DAVID TUMINI OGOLO A SEMANTIC PORTAL TO IMPROVE SEARCH ON RIVERS STATE INDEPENDENT NATIONAL ELECTORAL COMMISSION MASTER THESIS 2023

**NEAR EAST UNIVERSITY**

**INSTITUTE OF GRADUATE STUDIES**

**DEPARTMENT OF SOFTWARE ENGINEERING**

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**M.Sc. THESIS**

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**Nicosia**

**June, 2023**

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## Approval

We certify that we have read the thesis submitted by David Tumini Ogolo titled "**A Semantic Portal to Improve Search on Rivers State Independent National Electoral Commission.**" and that, in our combined opinion, it is fully adequate, in scope and quality, as a thesis for the degree of Master of Software Engineering.

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## Declaration

I hereby declare that all information, documents, analysis, and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of the Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

DAVID TUMINI OGOLO

-----/----/2023

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**DAVID TUMINI OGOLO**

**Abstract**

**A Semantic Portal to Improve Search on Rivers State Independent National Electoral Commission.**

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The use of semantic search portals in electoral processes has become popular because they have the ability to improve how easily accessible, efficient, and transparent electoral information is. This paper specifically focuses on applying a semantic search portal within Nigeria's Independent National Electoral Commission (INEC). Our objective is to provide an overview of the benefits and implications of implementing such a portal in the electoral domain. A semantic search portal utilizes the power of Semantic Web technologies and ontologies to enable efficient and intelligent information retrieval. The portal facilitates accurate and context-aware search results by organizing electoral data and knowledge in a structured and interconnected manner. This enables users, including citizens, researchers, and electoral officials, to access and retrieve relevant information about the electoral process, candidates, and policies. Developing and implementing a semantic search portal in collaboration with INEC Nigeria involves several crucial steps. These include creating a comprehensive ontology that captures the complexity of the electoral domain, integrating diverse data sources, utilizing natural language processing techniques for query understanding, and incorporating machine learning algorithms for search relevance and personalization. By embracing a semantic search portal, INEC Nigeria can unlock numerous benefits. Improved access to electoral information will empower citizens to make informed decisions and participate more actively in the democratic process. Electoral officials will have enhanced decision-making capabilities, leading to more efficient and effective administration of elections. The portal will also contribute to greater transparency in the electoral process, enabling stakeholders

to monitor and evaluate the system's integrity. Moreover, the semantic search portal can potentially provide data-driven insights, predictive analytics, and policy evaluation. This empowers stakeholders to leverage electoral data for evidence-based decision-making and strengthens democratic practices within the country.

***Keywords***: Semantic search portal, Electoral process, Inec Nigeria, Semantic web, Ontologies.

**Soyut**

**Rivers Eyaletinin Bağımsız Ulusal Seçim Komisyonu Üzerinde Aramayı İyileştirecek Anlamsal Bir Portal**

**David Tumini Ogolo**

**Yazılım Mühendisliği Bölümü Yüksek Lisans**

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Semantik arama portallarının seçim süreçlerinde kullanımı, seçim bilgilerinin erişilebilirliğini, verimliliğini ve şeffaflığını artırma potansiyelleri nedeniyle büyük ilgi görmüştür. Bu yazıda, özellikle Nijerya'daki Bağımsız Ulusal Seçim Komisyonu (INEC) içinde bir semantik arama portalının uygulamasına odaklanıyoruz. Amacımız, seçim alanında böyle bir portalın uygulanmasıyla ilgili faydalara ve sonuçlara genel bir bakış sağlamaktır. Semantik bir arama portalı, verimli ve akıllı bilgi alımını sağlamak için Semantik Web teknolojilerinin ve ontolojilerinin gücünden yararlanır. Portal, seçim verilerini ve bilgisini yapılandırılmış ve birbirine bağlı bir şekilde düzenleyerek, doğru ve bağlama duyarlı arama sonuçlarını kolaylaştırır. Bu, vatandaşlar, araştırmacılar ve seçim yetkilileri de dahil olmak üzere kullanıcıların seçim süreci, adaylar ve politikalarla ilgili bilgilere kolayca erişmesini ve bu bilgilere erişmesini sağlar. INEC Nijerya ile işbirliği içinde bir semantik arama portalının geliştirilmesi ve uygulanması birkaç önemli adımı içerir. Bunlar, seçim alanının karmaşıklığını yakalayan kapsamlı bir ontoloji oluşturmayı, çeşitli veri kaynaklarını entegre etmeyi, sorguyu anlamak için doğal dil işleme tekniklerini kullanmayı ve arama alaka düzeyi ve kişiselleştirme için makine öğrenimi algoritmalarını dahil etmeyi içerir. Anlamsal bir arama portalını benimseyen INEC Nijerya, sayısız avantajın kilidini açabilir. Seçim bilgilerine daha iyi erişim, vatandaşları bilinçli kararlar alma ve demokratik sürece daha aktif katılma konusunda güçlendirecektir. Seçim yetkilileri, seçimlerin daha verimli ve etkili bir şekilde yönetilmesine yol açacak şekilde gelişmiş karar verme yeteneklerine sahip olacak. Portal ayrıca seçim sürecinde daha fazla şeffaflığa katkıda bulunarak paydaşların sistemin bütünlüğünü izlemesine ve değerlendirmesine olanak tanıyacak. Ayrıca semantik arama portalı, veri odaklı içgörüler,

tahmine dayalı analitik ve politika değerlendirmesi sağlama potansiyeline sahiptir. Bu, paydaşlara kanıta dayalı karar verme için seçim verilerini kullanma yetkisi verir ve ülke içindeki demokratik uygulamaları güçlendirir.

Anahtar Kelimeler: Semantik arama portalı, Seçim süreci, Inec nijerya, Semantik web, Ontolojile

## Table of Contents

CHAPTER III: METHODOLOGY

## List of Appendix

## List of Tables

## List of Figures

## List of Abbreviations

| | | |
|---|---|---|
| **AACR** | : | Anglo-American Cataloguing Rules |
| **AI** | : | Artificial Intelligence |
| **API** | : | Application Programming Interface |
| **ARPA** | : | Advanced Research Projects Agency |
| **BI** | : | Business Intelligence |
| **CPU** | : | Central Processing Unit |
| **CSS** | : | Cascading Style Sheets |
| **DBMS** | : | Database Management System |
| **DCMI** | : | Dublin Core Metadata Initiative |
| **EAD** | : | European Assessment Document |
| **FOAH** | : | Friend of A Friend |
| **HCI** | : | Human-Computer Interaction |
| **HTML** | : | Hyper Text Markup Language |
| **HTTP** | : | Hypertext Transfer Protocol |
| **INEC** | : | Independent National Electoral Commission |
| **IOT** | : | Internet of Things |
| **ISBN** | : | International Standard Book Number |
| **IT** | : | Information Technology |
| **JS** | : | JavaScript |
| **LOD** | : | Linked Open Data |
| **MARCXML** | : | Machine-Readable Cataloging Extensible Markup Language |
| **ML** | : | Machine Learning |
| **MODS** | : | Metadata Object Description Schema |
| **NLP** | : | Natural Language Processing |
| **OLAP** | : | Online Analytical Processing |
| **OWL** | : | Web Ontology Language |
| **RAM** | : | Random Access Memory |
| **RDF** | : | Resource Description Framework |

| | | |
|---|---|---|
| **RDFS** | : | Resource Description Framework Schema |
| **RIF** | : | Rule Interchange Format |
| **SEO** | : | Search Engine Optimization |
| **SGML** | : | Standard Generalized Markup Language |
| **SKOS** | : | Simple Knowledge Organization System |
| **SPARQL** | : | Sparkle Protocol and RDF Query Language |
| **SVG** | : | Scalable Vector Graphics |
| **SW** | : | Semantic Web |
| **SWeML** | : | Symbolic-Weaving Machine Learning |
| **SWRL** | : | Semantic Web Rule Language |
| **UI** | : | User Interface |
| **URI** | : | Uniform Resource Identifier |
| **URL** | : | Uniform Resource Locators |
| **URN** | : | Uniform Resource Names |
| **W3C** | : | World Wide Web Consortium |
| **WWW** | : | World Wide Web |
| **XML** | : | Extensible Markup Language |

# CHAPTER I

## Introduction

### 1.1 Background of the Study

When a population chooses a person or persons to hold public office, it does so formally through an election process. Since the 17th century, elections have been the primary method for putting representative democracy into practice in today's world (Sagay, 2008). The goal of an election is to allow people to choose their representatives democratically. Through elections, citizens are given the opportunity to vote for the candidates of their choice, and the candidate with the most votes is elected (Eulau et al., 2023). At the federal, state, and municipal levels, elections are held to replace vacancies in the government's legislative, executive, and judicial branches. They are also used to fill positions in regional and municipal branches of government.

This election procedure does not have to be confined to the public sector; it may also be used in commercial and professional groups. Furthermore, numerous other organizations, such as clubs, non-profits, and businesses, use the election process to select their leaders. Elections are fundamental to democracy, giving citizens a voice in the political process. By participating in elections, citizens can exercise their right to vote and have a say in the direction of their government. People are given a fair and equal chance of getting involved in making choices thanks to the electoral process. The election process consists of several stages: nomination, campaign, voting, and counting votes. Nomination involves selecting candidates for election. The candidates then engage in campaigns, which include making speeches, attending rallies, and engaging in other activities to persuade voters to support them. Once the campaign period ends, citizens are allowed to vote. After the voting period, the votes are counted, and the candidate with the most votes is declared the winner.

According to Ojie (2006), in a democratic system of government, the individuals who exercise political authority do so with the express consent of the people, given through an open, free, and fair electoral process held at regular intervals. This means the people establish the government's agenda with the governed approval. However, in Nigeria, election fraud has been a significant obstacle to establishing a

foundation for democracy. Nigeria is among the countries with less effective election management. The election regulations and rules are institutionally ineffective, and the political heavyweights behave like gladiators, leaving the electorates with no control over the political process (Donald et al., 2020). The election laws are often murky, subject to frequent change or easy to manipulate. The political oligarchs, who represent special interests, impose unpopular candidates and employ every kind of political gimmick available to tilt the election in their favour and against the people's general will. This situation undermines the credibility of the election and the democratic process. To ensure that democracy thrives, elections must be free, fair, and based on credibility. Such elections serve as the foundation for democratic culture and society. Election integrity is significantly impacted by several issues, including the authority's legitimacy, independence or impartiality in the administration of elections and others (Olorunmola, 2023). INEC is the electoral body with the legal authority to plan, manage, and conduct every election in Nigeria for various political positions. Elections must be democratic, equitable, and reliable, and INEC is responsible for making that happen. Establishing democracy in Nigeria requires free, fair, and credible elections. The electoral body must ensure that the election regulations and rules are effective, and the political oligarchs must avoid imposing unpopular candidates or engaging in manipulative tactics. With these measures in place, Nigeria can build a solid democratic foundation and create a better future for its people.

The Internet's explosive expansion and widespread use have altered how we live, work, and interact daily. It is impossible to locate a part of our existence in the modern world that is not somehow linked to the Internet. From online banking to social media, e-commerce to online education, the World Wide Web has become an indispensable instrument for businesses and individuals (Dwivedi et al., 2021). The World Wide Web has transformed the most significant industries: online sales, entertainment, education, communication, and information sharing. The ease and convenience of online shopping have made e-commerce one of the economy's fastest-growing sectors (Reinartz et al., 2019). The availability of online entertainment, from streaming video and music services to online gaming, has changed how we entertain ourselves. Online education has opened up new opportunities for people of all ages to learn and acquire new skills.

Moreover, the World Wide Web has become essential for communication and information sharing. The ability to connect with people worldwide through social media platforms and online messaging services has made the world a smaller and more connected place. The Web has also become a vital source of information, with countless websites and online resources available on virtually any topic imaginable. Despite its ubiquitous presence in our daily lives, the World Wide Web is far from stagnant. It is constantly evolving, adapting to new technologies and changing user needs. It is simple to observe how the Web, in addition to being a revolutionary tool for performing tasks, is also a system that continues to develop and get better over time by looking at the many industries and areas that make up the Web, while the Internet is undoubtedly changing how we live our lives, it is also changing from within (Stansberry et al., 2020). The World Wide Web is a dynamic and ever-evolving system that promises to remain a vital part of our daily lives for many years.

The World Wide Web (web) information must go through one more stage before it can be given a significant meaning that will enable people and computers to work together or cooperate (Dwivedi et al., 2022). The vast bulk of information now published on the World Wide Web (www) is currently understandable for human beings but not by machines. There are billions of records on the Web, yet most are not helpful to all systems. However, using semantic tools to present the data in a highly structured and ordered manner will enable computers to analyze data at the semantic level, unlike most current systems, which only process data at the syntax level. Another approach to representing data is "The Semantic Web," which makes it possible to define and display data on the semantic level and better prepare computer systems to analyze it (Parsia, Patel-Schneider, 2004). Semantic Web technologies that impart semantic meaning to the content can be a valuable way to identify the process discussed earlier. Several other methods exist, but this is one of the most effective ones. A system or body of information known as the Semantic Web is linked so that machines can efficiently execute it globally. Another approach to describe it is a reliable method of signaling data accessible via the Internet or as a generic related knowledge base. Currently, computers revolve around a collection of data known as the Web. By asking web crawlers or search engine inquiries, end users or clients look for two documents. By reading individual words in the HTML code, the computer interprets it literally and displays the results.

Nevertheless, it cannot decipher the meaning of the paper users are sifting through. Let us use the simple expression "I Love Cooking" as an example. It is recognized as a word combination by search engines. Nevertheless, if we alter the word's grammar, such as by changing the language to Spanish or Japanese and saying "me encanta cocinar," the computer will not truly comprehend. Thanks to semantic web technologies, computers can comprehend the intent behind a user's requests for information on cooking, culinary tools, and related topics. Regardless of how the request is phrased, the computer will still understand it if the meaning remains the same. For instance, both "I enjoy cooking" and "I cook" convey the same meaning, and the computer can easily recognize that.

Over thirty years ago, Tim Berners-Lee was the first person to propose the concept of the World Wide Web. Tim Berners-Lee originally envisioned Web 2.0 as a platform facilitating human-to-human communication and machine interaction. When it was first introduced, it was envisioned as a platform for both human and automated communication (Gugerli, 2022). Until now, the second half of that assumption has been kept a secret, with the unfortunate result that vast quantities of data readily available to human researchers cannot be dissected and compiled by machines. People in the current period have less time for routine tasks, including scheduling appointments, determining the time and location of appointments, and making appointments. These are the kinds of tasks that machines can complete for people. However, currently, the vast majority of online content is created to be consumed by humans. For instance, the internet is brimming with information on weather, airline schedules, sports statistics, and TV and movie ratings, among other topics. Although a significant amount of information is available online, it is often difficult to use or customize it for our purposes or integration with other applications. For example, online calendars provide an excellent illustration of this issue. While it is relatively straightforward to view calendar data, extracting it for use on other websites or portable devices can be pretty challenging. Google has effectively addressed this issue by developing an API that facilitates the extraction and utilization of information. As a result, new languages such as OWL, RDF, and SPARQL have emerged, greatly aiding in data extraction and usage (Lee, 2004).

On the semantic web, Ontology is utilized as a formal technique to encode the concepts, relations, objects, and restrictions within the semantic model, as stated by Noy & McGuinness (2001). An ontology is a structured representation of items, their attributes, and the relationships between them. (Uschold and Grüninger, 1996). As a result, the axioms serve as the language's definitions and limitations. The way ontology describes information allows machines to use it for more than just presenting it; they can also implement automation, incorporate, and reuse the same information across many applications (Horrocks, 2008). An ontology is a precise and lucid representation of a specific domain that explicates and demonstrates the ideas, their characteristics, and their interconnections. In the realm of knowledge-based systems, a knowledge base is a go-to for applications needing access or sharing information about a particular domain. These systems set themselves apart by utilizing tools such as ontologies and rules to communicate information explicitly rather than relying on implicit code, as is typical of a computer program (Smith, 2013). The computer software that combines reasoning and a knowledge base to tackle complicated issues is known as a knowledge-based system. The ability to model inter-person connections in an area of interest is made possible by description logic (Baader et al., 2012). The utilization of logic-based representations of knowledge languages to formally articulate the terminological data of an application domain has been a proven and effective approach.

The advancement of new programming languages and technologies has led to the evolution of the Web, which has become more than just a platform for publishing static content. The Semantic Web is a new and evolving concept that aims to bring artificial intelligence to the Web. The Semantic Web is a revolutionary approach to enhancing search capabilities on the Internet. It surpasses the traditional phrase-matching process and focuses on understanding the user's intention behind their query. This innovative technology will transform how we search for information online. (Source: Wikipedia, 2023f). Through the power of machine comprehension, search results can now be delivered with even greater precision and relevance to a user's query. In addition to improving search capabilities, the Semantic Web also aims to enable machines to reason automatically. This means they can make inferences and draw conclusions from the available data. This would enable machines to perform tasks that currently require human intervention, such as identifying patterns in data and making predictions based on past trends. The Semantic Web boasts of an impressive automated

mash-up capability, enabling seamless aggregation and data integration from diverse sources. This feature empowers machines to amalgamate data from multiple websites into a unified view, providing users with effortless access to the required data. Overall, the Semantic Web represents a significant shift in how we interact with the Web, providing a more intelligent and intuitive user experience. As technology evolves and improves, it will profoundly impact our lives and work. The layers that Tim Berners Lee created for the semantic web are as follows:

1. Unicode and URI layer.
2. XML, XML schema layer, and RDF layer.
3. RDFS ontology.
4. SPARQL Query
5. Logic
6. Proof
7. Trust
8. User Interface

Various concepts have been studied and integrated into an application as part of this research project. RDF, ontology, SPARQL, and ideas for user interfaces are some of these topics. A standard for defining resources on the Web is known as RDF or Resource Description Framework. Ontology refers to the formalized description of items, object attributes, and object relationships within a semantic model. A query language called SPARQL is used to access and modify RDF-formatted data. The look and feel of the user interface that people interact with are called user interface concepts.

This research project explored the potential benefits of the Semantic Web in electoral processes. It demonstrated how these various concepts could be combined to create practical applications within the context of ontologies. By integrating these concepts successfully into an application, the project showed how the Semantic Web could be used to improve and automate electoral processes. Election processes are the study's area of interest. As a result, this work creates a formalized ontology of elections utilizing Protégé 5.0 as its implementation language and description logic as its language of representation.

## 1.2 Problem Statement

The ARPA Knowledge Sharing Effort (Neches, 1991) presented a novel approach to developing clever artificial intelligence systems using reusable components. This ground-breaking notion proposed that these reusable parts would act as the core or skeleton of novel systems, whereby specialized knowledge and unique reasoning techniques would be added to address a given problem. Combining already existent components to create more extensive and potent systems is possible with this strategy.

On the other hand, problem-solving approaches relate to the strategies utilized to address specific issues within that field. An "ontology" is a formal and explicit declaration of the ideas, traits, and connections that make up a domain; it stands in for the "static" knowledge associated with a domain (Husáková & Bureš, 2020). The basic blocks for developing intelligent systems are these ontologies and problem-solving methods. More effective and potent systems may be constructed more quickly by employing these components as the framework or backbone of a novel system and then integrating specialized knowledge and deductive reasoning techniques for a particular purpose (Gómez-Pérez, 1999a). Reusing these knowledge components offers high cost and time savings compared to developing them from scratch (Bollinger, 1990). This is because the processes involved in acquiring domain knowledge, constructing conceptual models, formalizing, and implementing such knowledge require considerable time and effort (Poulin, 1997). As a result, the time and money needed to construct new intelligent systems may be significantly decreased by reusing these knowledge components across various systems and jobs.

INEC is experiencing challenges in defining the functions of each electoral officer and developing efficient processes for conducting elections and more effortless and quick access to information and data required. This is a problem, even though there are significant benefits that can be achieved by utilizing Semantic Web technology to create search systems. After conducting thorough research, we concluded that implementing the Semantic Web concept would significantly improve the website's search functionality and effectively address the existing issue. By implementing the Semantic Web approach, INEC can improve the efficiency and effectiveness of their electoral processes and enhance its ability to provide accurate and timely information to stakeholders.

### 1.3 Purpose of the Study

The research project aims to provide a comprehensive understanding of the Semantic Web and its practical implications, which can contribute to developing innovative applications and technologies. The primary objective of this project is to gain an in-depth understanding of the Semantic Web, its advantages, disadvantages, and potential use in practical applications. The research project will likely involve thoroughly analyzing the Semantic Web concept, including its underlying principles, techniques, and technologies. The study will also involve evaluating the strengths and weaknesses of the Semantic Web and identifying potential areas where it can be applied to solve practical problems.

### 1.4 Specific Goals for this Research

The following list of study goals is more detailed:

1. To provide a common understanding of the structure of election processes.
2. Compile and analyze various data from many sources, such as the Independent National Electoral Commission (INEC) Website, into a single system, such as an ontology based on the OWL.
3. To enable the reuse of domain knowledge.
4. To run queries against the data received from OWL ontologies.
5. To give quick answers to queries

### 1.5 Research Questions

The following competence criteria for the river state were used to query the ontology:

1. Who are the key players in this election?
2. Who is eligible to hold the executive and senate positions?
3. For which positions do candidates run?
4. How can the political parties be identified?
6. What procedures take place on election day?
7. Who can cast a ballot?

## 1.6 Importance of the Study

Elections are an official procedure through which a group of people choose a person to hold a public office. They are the primary operating system of contemporary representative democracies. While it is often believed that election procedures are transparent and understood by all participants, this is not always the case. In order to make it easier to quickly and thoroughly grasp the election process and quickly access this information, this study proposes a defined ontology of electoral procedures. Concepts and relationships were identified and organized by acquiring domain knowledge into classes, subclasses, and instances. The results of this study are anticipated to provide a substantial contribution to the current state of knowledge and open the door for the effective implementation of an electoral ontology framework in Rivers State, Nigeria. In Rivers State, Nigeria, an electoral ontology is being effectively implemented, and this project intends to create a framework for it. Investigating and comprehending electoral ontology's current situation, as well as the obstacles to and influences on its growth in this part of Nigeria, is the central goal of this study. This study evaluates all eligible participants' openness to accept and use an Election Ontology. This study identifies, assesses, and suggests methods for involving stakeholders in creating an election ontology in Nigeria's Rivers State. The suggested framework outlines institutional, legal, and regulatory elements that must be considered while designing an efficient election procedure in Nigeria's Rivers State.

The results of this study provide a platform where members of the Independent National Electoral Commission (INEC), voters, and political parties may seek details on the election process, posts up for election, and candidates. In order to characterize the knowledge domain, the fundamental Semantic Web elements will be used in this study. The ontology processing component can be interacted with effortlessly by users via the system's user interface, which has been designed to be highly user-friendly and intuitive. Similarly, they would ordinarily do on conventional Web pages, and users may use the system to inquire and seek details about the candidate and electoral processes.

## 1.7 Limitations of the Study

This research project aims to analyze the concept of the Semantic Web and its potential to improve the organizational structure of the Independent National Electoral Commission (INEC). The research is limited in scope due to time constraints and will focus on developing ontologies specific to the rivers state election domain within the INEC. The semantic Web is a technology that enables machines to understand and interpret the meaning of data and information online. This study investigates how the Semantic Web might improve the efficacy and efficiency of INEC's organizational structure and election procedures in Rivers State. This will involve the development of ontologies, which are structured vocabularies that define the concepts and relationships within a specific domain.

The project will not cover all aspects of the INEC's electoral processes but will focus on specific ontology developments within the rivers state election domain. The aim is to understand better how the Semantic Web can support the INEC's work and identify areas where ontologies can be developed to improve the organization's decision-making processes.

# CHAPTER II

## Literature Review

### 2.1 Overview

Semantic Web technologies and ontologies have become increasingly common in the political and election domain, providing benefits such as enhanced machine-readability of descriptions and faster response to queries. Before using ontologies, other methods were utilized to solve election and political problems. This chapter aims to discuss these methods in detail and highlight some research done using ontologies and the results obtained. This chapter aims to comprehensively understand the benefits and challenges of using ontologies in the political and election domain.

### 2.2 Election in Nigeria

For a democracy to function, elections are a necessary component that can take many forms, depending on what the local polity deems appropriate (Robert & Obioha 2005). Regular, fair, and free elections rank among the most important institutions of liberal and participatory democracy. Candidates for the leadership of a particular group, society, or state are selected through democratic voting.

Ujo (2008) expressed a viewpoint regarding the distinction between the terms "voting" and "elections". According to Ujo, "elections" is a broad term encompassing various activities and tasks before, during, and after voting. These tasks may include planning, voter registration, constituency delineation, station layout, polling method, vote counting, and results announcement. In contrast, "voting" refers explicitly to the process by which individuals decide among various available options. He highlights that while voting is an essential part of the election process, it is only one of many tasks involved in conducting a successful election. Jim-nwoko (2019) examined the history of Nigerian elections and their effects on the nation over time. It mentions that the first election held in Nigeria took place in 1964 after the nation had become a republic in the previous year. The Northern People’s Congress (NPC), which controls the federal government, oversaw the elections, and the results were widely believed to have been rigged in favour of the NPC and its allies. The elections were marred by

violence and manipulations, and the resulting crises sparked many uprisings in the Western region. He contends that the unfortunate events and circumstances leading up to the Nigerian civil war were caused mainly by the fraud and violence committed during the 1964 elections. Due to the unfortunate political circumstances that developed, military control was justifiable for thirteen years (1966-1979).

Furthermore, (Wikipedia authors, 2023) mention that the 1979 election to reinstate civil rule in Nigeria was arranged by the Federal Military government of Olusegun Obasanjo within the framework of five political parties. Beyond the debate and legal battle over 2/3 of the 19 States, the election's conclusion did not spark any crises or destructive forces. Because it could not create a government, the NPN was forced to form a coalition with the Nigeria Peoples Party (NPP). In contrast to a "winner takes all!" style of politics, he notes that the National Assembly's rainbow makeup from 1979 to 1983 and the College of Governors of Nigeria's 19 states at the time showed the wisdom of power sharing. The five political parties won elections in their strongholds, but neither the North nor the South had only one party of each type. It was evident from the results of the 1983 elections that the NPN's plan and intention to win everywhere and for powerful political officeholders to "deliver their states," whatever that means in classical political terms, had once again sown the seed of destruction. President Shehu Shagari led the NPN's federal government, which was in charge of overseeing the elections. According to Adetayo (2023), most Nigerians found the elections of 2023 to be concerning, and many of them opted to keep silent and reflect on the situation of their country. Despite having strong feelings about Nigeria's future and the welfare of its citizens, they maintained objectivity when discussing the campaigns, political parties, and the election. As a result of violence, manipulations, and manipulated elections, (Jim-nwoko 2019) concludes that Nigeria's electoral history has been tainted. It implies that the "winner takes all" style of politics is not the best way to handle power distribution. He also contends that for Nigeria to learn from its past mistakes and prevent them from happening again in the future, it needs to resurrect its memory culture.

Asaolusam (2022) examines the electoral process in Nigeria and compares it with that of other West African countries, highlighting the differences in the electoral bodies responsible for overseeing the process, the voting systems used, campaign financing laws, and violence and intimidation during and after elections. INEC is responsible for organizing and conducting free and fair elections in Nigeria. At the

same time, Ghana and Senegal have their Electoral Commission and Independent National Electoral Commission, respectively. Nigeria uses a first-past-the-post voting system which is susceptible to vote-rigging and electoral fraud. In contrast, Ghana employs a proportional representation system, and Senegal has a hybrid system. They also suggest ways in which the electoral process in Nigeria can be improved. Furthermore, they recommend that INEC's independence and impartiality should be strengthened, measures to prevent vote-rigging and electoral fraud should be implemented, safety and security should be ensured for voters, transparency and accountability of the electoral process should be improved, and political tolerance and non-violent forms of political expression should be promoted.

## 2.3 Semantic Web Technologies

Here, we give a general concept of the Semantic Web and contrast it with the current Web. The conclusion explains some Semantic Web technologies, including RDFS/OWL, RDF Semantic Rules, and SPARQL.

### 2.3.1 Current Web

The contemporary web, created by Sir Tim Berners-Lee, has revolutionized how we access and interact with information. It comprises an extensive network of interconnected web pages, or hypertext documents, dispersed throughout the Internet. Users can navigate between these pages through hyperlinks, and web browsers are the gateway to viewing their content. Incorporating various media such as text, images, audio files, and videos, the web pages are located and accessed using Uniform Resource Locators (URLs) coded in HTML. The more recent web version, Web 2.0, introduced new possibilities and enhanced interactivity compared to the initial iteration. Web 2.0 allows for the easy sharing and rating of website information, empowering users to engage and participate. The emergence of popular social networking platforms like Facebook and Twitter played a significant role in this transformative shift. These platforms paved the way for the emergence of new concepts, such as blogs, wikis, and other social media websites, empowering individuals to contribute, collaborate, and share knowledge in a more streamlined manner. Despite the vast expanse of interconnected information online, current online applications pose challenges when faced with complex queries that require deep

intelligence and contextual understanding. However, Web 2.0, which emerged in 2000, was a direct response to these challenges. It sparked a wave of innovation, emphasizing the importance of enhancing search capabilities and leveraging intelligence to navigate the vast expanse of interconnected information. As technology continues to advance, the evolution of the web remains an ongoing process fueled by the quest for more intelligent search engines and refined user experiences.

