FILIET: An Information Extraction System

For Filipino Disaster-Related Tweets

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Abstract

The Philippines is considered the social media capital of the world, and the role of social media has become even more pronounced in the country during disasters. Twitter is among the many forms of social media. As experienced, information and data shared through Twitter have helped individuals, institutions, and organizations (government, public, and private) during emergency response, in making decisions, conducting relief efforts, and practically mobilizing people to humanitarian causes. However, extracting the most relevant information from Twitter is a challenge because natural languages do not have a particular structure immediately useful when programming. Another problem that information extraction faces is that some languages, like Filipino, is morphologically rich, making it even more difficult to extract information. Therefore, the goal of this research is to create Filipino Information Extraction Tool for Twitter (FILIET), a system that extracts relevant information from disaster-related tweets composed in Filipino.

***Keywords***: information extraction, disaster management, Twitter

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# Research Description

This chapter introduces the research undertaken in the field of Text Classification (TC) and Information Extraction (IE) in Natural Language Processing (NLP) for disaster management. This chapter is divided into four sections. The first section talks about the motivations and the problem that needs to be addressed. The second section discusses the objectives of the research. The third section details the scope and limitations of the study. Lastly, the fourth section tackles the significance of the research and its benefits to Philippine society.

## Overview of the Current State of Technology

According to a report of the United Nations International Strategy for Disaster Reduction (UNISDR) Scientific and Technical Advisory Group, disasters have destroyed lives, properties, and livelihood across the world. Just between 2000 and 2012, about 2 million people have died during disasters and an estimated US$ 1.7 trillion in damages have been recorded. In the same report, the UNISDR posits the use and research of new scientific and technological advancements in disaster management (Southgate et al., 2013).

Social media are online applications and platforms that aim to facilitate interaction, collaboration, and sharing of content. Social media can be accessed by computers or by smart phones. In a study of Universal McCann and an analysis of 24/7 Wall St., LLC about social media, the Philippines received a high rank in most of the categories. This led to the country being dubbed as the “Social Media Capital of the World” (Universal McCann, 2008; Stockdale & McIntyre, 2011).

Social media play a vital role in disaster management. For example, after the Haiti earthquake in 2010, numerous posts and photos were published in various social media sites. Just 48 hours later, the Red Cross has raised US$8 million. Social media have also enabled the generation of community crisis maps and interagency maps. They are maps that work as intermediaries between the public and relief organizations (Gao, Barbier & Goolsby, 2011). Patrick Meier, a crisis mapper, makes use of social media to improve the efficiency of relief efforts. He launched the website MicroMappers[[1]](#footnote-1), that quickly sorts through online data, from tweets to uploaded photos, and then displays the information on satellite maps, to assist in relief efforts during the disaster of Super Typhoon Haiyan (also called Yolanda) in the Philippines (Howard, 2013). To illustrate further how social media are significantly regarded, in a study commissioned by the American Red Cross[[2]](#footnote-2), it was revealed that 74% of the respondents expect response agencies to answer social media calls for help within an hour.

Twitter is a social media microblogging platform where users can post statuses in real-time. In times of disaster, Twitter is used to share information regarding the disaster including updates on response efforts. As part of the Philippine disaster management for natural calamities, the government has released an official newsletter detailing the official social media accounts and hashtags[[3]](#footnote-3). Filipino Twitter users tend to post tweets about requests for help and prayer. Other tweets pertain to traffic and weather updates, related observations, and class suspensions. While some users prefer to post messages in English, a large number of users also communicate with their native language when tweeting during disasters (Lee et al., 2013).

Knowing that various emergency response organizations aim to, as much as possible, attend to all requests for help, it would be very important and beneficial to have a system that is capable of extracting relevant disaster relief operation information from the contents that are posted by Filipino netizens in Twitter. Furthermore, it would be very helpful to have an information extraction system that is able to mine relevant information from the language that is dominant in the disaster-stricken areas, which, in the case of the Philippines, is the Filipino language and, at the same time, support the way how content is posted in Twitter like having certain formats (having #tags), writing style (TXTSPK and code-switched styles), etc. In general, having this system can open up opportunities for improving how disaster relief operations are planned and conducted in the Philippines, and eventually, can help save lives.

## Research Objectives

This section presents the general and specific objectives of the proposed research.

### General Objective

To develop an information extraction system that extracts relevant relief effort information from disaster-related tweets.

### Specific Objectives

The following are the specific objectives of the research:

1. To review different information extraction systems;
2. To identify the different types of disaster-related tweets and the relevant information needed in relief operations;
3. To review different NLP techniques that are applicable in pre-processing Twitter data;
4. To analyze different approaches used in implementing an information extraction system;
5. To evaluate existing tools and resources that could be incorporated in the information extraction components of the system;
6. To determine the metrics for assessing the performance or effectiveness of the information extraction system.

## Scope and Limitations of the Research

The research is about the design of an information extraction system for the Filipino language. Review of various information extraction systems to know the different approaches to implementation was covered. Different existing domain-independent, domain-dependent information extraction systems were also analyzed to understand their components, architectures, and implementation. Additionally, this study examined information extraction for MRL to grasp the techniques used to extract from MRL given that the Filipino language is considered an MRL.

For the system to extract relevant information, the research determined which information details are deemed relevant in times of disaster, especially in relief operations. The research also identified the different types of disaster-related Tweets to support the task of discerning relevant information from the given tweets. Other researches on the use of Twitter in disaster management were also evaluated to aid in the formulation of ontologies of the information extraction system developed in this study.

In terms of system performance, the research looked into different natural language processing techniques used for data preprocessing before feeding them into the information extraction system. Examples of the NLP techniques are text classification and text normalization. Text classification is the process of automatically assigning a text or document into a predefined category based on its content (Özsu & Liu, 2009). Texts may need to be classified according to categories so that the system can use appropriate algorithm to extract the information. Text normalization is the transforming of ill-formed words into their canonical forms (Han & Baldwin, 2011). The information extraction system will need a text normalizer as data coming from Twitter are noisy. Most of the text has no structure, incorrectly spelled words, and invented terms.

Different information extraction techniques were also examined. Some of these are Named Entity Recognition (NER), lexical analysis, and conference analysis. Lexical analysis involves splitting up sentences into words and performing Part-Of-Speech tagging to each word (Grishman, 1997). NER is the classification of each word into a category (Zhou & Su, 2002). Co-reference analysis is the resolving of references for the pronouns (Grishman, 1997).

Existing NLP tools for building information extraction systems were also reviewed. Examples of these tools are OpenNLP and Lingpipe. OpenNLP is a machine learning based toolkit for the processing of natural language text that can support a number of common NLP tasks like tokenization, sentence segmentation, part-of-speech tagging, named entity extraction, chunking, parsing, and co-reference resolution (Apache Software Foundation, 2010). On the other hand, Lingpipe is a toolkit for processing text using computational linguistics that can perform certain tasks like finding names of people/organizations/event, classify Twitter data, and check spellings (Alias-I, 2011).

Lastly, metrics were determined to measure system performance.

## Significance of the Research

Being the social media capital of the world, the Philippines generates a lot of diversified information that cannot be easily tapped because of the limited capabilities and tools that are available in processing the language unto which these information are written in, the Filipino language. With Twitter being one of the most commonly used social media platforms in the country, a new level of information dissemination has been established. With an information extraction system that is built for the Filipino language and at the same time for supporting texts that are found in Twitter, respective stakeholders can explore more possibilities and opportunities with regard to effectively utilizing such information from the web and use them for disaster management purposes.

From a disaster management standpoint, there are a number of advantages to having an information extraction system that is specifically made to work with Twitter texts that are written in the Filipino language.

First, respective stakeholders can collect disaster-related information in a way that is less strict because with an information extraction system built for the two languages, stakeholders can effortlessly accept and process information that are written in a much more natural and open way. With this, they can reach out to more people and to more places because they can have a system that can extract information from how Filipinos speak and communicate through the different social media platforms available, and to be specific, in Twitter.

Second, with an information extraction system, respective stakeholders can easily make use of the information that are written in the format of the different variations of the languages like the ‘TXTSPK’ and ‘Code Switching’. With a custom-built information extraction algorithm, the information extraction system will be able to increase the probability of accurately and precisely extracting relevant information.

Third, the information that can be extracted from Twitter can be further utilized to help in disaster relief efforts. With a system that can further categorize tweets automatically can help in extracting more straightforward and meaningful information about the current state of disasters. Certain types of tweets can indicate a specific set of relevant information that can be extracted. Take, for instance, Disaster Information Tweets. Information that can be extracted from this kind of tweets can include, but not limited to, the type of disaster, location of disaster and etc. Or take, for instance, Casualty Report Tweets. Information like the number of casualties or the names of missing people can be extracted from this type of tweets.

Lastly, with can information extraction system that can organize the extracted relevant information, respective stakeholders can now expedite the process of conducting relief operations since they can be presented with information that has already been processed to be easily read and understood by the normal people. With this information extraction system, the process of consolidating necessary relevant disaster-related information can be more intuitive and faster.

## Research Methodology

Scrum-based methodology, an iterative software development life cycle, was applied in the course of this research.



Figure ‑. Research Methodology Phases

Figure 1‑1 shows a diagram of the phases the research will undergo. The phases are as follows: investigation and research analysis, system design, system development, system integration and testing, system evaluation, and documentation. Regular consultation with the thesis adviser will also be conducted in order to keep the research on track for the whole duration of the thesis.

## Investigation and Research Analysis

This phase involves the study and understanding of the fundamental knowledge of the concepts, algorithms, techniques, and tools that can be used to implement the system as well as identifying the modules and requirements of the system to be developed. The key activity involved in this phase is literature reviews of related works. From the review process, the techniques, tools, and metrics were then compared to verify which can be adapted to the system.

### System Design

With the information takeaways from the earlier phase, system design commences. In this phase, appropriate architectures, algorithms, information extraction techniques, and other necessary tools are identified so that they can be effectively utilized in system creation. In addition, in this phase, necessary modules for the system are also identified based on the different processes and features that will be built into the system. The designs of the User Interfaces and the basic architecture for the databases are also covered in this stage. Finally, this phase also addressed data source identification for use and processing by the system. Once the data sources have been identified, data collection immediately commences.

### Sprints

There is a two-week timeframe for each sprint to ensure that there is progress in the research. Each member is expected to produce a working output based on the tasks assigned to him during the sprint planning meetings. The tasks may vary from developing a part of the system to conducting further study regarding a certain concept.

### Sprint Planning Meetings

At the beginning of each sprint, a sprint-planning meeting is conducted. Tasks that must be accomplished for the current sprint are discussed here. Included in these meetings is the assignment and division of the tasks among the members of the team. The evaluation of tasks from the previous sprint is also done here. If there are any unmet tasks, these will be carried over to the next sprint.

### Scrum Meetings

Scrum meetings of 10-15 minutes in duration are conducted daily. The purpose is to update each member about what has or has not been accomplished yet in the assigned tasks. This ensures that there is daily progress and if there are issues that hinder members from accomplishing their assigned tasks so that they can be assisted.

### System Development

From the design phase, system development follows. Data collection will also be done in this phase. Each team member is assigned to modules. The development of the system follows a scrum-based methodology wherein the system is developed in an iterative manner. Daily and weekly meetings, as well as regular consultations with the adviser, are conducted to assess the progress of the thesis and to plan the succeeding tasks.

### System Integration and Testing

All the modules that have been developed are integrated into one system. This phase is also about unit testing processes for each module to ensure that there will be no significant bugs that can be found after integration processes are completed. After finishing integration, the system is then subjected to another round of tests to check again for any faulty integration and bugs.

### System Evaluation

This phase is system performance evaluation following the metrics selected and reviewed. The following metrics have been identified so far: Precision, Recall, and F-measure results of the information extracted by the system. A number of tests of information extracted manually and those from the training set are undertaken to compare and validate results. The metrics can also be modified as needed depending on additional tests and findings in the future.

### Documentation

Documentation of activities, methodologies, and of the system developed is important for monitoring and modification or improvement purposes. It will also be used for further reference, in case there is a need to validate or cross-reference any future work.

### Calendar of Activities

Table 1‑1shows a Gantt chart of the activities for the thesis period. Each bullet represents one week worth of activities.

Table ‑. Timetable of Activities (April 2014 - April 2015)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Activities | Apr  (2014) | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr  (2015) |
| Investigation and Research | \_ \* \_ \* | \_ \_ \* \* | \_ \* \* \* | \* \* \* \* | \* \* \* \* |  |  |  |  |  |  |  |  |
| System Design |  |  |  |  | \_ \_ \* \* | \_ \* \* \* | \* \* \* \* | \* \* \* \* | \* \* \_ \_ | \_ \* \* \* | \* \* \_ \_ |  |  |
| System Development |  |  |  |  | \_ \_ \* \* | \_ \* \* \* | \* \* \* \* | \* \* \* \* | \* \* \_ \_ | \_ \* \* \* | \* \* \_ \_ |  |  |
| System Integration and Testing |  |  |  |  | \_ \_ \* \* | \_ \* \* \* | \* \* \* \* | \* \* \* \* | \* \* \_ \_ | \_ \* \* \* | \* \* \_ \_ |  |  |
| System Evaluation |  |  |  |  | \_ \_ \* \* | \_ \* \* \* | \* \* \* \* | \* \* \* \* | \* \* \_ \_ | \_ \* \* \* | \* \* \_ \_ | \* \* \* \* | \* \_ \_ \_ |
| Documentation | \_ \* \_ \* | \_ \_ \* \* | \_ \* \* \* | \* \* \* \* | \* \* \* \* | \* \* \* \* | \* \* \* \* | \* \* \* \* | \* \* \_ \_ | \_ \* \* \* | \* \* \* \* | \* \* \* \* | \* \_ \_ \_ |

# Review of Related Works

This chapter discusses the features capabilities, and limitations of existing research, algorithms, or software applications that are related or similar to this research.

## Machine Learning-Based Information Extraction Systems

This part discusses information extraction systems that use machine learning-based techniques.

##### Machine Learning for Information Extraction in Informal Domains (Freitag, 2000)

The researchers of the paper explored one variation of the slot-filling problem, specifically how to find the best unbroken fragment of text to fill a given slot in the answer template. A definite template is given to an IE task. The template consists of fields that need to be filled with instances from the text source. The researchers set two ways of simplifying how to study the behavior of the algorithms to be developed: to isolate each field, learn the problem and focus on fields that are not instantiated or have a unique instance in a text source. With this, they found two primary aspects: multi-strategy learning and feature engineering. Multi-strategy learning because they believed that there is no single representation for all IE problems. Feature engineering because the ML of a feature set is needed to help adapt to domains containing novel structures because they will target informal domains. The researchers used four ML components: rote learning, term-space learning, learning abstract structure with grammatical inference, and relational learning for information extraction. They conducted experiments to gauge the performance of the four components.

In summary, the researchers found that it is possible to perform IE from informal domains found in the internet. Also, they stated that ML is a rich source of ideas for different algorithms that can be trained to perform IE. They have shown that with the right ML techniques, training effective extractors with very simple document representations is feasible.

##### TOPO - Information Extraction System for Natural Disaster Reports from Spanish Newspaper Article (Téllez-Valero, 2005)

This information extraction system extracts information related to natural disasters from newspaper articles written in Spanish. The system extracts the following information: (1) information related to the disaster itself (date, place, and magnitude), (2) information related to buildings (number of destroyed buildings, affected houses), (3) information related to people (number of casualties, missing or wounded), (4) information related to infrastructure (number of affected hectares, economic losses. It is able to extract information on natural disasters like hurricanes, forest fires, inundations, droughts, and earthquake.

The system uses general information-extraction system architecture. First, the document is turned into Boolean vectors representing the presence and absence of certain words. This stage is the document feature extraction. To limit the dimension, they used information gain technique. After conversion to a Boolean vector, classification follows. They used Support Vector Machine (SVM), Naïve Bayes (NB), C4.5, and k-Nearest Neighbors (kNN). After classification, text that might contain relevant information is selected. This stage is the candidate text selection. This process uses grammar to select the text and a dictionary of names and number to treat grammar exceptions. Then the output becomes candidates of relevant information. The system will then select which of the information will be used. This system uses the same algorithms in the text classification stage. They used different classifiers for different outputs.

This architecture boasts of its portability because it is language independent and domain adaptive. It is language independent because its training features and candidate text segments are based on simple lexical rules. It is domain adaptive because it only needs to change the training corpus.

In this work, the text filtering stage was evaluated on 134 news reports on the metrics of precision, recall, and F-measure. The algorithm that produced the best result was the SVM. They obtained an F-measure from 72% to 88% on the classification of news reports. The information extraction stage was evaluated on 1353 text segments that consist of names, dates, and quantities randomly taken from 365 news reports. The best classifier for the name and quantities was SVM, while it was kNN for dates. The overall system obtained an average of 72% on the F-Measure.

##### EVIUS (Turmo & Rodriguez, 2000)

EVIUS is a multi-concept learning system for free text that follows a multi-strategy constructive learning (MCL) approach. The system also supports insufficient amounts of training corpora. M-TURBIO is the multilingual IE system where EVIUS is its component. The system’s input is both a partially parsed semantically tagged training corpus and a description of the desired target structure. The system’s approach to learn is by using MCL with constructive learning, closed-loop learning, and deductive restructuring (Ko, 1998). EVIUS decides which concepts to learn and updates the IE rule sets continuously. The system uses FOIL (First-Order Induction Learning) (Quinlan, 1990) to create an initial rule set from a set of positive and negative examples. Positive examples can be selected using a friendly environment either as text and ontology relations. Negative examples are automatically selected. If any uncovered positive examples remain after using FOIL, this is because there are insufficient examples. The system tries to develop recall by growing the positive examples with artificial examples (pseudo-examples). Combining the uncovered example vector and a randomly selected covered vector makes a pseudo-example. This is done as follows: For each dimension, one of both possible values is randomly selected as the value for the pseudo-example. The new set of positive examples is now executed again using FOIL, the resulting set will be combined with the first rule set.

## Rule-Based Information Extraction Systems

This part discusses information extraction systems that use rule-based techniques.

##### Vietnamese Real Estate (VRE) Information Extraction (Pham & Pham, 2012)

The Vietnamese Real Estate (VRE) Information Extraction system extracts information from Vietnamese real estate advertisements. It collects information like the type of estate, category of the estate, area, zone, price, name of the author, and contact details. The system uses the GATE framework for its architecture.

For its data, it has to pass specific criteria before it is fed into the system. First, input must be news articles related to real estate advertisements. Second, only one advertisement is allowed from each input data file. Lastly, it must be stripped off of all its HTML tags. After the data have met all the criteria, it will now go to data normalization. This process helps reduce ambiguity and assists in the annotation process. The necessary punctuation at the end of each sentence is also added. Second, it merges multiple paragraphs into one. Third, punctuations are normalized, redundant spaces are removed, and the first character after each punctuation is capitalized. Lastly, the telephone, price, area, and zone details are normalized to a common pattern. Upon completion, the data will now be manually annotated using Callisto, an annotation software.

After annotation, data are now ready to go to the information extraction system. It will go first through the tokenizer. The tokenizer will output two types of annotations, Word and Split. The Word annotation contains the part-of-speech, the word; it also checks if the first letter is capitalized, and has other features (kind and nation). This will be used to create the Java Annotation Pattern Engine (JAPE) rules. The Split annotation contains the delimiter. The next process is through the Gazetteer. Gazetteers are dictionaries that are created during system development and they include potential named entities (person, location) or categories, phrases used in contextual rules (name prefix or verbs that are likely to follow a person’s name), and potential ambiguous entities. The output of the gazetteer is a lookup annotation covering the specific semantics. After this process, the text or data will now be passed on to the JAPE transducer. The JAPE transducer is responsible for extracting the information. It uses JAPE rules to recognize the entities that will need to be extracted. The annotated documents are the output.

The system has been tested using a lenient criterion and a strict criterion. An entity that is recognized correctly when the type is correct but the span overlaps in the annotated corpus is called the lenient criterion. On the other hand, an entity that is recognized correctly when the type and span are the same in the annotated corpus is called strict criterion. On the lenient criterion on test data, it registered 96% on the F-measure. While on the strict criterion, it registered 91% on the F-measure. The problem is on the data. The writing styles of the people are very diverse. The system has a problem in recognizing some of the entities like the zone entity because some of the zone entities are very long and do not observe capitalization.

##### Business Specific Online Information Extraction from German Websites (Lee & Geierhos, 2009)

The Business Specific Online Information Extraction System is a system that extracts information from the information pages of a German business website like its company profile, contact page, and imprint, and then identifies relevant business specific information. The system concentrates on the extraction of specific business information like company names, addresses, contact details, names of CEOs, etc. With regard to how the researchers pre-process their chosen input data, they interpret the HTML structure of documents and analyze some contextual facts to transform the unstructured web pages into structured forms. The approach applied by the researchers is quite robust in the variability of the DOM (for the web pages); it is also upgradeable and keeps data up-to-date. The evaluation metrics showed high efficiency of information access to the generated data. In conclusion, they stated that the developed technique is also adaptive to non-German websites with slight language-specific modifications, and experimental results from real-life websites confirm the feasibility of their approach.

In their proposed system, the researchers had two main modules for processing and extracting information from the German Information Web Pages: one for establishing a relational database storing company information and the other is for providing a query module. Within these two modules are three sub-processes that are done to further process the input data: (A) Localization of the Information Pages on the Web; (B) Document Analysis and Information Extraction; lastly, (C) Query Processing. In sub-process A (Localization of the Information Page), a web crawler is fed with the URLs of the web pages that are stored in the specialized database and then it fetches them from the web. Afterwards, the proposed system will then retrieve the document by following the anchor tags that lead to the information pages. On the other hand, in sub-process B (Document Analysis and Information Extraction), the fetched Information Pages are sent to an ‘info analyzer’ module which examines the HTML content of the page and then extracts the needed information bits. Here, the system exploits the internal structure of the named entities and uses sublanguage-specific contexts or attribute classes to identify the attribute-value pairs. Lastly, in sub-process C, the user of the system is given the right to query the database for information bits that he/she needs and then add these bits to the index.

