure of the complement of A.

2. Preliminaries

Throughout this paper, (X, τ1, τ2) and (Y, σ1, σ2) (briefly, X and Y) will denote bitopological spaces.

Definition 2.1    Let S be a subset of a bitopological space X. Then S is said to be

τ1,2-open [9] if S = A∪B, where A∈τ1 and B∈τ2. The complement of τ1,2-open set is called τ1,2-closed. The family of all τ1,2-open sets (resp. τ1,2-closed sets) is denoted by (1, 2)*-O(X) (resp. (1, 2)*-C(X)). Notice that (1, 2)-open sets need not necessarily form a topology.
Definition 2.2 [9] Let S be a subset of a bitopological space X. Then

(i) the $\tau_{1,2}$-closure of S, denoted by $\tau_{1,2}$-cl(S), is defined as
\[ \bigcap \{ F: S \subseteq F \text{ and } F \text{ is } \tau_{1,2}\text{-closed} \}; \]

(ii) the $\tau_{1,2}$-interior of S, denoted by $\tau_{1,2}$-int(S), is defined as
\[ \bigcup \{ F: F \subseteq S \text{ and } F \text{ is } \tau_{1,2}\text{-open} \}. \]

Definition 2.3 A subset A of a bitopological space X is said to be

(i) $(1, 2)^*$-preopen set [11] if $A \subseteq \tau_{1,2}$-$\text{int} (\tau_{1,2}$-cl(A)).

(ii) $(1, 2)^*$-semi-open [9] if $A \subseteq \tau_{1,2}$-$\text{cl} (\tau_{1,2}$-int(A)).

(iii) $(1, 2)^*$-$\alpha$-open set [11] if $A \subseteq \tau_{1,2}$-$\text{int} (\tau_{1,2}$-cl(\tau_{1,2}$-int(A))).

(iv) regular-(1, 2)*-open set [19] if $A = \tau_{1,2}$-$\text{int} (\tau_{1,2}$-cl(A)).

The complements of the above open sets are called their respective closed sets.

The intersection of all $(1, 2)^*$-preclosed (resp. $(1, 2)^*$-$\alpha$-closed) subsets of X containing A is called $(1, 2)^*$-preclosure (resp. $(1, 2)^*$-$\alpha$-closure) of A and is denoted by $(1, 2)^*$-$\text{pcl}(A)$ (resp. $(1, 2)^*$-$\alpha$-$\text{cl}(A))$.

Definition 2.4 A subset A of a bitopological space X is called

(i) $(1, 2)^*$-generalized-$\alpha$-closed set (briefly, $(1, 2)^*$-g$\alpha$-closed) [17] if $(1, 2)^*$-$\alpha$-cl(A) $\subseteq U$ whenever $A \subseteq U$ and $U$ is $(1, 2)^*$-$\alpha$-open in X.

(ii) $(1, 2)^*$-$\alpha$-generalized closed set (briefly, $(1, 2)^*$-ag-closed) [17] if $(1, 2)^*$-$\alpha$-cl(A) $\subseteq U$ whenever $A \subseteq U$ and $U$ is $\tau_{1,2}$-open in X.

(iii) regular-(1, 2)*-generalized closed set (briefly, $(1, 2)^*$-rg-closed) [17] if $\tau_{1,2}$-cl(A) $\subseteq U$ whenever $A \subseteq U$ and $U$ is regular-(1, 2)*-open in X.

(iv) generalized-(1, 2)*-pre-closed set (briefly, $(1, 2)^*$-gp-closed) [20] if $(1, 2)^*$-pcl(A) $\subseteq U$ whenever $A \subseteq U$ and $U$ is $\tau_{1,2}$-open in X.
(v) weakly-(1, 2)*-generalized closed set (briefly, (1, 2)*-wg-closed) [18] if \( \tau_{1,2}\text{-cl}(\text{int}(A)) \subseteq U \) whenever \( A \subseteq U \) and \( U \) is \( \tau_{1,2}\)-open in \( X \).

(vi) weakly-(1, 2)*-closed set (briefly, (1, 2)*-w-closed) [18] (or (1, 2)*-\( \hat{g} \)-closed set [8]) if \( \tau_{1,2}\text{-cl}(A) \subseteq U \) whenever \( A \subseteq U \) and \( U \) is (1, 2)*-semi-open in \( X \).

The complements of the above mentioned closed sets are their respective open sets.

**Definition 2.5** A subset \( A \) of a bitopological space \( X \) is said to be (1, 2)*-generalized pre-regular closed (briefly, (1, 2)*-gpr-closed) [20] if \( (1, 2)*\text{-pcl}(A) \subseteq U \) whenever \( A \subseteq U \) and \( U \) is regular-(1, 2)*-open set.

The collection of all (1, 2)*-gpr-closed sets of \( X \) will be denoted by \( (1, 2)*\text{-GPRC}(X) \).

**Definition 2.6** A bitopological space \( (X, \tau_1, \tau_2) \) equipped with the family of all \( \tau_{1,2}\)-open sets will be called DRT-space [17] if \( \text{Int}_1(S) = \text{Int}_2(S) \) for each \( \tau_{1,2}\)-closed subset \( S \) of \( X \).

**Example 2.7** Let \( X = \{ a, b, c \} \), \( \tau_1 = \{ X, \emptyset, \{a\} \} \) and \( \tau_2 = \{ X, \emptyset, \{a, b\} \} \). Then \( (X, \tau_1, \tau_2) \) is DRT-space.

**Example 2.8** Let \( X = \{ a, b, c \} \), \( \tau_1 = \{ X, \emptyset, \{a\} \} \) and \( \tau_2 = \{ X, \emptyset, \{b, c\} \} \). Then \( (X, \tau_1, \tau_2) \) is not DRT-space, since \( \text{Int}_1(\{a\}) = \{a\} \neq \emptyset = \text{Int}_2(\{a\}) \).

3. (1, 2)*-rg\( \alpha \)-Interior and (1, 2)*-rg\( \alpha \)-Closure

**Definition 3.1** A subset \( A \) of a bitopological space \( X \) is called regular-(1, 2)*-\( \alpha \)-open set (briefly, (1, 2)*-\( \alpha \)-open) if there is a regular-(1, 2)*-open set \( U \) such that \( U \subset A \subset (1, 2)*\text{-\( \alpha \)-cl}(U) \).

**Definition 3.2** A subset \( A \) of a bitopological space \( X \) is called a regular generalized-(1, 2)*-\( \alpha \)-closed set (briefly, (1, 2)*-rg\( \alpha \)-closed) if \( (1, 2)*\text{-\( \alpha \)-cl}(A) \subset U \) whenever \( A \subset U \) and \( U \) is regular-(1, 2)*-\( \alpha \)-open in \( X \). We denote the set of all (1, 2)*-rg\( \alpha \)-closed sets in \( X \) by \( (1, 2)*\text{-RG\( \alpha \)C}(X) \).
Definition 3.3 Let $X$ be a bitopological space and let $x \in X$. A subset $N$ of $X$ is said to be $(1, 2)^*\text{-rg}_\alpha$-nbhd of $x$ if there exists a $(1, 2)^*\text{-rg}_\alpha$-open set $G$ such that $x \in G \subseteq N$.

Definition 3.4 Let $A$ be a subset of a bitopological space $X$. A point $x \in A$ is said to be $(1, 2)^*\text{-rg}_\alpha$-interior point of $A$ if $A$ is a $(1, 2)^*\text{-rg}_\alpha$-nbhd of $x$. The set of all $(1, 2)^*\text{-rg}_\alpha$-interior points of $A$ is called the $(1, 2)^*\text{-rg}_\alpha$-interior of $A$ and is denoted by $(1, 2)^*\text{-rg}_\alpha\text{-int}(A)$.

Theorem 3.5 If $A$ is a subset of a bitopological space $X$, then $(1, 2)^*\text{-rg}_\alpha\text{-int}(A) = \bigcup \{ G : G \text{ is } (1, 2)^*\text{-rg}_\alpha\text{-open}, G \subseteq A \}$.

Proof: Let $A$ be a subset of $X$. Then $x \in (1, 2)^*\text{-rg}_\alpha\text{-int}(A) \iff x$ is a $(1, 2)^*\text{-rg}_\alpha$-interior point of $A \iff A$ is a $(1, 2)^*\text{-rg}_\alpha$-nbhd of point $x \iff$ there exists $(1, 2)^*\text{-rg}_\alpha$-open set $G$ such that $x \in G \subseteq A$. Thus $x \in \bigcup \{ G : G \text{ is } (1, 2)^*\text{-rg}_\alpha\text{-open}, G \subseteq A \}$. Hence $(1, 2)^*\text{-rg}_\alpha\text{-int}(A) = \bigcup \{ G : G \text{ is } (1, 2)^*\text{-rg}_\alpha\text{-open}, G \subseteq A \}$.

Theorem 3.6 Let $A$ and $B$ be subsets of a bitopological space $X$. Then $(1, 2)^*\text{-rg}_\alpha\text{-int}(X) = X$ and $(1, 2)^*\text{-rg}_\alpha\text{-int}(\emptyset) = \emptyset$.

(i) $(1, 2)^*\text{-rg}_\alpha\text{-int}(A) \subseteq A$.

(ii) If $B$ is any $(1, 2)^*\text{-rg}_\alpha$-open set contained in $A$, then $B \subseteq (1, 2)^*\text{-rg}_\alpha\text{-int}(A)$.

(iii) If $A \subseteq B$, then $(1, 2)^*\text{-rg}_\alpha\text{-int}(A) \subseteq (1, 2)^*\text{-rg}_\alpha\text{-int}(B)$.

(iv) $(1, 2)^*\text{-rg}_\alpha\text{-int}((1, 2)^*\text{-rg}_\alpha\text{-int}(A)) = (1, 2)^*\text{-rg}_\alpha\text{-int}(A)$.

