Automated acoustic observatories

Scaling for the future

Ed Baker

University of York

What's the big goal?

Historically there are many.

- How many species are there?
- What are the distributions of these species?
- What do these species do?

- Can we accurately understand (model) an ecosystem?
- Can we do this for the entire biosphere?

Can we do everything?

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No.

How many species are there?

From an old sound recording to a new species in the genus *Horatosphaga* (Orthoptera: Tettigonioidea: Phaneropterinae: Acrometopini)

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What are the distributions of species?

Remarkably and immediately preceding this discovery, a large colony of **Tree Cricket** *Oecanthus pellucens* was also discovered at Dungeness in 2015. With at least 50 singing males and a similar number of females as well as nymphs this population may have a good chance of persisting (Walker, *loc. cit.*). This species had previously been recorded as singletons in Cambridge in 1996 and at Sittingbourne in Kent in 2005 (Beckmann & Sutton, 2015), and in 2010 the first breeding colony was reported from Jersey (David, 2013). In 2016, the Dungeness colony was again observed in August by David Walker, who estimated that over 100 singing males were present at the site (Sutton, 2016; Beckmann & Sutton, 2016).

Sutton, Beckmann & Nelson (2017)

What do these species do?

Abstract

1. Sexual signals may be acquired or lost over evolutionary time, and are tempered in their exaggeration by natural selection.
2. In the Pacific field cricket, *Teleogryllus oceanicus*, a mutation ("flatwing") causing loss of the sexual signal, the song, spread in <20 generations in two of three Hawaiian islands where the crickets have been introduced. Flatwing (as well as some normal-wing) males behave as satellites, moving towards and settling near calling males to intercept phonotactic females.

Zuk, Bailey, Gray & Rotenberry (2018)

The case for automation

- A desire to do more with the current resources
- Our collective abilities are insufficient to fulfil the major goals for every species

The case for sound

- At it's most basic it is a 2-dimensional problem (amplitude varying with time)

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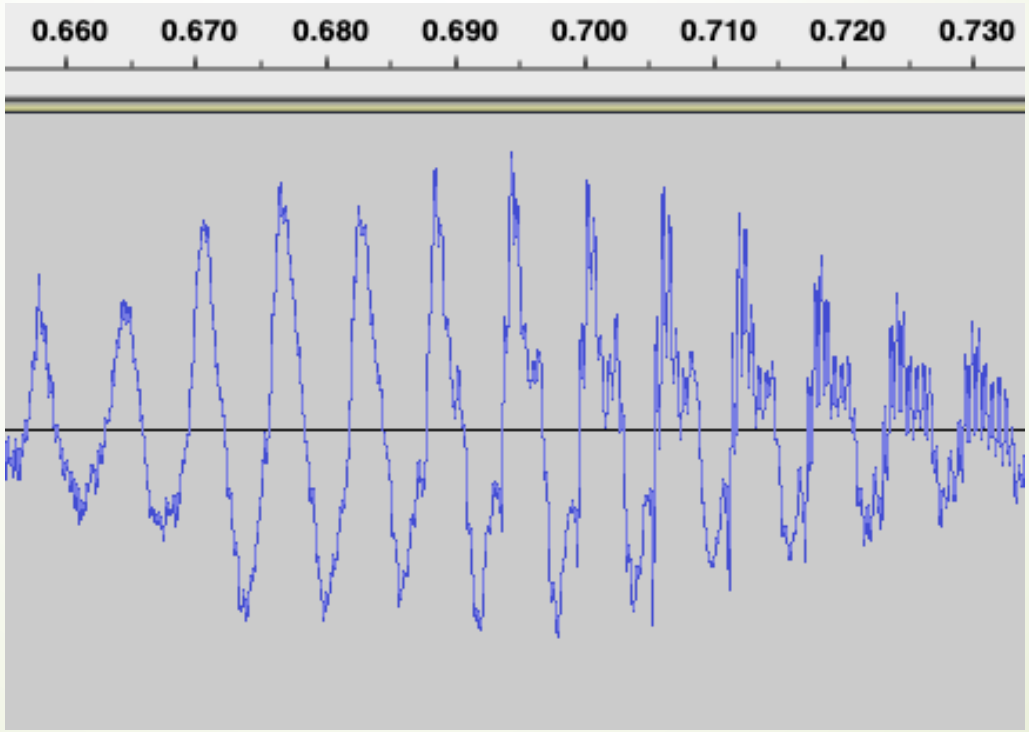

