Welcome
2017 Faculty Summit
Attendees

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Microsoft Research
Faculty Summit **2017**

AI for Earth:
AI for Protecting Wildlife, Forests, Fish

MILIND TAMBE

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Co-Founder, Avata Intelligence

USC Center for Artificial Intelligence in Society (CAIS.USC.EDU)

Mission Statement: Advancing AI research driven by…

American Academy of Social Work & Social Welfare

Grand Challenges of Social Work

- Ensure healthy development for all youth
- Close the health gap
- Stop family violence
- Advance long and productive lives
- End homelessness
- Achieve equal opportunity and justice

…

SUSTAINABLE DEVELOPMENT GOALS

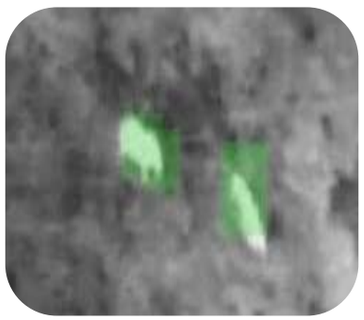
17 GOALS TO TRANSFORM OUR WORLD

Overview of CAIS Project Areas

AI for Earth






- Machine learning/planning: Predicting poaching spots, patrols
- Real-world: Uganda, South Asia…

Overview of CAIS Project Areas

AI for Public Safety and Security






- Game theory: security resource optimization
- Real-world: US Coast Guard, US Federal Air Marshals Service…

Overview of CAIS Project Areas

AI for Low Resource Communities






- Social networks: Spread HIV information, influence maximization
- Real-world pilot tests: Big improvements

Partnerships

- Wildlife Conservation

- Public Safety and Security

- Low Resource Communities

What Might We Lose?

Murchison Falls National Park, Uganda

Protecting Wildlife in Uganda

PAWS:
Protection Assistant for Wildlife Security

Fang

Massive forests (1000 sq miles) to protect, limited security resources:

- Generate “intelligently” randomized patrols
- Learn adversary models

Patrol boat in Bangladesh
at Global Tiger Conference, 2014

Patrol with Rangers, Indonesia
Trip with WWF, 2015

AI for Public Safety and Security

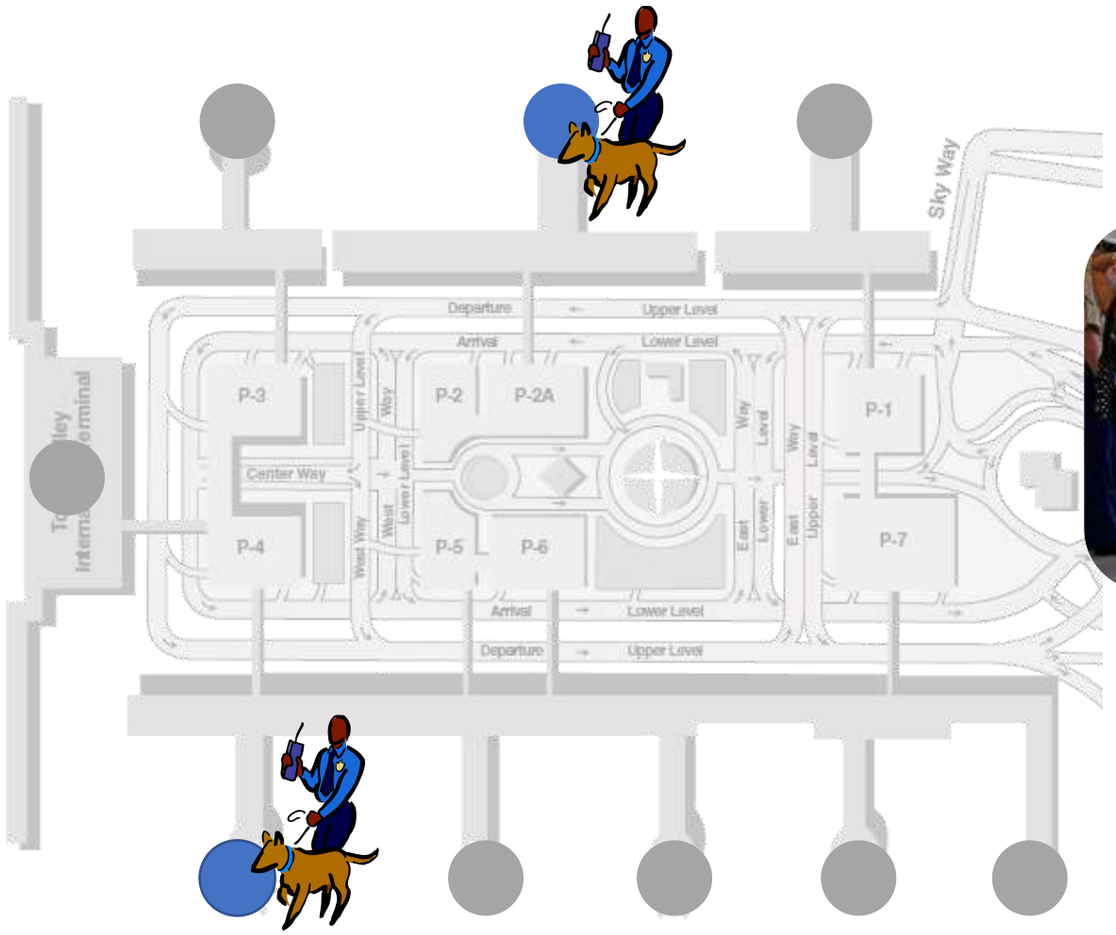
Jain

Pita

ARMOR: Assigning Limited Security Resources [2007]

Airports

2007



Canine patrol at LAX (ARMOR)

AI-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

Airports

2007

Player B

Player A

	Paper	Rock	Scissors
Paper	0, 0	1,-1	-1,1
Rock	-1, 1	0, 0	1, -1
Scissors	1, -1	-1, 1	0, 0

Model: Stackelberg Security Games

Kiekintveld

Set of targets, payoffs based on targets covered or not…

Stackelberg: Defender commits to *randomized* strategy, adversary responds

Challenges faced: Massive scale games; difficult for a human planner

Adversary

Defender

	Terminal #1	Terminal #2
Terminal #1	4, -3	-1, 1
Terminal #2	-5, 5	2, -1

AI-based DECISION AIDS TO ASSIST IN SECURITY

Security Game Deployments

Fang

Security Games

Airports

2007

Air Marshals

2009

Ports

2011

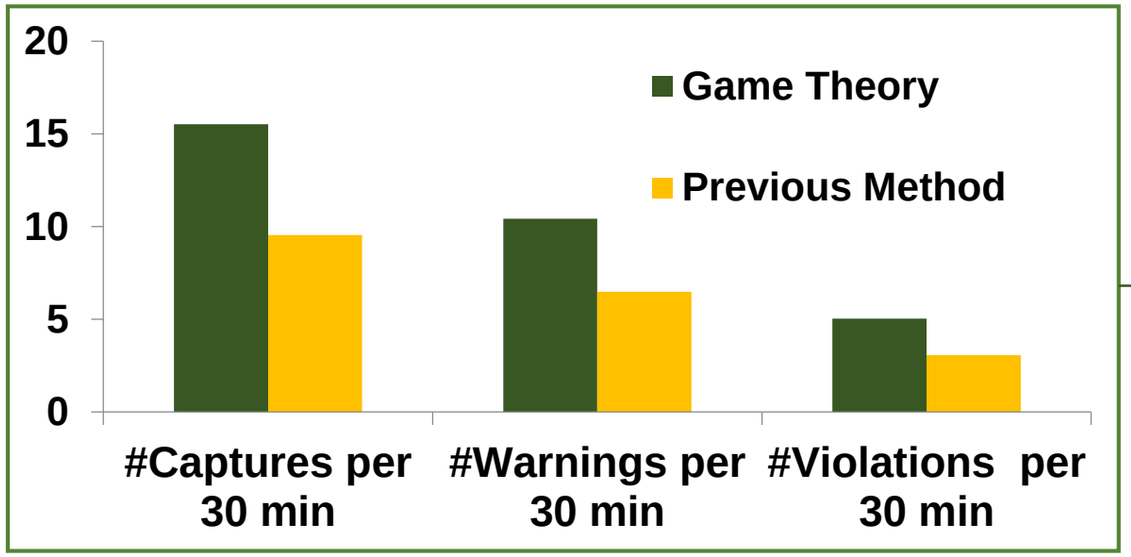
PROTECT: Ferry Protection Deployed

Global Applications of Security using Game Theory

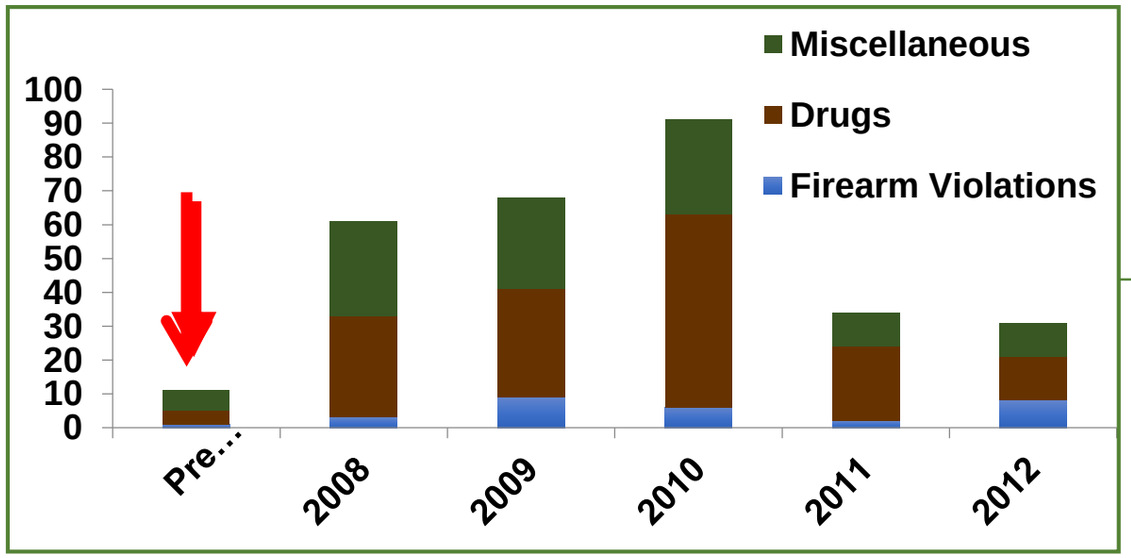
SOME RESULTS OF GAME THEORY for SECURITY

