Risk-based Randomization for Security

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Objective: Randomness for Security with Quality Guarantees

- *Limited /uncertain knowledge of opponents*
- *Opponent monitors defenses, exploits patterns*
- *Examples: Patrolling, inspection, surveillance,…*

Outline of Talk

- Research on randomization: Game theory
- ARMOR: Transitioning research at LAX
- IRIS and other research: FAMS

Part I: Game Theory for Security

How to randomly allocate security resources:

- Canine units/officers to terminals
- "Intelligent randomization"
- Uncertainty over adversary types

Part I: Game Theory: Bayesian Stackelberg Games

- Agent (police) commit to strategy first, e.g. canine units to terminals
- Adversaries optimize against police strategy
- Best random police strategy?

Adversary

Police

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

New Algorithms: Bayesian Stackelberg Games

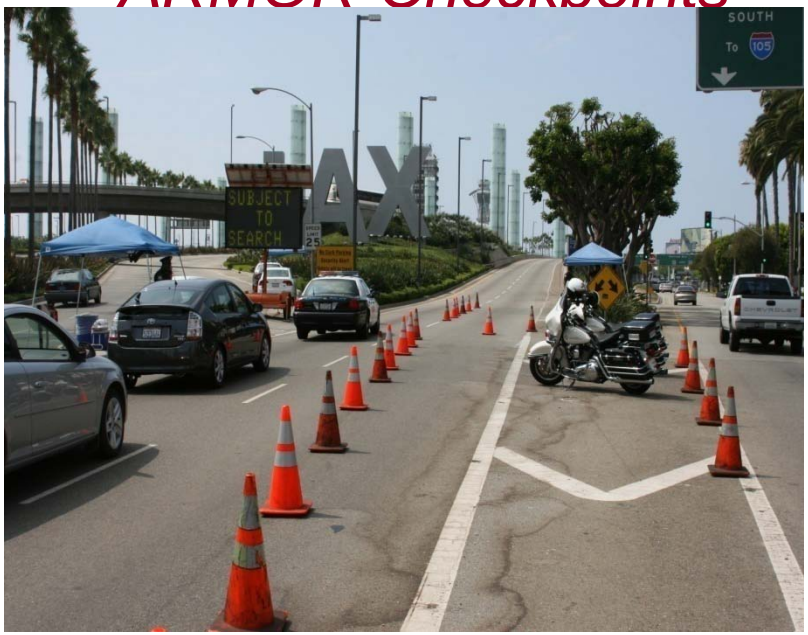
- DOBSS
  - Fastest to solve Bayesian Stackelberg games

- *Optimal (best) randomization for police to use*
  - *Example:*
    - *25% of times on terminal 1*
    - *30% on terminal 2*
    - *45% on terminal 3*

ARMOR: Transitioning to LAX Airport

- Randomized checkpoints and allocation of K9 units?