Proof: (i) Since $X$ and $\emptyset$ are $(1, 2)^*\text{-rg}_\alpha$-open sets, by Theorem 3.5, $(1, 2)^*\text{-rg}_\alpha\text{-int}(X) = \bigcup \{ G : G \text{ is } (1, 2)^*\text{-rg}_\alpha\text{-open}, G \subseteq X \} = X \cup \{ \text{all } (1, 2)^*\text{-rg}_\alpha\text{-open sets} \} = X$. That is $(1, 2)^*\text{-rg}_\alpha\text{-int}(X) = X$. Since $\emptyset$ is the only $(1, 2)^*\text{-rg}_\alpha$-open set contained in $\emptyset$, $(1, 2)^*\text{-rg}_\alpha\text{-int}(\emptyset) = \emptyset$.

(ii) Let $x \in (1, 2)^*\text{-rg}_\alpha\text{-int}(A) \Rightarrow x$ is a $(1, 2)^*\text{-rg}_\alpha$-interior point of $A$. $\Rightarrow A$ is a $(1, 2)^*\text{-rg}_\alpha$-nbhd of $x$. $\Rightarrow x \in A$. Thus $x \in (1, 2)^*\text{-rg}_\alpha\text{-int}(A) \Rightarrow x \in A$. Hence $(1, 2)^*\text{-rg}_\alpha\text{-int}(A) \subseteq A$.

(iii) Let $B$ be any $(1, 2)^*\text{-rg}_\alpha$-open set such that $B \subseteq A$. Let $x \in B$, then since $B$ is
(1, 2)*-rgα-open set contained in A, x is a (1, 2)*-rgα-interior point of A. That is \( x \in (1, 2)*-\text{rgα-int}(A) \). Hence \( B \subseteq (1, 2)*-\text{rgα-int}(A) \).

(iv) Let A and B be subsets of X such that \( A \subseteq B \). Let \( x \in (1, 2)*-\text{rgα-int}(A) \). Then \( x \) is a (1, 2)*-rgα-interior point of A and so A is (1, 2)*-rgα-nbd of \( x \). Since \( B \supseteq A \), B is also a (1, 2)*-rgα-nbd of \( x \). This implies that \( x \in (1, 2)*-\text{rgα-int}(B) \). Thus we have shown that \( x \in (1, 2)*-\text{rgα-int}(A) \Rightarrow x \in (1, 2)*-\text{rgα-int}(B) \). Hence \( (1, 2)*-\text{rgα-int}(A) \subseteq (1, 2)*-\text{rgα-int}(B) \).

(v) Let A be any subset of X. By the definition of (1, 2)*-rgα-interior, \( (1, 2)*-\text{rgα-int}(A) = \bigcap \{ F : A \subseteq F \in (1, 2)*-\text{RGαC}(X) \} \), if \( A \subseteq F \in (1, 2)*-\text{RGαC}(X) \), then \( (1, 2)*-\text{rgα-int}(A) \subseteq F \). Since \( F \) is (1, 2)*-rgα-closed set containing \( (1, 2)*-\text{rgα-int}(A) \), by (iii) \( (1, 2)*-\text{rgα-int}((1, 2)*-\text{rgα-int}(A)) \subseteq F \). Hence \( (1, 2)*-\text{rgα-int}((1, 2)*-\text{rgα-int}(A)) \subseteq \bigcap \{ F : A \subseteq F \in (1, 2)*-\text{RGαC}(X) \} = (1, 2)*-\text{rgα-cl}(A) \). That is \( (1, 2)*-\text{rgα-int}((1, 2)*-\text{rgα-int}(A)) = (1, 2)*-\text{rgα-int}(A) \).

**Theorem 3.7** If a subset A of the bitopological space X is (1, 2)*-rgα-open, then \( (1, 2)*-\text{rgα-int}(A) = A \).

**Proof:** Let A be (1, 2)*-rgα-open subset of X. We know that \( (1, 2)*-\text{rgα-int}(A) \subseteq A \). Also, A is (1, 2)*-rgα-open set contained in A. From Theorem 3.6. (iii) \( A \subseteq (1, 2)*-\text{rgα-int}(A) \). Hence \( (1, 2)*-\text{rgα-int}(A) = A \).

The converse of the above theorem need not be true, as seen from the following example.

**Example 3.8** Let \( X = \{a, b, c\} \), \( \tau_1 = \{X, \phi, \{a\}\} \) and \( \tau_2 = \{X, \phi, \{b\}\} \). Then the sets in \( \{X, \phi, \{a\}, \{b\}\} \) are called \( \tau_{1,2}\)-open; the sets in \( \{X, \phi, \{c\}, \{a, c\}, \{b, c\}\} \) are called \( \tau_{1,2}\)-closed; the sets in \( \{X, \phi, \{a\}, \{b\}\} \) are called regular-(1, 2)*-open; the sets in \( \{X, \phi, \{a\}, \{b\}, \{a, c\}, \{b, c\}\} \) are called (1, 2)*-rgα-open and (1, 2)*-RGαO(X) = \( \{X, \phi, \{a\}, \{b\}, \{c\}, \{a, b\}\} \). Now \( (1, 2)*-\text{rgα-int}(\{b, c\}) = \{b, c\} \), but it is not a (1, 2)*-rgα-open set in X.

**Theorem 3.9** If A and B are subsets of the bitopological space X, then \( (1, 2)*-\text{rgα-int}(A) \cup (1, 2)*-\text{rgα-int}(B) \subseteq (1, 2)*-\text{rgα-int}(A \cup B) \).

**Proof:** We know that \( A \subseteq A \cup B \) and \( B \subseteq A \cup B \). We have, by Theorem 3.6(iv), \( (1, 2)*-\text{rgα-int}(A) \subseteq (1, 2)*-\text{rgα-int}(A \cup B) \) and \( (1, 2)*-\text{rgα-int}(B) \subseteq (1, 2)*-\text{rgα-int}(A \cup B) \). This implies that \( (1, 2)*-\text{rgα-int}(A) \cup (1, 2)*-\text{rgα-int}(B) \subseteq (1, 2)*-\text{rgα-int}(A \cup B) \).
Theorem 3.10 If A and B are subsets of the bitopological space X, then $(1, 2)^*rg\alpha\text{-}int(A \cap B) = (1, 2)^*rg\alpha\text{-}int(A) \cap (1, 2)^*rg\alpha\text{-}int(B)$.

Proof: We know that $A \cap B \subset A$ and $A \cap B \subset B$. We have, by Theorem 3.6 (iv), $(1, 2)^*rg\alpha\text{-}int(A \cap B) \subset (1, 2)^*rg\alpha\text{-}int(A)$ and $(1, 2)^*rg\alpha\text{-}int(A \cap B) \subset (1, 2)^*rg\alpha\text{-}int(B)$. This implies that $(1, 2)^*rg\alpha\text{-}int(A \cap B) \subset (1, 2)^*rg\alpha\text{-}int(A) \cap (1, 2)^*rg\alpha\text{-}int(B) \rightarrow (1)$. Again, let $x \in (1, 2)^*rg\alpha\text{-}int(A) \cap (1, 2)^*rg\alpha\text{-}int(B)$. Then $x \in (1, 2)^*rg\alpha\text{-}int(A)$ and $x \in (1, 2)^*rg\alpha\text{-}int(B)$. Hence $x$ is a $(1, 2)^*rg\alpha\text{-}interior$ point of each of sets A and B. It follows that A and B are $(1, 2)^*rg\alpha\text{-}nbhd$ of x. Hence $x \in (1, 2)^*rg\alpha\text{-}int(A \cap B)$. Thus $x \in (1, 2)^*rg\alpha\text{-}int(A) \cap (1, 2)^*rg\alpha\text{-}int(B)$ implies that $x \in (1, 2)^*rg\alpha\text{-}int(A \cap B)$. Therefore $(1, 2)^*rg\alpha\text{-}int(A \cap B) \subset (1, 2)^*rg\alpha\text{-}int(A \cap B) \rightarrow (2)$. From (1) and (2), we get $(1, 2)^*rg\alpha\text{-}int(A \cap B) = (1, 2)^*rg\alpha\text{-}int(A) \cap (1, 2)^*rg\alpha\text{-}int(B)$.

Theorem 3.11 If A is a subset of a bitopological space X, then $\tau_{1,2}\text{-}int(A) \subset (1, 2)^*rg\alpha\text{-}int(A)$.

Proof: Let A be a subset of a bitopological space X. Let $x \in \tau_{1,2}\text{-}int(A) \Rightarrow x \in \cup \{ G : G$ is $\tau_{1,2}\text{-}open, G \subset A \} \Rightarrow$ there exists an $\tau_{1,2}\text{-}open$ set G such that $x \in G \subset A$. $\Rightarrow$ there exists a $(1, 2)^*rg\alpha\text{-}open$ set G such that $x \in G \subset A$, as every $\tau_{1,2}\text{-}open$ set is a $(1, 2)^*rg\alpha\text{-}open$ set in X. $\Rightarrow x \in \cup \{ G : G$ is $(1, 2)^*rg\alpha\text{-}open, G \subset A \} \Rightarrow x \in (1, 2)^*rg\alpha\text{-}int(A)$. Thus $x \in \tau_{1,2}\text{-}int(A) \Rightarrow x \in (1, 2)^*rg\alpha\text{-}int(A)$. Hence $\tau_{1,2}\text{-}int(A) \subset (1, 2)^*rg\alpha\text{-}int(A)$.

Remark 3.12 Containment relation in the above Theorem 3.11 may be proper as seen from the following example.

Example 3.13 In Example 3.8, let $A = \{a, c\}$. Now $(1, 2)^*rg\alpha\text{-}int(A) = \{a, c\}$ and $\tau_{1,2}\text{-}int(A) = \{a\}$. It follows that $\tau_{1,2}\text{-}int(A) \subset (1, 2)^*rg\alpha\text{-}int(A)$ and $\tau_{1,2}\text{-}int(A) \neq (1, 2)^*rg\alpha\text{-}int(A)$.