Ticketless Travelers Caught

- Game theory vs Previous Method



Arrests at LAX checkpoints



PAWS: Applying AI for protecting wildlife

Fang

Game Theory + Poacher Behavior Prediction

PAWS Patrols in the Field

Fang

Early Trials in Uganda and Malaysia

Important Lesson: Geography!

Uganda

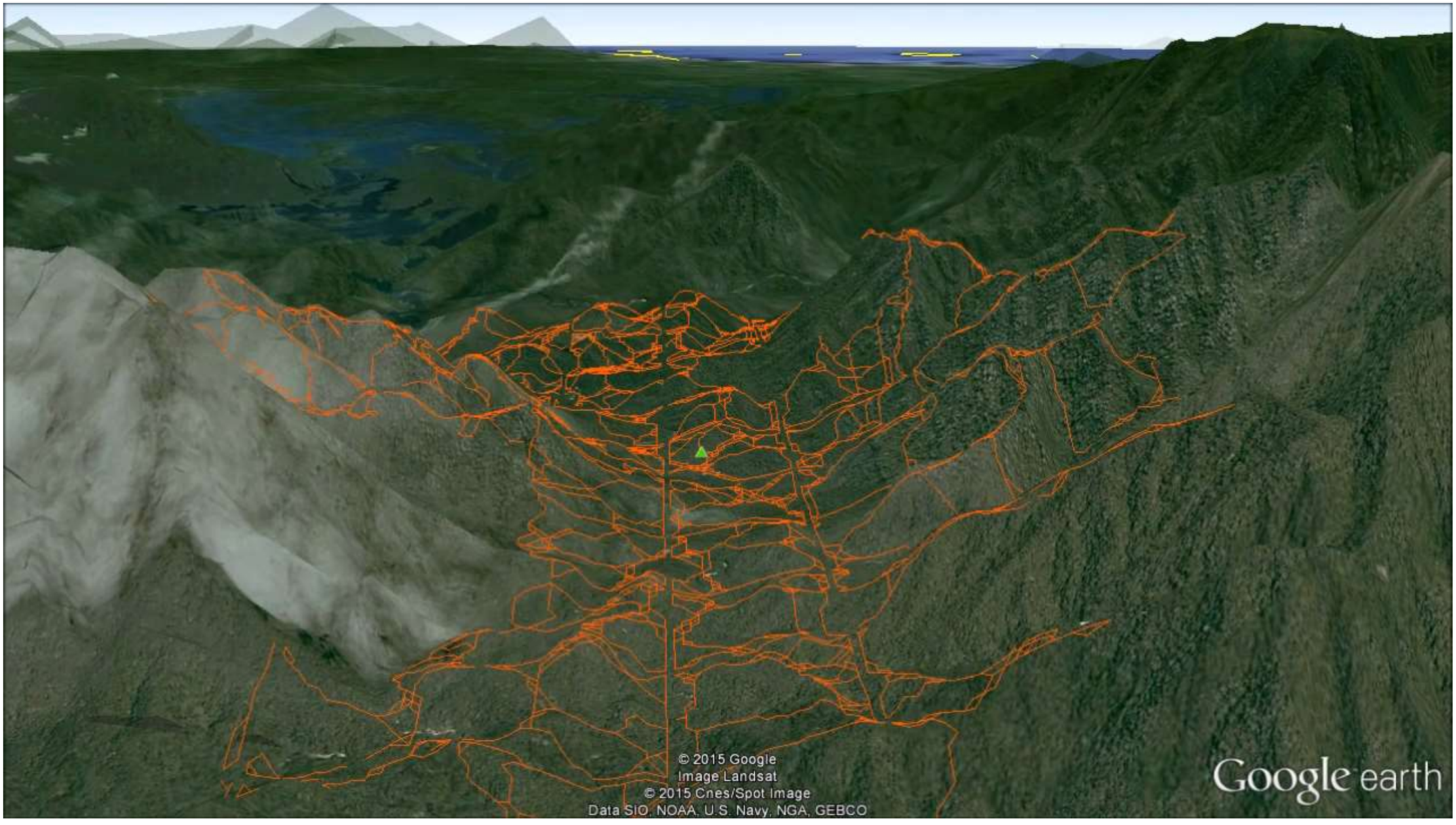
Andrew Lemieux

Malaysia

Panthera

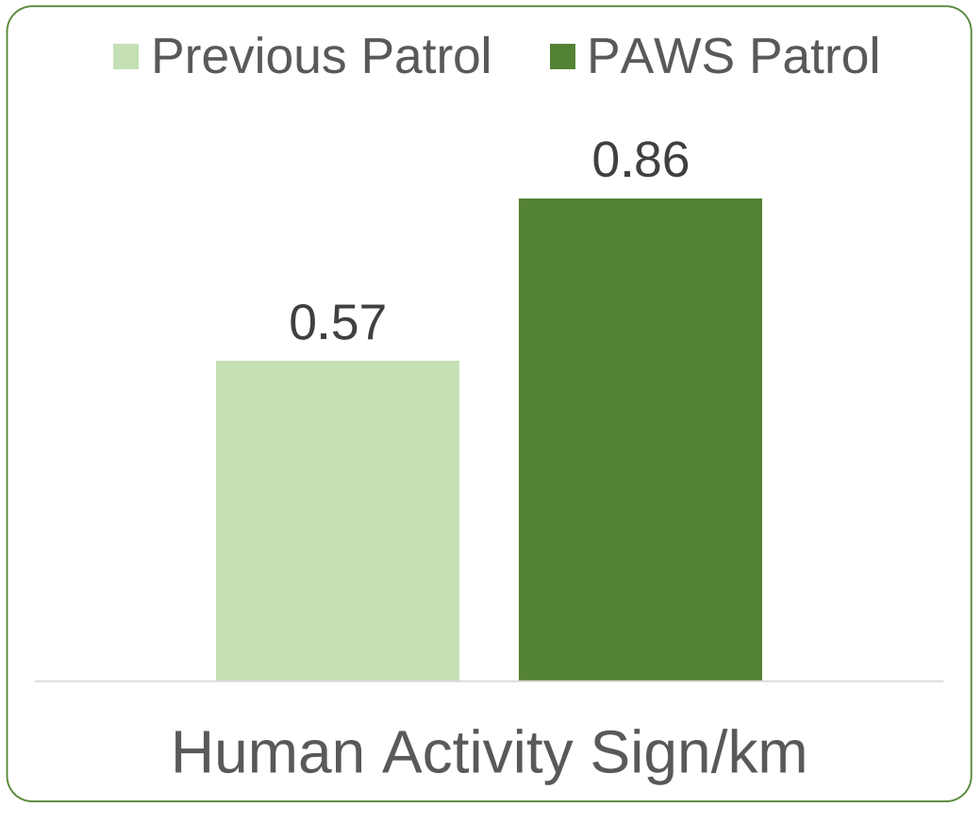
PAWS: Protection Assistant for Wildlife Security [2016]