ARMOR-Checkpoints



ARMOR-K9

ARMOR Deployment

September 28, 2007

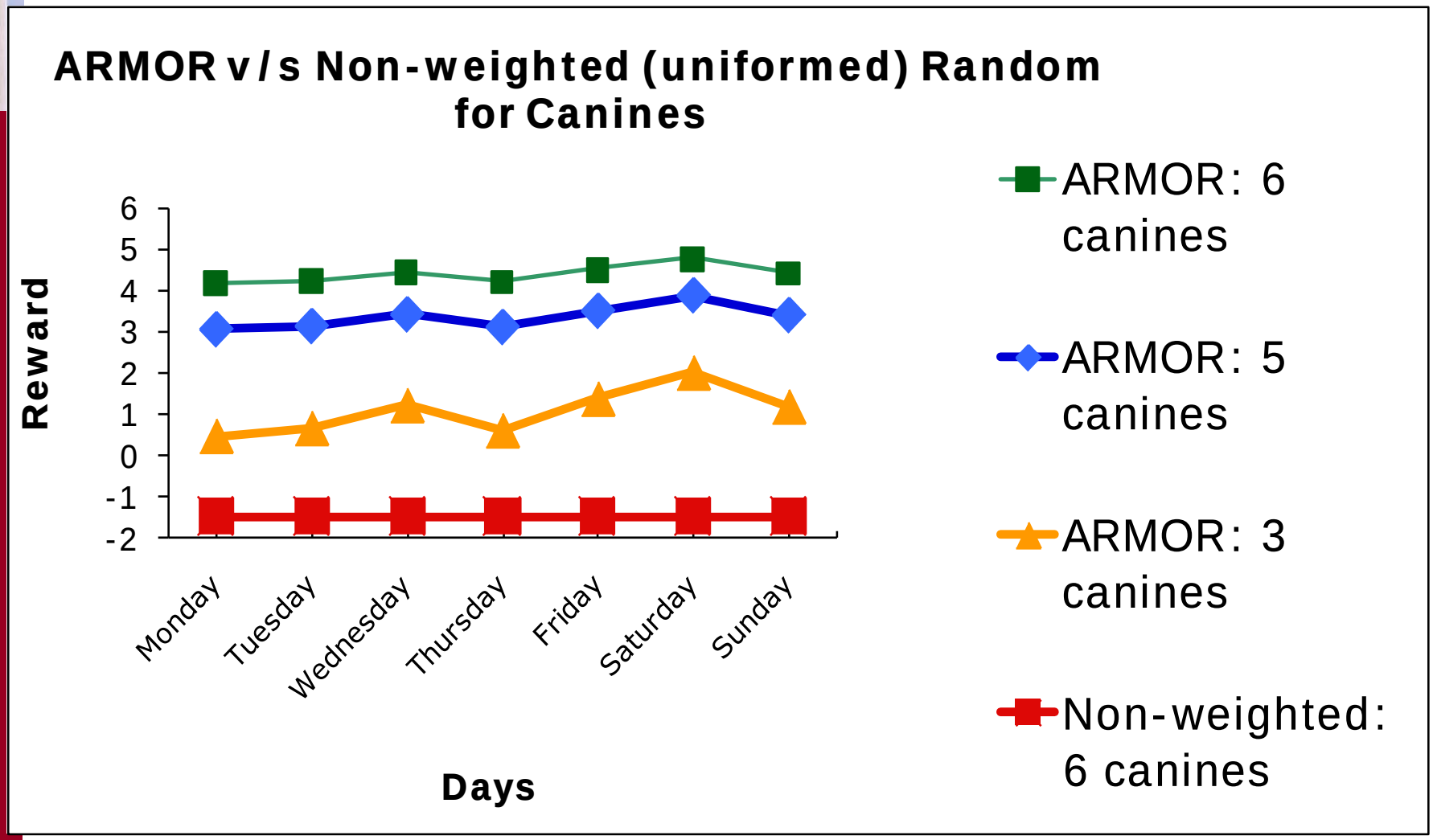
Newsweek National News

The Element of Surprise

To help combat the terrorism threat, officials at Los Angeles International Airport are introducing a bold new idea into their arsenal: random placement of security checkpoints. *Can game theory help keep us safe?*

Security forces work the sidewalk at LAX

Evaluation I: Quality Comparison



Evaluation II: USC students

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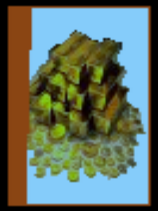
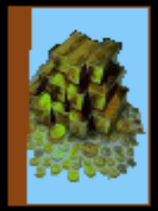
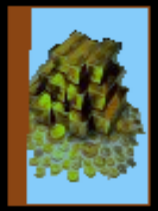
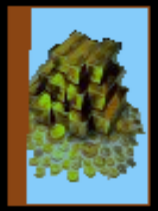
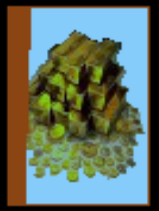
							
Your Rewards:							
8	5	3	10	1	3	9	4
Your Penalties:							
−3	−2	−3	−2	−3	−3	−2	−3
Pirate's Rewards:							
4	3	1	5	1	2	5	2
Pirate's Penalties:							
−8	−10	−1	−8	−1	−3	−11	−5

Evaluation III: LAWA Police

- Increase adversary cost/uncertainty, not defeat attacks:
  - Original approach not random; hard for humans to randomize
  - *"Unconsciously, (security forces) follow predictable patterns"*