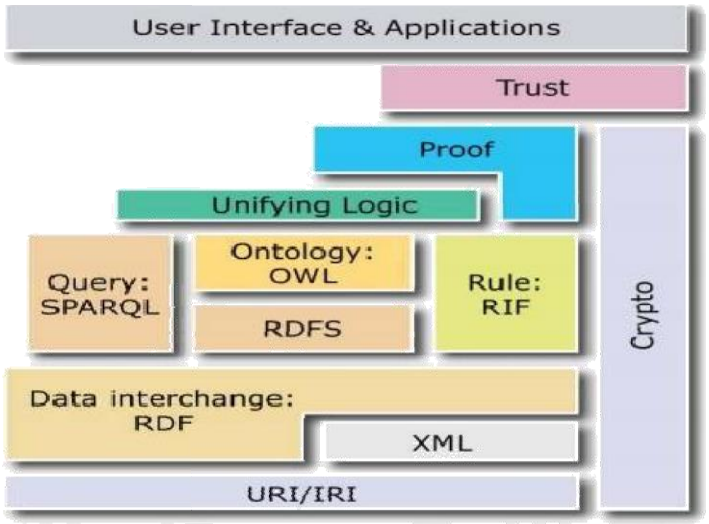
### 2.3.2 Semantic Web

The Semantic Web, according to Sir Tim Berners-Lee, "would bring structure to the concept of the Semantic Web, as envisioned by Sir Tim Berners-Lee, revolves around bringing structure to the vast content of web pages, creating a realm where programmers can efficiently perform complex tasks on behalf of clients (Berners-Lee, 2000). The fundamental idea behind the Semantic Web is to make web content readable by humans and understandable by machines. Currently, applications need help comprehending the intricacies of the modern web, limiting their capacity to communicate effectively with other applications. The Semantic Web introduces standardized methods for representing data in a format that computers can interpret, enabling them to provide users with relevant information to enhance their reasoning abilities. Moreover, the Semantic Web allows for the reuse of existing vocabularies. For instance, when describing a book and its author, two different vocabularies can be utilized: the Dublin Core language from the Dublin Core Initiative and the FOAF (Friend-of-a-Friend) vocabulary (Dodds, 2004). By leveraging these vocabularies, the Semantic Web expands on the current web infrastructure rather than replacing it. This enhancement is achieved by providing unambiguous meanings to the information, allowing for better comprehension of the data by machines (Stumme, 2006). According to John Markoff, the Semantic Web represents a significant technological advancement that equips computers with improved capabilities to organize and derive insights from Internet data, enabling more effective data processing (Markoff, n.d.). At the core of the Semantic Web lies the semantic layer cake, which offers various components for developing Semantic Web applications. Elena (2010) emphasizes the significance of Rules in the layer cake. These Rules enable computers and applications to scrutinize web content efficiently and extract new insights from existing knowledge. It goes without saying that these Rules are pivotal components. The Semantic Web aims to revolutionize how we interact with web content by enabling machines to

understand and utilize the vast amounts of data available. By employing standardized representations and intelligent processing, the Semantic Web enhances the web experience, enabling more efficient information retrieval, reasoning, and decision-making for users and applications.

Figure 2.1.

*An Illustration Of The Semantic Layer Cake*




### 2.3.3 Unicode and Uniform Resource Identifier (URI)

Unicode is a universal encoding system that gives a distinct number to every character in all writing systems. It enables software to exhibit and manage text in any language without requiring particular code or fonts. This has dramatically improved cross-cultural communication and enabled the creation of multilingual software. URIs, or uniform resource identifiers, are unique addresses used to identify systems and locate resources on the internet. Any object that can be identified and located using a URI, such as cities, people, documents, diseases, or food, can be considered a resource. URIs can be URLs (uniform resource locators) or URNs (uniform resource names). URLs identify and locate resources online, while URNs provide a name for resources without specifying their location. For example, an ISBN can be regarded as a URN for a book. URLs contain network addresses and access mechanisms (e.g., "HTTP" or "FTP") to access the resource. All URLs are URIs, but not all URIs are URLs.

Below is an example of a URL: http://www.example.com/mydata.txt
ftp://datalocation.com

Another subset of URI is URN, which uses the resource's name to identify it. If you know a book's International Standard Book Number, you can use URN to refer to the names of the books (ISBN).
Urn: ISBN: 089064653

Figure 2.2.
*XML Syntax Model*

```
<? xml version="1.0"?>

<book id="book1">

  <author>David Ogolo</author>

  <title>How to code with David</title>
```

### 2.3.4 Extensible Markup Language (XML)

XML, or Extensible Markup Language, is a versatile meta-language used for marking up documents. It allows users to create unique tags, making them adaptable to different content and applications. This flexibility enables the development of specialized markup languages tailored to specific needs, such as managing customer data. XML's standardized syntax allows software tools to read and understand XML documents, making it widely compatible. XML also provides a hierarchical structure for organizing documents with nested elements. It is a powerful tool for managing complex data and offers a standard document layout and structure. XML was developed as a simplified version of SGML (Standard Generalized Markup Language) to standardize document markup for large-scale publication and management. XML offers an easier way for developers to produce, manage, and display content in dynamic web-based applications. Figure 2 illustrates a basic XML syntax for describing a book. Some of XML's significant benefits include:

XML offers a comprehensive format.

It offers interoperability because it may be used with various platforms and instruments.

Compared to SGML, it is expandable and allows for creating new tags with less effort. Moreover, an XML tag may have any number of properties.

XML is W3C standard.

Most document types are suited to XML's hierarchical structure (though not for all types).

Information can be easily communicated in any human language, enabling multilingual texts using Unicode.

### 2.3.5 The Resource Description Framework (RDF)

The Resource Description Framework (RDF) is a standard developed by W3C for describing web resources. It allows any entity or concept, such as a person, book, or nation, to be identified by a Uniform Resource Identifier (URI). RDF provides a structured way to represent these resources, making it easy for software programs to distribute, reuse, and interpret the information. One of RDF's key features is its ability to encode relationships between resources. For example, an RDF book description can include links to related resources like reviews, citations, and other works by the same author. RDF data is typically represented as a graph, where resources are nodes and the links between them are edges. This allows for flexible and complex resource linkages that are easy to understand. RDF uses triples, consisting of a subject, predicate, and object, to represent information. The subject is often a URI that identifies a specific resource, the predicate describes the relationship between the subject and the object, and the object can be another URI, a literal value, or a blank node representing an unrecognized resource. This flexible and extendable format of RDF enables the expression of a wide range of relationships and structures, including intricate hierarchies, facilitating easy sharing and reuse of data among different applications and systems.

A simple triple (statement) is:

Joe's family name is Smith

Subject (Resource): Joe

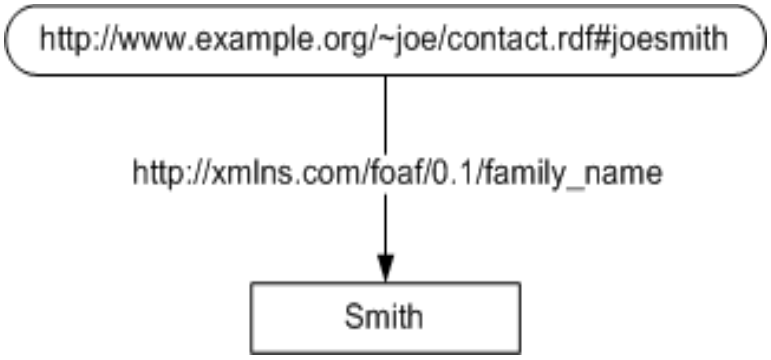
Predicate (Property): family_name

Object (Value): Smith

A triple must contain a subject and predicate that are both resources and have each been given a unique URI. However, an object can be simultaneously a resource or a simple value, such as a name, a number, or another value of that nature. A resource is shown in the example in Figure 2.3.

Figure 2.3.

*RDF Graph*




A variety of methods exist for serializing RDF triples:

RDF/XML: Since February 2004, the World Wide Web Consortium (W3C) has endorsed the XML serialization of RDF as a standard, making it a widely acknowledged format that is advised for usage in web development and programming. The World Wide Web Consortium (W3C) is an international group that creates web standards to guarantee that the Internet is usable, functional, and accessible on all platforms and devices.

N-Triples: The format for transporting and storing RDF data is called N-Triples and is easy to use. It uses plain text, meaning the data is presented in a machine- and human-readable way. As a result, working with it is simple for programmers, and machine processing and understanding are simple. The format is also acknowledged as a W3C recommendation, making it a widely recognized standard for presenting RDF data. Thanks to this vital suggestion, the format is guaranteed to be compatible and interoperable across many systems and platforms.

N3: Comparing Notation3 or N3 to the aforementioned RDF/XML standard has some advantages. First, N3 files demand less storage space than RDF/XML files, which might be advantageous when storage resources are scarce or expensive. Second, N3

files are smaller than RDF/XML files. Second, compared to RDF/XML, N3 is far more readable by humans. This refers to the fact that N3 files are written in a syntax more akin to natural language than XML, making them more straightforward for people to read and comprehend than the XML-like syntax used in RDF/XML. This makes the RDF data easier to understand and alter, which benefits developers and programmers who must work with it.

Turtle (Terse RDF Triple Language) is a format considered by the W3C as a recommended standard and is currently a candidate recommendation. Compared to the RDF/XML format, it is widely used in the RDF community because it is more human-readable and less verbose. While the RDF specification provides a basic vocabulary for describing connections between web resources, it lacks detailed information about subclasses or sub-properties. This means that developers often need to rely on external sources to understand the context and significance of the data they work with. To address this, the W3C has developed the Resource Description Framework Schema (RDFS), which expands the RDF specification by providing a broader vocabulary for defining relationships between resources. RDFS includes classes, attributes, and other elements that allow for more complex and comprehensive descriptions of web resources.

This is a list of the fundamental constructs that RDFS offers:

rdfs:Class

Srdfs:Resourcerdfs:subClassOf rdfs:subPropertyOf rdfs: domain

rdfs:range

Each object has a superclass named rdfs:Class, based on the RDFS specification (Brickley, 2004). The term "rdfs:Resource" also refers to anything that may be given a URI and used as the subject or object of an RDF triple.

The Rdfs:domain and Rdfs: range tags specify the domain and range of a property or predicate. If a class has a data property, the property is represented by the rdfs: domain. Moreover, the rdfs: range data type resembles a string or an integer. The rdfs: range is used if the property is an object property. They both must be instances of classes, including rdfs: domain. A class and a property that are, respectively, the subclass and sub-property of a specific class and property are shown using the rdfs:subClassOf and rdfs:subPropertyOf tags.

RDFS, which stands for the Resource Description Framework Schema, is also a tool for performing basic reasoning on data. Specifically, RDFS allows for inferring certain

statements based on direct relationships between concepts. To demonstrate this idea, an example is provided: if we know that a "Tiger" is a type of cat and that a "Cat" is a subclass of an "Animal," we can use RDFS to infer that a "Tiger" is also a type of an "Animal." A straightforward reasoning problem like this is one that RDFS is capable of handling. An ontology language called RDFS describes the connections between items in a knowledge domain. It permits defining properties that may be used to characterize these things and the creation of hierarchies of concepts and the connections between them. The ability of RDFS to infer new information based on relationships between things explicitly stated in the ontology gives it its reasoning skills. Applying logical rules or inference engines that utilize deduction or induction to draw inferences based on known information can accomplish this.

### 2.3.6 Ontology

Ontology is a philosophical study of existence and reality. In computer science, it refers to a formal representation of concepts and their relationships in a specific domain. It helps define and clarify knowledge in various fields by establishing terms, qualities, and connections. For example, a medical ontology would define terms like "disease" and "symptom" and explain their relationships. Ontologies facilitate information sharing and interpretation across systems by providing a consistent vocabulary, eliminating the need for complex translations. They are also used in automated systems to reason and derive conclusions from stored knowledge. For instance, an automated diagnosis system can use a medical ontology to generate plausible diagnoses based on patient symptoms and medical history. While several authors have provided their ontology definitions, we will stick with Stanford's. It is an exact express representation of concepts in the space of division (Natalya, 2000). The knowledge base refers to the ontology and all the data it contains.

The steps below can be used to develop an ontology:

Describe the domain idea (classes).

Set up a hierarchy of subclasses and super classes for the classes (this hierarchy is called taxonomy).

Explain the relationship and its characteristics.

Make the classes' actual world instances.

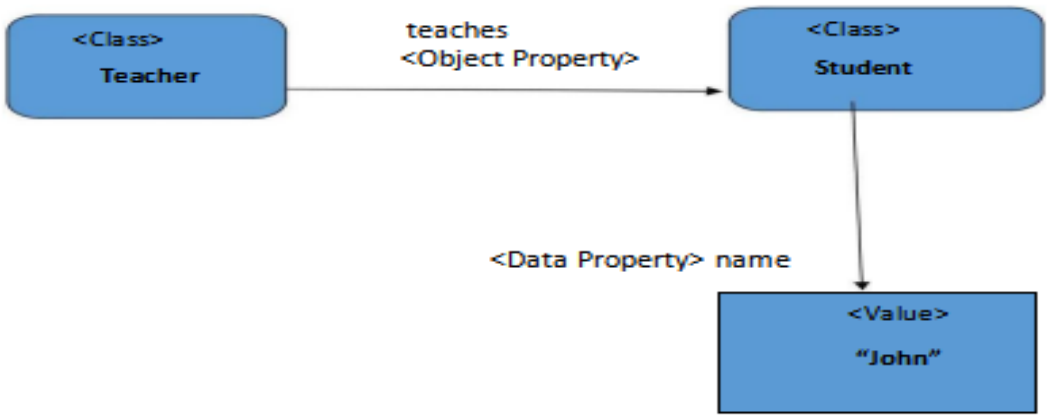
Some significant benefits of ontologies are outlined by (Natalya, 2000). Ontologies are used to make domain knowledge explicit, facilitate the reuse of domain knowledge, and share a common understanding of the data structure.

### 2.3.7 Web Ontology Language (OWL)

OWL, also known as the Web Ontology Language, was introduced in 2004 by the World Wide Web Consortium (W3C) as a universally recognized and standardized language for representing knowledge. It allows for describing and analyzing knowledge in a specific domain and is compatible with XML and other W3C standards. Built on the foundations of RDF and RDFS, OWL provides a more extensive vocabulary and advanced reasoning capabilities. It enables the creation of classes, properties, and constraints to describe relationships between concepts. OWL supports the classification of resources into groups based on their characteristics. It is designed to develop complex ontologies for various fields, such as engineering, finance, and medicine. OWL facilitates information sharing and integration by enabling the reuse of ontologies across different applications and systems. It has gained significant adoption in sectors like biology, government, and e-commerce thanks to its broad support from tools and software frameworks.

Figure 2.4.

*A Simple RDF*




Certain RDF and RDFS relations, like owl, can be replaced by RDF and RDFS: You can use Class for rdfs: Class. Furthermore, rdf Owl is used instead of property:

When a property is an object property, the owl: ObjectProperty identifier is used instead of DatatypeProperty. Depending on the expressivity, OWL contains three sublanguages: OWL Lite, OWL DL, and OWL Full.

OWL Full is a version of the Web Ontology Language (OWL) that combines the RDF and OWL syntax, offering the highest level of expressiveness. It includes all of OWL and additional RDF-specific constructs, allowing for the creation complex ontologies with various links and axioms. OWL Full is helpful in domains requiring extensive expressiveness and flexibility in knowledge representation. However, it lacks computational certainty, making it challenging for automated systems to reason effectively about OWL Full ontologies. Due to the complexity of the language, it is not easy to provide consistent computational processes for reasoning. As a result, OWL Full may not be suitable for applications that heavily rely on automated reasoning and inference.

OWL Lite is a Web Ontology Language (OWL) subset designed for users with simple modelling needs and limited resources. It provides a simplified OWL version, excluding complex features like property chains, qualified cardinality limits, and complex class expressions. Instead, it focuses on supporting basic constructs such as classes, properties, and individuals. OWL Lite also includes features for expressing simple domain constraints, like cardinality limits and value constraints, which enable more accurate and expressive ontologies. Despite its condensed feature set, OWL Lite is still a powerful language for representing knowledge in various fields. It suits applications with modest modelling requirements, such as product catalogues, organizational hierarchies, or basic knowledge bases. Furthermore, OWL Lite offers the advantage of lower computational complexity, making it easier to use and process, which is beneficial for applications with limited resources like embedded systems or mobile devices.

OWL DL (Description Logic) is an extension of OWL (Web Ontology Language) that aims to enhance expressiveness while maintaining computational completeness. Description logic is a formal logical framework used for knowledge representation, and OWL DL aligns closely with it. As a subset of first-order logic, description logic shares the same computational capabilities and well-defined semantics. This allows for reasoning about logical consistency and completeness of knowledge represented in description logic. OWL DL encompasses all the features of OWL Lite but also introduces additional expressive constructs like property chains, qualified cardinality

limitations, and complex class expressions. These constructs enable the development of more sophisticated and precise ontologies, facilitating the accurate representation of diverse knowledge domains. Despite its increased expressiveness, OWL DL retains computational completeness, ensuring reliable automated reasoning and inference on ontologies. Consequently, OWL DL is well-suited for a wide range of applications, particularly those that require automated reasoning and inference capabilities.

Figure 2.5.

*OWL Data Using Turtle Syntax In RDF*

```
@prefix rdf :<http://www.w3.org/1999/02/22-
rdf-syntax-ns#>@prefix
owl :<http://www.w3.org/2002/07/owl#>.
@prefix: http://someuri.org/

:Teacher  rdf:type    owl:Class .

:Student  rdf:type    owl:Class .

:name  rdf:type  owl:DatatypeProperty .

:lecture  rdfs:range    :Student
:Teacher   :name " Johni "^^xsd : string.
:Student :name " David "^^xsd : string.
:Teacher     :teaches  :Student .
```

### 2.3.8 SPARQL

SPARQL is the preferred query language for RDF (Resource Description Framework) data, combining the RDF Querying Language and the SPARQL framework. It was approved by the World Wide Web Consortium (W3C) in 2008 and has since gained widespread usage. SPARQL shares a similar structure to SQL, the popular language for querying relational databases. Due to this similarity, developers familiar with SQL will find learning and using SPARQL easier. SPARQL supports various query types, including SELECT, CONSTRUCT, DESCRIBE, and ASK, allowing programmers to extract data from RDF datasets in different formats, such as tabular data, RDF graphs, and RDF/XML documents. SPARQL queries enable searching for specific data patterns, filtering data based on predefined criteria, and generating new RDF triples from existing data within an RDF dataset. Its adaptability

and expressiveness make SPARQL a powerful tool for working with RDF data. One of its key features is the ability to query multiple RDF datasets, even if they are on different servers or have different formats. This enables developers to create robust applications that utilize data from diverse sources and perform complex searches across multiple data repositories. SPARQL operates on RDF graphs, which consist of triples containing a subject, predicate, and object. Queries are constructed by specifying patterns that match the triples in the graph, using URIs or variables to define the subject, predicate, and object of each triple. SPARQL provides various query operators, such as filters, aggregations, and sorting operations, to further refine and manipulate the query results.

Figure 2.6

*Example SPARQL Query*

```
SELECT ?book ?author
WHERE {
?book a <http://schema.org/Book> .
?book <http://schema.org/author> ?author .
FILTER (regex(str(?author), "David Ogolo", "i"))
 }
```

In this chapter, Machine learning and its types would be discussed briefly followed by the CNN architecture, which is the main architecture utilized to develop the FRCNN model.

In this case, the goal of the query is to retrieve data from an RDF graph regarding books written by J.K. Rowling. The query uses the SELECT statement to declare that the book and author information should be included in the results. The pattern to be matched, which consists of two triples, is specified by the WHERE statement. All resources with the type "http://schema.org/Book" are matched by the first triple. The second triple matches resources with a value for the variable '?author' in their 'http://schema.org/author' property. By applying a regular expression to the author value, the FILTER statement is then utilized to filter the results further.

The variable name must be preceded by a question mark (?). To specify the Uris of the employed triples, prefixes might be utilized. Consequently, a list of books David Ogolo wrote and the necessary author information is produced.

A simple SPARQL query is shown in Figure 2.7 that retrieves the capital of Nigeria from DBpedia, the semantic web equivalent of Wikipedia.

Figure 2.7.

*An Illustration of a SPARQL Query*

```
PREFIX dbr : <http:
//dbpedia.org/resource/> PREFIX dbo :
<http: //dbpedia.org/ontology/>
SELECT ?capital
WHERE {
 dbr:Nigeriadbo:capital ?capital. }
```

Complex SPARQL searches often include phrases like UNION, OPTIONAL, FILTER BY, and ORDER BY to retrieve data from several graphs. Figure 2.8 shows the output of a SPARQL query with the OPTIONAL keyword. The SPARQL engine will display the individual's name and age and any information it has about them from the graph if it contains that information. The OPTIONAL keyword must be used, and the graph must have age data to display anything.

Figure 2.8.

*An Example of a SPARQL Query Utilizing OPTIONAL*

```
PREFIX rdf:<http://www.w3.org/1999/02/22
rdf-syntax-ns#>PREFIX
foaf:http://xmlns.com/foaf/0.1/
 SELECT ?person
?nameWHERE
 ?person rdf:type  foaf:Person.

 ?personfoaf:name ?name OPTIONAL {

?personfoaf:age ?age .}

                    }
```

### 2.3.9 Rule Engine/Reasoning

Rule-based and ontology-based reasoning are the two main types of reasoning employed in the Semantic Web. Classification-based reasoning benefits from ontology-based reasoning based on RDFS and OWL axioms. It is not necessary to use an internal rule engine. You will require a rule engine and a language for defining the rules to employ rules-based reasoning. Some simple rule description languages are Rule Interchange Format (RIF), Notation 3 (N3) logic, and Semantic Web Rule Language (SWRL). Another kind of rule that requires a rule engine is the Jena rule.

The SWRL protocol supports both a human-readable form and XML. Both Pellet and Hermit, Protégé's ontology editor and reasoners, concur. It provides unary and binary predicates to describe classes and properties. Notation3, or N3 for short, is considered human-readable and enables the formulation of formulas inside of rules. It supports the Python-based CWM reasoning engine and is open-source. A rules system built on the semantic web can share and interchange rules using the Rule Interchange Format, or RIF. The numerous rule languages now in use can exchange rules using RIF. The Core Dialect, Basic Logic Dialect, and Production Rule Dialect are the three rule dialects that RIF supports.

### 2.3.10 User Interface

The user interface (UI) plays a crucial role in the Semantic Web architecture, enabling users to interact with the system and utilize its features. Its primary responsibility is to present data and information clearly and easily navigably. Positioned as the top layer in the architecture, the UI layer is often depicted as the final layer that users engage with. Components such as graphical user interfaces, forms, visualizations, and interactive dashboards are commonly found within this layer. The UI layer also provides users various tools and functionalities, including search and filtering options, allowing them to access and modify data differently. Although the UI layer is still being developed, research and development efforts continue within the Semantic Web environment. Eventually, standardized UI technologies such as voice assistants, natural language interfaces, and intelligent elements that adapt to user preferences may be implemented.

Moreover, other Semantic Web technologies like cryptography and trust can benefit the UI layer. Cryptography can safeguard user data and prevent unauthorized access, while trust mechanisms can establish confidence between users and the system.

These technologies can further enhance the usefulness and reliability of the UI layer in the Semantic Web.

### 2.3.11 Key Terms of Semantic Web

#### 2.3.11.1 Linked Open Data (LOD)

Linked Data is a structured technique for publishing machine-readable data that is linked to other related data on the web. It aims to increase data accessibility, discoverability, and connectivity based on the principles of the Semantic Web. Unique identifiers (URIs) are used to link different data resources. On the other hand, open data refers to freely accessible information that anyone can use. Linked Open Data (LOD) combines Linked Data and Open Data principles to create a globally accessible and interconnected information system. LOD uses RDF standards from the Semantic Web to express and link data, improving data connectivity and ease of use. LOD is often called a "virtual data cloud" because it allows users to access and add to data without changing the source. This enables various applications and use cases, fostering an open environment for data production, connection, and consumption on an Internet scale. Wikidata and DBpedia are notable examples of connected open data. Wikidata provides structured data to Wikimedia projects and other applications, while DBpedia links structured data from Wikipedia to other open data sources for widespread use.

#### 2.3.11.2 Schema Structure

A schema is a formal description of the structure of a database system, including the relationships between its elements. In the Semantic Web, a schema is used to specify attributes and connections of resources. Structured datasets like MARCXML, MODS, AACR, EAD, and RDFS are used to describe resources and can be organized into groups using a schema for database organization. Each dataset has specific rules for representing and organizing data in a domain or application. For example, MARCXML defines bibliographic data, MODS describes metadata for digital resources, and RDFS defines ontologies and vocabularies in the Semantic Web. Schemas provide rules and principles for data management, access, and formatting, resulting in a coherent and maintainable database system. In the RDF data model, the RDFS vocabulary is used to specify the schema structure, including classes, properties,

and constraints. The schema framework enables effective information handling and retrieval by organizing data in a standardized and structured manner.

### 2.4 Machine Learning, Internet of Things, Ontology and Semantic Web

The MAFALDA framework, introduced by (Ruta et al. 2018), aims to enhance machine learning analysis of Internet of Things (IoT) data streams. It addresses the limitations of IoT scenarios, where low-power micro-devices with limited processing capabilities continuously generate data. The framework provides a semantic description of the physical world instead of simple classification labels, treating machine learning as knowledge-based resource discovery. MAFALDA performs fine-grained event detection, characterizes statistical data distributions, and utilizes non-standard reasoning services for matchmaking. It leverages stream reasoning, Pervasive Knowledge-Based Systems, and advanced analytics to achieve efficient event recognition while minimizing processing power usage. MAFALDA utilizes data modelling, ontologies, and semantic-based annotation for data interpretation. The method involves defining the knowledge base and automating the training set creation. A traffic and road conditions case study validates the theory and compares the results with traditional machine learning systems. The study demonstrates the effectiveness of the semantic-enhanced approach, enabling semantic-based analysis of IoT data, data reuse, exchange with other devices, and compliance with Linked Data standards. The conclusion highlights that the proposed approach enhances the precision and effectiveness of machine learning in IoT applications.

In their study, (Ekaputra et al., 2022) explore the emerging field of Neuro-symbolic AI, which combines Machine Learning and Knowledge Representation techniques. They highlight the challenges the SWeML (Symbolic-Weaving Machine Learning) research area faces, specifically the lack of standardized reporting methods, which hampers system comparability and understandability. The authors propose a comprehensive framework for reporting SWeML systems to tackle this issue. The framework comprises four categories: System Settings, System Overview, System Details, and System Evaluation. They also introduce a classification system, reusable patterns, and visual representations to enhance the documentation of SWeML systems. The study emphasizes the importance of essential system information for fostering common understanding and comparability while suggesting methods to improve

documentation and enhance the machine-readability of system descriptions. The authors also address the need for standardized system descriptions and propose an audibility model encompassing ML resources, SW resources, and applications. This model aims to increase transparency in design decisions and operational details.

In their discussion of the ontology matching problem, (Doan et al. 2003) address the challenge of finding semantic mappings between two ontologies. They propose a GLUE system, which uses "anchor points" as concepts in one ontology with equivalents in the other. GLUE reduces the search space by utilizing anchor points and incorporates instance-based matching to find mappings between instances. The system integrates the results of anchor-based and instance-based matching to obtain the final mapping. GLUE extends the notion of anchor points to handle non-equivalent concepts and employs a multi-level approach to match taxonomies with different structures. GLUE utilizes machine learning approaches to semi-automatically build semantic mappings by generating a bipartite network and estimating the joint probability distribution of concepts. The system also uses a decision tree-based classification method to categorize the correspondences. Testing against various datasets has shown that GLUE outperforms other state-of-the-art ontology matching algorithms. The development of technologies like GLUE is crucial for the success of the Semantic Web.

In their study, Hussain et al. (2020) explore the relationship between the Semantic Web (SW) and Business Intelligence (BI) in the era of big data. They assess the progress and disparities in SW and BI, highlighting the benefits of merging them. The researchers discuss challenges and concerns in integrating SW and BI, propose novel strategies using XML and RDF to overcome data limitations and examine contextualization efforts in BI using SW. They compare two approaches for integrating SW with Online Analytical Processing (OLAP) - multidimensional model-oriented and OLAP analysis-oriented - each with its strengths and limitations. The study also discusses the contextualization of BI analysis, including using relevant external information and metadata. The researchers emphasize the importance of cloud technologies in managing big data due to their scalability, cost-effectiveness, data-sharing capabilities, and reliability.

