conTEXT – Lightweight Text Analytics using Linked Data

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ABSTRACT

The Web democratized publishing – everybody can easily publish information on a Website, Blog, in social networks or microblogging systems. The more the amount of published information grows, the more important are technologies for accessing, analysing, summarising and visualising information. While substantial progress has been made in the last years in each of these areas individually, we argue, that only the intelligent combination of approaches will make this progress truly useful and leverage further synergies between techniques. In this paper we develop a text analytics architecture of participation, which allows ordinary people to use sophisticated NLP techniques for analysing and visualizing their content, be it a Blog, Twitter feed, Website or article collection. The architecture comprises interfaces for information access, natural language processing and visualization. Different exchangeable components can be plugged into this architecture, making it easy to tailor for individual needs. We evaluate the usefulness of our approach by comparing both the effectiveness and efficiency of end users within a task-solving setting. Moreover, we evaluate the usability of our approach using a questionnaire-driven approach. Both evaluations suggest that ordinary Web users are empowered to analyse their data and perform tasks, which were previously out of reach.

Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: User Interfaces—*User-centered design, Natural language*; I.5.4 [**Text processing**]: Miscellaneous

Keywords

NLP, Text Analytics, Content Annotation, Linked Data

1. INTRODUCTION

The Web democratized publishing – everybody can easily publish information on a website, blog, in social networks or microblogging systems. The more the amount of published information grows, the more important are technologies for accessing, analysing, summarising and visualizing information. While substantial progress has been made in the last years in each of these areas individually, we argue, that only the intelligent combination of approaches will make this progress truly useful and leverage further synergies between techniques. Natural Language Processing (NLP) technologies, for example, were developed for text analysis, but are often cumbersome and difficult to use for ordinary people and it is even more difficult to make sense of the results produced by these tools. Information visualization techniques, such as data-driven documents [3], on the other hand can provide intuitive visualizations of complex relationships.

We showcase *conTEXT*[1] – a text analytics architecture of participation, which allows end-users to use sophisticated NLP techniques for analysing and visualizing their content, be it a weblog, Twitter feed, website or article collection. The architecture comprises interfaces for information access, natural language processing (currently mainly Named Entity Recognition) and visualization. Different exchangeable components can be plugged into this architecture. Users are empowered to provide manual corrections and feedback on the automatic text processing results, which directly increase the semantic annotation quality and are used as input for attaining further automatic improvements. An online demo of the conTEXT is available at `http://context.aksw.org`.

Motivation. Currently, there seems to be an imbalance on the Web. Hundreds of millions of users continuously share stories about their life on social networking platforms such as *Facebook*, *Twitter* and *Google Plus*. However, the conclusions which can be drawn from analysing the shared content are rarely shared back with the users of these platforms. The social networking platforms on the other hand exploit the results of analysing user-generated content for targeted placement of advertisements, promotions, customer studies etc. One basic principle of data privacy is, that every person should be able to know what personal information is stored about herself in a database (cf. OECD privacy principles[2]). We argue, that this principle does *not* suffice anymore and that there is an *analytical information imbalance*. People should be able to find out what patterns can be discovered

[1] We choose the name conTEXT, since our approach performs analyzes *with* (Latin 'con') text and provides contextual visualizations for entities discovered in a text corpus.

[2] `http://oecdprivacy.org/#participation`

and what conclusions can be drawn from the information they share.

Let us look at the case of a typical social network user Judy. When Judy updates her social networking page regularly over years, she should be able to discover what the main topics were she shared with her friends, what places, products or organizations are related to her posts and how these things she wrote about are interrelated. Currently, the social network Judy uses analyses her and other users data in a big data warehouse. Advertisement customers of the social networking platform, can place targeted adds to users being interested in certain topics. Judy, for example, is sneaker aficionado. She likes to wear colorful sports shoes with interesting designs, follows the latest trends and regularly shares her current favorites with her friends on the social network. Increasingly, advertisements for sportswear are placed within her posts. Being able to understand what conclusions can be drawn by analysing her posts will give Judy at least some of the power back into her hands she lost during the last years to Web giants analysing big user data.

conTEXT empowers users to answer a number of questions, which were previously impossible or very tedious to answer. Examples include:

- Finding all articles or posts related to a specific person, location or organization.
- Identifying the most frequently mentioned terms, concepts, people, locations or organizations in a corpus.
- Showing the temporal relations between people or events mentioned in the corpus.
- Discovering typical relationships between entities.
- Identifying trending concepts or entities over time.
- Find posts where certain entities or concepts co-occur.

The text analytics architecture and implementation we present in this article helps to mitigate the analytical information imbalance. With almost no effort, users can analyse the information they share and obtain similar insights as social networking sites.

Approach. conTEXT lowers the barrier to text analytics by providing the following key features:

- No installation and configuration required.
- Access content from a variety of sources.
- Instantly show the results of text analysis to users in a variety of visualizations.
- Allow refinement of automatic annotations and take feedback into account.
- Provide a generic architecture where different modules for content acquisition, natural language processing and visualization can be plugged together.

RDF and Linked Data is used in conTEXT in particular in the following ways:

- The linked-data aware *Natural Language Interchange format* (NIF) is used for integrating various NLP tools.
- The FOX and Spotlight Linked Data based disambiguation ensures that we work with real-world entities instead of surface forms.
- Linked Data background knowledge is used to enrich the result of the analysis and provide upper-level ontological knowledge for facilitating the exploration.
- Semantic annotations are encoded in RDFa and can be re-integrated back into the original data sources.

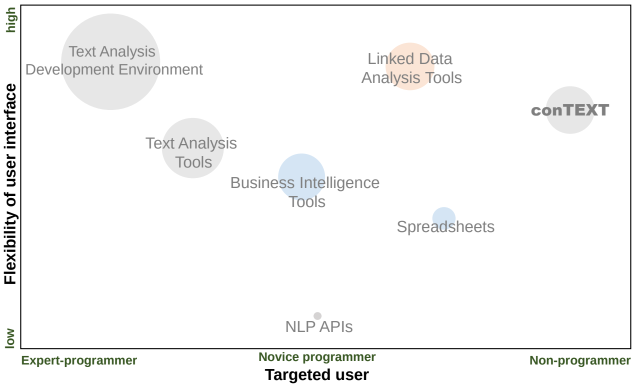


Figure 1: Flexibility of user interfaces and targeted user groups as well as genericity (circle size) and degree of structure (circle color) for various analytics platforms.