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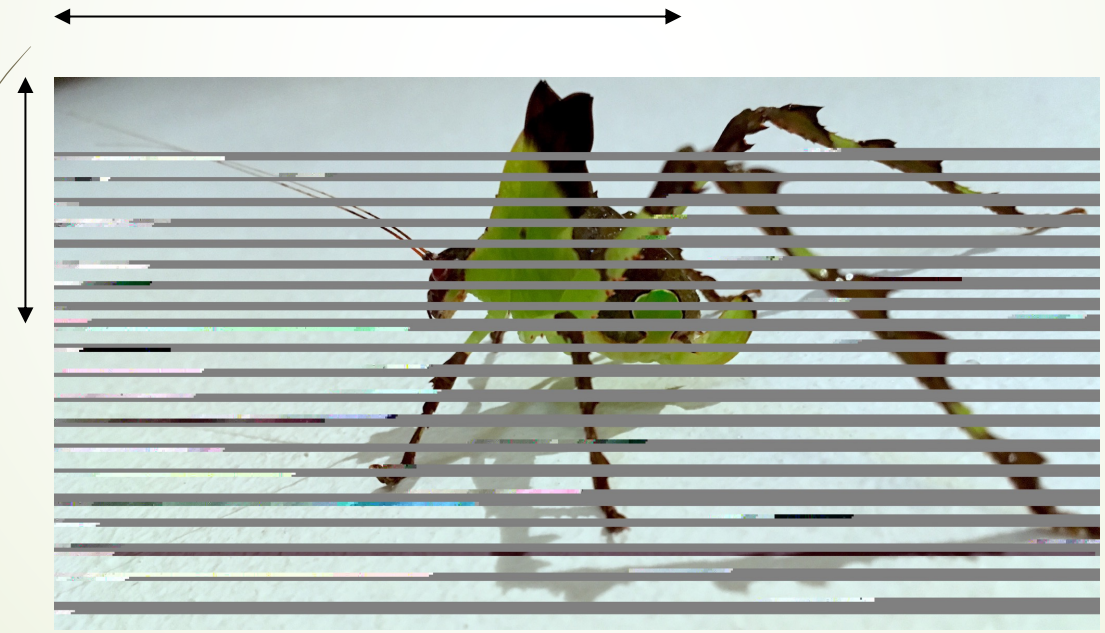

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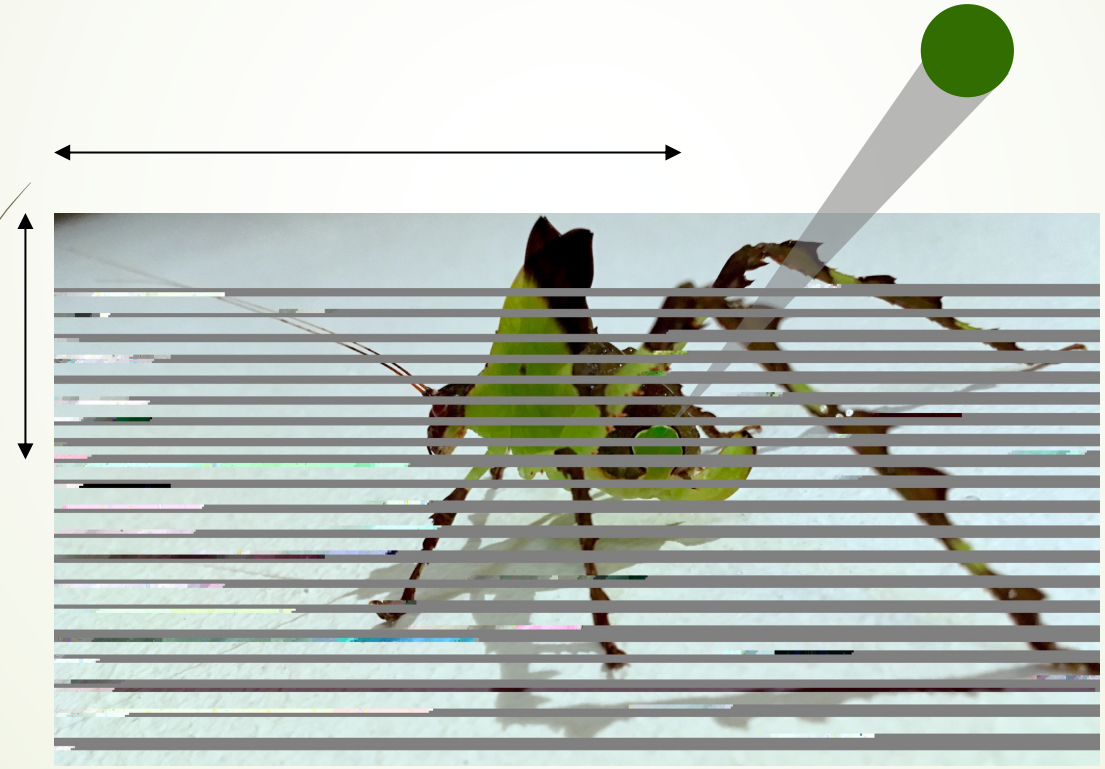

