**worldusabilityday**

**A Gold Mining Adventure**
Using Natural Language Processing, Machine Learning, and
Human-Centered Design to Find Gold in Unstructured Data

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AGENDA

Interpreting Unstructured
Listening Session Data

• Project Goals and Objectives
• Listening Session Process
• Find Gold in Unstructured Data
• Optimize NLP Visualizations With HCD
• HCD Project Outcomes
• Additional HCD Considerations/Puzzles

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# PROJECT GOALS AND OBJECTIVES

Improve the review process of unstructured listening session data by leveraging Artificial Intelligence and Human-Centered Design.

**Goals:**

Use HCD, Machine Learning (ML) and Natural Language Processing (NLP) to:

➢ Achieve high reliability (>80%) accuracy for review of listening session data

➢ Minimize/manage opportunities for human bias

**Objectives:**
- Derive Themes
- Determine Sentiment

| Listening Session Topic | Data Set |
|---|---|
| Prior Authorization | Data from several transcribed, national listening sessions summarized into one data set |

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# LISTENING SESSION PROCESS

| Without AI | With AI |
|---|---|
| Conduct listening sessions with stakeholders | Conduct listening sessions with stakeholders |
| Transcribe recorded audio into text | Transcribe recorded audio into text |
| **Manually** sort text snippets into thematic groups | **Use NLP** to categorize data into thematic groups |
| **Manually** identify the sentiment of themes | **Use ML** to assign sentiment to themes |
| **Retype findings** into a management summary | Visualize themes/sentiment; **automate reporting** |

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USE HCD AND NLP TO
Find Gold In Unstructured Data

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FIND GOLD IN UNSTRUCTURED DATA
# THEMES

### Themes
- Derive themes within unstructured data using Natural Language Processing
- Themes are scored and ranked by Tf-Idf* within the unstructured data

### Sub-themes
- Derive sub-themes within themes through verb/adverb/adjective proximity and word frequency
- Sub-themes are scored and ranked by frequency

\* **Tf-Idf = Term frequency, Inverse document frequency** – an algorithm used to evaluate how relevant or important a term is within a data set. The importance of a word increases proportionally to the number of times that word appears in the data set, but is offset by the frequency of the words in the data set.
https://en.wikipedia.org/wiki/Tf%E2%80%93idf

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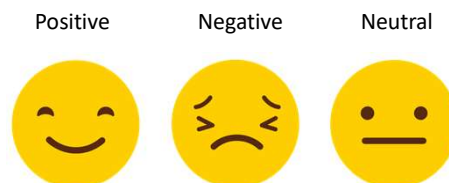FIND GOLD IN UNSTRUCTURED DATA
# HCD FOR THEMES

- Replace manual derivation of themes, which is highly prone to bias, with NLP-driven, numerically-based derivation of themes

    - ➢ Automates/accelerates the speed of extracting themes
    - ➢ Reduces bias

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FIND GOLD IN UNSTRUCTURED DATA
# SENTIMENT

Derive the Sentiment of unstructured data
using machine learning instead of manual sentiment assignment,
thereby reducing bias.

