

Cognitive Computing and z Systems

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Watson Research Center





Computer vs Brain

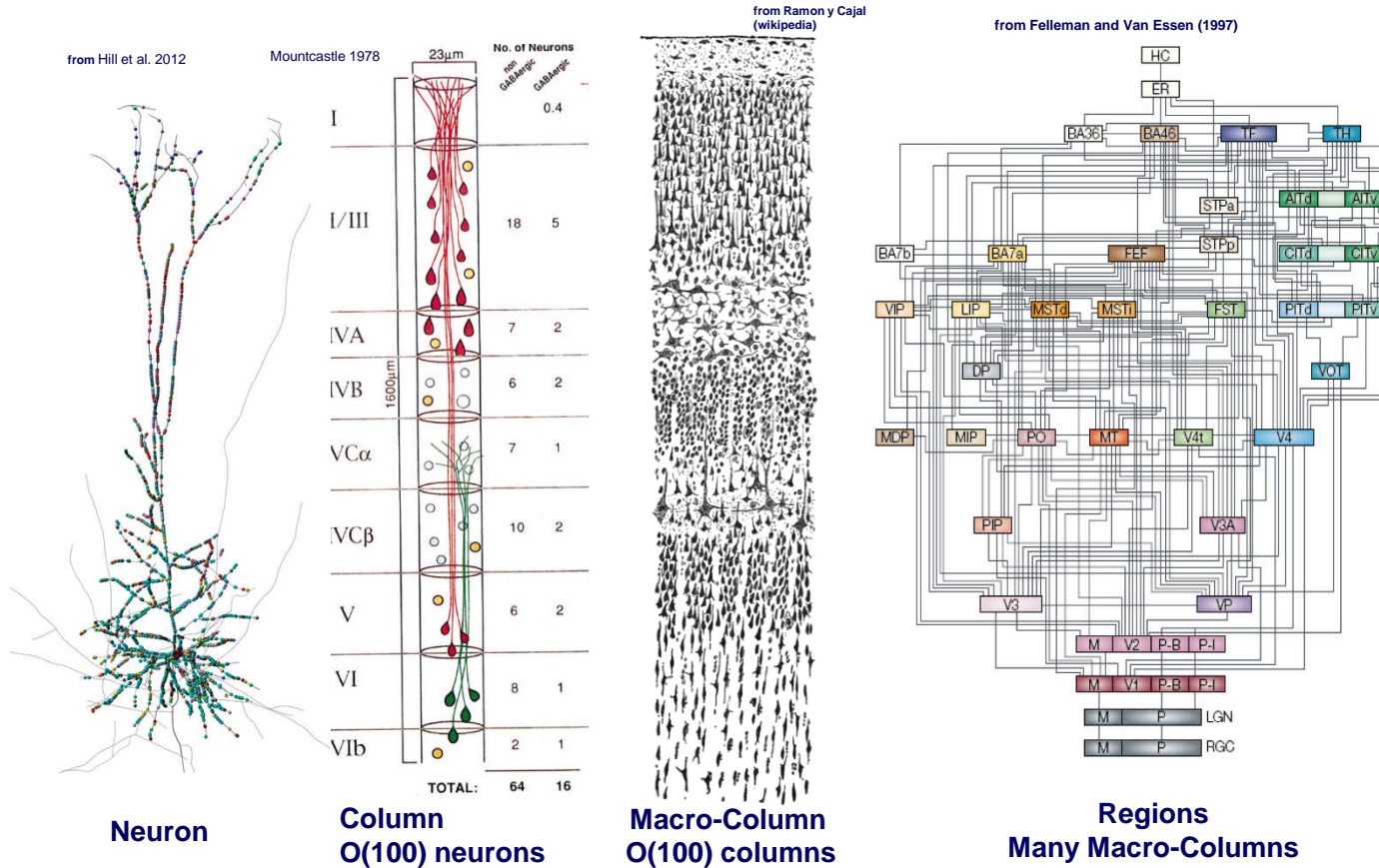


	Computer	Brain
Frequency	GHz	100 Hz
Power	kW (300W/chip)	20 W
Volume	~100 liters (one rack)	2 liters
Good for	High Performance Computing, Analytics, Enterprise Applications	Sensing, Learning, Predicting, Adapting, Pattern Recognition, Contextualizing

> 1 Billion

100 steps

Memory Retrieval



Neuron

Column
O(100) neurons

Macro-Column
O(100) columns

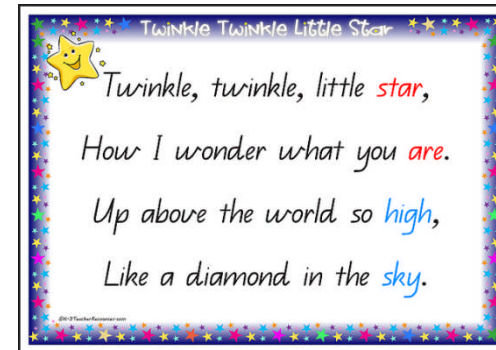
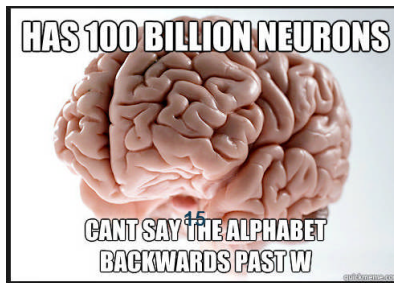
Regions
Many Macro-Columns

Time Sequences

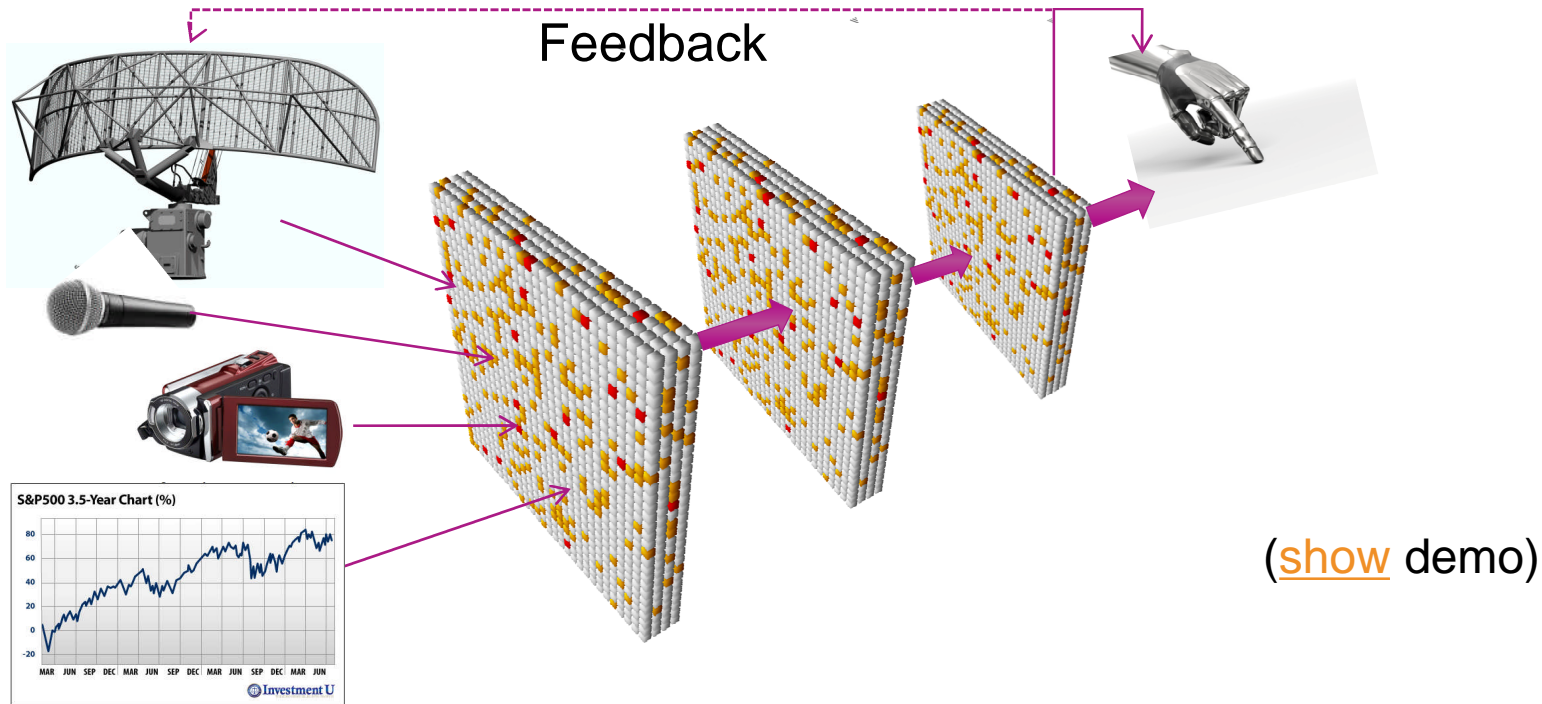


“saccade”

