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Centro de Integração de Dados e Conhecimentos para Saúde

Ministério da Saúde
FIOCRUZ
Fundação Oswaldo Cruz
Instituto Gonçalo Moniz

AtyImo Lab

computação UFBA

UFBA

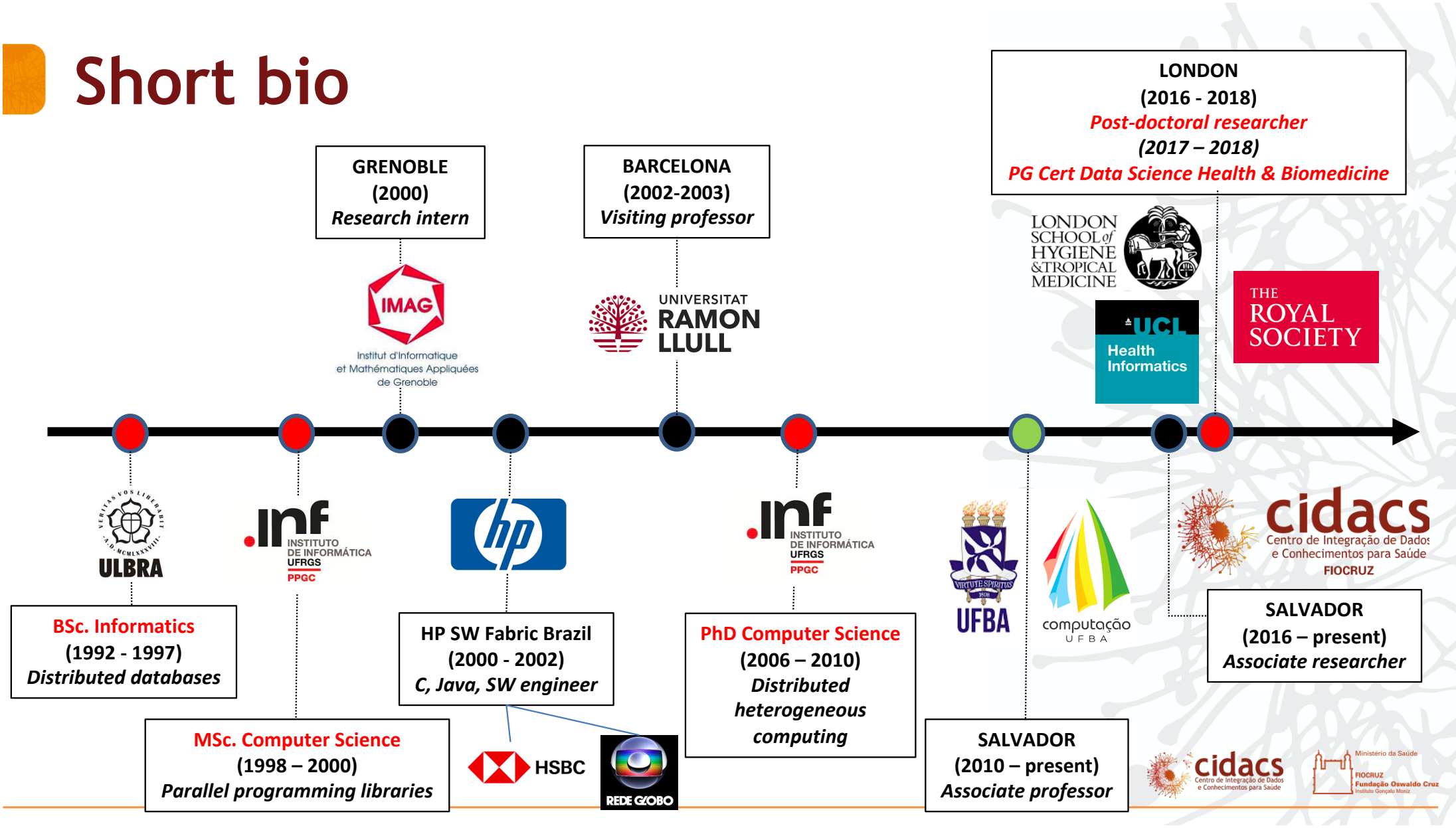
Educação em Ciência de Dados

MARCOS ENNES BARRETO

Professor Associado (DCC/UFBA)
Pesquisador Associado (CIDACS / University College London)
Newton International Fellow Alumnus (The Royal Society, UK)

Salvador, 3 de fevereiro de 2020

Short bio


BSc. Informatics
(1992 - 1997)
Distributed databases
MSc. Computer Science
(1998 – 2000)
Parallel programming libraries
GRENOBLE
(2000)
Research intern
HP SW Fabric Brazil
(2000 - 2002)
C, Java, SW engineer
HSBC
REDE GLOBO
BARCELONA
(2002-2003)
Visiting professor
PhD Computer Science
(2006 – 2010)
Distributed heterogeneous computing
SALVADOR
(2010 – present)
Associate professor
LONDON
(2016 - 2018)
Post-doctoral researcher
(2017 – 2018)
PG Cert Data Science Health & Biomedicine
SALVADOR
(2016 – present)
Associate researcher
ULBRA
INSTITUTO DE INFORMÁTICA UFRGS PPGC
IMAG
Institut d'Informatique et Mathématiques Appliquées de Grenoble
UNIVERSITAT RAMON LLULL
UFBA
computação UFBA
LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE
UCL Health Informatics
THE ROYAL SOCIETY
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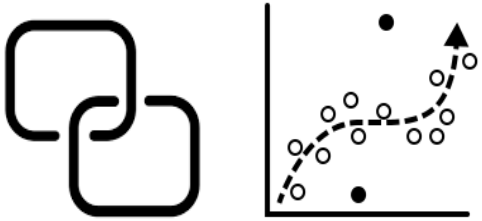
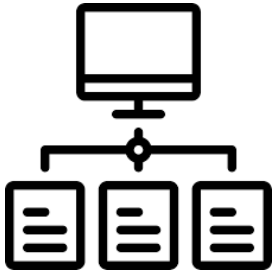
AtyImo Lab

www.atyimolab.ufba.br



big data
linkage &
analytics



hybrid
parallel
computing

cloud
robotics

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Projetos

- ✓ Scaling up **multimodal data fusion and analytical models** over multiple-GPU systems.
- ✓ Design and validation of **personalised risk prediction models** over Brazilian health care data.
- ✓ **Stratification of patients** suffering from myalgic encephalomyelitis/chronic fatigue syndrome.
- ✓ Standardisation of wearable-based algorithms for healthcare applications in developing countries.
- ✓ Early childhood development friendly index: assessing the enabling environment for Nurturing Care.
- ✓ The 100 million Brazilian linked data and datacentre.
- ✓ Treating heterogeneity and uncertainty in data integration: case study on Brazilian databases.
- ✓ Integrating socioeconomic and health data to combat malaria.
- ✓ Design of a scientific repository (data lake) for big data applications.
- ✓ Long-term surveillance platform for Zika virus and microcephaly.
- ✓ Inference on Causation from Examination of Familial Confounding (ICE FALCON).
- ✓ Brazilian twin cohort: data linkage on administrative databases.
- ✓ BAMBU - Metropolitan network for trial and innovation on future internet.
- ✓ IEEE Working Groups: Autonomous Robotics, Robot Task Representation, Ethical Design and Application of Robotic Systems, Personal Data Privacy Process.

Doutorado

Clícia Pinto

Parallel data linkage

Everton Mendonça

Risk prediction models

Julio Oliveira

Quantum machine learning

Alberto Sironi

Visual data mining

Mirlei Moura

Multivariate time series analysis

Tiago Machado

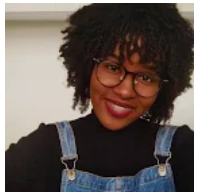
Risk prediction models for chronic kidney diseases

Mestrado

Patrick Ferraz

Climate and health data

Daniela Almeida

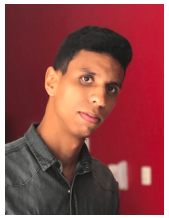


NLP

Andrea Leão

Transfer learning

Murilo Guerreiro



Health risk perception systems

Colaboradores

Robespierre Pita

Categorical data clustering

Juracy Bertoldo

Forecasting models

João Gondim

Data engineering

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www.atyimolab.ufba.br

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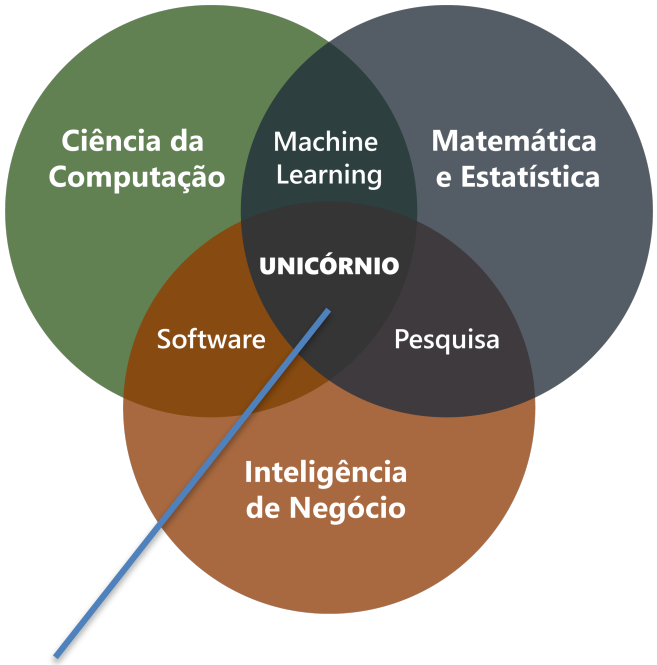
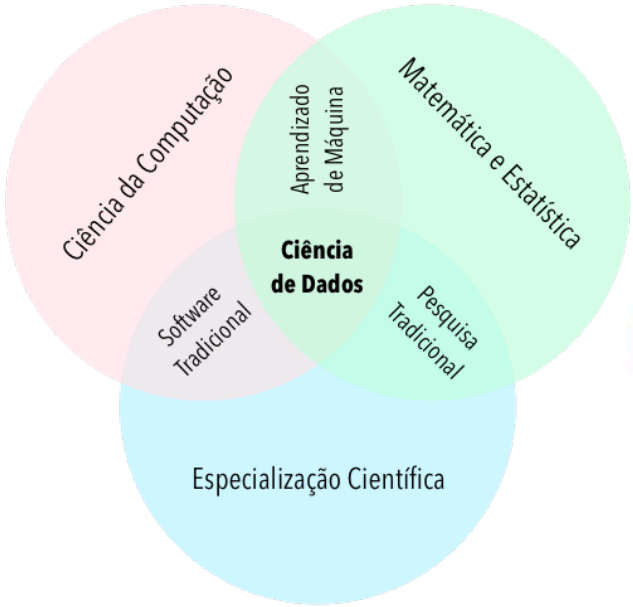
Agenda

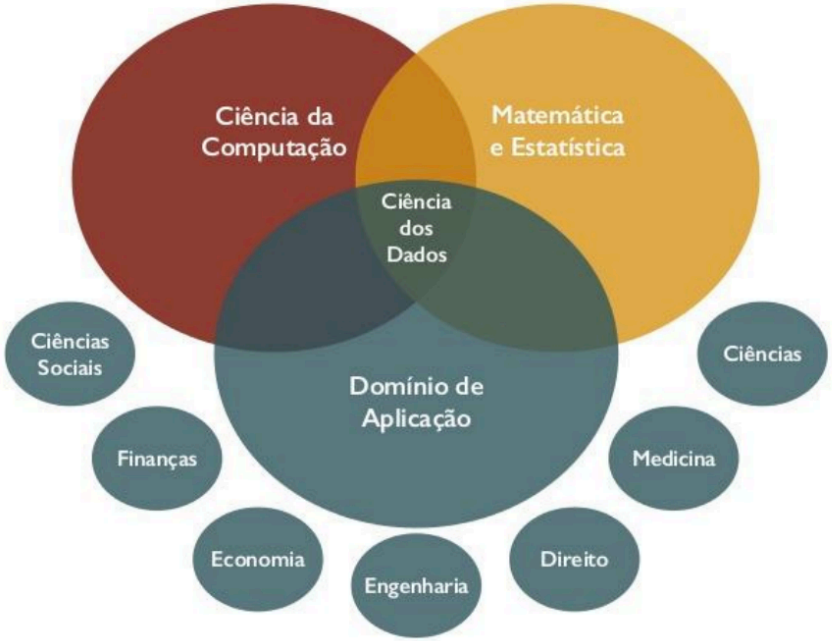
- Como definir Ciência de Dados
- Perfil professional
- Fluxo tradicional de Ciência de Dados
- Formação educacional em Ciência de Dados

