

# Scientific Listening

## Content Analysis for Online Discussion of Bipolar Disorder

### Intention

- Understand patient and physician's knowledge level of Bipolar Disorder
- Discover unmet need in Bipolar Disorder treatment and caregiving

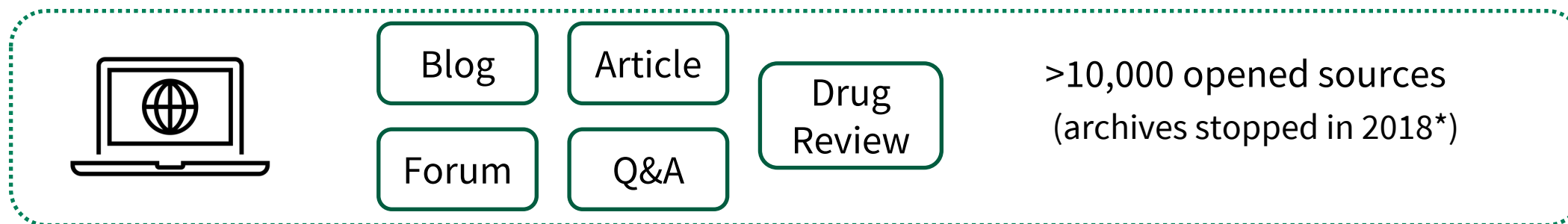
Bowen Lu  
Analyst, Data Service and Technology, Data Science

# Agenda

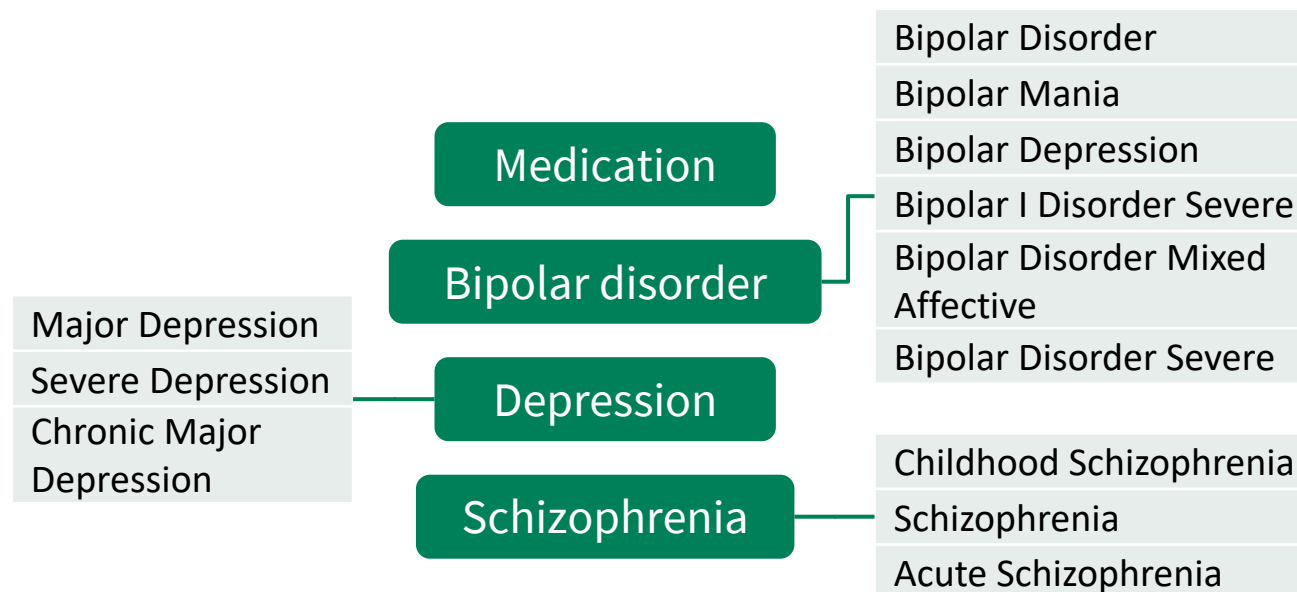
1. Data Source
2. Text Mining
3. Insights Example
4. Future Plan

## Data source

### A web-content database provided by our partner company



Extracting posts by the following key words:



# Overview of Data

## Online Posts (37953) (2001-2018)

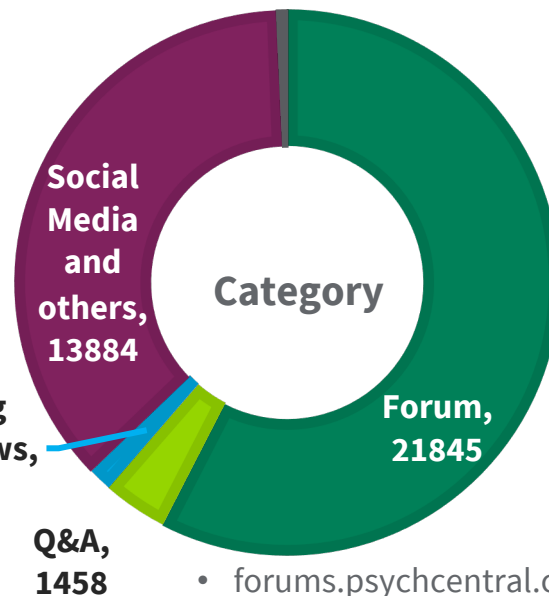
- mentalhealthdaily.com (126 posts)
  - natashatracy.com (41 posts)
  - peoplespharmacy.com (21 posts)
  - ibpf.org(17 posts)
  - ...
- Blog, 232**

- Reddit (8109 posts)
- Facebook (2540 posts)
- Twitter (609 posts)
- ...

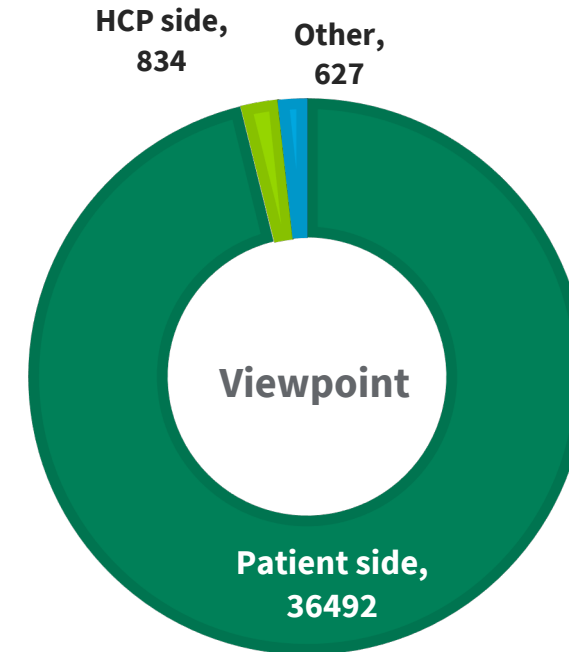
- drugs.com (358 posts)
- webmd.com (150 posts)
- medication.li (14 posts)
- ehealthme.com (12 posts)

- drugs.com (730 posts)
- dr-bob.org (641 posts)
- healthtap.com (43 posts)
- answers.yahoo.com (30 posts)
- ehealthme.com (12 posts)
- psychcentral.com/ask-the-therapist (2 posts)

- forums.psychcentral.com (5519 posts)
- www.crazymeds.us (4777 posts)
- www.crazyboards.org (2931 posts)
- bipolardisorderconnect.com (1188 posts)
- dailystrength.org (643 posts)
- ...



- dr-bob.org (641 posts)
- forums.studentdoctor.net (119 posts)
- healthtap.com (43 posts)
- conductdisorders.com (24 posts)
- usmleforum.com (3 posts)
- agingcare.com (2 posts)
- drhomeo.com (2 posts)



Not all data sources are professional and have content written by exact patient or physician.

So, we should consider evaluating data sources and focus on the ones that could benefit our research.

# Text Mining

Natural Language Processing Delimit paragraphs into single words, remove meaningless words

Love my latuda, I take a higher dose so I do take it around bedtime but had to go off of it do to running out and noticed a big difference. Inderal helps my anxiety, I take 10 mg 3x a day, but am more able to do normal things without panic attacks like run to the grocery store. Latuda did make me gain weight but that's the only side effect I remember. I think it's a great combo

## Text Cleaning

tokenization  
remove stop words  
text normalization

love latuda take higher dose take around  
bedtime go running big difference help anxiety  
take day able normal thing without panic attack  
like run grocery store latuda make gain weight  
side effect remember think great