ABCDE
ZYXWU ?



Cortical Learning



Spatial-temporal data stream

Lateral Connections

Memory Sequences

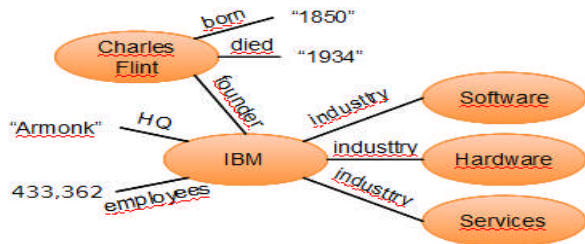
5

Graphs

Graph Database

RDF / Property Graph

Attributes



subject	predicate	object
Charles Flint	born	"1850"
Charles Flint	died	"1934"
Charles Flint	founder	IBM
IBM	HQ	"Armonk"
IBM	employees	433,362
IBM	industry	Software
IBM	industry	Hardware
IBM	industry	Services

Contextual Analysis

Topological Analytics

Collective Graph

Macro

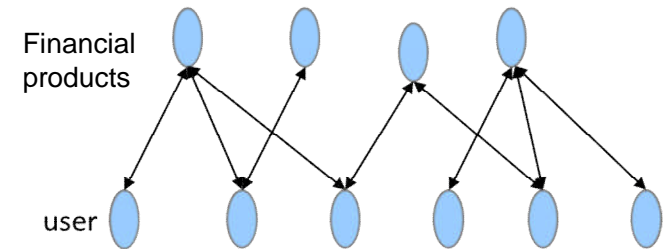


Collective Analysis

Graphical Models

Activity Graph

Micro & Reasoning



Customers who bought these insurance products also bought these financial services

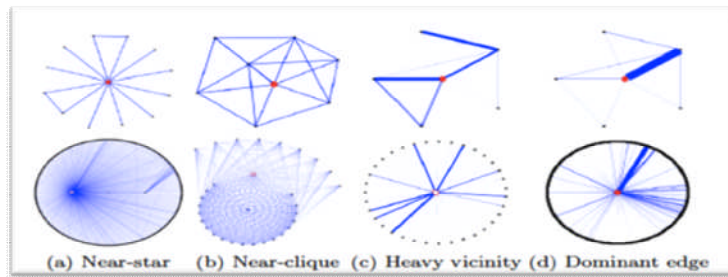
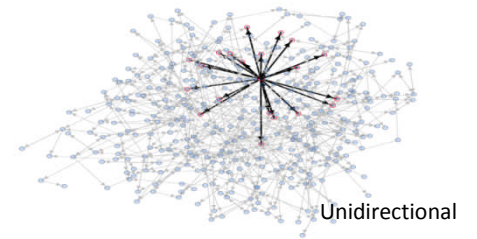
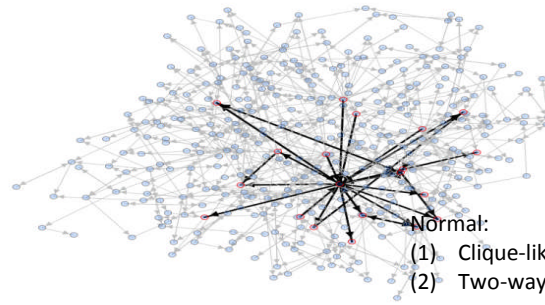
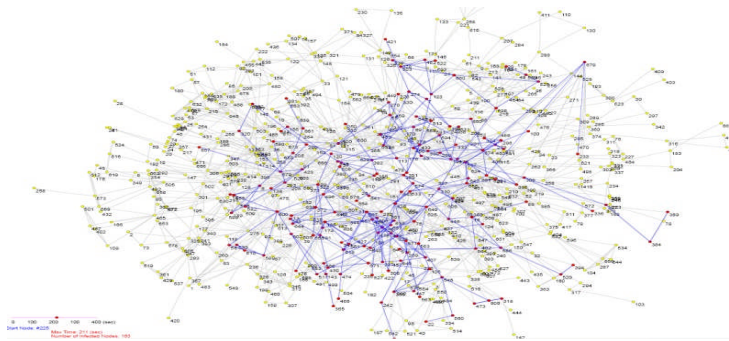
Dynamically discovered Relationships

Temporal, spatial, social, economic, hidden

(Show demo)

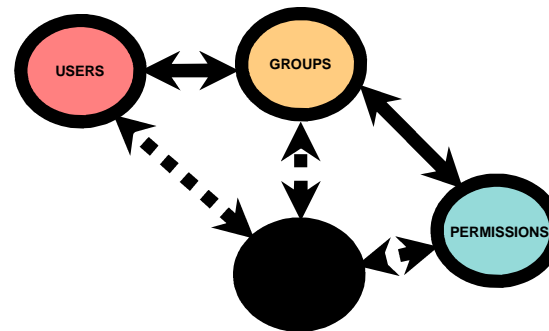
Ponzi Scheme

Network
Info Flow



Cyber Security

- Analyzes security policy and audit data
- Discovers anomalous behavior and misuse of entitlements
 - Access to the system
 - Use of system

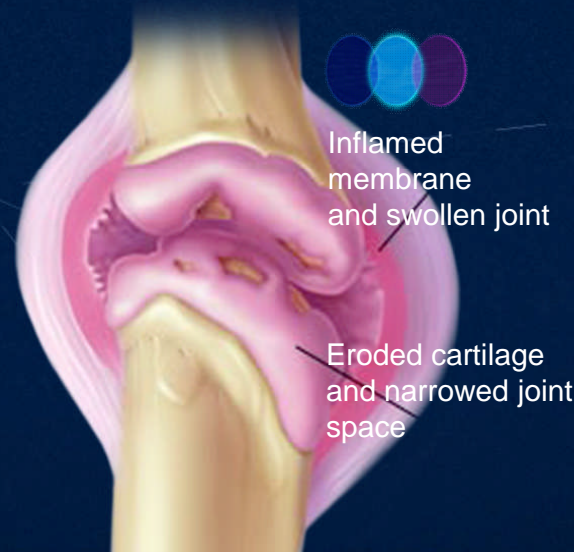


White House Initiative for Personalized Medicine

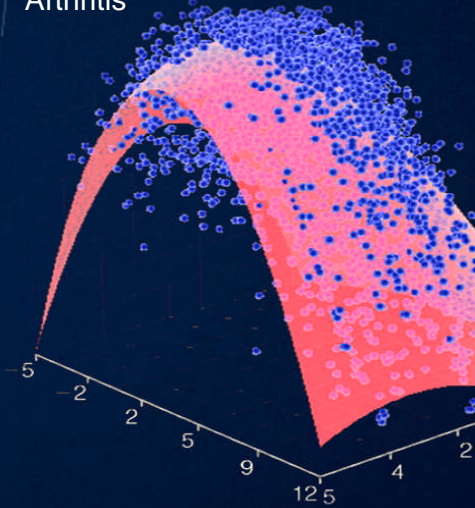
Heart Disease
Gene Essentiality
Alzheimer's Disease

