



Bioacoustic Systems, Biodiversity Assessment and the Smart Sound Meter

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Overview

- Potential impact of sound on wildlife
- Development of automated species identification systems
- Issues involved in generalised soundscape analysis
- ISRIE (Instrument for Soundscape Recognition, Identification and Evaluation)

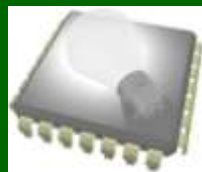


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Potential Impact of Sound on Wildlife

- Stress, annoyance, hearing loss
- Reproductive physiology (e.g. lose mating by reaction to noise)
- Retreat from favourable habitat
- Change in communication effectiveness
 - especially marine mammals



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Sender



“CHANNEL”

Dispersion

Multipath

Reverberation

Noise (wideband, impulsive)

Habitat modification

Loss of optimal spectral matching
(acoustic “niche”)

Increase in average signal level

Receiver



Disturbance
Interruption of function
Stress
Panic, even death

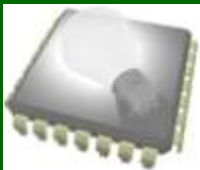


All worse in urban areas

Example – Great Tit (*Parus major*)

- Work at Leiden University* indicates that Great Tits change their song in urban environments:
 - Shorter, faster song
 - Increase in minimum frequency of song elements

* Slabbekoorn & den Boer-Visser, *Current Biology* **16**, 2326-2331, 2006

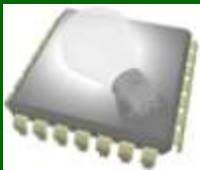


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Automated Species Identification

- Part of “Computer-aided Taxonomy”
- Increasing interest in ASI due to the taxonomic impediment
- Wide range of applications:
 - Pest detection/identification
 - Ecological studies
 - Species counting
 - Individual counting (some taxa)



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Acoustic Applications of ASI

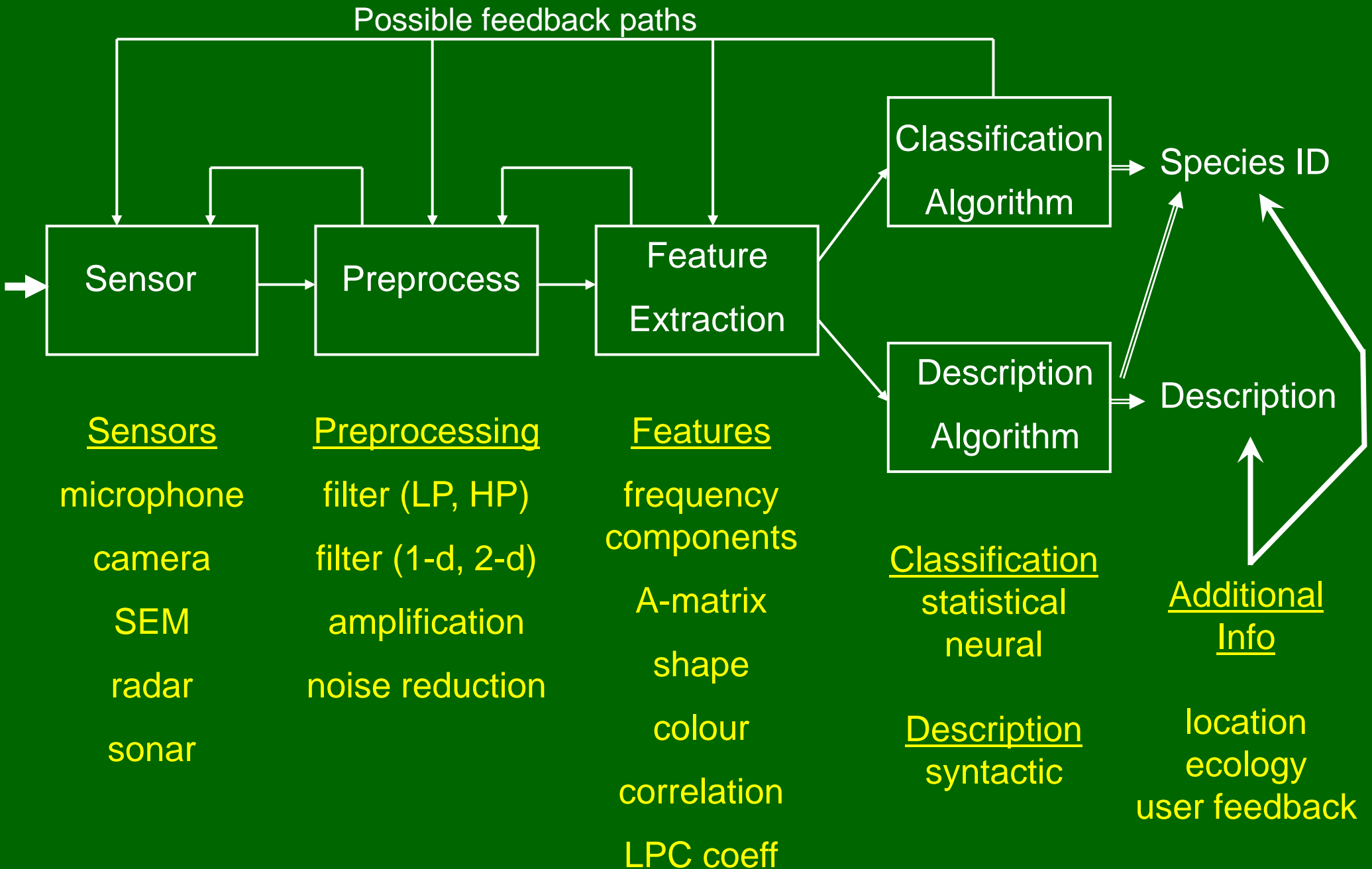
- Insects
 - Mosquitoes, Orthoptera, wood-boring pests
- Birds
 - Migration, bird strike, individual ID
- Mammals
 - Bats, elephants, deer, cetaceans
- Others including fish, amphibia