Game Theory + Poacher Behavior Prediction + Forest Street Map



PAWS: Preliminary Evaluation

Fang



PAWS:
Protection Assistant for Wildlife Security

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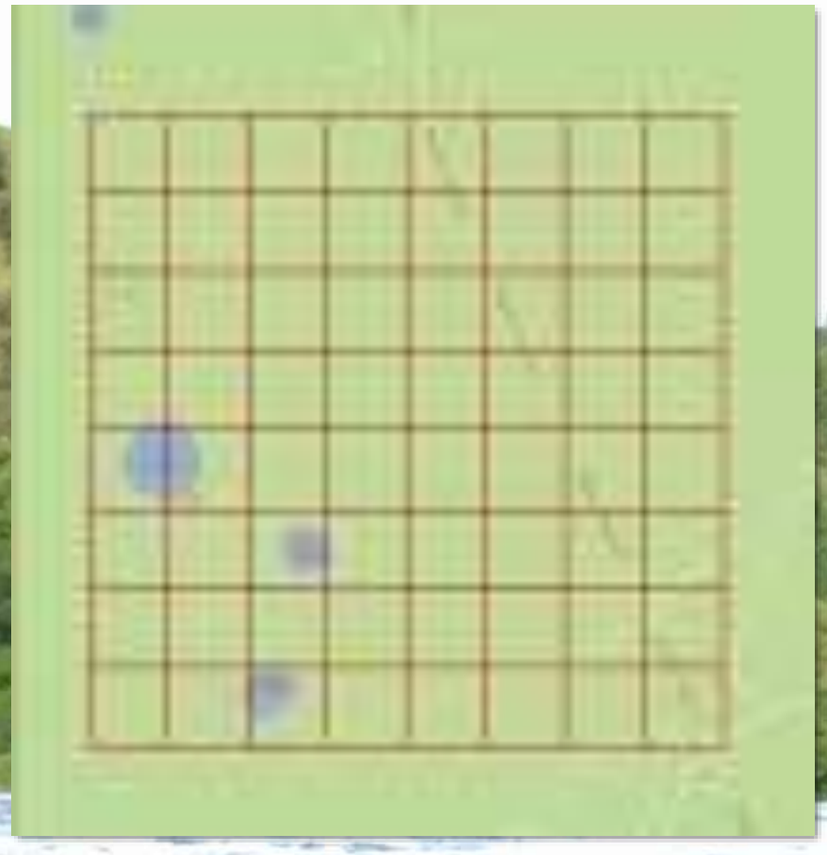
PAWS: Applying AI for protecting wildlife

Nguyen

Game Theory + Poacher Behavior Prediction



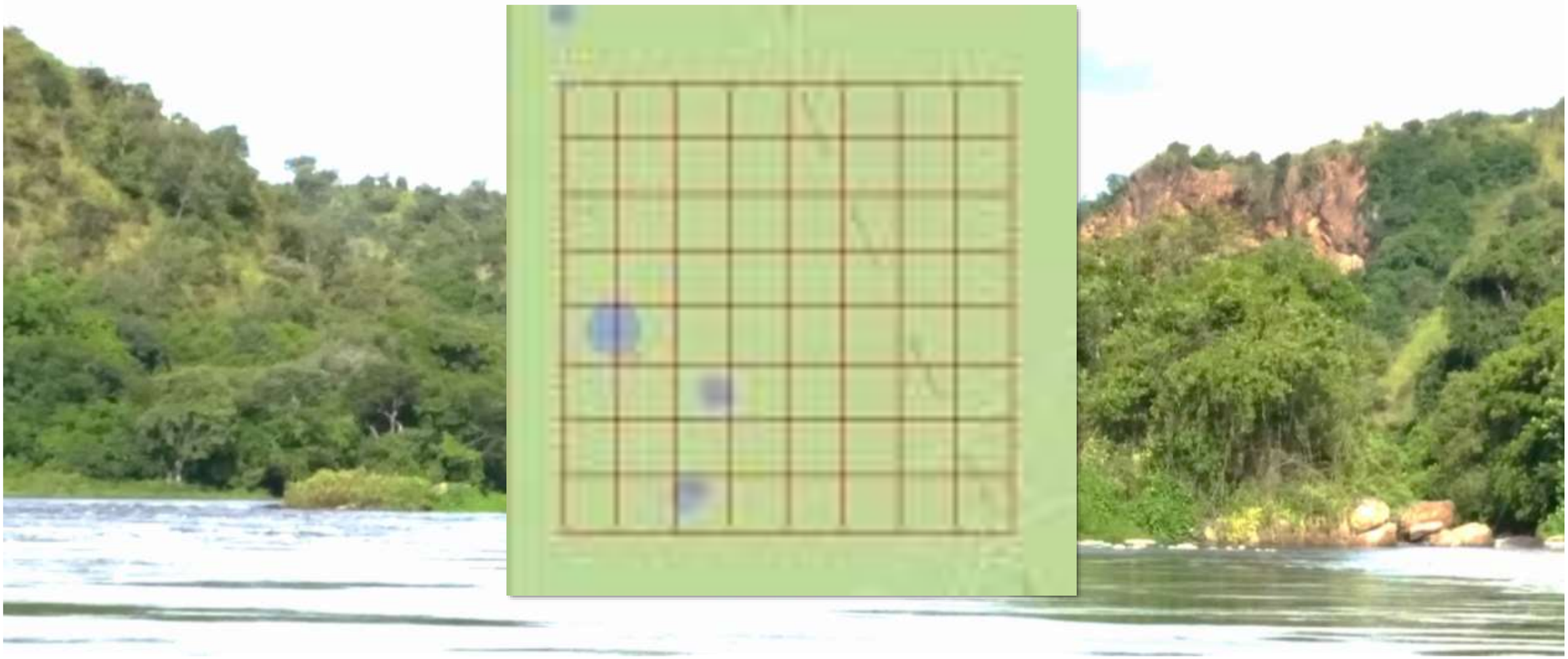
Predicting Poaching from Past Crime Data