Positive        Negative        Neutral

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## FIND GOLD IN UNSTRUCTURED DATA
# USING ML TO FIND SENTIMENT



**Key**
- Build Process
- Execution Process
- SME Support

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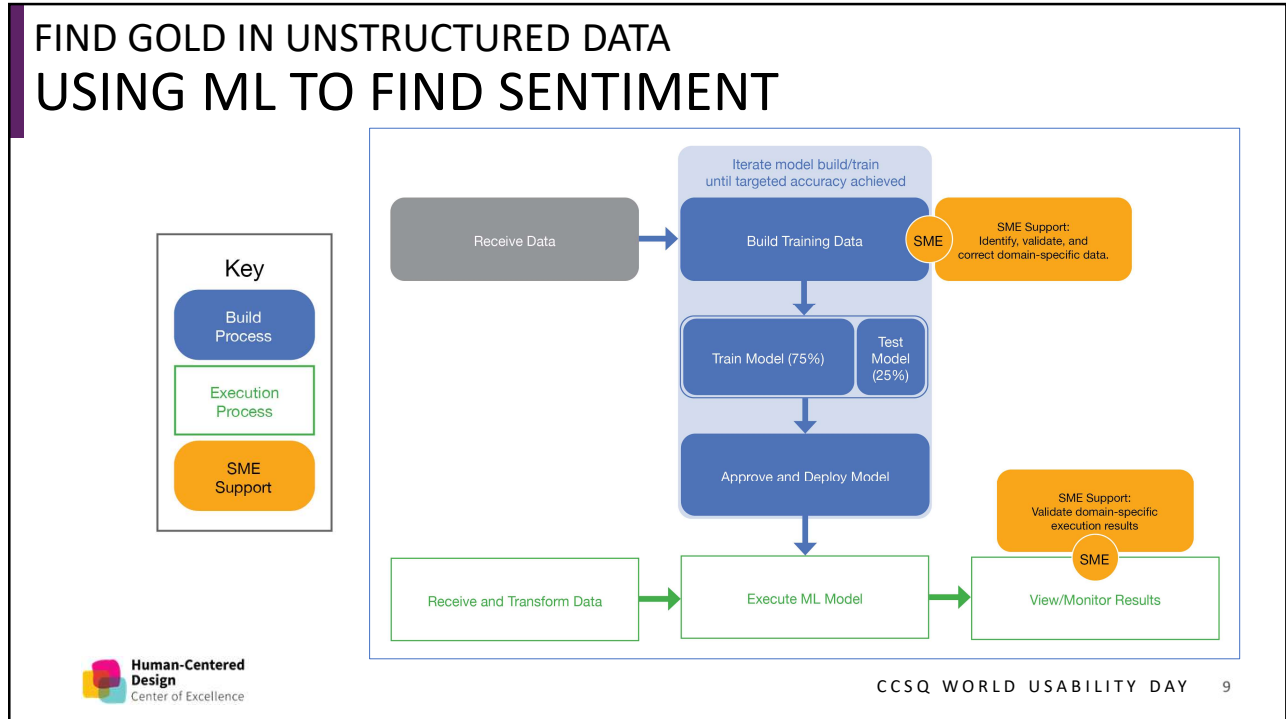
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## FIND GOLD IN UNSTRUCTURED DATA
# AI MODEL ACCURACY

- Trained and executed the following models to compare results
  - BERT (Google)
  - RoBERTa (Facebook)
  - DistilBERT (A smaller and lighter version of the BERT model)
- A pre-trained model with 150 Gb of data
- Results – RoBERTa produced superior results

| Model | Creator | Accuracy | F1 Score | MCC | Eval_Loss |
|-------|---------|----------|----------|-----|-----------|
| **RoBERTa** | **Facebook** | **0.8210** | **0.8210** | **0.6746** | **0.5046** |
| DistilBERT | Cornell University | 0.7354 | 0.7354 | 0.4932 | 0.7595 |
| BERT | Google | 0.7310 | 0.7310 | 0.6282 | 0.5615 |

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FIND GOLD IN UNSTRUCTURED DATA
## LISTENING SESSION THEMES WITH SENTIMENT



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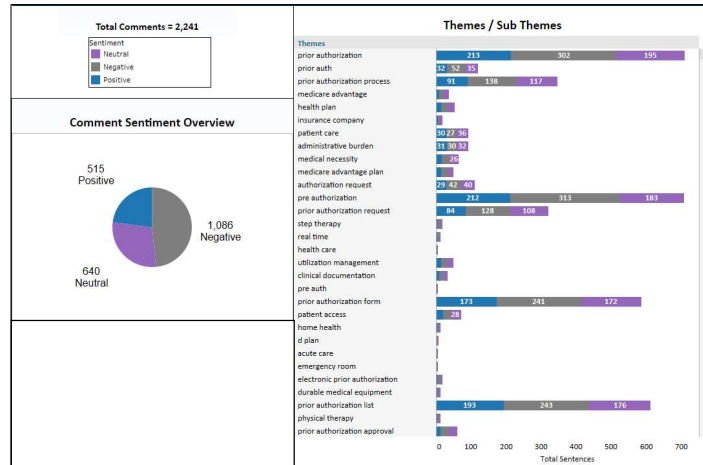
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## PROJECT GOALS AND OBJECTIVES ATTAINED

