

Purdue Homeland Security Institute

Recreating the 1999 Columbine High School Shooting with AnyLogic: Examining the Effectiveness of Active Shooter Mitigation Policies

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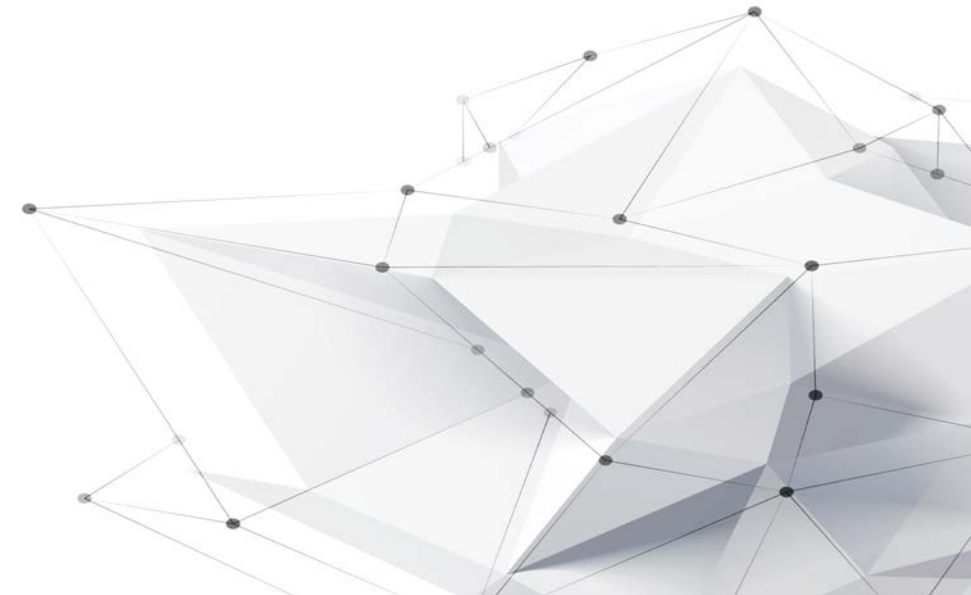
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Presentation Outline

1. Executive Summary
2. Measuring the Effectiveness of RUN.HIDE.FIGHT.®
3. AnyLogic's Ability to Recreate Historical Events
4. Measuring Policy Implications during Emergencies
5. Columbine Model Demonstration with RHF®
6. Question & Answer



1. Executive Summary

Modeling Historical Active Shooter Events to Measure Today's Mitigation/Response Policies.

	Overview	Limitations
Rise of the Active Shooter Incidents	<ul style="list-style-type: none">- 7.4 annual average incident (2000-2008) to 19.1 incidents per year (2009-2016). [1]- Mitigation/Response tactics such as RUN.HIDE.FIGHT.® [2] Avoid Deny Defend™ [3] and Advanced Law Enforcement Rapid Response Training [4] were implemented nationwide.	<ul style="list-style-type: none">- Inability to predict/prevent active shooter incidents.- Lack of mitigation/response training implementation among stakeholders.
Development of Active Shooter Incidents based on Hypothetical Events	<ul style="list-style-type: none">- Active shooter incident simulations within the commerce and academia infrastructure.- Implementing offensive measure (school resource officer/armed staff teachers).	<ul style="list-style-type: none">- The model layout were based on hypothetical infrastructure.- Limitations for civilian agents to avoid the shooter agent's threat.
Development of Concept Models to Implement Realism	<ul style="list-style-type: none">- The agents' ability to move based on their predetermined logic. Examples: line of fire, nearest target selection, hide/fight offense.	<ul style="list-style-type: none">- Unable to measure the pros/cons of one concept model to another due to integration challenges.
Development of Active Shooter Incidents based on Historical Events	<ul style="list-style-type: none">- Recreation of the incidents that have occurred in the library during the 1999 Columbine High School Shooting with the individual modeling concepts to learn the shooters agents minimum parameters, and the effectiveness of Run.Hide.Fight.®.	<ul style="list-style-type: none">- Pending implementation of law enforcement intervention w/wo contact team formation.

2. Measuring the Effectiveness of RUN.HIDE.FIGHT.®

Recreating the Columbine Library Incidents with AnyLogic.



Target Line: The escape route for the agents during the RUN phase.

Rectangular Area: Enabling the line of fire, hiding area, agent placement

Attractor: Agents' location determinant based on historical events.

Wall: Limiting the agent's movement within the library.

Rectangular Wall: Physical obstacles such as desks, chairs, and book shelves.