Theorem 3.14 If A is a subset of the bitopological space X, then $(1, 2)^*\text{w}\text{-}int(A) \subset (1, 2)^*rg\alpha\text{-}int(A)$, where $(1, 2)^*\text{w}\text{-}int(A)$ is given by $(1, 2)^*\text{w}\text{-}int(A) = \cup \{ G : G$ is $(1, 2)^*\text{w}\text{-}open, G \subset A \}$.

Proof: Let A be a subset of a bitopological space X. Let $x \in (1, 2)^*\text{w}\text{-}int(A) \Rightarrow x \in \cup \{ G : G$ is $(1, 2)^*\text{w}\text{-}open, G \subset A \}$. $\Rightarrow$ there exists a $(1, 2)^*\text{w}\text{-}open$ set G such that $x \in G \subset A$. 

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there exists a $(1, 2)^*\text{-rg}\alpha$-open set $G$ such that $x \in G \subseteq A$, as every $(1, 2)^*\text{-w}$-open set is a $(1, 2)^*\text{-rg}\alpha$-open set in $X$. \(\Rightarrow x \in \bigcup \{ G : G \text{ is } (1, 2)^*\text{-rg}\alpha\text{-open}, G \subseteq A \}. \Rightarrow x \in (1, 2)^*\text{-rg}\alpha\text{-int}(A)$. Thus $x \in (1, 2)^*\text{-w-int}(A) \Rightarrow x \in (1, 2)^*\text{-rg}\alpha\text{-int}(A)$. Hence $(1, 2)^*\text{-w-int}(A) \subseteq (1, 2)^*\text{-rg}\alpha\text{-int}(A)$.

**Example 3.15** Let $X = \{a, b, c\}$, $\tau_1 = \{X, \emptyset, \{a\}\}$ and $\tau_2 = \{X, \emptyset\}$. Then the sets in $\{X, \emptyset, \{a\}\}$ are called $\tau_1, \tau_2$-open; the sets in $\{X, \emptyset, \{b, c\}\}$ are called $\tau_1, \tau_2$-closed; the sets in $\{X, \emptyset\}$ are called regular $(1, 2)^*$-open; the sets in $\{X, \emptyset\}$ are called $(1, 2)^*$-open; $(1, 2)^*\text{RG}_{\alpha}(X) = P(X)$ where $P(X)$ is the power set of $X$ and the sets in $\{X, \emptyset, \{a\}\}$ are called $(1, 2)^*$-open. Let $A = \{a, b\}$. Then $(1, 2)^*\text{-rg}\alpha\text{-int}(A) = \{a, b\}$ and $(1, 2)^*\text{-w-int}(A) = \{a\}$. It follows that $(1, 2)^*\text{-w-int}(A) \subseteq (1, 2)^*\text{-rg}\alpha\text{-int}(A)$ and $(1, 2)^*\text{-w-int}(A) \neq (1, 2)^*\text{-rg}\alpha\text{-int}(A)$.

**Theorem 3.16** If $A$ is a subset of the bitopological space $X$, then $(1, 2)^*\text{-rg}\alpha\text{-int}(A) \subseteq (1, 2)^*\text{-gpr}\text{-int}(A)$, where $(1, 2)^*\text{-gpr}\text{-int}(A)$ is given by $(1, 2)^*\text{-gpr}\text{-int}(A) = \bigcup \{ G \subseteq X : G \text{ is } (1, 2)^*\text{-gpr}\text{-open}, G \subseteq A \}$.

**Proof:** Let $A$ be a subset of a bitopological space $X$. Let $x \in (1, 2)^*\text{-rg}\alpha\text{-int}(A) \Rightarrow x \in \bigcup \{ G : G \text{ is } (1, 2)^*\text{-rg}\alpha\text{-open}, G \subseteq A \}$. \(\Rightarrow \) there exists a $(1, 2)^*\text{-rg}\alpha$-open set $G$ such that $x \in G \subseteq A$. \(\Rightarrow \) there exists a $(1, 2)^*\text{-gpr}$-open set $G$ such that $x \in G \subseteq A$, as every $(1, 2)^*\text{-rg}\alpha$-open set is a $(1, 2)^*\text{-gpr}$-open set in $X$. \(\Rightarrow x \in \bigcup \{ G \subseteq X : G \text{ is } (1, 2)^*\text{-gpr}\text{-open}, G \subseteq A \}$. \(\Rightarrow x \in (1, 2)^*\text{-gpr}\text{-int}(A)$. Thus $x \in (1, 2)^*\text{-rg}\alpha\text{-int}(A) \Rightarrow x \in (1, 2)^*\text{-gpr}\text{-int}(A)$. Hence $(1, 2)^*\text{-rg}\alpha\text{-int}(A) \subseteq (1, 2)^*\text{-gpr}\text{-int}(A)$.

**Definition 3.17** Let $A$ be a subset of the bitopological space $X$. We define the $(1, 2)^*\text{-rg}\alpha$-closure of $A$ to be the intersection of all $(1, 2)^*\text{-rg}\alpha$-closed sets containing $A$. i.e., $(1, 2)^*\text{-rg}\alpha\text{-cl}(A) = \bigcap \{ F : A \subseteq F \subseteq (1, 2)^*\text{-RG}_{\alpha}(X) \}$.

**Theorem 3.18** If $A$ and $B$ are subsets of a bitopological space $X$. Then

(i) $(1, 2)^*\text{-rg}\alpha\text{-cl}(X) = X$ and $(1, 2)^*\text{-rg}\alpha\text{-cl}(\emptyset) = \emptyset$.

(ii) $A \subseteq (1, 2)^*\text{-rg}\alpha\text{-cl}(A)$.

(iii) If $B$ is any $(1, 2)^*\text{-rg}\alpha$-closed set containing $A$, then $(1, 2)^*\text{-rg}\alpha\text{-cl}(A) \subseteq B$.

(iv) If $A \subseteq B$ then $(1, 2)^*\text{-rg}\alpha\text{-cl}(A) \subseteq (1, 2)^*\text{-rg}\alpha\text{-cl}(B)$. 
(v) \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) = (1, 2)^*-\text{rg}\alpha\text{-cl}((1, 2)^*-\text{rg}\alpha\text{-cl}(A))\).

**Proof:**

(i) By the definition of \((1, 2)^*-\text{rg}\alpha\text{-closure}, x\) is the only \((1, 2)^*-\text{rg}\alpha\text{-closed}\) set containing \(X\). Therefore \((1, 2)^*-\text{rg}\alpha\text{-cl}(X) = \text{intersection of all the (1, 2)^*-rg\alpha-closed sets containing } X = \bigcap \{X\} = X\). That is \((1, 2)^*-\text{rg}\alpha\text{-cl}(X) = X\). By the definition of \((1, 2)^*-\text{rg}\alpha\text{-closure}, (1, 2)^*-\text{rg}\alpha\text{-cl}(\emptyset) = \text{intersection of all the (1, 2)^*-rg\alpha-closed sets containing } \emptyset = \emptyset \bigcap \text{any (1, 2)^*-rg\alpha-closed set containing } \emptyset = \emptyset\). That is \((1, 2)^*-\text{rg}\alpha\text{-cl}(\emptyset) = \emptyset\).

(ii) By the definition of \((1, 2)^*-\text{rg}\alpha\text{-closure} of A, it is obvious that A \(\subseteq (1, 2)^*-\text{rg}\alpha\text{-cl}(A)\).

(iii) Let B be any \((1, 2)^*-\text{rg}\alpha\text{-closed set containing } A\). Since \((1, 2)^*-\text{rg}\alpha\text{-cl}(A)\) is the intersection of all \((1, 2)^*-\text{rg}\alpha\text{-closed sets containing } A\), \((1, 2)^*-\text{rg}\alpha\text{-cl}(A)\) is contained in every \((1, 2)^*-\text{rg}\alpha\text{-closed set containing } A\). Hence in particular \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) \subseteq B\).

(iv) Let A and B be subsets of X such that A \(\subseteq B\). By the definition of \((1, 2)^*-\text{rg}\alpha\text{-closure}, (1, 2)^*-\text{rg}\alpha\text{-cl}(B) = \bigcap \{F : B \subseteq F \in (1, 2)^*-\text{RG}\alpha\text{C}(X)\}\). If B \(\subseteq F \in (1, 2)^*-\text{RG}\alpha\text{C}(X)\), then \((1, 2)^*-\text{rg}\alpha\text{-cl}(B) \subseteq F\). Since A \(\subseteq B\), A \(\subseteq B \subseteq F \in (1, 2)^*-\text{RG}\alpha\text{C}(X)\), we have \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) \subseteq F\). Therefore \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) \subseteq \bigcap \{F : B \subseteq F \in (1, 2)^*-\text{RG}\alpha\text{C}(X)\}\) = \((1, 2)^*-\text{rg}\alpha\text{-cl}(B)\). That is \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) \subseteq (1, 2)^*-\text{rg}\alpha\text{-cl}(B)\).

(v) Let A be any subset of X. By the definition of \((1, 2)^*-\text{rg}\alpha\text{-closure}, (1, 2)^*-\text{rg}\alpha\text{-cl}(A) = \bigcap \{F : A \subseteq F \in (1, 2)^*-\text{RG}\alpha\text{C}(X)\}\), if A \(\subseteq F \in (1, 2)^*-\text{RG}\alpha\text{C}(X)\), then \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) \subseteq F\). Since F is \((1, 2)^*-\text{rg}\alpha\text{-closed set containing } (1, 2)^*-\text{rg}\alpha\text{-cl}(A)\), by (iii) \((1, 2)^*-\text{rg}\alpha\text{-cl}((1, 2)^*-\text{rg}\alpha\text{-cl}(A)) \subseteq F\). Hence \((1, 2)^*-\text{rg}\alpha\text{-cl}((1, 2)^*-\text{rg}\alpha\text{-cl}(A)) \subseteq \bigcap \{F : A \subseteq F \in (1, 2)^*-\text{RG}\alpha\text{C}(X)\}\) = \((1, 2)^*-\text{rg}\alpha\text{-cl}(A)\). That is \((1, 2)^*-\text{rg}\alpha\text{-cl}((1, 2)^*-\text{rg}\alpha\text{-cl}(A)) = (1, 2)^*-\text{rg}\alpha\text{-cl}(A)\).