## 2.5 Election, The Semantic Web and Ontology

According to Wikipedia contributors (Wikipedia contributors, 2023a), an ontology is a representation, formal identifying, and definition of the categories, characteristics, and interactions between the concepts, data, and things that enable one, many, or all domains of discourse in computer science and information science. An integrated set of theories, techniques, descriptions, and implementations called ontological semantics tries to organize concepts related to meaning representation by computer programs and a semantic description as a representation (Nirenburg & Raskin, 2004).

Several different languages have ontologies implemented at the moment. At the beginning of the 1990s, several languages were developed and used to build ontologies. The most representative languages are FLogic (Kifer, 1995), OCML (Motta, 1999), LOOM (Gruber, 1993), Ontolingua (Gruber, 1993), and LOOM (McGregor, 1991). With the exception of FLogic, these languages adhere to a LISP-based grammar and are in a constant state of continuous growth, hence the term "classic languages" (Corcho, 2000). In recent years, XML has emerged as a standard for sharing data via the internet. Many XML-based languages have been created, mainly to implement ontologies in the area of ontologies in mind. A few examples include RDF (Lassila, 1999), RDF Schema (Brickley, 1999), XOL (Karp, 1999), SHOE (Luke, 2000), OIL (Horrocks, 2000), DAML+OIL (Horrocks, 2001), and OWL (Dean, 2003). The creation of these so-called "web-based languages" is still in its infancy, and they are subject to frequent change. There has also been much use of ontology construction methods. Even before the CYC ontology was developed, It was the subject of various methodological ideas published by (Lenat and Guha 1990). The Enterprise ontology's foundational steps were published by Uschold and King in 1995, a few years after completion. In the same year, Grüninger and Fox (1995) presented an approach to creating the TOVE ontology (Virtual Toronto Enterprise). An idea to integrate the two strategies is put out by Uschold (1996) a year later. At the 12th European Conference for Artificial Intelligence, the procedure for developing the ontologies for the Esprit KACTUS project (Bernaras, 1996) is described. METHONTOLOGY was mentioned for the first time in 1997 (Fernández, 1997), and it has since been broadened (Fernández, 1999a; Fernández, 2000). It recommends how to proceed with ontology creation and guides how to do ontology review and

reengineering (Gómez-Pérez, 1999b,c). In 1997 (Swartout), also described building domain ontologies using the SENSUS ontology. None of these methods takes into account the collaborative ontology construction process. The first approach to consider group development features is Co4 (Euzenat, 1995). In (Fernández, 1999b), a comparison of a few of these methods may be found. The necessity of creating technical platforms linked to ontologies has increased since 1996. The Ontolingua Server (Farquhar, 1996) of the Knowledge Systems Laboratory (KSL) at Stanford University was the first ontology website. Ontosaurus, created by the University of South California's Information Sciences Institute (ISI), debuted in 1997 (Swartout, 1997). Since then, several Java-based tools have been developed for ontology creation. These include WebOnto, which was developed in the Knowledge Media Institute of the Open University (UK) by Domingue in 1998; OILed, developed in the IST OntoKnowledge project by Bechhofer in 2001; OntoEdit, developed by the AIFB of the Karlsrhue University and spearheaded by Staab in 2000; Protégé2000, developed by the Stanford Medical Informatics in Stanford University by Noy in 2001; and WebODE, developed in the Universidad Politécnica de Madrid by Arpírez in 2001.

According to (Hamdouni et al. 2017), social network platforms have gained popularity due to the abundance of social data. Businesses, organizations, and researchers are interested in leveraging machine learning, the semantic web, and related tools to analyze the sentiments expressed by social media users and gain insights into their perspectives. They propose a methodology for sentiment analysis of Twitter and Facebook data using semantic web paradigms and domain ontologies to ensure accurate findings within the specific context. The framework consists of four main components: analytics dashboard, domain ontology, sentiment analysis, and social network extractor. The social network extractor retrieves information from Facebook and Twitter based on user-defined keywords and stores it in a database using official APIs. The domain ontology includes taxonomies relevant to the study's focus areas to aid in precise sentiment analysis. Sentiment analysis is performed by preprocessing and analyzing the text using SenticNet, a knowledge library, while SentiBank is used for image analysis if media attachments are present. The analytics console module provides graphical representations of the results for decision-making. The framework demonstrates high precision, recall, and F1-measure values, offering precise sentiment analysis results. During the French presidential election, the framework was tested by extracting relevant tweets and comments from Facebook using well-researched

keywords related to the candidates. The analyzed data, stored in a MongoDB database, was visualized through line charts showing daily positive sentiment evolution, a map displaying favourable sentiment distribution by region, a doughnut chart indicating the candidate with the most positive sentiment, and a bar chart comparing positive and negative sentiments for each candidate. The framework proved helpful by analyzing over 15 million tweets and retweets since March 7, 2017, providing valuable insights into voter sentiments towards political candidates during an election.

According to Schwabe et al. (2019), the variety of sources and extraction techniques inevitably raises the question of data quality. It presents the decision of whether or not to place trust in the knowledge gleaned from the Knowledge Graph by the user. This emphasizes how, in the end, data conveys a belief, opinion, or point of view of some agent. An ontology known as POLARE was introduced by them. As the political agents inside a political system, people and organizations are the fundamental notions of POLARE. Direct relations between Persons were first studied since they established indirect relations between Persons, which is the main objective of characterizing their various relations. Following this, relations between Persons and Organizations were looked at. In order to define Persons and Organizations, respectively, the POLARE ontology's relations were added as necessary. The FOAF vocabulary was used to describe Persons. Direct familial relations, portrayed as Direct Relationships in POLARE, are the initial type of relationship between people. The POLARE ontology offers a collection of vocabulary to express the connections between political agents by combining ideas from other vocabulary and adding certain classes and traits as necessary. The details in the preceding diagrams are represented using the Shapes Constraint Language suggested by the W3C9 to characterize the specific composition patterns intended to be realized in the knowledge graph.

Several facets of online interaction. E-participation, as defined by (Wimmer (2007), involves citizens in dialogue with elected officials through technology. He thinks it is a complicated topic that calls for input from many different fields, uses various techniques, and involves many different degrees of involvement. The policy life-cycle, tools, methodologies, and actors are only a few of its varied topics. The proposed ontology by (Wimmer, 2007) captures the uniqueness of e-participation as a sophisticated area of study and application. The ontology is organized hierarchically, with a top-level ontology collecting the broad notions of e-participation and various domain ontologies capturing particular facets. Subdomains are further separated

within the domain ontologies to capture more precise notions. The ontology also incorporates connections between concepts, such as is-a and part-of connections, allowing inference and reasoning. The ontology includes various classes, such as actors, aspects of success, e-participation areas, level of involvement, policy life-cycle, projects, research fields, tools and technologies, and generic classes. The ontology also has relationships outside hierarchies that represent relational linkages as perceived by people, allowing for quick and efficient searches through the vast body of knowledge in the area. The advantages of ontology concepts include their capacity to offer a shared and common understanding of a domain that can be conveyed across people and application systems and their ability to integrate human symbol interpretation with machine processability. The ontology can be used to locate e-participation initiatives in various fields, identify the people involved and who developed them, and identify which tools and technologies are most frequently utilized in particular e-participation projects.

In their study, (Santos and Rover 2016) look at the little-discussed connection between ontologies and electronic democracy. For electronic democracy, they created an ontology that can be used to understand its dynamics better, create applications, and assess its effectiveness. In the initial step of creating an ontology, activities are integrated to determine their scope and purpose, and questions about competence are generated. Knowledge sources are also identified, and the ontology's reuse is considered. In the second ontology-building activity, the words were listed, reusable parts were added, the terms were categorized, and the terms were described. As part of our third activity, we tried to define the classes, make classes and subclasses, and map the relationships between the constraints and data characteristics. The definition of an object's properties or the connections between classes allows for the encoding of domain knowledge in a machine-understandable way, making the ontology easier to reuse in later applications. The fourth phase in developing a domain ontology was putting the classes and object traits specified in practice. The domain ontology was implemented using Protege-OWL 4 and the Protege-Core Framework. The ontology evaluation by a domain expert and potential users occurred at the fifth and final step of the ontology-building process. If the expert believed the developed concepts and relationships sufficiently represented the domain, the critical elements of the ontology and a formal description of the knowledge area might be found.

The portrayal and description of politics present unique challenges for information systems. Moreira et al. (2011) argue that political names are generally well-defined and can be represented effectively in specialized dictionaries or knowledge bases. They developed an ontology called POWER, which formalizes the dynamic knowledge of the political scene, including roles, relationships, and interactions among entities. POWER adopts OWL2, DCMI, and SKOS standards and specifies domain-specific terminology. The ontology is populated with data from specific databases and websites, serialized in RDF/XML format, and stored in a Virtuoso triplet-store. The ontology can be expanded by adding new files to the triple-store. An upcoming online interface will allow users to access the datasets through a SPARQL endpoint. EMPOWERD (Enrichment Manager for POWER Datasets) is a system developed to manage information extraction from various sources and generate RDF statements using the POWER vocabulary. The process involves a bootstrap phase that semi-automatically generates instances from selected resources and an enrichment phase that incorporates new individuals and their properties using text-mining techniques and other tools to gather data from relevant sources.

## 2.6 Semantic Portals and Webpages

Semantic portals implement intelligence around specific domains and rely on ontologies to build and update this intelligence. They leverage semantics to provide and evaluate data, utilizing semantic web technologies for construction and maintenance. Semantic portals can serve as fundamental components of the Semantic Web, demonstrating the value of these technologies to a broad audience. They have the potential to popularize ontologies and establish naming conventions over the internet, reaching a large user base. Within these portals, collaborative ontology development is possible. While adding semantic descriptions to content increases the effort required for information development, this challenge is less significant for more extensive collections where the balance between ontology use and elaboration is better. Connecting portals become more effective than linking multiple small websites due to reduced ontological mediations. Semantic portals can bridge the gap between the Semantic Web and the current Web by incorporating non-semantic elements into their ontologies, thereby expanding the quantity of data accessible and processable using semantics.

### 2.6.1 MuseumFinland

MuseumFinland functions as a semantic portal devoted to Finnish Museums, as introduced by Hyvönen et al. in 2004. It represents an implementation of the ONTOVIEWS Semantic Web portal generator. The process of establishing ontologies and instances for MuseumFinland adheres to a partially automated approach. Initially, museums convert their collections into XML format. Subsequently, the information contained within the XML undergoes a series of conversions: from XML Schema to RDF format. This transformation process is facilitated by a tool that operates in a semi-automated manner. To manually edit and update the ontology and instances, the Protégé ontology editor is employed. However, it is important to note that the system lacks a distributed maintenance interface. MuseumFinland offers two primary features: a combined search utilizing keywords and multiple facets, as well as recommendation links. Predetermined rules guide the generation of recommendation links. Furthermore, the user interface of MuseumFinland is adaptable to different devices, including mobile phones and personal computers. However, the system does not support personalization based on individual users' preferences.

### 2.6.2 SEMPort

Users can access and view resources collected using RDF files utilizing the Semantic Portal platform. The content is modified using the Protégé web interface, a user-friendly tool for developing and modifying ontologies. With the help of this interface, users may meaningfully organise and arrange data so that it can be searched for and navigated through. The search engine employed by the Semantic Portal is ontology-based, which means that it bases its search operations on the structure and relationships specified in the underlying ontologies. The Jena API and Jena Reasoner are the site's computer programs to facilitate effective browsing and searching through big RDF data sets. Inferring additional information from the relationships specified in the ontologies using the Jena reasoner enables the generation of more thorough search results. In conclusion, the Semantic Portal offers users a powerful and simple method to explore and search through enormous amounts of data, utilizing the rich semantic structure offered by ontologies and the extensive search capabilities of the Jena API and Jena Reasoner.

### 2.6.3 SEAL

The SEAL framework, also known as the Semantic portal, was created to offer information access and provision through a portal. It was introduced by Maedche et al. in 2001 and 2002, with the AIFB website serving as the framework's case study. SEAL encompasses three primary functions: navigational views, semantic search, and semantic personalization. The data on the site is created using RDF CRAWLER. Users can display the portal's content in HTML format or RDF format for machines. Semantic search requires evaluating the keyword being searched to the knowledge base using semantic inferencing and ranking responses based on the relationship between them. Semantic customization is accomplished through users' semantic bookmarks and logfiles, allowing them to customize their experience. Semantic bookmarks are preconfigured query formulations that clients can customize by giving labels, selecting stylesheets, or marking them as the initial portion point. Furthermore, semantic logfiles capture which ontology concepts are accessed by users in order to review and organize the ontology.

### 2.6.4 KOAN

The KAON Portal is a software designed for constructing ontology-based web portals using the SEAL framework, as described by Ehrig et al. in 2002. KAON facilitates the creation of ontology-driven portals by aggregating information from various sources such as HTML, XML, relational databases, and RDF. This is achieved through the use of forms. One drawback of KAON is that any updates made to the information sources or modifications to the ontology are not immediately visible during runtime. Instead, the portal needs to be regenerated to reflect these changes. Searching using semantics and navigational positions, both of which are based on the SEAL technique, are the portal's primary features. Users can access portal content in HTML format, while agents can access it in RDF format, which aligns with the SEAL framework. This method does not offer user-based customization; instead, it focuses largely on building and administrating ontologies.

### 2.6.5 OntoWebber

A program called OntoWebber is used to build websites with plenty of data. For instance, as described by Jin et al. in 2001, the Semantic Web Community Portal

was developed to make sharing and exchanging information easier. The portal's content is created by gathering information from various internet websites and turning it into RDF format. OntoWebber's modelling functionality is its standout feature. Ontology construction is aided by domain modelling, whereas site view modelling concentrates on navigation, content, and display. Links, content, and presentation order are organized throughout the site view and structured by an authorized user, usually an administrator. Separated from the ontology are these display and navigational strategies. Several site view models divide people into various groups to enable customization in modification modelling. On the basis of these user groups, several presentations are offered. In this method, the administrator is in charge of setting up all personalization options as well as keeping track of the models and user groups. As a result, the administrator has total control over how the presentation is displayed, which may not be practical for a portal with a large number of users and a lot of data. Users have little control over their profiles, as well.

### 2.6.6 OntoWeb

The OntoWeb site serves as a transmission mechanism for the OntoWeb thematic network, which is supported by funding from the European Union. The portal's three main features are providing content, surfing, and querying. There are two ways to contribute material to the portal regarding information delivery: through forms or by syndicating annotated content from other websites based on a common ontology. The publication workflow for private, pending, or public material is made more accessible by the syndicator mechanism built into the OntoWeb interface. A privileged user manages this procedure. The OntoWeb site also provides two different ways of querying: term-based and template-based. Users of the system are, however, not given any adaptability features.

### 2.6.7 ODESeW

As Corcho et al. described in 2003, ODESeW is a framework made for creating knowledge portals. It acts as a platform for intranet and extranet uses under the Esperonto project, which the EU supports. A variety of information formats may be transmitted and received using ODESeW. Information modification and supply, display, browsing, and filtering are some of the crucial functions provided by the framework. A user's ability to add, alter, and delete class instances, attributes, and

relation instances is dependent on their read and write rights in ODESeW's content editing/provision system. However, inserting and deleting relation instances is difficult due to the interface. The rights provided to intranet and extranet users are considered when creating presentations inside ODESeW, resulting in various representations. Ontology-based and keyword-based alternatives are also provided for searching and querying. Although it might be difficult to insert relationship values in the ontology-based search, the framework does not place much focus on the connections between related information items. Through the cooperation of the Esperonto, Knowledge Web, and OntoGrid projects, an expanded version of ODESeW, known as ODESeW 2.0, was subsequently published, as mentioned by Corcho et al. in 2006. A User Ontology is used in this revised version to define read-only and write-only permissions for various data model components. Two more additions were made to the architecture: an alerting system for providing asynchronous communications about changes to the data model and a third-party communication gateway for integrating data from other sources. ODESeW's main goal is to make sharing information easier for project participants.

### 2.6.8 OntoWeaver

OntoWeaver is a framework made to make it easier to create and construct customized data-intensive websites. The framework uses presentation ontology and portal ontology to define various site interfaces and display layouts. OntoWeaver's main feature is customization, which is accomplished by modelling people using a User Ontology and putting customization rules into place to facilitate individualization. Administrators give Users several site views and layouts, resulting in a customized display that changes depending on the user and the situation. OntoWeaver also facilitates the content supply by employing templates and provides search capabilities using forms. Like OntoWebber, this strategy offers a foundation for customization that enables site developers to build intricate presentation styles and layouts for certain user groups or people. It should be highlighted, nonetheless, that viewers have no influence over their online accounts and that the display remains entirely under the whole authority of a privileged user.

### 2.6.9 Rewerse Portal

Work completed as part of the Rewerse project led to the creation of the Rewerse portal. It is based on SWED-E portal technology and mainly emphasizes logic and customization. Like SWED-E, the Rewerse site regularly refreshes its material by searching through well-known data sources for new or altered metadata. For maintaining material, there is not an interconnected web interface, though. The portal's primary features are personalized search and faceted search. To enable personalization, online users' browsing and professional distances are calculated, and predetermined filters are presented based on these distances. For example, the surfing distance is determined using ontological data about online sites, but the professional distance is determined using nodes that represent verified individuals. After that, a radar applet is used to display the distances. It is important to keep in mind that the portal's customization feature mostly focuses on showing individuals who are similar to the user in question and could not improve the surfing experience for consumers much.

### 2.6.10 REASE

The Knowledge Web and Rewerse initiatives both included the development of REASE (Repository of Semantic Web Learning Units). This repository intends to make it easier for people to create and share knowledge about ontology and Semantic Web technologies for higher education. New instructional resources, such tutorials and lectures, may be added by users to the repository to keep it current. Ontology-based investigate, browsing, and collaborative customization are just a few of the repository's standout features. To facilitate browsing functionality, the ontology hierarchy is used. With ontology-based search, the system offers acceptable values for connection properties, and the order of the search results may be determined by collaborative rating, alphabetical order, the date the document was created, and other factors. Participants must register with the portal to access the system's collaborative customisation feature. After logging in, members may add interesting content to their accounts and edit them online. By giving consumers the option to change the way search results are displayed or how they browse content using cooperative ranking, customization is accomplished.

Figure 2.9.

*Comparison Of Various Semantic Portals*

| | SEAL | KAON | ONTO Webber | OntoWeb | ODESeW | OntoWeaver | MuseumFinland | Rewerse | REASE | SEMPort |
|---|---|---|---|---|---|---|---|---|---|---|
| **Content editing/ provision** | Using RDF crawler and OntoEdit ontology engineering workbench | Syndicating from web pages, DB , RDF files and using Web forms. Do not operate in real-time | Collecting data from Web pages using wrappers and converts than into RDF | Syndicating mechanisms and the use of Web forms. Do not operate in real-time | Allows import/export of data. An interface to edit data and an external info gateway | Through knowledge acquisition forms (templates) | Semi-automatic tool to convert XML data to RDF, Probte (edit/update) | Based on SWED-Ewaivers (scanning known data sources) | Updated by users by using Web forms | Through RDF file aggregator web interface, Protégé (edit/update) and editing/provision on Web interface (editing). Operate in real-time |
| **Search** | Ontology-based. Ranking based on similarity to query | Ontology-based | - | Term-based and template-based | keyword based and ontology based | Search forms | Combined keyword and multi-faceted search | Faceted search | Ontology-based | Ontology-based using transitive and rule based reasoners |
| **Inference** | F-Logic based during search and navigation | KAON datolog engine, OWL reasoner (KA ON DL) | An inference engine is attached to navigation module | Based on SEAL (F-Logic) | Prolog inference engine | Jess inference engine to provide customization using rules | SWI-Prolog inference engine for navigation and search | Rule-based reasoner | Not specified | Jena owl and rule-based reasoners for navigation and search |
| **personalization** | Semantic bookmarks (predefined queries) | - | Customization based on different user types and rules | - | Customization onbasedon a user model | Customization based on user ontology and customization rules | Device-based adaptation (i.e. to PCs, mobiles) | Displays distances of online users and predefined filters | Collaborative ranking based ordering during navigation and search | A usermodel for suppotting AH (link sorting, link annotation, adaptive presentation) |

Numerous research studies have examined how ontologies and semantic web technologies are used in the electoral space. This research has demonstrated that using these technologies can result in advantageous outcomes, with most studies achieving better outcomes. In order to make it easier for users to share and reuse data across various platforms and apps, semantic web technologies are a set of standards and tools. Ontologies, in contrast, are a formal representation of knowledge or concepts often used to define a specific topic. Researchers have worked to increase the precision and dependability of data and information about elections by implementing these technologies in the election sector. Most studies indicate improved outcomes, demonstrating they have successfully met their objectives. These benefits include improvements in vote counting precision, higher electoral process transparency, or improved election data management. Despite this, there is still potential for improvement. Before the full potential of semantic web technologies and ontologies can be realized in the electoral domain, problems or restrictions still need to be resolved. Alternately, there is room for more significant investigation and study in this field, which could lead to even more substantial advancements. With the potential for even more substantial advancements in the future, the application of semantic web technologies and ontologies to the election domain has been an exciting.

# CHAPTER III

## METHODOLOGY

### 3.1 Overview

This chapter outlines the methods used in the study as well as the prior knowledge that influenced its design. The specific research inquiries and goals stated in Chapter 1 served as the foundation for the research design, methodologies, and supporting research used in this scientific investigation. Human-computer interaction approaches are presented in Section 3.2 as an introduction to the topic. It is explained why a Design-Science paradigm was chosen in Section 3.3. How to do research was covered in Section 3.4. The next sections, Section 3.5 on the analytical methodology employed in this study and Section 3.6 on the system development environment, discuss the investigation methodology and environment, respectively. In Section 3.7, the standards for system requirements were examined. Specifically, interactions between people and computers (HCI) are studied using several research philosophies and viewpoints, which are covered in the following section.

### 3.2 Investigations into Approaches in Human Machine Interactions

The primary goal of this study was to develop a conceptual structure for using a Nigerian electoral ontology. Human-computer interaction (HCI) researchers have examined the creation of technologies that enable people to utilize computers in novel ways and how people interact with them. Therefore, the discipline of interaction between humans and machines is thought to include this topic. The study aims to improve these linkages and provide a more pleasurable experience by focusing on how users get the information needed quickly. The HCI discipline employs a variety of research methodologies. The following strategies are covered in this section: the engineering approach, the traditional scientific method, and design science. The purpose of the following descriptions and explanations is to help you decide which research methodology is best for your study.

### 3.2.1 Design Science

According to (Hevner & Chatterjee 2004) and (Iivari 2007), design-science research concentrates on creating and usability artefacts to enhance the artefact's functional performance. Algorithms, machine and human interfaces, design approaches, and languages are examples of artefacts typically the focus of design-science research (Hevner & Chatterjee, 2004). These artefacts include constructs, models, procedures, and instantiations (Offermann & Platz, 2009; Von Alan et al., 2004). According to (Hevner and Chatterjee 2004), design-science studies require the design of a novel, practical artefact for a distinct issue domain. The artefact must be assessed to ensure it pertains to the given issue. As a prerequisite for an object to constitute a distinctive scientific involvement, Offermann and Platz (2009) continue by stating that it must either address a problem that has not been solved before or it must do so effectively. The goal must be carefully constructed and assessed, and the study results must be appropriately conveyed to audiences with management- and technology-focused interests.

### 3.2.2 Standard Science Methodology

Pather et al. (2003) defined conventional science as an approach that constructs and analyzes simulation models centered around verifiable evaluations using empirical techniques to gather quantitative data. The positivist research perspective is used in the conventional scientific method. Conventional scientific research focuses on data that can be observed, listened to, or felt in order to understand how things function. In addition to conducting experiments and making observations, the researcher develops and tests a hypothesis before the empirical investigation. The knowledge gained from this approach in HCI enables the researcher to draw inductive and deductive explanations about the results of empirical experiments. This methodology helps the researcher forecast the results and comprehend the link between the variables (Peffers et al., 2006).

### 3.2.3 Engineering-based Methodology

According to Hussain and Howard (2012), the engineering approach incorporates ideas from both traditional scientific methodologies and design science. The researcher uses this technique to assess the effectiveness of suggested remedies.

Using the concept as a starting point, the researcher creates an outline of prospective remedies, which are evaluated, analyzed, and assessed. Up to that point, no additional modifications are required, and the product is then prepared for its use. This technique emphasizes what people do or are capable of doing, as opposed to their idealized ideas of what they should be doing. The approach advises integrating research experiences, observations, and trials to understand the study topic fully. The engineering technique emphasizes that not all problems in software engineering are purely technological but instead centered around humans and take into consideration the social environment. As a result, it aims to comprehend issues relating to human-computer interaction and improve how people engage with technology (Hussain & Howard, 2012). The fundamental goal of this research is to create an artefact (an ontology) that integrates IT and people. No Election Ontology in Nigeria was found in the literature review. The design-science paradigm was used in this study based on its objectives and design. This choice is motivated by the next section.

### 3.3 Inspiring Factors for Design Science

This research aimed to develop a solution to an existing problem in Nigeria, specifically, the absence of a framework for implementing the Election ontology. In order to address the problem mentioned earlier, the main objective of this project is to create an ontology for Nigerian elections. The aforementioned challenge is one concerning information systems since it deals with how all parties involved in electioneering will accept and use a result of an information system. By considering the very concept of a structure supporting all of the various hardware, software, and graphical user interface components inside information systems, The relevance of design science to several fields of information-systems research was discussed by Offermann and Platz in 2009. Design science may be used to create information systems since it is problem-focused. Hevner and Chatterjee (2004), who agree, claim that the challenges in information systems that design science addresses might include the ones that necessitate human skills to provide efficacy in resolving them or when the needs are not specified and the circumstances do not appear to be clearly established. The context in which this study issue is situated includes people and technology; as a result, HCI is relevant, and Design Science, in particular, is essential.

The following section provides further information on the Design-Science research tenets used in this thesis.

### 3.3.1 Integrating Research Goals and Design Science Characteristics

Guidelines for conducting, assessing, and presenting design-science research explain how to do so (Hevner & Chatterjee, 2010b). The criteria are the practical rules for conducting design-science research (Peffers et al. 2007). Hevner et al. (2004) suggest seven guidelines for doing design-science research. These rules of design science are shown in Table 3.1 below.

Table 3.1.

*Design Science Guidelines*

| Guiding Principles | Details | Relevance to our study |
|---|---|---|
| **Design as an artefact** | An artefact used as a construct, model, technique, or instantiation must result from a design science study. | This research produced an artefact in the shape of a framework for adopting ontologies in Nigeria. |
| **Relevance of the issue** | The creation of technology solutions to solve major and pressing commercial issues is the aim of design science research. | Nigeria and other countries with comparable conditions may develop an electoral ontology using this approach. |
| **Design evaluation** | A design artefact's benefit, performance, and effectiveness must be thoroughly demonstrated through well-executed evaluation techniques. | The design was assessed via expert reviews. |
| **Research contributions** | The efficient design-science study must improve the design artefact, design processes, or both in a prominent and verifiable manner. | The research's primary achievement is the creation of the first election ontology. |

| | | |
|---|---|---|
| **Research rigour** | The production and assessment of the design artefact in the design-science study depend on rigorous methodologies. | As Peffers et al. (2007) recommended, proper meticulous processes were used to create and analyze the framework. |
| **Design as a search process** | Leveraging available resources to achieve desired goals while adhering to legal requirements in the problematic context is necessary for the quest for an efficient artefact. | The investigation heavily utilized existing knowledge, and all applicable regulations were upheld. |
| **Communication of research** | Effective communication of design-science studies is required for both management positions and technology-focused audiences. | This thesis also used papers with peer review to convey the framework. |

### 3.4 The Research Process

Robust techniques provide a methodical way of responding to the research questions and having well-planned study objectives and inquiries (Mackey & Gass, 2015). This powerful tool empowers researchers to promptly and systematically address their research queries with remarkable accuracy. Saunders et al. (2009) offer six stages for doing research: study philosophies, procedures, strategies, options, time frames, data collecting, and data analysis. Design science is the research approach used in this work, as was already indicated. A description of each following layer related to design science research is given in the following sections.

#### 3.4.1 Design Science Process Models

The concept of design science study, the objectives it should seek, and the realistic principles (guidelines) that advise carrying out and justifying it were all covered in earlier portions of the study. Peffers et al. (2007) assert that a methodology's three distinguishing characteristics extend beyond its guiding concepts and practical suggestions. It does not include a technique that offers a recognized manner to carry it out. Models of the design-science study process are employed to support research and contribute to expanding the body of information using scientific investigation

(Offermann & Platz 2009). Peffers et al., 2006; Pries-Heje and Baskerville, 2008; Vaishnavi and Kuechler, 2004; The design-science process has been modelled differently. It is essential to remember that while the number of stages in these various process models varies, all strategies accomplish the same goal of producing an artefact. Issue identification, solution design, and assessment are the three major categories into which these processes may be divided. The phases of four models of the design-science process are compared in Table 3.2.

Table 3.2.

