

# ACOUSTIC MONITORING OF BATS WITH SELF-ORGANIZING MAPS

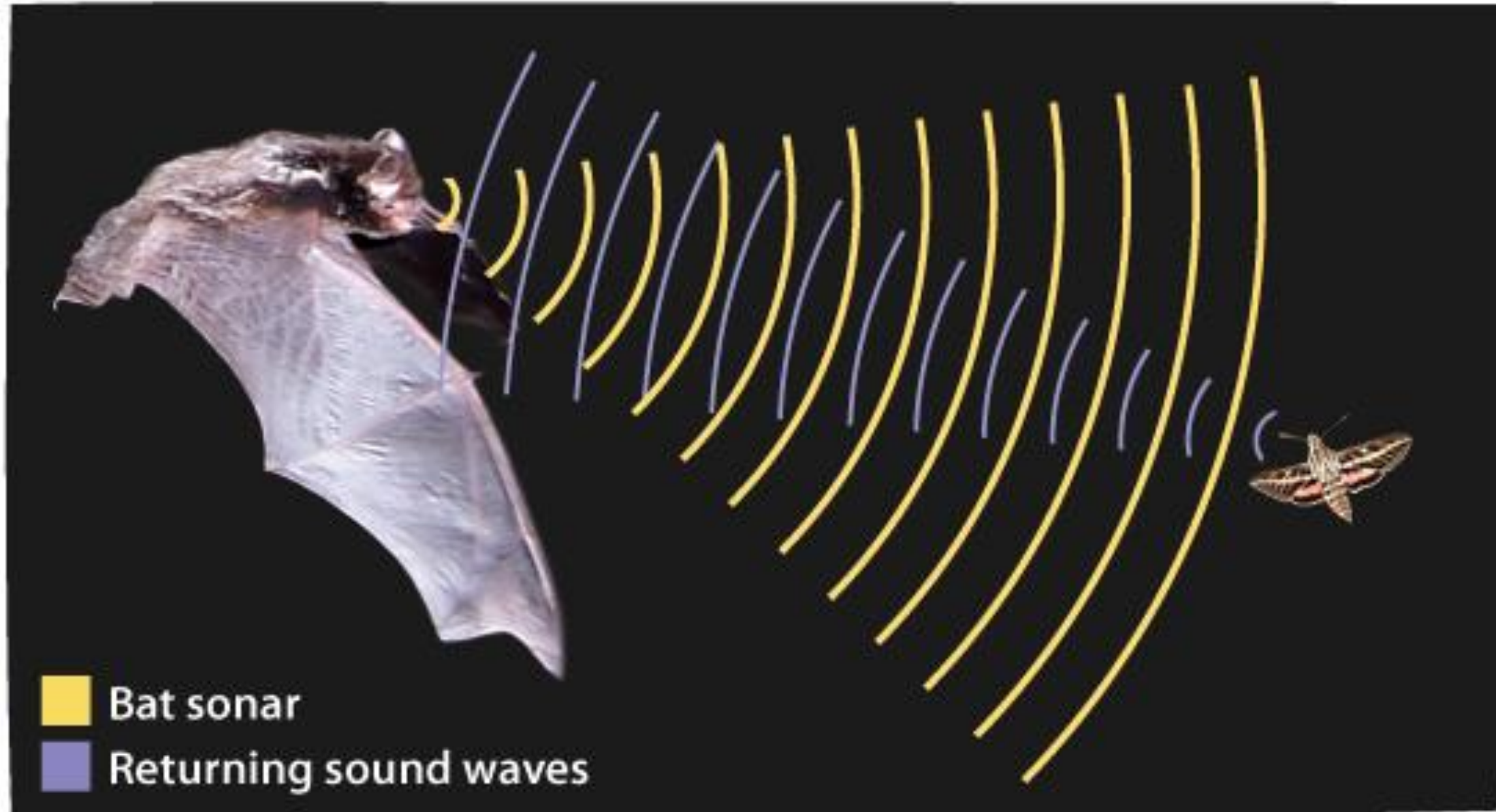
Arne Deloose

# BATS IN BELGIUM

- 18 species (1 200 species worldwide)
- Reported to the EU every six years (habitat directive)
- Monitoring difficult because bats are nocturnal flying animals → acoustic monitoring



