

Today

- Depression
- Schizophrenia
- Dementia – Alzheimer's Disease
- Ethics



HEALTHYPLACE.COM

Language as a marker



Quantifying Mental Health Signals in Twitter (Coppersmith et al., 2014)

- Automatically identify self-expressions of mental illness diagnoses
 - Leverage these to construct a labeled dataset

Quantifying Mental Health Signals in Twitter (Coppersmith et al., 2014)

- Genuine statements of diagnosis:
 - @USER The VA diagnosed me with PTSD, so I can't go in that direction anymore
 - I wanted to share some things that have been helping me heal lately. I was diagnosed with severe complex PTSD and... LINK
- Disingenuous statement of diagnosis:
 - LOL omg my bro the "psychologist" just diagnosed me with seasonal ADHD AHAHAHAHAHAHAHAHAHA IM DYING.

Quantifying Mental Health Signals in Twitter (Coppersmith et al., 2014)

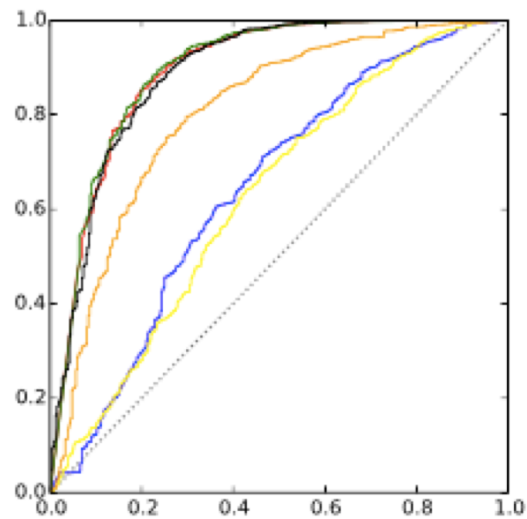
	Match	Users	Tweets
Bipolar	6k	394	992k
Depression	5k	441	1.0m
PTSD	477	244	573k
SAD	389	159	421k
Control	10k	5728	13.7m

Table 2: Number of users **matching** the diagnosis regular expression, **users** labeled with genuine diagnoses and **tweets** retrieved from diagnosed users for each mental health condition.

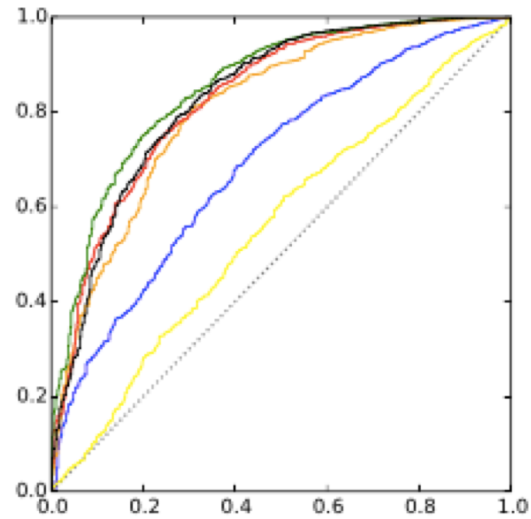
Features

- LIWC
- Language Models (LMs)
 - Unigrams (ULM)
 - Characters (CLM)
- Pattern of life
 - Social engagement
 - Insomnia
 - Exercise
 - Sentiment

