

Predictability and other Predicament

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dstillery

How 'predictable' is a predictive modeling task? (given the data)

Pizza for
Dinner?



Sexual
Orientation



Random

Deterministic

For now let's try to predict who is male ...



Predicting Probability (Male) in Facebook

```
00000d41ed774823fca142945ec915c0,1,,,,,,,,,en_GB,,
00000dee02d70cf8c0d79f96b6d1c59d,0,,,,,,,,,en_US,,
00000f232abfe25a80156fe069395460,0,1992,20,2,2,,,,,,,,,19,-5
00000f4ba0cff946b1c0e3b051287ede,0,1993,19,2,,,,,,,,,en_US,310,8
0000130571654e3afaa62f4e9d2e4f63,0,,,,,2,2,,,,,,,,,en_US,193,7
00001544469ae9b408869a463a1dd77a,1,1984,28,2,,,,,,,,,en_US,, -4
```

40% Men

Data:

Facebook public dataset with 200K
anonymized users, their
demographics and their likes

Methodology:

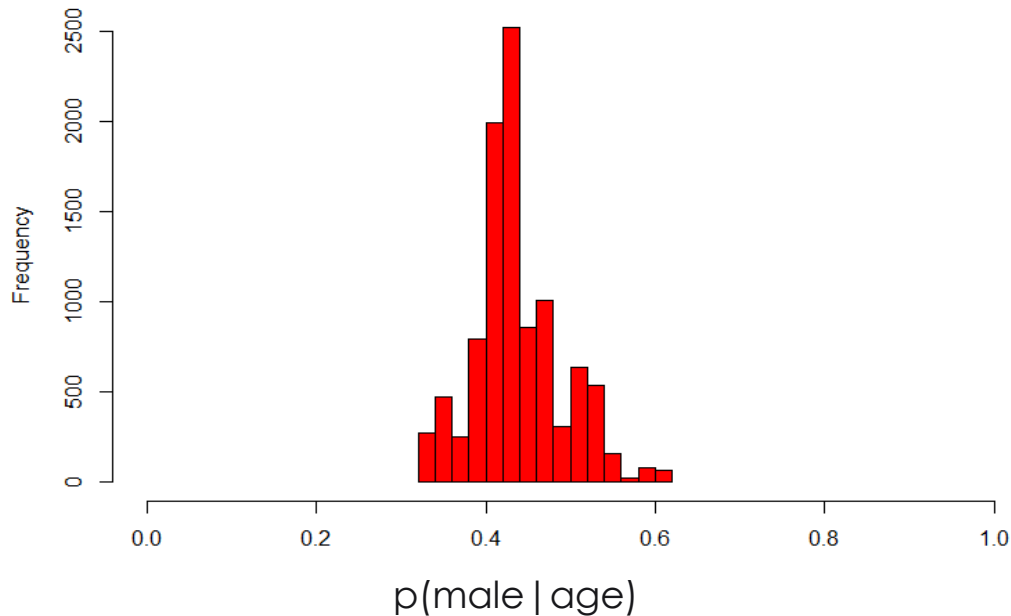
Logistic regression on sparse
representation

```
00001544469ae9b408869a463a1dd77a 100198443380917
00001544469ae9b408869a463a1dd77a 100248613695
00001544469ae9b408869a463a1dd77a 10050726267
00001544469ae9b408869a463a1dd77a 101021248409
00001544469ae9b408869a463a1dd77a 101054236602446
00001544469ae9b408869a463a1dd77a 101425333232551
00001544469ae9b408869a463a1dd77a 10148199466
00001544469ae9b408869a463a1dd77a 10150154095435553
00001544469ae9b408869a463a1dd77a 10161539667
00001544469ae9b408869a463a1dd77a 101844593108
00001544469ae9b408869a463a1dd77a 101936079845392
00001544469ae9b408869a463a1dd77a 101987301816
00001544469ae9b408869a463a1dd77a 102038567018
00001544469ae9b408869a463a1dd77a 102040023230884
00001544469ae9b408869a463a1dd77a 10212595263
00001544469ae9b408869a463a1dd77a 102168219824412
00001544469ae9b408869a463a1dd77a 1022548733
```

Take 1: Predict Gender Based on age ...



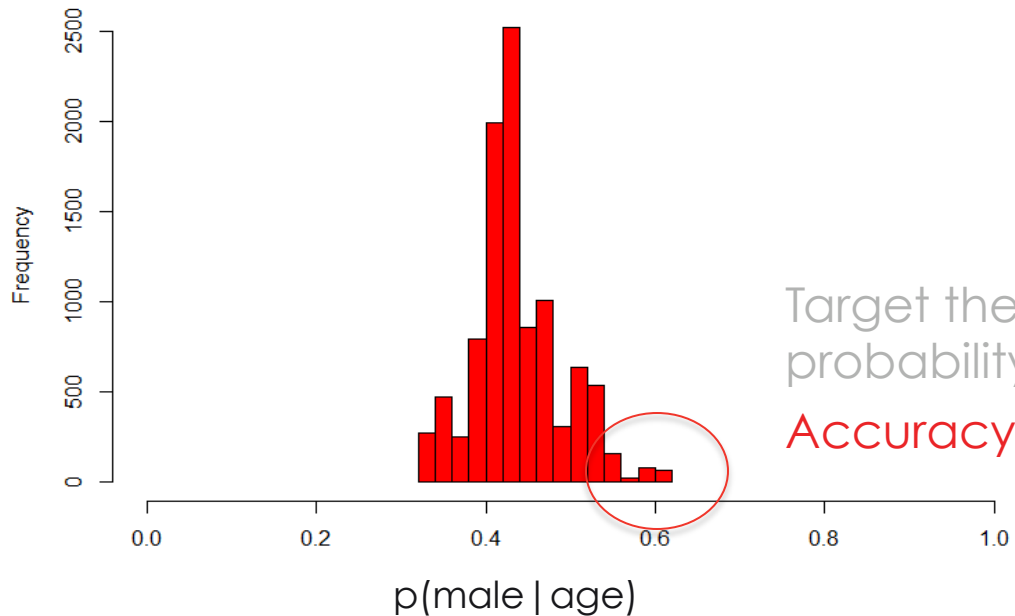
Gender based on age: very little signal ...



Overall Accuracy: 60%

AUC: 58%

Gender based on age: very little signal ...

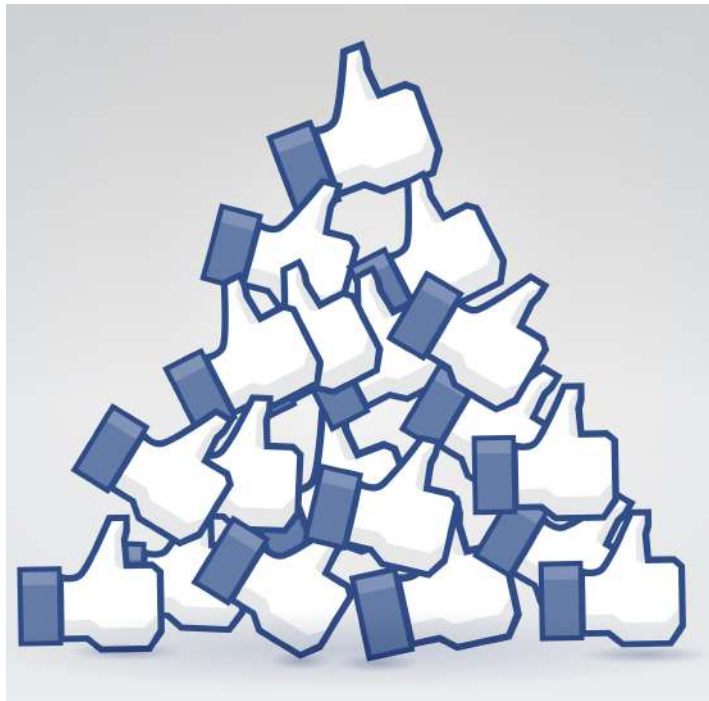


Overall Accuracy: 60%

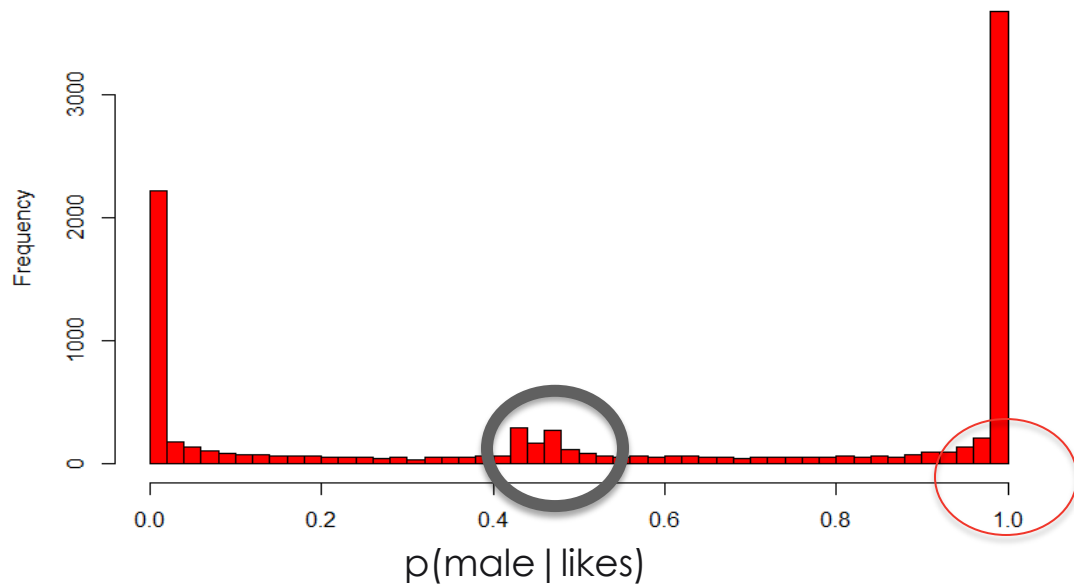
From small to bigger data ...