2. Measuring the Effectiveness of RUN.HIDE.FIGHT.®

Model Validation by Simulating Historical Events to Learn the Shooters' Speed and Range.



Table 1.

Historical Events Based On the Police Report

<u>Historical Parameters</u>	<u>Parameter</u>
Hide Duration	240 seconds
Incident Duration	420 seconds
Total Staff/Student Agents	56 agents
Total Casualties	22 agents
Total Shooter Agents	2 agents

Table 2.

Learned Parameters based on the Historical Events

<u>Minimum Parameters</u>	<u>Parameter</u>
Shooter Agents' Movement	2.83 FPS
Shooter Agents' Discharge Range	51.12 feet

2. Measuring the Effectiveness of RUN.HIDE.FIGHT.®

Implementing Parameters from the Historical Events to Learn the Discharge Scope.



Table 3.

Historical Events Based On the Police Report

<u>Historical Parameters</u>	<u>Parameter</u>
Hide Duration	240 seconds
Incident Duration	420 seconds
Total Staff/Student Agents	56 agents
Total Casualties	22 agents
Total Shooter Agents	2 agents
Shooter A Agent Discharge Interval	12.35 seconds
Shooter A Agent Discharge Interval	15.56 seconds

Table 4.

Learned Parameters based on the Historical Events

<u>Minimum Parameters</u>	<u>Parameter</u>
Shooter Agents' Movement	2.83 FPS
Shooter Agents' Discharge Range	51.12 feet
Shooter Agents' Discharge Scope	14.31 degrees

3. Recreation of Historical Events with AnyLogic

AnyLogic allows to model unique events and procure data sets for diverse analytics.

- Recreation of physical boundaries/infrastructure.
 - Firearm-proof shelter, automated door-lock, physical barriers.
- Diverse agent configuration with role-specific abilities.
 - Unarmed individuals: nearest exit detection, offensive logic (objects/firearm).
 - Police officers: contact team formation, magazine capacity, response time.
 - Active shooter: rate of discharge, fire power , unpredictability/randomness.
- Convenient data collection capabilities.
 - Model validation with output data to confirm the logic integrity.
 - On-time display of procured data while running simulations.
 - Experiment framework to run models with diverse parameters.
 - Ability to learn the minimum threshold during first responder events.
 - Easiness in model validation while referencing to the output data.

4. Measuring Policy Implications during Emergencies

The emergency policies are low frequency, high impact limiting evidence-based policy development and examination.

- Despite the increasing frequency of active shooter incidents, the examination of mitigation/response policies are limited due to its uniqueness.
 - 1999 Columbine High School.
 - 2007 Virginia Tech.
 - 2012 Sandy Hook Elementary School.
 - 2016 Orlando Nightclub.
 - 2017 Las Vegas Strip.
 - 2018 Stoneman Douglas High School.
- Limitations in recreating historical active shooter events in real-life to test the effectiveness of policies (data procurement).
 - Logistics in participants, infrastructure, reenacting historical event, stakeholders' contribution.
 - Limitations in data validation during what-if scenarios.

5. 1999 Columbine Model Demonstration with RHF[®]

All Run Scenario for Student/Staff Agents as Shooter Agents Enters the Library.



Table 5.

Parameter Overview for All Run Scenario

<u>Parameters</u>	<u>Parameter</u>
Shooter Agents' Movement	2.83 FPS
Shooter Agents' Discharge Range	51.12 feet
Shooter Agents' Discharge Scope	14.31 degrees
Shooter Agents' Discharge Interval	1 second
Run Probability	1.0
Hide Probability	0
Fight Probability	0
Hide Distance	0 feet
Fight Distance	0 feet

Table 6.

Parameter Overview for All Run Scenario

<u>Parameters</u>	<u>Count</u>
Student/Staff Agent: Survived	35
Student/Staff Agent: Casualty	21
Shooter Agent: Survived	2
Shooter Agent: Casualty	0

5. 1999 Columbine Model Demonstration with RHF[®]

All Hide Scenario for Student/Staff Agents as Shooter Agents Enters the Library.



Table 7.

Parameter Overview for All Run Scenario

<u>Parameters</u>	<u>Parameter</u>
Shooter Agents' Movement	2.83 FPS
Shooter Agents' Discharge Range	51.12 feet
Shooter Agents' Discharge Scope	14.31 degrees
Shooter Agents' Discharge Interval	1 second
Run Probability	0
Hide Probability	1.0
Fight Probability	0
Hide Distance	0 feet
Fight Distance	0 feet

Table 8.

