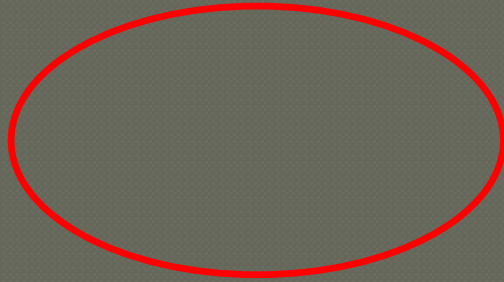


Neural Interfacing with Keyboard

Adam Kacmarsky
Tyler Brutsman
Thomas Glade

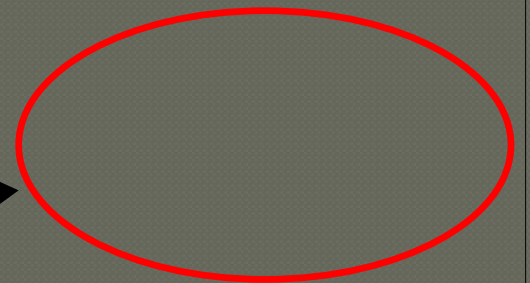
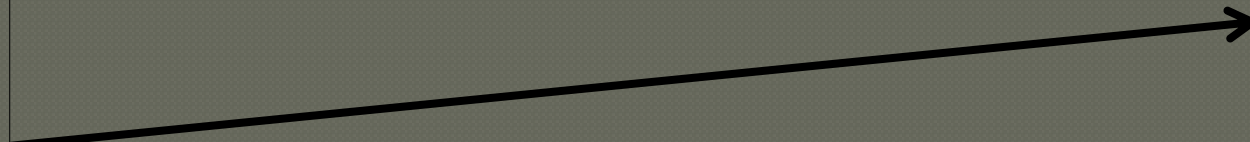
Background

Signal Set #1



- How does the brain work?

Signal Set #2



Goals

- Provide an interface from neural signals to keyboard output
 - Provide a method for training new signals quickly
 - Provide a framework that is easily modified and extend

Technical Information

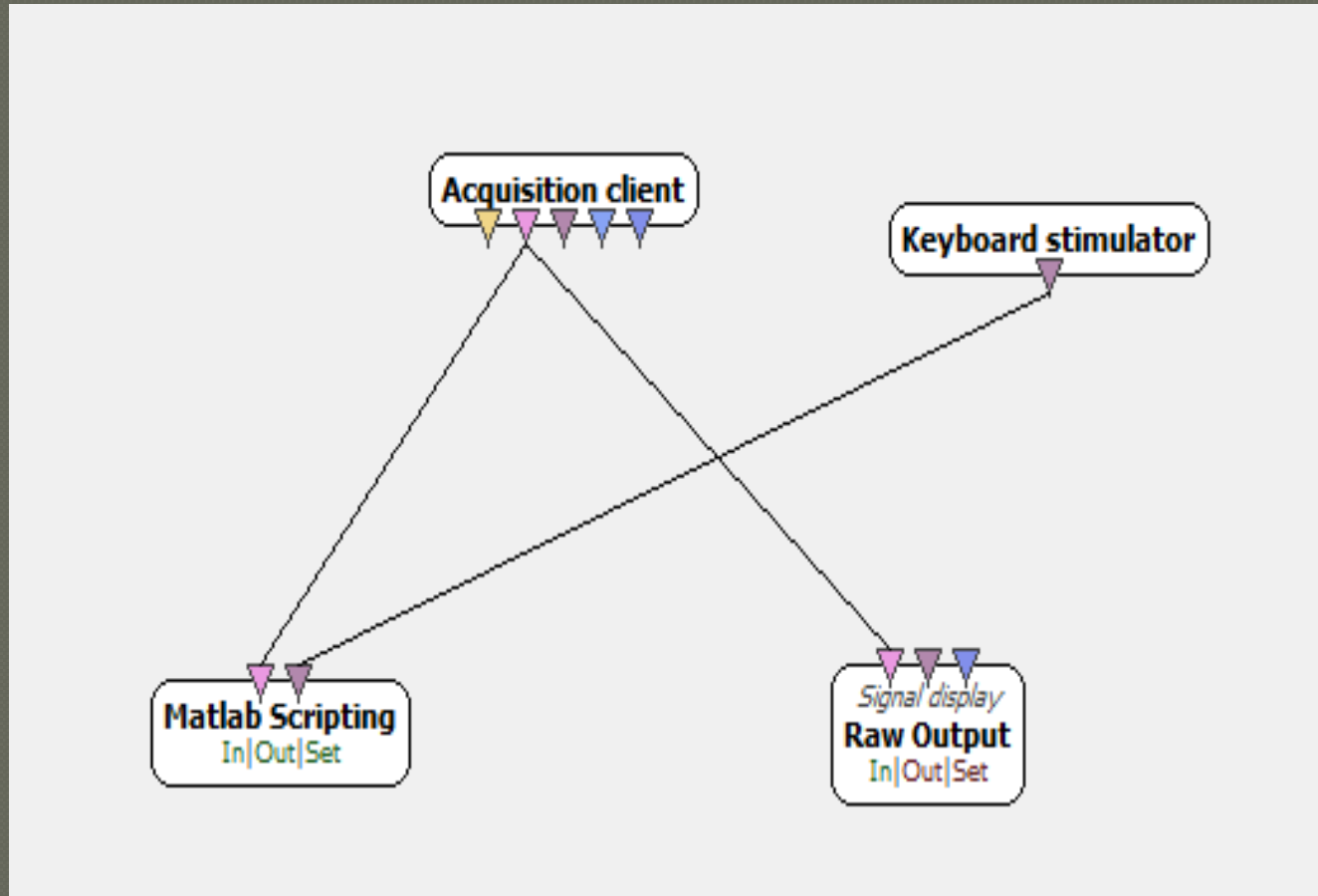
- Brain-Computer Interface (BCI)

- Emotiv EPOC

- 14 Sensors

- 128 Samples/second

- (picture: either headset or someone wearing headset)



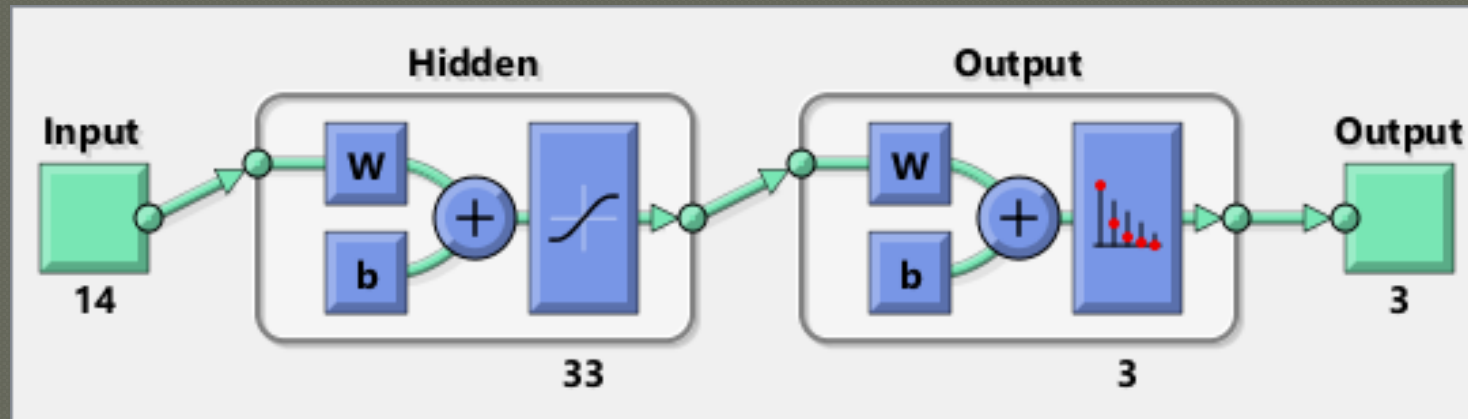
● Software

- OpenViBE
- MATLAB
- Toolboxes
 - Digital Signal Processing
 - Statistics and Machine Learning
 - Data Analytics

● Building training sets

● Neural Networks

- Good at pattern matching
- Quick, and can be implemented with built in MATLAB functions



Performance

Training Confusion Matrix

	1	2	3	
1	7 21.2%	0 0.0%	0 0.0%	100% 0.0%
2	0 0.0%	9 27.3%	0 0.0%	100% 0.0%
3	2 6.1%	0 0.0%	15 45.5%	88.2% 11.8%
	77.8% 22.2%	100% 0.0%	100% 0.0%	93.9% 6.1%
	1	2	3	
	Target Class			

Validation Confusion Matrix

	1	2	3	
1	3 42.9%	0 0.0%	0 0.0%	100% 0.0%
2	0 0.0%	2 28.6%	0 0.0%	100% 0.0%
3	1 14.3%	0 0.0%	1 14.3%	50.0% 50.0%
	75.0% 25.0%	100% 0.0%	100% 0.0%	85.7% 14.3%
	1	2	3	
	Target Class			

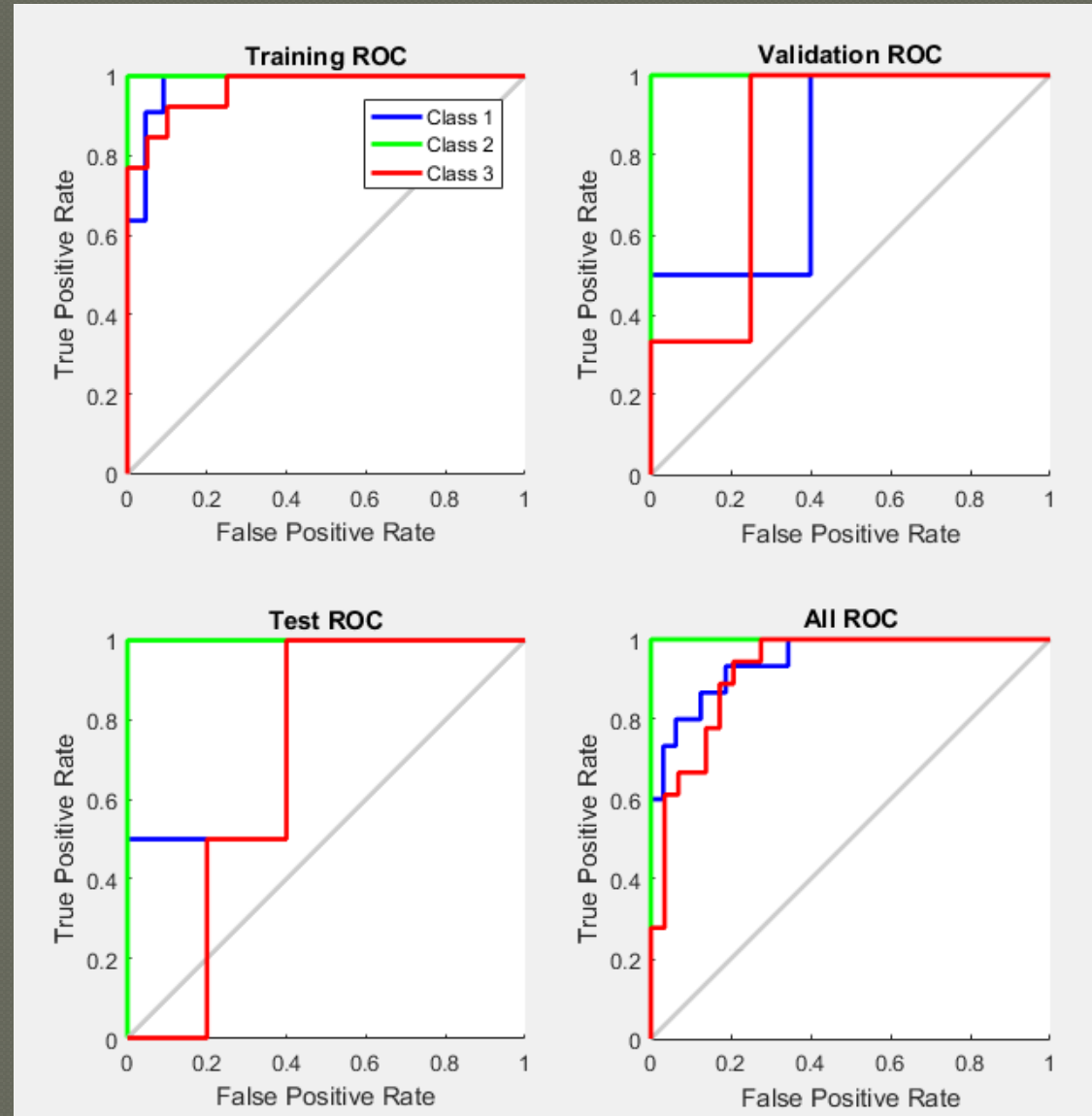
Test Confusion Matrix

	1	2	3	
1	2 28.6%	0 0.0%	0 0.0%	100% 0.0%
2	0 0.0%	2 28.6%	0 0.0%	100% 0.0%
3	0 0.0%	1 14.3%	2 28.6%	66.7% 33.3%
	100% 0.0%	66.7% 33.3%	100% 0.0%	85.7% 14.3%
	1	2	3	
	Target Class			

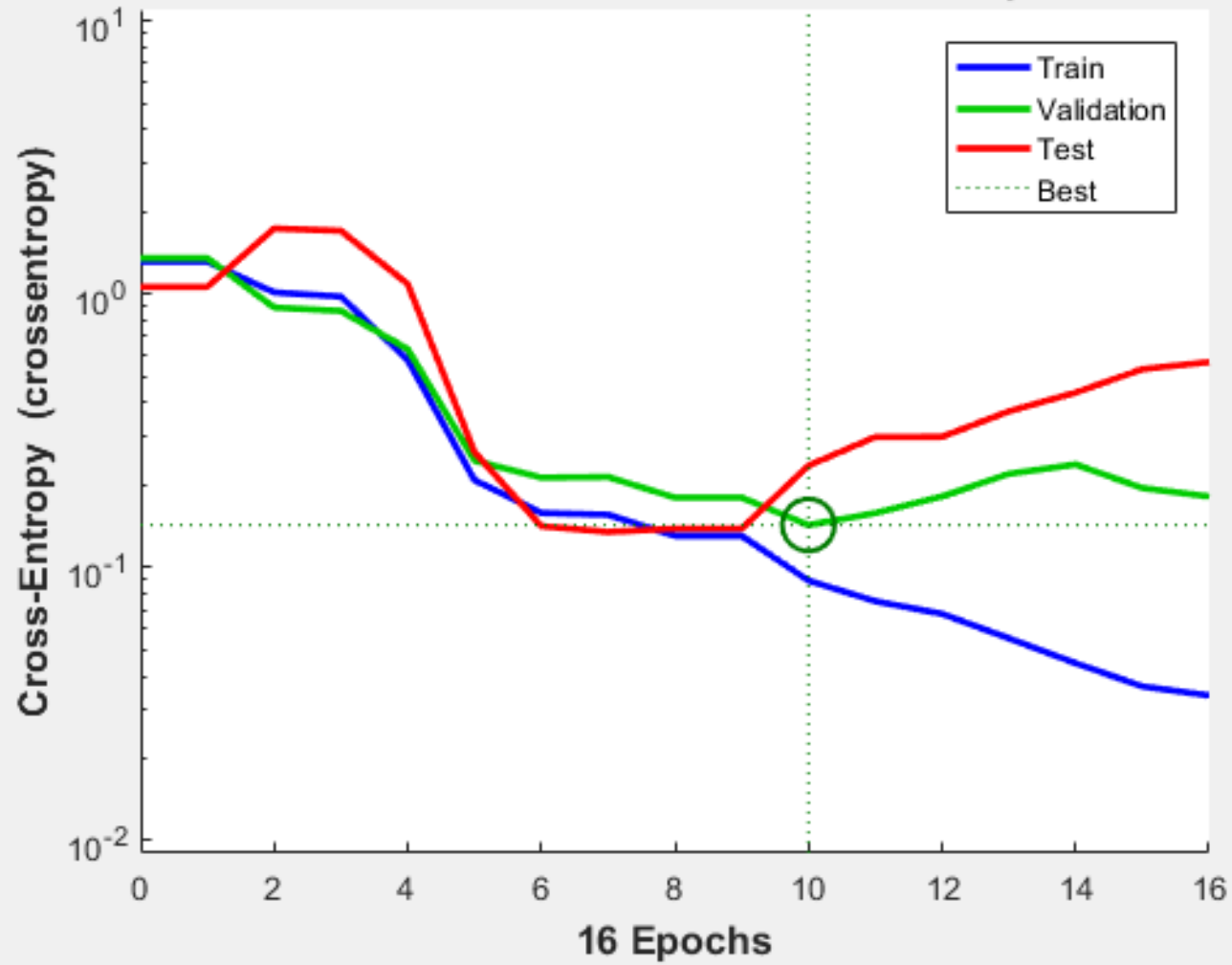
All Confusion Matrix

	1	2	3	
1	12 25.5%	0 0.0%	0 0.0%	100% 0.0%
2	0 0.0%	13 27.7%	0 0.0%	100% 0.0%
3	3 6.4%	1 2.1%	18 38.3%	81.8% 18.2%
	80.0% 20.0%	92.9% 7.1%	100% 0.0%	91.5% 8.5%
	1	2	3	
	Target Class			

Receiver Operating Characteristic

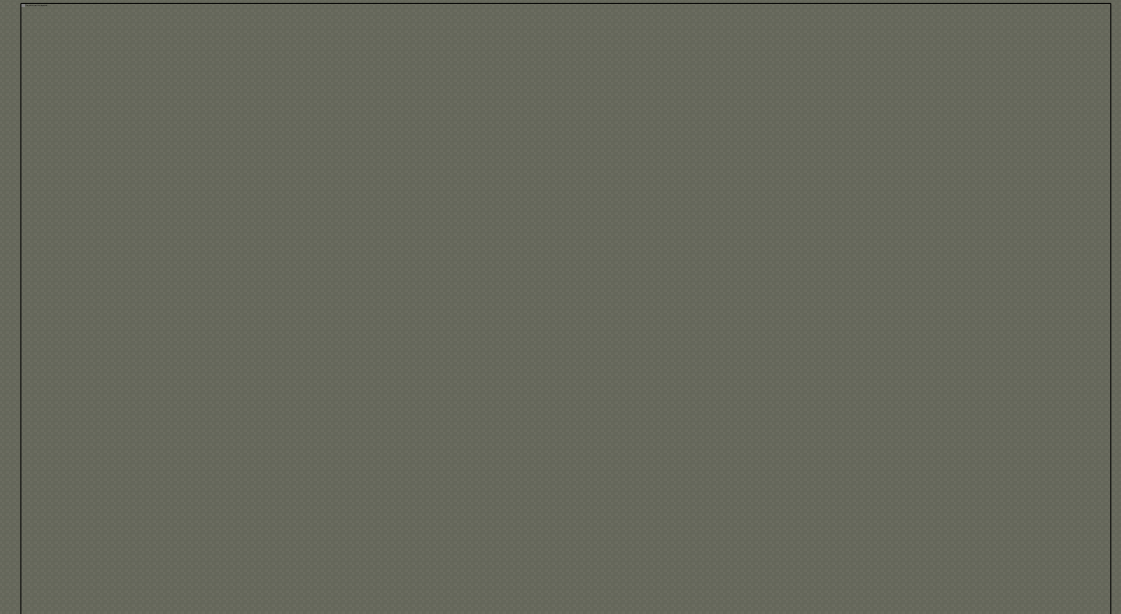
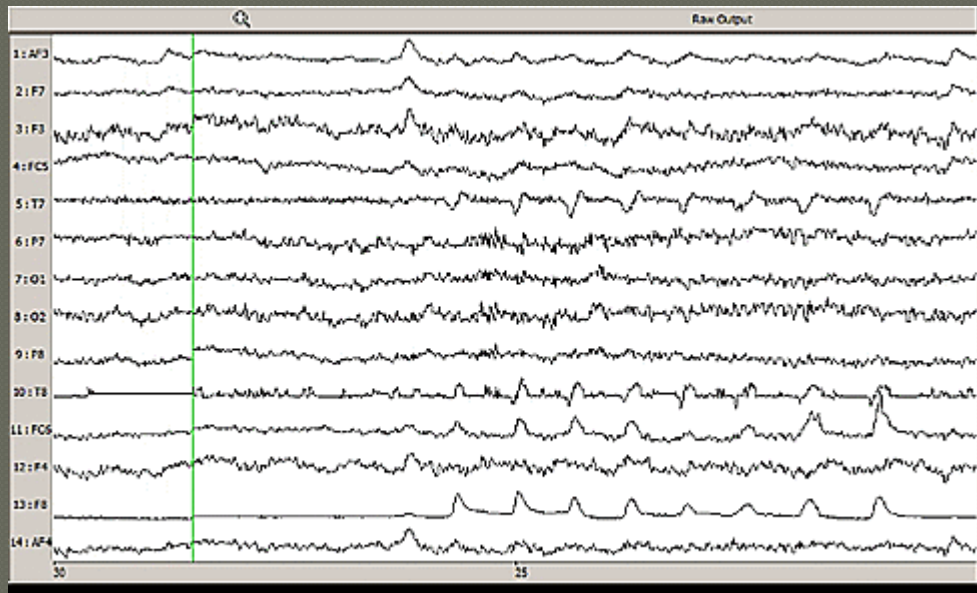
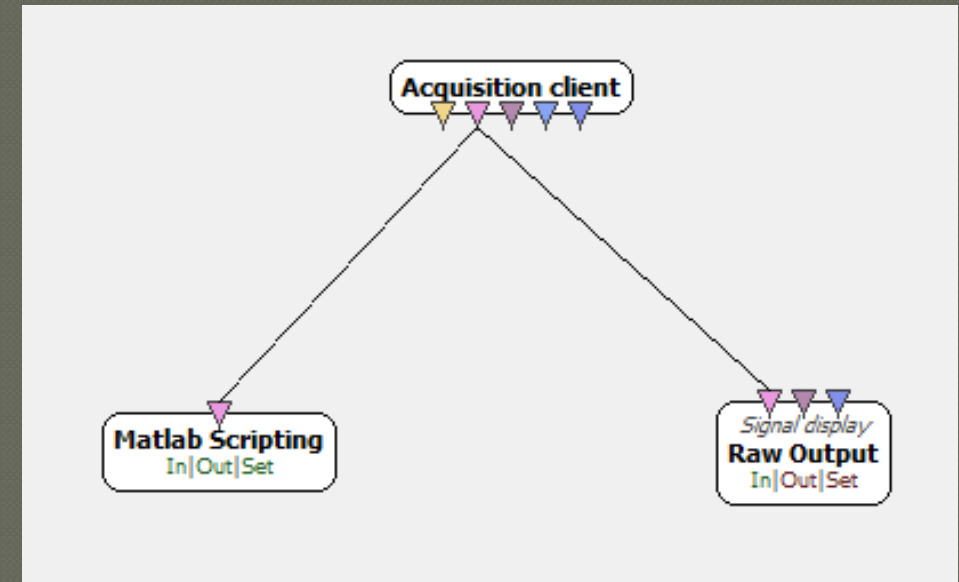


Best Validation Performance is 0.14284 at epoch 10



○ Classifier

- Output is $N \times 1$ matrix where $N = (\text{number of keys}) + 1$
- Each point in the matrix is the certainty the net has of that output
- The highest is selected, and transformed to keyboard output.



Demo

Conclusion

○ Costs

Emotiv EPOC:	\$400 - \$500
MATLAB:	<u>\$100 - \$200</u>
Total Cost:	\$500 - \$700

○ Applications

- Low – Mobility Patients
- Gesture Recognition

○ Future Work

- Include external application to set variables/create keyboard stimulation file

Special Thanks

- ◉ Dr. Amy Banic
- ◉ Angela ???
- ◉ Dr. Ruben Gamboa

Q&A