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Innovation Report and planning for the next period 2



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AUTHOR(S)	Saverio Barabuffi (SSSA), Yijiang Fan (SSSA), Andrea Piccaluga (SSSA), Giulio Ferrigno (SSSA), Enrico Marcazzan (SSSA)
CONTRIBUTOR(S)	Rajesh Sharma (UT), Kalev Koppel (STACC)
EDITOR(S)	Valerio Grossi (CNR)
REVIEWER(S)	Beatrice Rapisarda (CNR), Todor Galev (CSD)
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EXECUTIVE SUMMARY

This deliverable provides the overview of activities that have been undertaken by SoBigData partners towards the spreading of entrepreneurial skills and mind-set among students, researchers and professors.

All activities aimed at training future entrepreneurs were divided into three sections. The first one is devoted to the students through the Master in Big Data Analytics & Social Mining at University of Pisa. The second is aimed to describe the involvement of SoBigData in the Contamination Lab project, also open to PhD students. The third describes the link with the business world through Challenge Us (both in its 2021 edition and in the planning phase of the 2023 edition). Analysing the skills of SoBigData partners, in Appendix A.1 it is shown (1) specific programs which have been tailored to participants with background in management or in computer or data science, (2) multidisciplinary courses and various events organised by the partner to spread an entrepreneurial mind-set, and (3) information about support activities provided by partners' incubators and acceleration programs for projects and start-ups created by students and researchers. Appendix A.2 shows the evaluation index of the firms participating into Challenge Us 2021 competition.

DISCLAIMER

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SoBigData++ strives to deliver a distributed, Pan-European, multi-disciplinary research infrastructure for big social data analytics, coupled with the consolidation of a cross-disciplinary European research community, aimed at using social mining and big data to understand the complexity of our contemporary, globally-interconnected society. SoBigData++ is set to advance on such ambitious tasks thanks to SoBigData, the predecessor project that started this construction in 2015. Becoming an advanced community, SoBigData++ will strengthen its tools and services to empower researchers and innovators through a platform for the design and execution of large-scale social mining experiments.

This document contains information on SoBigData++ core activities, findings and outcomes and it may also contain contributions from distinguished experts who contribute as SoBigData++ Board members. Any reference to content in this document should clearly indicate the authors, source, organisation and publication date.

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GLOSSARY

EC	European Commission
EU	European Union
H2020	Horizon 2020 EU Framework Programme for Research and Innovation

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1 Relevance to SoBigData++

SoBigData is a research infrastructure (RI) for ethic-sensitive scientific discoveries and advanced applications of social data mining to the various dimensions of social life, as recorded by "big data". Although SoBigData is primarily aimed at serving the needs of researchers, the openly available datasets and open-source methods and services provided by the new research infrastructure will also impact industrial and other stakeholders. To widen the project impact beyond the scientific communities, various training activities were organised for students, researchers and professors of the SoBigData partners. This set of activities helps to reach other researchers and students of partner organisations and universities and widen the impact of Task 5.3 "Entrepreneurial skills for big data entrepreneurs" beyond the SoBigData project.

In addition, the Challenge Us program provides free consultancy services to firms interested in exploiting the potential of their own data, thus helping the interaction of the consortium with the industrial world. The implementation of the Challenge Us - 2021 program was re-scheduled and the results from the first call for applications were announced in mid-July 2021, while the final event was hosted by Sant'Anna School of Advanced Studies on November 22. The current document includes the Challenge Us statistics and results.

1.1 Purpose of this document

The purpose of this document is to demonstrate the contribution of each SoBigData partner in the development of entrepreneurial skills and mind-set among students and researchers. Moreover, this report provides information on partners' support activities that help participants to develop entrepreneurial ideas into start-ups. In addition, it highlights how the Challenge Us program has been organised.

1.2 Relevance to project objectives

Task 5.3 contributes to the creation of an interdisciplinary community of social data scientists by leveraging entrepreneurial training courses and materials, offered by partners to spur the entrepreneurial mindset among students and researchers. The Challenge Us program serves as a hotspot which facilitates interaction with the external industrial world.

1.3 Relation to other work packages

Task 5.3 interacts with three tasks within the WP4 NA3 - Training, and namely tasks T4.1 - Online Training Modules, T4.2 - Summer schools, T4.3 - Datathons. It also interacts with WP3 for the communication and promotion of the program.

1.4 Structure of the document

This report is divided into 6 different sections and 2 final appendixes:

- Section 1 consists of an introduction and highlights the main purpose of this document and its relevance to the SoBigData project.
- Section 2 is devoted to the description of the involvement of SoBigData project in the programme of the Master in Big Data at Pisa University.
- Section 3 analyses the involvement and outcomes of SoBigData into “Contamination Lab”.
- Section 4 reports the project proposals in which SoBigData is involved to engage industries, policy makers and public bodies.
- Section 5 analyses the Challenge Us – 2021 and reports the subsequent planning process of Challenge Us – 2023.
- Section 6 provides final thoughts and conclusions.
- Appendix A1 provides training activities, courses and events organised to spread entrepreneurial skills and facilitate the creation and development of start-ups.
- Appendix A2 the evaluation indexes of Challenge Us – 2021.

2 Master in Big Data Analytics & Social Mining

SoBigData++ is the main contributor of the Master in Big Data Analytics & Social Mining at University of Pisa¹. The goal of the Master is to train future data scientists in a multidisciplinary environment. The developed professional skills will permit the students to appropriately collect and analyse big data to obtain knowledge useful for decision-making processes and to develop innovative services, without forgetting the ethical and legal implications of the use of big data.

The challenge of this type of training is solved considering together technological competences, analytical tools, narratives and ethics, stimulating a multidisciplinary approach: data mining and machine learning, data analysis and visualization, complex systems and network analysis, computational sociology and social simulation, ethics, computational sociology and social simulation, ethics, data journalism and storytelling, are the main disciplines for a (responsible) future data scientist. Moreover, the training is completed by the involvement of the students into real-case projects and business.

In particular, the courses of the Master are the following:

“Advanced topics in network science, “Allineamento”, Big Data Ethics, Big Data for Society, Big Data sources, crowdsourcing and crowdsensing, Data driven innovation, Data Management for Business Intelligence, Data Mining & Machine Learning, Data Visualization and Data Journalism, Deep Learning, Deep Learning for Multimedial Retrieval & Analysis, High Performance & Scalable Analytics, NO-SQL Big Data Platforms, Information Retrieval, Social Network Analysis, (Statistical and Neural Machine Learning for Text Analysis in the 2020/2021 edition), Statistical Methods for Data Science, (Text analysis & Web Mining in the 2021/2022 edition), Time Series and Mobility Data Analysis, (Web Mining in the 2020/2021 edition) and the internship programme.”

The Master follows two directions. The first is called “Open Lab”, a lab open to students for experiencing the methods learnt during classes, in which they can develop a multidisciplinary approach, provided by a tutor. The second is called “Teaching session”, devoted to specific course activities.

So far, the 82% of the past students work in the field of data analysis, in particular in the following areas:

- insurance
- research
- telecommunication
- marketing
- mobility and other analysis-related contexts.

¹ Link to 2023 edition: <https://masterbigdata.it/en>

3 Contamination Lab: PhD+ and CYB+

During 2021 and 2022, SoBigData++ collaborated with the “Contamination Lab” (in particular with the “PhD+” and “Create Your Business+ - CYB+”, programmes), a project of the University of Pisa (in collaboration with Scuola Normale Superiore, Sant’Anna School of Advanced Studies and IMT School for Advanced Studies Lucca) that aims to promote and disseminate the culture of entrepreneurship and innovation, the valorisation of one's own ideas and interdisciplinarity. This project allowed participants from different disciplinary backgrounds to get to know each other and work together on common projects, acquiring planning, organisational and communication tools and skills (<http://contaminationlab.unipi.it/>).

In 2021, the lab was executed into three different lines, called “PhD+”, “CYB+”, and “Soft Skills for tomorrow enterprises”. In particular, SoBigData collaborated with both “PhD+” and “CYB+”. “PhD+” is the University of Pisa's programme aimed at promoting and encouraging entrepreneurship and innovation among undergraduate students, PhD students, and lecturers. It consists of a series of interactive and engaging seminars, plus coaching and mentoring activities on entrepreneurial projects led by international experts in the field of innovation and technology transfer (<http://contaminationlab.unipi.it/phdplus-2022/>).

In 2021 edition there were 128 participants. “CYB+” is the advanced program of the lab, aimed to strengthen the process of building and developing of innovative enterprise projects. In 2021 edition there were 67 participants. The big data-related proposed potential projects in “CYB+” were:

- Kronos – a web platform that supports firms in selecting optimal strategies by using artificial intelligence and machine learning;
- Spesiamo – a mobile app for instant price comparison of supermarket products.

In 2022, “PhD+” was followed by 159 participants, whereas “CYB+” by 39. The big data-related proposed potential projects in “CYB+” were:

- AccioMarket – mobile app for online shopping in automatized grocery stores;
- Liquid Brain – portable machine vision AI platform based on data-driven approach and continual learning.

Moreover, “Contamination Lab” was central in the development of a spinoff called “Continualist”, an innovative startup that creates AI radical technologies to solve AI-software systems’ problems that require human, budget and time resource-consuming (<https://www.continualist.com/>).