Amyotrophic Lateral Sclerosis

Fastest Microprocessor
TBs of Main Memory
Parallelization
SIMD

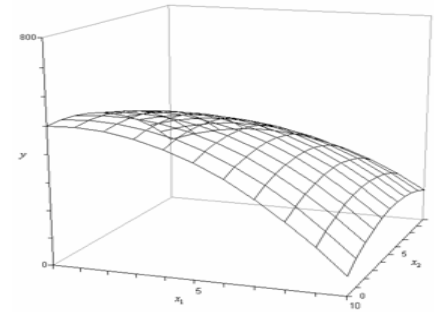
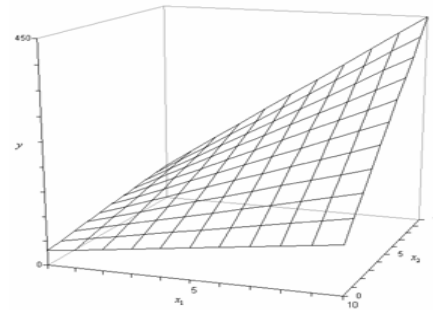


Rheumatoid Arthritis



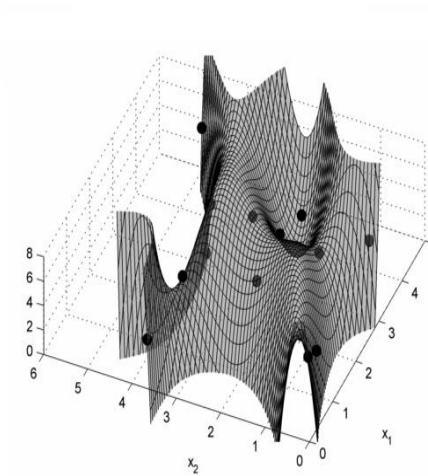
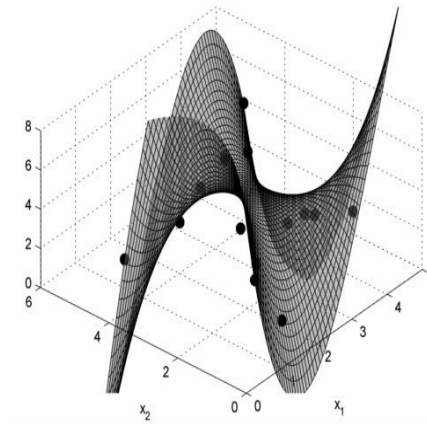
Loan Default

- Input Data
 - Gender
 - Mortgage
 - Debt/Income Ratio
 - Balance Outstanding
 - Employed
 - Married
- Output:
 - Default, Confidence Level
- Economics: Labor Market
- Engineering: Failure of a Product, System, Process
- Demographics: Voter Registration



Credit Card Fraud Detection

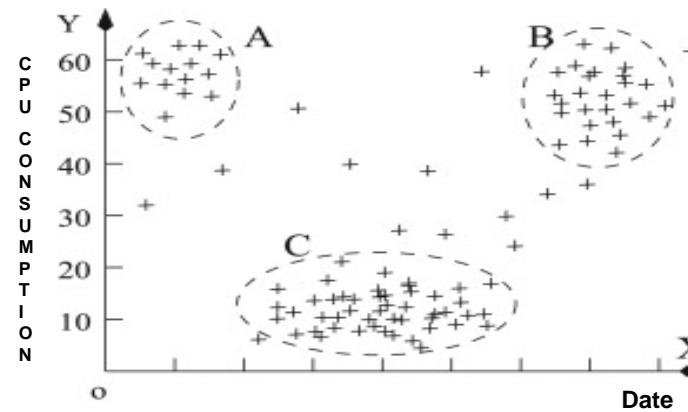
- Input Data
 - Transaction
 - Merchant
 - 500 USD
 - Credit Limit
 - Time
 - Item



- Output:
 - Default

Model Trees

- Customer Segmentation
- Risk
- Investment



Deep and Shallow Learning

Stem to Drug Class:

Word: CONCEPT_Olanzapine Position in vocabulary: 473840

Word	Distance
CONCEPT_Atypical_antipsychotic	0.776122
CONCEPT_Antidepressant	0.749192
CONCEPT_Fluoxetine	0.743936
CONCEPT_Escitalopram	0.741167
CONCEPT_Trazodone	0.738563
CONCEPT_Mianserin	0.737606
CONCEPT_Sertraline	0.735966
CONCEPT_Antipsychotic	0.735248
CONCEPT_Norepinephrine_reuptake_inhibitor	0.733836
CONCEPT_Selective_serotonin_reuptake_inhibitor	0.730870
CONCEPT_Mirtazapine	0.729193
CONCEPT_Maprotiline	0.728750
CONCEPT_Lurasidone	0.727250

Deep and Shallow Learning

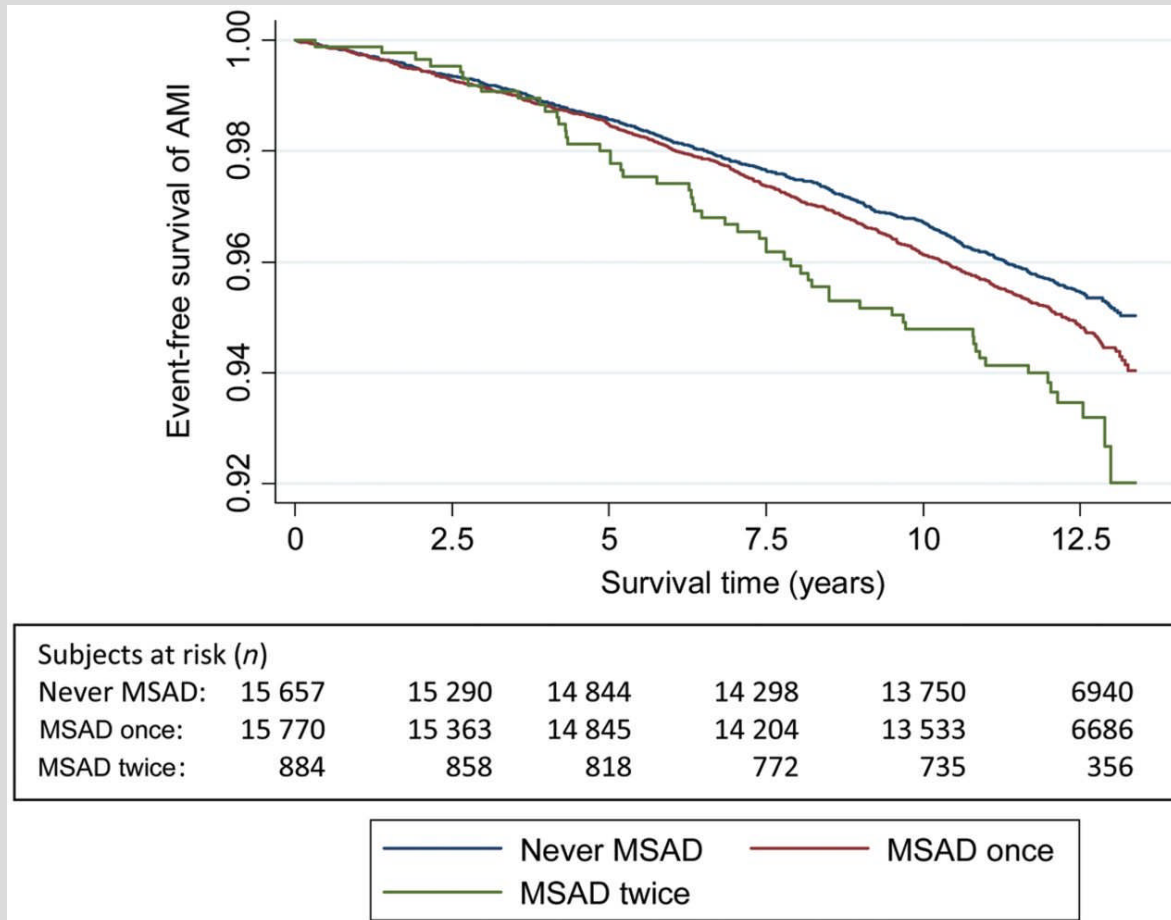
Stem to Disease State:

Word: CONCEPT_Truvada Position in vocabulary: 2381858

Word	Distance
CONCEPT_AIDS	0.637585
CONCEPT_HIV/AIDS	0.594723
CONCEPT_Terminal_illness	0.592508
CONCEPT_Leukemia	0.571637
CONCEPT_Heart_disease	0.569702
CONCEPT_Sexually_transmitted_disease	0.567041
CONCEPT_Sexual_health	0.562864
CONCEPT_Lung_cancer	0.561791
CONCEPT_HIV	0.553729

Deep and Shallow Learning

Disease State to Prognosis:



Source: Symptoms of anxiety and depression and risk of acute myocardial infarction: the HUNT 2 study, Lise Tuset Gustad, Lars Erik Laugsand, Imre Janszky, Håvard Dalen, Ottar Bjerkeset DOI: <http://dx.doi.org/10.1093/eurheartj/eh387.1394-1403>

Identifying Costs

- Top utilization members
- Cost of actual high-utilization members

Targeted Population	# Members Identified	Identification Accuracy	Predicted Plan Year Cost (\$M)	Actual Plan Year Cost (\$M)	% of Total Cost Covered
1%	1,485	99.9%	\$129.21	\$128.24	11%
2%	2,970	99.5%	\$206.31	\$205.91	18%
3%	4,455	99.0%	\$266.05	\$267.19	23%
4%	5,940	97.5%	\$315.75	\$315.91	27%
5%	7,425	95.2%	\$358.66	\$358.18	31%
6%	8,910	92.1%	\$396.73	\$396.15	34%
7%	10,395	87.6%	\$430.87	\$429.23	37%
8%	11,880	83.0%	\$461.92	\$459.78	39%
9%	13,365	78.2%	\$490.33	\$487.24	42%
10%	14,850	73.7%	\$516.62	\$512.7	44%

Cost Trend Detection

Leverage pattern detection technology to identify the emerging cost drivers, understand factors that drove healthcare cost from going up/down

We analyze individual factors as well as potential combinations of factors.

We estimate the overall impact that each factor has on overall costs

We also investigated whether the cost increase due to a factor is driven by an increase in frequency (utilization) or an increase in cost per occurrence (unit cost).

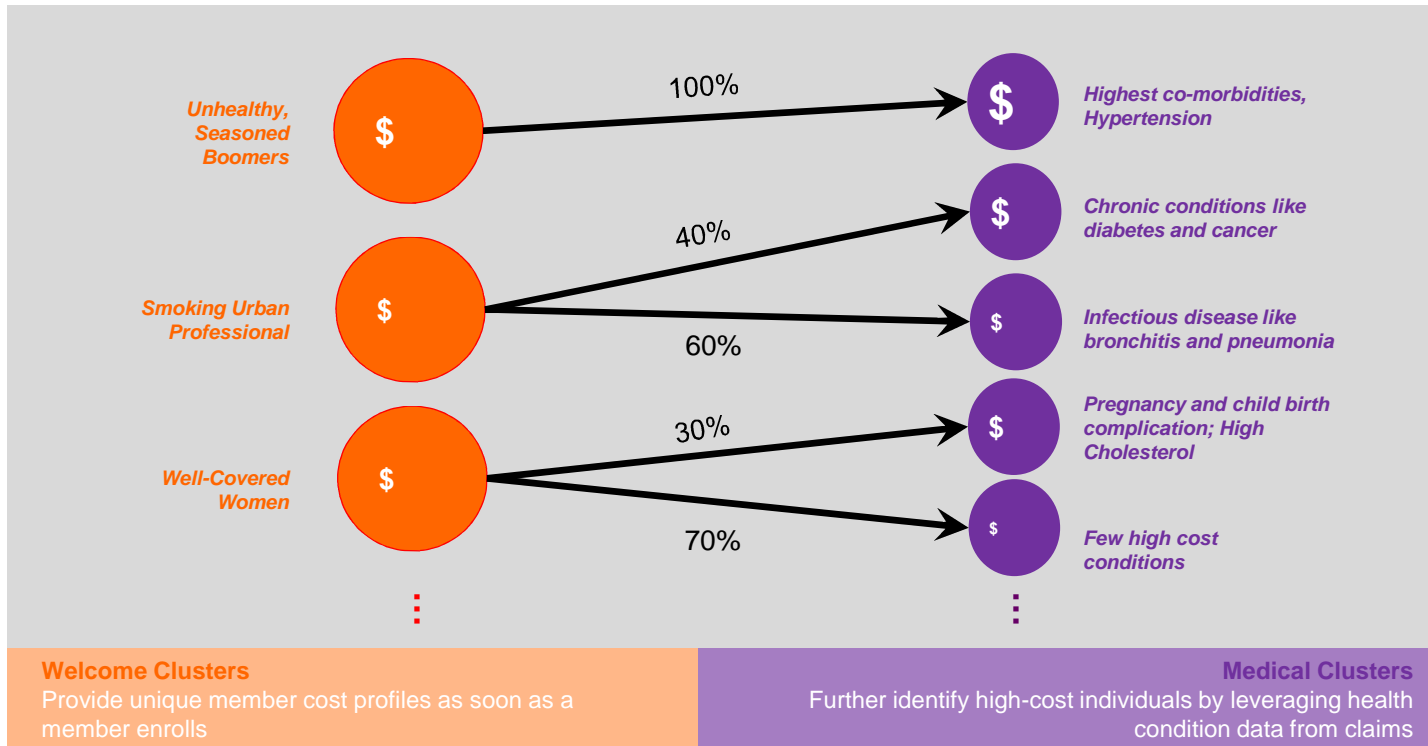
Cost Category: Primary Care Physician Market: Tampa-St Petersburg, FL
 Objective: To determine the major factors that drive cost increase
 Data: As of December 2010. Adjusted for Membership Composition.

Qtr4 2009 vs Qtr4 2010
Factors with High \$ Cost Impact (>\$10k), in descending order of \$ cost impact