For the Information Page Analyser (info analyser) in sub process B, the input data has to go through a number of processes to finally extract the information needed by the user. When given an Information Page, the analyser starts by pre-processing the frame structure and existing JavaScript of the page. Before creating the expressive DOM Tree, the HTML file of the page has to be validated and corrected, if needed, by using a special tool called ‘tidy’. After doing so, the system will now be able to locate the minimal data region (or the data region of the information bit searched for) surrounded by a number of HTML tags which contain the information record being searched. By doing a depth- first traversal of the expressive DOM tree, the desired subtree can be isolated based on the headings of the data record like the following: “Herausgeber” (publisher), “Betreiber” (operator), “Anbieter” (provider), etc. The system was programmed to disregard domain-name irrelevant information; thus, the analyser will work further with a pruned DOM tree. After identifying the minimal data region, all information bits that are relevant to the domain name are extracted by using the Named-Entity Recognition technique and the attribute-value process (each attribute has a corresponding value that is indicated by the structure of the HTML file it is in) with respect to its external contexts and internal features. The system’s analyser module considers about 20 attribute classes and searches their corresponding values on the information page of business websites. The following are some of the attribute classes that are considered by the analyser: company name, address, phone and fax number, e-mail, CEO, management board, domain owner, contact person, register court, financial office, register number, value added tax number (VAT ID), and etc. After extracting the information bits needed from the pruned DOM trees, the information bits are then normalized to make sure that all information are consistent. The following are the classes that are affected by the normalization process: company names, legal form, register number, address (street, zip code, city), contact (phone and fax number, email), person name, and legal notification (tax number, VAT ID).

To conclude, the system performed surprisingly accurate with an average precision score of 99.1% and a recall score of 91.3% from a small test corpus that was composed of approximately 150 business web pages. The only encountered problem by the system was when value for certain attributes were erroneously represented like text in phone numbers, among others.

## Template-Based Architecture

A template-based information extraction system uses templates to extract information. A template-based information extraction will only be able to extract information that is deemed important by the user. Its performance is based on how the user created the templates (Corney et al., 2008).

##### An Open Architecture for Multi-Domain Information Extraction (Poibeau, 2001)

Thierry Poibeau has provided a general architecture for developing information extraction systems regardless of its domain (Poibeau, 2001). In his paper, he proposed an information extraction architecture that takes advantage of the capabilities of machine learning to help researchers define new templates (this is where the extracted information is being filled in) with respect to the IE system’s domain.

Poibeau’s architecture is divided into 5 main modules: (1) the module for extracting information from the structure of the text; (2) the module for named entity recognition which is responsible for recognizing places/dates/etc.; (3) the module for the semantic filters; (4) the module for the extraction of specific domain-dependent information; and lastly, (5) the module for filling in a result template.

In module 1, a number of information are extracted from the structure of the input text. It is in this module where information that is embedded in the structure of the text is extracted such as those that are written in HTML or XML formats. On the other hand, in module 2, relevant information are extracted/recognized through linguistic analysis. This module is responsible for recognizing the different named entities present in the input text like names, places, and dates. Poibeau made use of the finite-state tool *Intex* to develop this module. Furthermore, in module 3, text categorization is performed on the set of so-called “semantic signatures” that were produced from a semantic analysis of the input text. Poibeau made use of the French system Intuition™ to develop this module. In addition, in module 4, specific information like the specific relationships between named entities are extracted by applying a grammar of transducers or extraction patterns on the input text. Lastly, in module 5, all the information extracted from the input text are linked together to fill in a specific result template(s) that present(s) a summarized view of the extracted information. Figure 2‑1 illustrates the general architecture proposed by Poibeau.

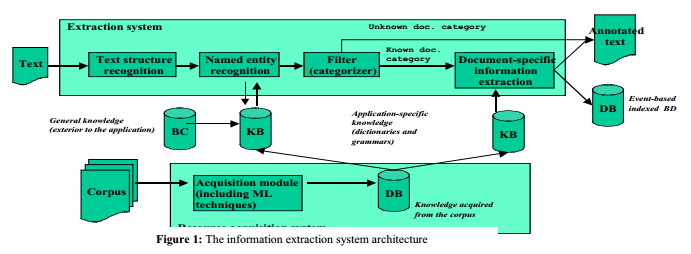


Figure ‑. Poibeau's General Architecture

## Ontology-Based Information Extraction Systems

This part discusses information extraction systems that use ontology-based techniques.

##### Ontology-Based Information Extraction (OBIE) System for French Newspaper Articles (Nebhi, 2012)

As most information extraction systems are based on the English language, it poses a problem for other languages in terms of limited tools available. To address this problem, the system maps the extracted entities to the ontology.

This system extracts names of persons, locations, and organizations from French newspaper articles. It collects data from LeMonde.fr. The system uses the GATE framework for annotation of entities in text and maps them to the ontology. It uses DBpedia databank that is based on Wikipedia projects. It contains 3,220,000 instances and is organized into a hierarchy of 320 classes and 1650 different properties. The system consists of 4 parts: pre-processing, gazetteer, rule-based semantic annotation, and the output. First, the system will pre-process the text. It will perform tokenizer, sentence splitter and POS tagger using the GATE application. After it is pre-processed, it will now go to the gazetteer. It will perform a lookup for the named entity recognition. After it passes through the gazetteer, grammar rules will be applied to create semantic annotation. The rules are written in JAPE which is part of the GATE framework. The system contains approximately 100 rules.

The system is evaluated using the Balance Distance Metrics (BDM) to consider ontological similarity. They manually annotated the documents using concepts on DBpedia ontology, and then compared it with the gold standard. They only evaluated person-, organization-, and location-named entities. The system scored an average of 0.94 on the BDM and achieved a 91% F-Measure.

## Other Information Extraction Systems

This part discusses information extraction systems that use other techniques.

##### SOMIDIA - Social Monitoring for Disaster Management (Cheng et al., 2013)

SOMIDIA is a crisis-mapping system that focuses on plotting disaster on an interactive map in near real time. SOMIDIA collects data from different sources like news feeds, posts, SMS, blogs, and microblogs. One of the main components of SOMIDIA is its information extraction module. It extracts from both Filipino and English texts.

For the information extraction module, first, documents go through a tokenizer. They use OpenNLP to tokenize the document, then it will go to a sentence splitter. The sentence splitter accepts a list of tokens and an annotation list. It has a list of abbreviations so that the system can distinguish abbreviation periods from a period. The goal of the sentence splitter is to separate sentences by adding appropriate ending markers (period). The system uses OpenNLP’s sentence splitter for its sentence detection. After the document has been split into sentences, it will go through a language guesser. They needed to differentiate English text from Filipino text because the language has different extraction techniques. They used frequency distribution of the words to detect the language. The output of the language guesser is the document with added metadata of the language. If the text is in English, the language guesser will pass the document to the POS tagger. Otherwise, it would be passed on to a Filipino NER.

For the English information extraction module, first it will go through the POS tagger. It uses the OpenNLP’s POS tagger function. The output is a list of tokens with its corresponding POS tags. After the POS tagger, it will go through a ‘chunker’. The chunker groups the tokens into their corresponding part-of-speech tag. This will be used to determine noun and verb phrases. It uses OpenNLP’s noun and verb chunker. After chunking, it will pass through the English NER. The NER only focuses on proper nouns. It uses LingPipe because of its flexibility. LingPipe’s NER uses three types of approaches, dictionary-based, rule-based, and statistic-based approaches. After the NER, it will go through co-reference resolution. The co-reference resolution will find the noun counterpart of the pronouns. It uses the Russian Mitkov algorithm for the resolution and WordNet for the lexicon. The normalization (standardizing data, collapsing of same sentences) will be done in this phase. The last step is the information extraction phase. It uses JAPE rules to extract the information, and the rules are paired with the two-tiered bootstrapping algorithm. The first tier bootstrapping algorithm starts with a small seed of words or rules. Then from the seed, it will try to learn the extraction pattern. The learned pattern will be used to generate a new extraction pattern. The process will then be repeated. The second-tiered bootstrap is responsible for keeping the most relevant extraction pattern.

For the Filipino extraction module, the document will go through the Filipino NER. They created their own NER because there is no existing Filipino NER tool. It uses dictionary-based and rule-based approaches for their NER. After tagging, it will now go through the Filipino extractor; the Filipino extractor has pre-defined rules (e.g. <event> sa <location>) that will extract the needed information.

The system is evaluated using precision, recall, and F-measure. They evaluated it on Tweets and news feeds. For English tweets, it scored a 75.17% F-measure on extracting disaster and 62.83% on extracting location. For Filipino Tweets, it scored 82.13% F-measure on disaster and 56.32% on extracting location. For news feeds, it scored 45.40% F-measure on English news feeds, while 38.82% on Filipino news feeds. The tweets scored higher because it is much easier to extract patterns on shorter text. The needed information will most likely be located near the text. On longer texts, the information needed might be located far away.

Table 2‑1 shows a summary of all the reviewed information extraction systems. The table lists the system name, the language, and type of data it can extract, the domain, NLP pre-processing techniques, information extraction techniques, and evaluation metrics used by the system.

Table 2‑1. Summary of Reviewed Information Extraction Systems

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| System | Language | Type of Data | Domain | Pre-processing Techniques | Information Extraction Techniques | Evaluation Metrics |
| Machine Learning for Information Extraction in Informal Domains  (Freitag, 2000) | N/A | Documents (i.e. email) | Informal Domain | Not mentioned | Machine Learning-Based | Precision, Recall |
| TOPO - Information Extraction System for Natural Disaster Reports From Spanish Newspaper Article  (Téllez-Valero, 2005) | Spanish | Free-text | Natural Disasters | Text Classification, Document Feature Extraction | Machine Learning- Based | Precision, Recall, F-measure |
| VRE Information Extraction System  (Pham & Pham, 2012) | Vietnamese | Free text | Real Estate Advertisement | Text Normalization | Rule-Based | Precision, Recall, F-measure |
| Business Specific Online Information Extraction from German Websites  (Lee & Geierhos, 2009) | German | Structured Text | Business Specific Information | Named Entity Recognition, Text Normalization, Attribute-Value Process | Rule-Based | Precision, Recall |
| Ontology-Based Information Extraction (OBIE) System  (Nebhi, 2012) | French | Free text | News article | Tokenization, POS Tagging, Sentence Splitter | Rule-Based, Ontology | Precision, Recall, F-measure, BDM |
| Social Monitoring for Disaster Management  (Cheng et al., 2011) | English, Filipino | Free text | News article, tweets | Tokenization, Sentence Splitter, Language Guesser | Machine-Learning Based | Precision, Recall, F-measure |

## 

## Disaster Management – Relief Operations

This part discusses more about Relief Operations and the different information that are essential to this aspect of Disaster Management.

##### Humanitarian Knowledge Management (King, 2005)

This paper discusses the complexities and numerous challenges that many humanitarian organizations face whenever complex international humanitarian emergencies occur and how certain critical information in relation to disaster management activities, such as humanitarian assistance or relief operations can be utilized to help facilitate needed actions. King mentioned that the problem lies on the management of the data needed about these emergencies. In his paper, King stated that data management includes identifying, presenting, and disseminating critical information about the situation although such critical information, in itself, present a serious problem that could greatly affect data management. The problem lies in how this critical information is gathered: what information should be gathered and where should these be taken from? Upon efficiently identifying this in the early stages of these kinds of activities, as King mentioned, humanitarian organizations can more effectively make contingency plans and respond to natural disasters and complex emergencies and at the same time, potentially save a significant number of lives.

In the paper, a specific section was made to discuss what information are essential and crucial to different humanitarian organizations whenever they would conduct relief operations as a response to international complex emergencies like natural disasters and etc. According to King, humanitarian organizations like NGOs, UN agencies, local and national government, etc. need two specific types of information: (1) background and (2) situational information. Furthermore, information that is not within these types is more pertinent, relevant and critical to various specific personnel that are also within the said organizations. To support this claim, King gave an example through a scenario. He mentioned, “*policy makers want “big picture snapshot” analysis in order to understand the issues, to make decisions on providing assistance, and to be alerted to problems and obstacles*…*field personnel and project and desk officers in aid organizations, on the other hand, need more detailed operational and programmatic information in order to plan and implement humanitarian assistance and reconstruction programs.*”

With all of these, King listed down four main categories for the different vital information that is needed by organizations whenever they would conduct relief operations. Table 2‑2 lists the four categories as well as their description and guide question that helps in determining which category the information belongs to.

## Twitter and Disaster

This part discusses the uses of Twitter in times of disaster, the information that are useful during disasters, the information that can be extracted from disaster-related tweets and lastly, systems that make use of Twitter for disaster management procedures.

##### Extracting Relevant Information Nuggets from Disaster-Related Messages in Social Media (Imran et al., 2013)

This paper focuses on the extraction of relevant information from disaster-related tweets. The data set the authors worked with are Twitter data during hurricane Joplin on May 22, 2011 with #joplin. Their approach includes text classification and information extraction.

First, the tweets were classified into their respective categories. Table 2‑3 lists the categories for the tweets. After filtering the tweets, only those of the Informative category were used. The informative tweets were further categorized into the information types they contained, which is listed in Table 2‑4. The basis for the categories was from the ontology by Vieweg et al. (2010).

Table ‑. Four Main Categories of Vital Information

|  |  |  |
| --- | --- | --- |
| Category | Description | Guide Questions |
| Situational Awareness | Information about the latest situation on the ground and information about the conditions, needs, and locations of affected populations | * What is the latest/current humanitarian situation in the country? * What are the most recent severity indicators? (Death tolls, mortality rates, malnutrition rates, economic impact, infrastructure damage, etc.) * Who are the affected populations (refugees, IDPs, children and other vulnerable groups, resident populations, etc.); how many are there, and where are they located? * What are the conditions and humanitarian needs of the affected populations? * What is the assessment of damage to infrastructure? (Transport, buildings, housing, communications, etc.) * What is the latest/current security situation in the affected areas of the country? |
| Operational / Programmatic | Information necessary to plan and implement humanitarian assistance programs | * Where are and what are the conditions of the logistical access routes for delivering humanitarian assistance? * Who’s doing what where? What humanitarian organizations are working in the country, what are their programs, what are their capacities, and where are they working? * How is the host country/government responding and can it provide more? * What are the programmatic/financial needs of the humanitarian organizations? * What and how much are being provided to the humanitarian response organizations and who are the donors? |
| Background | Information about the unique history, geography, population, political and economic structure, infrastructure and culture of the country to be able to compare the emergency situation and conditions to previous normal conditions; and lastly | * What are the country’s population (national, province/state, city/town) and composition (ethnicity, religion, age cohorts, urban/rural, political, etc.)? * What is the geography of the country? * What are the country’s past disasters and natural hazards? * What are the most recent annual baseline health indicators for the population? (crude mortality rate, infant/child mortality rates, HIV adult prevalence, malnutrition, etc.) * What are the annual economic indicators? (GDP, GNP, agricultural/food production, staple food prices, etc.) |
| Analysis | Humanitarian information needs to be interpreted in context and related to other thematic information. Analysis can include evaluations of issues and responses, projections about the future, and recommendations for policies and actions | * What are the causes and contributing factors of the emergency? * What are the constraints to providing humanitarian assistance? (Insecurity, inaccessibility, government, interference, etc.) * How effective are humanitarian assistance programs and responses? * What are the future impacts of the emergency? * What are the options and recommendations for action? |

## 

Table ‑. Tweet Categories

|  |  |
| --- | --- |
| Category | Description |
| Personal Only | If a message is only of interest to its author and his/her immediate circle of family/friends and does not convey any useful information to other people who do not know the author. |
| Informative  (Direct) | If the message is of interest to other people beyond the author's immediate circle, and seems to be written by a person who is a direct eyewitness of what is taking place. |
| Informative  (Indirect) | If the message is of interest to other people beyond the author's immediate circle, and seems to have been seen/heard by the person on the radio, TV, newspaper, or other source. The message must specify the source. |
| Informative  (Direct or Indirect) | If the message is of interest to other people beyond the author's immediate circle, but there is not enough information to tell if it is a direct report or a repetition of something from another source. |
| Others | If the message is not in English, or if it cannot be classified. |

To classify the tweets into the categories mentioned, Naïve Bayesian classifiers were trained and implemented using Weka. Their features include binary features (if the tweet contains the ‘@’ symbol, hashtags, emoticons, links or URLs, and numbers), scalar features (the length of the tweet), and text features (unigrams, bigrams, POS tags, POS tag-bigrams, and VerbNet classes).

For each informative tweet category, various types of information, referred to as information nuggets, were extracted. Table 2‑5 shows the extractable information nugget per informative tweet category as well as that category’s type subsets. The location references, time references, and number of casualties were extracted using the Stanford Named Entity Recognizer. All the Twitter Handlers (i.e. all words starting with the ‘@’ symbol and URLs) were extracted from the tweet for the sources. Caution/Advice and Damaged Object were extracted using the Stanford Part of Speech Tagger and WordNet. For the intention of the tweet, another classifier was trained to determine if the tweet is a donation effort or a request for help. Lastly, the type information nugget pertains to the Type Subset column. For each informative tweet category, another classifier was trained to classify the category into its corresponding subset.

Table ‑. Informative Tweet Categories

|  |  |
| --- | --- |
| Category | Description |
| Caution and advice | If a message conveys/reports information about some warning or a piece of advice about a possible hazard of an incident.  Example: “Alerto sa Mayon Volcano, itinaas ng Phivolcs sa level 2” |
| Casualties and damage | If a message reports the information about casualties or damage done by an incident.  Example: “Bush fires destroy 50 hectares in Baler, Aurora – NDRRMC http://t.co/Oc70OMeung49” |
| Donations of money, goods or services | If a message speaks about money raised, donation offers, goods/services offered or asked by the victims of an incident  Example: “Repacking of Mineral waters! (@ Dano Residenza) http://t.co/iHUn4XA7jb” |
| People missing, found, or seen | If a message reports about the missing or found person affected by an incident or a celebrity seen visiting ground zero  Example: “@philredcross missing joahnna nicole juliana ortiz sn isidro sulat eastern samar maytigbao church evacuation http://t.co/PGLnSEOtmY” |
| Information source | If a message conveys/contains some information sources like photo, footage, video, or mentions other sources like TV, radio related to an incident.  Example: “VIDEO: Alert level 2, itinaas sa Mayon Volcano http://t.co/g6U5AziDFt” |

Table ‑. Extractable Information Nugget per Informative Tweet Category

|  |  |  |
| --- | --- | --- |
| Informative Tweet Category | Information Nugget | Type Subsets |
| Caution and advice | Location references  Time references  Caution/Advice  Source  Type | Warning issued or lifted  Siren heard  Shelter open or available  Disaster sighting or touchdown |
| Casualties and damage | Location references  Time references  Number of Casualties  Damaged Object  Source  Type | Infrastructure  Death  Injury  Unspecified  No Damage  Both Infrastructure and People |
| Donations of money, goods or services | Location references  Time references  Intention of Tweet  Source  Type | Money  Blood  Voluntary Work  Food  Equipment  Shelter  Discounts  Other |
| Information source | Location references  Time references  Source  Type | Photo  Video  Website  TV Channel  Radio Station  Unspecified |

##### **Practical Extraction of Disaster-Relevant Information from Social Media (Imran et al.,** 2013)

Based on their previous paper Extracting Relevant Information Nuggets from Disaster-Related Messages in Social Media, after classifying the tweets into the informative tweet category, they extracted the information by employing a different approach. This time, they used two datasets: (1) tweets during hurricane Joplin on May 22, 2010 with #joplin and (2) tweets during hurricane Sandy on October 29, 2012 with #sandy #nyc.

To detect class-relevant information, they treated it as a sequence-labeling task. For each token in the tweet, they labeled it as either part of the relevant information or not. The (+) label indicates that the token is part of the relevant information while the (-) label indicates that it is not. After labeling, they applied Conditional Random Fields (CRF) to extract the information. A tool they also used in this paper is ArkNLP, a Twitter-specific POS tagger.

##### Safety Information Mining - What can NLP do in a disaster (Neubig et al., 2011)

In the article presented by Neubig and his team of researchers, they described the efforts of researchers in the field of Natural Language Processing in creating an information extraction system that aided in the relief operations during the 2011 East Japan Earthquake. The system that was described was primarily built to ease the mining of information regarding the safety of those affected by the earthquake from one of the most prevalent information source during that time, that is, Twitter. The system included subsystems that work for the following NLP and IE techniques like word segmentation, named entity recognition, and tweet classification.

The development cycle of the IE system has two phases: (1) resource-building phase and the (2) actual IE system development phase. To begin the development of the information extraction system, the researchers first started out by making the prerequisite resources for the system (or the resource-building phase). The researchers first focused on developing the different Language Resources and Tweet Corpus of the system. These language resources included dictionaries (used to improve the performance of the different text analyzers and classifiers in the system) and a labeled corpus of tweets (this contains safety information about the disaster and was used for the extraction from unlabeled tweets).

For the creation of the dictionaries, the researchers made use of the “Balanced Corpus of Contemporary Written Japanese” and the “UniDic dictionary” for general domain languages while the “Mozc Japanese Input Method Dictionary” and other publicly available resources like the last names specific to northeast Japan and the database of postal code were used for the domain-specific language. An additional list containing station names and locations, landmarks, etc. were made to aid in the extraction process.

For the creation of the Tweet corpus, the researchers collected tweets that contain the word ‘earthquake’, and those that contains the following hashtags: #anpi (safety information), #hinan (evacuation), #j\_j\_helpme (help request) and #save\_<location>. To complete the corpus, the researchers tried to recognize the topic of the tweet (tweet classification) and the people mentioned in the tweet (named-entity recognition). To do so, the researchers defined nine classifications for the labels/topic of the tweets and are (1) I - Himself/Herself is alive; (2) L - Alive; (3) P - Passed away; (4) M - Missing; (5) H - Help request; (6) S - Information request; (7) O - Not safety information; (8) R - External link; and lastly, (9) U - Unknown.

