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New York Election Audits – Problems and Solutions

Elections conducted with optical scanners need to be audited to find errors due to calibration drift on Election Day and other causes.[1] Audits confirm election outcomes and give all stakeholders confidence in the outcomes. Yet in these times we need audits to be simple and inexpensive.

What We Propose

- Our audit procedure reduces the mandatory county-wide minimum audit by one third from 3% to 2%. Savings from this reduction are reallocated to enable every contest to be audited, and to audit close races rigorously enough to detect incorrect winners.

- A narrow victory margin of 0.35% or less triggers a full hand count, due to the possibility that a partial hand count would fail to detect outcome-altering miscounts in such rare close races. 0.35% is a lower percentage than required by some other states, and by New York for the 2009 pilot,[2] but it is based on reported error rates of optical scanners.[3, 4]

Advantages

- Simplicity, Low Cost, and Power -- Based on Dr. Ron Rivest's[5] simple rule for determining the number of units to audit[6] and some New York-specific adjustments, our audit procedure uses only elementary-school arithmetic, keeps most audits small and inexpensive, yet provides close to 99% assurance of correct winners in all contests.[7]

- NY's current fixed 3% audit would not verify the winners in many recent elections -- over 17% of US House races, over 12% of State Senate races and over 22% of Assembly races.[8] Using the fixed-percent approach, achieving close to 99% assurance of correct winners would require *more than half* of all ballots to be audited. We show how New York can achieve that level of assurance by using plain arithmetic and readily available election data to quickly determine the smallest audit that yields high confidence in the outcome of each contest.

Basic Principles of Election Audits

- Confidence in the outcome of a contest requires sufficient auditing to detect miscounted votes whenever the outcome is wrong. If miscounted votes are detected, and as a result an outcome becomes questionable, the initial audit must be expanded. When the initial or expanded audit confirms that an outcome is correct, the audit is terminated. Rarely a full hand count will be needed to determine or confirm a correct winner.

- Audit arithmetic must be simple so officials can implement audits without specialized training in statistics and without the use of untrusted software.

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[1] http://www.votersunite.org/Info/OpScansInTheNews.pdf
[2] The NY pilot used a 1% victory margin to trigger a full hand count; MN uses 0.5%; OH uses 0.5% for non-statewide contests.
[3] http://www.ceimn.org/files/ceimn.report_color.pdf
[4] http://www.freedom-to-tinker.com/blog/appel/optical-scan-voting-extremely-accurate-minnesota
[5] Ronald L. Rivest is the Viterbi Professor of Electrical Engineering and Computer Science in MIT's Department of Electrical Engineering and Computer Science, a member of MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL), a member of the lab's Theory of Computation Group and a founder of its Cryptography and Information Security Group. Dr. Rivest serves on the EAC's Technical Guidelines Development Committee (TGDC). The TGDC wrote the federal voting systems standards adopted by the New York State Board of Elections.
[6] http://people.csail.mit.edu/rivest/Rivest-ASimpleRuleOfThumbForElectionAuditSizeDetermination.pdf
[7] More rigorous methods that require much more election data and many more complex calculations are theoretically possible, but currently impractical on a large scale. See: http://repositories.cdlib.org/ischool/2009-032/
[8] http://sites.google.com/site/evoterproject/files/NYAuditGraphs.pdf

- For election outcomes to be credible, all voting systems and their audits should be *software-independent*[9] and well understood by all stakeholders including election officials, candidates, election observers and voters. All procedures must be fully transparent to allow watchers to observe them.

- The initial audit for a contest varies in size according to the preliminary margin of victory. Generally, the smaller the margin, the more audit-units (machines, election districts, batches of ballots) must be audited.

- The chance of finding audit-units that contain miscounted votes depends crucially on the *number* of units audited. There is no single "right percentage" of units to audit for all contests.

How We Solved the Statistical Problems

- PROBLEM: The smaller the number of audit-units used for a contest, the larger the percentage of units that must be audited. This increases workload and cost. SOLUTION: Rather than using whole machines as audit-units as in current NY law, we propose splitting machines and election districts (EDs) into "precinct-count ED-fractions" and "central-count ED-fractions" to increase the total number of units. The State Board of Elections has agreed to this in principle.

- PROBLEM: The number of audit-units that must be selected to audit a contest varies with the number of units where the contest is on the ballot (size of the pool from which to draw units for auditing). Differing pool sizes complicate the math. SOLUTION: We use a "draw with replacement" method to select audit-units. This allows use of simplified arithmetic to determine the number of _draws_ needed to select units for the initial audit of any contest regardless of its pool size.[10]

- PROBLEM: Audit-units of different sizes can contain and conceal different numbers of miscounted votes, and miscounts concentrated in a few large units could change an outcome. When units have different sizes this complicates the math. Also, the size of each unit must be known soon after the election to calculate either the number of units for the initial audit, or a probability that each unit will be randomly selected for auditing. SOLUTION: We simplify by calculating a mean-to-maximum relative size ratio for each contest before the election by using the number of active registered voters in all audit-units where a contest appears on the ballot, and the statutory maximum number of active registered voters per ED, to estimate the average and maximum relative audit-unit sizes respectively. The mean-to-maximum-size ratio is used to adjust the size of the initial audit by assuming that all audit-units are the maximum relative size. This ensures that the audit will be large enough to detect at least one ED-fraction with a large number of miscounted votes if the outcome is wrong.

- PROBLEM: Errors may be widely distributed among many EDs or concentrated in only a few EDs. Audits must be able to detect both types of vote miscount distribution. SOLUTION: We start with the minimum initial audit that can detect both kinds of error distribution, and if either type is found, the audit for that contest is enlarged.

- PROBLEM: A random audit might miss large errors concentrated in a few EDs. SOLUTION: We allow candidates receiving over 5% of the vote to designate a small number of EDs to be audited.

Sources for our audit procedure

Our audit procedure is based on research published by The American Statistical Association,[11] M.I.T.,[12, 13, 14, 15] Northeastern University,[14, 15] the State of California [16] and the E-Voter Education Project.[8, 17] We use a simple statistical technique to reduce the risk of certifying an incorrect electoral outcome (wrong winner of a contest), using a minimal amount of election data that is already available to counties.

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[9] http://en.wikipedia.org/wiki/Software_independence

[10] "Draw with replacement" means that after each "draw," the identification of the selected audit-unit is recorded and then the audit-unit is put back into the pot so it is available to be chosen again in subsequent draws. (An audit-unit drawn more than once for a contest needs to be audited only once for that contest.)

[11] http://verifiedvoting.org/downloads/TAS_paper.pdf

[12] http://people.csail.mit.edu/rivest/Rivest-ASimpleRuleOfThumbForElectionAuditSizeDetermination.pdf

[13] http://theory.lcs.mit.edu/~rivest/Rivest-OnEstimatingTheSizeOfAStatisticalAudit.pdf

[14] http://theory.lcs.mit.edu/~rivest/AslamPopaRivest-OnEstimatingTheSizeAndConfidenceOfAStatisticalAudit.pdf

[15] http://www.usenix.org/events/evt08/tech/full_papers/aslam/aslam.pdf

[16] http://www.sos.ca.gov/elections/peas/final_peaswg_report.pdf

[17] http://www.votetrustusa.org/pdfs/VTTF/EVEPAuditing.pdf