

Can Machine Learning answer  
questions in Ornithology?



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## Aims

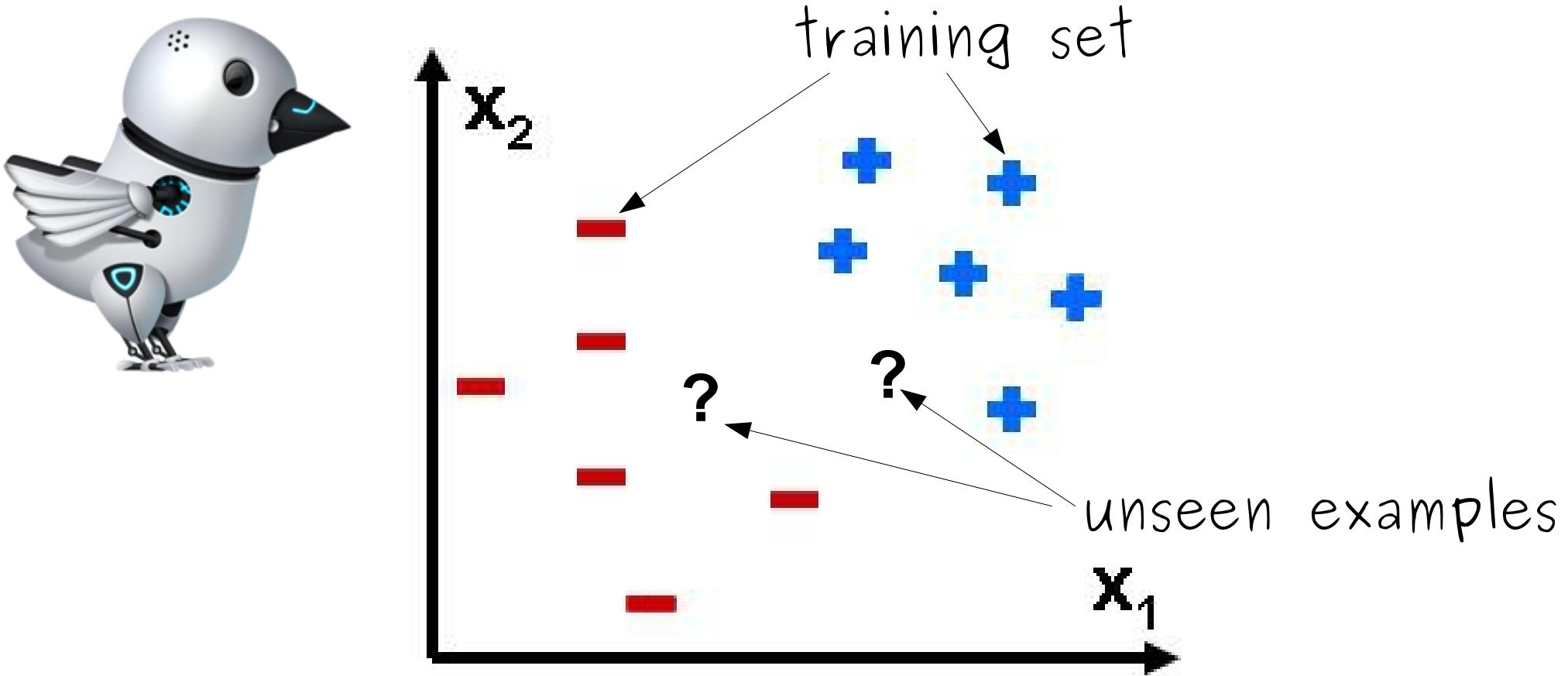
- Do birds develop regional variations of their song?
- Is the frequency domain sufficient to answer the question?

