How Textual Datasets Enhance the PADI-Web Tool?

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Abstract: The ability to rapidly detect outbreaks of emerging infectious diseases is a health priority of global health agencies. In this context, event-based surveillance (EBS) systems gather outbreak-related information from heterogeneous data sources, including online news articles. EBS systems, thus, increasingly marshal text-mining methods to alleviate the amount of manual curation of the freely available text. This paper documents the use of datasets obtained through an EBS system, PADI-Web (Platform for Automated extraction of Disease Information from the web), dedicated to digital outbreak detection in animal health. This paper describes the datasets used for improving 3 important tasks related to PADI-Web, i.e., news classification, information extraction and dissemination.

1 INTRODUCTION

The ability to identify emerging and re-emerging diseases is challenging for practitioners in the health domain (WHO, 2014). In this context, event-based surveillance (EBS) gathers information from heterogeneous data sources, including online news articles (Barboza et al., 2013). EBS systems integrate text-mining methods to deal with huge amounts of textual data (Mutuvi et al., 2021). Text mining aims at discovering new information from textual datasets (i.e., corpus) (Meng, 2021). Different text-mining methods associated with labeled textual datasets (i.e., news data) are integrated into the main steps of EBS systems, these methods include data acquisition, information retrieval (i.e., identification of relevant texts), epidemiological information extraction and locating information to communicate to end-users.

This paper focuses on the use of datasets to mine news data pertaining to the health domain. These data science approaches are integrated into an EBS system called PADI-Web (Platform for Automated extraction of Disease Information from the web). PADI-Web is dedicated to animal health surveillance and addresses disease-based and symptom-based surveillance.

PADI-web collects news articles based on Google News due to its international coverage and flexible RSS feeds. To detect news dealing with dedicated diseases (e.g., avian influenza, West Nile virus, African swine fever) or unknown diseases (i.e., Disease X), the RSS feeds use specific keywords (e.g., disease names, association of terms on hosts and symptoms). The collected news items are automatically classified as ”relevant” or ”irrelevant” using machine learning techniques (Kowsari et al., 2019). The relevant news corresponds to recent or current infectious animal health events. Moreover, a more fine-grained classi-

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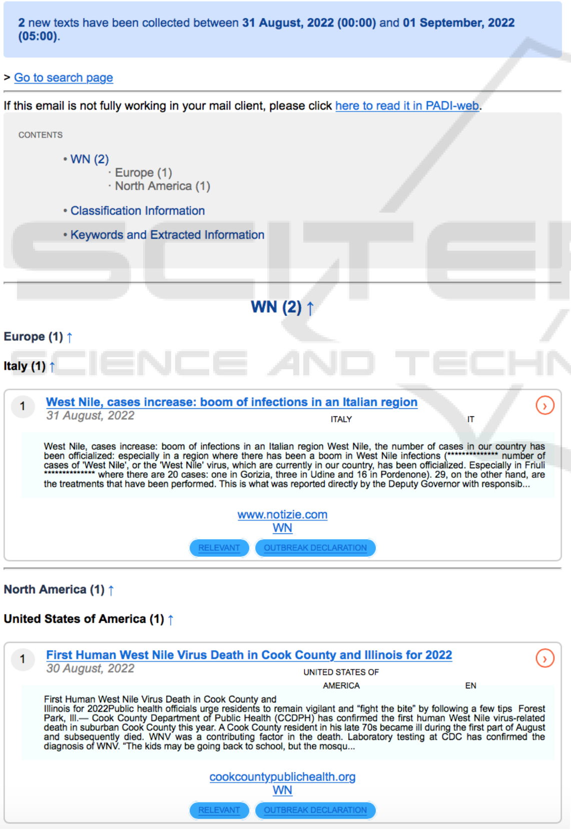
fication using machine learning approaches has been implemented to highlight more accurate topics. To identify key pieces of epidemiological information in the news (i.e., location and date of outbreaks, affected hosts, their numbers and encountered clinical signs, and so forth), PADI-web integrates information extraction (IE) methods (Schmitt et al., 2019). Finally, our system proposes automatic notifications to end-users (see Figure 1). The outputs of the PADI-Web system are accessible at https://padi-web.cirad.fr/en/

This paper is an overview of the datasets used and produced to improve the modules of PADI-Web and for its dissemination. The paper is structured as follows: In Section 2 we describe the datasets used for improving PADI-Web (i.e., the classification, extraction and dissemination tasks), while Section 3 proposes a discussion of the future directions of this work.