After developing the prerequisite resources, the researchers proceeded with the actual development of the information extraction system. According to Neubig et al., the first step in IE for the Japanese language is Morphological Analysis. The MA is responsible for the tokenization and POS tagging of the tweets and for this, they made use of an open-source tool called KyTea. To accommodate the proper named-entity recognition in the Japanese language, the researchers trained the POS tagging model and replaced all proper nouns with subcategory tags (e.g. “first name”, “last name”, “place name”, and etc.) together with the introduction of a Conversational & News Text Corpus (containing a large list of Japanese first and last names). However, even though the POS tagging has been polished, the NER still failed to detect named entities that are grouped (NER still works on a word-by-word basis) that’s why the researchers made a simple rule-based system to accommodate the grouping of the Japanese named entities.

With all these, the researchers finally combined the two developed systems (the language resources and the MA system) to make the final information extraction system. The combination of the language resources with the MA system tends to increase the performance (accuracy) of the developed information extraction system by being able to accommodate the variations in the different styles in the different datasets that were used in this research.

# Theoretical Framework

This chapter presents a discussion on the different theoretical concepts associated to information extraction systems, and as well as common architectures, approaches, modules, and resources needed in developing such systems.

## Information Extraction

There is already huge amount information freely available in the internet. The problem is that people could not process these information easily because of the huge volume. It becomes more difficult as the information are written in natural language, which can be ambiguous. However, using an information extraction system, it can now automatically collect information from different sources like news, papers, and journals. Information extraction is the identification of the class of events or relationship and the extraction of relevant arguments of the event or relationship inside a natural language. It involves the creation of a structured representation of the facts that will be extracted. An information extraction system can only extract those facts that are represented (Grisham, 1997).

An information extraction system is divided into two parts, local text analysis and discourse analysis. Local text analysis is responsible for extracting the information from a text document. It consists of lexical analysis, name recognition, partial syntactic analysis, and scenario pattern analysis. Lexical analysis is responsible for splitting up the text into tokens. After splitting the text, it looks up a dictionary to fill out the part of speech and features of each token. After lexical analysis, it goes through name recognition. Name recognition is responsible for identifying proper nouns, aliases, and other special forms (dates and currency). It uses regular expressions that are stated in the POS, syntactic features, and orthogonal features to identify names. It also uses a dictionary that contains the list of proper nouns such as company names to easier identification. After going through name recognition, it passes through a partial syntactic analysis to identify some of the syntax of the text. It is responsible for identifying some of the like noun groups and verb groups. However, some systems do not implement a syntactic analysis. After syntactic analysis, it goes through scenario pattern matching. Scenario pattern matching is the extraction of related events or relationship relevant to the scenario. The outputs of the scenario pattern matching are two clauses. The first clause is a reference to an event structure while the second clause is a reference to a created entity (Grisham, 1997).

After going through the phases of local text analysis, it can now pass through the discourse analysis. Discourse analysis is the combination of all the information extracted during the local text analysis, and the formatting of the information. Under the discourse analysis are co-reference analysis and inference. Co-reference analysis attempts to resolve anaphoric references (pronouns and definite noun phrases). To determine which entity is referenced, the most recent previous mention of the entity is the anaphoric reference. After the co-reference analysis, it will undergo inference and event merging. Inference is responsible for making implicit information explicit. It uses system production rules to implement the inference module. After the inference, it can now be place in the data representation. Figure 3‑1 shows the general flow of an information extraction system (Grisham, 1997).

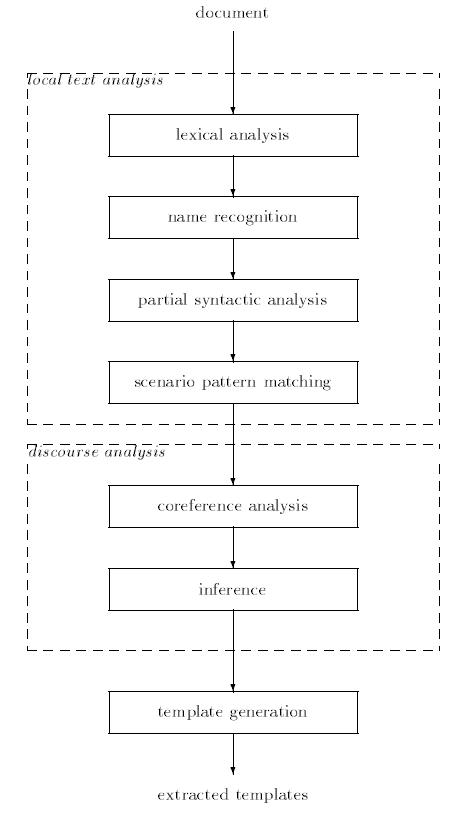


Figure ‑. Structure of an Information Extraction System

### Information Extraction Modules

This section explains the different modules that are commonly used in information extraction systems.

#### Tokenizer

Tokenizer is the module that segments a given text into tokens for further use in the natural language process. Tokens are usually the elements between spaces in the given input string. This module of natural language processing encounters several difficulties that need to be addressed such as tokenizing, email addresses, and uniform resource locators (URLs). Tokenizers today can identify that "15MB" is interpreted as "15 megabytes" if even there is no space between '15' and 'MB', and words with punctuation marks are also read correctly if tokenized. However, these tokenizers face two major problems, first is that the tokenizer performs its task independent of any knowledge, contained in the system. Another problem is that tokenizers are hard coded in the system. Thus, systems using these tokenizers end up tokenizing the input text without even caring whether the output of the tokenization made sense.

The researchers invented a tokenizer that validates the proposed output of the tokenization in a linguistic knowledge component, and this proposal validation repeats until there is no more possible segmentation or the text is validated. Lastly, the invented tokenizer also includes a language-specific data that contain a precedence hierarchy for punctuation (Bradlee et. al., 2001).

#### Sentence Splitter

The sentence splitter is a cascade of finite-state transducers that segments the text into sentences, and this module is used for the POS tagger (Cunningham et al., 2002). This module uses the set of regular expression-based rules that define sentence breaks like using periods, exclamation marks, and question marks (Zeng et al., 2006).

#### Normalizer

The presence of text speaks, slangs, and lingos is very high in SMS, social networks, and microblog sites. This presence makes it difficult for information extraction. In Aw and colleague’s work (2006), they viewed text normalization as a specialized machine translation problem, called SMS Normalization. They see that text speaks, slangs, and lingos are just a variant of the English language. However, applying general machine translation will not work against SMS Machine Translation. General machine translation is based on non-standard words that have been well studied. However, with SMS, most of the lingos, for example “b4” (before) and “bf” (boyfriend) are not formally defined by linguistics yet. These words can still evolve as time passes by and more new text speaks, slangs, and lingos might be created by the younger generation.

There are two types of approaches used in Aw and colleague’s paper (2006): basic word-based model and phrase-based model. In basic word model, an SMS word will be mapped to exactly one word. In phrase-based model, the SMS text will be split into k-phrases and the English words will also be split into k-phrases. Then, it will map the SMS phrase to an English phrase.

#### POS Tagger

The tagger produces a part-of-speech tag as an annotation on every word or symbol. These annotations produced can be used by a grammar checking tool to increase its power and coverage (Cunningham et al., 2002).

#### Gazetteer

The gazetteer contains lists of cities, organizations, days of the week, etc. It does not only contain entities, but also names of useful indicators, such as typical company designators (e.g. ‘Ltd.’), titles, etc. The gazetteer lists are collected into finite state machines, which can match tokens (Cunningham et al., 2002).

#### Lemmatizer

Lemmatization is the reduction of inflectional forms and sometimes derivationally related forms of a word to a common base form. It uses vocabulary and morphological analysis to remove inflectional ending and return the root word (Manning et al., 2008). The traditional method of lemmatizing is to use morphological rules and dictionaries. However, with the presence of new words, it will be very difficult for the lemmatizer. Statistical method needs a large training corpus. StaLe is a lightweight statistical lemmatizer. In StaLe, the system produces result tokens based on the rules. Figure 3‑2 shows StaLe’s lemmatization process. Each token will be ranked according to its confidence factor and then pruned according to its candidate check-up phase. Those who pass will be the lemma of that word. However, if no token passed the candidate check-up phase, the input word will be the lemma. The problem with StaLe is that it sometimes produces a nonsense word resulting to a poorer outcome than a traditional dictionary-based lemmatizer.

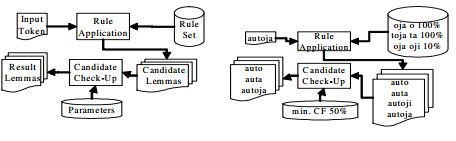


Figure ‑. StaLe Lemmatization Process

#### Co-reference Resolution

This module consists of a main module and a set of submodules. The main module is responsible for initializing the submodules, and executes them in a particular order, then combines the results generated from the submodules, and eventually performs some post-processing over the result. There are three submodules in the main module: quoted-text module, pleonastic-it module, and pronoun-resolution module. The quoted text submodule recognizes the quoted fragments inside the text. The identified fragments are used by the pronoun-resolution submodule. The next module is the pleonastic-it submodule; it is responsible for finding pleonastic occurrences of “it”. The last and the main function of the co-reference resolution module is in the pronoun-resolution submodule. This submodule uses the results of the other two submodules after execution. The module works following an algorithm; first, it inspects the appropriate context for all candidate antecedents for this kind of pronoun and then chooses the best antecedent, if there is any. Then it creates the co-reference chains from the individual anaphor/antecedent (this step is performed from the main co-reference module) (Dimitrov, 2005).

#### Named-Entity Recognition

Named-entity recognition (NER) involves the automatic or semi-automatic processing of a series of words and then extracting or recognizing tokens in the text that refer to named entities (Lim et al., 2007). Named entities are phrases that contain the names of persons, organizations, and locations.

## Information Classification

Text classification or information classification is the automatic classification of text into different categories based on their content. It consists of several important components: document representation, dimensionality reduction, classification algorithm, and performance evaluations (Shen, 2010). This will be useful as different types of text may need different types of extraction techniques.

### Document Representation

Classification algorithms cannot understand texts directly. The text must be converted into some form that can be easily understood by the algorithm. There are different methods that could be used to represent documents. The traditional representation of documents is the Bag-of-Words (BOW) representation, which is based on the Vector Space Model. The use of BOW may vary as it can have different representations (Shafiei et al., 2007), one of which is word representation. In word representation, each word in the document is considered as a feature. The problem with word representation is the ‘curse’ of dimensionality because text documents have a lot of unique words (Shafiei et al., 2007).

Another representation is term representation. Here, it uses multi-words or phrases as its feature. This drastically reduces the number of features. However, there has been mixed results on experimental results (Shafiei et al., 2007).

Character N-gram is another feature representation that could be used. Character N-gram takes n characters as a feature. Instead of focusing on the word, the character n-gram uses the characters. This makes model language independent. It is less susceptible to typographical errors and grammatical errors. It also does not require any linguistic preprocessing (Shafiei et al., 2007).

### Dimensionality Reduction (Feature Selection)

The problem with text classification is the huge number of features present in the vector space. This huge number of features could drastically reduce the performance of the algorithm. It is important that when a number of features are reduced, accuracy is not sacrificed. The reduction of feature is called feature selection. There are different methods that could be used in feature selection.

Document Thresholding (DT) counts all the occurrences of each word in the document, then all the words that did not reach the specified threshold will be removed. The rationale behind this is that those words that have few occurrences are irrelevant (Wei et al., 2010).

Information Gain (IG) measures bits of information that could be gained in a document. The information gain of a word (w) is defined as:

where is the set of all possible categories and is the probability of a document classified into a category. This will be computed for all the words in the documents. Then, the words that did not reach the specified threshold are removed (Wei et al., 2010).

Mutual Information (MI) is the modeling of the word to a category. The mutual information criterion between term *t* and category *c* is defined as:

and is estimated using

where,

A = number of times *t* and *c* co-occurs

B = number of times *t* occurs without *c*

C = number of time *c* occurs without *t*

N = number of documents

### Classification

There are different classification algorithms that could be used in classifying text. One of which is the Bag-of-Word technique. In the work of Sriram et al., (2010), they classified short-text messages (Tweets) into news (N), events (E), opinions (O), deals (D), and private messages (PM). They used Bag-Of-Words to classify the tweets. First, they were able to extract 8 features: author, presence of shortening of words, slangs, time-event phrases, opinion words, emphasis on words, currency, and percentages. They used the author feature to determine the type of user. Corporate tweeters composed their message in a professional way. It uses less slangs, emotions, and shortening because they wanted to convey their message clearly. On the other hand, personal tweets contain usage of slangs, emotions, and shortening. These features can be used to distinguish corporate tweeters from personal tweeters. They collected 5407 English tweets, broken down into N = 2107, O = 625, D = 1100, E = 1057, and PM = 518. They also contained 6747 unique words. For the classification, they tried different setups: BOW, BOW and author feature (BOW-A), BOW and the seven features (BOW-7F), the 8 features (8F), and BOW and the 8 features (BOW-8F).

Another type of classification that could be used is the k-nearest neighbor (k-NN). k-NN is an instance-based lazy learner. It means it only trains when a new instance comes in. k-NN computes for the k nearest instances (neighbors). Then, k-NN will use the neighbors’ categories to determine the class of the unknown instance. There are several ways to compute for the distance between the neighbors and the instances, Euclidean distance and Manhattan distance are some examples (Wajeed & Adilakshmi, 2011).

### Term Frequency-Inverse Document Frequency (TF-IDF)

Term Frequency – Inverse Document Frequency (TF-IDF) is a term weighting scheme that uses term frequency (TF) on the given document and its importance in relation to the whole collection or inverse document frequency (IDF) (Sammut, 2011; Zsu, 2009).

where,

N: number of documents in the collection

dj: number of documents containing term j

fij: frequency of term j in document i

Wij: is the weight of term j in document i

## Information Extraction Architecture

This section discusses the different architectures that can be applied in an information extraction system.

### Adaptive Architecture

The problem with some information extraction systems (knowledge-based systems) is that they are not portable and are highly dependent to the domain. With sources rapidly growing and becoming more diverse, it will be very hard for an information extraction system to extract as these text are unstructured, especially given the natural language used. Another problem is that an error may propagate as it goes through each module, as the modules in information extraction architecture are cascaded. The use of machine-learning techniques tries to solve these problems. Adaptive Information Extraction systems use machine-learning techniques to automatically learn rules that will extract certain information (Turmo et al., 2006).

#### LearningPinocchio (Ciravegna & Lavelli, 2004)

LearningPinocchio is an adaptive information extraction system that uses induction rules to extract information. Machine-learning techniques are used to learn the rules over the training examples marked by XML tags. LearningPinocchio has two parts, preprocessor and modules. The preprocessor performs tokenization, lemmatization, POS tagging, and Gazetteer lookup. After doing the preprocessing, information can proceed to the modules. This is where the tags will be annotated. The modules may consist of NER, text zonings, and other IE tasks. Figure 3‑3 illustrates the architecture used by LearningPinocchio.

Each module has three modes: training, testing, and production. Training mode is responsible for inducing the rules and learning how to apply IE rules in a specific scenario. The training mode accepts two inputs. First, it needs the module definition that includes a set of system parameters. Second is the preprocessed training corpus that has been tagged with XML. The output of the training mode is a set of rules that will be used in the testing and production modes. The testing mode is for testing on unseen tagged corpus. This mode tells how well the module performed in a certain application. The input for the testing mode is a module with induced rules and a test corpus that has been tagged with information that needed to be extracted. In this mode, it is still possible to retrain the model by adjusting the parameters to improve performance. The output is corpus tagged with XML and statistics on the performance of the module, and details of the mistakes as well. The production mode handles receiving the tagged corpus and the XML tags to the corpus.

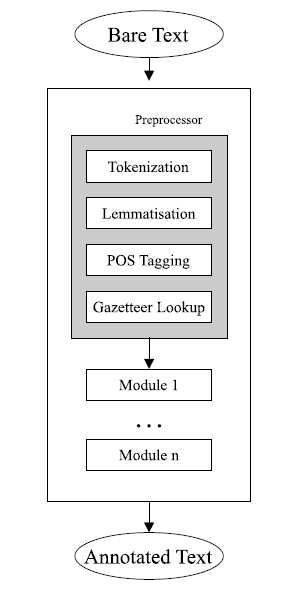


Figure ‑. Architecture of LearningPinocchio

For inducing rules, LearningPinocchio uses (LP)2 a covering algorithm especially for user-defined IE, to learn from training corpus marked with XML tags. It is a two-step process to induce the rules that will add XML tags to the text. Figure 3‑4 shows the process of the inducing process of (LP)2. First, it induces tagging rules that will add preliminary tags. Second, it improves on the tagged rules by inducing correction rules.

A tagging rule consists of a left-hand side, which is the pattern of conditions of a sequence of words, and a right-hand side, which is the action that will insert the tags in the text. The rule-induction algorithm uses positive examples to learn the rules. Positive examples are instances that have been manually tagged by a specialist. For each positive example, the algorithm first initializes rules. Then, it will generalize the rules. Lastly, it will keep the best rules. The algorithm will repeat for each positive example. Information, like word window, lexical items, lemma, lexical category, lexical case, and user-defined semantic classes could be used as a condition in the initial rules. After getting the generalizations, they will be tested on training corpus to see if they will be accepted as best rules or contextual rules.

Best rules are rules that are highly dependable because they are able to cover most of the cases and their error rate is less than the threshold. These rules are sorted in decreasing number of covered cases. If the rules have the same number of matches, they are sorted according to their error rate. However, if they have the same number of matches and error rate, the one with the generic condition is preferred. The algorithm only keeps k generalizations. Although best rules can correctly tag the information, the problem is the low recall. The role of the contextual rules is to increase the recall without sacrificing precision. Contextual rules are additional rules that will correct the problem.

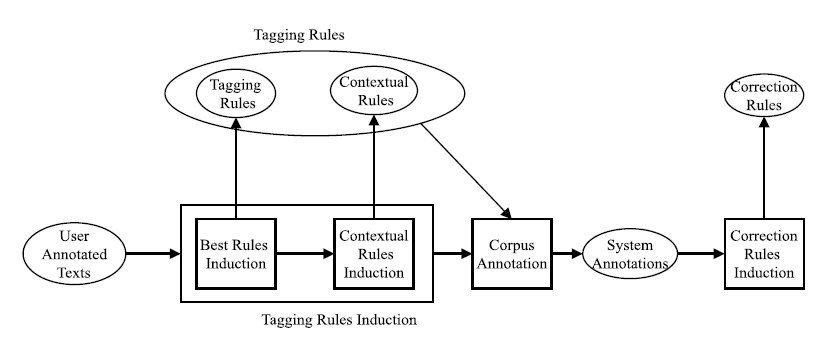


Figure ‑. Rule-Induction Step

Correction-inducing rules are almost the same as the inducing rules. The difference is that the left-hand side of the correction-inducing rules contains the text and the tags and the right hand side, instead of adding tags, is shifting the misplaced tags. To select and apply the correction rules, the same algorithm as the inducing rules are used. Figure 3‑5 illustrates the algorithm used by LearningPinocchio for choosing the best rules.

The information extraction process of LearningPinocchio consists of four (4) steps: initial tagging, contextual tagging, correction, and validation. The initial tagging will first tag the text. Next, the contextual tagging will further tag those that are missed during initial tagging, until no more tags can be placed. The third step will correct the errors. The last step will validate the tags. Figure 3‑6 shows the process of the information extraction.

LearningPinocchio was tested in two languages, English and Italian. They trained the system on a corpus and tested the induced rules on unseen texts. The system was tested in two tasks: CMU Seminar announcements and Austin job announcements.On CMU Seminar announcements, tokenization and POS tagging were performed. A gazetteer was not done for a fair comparison. The IE must be able to extract the speaker’s name, start time, end time, and location. They compared it to Rapier, symbolic-based (Califf, 1998), BWI, symbolic based, (Freitag & Kushmerick, 2000), SRV, WHISK (Soderland, 1999), and HMM, statistic-based (Freitag & McCallum, 1999). Based on the results, (LP)2 was able to achieve the highest score among the IE systems. (LP)2 was able to accurately extract the start time and end time, with 99.0% and 95% F-measures, respectively. However, it had difficulty in extracting the location and speaker’s name with F-measures 77.6% and 75.1%, respectively. Overall, (LP)2 has the highest performance in All Slots with a score of 86.0%.

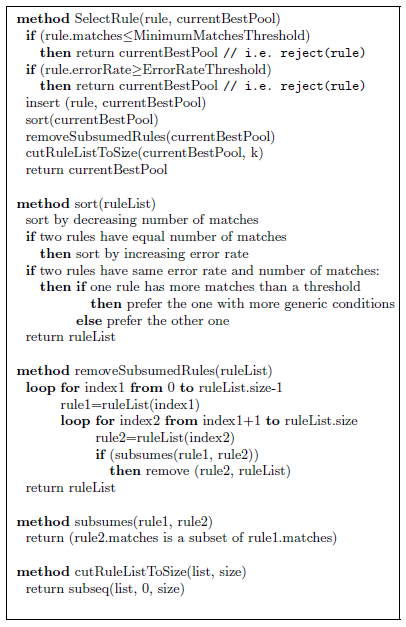


Figure ‑. Algorithm for Choosing the Best Rules

On Austin job announcements, the IE systems must be able to extract message ID, job title, salary offered, company offering the job, recruiter, state, city, and country where the job is offered, programming language, platform, application area, required and desired years of experience, required and desired degree and posting date. The same preprocessing as with the CMU Seminar announcements was done. Based on the results, (LP)2 outperformed Rapier in almost all the aspects. Rapier was able to outperform (LP)2 in salary, desired year, and desired degree. However, in the overall performance, (LP)2 has a higher performance in All Slots with a score of 84.1%.

#### IE2 (Aone et al., 1998)

Aone and his team of researchers (1998) have presented an adaptive Information Extraction system that can be used to extract information from different types of texts like unstructured, structured, and semi-structured texts. In their article, they presented the architecture they used in building the system. Aone’s IE system has six main modules in its architecture.