PAWS: Applying AI for protecting wildlife

Nguyen

Poacher Behavior Prediction

Predicting Poaching from Past Crime Data

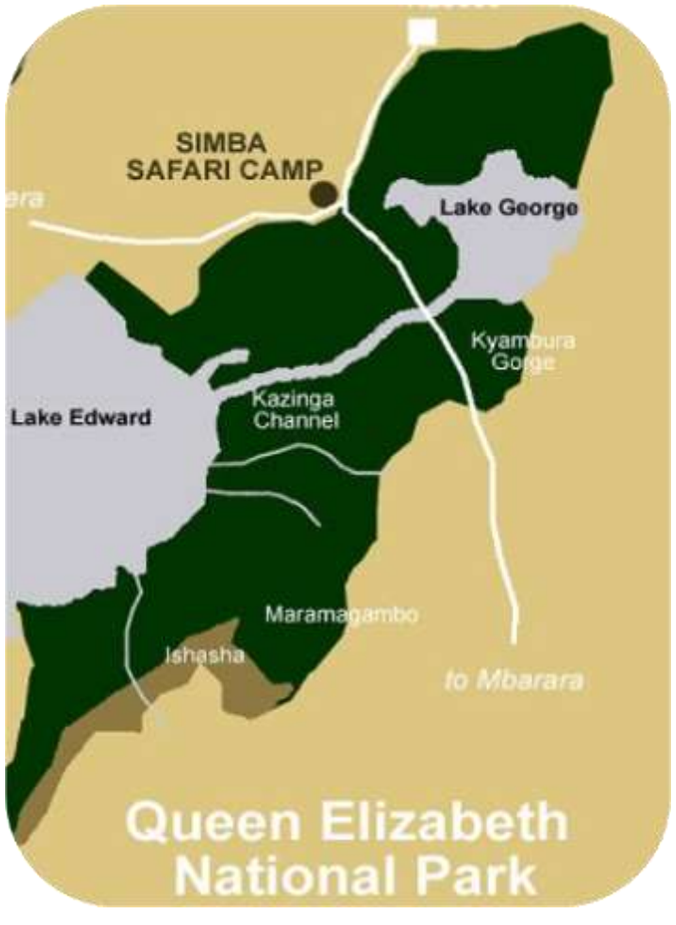


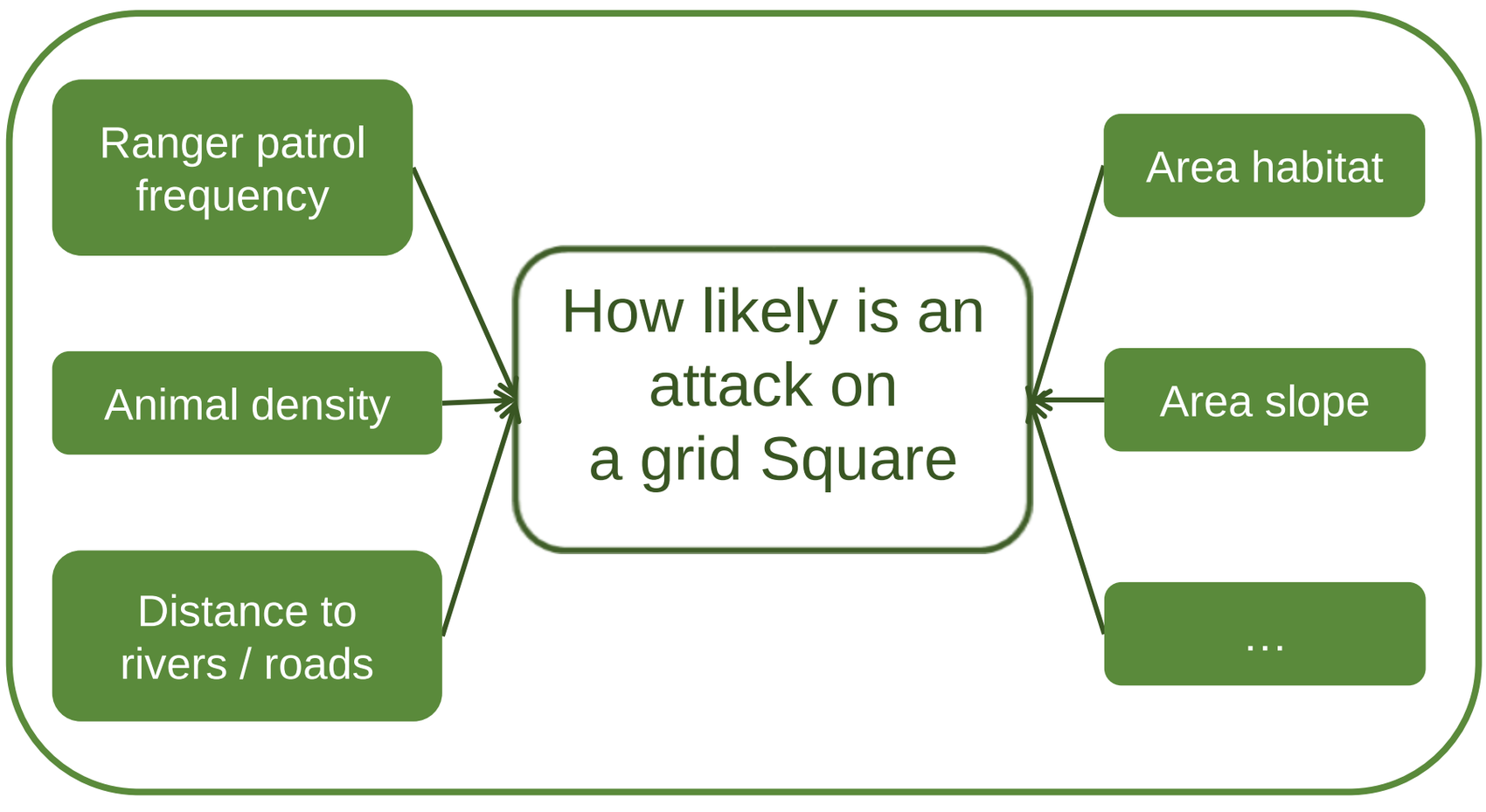
Poacher behavior prediction

Nguyen

Data from Queen Elizabeth National Park, Uganda

Number of poaching attacks over 12 years: ~1000

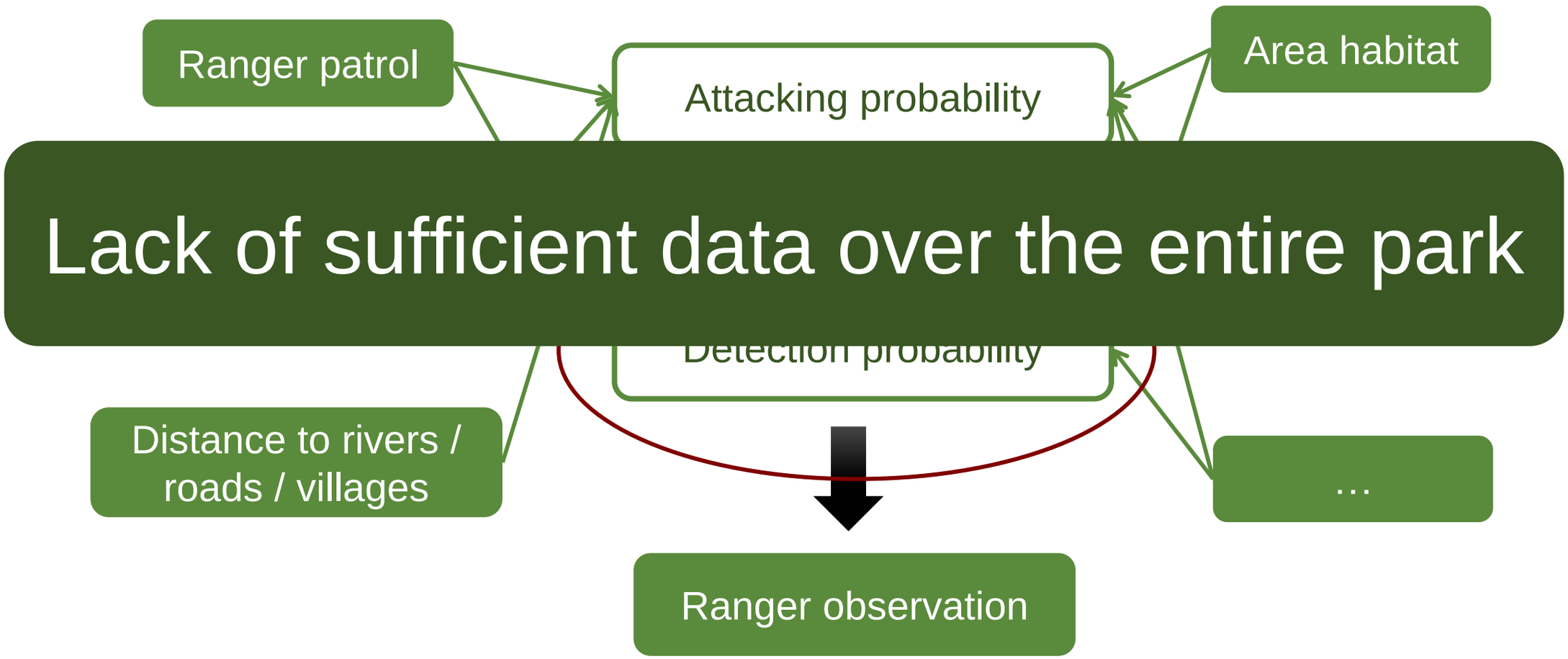




Initial Attempt Behavioral Game Theory Models: Dynamic Bayes Net

Nguyen

$$\text{Adversary's probability of choosing target j} = \frac{e^{SEU^{adversary}(x,j)}}{\sum_{j'=1}^{M} e^{SEU^{adversary}(x,j')}}$$



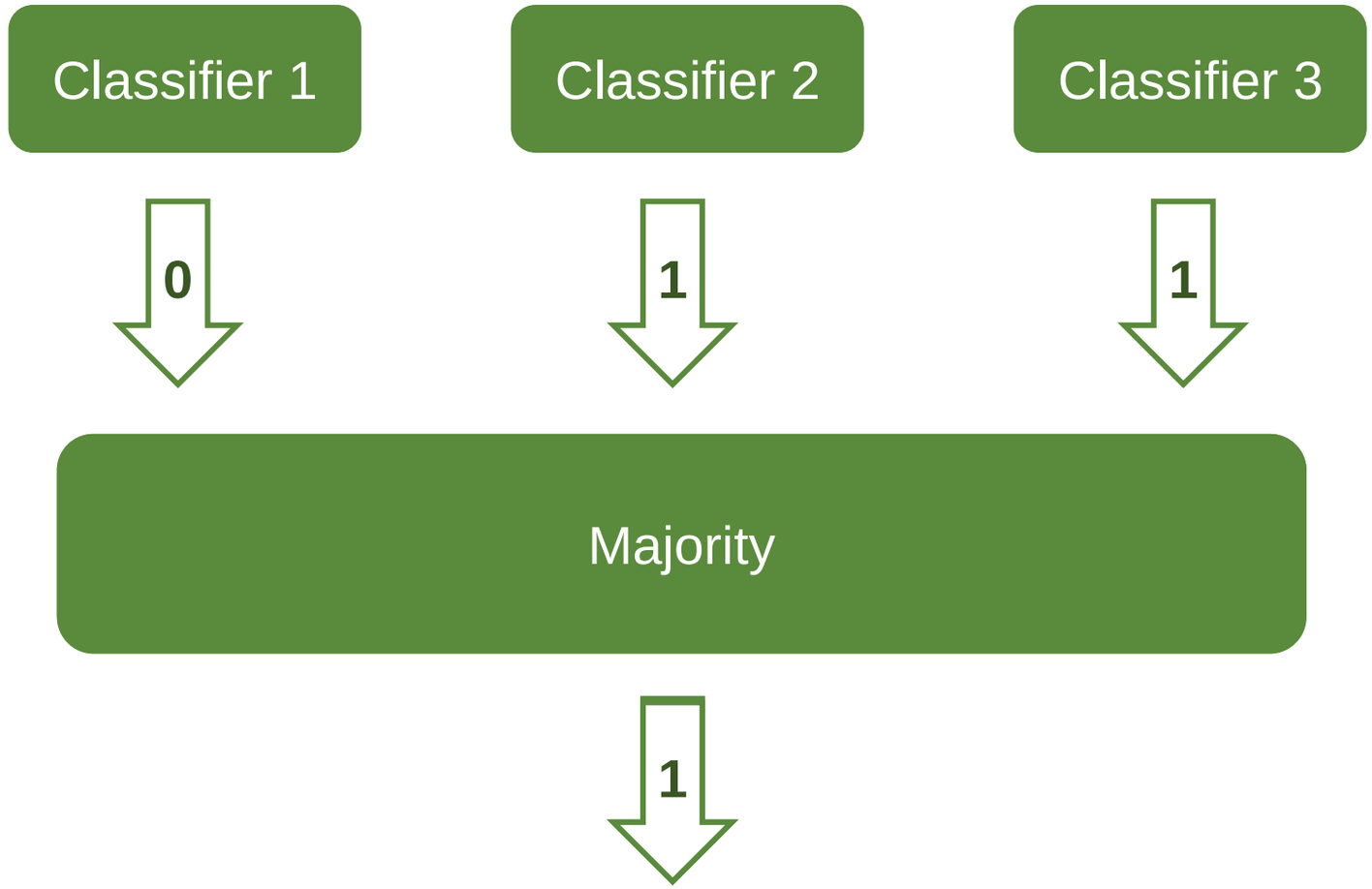
Poacher Behavior Prediction


Kar


Ford

Poacher Behavior Prediction

Ensemble of Decision Trees (with feature boosting)

