Data Science in L.A.'s "Silicon Beach": Shadow Vocation or Emergent Profession?

2015 CSU-POM Conference
CSU Northridge
Saturday, February 28, 2015

Wayne Smith, Ph.D.
Department of Management
CSU Northridge
ws@csun.edu

This presentation is available at:

smithw.org/csupom.pdf or github.com/wsphd/csupom/

Motivation

- Background/Preliminaries

- I apologize…
  - "cloud computing", "big data", "[xyz] analytics", and perhaps most confusing of all, "data science"
  - These are generally *industry* buzz "terms", not necessarily *our* terms.
  - I prefer *decision-support systems*, *predictive modeling, statistical computing,* and *mathematical optimization*, but most of the folks I routinely work with prefer the term "data science". We might, however, agree on the terms *reproducible research*, *data analytics* and *information visualization*.

- I am on the steering committee for the LA R/Data science Meetup group
  - There are a few other Ph.D.s heavily involved too—Szilard Pafka (primary lead), David McArthur, Rob Gould, Jeremy Miles, Tim Triche, Eduardo Arino de la Rubia, and others

- "*Data* as the *new Oil*" Challenges and Opportunities
  - Is there a perturbation (disequilibrium) in this labor market?
  - Exactly what is the production, operations, transportation, logistics of *bits* viz. *atoms?*
  - What is our institutional role (if any) in this (increasingly, non-college) community?
  - Are we witnessing the emergence of a new *data guild* in the modern service economy?

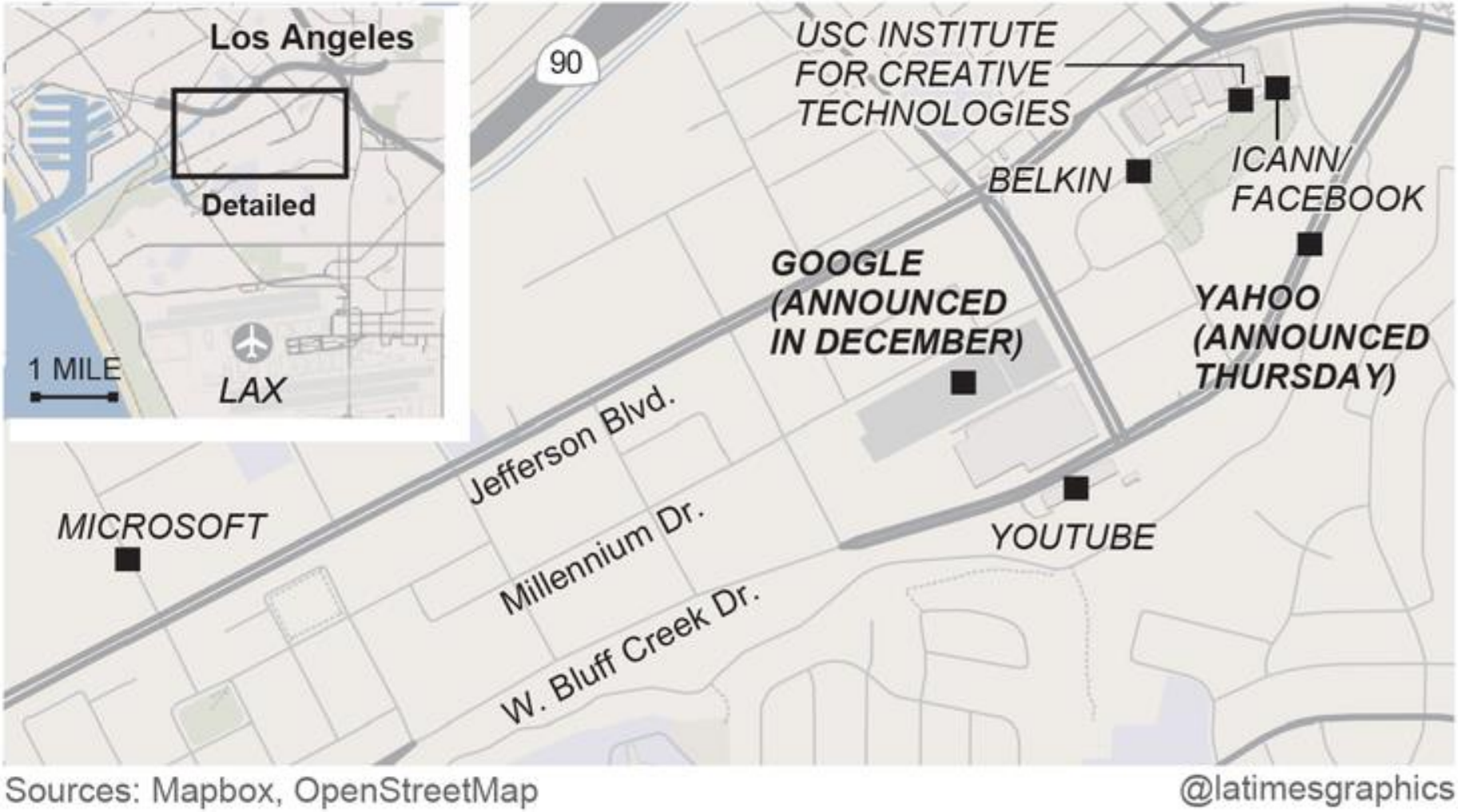
Los Angeles Times
Business

Playa Vista turning into Silicon Valley South as tech firms move in

This article is related to: Business, Eric Garcetti, , Marissa Mayer, LAX

Yahoo has signed a long-term lease for about 130,000 square feet at the new Collective campus, which is still under construction in Playa Vista. (Marcus Yam / Los Angeles Times)