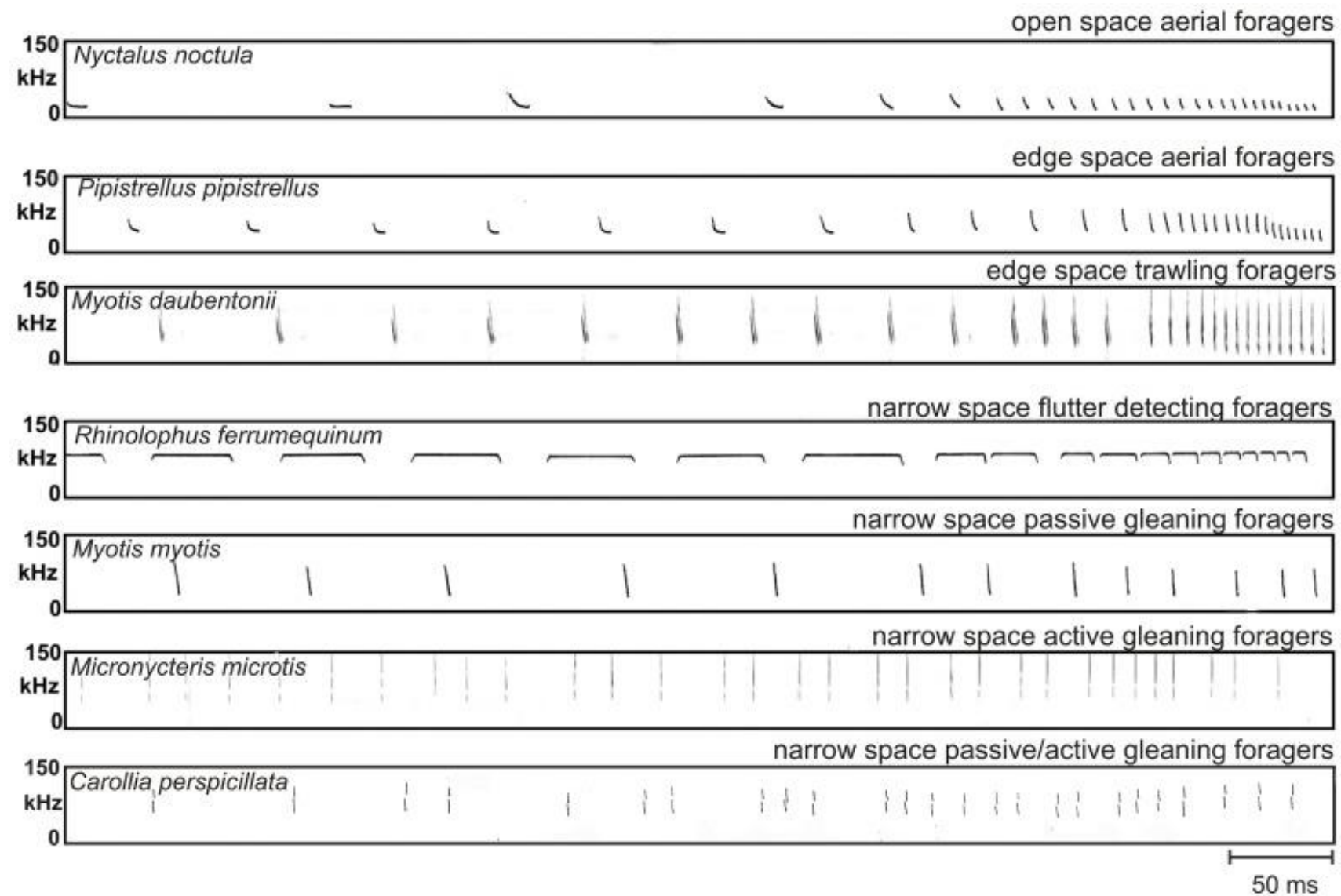
# ECHOLOCATION



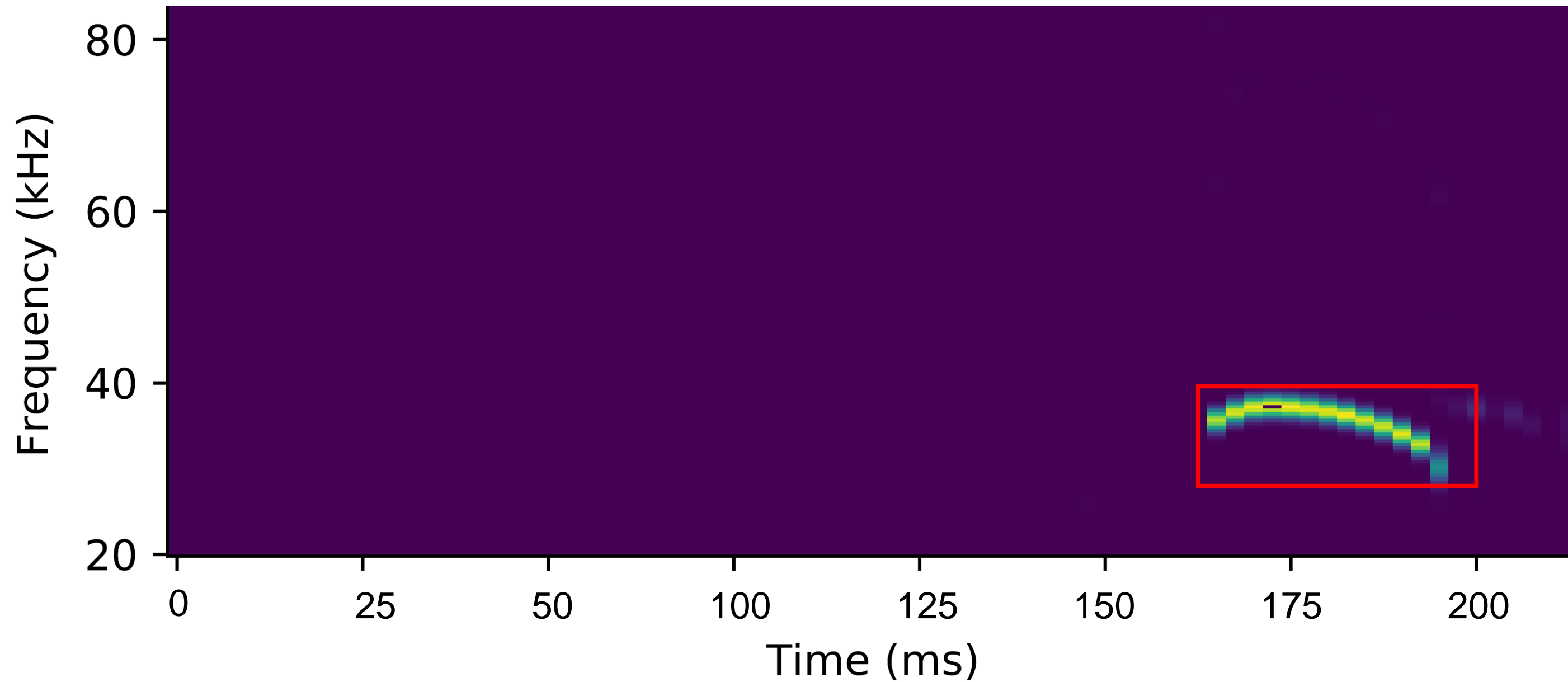


# ACOUSTIC MONITORING

- Different bats use different sounds
- Recorded using bat detectors

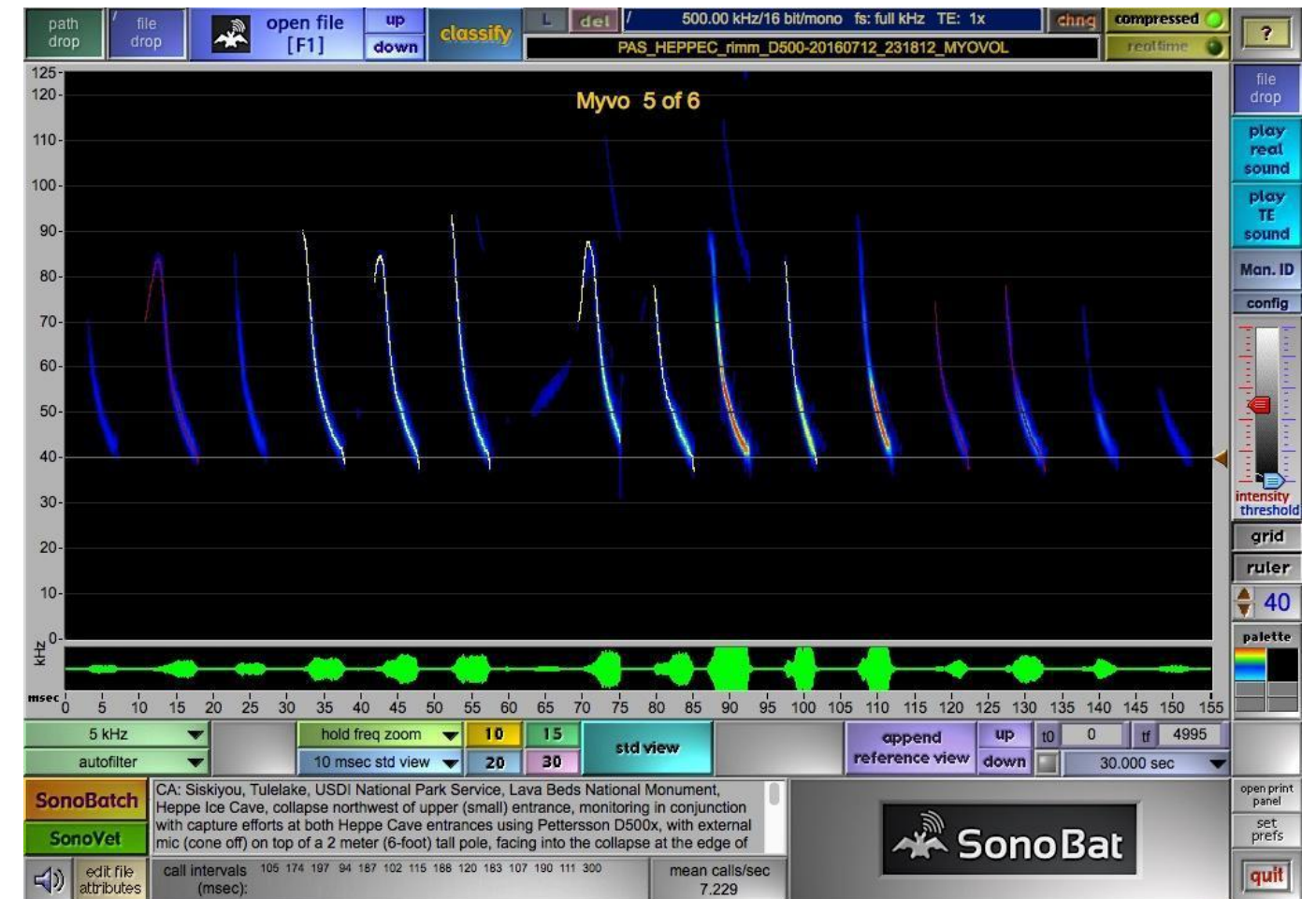


# SPECTROGRAM



# ANALYSIS

- Manual analysis
  - Time consuming
  - High expertise
- Commercial software
  - Regionality (reference library)
  - Expensive licenses
  - Limited costumization



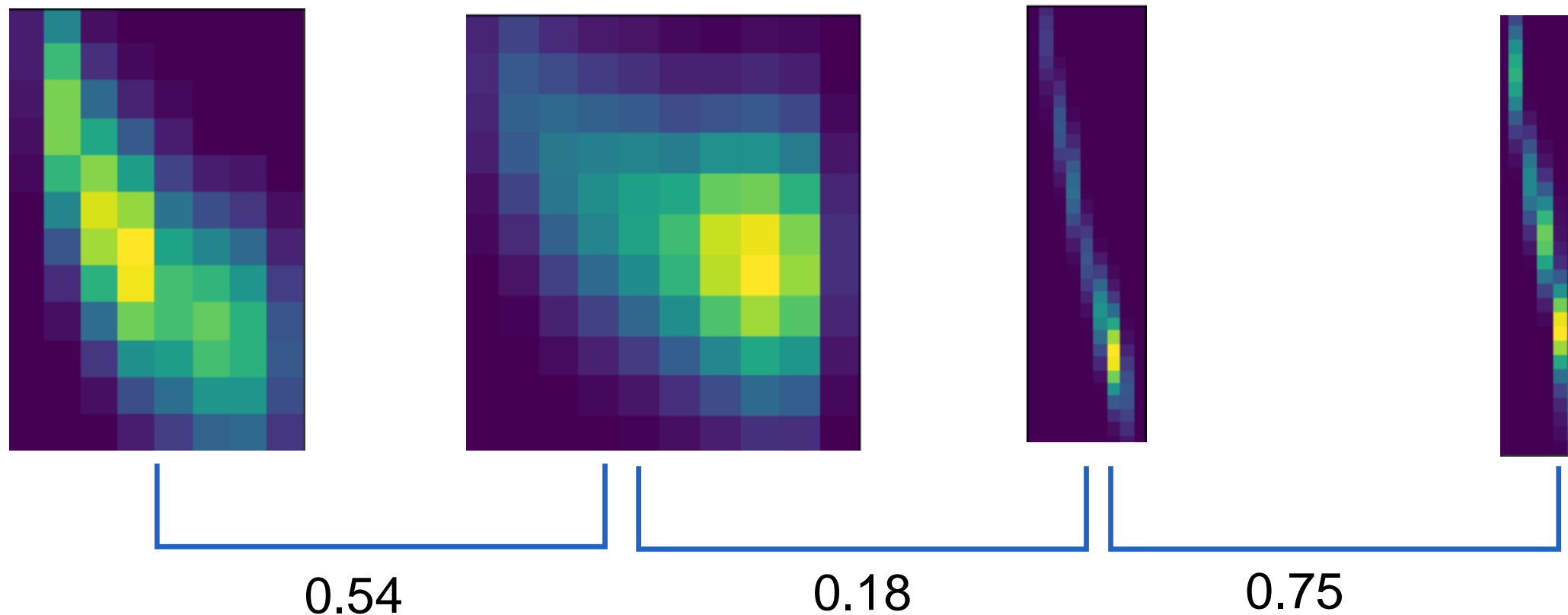
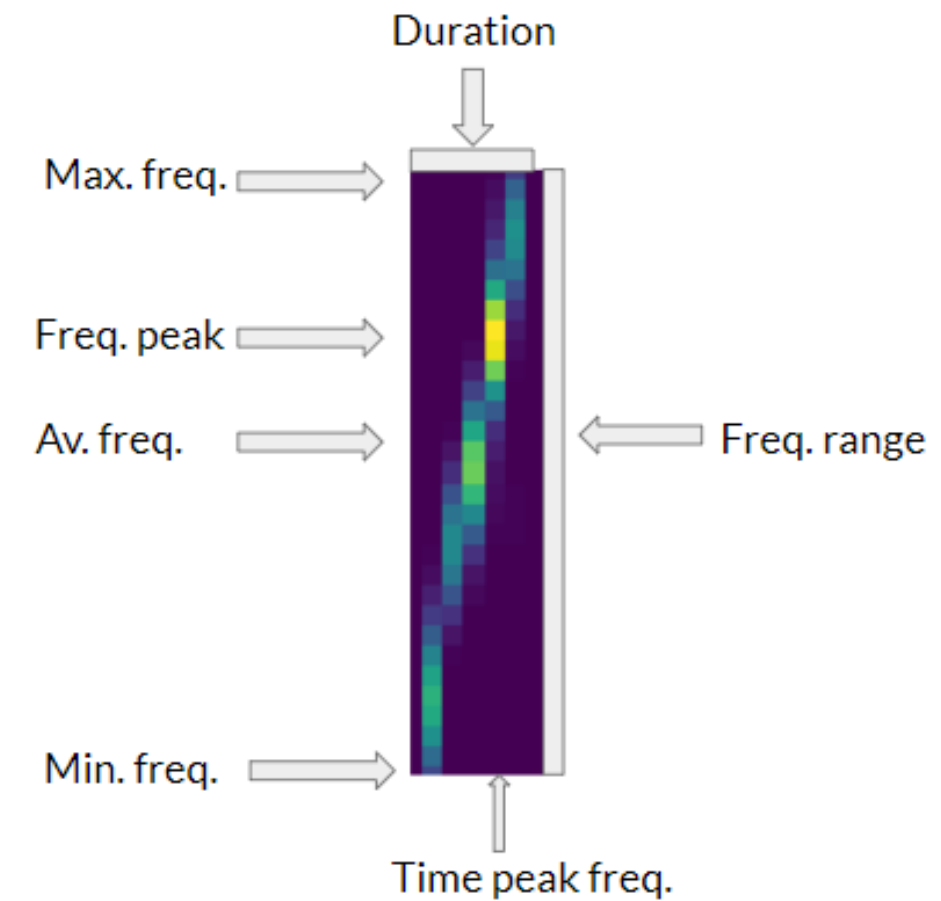


# PARTIAL SOFTWARE TOOL

- Uses both manual input and automated techniques
- Software:
  - Extracts all sounds
  - Computes features
  - Divides sounds into groups
- User:
  - Labels groups instead of sounds

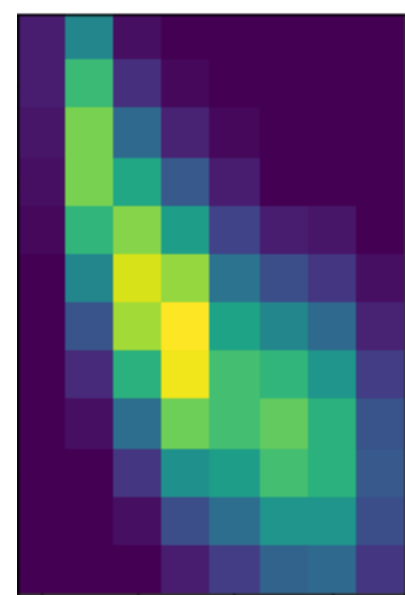
# FEATURES

- Frequency features
  - Average frequency, duration,...
- Relative shape features
  - Reference library
  - SSIM