Take 2: Gender based all your likes



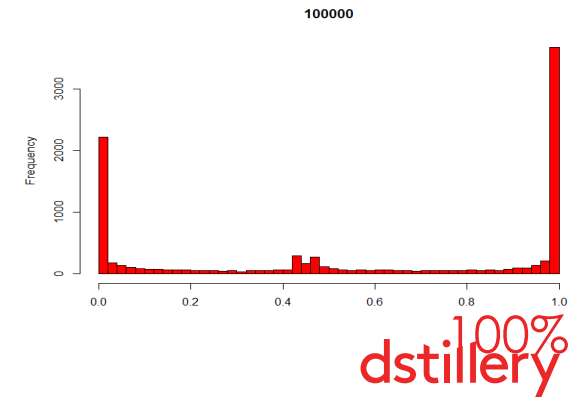
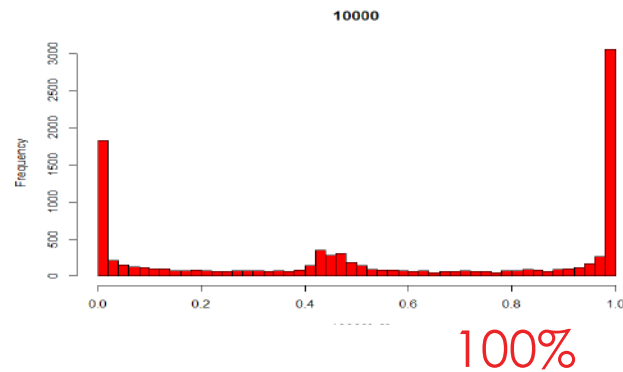
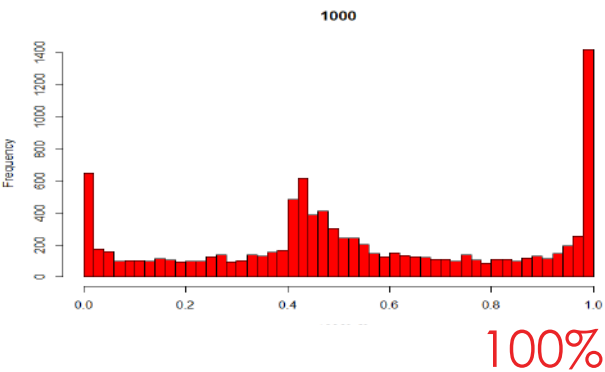
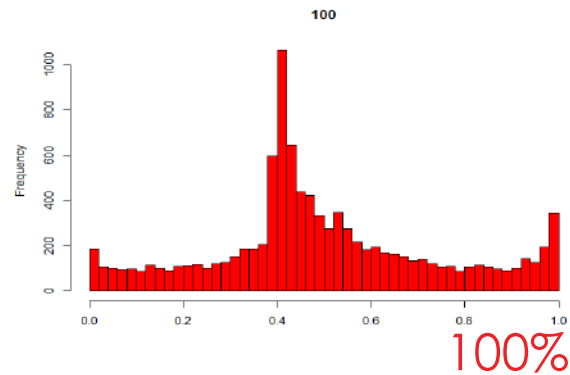
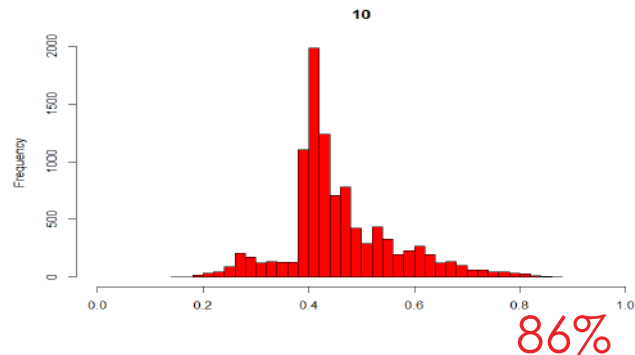
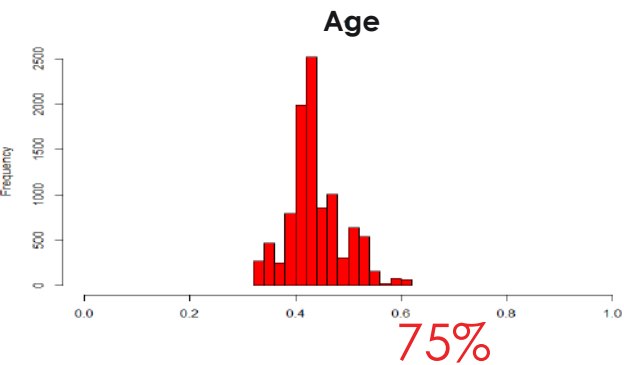
Predict gender base on all likes: a lot of signal ...



Target top 1%
Accuracy: 100%

Overall Accuracy: 83%

Progression: from age to all 'likes'



But what happens if your problem is a mixture of both?



Random

Deterministic

Programmatic Advertising

The screenshot shows the New York Times homepage from July 17, 2012. Several programmatic advertisements are highlighted with red boxes:

- Top Left:** A small ad for "THE ALL-NEW CADILLAC XTS" with the Cadillac logo.
- Top Right:** A car image ad for "THE ALL-NEW CADILLAC XTS".
- Search Bar:** An "ING DIRECT" sponsored search bar.
- Bottom Right:** A large video ad for "INTRODUCING THE ALL-NEW CADILLAC XTS" with a "CLICK FOR SOUND" button and a "LEARN MORE" link.

The main content area includes articles such as "Fiscal Crisis in States Will Last Beyond Slump, Report Warns" and "Mormons' First Families Rally Behind Romney". The "TimesCast" section features a video player for "TimesCast Politics: Running Mate Speculation".

Predicting digital events based on browsing histories



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
# Positive	217
# Negatives	2,170
# Features	362,059
Parent Model	1723531
HDFS Path	hdfs://hdfs2/user/sgd/models/19945/OL19945_FM2_BS20160306123636.model

Logistic Regression
Stochastic gradient descent
Hashing
Streaming
L1 & L2 Penalties

Top Features with Highest Scores

Show 10 entries

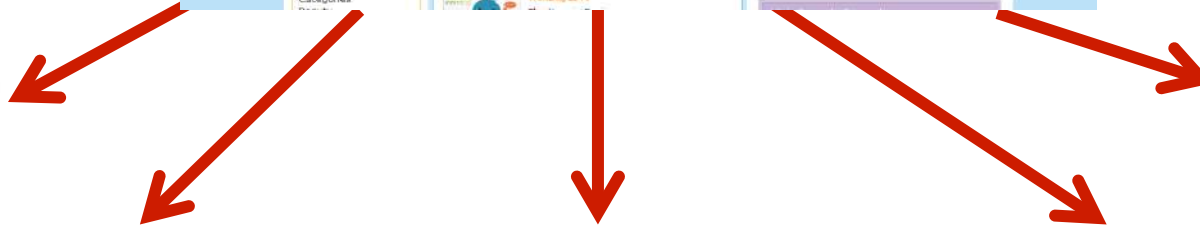
Search:

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

Witness a spike in human predictability ..



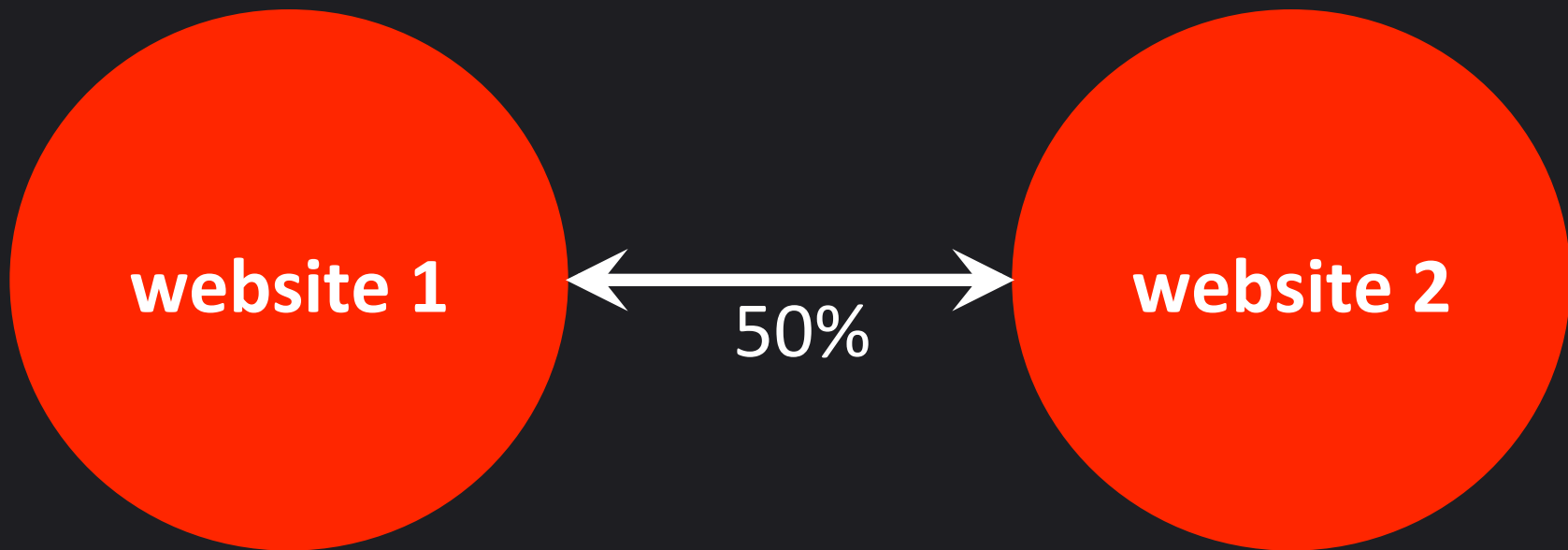
Death of
free will?



URL's that are very predictive for more than 10 brands

www.womenshealthbase.com
www.filmannex.com
www.ffog.net
www.drugsnews.org
www.menshealthbase.com
www.dailyfreshies.com
www.hark.com
www.gossipcenter.com
www.articletrunk.com
www.411answers.com
www.dailyrx.com
www.all-allergies.com
www.knowvehicles.com
www.chinaflix.com
www.parentingnewsstories.com
www.wrestlingnewz.com
www.gourmandia.com

Traffic overlap of cookies from Bid Request



What website am I?

Web Site	Percent Common Users
www.youtube.com	55%
www.weather.com	28%
www.foxnews.com	23%
www.imdb.com	22%
www.ehow.com	22%
www.latimes.com	20%
www.washingtonpost.com	19%
wiki.answers.com	18%
abcnews.go.com	18%
www.forbes.com	17%
www.dailymail.co.uk	14%
www.examiner.com	13%
premiumweathersite1.com	11%
www.politico.com	11%
www.nydailynews.com	11%
www.usatoday.com	11%
www.slate.com	10%
content.usatoday.com	10%
www.nypost.com	9%
www.npr.org	9%

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Supreme Court Faces Crucial Rulings in Coming Term

By ADAM LIPTAK 12:29 PM ET

The justices, starting on Monday, are expected to take up same-sex marriage, the Voting Rights Act of 1965 and affirmative action in higher education.

Kurds to Pursue More Autonomy if Syrian Regime Falls

By TIM ARANGO

Some in the long divided and oppressed ethnic group are

ARTHUR OCHS SULZBERGER, 1926 - 2012

OPINION »

EDITORIAL APPRECIATION
A Publisher and Projectionist

A personal reminiscence of Arthur Ochs Sulzberger, the man who led The New York Times for 34 years.

BUSINESS DAY »

COMMON SENSE
Are You Better Off? That Depends on Who You Are

The people who should be most receptive to Mitt Romney's message are less likely to vote for him.