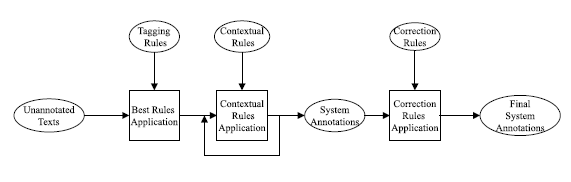


Figure ‑. Information Extraction Process of LearningPinocchio

Module 1 is responsible for the named-entity recognition part of the IE system. For this module, they used a commercial tool called NetOwl Extractor 3.0 to recognize general named-entity types. It is in this module where time/numerical expressions, names (persons, places, organizations), acronyms (organization names, locations), and semantic subtypes (country, city) are being recognized and extracted. Module 2 or the Custom NameTag module is responsible for the recognition of restricted-domain named-entities by using pattern matching. The output phrases for this module are SGML-tagged (Standardized Generalized Markup Language) into the same input document. On the other hand, Modules 3 and 4 are responsible for SGML-tagging the phrases in the sentences that are considered to be values for the slots defined in the templates and they work hand-in-hand. Module 3 or the PhraseTag module works by applying syntactico-semantic rules to identify the noun phrases in the previously recognized/extracted named-entities. Module 4 or the EventTag module works by applying a set of custom-built syntactico-semantic multi-slot rules to recognize/extract events from the input sentence. Module 5 or the Discourse Analysis Module is responsible for co-reference resolution or the merging of the previously extracted noun phrases. This module is implemented using three different strategies so that it can be modified to reach optimal performance regardless of the extraction scenario. Strategy A or the Rule-Based Strategy uses a set of custom-built rules to resolve definite noun phrases and singular personal pronoun co-reference. Strategy B or the Machine Learning-Based Strategy uses a decision tree that has been formed from learning a corpus tagged with co-references. Strategy C or the Hybrid Strategy uses Strategy A to filter false antecedents and then uses Strategy B to rank the remaining antecedents. In general, Module 5 is just merging the partial templates formed by the previous module. Lastly, Module 6 or the TempGen Module is responsible for the completion of the templates generated from the previous module by considering the consistency of the values in the slots of the event templates after resolving the noun phrase co-references and the generation of the output in the desired format. Figure 3‑7 illustrates the architecture of the system proposed by Aone et al.

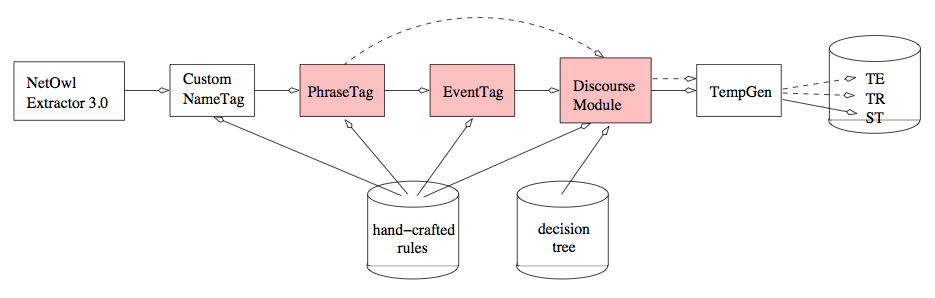


Figure ‑. Architecture of IE2 Adaptive Information Extraction System

#### SOMIDIA (Cheng et al., 2013)

SOMIDIA uses an adaptive information extraction system that extracts relevant information (English and Filipino) from different sources (i.e. blogs, social media sites, news articles). After crawling the internet for documents, the documents are fed to the information extraction system. First, it performs a tokenizer. They used OpenNLP to do the tokenization (OpenNLP, 2013). Then, it goes through the sentence splitter. It accepts a tokenized document. The system will now split the document into sentences. They use OpenNLP for the sentence detection (OpenNLP, 2013). After the sentence splitter, the document will be classified into English documents or Filipino documents. This is done because different information extraction modules will be applied for English and Filipino. For English, they used POS Tagger, Chunker, English NER, Co-reference Resolution and English Extractor. For Filipino, they used Filipino NER and Filipino Extractor. The English information extraction process has POS Tagger, Chunker, English NER, Co-reference Resolution, and English Extractor. The Filipino information extraction process has Filipino NER and Filipino Extractor. For the Filpino NER, they build their own gazetteer for there is no existing gazetteer for Filipino. They used dictionary-based and rule-based approach in implementing the NER. Figure 3‑8 describes the architecture of SOMIDIA.



Figure ‑. SOMIDIA Architecture

For SOMIDIA to adapt to new instances, the rules must be adaptable. SOMIDIA has a pattern extractor module that is mainly responsible for extracting different patterns from a set of documents and seed words so that they can be later used for the extraction process. SOMIDIA defines a document as any text that is related to the domain of the extraction system. This module of the system works in this manner: For each document, it will identify first the seed words present in the document. Seed words are words that will be extracted. For each seed word identified, the module will try to generate possible rules by using Windowing, a term to describe the section of the document that is considered for computation. The module experiments with all possible combinations of tokens and window setups to produce as much rules by considering a number of windowing concepts like the minimum window size, maximum left window size, and maximum right window size. The minimum window size is the minimum number of tokens that is included in the window. In addition, the maximum left window size is the maximum number of tokens included in the window that is found to the left of the seed word. On the other hand, the maximum right window size is the maximum number of tokens included in the window that is found to the right of the seed word. After generating all possible rules from the combination of tokens and various window setups, it then stores the generated rules for that specific seed word in a HashMap together with the number of times the rules were generated. This process is done continuously until rules are generated for all the seed words in the document and until all of the documents are completely processed.

After the process of generating rules, the module will do some optimization of the rules generated to further improve the efficiency of the extraction module. The module will minimize rules by removing rules that fall into these two scenarios: (1) rules that occur only once because they are too specific and they would only work with a very small percentage of the documents and (2) rules that are able to extract more than its corresponding occurrence because these rules are too general and may have the tendency to extract irrelevant data.

## Ontology

Ontologies are sets of classes (concepts), attributes, and relationships that are used to represent a domain knowledge. They are in a language (first-order logic) that can be abstracted from the data structures and implementations. Because ontologies are in the semantic level, they could be used to combine heterogeneous database, thus, making interoperability between systems possible (Gruber, 2009). Cimiano (2006) said that as the number of applications using ontologies is growing, then every such application must now be clearly and formally defined into an ontology.

Cimiano (2006) formally defines ontology as

where,

.

In Vangelis et al. (2011), they presented four levels of classification on how an IE system exploited the ontology. The first level is the use of domain entities (including the variations), and word classes. For the first level, they can be represented by a gazetteer (flat) or ontologies (structured). By using ontologies, it can identify the text based on some constraints posed by the conceptual properties. An example system that uses the first level ontology is LearningPinocchio (Ciravegna & Lavelli, 2004). The second level uses concept hierarchies. In the second level, they focus more on taxonomic relations (consists of super/sub-ordination, “is-a” and “part-of” relationships). They could be used to generalize or specify extraction rules or check constraints. An example system is NAMIC (Basili et al., 2003). The third level uses the concepts’ properties and relationships between concepts. These properties and relationships could then be used as guides for the information extraction process. An example system would be OBIE (Wang et al., 2005). The fourth level is the domain model. It combines the first three levels to be able to semantically interpret information. Domain models can merge with different structures, check consistency, make valid assumptions (for missing values), and discover implicit information. An example is BOEMIE (Maedche, 2002). BOEMIE uses bootstrap or layered extraction process for its information extraction process. First, it extracts the entities, and then the relations. BOEMIE populates and enriches the ontology. It adds new individual entities and at the same time adds new concepts and relations.

### Ontology Design

In creating a domain-specific ontology, the following tasks must be done: selection of domain and scope, consideration of reusability, finding important terms, defining classes and class hierarchy, defining properties of classes and constraints and creation of instances of classes (Saloun & Klimanek, 2011).

There are different approaches to creating ontology: hand-making by expert, automatic, and semi-automatic. In hand-made by expert, the ontology is manually done by the experts. Its advantage is that the result will be in high quality. However, they are very expensive and time consuming. In an automatic approach, the creation of the model is done by a machine. It is fast and low cost, but the problem is that implementing it will be very difficult and will result to inaccurate models. In a semi-automatic approach, the concepts and relationship will be generated by a machine, and the expert will complete and validate it. It produces relatively good results at a short amount of time. The disadvantage is that the machine-generated concepts and relations might be inaccurate and might also cause an inconvenience (Saloun & Klimanek, 2011).

### Ontology Population

Ontology Population is the extraction and classification instances of classes and relationships of an ontology. There are three approaches for ontology population: manual, semi-automatic and automatic approaches. The manual population of ontology should be done by experts and a knowledgeable engineer. This could be costly and time consuming and the automatic approach might be inaccurate. For automatic and semi-automatic approaches, they have a common approach. They do entity name recognition, NLP techniques, and information extraction.

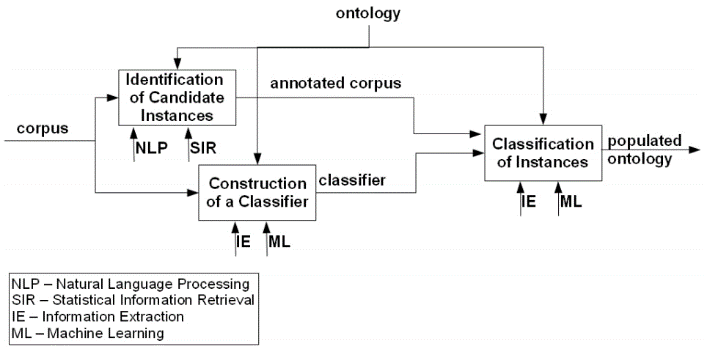


Figure ‑. Process of Semi-Automatic Ontology Population

In Faria & Girardi (2011), the techniques they used are NLP and IE. The process has two phases: Extraction and Classification of Instances and Instance Representation. For the Extraction and Classification of Instances, all the possible relationships and class instances are generated. They consist of Corpus Analysis (Morpho-lexical analysis, Named-Entity Recognition and Co-reference), Specification of Extraction and Classification Rules, and Extraction and Classification of Instances. Then, they will manually generate a set of extraction rules based on the last task. After generating the rules, it will now use the extraction rules to look for text matching the patterns. This will now produce the instances. After the first phase, it will now go to Instance Representation. Instance Representation has two tasks: Refinement of Instances and Ontology Population. For Refinement of Instances, it will try first to see if the instance already exists in the ontology. If it does not, then it will go to . If it already exists in the ontology, it will look in to see if the instance needs to be updated. If it is, then it will be part of If not, it will be discarded. After refinement, the instance is now ready to fill the ontology. Given , it will now look in the ontology to find the class. Then if a class is found, the instance will now be instantiated. Figure 3‑9 shows the process of Faria & Girardi’s (2011) semi-automatic ontology population.

## Twitter[[4]](#footnote-4)

Twitter is a microblogging social media platform wherein users may post messages of up to 140 characters long. Each of these posts is known as a "tweet". Mainly, a tweet is an expression of a moment or idea. Tweets may contain text, photos, and videos. Millions of tweets are shared in real time, every day.

A tweet may be replied to, retweeted, ‘favorited’, and may contain hashtags. A "reply" to a tweet is when another user comments or joins in the conversation of a tweet. A "retweet" is where you share the tweet of another user. A "favorite" indicates that a user likes the tweet. "Hashtags" assign a topic to the tweet. Thus, if one searches for #WorldYouthDay, the search results will contain all tweets with related topics about World Youth Day. When a Twitter user "follows" another user, this means that they subscribe to the tweets posted by that user (Twitter, n.d.).

### Use of Twitter

Aside from Twitter’s social media aspect, Twitter has been used as a source of data for various fields, one of which is in disaster management (Imran et al., 2013). Other fields that Twitter data have contributed to are linguistics (Mocanu et al., 2013), prediction (Tumasjan et al., 2010; Choy et al., 2012), real-time event detection (Sakaki et al., 2010), marketing (Jansen et al., 2009; Bollen et al., 2011), sentiment analysis, and opinion mining (Pak et al., 2010), education (Grosseck et al., 2008; Junco et al., 2011), newscasting (Phelan et al., 2009), medicine (Hawn, 2009; Chew & Eysenbach, 2010), and business processes (Culnan et al., 2010).

### Twitter and Disasters

During disasters, Filipino Twitter users tend to retweet about request for help and prayer. Other tweets pertain to traffic updates, weather updates, observations, and class suspensions. While some users have a preference to post in English, there is still a larger number of users that use their native language when tweeting during disasters (Lee et al., 2013).

As part of the disaster management of the Philippines for natural calamities, the government has released an official newsletter indicating the official social media accounts and hashtags (Official Gazette of the Republic of the Philippines, 2012). Table 3‑1 shows some of the official twitter accounts of government institutions as well as the official hashtags being used during disasters.

Table 3‑2 shows the extractable information from the tweets per disaster.

Table ‑. Examples of official government institution

|  |  |  |
| --- | --- | --- |
| Category | Official Government Institution  Twitter Account | Unified Hashtag |
| Typhoon | @dost\_pagasa | #(storm name)PH  (i.e. #YolandaPH, #GlendaPH) |
| Flood | @PAGASAFFWS, @MMDA | #FloodPH |
| Volcanic activities, earthquakes, and tsunamis | @phivolcs\_dost | #EarthquakePH |
| Relief and rescue efforts | @PIAalerts, @PIANewsDesk, @NDRRMC\_Open, @pcdspo, @DSWDserves | #ReliefPH  #RescuePH |
| Suspension of classes | @DepEd\_PH | #walangpasok |

Table ‑. Examples of disaster-related tweets with extractable information

|  |  |  |
| --- | --- | --- |
| Type of Disaster | Tweet | Extractable Information |
| Typhoon | @ANCALERTS:  NDRRMC says 77 dead, 220 injured, 5 missing due to Typhoon Glenda #GlendaPH | * 77 dead * 220 injured * 5 missing * Typhoon Glenda |
| Typhoon | @ABSCBNChannel2:  Bagyong Glenda patuloy na nagbabanta sa Luzon. #GlendaPH pic.twitter.com/2ygRWj6Z3D | * Typhoon Glenda * Luzon |
| Typhoon | @rapplerdotcom:  #GlendaPH: Marikina River now at alert level 1 [rplr.co/1mSTdnR](http://t.co/rqpfnzcLza)[pic.twitter.com/mECHfZfiyK](http://t.co/mECHfZfiyK) | * Marikina River * Alert level 1 |
| Typhoon | [@ABSCBNNews](https://twitter.com/ABSCBNNews/):  200 families in Lagna lose homes due to 'Glenda' [bit.ly/UfEDeO](http://t.co/6Kn0frqBsJ)[#southAlerts](https://twitter.com/search?q=%23southAlerts)[#GlendaPH](https://twitter.com/search?q=%23GlendaPH) | * 200 families * Laguna * Glenda |
| Earthquake | @dswdserves:  DSWD Region 11 prepositioned 12,170 food packs&55,206 assorted food for victims of recent quake in Davao Occ. [#EarthquakePH](https://twitter.com/search?q=%23EarthquakePH)[@dinkysunflower](https://twitter.com/dinkysunflower/) | * DSWD Region 11 * 12,170 food packs * 55,206 assorted food * Davao Occ |
| Earthquake | [@phivolcs\_dost](https://twitter.com/phivolcs_dost/):  No expected damage from 6.1-magnitude [#earthquakePH](https://twitter.com/search?q=%23earthquakePH) off Davao Occidental; aftershocks expected: [bit.ly/1ra30ZZa](http://t.co/IRX5SMSr3h) | * + magnitude * Davao Occidental |
| Earthquake | @manila\_bulletin:  BREAKING: 6.1 magnitude quake felt, east of Davao at 3:59PM. #EarthquakePH | * + magnitude * Davao * 3:59pm |
| Earthquake | @seanbofill:  Magnitude 6.1 earthquake recorded in Davao earlier today. #EarthquakePH | * Magnitude 6.1 * Davao |
| Flood | [@saabmagalona](https://twitter.com/saabmagalona/):  Ortigas st across La Salle GH ankle-deep [#floodph](https://twitter.com/search?q=%23floodph) | * Ortigas st * La Salle GH * Ankle-deep |
| Flood | [@MMDA](https://twitter.com/MMDA/):  [#FloodPH](https://twitter.com/search?q=%23FloodPH): As of 11:12 am, Orense to Estrella Southbound, leg deep, not passable to light vehicles | * 11:12am * Orense * Estrella Southbound * Leg deep * Not passable to light vehicles |
| Flood | @rqskye:  @MovePH MT @PIAalerts 5m: #FLOODPH ALERT: Greenhills, La Salle Street, San Juan, Metro Manila: Knee-high. #TrafficPH | * Greenhills * La Salle Street * San Juan * Metro Manila * Knee-high |
| Flood | @rqskye:  @MovePH MT @MakatiTraffic 11:27am: Flooded area in Brgy. Pio del Pilar: Medina St. corner... tl.gd/n\_1s2geia |#FloodPH #TrafficPH | * 11:27am * Brgy. Pio del Pilar * Medina St. corner |

## Evaluation Metrics

This section discusses the different metrics that will evaluate the performance of the information extraction system.

### F-measure

Precision and recall are the two primary metrics. Given a subject and a gold standard, precision is the percentage of cases that the subject is correctly classified as positive or true in the gold standard.

Recall is the percentage of cases in the gold standard that is correctly classified as positive or true by the subject.

The two metrics are often combined as their harmonic mean known as the F-measure (Hripcsak and Rothschild, 2005).

The True positive category means a positive instance is correctly predicted as positive while the False positive category denotes a negative instance is predicted as positive. Then, the True negative category signifies a negative instance predicted correctly as negative while the False negative means a positive instance is predicted as negative (Davis and Goadrich, 2006). Figure 3‑3 shows its confusion matrix.

Table ‑. Confusion Matrix (Davis and Goadrich, 2006)

|  |  |  |
| --- | --- | --- |
|  | Actual Positive | Actual Negative |
| Predicted Positive | True Positive | False Positive |
| Predicted Negative | False Negative | True Negative |

### Kappa Statistics

The common way of summarizing inter-rater agreement among observers is the kappa statistics. It allows measurement not only by chance and the observed agreement beyond chance is divided by the maximum agreement (beyond chance) that is possible for the dataset. The general kappa formula is

where and are the observed and expected proportions of agreement, respectively (Malpica et al., 2005).

## Tools

This section discusses the different NLP tools that could be used in implementing the information extraction system.

### ANNIE (Cunningham et al., 2002)

ANNIE or A Nearly New IE System is a system that contains different modules for NLP tasks. ANNIE is part of the GATE framework. ANNIE uses finite state transducers and JAPE rules to implement the modules. ANNIE has a tokenizer, gazetteer, sentence splitter, semantic tagger, and name matcher. This will be used for the POS tagger and the JAPE.

#### Gazetteer

The gazetteer contains the list of names, organizations, cities, days of the weeks, and others in plain text. It uses index files to access the lists which will be compiled in the finite state machines.

#### Sentence Splitter

The sentence splitter uses finite state transducers to split the text into sentences. It uses the gazetteer to check if punctuation is part of abbreviations or signals the end of the sentence. The sentence is annotated with the type “Sentence”; the breaks with “Split”. The sentence splitter is domain and application independent.

#### Part-Of-Speech (POS) Tagger

ANNIE POS Tagger uses a modified version of Brill Tagger. It uses lexicons and rule sets that have been trained in the Wall Street Journal corpus. However, the lexicon and rule sets can be changed based on the requirements. There are two additional lexicons, the lexicon for all caps and the lexicon for lowercase.

#### Semantic Tagger

The semantic tagger uses JAPE rules to annotate the entities. The grammar could be designed in such a way that it would recognize the entities. The output of the semantic tagger is the annotated text, which will be needed by the orthographic co-reference.

### Weka (Weka 3, n.d.)

Waikato Environment Knowledge Analysis (Weka) is a Java-based open source collection of machine-learning algorithms that are used in data-mining tasks. It contains various tools for preprocessing, classification, regression, clustering, and visualization. It provides a library that could be used and it is also flexible as users can extend the API to customize the machine-learning algorithms (Weka 3, n.d.).

### JENA API (McBride, 2002)

JENA is a semantic web application that helps in building ontologies. It is a Java-based API that handles OWL and SPARQL. It also includes inference engines based on OWL and RDF. This will be used to create and manage the ontology.

Code Listing 3‑1 shows how to create an ontology.

Code Listing ‑. Ontology Model Creation

|  |
| --- |
| OntModel ontModel = ModelFactory.createOntologyModel(<model spec>); |

Code Listing 3‑2 shows how to create a class.

Code Listing ‑. Ontology Class Creation

|  |
| --- |
| Resource r = m.getResource(NS+”Paper”);  OntClass paper = r.as(OntClass.class); |

Code Listing 3‑3 shows how to create object properties.

Code Listing ‑. Ontology Object Property Creation

|  |
| --- |
| ObjectProperty hasProgramme = m.createObjectProperty( NS + "hasProgramme" );  hasProgramme.addDomain( orgEvent );  body.addRange( programme );  body.addLabel( "has programme", "en" ); |

Code Listing 3‑4 shows how to create instance/individuals.

Code Listing ‑. Ontology Instance Creation

|  |
| --- |
| OntClass c = m.createClass( NS + "SomeClass" );  Individual ind0 = m.createIndividual( NS + "ind0", c );  // second way: use a call on OntClass  Individual ind1 = c.createIndividual( NS + "ind1" ); |

### ArkNLP (Gimpel et al., 2011)

ArkNLP developed by Carnegie Mellon is a Java-based Tokenizer and POS tagger that was specifically made for Twitter. For the tokenizer, it now identifies the emoticon tokens. For the POS tagger, it can also tag slangs and emoticons. This will be used for tokenizing the tweets. Code Listing 3‑5 shows a sample code of how to use the tokenizer feature.

Code Listing ‑. Tweet Tokenization

|  |
| --- |
| List<String> tokens = Twokenize.tokenizeRawTweetText(text); |

### NormAPI (Nocon et al., 2014)

NormAPI is a text normalization API that is specifically built for the Filipino language. It currently has implementations for Dictionary Substitution Approach (DSA) and Statistical Machine Translation (SMT). The user can choose if the normalization will perform: (1) DSA only, (2) SMT only, (3) SMT after DSA, or (4) SMT before DSA. NormAPI accepts file or text as input. It also allows setting configuration files and training a new model. This will be used for the text normalization.