# What is Machine Learning?



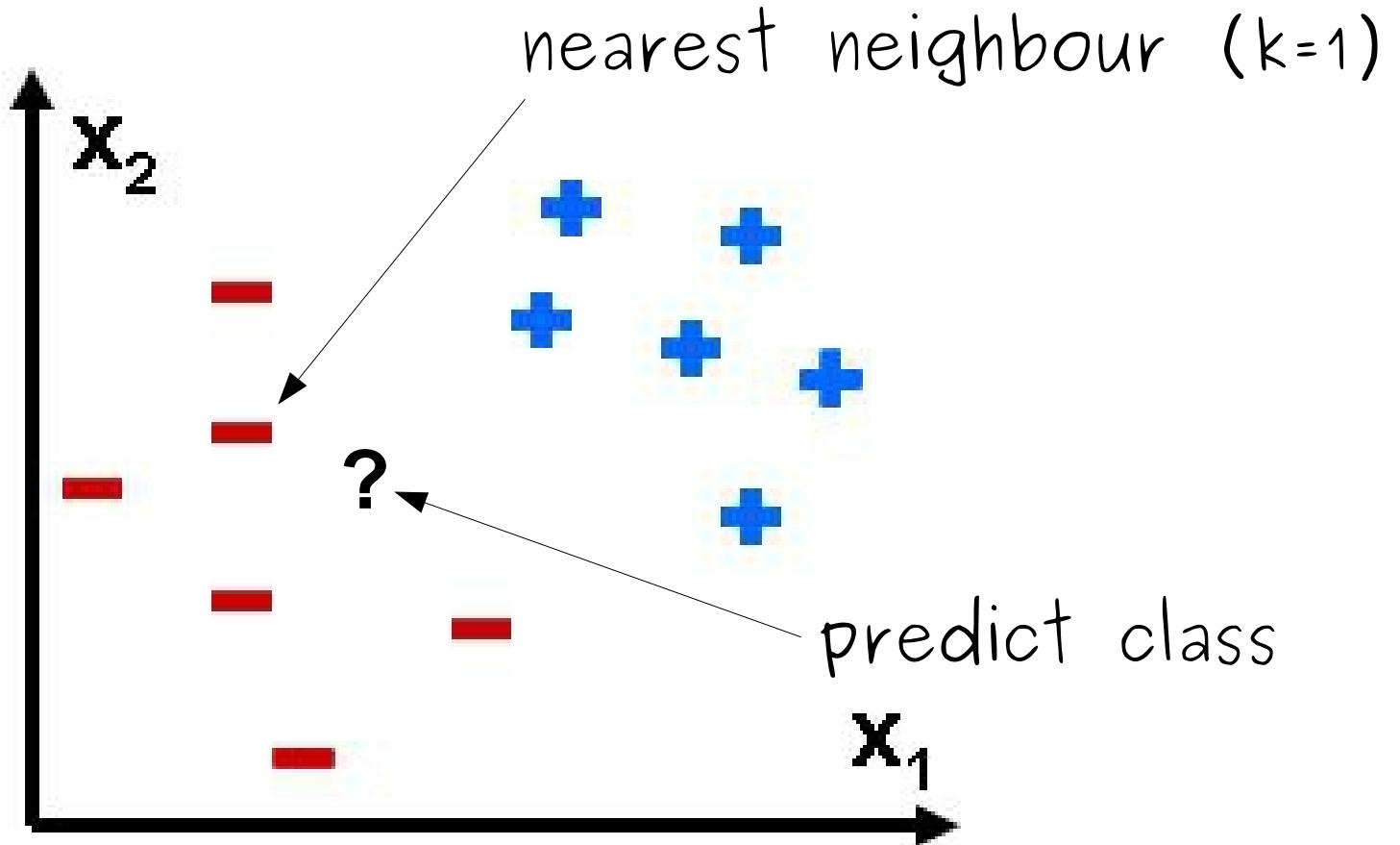
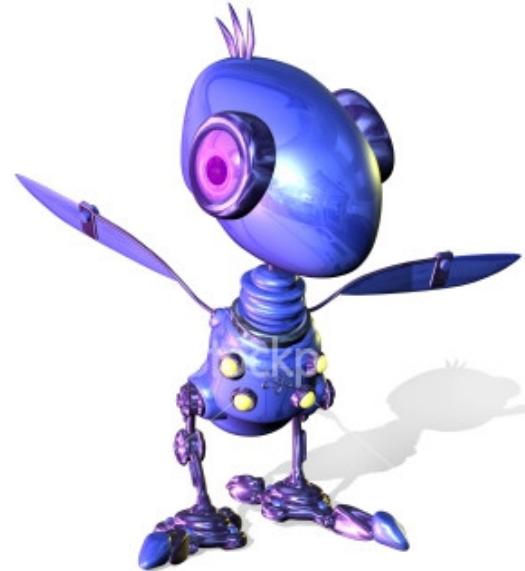
- Learn from data
- Perform analysis or make predictions