Parameter Overview for All Hide Scenario

<u>Parameters</u>	<u>Count</u>
Student/Staff Agent: Survived	0
Student/Staff Agent: Casualty	56
Shooter Agent: Survived	2
Shooter Agent: Casualty	0

5. 1999 Columbine Model Demonstration with RHF[®]

All Fight Scenario for Student/Staff Agents as Shooter Agents Enters the Library.

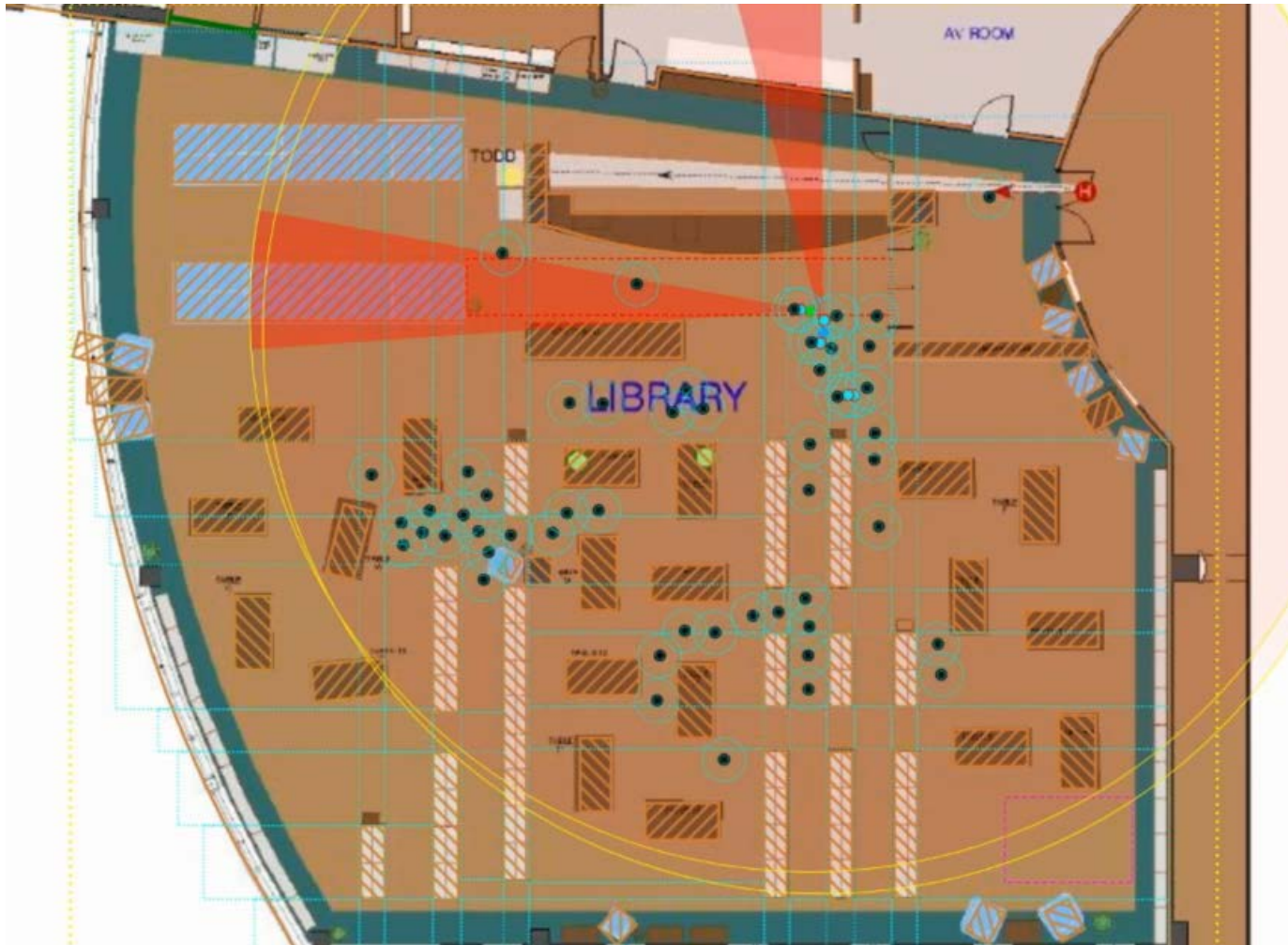


Table 9.