## Feature Extraction

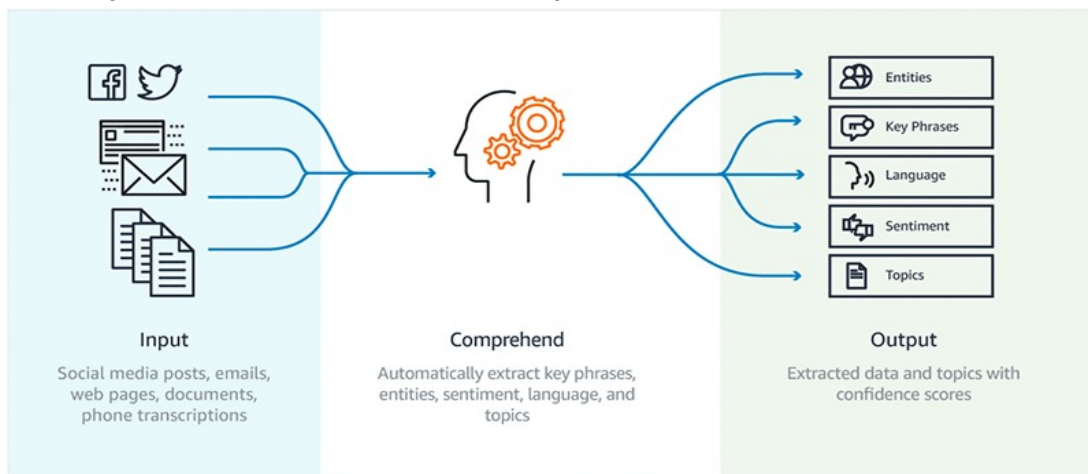
TfidfVectorizer  
CountVectorizer

[One-dimensional Array]

## Named Entity Recognition

Extract and highlight medical terms by AWS Medical Comprehend

(picture source: AWS Comprehend)



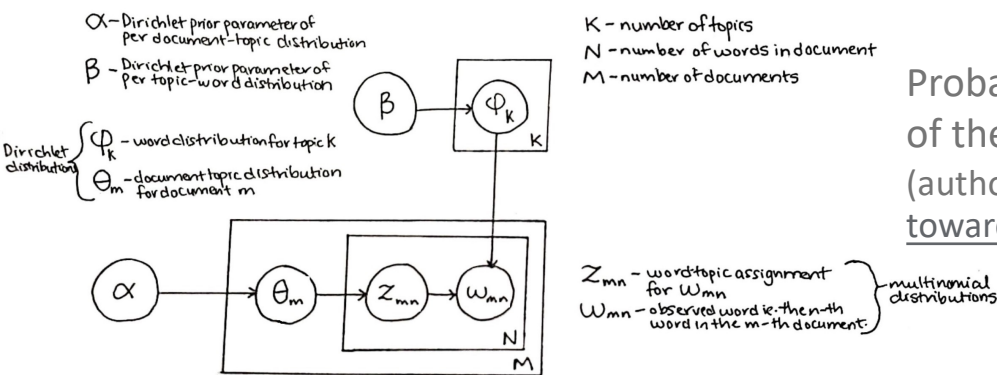
> > > After experiencing diminishing returns with treatment for the past two weeks, I have come to the conclusion that my discontinuation of Abilify MEDICATION is responsible for this diminution of response. > > > > I would prefer to not take Abilify MEDICATION because it raises my triglycerides level TEST\_TREATMENT\_PROCEDURE to over 400 mg/dL and keeps me 50 pounds overweight MEDICAL\_CONDITION. I might try Latuda MEDICATION first before returning to Abilify MEDICATION. Well, Latuda MEDICATION did not produce acceptable results. At 40 mg, it did not produce a satisfactory antidepressant response, and it left me feeling cognitively numb MEDICAL\_CONDITION and in a "brain ANATOMY -fog". Still, I believe that Latuda MEDICATION will help some people with depression MEDICAL\_CONDITION. Researchers are looking closely at 5-HT7 receptor antagonism and its antidepressant effects. Latuda MEDICATION does this. Some people may not need the D2/D3 partial agonism of Abilify MEDICATION, in which case, Latuda MEDICATION might be a good choice for its lack of metabolic side effects MEDICAL\_CONDITION. I restarted Abilify MEDICATION at 10 mg few days ago, and I am beginning to recapture an antidepressant response. Currently: Parnate MEDICATION 80 mg nortriptyline MEDICATION 150 mg Lamictal MEDICATION 200 mg Abilify MEDICATION 10 mg lithium MEDICATION 300 mg prazosin MEDICATION 6 mg It pisses me off that I need to take so many drugs, but beggars can't be choosers. - Scott



# Text Mining

## Topic modeling (LDA model)

Discover topics in posts by calculating most relevant terms



Probabilistic graphical representation of the LDA model with plate notation (author: Haaya Naushan, reference: [towardsdatascience.com](https://towardsdatascience.com))

