How Natural Language Processing Can Be Applied in Human Services

The Arc of Illinois Executive Leadership Forum

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J. Edgar Mihelic,
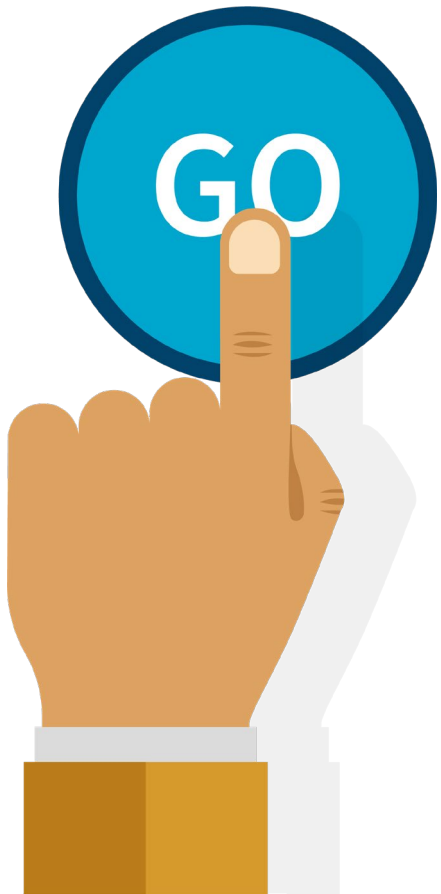MA, MA, MBA

Director, Data
Analytics

CSS

Mandy Carlino,
PMP

Associate
Director, Client
Projects

MediSked

Today's Presenters

Agenda

○ Clinical Services at Community Support Services

○ Machine Learning: Understanding Sentiment Analysis for Human Services

○ Feeling vs. Knowing: Data-Driven Stories

○ Bringing it all Together: Lessons Learned and What's Next?

Data Disclaimer

- All the data in this presentation has been deidentified. We've changed the names and altered stories to preserve the privacy of the individuals, but each of the data stories are based on real people.

- We've used machine learning/artificial intelligence in this presentation, which is in very early stages for Human Services. These results are not intended for clinical decision support, human resource management, or any purpose other than to illustrate and raise the bar on what could be possible in the next decade.

Clinical Services at Community Support Services (CSS)
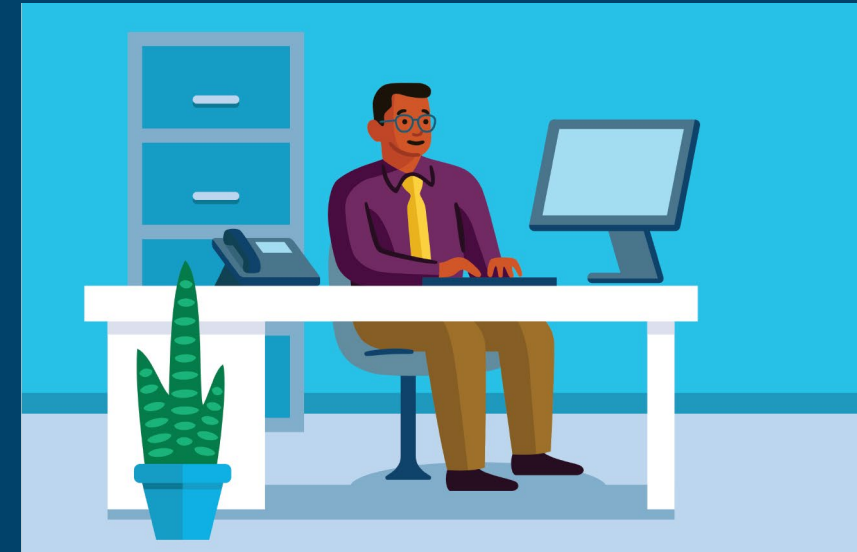
About Community Support Services (CSS)

- Founded in 1981 by parents, educators and community leaders

- Serves individuals across more than fifty communities in west suburban Cook and eastern DuPage counties

- Our staff is committed to helping people with I/DD live their lives to the fullest by creating an environment in which the participants can flourish, strive for independence, and contribute to community life.

- Conversations and feedback from our participants and their families have shaped the high quality, relevant programming on offer.

    - Surveys of these stakeholders often show over 95% approval.

