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**TECHNICAL REVIEW FOR THE COURSE:**

**DATA MINING & INFORMATION RETRIEVAL ON THE WEB**

# **Refugee Crisis: A Twitter-based Event Summarisation**

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## ***Abstract***

In this paper, we delve into the cosmos of the Social Media, and in particular, to the source code that retrieves needed information in the form of tweets on the Refugee Crisis subject, processes it, uses techniques such as the Latent Dirichlet Allocation to detect emerging Topics and performs an Affective Analysis, classifying each topic into one of a series of sentiments. The paper concludes with a thorough presentation of the Web APP implemented to demonstrate Statistical Data on the subject, as well as the results, observations and conclusions drawn from the topic detection and affective analysis.

*Keywords:* Event Summarisation, Topic Detection, Affective Analysis, Data Mining, Machine Learning.

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## ***Περίληψη***

Σε αυτή την εργασία μπαίνουμε στον κόσμο των Κοινωνικών Μέσων και συγκεκριμένα στον πηγαίο κώδικα ο οποίος ανακτά πληροφορία σε μορφή κειμένων Tweet πάνω στο θέμα της Προσφυγικής Κρίσης, την επεξεργάζεται, χρησιμοποιεί τεχνικές όπως η Latent Dirichlet Allocation με σκοπό να εντοπίσει Αναδυόμενα Θέματα και εφαρμόζει Ανάλυση Επιμέρους Συναισθημάτων, κατηγοριοποιώντας το εκάστοτε θέμα σε ένα από μία σειρά από συναισθήματα. Στο τέλος γράφουμε μία εκτενή παρουσίαση της Web Εφαρμογής η οποία υλοποιήθηκε για να επιδείξει Στατιστικά Δεδομένα πάνω στο θέμα, καθώς και τα αποτελέσματα, τις παρατηρήσεις και τα συμπεράσματα τα οποία βγάλαμε από τον Εντοπισμό Γεγονότων και την Ανάλυση Επιμέρους Συναισθημάτων.

*Λέξεις Κλειδιά:* Σύνοψη Γεγονότων, Εντοπισμός Θεμάτων, Ανάλυση επιμέρους Συναισθημάτων, Εξόρυξη Δεδομένων, Μηχανική Μάθηση.

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## 1. Introduction

The Syrian civil war has been described as the single greatest humanitarian crisis to hit mankind after the Second World War. In a country with a population that spans 22 million, more than 250,000 people have died whilst about 10 million have been forced to flee their very homes. Four years and counting from the outbreak of the war, ceasefire efforts have yet to yield the expected results. The wavering and constantly changing attitudes of the West in terms of which side they support, and the military reinforcement to both the Islamic State, and subsequently, the Assad regime, only served to destabilise the region. The relentless bombing of cities, the massacres of civilians and the sheer amount of destruction of property, and destruction in general, resulted in the formation of a large refugee wave that has overwhelmed the shores of the Mediterranean Basin. In the past couple years, mainly, people attempt to cross over into the European territory by the hundreds, seeking asylum. In their journey to the heart of Europe, Greece is the refugees' main avenue. European States facing this wave of daily influx of people on European coasts are unable to make a joint decision in terms of managing the problem, leading several countries to close their borders, trapping thousands of refugees on Greek territory in the process. What's in store for these people has proved to be a major issue for many a country. With but a mere glance on social media, one witnesses the supporting positions of many toward refugees as well as positions of solidarity whilst simultaneously observing others', at the very least, hostile, xenophobic and deprecatory opinions. The average Joe states their opinion, views and proposes solutions to the arising problems every day on such platforms. Twitter is a representational sample of how information is diffused through a network and of the people who touch upon it. When it comes to this subject, everyone has something to say and add; politicians, journalists, celebrities and ordinary people alike. From serious or political, to populist or ethnocentric, there's a vast diversity of different opinions on the table. Even humour and trolling, with their own distinguishing touch, contribute to the virality of it all. At the end of the day, all this interminable user-produced wealth of information regarding people's feelings, passions, sentiments, moods, and emotions begs to be analysed in the eyes of a researcher. There's more than one way to approaching affect, a subject that triggered the interest of people for quite some time. Peeking through Aristotle's mind for a second, affect is a force to be reckoned with. One strong enough to shift and manipulate our judgement by transforming our condition, accompanied by pleasure and pain. Rene Descartes, on the other hand, believed that affect is intimately connected to the soul – extensions of it one might argue – perceptions, feelings and emotions emanating from it. Claims such as these, or Aristotle's argument that affect is produced through mimesis have been very controversial, however, from the perspective that we examine affect, it is something much more tangible and hands-on. Affect is viewed more like an intermediate; an interface between the digital domain and the embodied human experience.