Ciência de Dados

- ✓ Ciência de dados é uma área interdisciplinar voltada para o estudo e a análise de dados econômicos, financeiros e sociais, estruturados e não-estruturados, que visa a extração de conhecimento, detecção de padrões e/ou obtenção de *insights* para possíveis tomadas de decisão. Wikipédia







"A mythical beast with magical powers who's rumored to exist but is never actually seen in the wild." Quora

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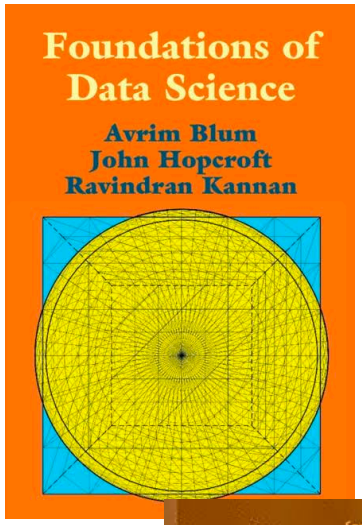
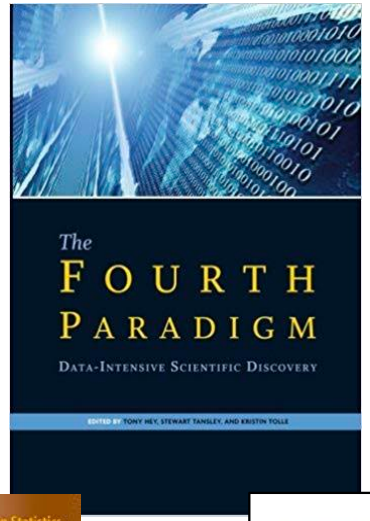
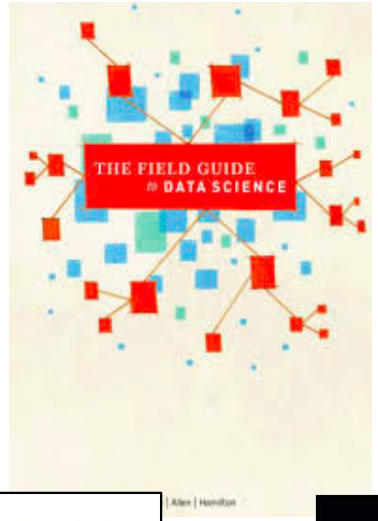
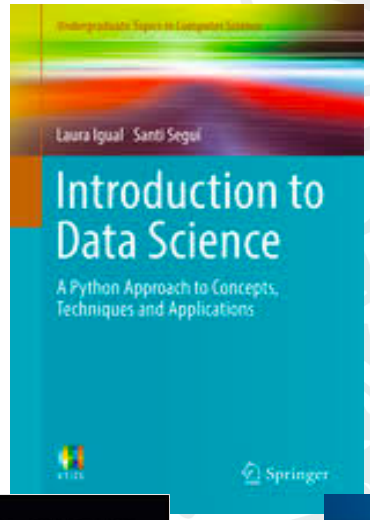
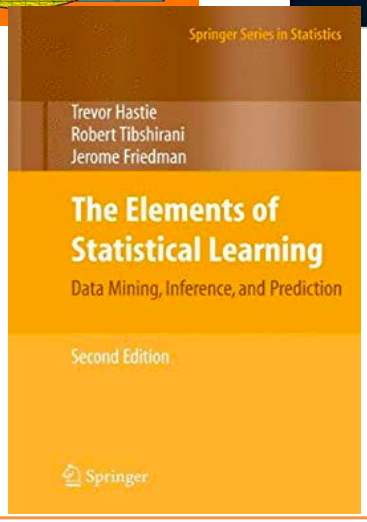
Ciência de Dados

