Chapter 6

Performance Evaluation

6.1 INTRODUCTION

Most of the software systems ignoring quality requirements towards the start of the software development cycle which is not accomplish their quality targets. For example the issue can be loss of efficiency, incomes, clients, expense occupies and so forth emerge when programming frameworks are built without having execution personal as main priority. Modifying such issues so as to settle subsequently (the code) is unreasonable or even barely feasible. The software in the wake of altering such issues may be wrong or may not execute the programming, which has been built under execution contemplations. In this manner, performance is one of the discriminating quality, necessities to the achievement of a software framework and must be coordinated from the earliest starting point into programming advancement to anticipate performance issues.

In spite of the numerous exploration endeavors, requirements engineering keep on having massive puzzled requirements, which should be inclined to ambiguity (Maplesden et al., 2015). Past ten years the choices are made without a key data, which could be accessible, a strategy if embraced. The full effect of choice is regularly hazy. This work outlines a way for experts an exhaustive context aware system, setting mindful system performance with more prominent utilization of pattern properties. Likewise depicts a percentage of the obstructions to enhance cross-domain information utilization that may succeed.

This chapter exhibits the performance study in three modules namely: Data collection, ontology and fuzzy module. CaRePa is evaluated through different approaches as discussed: survey approach, SPPS tool, ontology approach and fuzzy approach. These approaches are briefed in the subsequent sections.

6.2 CaRePa PERFORMANCE FRAMEWORK

The procedure embraced via CaRePa to create ceaseless change which includes assessing the recognized patterns. This is an essential component to look for context data from examiner; space master; analysts and designers on the level of fulfillment of the survey questions relating to requirement patterns with their property values.
Further, performance is analysed using ontology, fuzzy and statistical analysis is given in Figure 6.1. To work with ontology, there is a need of getting context properties to RDF file format, which enhances the work as the file converter section. Current section introduces the effects of the assessment as component of the CaRePa execution and final representation. Performance evaluation of the proposed system is compared with PABRE (Renault et al, 2009) and other works based on query to end users. The subsequent sections describe the framework related to CaRePa in detail.

6.3 DATA COLLECTION MODULE

In this section, context requirement patterns are validated with different stakeholders in the software company. This evaluation is based on the input from the domain expert, analyst, software engineer and Developer/Tester. Based on their input, following Table 6.1 shows the survey results of proposed context aware requirement patterns (CaRePa). Here, SQ1-SQ12 refers the questionaries’ addressed by the stakeholders.
Survey results of context aware requirement patterns (CaRePa) is provided in Figure 6.2 and Table 6.1. This demonstrates that the association of patterns towards designer and programming specialists are less because of their role primarily focuses on design, coding and testing rather than analysis. It ought to overcome comprehension of members and their own translation of the inquiry.

![Survey On CaRePa](image)

**Table 6.1. Survey Results of CaRePa**

Survey results of context aware requirement patterns (CaRePa) is provided in Figure 6.2 and Table 6.1. This demonstrates that the association of patterns towards designer and programming specialists are less because of their role primarily focuses on design, coding and testing rather than analysis. It ought to overcome comprehension of members and their own translation of the inquiry.

![Survey On CaRePa](image)

**Figure 6.2. Result analysis**

In this module statistical examination of the input data can be implemented. On the way to work with statistical analysis there is a need of variables. Properties of CaRePa to address these properties are listed below and used for the statistical analysis.
**Context Requirement Properties (CRP):** RE activity (CRP1), Pattern Type (CRP2), Stakeholders (CRP3), Context Information (CRP4), Context Type (CRP5), Event Information (CRP6), Available Service (CRP7), User Preference (CRP8), Action Taken (CRP9), Service Priority (CRP10), Negotiation Rules (CRP11) and Temporal Context (CRP12).