**Goals achieved:**
- Achieved high reliability (>80%) accuracy for sentiment assignment of listening session data
- Minimized human bias by utilizing ML and NLP modeling

| Objectives | Results |
|---|---|
| **Derive Themes/sub-themes** | • Deep learning algorithms determine the themes based on prevalence of text content and determine sub-themes based on theme proximity and frequency |
| **Determine Sentiment** | • Achieved >80% accuracy<br>• Machine learning algorithms determine sentiment at multiple levels:<br>    • Overall sentiment<br>    • Sentiment by themes<br>    • Sentiment by stakeholders |

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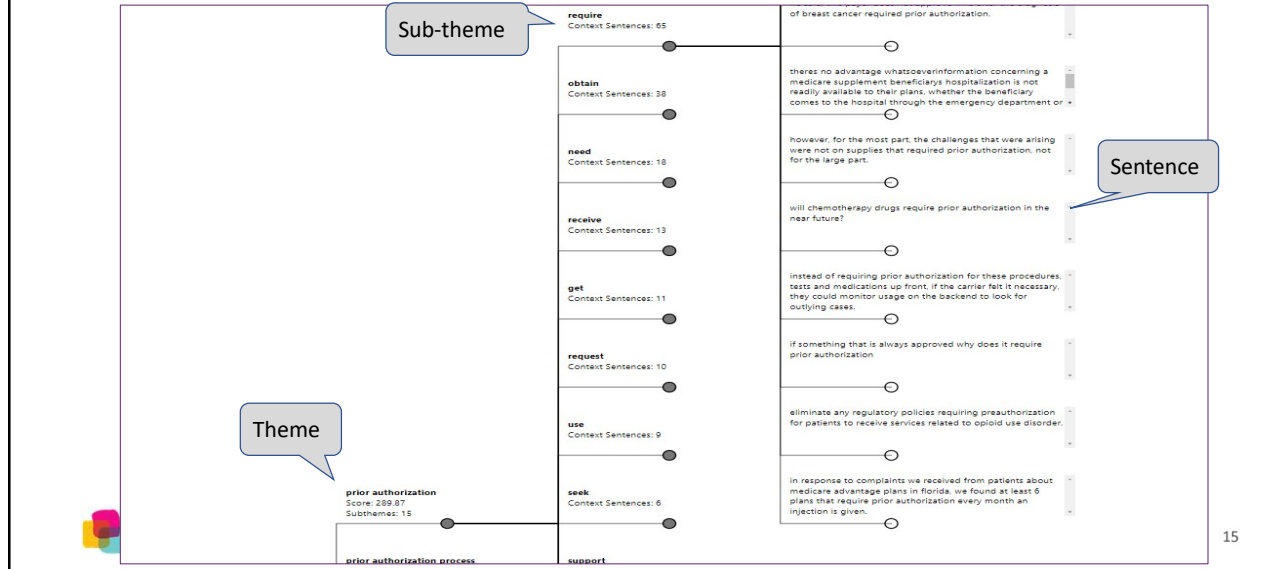Note: a 508 compliant PDF is forthcoming
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## Slide 17

**OPTIMIZING NLP VISUALIZATIONS – ATTEMPT 4 SUCCESSFUL**

Themes and Sub-themes (Interactive, Theme-driven View)

Theme

Sub-themes

Sentence

Interactive Filters

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## Slide 18

# ATTAINED PROJECT GOALS AND OBJECTIVES

**Goals achieved:**

- Identified a visualization technique that made it possible to interpret listening session data with a large number of themes/sub-themes and their associated sentiment by using an interactive dashboard.