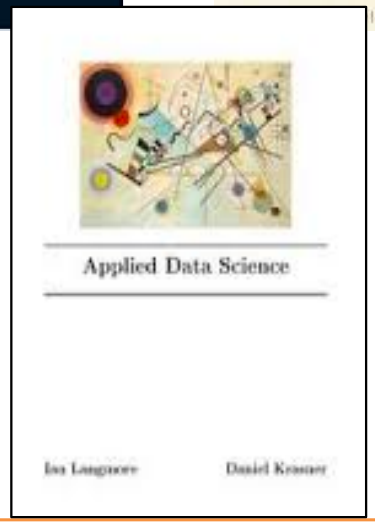


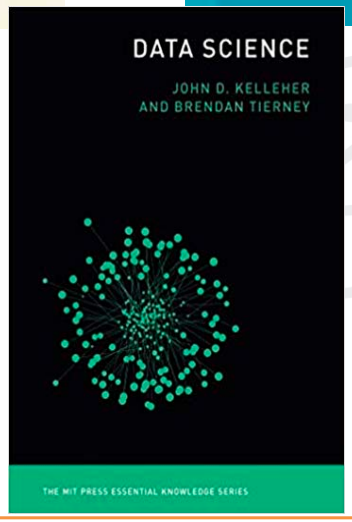


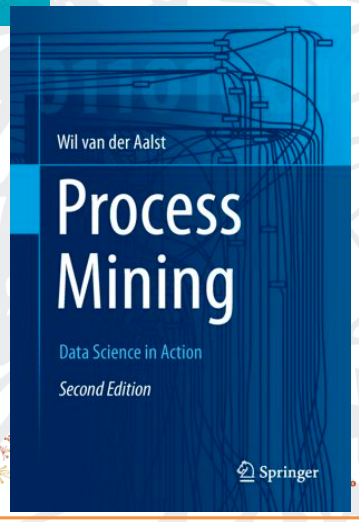




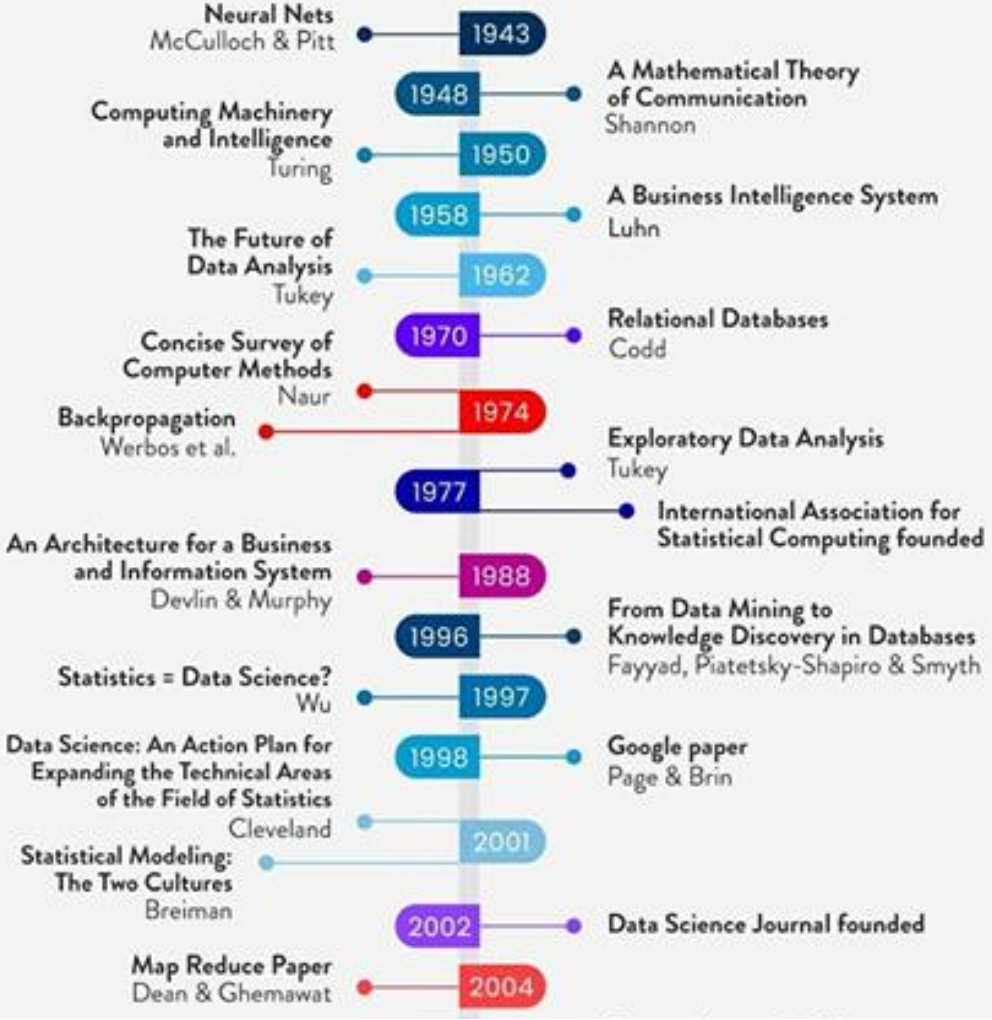


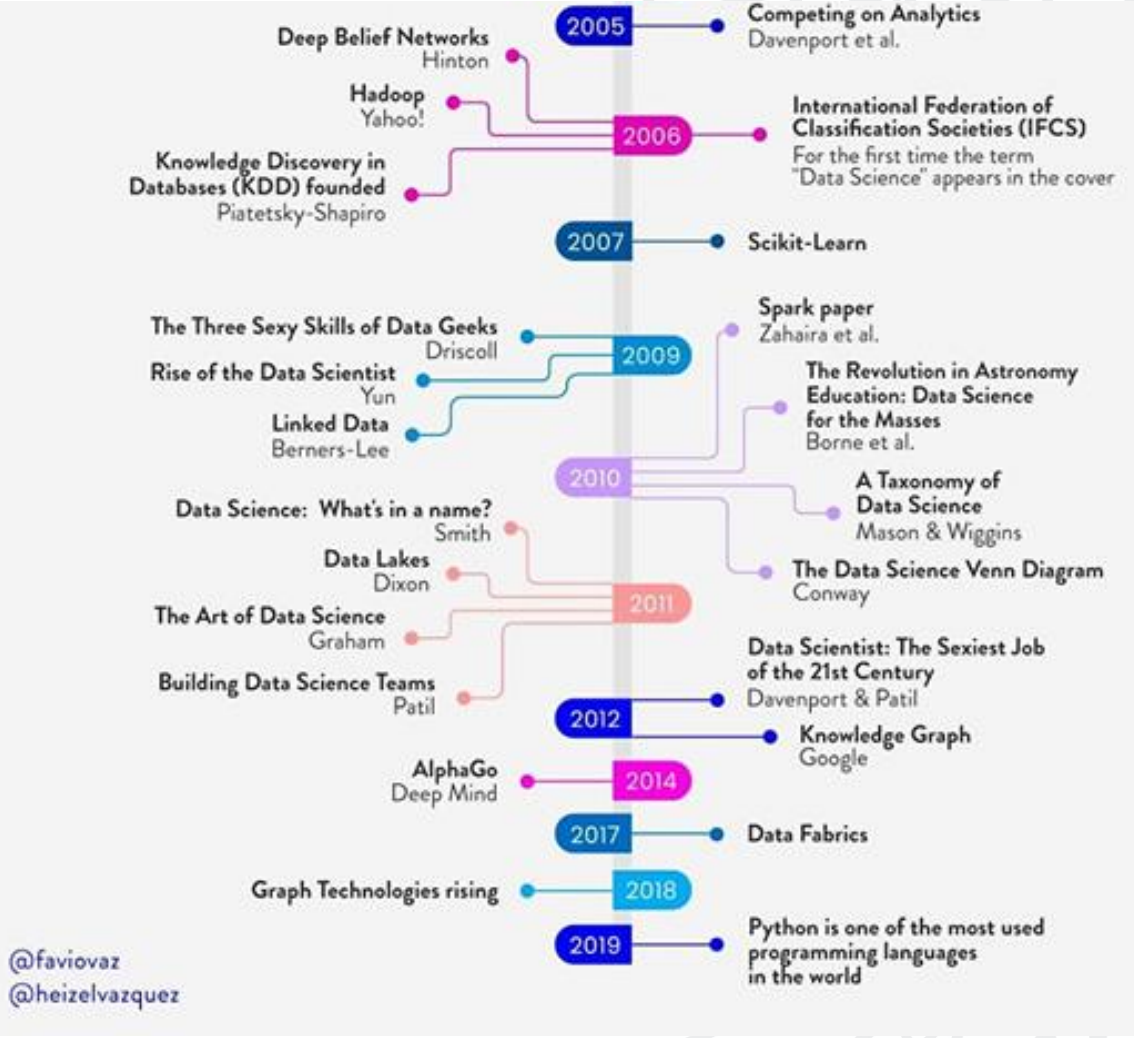






DATA SCIENCE **TIMELINE**





Perfil profissional

Data Scientist

also known as Data Managers, statisticians.

A data scientist will be able to take data science projects from end to end. They can help store large amounts of data, create predictive modelling processes and present the findings.

Skills: Mathematics, Programming, Communication

Will use programmes such as:

SQL, Python, R

Data Engineers

also known as database administrators and data architects.

They are versatile generalists who use computer science to help process large datasets. They typically focus on coding, cleaning up data sets, and implementing requests that come from data scientists.

Skills: Programming, Mathematics, Big data

Will use programmes such as:

Hadoop, NoSQL, and Python

Data Analysts

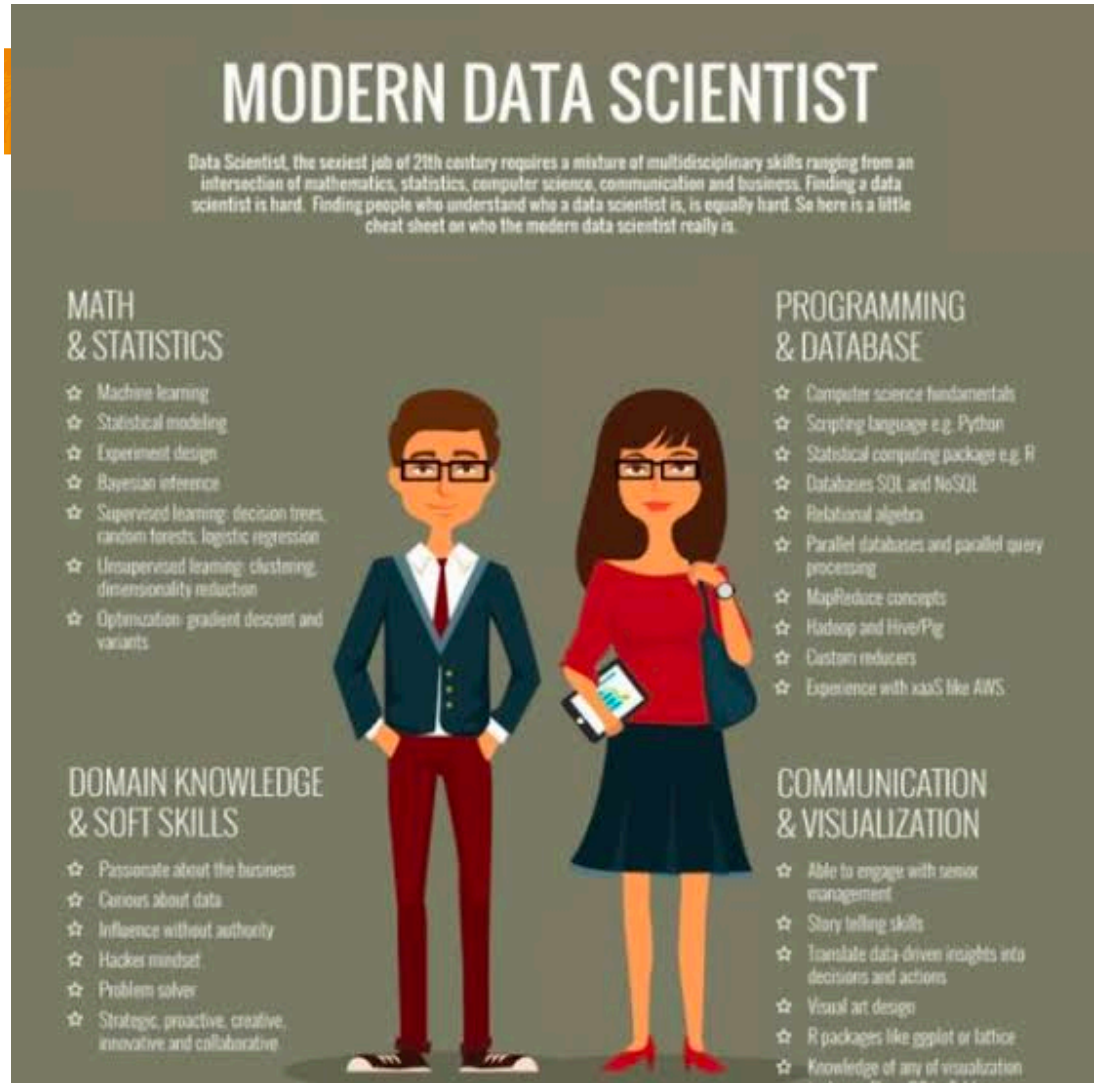
also known as business Analysts.

They typically help people from across the company understand specific queries with charts.

Skills: Statistics, Communication, Business knowledge

Will use programmes such as:

Excel, Tableau, SQL



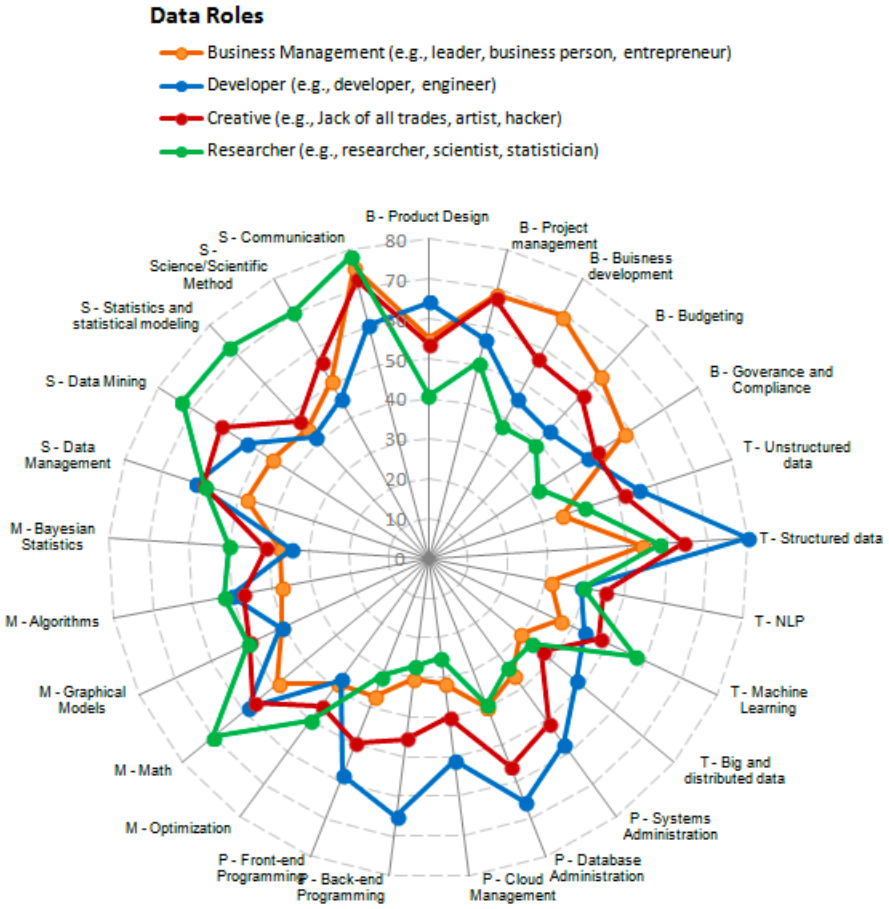
	Statistician	Data Scientist
Image	Baseball (Cricket)	HBR Sexiest Job of 21st Century
Mode	Reactive	Consultative
Works	Solo	In a team
Inputs	Data File, Hypothesis	A Business Problem
Data	Pre-prepared, clean	Distributed, messy, unstructured
Data Size	Kilobytes	Gigabytes
Tools	SAS, Mainframe	R, Python, awk, Hadoop, Linux, …
Nouns	Tables	Data Visualizations
Focus	Inference (why)	Prediction (what)
Output	Report	Data App / Data Product
Latency	Weeks	Seconds

Área	Analista de BI	Cientista de Dados
Foco	Relatórios, KPI's, Tendências	Padrões, Correlações, Modelos Preditivos
Processo	Estático, Comparativo	Exploratório, Experimental, Visual
Fontes de Dados	Data Warehouses, Bancos Transacionais	Big Data, Dados Não-Estruturados, Bancos Transacionais e NoSQL, Dados Gerados em Tempo Real
Qualidade dos Dados na Fonte	Alta	Baixa ou Média (requer processo de limpeza e transformação)
Modelo de Dados	Esquema de dados bem definido na fonte	Esquema de dados definido no momento da consulta
Transformações nos Dados	Pouca ou nenhuma (dados já organizados na fonte)	Transformação sob demanda, necessidade de complementar os dados
Análise	Descritiva, Retrospectiva	Preditiva, Prescritiva
Responde à pergunta:	O que aconteceu?	O que pode acontecer?

