Whale Song Unit Classification

An Exploration
Using Linear Prediction Vector Quantization and Hidden Markov Modeling

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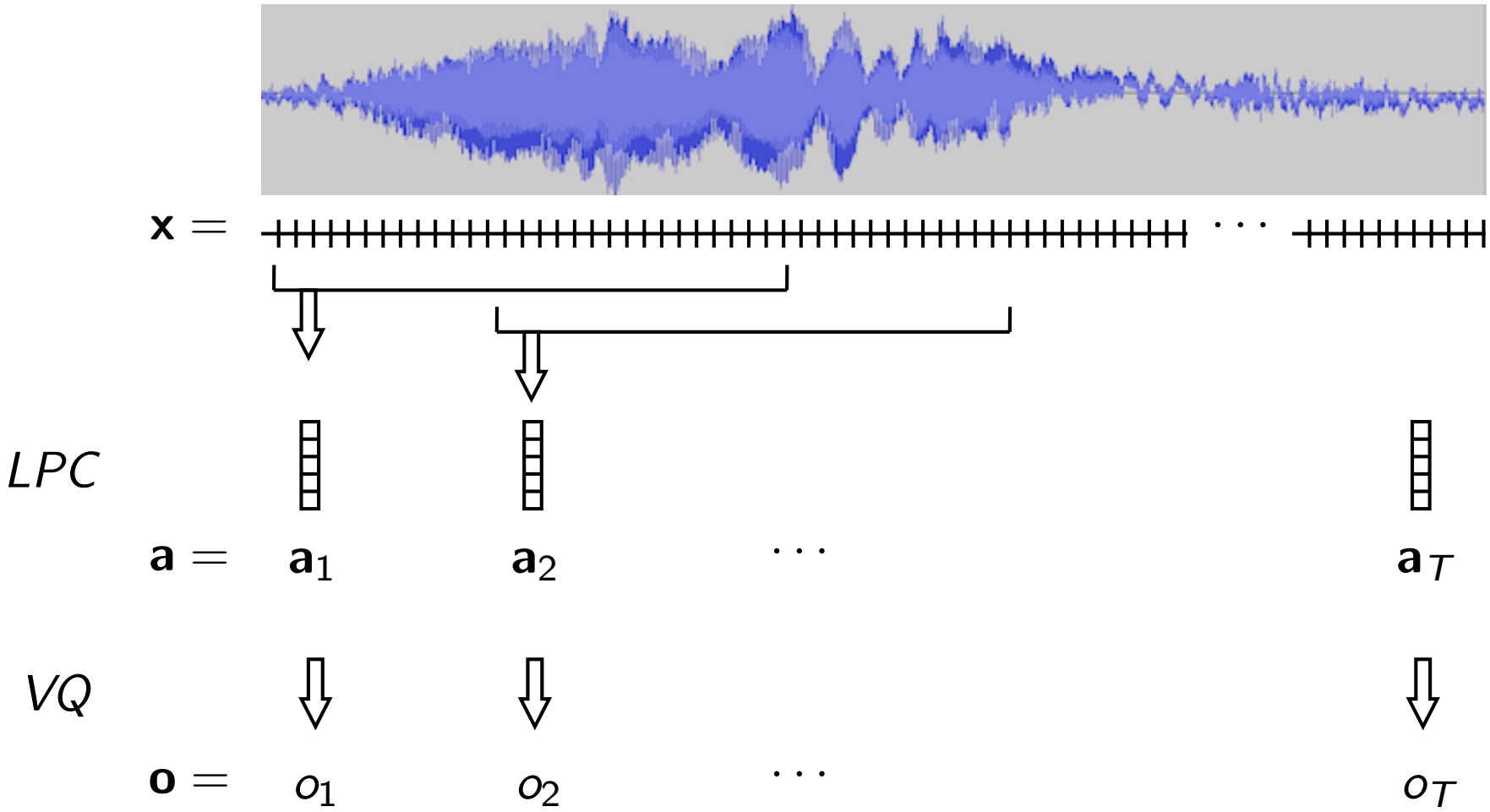
My background

- "Geospatial Image Stream Processing: Models, Techniques, and Applications in Remote Sensing Change Detection."
  Ph.D. Dissertation. Computer Science Dept., UC Davis, 2007.

- "Implementation and Experimentation with Speech Recognition --Isolated Digits– Using LPC Vector Quantization and HMM,"
  BS. Thesis, Systems Engineering Dept., Universidad Autónoma de Manizales, Colombia, 1993.

Linear Predictive Coding and Vector Quantization



HMM Operations

With λ denoting an HMM

- For given $\mathbf{o}$ and λ, compute $P[\mathbf{o}|\lambda]$
- For a given $\mathbf{o}$, learn a model λ^* such that $P[\mathbf{o}|\lambda^*]$ is maximized

"whale10": On a Selection of Units from 10 Song Files

- Classes with at least 20 unit instances
- Approximately 80% for training, 20% for a testing
- 752 training song unit instances
- $N = 64$ states, $M = 2048$ symbols
- 13 classes:

ascending_moan	descending_shriek	gurgle	trill
ascending_shriek	groan	modulated_cry	
cry	grunt	modulated_moan	
descending_moan	grunts	purr	

Classification on 178 Test Sequences

Confusion matrix:	0	1	2	3	4	5	6	7	8	9	10	11	12	tests	errors
ascending_moan	0	1	0	4	1	0	0	0	1	0	0	0	0	0	7	6
ascending_shriek	1	1	11	0	1	0	0	0	0	5	0	0	0	0	18	7
cry	2	0	0	4	2	0	0	0	0	1	0	1	2	0	10	6
descending_moan	3	1	2	2	17	0	1	0	2	0	0	1	1	3	30	13
descending_shriek	4	0	1	0	0	4	0	0	0	0	0	0	0	0	5	1
groan	5	0	0	1	0	0	3	0	0	3	0	0	0	0	7	4
grunt	6	0	0	0	1	0	2	13	0	3	0	1	0	0	20	7
grunts	7	0	0	0	0	0	0	0	4	0	0	0	0	0	4	0
gurgle	8	0	1	3	3	0	2	2	0	27	0	2	1	1	42	15
modulated_cry	9	0	0	0	0	1	0	0	0	0	4	0	0	0	5	1
modulated_moan	10	0	0	2	3	0	1	1	0	0	0	9	0	0	16	7
purr	11	0	0	0	1	0	1	0	0	2	0	0	2	0	6	4
trill	12	0	0	0	1	0	1	1	0	1	1	0	0	3	8	5

	class	accuracy	tests	candidate order												
ascending_moan	0	14.29%	7	1	2	0	0	2	1	0	0	0	1	0	0	0
ascending_shriek	1	61.11%	18	11	0	2	2	0	0	0	2	0	1	0	0	0
cry	2	40.00%	10	4	2	1	1	1	1	0	0	0	0	0	0	0
descending_moan	3	56.67%	30	17	6	1	3	3	0	0	0	0	0	0	0	0
descending_shriek	4	80.00%	5	4	1	0	0	0	0	0	0	0	0	0	0	0
groan	5	42.86%	7	3	0	2	2	0	0	0	0	0	0	0	0	0
grunt	6	65.00%	20	13	4	0	2	1	0	0	0	0	0	0	0	0
grunts	7	100.00%	4	4	0	0	0	0	0	0	0	0	0	0	0	0
gurgle	8	64.29%	42	27	9	1	0	1	1	1	1	1	0	0	0	0
modulated_cry	9	80.00%	5	4	1	0	0	0	0	0	0	0	0	0	0	0
modulated_moan	10	56.25%	16	9	2	2	1	0	1	1	0	0	0	0	0	0
purr	11	33.33%	6	2	1	1	1	0	1	0	0	0	0	0	0	0
trill	12	37.50%	8	3	0	1	0	1	0	1	1	0	0	0	1	0
TOTAL		57.30%	178	102	28	11	12	9	5	3	4	1	2	0	1	0