4 Project proposals to engage industry, policy makers and public bodies

We report three project proposals where SoBigData++ was involved during 2021 and 2022. The project proposals focus on engaging industries, policy makers and public bodies (as part of the T5.1). In particular, the strategy is to participate in those projects as service providers for the development and the experimentation of real cases. The proposal projects in which SoBigData++ was involved are Project Idemera, Project ROSA and Project GreenDIGIT. In the following subsection, we report the details of these proposal projects.

4.1 Project IDEMERA

Project IDEMERA is part of the Restart and Transition Plan of the Belgium Federal Government to boost the emergence of promising RI within Federal Research Institutions. SoBigData++ collaborates with Sciensano (<https://www.sciensano.be/>), a Belgian public research institution with legal personality established in 2018, to build reliable, accurate and robust datasets on food consumption and risk assessment of food.

The project abstract is reported in the following:

“Research infrastructure unit for integrated Data Mining and Data Analytics for facilitated exposure and risk assessment of food in the EU Over the past decades, an exponential rise and wide scale availability of information in the form of diverse data types have been observed across all scientific domains. Despite an ever-increasing pool of data, efficient and robust Data Analytics that is multidimensional and concerns multi-criteria, remains under-addressed in the domain of food. Reliable and robust data for the purposes of food exposure and associated risk assessment remains largely unaddressed at both national and European level. To ensure reliability and accuracy in assessments, a strategic selection of a representative set of food & commodities and their (semi-)automated classification that is both transparent and has high representativeness, is crucial. There are single solution tools to calculate risk exposure that utilize simple statistical building models (e.g., Monte Carlo Risk Assessment or MCRA). However, such solutions focus only on a limited and specific set of values that do not address the entire data lifecycle. Such limitations pose serious roadblocks to the correct interpretations of hazards and exposure risks originating from food.

Furthermore, policymakers and control agencies base their decisions on risk assessment data to design and update standards/policies that are implemented in the interests of human health. Therefore, they should have access to the most reliable, accurate and robust datasets and analyses. At an (inter)national level, Big Data Analytics & environmental exposure assessment does exist at a research infrastructure (RI) level (e.g., EIRENE-RI). In the case of food consumption and risk assessment, this does not exist. In this emerging RI unit, our objective is to develop an integrated platform for Data Mining and Data Analytics for facilitated exposure and risk assessment of food in the EU. By means of a collaboration with an emerging ESFRI-RI (SoBigData RI) and FoodCASE (Premotec GmbH), we will design and implement an e-RI unit, which will be based on European guidelines (ESFRI and EOSC).

The complete data lifecycle will yield services that will integrate Open Access databases (food consumption, products), data analysis methodologies and risk assessment modelling on (non-)food consumer products. IDEMERA will enable the customized selection of data (e.g., collection of occurrence data on diverse risks such as contaminant, illegal food additives, etc.), advanced data & information visualization capabilities (e.g., based on food origin, automated encoding in food classification systems such as FoodEx2, etc.) by employing methods in data mining, Big Data Analytics & Machine Learning. Diverse target user groups (researchers, food business operators (FBOs), food control/inspection agencies, consumers) will be addressed for an interdisciplinary assessment of aggregated risks to health. Sciensano had previously developed a strategy for the identification of relevant selection criteria and scoring system for commodities' ranking for a representative sampling methodology in case of food data. This strategy employs simple programming that enables specific selection of samples that is limited to the immediate research needs of a given project. Extrapolation of these methods is usually not possible and therefore a need to improve/expand the methodology has already been identified. With the help of this project, we will aim to further strengthen these approaches using robust large-scale data science methodologies, like multi criteria decision analysis (MCDA).

The first prototype of this methodology will be developed as a test case within the framework of SoBigData RI. In the test phase, the developed methodologies (or services) will be provided to a specific subset of users to test out usability, efficiency, access procedures and for consequent calibration of the prototype. Sciensano's in-house expertise in data procurement, risk assessment & experience with EFSA tools (FAIM, FEIM, DietEx, etc.), coupled with e-infrastructure from Premotec GmbH & high-performance computing from SoBigData RI, will support the development of aggregated data systems for exposure and risk assessment data analytics. The subsequent services will provide a 'one-stop' solution for target users interested in data on food consumption and risk assessment. The outputs will be periodically revised and updated to keep the e-RI unit sustainable, relevant and aligned with ESFRI and EOSC objectives. IDEMERA will additionally collaborate with EOSC, EuroFIR & METROFOOD-RI to contribute to wide access, support EU science, and fulfill standards of FAIR data."

SoBigData RI budget: the RI supports this action as part of the original mission of engaging communities and will not receive extra funds.

4.2 Project ROSA

Project ROSA is developed by a consortium of EU Institutions, European public and private research centres, and European industries² to build a framework for environmentally sustainable Artificial Intelligence.

² European Science Foundation, Institut Des Hautes Etudes Economiques et Commerciales, Ecole Centrale D'electronique, Turku University, Consiglio Nazionale Delle Ricerche, Siec Badawcza Lukasiewicz - Poznanski Instytut Technologiczny, IEEE Technology Center GmbH, Australo Interinnov Marketing Lab, Fraunhofer Gesellschaft Zur Forderung Der Angewandten Forschung Ev, Yiotis Anonimos Emporiki & Viomixaniki Etaireia, Kompetenzzentrum Automobil, Infineon Technologies Ag, Iotam Internet Of Things Applications And Multi Layer Development Ltd, Chilton Computing Limited, Response Ability Consulting Pty Ltd.

The project abstract is reported in the following:

“Effectiveness of an AI process is achieved when it delivers sufficient output to deal with the question put to it without any margin of error other than a statistically acceptable one. In the different energy transition scenarios, the notion of sobriety (understood as frugality or responsible consumption and/or production) is considered as a key variable and one of the pillars of the ecological transition. Current responses to these challenges tend to oppose in some way energy efficiency to AI performance. We consider this as not acceptable, given the ongoing climate crises and the AI industry’s promises for humanity. At the same time, it is the uses as much as the technological advances that allow to reduce the carbon footprint of human activities.

The choice of carbon footprint itself, as a single indicator, is problematic. It is not an indicator that decision makers and economic actors can easily base their decisions on, because it is limited to proposing an impact equivalent but does not make it possible to identify, at a high level of granularity, the “generating factor” of this impact within the production process and, even more so, within the framework of the product/service life cycle. The ambition of energy or data efficiency therefore implies not limiting oneself to the energy consumption, the carbon footprint or the data usage of a production process at the macro level but considering it as a sum of interdependent activities, all of which generate consumption of resources and are therefore liable not to be frugal. Some industries are more in tension than others on these subjects, and the Artificial Intelligence industry is one of them. Hence, we propose an operational framework of sobriety regarding the design and use of AI both as an industrial process itself and when applied in industry/business processes, which will not impair or diminish performance nor accuracy. To ensure integration within the research landscape by using the SoBigData RI as a vector to promote and share the project results.”

SoBigData RI budget: 137,500 euro (for SoBigData++ the link will be done by CNR-ISTI as coordinators of the RI).

4.3 Project GreenDIGIT

Project GreenDIGIT is developed by a consortium of European public research centres and industries³ to improve the energy efficiency of digital infrastructures.

³ Universiteit Van Amsterdam, Cesnet Zajmove Sdruzeni Pravnickyh Osob - Cesnet, Consiglio Nazionale Delle Ricerche, Centre National De La Recherche Scientifique, Organisation - Agencia Estatal Consejo Superior De Investigaciones Cientificas, Ebrains, Egi Foundation, Sorbonne Universite, Szamitastechnikai Es Automatizalasi Kutatointezet, Technische Universitaet Muenchen, Panepistimio Thessalias - University Of Thessaly, Instytut Chemii Bioorganicznej Polskiej Akademii Nauk, Consorzio Nazionale Interuniversitario Per Le Telecomunicazioni, Greenspector.

The project abstract is reported in the following:

“The impact of digital services and technologies on the environment is a priority in the operation of existing digital services, and in the design of future digital infrastructure solutions. Energy consumption and carbon footprint are the two most talked about aspects, and indeed, digital infrastructures today contribute 3 to 4% of the total greenhouse gas (GHG) emissions in the world, with growth of 8% per year.

In particular, the part of the networking infrastructure alone is responsible for 2 to 14% of digital impacts according to various sources, mainly due to their electricity consumption. Digital Research Infrastructures are a fundamental tool in the development of research from design to market. Moreover, digital services are becoming a ‘+1 instrument’ to many of the thematic (i.e., science discipline specific) ESFRIs as well because of the big data challenges triggered by modern scientific instruments.

The 4 RIs that propose GreenDIGIT represent significant stakeholders of the ESFRI DIGIT area (SLICES, SoBigData, EBRAINS), and they underpin as digital service providers for over 20 thematic ESFRIs (EGI). Addressing energy efficiency within these infrastructures is therefore of utmost importance to achieve lower environmental impact not only within the DIGIT domain, but also across the whole ESFRI landscape. First, the technologies developed in the proposal will improve the energy efficiency and will lower the environmental impact of the participating RIs. Second, GreenDIGIT will work with the thematic ESFRIs and will act as a role model to lower the environmental impact of their digital services. Third, some of these solutions will be developed in synergy with advanced EU projects in the area of energy efficiency of digital systems (e.g., the HEU 6GREEN project as well as international projects), thus multiplying the potential impact of these solutions even beyond the RIs domains. Finally, GreenDIGIT will also go beyond the analysis and provide both prototyping and capacity building for digital services and infrastructures that will be established in the future.”

