Academic Common Curriculum on Linguistic Data Science - LDS

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Acronyms List

A3ES	Agency for Assessment and Accreditation of Higher Education
CA	COST Action
EHEA	European Higher Education Area
EMDM	Erasmus Mundus Design Measures
EMJMD	Erasmus Mundus Joint Master Degree
EMLDS	European Master in Linguistic Data Science
ENQA	European Association for Quality Assurance
EU	European Union
LDS	Linguistic Data Science
LLD	Linguistic Linked Data
LLOD	Linguistic Linked Open Data
LL2DS	Linking Linguistics to Data Science
LOD	Linked Open Data
NLP	Natural Language Processing

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EXECUTIVE SUMMARY

The document outlines the collaborative efforts of members of the NexusLinguarum COST Action in crafting and presenting a proposal for an Erasmus Mundus Joint Master (EMJM) to the European Union[1]. This endeavour unfolded in two key phases. The first stage involved the development of the Linking Linguistics to Data Science (LL2DS) project, which was submitted as part of the Erasmus Mundus Design Measures program (ERASMUS-EDU-2022-EMJM-DESIGN). The aim of the LL2DS project was to establish a groundbreaking Erasmus Mundus Joint Master (EMJM), recognized globally for its innovative fusion of Linguistics and Data Science. This project led to the second phase, which involved submitting a fully designed EMJM.

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[1] The Consortium submitted an application for an EMJM grant under the title European Master in Linguistic Data Science (EMLDS, Project Number 101180353). Results are expected to be published in July 2024. This report partially reflects the submitted application to the EU.

1. Introduction

Linking Linguistics to Data Science (LL2DS) was a project funded under the Erasmus+ action Erasmus Mundus Design Measures (ERASMUS-EDU-2022-EMJM-DESIGN). It aimed at designing a new study programme at Master level in the field of **linguistic data science** (LDS). The project duration was from 01/11/2022 to 29/02/2024.

As a result of the activities of the LL2DS project, a proposal was elaborated for a *European Master in Linguistic Data Science* (EMLDS), a 120 ECTS English-language programme awarding a Joint Degree. Based on the collaboration amongst four European universities and their associated partners, the European Master in Linguistic Data Science master aims at providing a novel approach to linking Linguistics to Computer Sciences and Data Science in terms of its methodology, scientific content, pedagogical approach, and curricular structure. The EMLDS proposal, submitted on 14/02/2024, is currently under evaluation by the European Commission.

Both initiatives arose from the collaboration generated within the COST Action CA18209 - European Network for Web-centred Linguistic Data Science (NexusLinguarum). One of the main goals of the Action was *to work out a curriculum for a Europe-wide master degree that the participating institutions could adopt to train a new generation of researchers in the area, thus introducing linguistic data science in a cross-discipline academic infrastructure*. The LL2DS project and the EMLDS proposal constitute the practical realisation of this endeavour.

2. Motivation for a common curriculum on Linguistic Data Science

The main goal of this COST Action, as stated in its Memorandum of Understanding (MoU), is to "promote synergies across Europe between linguists, computer scientists, terminologists, language professionals, and other stakeholders in industry and society, to investigate and extend the area of linguistic data science." LDS is considered by the community as a subfield of Data Science (DS), with Linguistics playing a key theoretical and methodological role in the extraction of both structured and unstructured knowledge from language resources, thereby facilitating its organisation, representation, and sharing at different levels of analysis (e.g. morphological, lexical, semantic, syntactic).

In addition to Linguistics, related areas such as computational linguistics, corpus linguistics, data modelling, natural language processing (NLP), artificial intelligence, and deep learning, are also critical in LDS, supporting the in-depth processing and encoding of considerable amounts of linguistic data while ensuring its (re)usability in multilingual applications, as well as in different domains (e.g. eHealth, digital humanities, lexicography, finance). Building on complementary initiatives such as the H2020 ELEXIS and Prêt-à-LLOD projects, as well as the ERC-awarded LiLa project, NexusLinguarum has been working on modelling, interlinking, evaluating, and enriching multilingual language resources to make them available to academia, industry, other institutions, and citizens in general, in a machine-processable way, thus contributing towards the development of an ecosystem where knowledge can be linked and shared, in open access, across languages and domains.

