INVESTIGATING CRIME DISPLACEMENT THEORY: AN AGENT-BASED REINFORCEMENT LEARNING APPROACH

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A BRIEF HISTORY…

- Does crime **move** from one location to another when an **intervention** measure is deployed? This question has spurred a significant debate among scholars within the environmental criminology domain.
- Some argue that crime can move from one **location** to another under certain circumstances with no net reduction in cases if, for example, opportunities for crime are vast over **space** and **time**.
- Evidence to support this idea that crime "just moves" (**displacement**) in the aftermath of situational crime prevention is **minuscule**.
- A vast amount of research provides evidence on the **contrary**, where crime relocates in only a small number of cases, while a surge in benefits in surrounding areas not targeted by interventions is a more likely outcome (**diffusion of benefits**)

Johnson, S.D., Guerette, R.T. & Bowers, K. Crime displacement: what we know, what we don't know, and what it means for crime reduction. *J Exp Criminol* **10,** 549–571 (2014). https://doi.org/10.1007/s11292-014-9209-4

R V G CLARKE. "SITUATIONAL" CRIME PREVENTION: THEORY AND PRACTICE.The British Journal of Criminology, 20(2):136–147, 4 1980.ISSN 0007-0955. doi: 10.1093/oxfordjournals.bjc.a047153. URLhttps://doi.org/10.1093/oxfordjournals.bjc.a047153.

REINFORCEMENT LEARNING FOR OFFENDER DECISION-MAKING?

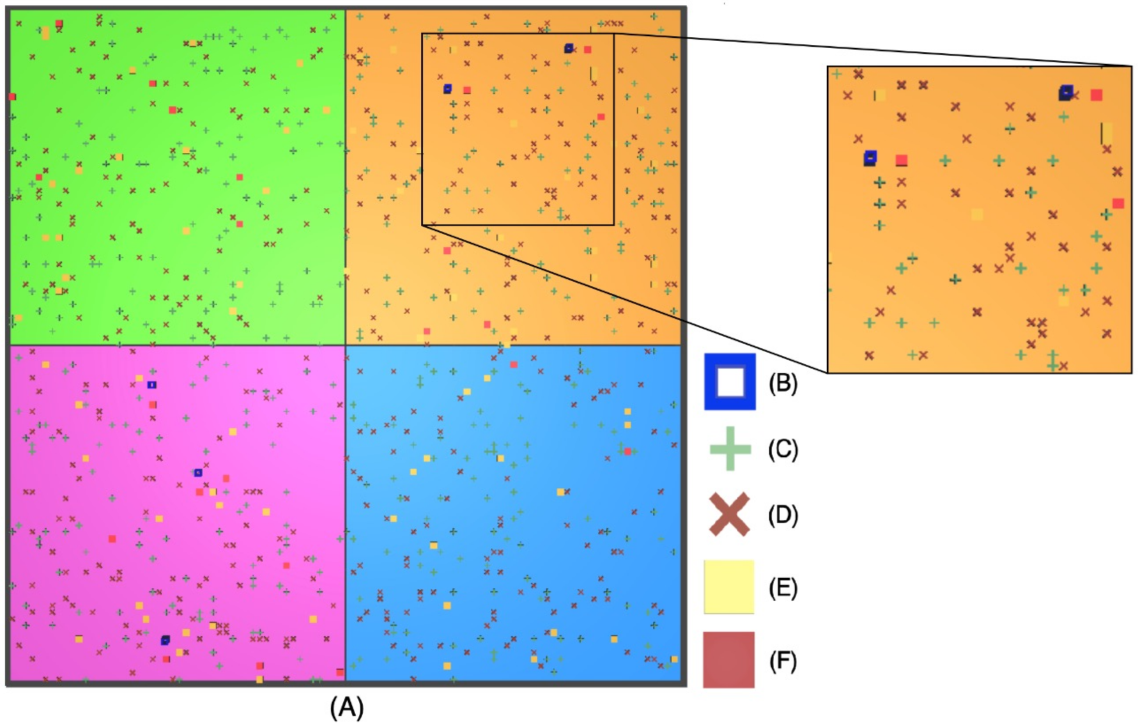


Figure 1: Example Model Environment, where (A) is the environment space on a 100 x 100 grid which includes five offender agents (B), 100 targets (C) and interventions (D) at each of the four spatial boundaries, 100 nodes (E) were also scattered throughout the environment, of these, 23 were routine activity nodes (F), where each offender has five assigned nodes (the same node can be assigned to two or more offenders).

