



From Bioinformatics to Astroinformatics curriculum : A French experience

Engelbert MEPHU NGUIFO
Clermont Auvergne University (UCA)

BigSkyEarth Cost Action meeting
Sorrento (Italy), October 24-25, 2016

Summary

- Goal
- Bioinformatics education
 - France
 - Worldwide
- Outcome : Lesson learned

Goal

Objective of the meeting :

« ... will address the question of **how to train** a new generation of **astronomy** and **Earth observation** scientists in the age of interdisciplinarity driven by big data.

Modern data-intensive research requires natural science students trained in software engineering, algorithms, and data mining, data management and visualization.

These trends challenge the current paradigm of what constitutes **education in astronomy or Earth observation.** »

Goal

- No
 - Define a curriculum for Astroinformatics
 - Compare Bioinformatics to Astroinformatics courses
 - Looking to research in both disciplines
- Yes
 - Can lessons learned in Education from Bioinformatics contribute to Astroinformatics ?

Goal

- Biology

-

- ...

- Bioinformatics

- ...

- Physics

-

-

- Astronomy

- ...

- ...

- Astroinformatics

- Physicoinformatics

- ...

Goal

- Podcast of Pauline Barmby (Department of Physics And Astronomy at Western University in London, Ontario, Canada), May 6, 2012

« ... Astroinformatics is the sub-field of astrophysics that involves organizing, describing, classifying, visualizing, and mining astronomical data.

It's similar to bioinformatics in biology, which arose out of the need to deal with the large volume of data produced by *molecular* biology (e.g., genome sequencing). ... »

Goal

- Podcast of Pauline Barmby (Department of Physics And Astronomy at Western University in London, Ontario, Canada), May 6, 2012

« While astrophysicists have often had to deal with large quantities of data, the idea of **astroinformatics as a separate research area is relatively new.**

Like bioinformatics some years ago, astroinformatics is currently in something of a boundary area between astrophysics and computer science, and the methods of doing things are still being sorted out.

The reason that astroinformatics has emerged as its own research area is that we are experiencing a major change in the kind of **observational data** that's become available. ... »

Bioinformatics Education

A brief history of genome research and bioinformatics in France

Article in *Bioinformatics* 16(1):65-75 · February 2000 with 10 Reads

DOI: 10.1093/bioinformatics/16.1.65 · Source: PubMed



1st [Antoine Danchin](#)

48.66 · Institute of Cardiometaboli

Abstract

The development of *in silico* genomics has progressed slowly in France for a number of political reasons. Two administrative organizations, the Groupement de Recherche sur les Génomes (GREG) and the Groupement de Recherche 1029 (GDR 1029) of the Centre National de la Recherche Scientifique (CNRS) have been established. These organizations have created the dynamics that hopefully will place France (which coordinated consortia that completed several of the first large microbial genomes) among the developed nations that support Large-Scale Biology.

Bioinformatics Education

- History in France :
 - Before 1985 :
 - Already research in Bioinformatics
 - Some significant events :
 - Increase of Biological data bases (GenBank, SwissProt, ...)
 - Efficient programs (Alignment, ...)
 - **Industrial interest**
 - ...
 - 1985 : Need for education
 - No academic program (Bachelor, Master)
 - PhD Student (Self-training or specialized courses)

Bioinformatics Education

- History in France :
 - After 1985 : 3 periods
 - First period : (til 1991)
 - Master Program :
 - » CS courses in Biology program → Biologist with CS background
 - » Biology courses in CS program → CS scientists with Bio background
 - » 1987 : « Master in Bioinformatique » ---- 1st in Europe
 - Second period : (1991-1997)
 - ...
 - Third period : (1997-)
 - Master Program :
 - » Bio & CS courses : Need for a bioinformatician profile
 - Undergraduated program

