

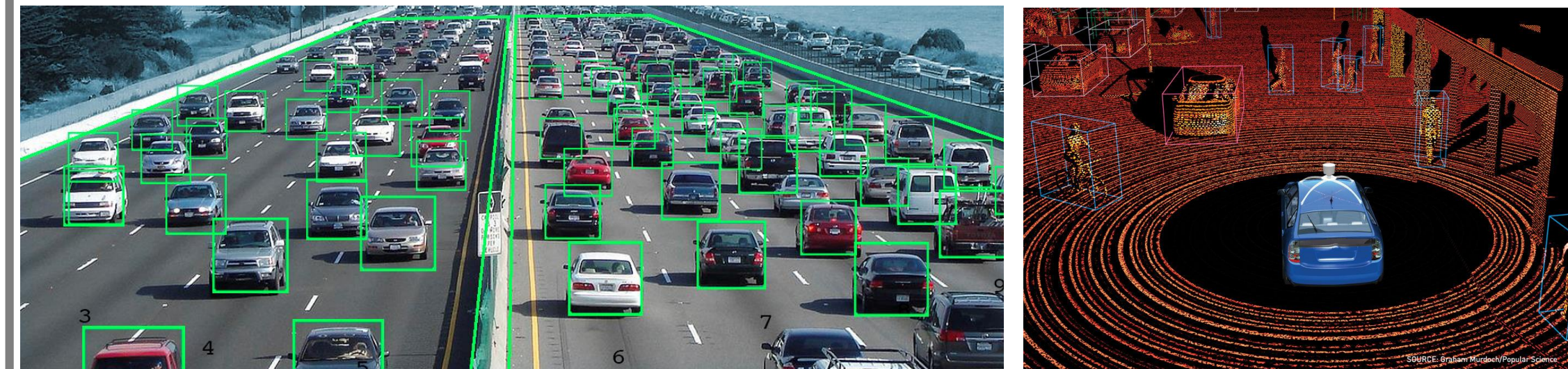


Classification of Accelerating Vehicles with your Cellphone

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Background

- Audio classification of vehicles would allow simple detector systems and low-light vehicle classification
- Prior work focuses on constant velocity (not-accelerating) movement of ~3 vehicle classes with 50-82% accuracy^[1-3]
- Proof of classification using cell-phone quality recordings of training and test set desirable for ease of implementation