By ANDREA CHANG AND PETER JAMISON
contact the reporters


Los Angeles
Detailed
1 MILE
LAX
90
USC INSTITUTE FOR CREATIVE TECHNOLOGIES
BELKIN
ICANN/ FACEBOOK
GOOGLE (ANNOUNCED IN DECEMBER)
YAHOO (ANNOUNCED THURSDAY)
Jefferson Blvd.
Millennium Dr.
W. Bluff Creek Dr.
MICROSOFT
YOUTUBE
Sources: Mapbox, OpenStreetMap
@latimesgraphics

Forbes

Gil Press
Contributor

I write about technology, entrepreneurs and innovation.

Opinions expressed by Forbes Contributors are their own.

TECH 12/01/2012 @ 5:32PM | 15,988 views

Big Data News of the Week: Beautiful $300,000 Minds

+ Comment Now

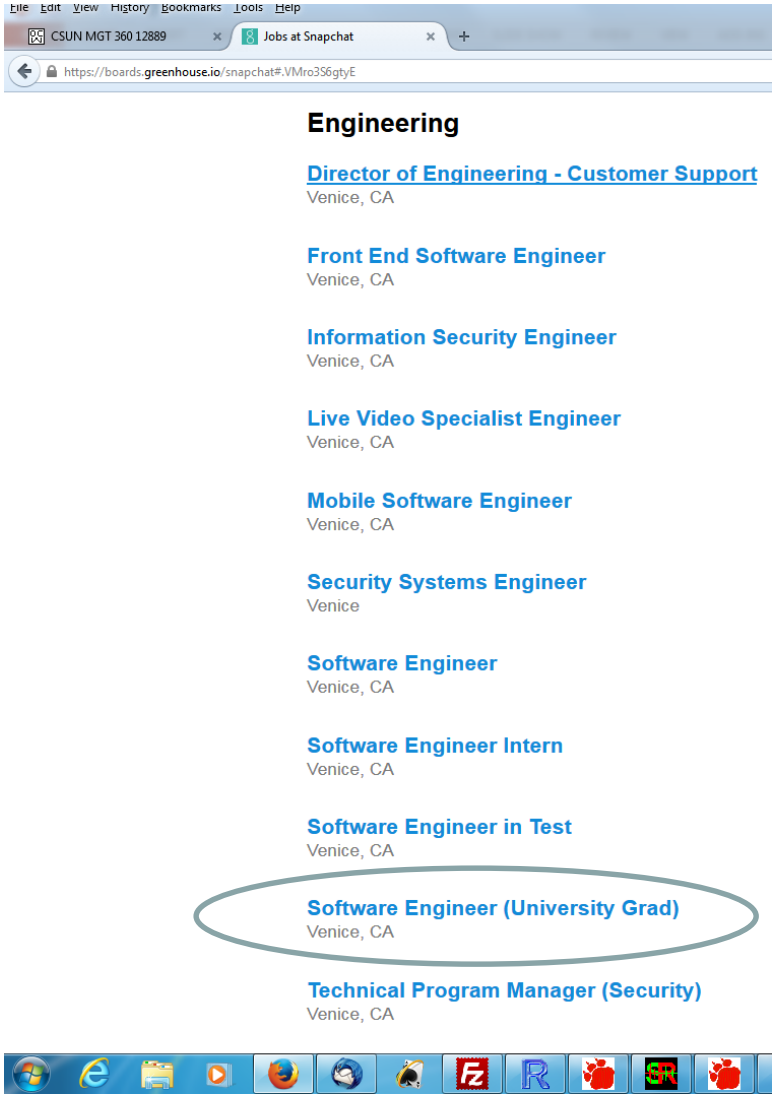
Jeff Hawkins at eTech 2007 (Photo credit: Wikipedia)

While many saw big data as the winner of the recent elections, I voted for Big Intuition, citing Bill Clinton's insight and advice as an example of how decisions and data science—in political campaigns or any other endeavor—cannot be automated and must rely on human judgment an domain expertise.

This week, Matthew Jones, a historian at Columbia who is working on the history of data mining, came to a similar conclusion after auditing Rachel Schutt's introduction to data science class: "Data science depends utterly on algorithms but does not reduce to those algorithms. The use of those algorithms rests fundamentally on what sociologists of science call 'tacit knowledge'—practical knowledge not easily reducable to articulated rules—or perhaps impossible to reduce to rules."