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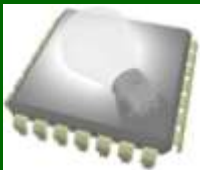
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Generic Species Identification System



Project: Recognition of British Orthoptera

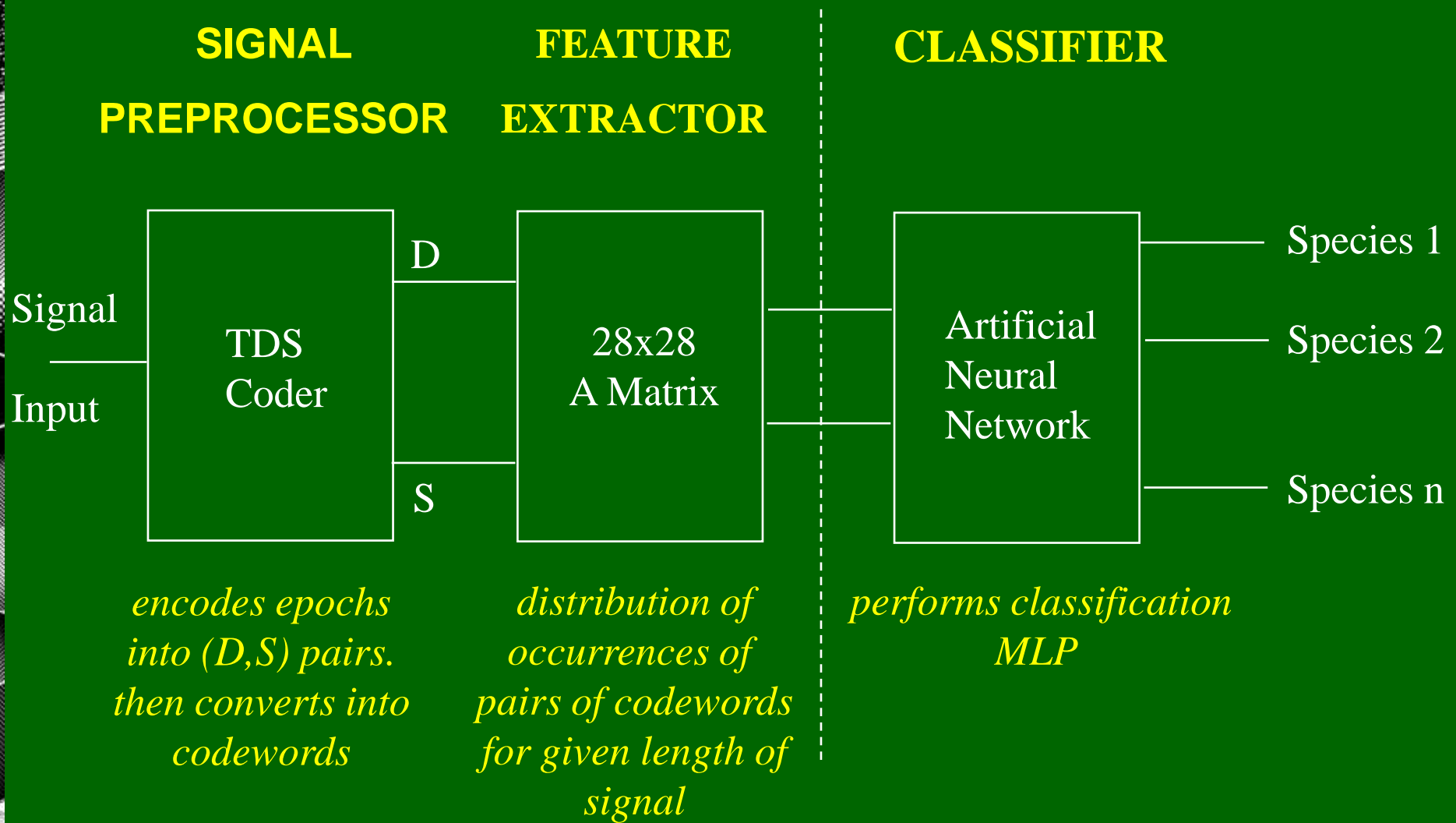
- Uses Time Domain Signal Coding to extract features related to short term temporal structure.
- Project to assess feasibility of ASI for rapid biodiversity assessment and ecological studies.
- Also assess feasibility of automated soundscape analysis



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SCHEMATIC DIAGRAM OF BIOACOUSTIC SPECIES IDENTIFICATION SYSTEM