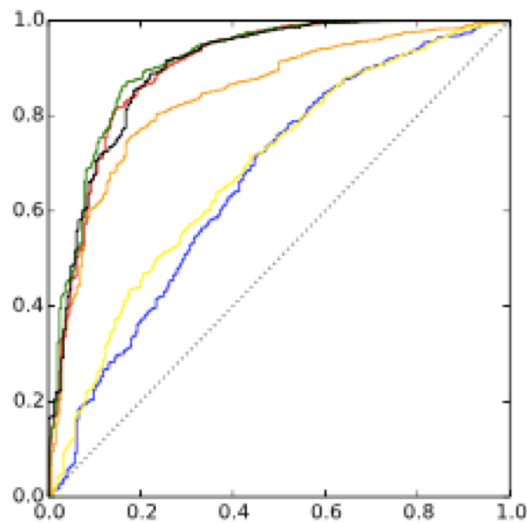
Bipolar



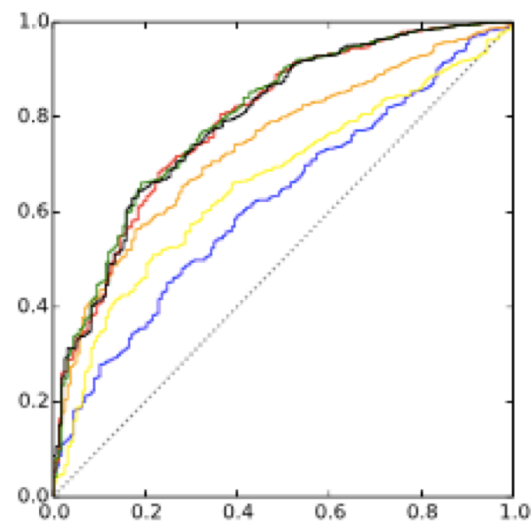
Depression



PTSD



SAD



Depression

- Mood disorder that causes a persistent feeling of sadness and loss of interest
- Statistics
 - 16 million adults had at least 1 major depressive episode in 2012 (NIMH)
 - 350 million people worldwide suffer from depression (WHO)
 - Depression is the cause of over 2/3 of suicides in the US each year (White House Conference on Mental Health)
 - Women experience depression at 2x the rate of men (Journal of AMA)

Telltale Signs of DEPRESSION

Everyone feels sad, lonely or depressed at times. But when these feelings last for a long time and become overwhelming, it maybe time to seek medical help.



Loss of interest in hobbies and activities



Difficulty remembering, concentrating or making decisions



Loss of appetite or over-eating



Feeling worthless, guilty or helpless



Feeling irritable or having a short temper



Feeling fatigued



Insomnia or excessive sleeping



Feeling hopeless or pessimistic



Continuous sad, anxious, or negative thoughts



Thoughts of suicide, or suicide attempts

Diagnosis

- Diagnostic assessment by GP, psychologist, or psychiatrist
 - Examine biological, psychological, social factors
- Rating scales
 - Hamilton rating scale for depression
 - Beck depression inventory
 - Suicide behaviors questionnaire

Treatments

- Psychotherapy
- Medication – antidepressants
- Electroconvulsive therapy
- Lifestyle
 - Exercise
 - Smoking cessation
 - Diet

Predicting Depression via Social Media

(De Choudhury et al., 2013)

- Use crowdsourcing to identify Twitter users with clinical depression
- Measure behavioral attributes from tweets 1 yr prior to diagnosis
- Estimate risk of depression *before* diagnosis

Data

- Depression screening test: CES-D questionnaire
 - <http://cesd-r.com>
 - Amazon Mechanical Turk
 - Workers could opt in to share Twitter username
 - Quality control
- Self-reported information
 - Clinical diagnosis of depression
 - Estimated time of onset
 - Using antidepressants

Data

- 1,583 responses; 40% shared Twitter feeds
- 476 users with depression diagnosis (after removing noisy responses)
 - 243 male, 233 female
- 171 users who scores positive for depression on CES-D
- 2,157,992 tweets retrieved

Data

Having a job again makes me happy. Less time to be depressed and eat all day while watching sad movies.

“Are you okay?” Yes.... I understand that I am upset and hopeless and nothing can help me... I’m okay... but I am not alright