2 new texts have been collected between **31 August, 2022 (00:00)** and **01 September, 2022 (05:00)**.

> Go to search page

If this email is not fully working in your mail client, please click here to read it in PADI-web.

CONTENTS

- WN (2)
  - Europe (1)
  - North America (1)
- Classification Information
- Keywords and Extracted Information

WN (2) ↑

Europe (1) ↑

Italy (1) ↑

1 West Nile, cases increase: boom of infections in an Italian region
31 August, 2022 ITALY IT

West Nile, cases increase: boom of infections in an Italian region West Nile, the number of cases in our country has been officialized: especially in a region where there has been a boom in West Nile infections (************** number of cases of 'West Nile', or the 'West Nile' virus, which are currently in our country, has been officialized. Especially in Friuli ************** where there are 20 cases: one in Gorizia, three in Udine and 16 in Pordenone). 29, on the other hand, are the treatments that have been performed. This is what was reported directly by the Deputy Governor with responsib...

www.notizie.com
WN

RELEVANT OUTBREAK DECLARATION

North America (1) ↑

United States of America (1) ↑

1 First Human West Nile Virus Death in Cook County and Illinois for 2022
30 August, 2022 UNITED STATES OF AMERICA EN

First Human West Nile Virus Death in Cook County and Illinois for 2022Public health officials urge residents to remain vigilant and "fight the bite" by following a few tips Forest Park, Ill.— Cook County Department of Public Health (CCDPH) has confirmed the first human West Nile virus-related death in suburban Cook County this year. A Cook County resident in his late 70s became ill during the first part of August and subsequently died. WNV was a contributing factor in the death. Laboratory testing at CDC has confirmed the diagnosis of WNV. "The kids may be going back to school, but the mosqu...

cookcountypublichealth.org
WN

RELEVANT OUTBREAK DECLARATION

Figure 1: PADI-web notification for West Nile virus (WN).

2 PADI-Web DATASETS

After a web-crawling approach is used to collect online news texts, PADI-Web uses a classification module to identify the relevant texts and sentences that describe outbreak-related events. The system extracts epidemiological information, such as hosts, locations, dates and symptoms, from the collected news text data. The PADI-Web pipeline summarized in Figure 3 and detailed in (Arsevska et al., 2018; Valentin et al., 2020a; Valentin et al., 2021a) collected more than 400,000 news items dealing with animal health to extract the epidemiological events. Several datasets have been built to test and validate the usefulness of PADI-Web as an EBS system, as well as to create new features (e.g., modules) in successive versions of the tool. This paper summarizes the multiuse of the PADI-Web datasets freely available on Dataverse (Arsevska et al., 2017; Valentin et al., 2019; Rabatel et al., 2017; Valentin et al., 2020b; Roche and Arsevska, 2018) for the different tasks summarized in the following subsections.

2.1 Corpora for Improving Classification

In the second version of PADI-Web (Valentin et al., 2020a), a dedicated module uses a supervised machine learning approach to predict if a news item is relevant. Relevant news is text dealing with a new, suspected or unknown outbreak. For this classification task, specific labeled data must be used. For instance, a dataset of news can be used to learn a model for classification (Rabatel et al., 2017). Currently, the trained classification models integrated into PADI-web reach a mean accuracy score of 0.94 for the article-level relevance task using a random forest classifier. Moreover, this corpus is used for the information extraction process (see the following subsection).

In the third version of PADI-Web, a fine-grained classification on a sentence level is proposed (Valentin et al., 2021a). A dataset of sentences has been manually labeled to train the model for sentence classification (Valentin et al., 2019). Each sentence has two labels, an event label (e.g., current event, old event, general information) and an information label (e.g., descriptive epidemiology and distribution, preventive and control measures, economic and political consequences).

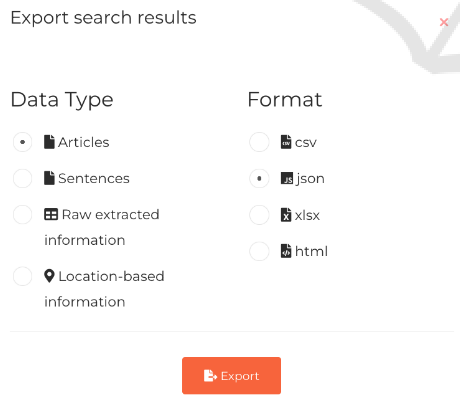
Epidemiological information can be extracted from relevant news and sentences as detailed in the following subsection.