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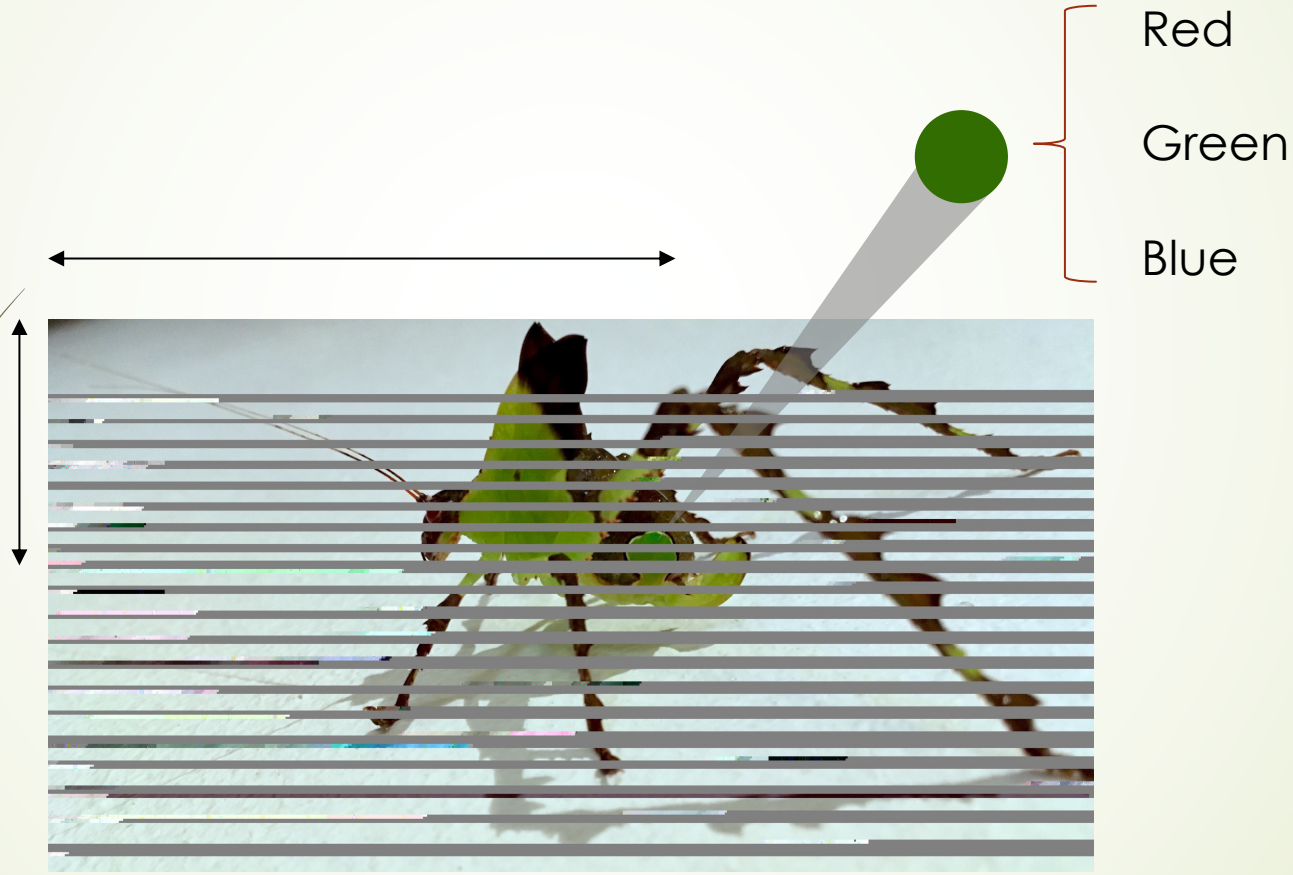