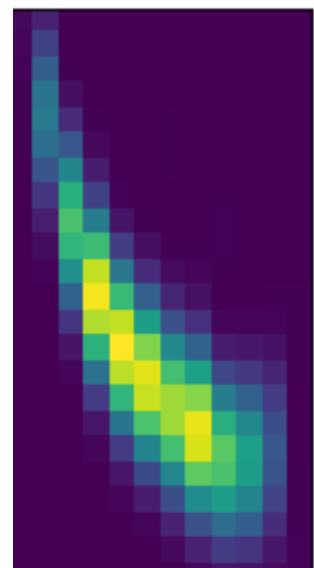




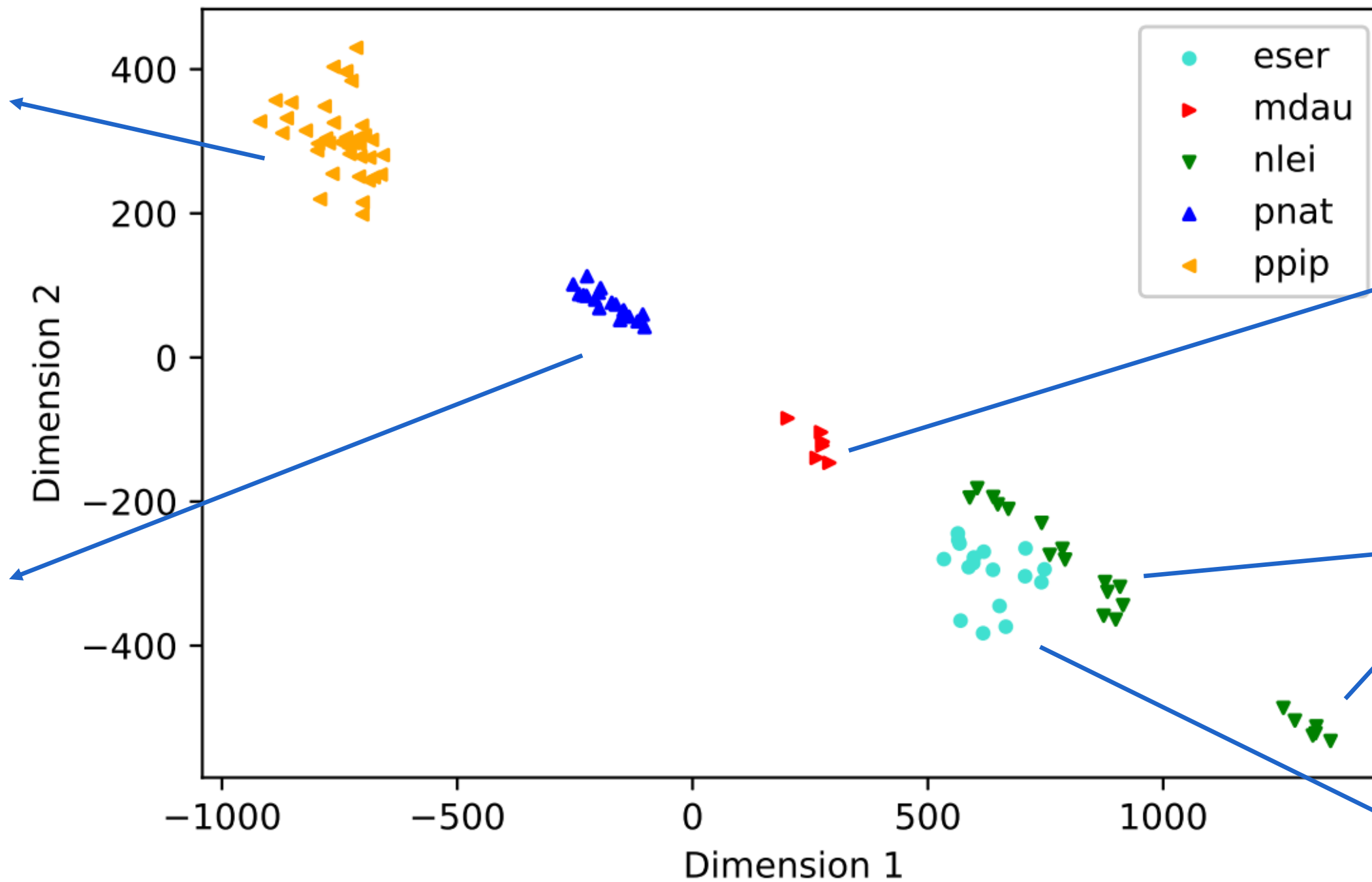
# DISTANCE BETWEEN FEATURES (MDS)



