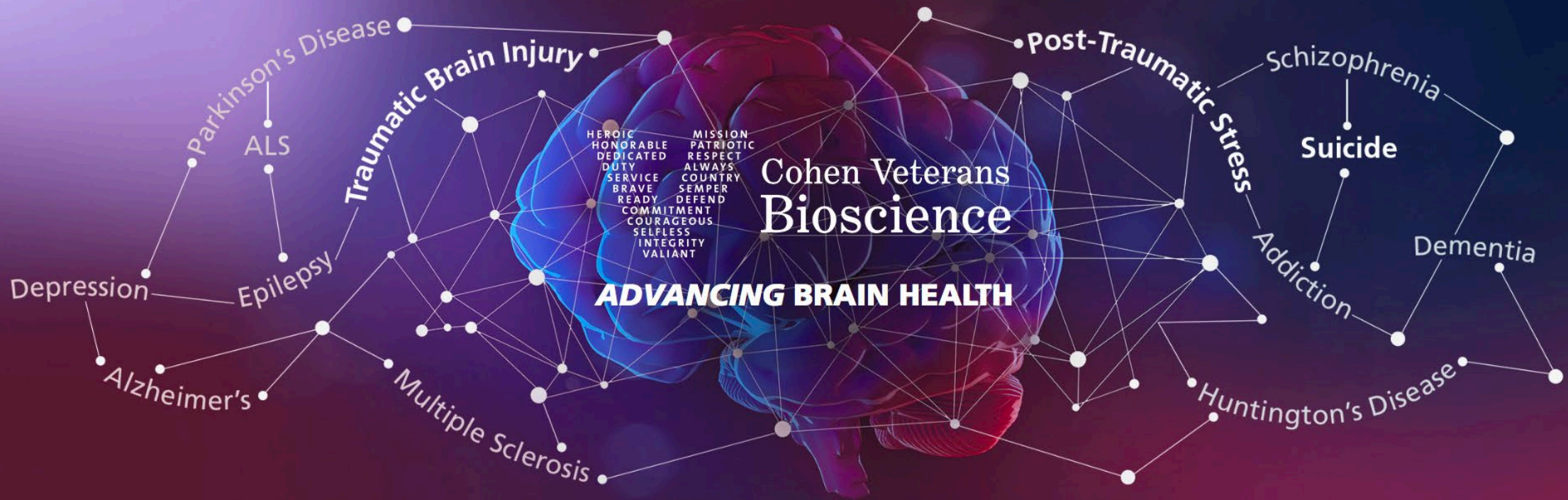




Integrating Multimodal Data in AI for Neurological and Psychiatric Disorders

Advances, Challenges, and Future Directions

Lee Lancashire PhD

Chief Data & AI Officer

Cohen Veteran's Bioscience

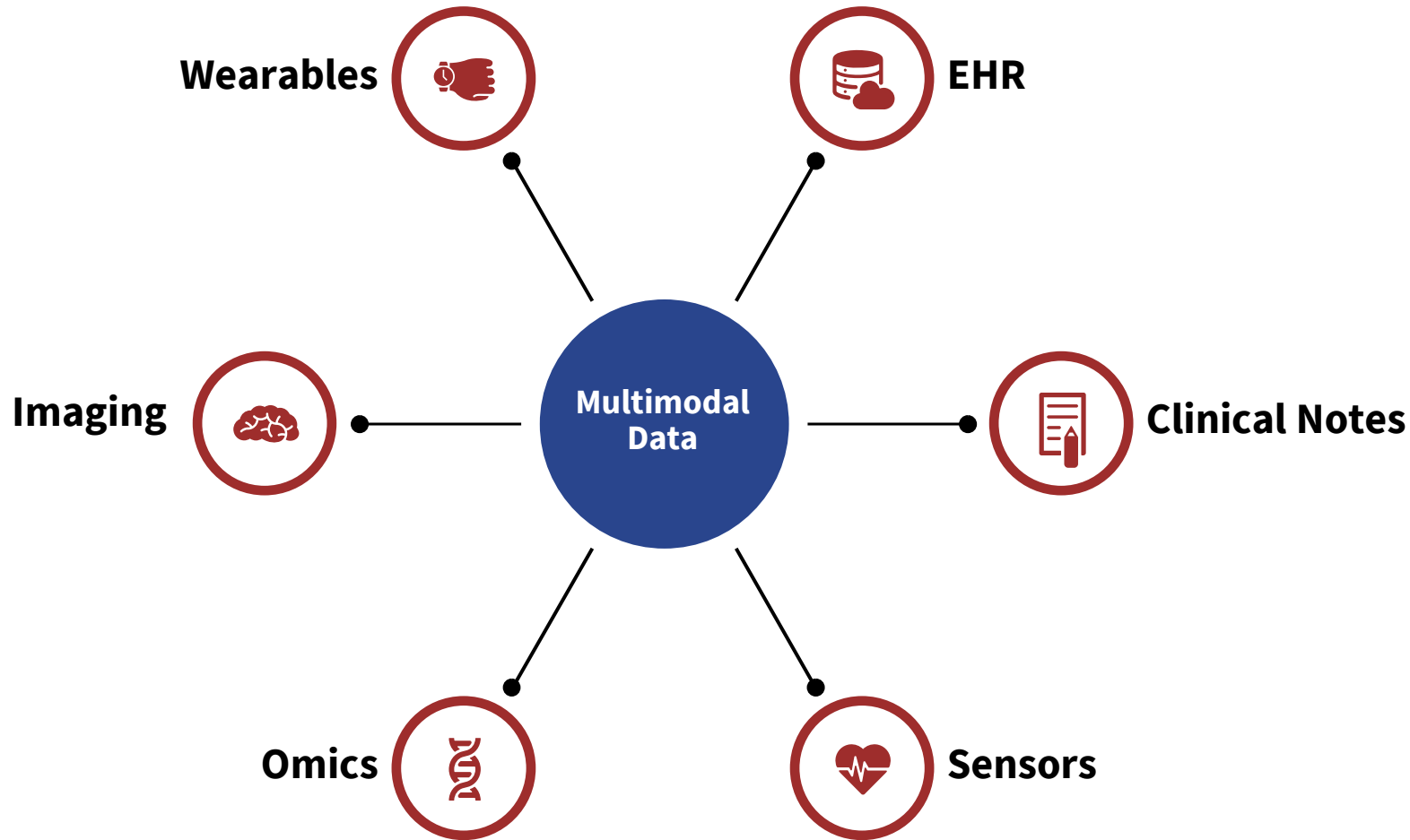
DISCLOSURE & DISCLAIMERS

- Dr. Lancashire is a full-time employee of Cohen Veteran's Bioscience.



Systems Modeling and GenAI

Constructing Comprehensive Disease Models at the Intersection of Biology and AI



- Enhanced model robustness
- Increased domain coverage
- Improved creativity and innovation



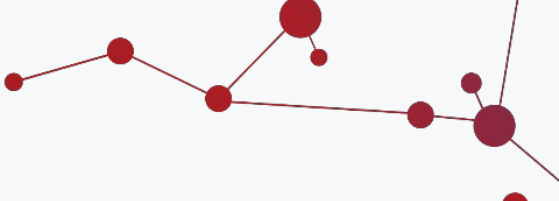
The Power of Multimodal Data

Models capable of ingesting multimodal data remove the constraint of single data types

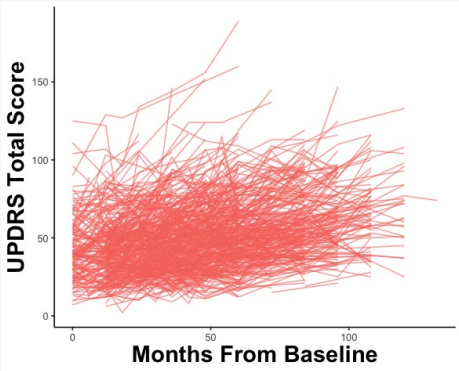


- **Deeper Insights:** Integration of data for comprehensive disease understanding
- **Building Advanced Disease Models:** Create holistic models of biology for enhanced understanding and treatment
- **Data Quality** directly influences AI model accuracy and reliability.
- **Embracing Diversity:** Varied data will reduce bias and improve accuracies and diagnostic precision.
- **Navigating Challenges** such as data silos and interoperability between different data types using techniques such as federated learning.