This irreducible knowledge is of two kinds: Expertise and experience in a specific domain (as in "Clinton knows how to run political campaigns"); and—specifically for data scientists—experience with and understanding of the tools they apply. Says Jones: "The hubris one might have when using an algorithm must be tempered through a profound familiarity with that algorithm and its particular instantiation."

Difference at B.A./B.S. level — *recommended* or *required (Snapchat)*



Some tools
(other than *R*)

- COTS (Non-FOSS)
  - SAS, IBM SPSS, Stata, S-PLUS, BMDP, Lisrel, EQS, HLM, MPLUS, SmartPLS, …
  - Mathematica, @Risk/Excel add-ins, RATS, Matlab, Simscript, Arena, etc.
  - IBM Netezza, MS Anal. Serv., Oracle Adv. Anal., SAP HANA, Teradata Miner, etc.
  - UCINET/NVivo/Tropes, ConQuest, ArcGIS, AutoDesk, etc.
  - IBM CPLEX, MOSEK, GUROBI, Frontline, etc.
- FOSS/GNU
  - Domain-specific?
    - GRETL/xBUGS, Ggobi, Pajek, lisp-stat, Netlib/BLAS/LAPACK/FFTPACK, etc.
    - Sage, Octave, Scilab, Java/Colt/JFreeCharts, Gephi, incanter, Protovis, D3, etc.
    - G(NU)LPK, COIN-OR, NLOpt, CSDP, BLAS, NASTRAN, WordNet, statconn, etc.
  - General-purpose?
    - jQuery/jqueryUI/flot/jstat, BIRT, RapidMiner, Pentaho, MongoDB, etc.
    - Apache Hadoop/Spark/Flink/Solr/CouchDB/Lucene/OpenNLP/Mahout, etc.
    - Python — iPython/NumPy/matplotlib/statmodels/Blaze/Bokeh/scikit-learn, etc.
    - Julia — iJulia/Juno/MultivariateStats/MLBase/TimeSeries/Gadfly/JuMP, etc.

General Coordination

- *Monthly Meetups* (physical, not virtual)
  - E.g., `www.datascience.la`
  - Monthly meetings (50-200 people)

  - By language/platform/environment: R, Python
  - By technology/workflow: Visualization, DW/BI, Machine Learning
  - By sector/domain: AdTech, FinTech
  - By management "level": a few directors- and mangers-only events (by invitation only)

- *Annual Conferences* (physical, not virtual)
  - E.g., "Big Data camp" at Direct TV (El Segundo)
  - `http://insidebigdata.com/2014/06/03/free-conference-big-data-camp-2014/`
  - Multiple, parallel tracks
  - Vendor support (all expenses covered fully)
  - Last three years' attendance—200 (2013), 500 (2014), 800 expected (2015)

A few good MOOCs

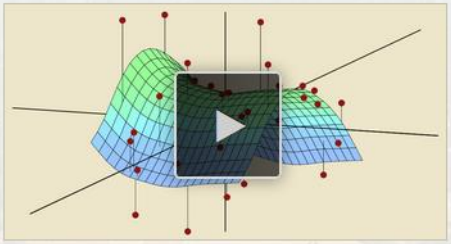
Stanford University

ABOUT

Register Log in

Statistical Learning

REGISTER FOR STATLEARNING



overview

ABOUT THIS COURSE

This is an introductory-level course in supervised learning, with a focus on regression and classification methods. The syllabus includes: linear and polynomial regression, logistic regression and linear discriminant analysis; cross-validation and the bootstrap, model selection and regularization methods (ridge and lasso); nonlinear models, splines and generalized additive models; tree-based methods, random forests and boosting; support-vector machines. Some unsupervised learning methods are discussed: principal components and clustering (k-means and hierarchical).

This is not a math-heavy class, so we try and describe the methods without heavy reliance on formulas and complex mathematics. We focus on what we consider to be the important elements of modern data analysis. Computing is done in R. There are lectures devoted to R, giving tutorials from the ground up, and progressing with more detailed sessions that implement the techniques in each chapter.

Course Number **StatLearning**

Classes Start **Jan 19, 2015**

Classes End **Apr 05, 2015**

Estimated Effort **3 hours per week**

Price **Free**

OUR RESEARCH COMMUNITY

Stanford University pursues the science of

A few good (open, free) books

An Introduction to Statistical Learning

with Applications in R

Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani

Home

About this Book

R Code for Labs

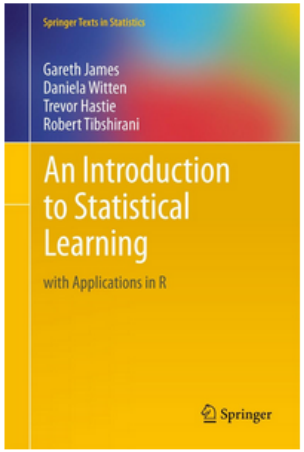
Data Sets and Figures

ISLR Package

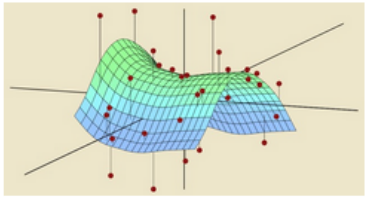
Get the Book

Author Bios

Errata



Download the book PDF
(corrected 4th printing)



Statistical Learning MOOC covering the entire ISL book offered by Trevor Hastie and Rob Tibshirani.

