VoTeR Center

UConn Voting Technology Research Center

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Statistical Analysis of the Post Election Audit Data
2008 February Elections

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Summary

The University of Connecticut Voting Technology Research (VoTeR) Center received the data gathered in the post-election audit performed in the State of Connecticut following the February 2008 election. The audits of the randomly selected 10% of the districts were conducted in February and March of 2008, and the returns were subsequently conveyed by the Office of the Secretary of the State (SOTS) to the VoTeR Center. The audit data received by the Center contains 624 records per each party, where each record represents information about a given candidate. Specifically, each record contains the following significant information: date, district, machine seal number, office, candidate, machine counted total, undisputed hand counted total, questionable hand counted total, overall hand counted total, that is, the sum of undisputed and questionable ballots. This report contains several statistical analyses of the audit returns.

Among the 624 records about 98% of the records show discrepancy of 0 votes between the machine counts and audit hand counts, and the rest show discrepancy of 4 votes or lower. These results hold for both parties. The highest absolute discrepancy is 4 (four) and it can be seen only once for each party.

This analysis was performed on request of the Office of the Secretary of the State.

1 Preface

The University of Connecticut Voting Technology Research (VoTeR) Center received the data gathered in the post-election audit performed in the State of Connecticut following the February 2008 election. The audits of the randomly selected 10% of the districts were conducted in February and March of 2008, and the returns were subsequently conveyed by the Office of the Secretary of the State to the VoTeR Center. For the definition of the audit see Connecticut Public Act 07-194 AN ACT CONCERNING THE INTEGRITY AND SECURITY OF THE VOTING PROCESS, approved July 5, 2007. The Act requires that 10% of the districts are audited. For the instructions on conducting the audit, see Audit Procedures Optical Scan Voting Equipment, Office of the Secretary of the State, November 2007. The Center is currently working with the Office of the Secretary of the State in order to develop the criteria that will be used in the future elections audits (starting with November 2008) to identify audit returns that report certain discrepancies that will cause additional audits and/or examination of equipment to be requested. This report contains several statistical analyses of the audit returns and recommendations.

This report presents analysis of the post election audit data.

This analysis was performed on request of the Office of the Secretary of the State.

2 Overview of the Analysis

This report contains several statistical analyses of the audit returns. The analysis did not identify any major problems in the data provided. In most cases the machine count was reported to be identical to the hand count, even in the presence of questionable ballots. Some records, however, have discrepancies between the hand counted totals and machine counted totals. The close investigation of that data suggests that in most such cases the error occurred because of the questionable ballots. A more detailed analysis of the data is provided in Section 4 of the report.

3 Introduction and Notation

Throughout this document we use the following notation:

- M is used to denote the machine counted ballots

- U is used to denote the number of undisputed hand counted ballots

- Q is used to denote the number of questionable hand counted ballots

- H is the sum of undisputed and questionable ballots, that is, $H = U + Q$

- D is the discrepancy between the hand counted total and machine total, that is, $D = H - M$

- |D| is the absolute value of the discrepancy (the positive value of D)

Thus for a given candidate, we define discrepancy D as the difference between H (the sum of the undisputed ballots U and the questionable ballots Q) and M (the machine count).

If the discrepancy D is positive then we say that we observe a machine undercount relative to the hand count H, i.e., the machine counted fewer ballots in a certain race than the auditors.

If the discrepancy D is negative then we say that we observe a machine overcount relative to the hand count H, i.e., the machine counted more ballots in a certain race than the auditors.

Note that this presupposes that the hand count does not contain (human) errors. This is not necessarily so in reality. In general it is not possible to ascertain whether the hand counted data contain errors, and so we assume that the hand counted data is reported correctly.

4   Statistical Analysis

The audit returns were reported separately for the Democratic Primary (DP) and the Republican primary (RP), thus in the analysis below the results are presented separately for each primary, e.g., for DP and RP.

4.1   Absolute Value of Discrepancy

First we give the analysis considering the absolute number of discrepancies, |D|. Over all 624 records, the average absolute discrepancy is 0.03 votes for both DP and RP, and the standard deviations are 0.27 for RP and 0.28 for DP, suggesting that the occurrences of discrepancies are reasonably clustered in the vicinity of the average. Tables 1 and 2 present tiered views of the absolute discrepancies for RP and DP correspondingly.