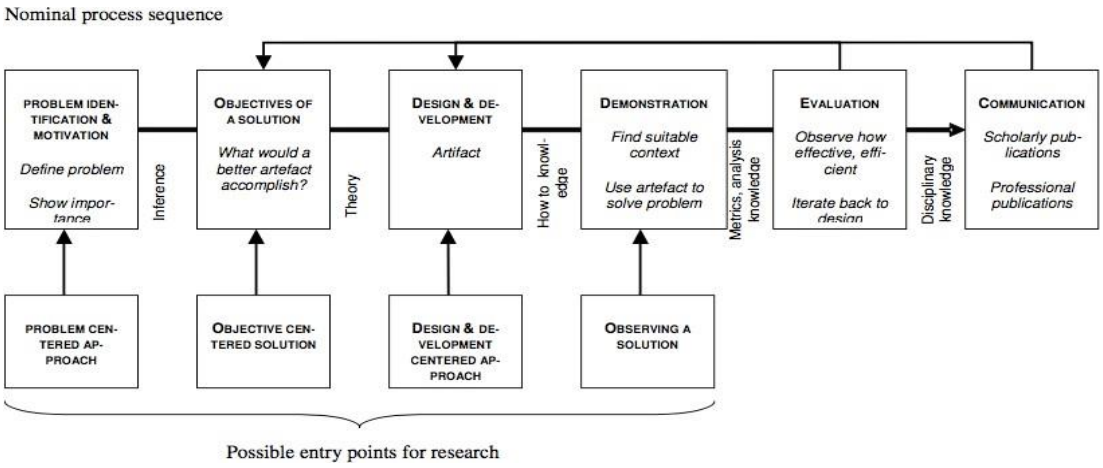
*Comparison Of The Phases In Four Models Of The Design-Science Process.*

| **Phases** | **Takeda et al. (1990)** | **March & Smith (1995)** | **Nunamaker et al. (1991)** | **Vaishnavi & Kuechler (2004)** | **Peffers et al. (2007)** |
|---|---|---|---|---|---|
| **Problem identification** | An inventory of the issues | | Create an intellectual structure. | Understanding of the issue | Decide what the issue is |
| **Solution design** | Suggestion | Build | Create a system framework. | Suggestion | Specify the goals. |
| | Development | | Designing and analyzing systems<br>Create the system. | Invention | Creation and improvement |
| **Evaluation** | Conduct an assessment to verify the solution. | Evaluate | Examine and analyze the system. | Evaluation | Exhibition<br>Assessment |
| | Resolution on the solution to be adopted | | | Termination | Communication |

A popular model of the design-science research process was created by (Peffers et al., 2007) to integrate significant earlier studies. This model differs from the others in Table 3.2 in that it splits the problem recognition phase into the problem finding and motivation phases, identifies the goals for resolving the problem, redesigns the solution stage of planning as the process of design and development, splits the assessment phase towards the demonstration and assessment phases, and finally adds a new phase called interaction. Goals are prioritized above everything else in a problem-focused approach that seeks a resolution. This paradigm differs because it acknowledges that the study may have several input points from various environments, as shown in Figure 3.1.

Figure 3.1.

*Model Of The Design-Science Study Procedure*



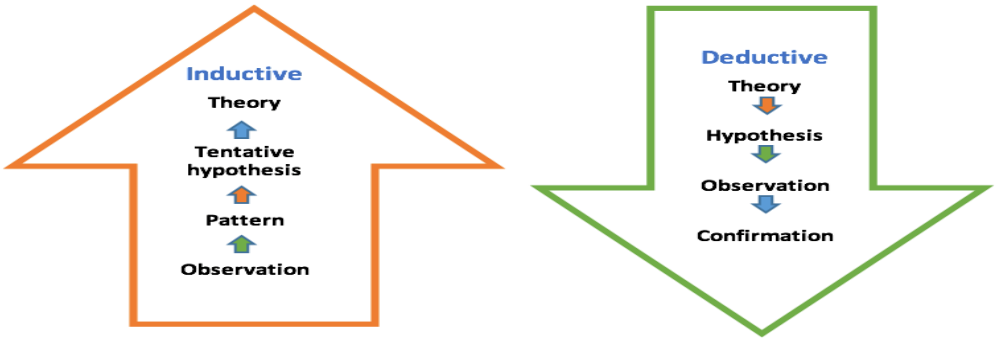

The research methods and approaches employed to accomplish the research objective are discussed in the following section.

### 3.4.2 The Research Strategy

Reasoning is the process of drawing inferences, establishing hypotheses, or developing explanations based on information. According to (Klauer and Phye 2008), (Saunders et al. 2009), and others, the deductive and inductive methods of reasoning are two distinct ways of thinking. According to Saunders et al. (2009), research guides in evaluating the results and determining their relevance. A deductive and an inductive research project go through the stages shown in Figure 3.2 below.

Figure 3.2.

*Deductive And Inductive Logic Phases*




Deductive reasoning employs identifying a dataset or trend to build a hypothesis, whereas inductive reasoning uses the same information to produce a theory. As seen in Figure 3.2 above, deductive reasoning produces a hypothesis to test a theory in light of the available evidence. Table 3.3 below demonstrates the distinctions between the deductive and inductive approaches.

***Table 3.3***:

*Deductive And Inductive Approaches*

| **Deductive** | **Inductive** |
|---|---|
| It is a top-bottom strategy. | It is a bottom-up strategy. |
| Quantitative data is often collected. | Most often, it gathers qualitative data. |
| It compares the evidence with the hypothesis. | It creates a theory based on the evidence. |
| A researcher is not dependent on the subject being investigated. | The researcher participates in the research endeavour. |
| It makes an effort to clarify the causes of the varying connections. | It strongly emphasises having a thorough comprehension of the subject at hand. |
| It is an organized strategy. | Because of its more flexible structure, it permits alterations as the research process advances. |
| It switches from the broad to the detailed | It shifts from the particular to the broad |

### 3.4.3 The Research Strategy

A research plan lays forth the general method the researcher will use to deal with the study's problems. The research plan, which also includes the methods employed to conduct the research, should offer the general direction of the study. According to Babbie (2013) and Creswell (2013) b, the research strategy may alter over time. According to Saunders (2011), the best method to select an effective research strategy is to take into account the objectives and research questions of the study, as well as the volume of preliminary information on the subject, the time and resources that are available, and the researcher's philosophical underpinnings. Researchers can use a variety of ways to approach their research, according to Yin (2009). Table 3.4 lists these tactics and examples of how they can be used.

Table 3.4.

*Various Research Techniques And How They Are Used*

| Type | Purpose | control over an occurrence is necessary | accentuate the present-day happenings |
|---|---|---|---|
| **Experiment** | A scientific experiment in which you carry out a set of tasks and closely monitor their results in order to learn more | Positive | Positive |
| **Ethnographic** | gaining knowledge of culture, morals, or viewpoints | Negative | Positive |
| **Grounded Theory** | carrying out research without having any previous notions or hypotheses; utilizing the results to create new theories | Negative | Negative |
| **Archival research** | recognizing how society discriminates against women | Negative | Positive / Negative |

| | | | |
|---|---|---|---|
| **History** | being aware of the significance that individuals give to the events in their lives. Additionally, this is utilized to review treatment session transcripts. | Negative | Negative |
| **Case Studies** | Gaining insight into the methodology or rationale utilized by an individual, collective, corporation, or community to tackle a problem or implement a course of action. | Negative | Positive |
| **Survey** | Obtain feedback from others on a subject. | Negative | Positive |
| **Action Research** | assembling groups of individuals to carry out a study. The goal is to utilize studies to identify social issues and promote social transformation. | Negative | Positive |

### 3.4.4 The Option for Research

Saunders et al. (2009) and Yin (2003) both state that research can be performed using two ways a qualitative approach, a quantitative research design, or both (hybrid approaches). The approaches to qualitative, quantitative, and hybrid study are covered in this section.

### 3.4.5 The Qualitative Research Design

Qualitative research is a highly effective approach in providing a comprehensive and detailed account of social or cultural phenomena (Offermann & Platz, 2009). With the aid of qualitative research, the researcher will be able to gather, assess, and interpret participant data from individual experiences, introspective thoughts, and personal narratives in order to gain a thorough understanding of people's voting habits, motivations for voting, and opinions regarding voting and electoral processes. Findings, screenings, and evaluations of documentaries should all be included in qualitative research, according to Myers (1997), and open spaces should be used for this purpose. The limitations of qualitative research, such as the

researcher's personal biases and subjective interpretations, as well as the difficulty of extrapolating findings to a broad population given the small sample size, are well demonstrated by Mackey and Gass (2015). In 2009, Leech and Onwuegbuzie and Cameron both shared these opinions. The approach of qualitative analysis is theoretically based on post-positivism. According to post-positivists, human knowledge is hypothetical and not based on unquestionable, solid principles. They contend that knowledge is fundamental and has a basis because the outside world exists regardless of how a person perceives it (Creswell, 2013b). When conducting studies, it is crucial to rely on scientifically testable and scrutinizable methods. That is why deductive approaches are a popular choice, as they allow for drawing specific conclusions based on a general assumption through a sequence of well-defined steps, meeting the necessary standards for thoroughness and accuracy (Yin, 1989; Morse, 2003). A qualitative study method is advised as the recommended research approach for this topic. By aiding in developing hypotheses and additional research and comprehension of quantitative data, it also analyzes and provides deeper insights into problems that happen in the real world.

### 3.4.6 The Quantitative Research Design

According to Thomas (2010), quantitative analysis is an information-collection strategy (including survey, correlational, naturalistic-comparative, and experimental research) used to examine a topic that appeals to a researcher or the study team. An intricate measurement process measures a concept or subject with some factors, and the findings are statistically analyzed. According to Creswell (2002) and Yin (1989b), adequately supervised, devoid-of-value (or value-neutral) techniques which are capable of validating and testing hypotheses through the process of falsification are the cornerstones of quantitative research designs' efforts to be generalizable. Quantitative scholars usually emphasize sample size and statistics to show broad generalizability. Some quantitative researchers have the most simplistic thinking when they dismiss the importance of setting and context as unimportant or unmanageable. Constructivism is the theoretical foundation for the qualitative research methodology (ibid). According to Bergman (2008) and Saunders (2011), quantitative studies should help the researcher collect, analyze, and derive quantitative data on participants' attitudes, behaviours, or viewpoints. Quantitative research methods efficiently deliver information broadly from a range of units (Creswell, 2013b) while being superficial

(Morse, 2003), but they do not study a topic or notion in detail. There are certain restrictions on this study's approach. One of the most common criticisms of quantitative research is that some models rely too heavily on statistics, give too much weight to mathematical averages, and fail to consider the complexity of human behaviour. Some methods solely concentrate on numerical data (Yin, 1989a; Thomas, 2010) and lack the intricacy and detail that participants ascribe to events.

### 3.4.7 Mixed-method Research Design

A mixed-method study design integrates the methods for obtaining and analyzing data used in quantitative and qualitative research approaches to explore the research topic (Bergman, 2008; Creswell, 2013b). Mixed-method research combines various approaches and techniques to understand different social science issues better. This research design, as described by Teddlie and Tashakkori (2011), involves using both qualitative and quantitative methods during the research process. The philosophical assumptions behind the collection and analysis of data drive the direction of the research, as explained by Morse (2003) and Teddlie and Tashakkori (2011). Utilizing mixed-method research for analyzing study problems is the optimal approach as it provides a more comprehensive and conclusive evidence base than solely relying on qualitative or quantitative analysis. Esteemed scholars such as Bergman (2008), Morse (2003), and Teddlie & Tashakkori (2011) have established that combining both approaches results in a more profound understanding of research difficulties than using either approach alone. According to Thomas (2010), knowledge is inherently imperfect, yet ongoing inquiry causes knowledge to self-correct. Qualitative comprehension is a foundation for quantitative understanding, and the two can be corrected. Conversely, qualitative understanding can correct quantitative knowledge by highlighting potential avenues that have been overlooked. The philosophy that underpins mixed-method study design is pragmatism (Morse, 2003; Creswell & Clark, 2011).

### 3.4.8 Time Horizon

When it comes to when the research should be conducted, there are two main options. Cross-sectional or longitudinal designs are available. The pros and disadvantages of both options are presented in Table 3.5 below for comparison.

Table 3.5.

*Benefits And Drawbacks Of Cross-Sectional And Longitudinal Investigations*

| Time Horizon | Benefits | Drawbacks |
|---|---|---|
| **Cross-sectional design** | reasonably priced, and it requires minimal time to complete<br>One can confidently calculate the probability of achieving an intriguing outcome by sampling from the entire population.<br>It is possible to evaluate several results and risk variables.<br>There is no harm in continuing. | Making a causal conclusion is challenging.<br>Just a glimpse; if a different time or frame had been used, the circumstance might have produced different outcomes.<br>Prejudice is associated with prevalence and incidence. |
| **Longitudinal design** | useful for identifying trends<br>More data collected over extended time frames enables better and more precise results.<br>Very low validity | a deadline which is entirely contingent on the replies<br>The process of gathering all the necessary data takes a very long period. |

### 3.5 The Research Methods Used Throughout This Report

A conceptual framework was created in this study to support the implementation of an election ontology in Nigeria. This information technology artefact was created using the Design-Science research methodology. The research approach used to create the framework artefact, which was later validated, is described in this section.

Sections 4.3 and 4.4 will thoroughly cover the theory of the various options and tactics research could use during the study. After considering numerous options, the decisions taken for this research are shown below. The choices are described in narrative detail in the following paragraphs.

Table 3.6.

*Various Options And Tactics Research Used*

| Research Aspect | Research angle of choice |
|---|---|
| **Research Paradigms** | Design theory with pragmatism |
| **Research Approaches** | Inductive |
| **Research strategies** | Case Study |
| **Choices** | Qualitative |
| **Time Horizon** | Cross-sectional |
| **Data-collection tools and techniques** | Literature Review Observations |
| **Sampling** | Convenience sampling Purposive sampling |
| **Data triangulation and evaluation** | descriptive data analysis Content evaluation Review of academic publications |

### 3.5.1 The Study Philosophy

The two extreme and dominant perspectives are positivism and interpretivism (Creswell, 2013b). It is simple to see the main difference comparing the two tactics. A positivist method, on the other hand, solely assesses information from an objective standpoint, claim Guba and Lincoln (1994), whereas an interpretative approach analyzes knowledge from a range of perspectives. Instead of taking a positivist or interpretative stance, this study used a pragmatic approach combined with design-science approaches. The first paradigm used to frame this study is the pragmatism paradigm, which Peirce, James, Mead, and Dewey created (Jonker 2009). According to Guba and Lincoln (1994), the worldview of pragmatism is shaped by actual events,

actual situations, and actual results rather than by preexisting conditions. All competing realities and philosophical systems are welcome in the pragmatic philosophy. A realistic paradigm provides the intellectual basis for mixed-method studies. This approach involves utilizing multiple methods to address a research issue and gain a comprehensive understanding of the problem at hand. As a result, the researcher can select the study's methodologies, tactics, and procedures that best satisfy its goals and objectives (Teddlie & Tashakkori, 2011; Patton, 1990). The researcher combined this study's qualitative and quantitative methods using focus groups, questionnaires, findings, and expert opinions. The design-science paradigm guides this study, with the primary goal of producing an ICT framework (ontology) in the form of an artefact through a conceptual approach. Design science, as envisioned by Hevner et al. (2004), supports a pragmatic research paradigm that encourages the development of novel products to address contemporary issues. According to Hart and Gregor (2007), a significant and significant design-science research contribution must offer a brand-new artefact pertinent to its context and stuffed with new information. Some examples of these artefacts are buildings, models, frameworks, architectures, design theories, design principles, approaches, instantiations, and studies from Peffers et al. (2006) and Kuechler and Vaishnavi (2012).

### 3.5.2 The Research Approach

A semantic framework that was created for this study has the potential to be used to deploy election ontologies in Nigeria successfully. This study strongly emphasised having a thorough awareness of the situation being investigated; as a result, an inductive research methodology was used. The study gathered qualitative data to design and create the Nigerian semantic framework.

### 3.5.3 The Study Strategy

This research project aims to develop a robust semantic framework that can be utilized to execute electoral ontologies in Nigeria efficiently. This research considered the pros and cons of the existing voting process and an analytical structure for an election ontology. It also looked at the voting system today and its advantages and downsides. This study was forced to focus on a present occurrence: "elections" that did not demand supervision.

### 3.5.4 The Choice of Study

A qualitative technique approach was used in this investigation. This approach aims to reach reliable findings backed by evidence for a particular phenomenon (Saunders, 2011). It also examines problems that arise in the actual world and offers deeper insights into them. In addition to aiding in developing hypotheses, future research, and interpretation of quantitative data, the researcher could compare and validate the data confidently with this model's assistance.

### 3.5.5 The Time Horizon

Due to the researcher's restricted resources, including time and money, this study is cross-sectional.

## 3.6 System Development Environment

Methods and procedures for developing, testing, and debugging software or systems are gathered in a development environment. The development environment is a crucial problem, and a decision must be made by selecting the best environmental alternative for the customer from the various options accessible. As a result, the application will be a comprehensive program created using the SPARQL server as the back-end tool and OWL and RDF as the front-end method.

### 3.6.1 Front-end Development

Front-end web development involves using HTML, CSS, RDF, and JavaScript (JS) to create websites and online applications that are visually appealing and user-friendly. HTML is the fundamental markup language to structure webpages and create visual elements like tables, photos, and links. It allows for including hyperlinks, which direct users to other web pages. Web browsers interpret and display HTML files along with their content. CSS is a stylesheet language that determines the layout and appearance of web pages. It helps define a website's style, colours, and fonts, making it visually distinctive. CSS separates presentation from content, making it scalable, versatile, and accessible. JavaScript, a scripting language, is widely used for web-browser scripting, enabling dynamic interactions, content manipulation, and communication. It is also used in server-side scripting, coding, and software

development. JavaScript has syntax and features influenced by the C language but is distinct from Java. Together, these technologies empower front-end developers to create engaging and interactive web experiences for users.

The Web Ontology Language (OWL) is a Semantic Web language used to create knowledge representations known as ontologies. Ontologies help define interconnected networks and catalogues that form the basis of knowledge structures in various domains. In an ontology, verbs express relationships between items, while nouns represent classes of objects. Ontology models are commonly used to share data derived from multiple sources on the web. In contrast, class hierarchies tend to be more rigid, less diverse, and reliant on structured data sources such as corporate databases. OWL's semantics are based on the Resource Description Framework (RDF) standard developed by the World Wide Web Consortium. These tools have significant benefits for institutions, government agencies, and businesses.

### 3.6.2 Backend Selection

Back-end development tools integrate the work of front-end development and are in charge of server-side systematic logic processes. The database is designed using SPARQL as the backend. Semantic query languages include SPARQL, SPARQL Protocol, and RDF Query Language.

It has an RDF query language that can specify queries for datasets to manage and analyze data stored in the RDF format. It was created by the RDF Data Access Working Group (DAWG) of the W3C and handled linked data, one of the fundamental elements of the Semantic Web service. SPARQL varies from other DBMSs in several respects, as will be covered in the following sections.

A SPARQL query may include aggregates, graph patterns, triple stores, and optional parameters. There are numerous programming language implementations. ViziQuer, for example, allows users to link SPARQL searches to their SPARQL endpoint and semi-automatically generate them.

Additionally, solutions exist for converting SPARQL query information into several query languages, including SQL and Mysql.

A dataset management system used in the semantic web is called SPAROL. SPARQL enables querying of RDF and Linked Data. SPARQL software is available for free. Fast, dependable, and user-friendly SPARQL database servers are available.

Client/server and embedded systems are compatible with SPAROL Server. There is a sizable selection of SPARQL software available.
Numerous other significant and well-known websites, including Wikipedia, Dtpedia, Amazon, Google (for search maps), and portals for open government data, also employ SPARQL.

### 3.7 System Requirement Specifications

When creating semantic web services for data linked to the government, specific hardware and software requirements should be met regarding software development. Even the least complex system has specific criteria for creating that particular program, albeit the complexity of the system affects how many there are.

#### 3.7.1 Hardware Requirement

Every system is made up of components that are combined to function as a single entity to accomplish a common objective. The following hardware devices are necessary for the system's implementation:

Client Machine:

| | |
|---|---|
| Processor | : Single Core (1.4 GHz) of CPU |
| Monitor | : SVG Color Monitor |
| Memory | : At least 1GB of RAM |

Server Machine:

| | |
|---|---|
| Processor | : Core 2 Duo of CPU |
| Monitor | : SVG Color Monitor |
| Memory | : At least 2GB of RAM |
| Free space | : 10 GB and more |

#### 3.7.2 Software Requirement

The system will also require software to develop the plan:

- Operating system: Windows 7 is one of the popular operating systems as it is secure, provides many features, and is more responsive than other Windows.

- Database: SPARQL is used as a dataset as it is simple to maintain and retrieve datasets by the effortless syntax that is simple to read and write.
- Development environments and Programming language: The website's code is HTML and CSS. Moreover, JavaScript is utilized for styles and behaviour, and RDF and OWL for server-side programming.

The following software must be installed on the computer system to implement the new stem effectively

Client Machine:

| | |
|---|---|
| Operating System | : Windows 7 and Higher |
| Dependencies | : JavaScript |
| Browser | : Edge/Explorer, Google Chrome, or Firefox |

Server Machine:

| | |
|---|---|
| Database | : BerkelyDB (rdflib plugin) |
| Dependencies | : JQuery, Rdflib |
| Ontology Model | : Protégé 5.5.0 Editor |
| Web Server | : PythonAnywhere (flask) |

# CHAPTER IV

# System Architecture, Analysis and Design

## 4.1 System Analysis and Design

The terms "analysis" and "synthesis" find their roots in the ancient Greek language, signifying "to take apart" and "to put together" correspondingly. These expressions are employed in various scientific fields, ranging from mathematics and logic to economics and psychology, to represent similar investigative techniques. "Analysis" denotes "the methodology used to break down a mental or substantial entity into its components." At the same time, "synthesis" means "the methodology used to integrate separate parts or elements to form a coherent entity" (Wikipedia contributors, 2023a). Experts in system analysis employ a procedure to examine the dynamic systems, culminating in an overall impression. System analysis facilitates direct involvement in a project instead of regarding it as a mere module. This ensures the precise execution and evaluation of the project. Once the project is completed, the developer offers a trial to the customer. If there are any problems, it is crucial to address them. System analysis is concerned with the examination of the system domain in order to appreciate the problem at hand properly. It entails gathering and analysing data, detecting issues, and breaking down a system into its constituent parts. System analysis is done to examine a system or its components and determine the goals of the system. It is a strategy for addressing problems that improve the system and ensures that all parts function effectively to serve their intended purposes (System Analysis and Design - Overview, n.d.).

According to (System Analysis and Design - Overview n.d.), designing a new business system or updating an old one includes specifying its components or modules to meet the necessary criteria. Before making any plans, it is essential to understand the current setup and decide how to make the most effective use of computers. According to Wikipedia authors (2023b), system design might be considered the application of system theory to product creation. System analysis and design refer to investigating a business problem to resolve it by implementing better procedures and practices. System analysis and design are connected to organizational shape, performance improvement, and achieving objectives for profitability and growth. The

emphasis is on how systems work, subsystems interact, and how each helps accomplish a common goal. System analysis involves looking at a system to see how well it functions, what changes must be made, and the calibre of the output. The primary goals of the activities are to gain a thorough understanding of the current system, its advantages and disadvantages, and the justifications for restructuring, replacing, or automating it. It is the procedure of gathering and analyzing data, determining the issues, and breaking down a system into its constituent parts, such as risk planning and cost estimation. The project analyst often organizes it. The system that is recommended aims to develop a plan for better amenities. The proposed method can overcome all the shortcomings of the present setup and reduce the time required for online voting services.

### 4.1.1 Existing System

Semantic web technologies provide the fundamentals for exchanging knowledge and information to coordinate business activities. However, INEC's expansion utilizes the ability to connect community involvement, and there is an essential requirement to consider the use of integrated network infrastructure in public service and provide citizens with government services stored in these various systems due to the lack of interoperability. Despite the lack of compatibility in the current system, semantics is expected to improve from the new approach. The manual data processing approach shows several issues, including:

- The amount, variety, and complexity of records that must be retained are frequently too tremendous for manual processing.
- The manual collecting of data involves a large workforce, a lot of time and energy, much travel, and much physical power.
- Daily, several operational and record maintenance steps must be completed.
- Manual computation is required.
- Information may be lost when records are taken, misplaced, or defaced. consumes a significant amount of papers
- Human mistake is a common cause of inaccuracies in manual record-keeping.
- Absence of a single information hub.
- Difficult to extract contents.
- Not the best structure for SEO.

- Navigation and orientation challenges.

Information interlinking is impossible in the current system due to a lack of integration capability. To get beyond all these restrictions and increase the accuracy of the process, the design must be online and automated. Ontology and semantic web services can address the issues the existing system is now experiencing.

### 4.1.2 Proposed System

When creating semantic web services for data linked to the government, specific hardware and software requirements should be met regarding software development. Even the least complex system has specific criteria for creating that particular program, albeit the complexity of the system affects how many there are.

For INEC, the newly suggested system attempts to put into practice a semantic electoral ontology. While offering adequate protection, the method reduces physical effort. There are several issues and operational difficulties with the existing approach. The recommended method tries to eliminate or significantly reduce these difficulties. The suggested will offer integrated network infrastructure for INEC and would promote transparency and perform public services. The current state of e-government is rife with several serious flaws and deficiencies. In a system with less production, a significant difference frequently occurs.

While gathering requirements, we identified some problems with the manual method (current system). Among these were the following problems:

- Papers and pen technique: The traditional approach is primarily manual.
- Data on elections and the electoral process operations are not systematic.
- Information Accuracy: The outdated manual and systematic procedures, in particular, make it easier for information to be incorrectly kept (managed).
- Redundant data: Locating information or specifics on a person in numerous locations is straightforward. Unorganized information processing is attributed to errors, incorrect datasets, and repetitive datasets from several data sources.
- Making decisions: The efficacy of the current system is poor, and decision-making is frequently drawn out.

The new approach is simple for connected data and semantic web services. The system requires weak standards, which it will accept in readily usable formats. The following are provided:

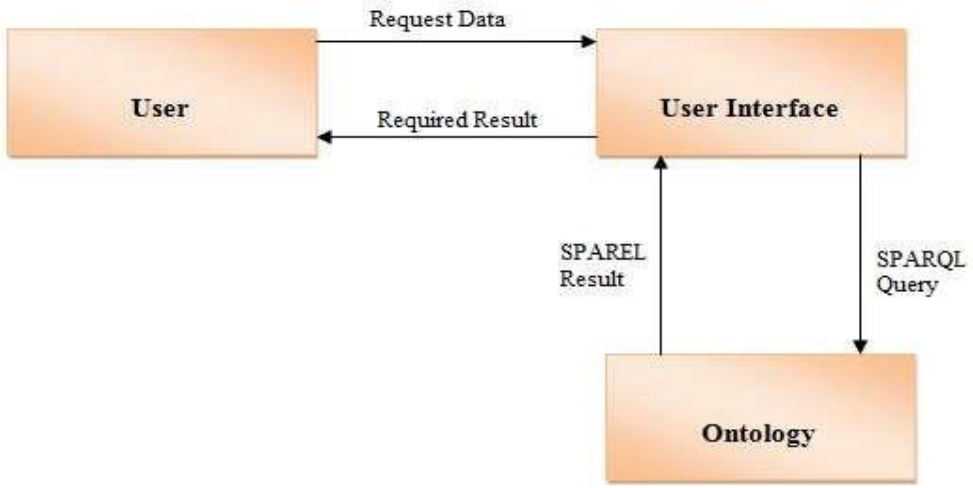
- Reduce manual data access as much as possible.
- The processes that take the fewest steps in time.
- Enhanced performance and better customer service.
- Friendly to use and interactive.

## 4.2 System Architecture

The ontology language has a few benefits. Semantic Web tools and technologies demonstrate the benefits of this research project's constructed semantic search engine. Figure 5.1 below provides a broad overview of the system structure.
The fundamental structure of our semantic system is seen in Figure 4.1. Protege editor, Python, Flask, rdflib, Jena APIs, and SPARQL queries to retrieve data from ontologies are the technologies we have utilized in our work. We constructed the Semic Web Portal Ontology in Protégé 5.5.0, containing all our information. To connect with our ontology and extract data from it, we utilized Python and rdflib programming languages. The data from the university is loaded into our Flask application using, rdflib, SPARQL queries. All the information is saved in the user ontology once the user has finished the search.

The electoral system includes data about voters, candidates, actors, electoral officers, electoral processes, and political positions. The data is kept in an owl file made using the Protégé editor.

Figure 4.1.
*Architecture Of The Proposed System*



The system's main component is an internet-based user interface for accessing material saved in RDF format and arranged according to an electoral ontology. Using an RDF file created with the defined election ontology, the system interface pulls all the data it displays from this file. The processed ontology is used to recover data for various data on the department's lectures, courses, and other pertinent data. The Independent National Electoral Commission is the targeted domain, and its websites were used to collect the data and information.

The university ontology is being processed using rdflib. Utilizing a connection to a rdf BerkeleyDB plugin, the interface retrieves the crucial data from this model. The Web interface is a separate module that connects to the rdflib model to recognize client data and display information obtained from the model.

In terms of utility, the web interface offers a natural and easy-to-use interface that enables users to browse the system and provides search capabilities to quickly locate what they are looking for in light of a particular specification.

