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Preface by Susan Gregurick

Scientific breakthroughs in life sciences rest on our ability to connect and compare data across different locations, across different species and over different scales. This is true in the US, in Europe and anywhere else.

Though the NIH is in many aspects different from ELIXIR, when it comes to data our goals are the same. When we look at the NIH Strategic Plan for Data Science and compare it with the ELIXIR Scientific Programme 2019-23, we find many similar themes and the same commitment to open data and open science. We both want to maximise the value of life science data and enable our researchers to freely access and share their data, without compromising security and privacy of the data donors.

I collaborated with my European colleagues early in ELIXIR development more than 10 years ago and have been following the development of ELIXIR since. In recent years there have been many more projects on which we work together. To name a few, I mention the collaboration on the compact identifiers resolution service, or FAIRshake, a software to assess the FAIRness of bioinformatics tools and analyses.

In 2019, we also started working on our Authorisation and Authentication service, the Researcher Auth Service (RAS), to streamline access to our open data resources. The experience of ELIXIR experts from developing and operating the ELIXIR AAI helped us to establish the necessary protocols early on in the development. Because both NIH and ELIXIR use the same open standards, the RAS and the ELIXIR AAI services will be compatible, which will further facilitate exchange of ideas and scientific collaboration between ELIXIR and NIH.

I was honoured to be invited to ELIXIR’s 5th Anniversary in December 2018. Seeing the energy and commitment of everyone in ELIXIR, I am convinced that its Scientific Programme for the next five years will be a great leap forward. I wish my ELIXIR colleagues every success and hope that our collaboration will continue to thrive.

Susan Gregurick
NIH Associate Director for Data Science and Director of the NIH Office of Data Science Strategy
Introduction by ELIXIR Director

With the successful completion of the ELIXIR-EXCELERATE project and the first Scientific Programme (2014-2018), we have entered a new stage in ELIXIR development.

In 2019 we began the implementation of the second Scientific Programme (2019-23) and launched 28 new technical and scientific projects worth €6 million. These new projects lay the foundation for achieving our strategic objectives. They will strengthen the portfolio of our existing services and develop new ones that will address some of the bottlenecks in bioinformatics, such as responsible sharing of sensitive data or the reproducibility and reusability of bioinformatics workflows.

In this report you will learn how we progressed towards this goal and about the first preliminary results of our activities achieved in 2019 (p. 15). It will also give you an overview of the breadth of the activities in our ELIXIR Nodes (p. 36), in our Platforms and Communities (p. 21).

When I look back on our activities in 2019, they all have one common denominator - our effort to support and facilitate scientific collaboration at every level and across domains, countries and continents. This includes integrating experts from new Nodes into our Platforms, linking up ELIXIR Nodes through Implementation Studies, connecting teams through Staff Exchange projects or connecting experts worldwide through our partnership with Global Alliance for Genomics and Health.

In 2019 we launched new initiatives to support collaboration between industry and academia (the ELIXIR Knowledge Exchange Scheme and Bioinformatics Industry Forum, p. 52) and firmly established the ELIXIR Biohackathon. Its second edition was held in November 2019 in Paris and brought together over 100 researchers and developers, including from industry (p 16).

Looking forward, I believe that enabling collaboration is the cornerstone for our success. As we enter the second Scientific Programme, I am keen to build on our previous successes and further strengthen collaboration with our partners in Europe and globally.

Niklas Blomberg
ELIXIR Director
ELIXIR services

ELIXIR coordinates the provision of life science services, developed and managed across Europe by ELIXIR Nodes. These services are freely available to researchers around the world and support efficient manipulation, analysis, storage and exchange of life science data.

The portfolio of ELIXIR services is organised into five technical Platforms: Data, Tools, Compute, Interoperability and Training. Additionally, selected services are part of three key services collections: ELIXIR Core Data Resources, ELIXIR Deposition Databases and ELIXIR Recommended Interoperability Resources.

The ELIXIR Platforms also coordinate joint transnational services, such as ELIXIR Authentication and Authorisation Infrastructure (ELIXIR AAI) or the ELIXIR Training portal (TeSS).

By the end of 2019, the ELIXIR service portfolio counted 215 resources1. The findability and accessibility of these resources is supported by three ELIXIR registries: (1) bio.tools for software metadata and descriptions, (2) FAIRsharing: for databases, standards and policies, and (3) TeSS for training courses and training materials2.

Highlights

One new Service Delivery Plan was concluded with ELIXIR Nodes in 2019, which brings the total number of these Plans to 14. Several ELIXIR Nodes ran service selection processes in 2019 to ensure that the service portfolios remain up-to-date and reflect the needs of their national users.

ELIXIR Core Data Resources (CDRs) were for the first time presented as a collective entity within the global open data infrastructure. In a paper first published in April 2019, ELIXIR presents data collected for the period of 2013-20183. The results reveal that the quantity of data stored in the Core Data Resources reached over 2.72 billion entries. While the volume of data managed by CDRs has tripled and the number of users accessing the CDRs has doubled between 2013-2018, the number of staff working in these resources has increased by only one sixth. This illustrates the value for money that CDRs offer and the scalability of their technical solutions. On the other hand, it raises questions about sustainability in the longer term.

Orphadata4 was selected as ELIXIR Core Data Resource. Orphadata, is a platform to aggregate rare disease datasets from the Orphanet database, joined the list of ELIXIR Core Data Resources in January 2019.

By 2019 the ELIXIR AAI had enabled 3306 users organised in 709 groups to use 133 relying scientific services. Use of the ELIXIR AAI has grown beyond internal ELIXIR services to include public ELIXIR services such as the ELIXIR Germany de.NBI cloud5; commercial cloud providers, EUDAT’s B2ACCESS service and the EMBL-EBI Unified Submissions Interface.

The Biocontainers registry reached the milestone of over 8500 containerised software tools. The Biocontainers community also developed a new BioContainers API which follows the GA4GH specification for tool registries. The API enables the deposition of bioinformatics tools into public repositories and their execution in public cloud environments.

The Training Platform launched the Training Metrics Database6 to summarise and present the ELIXIR training activities. The database provides information about the number of training events, number of participants, number of trainers, and collects demographics, quality and impact data from ELIXIR training events.

Galaxy Europe7 reached over 12,000 unique users who executed more than six million analysis jobs and uploaded nearly 13 million datasets. With more than 2,000 scientific tools available, the platform is the biggest Galaxy instance in Europe covering many bioinformatics topics and communities. It is hosted and managed by the University of Freiburg (part of de.NBI / ELIXIR Germany).

ELIXIR France launched FAIDARE as an asset of the ELIXIR Plant Sciences Community8. Based on the Breeding API (BrAPI), FAIDARE enables data discovery through federations of distant Plant informations systems. FAIDARE currently provides search access to data from seven ELIXIR Nodes plus one USDA database and allows users to perform detailed searches of accessions and phenotyping data.

1 https://elixir-europe.org/services/list, excluding services from eight ELIXIR Nodes that have yet to conclude their Service Delivery Plans.
2 The ELIXIR Training Platform operates two additional databases: (1) The training metrics database, (2) the database of trainers profiles.
4 http://www.orphadata.org/
5 http://de.nbi
6 https://training-metrics-dev.elixir-europe.org/
7 https://usegalaxy.eu
8 https://urgi.versailles.inra.fr/FAIDARE/
ELIXIR Services in numbers

215 Services in total:

- **17** Compute
- **92** Data resources
- **19** Interoperability
- **77** Tools
- **10** Training

Core Data Resources

- 2.72 billion data entries
- Accessed by 3 million IP addresses per month
- Cited in 57,617 articles

ELIXIR registries

**Bio.tools:**
- Number of entries: ~15000
- **5014** entries in 2019
- Number of annotations: **296861**
- **84783** annotations in 2019
- Number of contributors: **1831**
- **789** new contributors

**FAIRsharing:**
- 1342 databases
- 130 policies
- 1361 standards

**ELIXIR TeSS:**
- 1357 training materials
- 31 training workflows
- 73 content providers

**BioContainers:**
- 8.5k tools
- 25.7k versions
- 75k containers and packages
Commissioned Services

ELIXIR Commissioned Services are funded through the ELIXIR budget to drive the integration of services operated by the ELIXIR Nodes. They are proposed and managed by a particular Platform or Community, agreed with the ELIXIR Heads of Nodes Committee, and approved by the ELIXIR Board.

“...The launch of these 30 new Commissioned Services marks a new phase in ELIXIR’s development. Building on the achievements of the 2014-18 Scientific Programme, we are now in a position to address some of the major challenges in computational biology, such as responsible sharing of sensitive human data or the reproducibility of life science data analysis.”

Niklas Blomberg, ELIXIR Director

During the first ELIXIR Scientific Programme (2014-18), Commissioned Services complemented the activities funded by the ELIXIR-EXCELERATE project. In the second programming cycle (2019-23), ELIXIR Commissioned Services have become the main instrument to achieve the strategic objectives of the Scientific Programme for 2019-2023.

There were 30 Commissioned Services launched in 2019 to implement the ELIXIR Scientific Programme (three in January, the rest in June 2019). These 30 new projects receive over €6 million in total, which represents the largest tranche of projects funded by ELIXIR to date.

Starting from 2019, Commissioned Services have taken the form of seven different categories:

• Platform Tasks
• Community Implementation Studies
• Community-led Implementation Studies
• Strategic Implementation Studies
• Infrastructure Services
• Staff Exchange Programme
• ELIXIR Industry Engagement

The Platform Tasks drive the work of the ELIXIR Platforms as defined in the Scientific Programme 2019-23 (see ELIXIR Platforms for details). The Community Implementation Studies support the development of the ELIXIR Communities (see ELIXIR Communities for details), Strategic Implementation Studies cut across multiple Communities and Platforms with a goal to strengthen the impact of ELIXIR services in selected areas. Infrastructure services support the operation of transnational services coordinated by ELIXIR.

The Staff Exchange Programme supports exchange of staff between ELIXIR Nodes and the ELIXIR Hub (see ELIXIR Capacity building for details). The ELIXIR Industry Engagement activities include the ELIXIR Innovation and SME Forum, the ELIXIR Bioinformatics Forum, the ELIXIR Knowledge Exchange Scheme and other activities supporting collaboration with industry (see ELIXIR Industry programme for details).

In 2019, there was also a number of Implementation Studies ongoing that were initiated under the previous Scientific Programme (2014-18).

Each Commissioned Service is led by a team of experts from one or more ELIXIR Nodes, drawing on their national scientific priorities and expertise. Their collaborative nature also enables newly established Nodes to take part in ELIXIR work and quickly integrate their national communities into ELIXIR.
Commissioned Services in numbers

- **55** Commissioned Services running in 2019
- **20** Platform Tasks
- **5** Community Implementation Studies
- **4** Strategic Implementation Studies
- **1** Infrastructure services
- **23** Implementation Studies (from 2014-2018 Programme)
- **2** Staff Exchange Programmes
- **397** Teams involved in Commissioned services

Connection between ELIXIR Nodes facilitated by ELIXIR Commissioned Services in 2019
At the start of 2019, ELIXIR was coordinating two ongoing research projects supported by the European Union:

- **EXCELERATE (2015-2019)**, a flagship project to implement the ELIXIR first Scientific Programme.
- **CORBEL (2015-2020)**, a cluster project bringing together 13 ESFRI biomedical research infrastructures to harmonise user access to shared resources.

Additional two projects coordinated by ELIXIR kicked-off in 2019:

- **EOSC-Life (2019-2023)**, is a continuation of the CORBEL project, with the aim to create an open collaborative digital space for life sciences in the European Open Science Cloud (EOSC). The 13 participating ESFRI research infrastructures work together to establish a common framework for publishing their data resources and link these data to open and reusable tools and workflows accessible to users via Europe’s national and international life-science clouds.

  EOSC-Life will also connect users across Europe to a single login authentication and resource authorisation system and develop data policies needed to preserve and deepen the trust given by research participants and patients volunteering their data and samples.

  The project kicked-off in March 2019 and will run for five years until February 2023.

- **FAIRplus (2019-2022)** is a public-private partnership, funded by the EU’s Innovative Medicines Initiative (IMI) and the European Federation of Pharmaceutical Industries and Associations (EFPIA).

  The project aims to increase the findability, accessibility, interoperability and reusability of data from selected IMI projects and internal data from pharmaceutical industry partners. The tools and guidelines developed by FAIRplus will facilitate the application of FAIR principles to life science data and will enable wider adoption of best practices in research data management.

  The project kicked-off in January 2019 and will run for three and a half years until June 2022.

In addition, ELIXIR participated as a partner in seven EU projects:

- **AACR2 (Authentication and Authorisation for Research and Collaboration 2)**
- **EOSCPilot**
- **RI-PATH (Charting Impact Pathways of Investment in Research Infrastructures)**
- **eTRANSAFE (Enhancing TRANslational SAFety)**
- **The European Joint Programme on Rare Diseases (EJP-RD)**
- **EU-STANDS4PM (Standards for in Silico Models in Personalised Medicine)**
- **CINECA (Common Infrastructure for National Cohorts in Europe, Canada and Africa)**
ELIXIR-EXCELERATE

ELIXIR-EXCELERATE is a €19 million project to fast-track the implementation of ELIXIR first Scientific Programme (2015-2019).

After four years, the ELIXIR-EXCELERATE project successfully concluded in August 2019. achieving its main goal of integrating bioinformatics services across Europe into a federated infrastructure for life science data, ELIXIR-EXCELERATE laid the groundwork for cost-effective and sustainable operation of ELIXIR for the benefit of a global community.

The project’s final review, which took place in June 2019 in Lisbon, Portugal, highlighted the coordination effort involved in linking life science research resources across ELIXIR members. ELIXIR-EXCELERATE has transformed ad hoc collaboration between the 47 partners from 17 countries in the project into systematic and sustained links between the national infrastructures.

The structure established by ELIXIR-EXCELERATE where ELIXIR Platforms providing bioinformatics services, collaborate with domain specific Use Cases, proved to be an effective model for developing resources tailored to the specific needs of different scientific fields.

The initial four Use Cases proposed by ELIXIR-EXCELERATE covered Human data, Rare diseases, Marine metagenomics and Plant sciences. Over the course of the project, the four Use Cases have become Communities and their number expanded to eleven, covering new domains and technology areas.

“ELIXIR has become a fully operational infrastructure supporting basic and translational research and helping with global challenges related to human health, food safety, biodiversity, bioeconomy and more. (...) Thus, the ELIXIR-EXCELERATE project represents without doubt a clear success story.”

From ELIXIR-EXCELERATE Final Review Report
Outputs developed during ELIXIR-EXCELERATE

Basic facts

19.8 million

Four years
(September 2015-August 2019)

47 institutes

17 countries

Data

Defining a ‘Core Data Resource’ and establishing ELIXIR Core Data Resources

The concept of Core Data Resource is to identify the most critical and essential resources for life sciences in Europe. It enables ELIXIR to advocate for these resources to be sustained in the long-term and so that they support the scientific needs of the biomedical research.

The initial list of ELIXIR Core Data Resources was defined in July 2017. By the end of ELIXIR-EXCELERATE there were 19 ELIXIR Core Data Resources.

Annotation Submission system

Linking academic papers to underlying data in ELIXIR data resources supports the reproducibility of research. The Annotation Submission System allows automatic submission of annotations to Europe PMC by third party providers. Europe PMC then makes them available through the Europe PMC Annotations API.

Tools

Bio.tools
Registry with information about a range of life science and bioinformatics tools and data services worldwide.
- 17,125 data entries
- 496, 200 annotations
- 1,449 contributors
- ~12,400 monthly users

OpenEBench
A service for the evaluation of bioinformatics tools, web services and workflows from a scientific and technical perspective.