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## 2. Source Code Structure

The project is written in the format of and can be executed by Python 3.x. The source code is editable by and runs with any Python 3 IDE; our team opted to employ the Visual Studio IDE with Python Tools enabled, benefiting from its advanced intellisense features, rendering code-writing faster and easier, its deep github integration, making code versioning virtually seamless and automatic, and utilising its robust programming qualities, such as its unabridged breakpoint experience, facilitating comprehension and code tweaking.

The Code used for this project is divided into four main Categories:

**Tab. 1.** Source Code Contextual Categories

Category	File Name	Deception
Streaming	Streaming.py	Accesses Twitter's API, and streams and saves keyword-filtered twitter content into a NoSQL Database.
Processing	Processing.py	Handles the per tweet processing, extracting useful information and transforming it into a format usable by the algorithms used afterwards.
Topic Detection	TopicDet.py	Given the finalised database structure, data are read, and clustering Topic Detection algorithms run, providing the topics and top tweets correlated with each for the affective analysis.
Affective Analysis	AffAnalys.py	For this part, the previously unearthed topics are fed into the classification algorithm which is used to provide insight as to which sentiment each topic expresses amongst the 14 + Neutral ones.

### 2.1. Prerequisites

The data, results, statistics and raw information are, for the most part, completely reproducible; with obvious exceptions like the tweets that Streamining.py would yield when run being different because of streaming's nature. However, even such hurdles are easily overcome by our providing the raw data through our open github repository <https://github.com/N1h11sT/Data-Mining-From-Twitter>.

For one to fully execute the code and come into the same results, there are certain prerequisites. To wit, one needs have:

- Twitter API's credentials, acquirable from <https://apps.twitter.com/app/new>. In particular, the 1<sup>st</sup> step (Streaming.py) asks for the consumer key, the consumer secret, the access token, and the access secret.
- Python library Tweepy, acquirable by python command "pip install tweepy", which is used to interface python with Twitter's API.
- MongoDB, downloadable from <https://www.mongodb.org>, which is used to save the Raw twitter-provided JSON by the 1<sup>st</sup> step (Streaming.py), as much as any collections created by the 2<sup>nd</sup> step (Processing.py). For it to be operational, the folder "data" and subfolder "db" should be available, let alone created, in the root directory of the OS drive (e.g. "C:\data\db").
- Python library PyMongo, acquirable by python command "pip install pymongo", which is used to interface python with our NoSQL database of choice, MongoDB.