In order to address the ongoing challenges of semantic interoperability while preserving - and fostering - linguistic diversity, this growing LDS community has been focusing on the development - and enhancement - of standards and best practises, in line with the FAIR principles[2]. To further strengthen this community's contribution to the linguistic digital landscape, especially - though not exclusively - in Europe, it is paramount to provide formal education programmes within the scope of the Linguistic Linked Open Data (LLOD) paradigm, aimed not only at new generations of researchers but also at people who wish to retrain in complementary or other related fields. Given the multidisciplinary nature of LDS, and the pivotal role of languages and linguistic resources towards a more empowered, active, and digitally-literate society, it is believed that the profiles emerging from the new Master study programme would be highly sought after, both in academia and outside of it. Furthermore, such new studies would contribute to stabilise and internationalise curricula and teaching practises in an innovative research area, with a promising - and flourishing - community.

There is high potential in LDS as a research field, given its cross-disciplinary framework and cutting-edge nature, aiming to respond to contemporary challenges. In addition, its impact outside of academia cannot be underestimated, especially given the increasing number of business sectors - and applications - that rely on multilingual and semantically interoperable linguistic data.

3. Linking Linguistics to Data Science - LL2DS

The general objective of the LL2DS project was the design of a fully integrated Erasmus Mundus Joint Master (EMJM), delivered by a consortium involving the NOVA University of Lisbon (Portugal), the Università Cattolica del Sacro Cuore of Milan (Italy), the University of Zaragoza (Spain), the University of Galway (Ireland) and the National Institute for Research in Digital Science and Technology – INRIA (France). During the process, other European and non-European universities and institutions were invited to join the consortium to provide additional skills identified as being fundamental to completing the curriculum.

By providing students with a set of interdisciplinary, as well as intercultural competences, the Master programme to be designed within the scope of the LL2DS project intended to train (academic and non-academic) profiles that are - and will increasingly be - in high demand in the job market, thereby fostering youth employment and, on the other hand, allowing graduates in other areas to find complementary training or the opportunity to redirect their professional pathways. Supported by an ecosystem where multilingual language resources are combined with NLP and Linked Data, thereby contributing to making linguistic data available to everyone, the LL2DS project and the projected Master programme are in line with some of the priorities defined by the European Commission for the 2019-2024 agenda, namely Priorities 2 (A Europe fit for the digital age) and 3 (An Economy that works for people).

In addition, all the partners involved in this project have demonstrated a relevant track record in the LDS field, leading funded H2020 and ERC projects (such as ELEXIS[3], Prêt-à-LLOD[4] and

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[2] https://www.go-fair.org/fair-principles/
[3] www.elex.is
[4] https://pret-a-llod.github.io/

LiLa[5], referred to in the previous subsection) and international networks like ENeL and NexusLinguarum, one of the biggest COST Actions in what concerns both the overall number of participants and the number of countries involved. Furthermore, the LL2DS partners have coordinated various dissemination and advanced training initiatives in this field, namely the Lisbon Summer School in Linguistics, the biennial Conference on Language, Data and Knowledge (LDK), the TOTh Conference, Training and Workshops[6], the Datathon on Linguistic Linked Open Data or the PROPOR 2022 - International Conference on the Computational Processing of Portuguese. Special emphasis should also be given to the participation, by NOVA CLUNL, in the PORTULAN-CLARIN infrastructure, an example of the importance of multilingual language resources - also in what concerns under-resourced languages - and how such multilingual work is perceived as one of the pillars of the LL2DS project.

This expertise can help foster international contacts across academia and particularly in industry, which can be quite relevant in the design of the curricular plan, as well as in the hosting of internships. Overall, students from the Erasmus Mundus Master to be proposed could greatly benefit from such international networks, across disciplines and communities, and also from the multilingual environment and resources available. The focus on mandatory student and staff mobility is also an added value of this programme, and could help recruit students with a top-level profile.

Ultimately, LL2DS's specific objectives were as follows:

1. to build the foundation for a Pan-European Master degree in the field of LDS;
2. to strengthen LDS as a research field, with strong emphasis on its interdisciplinary basis;
3. to consolidate an interdisciplinary consortium with leading partners in LDS;
4. to develop a solid, yet diversified, curriculum in this area, providing students with essential scientific, technological, and intercultural skills;
5. to design measures aimed at the international mobility of both staff and students;
6. to design a set of rules for the student admission, monitoring, and evaluation;
7. to synchronise the partners' efforts for the accreditation of the planned Pan-European Master degree and for the promotion of these studies.

The project coordination was attentive to the principles of transparency and good management, as well as to the remarks made by the European Commission in the evaluation report.