Perfil profissional

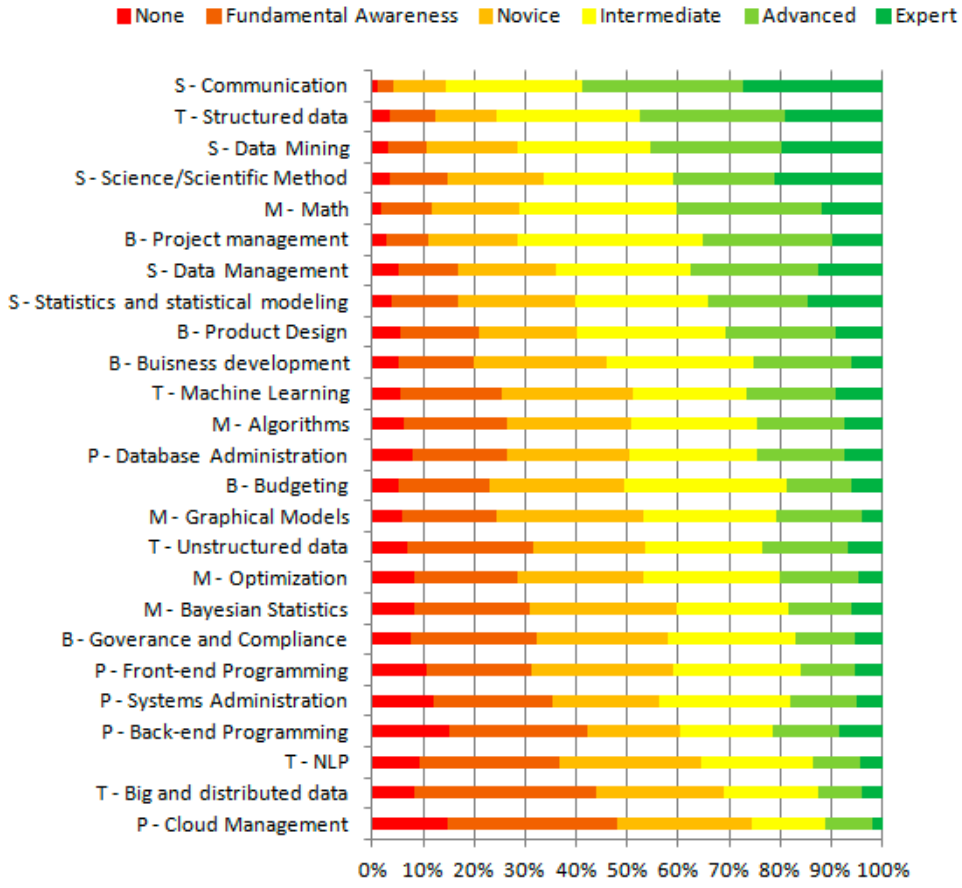
Proficiency in Data Science Skills by Job Role

AnalyticsWeek
BUSINESS BROADWAY



Note: Data are based on responses from 490 data professionals. Data professionals were asked to rate their proficiency across 25 skills using a scale from 0 (don't know) to 100 (expert).
This graph is based on respondents who selected only one primary job role. Business (n = 65); Developer (n = 47); Creative (n = 25); Researcher (n = 101)

Proficiency in Data Science Skills



Note: Data are based on responses from 490 data professionals. Data professionals were asked to rate their proficiency across 25 skills using a scale from 0 (don't know) to 100 (expert).

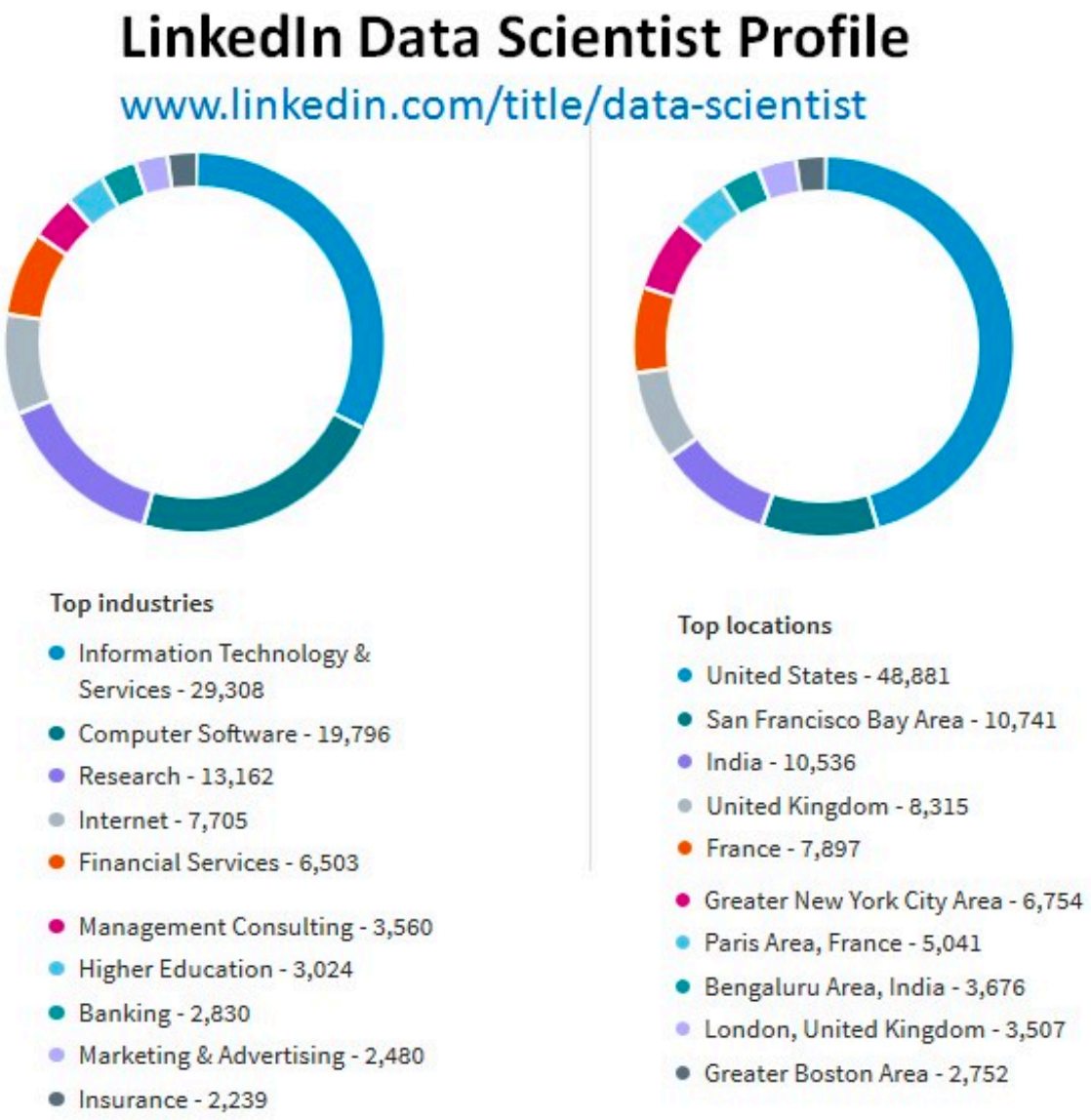
Perfil profissional

A Data Scientist at the office

https://towardsdatascience.com/the-data-scientist-unicorn-8c86cb712dde

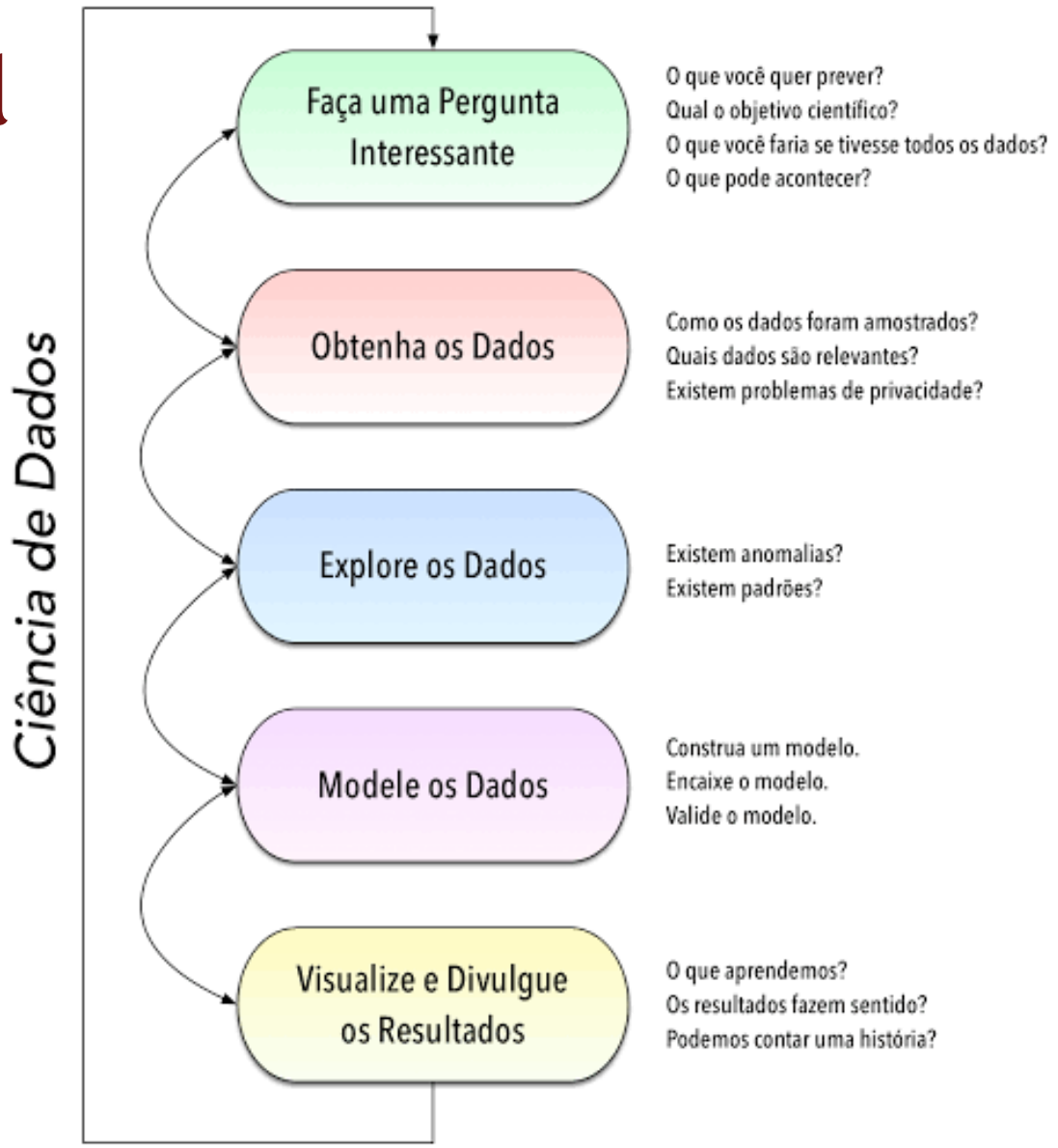
How many data scientists are there and is there a shortage?