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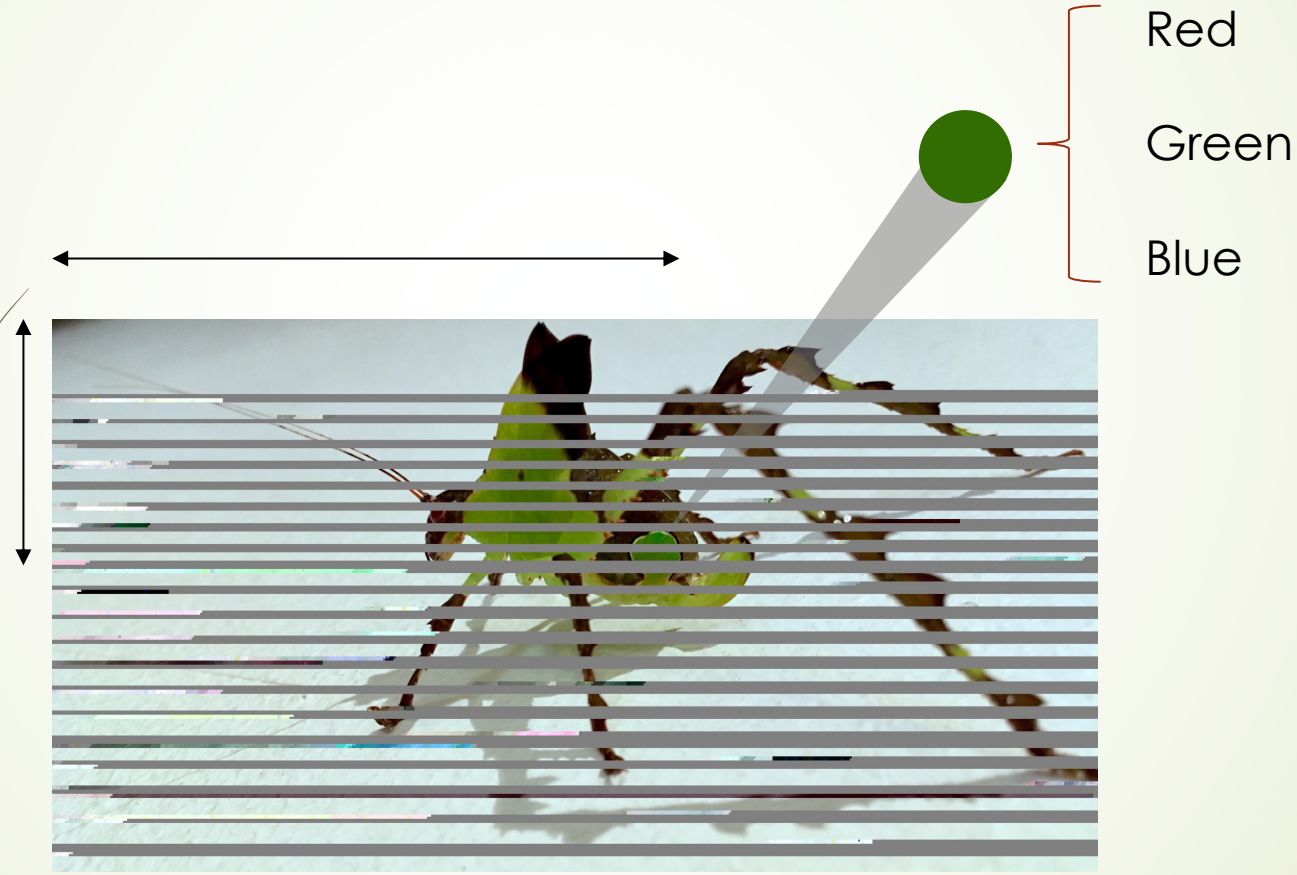

5-dimensional

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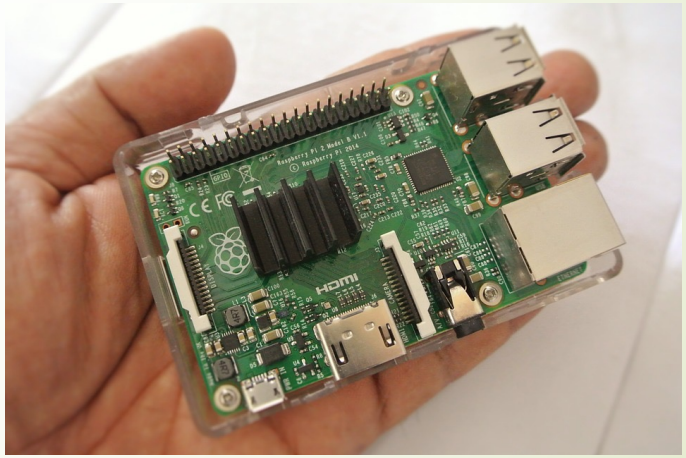

2010s

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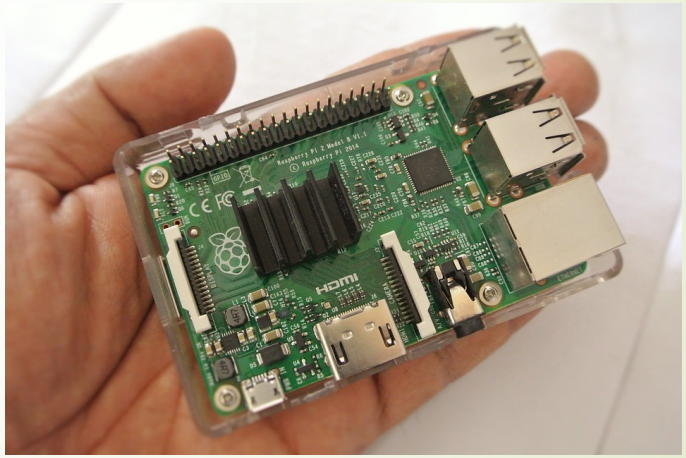
£2,000



