

Welcome to Data Bootcamp

Joseph Adler, Drew Conway, Jake Hofman, Hilary Mason

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@jadler, @hmason, @drewconway, @jakehofman

Joseph Adler

LinkedIn

Joseph Adler has many years of experience in data mining and data analysis at companies including DoubleClick, American Express, and VenSign. He graduated from MIT with an B.Sc. and M.Eng in Computer Science and Electrical Engineering. He is the inventor of several patents for computer security and cryptography, and the author of "Baseball Hacks" and "R in a Nutshell". Currently, he is a senior data scientist at LinkedIn.



Hilary Mason

bit.ly

Hilary is the lead scientist at bit.ly, where she is finding sense in vast data sets. She is a former computer science professor with a background in machine learning and data mining, has published numerous academic papers, and regularly releases code on her personal site, www.hilarymason.com. She has discovered two new species, loves to bake cookies, and asks way too many questions.



► [Web site](#)

Drew Conway

New York University

Drew Conway is a PhD student in political science at New York University. Drew studies terrorism and armed conflict; using tools from mathematics and computer science to gain a deeper understanding of these phenomena.



► [Web site](#)

Jake Hofman

Yahoo!

Jake Hofman is a member of the Human Social Dynamics group at Yahoo! Research. His work involves data-driven modeling of social data, focusing on applications of machine learning and statistical inference to large-scale data. He holds a B.S. in Electrical Engineering from Boston University and a Ph.D. in Physics from Columbia University.



Please *do* try this at home

All of the materials from today's tutorial are available on Github:

Clone the repository for data/code/slides

```
git clone https://github.com/drewconway/strata_bootcamp
```

You may be bored if you already know how to ...

- ▶ Acquire data from APIs
- ▶ Clean/explore/visualize data
- ▶ Classify and cluster image and text data
- ▶ Work with large data sets
- ▶ Build simple mashups
- ▶ Work with unix tools on the command line, e.g.

```
$ sed -e 's/<[^>]*>//g' < page.html > page.txt
```

Data-dependent products



Not Interested

Our best guess for Jake: **5 stars**

Average of 4,275,920 ratings: **3.8 stars**

The Big Lebowski

1998 **R** 117 minutes

Slacker Jeff "The Dude" Lebowski (Jeff Bridges) gets involved in a gargantuan mess of events when he's mistaken for another man named Lebowski, whose wife has been kidnapped and is being held for ransom. All the while, Dude's friend, Walter (John Goodman), stirs the pot. Brothers Joel Coen and Ethan Coen write and direct this cult comedy classic that also stars Steve Buscemi, Philip Seymour Hoffman, Julianne Moore and John Turturro.

Cast: Jeff Bridges, John Goodman, Philip Seymour Hoffman, Steve Buscemi, Julianne Moore, Tara Reid, Peter Stormare, David Huddleston, Philip Moon, Mark Pellegrino, Flea, Torsten Voges, Jimmie Dale Gilmore, Jack Kehler, John Turturro, James G. Hoosier, Richard Gant, Christian Clemenson, David Thewlis, Peter Siragusa, Sam Elliott, Ben Gazzara, Jon Polito, Asia Carrera, Paris Themmen

Director: Joel Coen

Genres: Comedy, Cult Comedies, Universal Studios Home Entertainment, Blu-ray

This movie is: Quirky, Witty

Format: DVD and streaming (Blu-ray availability date unknown) (HD available)

Play

Add to Instant Queue

Add to DVD Queue

Play Trailer

Recommended based on your interest in:
 Fargo, O Brother, Where Art Thou? and No Country for Old Men

- ▶ Effective/practical systems that learn from experience impact our daily lives, e.g.:
 - ▶ Recommendation systems
 - ▶ Spam detection
 - ▶ Optical character recognition
 - ▶ Face recognition
 - ▶ Fraud detection
 - ▶ Machine translation
 - ▶ ...

Black¹-boxed?



★ Google Prediction API (Labs)

[Home](#) [Docs](#) [FAQ](#) [Forum](#) [Terms](#)

What is the Google Prediction API?

The Prediction API enables access to Google's machine learning algorithms to analyze your historic data and predict likely future outcomes. Upload your data to [Google Storage for Developers](#), then use the Prediction API to make real-time decisions in your applications. The Prediction API implements [supervised learning](#) algorithms as a RESTful web service to let you leverage patterns in your data, providing more relevant information to your users. Run your predictions on Google's infrastructure and scale effortlessly as your data grows in size and complexity.

How do I start?

- [Learn more](#) about Google Prediction API.
- [Request access](#).
- Try out the [sample code](#).