    Director Butts, LAWA police

January 2009 arrest record

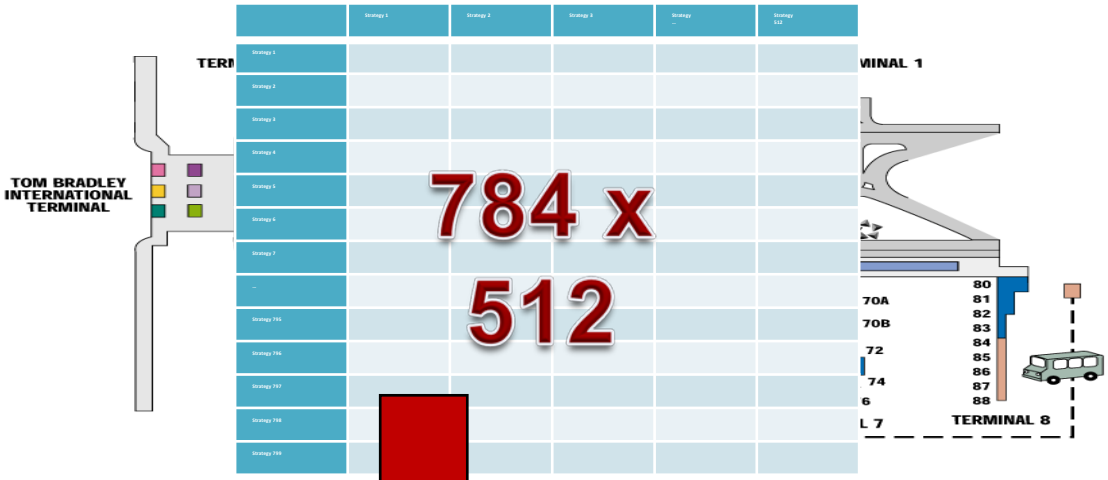
- January 3rd Loaded 9/mm pistol discovered in a car
- January 9th 16-handguns, 5-rifles, 1-black-powder pistol, loaded!
- January 10th Two unloaded shotguns (no arrest)
- January 12th Loaded 22/cal rifle discovered in a car
- January 17th Loaded 9/mm pistol discovered in a car
- January 22nd Unloaded 9/mm pistol in a car (no arrest)

