Scheduling of Patrols Within the UPLB Campus Using an Opportunistic Crime Security Game

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Introduction

- Patrolling is one of the most common practices done by security entities
- There are two challenges faced when deploying patrols
  - Limitations to resources, as full coverage is costly
  - Patrol movements can be observed by enemies, and avoiding predictability is a must

Introduction

- Randomization of patrol movements can help against predictability, but full dependence on pure randomization causes inconsistencies.
    - Higher priority areas may not be visited sufficiently
    - Several areas may receive too few or too many visits day by day
- Randomization cannot be effectively executed by human subjects without assistance.
    - Patrols ordered to “move randomly” are still susceptible to personal biases, and patterns may still develop patterns

Introduction

- This study aims to assist the UPLB University Police Force in deploying patrols optimally within the campus.
- A scheduling program is developed that addresses the following:
  - Deploy patrols randomly, but with weighted probabilities (high priority areas get higher probabilities)
  - Create patrolling schedules that make it harder for enemies to predict patrol movements

Review of Literature

Stackelberg Security Games (SSGs)

- Leader/defender constantly deploys patrols to protect targets, knowing that followers/attackers are observing and are planning an attack
- When patrol movements are more difficult to predict, attackers will find it harder to figure out when and where to attack

Review of Literature

Three categories of SSGs:

- Infrastructure security games (organized crime, terrorist attacks)
- Green security games (poachers, illegal loggers, illegal fishing)
- Opportunistic crime security games (urban crime)

Review of Literature

Primary challenges of SSGs:

- Scalability (complexity increases as the amount of resources and targets increase)
- Robustness (assumptions may be inaccurate, researches often adjust the algorithm using obtained data)
- Bounded Rationality (adversaries are not perfectly rational, not selecting the optimal strategy as assumed by game theory)

Review of Literature

Opportunistic Crime Security Games

- Crimes occurring in public areas, such as UPLB, are considered opportunistic
- Criminals do not plan ahead, instead they commit crime when they see a chance
- Crime data can be used to in planning and adapting the security entity's strategy, prioritizing areas with higher crime rates
- If criminals perceive a greater risk, they are often discouraged from committing crime

Materials and Methods

Software used for this research

- Java 11
- Eclipse Integrated Development Environment (IDE) version 2020-12

Materials and Methods

- The campus is divided into 3 zones, and each zone into patches
- User sets the schedule length, interval length and the number of patrols deployed in each zone
- Each patrol only moves within the zone they're assigned to, except during emergencies.
- Zoning ensures patrols are spread fairly well across campus

Materials and Methods

- Patches have “weight” values, determined by their priority level
- Each zone has its own probability distribution influenced by the weights of the patch they contain
- A patch’s probability is determined by its weight divided by the sum of all weights in the zone

Patch	Weight
Alpha	20
Bravo	40
Charlie	10
Delta	10
Echo	5

Materials and Methods

- For each zone, in between intervals, the scheduling program selects patches equal to the number of patrols in the zone.
- A patch may be selected for consecutive patches
- More patrols in each zone improve coverage