This book provides an introduction to statistical learning methods. It is aimed for upper level undergraduate students, masters students and Ph.D. students in the non-mathematical sciences. The book also contains a number of R labs with detailed explanations on how to implement the various methods in real life settings, and should be a valuable resource for a practicing data scientist.

For a more advanced treatment of these topics: *The Elements of Statistical Learning*.

Slides and videos for Statistical Learning MOOC by Hastie and Tibshirani available separately here. Slides and video tutorials related to this book by Abass Al Sharif can be downloaded here.

"An Introduction to Statistical Learning (ISL)" by James, Witten, Hastie and Tibshirani is the "how to" manual for statistical learning. Inspired by "The Elements of Statistical Learning" (Hastie, Tibshirani and Friedman), this book provides clear and intuitive guidance on how to implement cutting edge statistical and machine learning methods. ISL makes modern methods accessible to a wide audience without requiring a background in Statistics or Computer Science. The authors give precise, practical explanations of what methods are available, and when to use them, including explicit R code. Anyone who wants to intelligently analyze complex data should own this book.
Larry Wasserman, Professor, Department of Statistics and Department of Machine Learning, CMU.

Highly granular "career/tech fairs"

Targeted JOB FAIRS
A Dice Service

Get Notified

Calendar of Upcoming Events:

HOME | FAQS | GALLERY | ABOUT | CONTACT | RESUME B

Los Angeles, CA - Tech and Engineering

Dice

Los Angeles - Four Points by Sheraton LAX
9750 Airport Blvd
Los Angeles, CA 90045
Map This Event

Feb 18, 2015
11:00am-3:00pm

JOB SEEKER | EMPLOYER

Need to hire tech, engineering, and security-clearance professionals?

Take advantage of the team that knows the language and habits of these unique candidates. We provide one of the easiest and most cost-effective ways to gain face-to-face access to qualified job seekers in your field. Meet hundreds of candidates with proficiency and experience in the following areas:

Information Technology (all disciplines) ▸ Engineering (all disciplines)
Telecommunications ▸ Internet / E-Commerce ▸ Government ▸ Aerospace ▸ Defense
Electronics ▸ Cloud ▸ Mobile ▸ All other related fields