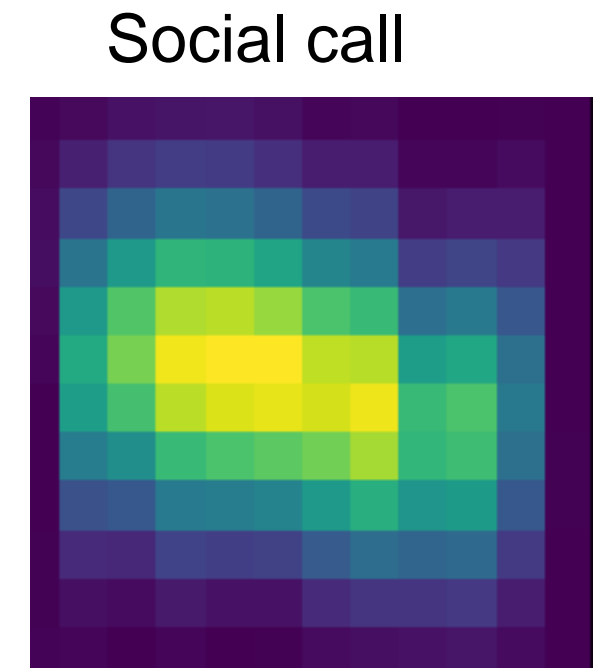
48 kHz



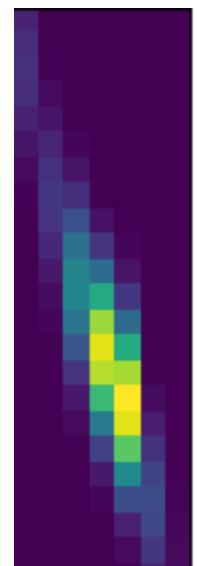
41 kHz



38 kHz



25 kHz

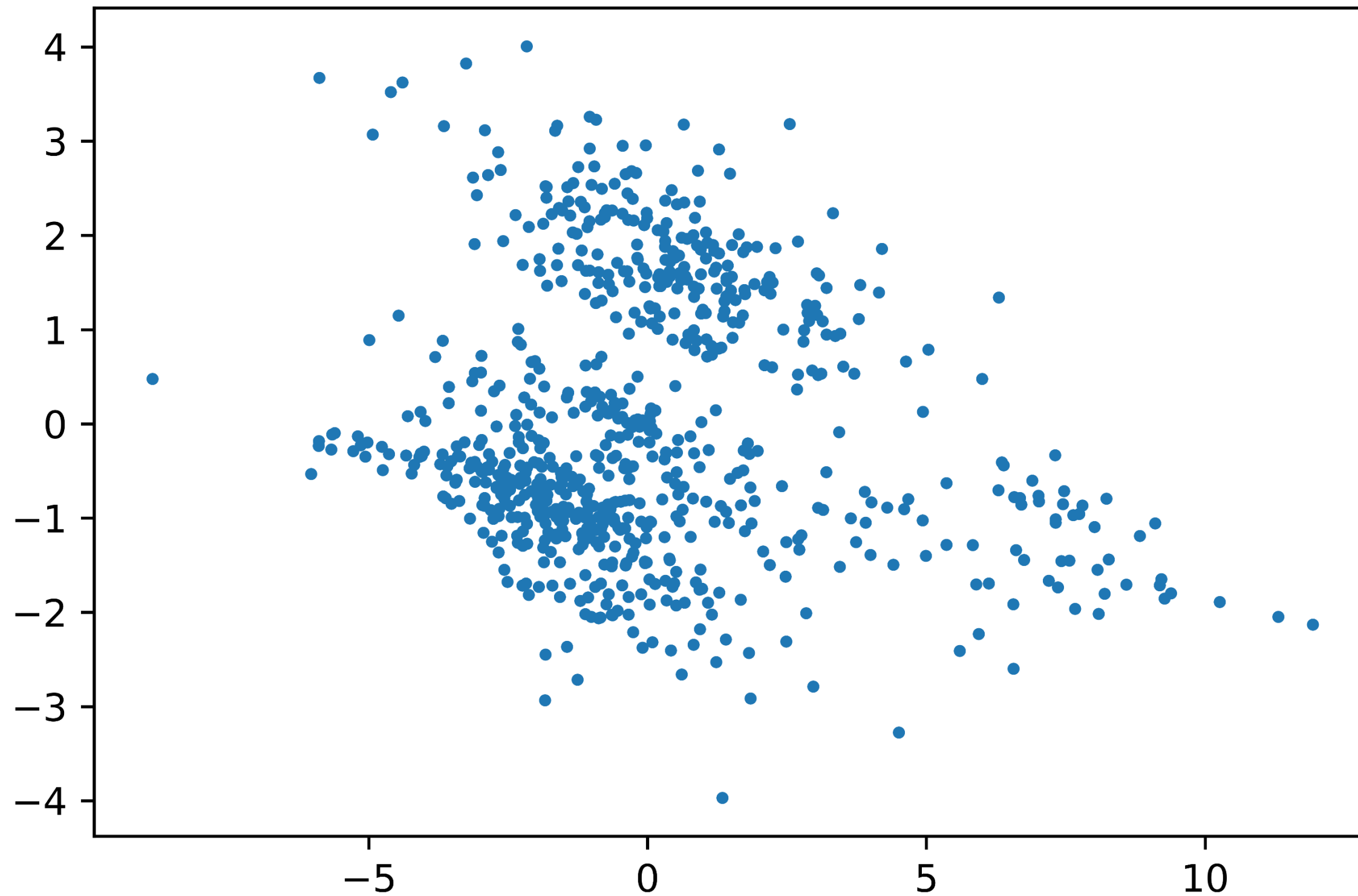


32 kHz

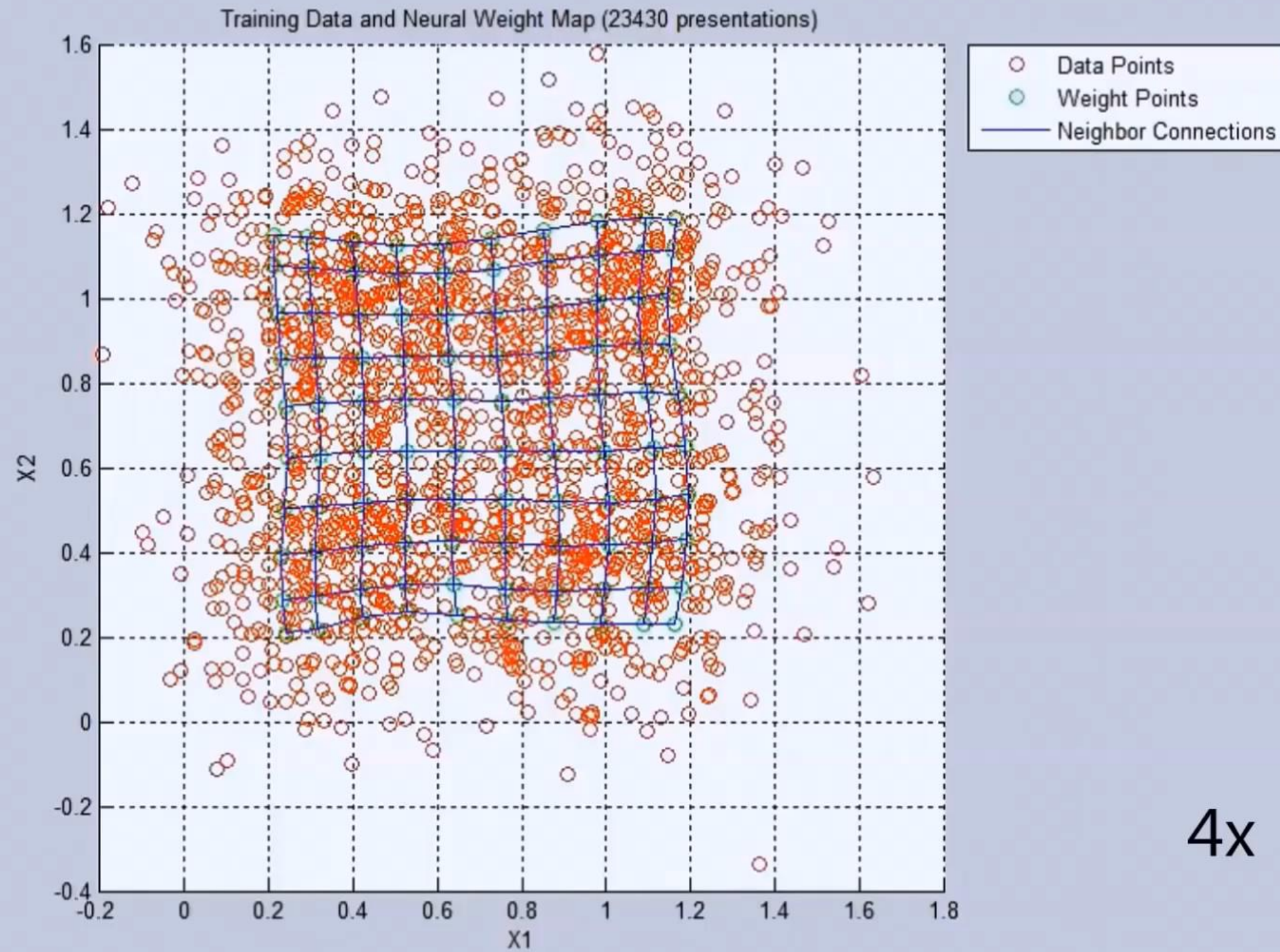


32 kHz

# MDS WITH UNLABELED DATA



# SOM



4x

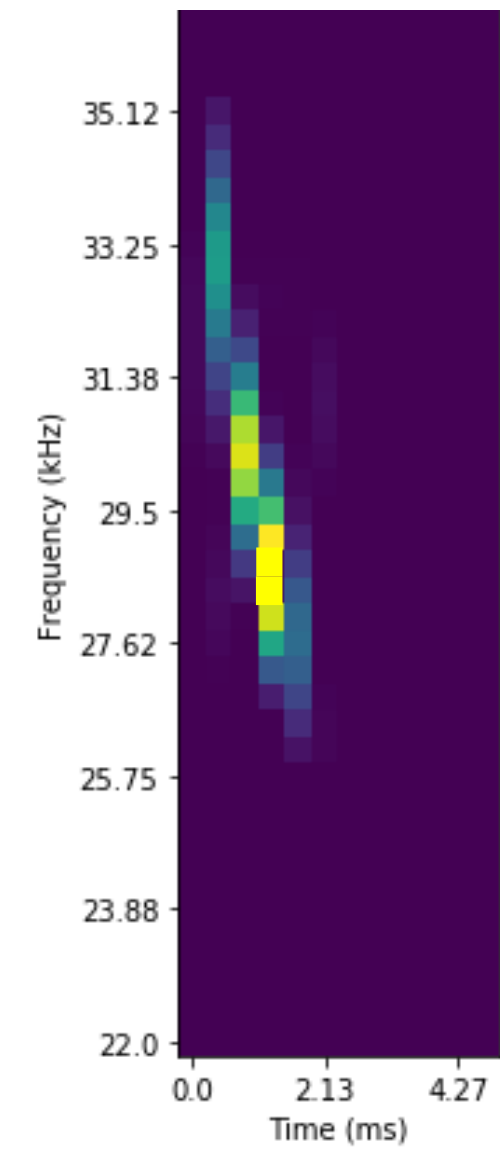
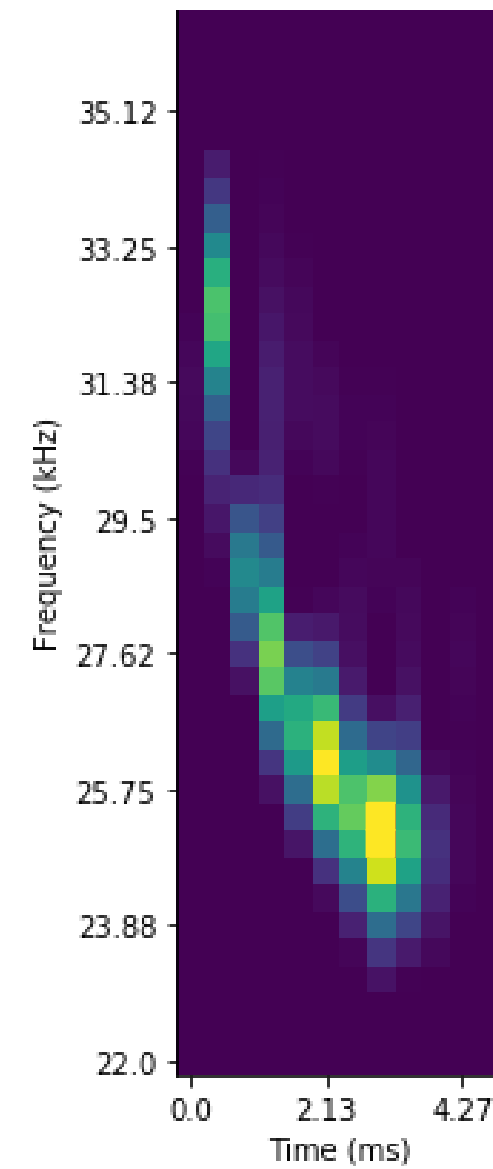
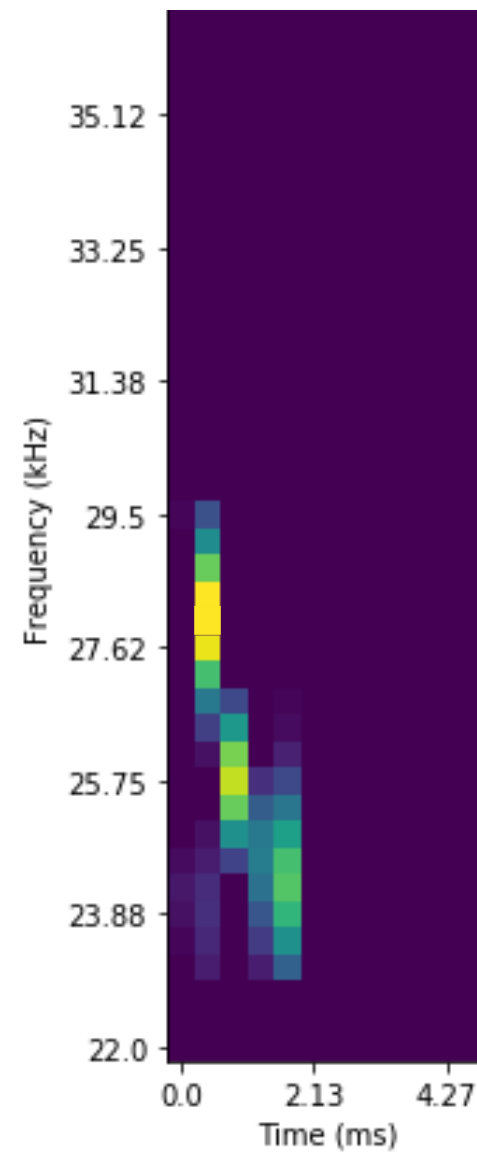
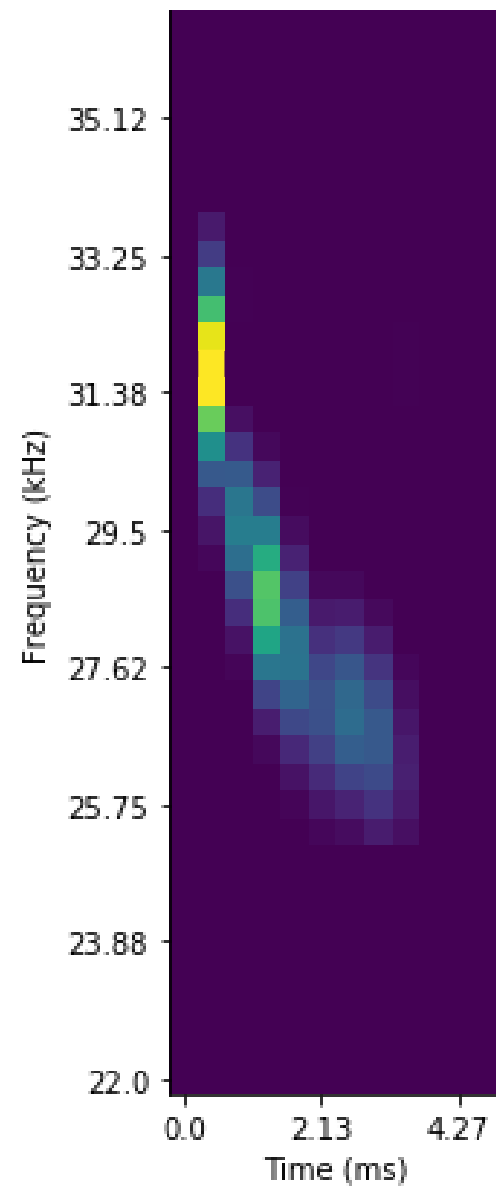


# EXAMPLE APPLICATION

- Six random recordings with 726 pulses
- Standard reference library with 5 species
- 100 groups (neurons)

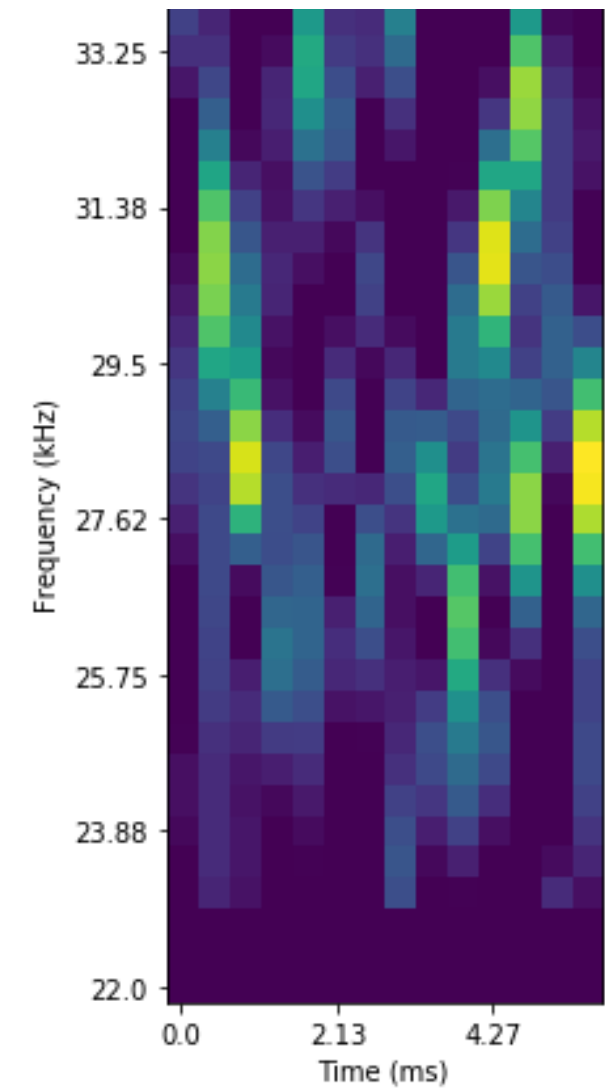
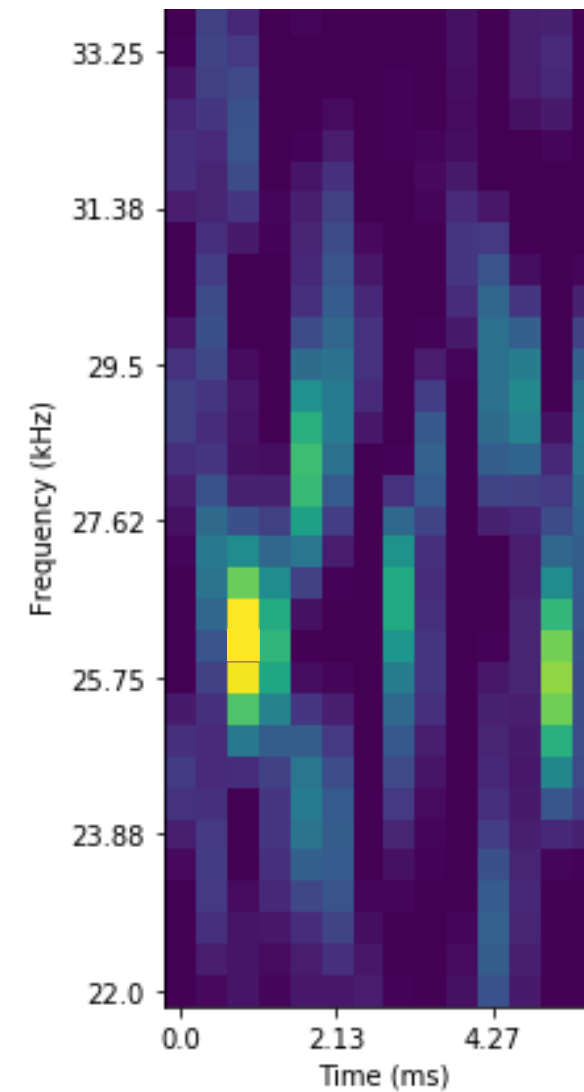
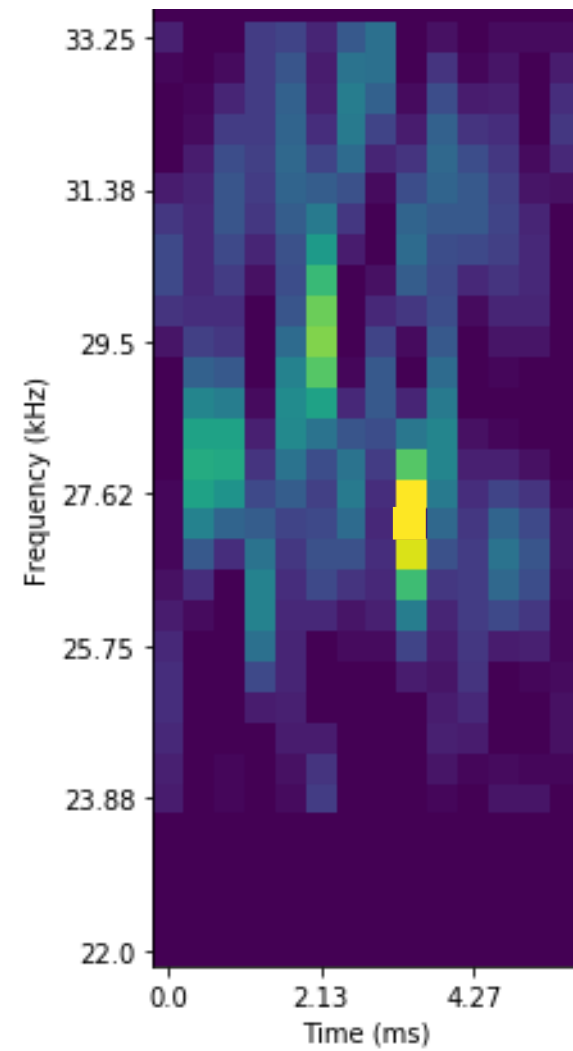
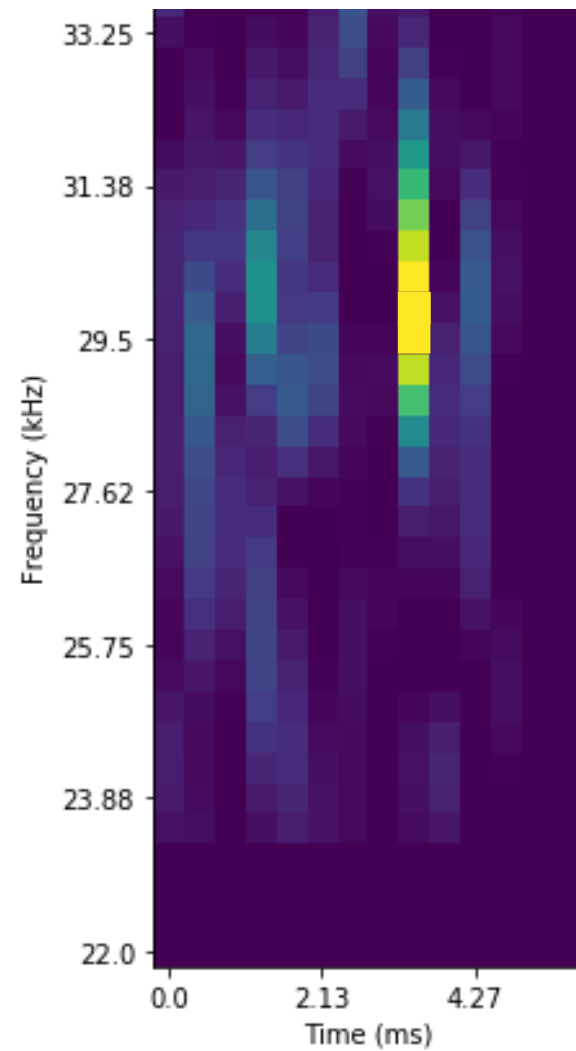
# CONTENTS OF ONE NEURON