Bioinformatics Education

Example : Bachelor in Biology, speciality Bioinformatics

Semestre S5			Semestre S6		
		crédits			crédits
UE 1	Biologie moléculaire	6	UE 1	Bio-informatique	3
UE 2	Génétique	3	UE 2	Projet Professionnel 3	3
UE 3	Métabolisme	3	UE 3	Génomique fonctionnelle et génétique	3
UE 4	Programmation I	6	UE 4	Travaux Pratiques	3
UE 5	Algorithmique	3	UE 5	Programmation II	6
UE 6	Base de données I	3	UE 6	Bio-statistiques avancées	3
UE 7	biostatistique	3	UE 7	Modélisation de systèmes biologiques	3
UE 8	Anglais scientifique	3	UE 8	UE de spécialisation	6

Bioinformatics Education

- In France :
 - Academic program (<https://jebif.fr/fr/bioinformatique/les-formations/>)
 - Bachelor
 - **Master**
 - PhD
 - Specialized courses / Training
 - But, not a discipline → Interdisciplinarity
 - Biology
 - Computer science

Bioinformatics Education

French Bioinformatics Platforms Network (RENABI)

RENABI gathers 13 french bioinformatics platforms, 8 of them depending on the corresponding genopole. These 13 platforms are : the platform of the genopole of Lille the platform of OUEST-Genopole the platform of the genopole Grand-Est (Strasbourg) the Computing Center of Pasteur Paris the Paris Resource in Structural Bioinformatics (Ressource Parisienne en Bioinformatique Structurale, RPBS) the MIG (Mathematics Computing and Genome) unit of INRA Jouy-en-Josas Genoplante-Info, maintained by the URGI (Genomic-Info Research Unit) unit of INRA in Evry. the Genoscope, national DNA sequencing center in Evry the Rhône-Alpes Bioinformatics Center, PRABI (Lyon-Grenoble) the Bioinformatics Center of Bordeaux (CBiB) the platform of the genopole of Toulouse the IGS (Genomic and Structural Information) platform of the genopole of Marseille-Nice the IMGT (ImMunoGeneTics) platform and other servers in association with the genopole Montpellier Languedoc-Roussillon They provide: computing capacity, storage capacity (for local users mainly), access to the most used software and to the new tools developed locally, support for these software and tools, teaching and training in bioinformatics.

Bioinformatics Education

Welcome to the French Institute of Bioinformatics.

The French Institute of Bioinformatics (referred to as IFB hereafter) is a national service infrastructure in bioinformatics that was created following the call for proposals, "National Infrastructures in Biology and Health", of the "Investments for the Future" initiative (ANR-11-INBS-0013).

This project gathers together the bioinformatics platforms of the main French research organizations, **CNRS**, **INRA**, **INRIA**, **CEA** and **INSERM**, as well as **CIRAD**, the **Pasteur** and **Curie** Institutes, and the French universities. There are currently 30 **platforms** grouped into six regional centers that span the whole of France.

IFB's principal mission is to provide basic **services** and resources in bioinformatics for scientists and engineers working in the life sciences.

IFB is the French node of the European research infrastructure, **ELIXIR**.

IFB's partners in the French Bioinformatics community are the **French Society of Bioinformatics** (SFBI) and **the CNRS network for Bioinformatics research** (GdR BIM). A list of French laboratories having a Bioinformatics activity is available **here**.

Bioinformatics Education


- Worldwide :
 - Recommendation from the Curriculum Task Force of the ISCB Education Committee, **of curricular guidelines for those who train and educate** bioinformaticians.



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MESSAGE FROM ISCB

Bioinformatics Curriculum Guidelines: Toward a Definition of Core Competencies

Lonnie Welch , Fran Lewitter, Russell Schwartz, Cath Brooksbank, Predrag Radivojac, Bruno Gaeta, Maria Victoria Schneider

Published: March 6, 2014 • <http://dx.doi.org/10.1371/journal.pcbi.1003496>

Bioinformatics Education

- Methods
 - Survey of Directors of Bioinformatics Core Facilities
 - Capture perspectives from representatives of employers of professional bioinformaticians
 - Survey of Career Opportunities
 - Analysis of the ISCB - Membership Job Board postings
 - Preliminary survey of existing curricula
 - 72 awarding Bachelor of science, arts or technology
 - 38 awarding Master of science, research or biotechnology
 - 39 awarding PhD

Bioinformatics Education

Table 2. Core competencies for each bioinformatics training category.