Blow: 40 Days of Night
Nocera: College Rankings
Editorial: Overhaul Special Education
Glanville: Team as Family
Op-Ed: The N.F.L. Lockout and the Modern Economy

No platform fees.
Trade free for 60 days.

SPORTS »

What website am I?

Web Site	Percent Common Users
www.filmannex.com	96%
www.ffog.net	93%
www.drugsnews.org	93%
menshealthbase.com	89%
www.womenshealthbase.com	85%
www.hark.com	85%
womenshealthbase.com	81%
www.articletrunk.com	81%
411answers.com	78%
www.dailyrx.com	74%
www.all-allergies.com	70%
knowvehicles.com	67%
modernbaby.com	63%
parentingnewsstories.com	59%
www.thefutoncritic.com	59%
www.gourmandia.com	59%
www.gossipcenter.com	59%
dailyfreshies.com	56%
www.greeting-cards.com	56%

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HIPHOPHAVOC TOP STORY



LIL WAYNE BREAKS ELVIS PRESLEY'S BILLBOARD RECORD

LOS ANGELES (Reuters) - Lil Wayne toppled Elvis Presley to become the new King of the Billboard Hot 100 singles chart on Thursday, with a

TOP NEW EXCLUSIVES

DJ Drama ft Fabolous, T Pain, Yo Gotti - [Go In Down](#)
Belly ft Juicy J - [1200](#)
J Cole ft Major Lazer - [Get Free ColeWorld](#)
J.Ford ft Peedi Crakk - [Favorite](#)
Mistah FAB ft Willie Joe - [Automatic](#)

[See All Exclusives](#)

HIPHOPHAVOC E-MAIL

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Password:

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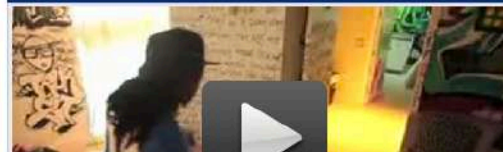
SEARCH SITE CONTENT

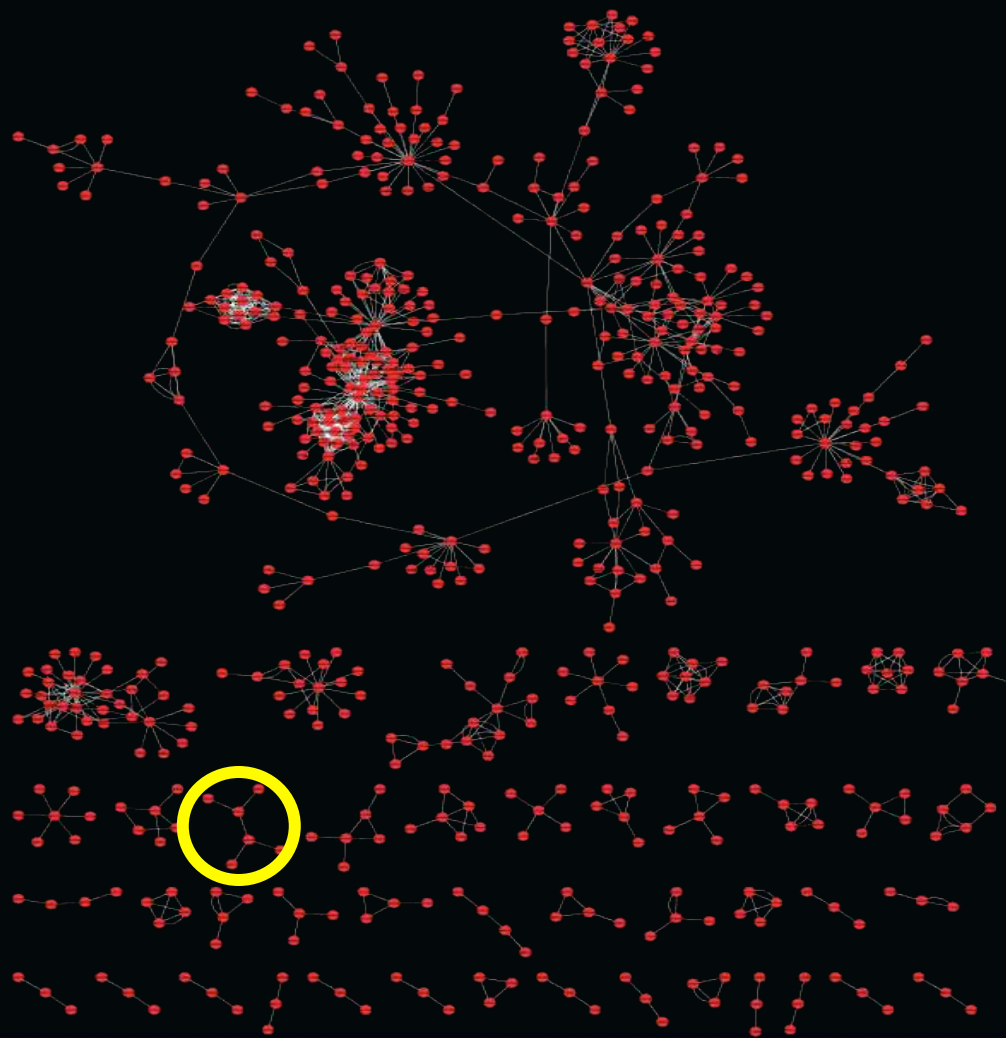
UNDERGROUND HITZ

Roc Marciano - [I Shot The King\(Prod by Roc Marciano\)](#)
Mikkey Haisted ft Twista - [Get Low\(Prod. By The Legendary Traxster\)](#)
Mistah F.A.B. - [Swimming Pools](#)
Chino XL ft. Sick Jacken, Immortal Technique, DV Alias Krisi - [Arm Yourself](#)
Graff - [Bands A Make Her Dance\(G Mix\)](#)

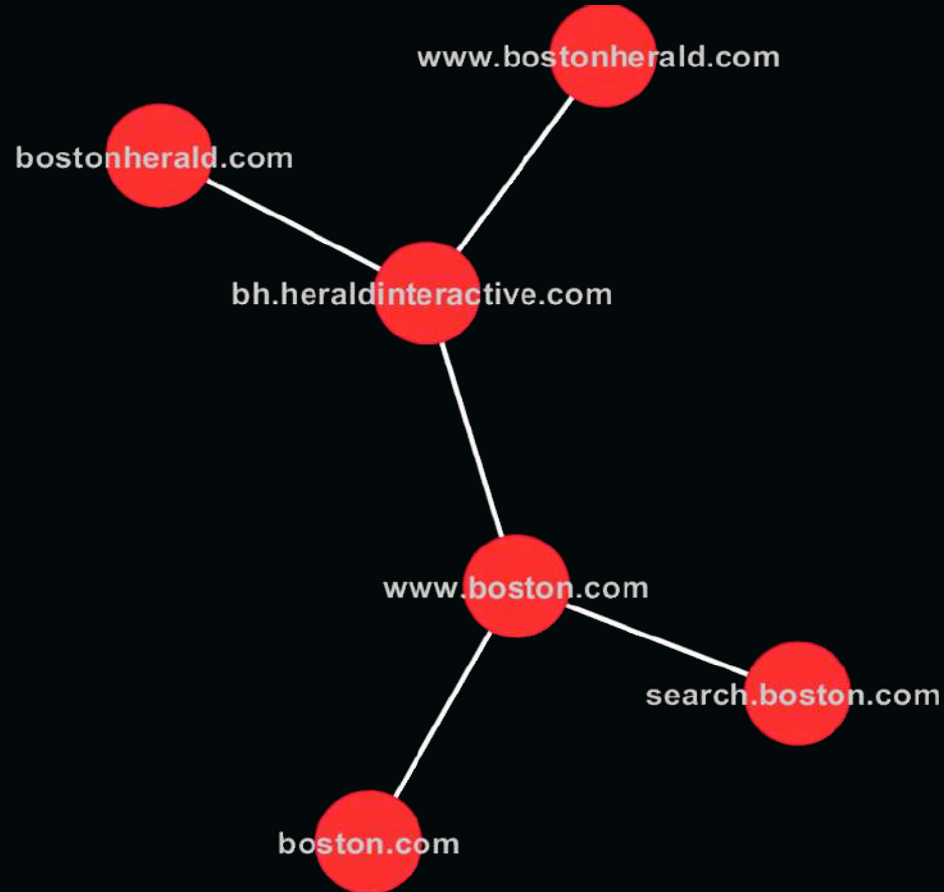
[See All UG Hitz](#)

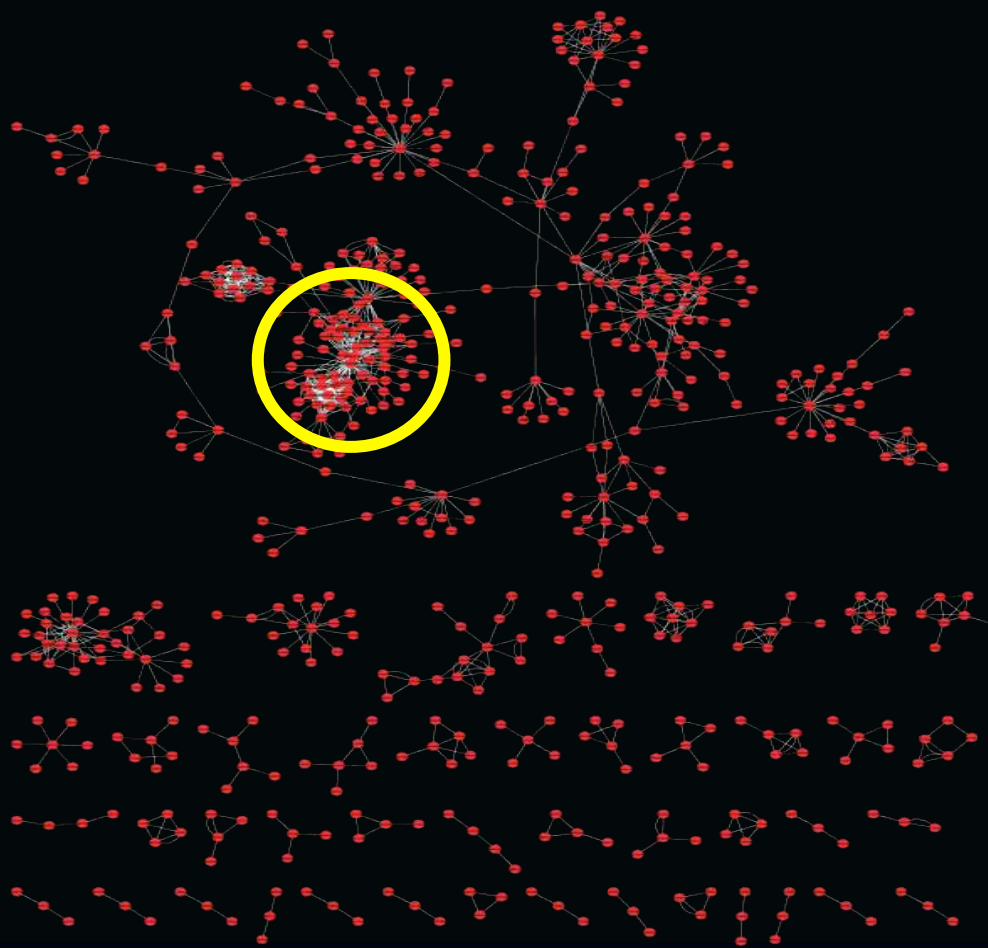
LIL WAYNE-SAME DAMN TUNE(DIRECTED BY DJ SCOOB DOO)