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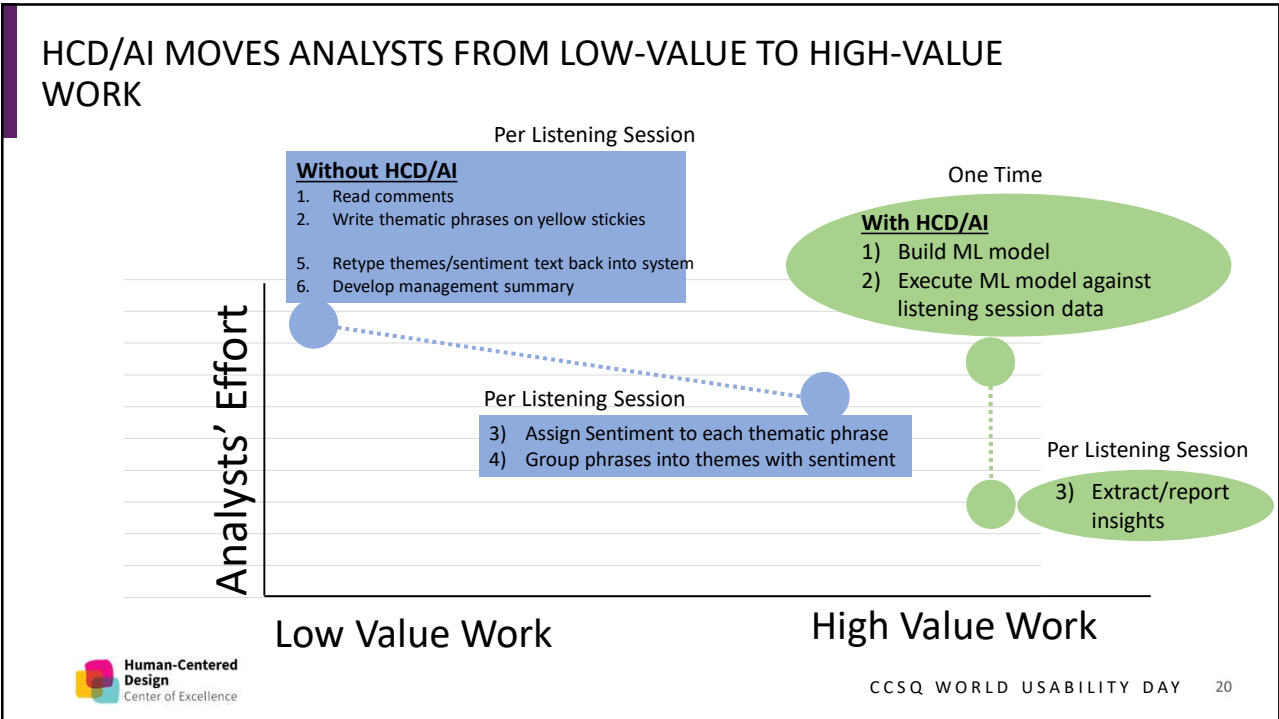Center of Excellence

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## HCD Project Outcomes

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## HCD/AI MOVES ANALYSTS FROM LOW-VALUE TO HIGH-VALUE WORK

Per Listening Session

**Without HCD/AI**
1. Read comments
2. Write thematic phrases on yellow stickies

5. Retype themes/sentiment text back into system
6. Develop management summary

One Time

**With HCD/AI**
1) Build ML model
2) Execute ML model against listening session data

Analysts' Effort

Per Listening Session

3) Assign Sentiment to each thematic phrase
4) Group phrases into themes with sentiment