	Bioinformatics User	Bioinformatics Scientist	Bioinformatics Engineer
(a) An ability to apply knowledge of computing, biology, statistics, and mathematics appropriate to the discipline.		X	X
(b) An ability to analyze a problem and identify and define the computing requirements appropriate to its solution.		X	X
(c) An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs in scientific environments.			X
(d) An ability to use current techniques, skills, and tools necessary for computational biology practice.	X	X	X
(e) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.			X

Bioinformatics Education

(e) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.			X
(f) An ability to apply design and development principles in the construction of software systems of varying complexity.			X
(g) An ability to function effectively on teams to accomplish a common goal.	X	X	X
(h) An understanding of professional, ethical, legal, security, and social issues and responsibilities.	X	X	X
(i) An ability to communicate effectively with a range of audiences.	X	X	X
(j) An ability to analyze the local and global impact of bioinformatics and genomics on individuals, organizations, and society.	X	X	X
(k) Recognition of the need for and an ability to engage in continuing professional development.	X	X	X
(l) Detailed understanding of the scientific discovery process and of the role of bioinformatics in it.	X	X	X
(m) An ability to apply statistical research methods in the contexts of molecular biology, genomics, medical, and population genetics research.	X	X	X
(n) Knowledge of general biology, in-depth knowledge of at least one area of biology, and understanding of biological data generation technologies.	X	X	X

Bioinformatics Education

Brief Bioinform. 2010 Nov;11(6):544-51. doi: 10.1093/bib/bbq021. Epub 2010 Jun 18.

Bioinformatics training: a review of challenges, actions and support requirements.

Schneider MV¹, Watson J, Attwood T, Rother K, Budd A, McDowall J, Via A, Fernandes P, Nyronen T, Blicher T, Jones P, Blatter MC, De Las Rivas J, Judge DP, van der Gool W, Brooksbank C.

Author information

Abstract

As bioinformatics becomes increasingly central to research in the molecular life sciences, the need to train non-bioinformaticians to make the most of bioinformatics resources is growing. Here, we review the key challenges and pitfalls to providing effective training for users of bioinformatics services, and discuss successful training strategies shared by a diverse set of bioinformatics trainers. We also identify steps that trainers in bioinformatics could take together to advance the state of the art in current training practices. The ideas presented in this article derive from the first Trainer Networking Session held under the auspices of the EU-funded SLING Integrating Activity, which took place in November 2009.

PMID: 20562256 DOI: [10.1093/bib/bbq021](https://doi.org/10.1093/bib/bbq021)

Bioinformatics Education

Brief Bioinform. 2010 Nov;11(6):552-62. doi: 10.1093/bib/bbq023. Epub 2010 Jul 2.

Bioinformatics training: selecting an appropriate learning content management system--an example from the European Bioinformatics Institute.

Wright VA¹, Vaughan BW, Laurent T, Lopez R, Brooksbank C, Schneider MV.

⊕ Author information

Abstract

Today's molecular life scientists are well educated in the emerging experimental tools of their trade, but when it comes to training on the myriad of resources and tools for dealing with biological data, a less ideal situation emerges. Often bioinformatics users receive no formal training on how to make the most of the bioinformatics resources and tools available in the public domain. The European Bioinformatics Institute, which is part of the European Molecular Biology Laboratory (EMBL-EBI), holds the world's most comprehensive collection of molecular data, and training the research community to exploit this information is embedded in the EBI's mission. We have evaluated eLearning, in parallel with face-to-face courses, as a means of training users of our data resources and tools. We anticipate that eLearning will become an increasingly important vehicle for delivering training to our growing user base, so we have undertaken an extensive review of Learning Content Management Systems (LCMSs). Here, we describe the process that we used, which considered the requirements of trainees, trainers and systems administrators, as well as taking into account our organizational values and needs. This review describes the literature survey, user discussions and scripted platform testing that we performed to narrow down our choice of platform from 36 to a single platform. We hope that it will serve as guidance for others who are seeking to incorporate eLearning into their bioinformatics training programmes.

