After the Election: Audits and Recounts

Joseph Lorenzo Hall NSF ACCURATE Postdoctoral Research Associate

UC Berkeley School of Information Princeton University Center for Information Technology Policy

Carter Center 2008 US Presidential Election Study Mission 6 November 2008

This material is based upon work supported by the National Science Foundation under A Center for Correct, Usable, Reliable, Auditable and Transparent Elections (ACCURATE), Grant Number CNS-0524745. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

Outline

- Recount vs. Audit
- Types of Recount, Audits
- Case Study: California Tallying Process
 - Methodology
 - Findings
 - Security
 - Transparency
 - Efficiency

Recount vs. Audit

- $\cdot\,$ Audits are regular events, Recounts not
- Recountability
 - Must have something to recount.
- Auditability
 - Various auditing goals
- Other big differences:
 - Vote totals can change in a recount.
 - Laws specify much of recount procedure

Types of Recounts

- Goal of a recount: count over again
- Voters, Candidates, Officials and Courts can initiate them. (first two must pay)
- Triggered based on closeness, etc.
 - MN Senate race, Coleman (R) vs. Franken (D):
 - Full recount when < 0.5%
 - Starts after canvass (14 days from now)
 - *After* MN's 3% statutory audit.
- \cdot Recounts are relatively boring. Audits...

Audits: Checking the Math

- If we can't access to the inner workings of the system, what then?
- Audit. Check input vs. output.
- By "audit", we mean: comparing two sets of software-independent records
 - 38 states keep independent records
 - Only 17 actually count them
- There are other notions of "audit"

Goals in Audits

- Minimize administrative burden
- Objectivity (~ minimize subjectivity)
- Increase public confidence
- Deter fraud
- Detect systemic error
- Provide feedback (quality control)
- Incentives and benchmarks
- Confirm the result

Types of Manual Tally Audits

- Fixed percentage audits (OK)
- Tiered audits (Better)
- Tuned audits (Even better)
- Hybrid audits (Best)
 - Combining a fixed % with another model
- Polling audits (Bad)

Fixed Percentage Audits

- A fixed percentage of audit units are chosen randomly.
- Strengths:
 - Pinpoint error, fraud
 - Decent sample for quality control
 - Predictable administrative costs
- Weaknesses:
 - Confidence can be low in close races

Tuned Percentage Audits

- Percentage of units based on margin.
- Strengths:
 - Can fix desired confidence in results, vary sample size
- Weaknesses:
 - Costs are much harder to predict
 - Undervalues administrative feedback (quality control)

Polling Audits

- Percentage of ballots audited in *each* polling place by "auditing army"
- Strengths:
 - Distributes work
 - Very accurately predicts global discrepancy
- Weaknesses:
 - *No information* as to source of error
 - *Very challenging* to staff, conduct
 - Very small errors would not be detected

High-Level: What to Audit?

- $\cdot\,$ Post-election auditing lit. has exploded
- Brennan Center / Samuelson Clinic convened a blue ribbon panel
- Examined:
 - Fixed-percentage audits
 - Margin-dependent audits (tiered and non-)
 - Polling audits
- Rec: Margin-dependent with a floor.

Low-Level: How to Audit?

- CA has had manual tallies since 1965.
- $\cdot\,$ Little is prescribed by election law
 - Tally must compare ballots in 1% of precincts
 - Must be randomly chosen and completed *before* the canvass is over (28 cal. days)
 - Must include all types of ballots
- We set out with a group of researchers to improve the security, efficiency and transparency of CA's manual count.



13

Low-Level: How to Audit?

- CA has had manual tallies since 1965.
- $\cdot\,$ Little is prescribed by election law
 - Tally must compare ballots in 1% of precincts
 - Must be randomly chosen and completed *before* the canvass is over (28 cal. days)
 - Must include all types of ballots
- We set out with a group of researchers to improve the security, efficiency and transparency of CA's manual count.

How Does the Tally Work?

- Precincts chosen randomly
- $\cdot\,$ Materials are retrieved, verified, sorted
- Typically four people perform tally: Caller, Witness and two Talliers
- Use a tally sheet and announce "10's"
- Hand tally is compared to electronic
- Discrepancies must be reconciled





How Does the Tally Work?