Compute

ELIXIR Authentication and Authorisation Infrastructure (ELIXIR AAI)
The ELIXIR AAI was developed to streamline access to datasets distributed across ELIXIR Nodes. It offers a centralised system to check user identities, which are provided by host institutes such as universities. This enables the data providers to control access to the data to users who are deemed trustworthy.
- 150 services connected to ELIXIR AAI
- 200+ identity providers
- ~3,300 individual logins per month (based on 2019 usage)

Cloud and Compute integration
By the end of the ELIXIR-EXCELERATE, nearly all ELIXIR Nodes had cloud services and/or cloud service providers affiliated with them. Work to integrate these services is being implemented through the EOSC-Life project, co-led by the ELIXIR Compute Platform.
- 60,000+ compute cores
- 24,000+ TB storage
- 3,000+ compute users

Interoperability

ELIXIR Recommended Interoperability Resources
Existing resources that facilitate services to follow FAIR principles or actively link together different services were consolidated by a strategic review process to form the ELIXIR Recommended Interoperability Resources.

Bring Your Own Data (BYOD) Workshops
BYODs are a combination of a hackathon and a tutorial on FAIRification.
- 10 BYODs were hosted
- 19 Bioschemas meetings
- 1 European Biohackathon

Training

ELIXIR Training events
- 850+ Training events organised
- 19,000+ researchers trained from
- 60 countries
- 2200+ days of training

ELIXIR Training e-Support System (ELIXIR TeSS)
An online registry that collects, disseminates and organises information about bioinformatics training from ELIXIR Nodes and third party providers.
- 1,200+ training materials
- 65 organisations providing training
- 18 ELIXIR Nodes

Established pool of ELIXIR Trainers
The ELIXIR Train-the-Trainer course was developed to enable ELIXIR Nodes to support their members in increasing their training capacity.
- 19 Train-the-Trainer events
- 218 Trainers trained
- 11 Nodes involved
Rare Diseases
Quality Metrics for Genomics Datasets
The publication ‘Documentation on adequate quality reporting standards for genomics datasets’ sets out five quality metrics to enable comparisons of genomic datasets.

14 events organised as dedicated training workshops, webinars and conference talks.

The Rare Disease Registry
Developed in collaboration with other rare disease initiatives, the registry is hosted on bio.tools with benchmarking (i.e. service uptime, citations) via OpenEBench.

• 100+ resources in the Rare Disease Registry

Containerised workflows for rare disease variant calling
In collaboration with RD-Connect, the Rare Disease Use Case adapted the existing RD-Connect pipeline to GA4GH and Common Workflow Language (CWL) standards. It is now accessible to run on the cloud.

Marine Metagenomics
• 12 Marine Metagenomics workshops
• 300 researchers trained

Reference datasets
Manually curated and annotated reference databases for genome, protein and gene sequences.
• MarRef: complete marine prokaryote genomes
• MarDB: partially complete marine prokaryote genomes
• MarCat: marine genes and proteins from metagenomic samples
• MarFun: complete marine fungal genomes
• METdb: A transcriptomics database for marine micro-eukaryotes where all data is consistently processed using standardised de-novo assembly and annotation pipelines
• ITStoneDB: collection of eukaryotic ribosomal RNA Internal Transcribed Spacer 1 (ITS1) sequences

Metagenomics Tool and pipeline evaluations
MGnify, a pipeline for analysis and archiving metagenomic data run by EMBL-EBI and fully described in CWL to support scalability and interoperability.

META-pipe, a pipeline for analysis of metagenomics samples, for use by researchers, offered as a cloud service.
• 22 databases
• 12 tools

Plants Sciences
MIAPPE
The Minimum Information About a Plant Phenotyping Experiment (MIAPPE) aims to harmonise data from plant phenotyping experiments. The Plant Sciences Use Case, together with partners developed a new Plant Phenotypic Experimental Ontology, an implementation of MIAPPE that defines the information necessary to describe and reuse a phenotyping dataset following FAIR principles.

BrAPI
The Breeding API (BrAPI) was developed to enable researchers to exchange plant phenotype and genotype data between crop breeding applications.

Federated Human Data
The European Genome-phenome Archive (EGA) as a federated network
With coordination from ELIXIR, the EGA is moving towards a decentralised federated network. This means that sensitive data can be stored within the country it was produced in. A powerful element of this is the ability for researchers to host data locally whilst submitting metadata to central EGA, which enables international researchers to learn about the existence of such datasets.

Collaborations and fetching data
Developed specific APIs to facilitate extracting data of specific types:
• HTSget: a GA4GH approved standard for requesting and transferring genomic data
• RDconnect: enabling researchers to view raw (variant) sequencing data in real time

Standards for data use
The Data Use Ontology, developed in collaboration with GA4GH, defines the standards required for federated authentication and permissions management.

Industry
ELIXIR Innovation and SME Forum
The ELIXIR Innovation and SME Forums allow companies to learn more about the emerging ELIXIR services and forge strong links with local ELIXIR Nodes running these services.
• 7 Innovation and SME Forums organised
• Attended by ~ 700 participants
• 93% of participants said they’d recommend the event to others

Supporting research and innovation in industry
Measuring and showcasing the impact of ELIXIR on innovation in industrial settings.
Two reports:
• Public data resources as a business model for SMEs: The role of public bioinformatics infrastructure in supporting innovation in life sciences (2018)
• Supporting innovation in bioinformatics: How ELIXIR Connects public bioinformatics infrastructure with industry (2019)
Progress against ELIXIR Strategic Objectives

The following section highlights selected activities carried out in 2019 that significantly contributed to achieving the five strategic objectives of ELIXIR, as defined in the Scientific Programme for 2019-2023.

These five ELIXIR-wide objectives cascade down to the more specific objectives in ELIXIR Platforms, Communities, and in scientific and technical collaboration with ELIXIR partners. For a detailed overview, see the Platforms and Communities section (p. 21 and p. 32).

The five strategic Objectives of the 2019-23 Programme

1. ELIXIR will operate a portfolio of integrated services that meet the data needs of life scientists at a European scale

2. ELIXIR Communities will drive service uptake, support standards development, and connect ELIXIR’s experts in life science disciplines

3. ELIXIR Core Data Resources will be the global standard for bioinformatics resource management and the foundation for an international funding and life cycle management strategy that secures the long-term sustainability of those resources

4. ELIXIR will be the recognised and trusted life science foundation of the European Open Science Cloud

5. All ELIXIR Nodes will connect life science users in academia and industry to our open, federated service network
1 ELIXIR will operate a portfolio of integrated services that meet the data needs of life scientists at a European scale

Expansion of Galaxy support

In 2019, ELIXIR continued and extended services provided by the Galaxy Europe platform, which gives access to a free data analysis environment together with repositories of analysis workflows and reference data. In December 2019, the platform reached over 12,000 users who executed more than six million analysis jobs and uploaded nearly 13 million datasets.

To keep up with the growing demand and increase the computational capacity of Galaxy Europe, the ELIXIR Galaxy Community started the development of a network of data centres and High Performance Computing clusters in ELIXIR Nodes to share their computation power in support of the Galaxy Europe users. The proposed Pulsar Network will connect data centers in Belgium, Czechia, Germany, Italy, Portugal, Norway, Spain, and the UK to distribute the computational tasks requested by Galaxy Europe users (planned for July 2020).

Biohackathon Europe: Supporting the community of software developers

In November 2019, ELIXIR brought together over 150 bioinformaticians, trainers and software developers in Paris, France, for the second Biohackathon Europe. This five-day event enabled researchers and technical experts to speed up the further development of software tools and pipelines for life sciences.

The participants worked on over 30 projects ranging from rare disease pathway maps and plant metadata standardisations to FAIR identifier mapping. This was also the first year that industry was invited to submit projects, and there were several attendees from Google, Oracle and BASF.

Based on participants’ feedback, the event accelerated the outcomes of projects by a factor between 3 and 5 with 16 % of participants stating that they would never be able to achieve the same outcome without the help received during the event.

The benefits of attending the Biohackathon were also visible on a personal level. Over 70 % of participants said that attending the event improved their technical skills, the vast majority (91 %) of them broadened their professional network and learned more about other technical fields and domains.
Figure 1. A survey following the end of the 2019 ELIXIR Biohackathon revealed participant’s perceptions in terms of personal development (N = 111 replies).

<table>
<thead>
<tr>
<th>Perception</th>
<th>Considerably</th>
<th>Moderately</th>
<th>Slightly</th>
<th>Not at All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation/communication skills</td>
<td>27%</td>
<td>15%</td>
<td>9%</td>
<td>49%</td>
</tr>
<tr>
<td>Understanding of other technical fields/specialities</td>
<td>24%</td>
<td>8%</td>
<td>11%</td>
<td>70%</td>
</tr>
<tr>
<td>Understanding of other cultures</td>
<td>23%</td>
<td>14%</td>
<td>9%</td>
<td>54%</td>
</tr>
<tr>
<td>Understanding of other sectors’ needs</td>
<td>14%</td>
<td>11%</td>
<td>12%</td>
<td>50%</td>
</tr>
<tr>
<td>Professional network</td>
<td>14%</td>
<td>15%</td>
<td>3%</td>
<td>37%</td>
</tr>
<tr>
<td>Employment</td>
<td>14%</td>
<td>15%</td>
<td>3%</td>
<td>34%</td>
</tr>
<tr>
<td>Teamwork</td>
<td>15%</td>
<td>8%</td>
<td>11%</td>
<td>65%</td>
</tr>
<tr>
<td>Technical skills</td>
<td>16%</td>
<td>16%</td>
<td>4%</td>
<td>49%</td>
</tr>
</tbody>
</table>

Figure 2. Based on a participants survey, it was estimated that the Biohackathon accelerated the outcomes of projects by a factor between 3 and 5 (on average), with 16% of participants stating that they would never be able to achieve the same outcome without the help received during the event.

Survey question: Without the Biohackathon how long would have taken you to reach the same outcome?

![Survey question response chart](chart.png)
Data curation practices and sustainable curation

To provide services for scalable, high quality curation of biological data the ELIXIR Data Platform carried out a user research and community survey to understand and identify common workflow patterns and practices in manual curation. The results were published in a paper by in the ELIXIR F1000R channel.

Europe PMC also integrated automatic tagging of experimental methods mentioned in scientific papers. The service was launched in December 2019, and was included in production instance of Europe PMC in early 2020.

Extending support for BioContainers

In 2019 ELIXIR- in collaboration with partners - launched the BioContainers registry, which now provides over 8,100 containerised tools. BioContainers is a community-driven project that provides the infrastructure and basic guidelines to create, manage and distribute bioinformatics containers. These containers package up code and all additional software needed to run the code. Using containers, researchers can run such containerised tools on any computers and in any computing environments without having to install any additional software or worry about the specific version of software that the original developer used.

There are three ongoing project to support further development of BioContainers:

- Packaging, containers and deployment to maintain and extend the function of BioContainers (Tools Platform)
- Container Orchestration to enable standardised containers to be deployed across the Nodes. (Compute Platform)
- Deploying Reproducible Containers and Workflows Across Cloud Environments - a Strategic Implementation Study linking national infrastructure in 12 Nodes with the ELIXIR Compute and Tools Platforms developments.

2 ELIXIR Communities will drive service uptake, support standards development, and connect ELIXIR’s experts in life science disciplines

Four new ELIXIR Communities established

In 2019, ELIXIR expanded the portfolio of ELIXIR Communities from seven to eleven. The new Communities include Structural Bioinformatics, Intrinsically Disordered Proteins and Microbial Biotechnology which started their activities in July 2019, and the human Copy Number Variation Community, which kicked-off in January 2019 (and was approved in December 2018).

The four new Communities defined their priorities and objectives and selected their leadership teams.

Collaboration with GA4GH on global standards for secure sharing of genomics data

In 2019, ELIXIR continued its collaboration with the Global Alliance for Genomics and Health (GA4GH). In May, ELIXIR and GA4GH agreed a new Strategic Partnership to develop technical standards and regulatory framework for responsible sharing of genomic data across national borders.

The roadmap for such framework was published in Nature Reviews Genetics in August 2019. It details the challenges and opportunities around accessing whole-genome level sequencing data, as well as phenotypic and biomolecular data across national borders, without compromising on data security.

With healthcare providers soon to become the main producer and consumer of genomic data, research service operators face novel challenges in facilitating cross-border collaboration, data exchange and re-use. The authors demonstrate that European research infrastructures are well-positioned to address these challenges and support the rapid implementation of widespread genomic data access.

The support the development of such framework, the ELIXIR Human Data Communities initiated three three Strategic Implementation studies worth over €1.5 million:

- Rare Disease Infrastructure to align existing international infrastructures (RD-Connect, European Genome-phenome Archive, and tranSMART) with the general ELIXIR infrastructure.
- ELIXIR Federated Human Data to provide secure, standardized, documented and interoperable services under the framework of the European Genome-phenome Archive (EGA).
- ELIXIR Beacon to extend the Beacon protocol to become the reference ELIXIR Data Discovery product and support the integration of the Beacon API with human data resources throughout ELIXIR

ELIXIR Core Data Resources will be the global standard for bioinformatics resource management and the foundation for an international funding and life cycle management strategy that secures the long-term sustainability of those resources.

The usage of ELIXIR Core Data Resources presented for the first time

A paper published in May 2019 presented for the first time the impact and usage of ELIXIR Core Data Resources (CDRs) as a collective entity within the global open data infrastructure. Authored by members of the ELIXIR Data Platform together with the managers of the Core Data Resources, the paper shows the critical value of ELIXIR Core Data Resources for life science research.

The figures presented in the paper are based on data collected in 2013-2017, the results show that the ELIXIR Core Data Resources are collectively accessed millions of times per month by hundreds of thousands of users across the world. They are explicitly mentioned (by name, or accession number) in 17% of open access publications in Europe PMC and are used extensively across all fields of life science research, in both industry and academia.

"EOSC-Life will bring together the resources, tools, skills and expertise necessary to transform the fragmented research data landscape into an open space for digital biology. Our ultimate goal is to maximise the collective potential of biomedical ESFRI research infrastructures and the researchers using them. By the end of this project EOSC-Life will be established as the new norm for digital biology in Europe – accessible by Europe’s 500,000 life scientists."

Niklas Blomberg, ELIXIR Director

ELIXIR will be the recognised and trusted life science foundation of the European Open Science Cloud

EOSC-Life kicked-off

The EOSC-Life project aims to develop the life science component of the European Open Science Cloud (EOSC). With ELIXIR as Coordinator, the project brings together 13 Life Science ESFRI research infrastructures to connect research infrastructure services across Europe to EOSC. It started in March 2019, with the kick-off meeting organised in Amsterdam, The Netherlands.

The project will provide researchers with access to advanced data services, technology platforms, samples and support services through EOSC in full compliance with all ethical, regulatory and legal requirements.

Key figures:

Project Duration: 1 March 2019 – 28 February 2023 (48 months)
Partners: 46 Partners, 17 Linked Third parties, 12 Third parties
Resources: €23.7 million, 11 Work Packages, 34 Deliverables
ELIXIR AAI defined as part of EOSC architecture
The ELIXIR Compute Platform developed and published a blueprint for the Life Science Authentication and Authorisation Infrastructure (AAI)4. Building on the earlier development within the CORBEL project, the Life Science AAI will provide standards and technical framework for identity and access management across all biomedical research infrastructures.

It will be operated by the e-infrastructures (GEANT, EGI and EUDAT) that will provide the core AAI components; the participating biomedical research infrastructures will build on top of these core components to cater to the needs of their respective user communities.

5 All ELIXIR Nodes will connect life science users in academia and industry to our open, federated service network

**Staff Exchange Programme boosts capacity in ELIXIR Nodes**

The ELIXIR Staff Exchange programme allows members of an ELIXIR Node to travel and work in other ELIXIR Nodes, or to attend a specific ELIXIR-related event. The 2019 Call for proposals allocated €100,000 for Staff Exchange Projects. It resulted in 15 new Staff Exchange projects: three of them started already in 2019, the remaining 12 started in early 2020.