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Field Tests at Nature Reserves in Yorkshire

Problems Encountered

- Low signal level (grasshoppers not loud)
- Interfering signals
 - Biophony (birds, other insects)
 - Geophony (wind, possibly rain)
 - Anthropophony (cars, tractors, motor bikes, aircraft)



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Recognised Sounds

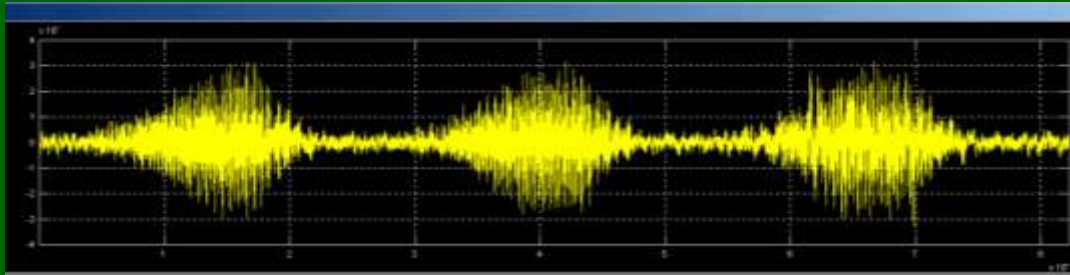
- 13 sounds were used to train the MLP:
 - 4 grasshopper species (TARGET);
 - 1 blow fly (unknown species);
 - 2 car (metalled road and dirt road);
 - 4 birds (3 different alarm calls of undetermined origin and chiff-chaff);
 - 1 single engine light aircraft;
 - 1 background sound (mainly wind noise).



