

# Scaling ML in Digital Advertising

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dstillery

# Programmatic Advertising

The screenshot shows the New York Times homepage with several programmatic advertisements highlighted in red boxes:

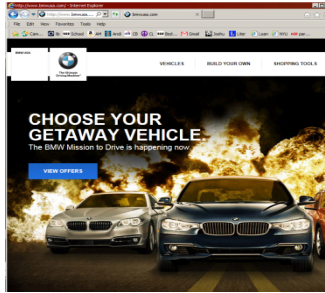
- Top Left:** "THE ALL-NEW CADILLAC XTS" banner.
- Top Right:** Image of a Cadillac XTS.
- Search Bar:** "ING DIRECT" advertisement.
- Left Sidebar:** Navigation menu with categories like "WORLD", "U.S.", "POLITICS", "NEW YORK", "BUSINESS", "DEALBOOK", "TECHNOLOGY", "SPORTS", "SCIENCE", "HEALTH", "ARTS", "STYLE", "OPINION".
- Main Content:**
  - Fiscal Crisis in States Will Last Beyond Slump, Report Warns** by MARY WILLIAMS WALSH and MICHAEL COOPER. 11:00 AM ET. Summary: Long after the economy rebounds, states will face financial problems that include rising health care costs and underfunded pensions, a task force of budget experts said.
  - Unity Government in Israel Disbanding Over Draft Dispute** by JODI RUDOREN and RICK GLADSTONE. 35 minutes ago. Summary: The head of the centrist Kadima Party said it had "no choice" but to pull out because of differences over a proposed universal draft.
  - Cautious on Growth, Bernanke Offers No Hint of New Action** by BINYAMIN APPELBAUM. 40 minutes ago. Summary: Ben S. Bernanke, the
- TimesCast:** Video player for "TimesCast Politics: Running Mate Speculation". Summary: The latest hints. | Trying to break the story. | Christie out of the running. | Campaign ad sniping goes on. | A report from a gathering of Mormons.
- OPINION:** "Islamic School for Girls At a Koran school in Syria, girls learned about both Islam and women's rights." Authors: Brooks: Capitalism Debate, Bruni: A Civic Vacuum, Editorial: The Power of Anonymity, Taking Note: Look Over Here!, Warren Rudman, Chuck Hagel: We Need Disclosure.
- MARKETS:** Table showing S&P 500, Dow, and Nasdaq indices.
- Bottom Right:** "INTRODUCING THE ALL-NEW CADILLAC XTS" video player with "CLICK FOR SOUND" and "LEARN MORE" buttons.