“empty” feelings I WAS JUST TALKING ABOUT HOW I I HAVE EMOTION OH MY GOODNESS I FEEL AWFUL

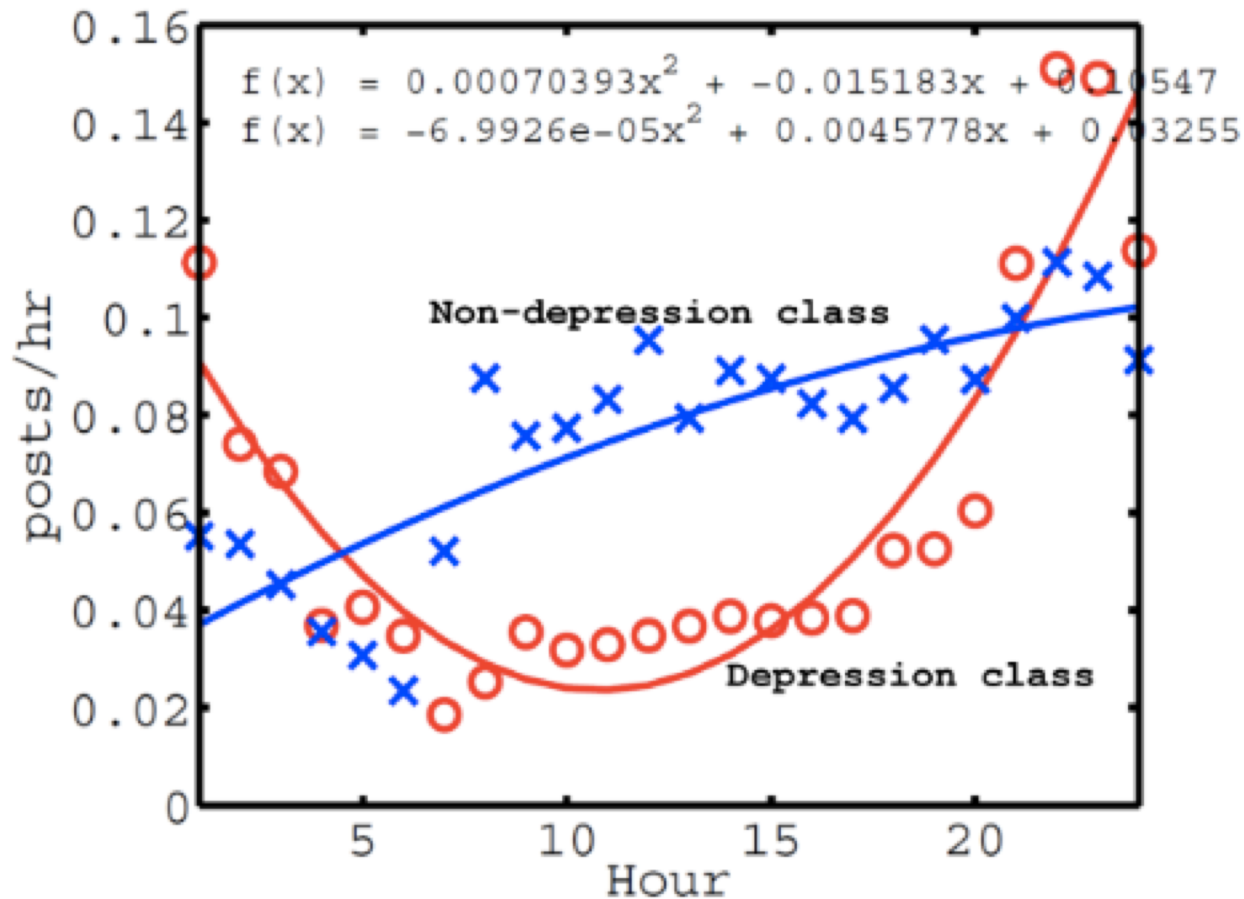
I want someone to hold me and be there for me when I’m sad.

Reloading twitter till I pass out. *lonely* *anxious* *butthurt*
frustrated *dead*

Measuring Depressive Behavior

- Engagement
- Insomnia index
- Egocentric network measures
- Emotion
- Linguistic style
- Depression language

Tweet Activity and Depression



Depression prediction

	precision	recall	acc. (+ve)	acc. (mean)
engagement	0.542	0.439	53.212%	55.328%
ego-network	0.627	0.495	58.375%	61.246%
emotion	0.642	0.523	61.249%	64.325%
linguist. style	0.683	0.576	65.124%	68.415%
dep. language	0.655	0.592	66.256%	69.244%
demographics	0.452	0.406	47.914%	51.323%
all features	0.705	0.614	68.247%	71.209%
dim. reduced	0.742	0.629	70.351%	72.384%

Schizophrenia

- Chronic mental disorder
- Symptoms:
 - Positive: hallucination, delusion, thought disorders, movement disorders
 - Negative: “flat affect”, reduced feelings of pleasure, reduced speaking
 - Cognitive: poor executive functioning, trouble focusing or paying attention, problems with working memory