Parameter Overview for All Run Scenario

<u>Parameters</u>	<u>Parameter</u>
Shooter Agents' Movement	2.83 FPS
Shooter Agents' Discharge Range	51.12 feet
Shooter Agents' Discharge Scope	14.31 degrees
Shooter Agents' Discharge Interval	1 second
Run Probability	0
Hide Probability	0
Fight Probability	1.0
Hide Distance	0 feet
Fight Distance	0 feet

Table 10.

Parameter Overview for All Fight Scenario

<u>Parameters</u>	<u>Count</u>
Student/Staff Agent: Survived	51
Student/Staff Agent: Casualty	5
Shooter Agent: Survived	0
Shooter Agent: Casualty	2

5. 1999 Columbine Model Demonstration with RHF[®]

All Run Scenario with 20 feet hide, and 5 feet fight range.



Table 9.

Parameter Overview for All Run Scenario

<u>Parameters</u>	<u>Parameter</u>
Shooter Agents' Movement	2.83 FPS
Shooter Agents' Discharge Range	51.12 feet
Shooter Agents' Discharge Scope	14.31 degrees
Shooter Agents' Discharge Interval	1 second
Run Probability	1.0
Hide Probability	0
Fight Probability	0
Hide Distance	20 feet
Fight Distance	5 feet

Table 10.

Parameter Overview for All Fight Scenario

<u>Parameters</u>	<u>Count</u>
Student/Staff Agent: Survived	47
Student/Staff Agent: Casualty	9
Shooter Agent: Survived	0
Shooter Agent: Casualty	2

5. 1999 Columbine Model Demonstration with RHF[®]

Run, Hide, Fight probabilities set to 33% each.