300 Million (US) consumer



Interacting with brand sites

Using Digital Devices



Measurement

Conversion

If we win an auction we serve ad of brand

100 ms to bid

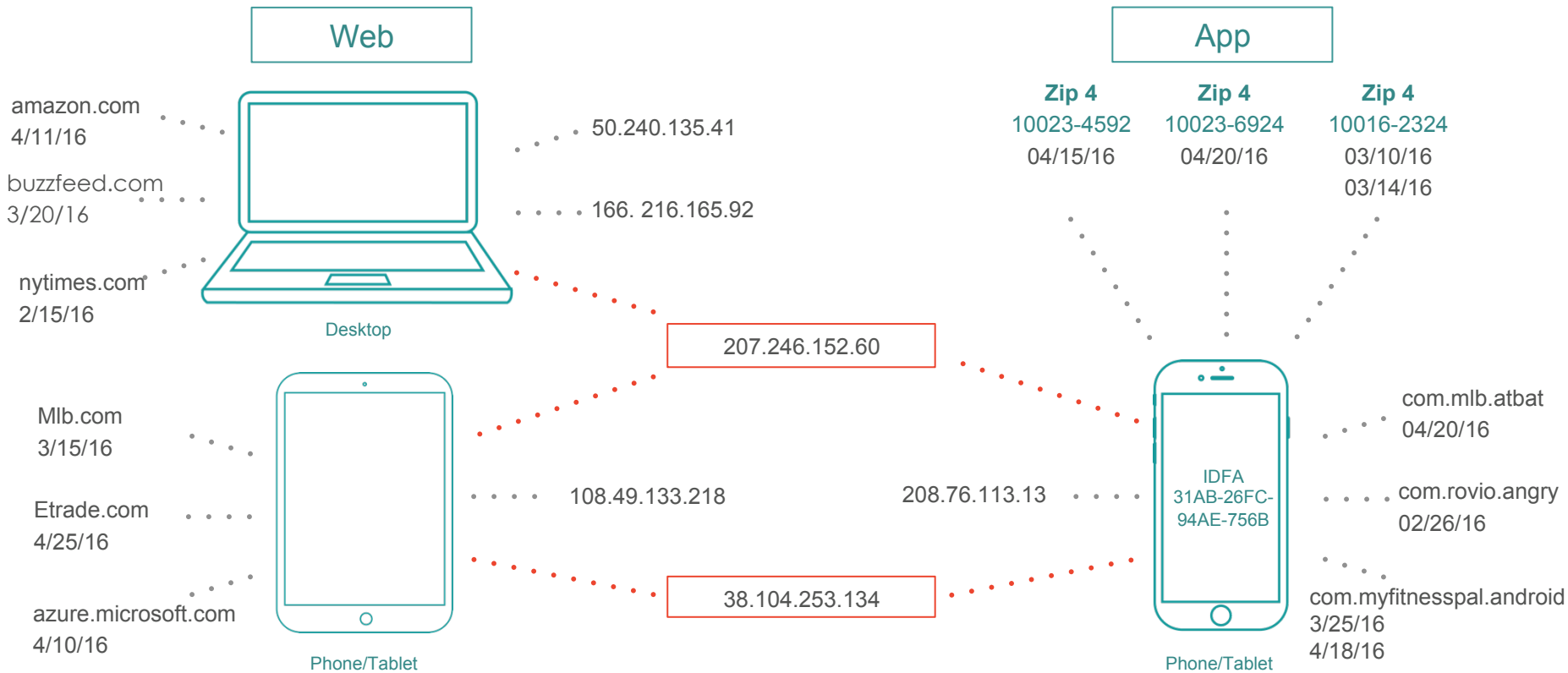
Work with Brand



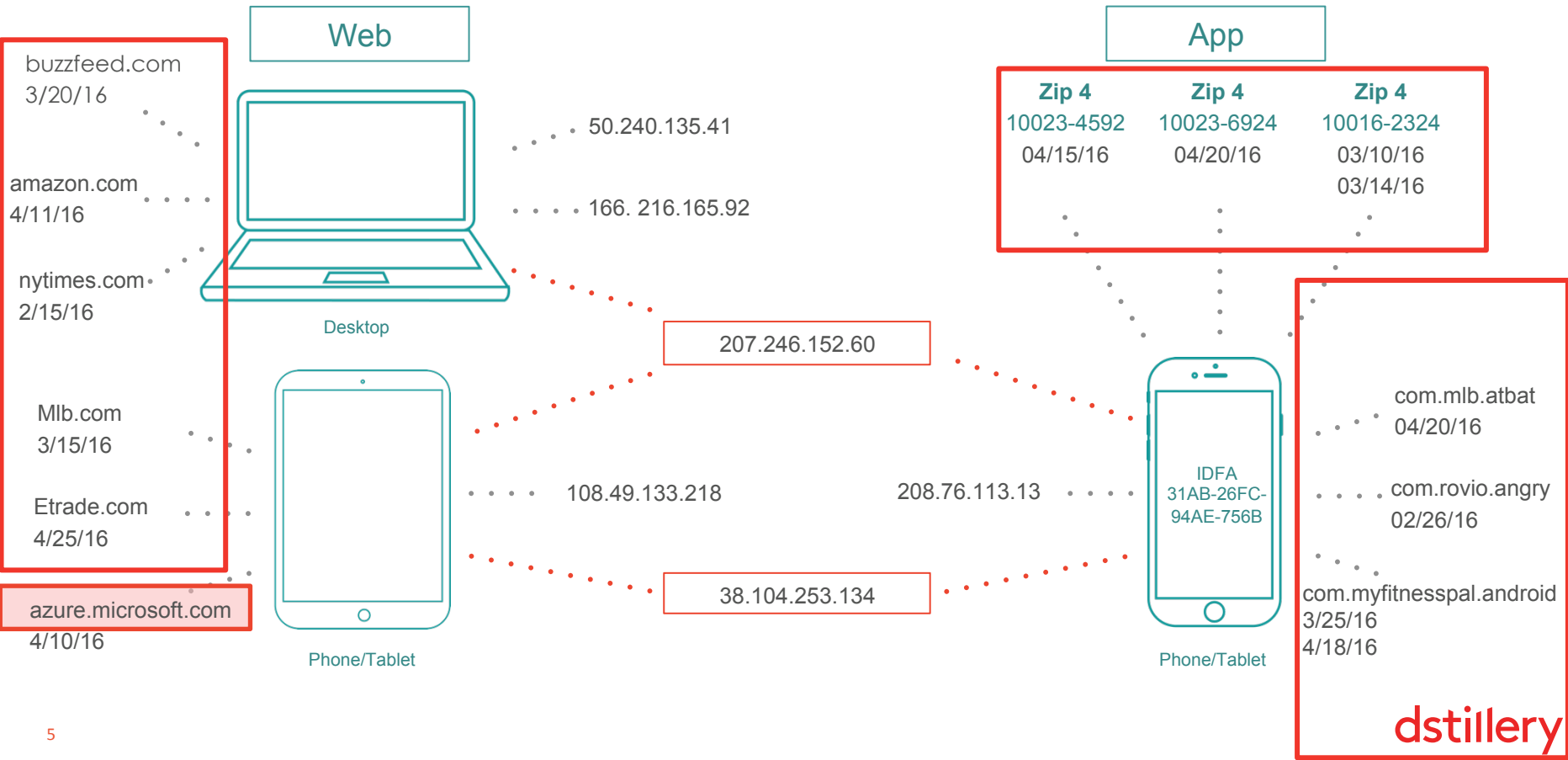
100 Billion bid requests per day

dstillery

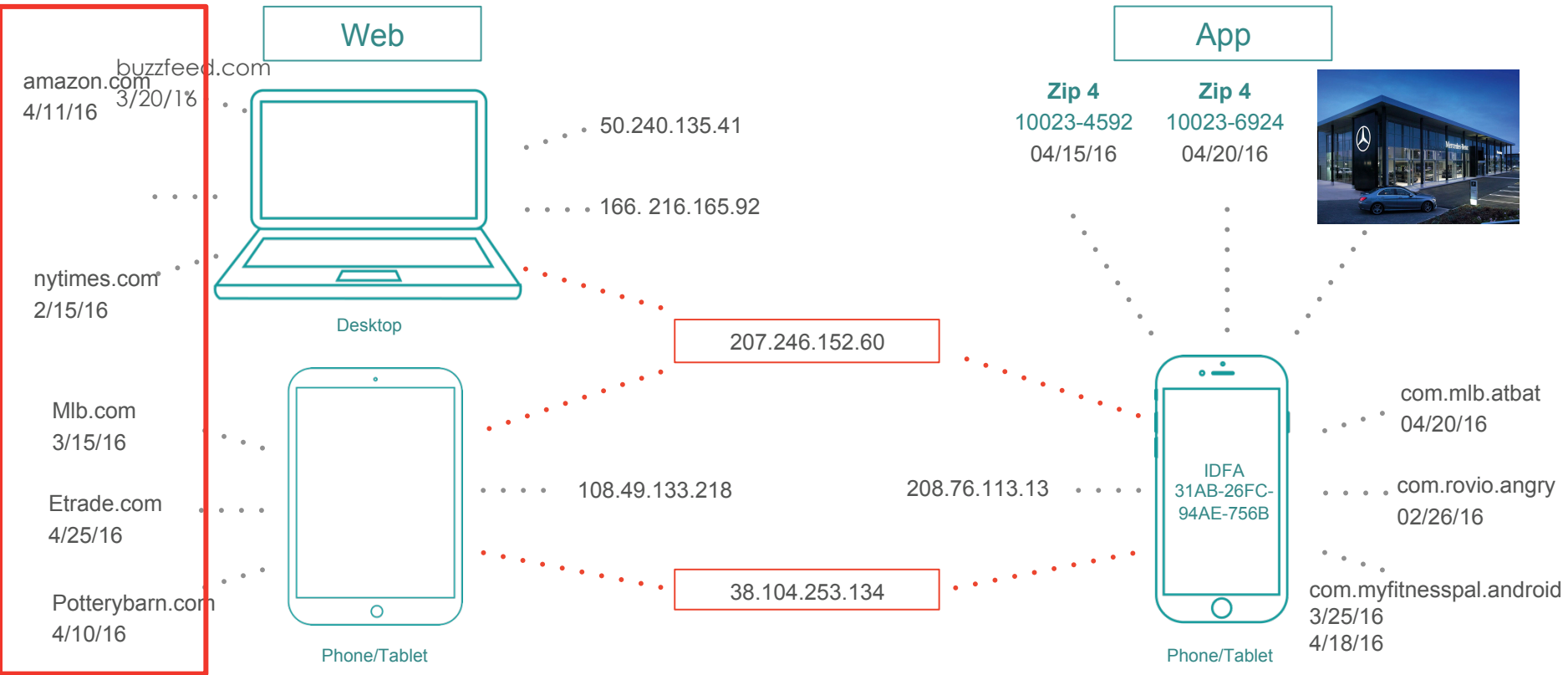
# Dstillery Data: 100 Billion events per day across devices



# Predicting events on pretty much everything



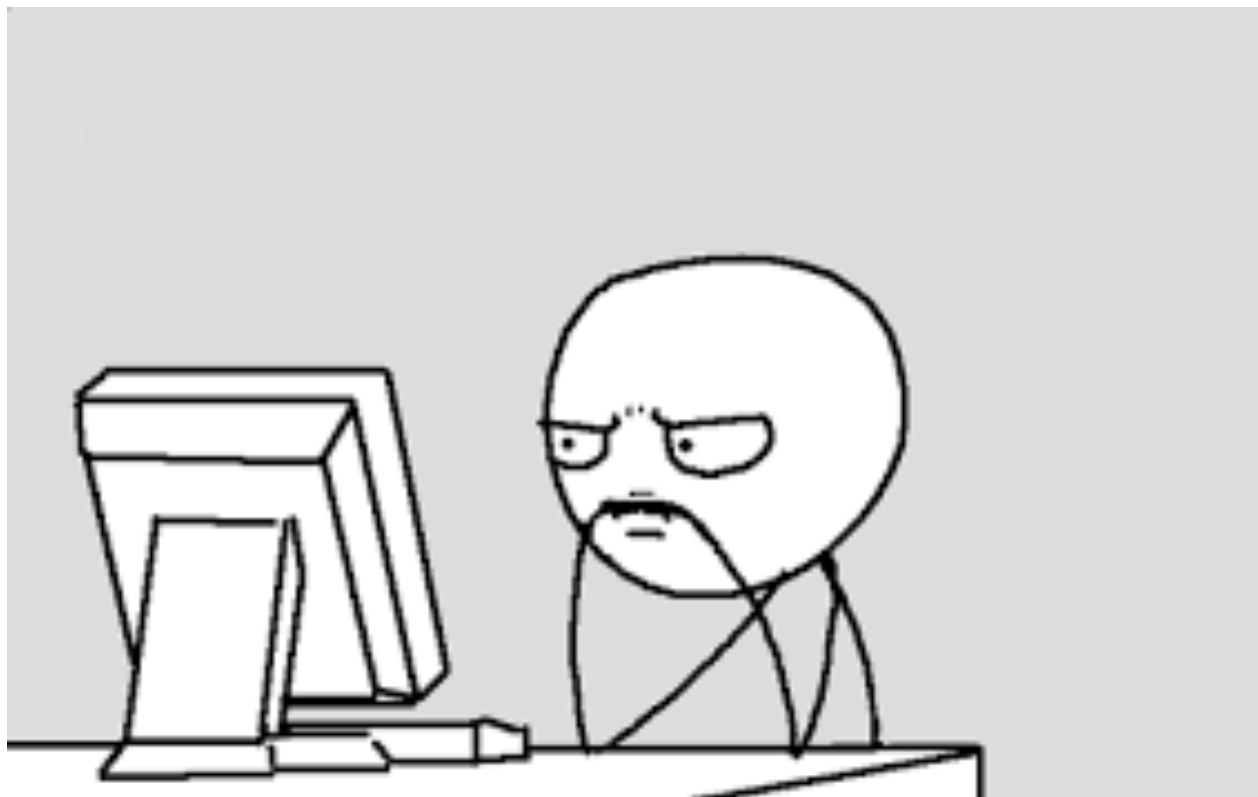
# Predict who will go to a Mercedes Car dealership ..