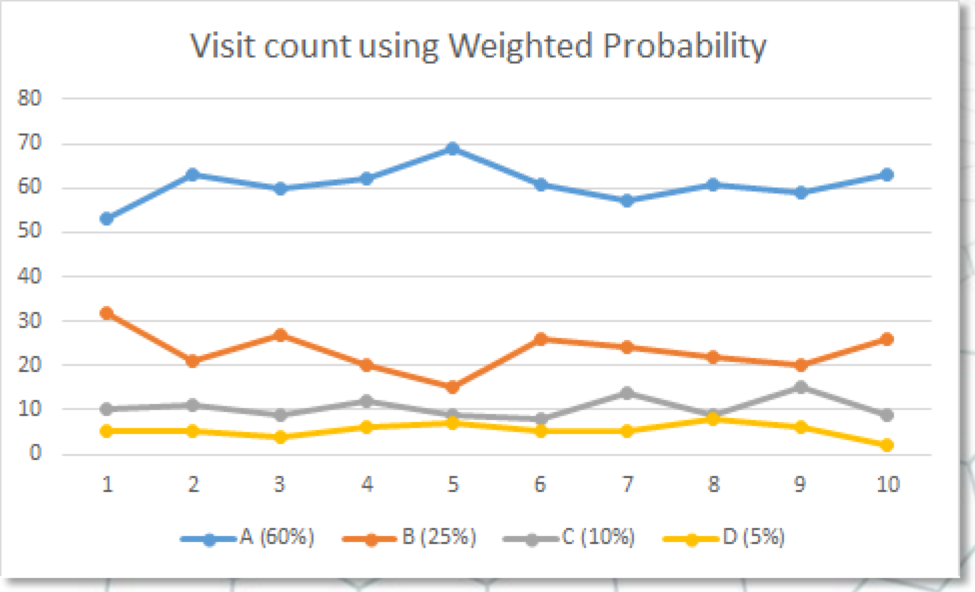
Materials and Methods

- Each patrol has an estimated “mileage” value that calculates how far said patrol has travelled
- When assigning which patrol to visit what patch, the program aims to keep the average mileage low (each zone gets an exclusive average mileage)

"Alpha" Estimated Mileage: 3590	"Bravo" Estimated Mileage: 3570	"Charlie" Estimated Mileage: 5030	"Delta" Estimated Mileage: 6800
1: Oblation Park	1: Palma Bridge	1: CEAT	1: Forestry Dorms
2: Carabao Park	2: Main Library	2: CEAT	2: Forestry Dorms
3: BioSci	3: Main Library	3: Animal Science Area	3: Forestry Dorms
4: Palma Bridge	4: BioSci	4: DL Umali Hall	4: Forestry Dorms
5: Main Library	5: Carabao Park	5: CEAT	5: Univ. Health Service
6: Main Library	6: CEM/Raymundo Gate	6: DL Umali Hall	6: CFNR
7: CEM/Raymundo Gate	7: Oblation Park	7: YMCA	7: Univ. Health Service
8: Oblation Park	8: Carabao Park	8: DL Umali Hall	8: Forestry Dorms
9: Palma Bridge	9: BioSci	9: Student Union Building	9: Splash Properties
10: Oblation Park	10: Math Building	10: DL Umali Hall	10: Forestry Dorms
11: Main Library	11: Palma Bridge	11: Animal Science Area	11: Forestry Dorms
12: Main Library	12: Oblation Park	12: Animal Science Area	12: Forestry Dorms
13: CEM/Raymundo Gate	13: Oblation Park	13: DL Umali Hall	13: CFNR
14: Carabao Park	14: Palma Bridge	14: DL Umali Hall	14: CFNR
15: Main Library	15: Oblation Park	15: YMCA	15: CFNR

Results and Discussion

- The effectiveness of the scheduler increases as the number of patrols increase.
- The scheduler kept visit frequencies consistent, and higher priority areas are sufficiently visited
- Attackers may observe how often an area is visited, but not predict when the visits occur



Results and Discussion

- Comparing the schedulers output to a system using Uniform Randomization shows that weighed probability is more effective
  - Visit frequencies were nearly equal to each other, which in the real world, would be inefficient
- Comparisons to unaided human decision making could not be conducted as information on current patrol strategies was confidential.

Results and Discussion

- The zoning approach has provided several limitations
  - Inability to transfer patrols between zones midway
  - Patrols still have a tendency to cluster in one area of the zone
  - Zones with zero assigned patrols are unguarded for the duration of the generated schedule
- Long duration schedules cannot be generated properly as patrols have no way to reset mileage values, which would have reflected personnel replacements/shifts.
- It is possible to keep the average mileage lower if the scheduler can look ahead into the schedule when assigning patrols.

Conclusion and Future Work

- This scheduler is capable of deploying patrols around the campus while avoiding predictability
- High priority areas are ensured a sufficient amount of visits, while lower priority areas will not be neglected.
- Implementations on zoning, scheduling, and assignment can still be improved by more dynamic approaches

Conclusion and Future Work

- Real-time data on patrol locations would improve the scheduler's algorithm, which can be obtained by simulation integrated into the system itself, or real world GPS data.
- Future studies may look into larger domains with different constraints and environments, such as subdivisions or public events.