The article is structured as follows: We show that conTEXT fills a gap in the space of related approaches in Section 2. The general workflow and interface design is presented in Section 3. The different visualizations and views supported by conTEXT are discussed in Section 4 before we present our implementation in Section 5. We show the results of a qualitative and quantitative user evaluation in Section 6 and discuss some more general aspects in Section 7 before we conclude in Section 8.

2. RELATED WORK

Analytics (i.e. the discovery and communication of meaningful patterns in data) is a broad area of research and technology. Involving research ranging from *Natural Language Processing* (NLP) and *Machine Learning* to *Semantic Web*, this area has been very vibrant in recent years. Related work in the domain of analytics can be roughly categorized according to the following dimensions:

- *Degree of structure.* Typically, an analytics system extracts patterns from a certain type of input data. The type of input data can vary between *unstructured* (e.g. text, audio, videos), *semi-structured* (e.g. text formats, shallow XML, CSV) and *structured* data (e.g. databases, RDF, richly structured XML).
- *Flexibility of user interface.* Analytics systems provide different types of interfaces to communicate the found patterns to users. A flexible UI should support techniques for *exploration*, *visualization* as well as even *feedback and authoring* of the discovered patterns. This dimension also evaluates the *interactivity* of UIs, *diversity* of analytical views as well as the capability to *mix* results.
- *Targeted user.* An analytics system might be used by different types of users including *non-programmer*,

novice-programmer and *expert-programmer*.

- *Genericity.* This dimension assesses an analytics system in terms of *genericity of architecture* and *scalability*. These features enable reuse of components as well as adding new functionality and data at minimal effort.

Figure 1 provides an abstract view of the state-of-the-art in analytics according to these dimensions.

Text analysis development environments usually provide comprehensive support for developing customized text analytics workflows for extracting, transforming and visualizing data. Typically they provide a high degree of genericity and interface flexibility, but require users to be expert-programmers. Examples include the *IBM Content Analytics platform* [1], *GATE* [4], *Apache UIMA* [7].

Text analysis tools provide a higher level of abstraction (thus catering more novice users) at the cost of genericity. Yang et al. [20] recently published an extensive text analytics survey from the viewpoint of the targeted user and introduced a tool called *WizIE* which enables novice programmers to perform different tasks of text analysis. Examples include *Attensity*[3], *Thomson Data Analyzer*[4] *Trendminer* [19] and *MashMaker* [6].

Business intelligence (BI) tools are applications designed to retrieve, analyse and report mainly highly-structured data for facilitating business decision making. BI tools usually require some form of programming or at least proficiency in query construction and report designing. Examples include *Zoho Reports*[5], *SAP NetWeaver*[6], *Jackbe*[7], and *RapidMiner* [12].

Spreadsheet-based tools are interactive applications for organization and analysis of data in tabular form. They can be used without much programming skills, are relatively generically applicable and provide flexible visualizations. However, spreadsheet-based tools are limited to structured tabular, data and can not be applied to semi-structured or text data. Examples include *Excel*, *DataWrangler* [13], *Google Docs Spreadsheets* and *Google Refine*.

NLP APIs are web services providing natural language processing (e.g. named entity recognition and relation extraction) for analysing web pages and documents. The use of these APIs requires some form of programming and flexible interfaces are usually not provided. Examples include *Alchemy*, *OpenCalais*, *Apache OpenNLP*.[8]

Linked Data analysis tools support the exploration, visualization and authoring of Linked Data. Examples include *Facete*[9] for spatial and *CubeViz*[10] for statistical linked data. Dadzie and Rowe [5] present a comprehensive survey of approaches for visualising and exploring Linked Data. They conclude that most of the tools are designed only for tech-users and do not provide overviews on the data.

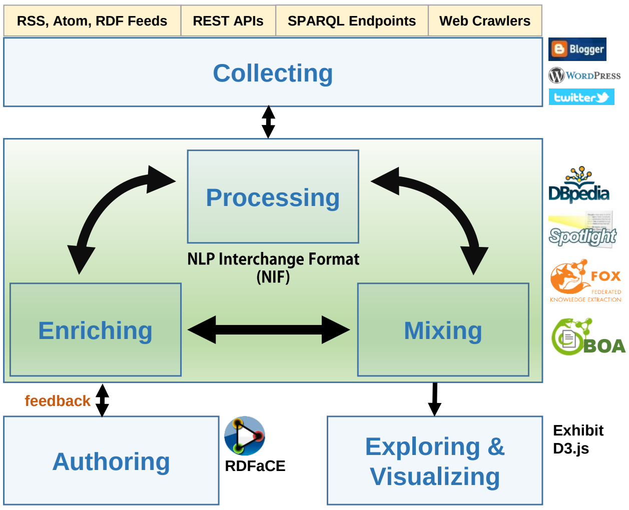


Figure 2: Text analytics workflow in conTEXT.

When comparing these different analytics tool categories according to the dimensions genericity, UI flexibility, target users and degree of structure we discovered a lack of tools dealing with unstructured content, catering non-expert users and providing flexible analytics interfaces. The aim of developing the text analytics tool conTEXT is to fill this gap.

3. WORKFLOW AND INTERFACE DESIGN

Workflow. Figure 2 shows the process of text analytics in conTEXT. The process starts by collecting information from the web or social web. conTEXT utilizes standard information access methods and protocols such as RSS/ATOM feeds, SPARQL endpoints and REST APIs as well as customized crawlers for SlideWiki, WordPress, Blogger and Twitter to build a corpus of information relevant for a certain user.

The assembled text corpus is then processed by Natural Language Processing (NLP) services. While conTEXT can integrate virtually any NLP services, it currently implements interfaces for *DBpedia Spotlight* [17] and the *Federated knOwledge eXtraction Framework* (FOX) [18] for discovering and annotating named entities in the text. DBpedia Spotlight annotates mentions of *DBpedia* resources in text thereby links unstructured information sources to the Linked Open Data cloud through DBpedia. FOX is a knowledge extraction framework that utilizes a variety of different NLP algorithms to extract RDF triples of high accuracy from text. Unlike DBpedia Spotlight, which supports all the DBpedia resource types, FOX is limited to `Person`, `Location` and `Organization` types. On the other hand, since FOX federates the results of different NLP algorithms, the recall and precision of annotations are higher.