Table 1: Absolute value of discrepancy in RP.

Description	Counts	% of Counts
Records with discrepancy |D| of 0	610	97.76%
Records with discrepancy |D| of 1-3	13	2.08%
Records with discrepancy |D| of 4	1	0.16%
Totals:	**624**	**100%**

Table 2: Absolute value of discrepancy in DP.

Description	Counts	% of Counts
Records with discrepancy |D| of 0	611	97.92%
Records with discrepancy |D| of 1-3	12	1.92%
Records with discrepancy |D| of 4	1	0.16%
Totals:	**624**	**100%**

Table 3 presents tiered view of the absolute discrepancies by the percentage of discrepancy for RP and DP. We note that the highest discrepancy here is a single case of 4 (four) votes for both RP and DP.

Table 3: By Percentage of Discrepancy

Description	Counts	% of Counts
Records with discrepancy less than 0.5%	623	99.84%
Records with discrepancy 0.5% to 1%	1	0.16%
Totals:	**624**	**100%**

The next two histograms show the error range between hand counted and machine counted ballots for the 624 records for RP and DP.
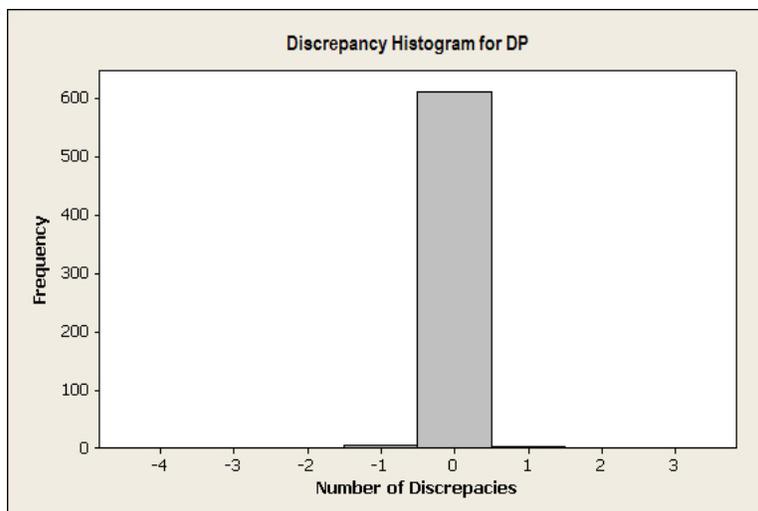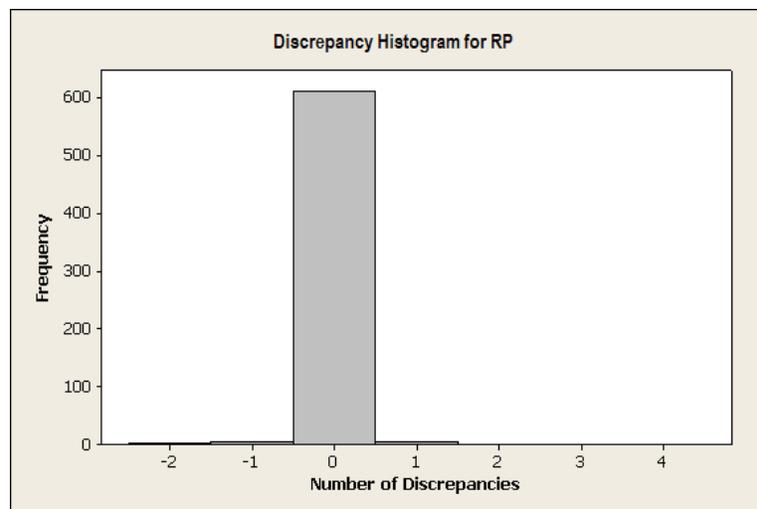
4.2 Undercount and Overcount Discrepancies

When considering negative discrepancies (overcounts) and positive discrepancies (undercounts) over the 624 records, the average discrepancies are 0.009 and -0.009, and the standard deviations are 0.27 and 0.28 for RP and DP correspondingly, again suggesting tight clustering of discrepancies about the average.