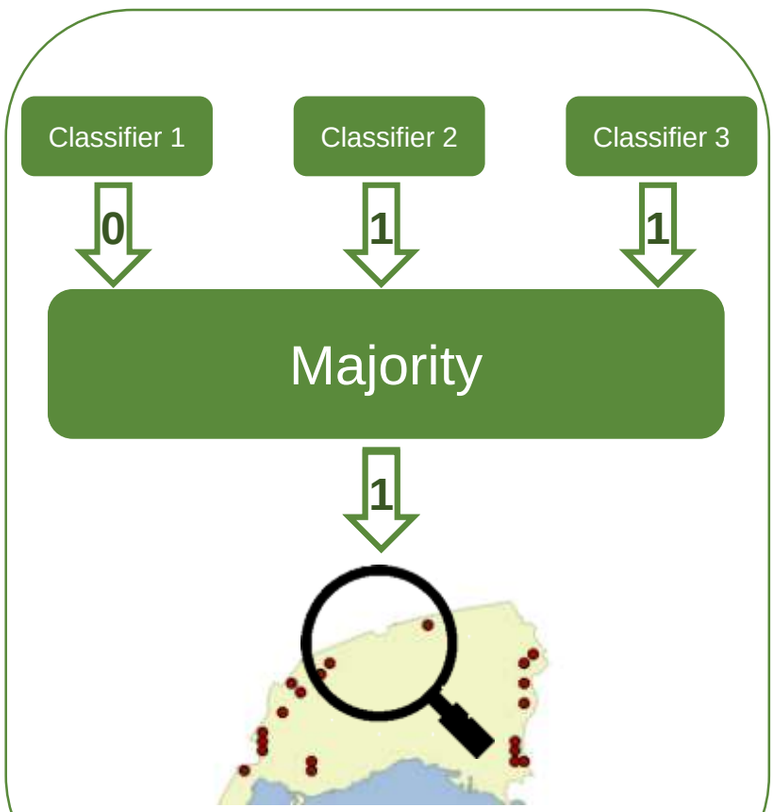


Boost Decision Tree Ensembles with with Graphical Models

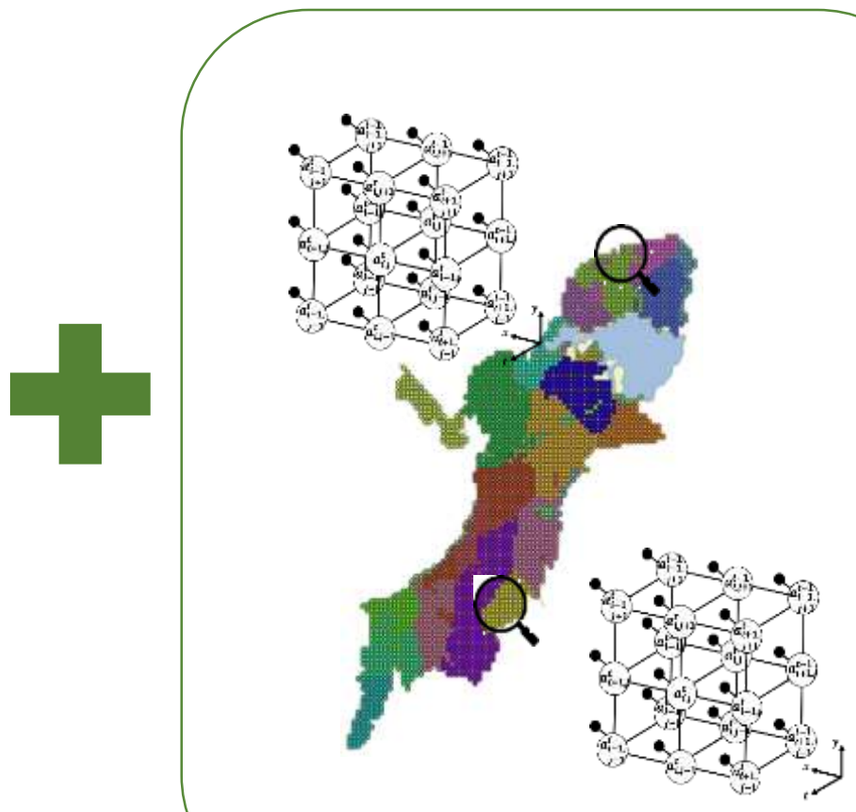

Gholami


Nguyen

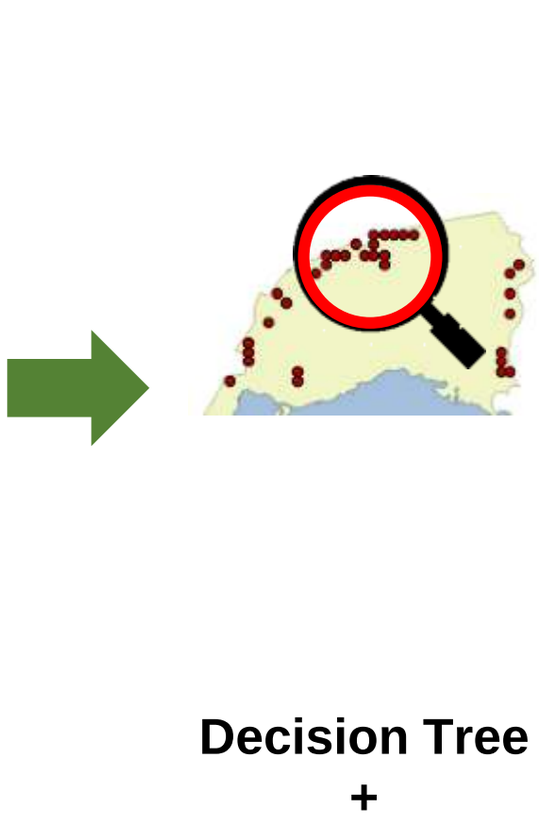
- Boost in “heavily monitored” regions of the park:
  - Improve accuracy
  - Learn local poachers’ behavior; distinct parameters