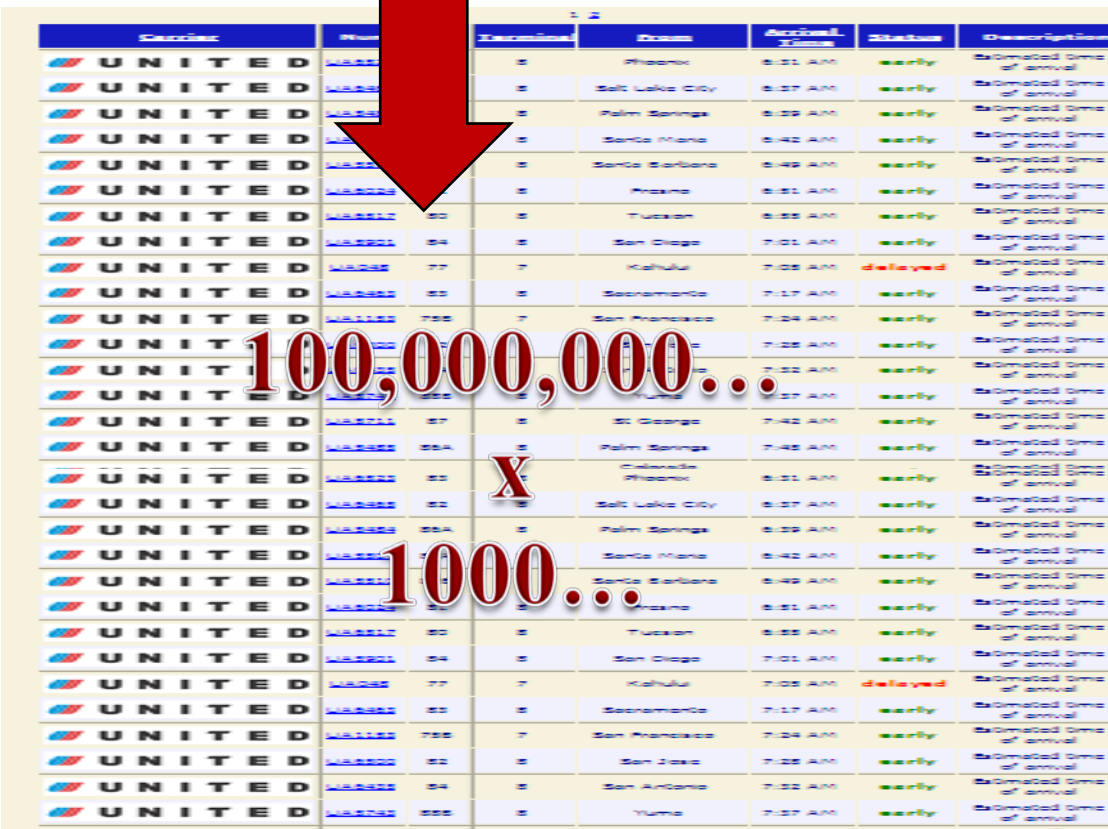
Evaluation III: LAWA Police

PART III: Current and Future Research

Organization	Task of interest	Key contact	Current Status
Los Angeles World Airports (LAWA)	Canine patrols, Vehicle checkpoints, foot patrols,…	Director Jim Butts jbutts@lawa.org	ARMOR deployed successfully since August 2007. Completed.
Federal Air Marshals (FAM)	Randomizing placement of air marshals	Jim Curren James.B.Curren@secureskies.net	Project kickoff: 4/2008 Current
Port of Long Beach (POLB)	Randomizing patrols	Cosmo Perrone Perrone@polb.com	Negotiation phase. Toured the port.
Transportation Security Administration (TSA)	Mobile security at airports	Andrew Cox Andrew.cox@dhs.gov	Discussion on-going.
Critical infrastructure red team (DHS)	Infrastructure protection	Richard Alt richard.alt@dhs.gov	Will recommend ARMOR to infrastructure protection forces
Los Angeles Sheriff Dept (LASD)	Randomized checks of the mass transit system	Capt Jordan, LASD pjjordan@lasd.org	Initial discussion July 2008.
Transportation Security Administration (TSA)	Randomizing Land Side transportation security	Ash Chatterjee Ash.Chatterjee@dhs.gov	Initial discussion November 2007. To follow-up.
Richmond Airport Police Department	Randomizing patrols	Chief Quenton Trice qtrice@flyrichmond.com	Initial email discussion January 2008. To follow up.
Coulee Dam	Randomizing patrols and	Dave Everett ,Chief of Security	Initial discussion January