SoBigData RI budget: 335,000 euro (for 3 SoBigData++ partners CNR-ISTI, CNR-IIT, EGI).

5 Challenge Us 2021 analysis and results

The Challenge Us program has the goal to give the possibility to small and medium-sized enterprises to enter the world of big data and exploit its potential. The initiative helps the companies by providing free of charge service in accomplishing the proof of concept for their proposals, exploiting data analysis and data management tools. The Challenge Us was designed to build a bridge between industry and academia, offering the free support of SoBigData++ scientists to design solutions and produce proof of concepts, harvesting the data provided by the firms. It is a widespread opinion that companies must be able to exploit these data to continue to remain competitive on the global market through the offer of new products/services or make their processes more efficient. In fact, a recent survey conducted by KPMG shows that 75% of TMT companies believe that using enterprise effectively can radically change their business models (KPMG, 2022). The use and analysis of this large amount of data can in fact be crucial to understand and predict the behaviour of their customers, predict when a machine will need maintenance, or add new services to improve their offer.

The first edition of Challenge Us was held in 2021 and it was organised by Sant'Anna School of Advanced Studies. By June 30 the companies had to submit the applications, then from July 15 to November 1 there was the execution period of the project, while the final event took place November 22 in the main hall of the Sant'Anna School of Advanced Studies.

In the first stage of the Challenge Us, we invited proposals to submit a problem or a potential idea of exploitation of data. The companies needed to indicate in the proposal the problem that they intended to solve with the use of big data; its relevance in the company's business and the national / international market; the types of data; the users involved; the application scenarios; the impact of the proposed solution, the degree of innovation; the type of support requested; the previous experience of the company with data analysis.

In the 2021 edition of Challenge Us, 4 companies out of 6 were selected, according to the criteria of quality, originality, feasibility and overall score. Seven partners (Sant'Anna School of Advanced Studies, University of Tartu, University of Sheffield, Italian National Centre of Research, University of Pisa, Scuola Normale Superiore, ETH, Sapienza University of Rome and Center for the Study of Democracy) and ten individuals from the partner institutions participated to the process of selection. Each proposal was evaluated by three individuals from three different institutions, to remove forms of bias. In Appendix A.2 are reported the evaluation indexes for each reviewer, the selection ranking and the average score of the 6 companies.

We report in detail the project description and expected impact for each company:

- **A2A** requested to study the predictability on short time scales of the price and limit order book dynamics of assets traded in the electronic markets. The predictability on short time scales of the price of commodities allows the optimal execution of A2A's orders as well as portfolio hedging and risk management activities. The solution of the problem by AI and machine learning techniques provides a positive impact on market transparency for several bigger and smaller market participants.
- **BizPortal** requested support in filtering multiple international news sources based on pre-defined keywords dictionary related to public procurement contract award and related activities, and in matching company names and company ID on relevant news. The solution of the problem

contributes to global data industry innovation on public procurement contract awards, to real-time monitoring of social processes with public impact and to anti-corruption transparency.

- **CESUE** requested support in improving big data management from social media and readerships to improve the impact on public opinion on domestic and foreign investments in Italy.
- FreedaMedia requested support in optimizing production to reduce waste and anticipate market directions through big data analysis.
- **GIUSTA** requested support in optimizing the delivery flows in real-time according to several constraints (e.g., riders' placement, source, destination, time, traffic, vehicle, quantity of goods, etc.) to improve the effectiveness and efficiency of their services thanks to the implementation of efficient data integration process over data sources, the optimization of the flow and the development of data-driven decisions.
- **Omnitech** requested support in developing a machine capable of forecasting future hydrogeological events by using real time and historical weather data. The solution of the problem provides the development of a risk-index potentially helping public administrations, companies and people in providing information about specific risk of damages and injuries/deaths.

The selected companies were: A2A, BizPortal, GIUSTA and Omnitech.

- **A2A** is an Italian company that generates, distributes, and markets renewable energy, electricity, gas, integrated water supply, and waste management services. The company asked for the support of Scuola Normale Superiore to handle their big data to improve their price system.
- **BizPortal** was founded in Bulgaria in 2014 as a global open data collection and analytics solutions provider. BizPortal's flagship product is TenderAlpha.com – a global government contract database product consisting of aggregated government procurement contract awards and related company information from more than 50 countries worldwide with 10+ years of historical records and various ongoing delivery options. Bizportal asked for the help of SoBigData to explore the possibility to use their data to improve internal processes and operations.
- **GIUSTA** is a food delivery company promoting a new delivery model, which aims to be sustainable for restaurants, ethical for riders and guaranteed for consumers. Giusta requested the support of SoBigData to create a database by connecting different data sources together and to improve forecasts regarding the trend in demand for their products.
- **Omnitech** is a company active in technology, research, and innovation, engaged in the design of innovative platforms with high technological value, as well as in the production, installation, assistance, maintenance and marketing of software and hardware products. The company has asked SoBigData++ for support to be able to combine data from different sources and be able to make more accurate climate predictions.

In the project execution phase, selected proposals were assisted in the resolution of the "challenge" by a team of expert data scientists belonging to the European consortium SoBigData++ and have been able to use the methodologies and software tools available on SoBigData++ big-data analysis platform. The types of support provided by SoBigData++ partners range from studying the potential of the available data in the reference business context, or solving a specific problem already identified by the company, to providing the necessary tools to enable problem solution by the company itself. In the 2021 edition the skills of optimization, machine learning, natural language processing, financial modelling and big data management were requested from SoBigData++ partners by the firms which participated to the Challenge Us program. In

Table 1 are reported the SoBigData++ partners and the specific Big Data skills requested by each company that participated in the Challenge Us 2021.

Companies	SoBigData++ Partners	Skills requested
A2A	Scuola Normale Superiore	Machine Learning for short term predictions
Bizportal	Center for the Study of Democracy University of Tartu	Machine Learning Natural Language Processing
GIUSTA	Sapienza University of Rome Italian National Centre of Research	Optimization for predictions
Omnitech	Italian National Centre of Research	Big data management

Table 1 - Companies, SoBigData++ Partners and Skills requested

Ultimately during the final event, the firms presented the results of their collaboration with SoBigData partners. Each company had 15 minutes to show the results of the project and to indicate possible future developments. At the end of each presentation, an interesting Q&A session took place, and it produced interesting ideas for the various projects. The event was attended by about twenty people and the problems related to the organisation of the event due to Covid-19 pandemic were underlined. At the end of the event, the 2023 edition of Challenge us was launched which will be organised by the University of Tartu.

5.1 Planning Challenge Us 2023

The final event of the second edition of Challenge Us will be held in September 2023 and will be organised by the University of Tartu, and STACC (Software Technology and Applications Competence Center), Estonia.

Challenge Us 2023⁴ will follow a more international and “open-to-industry” collaboration spirit compared to the first edition, as confirmed by the presence of STACC, a machine learning and data science company that aims to develop artificial intelligence solutions. The Task leader and task members have done a few rounds of planning meetings to discuss the first edition and what needs to be improved to make the second version more successful. The organisers have already collected the competencies each partner can offer for the selected companies. The team also proposed amendments in the proposals for the website of Challenge Us and registration form to facilitate the process of application for the target group. SoBigData++'s sole purpose in this initiative is the dissemination of the culture and potential of Big Data in industrial processes.

Companies expect clear value proposals from the consortium to opt for their participation in the contest. Also, data security issues could be explained in more detail to encourage participation.

⁴ <http://sobigdata.eu/challenge-us-2023>

Each selected project will be developed in maximum four months, from the date of proposal submission to the final presentation:

- Call opening on 15 March 2023
- Deadline to submit: 30 April 2023
- Notification to winners: 16 May 2023
- Execution Period: 16 May - 30 August 2023
- Final Event: 15 September 2023

The planned improvements were focused on websites, communication and dissemination of the event. Moreover, a more intense effort of SoBigData++'s partners in engaging with firms localized in their ecosystem was requested.

6 Conclusions

This report represents a variety of activities that have been undertaken by SoBigData to spread entrepreneurial skills and mindset among students and researchers by implementing both theoretical and practical entrepreneurial courses, different events and courses related to data science to improve entrepreneurial skills and develop entrepreneurial ideas. Those ideas can be developed further with help of incubators and accelerators and training activities provided. We can already see the emerging of Big Data spinoffs and hopefully stimulating activities provided by partners of SoBigData will lead to the creation of more new businesses.

SoBigData++ is also partner of European project proposals which focus on environmentally sustainable Artificial Intelligence and energy efficiency of digital infrastructures. This project proposals also engage industries, policy makers and public bodies.

Finally, we reported the actions undertaken to conduct the Challenge Us program, whose first edition already took place in 2021, organised by Sant'Anna School of Advanced Studies. In 2023 the second edition organised by University of Tartu and STACC will be launched. The 2021 edition has ended with success, but it is noticeable that the companies reached are mainly Italian with one exception. A significant improvement for the upcoming edition will be spreading the reach of the program to other geographical areas, exploiting the presence of the SoBigData++ partners on their territory.