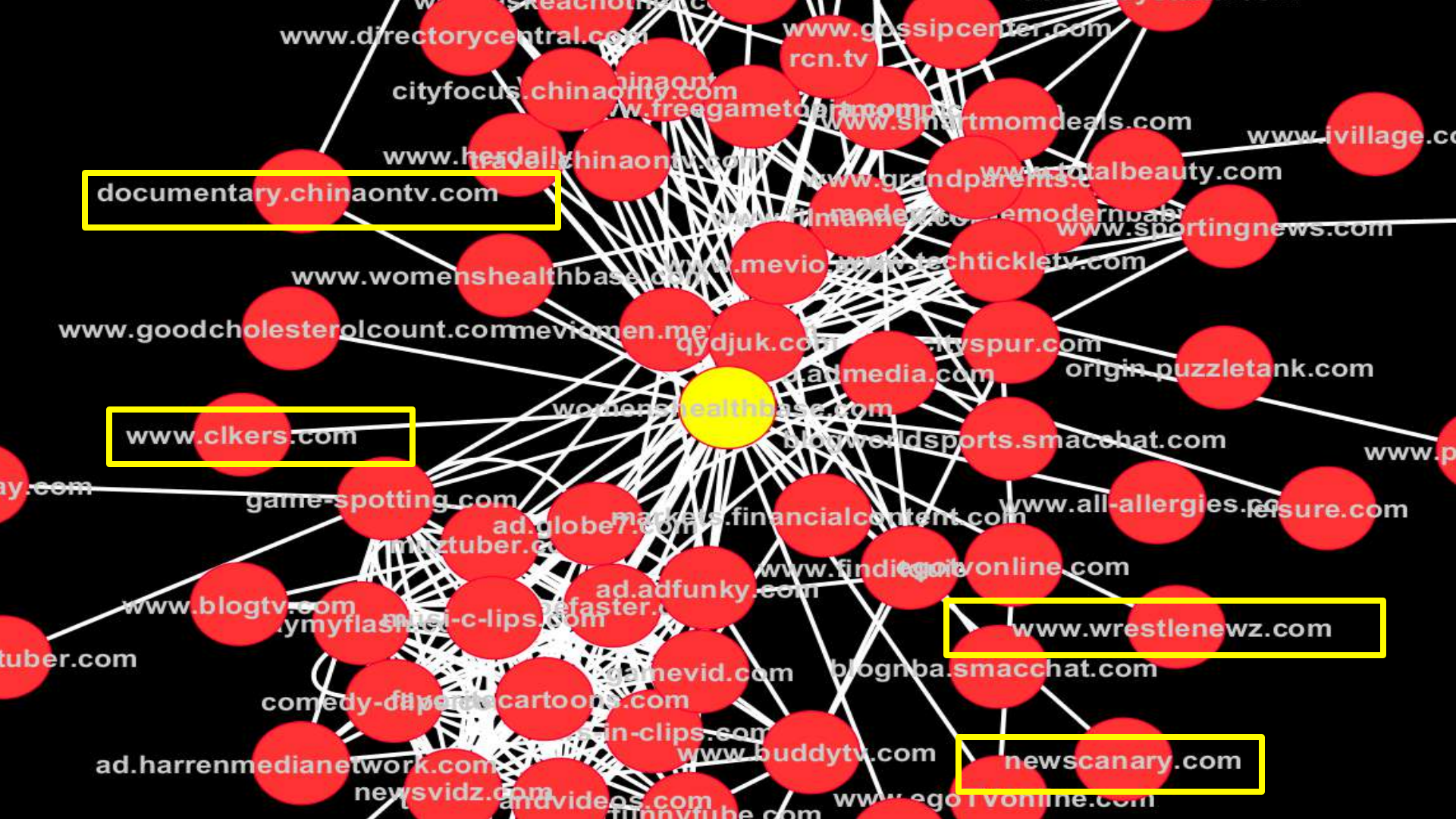


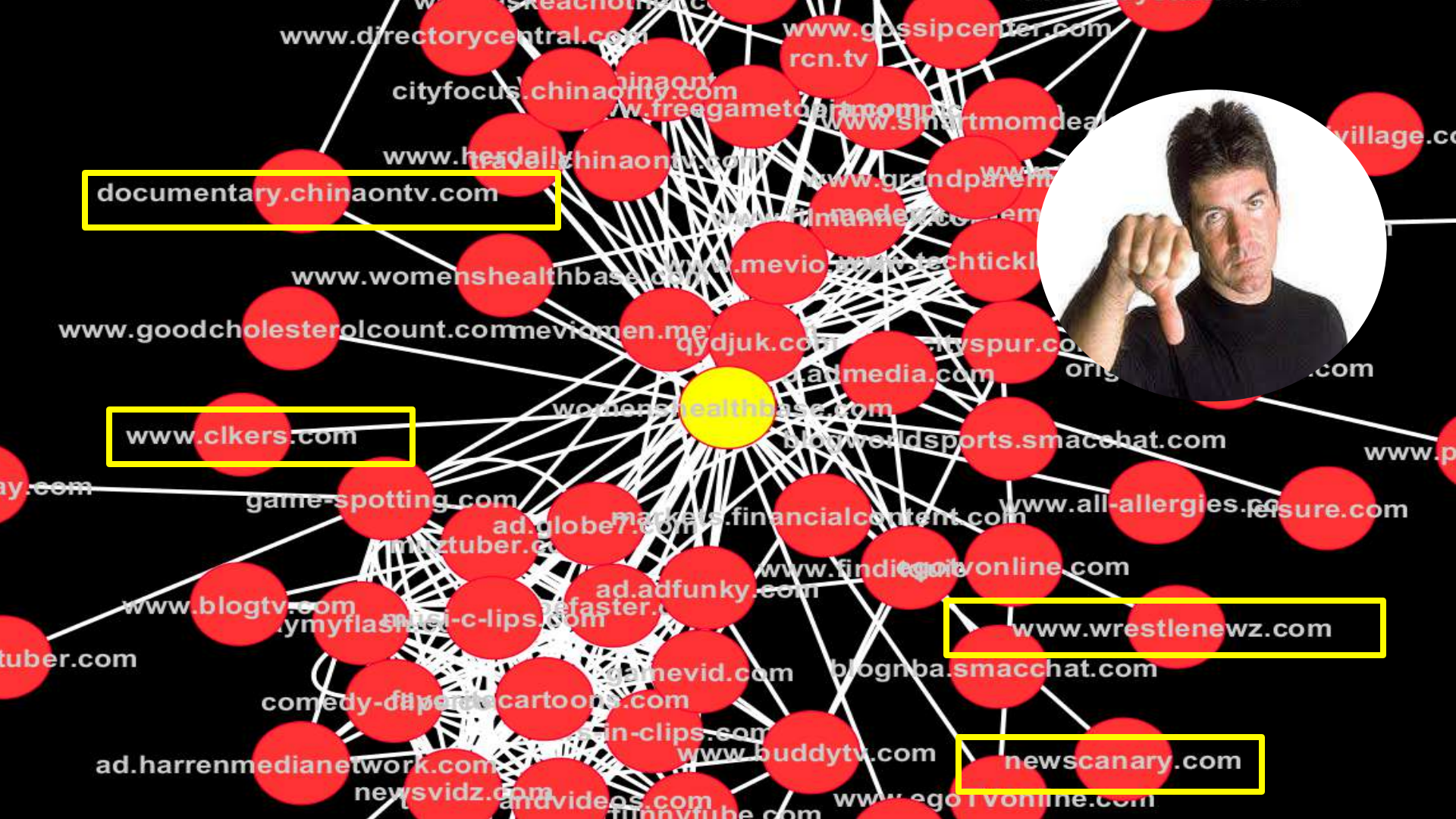


Boston Herald





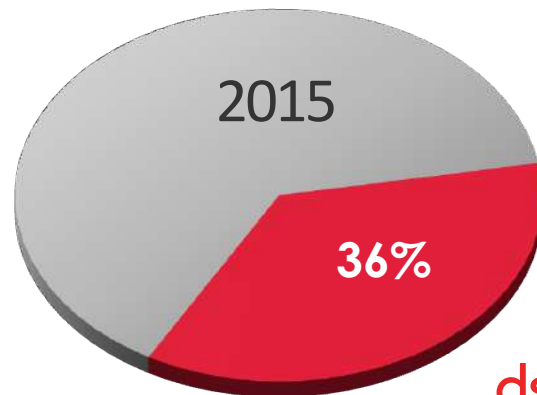
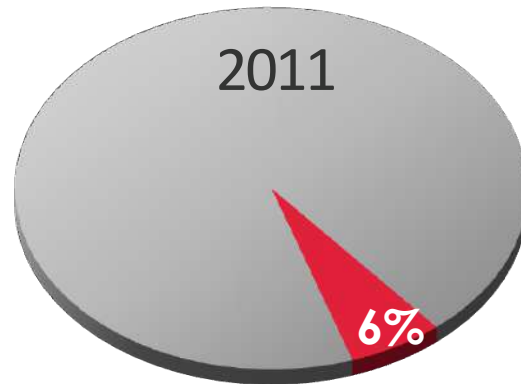




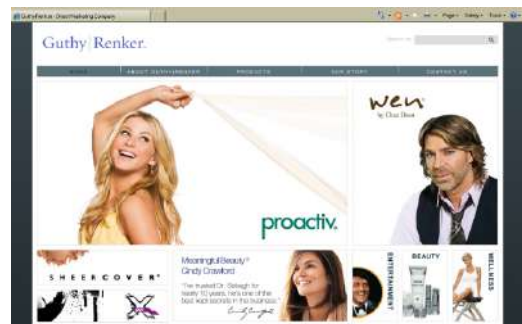
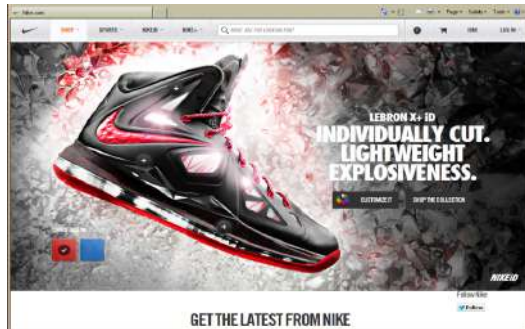
Witness a spike in predictability ..