Schizophrenia and language

- “Negative thought disorder”
 - Alogia – poverty of speech
- “Positive thought disorder”
 - Derailment
 - Tangentiality

Schizophrenia and language

- Derailment

“I always liked geography. My last teacher in that subject was Professor August A. He was a man with black eyes. I also like black eyes. There are also blue and grey eyes and other sorts, too...” (Bleuler, 1950)

- Tangentiality

“Well, in myself I have been okay what with the prices in the shops being what they are and my flat is just round the corner. I keep a watch for the arbiters most of the time since it is just round the corner. There is not all that much to do otherwise.”

Schizophrenia and language

- Word-level abnormalities

“I got so angry I picked up a dish and threw it at the geshinker”

“So I sort of bawked the whole thing up”

Word salad

“They’re destroying too many cattle and oil just to make soap. If we need soap when you can jump into a pool of water, and then when you go to buy your gasoline, my folks always thought they should, get pop but the best thing to get, is motor oil, and, money. May may as well go there and, trade in some, pop caps and, uh, tires, and tractors to grup, car garages, so they can pull cars away from wrecks, is what I believe in. So I didn’t go there to get no more pop when my folks said it. I just went there to get a ice-cream cone, and some pop, in cans, or we can go over there to get a cigarette”

Quantifying the Language of Schizophrenia in Social Media (Mitchell et al., 2015)

- Data: 174 Twitter users with self-stated diagnosis of schizophrenia
 - Age and gender matched controls, balanced dataset
- Features:
 - LIWC
 - Open-vocabulary approaches
 - LDA, Brown clustering, character n-grams, perplexity

LIWC analysis

- Schizophrenia users had more words from these categories: Cognitive mechanisms, death, function words, negative emotion
- And fewer words from these categories: home, leisure, positive emotion

Classification results

Features	SVM	MAXENT
Perplexity (ppl)	52.0	51.4
Brown-Cluster Dist (BDist)	53.3	72.3
LIWC	68.8	70.8
CLM	77.1	77.2
LIWC+CLM	78.2	77.2
LDA Topic Dist (TDist)	80.4	80.4
CLM+TDist+BDist+ppl	81.2	79.7
CLM+TDist	81.5	81.8
LIWC+TDist	82.3	81.9

Linguistic Analysis of Schizophrenia in Reddit Posts

Reddit:

- No limits on post length
- Subreddits
- Python API Wrapper (PRAW)

Data

- Subreddits:

r/schizophrenia

r/schizophrenic

r/AskReddit: “Any Redditors With Schizophrenia?”

- Manual inspection for formal diagnosis
e.g. “my diagnosis of schizophrenia”

Data

- SZ: 159 users; 66,454 comments
- Control: 159 users; 113,570 comments

At least 10 posts per user

LIWC Analysis

- Comparison of LIWC findings across 5 studies in multiple domains (Reddit, Twitter, discussion boards)
- SZ indicators across studies:
 - increased: negative emotion, first person singular pronouns, tentative, cognitive process, health, anxiety, third person plural pronouns
 - decreased: leisure
- SZ indicators in Reddit:
 - increased: word count

LIWC Analysis

Logistic Regression: 81.56% accuracy

Control (CTL)		Schizophrenia (SZ)	
Weight	Feature	Weight	Feature
-1.2748	Sadness	1.6105	Health
-1.1109	Quotation mark	1.0717	Interrogatives
-0.8715	3rd person singular	1.0614	Tentative
-0.7956	Feel	0.9825	Hear
-0.7949	Articles	0.9426	Colon
-0.7302	Nonfluencies	0.9304	Death
-0.6705	Adjectives	0.8021	Biological processes
-0.6329	See	0.7642	1st person singular
-0.6214	Motion	0.6975	Parentheses
-0.6182	Present focus	0.6478	Verbs

Dementia

- Broad category of brain diseases that cause long term decrease in ability to think and remember
- Most common type - Alzheimer's disease (AD)
 - 60%-70% of cases
- Affects 27.5 million people
 - 3% of people 65-74
 - 19% of people 75-84
 - ~50% of people >85
- \$604 billion in costs per year