Appendix A1. Entrepreneurial skills for big data entrepreneurs

A1.1 Entrepreneurial and data science related courses

In this section, we report the programs related to entrepreneurship for master, bachelor and PhD students as well as entrepreneurial courses available for students with background in management or computer and data science, that are supported/updated by materials and tools of SoBigData. Moreover, data science related courses for students with a background in management were included in this section because those courses help students with an entrepreneurial mindset better understand the phenomenon of Big Data.

A1.1.1 King's College London

Business and Management and International Management programmes for bachelor students offer a range of entrepreneurial topics such as International Business, Technology & Innovation, Psychology of Entrepreneurship & Innovation, Entrepreneurial Family Firms, Crafting Entrepreneurial Opportunities, Business and Entrepreneurship in Contemporary China, Introduction to Entrepreneurship & Venture Capital. Those programs also include basic data science courses such as Quantitative Data Analytics and Statistics for Economists. The Digital Culture program for bachelor and master students provides courses such as Management for the Digital Domain and Digital Entrepreneurship. The Computer Science Master program provides a variety of data science-related courses. Moreover, this master program offers some basic management courses such as Introduction to Management and Principles of Marketing.

A1.1.2 TU Delft

Master in Management of Technology offers entrepreneurial courses such as Technology, Strategy and Entrepreneurship and Leadership and Technology Management. Minors Management of Technology offers courses such as Introduction to Technology-Based Entrepreneurship, Finance for Entrepreneurs.

A1.1.3 Rovira i Virgili University

University offers various master programmes related to entrepreneurship such as Master in Entrepreneurship, Master in Business Management, Master in Business Administration. Entrepreneurial courses that are part of those programs are Entrepreneurialism and Business Plans, Management Skills, Business Cases and Experiences, Financial Management of an Entrepreneurial Project, Entrepreneurial Competencies, Strategy and Marketing for the Entrepreneur, Strategic Diagnosis and Entrepreneurial Management. Moreover, the course Tools for Entrepreneurship is offered in every bachelor of the Engineering Faculty. Data science-related courses are offered by several master programs such as Computational Engineering and Mathematics, Computer Security Engineering and Artificial Intelligence and Master in Artificial Intelligence.

A1.1.4 University of Tartu

University offers various master programmes related to entrepreneurship such as The Business Administration, The Innovation and Technology Management. Entrepreneurial courses that are part of those programs are Business Communication, Principles of Entrepreneurship, Project Management, Business Environment in the Baltic Sea Region, Basics of Innovation, Strategic Management, Business Analysis, Business Process Management, Software Product Management, Innovation Management, Innovative Organisation and intrapreneurship, Business Growth Strategies. Moreover, entrepreneurial courses like

Digital Product Management Industry Project, Introduction to Software Entrepreneurship, Software Entrepreneurship Project, Principles of Entrepreneurship are offered for students in IT, data science and computer science. Data science related courses are offered by programs such as Computer Science, Conversion Master in IT, Data Science, Software Engineering. There are several data science related courses available for management students: Business Data Analytics, Introduction to Programming, Machine Learning.

A1.1.5 ETH Zurich

University offers various programmes related to entrepreneurship such as Entrepreneurial Leadership in Technology Ventures, Management, Technology and Economics Master. Entrepreneurial courses that are part of those programs are Entrepreneurial Strategies & Lean Innovation, Entrepreneurial Leadership, Entrepreneurial Marketing & Sales, Business Development of Technology Ventures, Advanced Studies in Entrepreneurship, Innovation in Digital Space, Open- and User Innovation, Alliance Advantage - Exploring the Value Creation Potential of Collaborations, Corporate Strategy, Digital Health Project, Mastering Digital Business Models, Leading the Technology-Driven Enterprise. Moreover, entrepreneurial courses like Technology and Innovation Management, Discovering Management are offered by programs such as Electrical Engineering and Information Technology, Computer Science. There are several data science related courses available for management students: Bayesian Data Science, Hacking for Social Sciences - An Applied Guide to Programming with Data.

A1.1.6 University of Sheffield

University offers various courses related to entrepreneurship as part of the Business Management program. Among those courses, students can find courses about International Business, Creativity and Innovation, New Venture Creation, Enterprise and Entrepreneurship, Business Management in Context, Business Strategy, Business Intelligence, Business Statistics. Moreover, plenty of entrepreneurial courses are offered for students with engineering and computer science backgrounds. Among them courses like Software Hut, Managing Engineering Projects and Teams, Genesys, AI Group Project. Those courses give students an opportunity to experience the processes of engineering a real software system for a real client in a competitive environment.

A1.1.7 Sapienza University of Rome

University offers various programmes related to entrepreneurship such as Business Administration, Business Management, Management of Technologies, Innovation and Sustainability. Entrepreneurial courses that are part of those programs are Business Strategies, Business Plan, Strategic Analysis for Business Decisions, Business Crisis and Recovery, Strategic and Innovation Management, Entrepreneurship and New Ventures Finance, Business Negotiation and Contracts, Strategic Management, Business Intelligence, Start-up and Business Creation, The Technological Innovation of products and processes, Planning and Strategic Management, Project Management, Technologies for 4.0 Industries. Moreover, there are entrepreneurial courses that are offered for students with data science and computer science backgrounds. Among them courses like Digital Entrepreneurship, Data Driven Economics, Business and Computer Science. There are also some data science related courses provided for students with a background in management, such as Statistics for Business Decisions, Statistics for Management, Quantitative portfolio selection for management, Business Data Science, Data Analysis and Data Mining.

A1.1.8 University of Amsterdam

University offers various programmes related to entrepreneurship, such as Business Administration, Entrepreneurship, Business Administration with specialisation in Big Data & Business Analytics. Entrepreneurial courses that are part of those programs are Strategy and Organisation, Business Operations and Processes, Innovation Management, Company Assignment, International Business, Business Law and Ethics, Digital Innovation and Entrepreneurship, Management and Leadership in the Digital Age, Introduction to Social Entrepreneurship, Digital Business Models, Entrepreneurship and Business in China, Venture Challenge, Entrepreneurship in Science & Technology, Start-up Psychology, Big Data Strategy & Implementation, Digital Transformations, Law & Ethics for Big Data, The Entrepreneurial Venture, The Startup Project, Creative Entrepreneurship. Moreover, there are entrepreneurial courses that are offered for students with data science and computer science backgrounds. Among them courses like Principles of Management, Business Law & Ethics, Entrepreneurship Hackathon, Data-Driven Business Innovation and Entrepreneurship, Data Systems Project, Dynamics in Business and IT, Data-Driven Business Innovation and Entrepreneurship. There are also some data science related courses provided for students with background in management, such as Deep Learning, System Optimisation, Quantitative Marketing, Language Technology, Machine Learning, Big Data Infrastructures & Technology, Coding Lab, Data Stewardship, Statistics, Introduction to Python, Business Analytics, Information and Data Management, Project Qualitative Research Methods and Analysis, Quantitative Data Analysis.

A1.1.9 Central European University

Central European University offers a master program in Technology management and innovation. This program covers different topics related to entrepreneurship, such as Introduction to Entrepreneurship, Technology Based Entrepreneurship, Best Practices in IT Service Management, Boardroom Global Challenge, Digital Transformations, Innovation Imperatives, Challenges and opportunities of connected business models, Introduction to Agile Project Management. There are also some data science related courses

provided for students with a background in management, such as Data Management and Analysis with Python, Web Scraping with R, Data Management and Analysis with R, Opportunities and challenges of IoT, Quantitative Decision Making.

A1.1.10 Aalto University

Department of Management Studies offers various entrepreneurial courses, such as Designing Business Models for Shared Value (in Industry 4.0), Global Brand Management - Real-life case competition, Doing Business in Emerging Markets, International Business in the Era of Disruptions, Business Negotiations, Entrepreneurship and Innovation Management, Energy Business and Innovation, Entrepreneurship and Innovation Management, Sustainable Entrepreneurship, Venture Formation, Entrepreneurship and Society, Business Model Design, Business Communication Skills, Design and Creativity in Business, Data-Driven Business, How to change the world: Innovating toward sustainability, Introduction to business, Corporate Entrepreneurship and Innovation, Doing Business in Russia, Global Online Collaboration and Team Management, Business Decisions, Strategic Information Technology Management, Business Analytics, Digital Business. Moreover, there are entrepreneurial courses that are offered for students with data science and computer science backgrounds. Among them courses like Blockchain Business Applications, ICT Enabled Service Business and Innovation, Global Business in the Digital Age, Introduction to Digital Business and Venturing, Digital Business Management, Data Science project.

There are also some data science related courses provided for students with a background in management, such as Data-Driven Decision Making, MySQL for Data Analytics, Data Science for Business, Quantitative Methods for Management Studies.

A1.1.11 KTH Royal Institute of Technology

Entrepreneurship and Innovation Management master program offers various entrepreneurial courses, such as Entrepreneurship, Management of Technology Innovation and Creativity, Project in Entrepreneurship and Innovation Management. Moreover, there are entrepreneurial courses that are offered for students with ICT and Engineering background. Among them courses like Entrepreneurship for Engineers, ICT Innovation Study Project, e-Business Strategies, Technology-based Entrepreneurship, Business Development Lab of Entrepreneurship Engineers, Industrial Development and Entrepreneurship, Entrepreneurship in Technology and Health, Entrepreneurship, Entrepreneurship in Developing Countries, Business Economics and Entrepreneurship, Entrepreneurship and Management, Business Calculation and Entrepreneurship, Social Entrepreneurship.