Factor1	Factor2	2010 Paid Amt	2009 Paid Amt	2009 Membership- Adjusted Paid Amt	\$ Increase in Paid Amt (mem-adj)	Overall Factor Estimate ⁽²⁾	Overall \$ Cost Impact Estimate ⁽³⁾	Utilization Factor Estimate ⁽²⁾	Utilization \$ Cost Impact Estimate ⁽³⁾	Unit Cost Factor Estimate ⁽²⁾	Unit Cost \$ Cost Impact Estimate ⁽³⁾
Dialysis (Procedure Group)		\$ 675,477	\$ 532,910	\$ 527,823	\$ 147,654	2.10	\$ 353,821	1.90	\$ 319,983	1.04	\$ 25,980
Age 20 to 29	Male	\$ 966,594	\$ 635,588	\$ 765,293	\$ 201,301	1.54	\$ 340,818	1.15	\$ 126,077	1.23	\$ 181,631
HMO Product		\$ 2,693,355	\$ 2,870,591	\$ 2,381,225	\$ 312,130	1.10	\$ 244,850	1.20	\$ 448,892	0.92	\$ (234,205)
Polk County	Electrocardiogram	\$ 664,092	\$ 553,116	\$ 522,249	\$ 141,843	1.44	\$ 202,917	1.26	\$ 135,001	1.10	\$ 60,372
Service Provider 9283503	HMO Product	\$ 470,422	\$ 371,203	\$ 341,711	\$ 128,711	1.57	\$ 171,157	1.56	\$ 168,679	0.99	\$ (4,752)
Service Provider 1827323	HMO Product	\$ 461,020	\$ 358,354	\$ 338,926	\$ 122,094	1.50	\$ 152,691	1.52	\$ 157,717	0.90	\$ (51,224)
Hillsborough County		\$ 247,217	\$ 204,621	\$ 173,532	\$ 73,685	1.62	\$ 94,614	1.70	\$ 101,795	0.96	\$ (10,020)
New Patient Office 1st (Procedure Group)		\$ 239,569	\$ 216,742	\$ 216,751	\$ 22,817	1.40	\$ 68,448	1.20	\$ 39,928	1.10	\$ 21,779
Subsequent Intensive Care (Procedure)		\$ 63,664	\$ -	\$ -	\$ 63,664	12.67	\$ 58,639	8.40	\$ 56,085	1.04	\$ 2,449
Lee County	PPO Product	\$ 199,602	\$ 174,325	\$ 196,540	\$ 3,062	1.40	\$ 57,029	1.03	\$ 5,814	1.31	\$ 47,234
Cardiac Catheterization (Procdeure)		\$ 187,536	\$ 94,999	\$ 96,990	\$ 90,546	1.27	\$ 40,383	1.01	\$ 1,798	1.24	\$ 36,576
34684 Zip		\$ 228,566	\$ 171,084	\$ 170,800	\$ 57,766	1.20	\$ 38,094	1.10	\$ 20,779	1.04	\$ 8,791
Pasco County	PPO Product	\$ 263,308	\$ 229,126	\$ 210,724	\$ 52,585	1.10	\$ 23,026	1.37	\$ 70,919	0.68	\$ (123,917)
Rehab/Physical Therapy (Procedure Group)		\$ 54,759	\$ 77,755	\$ 59,565	\$ (4,806)	1.71	\$ 22,690	1.90	\$ 25,939	0.90	\$ (6,084)
Pinellas County	PPO Product	\$ 95,050	\$ 128,938	\$ 196,135	\$ (101,085)	1.29	\$ 21,368	0.90	\$ (10,532)	1.40	\$ 27,326
Charlotte County		\$ 201,698	\$ 38,198	\$ 36,778	\$ 164,921	1.10	\$ 18,336	1.09	\$ 16,654	1.00	\$ -
Doppler Color Flow Add-On		\$ 31,390	\$ 90,745	\$ 69,829	\$ (38,439)	1.90	\$ 14,869	1.70	\$ 12,925	1.02	\$ 615
Service Provider 4180502		\$ 15,760	\$ 380,450	\$ 240,958	\$ (225,198)	5.86	\$ 13,069	11.68	\$ 14,411	0.58	\$ (11,411)
Drug Administration (Procedure Group)		\$ 13,426	\$ 189,639	\$ 156,626	\$ (143,200)	21.00	\$ 12,787	31.00	\$ 12,993	0.98	\$ (274)
Collier County	HMO Product	\$ 26,814	\$ 204,847	\$ 210,356	\$ (183,542)	1.90	\$ 12,701	1.87	\$ 12,492	0.77	\$ (7,810)
Service Provider 4983045		\$ 24,450	\$ 451,032	\$ 462,556	\$ (438,106)	2.00	\$ 12,225	2.01	\$ 12,286	0.99	\$ (247)
Service Provider 554802		\$ 51,827	\$ 2,654	\$ 1,937	\$ 49,890	0.90	\$ (5,759)	1.00	\$ -	0.93	\$ (3,901)
Echocardiogram (Procedure Group)		\$ 82,456	\$ -	\$ -	\$ 82,456	0.84	\$ (15,706)	0.80	\$ (20,614)	1.10	\$ 7,496
Refraction (Procedure Group)	HMO Product	\$ 191,564	\$ 11,801	\$ 11,028	\$ 180,536	0.81	\$ (44,935)	0.90	\$ (21,285)	0.94	\$ (12,228)
Doppler Echo Heart Exam (Procedure)		\$ 66,511	\$ 5,710	\$ 7,274	\$ 59,238	0.19	\$ (283,548)	0.21	\$ (250,209)	0.96	\$ (2,771)

Member Clustering

Provide actionable insights into member cost profiles and health characteristics and serve as an effective communication tool with other lines of business across the enterprise

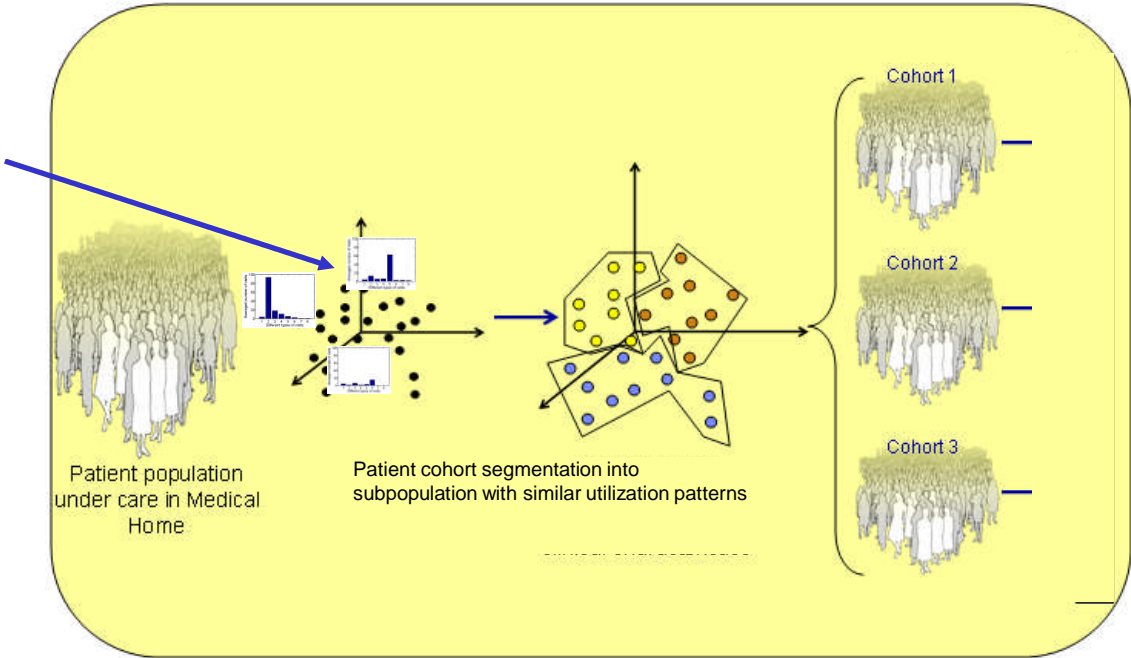


Welcome Cluster		Summary Description	Avg Cost (PMPM)	Medical Cluster		% Pop	Avg Cost (PMPM)	Health Summary
A	Unhealthy, seasoned boomers	Most expensive with the highest co-morbidities. Oldest smokers.	\$1,004	A1	Smoking boomers with high co-morbidities	4.2%	\$1,045	Highest in cancer, heart disease, and co-morbidities
B	Smoking young urban professionals	Second most expensive. Younger smokers	\$505	B3	Young smokers with chronic conditions	1.8%	\$903	Chronic conditions like diabetes, cancer, and gastrointestinal issues
				B7	Young smokers prone to acute conditions	2.9%	\$296	Infectious diseases such as bronchitis and pneumonia
C	Proactive, healthy boomers	Somewhat expensive. Second oldest, non-smokers.	\$325	C2	Boomers with costly chronic conditions	3.1%	\$1,002	Musculoskeletal and connective tissue diseases
				C5	Boomer with high cholesterol	11.7%	\$467	High cholesterol and ADHD
				C8	Well managed boomers	27.7%	\$255	Cholesterol and mood disorder medications
D	Well-covered women	Inexpensive. Younger, non-smoking females with high plan richness.	\$275	D4	Well-covered women with pregnancy complications	4.3%	\$532	Pregnancy and child birth complications
				D9	Busy well-covered women	10.4%	\$212	Hypertension, use of antidepressants
E	Health-conscious women	Inexpensive. Younger, non-smoking females with low plan richness.	\$206	E10	Health-conscious women with high cholesterol	7.8%	\$206	Highest in cholesterol and mood disorders
F	Busy, well-covered young men	Inexpensive. Younger males, non-smoking males with high plan richness.	\$156	F6	Busy stressed young men	4.7%	\$401	Hypertension and heart medications
				F12	Healthy well-covered young men	16.5%	\$102	Few costly conditions
G	Health-conscious, young men	Least expensive. Younger, non-smoking males with low plan richness.	\$120	G11	Healthy risk-taking young men	4.9%	\$120	Few costly conditions

