

Distilling the Outcomes of Personal Experiences: A Propensity-scored Analysis of Social Media



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Bing

should I try to|

should i try to **sleep**

should i try to **get pregnant**

Bing

what happens if you

what happens if you **don't eat**

what happens if you **drink alcohol**

what happens if you **don't**

Bing

how to get |

how to get **away with murder**

how to get **rid of**

how to get **a passport**

how to get **a job**

how to get **free robux**

how to get **rid of mice**

how to get **started**

how to get **in**

Goal: Build an **open** and **domain agnostic** system for querying about the outcomes of **any** experience people may have.

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“Long-tail” of situations and experiences

- **Explore a situation: What happens ...?**
 - when depressed, after disease diagnosis, after being fired, ...
- **Understand the effects of a potential action: Should I ...?**
 - get pregnant, ask for divorce, lose belly fat, change last name, ...
- **Plan for outcomes/goals: How to ...?**
 - lose weight, get admitted to MIT, increase income, find true love

Applications for individuals, policy makers, and others

Social Media Posts: A Proxy to User Experiences

Experiences & situations

I **ate** lots of fried things **today** and thoroughly enjoyed it. 🍔 🍟 🍗

I'm glad I **went** to the **show**. It was an experience I had to have, and I'm thankful.

I **had** my first **car accident** this morning

Social Media Posts: A Proxy to User Experiences

Experiences & situations

Post-hoc events (potential outcomes)

I **ate** lots of fried things **today** and thoroughly enjoyed it. 🍔 🍟 🍗

Everyone got problems losing weight and I got problems **gaining weight** 😞

I'm glad I **went** to the **show**. It was an experience I had to have, and I'm thankful.

i **was** just woken up to a strawberry milkshake and a **relaxed** household. this is nice.


I **had** my first **car accident** this morning

Not having a car this week and maybe next week will be the longest, most hardest thing ever 😞 What a great Valentines Day 😞

Social Media Timelines: Experiencing Depression

I'll start running again
this weekend, join me 

at work, understaffed
several days already 


no motivation, I feel how heavy
my depression is in my bones 

attending to others,
makes me soon tired 

don't self-harm,
remember yr worth 

have depression
& feel like laying bed 

The days at work seem
longer and longer 

his sadness makes me
feel lost & tired.. 


some days I feel the
urge to self-harm 

The movie last
evening was great! 


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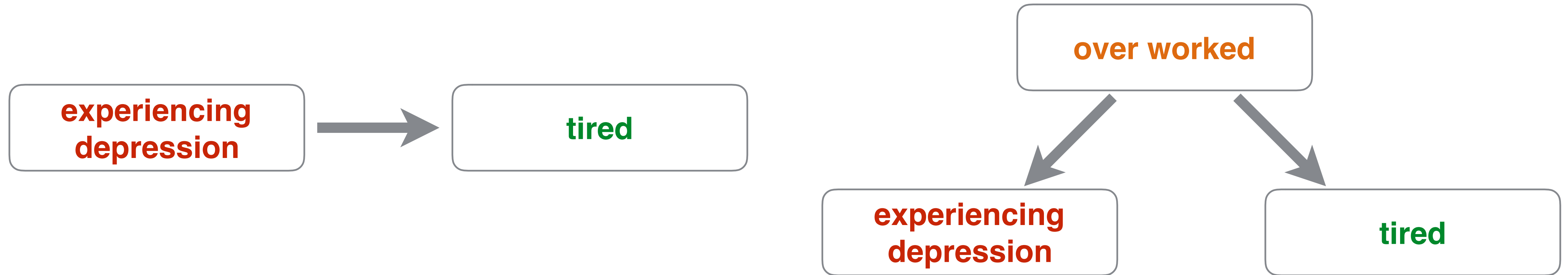
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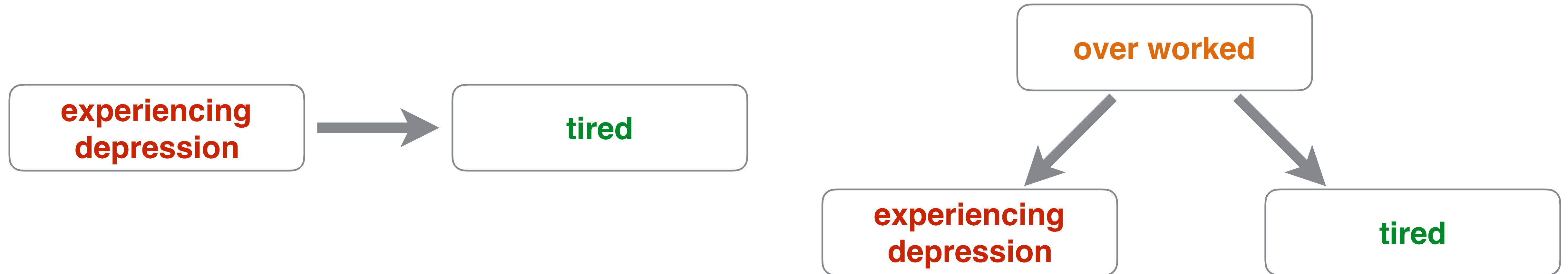
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Confounding Bias & Matching



Confounding Bias & Matching



Matching: For every user with a particular experience, find another user with identical characteristics (prior to the experience) who didn't have the experience.