Community Support Services

Our Mission

A private, nonprofit agency that initiates, provides, and promotes services for people with intellectual/developmental disabilities and their families, within their communities, in order to **strengthen their independence**, **self-esteem**, and ability to **participate in and contribute to community life (CSS).**

CSS' Programs

1. 24-hour Residential Services, individuals in houses of up to six participants. We have eight homes currently.

2. Independent Living, these folks in independent living often live and work on their own, but sometimes need help with budgeting or other activities

3. Community Day Services, providing opportunities for those who live in the houses to socialize and learn in larger groups at our locations in Cicero and Brookfield.

4. Respite Services

5. Clinical team providing counseling and behavioral therapy

6. Case Management

7. Supported Employment – CSS Academy Programs

8. Senior Services

CSS Background

- 100 staff

- Supporting 404 individuals in the last nine months of the current fiscal year, from 7/1/2022 to 3/31/2023.

- Operating budget of $7 million a year

  - Of that budget, approximately 70% of it comes from contracts with the state.

  - 25% is received from local units of government, mainly the seven funded townships where we provide services, as well as some HUD money through the Community Development Block Grant (CDBG) program.

- Supporting these program units are administrative units in finance, human resources, operations, and development.

Machine Learning: Understanding Sentiment Analysis for Human Services

# Applications for Machine Learning Processing in Human Services

- **Sentiment Analysis** is an approach to **machine learning / natural language processing (NLP)** that identifies the emotional tone behind a body of text

- In this presentation, we use MediSked's tools to study service notes from a variety of service settings to look for trends in tone that may be related to signs of depression and/or anxiety for an individual

- Machine Learning, Natural Language Processing and Sentiment Analysis are in their early stages in 2023, so the purpose of this work is to help advance technologies for home and community-based services – these results do not tell the whole story!

  https://www.medisked.com/sentiment-analysis-tool/

Sentiment Analysis
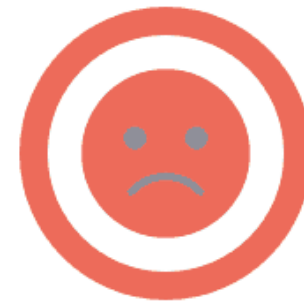
Positive   Negative   Neutral

HHS has Identified Machine Learning as a Goal for Person-Centered Outcomes by 2029

Human Service Providers have Plentiful Unstructured Service Notes / Clinical Notes

- Leverage leading technology solutions to improve data capacity for person-centered outcomes and comparative clinical effectiveness research
- Use AI solutions to enhance accessibility and interoperability of unstructured data to advance person-centered outcomes
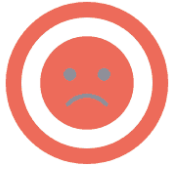
Term	Description
Predictive decision support (*Model*)	Technology intended to support decision-making based on algorithms that derive relationships from training or example data and then are used to produce an output or outputs.
Transparency	Sufficient information provided on the model, including input data, validation of performance, and intended use.
Trustworthiness	Model risks identified, mitigated, managed, and evaluated to provide confidence in the positive impact of using the model, and information about steps taken to govern the model and address negative impacts and/or reduce bias or harm are documented.
Fair (*Unbiased, Equitable*)	Model does not exhibit prejudice or favoritism toward an individual or group based on their inherent or acquired characteristics. The impact of using the model is similar across same or different populations or groups.
Appropriate	Model is well matched to specific contexts and populations to which it is applied.
Valid	Model has been shown to estimate targeted values accurately and as expected in both internal and external data.
Effective	Model has demonstrated benefit in real-world conditions.
Safe	Model is free from any unacceptable risks and for which the probable benefits outweigh any probable risk.

ASPE

OFFICE OF THE SECRETARY
PATIENT-CENTERED OUTCOMES
RESEARCH TRUST FUND

Building Data Capacity for Patient-Centered Outcomes Research

2020 2029

OS-PCORTF Strategic Plan

September 2022

CSS

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Machine Learning Sentiment

Positive

RL independently exercised by using the bike pedals for 20 minutes. He was verbally prompted to use the computer to look up his area of interest and he researched trains. He was verbally prompted to speak clearly while talking and work on better posture. Staff praised RL on a great job, he smiled and said I try for you and laughed.

Negative

BH arrived at program on time. He was prompted to be socially appropriate with peers but refused. BH became frustrated and verbally aggressive towards staff. BH was asked to stop and to talk about what was making him upset but refused. He became verbally and physically aggressive towards his peer. BH was restrained. He eventually calmed down and talked about what upset him.

Notes have been edited for representation purposes

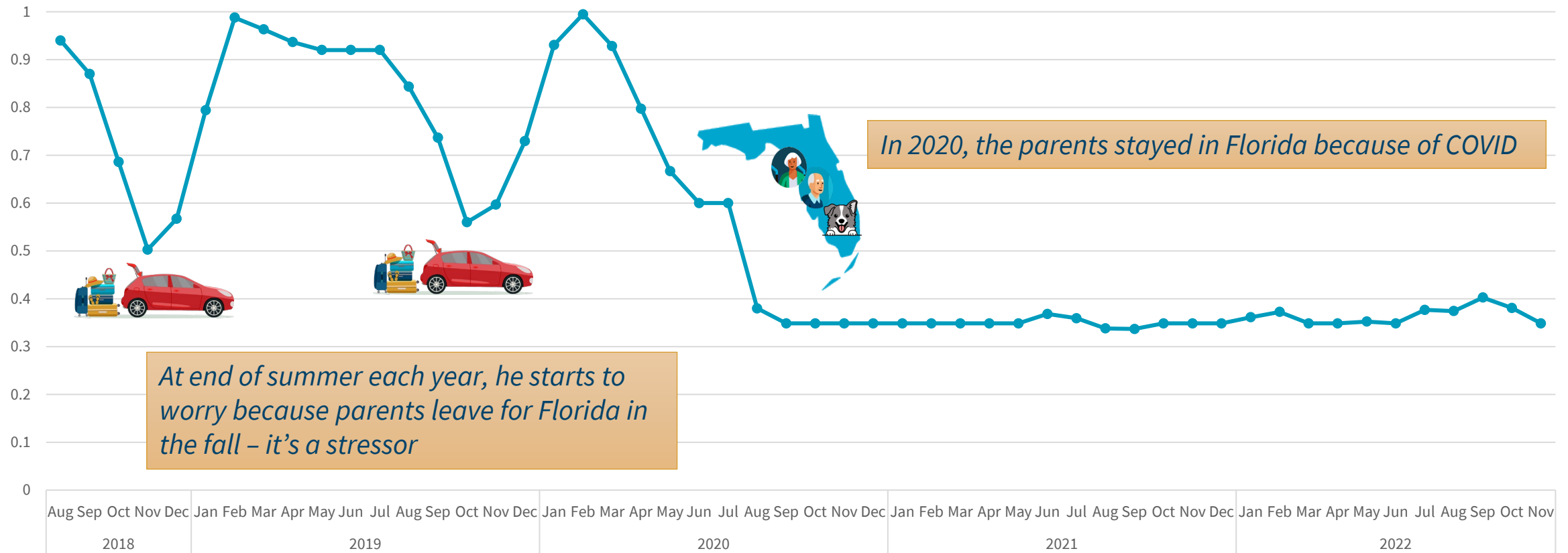# Feeling vs. Knowing: Data-Driven Stories

A Look at Joe's Story

Early 50s, Male

Average Natural Language Processing (NLP) Composite Score Over Time

In 2020, the parents stayed in Florida because of COVID

At end of summer each year, he starts to worry because parents leave for Florida in the fall – it's a stressor

	2018			2019				2020				2021			2022

(x-axis months: Aug Sep Oct Nov Dec | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov)

(y-axis: 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1)