Table 4 and Table 5 present discrepancies for the records that indicate overcounts, correspondingly for RP and DP.

Table 3: Records indicating overcounting: 6 records with negative values of discrepancy (RP).

Description	Counts	% of Counts
Records with discrepancy D of -1	4	66.66
Records with discrepancy D of -2	2	33.34
Totals:	**6**	**100**

Table 4: Records indicating overcounting: 8 records with negative values of discrepancy (DP).

Description	Counts	% of Counts
Records with discrepancy D of -1	5	62.5
Records with discrepancy D of -2	1	12.5
Records with discrepancy D of -3	1	12.5
Records with discrepancy D of -4	1	12.5
Totals:	**6**	**100**

Tables 5 and 6 below present discrepancies for the records that indicate undercounts, correspondingly for RP and DP.

Table 5: Records indicating undercounting: 8 records with positive values of discrepancy (RP).

Description	Counts	% of Counts
Records with Discrepancy D of 1	5	62.5
Records with Discrepancy D of 2	1	12.5
Records with Discrepancy D of 3	1	12.5
Records with Discrepancy D of 4	1	12.5
Totals:	**8**	**100**

Table 6: Records indicating undercounting: 5 records with positive values of discrepancy (DP).

Description	Counts	% of Counts
Records with Discrepancy D of 1	3	60
Records with Discrepancy D of 2	1	20
Records with Discrepancy D of 3	1	20
Totals:	**5**	**100**

4.3   Statistics for Questionable Ballot Counts

Tables 7 and 8 present statistics with respect to the questionable ballots per candidate.

Table 7: Questionable Ballot Counts (RP).

Description	Counts	% of Counts
Records with questionable count Q of 0	591	94.71
Records with questionable count Q > 0 to 1% (or < = 6 candidate votes)	33	5.29
Totals:	**624**	**100%**

Table 8: Questionable Ballot Counts (DP).

Description	Counts	% of Counts
Records with questionable count Q of 0	571	91.51
Records with questionable count Q > 0 to 1% (or < =6 candidate votes)	50	8.01
Records with questionable count Q > 1% to 2 % (or < =12 candidate votes)	1	0.16
Records with questionable count Q > 2% to 4% (or < =24 candidate votes)	2	0.32
Totals:	**624**	**100%**

From the tables above we can see that over 90% of the records indicate that the number of questionable ballots is 0 for both parties. Also we can observe that for RP less than 6% of records indicate that number of questionable ballots is less than 1%. For DP about 8% of all records indicate that number of questionable ballots is less than 1%, there is 1 record for which number of questionable ballots is 10, and correspondingly there are 2 records for which number of questionable ballots is 14 in one case and 21 in another.

About the UConn VoTeR Center

Following our participation in the Connecticut Voting Technology Standards Board in 2005, the Voting Technology Research (VoTeR) Center was established in 2006 to advise state government in the use of voting technologies, to research, investigate and evaluate voting technology and voting equipment, and to develop and recommend safe use procedures for the computerized voting technology in elections. The personnel of the Center includes several faculty members, graduate students, and staff of the Computer Science and Engineering department at the University Of Connecticut.

The work of the VoTeR Center in the State of Connecticut is funded by the Office of the Connecticut Secretary of the State (SOTS), and we function in close contact with the SOTS Office personnel. We offer the State an independent, objective analysis of the voting technologies offered by several vendors, we advise the State on selecting and administering the voting equipment for its election needs, and we are not associated with any of the voting technology vendors. The evaluations of the voting technology are performed at the VoTeR Center Lab at the University of Connecticut. These include hands-on evaluations, exploration of possible attack vectors, physical integrity checks of the terminals and memory cards, and mitigation strategies. It is worth pointing out that the VoTeR center is not involved in the State's policies for choosing a vendor to procure the voting technology, but limited to evaluating these technologies before deployment and use by the State. In this sense the VoTeR Center is a third party independent technical consulting resource for the State of Connecticut.

The VoTeR Center personnel assisted the State in developing safe use procedures for the Optical Scan terminals for this election. The procedures in place for the election include strict physical custody policy, tamper-resistant protection of the equipment, and random post-election audits.