- MongoClient, downloadable from <https://github.com/rsercano/mongoclient/releases>, which is used to provide a user-friendly Graphical User Interface, easing visualisation of the JSON format used by the data.
- NLTK, downloadable from <https://pypi.python.org/pypi/nltk>, which is used for the normalisation, stopwords removing and stemming processes by the 2<sup>nd</sup> step (Processing.py) and Tokenisation by the 3<sup>rd</sup> step (TopicDet.py). For it to work, the commands:
  - import nltk
  - nltk.download()
 need first run via python, downloading the Stopwords by navigating to
  - (Tab) Corpora → (Row) Stopwords
 installing them.
- Stanford University's NER, downloadable from <http://nlp.stanford.edu/software/CRF-NER.shtml#History>, which is used to identify any NLP Named Entities within a tweet's text.
- Python library NumPy, downloadable from <http://www.lfd.uci.edu/~gohlke/pythonlibs/#numpy>, can be installed using the python command "pip install {path\_to\_the\_file}", where {path\_to\_the\_file} is the actual file's path on one's compute. NumPy is used to bring the data into an LDA-readable array format by the 3<sup>rd</sup> step (TopicDet.py), and is also a prerequisite for other functions such as Python's SciPy library and 4<sup>th</sup> step's (AffAnalys.py) classification.
- Python library SciPy, downloadable from <http://www.edna-site.org/pub/wheelhouse>, can be installed using the python command "pip install {path\_to\_the\_file}", where {path\_to\_the\_file} is the actual file's path on one's compute. SciPy is solely used as a prerequisite for the classification part by the 4<sup>th</sup> step (AffAnalys.py).
- Python library SciKit-Learn, acquirable by python command "pip install scikit-learn", which is used by the 4<sup>th</sup> step (AffAnalysis.py) for Machine Learning Classification purposes.

## 2.2. Methodology

### 2.2.1. Streaming

The Streaming programming part, Streaming.py, is responsible for downloading the Raw content from twitter and saving it locally for later use. All Source Code files are divided into regions, each beginning with the region "Imports" where all the necessary libraries (dependencies) are loaded and region "Initialisation" in which the basic variables are assigned to their initial values. The "Imports" region as well as any "Functions" one will be hereinafter disregarded, and counting is to start from "Initialisation".

In this instance, the process entails initialising directories, database connections and Twitter API's keys.

The code continues with the region "Listener", handling, once called, the creation of a listener responsible for streaming, loading, and saving the data into the Mongo Database.

Lastly, the code ends with the region “Main” where the programme authenticates itself to the API and the listener is called with certain parameters, like tracking only English tweets which contain any word within a given list.

### 2.2.2. Processing

The Processing programming part commences with the initialisation of directories which differ from computer to computer, and NLP tools we utilise later.

The second region is “Checks” which holds the programme execution in case there are already data in the Mongo Collections that we’re about to add to so that data duplication is evaded.

The region “InfoAcquisition” follows, wherein we acquire the basic tweet’s information (Tweet ID, User Screenname, etc.) which will be subject to analysis and change.

Afterwards, in the region “PreProcessing”, a data cleaning and extrapolation takes place. Therein the base tweet’s text is crawled upon and the links, hashtags, user mentions, and retweet-or-not information is ripped out of the text and inserted into their own distinct fields.

The fifth region is “NLP”, in which Natural Language Processing algorithms are used to remove stopwords, special characters, and get the Named Entities of each tweet.

The next region in line is the “Stemming” one, wherein Stemming is applied to the thus far processed tweet, resulting in a stemmed tweet text.

On the last region “SavingTheData”, as its name aptly suggests, the Data is assembled, tailored into a MongoDB suitable format, and is subsequently inserted into the database’s collection.

Lastly, the Date-Time of each tweet is inserted into a character separated file so that we can plot the per-hour distribution of tweets.

### 2.2.3. Topic Detection

The Topic Detection programming part is generally responsible for extrapolating topics via Natural Language Processing techniques.

As was the case for the previous file, here too, we start with the region “initialisation” where directory paths are set and a connection to the MongoDB is established.

The second region is the “Pre-Processing”, in which variables are filled with the appropriate tweet words and frequencies of its word, to be fed to the LDA in the next step.

Next in line is the region “LDA”, wherein the LDA model is created, and with the frequency table passed to it, it used to infer and determine topics arising from the data at hand. The Tweet ID of each tweet, Topic ID/number as given by the LDA and its LDA weight are saved into a file.

After the aforementioned file is sorted by ascending Topic ID and descending Weight, the top 100 tweets per topic are extracted for affective classification through Machine Learning and the top 10 are extracted for manual observation.