The Programme Guide for the 2024 Erasmus+ call outlines a series of expected deliverables that applicants are advised to incorporate into their applications. Consequently, we have chosen to prioritise these deliverables as the main subjects to be addressed in this report. Deliverables related to LLD2S, can be accessed on the Funding & Tenders platform.

Although NOVA was the designated beneficiary of the LLD2S project, the partners have united to form a cohesive consortium aimed at accomplishing the objectives outlined in the application. Each partner has identified its administrative contact points and validated the staff

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[5] https://lila-erc.eu/#page-top
[6] https://toth.condillac.org/training

members assigned to the project. Furthermore, the selection and invitation of associated partners were thoroughly deliberated and unanimously approved by all consortium members. The Periodic Report was submitted to the European Commission in due time. The Consortium is dedicated to securing full accreditation for the program at the European level, facilitated through the European Association for Quality Assurance in Higher Education.

LL2DS required the submission of five deliverables: 1) website, 2) competitive audit and survey analysis, 3) intermediate report, 4) curriculum design, and 5) final report. As 3) and 5) are internal management outputs, 1), 2) and 4) are those transferrable to the implementation of the European Master in Linguistic Data Science (EMLDS). A Student Agreement Draft and a Partnership Agreement Draft were elaborated and are part of the Final Report.

The Consortium's original composition has undergone a slight change, now consisting of four universities: NOVA, UNICATT, UoG, and UNIZAR. INRIA remains an Associated Partner, along with the University of Aveiro and Lexicala by K Dictionaries. External partners, whether academic or industrial, have agreed to collaborate with the consortium either as invited teachers or by offering internships to students. So far, we have garnered support from the following academic partners: Universidad Politécnica de Madrid (Spain), Charles University (Czech Republic), and industrial partners: Priberam (Portugal), Unbabel (USA), Datrix (Italy), and Semantic Web Company (Austria). The number of external partners is expected to increase gradually over time.

In February 2024, we submitted:
1. The full proposal
2. The proofs of accreditation
3. The partnersip agreements
4. The student agreements
5. The diploma proposal
6. The list of previous project of the consortium
7. The Budget
8. The EMLDS Website: https://emlds.fcsh.unl.pt/
9. Competitive Audit and Survey Analysis

4. The Competitive Audit and Survey Analysis

4.1. The survey: general presentation

The survey[7] that underlies the competitive audit and survey analysis was analysed and approved by the Research Ethics Committee of the Faculty of Social Sciences and Humanities of NOVA University Lisbon.

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[7] https://clunl.fcsh.unl.pt/wp-content/uploads/sites/12/2023/05/x00y_survey.pdf

The participation in this survey involved answering 3 questions on knowledge areas, specific skills and competences, existent and foreseen job offers, challenges and difficulties, availability to host internships, and contributions to the different areas of activities. The 3 specific questions will depend on your stakeholder profile, as described below:

     i. Potential employer: relevant knowledge areas, specific skills and competences, existent and foreseen job offers, challenges and difficulties from the perspective of industry, availability to host internships.

     ii. Academic: relevant knowledge areas, specific skills and competences, existent and foreseen job offers, challenges and difficulties from the perspective of the academy, contributions to the different areas of activities.

     iii. Potential student: relevant knowledge areas, specific skills and competences, job expectations, challenges and difficulties.

The survey was disseminated to potential stakeholders: academics, potential students and potential employers.

4.2. The Competitive audit and survey analysis: general presentation

The survey analysis contributed to the integrated competitive audit, which merged the survey results with a market study on existing master's programs in related subjects.

We enlisted a company to perform the competitive audit and survey analysis. We consider this essential for aligning the curriculum design with both student needs and market demands. The study is divided into three parts:

1. Comparative analysis of the current educational offerings provided by European and North American institutions in the field of linguistic data science
2. Presentation of survey results involving academics, prospective students, and potential employers, offering valuable insights into the interest and opportunities surrounding the program.
3. Tracing the career paths of linguistic data science master's program graduates and pinpointing potential employers in the field.

The study ends with a synthesis and conclusions drawn from its findings.

NOTE: Regarded by the EU as a sensitive document, the results of the study will be accessible after the evaluation process.

5. European Master in Linguistic Data Science – EMLDS

5.1. General presentation

EMLDS has three different objectives:
   a. to increase the competitiveness of linguistics, computer science and data science as disciplines, by firmly linking them to the shifting demands of the academic and professional job market, specifically the growing need for accurate, accessible, and inspiring knowledge;
   b. to strengthen linguistic data science as an educational and research field, given its cross-disciplinary framework and cutting-edge nature, aiming to respond to contemporary social and technological challenges;
   c. to equip students with the methodological and critical instruments to assess fundamental technical, ethical and political implications of linguistic data science at the local, national, regional, European and global levels.