A1.1.12 Leibniz Universität Hannover (LUH)

LUH offers a Bachelor of Science program in Economics and Management, which provides a foundation course in Business administration with a module focused on start-ups. Information technology related courses are also present in this program, with the courses of Business Analytics with Python/GUROBI/LaTex, Innovation and learning, Introduction to empirical work with R and Programming for finance. A greater number of IT and data science related course also offered at master level in the Master of Science in

Economics and Management, the courses are: Information Systems; Operations Research; Data Analytics; Operations Research II - Advanced methods of linear and integer programming; Optimization Modelling with GAMS; Development of mobile ANDROID applications; IT project management; Computer internship SAP with the modules CO, FI and HR; Information processing in service companies and Master seminar on business informatics, energy and mobility. On the other hand, LUH offers Bachelor and Master programs in Computer Science and in Computer Engineering. In these study programs, besides the fundamental courses in IT, the students can choose elective courses like the minor in Business administration (divided into financial accounting, strategic management, marketing, resources, organisation). In addition, other managerial courses are offered to students of other engineering programs, like Condition Assessment and Asset Management, Practical Knowledge for Tech-Start-up-Founders, Innovation Management for Engineers, Management of Industrial Enterprises.

A1.1.13 Paris School of Economics (PSE)

PSE, for the nature of the institution, does not offer degree programmes in computer science or data science, but courses from these fields are offered to the students of the Master in Analysis and Policy in Economics and the Master in Public Policy and Development, the courses in question are R practise class and Machine Learning in Economics. On the other hand, managerial courses are present in the programs of Master in Economics and Psychology and of Master in Sustainable Impact Analysis, with the courses of Creativity and innovation, Investment decision, Innovation and intangible asset evaluation, Organisational and managerial practices.

A1.1.14 University of L'Aquila

University of L'Aquila offers a bachelor degree in Economics and Management and a master degree in Management, Economics and Finance, the courses in these programs mainly cover the fields of economics and business with only the course of Computational financial mathematics related to the fields of IT and data science. Besides, the Bachelor in Computer Engineering offers a course in Economic applied to engineering; the Master in Applied Data Science offers the courses of Business Administration, Network and decision models, Economics of digital transformation, Information law and ethics, Business law and data processing, Methods and techniques for business and economics, Big data processing management and mining, Modelling and Data analytics.

A1.1.15 Scuola Normale Superiore (SNS)

SNS participates to the program of the National PhD in Artificial Intelligence for Society, in collaboration with University of Pisa, Italian National Centre for Scientific Research, Sant'Anna School of Advanced Studies, IMT School for Advanced Studies, University of Florence, University of Modena and Reggio Emilia, University of Siena and University of Trento. Among the courses offered, several courses are related to the area of business and finance, the courses are: Mathematical model for quantitative finance and Quantitative finance.

A1.1.16 Sant'Anna School of Advanced Studies

The Sant'Anna School of Advanced Studies offers several programs related to entrepreneurship, such as PhD in Management Innovation, Sustainability and Healthcare, Master degree in Innovation and Management and the Honours Bachelor and Master degree in Economics and Management. There are various entrepreneurial courses, like High-Tech Entrepreneurship, Managing Innovation Lab, Open Innovation Modelling and R&D, Start-Up Lab, Strategy and Innovation Management, Introduction to International Business, Design Thinking & Entrepreneurship, Economics and Management of Innovation, Experimental methodologies for management research, Innovation waves and technological change, Bridging Innovation & Sustainability, Effective Managerial Decision Making. The students of the Honours Bachelor and Master degree in Industrial and Information Engineering, can access the business course of the Honours program in Economics and Management, the courses are Technology Innovation Management, Financial Metrics, Management of Innovation and Common Good, Innovative Entrepreneurship, Principles of Business strategy and management. The students with a business background can access to data science and information technology courses like: ICT Innovation - Product Design and Development, Information System and Knowledge Management, Data Analysis and Forecasting, Statistical Learning and Large Data, Programming and Data Analytics with Python, Methods of Social Science Research in the Big Data era, Introduction to Excel VBA programming.

Sant'Anna School of Advanced Studies also offers the aforementioned National PhD in Artificial Intelligence for Society. PhD students can access business and finance courses besides the characterising courses related to artificial intelligence.

A1.1.17 University of Pisa

The University of Pisa offers various entrepreneurial courses, such as Economics and commercial business management, strategies and governance in the family business, small and medium enterprise organisation, Strategy and entrepreneurship, Business Organization, Business Management. Moreover, there are entrepreneurial courses that are offered for students with a data science background. Among them courses like Innovation Management, Business and project management, Management of Innovations, Information Technology for Business Management, Design of smart products and services and data-driven strategic analysis, Business organisation, Business management. There are also some data science related courses provided for students with background in management, such as Optimization for decision support systems, Data analysis for energy management and sustainability, Data Mining and Intelligent Systems, Big Data and information systems, Elements of Data Processing for the economy and for business, Business statistics, Business information system and data management, statistics. Moreover, University of Pisa provides for Master students in Computer Science a Laboratory on ICT startup building. This course will help students to eventually reach the stage of pitching the startup project in front of a seed venture capitalist or drafting a project proposal for seed funding.

A1.1.18 IMT School for Advanced Studies Lucca

IMT School for Advanced Studies Lucca offers various entrepreneurial courses for students with a background in Computer science. Those courses cover topics, such as Behavioural Strategy and Business Behaviour, Project Management, Management of Complex Systems: Approaches to Problem Solving, Firms, Business Analytics and Managerial Behaviour, Decision-Making in Economics and Management, Critical Thinking, Business Model for Emerging Markets, Industrial Organization.

A.1.2 Multidisciplinary courses and other events

In this section, we described other entrepreneurial training activities and events that have been undertaken by SoBigData partners to spread the entrepreneurial skills, spirit and mind-set for big data entrepreneurs among students and researchers with different backgrounds of the Universities and Organizations that constitute the SoBigData partners. Those activities engage students in a multidisciplinary collaboration to tackle real world problems and develop their entrepreneurial ideas.

A.1.2.1 King's College London

King's Experience Enterprise Award

The King's Experience Enterprise Award helps to develop the 7 Skills of an Entrepreneurial Mindset. The Enterprise Award is made up of a variety of learning experiences and opportunities. The award is open to all undergraduate and postgraduate students and staff from any faculty. <https://www.kcl.ac.uk/entrepreneurship/learn-entrepreneurial-skills/kings-enterprise-award>

Entrepreneurship: From Business Idea to Action

In the course Entrepreneurship: From Business Idea to Action, participants will enhance understanding of business and improve skills in entrepreneurship. Participants will learn how to approach key stages of entrepreneurship, from coming up with a business idea to writing a business plan. Using case studies of local businesses and entrepreneurship in the MENA region, participants will learn how to apply business concepts and ideas to different contexts. Participants will also practise pitching their business ideas and learn about developing their enterprise within an entrepreneurship ecosystem.

<https://www.kcl.ac.uk/short-courses/entrepreneurship-idea-action-future-learn>

Introduction to Business Management

In this course, participants will develop a range of business management skills and learn how to use and apply useful business concepts, tools and terminology whilst exploring four key aspects of business management:

managing money, managing people, managing information, and self-management.

Business & Management online summer school

This course explores a wide range of essential business concepts and principles, encompassing strategy, marketing, entrepreneurship, innovation, organisation and more, with topics chosen to best prepare participants for a successful international career in business or management. Essential theories and concepts will be illustrated with case studies to demonstrate how to put learning into practice and successfully deal with modern business dilemmas.

<https://www.kcl.ac.uk/short-courses/business-management-summer-online>

A.1.2.2 TU Delft

Technology, Entrepreneurship and Innovation

This course offers theoretical fundamentals of entrepreneurship and technology innovation. Students create a case study of an existing start-up analysing its entrepreneurial journey and how it fits the broad technology development process and how it navigates the relevant entrepreneurial ecosystem.

<https://www.tudelft.nl/tbm/dce/education/master-courses/technology-entrepreneurship-and-innovation>

Technology, Entrepreneurship and Health

The Technology Entrepreneurship and Health course has a specific focus on the healthcare systems. Students will learn the theoretical fundamentals of entrepreneurship and technology within the context of health and life science. Using a case study of an existing health start-up, students will analyse its entrepreneurial journey, how it fits the broad technology development process and how it navigates the health system to find a way to deliver its services to healthcare institutes in a sustainable manner. Throughout the course students will develop the skills to analyse the emergence of innovative business opportunities and how these are exploited.

<https://www.tudelft.nl/en/tpm/dce/education/master-courses/technology-entrepreneurship-and-health>

Technology, Entrepreneurship and Sustainability

This course has a focus on innovation and entrepreneurship related to the circular economy and new sustainable energy technologies. Using methods and theories to analyse entrepreneurial opportunities, students will gain a deep understanding of circular business models. Students will reflect on a case study of a start-up with a focus on sustainability or circularity and analyse its entrepreneurial journey.

