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Cartagena, Colombia | May 18-20 | In partnership with COLCIENCIAS

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ANURA: Sensor Networks for Classifying and Monitoring Frogs Based on Their Vocalizations

Eduardo Freire Nakamura
Assistant Professor, FUCAPI and UFAM, Brazil

Main Research Challenges

- Grand aligned challenges
  - Ubiquitous Computing[1]
  - Biological Diversity and Ecosystem Functioning[2]
- We need to understand the Earth's physical systems
  - Climates, geology, hydrology, ...
- The rainforest is a key environment
  - Let's start with the Amazon forest

[1] Computing Research Association. **Grand Challenges in Computer Research**, 2002.
[2] National Academy of Sciences, **Grand Challenges in Environmental Sciences**, 2001.

Key Problems

- An environment of extremes
  - Relative humidity: 70-90%
  - Temperature: 64-122 ^{o}F
  - Huge area, limited accessibility
- Additional challenges to WSNs
- Ecological issues
- Where should we start?

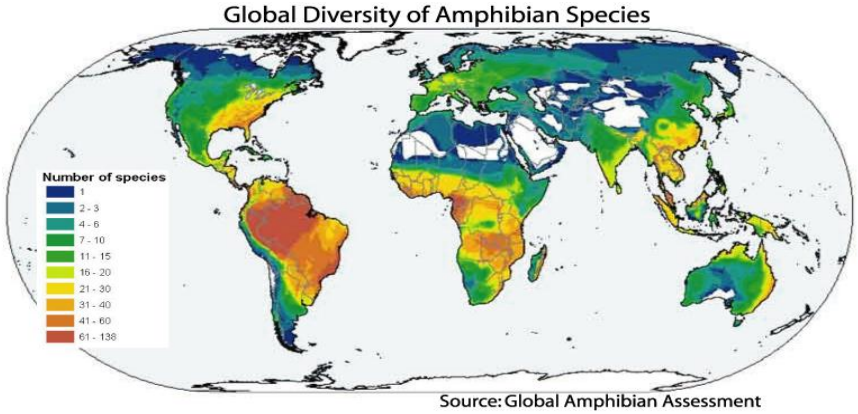
The Anura Project

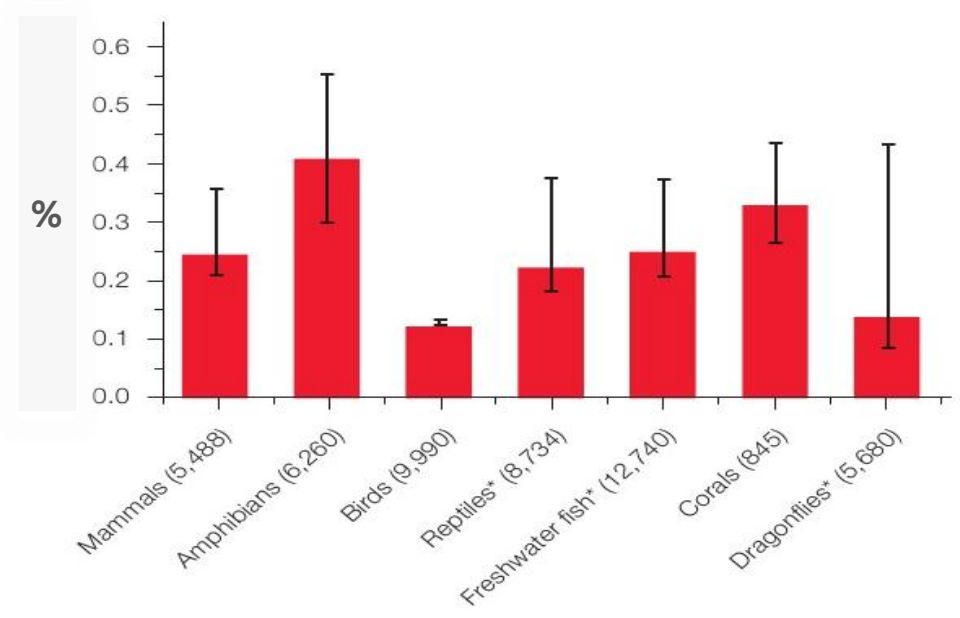
- *ANURA: Sensor Networks for Classifying and Monitoring Frogs Based on Their Vocalizations as an Early Indicator for Ecological Stress in Rain Forests*