In pursuit of these objectives, we developed a two-year program structured into four components:

   a. Induction Days
   b. Coursework in Semester 1 and Semester 2,
   c. Thematic training sessions and orientation seminar in Semester 3, to be held on a rotating basis by each of the Consortium members, and
   d. Master dissertation, internship with report or project in Semester 4, in the university of the student's choice.

Students will also have the possibility of attending Portuguese, Spanish, Irish and Italian courses during the semester they are at NOVA, UNIZAR, UoG or UNICATT, respectively.

5.2. Courses and semester distribution

Students can follow four different mobility paths, as described ahead in the "curriculum design" section. Each path has its own curricular specificities and its own balance of the involved scientific areas, so the student can choose the path that accommodates best to their background and interests. Mobility paths are proposed by each candidate at application stage and are afterwards confirmed by the Joint Admissions Committee.

Figure 1: EMLDS - Mobility paths

5.3. Academic schedule and semester structure

The program is divided into four semesters. Each course is assigned to one or more scientific areas: Linguistics (LI), Computer Science (CS), Data Science (DS), Other (O).

The curriculum design of the EMLDS is aligned with the European Commission's objectives for the Erasmus Mundus Initiative: to increase the attractiveness and excellence of European higher education in the world and to attract talent to Europe. The EMJM paves the way for institutional academic cooperation to display European excellence in higher education and promotes individual mobility for all students, with EU-funded scholarships for the best candidates. The close relationship between academia and industry contributes to the consolidation of the knowledge-based economy and society, as well as to the improvement and diversification of the profile of professionals in the field of Linguistic Data Science.

EMLDS includes compulsory physical mobility for all enrolled students consisting of a minimum of two study periods in two countries. These two countries must be different from the country of residence of the student at enrolment stage. Each of the two mandatory study periods must correspond to a workload of at least one academic semester (30 ECTS credits or equivalent). The rest of the study periods can be freely organised. Compulsory mobility periods cannot be replaced by virtual mobility (distance learning).

When submitting their application to the master's programme, candidates will have the opportunity to choose where they will start their studies. Students interested in starting their studies with a strong component in the field of Linguistics can choose to begin Semester 1 at

NOVA or UNICATT, and then attend Semester 2 at UNIZAR, where the curriculum structure is more focused in the scientific area of Computer Science. If students want to start their studies in UoG, they will invest stronger in the field of Data Science, and they should attend the Semester 2 at NOVA or UNICATT. The examination period of the first semester will occur in December/January. The examination period of the second semester will be held in June/July.

All students will be required to attend the Welcoming week, consisting of three induction days, which comprehend three modules: *Fundamentals of Linguistics*, *Fundamentals of Computer Science* and *Soft Skills and Motivation*. The hosting of these days will be secured by NOVA in 2025, by UNICATT in 2026, by UoG in 2027 and by UNIZAR in 2028. In the EMLDS's second edition, these will also be the hosts of the Datathon in Semester 3 and both the Induction Days and the Datathon will occur in the same week, providing an opportunity for 1st-year and 2nd-year students to meet and cooperate. If a student is not starting his/her path in the university that hosts the Welcoming week and has not the means to travel there, he/she can attend the three modules online, as they will be offered in a blended learning model.