Code Listing ‑. Text Normalization with NormAPI

|  |
| --- |
| String normalizedText = NormAPI.normalize\_Text(shortcutText); |

# The FILIET System

This chapter presents the proposed system. It is divided into six sections. The first section will discuss the system overview. The second section outlines the objectives of the system. The third section tackles the scope and limitations of the system based on the outlined objectives. The fourth section presents the architectural design. The fifth section discusses the front-end and back-end features. Lastly, the sixth section will present the resources that will be used in implementing the system.

## System Overview

Filipino Information Extraction for Twitter (FILIET) is a hybrid information extraction system that incorporates the architectures of an adaptive IE system and a rule-based IE system for Filipino disaster related tweet. The FILIET system will work with extracting information from tweets that were written in Filipino and English, along with their variations such as TXTSPK and code-switch. The system will follow the methodology described below. The disaster-related tweets will be loaded into the system. The system will then classify according to the following categories: (1) caution and advice, (2) casualties and damage, (3) donations, (4) call for help, and (5) others. The tweets will now proceed to the information extraction engine of the system wherein the system will extract relevant information from the tweets with regard to its given type of disaster. Extracted information from the given tweets will vary based on the type of information the tweet contains.

## System Objectives

This section will discuss the objectives of the system.

### General Objective

To develop an information extraction system that extracts relevant information from disaster-related tweets and considers the different available variations of the Filipino language.

### Specific Objectives

The following are the specific objectives of the system:

1. To preprocess the tweets;
2. To extract relevant features from the tweets;
3. To classify the tweets into according to their content (i.e. caution and advice, casualties and damages, donations, and others);
4. To extract relevant information according to the type of tweet.

## System Scope and Limitations

The system to be developed in this research is expected to be able to do a number of tasks that are within the scope of extracting information from Filipino disaster-related tweets. These tasks include the following: Text Preprocessing, Feature Extraction, Disaster Classification, and actual Information Extraction.

The system must be able to perform some preprocessing techniques onto the input tweet. These preprocessing tasks shall be limited to the following: (1) text normalization to include support for input tweets that were written in the TXTSPK format; (2) text tokenization, to enable word level analysis of the input tweet; (3) part-of-speech tagging, to enable semantic level analysis of the input tweet; (4) named-entity recognition, to enable proper identification of named-entities; and lastly, (5) disaster keyword tagging, to enable proper recognition of disaster words in the input tweet. Lastly, by looking at the initial data and from the study of (Lee et al., 2013), it was observed that a high probability that Filipinos will post tweets in the Filipino language and that TXTSPK and code-switching were the variations being used.

Moving on, the system must be able to extract features from the input tweet. The features that will be extracted from the input tweet are categorized into two: (1) binary features, those that have discrete values 0 and 1; and (2) nominal features, those that have continuous values. For the binary features, they will be limited to the following: Presence features (presence of keywords like disaster words, mentions, hashtags, emoticons, retweets, and Code Switching).On the other hand, the nominal features will be limited to the following: (1) Tweet length; (2) User; and lastly, (3) Location.

Using the extracted features, the system must be able to classify the input tweet based on the type of tweets. The tweet must be classified into the following: caution and advice (CA), casualties and damage (CD), donations (D), and others (O). This is important because each type of tweet will have different extracted information. The categories are based on Extracting Relevant Information Nuggets from Disaster-Related Messages in Social Media by (Imran et al., 2013).

The system must be able to extract two types of information from the given input tweet. The two main types of information are (1) General Information and the (2) Type-Specific Information. For the General Information, only the location references, time references, and source shall be extracted from the input tweet. On the other hand, for the Type-Specific Information, the following shall be extracted from the input tweet: (a) for caution and advice tweets: the caution and/or advice part of the tweet; (b) for casualties and damage tweets: the number of casualties and the damaged objects; and (c) for donation tweets: if the tweet is a donation effort or a request for help and what are the objects being donated or requested. The information to be extracted are also based on the study by (Imran et al., 2013).

The data that will be used in the development of the system will come from the Twitter Web Crawler developed by the De La Salle University - College of Computer Studies as well as from the crawler to be developed by the group. The system will only be processing data that are written in the Filipino language.

## Architectural Design

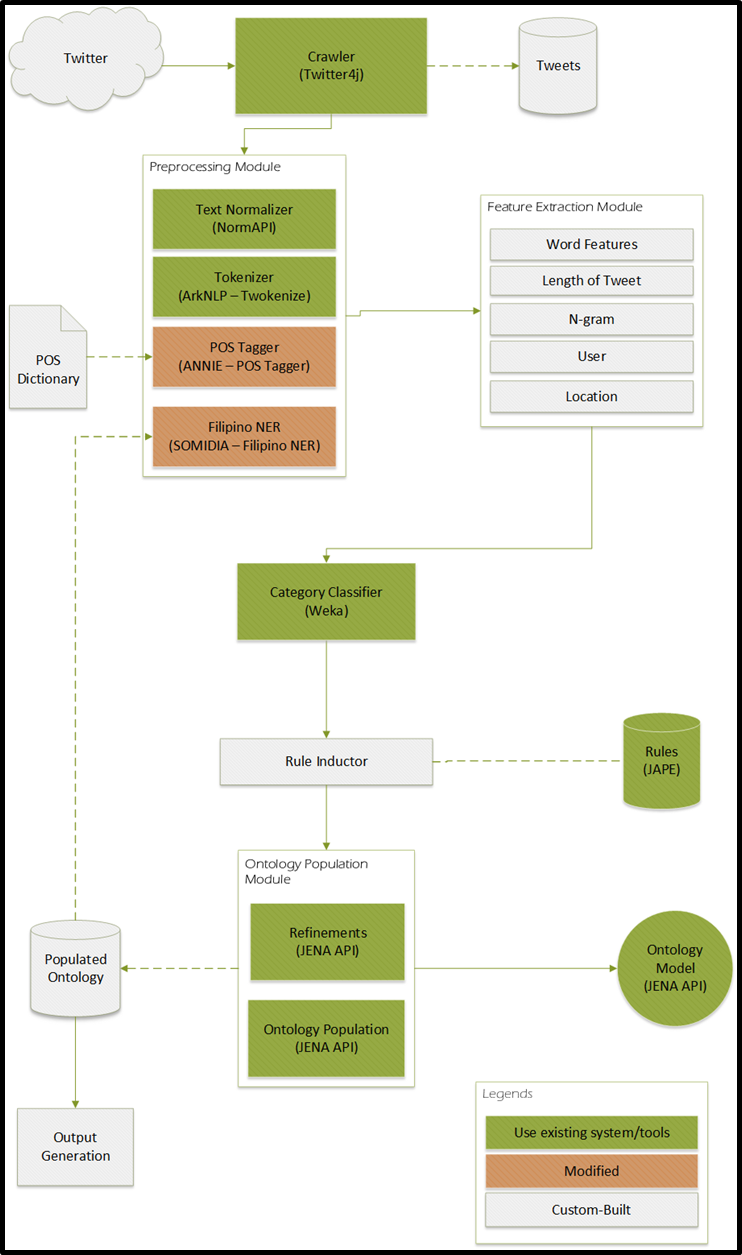


Figure ‑. FILIET Architectural Design

### Crawler Module

This module will be crawling Twitter to retrieve tweets. The system will continuously collect the tweets using Twitter’s Stream API through the Twitter4j library.

### Preprocessing Module

This module will be responsible for preprocessing the input tweets before they are passed on to the information extraction module. This module will include the following text processing techniques: text normalizer, tokenizer, and POS Tagger. After going through this module, the preprocess tweets will then be passed on to the Information extraction module.

#### Text Normalizer

The first step in preprocessing the input tweets is text normalization. The main responsibilities of the text normalizer are (1) to convert the TXTSPK format of the tweets into full-word format so that the information when extracted will be consistent and (2) remove emoticons, links, and hashtags. The text normalizer will accept a text as input. The output of this module is the normalized tweets where the TXTSPK is converted to its full form, and links and emoticons are removed. For this module, the researchers will use NormAPI (Nocon et al., 2014). Table 4‑1 shows a sample input and its corresponding output.

Table ‑. Sample Input/Output for Text Normalizer

|  |  |
| --- | --- |
| Input | Output |
| <tweet>  Dear Adnu sana po damit naman ang idonate natin para sa mga binagyo in case na may donation na ganapin. Plus canned goods na rin. Haha. :)  </tweet> | <tweet>  Dear Adnu sana po damit naman ang idonate natin para sa mga binagyo in case na may donation na ganapin. Plus canned goods na rin. Haha.  </tweet> |
| <tweet>  Kailangan na talaga ng military efforts sa most part of Leyte. Nagkakagulo na.  </tweet> | <tweet>  Kailangan na talaga ng military efforts sa most part of Leyte. Nagkakagulo na.  </tweet> |

#### Tokenizer

After normalizing the tweets, the tokenizer will now split the input tweets into tokens like numbers, punctuations, words, abbreviations and other special characters like emoticons, hashtags, mentions, and the like. The tokenizer will take as an input the normalized tweet from the Text Normalizer. The tokenizer will output an array containing the tokenized tweet in a form that is similar to this. Tokenized = {“@<username>”, “<punctuations>”, “#<hashtag>”...} or an array that would contain all the tokens in a given tweet. For this module, the researchers will use ArkNLP’s Twokenize (Gimpel et al., 2011). Table 4‑2 shows a sample input and its corresponding output.

Table ‑. Sample Input/Output Tokenizer

|  |  |
| --- | --- |
| Input | Output |
| <tweet>  Dear Adnu sana po damit naman ang idonate natin para sa mga binagyo in case na may donation na ganapin. Plus canned goods na rin. Haha.  </tweet> | <tweet>  "Dear", "Adnu", "sana", "po", "damit", "naman", "ang", "idonate", "natin", "para", "sa", "mga", "binagyo", "in", "case", "na", "may", "donation", "na", "ganapin", ".", "Plus", "canned", "goods", "na", "rin", ".", "Haha", "."  </tweet> |
| <tweet>  Kailangan na talaga ng military efforts sa most part of Leyte. Nagkakagulo na.  </tweet> | <tweet>  "Kailangan", "na", "talaga", "ng", "military", "efforts", "sa", "most", "part", "of", "Leyte", ".", "Nagkakagulo", "na", "."  </tweet> |

#### POS Tagger

After tokenizing the tweets, the POS tagger will accept the tokenized Filipino tweet as an input and then, it will tag each token with its corresponding part-of-speech. Each of the tokens can be tagged as a noun, a verb, an adjective, an adverb or others. After tagging the tokens, the POS tagger will then output the tokens with their corresponding POS tag in the form of a text. For the module, the researchers are considering modifying ANNIE’s POS Tagger (Cunningham et al, 2002) for Filipino, or use Filipino Tagger Dictionary (Oco & Borra, 2011). Table 4‑3 shows the sample input and output of POS tagger.

Table ‑. Sample Input/Output POS Tagger

|  |  |
| --- | --- |
| Input | Output |
| <tweet>  "Dear", "Adnu", "sana", "po", "damit", "naman", "ang", "idonate", "natin", "para", "sa", "mga", "binagyo", "in", "case", "na", "may", "donation", "na", "ganapin", ".", "Plus", "canned", "goods", "na", "rin", ".", "Haha", "."  </tweet> | <tweet>  "Dear\_UH", "Adnu", "sana\_VOTF", "po\_MAHM", "damit\_NCOM", "naman\_ENCL", "ang\_NA", "idonate", "natin\_PNGP", "para\_PRTA", "sa\_NCOM", "mga\_NA", "binagyo", "in\_IN", "case\_VBP", "na\_NA", "may\_MAEM", "donation\_NN:UN", "na\_NA", "ganapin", ".\_PSNS", "Plus\_JJ", "canned\_JJ", "goods\_NNS", "na\_NA", "rin\_ENCL", ".\_PSNS", "Haha\_NN", ".\_PSNS"  </tweet> |
| <tweet>  "Kailangan", "na", "talaga", "ng", "military", "efforts", "sa", "most", "part", "of", "Leyte", ".", "Nagkakagulo", "na", "."  </tweet> | <tweet>  "Kailangan\_VOTF", "na\_NA", "talaga\_IRIA", "ng\_NA", "military\_NCOM", "efforts\_NNS", "sa\_NCOM", "most\_JJS", "part\_JJ", "of\_IN", "Leyte\_NPRO", ".\_PSNS", "Nagkakagulo", "na\_NA", ".\_PSNS"  </tweet> |

#### Filipino NER

The Filipino NER will identify the proper nouns in the tweets. The module will accept the tweets that have passed through the preprocessing module. The outputs of the NER are tagged as proper nouns in the tweet. For the gazetteer, the plan is to use the SOMIDIA gazetteer and update the gazetteer. Table 4‑4 shows a sample input and its corresponding output.

Table ‑. Sample Input/Output Gazetteer

|  |  |
| --- | --- |
| Input | Output |
| <tweet>  "Dear\_UH", "Adnu", "sana\_VOTF", "po\_MAHM", "damit\_NCOM", "naman\_ENCL", "ang\_NA", "idonate", "natin\_PNGP", "para\_PRTA", "sa\_NCOM", "mga\_NA", "binagyo", "in\_IN", "case\_VBP", "na\_NA", "may", "donation\_NN:UN", "na\_NA", "ganapin", ".\_PSNS", "Plus\_JJ", "canned\_JJ", "goods\_NNS", "na\_NA", "rin\_ENCL", ".\_PSNS", "Haha\_NN", ".\_PSNS"  </tweet> | <tweet>  "Dear\_UH", "Adnu", "sana\_VOTF", "po\_MAHM", "damit\_NCOM", "naman\_ENCL", "ang\_NA", "idonate", "natin\_PNGP", "para\_PRTA", "sa\_NCOM", "mga\_NA", "binagyo", "in\_IN", "case\_VBP", "na\_NA", "may", "donation\_NN:UN", "na\_NA", "ganapin", ".\_PSNS", "Plus\_JJ", "canned\_JJ", "goods\_NNS", "na\_NA", "rin\_ENCL", ".\_PSNS", "Haha\_NN", ".\_PSNS"  </tweet> |
| <tweet>  "Kailangan\_VOTF", "na\_NA", "talaga\_IRIA", "ng\_NA", "military\_NCOM", "efforts\_NNS", "sa\_NCOM", "most\_JJS", "part\_JJ", "of\_IN", "Leyte\_NPRO", ".\_PSNS", "Nagkakagulo", "na\_NA", ".\_PSNS"  </tweet> | <tweet>  "Kailangan\_VOTF", "na\_NA", "talaga\_IRIA", "ng\_NA", "military\_NCOM", "efforts\_NNS", "sa\_NCOM", "most\_JJS", "part\_JJ", "of\_IN", "<location: Leyte/>", ".\_PSNS", "Nagkakagulo", "na\_NA" ".\_PSNS"  </tweet> |

### Feature Extraction Module

This module is responsible for extracting the feature from the tweet. The module will extract the presence of disaster words, tweet length, character n-gram, user, location, and trusted accounts. The Feature Extraction Module will take the preprocessed tweets as inputs, then output the tweet with the features. Table 4-13 shows a sample of the features and their respective values.

#### Presence

The Presence feature is a binary feature that indicates the presence of keywords like disaster words, mentions, hashtags, emoticons, retweets, and Code Switching in the input tweet. The value of “1” is given if the keyword is present; otherwise it is given “0”.

#### Tweet Length

The Tweet Length feature essentially counts the length of the input tweet.

#### N-gram

The N-gram feature is mainly responsible for generating/extracting the different n-grams for the input tweets, specifically, the bi-gram and the tri-gram of the input tweets. To accomplish the n-gram generation/extraction tasks, the module will make use of the SRILM tool, which is specifically built for generating/extracting n-gram models.

#### User

The User feature will help in determining the type of disaster. For example, @dost\_pagasa will tweet about typhoons.

### Category Classifier Module

Using the extracted features, the Category Classifier Module will classify the tweets into the following categories: (1) caution and advice (CA), (2) casualties and damage (CD), (3) donations (D), (4) call for help (CH), and (5) others (O). The module will use Weka (Weka, n.d.) and will try out different classifiers. Table 4‑5 shows a sample input/output of the Category Classifier Module.

Table ‑. Sample Input/Output Category Classifier Module

|  |  |
| --- | --- |
| Input | Output |
| <tweet>  "Dear\_UH", "Adnu", "sana\_VOTF", "po\_MAHM", "damit\_NCOM", "naman\_ENCL", "ang\_NA", "idonate", "natin\_PNGP", "para\_PRTA", "sa\_NCOM", "mga\_NA", "binagyo", "in\_IN", "case\_VBP", "na\_NA", "may", "donation\_NN:UN", "na\_NA", "ganapin", ".\_PSNS", "Plus\_JJ", "canned\_JJ", "goods\_NNS", "na\_NA", "rin\_ENCL", ".\_PSNS", "Haha\_NN", ".\_PSNS"  </tweet> | <tweet type=”D”>  "Dear\_UH", "Adnu", "sana\_VOTF", "po\_MAHM", "damit\_NCOM", "naman\_ENCL", "ang\_NA", "idonate", "natin\_PNGP", "para\_PRTA", "sa\_NCOM", "mga\_NA", "binagyo", "in\_IN", "case\_VBP", "na\_NA", "may", "donation\_NN:UN", "na\_NA", "ganapin", ".\_PSNS", "Plus\_JJ", "canned\_JJ", "goods\_NNS", "na\_NA", "rin\_ENCL", ".\_PSNS", "Haha\_NN", ".\_PSNS"  </tweet> |
| <tweet>  "Kailangan\_VOTF", "na\_NA", "talaga\_IRIA", "ng\_NA", "military\_NCOM", "efforts\_NNS", "sa\_NCOM", "most\_JJS", "part\_JJ", "of\_IN", "Leyte\_NPRO", ".\_PSNS", "Nagkakagulo", "na\_NA", ".\_PSNS"  </tweet> | <tweet type=”D”>  "Kailangan\_VOTF", "na\_NA", "talaga\_IRIA", "ng\_NA", "military\_NCOM", "efforts\_NNS", "sa\_NCOM", "most\_JJS", "part\_JJ", "of\_IN", "<location: Leyte/>", ".\_PSNS", "Nagkakagulo", "na\_NA" ".\_PSNS"  </tweet> |

### Rule Inductor Module

The Rule Inductor module will accept tokenized and tagged tweets. It will now apply the rules coming from the database. It will look for patterns in the text and apply the classification. It will generate the instances that will be used to populate the ontology.

### Ontology Population Module

The ontology population module is responsible for filling up the ontology with extracted information from the previous module instances. It has two sub-modules: Ontology Population and Ontology Retrieval. Both submodules takes advantage of the OWL API to manipulate and modify the contents of the ontology. The structure of the ontology that will be used for this module and this system will be made using the Protégé ontology tool. Appendix I shows the representation of the ontology in OWL format.

#### Ontology Population

The Ontology Population module will be responsible for storing the extracted information to the ontology by filling up the fields and asserting the relations that exists within the ontology. This sub-module would include pre-requisite functions to facilitate a seamless exchange pf information between the system and the ontology like saving, loading, and etc. Due to the nature of ontologies, there is no need to check for duplicate instances within the ontology as the ontology will do the checking and validating for this kind of scenario.

#### Ontology Retrieval

The Ontology Retrieval module will be responsible for retrieving the information that was stored in the ontology by getting all the instances of ontological classes and assertions that exists within the ontology. This sub-module would include pre-requisite functions to facilitate a seamless retrieval of stored information between the system and the ontology like saving, loading, and etc. Due to the structure of the ontology designed for the system, the main point of contact for the retrieval process is the instances of the Tweet class of the ontology. Further retrieval of information will be based on the relations that different instances from different classes have with the instances of the Tweet class.

### Data Sources

The data that will be collected will come from the filtered tweets. Some of these will be provided by the Twitter Web Crawler developed by the De La Salle – College of Computer Studied, while the rest will come from the Crawler module to be discussed in the next section. The list of trusted Twitter accounts is based on the list provided by SOMIDIA.

To be able to crawl the tweets that are strictly related to disaster relief operations, the researchers will make use of certain national official hashtags that are used by a number of relief organizations in the country. Examples of the unified hashtags are #ReliefPH, #RescuePH, #PHalert

The output of the crawler will be saved in a CSV file. Each entry in the CSV file will have the following content: <tweet ID>,<username>,”<tweet>”,”<date and time it was tweeted>”,<longitude>,<latitude>. Error! Reference source not found. Table 4‑6 shows a sample of what can be seen in the CSV file.

Table ‑. Sample Entries of Tweets in CSV File

|  |  |
| --- | --- |
| # | Sample Output |
| 1 | 5280d16567833c59e17ebb66, SandyCervas, Dear Adnu sana po damit naman ang idonate natin para sa mga binagyo in case na may donation na ganapin. Plus canned goods na rin. Haha. :) , 11/11/2013 8:45, 13.7053384, 123.1980436 |
| 2 | 414017377517326337,Ehmai123,"""@ANCALERTS: Magnitude 4.3 quake jolts Antique, Boracay http://t.co/c2BczJEa6Y"" Lindol everywhere :3","Fri Dec 20 21:00:09 CST 2013",14.527157,121.0033549 |

#### Gazetteer

The gazetteer is a text file that contains the list of names and locations to identify the proper nouns in the tweets. This will be used for the Filipino NER module. The plan is to update and use SOMIDIA’s gazetteer. Table 4‑7 shows a sample gazetteer for the storm names in the Philippines.