# CHAPTER V
# Implementation and Evaluation

## 5.1 Domain of the System

The Independent National Electoral Commission (INEC) was the primary subject of the study, and the researchers sought to gather facts and figures from INEC's websites. This was accomplished by creating an electoral ontology, a formal definition of a common understanding of the election domain. Concepts including election dates, candidates, political parties, results from polling places, and other related concepts were all included in this ontology.

The Protégé Ontology Editor, a program for editing and maintaining ontologies, was used by the researchers to manually add items from INEC's web pages and other sources to the electoral ontology once it had been created. They gathered and arranged the crucial information for their research from INEC's websites by adding entries in a disciplined and methodical manner.

The researchers could easily add and modify ontology entries using the Protégé Ontology Editor and establish connections between various ontology elements. The data was then easily accessible for retrieval and analysis thanks to the database where the ontology entries had been saved.

## 5.2 Storage and Representation of Information

The core domain of the system is the Independent National Electoral Commission (INEC), and an ontology is used to describe the information it contains. Elections are the subject matter of this particular ontology, which is a formal definition of a shared conception of a domain.

The researchers developed an electoral ontology file to keep track of all the data about INEC, including its attributes, subcategories, and connections. This document included details on candidates, polling unit results, other relevant ideas, and all the links between these concepts.

To create and update the electoral ontology file, the researchers utilized the Protégé Ontology Editor. A database was used to hold the ontology file, making accessing and evaluating the information simple. It also made it simple for users to alter already-existing relationships and build new ones.

The researchers developed an organized and orderly method of arranging the data by representing INEC and its content using an ontology. Thanks to this, they could do a more thorough analysis of the data, which gave them access to insights they would not have otherwise.

### 5.3 Ontology Language

In order to create the electoral ontology, the OWL ontology language was employed. In juxtaposition with various ontology-building languages, this language was chosen since it is currently the most competent and reliable ontology language available. OWL, or Web Ontology Language, is a powerful language utilized to create ontologies, which are systems that define knowledge and data in an organized, ordered manner. It offers an effective tool for data analysis and reasoning while enabling the construction of intricate links between ideas. It is simpler to exchange and reuse ontologies across many applications and domains because of OWL's standardized syntax and semantics, which is one of the advantages of utilizing it. OWL is also intended to be scalable, easily accommodating large and complicated ontologies.

### 5.4 Ontology Processing

We processed the ontology data using the RDFLIB model to make communication with end users more accessible. With this model's help, they could access the ontology using SPARQL queries, a potent tool for exploring and modifying RDF data. The ontology data could be accessed using the RDFLIB model, and SPARQL queries could be run against it. This enabled the researchers to extract specific data from the ontology and provide it to end users helpfully. The model then returned the queries' responses as RDF data, which could be processed and examined further.

## 5.5 Web Interface

In the project's context, an interface was developed to offer a user-friendly manner to search and retrieve the data in the ontology. An interface consists of menus or instructions that lets users communicate with software. It enables the end user to configure the machine's visual interface as well as navigate through all of its menus and settings. Thanks to the interface's user-friendly design, users can construct queries with various criteria to search for certain information inside the ontology. This allowed important information and insights to be extracted from the vast data recorded in the ontology without needing specialist knowledge or technological competence. The system's visual appearance may also be adjusted with an interface, making it more approachable and user-friendly. Users could browse the system and get the information they wanted with little effort because of the interface's clarity and intuitiveness.

## 5.6 Application Development Platform

Commonly used technologies like HTML and CSS create the system's interface. HTML is a widely accepted markup language utilized to create pages meant to be viewed in internet browsers. On the other side, CSS is a style sheet language that is used to indicate how a piece of code written in a markup language such as HTML or XML should be displayed. The layout and design of the menus, search interface, and other system components, as well as additional visual aspects of the system, are handled by HTML and CSS technologies. Users may navigate through the menus and conduct searches based on various criteria thanks to the system's user-friendly interface, which is made possible using HTML and CSS.

## 5.7 System Design

The RDFLIB model, the interface, and the election ontology are the three essential parts of the search system application created for this research project. The search system application is based on the election ontology, which also serves as the principal repository for all the data that the system uses. The program uses election ontology as its central data resource. The developed ontology file contains all the data,

including all the attributes, categories, and connections related to INEC. Ontology processing and end-user communication are the responsibilities of the RDFLIB model. The interface controls how the system is visually presented and enables users to navigate the application's numerous menus.

According to the creator, RDFLib is an authentic Python tool for creating and manipulating RDF. RDFLib offers most of the tools you'll need to work with. A graph-oriented interface featuring repository models for in-memory, tenacious on-disk (Berkeley DB), and remote SPARQL endpoints that different store implementations may provide access to the election ontology, the RDFLib model will be ready to respond to requests from the system interface.

All interface responsibilities include receiving client data, generating demand data, and sending acceptable data or messages to the RDFLib model. The client's interaction with the RDFLib model is facilitated by the HTML/CSS language used as the interface. The interface solely comprises making queries to the RDFLib model and receiving responses or feedback in the form of an HTML-formatted page. It does not maintain any data.

## 5.8 The Election Ontology

An OWL ontology named Election Ontology was created to organize data regarding the Independent National Electoral Commission. The elements that make up the constructed ontology are as follows.

### 5.8.1 Classes and Class Hierarchy

Figure 5.1 displays the election ontology's classes and class hierarchy. Compared to ontologies that revolve around the current knowledge repository in education, the number for classes might not be as large. This is because constructing an ontology relies on the developer and how far they want to go. The categories of academic ontology are listed below.

- Accreditation and Voting Procedures at Election: This lesson outlines the procedures for registering to vote and participating in an election.
- Actors: it shows information about the actors involved in an election.
- Candidates: it shows the information about all contesting candidates.

- Collation of Election Result and Making of Return describes the procedure of collating results and making election returns.
- Election Collation Levels: it gives information about the levels at which an election is collated.
- Electoral Officers: it gives information about electoral officers and their roles.
- Geopolitical Zones: it gives details about the zones in Rivers State.
- Political Party: it gives information about Political Parties and their structure.
- Political Position: it describes the Political Position candidates can contest for.
- Procedures: it identifies procedures on how to vote and confirm polling unit location.
- Voters: information about voters in an election.

In the figure below, the classes involved in this research are depicted.

Figure 5.1.

*The Hierarchy Of Classes From The Election Ontology Shown In Protégé*

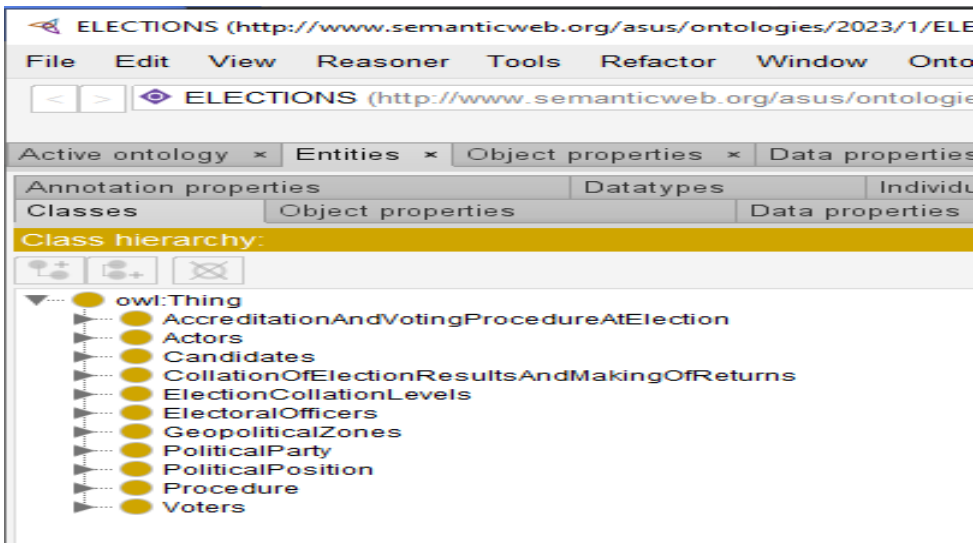


Figure 5.2.

*The Election Ontology Class Hierarchy Is Represented Using Owlviz Using Protégé.*

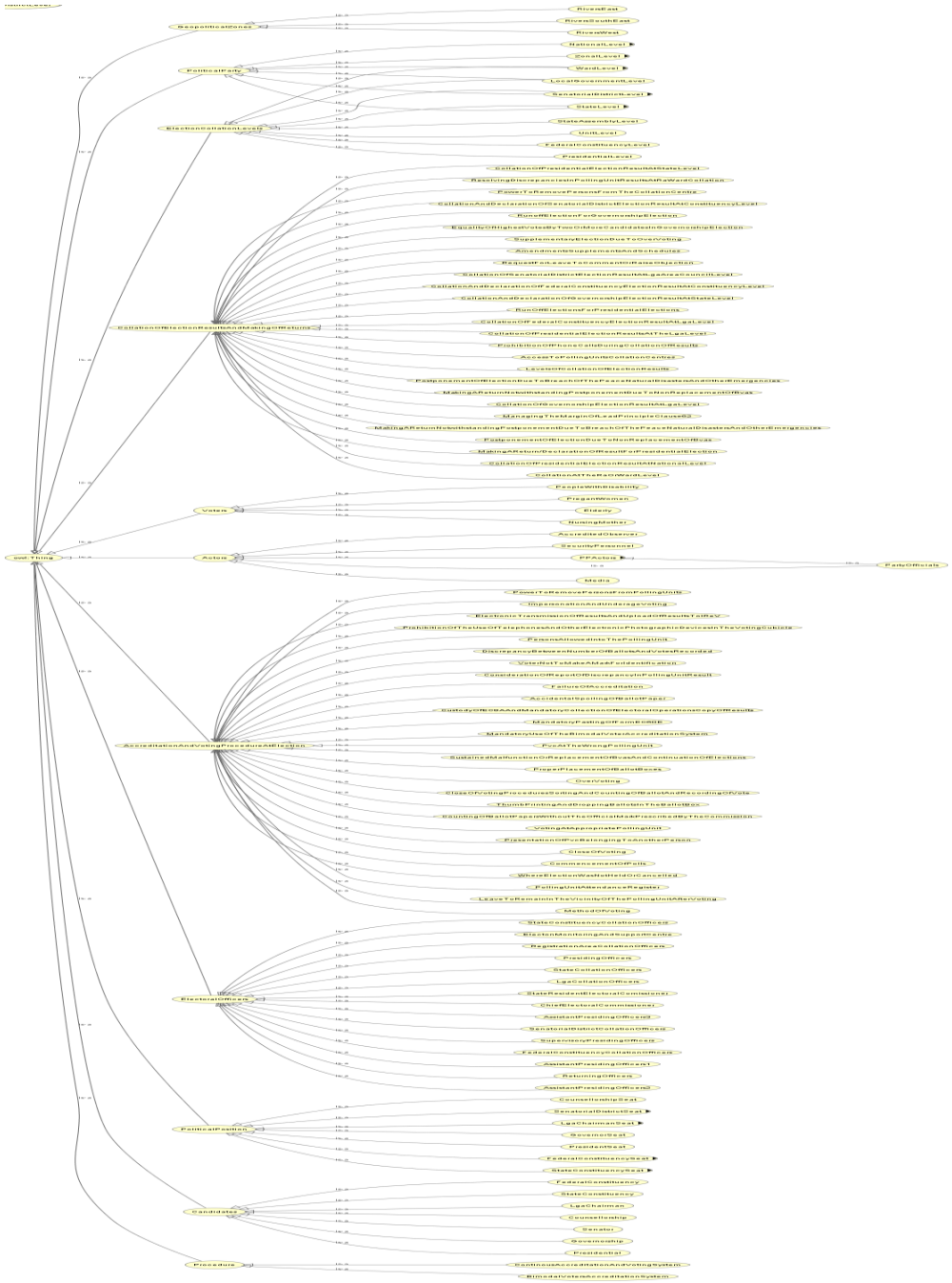


Figure 5.3.

*Leveraging Protégé, Owlviz Represents The Voting Class Hierarchy's Accreditation And Voting Process*

Figure 5.4.

*Owlviz Representation Of Actors Class Hierarchy Using Protégé*

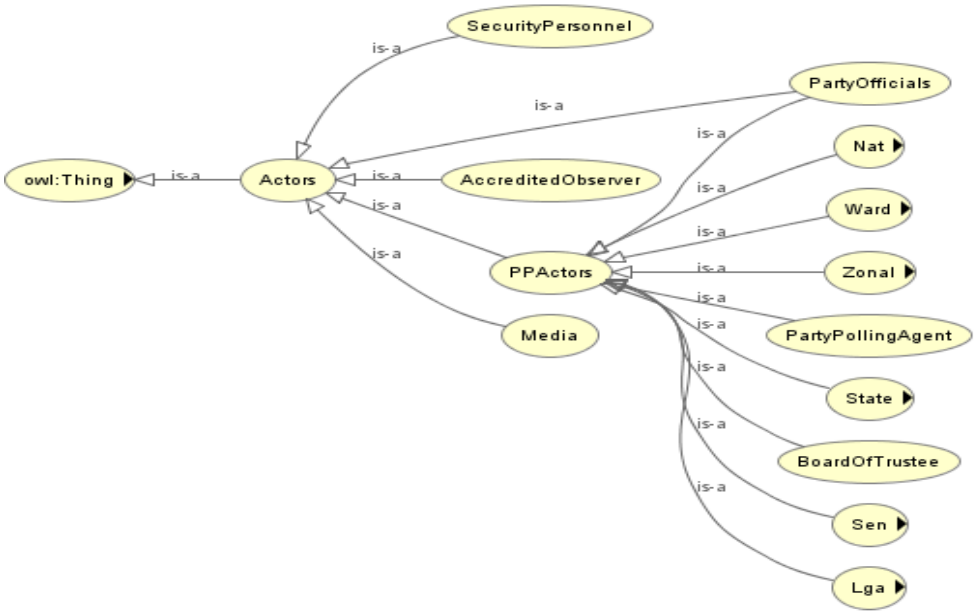



Figure 5.5:

*Candidate Class Hierarchy Is Shown By Owlviz Using Protégé*

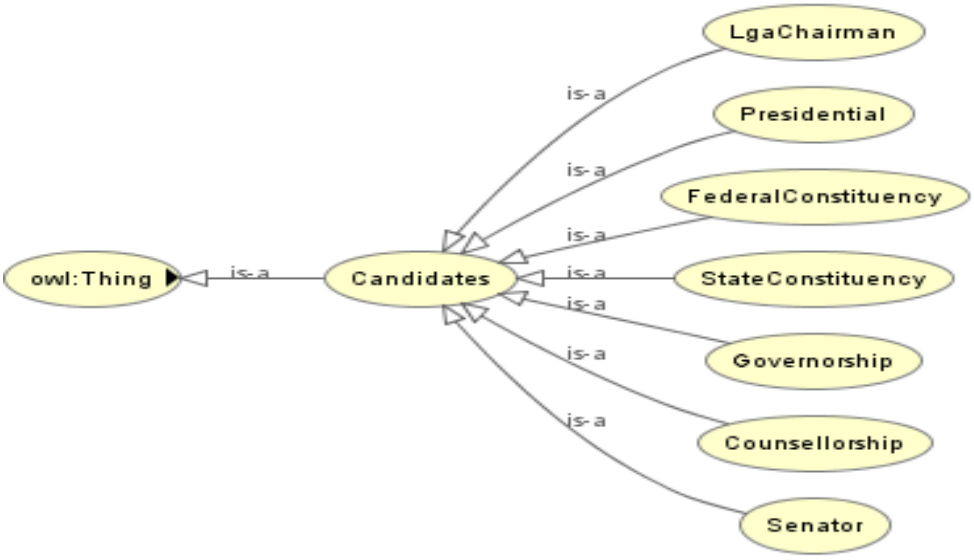


Figure 5.6.

*Owlviz Representation Of The Collation Of Election Results And Making Returns Class Hierarchy Using Protégé*

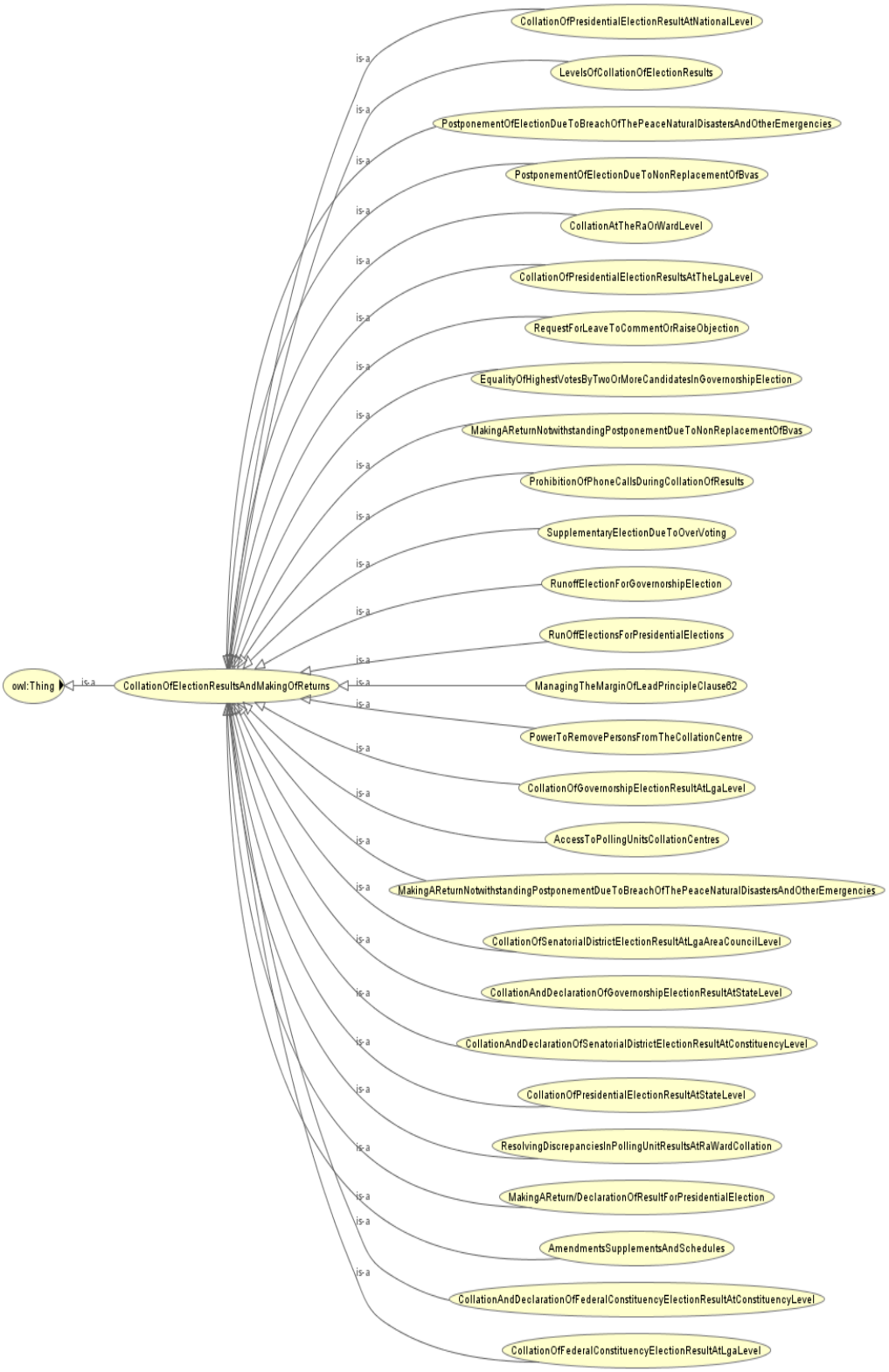


Figure 5.7.

*Employing Protégé, Owlviz Presents The Election Collation Levels Class Hierarchy.*

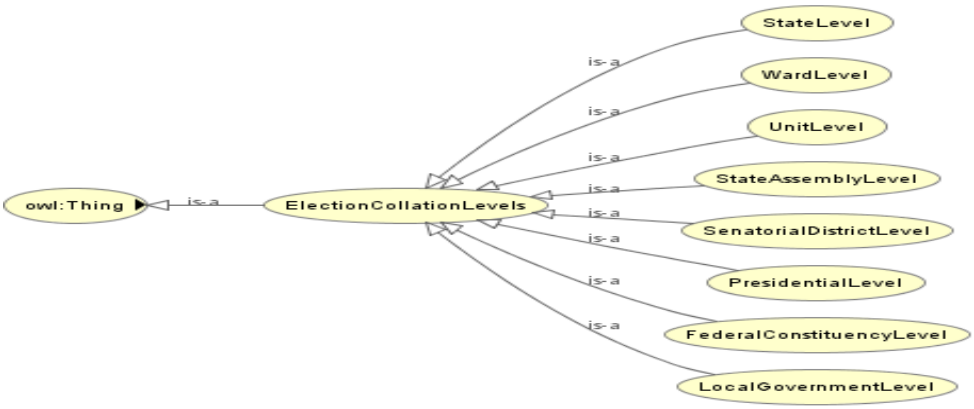



Figure 5.8.

*The Class Structure Of Electoral Officers As Shown By Owlviz Using Protégé*

Figure 5.9.

*The Class Structure Of The Geopolitical Zones Is Represented Using Owlviz By Protégé.*


Figure 5.10.

*Utilizing Protégé, Owlviz Depicts The Class Hierarchy Among Political Parties.*

Figure 5.11

*Using Protégé, Owlviz Depicts The Political Position Class Hierarchy.*

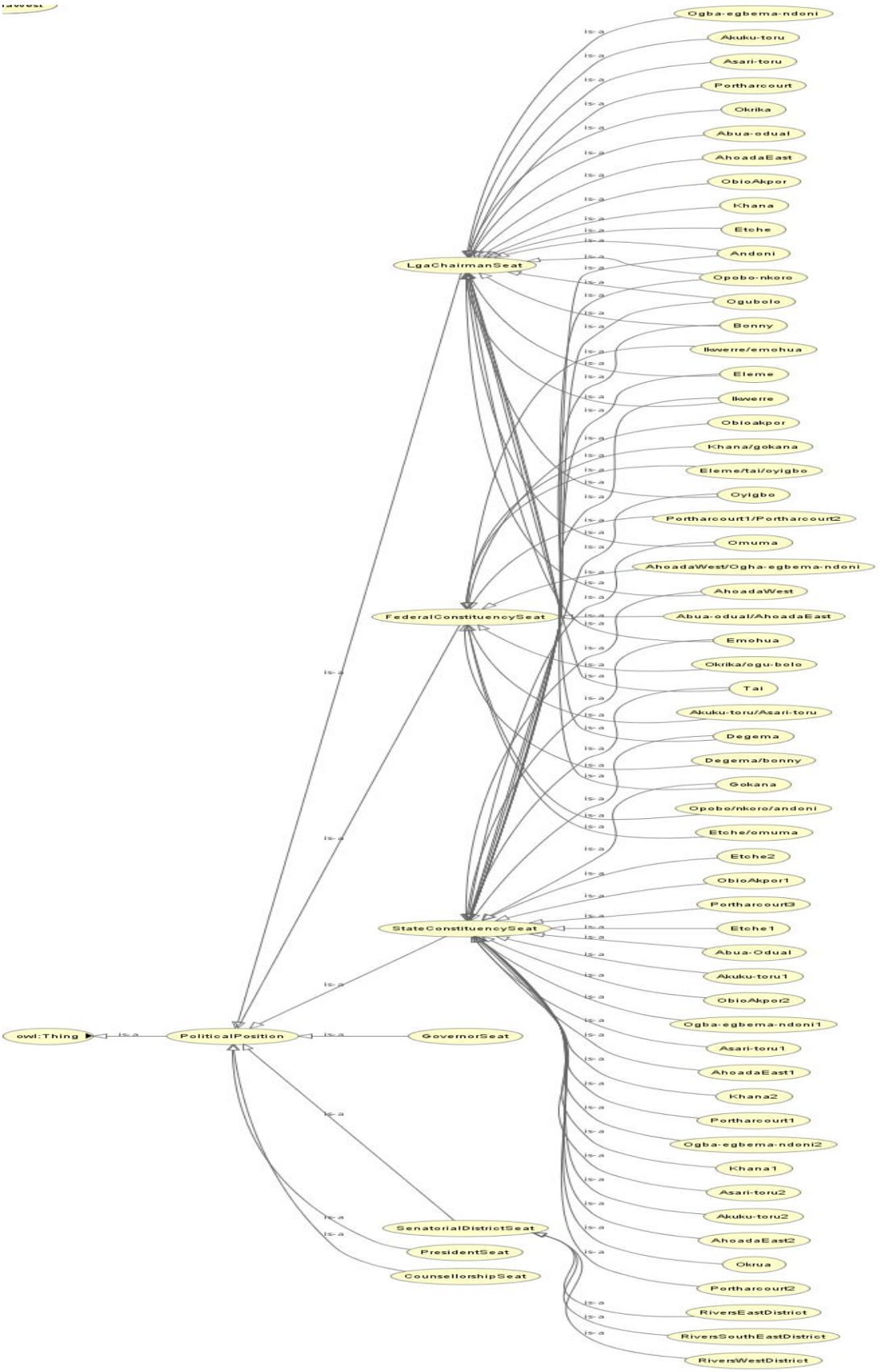


Figure 5.12.

*Utilizing Protégé, Owlviz Represents The Hierarchy Of The Procedure Class.*

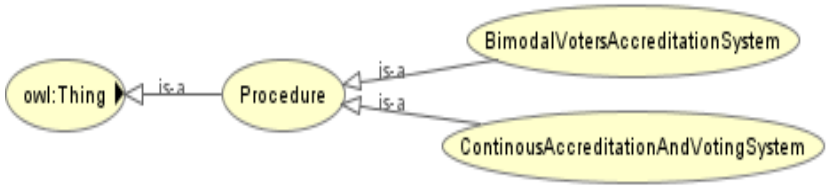
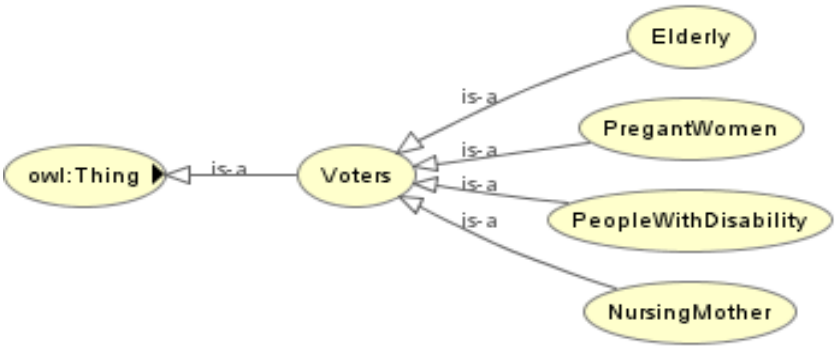



Figure 5.13.

*Utilizing Protégé, Owlviz Depicts The Voters Class Hierarchy.*




### 5.8.2 Object Properties on Ontology

In Figure 5.14 below, you will see a list of the object characteristics utilized in this project. Linking two people together are object attribute. Range and domain are defined for object attributes. Figure 4.3 illustrates the many object attributes employed in the Election ontology. Some of them are reciprocal to one another. Below is a screen capture demonstrating the usage of a few of the different object attributes.

Figure 5.14.