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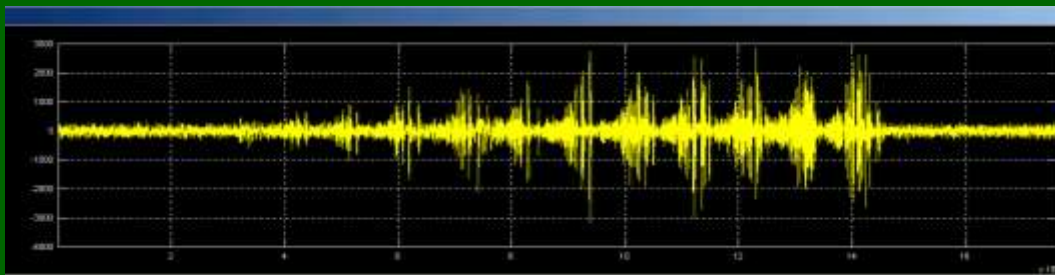
MOTTLED GRASSHOPPER



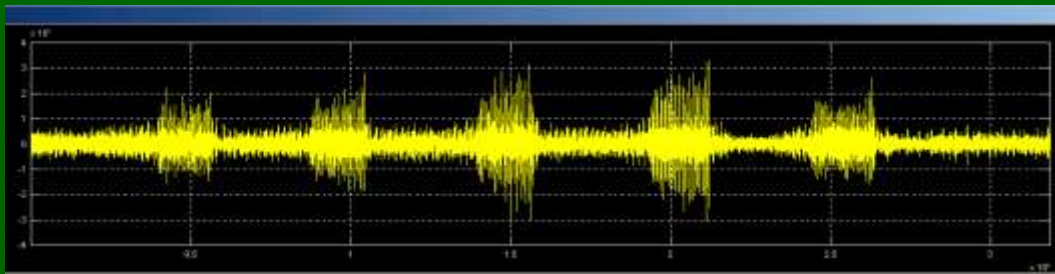
A-MATRICES



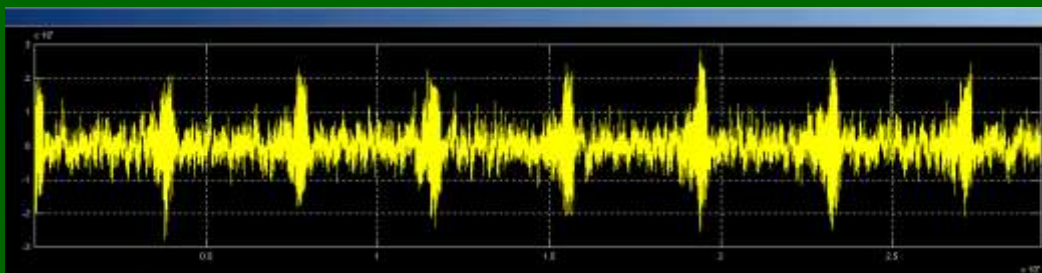
MEADOW GRASSHOPPER



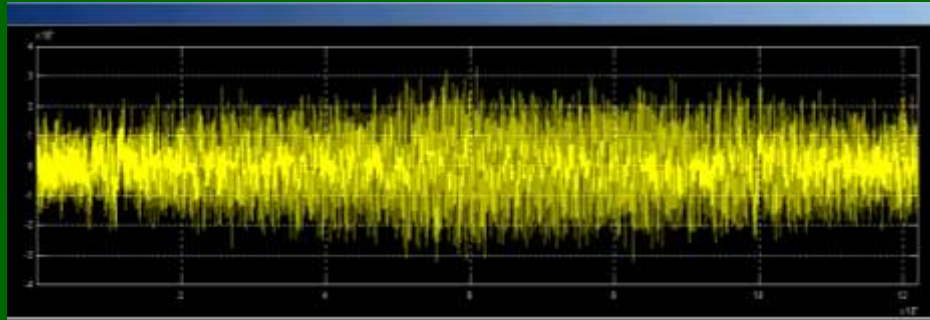