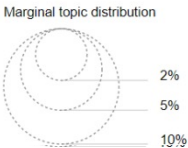
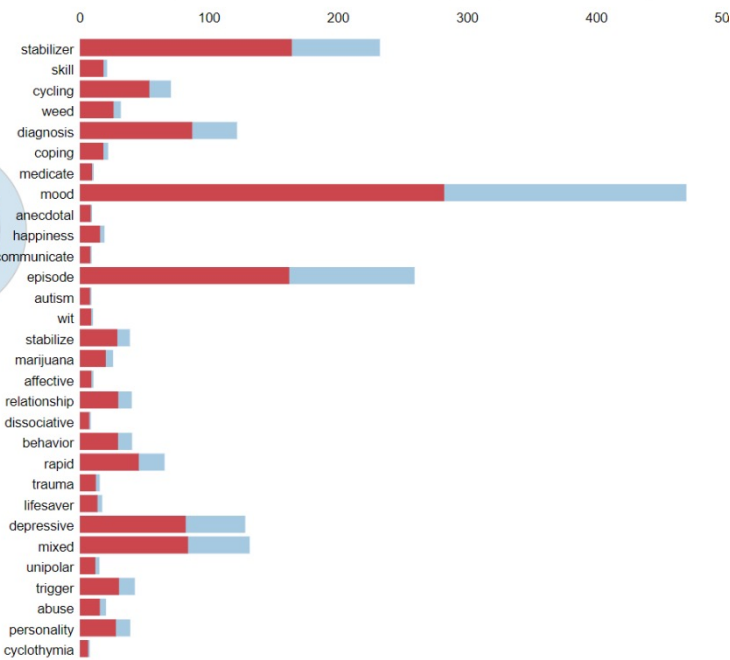
Selected Topic:  Previous Topic Next Topic Clear Topic

Slide to adjust relevance metric:(2)  
 $\lambda = 0.1$

Intertopic Distance Map (via multidimensional scaling)



Top-30 Most Relevant Terms for Topic 7 (28.2% of tokens)



Overall term frequency  
Estimated term frequency within the selected topic

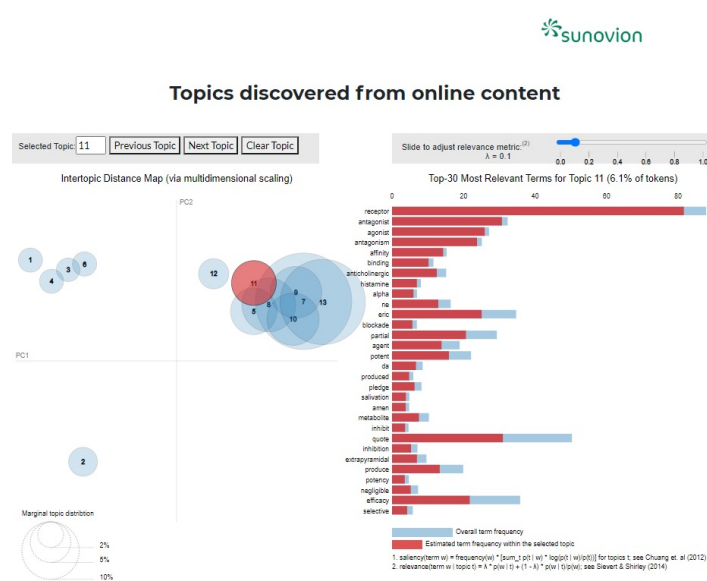
1. saliency(term w) = frequency(w) \* [sum\_t p(t | w) \* log(p(t | w)/p(t))] for topics t; see Chuang et. al (2012)  
2. relevance(term w | topic t) =  $\lambda * p(w | t) + (1 - \lambda) * p(w | t)/p(w)$ ; see Stevart & Shirley (2014)

| Cluster | Topics                                |
|---------|---------------------------------------|
| 1       | No specific                           |
| 2       | Drug commercial, prescription         |
| 3       | Ask for experience of taking the drug |
| 4       | No specific                           |
| 5       | Price, insurance, payment             |
| 6       | No specific                           |
| 7       | Patient experience; emotion; drugs    |
| 8       | Patient experience; caregiving        |
| 9       | Weight, metabolism                    |
| 10      | Diet, calories, grapefruit            |
| 11      | Drug action (receptor, antagonism)    |
| 12      | Pregnancy, breastfeeding              |
| 13      | Drug's side effect                    |



# Web application: key words search

Example: Search posts contain word “receptor” in Cluster 11



(Drug action)

Select a cluster you want to take look

Cluster 11

Key words search

receptor

For multiple keywords, please separate by "+"  
(example: sleep+weight+diet)

Search online content

Key word: receptor



<http://dr-bob.org/babble/20101020/msgs/967476.html>

>> **Lurasidone HCl MEDICATION** ( **Latuda MEDICATION** ) tablets have been approved by the U.S. Food and Drug Administration to treat adult schizophrenia MEDICAL\_CONDITION >>>>> - Scott >> How soon until it hits the market? Was it being used elsewhere before it was approved by the U.S.? Available in pharmacies in February 2011. That's what the website says. I might be trying this one. Though I'm never crazy about antagonizing dopamine receptors-one of the reasons why I'm not taking an AP right now.