KDnuggets



https://www.kdnuggets.com/2018/09/how-many-data-scientists-are-there.html

Fluxo tradicional



Fluxo tradicional de Ciência de Dados

Big Data Research 2 (2015) 49–52

Contents lists available at ScienceDirect

Big Data Research

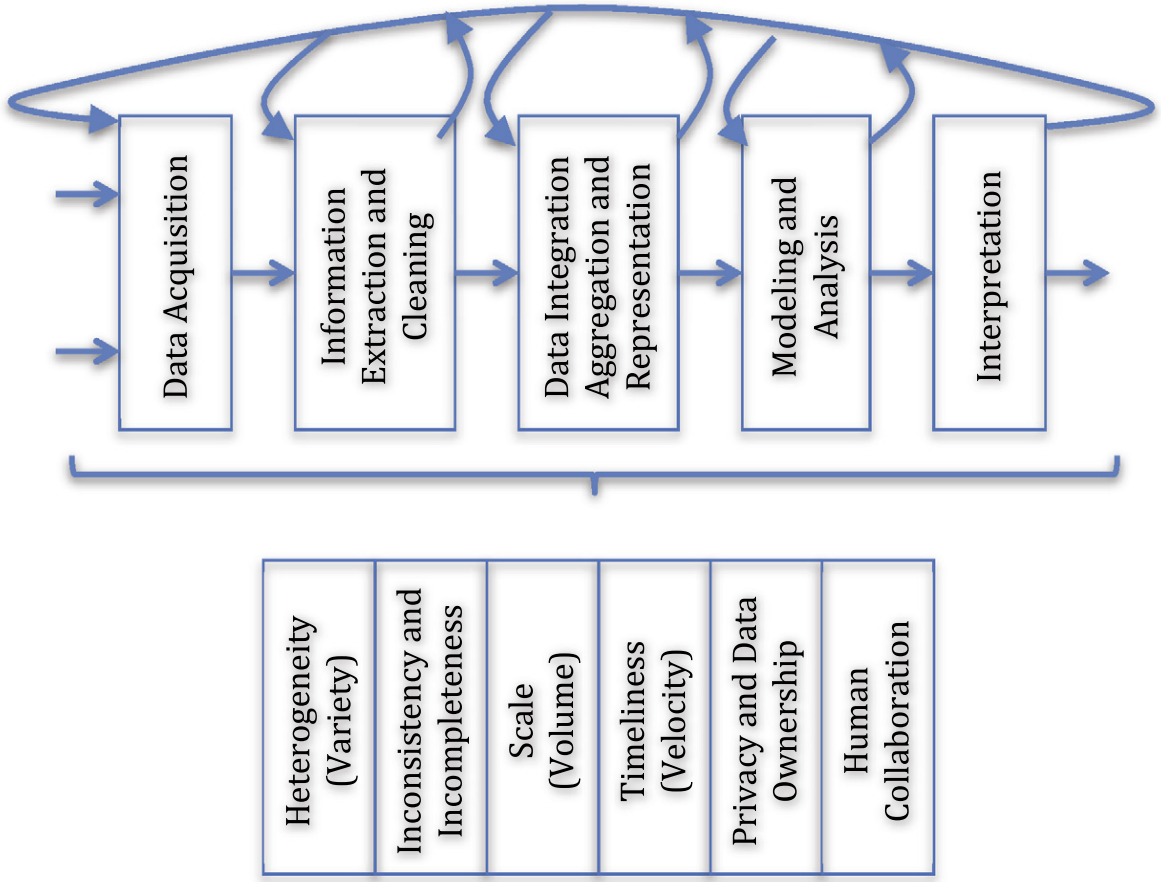
www.elsevier.com/locate/bdr

Big Data and Science: Myths and Reality ☆

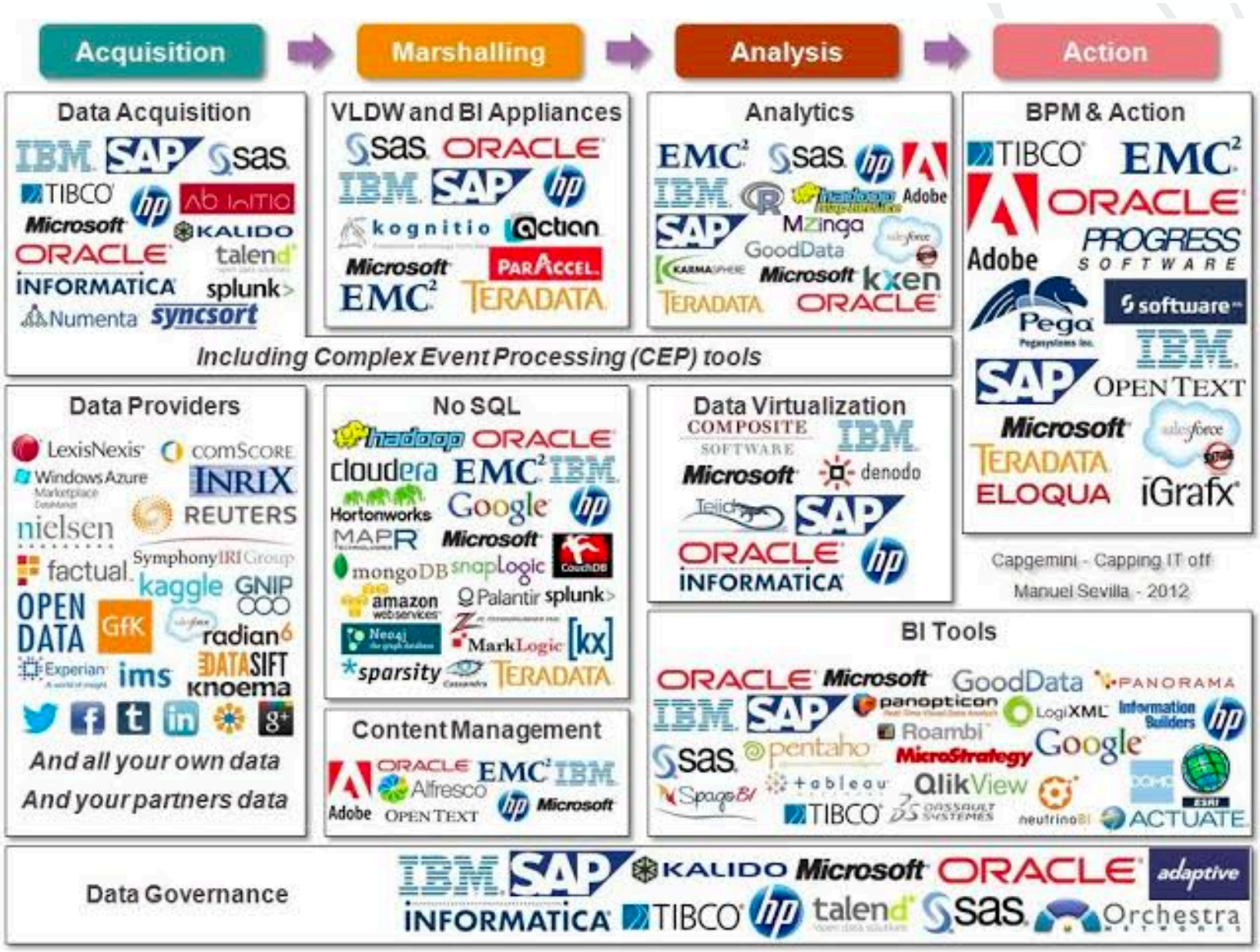
H.V. Jagadish

University of Michigan, United States

Phases in the Big Data Life-Cycle



Infinidade de ferramentas



Mas antes de iniciar este fluxo...

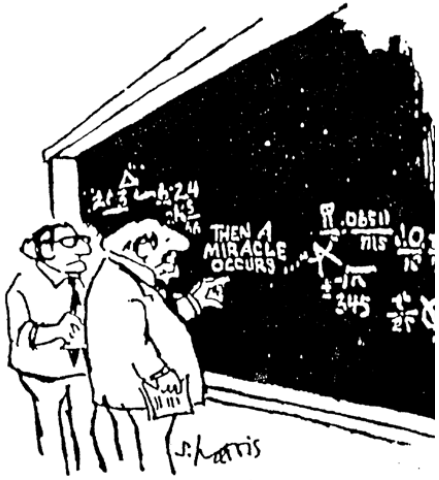
Data-Driven vs. Hypothesis-Driven Research: Making sense of big data

Willy Shih and Sen Chai

empirical data-collection driven approach

Published Online: 30 Nov 2017 | https://doi.org/10.5465/ambpp.2016.14843abstract

Input → BLACK BOX → Output



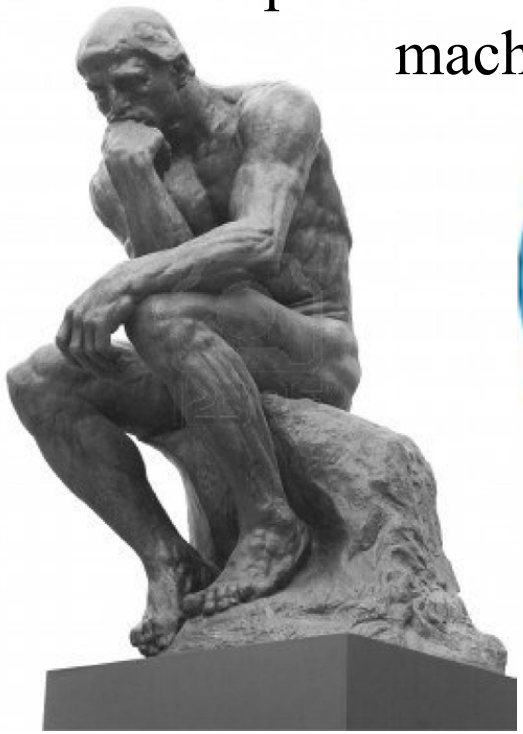
"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

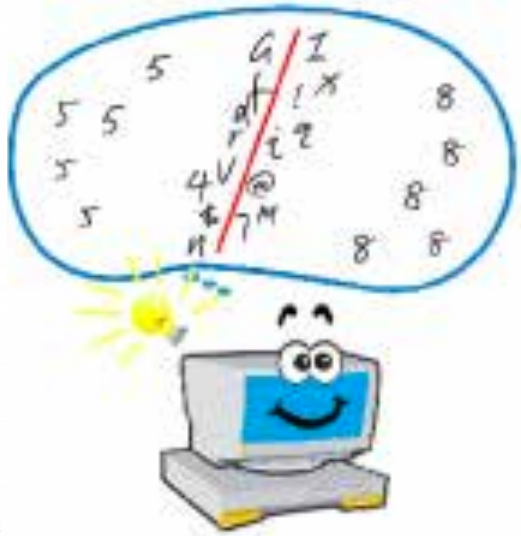
Defining the scientific method

The rise of 'omics' methods and data-driven research presents new possibilities for discovery but also stimulates disagreement over how science should be conducted and even how it should be defined.

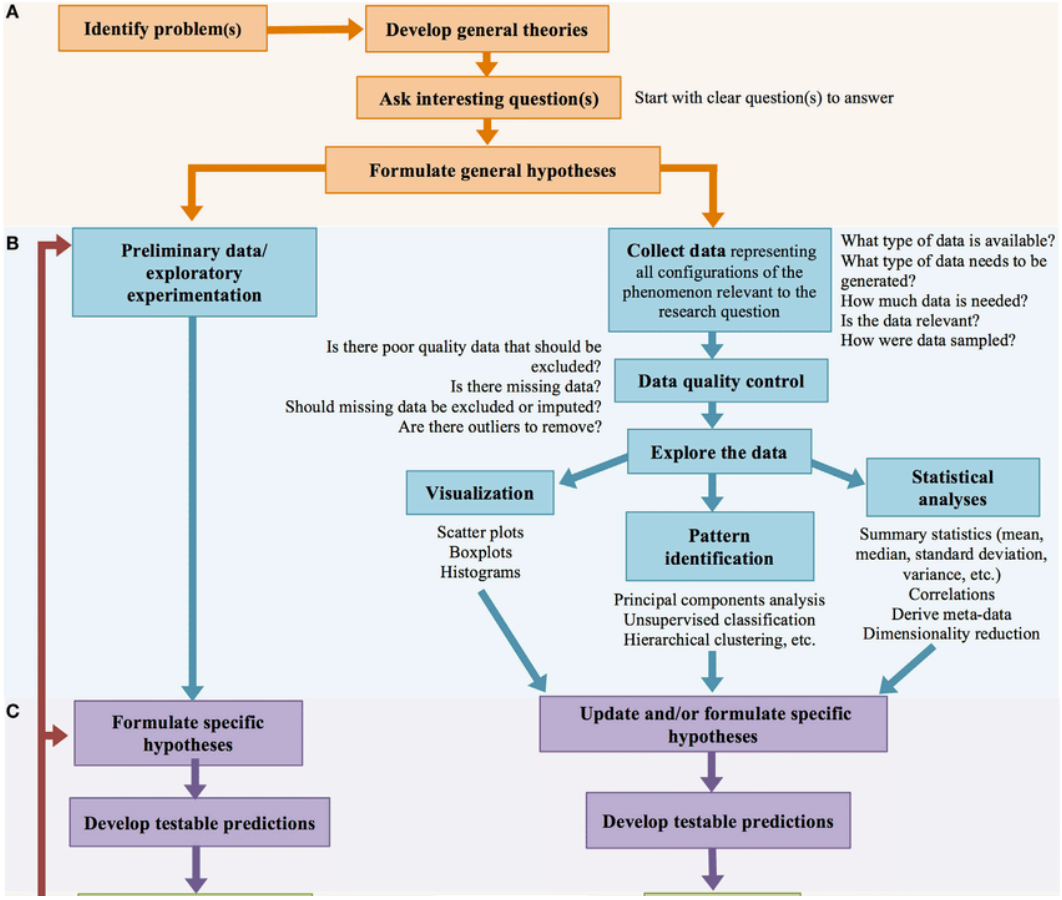
NATURE METHODS | VOL.6 NO.4 | APRIL 2009 | 237

