Independent Audit of the ShotSpotter Accuracy

March 28, 2022

Prepared by:
Edgeworth Analytics

Prepared for:
ShotSpotter

www.edgeworthanalytics.com

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I. EXECUTIVE SUMMARY

According to a report from the Brookings Institution, 88 percent of gunshot incidents go unreported to police.[1] The ShotSpotter system is an acoustic gunshot detection service that detects, locates, and alerts police to gunfire, including those incidents that otherwise would have gone unreported. ShotSpotter enables law enforcement agencies to provide a precise and rapid response to detected incidents. The system uses wireless sensors throughout a coverage area to capture loud, impulsive sounds that may be gunfire. The data are transmitted to a central cloud service that filters out sounds that are clearly not gunshots and provides a location determined by triangulation enabled by sensors. Trained ShotSpotter employees, located across two ShotSpotter Incident Review Centers, listen to the pulses from the sensors that detected the incident audio with playback tools, analyze the visual waveforms to see if they match the typical pattern of gunfire, and either publish the incident as gunfire or dismiss it as non-gunfire. The entire process is intended to take less than 60 seconds from the time of the gunfire to the time law enforcement is alerted to allow for a timely law enforcement response.

ShotSpotter claims that its system is 97% accurate and has a false positive rate—the rate at which gunfire is detected when none occurred—of 0.5%. To determine the accuracy rate for its system, ShotSpotter analyzes information from clients on possible errors, determines whether an error occurred, and catalogs any errors found. In 2021, ShotSpotter commissioned Edgeworth Analytics to conduct an independent audit of the 2019 and 2020 data and analyses that it uses to support its claims. Our audit confirmed that ShotSpotter correctly detected, classified, and published gunfire incidents with 97.59% accuracy. ShotSpotter commissioned Edgeworth Analytics to conduct an additional independent audit of its 2021 data and analysis. Based on our analyses, our audit has yielded five important insights:

- ShotSpotter's accuracy in 2021 was slightly better than 2019 and 2020, and its reports of gunfire when there was none were down in 2021.
- Specifically, ShotSpotter published 146,804, 233,966, and 291,726 gunfire alerts to clients in 2019, 2020, and 2021, respectively.[2] For these years across all clients, our audit confirmed that based on client reports ShotSpotter correctly detected, classified, and published gunfire with 97.69% accuracy, which is slightly higher than the 2019 and 2020 accuracy rate of 97.59%.
- From 2019 to 2021, the ShotSpotter system published alerts of gunfire when clients subsequently indicated that none occurred 0.36% of the time, a decrease from 0.41% in 2019 and 2020.
- Despite substantial variation in the intensity of reporting of potential errors across clients, ShotSpotter's accuracy rate does not appear to be sensitive to differences in clients' propensity to report potential errors.

1 https://www.brookings.edu/research/the-geography-incidence-and-underreporting-of-gun-violence-new-evidence-using-shotspotter-data/.

2 A small number of ShotSpotter accounts—six in 2019, 12 in 2020, and eight in 2021—were for clients for which feedback was not expected. These included new clients, pilot programs, and clients who terminated their service, as well as some low volume clients. Excluding these accounts, there were 144,739 alerts in 2019, 229,359 alerts in 2020, and 286,438 alerts in 2021 with an accuracy rate of 97.66% on average across the years.

- No single client exerts a disproportionate effect on ShotSpotter's overall error reporting rate such that the accuracy rate would change significantly.

This report discusses Edgeworth Analytics' approach to auditing ShotSpotter's data and analysis and our additional testing, intended to ensure the validity of our results.

II. SHOTSPOTTER DATA SOURCES

Edgeworth Analytics obtained data from ShotSpotter for 2019 to 2021. We discussed the data available and ShotSpotter's error tracking and reporting process with ShotSpotter personnel. Based on our discussions with ShotSpotter personnel, we requested the following data:

- The number of published incidents sent to clients, by location;
- Potential errors identified by clients for investigation and ShotSpotter's conclusions regarding those potential errors; and
- Several samples of "Monthly Scorecards," which are documents sent to clients summarizing the activity detected and the error rates.