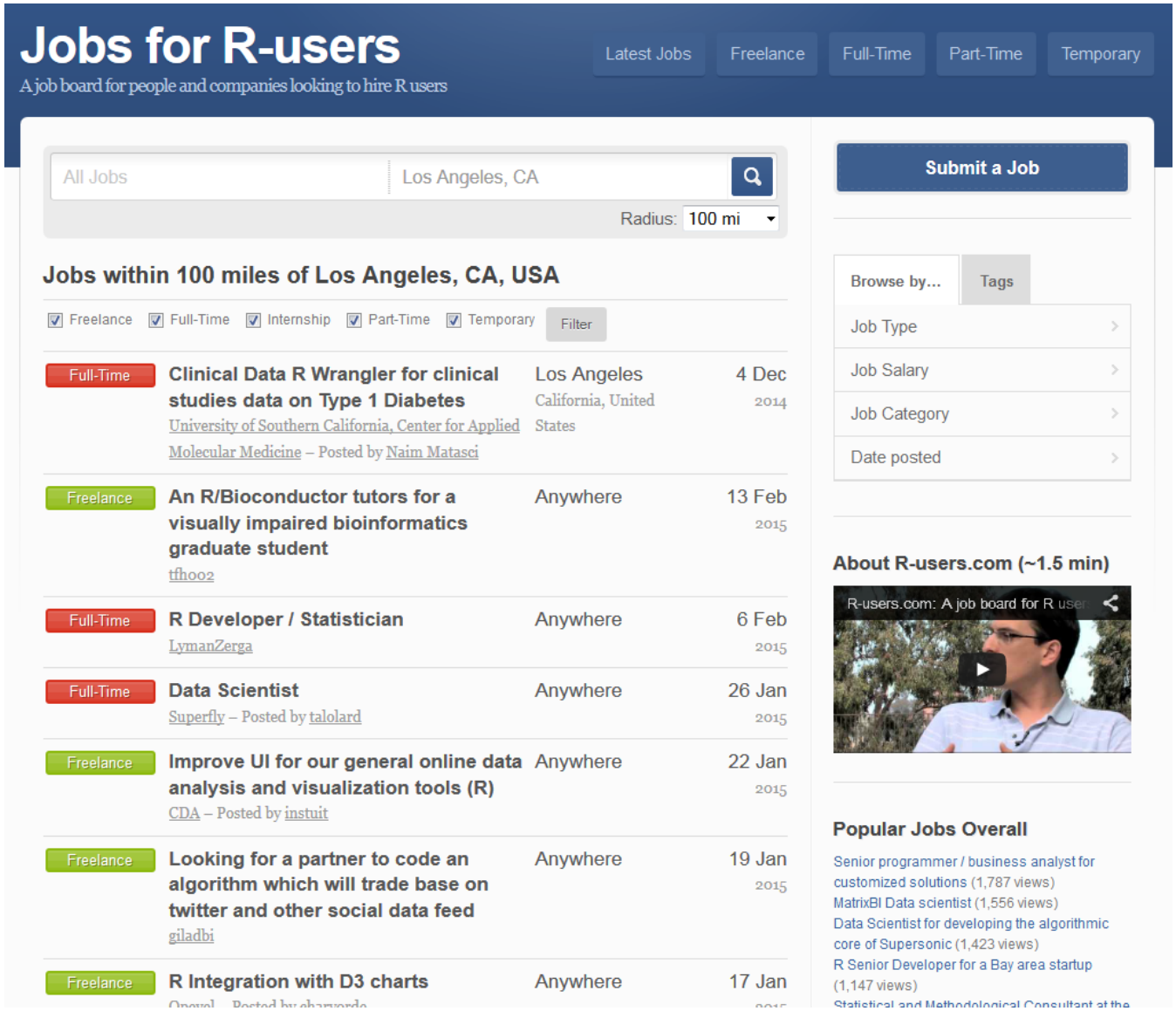
SPONSORS

COMPANY LINEUP

CAREER FAIR TYPES

- Technology, Engineerin Security Clearance
- Oil & Gas and Energy
- All Professions Diversity

Specific "job postings/sites"



Jobs for R-users

A job board for people and companies looking to hire R users

Latest Jobs | Freelance | Full-Time | Part-Time | Temporary

All Jobs | Los Angeles, CA

Radius: 100 mi

Submit a Job

Jobs within 100 miles of Los Angeles, CA, USA

Freelance | Full-Time | Internship | Part-Time | Temporary | Filter

Full-Time	**Clinical Data R Wrangler for clinical studies data on Type 1 Diabetes** University of Southern California, Center for Applied Molecular Medicine – Posted by Naim Matasci	Los Angeles California, United States	4 Dec 2014
Freelance	**An R/Bioconductor tutors for a visually impaired bioinformatics graduate student** tfhoo2	Anywhere	13 Feb 2015
Full-Time	**R Developer / Statistician** LymanZerga	Anywhere	6 Feb 2015
Full-Time	**Data Scientist** Superfly – Posted by talolard	Anywhere	26 Jan 2015
Freelance	**Improve UI for our general online data analysis and visualization tools (R)** CDA – Posted by instuit	Anywhere	22 Jan 2015
Freelance	**Looking for a partner to code an algorithm which will trade base on twitter and other social data feed** giladbi	Anywhere	19 Jan 2015
Freelance	**R Integration with D3 charts**	Anywhere	17 Jan

Browse by... | Tags

- Job Type
- Job Salary
- Job Category
- Date posted

About R-users.com (~1.5 min)

R-users.com: A job board for R user

Popular Jobs Overall

Senior programmer / business analyst for customized solutions (1,787 views)
MatrixBI Data scientist (1,556 views)
Data Scientist for developing the algorithmic core of Supersonic (1,423 views)
R Senior Developer for a Bay area startup (1,147 views)

DATA SCIENCE GOES TO COLLEGE WITH DATAFEST

AUGUST 6, 2014 EDUCATION AMELIA MCNAMARA LEAVE A COMMENT 0

Below is the first of several exciting data science developments for the younger generation, happening right here in Los Angeles. This project is unique because it engages undergraduates in *real* data analysis, something that happens quite rarely in a classroom. If projects like this catch on as a new trend, we're going to have some real competition for our jobs in a few years!

DATAFEST

2014 UCLA DataFest contestants

DataFest is an event for undergraduates that began at UCLA and is now spreading across the country. Each year, we find an interesting "data sponsor" (i.e. an active company willing to share their data) and give students 48 hours to come up with interesting insights. We provide the food, coffee, energy drinks and wifi, they do the data cleaning, exploratory data analysis, and presentations. This is similar to the 'hackathons' many in our group are familiar with, with a data twist.

Should a semester of "data science" substitute for second-semester Algebra II in LAUSD?

INTRODUCTION TO DATA SCIENCE FOR HIGH SCHOOL STUDENTS

AUGUST 20, 2014 EDUCATION AMELIA MCNAMARA LEAVE A COMMENT 0

Another exciting development in data science coming from our department at UCLA is a high school class called Introduction to Data Science (IDS). This project has been made possible by a National Science Foundation grant to support Mobilize, for which Rob Gould (mentioned in my previous post on DataFest) is the Principal Investigator.