PMID: 20601435 DOI: [10.1093/bib/bbq023](https://doi.org/10.1093/bib/bbq023)

Bioinformatics Education

Brief Bioinform. 2013 Sep;14(5):528-37. doi: 10.1093/bib/bbt043. Epub 2013 Jun 25.

Best practices in bioinformatics training for life scientists.

Via A¹, Blicher T, Bongcam-Rudloff E, Brazas MD, Brooksbank C, Budd A, De Las Rivas J, Dreyer J, Fernandes PL, van Gelder C, Jacob J, Jimenez RC, Loveland J, Moran F, Mulder N, Nyrönen T, Rother K, Schneider MV, Attwood TK.

⊕ Author information

Abstract

The mountains of data thrusting from the new landscape of modern high-throughput biology are irrevocably changing biomedical research and creating a near-insatiable demand for training in data management and manipulation and data mining and analysis. Among life scientists, from clinicians to environmental researchers, a common theme is the need not just to use, and gain familiarity with, bioinformatics tools and resources but also to understand their underlying fundamental theoretical and practical concepts. Providing bioinformatics training to empower life scientists to handle and analyse their data efficiently, and progress their research, is a challenge across the globe. Delivering good training goes beyond traditional lectures and resource-centric demos, using interactivity, problem-solving exercises and cooperative learning to substantially enhance training quality and learning outcomes. In this context, this article discusses various pragmatic criteria for identifying training needs and learning objectives, for selecting suitable trainees and trainers, for developing and maintaining training skills and evaluating training quality. Adherence to these criteria may help not only to guide course organizers and trainers on the path towards bioinformatics training excellence but, importantly, also to improve the training experience for life scientists.

KEYWORDS: bioinformatics; bioinformatics courses; train the trainers; training; training life scientists

PMID: 23803301 PMCID: [PMC3771230](#) DOI: [10.1093/bib/bbt043](#)

Bioinformatics Education

[Brief Bioinform.](#) 2012 May;13(3):383-9. doi: 10.1093/bib/bbr064. Epub 2011 Nov 22.

Bioinformatics Training Network (BTN): a community resource for bioinformatics trainers.

[Schneider MV¹](#), [Walter P](#), [Blatter MC](#), [Watson J](#), [Brazas MD](#), [Rother K](#), [Budd A](#), [Via A](#), [van Gelder CW](#), [Jacob J](#), [Fernandes P](#), [Nyrönen TH](#), [De Las Rivas J](#), [Blicher T](#), [Jimenez RC](#), [Loveland J](#), [McDowall J](#), [Jones P](#), [Vaughan BW](#), [Lopez R](#), [Attwood TK](#), [Brooksbank C](#).

⊕ Author information

Abstract

Funding bodies are increasingly recognizing the need to provide graduates and researchers with access to short intensive courses in a variety of disciplines, in order both to improve the general skills base and to provide solid foundations on which researchers may build their careers. In response to the development of 'high-throughput biology', the need for training in the field of bioinformatics, in particular, is seeing a resurgence: it has been defined as a key priority by many Institutions and research programmes and is now an important component of many grant proposals. Nevertheless, when it comes to planning and preparing to meet such training needs, tension arises between the reward structures that predominate in the scientific community which compel individuals to publish or perish, and the time that must be devoted to the design, delivery and maintenance of high-quality training materials. Conversely, there is much relevant teaching material and training expertise available worldwide that, were it properly organized, could be exploited by anyone who needs to provide training or needs to set up a new course. To do this, however, the materials would have to be centralized in a database and clearly tagged in relation to target audiences, learning objectives, etc. Ideally, they would also be peer reviewed, and easily and efficiently accessible for downloading. Here, we present the Bioinformatics Training Network (BTN), a new enterprise that has been initiated to address these needs and review it, respectively, to similar initiatives and collections.