£25

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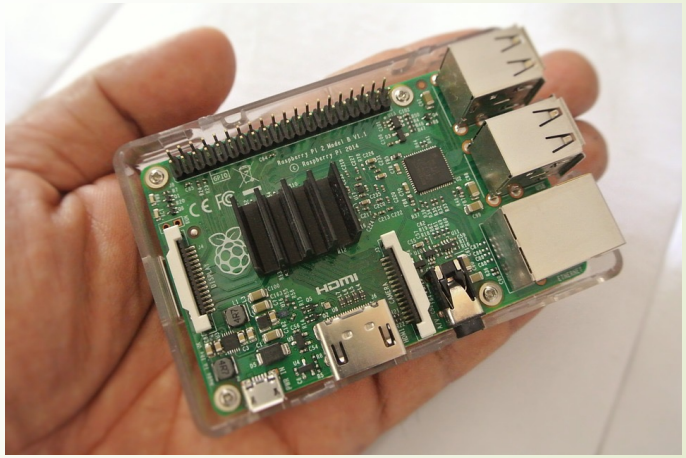

8x cheaper

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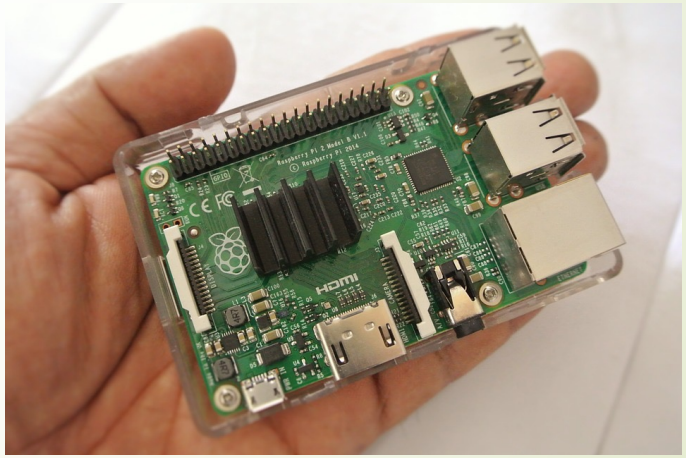

720x more calculations per second

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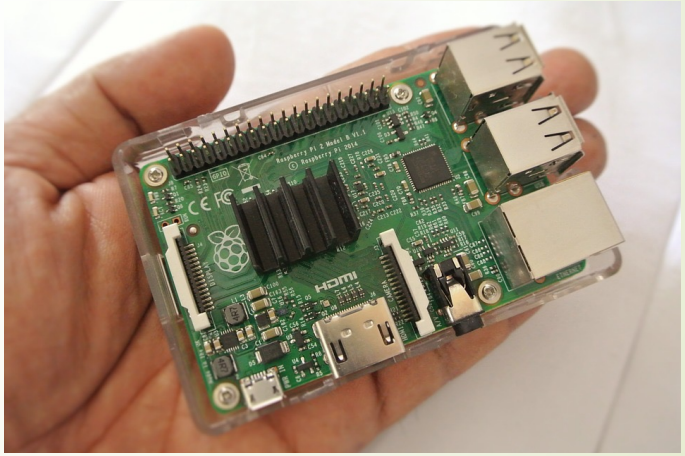

> 1,500x more RAM

Correcting for inflation..

Increase in computational power per £: 57,600x

Using about 1/4000 of the energy

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Disposable super computer than can be battery/solar powered.

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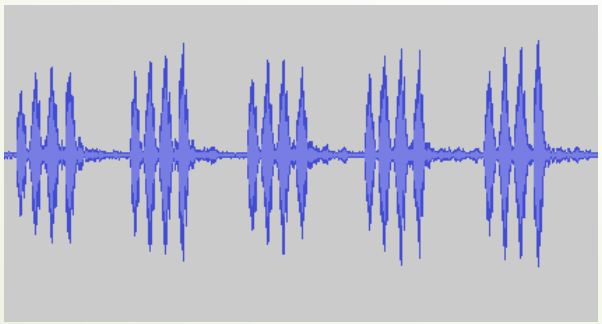
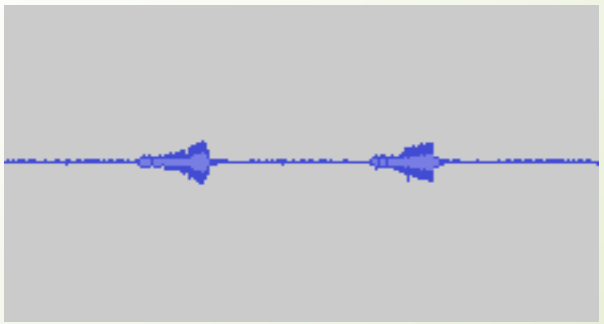
- Structure of calls





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- Song is stereotypical/neurologically controlled INATE not LEARNED
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- Calling song attracts mates

What should we automate?