<https://www.tudelft.nl/en/tpm/dce/education/master-courses/technology-entrepreneurship-and-sustainability>

Idea to Start-up

Idea to Start-up is a Master Course where students become entrepreneurs. By working in a team, the student builds a viable evidence-based business model – from a business idea they identify a business opportunity, they validate it, and they build a viable business model for a sustainable innovation-driven company. The students will master a protocol to proactively assess the merit of a technology start-up.

The business ideas can be based on different fields:

- Deep Technology: the student identifies a business opportunity using substantial scientific advances and cutting-edge engineering to create a competitive advantage in the market (<https://www.tudelft.nl/tbm/dce/education/master-courses/idea-to-startup-deep-technology>).
- IT & AI: the student identifies a business opportunity using computer sciences. Applications can range from mobility, cyber security to predictive maintenance, and so on (https://studiegids.tudelft.nl/a101_displayCourse.do?course_id=56511).
- Health & Life sciences: business ideas are based on life science and biomedical technologies and sourced from challenges in the well-being and health care industry (<https://www.tudelft.nl/tbm/dce/education/master-courses/idea-to-startup-health-life-sciences>).
- Energy & Sustainability: focus on ensuring a sustainable and energy efficient environment (topics may include circular economy, renewables, cleantech, agriculture, and water and waste management)(<https://www.tudelft.nl/tbm/dce/education/master-courses/idea-to-startup-energy-sustainability>).
- Global food change: students will focus on agro-food technologies transforming traditional supply chains, rural farming, and energy solutions globally and locally (<https://www.tudelft.nl/tbm/dce/education/master-courses/idea-to-startup-global-food-change>).

Turning Technology into business

Turning Technology into Business (TTiB) aims to equip participants with a strong conceptual foundation to actively understand the dynamic process of technology-based entrepreneurship. Participants learn how business strategies are best formulated and how (through entrepreneurship) technology can create value (<https://www.tudelft.nl/tbm/dce/education/master-courses/turning-technology-into-business>).

Ready to Start-up

Ready to start-up is a highly interactive course in which students will gain all knowledge and receive the tools needed to build their business successfully and – most importantly – apply the concepts to their own business (<https://www.tudelft.nl/tbm/dce/education/master-courses/start-dce-advanced-course>).

A.1.2.3 University of Tartu

STARTER

The semester-long STARTER programme consists of workshops that guide teams from ideation to business model. Teams receive individual mentoring from start-up founders or entrepreneurs and regular performance evaluations from instructors. The programme starts with the Idea Hackathon open to all students across disciplines (<https://www.startuplab.ut.ee/projects/starter>).

Kaleidoskoop

Kaleidoskoop is the biggest student pitching competition in South-Estonia. It takes place in two stages. First, the student teams have to pitch their idea to judges at the Kaleidoskoop Pre-selection (<https://www.startuplab.ut.ee/projects/kaleidoskoop>).

UnivEntre Ukraine

In November 2021, a new international cooperation project UnivEntre was launched led by the University of Tartu Startup Lab. The project focuses on improving the efficiency of the Ukrainian higher education system to promote the country's innovation capacity and the quality of education. The project will run until 1 June 2024. Startup Lab will educate business lecturers at Ukrainian universities and share Estonia's experiences on how to make cooperation between universities and the business sector effective (<https://www.startuplab.ut.ee/projects/univentre-ukraine>).

A.1.2.4 ETH Zurich

Design Thinking: Human-Centred Solutions to Real World Challenges

The goal of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in teams to solve a set of design challenges that are organised as a one-week, a three-week, and a final six-week project in collaboration with an external project partner (<https://www.sparklabs.ch/ethz>).

Enabling Entrepreneurship: From Science to Startup

This course is for students who have developed a technology and are keen to evaluate the steps in starting a startup. This is also relevant for students who would like to start a startup but do not have a technology but

are clear on a specific market and the impact they would like to create. The students will have exposure to investors and entrepreneurs through the course, to gain insight to commercialise their idea

<http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheit.view?semkez=2020W&ansicht=ALLE&lerneinheitId=140459&lang=en>

Technology Entrepreneurship

This course aims to equip future leaders with strategies, frameworks and tools for understanding, analysing and building technology ventures. In so doing, this course lays particular emphasis on providing an overview of various technology-related dimensions of the entrepreneurial journey, including founding, financing and growing a venture.

<http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheit.view?semkez=2020W&ansicht=ALLE&lerneinheitId=140588&lang=en>

>>venture>>

It is a competition for up-and-coming entrepreneurs in Switzerland. It empowers young innovators to develop their business ideas into start-up companies by connecting them with the people and resources they need. It is a joint initiative between ETH Zurich, McKinsey & Company, Knecht Holding, Innosuisse and the EPFL (www.venture.ch).

Technology Entrepreneurship

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<http://www.vvz.ethz.ch/Vorlesungsverzeichnis/lerneinheit.view?semkez=2020W&ansicht=ALLE&lerneinheitId=140588&lang=en>

A.1.2.5 The University of Sheffield

Enterprise and Entrepreneurship

In the Enterprise and Entrepreneurship, students learn how and why the 'enterprise culture' has become such a popular phrase for individuals, organisations, communities and governments alike. This is done by

examining the various historical, economic, political and social assumptions about the nature of enterprise and entrepreneurship. In addition, because there is always an important human story behind enterprise activity and the creation of a small business, the course will examine many individual and organisational stories (from emerging, growing and mature businesses) in order to assess the factors and challenges involved in starting and running your own business. In this course, students will also have the opportunity to evaluate their personal orientations to entrepreneurship and sharpen their appreciation of what it is like being self-employed, working in the family business, being an owner-manager, being a corporate entrepreneur or running a franchise business.

<https://www.sheffield.ac.uk/programmeregulationsfinder/unit?code=MGT229&org=SHEFFIELD&start=2006-09-25&loc=SHEFFIELD&cal=AUT%20SEM&year=2020>

Workshop and Programs

University of Sheffield offers one-off workshops and longer programs will help hone both entrepreneurial knowledge and plans. The available programs are:

- Ideas for Good: Come and help solve real-world problems. This program brings together subject experts, industry leaders, students, staff and graduates to solve pressing issues in the world today.
- How to find a problem worth solving
- How to create innovative solutions
- How to hone your solution, ensuring it works
- Keeping the main thing, the main thing: Prioritising work
- Why start a new venture: Vision/Values/Mindset
- Competitor analysis and company positioning
- Understanding IP
- Company registration and structures

<https://www.sheffield.ac.uk/entrepreneurship/workshops-programmes>

Engineering: You are hired

By working in interdisciplinary teams, students take part in this week-long industry-led project. The projects are based on problems provided by industrial partners, and students will come up with ideas to solve them and proposals for a project to develop these ideas further.

<https://www.sheffield.ac.uk/engineering/study/youre-hired>

Global Engineering Challenge

The annual Global Engineering Challenge is a cross-faculty event aimed at taking on real-life engineering projects and developing skills of teamwork, design, problem-solving, communication and global awareness, as well as technical knowledge.

<https://www.sheffield.ac.uk/engineering/study/global-engineering-challenge>

A.1.2.6 University of Amsterdam

Sefa Entrepreneurship day

Sefa Entrepreneurship Day is an event for ambitious students who are eager to become an entrepreneur or simply are interested in the entrepreneurial and business world. The main goal of Sefa Entrepreneurship Day is to inspire, motivate, and inform these students on their future possibilities in the entrepreneurial world and beyond, as well as support existing start-ups and scale-ups. The mission is to connect students to interesting companies, where valuable and vital knowledge can be shared and exchanged, enabling students to have a better grasp of the business world.

<https://sefa.nl/product/events/sefa-entrepreneurship-day/>

A.1.2.7 Aalto University

IDBM Capstone: Industry Project

The IDBM Industry Project course follows a challenge-based learning approach where students participate in real-life business projects and practice working in multi-disciplinary teams. Field experts offer mentoring for each project team.

<https://mycourses.aalto.fi/course/view.php?id=37356>

Capstone: Business Intelligence

The objective of the course is to give the students an understanding of the data informed decision-making. The focus is on business-oriented analytical skills, which enable the students to work with the data, to understand them and turn them into intelligence and actions.

<https://mycourses.aalto.fi/course/view.php?id=36986>

Capstone: Business Process Management in Digital era

The course deals with business process management in the digital era, the complete syllabus of the course is not yet available.

<https://mycourses.aalto.fi/course/view.php?id=36993>

A.1.2.8 Universitat Pompeu Fabra

Explorer

Explorer helps participants to experiment entrepreneurship as a career option. During 12 weeks participants will be working on their idea and turning it into a solution that contributes to achieving the Sustainable Development Goals 2030. With a practical focus and based on social learning dynamics, Explorer is designed so that participants become actors of change through the building of economically sustainable projects in different industries, sectors and types of organisations.

<https://en.explorerbyx.org/>

From science to the market

Science-based entrepreneurship programs offer different entrepreneurial training and individual tutoring.

<https://www.cienciamercat.cat/ca/>

Start-UP Flama

This course offers training activities for entrepreneurs with a business idea. Participants will learn how to use a simple tool Business Model Canvas that will help them to improve their business ideas.

https://nanomooocs.cat/courses/course-v1:UPF+Flama+2021_Flama/about

A.1.2.9 Leibniz Universität Hannover

LUH offers a multidisciplinary degree program: BS in Engineering and Business Administration, where the students acquire in parallel the foundations and conceptions of Engineering and Business Sciences.