*The Election Ontology Object Properties*

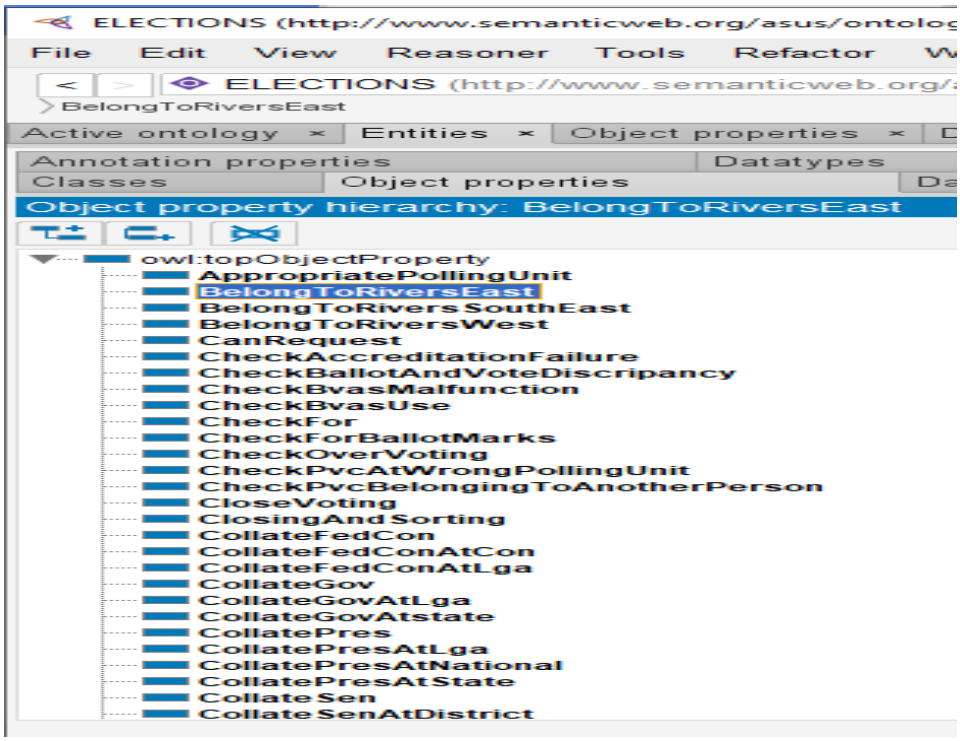



Figure 5.15:

*The election ontology Object properties.*

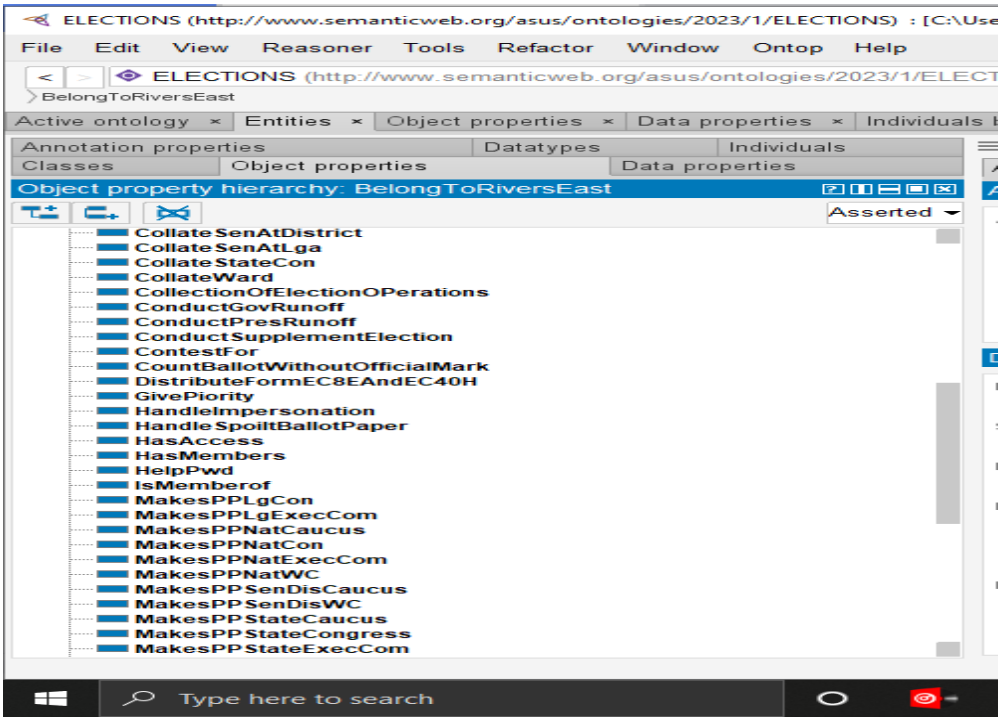


Figure 5.16.

*The Election Ontology Object Properties.*

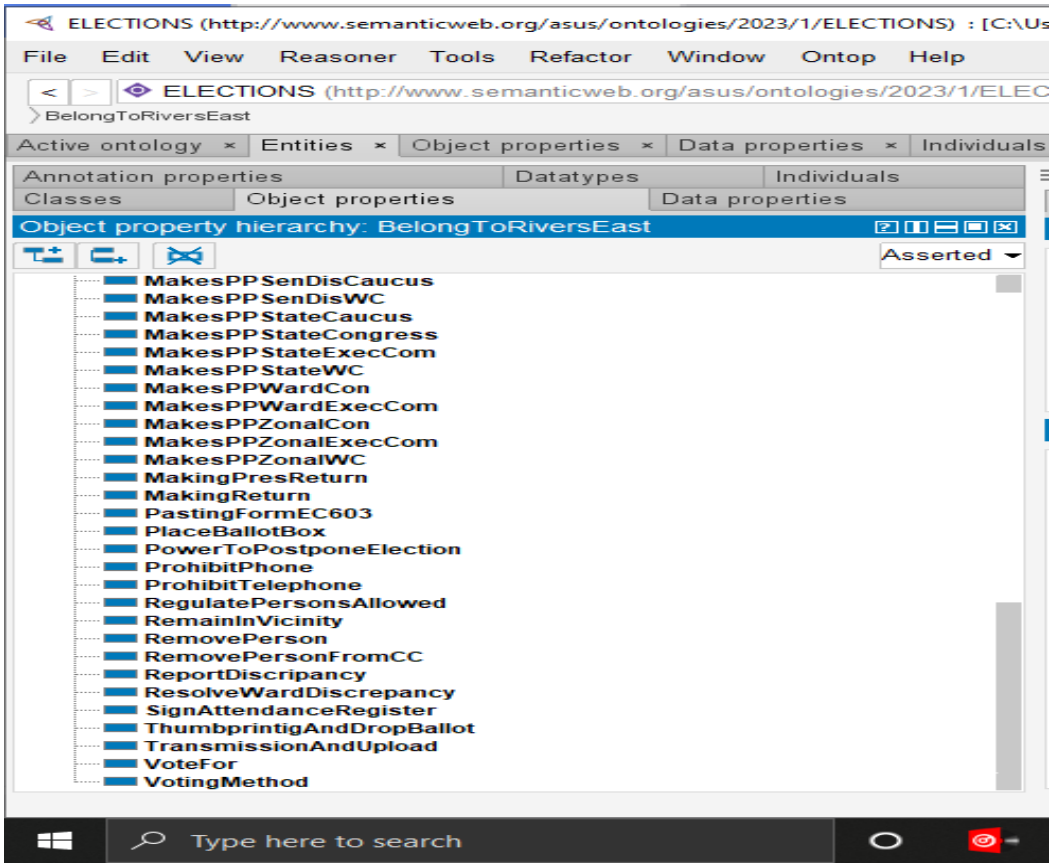



Table 5.1

*Some Object Properties*

| **Property Name** | **Domain** | **Range** |
|---|---|---|
| AppropriatePolling Unit | VotingAtAppropriate PollingUnit | BimodalVotersAccreditationSyst em |
| BelongToRiversEas t | Voters Candidates | RiversEast |
| BelongToRiversSo uthEast | Voters Candidates | RiversSouthEast |
| BelongToRiversWe st | Voters Candidates | RiversWest |
| canRequest | PartyPollingAgent | RequestForLeaveToCommentOr RaiseObjection |

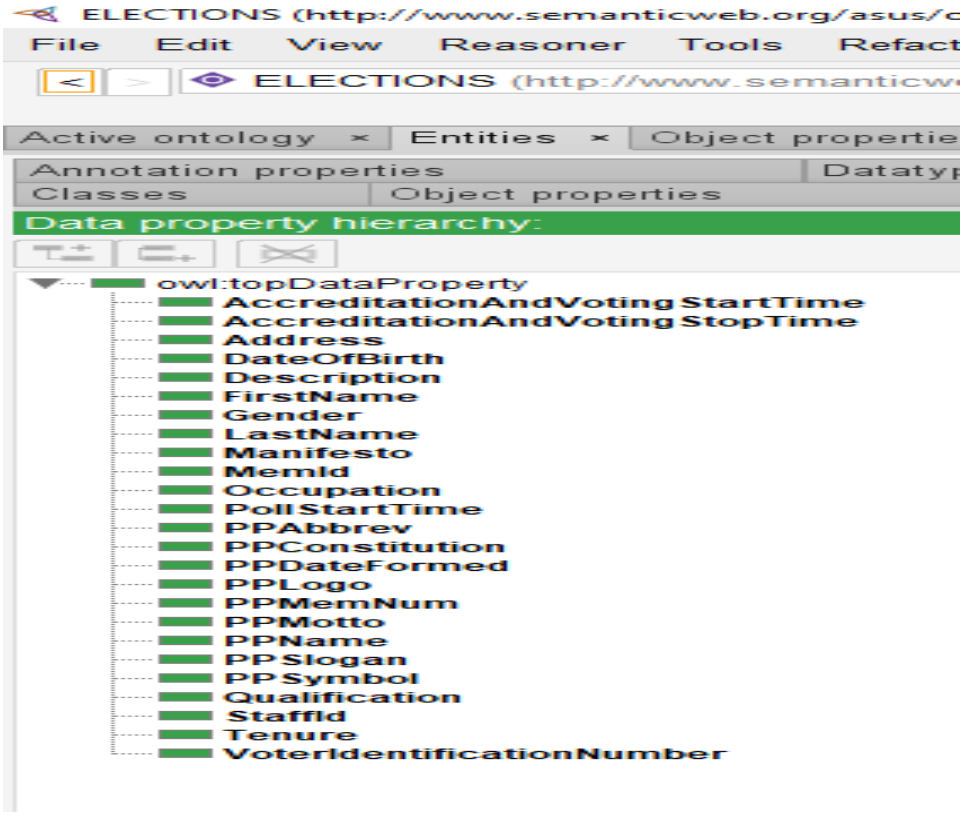
| | | |
|---|---|---|
| CheckAccreditationFailure | AssistantPresidingOfficers1 | FailureOfAccreditation |
| CheckBallotAndVoteDiscripancy | RegistrationAreaCollationOfficers PresidingOfficers | DiscrepancyBetweenNumberOfBallotsAndVotesRecorded |
| CheckBvasMalfunction | SupervisoryPresidingOfficers ElectonMonitoringAndSupportCentre | SustainedMalfunctionOrReplacementOfBvasAndContinuationOfElections |
| CheckFor | RegistrationAreaCollationOfficers, PresidingOfficers | WhereElectionWasNotHeldOrCancelled |
| CheckForBallotMarks | AssistantPresidingOfficers2 | VoterNotToMakeAMarkForIdentification |
| CheckPvcAtWrongPollingUnit | AssistantPresidingOfficers1 | PvcAtTheWrongPollingUnit |
| CheckPvcBelongingToAnotherPerson | SecurityPersonnel | PresentationOfPvcBelongingToAnotherPerson |
| CloseVoting | PresidingOfficers | CloseOfVoting |

### 5.8.3 Data type Properties

Data attributes play a significant role in ontologies. To retain a given data value, data type features are utilized, such as adding the attributes FirstName, LastName, Memid, location, and so on. On the other hand, object attributes create relationships between two classes, or, to put it another way, they connect two individuals. Several data type features, which are depicted in Figure 5.17 below, are used in this study.

Figure 5.17.

*The Election Ontology List Of Data Type Properties.*




### 5.8.4 Individual

With the use of the protege ontology editor, individuals are manually inserted. RDF data from the INEC website may be automatically retrieved using this. The figures below, 4.5 and 4.6, respectively, are examples of an electoral process. However, it should be mentioned that generating the instances took time. Semantic web expertise is required, for instance, in construction. We will either incorporate screen scrapers or instance generation into the UI for creating websites in the future.

Figure 5.18.

*Instances of Collation Of Election Results And Making Of Returns*


Figure 5.19.

*The Instances of Political Parties*

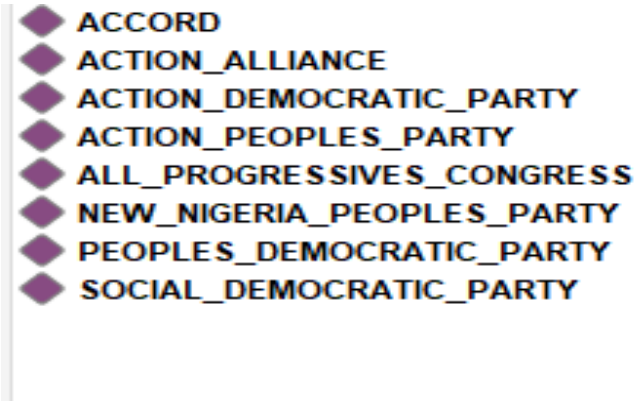
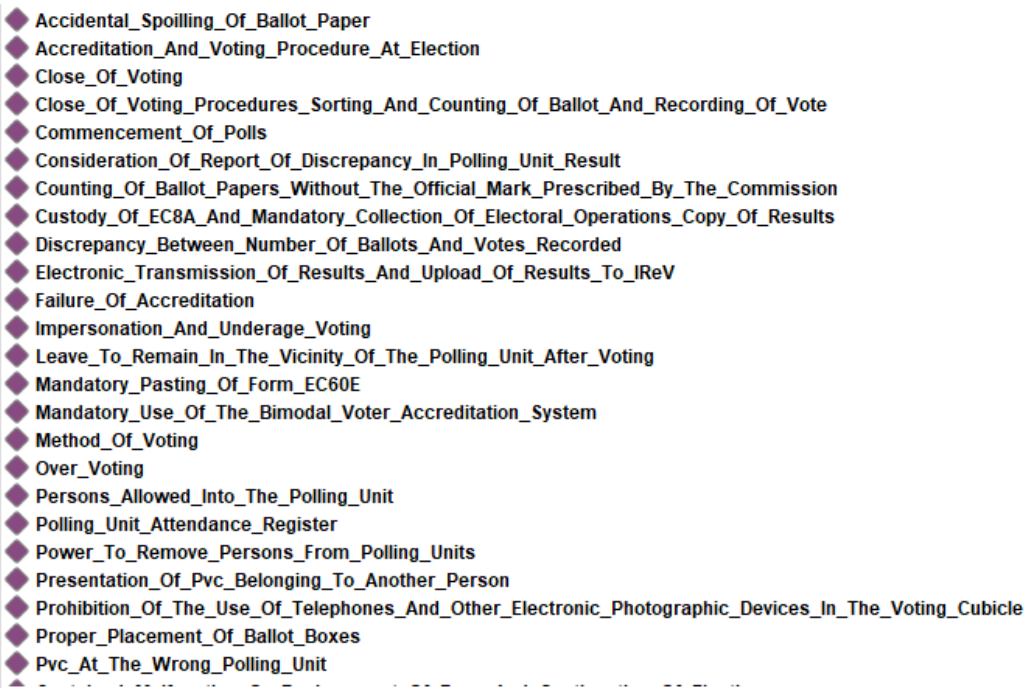


Figure 5.20.

*Instances of Voters*


Figure 5.21.

*Instances of Accreditation And Voting Procedure At Election.*




## 5.9 Ontology-based Search Engine

The web application for the ontology-based search engine was created in Python using the Flask framework. When addressing election-related queries, the programme uses the **election.owl** ontology. The following features of the application:

- Search for instances of a class
- Search for subclasses of a class
- Search for instances using a free text search

### 5.9.1 Search for Instance of a Class

To search for instances of a class, click on the relevant link from the home page. For example, if you want to search for PoliticalParty instances, click the "Search Political Party" link. Enter your search query in the form, and click "Search". The application will return a list of instances that match your query.

### 5.9.2 Search for Subclasses of a Class

To search for subclasses of a class, click on the link from the home page. For example, if you want to search for subclasses of PoliticalParty, click on the "Search Political Party Subclasses" link. The application will return a list of subclasses of PoliticalParty (this functionality is used to load data prior to the initiation of user search to give the user all classes and subclasses for searching).

### 5.9.3 Search for Instances Using a Free Text Search

To search for instances using a free text search, enter your search query in the form on the home page and click "Search". The application will return a list of instances that match your query.

## 5.10 Application Development (Functions and Classes)

We are utilizing the rdflib berkelyDB plugin for permanent storage. First, the application creates persistent databse for ontology triple store or establishes a connection if it already exists (Configuration.py). In each endpoint, the application receives a request from the front end and builds a query for the received input using **Queries.py (**which returns the SPARQL query). The SPARQL query is then passed to **Executer.py** to fetch results from the triple ontology store.

Three functions are then defined to use SPARQL queries to extract data from the database. **GetClasses**, **GetClassReuslt,** and **GetFreeTextResult,** are three functions that pull data from the database in response to various query types. These procedures accept a query parameter, run the query against the ontology database, extract and format the pertinent data, and then return the findings.

Processing a request for the Flask application is done using the following collection of functions. Request and _class are the two arguments that the process function requires. In order to extract results from the database, it receives the form data from a POST request and gives it to the **getClassReuslt** method. The getClasses function also obtains a list of classes associated with the class argument. A list of these two sets of outcomes are returned.

The index.html template, the application's home page, is defined to be rendered via the index endpoint.

When a POST request is made, the endpoint gets the request string and sends it to the **getFreeTextResult** function, which uses it to extract database results from a free text query. The outcomes are shown on the page. Each of the following endpoints (q1–q10) is defined.

Each endpoint uses the process function to retrieve the necessary results from the database and then passes those results to the appropriate HTML template for display on the website.

This Python script provides a Flask application that establishes a connection to an ontology database and extracts data to provide information in response to questions about an election scenario.

## 5.11 Snapshot of the System

### 5.11.1 Free Text

Once the user inputs their query, they can initiate the search process by clicking the search button (figure 5.22). The system then processes the query and searches the ontology to retrieve instances that match the user's input. The search results are then presented to the user in a format that is easy to understand and navigate (figure 5.23). This may include a list of instances that match the search query and additional information about each instance, such as its properties, relationships to other instances, and other relevant details.

When a user clicks on an instance, the application will redirect them to a new page that contains further details related to the selected instance. These details could include information about the instance's properties, relationships to other instances, and other relevant information associated with it (figure 5.24). In order to facilitate easy navigation, the application provides a Back button at the bottom of the page. By clicking on this button, users can quickly return to the previous page they were on, allowing them to continue their exploration of the ontology.

This functionality is designed to make it easier for users to delve into the details of specific instances within the ontology, providing a more in-depth understanding of its knowledge. It also ensures that users can easily navigate back and forth between different pages within the application, making the user experience smoother and more intuitive.

Overall, this functionality provides a user-friendly and intuitive way for individuals to search for specific instances within an ontology, making it easier to explore and understand the information contained within the ontology.

Figure 5.22.

*Home Page And The Free Text Search.*

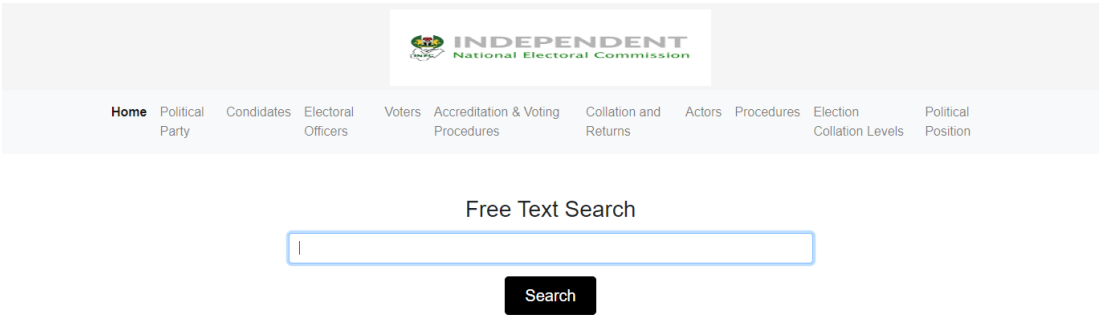


Figure 5.23.

*Result Of Searching The Text "Action".*

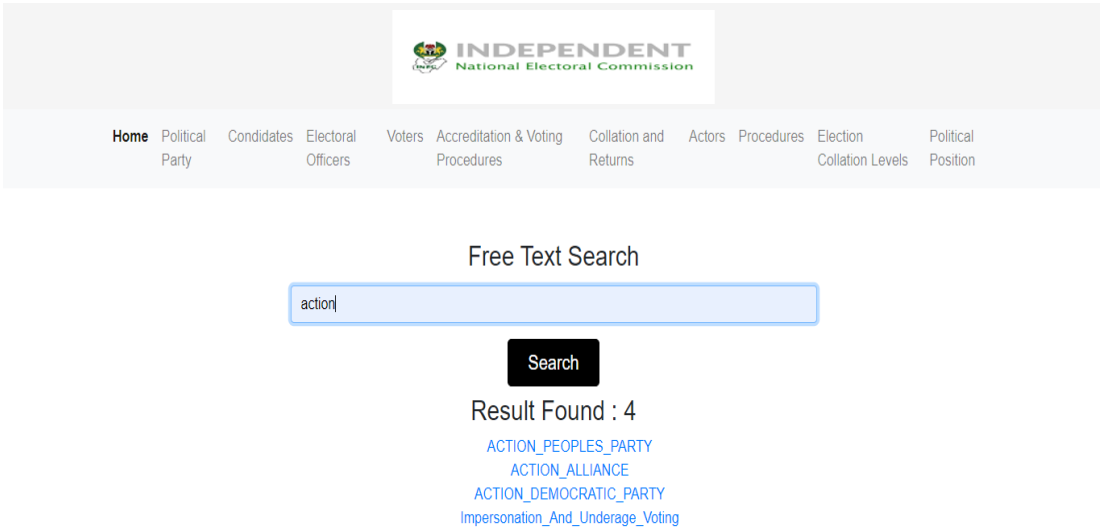
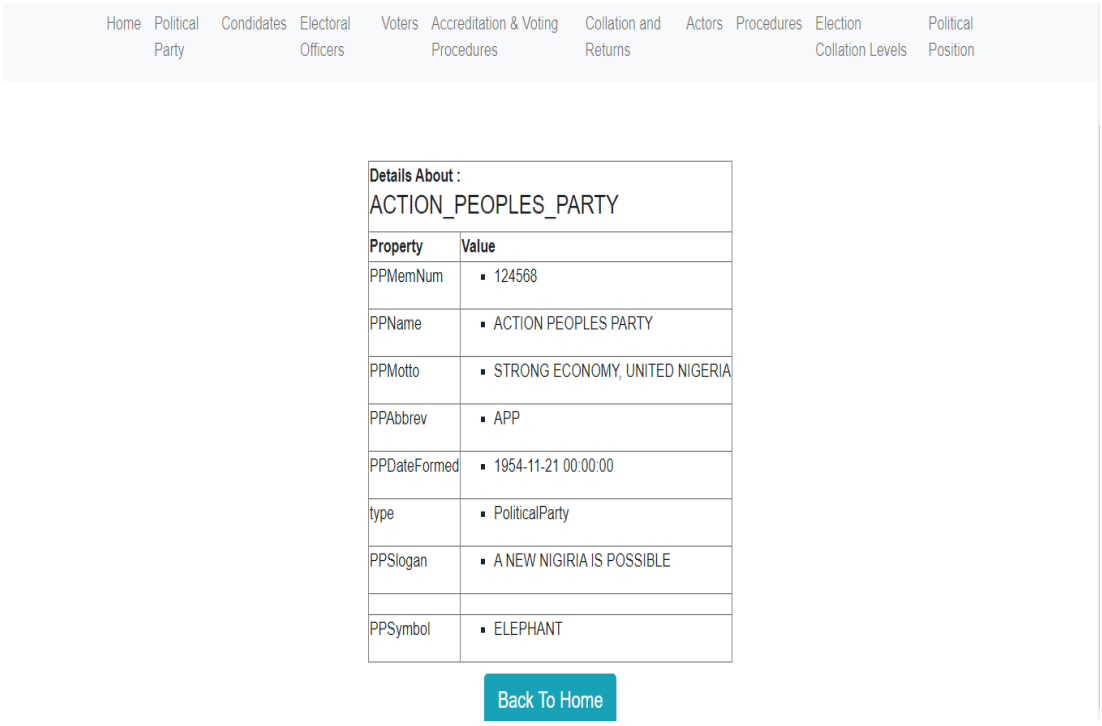



Figure 5.24.

*The Details Of One Of The Searched Results.*



### 5.11.2 Class-based Search

Class-Based Search is a functionality within an ontology that allows users to search for instances based on their class or category. In an ontology, classes represent a group of instances that share common characteristics or properties. Using Class-Based Search, users can input a search query that specifies a particular class or category of interest. The system then searches the ontology for instances that belong to the specified class or category and presents the results to the user. Class-based search can be handy when working with large and complex ontologies, as it allows users to focus their search on specific categories of information rather than searching the entire ontology. It also provides a way to retrieve related instances based on their shared properties and characteristics, which can help discover new knowledge and insights within the ontology domain.

Figure 5.25.

*The Shows the Political party class and the list of all Political Parties.*

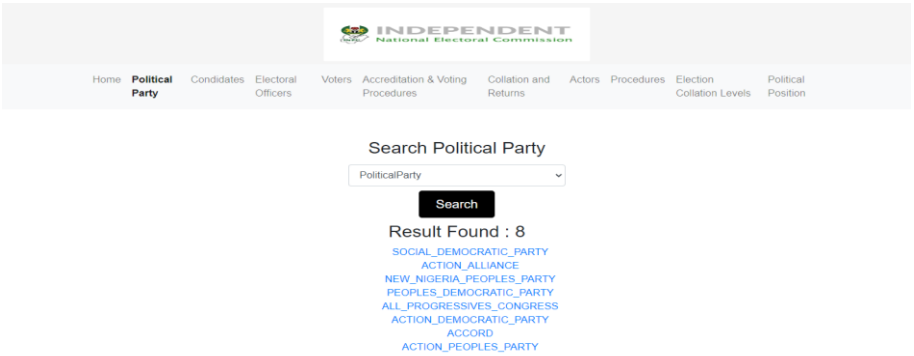


Figure 5.26

*Shows The Details Political Party.*

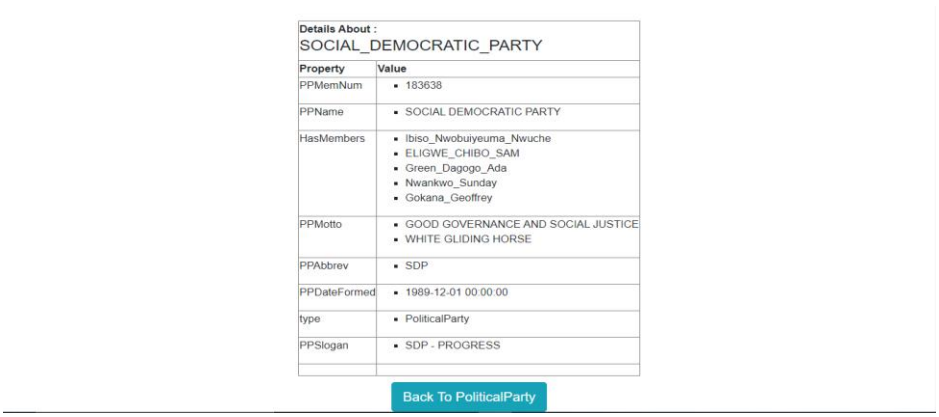



Figure 5.27.

*Shows The Candidates' Class And Showing The List Of Candidates' Details.*

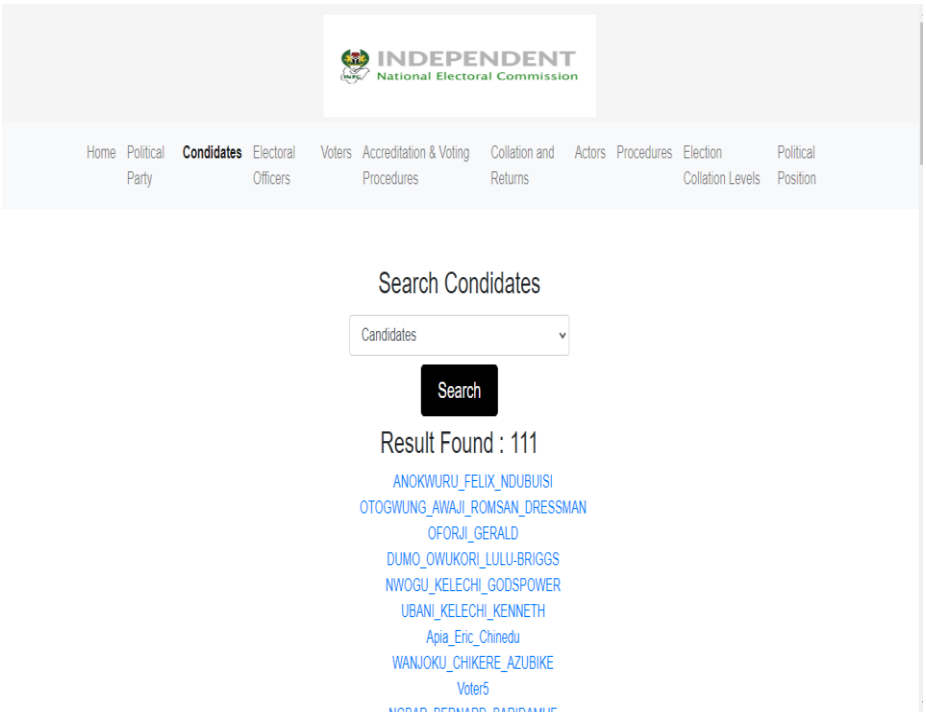


Figure 5.28.