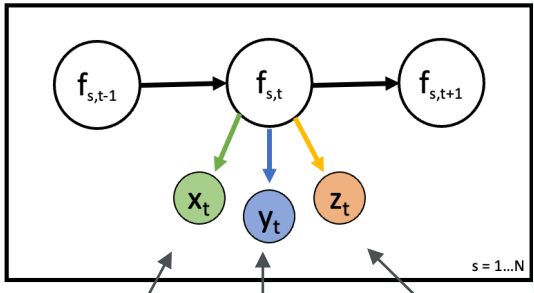
Developing Dynamic Latent Factor Models for PD



Clinical Scores



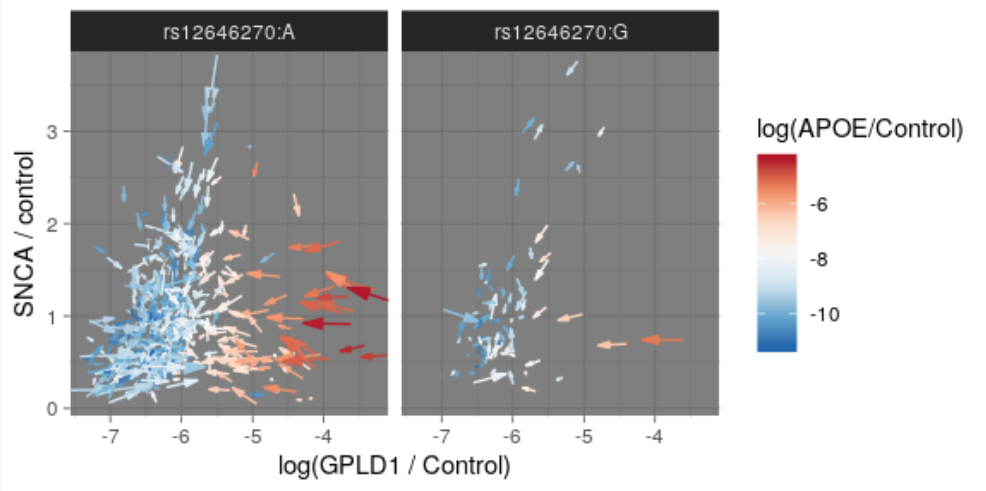
Latent Variable Model



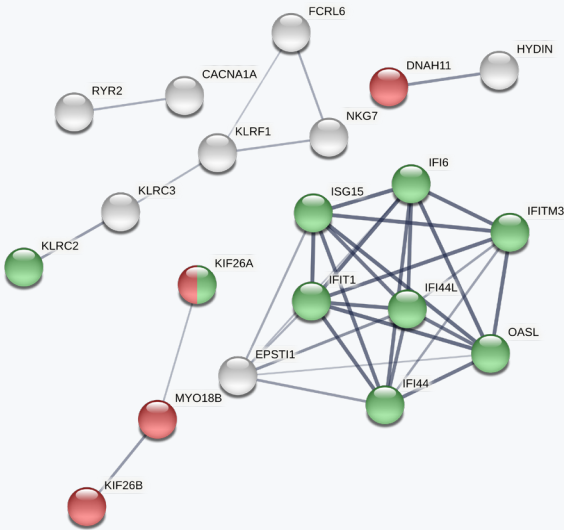
$$f_t \sim N(Af_{t-1}, \Omega)$$

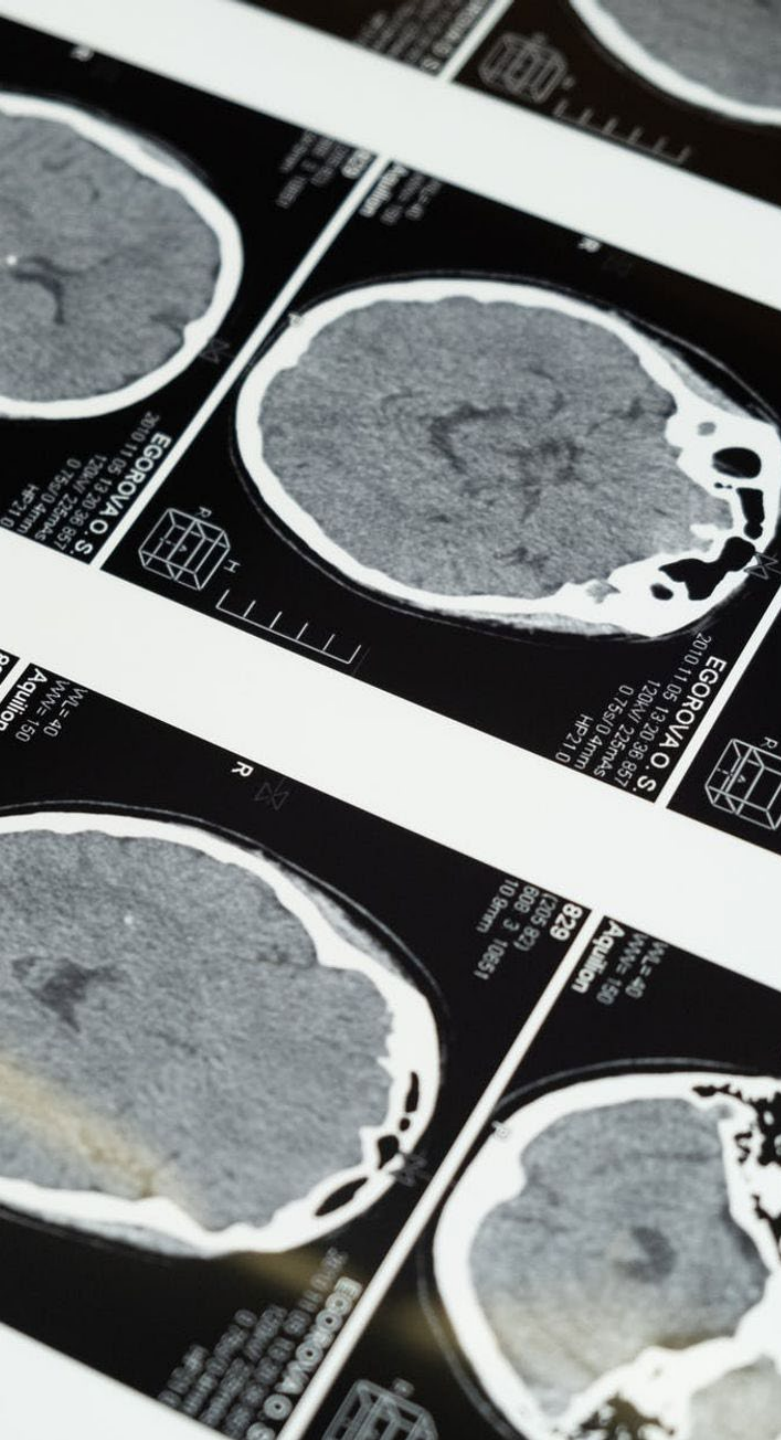
$$z_t \sim \text{NegBinom}(e^{b_0 + Wf_t}, \phi)$$

Input Variables



Model Outputs





Leveraging Deep Learning for EHR Data

• Challenges

- Unstructured Electronic Health Records (EHR) data, including clinical notes, poses challenges with its varied formats.
- The complexity and lack of standardization in unstructured data pose obstacles to straightforward analysis and extraction of actionable insights.

• Current Insights

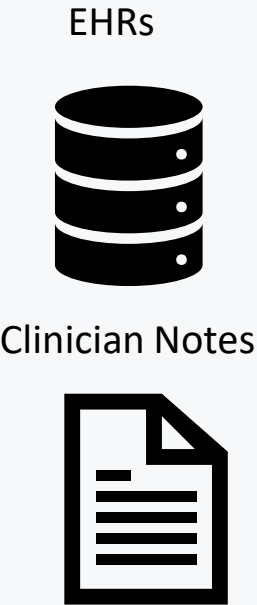
- Deep learning LLMs show promise in extracting meaningful information from unstructured EHR.
- These techniques excel in processing natural language, identifying medical entities, and inferring patient conditions.

• Enhancing Patient Care

- Application of AI to HER data can lead to more accurate diagnoses, personalized treatment plans, and predictive patient outcomes.
- Enables comprehensive aggregation and analysis of vast amounts of clinical data, uncovering new disease correlations and treatment possibilities.