PMID: 22110242 PMCID: [PMC3357490](#) DOI: [10.1093/bib/bbr064](#)

Bioinformatics Education

Bioinformatics. 2015 Jan 1;31(1):140-2. doi: 10.1093/bioinformatics/btu601. Epub 2014 Sep 4.

The GOBLET training portal: a global repository of bioinformatics training materials, courses and trainers.

Corpas M¹, Jimenez RC¹, Bongcam-Rudloff E¹, Budd A¹, Brazas MD¹, Fernandes PL¹, Gaeta B¹, van Gelder C², Korpelainen E¹, Lewitter F¹, McGrath A¹, MacLean D¹, Palagi PM¹, Rother K¹, Taylor J¹, Via A¹, Watson M¹, Schneider MV¹, Attwood TK¹.

⊕ Author information

Abstract

SUMMARY: Rapid technological advances have led to an explosion of biomedical data in recent years. The pace of change has inspired new collaborative approaches for sharing materials and resources to help train life scientists both in the use of cutting-edge bioinformatics tools and databases and in how to analyse and interpret large datasets. A prototype platform for sharing such training resources was recently created by the Bioinformatics Training Network (BTN). Building on this work, we have created a centralized portal for sharing training materials and courses, including a catalogue of trainers and course organizers, and an announcement service for training events. For course organizers, the portal provides opportunities to promote their training events; for trainers, the portal offers an environment for sharing materials, for gaining visibility for their work and promoting their skills; for trainees, it offers a convenient one-stop shop for finding suitable training resources and identifying relevant training events and activities locally and worldwide.

AVAILABILITY AND IMPLEMENTATION: <http://mygoblet.org/training-portal>.

© The Author 2014. Published by Oxford University Press.

PMID: 25189782 PMCID: [PMC4271145](https://pubmed.ncbi.nlm.nih.gov/PMC4271145/) DOI: [10.1093/bioinformatics/btu601](https://doi.org/10.1093/bioinformatics/btu601)

Bioinformatics Education

[PLoS Comput Biol.](#) 2015 Apr 9;11(4):e1004143. doi: 10.1371/journal.pcbi.1004143. eCollection 2015.

GOBLET: the Global Organisation for Bioinformatics Learning, Education and Training.

[Attwood TK](#), [Bongcam-Rudloff E](#)², [Brazas ME](#)³, [Corpas M](#)⁴, [Gaudet P](#)⁵, [Lewitter F](#)⁶, [Mulder N](#)⁷, [Palagi PM](#)⁸, [Schneider MV](#)⁹, [van Gelder CW](#)¹⁰; [GOBLET Consortium](#).

⊕ **Collaborators (54)**

⊕ **Author information**

Erratum in

Correction: GOBLET: The Global Organisation for Bioinformatics Learning, Education and Training. [PLoS Comput Biol. 2015]

Abstract

In recent years, high-throughput technologies have brought big data to the life sciences. The march of progress has been rapid, leaving in its wake a demand for courses in data analysis, data stewardship, computing fundamentals, etc., a need that universities have not yet been able to satisfy--paradoxically, many are actually closing "niche" bioinformatics courses at a time of critical need. The impact of this is being felt across continents, as many students and early-stage researchers are being left without appropriate skills to manage, analyse, and interpret their data with confidence. This situation has galvanised a group of scientists to address the problems on an international scale. For the first time, bioinformatics educators and trainers across the globe have come together to address common needs, rising above institutional and international boundaries to cooperate in sharing bioinformatics training expertise, experience, and resources, aiming to put ad hoc training practices on a more professional footing for the benefit of all.