Decision Tree



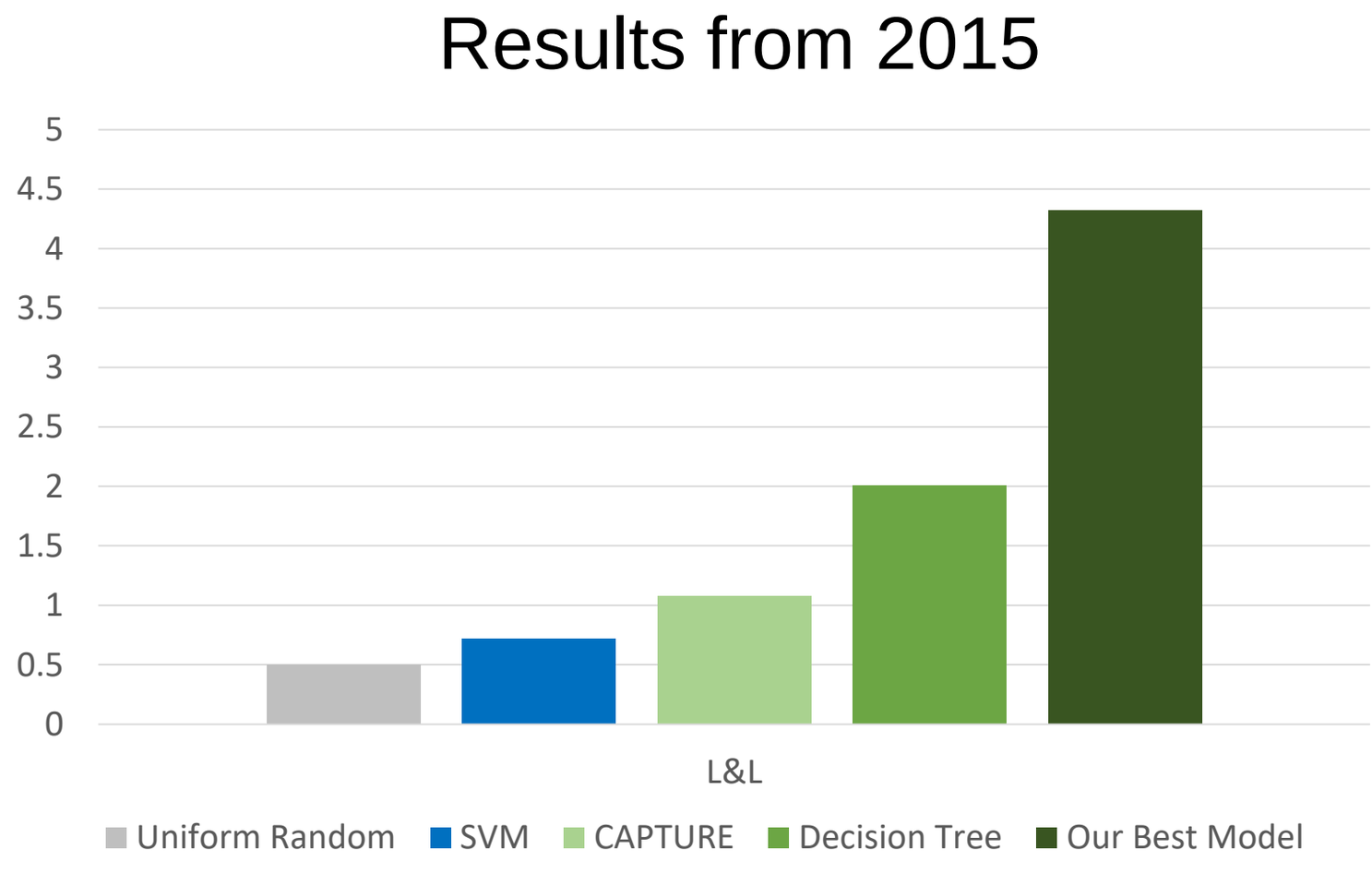
Graphical model



Decision Tree + Graphical model

Poacher Attack Prediction

Poacher Behavior Prediction

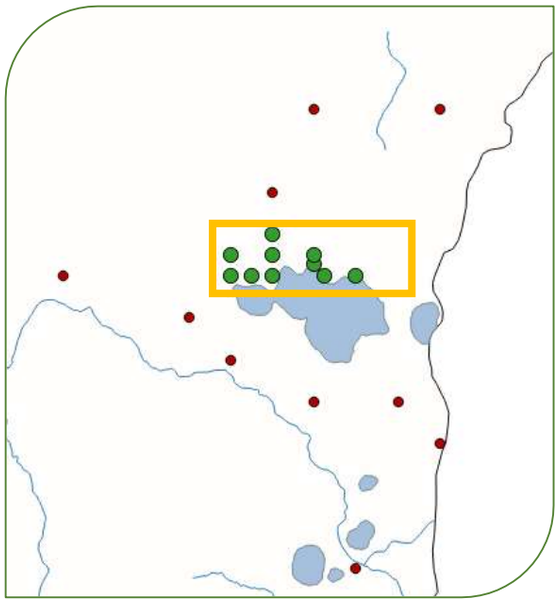


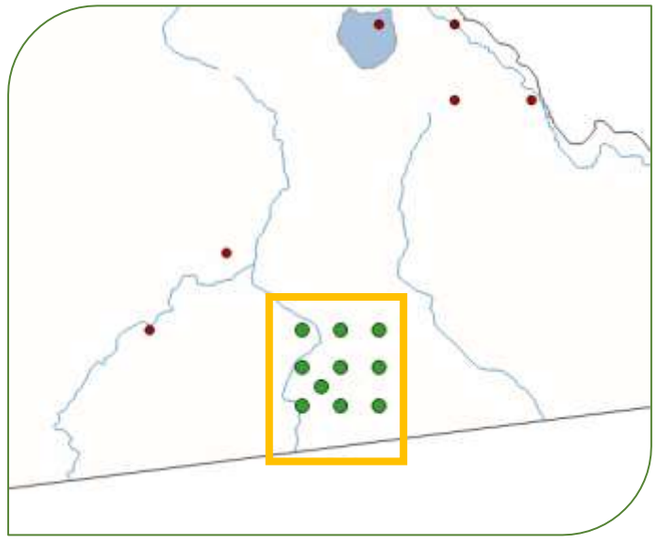
Real-world Deployment (1 month)

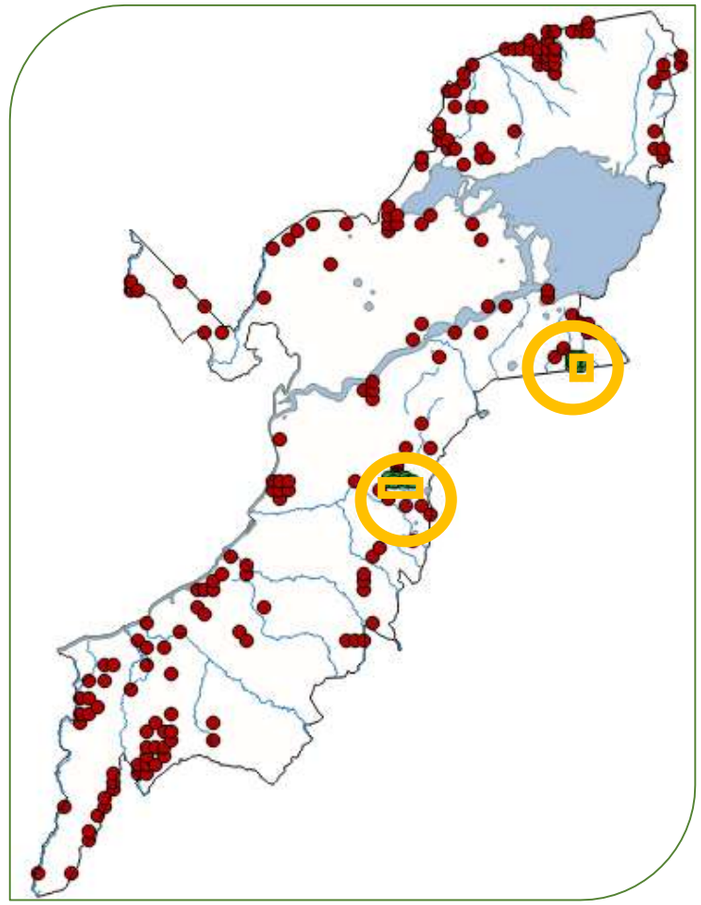

Kar


Ford

- Two 9-sq. km patrol areas
  - Where there were infrequent patrols
  - Where no previous hot spots







Real-world Deployment: (1 month)

Real-world Deployment: Results

- Two 9 sq KM patrol areas: Predicted hot spots with infrequent patrols

- Trespassing: 19 signs of litter etc.
- Snaring: 1 active snare
- Poached Animals: Poached elephant
- Snaring: 1 elephant snare roll
- Snaring: 10 Antelope snares

- Hit rates (per month)
  - Ours outperforms 91% of months

Historical Base Hit Rate	Our Hit Rate
Average: 0.73	3

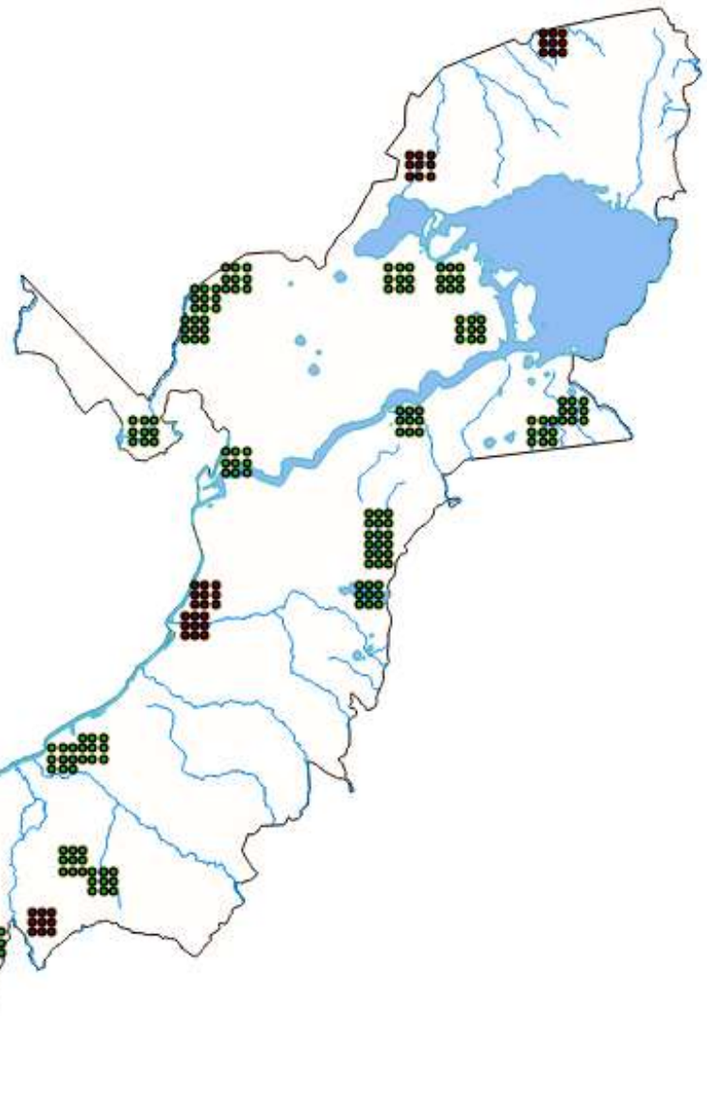
Real-world Deployment: Field Test 2 (6 months)


Gholami


Ford

- 2 experiment groups (27 areas of 9 sq KM each)
  - **1:HIGH: 5 Areas**
  - **2: LOW: 22 Areas**

