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SciPar: A Collection of Parallel Corpora from Scientific Abstracts

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Abstract

This paper presents SciPar, a new collection of parallel corpora created from openly available metadata of bachelor theses, master theses and doctoral dissertations hosted in institutional repositories, digital libraries of universities and national archives. We describe first how we harvested and processed metadata from 86, mainly European, repositories to extract bilingual titles and abstracts, and then how we mined high quality sentence pairs in a wide range of scientific areas and sub-disciplines. In total, the resource includes 9.17 million segment alignments in 31 language pairs and is publicly available via the ELRC-SHARE repository. The bilingual corpora in this collection could prove valuable in various applications, such as cross-lingual plagiarism detection or adapting Machine Translation systems for the translation of scientific texts and academic writing in general, especially for language pairs which include English.

Keywords: Parallel Corpus, Machine Translation, Scientific Research, European Languages

1. Introduction

The significant improvements in Machine Translation (MT) that have been achieved with the use of SMT (Statistical Machine Translation) and especially NMT (Neural Machine Translation) systems in recent years, have been mainly driven by the compilation of large-scale parallel corpora. Many of these corpora cover general language use, while domain-specific ones able to capture and model different word/term/phrase translations and styles of writing are rather scarce.

Chu and Wang (2018) highlighted that there are few or no parallel corpora for the majority of language pairs and domains, although there has been significant work in data acquisition over the last years. In fact, the legal and biomedical domains are among the few cases research has focused on to propose new methods for training domain-adapted MT systems. The broad domain of scientific research and academic texts is one of those remaining relatively under-resourced, despite its importance. This importance is becoming increasingly apparent by recent empirical evidence that the research performance of a university declines as the linguistic distance of its local language from English increases, because English is the dominant language of scientific publications (Cao et al., 2021).

Institutional repositories of universities, digital libraries and national archives contain a wealth of content and metadata from bachelor and master theses, doctoral dissertations and other scientific publications. The openly available abstracts and titles are quite often translated by their respective authors in at least 2 languages: English and their native language. To the best of our knowledge, these rich sources of parallel data have not been exploited systematically to create parallel corpora related to scientific research. The few notable exceptions concern high-resource language pairs (e.g. English-Spanish, English-Portuguese, English-French), as mentioned in Section 2.

In this paper, we report on the construction of SciPar, a multilingual parallel corpus of theses and dissertations abstracts with 9.17 million sentence pairs in 31 language pairs, covering many European languages. The data have been assembled from 86 repositories and archives (see Table 4 in Appendix) with openly available metadata. The method that we used leverages the way the metadata records are stored in those repositories, and results in well aligned sentence pairs with academic content. The fact that several repositories contain theses and dissertations from multiple universities or university departments indicates that the proposed resource is constituted by a wide variety of scientific subjects and disciplines. Thus, we believe the corpus is especially useful since other multilingual corpora from scientific articles, theses and dissertations generally -and rather unevenly- focus on the biomedical domain (see Section 2).

We think that this resource will be useful in NLP (Natural Language Processing) research and especially useful for research related to the translation of scientific texts from and to English, so as to facilitate equitable access to scientific knowledge and accelerate research.

2. Related Work

To the best of our knowledge, there are not many parallel corpora based on academic theses and dissertations. A notable dataset which is freely available in the OPUS collection (Tiedemann, 2012) is the CAPES[1] parallel corpus (Soares et al., 2018), which has been extracted from the corresponding Brazilian governmental body responsible for overseeing post-graduate programs. The corpus consists of ~1.2 million sentence pairs in the English-Portuguese language pair and has been evaluated with SMT and NMT systems, as well as manual assessment.

[1] https://opus.nlpl.eu/CAPES.php

SciELO[2] is a distinct -yet similar- corpus which is also available on OPUS (Tiedemann, 2012) and relies on the SciELO database of scientific articles. The corpus is based on full texts -not just abstracts- and contains aligned sentences in English, Portuguese and Spanish (Neves et al., 2016). The most recent version of the corpus contains 3.3 million sentence pairs from various scientific disciplines, includes relative metadata (journal name, subject category, etc.) of which a subset is trilingually aligned. Its quality has been evaluated automatically (with SMT systems) and manually (Soares et al., 2019). As the authors highlighted, a straightforward use case of a parallel corpus with scientific texts is cross-lingual plagiarism detection, i.e., when an author translates a text from another language and presents it as an original work.