<http://dr-bob.org/babble/20110115/msgs/977568.html>

I like that it does not seem to have affinity for the 5-HT<sub>2C</sub> or histamine receptors, if that would work for you. It shouldn't cause much weight gain MEDICAL\_CONDITION. How do you know of Dr. Amsterdam, have you spoken with him before? >> I would try an MAOI TEST\_TREATMENT\_PROCEDURE first before venturing down the antipsychotic road. Of course, you might need one as an augmentor anyway. I should check out **lurasidone MEDICATION** to see what properties it has. >>> <http://jpet.aspetjournals.org/content/early/2010/04/19/jpet.110.167346> >>> Interesting drug. I will probably give it a try if my doctor still wants to proceed with giving it a trial. >>> - Scott

<http://dr-bob.org/babble/20110115/msgs/978143.html>

> Thanks for the suggestion, SLS. Here's my list of helpful meds... **Lurasidone MEDICATION** ( **Latuda MEDICATION** ) should reach store shelves very soon. The drug was developed as an antipsychotic, but has shown activity as an antidepressant TEST\_TREATMENT\_PROCEDURE as well. I will most likely try this drug next. It is a potent antagonist of 5-HT<sub>7</sub> receptors along with being a partial agonist TEST\_TREATMENT\_PROCEDURE of 5-HT<sub>1a</sub> receptors. **Lurasidone MEDICATION** is also an antagonist at D<sub>2</sub> and 5-HT<sub>2a</sub> receptors similar to the other atypical antipsychotics. Linkage will most likely be able to characterize the 5-HT<sub>7</sub> receptor and its functions. It might be a good time for us to explore the 5-HT<sub>7</sub> receptor. - Scott

<http://dr-bob.org/babble/20120202/msgs/1009172.html>

**Latuda MEDICATION** ( **lurasidone MEDICATION** ) is an atypical antipsychotic that has been out for about a year. Weight gain MEDICAL\_CONDITION and metabolic side effects don't seem to be problems according to what I've read. **Latuda MEDICATION** is a relative of **Geodon MEDICATION** ( **ziprasidone MEDICATION** ), but lacks the NE/5-HT reuptake inhibition of **Geodon MEDICATION**. **Latuda MEDICATION** also blocks 5-HT<sub>7</sub> receptors, an effect that might explain its purported antidepressant properties. - Scott



In the result page:

1. Full text of posts are displayed, with source URL
2. Medical terms are recognized by AWS Medical Comprehend, which may be incorrect but reflect people's knowledge level.

**ANATOMY** **MEDICATION** **MEDICAL\_CONDITION** **TEST\_TREATMENT\_PROCEDURE**

# Get insights from topics and actual posts

## Example 1: Pregnant women do not know if a medication is safe for breastfeeding (unmet needs)

- 443 posts discuss pregnancy, **78 out of 443 (17.6%)** mention breast feeding
- 353 authors discuss pregnancy, **70 out of 353 (19.8%)** mention breast feeding

<http://community.babycenter.com/post/a42121696/latuda?cpg=3#c2499071772>

I am taking **Latuda MEDICATION** (which, might I say, has been a wonder drug for me as well) but am trying to conceive. I plan to stay on the medication throughout the **pregnancy MEDICAL\_CONDITION**, but it is unclear whether I will be able to **breastfeed**. What was your experience?

<http://community.babycenter.com/post/a42121696/latuda?cpg=4#c2522139919>

I was switched to **latuda MEDICATION** when my husband and I decided to try to get **pregnant MEDICAL\_CONDITION**. It is a class B drug and safer than any other atypical antipsychotic out there. I'm almost 8 months **pregnant MEDICAL\_CONDITION** now and my baby appears to be very **healthy MEDICAL\_CONDITION**. I have had one dose increase (2nd trimester) and really need another one now (I'm up 60mg). My doctor pulled me from work in hopes the reduced stress would avoid the need for an increase. We will see. I'm planning on **breastfeeding** as well. I haven't seen any publications out there on safety during **breastfeeding** and none of my doctors (psych or OB) know of any studies on it. Since my baby is healthy so far with me being on it all through **pregnancy MEDICAL\_CONDITION**, I'm thinking the benefits of breastmilk outweigh any risks from **latuda MEDICATION**. Good luck! I've been diagnosis **Type I bipolar MEDICAL\_CONDITION** for about 15 years so hoping I will be able to manage symptoms through sleepless nights.