Use of the context properties and its applicability with the values of each property, can be analysed using the statistical method. These properties are applied for statistical tests like: mean, standard deviation, frequency, t-test, ANOVA, chi-square to ensure the quality of the data retrieved from the stakeholder. Basic concepts involved in the statistical analysis are given below:

- **Population**: Accumulation of all people or questions or things under study and signified by \( N \)
- **Sample**: A portion from the \( N \) and is indicated as \( n \)
- **Variable**: Features for an individual or article. Subjective and Quantitative variables
- **Parameter** \((x)\): Features of the \( N \)
- **Statistic**: Features of the \( n \)

In statistics, mean \((\mu)\) and expected worth are spent on the other hand to indicate to one measure of the focal propensity both of a likelihood appropriation or of the irregular variable portrayed by that conveyance (Cinlar, 1975).

\[
\mu = \frac{\sum x}{N} \quad \text{……………… (1)}
\]

In statistics, the standard deviation (sigma \(\sigma\) or \(s\)) is a measure that is utilized to evaluate the measure of variety or scattering of a set estimations of information. A standard deviation near 0 shows that the information guides incline toward be near the mean (called the normal quality) of the set, while an elevated requirement deviation demonstrates that the information focuses are spread out over a more extensive scope of qualities (Bland and Altman, 1996).

\[
\sigma = \sqrt{\frac{\sum (x-\mu)^2}{N}} \quad \text{……………… (2)}
\]

Table 6.2 and Figure 6.3 provides the descriptive statistics about the context requirement properties mentioned earlier. Here \(N\) samples are considered for 173 data set, which is extracted from the pool of data set.
<table>
<thead>
<tr>
<th>Context Requirement Property</th>
<th>N</th>
<th>Range</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP1</td>
<td>173</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>2.34</td>
<td>1.003</td>
<td>1.006</td>
</tr>
<tr>
<td>CRP2</td>
<td>173</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2.00</td>
<td>.816</td>
<td>.667</td>
</tr>
<tr>
<td>CRP3</td>
<td>173</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>2.25</td>
<td>1.140</td>
<td>1.299</td>
</tr>
<tr>
<td>CRP4</td>
<td>173</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>2.26</td>
<td>1.143</td>
<td>1.306</td>
</tr>
<tr>
<td>CRP5</td>
<td>173</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>2.37</td>
<td>1.219</td>
<td>1.486</td>
</tr>
<tr>
<td>CRP6</td>
<td>173</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2.03</td>
<td>.866</td>
<td>.749</td>
</tr>
<tr>
<td>CRP7</td>
<td>173</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1.77</td>
<td>.677</td>
<td>.459</td>
</tr>
<tr>
<td>CRP8</td>
<td>173</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>.52</td>
<td>.503</td>
<td>.253</td>
</tr>
<tr>
<td>CRP9</td>
<td>173</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>1.71</td>
<td>1.172</td>
<td>1.374</td>
</tr>
<tr>
<td>CRP10</td>
<td>173</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2.27</td>
<td>.607</td>
<td>.368</td>
</tr>
<tr>
<td>CRP11</td>
<td>173</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>.66</td>
<td>.478</td>
<td>.228</td>
</tr>
<tr>
<td>CRP12</td>
<td>173</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>.44</td>
<td>.500</td>
<td>.250</td>
</tr>
</tbody>
</table>

Table 6.2. Descriptive statistical analysis of selected data set

Figure 6.3. Frequency graph
T-Test: Difference between two means: A T-test is a measurable speculation test in which the test measurement takes after a Student's T-conveyance, if the invalid theory is bolstered. It can be utilized to decide, if two arrangement of information are fundamentally unique in relation to each other (Bland and Altman, 1996). Most ordinarily it is connected, when the test measurement would take after an ordinary conveyance and if the estimation of a scaling term in the test measurement are known. At the point when the scaling term is obscure and is supplanted by an appraisal in light of the information, the test measurement (under specific conditions) takes after Student's T-dissemination (Cinlar, 1975).

\[
t = \frac{\bar{X}_1 - \bar{X}_2}{S \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \sim t_{n_1+n_2-2} \text{ df} \]

where \( S = \text{Sample SD} \)

Table 6.3 provides the statistical representation of the T-test and its difference while considering the CRP5, 6, 8, 9, 10.