– 9 pulses



# CONTENTS OF ANOTHER NEURON

– 28 pulses





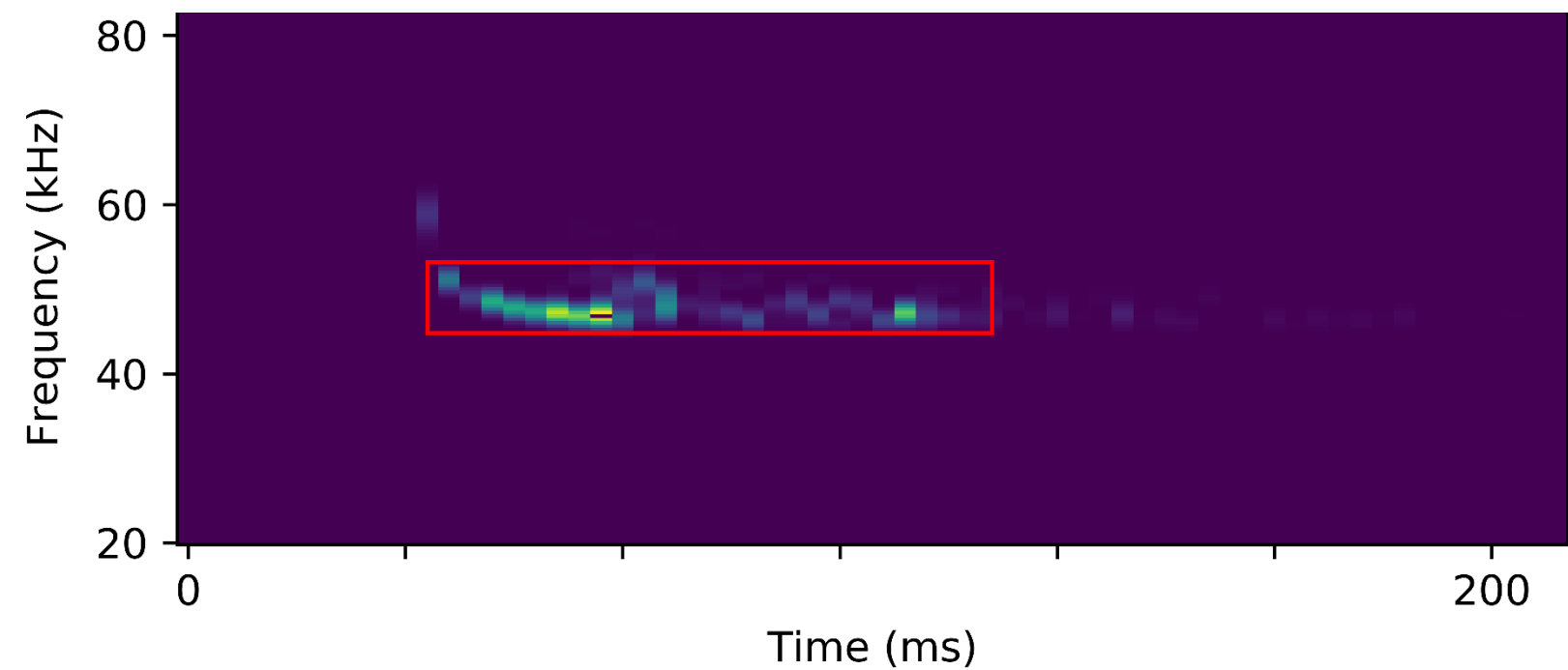
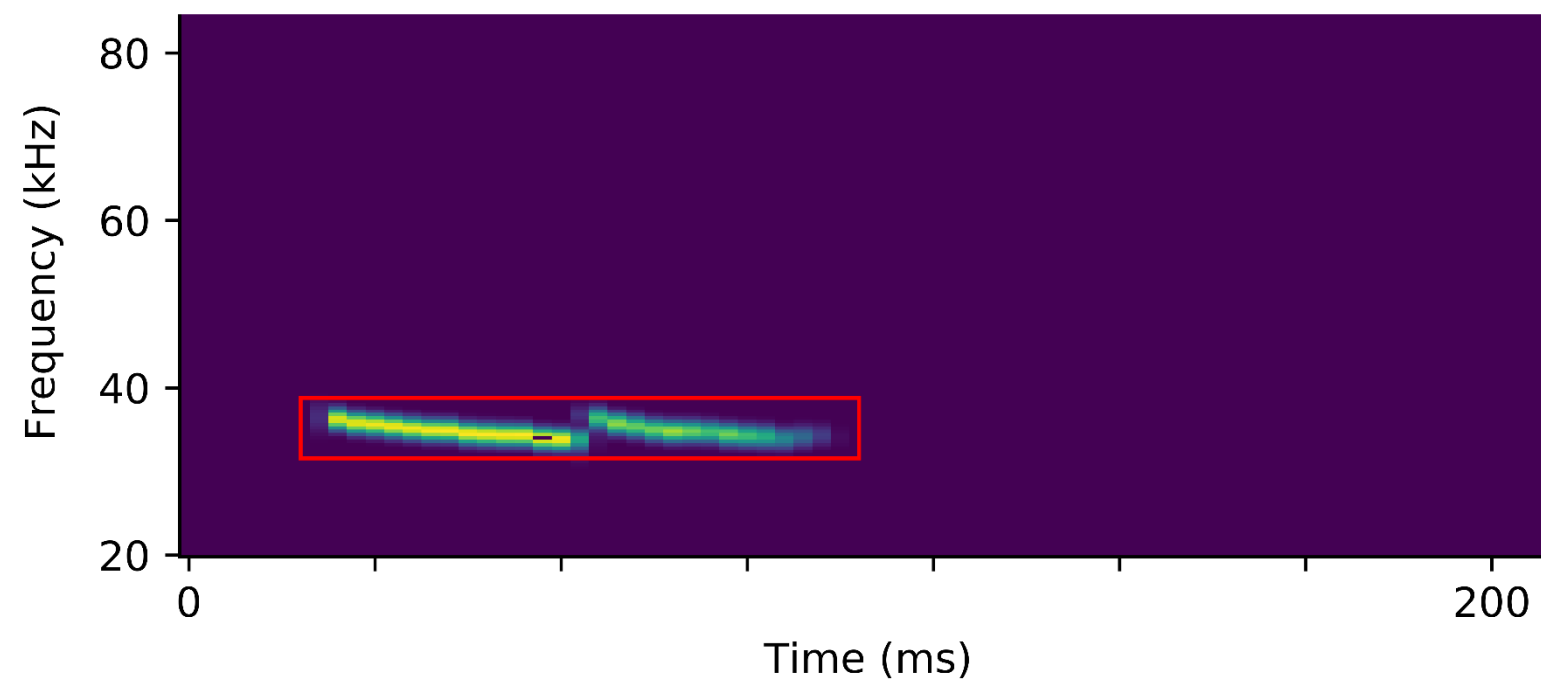
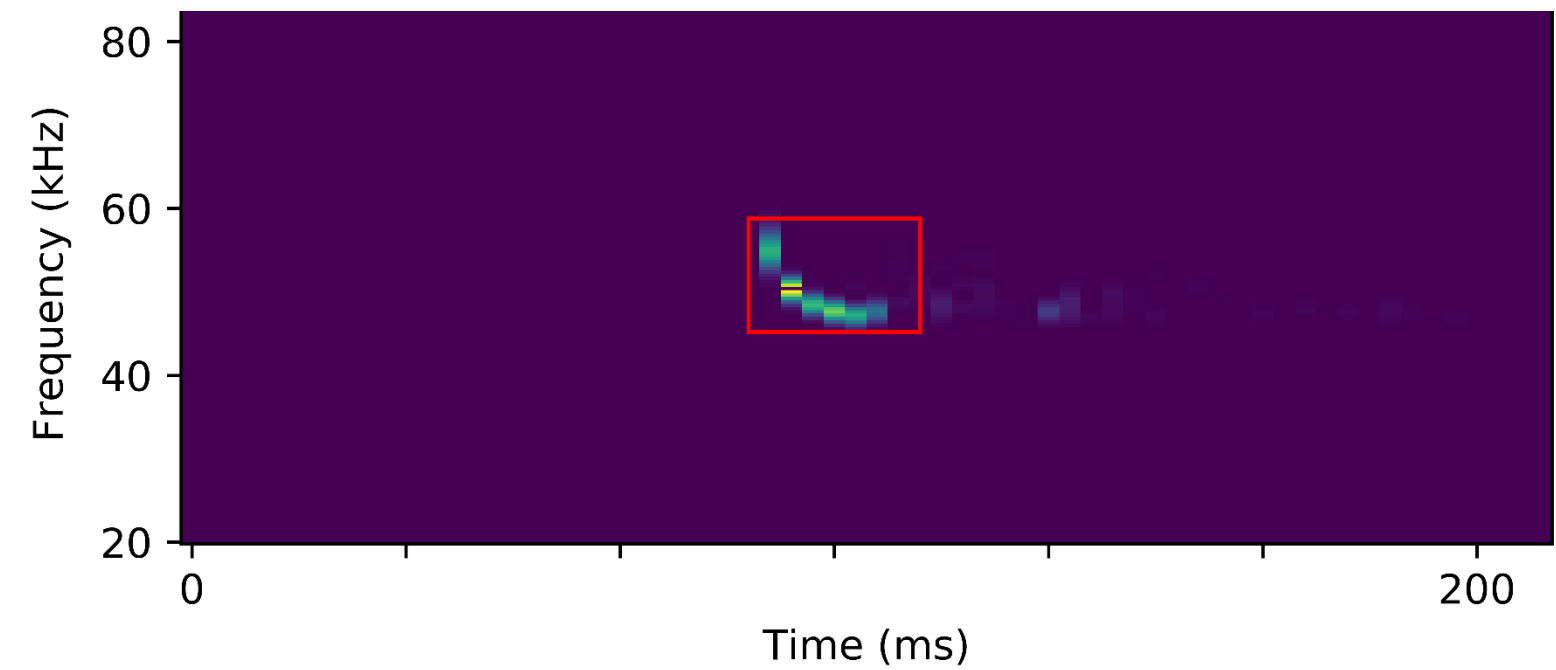
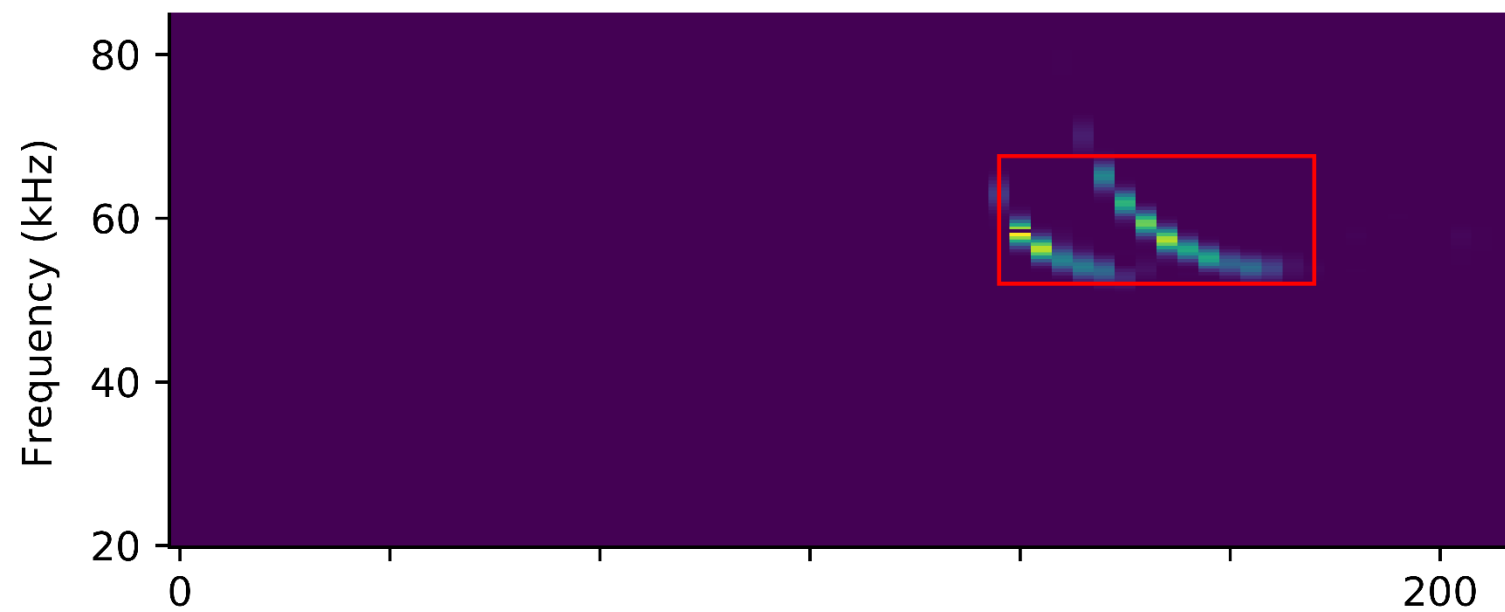
# CONCLUSION