In high-dimensional spaces (e.g., textual data from social media), identical matches cannot be found; instead project units to a single dimension.

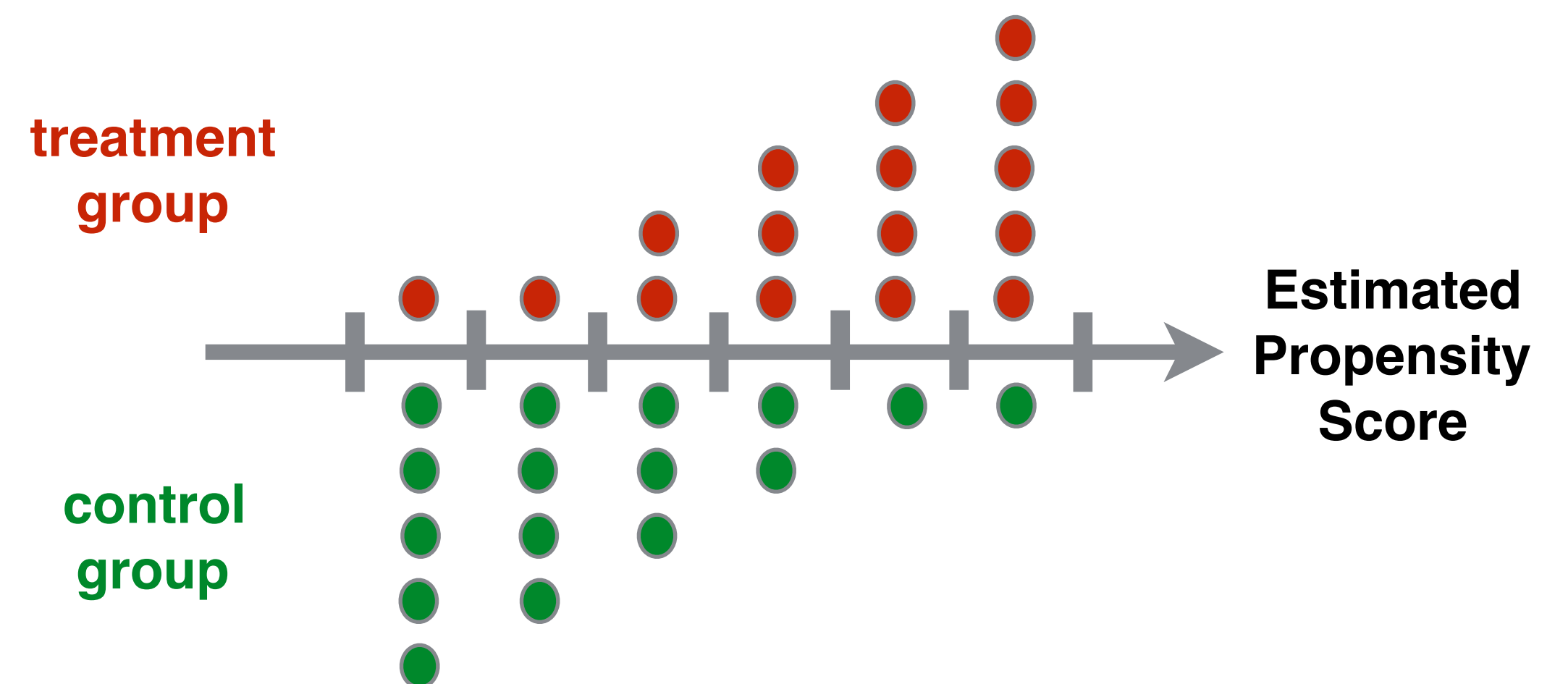
Propensity Score Matching

Propensity score (PS): the probability of a user to have a given experience.

PS estimator: learn an estimator that uses the terms used by a user in the past to determine her propensity to have the experience.

Match and compare (**treatment group**) users with a given experience **with** (**control group**) users who did not have the experience, but with the same or similar propensity score.

Determine average outcomes across user groups with different propensities to have the experience.



Does It Work?

Precision: Are the outcomes we distill likely to be correct across semantic domains?

Coverage: How well do we cover the breadth of outcomes likely to occur after an experience?

Types: What kinds of outcomes (words) do we recover? Do they capture actual causal relationships?

Exploration: Are there other insights we can gain about the outcomes?