One of the first large parallel corpora of scientific papers was the ASPEC (Asian Scientific Paper Excerpt Corpus) which consists of about 3.7 million sentence pairs in English, Japanese and Chinese collected from paper abstracts (Nakazawa, 2016). The data of ASPEC are annotated according to their scientific field (e.g. physics, biology, nuclear engineering, etc.) and have been used repeatedly in the Workshops on Asian Translation (WAT).

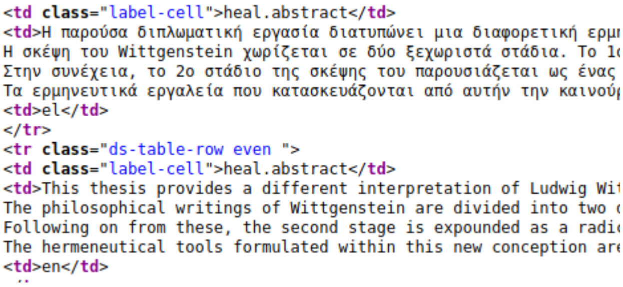
Most scientific-related corpora focus on the biomedical domain, as it is a recurring shared task of the Workshops on Machine Translation (WMT). Some examples mentioned in Névéol et al. (2018) include the EDP corpus which has been constructed from open access journals in English and French, the MEDLINE corpus from the vernacular titles of articles in English, French, Spanish and Portuguese and the BVS corpus which has been constructed from biomedical abstracts in English, Portuguese and Spanish (Soares and Krallinger, 2019).

3. Methodology

The process we have followed in this paper for constructing the proposed multilingual resource contains the following tasks: (a) harvesting the web pages of the institutional repositories, (b) parsing their metadata, (c) locating entries with parallel content, and (d) mining sentence pairs.

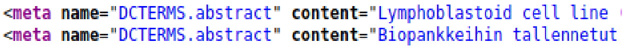
We acquired the freely available metadata from 86 institutional repositories, national archives and digital libraries[3]. These repositories contain entries of bachelor and master theses, PhD dissertations, as well as -to a lesser extent- other scientific publications. Most of these repositories have been built using the DSpace (Smith et al., 2003) and the EPrints[4] open-source repository software packages.

As expected, repositories differ in the type and way they store records, even if they use the same open-source repository software. Such an example can be seen by contrasting the source code of the web pages in Figure 1 and Figure 2. In particular, a thesis abstract from DSpace@NTUA[5] (Digital Library of the National Technical University of Athens) is displayed in Figure 1, while in Figure 2, there is a thesis abstract from HELDA[6] (Digital Repository of the University of Helsinki).



```
<td class="label-cell">heal.abstract</td>
<td>Η παρούσα διπλωματική εργασία διατυπώνει μια διαφορετική ερμ
Η σκέψη του Wittgenstein χωρίζεται σε δύο ξεχωριστά στάδια. Το 1
Στην συνέχεια, το 2ο στάδιο της σκέψης του παρουσιάζεται ως ένας
Τα ερμηνευτικά εργαλεία που κατασκευάζονται από αυτήν την καινού
<td>el</td>
</tr>
<tr class="ds-table-row even ">
<td class="label-cell">heal.abstract</td>
<td>This thesis provides a different interpretation of Ludwig Wi
The philosophical writings of Wittgenstein are divided into two
Following on from these, the second stage is expounded as a radi
The hermeneutical tools formulated within this new conception are
<td>en</td>
```

Figure 1: Thesis abstract from DSpace@NTUA



```
<meta name="DCTERMS.abstract" content="Lymphoblastoid cell line
<meta name="DCTERMS.abstract" content="Biopankkeihin tallennetut
```

Figure 2: Thesis abstract from HELDA

Thus, we followed an approach which was modified for each repository accordingly. Below, we outline the basic steps of our methodology:

- Initially, we identified the pattern of each repository structure and generated the potential URLs of the item records (i.e. theses, dissertations, etc.), which we fetched as HTMLs using the GNU Wget[7] package.
- The HTMLs of the metadata records were parsed using the Beautiful Soup[8] Python package. Custom scripts were developed to extract the parallel titles/abstracts from them and create a document pair for each record. We used the fastText language identification software (Joulin et al., 2017) to verify the language of each document and overcome possible metadata inconsistencies. In some cases, we had to filter out documents based on a low number of tokens for both languages.
- The NLTK[9] library (Bird et al., 2009) was used to split documents into sentences and the LASER toolkit[10] (Artetxe and Schwenk, 2019) was used to mine parallel sentences from the document pairs.
- Finally, the sentence pairs for each language pair were concatenated in a single file and were filtered so as to discard alignments with limited or no use (e.g. duplicates, segments containing only digits, etc.) for training MT systems (Papavassiliou et al., 2018).

The LASER toolkit assigns a score to each sentence pair as an indicator of the strength of the alignment. In recent works, such as WikiMatrix (Schwenk et al., 2021) and

[2] https://opus.nlpl.eu/SciELO.php
[3] We experimented with approximately 20 additional repositories which did not yield any parallel data.
[4] https://www.eprints.org/
[5] https://dspace.lib.ntua.gr/xmlui/
[6] https://helda.helsinki.fi/
[7] https://www.gnu.org/software/wget/
[8] https://www.crummy.com/software/BeautifulSoup/
[9] https://www.nltk.org/
[10] https://github.com/facebookresearch/LASER

CCMatrix[11] (Schwenk et al., 2020), specific values for the threshold of this score (1.04 and 1.06 respectively) were experimentally set and proposed. Considering the scope of these works, i.e., mining sentence pairs globally from large monolingual corpora, the selection of such high values seems reasonable. However, in our case we are confident that the targeted document pairs are parallel and well structured, and consequently, a lower threshold could be used. After experimentation, we found that approximately 6.3% of identified sentence pairs got a score between 0.98 and 1.04 and most of them originated from titles, which constitute very good translations. Therefore, in this work we used 0.98 as a threshold.

Unfortunately, several academic repositories do not provide metadata in a structured way (e.g. a single thesis abstract may have been written in two languages with a distinct entry for each one) or the actual textual content that we are interested in is not contained in the source code of the web pages of the repository. Additionally, even though most repositories store records with the same web address followed by a numerical ID in ascending order (e.g. https://dspace.tul.cz/handle/15240/{ID}), there are several repositories which do not have any underlying patterns (or at least, we could not discern any) and thus, did not yield any data. We believe that our methodology has many limitations and is clearly not compatible with all repositories; however, we also believe that the data science community could provide valuable assistance in making existing academic repositories more accessible as they constitute extremely valuable sources of high-quality data.

4. Corpus Description and Information

The resource consists of 9,172,462 sentence pairs in 31 language pairs covering 25 languages in total[12]. In Table 1, we list the number of sentence pairs for each of the 24 bilingual EN-X corpora. There are significant differences in the number of parallel sentences among language pairs, partly attributed to the data availability for each language, as well as to the number and size of each country's repositories which were used. For example, we were not able to mine EN-DA (English-Danish) sentence pairs from any of the five Danish repositories we experimented with, as we could not discern any patterns in their metadata record structure. The 4th column of Table 1 displays the average LASER score for each language pair. The relatively high scores reflect the high quality of the generated corpora. In the 5th and 6th columns of Table 1, the total number of words for each language in each bilingual corpus are reported.

In Table 2, the seven bilingual corpora in language pairs not paired with English are presented. These corpora are small compared to the ones reported in Table 1 because abstracts are not usually available in a third language (besides English and the native language) and when it happens it is mainly due to regional reasons. For instance, the MK-SQ (Macedonian-Albanian) collection originated from the repository of the South East European University[13] (Library "Max van der Stoel"), which include trilingual abstracts in English, Macedonian and Albanian.

The resource is related to "scientific research" and "academic writing", as evidenced by the origins of the raw data we used. After manual inspection we found that the parallel sentences cover scientific areas as diverse as economics, social sciences, medicine, informatics, mathematics, engineering, environmental studies, gender studies, history, philosophy, etc.