Epidemiology - the antidote to machine learning





Prof. Andrew Hayward (UCL)



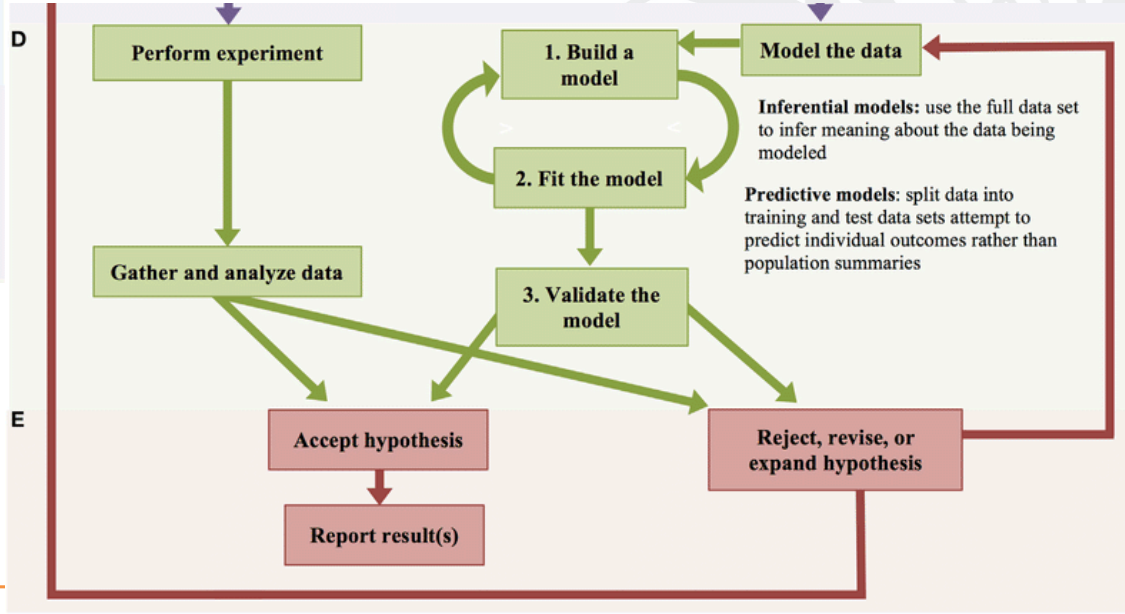
The Scope of Big Data in One Medicine: Unprecedented Opportunities and Challenges

Molly E. McCue[1] and Annette M. McCoy[2]*

frontiers in Veterinary Science

REVIEW
published: 16 November 2017
doi: 10.3389/fvets.2017.00194

Big data scientific method. Hypothesis-driven and data-driven scientific methods progress through parallel stages. (A) Framing the problem and general hypotheses. (B). Data collection and exploratory experimentation/analysis. (C) Formulation of specific hypotheses. (D) Testing the hypotheses. (e) Accepting or rejecting the hypotheses.



Formação profissional

Forget looking through a telescope at the stars. An astronomer today is more likely to be online: digitally scheduling observations, running them remotely on a telescope in the desert, and downloading the results for analysis.

Our education system needs to change, too

Classic images of science include Albert Einstein writing down the equations of relativity, or Marie Curie discovering radium in her laboratory.

Computation, however, is rarely mentioned, and so many key skills are left undeveloped.

http://theconversation.com/why-data-driven-science-is-more-than-just-a-buzzword-76949

Formação profissional

Curriculum Guidelines for Undergraduate Programs in Data Science

Park City Math Institute (PCMI)
Undergraduate Faculty Group*

Key Competencies for an undergraduate Data Science Major

Computational and Statistical Thinking
Mathematical Foundations
Model Building and Assessment
Algorithms and Software Foundation
Data Curation
Knowledge Transference – Communication and Responsibility

Annual Review of Statistics 2017. 4:15-30, Posted with permission from the Annual Review of Statistics and Its Application, http://www.annualreviews.org/

https://doi.org/10.1146/annurev-statistics-060116-053930

An Outline of the Data Science Major

1. Intro to Data Science
   - Intro to Data Science I
   - Intro to Data Science II
2. Mathematical Foundations
   - Mathematics for Data Science I
   - Mathematics for Data Science II
3. Computational Thinking
   - Algorithms and Software Concepts
   - Databases and Data Management
4. Statistical Thinking
   - Intro to Statistical Models
   - Statistical and Machine Learning
5. Course in an Outside Discipline
6. Capstone Course

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Formação profissional

The democratization of data science education

Sean Kross* kross@jhu.edu
Roger D. Peng* rdpeng@gmail.com
Brian S. Caffo* bcaffo@gmail.com
Ira Gooding** iragooding@jhu.edu
Jeffrey T. Leek* jtleek@gmail.com

* Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health
** Center for Teaching and Learning, Johns Hopkins Bloomberg School of Public Health

Course	Enrollment	Completions
Mathematical Biostatistics Boot Camp 1	109,789	4,150
Mathematical Biostatistics Boot Camp 2	23,842	944
Computing for Data Analysis	243,987	21,069
Data Analysis	193,126	6,500
Biostatistics Case Study	39,140	3,322

Table 1. Number of Students in Initial Online Courses
The size of the student enrollment and completion numbers from the initial courses we created for Coursera.org strongly encouraged our development of the Data Science Specialization.

1. **The Data Scientist's Toolbox** (*11*) - covering version control and the most common tools used by data scientists.
2. **R programming** (*12*) - covering the fundamentals of how to program in R
3. **Getting and cleaning data** (*13*) - covering how to obtain data from databases, the web, and other sources, then clean it up.
4. **Exploratory data analysis** (*14*) - covering plotting and other initials explorations of a data set.
5. **Reproducible research** (*15*) - covers the basics of R markdown, literate programming, and the principles of reproducible research
6. **Statistical inference** (*16*) - covers probability and statistical inference.
7. **Regression models** (*17*) - covers linear models and their application to real data.
8. **Practical machine learning** (*18*) - covers the basics of machine learning and predicting in R.
9. **Developing data products** (*19*) - covers technologies for building data products like R packages, swirl courses, and Shiny apps.

PeerJ Preprints | https://doi.org/10.7287/peerj.preprints.3195v1 | CC BY 4.0 Open Access | rec: 27 Aug 2017, publ: 27 Aug 2017

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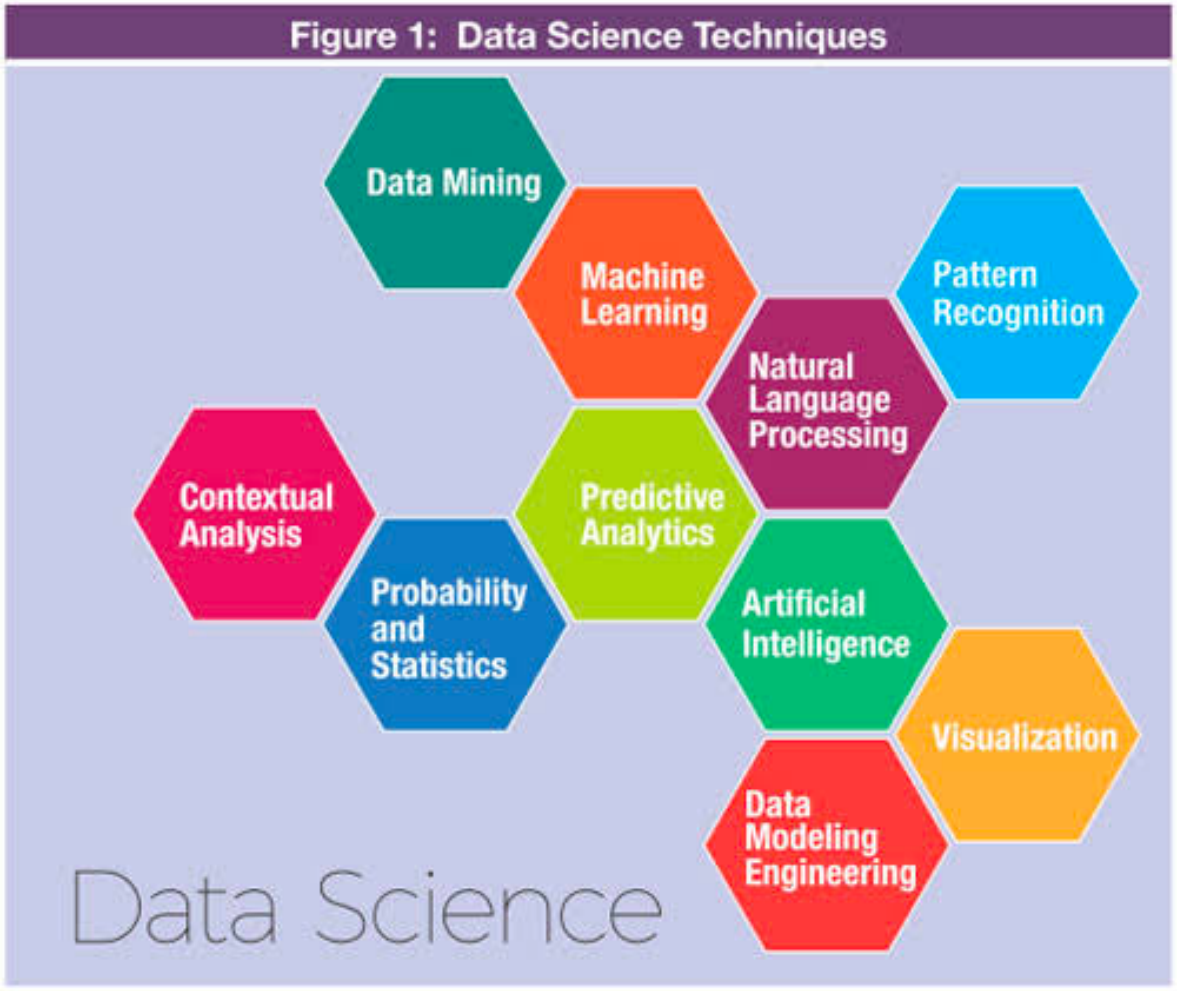
Formação profissional

https://www.idsucla.org/

Curriculum Overview

Unit #	Title	Description
Unit 1	Data and Visualizations	Introduces students to fundamental notions of data analysis—such as distribution and multivariate associations and emphasizes creating and interpreting visualizations of real-world processes as captured by data
Unit 2	Distributions, Probability, and Simulations	Students use numerical summaries to describe distributions and introduces probability through the lens of computer simulations for informal inference
Unit 3	Data Collection Methods: Traditional and Modern	Prepares students to learn about the various ways of collecting data, including Participatory Sensing, and the effect that data collection has on their interpretation of the patterns they discover
Unit 4	Predictions and Models	Students learn to make and how to use mathematical and statistical models to predict future observations and how data scientists measure the success of these predictions

Formação profissional



Source: A. Sood and M. Rinehart. Reprinted with permission.