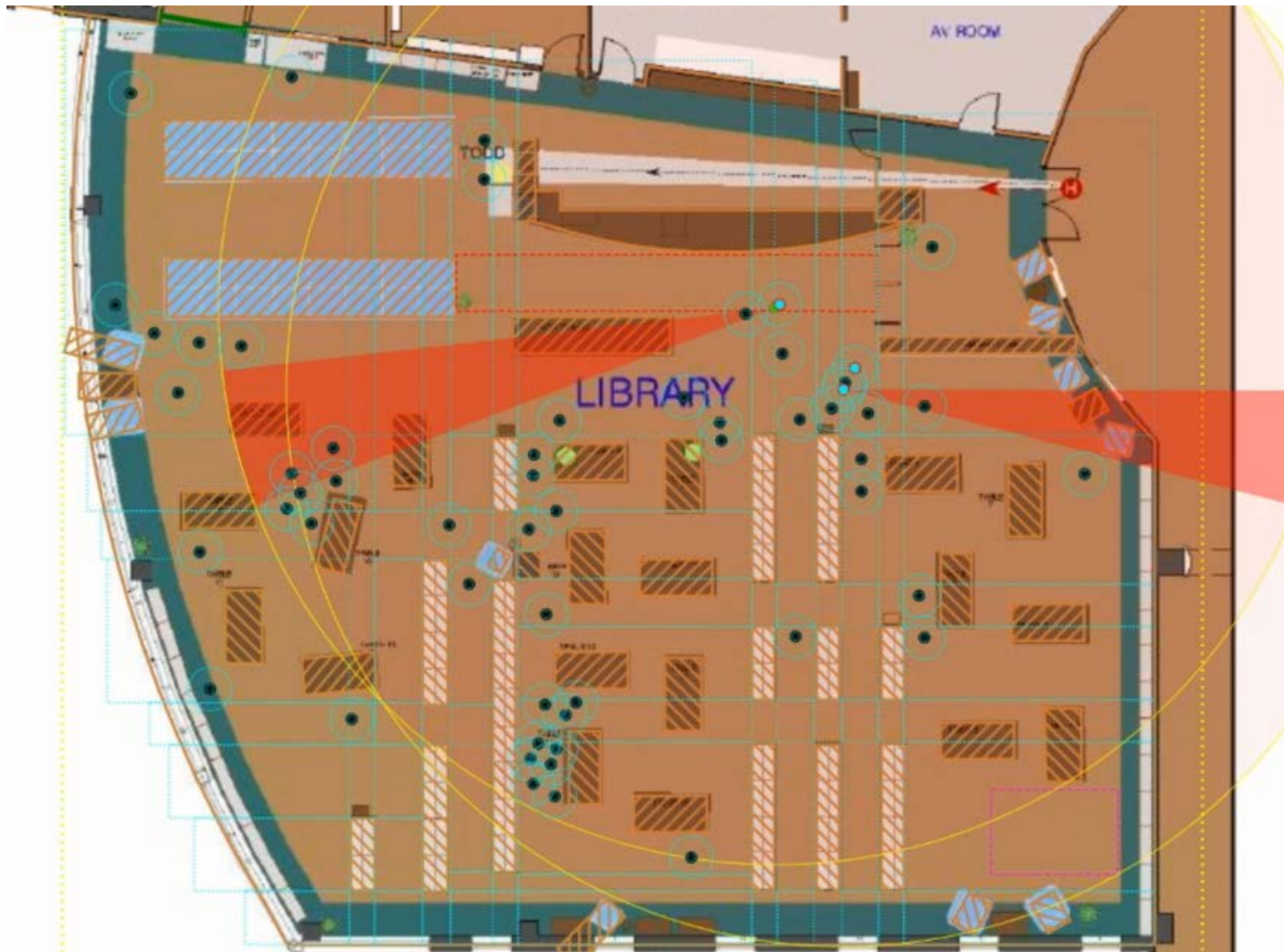


Table 9.

Parameter Overview for All Run Scenario

<u>Parameters</u>	<u>Parameter</u>
Shooter Agents' Movement	2.83 FPS
Shooter Agents' Discharge Range	51.12 feet
Shooter Agents' Discharge Scope	14.31 degrees
Shooter Agents' Discharge Interval	1 second
Run Probability	.33
Hide Probability	.33
Fight Probability	.33
Hide Distance	0 feet
Fight Distance	0 feet

Table 10.

Parameter Overview for All Fight Scenario

<u>Parameters</u>	<u>Count</u>
Student/Staff Agent: Survived	53
Student/Staff Agent: Casualty	3
Shooter Agent: Survived	0
Shooter Agent: Casualty	2

5. 1999 Columbine Model Demonstration with RHF®

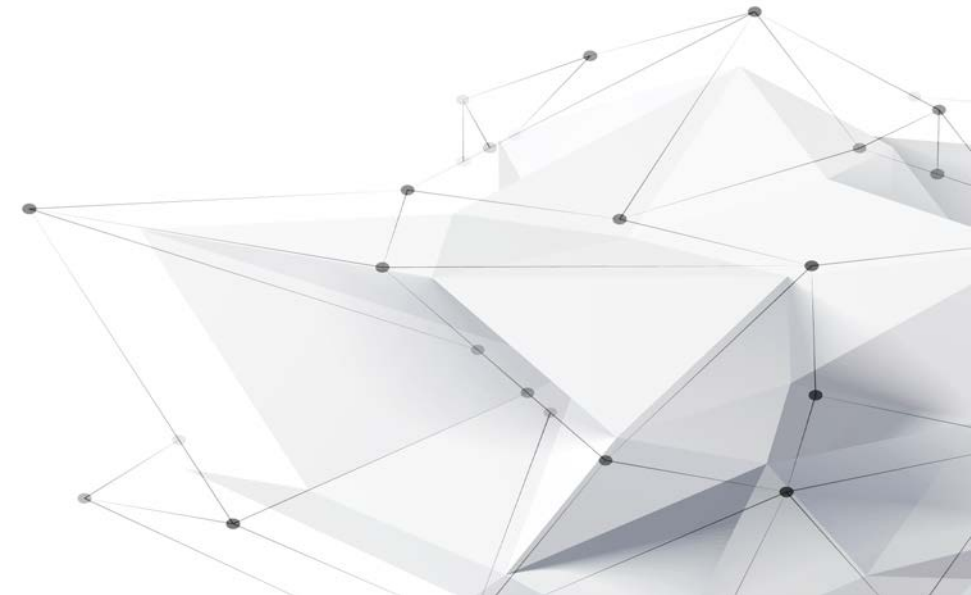
Table 11.

Casualties per Scenarios

<u>Parameters</u>	<u>Historical</u>	<u>All Run</u>	<u>All Hide</u>	<u>All Fight</u>	<u>20 Ft. Hide, 5 Ft. Fight</u>	<u>33% per Run, Hide, and Fight</u>
Student/Staff Agent: Survived	34	53	0	51	47	53
Student/Staff Agent: Casualty	22	3	56	5	9	3
Shooter Agent: Survived	2	0	2	0	0	0
Shooter Agent: Casualty	0	2	0	2	2	2

Note: AnyLogic allows for extensive testing through modeling of policy alternatives.

6. Question and Answer



References

- [1] - <https://www.fbi.gov/about/partnerships/office-of-partner-engagement/active-shooter-incidents-graphics>
- [2] - <http://www.houstonoem.org/run-hide-fight-surviving-an-active-shooter-event/>
- [3] - <http://www.avoiddenydefend.org/>
- [4] - <https://alerrt.org/>