The year-long IDS course is piloting in 10 LAUSD high schools this academic year. For the pilot year, we've recruited 10 brave classroom teachers who were willing to learn a lot of new material and pedagogy. Most of the teachers have taught statistics before (either "regular" statistics or Advanced Placement) however they are not experienced with data science.

IDS is a computation-heavy course, as a major component of the course are completed using hands-on labs using R within RStudio. The team has written an R package to simplify some of the R syntax issues that trip up beginners, and instead of teaching traditional statistical tests and formulas the course is focused on randomization as a basis for making inference, both formal and informal.

Relative importance of "data science" skills, knowledge, and abilities in general B.A./B.S.?

Figure 41: Employers rate the importance of candidate skills/qualities

Skill/Quality	Weighted Average Rating*
Ability to work in a team structure	4.55
Ability to make decisions and solve problems	4.50
Ability to plan, organize and prioritize work	4.48
Ability to verbally communicate with persons inside and outside the organization	4.48
Ability to obtain and process information	4.37
Ability to analyze quantitative data	4.25
Technical knowledge related to the job	4.01
Proficiency with computer software programs	3.94
Ability to create and/or edit written reports	3.62
Ability to sell or influence others	3.54

**5-point scale, where 1=Not at all important; 2=Not very important; 3=Somewhat important; 4=Very important; and 5=Extremely important*

Source: Job Outlook 2014, National Association of College and Employers

THE WALL STREET JOURNAL.

Business Education: Should Harvard Business School Hit Refresh? --- Some Students, Faculty and Alumni Say the Elite M.B.A. Program Has Been Slow to Teach Management for a Tech Era

Korn, Melissa; Gellman, Lindsay. **Wall Street Journal, Eastern edition** [New York, N.Y] 05 Feb 2015: B.7.

Hide highlighting

Abstract (summary) Translate

[...]competitors like Stanford University's Graduate School of Business and Massachusetts Institute of Technology's Sloan School of Management have established themselves as pre-eminent tech-industry feeders, according to the schools' annual career reports.

Full Text Translate | Turn on search term navigation

Does Harvard Business School need to hit refresh?

The institution that required students to carry laptops as early as 1984 and sent graduates to top posts at Hewlett-Packard Co. and Facebook Inc. is not keeping up when it comes to teaching management in a tech-focused era, say students, faculty and alumni. Meanwhile, competitors like Stanford University's Graduate School of Business and Massachusetts Institute of Technology's Sloan School of Management have established themselves as pre-eminent tech-industry feeders, according to the schools' annual career reports.

To be sure, HBS is still in high demand among b-school applicants, and it accepts only 12% of those who apply to its two-year M.B.A. program. But the school's size and legacy may complicate its attempts to keep ahead of rapid changes in technology and business.

Compared with MIT and Stanford, "we have, in a sense, less tech in the air," says the business school's dean, Nitin Nohria, though he points out that HBS sends many graduates to leading tech companies each year.

Students, faculty and alums, say HBS's strict adherence to the case-study teaching method focuses on business dilemmas from years or decades past, rather than the current forces shaping the business of technology, which include issues in which graduates are expected to be well versed.

Nick Taranto, a 2010 HBS grad and co-founder and co-CEO of Plated Inc., an online food-delivery startup, says the school prepared

4-year Schools in this *New* "Service" Economy in CA?

- USC, M.S. (part of the C.S. Dept.)
  - http://www.cs.usc.edu/academics/masters/msdata.htm
- UCI Extension, certificate
  - http://unex.uci.edu/areas/it/data_science/
- UC Berkeley, M.S. (online) (part of the School of Information)
  - http://datascience.berkeley.edu/
- CSU Fullerton, certificate, online, accelerated
  - http://extension.fullerton.edu/professionaldevelopment/certificates/data-science
- Near Fails:
  - *UCOnline* – Outside investors want the students, faculty, and curriculum, but not the *bureaucracy.*
  - *CSUOnline* – Severe misunderstanding of the *market dynamics* for this service catchment group.
- Is CSU (mainstream) appropriate? Inter-disciplinary? Other approaches/ideas?

CCC's in this *New* "Service" Economy?

- 15 CA Community Colleges will offer Bachelor's Degrees beginning in 2017.

- **Airframe manufacturing technology,** Antelope Valley College
- **Industrial automation,** Bakersfield College
- **Emergency services and allied health systems,** Crafton Hills College
- **Mortuary science,** Cypress College
- **Equine industry,** Feather River College
- **Dental hygiene,** Foothill College and West Los Angeles College
- **Bio-manufacturing,** Mira Costa College
- **Respiratory care,** Modesto Junior College and Skyline College
- **Automotive technology,** Rio Hondo College
- **Health information management,** Mesa College
- **Occupational studies,** Santa Ana College
- **Interaction design,** Santa Monica College
- **Health information management,** Shasta College

Candidate Explanations (1/4)
(STEMish)

- Mathematics
  - *Abstract ("pure") Reasoning*, esp. w/ functions over *Empirical ("applied") Method* esp. w/ algorithms
  - "Employers value *concrete results* with data; I need to know *computer and data technologies*."
- Statistics (stochastic inference)
  - Privilege *specification* (narrow, overfitted results) over *generalization* (broader theory development)
  - "If I have more *data*, then I believe that I will have proportionally more *information*."
- Engineering
  - Scale; Parallelism; "Utility Computing"
  - "My (often, very) small firm uses Amazon EC2, Google Compute Engine, and Microsoft Azure."
- Computer Science (machine learning)
  - Clustering, classification, dimension reduction, cross-validation, feature extraction, and convexity
  - "I need *computationally-intensive* and *unsupervised* (no response var.) approaches for big data".