<table>
<thead>
<tr>
<th>CRP</th>
<th>Test Value</th>
<th>t</th>
<th>Degree of Freedom (df)</th>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>CRP5</td>
<td>4.955</td>
<td>52</td>
<td>.000</td>
<td>-.321</td>
<td>- .45</td>
<td>-.19</td>
</tr>
<tr>
<td>CRP6</td>
<td>8.020</td>
<td>52</td>
<td>.000</td>
<td>1.0189</td>
<td>.764</td>
<td>1.274</td>
</tr>
<tr>
<td>CRP8</td>
<td>-5.391</td>
<td>52</td>
<td>.000</td>
<td>-.358</td>
<td>-.49</td>
<td>-.23</td>
</tr>
<tr>
<td>CRP9</td>
<td>-7.076</td>
<td>52</td>
<td>.000</td>
<td>-.491</td>
<td>-.63</td>
<td>-.35</td>
</tr>
<tr>
<td>CRP10</td>
<td>10.854</td>
<td>52</td>
<td>.000</td>
<td>23.038</td>
<td>18.78</td>
<td>27.30</td>
</tr>
</tbody>
</table>

Table 6.3. t-Test statistics

ANOVA: Here, one way examination of variance (ANOVA) is utilized to figure out if there are any critical contrasts between the means for three or more free (irrelevant) bunches. This aide will give a brief prologue to the restricted ANOVA, including the presumptions of the test and when this test is to be utilized/done (Cinlar, 1975). Investigation of change (ANOVA) is a gathering of measurable (ie statistical) models used to break down the distinctions among gathering implies and their related systems, created by analyst and transformative researcher Ronald Fisher. In the
ANOVA setting, the watched change in a specific variable is divided into parts owing to various wellsprings of variety. In its least complex structure, and in this manner sums up the T-test to more than two gatherings (Bland and Altman, 1996). ANOVAs are valuable for looking at (testing) three or more means (gatherings or variables) for factual noteworthiness as specified in the Table 6.4.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP1</td>
<td>Between Groups (Combined)</td>
<td>2.700</td>
<td>1</td>
<td>2.700</td>
<td>2.749</td>
</tr>
<tr>
<td></td>
<td>Unweighted</td>
<td>2.700</td>
<td>1</td>
<td>2.700</td>
<td>2.749</td>
</tr>
<tr>
<td></td>
<td>Weighted</td>
<td>2.700</td>
<td>1</td>
<td>2.700</td>
<td>2.749</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>69.738</td>
<td>71</td>
<td>.982</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>72.438</td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP5</td>
<td>Between Groups (Combined)</td>
<td>1.402</td>
<td>1</td>
<td>1.402</td>
<td>.943</td>
</tr>
<tr>
<td></td>
<td>Unweighted</td>
<td>1.402</td>
<td>1</td>
<td>1.402</td>
<td>.943</td>
</tr>
<tr>
<td></td>
<td>Weighted</td>
<td>1.402</td>
<td>1</td>
<td>1.402</td>
<td>.943</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>105.611</td>
<td>171</td>
<td>1.487</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>107.014</td>
<td>172</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP12</td>
<td>Between Groups (Combined)</td>
<td>.734</td>
<td>1</td>
<td>.734</td>
<td>3.024</td>
</tr>
<tr>
<td></td>
<td>Unweighted</td>
<td>.734</td>
<td>1</td>
<td>.734</td>
<td>3.024</td>
</tr>
<tr>
<td></td>
<td>Weighted</td>
<td>.734</td>
<td>1</td>
<td>.734</td>
<td>3.024</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>17.238</td>
<td>171</td>
<td>.243</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>17.973</td>
<td>172</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP3</td>
<td>Between Groups (Combined)</td>
<td>2.981</td>
<td>1</td>
<td>2.981</td>
<td>2.337</td>
</tr>
<tr>
<td></td>
<td>Unweighted</td>
<td>2.981</td>
<td>1</td>
<td>2.981</td>
<td>2.337</td>
</tr>
<tr>
<td></td>
<td>Weighted</td>
<td>2.981</td>
<td>1</td>
<td>2.981</td>
<td>2.337</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>90.580</td>
<td>71</td>
<td>1.276</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>93.562</td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP7</td>
<td>Between Groups (Combined)</td>
<td>.545</td>
<td>1</td>
<td>.545</td>
<td>1.190</td>
</tr>
<tr>
<td></td>
<td>Unweighted</td>
<td>.545</td>
<td>1</td>
<td>.545</td>
<td>1.190</td>
</tr>
<tr>
<td></td>
<td>Weighted</td>
<td>.545</td>
<td>1</td>
<td>.545</td>
<td>1.190</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>32.496</td>
<td>171</td>
<td>.458</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>33.041</td>
<td>172</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6.4. ANOVA Analysis
Chi Square: Chi-squared test, also referred to as $\chi^2$ test (or chi-square test), is any statistical hypothesis test in which the sampling distribution of the test statistic is a chi-square distribution when the null hypothesis is true. Chi-squared tests are often constructed from a sum of squared errors, or through the sample variance. Test statistics that follow a chi-squared distribution arise from an assumption of independent normally distributed data, which is valid in many cases due to the central limit theorem. A chi-squared test can then be used to reject the hypothesis that the data are independent. Here in Table 6.5 represents the test statistics of all context requirement properties.