Predictive Models using EHR Data

Raw Data



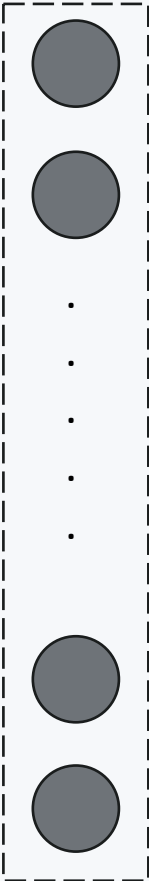
Context Extraction

Timestamp	Variable	Value
0	Age	35
0	Sex	M
0	PTSD	Yes
0	PHQ-9	10
30	Age	35
30	PHQ-9	NA
30	Sex	M
30	PTSD	Yes
30	TX	CBT
60	PHQ-9	20
60	Tx	Family
120	Age	35
120	PHQ-9	2
0	Age	45
0	Client Type	F
0	PHQ-9	NA
15	Age	45
15	PHQ-9	3
15	Tx	Couples

Tokenization

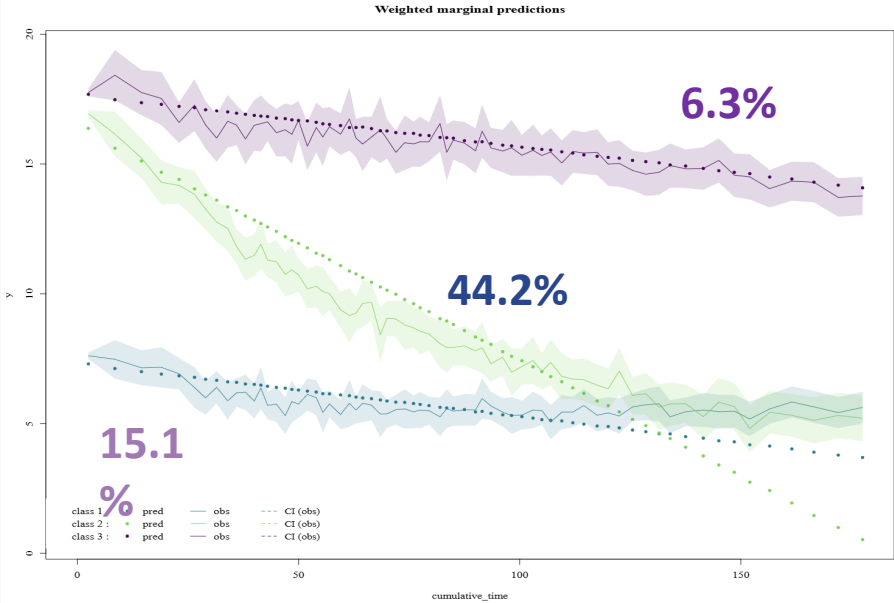
```
{
  [T0 Age_35 Sex_M PTSD_Y PHQ9_10 Tx_NA]
  [T30 Age_35 Sex_M PTSD_Y PHQ9_NA Tx_CBT]
  ...
  [T15 Age_45 Sex_NA PTSD_NA PHQ9_3 Tx_Couples]
}
```

Embedding

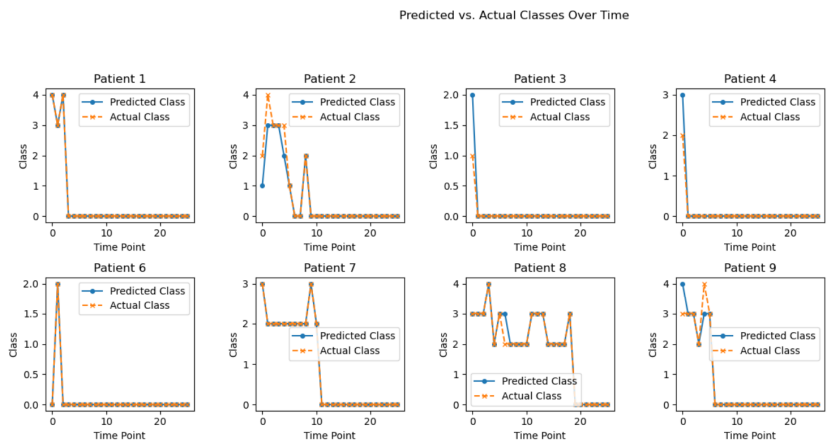


Prediction

Overall Remission



Visit x Visit Predictions using LSTM



Transparency and Explainability in AI: The Black Box Problem

The Challenge

AI models are not always transparent or easily understood

This may be concerning in healthcare, where decisions impact patient outcomes

Strategies

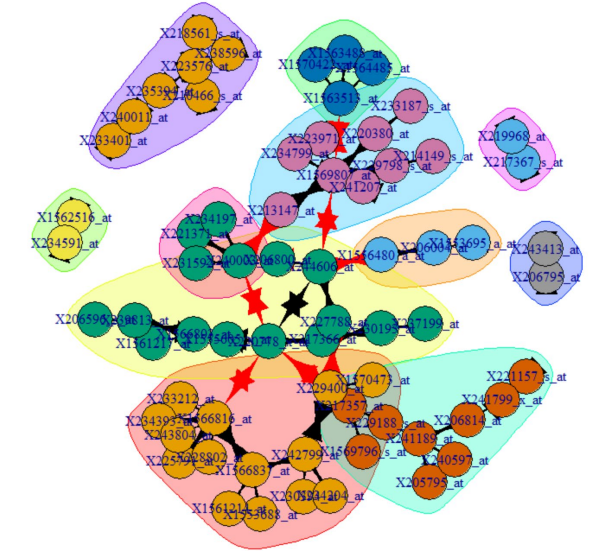
Utilizing feature importance visualization and model-agnostic explanation techniques to improve model interpretability

Validation

Need for rigorous validation of AI models in diverse and real world settings to ensure model reliability and safety

Ethical Considerations

Model deployment should consider bias, equity and informed consent



ADVANCING BRAIN HEALTH

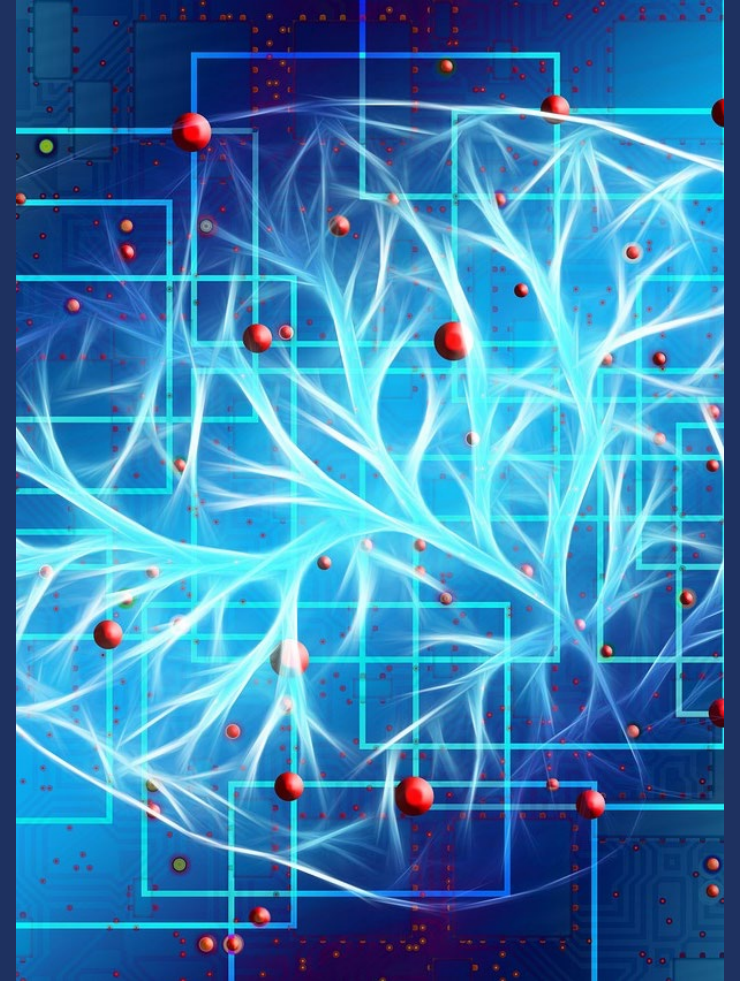
What's Next?

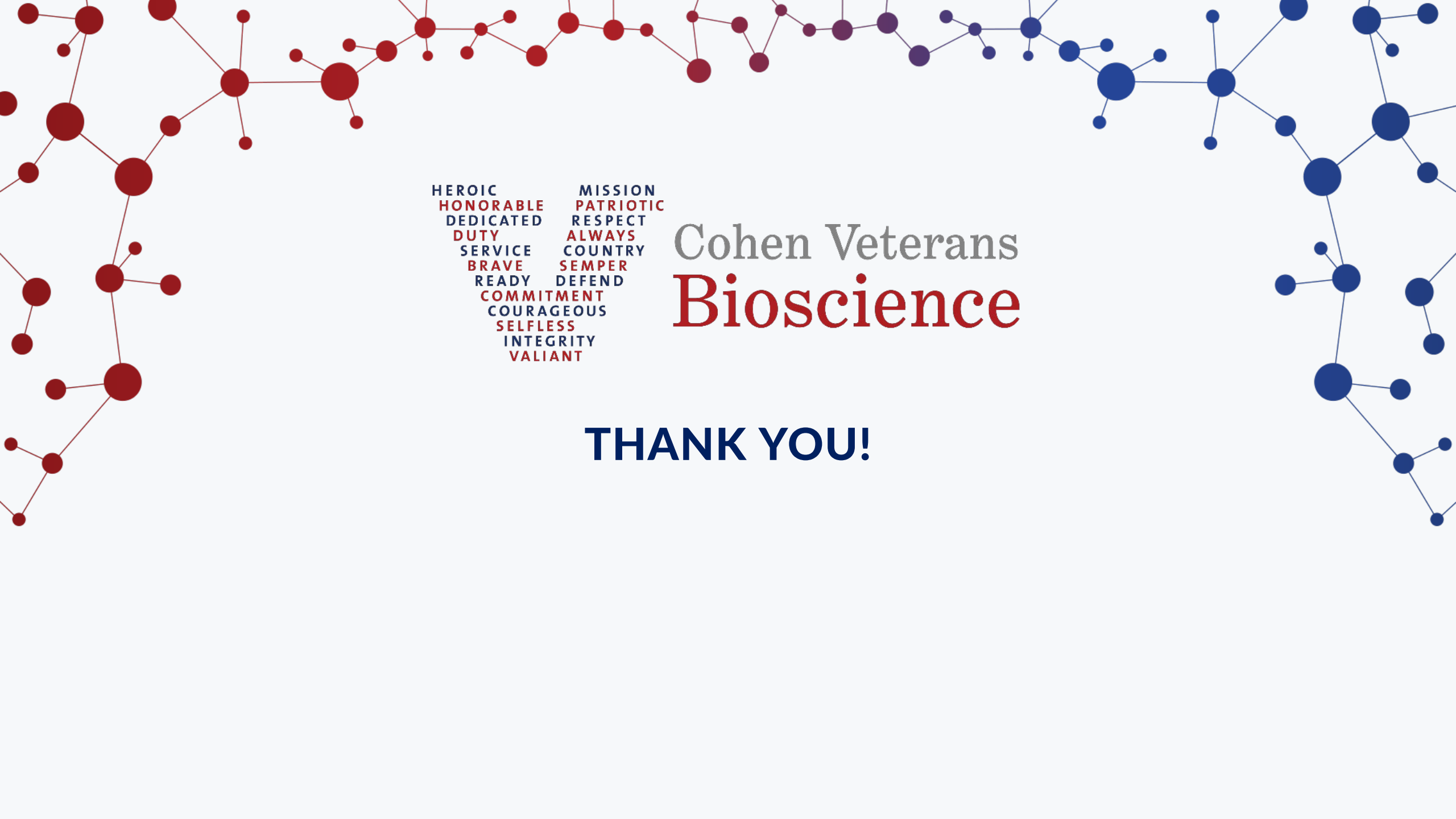
1 New Modalities to enrich our understanding of the brain

2 New Tools such as causal AI

3 Better Disease Understanding by leveraging the entire biological system

4 Impacting Patient Care through personalized medicine





HEROIC
HONORABLE
DEDICATED
DUTY
SERVICE
BRAVE
READY
COMMITMENT
COURAGEOUS
SELFLESS
INTEGRITY
VALIANT

MISSION
PATRIOTIC
RESPECT
ALWAYS
COUNTRY
SEMPER
DEFEND

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THANK YOU!