Evaluation Setup

Selected 39 experiences across 9 semantic domains

- (should, why, what, why, vs, or)-search queries from Bing.com were semantically annotated
- Selected top decision-queries by popularity within domain

Twitter user identification

- Firehose Twitter data, March to May 2014

1st person personal and possessive pronoun

AND

experience phrase

AND

verbs and verbal phrases

- Many report on mental health issues, just a few discuss constructions tasks

Category		Experience / Event	Treatment	
			Users	Msgs
Business	Construct. and Maintenan.	*Building stairs	24	8.3K
		*Cleaning countertops	8	3.7K
		*Installing a garbage disposal	29	8.2K
		Painting the deck	592	164K
	Financial Services	Owning a good credit card	2291	920K
		Paying credit card debts	414	233K
		Buying life insurance	1881	561K
		Having pension	2344	796K
Investing	*Incorporating one's business	28	9.1K	
	Becoming a broker	855	355K	
		Investing money	23981	9.8M
		Total	32447	12.8M
Health	Diseases	Having high blood pressure	5279	1.9M
		Having gout	364	118K
		Having high cholesterol	1384	522K
		Having kidney stone	727	259K
		*Having high triglycerides lev.	27	12K
	Mental	Suffering from depression	25207	10.5M
		Suffering from OCD	11429	4.8M
		Being a sociopath	1491	676K
		Being a psychopath	2895	1.3M
		Suffering from anxiety	53983	22.6M
		Suffering from bipolar disord.	13723	6.3M
	Pharmacy	Taking Prozac	617	222K
		Taking Lorazepam	47	19.4K
		Taking Promethazine	242	118K
		Taking Tramadol	397	161K
Taking Xanax		3300	1.4M	
		Total	121112	50.9M
Society	Issues	Losing belly fat	93	24.8K
		Increasing gross income	135	93.2K
	Law	Getting divorced	2717	1.2M
		Becoming a notary	65	22.7K
		Applying for social security	6172	2.3M
		Filing for bankruptcy	921	347K
		*Having a living trust	18	7.5K
	Relationsh.	Finding true love	1885	654K
		*Recovering after adultery	9	4.4K
		Filing divorce	422	178K
		Dealing with jealousy issues	789	370K
		Changing last name	1019	403K
		Total	14245	5.7M

Raw Results: Examples

Society\Issues\Belly Fat

Outcome	Count	Absolute Increase	Z-Score
Burn	156	62.2%	8.96
Ab_workout	13	8.5%	5.82
Workout_lose	13	8.5%	5.82
Help_burn	8	11.1%	5.82
add_video	26	14.0%	5.75
url_playlist	26	14.0%	5.75
Fitness	39	18.6%	5.51
Ab	43	19.1%	5.51
Playlist_metion	30	15.3%	5.39
Biceps	7	4.7%	4.74

Health\Diseases\Gout

Outcome	Count	Absolute Increase	Z-Score
Flare_up	35	4.1%	12.33
Uric_acid	27	2.9%	10.36
Uric	28	2.9%	10.11
Flare	81	4.9%	9.92
Big_toe	38	2.9%	9.86
Joint	301	7.2%	7.22
Aged	32	1.7%	6.51
Correlation	45	2.8%	6.11
Bollock	53	2.5%	5.96
Shite	108	3.4%	5.93

It is easy to observe that the extracted outcomes are topically related.

But, How Well Do We Do?

Experience	Outcome
taking Lorazepam	stage
taking Tramadol	pharmacy
taking Xanax	liquor store
taking Prozac	mental illness

But, How Well Do We Do?

	Experience	Outcome
✗	taking Lorazepam	stage
✓	taking Tramadol	pharmacy
✗	taking Xanax	liquor store
✓	taking Prozac	mental illness

Domain: Health\Pharmacy

But, How Well Do We Do?

	Experience	Outcome	Experience tweet	Outcome Tweet
✗	taking Lorazepam	stage	I was freaking out earlier.. took 2 lorazepam to calm down	lately I'm better at managing my stage fright, last talks were much better
✓	taking Tramadol	pharmacy	the headache from taking tramadol is worse than the pain for which I took it	got my pharmacy tech license today! to start new job beginning of may
✗	taking Xanax	liquor store	forensics swap team came & examined it.. I was like k going to jail but I take my xanax w me!	the liquor store is right next to my building and I'm soooooo lazy
✓	taking Prozac	mental illness	the fact that she is no longer here still devastates me. the week she passed I was on a prozac diet	I'm no doctor but mental illness is real & getting through loss is difficult

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Evaluating the outcomes is challenging.

Domain: Health\Pharmacy

Precision: Are Outcomes Likely To Be Correct?

Ask crowd-workers: Someone **having gout** will later on be more likely to talk about **big toe**?

Pairs of tweets

I thought uric acid was just a number. Tsk. I'm too young to **have gout!**



I'm feeling a little something in my right **big toe**, and I have a drinking session tomorrow.



doctor says **I have gout..** and I wanted to go to a marathon next month



Wow, another attack of gout on my **big toe** feel sick with the pain **#gettingold**



Search results

having gout big toe

All Images Videos Shopping News More Settings Tools

About 639,000 results (0.79 seconds)

The most common sign of **gout** is a nighttime attack of **swelling**, tenderness, redness, and sharp pain in your **big toe**. You can also get **gout** attacks in your **foot**, ankle, or knees, or other **joints**. The attacks can last a few days or many weeks before the pain goes away. Another attack may not happen for months or years.