- Tool dramatically reduces analysis time
- Challenges:
  - Rare species with a few pulses?
  - How many groups? Size reference library?
  - Similar species?

# QUESTIONS?

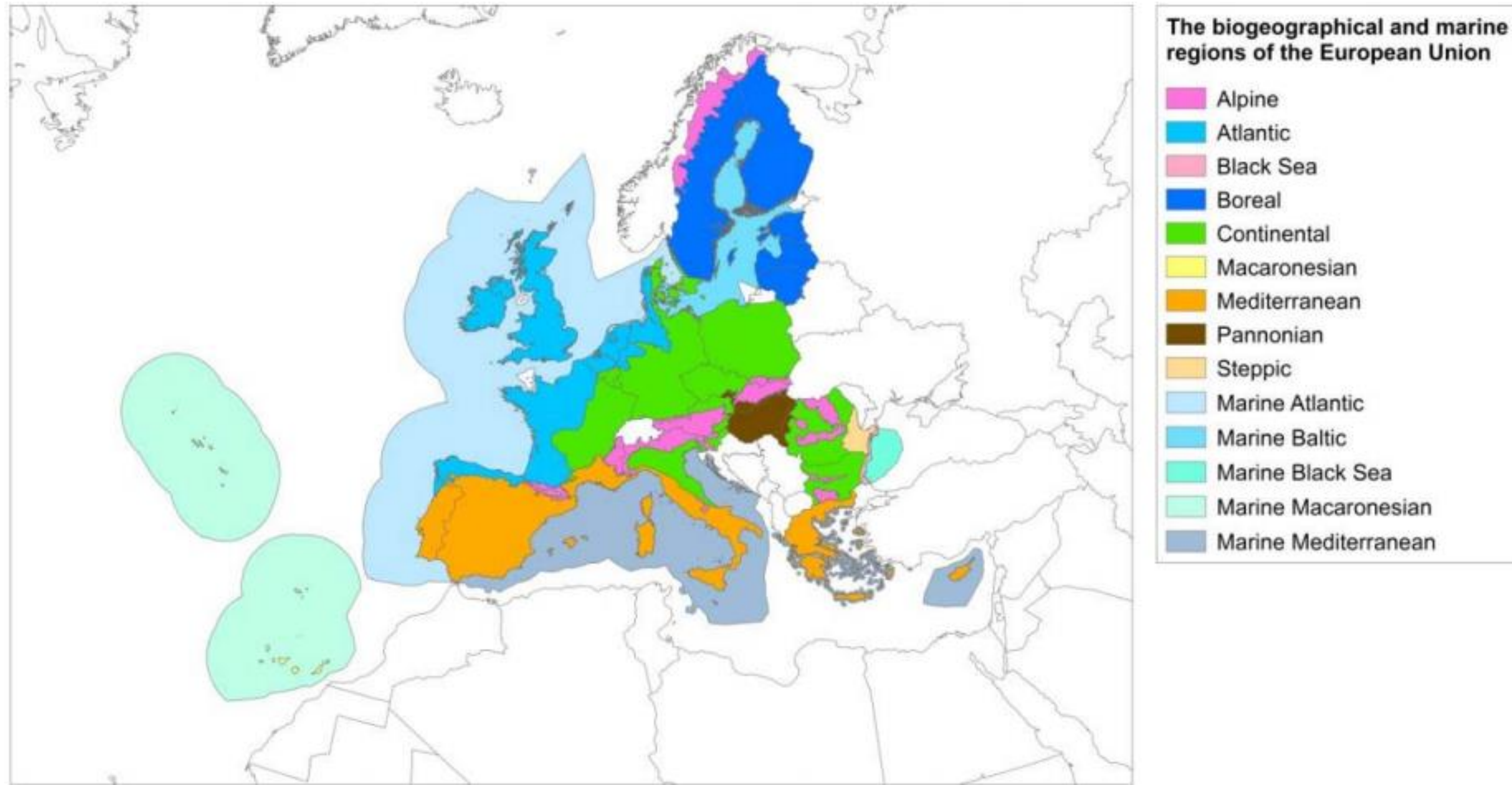


# CHALLENGES: DOUBLE AND ECHO





# BIOGEOGRAPHICAL REGIONS



# HANDHELD DETECTOR



# NEW SPECIES

Dataset	Species	Number	P	Cohen's kappa
Training	eser	12	0.67	0.55
Training	nlei	10	0.58	0.46
Training	ppip	12	0.98	0.95
Validation	hsav	13	0.94	0.93
Validation	msch	52	0.73	0.42
Validation	ppyg	17	0.06	−0.19

Table 7.3 Results of experiment 3. Top half shows the training dataset (INBO), bottom half shows the validation dataset (Barataud). The bat species are: *Eptesicus serotinus* (eser), *Nyctalus leisleri* (nlei), *Pipistrellus pipistrellus* (ppip) *Hypsugo savii* (hsav), *Myotis schreibersii* (msch) and *Pipistrellus pygmaeus* (ppip). P is the relative observed agreement. The number of neighbours (K) is five.

