Unlocking the Mysteries of Dementia: How Generative AI Helps Decode Patient Symptoms



Memory and Aging Center

Department of Neurology

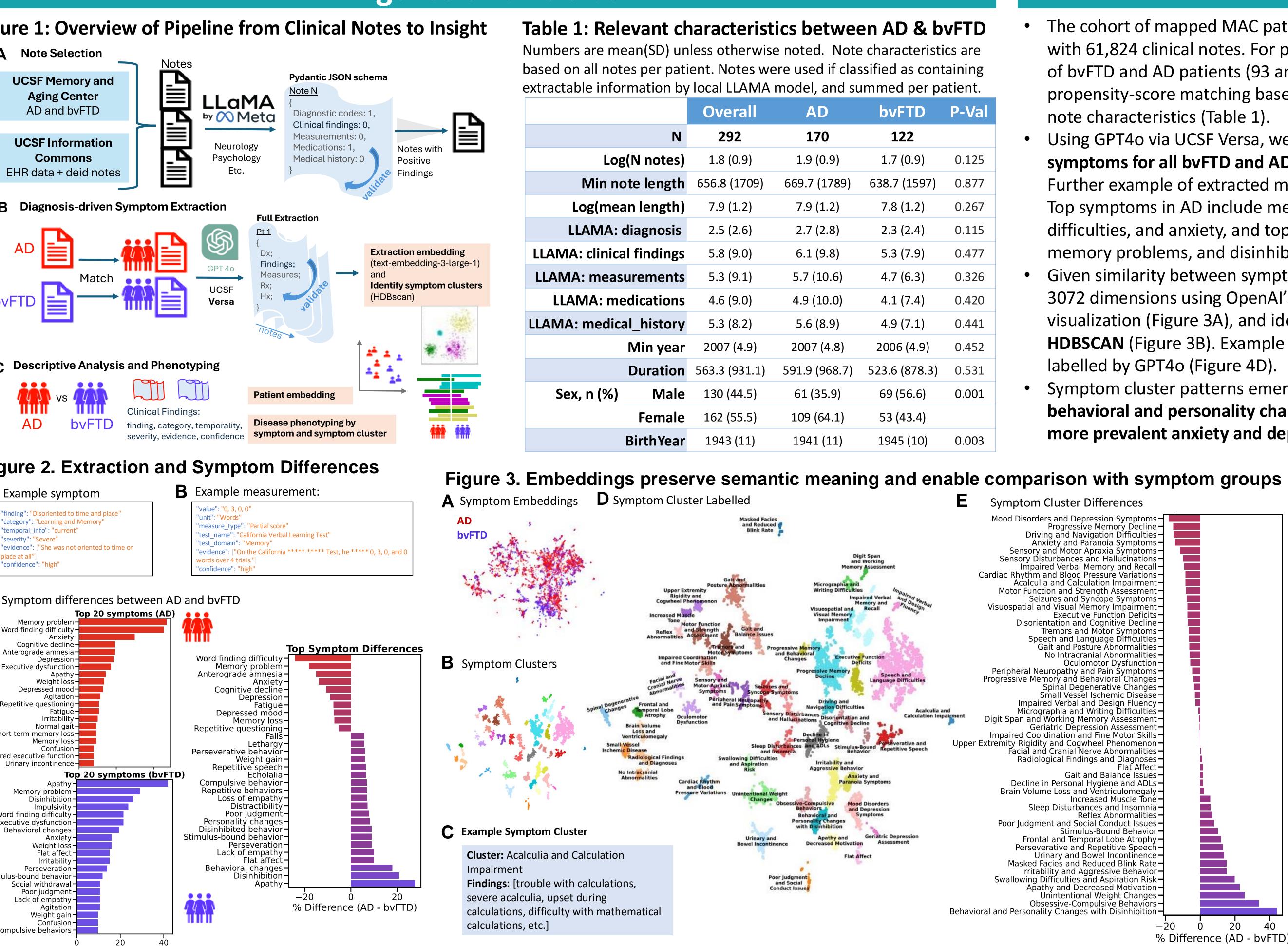
Background

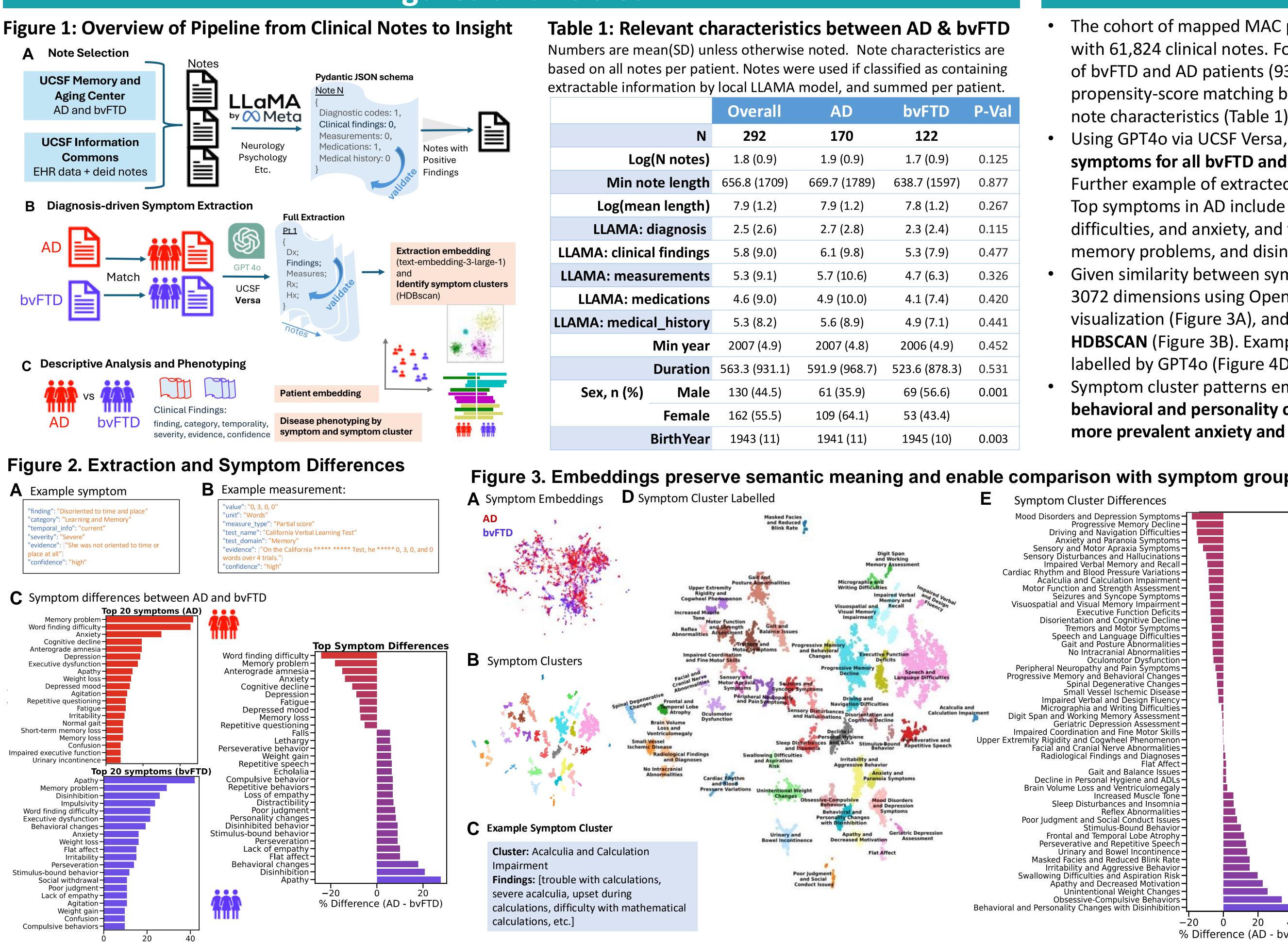
- Dementia encompasses diverse clinical syndromes affecting cognitive function, such as in Alzheimer's Disease (AD) and behavioralvariant Frontotemporal Dementia (bvFTD).
- The heterogeneous presentation of symptoms often results in diagnostic challenges, leading to delays and potential misdiagnoses.
- While electronic health records (EHRs) contain structured billing data, crucial clinical information remains embedded within unstructured narrative notes, presenting an opportunity for advanced natural language processing approaches.

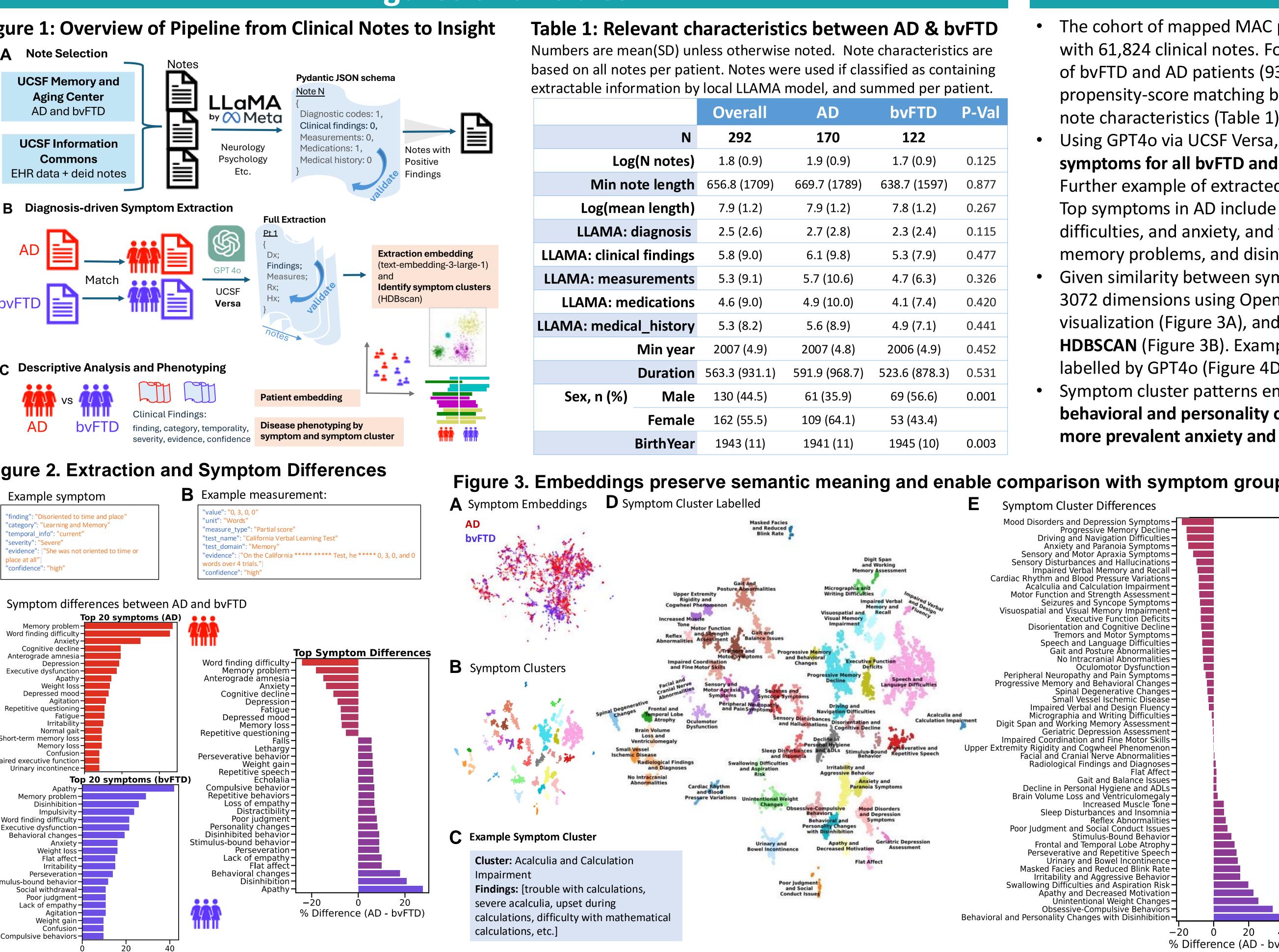
Methods

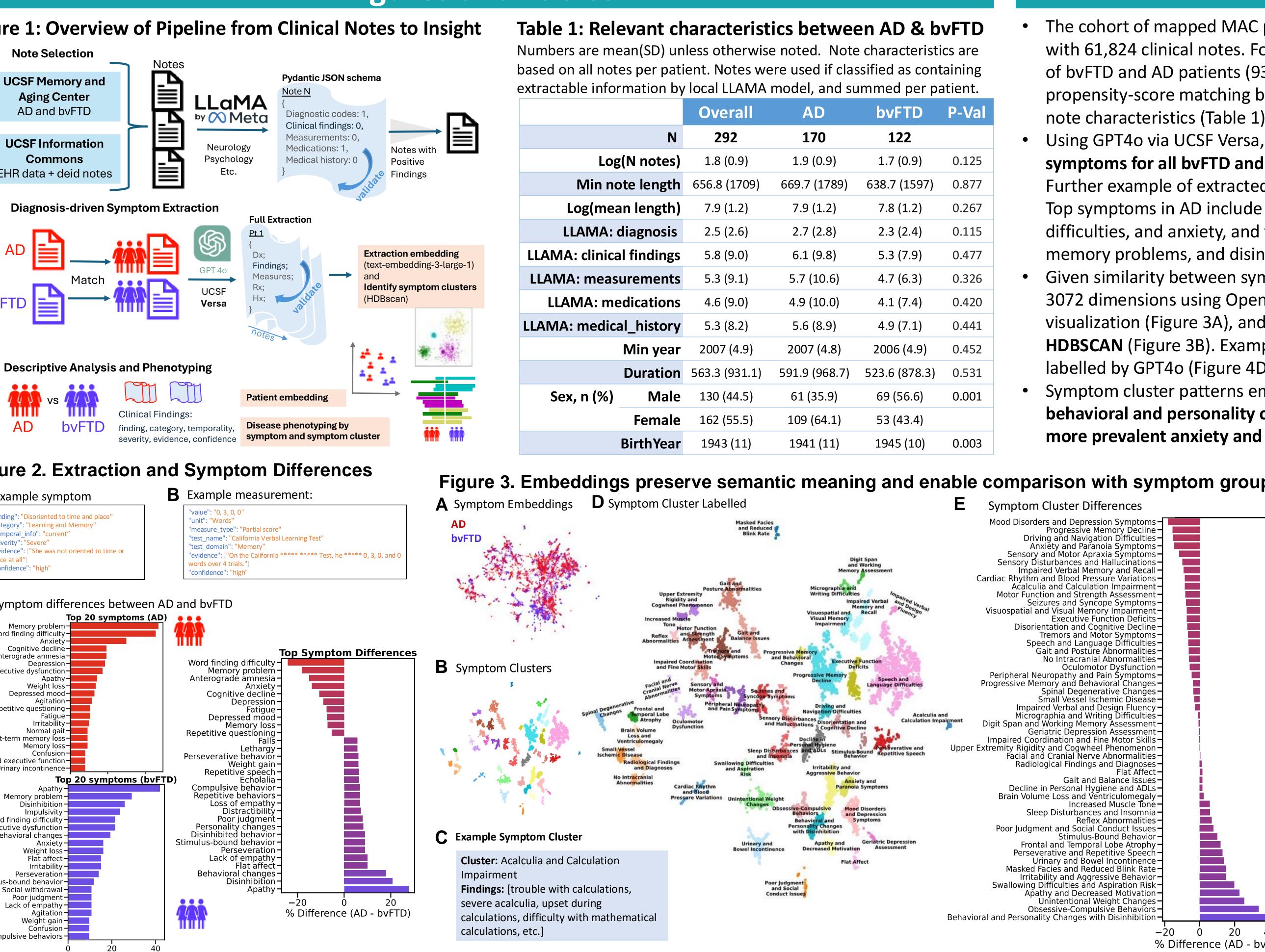
- We leverage Large Language Models (LLMs) to analyze clinical data from the UCSF de-identified clinical data warehouse for patients with Memory and Aging Center (MAC) diagnoses.
- For efficiency, a local **LLAMA 3.3 model** was utilized to extract binary indicators of categories (clinical findings, diagnoses, measurements, medications, and medical history) by enforcing a structured JSON output schema via Pydantic (Figure 1A). This is done on notes from neurology, psychology, and related fields.
- **GPT40** via UCSF Versa API was utilized to identify findings for AD and bvFTD patients for this proof of concept (Figure 1B). Further clinical symptom embeddings that preserve semantic similarity were obtained using OpenAI's text-embedding-3 model. Clusters of concept embeddings were obtained via HDBSCAN to reveal distinctive symptom patterns. UMAP was utilized for visualization in 2 dimensions.
- To enable phenotyping and insight, AD and bvFTD were compared based on both extracted symptom and symptom clusters. Patient embeddings were obtained by averaging across embedding of findings (Figure 1C).

4	Note Selection
l	UCSF Memory a Aging Center AD and bvFTD
	UCSF Informati Commons HR data + deid no









mpaired executive function

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Figures and Tables



	Overall	AD	bvFTD	P-Val
J	292	170	122	
;)	1.8 (0.9)	1.9 (0.9)	1.7 (0.9)	0.125
h	656.8 (1709)	669.7 (1789)	638.7 (1597)	0.877
)	7.9 (1.2)	7.9 (1.2)	7.8 (1.2)	0.267
5	2.5 (2.6)	2.7 (2.8)	2.3 (2.4)	0.115
S	5.8 (9.0)	6.1 (9.8)	5.3 (7.9)	0.477
S	5.3 (9.1)	5.7 (10.6)	4.7 (6.3)	0.326
S	4.6 (9.0)	4.9 (10.0)	4.1 (7.4)	0.420
У	5.3 (8.2)	5.6 (8.9)	4.9 (7.1)	0.441
r	2007 (4.9)	2007 (4.8)	2006 (4.9)	0.452
n	563.3 (931.1)	591.9 (968.7)	523.6 (878.3)	0.531
е	130 (44.5)	61 (35.9)	69 (56.6)	0.001
е	162 (55.5)	109 (64.1)	53 (43.4)	
r	1943 (11)	1941 (11)	1945 (10)	0.003

- note characteristics (Table 1).
- memory problems, and disinhibition (Figure 2C).
- labelled by GPT4o (Figure 4D).

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Results

The cohort of mapped MAC patients comprised of 4,690 patients with 61,824 clinical notes. For proof of concept, we identified cohorts of bvFTD and AD patients (93 and 140 patients, respectively) with propensity-score matching based on demographics and per-patient

• Using GPT4o via UCSF Versa, we extracted **12,637 distinct clinical** symptoms for all bvFTD and AD notes, example shown in Figure 2A. Further example of extracted measurement is shown in Figure 1B. Top symptoms in AD include memory problems, word-finding difficulties, and anxiety, and top symptoms in bvFTD include apathy,

Given similarity between symptoms, we embedded symptoms into 3072 dimensions using OpenAl's embedding model and UMAP for visualization (Figure 3A), and identified **51 symptom clusters with** HDBSCAN (Figure 3B). Example cluster in Figure 3C. Clusters are

Symptom cluster patterns emerge: **bvFTD patients exhibited more** behavioral and personality changes, while AD patients showed more prevalent anxiety and depression symptoms (Figure 4E).

Conclusions

- This novel approach, via LLMbased structured information extraction and traditional data analytics, demonstrates promising results for enhanced symptom characterization and phenotyping in dementia.
- Our findings suggest potential applications in improving diagnostic accuracy, developing prediction models, and optimizing treatment strategies in dementia care.
- We aim to extend this proof of concept to other domains (e.g., measurements, medications) and across dementia syndromes.