LESSER MARSH GRASSHOPPER



COMMON GREEN GRASSHOPPER



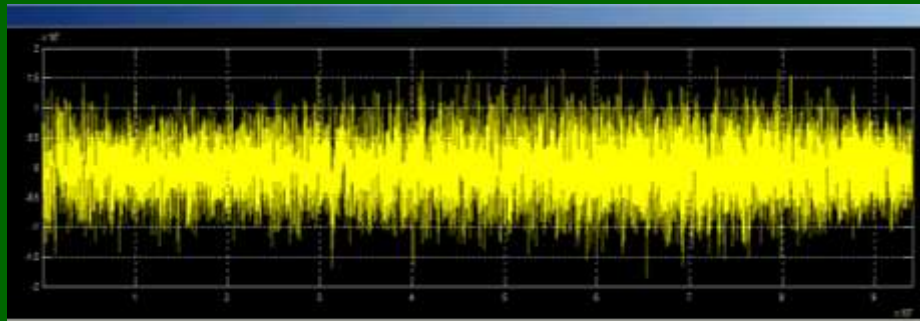
LIGHT AIRCRAFT



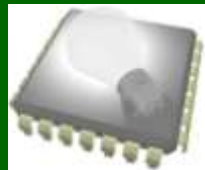
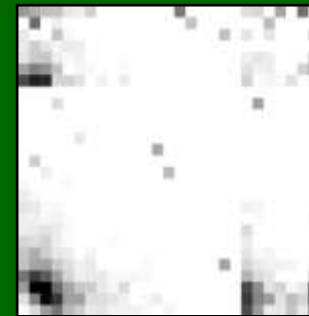
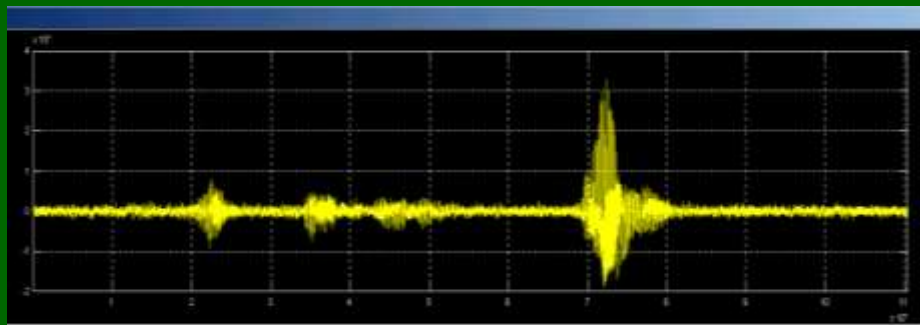
A-MATRICES



