Green Security

How Can AI Help in Protecting Forests, Fish and Wildlife

MILIND TAMBE
Helen N. & Emmett H. Jones Professor in Engineering
University of Southern California
WHAT MIGHT WE LOSE?

Murchison Falls National Park, Uganda
WHAT MIGHT WE LOSE?

Murchison Falls National Park, Uganda
PAWS: PROTECTION ASSISTANT for WILDLIFE SECURITY

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

• How to Efficiently Patrol/Protect forests with limited resources
• PAWS patrols: Exploit past poaching data, avoid predictability

Patrol boat in Bangladesh at Global Tiger Conference, 2014

Patrol with Rangers, Indonesia Trip with WWF, 2015
AI-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

Airports

2007
AI-based DECISION AIDS TO ASSIST IN SECURITY
**AI-based DECISION AIDS TO ASSIST IN SECURITY**

### Game Theory

**Player A**
- Paper
- Rock
- Scissors

**Player B**
- Paper
- Rock
- Scissors

<table>
<thead>
<tr>
<th></th>
<th>Paper</th>
<th>Rock</th>
<th>Scissors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>0, 0</td>
<td>1,-1</td>
<td>-1,1</td>
</tr>
<tr>
<td>Rock</td>
<td>-1, 1</td>
<td>0, 0</td>
<td>1, -1</td>
</tr>
<tr>
<td>Scissors</td>
<td>1, -1</td>
<td>-1, 1</td>
<td>0, 0</td>
</tr>
</tbody>
</table>
Al-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

Airports

Canine patrol at LAX (ARMOR)

2007
AI-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

Airports

2007

Air Marshals

2009

Ports

2011
PROTECT: FERRY PROTECTION DEPLOYED [2013-]
AI-based DECISION AIDS TO ASSIST IN SECURITY

Game Theory

- Airports
- Air Marshals
- Ports
- Trains

2007
2009
2011
2013
GLOBAL PRESENCE OF SECURITY USING GAME THEORY

SUCCESSFULLY TESTED

Gulf of Mexico (Near Corpus Christi, Texas) — ARMOR-FINE
ARMOR-FINE intelligently-randomized schedules for U.S. Coast Guard patrol boats to thwart the illegal fishing of decimated shark and red snapper populations. (2013)

Los Angeles Metro — TRUSTE
The Los Angeles Sheriff’s Department, which LA Metro subcontracted for security, employed TRUSTE to intelligently randomize patrol schedules to deter fare evasion. The Sheriff’s Department later ran pilot security experiments to assess their effectiveness in deploying scarce police personnel to deter crime and terrorism on LA Metro. (2011–2015)

Uganda — PAWS
Uganda’s national park rangers tested PAWS at Queen Elizabeth National Park to intelligently randomize patrol schedules to prevent the slaughter of elephants, including Cope’s buffalos, wetland and great hornbills, which are revered as sacred and exported as “bush meat.” (2014)

Malaysia — PAWS
Firehose, also known as “Get Real,” is committed to ensuring the survival of tigers and other wild cats. In cooperation with the nonprofit Green Kite, began testing PAWS in forests in northwestern Malaysia, to evaluate its ability to generate effective patrols in the challenging, hostile terrain. (2014)

DEPLOYED

Ports — PROTECT
PROTECT intelligently randomizes U.S. Coast Guard patrols to optimize scarce resources to secure crowded ports, bridges and ferry terminals. PROTECT is deployed at:
- Port of New York and New Jersey
- Port of Boston
- Port of Seattle
- Port of Los Angeles–Long Beach

Staten Island Ferry — PROTECT
PROTECT provides protection to the Staten Island Ferry, which carries up to 4,000 passengers at peak times.

Los Angeles International Airport — ARMOR
ARMOR intelligently randomizes movements of checkpoints along the five roads that lead into the airport.

U.S. Air Traffic — IRIS
As part of its multilayered strategy to prevent attacks, the Transportation Security Administration (TSA) has since 2009 deployed Milind Tambe’s IRIS system, which intelligently randomizes federal air marshals’ flight schedules to make their air patrols unpredictable to would-be terrorists.

FUTURE TEST SITES

Singapore — STREETs
Singaporean traffic authorities could employ STREETs to intelligently randomize police patrols to catch reckless drivers, a big problem in this island nation.

POSSIBLE FUTURE TEST SITES

Vietnam, Cambodia, Bangladesh, Indonesia — PAWS

Madagascar — PAWS
Attitude, working with Meredith Greer, an associate professor of conservation social sciences at Michigan State University, and a Malagasy civil society group called Alliance Vohéaky Group (AVG), hopes to eventually employ PAWS in Madagascar to randomize patrol schedules for rangers, police and natural park officials to reduce environmental threats, especially illegal logging.
SOME RESULTS OF GAME THEORY for SECURITY

Game Theory in the Field

Ticketless Travelers Caught

• Game theory vs Previous Method

Arrests at LAX checkpoints
GAME THEORY FOR PATROLS [2013]

Congressional Subcommittee Hearing
PAWS: APPLYING AI FOR PROTECTING WILDLIFE

Game Theory + Poacher Behavior Prediction

Predicting Poaching from Past Crime Data

Poachers attack targets

Learn from crime data

Game Theory calculate randomized patrols

Patrollers execute patrols
POACHER BEHAVIOR PREDICTION

Queen Elizabeth National Park, Uganda

12 years of patrols, 125000 observations

How likely is an attack on a grid Square

- Ranger patrol frequency
- Animal density
- Distance to rivers / roads
- Area habitat
- Area slope
- ...

Queen Elizabeth National Park, Uganda

12 years of patrols, 125000 observations
PAWS INITIAL SYSTEM [2016]

Game Theory + Poacher Behavior Prediction

12 years of patrols, 125000 observations

Dry Season (June-August 2008)
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

Human Activity Sign/km

Previous Patrol: 0.57  
PAWS Patrol: 0.86

Human Activity Sign/km
PAWS COLLABORATIONS
AI DECISION AIDS for PROTECTING FORESTS, FISHERIES, RIVERS

Protecting Forests, Fish, Rivers

FOREST PROTECTION

FISHERY PROTECTION

RIVER POLLUTION PREVENTION
AI and GAME THEORY WORLDWIDE FOR SOCIAL GOOD

Thank you to sponsors:
THANK YOU

tambe@usc.edu

http://teamcore.usc.edu/security
EVALUATING DEPLOYED SECURITY SYSTEMS NOT EASY

How Well Optimized Use of Limited Security Resources?

Security Games superior
vs
Human Schedulers/”simple random”

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulated adversary</td>
<td>Compare real schedule</td>
<td>“Mock attackers”</td>
</tr>
<tr>
<td>Human subject adversaries</td>
<td>Scheduling competition</td>
<td>Capture rates of real adversaries</td>
</tr>
<tr>
<td>Expert evaluation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FIELD EVALUATION OF SCHEDULE QUALITY

Improved Patrol Unpredictability & Coverage for Less Effort

PROTECT (Coast Guard): 350% increase in defender expected utility
July 2011: Operational Excellence Award (US Coast Guard, Boston)

June 2013: Meritorious Team Commendation from Commandant (US Coast Guard)

September 2011: Certificate of Appreciation (Federal Air Marshals)

February 2009: Commendations LAX Police (City of Los Angeles)