NLP and Semantic Measures for analysing psychological constructs

By Matilda Andersson and Alexandra Antgren

Problem

Research questions

Implementation

Results

Conclusion and further work

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Research questions

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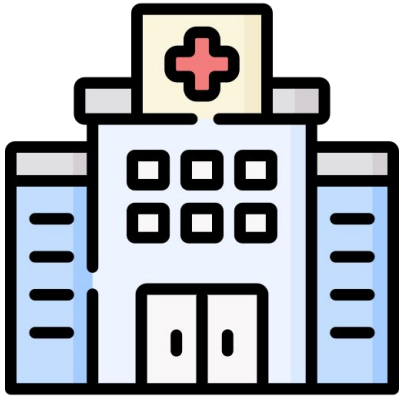
Conclusion and further work



Icons from Flaticon

*Rate each of the following statements on a scale of 1 ("not at all typical of me") to 5 ("very typical of me"). Please do not leave any items blank.

	Not at all typical of me 1	2	3	4	Very typical of me 5
1. If I do not have enough time to do everything, I do not worry about it.	○	○	○	○	○

- Current method: numerical rating scales → the dominant method for measuring people's mental state

- Our method: Open-ended responses→ semantic space → explore whether the semantic space correlates with if a person has anxiety/depression or not.

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1) How well can question-based computational language assessments (QCLAs) correlate with traditional numerical rating scales?

2) Can QCLAs and semantic representations be used for predicting depression/anxiety?

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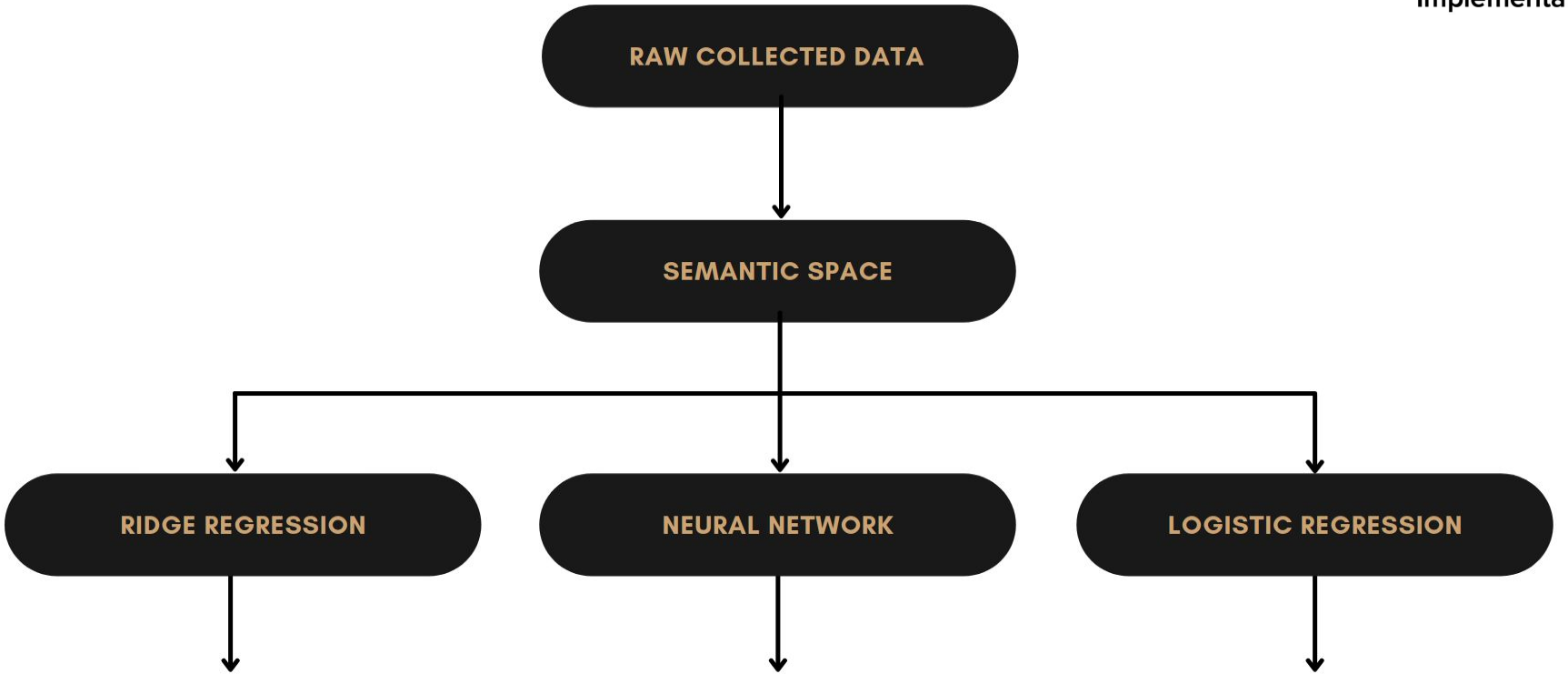

RAW COLLECTED DATA
SEMANTIC SPACE
RIDGE REGRESSION
NEURAL NETWORK
LOGISTIC REGRESSION
NUMERICAL VALUE
CORRESPONDING TO
PHQ9 OR GAD7 SCALES
CLASS PREDICTION
ORDINAL CLASSES OF
CONDITION SEVERITY
BINARY PREDICTION
DIAGNOSE DEPRESSION
/ANXIETY OR NOT?

RAW COLLECTED DATA

*Over the last 2 weeks, have you been worried or not?

Write descriptive words relating to those aspects that are most important and meaningful to you.

Write only one descriptive word in each box.

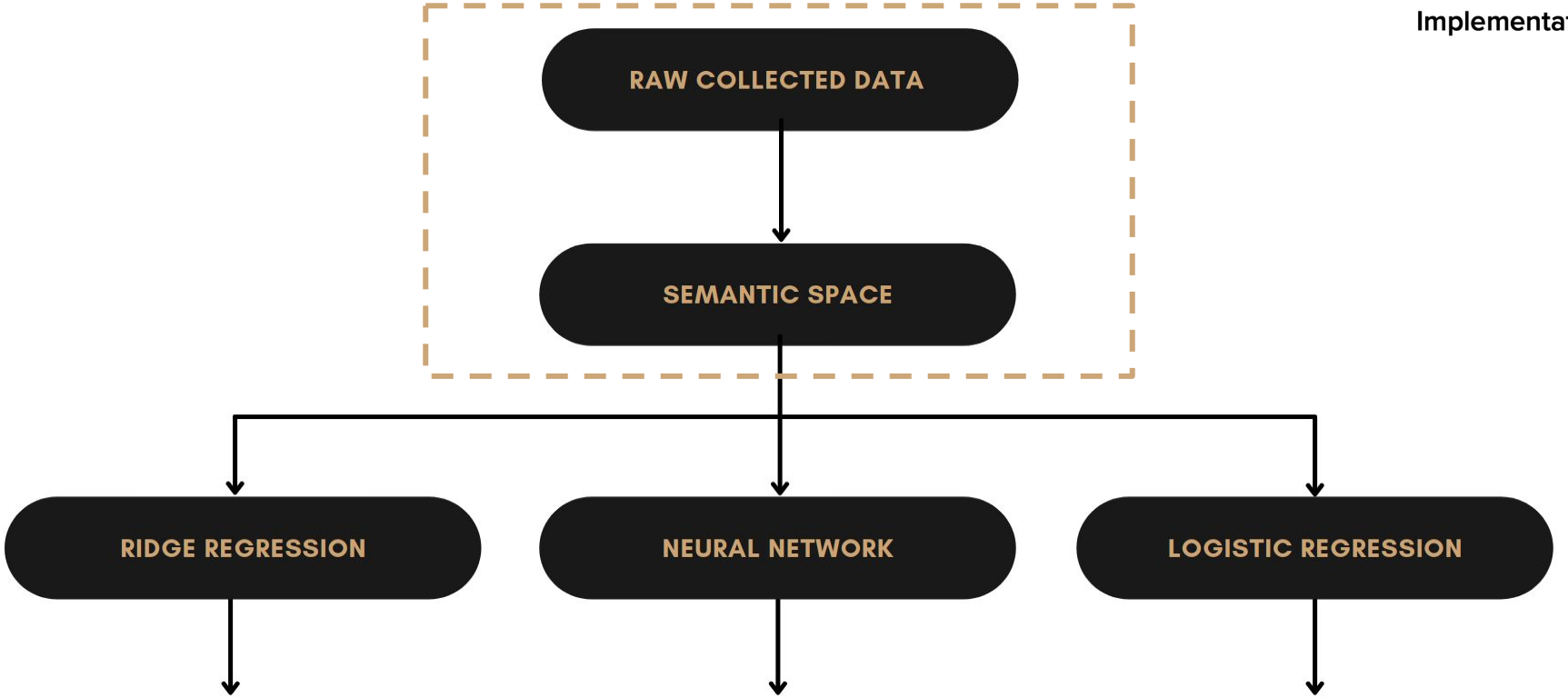
Word 1		Word or phrase 1	
Word 2		Word or phrase 2	
Word 3		Word or phrase 3	
Word 4		Word or phrase 4	
Word 5		Word or phrase 5	

RIDGE REG

NUMERICA

CORRESPO

PHQ9 OR GA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SEMANTIC SPACE
RIDGE REGRESSION
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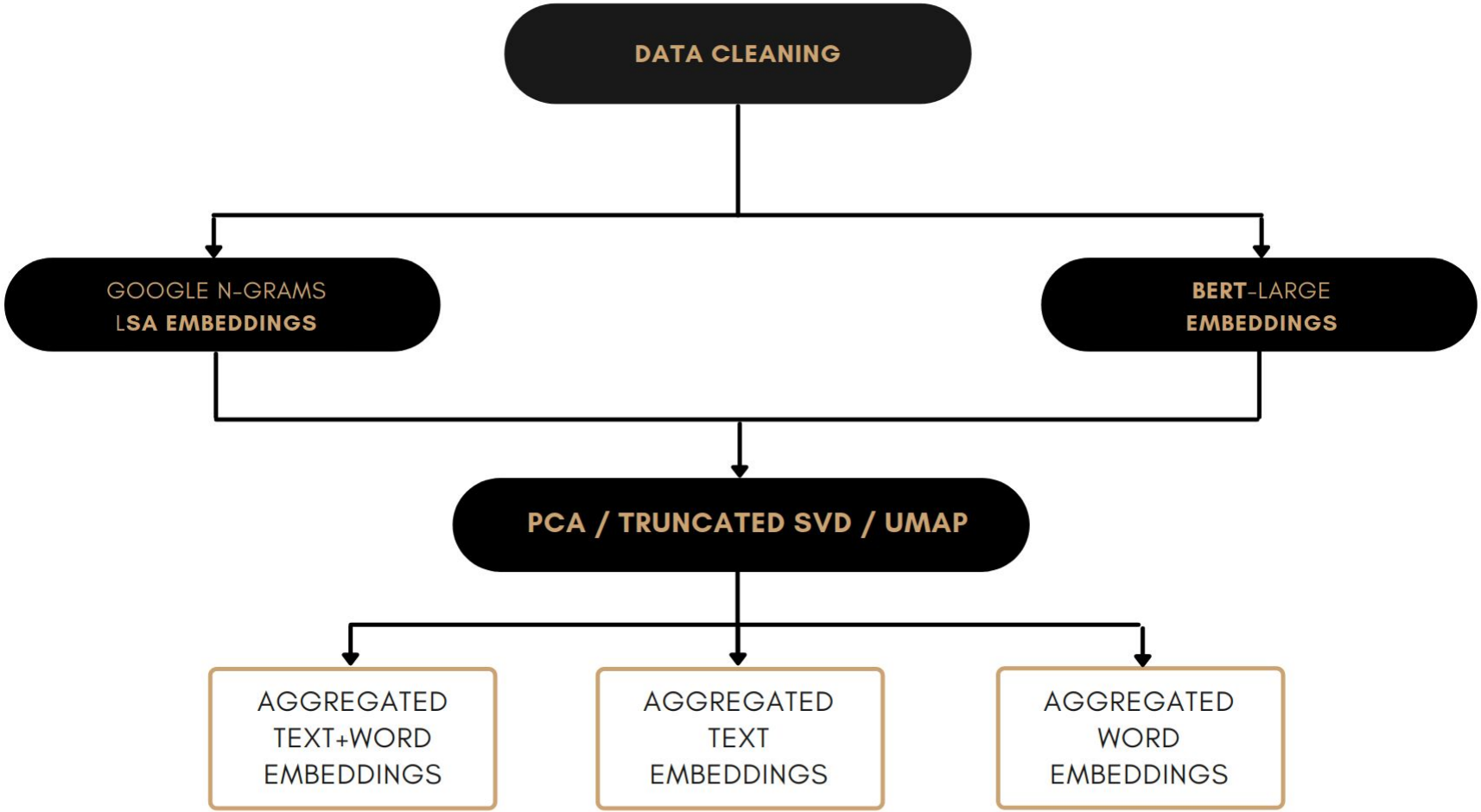
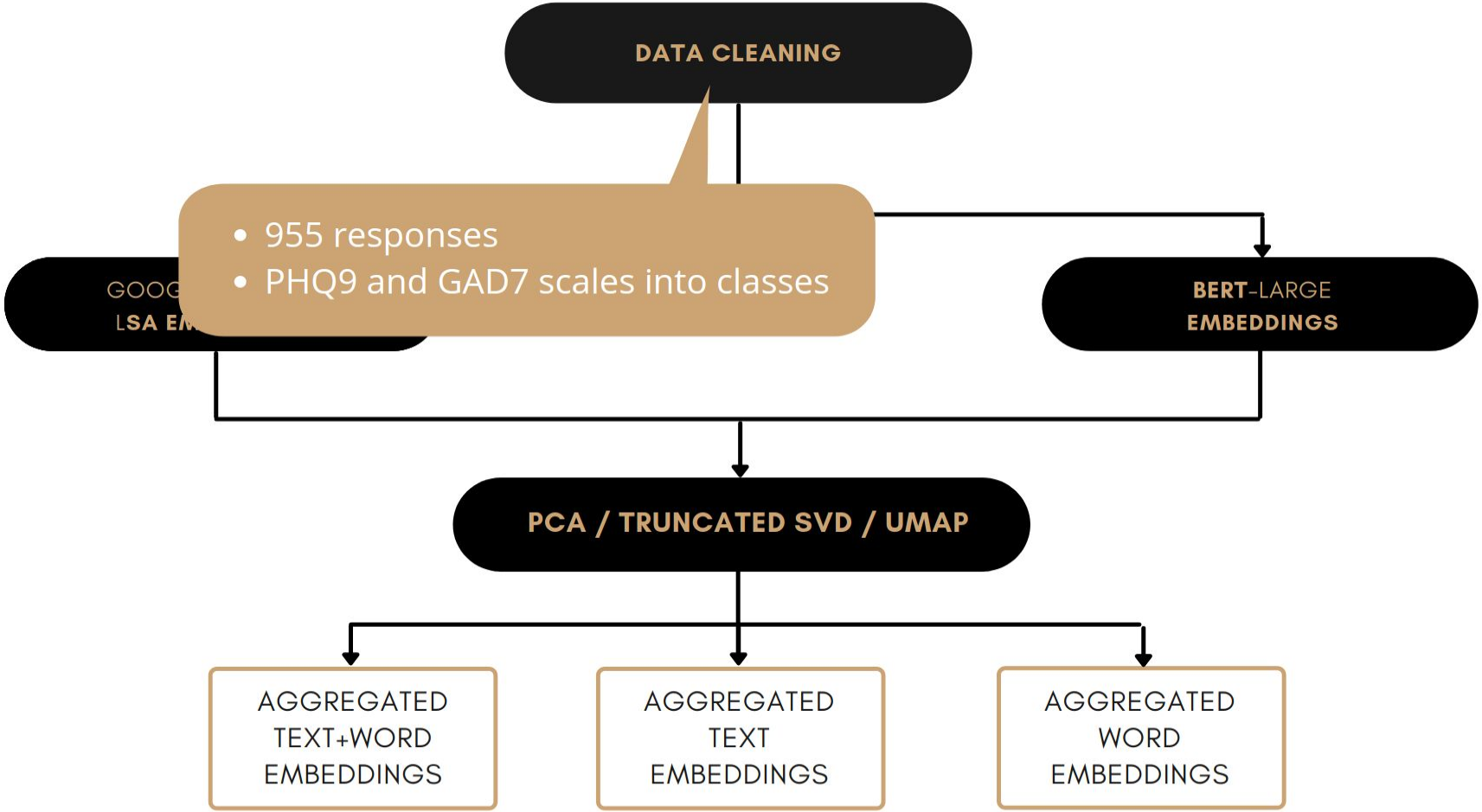
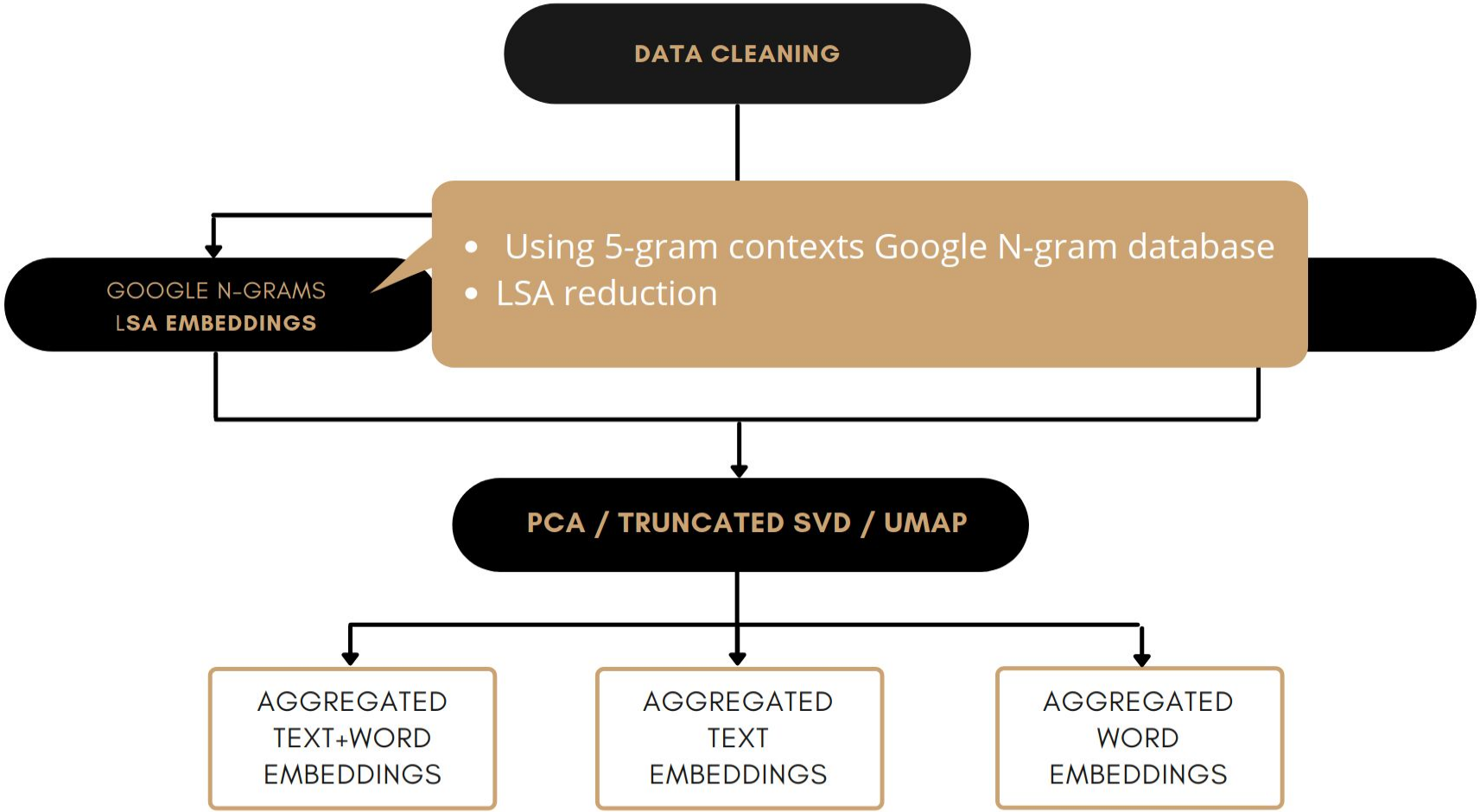
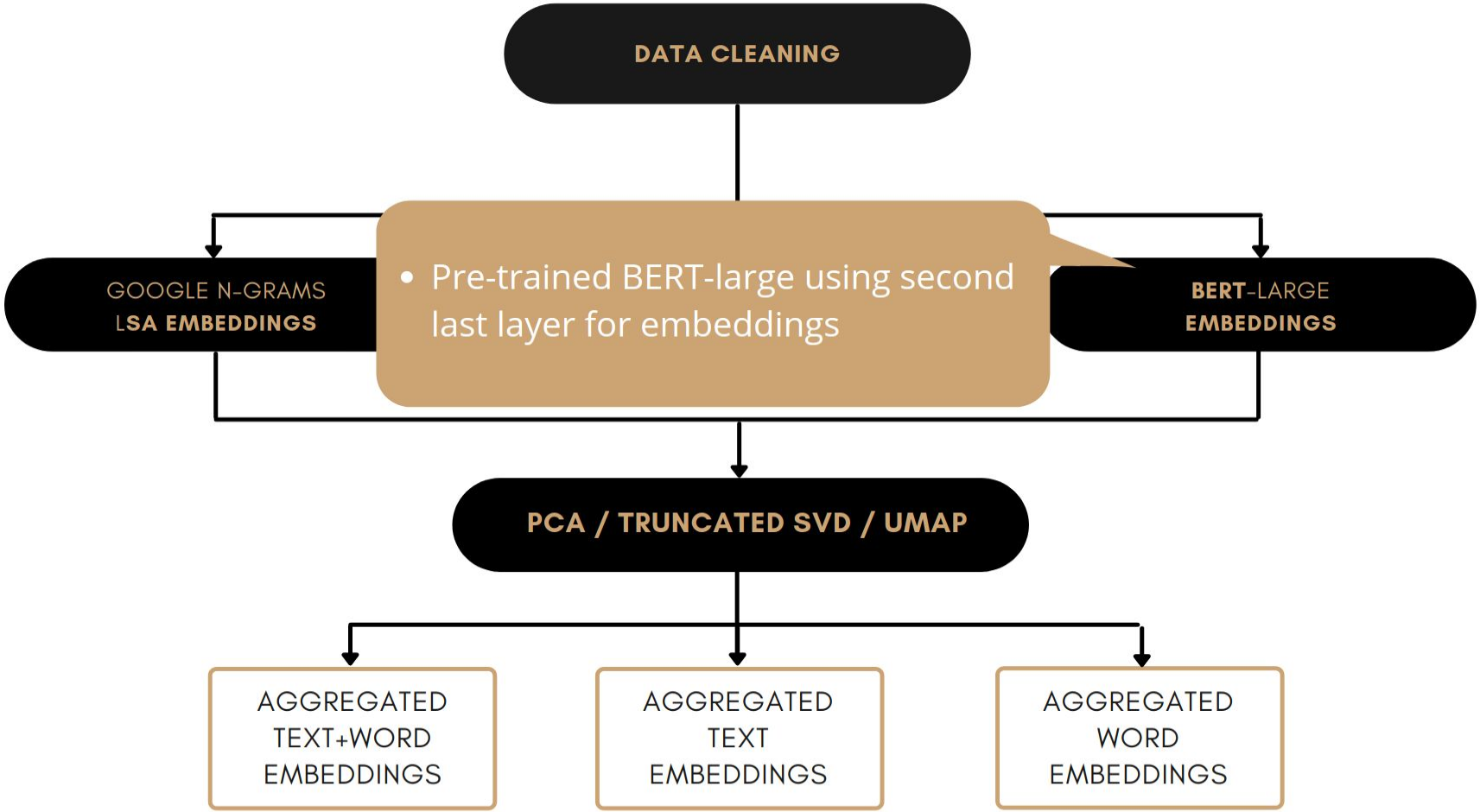
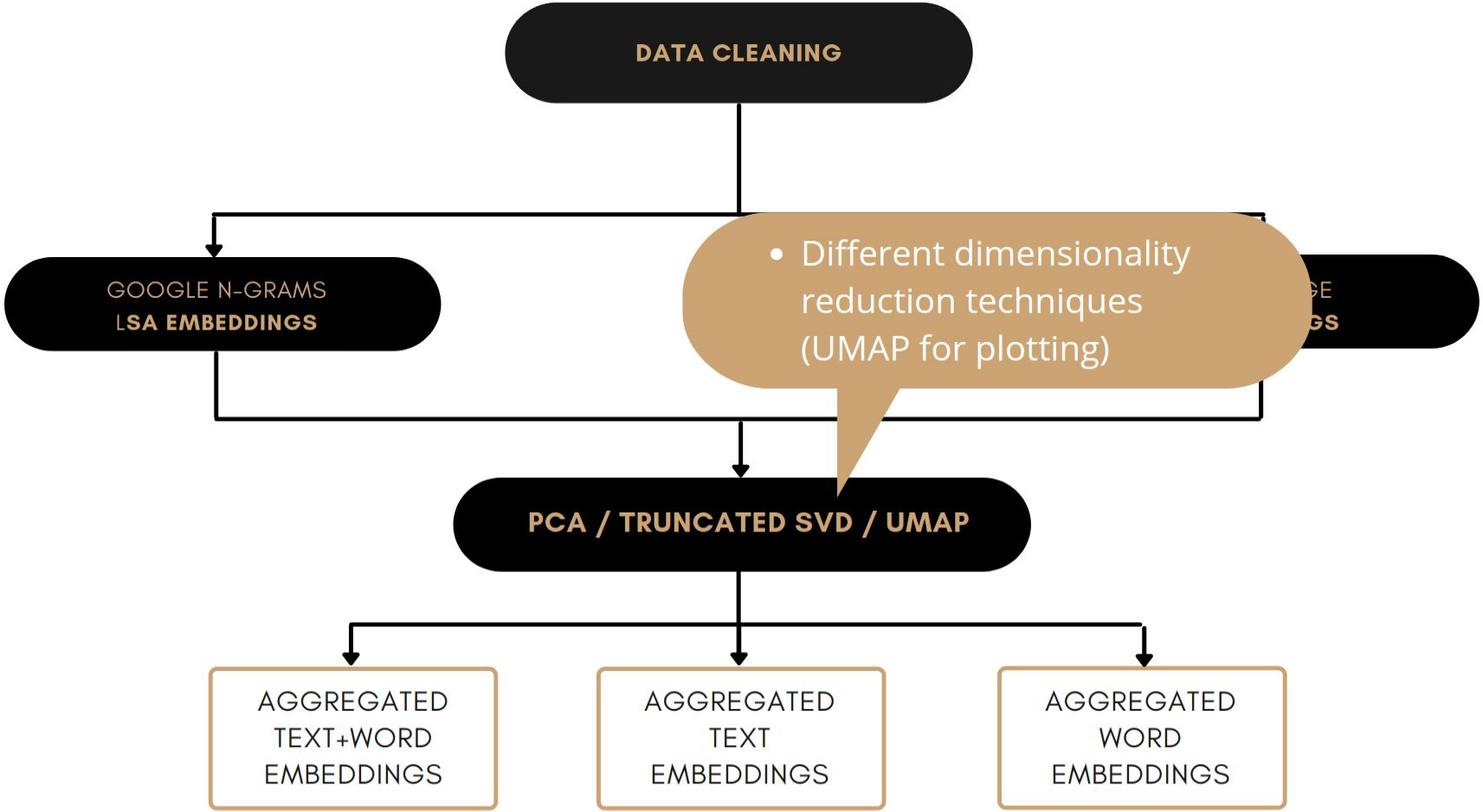
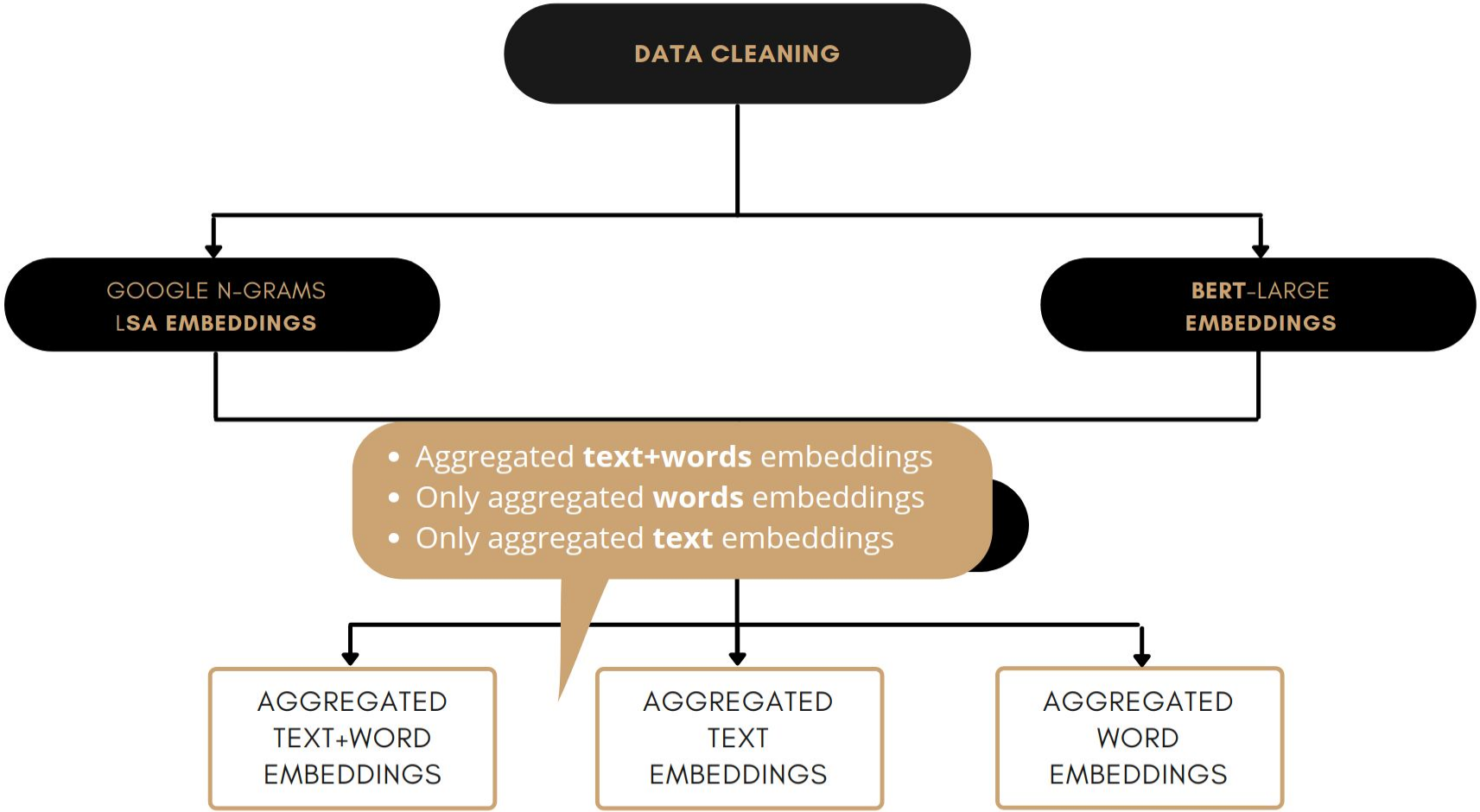

DATA CLEANING
GOOGLE N-GRAMS
LSA EMBEDDINGS
BERT-LARGE
EMBEDDINGS
PCA / TRUNCATED SVD / UMAP
AGGREGATED
TEXT+WORD
EMBEDDINGS
AGGREGATED
TEXT
EMBEDDINGS
AGGREGATED
WORD
EMBEDDINGS

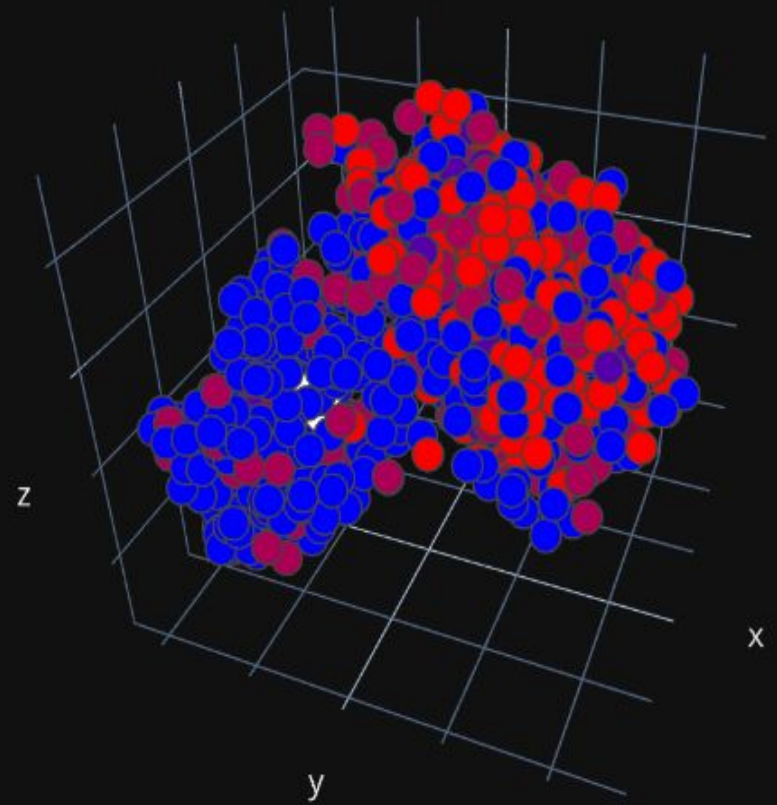

DATA CLEANING
• 955 responses
• PHQ9 and GAD7 scales into classes
GOOG
LSA EM
BERT-LARGE
EMBEDDINGS
PCA / TRUNCATED SVD / UMAP
AGGREGATED
TEXT+WORD
EMBEDDINGS
AGGREGATED
TEXT
EMBEDDINGS
AGGREGATED
WORD
EMBEDDINGS


DATA CLEANING
GOOGLE N-GRAMS
LSA EMBEDDINGS
• Using 5-gram contexts Google N-gram database
• LSA reduction
PCA / TRUNCATED SVD / UMAP
AGGREGATED TEXT+WORD EMBEDDINGS
AGGREGATED TEXT EMBEDDINGS
AGGREGATED WORD EMBEDDINGS


DATA CLEANING
GOOGLE N-GRAMS LSA EMBEDDINGS
• Pre-trained BERT-large using second last layer for embeddings
BERT-LARGE EMBEDDINGS
PCA / TRUNCATED SVD / UMAP
AGGREGATED TEXT+WORD EMBEDDINGS
AGGREGATED TEXT EMBEDDINGS
AGGREGATED WORD EMBEDDINGS


DATA CLEANING
GOOGLE N-GRAMS
LSA EMBEDDINGS
• Different dimensionality reduction techniques (UMAP for plotting)
PCA / TRUNCATED SVD / UMAP
AGGREGATED TEXT+WORD EMBEDDINGS
AGGREGATED TEXT EMBEDDINGS
AGGREGATED WORD EMBEDDINGS


DATA CLEANING
GOOGLE N-GRAMS
LSA EMBEDDINGS
BERT-LARGE
EMBEDDINGS
• Aggregated text+words embeddings
• Only aggregated words embeddings
• Only aggregated text embeddings
AGGREGATED
TEXT+WORD
EMBEDDINGS
AGGREGATED
TEXT
EMBEDDINGS
AGGREGATED
WORD
EMBEDDINGS


z
y
x


3
2.5
2
1.5
1
0.5
0

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1) How well can QCLAs correlate with traditional numerical rating scales?

- **Spearman's correlations** measures the strength and direction of association between two variables
- Value between -1 and +1

	Depression	Anxiety
Baseline Dummy Classifier	0.102	-0.020
Ridge Regression	0.717	0.648
MLP Neural Network	0.642	0.527

2) Predicting numerical value on PHQ-9 or GAD-7 scales

Depression scale predicted vs. self reported		
	Mean Abs Error	R^2
Baseline	1.232	0.0
Words + Text	0.764	0.528
Words	0.813	0.492
Text	0.838	0.432

Anxiety scale predicted vs. self reported		
	Mean Abs Error	R^2
Baseline	0.994	0.0
Words + Text	0.676	0.420
Words	0.695	0.403
Text	0.752	0.300

2) Predicting **depression/anxiety** severity class

Depression	Precision	Recall	F1-score
Accuracy			0.39
Macro average	0.52	0.39	0.34
Weighted average	0.51	0.39	0.35

Anxiety	Precision	Recall	F1-score
Accuracy			0.42
Macro average	0.45	0.40	0.35
Weighted average	0.46	0.42	0.36

2) Predicting **depression, anxiety** diagnose or not?

Logistic Reg.	No depression diagnose	Depression diagnose	Accuracy	Macro avg.	Weighted avg.
Baseline - F1-score	0.65	0.29	0.53	0.47	0.53
Our model - F1-score	0.77	0.56	0.70	0.66	0.70

Logistic Reg.	No anxiety diagnose	Anxiety diagnose	Accuracy	Macro avg.	Weighted avg.
Baseline - F1-score	0.51	0.49	0.50	0.50	0.50
Our model - F1-score	0.64	0.70	0.68	0.67	0.67

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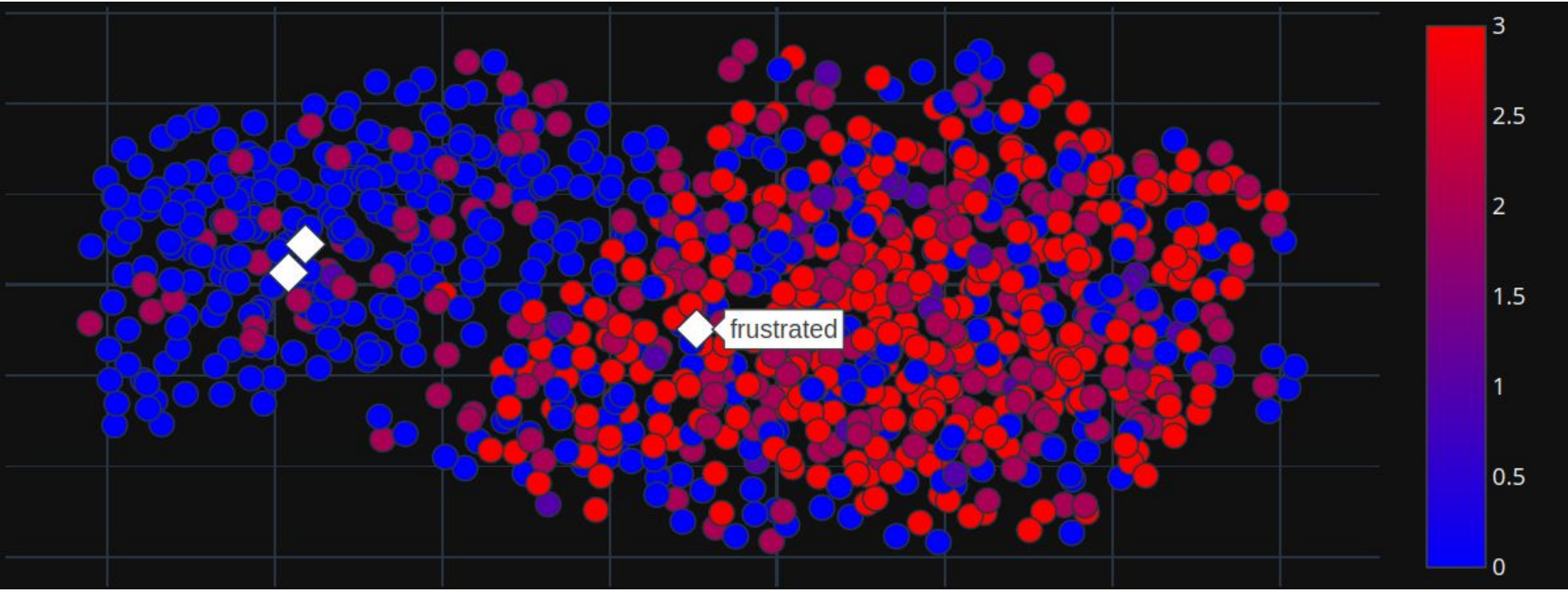
- Results show that semantic measures correlate well with numerical rating scales
- However, the reliability of a self reported scale provides limits on how well they can be predicted
- Future work could focus on a broader range of psychological constructs where evaluation is not based on self reported numerical scales but objective measures like clinical interviews

Thank you for listening!

Questions?

3) Visualizations



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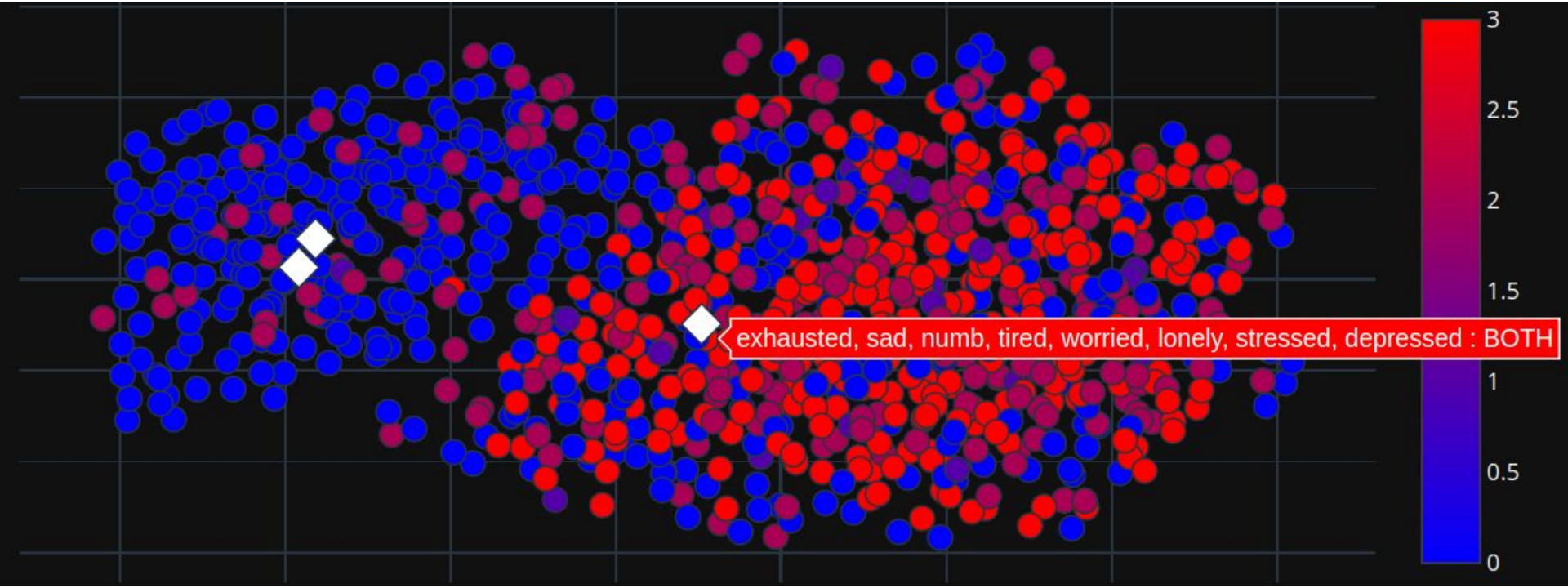

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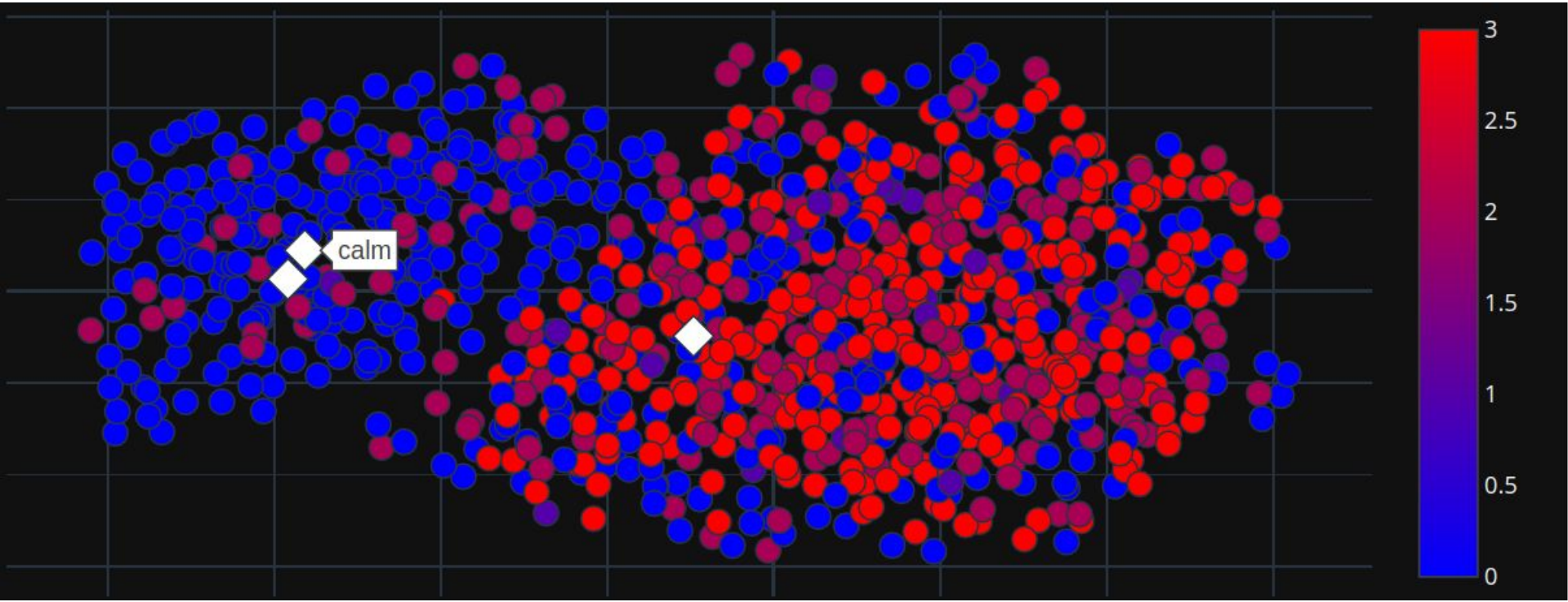

3) Visualizations