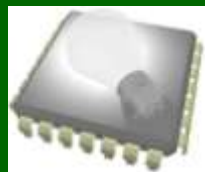
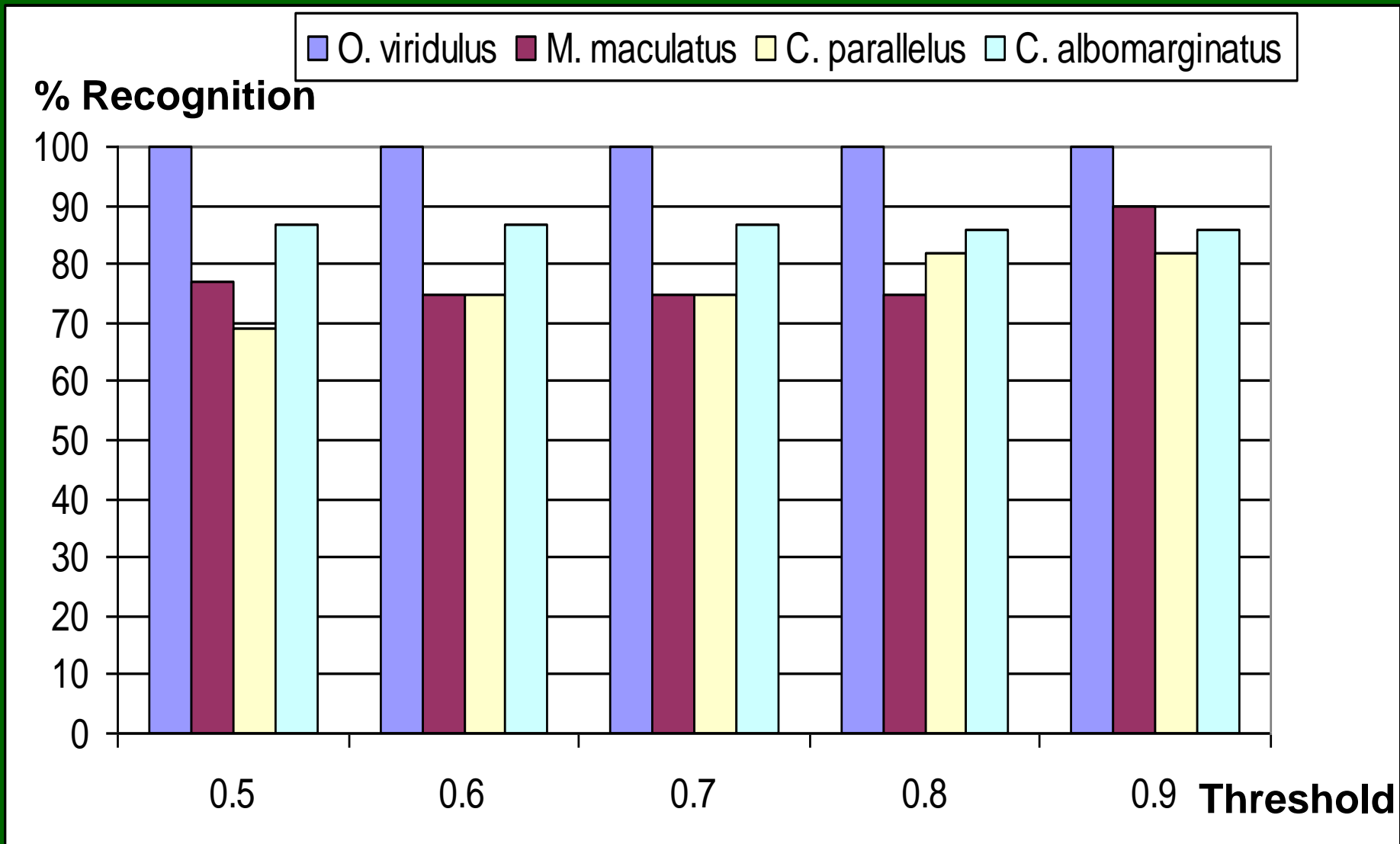
CAR ON TARMAC