Meet 'Non-Human traffic'

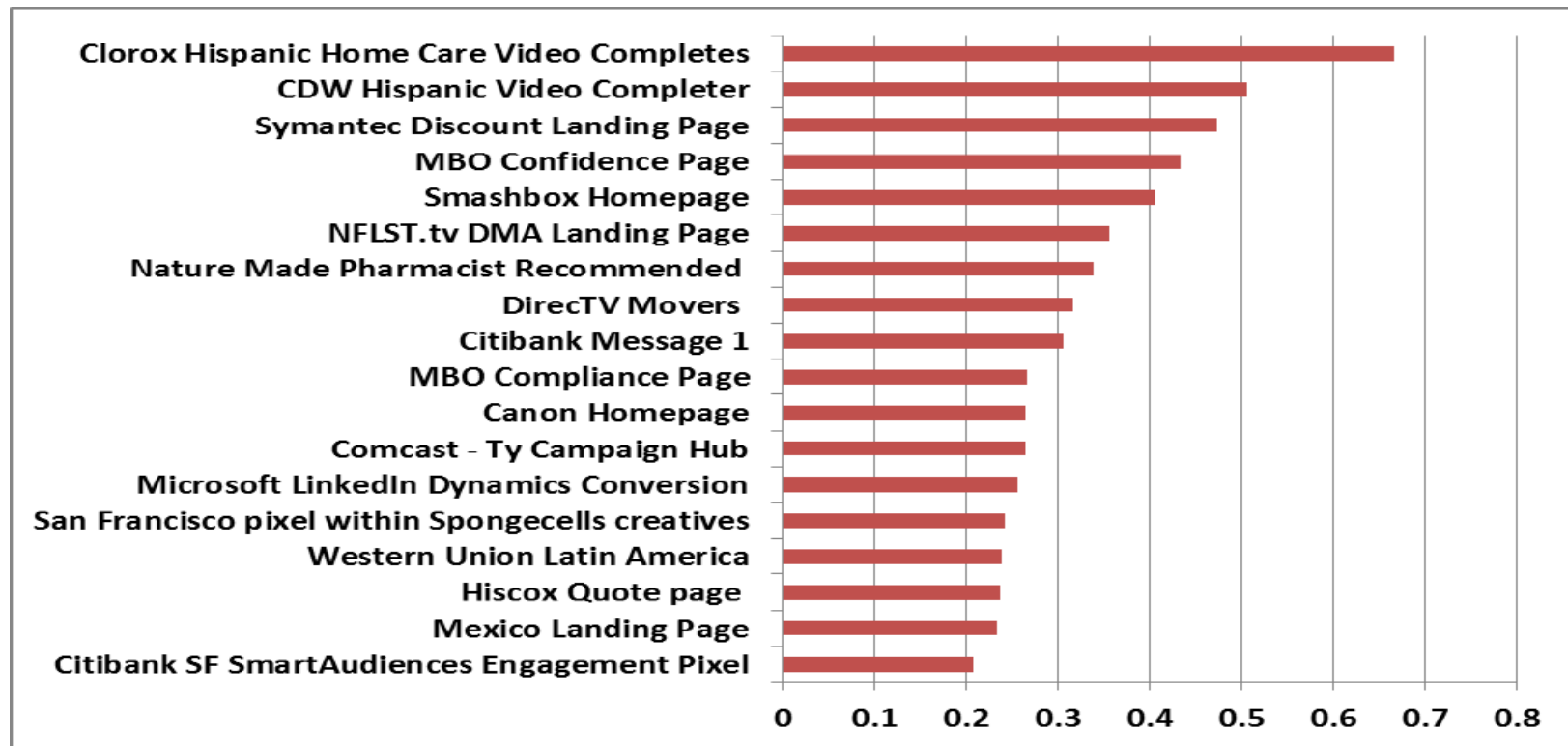


Bots are executing conversion events

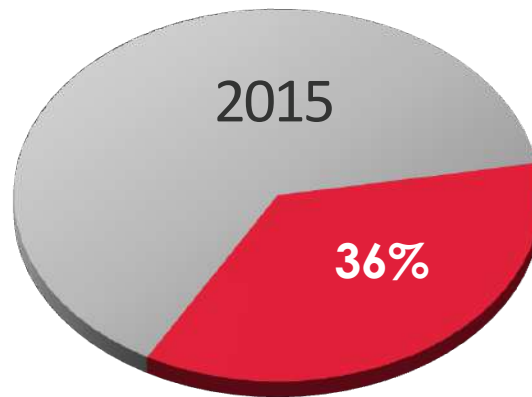


- 'Cookie Stuffing' increases the value of the ad for retargeting
- Messing up Web analytics ...
- Messes up my models because a bot is easier to predict than a human

Percent bot traffic on conversion metrics



Two populations surfing the we: Bot vs. Human

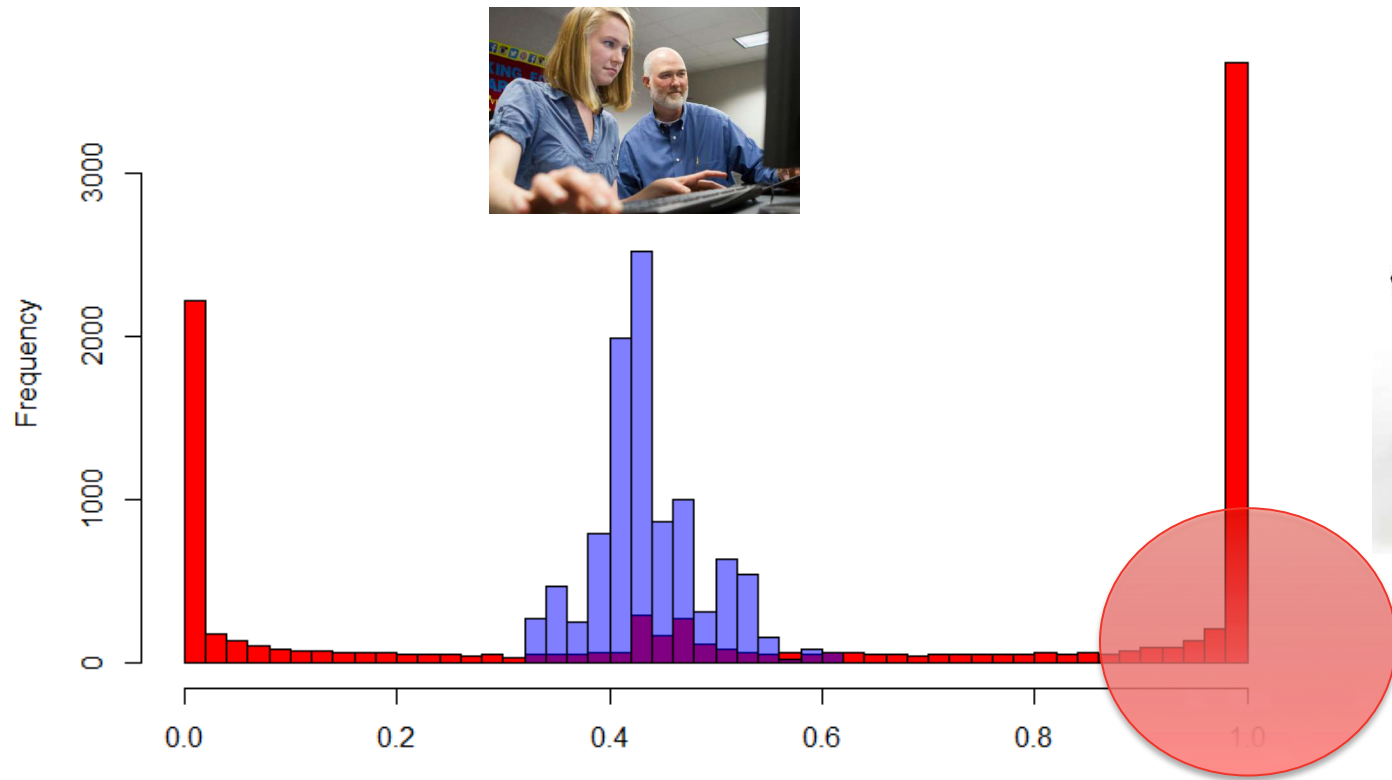




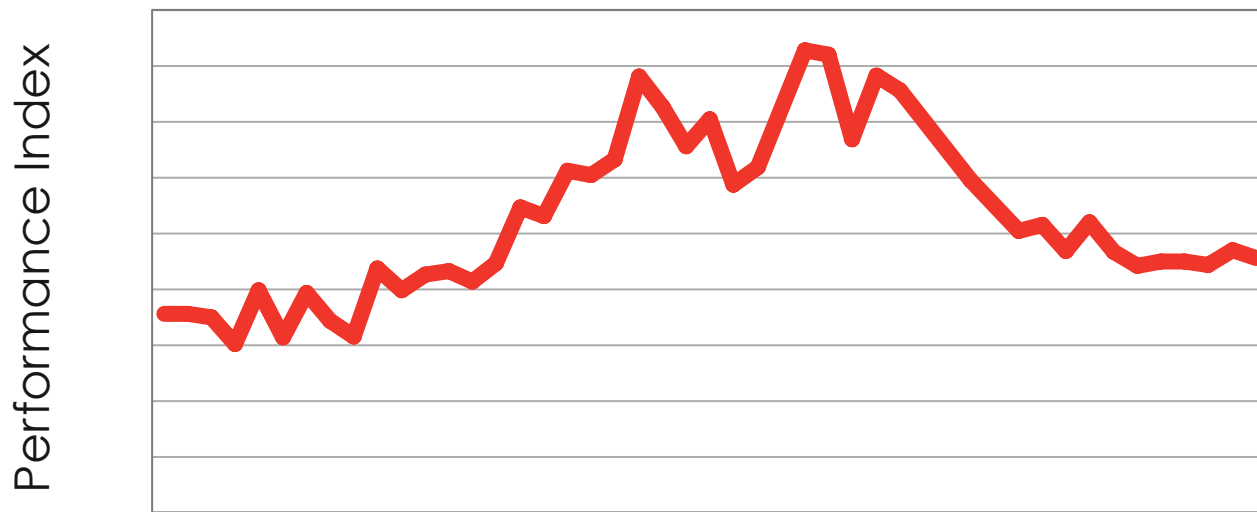
Random

Deterministic

Bot activity has more signal – higher predictions



Eliminate labels generated by bots



3 more weeks in spring 2012

What about Clicks?

