Modeling Maritime Contraband Trafficking Activities with the Agent-based Approach

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Blindspot Solutions

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Outline

**Blindspot Solutions**
- Company Introduction

**Maritime Drug Smuggling**
- General Problem
- JIATF-S and Motivation

**BANDIT Platform**
- Architecture
- Environment
- Agent behaviors

**Scenarios**
- Single mode
- Batch mode

**Summary**
- ... and what to do next
Blindspot Solutions was founded in 2013. We build our solutions on cutting edge research in game theory, optimization and algorithmic security as well as on broad knowledge in software engineering of large distributed systems.

**STRATEGIC OPTIMIZATION:** Optimal audit processes, randomized asset allocation, randomized security strategies

**PLANNING & SCHEDULING:** Logistics planning, manufacturing scheduling, inspection scheduling

**INTELLIGENT DATA ANALYSIS:** Large data volumes processing and analysis using machine learning techniques
Overview of Security Projects
We have transferred our technologies from research to industry in the following and other cases

**LOS ANGELES METRO INSPECTIONS** *(improving efficiency of LA Metro fare inspectors)*
Development of domain model, design of fare evasion strategies, optimization of inspector allocations and routes.

**INTERDICTION OF DRUG TRAFFICKING ROUTES** *(improving prediction capabilities of JIATF-S)*
Optimization of naval asset allocation with respect to behavioral models of drug traffickers using predictive modeling and game theory.

**BEHAVIOR MODELING OF MARITIME PIRACY** *(piracy activity prediction)*
Development of agent-based model of maritime piracy in the Indian Ocean, integration of real-world data, prediction of pirates’ activity. Used by Naval Research Lab. in Monterey for strategy validation.
Overview of Optimization Projects

We have transferred our technologies from research to industry in the following and other cases:

**AIR TRAFFIC OPTIMIZATION** *(12 % trajectory length reduction)*
Advisory tool for a major producer of air traffic control systems. The tool detects mid-term collision between civilian airplanes and proposes solution to the air traffic controller.

**PRIVATE JET RENTAL OPTIMIZATION** *(enabling jet rental business)*
Optimization of private jet rental and schedule generation using multi-agent paradigm.

**OPTIMIZATION OF THE LOGISTICS CHAIN** *(reducing travel time by 10%, enabling company expansion to other regions)*
Optimization of logistics chain, visualization and decision support tool for operators.
Overview of Inspection Projects
We have transferred our technologies from research to industry in the following and other cases

PETROL STATION INSPECTION OPTIMIZATION
(reducing travel time by 20%)
Software for scheduling of inspections of petrol stations in Czech regions. Optimization of travel time and schedule unpredictability

PRE-SHIPMENT INSPECTION ANALYSIS
(enabling development of a scheduling tool)
Analysis of inefficiencies and process redesign of pre-shipment inspection process in China.
Maritime Drug Smuggling – Problem
Slides describing the JIATF-S activities were removed.
## BANDIT Simulation

**Agent-based Simulation of the Maritime Drug Smuggling Problem**

### Environment

<table>
<thead>
<tr>
<th>Geography</th>
<th>Boundaries</th>
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<tbody>
<tr>
<td>Metoc</td>
<td>Waves</td>
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<tr>
<td></td>
<td>Wind</td>
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<td>Currents</td>
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### Agents

<table>
<thead>
<tr>
<th>Smugglers</th>
<th>Model of Intel</th>
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<tr>
<td>White Traffic</td>
<td>Fishermen</td>
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<tr>
<td></td>
<td>Merchant Traffic</td>
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<tr>
<td>Blue team</td>
<td>Asset Allocation</td>
</tr>
</tbody>
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Architecture

Environment

Storages

Storage

Storage

Dynamic Model

Physics

Time

Controller

Agent

Agent

Agent

Agent

Sensoric information

Actions
Environment

Geography
- Coast line polygons
- Extracted from OpenStreetMaps
- Simplified polygons by inflation by 100 meters
- EASTPAC & CARIB

Metoc
- Current and Forecast data (6h interval 6-72hrs)
  - Wind
  - Currents
  - Waves
  - ESRI GRID data
Agent Models
Behavioral State Machines (BSM)

BSM - Oriented graph
Nodes $\rightarrow$ Activities (States)
Edges $\rightarrow$ Event-triggered transitions
Behavioral State Machines (BSM)

States and transitions

Guard = Boolean predicate applied on an event

hBSM – hierarchical BSM
States can contain BSM

Start

Input Event

Transition guards

Generate internal response output

Internal response guards

Switch state

onExit function

onExit output

onEntry function

End

onEntry output with onExit output

internal response output
AIS traces replay

- fidelity corresponds to data quality and coverage

Generative model

- fidelity corresponds to model quality
- allows what-if scenarios
- allows interaction
<table>
<thead>
<tr>
<th>Phase 1:</th>
<th>Out of scope</th>
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<tbody>
<tr>
<td>Phase 2:</td>
<td>Allocation algorithm</td>
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<td></td>
<td>Patrolling algorithm</td>
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<td>Detection + Interaction</td>
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<td></td>
<td>Smuggler knowledge collection and sharing</td>
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</table>
Smugglers behavior models

WAYPOINTS

TARPING

FUNNELING

TRANS SHIPMENT
Scenarios

Single mode  Batch mode
Phase 2 plans

Behavior modeling

- Use Meta programming system (MPS)
- Develop domain specific language (DSL)
- Allow non-programmers to script behavior

Game-theoretic model of smuggling

- Extension of transit game (used for piracy)
- Utilization of Markov models
- Integration of METOC and sensors

Blue team model

- Asset allocation simulation
- Modeling of different assets
- Model of sensor performance
Summary

Platform for modeling of illegal maritime activities

Integration of Agent-based simulation, behavior modeling, (game theory)

Interested in modeling other illegal activities

Thank you.

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