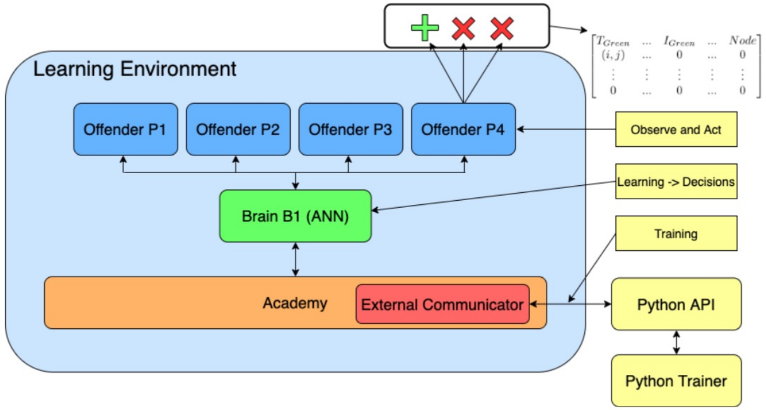
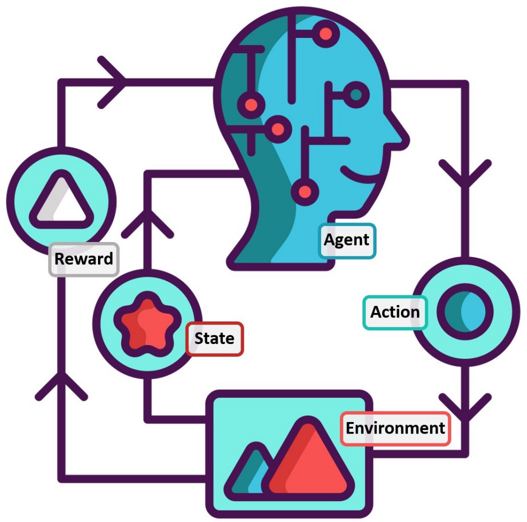
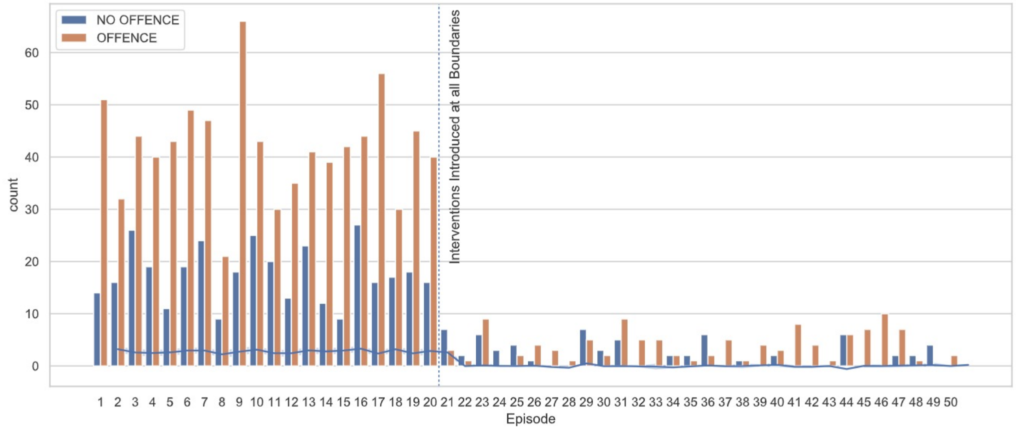