AD Symptoms

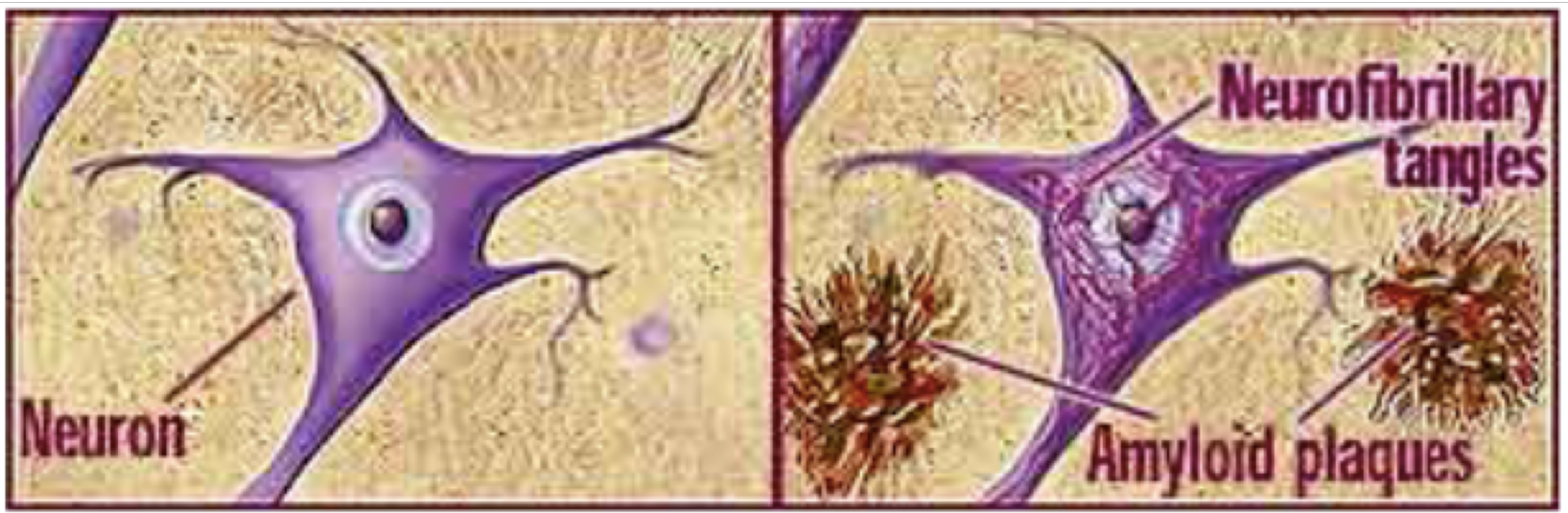
- Short-term memory loss
- Problems with language
- Disorientation
- Mood swings
- Decreased motivation