[3] `http://www.attensity.com`
[4] `http://thomsonreuters.com/thomson-data-analyzer/`
[5] `http://www.zoho.com/reports/`
[6] `http://sap.com/netweaver`
[7] `http://jackbe.com/`
[8] A complete list of NLP APIs is available at `http://nerd.eurecom.fr/`
[9] `http://aksw.org/Projects/Facete`
[10] `http://aksw.org/Projects/CubeViz`

Processing stage	Component	Input	Output
Information access	RSS/Atom feeds RDF/SPARQL endpoints REST APIs Custom crawlers & scrapers	Textual or semi-structured Web resources	Corpus with metadata (e.g. temporal annotations)
Named Entity Recognition	DBpedia Spotlight FOX	Corpus	Semantically annotated corpus
Enrichment, authoring & feedback	BOA RDFaCE	Semantically annotated corpus	Automatically and manually enriched semantic annotations
Visualization & exploration	Faceted browsing Map view Timeline view Tag cloud Chordal graph view Matrix view Trend view	Semantically annotated and enriched corpus	Exploration and visualization widgets leveraging various semantic annotations

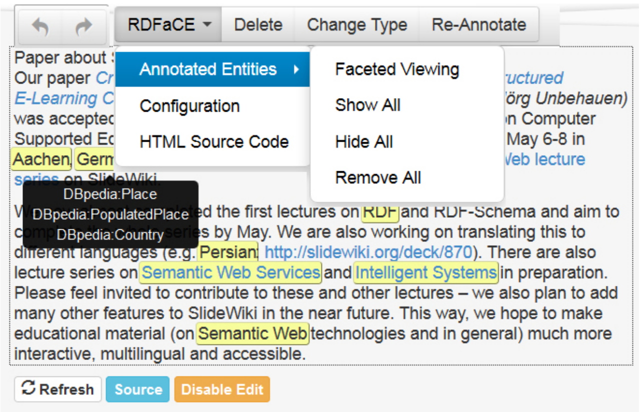
Table 1: conTEXT's extensible architecture supports a variety of plug-able components for various processing and interaction stages.

The processed corpus is then further enriched by two mechanisms:

- DBpedia URIs of the found entities are de-referenced in order to add more specific information to the discovered named entities (e.g. longitude and latitudes for locations, birth and death dates for people etc.).
- Entity co-occurrences are matched with pre-defined natural-language patterns for DBpedia predicates provided by *BOA* (BOotstrapping linked datA) [8] in order to extract possible relationships between the entities.

The processed data can also be joined with other existing corpora in a *text analytics mashup*. Such a mashup of different annotated corpora combines information from more than one corpus in order to provide users an integrated view. Analytics mashups help to provide more context for the text corpus under analysis and also enable users to mix diverse text corpora for performing a comparative analysis. For example, a user's Wordpress blog corpus can be integrated with corpora obtained from her Twitter and Facebook accounts. The creation of analytics mashups requires dealing with the heterogeneity of different corpora as well as the heterogeneity of different NLP services utilized for annotation. conTEXT employs *NIF* (NLP Interchange Format) [10] to deal with this heterogeneity. The use of NIF allows us to quickly integrate additional NLP services into conTEXT.

The processed, enriched and possibly mixed results are presented to users using different views for exploration and visualization of the data. *Exhibit* [11][11] (structured data publishing) and *D3.js* [3][12] (data-driven documents) are employed for realizing a dynamic exploration and visualization experience. Additionally, conTEXT provides an authoring user interface based on the *RDFa Content Editor* (RDFaCE) [15] to enable users to revise the annotated results. User-refined annotations are sent back to the NLP services as feedback for the purpose of learning in the system.



Paper about
Our paper Cr ructured
E-Learning C örg Unbehauen)
was accepted n Computer
Supported Ec May 6-8 in
Aachen, Germ Veb lecture
series on SlideWiki.

W ed the first lectures on RDF and RDF-Schema and aim to
c s by May. We are also working on translating this to
different languages (e.g. Persian; http://slidewiki.org/deck/870). There are also
lecture series on Semantic Web Services and Intelligent Systems in preparation.
Please feel invited to contribute to these and other lectures – we also plan to add
many other features to SlideWiki in the near future. This way, we hope to make
educational material (on Semantic Web technologies and in general) much more
interactive, multilingual and accessible.

Figure 3: conTEXT authoring interface allowing manual revisions of the automatically generated semantic annotations.

Progressive crawling and annotation. The process of collecting and annotating a large text corpus can be time-consuming. Therefore it is very important to provide users with immediate results and inform them about the progress of the crawling and annotation task. For this purpose, we have designed special user interface elements to keep users informed until the complete results are available. The first indicator interface is an animated progress bar which shows the percentage of the collected/annotated results as well as the currently downloaded and processed item (e.g. the title of the blog post). The second indicator interface is a real-time tag cloud which is updated while the annotation is in progress. We logged all crawling and processing timings during our evaluation period. Based on these records, the processing of a Twitter feed with 300 tweets takes on average 30 seconds and the processing of 100 blog posts approx. 3-4 minutes on standard server with i7 Intel CPU (with parallelization and hard-ware optimizations further significant acceleration is possible). This shows, that for typical crawling and annotation tasks the conTEXT processing can be performed in almost real-time thus providing instant results to the users.

[11] http://simile-widgets.org/exhibit3/
[12] http://d3js.org/

Parameter	**Description**
text	annotated text.
entityUri	the identifier of the annotated entity.
surfaceForm	the name of the annotated entity.
offset	position of the first letter of the entity.
feedback	indicates whether the annotation is correct or incorrect.
context	indicates the context of the annotated corpus.
isManual	indicates whether the feedback is generated by user or by other NLP services.
senderIDs	identifier(s) of the feedback sender.

Table 2: NLP Feedback parameters.

Authoring interfaces. A lightweight text analytics as implemented by conTEXT provides direct incentives to users to adopt and revise semantic text annotations. Users will obtain more precise results as they refine annotations. On the other hand, NLP services can benefit from these manually-revised annotations to learn the right annotations. conTEXT employs the RDFa Content Editor RDFaCE within the faceted browsing view and thus enables users to edit existing annotations while browsing the data (cf. Figure 3). The WYSIWYM (What-You-See-Is-What-You-Mean) interface [14] provided by RDFaCE enables integrated visualization and authoring of unstructured and semantic content (i.e. annotations encoded in RDFa). The manual annotations are collected and sent as feedback to the corresponding NLP service. The feedback encompasses the parameters specified in Table 2.

Exploration and visualization interfaces. The dynamic exploration of content indexed by the annotated entities facilitates faster and easier comprehension of the content and provide new insights. conTEXT creates a novel entity-based search and browsing interface for end-users to review and explore their content. On the other hand, conTEXT provides different visualization interfaces which present, transform, and convert semantically enriched data into a visual representation, so that, users can explore and query the data efficiently. Visualization UIs are supported by noise-removal algorithms which will tune the results for better representation and will highlight the picks and trends in the visualizations. For example, we use a frequency threshold when displaying single resources in interfaces. In addition, a threshold based on the Dice similarity is used in interfaces which display co-occurrences. By these means, we ensure that the information overload is reduced and that information shown to the user is the most relevant. Note that the user can chose to deactivate or alter any of these thresholds.