ShotSpotter data on published incidents are tracked in ShotSpotter's own systems. However, information on potential errors relies on clients reporting those potential errors to ShotSpotter. When an error report comes in from a client, ShotSpotter creates a ticket and the incident is reviewed. The conclusion of the review may result in one of several outcomes:

- A gunfire incident did not occur, but ShotSpotter published an alert for one—this is referred to as a "false positive;"
- A gunfire incident occurred and ShotSpotter detected it, but an alert was not published for gunfire—this is referred to as a "false negative;"
- A gunfire incident occurred and was not detected by ShotSpotter—this is referred to as a "missed" incident;
- ShotSpotter failed to accurately identify the location of the gunfire to within 25 meters of the actual location—this is referred to as a "mislocated" incident; or
- The error report was incorrect, or the incident was one that ShotSpotter is not intended to detect, such as gunfire outside the coverage area, indoors, or of a small caliber weapon (i.e., less than 25mm).

We used these data to conduct our audit.

III. EDGEWORTH ANALYTICS AUDIT RESULTS AND ROBUSTNESS CHECKS

First, Edgeworth conducted an analysis to ensure that the data were complete and accurate. Specifically, we compared the published incidents and errors detected in the Scorecards to those in the underlying data we received. Our analysis confirmed that the data appeared to be complete and accurate.

Once the data were validated, we reviewed the data and consolidated it into a format suitable for our analysis. This involved combining reporting of events across data sources and reviewing data fields and the possible outcomes of error reports. Using these data, we independently calculated the accuracy across the categories ShotSpotter uses for its reporting. Our analysis confirmed that the accuracy rate across all ShotSpotter clients for 2019, 2020, and 2021 was 97.42%, 97.70%, and 97.82%, respectively. Having audited and validated ShotSpotter's claims, we conducted additional analyses to confirm that these results are robust.

Since accuracy reporting depends on clients informing ShotSpotter of potential errors, we tested whether differences in the intensity of reporting may have unduly influenced the reported accuracy. For example, if a client with a relatively high volume of published gunshot incidents rarely reports potential errors, then the reported accuracy rate may be higher than the actual rate. To test for this issue, we identified the areas where the intensity of reporting potential errors was at or below the 5th and 10th percentile of client reporting intensity. As shown in Table 1 below, if these clients are removed from the data entirely—an extreme test—then the overall accuracy would decrease by less than 1%.[3] Alternatively, assuming these clients with low reporting intensity all had the reporting intensity of the 5th or 10th percentile client and that all additional reports were erroneous ShotSpotter alerts, the overall accuracy rate would again decrease by less than 1%. These accuracy rates are not statistically significantly different from the overall accuracy rate for all ShotSpotter clients.

FIGURE 1

SHOTSPOTTER ACCURACY RATES

BY EXCLUSION THRESHOLD

2019-2021

		Client Feedback Rate Threshold		
ShotSpotter Alerts	**Year**	**All Data**	**>5th Percentile**	**>10th Percentile**
[a]	**[b]**	**[c]**	**[d]**	**[e]**
Excluding Selected Accounts	2019	97.39%	97.03%	96.65%
	2020	97.66%	97.26%	96.96%
	2021	97.79%	97.41%	97.26%
All Data	2019	97.42%	97.40%	96.81%
	2020	97.70%	97.68%	97.68%
	2021	97.82%	97.71%	97.42%

Note: Excluded accounts include new, pilot program, and service terminated clients as well as clients from which feedback was not expected.

3 This analysis is conservative as it is only conducted on the more restrictive set of clients excluding those not providing or expected to provide feedback.

About Edgeworth Analytics

Through consulting and education, Edgeworth Analytics empowers professionals and organizations to unlock data's potential. Data is the lifeblood of every organization. But the amount and complexity of data grows every day. Using proven methods for gathering, structuring, analyzing, and applying data, we help companies transform their data from a source of anxiety to a consistent driver of stronger operational and competitive performance. Our unique approach to data analytics consulting is rooted in the expertise and real-world experience of our sister company Edgeworth Economics, a firm of PhD economists who rigorously apply economic principles and hard data to high-stakes litigation, regulatory, and other challenges.

Edgeworth Analytics makes data analysis accessible and easy to understand for practitioners across a range of business services—including human resources, sales, operations, strategy, and finance—as well as for those looking to better understand the effects of a proposed or existing policy, investment, or regulation on industries, local markets, regional economies or the global economy. In our consulting service, our team works closely with clients to deliver key insights and targeted recommendations, while providing a working understanding of sound data analysis long after the project ends. Our teaching program equips professionals to become comfortable with data and to better understand their KPIs and dashboards.

Contacts:

Edgeworth Analytics:
mediarelations@edgeworthanalytics.com
+1 202-559-7995