[Gout \(Gouty Arthritis\): Symptoms, Treatment, Causes, & More - WebMD](#)
www.webmd.com/arthritis/tc/gout-topic-overview

About this result • Feedback

People also ask

- How do you get rid of gout?
- Can you get gout in your hands and fingers?
- How long does it take for gout to go away?
- What does it feel like to have gout?

Feedback

[Gout Pictures: Causes, Symptoms, and Treatments - WebMD](#)
www.webmd.com/arthritis/ss/slideshow-gout

See what **gout** looks like, and learn about the causes, symptoms, and treatments of this painful form of arthritis -- including how to avoid **gout** attacks through ...

"having gout" "big toe"

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[5 Best Gout Treatments - Just released: November 15, 2016.](#)
Ad · [natural-gout-treatment.org/Top-2016](#)
Just released: November 15, 2016. Don't try anything before you read Natural-Gout-Reviews.org and its owners sell ... This occurs most commonly in the ... Full Review · Joint Pain · Natural Remedies · Up-to-date Information Best Gout Remedy Product Reviews of 2016 | Natural-Gout-Treatment.org

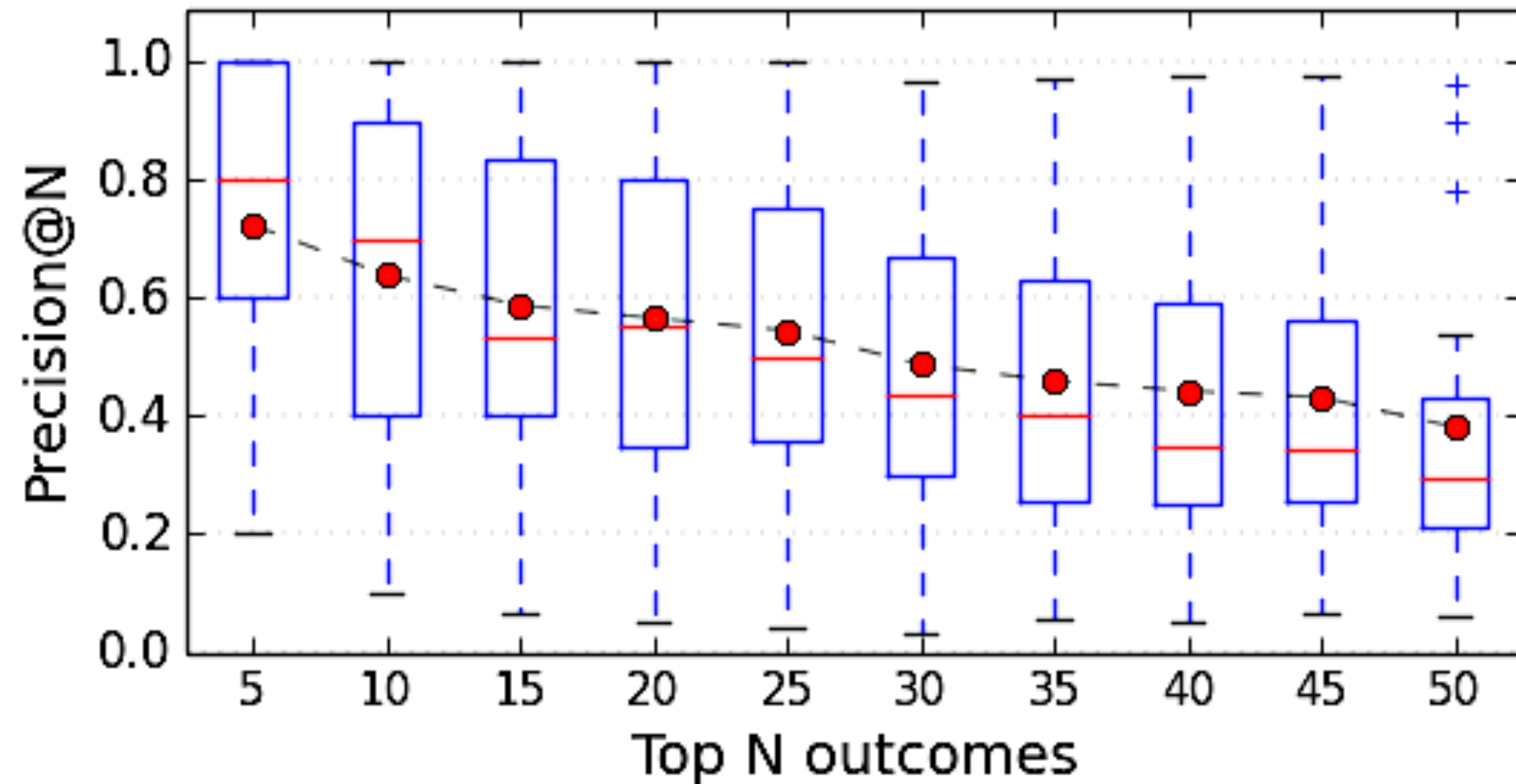
[48 Hours & Gout was Gone - Learn the quickest way to kill Gout.](#)
Ad · [www.goutfix.com/Guaranteed](#)
Learn the quickest way to kill **Gout**. Don't take anything before reading Most of all, you know that you want the pain gone and gone for ... Superior Quality · Joint Pain · Natural Solution · Liquid Formulation Kill Gout in Minutes With This

