Medical Artificial Intelligence at the University of Georgia

Michael A. Covington, Ph.D.
Associate Director
Institute for Artificial Intelligence

The Institute for Artificial Intelligence

- Started as a small research group in 1984
- Offers a 2-year master's degree in AI
- Collaborates with faculty in many departments and specialties on a wide variety of projects

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My research group

- Natural language processing
- Bridging the gap between language technology and brain science

Today

- One “normal” AI project
  - Finding patient-oriented medical-journal articles
- Three unusual ones
  - Idea density in writing or speech
  - Phonetic detection of reduced muscle movement in schizophrenia
  - Semantic detection of disorganized speech in schizophrenia

Finding patient-oriented evidence in medical journal article abstracts

Example of the kind of AI application that is becoming normal – almost commonplace

David Robinson, M.S. candidate

Michael A. Covington, Ph.D.

Mark Ebell, M.D.

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Finding patient-oriented evidence in medical journal article abstracts

- Problem: 800,000 articles are published in medical journals every year (see PubMed).
- Nobody has time to read them all to see if they are clinically useful!
- At 2 minutes each, even reading the abstracts would take > 12 people working full-time.

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Finding patient-oriented evidence in medical journal article abstracts

- Solution: Train a computer to find patient-oriented evidence.
- Looking for randomized controlled trials (not case reports or anecdotes).
- Looking for things that matter to the patient (longevity or symptoms, not physiological measurements).

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Finding patient-oriented evidence in medical journal article abstracts

- Method: **machine learning.**
- Hand-classify some hundreds of abstracts into patient-oriented or not.
- Have the computer **automatically learn** what words and phrases indicate that a study contains patient-oriented evidence.
- So far, 80% success, and still improving!

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Finding patient-oriented evidence in medical journal article abstracts

This kind of AI is nowadays
so widely used that some people
don't realize it's artificial intelligence.

Paradox: If it works, they won't call it AI!

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Next 3 studies:

Using natural language processing in psychological measurement and psychiatry

Key idea:

The technologies that enable computers to *understand* language can also help us make *measurements* of language.

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Deeper goal:

Define mental illness as measurable impairment, not "abnormality."

This is not just good science – it's also good for the dignity of the patient!

Idea density in writing or speech

Idea density is the amount of information (counted as things that can be true or false) packed into a given number of words.

Idea density in writing or speech

"The brown dog barked at night"

1. Dog was brown
2. Dog barked
3. It happened at night

3 ideas, 6 words, idea density = 50%

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Idea density in writing or speech

Snowdon, Kemper et al. (JAMA 1996) found that low idea density in writing predicts Alzheimer's disease **50 years later**!

But it required tedious hand-scoring of the idea density of the subjects' essays.

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Idea density in writing or speech

We created easy-to-use **software** for measuring idea density automatically.

Cati Brown, (then) Ph.D. candidate
Tony Snodgrass, M.S. candidate
and others under my direction