Formação profissional

edX

Future Learn

DataCamp

coursera

kaggle

UDACITY

Udemy

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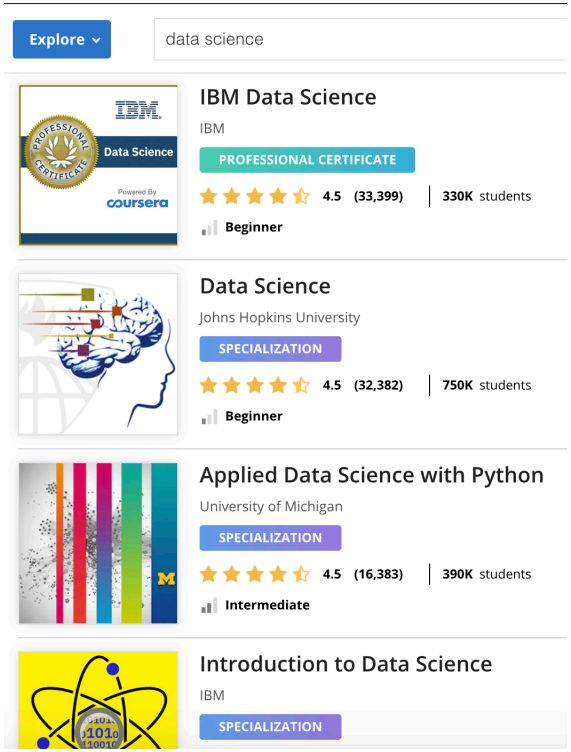

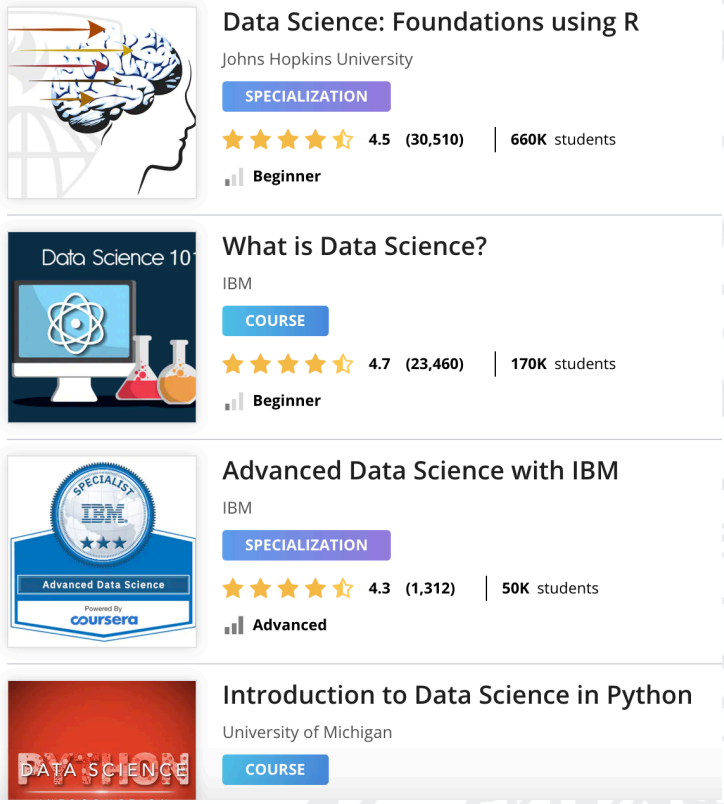

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EUxemplo

elasticsearch

Core Elasticsearch: Developer

Mind Project thinking with data

Big Data Methods in R

Administrative Data Research Centre England

Confident Spatial Analysis

Introduction to Spatial Data & Using R as a GIS

Swansea University Prifysgol Abertawe

Advanced Analysis of Linked Health Data

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Preventing the Zika Virus: Understanding and Controlling the Aedes Mosquito

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Research Methods for Multilevel Data

Research Methods for Quantitative Data

Phenotyping Methods for Linked EHRs - CALIBER

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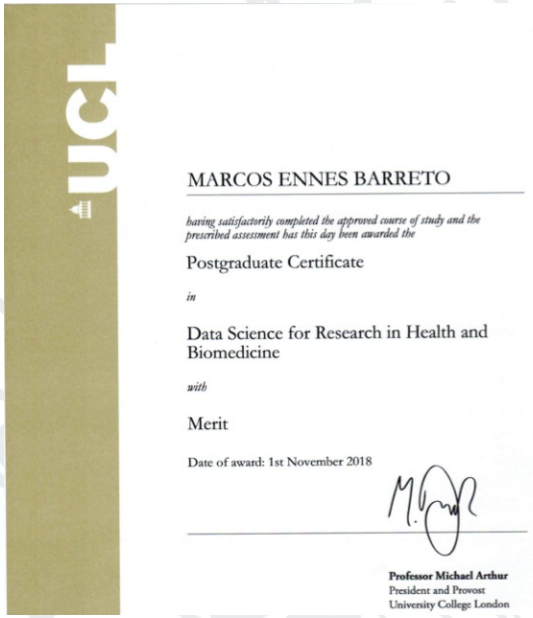
Using Machine Learning in Health Research



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Learn to Code for Data Analysis

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Artificial Intelligence

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Por **Lisandra Matias**

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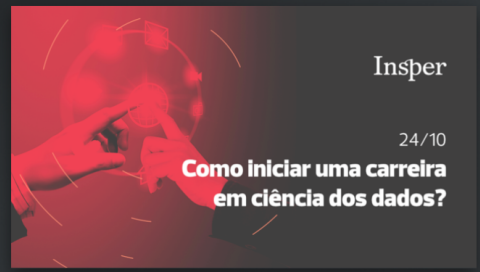

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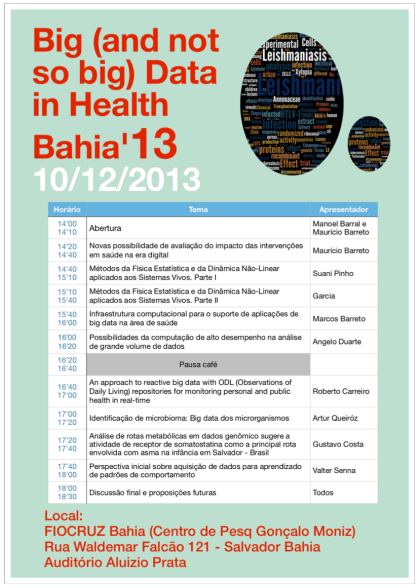
Big (and not so big) Data in Health Bahia'13
10/12/2013
Horário | Tema | Apresentador
14'00 14'10 | Abertura | Manoel Barral e Mauricio Barreto
14'20 14'40 | Novas possibilidade de avaliação do impacto das intervenções em saúde na era digital | Mauricio Barreto
14'40 15'10 | Métodos da Física Estatística e da Dinâmica Não-Linear aplicados aos Sistemas Vivos. Parte I | Suani Pinho
15'10 15'40 | Métodos da Física Estatística e da Dinâmica Não-Linear aplicados aos Sistemas Vivos. Parte II | Garcia
15'40 16'00 | Infraestrutura computacional para o suporte de aplicações de big data na área de saúde | Marcos Barreto
16'00 16'20 | Possibilidades da computação de alto desempenho na análise de grande volume de dados | Angelo Duarte
16'20 16'40 | Pausa café
16'40 17'00 | An approach to reactive big data with ODL (Observations of Daily Living) repositories for monitoring personal and public health in real-time | Roberto Carreiro
17'00 17'20 | Identificação de microbioma: Big data dos microrganismos | Artur Queiróz
17'20 17'40 | Análise de rotas metabólicas em dados genômico sugere a atividade de receptor de somatostatina como a principal rota envolvida com asma na infância em Salvador - Brasil | Gustavo Costa
17'40 18'00 | Perspectiva inicial sobre aquisição de dados para aprendizado de padrões de comportamento | Valter Senna
18'00 18'30 | Discussão final e proposições futuras | Todos
Local:
FIOCRUZ Bahia (Centro de Pesq Gonçalo Moniz)
Rua Waldemar Falcão 121 - Salvador Bahia
Auditório Aluizio Prata


7 de abril de 2014
Big (and not so big) Data in Health Bahia
II Workshop on Big Data - Bahia
LOCAL:
Auditório Aluizio Prata, FIOCRUZ Bahia (CPqGM)
Rua Waldemar Falcão,121 - Salvador/BA
Linhas Temáticas
Perspectivas para a Saúde através da Ciência dos Dados
Big Data em Genômica e Proteômica
Programação
14:00 Abertura
14:10 Tema 1: Ciência dos Dados Bruno Domingues (Intel)
15:05 Tema 2: "How will Big Data change Healthcare Delivery and the Life Sciences Industry? " Mark Blatt (Intel)
16:00 Coffee Break
16:20 Tema 3: Metagenômica na era do Big Data Aristóteles Góes Neto (UEFS)
17:15 Tema 4: Desafios em Dados Genéticos: Seleção e/ou Redução de Variáveis Rosemeire Fiaccone (UFBa) Paulo Canas (UFBa)
18:10 Encerramento
Organização:
Suani Pinho (UFBa)
Marcos Barreto (UFBa)
Angelo Duarte (UEFS)
Apoio:
Website: https://plus.google.com/events/c1ca6ah11f92701m6jnbrka6


III Workshop
10 de junho de 2015
Big (and not so big) Data in Health Bahia
"PREPARANDO O BIG DATA PARA SER EFETIVO"
LOCAL
FIOCRUZ Bahia
Auditório Aluizio Prata,
Rua Waldemar Falcão,121
Salvador/BA
Apoio
Programação
14:00 Abertura: Mensagem de boas-vindas MANOEL BARRAL (FIOCRUZ - BA)
14:20 Tema 1: Tendências do uso da Big Data em saúde pública CHRISTOVAM BARCELLOS (ICICT - FIOCRUZ)
15:30 Intervalo Café
15:50 Tema 2: Desafios na governança de infraestruturas em ambientes de computação de alto desempenho em Big Data RENATO MICELI (SENAI CIMATEC)
17:00 Encerramento: Perspectivas de projetos de Big Data em saúde na Bahia MAURICIO BARRETO (FIOCRUZ - BA)
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AUDITÓRIO DO TECNOCENTRO
PALESTRA
Placing AI at the service of public health:
The key role of data management and linkage
Sabina Leonelli
Co-diretora do Exeter Centre for the Study of the Life Sciences e líder do grupo de pesquisa sobre "Data Governance, Algorithms and Values" do Exeter Institute for Data Science and Artificial Intelligence (IDSAI). É também pesquisadora do Alan Turing Institute em Londres, editora chefe da revista internacional History and Philosophy of the Life Sciences, editora associada da Harvard Data Science Review, vice-presidente da Associação Europeia de Filosofia da Ciência, membro do comitê diretor da Sociedade para a Filosofia da Ciência na Prática e embaixadora do Plano S, lançado pela Science Europe. Suas pesquisas são financiadas em grande parte pelo Conselho Europeu de Pesquisa tendo por foco a filosofia, a história e a sociologia da ciência interessa no uso de dados, especialmente o impacto do Big Data e as implicações epistêmicas e éticas da curadoria e gerenciamento de dados de pesquisa. Em 2018 recebeu o prêmio Lakatos por seu livro Data-Centric Biology: A Philosophical Study.
DEBATEDORES
Profª drª Marcos Barreto
Ciência da Computação - UFBA
Drª Gustavo Matta
Ciências Sociais - Fiocruz
Profª drª Giovanni Rolla
Filosofia - UFBA
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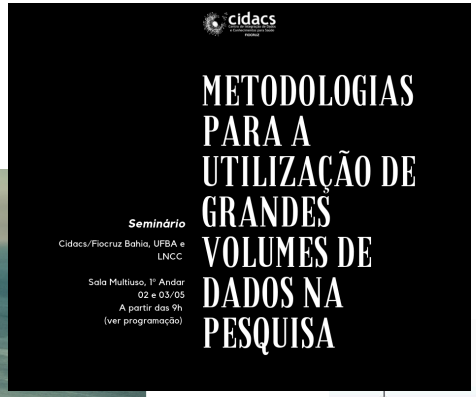
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METODOLOGIAS PARA A UTILIZAÇÃO DE GRANDES VOLUMES DE DADOS NA PESQUISA
Seminário
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O FUTURO DA SAÚDE NO BRASIL:
COMPROMISSO SOCIAL DA CIÊNCIA