*Showing The Details Of A Candidate.*

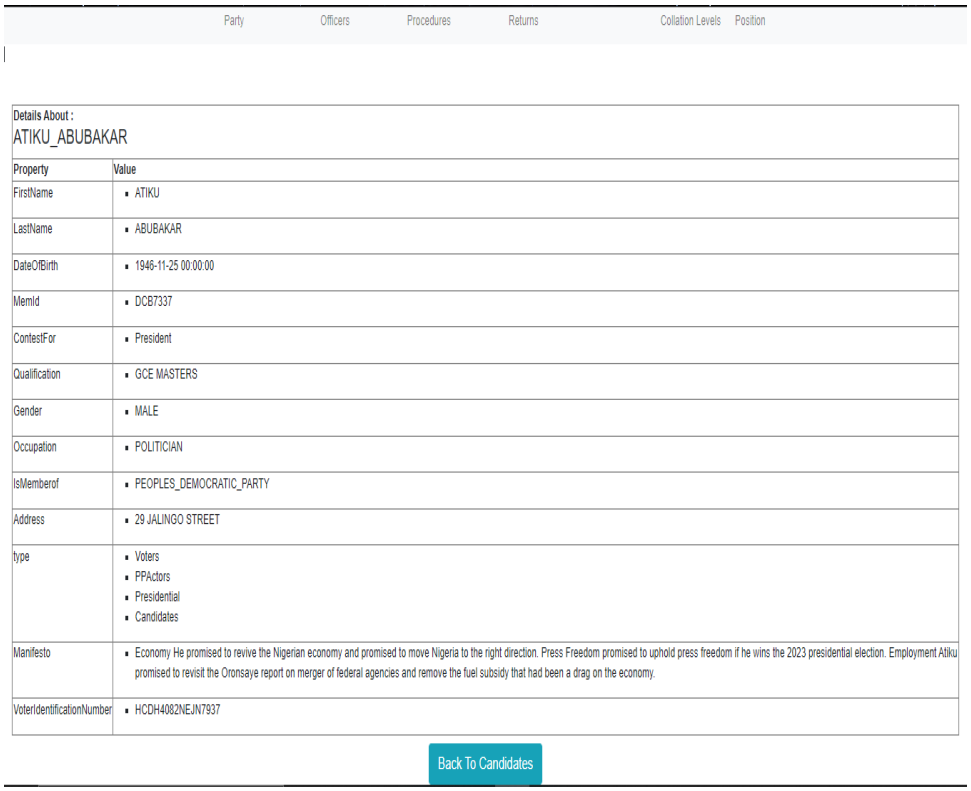



Figure 5.29.

*Shows The Electoral Officers' Class And The List Of Electoral Officers' Details.*

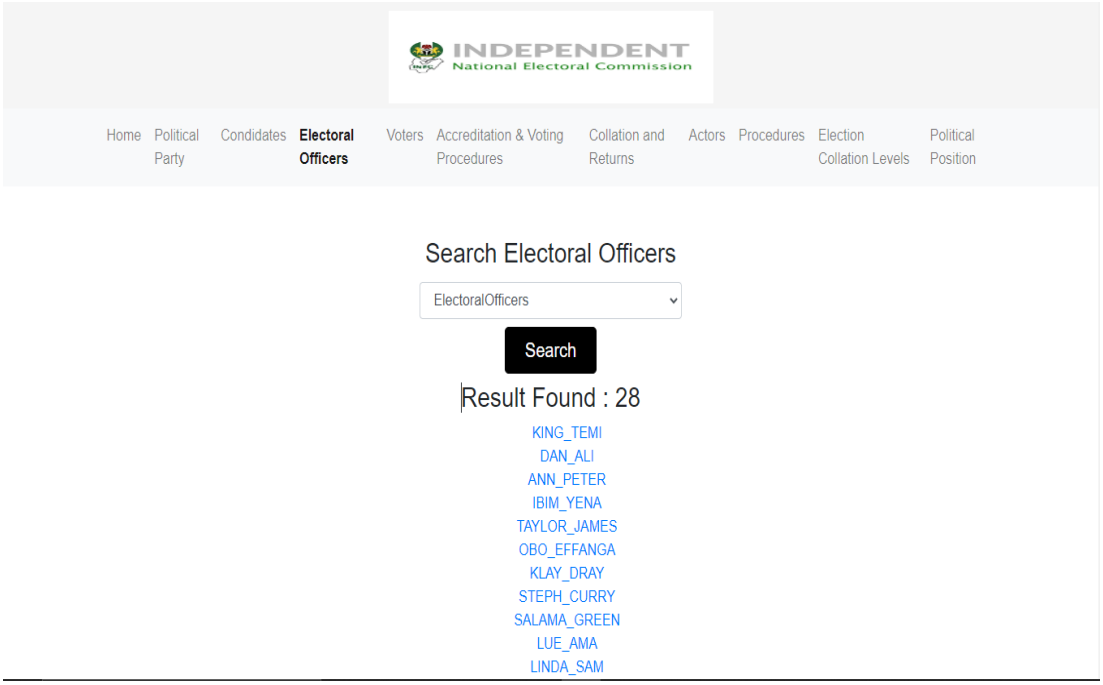


Figure 5.30.

*Shows The Details Of An Electoral Officer.*

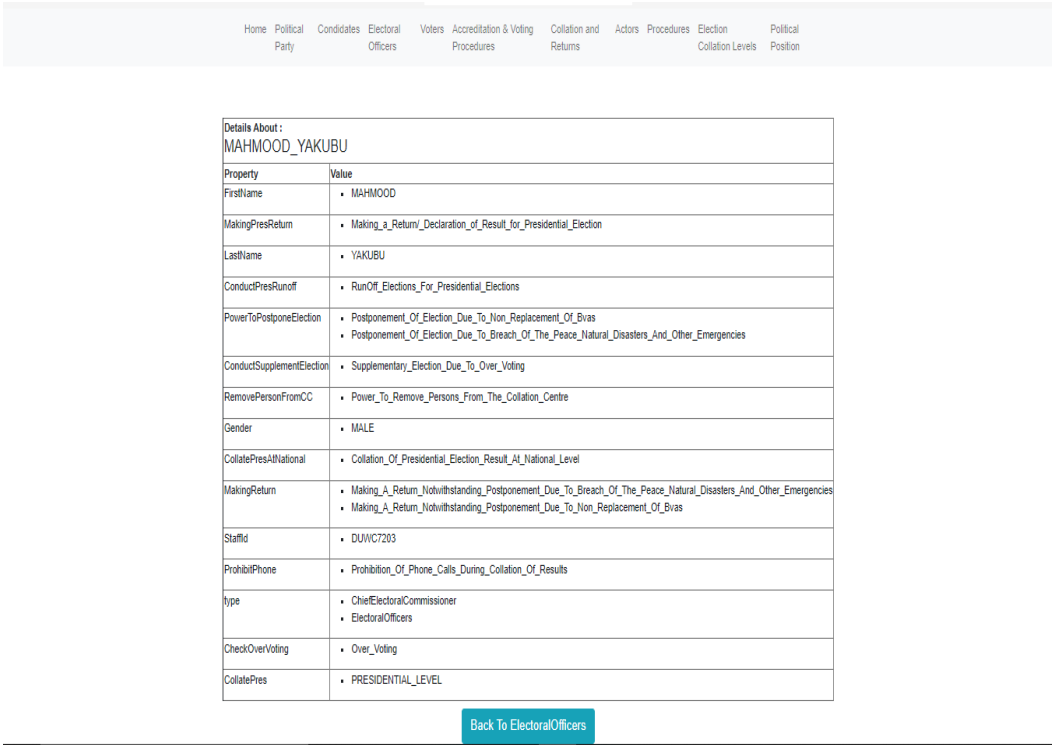



Figure 5.31

*Shows The Voters' Class And The List Of Voters'.*

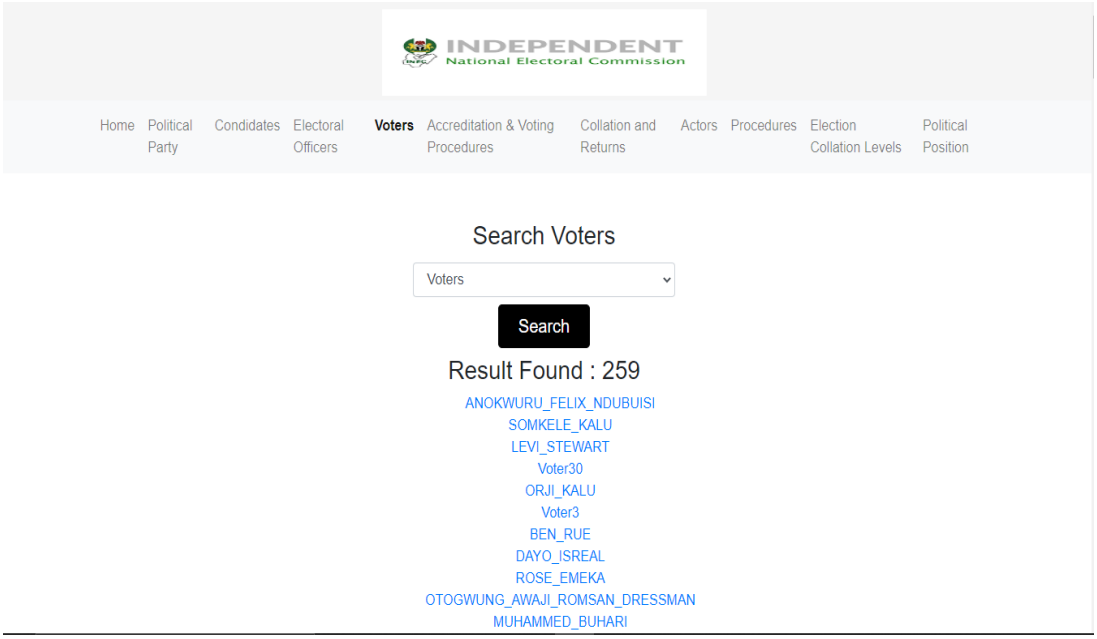


Figure 5.32.

*Showing The Details Of A Voter.*

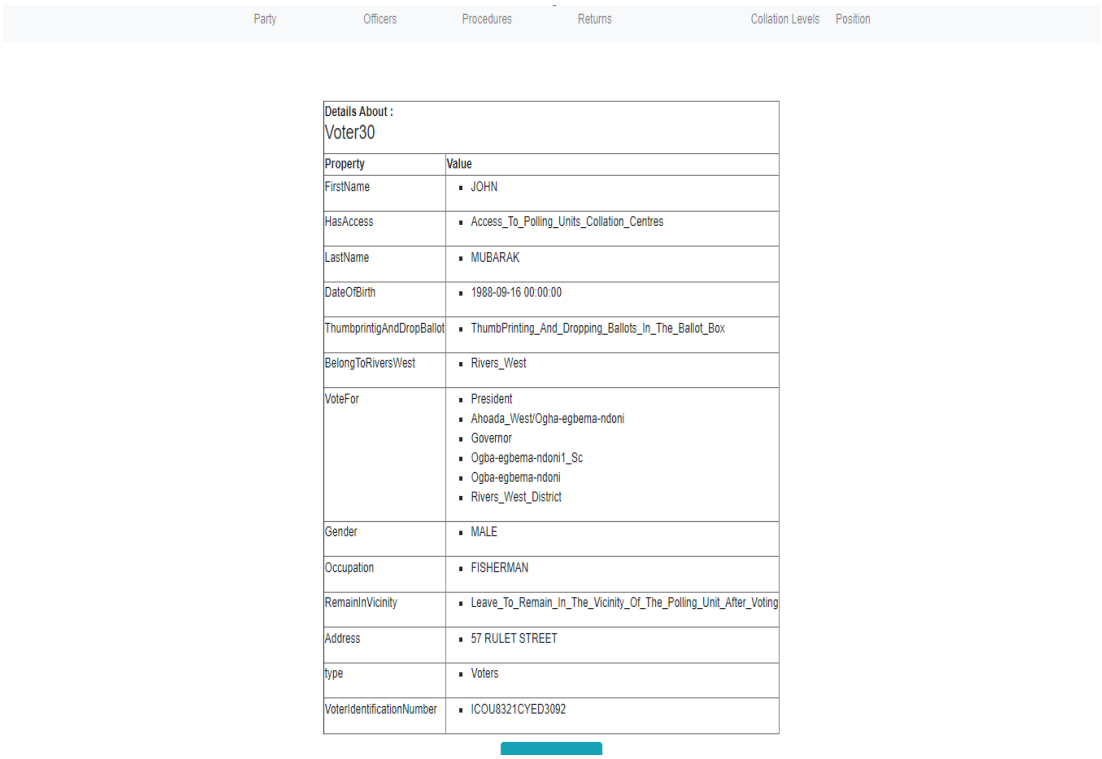



Figure 5.33.

*Shows The Accreditation And Voting Procedures Class And The List Of Procedures*

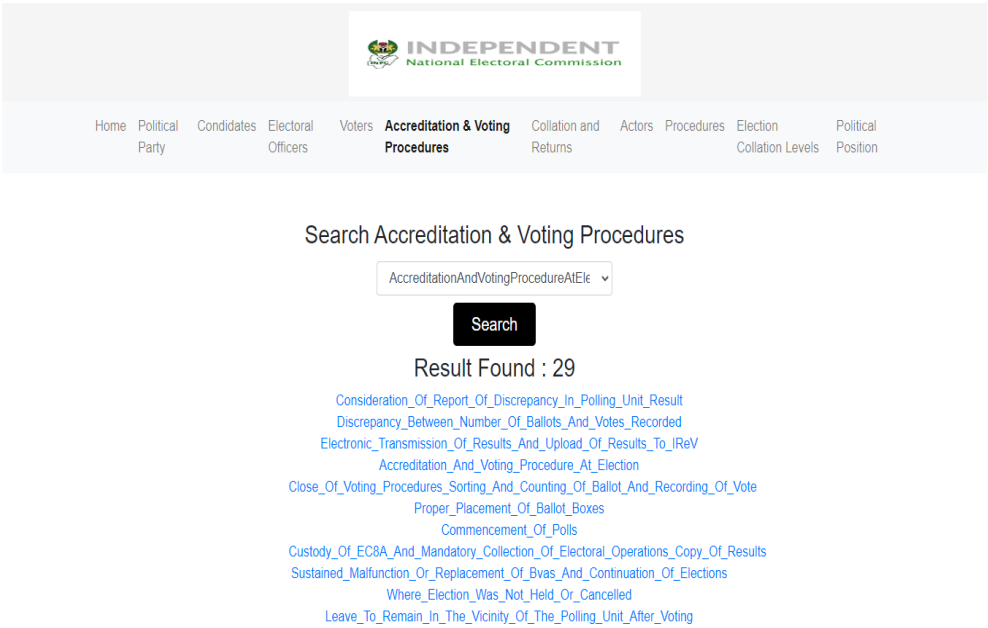



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Figure 5.34:

*Showing The Details Of The Consideration Of Report Of Discrepancy In Polling Units Result.*

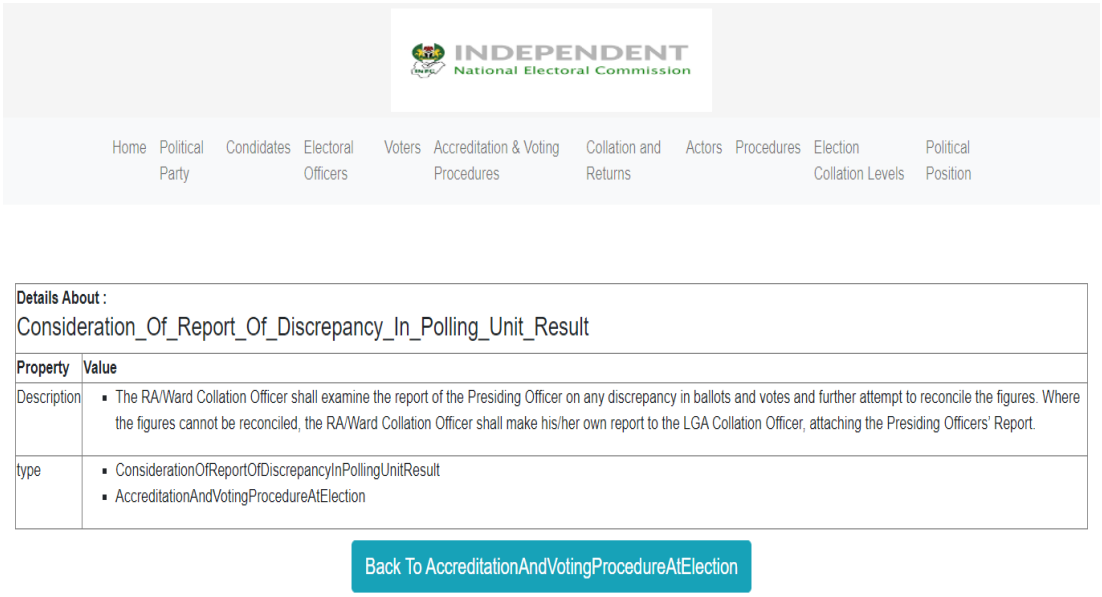



Figure 5.35.

*Showing The Election Collation Levels Class The List Of Levels.*

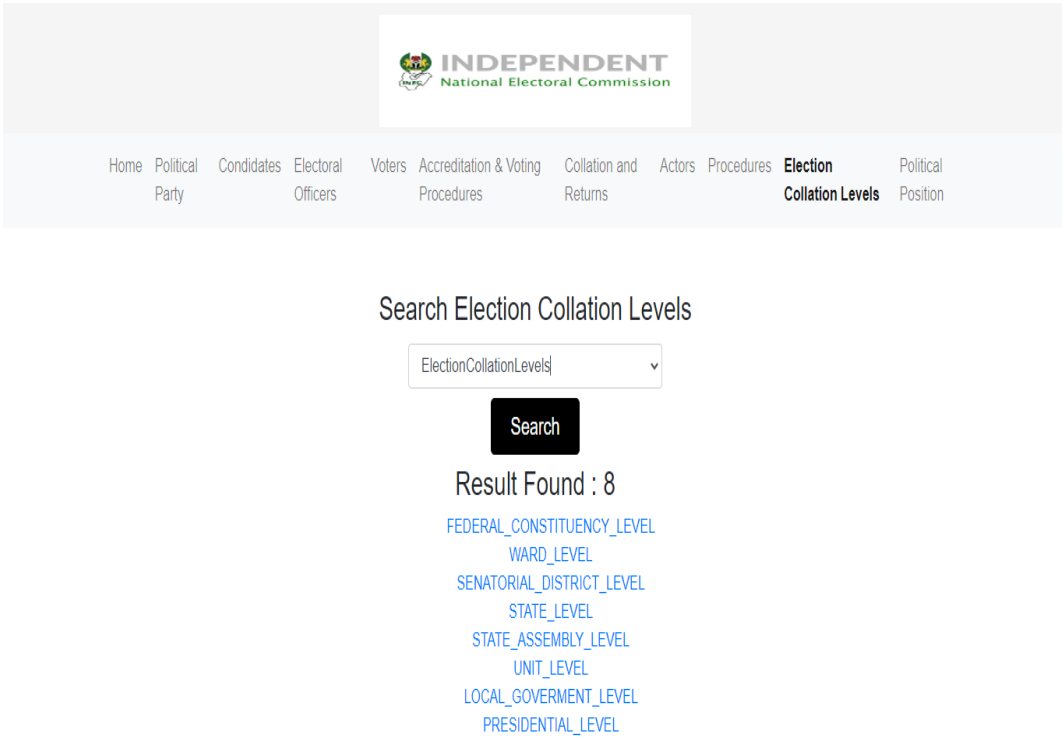


Figure 5.36.

*Shows The Details Of The Electoral Collation Levels.*

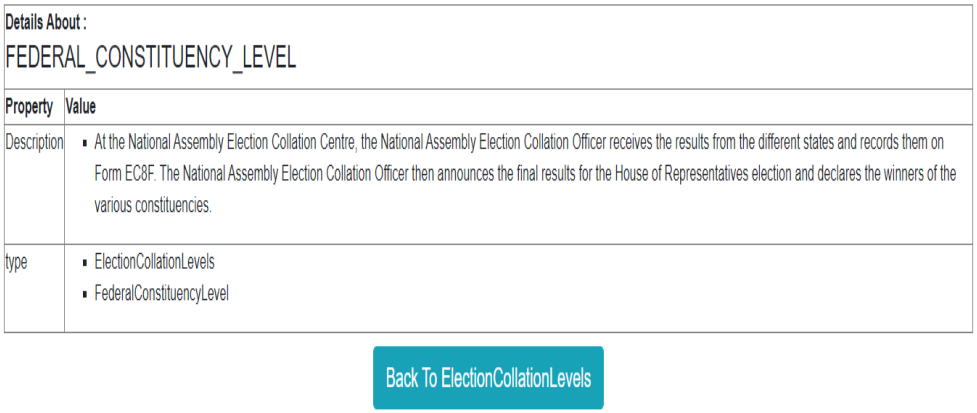
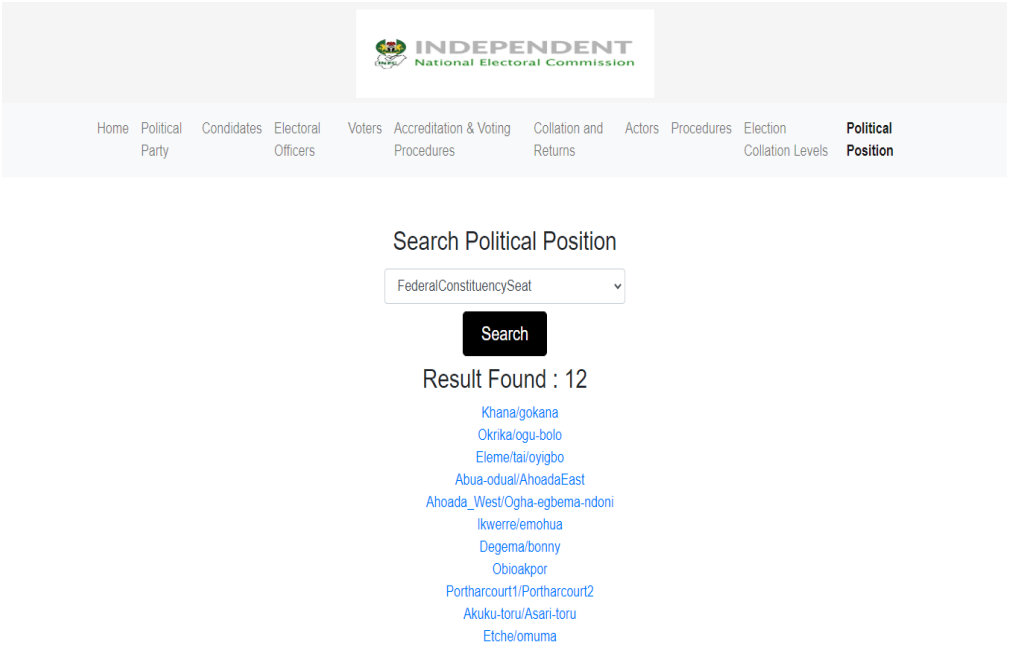




Figure 5.37.

*Shows The Political Position Class (Federal Constituency Seats).*



## 5.12 Limitation

The ontology-based search engine has the following limitations:

1. The application only works with the election.owl ontology. It cannot be used with other ontologies.
2. The application only searches for instances and subclasses of classes. It cannot search for properties or relationships between instances.
3. The application uses a simple keyword search algorithm. It does not support advanced search features such as wildcards or Boolean operators.
4. The application may be slow when querying large datasets.

## 5.13 Evaluation and Testing

Evaluating a system is a crucial step in the development process as it helps determine its effectiveness in meeting its intended goals and objectives. One approach to evaluating a system is through task-based information, which involves assessing the system's performance in completing specific tasks. Task-based evaluation tests and evaluates a system based on its ability to perform specific tasks and achieve specific goals. The process typically involves setting up a series of tasks the system must perform and evaluating its performance against pre-defined criteria. Task-based evaluation has several advantages over other evaluation methods. Firstly, it allows for a more objective assessment of the system's performance, as the tasks are clearly defined and measurable. Secondly, it indicates how well the system performs in real-world scenarios, as the tasks are designed to mimic real-world situations. Finally, task-based evaluation can identify specific areas of the system that need improvement, enabling developers to make targeted changes and improvements. The assessment of an application with respect to task-based data entails various processes, which are outlined below:

Step 1: Defining the task
Step 2: Identifying the user
Step 3: Creating scenarios
Step 4: Conducting the evaluation
Step 5: Analyzing the results
Step 6: Reporting the results

Step 7: Implementing the recommendations

Evaluating a system based on task-based information involves assessing its ability to perform specific tasks and achieve its intended goals. By following these steps, developers can gain valuable insights into the system's performance, identify areas for improvement, and make targeted changes and enhancements to improve the system's effectiveness and efficiency.

### 5.13.1 User Studies

We conducted a comprehensive study to analyze user performance and feedback using our newly developed portal system compared to an older one. To evaluate the effectiveness of our innovative system, we juxtaposed it with a conventional semantic web portal structure. All users, including unauthorized ones, were required to navigate through both structures and answer all the questions. Furthermore, we randomly switched the structures between users to ensure unbiased results.

### 5.13.2 Experimental Setup

We conducted a comprehensive study to analyze user performance and feedback using our newly developed portal system compared to an older one. To evaluate the effectiveness of our innovative system, we juxtaposed it with a conventional semantic web portal structure. All users, including unauthorized ones, were required to navigate through both structures and answer all the questions. Furthermore, we randomly switched the structures between users to ensure unbiased results.

### 5.13.3 Experiment with the First System Called Baseline

The first tested system was the INEC Website search system, the Baseline system. Before the actual experiment began, we performed a sample search using the Baseline system. This sample search was designed to provide the participants with an example of using the system and what to expect. We wrote the number of each task on a piece of paper, folded them and put them in a jar. Each task was evaluated randomly to ensure that the experiment results were unbiased. This means we did not know which task we would use first, and this randomization balanced out any potential bias.

After the sample search, the actual experiment began. We used the Baseline system to perform a habituated search effort, which means that we used the system in the way that they usually would. During the search, we noted down the appropriate responses. This means that we wrote down the relevant search results or any other information that they found useful. This experiment aimed to determine how effective the Baseline system was in providing users with the needed information. By starting with the Baseline system, the experimenters could establish a baseline for the performance of the Semantic search system and make a more informed comparison.

### 5.13.4 Experiment with the Second System, Called the Proposed System

The experiment began with a sample search of the Proposed system. This sample search was designed to provide us with an understanding of how the system works and what we can expect. After completing the sample search, we tried some example queries to see how it works. This example query was used to help us become familiar with the Proposed system before the experiment began. Finally, we were given the real semantic search system task using the Proposed system. This task aimed to evaluate the Proposed system's effectiveness in providing users with the necessary information. By providing a sample search and an example query before the experiment, we could familiarize ourselves with the Proposed system and ensure we were comfortable using it. This also helped to minimize any potential bias, as we had a chance to become familiar with both systems before the experiment began.

How often do you use Independent National Electoral Commission Website to search for information (i.e., candidate, electoral processes, etc.)?

Table 5.2

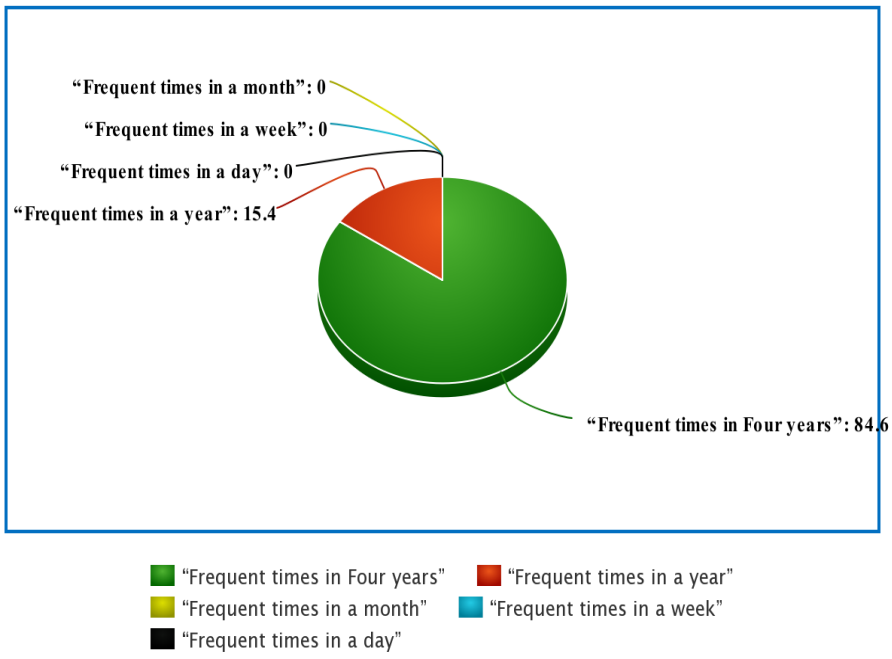
*Illustrate How Often You Use Independent National Electoral Commission Website To Search For Information*.

| S/N | Period | Number of times | Percentage% |
|---|---|---|---|
| **1** | "Several times in the past four years" | 11 | 84.6 % |
| **2** | "Several times throughout the year" | 2 | 15.4 % |

| | | | |
|---|---|---|---|
| **3** | "Several times throughout the month" | - | - |
| **4** | "Several times during the week" | - | - |
| **5** | "At regular intervals throughout the day" | - | - |
| | **Total** | | **100 %** |

Figure 5.38

*Pictorial Representation Of Table 5.2*




Based on Table 5.2, it can be confidently stated that the INEC Website is frequently used by most of its users (84.6%), who visit it at least 11 times within four years to search for information. However, a small percentage (15.4%) of users only utilize the website at least twice a year for information searches, indicating that the INEC Website search system is not commonly utilized.