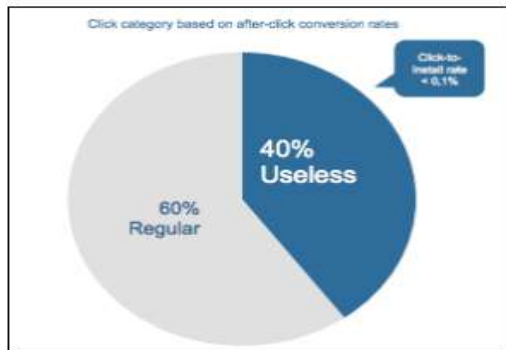
“Measure of consumers interest in the product”



Report: 40% Of Clicks On Mobile Ads Are Fraudulent Or Accidental

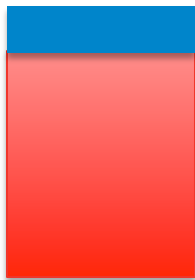
Pamela Parker on September 5, 2012 at 5:42 pm

Mobile advertising may still be in its infancy, but if [a new study](#) by Trademob is correct, click fraud on mobile ads is already quite well developed. The mobile app marketing company conducted research that showed that 40% of mobile ad clicks are either accidental or fraudulent.



Old days of the Click Metric ...

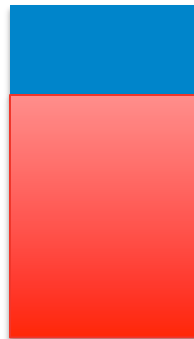
Strategy 1:
target women



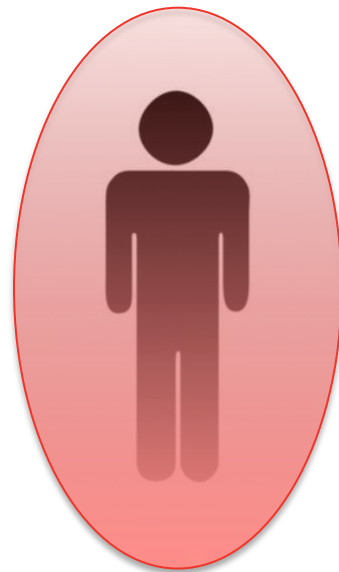
intentional

<

accidental

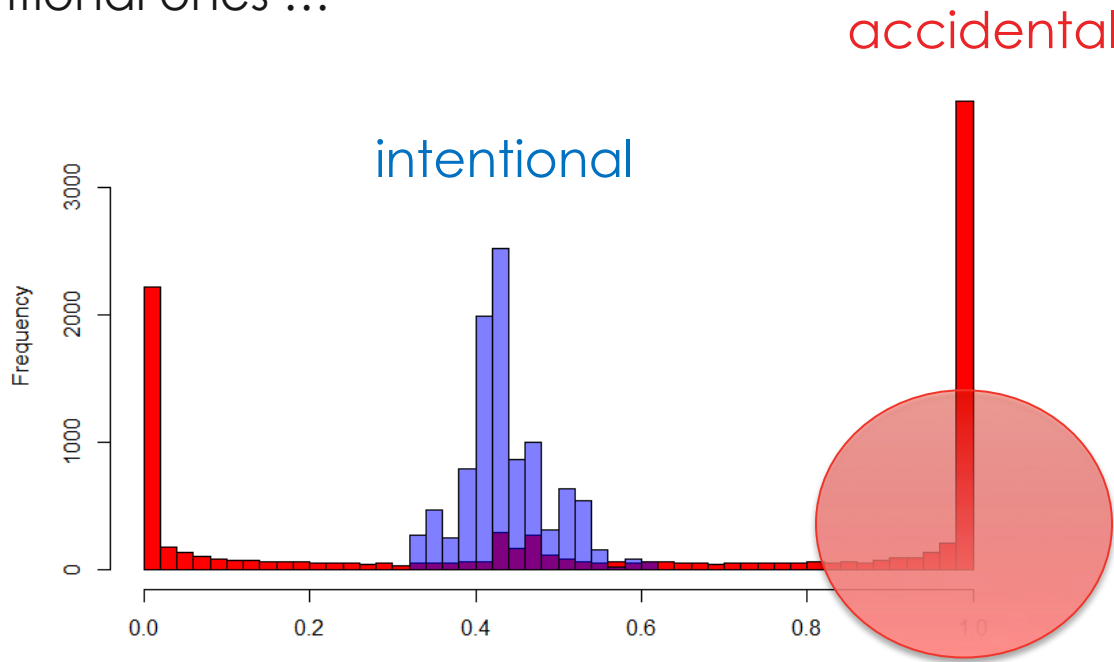


Strategy 2:
target men



Accidental clicks are more predictable than intentional

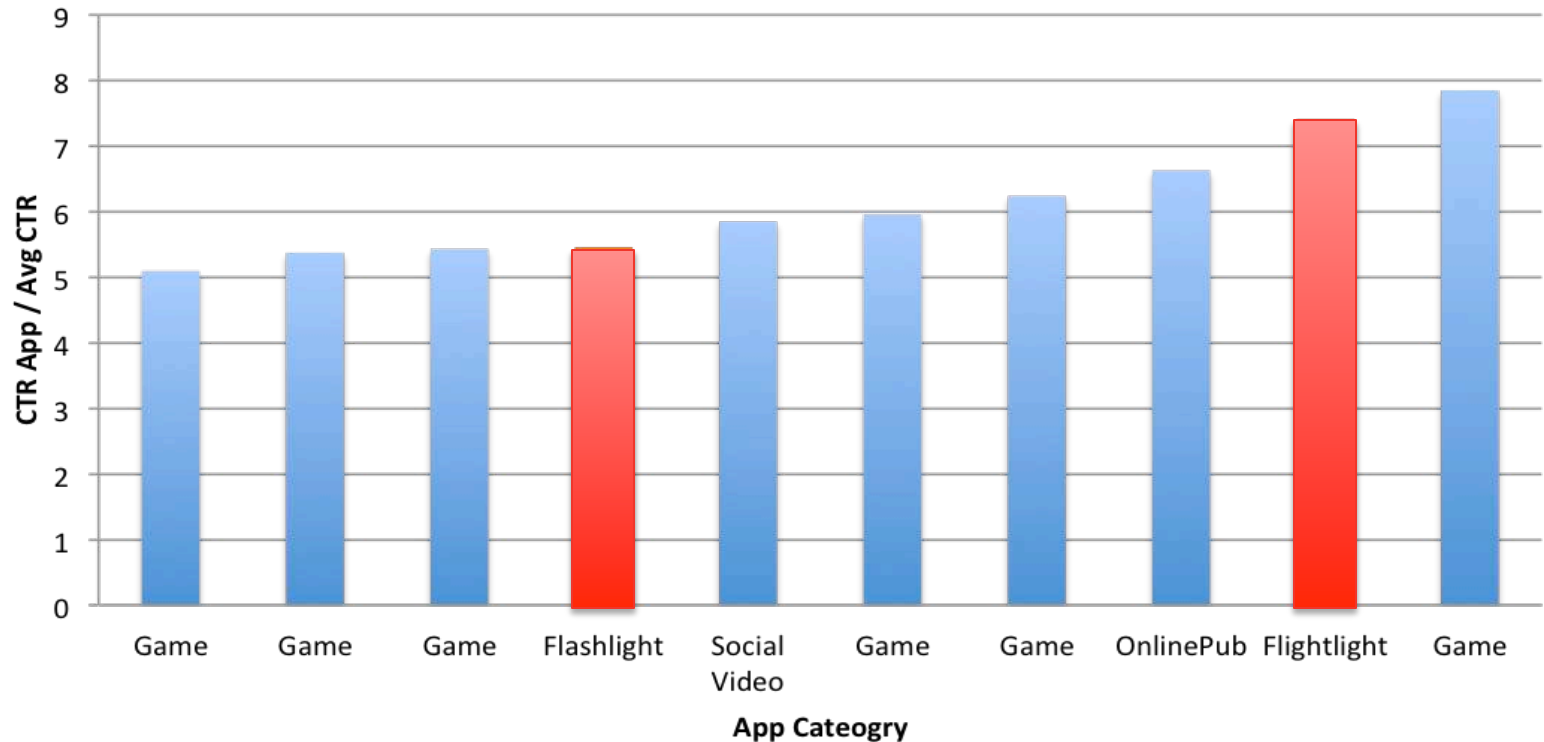
Model learns to predict the accidental much more easily than the intentional ones ...



I will only target clicks that are likely to happen accidentally but not randomly ...

Accidents: People fumbling in the dark ...