Utilization Pattern Analysis and Hot Spotting

Utilization Profiles

Visit Type	Description
1	PCP visit
2	Specialist visit
3	Emergency visits
4	Outpatient hospital visits
5	Inpatient hospital visits
6	Patient's home



Detecting impairment (intoxication) with Speech Coherence

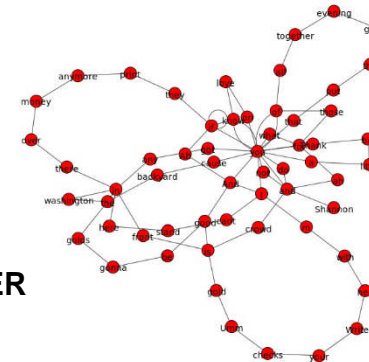
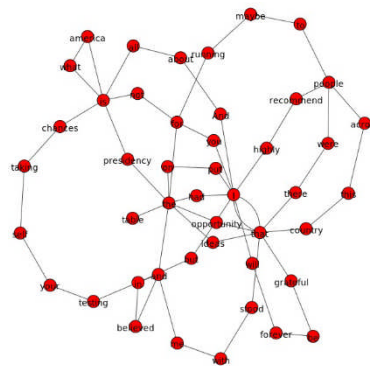
(AAAI 2014)



<https://www.youtube.com/watch?v=e2h-DgYcCtw>



<https://www.youtube.com/watch?v=21z30aNO3cA>

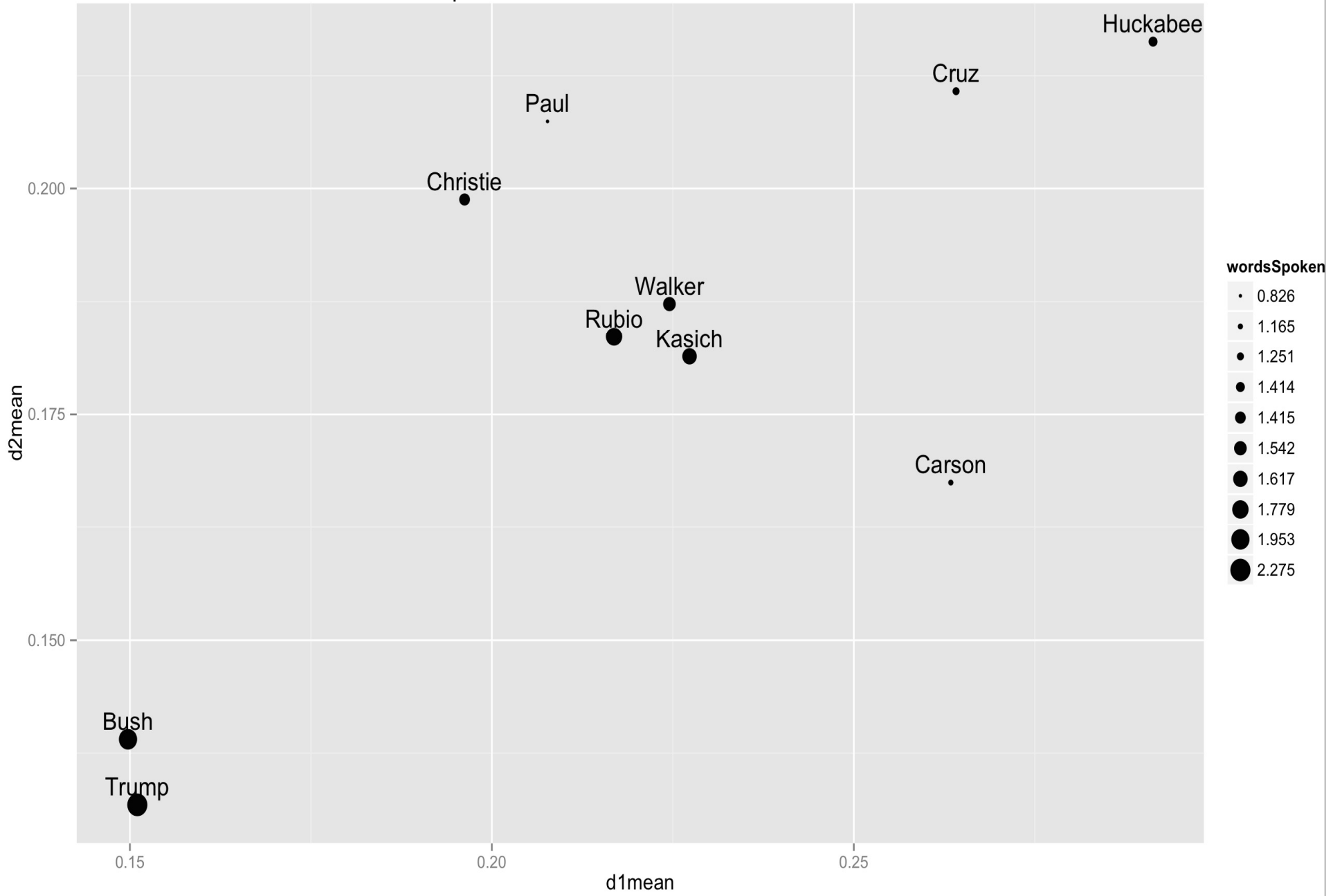


FEATURE	SOBER	NON-SOBER
Lemmatized-Nodes	352	350
Lemmatized-Edges	985	1073
Lemmatized-Loop Len 1	8	4
Lemmatized-Loop Len 2	44	64
Lemmatized-Loop Len 3	284	442
Lemmatized-Loop Len 4	1712	2956