[Pictures Of Gout Big Toe - Find Facts, Symptoms & Treatments.](#)
Ad · [Lifescript.com/Health](#)
Find Facts, Symptoms & Treatments. Trusted By 50 Million Visitors. In addition to the **big toe**, **gout** pain and stiffness can occur in another foot joint ... Patient Stories · Health Care · Get Support · Clinical Trials

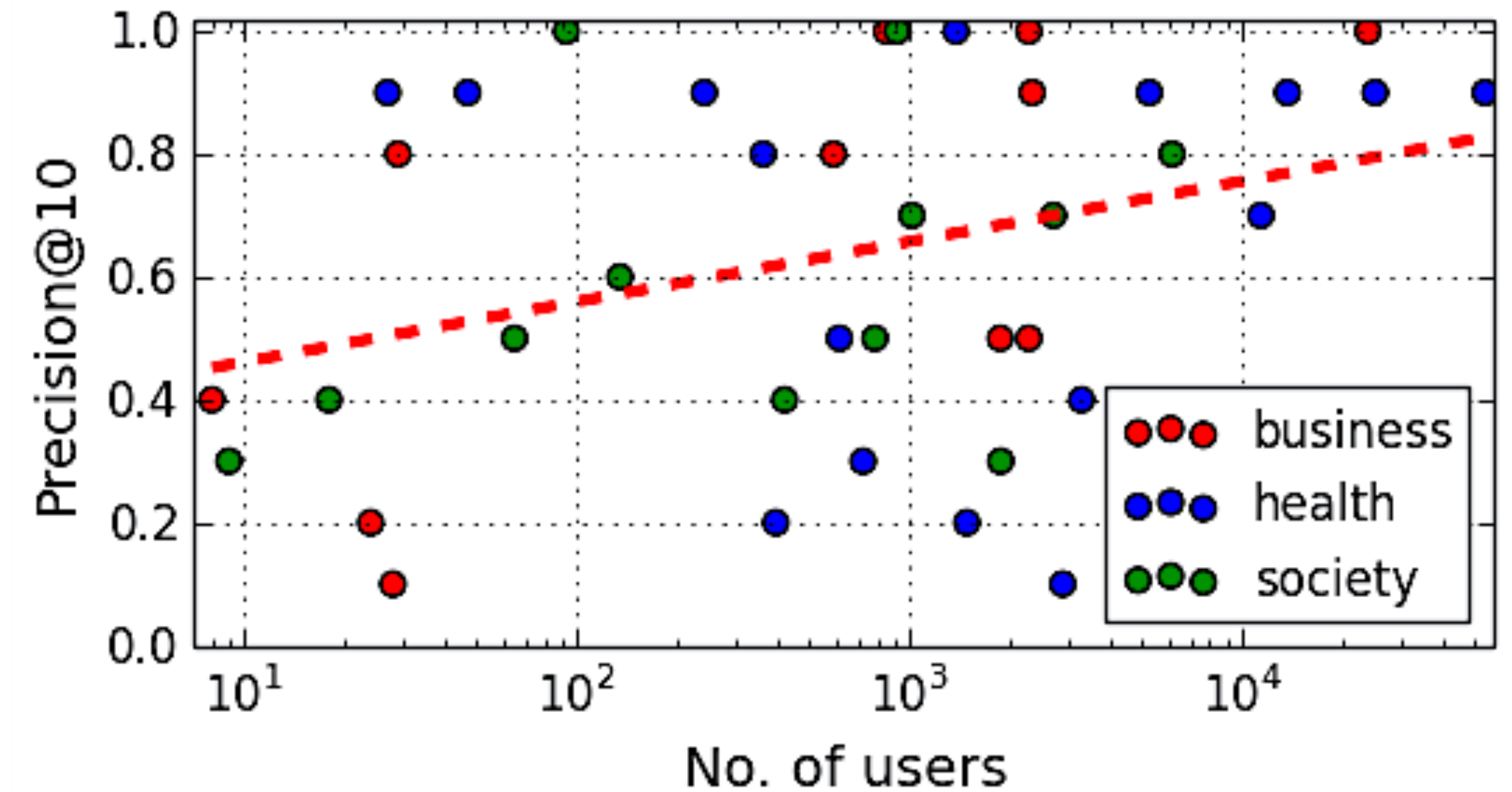
[10 Gout Trigger Foods - Gout toe](#)
Ad · [ActiveBeat.co/Gout](#)
Suffering from **gout** symptoms? You must avoid these 10 foods! Gout is a painful condition that affects 1-2% of North Americans through their ... Clean Up · The Roof · Acid Reflux 10 Trigger Foods For Gout | ActiveBeat

Precision: Are the Outcomes Correct?