<table>
<thead>
<tr>
<th>CRP</th>
<th>CRP1</th>
<th>CRP2</th>
<th>CRP3</th>
<th>CRP4</th>
<th>CRP5</th>
<th>CRP6</th>
<th>CRP7</th>
<th>CRP8</th>
<th>CRP9</th>
<th>CRP10</th>
<th>CRP11</th>
<th>CRP12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>5.74$^a$</td>
<td>.027$^b$</td>
<td>4.753$^a$</td>
<td>4.644$^a$</td>
<td>40.904$^c$</td>
<td>1.836$^b$</td>
<td>14.32$^b$</td>
<td>.123$^d$</td>
<td>4.753$^a$</td>
<td>25.34$^b$</td>
<td>7.247$^d$</td>
<td>1.10$^b$</td>
</tr>
<tr>
<td>Df</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
<td>.125</td>
<td>.986</td>
<td>.191</td>
<td>.200</td>
<td>.000</td>
<td>.399</td>
<td>.001</td>
<td>.725</td>
<td>.191</td>
<td>.000</td>
<td>.007</td>
<td>.292</td>
</tr>
</tbody>
</table>

Table 6.5. Statistics of Chi-square test

Conclusion of the statistical analysis leads to select seven of the context requirement properties (CRP's), useful for doing the fuzzy analysis which can be discussed in the Table 6.9.

6.4 ONTOLOGY CaRePa

This section deals with the ontology based performance issue, depicting how heterogeneous patterns in the context information sources can be changed into semantically enhanced data. Here, RDF (Resource Description Framework) depiction gives data, concerning the static data about the sensor, including area, what the sensor measures, unit of estimation etc. It is useful to get the differences between this kind of static sensor data and the real sensor yield (Brickley and Jones, 2001). This work wish to perform different sorts of numerical operations of ontology information. While a scope of the system is accessible to change over, say, Excel data to RDF, the execution structure is intended to incorporate contextual information with different information streams (McGuinness et al., 2004).

This type of scenario analysis is at the core of the performance framework approach and provides the analyst / project manager with contextualized information, based on several data sources.
The ontological methodology depicted in the performance framework intends to enhance the integration of the expanding number of information sources accessible inside the context aware system, and the more conventional, existing, context information (Fuchs et al., 2008). Past ways to deal with the integration of such information have depended on the utilization of information models, extensive partner agreement, and are particular to the ubiquitous computing.