Lets talk scaling? Most Limited resource?



Personally: Waiting for your model estimation sucks!

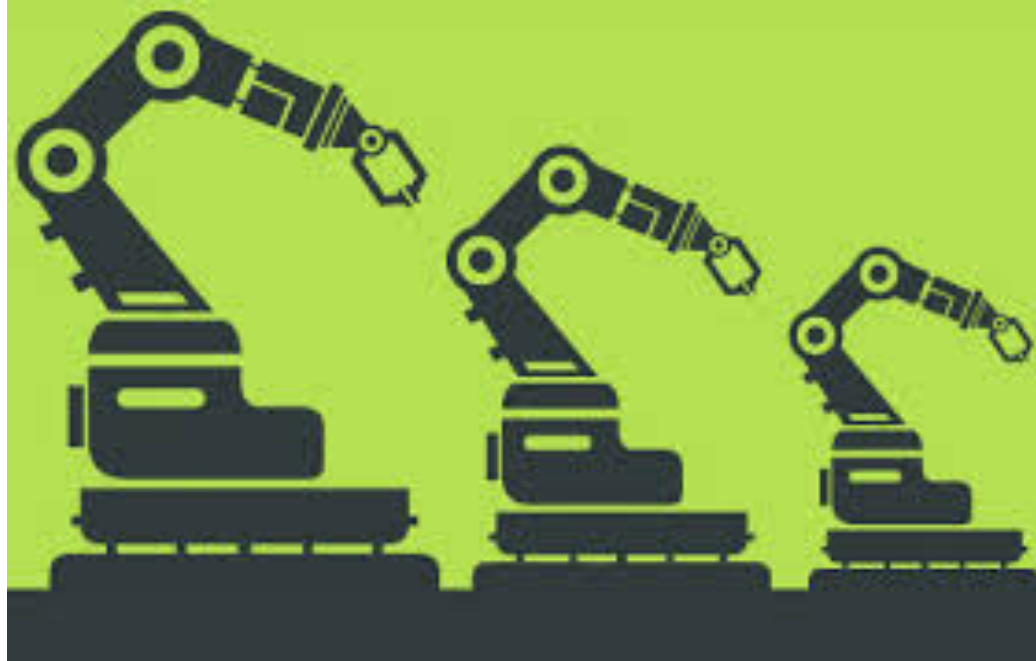




# Tip of the iceberg ...



# World of Digital Advertising



Automation beats scaling

# Scaling the Solution, not the ML ...

Build/manage thousands of models with limited DS resources ...

- All kinds of target/baserates:  
various types of conversion, click, viewability, video completion, store visits, purchases
- Typically low predictability
- Create additional model for new target with a flip of a switch in hours
- Manage the feature space and automate deployment

Score ~200 Million examples daily against 10K models

- Less than 0.005 ms each

Economic efficiency

# DS Dashboard ...

317

Campaigns on Optimus (out of 432 active campaigns; 249 auto set prices; 83 auto create targetgroups)

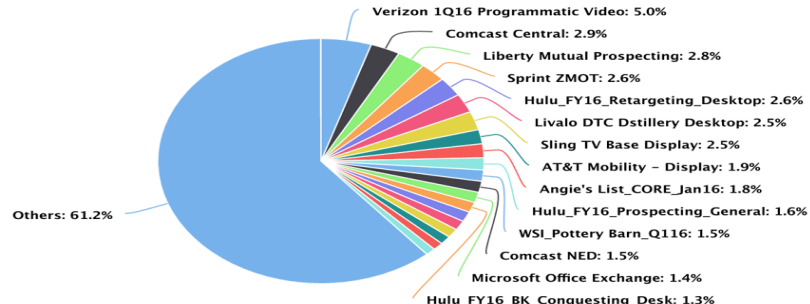
3116

SGD models were built in the past 24 hours

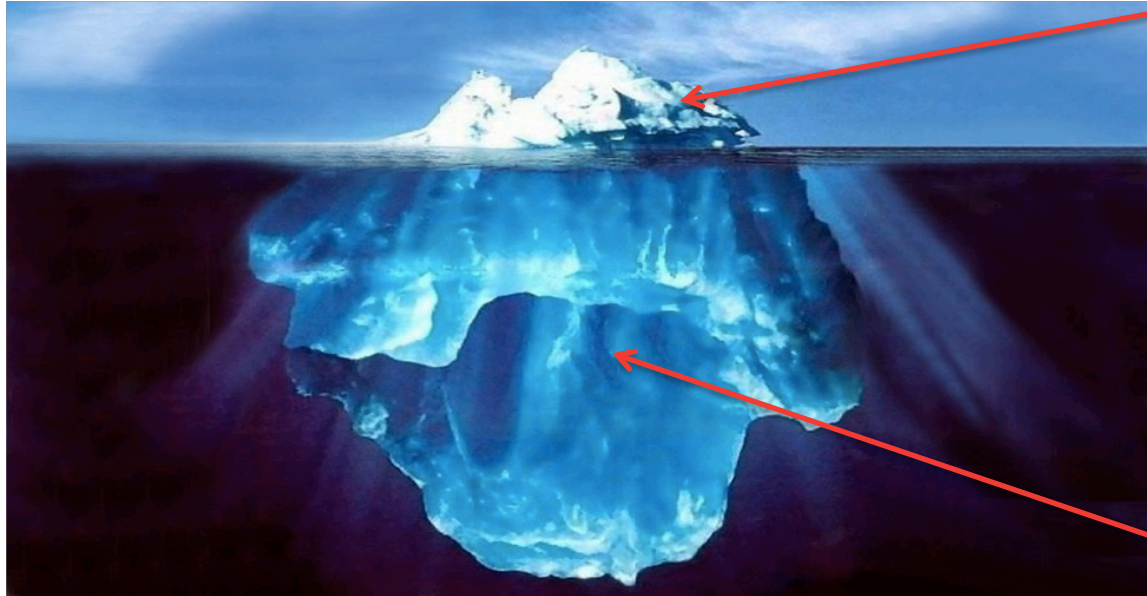
## Projects:

- [CFP Sampler Specs](#)
- [Data Nexus](#)
- [DS Crosswalk](#)
- [Inventory Stats](#)
- [Optimus Campaigns](#)
- [Place Still Tag Index](#)
- [Seg Avails](#)
- [Sport](#)
- [Segrank Campaigns](#)
- [Exchange Specific Stats](#)
- [Optimus Decider Audit Trail](#)

## Top campaigns by daily revenue



# Automating Machine Learning

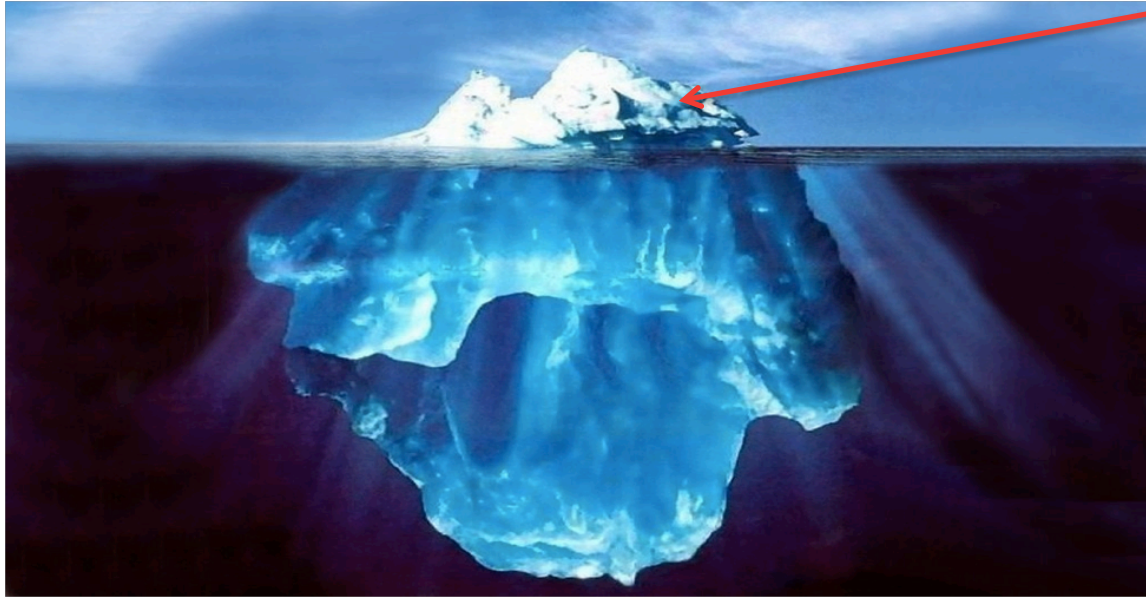


Strategic ML Choices ...