Candidate Explanations (2/4)
(Sociological)

- Psychology
  - Ego-centrism, absolutism, and perhaps, (philosophically) nihilism
  - "*You don't know me!* Universities mostly just teach theories and I mostly just learn how to write papers."
- Sociology
  - Exponential Random Graph Models (agent- and ego-networks)
  - "I just need to immerse myself in the right industry, the right organization, and the right community *eco-system*."
- Cognitive Science
  - *Exploratory, Dynamic Visualization* is the new *Descriptive Statistics*
  - "Don't use messy *assumptions, hypotheses, models, inference, and diagnostics*; just display *high-dimensional graphs*."
- Political Science
  - *Rational Choice* theory (perceived minimal efficacy in structural, government change); *Elite* theory
  - "If I don't take this *job*, someone with an H1-B Visa might; besides an income, I gain power through my *skills*."
- Higher Education
  - *Just-in-time* training (short-term, practical) is different than *just-in-case* education (long-term, holistic).
  - "I want shallow, *just-in-time* theories for my practice (to answer the boss' questions next week)."
- K-12 Education
  - Auto-didactism, Self-directed learning
  - "Technology is ubiquitous; I can learn myself from Linux, Raspberry Pi, Apps, Arduino projects, and 3D printing."

Candidate Explanations (3/4)
(Economic/Business)

- Neo-Classical Economics
  - Supply and Demand
  - "There is a *shortage* of individuals with "data scientist" skills; I can *exploit* that market disjunction."
- Empirical Finance
  - Loan-to-Value
  - "I might not achieve my *potential*, but at least I'm not in *debt*."
- Information Systems
  - Data management; Complex SQL Joins; rectangular transformations; unstructured text; file I/O
  - "The difficult *data queries* all come through me anyway; I'll might as well do the *analysis* too."
- Management
  - Organizational Theory (matrix functions); *Extreme* Theory Y
  - "I don't want to. *work for the man;* I really, truly have an *entrepreneurial mindset* in my soul."

Candidate Explanations (4/4)
(Other/Interdisciplinary)

- Behavioral Economics
  - Extreme Discounting
  - "I am deliberately *overweighting* short-term preferences and *underweighting* long-term goals."

- History
  - Merchant-Craftsmen (some land) and Craft Guilds (no land) (apprentice → journeyman → master)
  - "Trades[men] and crafts[men] have always created local, supportive, and persistent *communities*."

Open Questions

- Is this observation an *itinerant, ephemeral fad* or a *persistent structure*?
- Is this eco-system *geographic-specific* or due to its virtual nature, *widespread*?
- *Vis-à-vis* other paid work, is this type of work off-shorable over time?
- If this sector is indeed *growing*, is it still just a *small part* of the economy anyway?
- Is this phenomenon (like some other aspects of IT) *gender-skewed*?
- Does the evidence suggest privileging *competencies* over *degrees*?
- Is my anecdotal experience with these "professionals", ultimately, the triumph of *practice* over *theory* (as seen from the perspective of a prospective, potentially confused, *soon-to-be-in-some-debt-from-a-student-loan* CSU student)?

Open Questions

- Without college degrees, how will these "data scientists" eventually lead/be ethical/well-rounded, etc. over a 40-year career arc?
  - What about Licensing? Certifications? CPE? "Badges"? Join professional (paid) associations?
  - How will they get promoted? Corollary: How, if ever, will their *model building* get more rigorous?
  - Can they can just enroll into holistic B.S./B.A. (pre-M.S./M.B.A.) programs later in life?
  - If applied math, computer science, statistics, and business are all individual degrees *now*, then how could we possibly make a single "data science" degree (all of them together) in the *future*?
- What is the role of Ph.D.'s and academics (other than paid consulting)?
  - If we help (e.g., lectures, provide experts, networking, FOSS software, etc.), are we, in fact, inadvertently and unexpectedly, helping some young folks *not* go to College?
  - What do we tell our Deans and Provosts about our deep involvement with individuals who able-but-unwilling to (traditional, B.A./B.S.) college?
- Isn't this phenomenon, if evident, just a new version of (yet one more) vocation?
  - The CSU, as one component of the CA Master Plan, doesn't "train" individuals (non-professionals) into vocations. We "educate" individuals for broader (professional and life) success.
- Does any of this matter to our programs in either the short-run or long-run?
  - Your thoughts?