- Financial Support
  - LACCIR - Microsoft
  - PRONEX - FAPEAM/CNPq (Brazil)

Motivation

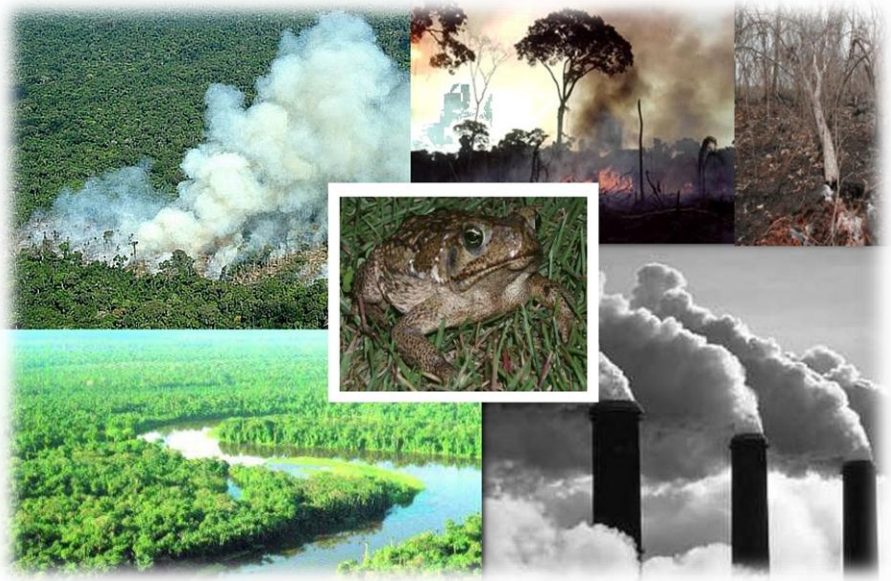
- Amphibians are very sensitive to changes (Carey et al., 2001)
  - Climate changes, deforestation, water contamination...