Besides the Staff Exchange Programme, ELIXIR also introduced an exchange scheme for industry partners in ELIXIR Nodes. The ELIXIR Knowledge Exchange Scheme allows individual members in ELIXIR Nodes to spend time at an industry partners’ facilities to work on a joint project or organise a meeting to exchange their experience. The first call for proposal closed at the end of October 2019, two pilot projects were selected.

**Industry - academia collaboration**

The strategic collaboration with Hannes Rothe from the Freie Universität Berlin, Germany, aims to map and measure the usage and impact of public bioinformatics resources in industrial research and development. The first result of the collaboration was a paper submitted for the European Conference on Information Systems held in June 2019 in Stockholm and Uppsala⁵, which won the prize for the most innovative research paper.

ELIXIR also launched a new initiative to support collaboration with the bioinformatics industry, the ELIXIR Bioinformatics Industry Forum. The goal of this new series of events is to bring together providers and consumers of bioinformatics services (clouds, HPC clusters, analytics pipelines and others) to discuss existing bottlenecks and solutions to the challenges in working with biological data.

The first event took place in May 2019 in London, organised with support from ATOS/Bull, Microsoft, Aridhia and Illumina. It attracted over 80 experts from 45 different organisations representing large IT companies, SMEs and academic researchers.

**Training**

The Training Platform started the development of the Training Toolkit to help ELIXIR Nodes to develop, deliver and evaluate their training activities. The toolkit will include guidelines for (1) designing training courses and learning paths that connect different training packages, for (2) collecting and analysing feedback for impact assessment.

The Platform also released the Training Metrics Database⁶ which streamlines data collection, storage, and visualisation for assessing the impact and the quality of the ELIXIR training events. The database collects and presents data from all ELIXIR training events and presents general summaries of the training events.

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⁶ https://training-metrics-dev.elixir-europe.org
ELIXIR Platforms

ELIXIR activities are divided into five Platforms, each focusing on one specific area in bioinformatics service provision: Data, Tools, Interoperability, Compute and Training.

The Platforms coordinate the development and operation of ELIXIR services across the ELIXIR Nodes, drawing on their technical expertise and resources.

Each Platform has three Platform Leads, appointed by the ELIXIR Heads of Nodes Committee. The Platform work across ELIXIR Nodes is coordinated by a Platform Coordinator, based at the ELIXIR Hub, who provides support to their Platform Leads, oversees implementation projects and liaises with other ELIXIR Platforms and Communities.

People in ELIXIR Platforms in 2019

In 2019, the ELIXIR Heads of Nodes Committee appointed six new Platform Leads who took up their roles in January 2020.

Three new leads (Salvador Capella, ELIXIR Spain; Björn Grüning, ELIXIR Germany; and Hervé Ménager, ELIXIR France) will replace the Tools Platform leadership team. Patrick Ruch (ELIXIR Switzerland) and Silvio Tosatto (ELIXIR Italy) will be the new leads in the Data Platform. The Training Platform will have one new lead - Fotis Psomopoulos (ELIXIR Greece).

Starting from January 2020, all Platform leads will serve a two-year term.

<table>
<thead>
<tr>
<th>Platform Leadership in 2019</th>
<th>ELIXIR Hub Technical Team</th>
<th>Jerry Lanfear ELIXIR CTO</th>
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<tbody>
<tr>
<td>(until December 2019)</td>
<td></td>
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<tr>
<td>Tools Platform</td>
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<tr>
<td>Alfonso Valencia, ELIXIR Spain</td>
<td>Søren Brunak, ELIXIR Denmark</td>
<td>Jen Harrow Platform Coordinator</td>
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<tr>
<td>Jo McEntyre, EMBL-EBI</td>
<td>Christine Durinx, ELIXIR Switzerland</td>
<td>Rachel Drysdale, Platform Coordinator</td>
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<tr>
<td>Ludek Matyska, ELIXIR Czech Republic</td>
<td>Steven Newhouse, EMBL-EBI</td>
<td>Tommi Nyrönen, ELIXIR Finland</td>
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<td>Carole Goble, ELIXIR UK</td>
<td>Chris Evelo, ELIXIR Netherlands</td>
<td>Helen Parkinson, EMBL-EBI</td>
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<tr>
<td>Patricia Palagi, ELIXIR Switzerland</td>
<td>Celia van Gelder, ELIXIR Netherlands</td>
<td>Gabriella Rustici, ELIXIR UK</td>
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Tools: Services and connectors for access and exploitation

The ELIXIR Tools Platform improves the discovery, quality, and sustainability of bioinformatics software. The main objective is to (1) allow researchers to find, compare, access and deploy software resources and analytical workflows, (2) help software developers to describe, develop and monitor their products, and (3) help establish and host continuous benchmarking efforts across life science domains.

Major achievements in 2019

The focus of the Platform in 2019 was to build on the progress made through the Implementation Study on Biocontainers. The Platform incorporated new technologies for software containerisation into the Biocontainers registry, and explored the federation of the platform to facilitate its sustainability in the long-term.

The team also started to plan the implementation of the new ecosystem for the Tools Platform, where components of that ecosystem (bio.tools, Biocontainers, OpenEBench, Galaxy and others) will contribute their content into a central repository to facilitate data and metadata integration, homogenization, and curation. Both Bio.tools and OpenEbenc groups have begun to engage with the different ELIXIR Communities to capture their specific requirements around tools registration and benchmarking.

Finally, the best practices group started to examine FAIR principles around research software and continue to promote the four simple recommendations for open source software (4OSS).

Task 1: Packaging, containerisation & deployment

The new BioContainers API follows the GA4GH specification for tool registries that enables the deposition of bioinformatics containers into public repositories and their execution in public cloud environments.

During the Biocontainer Implementation Study, more than 1,000 bioinformatics resources were added to BioContainers, increasing the number of tool containers to 8,500 bioinformatics tools and 75,000 containers.

Task 2: Performance benchmarking & technical monitoring

The Scientific Benchmarking data model was released, based on the feedback provided by different scientific communities. The OpenEBench team deployed the scientific benchmarking front-end, improving the user experience in accessing the benchmarking data.

The team also reached an agreement to make publicly available the results from the DREAM Challenges to facilitate their use, reuse, and further exploration. This set the foundations to host future DREAM challenges directly in OpenEBench. To make possible such collaboration, new visualization mechanisms were generated leading to the establishment of the plots visualization gallery.

OpenEBench has also initially developed a set of metrics based on the FAIR principles applied to research software to understand the challenges in automatically measuring different aspects of software quality. This effort will contribute to identifying general trends about how bioinformatics software is produced, maintained and used by the scientific community.

Task 3: Registry of bioinformatics tools metadata and identifiers

The bio.tools team engaged with the proteomics community to curate additional 189 tools. A total of 751 tools within the proteomics domain are now accessible via bio.tools.

The fast content growth in bio.tools, reaching close to 15,000 entries by the end of 2019, was driven by the usage of automatic tool annotation pipeline Pub2Tools. Pub2Tools finds relevant recent publications that describe bioinformatics tools, annotates them using EDAM terms and creates bio.tools entries. Several smaller tools were developed in collaboration between ELIXIR Nodes in Estonia, Norway, France and Germany to enhance EDAM usage by displaying and selecting EDAM term information.

Interoperability between the major Tools Platform components was increased by finding DOI matches between Galaxy Tools, bio.tools and Debian Med tools and adding a frontend to render an interactive report on the obtained data.

Finally the team has implemented badges for tool cards that highlight ELIXIR resource collections (ELIXIR Core Data Resources, ELIXIR Deposition Databases, ELIXIR Communities).

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2 https://biocontainers.pro
3 http://dreamchallenges.org
5 https://pub2tools.readthedocs.io/en/latest
6 https://github.com/inkuzmin/edam-select
### Task 4: Software Best Practices

Task 4 had three main outcomes in 2019: (1) the organization of a workshop\(^8\) targeting researchers and software developers focusing on the 4 recommendations for open research software that took place in Athens, July 2019; (2) capturing best practices in software management by interviewing participants at the ELIXIR Biohackathon in November 2019, and (3) a publication on FAIR principles for research software\(^9\), that sets the framework for connecting metrics to the proposed Software Management Plan.

### Highlights

2019 saw the end of the ELIXIR-EXCELERATE project, which has set the foundation of ELIXIR and its platforms including the consolidation around bio.tools and the emergence of OpenEBench as tasks within the new ELIXIR Tools Platform programme. The new Scientific Programme (2019-23) is broadening the scope of the ELIXIR Tools Platform by highlighting the relevance of software containers and the role of ELIXIR Communities driving many of the actions.

Over 8,500 software tools are now containerized and accessible through the BioContainer registry, facilitating the progress of reproducible research. Containers are now built and deployed using a continuous integration system and deposited into the ELIXIR software containers registry. This effort on the generation of software containers had removed substantial challenges in correctly installing and configuring when running bioinformatics workflows. Integration of containers and conda packages with the tools metadata central ecosystem will contribute to consolidation of all available tools and their associated versions into a single, shared and reusable place in an automated way.

The Platform initiated the development of the new Tools Platform ecosystem, allowing contribution within and beyond ELIXIR. The development work includes depositing and consuming bioinformatics resources from a central repository: a proof of concept initially brought together 2,000 bioinformatics resources representing the diversity of bioinformatics software. To complement this, an initial set of FAIR metrics for software tools were calculated to assess the possibility of automation of the whole process and their integration into the Platform ecosystem.

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Data: Sustaining Europe’s life science data infrastructure

The ELIXIR Data Platform drives the use, re-use and value of life science data. The main objective is to build and maintain a portfolio of interconnected data resources with the Core Data Resources (CDRs) and Deposition Databases (EDDs) at its centre. Based on quality criteria, the Platform also provides materials to support the discussion about sustainability of data resources within the Global Biodata Coalition.

The Platform also connects data with scientific literature and supports scalable curation workflows for both professional and community curators.

Major achievements in 2019

Task 1: Administration and support for Core Data Resource and Deposition Database portfolio

2019 saw three publications focussed on the Core Data Resources and Deposition Databases portfolio:
- The ELIXIR Core Data Resources: fundamental infrastructure for the life sciences
- The Annual Indicator Monitoring and Periodic Review Processes: ELIXIR Core Data Resources and Deposition Databases
- The ELIXIR Core Data Resource Profiles slideset

The third round of selection of ELIXIR Cores Data Resources and Deposition Databases was launched in October 2019, and will conclude in June of 2020.

Task 2: Literature-Data Integration

In 2019 the plan for the Literature-data integration task was laid out. The aim is to build a connected ELIXIR data ecosystem through outreach activities such as webinars and hackathons that will promote deep integration between ELIXIR data resources. The Literature-Data Integration team developed an outreach campaign, starting with a webinar to take place in 2020 on how research articles can be linked to the underlying data via Europe PMC. Expanding on this, a hackathon will be organised to explain how to use the Europe PMC service ecosystem to develop new workflows and applications.

Task 3: Scalable curation

Experimental Methods tagging - The Data Platform conducted a user research project on curation practices, as part of the ELIXIR-EXCELERATE project. The aim of the project was to understand and identify common curation workflow patterns and practices. The analysis of the data showed that curators often look for the experimental methods as one of the key parameters in article selection for curation. By consulting domain experts, curators of ELIXIR Data Resources, a dictionary with experimental method terms and corresponding IDs was created and used to text mine those terms from literature. As a result, articles in Europe PMC can be retrieved based on experimental method mentions.

In 2019 a new mechanism was established to enable deep links between added-value databases and research publications in Europe PMC. The ELIXIR Data Platform collaborated with the neXtprot database at SIB (ELIXIR Switzerland) to demonstrate the deep linking mechanism. Deep links point to the precise sentence in a full text article. Data records with deep links are therefore less ambiguous than simple links to the source article.

Task 4: Long term sustainability

The Data Platform contributes to the Global Biodata Coalition (GBC), which is working on behalf of biomedical and life sciences research funders to help coordinate and sustain funding for the global infrastructure of biodata resources. The GBC Board of Funders will meet in June 2020 and consider, among other issues, their scientific programme.

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3 Drysdale R and Martin C. ELIXIR core data resources profiles. *F1000Research* 2019, 8(ELIXIR):236 (slides), (https://doi.org/10.7490/f1000research.1116460.1)
5 http://www.globalbiodata.org/
Timeline of selection and review process for ELIXIR Core Data Resources and ELIXIR Deposition Databases.

Highlights
The "ELIXIR Core Data Resources: fundamental infrastructure for the life sciences" article was a landmark publication for the ELIXIR Data Platform. Appearing first as a preprint in bioRxiv\(^6\), the article is the culmination of several years' work, beginning in the ELIXIR-EXCELERATE project. The paper builds upon the definition of the Indicators used for Core Data Resource selection\(^7\), the selection of Core Data Resources\(^8\),\(^9\), the implementation of annual indicator monitoring\(^10\), and the combined efforts of those directly involved in the ELIXIR-EXCELERATE Work Package 3 and the Core Data Resource Forum, made up of the managers of the Core Data Resources.

Describing the Core Data Resources as an infrastructure in terms of their scale, usage, citations, ecosystem of interrelationships, open data and FAIR data leadership, and funding horizon, the article enables a better understanding of the characteristics of that infrastructure, and thereby illustrates the risk to the life science bioinformatics community of failing to secure their long term sustainability.

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Computer: Identity, access and hybrid cloud deployment

The ELIXIR Compute Platform develops and integrates cloud, compute, storage, access and identity management services for the life science research community, so that researchers can easily access, share and analyse data and workflows from different sources using powerful shared facilities.

The objective is to combine all components of the ELIXIR Compute services into a seamless workflow through co-development of GA4GH international standards for cloud and researcher identity. The ELIXIR Compute workflow relies on ELIXIR AAI which allows researchers to securely access and create virtual analysis environments and access large biological data resources. By working closely with a range of infrastructure partners through key projects such as EOSC-Life, the Compute Platform is developing sustainable and supported resources for accessing, analysing and transferring data.

Major achievements in 2019

Task 1: Identity and access management, including AAI

The establishment of the Common ELIXIR Authentication and Authorisation Infrastructure (AAI) service in 2018-2019, which is the basis of the European Life Science AAI in the EOSC-Life project. By November 2019 the ELIXIR AAI had enabled 3306 users organised in 709 groups to use 133 relying scientific services. ELIXIR AAI experts are leading technical and policy Working Groups to coordinate the testing and implementation of Life Science AAI with key infrastructures including INSTRUCT-ERIC, BBMRI-ERIC, GEANT and EGI.

Task 2: Making datasets available in relevant cloud providers

The Platform investigated various data transport mechanisms to organise data transfers between core biological data resources. The Platform tested a number of data transfer and data distribution mechanisms including established data transfer protocols (e.g. GridFTP, FTS), data distribution and replication services (e.g. Reference Data Set Distribution Service 1). New protocols such as FTS3 and htsget, a genome data specific standard, have been integrated into the Compute Platform.

Task 3: Defining and coordinating an ELIXIR hybrid cloud ecosystem

This task provides visibility of the considerable cloud and compute e-Infrastructure services for life science that are available through ELIXIR Nodes. By 2019 this comprised 80,000 compute cores, 50,000 TB storage and 3,100 users. These services are fully utilised; access can be gained by complying with national or organisational access policy, specific international collaboration project, or payment.

Task 4: Community containers being deployed and operated at scale

In Task 4, the Platform coordinated expertise in the Nodes and related projects (e.g. EOSC-Life, EOSC-Hub) to establish ELIXIR-wide standards, protocols and processes for the orchestration of containerised applications and workloads provided by ELIXIR Communities. This included the development of a harmonised and interoperable API specifications to users to execute and manage the lifecycle of their containerised applications on cloud platforms made available from ELIXIR Nodes and European e-Infrastructures.

Highlights

The ELIXIR AAI 2 has grown to be a full production Infrastructure Service with 133 relying services by end of 2019 (71 production services and 62 test services). The use of the ELIXIR AAI has grown to include public ELIXIR services such as the ELIXIR Germany de.NBI cloud, Helix Nebula Science Cloud (to access commercial cloud providers), EUDAT’s B2ACCESS service (to access other EUDAT services) and the EMBL-EBI Unified Submissions Interface.