Infrastructure

# Automating Machine Learning

**Strategic ML Choices ...**



# ML Strategy: robustness & interpretation beats peak performance

- Feature engineering
  - Sparse binary or hostnames: easy to code all kinds of data
  - ~100 Million (possible) features
  - Stay 'close' to the raw data
  - Hashing to ensure consistent feature space
  - One MUST fit all ...
- Algorithm
  - Logistic regression (and some Naïve Bayes)
  - Stochastic gradient descent
  - Penalties & Heuristics for Learning Rate Estimate
  - Constant refresh every ~3 days
  - Stacking & Transfer Learning & Sampling





# SGD Model (Model ID: 1728493)

**Marketer** Microsoft (Empowering Media SF) [6000]  
**Offer** Microsoft Azure Evergreen [7599]  
**Offer Level** 40: Free Trial [19945]  
**Model Created At** 2016-03-06 12:36:39  
**Model Event End Time** 2016-03-06 17:40:00  
**# Positives** 217  
**# Negatives** 2,170  
**# Features** 362,059  
**Parent Model** [1725331](#)  
**HDFS Path** hdfs://hdfs2/user/sgd/models/19945/OL19945\_FM2\_BS20160306123636.model

## Top Features with Highest Scores

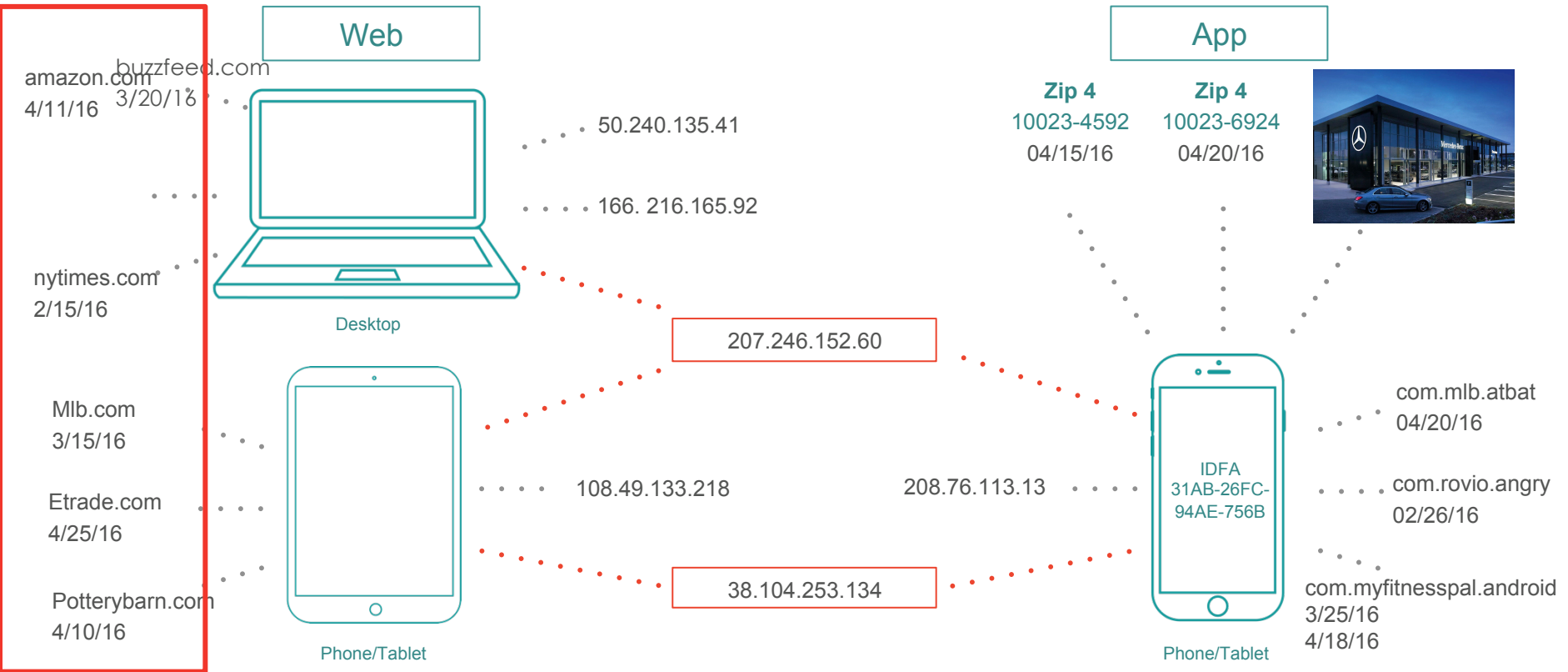
Show 10 entries

Search:

Feature	Coef
[46303095]	3.117
<a href="#">blogs.msdn.com</a> [33892607]	3.010
<a href="#">www.why-recycle.com</a> <a href="#">www.technet.com</a> [46550201]	2.932
<a href="#">www.lz95.org</a> [35757707]	2.779
<a href="#">www.dorisandjillycook.com</a> <a href="#">www.dotnetfunda.com</a> <a href="#">www.edenprairiecenter.com</a> [35375642]	2.508
<a href="#">www.onebox.com</a> <a href="#">www.avanquest.com</a> [35325508]	2.467
<a href="#">www.office.com</a> [46380052]	2.410
[46305049]	2.297
<a href="#">www.verbasoftware.com</a> [46446087]	2.294
<a href="#">www.rosebyrne.org</a> <a href="#">www.socialapocalypse.com</a> <a href="#">www.milfmovies.biz</a> <a href="#">www.milwaukee-wisconsin-wi.com</a> <a href="#">www.msexchange.org</a> [35355270]	2.288



# Predict who will go in 7 days to a Mercedes dealership



# Identify people who will go to Mercedes dealerships



URL	Logistic Parameter
<a href="http://www.mercedesremotestart.com">www.mercedesremotestart.com</a>	2.97
<a href="http://www.girardtoyota.com">www.girardtoyota.com</a>	2.92
<a href="http://www.bluelineprop.com">www.bluelineprop.com</a>	2.91
<a href="http://www.toyotaoflaredo.com">www.toyotaoflaredo.com</a>	2.70
<a href="http://www.pikespeakacura.com">www.pikespeakacura.com</a>	2.44
<a href="http://www.motorcarsacura.com">www.motorcarsacura.com</a>	2.39
<a href="http://www.hobsonrealtors.com">www.hobsonrealtors.com</a>	2.35
<a href="http://www.fayettevillencmls.com">www.fayettevillencmls.com</a>	2.35
<a href="http://www.coast2coastmixtapes.com">www.coast2coastmixtapes.com</a>	2.28
<a href="http://www.fwproperties.com">www.fwproperties.com</a>	2.26
<a href="http://www.dealeron.com">www.dealeron.com</a>	2.25
<a href="http://www.smartfitnesscoach.com">www.smartfitnesscoach.com</a>	2.23
<a href="http://www.pearsonlongman.com">www.pearsonlongman.com</a>	2.21
<a href="http://www.pattersonauto.com">www.pattersonauto.com</a>	2.14
<a href="http://www.acuraofmodesto.com">www.acuraofmodesto.com</a>	2.11
<a href="http://www.f2it.co.uk">www.f2it.co.uk</a>	2.10
<a href="http://www.keyeshyundai.com">www.keyeshyundai.com</a>	2.09
<a href="http://www.stevenscreekhyundai.com">www.stevenscreekhyundai.com</a>	2.06
<a href="http://www.columbusrealtors.com">www.columbusrealtors.com</a>	2.05
<a href="http://www.whitmanathletics.org">www.whitmanathletics.org</a>	2.05
<a href="http://www.napletonautosales.com">www.napletonautosales.com</a>	2.02
<a href="http://www.dealerelite.net">www.dealerelite.net</a>	2.00
<a href="http://www.valuinsight.com">www.valuinsight.com</a>	1.99
<a href="http://www.travel-shows.com">www.travel-shows.com</a>	1.98
<a href="http://www.gorealestateagents.com">www.gorealestateagents.com</a>	1.98