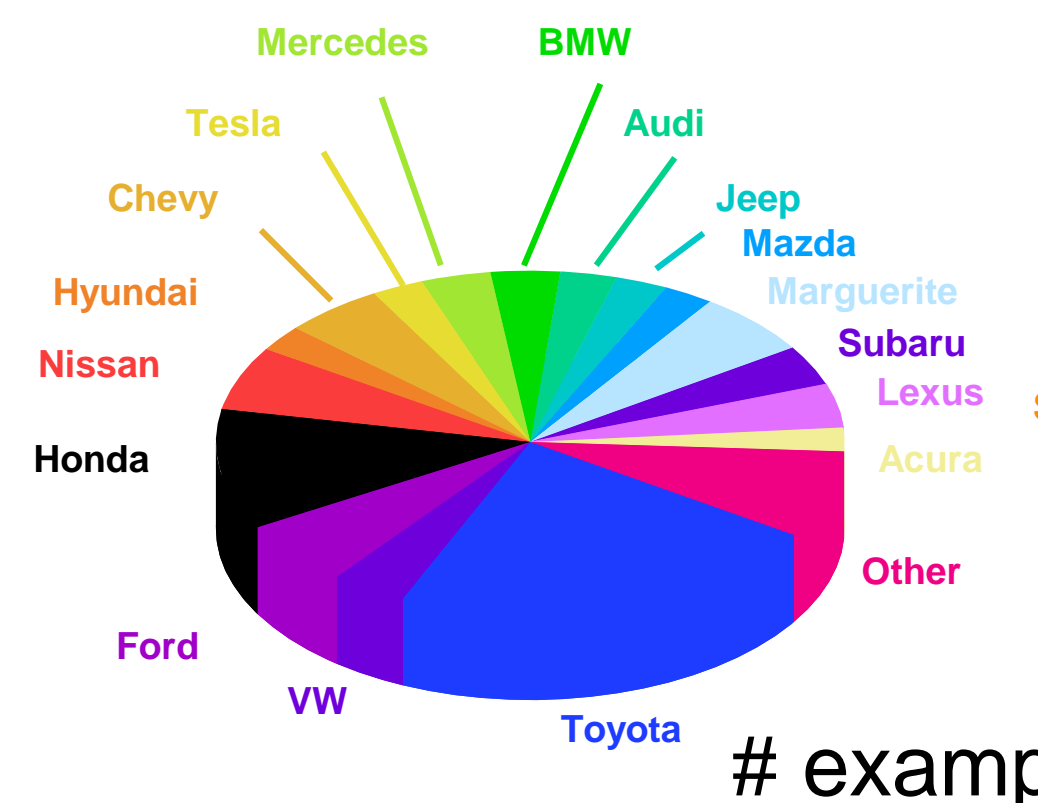
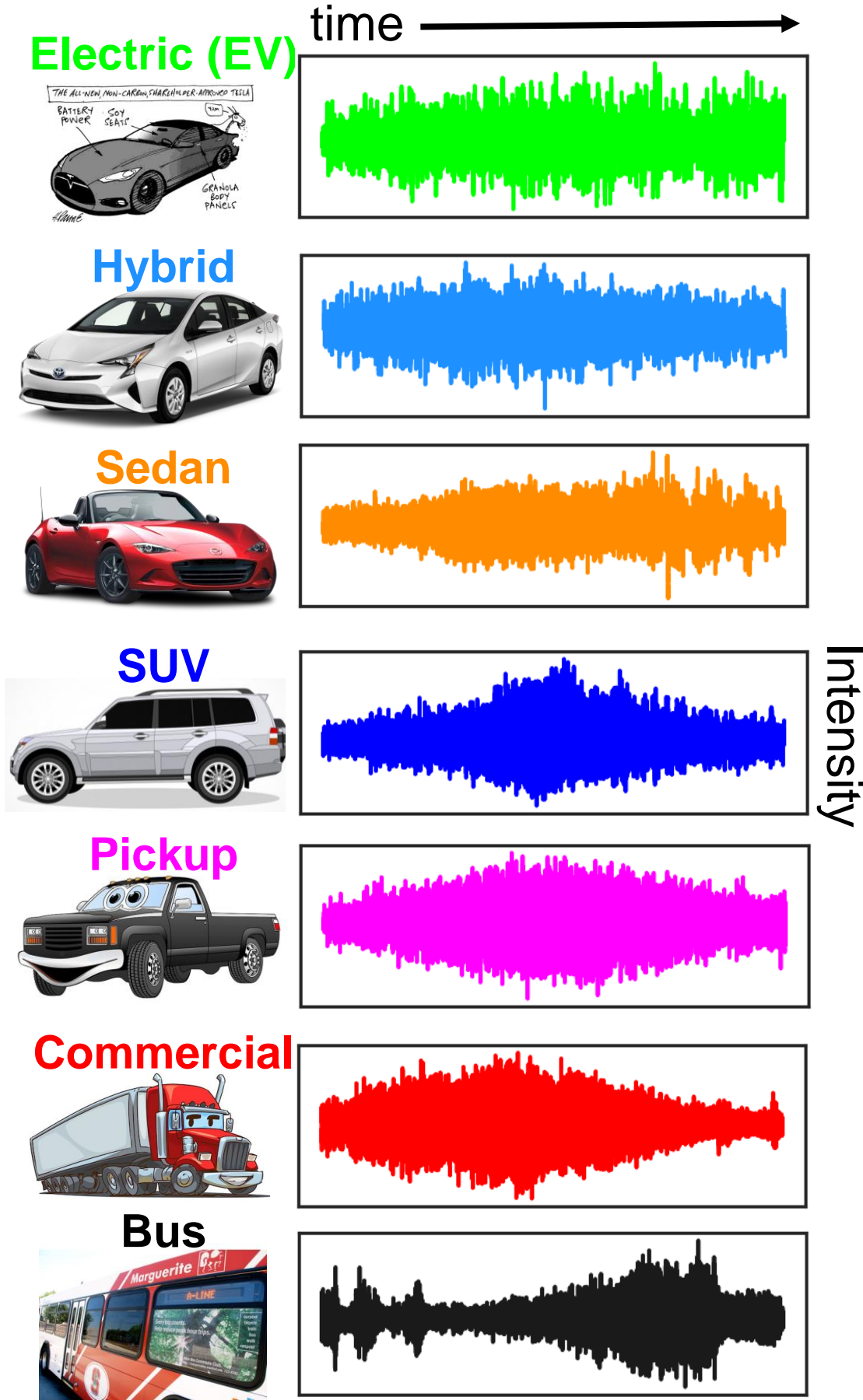
Data Collection