### 2.2.4. Affective Analysis

The Affective Analysis programming part handles the automatic classification of topics, in terms of affect expressed, using Machine Learning Algorithms.

Apart from the usual “Initialisation” region handling the usual, the first region, “TrainingPreProcessing”, is used to initialise classification-specific variables, such as the top 100

tweets to be fed to the classifiers, the manually annotated tweets serving as a ground truth, the training and the testing set.

Within the region “Classifying” lies the code for classifier Training, getting the Accuracy on the Training Set, Classifying, and getting the Predictions for the Support Vector Machines, Naïve Bayes, and Decision Trees algorithms.

Lastly, a k-fold cross-validation method for each algorithm is implemented on the “CrossValidation” region.

## 3. Web APP

### 3.1. Data

The Web APP, reachable from the URL <http://andyfou.github.io/refugee-crisis/>, is in essence, a means of demonstrating and presenting Statistical Data on the subject of the Refugee Crisis, as well as visualising the results, observations, and conclusions drawn from the Topic Detection and Affective Analysis performed on Twitter Data by the code described in Section 2.

We’ve worked on 130,782 tweets, posted by 84,117 different users, containing a cumulative set of 44,559 unique words, categorised between 15 sentiments [Fig. 1].



Fig. 1. General Information

We came to possess this information through Twitter’s API by tracking posts (tweets) which contain certain words. Lots of the words, like “migrants”, “islamists” and “ISIS”, were explicitly on the Refugee Crisis theme on a more general manner. Strictly border-related words included “open borders”, “border closure” and “no borders”, whilst location-related words consisted of words like “Syria”, “Iraq”, and “Afganistan”. Certain entities, as is the case with “@Moving Europe”, “UN Refugee Agency” and “European Mobilisation”, were bound to provide useful information and were, therefore, also incorporated. Lastly, as this is Twitter we’re dealing with, hashtags could hardly be overlooked. Those were along the lines of “RefugeeCrisis”, “RefugeesWelcome”, and #SolidarityWithRefugees”.

Query words					
General	General	Border-related	Hashtags	Locations	Entities
migrants	refugees	borders	#RefugeeCrisis	Syria	European Mobilisation
migration flow	migration crisis	open borders	#refugeesGr	Iraq	Amnesty International
migrant camps	refugee camps	border closure	#refugeeswelcome	Afghanistan	Frontex
irregular migrants	asylum seekers	border share	#FortressEurope	Pakistan	UNHCR
human rights	solidarity	No borders	#ProMuslimRefugees	Idomeni	UN Refugee Agency
ISIS	daesh	#OpenTheBorders	#helpiscoming	Catala	@Moving Europe
muslims	islamists		#solidaritywithrefugees	Lesbos	
Balkan route	refugees		#safe passage	Lesvos	
Aylan			#antireport	Lesbos Island	

Fig. 2. Tracked Words



The capturing process commenced on April 23, 2016 and lasted through May 03, 2016. The amount of tweets posted in the course of a day over that period, varied, hinting and indicating a certain likelihood that there's an emerging topic at the times when count peaks [Fig. 3]. It should be noted that the decrease in the average tweet count per day before roughly half the days compared to that after as portrayed in the plot below is not indicate of, nor does it represent the real average tweet count difference, but is in fact a mere by-product of switching the Tweet Streaming process to a computer of a lower calibre. Given the Twitter API's 1%-of-data limitation imposed on our algorithms and the ramifications of having the process being subject to a computer's specifications, it is hardly the case that the actual figure of tweets per hour is the ones on the plot below; however, the relative figures are more than enough for our ends.

