Deploying PAWS

Field Optimization of the Protection Assistant for Wildlife Security

Fang et al.

Presentation:
Rock Stevens, 9/20/2016

1.

Motivation

Protection Assistant for Wildlife Security (PAWS)

What is **PAWS**?

- Poaching threatens species & ecosystems
- Deploy more effective defense

- “Green security games”
- Repeated Stackelberg
- Patrols (D) vs. Poachers (A) WRT animal densities

PAWS Deployment

Defender strategy

$$\mathbf{c} = \langle c_i \rangle$$

C_i -> probability that defender resource is deployed at target *i*

Attacker Utility

Attacker penalty for i defense

Attacker reward for i undefended

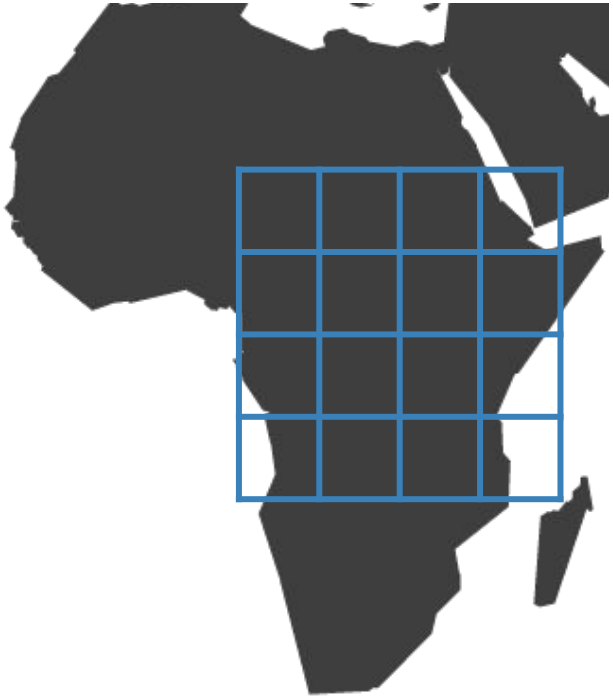
$$U_i^a = c_i U_{p,i}^a + (1 - c_i) U_{r,i}^a$$

$$U_i^d = c_i U_{r,i}^d + (1 - c_i) U_{p,i}^d$$

Defender Utility

Defender reward for i defense

Attacker penalty for i undefended



- Zero-sum game
- Attacker reward is determined by animal density

2.

PAWS-Initial

What was wrong with the original PAWS?

PAWS-Initial issues

- Ignores topology
- Assumes known / fixed animal density
- Cannot scale
- Scheduling constraints

We can make it better!

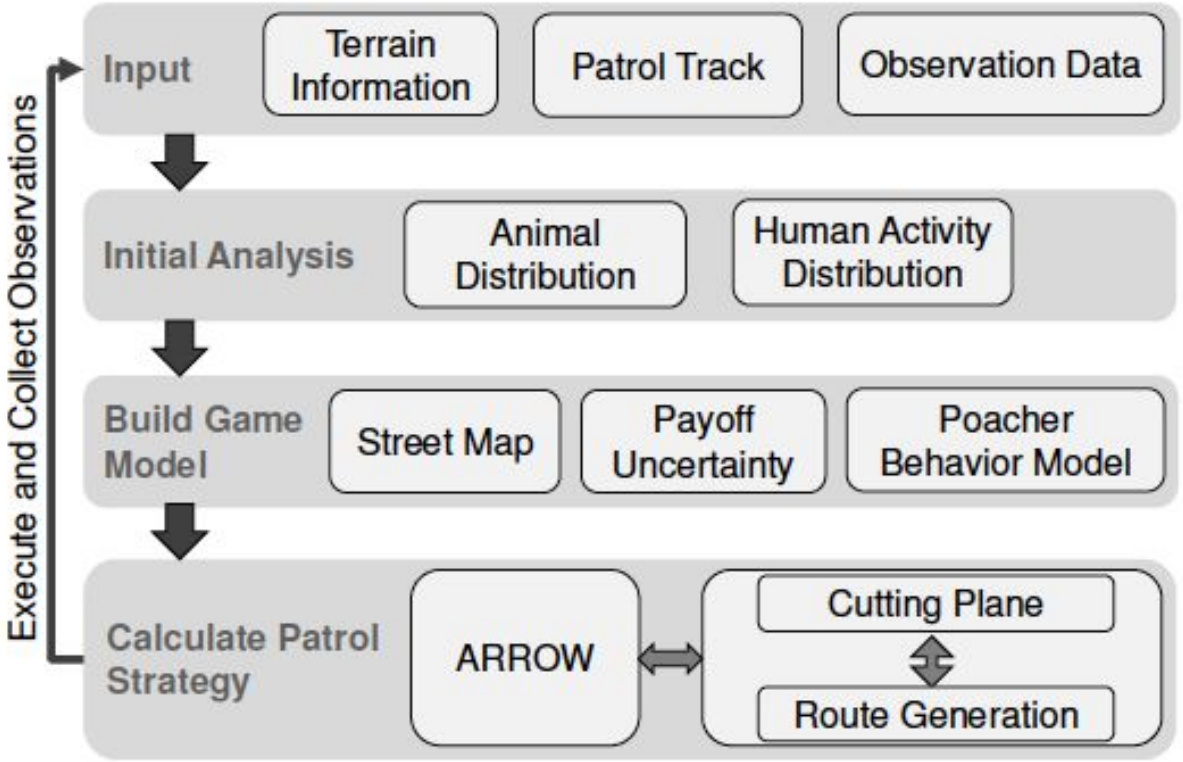
3.

PAWS

PAWS 2.0

PAWS improvements

- “Street maps” include topology
  - It drives decisions!!!
- Handle uncertainty with concept of minimax regret
- Increase scalability with cutting plane framework
- Build in temporal and terrain constraints



- Iterative, self-adjusting feedback

Building the **Street Map**

- 1km x 1km targets, 50m x 50m raster pieces
- 50m contour lines
- Determine the accessibility type for each raster piece
- Define Key Access Points (KAPs)
  - Each grid cell can be reached
  - Borders + Logical Points
- Find route segments to link the KAPs
  - Connect locally with weighted distance metrics WRT elevation

Calculating **Defender Strategies**

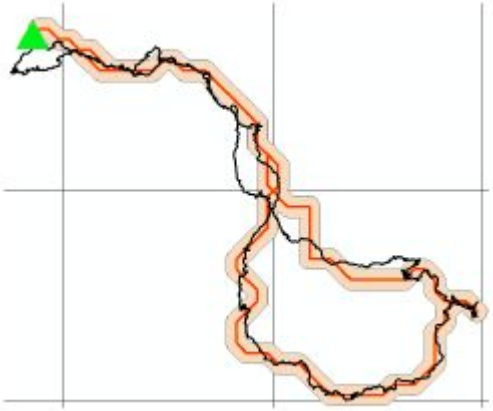
- Include routes over entire conservation area
- Start & Stop at basecamps
- Account for payoff uncertainty
- Bounded rationality of poachers

ARROW + BLADE address these issues

- ARROWS minimizes regret or utility loss for the patrollers but doesn't consider routes
- BLADE iteratively optimizes routes to cover targets of high value

PAWS IRL

- 4-5 day patrols w/ 3-7 patrollers
- Recommended patrol close to actual guided path
- Reliable for real-world implementations



4.

Synthesis and Opinion

Can **we** make it better?

Can we make **PAWS** better???

- Logistical constraints
  - Food, water, GPS signal
- **Attention** is a finite resource
- Improved definition of defended