Start with what people can't do

- Can work in human-audible and ultrasound simultaneously

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- Can work in human-audible and ultrasound simultaneously
- Can do 24/7 for a week without sleeping

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  We can test this and get reliable numbers

What do people do?

- Unaccountable
  How did the computer reach that conclusion?
  If we choose how it makes a decision, we can make it explain how I got there
  Cite the published key / collection used to make ID
- Error rate
  How do we know the computer is right? (False positive / false negative)

  We can test this and get reliable numbers
  Relies on every study depositing voucher specimens

There are an awful lot of publications that don't link their results to voucher specimens, keys, sound recordings, or anything else

Automated systems can do this on their own

Major concerns

- Unaccountable
  How did the computer reach that conclusion?
  If we choose how it makes a decision, we can make it explain how I got there
  Cite the published key / collection used to make ID
  Cite the algorithm and it's version used to make the ID
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  How do we know the computer is right? (False positive / false negative)

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  Relies on every study depositing voucher specimens
  Automatically submit sample sound files to a repository

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  - Only aware of a handful of species

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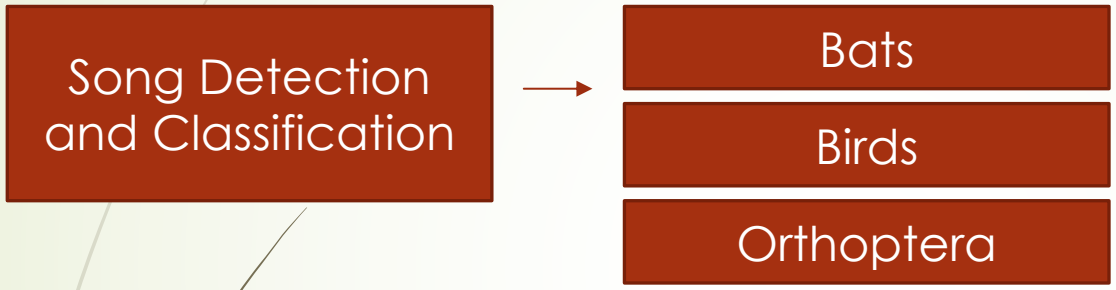
How do we deal with songs of unknown species?

Automated Acoustic Observatories

Song Detection and Classification

Automated Acoustic Observatories



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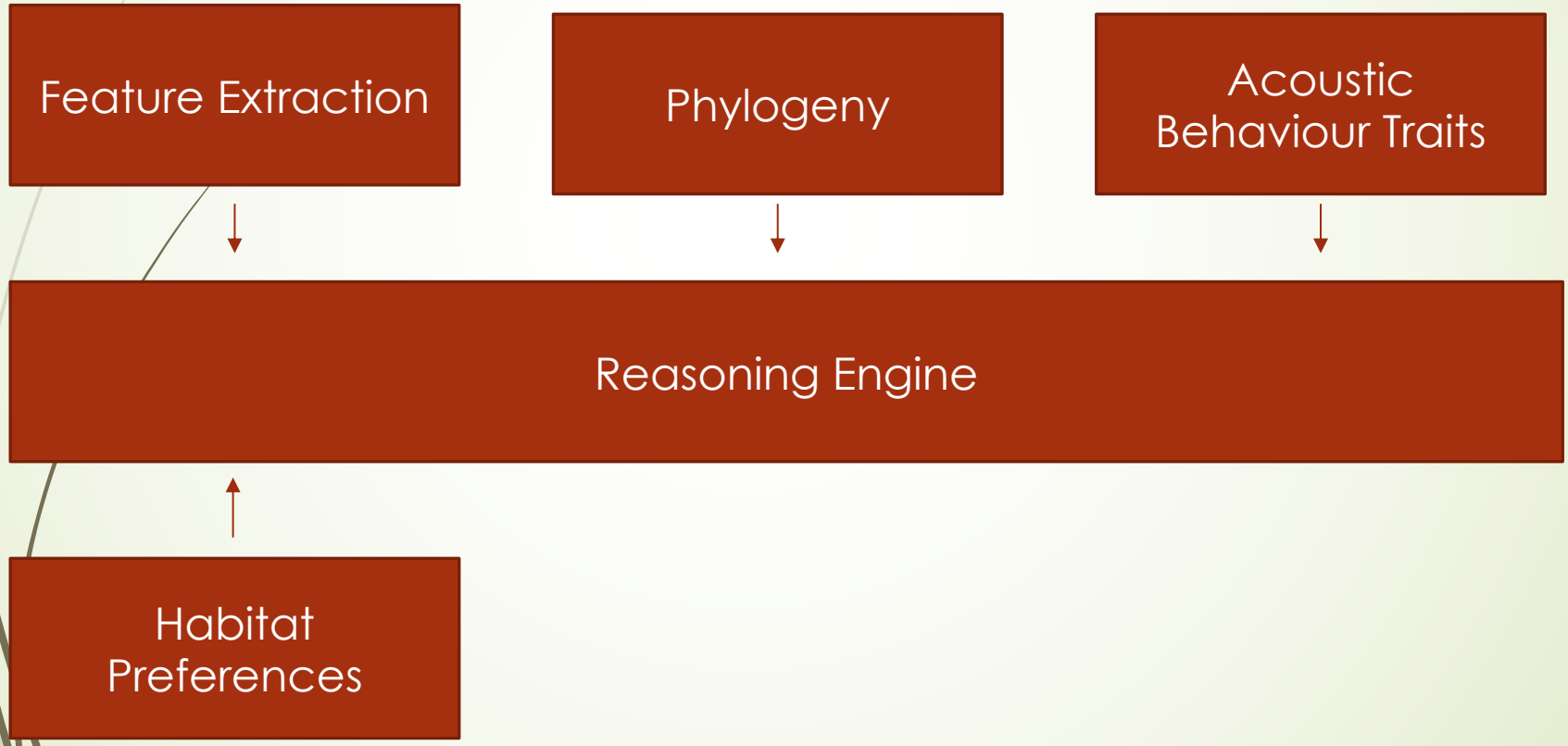