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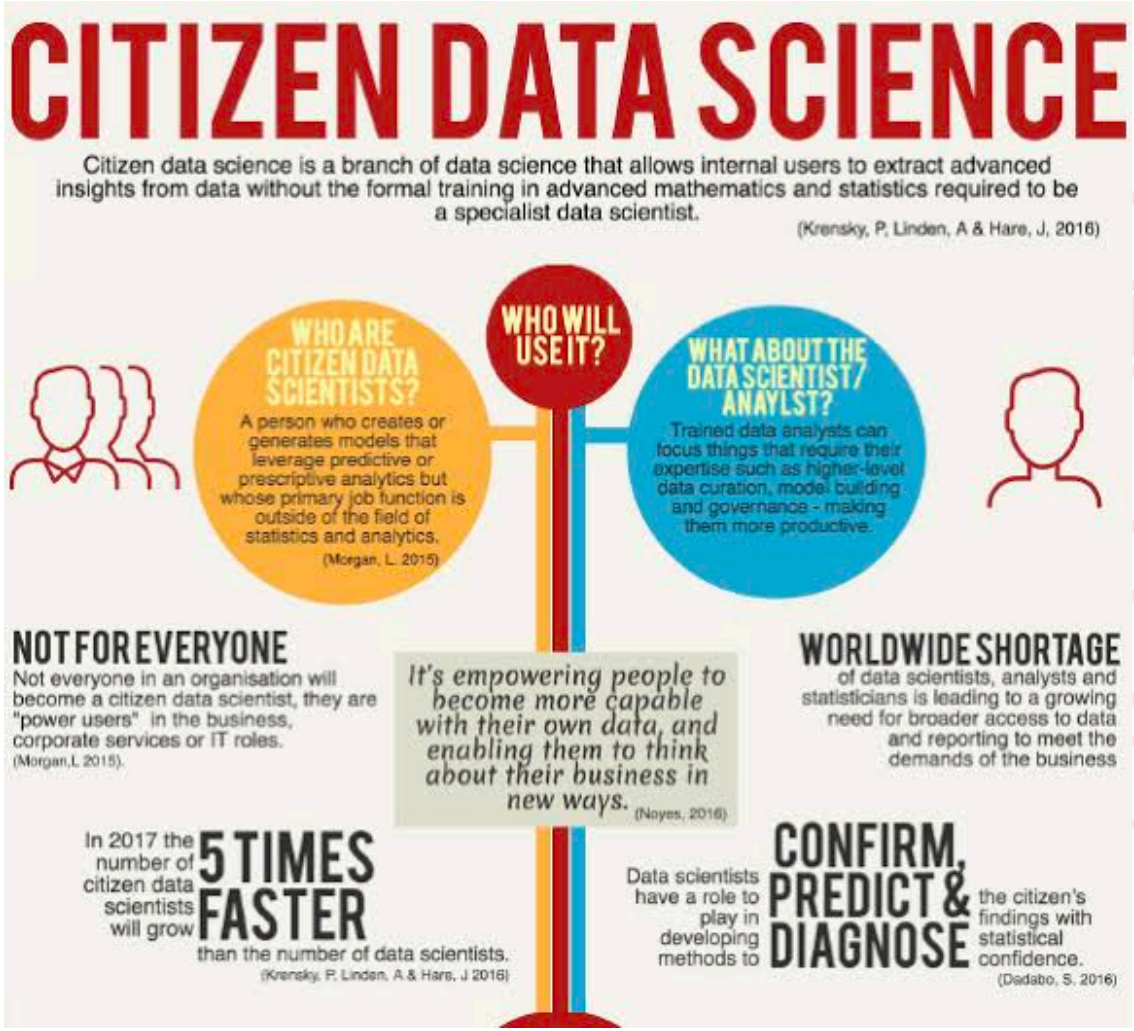
Novas perspectivas



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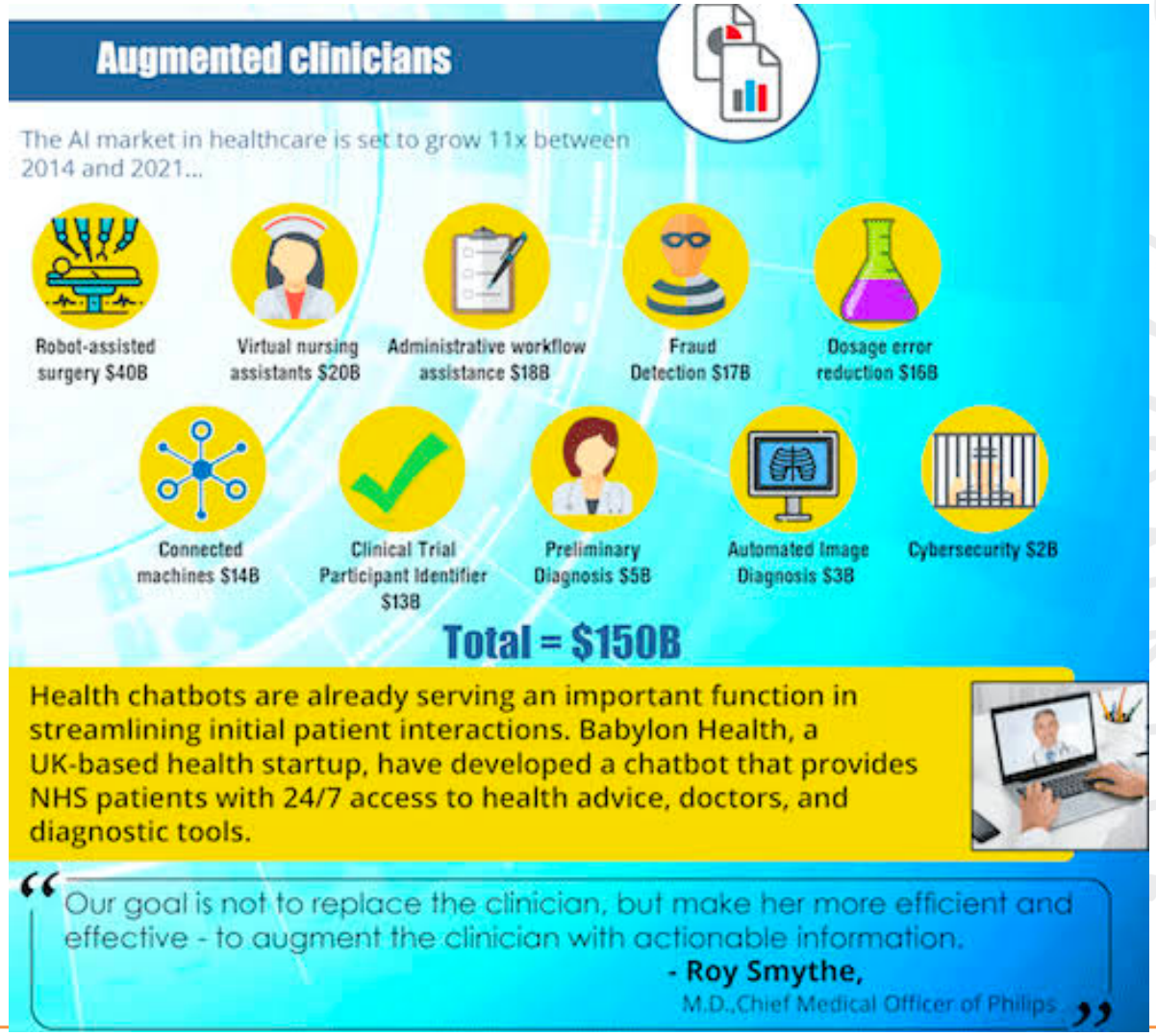
Novas perspectivas



A new twenty-first century science for effective epidemic response

Box 2

Precision public health

Precision medicine refers to the use of genomic sequencing to retrace the specific course of a disease in individual patients, with the aim of being able to choose the best treatment option for each person. In public health, the analogous idea of precisely directing the right intervention to the right population is equally appealing. The potential of such an approach has been illustrated by the

Box 3

Epidemic ethics

In 2016, the PREVENT project received Wellcome funding to provide ethics guidance "at the intersection of pregnancy, vaccines, and emerging and re-emerging epidemic threats"[93]. This was in response to the newly recognized association between infection with Zika virus during pregnancy and microcephaly in the newborn. Developing a vaccine was an obvious route to explore, but many researchers felt that they could not conduct clinical trials with pregnant women because it is generally assumed that the risk to the woman, the fetus or both outweighs any potential benefit. However, as Heyrana et al. argue: "Preventing pregnant women from participating in clinical trials is well intentioned but misguided."[94].

Table 1 | Selected key areas to integrate into twenty-first century epidemic responses

Area	Key areas and/or disciplines
Governance and infrastructure	Local, national and international organizations; integrate accountability and transparency across multiple stakeholders; improve data sharing, improve logistics and crisis management
Engagement and communication	Encourage a community-led response, community engagement and health diplomacy
Social sciences	Anthropology, political science, human geography, linguistics
Ethics	Consent, clinical trial designs
Emerging technologies	Pathogen genomics, metagenomics, systems serology and analytics, data science and artificial intelligence
Research and development	Diagnostics, therapeutics and vaccines
One Health	Ecology and environmental, veterinary and agricultural sciences

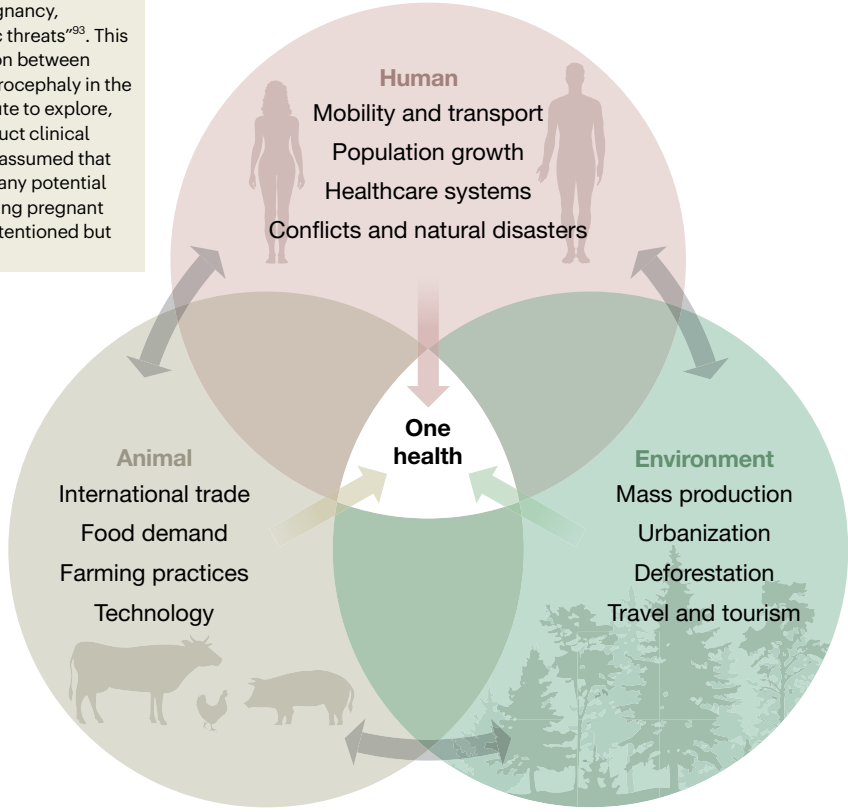


Fig. 1 | An ecosystem of interactions. The tightly interconnected nature of human, animal and environmental health makes the emergence and decline of epidemics difficult to predict. One Health integrates multiple perspectives in a framework that emphasizes the need to consider any particular aspect in this broader context.

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MANAGING ORGANIZATIONS

Why Data Science Teams Need Generalists, Not Specialists

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EDUCAÇÃO EM CIÊNCIA DE DADOS

Marcos Barreto

marcosb@ufba.br / www.atyimolab.ufba.br

COLABORADORES CIENTÍFICOS:

APOIADORES:

Parque Tecnológico da Bahia
Rua Mundo, 121, Trobogy
Salvador - Ba, CEP 41745-715

www.cidacs.bahia.fiocruz.br
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