The RDF document structure and its graph have been explained in the following section. The CaRePa ontology schema uses seven individual patterns to describe the context scenario in an efficient manner.

```xml
<?xml version="1.0"?>
<!DOCTYPE rdf:RDF [
<!ENTITY owl "http://www.w3.org/2002/07/owl#" >
<!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
<!ENTITY pattern "http://localhost:3030/carepapattern#" >
<!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
<!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#" >
]
<rdf:RDF xmlns="http://www.w3.org/2002/07/owl#"
xml:base="http://www.w3.org/2002/07/owl"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
xmlns:pattern="http://localhost:3030/carepapattern#"
xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"/>
```

Figure 6.4. Ontology Schema - Namespaces

Schema for the RDF is not comparable expansion. It specifies mechanisms for illustrating groups of attached properties and the connections between these properties. RDF Schema is composed with RDF consuming the terms defined in document. These properties are used to limit characteristics of other properties, such as the context domains and ranges of property values as mentioned in the Figure 6.4 and Figure 6.5.

```xml
<!-- http://www.co-ode.org/ontologies/ont.owl#name -->
<DatatypeProperty rdf:about="http://www.co-ode.org/ontologies/ont.owl#name">
<rdfs:range rdf:resource="&xsd:string"/>
</DatatypeProperty>
```

Figure 6.5. Ontology Schema - Data Property
Application of the schema-namespace to CaRePa can produce the CaRePa ontology schema for namespace and data property as mentioned in the Figure 6.6 and Figure 6.7.

```
<Class rdf:about="&pattern;action_pattern"/>
<Class rdf:about="&pattern;activity_pattern"/>
<Class rdf:about="&pattern;domain_pattern"/>
<Class rdf:about="&pattern;issue_pattern"/>
<Class rdf:about="&pattern;policy_pattern"/>
<Class rdf:about="&pattern;state_pattern"/>
<Class rdf:about="&pattern;verify_pattern"/>
```

Figure 6.6. CaRePa Ontology Schema - Pattern Classes

```
<NamedIndividual rdf:about="file://validation/domain_pattern.rdf#action_pattern">
  <rdf:type rdf:resource="&pattern;action_pattern"/>
  <pattern:action_taken>Critical</pattern:action_taken>
  <pattern:user_preference>Not Required</pattern:user_preference>
  <pattern:negotiation_rules>Applicable</pattern:negotiation_rules>
  <pattern:context_type>Computing</pattern:context_type>
  <pattern:type>Product</pattern:type>
  <pattern:service_priority>High</pattern:service_priority>
  <pattern:temporal_context>Required</pattern:temporal_context>
  <pattern:name>Action Pattern</pattern:name>
  <pattern:context_info>Notification</pattern:context_info>
  <pattern:available_service>Event Service</pattern:available_service>
  <pattern:event_info>User Information</pattern:event_info>
  <pattern:re_activity>
    <rdf:Description>
      <rdf:Seq/>
    </rdf:Description>
  </pattern:re_activity>
  <pattern:stack_holders>
    <rdf:Description>
      <rdf:Seq/>
    </rdf:Description>
  </pattern:stack_holders>
</NamedIndividual>
```

Figure 6.7. CaRePa Ontology Schema - Individual Entity for Action Pattern

In the same way RDF graph model is represented in Figure 6.8 and Figure 6.9.
Figure 6.8. RDF Graph Model for CaRePa Annotation Properties

Figure 6.9. CaRePa RDF Graph Model for an Individual Entity for Action Pattern
CaRePa RDF defined data can be uploaded into the Fuseki server and the context patterns related data sets are uploaded into the Fuseki server (Michel et al., 2016) as mentioned in Figure 6.10. With all these data set, query processing done through SPARQL and basic query format is given in Figure 6.11.

![Fuseki Server](image)

**Figure 6.10. Fuseki Server**

CaRePa template and patterns can be converted into Resource Description Framework (RDF) file, which can be validated using RDF validator and uploaded into the Fuseki server as given in Figure 6.10. Then the verification of the model is conducted with SPARQL query analyzer to ensure the performance (Michel et al., 2016). The basic SPARQL query structure provided in the Figure 6.11.