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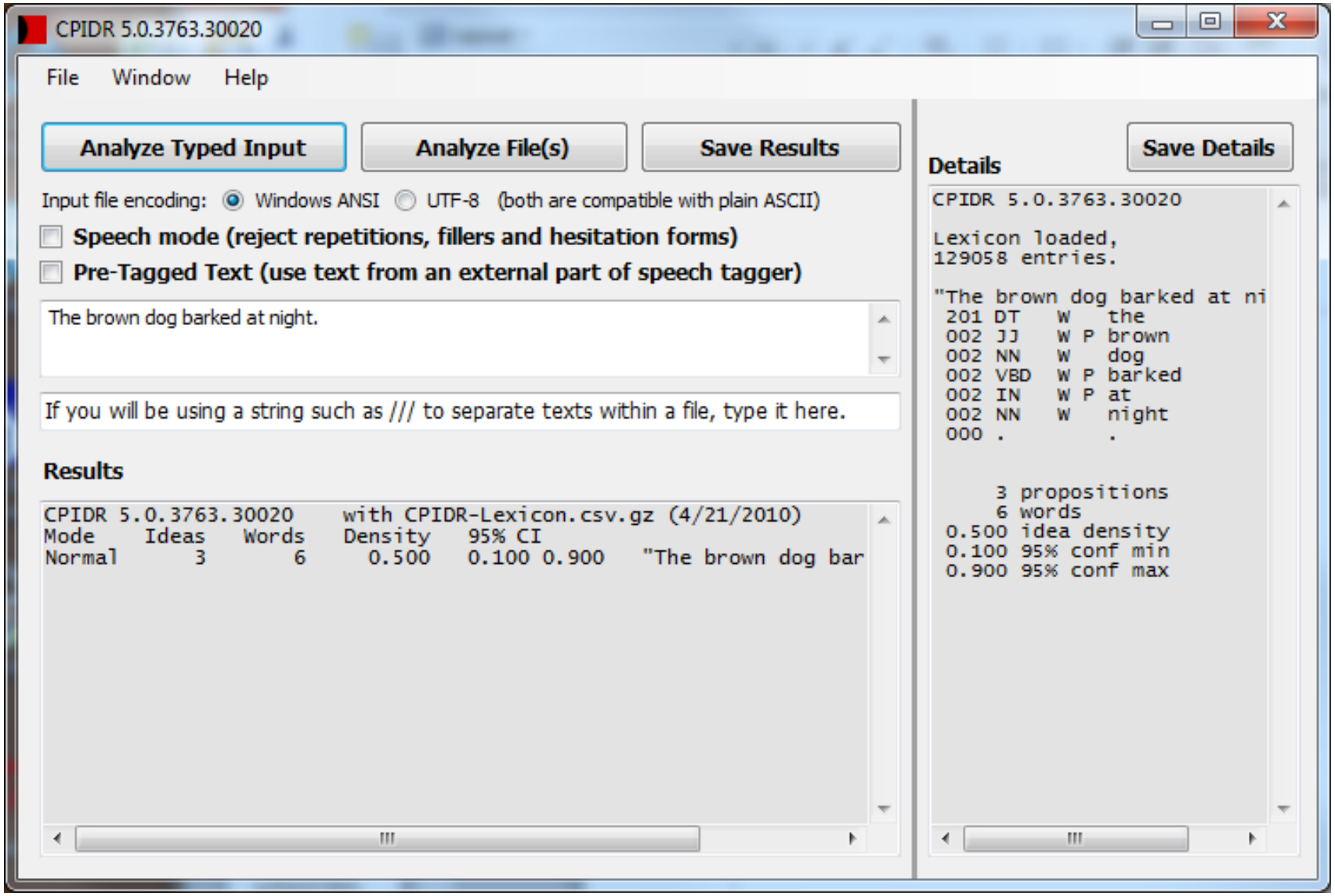
CPIDR 5.0.3763.30020
File
Window
Help
Analyze Typed Input
Analyze File(s)
Save Results
Input file encoding:
Windows ANSI
UTF-8
(both are compatible with plain ASCII)
Speech mode (reject repetitions, fillers and hesitation forms)
Pre-Tagged Text (use text from an external part of speech tagger)
The brown dog barked at night.
If you will be using a string such as /// to separate texts within a file, type it here.
Results
CPIDR 5.0.3763.30020 with CPIDR-Lexicon.csv.gz (4/21/2010)
Mode Ideas Words Density 95% CI
Normal 3 6 0.500 0.100 0.900 "The brown dog bar
Details
Save Details
CPIDR 5.0.3763.30020
Lexicon loaded,
129058 entries.
"The brown dog barked at ni
201 DT W the
002 JJ W P brown
002 NN W dog
002 VBD W P barked
002 IN W P at
002 NN W night
000 . .
3 propositions
6 words
0.500 idea density
0.100 95% conf min
0.900 95% conf max

Studies of schizophrenia

Schizophrenia is a common, severe mental illness causing lifetime impairment.

- Cause unknown
- Hits 1% of population
- Usually not diagnosed until patient is severely disabled and miserable

Studies of schizophrenia

We want to develop
language-based measurements to
detect, track, and understand schizophrenia.

- Earlier, better treatment
- Better research

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Phonetic detection of reduced muscle movement in schizophrenia

Michael A. Covington, Ph.D.
Anya Lunden, Ph.D.
Michael Compton, M.D. (Emory, GWU)
and a large team

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Phonetic detection of reduced muscle movement in schizophrenia

Schizophrenia produces impaired movement of muscles, especially around the face.

We can detect this by analyzing the sound pattern of speech.