Semester 3 is reserved for attending in-depth thematic seminars and, in combination, will make up the Autumn School. This school will include guest lecturers from industry and partner universities, whose travel, subsistence, and remuneration costs will be covered by the EMJM project, in the event that the EMLDS is approved under the EMJM programme. During Semester 3, students will attend the Orientation Seminar, where they will have access to scientific, methodological and educational resources to decide on the topic they will work on in Semester 4 (corresponding to the Non-Curricular Component. Semester 3 will be organised in a rotating basis in each Consortium member institution, under the following scheme:
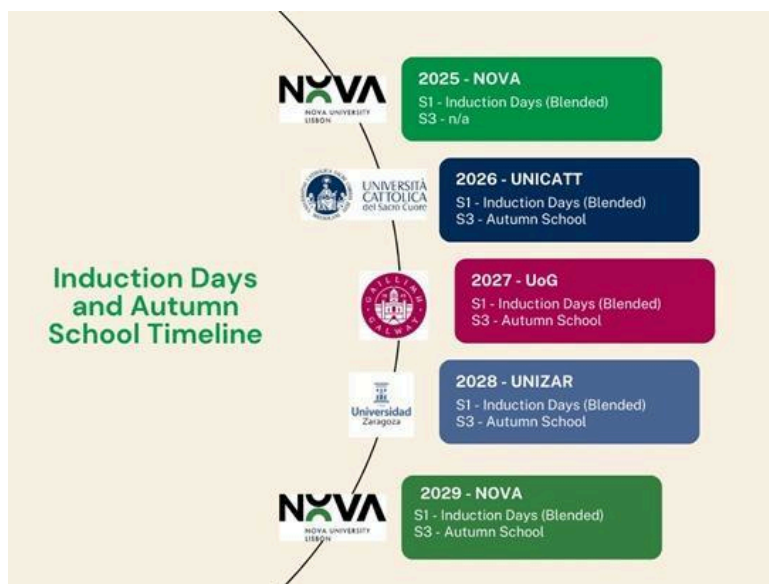

Figure 2: Induction days and Autumn School timline

In Semester 4, students will do an internship in one of the programme's partner companies/institutions or in another institution agreed upon by their supervisor, as well as complete the non-curricular component, which will lead to the master's degree achievement.

Semester 4, for each student, must take place at their supervisor's affiliation institution. The combination of research work and internships in partner organisations will provide EMLDS master's graduates with diversified scientific, technical and soft skills necessary for their future academic and professional lives.

From the moment of enrolment until the end of the study cycle, the EMLDS student will be enrolled in the four partner universities of the Consortium for all semesters and will, finally, obtain a joint diploma from these institutions.

All paths assure a minimum of 28 ECTS in the main scientific areas of the degree - linguistics, computer science and data science -, regardless of the options chosen by the students. Students can, thus, focus on the areas of their preference without compromising a solid base training in the three main scientific areas relevant for the field of linguistic data science.

5.4. Award of the degree and Joint Recognition

Students who obtain 120 ECTS as part of the approved programme of study, with at least 60 ECTS obtained in the first year, and successfully defend their master's dissertation, internship report or project, are eligible to be awarded a Joint Degree from NOVA, UNICATT, UoG and UNIZAR.

The Consortium members reserve the right not to issue the Degree if the student has not fulfilled all obligations to the Consortium, financial or otherwise. This right is reflected in the terms and conditions of the Student Agreement, signed upon enrolling in the program. The Consortium must endeavour to mitigate the circumstances of the debt arising and the sanctions being enforced.

The diploma is issued together with the academic transcript of records.

Students who are not eligible to be awarded the master's degree will not receive a lower degree award. Students who do not receive the master's degree can obtain a transcript of the courses and grades received. The individual Consortium members may also issue a certificate of attendance in line with their internal regulations and can also consider the credits received during this program toward the completion of their own degree programs.

5.5. Curriculum Structure

As described in the 'Academic schedule and semester structure' section, students can choose where to start their studies, according to 4 paths: i) semestre 1 in NOVA + semester 2 in UNIZAR; ii) semestre 1 in UNICATT + semester 2 in UNIZAR; iii) semestre 1 in UoG + semester 2 in NOVA; or iv) semestre 1 in UoG + semester 2 in UNICATT. The third semester offers in-depth thematic seminars, with the participation of guest lecturers from industry and partner universities, and the Orientation Seminar, in which students will have access to scientific, methodological and educational resources to decide on the topic of their non-curricular component, to be completed in semester 4. Students can opt on one among three possibilities:

dissertation, internship with report or project, according to their scientific and professional choices. The Orientation Seminar will provide guidance regarding these choices, as well as the choice of the university where the semester will take place.

Internships and projects will occur in approved host institutions/companies, as the Associated Partners or in External Partners of the EMLDS, contributing to the diversification of the profile of professionals in the field of Linguistic Data Science and demonstrating the relevance of the close relationship between academia and industry for the consolidation of the knowledge-based economy and society.