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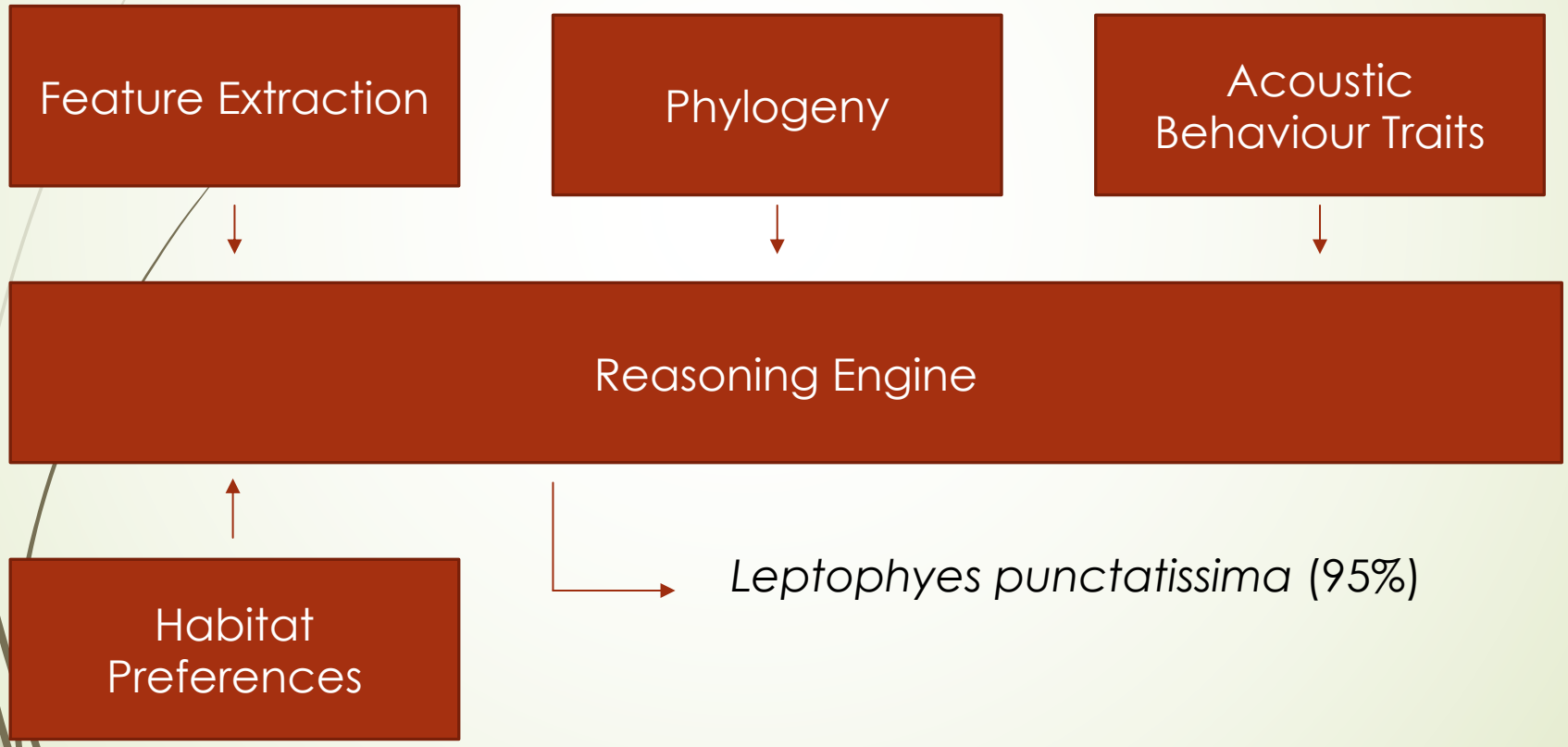