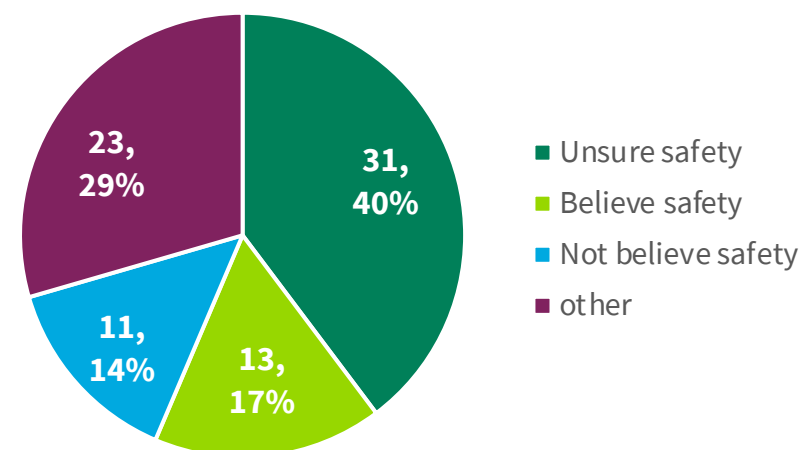
<http://community.babycenter.com/post/a42121696/latuda?cpg=4#c2523800455>

I am currently on both **lamictal MEDICATION** and **latuda MEDICATION** and am 22 weeks. My baby is very **healthy MEDICAL\_CONDITION**. While I empathize with your concerns, being emotionally unstable during **pregnancy MEDICAL\_CONDITION** can be augh bigger risk to your child than being on certain medications. Ultimately, it is a decision that you will have to make with your prenatal care practioner and your psychiatrist...and SO. However, there is a lot of mixed information about taking **lamictal MEDICATION** or **latuda MEDICATION** while **breastfeeding** which is currently what I'm trying to figure out too. Best wishes to you!

<http://community.babycenter.com/post/a42121696/latuda?cpg=4#c2522940682>

Currently **pregnant MEDICAL\_CONDITION**. 30 weeks. And I've been taking **Latuda MEDICATION** the entire time. Baby is completely **healthy MEDICAL\_CONDITION**. Doctor did inform me that **breastfeeding** would not be a safe option. My body currently filters the medicine so much the baby barely gets it right now. But to **breastfeed** on it would be giving the baby a more intense dose.

Breast feeding post (78)

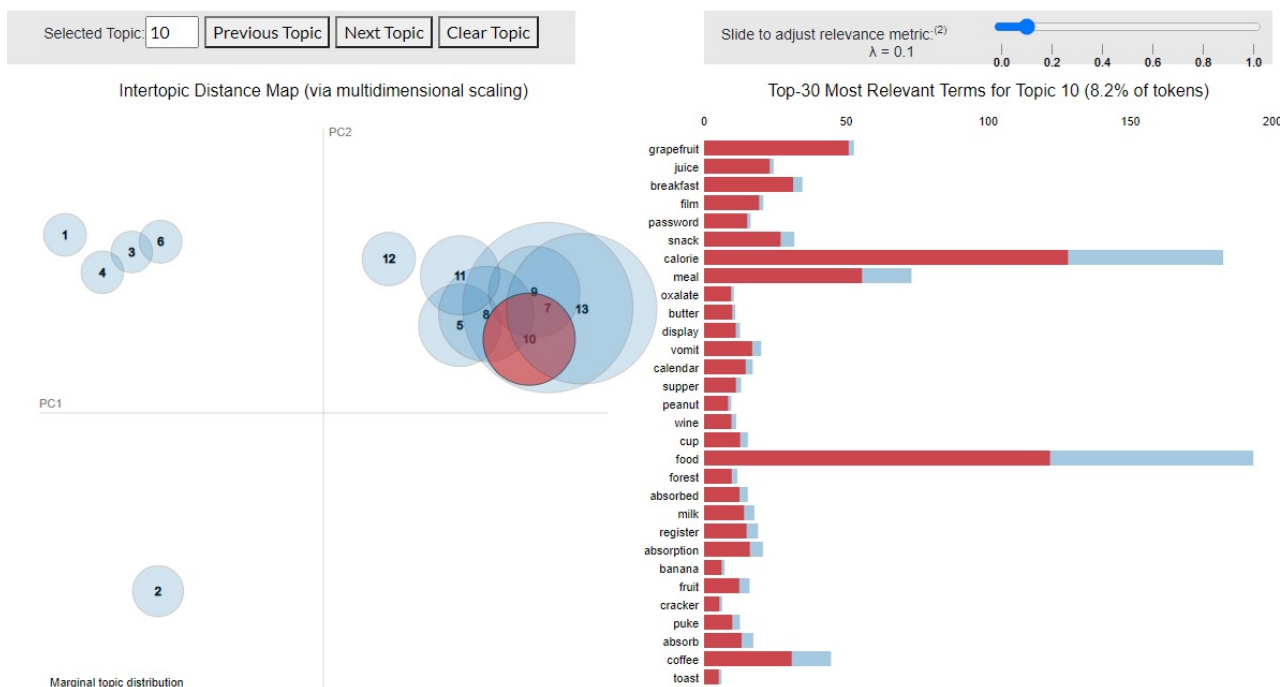


There is no published experience with the medication during breastfeeding

# Get insights from topics and actual posts

## Example 2: Why should avoid grapefruit or grapefruit juice while taking the medication? (knowledge level)

### Topics discovered from online content



<http://forum.schizophrenia.com/t/just-started-latuda-does-it-matter-if-i-alternate-between-taking-it-in-afternoon-and-night/96713>