PMID: 25856076 PMCID: [PMC4391932](#) DOI: [10.1371/journal.pcbi.1004143](#)

Bioinformatics Education

OPEN ACCESS Freely available online

PLoS COMPUTATIONAL BIOLOGY

Editorial

Ten Simple Rules for Developing a Short Bioinformatics Training Course

Allegra Via¹, Javier De Las Rivas², Teresa K. Attwood³, David Landsman⁴, Michelle D. Brazas⁵, Jack A. M. Leunissen⁶, Anna Tramontano¹, Maria Victoria Schneider^{7*}

1 Biocomputing Group, Department of Physics, Sapienza University of Rome, Rome, Italy, **2** Bioinformatics & Functional Genomics Research Group, Cancer Research Center (IBMCC, CSIC/USAL), Salamanca, Spain, **3** Faculty of Life Sciences and School of Computer Science, University of Manchester, Manchester, United Kingdom, **4** Computational Biology Branch, National Center for Biotechnology Information, National Library of Medicine, National Institutes of Health, Maryland, United States of America, **5** Informatics and Bio-computing, Ontario Institute for Cancer Research, MaRS Centre, Toronto, Canada, **6** Laboratory of Bioinformatics, Wageningen University, Wageningen, The Netherlands, **7** Outreach and Training Team, EMBL Outstation, European Bioinformatics Institute, Wellcome Trust Genome Campus, Hinxton, United Kingdom

Bioinformatics Education

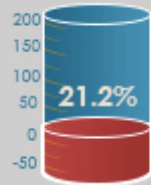
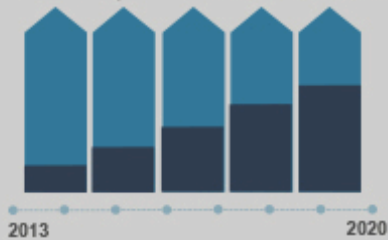
- **Ten Simple rules** for a short bioinformatics course :
 - Set **Practical and Realistic** Expectations
 - Verify That Trainees' **Expectations** Match Course **Scope**
 - Plan **Exercises and Activities** and Test Resources **before** Delivery
 - Ensure Computational Equipment **Preparedness** and Hands-On Support Availability
 - Use the Dynamic World of Bioinformatics **Resources and Tools** as a Learning Opportunity
 - Balance **Concepts with Practical** Outcomes
 - Reinforce Learning with Contextual and “Real World Experience” **Examples**
 - Ensure the Methods/Tools Have **Relevance** to the Trainee Experience and Scientific Research Needs
 - Allow for **Interactivity** and Provide Time for Reflection, Individual Analysis, and Exploration
 - Encourage **Independent** Thinking and Problem Solving

Bioinformatics Education

Global Bioinformatics Market Size and Forecast, 2013 - 2020 (\$Million)

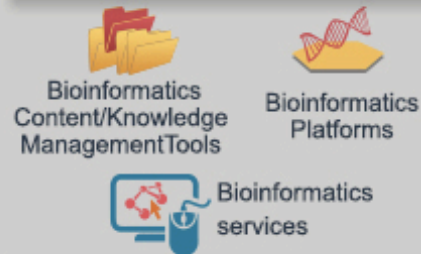
Global Bioinformatics Market

Market by 2020 - \$12.86 Billion



Growing at
a CAGR of
21.2%
(2014 - 2020)

Global Bioinformatics Market By Technology and Services



Global Bioinformatics Market By Application

- Genomics
- Chemoinformatics and Drug Design
- Proteomics
- Transcriptomics
- Metabolomics

Global Bioinformatics Market By Sector

- Medical Bioinformatics
- Animal Bioinformatics
- Agricultural Bioinformatics
- Academics
- Others (Microbial genome)

Global Bioinformatics Market By Geography



Global Bioinformatics Market Dynamics

Drivers

- Need for integrated data
- Increasing growth in proteomics and genomics
- Drug discovery and development
- Government initiatives

Restraints

- Need for skilled Personnel
- Common data formats
- Pharmaceutical sector saturation

↑ For More Details See Table of Contents ↑

Source : "Allied Market Research"

Outcome

- Market : Career opportunities
- Profile
- Core competencies
 - Study level (Bachelor, Master, PhD)
- Training resources
 - Astro training network
 - Society task force on Education
 - Platforms for shared resources
- Strong support of institutions
 - Different levels : Politics, Univ., ...