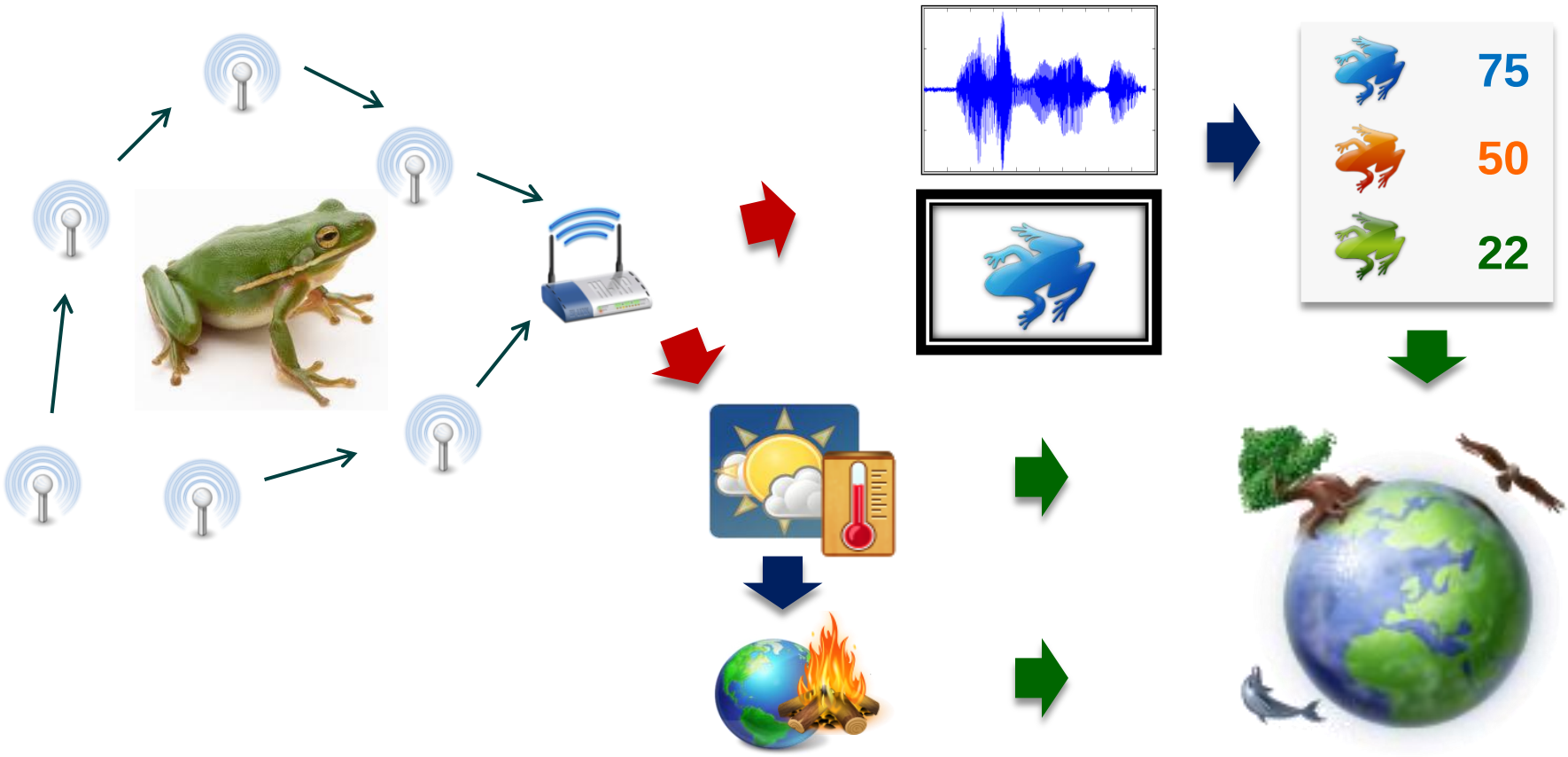


Motivation

- Anura (Frogs and Toads)
  - Closely related to the ecosystem (Alexander & Eischeid, 2001)
  - Fairly easy to be monitored



Our Approach



First Steps

Initial Dataset

Species	Individuals
Hylaedactylus	8
Rhinella granulosa	3
Adenomera andreae	8
Ameerega trivittata	5
Hyla minuta	11
Hypsiboas cinerascens	2
Leptodactylus fuscus	4
Osteocephalus oophagus	4
Scinax ruber	4
Total	49