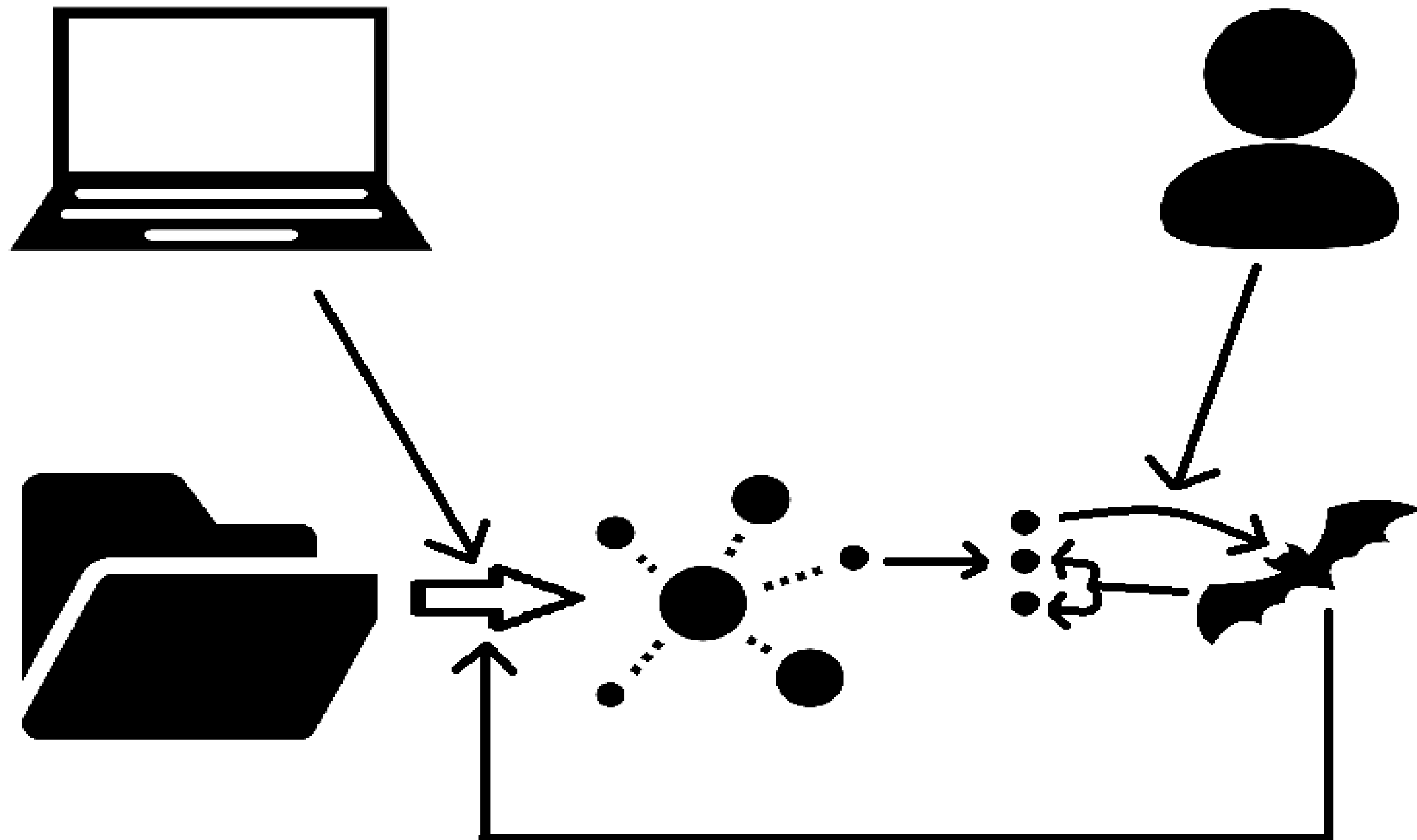


# MORPHOLOGY

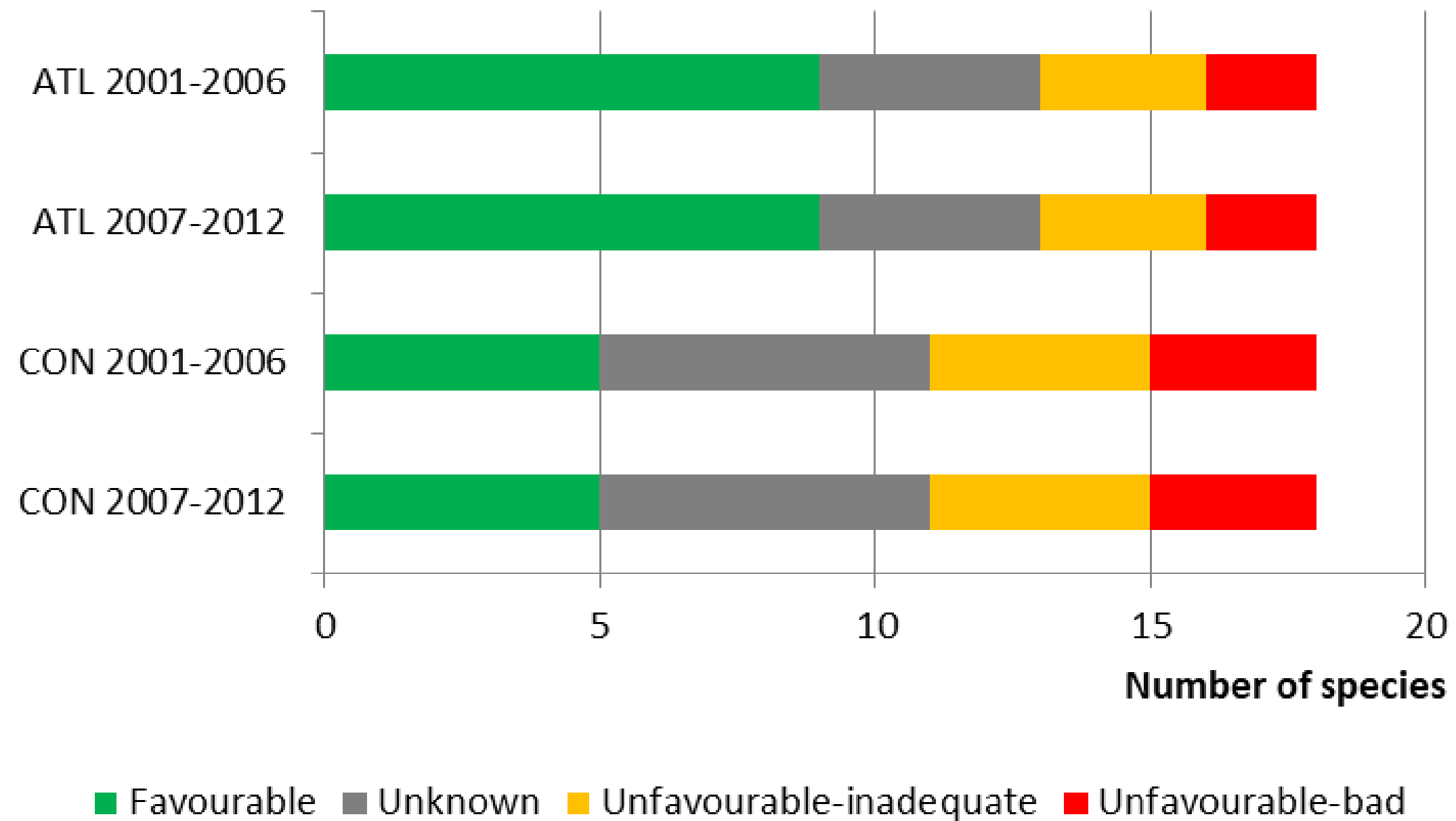




# GRAPHICAL



# CURRENT STATUS BELGIUM



# VISUALISATION TOOL

dim1  0

dim2  9

point  0.00

max time  10.00

max freq  80

min freq  20

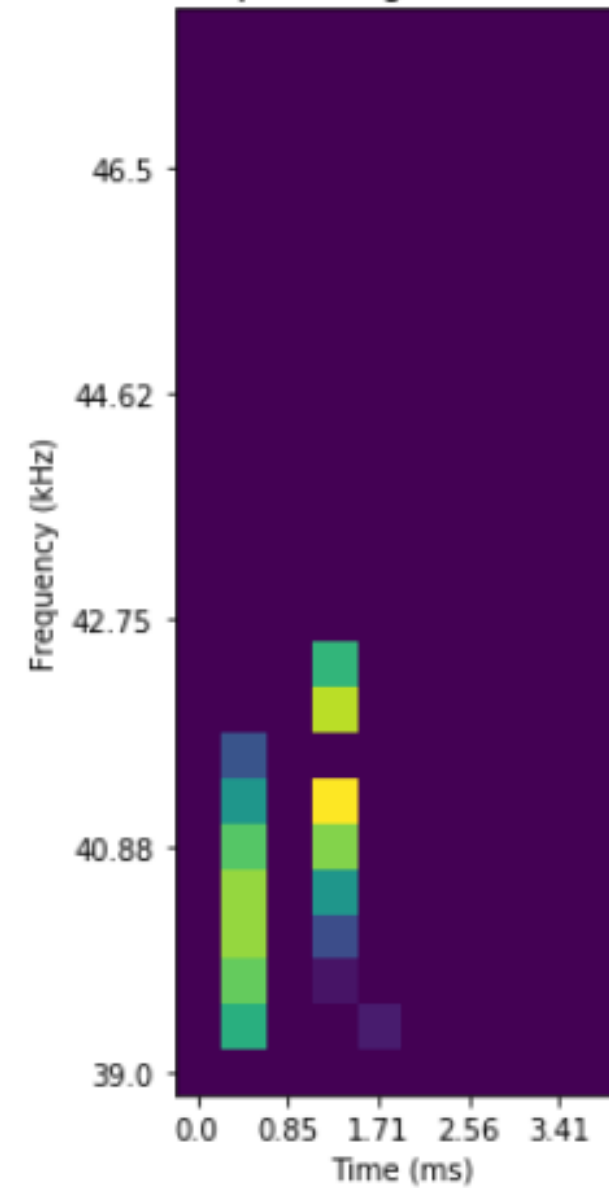
figure size  7.00

✓ Context on/off

✓ FI on/off

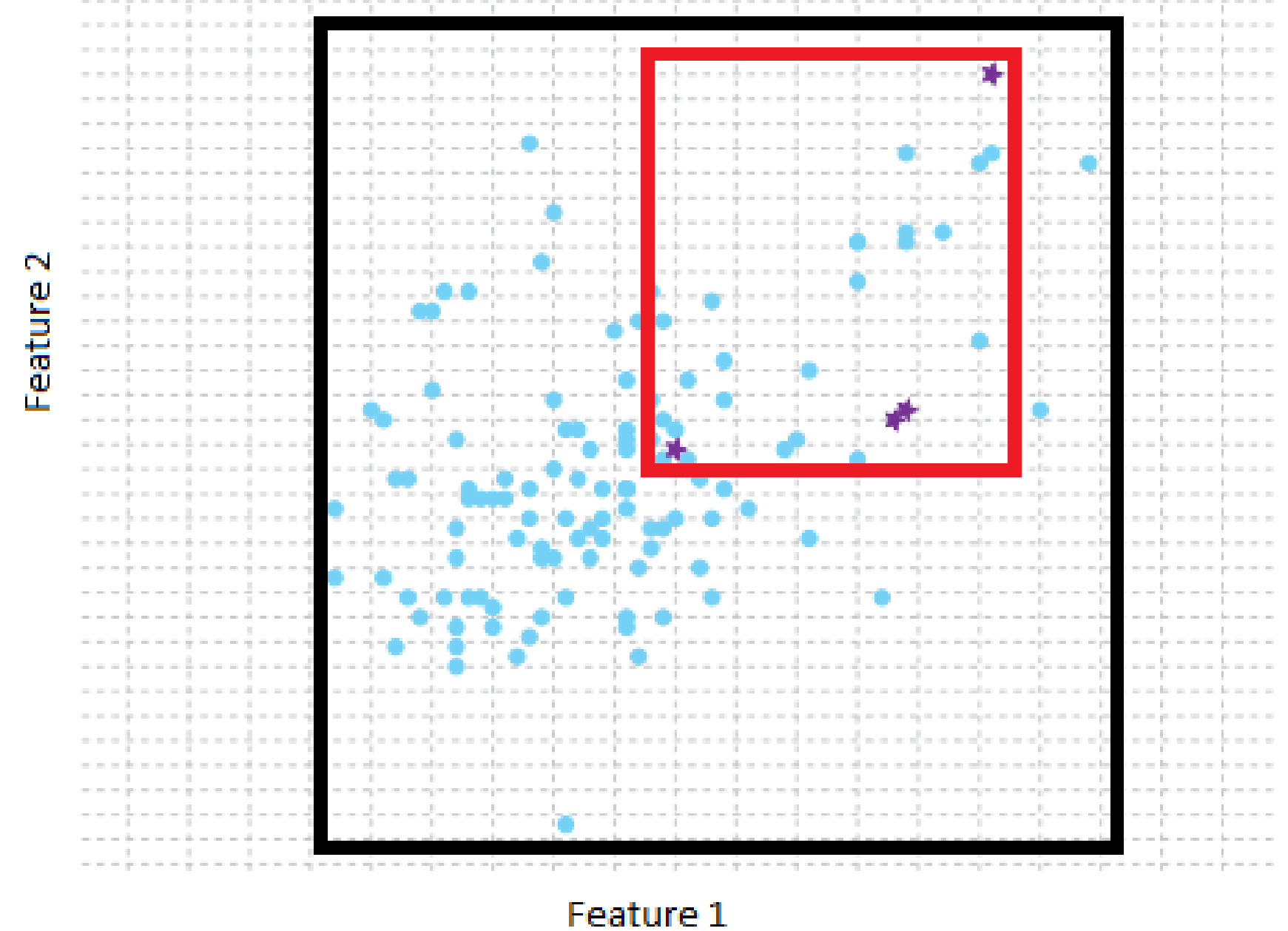
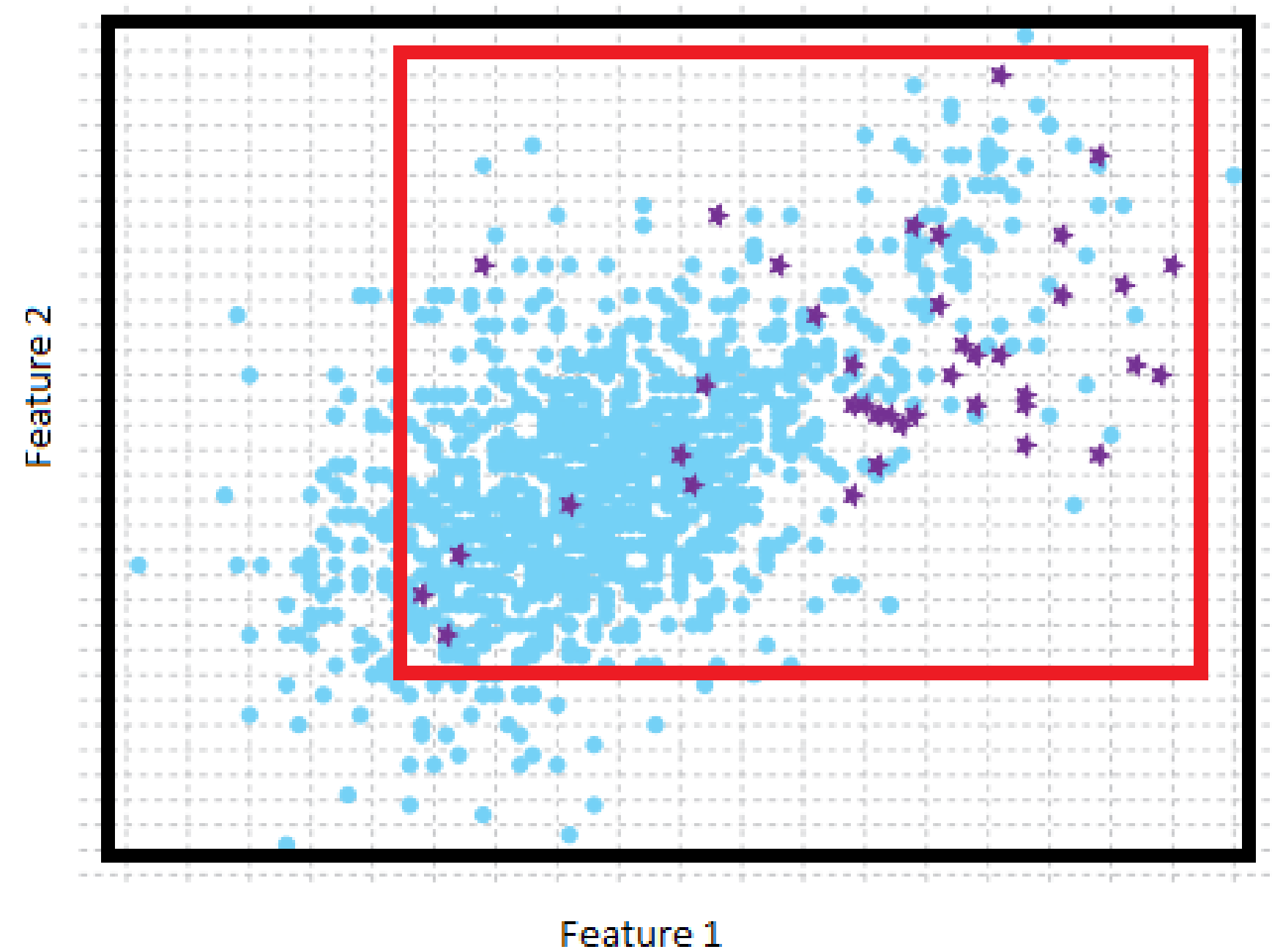
Next point