stop sign @ Stanford

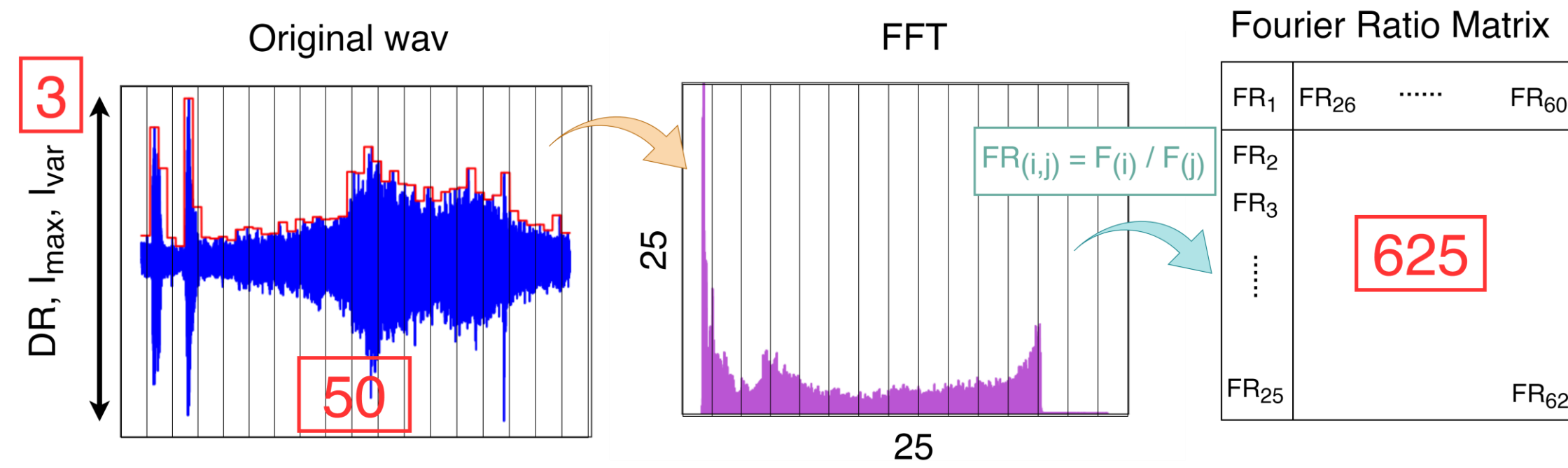


shot on iphone SE

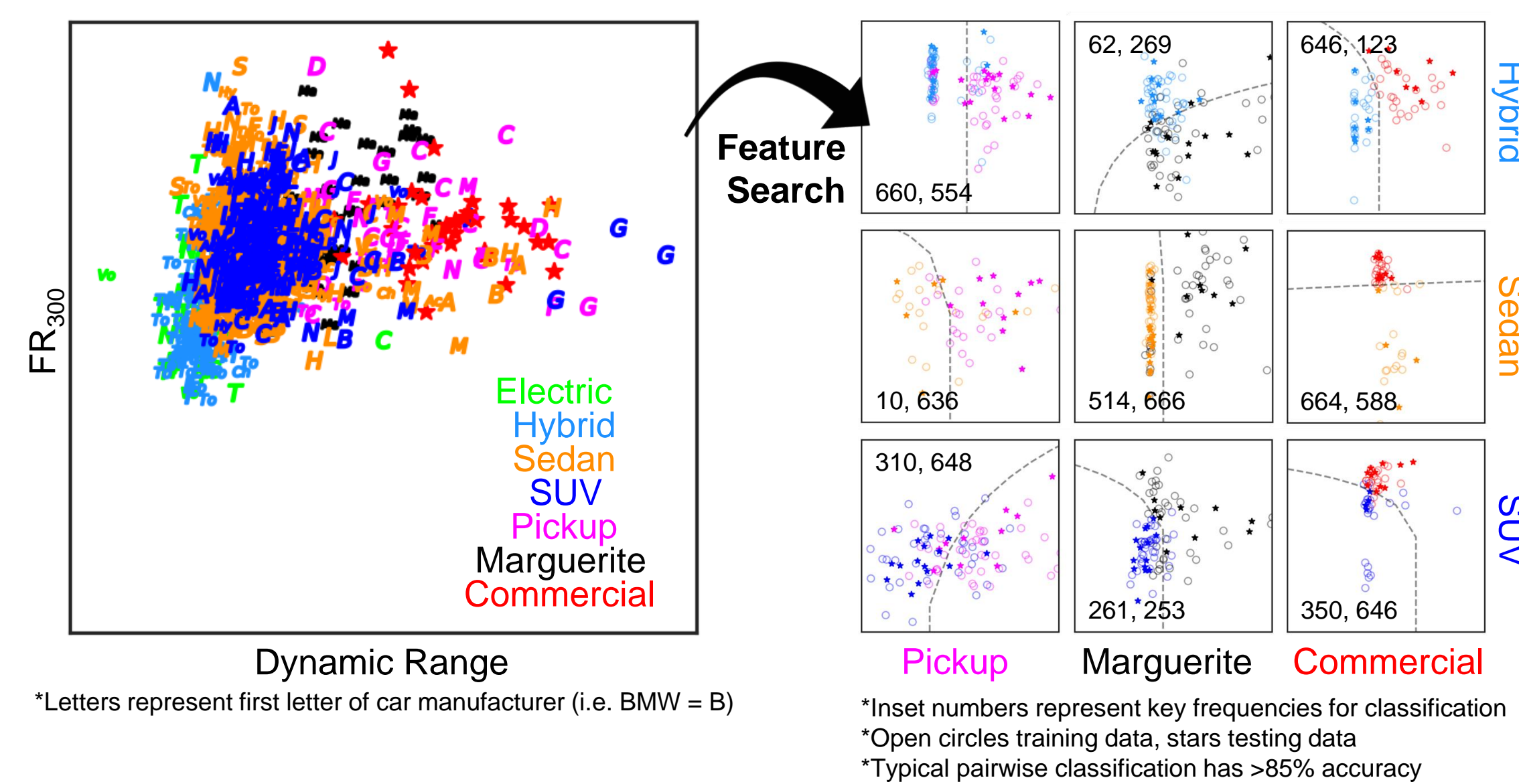


examples = 927

Feature Extraction



Selecting Key Frequencies via Pairwise SVMs



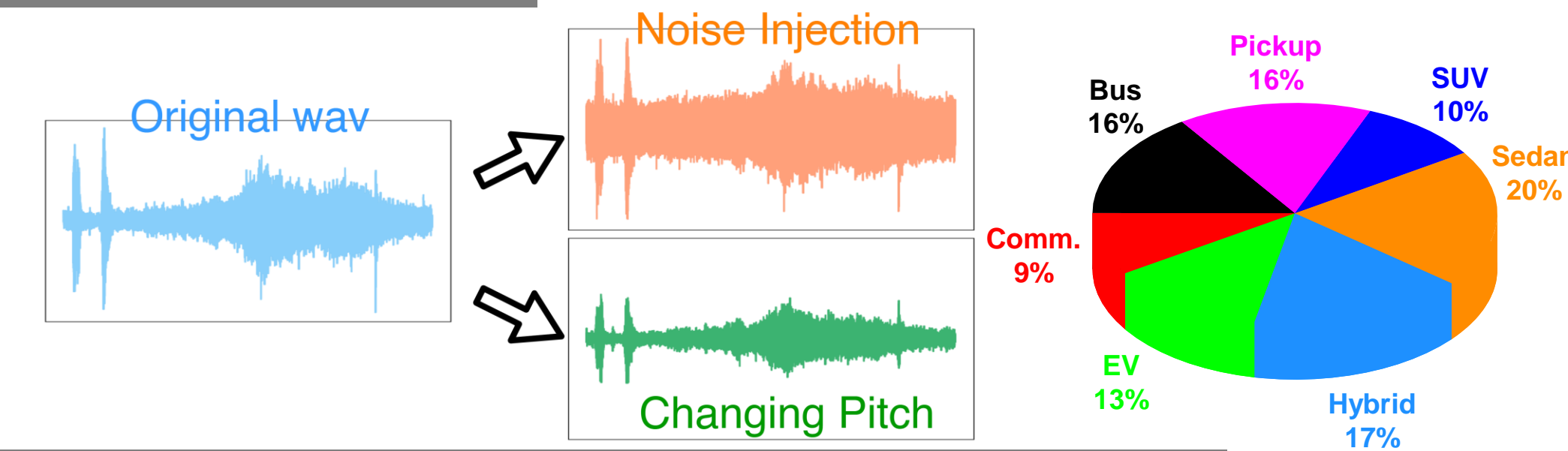
Results and Discussion

5 Classes				7 Classes			
Hidden Layers and Neurons	Features	Train Accuracy	Test Accuracy	Hidden Layers and Neurons	Features	Train Accuracy	Test Accuracy
None: Softmax only	all audio and frequency (678)	94%	69%	None: Softmax only	all audio and frequency (678)	79%	38%