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A Look at Maggie's Story

Mid 50s

Average Natural Language Processing (NLP) Composite Score Over Time

Lived in an apartment with limited supports

Moved to a group home in the suburbs with other housemates

Is anxious about upcoming medical procedures

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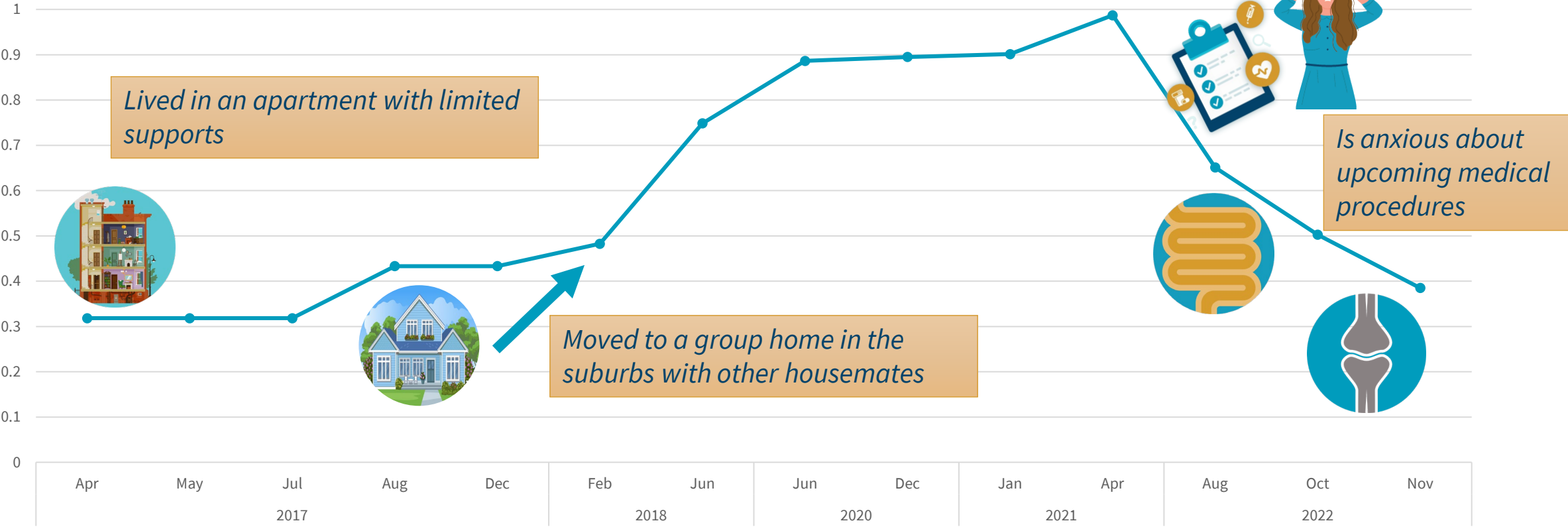
A Look at Shawn's Story

Average Natural Language Processing (NLP) Composite Score Over Time

- Diabetes and anxiety medication
- Services moved to telehealth during pandemic

Obesity, mobility issues with legs (vascular necrosis)

Low salt

Exercise routine

Burned self making fried food → Hospital visit

- Hospitalized: diabetes, mobility
- Amputation – vascular necrosis

Scooter, errands for mom

0.8

0.6

0.4

0.2

0

-0.2

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec | Jan Feb

2018   2019   2020   2021   2022   2023

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A Look at Mark's Story

Average Natural Language Processing (NLP) Composite Score Over Time

Male – Late 40s

Hospitalized due to injury from throwing furniture

Feces mess, cursing at staff, housemate

Rude to housemate's dad bc he misses his own

Cursing through the night, yelling, med refusal, no hygiene

Threw groceries at cashier

Dr switched to injection bc of med refusals

Hospitalized due to throwing chair down the stairs

Threw change at staff, cursing, med refusal

Sleeping all day

Occasional attention needs but better; Binge drinking soda and vomiting

Legend:
- Positive %
- Neutral %
- Negative %
- Compound Score
- Trend Line

Left axis: BASELINE SCORE
Right axis: SENTIMENT CATEGORY PERCENTAGE

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Outcomes in Hindsight: Intersectionality [Dual Diagnosis of I/DD and Behavioral Health]

- Intersectionality of dual diagnosis needs to be taken into consideration when supporting Mark

- Mark has Mild IDD, Fragile X, Schizoaffective Disorder, and Dysthymia - Persistent depressive disorder

- According to a research study, high conformity to self-reliance norms exerts a particularly damaging effect on the mental health of men with disabilities. Given that men with disabilities are more likely to rely on help and support from others, these results provide important insights for the delivery of services to men with disability.