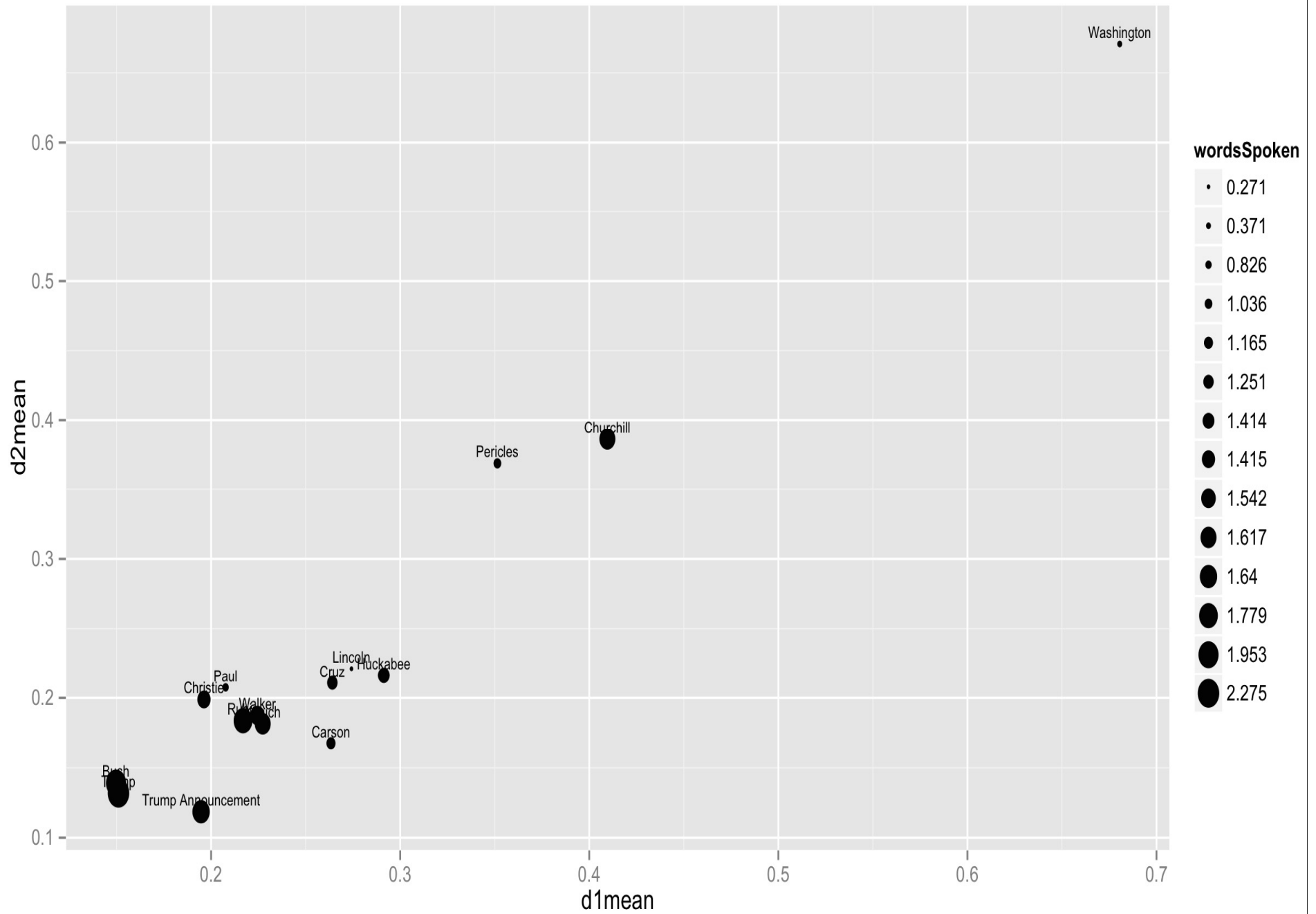
Coherence:

Phrase to phrase-median **0.2201** 0.0049
 Alternate phrases-median **0.2895** 0.0045

Republican Presidential Debate Coherence

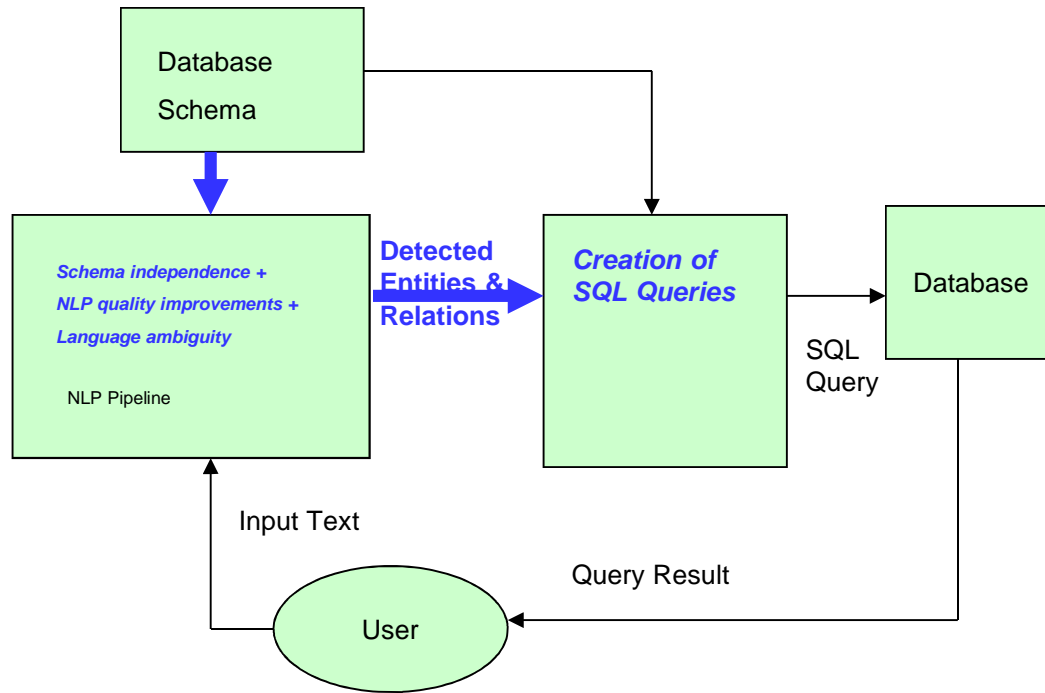


Coherence Historic Context



PolicyHolder	Date of Claim	Claim	Deductible	Location	Policy
PersonA	2/3/12	100	500	Florida	8,000
PersonB	4/5/13	1,000	3000	Texas	12,000
PersonC	6/3/14	50,000	100,000	New York	100,000

Natural Language Pipeline



What Policy Limit does PersonA have?

```
SELECT PersonA, Policy Limit
```

```
From Table
```

```
WHERE PolicyHolder = PersonA
```

What is the highest claim paid this year?

```
SELECT MAIXIMUM (claim)
```

```
From Table
```

What is the deductible for PersonB?

What is the location of PersonC?


Sentiment Analysis on new Offerings

Reviews.com TV Providers

TV Provider Reviews Expert Q&A Compare Top Lists ▾

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Read More TV Providers Reviews ▾

 **AT&T U-verse® Review**

★★★★☆ [LEARN MORE >](#)

AT&T U-verse® provides TV service through a reliable fiber optic network and sets themselves apart from competitors by allowing you to simultaneously record up to four programs. [Learn More](#)

Updated: February 3, 2014

The Good

Record up to four shows at once:

Most cable companies provide DVRs that are only capable of recording two shows at once. For many households, this will be plenty. But for viewers that have a lot of favorite shows, having a DVR that is capable of recording more can be a huge benefit. U-verse® allows customers to choose from a number of DVR options, with the higher-end U-verse® DVR being able to simultaneously record up to four shows at once. With plenty of hard drive space, you'll be able to record 233 hours of standard definition television, and up to 85 hours of high definition. If you're serious about staying up to date with your favorite shows, the U-verse® DVR can definitely help.