Cause

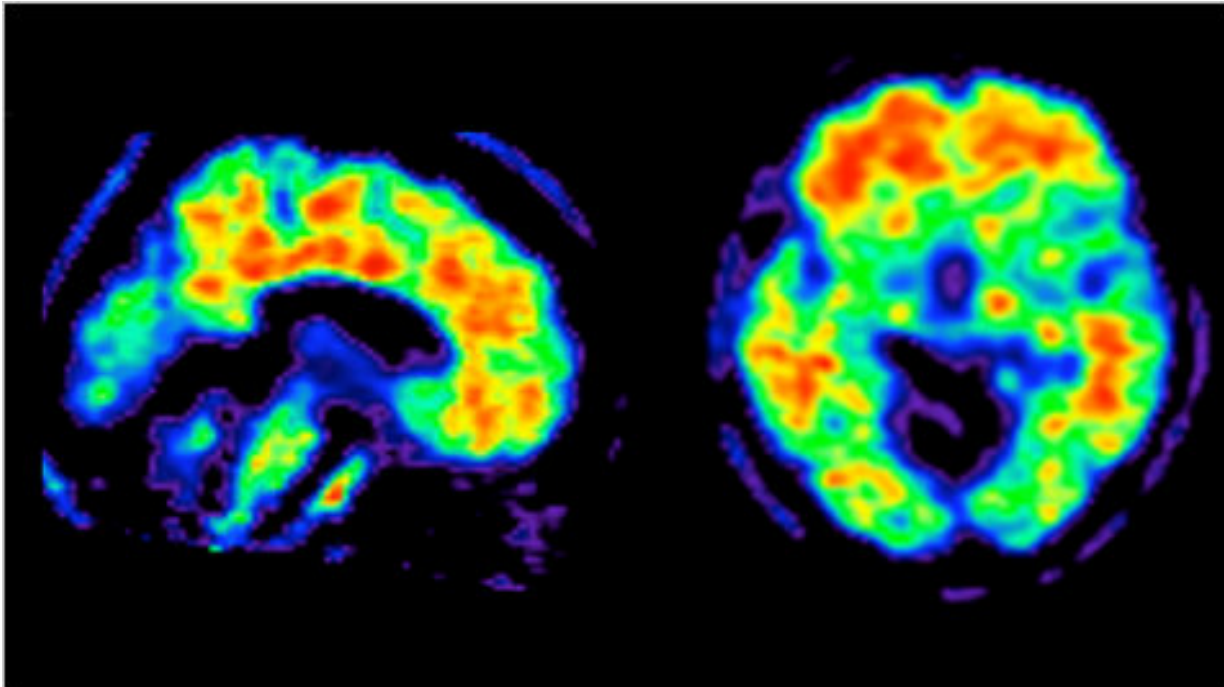
- 70% of risk is believed to be genetic
- Risk factors:
 - Head injuries
 - Depression
 - Hypertension

Pathology

- Amyloid plaques
- Tau tangles



Amyloid plaques



Diagnosis

- Can only be definitively diagnosed in a postmortem brain tissue examination
- Clinical assessment

Clinical Assessment

- Medical history
- Physical exam
- Neurological exam
- Mental status tests

Mental status tests

- Mini-mental state exam (MMSE)
 - <http://www.dementiatoday.com/wp-content/uploads/2012/06/MiniMentalStateExamination.pdf>
- Mini-cog
 - http://www.alz.org/documents_custom/minicog.pdf



Normal
Score 10



Mild
Cognitive
Impairment
(Numbers error
and
placement
of hands)
Score 8



Moderate
Cognitive
Impairment
Score 4



Severe
Cognitive
Impairment
Score 2

Sunderland, 1989

UB

74

Stages of AD

Mild Cognitive Impairment



Duration: 7 years

Disease begins in
Medial Temporal Lobe

Symptoms:
Short-term
memory loss

Mild Alzheimer's



Duration: 2 years

Disease spreads to
Lateral Temporal &
Parietal Lobes

Symptoms include:
Reading problems
Poor object recognition
Poor direction sense

Moderate Alzheimer's



Duration: 2 years

Disease spreads to
Frontal Lobe

Symptoms include:
Poor judgment
Impulsivity
Short attention

Severe Alzheimer's



Duration: 3 years

Disease spreads to
Occipital Lobe

Symptoms include:
Visual problems

Stages of AD

- Pre-dementia
 - Mild Cognitive Impairment (MCI)
 - Short-term memory loss
- Early
 - Increased impairment of learning and memory
- Moderate
 - Increased impairment of learning and memory

Treatment

- Medication for symptoms
- Clinical trials

Language Indicators of AD

- Can we predict AD from writing analysis?

Case study: Agatha Christie



Nun Study

- Longitudinal study, 1986- (David Snowden)
- 678 Roman Catholic sisters
- Homogenous group
- Autobiographical essays

Nun Study - excerpts

- "It was about a half hour before midnight between February 28 and 29 of the leap year 1912 when I began to live, and to die, as the third child of my mother, whose maiden name is Hilda Hoffman, and my father, Otto Schmidt..."
- "I was born in Eau Claire, Wisconsin on May 24, 1913, and was baptized in St. James Church..."