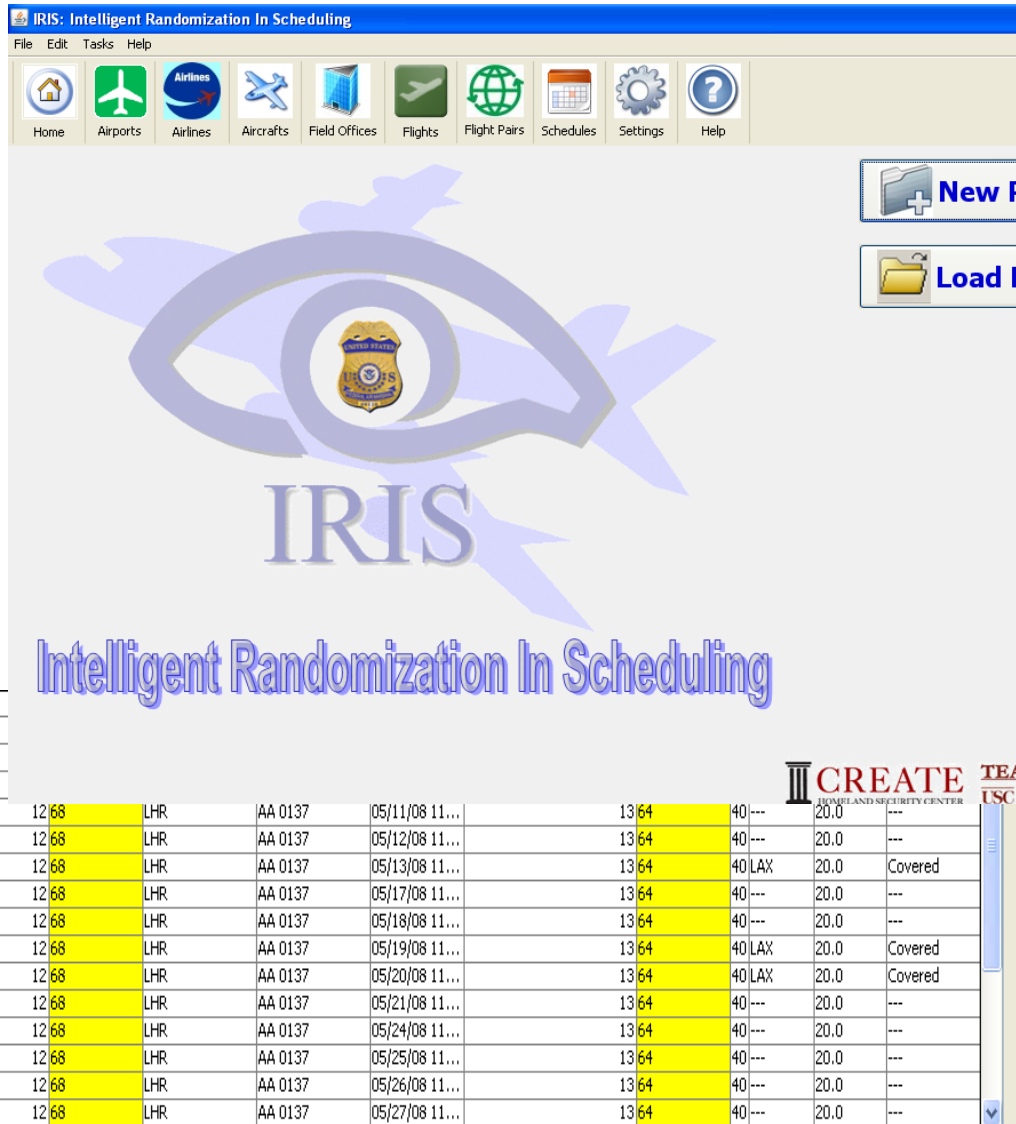
Federal Air Marshals (FAMS)…





IRIS Randomized Scheduler for FAMS

- Focus on international sector
- Software delivery: March 16



Challenges in IRIS

- Run-time
- Scheduling constraints

	ARMOR Game actions	ARMOR Runtime	IRIS Runtime
FAMS City 1	6,048	4.74s	0.09s
FAMS City 2	85,275	435.6s*	1.57s

Conclusion

- ARMOR: Randomness with quality requirements
  - Game theory software
- ARMOR at LAX: since August 2007
- IRIS with federal air marshals: March 2009