Per Listening Session

3) Extract/report insights

Low Value Work          High Value Work

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# HCD HELPS TO FIND GOLD IN UNSTRUCTURED DATA

➢ Artificial Intelligence automates previously manual tasks which:
  • Achieve high reliability (>80%) accuracy
  • Minimize human bias
  • Accelerate the speed of review for each listening session
  • Move analysts from low-value to high-value work

➢ Interactive visualizations are far superior to static visualizations by maximizing human-centered design to target insights, including:
  • Numerous filters
  • Drill-down capability (theme->sub-theme->sentiment)

➢ Accurate, SME-driven labelling of machine learning training data is crucial to modeling success

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# ADDITIONAL HCD CONSIDERATIONS/PUZZLES

**Themes/Sentiment**
  • Static Data Set vs Changing Data Set
    – Changing data sets increase complexity and tracking overhead
  • Subject Matter Expert Data Labelling
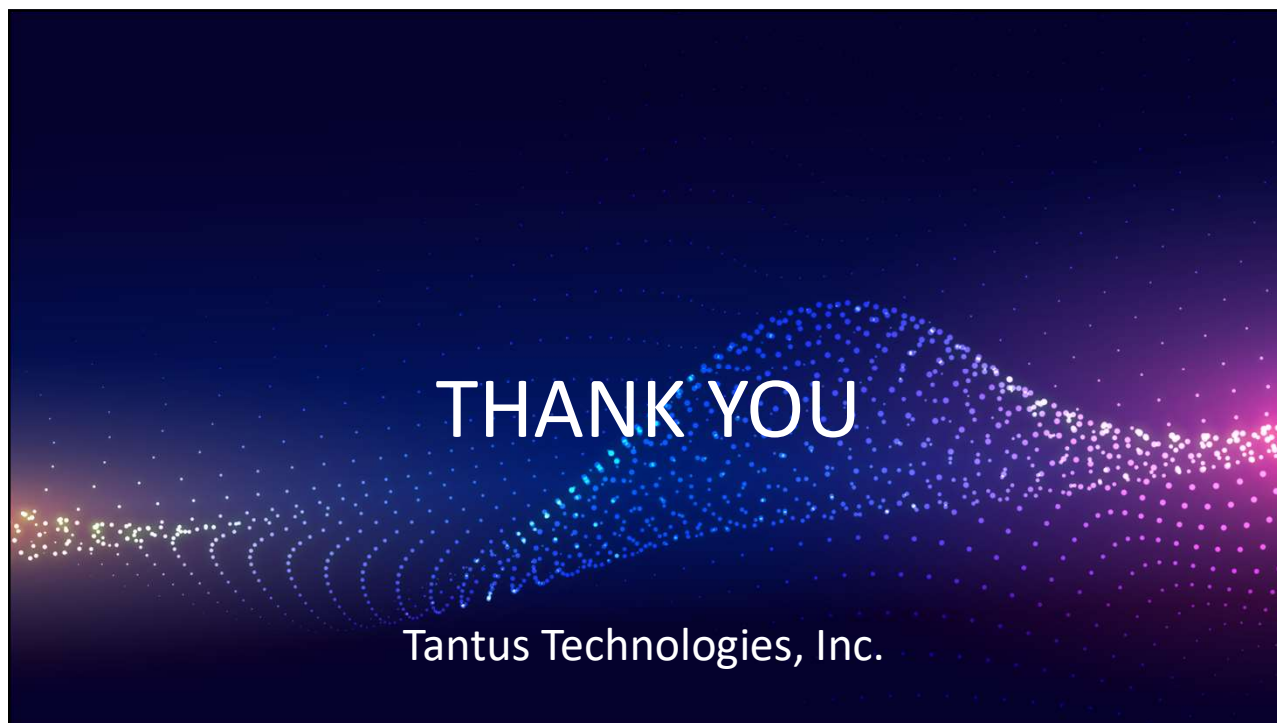
**Visualizations**
  • Multiple Months of Listening Session Data
    – Increases visualization complexity
    – How to track the review process as data changes over months

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# THANK YOU

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