Features

- Lightweight RESTful API
- Asynchronous training
- Automatically selects from several available machine learning techniques
- Supported inputs: numeric data or unstructured text
- Outputs hundreds of discrete categories
- Accessible from many platforms: Google App Engine, Apps Script (Google Spreadsheets), web & desktop apps, and command line

Uses

- Language identification
- Customer sentiment analysis
- Product recommendations & upsell opportunities
- Message routing decisions
- Diagnostics
- Document and email classification
- Suspicious activity identification
- Churn analysis
- And many more...

¹s/black/blue/g

- ▶ Web service APIs expose lots of data



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Dashboard Directory Newest Most Popular By Category API Scorecard Add API

Web Services Directory

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Filter APIs

Keywords:

Category:

Company:

Protocols / Styles:

Data Format:

Managed By:

Date:

View by Category

Sort by:

Viewing 1 to 1446 of 1446 APIs

API	Description	Category	Mashups
Google Maps	Mapping services	Mapping	1799
Flickr	Photo sharing service	Photos	476
YouTube	Video sharing and search	Video	413
Amazon eCommerce	Online retailer	Shopping	315
Twitter	Microblogging service	Social	260
eBay	Online auction marketplace	Shopping	178
Microsoft Virtual Earth	Mapping services	Mapping	173
del.icio.us	Social bookmarking	Bookmarks	139
Google Search	Search services	Search	135
Yahoo Maps	Mapping services	Mapping	131
Yahoo Search	Search services	Search	126
411Sync	SMS, WAR, and email messaging	Messaging	120
Last.fm	Online radio service	Music	120
Facebook	Social networking service	Social	107

- ▶ Many free, public data sets available online

Infochimps



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Some Interesting Datasets

- Stock Symbols & Metadata for all three US Stock Exchanges
- Word List - 1000 Most Frequent Words from an Internet Corpus
- Household Debt-Service Payments and Financial Obligations as a Percentage of Disposable Personal Inc

Top Tags

government census population america
demographics state selected olympics type

Step 1: Have data

Step 2: ???

Step 3: Profit

Fwd: Yahoo! supercomputing cluster RFP - i have no idea. i have no idea. O
non urgent - whoops! yes that's what i meant, thanks for decoding my questi
SourceForge.net: variational bayes for network modularity - can i get admin
Byline - iPhone Apps, iPhone 3G apps and iPod touch Applications Gallery a
Laurence J. Peter: Facts are stubborn things, but statistics are more pliable.
Re: JAFOS 2008, Applied Math Session - yes. the listening post dude. On N
Access to over 5,000 Health Plan Choices! - Affordable health insurance. Ins
More effective - If you are having trouble viewing this email click here. Thurs
Special Offer! Cialis, Viagra, VicodinES! - Order all your Favorite Rx~Medica
Financial Aid Available: Find Funding for Your Education - Get the financial a
Find The Perfect School and Financial Aid for your College Degree - HI ! It h
PHARMA_viagra_PHARMA_cialis - Wanted: web store with remedies. N

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Special Offer! Cialis, Viagra, VicodinES! - Order all your Favorite Rx~Medica
Financial Aid Available: Find Funding for Your Education - Get the financial a
Find The Perfect School and Financial Aid for your College Degree - HI ! It h
PHARMA_viagra_PHARMA_cialis - Wanted: web store with remedies. N

- ▶ How did you solve this problem?
- ▶ Can you make this process explicit (e.g. write code to do so)?



- We learn quickly from few, relatively unstructured examples ... but we don't understand *how* we accomplish this

Everything old is new again²

- ▶ Many fields ...
 - ▶ Statistics
 - ▶ Pattern recognition
 - ▶ Data mining
 - ▶ Machine learning
- ▶ ... similar goals
 - ▶ Extract and recognize patterns in data
 - ▶ Interpret or explain observations
 - ▶ Test validity of hypotheses
 - ▶ Efficiently search the space of hypotheses
 - ▶ Design efficient algorithms enabling machines to learn from data

²<http://cbcl.mit.edu/publications/theses/thesis-rifkin.pdf>

Glossary

Machine learning

Statistics

network, graphs

model

weights

parameters

learning

fitting

generalization

test set performance

supervised learning

regression/classification

unsupervised learning

density estimation, clustering

large grant = \$1,000,000

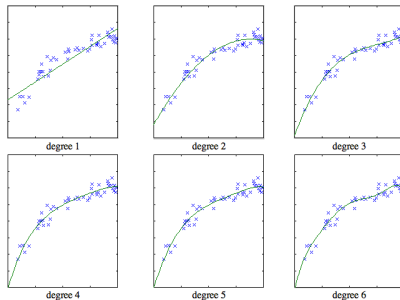
large grant = \$50,000

nice place to have a meeting:
Snowbird, Utah, French Alps

nice place to have a meeting:
Las Vegas in August

³<http://anyall.org/blog/2008/12/statistics-vs-machine-learning-fight/>

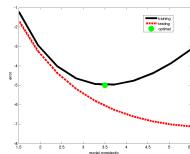
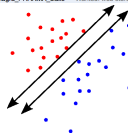
- ▶ We would like models that:
 - ▶ Provide predictive and explanatory power
 - ▶ Are complex enough to describe observed phenomena
 - ▶ Are simple enough to generalize to future observations