Precision @rank by treatment effect



Precision@10 vs. data volume

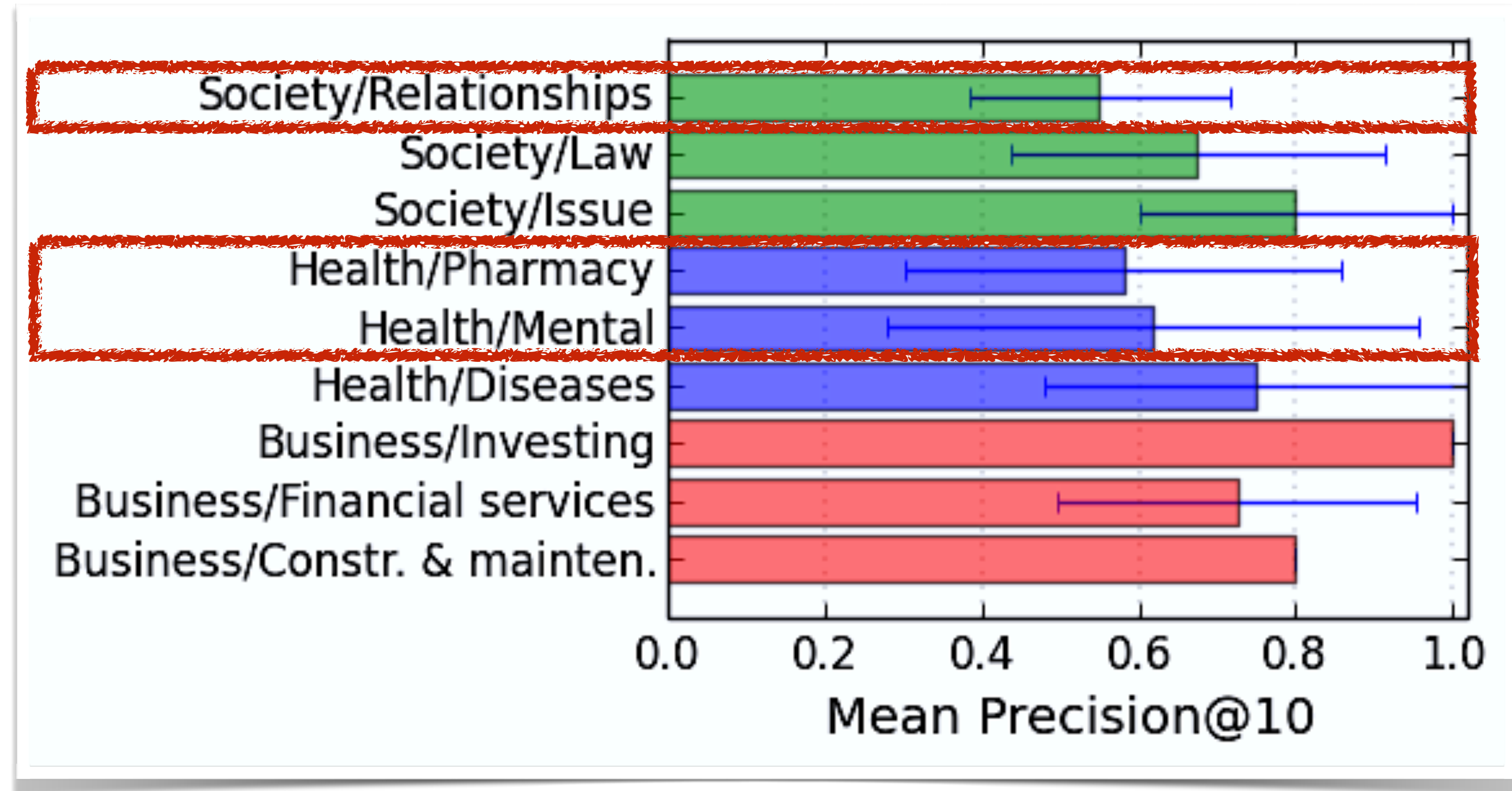


Outcomes with larger treatment effects
are more likely to be perceived as correct.

Precision: Are the Outcomes Correct?