The ELIXIR Compute Platform participation in European Open Science Cloud (EOSC) activities has been established with the use of (1) public clouds through EGI, (2) commercial clouds through the HelixNebula Science Cloud, and (3) generic EU data services through EUDAT.

Application oriented work that was supported in the now completed EOSCPilot project continues in EOSC-Life (with ELIXIR Compute Platform leadership in the Work Package 5 (AAI) and Work Package 7 (Cloud)) and is complemented by ongoing infrastructure related engagement in EOSC-Hub.

1 https://github.com/EMBL-EBI-TSI/RDSDS
Identity and access management. Get ELIXIR ID for software, storage and compute.

Data transfer and availability

Container orchestration. The execution of software workflow loads.

ELIXIR hybrid cloud. Data and compute services across Europe.

Scientific software environment.

Data resources from ELIXIR Nodes

Human genome data by permission of Data Access Committee

Data from ENA, UniProt, TaraOceans, Ocean Sampling Day, biosample DG, EUROSCO, EGA
Interoperability: Integration of data and services

The ELIXIR Interoperability Platform supports an interoperable bioinformatics ecosystem composed of distributed resources providing data, tools and services, based upon the concept of FAIR data (Findable, Accessible, Interoperable, and Reusable). The scope of the Platform spans different data types, tools, and services, and different life science domains and communities.

The Platform participates in international standards initiatives, notably Research Data Alliance, GA4GH, Common Workflow Language and GO-FAIR, in the orchestration of technical tasks and activities in ELIXIR Nodes and in EU projects such as FAIRplus, EOSC-Life, and EJP-RD, and by dedicated Platform investments. This involves building the foundation of Interoperability services, to ensure that the services are fit-for-purpose both at the national policy and end-user implementation levels.

In FAIRplus, the focus is weighted towards methodologies to support the FAIRification of existing datasets in the pharmaceutical sector. EOSC-Life works on constructing a FAIR service ecosystem across the common data-driven challenges in the biomedical sciences, leveraging the Common Workflow Language and the Bioschemas metadata frameworks.

The FAIRification Pipeline from FAIRPlus, which applies documented and validated processes to datasets. FAIRness is assessed as the data enters the pipeline, and again after the data exits. Members of the Interoperability Platform play a lead role in FAIRplus and are charged with disseminating the work beyond the project partners and across ELIXIR.

Major achievements in 2019

The ELIXIR 2019-2023 Scientific Programme has introduced collaborations across the different ELIXIR projects. These interactions collectively build up the interoperability technical implementations to fill the gaps in the FAIR Service Architecture Framework, and are driven by many specific Community use cases, interactions with projects and by ELIXIR’s Data Management Network.

Task 1: FAIR Service Architecture

The Recommended Interoperability Resource (RIR) selection call opened for 2019/2020 in Autumn 2020 and periodic Quality Assessment review of current RIRs was initiated. The Platform also initiated a programme of cross-RIR interoperability and RIR dissemination in other ELIXIR Platforms.

FAIRsharing1, the ELIXIR standards catalogue started a joint project with DataCite to work with publishers to identify common criteria for data repository selection that works for publishers.

Molgenis became a key service in two Canadian-European projects in large-scale integrated cohort data analysis (CINECA, EUCAN).

InterMine released a new version that now imports data into Galaxy from any InterMine server2.

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The FAIRification pipeline and FAIR cookbook\(^3\) with reusable recipes and toolkits developed in FAIRplus has been applied to datasets from four IMI projects.

Bioschemas doubled its coverage to over 80 resources and over 20 million pages, and proposed 30 new profiles and 17 types. Other ESFRI research infrastructures including DiSSCo for biodiversity and IBISBA have taken up the approach for Taxon and Workflows respectively. The Tools Platform’s OpenEBench reports 23% of tools tested have Bioschemas markup.

The partnership with the Common Workflow Language and the Tools Platform resulted in the adoption of CWL in the EOSC-Life Tools Collaboratory and its Workflow Hub registry. CWL was also combined with research object packaging through RO-Crate\(^4\) to provide a cross-workflow platform exchange mechanism for the EOSC-Life partners.

**Task 2: Interoperability with a purpose**

Founded the ELIXIR Data Management Network, to support national policy implementations for data management.

Piloted FAIR Common Data Management Toolkit, using RIRs and Node Services with a focus on Plant Sciences. Initiated Plant genotype-to-phenotype data FAIRification to extend the success of MIAPPE and BrAPI.

Released a comprehensive MetDB reference dataset through the standardisation of methods via CWL in the scope of metagenomics to facilitate the annotation flow from ENA to UniProt. Two CWL pipelines were delivered for the assembly and annotation of eukaryotic transcriptome data as part of the MGnify CWL pipeline development.

**Task 3: Capacity building**

Organised seven Bioschemas meetings. The ELIXIR-Biohackathon increased the adoption of Bioschemas standards among ELIXIR Node resources and supported the integration of CWL in Galaxy and the development of the pilot FAIR Common Data Management Toolkit.

Engaged with international standards initiatives and policy organisations including EOSC Secretariat; RDA FAIR Data Maturity and Research Schemas Working Groups, GO-FAIR INTER and Discovery INs, and OECD and G7 open data and data access policy meetings.

International scientific outreach included: international invited keynotes at SWAT4LS, Neuroinformatics 2019 and COMBINE 2019; invited presentations at FORCE11, IEEE eScience Conference, the Genomic Standards Consortium Meeting and the IDP winter school in Brixen, Italy, and visits to Icahn School of Medicine at Mount Sinai in New York, and the US FDA in Silver Spring, USA.

**Task 4: Interoperability Services for the Cloud**

Cloudification for the EOSC-Life project including the Ontology Lookup Service for the cloud.

The Platform’s ongoing activities in gap analysis to build the best-practice guidelines for the EOSC Datasets Minimum Information and Bioschemas in EOSC-Enhance collaboration with OpenAIRE.

**Highlights**

The Data Intelligence Journal FAIR special issue\(^5\) publications showcased the work of many Platform members on interoperability operations such as the FAIR Computational Workflows, Interoperability in the Rare Diseases use case, Persistent Identifiers, FAIR CMMi for capability maturity modeling, and FAIR data reuse and citation.

The work of the Interoperability Platform was recognised in 2019 in two publications by the European Research Council\(^6\) and the OECD\(^7\) which mentioned ELIXIR’s Interoperability resources as the recommended metadata services for data sharing guidelines.

The platform provided key implementation case studies for Research Data Alliance FAIR Working Group, and the Global Alliance for Genomics and Health. Members of the Platform gave presentations at invitation only meetings and contributed to the OECD Revisions to the Recommendation of the Council concerning Access to Research Data from Public Funding and to the activities of the G7 Open Science WG and EOSC Executive Board WGs.

An impact of production-level implementation of the Platform services has been demonstrated by the EMBL-EBI Metagenomics MGnify database that fully adopted CWL methods of reusable workflows and has interleaved pipelines with the US-based MG-RAST programme. The CWL implementation allows for easy version comparison and reuse of tool descriptions and subworkflows, enables horizontal scalability, and significantly reduces processing time in the transcriptomic assembly pipeline\(^8\). The tested CWL methodology has now been embedded within the ELIXIR tools-interoperability workplan and EOSC projects (EOSC-Life, IBISBA1.0, Bioexcel).

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Training: Professional skills for managing and exploiting data

Having supported more than 850 training events since 2015, the ELIXIR Training Platform builds a community of trainers across the ELIXIR Nodes and offers a portal to register training materials and events in all topics for life sciences. The Platform also strengthens national training programmes and helps develop training capacity in the ELIXIR Nodes.

Following the completing of the ELIXIR-EXCELERATE project, the Training Platform pursues thee major objectives as defined in the ELIXIR Scientific Programme for 2019-23:

- Establish and implement best practices in bioinformatics training through a training Toolkit
- Support training providers across Europe in creating and delivering training for developers, researchers and trainers.
- Build a sustainable training infrastructure.

These activities are implemented within each ELIXIR Node through the ELIXIR Training Coordinators.

Major achievements in 2019

The Platform activities are divided into four major tasks: (1) training toolkit development; (2) gap analysis, training materials development and training delivery by the co-production model; (3) development and maintenance of the training infrastructure using TeSS as the ELIXIR Training portal; and (4) building capacity by training the trainers and managers.

Task 1: Training toolkit

In 2019 ELIXIR Spain led the collection of ELIXIR training best practices and guidelines, which will form the core materials in the Training toolkit. These resources cover course development and organization, instructor training, impact assessment, online documentation for implementing Bioschemas specifications for training events, and others.

In addition ELIXIR UK worked with the ELIXIR Training Coordinators to ensure sustained adoption of the short and long-term feedback strategies and the use of the Training Metrics Database (see below). ELIXIR-UK also investigated how to tailor the training impact assessment strategy to the needs of ELIXIR Platforms, Services and Communities.

Task 2: Gap analysis, training materials development and training delivery

ELIXIR Greece led a gap analysis on the needs for training in bioinformatics across platforms and communities. Based on the results ELIXIR Sweden ran a first call for proposals to select a set of seven established training events which will receive funding to cover trainers travel in 2020.

ELIXIR Slovenia led the planning of hackathons in 2020 to develop new training materials on the topics for which no material is available at the moment.

Task 3: Training Technical Infrastructure – TeSS

ELIXIR UK maintains TeSS, the ELIXIR’s registry for training events and materials. TeSS currently displays information from 76 training content providers, collecting over 11,000 training events and 1357 training materials.

To make all e-learning solutions across ELIXIR easily findable through TeSS, ELIXIR Belgium established a working group to gather the ELIXIR e-learning portfolio from across ELIXIR Nodes.

Task 4: Training Capacity Building

In June 2019, a training hackathon took place in Oeiras, Portugal, to further develop the Train-the-Trainer (TtT) training materials.

Nine TtT courses took place in 2019, led by ELIXIR Switzerland and ELIXIR Italy. Six others are planned for 2020.

A Gap analysis on the needs for training on management and operations has been run by the ELIXIR Hub.
**Highlights**

The Training Metrics Database\(^1\) summarises the ELIXIR training activities (number of events, number of participants, number of trainers and others) collects demographics, quality and impact data of ELIXIR-badged training events. It was released in 2019 as one of the outcomes of the ELIXIR-EXCELERATE project.

To learn more about the bioinformatics training needs in ELIXIR Nodes and ELIXIR users, the Training Platform conducted a survey and collected responses from 186 researchers in all ELIXIR Nodes as well as from stakeholders who are active in life science research outside ELIXIR Nodes. The responses have been analysed at various levels of detail (country, Node, academic status, etc), the overall results will be presented in a White Paper to be published in 2020.

Six topics of interest have been identified through the gap analysis: Data Management / Data Stewardship / Machine Learning / Single Cell / Containers / Workflows / Software Management.

Regarding training needs on management and operations, the analysis revealed topics of interest in the following areas: leadership, project management, financial management, service management, and personal development.

The Trainers’ Directory collects information about all available trainers in ELIXIR Nodes and is available internally via the ELIXIR intranet. It is a searchable database that allows users to search for trainers by courses they have taught in the past and contact them. By March 2020 the Directory contained 33 trainers.

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1. [https://training-metrics-dev.elixir-europe.org/](https://training-metrics-dev.elixir-europe.org/)
ELIXIR Communities

ELIXIR Communities bring together experts from across ELIXIR Nodes and partner organisations to develop standards, services and training within specific life science domains. They are ELIXIR’s means to capture the needs of a particular research community and translate them into formal requirements that drive the work of the ELIXIR Platforms. This close collaboration ensures that the services developed by the ELIXIR Platforms serve the needs of their research communities.

ELIXIR recognises three different types of communities: those focused on a specific research field (e.g. Rare Diseases), those dealing with specific technology (e.g. Proteomics) and those providing specialist user support (e.g. Galaxy). In 2019, there were eleven ELIXIR Communities, including three Communities grouped under the Human Data Communities umbrella (p. 34).

The ELIXIR Communities have diverse interests ranging from scientific research domains to specific technical experimental or computational platforms. They also range in emphasis from pure technical development to community building. They nevertheless share some common goals: participating in and driving the development of data and metadata standards, often in collaboration with global partners; driving the uptake of standards, for example by designing federated data networks linked by common APIs; the design, evaluation and containerization of workflows, making use of openly available tools, that the research community can use to execute routine, large volume tasks; and ensuring that data held by and shared by ELIXIR Node partners conform as much as possible to the FAIR Principles.

The ELIXIR Communities also play a critical role in facilitating collaboration with other biomedical research infrastructures, as in many cases members of ELIXIR Communities from ELIXIR Nodes have close links with the national Nodes of other research infrastructures. On the other hand, members of ELIXIR Communities have the opportunity to engage in and drive global standardisation efforts via ELIXIR.
Major achievements in 2019
The Plant Sciences Community played a major role in the development and dissemination of two standards: MIAPPE (Minimum Information About a Plant Phenotyping Experiment) and BrAPI (Breeding API). These two standards provide the framework for describing and accessing plant phenotype data from a distributed network of repositories.

Building on top of these standards, the Community developed and released FAIDARE, the ELIXIR plant data search service which provides search access to data from seven ELIXIR Nodes plus one database from USA. In addition, MIAPPE and BrAPI played an important role in documenting and advertising plant genome submissions to EMBL-EBI databases, including genome update challenges via two Implementation Studies.

The Marine Metagenomics Community completed its ELIXIR-EXCELERATE activities in 2019. These resulted in the expansion of pipelines to increase the scope of analysis, updating tools and the analysis pipeline to meet the demands of the Community.

The Community also generated benchmark datasets evaluating amplicon analyses across a range of biomes and developed six different marine shotgun metagenomics datasets. The analysis pipelines were described in the Common Workflow Language to enable reproducibility, facilitate comparisons and enhance development agility. The pipelines were deployed in a cloud environment to increase compute capacity. To allow federated searches across different programmatic interfaces, the Community also generated examples for all the resources involved.

The Galaxy Community has two roles: developing the Galaxy infrastructure, and building and widening the Galaxy community in Europe. Technical developments included integration of ELIXIR AAI into Galaxy, establishing a network of remote servers across Europe to process jobs from usegalaxy.eu, and establishing a network of CVMFS (CernVM File System) mirrors that enables distribution of reference data across Galaxy instances. They also supported the expansion of the network of usegalaxy.* servers in Europe.

In 2019 the Community started a new implementation study focussed on meeting the needs of other ELIXIR Communities (metabolomics, metagenomics, structural bioinformatics, plants and proteomics).

The Proteomics Community focuses on standardising and evolving infrastructure for proteomics data. The Community continued work on their Implementation Study “Crowd-sourcing the annotation of public proteomics datasets to improve data reusability” and started a new Implementation Study “Comparison, benchmarking and dissemination of proteomics data analysis pipelines”.

To further develop the proteomics infrastructure, the Community held a meeting on Proteomic Privacy to discuss the risk of re-identification in clinical proteomics data and their implications for proteomics data management.

It also started work towards adopting the Beacon technology for proteomics data.

The Metabolomics Community concentrates on technical progress in improving the analysis and utility of metabolomics data. In its Implementation Study on “Metabolite Identification” it is developing an optimised Galaxy pipeline for metabolite identification including some tool development and mechanisms for import and export of workflows between infrastructures.

In 2019, the Metabolomics Community was awarded a new Implementation Study to improve the technology underlying fluxomics analysis using metabolomics data. It comprises of cataloguing and developing tools for fluxomics analysis to develop a standardized fluxomics workflow and standards for isotopic tracer data deposition.

New ELIXIR Communities
In addition to these five well-established Communities ELIXIR approved the establishment of another three Communities in 2019.

The Microbial Biotechnology Community will develop a formal framework for microbial biotechnology to manage and manipulate strains, samples, knowledge, data and metadata.