Nun Study - findings

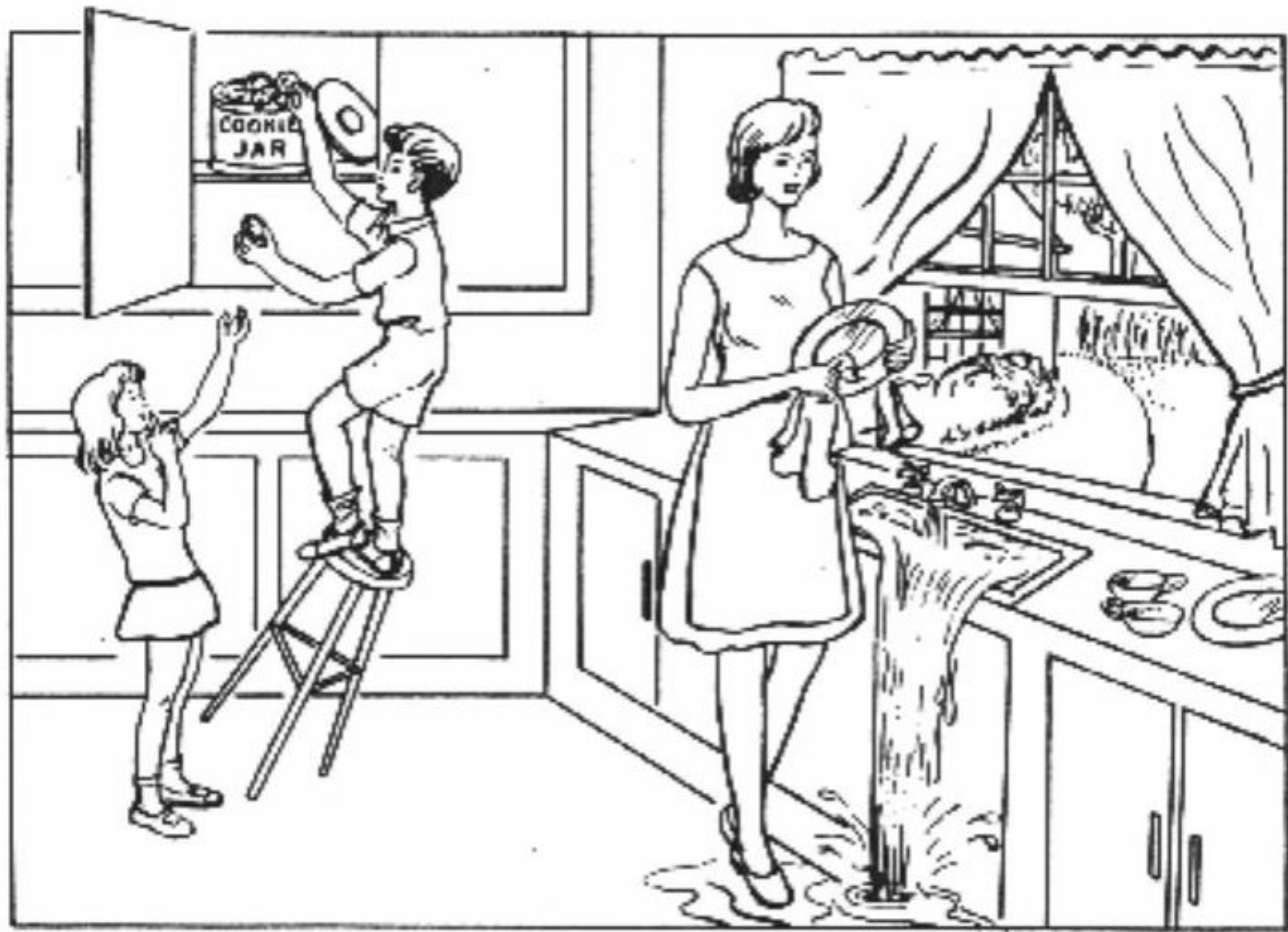
- Sisters who scored poorly on
 - Idea density
 - Grammatical complexitywere much more likely to develop dementia
- E.g. sisters in lower third of idea density were **60 times** more likely to develop AD than sister in upper third
- Using essays, predict with 92% accuracy whether the brain would contain plaques post-mortem

Vector-space topic models for detecting Alzheimer's disease (Yancheva & Rudzicz, 2016)

- Measure semantic content deficiency
 - Idea density – ratio of semantic units to total number of words
 - Efficiency – rate of semantic units over duration of speech sample

Measuring semantic content

- Picture description task
- Human-supplied information content units (hsICUs)



Method

- Data: DementiaBank

- Samples:

- <http://www.talkbank.org/browser/index.php?url=DementiaBank/English/Pitt/Dementia/cookie/010-4.cha>

- <http://talkbank.org/browser/index.php?url=DementiaBank/English/Pitt/Control/cookie/013-0.cha>

DementiaBank Subset

Table 1: Distribution of dataset transcriptions.