BLOW FLY



Recognition Accuracy for Whole Song



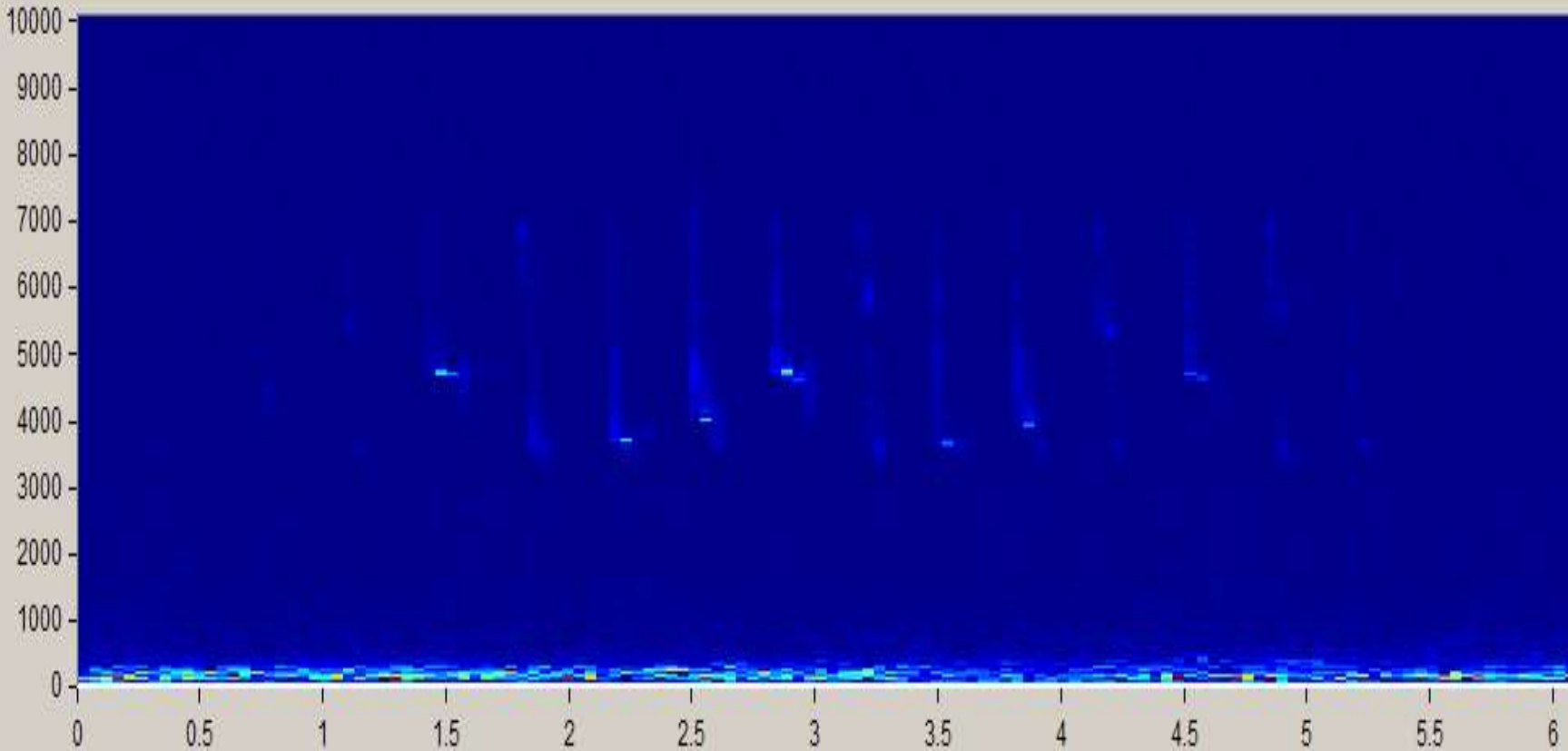
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Recognition of Chiff-chaff

W4: sonogram(w2,4096)

Frequency
(Hz)



Block (s)	1	2	3	4	5	6	
Chiff-chaff		1	1	1			
Aircraft	0.45				1	0.16	
Background	0.43					0.18	

Issues for Generalised Soundscape Analysis

- Scalability
 - Increasing number of sounds to be recognised
 - Scaling up from 13 to 300+ may be difficult to achieve
 - Each sound needs “unique” features
 - One approach (used in ISRIE) is to group sounds in categories, possibly 6-10



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ISRIE

- Instrument for soundscape recognition, identification and evaluation
- EPSRC funded 3 year project involving:
 - Universities of York, Newcastle (was Huddersfield), Southampton
 - WS Atkins and Cambridge University as consultants



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ISRIE (cont)

- York
 - Sound source separation, real-time system
 - Signal processing and identification
- Newcastle
 - Sensor network, sensor fusion
- Southampton
 - Sound archives, testing, legislation

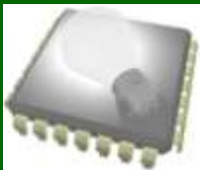


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ISRIE (cont)

- ISRIE aims to label sounds in categories in real-time and can be stand-alone or networked
 - E.g. not just “level reached 70dB at 22.35” but includes “sound was aircraft in direction X”
- Aim is to provide an objective analysis



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