![Basic SPARQL Query](image)

**Figure 6.11. Basic SPARQL Query**
SPARQL query retrieves 6X6 records which is used for query result analysis. Each query topic have focus on one of the context aware requirement patterns proposed in this thesis. For example QueryTopic1 has domain pattern, QueryTopic2 has issue pattern likewise till QueryTopic7. While retrieving the 36 records can be categorized correctly retrieved and incorrectly retrieved. This category can be separated based on the retrieved data set as mentioned in the Table 6.6. Finally result analysis is presented in the Figure 6.13.
Each QueryTopic can be addressed based on the CaRePa pattern specified in the methodology. Then the patterns based properties are defined already for each pattern. Consider that the QueryTopic1 is related to domain pattern. In this query, retrieves 36 tuples based on the limitation specified. Out of this 36 records how many are correctly retrieved is a challenging task which is majorly depends on the experts judgement. Based on the experts opinion most of the pattern attributes defined with the help of empirical studies. For example, consider QueryTopic1 for correspondent pattern. Here, correspondent pattern properties are matched with the domain pattern. Where there is very less pattern properties matches as given in the Table 6.6 QueryTopic1.
Figure 6.13. SPARQL Query Analysis Result
Precision and recall can be calculated based on the formulas as given below:

\[
\text{Precision} = \frac{\text{Relevant retrieved records}}{\text{Maximum Limit of records}} \quad \ldots \ldots \ldots \ldots \quad (3)
\]

\[
\text{Recall} = \frac{\text{Relevant retrieved records}}{\text{Maximum relevant records}} \quad \ldots \ldots \ldots \ldots \quad (4)
\]

<table>
<thead>
<tr>
<th>Patterns</th>
<th>Precision</th>
<th>Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain Pattern</td>
<td>0.5</td>
<td>0.69</td>
</tr>
<tr>
<td>Issue Pattern</td>
<td>0.44</td>
<td>0.76</td>
</tr>
<tr>
<td>State Pattern</td>
<td>0.56</td>
<td>0.69</td>
</tr>
<tr>
<td>Activity Pattern</td>
<td>0.44</td>
<td>0.76</td>
</tr>
<tr>
<td>Policy Pattern</td>
<td>0.58</td>
<td>0.84</td>
</tr>
<tr>
<td>Action Pattern</td>
<td>0.47</td>
<td>0.68</td>
</tr>
<tr>
<td>Correspondent pattern</td>
<td>0.44</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Table 6.7. Precision Recall

Precision acquires all retrieved records into arrangement, but it can be assessed at a given limit of records, allowing only the top results retrieved by the SPARQL query. Recall in retrieval of information is the portion of the records that are applicable to the successfully retrieved query as given in Table 6.7. With this work, the correctness of the records is inferred and validated with the domain experts. Result analysis of this work is presented in Figure 6.14.
6.5 FUZZY SET AND CaRePa

Fuzzy by Mamdani and Assilian (1975) evaluated about unclearness with individual dubiousness by the individual contemplations will be dispersed together with indistinct way of output; etymological measure recommended true method for connecting such circumstances. Progressively, the past work was informed in Chapter 4. In this exploration, the four linguistic scales are utilized to assess CaRePa attributes to the respective fuzzy numbers as listed in Table 6.8.

<table>
<thead>
<tr>
<th>Fuzzy Measures in different scales</th>
<th>Resultant Member Function Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Acceptable (SA)</td>
<td>(Min 0.75, to Max 1.0)</td>
</tr>
<tr>
<td>Acceptable (A)</td>
<td>(Min 0.5 to Max 1.0)</td>
</tr>
<tr>
<td>Unacceptable (UA)</td>
<td>(Min 0.0 to Max 0.5)</td>
</tr>
<tr>
<td>Strongly Unacceptable (SUA)</td>
<td>(Min 0.0 to Max 0.25)</td>
</tr>
</tbody>
</table>

Table 6.8. Scale for weights of CaRePa context attributes.