The Intrinsically Disordered Proteins (IDP) Community will focus on structural bioinformatics and will provide methods and tools to analyse, predict, archive and validate the three-dimensional structure data of biomacromolecules such as proteins, RNA and DNA.

These Communities will start their work in 2020 with the award of dedicated Implementation Studies.
ELIXIR Human Data Communities

The ELIXIR Human Data Communities (HDCs) bring together three human data-focused ELIXIR Communities: Federated Human Data, Rare Diseases, and human Copy Number Variation. It works as an umbrella structure to develop and coordinate a long-term strategy for responsible access to and reuse of sensitive human data across all biomedical domains.

Of critical importance is to ensure these data are accessed in line with EU’s General Data Protection Regulation (GDPR) and ethical policies to preserve the trust given by citizens who consent to their data being accessed.

Major achievements in 2019

Federated Human Data Community

2019 saw the transformation from the Human Data Use Case in ELIXIR-EXCELERATE to the ELIXIR Federated Human Data Community, which has been funded by the ELIXIR Federated Human Data Strategic Implementation Study. This three-year project funds 17 of the 23 ELIXIR Nodes to coordinate the implementation of rapid, secure, seamless, cross-boundary, federated access to sensitive human data that has been consented for secondary use.

Key achievements in 2019 include the first face-to-face meeting of the Community at the ELIXIR All Hands 2019, and first versions of the federation structure, organisation, operation, and policy documents of the European Genome-phenome Archive (EGA).

Rare Diseases Community

Similar to the ELIXIR Federated Human Data Community, the ELIXIR Rare Diseases Community was formed in 2019 as a continuation of the ELIXIR-EXCELERATE Rare Diseases Use Case. A Rare Diseases Strategic Implementation Study was funded, supporting three distinct Work Packages focussed on (1) Rare disease infrastructure for -omics data analysis and interpretation, (2) FAIR metrics for the rare disease community’, and (3) ELIXIR Rare Diseases Community training infrastructure. This project started in January 2019 and runs for a total of three years.

ELIXIR Beacon

The Beacon API protocol was accepted as a core, lightweight discovery and data sharing protocol in the Roadmap to share one million human genomes by 2022 (see below). The ELIXIR Beacon Strategic Implementation Study was funded by ELIXIR to support the development and implementation of the protocol across the ELIXIR Nodes over the next three years.

As part of this Implementation Study the extension of the Beacon protocol to v2.0 was strategically planned across most of 2019. The vision is to promote the Beacon protocol to enable more powerful and scientifically relevant queries and responses. A roadmap to test and approve this new version of the specification in 2020 was designed and approved. Additionally, the ELIXIR Beacon team launched the prototype ELIXIR Beacon Network as a service. The query interface for this network is hosted by ELIXIR Finland and is accessible as a sub-domain of the ELIXIR Europe website.

Also in 2019, the HDCs supported the adoption of the Beacon for the discovery of plant genomics and human proteomics variation data, demonstrating impact and uptake of the protocol beyond human genomics.

Human Copy Number Variation Community

The human Copy Number Variation Community was established in 2019 as the third Community within the ELIXIR Human Data Communities. The main goal of the Community is to implement processes to make the detection, annotation and interpretation of the Copy Number Variations (CNV) easier.

The dedicated Implementation Study for this Community started in June 2019 and has eight themes covering optimal CNV detection pipelines for research and diagnostics, reference datasets, data exchange formats, data discovery and others.

Emerging Human Data Communities

In 2019, the ELIXIR Human Data Communities worked with researchers in food and nutrition, proteomics, and toxicology to ensure the coordination and strategy alignment so that these researcher communities also work towards the FAIRification of sensitive human data consented for secondary use. The need for ‘Health Data’ and ‘Cancer Data’ ELIXIR Focus Groups was also identified in 2019.

National and Global Initiatives and key European Commission funded projects

ELIXIR positioned itself for involvement in the coordination and delivery of the European ‘1+ Million Genomes’ initiative, which sets out to deliver cross-border access to human genomes in the European Union by 2022. Expertise and infrastructure developed within the ELIXIR Human Data Communities will be key if the aims of the Declaration are to be met. This work also sees coordination across a wide range of ELIXIR-associated EU projects such as EJP-RD, CINECA, EOSC-Life, EUCANcan, FAIRplus and others and will continue into 2020 and beyond.

Highlights

In 2019, the ELIXIR Human Data Communities published a Roadmap article in Nature Reviews Genetics to outline the recommendations and necessary minimal infrastructure requirements to enable a coordinated, secure, federated environment that enables population-scale genomic, phenotypic and biomolecular data to be accessible across international borders.

This article brought together key stakeholders across ELIXIR, ELIXIR member states, other European Research Infrastructures, as well as a global standard setting agency.

Critical to providing infrastructure to support this secure and federated environment to access data at scale across borders is the generation and implementation of a suite of gold-standard and fit-for-purpose bioinformatic standards. In 2019, ELIXIR formed the first Strategic Partnership with the Global Alliance for Genomics and Health. This Strategic Partnership enables ELIXIR to contribute to the generation and implementation of GA4GH standards across Europe. Working towards developing these standards is a key component of the ELIXIR Human Data Communities strategy.

“The investment that ELIXIR is making into infrastructure for cross-border data sharing is significant. ELIXIR Nodes have experience in developing solutions to enable cross-border data sharing, and many of the services they run, such as the European Genome-phenome Archive (EGA), will be key to the successful implementation of this initiative.”

Serena Scollen, ELIXIR Head of Human Genomics and Translational Data

Minimum recommendations for EU-wide infrastructure to access and analyse genomic data

<table>
<thead>
<tr>
<th>Necessary minimal infrastructure component</th>
<th>In development</th>
<th>Implemented at scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standards</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genomics data and clinical information standards geared towards specific disease communities</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td><strong>Application Programming Interfaces</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common application programming interfaces to enable remote data discovery and access</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Secure federated clouds</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computational resources, including secure, federated cloud computing environments that offer secure access across national boundaries to raw data and interoperable</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Legal and regulatory frameworks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory frameworks that enable access to and the processing of genomic data across borders, including the management of transnational user access and compliance</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td><strong>Tools, services and workflows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A repository of tools and services, including workflows to analyse deposited data while enabling these analysis workflows to operate on data across national borders. This will contribute towards data reproducibility and provenance, which are of high importance in both research and clinical practices</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Training and Capacity building programme</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A training and capacity-building programme to develop the skills and workforce required for genomics and big data in health care as well as shift the culture towards openness and integration of research data across national boundaries</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>
Updates from ELIXIR Nodes

**ELIXIR Belgium**

**Head of Node:** Frederik Coppens (VIB)
**Deputy Head of Node:** Kim De Ruyck (VIB)
**Lead institute:** Vlaams Instituut voor Biotechnologie (VIB)
**Participating institutes:** 7
**Website:** https://www.elixir-belgium.org

| Implementation Studies participated in 2019 | 16 |
| Implementation Studies led | 3 |
| Events organised | 12 |
| Papers published | 8 |
| Number of research grants | 4 |
| Total ELIXIR Services managed | 13 |
| Staff exchange projects | 2 |
| Node staff members | 40 |

**Highlights**

- The funding for the ELIXIR Belgium project “ELIXIR Infrastructure for Data and Services to strengthen Life-Sciences Research in Flanders” was extended until 2022.
- Launched the national instance usegalaxy.be, supporting ELIXIR AAI.
- Expanded the core team with 5 members, kickstarting data management with fairdonhub.be and cloud deployment activities.
- Initiated the project “Implementing EOSC: ESFRI driven Open Science” to stimulate collaboration between ESFRIs in Flanders.
- Established the first Service Delivery Plan with 13 Node Services.
- Organised the community events “Research Data Management & Data Stewardship” and “ELIXIR Belgium meeting”.

**ELIXIR Czech Republic**

**Head of Node:** Jiri Vondrasek (Institute of Organic Chemistry and Biochemistry AS CR)
**Deputy Head of Node:** Ludek Matyska (Masaryk University)
**Node Coordinator:** Anna Strachotova (Institute of Organic Chemistry and Biochemistry AS CR)
**Lead institute:** Institute of Organic Chemistry and Biochemistry AS CR
**Participating institutes:** 14
**Website:** http://www.elixir-czech.cz/

| Implementation Studies participated in 2019 | 6 |
| Implementation Studies led | 1 |
| Events organised | 16 |
| Papers published | 33 |
| Number of research grants | 3 |
| Total ELIXIR Services managed | 23 |
| Node staff members | 110 |

**Highlights**

- Migration of new tools to computational clusters CESNET and CERIT-SC.
- Implemented pipelines DANTE, Chip-Seq mapper, cpPredictor, and beta version of rboAnalyzer.
- Released a new web based services and programmes IOM.
- Released a beta version of database REXdb, UNICADB, SWICZ-2DE, rPredictor, AmtDb, MolMedb, ShinySOM.
- Collaborated with ELIXIR Switzerland and EMBL-EBI to create a IDSM database via a system of federated services UniProt and ChEMBL/ChEBI. Established new SPARQL endpoints.
- Participated in development of a new PDBe query system, led by EMBL-EBI.
- Launched a profile video, presenting ELIXIR and ELIXIR Czech Republic¹.
- Organised ELIXIR CZ Info days for potential users.

ELIXIR Denmark

Head of Node: Søren Brunak (Technical University of Denmark)
Node Coordinator: Myhanh Nguyen (Technical University of Denmark)
Lead institute: Technical University of Denmark
Participating institutes: 4
Website: https://www.elixir-denmark.org

Implementation Studies participated in 2019: 8
Implementation Studies led: 1
Events organised: 2
Number of research grants: 3
Total ELIXIR Services managed: 2
Node staff members: 10-20

Highlights
ELIXIR Denmark organised the Fifth Annual Danish Bioinformatics Conference in Odense in August 2019 with over 100 participants and the GATK4 workshop for PhD students in January-February 2019.

The Node also continued the work on the bio.tools platform. The bio.tools team engaged with the proteomics community to curate additional proteomics 189 tools and developed an automatic annotation pipeline Pub2Tools² which finds relevant publications that describe bioinformatics tools and automatically creates a new entry in bio.tools.

EMBL-EBI

Heads of Node: Ewan Birney and Rolf Apweiler
Website: http://www.ebi.ac.uk/

Implementation Studies participated in 2019: 44
Implementation Studies led: 7
Events organised: 4
Papers published: 5
Number of research grants: 7
Total ELIXIR Services managed: 31
Staff exchange projects: 2
Node staff members: 68

Highlights
• Completing involvement in ELIXIR-EXCELERATE project; EMBL-EBI was lead or co-lead on several Work packages in the project.
• Explored work on deployment of Beacons for proteomics data.
• Continued work on EU-STANDS4PM.
• Participated in Data Management Expert Network in preparation for the ELIXIR CONVERGE kick-off.
• Collaborated with ELIXIR Czech Republic and ELIXIR Switzerland on the IDSM database via system of federated services UniProt and ChEMBL/ChEBI.
• Developed PDBe-KB via PDBe query in collaboration with ELIXIR Czech Republic.

² https://pub2tools.readthedocs.io/en/latest
ELIXIR Estonia

Head of Node: Jaak Vilo (University of Tartu)
Deputy Head of Node: Hedi Peterson (University of Tartu)
Lead institute: University of Tartu
Participating institutes: 3
Website: http://elixir.ut.ee/

| Implementation Studies participated in 2019 | 2 |
| Events organised | 5 |
| Papers published | 2 |
| Number of research grants | 5 |
| Total ELIXIR Services managed | 9 |
| Node staff members | 14 |

Highlights
- Published an update article for Recommended Interoperability Resource g:Profiler³.
- Started a project for personalized medicine solutions in Estonia to develop IT solutions for personalised medicine and make these available to doctors and citizens.

ELIXIR Finland

Head of Node: Tommi Nyrönen (CSC - IT Center for Science Ltd.)
Deputy Head of Node: Ilkka Lappalainen (CSC - IT Center for Science Ltd.)
Node Coordinator: Jesse Oikarinen (CSC - IT Center for Science Ltd.)
Lead institute: CSC - IT Center for Science
Website: http://www.elixir-finland.org/

| Implementation Studies participated in 2019 | 15 |
| Implementation Studies led | 4 |
| Events organised | 10 |
| Papers published | 13 |
| Number of research grants | 10 |
| Total ELIXIR Services managed | 6 |
| Node staff members | ~40 |

Highlights
- Successfully completed the implementation of the ELIXIR Compute Platform⁴ as part of the ELIXIR-EXCELERATE project (in collaboration with EMBL-EBI and ELIXIR Czech Republic).
- Started an Innovative Medicine Initiative project with ELIXIR Sweden to build a central repository of digital pathology slides to support the development of artificial intelligence tools.
- The GA4GH approved two new global standards (GA4GH Passports and DUO) developed within the Data Use & Researcher Identities workstream, co-led by ELIXIR Finland. These standards allow service providers to streamline communications of sensitive data access rights and improve existing internet standards.
- ELIXIR Finland services attracted over €2 million of national and European funding to develop an integrated platform for health and biomedical research.
- Supported 1,980 biomedical research projects led by Finnish and international investigators.
- Contributed to the revision of the Finnish Genome Law and became the ICT solution provider for the national authority for secondary use of health data⁵.
- Co-led the technical interoperability for the EU 1 million genomes initiative and took part in the Finnish reflection group for it.

³ https://doi.org/10.1093/nar/gkz369
⁵ https://findata.fi
**ELIXIR France**

**Head of Node:** Claudine Medigue and Jacques van Helden (IFB)  
**Deputy Head of Node:** Anne-Françoise Adam-Blondon (URGV - Plant Genomics Research)  
**Lead institute:** IFB-Core  
**Website:** http://www.france-bioinformatique.fr/

| Implementation Studies participated in 2019 | 17  |  
| Implementation Studies led | 4  |  
| Events organised | 36  |  
| Total ELIXIR Services managed | 29  |  
| Staff exchange projects | 2  |  
| Node staff members | ~ 400  |  

**Highlights**

- ELIXIR France was successfully evaluated by an international committee mandated by the national authorities.
- The first French service - Orphadata - selected as Core Data Resource.
- Released a new services, the Plant Data Portal6.
- Hervé Ménager appointed co-Lead of the Tools Platform (effective from 2020).
- Christophe Béroud (Université Aix-Marseille) and David Salgado (IFB-Core) appointed co-Leads of the human Copy Number Variations Community, Victor Fromion (INRA) appointed co-Lead of the Microbial Biotechnology Community.
- Launched a Beacon portal for sharing plant genomic variant data7.
- Hosted the second ELIXIR Biohackathon in Paris.

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**ELIXIR Germany**

**Head of Node:** Alfred Pühler (de.NBI, Bielefeld University)  
**Lead institute:** Bielefeld University  
**Participating institutes:** 20  
**Website:** https://www.denbi.de/

| Implementation Studies participated in 2019 | 10  |  
| Implementation Studies led | 1  |  
| Events organised | 79  |  
| Papers published | 3  |  
| Number of research grants | 4  |  
| Total ELIXIR Services managed | 3  |  
| Staff exchange projects | 1  |  
| Node staff members | 37  |  

**Highlights**

- Completed legal steps necessary for finalising the ELIXIR Germany Collaboration Agreement.
- Björn Grüning (University of Freiburg) was selected as one of the Tools Platform leaders, Astrid Junker (IPK Gatersleben) was selected as one of the Plant Sciences Community leaders.
- Secured further funding for additional staff positions for ELIXIR Germany.