The Bad

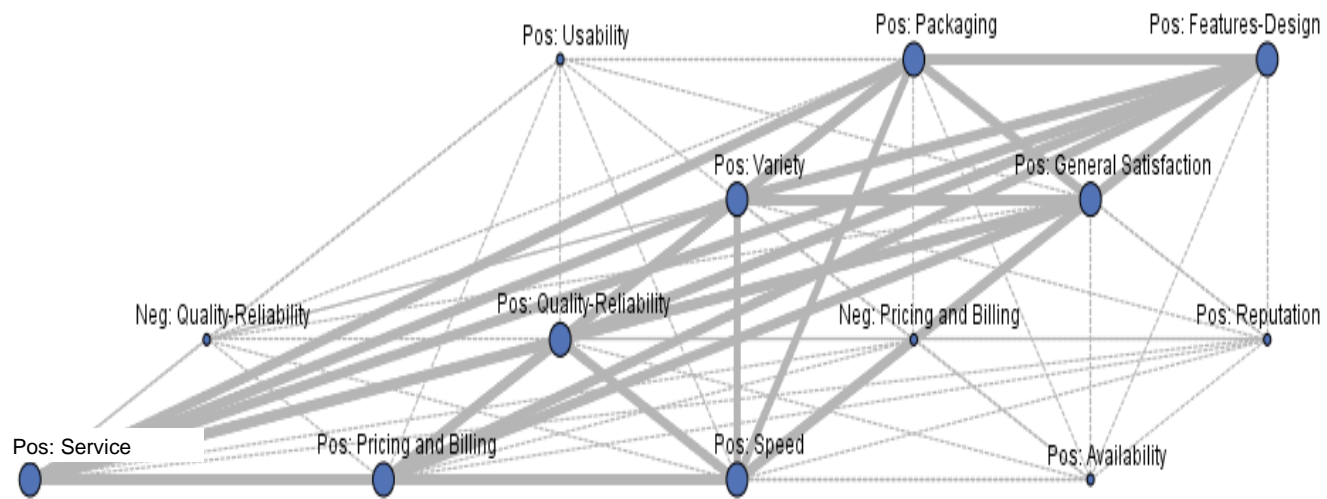
Limited availability:

One of the major drawbacks to AT&T U-verse® is the limited availability. Even though U-verse® is currently available in just over 20 states, relative to standard cable and satellite, access to fiber optic networks is limited. There are multiple companies out there making a push for fiber optic networks, so availability will most likely increase over the next several years. In the meantime, if you're determined to get TV services through AT&T you can take advantage of a partnership with DirecTV.

Prices increase after six months:

<http://www.reviews.com/tv-providers/att-u-verse/>

<http://twothrifysisters.com/att-u-verse-reviews/>



Category	#Descri...	#Respo...
All Records	--	2
Uncategorized	--	0
No concepts extracted	--	0
Neg: Quality-Reliability	36	1
Neg: General Dissatisfaction	19	2
Pos: General Satisfaction	19	2
Pos: Usability	17	1
Pos: Quality-Reliability	14	2
Neg: Variety-Size-Weight	8	0
Neg: Usability	8	0
Pos: Features-Design	8	2
Pos: Size-Weight	7	0
Other: Don't Know	6	0
Pos: Reputation	5	1
Other: Not Used-Not Applicable	4	0
Pos: Storage	3	0
Pos: Would Recommend	3	0
Pos: Pricing and Billing	3	2
Pos: Comfort	3	0
Pos: Availability	3	1
Neg: Instructions	3	0
Neg: Pricing and Billing	2	1
Pos: Speed	2	2
Pos: Variety	2	2
Pos: Packaging	2	2
Pos: Safety	1	0
Pos: Instructions	1	0

Concept	Count
picture	(2)
family	(2)
area	(2)
packaging	(2)
excellent	(2)
like	(2)
good	(2)
dislike	(2)
large	(2)
internet speed	(2)
definition television	(1)
entry level tv plan	(1)
working house phone	(1)
phone service from at&t uverse	(1)
cable companies	(1)
cell phones	(1)
cable service	(1)
cable tv providers	(1)
bundle tv	(1)
watch television	(1)
tv	(1)
telephone service	(1)
tv packaging	(1)
cable	(1)
tv guy	(1)
solis	(1)
USD29	(1)
USD19	(1)

Id	Response	Categories
1	<p>Record up to four shows at once: Most cable companies provide DVRs that are only capable of recording two shows at once. For many households, this will be plenty. But for viewers that have a lot of favorite shows, having a DVR that is capable of recording more can be a huge benefit. U-verse® allows customers to choose from a number of DVR options, with the higher-end U-verse® DVR being able to simultaneously record up to four shows at once. With plenty of hard drive space, you'll be able to record 233 hours of standard definition television, and up to 85 hours of high definition. If you're serious about staying up to date with your favorite shows, the U-verse® DVR can definitely help. Huge channel selection: AT&T U-verse® offers customers a number of different TV packages to choose from. These packages offer a variety of local, sports, kids and family, lifestyle, and entertainment channels. U-verse® also has a solid offering of premium channels, movie channels, as well as access to pay-per-view events. With up to 440 channels available (180+ in HD), everyone in the family is certain to find channels they enjoy. All channels won't be available in every region, so be sure to check with U-verse® representatives for specific offerings in your area. Fiber optic network brings clear picture and fast internet speeds: AT&T U-verse® is one of very few cable TV providers that utilizes a fiber optic network. Understanding the technical specifications of fiber optics may not be high on your priority list, but the important thing to take away is that this technology has the ability to deliver a less distorted signal, and consequently, you can expect a high quality picture. If you're looking to bundle TV and Internet you'll also appreciate the Internet speeds that accompany fiber optic networks. If you're lucky enough to live in an area where fiber optic networks are available, AT&T U-verse® is definitely worth looking into. Competitive basic package pricing: Not everyone is interested in getting every possible channel and the highest quality DVR. One benefit of U-verse® is the relatively cheap entry level package starting at \$19 per month when you bundle with Internet. If you're looking for cable only, you can get a respectable package for \$29 per month for six months. Although the high end U-verse® packages can get pricy, these entry level options are competitive. If you're looking for a low cost, entry level TV plan, AT&T U-verse® may be a good choice, but be sure to check with AT&T U-verse® for local pricing.</p>	Pos: Pricing and Billing Pos: Packaging Pos: Features-Design Pos: Quality-Reliability Pos: Speed Pos: Variety Pos: Availability Neg: General Dissatisfaction Neg: Pricing and Billing Pos: General Satisfaction Pos: Reputation
2	<p>Customer service has been unexpectedly decent. I have been able to get in touch with a real live person whenever I have had questions and they have actually been knowledgeable and pleasant. My questions have been answered and minor situations resolved with the customer representative I have been in touch with. The internet speed has been comparable to my last service provider if not even a little faster. I was actually surprised but in a good way. I really wasn't expecting it to be any faster than my last provider, and with the way that my luck has been going with internet providers I wasn't sure what to expect. The bottom line is that there are no complaints from anyone in the house where the speed of the internet is concerned. Our cable service is a lot better than the last service that we had and that is incredible. The number and variety of channels that we have with this new "Complete Package" from AT&T Uverse is my favorite part of the entire package. I am just a big TV guy and when I sit to watch television, I expect to have enough of a variety of channels to find something to</p>	Pos: General Satisfaction Pos: Features-Design Neg: Quality-Reliability Pos: Packaging Pos: Quality-Reliability Pos: Speed Neg: General Dissatisfaction Pos: Pricing and Billing Pos: Usability Pos: Variety

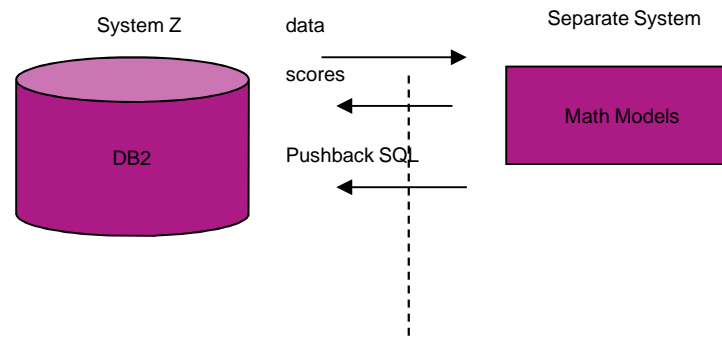
Collaborations

Analytics for:

- Fraud
- Risk
- Temporal Data Patterns
- Health
- Insurance

Stale Data for Analytics

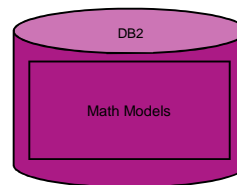
Before:



Optimized Real Time Analytics on Z

After:

- Up to 7X increase end to end.
- Neural network. On Z: performance increase by 42x,
- Logistic regression by 1.8x, saving 46%-95% of CPU time;
- Increased the speed of data transformations (by 2x) and aggregate operations (by 2x)



System Z