The above representation of SUA considered with lower bound worth, is 0, center bound quality is 0 and upper bound worth is 0.25. Here, at whatever point an esteem under "0" and a quality more noteworthy than "0.25" can be derived but they might not be set in chose for 'SUA' as would not derive in scope: 0 to 0.25. Whereas
this provides us the clear view about what amount achieves an endorsed estimation of sharply acceptable based on the membership function given below.

![Membership Function](image)

**Figure 6.15 Member function of an input**

Membership functions for CaRePa context requirement properties and here ‘Crp’ is an input sample (Osman and Bahattin, 2009).

Strongly Acceptable (SA)

\[
\begin{align*}
0 & \quad Crp \leq 0.75 \\
(Crp - 0.75) / 0.25 & \quad 0.75 \leq Crp \leq 1 \\
1 & \quad Crp = 1
\end{align*}
\]

Acceptable (A)

\[
\begin{align*}
0 & \quad Crp \leq 0.5 \\
(Crp - 0.5) / 0.25 & \quad 0.5 \leq Crp \leq 0.75 \\
(1 - Crp) / 0.25 & \quad 0.75 \leq Crp \leq 1 \\
0 & \quad Crp \geq 1
\end{align*}
\]

Unacceptable (UA)

\[
\begin{align*}
0 & \quad Crp \leq 0 \\
(Crp - 0) / 0.25 & \quad 0 \leq Crp \leq 0.25 \\
(0.5 - Crp) / 0.25 & \quad 0.25 \leq Crp \leq 0.5 \\
0 & \quad Crp \geq 0.25
\end{align*}
\]
Strongly Unacceptable (SUA)

\[
\begin{cases}
0 & Crp \leq 0 \\
(0.25 - Crp)/0.25 & 0 \leq Crp \leq 0.25 \\
0 & Crp \geq 0.25
\end{cases}
\]

6.5.1 FUZZY RULES CONSTRUCTION

The fuzzy system develop environment in MATLAB is characterizes the qualities into a fuzzy engine. The enrollment capacity editorial manager appears and deals with all the participation capacities associated with all information and yield variables for the whole fuzzy system. The fuzzy method is defined using the following steps:

**Step1:** Planning the participation capacity and their phonetic expression is made on lower, center and upper bound qualities as appeared in Table 6.8.

**Step2:** The weights of the attributes is initially calculated and the list of values calculated for each attributes and the basic values calculated concluded with membership functions.

**Step3:** The inference rules description given in Figure 6.1, converts rules if-then, in that accompanying result (Osman and Bahattin, 2009) can be a component of the variables.

**Step4:** Defuzzification done with centroid method.

**Step5:** Validation of the fuzzy inference model is classified the set by the data derived for this purpose and the set was classified with the expert in the context requirement area.
6.5.2 RESULTS AND DISCUSSION

In this section, the fuzzy inference system was implemented using the MATLAB with the specific properties as listed:

- Type of the engine: ‘mamdani’
- Fuzzy logic operators for decision making: AND, OR
- Implication and aggregation method: MIN, MAX
- Defuzzification: ‘Centroid’
To understand clearly, there is a need to discuss about the demonstration of context requirement (CR). Here, the fuzzy inference model explained with CR1 work procedure:

- Fuzzification gathers the fuzzy inputs and further fuzzified values are applied into the fuzzy engine to select appropriate rule.
- Rule: IF (‘REActivity’ is Acceptable with membership degree) AND (…)
  THEN context requirement1 (CR1) classified as ‘Acceptable’.
- Furthermore, diffuzification of context requirements into combined output to the crisp output. So, output of CR1 is 0.5, which is acceptable in the linguistic scale.
- Validation consider the expert (analyst) input and validation set of fuzzy engine. The result gathered from the fuzzy inference engine with the data set is shown in the Table 6.9.
### Table 6.9. Result of fuzzy model to CaRePa

Classification of data set with fuzzy model and the same data set classified by the requirement expert where both results convey validation is mentioned in Table 6.10.