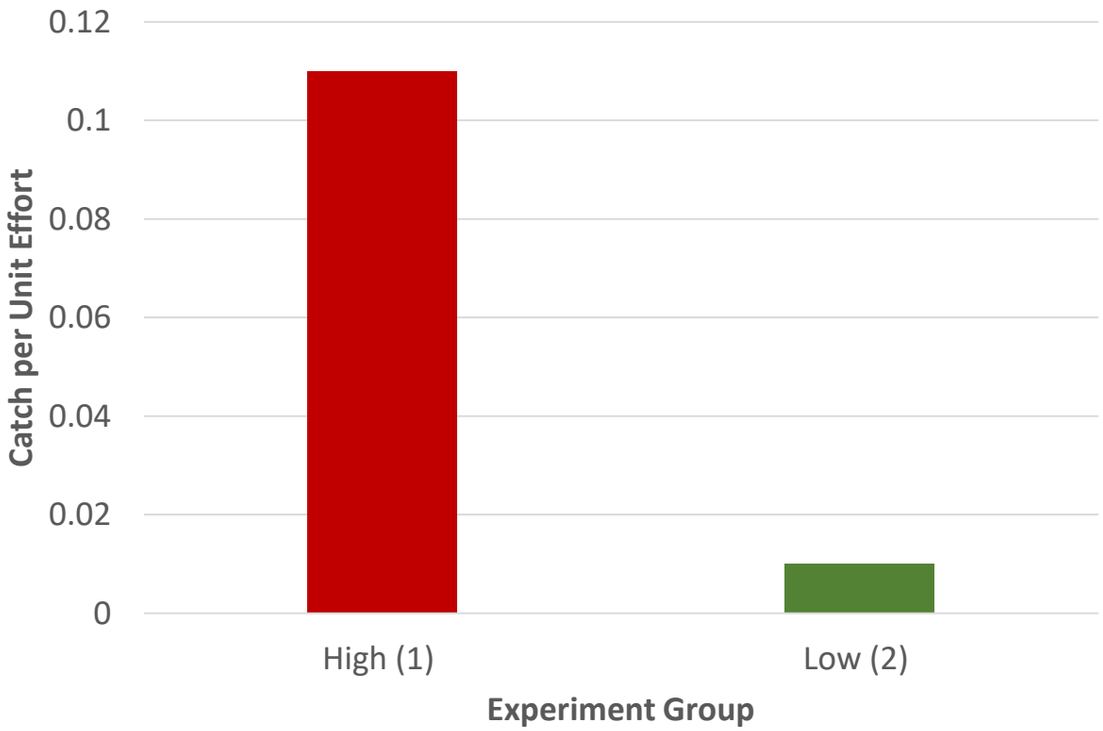
- Rangers trained; unaware of this classification

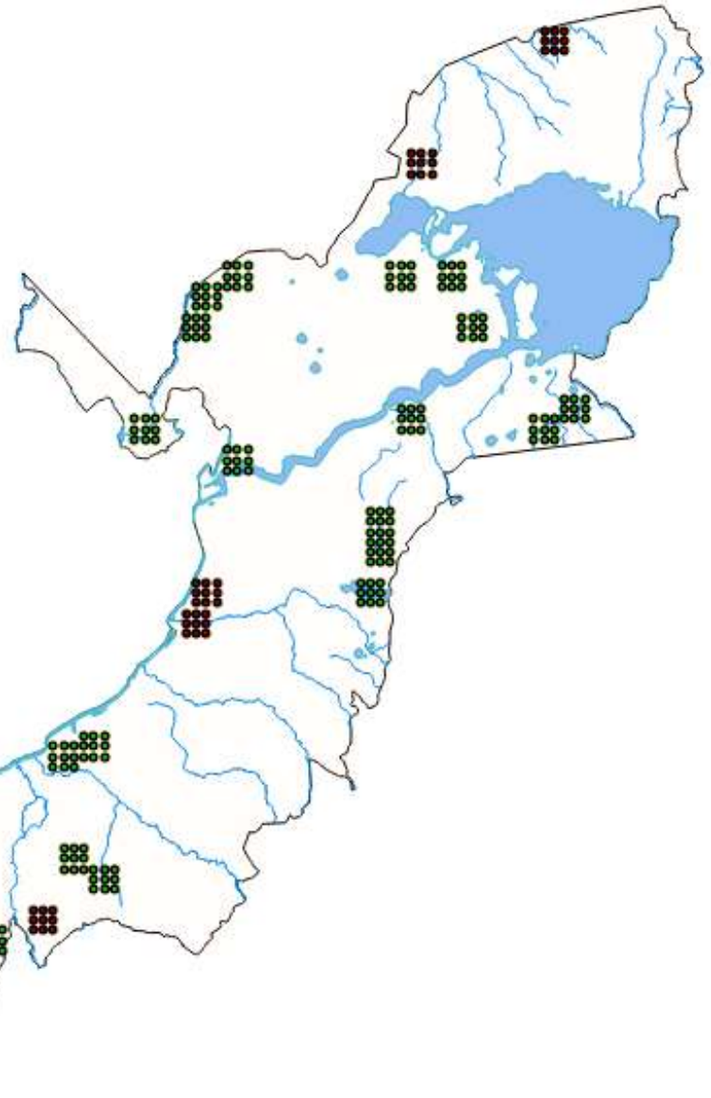


Real-world Deployment: Field Test 2 (6 months)

- Catch Per Unit Effort (CPUE)
  - ➢ Unit Effort = km walked
  - ➢ Our high CPUE**: 0.11**
  - ➢ Our low CPUE**: 0.01**

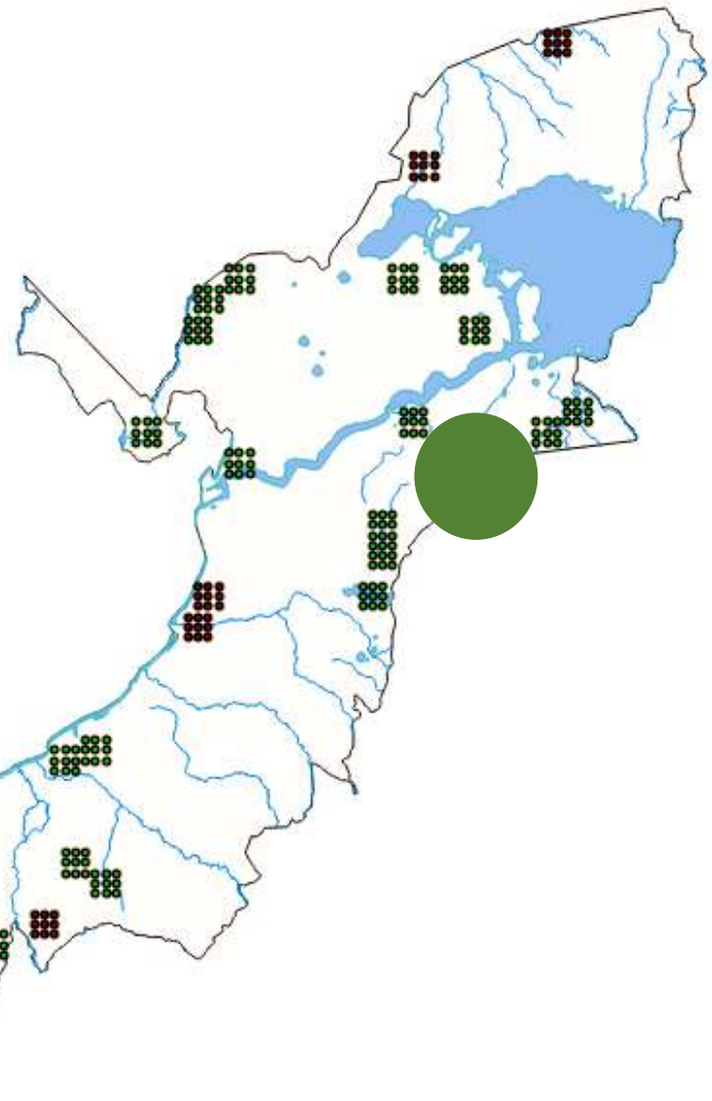
Historical CPUE: **0.04**





Field Test Side Effects: Queen Elizabeth National Park

- Rangers followed poachers' trail; ambushed camp
  - Arrested one (of 7) poachers
  - Confiscated 10 wire snares, cooking pot, hippo meat, timber harvesting tools.



- Pursuit of poachers
- Signs of road building, fires, illegal fishing

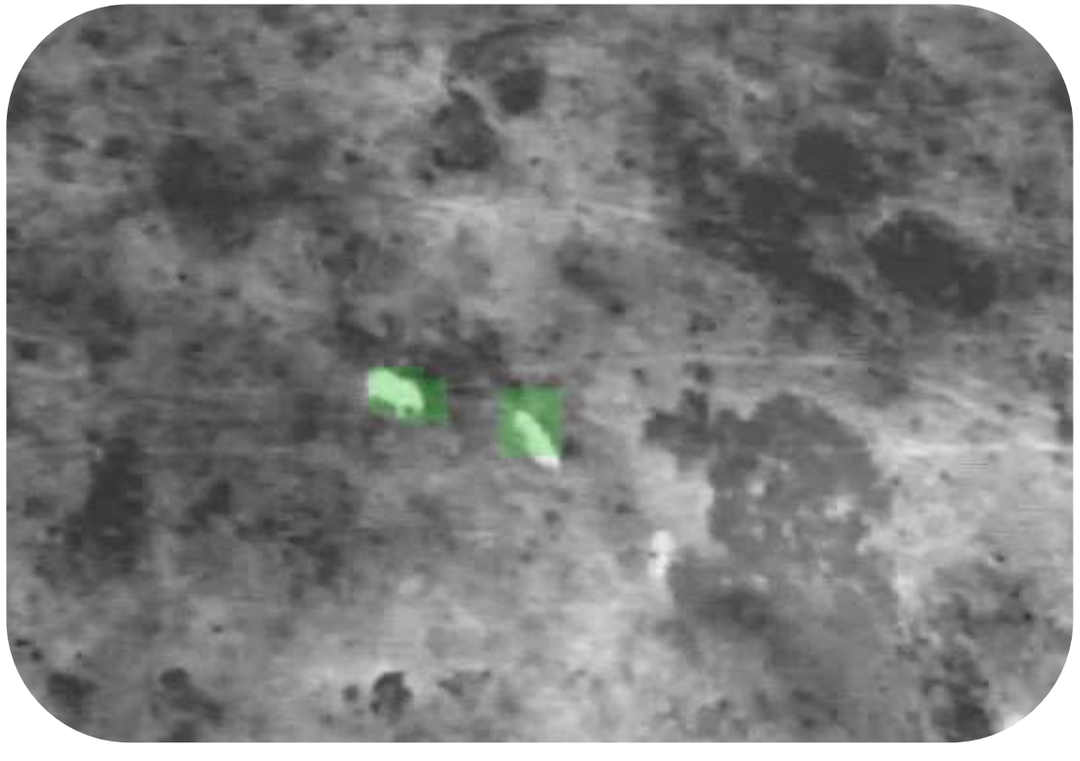
Next Steps

- Deployments in other parks
  - Murchison Falls National Park, Uganda (WCS); Cambodia (WWF)
  - Inclusion for general deployment worldwide