Table ‑. Sample Gazetteer for Storm Names (Philippines)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Agaton  Amang  Ambo  Auring  Basyang  Bebeng  Bising  Butchoy  Caloy  Chedeng  Cosme  Crising  Dante  Dindo  Dodong  Domeng  Egay  Emong  Enteng  Ester | Falcon  Feria  Florita  Frank  Gener  Gloria  Goring  Gorio  Hanna  Helen  Henry  Huaning  Igme  Inday  Ineng  Isang  Jolina  Juan  Juaning  Julian | Kabayan  Karen  Katring  Kiko  Labuyo  Lando  Lawin  Luis  Marce  Maring  Milenyo  Mina  Nando  Neneng  Nina  Nonoy  Ofel  Ompong  Ondoy  Onyok | Pablo  Paeng  Pedning  Pepeng  Quedan  Queenie  Quiel  Quinta  Ramil  Ramon  Reming  Rolly  Santi  Seiang  Sendong  Siony  Tino  Tisoy  Tomas  Tonyo | Udang  Unding  Ursula  Usman  Venus  Vinta  Violeta  Viring  Waldo  Weng  Wilma  Winnie  Yayang  Yolanda  Yoyong  Yoyoy  Zeny  Zigzag  Zoraida  Zosimo |

#### Rules

Based on the tweets, the rules will be handcrafted using JAPE. Then, the rules will now be stored in the database which will be used for extracting the information. Table 4‑8 shows a sample of the rules.

Table ‑. Sample Extracted Rules

|  |
| --- |
| Rules |
| <string: naman><disaster><string:sa> AS Disaster |
| <string: magnitude><number>AS Intensity |
| <POS: NNS><location><POS: PSNS>AS Location |

#### Seed Words

The seed words will be used for generating the rules. The list of seed words will be stored in a text file. It will SOMIDIA’s seed word and will update it. Table 4‑9 shows the excerpts of the list of seed words.

Table ‑. Excerpts of the List of Seed Words

|  |  |  |  |
| --- | --- | --- | --- |
| tubig  kuryente  pagkain  tulong  donation  damit  gutom | rice  kanin  bigas  inumin  sardinas  sardines  canned goods | water  clothes  food  help  bahay  gamot  medicine | health kit  medical kit  relief goods  kasuotan  instant noodles  damit  pera |

#### POS Dictionary

The POS Dictionary is a dictionary that contains a list of words with its POS tag. This will be used in the POS Lookup. The dictionary is stored in a file. It contains a list of English and Filipino words. Table 4‑10 shows a sample of the excerpts of the POS dictionary

Table ‑. Excerpts of the POS Dictionary

|  |  |
| --- | --- |
| storms storm ENG NNS  storms storm ENG VBZ  storm storm ENG NN  storm storm ENG VB  bukid bukid TAG NCOM 2  bukirin bukirin TAG NCOM 2 | buko buko TAG NCOM 2  bula bula TAG NCOM 2  bulag bulag TAG NCOM 2  bulak bulak TAG NCOM 2  bulalas bulalas TAG NCOM 2 |

#### Ontology

For the ontology, this will be created manually. The domain of the ontology will be disaster, specifically for relief operations. The next step would be identification of the terms. After identifying the terms, the concept, properties, and constraints will be defined. Class instantiations then follow. The format of the ontology will be in OWL. Figure 4‑2 shows the ontology of the system.

## System Functions

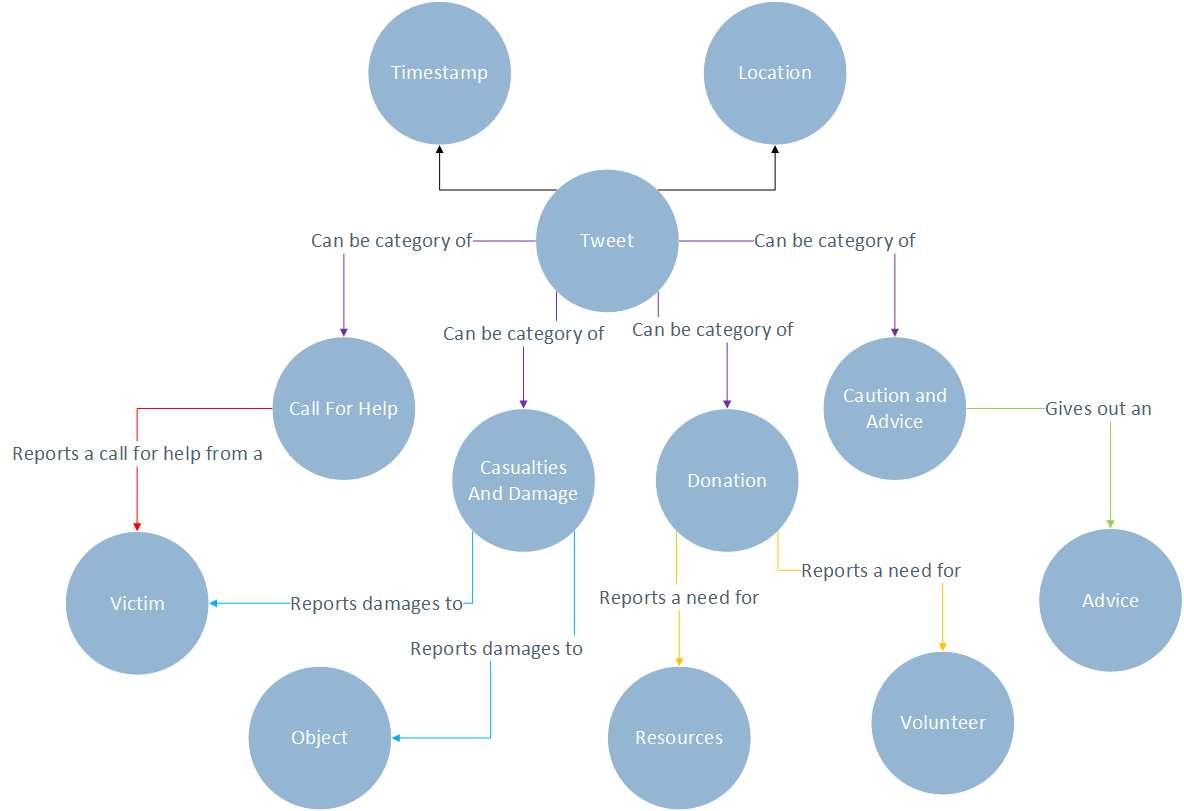


Figure ‑. FILIET Ontology

This section discusses the functions of the proposed systems.

### Tweet Retrieval

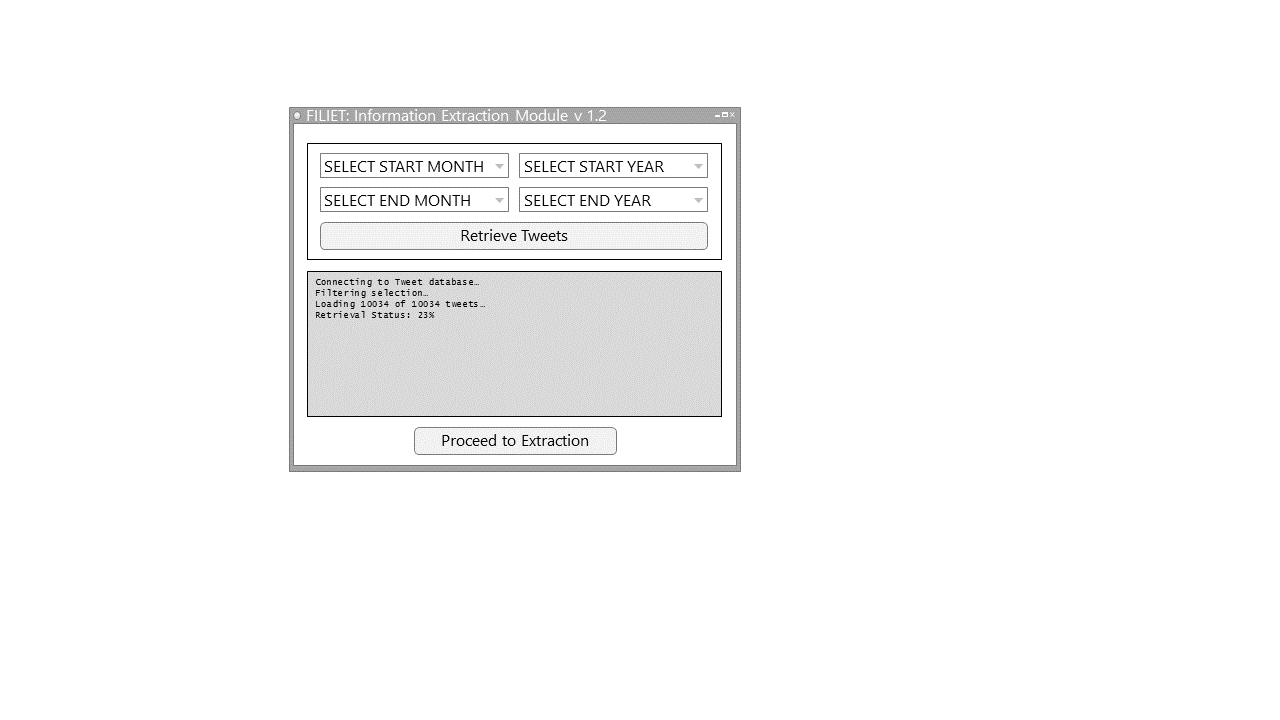


Figure ‑. Tweet Retrieval Screenshot

In this function, the system will access the tweets that were stored in the database by the Twitter crawler. The user can opt to filter the tweets for retrieval. Figure 4‑3 shows the screenshot of this function.

### Information Extraction

In this system function, the information extraction process starts with feature extraction which shall then be used for the classification of the tweets based on the categories defined in the system. After classification, the tweets shall then be examined for possible rules. The rules to be generated will then be applied to the tweets. Extracted information will be fed into the next function. Figure 4‑4 shows a screenshot of this function.

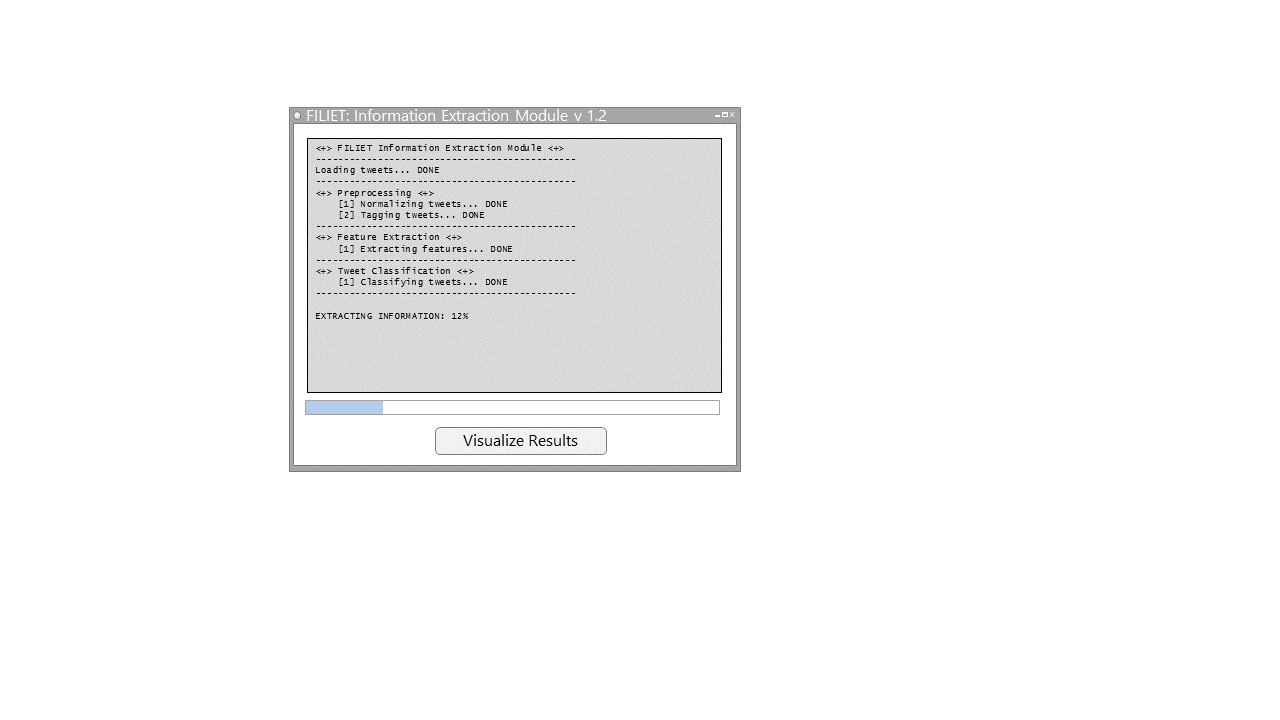


Figure ‑. Information Extraction Screenshot

### Ontology Population

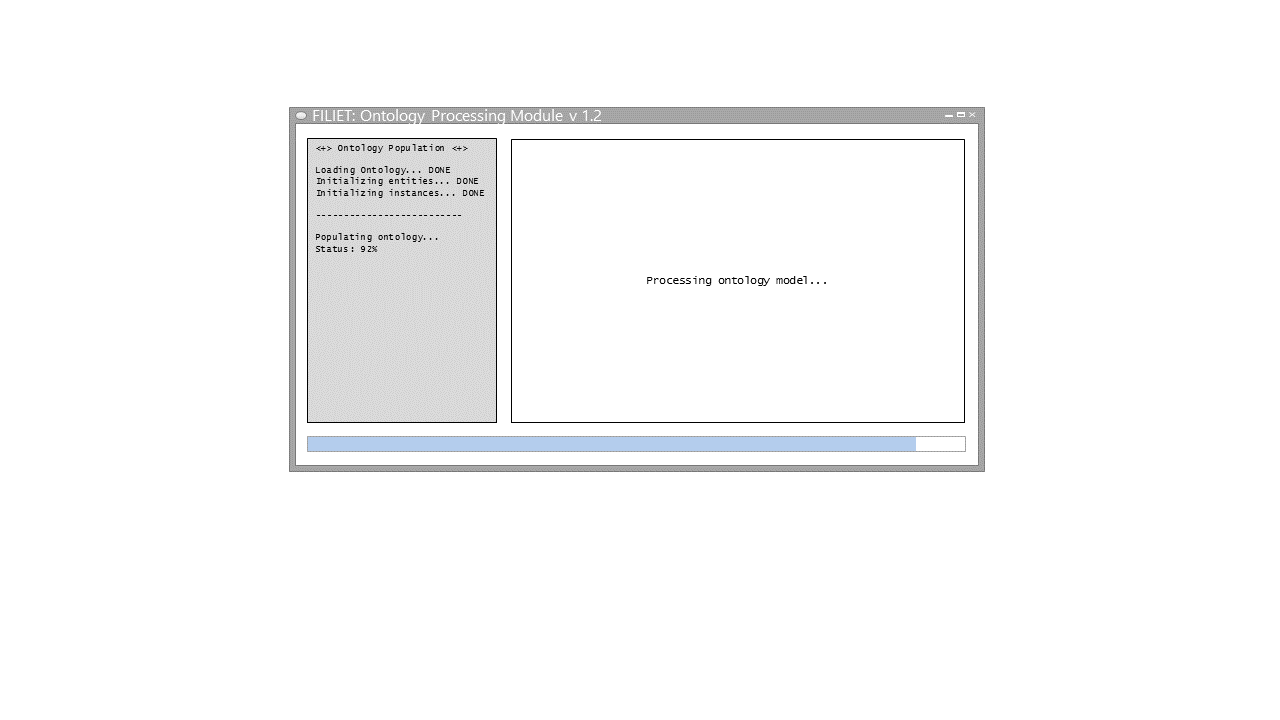


Figure ‑. Ontology Population Screenshot

In this system function, the extracted information will be initialized as entity instances for population of the ontology. The system, by default, automatically validates each of the extracted information before being introduced to the ontology. During validation, the system will check if the entity instances exist and if they do, the system will match the instances to their corresponding entity class/es. If they do not, the instances will immediately be discarded. Figure 4‑5 shows the screenshot of this function.

### Ontology Retrieval

In this system function, the populated ontology and the details of the instances per entity class can also be viewed. Relationships within entities can be seen or searched given a selected instance from the ontology model. Figure 4‑6 shows a screenshot of this function.

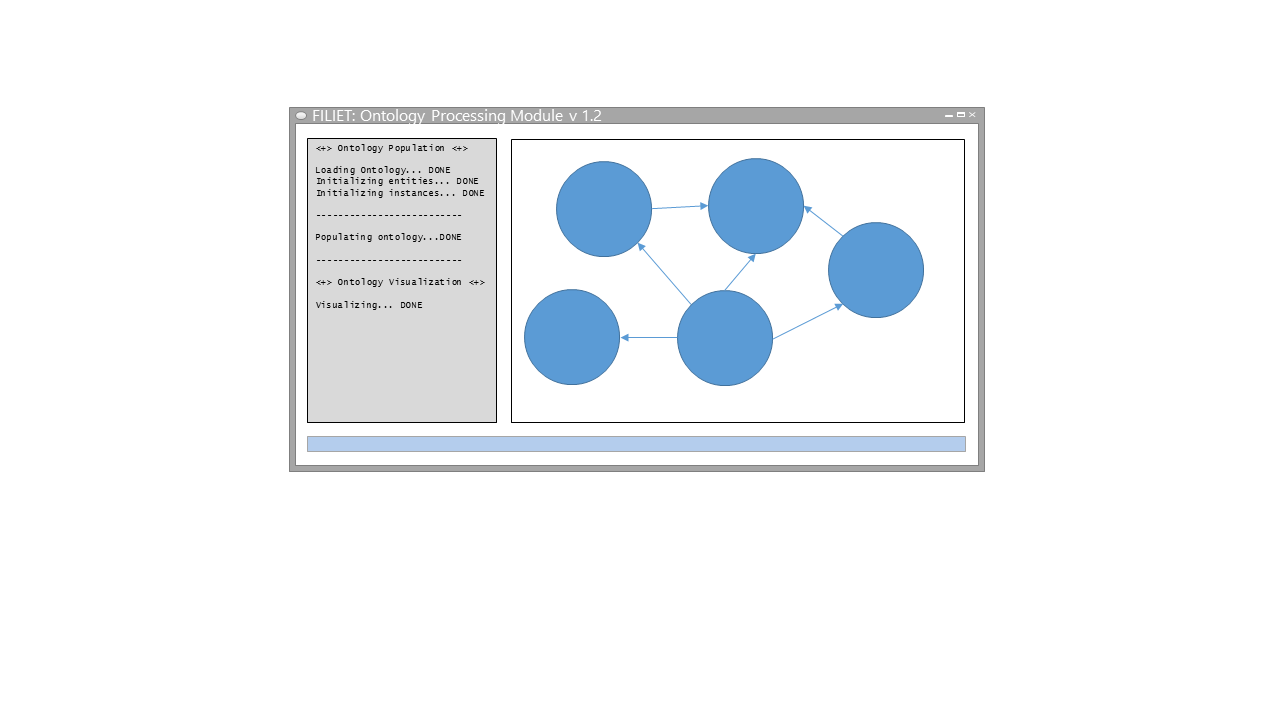


Figure ‑. Ontology Access Screenshot

## Physical Environment and Resources

This section outlines the minimum software and hardware requirements of the system.

### Minimum Software Requirements

* Windows 7
* MySQL
* Java 1.7.0

### Minimum Hardware Requirements

* 2 GB RAM
* Server

# Design and Implementation Issues

This chapter discusses the design and implementation of the system as well as the issues encountered during its development.

## Resource Gathering

### Dataset Building

There are two datasets that are used. The first dataset is composed of combined Mario and Ruby tweets. The second dataset is composed of purely Ruby tweets. Both of them are manually tagged into four categories, Caution and Advice (CA), Casualty and Damage (CD), Call for Help (CH) and Donation (D). Table 5‑1 details the contents of the two datasets.

Table ‑. Contents of Each Dataset

|  |  |  |
| --- | --- | --- |
| **Category** | **Number of Instances** | |
| **Mario Dataset** | **Ruby Dataset** |
| CA | 567 | 1000 |
| CD | 72 | 202 |
| CH | 19 | 63 |
| D | 21 | 43 |
| O | 681 | 999 |
| **Total** | **1360** | **2307** |

### Feature Words

Feature Words are words that are used for the classification module. The words are collected from the Ruby dataset. From the Ruby dataset, all the categories are grouped together. Then, collected unique words from each category, excluding stop words. Refer to Appendix D for the list of stop words. Each word is then weighted using the TFIDF weighting schemes. Then, the top n-% from each category is now collected, in this case 10%, 20% and 30% was used. Refer to Appendices E, F and G for the list of top 10%, 20% and 30% feature words. If there are words that appeared in other category, then the word is removed.

## Crawler Module

The crawler module is responsible for the collection of disaster-related tweets. It uses Twitter4j API (Twitter4j, n.d.), an unofficial Java library that uses Twitter API, to crawl Twitter. This module uses an authenticated account that follows users. In order to get disaster-related tweets, the official hashtags used by the government were used to filter the tweets (please refer to Appendix C for the list of hashtags used). The module uses Twitter’s User Stream API to continuously listen for new tweets. Each tweet is then stored into the database.

Code Listing ‑. Crawl for tweets with the specified keywords

|  |
| --- |
| // Filters  FilterQuery fq = new FilterQuery();  String keywords[] = {"#reliefPH","#nopower", "#nowater", "#roadalert", "#tracingPH", "#rescuePH", "#floodPH", "#queenieph"};  fq.track(keywords);    TwitterStream tweetStream = twitterStreamFactory.getInstance();  tweetStream.addListener(listener);  tweetStream.filter(fq); |

Twitter4j retrieves the tweets the moment a tweet is updated in the account’s timeline. The listener is handled by the UserStreamListener, specifically the onStatus() method. The method will first receive a Status object. This contains all information regarding the tweet. Then, the following information is then processed: TweetID, User, Tweet, Latitude, Longitude, Language, IsUrl, IsHashtag, and IsRetweet to a Tweet object. After binding the Status object to the Tweet object, the Tweet object handles the storing of the tweet information to the database.

Code Listing ‑. Store the Twitter status to the database

|  |
| --- |
| Tweet tweet = new Tweet(status);  try {  tweet.StoreTweet();  } catch (SQLException e) {  e.printStackTrace();  } |

There were several issues encountered in the crawler module. In the first implementation of the crawler module, it was ran to collect tweets during the Typhoon Mario. The some of the tweets that were collected were in multi-line format. The collected tweets are then manually cleaned in order to remove the line breaks. Another problem encountered was the amount of irrelevant tweets that the crawler is collected. Even with using the official hashtags as a filter, the crawler is still getting numerous irrelevant tweets because people use the hashtags irresponsibly.