2.2 Corpora for Improving Extraction

To build a model for extracting information, epidemiological entities (e.g., locations, diseases, hosts, dates, number of cases) are also manually labeled in the news (Rabatel et al., 2017). In the first version of PADI-Web (Arsevska et al., 2018), the information extraction module consisted of two stages: (1) candidate identification and (2) candidate verification. Candidate identification aims to detect all the possible candidates for each type of epidemiological entity extracted from the news data. Each candidate in the labeled dataset is associated with elements that describe its context, e.g., its surrounding words. Rules to identify a candidate based on its context are automatically discovered using a data mining technique. These rules represent the features of supervised machine learning approaches. A support vector machine (SVM) model is trained on the labeled dataset to predict whether the candidates are relevant. To learn this named entity recognition model, the labeled data (Rabatel et al., 2017) have been used (Arsevska et al., 2018).

In the last version of PADI-Web (Valentin et al., 2021a), a well-known named entity recognition tool, spaCy, was integrated into the version. Classic models associated with this tool recognize generic named entities, such as locations and organizations. Moreover, specific models for entity recognition related to the animal disease surveillance domain are implemented using the spaCy tool. The labeled dataset described above (Rabatel et al., 2017) is used to enrich the current spaCy models.

The epidemiological data that can be downloaded (see Figure 2) are used in different studies summarized in the following subsection.



Export search results ×

Data Type

● Articles

○ Sentences

○ Raw extracted information

○ Location-based information

Format

○ csv

● json

○ xlsx

○ html

Figure 2: PADI-web data to download.

2.3 Datasets for Analysis and Dissemination

The relevant signals detected with PADI-Web for African swine fever, foot-and-mouth disease, bluetongue and avian influenza in 2016 are manually labeled in (Arsevska et al., 2017). Each row represents the collected news's extracted epidemiological information about a potential outbreak (a signal). Each signal is constructed with one location automatically detected as correct in the news, combined with all other epidemiological information types detected in the same news article. This enables us to conduct a retrospective analysis highlighting the sensitivity of PADI-Web to detect primary outbreaks. From January to June 2016, PADI-Web detected signals for 64% of all the primary outbreaks of African swine fever, 53% of the avian influenza outbreaks, 25% of the bluetongue outbreaks and 19% of the foot-and-mouth disease outbreaks.

Another retrospective study proposed to evaluate the capacity of the three EBS systems (i.e., ProMED, HealthMap and PADI-Web) to detect early COVID-19 emergence signals (Valentin et al., 2021b; Valentin et al., 2020b). We discussed how an EBS system focusing on animal health (i.e., PADI-web) could detect a newly emerging pathogen. This aspect is crucial in a One Health context and for syndromic surveillance.

Finally, specific corpora are built for training and dissemination (e.g., courses[1], tutorials[2], etc.). In this context, the corpus dealing with African swine fever disease called ”ASF corpora” (Roche and Arsevska, 2018) is used (i) for classification tasks using machine learning algorithms with the Weka tool[3] and (ii) for terminology extraction based on the BioTex software[4]. This enables highlighting different directions so the same corpus can be used as if dealing with animal disease surveillance.

3 DISCUSSION

In this paper, we presented a summary of the datasets used to improve some modules of PADI-Web. More specifically, the datasets described in the previous subsection are used to learn models to extract and analyze epidemiological information in news articles. These events are based on: (i) The classification of documents and sentences and; (ii) information extraction.

Based on these PADI-Web modules, end-users could apply specific methods to extract events (i.e., the detection or suspicion of a disease at a specific location and date). First, a fine-grained classification enables highlighting texts dealing with ”Outbreak declaration” (i.e., document classification). The second step consists of extracting a group of epidemiological information, such as locations, hosts and