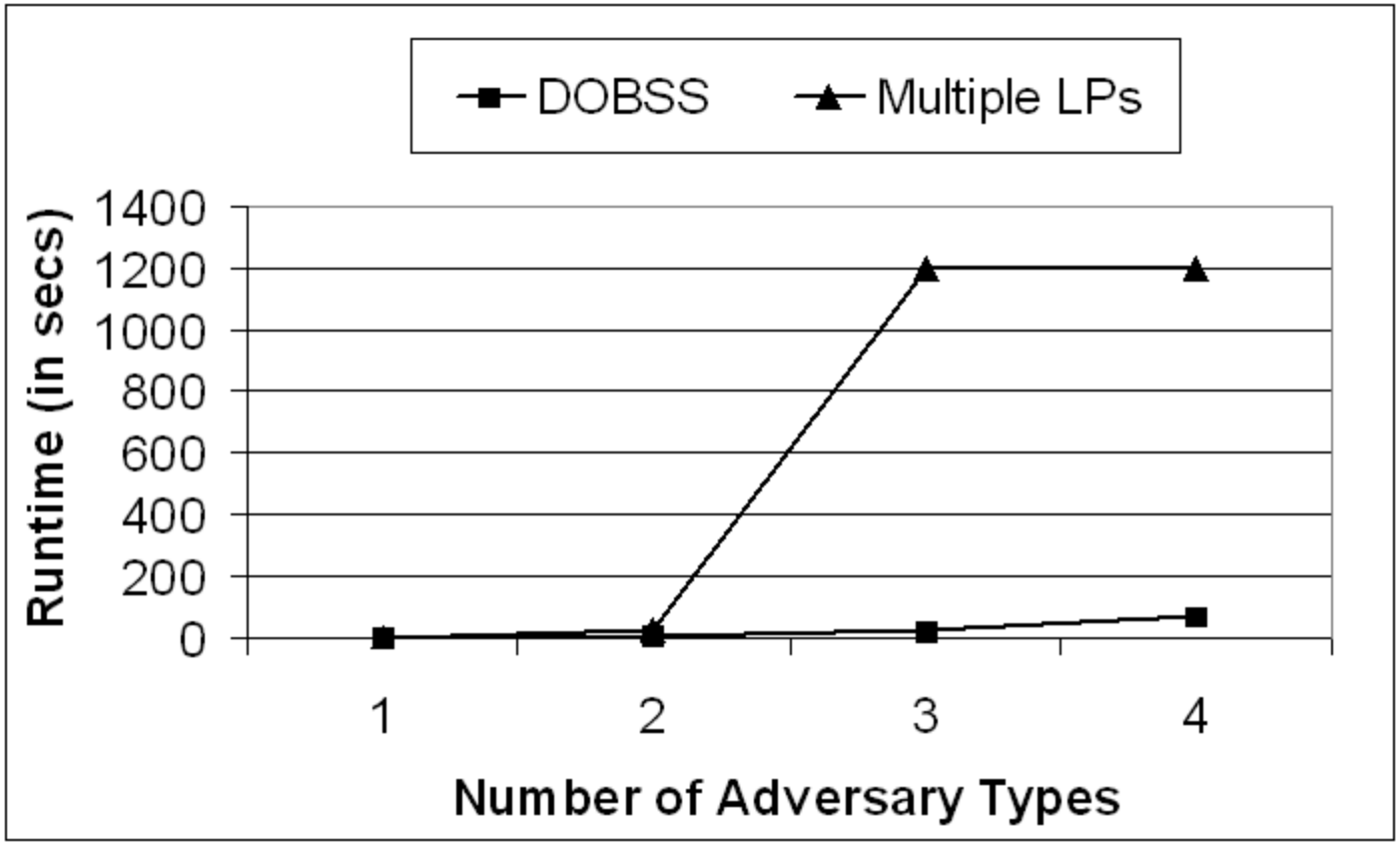
THE END

Bayesian Stackelberg Game: New Algorithms

- Mixed-integer linear program (MILP)
  1. Exact Solution
     - DOBSS
     - Decomposition
  2. Heuristic solution
     - ASAP

- *Optimal Mixed strategies: Weights for randomization*

Run Time Comparison



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Federal Air Marshals (FAM)	Randomizing placement of air marshals	Jim Curren James.B.Curren@secureskies.net	Discussions on-going since Novmeber 2007. Projected to start project April 2008.
Transportation Security Administration (TSA)	Mobile security at airports	Andrew Cox Andrew.cox@dhs.gov	Discussion on-going since January 2007. Projected to start project Summer 2008.
Transportation Security Administration (TSA)	Randomizing Land Side transportation security	Ash Chatterjee Ash.Chatterjee@dhs.gov	Initial discussion November 2007. To follow-up.
Richmond Airport Police Department	Randomizing patrols	Chief Quenton Trice qtrice@flyrichmond.com	Initial email discussion January 2008. To follow up.
Coulee Dam Washington State	Randomizing patrols and assignments	Dave Everett ,Chief of Security daeverett@pn.usbr.gov	Initial discussion January 2008. To follow up.
The Port Authority of New York and New Jersey	Under discussion	Connie Lee CChiMeiLee@panynj.gov	Discussion starting up.

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		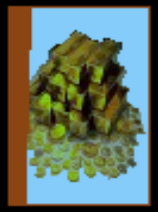	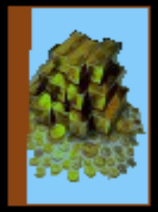	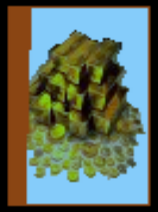	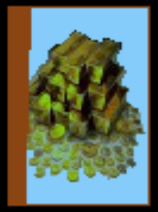		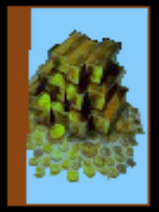
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SEPTEMBER 2007