**Theorem 3.19** If A \(\subseteq X\) is \((1, 2)^*-\text{rg}\alpha\text{-closed}, then \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) = A\).

**Proof:** Let A be \((1, 2)^*-\text{rg}\alpha\text{-closed subset of } X\). We know that A \(\subseteq (1, 2)^*-\text{rg}\alpha\text{-cl}(A)\). Also A \(\subseteq A\) and A is \((1, 2)^*-\text{rg}\alpha\text{-closed}. By Theorem 3.19, (iii) \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) \subseteq A\). Hence \((1, 2)^*-\text{rg}\alpha\text{-cl}(A) = A\).

The converse of the above Theorem need not be true as seen from the following example.
Example 3.20 Let $X = \{a, b, c, d, e\}$, $\tau_1 = \{X, \emptyset, \{a\}, \{d\}, \{a, d\}\}$ and $\tau_2 = \{X, \emptyset, \{e\}\}$. Then the sets in $\{X, \emptyset, \{a\}, \{d\}, \{a, e\}, \{d, e\}, \{a, d, e\}\}$ are called $\tau_1$-$\omega$-open; then $(1, 2)^*\omega\operatorname{C}(X) = \{X, \emptyset, \{b\}, \{c\}, \{b, c\}, \{a, b, c\}, \{b, c, d\}, \{b, c, e\}, \{a, b, c, d\}, \{a, c, d, e\}, \{b, c, d, e\}, \{a, b, d, e\}, \{a, b, c, e\}\}$. Now $(1, 2)^*\omega\operatorname{cl}(\{a\}) = \{a\}$, but $\{a\}$ is not $(1, 2)^*\omega$-closed subset in $X$.

Theorem 3.21 If $A$ and $B$ are subsets of a bitopological space $X$, then $(1, 2)^*\omega\operatorname{cl}(A \cap B) \subset (1, 2)^*\omega\operatorname{cl}(A) \cap (1, 2)^*\omega\operatorname{cl}(B)$.

Proof: Let $A$ and $B$ be subsets of $X$. Clearly $A \cap B \subset A$ and $A \cap B \subset B$. By Theorem 3.19(iv), $(1, 2)^*\omega\operatorname{cl}(A \cap B) \subset (1, 2)^*\omega\operatorname{cl}(A)$ and $(1, 2)^*\omega\operatorname{cl}(A \cap B) \subset (1, 2)^*\omega\operatorname{cl}(B)$. Hence $(1, 2)^*\omega\operatorname{cl}(A \cap B) \subset (1, 2)^*\omega\operatorname{cl}(A) \cap (1, 2)^*\omega\operatorname{cl}(B)$.

Theorem 3.22 In a DRT space, union of arbitrary $(1, 2)^*\omega$-closed subsets of $X$ is also $(1, 2)^*\omega$-closed.

Proof: Assume that $A$ and $B$ are $(1, 2)^*\omega$-closed set in $X$. Let $U$ be regular $(1, 2)^*\omega$-open in $X$ such that $A \cup B \subset U$. Then $A \subset U$ and $B \subset U$. Since $A$ and $B$ are $(1, 2)^*\omega$-closed, $(1, 2)^*\omega\operatorname{cl}(A) \subset U$ and $(1, 2)^*\omega\operatorname{cl}(B) \subset U$. Hence $(1, 2)^*\omega\operatorname{cl}(A \cup B) = ((1, 2)^*\omega\operatorname{cl}(A)) \cup ((1, 2)^*\omega\operatorname{cl}(B))$. That is $(1, 2)^*\omega\operatorname{cl}(A \cup B) \subset U$. Therefore $A \cup B$ is $(1, 2)^*\omega$-closed set in $X$.

Example 3.23 Let $X = \{a, b, c\}$, $\tau_1 = \{X, \emptyset, \{a\}\}$ and $\tau_2 = \{X, \emptyset, \{a, b\}\}$. Then $(X, \tau_1, \tau_2)$ is DRT-space. Then the sets in $\{X, \emptyset, \{a\}\}$ are called $\tau_1$-$\omega$-open; the sets in $\{X, \emptyset, \{c\}, \{b, c\}\}$ are called $\tau_1$-$\omega$-closed; the sets in $\{X, \emptyset\}$ are called regular-(1, 2)-open; the sets in $\{X, \emptyset\}$ are called $(1, 2)^*\omega$-open and $(1, 2)^*\omega\operatorname{O}(X) = P(X)$ where $P(X)$ is the power set of $X$. In a DRT space, union of arbitrary $(1, 2)^*\omega$-closed sets is also $(1, 2)^*\omega$-closed.

Theorem 3.24 If $A$ and $B$ are subsets of a DRT space $X$, then $(1, 2)^*\omega\operatorname{cl}(A \cup B) = (1, 2)^*\omega\operatorname{cl}(A) \cup (1, 2)^*\omega\operatorname{cl}(B)$.

Proof: Let $A$ and $B$ be subsets of a DRT $X$. Clearly $A \subset A \cup B$ and $B \subset A \cup B$. Hence $(1, 2)^*\omega\operatorname{cl}(A) \cup (1, 2)^*\omega\operatorname{cl}(B) \subset (1, 2)^*\omega\operatorname{cl}(A \cup B) \to (1)$. Now to prove $(1, 2)^*\omega\operatorname{cl}(A \cup B) \subset (1, 2)^*\omega\operatorname{cl}(A) \cup (1, 2)^*\omega\operatorname{cl}(B)$. Let $x \in (1, 2)^*\omega\operatorname{int}(A \cup B)$ and suppose $x \notin (1, 2)^*\omega\operatorname{cl}(A) \cup (1, 2)^*\omega\operatorname{cl}(B)$. Then there exist $(1, 2)^*\omega$-closed sets...
A_1 and B_1 with A \subset A_1, B \subset B_1 and x \not\in A_1 \cup B_1. We have A \cup B \subset A_1 \cup B_1 and A_1 \cup B_1 is (1, 2)*-rg\alpha-closed set by the Theorem 3.23 such that x \not\in A_1 \cup B_1. Thus x \not\in (1, 2)*-rg\alpha-cl(A \cup B) which is a contradiction to x \in (1, 2)*-rg\alpha-cl(A \cup B). Hence (1, 2)*-rg\alpha-cl(A \cup B) \subset (1, 2)*-rg\alpha-cl(A) \cup (1, 2)*-rg\alpha(B) \rightarrow (2). From (1) and (2), we have (1, 2)*-rg\alpha-cl(A \cup B) = (1, 2)*-rg\alpha-cl(A) \cup (1, 2)*-rg\alpha(B).

**Theorem 3.25** For an x \in X, x \in (1, 2)*-rg\alpha-cl(A) if and only if \forall V \in (1, 2)*-rg\alpha-open set V containing x.

**Proof:** Let x \in X and x \in (1, 2)*-rg\alpha-cl(A). To prove \forall V \in (1, 2)*-rg\alpha-open set V containing x. Prove the result by contradiction. Suppose there exists a (1, 2)*-rg\alpha-open set V containing x such that V \cap A = \emptyset. Then A \subset X - V and X - V is (1, 2)*-rg\alpha-closed set. This shows that x \not\in (1, 2)*-rg\alpha-cl(A), which is contradiction. Hence \forall V \in (1, 2)*-rg\alpha-open set V containing x.

Conversely, let V \cap A \neq \emptyset for every (1, 2)*-rg\alpha-open set V containing x. To prove x \in (1, 2)*-rg\alpha-cl(A). We prove the result by contradiction. Suppose x \not\in (1, 2)*-rg\alpha-cl(A). Then there exists a (1, 2)*-rg\alpha-closed subset F containing A such that x \not\in F. Then x \in X - F and X - F is (1, 2)*-rg\alpha-open. Also (X - F) \cap A = \emptyset, which is a contradiction. Hence x \in (1, 2)*-rg\alpha-cl(A).

**Theorem 3.26** If A is a subset of a bitopological space X, then (1, 2)*-rg\alpha-cl(A) \subseteq \tau_{1,2}-cl(A).

**Proof:** Let A be a subset of a space X. By the definition of \tau_{1,2}-closure, \tau_{1,2}-cl(A) = \cap \{F \subset X : A \subset F \in (1, 2)*-C(X)\}. If A \subset F \in (1, 2)*-C(X), then A \subset F \in (1, 2)*-RG\alpha C(X), because every \tau_{1,2}-closed set is (1, 2)*-rg\alpha-closed. That is (1, 2)*-rg\alpha-cl(A) \subset F. Therefore (1, 2)*-rg\alpha-cl(A) \subset \cap \{F \subset X : A \subset F \in (1, 2)*-C(X)\} = \tau_{1,2}-cl(A). Hence (1, 2)*-rg\alpha-cl(A) \subset \tau_{1,2}-cl(A).