# 'In the market' signal



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<a href="http://www.dealeron.com">www.dealeron.com</a>	2.25
<a href="http://www.smartfitnesscoach.com">www.smartfitnesscoach.com</a>	2.23
<a href="http://www.pearsonlongman.com">www.pearsonlongman.com</a>	2.21
<a href="http://www.pattersonauto.com">www.pattersonauto.com</a>	2.14
<a href="http://www.acuraofmodesto.com">www.acuraofmodesto.com</a>	2.11
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# Real Estate



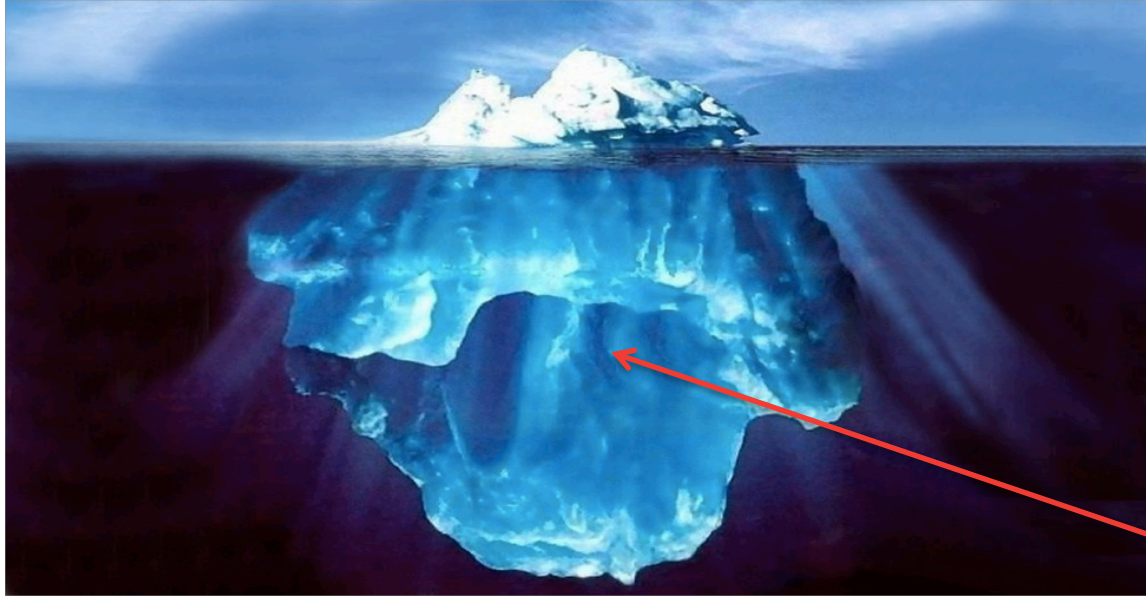
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# Fitness ...



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# Automating Machine Learning



**Infrastructure**

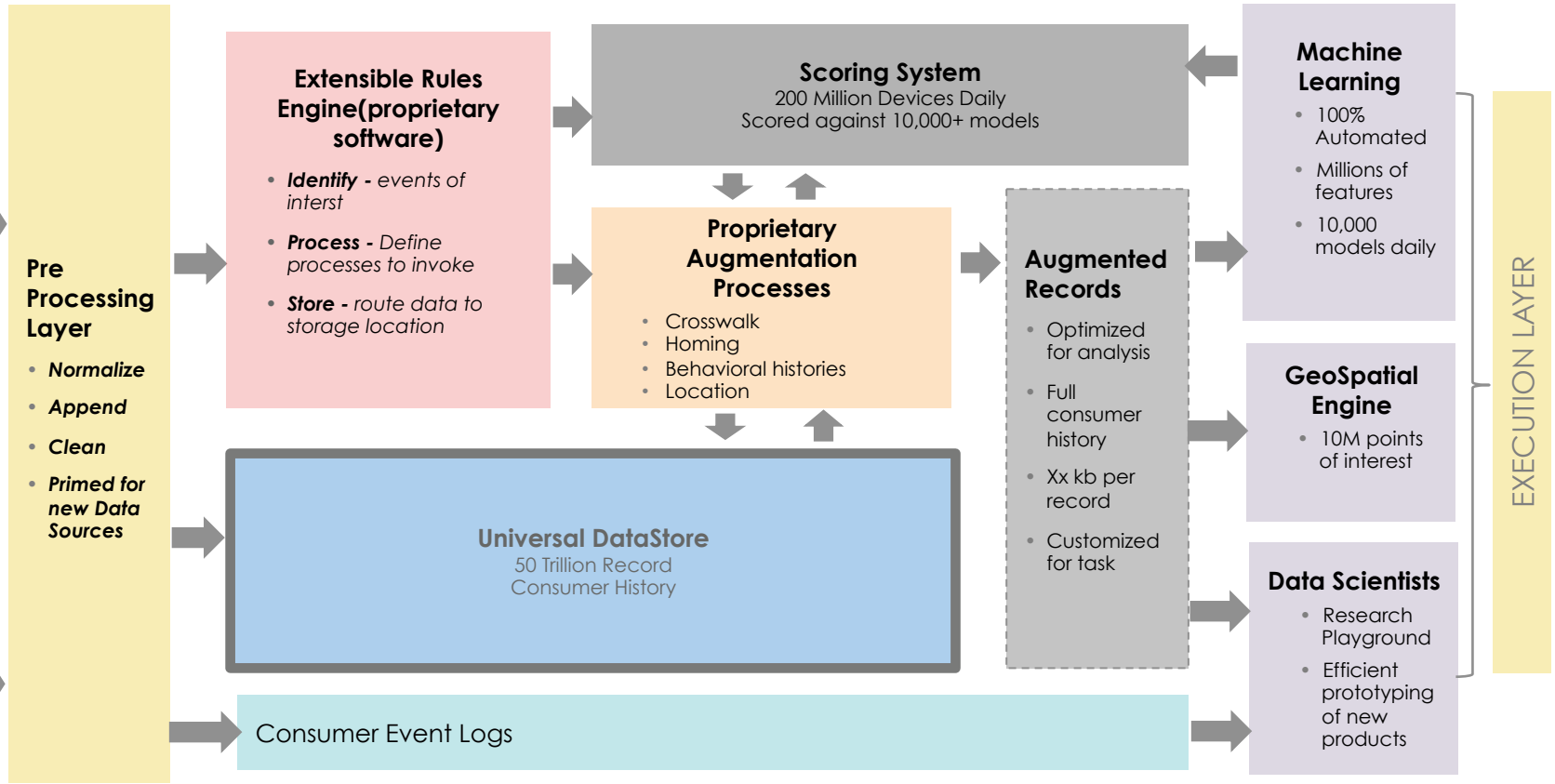
Consumer Sensors Pipe  
Data Into ..

Streaming Data Infrastructure Unlocking Access to 50 Trillion record Consumer  
History..