Linked Data interface for search engine optimization (SEO). The `Schema.org` initiative provides a collection of shared schemas that Web authors can use to markup their content in order to enable enhanced search and browsing features offered by major search engines. *RDFa*, *Microdata* and *JSON-LD* are currently approved formats to markup web documents based on Schema.org. There are already tools like *Google Structured Data Markup Helper*[13] which help users to generate and embed such markup into their web content. A direct feature of the Linked Data based text analytics with conTEXT is the provisioning of a *SEO* interface. conTEXT encodes the results of the content annotation (automatic and revisions by the user) in the *JSON-LD*[14] format which can be directly exposed to schema.org aware search engines. This Linked Data interface employs the current mapping from the DBpedia ontology to the Schema.org vocabularies[15]. Thus the conTEXT SEO interface enables end-users to benefit from better exposure in search engines (e.g. through Google's *Rich Text Snippets*) with very little effort.

4. VIEWS

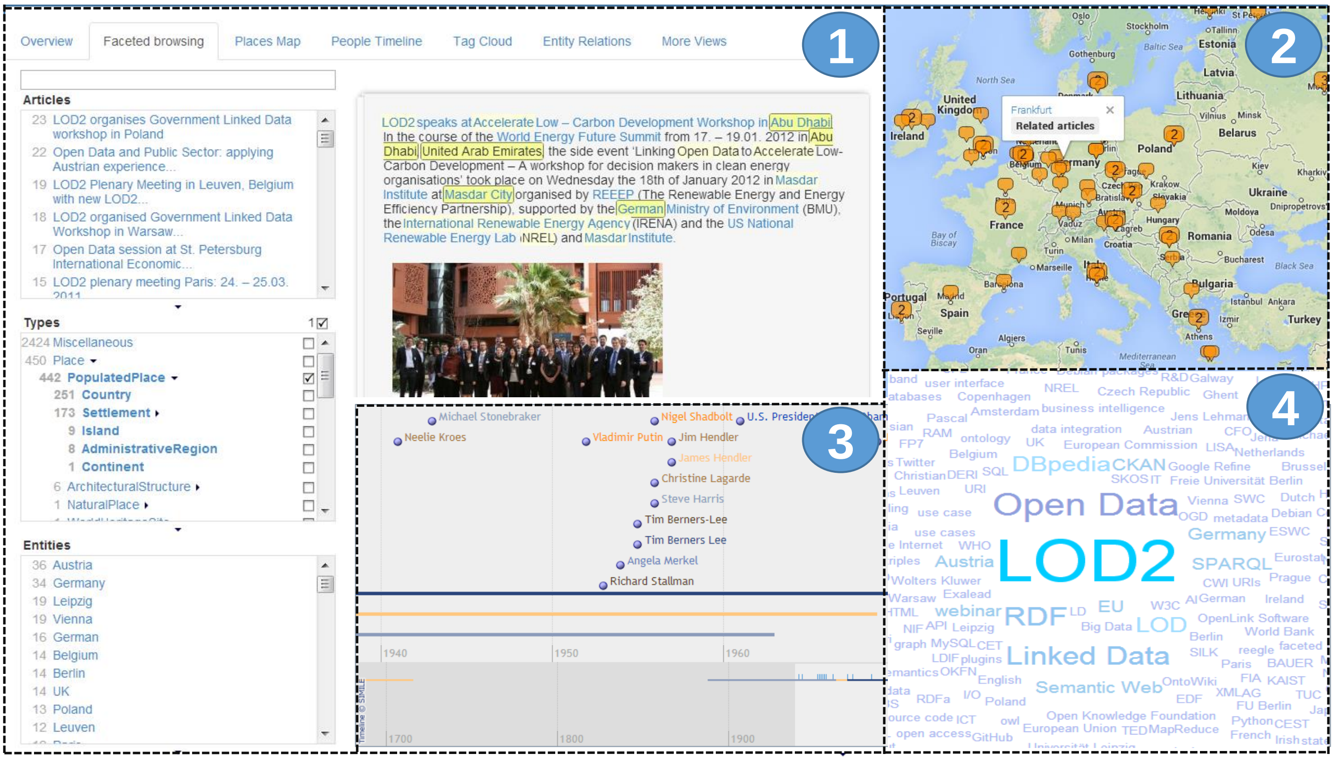
A key aspect of conTEXT is to provide intuitive exploration and visualization options for the annotated corpora. For that purpose, conTEXT allows to plugin a variety of different exploration and visualization modules, which operate on the conTEXT data model capturing the annotated corpora. By default, conTEXT provides the following views for exploring and visualizing the annotated corpora:

- *Faceted browsing* allows users to quickly and efficiently explore the corpus along multiple dimensions (i.e. articles, entity types, temporal data). The faceted view enables users to drill a large set of articles down to a set adhering to certain constraints.
- *Places map* shows the locations and the corresponding articles in the corpus. This view allows users to quickly identify the spatial distribution of locations refereed to in the corpus.
- *People timeline* shows the temporal relations between people mentioned in the corpus. For that purpose, references to people found in the corpus are enriched with birth and death days found in DBpedia.
- *Tag cloud* shows entities found in the corpus in different sizes depending on their prevalence. The tag cloud helps to quickly identify the most prominent entities in the corpora.
- *Chordal graph view* shows the relationships among the different entities in a corpus. The relationships are extracted based on the co-occurrence of the entities and their matching to a set of predefined natural language patterns.
- *Matrix view* shows the entity co-occurrence matrix. Each cell in the matrix reflects the entity co-occurrence by entity types (color of the cell) and by the frequency of co-occurrence (color intensity).
- *Trend view* shows the occurrence frequency of entities in the corpus over the times. The trend view requires a corpus with articles having a timestamp (such as blogposts or tweets).
- *Image view* shows a picture collage created from the entities Wikipedia images. This is an alternative for tag cloud which reflects the frequent entities in the corpora by using different image sizes.