How frequently do you employ web search engines to acquire information, as outlined in Table 5.3?

Table 5.3

*Displays The Frequency Of Your Internet Search Engine Usage For Information Retrieval.*

| S/N | Period | Number of times | Percentage% |
|---|---|---|---|
| **1** | "Several times in the past four years" | - | - |
| **2** | "Several times throughout the year" | - | - |
| **3** | "Several times throughout the month" | 1 | 10 % |
| **4** | "Several times during the week" | 3 | 30 % |
| **5** | "At regular intervals throughout the day" | 6 | 60 % |
| | **Total** | | **100 %** |

Figure 5.39

*Pictorial Representation Of Table 5.3*

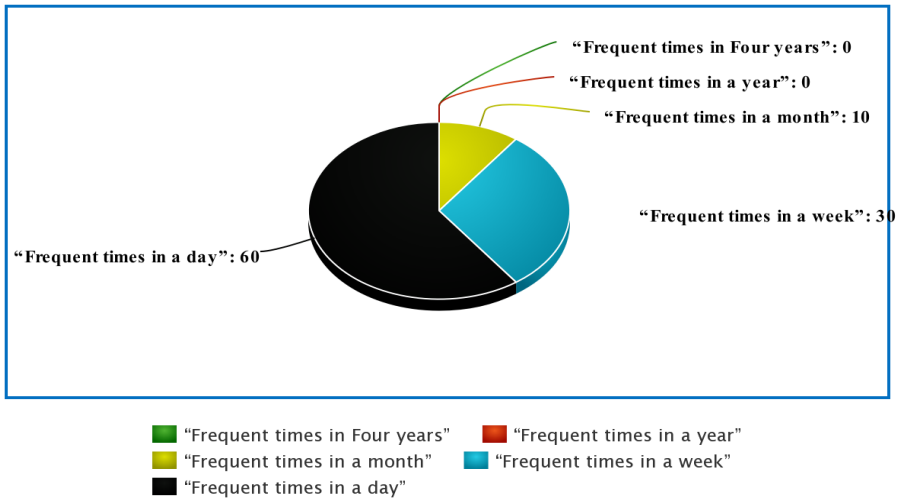



Table 5.3 indicates that a significant majority of individuals, approximately 60%, rely on web search engines to access information at least six times daily. Additionally, 30% utilize these search engines at least thrice weekly, while another 10% use them once a week. Notably, there were no reports of search engines being used so infrequently for

one or four years. This data underscores the crucial role that search engines play in our online activities.

To thoroughly evaluate the search system of the INEC website, a list of tasks has been compiled. These tasks will effectively assess both the baseline and proposed semantic search systems. For more detailed information, please refer to Table 5.4.

Table 5.4.

*Tasks For INEC Website (Baseline) And Semantic Portal (Proposed System)*

| S/N | Task | Baseline system Time (sec) | Proposed system Time (sec) |
|---|---|---|---|
| **1** | Please search for a political party and details about it | 22 | 7 |
| **2** | Search for a governorship candidate "SIMINALAYI FUBARA" and details about him | 57 | 12 |
| **3** | Search for Candidates according to the position they are contesting for "Federal constituency." | 16 | 7 |
| **4** | Search for the election collation levels | 18 | 6 |
| **5** | Find the candidate for your Senatorial district and Federal constituency. | 45 | 14 |
| **6** | Assuming you are a presiding electoral officer, check the duties you can perform during an election | 48 | 9 |
| **7** | Under the accreditation and voting procedure, provide details about impersonation and underage voting. | 74 | 11 |
| **8** | Check for what an Actor security personnel can do during the election and details about them | 36 | 19 |
| **9** | Check the list of Election collation and return procedures | 34 | 6 |

| | | |
|---|---|---|
| **TOTAL** | **350** | **91** |
| **AVERAGE** | **38.9** | **10.1** |

Figure 5.40.

*The Baseline In Comparison With The Proposed System*

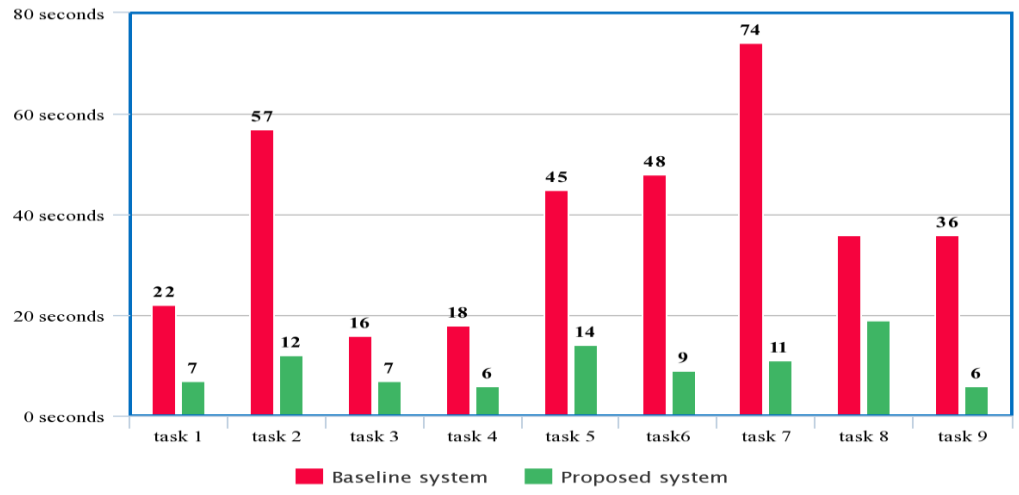



Figure 5.41.

*The Average Time Of Baseline In Comparison With The Proposed System.*

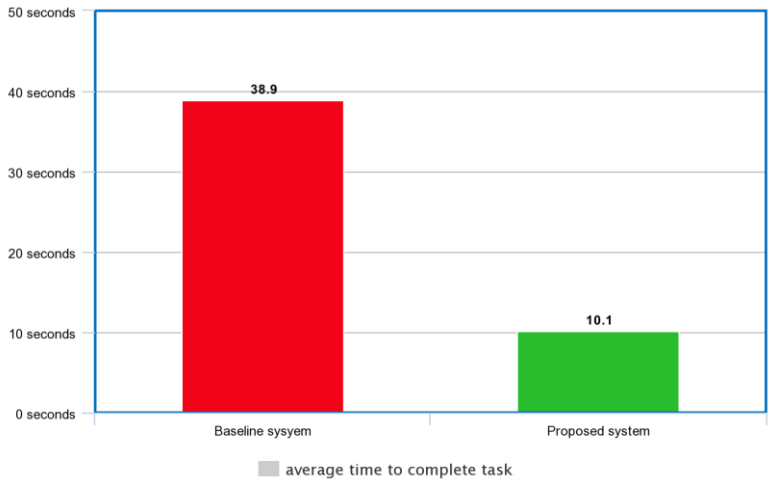
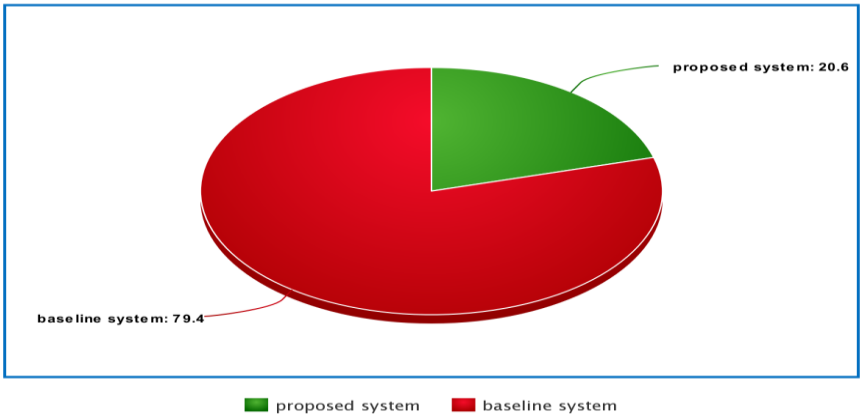


Figure 5.42.

*The Average Time Of Baseline In Comparison With The Proposed System.*




### 5.13.5 Analyzing and Evaluating Results Gotten from the Proposed and Baseline System

The main factor used to assess the systems was the time it took to complete a search task. This was measured after users interacted with both systems to determine which was more efficient. This metric provides insight into how quickly users can find the desired information using each system. A comparison was made based on several factors further to analyze the performance of the proposed and baseline systems. The time required to complete the search task was examined to determine if the proposed system outperformed the baseline system in speed and efficiency. The quality and relevance of the obtained search results were assessed, which likely affected the comparison between the two systems. The experiment's findings revealed that the proposed semantic search system, the "proposed portal system," was significantly better than the baseline system. This suggests the proposed system can provide users with the necessary information more quickly and efficiently than the baseline system. Specifically, the proposed system allowed users to acquire more necessary information in a shorter period than the baseline system. Therefore, the proposed system can provide users with more relevant information faster than the baseline system.

In conclusion, the experiment's results demonstrate that the proposed semantic search system is more effective than the baseline system in providing users with the necessary information. By evaluating both systems' efficiency and effectiveness, the experimenters could determine the superiority of the proposed system. These findings

serve as a basis for future development and implementation, allowing for recommendations to be made regarding improvements and advancements in the semantic search system.

# CHAPTER VI

# Conclusion, Limitations & Recommendations

## 6.1 Conclusion

The development of a semantic search site for INEC Rivers State in Nigeria was the major objective of this study. Using the semantic web and ontologies to create an election semantic search portal offers significant advantages in improving the efficiency, accuracy, and user experience of searching and accessing electoral information. By harnessing the power of semantic technologies, such as RDF (Resource Description Framework) and ontologies, we create a robust and structured framework that enables precise and context-aware searching within the complex domain of elections. One of the key benefits of employing the semantic web and ontologies in an election search portal is the ability to capture the semantics and relationships of the electoral data. By defining the concepts, properties, and relationships relevant to elections within an ontology, we organize and structure the vast amount of data associated with the electoral process. This facilitates meaningful and context-aware search, enabling users to retrieve accurate and relevant information based on their needs and queries. Using ontologies also enables the integration and interoperability of diverse data sources within the election search portal. By mapping disparate data sets to a common ontology, the search portal can seamlessly access and retrieve information from various sources, such as voter, and candidate profiles, election processes, and legal and political parties. This integration allows users to obtain a comprehensive and holistic view of the electoral landscape, reducing the need for manual data aggregation and improving data accuracy and consistency.

Moreover, the semantic capabilities of the search portal enable advanced querying and reasoning functionalities. We employ SPARQL (SPARQL Protocol and RDF Query Language) queries to retrieve specific information, filter results based on desired criteria, and navigate complex data relationships. Additionally, ontologies support reasoning mechanisms, allowing the search portal to infer implicit knowledge, identify patterns, and provide valuable insights to users. This enhances the intelligence of the search portal and empowers users with a more profound understanding and analysis of electoral data. Furthermore, the user experience of the election semantic search portal is significantly enhanced through semantic technologies. By leveraging

the semantic richness of the underlying data, the search portal can provide intuitive and user-friendly interfaces. Users can interact with the search portal using natural language queries, reducing the need for complex syntax and technical expertise. The portal can also offer suggestions and recommendations, enabling a seamless and personalized user journey. Creating an election semantic search portal also promotes transparency and access to information in the electoral domain. The portal facilitates public access to electoral information by providing a centralized and user-friendly interface, empowering voters, researchers, and journalists with accurate and timely data. This transparency strengthens democratic processes, fosters informed decision-making, and encourages citizen engagement. However, it is essential to acknowledge specific challenges associated with using the semantic web and ontologies in creating an election search portal. Building and maintaining a comprehensive election ontology requires collaboration among domain experts, data providers, and ontology engineers. The ontology must be continually updated to accommodate evolving electoral processes and incorporate new data sources. Another challenge is ensuring the quality and accuracy of the data sources integrated into the search portal. Data inconsistencies, errors, and biases can impact the reliability of search results and undermine user trust. Establishing data quality assurance mechanisms, data governance frameworks, and verification processes is crucial to address these challenges.

### 6.2 Limitations

While there are many benefits to utilizing the semantic web and ontologies to build an election semantic search portal, there are some drawbacks as well that need to be comprehended and resolved. The intricacy and work involved in creating and keeping up with the ontology itself is one of its key drawbacks. Creating a comprehensive and accurate election ontology demands domain expertise, collaboration among various stakeholders, and continuous updates to capture evolving electoral processes and new data sources. The ontology development process can be time-consuming and resource-intensive, requiring careful consideration of the domain's intricacies and the diverse needs of users. Moreover, the scalability of the semantic search portal can be a challenge when dealing with large-scale elections or expanding user bases. As the volume and diversity of electoral data increase, the performance of the search portal may be affected. Efficient querying, retrieval, and

reasoning over vast data require significant computational resources and optimization techniques to ensure acceptable response times.

Another limitation concerns the quality and availability of data sources integrated into the search portal. The effectiveness of the semantic search heavily relies on the data's accuracy, consistency, and relevance. Inaccurate or incomplete data can lead to misleading search results and undermine the trust and usefulness of the portal. Ensuring data quality, establishing data governance practices, and collaborating with reliable data providers are essential to mitigate these limitations. Furthermore, the adoption and user acceptance of the search portal can be influenced by factors such as technical expertise, user familiarity with semantic technologies, and interface design. Semantic technologies often require a certain level of technical understanding, which may limit access for users with limited technical skills. Providing user-friendly interfaces, clear instructions, and support resources can help bridge this gap and encourage broader adoption of the search portal. Additionally, achieving interoperability with existing systems and data formats can be challenging. Many electoral systems and data sources may use different standards, forms, or structures, making integration and data harmonization complex. Developing standardized data exchange protocols, mapping mechanisms, and collaboration with data providers are crucial to ensure interoperability and maximize the potential of the search portal.

Lastly, privacy and security concerns must be addressed when handling sensitive electoral data within the search portal. Safeguarding voter information, ensuring compliance with data protection regulations, and implementing robust security measures are essential to maintain the trust and confidentiality of users.

### 6.3 Recommendations

As technology continues to evolve, several key areas can be explored further to enhance the capabilities and impact of the search portal. The future work on using the semantic web and ontologies to create an election semantic search portal holds immense potential for advancing the accessibility, efficiency, and transparency of electoral information. One avenue for future work is refining and expanding the election ontology. Continuous efforts should be made to update the ontology to reflect the evolving landscape of electoral processes, including new data sources, emerging concepts, and evolving voter behaviours. Collaboration among domain experts,

ontology engineers, and data providers can help ensure that the ontology remains comprehensive, accurate, and aligned with the needs of diverse stakeholders. Another area of focus is the integration and harmonization of heterogeneous data sources. As electoral systems generate vast amounts of data, future work should concentrate on developing effective mechanisms for integrating data from various sources and formats. Standardization efforts, mapping techniques, and data transformation processes can facilitate interoperability and seamless integration of diverse data sets within the search portal.

Enabling users to interact with the search portal using natural language queries and receiving relevant and accurate results can significantly improve user satisfaction and engagement. Additionally, advancements in natural language processing (NLP) can significantly enhance the user experience of the search portal. Future work should explore the development of sophisticated NLP algorithms to improve query understanding, support multilingual capabilities, and handle complex search scenarios. Future work on the search portal should also address privacy and security concerns. Robust mechanisms for data anonymization, access control, and compliance with data protection regulations must be implemented to ensure the privacy and confidentiality of sensitive electoral data. Ongoing research and technological advancements in privacy-preserving techniques can contribute to mitigating these concerns and building user trust.

Furthermore, leveraging machine learning and artificial intelligence (AI) techniques can enhance the capabilities of the search portal. Machine learning algorithms can improve search relevance, personalize search results, and assist in data validation and quality assurance processes. By harnessing the power of AI and machine learning techniques, we can enhance search capabilities, data integration, and personalization within the search portal, ultimately empowering users and improving democratic processes. One of the key advantages of employing AI and machine learning in an election semantic search portal is the ability to improve search relevance and accuracy. Machine learning algorithms can analyze vast amounts of electoral data, including voter information, candidate profiles, election results, and legal frameworks, to identify patterns, relationships, and trends. The search portal can provide more precise and context-aware search results by training these algorithms on historical data, ensuring users find the most relevant and accurate information.

Additionally, machine learning algorithms enable the search portal to learn and adapt continually to user preferences and behaviours. The portal can analyze search patterns, click-through rates, and user feedback through user interactions to personalize search results, offer recommendations, and enhance the overall user experience. This personalization improves user satisfaction and helps users discover new insights and perspectives within the electoral domain. Furthermore, machine learning techniques can facilitate data integration and harmonization within the search portal. The portal can provide a unified and comprehensive view of electoral information by automatically mapping and aligning heterogeneous data sources. Machine learning algorithms can assist in data cleansing, normalization, and reconciliation, ensuring data consistency and accuracy across different sources. This integrated data approach enhances the completeness and reliability of search results, supporting users in making informed decisions. AI and machine learning also enables advanced analytics and predictive modelling within the search portal. By leveraging historical electoral data, the portal can generate predictive insights, forecast election outcomes, and identify potential trends or anomalies. These predictive capabilities provide valuable information to users, including politicians, researchers, and voters, enabling them to make data-driven decisions, anticipate electoral dynamics, and understand the potential impact of policy changes.

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# APPENDIX A

## Code

```
from datetime import datetime
from rdflib import Literal
import rdflib
import os
from flask import Flask, render_template, request, redirect, url_for,
send_from_directory, make_response
from flask import send_file
import pandas as pd
import json
from core import  Configuration, Executer,Queries
import io
import uuid
import sys
import traceback
app = Flask(__name__)
dirname = os.path.dirname(__file__)
app.config['FILE_UPLOADS'] = dirname+"/data/"
app.config['RAW'] = dirname+"/raw/"
def getClasses(c):
    prefix = "http://www.semanticweb.org/asus/ontologies/2023/0/election#"
    prefix1 = "http://www.semanticweb.org/asus/ontologies/2023/1/ELECTIONS#"
    config = Configuration.Configuration("electionDB", "Election.owl") # args ->
endpoint, databaseName, database source
    gdb = config.GetCreateDB()
    exe = Executer.Executer(gdb)
    result = exe.executeLocalQuery(Queries.subClassQuery(c))
    _result = []
    local_name = ""
    for res in result:
        print("********** ",res["sub"], " ********** ")
        if res["sub"].startswith(prefix):
```

```
            local_name = res["sub"][len(prefix):]
        elif res["sub"].startswith(prefix1):
            local_name = res["sub"][len(prefix1):]
        _result.append(local_name)
    return _result
def getClassReuslt(c):
    prefix = "http://www.semanticweb.org/asus/ontologies/2023/0/election#"
    prefix1 = "http://www.semanticweb.org/asus/ontologies/2023/1/ELECTIONS#"
    config = Configuration.Configuration("electionDB", "Election.owl") # args ->
endpoint, databaseName, database source
    gdb = config.GetCreateDB()
    exe = Executer.Executer(gdb)
    result = exe.executeLocalQuery(Queries.getClassInstances(c))
    _result = []
    local_name = ""
    for res in result:
        print("********** ",res["sub"], " ********** ")
        if res["sub"].startswith(prefix):
            local_name = res["sub"][len(prefix):]
        elif res["sub"].startswith(prefix1):
            local_name = res["sub"][len(prefix1):]
        _result.append(local_name)
    return _result
def getFreeTextResult(text):
    prefix = "http://www.semanticweb.org/asus/ontologies/2023/0/election#"
    prefix1 = "http://www.semanticweb.org/asus/ontologies/2023/1/ELECTIONS#"
    config = Configuration.Configuration("electionDB", "Election.owl") # args ->
endpoint, databaseName, database source
    gdb = config.GetCreateDB()
    exe = Executer.Executer(gdb)
    result = exe.executeLocalQuery(Queries.freeText(text))
    _result = []
    local_name = ""
    for res in result:
```

```
        print(">>>>>> ",res["ins"], " >>>>>> ")
        local_name = removePrefix(res["ins"])
        _result.append(local_name)
    return _result
def process(request, _class):
    result = None
    req = ""
    if request.method == 'POST':
        req = request.form.get('requestedString')
        print('\n Requested String: ', req, "\n")
        result = getClassReuslt(req)
    classes = getClasses(_class)
    #print(">>>> political Party >>> ")
    print(classes)
    data=[]
    data.append(classes)
    data.append(result)
    return data , req
@app.route('/', methods=["GET", "POST"])
def index():
    data = None
    if request.method == 'POST':
        req = request.form.get('requestedString')
        data = getFreeTextResult(req)
        #print(data)
    print('Request for index page received')
    return render_template('index.html', data=data)
@app.route('/q1', methods=["GET", "POST"])
def q1():
    data, req = process(request, "PoliticalParty")
    return render_template('q1.html', data=data, name=req)
@app.route('/q2', methods=["GET", "POST"])
def q2():
    #Candidates, ElectoralOfficers, Voters
```

```
    data, req = process(request, "Candidates")
    return render_template('q2.html', data=data, name=req)
@app.route('/q3', methods=["GET", "POST"])
def q3():
    data, req = process(request, "ElectoralOfficers")
    return render_template('q3.html', data=data, name=req)
@app.route('/q4', methods=["GET", "POST"])
def q4():
    #Candidates, ElectoralOfficers, Voters
    data, req = process(request, "Voters")
    return render_template('q4.html', data=data, name=req)
@app.route('/q5', methods=["GET", "POST"])
def q5():
    #Candidates, ElectoralOfficers, Voters
    data, req = process(request, "AccreditationAndVotingProcedureAtElection")
    return render_template('q5.html', data=data, name=req)
@app.route('/q6', methods=["GET", "POST"])
def q6():
    #Candidates, ElectoralOfficers, Voters
    data, req = process(request, "CollationOfElectionResultsAndMakingOfReturns")
    return render_template('q6.html', data=data, name=req)
@app.route('/q7', methods=["GET", "POST"])
def q7():
    #Candidates, ElectoralOfficers, Voters
    data, req = process(request, "Actors")
    return render_template('q7.html', data=data, name=req)
@app.route('/q8', methods=["GET", "POST"])
def q8():
    #Candidates, ElectoralOfficers, Voters
    data, req = process(request, "Procedure")
    return render_template('q8.html', data=data, name=req)
@app.route('/q9', methods=["GET", "POST"])
def q9():
    #Candidates, ElectoralOfficers, Voters
```

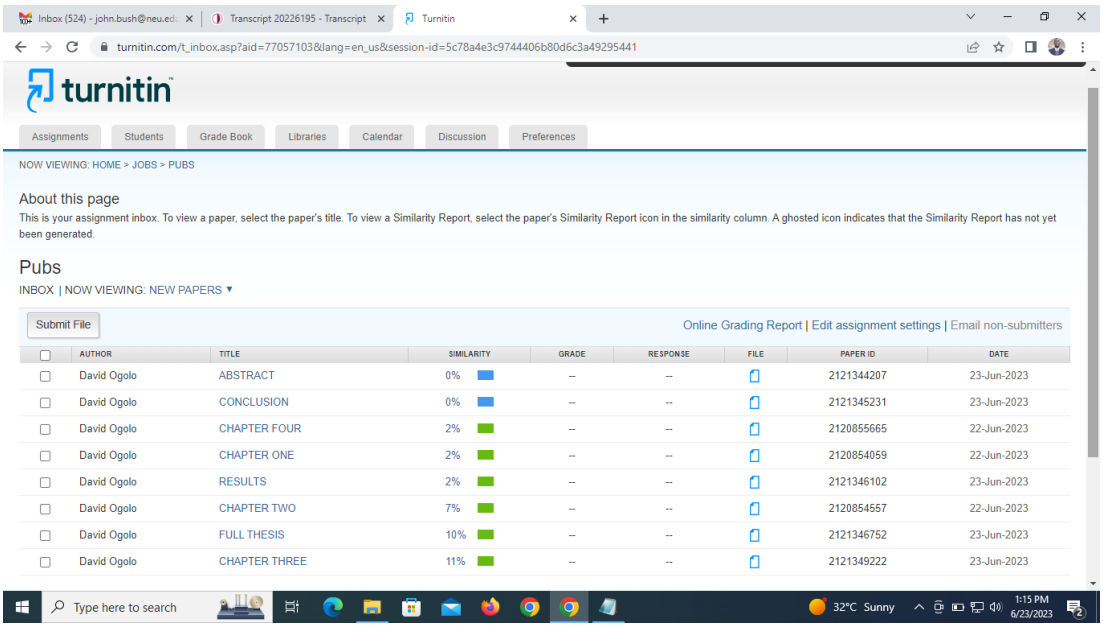
```
    data, req = process(request, "ElectionCollationLevels")
    return render_template('q9.html', data=data, name=req)
@app.route('/q10', methods=["GET", "POST"])
def q10():
    #Candidates, ElectoralOfficers, Voters
    data, req = process(request, "PoliticalPosition")
    return render_template('q10.html', data=data, name=req)
def removePrefix(s):
    prefix = "http://www.semanticweb.org/asus/ontologies/2023/0/election#"
    prefix1 = "http://www.semanticweb.org/asus/ontologies/2023/1/ELECTIONS#"
    prefix2 = "http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    local_name = ""
    if s.startswith(prefix):
        local_name = s[len(prefix):]
    elif s.startswith(prefix1):
        local_name = s[len(prefix1):]
    elif s.startswith(prefix2):
        local_name = s[len(prefix2):]
    return local_name
@app.route('/detail', methods=["GET"])
def detail():
    try:
        config = Configuration.Configuration("electionDB", "Election.owl") # args ->
endpoint, databaseName, database source
        gdb = config.GetCreateDB()
        exe = Executer.Executer(gdb)
        variables = set()
        req = ""
        data = []
        req = request.args.get('search')
        ppage = request.args.get('p').strip()
        pName = ""
        if ppage == "q1":
            pName = "PoliticalParty"
```

```
elif ppage == 'q2':
    pName = "Candidates"
elif ppage == 'q3':
    pName = "ElectoralOfficers"
elif ppage == 'q4':
    pName = "Voters"
elif ppage == 'q5':
    pName = "AccreditationAndVotingProcedureAtElection"
elif ppage == 'q6':
    pName = "CollationOfElectionResultsAndMakingOfReturns"
elif ppage == 'q7':
    pName = "Actors"
elif ppage == 'q8':
    pName = "Procedure"
elif ppage == 'q9':
    pName = "ElectionCollationLevels"
elif ppage == 'q10':
    pName = "PoliticalPosition"
elif ppage == 'index':
    pName = "Home"
print("<<<<<<<<<<<"+req+">>>>>>>>>>>>>>>>>>>>>>\n")
#if request.method == 'GET':
result = None
result = exe.executeLocalQuery(Queries.instanceDetail(req))
result_dict = {}
for res in result:
    prop = removePrefix(res["p"])
    if prop not in result_dict:
        result_dict[prop] = []
    sub = removePrefix(res["s"]) if res["s"] else ""
    obj = None
    if type(res["o"]) == rdflib.term.Literal:
        obj = str(res["o"].value)
    else:
```

```
                obj = removePrefix(res["o"]) if res["o"] else ""
            if sub and 'NamedIndividual' not in sub:
                result_dict[prop].append(sub)
            if obj and 'NamedIndividual' not in obj:
                result_dict[prop].append(obj)
        print(result)
        return render_template('details.html', result=result_dict, name=req, prev=
ppage, pName=pName)
    except Exception as e:
        print("Exception > ")
        print(traceback.format_exc())
    #result = exe.executeLocalQuery(Queries.subClassQuery("PoliticalParty"))
@app.errorhandler(500)
def internal_error(exception):
    print("500 error caught")
    etype, value, tb = sys.exc_info()
    print(traceback.print_exception(etype, value, tb))
def initiate(fileName, startDate):
    pass
if __name__ == '__main__':
   app.run(debug=False, host="0.0.0.0")
```

# APPENDIX B

## Similarity Report




Supervisor: Assist. Prof. Dr. John Bush IDOKO
Date: 16/06/2023

Signature: 

europass

# David Ogolo

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## ABOUT ME

Results-oriented Software Engineer and IT Professional with years of experience in designing, developing, and maintaining innovative software solutions. Proficient in various programming languages and frameworks, with a strong background in information technology. Adept at collaborating with cross-functional teams to deliver high-quality products. Dedicated to staying updated with the latest industry trends and technologies to drive continuous improvement and deliver exceptional results.

## WORK EXPERIENCE

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•

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**Website** https://coursera.org/share/e2f858b075d3460150bb34b000252876

**HTML, CSS, AND JAVASCRIPT FOR WEB DEVELOPERS** coursera

**Website** https://coursera.org/share/d457840d6ccb87ca2ef0369c58e37fc2