Empowering  
Scientists & Machines

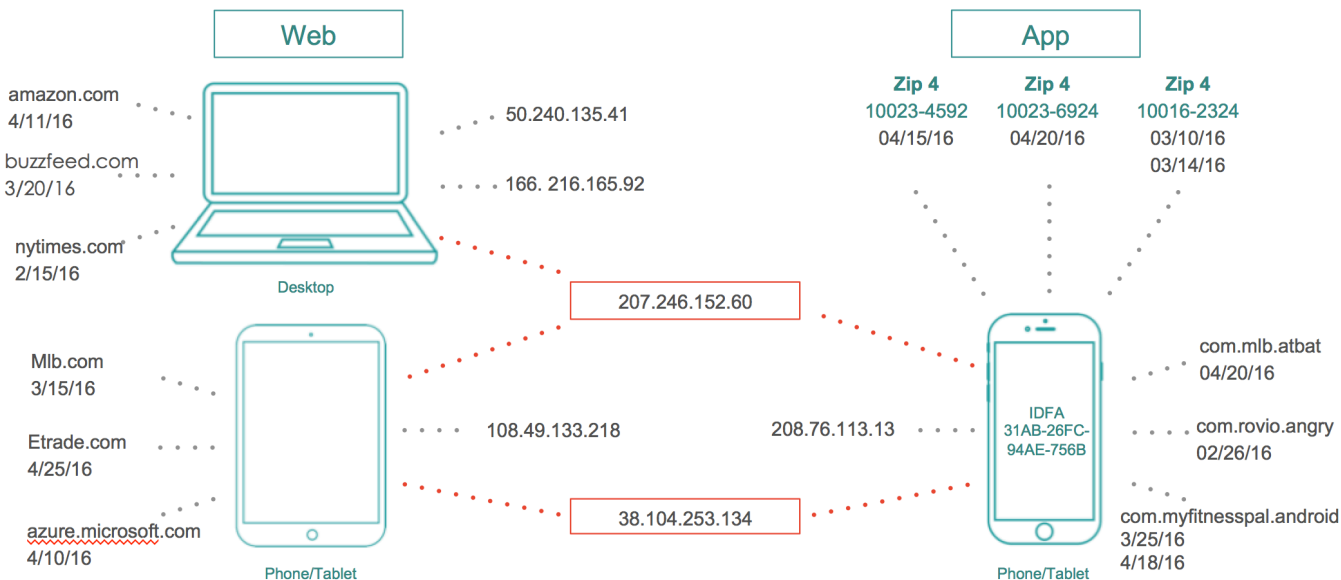
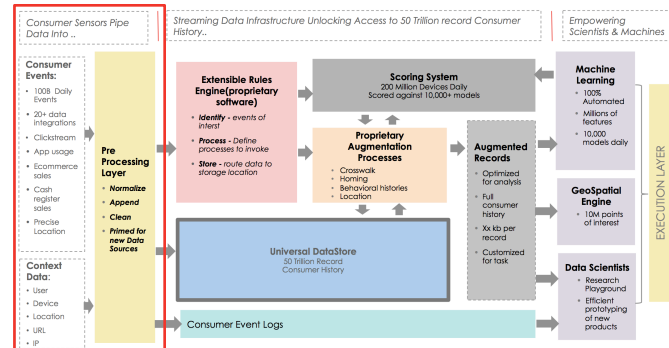
- Consumer Events:**
- 100B Daily Events
  - 20+ data integrations
  - Clickstream
  - App usage
  - Ecommerce sales
  - Cash register sales
  - Precise Location

- Context Data:**
- User
  - Device
  - Location
  - URL
  - IP



# Consumer Events Data

- Cleaning & consistent format
- Bot detection
- Appending contextual information

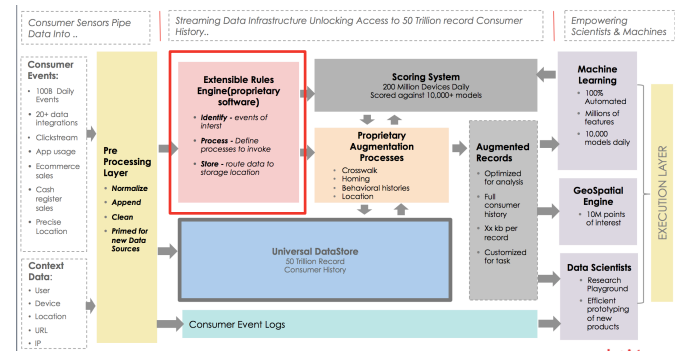
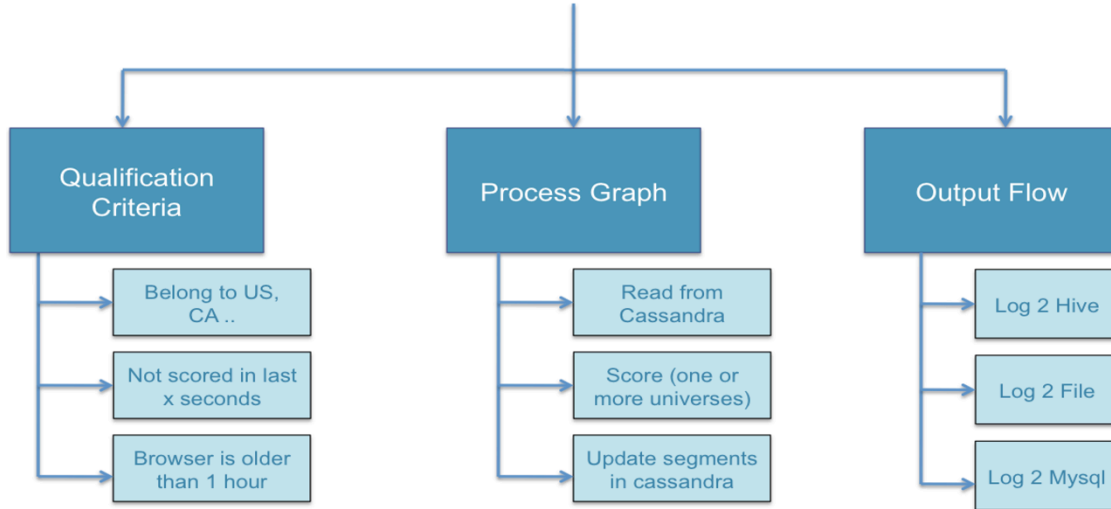