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6 [https://urgi.versailles.inra.fr/data-discovery](https://urgi.versailles.inra.fr/data-discovery)  
7 [https://services.cbib.u-bordeaux.fr/beacon-plants-web/](https://services.cbib.u-bordeaux.fr/beacon-plants-web/)
ELIXIR Greece

Head of Node: Babis Savakis (Biomedical Sciences Research Centre (BSRC) “Alexander Fleming”)
Lead institute: Biomedical Sciences Research Centre (BSRC) “Alexander Fleming”
Participating institutes: 15
Website: https://www.elixir-greece.org/

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<td>5</td>
<td>6</td>
</tr>
<tr>
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</tr>
<tr>
<td>Events organised</td>
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<td>5</td>
</tr>
<tr>
<td>Papers published</td>
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</tr>
<tr>
<td>Number of research grants</td>
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<td>9</td>
</tr>
<tr>
<td>Total ELIXIR Services managed</td>
<td>21 (+ 10 emerging)</td>
<td>60-70</td>
</tr>
<tr>
<td>Node staff members</td>
<td>~20</td>
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Highlights
The Greek ELIXIR Node conducted an evaluation by its Scientific Advisory Committee and with very good feedback. It coordinates the Fluxomics Implementation Study and participates in four other Implementation Studies.

The Node released a number of services:
- A pilot of the national Cloud Infrastructure based on a powerful, heterogeneous computational cluster using containerization technologies to support a broad service spectrum8.
- Catalogue of data management plan generation resources9.
- Updated database for experimentally supported miRNA targets on non-coding transcripts10.
- Co-authored an article calling unrestricted access to public genome data11.

ELIXIR Hungary

Head of Node: Gyorffy Balazs (Hungarian Academy of Sciences)
Lead institute: Institute of Enzymology, Research Centre of Natural Sciences, Hungarian Academy of Sciences
Participating institutes: 11
Website: http://elixir-hungary.org/

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<th>Greece</th>
<th>Hungary</th>
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<tr>
<td>Implementation Studies participated in 2019</td>
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</tr>
<tr>
<td>Implementation Studies led</td>
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<tr>
<td>Number of research grants</td>
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<td>9</td>
</tr>
<tr>
<td>Node staff members</td>
<td>~20</td>
<td>60-70</td>
</tr>
</tbody>
</table>

Highlights
- The ELIXIR Collaboration Agreement between ELIXIR and the Hungarian ELIXIR Node was signed in December 2019. With this the Hungarian ELIXIR Node has been officially established.
- Realised a Staff exchange project with EMBL-EBI to integrate ELIXIR Hungary research on intrinsically disordered protein into international databases managed by EMBL-EBI.

8 https://egci-beta.imsi.athenarc.gr
9 https://dmplanner.athenarc.gr
ELIXIR Ireland

Head of Node: Denis Shields (Systems Biology Ireland)
Deputy Head of Node: Colm Ryan (Systems Biology Ireland)
Lead institute: Systems Biology Ireland
Website: http://www.ucd.ie/sbi/

| Implementation Studies participated in 2019 | 1 |
| Implementation Studies led | 1 |
| Papers published | 18 |
| Number of research grants | 17 |
| Node staff members | 6 |

Highlights
ELIXIR Ireland is represented by Systems Biology Ireland, based at the University College Dublin. In 2019, Systems Biology Ireland participated in the launch of Precision Oncology Ireland aiming to develop new diagnostics and therapeutics for personalised cancer treatment. The consortium comprises five Irish universities, six Irish cancer research charities, and 10 companies.

ELIXIR Israel

Head of Node: Michal Linial (Israel Institute for Advanced Studies)
Deputy Head of Node: Danny Ben-Avraham (Weizmann Institute of Science)
Lead institute: Weizmann Institute of Science
Participating institutes: 8
Website: http://new.huji.ac.il/en

| Events organised | 1 |
| Total ELIXIR Services managed | 3 |
| Staff exchange projects | 1 |
| Node staff members | 4 |

Highlights
ELIXIR Israel hosted the Israel Bioinformatics core forum where 60 bioinformaticians from all of Israel’s core facilities came for a full day of talks and network activities.
**ELIXIR Italy**

*Head of Node:* Graziano Pesole (National Research Council, Italy)
*Deputy Head of Node:* Silvio Tosatto (University of Padua (UNIPD))
*Node Coordinator:* Giacomo Tartari (University of Bologna “Alma Mater”)  
*Lead institute:* CNR Institute of Biomembrane and Bioenergetics  
*Participating institutes:* 23  

<table>
<thead>
<tr>
<th>Implementation Studies participated in 2019</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation Studies led</td>
<td>3</td>
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<tr>
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<td>Number of research grants</td>
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<tr>
<td>Total ELIXIR Services managed</td>
<td>47</td>
</tr>
<tr>
<td>Node staff members</td>
<td>70-100</td>
</tr>
</tbody>
</table>

**Highlights**

- ELIXIR-IT kickstarted the activities of its Industry Working Group with the event “Innovation and SME Forum: Data management in the life sciences - a driver for innovation” on 27 - 28 November 2019 in Milan.
- Six more Italian research institutions and universities joined the Node.

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**ELIXIR Luxembourg**

*Head of Node:* Reinhard Schneider (Luxembourg Centre for Systems Biomedicine)  
*Deputy Head of Node:* Wei Gu (Luxembourg Centre for Systems Biomedicine)  
*Lead institute:* Luxembourg Centre for Systems Biomedicine  
*Website:* [http://elixir-luxembourg.org/](http://elixir-luxembourg.org/)

<table>
<thead>
<tr>
<th>Implementation Studies participated in 2019</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Implementation Studies led</td>
<td>1</td>
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<tr>
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<tr>
<td>Papers published</td>
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<tr>
<td>Number of research grants</td>
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<tr>
<td>Total ELIXIR Services managed</td>
<td>3</td>
</tr>
<tr>
<td>Node staff members</td>
<td>20-25</td>
</tr>
</tbody>
</table>

**Highlights**

- Released the Data Information System (DAISY)\(^{12}\) to support research institutions to map their data and data flows in accordance with GDPR’s accountability requirement.  
- Leading the EU 1+Million Genome ELSI Working Group and a member of the Interoperability Working Group.  
- Co-organised the TransMed (Translational Medicine) 2019 COSI (Community of Special Interest Group) satellite meeting at ISMB 2019.

\(^{12}\) [https://bio.tools/Data_Information_System_DAISY](https://bio.tools/Data_Information_System_DAISY)
ELIXIR Netherlands

Head of Node: Jaap Heringa (Dutch Techcentre for Life Sciences)
Deputy Head of Node: Morris Swertz (University of Groningen)
Lead institute: Dutch Techcentre for Life Sciences
Participating institutes: 11
Website: www.dtls.nl/elixir-nl/elixir-nl/

| Implementation Studies participated in 2019 | 14 |
| Implementation Studies led | 6 |
| Events organised (co-organised) | 44 |
| Papers published | 9 |
| Number of research grants | 19 |
| Total ELIXIR Services managed | 9 |
| Staff exchange projects | 1 |
| Node staff members | 41 |

Highlights
A major ongoing focus of ELIXIR Netherlands was FAIR-based Data Stewardship:
- The Data Stewardship Wizard developed in collaboration with ELIXIR Czech Republic can now generate data management plans has been published. 13
- Defined a Competency Framework defining job criteria and skills for data stewards. 14
- Developed data stewardship courses for researchers and data stewards.

Other important activities included:
- Co-organised Health-RI, the Dutch federated health data infrastructure.
- Further developed the concept of distributed data analysis (Personal Health Train)15.
- Tested the coupling of national and ELIXIR AAI federations

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ELIXIR Norway

Head of Node: Inge Jonassen (University of Bergen)
Deputy Head of Node: Finn Drabløs (Norwegian University of Science and Technology)
Node Coordinator: Christine Stansberg (University of Bergen)
Lead institute: University of Bergen
Participating institutes: 4
Website: http://www.elixir-norway.org/

| Implementation Studies participated in 2019 | 7 |
| Implementation Studies led | 2 |
| Events organised | 17 |
| Papers published | 15 |
| Number of research grants | 6 |
| Total ELIXIR Services managed | 5 |
| Staff exchange projects | 1 |
| Node staff members | 53 |

Highlights
- Awarded a national grant to facilitate FAIR data management, including collecting data from other data generating research infrastructures and core facilities.
- Organised first meeting with newly established stakeholder panel representing various user groups.
- Established selection process for ELIXIR Norway services.
- Released the MarFun16, a database for marine fungi, updated two existing databases: MarRef and MarDB.
- Upgraded the SalmoBase 2.0, Atlantic Salmon genomics data resource.

14 https://zenodo.org/communities/nl-ds-pd-ls/?page=1&size=20
15 https://pht.health-nl.nl
16 https://mmp.sfb.uit.no/databases/marfun/#/
ELIXIR Portugal

Head of Node: Mário J. Gaspar da Silva (Instituto Superior Técnico)
Deputy Head of Node: Ana Portugal Melo (Instituto Gulbenkian de Ciência)
Lead institute: Instituto de Engenharia de Sistemas e Computadores
Participating institutes: 3
Website: http://elixir-portugal.org/

| Implementation Studies participated in 2019 | 10 |
| Events organised | 18 |
| Papers published | 4 |
| Number of research grants | 2 |
| Total ELIXIR Services managed | 7 |
| Staff exchange projects | 1 |
| Node staff members | 50-60 |

Highlights

Ready for BioData Management? is a capacity building programme for data management in the life sciences that started with a plan to host an event to raise awareness of data management plans. Data management experts were challenged to design a hands-on exercise supported by a home-made DMP-canvas.

A very well-received first event spawned a flagship programme, with an increasing variety of capacity building offers. Currently ELIXIR Portugal offers an introductory workshop for data management plans and advanced data management plans, and a class modules (Introduction to Data Management and Demystifying data management plans).

ELIXIR Annual Report 2019

17 http://ready4biodatamanagement.biodata.pt/.

ELIXIR Slovenia

Head of Node: Brane Leskošek (University of Ljubljana)
Lead institute: University of Ljubljana
Participating institutes: 7
Website: http://www.elixir-slovenia.org/

Implementation Studies participated in 2019 | 11 |
Events organised | 13 |
Papers published | 6 |
Number of research grants | 13 |
Total ELIXIR Services managed | 1 |
Staff exchange projects | 1 |
Node staff members | 32 |

Highlights

ELIXIR-SI continues its activities through the core national group at the Faculty of Medicine of the University of Ljubljana, with main focus on data management, e-learning and wet-lab genomics. A major highlight is approval of a national project (ELIXIR-SI RI-SI-2) with a budget of €5.3 million.

ELIXIR Slovenia continued the development and delivery of e-learning courses and webinars across Europe through the ELIXIR e-learning platform developed by ELIXIR Slovenia. The e-learning team also developed the ELIXIR e-learning vision and strategy which is now being implemented within ELIXIR Programme 2019-2023.

ELIXIR Slovenia staff was also involved in other ELIXIR Platforms and Communities, co-leading the Plant Sciences Community, and actively participating in the Compute Platform, Rare Diseases and other Human data communities. At national level, ELIXIR Slovenia developed a number of support services for the Slovenian community and are leading or partnering in several national and international grant applications.

18 https://elixir.mf.uni-lj.si
ELIXIR Spain

**Head of Node:** Alfonso Valencia (Barcelona Supercomputer Centre)

**Node Coordinator:** Salvador Capella-Gutierrez (Barcelona Supercomputer Centre)

**Lead institute:** Spanish National Bioinformatics Institute

**Participating institutes:** 13

**Website:** https://inb-elixir.es

| Implementation Studies participated in 2019 | 25 |
| Implementation Studies led | 4 |
| Events organised | 19 |
| Total ELIXIR Services managed | 24 |
| Node staff members | 30 |

**Highlights**

- The Spanish National Bioinformatics Institute (INB, ELIXIR Spain) brings developments in ELIXIR as well as in other international initiatives, such as GA4GH, into the Spanish national health system.
- The Barcelona Supercomputing Center (BSC), the ELIXIR Spain/INB Coordinator, continued its support for gender equality in biomedicine within the Bioinfo4Women programme19 and organised the first Advances in Computational Biology conference to promote research done by women, which featured exclusively female speakers.

The Barcelona Supercomputing Centre also kicked-off the EUCANCan project to foster re-use of genomic data related to different types of cancer. BSC is the project Coordinator with the partners from Spain, France, Germany, the Netherlands and Canada. EUCANCan was also selected as the GA4GH driver project.

19 [https://bioinfo4women.bsc.es/](https://bioinfo4women.bsc.es/)

ELIXIR Sweden

**Head of Node:** Bengt Persson (NBIS - National Bioinformatics Infrastructure Sweden)

**Deputy Head of Node:** Mikael Borg (NBIS - National Bioinformatics Infrastructure Sweden)

**Lead institute:** NBIS - National Bioinformatics Infrastructure Sweden

**Website:** https://nbis.se/

| Implementation Studies participated in 2019 | 17 |
| Events organised | 34 |
| Papers published | 2 |
| Number of research grants | 4 |
| Total ELIXIR Services managed | 1 |
| Staff exchange projects | 1 |
| Node staff members | 89 |

**Highlights**

- ELIXIR Sweden (NBIS) continued its expansion during 2019 and provided bioinformatics support to ~250 principal investigators in Sweden. In addition, it arranged around 250 drop-in sessions at all sites in Sweden, providing consultancy to new users, especially from the clinical side.
- Contributed to the development of the federated EGA. The Swedish EGA node was piloted in a test environment; the system is now technically ready.
- Worked on the Data Stewardship Wizard to meet the increased need for data management.
- Organised together with ELIXIR Finland an ELIXIR Innovation and SME Forum in Stockholm, focussing on genomics and associated data in national healthcare.
- Organised a large number of courses, including the highly appreciated RauR in Visby, with many international participants.
ELIXIR Switzerland

Head of Node: Ron Appel and Christine Durinx (SIB Swiss Institute of Bioinformatics)
Lead institute: SIB Swiss Institute of Bioinformatics
Website: http://www.sib.swiss/

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Highlights

• Organized the [BC]2 Basel Computational Biology Conference, on “Big Data in Molecular Medicine”, with scientists from 30 countries.
• Organised 10th edition of the SIB Awards.
• Created an SIB Data Protection and Security Board to reinforce protection for SIB resources, data and infrastructures.
• The national secure IT infrastructure for sensitive data processing (BioMedIT project - part of the Swiss Personalized Health Network - became operational.
• Launched the in silico talks series - short online talks by SIB scientists (8 videos).
• Held the 1st edition of the Certificate of Advanced Studies in Personalised Molecular Oncology, co-organized by SIB Clinical Bioinformatics: 20 participants, 100% success.

ELIXIR United Kingdom

Heads of Node: Carole Goble (University of Manchester) and Neil Hall (Earlham Institute)
Node Coordinator: Cartherine Hunter (Earlham Institute)
Lead institute: Earlham Institute
Participating institutes: 18
Website: http://elixiruknode.org/

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Highlights:

• ELIXIR UK took concrete steps towards BioFAIR, a national “Big Ideas Pipeline” project, highlighted in the 2019 UK’s national infrastructure roadmap. BioFAIR will develop a national data sustainability institute to support the coordination and development of UK life science data.
• Three new members (Universities in Cardiff, Bradford, Leicester) take the ELIXIR UK membership to 18 organisations and strengthens ELIXIR UK Human Data activities.
• ELIXIR UK services and ELIXIR Core Data Resource CATH saw a 4-fold increase in the number of entries. ELIXIR TeSS, the ELIXIR Training Portal managed by ELIXIR UK increased its user-base by 77%. FAIRsharing partnered with Datacite to advise publishers on data repositories.
Representation of ELIXIR Nodes in ELIXIR Platforms and Communities

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Capacity building and staff exchange

The ELIXIR Staff Exchange Programme allows members of an ELIXIR Node to travel and work in other ELIXIR Nodes, or to attend a specific ELIXIR-related event. The purpose of the programme is to support capacity building in ELIXIR Nodes and the exchange of best practice in the operation and management of bioinformatics services. Additionally, the programme aims to support the professional development of Node personnel to attract and develop a diverse pool of talent across ELIXIR.