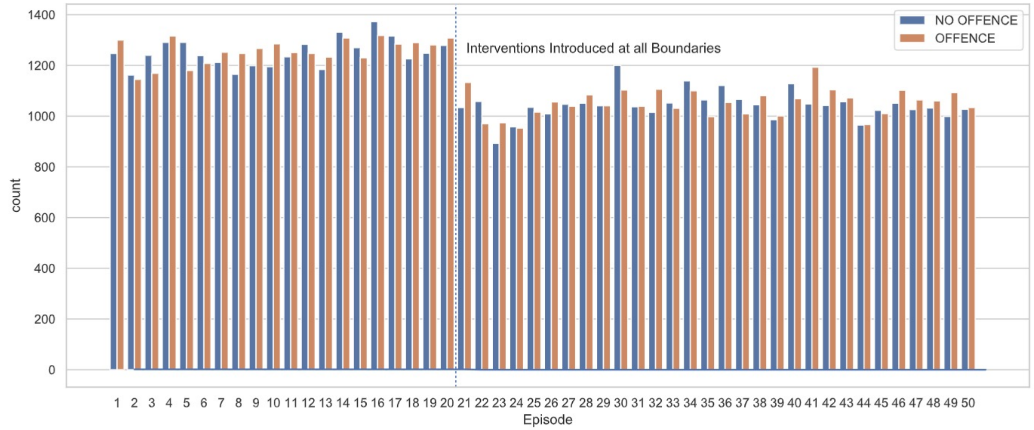
Figure 8: A block diagram of the reinforcement learning life cycle in ml-agents [Juliani et al., 2018]