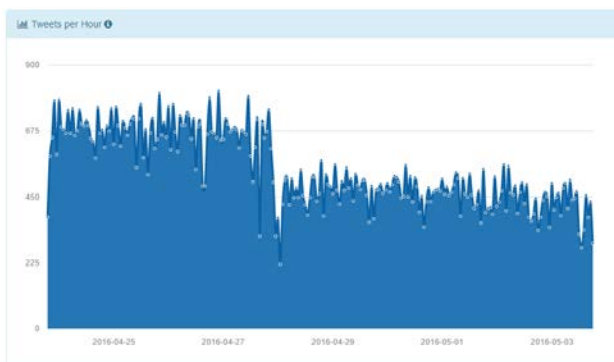


Fig. 3. Tweets Per Hour

The table below displays the twitter users who had posted the most tweets related to the Refugee Crisis within the span of our capturing twitter data. Apart from their screennames, one can see the total number of their posts, their followers count, and the locations they'd declared they live in. Because of this field's nature, anyone can type anything and twitter accepts it without verification, rendering it, for all intents and purposes, unreliable.

Quite peculiar is the fact that the user with the most overall tweets, "cyberahsokatano", has but one follower, whilst others span in the thousands. This could potentially mean that the account is a so called troll/spammer, and this behaviour is highly likely to introduce *noise* into our dataset. Approximately half of the most active users seem to either be a news agency or self-appointed people operating as such, or accounts for reporting terrorism [Tab. 2].

As a result, given how news articles, or tweets for that matter, are articulated, the topics identified by the Latent Dirichlet Allocation and classified by Naïve Bayes, Support Vector Machines, and Decision Trees are of the class "neutral". Another decisive factor that can't be ignored, arguably having played an even more crucial role still to the "neutral" results, is the fact that the training set used by the machine learning algorithms was not in the least Refugee Crisis related; on the contrary, it was everyday life tweets that were thematically all over the place.

Tab. 2. Top Users by tweets count

#Freq	Username	Followers	Location
322	cyberahsokatano	1	Starkiller Base
287	khalidrafiq138	1092	Pakistan
183	pakistanpeak	1110	Санкт-Петербург
143	pakistani_news	10180	Pakistan
120	Hash_Pakistan	177	+923437577075
107	CtrISec2	2887	Worldwide
94	CtrISec0	3546	Worldwide
91	CtrISec1	2748	Worldwide

Since the reported Users per Day are also subject to the computational power of the machine handling the capturing at that point in time, the decrease in the average users count per day before roughly half the days compared to that after, can also be attributed to it. The counts depicted in the first and last day can be disregarded altogether as they would have had to have started at 00:00:00 and end at 23:59:59 to be representative, which they had not. Having taken that into consideration, we can conclude that the average number of users tweeting about the Refugee Crisis has remained considerably uniform and unflinching [Fig. 4].

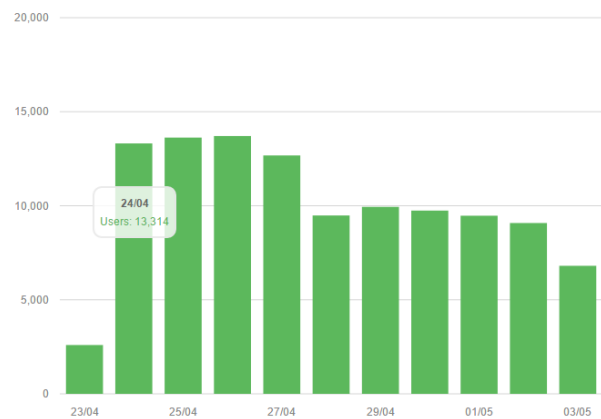


Fig. 4. Users per Day

The country whose citizens tweeted the most in that time span was the USA, followed closely by the UK and Pakistan respectively. At this point it should be made clear that we were tracking solely English tweets, ergo, the USA and UK being rocketed to the top should come as no surprise. Pakistan itself did come third in tweets count, however, one should consider that English is one of its two official languages.

India and Australia, falling considerably behind, were the last two countries in the Top 5. Australia is found to have a fifth of UK's share of tweets, although it is a third of UK population-wise. Interestingly, in spite of its being an order of magnitude larger in population than the UK, the USA citizens' post count did not reflect the fact in the statistics.