**Remark 3.27** Containment relation in the above Theorem may be proper as seen from the following example.

**Example 3.28** Let X = \{a, b, c\}, \tau_1 = \{X, \emptyset, \{a\}\} and \tau_2 = \{X, \emptyset, \{a, b\}\}. Then the sets in \{X, \emptyset, \{a\}\} are called \tau_{1,2}-open; the sets in \{X, \emptyset, \{c\}, \{b, c\}\} are called \tau_{1,2}-closed; the sets in \{X, \emptyset\} are called regular-(1, 2)*-open; the sets in \{X, \emptyset\} are called (1, 2)*-rg\alpha-open.
and $(1, 2)*$-RGαO(X) = P(X) where P(X) is the power set of X. Then $(1, 2)*$-rgα-cl({a}) = {a} and $\tau_{1,2}$-cl({a}) = X. It follows that $(1, 2)*$-rgα-cl({a}) $\subseteq \tau_{1,2}$-cl({a}) and $(1, 2)*$-rgα-cl({a}) $\neq \tau_{1,2}$-cl({a}).

**Theorem 3.29** If A is a subset of a bitopological space X, then $(1, 2)*$-rgα-cl(A) $\subseteq (1, 2)*$-w-cl(A), where $(1, 2)*$-w-cl(A) is given by $(1, 2)*$-w-cl(A) = $\cap \{ F \subseteq X : A \subseteq F \text{ and } F \text{ is } (1, 2)*$-w-closed \}.

**Proof:** Let A be a subset of X. By definition of $(1, 2)*$-w-closure, $(1, 2)*$-w-cl(A) = $\cap \{ F \subseteq X : A \subseteq F \text{ and } F \text{ is } (1, 2)*$-w-closed \}. If A $\subseteq$ F and F is $(1, 2)*$-w-closed subset of X, then A $\subseteq$ F $\in (1, 2)*$-RGαC(X), because every $(1, 2)*$-w-closed is $(1, 2)*$-rgα-closed subset in X. That is $(1, 2)*$-rgα-cl(A) $\subseteq$ F. Therefore $(1, 2)*$-rgα-cl(A) $\subseteq (1, 2)*$-w-cl(A). Hence $(1, 2)*$-rgα-cl(A) $\subseteq (1, 2)*$-w-cl(A).

**Remark 3.30** Containment relation in the above Theorem 3.30, may be proper as seen from the following example.

**Example 3.31** In Example 3.8, clearly if A = {a}, then $(1, 2)*$-rgα-cl(A) = {a} and $(1, 2)*$-w-cl(A) = {a, c}. That is $(1, 2)*$-rgα-cl(A) $\subseteq (1, 2)*$-w-int(A) and $(1, 2)*$-rgα-cl(A) $\neq (1, 2)*$-w-cl(A).

**Theorem 3.32** If A is a subset of a bitopological space X, then $(1, 2)*$-gpr-cl(A) $\subseteq (1, 2)*$-rgα-cl(A) where $(1, 2)*$-gpr-cl(A) is given by $(1, 2)*$-gpr-cl(A) = $\cap \{ F \subseteq X : A \subseteq F \text{ and } F \text{ is } (1, 2)*$-GPRC(X) \}.

**Proof:** Let A be a subset of X. By definition of $(1, 2)*$-rgα-closure, $(1, 2)*$-rgα-cl(A) = $\cap \{ F \subseteq X : A \subseteq F \text{ and } F \text{ is } (1, 2)*$-RGαC(X) \}. If A $\subseteq$ F $\in (1, 2)*$-RGαC(X), then A $\subseteq$ F $\in (1, 2)*$-GPRC(X), because every $(1, 2)*$-rgα-closed is $(1, 2)*$-gpr-closed subset in X. That is $(1, 2)*$-gpr-cl(A) $\subseteq$ F. Therefore $(1, 2)*$-gpr-cl(A) $\subseteq (1, 2)*$-rgα-cl(A). Hence $(1, 2)*$-gpr-cl(A) $\subseteq (1, 2)*$-rgα-cl(A).

**Theorem 3.33** Let A be any subset of a bitopological space X. Then

(i) $((1, 2)*$-rgα-int(A))$^c$ = $(1, 2)*$-rgα-cl(A$^c$)

(ii) $(1, 2)*$-rgα-int(A) = $((1, 2)*$-rgα-cl(A$^c$))$^c$
(iii) \((1, 2)^*\text{-rg}\alpha\text{-cl}(A) = ((1, 2)^*\text{-rg}\alpha\text{-int}(A^c))^c\)

**Proof**: (i) Let \(x \in ((1, 2)^*\text{-rg}\alpha\text{-int}(A))^c\). Then \(x \notin (1, 2)^*\text{-rg}\alpha\text{-int}(A)\). That is every \((1, 2)^*\text{-rg}\alpha\text{-open}\) set \(U\) containing \(x\) is such that \(U \not\subset A\). That is every \((1, 2)^*\text{-rg}\alpha\text{-open}\) set \(U\) containing \(x\) is such that \(U \cap A^c \neq \emptyset\). By Theorem 3.26., \(x \in (1, 2)^*\text{-rg}\alpha\text{-cl}(A^c)\) and therefore \(((1, 2)^*\text{-rg}\alpha\text{-int}(A))^c \subset (1, 2)^*\text{-rg}\alpha\text{-cl}(A^c)\). Conversely, let \(x \in (1, 2)^*\text{-rg}\alpha\text{-cl}(A^c)\). Then by Theorem 3.26., every \((1, 2)^*\text{-rg}\alpha\text{-open}\) set \(U\) containing \(x\) is such that \(U \cap A^c \neq \emptyset\). That is every \((1, 2)^*\text{-rg}\alpha\text{-open}\) set \(U\) containing \(x\) is such that \(U \not\subset A\). This implies by Definition of \((1, 2)^*\text{-rg}\alpha\text{-interior}\) of \(A\), \(x \notin (1, 2)^*\text{-rg}\alpha\text{-int}(A)\). That is \(x \in ((1, 2)^*\text{-rg}\alpha\text{-int}(A))^c\) and \((1, 2)^*\text{-rg}\alpha\text{-cl}(A^c) \subset ((1, 2)^*\text{-rg}\alpha\text{-int}(A))^c\). Thus \(((1, 2)^*\text{-rg}\alpha\text{-int}(A))^c = (1, 2)^*\text{-rg}\alpha\text{-cl}(A^c)\).

(ii) Follows by taking complements in (i).

(iii) Follows by replacing \(A\) by \(A^c\) in (i).

**References**


CLOUD COMPUTING AND ITS SERVICE TECHNIQUES
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ABSTRACT:

Cloud computing is among the foremost promising technologies of the recent days, with the potential to achieve $204 billion by the tip of 2016. The majority major technical school corporations offer cloud services of 1 kind or another like computing clusters and cloud storage. Cloud services will be provisioned as package as a Service (SaaS), Platform as a Service (PaaS) or Infrastructure as a Service (IaaS) and that they will be deployed as personal, community, public or hybrid clouds. Cloud computing provides many benefits like ease-of-deployment, no maintenance and up-front prices, and fast and economical measurability. However it will create many challenges with regards to security of knowledge and privacy problems, and plenty of security sensitive corporations tend to keep off from cloud services thanks to this terribly reason.

Keyword:
Broadband, Agility, Cloud, Community, Data Portability, Elasticity, Hybrid.

INTRODUCTION:

Cloud computing is that the on-demand accessibility of ADPS resources, particularly knowledge storage and computing power, while not direct active management by the user. The term is usually accustomed describe knowledge centers accessible to several users over the web. Cloud computing is that the the utilization of varied services, like software system development platforms, servers, storage and software system, over the web, usually spoken because the "cloud."
CLOUD COMPUTING CHARACTERISTICS:

The back-end of the appliance (especially hardware) is totally managed by a cloud vendor. A user solely pays for services used (memory, time interval and information measure, etc.). Services are scalable. Many cloud computing advancements are closely associated with virtualization. The flexibility to pay on demand and scale quickly is basically a result of cloud computing vendors having the ability to pool resources which will be divided among multiple shoppers. It is common to categorise cloud computing services as infrastructure as a service (IaaS), platform as a service (PaaS) or software system as a service (SaaS).

CLOUD TYPES:

Software as a Service (SaaS)

Cloud application services, or software system as a Service (SaaS), represent the biggest cloud market and are still growing quickly. SaaS uses the net to deliver applications that are managed by a third-party vendor and whose interface is accessed on the clients’ aspect. Most SaaS applications are often run directly from an internet browser with none downloads or installations needed, though some need plugins.
Well-liked SaaS giving sorts embody email and collaboration, client relationship management, and healthcare-related applications. Some massive enterprises that don't seem to be historically thought of as software system vendors have started building SaaS as a further supply of revenue so as to realize a competitive advantage.

**Platform as a Service (PaaS)**

Cloud platform services, or Platform as a Service (PaaS), square measure used for applications, and alternative development, whereas providing cloud parts to software system. What developers gain with PaaS may be a framework they will build on to develop or customise applications. PaaS makes the event, testing, and preparation of applications fast, simple, and cost-efficient.

**A structure as a Service (IaaS),**

Cloud infrastructure services, referred to as Infrastructure as a Service (IaaS), square measure self-service models for accessing, monitoring, and managing remote datacenter infrastructures, like reckon (virtualized or vacant metal), storage, networking, and networking services (e.g. firewalls). rather than having to buy hardware outright, users should buy IaaS supported consumption, like electricity or alternative utility charge.
ADVANTAGES OF CLOUD COMPUTING:

1. **Value Savings:** If you're distressed concerning the value tag that may go together with creating the switch to cloud computing, {you square measuren't|you are not} alone 2 hundredth of organizations are involved concerning the initial value of implementing a cloud-based server.

2. **Security:** several organizations have security considerations once it involves adopting a cloud-computing answer. By victimization secret writing, data is a smaller amount accessible by hackers or anyone not approved to look at your knowledge. As one more security live, with most cloud-based services, totally different security settings are often set supported the user. whereas 2 hundredth of cloud user claim disaster recovery in four hours or less, solely Sep 11 of cloud users might claim identical.