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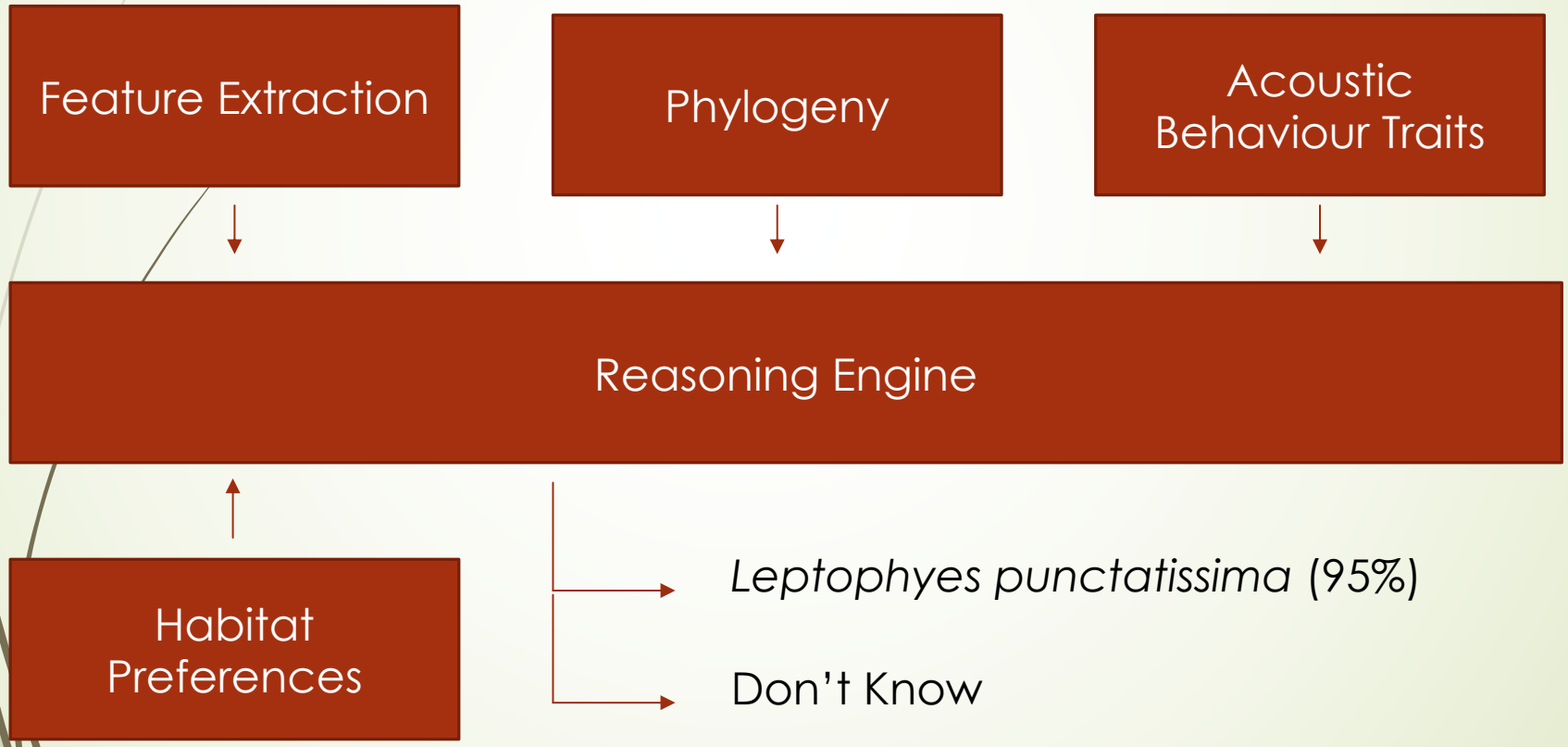

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