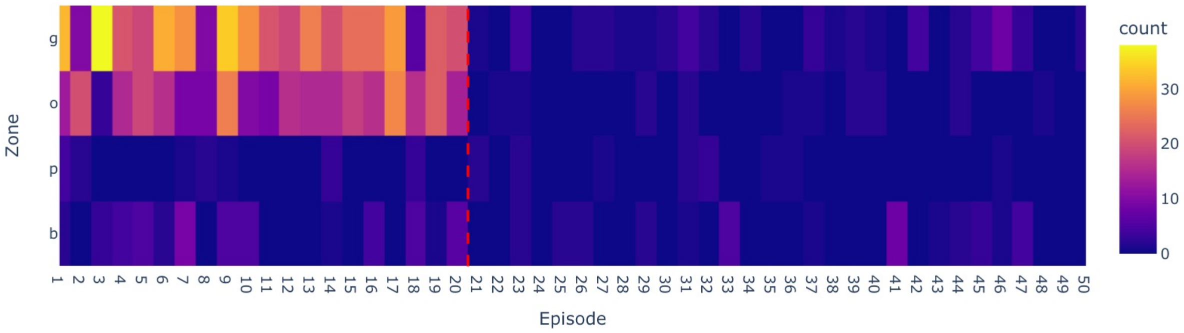
RESULTS

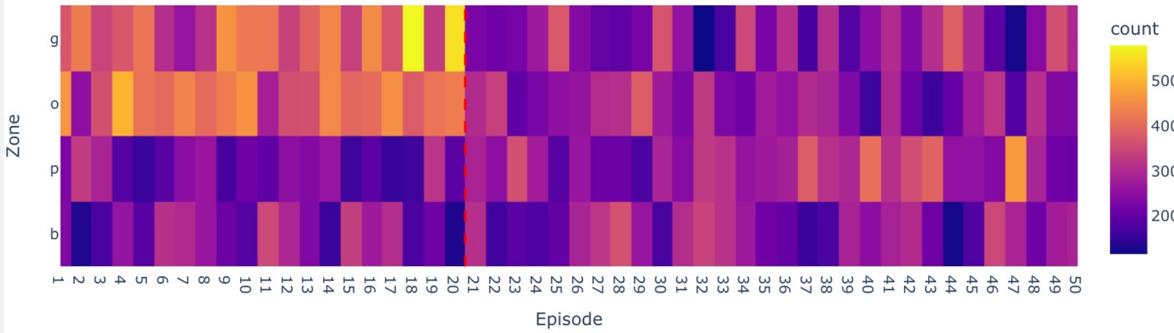


(**a**) Decision-Making - Reinforcement Learning

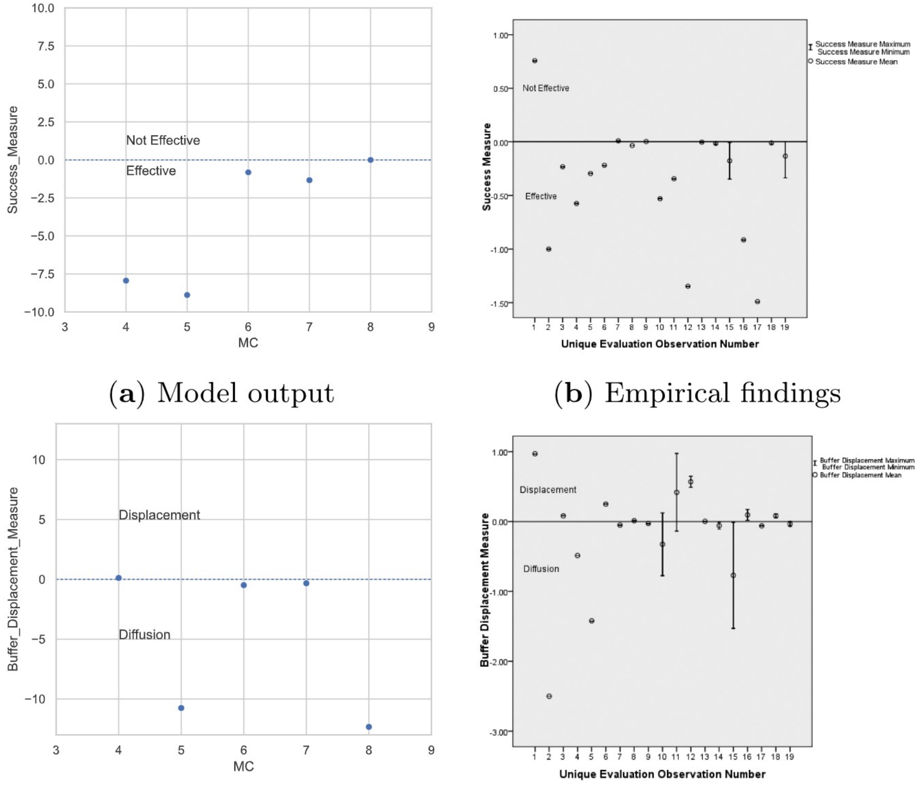


(**c**) Decision-Making - Random





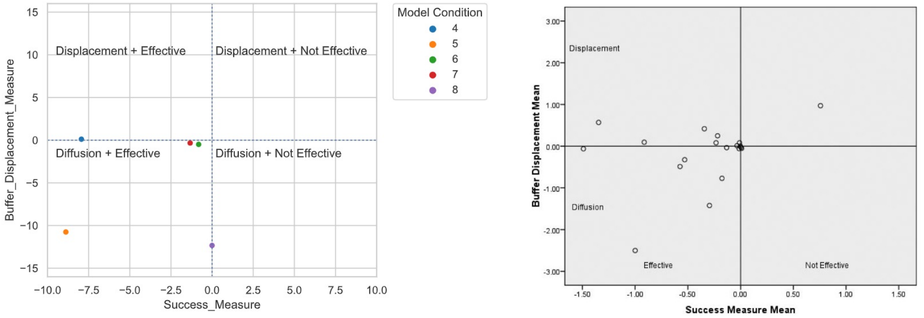
THE EMPIRICAL VS THE SIMULATION



(**a**) Model output (**b**) Empirical findings

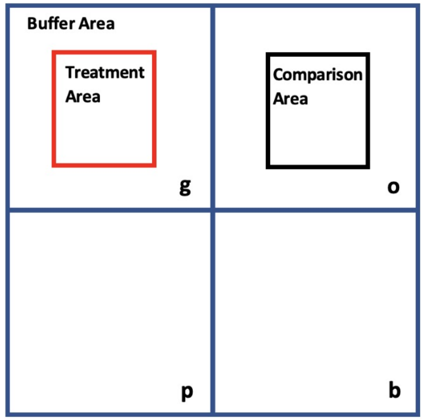
(**c**) Model output (**d**) Empirical findings