You can have some snacks. 350 calories at night could be A cup of yogurt with honey Or fruit yogurt + An apple and another fruit + A cup of almond or coconut milk Don't forget you should not eat **grapefruit** with **Latuda MEDICATION**

<http://forums.psychcentral.com/bipolar/385241-article-why-shouldnt-i-drink-grapefruit-juice-my-meds.html#post4338576>

Article--Why Shouldn't I Drink **Grapefruit** Juice With My Meds? I personally love **grapefruit**, so I was a little bummed when I found out I should avoid it with **Latuda MEDICATION**. For some weird reason, I was thinking about **grapefruit** this afternoon. Thought I would share this article since there are a lot of psychiatric meds you that you have to avoid **grapefruit** with. Sorry fellow lovers of **grapefruit**... Why Shouldn't I Drink **Grapefruit** Juice With My Meds?

<http://forums.psychcentral.com/schizophrenia-psychosis/340227-roll-call-27-a-39.html#post3799452>

Yeah I was getting it from what I thought at first was diet 7 up bc I thought maybe that had **grapefruit** juice in it. Then I got it from diet coke. I was on the bus making weird faces and pacing. I thought I was gonna lose my mind. That's when I said no more. When I get akathisia I feel like I'm gonna fall through the floor. So then I have to move constantly. It's horrid! Horrible intense **anxiety MEDICAL\_CONDITION** and **agitation MEDICAL\_CONDITION**. Then I have to take **mass MEDICAL\_CONDITION** amounts of **congentin MEDICATION**, **visteral MEDICATION** and **inderal MEDICATION** to get it to go away. I was on **latuda MEDICATION** for about 2 months and I just couldn't handle it anymore.

[http://forums.thebump.com/discussion/12484585/looks-like-someone-has-a-case-of-the-mondays-randoms/p6#Comment\\_85287813](http://forums.thebump.com/discussion/12484585/looks-like-someone-has-a-case-of-the-mondays-randoms/p6#Comment_85287813)

It interferes with drug metabolism. It means that **latuda MEDICATION** is metabolized through a CYP3A4 pathway, which is inhibited by **grapefruit** juice, this increasing the drugs bioavailability. Meaning that the person gets more active ingredient than anticipated. It's an incredibly common **phenomena MEDICAL\_CONDITION**, and we try to develop drugs that avoid the enzyme when possible. (Did you really expect an answer, or did I make an ass out of myself?)

# Get insights from topics and actual posts

Example 2: Why should avoid grapefruit or grapefruit juice while taking the medication? (knowledge level)

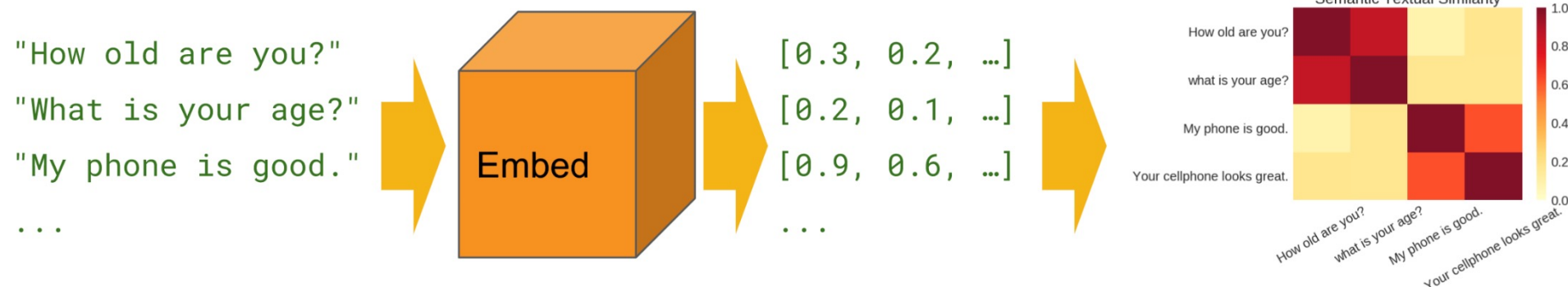
## Tool

### Universal Sentence Encoder

(developed by Google, trained by a variety of language corpus, run on Tensorflow framework)

1. Split each post into a list of sentences, select question sentences ended with “?”
2. Put question sentences into the model. It encodes each question into a 512 dimensional vector
3. Calculate the similarity between each two vectors
4. Plot them on Clustermaps: vectors with high similarity are gathered

(picture source: TensorFlow Hub)



# Get insights from topics and actual posts

## Example 2: Why should avoid grapefruit or grapefruit juice while taking the medication? (knowledge level)

Ant the grapefruit extract.....why is that?  
What the heck does have that you can't drink grapefruit juice with it?!