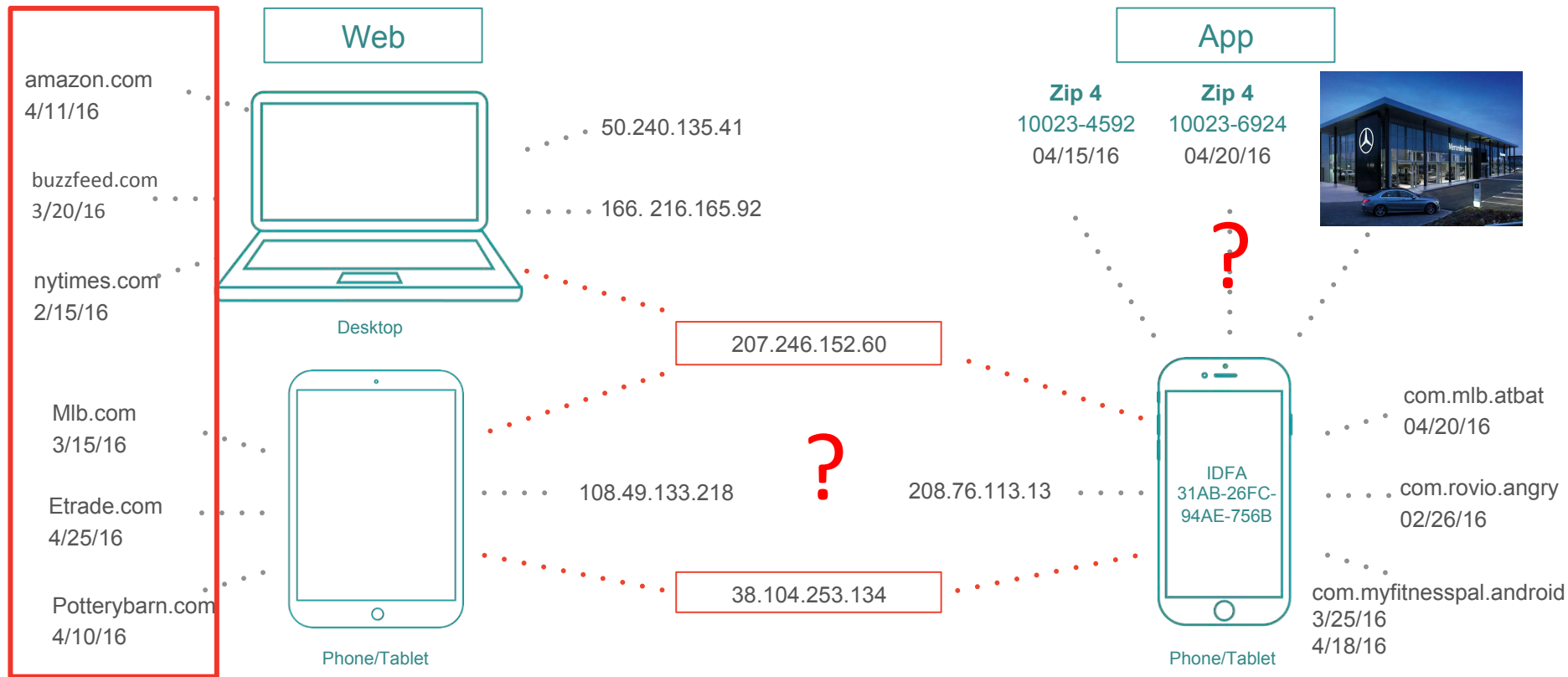
Top 10 Apps by CTR



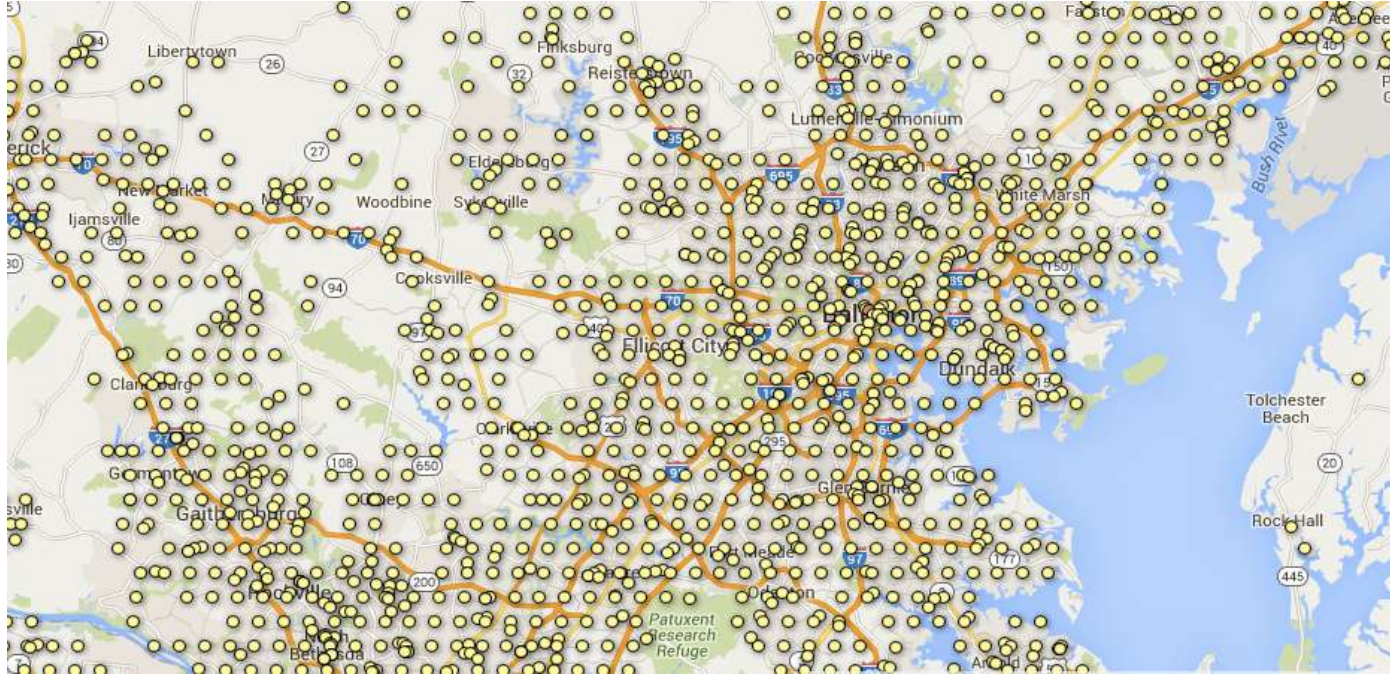
Predict something that cannot be faked?
Who will visit a dealership ?



My actual data: 100 Billion daily events across devices ...



Location (in)accuracy



‘Superman effect’

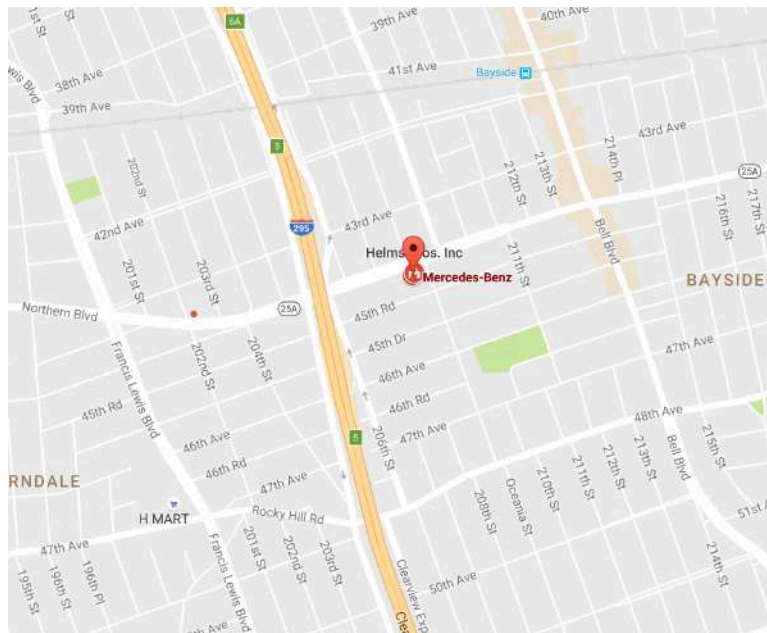


30% smart phone
users travel faster
than speed of sound
(every day ...)

‘People Piles’



Potentially three populations in the location prediction



- People who are indeed at dealership and their history
- People who are somewhere close
- People who hacked into your WIFI

Identify people who will go to Mercedes dealerships



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

'In the market' signal



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

Real Estate



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

Fitness ...



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

How much randomness can a model absorb?

We will randomly switch the gender value for increasing percentages

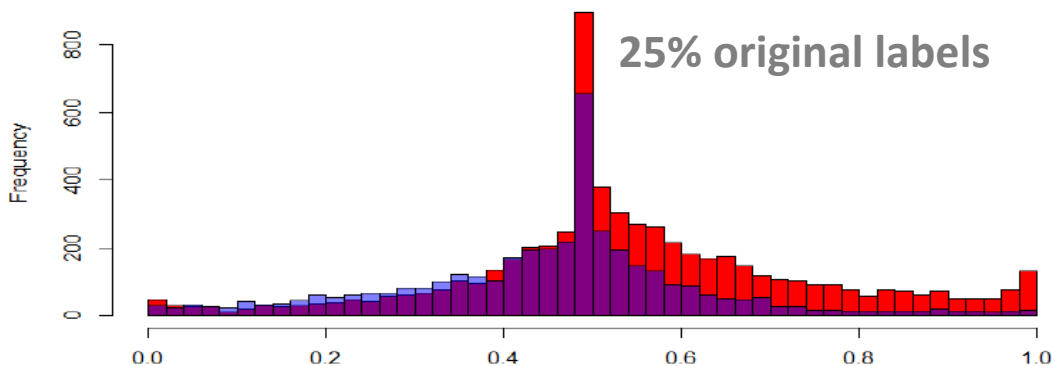
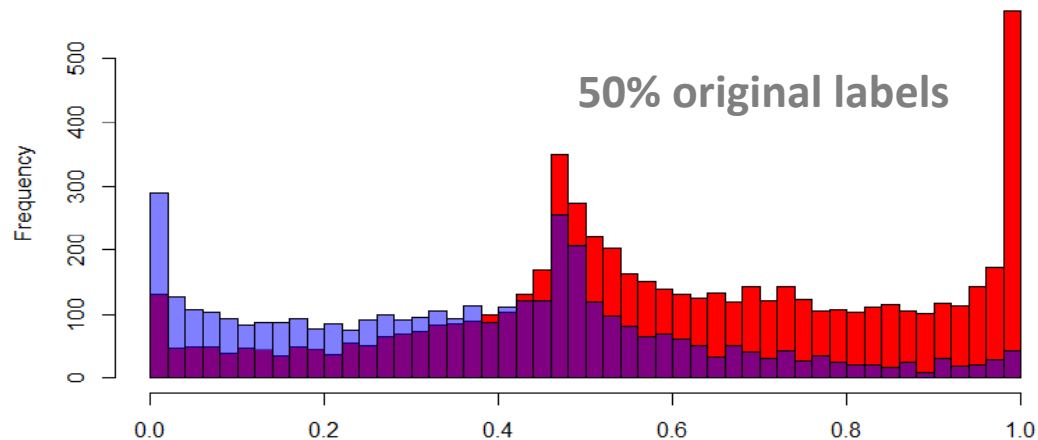
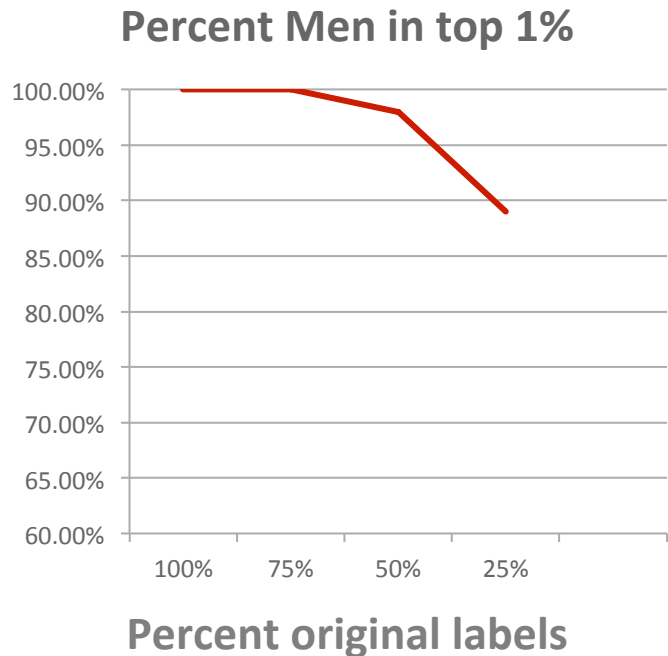
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Performance is surprisingly stable even under random noise

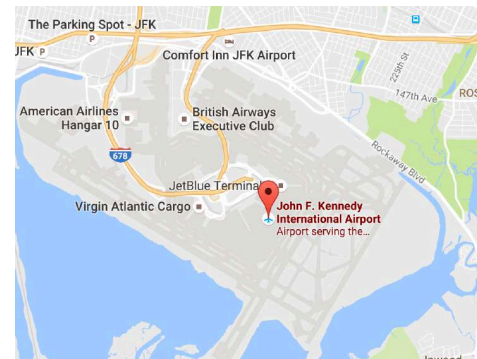


Identify people who will go to Mercedes dealerships?