A.1.2.10 Sant'Anna School of Advanced Studies

Industry 4.0 Innovation Boot-Camp

The Course is designed for policy-makers, public officers, entrepreneurs, investors, businessmen, lawyers, practitioners, consultants, engineers and other professionals interested either in bringing robotics and AI products onto the market or in making use of robotics and AI solutions or industrial processes in their businesses.

<https://www.santannapisa.it/en/formazione/industry-40-innovation-boot-camp>

Advanced Course "High Tech Entrepreneurship"

The objectives of the course are to provide participants with an appropriate knowledge of the tools necessary for the analysis of business planning processes that lead to the creation of a new business.

<https://www.santannapisa.it/it/formazione/advanced-course-high-tech-entrepreneurship>

Summer School "The Regulation of Robotics and AI in Europe: Legal, Ethical and Economic Implications"

The Summer School aims to provide participants with the knowledge and interdisciplinary skills necessary to understand the different issues posed by the development and diffusion of robotics in EU, namely to: design robots/counsel enterprises, ensuring compliance with applicable regulation, technical-ethical standards, social acceptability and respect of the CFR, develop risk-management strategies and entrepreneurship models, as well as define new EU policies on these matters. The Course is intended for international students, policy makers, engineers, philosophers and professionals from different backgrounds.

<https://www.santannapisa.it/it/summer-school-regulation-robotic-ai-europe-22-23>

Seasonal school "Management of Innovation and Common Good"

This Seasonal School addresses some of the main issues regarding innovation management and knowledge exchange (including technology transfer) with a broad vision which includes sustainability and health management. The specific approach of this Seasonal School (1) aims at arousing the interest of participants from different scientific disciplines and (2) focuses on the goal of contributing to the common good

<https://www.santannapisa.it/it/seasonalschool/management-of-innovation-and-common-good>

Seasonal school: “Economics of Innovation and Technological change”

The Seasonal School programme on “Economics of Innovation and Technological Change” addresses both the theoretical and the empirical underpinnings of the economics of innovation and technical change, as well as recent debates at the frontier of the field. The topics covered include: technological paradigms and trajectories, innovation and firm strategies, sectoral patterns of innovation, analysis of patent data, innovation and economic growth, innovation and competitiveness, innovation and intellectual property rights.

<https://www.santannapisa.it/it/seasonalschool/economics-innovation-and-technological-change>

A.1.2.11 University of Pisa

Contamination Lab Pisa

The Contamination Lab is a project of the University of Pisa in collaboration with Scuola Normale Superiore, Sant’Anna School of Advanced Studies and IMT School for Advanced Studies Lucca.

Contamination Lab Pisa aims to promote and disseminate the culture of entrepreneurship and innovation, the valorisation of one’s own ideas and interdisciplinarity. It allows participants from different disciplinary backgrounds to get to know each other and work together on common projects, acquiring planning, organisational and communication tools and skills.

<http://contaminationlab.unipi.it/>

PhD+

PhD+ is the University of Pisa’s programme aimed at promoting and encouraging entrepreneurship and innovation among undergraduate students, PhD students, PhD students and lecturers. It consists of a series of interactive and engaging seminars, plus coaching and mentoring activities on entrepreneurial projects led by international experts in the field of innovation and technology transfer.

<http://contaminationlab.unipi.it/phdplus/>

Conthackt

Conthackt is an event aimed at scouting for innovative ideas and solutions that can be developed into start-ups and spin-offs. The 2022 edition focused on creating scalable and sustainable business models in compliance with the Sustainable Development Goals (Agenda 2030), such as Agrifood, Urban Mobility, Digital Solution, Health and Climate.

<http://contaminationlab.unipi.it/conthackt-edizione-2022/>

A.1.2.12 French National Centre for Scientific Research (CNRS)

Medal of Innovation

With the Medal of Innovation, which was created in 2011, the CNRS rewards outstanding scientific research that has led to breakthrough technological, therapeutic, or social innovation.

<https://www.cnrs.fr/fr/talents/cnrs?medal=41>

The HSS Innovatives

A series of events organised by the CNRS around themes with strong innovation potential for 2025, the HSS Innovatives forum is a key occasion for strengthening partnerships with socioeconomic actors. It allows laboratories and companies to communicate about their needs and advances in view of future applications and encourages researcher initiatives in technology transfer activities. The Innovatives touch on various subjects, including the humanities and social sciences, the vehicles of the future, big data, etc.

<https://innovatives.cnrs.fr/>

Start-up Connexion

These meetings between investors and researcher-entrepreneurs, which were launched by the Groupe AEF and the CNRS, target start-ups originating from the world of academic research. They identify innovative projects with high economic value, give visibility to budding companies, and facilitate financing.

<https://www.startup-connexion.com/>

Innovation Tuesdays

Innovation Tuesdays, organised by the CNRS and the Club de Paris des Directeurs de l'Innovation, are free inter-institutional conferences. They are open to students from all universities, prestigious higher-education institutions and professional schools who have just completed their training, as well as innovation professionals including directors of innovation, R&D, marketing, and brands along with project directors and managers, researchers, designers, creators, producers, and entrepreneurs. By bringing together such a diversity of actors, these conferences facilitate networking for the many talents needed for innovation.

<https://mardis-innovation.fr/>

A.1.3 Incubators | Accelerators

In this section, we described activities that have been paved to support and develop potentially interesting entrepreneurial ideas. Moreover, Big Data spin-offs that spurred from those training activities were described.

A.1.3.1 King's College

Women Entrepreneurship Network

The Women Entrepreneurs Network aims to achieve gender parity across the Entrepreneurship Institute's activities, with a key aim to ensure that half of the ventures on the King's 20 Accelerator are women-led. The network is open to all students, staff and alumni at King's and increases their exposure to entrepreneurial skills, knowledge sharing and community building. Throughout the year, the network runs events, workshops and classes including, workshops on launching your own business, coding classes and an annual two-day retreat.

<https://www.kcl.ac.uk/entrepreneurship/develop-your-idea/women-entrepreneurs-network>

King's 20

King's 20 Accelerator is the Entrepreneurship Institute's flagship programme supporting the 20 brightest and highest potential ventures from across the King's to take their ideas and ventures to the next level. Participants will receive an estimated £60,000 support which includes among other benefits: 3-month intensive accelerator based around bi-monthly sprints, 9-months of follow-on support including networking opportunities with investors through our bi-monthly investor interactions, 10 in-house expert mentors (incl. a growth, designer, technologist, investor, & 2 coaches) & regular external mentors, A package worth £20,000 including 12-months free accounting, £10,000 access to AWS and Google Cloud credits, software discounts etc, Wide collaboration opportunities across the King's College London eco-system and King's20 alumni network.

<https://www.kcl.ac.uk/entrepreneurship/scale-your-venture/kings20-accelerator>

Idea Factory

Idea Factory is King's College London's flagship idea generation competition. The competition aims to nurture the biggest and best ideas from across the university that have the potential to grow into ventures. Participating in Idea Factory is a great way to win support to help make an idea a reality. Taking part in supporting workshops will give you skills in sustainably disrupting your idea, learning how to thoroughly validate your idea, and pitching your idea with clarity and enthusiasm.

And new for year 2022/23 is the Engineers in Business Competition (EIBC), designed to encourage engineering students and alumni to supplement their engineering skills with commercial and business education.

<https://www.kcl.ac.uk/entrepreneurship/develop-your-idea/idea-factory>

Entrepreneurship Institute

The Entrepreneurship Institute is the dedicated entrepreneurship hub within King's College London. The Entrepreneurship Institute's role is to help all students, staff and alumni to develop an entrepreneurial mindset of their own, supporting whatever career or future they had in mind.

<https://www.kcl.ac.uk/entrepreneurship/about-us/about-us>

A.1.3.2 TU Delft

YES! Delft

Tech incubators turn promising ideas and teams into solid start-ups and help them grow into successful companies. Experts, mentors, corporate partners, and investors help to build tomorrow's leading firms.

<https://www.yesdelft.com/>

Delft Enterprises

Delft Enterprises participates in innovative, early stage and technology-based spin off companies of Delft University of Technology. The aim is to empower and speed up the development of these start-ups, as part of the ambition of the university to turn scientific knowledge into economic and social value.

<https://www.delftenterprises.nl/>

RoboHouse

RoboHouse offers a range of workshops, courses and practical programs for innovators by focusing on high-end robotics and AI solutions for organisations.

<https://robohouse.nl/>

A.1.3.3 University of Tartu

Startup Lab

Startup Lab provides hands-on entrepreneurship training and pre-incubation services for all students across disciplines. It is the place where students can turn their ideas into reality by testing the viability of their solutions, improve teamwork skills, and broaden their networks. Startup Lab provides workshops and webinars supervised by entrepreneurs, field experts, and mentors. In addition, Startup Lab has launched the aforementioned projects: Starter, Kaleidoskoop, UnivEntre Ukraine. In the past it had organised the projects: SmartUp Lab, Innosme Ukraine, NGAL 2015-2019, Starter Advanced, Eboat 2019, Starter @ Ukraine and EstLat Accelerate.

<https://www.startuplab.ut.ee/en>

<https://www.startuplab.ut.ee/projects>

A.1.3.4 ETH Zurich

Entrepreneurship group

The ETH Entrepreneurship group supports entrepreneurs and supports start-ups on their path to success. It supports ETH students, employees, professors and alumni/-ae wishing to set up their own companies in navigating the entrepreneurial ecosystem at ETH Zurich. ETH Entrepreneurship group offers services of start-up consultation, spin-off recognizing and licensing and investor inquiries.

<https://ethz.ch/en/industry/entrepreneurship/discover-entrepreneurship-ecosystem.html>

ETH entrepreneurial ecosystem comprehends support for students and more, incubators and accelerators, business competitions, training and courses. The ecosystem incorporates ETH centres, departments and internal initiatives; external collaboration and resources; funding and industry.

<https://ethz.ch/en/industry/entrepreneurship/discover-entrepreneurship-ecosystem.html>

Student Project House

Student Project House is a place where students can think outside the 'curriculum box' and learn how to identify needs, design solutions, and test hypotheses. The Student Project House provides an ideal place for students to enjoy the freedom of combining what they've learned with the freedom to explore, leading to great innovations.

www.sph.ethz.ch

Chair of entrepreneurship

The ETH's Department of Management, Technology and Economics focuses on research and teaching in the area of entrepreneurship, with emphasis on innovative and aspirations-driven entrepreneurial activity, aiming at high impact ventures.

www.entgroup.ethz.ch/

ETH Entrepreneur Club

The ETH Entrepreneur Club is a student-run initiative with the vision to empower the next generation of entrepreneurs and encourage them to pursue their dreams. They host a co-working space with 25+ early stage, ETH-related startups and organise 30+ events per year.

<https://www.entrepreneur-club.org/>

Wyss Zurich

Wyss Zurich is the joint accelerator of the University of Zurich and ETH Zurich that is dedicated to the emerging fields of regenerative medicine, robotics, and related hybrid technologies.

<https://www.wysszurich.ch/>

ESA BIC Switzerland

The ESA Business Incubation Centre Switzerland (ESA BIC Switzerland) is a nationwide initiative that opened in 2016, powered by the European Space Agency (ESA) and ETH Zurich. It supports entrepreneurs and young start-ups alike to exploit space systems or technologies to develop their non-space business on earth or use earth-based technology for space-related applications.

www.esabic.ch

ETH Foundation

The ETH Foundation aims to support research, teaching, and translation at ETH Zurich. It allocates charitable donations from companies, foundations, and private individuals to ETH Zurich.

www.ethz-foundation.ch

ETH Innovation & Entrepreneurship Lab

The ieLab is ETH Zurich's deep technology accelerator and home to Pioneer Fellows and ETH spin-offs alike. It offers office- and lab- space, individual coaching, entrepreneurship education and access to its wide start-up network of coaches, entrepreneurs, and investors.

ETH Pioneer Fellowship

The Pioneer Fellowship is a CHF 150K donation given to aspiring ETH entrepreneurs to apply their research findings in developing highly innovative products or services based on ETH research and use these for the benefit of society. Pioneer Fellows are hosted in the Innovation & Entrepreneurship Lab.

www.ethz.ch/pioneerfellowship

ETH AI Center

As ETH's central hub for artificial intelligence, ETH AI Center brings together researchers of AI foundations, applications, and implications across all departments. The Center fosters research excellence, industry innovation, and AI entrepreneurship to promote trustworthy, accessible, and inclusive AI systems.

<https://ai.ethz.ch>

Talent Kick

The Talent Kick program supports future entrepreneurs by helping to form strong cross-university teams, leveraging synergies to degree programs until you graduate, leadership coaching for self-development and growth, mentoring by experienced entrepreneurs & executives, financial support of 5k CHF for the best projects.

<https://ai.ethz.ch/entrepreneurship/talent-kick.html>

A.1.3.5 The University of Sheffield

Sheffield Innovation Programme

Sheffield Innovation Programme (SIP) is a regional initiative which aims to stimulate business growth and promote the development of long-term relationships with SMEs; this is achieved by providing access to a broad range of academic expertise and university facilities. The support is in the form of bespoke research and innovation based consultancy, workshops and other events.

<https://sip.ac.uk/>

A.1.3.6 Central European University

CEU iLab

CEU iLab makes entrepreneurship more accessible by providing mentoring, know-how, network and a community for high-impact teams.

<https://www.ilab.ceu.edu/incubation>

A.1.3.7 Universitat Pompeu Fabra

En Residència Àrea Tallers

Training sessions, personalised mentoring and free co-working space are offered for the participants to develop innovative projects.

<https://www.upf.edu/web/area-tallers/en-residencia>

Espais d'Incubació UPF Business Shuttle

Start-up Incubator that aims to contribute to the development of new technology-based companies and innovations.

<https://www.upf.edu/web/innovacio/espais-d-incubacio>

A.1.3.8 KTH Royal Institute of Technology

KTH Innovation

KTH Innovation is providing world-class support for new ideas from students, researchers and employees. KTH Innovation works closely with regional and international partners, with the mission of enabling more technology and knowledge from KTH to create impact in society.

<https://www.kth.se/en/om/innovation/om/innovationskraft-pa-kth-1.504834>

A.1.3.9 Barcelona Supercomputing Center

Innovation Journey

Barcelona Supercomputing Center promotes the exchange of knowledge and expertise between academia and private enterprise to maximise research potential by transforming academic potential into practical

applications. The Innovation Journey program exposed entrepreneurial researchers to new opportunities that existed for their projects with the overarching goal of broadening the impact of the new technologies into the market.

<https://www.bsc.es/tech-transfer/entrepreneurship/innovation-journey>

A.1.3.10 EGI

EGI Digital Innovation Hub

The EGI Digital Innovation Hub is a virtual space where companies and technical service providers meet to test solutions before investing. EGI DIH offers different services on advanced computing to help companies in digitalization by improving their productivity.

<https://www.egi.eu/business/>

EOSC Digital Innovation hub

Digital Innovation hub is an international and multi-partner cooperation that supports companies in easily accessing the digital technologies and services offered by the EOSC. It combines 4 main pillars to help companies become more competitive: Pilot design and co-design, Technical Access, Training & Support and Visibility.

<https://eosc-dih.eu/>

A.1.3.11 Sapienza University of Rome

The Research and Technology Transfer Area supports innovation and technology transfer through interaction with Sapienza University of Rome's structures and research groups and identifying and monitoring research results and technological expertise. In particular, through supporting the generation of enterprises based on technologies and skills developed at Sapienza University of Rome; helping to define development strategies; the collaboration other Universities and/or private bodies; sharing of research infrastructures and innovation labs (Saperi&Co, Open Labs Rete Civis).

<https://www.uniroma1.it/en/pagina/innovazione-e-imprenditorialita-accademica>

A.1.3.12 French National Centre for Scientific Research (CNRS)

CNRS is equipped with a dedicated technology transfer department, with twelve transfer focus (among which the field of big data is present).

Supporting pre-maturation

The CNRS has implemented a policy aimed at assisting and encouraging the creation of companies in laboratories, in an effort to ensure effective technology transfer. A series of mechanisms and resources supports technological pre-maturation and assists researchers-entrepreneurs in evaluating the possibility of bringing an innovation to market, investing in the company's capital, and promoting future partnerships.

Investing in start-ups

Through CNRS innovation (formerly Fist SA), its national technology transfer subsidiary, the CNRS has already taken a stake in 26 start-ups with high innovation potential. These companies operate in major research fields such as information technology and communication, biology, physics, and chemistry. These investments reflect the CNRS's long-term commitment to promising companies.

<https://www.cnrsinnovation.com/?lang=en>

In addition to support to start-ups, CNRS also offers a series of services to assist entrepreneurs in technology transfer: mapping (an analysis of scientific and technical information embedded in scientific publications and patents, which is a strategic decision-making tool for your IP and R&I management), Scouting and Open innovation, Teaching and training session, Market Survey, Techno-economic expertise (Connecting the technological supply and demand), Technology Transfer (finding partners, negotiating exploitation contracts and looking after its good implementation), Scientific and technological watch (identify innovations, new concepts, weak signals and emerging trends in the domain of the interested company).

<https://www.cnrsinnovation.com/consulting-services/?lang=en>

Appendix A2. Evaluation Indexes

	<i>Reviewer 1</i>			
	Quality score	Originality	Feasibility	Overall Score
a2a	3	3	4	4
Bizportal	3	3	4	4
Cesue	3	3	3	4
Freedamedia	3	3	3	3
Giusta	5	4	5	5
Omnitech	4	5	4	5

	<i>Reviewer 2</i>			
	Quality score	Originality	Feasibility	Overall Score
a2a	5	4	5	5
Bizportal	4	3	4	4
Cesue	3	2	3	3
Freedamedia	4	4	3	4
Giusta	3	3	2	2
Omnitech	4	5	4	4

	<i>Reviewer 3</i>			
	Quality score	Originality	Feasibility	Overall Score
a2a	3	3	4	4
Bizportal	3	3	4	4
Cesue	2	2	2	2
Freedamedia	3	3	4	4
Giusta	3	3	3.5	4
Omnitech	4	3	4	4

Final Ranking	Average score
Omnitech	4.17
a2a	3.92
Bizportal	3.58
Giusta	3.54
Freedamedia	3.42
Cesue	2.67