mono/A048\_ALO.WAV, timestep: 24, region: 2, distance: 0.24201256004166802

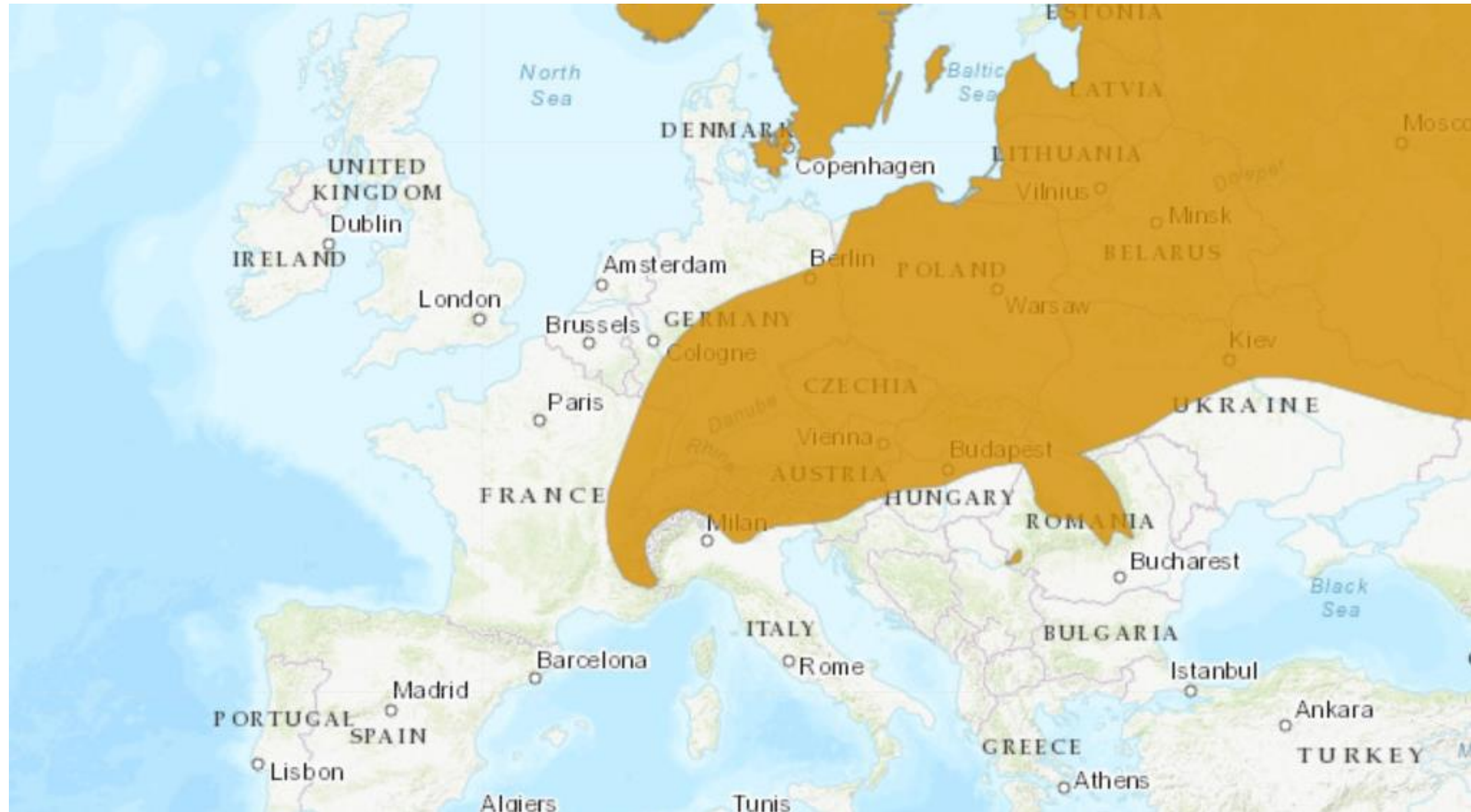




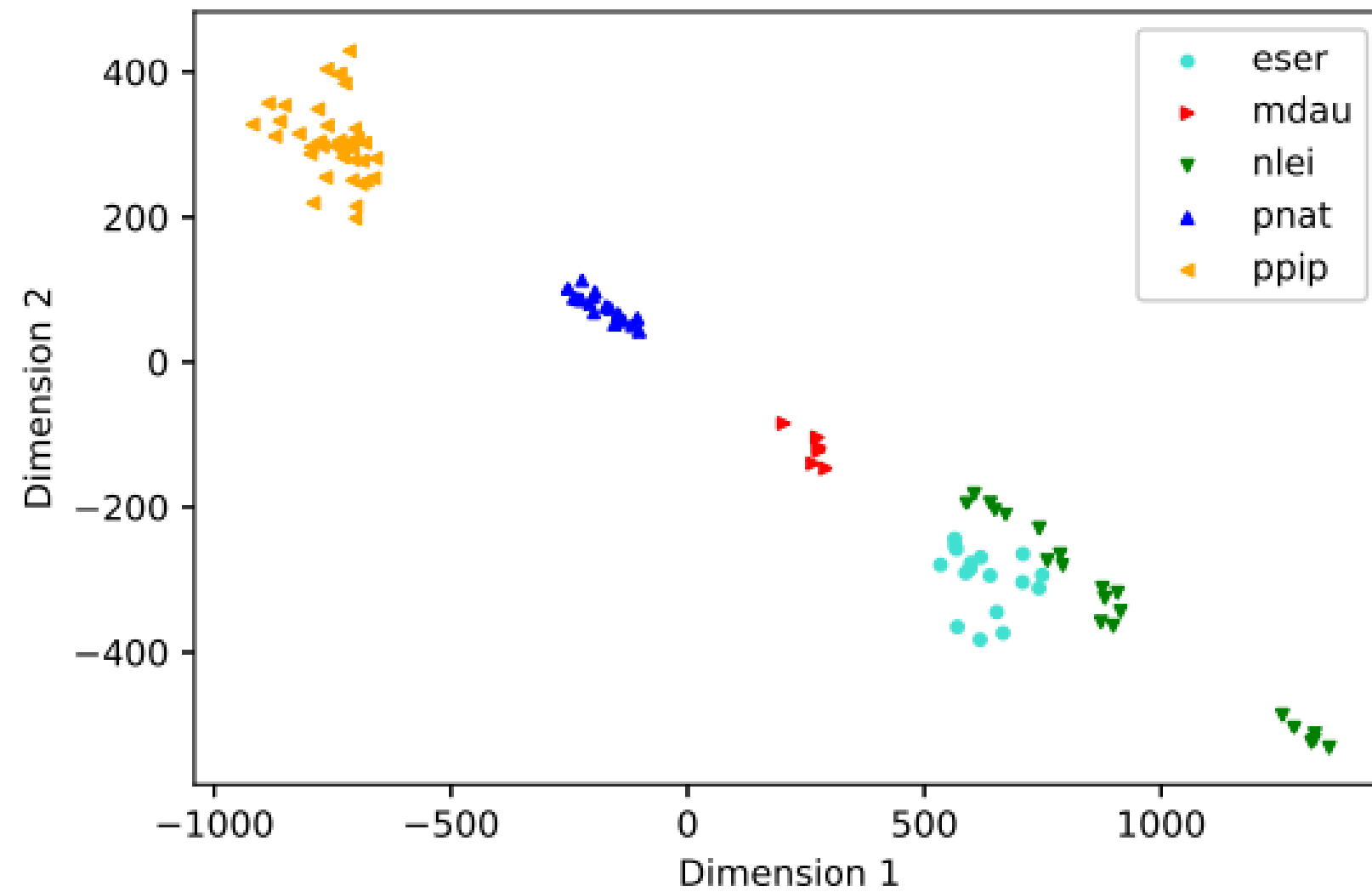
# CLASS BOUNDARIES



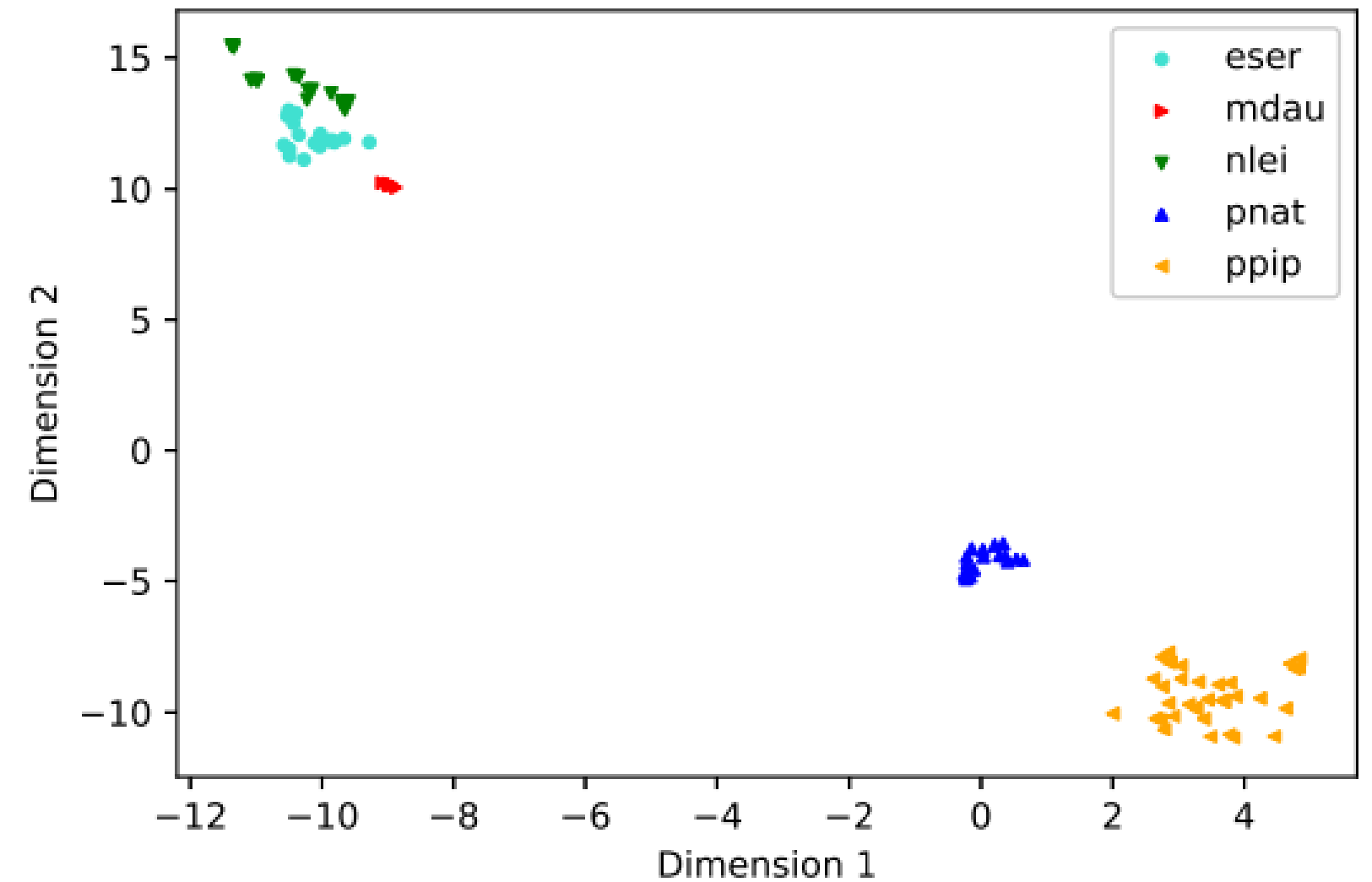
# BOUNDARIES NORTHERN BAT



# MDS/TSNE



(a) MDS



(b) TSNE