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6700447/

A Look at Eugene's Story

Average Sentiment Score Over Time

Male – Late 70s

Pain in left side

Fell in shower and hurt hip

Hitting, cursing at house mates

Yelling at housemates

Cursing, throwing bottles at housemates. Injured foot

Dr reduced Haldol bc of side effects + "Parkinson like movements"

Occasional screaming, throwing, mood issues, but better

Reconnected with his nephew

Legend:
- Positive %
- Neutral %
- Negative %
- Compound Score
- Trend Line

X-axis: 8 | 9 | 10 | 11 | 12 (2020) | 1 | 2 | 3 | 4 | 5 | 6 | 10 | 11 | 12 (2021) | 1 | 3 (2022)

Left Y-axis: COMPOUND AND BASELINE SCORE (-0.3 to 0.5)

Right Y-axis: SENTIMENT CATEGORY (0% to 100%)

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Outcomes in Hindsight: Intersectionality [I/DD and Older Adults]

- Intersectionality of aging and disability needs to be taken into consideration when working with Eugene

- Eugene fell many times and sustained injuries that required ED visits, stitches, and follow up visits.

  - More than 1 in 4 older adults fall each year

  - Each year, 3 million older people are treated in emergency departments for fall injuries

  - Solution: additional falls prevention interventions and medication review

Gleaning Valuable Information from Staff Notes

- After reviewing thousands of service notes, it became evident that notes can show contention between staff and individuals

- AI can be used to identify negativity among staff notes that may translate to staff that could use re-training, pairing staff with different individuals that they may be more compatible with, or other interventions

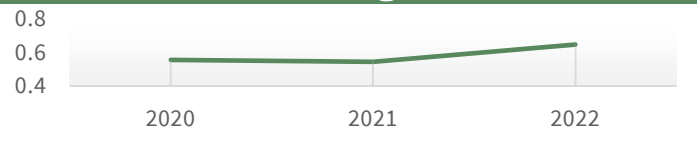- Lots of opportunity on the staff side for agencies to explore in the future

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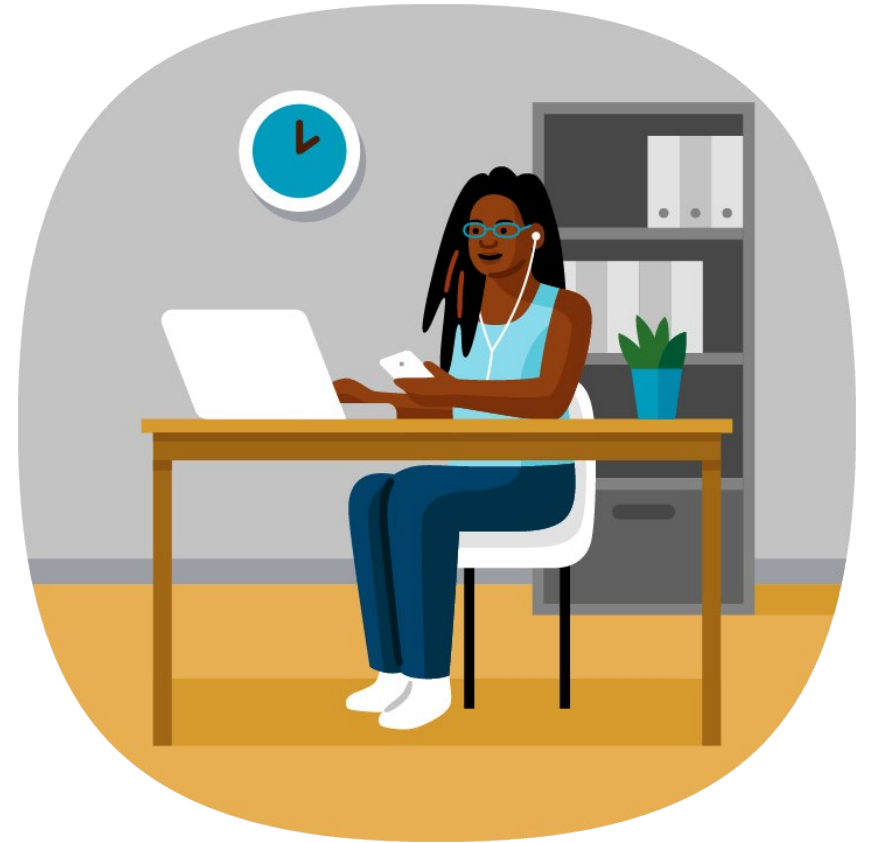
Sometimes if you can't change the staff, change the staff…