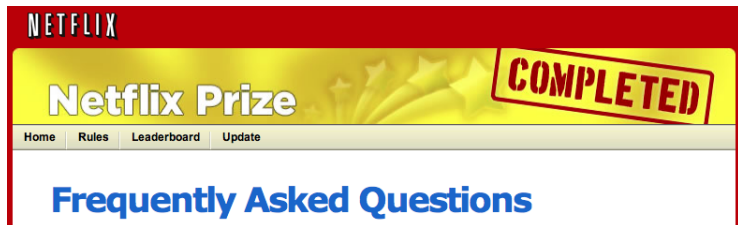
Roadmap, take 2⁴

1. Get data
2. Visualize/perform sanity checks
3. Clean/filter observations
4. Choose features to represent data
5. Specify model
6. Specify loss function
7. Develop algorithm to minimize loss
8. Choose performance measure
9. "Train" to minimize loss
10. "Test" to evaluate generalization

Fed: Yahoo! supercomputing cluster RFP - I have no idea. I have no idea. O
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Special Offer Cialis, Viagra, Vioxx/ESI - Order all your Favorite Rx-Medica
Financial Aid Available: Find Funding for Your Education - Get the financial
Find The Perfect School and Financial Aid for your College Degree - Hi I'll h
PHARMA_vioxxa_PHARMA_cialis - Wanted: web store with remedies. N



⁴<http://www.dataists.com/2010/09/a-taxonomy-of-data-science/>



How does Cinematch do it?

Straightforward statistical linear models with a lot of data conditioning. But a real-world system is much more than an algorithm, and Cinematch does a lot more than just optimize for RMSE. After all, we have a website to support. In production we have to worry about system scaling and performance, and we have additional sources to data we can use to guide our recommendations. But, as mentioned in the [Rules](#) and just to be perfectly clear, for the purposes of the Prize the RMSE values we report here do not use any of this extra data.

Shipping = Feature

Add an asymmetric frequency feature $\mathbf{y}_{j,f_{ut}}^{(3)}$: **SBRAMF-UTB-UTF-MTF-ATF-MFF-AFF**

$$\widehat{r}_{uit} = \mu_i + \mu_u + \mu_{u,t} + \mu_{i,\text{bin}(t)} + \left(\mathbf{p}_i^{(1)} + \mathbf{p}_{i,\text{bin}(t)}^{(2)} + \mathbf{p}_{i,f_{ut}}^{(3)} \right)^T \left(\mathbf{q}_u^{(1)} + \mathbf{q}_{u,t}^{(2)} + \frac{1}{\sqrt{|N(u)|}} \sum_{j \in N(u)} \left(\mathbf{y}_j^{(1)} + \mathbf{y}_{j,\text{bin}(t)}^{(2)} + \mathbf{y}_{j,f_{ut}}^{(3)} \right) \right) \quad (34)$$

Model extension (+)	epoch time	#epochs	probeRMSE, $k = 50$ features
SBRMF - SVD with biases	17[s]	69	0.9054
SBRAMF - asymmetric part	50[s]	30	0.8974
+ UTB - user time bias	61[s]	50	0.8919
+ UTF - user time feature	62[s]	38	0.8911
+ MTF - movie time feature	74[s]	37	0.8908
+ ATF - asymmetric time feature	74[s]	44	0.8905
+ MFF - movie frequency feature	149[s]	46	0.8900
+ AFF - asymmetric frequency feature	206[s]	45	0.8886 (0.8846 with $k = 1000$)

Data jeopardy

Regardless of scale, it's difficult to find the right questions to ask of the data

Data hacking

Cleaning and normalizing data is a substantial amount of the work (and likely impacts results)

Data hacking

The ability to iterate quickly, asking and answering many questions, is crucial

Data hacking

Hacks happen: `sed/awk/grep` are useful, and scale

Data “science”

Simple methods (e.g., linear models) work surprisingly well, especially with lots of data

Data “science”

It's easy to cover your tracks—things are often much more complicated than they appear