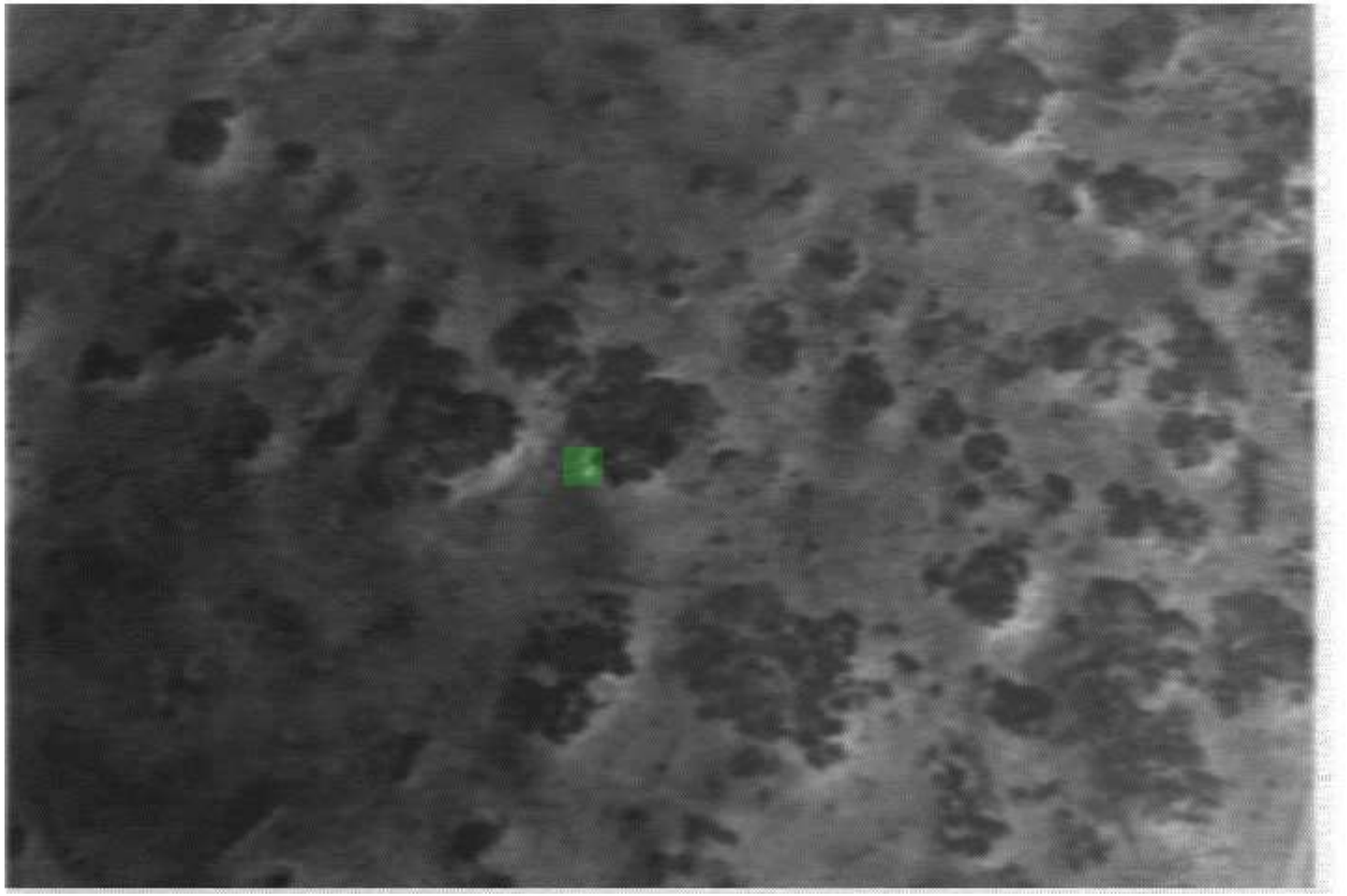
Green Security Games: Patrolling From the Sky

Bondi

Credit:
Arvind Iyer, AirShepherd



Three Poachers Hiding



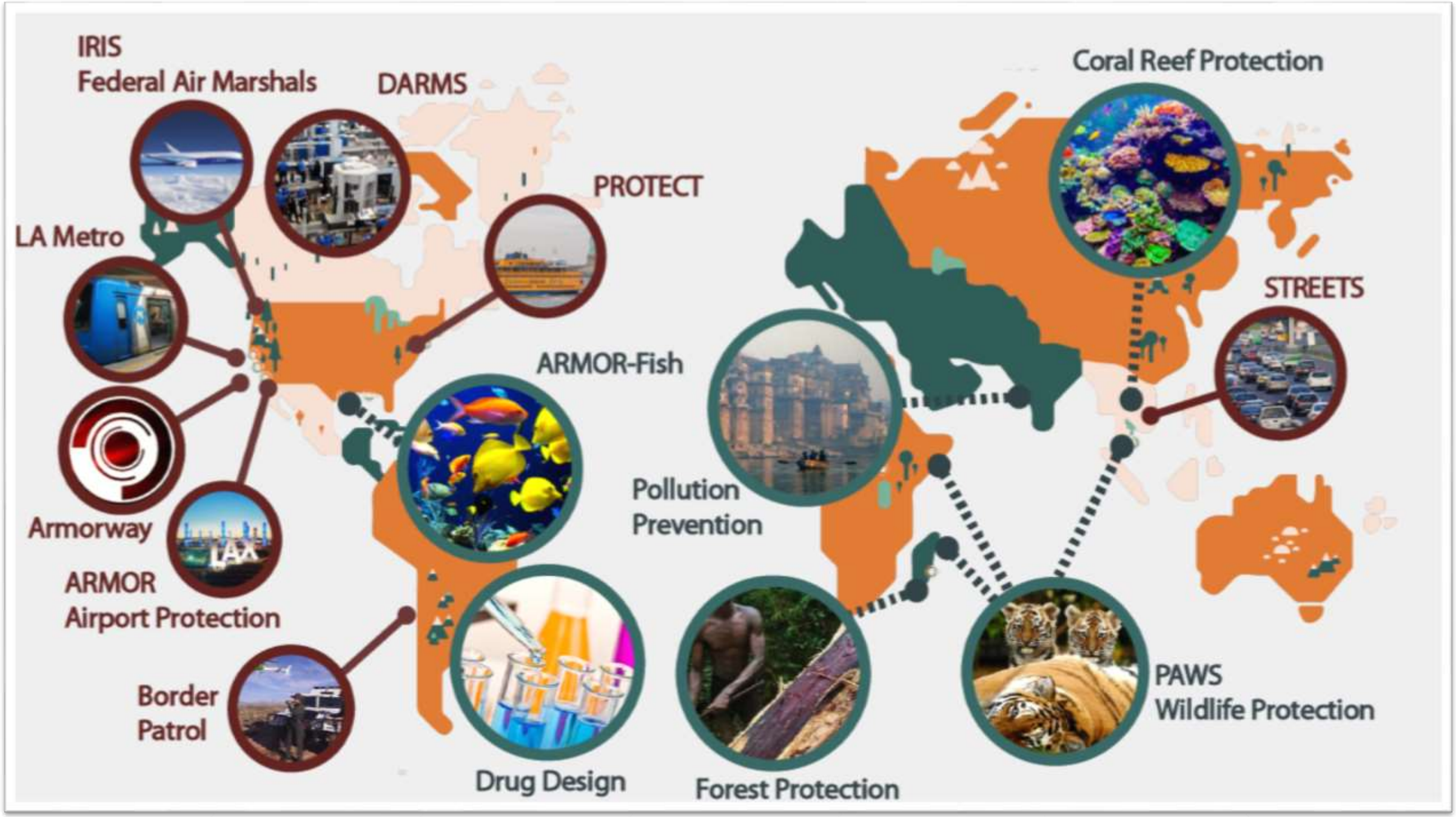
Towards the Future: AI for Earth

- Significant potential: AI for Earth

- Not just applications; novel research challenges:
  - Fundamental computational challenges from use-inspired research
  - Designing AI for Earth:
    - Interpretability
    - Complementing human autonomy

- Methodological challenges:
  - Encourage interdisciplinary research: measures impact in real world

AI for Social Good



THANK YOU

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