The ELIXIR Staff Exchange programme has three components:

- **Staff Exchange projects,**
- **Travel Grant Scheme and**
- **Knowledge Exchange Scheme.**

The Staff Exchange projects support the exchange of staff between ELIXIR Nodes for short periods of time (around three to six months) or for a series of shorter trips over a similar timeframe.

The Travel Grant Scheme provides funding to people in ELIXIR Nodes to attend ELIXIR-related events, to travel for short-term visits to another ELIXIR Node or to the ELIXIR Hub.

The Knowledge Exchange Scheme allows ELIXIR Node members (individuals or teams) to spend a short period of time hosting visits from industry staff or working at industry partners’ facilities.

Connecting national bioinformatics communities to international initiatives

One of the benefits of joining ELIXIR is that the national researchers and other experts have easier access to international initiatives and services. Researchers from new ELIXIR Nodes can quickly establish collaboration with other ELIXIR Nodes and integrate their work into the Europe-wide community. A 2019 ELIXIR Travel grant awarded to Bálint Mészáros from ELIXIR Hungary to visit EMBL-EBI is a good example.

During his visit to EMBL-EBI, Bálint received personalized training on how to integrate his lab’s intrinsically disordered protein data into the IntAct and Complex Portal databases operated by EMBL-EBI. As a result, the two databases in Hungary (Disordered Binding Site, DIBS, and Mutual Folding Induced by Binding database, MFIB) will be fully integrated into these international resources (IntAct is an ELIXIR Core Data Resource). Adopting the standard used at IntAct also improved the interoperability of these databases with other relevant resources hosted at EMBL-EBI and other ELIXIR Nodes.

After he returned back to Hungary, Bálint was able to train 11 of his colleagues from across ELIXIR Hungary (Research Centre for Natural Sciences, Eötvös Loránd University and Pázmány Péter Catholic University) to become IntAct curators. This will build a core curator team in Hungary who will contribute to the next release of DIBS and MFIB. The Hungarian curators will also join the IMEx consortium as the DIBS/MFIB team, which will further strengthen links of the Hungarian protein-protein interaction community to the major international initiatives in the field.
In 2019, there were two ongoing Staff Exchange projects and 12 Travel grants. The 2019 Call for proposal resulted in 15 new Staff Exchange projects. Three of them started already in 2019, the remaining 12 started in early 2020. The first two Knowledge Exchange Scheme projects were selected in 2019 and started early in 2020.

**Masters Programme for the Management of Research Infrastructures**

The Executive Masters Programme for the Management of Research Infrastructures (EMMRI), offered by the University of Milano-Bicocca, allows professionals from research infrastructures to increase their knowledge in various aspects of research infrastructure management. 

ELIXIR invited personnel from ELIXIR Nodes to enroll in one or several modules of the programme. The first call for interest took place in 2018 and resulted in selection of seven staff members from five ELIXIR Nodes who participated in the second round of the programme (2018-2020) and attended individual modules throughout 2019.

The second call for interest was held in 2019. In this call seven members of ELIXIR Nodes and the ELIXIR Hub were selected for the third run of the programme (2020-2021).

The course fees, travel and accommodation costs related to the programme is funded by the ELIXIR Hub.

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**Staff exchange programme in 2019**

- **162,000€**
  - Total budget allocated to projects selected in 2019 (+ €24k to ELIXIR Knowledge Exchange Scheme)

- **11**
  - People involved

- **15**
  - New projects approved in 2019

- **7**
  - ELIXIR Node staff trained in research infrastructure management (EMMRI)

- **8**
  - ELIXIR Nodes involved
    - EMBL-EBI, ELIXIR France, ELIXIR Italy, ELIXIR Luxembourg, ELIXIR Netherlands, ELIXIR Switzerland, ELIXIR UK, ELIXIR Israel

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1 https://emmri.unimib.it
Strengthening global collaboration

As users access ELIXIR services from across the world and many ELIXIR services are run under international funding arrangements, collaboration with partners beyond Europe is an integral part of ELIXIR’s mission.

ELIXIR has established formal collaborations with international initiatives related to research infrastructures and bioinformatics. It collaborates with GA4GH in developing standards for responsible sharing of genomics data, and it regularly interacts with the Group of Senior Officials (GSO) on Global Research Infrastructures of the G7.

Highlights from ELIXIR international engagement activities in 2019:

- Three separate visits to the ELIXIR Hub by Australian delegations, primarily to develop a Collaboration Strategy between ELIXIR and the newly initiated Australian BioCommons pathfinder project.
- Facilitating the attendance of delegates from Australia (Australian BioCommons), South Africa (H3ABioNet) and USA (NIH) at the ELIXIR All Hands meeting 2019.
- A collaboration with the GSO to develop a self-assessment framework for Global Research Infrastructures, which was subsequently published as a guide for other research infrastructures.
- Organising several special sessions at the ISMB/ECCB joint conference
- Developing a collaboration with the Global Biodiversity Information Facility alongside EMBL-EBI to crosslink metagenomics and species occurrence data.

ELIXIR Global partners

- 6 Countries
- 18 Global initiatives
- 4 Intergovernmental organisations
ELIXIR’s performance and impact

Whilst ELIXIR enables great and useful science to take place, it rarely shares the limelight when significant scientific breakthroughs are showcased in the media. One underlying cause of this disconnect lies at the heart of ELIXIR’s mission to make open science a reality. More often than not, virtual bioinformatics infrastructures provide vital services that are free at the point of use and hence taken for granted and scarcely acknowledged. This is compounded by the fact that socio-economic impact pathways are generally long-winded, complex and multifaceted.

In line with the general trend to measure and communicate the impact of research investments beyond the scientific sphere, ELIXIR ramped up its activities in this area during 2019.

RI-PATHS

As part of the RI-PATHs project (Research Infrastructure imPact Assessment paTHways), ELIXIR hosted a second participatory workshop in May 2019, focusing on approaches to measure network effects and intangible benefits of high relevance to distributed infrastructures. This was followed by the start of the piloting phase of the RI-PATHs project, in which ELIXIR, as a case-study, currently receives the mentoring advice of impact evaluators and economists.

During the piloting, one of ELIXIR’s flagship annual events, the Biohackathon, was examined in terms of performance and impact (see p. 16). This approach will be rolled out to other large ELIXIR Forums that receive significant financial support from ELIXIR, e.g. the annual All Hands meeting and the SME and Innovation events.

Also during the piloting phase, ELIXIR was able to put together a list of its impact areas, or ‘areas of change’ (see figure below), which aim to rationalise and better communicate the range of benefits arising from its funded activities.

Impact indicators

For the first time in 2019, ELIXIR consolidated a list of the performance and impact indicators it currently monitors, whilst working to develop new ones to measure its scientific and socio-economic impacts using text-mining. This was done in parallel to providing feedback on several occasions to the ESFRI Working Group on Monitoring of Research Infrastructures Performance, leading to the publication of their report in December 2019. ELIXIR provided further support to ESFRI, building on its early efforts to estimate its cost as a virtual and distributed research infrastructure. In this context, ESFRI invited ELIXIR to contribute a case study to the economists in the Centre for Industrial Studies in Milan, Italy, resulting in a tool for cost estimation of Research Infrastructures included (or willing to be) in the ESFRI Roadmap.

Plans for the future

ELIXIR has adopted the strategy of building its internal capacity in performance and impact evaluation, as opposed to working with external consultants as part of one-off evaluations. Towards the end of 2019, ELIXIR funded a Staff Exchange project involving three Nodes (Portugal, Norway and Italy) entitled “Empowering ELIXIR Nodes to measure and communicate their performance and impact”.

This project is a collaboration with the EU project RI-TRAIN, and supports the field studies of those involved in their ELIXIR-sponsored Executive Masters in the Management of Research Infrastructure (see p. 49). Work will also continue to embed performance and impact in ELIXIR’s processes related to the funding it awards and, finally, a Toolkit to support Nodes will be developed and rolled out in 2020.

Who benefits directly

<table>
<thead>
<tr>
<th>Industry</th>
<th>Service Providers</th>
<th>Academia</th>
<th>Research Community</th>
<th>Funders</th>
</tr>
</thead>
</table>

Direct impact

- Research Efficiency
- Bioinformatics resource uptake
- Research Infrastructure sustainability
- Skills development
- Research dissemination
- Relationship Capital
- Policy Influence
- Public Awareness

ELIXIR’s impact areas aim to rationalise and better communicate the range of benefits arising from its funded activities.

Industry engagement

ELIXIR’s Industry engagement aims to bridge the gap between industry and academia by creating opportunities for knowledge exchange, networking and collaborations. It supports researchers in industry and academia to drive scientific advances through open innovation and FAIR data practices.

ELIXIR SME and Innovation Forum

The ELIXIR Innovation and SME Forum helps ELIXIR Nodes to engage with innovative companies in their respective countries. It further creates an opportunity for SMEs to showcase their services and research to an expert audience and create links with academics and industry participants.

In 2019, three Innovation and SME Forums took place:
- Data Management in the Life Sciences - a Driver for Innovation, 5-6 March 2019, Stockholm, Sweden
- Distributed Data Analysis - The (Health) Data Train, 10-11 October 2019, Utrecht, Netherlands
- Genomics and Associated Data in National Healthcare Initiatives, 27-28 November 2019, Milan, Italy

New forum for academia and industry to address bioinformatics bottlenecks

ELIXIR launched a new initiative to support collaboration with the bioinformatics industry - the ELIXIR Bioinformatics Industry Forum. This new series of events brings together providers and consumers of bioinformatics services (clouds, HPC clusters, analytics pipelines and others) to discuss existing bottlenecks and solutions to the challenges in working with biological data.

The first event took place in May 2019 in London, organised with support from ATOS/Bull, Microsoft, Aridhia and Illumina. It attracted over 80 experts from 45 different organisations representing large IT companies, SMEs and academic researchers.

ELIXIR Finland and BC Platforms collaborate to support data standardization and access

The main aim of ELIXIR’s Innovation and SME Forums is to encourage collaboration between large companies, SMEs and ELIXIR Nodes. A long-term impact survey of previous attendees in 2019 revealed that 82% of respondents indicated that the event facilitated new collaborations, 18% reported that it enhanced product development or publication of work.

An example of a successful collaboration comes from BC Platforms, a genomic data management and analysis company from Finland. After attending the ELIXIR Innovation and SME Forum in Helsinki in January 2017 and talking with academics from ELIXIR Finland, they established a joint project with ELIXIR Finland. The progress of this collaboration was presented in March 2019 at another ELIXIR Innovation and SME Forum in Stockholm, Sweden.

BC Platforms and ELIXIR Finland are working together on a platform that combines clinical and genome data from different sources, and without compromising patient privacy. ELIXIR Finland (Finish IT Center for Science – CSC) is providing their cloud and compute services which allows for automated processing and combination without having to worry about data conversions or data formats.
Connecting public bioinformatics infrastructure with industry

In July 2019, ELIXIR published a new report to present the different ways in which ELIXIR Nodes engage with companies and SMEs. Featuring a series of success stories, it highlights industry-academia collaboration across ELIXIR and the different ways ELIXIR Nodes interact with their counterparts in industry. It also presents some of the ELIXIR-wide initiatives to support industry-academia collaboration.

Knowledge Exchange Scheme between academia and industry

ELIXIR piloted a new initiative to bring researchers in industry and academia closer - the ELIXIR Knowledge Exchange Scheme. This new initiative gives individual members of ELIXIR Nodes the chance to spend time at an industry partners’ facilities: it will cover travel and accommodation expenses for ELIXIR Nodes staff members so that they can work on a collaborative project with industry or organise joint workshops to exchange their experience, or provide funds to host a workshop around a topic of mutual interest.

The first call for proposal closed at the end of October 2019, two pilot projects were selected.

The first project will link ELIXIR Portugal and the ELIXIR plant infrastructure with the pulp and paper industry (The Navigator Company, RAIZ Forest and Paper Research Institute) in a collaborative workshop. In the second project, ELIXIR Luxembourg will team up with the Cambridge-based company Petagene to work on data compression and encryption technologies.

“There is a rich ecosystem of small and large companies that work with bioinformatics data or need bioinformatics services. The success stories presented in our report are really the tip of the iceberg and there is huge potential for collaboration, both in our Nodes and in the companies. The goal of the report is to showcase the opportunities for open innovation in life science research and inspire others to follow.”

Katharina Lauer, ELIXIR Industry Officer
Communications

ELIXIR at ISMB/ECCB in Basel
ELIXIR was the silver sponsor of the joint ISMB/ECCB Conference, held in July 2019 in Basel, Switzerland.

The programme of the conference featured dedicated ELIXIR sessions, showcasing ELIXIR’s activities and achievements. The ELIXIR Special Track included presentations of the ELIXIR partnership with the Global Alliance for Genomics and Health, the ELIXIR Beacon project and the Bioschemas metadata specifications for software tools.

ELIXIR, SIB Swiss Institute of Bioinformatics (ELIXIR Switzerland) and the EMBL-EBI presented their activities in the conference exhibition.

FAIRplus communications
Leading the communications activities in the FAIRplus project, ELIXIR launched the project website early in 2019, developed communications plan and communications materials for the project. The FAIRplus social media accounts (twitter and linkedIn) together with the FAIRplus Newsletter were the main communications channels in the project throughout the year.

To promote the project goals, ELIXIR worked with journalists from GenomeWeb on an article explaining the importance of FAIR principles for genomics data and presenting the goals of FAIRplus to a wider audience in genomic research.

ELIXIR website and intranet
The development of the ELIXIR website in 2019 focused on enriching the content and presenting ELIXIR activities in a more coherent way across the Platforms, Communities and other initiatives.

The new vacancies page on the ELIXIR website, launched in 2019, allows ELIXIR Nodes as well as companies and SMEs to directly submit and advertise their job offers. The jobs widget developed in conjunction with the vacancies page allows ELIXIR Nodes to embed the page on their own website.

The number of unique visitors on the ELIXIR website rose by over 17% in 2019, as compared to 2018, and exceeded 100,000 visitors. By 31 December 2019, the ELIXIR intranet had 974 registered users, of which 275 registered in 2019. The number of intranet section views in 2019 was over 7,000.

ELIXIR Gateway on F1000Research
The ELIXIR Gateway on F1000Research was launched in December 2015, as a platform to collect and capture ELIXIR’s research and technical outputs.

The Gateway Advisory Board reviews the submitted articles and prior to the peer-review process to ensure the papers published in the gateway are relevant to ELIXIR and within the ELIXIR scope. The members of the Board are Heads of Nodes and other senior managers in ELIXIR. The Board was extended in 2019 by two members (Ana Portugal Melo and Fotis Psomopoulos).

Members of the Advisory Board of the ELIXIR F1000R gateway:

- Niklas Blomberg, ELIXIR Director
- Inge Jonassen, University of Bergen, Head of ELIXIR Norway
- Arlindo Oliveira, Instituto Superior Técnico, Portugal
- Bengt Persson, Uppsala University, Sweden, Head of ELIXIR Sweden
- Graziano Pesole, University of Bari Aldo Moro, Head of ELIXIR Italy
- Fotis Psomopoulos, Centre for Research and Technology Hellas (CERTH), Greece, Co-Lead of the ELIXIR Training Platform
- Ana Portugal Melo, Instituto Gulbenkian de Ciência, Deputy Head of ELIXIR Portugal

ELIXIR Gateway on F1000Research

1 www.fairplus-project.eu
3 https://elixir-europe.org/about-us/vacancies
## ELIXIR Communications in numbers

### ELIXIR communications
- 30 news releases published
- 100,537 website visitors
- 103 newsletters sent
- 187 vacancies posted by ELIXIR Nodes and companies
- 778 twitter posts
- 2983 retweets
- 4747 tweet favourites
- 75 LinkedIn posts

### FAIRplus communications
- 128 twitter posts
- 410 retweets
- 624 tweet favourites
- 21 LinkedIn posts
- 3 newsletters sent

### ELIXIR F1000R gateway:
- 6 peer-reviewed papers published
- 5 strategy documents, technical reports and white papers,
- 29 slides posted
- 41 posters posted

### Publications:
- 3 new print publications

### Events:
- 40 meetings organised in 2019
  - Attended by 1953 participants
  - Presented at 10 conferences
  - Supported 4 conferences as a sponsor:
    - ISMB/ECCB
    - Galaxy Community Conference
    - Biocuration conference
    - GAGH Annual conference
In 2019, the ELIXIR Hub consolidated its structure by creating the Administration and Operations team led by Susanna Repo, newly appointed as Head of Operations.