Figure 11: Treatment and Displacement/Diffusion effects of intervention measures (source for (b) and (d) is [GUERETTE and BOWERS, 2009]).



(**a**) Model output (**b**) Empirical findings

Figure 12: Buffer Displacement Measure plotted against Treatment Effects (source for (b) is [GUERETTE and BOWERS, 2009]).



ROB T. GUERETTE and KATE J. BOWERS.ASSESSING THE EX-TENT OF CRIME DISPLACEMENT AND DIFFUSION OF BENE-FITS: A REVIEW OF SITUATIONAL CRIME PREVENTION EVALU-ATIONS*.Criminology, 47(4):1331–1368, 11 2009. ISSN 00111384. doi:10.1111/j.1745-9125.2009.00177.x. URLhttp://doi.wiley.com/10.1111/j.1745-9125.2009.00177.x.

CONCLUDING REMARKS

- This study set out to design, develop and analyse a novel agent-based reinforcement learning model to study the aftermath of situational crime prevention initiatives.
- The results support the arguments made for situational crime prevention initiatives, namely that "the amount of crime prevented has been invariably shown to exceed the amount of crime displaced".
- Intervention initiatives should not be **<=10%** of the number of targets in the treatment boundary; this would likely lead to displacement post-intervention. All intervention initiatives should be **30 to >=50%**; these initiatives are more likely to be the most effective and lead to diffusion of crime control benefits.

Robert Barr and Ken Pease. Crime Placement, Displacement, and Deflection. Crime and Justice, 1990. ISSN 0192-3234. doi: 10.1086/449167.

R V G CLARKE. "SITUATIONAL" CRIME PREVENTION: THEORY AND PRACTICE. The British Journal of Criminology, 20(2):136–147, 4 1980.ISSN 0007-0955. doi: 10.1093/oxfordjournals.bjc.a047153. URL https://doi.org/10.1093/oxfordjournals.bjc.a047153.

Richard Wortley. Situational precipitators of crime. In Environmental Criminology and Crime Analysis: Second Edition. 2016. ISBN 9781317487104. doi:10.4324/9781315709826.

INTERESTED?

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Recent Publications

- Olmez, S.; Douglas-Mann, L.; Manley, E.; Suchak, K.; Heppenstall, A.; Birks, D.; Whipp, A. Exploring the Impact of Driver Adherence to Speed Limits and the Interdependence of Roadside Collisions in an Urban Environment: An Agent-Based Modelling Approach. *Appl. Sci.* **2021**, *11*, 5336. https://doi.org/10.3390/app11125336

- Sedar Olmez, Obi Thompson Sargoni, Alison Heppenstall, Daniel Birks, Annabel Whipp, Ed Manley (2021, March 22). "3D Urban Traffic Simulator (ABM) in Unity" (Version 1.1.0). *CoMSES Computational Model Library*. Retrieved from: https://www.comses.net/codebases/32e7be8c-b05c-46b2-9b5f-73c4d273ca59/releases/1.1.0/

- Heppenstall, A., Crooks, A., Malleson, N., Manley, E., Ge, J. and Batty, M., 2021. Future Developments in Geographical Agent-Based Models: Challenges and Opportunities. *Geographical analysis*, *53*(1), pp.76-91.

- Birks, D., Coleman, A. and Jackson, D., 2020. Unsupervised identification of crime problems from police free-text data. *Crime Science*, *9*(1), pp.1-19.