[1] https://agritrop.cirad.fr/600001/

[2] https://agritrop.cirad.fr/597999/

[3] http://old-www.cms.waikato.ac.nz/ml/weka

[4] https://github.com/sifrproject/biotex

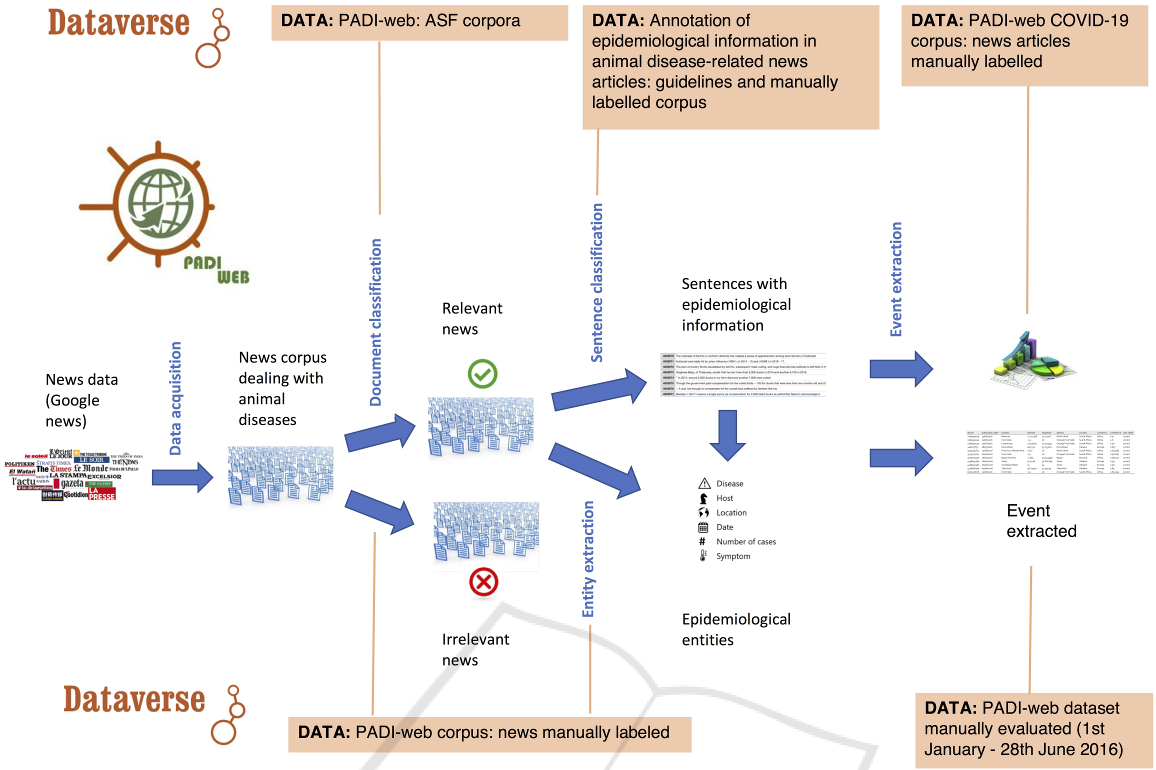

Dataverse
DATA: PADI-web: ASF corpora
DATA: Annotation of epidemiological information in animal disease-related news articles: guidelines and manually labelled corpus
DATA: PADI-web COVID-19 corpus: news articles manually labelled
PADI WEB
Document classification
Sentence classification
Event extraction
Data acquisition
Entity extraction
News data (Google news)
News corpus dealing with animal diseases
Relevant news
Irrelevant news
Sentences with epidemiological information
Disease
Host
Location
Date
Number of cases
Symptom
Epidemiological entities
Event extracted
Dataverse
DATA: PADI-web corpus: news manually labeled
DATA: PADI-web dataset manually evaluated (1st January - 28th June 2016)

Figure 3: PADI-web process and datasets used.

symptoms, from these specific documents. The algorithm implemented into PADI-Web consists of: (i) selecting sentences with locations (*pivot sentence*); (ii) extracting epidemiological information in a context of 3 sentences (i.e., pivot sentence + one sentence before and after the pivot sentence). This type of extraction is called ”location-based information” in the PADI-Web system. An extension of this algorithm will be integrated into our EBS system. In this extension, pivot sentences will be sentences associated with the label ”Current event” (i.e., sentence classification).

In summary, in the next extensions of PADI-Web, five types of extractions will be proposed to end users:

- All events extracted in relevant articles based on locations extracted with spaCy;
- All events extracted in relevant articles based on locations extracted with spaCy learnt with labeled data;
- All events extracted at the beginning of the articles;
- All events extracted in Outbreak articles (i.e., document-based classification);
- All events extracted in Outbreak articles (i.e., document-based classification) and Current event sentences (i.e., sentence-based classification).

End-users will be able to use and compare epidemiological information obtained with these five strategies for surveillance.

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