None: Softmax only	selected audio and frequency (40)	94%	75%	None: Softmax only	selected audio and frequency (40)	82%	36%
1 Hidden Layer 20 Neurons	all audio and frequency (678)	91%	65%	1 Hidden Layer 20 Neurons	all audio and frequency (678)	69%	43%
1 Hidden Layer 20 Neurons	selected audio and frequency (40)	97%	66%	1 Hidden Layer 20 Neurons	selected audi and frequency (40)	64%	52%
1 Hidden Layer 20 Neurons	all audio and frequency (678)	91%	64%	1 Hidden Layer 20 Neurons	all audi and frequency (678)	91%	61%
RNN	.wav file (50x50)	82%	65%	RNN	.wav file (50x50)	62%	54%

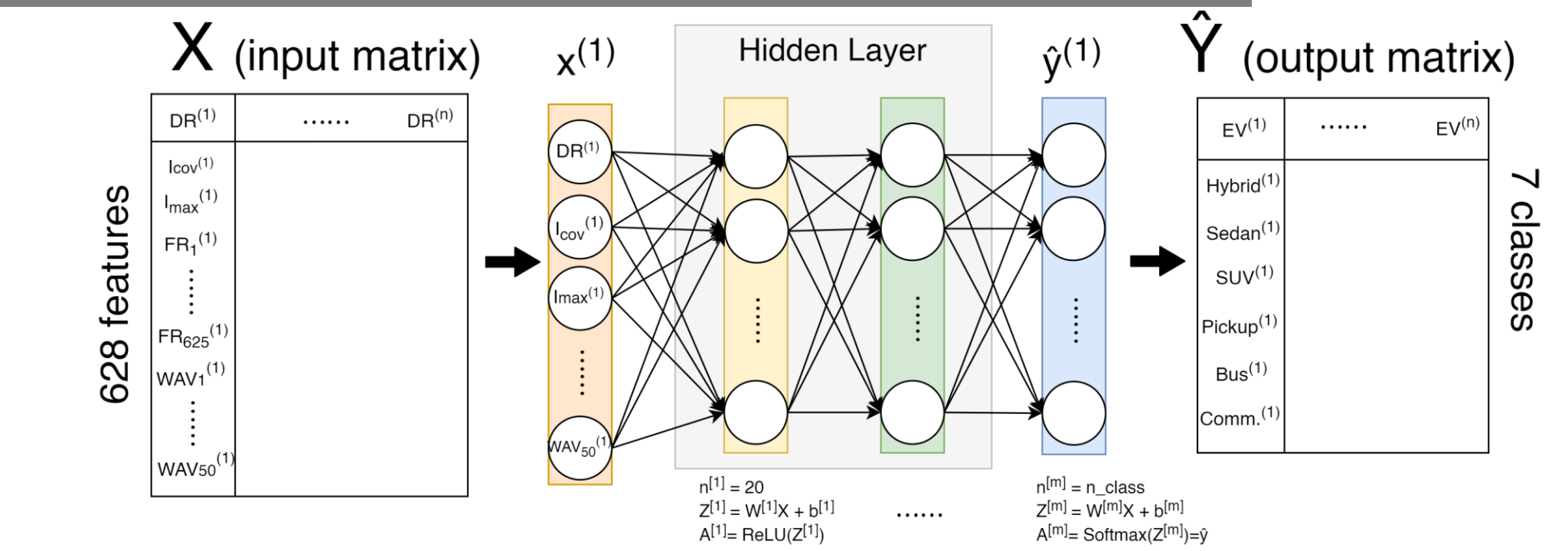
- Higher accuracy achieved in 5 class problem than 7 class problem
- SVM-feature selection slightly improves accuracy, faster speed
- Slight advantage of data augmentation in 7 class problem
- High train, lower test accuracy implies overfitting data
- RNN doesn't shine; performs lacks very distant memory