Even with negative notes, staff's writing style is one thing; but actions or inactions are another

Average Compound Score for Jonathan's Notes by Staff Member


Staff A
Staff B
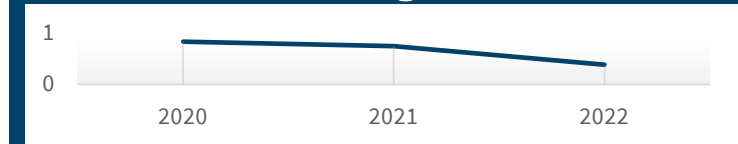Staff C
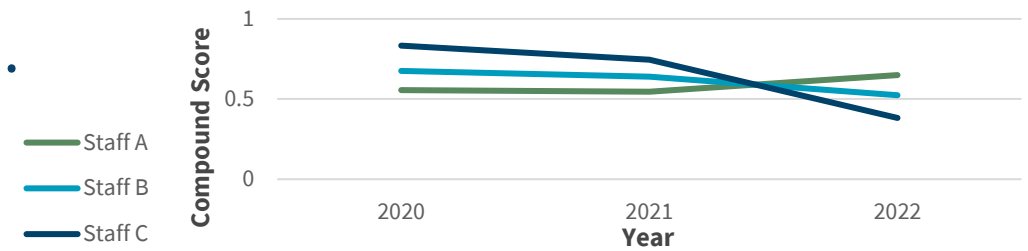
Staff A (Least Negative)

- Most of the day Jonny was up and downstairs. He watched TV in the den. He took his morning meds but refused his evening meds. Even without taking his meds, he still was polite and talked with me.

- Jonny's day was not very good. He refused to eat dinner with house mates and tossed his blanket down the stairs. I sat and spoke with Jonny who was crying. He stated that he didn't know "why he is so angry." I will follow up with the team concerning his behavior.

Staff B
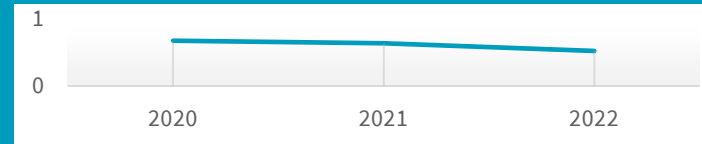
- Jon refused both meds today. He was more quiet than usual with me. He helped with lunch and emptying the dishwasher.

- Jon took his morning and bedtime medications. He was given praise for doing so. Jon continues to struggle with his social skills, as well as his hygiene. Staff will continue to offer Jon support. All behaviors are being tracked.

Staff C (Most Negative)

- He was disruptive in the afternoon making threats at staff for no apparent reason. He apologized later.

- Jonathan continues to target staff with aggressive behaviors. He continues to refuse all scheduled medications.

- He failed to complete his daily hygiene. He refused all medications throughout the entire day. Jonathan spent time yelling at staff. He also attempted to kiss staff. Jonathan told staff, "I love you so much... that I hate you."

These are all legitimate negative notes for a person's sentiment that has been trending negative. The names have been changed, but notice how some staff use preferred names versus given names

Impact of Turnover on Service Note Quality

- For this study we examined notes from CSS from 24 Hour residential services and day program.

- We found inconsistencies in the quality of the written services notes and found some staff were writing notes that were thorough and concise while others gave very templated responses that did not offer any meaningful information

- CSS is affected by the ongoing DSP workforce crisis and has experienced significant turnover the past few years

- Lesson Learned: A note training refresher and additional re-training may be helpful to get staff on the same page about writing quality services notes

Bringing it all Together:
Lessons Learned and What's Next?

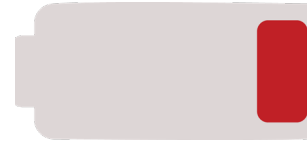# Machine Learning in Human Services: The Next Frontier

Today we described applications for machine learning that focus on sentiment analysis. In the years ahead, the next frontiers for mining service note data include, but are not limited to:

Health Diagnosis & Events

Detecting Abuse & Neglect

Identifying Unmet Needs

Transportation Needs

Feedback on Staff & Programming

Employment Outcomes

Community Integration & Relationship Highlights

Housing and Food Security Needs

Thank you!