Although we did not conduct an analysis to determine the direction of the translation of the abstracts in our corpus, we refer the interested reader to a survey focused on the abstract writing practices of the MEDLINE corpus conducted by Névéol et al. (2020). In this survey, it was found that authors typically write abstracts in their native language first and then translate it into English, either manually or with the aid of a machine translation method (i.e. post-editing an automatic translation). It is worth noting that the aforementioned survey concerned a biomedical corpus created from abstracts of Spanish-, Portuguese- and French-speaking authors, whereas SciPar covers a wider range of scientific areas and languages. Therefore, to say that the findings of the survey in Névéol et al. (2020) also apply to the corpus described in this paper, could only be a conjecture; albeit a plausible one.

We include examples of parallel sentences from the abstracts we harvested in Table 3. The examples demonstrate the general function and style of an abstract, i.e. to present and summarize a long study in a concise manner using a formal and descriptive writing. In scientific texts, there are usually concepts and terms with varying meanings across different sub-disciplines. For example, as we can see in the first two rows (English-Slovak parallel sentences) of Table 3, the word "beam" may take different meanings; the laser beam (lúča) in physics and the structural part of a building (nosníky) in structural engineering and architecture. Similarly, in the last two rows (English-Greek sentence pairs) of Table 3, the word "derivatives" refers to mathematical derivatives (παραγώγους) in the 3rd row and to financial derivatives (παράγωγα) in the 4th row. This feature of our resource may prove especially useful in NMT systems as they are able to learn from different contexts and handle cases as in the aforementioned examples; for example, there have been applications of multi-domain architectures which predict the domain of an input sentence with pre-trained classifiers, annotate it (e.g. with a domain tag) and translate it accordingly (Chu and Wang, 2018).

[11] WikiMatrix and CCMatrix are both freely available on OPUS (Tiedemann, 2012).

[12] List of ISO 639-1 language codes: en (English), fr (French), pt (Portuguese), el (Greek), de (German), cs (Czech), hr (Croatian), pl (Polish), sv (Swedish), es (Spanish), fi (Finnish), sl (Slovenian), lv (Latvian), lt (Lithuanian), is (Icelandic), et (Estonian), nb (Norwegian Bokmål), sk (Slovak), it (Italian), hu (Hungarian), sq (Albanian), mk (Macedonian), ru (Russian), bg (Bulgarian), nn (Norwegian Nynorsk)

[13] https://library.seeu.edu.mk/

L1	L2	Sentence Pairs	Avg. score	L1 Words	L2 Words
en	bg	2,301	1.148	47,025	45,272
en	cs	1,064,384	1.190	20,942,952	17,833,886
en	de	890,184	1.149	20,216,199	18,457,056
en	el	742,986	1.155	19,534,059	19,980,967
en	es	354,459	1.184	9,236,195	10,543,904
en	et	83,478	1.144	1,773,673	1,253,635
en	fi	457,341	1.120	9,436,244	6,124,499
en	fr	1,123,121	1.178	27,771,546	31,624,558
en	hr	806,580	1.194	19,445,123	16,907,339
en	hu	27,421	1.088	495,174	400,535
en	is	110,830	1.106	2,574,566	2,198,031
en	it	31,279	1.183	856,093	916,726
en	lt	177,436	1.136	3,430,457	2,717,295
en	lv	347,472	1.176	7,457,218	5,867,501
en	mk	4,940	1.179	120,131	117,295
en	nb	56,055	1.164	1,193,905	1,088,614
en	nn	2,380	1.160	44,974	38,363
en	pl	862,075	1.185	18,957,369	15,540,882
en	pt	974,167	1.200	27,278,294	28,790,336
en	ru	3,063	1.151	56,030	47,966
en	sk	60,467	1.213	1,166,108	965,639
en	sl	300,016	1.176	6,603,118	5,873,979
en	sq	7,779	1.196	212,599	230,419
en	sv	670,815	1.185	15,398,948	13,625,108

Table 1: Composition of EN-X bilingual corpora

L1	L2	Sentence Pairs	Avg. score	L1 Words	L2 Words
de	es	268	1.202	5,283	6,227
de	fr	281	1.200	5,345	6,097
de	ru	198	1.198	3,462	3,146
es	fr	4,915	1.179	123,929	121,939
es	ru	728	1.151	15,830	11,764
fr	ru	1,333	1.144	27,711	20,570
mk	sq	3,710	1.191	99,645	110,914