# Sampler

- Extensible Rules Engine

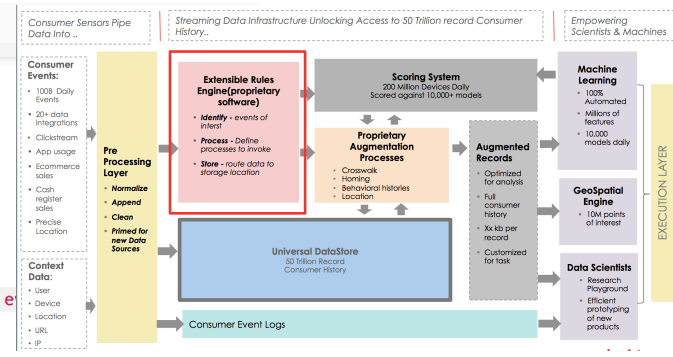
## Samplers / Filters



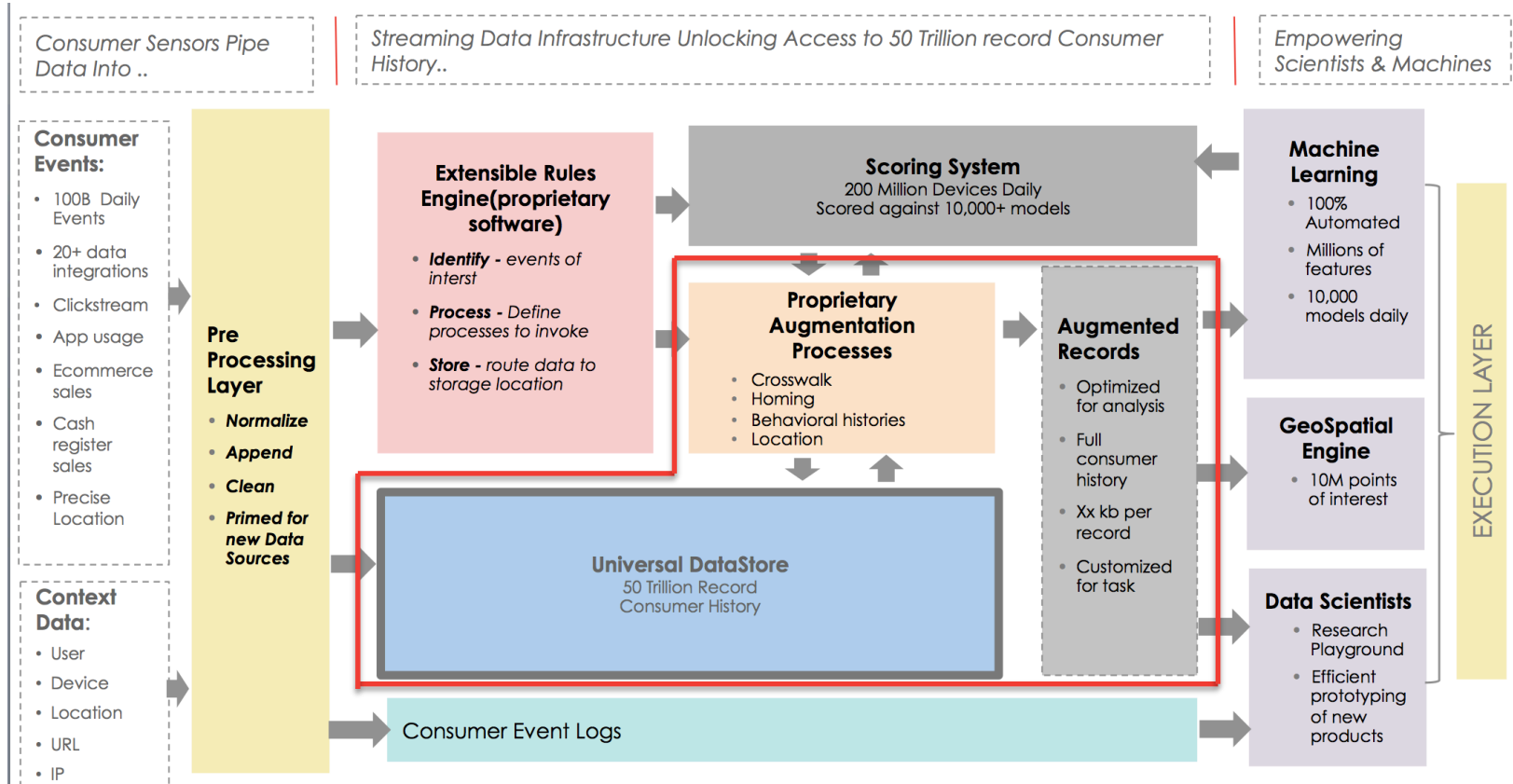
id 112  
 desc SGD RON Sampler  
 process init-request;populate-cookies-from-req;refresh-ssc(adh,vstcnt,lbh,sglst,browser\_prop);feature-map(2);score(display,5:6:11:14:17:18,false,-1,false,true);cfp-to-kafka(cfpBaseline)  
 mode ON  
 destination  
 precondition none  
 sampler\_interval 86400  
 spec {"isQ":"return (event.eventType == 6 && event.audienceType == 72 && (event.getCountry() == \"US\" || e \\\"CA\\\" || event.getCountry() == \"GB\\\" || event.getCountry() == \"ZZ\\\" || event.getCountry() == \"unknown\\\"));\",\"onQ\":\"\",\"onR\":\"\"}  
 type groovyTemplate  
 version 3

id 113  
 desc Fracture INS  
 process init-request;populate-cookies-from-req;refresh-ssc(adh,vstcnt,lbh,sglst,browser\_prop);feature-map(2);cfp-to-kafka(cfpBaseline);  
 mode ON  
 destination  
 precondition none  
 sampler\_interval 0  
 spec {"isQ":"return (event.getBrowserId() % 1000 == 0) && event.getBrowserId() > 999999999 && event.environmentType != \"APP\\\";\",\"onQ\":\"\",\"onR\":\"\"}  
 type groovyTemplate  
 version 2

id 114  
 desc Bid Sampler 0.125%  
 process init-request;populate-cookies-from-req;refresh-ssc(adh,vstcnt,lbh,sglst,browser\_prop);cfp-to-kafka(cfpBaseline)  
 mode ON  
 destination  
 precondition none  
 sampler\_interval 0  
 spec {"isQ":"return ((new Random()).nextInt(800) == 1 && event.environmentType != \"APP\\\" && event.eventType == 10 && (event.getCountry() == \"US\\\" || event.getCountry() == \"CA\\\" || event.getCountry() == \"GB\\\"));\",\"onQ\":\"\",\"onR\":\"\"}  
 type groovyTemplate  
 version 2



# Event Data Enrichment




# Augmented Event Data (Json)

<b>EventData</b>	Data describing current event. Time, IP, etc.
<b>GeoData</b>	Info derived from precise physical location.
<b>DeviceData</b>	All data regarding the event device, including historical observations.
<b>VisitData</b>	List of historical visits by this device.
<b>ScoresData</b>	Thousands of propensity scores from the Dstillery machine learning system.
<b>LinkedData</b>	List of linked devices as well as list of linked visits.
<b>SegmentData</b>	Segments historically stored against device, as well as segments derived from all of the above augmented features.

 Paste JSON here

```
{
  "featureid": 99, "offerlevelid": 28568, "score": -0.28205407,
  "featureid": 100, "offerlevelid": 28568, "score": -0.020146718,
  "featureid": 102, "offerlevelid": 28568, "score": -0.025014956,
  "featureid": 9, "offerlevelid": 100, "score": 58.0,
  "featureid": 10, "offerlevelid": 100, "score": 62.0,
  "featureid": 14, "offerlevelid": 100, "score": 173.0,
  "featureid": 15, "offerlevelid": 100, "score": 2.9827585,
  "featureid": 23, "offerlevelid": 100, "score": 1.0,
  "featureid": 49, "offerlevelid": 100, "score": 5.1532917,
  "sgdattrscount": 1,
  "sgdattrslist": [
    { "featuremapperid": 2, "sparseentriescount": 62, "sparseentrieslist": [
      { "id": 46275894, "value": 1.0 },
      { "id": 46425750, "value": 1.0 },
      { "id": 46392250, "value": 1.0 },
      { "id": 33561858, "value": 1.0 },
      { "id": 48004636, "value": 1.0 },
      { "id": 46366453, "value": 1.0 },
      { "id": 25070000, "value": 1.0 },
      { "id": 46160000, "value": 1.0 },
      { "id": 17001004, "value": 1.0 },
      { "id": 46371004, "value": 1.0 }
    ]
  ]
}
```

Edit your JSON directly in the textarea above. The JSON editor will get updated when you leave the field.

 ... or call a JSONP endpoint



URL:

Example: <http://example.com/info.json?callback=?> # do not forget to put the actual callback name in the field on the left

 JSON editor

Legend: **array** **object** **string** **number** **boolean** **null**

```
{
  "eventattr": {
    "actiontakerinfocount": 0,
    "actiontakerinfolist": []
  },
  "appauditid": "zZJonVgkyYLTgAAABLC"
}
```

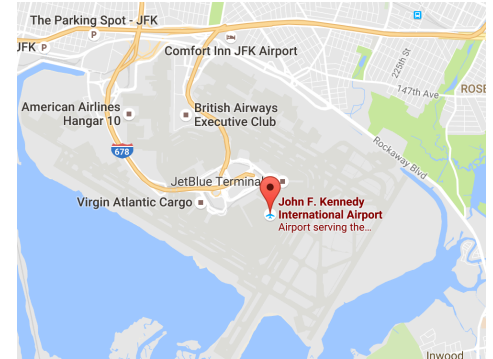
	<b>eventattr</b>	{ "actiontakerinfocount": 0, "actiontakerinfolist": [], "appauditid": "zZJonVgkyYLTgAAABLC" }
	<b>actiontakerinfocount</b>	0
	<b>actiontakerinfolist</b>	[]