It says you can't have grapefruit or grapefruit juice?  
Bipolar meds commercial "you should avoid grapefruit or grapefruit Juice while on really?...

Are you even safe to be around the Hanes fruit guys or are they all going to be fruit ninja'd into a fruit salad?  
Why can't you eat a grapefruit while taking

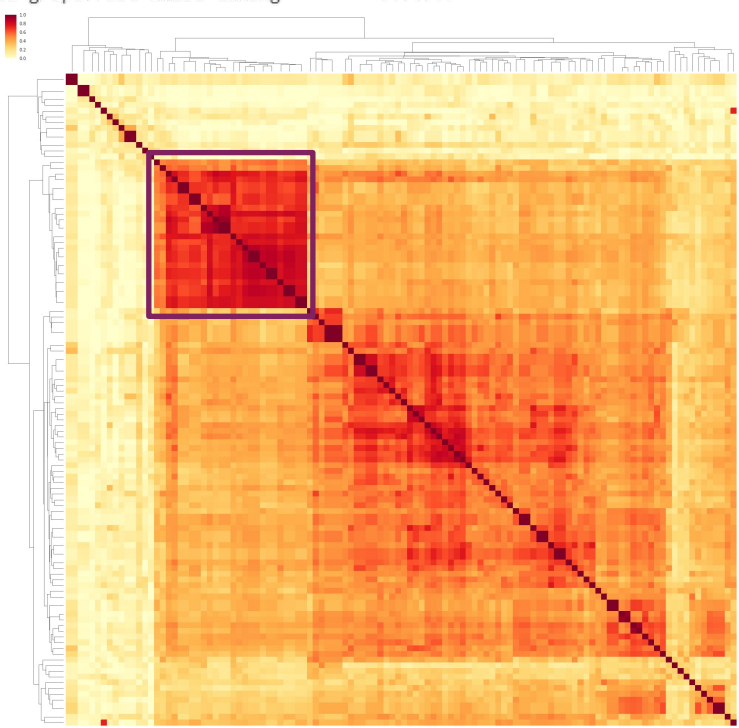
Why must you avoid grapefruit and grapefruit juice while on #  
Why can't you drink grapefruit juice on

Why can't you drink grapefruit juice while taking ?  
Avoid grapefruit and grapefruit juice????

Avoid grapefruit and grapefruit juice while taking first of all LATUDA??  
Avoid Grapefruit or drinking grapefruit juice while taking .. What?

Avoid grapefruit and grapefruit juice while taking .. Alright?  
You can't eat a fruit?

If you are using Latuda you are to avoid Grapefruit and Grapefruit Juice?  
Avoid grapefruit while taking ..?????



Universal  
Sentence  
Encoder



Heatmap

Extract questions from posts and categorize them,  
discover **most frequently asked questions**

286 posts and replies about grapefruit issues,  
only find less than 20 matched answers

- “It can affect (increase) the blood level of the drug” - 6 posts
- “It increases the effect because it causes levels of the drug to accumulate in the body.”
- “the person gets more active ingredient than anticipated.”
- “Ingesting grapefruit or grapefruit products can cause a dangerous buildup of the amount in your system.”
- “It inhibits the liver enzyme that metabolizes the drug, increasing serum levels and causing side effects.”
- “It has a tendency to affect mood swings.”
- “The body may absorb too much of the drug and it can be toxic.”
- “It can cause restlessness or restless legs.”
- “Your limbs will fall off.”
- “Life-threatening”, “You will die”



# Future Plan

## **1. Involve more up-to-date online discussion about Bipolar Disorder**

- Collect public posts and replies on social media (Twitter, Reddit) until 2021

## **2. Find solutions to get more Physician and Patient discussion online**

- Collect social media posts written by authors with his/her bio containing HCP related titles
- Get access to HCP communities like Doximity and Sermo

## **3. Upgrade the web application and hold more insights**

- Build pipeline to capture, process, and display new content
- Display online posts from patient, HCP, or KOL, in a separate section
- Conduct collective analysis on the topics, knowledge level, and frequently asked questions

# Thank You!