Scientific areas

Scientific Area Path1: NOVA/UNIZAR	Initials	Mandatory ECTS	Minimum Optional ECTS
Linguistics	LI	40.3	12.5
Computer Science	CS	32.8	7.5
Data Science	DS	23.8	25
Other	O	8	0
Total ECTS		105	45

Table 1: ECTS distribution in Mobility Path 1 (NOVA/UNIZAR)

Scientific Area Path 2: UNICATT/UNIZAR	Initials	Mandatory ECTS	Minimum Optional ECTS
Linguistics	LI	32.3	7.5
Computer Science	CS	48.8	2.5
Data Sciences	DS	27.8	5
Other	O	14	0
Total ECTS		123	15

Table 2: ECTS distribution in Mobility Path 2 (UNICATT/UNIZAR)

Scientific Areas Path 3: UOG/NOVA	Initials	Mandatory ECTS	Minimum Optional ECTS
Linguistics	LI	32.8	5
Computer Science	CS	27.8	10
Data Sciences	DS	36.3	10
Other	O	13	0
Total ECTS		110	25

Table 3: ECTS distribution in Mobility Path 3 (UOG/NOVA)

Scientific Areas Path 4 UOG/UNICATT)	Initials	Mandatory ECTS	Minimum Optional ECTS
Linguistics	LI	33.8	3
Computer Science	CS	30.8	3
Data Sciences	DS	36.3	6
Other	O	13	6
Total ECTS		114	18

Table 4: ECTS distribution in Mobility Path 4 (UOG/UNICATT)

NOTE: The EMLDS proposal is under evaluation by the European Commission at the time of writing. Owing to that, the detailed curriculum cannot be disclosed at this stage, along with

other specific details of the proposal, but they will be fully accessible after the evaluation process (in case of acceptance).

6. Impact and ambition

Currently, the field of Data Science has gained a lot of popularity, mainly due to the need of analysing the explosion of data available on the Internet and the relevance of data for the development and success of ICT technologies. However, even though data science includes language processing, very often data scientists treat textual data like a stream of characters, ignoring its linguistic properties. The delivery of a Europe-wide master's degree focused on Linguistic Data Science can have a significant impact on this approach and on the results it enhances. This EMLDS will train a new generation of data scientists who are able to make better use of the language data they have available, not ignoring the linguistic richness of the datasets. This new generation of researchers and practitioners will have a privileged view that will enable new understandings of topics in fields as diverse as literature, social sciences, biomedicine or linguistics. By breaking the silos of existing data storage and analysis, new interactions between a range of different research disciplines will be promoted. This will result also in lowering language barriers across Europe (and beyond), which will also have an impact in other societal challenges in the long run, such as increased cultural and scientific exchange, and increased flow of professionals across borders. As previously stated, with this ambitious programme, we will crucially contribute to the main objectives of the Erasmus Mundus:

a. the enhancement of quality in European higher education;
b. the promotion of the European Union as a centre of excellence in learning around the world;
c. the promotion of intercultural understanding through cooperation with third countries as well as for the development of third countries in the field of higher education.

7. Sustainability

Data science is in high demand in the market and it is predicted to continue to grow exponentially in the future, with an estimated Compound Annual Growth Rate (CAGR) of 13.2% from 2021-28. Linking linguistics to data science is critical in the current global world we live in, since it enables us to identify various types of patterns and to analyse language data to a level of detail that was simply not possible before. Hence, in terms of medium/long-term strategy, EMLDS will continue after the EU funding period, redesigning and adapting itself as the study field is extremely permeable to societal evolution.

The **first priority is to establish EMLDS as a brand**, bringing and monitoring its visibility on a regular basis. As a brand, the master will more easily reach companies, universities and families, therefore potentiating the number of applicants for self-funded slots.

The **second sustainability priority** is to prospect new funding sources for EMLDS, namely for scholarships, via public or private funding, with the objective of supporting exploring other funding instruments during EMLDS duration. Self-funded students are vital for EMLDS

continuation. EMLDS is committed to developing a strategy to reach self-funded excellent students worldwide. The added-value of the programme will be made clear in its communication and employability results. The Consortium commits to implement the dissemination strategy and to establish assiduous communication with applicants who will be self-funded students in order to inform them on the available alternatives

The **third priority is to properly enhance the network of alumni and corporate partners**. If duly engaged, alumni will be the most relevant ambassadors of the programme, as the organisations where they work will expectedly look for candidates with the same kind of academic path. EMLDS will strengthen its ties with labour market actors by sharing with them the added value of the EMLDS before its kick-off and during its implementation. Industry representatives will be invited to participate in classes, thus strengthening the relationship with EMLDS students. The global relevance of the programme will be an asset. EMLDS will be recognised worldwide as a European programme rooted in cutting-edge research, conducted by renowned and experienced teachers and delivering excellent education to students who will perform successfully at the academic and professional level.