3. **Flexibility:** The cloud offers businesses a lot of flexibility overall versus hosting on a neighborhood server. And, if you wish additional information measure, a cloud-based service will meet that demand instantly, instead of undergoing a fancy (and expensive) update to your IT infrastructure. This improved freedom and suppleness will build a major distinction to the general potency of your organization. A sixty fifth majority of respondents to Associate in Nursing InformationWeek survey aforementioned “the ability to quickly meet business demands” was one in every of the foremost necessary reasons a business ought to move to a cloud surroundings.

4. **Mobility:** Cloud computing permits mobile access to company knowledge via smartphones and devices, which, considering over two.6 billion smartphones square measure getting used globally nowadays, may be a good way to make sure that nobody is ever neglected of the loop. employees with busy schedules, or WHO live a protracted method far from the...
company workplace, will use this feature to stay instantly up so far with shoppers and colleague.

**DISADVANTAGES:**

1. **Network affiliation Dependency**
   
   Advantages of cloud computing, your business should have an online affiliation. sadly, there's no thanks to get around this truth. you wish a network so as to send files to the cloud and retrieve them.

2. **Restricted Options**
   
   Not all cloud suppliers square measure created equally. after you use cloud computing for storage and backup, you must ideally be operating with a supplier WHO offers the worth of unlimited information measure. you will conjointly expertise restricted cupboard space or accessibility. SaaS offerings might sometimes begin with a free package, however you may be charged for premium offerings and additional area.

3. **Loss of management**
   
   Speak one-on-one with a representative WHO will address your access considerations, and find out about the measures that the Hosted Services company takes to make sure the integrity and safety of their cloud servers.

4. **Security**
   
   Cloud hacking cases as recent because the past few months have shown that not all cloud suppliers square measure as secure as they claim to be. As a business, you can’t afford to own sensitive data concerning your company or your shoppers fall victim to hackers. one in every of cloud computing’s greatest disadvantages is that you just don’t invariably recognize that suppliers you'll be able to trust. Because of the recognition of SaaS suppliers, they get targeted a lot of oft, and a lot of simply, than a Hosted supplier.

5. **Technical problems**
   
   If you expertise any technical problems, you've got no selection however to decision your hosted provider’s technical support for facilitate. you can't fix your cloud computing issues in-house, and a few suppliers don't supply continuous technical support.

**CONCLUSION**

Cloud computing is one in every of the foremost exciting technologies within the recent decade with potential to grow {much a lot of|far a lot of|rather more|way more} chop-chop as net access becomes more and more present. Its simple use, low maintenance and up-front prices and simple scaling makes it the proper candidate for several start-up businesses.
within the fashionable entrepreneurial world. however security of personal knowledge remains an enormous concern and within the absence of concrete laws to make your mind up whether or not the liability of information leaks is on the service suppliers or not, the shoppers square measure sure to take preventive measures themselves and use cloud on their own risk. nonetheless, cloud computing is here to remain for the predictable future and it might be prudent for several businesses to adopt it

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A STUDY ON LIE GROUPS, LIE ALGEBRAS AND REPRESENTATIONS
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ABSTRACT:

This textbook treats Lie groups, Lie algebras and their representations in an elementary but fully rigorous fashion requiring minimal prerequisites. In particular the theory of matrix Lie groups and their Lie algebra is developed using only linear algebra, and motivation and intuition proofs is provided than in most classic texts on the subject. In addition to its accessible treatment of basic theory of Lie group and Lie algebras, the book also noteworthy for including a treatment of the Baker-Campbell-Hausdorff formula and its use in place of the frozen.

KEYWORDS:

Lie groups, Lie algebras, baker – Campbell – Hausdorff, theory of matrix

INTRODUCTION

Lie groups and Lie algebras, and their representation together called Lie theory, originated in the study of natural symmetries of solutions of differential equations. However, unlike say the mite collection of symmetries of the hexagon, these symmetries occurred in continuous families, just as the rotational symmetries of the plane form a continuous family isomorphic to the unit circle. The theory as we know it today began with the ground-breaking work of the Norwegian mathematician Sophus Lie, who introduced the notion of continuous transformation group and showed the crucial role that Lie algebras play in their classification and representation theory. Lie's ideas played a central role in Felix Klein's grand "Erlangen program" to classify all possible geometries using group theory.

Today Lie theory plays an important role in almost every branch of pure and applied mathematics, is used to describe much of modern physics, in particular classical. In the 19th century, when group wear dealt with they were generally understood to be subsets the of the permutations of a set or automorphisms GL(V).
In mathematics, Lie group–Lie algebra correspondence allows one to study Lie group algebra which are linear objects. This means that applying a given transformation to one solution of the differential equation gives us another solution.

Hence one can quickly and easily generate new solutions from old one, "buy one, get one free.

**SOME BASIC DEFINITIONS AND EXAMPLES**

**DEFINITION**

A Lie group $G$ is an abstract group and a smooth $n$-dimensional manifold so that multiplication $G \times G \to G: (a; b) \mapsto ab$ and inverse $G \to G: a \mapsto a^{-1}$ are smooth.

**DEFINITION**

A Lie algebra over $K = \mathbb{R}$ or $\mathbb{C}$ is a vector space $V$ over $K$ with a skew-symmetric $K$-bilinear form (the Lie bracket) $[,] : V \times V \to V$ which satisfies the Jacobi identity $[X; [Y; Z]] + [Y; [Z; X]] + [Z; [X; Y]] = 0$ (1.3) Jacobi for all $X, Y, Z \in V$.

We relate the two via so-called left invariant vector fields. We use the standard notation $L_g: G \to G; h \mapsto gh$ and $R_g: G \to G; h \mapsto hg$ and define

**DEFINITION**

A vector field $X$ on a Lie group $G$ is called left invariant if

$d(L_g)h(X(h)) = X(gh)$ for all $g, h \in G$.

or for short $(L_g)_\circ(X) = X$.

**DEFINITION**

Let $H$ and $G$ be Lie groups.

(a) $\hat{A}: H \to G$ is called a Lie group homomorphism if it is a group homomorphism and smooth.

(b) $\hat{A}$ is called a Lie group isomorphism if it is a group isomorphism and $\hat{A}$ and $\hat{A}^{-1}$ are smooth.

Similarly, we define Lie algebra homomorphism and isomorphisms.

Note that $\hat{A}$ is a group homomorphism iff $\hat{A} \pm L_g = L\hat{A}(g) \pm \hat{A}$.

A homomorphism $\hat{A}: G \to \text{GL}(n; \mathbb{R})$ resp. $\text{GL}(n; \mathbb{C})$ is called a real resp. complex representation.
**DEFINITION**

If $G$ is a Lie group with Lie algebra $\mathfrak{g}$, then the exponential map is defined as: exp: $\mathfrak{g} \to G$ where $\exp(\dot{X}) = \dot{X}(1)$ with $\dot{X}(0) = X$

**DEFINITION**

Let $\mathfrak{g}$ be a Lie algebra.

(a) A linear isomorphism $A: \mathfrak{g} \to \mathfrak{g}$ is an automorphism if it is a Lie algebra homomorphism. Let $\text{Aut}(\mathfrak{g}) = \text{GL}(\mathfrak{g})$ be the set of automorphisms of $\mathfrak{g}$.

(b) A linear map $A: \mathfrak{g} \to \mathfrak{g}$ is a derivation if $A[X; Y] = [AX; Y] + [X; AY]; \forall X; Y \in \mathfrak{g}$

**DEFINITION**

A Lie algebra is called compact if it is the Lie algebra of a compact Lie group.

**DEFINITION**

A Lie algebra $\mathfrak{L}$ over a field $k$ is a $k$-vector space together with a bilinear map $\lbrack \cdot; \cdot \rbrack: \mathfrak{L} \times \mathfrak{L} \to \mathfrak{L}$ satisfying (1) $\lbrack x; x \rbrack = 0$ for all $x \in \mathfrak{L}$; (2) Jacobi identity: $\lbrack x; \lbrack y; z \rbrack \rbrack + \lbrack y; \lbrack z; x \rbrack \rbrack + \lbrack z; \lbrack x; y \rbrack \rbrack = 0$

**PROPOSITION**

If $\dot{A}: H \to G$ is a Lie group homomorphism, then $d\dot{A}e : T_{e}H \to T_{e}G$ is a Lie algebra homomorphism

**PROOF**

Recall that for any smooth map $f$, the (smooth) vector fields $\dot{X}_i$ are called $f$-related to $Y_i$ if $(df)p(\dot{X}_i(p)) = Y_i(f(p))$ for all $p$ and that in that case $[\dot{X}_1; \dot{X}_2]$ is $f$-related to $[Y_1; Y_2]$. Thus, if we denote by $\dot{X}_i$ the left invariant vector field on $H$ with $\dot{X}_i(e) = v_i$ for $i = 1; 2$, and by $Y_i$ the left invariant vector field on $G$ with $Y_i(e) = d\dot{A}e(v_i)$, all we need to show is that $\dot{X}_i$ and $Y_i$ are $\dot{A}$ related. Indeed, it will then follow that $d\dot{A}e([\dot{X}_1; \dot{X}_2]e) = [Y_1; Y_2]e$.

They are $\dot{A}$ related since

$$d(\dot{A}g(\dot{X}(g))) = d(\dot{A})gd(Lg)e(v) = d(\dot{A} \pm Lg)e(v) = d(L\dot{A}(g) \pm \dot{A})e(v)$$

$$= d(L\dot{A}(g))d(\dot{A})e(v) = Y(\dot{A}(g))$$

If $\dot{A}: H \to G$ is a Lie group homomorphism
PROPOSITION

If $H$ and $G$ are Lie groups with $H$ simply connected, then for any Lie algebra homomorphism $\tilde{A}: h \to g$ there exists a unique Lie group homomorphism $\tilde{A}: H \to G$ with $d\tilde{A} = \tilde{A}$.