E.g., finding true love, dealing with jealousy

E.g., suffering from bipolar disorder, taking lorazepam

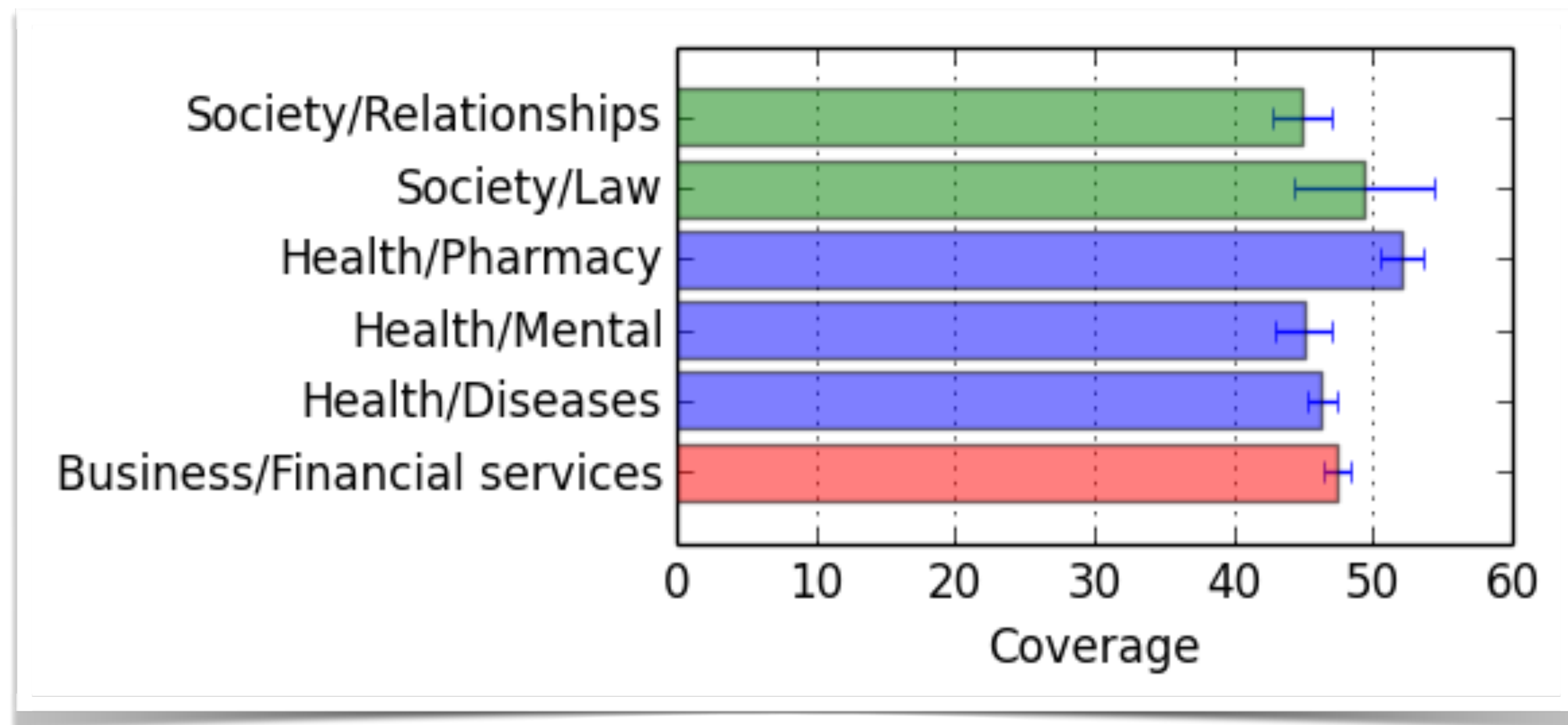


Mean Precision@10 across domains

Coverage: Do We Recover Known Outcomes?

ConceptNet5 (encyclopedia-based knowledge graph)

- coverage of both related concepts and shared relationships e.g.,
[Xanax **UsedFor** anxiety], [divorce **Causes** drink], [Lorazepam **isA** drug]
- higher discovery rates for outcomes with larger treatment effects



Types: What Kind of Outcomes We Distill?

Causal-like relations discovered at higher rates

- **implementation steps** e.g., HasSubEvent, HasFirstSubEvent
- **motivations and prerequisites** e.g., MotivatedByGoal, HasPrerequisite
- **implications** e.g., Desires, NotDesires, CapableOf, UsedFor, Causes

We miss more conceptual or descriptive relationships

- **definitions, alternate names or similar actions** e.g., DefinedAs, RelatedTo, IsA, SimilarTo

	HasFirstSubevent	HasPrerequisite	MotivatedByGoal	HasLastSubevent	Desires	CapableOf	HasSubevent	UsedFor	NotDesires	Causes	ReceivesAction	CausesDesire	HasProperty	HasA	DefinedAs	NotCapableOf	RelatedTo	IsA	SimilarTo	DerivedFrom
Prozac	66%	60%	56%	51%	54%	52%	50%	44%	51%	46%	42%	41%	40%	38%	31%	38%	30%	25%	9%	13%
Xanax	68%	57%	57%	50%	54%	51%	52%	42%	49%	47%	43%	45%	41%	40%	39%	38%	26%	26%	17%	12%
Lorazepam	65%	59%	59%	67%	56%	53%	52%	54%	52%	45%	44%	53%	41%	42%	42%	38%	28%	27%	20%	14%
Promethazine	60%	65%	61%	68%	56%	54%	54%	56%	52%	50%	49%	41%	45%	43%	38%	39%	42%	32%	20%	17%
Tramadol	68%	66%	64%	61%	56%	55%	56%	60%	52%	55%	46%	33%	44%	44%	44%	38%	43%	32%	17%	22%

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	HasFirstSubevent	HasPrerequisite	MotivatedByGoal	HasLastSubevent	Desires	CapableOf	HasSubevent	UsedFor	NotDesires	Causes	ReceivesAction	CausesDesire	HasProperty	HasA	DefinedAs	NotCapableOf	RelatedTo	IsA	SimilarTo	DerivedFrom
Prozac	66%	60%	56%	51%	54%	52%	50%	44%	51%	46%	42%	41%	40%	38%	31%	38%	30%	25%	9%	13%
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Exploration: When Do They Occur?