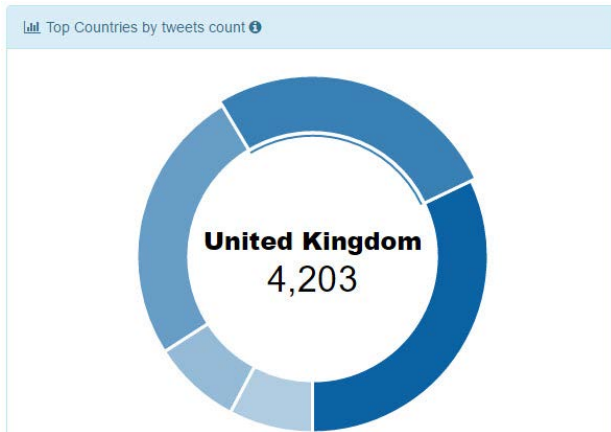


Fig. 5. Top Countries by Tweets Count

Some of the most prominent tweets in terms of relevance, such as “Pentagon working to ‘Take Out’ ISIS’s Internet: The US Military’s secretive Cyber Command (CYBERCOM) is working to destroy the ISIS g...” are on display [Fig. 6] as well. People express their opinions and feelings; they show memetic tendencies in the form of retweeting, and seek to raise awareness and inform.

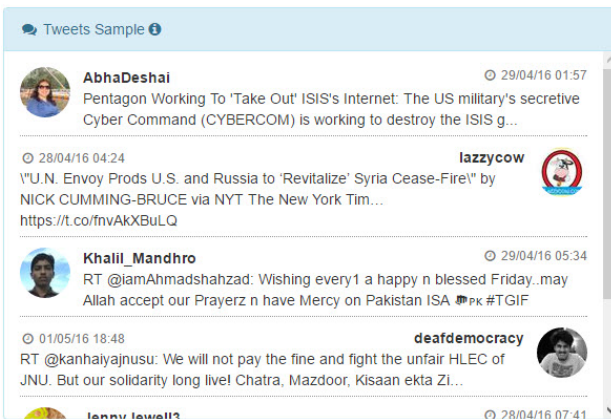


Fig. 6. Tweets Sample

Analysing the frequency with which words occurred in the tweets’ text, the following Word Cloud formed, with the most eye-catching ones being “Syria” and “ISIS”, naturally [Fig. 7].



Fig. 7. Most Frequent Hashtags Tweets Sample

### 3.2. Events

On the “Events” part of the Web APP, there’s a timeline reflecting the detected events in a chronological order, starting from the US Special Forces Troops. In addition to the actual event’s description and the time and date it took place, there’s also a relevant tweet and its link to the actual twitter, along with statistical data and the topic’s classified sentiment.

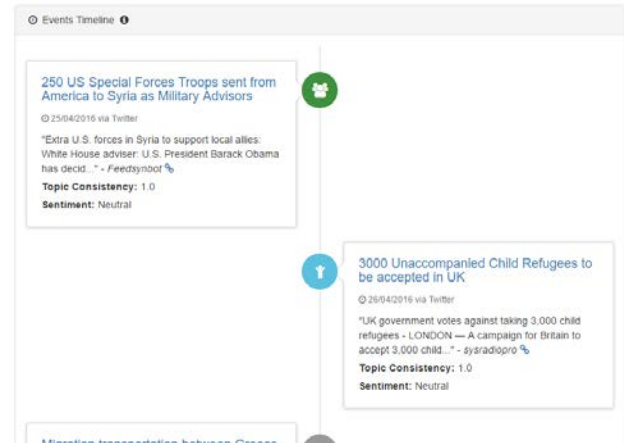


Fig. 8. Events Timeline

There is a total of 25 topics given by the LDA, organised into four categories based on their relevance [Fig. 8]:

- Most Relevant
- Considerably Relevant
- Doubly Themed
- Irrelevant



Fig. 9. Event Summarisation, group by Relevance

with the Most Relevant ones being:

Tab. 3. Most Relevant Detected Topics

#	Topic
1	<b>US Special Forces Troops</b>
	Consistency: 10/10    Annotation: Periodical    Sentiment: Neutral
2	<b>Twin Car Bombings</b>
	Consistency: 8/10    Annotation: Periodical    Sentiment: Neutral
3	<b>Sleeper Cells Warnings</b>
	Consistency: 8/10    Annotation: Periodical    Sentiment: Neutral
4	<b>Aleppo Airstrikes</b>
	Consistency: 10/10    Annotation: Periodical    Sentiment: Neutral
5	<b>Unaccompanied Children Refugees in UK</b>
	Consistency: 10/10    Annotation: Periodical    Sentiment: Neutral
6	<b>Migration Crisis in Greece and Turkey</b>



	Consistency: 8/10	Annotation: General	Sentiment: Neutral
7	<b>Kurdish &amp; Syrian Government against ISIS</b>		
	Consistency: 9/10	Annotation: Periodical	Sentiment: Neutral
8	<b>John Kerry asks for Syria truce</b>		
	Consistency: 8/10	Annotation: Periodical	Sentiment: Neutral

The first topic, US Special Forces Troops, is covered by the BBC News in their article: “*Syria conflict: Obama to deploy 250 more special forces troops*” [1].

The second topic, Twin Car Bombings, is covered by the BBC News in their article “*Twin car bomb attacks kill 28 people in southern Iraq*” [2].

The third topic, Sleeper Cells Warnings, is covered by the Daily Express Tabloid Newspaper in their article: “EU free movement has allowed ISIS sleeper cells into the UK, warns security chief” [3].

The fourth topic, Aleppo Airstrikes, is covered by the CNN in their article: “Kerry expresses outrage after 50 killed in strike on Syrian hospital” [4].

The fifth topic, Unaccompanied Children Refugees in UK, is covered by the daily newspaper The Guardian [5].

The sixth topic, Migration Crisis in Greece and Turkey, is covered by News agency’s Reuters article: “More migrants ferried from Greece to Turkey under EU deal” [6].

The seventh topic, Kurdish & Syrian Government against ISIS, is covered by the independent press agency’s ARAnews article: “Clashes erupt between Syrian regime and Kurdish forces in Qamishli” [7].

The eighth topic, John Kerry asks for Syria truce, is covered by the daily newspaper The Guardian in their article

“John Kerry says several proposals on table for partial Syria truce” [8].

The Considerably Relevant topics are:

**Tab. 4.** Considerably Relevant Detected Topics

#	Topic
1	<b>Manus Detention Centre found Illegal</b>
	Consistency: 10/10    Annotation: Periodical    Sentiment: Neutral
2	<b>Extremist-Muslim behaviour in Western societies</b>
	Consistency: 10/10    Annotation: General    Sentiment: Neutral
3	<b>Provoking Thoughts and Prayers for Refugee Crisis</b>
	Consistency: 10/10    Annotation: General    Sentiment: Neutral
4	<b>Politicians of Pakistan against PM Nawaz Sharif</b>
	Consistency: 8/10    Annotation: Periodical    Sentiment: Neutral
5	<b>Donald Trump Wall for Illegal Immigrants</b>
	Consistency: 7/10    Annotation: General    Sentiment: Neutral
6	<b>Islamophobia</b>
	Consistency: 6/10    Annotation: General    Sentiment: Neutral
7	<b>VP Biden's surprise visit to Baghdad</b>
	Consistency: 6/10    Annotation: Periodical    Sentiment: Neutral
8	<b>United Cyber Caliphate (UCC) releases 'Kill List'</b>
	Consistency: 4/10    Annotation: Periodical    Sentiment: Neutral

These have been the best of our results. The Doubly Themed and Irrelevant topics, although they are indeed real topics, go beyond the scope of this paper and will not be explicitly referenced here, whilst remaining available in the Web APP itself.

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