PROOF

Recall that $\text{Graph}(\tilde{A}) = (v; \tilde{A}(v))$ is a Lie subalgebra and hence by Proposition 1.11 there exists a connected subgroup $A \subseteq H \times G$ with Lie algebra $\text{Graph}(\tilde{A})$. Let $\pi_1$ and $\pi_2$ be the projections from $H \times G$ to the first and second factor. They are clearly homomorphisms and $\pi_1: A \to G$ is a covering since $d(\pi_1)\alpha$ is clearly an isomorphism. Since $H$ is simply connected, $A$ is isomorphic to $H$. Thus we get a homomorphism $\pi_2: G \to A \to G$ which by construction has derivative $\tilde{A}$.

PROPOSITION

Let $g$ be a real or complex Lie algebra with Killingform $B$.

(a) If $A \in \text{Aut}(g)$, then 
   \[ B(AX; AY) = B(X; Y). \]

(b) If $L \in \text{Der}(g)$, then 
   \[ B(LX; Y) + B(X; LY) = 0. \]

PROOF

One easily show that if $A$ is an automorphism, then $\text{ad}AX = A \pm \text{ad}X \pm A_i 1$. Thus $B(AX; AY) = \text{tr}(\text{ad}AX \pm \text{ad}AY) = \text{tr}(A \pm \text{ad}X \pm \text{ad}Y \pm A_i 1) = \text{tr}(\text{ad}X \pm \text{ad}Y)$ which proves our first claim.

If $L$ is a derivation, $etL$ is an automorphism and thus $B(etLX; etLY) = B(X; Y)$. Differentiating at $t = 0$ proves our second term.

PROPOSITION

Let $g$ be a complex semisimple Lie algebra. If $g$ is a subalgebra of $\text{gl}(n; \mathbb{C})$ and $e$ is a compact real form of $g$, then the connected Lie subgroup $K$ of $\text{GL}(n; \mathbb{C})$ whose Lie algebra is $e$ is compact.

PROOF

The definition of a compact real form is that there is a simply connected compact matrix Lie group $K$ whose Lie algebra $el$ is isomorphic to $t$. Let $\varphi: tL \to tC \text{gl}(n; \mathbb{C})$ be a Lie algebra isomorphism. By Theorem 3.7, there is an associated Lie group homomorphism $<\varphi>: KI \to \text{GL}(n; \mathbb{C})$, and let $K$ be the image of this homomorphism. Since the image of a compact
set under a continuous map is compact, $K$ is compact (and hence closed). Furthermore, since
the image of $t$ is $t$, Proposition tells us that $K$ is the connected Lie subgroup of $GL(n; \mathbb{Q})$ with
Lie algebra $t^0$

**THEOREM**

Let $G$ be a Lie group. Denote by $G^0$ the connected component of unity. Then $G^0$ is a
normal subgroup of $G$ and is a Lie group itself. The quotient group $G/G^0$ is discrete.

**PROOF**

We need to show that $G^0$ is closed under the operations of multiplication and
inversion

Since the image of a connected topological space under a continuous map is
connected, the inversion map $i$ must take $G^0$ to one component of $G$, that which contains $i(1) = 1$, namely $G^0$.

In a similar way one shows that $G^0$ is closed under multiplication.

To check that this is a normal subgroup, we must show that if $g \in G$ and $h \in G^0$, then
$ghg^{-1} \in G^0$. Conjugation by $g$ is continuous and thus will take $G^0$ to some connected
component of $G$; since it fixes 1, this component is $G^0$

**CONCLUSION**

Lie groups lie algebra and representation theory are the main focus of the texts the
book also often –intimidating machinery of whey group, group, lie algebra and their
representations.

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GENERAL GUIDELINES FOR AUTHORS

❖ The manuscript of the paper should contain:
  ➢ Title of the paper, all in capital letters.
  ➢ Names of authors along with designation and place of work.
  ➢ Abstract in the range of 50-100 words followed by 5 key words.
  ➢ Introduction followed by text.
  ➢ Conclusions.
  ➢ References.
  ➢ Notations (In case of mathematical papers)
  ➢ Acknowledgements

❖ The original typescript should be typed in double space on one side of a good quality A-4 size bond paper with wide margins on the left and right side. All pages should be numbered consecutively starting from title page to the end of the paper.
  ➢ Generally, the maximum length of the paper should be upto 10/A-4 size pages including text, figures, tables etc. which is equivalent to 3500 words, each page being approximately 300 words-equivalents.

❖ Mathematical symbols and abbreviations used in the paper be explained at the place where they occur first, and arranged, alphabetically in an appendix ‘NOTATIONS’ at the end of the paper.

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  • **Current opinions**: Very recent innovations in all fields expressed in about 50 words.

  • **Research Communications**: Break through discoveries and inventions from cutting edge research laboratories explained in about 100 words.

  • **Research Article**: Original, research work of major significance, not exceeding 3500 words and published in any journal.

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number. Clarity of concepts with lucid presentation preferred over textbook style.

- Only SI (System International) units must be used throughout the paper.

- The number of figures should be kept to the minimum. Each figure should be numbered and have proper legends. In case of line drawings one set of originals and two copies should be submitted. Line drawings should be roughly twice the final printed size. Only black and white photographs accepted in most essential cases. Photocopies of photographs and other data not acceptable. Photomicrographs and other photographs that require it must have a scale bar and the lettering in the legends should be sufficiently large to be clear after reduction to print size.

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  Perambalur-621 212

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NUMBER THEORY PALINDROME

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ABSTRACT

In this paper, palindromes are a base 10 system, 2 digit and 3 digit basis for the natural numbers. To show variety the number of steps necessary to convert every two digit number into a word.

KEY WORD

Palindromic Numbers,n-Natural ,n-Even,n-odd,n-square,n-Cube,n-Prime.

INTRODUCTION

Number theory could be branch of mathematics devoted primarily to the study of the integers. “Mathematics is that the queen of the sciences and range theory is that the queen of mathematics”. The older term for number theory is arithmetic. By the twentieth century, it had been superseded by “number theory”.

The theory of numbers has always is concerned with the properties of Natural numbers and even to the set of all integer. Infact some results of number theory are most easily proved by making use of the properties of real or complex numbers even through the statements may involve only numbers.

A palindrome is a word or phase that reads the same forward and backward. Such as the word “ level ” and the phase “ madam”.

PALINDROMIC NUMBERS :

Numbers whose digits browse constant forward and backward are referred to as palindromes.

EXAMPLE :

22, 1234321 and 2002 .

All single digits area unit thought-about palindromes in a very base ten system.
In deriving such a formula, one must consider the choice for each position within the number. Clearly, the two outside digits (the first and last digits) must be the same number and can be any of the digits 1 through 9. Therefore, for any k digits palindrome, there are nine choices for the first and last digits.

Furthermore, for any K digit palindrome, the middle digit (for an odd number of digits) or the middle two (for an even number of digits) must also be the same. These digits may also be chosen from the digits 0 through 9, giving ten choices for the middle position (s). Looking at the chart below one is healthier able to visualize a pattern.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>(t = u) 1 through 9</td>
<td>t u</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1 1</td>
</tr>
<tr>
<td>3</td>
<td>(h = u) 1 through 9</td>
<td>h t u</td>
</tr>
<tr>
<td></td>
<td>(t) 0 through 9</td>
<td>1 0 1</td>
</tr>
<tr>
<td>4</td>
<td>(th = u) 1 through 9</td>
<td>th h t u</td>
</tr>
<tr>
<td></td>
<td>(h = t) 0 through 9</td>
<td>1 0 0 1</td>
</tr>
<tr>
<td>5</td>
<td>(tth = u) 1 through 9</td>
<td>tth th h t u</td>
</tr>
<tr>
<td></td>
<td>(th = t) 0 through 9</td>
<td>1 0 0 0 1</td>
</tr>
<tr>
<td></td>
<td>(hth = tth = u) 1 through 9</td>
<td>hth tth th h t u</td>
</tr>
</tbody>
</table>
From the above table, one notices that ninety thousands palindroms can be made with both four digits and five digits.

There are nine thousands palindroms using either five digits. One can also observe the increasing power of ten that occurs every two rows.

**EXAMPLE:**

Three and four digits palindromes have one 10 multiplied by 9. Five digit palindromes have a $10^2$ multiplied by 9.

Regardless of the number of digits in the palindrome, there are only nine choices for the first and last digits, since zero can not be considered for the first digit.

Therefore, the subsequent formula may be wont to realize the whole variety of palindromes that may be created with K digits

When K is even : $10^{(K/2-1)} \times 9$

When K is odd : $10^{(K+1/2-1)} \times 9$

**EXAMPLE:**

<table>
<thead>
<tr>
<th>Digits in palindrome</th>
<th>Even $= 10^{(K/2-1)} \times 9$</th>
<th>Odd $= 10^{(K+1/2-1)} \times 9$</th>
<th>Pattern and answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$10^{(0/2-1)} \times 9$</td>
<td>$10^0 \times 9 = 9$</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>$10^{(0+1/2-1)} \times 9$</td>
<td>$10^1 \times 9 = 90$</td>
<td></td>
</tr>
</tbody>
</table>
Number can be converted into palindromes using a reverse and add rule.

**EXAMPLE:**

Take a two digits number that is not a palindrome, say 45. Reverse the digits and add these two numbers together\(45 + 54 = 99\).

If one is not successful after one step, repeat the steps until a palindrome is reached.

\(67 + 76 = 143\) is not a palindrome, but \(143 + 341 = 484\) is, all two digits numbers can be converted into a palindrome in a finite number of steps.

Most are quite straightforward to convert, but there are many 2 digit numbers that need a bit of persistence.

There are several shortcuts one can take to determine how many steps will be necessary to convert a two digits number into a palindrome.

The first shortcut to consider is if a number \(N\) is a \(k\)–step palindrome (meaning it requires \(k\) iterations of the reverse and add rule to turn \(N\) into a palindrome).

**EXAMPLE:**

Let \(t = \) tens digits of \(N\),

Where \(1 \leq t \leq 9\).