Model Selection

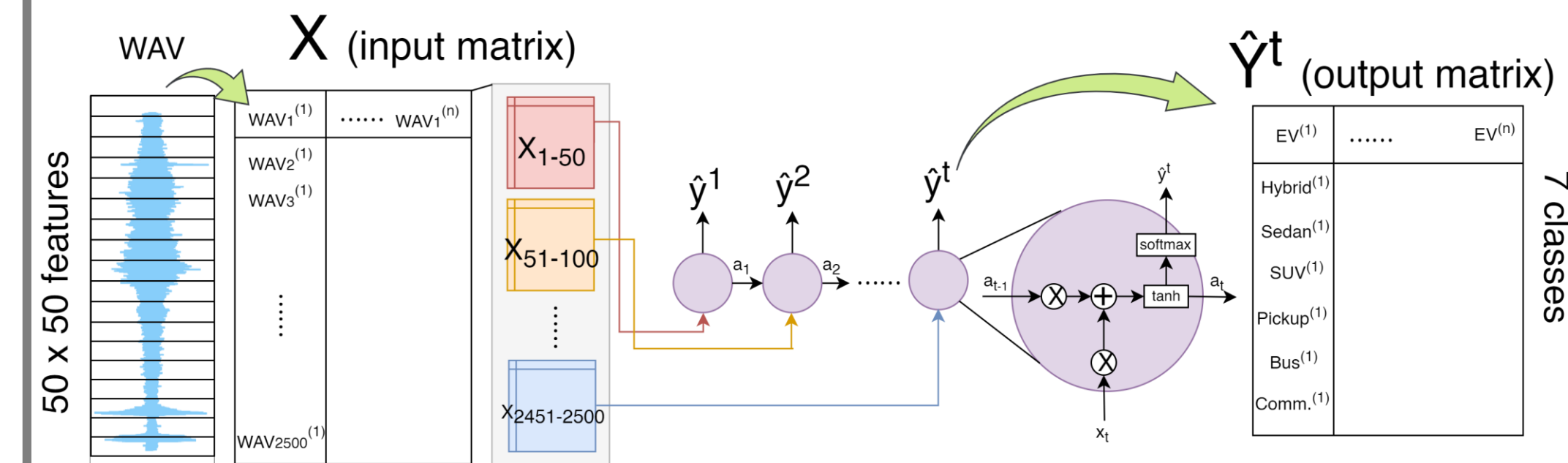
Data Augmentation



Model 1: Fully-Connected Neural Network



Model 2: Recurrent Neural Network



Conclusion & Future Works

- Throughout the study, we found that incorporating features from both intensity-space and frequency-space were key to higher accuracy
- The addition of two classes from 5 to 7 led to significantly lower accuracies
- Small gains were achieved by fine-tuning our model, leading to 75% accuracy on the 5-class and 61% accuracy on the 7-class problem
- Future work targets optimizing early-stopping for our models. Additionally, we will aim to develop new features in intensity-space

References

[1] Mayvan, A. D., S. A. Beheshti, and M. H. Masoom. "Classification of vehicles based on audio signals using quadratic discriminant analysis and high energy feature vectors." International Journal on Soft Computing 6.1 (2015): 53.
 [2] Alexandre, Enrique, et al. "Hybridizing extreme learning machines and genetic algorithms to select acoustic features in vehicle classification applications." Neurocomputing 152 (2015): 58-68.
 [3] Wieczorkowska, Alicja, et al. "Spectral features for audio-based vehicle and engine classification." Journal of Intelligent Information Systems 50.2 (2018): 265-290.