Learning and Planning Under Uncertainty for Wildlife Conservation

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Srepok Wildlife Sanctuary
Cambodia

43,269 patrol observations recorded 2013 – 2018

Illegal campsite
Elephant tracks
Snare

Photos by Lily Xu
PAWS Overview
Protection Assistant for Wildlife Security

Features
- roads
- rivers
- land cover

Predicted risk maps
- overall risk
- dry season
- rainy season

historical effort
illegal activity
Photos by James Lourens and Lily Xu

Snares per sq. km patrolled

- High
- Medium
- Low

# Observations / # Cells

- 0
- 0.1
- 0.2
- 0.3
- 0.4

over 1000 snares!
"I am super excited with the results. Let's get this going on other countries too this year."

—Rohit Singh, WWF Zero Poaching Lead
Srepok, Cambodia
43,269 patrol observations
2013 – 2018

Royal Belum, Malaysia
824 patrol observations
June – August 2018

Deployment to 1000+ protected areas
The Dual Mandate

Data-rich parks: build predictive models to plan patrols

Data-scarce parks: conduct patrols to detect illegal activity and improve the predictive model

[Xu et al., AAAI-21]
Species prioritization

\[ \mu_1 = 0.6 \]
\[ \mu_2 = 0.7 \]
\[ \mu_3 = 0.3 \]
\[ \mu_4 = 0.5 \]
\[ \mu_5 = 0.2 \]

Unknown poaching prob \( \mu_i \)

- Vulnerable
- Less vulnerable

[Xu et al., IJCAI-22]
How do adversaries respond to our patrols?
Deterrence is key

past patrol effort

illegal activity

deterrence

displacement

[Xu et al., UAI-21]
Robust planning

Past patrol effort

Illegal activity

0.17 → 0.12

0.23 → deterrence!

Sequential decision-making

Uncertainty?

Robust patrol planning

[Xu et al., UAI-21]
PAWS Overview

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Collaboration with conservation NGOs

Field tests in Cambodia and Uganda

[Xu et al., ICDE-20]

Global deployment
New AI Methodology

- Multi-armed bandits to explore/exploit
  [Xu et al., AAAI-21]

- Ranked prioritization with online allocation
  [Xu et al., IJCAI-22]

- Robust sequential decision-making
  [Xu et al., UAI-21]
AI for Conservation

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Computational challenges

Deploying AI in the real world

AI has much to learn from conservation and other real-world challenges!
Lessons Learned

**Project design + scoping**
- Begin with simple computational approaches
- Incremental deployment before ambitious project design

**Deployment**
- Real-world deployment is necessary for effective technology transfer
- Large-scale deployment requires quality engineering
- Evaluate with self-contained experiments

**Marrying research + practice**
- Integrate domain expertise into algorithm design
- Consider real-world constraints as research challenges, not limitations
- Limited data inspire research directions to close the gap