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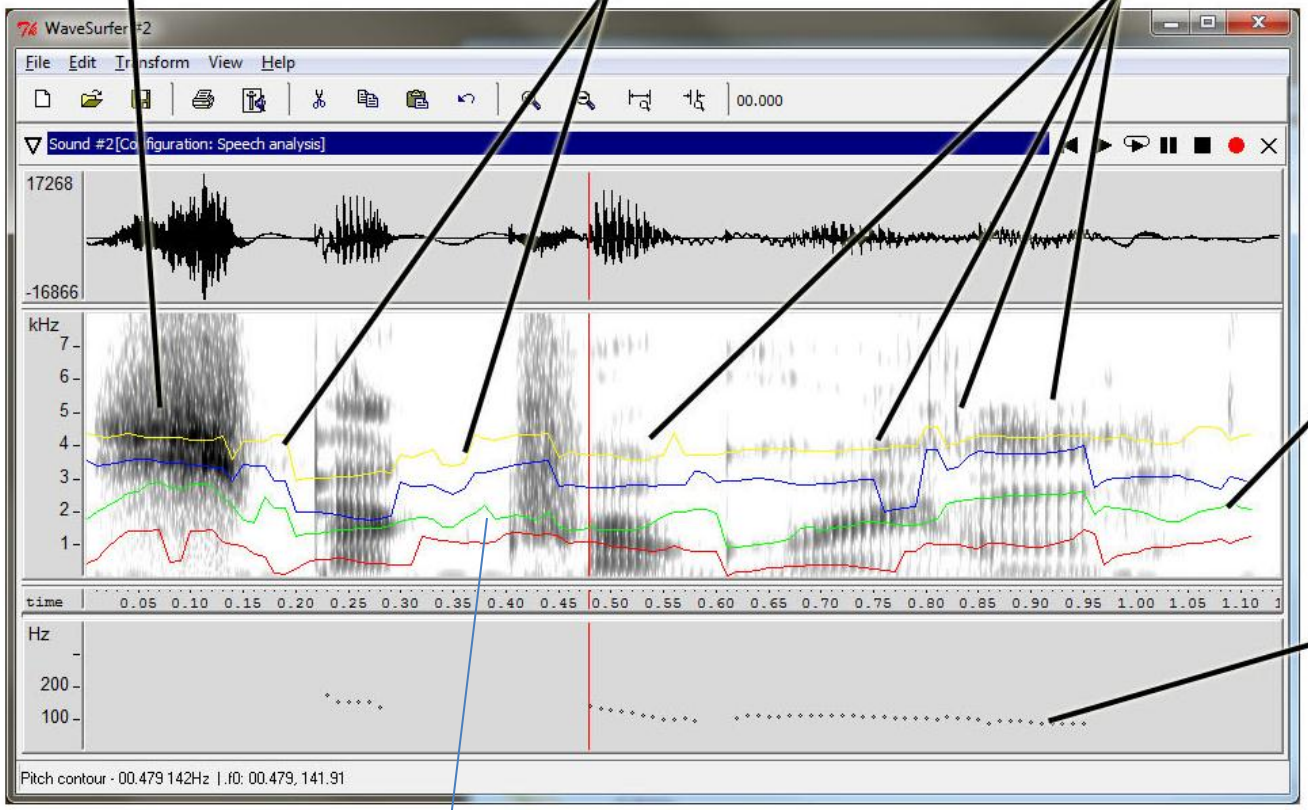
Fricative (hissing sound)

Sound interrupted by a stop consonant

Vowels and sounds such as L, R, M, N



Waveform

Spectrum (components of waveform)

Pitch (when vocal cords are vibrating)

Colored lines track formants (resonant frequencies)

When pitch is measured, we get a frequency in Hertz

Green line: tongue front-back movement, demonstrably less variable in patients with more severe schizophrenia.

Phonetic detection of reduced muscle movement in schizophrenia

We want to study this further with
a larger set of patients
and
study phonetic effects of
depression, Parkinson's Disease, and others.

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Semantic detection of disorganized speech in schizophrenia

One of the most recognizable symptoms of schizophrenia is **disorganized speech** –
inability to stay on topic,
inability to communicate.

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Semantic detection of disorganized speech in schizophrenia

Unpublished work begun with
GlaxoSmithKline in 2001
and soon to resume with the
Current UGA/Emory/GWU team…

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Semantic detection of disorganized speech in schizophrenia

Simple test:

- Give the patient a picture to describe.
- Does he mention all the objects that are reasonably prominent in it?

This works!

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Semantic detection of disorganized speech in schizophrenia

More sophisticated test:

- Give the patient a picture to describe.
- How orderly is the description?

Hemali Vin, B.S. candidate

More work planned

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Many other projects are

in progress or contemplated.

(We also do plenty of non-medical AI.)

See us on the Web at:

www.ai.uga.edu/mc

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