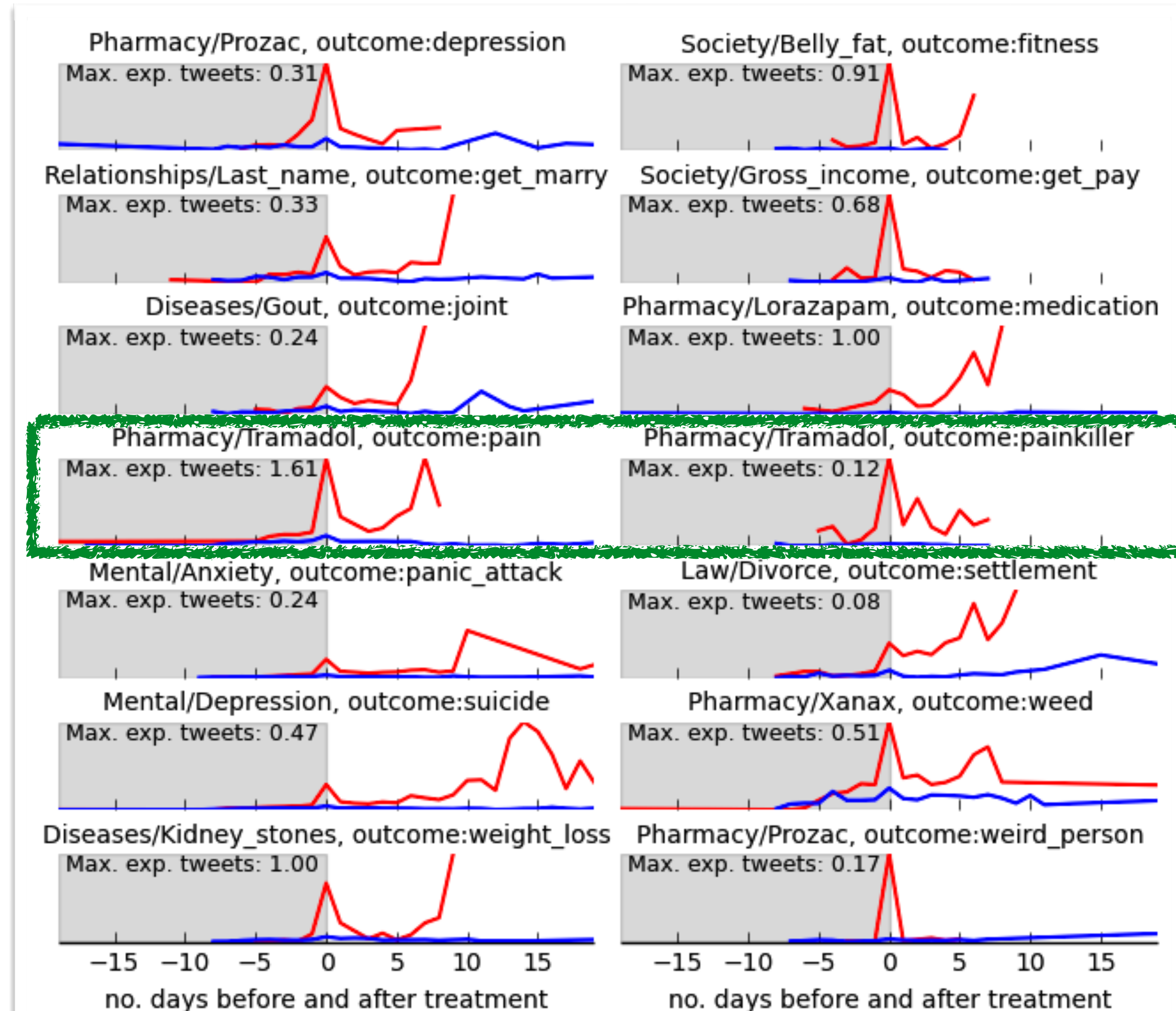
Temporal relationships with the target experience

- likely to occur with the experience
- more likely to occur several days later

Temporal interplay among the outcomes of an experience

treatment

control



Assumptions & Limitations

All confounding variables are included in the observed covariates (the terms used by a user)

→ Difficult to argue that all relevant aspects of individuals' lives are captured in their Twitter streams

One person outcome is independent of whether another person has the target experience

→ Conversations may contain e.g., retweets or use same hashtags

+ use of predefined time periods, ignore repeating events, etc.

Summary

Propensity score analysis can be applied to social media to distill relevant outcomes.

Results are challenging to evaluate, discussion context and topical information helps human judges.

Outcomes with larger treatment effects and larger statistical significance are more likely to be perceived as correct.

More likely to discover causally related concepts & known outcomes.

Applications for individuals, policy makers, and others.

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**KEEP
CALM
AND
QUESTION
EVERYTHING**