- Precincts chosen randomly
- $\cdot\,$ Materials are retrieved, verified, sorted
- Typically four people perform tally: Caller, Witness and two Talliers
- Use a tally sheet and announce "10's"
- Hand tally is compared to electronic
- Discrepancies must be reconciled



- Certres	whithle nearly	NUMBER OF VOTES CAST FOR FACH CANDIDATE		TOTAL	
TALLY AS ILLUSTRATED with indefinition Out of (The Number of Votes Must be Written Out of		NUMBER OF VOIES CAST FOR EACH CARDIDATE			
FULL LENGTH IN THIS COUNTY		1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 20 1 2 3 4 5 6 7 8 9 30 1 2 3 4 5 6 7 8	9 40		
		41 2 3 4 5 6 7 8 9 50 1 2 3 4 5 6 7 8 9 60 1 2 3 4 5 6 7 8 9 70 1 2 3 4 5 6 7 8	9 80		
		81 2 3 4 5 6 7 8 9 90 1 2 3 4 5 6 7 8 9 100 1 2 3 4 5 6 7 8 9 110 1 2 3 4 5 6 7 8	9 120		
		121 2 3 4 5 6 7 8 9 130 1 2 3 4 5 6 7 8 9 140 1 2 3 4 5 6 7 8 9 150 1 2 3 4 5 6 7 8	9 160		
		161 2 3 4 5 6 7 8 9 170 1 2 3 4 5 6 7 8 9 180 1 2 3 4 5 6 7 8 9 190 1 2 3 4 5 6 7 8	9 200		
		201 2 3 4 5 6 7 8 9 210 1 2 3 4 5 6 7 8 9 220 1 2 3 4 5 6 7 8 9 230 1 2 3 4 5 6 7 8	9 240		
had	C. T. States	241 2 3 4 5 6 7 8 9 250 1 2 3 4 5 6 7 8 9 260 1 2 3 4 5 6 7 8 9 270 1 2 3 4 5 6 7 8	9 280		
	Voles	281 2 3 4 5 6 7 8 9 290 1 2 3 4 5 6 7 8 9 300 1 2 3 4 5 6 7 8 9 310 1 2 3 4 5 6 7 8	9 320		
		321 2 3 4 5 6 7 8 9 330 1 2 3 4 5 6 7 8 9 340 1 2 3 4 5 6 7 8 9 340 1 2 3 4 5 6 7 8 9 350 1 2 3 4 5 6 7 8	9 360		
		361 2 3 4 5 6 7 8 9 370 1 2 3 4 5 6 7 8 9 380 1 2 3 4 5 6 7 8 9 390 1 2 3 4 5 6 7 8	9 400	0000	
		401 2 3 4 5 6 7 8 9 4101 2 3 4 5 6 7 8 9 4201 2 3 4 5 6 7 8 9 4301 2 3 4 5 6 7 8 9 4001 2 3 4 5 6 7 8 9 4001 2 3 4 5 6 7 8 9 4001 2 3 4 5 6 7 8 9 4001 2 3 4 5 6 7 8 9 4001 2 3 4 5 6 7 8 9 4001 2 3 7 8 8 9 4001 2 3 7 8 8 9 8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8	9 440		
		441 2 3 4 5 6 7 8 9 450 1 2 3 4 5 6 7 8 9 460 1 2 3 4 5 6 7 8 9 470 1 2 3 4 5 6 7	9 400		
	100 0 0 0 0 0	481 2 3 4 5 6 7 8 9 490 1 2 3 4 5 6 7 8 9 500 1 2 3 4 5 6 7 8 9 510 1 2 3 4 5 6 7 8	Y 520		
	TRANSFER AND	123456789 10123456789 20123456789 3012345678	9 40	2	
		41 2 3 4 5 6 7 8 9 50 1 2 3 4 5 6 7 8 9 60 1 2 3 4 5 6 7 8 9 70 1 2 3 4 5 6 7 8	9 80	2	
		81 2 3 4 5 6 7 8 9 90 1 2 3 4 5 6 7 8 9 100 1 2 3 4 5 6 7 8 9 110 1 2 3 4 5 6 7 8	9 120	2	
		121 2 3 4 5 6 7 8 9 130 1 2 3 4 5 6 7 8 9 140 1 2 3 4 5 6 7 8 9 150 1 2 3 4 5 6 7 8	9 16	0	
		161 2 3 4 5 6 7 8 9 170 1 2 3 4 5 6 7 8 9 180 1 2 3 4 5 6 7 8 9 190 1 2 3 4 5 6 7 8	9 20	0	
		201 2 3 4 5 6 7 8 9 210 1 2 3 4 5 6 7 8 9 220 1 2 3 4 5 6 7 8 9 230 1 2 3 4 5 6 7 8	9 24	0	
had	votes	241 2 3 4 5 6 7 8 9 250 1 2 3 4 5 6 7 8 9 260 1 2 3 4 5 6 7 8 9 270 1 2 3 4 5 6 7 8	9 28	90	
		281 2 3 4 5 6 7 8 9 290 1 2 3 4 5 6 7 8 9 300 1 2 3 4 5 6 7 8 9 310 1 2 3 4 5 6 7	9 32	0	
		321 2 3 4 5 6 7 8 9 330 1 2 3 4 5 6 7 8 9 340 1 2 3 4 5 6 7 8 9 350 1 2 3 4 5 6 7	9 36	60 00 40 80	
		361 2 3 4 5 6 7 8 9 370 1 2 3 4 5 6 7 8 9 380 1 2 3 4 5 6 7 8 9 390 1 2 3 4 5 6 7 1	9 40		
		401 2 3 4 5 6 7 8 9 410 1 2 3 4 5 6 7 8 9 420 1 2 3 4 5 6 7 8 9 430 1 2 3 4 5 6 7	3 9 44		
		441 2 3 4 5 6 7 8 9 450 1 2 3 4 5 6 7 8 9 460 1 2 3 4 5 6 7 8 9 470 1 2 3 4 5 6 7	8 9 41		
		481 2 3 4 5 6 7 8 9 490 1 2 3 4 5 6 7 8 9 500 1 2 3 4 5 6 7 8 9 510 1 2 3 4 5 6 7	8 9 5		