An Example: *Adenomera Andreae*

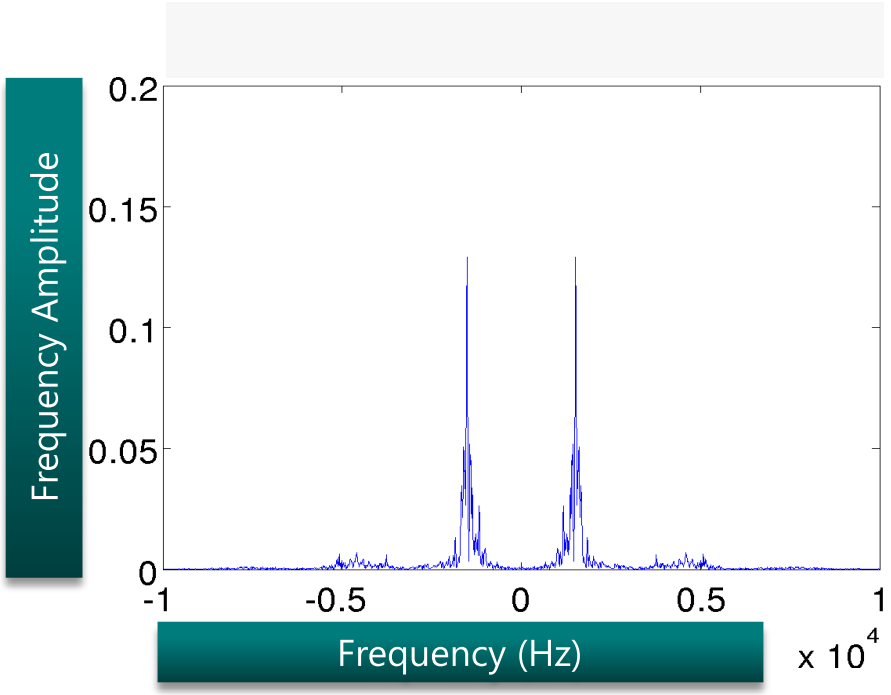
Other Species

Rinella granulosa

Ameerega trivittata

Feature Extraction

- Features being used
  - (R) Zero Crossing Rate
  - (S) Spectral Centroid
  - (B) Bandwidth
  - MFCCs (Mel-Fourier Cepstral Coefficients)



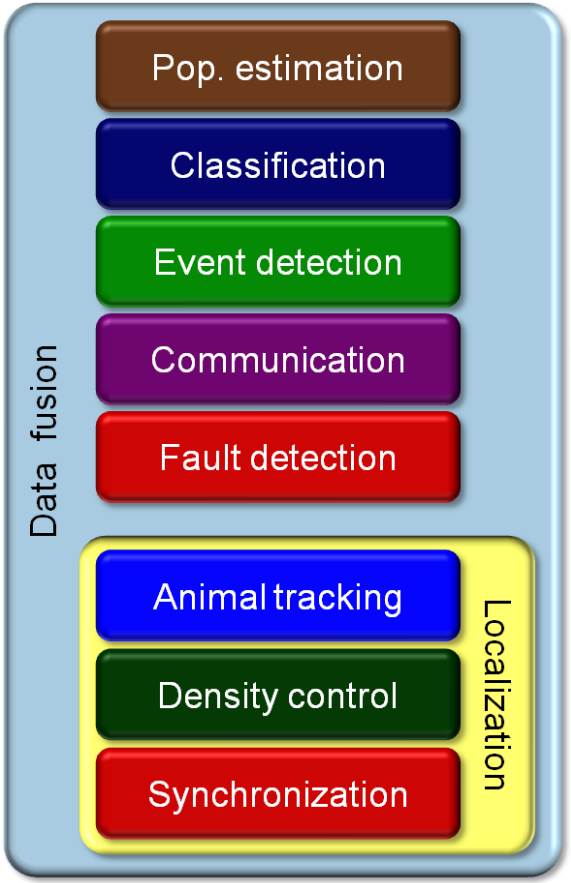
First Results (Sucess Rate)

Features Used for Classification	5-NN			10-NN		
	α = 0.4	α = 0.5	α = 0.6	α = 0.4	α = 0.5	α = 0.6
MFCC (human method)	97.07%	97.12%	97.17%	96.45%	97.02%	96.77%
RSB (anura method)	87.98%	89.83%	91.39%	87.93%	90.21%	91.06%
R & MFCC (human, anura methods)	97.27%	97.40%	97.30%	96.79%	97.27%	96.86%
S & MFCC (human, anura methods)	98.10%	98.14%	98.22%	97.59%	97.77%	97.86%
B & MFCC (human, anura methods)	97.75%	97.91%	97.80%	96.99%	97.35%	97.19%
RSB & MFCC (human, anura methods)	98.41%	98.53%	98.43%	97.89%	97.95%	97.89%

A Key Problem: Communication Efficiency

Contributions to CS

- Make it work in the forest
- Counting is too difficult
  - Measure the vocal activity
- Current contribution
  - Event detection and tracking
  - Communication protocols
  - Fault detection
  - Localization