Class	Subjects	Samples	Tokens
AD	168	255	24,753
CT	98	241	26,654
Total	266	496	51,407

Automatic ICU generation

- Train word vector model on large general purpose corpus (GloVe)
- Extract vector representations of words in DementiaBank corpus
- Cluster vectors separately for AD and control group -> represent “topics”

	ID	Cluster words
Control	C0	window, floor, curtains, plate, kitchen
	C1	dishes, dish
	C2	running, standing, action, hand, counter
	C3	water, sink, drying, overflowing, washing
	C4	stool, legged
	C5	mother, boy, girl, sister, children
	C6	cookie, cookies, sakes, cream
	C7	jar, cups, lid, dried, bowl
	C8	see, going, getting, looks, know
	C9	reaching, falling, fall, summer, growing
Dementia	D0	cookie, cookies, cake, baking, apples
	D1	dishes, dish, eating, bowls, dinner
	D2	boy, girl, mother, sister, lady
	D3	going, see, getting, get, know
	D4	stool, floor, window, chair, curtains
	D5	jar, cups, jars, dried, honey
	D6	sink, drying, washing, spilling, overflowing
	D7	mama, huh, alright, johnny, ai
	D8	running, fall, falling, reaching, hand
	D9	water, dry, food

Cluster analysis

- Do clusters match hsICUs?
- Do the topics differ between groups?

Cluster analysis

- Do clusters match hsICUs?
 - Yes (except “dishcloth”)
- Do the topics differ between groups?
 - Yes!
 - Control group: overflowing, sink, indifferent, mother, apron, window, curtain, cupboard, counter
 - AD group: brother, sister, son, daughter

Quantifying Irrelevance

- Align pairs of clusters between 2 models
- All control clusters are recalled by AD model
- D7 not recalled by control model –
“extraneous terms”

Are topics discussed in same contexts?

- Augment word vectors with local context windows
- Results:
 - All control cluster words were used in the same contexts by both groups
 - Frequency of control words is higher in control group than AD group

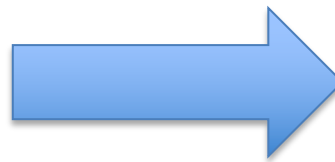
Classification

- Features:
 - Distance metrics for AD and control clusters
 - Idea density
 - Idea efficiency
- Random Forest classifier, 10-fold cross-validation
- Compare models (control, AD, combined), feature sets, and context
- Baseline: hsICU features

Classification results

Model	Features	Accuracy	Precision	Recall	F-score
Baseline	hsICUs	0.73	0.74	0.73	0.72
Baseline	LS&A	0.76	0.77	0.76	0.76
Baseline	hsICUs + LS&A	0.80	0.80	0.80	0.80
control	distance-based	0.68	0.69	0.68	0.68
dementia	distance-based	0.66	0.67	0.66	0.66
combined	distance-based	0.68	0.69	0.68	0.68
control	distance-based + idea density + idea efficiency	0.74	0.76	0.74	0.74
dementia	distance-based + idea density + idea efficiency	0.74	0.75	0.74	0.74
combined	distance-based + idea density + idea efficiency	0.74	0.75	0.74	0.74
control	distance-based + idea density + idea efficiency + LS&A	0.79	0.79	0.79	0.79
dementia	distance-based + idea density + idea efficiency + LS&A	0.77	0.78	0.77	0.77
combined	distance-based + idea density + idea efficiency + LS&A	0.80	0.80	0.80	0.80

Ethics



Ethics in NLP workshop

- <http://www.ethicsinnlp.org/accepted-papers>

Conclusions

- NLP and speech processing are very useful tools for prediction of mental illness!
- Social media approaches for data collection
- Ethical considerations