# The Classification problem

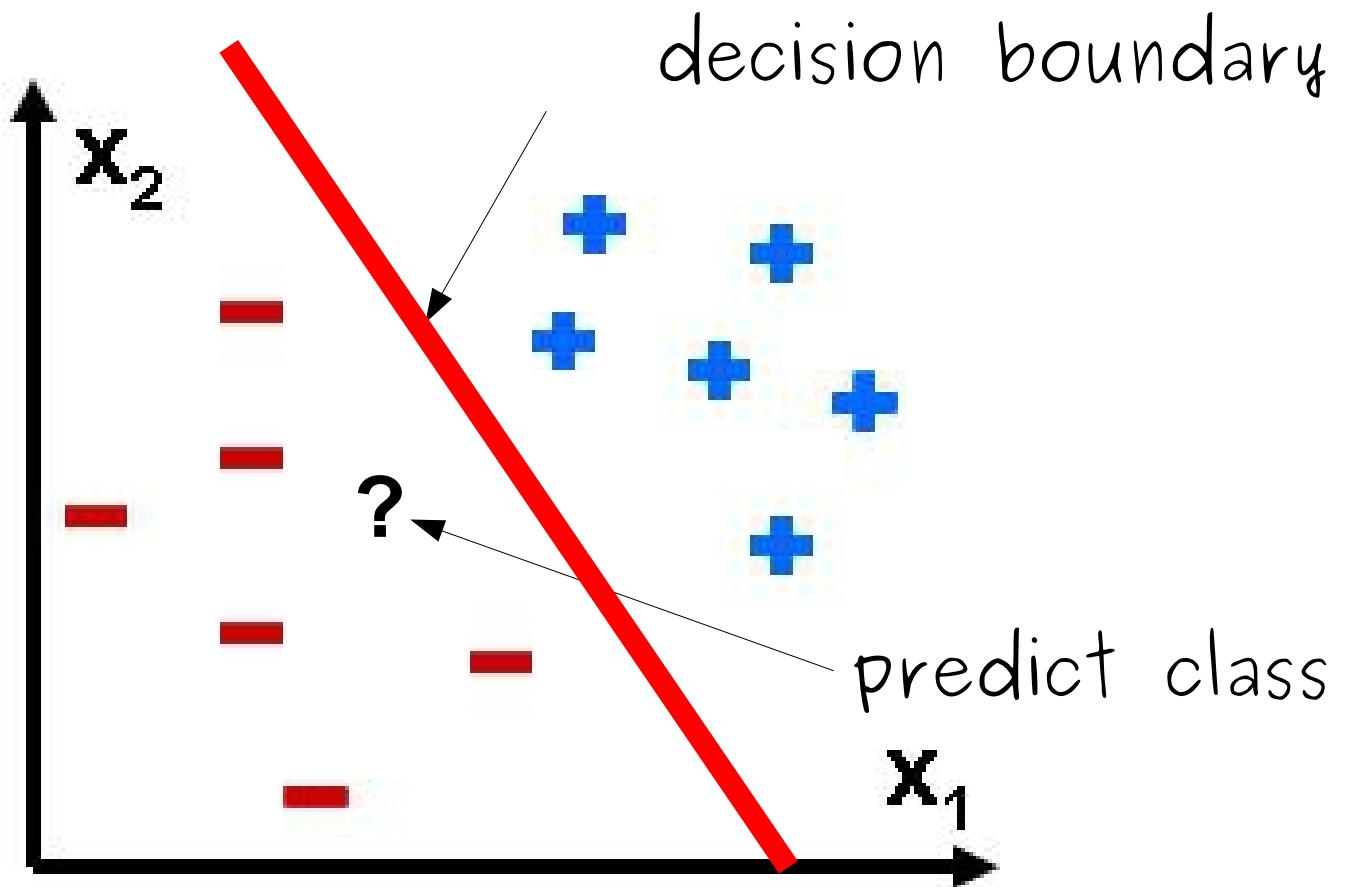


- $x_1, x_2$  are features
- '+', '-' are classes

# k-Nearest Neighbours

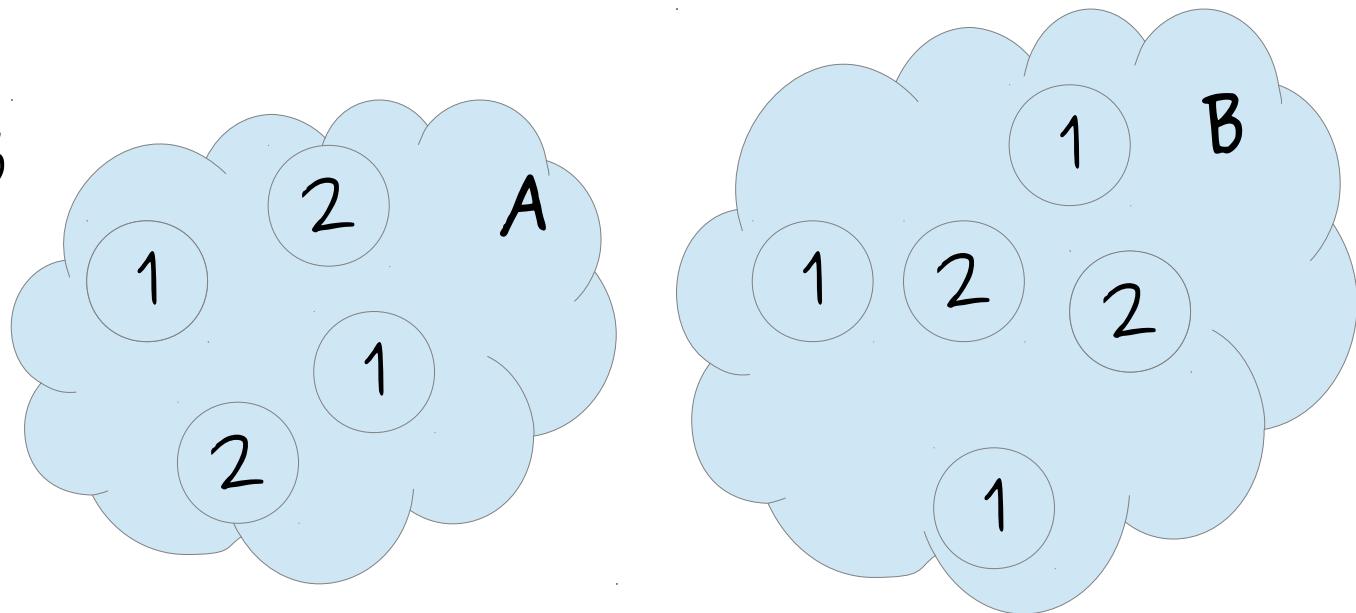


# Logistic regression



# Experiments

- regions: A, B
- species: 1, 2



- comparisons:  $1A - 2A, 2A - 2B, 1A - 1B, 2A - 2B$
- hypothesise that:  $\text{sim}(1A - 2A) > \text{sim}(1A - 1B)$   
 $\text{sim}(1B - 2B) > \text{sim}(2A - 2B)$



# Data set

A set of WAV recordings

Fast Fourier Transform

A set of frequency components

Scoring function

Feature selection

A reduced feature set

Binary classification

A set of predictions

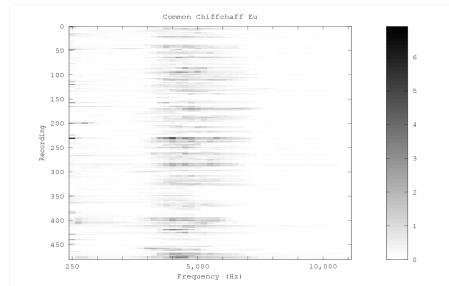
Load as a sequence  
of samples

Feature  
extraction

} for each  
comparison  
pair

# Dimensionality reduction (1)

FFT size/2



Scoring function:

$$S(f) = \frac{|\mu_{class_1}^{(f)} - \mu_{class_2}^{(f)}|}{\sigma_{class_1}^{(f)} + \sigma_{class_2}^{(f)}}$$

100 dimensions

perform Logistic  
Regression

# Dimensionality reduction (2)

100 dimensions

## Neighbourhood Components Analysis

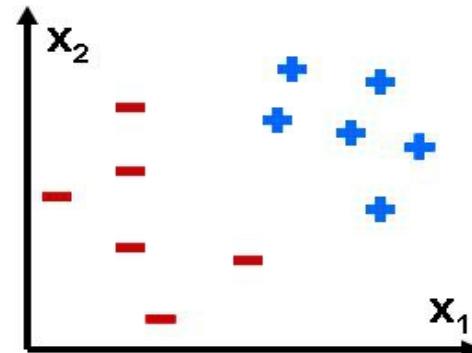
Jacob Goldberger, Sam Roweis, Geoff Hinton, Ruslan Salakhutdinov

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2 dimensions

perform kNN





# Binary classification

A set of predictions

Test set

Performance score

(Accuracy, ROC area etc.)

A single-valued indicator of dissimilarity

# Function of bird song (1)

mahmoud aboshabana  
creativity come from inside

Yes, the weather is really nice today



Information transmission:

- Food calls
- Alarm calls



ANGRY BIRDS

# Function of bird song (2)

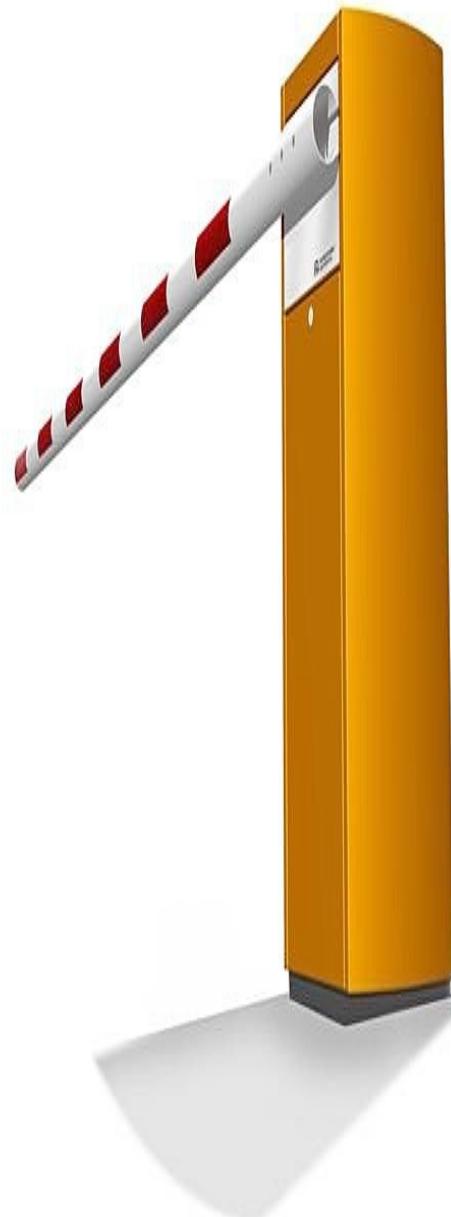


# Function of bird song (3)



HT

# Function of bird song (4)



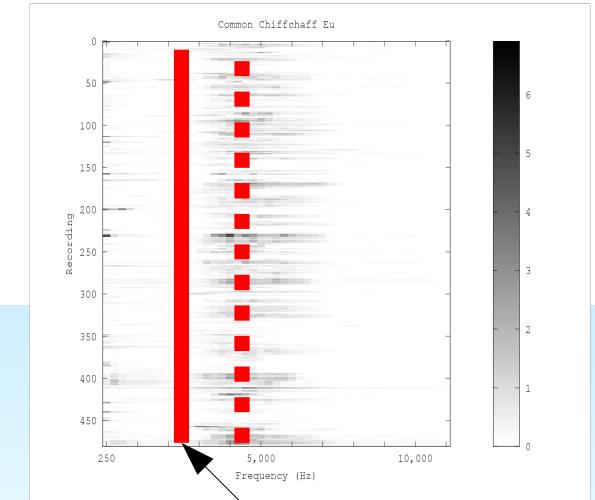
# Habitat influences (open habitat)



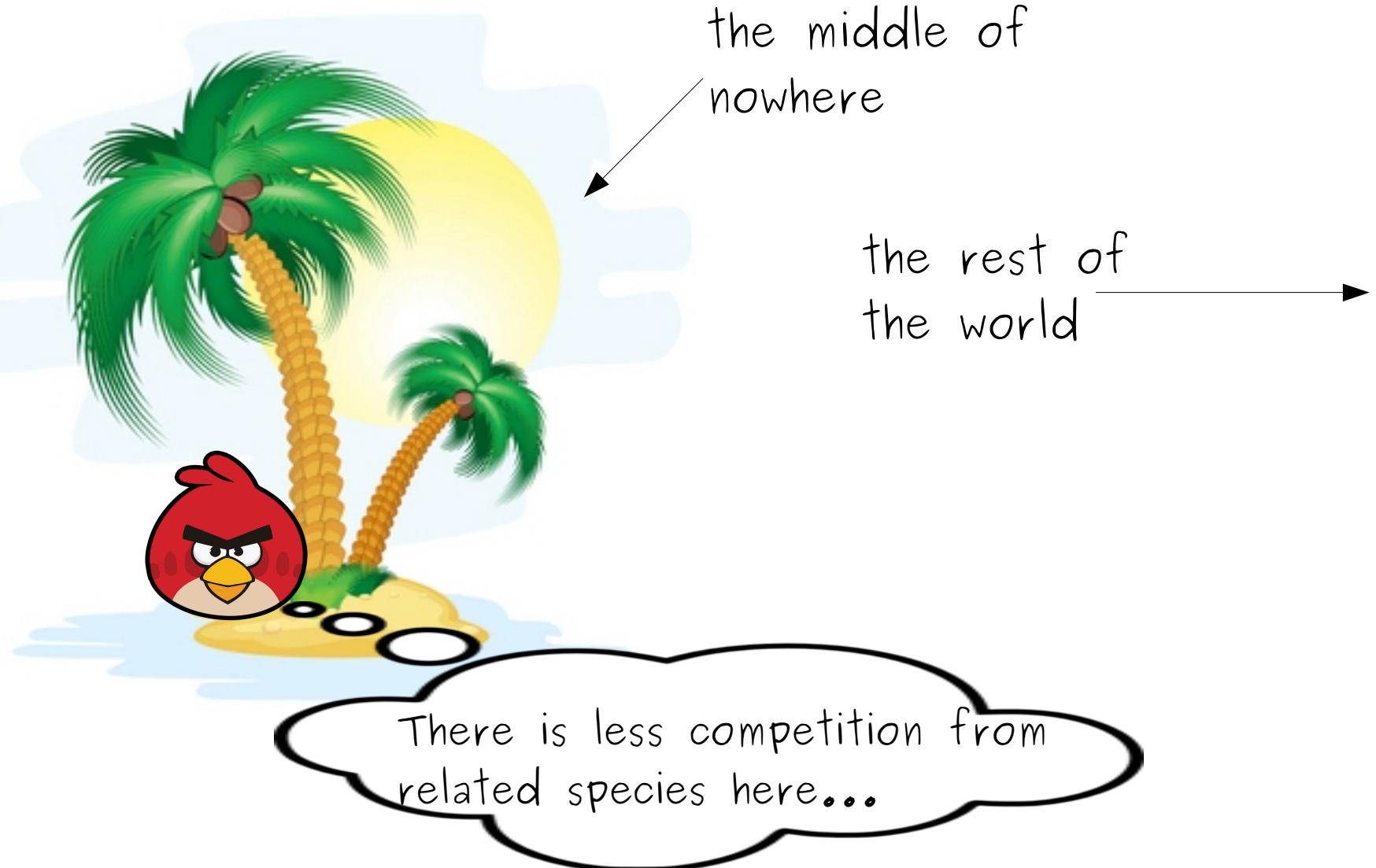
# Habitat influences (forest habitat)

We prefer singing  
near or on the  
ground!

'sound window'

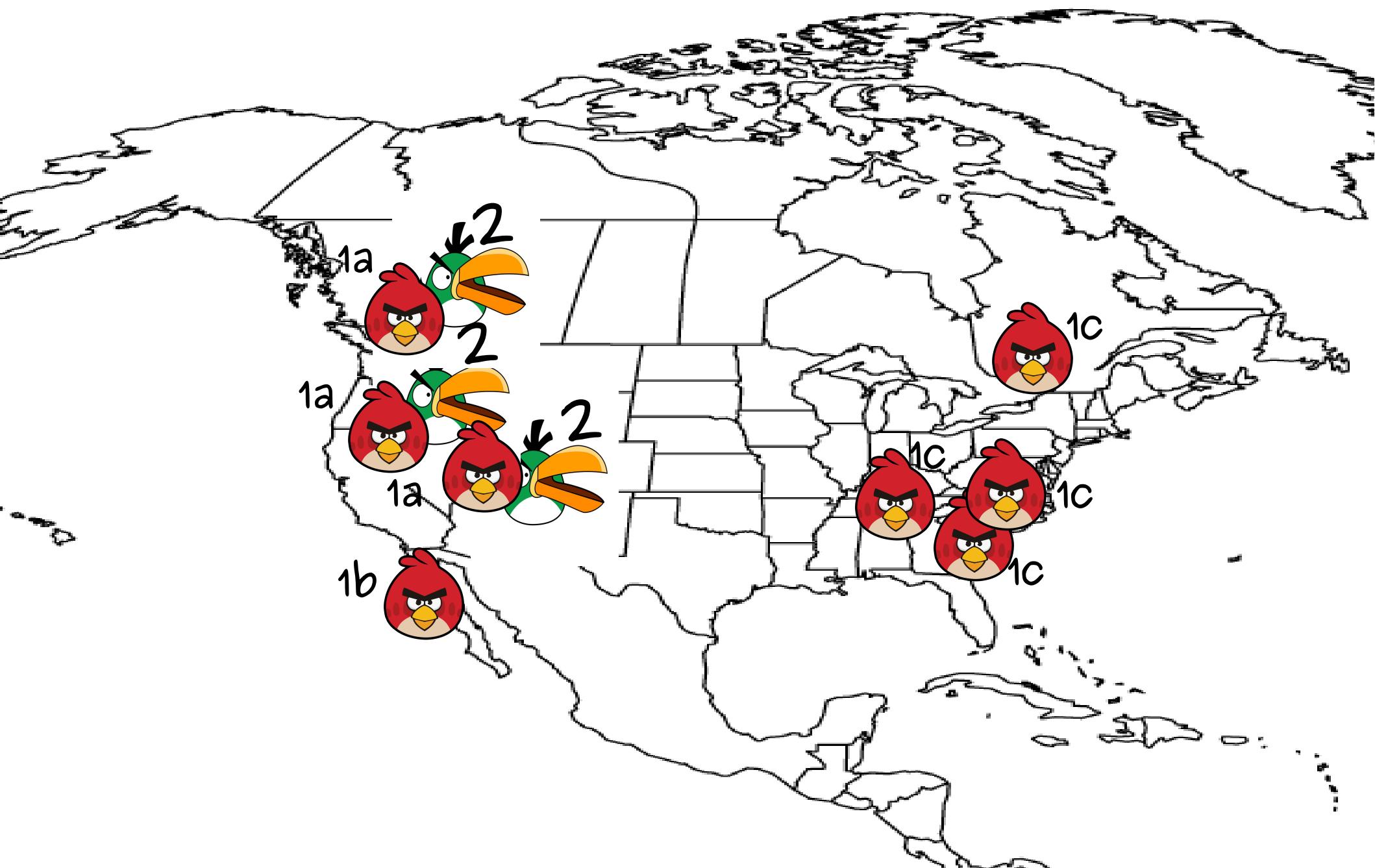


# Other factors (e.g. isolation)



1 - Fox Sparrow  
2 - MacGillivray's Warbler

# Experiments

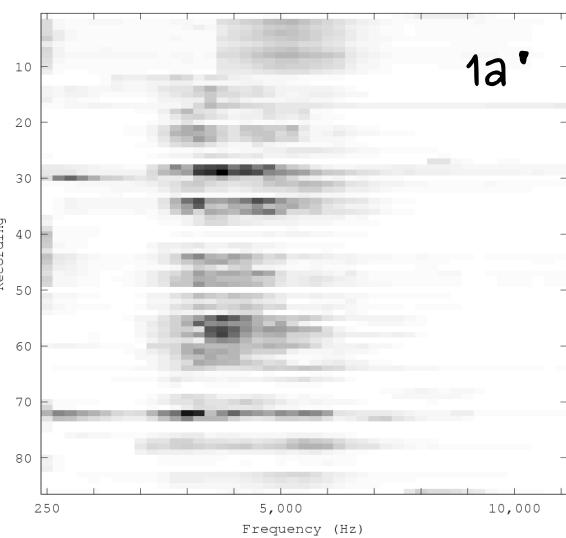


# Results (best 100 features)

Class 1

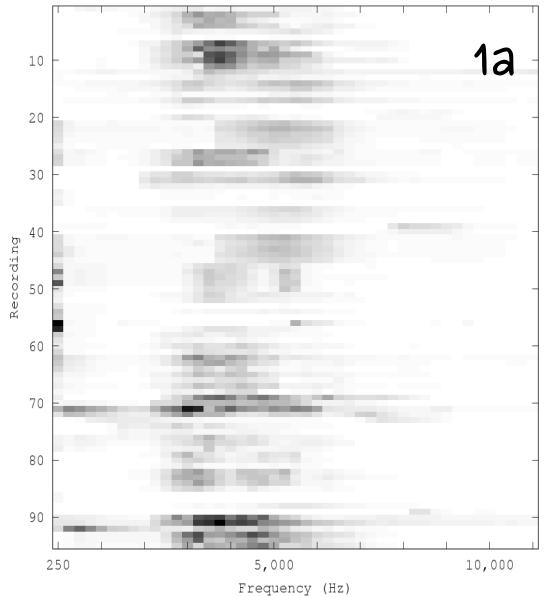
Fox Sparrow cmp McGW

1a'



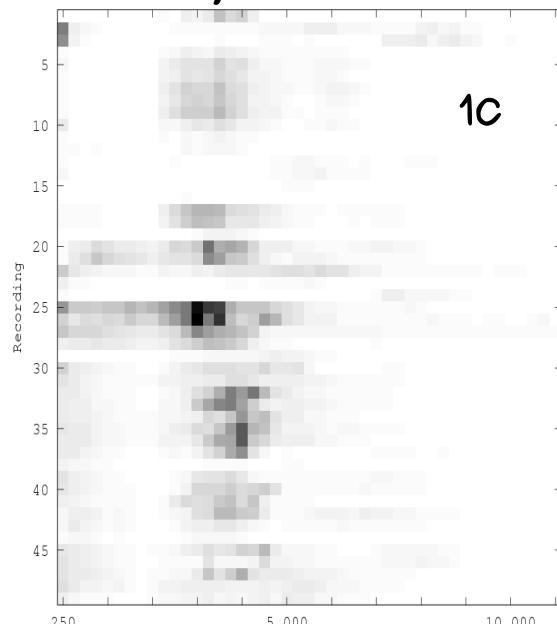
Fox Sparrow EaNA

1a



Fox Sparrow WeNA

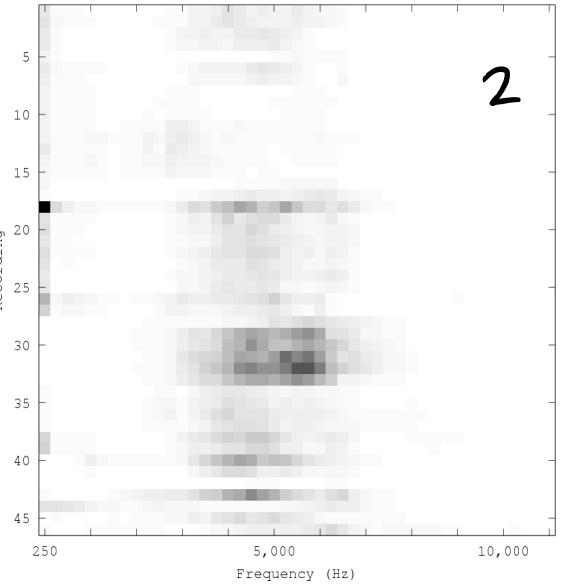
1c



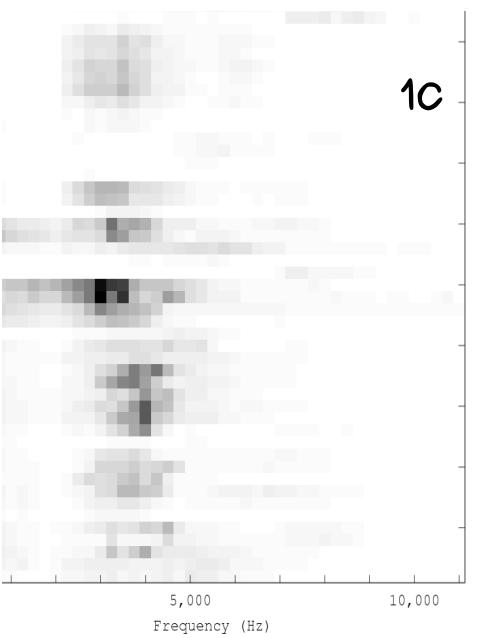
Class 2

MacGillivrays Warbler

2



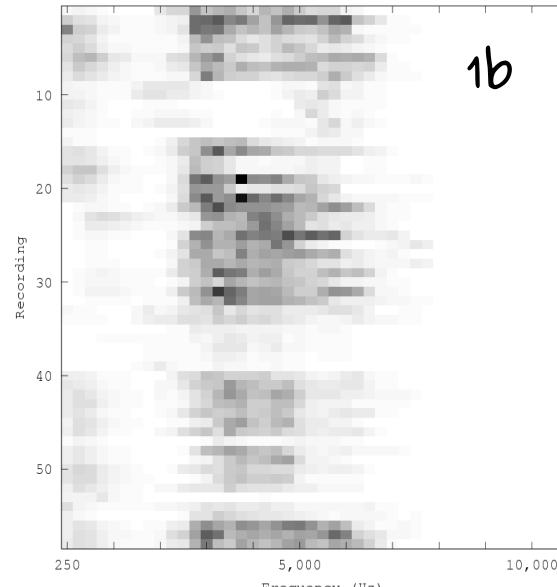
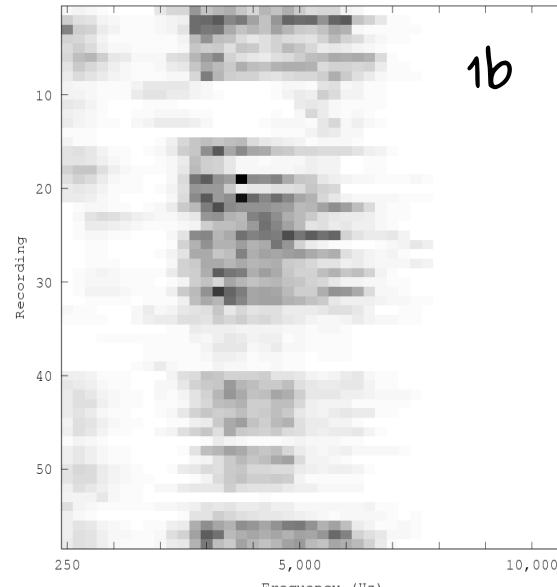
1c



Recording

Fox Sparrow Mex

1b



NCA:

0.28

LR:

0.23

0.19

0.21

0.07

0.02

# Thank you!



Questions?