[13] `https://www.google.com/webmasters/markup-helper/`

[14] JSON for Linked Data `http://json-ld.org/`

[15] `http://schema.rdfs.org/mappings.html`



Articles

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Types 1☑

2424 Miscellaneous □
450 Place □
442 PopulatedPlace ☑
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9 Island □
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1 NaturalPlace □

Entities

36 Austria
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14 Berlin
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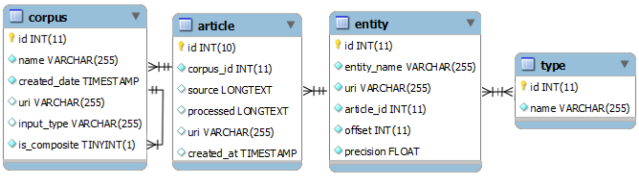
LOD2 speaks at Accelerate Low – Carbon Development Workshop in Abu Dhabi
In the course of the World Energy Future Summit from 17. – 19.01. 2012 in Abu Dhabi United Arab Emirates the side event 'Linking Open Data to Accelerate Low-Carbon Development – A workshop for decision makers in clean energy organisations' took place on Wednesday the 18th of January 2012 in Masdar Institute at Masdar City organised by REEEP (The Renewable Energy and Energy Efficiency Partnership), supported by the German Ministry of Environment (BMU), the International Renewable Energy Agency (IRENA) and the US National Renewable Energy Lab (NREL) and Masdar Institute.

Figure 4: Different views for search and exploration of an analysed corpus: 1) faceted browser allowing to browse articles in the corpus using the DBpedia ontology, 2) map view showing locations mentioned in the corpus on the map, 3) timeline showing events related to named entities found in the corpus, 4) tag cloud indicating popular concepts mentioned in the corpus.

5. IMPLEMENTATION

conTEXT is a Web application implemented in *PHP* and *JavaScript* using a relational database backend (MySQL). The application makes extensive use of the model-view-controller (MVC) architecture pattern and relies heavily on *JSON* format as input for the dynamic client-side visualization and exploration functionality.



corpus
id INT(11)
name VARCHAR(255)
created_date TIMESTAMP
uri VARCHAR(255)
input_type VARCHAR(255)
is_composite TINYINT(1)

article
id INT(10)
corpus_id INT(11)
source LONGTEXT
processed LONGTEXT
uri VARCHAR(255)
created_at TIMESTAMP

entity
id INT(11)
entity_name VARCHAR(255)
uri VARCHAR(255)
article_id INT(11)
offset INT(11)
precision FLOAT

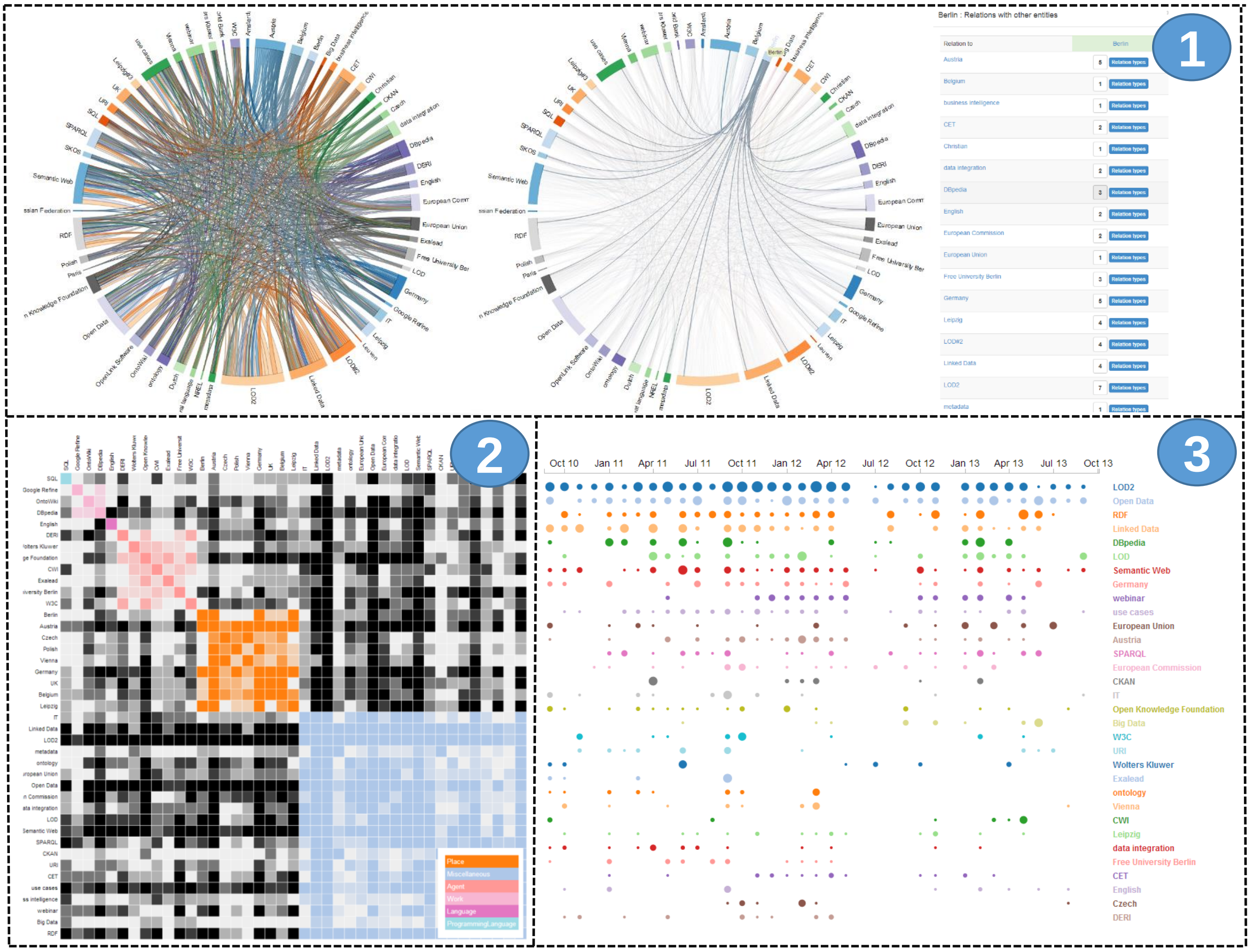
type
id INT(11)
name VARCHAR(255)

Figure 6: conTEXT data model.