\(u = \) units digits of \(N\), Where \(0 \leq u \leq 9\).

Suppose \(t = 4\) and \(u = 5\).

\(N = 10(t) + u\)

\(N = 10(4) + 5\)

\(N = 45\).

**ONE STEP PALINDROME:**
\[ N = 45 \text{ and } N' = 54 \]
\[ N + N' = 45 + 54 \]
\[ = 99. \]

So 45 is one step palindrome.

**TWO STEP PALINDROME:**

1) \[ N = 19 \text{ and } N' = 91 \]
\[ N + N' = 19 + 91 \]
\[ = 110. \]

Again add this value,

\[ N + N' = 110 + 011 \]
\[ = 121. \]

So 19 is two – step palindrome.

\[ N = 28 \text{ and } N' = 82 \]
\[ N + N' = 28 + 82 \]
\[ = 110. \]

Again add this value,

\[ N + N' = 110 + 011 \]
\[ = 121. \]

So 19 is two – step palindrome.

**THREE STEP PALINDROME:**

\[ N = 59 \text{ and } N' = 95 \]
\[ N + N' = 59 + 95 \]
\[ = 154 \]

Again add this value,
\[ N + N' = 154 + 451 \]
\[ = 605 \]

Again add this value,
\[ N + N' = 605 + 506 \]
\[ = 1111. \]

So 59 is three – step palindrome.

Using the higher than mentioned cutoff and a few quaint computation.

The following table was created to indicate range\{the amount\{the quantity\} of steps necessary to convert every 2 digit number into a word.

<table>
<thead>
<tr>
<th>Steps needed</th>
<th>Sum of ten digit &amp; one digit ((t + u))</th>
<th>Values of (n) being a two digit number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Already palindrome</td>
<td>11, 22, 33, 44, 55, 66, 77, 88 &amp; 99.</td>
</tr>
<tr>
<td>1</td>
<td>(t + u \leq 9)</td>
<td>10, 12, 13, 14, 15, 16, 17, 18, 20, 21, 23, 24, 26, 27, 30, 31, 32, 34, 35, 36, 40, 41, 42, 43, 45, 50, 51, 52, 53, 54, 60, 61, 62, 63, 70, 71, 72, 80, 81 &amp; 90.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>71 = 7 + 1 = 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90 = 9 + 0 = 9.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(t + u = 10)</td>
<td>19, 28, 37, 46, 64, 73, 82 &amp; 91.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>37 = 3 + 7 = 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>46 = 4 + 6 = 10</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(t + u = 11)</td>
<td>29, 38, 47, 56, 74, 83 &amp; 92.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>38 = 3 + 8 = 11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>92 = 9 + 2 = 11</td>
<td></td>
</tr>
</tbody>
</table>
| 2   | t + u = 12 | 39, 48, 57, 75, 84 & 93.  
Example: 
48 = 4 + 8 = 12  
93 = 9 + 3 = 12.  |
|-----|------------|--------------------------------------------------------|
| 2   | t + u = 13 | 49, 58, 67, 76, 85 & 94.  
Example: 
40 = 4 + 9 = 13  
85 = 8 + 5 = 13.  |
| 3   | t + u = 14 | 59, 68, 86 & 95.  
Example: 
68 = 6 + 8 = 14  
86 = 8 + 6 = 14.  |
| 4   | t + u = 15 | 69, 78, 87 & 96.  
Example: 
78 = 7 + 8 = 15  
69 = 6 + 9 = 15 |
| 6   | t + u = 16 | 79 & 97  
Example: 
79 = 7 + 9 = 16  
97 = 9 + 7 = 16.  |
Example:
89 = 8 + 9 = 17
98 = 9 + 8 = 17

THE PALINDROMIC CALCULATION FOR 89

1. 89 + 98 = 187
2. 187 + 781 = 968
3. 968 + 869 = 1837
4. 1837 + 7381 = 9218
5. 9218 + 8129 = 17347
6. 17347 + 74371 = 91718
7. 91718 + 81719 = 173437
8. 173437 + 734371 = 907808
9. 907808 + 808709 = 1716517
10. 1716517 + 7156171 = 8872688
11. 8872688 + 8862788 = 17735476
12. 17735476 + 67453771 = 85189247
13. 85189247 + 74298158 = 159487405
14. 159487405 + 504784951 = 664272356
15. 664272356 + 653272466 = 1317544822
16. 1317544822 + 2284457131 = 3602001953
17. $3602001953 + 3591002063 = 7193004016$
18. $7193004016 + 6104003917 = 13297007933$
19. $13297007933 + 33970079231 = 47267087164$
20. $47267087164 + 46178076274 = 93445163438$
21. $93445163438 + 83436154439 = 176881317877$
22. $176881317877 + 778713188671 = 955594506548$
23. $955594506548 + 845605495559 = 1801200002107$
24. $1801200002107 + 7012000021081 = 8813200023188$ 

As one can see from above table the sum of the digit in two digit numbers see to be a key in figuring out the number of steps it will take to covert those two digits into palindromes.

Let us take a look at each sum $t + u$. The original two digits number will be called $N$ and can be written as $10t + u$.

$1 \leq t \leq 9$ and $0 \leq u \leq 9$ we will also required that $t \neq u$. Since otherwise, these would be palindromes already, this requirement eliminates the largest possible sum that $t + u$ can be namely 18.

Let us look at the cases, where $t + u \geq 1$ and $t + u \leq 17$.

Finding the add from applying the primary step to the numbers is that the key to finding what percentage steps ar required for variety to be born-again into a word.

If $N$ is that the original 2 digit range and $N^\prime$ is that the range created once reversing the digits, then

Let $N_2 = N + N^\prime$

$= 10(t + u) + (t + u)$

At this point, one must separate the sum into two cases.
**CASE 1: \((t + u \leq 9)\)**

In this case, \(t + u\) is the units digit of \(N_1\) and \(t + u \geq 1\). Also, \(t + u\) is that the tens digit of \(N_1\).

Hence, the primary step range \(N_1\) could be a 2 digit word.

**EXAMPLE**

\[
N = 27, \quad N' = 72
\]

\[
N_1 = 10(t + u) + (t + u)
\]

\[
N_1 = 10(2 + 7) + (7 + 2)
\]

\[
= (20 + 70) + (7 + 2)
\]

\[
= 99.
\]

\(N_1 = 99\) is a palindrome.

**CASE 2: \((t + u \geq 10)\)**

Here, when \(N\) and \(N'\) are added together, carrying a ten or regrouping takes place. The units digits of \(N_1\) is now \(t + u + 1 \geq 10\),

And 1 is carried over to the tens place. The tens digit of \(N\), is then \(t + u + 1 \geq 10\), but since this is greater than 10.

It reduced to \(t+u+1-10 = t+u-9\), and 1 has to be carried over to the hundred places.

**EXAMPLE**

\[
N = 47, \quad N' = 74 \text{ and } 4 + 7 \geq 10.
\]

Here, \(47 + 74 = 121\),

So 47 is a one step palindrome.

As one will see from the previous example, we had a one – step palindrome. Where the sum of the ten digit and the one digit was eleven therefore, \(N\) is a one – step palindrome If \(t + u \leq 9\) (or) \(t + u = 11\).
One can continue in this fashion to check the remaining two digit numbers to see how many steps are needed to convert into them palindromes.

There are solely a number of cases left to examine,

When \( t + u = 0 \) and \( t \neq u \).

We find that.

**STEP 1:**

\[
N_1 = 100(1) + 10(t + u - 9) + (t + u - 10)
\]

\[
= 100(1) + 10(1) + 0
\]

\[
= 110 \quad \text{(Since } 10 = t + u).\]

**STEP 2:**

\[
N_2 = N_1 + N'_1
\]

\[
= 110 + 011
\]

\[
= 121.
\]

\( N \) is a two – step palindrome.

Since when \( t + u = 10 \) and \( t \neq u \), the two digit number \( N \) can be converted into a two – step palindrome.

**2.2 DECIMAL PALINDROMIC NUMBERS:**

All numbers in base 10 with one digit are palindromic, the number of palindromic numbers with two digits is nine.

There are 90 palindromic numbers with their digits. (Using the rule product 9 choices for the first digit which determine the third digit as well multiplied by 10 choices for the second digit)

**EXAMPLE**

For some styles of palindromic numbers these values are listed below. Here 0 is included.
1) n – NATURAL:

\[10^1 = 10 \{0, 1, 2, 3, 4, 5, 6, 7, 8 & 9\}\]
\[10^2 = 19 \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 22, 33, 44, 55, 66, 77, 88 & 99\}\]

2) n – EVEN:

\[10^1 = 5\{0, 2, 4, 6 & 8\}\]
\[10^2 = 9\{0, 2, 4, 6, 8, 22, 44, 66 & 88\}\]

3) n – ODD:

\[10^1 = 5\{1, 3, 5, 7 & 9\}\]
\[10^2 = 10\{1, 3, 5, 7, 9, 11, 33, 55, 77 & 99\}\]

4) n – SQUARE:

\[10^1 \& 10^2 = 4\{0, 1, 4 & 9\}\]
\[10^3 = 7\{0, 1, 4, 9, 121, 289 & 484\}\]

5) n – CUBE:

\[10^1 \& 10^2 = 3\{0, 1, 8\}\]
\[10^3 = 7\{0, 1, 8, 343, 1331 & 1367631\}\]

6) n – PRIME:

\[10^1 = 4\{2, 3, 5 & 7\}\]
\[10^2 = 5\{2, 3, 5, 7 & 11\}\]

Its all the natural, even odd, square, cube & prime numbers are palindrome.

CONCLUSION

In this papers, the basic of number theory and palindromic numbers, l. The main aim of this study is to know where the palindromic numbers used in every day life. Amazing properties of palindromic number are used in solving puzzles etc. This project is a interesting application of the palindromic numbers an important role in modern cryptography or coding systems.
REFERENCE

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