<table>
<thead>
<tr>
<th>Context Requirement (CR)</th>
<th>RE Activity</th>
<th>Pattern Type</th>
<th>Context Type</th>
<th>Event Info.</th>
<th>User Info.</th>
<th>Action Taken</th>
<th>Service Priority</th>
<th>Rules</th>
<th>Output</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR1</td>
<td>0.398</td>
<td>0.110</td>
<td>0.530</td>
<td>0.290</td>
<td>0.582</td>
<td>0.459</td>
<td>0.561</td>
<td>0.50</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>CR2</td>
<td>0.450</td>
<td>0.321</td>
<td>0.432</td>
<td>0.214</td>
<td>0.320</td>
<td>0.213</td>
<td>0.654</td>
<td>0.45</td>
<td>UA</td>
<td></td>
</tr>
<tr>
<td>CR3</td>
<td>0.234</td>
<td>0.421</td>
<td>0.540</td>
<td>0.623</td>
<td>0.450</td>
<td>0.640</td>
<td>0.432</td>
<td>0.56</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>CR4</td>
<td>0.560</td>
<td>0.621</td>
<td>0.643</td>
<td>0.662</td>
<td>0.640</td>
<td>0.720</td>
<td>0.540</td>
<td>0.71</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>CR5</td>
<td>0.122</td>
<td>0.312</td>
<td>0.240</td>
<td>0.000</td>
<td>0.322</td>
<td>0.000</td>
<td>0.112</td>
<td>0.24</td>
<td>SUA</td>
<td></td>
</tr>
<tr>
<td>CR6</td>
<td>0.342</td>
<td>0.440</td>
<td>0.540</td>
<td>0.760</td>
<td>0.450</td>
<td>0.660</td>
<td>0.453</td>
<td>0.60</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>CR7</td>
<td>0.921</td>
<td>0.657</td>
<td>0.660</td>
<td>0.870</td>
<td>0.840</td>
<td>0.794</td>
<td>0.741</td>
<td>0.86</td>
<td>SA</td>
<td></td>
</tr>
<tr>
<td>CR8</td>
<td>0.623</td>
<td>0.544</td>
<td>0.663</td>
<td>0.621</td>
<td>0.582</td>
<td>0.214</td>
<td>0.411</td>
<td>0.60</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>CR9</td>
<td>0.200</td>
<td>0.127</td>
<td>0.311</td>
<td>0.000</td>
<td>0.220</td>
<td>0.110</td>
<td>0.210</td>
<td>0.24</td>
<td>SUA</td>
<td></td>
</tr>
<tr>
<td>CR10</td>
<td>0.220</td>
<td>0.344</td>
<td>0.213</td>
<td>0.311</td>
<td>0.221</td>
<td>0.000</td>
<td>0.621</td>
<td>0.36</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 6.10. Fuzzy model with result of expert prediction

<table>
<thead>
<tr>
<th>Fuzzy Model Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Classification</strong></td>
</tr>
<tr>
<td><strong>Requirement Expert</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Total Observed</strong></td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
</tr>
</tbody>
</table>

* No. of context requirement classified correctly by fuzzy model

**SA** - Strongly Acceptable

**A** - Acceptable

**UA** - UnAcceptable

**SUA** - Strongly UnAcceptable

6.6 MEASURE WITH OTHER WORKS

Different approaches addressed within CaRePa as given in Figure 6.18, consider characteristics of IEEE830 standard mentioned in PABRE (Renult et al., 2009). Figure 6.19 has the list of seven non-functional metrics considered from IEEE830 standard to make the performance evaluation of CaRePa with other methods.
6.7 SUMMARY

In this chapter performance demonstrates that the contribution of Requirement Pattern for engineers and programming architects are less in light of their part predominantly concentrates on configuration, coding and testing instead of investigation. It ought to overcome comprehension of members and their own understanding. This chapter demonstrates how CaRePa properties are taken into consideration for ontology design and fuzzy method. All these approaches are discussed in detailed with the result of the analysis and its interpretation.