

### What Is Digital Twin?

#### **Definition:**

Digital twin is the virtual representation of a physical object, process, system, or environment that is designed to accurately imitate its real-world counterpart.

#### Features:

- ✓ Real-time data integration
- ✓ Simulation capabilities
- ✓ Feedback loop
- Analytic and predictions
- ✓ Customization

#### **Applications:**

- > Industry
- > Healthcare
- Smart Cities
- > Aerospace
- > Energy

#### **Our Goal:**

Create digital twins for older adults to simulate their behavior Predict their MCI score

## **Building Deep Digital Twins for Prediction of AD/ADR/MCI in Older Adults** M. Mehdi Hosseini<sup>1</sup>, Hiroko H. Dodge<sup>2</sup>, Mohammad H. Mahoor<sup>1,3</sup> <sup>1</sup>Ritchie School of Engineering & Computer Science, University of Denver, CO <sup>2</sup>Department of Neurology, Massachusetts General Hospital, Harvard Medical School, Boston, MA <sup>3</sup>DreamFace Technologies, LLC, Denver, CO

## **Project Highlights**

#### Probability Probability Dec → x̂ → Z — Vector Vector P(X|Z,Y)Q(Z|X)Reconstruction Output ) Audio f Video Image 🕅 Face 🗊 Language 🥔 Meta-Data MCI Cognitive Score Alzheimer's

#### **Requirements:**

## Dataset: I-CONECT (NCT02871921)

- Includes interview files, such as transcripts, with human subjects on almost 100 topics.
- Language Model: GPT-2
  - •Fine-tuned for each participant, separately, to mimic their answer to different questions.
- MCI-Predictor: C-VAE (Conditional-Variational Auto Encoder)
  - •Receives the extracted features of each question-answer (using BERT model), along with the conditions of subject, topic, and interview time, to predict the MCI score of each participant using the answers generated by the digital twin.

<b>Digital Twin Evaluation: Perplexity</b>							
Table 1- Average perplexity score for each partici							
	Participant 1	Participant 2	Participant 3				
Score	256	475	261				
BEST: 1			5				

## **Methodology:**



# **Conclusion:**

## **Future Directions:**

× Inclusion of *multi-modal* data can improve subject-based digital twins for MCI prediction. **×** Foundation models could be studied in the matter of mimicking subjects' behavior, where they can be utilized for fine-tuning a digital twin.

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#### **Experimental Results**

pant. Participant 4 218 50K: WORST

Predictor Evaluation: MCI Error (+3 months)						
Table 2- Mean absolute error (MAE) and STD for MCI predictor.						
	Participant 1	Participant 2	Participant 3	Participant 4		
MAE	0.28	0.65	2.74	3.83		
STD	0.45	0.47	0.90	1.43		



#### **Takeaway Statements**

• Digital twins can help to emulate the future behavior of people in question answering scenarios.

• C-VAEs can understand the complexity of different subjects and the time of interview in the matter of MCI prediction.