Final Comments: Our Contribution

Our Research

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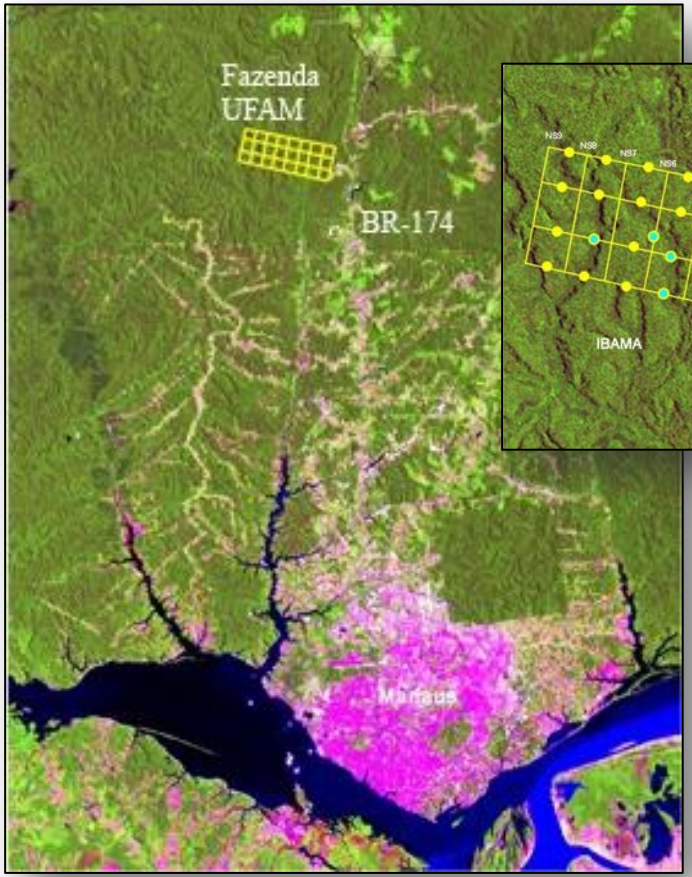
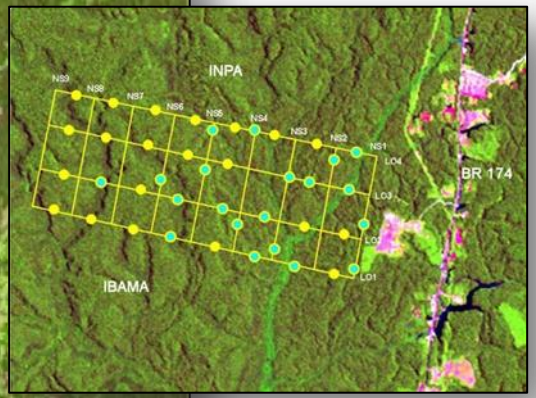
  - M.Sc. Student Antonio Ramos (FUCAPI)
  - M.Sc. Student Afonso Ribas (FUCAPI)
  - ...

Thank You

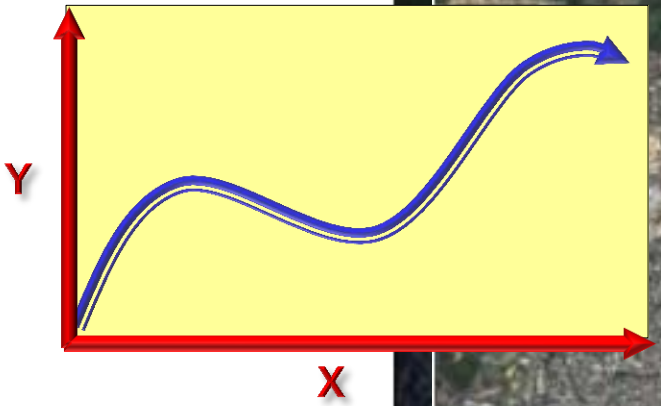
Questions?

Site For “Long-term” Monitoring





Monitoring the Bare-Faced Tamarin



Monitoring Forest Fire

- Amazon
  - Fire of 30cm
  - Fire in line
  - Up to 40% of species are affected
- Satellite
  - Delay
  - Granularity
- Sensor Networks
  - Realtime
  - Cheaper Technology
  - Hard deployement