Claudia Perlich

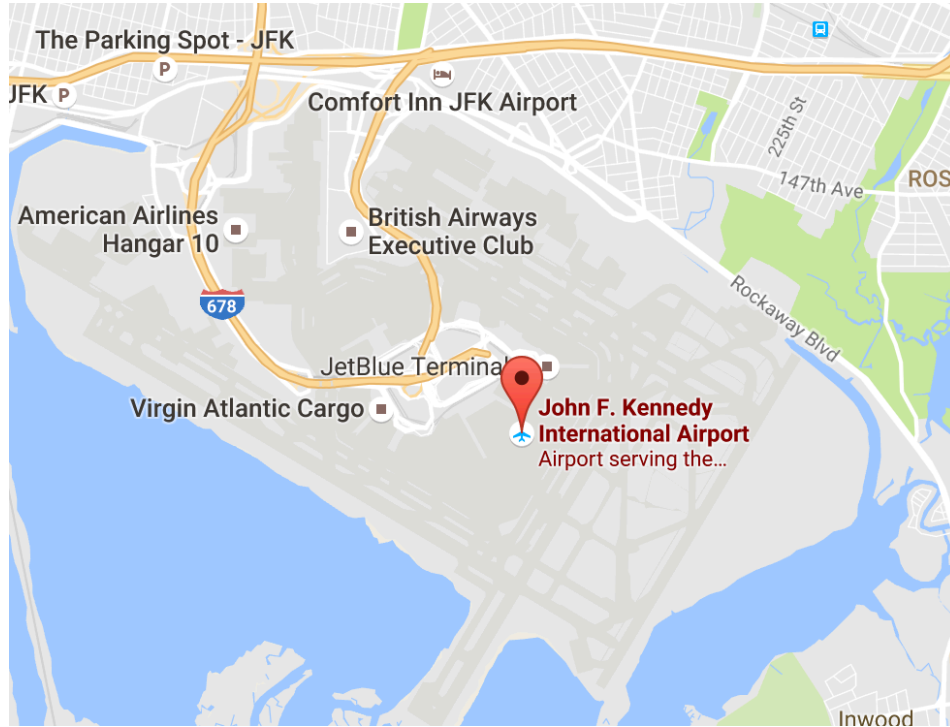
Thank You!

dstillery

# Where do we find frequent traveler?



# What do you think indicates people going to JFK?



## URL

[www.iglesiaelfaroinc.org](http://www.iglesiaelfaroinc.org)  
[www.jumpseatnews.com](http://www.jumpseatnews.com)  
[www.bluelineprop.com](http://www.bluelineprop.com)  
[www.ktxdtv.com](http://www.ktxdtv.com)  
[www.southjefffootball.org](http://www.southjefffootball.org)  
[www.unitedafa.org](http://www.unitedafa.org)  
[www.parliamenthouse.com](http://www.parliamenthouse.com)  
[www.yunghova.com](http://www.yunghova.com)  
[www.interlinetravel.com](http://www.interlinetravel.com)  
[www.aclin.org](http://www.aclin.org)  
[www.swissport.com](http://www.swissport.com)  
[www.gcsanc.com](http://www.gcsanc.com)  
[www.swacu.org](http://www.swacu.org)  
[www.airlinepilotcentral.com](http://www.airlinepilotcentral.com)  
[www.homotrophy.com](http://www.homotrophy.com)  
[www.beggfuneralhome.net](http://www.beggfuneralhome.net)  
[www.tvathletics.org](http://www.tvathletics.org)  
[www.2shopper.com](http://www.2shopper.com)  
[www.nextmagazine.com](http://www.nextmagazine.com)  
[www.dailyjocks.com](http://www.dailyjocks.com)  
[www.pullzone.com](http://www.pullzone.com)  
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[www.myerspolaris.com](http://www.myerspolaris.com)  
[www.ryandeyer.com](http://www.ryandeyer.com)  
[www.okllo.com](http://www.okllo.com)  
[www.ifihadtochoose.com](http://www.ifihadtochoose.com)  
[www.ivoirmixdj.com](http://www.ivoirmixdj.com)

## Logistic Parameter

2.38  
2.25  
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1.86  
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URL	Logistic Parameter
<a href="http://www.iglesiaelfaroinc.org">www.iglesiaelfaroinc.org</a>	2.38
<a href="http://www.jumpseatnews.com">www.jumpseatnews.com</a>	2.25
<a href="http://www.bluelineprop.com">www.bluelineprop.com</a>	2.21
<a href="http://www.ktxdtv.com">www.ktxdtv.com</a>	2.14
<a href="http://www.southjefffootball.org">www.southjefffootball.org</a>	2.1
<a href="http://www.unitedafa.org">www.unitedafa.org</a>	2.09
<a href="http://www.parliamenthouse.com">www.parliamenthouse.com</a>	2.07
<a href="http://www.yunghova.com">www.yunghova.com</a>	2.06
<a href="http://www.interlinetravel.com">www.interlinetravel.com</a>	2.03
<a href="http://www.aclin.org">www.aclin.org</a>	2.03
<a href="http://www.swissport.com">www.swissport.com</a>	2.03
<a href="http://www.gcsanc.com">www.gcsanc.com</a>	2.01
<a href="http://www.swacu.org">www.swacu.org</a>	2.01
<a href="http://www.airlinepilotcentral.com">www.airlinepilotcentral.com</a>	1.97
<a href="http://www.homotrophy.com">www.homotrophy.com</a>	1.97
<a href="http://www.beggfuneralhome.net">www.beggfuneralhome.net</a>	1.94
<a href="http://www.tvathletics.org">www.tvathletics.org</a>	1.92
<a href="http://www.2shopper.com">www.2shopper.com</a>	1.91
<a href="http://www.nextmagazine.com">www.nextmagazine.com</a>	1.91
<a href="http://www.dailyjocks.com">www.dailyjocks.com</a>	1.87
<a href="http://www.pullzone.com">www.pullzone.com</a>	1.87
<a href="http://www.diamondoffshore.com">www.diamondoffshore.com</a>	1.86
<a href="http://www.myerspolaris.com">www.myerspolaris.com</a>	1.86
<a href="http://www.ryandeyer.com">www.ryandeyer.com</a>	1.86
<a href="http://www.okllo.com">www.okllo.com</a>	1.84
<a href="http://www.ifihadtochoose.com">www.ifihadtochoose.com</a>	1.83
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FRIDAY, SEP 16	7:30 PM	FRIDAY, SEP 16	9:30 PM	SATURDAY, SEP 17	11:00 AM	SATURDAY, SEP 17	11:00 AM	SATURDAY, SEP 17	11:00 AM	SATURDAY, SEP 17	11:00 AM
S318	--	S323	--	BC04	--	AL01	--	S320	--	S312	--
WR06	--	S108	--	S305	--	S301	--	BRUINS-TILL	--	EAGLE WHITE-CARLSO	--
WHEAT RIDGE, WR-B PROSPECT P		WESTMINSTER, SL-D WOLF RUN P		LITTLETON, SJ-C EASTON PARK #:		LITTLETON, SJ-A EASTON PARK #:		LITTLETON, SJ-E EASTON PARK #:		LITTLETON, SJ-F EASTON PARK #:	

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- Raw Fish or Cooked Fish?
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- Books
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**College Football or NFL Football?**  
By The Serpent - Monday, September 14, 2009

OR

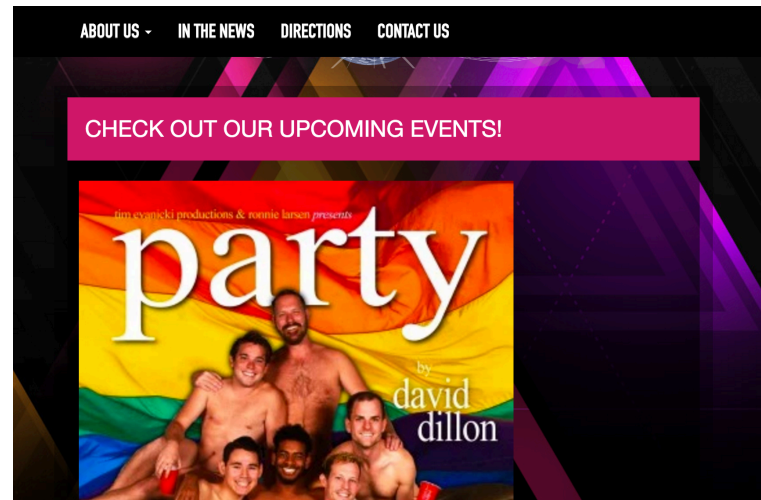
College Football  
 NFL Football

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♥ HOMOTROPHY

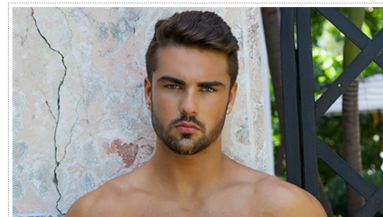
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Predict who is a traveler?



People who work at  
JFK ...