Figure 6 shows the conTEXT data model, which comprises `Corpus`, `Article`, `Entity` and `Entity_Type` tables to represent and persist the data for text analytics. A corpus is composed of a set of articles or a set of other corpora (in case of a mixed corpus). Each article includes a set of entities represented by URIs and an annotation score. The `Entity_type` table stores the type(s) for each entity. As described in Section 3, conTEXT employs NIF for interoperability between different NLP services as well as different corpora. Code 1 shows a sample NIF annotation stored for an article. In order to create the required input data structures for different visualization views supported by D3.js and Exhibit, we implemented a *data transformer* component. This component processes, merges and converts the stored NIF formats into the appropriate input formats for visualization layouts (e.g. D3 Matrix layout or Exhibit Map layout). After the transformation, the converted visualization input representations are cached on the server-side as JSON files to increase the performance of the system in subsequent runs.

```
{
  "@article":"http://blog.aksw.org/2013/dbpedia-swj"
      ,
  "@context":"http://persistence.uni-leipzig.org/
      nlp2rdf/ontologies/nif-core#",
  "resources":[{
    "@id": "http://dbpedia.org/resource/DBpedia",
        "anchorOf": "DBpedia",
        "beginIndex": "1144",
        "endIndex": "1151",
        "@confidence": "0.9",
        "@type": "DBpedia:Software"
  }, {
    "@id": "http://dbpedia.org/resource/Freebase_(
        database)",
        "anchorOf": "Freebase",
        "beginIndex": "973",
        "endIndex": "981",
        "@confidence": "0.9",
        "@type": "DBpedia:Misc"
  }, ... ]
}
```

Code 1: Generated semantic annotations represented in NIF/JSON.



Berlin : Relations with other entities

Relation to	Berlin	
Austria	5	Relation types
Belgium	1	Relation types
business intelligence	1	Relation types
CET	2	Relation types
Christian	1	Relation types
data integration	2	Relation types
DBpedia	3	Relation types
English	2	Relation types
European Commission	2	Relation types
European Union	1	Relation types
Free University Berlin	3	Relation types
Germany	5	Relation types
Leipzig	4	Relation types
LOD#2	4	Relation types
Linked Data	4	Relation types
LOD2	7	Relation types
metadata	1	Relation types

Figure 5: Different views for visualizing an analysed corpus: 1) chordal graph view showing co-occurrence relationships between entities, 2) matrix view showing clusters of co-occurring entities, 3) trend view indicating the popularity of entities in a corpus over time.

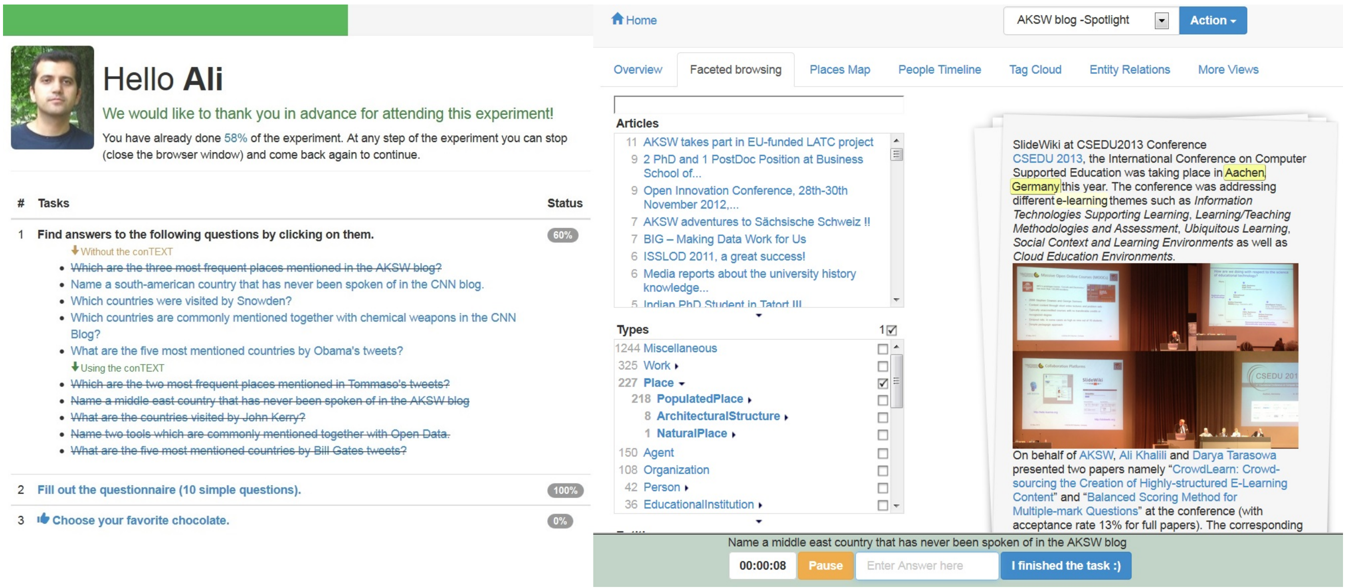
One of the main design goals during the development of conTEXT was modularity and extensibility. Consequently, we realized several points of extensibility for implementation. For example, additional visual analysis views can be easily added. Additional NLP APIs and data collectors can be registered. The faceted browser based on Exhibit can be extended in order to synchronize it with other graphical views implemented by D3.js and to improve the scalability of the system. Support for localization and internationalization can be added into the user interface as well as to the data processing components.

6. EVALUATION

The goal of our evaluation was two-fold. First, we wanted to provide quantitative insights in the usefulness of conTEXT. To this end, we carried out a task-driven usefulness study where we measured the improvement in efficiency and effectiveness that results from using conTEXT. Second, we aim to evaluate the usability of our approach.

6.1 Usefulness study

Experimental Setup. To achieve the first goal of our evaluation, we carried out controlled experiments with **25** users on a set of 10 questions pertaining to knowledge discovery in corpora of unstructured data. For example, we asked users the following question: “What are the five most mentioned countries by Bill Gates tweets?”. The 10 questions were determined as follows: We collected a set of 61 questions from 12 researchers of the University of Leipzig. These questions were regarded as a corpus and analysed using conTEXT. After removing questions that were quasi-duplicates manually, we chose 10 questions that we subdivided into 2 sets of 5 questions. Each of users involved in the evaluation was then asked to solve one set of questions with conTEXT and the other one without the tool. To ensure that we did not introduce any bias in the results due to distribution of hard questions across the two sets, one half of the users was asked to solve the first set of questions with conTEXT while the others did the same with the second set and vice-versa. We



Hello **Ali**

We would like to thank you in advance for attending this experiment!

You have already done 58% of the experiment. At any step of the experiment you can stop (close the browser window) and come back again to continue.

#	Tasks	Status
1	**Find answers to the following questions by clicking on them.** Without the conTEXT • ~~Which are the three most frequent places mentioned in the AKSW blog?~~ • Name a south-american country that has never been spoken of in the CNN blog. • Which countries were visited by Snowden? • Which countries are commonly mentioned together with chemical weapons in the CNN Blog? • What are the five most mentioned countries by Obama's tweets? Using the conTEXT • ~~Which are the two most frequent places mentioned in Tommaso's tweets?~~ • ~~Name a middle east country that has never been spoken of in the AKSW blog~~ • ~~What are the countries visited by John Kerry?~~ • ~~Name two tools which are commonly mentioned together with Open Data.~~ • ~~What are the five most mentioned countries by Bill Gates tweets?~~	60%
2	**Fill out the questionnaire (10 simple questions).**	100%
3	**Choose your favorite chocolate.**	0%

Articles

11	AKSW takes part in EU-funded LATC project
9	2 PhD and 1 PostDoc Position at Business School of...
9	Open Innovation Conference, 28th-30th November 2012,...
7	AKSW adventures to Sächsische Schweiz !!
7	BIG – Making Data Work for Us
6	ISSLOD 2011, a great success!
6	Media reports about the university history knowledge...
5	Indian PhD Student in Tatort !!!

Types 1☑

1244	Miscellaneous	□
325	Work	□
227	**Place**	☑
218	**PopulatedPlace**	□
8	**ArchitecturalStructure**	□
1	**NaturalPlace**	□
150	Agent	□
108	Organization	□
42	Person	□
36	EducationalInstitution	□

SlideWiki at CSEDU2013 Conference
CSEDU 2013, the International Conference on Computer Supported Education was taking place in Aachen, Germany this year. The conference was addressing different e-learning themes such as *Information Technologies Supporting Learning, Learning/Teaching Methodologies and Assessment, Ubiquitous Learning, Social Context and Learning Environments* as well as *Cloud Education Environments.*

On behalf of AKSW, Ali Khalili and Darya Tarasowa presented two papers namely "CrowdLearn: Crowd-sourcing the Creation of Highly-structured E-Learning Content" and "Balanced Scoring Method for Multiple-mark Questions" at the conference (with acceptance rate 13% for full papers). The corresponding

Name a middle east country that has never been spoken of in the AKSW blog

Figure 7: conTEXT task evaluation platform: Left – task view showing the tasks assigned to an evaluation subject, Right – individual task.

evaluated the users' efficiency by measuring the time that they required to answer the questions. Note that the users were asked to terminate any task that required more than 5 minutes to solve. In addition, we measured the users' effectiveness by comparing the answers of each user to a gold standard which was created manually by the authors. Given that the answers to the questions were sets, we measured the similarity of the answers A provided by the each user and the gold standard G by using the *Jaccard* similarity of the two sets, i.e., $\frac{|A \cap G|}{|A \cup G|}$. A screenshot of the task evaluation platform[16] is shown in Figure 7. The platform provided users with a short tutorial on how to perform the tasks using conTEXT and how to add their responses for the questions.

Results. The results of our first series of evaluations are shown in Figures 8 and 9. On average, the users required 136.4% more time without conTEXT than when using the tool. A fine-grained inspection of the results suggests that our approach clearly enables users to perform tasks akin to the ones provided in the evaluation in less time. Especially complex tasks such as "Name a middle-eastern country that has never been spoken of in the AKSW blog" are carried out more than three times faster using conTEXT. In some cases, conTEXT even enables users to carry out tasks that seemed out of reach before. For example, the question "What are the five most mentioned countries by Bill Gates' tweets?" (Q10) was deemed impossible to answer in reasonable time by using normal search tools by several users. A look at the effectiveness results suggests that those users who tried to carry out these task without conTEXT failed as they achieve an average Jaccard score of 0.17 on this particular task while users relying on conTEXT achieve 0.65. The overall Jaccard score with conTEXT lies around 0.57, which suggests that the tasks in our evaluation were non-trivial. This is confirmed by the overall score of 0.19 without conTEXT. Interestingly, the average effectiveness results achieve by users with conTEXT are always superior to those achieved without conTEXT, especially on task Q8, where users without conTEXT never found the right answer. Moreover, in all cases, the users are more time-efficient when using conTEXT than without the tool.

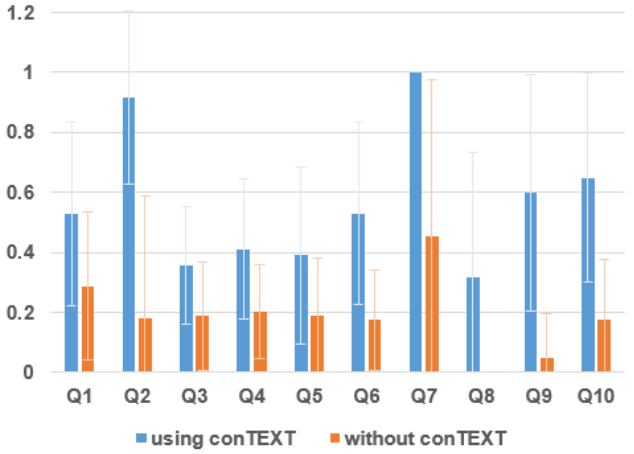


Figure 8: Average Jaccard similarity index for answers using and without the conTEXT.

6.2 Usability study

Experimental Setup. The goal of the second part of our evaluation was to assess the usability of conTEXT. To achieve this objective, we used the standardized, ten-item Likert scale-based *System Usability Scale* (SUS) [16] questionnaire and asked each person who partook in our useful-

[16] http://context.aksw.org/nlp/evaluation

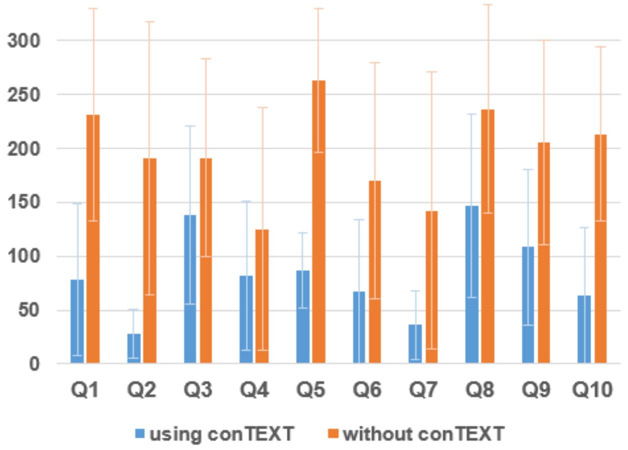


Figure 9: Average time spent (in second) for finding answers using and without the conTEXT.

ness evaluation to partake in the usability evaluation. The questions were part of a Google questionnaire and can be found at `http://goo.gl/JKzgdK`.

Results. The results of our study (cf. Figure 10) showed a mean usability score of **82** indicating a high level of usability according to the SUS score. The responses to question 1 suggests that our system is adequate for frequent use (average score to question 1 = 4.23 ± 0.83) by users all of type (4.29 ± 0.68 average score for question 7). While a small fraction of the functionality is deemed unnecessary by some users (average score of 1.7± 0.92 to question 2, 1.88±1.05 to question 6 and 1.76±1.09 to question 8), the users deem the system easy to use (average score of 4.3± 0.59 to question 3). Only one user suggested that he/she would need a technical person to use the system, while all other users were fine without one. The modules of the system in itself were deemed to be well integrated (4.23±0.66 average score to question 5). Overall, the output of the system seems to be easy to understand (4.11 ± 1.05 score to question 9) while users even without training assume themselves capable of using the system (1.52± 0.72 to question 10). These results corroborate the results of the first part of our evaluation as they suggest that conTEXT is not only easy to use but provides also useful functionality.

7. DISCUSSION

The incentive for each author to use conTEXT is the ease of analysing unstructured and semi-structured data and the resulting sophisticated user interfaces. While this motivation is personal and the immediately perceptible benefit is local, there are far reaching effects as a result of the semantically annotated information being entirely publicly accessible in structured form. We now discuss how conTEXT, by design, is helping to democratize the use of NLP technology, helps alleviating the Semantic Web's chicken-and-egg problem and harnesses the power of feedback loops.

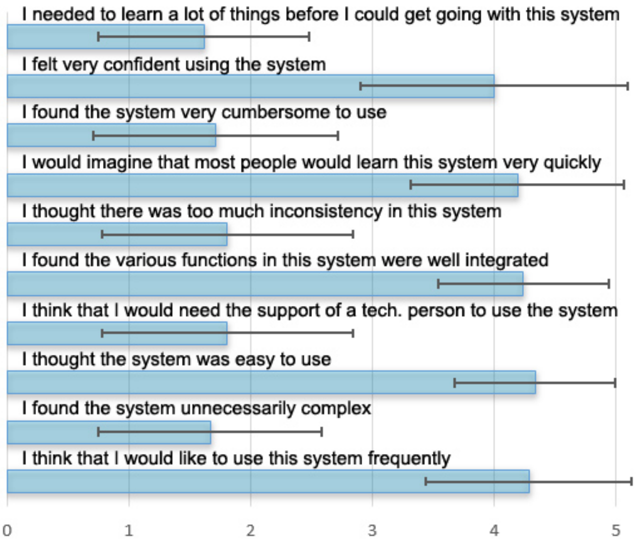


Figure 10: Result of usability evaluation using SUS questionnaire.

7.1 Democratizing the NLP usage

With conTEXT natural language processing technology is made more accessible, so that sophisticated text analytics can be used with just a few clicks by ordinary users. This was achieved by abstracting from a particular technology (e.g. by using the NIF format) and by supporting a) typical input formats for corpus generation (such as social networking feeds) and b) sophisticated visualizations employing the data-driven document metaphor. As a result, ordinary users can observe the power of natural language processing and semantic technologies with minimal effort. By directly showing the effect of semantic annotations and demonstrating the benefits for improved navigation, exploration and search, users will gain a better understanding of recent technology advances. On the other hand, users will regain control and command of their information, since they are empowered to perform similar analyses as major social and advertising networks do. If users discover using conTEXT, that the patterns of their communication habits do not correspond to what they would like others to observe, they can delete certain information and alter their blogging habits (e.g. publish more post on professional than leisure activities).

In addition to gaining insights into their own communication habits, users can also more easily discover communication habits of people in charge (e.g. politicians) or do quicker fact checking. Answering questions, such as 'What has Angela Merkel said about the Syria conflict?' or 'What are commercial property development areas discussed in the last two years by the city council?' become dramatically easier to answer, even when the information source is a large unstructured text corpus.

7.2 Alleviating the Semantic Web's chicken-and-egg problem

Recently we could observe a significant increase of the amount of structured data publishing on the Web. However, this increase can be attributed primarily to article metadata being made available and already to a much lesser extend to just a few entity types (people, organizations, products) being prevalent [2]. As a consequence, we still face the chicken-and-egg problem to truly realize the vision of a Web, where large parts of the information are available in structured formats and semantically annotated. Before no substantial amount of content is available in semantic representations, search engines will not pick up this information and without better search capabilities publishers are not inclined to make additional effort to provide semantic annotations for their content. The latter is particularly true for unstructured and semi-structured content, which is much more difficult to annotate than structured content from relational databases (where merely some templates have to be adopted in order to provide e.g. RDFa).

conTEXT can help to overcome this problem, since it provides instant benefits to users for creating comprehensive semantic annotations. The result of an annotation with conTEXT can easily be exported, re-integrated or published along the original content. Also, we plan to provide conTEXT as a service, where a user's content is continuously ingested and processed, the user is informed about updates and thus the semantic representations of the content evolve along with the content itself.

7.3 Harnessing the power of feedback loops

Thomas Goetz states in his influential WIRED Magazin article [9]: 'Provide people with information about their actions in real time, then give them a chance to change those actions, pushing them toward better behaviors.' With conTEXT, we want to give users direct feedback on what information can be extracted from their works. At the same time we want to incorporate their feedback and revisions of the semantic annotations back in the NLP processing loop. Incorporating user feedback was so far not much in the focus of the NLP community. With conTEXT, we aim to contribute to changing this. We argue, that NLP technology achieving, for example, 90% precision, recall or f-measure, might not fulfill the requirements of a number of potential use cases. When we can increase the quality of the NLP through user feedback, we might be able to substantially extend the range of potential NLP applications. The user feedback here serves two purposes: One the one hand, it directly increases the quality of the semantic annotation. On the other hand, it can serve as input for active learning techniques, which can further boost precision and recall of the semantic annotation.

8. CONCLUSION

With conTEXT, we showcased an innovative text analytics application for end-users, which integrates a number of previously disconnected technologies. In this way, conTEXT is making NLP technologies more accessible, so they can be easily and beneficially used by arbitrary end-users. conTEXT provides instant benefits for annotation and empowers users to gain novel insights and complete tasks, which previously required substantial development.

In future, we plan extend work on conTEXT along several directions. We aim to investigate, how user feedback can be used across different corpora. We consider the harnessing of user feedback by NLP services an area with great potential to attain further boosts in annotation quality. On a related angle, we plan to integrate revisioning functionality, where users can manipulate complete sets of semantic annotations instead of just individual ones. In that regard, we envision that conTEXT can assume a similar position for text corpora as have data cleansing tools such as OpenRefine for structure data.

Acknowledgment

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