The internal structure of the ELIXIR Hub thus included five teams: Administration and Operations, External Relations, Human Genomics and Translational Data, Legal Services, Project Management and Technical team. The heads of these five teams, together with ELIXIR Director, also form the management team of the ELIXIR Hub.

Three new members were appointed in 2019. Nikki Couts joined the ELIXIR Project Management Unit as Project Support Coordinator, and Jilly Cheshire strengthened the Administration and Operations team as Administrative Assistant. Erin Haskell replaced Premysl Velek in the post of ELIXIR Communications Officer.

The ELIXIR Hub works closely with three external contractors who support the Hub activities in technical coordination, event management and communications. Pascal Kahlem works within the Technical team as the ELIXIR Training Platform Coordinator; Dana Cernoskova supports the ELIXIR Hub as event organiser, and Premysl Velek supports the ELIXIR communications activities within the External Relations team (from July 2019).
The highest decision-making body in ELIXIR is the ELIXIR Board, composed of representatives of ELIXIR members. The ELIXIR Scientific Advisory Board (SAB) advises the Board on ELIXIR scientific strategy and reviews the applications from ELIXIR Nodes. The SAB is an independent body, made up of leading experts from around the world. The committee also includes two independent ethics advisors to advise on ethical, legal and social issues related to ELIXIR. The members are appointed by the ELIXIR Board.

The Heads of Nodes Committee has a major role in developing and agreeing the ELIXIR scientific and technical strategy. The committee is composed of scientific representatives of each of the ELIXIR Nodes.

The Head of Node is appointed by each Node according to national processes.

The Industry Advisory Committee (IAC) consists of experts from industry users, including SMEs, suppliers and publishers who provide high-level strategic advice and input from industry stakeholders. Members of the IAC are appointed by the ELIXIR Board.

The ELIXIR Director leads the ELIXIR Hub and is responsible to the ELIXIR Board for implementing ELIXIR Scientific Programme. ELIXIR Director chairs the Heads of Nodes Committee.
ELIXIR Board members in 2019
Chair: Ferran Sanz (Spain)
Vice-Chairs: Isabel Rocha (Portugal) and Christopher Rawlings (UK)

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<tr>
<th>Member</th>
<th>Administrative delegate</th>
<th>Scientific delegate</th>
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</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Laurence Lenoir</td>
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<td></td>
<td>Michele Oleo</td>
<td></td>
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<tr>
<td></td>
<td>Didier Flagotthier</td>
<td></td>
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<tr>
<td>Czech republic</td>
<td>Jan Burianek</td>
<td>Jaroslav Koča</td>
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<tr>
<td>Denmark</td>
<td>Stine Vad Bovstrup (replaced Troels Rasmussen in September 2019)</td>
<td>Anders Krogh</td>
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<tr>
<td>EMBL</td>
<td>Sliite Schumacher</td>
<td>Edith Heard (replaced Iain Mattaj in January 2019)</td>
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<td></td>
<td></td>
<td>Alvis Brazma (replaced Janet Thornton in February 2019)</td>
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<tr>
<td>Estonia</td>
<td>Toivo Rääm</td>
<td>Lili Milani (replaced Pärt Peterson in June 2019)</td>
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<td></td>
<td>Mr. Prit Tamm</td>
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<tr>
<td>Finland</td>
<td>Riina Vuorento</td>
<td>Per Öste</td>
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<td>Sirpa Nuotio</td>
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<td>Eric Guittet</td>
<td>Frédéric Boccard</td>
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<td>Alexander Goesmann</td>
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<td>Maria Gkizeli</td>
<td>Christos Ouzounis</td>
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<td>Gábor Tóth</td>
<td>László Patthy</td>
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<tr>
<td>Ireland</td>
<td>Garry Purcell</td>
<td>Maria Nash</td>
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<tr>
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<td>Ilana Lowi</td>
<td>Iris Eisenberg (replaced Yossi Kalifa in October 2019)</td>
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<tr>
<td>Italy</td>
<td>Salvatore La Rosa</td>
<td>Rita Casadio</td>
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<tr>
<td>Luxembourg</td>
<td>Lynn Wenandy</td>
<td>Rudi Balling</td>
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<tr>
<td></td>
<td>Jean-Claude Milmeister (replaced Vera Soares in March 2019)</td>
<td>Regina Becker</td>
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<tr>
<td>Netherlands</td>
<td>Bea Pauw</td>
<td>Ruben Kok</td>
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<td>Norway</td>
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<td>Rein Aasland</td>
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<td>Stig Omholt</td>
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<td>Tiago Saborida</td>
<td>Isabel Rocha</td>
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<td>Slovenia</td>
<td>Albin Kralj</td>
<td>Damjana Rozman</td>
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<td>Spain</td>
<td>Rafael de Andrés Medina (retired in October 2019)</td>
<td>Ferran Sanz</td>
</tr>
<tr>
<td></td>
<td>Cristina Bauluz</td>
<td></td>
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<tr>
<td>Sweden</td>
<td>Karl Gertow (resigned in August 2019)</td>
<td>Björn Andersson</td>
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<tr>
<td>Switzerland</td>
<td>Doris Wohlfender-Bühler (replaced Isabella Beretta in May 2019)</td>
<td>Christian von Mering</td>
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<tr>
<td></td>
<td>Laurent Salzarulo (Deputy, appointed in May 2019)</td>
<td></td>
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<tr>
<td>United Kingdom</td>
<td>Mark Palmer</td>
<td>Christopher Rawlings</td>
</tr>
<tr>
<td></td>
<td>Amanda Collis</td>
<td></td>
</tr>
</tbody>
</table>
### ELIXIR Heads of Nodes Committee in 2019

<table>
<thead>
<tr>
<th>Member</th>
<th>Head of Node</th>
<th>Deputy Head of Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Dr Frederik Coppens (replaced Yves van de Peer in July 2019)</td>
<td>Kim De Ruyck (appointed in July 2019)</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Jiří Vondrášek</td>
<td>Ludek Matyska</td>
</tr>
<tr>
<td>Denmark</td>
<td>Søren Brunak</td>
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<tr>
<td>EMBL</td>
<td>Rolf Apweiler and Ewan Birney (joint Heads of Nodes)</td>
<td>Johanna McEntyre</td>
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<tr>
<td>Estonia</td>
<td>Prof. Jaak Vilo</td>
<td>Hedi Peterson</td>
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<tr>
<td>Finland</td>
<td>Tommi Nyrönen</td>
<td>Ilkka Lappalainen</td>
</tr>
<tr>
<td>France</td>
<td>Jacques van Helden and Claudine Médigue (joint Heads of Nodes)</td>
<td>Anne-Françoise Adam-Blondon</td>
</tr>
<tr>
<td>Germany</td>
<td>Alfred Pühler</td>
<td>Andreas Tauch</td>
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<td>Greece</td>
<td>Babis Savakis</td>
<td>Martin Reczko</td>
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<td>Hungary</td>
<td>Balázs Győrffy</td>
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<tr>
<td>Ireland</td>
<td>Denis Shields (replaced Walter Kolch in September 2019)</td>
<td>Colm Ryan</td>
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<tr>
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<td>Michal Linial</td>
<td>Dan Ben-Avraham</td>
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<td>Silvio Tosatto</td>
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<tr>
<td>Luxembourg</td>
<td>Reinhard Schneider</td>
<td>Wei Gu (replaced Dietlind Gerloff in October 2019)</td>
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<tr>
<td>Netherlands</td>
<td>Jaap Heringa</td>
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<td>Inge Jonassen</td>
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<td>Sweden</td>
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<td>Mikael Borg</td>
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<tr>
<td>Switzerland</td>
<td>Ron Appel and Christine Durinx (joint Heads of Nodes)</td>
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<tr>
<td>United Kingdom</td>
<td>Carole Goble and Christine Durinx (joint Heads of Nodes)</td>
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<tr>
<td>Cyprus (Observer)</td>
<td>George Spyrou</td>
<td>Vasilis Prompononas</td>
</tr>
</tbody>
</table>

### Scientific Advisory Board in 2019:

Chair: Francis Ouellette, Origin Bioinformatics, Canada  
Vice-Chair: Janet Kelso, Max Planck Institute for Evolutionary Anthropology, Germany

- Pascal Borry (University of Leuven, Belgium)
- Philip Bourne (University of Virginia, USA) (appointed in April 2019)
- Robert Gentleman (23andMe, USA)
- Melissa Haendel (Oregon Health and Science University, USA)
- Larry Hunter (University of Colorado, USA)
- Elina Ikonen (University of Helsinki, Finland)
- Nicola Mulder (UCT Computational Biology Group (NBN), South Africa)
- Susan Wallace (University of Leicester, UK)
- Doreen Ware (USDA ARS, Cold Spring Harbor Laboratory, USA)

### Industry Advisory Committee members in 2019:

Chair: Elizabeth Reynolds, General Bioinformatics, UK  
Vice-Chair: Abel Ureta-Vidal, Eagle Genomics, UK

- Ian Barrett (AstraZeneca, UK)
- Thomas Exner (Edelweiss Connect GmbH, Switzerland) (appointed November 2019)
- Andreas Kremer (ITTM, Luxembourg)
- Natalia Jiménez Lozano (Atos, UK)
- Klaus Maisinger (ILLUMINA, UK)
- Filip Pattyn (OntoForce, Belgium)
- Jörg Peplies (Ribobcon GmbH, Germany) (appointed in April 2019)
- María Rodríguez Martínez (IBM, Switzerland)
- Philippe Sanseau (GlaxoSmithKline, UK)
- Catherine Sirven (Bayer, France) (appointed in November 2019)

- Iain Hrynaszkiewicz (Nature Publishing Group, UK) (stepped down in July 2019)
- Christian Paulitz (Bayer CropScience, Germany) (stepped down in November 2019)
## Financial data

### ELIXIR Income and Expenditure for 2019

<table>
<thead>
<tr>
<th></th>
<th>2019 Actual</th>
<th>2019 Revised</th>
<th>Original</th>
<th>2018 Actual</th>
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<tr>
<td><strong>Income</strong></td>
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<td>€000</td>
<td>€000</td>
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<tr>
<td><strong>ELIXIR Member state contributions</strong></td>
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<tr>
<td>Ordinary contributions (a)</td>
<td>7.089</td>
<td>7.089</td>
<td>7.000</td>
<td>6.913</td>
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<tr>
<td>Foreign exchange (loss)/gain on sterling contributions (b)</td>
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<td></td>
<td>(71)</td>
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<tr>
<td>Grant income (c)</td>
<td>627</td>
<td>1.200</td>
<td>800</td>
<td>1.221</td>
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<tr>
<td><strong>Net income</strong></td>
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<td>8.289</td>
<td>7.800</td>
<td>8.063</td>
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<tr>
<td><strong>Expenditure</strong></td>
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<td>Technological Activities</td>
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<tr>
<td>Salaries</td>
<td>571</td>
<td>600</td>
<td>700</td>
<td>538</td>
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<td>Running costs</td>
<td>354</td>
<td>400</td>
<td>400</td>
<td>252</td>
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<td>Commissioned services</td>
<td>3.014</td>
<td>6.900</td>
<td>5.900</td>
<td>3.347</td>
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<td><strong>Total expenditure Technological Activities</strong></td>
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<td>7.900</td>
<td>7.000</td>
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<tr>
<td>Directorate and Administrative expenditure</td>
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<td>Salaries</td>
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<td>900</td>
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<td>Running costs</td>
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<td>400</td>
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<td><strong>Total expenditure Directorate and Administration</strong></td>
<td>1.227</td>
<td>1.300</td>
<td>1.200</td>
<td>1.115</td>
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<tr>
<td>Support and Admin infrastructure costs</td>
<td>674</td>
<td>800</td>
<td>700</td>
<td>578</td>
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<td>Grant expenditure incurred</td>
<td>1.076</td>
<td>1.200</td>
<td>800</td>
<td>1.298</td>
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<td><strong>Total expenditure</strong></td>
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<td>11.200</td>
<td>9.700</td>
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<td>Surplus / (Deficit) (d)</td>
<td>(2.911)</td>
<td>(1.900)</td>
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<tr>
<td></td>
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<td>(a) ELIXIR Member state contributions</td>
<td>€000</td>
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<td>Belgium</td>
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<td>Finland</td>
<td>96</td>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>1.082</td>
<td>1.153</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>1.499</td>
<td>1.447</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>87</td>
<td>49</td>
<td></td>
<td></td>
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<tr>
<td>Hungary</td>
<td>46</td>
<td>47</td>
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<tr>
<td>Ireland</td>
<td>80</td>
<td>76</td>
<td></td>
<td></td>
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<tr>
<td>Israel</td>
<td>124</td>
<td>91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>800</td>
<td>852</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td>15</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>338</td>
<td>329</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>195</td>
<td>181</td>
<td></td>
<td></td>
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<tr>
<td>Portugal</td>
<td>82</td>
<td>86</td>
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<tr>
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<td>17</td>
<td>19</td>
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<tr>
<td>Spain</td>
<td>526</td>
<td>597</td>
<td></td>
<td></td>
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<tr>
<td>Sweden</td>
<td>223</td>
<td>200</td>
<td></td>
<td></td>
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<tr>
<td>Switzerland</td>
<td>295</td>
<td>256</td>
<td></td>
<td></td>
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<tr>
<td>United Kingdom</td>
<td>1.177</td>
<td>1.011</td>
<td></td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>7.089</strong></td>
<td><strong>6.913</strong></td>
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</tr>
</tbody>
</table>
The ELIXIR Board approved that, from January 2016, the UK will pay its member state contributions in Sterling (Elixir/2015/28). The difference between the value of these contributions valued in Euros at the date of payment and the date of the approval of the 2019 budget was a loss of €68k (2018: loss of €71k).

<table>
<thead>
<tr>
<th>Grant income</th>
<th>2019</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grant funding awarded</td>
<td>6.144</td>
<td>5.851</td>
</tr>
<tr>
<td>Grant income earned in the current year</td>
<td>627</td>
<td>1.221</td>
</tr>
<tr>
<td>Grant expenditure incurred in the current year</td>
<td>(1.076)</td>
<td>(1.298)</td>
</tr>
<tr>
<td><strong>Unutilised grant income</strong></td>
<td><strong>1.734</strong></td>
<td><strong>2.498</strong></td>
</tr>
</tbody>
</table>

This surplus is included in the EMBL general reserve, but has been ring-fenced for the use by ELIXIR.

The following countries have amounts due or prepaid at 31 December 2019:

<table>
<thead>
<tr>
<th></th>
<th>2019 Contribution owing</th>
<th>Prepayments for 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>€000</td>
<td>€000</td>
</tr>
<tr>
<td>Hungary</td>
<td>-</td>
<td>1.530</td>
</tr>
<tr>
<td>Italy</td>
<td>800</td>
<td>-</td>
</tr>
<tr>
<td>Norway</td>
<td>-</td>
<td>199</td>
</tr>
<tr>
<td><strong>Unutilised grant income</strong></td>
<td><strong>800</strong></td>
<td><strong>1.775</strong></td>
</tr>
</tbody>
</table>
Credits and acknowledgments

This report was produced on the direction of the ELIXIR Board by the ELIXIR External Relations team at the ELIXIR Hub.

With a special thanks to all who contributed to the development of ELIXIR in 2019, notably the ELIXIR Heads of Nodes, Platform and Community Leads, Training and Technical Coordinators and members of the various Tasks groups within Platforms.

Hinxton, UK, May 2020

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