Table 2: Composition of bilingual corpora which do not include English

Besides the straightforward use of parallel corpora in MT, there are also techniques, such as data augmentation and back-translation, which leverage monolingual sentences to improve the quality of NMT systems (Sennrich et al., 2015) or better adapt them to a specific domain (Mahdieh et al., 2020), e.g. that of scientific research. The monolingual parts of our corpus may prove useful for these purposes and, in Figure 3, the total number of words for each language are presented.

Source Sentence	Target Sentence
Optoelectronic sensors are detectors based on the principle of scanning the **beam** in the range or they capture image.	Optoelektronické snímače sú detektory zaloţené na princípe snímania svetelného **lúča** v príslušnom spektre či snímanie obrazu.
The main **beams** are made of welded structural upright profile.	Hlavné **nosníky** sú tvorené zo zváranej konštrukcie skriňového profilu.
The first complex potential of Kolosov–Muskhelishvili (or one of its two first **derivatives**) is used, together with optical methods for its evaluation, on the aforementioned contour.	Χρησιμοποιείται το πρώτο μιγαδικό δυναμικό των Kolosov-Muskhelishvili (ή μια από τις δύο πρώτες **παραγώγους** του), μαζί με οπτικές μεθόδους για τον υπολογισμό του, στην προαναφερθείσα καμπύλη.
Initially, an introduction to financial **derivatives** and the Monte-Carlo simulation method will be given.	Αρχικά θα πραγματοποιηθεί μια εισαγωγή στα **παράγωγα** χρηματοοικονομικά προϊόντα και στην μέθοδο προσομοίωσης Monte-Carlo.

Table 3: Examples of different word meanings in different scientific disciplines

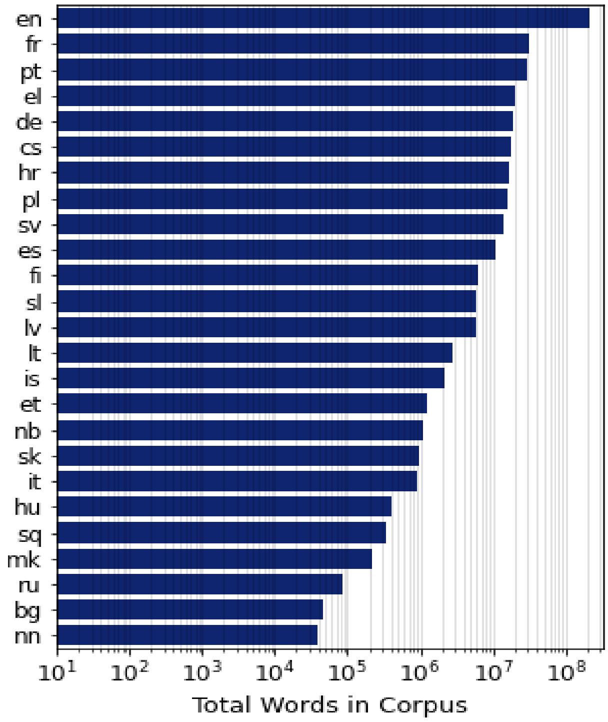


Figure 3: Total words in corpus by language (horizontal axis in log-scale)

5. License and Copyright Issues

The vast majority of the texts that we have acquired and processed in order to create this resource are provided under Creative Commons (CC) licenses. Nevertheless, we should note that although the texts of some theses and dissertations are copyrighted or do not allow derivative works, the titles and abstracts by themselves constitute freely and publicly available metadata. Therefore, the resulting resource has been made publicly available via the ELRC-SHARE repository in TMX format (link to resource), under a non-standard license.

6. Conclusion and Further Research

In this work, we presented SciPar, a new parallel resource comprising 9.17M segment alignments that were generated for 31 language pairs, based on the openly available metadata on institutional repositories, digital libraries of universities and national archives. The data are related to the broad domain of scientific research, as they originated from abstracts of various fields and sub-disciplines. We believe that the corpus can prove useful in training or adapting MT systems for scientific texts, especially regarding under-resourced languages.