How Does the Tally Work?

- Precincts chosen randomly
- $\cdot\,$ Materials are retrieved, verified, sorted
- Typically four people perform tally: Caller, Witness and two Talliers
- Use a tally sheet and announce "10's"
- Hand tally is compared to electronic
- Discrepancies must be reconciled





Case Study Methodology

- \cdot Examine existing procedures for the tally
- Worked with San Mateo in-depth
- Iteratively developed new procedures
- San Mateo used our interim procedures
- Observed tally process in San Mateo as well as Alameda and Marin.
- Revised and generalized procedures such that any CA county can use them.

Findings: Security

- Selection and tally must take place *after* ballots are counted
- Tally should take place soon after selection and seals verified
- Counting must be blind (not *too* blind)
- Certain procedures need expert review when revised
- Tally process should be resistant to insider attacks



Findings: Security

- Selection and tally must take place *after* ballots are counted
- Tally should take place soon after selection and seals verified
- Counting must be blind (not *too* blind)
- Certain procedures need expert review when revised
- Tally process should be resistant to insider attacks

Random Selection of Precincts 41 = 430400 1040 = 9502930= 421000 4 9 3 472 = 440400 5. _ 7 6 1 = 835500 1.00 . .

Findings: Security

- Selection and tally must take place *after* ballots are counted
- Tally should take place soon after selection and seals verified
- Counting must be blind (not *too* blind)
- Certain procedures need expert review when revised
- Tally process should be resistant to insider attacks

Findings: Transparency

- Provide public notice of the tally
- Publish tally procedures
- Publish useful data, digital & hardcopy
- Ensure clear lines of communication for observers

Findings: Efficiency

- Randomness w/ dice can be inefficient
- \cdot Electronic results need to be fine-grained
- \cdot Adverse effects of good team demeanor
- Pre-fill tally sheets
- Consider using RFIDs to ease pressure on chain-of-custody.

http://www.josephhall.org/dicebins.php

Dice Binning Calculator for Post-Election Audits

Joseph Lorenzo Hall (joehall@berkeley.edu), UC Berkeley School of Information

To increase the transparency of the 1% manual tally process, a few California counties have begun to use 10-sided dice to produce *publicly-verifiable* random numbers (See Cordero, Wagner and Dill 2006). Unfortunately, using 10-sided dice to 1) select from only a few precincts or 2) to select from many precincts can require a lot of re-rolling of the dice. To increase the efficiency of the process, Cordero et al. suggest "binning" the dice rolls so that each precinct has a *range* of corresponding values, of *equal width*, that allow a higher percentage of dice rolls to "hit". This calculator implements this idea. It can also output the binning data in a form that is easily pasteable into a spreadsheet. Please click here for source code and licensing information.

Settings

Number of dice: 2 Number of precincts: 13 (By default, it starts with 2 dice and 13 precincts.)

Calculate

Results

- Range is 100. (This is the quantity of random numbers 2 dice can produce.)
- Rounded interval is 7. (This is the number of random numbers per bin.)
- Interval modulus is 9 (9% of rolls). (This is the number of random numbers that will require a re-roll.)

Paste these bins into a spreadsheet

6 Novem Roll 00-06, pick precinct 1 Roll 07-13, pick precinct 2 Roll 14-20, pick precinct 3





Findings: Efficiency

- Randomness w/ dice can be inefficient
- \cdot Electronic results need to be fine-grained
- \cdot Adverse effects of good team demeanor
- Pre-fill tally sheets
- Consider using RFIDs to ease pressure on chain-of-custody.





Findings: Efficiency

- Randomness w/ dice can be inefficient
- \cdot Electronic results need to be fine-grained
- \cdot Adverse effects of good team demeanor
- Pre-fill tally sheets
- