The University of Texas at El Paso

Senior Design Review: Acoustic Feature Analyzer

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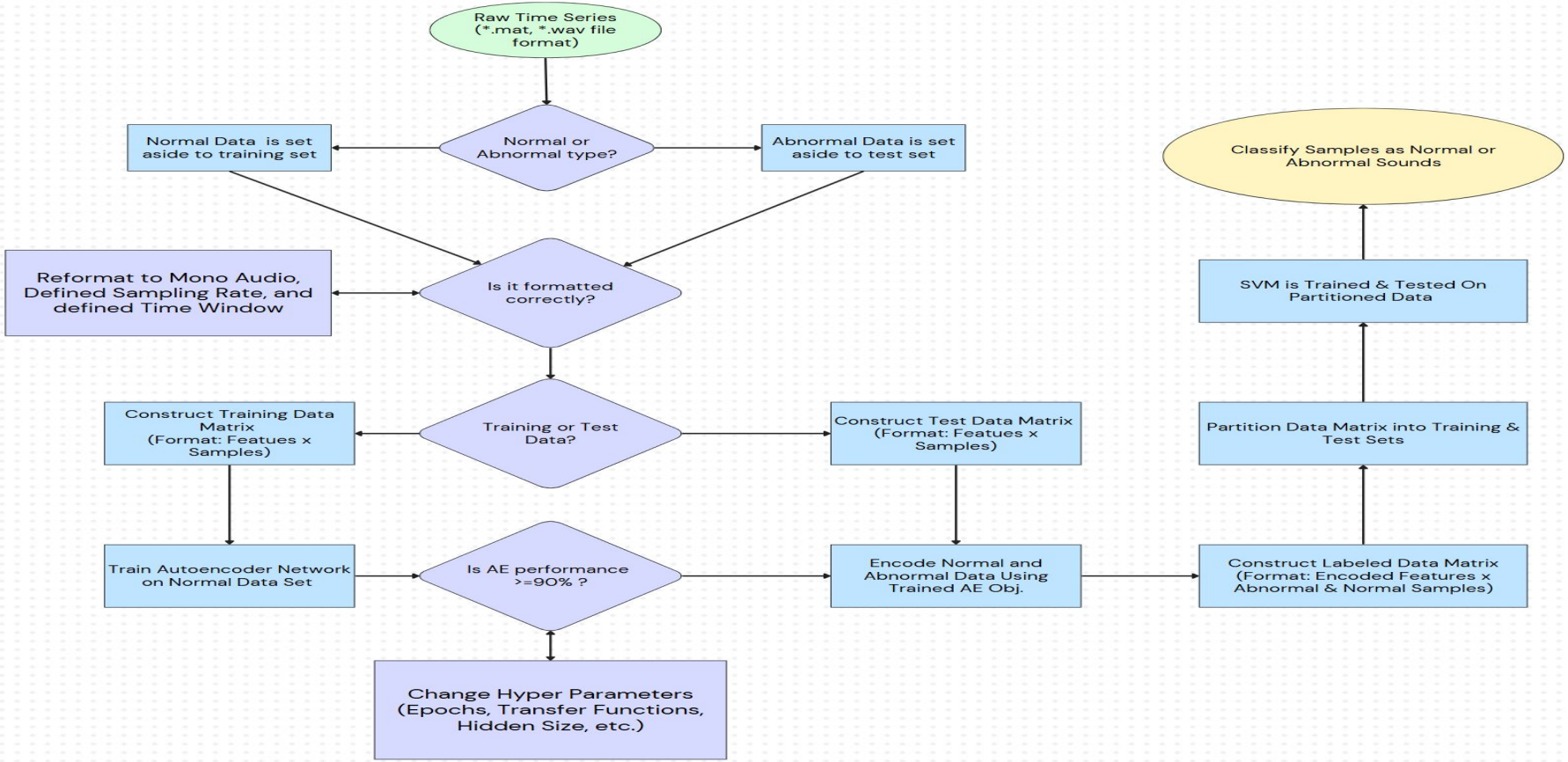


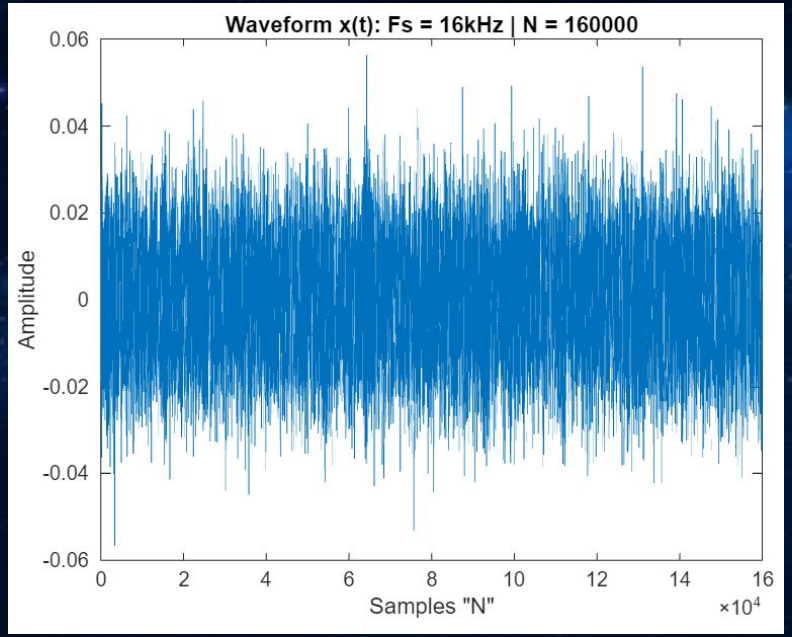
Product Diagram

Model/Structure	Type	Accuracy	Interpretability	Training Time	Suitability for Audio	Key Strengths	Key Weaknesses
Autoencoder (AE)	Unsupervised	High	Low	Moderate	Great	- Learns compressed representations - Good for anomaly detection - Can denoise audio	- May learn irrelevant patterns - Hard to interpret latent space
Variational Autoencoder (VAE)	Unsupervised	High	Low	Long	Great	- Captures complex distributions - Can generate synthetic audio - Regularizes latent space	- Latent features are abstract - More sensitive to tuning
Convolutional Autoencoder (CAE)	Unsupervised	High	Moderate	Long	Excellent	- Captures frequency/spatial patterns - Works well with spectrograms - Can handle noise	- Needs large data for good features - May blur fine details
Gaussian Mixture Model (GMM)	Unsupervised	Moderate	High	Moderate	Good	- Good for modeling sound distributions - Can separate mixed audio sources - Handles uncertainty well	- Assumes Gaussian distributions - Prone to overfitting with high-dimensional data

Competitive Analysis

Design Requirements

Model can be trained on time series data (Determined by model structure).



Design Requirements

Chosen model must be **<u>unsupervised</u>**.

- No Labeling Row/Column
- Purely Numerical Array

160000x8 double

	1	2	3	4	5	6	7	8
1	-0.0153	-0.0193	-0.0126	-0.0077	-0.0063	-0.0082	-0.0123	-0.0125
2	-0.0145	-0.0099	-0.0061	-0.0075	-0.0155	-0.0106	-0.0076	-0.0112
3	-0.0093	-0.0094	-0.0077	-0.0138	-0.0120	-0.0106	-0.0062	-0.0099
4	-0.0116	-0.0070	-0.0132	-0.0170	-0.0171	-0.0094	-0.0110	-0.0076
5	-0.0037	-6.1035e-05	-0.0079	-0.0144	-0.0146	-0.0132	-0.0090	-0.0098
6	0.0087	0.0070	-2.7466e-04	-0.0051	-0.0099	-0.0135	-0.0084	-0.0051
7	0.0028	0.0142	0.0166	0.0031	-0.0072	-0.0048	-0.0121	-0.0018
8	-0.0073	0.0103	0.0097	0.0118	0.0040	-0.0127	-0.0097	-0.0121
9	-0.0111	-0.0171	-0.0134	-0.0078	-8.5449e-04	-0.0127	-0.0181	-0.0204
10	-0.0126	-0.0203	-0.0221	-0.0203	-0.0176	-0.0051	-0.0082	-0.0032
11	-0.0047	-0.0172	-0.0236	-0.0185	-0.0176	-0.0105	0.0027	0.0020
12	-0.0107	-0.0111	-0.0171	-0.0200	-0.0095	-0.0126	-8.8501e-04	-0.0026
13	-0.0017	-0.0049	-0.0140	-0.0154	-0.0179	-0.0093	-0.0077	-0.0031
14	-0.0063	-0.0084	-0.0090	-0.0201	-0.0184	-0.0162	-0.0101	-0.0028
15	-0.0111	-0.0069	-0.0022	-0.0076	-0.0113	-0.0110	-0.0074	-0.0101
16	-0.0128	-0.0011	-0.0023	-7.3242e-04	-5.7983e-04	-0.0067	-0.0039	-0.0040
17	-0.0109	-9.4604e-04	0.0077	0.0043	0.0050	-3.0518e-04	0.0034	-0.0063
18	-0.0031	0.0076	0.0186	0.0138	0.0086	0.0035	2.7466e-04	-0.0037
19	0.0066	0.0148	0.0117	0.0163	0.0144	0.0066	-5.7983e-04	0.0031
20	0.0091	0.0091	0.0099	0.0156	0.0203	0.0085	0.0079	0.0098
21	0.0028	7.6294e-04	-0.0013	0.0093	0.0169	0.0058	0.0077	0.0055
22	-0.0043	-0.0106	-0.0139	-0.0137	-0.0020	5.4932e-04	0.0010	2.1362e-04
23	-0.0172	-0.0145	-0.0199	-0.0255	-0.0074	0.0026	0.0031	-0.0055
24	-0.0210	-0.0234	-0.0251	-0.0208	-0.0089	0.0014	4.8828e-04	-0.0060
25	-0.0295	-0.0294	-0.0215	-0.0211	-0.0056	-0.0060	-0.0033	-0.0146
26	-0.0176	-0.0194	-0.0163	-0.0190	-0.0148	-0.0089	-0.0095	-0.0186
27	-0.0117	-0.0091	-0.0240	-0.0212	-0.0147	-0.0133	-0.0127	-0.0121
28	-0.0094	-0.0188	-0.0220	-0.0226	-0.0123	-0.0178	-0.0113	-0.0084
29	-0.0094	-0.0069	-0.0089	-0.0170	-0.0117	-0.0208	-0.0189	-0.0071

Rows of Time Samples “N”

Columns of Waveforms “x(t)”

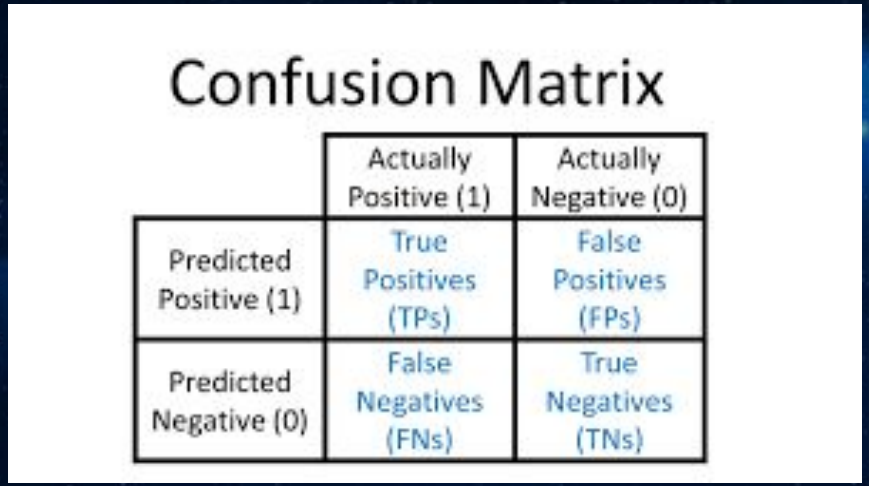
Design Requirements

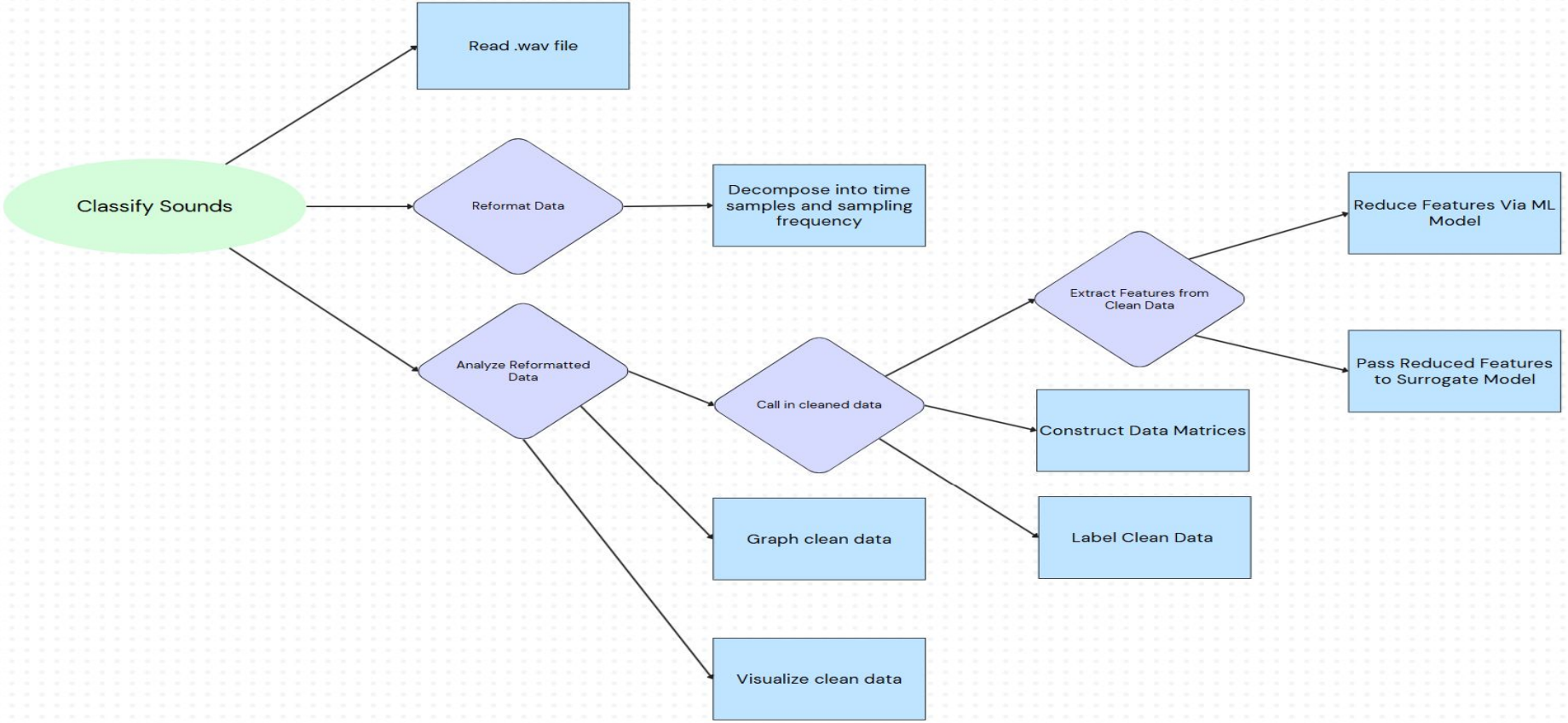
Chosen unsupervised model must work with “relatively” small data sets.

- **200 >= Number of Sound Files in Data Set >= 50000**
- **Visuals provided use 200 total samples of audio files with 160000 points, a sampling rate (Hz) of 16000 Hz, 7 Channel Audio, and a total time length of 10 seconds.**
- **Shown tests take on the 1 second chunks of each sound sample.**

Design Requirements

Most Importantly: Chosen Model must categorize sounds into specified categories.





Function Model

Q&A

Design Requirements

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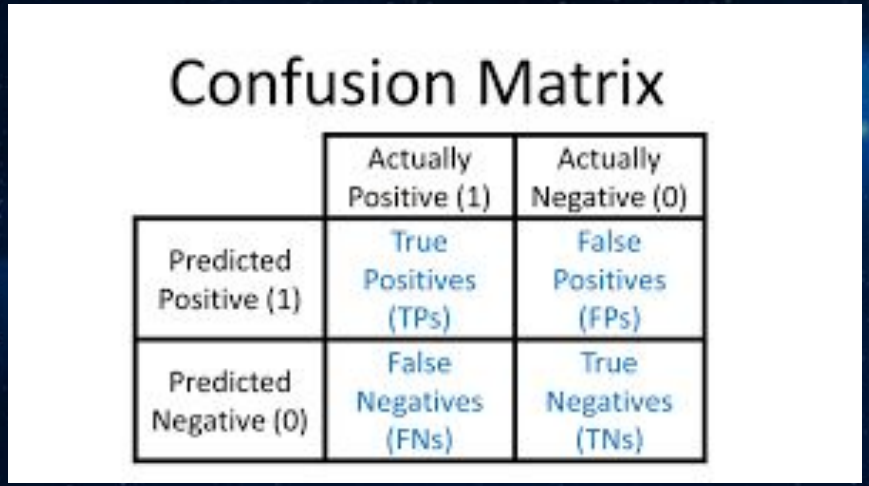

Thank you!