In the future, we aim to further augment the resource with newly published content and to exploit it in experiments involving comparison of sentence alignment algorithms, induction of bilingual lexica, and MT domain adaptation. Furthermore, we plan to categorize the sentence pairs according to scientific sub-disciplines (e.g. physics, philosophy, medicine, sociology, etc.).

7. Acknowledgements

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Appendix: Institutional Repositories Harvested for the Creation of the Corpus

Name of Repository	URL	Name of Repository	URL
DSpace at Riga Stradiņš University	https://dspace.rsu.lv/	National Archive of PhD Theses	https://phdtheses.ekt.gr/
Malmö University Electronic Publishing	http://muep.mau.se/	Nemertes - Institutional Repository of the University of Patras	https://nemertes.library.upatras.gr/
Eldorado - Repository of the TU Dortmund	https://eldorado.tu-dortmund.de/	OpenstarTs - The institutional repository of the University of Trieste	https://www.openstarts.units.it/
Epsilon Archive for Student Projects - Swedish University of Agricultural Sciences	https://stud.epsilon.slu.se/	OPUS - Publication Server of the University of Stuttgart	https://elib.uni-stuttgart.de/
Open access publications in the SLU publication database - Swedish University of Agricultural Sciences	https://pub.epsilon.slu.se/	Pandemos - Digital Library, Panteion University	http://pandemos.panteion.gr/
Aalto University Publication Archive	https://aaltodoc.aalto.fi/	Polynoe - University of West Attica Institutional Repository	https://polynoe.lib.uniwa.gr/
Amitos: University of Peloponnese Repository	https://amitos.library.uop.gr/	PSEPHEDA - Digital Library and Institutional Repository - University of Macedonia	https://dspace.lib.uom.gr/
AMUR - Adam Mickiewicz University Repository	https://repozytorium.amu.edu.pl/	Publication System of the University of Tübingen	https://publikationen.uni-tuebingen.de/
APOTHESIS - Institutional Repository of the Hellenic Open University	https://apothesis.eap.gr/	PYXIDA - Institutional Repository of the Athens University of Economics and Business	http://www.pyxida.aueb.gr/
CRZP – Centrálny register záverečných prác	https://opac.crzp.sk/	Refubium - Freie Universität Berlin Institutional Repository	https://refubium.fu-berlin.de/
Charles University Digital Repository	https://dspace.cuni.cz/	Repositorio institucional de la Universidad Pública de Navarra	https://www.unavarra.es/academica-e
CRIS - Repository of the Lithuanian University of Health Sciences	https://www.lsmuni.lt/cris/	RepositóriUM - Institutional Repository of the University of Minho	http://repositorium.sdum.uminho.pt/
Croatian Digital Dissertations Repository - National and University Library in Zagreb	https://dr.nsk.hr/	Repository - Norwegian University of Life Sciences	https://nmbu.brage.unit.no/
Czech Technical University Digital Library	https://dspace.cvut.cz/	Repository of the Norwegian University of Science and Technology	https://ntnuopen.ntnu.no/
DABAR - Digital Academic Archives and Repositories	https://dabar.srce.hr/	Repository of the Technical University of Liberec	https://dspace.tul.cz/
DIAL.pr - Research Publications (UCLouvain, USL-B, UNamur)	https://dial.uclouvain.be/pr/boreal/	Repository of the University of Ljubljana	https://repozitorij.uni-lj.si/
Digital Library - University of West Bohemia in Pilsen	https://dspace5.zcu.cz/	Repository of UKIM - Ss. Cyril and Methodius University in Skopje	https://repository.ukim.mk/
Digital Library of National Technical University of Athens	https://dspace.lib.ntua.gr/	Repository of UOI (University of Ioannina) "Olympias"	https://olympias.lib.uoi.gr/
Digital library of University of Maribor	https://dk.um.si/	Research at Burgas Free University	http://research.bfu.bg:8080/
Digital Repository of Agricultural University of Athens	http://dspace.aua.gr/	Research Information System of the University of Bamberg	https://fis.uni-bamberg.de/