Further Reading
(peer reviewed)

- Baumer, B., Centinkaya-Rundel, M., Bray, A., Loi, L., and Horton, N. (2014) , "R Markdown: Integrating A Reproducible Analysis Tool into Introductory Statistics", *Technology Innovations in Statistics Education*, 8(1) [https://escholarship.org/uc/item/90b2f5xh]

- Brynjolffson, E., Hitt, L. M., and Kim H. H. (April, 2011), Strength in Numbers: How does data-driven decision-making affect firm performance? (working paper) [http://ssrn.com/abstract=1819486]

- Cetinkaya-Rundel, M., Diez, D., and Barr, C. (2013) , "OpenIntro Statistics: an Open-source Textbook", *Technology Innovations in Statistics Education*, 7(3) [https://escholarship.org/uc/item/6msox5nf]

- Finzer, W. (2013) , "The Data Science Dilemma", *Technology Innovations in Statistics Education*, 7(2) [https://escholarship.org/uc/item/7gv0q9dc]

- Friedman, J. (2001) , "The Role of Statistics in the Data Revolution", *International Statistical Review*, 49(1) p. 5-10

Further Reading
(peer reviewed)

- Garfield, J., and Ben-Zvi, D. (2007) , "How Students Learn Statistics Revisited: A Current Review of Research on Teaching and Learning Statistics", *International Statistical Review*, 75(3) p. 372-396

- Gould, R. (2010) , "Statistics and the Modern Student", *International Statistical Review*, 78(2) p. 297-315

- Hardin, J., Hoerl, R., Horton, N., and Nolan, D. (Oct. 12, 2014), Data Science in the Statistics Curricula : Preparing Students to "Think with Data" [http://arxiv.org/ftp/arxiv/papers/1410/1410.3127.pdf]

- Horton, N., Baumer, B., and Wickham, H. (Feb. 1, 2015) , "Setting the stage for data science: integration of data management skills in introductory and second courses in statistics" [http://arxiv.org/pdf/1502.00318.pdf]

- Kaplan, D. (2007) , "Computing and Introductory Statistics", *Technology Innovations in Statistics Education*, 1(1) [https://escholarship.org/uc/item/3088k195]

Further Reading
(peer reviewed)

- Koenker, R., and Mizera, I. (2014), "Tidy Data", *Journal of Statistical Software*, 60(5) Sep. [http://www.jstatsoft.org/v60/i05/paper]

- Nolan, D., and Lang, D. T. (2010), "Computing in the Statistics Curricula", *American Statistician*, 64(10) p. 97-107 [http://www.stat.berkeley.edu/~statcur/Preprints/ComputingCurric3.pdf]

- Tambe, P. (April, 2011), "Big Data Investment, Skills, and Firm Value", *Management Science* (pre-print) [http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2294077]

- Wickham, H. (2014), "Tidy Data", *Journal of Statistical Software*, 59(10) Aug. [http://www.jstatsoft.org/v59/i10/paper]

Further Reading
(non peer-reviewed)

- Davenport, T., and Patil, D. J. (2012), "Data Scientist: The Sexiest Job of the 21st Century", *Harvard Business Review*, October.

- History of the Organization of Work
  - http://www.britannica.com/print/topic/648000

- Los Angeles Economic Development Corporation
  - *High Tech in LA* (October, 2014)
  - http://laedc.org/wp-content/uploads/2014/10/High-Tech-in-LA_20141006_FF.pdf

- McAfee, A., and Brynjolfsson, E. (2012), "Big Data: The Management Revolution", *Harvard Business Review*, October.

- McKinsey Global Institute Report (Manyika, J. et al.)
  - *Big data: The next frontier for innovation, competition, and productivity* (May, 2011)
  - http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation

Further Reading
(additional references)

- Journals:
  - J. of Data Science; Big Data; Machine Learning; Data Mining and Data Discovery; J. of Statistical Science; Technology Innovations in Statistical Education; International Statistical Review; J. of Statistics Education; Intl. J. of Math. Ed. In Science and Tech.
- Periodicals
  - Analytics Magazine (http://www.analytics-magazine.org/)
- "Academic" Conferences
  - INFORMS Big Data conference (April, 2015) (Huntington Beach, CA)
    - http://meetings2.informs.org/wordpress/analytics2015/
  - ACM SIGMOD "Management of Data" conf. (May/June, 2015) (Melborne, VIC, AU)
    - http://www.sigmod2015.org/
  - ACM KDD "Knowledge Discovery and Data Mining" conf. (Aug, 2015) (Sydney, AU)
    - http://www.kdd.org/kdd2015/
- "Practice" Conferences
  - R Users Conference (June/July, 2015) (Denmark) (2014 was held at UCLA)
  - R in Finance 2015; PythonQuants Conference 2014; SciPy 2015; JuliaCon 2015
- Organizations
  - **AMERICAN INSTITUTE OF BIG DATA PROFESSIONALS** (http://aibdp.org/)