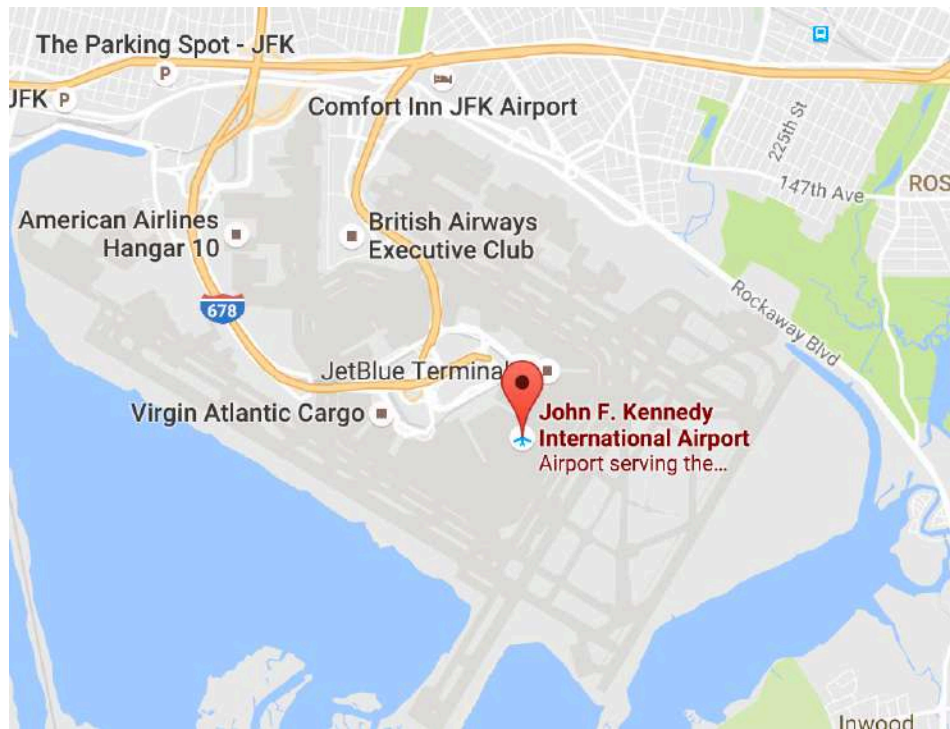


My predictions might be better
than my 'ground truth'

Where do we find frequent traveler?



What do you think indicates people going to JFK?



URL

Logistic Parameter

www.iglesiaelfaroinc.org	2.38
www.jumpseatnews.com	2.25
www.bluelineprop.com	2.21
www.ktxdtv.com	2.14
www.southjefffootball.org	2.1
www.unitedafa.org	2.09
www.parliamenthouse.com	2.07
www.yunghova.com	2.06
www.interlinetravel.com	2.03
www.aclin.org	2.03
www.swissport.com	2.03
www.gcsanc.com	2.01
www.swacu.org	2.01
www.airlinepilotcentral.com	1.97
www.homotrophy.com	1.97
www.beggfuneralhome.net	1.94
www.tvathletics.org	1.92
www.2shopper.com	1.91
www.nextmagazine.com	1.91
www.dailyjocks.com	1.87
www.pullzone.com	1.87
www.diamondoffshore.com	1.86
www.myerspolaris.com	1.86
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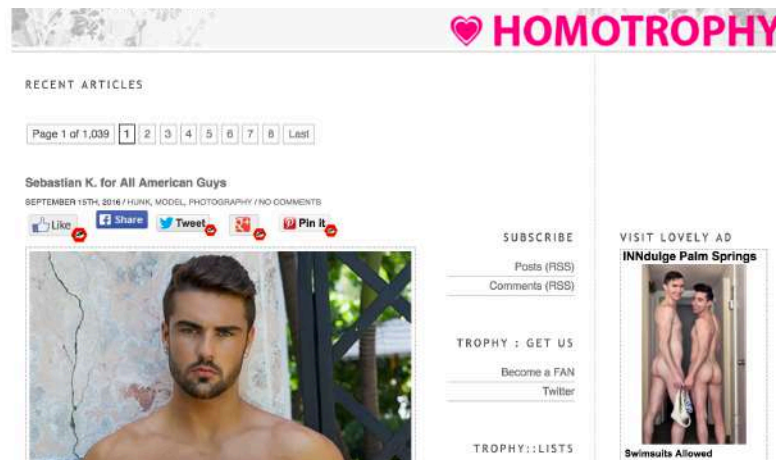
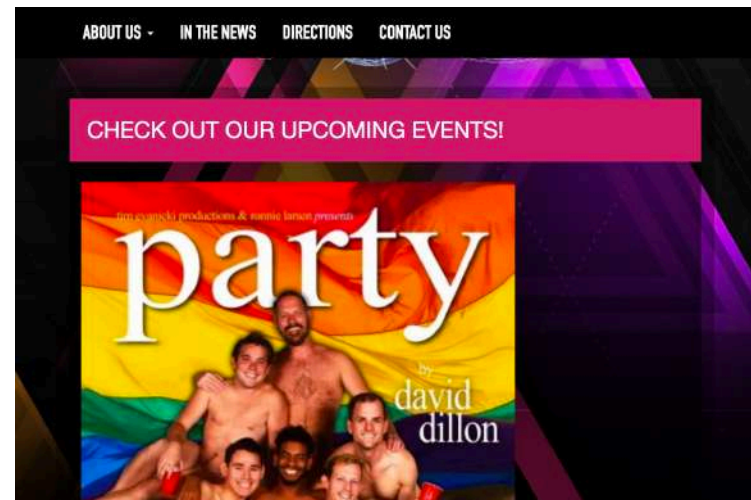


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Predict who goes to JFK?



People who
work there ...



Random

Deterministic

Predict who goes to JFK?



People who
work there ...



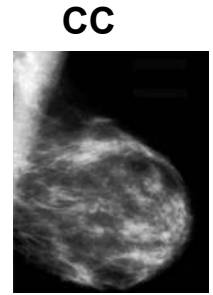
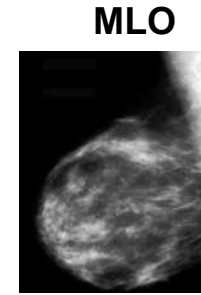
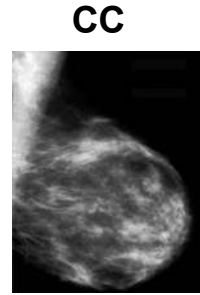
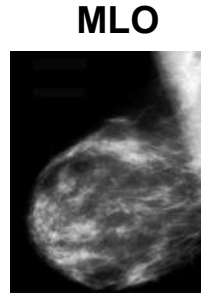
Random

Deterministic

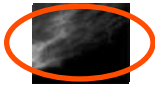
Siemens: Breast Cancer Detection in Mammograms



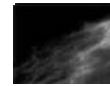
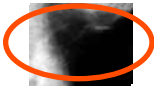
1712 Patients



6816 Images



Malignant



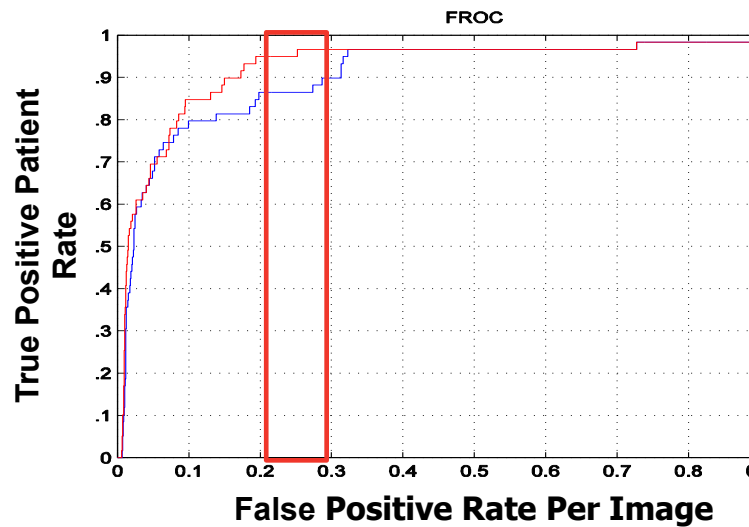
105,000 Candidates



$[x_1, x_2, \dots, x_{117}]$

Image feature vector

Great Results!



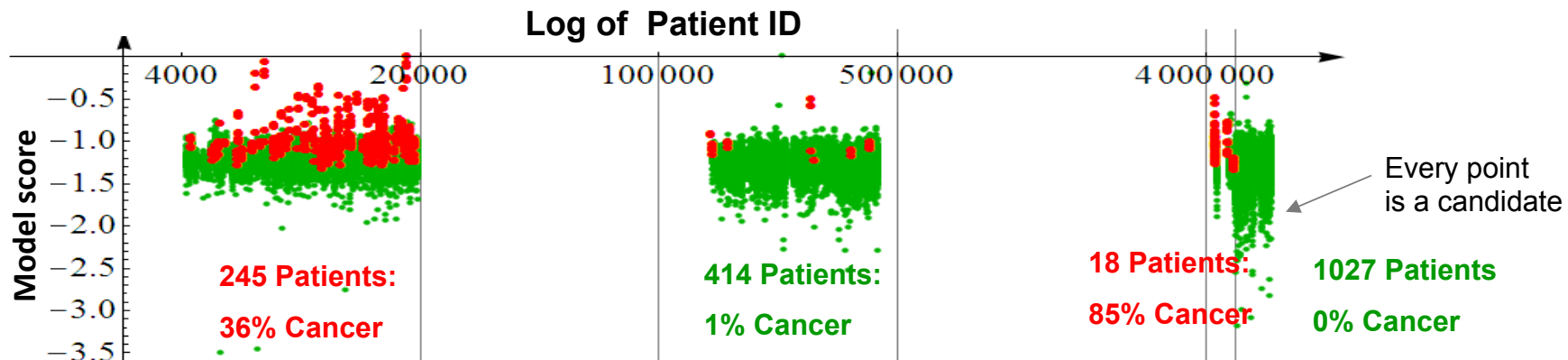
FROC: 0.093



Sent 60% of
healthy women
home

Except ...

Something is strange about the Patient ID



Patient ID is extremely predictive

The model learned the implicit location of the fMRI...

An ornate, golden-brown frame with intricate carvings of vines and leaves surrounds a dark blue rectangular area. The frame has a wide, decorative border with repeating patterns.

Big Picture?

Beware of (unintentional) discrimination based on predictability



LinkedIn Jobs: Targeted Email Delivery is Here



LinkedIn just rolled out an exciting new feature that makes it even easier to reach qualified candidates automatically. Members who view jobs on LinkedIn will now receive targeted job recommendations automatically via email. Powered by LinkedIn's 'Jobs You May Be Interested In' system, the emails include jobs that are personalized for each recipient based on his or her professional profile.



Claudia Perlich

Thank You!

dstillery