Digitala Vetenskapliga Arkivet	https://www.diva-portal.org/	Skemman - Digital Repository of 8 Icelandic Universities	https://skemman.is/
Dione - University of Piraeus	https://dione.lib.unipi.gr/	SZTE Repository of Dissertations	https://doktori.bibl.u-szeged.hu/
DSpace at University of Tartu	https://dspace.ut.ee/	TBU DSpace - Digital Library of Tomas Bata University in Zlin	https://digilib.k.utb.cz/
EMU DSpace - Estonian University of Life Sciences	https://dspace.emu.ee/	Technical University Wien Bibliothek	https://repositum.tuwien.at/
Erdélyi Digitális Adattár - Transylvanian Digital Database	https://eda.eme.ro/	Tesis Doctorals en Xarxa	https://www.tdx.cat/
E-resource repository of the University of Latvia	https://dspace.lu.lv/dspace/	Thèses-EN-ligne	https://tel.archives-ouvertes.fr/
eRIKA - Andrzej Frycz Modrzewski Krakow University's Repository	https://repozytorium.ka.edu.pl/	Trepo - Open Institutional Repository of Tampere University	https://trepo.tuni.fi/
ESTUDO GERAL - Digital Repository of the University of Coimbra	https://estudogeral.uc.pt/	UIBrepository - Universitat de les Illes Balears	https://dspace.uib.es/
Faculty of Humanities and Social Sciences Institutional Repository - University of Zagreb	http://darhiv.ffzg.unizg.hr/	UiT Munin - Open Research Archive - The Arctic University of Norway	https://munin.uit.no/
GNOSIS - Institutional Repository of the University of Cyprus	https://gnosis.library.ucy.ac.cy/	Universidade de Brasilia - Institutional Repository	https://repositorio.unb.br/
Gothenburg University Publications Electronic Archive	https://gupea.ub.gu.se/	Universidade de Lisboa - Institutional Repository	https://repositorio.ul.pt/
HELDA - Digital Repository of the University of Helsinki	https://helda.helsinki.fi/	Universidade Federal da Paraiba - Institutional Repository	https://repositorio.ufpb.br/
HELLANICUS - Institutional Repository of the University of the Aegean	https://hellanicus.lib.aegean.gr/	Universidade Federal de Santa Catarina - Institutional Repository	https://repositorio.ufsc.br/
Hirsla, Landspítali University Hospital research archive	https://www.hirsla.lsh.is/	Università Cattolica del Sacro Cuore - Doctoral Theses Archive	https://tesionline.unicatt.it/
Institutional Repository of Democritus University of Thrace	https://repo.lib.duth.gr/	Universität Wien - Universitäts Bibliothek	https://othes.univie.ac.at/
Institutional repository for peer reviewed articles published in open access and doctoral dissertations by Icelandic Universities	https://opinvisindi.is/	Universite de Montreal - Papyrus Institutional Repository	https://papyrus.bib.umontreal.ca/
Institutional Repository of the Faculty of Mechanical Engineering and Naval Architecture (FAMENA), University of Zagreb	http://repozitorij.fsb.hr/	University of Bologna - Institutional Doctoral Theses Repository	https://amsdottorato.unibo.it/
Jagiellonian University Repository	https://ruj.uj.edu.pl/	University of Debrecen Electronic Archive	https://dea.lib.unideb.hu/dea/
Karolinska Institutet Open Archive	https://openarchive.ki.se/	University of Lodz Repository (RUĹ□)	https://dspace.uni.lodz.pl/
Ktisis - Open access institutional repository of the Cyprus University of Technology	https://ktisis.cut.ac.cy/	University of Oslo - DUO Research Archive	https://www.duo.uio.no/
Lauda - University of Lapland's institutional repository	https://lauda.ulapland.fi/	University of Warsaw Repository	https://depotuw.ceon.pl/
Library “Max van der Stoel” - South East European University	https://library.seeu.edu.mk/	UTUPub - Open Institutional Repository of the Unversity of Turku	https://www.utupub.fi/
Medical Academic Repository of MU-Varna	https://repository.mu-varna.bg/	International Federation of Library Associations and Institutions	http://library.ifla.org/

Table 4: Names and links of institutional repositories harvested for the creation of the corpus