## Preprocessing Module

### Text Normalizer

The first task to do in the Preprocessing Module is to clean the tweets by normalizing the text the tweet contains. To accomplish this task, the NormAPI library was used. Using the API is easy to use because only the normalize\_Text(String) method is needed.

Code Listing ‑. Using NormAPI

|  |
| --- |
| String normalizedText = NormAPI.normalize\_Text(shortcutText); |

The normalization starts with the initialization of the Normalizer. The Normalizer needs a class that has implemented a NormalizerInterface.

Code Listing ‑. NormAPI Approach

|  |
| --- |
| normalizer = new Normalizer(new NormApiImpl()); |

To use the Normalizer, invoke the executeStrategy(String). The executeStrategy() will expect a String object that contains the actual tweet. The Normalizer will return a String object that is now normalized.

Code Listing ‑. FILIET Normalizer Execution

|  |
| --- |
| normalizedTweet = normalizer.executeStrategy(text); |

The only issue in using NormAPI to set up all the necessary pre-requisite tools and packages that NormAPI needs. There came a point in time where all the pre-requisites were installed and properly working but NormAPI still would not work. With the help of one of the API’s proponents, the cause of the error was found out to be that the copy of NormAPI.jar included in the installation files was the wrong one.

### Tokenizer

This is the second step in processing the incoming tweets that will be coming from web crawler or a CSV file. The tokenizer takes a tweet and parses them into tokens. It returns a Sentence object that contains the array list of Tokens.

The Tokenizer module has two implementations: ArkNLP (Gimpel et al., 2011) and OpenNLP (Apache Software Foundation, 2010). However, other implementations could be easily added by implementing the TokenizerInterface. The TokenizerInterface returns a Sentence object that contains the tweets.

The tokenizer from ArkNLP is called using the static method tokenizeRawTweetText(String text) from the ArkNLP Library. It will then return the tokenized tweet through an array list of string.

Code Listing ‑. ArkNLP Tokenizer Approach

|  |
| --- |
| List<String> tokens = Twokenize.*tokenizeRawTweetText*(text); |

For the OpenNLP tokenizer, a TokenizerModel is needed to initialize the TokenizerME.

Code Listing ‑. OpenNLP Tokenizer Approach

|  |
| --- |
| List<String> tokens = Twokenize.*tokenizeRawTweetText*(text); |

To use the tokenizer in FILIET, a Tokenizer must be initialized first. The Tokenizer is accepting a class that implemented the TokenizerInterface, which is either the ArkNLP or OpenNLP approach. This is done so that tokenizer could be easily modified in the future.

Code Listing ‑. Tokenizer Implementations in FILIET

|  |
| --- |
| // ArkNLP implementation  Tokenizer tokenizer = new Tokenizer(new ArkNLPTokenizerImpl());  // OpenNLP implementation  Tokenizer tokenizer = new Tokenizer(new OpenNLPTokenizerImpl()); |

Both implementations implement the TokenizerInterface wherein they will only call the tokenize() method to tokenize the tweet. This returns an array of strings where each element is a token of the tweet.

Code Listing ‑. OpenNLP Tokenizer Approach

|  |
| --- |
| tokens = tokenizer.tokenize(text); |

To execute the tokenizer in FILIET, call the executeStrategy(String).

Code Listing ‑. FILIET Tokenizer Execution

|  |
| --- |
| tokens = tokenizer.executeStrategy(normalizedTweet); |

The issue of implementing the OpenNLP tokenizer is that it needs a model. There are currently no Filipino model that could be used for the tokenizer, so the group used an English model. Another issue in OpenNLP is tokenizing emoticons. It splits them into two tokens, when it should only be one. In comparison to ArkNLP tokenizer, ArkNLP is very simple to use as it only needs to call a static method from the library. It is much more adept to tweets, because it can handle emoticons. Also, ArkNLP performs significantly faster than OpenNLP. Therefore, ArkNLP tokenizer was preferred.

### POS Tagger

After tokenization, each of the tokens will be tagged with its corresponding parts-of-speech tag. The POSTagger will return the Sentence object that now contains the POS Tags. The POSTagger uses a lookup to tag each token.

The POS Tagger starts with the initialization of the POSTagger. The POSTagger needs a class that has implemented a POSTaggerInterface.

Code Listing ‑. POS Dictionary Look-up Approach

|  |
| --- |
| POSTagger post = new POSTagger(new POSHashLookupImpl()); |

To use the POS Tagger, invoke the executeStrategy(Sentence). The executeStrategy() will expect a Sentence object that contains the array list of tokens. The POSTagger will return a Sentence object that is now tagged with POS.

Code Listing ‑. FILIET POS Tagger Execution

|  |
| --- |
| tokens = post.executeStrategy(tokens); |

The main issue in implementing the POS Tagger is that there are no available tools for the Filipino Language. The look-up approach implemented uses a dictionary that contains the tags for each word. However, the words found in the dictionary is not suitable for tweets since it was extracted from the novels *Noli Me Tangere* and *El Filibusterismo*.

### Filipino NER

Named Entity Recognition module accepts a Sentence object that contains the tokenized and POS tagged tweet. Using a dictionary, it tags the words that are locations. The NER module needs an object that implements the NER Interface. This object contains the actual implementation of the NER. The SomidiaNERImpl contains the implementation of a lookup NER. It uses the dictionary from SOMIDIA.

Code Listing ‑. SOMIDIA’s NER Approach

|  |
| --- |
| NamedEntityRecognizer ner = new NamedEntityRecognizer (new SomidiaNERImpl()); |

After the initialization, the NamedEntityRecognizer can now be used by calling the executeStrategy(Sentence). The method returns the Sentence that is now tagged with NER.

Code Listing ‑. FILIET Filipino NER Execution

|  |
| --- |
| tokens = ner.executeStrategy(tokens); |

The main issue in this module is that it can only tag one-word locations. It only looks at one token at a time. The problem now arises from locations that contains two or more words because the current approach does not support them. Another problem facing the NER module is that there are locations that are considered as adjectives and vice versa. In the NER gazetteer, locations like “Maginhawa” and “Salamat” could be considered as other type. So, when the NER encountered a tweet like “Maraming salamat po”. The word “Salamat” will be tagged as a named entity when it should not be.

### Preprocessor Manager

This module is responsible for initializing all of the sub-modules under the preprocessing module. The preprocessor manager accepts a String and then outputs a Sentence object that has been normalized, tokenized, POS tagged and NER tagged.

First, the preprocessor must be initialized. The preprocessor manager will then initialize the sub-modules. For the normalizer, it will initialize a normalizer using a NormApiImpl object. The tokenizer is initialized with ArkNLPTokenizer object. The POS Tagger is initialized with POSHashLookupImpl. Lastly, the NER Tagger is initialized with SomidiaNERImpl.

Code Listing ‑. FILIET Preprocessor Manager Initialization

|  |
| --- |
| PreprocessorManager preprocess = new PreprocessorManager();  Sentence preprocessed = preprocess.PreprocessText(String); |

## Feature Extraction Module

The feature extractor module is for extracting, word features and presence features inside a tweet. The module requires word files that contains the word features. The feature extractor will then count how many times a word from the features appeared in the tweet. For the presence of hashtags, it will check each token if it contains *“#”* sign. If it contains a hashtag, it will be labeled as 1, else 0. For the presence of mentions, it will check each token if it contains *“@”*. Then, it will label it as 1, else 0. Lastly, for the presence of URL, it will check each token will contain “http”. If it does, it will label it as 1, else 0. The feature extractor uses the top 20% TFIDF scores for the word features for each category, excluding stop words.

To use this, FeatureExtractor must first be initialized. It requires one parameters, the path to the n-gram files and the path to the word files.

Code Listing ‑. FILIET Feature Extraction Initialization

|  |
| --- |
| String word = "./resources/model/word/ruby-word";  FeatureExtractor fe = new FeatureExtractor(word); |

After initializing, the FeatureExtractor can either do single processing or batch processing. For the single processing, the method extract(Sentence) is used. The method will be expecting a Sentence object that has been preprocessed. Then it will output a Sentence object that now contains extracted features. For the batch processing, the method extract(String, String) is used, where the method expects the path to a CSV file that contains the tweets, and the path where the output will be saved.

Code Listing ‑. FILIET Feature Extraction Execution

|  |
| --- |
| // Single Processing  fe.extract(sentence);  // Batch Processing  String tweets = "./resources/tweets/mario-datasets/original/ruby-dataset.csv”;  String saveModel = "./resources/tweets/test-extracted/mario-tfidf/ruby-extracted.csv  fe.extractFeatures(tweets,saveModel); |

## Category Classifier Module

The classifier module categorizes the tweet into one of the following categories: Caution and Advice (CA), Casualties and Damage (CD), Donation (D), Call for Help (CH), and Other (O). The classifier uses a model in order to classify the tweets. Models are trained using Weka (Weka, n.d.). The classifier module accepts a String object that has passed through the Preprocessing Module and Feature Extractor Module and returns the category of the tweet.

First, the classifier must be initialized. The classifier accepts a class that has implemented a ClassifierInterface. The ClassifierImpl class has two constructors. If there is no provided path, the classifier will use the default model.

Code Listing ‑. FILIET Classifier Implementations

|  |
| --- |
| // Default model  Classifier classifier = new Classifier(new ClassifierImpl());  // Path to the model resource.  Classifier classifier = new Classifier(new ClassifierImpl("./resources/model/classifier/testmodel.model")); |

The classifier will then initialize a ClassifierBuilder class. This class is responsible for binding the Sentence object to an Instance object that will be used for the classification. The ClassifierBuilder has two constructors. The first constructor takes no parameters. This will set the word file to its default. The second constructor takes a parameter: path to the word file.

Code Listing ‑. Classifier Builder Initialization

|  |
| --- |
| // Default model  ClassifierBuilder builder = new ClassifierBuilder();  // Path to the model resource.  ClassifierBuilder builder = new ClassifierBuilder(wordPath); |

To run the classification, invoke the executeStrategy(Sentence) method.

Code Listing ‑. FILIET Classifier Execution

|  |
| --- |
| String category = classifier.executeStrategy(temp); |

## Rule Inductor Module

Information extractor is the module responsible for extracting the relevant information from the tweets. The module accepts preprocessed and classified tweets and outputs the Sentence object with the extracted information. It uses the hand-crafted rules to extract the information.

To initialize the Rule Inductor module, the constructor accepts a single string parameter. This is the file path to the rule file.

Code Listing ‑. Rule Inductor Initialization

|  |
| --- |
| RuleInductor ruleInductor = new RuleInductor(rulePath); |

For the rule file, the rules are categorized into four categories. They are separated by <Category>: [category]. One rule is listed per line. Then, the <end> tag is used to signify the end of list for that [category]. Refer to Appendix G for the complete list of extraction rules.

Code Listing ‑. Sample Extraction Rules for CA Category

|  |
| --- |
| <Category>: CA  <pos:JJ> <pos:NN> <pos:PSNS> <number:ANY>  <ner:LOCATION>[as]LOCATION  <pos:JJ> <string:#1>  <pos:JJ> <string:#2>  <pos:JJ> <string:#3>  <pos:VBZ> <string:classes> <pos:IN> <pos:JJ> <pos:VBZ>  <pos:VBP> <string:classes> <pos:IN> <pos:JJ> <pos:VBZ>  <string:#walangpasok> <pos:JJ> <pos:VBZ>  <string:signal> <pos:NN> <pos:PSNS> <number:ANY>  <string:#walangpasok> <pos:PSNS> <string:klase>  <string:#walangpasok> <string:sa> <pos:PIDP> <pos:NA> <string:antas>  <end> |

For the construction of extraction rules, each rule can consist of the following tags: string, number, pos, ner. The string tag will match to the token’s word. The pos tag will match to the token’s POS. The number tag is used to match numbers. Lastly, the ner will match to the token’s NER. To use wildcards, the key “ANY” to match any values.

The Rule Inductor module uses match(Sentence) method to apply the rules.

Code Listing ‑. Rule Inductor Initialization

|  |
| --- |
| ruleInductor.setExtractedInformation( ruleInductor.match( extractedTweet ) ); |

The implementation of the FILIET architecture itself presents the problem of propagation of errors that may arise from the different modules that precede it. Another problem is the over application of rules. Even if the tweets are already categorized, thus only applying these specific set of rules, the tweet can still be matched to various rules making the system extract extraneous information.

## Ontology Population Module

After extracting the relevant information from the tweets based on their respective categories, they are now stored to an ontology that contains object relations between the different extracted information. The actual structure of the ontology was made using an external tool called Protegé that makes use of the OWL API. This module takes an instance or a list of instance of categorized tweet classes. The categorized tweet classes include the following: the CallForHelpTweet class for containing the information that were gathered under the Call For Help category; CasualtiesAndDamageTweet class for containing the information that were gathered under the Casualties and Damage category; CautionAndAdviceTweet class for containing the information that were gathered under the Caution and Advice category; lastly, DonationTweet class for containing the information that were gathered under the Casualties and Damage category. This module has two sub-parts that are both responsible for storing and accessing information in the ontology. The OntologyModule class is responsible for storing the extracted information to the ontology and the OntologyRetriever class is responsible for retrieving the information that was stored in the ontology.

The actual storing of information involves more sub modules or methods which helps streamlined the process. The process starts with the call to the respective method for storing the information extracted from its tagged category. Inside this method, there are certain variables that should be initialized so that they can be interfaced with the actual ontology. A sample code listing below shows the different variables to be initialized – take the addCautionAndAdviceReport for example.

Code Listing ‑. addCautionAndAdviceReport Initialization

|  |
| --- |
| // PREPARE THE TWEET INDIVIDUAL  OWLIndividual tweetIndividual = addTweetInformation(ca);    // PREPARE THE REASONER AND PREREQUISITE STUFF  OWLDataFactory dataFactory = manager.getOWLDataFactory();    // INSTANTIATE CLASSES NEEDED FOR THIS OPERATION  OWLClass cautionAdviceClass = dataFactory.getOWLClass(IRI.create(CAUTION\_ADVICE\_CLASS\_IRI));  OWLClass adviceClass = dataFactory.getOWLClass(IRI.create(ADVICE\_CLASS\_IRI));    // CREATE THE NEEDED INDIVIDUALS FOR THIS OPERATION  OWLIndividual caIndividual = dataFactory.getOWLNamedIndividual(IRI.create(BASE\_IRI + "\_CA-I\_" + ca.getTweetAdvice().replace(" ", "\_")));  OWLIndividual adviceIndividual = dataFactory.getOWLNamedIndividual(IRI.create(BASE\_IRI + "\_A-I\_" + ca.getTweetAdvice().replace(" ", "\_"))); |

After initializing the different needed variables, the next step is to prepare the Tweet individual that will serve as the root individual for storing all the extracted information into the ontology. To do so, call the addTweetInformation method with an instance of the CautionAndAdviceTweet class as a parameter for this method. This method will return an OWLIndividual that will be used as a prerequisite for completing the storage process. Furthermore, this method prepares the Tweet individual to include other information that was extracted including the Tweet Location and the Tweet Timestamp. A sample code listing below shows how the addTweetInformation method works.

Code Listing ‑. Prerequisite Class Instantiations

|  |
| --- |
| // PREPARE THE REASONER AND PREREQUISITES  OWLDataFactory dataFactory = manager.getOWLDataFactory();    // INSTANTIATE CLASSES NEEDED FOR THIS OPERATION  OWLClass tweetClass = dataFactory.getOWLClass(IRI.create(TWEET\_CLASS\_IRI));  OWLClass locationClass = dataFactory.getOWLClass(IRI.create(LOCATION\_CLASS\_IRI));  OWLClass timestampClass = dataFactory.getOWLClass(IRI.create(TIMESTAMP\_CLASS\_IRI)); |

Code Listing ‑. Ontology Individual Creations

|  |
| --- |
| // CREATE THE NEEDED INDIVIDUALS FOR THIS OPERATION  OWLIndividual tweetIndividual = dataFactory.getOWLNamedIndividual(IRI.create(BASE\_IRI + "\_TI\_" + t.getTweetContent().replace(" ", "\_")));  OWLIndividual locationIndividual = dataFactory.getOWLNamedIndividual(IRI.create(BASE\_IRI + "\_LI\_" + t.getTweetContent().replace(" ", "\_")));  OWLIndividual timestampIndividual = dataFactory.getOWLNamedIndividual(IRI.create(BASE\_IRI + "\_TSI\_" + t.getTweetContent().replace(" ", "\_"))); |

Code Listing ‑. Class-Individual Assertions

|  |
| --- |
| Set<OWLClassAssertionAxiom> classAssertion = new HashSet<OWLClassAssertionAxiom>();    ....  OWLClassAssertionAxiom lAssertion = dataFactory.getOWLClassAssertionAxiom(locationClass, locationIndividual);  classAssertion.add(lAssertion);  ....    manager.addAxioms(filietOntology, classAssertion); |

Code Listing ‑. Data Property Assertion

|  |
| --- |
| Set<OWLDataPropertyAssertionAxiom> dataAssertion = new HashSet<OWLDataPropertyAssertionAxiom>();    // These are the data properties for the Tweet Individual  OWLDataProperty tweetHandle = dataFactory.getOWLDataProperty(IRI.create(BASE\_IRI + "tweetHandle"));  OWLDataPropertyAssertionAxiom tweetHandleDataPropertyAssertion = dataFactory.getOWLDataPropertyAssertionAxiom(tweetHandle, tweetIndividual, t.getTweetHandle());  dataAssertion.add(tweetHandleDataPropertyAssertion);  OWLDataProperty tweetContent = dataFactory.getOWLDataProperty(IRI.create(BASE\_IRI + "tweetContent"));  OWLDataPropertyAssertionAxiom tweetContentDataPropertyAssertion = dataFactory.getOWLDataPropertyAssertionAxiom(tweetContent, tweetIndividual, t.getTweetContent());  dataAssertion.add(tweetContentDataPropertyAssertion);  ....  manager.addAxioms(filietOntology, dataAssertion); |

Code Listing ‑. Object Property Assertion

|  |
| --- |
| Set<OWLObjectPropertyAssertionAxiom> objectAssertion = new HashSet<OWLObjectPropertyAssertionAxiom>();    OWLObjectProperty hasThisInfo = dataFactory.getOWLObjectProperty(IRI.create(BASE\_IRI + "has\_this\_information"));  OWLObjectPropertyAssertionAxiom hasLocationAssertion = dataFactory.getOWLObjectPropertyAssertionAxiom(hasThisInfo, tweetIndividual, locationIndividual);  objectAssertion.add(hasLocationAssertion);  OWLObjectPropertyAssertionAxiom hasTimestampAssertion = dataFactory.getOWLObjectPropertyAssertionAxiom(hasThisInfo, tweetIndividual, timestampIndividual);  objectAssertion.add(hasTimestampAssertion);    manager.addAxioms(filietOntology, objectAssertion); |

After preparing the Tweet individual, the next step is to assert or tell the ontology that the newly instantiated classes are instances of the instantiated Ontological classes. A sample code listing below shows how to assert individual instances as class instances.

Code Listing ‑. Asserting Individual Instances as Class Instances

|  |
| --- |
| Set<OWLClassAssertionAxiom> classAssertion = new HashSet<OWLClassAssertionAxiom>();    OWLClassAssertionAxiom caAssertion = dataFactory.getOWLClassAssertionAxiom(cautionAdviceClass, caIndividual);  classAssertion.add(caAssertion);  OWLClassAssertionAxiom adAssertion = dataFactory.getOWLClassAssertionAxiom(adviceClass, adviceIndividual);  classAssertion.add(adAssertion);    manager.addAxioms(filietOntology, classAssertion); |

After asserting that the newly instantiated classes are instances of the instantiated Ontological classes, the next step is to add the extracted information to the different individuals as their respective data properties. A sample code listing below shows how to add data properties to the individuals that were instantiated.

Code Listing ‑. Adding Data Properties to Instantiated Individuals

|  |
| --- |
| Set<OWLDataPropertyAssertionAxiom> dataAssertion = new HashSet<OWLDataPropertyAssertionAxiom>();    OWLDataProperty tweetAdvice = dataFactory.getOWLDataProperty(IRI.create(BASE\_IRI + "tweetAdvice"));  OWLDataPropertyAssertionAxiom adviceDataPropertyAssertion = dataFactory.getOWLDataPropertyAssertionAxiom(tweetAdvice, adviceIndividual, ca.getTweetAdvice());  dataAssertion.add(adviceDataPropertyAssertion);    manager.addAxioms(filietOntology, dataAssertion); |

After adding data properties to the individuals that were instantiated, the next step is to assert or tell the ontology the different relations that connect the different individuals that were instantiated. In ontological terms, this is called Object Properties. This is the part where connecting the different individuals are connected so that they would make sense when stored into the ontology. Examples of these connections include the “has\_this\_information” connection, the “gives\_out\_an” connection and the like. A sample code listing below shows how to add object properties between the individuals that were instantiated.

Code Listing ‑. OntologyModule Initialization

|  |
| --- |
| Set<OWLObjectPropertyAssertionAxiom> objectAssertion = new HashSet<OWLObjectPropertyAssertionAxiom>();    // Say that the Tweet Individual is of the category CA Individual  OWLObjectProperty canBeOfTheCategory = dataFactory.getOWLObjectProperty(IRI.create(BASE\_IRI + "can\_be\_of\_the\_category"));  OWLObjectPropertyAssertionAxiom canBeAssertion = dataFactory.getOWLObjectPropertyAssertionAxiom(canBeOfTheCategory, tweetIndividual, caIndividual);  objectAssertion.add(canBeAssertion);    OWLObjectProperty givesOutAn = dataFactory.getOWLObjectProperty(IRI.create(BASE\_IRI + "gives\_out\_an"));  OWLObjectPropertyAssertionAxiom givesAssertion = dataFactory.getOWLObjectPropertyAssertionAxiom(givesOutAn, caIndividual, adviceIndividual);  objectAssertion.add(givesAssertion);    manager.addAxioms(filietOntology, objectAssertion); |

After adding the object properties, the complete extracted information can now be finally stored to the ontology. Storing information to the ontology is simple done by calling the function saveFilietOntology.

### OntologyModule

The OntologyModule class is the main class responsible for working around the storage and verification of the extracted information in the ontology that was designed for the use of the system. It has respective functions for the different pre-requisite steps that shall be taken before actually accessing and modifying the contents of the ontology. There are respective functions for loading, saving and removing the ontology from its manager. Also, general-purpose functions were included to streamline the process of verifying the information to the ontology. These functions include a categorized tweet information viewer and a data property value viewer.

To store information into the ontology, certain classes have to be initialized so that they can be manipulated within the module.

Code Listing ‑. OntologyModule Initialization

|  |
| --- |
| // Classes for containing the extracted information per category  CallForHelpTweet oCH = new CallForHelpTweet();  CasualtiesAndDamageTweet oCD = new CasualtiesAndDamageTweet();  CautionAndAdviceTweet oCA = new CautionAndAdviceTweet();  DonationTweet oD = new DonationTweet();  // Class for actually initializing the module  OntologyModule oModule = new OntologyModule(); |

After initializing the necessary classes, the extracted information will now be stored into the new initialized classes based on its given category. For instance, let’s take the information that was extracted from a tweet that was categorized to be a Caution and Advice tweet. A sample code listing below shows how to temporarily store the extracted information into its respective categorized tweet class.

Code Listing ‑. Sample Initialization of Categorized Tweet Information Instance

|  |
| --- |
| // SAMPLE INITIALIZATION FOR CAUTION AND ADVICE REPORTS  oCA.setTweetHandle("theonlykyleeeee");  oCA.setTweetContent(":(( RT WARNING! Baha sa Guadalupe!");  oCA.setTweetGeoLocation("10.00000121, 145.345300023");  oCA.setLocationInTweet("Guadalupe");  oCA.setTweetTimestamp("12/27/2014:00:13:67:40");  oCA.setTweetDate("December 27, 2014");  oCA.setTweetAdvice("WARNING! Baha sa Guadalupe!"); |

After temporarily storing the extracted information, actual storage of the information to the ontology now follows. Storing the extracted information is a fairly simple process; as it would only require calling one function and requires only one input. The catch, though, is that there are different methods for certain categories of tweet. Also, if you would want to verify if the storage process has been successful, you could do a rough view of the contents of the ontology just by calling a simple view method.

Code Listing ‑. Storing Information in the Ontology

|  |
| --- |
| try {  oModule.loadOntology();  // Permanently store information to the ontology  oModule.addCautionAndAdviceReport(oCA);  oModule.addCasualtiesAndDamageReport(oCD);  oModule.addDonationReport(oD);  oModule.addCallForHelpReport(oCH);  // View the contents of the ontology  oModule.displayStoredTweets();  oModule.removeOntologyFromManager();  } catch (OWLOntologyCreationException e) {  e.printStackTrace();  } |

In developing the OntologyModule class, there were some issues encountered with its actual implementation because of a number of reasons. First, the documentation that came with the API was not that comprehensive and streamlined in a way that there were actually no complete descriptions about the different methods that can be utilized; though, there were code samples that were confusing. With this type of documentation, there was difficulty in customizing the implementation of the different methods within the API to suit the needs and requirements of the system. Also, debugging/testing of the module was difficult because there was no complete reference for the actual functions of each method including its parameters and its outputs. Manipulation and modification of the actual ontology is a challenge because two different tools used. It is imperative to check if the changes are properly reflected in order for the module to function properly. If there are changes to the ontology, use Protegé first to fix the structure of the ontology and the different dependencies that might be affected upon performing the changes and then, modify the Java code so that there will be seamless interaction between the system and the ontology behind it.

### OntologyRetriever

The OntologyRetriever class is the main class responsible for working around the retrieval of the extracted information in the ontology that was designed for the use of the system. It has respective functions for the different pre-requisite steps that shall be taken before actually accessing and modifying the contents of the ontology. There are respective functions for loading and removing the ontology from its manager. Also, general-purpose functions were included to streamline the process of retrieving the information to the ontology. These functions include a categorized tweet information retriever and a data property value retriever. Also, category-specific functions were included to properly organize the information that was retrieved. These functions include a constructor method for retrieved Caution and Advice, Casualties and Damage, Call for Help, and Donation tweets, which just make each of the set of extracted information an instance of each of the classes representing the mentioned categories.

To retrieve the information from the ontology, one class has to be initialized so that other modules can manipulate it.

Code Listing ‑. OntologyRetriever Initialization

|  |
| --- |
| OntologyRetriever or = new OntologyRetriever(); |

After initializing the needed class, actual retrieval of the information from the ontology now follows. Retrieving the information stored in the ontology is a fairly simple process, as it would only require calling one function and requires no input. A variable of the type RetrievedTweetis needed to contain the information that will be returned by the retrieval function of the module. The variable should be of type RetrievedTweet because the retrieval function, logically, returns four ArrayLists for the different categories of the information.

Code Listing ‑. RetrievedTweet Class Structure

|  |
| --- |
| public class RetrievedTweet {  ArrayList<CallForHelpTweet> retrievedCFHTweets;  ArrayList<CasualtiesAndDamageTweet> retrievedCADTweets;  ArrayList<CautionAndAdviceTweet> retrievedCATweets;  ArrayList<DonationTweet> retrievedDTweets;    ......  } |

Code Listing ‑. OntologyRetriever Execution

|  |
| --- |
| try {  or.loadOntology();  RetrievedTweet rt = or.getStoredTweets();  or.removeOntologyFromManager();  } catch (Exception e) {  e.printStackTrace();  } |

In developing the OntologyRetriever class, almost the same issues as the ones mentioned in the OntologyModule were encountered. First, the documentation that came with the API was not that comprehensive and streamlined. With this type of documentation, there is difficulty in customizing the implementation of the different methods that are concerned with ontology retrieval within the API to suit the needs and requirements of the system’s retrieval method. Debugging/testing the module is hard because there is no complete reference for the actual output of each method including the effects of combining different methods to achieve a certain output from the ontology. Second, there have been some difficulties in structuring and implementing the actual retrieval method code because there is a need to look at the initial contents of the ontology and its actual relations and structures to be able translate the logical connections and relations between the instances stored in the ontology to a physical working code that will facilitate the exchange of information between the ontology and system. There should be a way to remember the specific the relational connections between the instances to and “simulate” them in order to reverse the process of adding/storing to the ontology; thus, essentially, enabling a retrieval process. Also, with this, essentially, the same difficulty of working with two separate tools was encountered.

# Results and Observation

## Data Gathering

## Evaluation of Classifier Module

The main objective of the classifier module is to classify the tweets into categories: Caution and Advice (CA), Casualties and Damage (CD), Call for Help (CH), Donations (D), and Others (O). The accuracy of the classifier module will greatly affect the rule induction module as the rule induction module is dependent on the category to know what rules will be applied to the tweets.

### Methodology

The classifier is tested on two datasets, the Mario dataset and the Ruby dataset. The Mario dataset contains 1360 instances and the Ruby dataset contains 2307 instances. The results are then compared to the manual annotations. All the classifiers are tested using 10 cross-fold validation. Then the dataset is run through the feature extractor module to extract the features from the tweets. The dataset is tested on varying number of word features to determine the optimal features. The experiment tested on top 10%, 20% and 30% of the highest TF-IDF scores. The list excluds the stop words. Refer to Appendix E, F, and G for the complete list of the feature words. The classifier is validated using the 10 cross-fold validation. The performance of the classifier is measured using precision, recall and f-measure.

### Results and Observation

Table 6‑1 shows the results of the classifier for the Mario dataset using the top 10% highest TFIDF scoring words. Table 6‑2 shows the results of the classifier for the Mario dataset using the top 20% highest TFIDF scoring words. Table 6‑3 shows the results of the classifier for the Mario dataset using the top 30% highest TFIDF scoring words. Table 6‑4 shows the result of the classifier for the Ruby dataset using the top 10% highest TFIDF scoring words. Table 6‑5 shows the result of the classifier for the Ruby dataset using the top 20% highest TFIDF scoring words. And, Table 6‑6 shows the result of the classifier for the Ruby dataset using the top 30% highest TFIDF scoring words.

Table ‑. Using Top 10% Word Features for Mario Dataset

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Algorithm** | **Precision** | **Recall** | **F-measure** | **Kappa** |
| J48 | 0.812 | 0.813 | 0.807 | 0.6636 |
| Random Forest | 0.841 | 0.842 | 0.84 | 0.7201 |
| kNN-3 | 0.792 | 0.791 | 0.786 | 0.6245 |
| kNN-5 | 0.781 | 0.779 | 0.779 | 0.6001 |
| kNN-7 | 0.77 | 0.768 | 0.759 | 0.5771 |
| Naïve Bayes | 0.731 | 0.725 | 0.719 | 0.5141 |
| Bayesian Network | 0.752 | 0.752 | 0.747 | 0.5553 |
| **Average** | **0.78271429** | **0.781429** | **0.776714** | **0.607829** |

Table ‑. Using Top 20% Word Features for Mario Dataset

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Algorithm** | **Precision** | **Recall** | **F-measure** | **Kappa** |
| J48 | 0.82 | 0.819 | 0.814 | 0.675 |
| Random Forest | 0.855 | 0.856 | 0.854 | 0.942 |
| kNN-3 | 0.796 | 0.794 | 0.789 | 0.6293 |
| kNN-5 | 0.784 | 0.782 | 0.776 | 0.606 |
| kNN-7 | 0.78 | 0.78 | 0.773 | 0.6015 |
| Naïve Bayes | 0.751 | 0.73 | 0.726 | 0.5372 |
| Bayesian Network | 0.751 | 0.73 | 0.726 | 0.862 |
| **Average** | **0.791** | **0.784429** | **0.779714** | **0.693286** |

Table ‑. Using Top 30% Word Features for Mario Dataset

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Algorithm** | **Precision** | **Recall** | **F-measure** | **Kappa** |
| J48 | 0.833 | 0.834 | 0.831 | 0.7043 |
| Random Forest | 0.86 | 0.862 | 0.858 | 0.7527 |
| kNN-3 | 0.798 | 0.796 | 0.788 | 0.6293 |
| kNN-5 | 0.794 | 0.793 | 0.786 | 0.6244 |
| kNN-7 | 0.807 | 0.804 | 0.798 | 0.6451 |
| Naïve Bayes | 0.751 | 0.731 | 0.734 | 0.5464 |
| Bayesian Network | 0.739 | 0.733 | 0.73 | 0.5365 |
| **Average** | **0.797429** | **0.793286** | **0.7893** | **0.6341** |

Table ‑. Using Top 10% Word Features for Ruby Dataset

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Algorithm** | **Precision** | **Recall** | **F-measure** | **Kappa** |
| kNN-3 | 0.924 | 0.91 | 0.914 | 0.8559 |
| kNN-5 | 0.927 | 0.927 | 0.925 | 0.8793 |
| kNN-7 | 0.908 | 0.909 | 0.905 | 0.8494 |
| Random Forest | 0.953 | 0.952 | 0.952 | 0.9219 |
| J48 | 0.921 | 0.922 | 0.92 | 0.8721 |
| Naïve Bayes | 0.917 | 0.917 | 0.916 | 0.8649 |
| Bayesian Network | 0.931 | 0.93 | 0.928 | 0.8848 |
| **Average** | **0.92585714** | **0.923857** | **0.922857** | **0.875471** |

Table ‑. Using Top 20% Word Features for Ruby Dataset

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Algorithm** | **Precision** | **Recall** | **F-measure** | **Kappa** |
| kNN-3 | 0.936 | 0.934 | 0.931 | 0.8896 |
| kNN-5 | 0.924 | 0.922 | 0.918 | 0.8695 |
| kNN-7 | 0.908 | 0.904 | 0.895 | 0.8376 |
| Random Forest | 0.967 | 0.966 | 0.966 | 0.9446 |
| J48 | 0.931 | 0.931 | 0.93 | 0.8875 |
| Naïve Bayes | 0.926 | 0.925 | 0.925 | 0.8782 |
| Bayesian Network | 0.931 | 0.93 | 0.928 | 0.8848 |
| **Average** | **0.931857** | **0.930286** | **0.927571** | **0.884543** |

Table ‑. Using Top 30% Word Features for Ruby Dataset

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Algorithm** | **Precision** | **Recall** | **F-measure** | **Kappa** |
| kNN-3 | 0.934 | 0.931 | 0.928 | 0.8857 |
| kNN-5 | 0.916 | 0.912 | 0.906 | 0.8521 |
| kNN-7 | 0.892 | 0.887 | 0.874 | 0.984 |
| Random Forest | 0.966 | 0.965 | 0.964 | 0.943 |
| J48 | 0.928 | 0.929 | 0.927 | 0.98 |
| Naïve Bayes | 0.932 | 0.929 | 0.929 | 0.8851 |
| Bayesian Network | 0.934 | 0.932 | 0.931 | 0.8891 |
| **Average** | **0.928857** | **0.926429** | **0.922714** | **0.917** |

Table ‑. Average of the results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Precision** | **Recall** | **F-measure** | **Kappa** |
| **Mario-10** | 0.7827 | 0.7814 | 0.7767 | 0.6078 |
| **Mario-20** | 0.791 | 0.7844 | 0.7797 | 0.6933 |
| **Mario-30** | 0.7974 | 0.7933 | 0.7893 | 0.6341 |
| **Ruby-10** | 0.9259 | 0.9239 | 0.9229 | 0.8755 |
| **Ruby-20** | 0.9319 | 0.9303 | 0.9276 | 0.8845 |
| **Ruby-30** | 0.9289 | 0.9264 | 0.9227 | 0.917 |

The results of the classifier shows a very high score in the Ruby dataset. The average scores of the precision, recall and f-measures in the Ruby dataset are all greater than 90%, while the results in the Mario dataset only scored around 80% in precision, recall, and f-measures. This is because the words that are extracted came from the Ruby dataset. For the number of feature words, the top 20% feature word is the highest for the Mario dataset, while the top 30% feature word is the highest for the Ruby dataset. For the Mario dataset, the feature words in the top 30% are introducing irrelevant features to the classifier. Lastly for the algorithm, in all of the results, random forest algorithm scored the highest, with greater than 95% f-measure for the Ruby dataset and 84% f-measure for the Mario dataset. Naïve Bayes, however, performed the worst in both datasets with 91% f-measure for Ruby dataset and 71% f-measure for Mario dataset. It seems that the Naïve Bayes and Bayesian Network is having difficulty in classifying because of the sheer number of features present. For the k-nearest neighbor (kNN), *k = 3* is the optimal number of neighbors for both dataset. As k increases, there is a significant decrease in f-measure. This is because it introduces noise.

## Evaluation of Information Extraction

The object of the rule induction module is to extract the relevant information on the tweet based on the classified category. For the CA category the following information is extracted: location mentioned in the tweet and the advice/caution. For the CD category, location in tweet, the object that is destroyed, the details of the object, and the victim’s name. For the CH category, the location in tweet and the victim’s name. For the D category, the location in tweet, the items to be donated and the details of the item.

### Methodology

The dataset used is casualties and damages dataset that contains only instances labelled with CD. This contains 202 instances. The goal of this experiment is to check the efficiency of the hand-crafted rules.

### Results and Observation

Table 6‑7 shows the results of the information extraction for the category CD. The Location got a low score for the measures because there are locations that are not a single word, these locations cannot be extracted by the system. The Object Name got a high score because it mostly consists of one word which is easily extracted by the system. While the Object Detail got a fair score because the system extracts any value that looks like it is part of the Object Name even if it is irrelevant, also the system is not able to extract spelled out values. Victim Name got a high score for the measures because most of the tweets do not have a victim name so the system extracts a null.

Table ‑. Ruby Information Extraction Results (CD)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Precision | Recall | F-Measure |
| Location | 0.2396 | 0.3433 | 0.2822 |
| Object Name | 1.0 | 0.8529 | 0.9206 |
| Object Detail | 1.0 | 0.6485 | 0.7867 |
| Victim Name | 1.0 | 0.9901 | 0.9950 |

# Conclusion and Recommendation

This chapter is divided into two sections. The first section presents the conclusion of the study and whether objectives of the research was achieved. The second section details the recommendations for possible areas of improvement per module.

## Conclusion

The results shows that the random forest is the best algorithm for the classifier. The result for the random forest is consistent to the Mario and Ruby datasets. The features used is the top 30% features resulted the best for the classifier. For the information extraction, the module is having difficulty in extracting the location in the tweet because of the NER as the module could not completely extract the multi-words location. Also, some of the words tagged that are originally tagged to be a location entity could also be tagged to be an entity of a different type like an adjective, verb and the like. There will be problem extracting victim names as the NER could not identify people’s name.

## Recommendation

Listed below are some areas where improvements can be made for the system.

### Preprocessing Module

* Inclusion of a lemmatizer sub-module so as to facilitate a cleaner dataset for subsequent modules. With Filipino being a morphologically rich language, words such as “bumabaha”, “binabaha”, and “binaha” all pertain to their root word which is “baha”. With a lemmatizer, certain words will be tagged to their corresponding root word which will then simplify the job of the other modules.
* The current implementation of the POS Tagger makes use of a look-up dictionary extracted from a novels. Possible recommendations for this is to either improve upon the POS dictionary itself so that it can accommodate Twitter corpora or to create a stable POS Tagger for the Filipino language.
* Multi-worded named entities are not recognized because the system only processes on a one-token basis. Inclusion of a chunker sub-module will group related words which can help the next module identify multi-worded named entities (i.e. St. Ana, Tacloban City)
* Improve the Filipino NER dictionary in order to recognize the names of people and to be able to detect the named entities in hashtags (i.e. #cebucity, #taclobancity). By doing so, this may contribute to more accurate extraction of information.

### Category Classifier Module

* Improve Categorization of tweets because there are ambiguous tweets due to ambiguity of the Filipino language, there are tweets that fall under two or more categories. There are also tweets that are uncategorized that does not fall under the existing categories.

### Ontology Population Module

* Inclusion of a mechanism to be able to store multiple instances of classes that are found within the structures of the actual ontology. Ontological classes that could include multiple instances per instance of the root Tweet class are the Location class, Victim Class, and Object classes. As encountered in the different tweet instances that were processed by the system, there are actually tweets that had multiple locations, objects and victims related to the said instances. For instance, “Laguna, Cavite & Quezon” can be found in the location that can be extracted from the given tweet instance.
* Inclusion of more class specific fields for the ontology since, currently, the information that is stored for instances of different ontological classes seemed to be lacking. Like for example, the information that is stored for the Victim class is only limited to just the victim name. Further details can be added to this class like victim details and the like.
* Inclusion of a more powerful and streamlined visualization for the ontology. With the current implementation of the visualization of the ontology, the system does not take advantage of the powerful features of using ontology to store information. The current view is limited to just viewing the information stored in the ontology in table form and there is no concrete step for the users to search and manipulate its results within the ontology.
* Inclusion of a more generalized ontological population approach to facilitate a more open and non-strict way of storing information into the ontology. With the current implementation, the system provides a very linear way of storing information by starting with the root Tweet class instance until the related instances from other classes are all linked before actually storing them into the ontology. With a generalized ontological population approach, the system can be able to manipulate the information stored in a more customizable way by being able to separately store instances for different classes.

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Examples of Filipino Morphemes

|  |  |  |  |
| --- | --- | --- | --- |
| Morpheme Element | Root Word | Prefix / Suffix | Filipino Word |
| Elision | bigay | na- ; -an | nabigyan |
| Epenthesis | patay | -an | patayan |
| Metathesis | peteh (cebuano) | -en | pehten |
| Replacement | utos | -an | utusan |
| Nasal Assimilation | bigay | pan- | pamigay |
| Infixation | kain | -um- | kumain |
| Reduplication | matamis | - | matamis-tamis |

List of Unified Hashtags Used in the Crawler Module

|  |
| --- |
| #reliefph |
| #nopower |
| #nowater |
| #roadalert |
| #tracingPH |
| #rescuePH |
| #floodph |
| #marioph |
| #rubyph |

List of Filipino Stop Words

|  |  |  |  |
| --- | --- | --- | --- |
| sa  ng  ang  mga  kay  ni  si  kina  nina  sina  at  kaya  pati | saka  maging  man  ni  o  kapag  kung  sakali  datapwat  kahit  ngunit  samantala  subalit | dahil  sapagkat  para  upang  nang  ilalim  kinaroroonan  likod  taas  nasa  mula  hanggang  para | alinsunod  ayon  hinggil  patungkol  tanong  tungkol  ukol  wika  payag  sang-ayon  labag  laban  tulong  pamamagitan |

TFIDF Word Features (10%)

| Caution and Advice | | |
| --- | --- | --- |
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| Call For Help | | |
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TFIDF Word Features (20%)

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| Casualty and Damage | | |
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| Call For Help | | |
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| Donation | | |
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Extraction Rules

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| Casualty and Damage |
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| --- |
| Call For Help |
| <pos:MANH> <pos:CONG> <pos:NCOM> |

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| Donation |
| <ner:LOCATION>[as]LOCATION  <pos:VOBF> <pos:NA> <pos:NA> <pos:NN>[as]DONATION  <number:ANY> <ner:UNIT>[as]UNIT  <number:ANY> <pos:NN:UN> <ner:UNIT>[as]UNIT <string:packs> |

Representation of Ontology in OWL Format

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2. The American Red Cross, *Web Users Increasingly Rely on Social Media to Seek Help in a Disaster*, Press Release, Washington, DC, August 9, 2010. http://newsroom.redcross.org/2010/08/09/press-release-web-users-increasingly-rely-on-social-media-to-seek-help-in-a-disaster/ [↑](#footnote-ref-2)
3. Official Gazette of the Republic of the Philippines, *Prepare for natural calamities: Information and resources from the government*, July 21, 2012. http://www.gov.ph/crisis-response/government-information-during-natural-disasters/ [↑](#footnote-ref-3)
4. Twitter, a microblogging social media platform. http://www.twitter.com/ [↑](#footnote-ref-4)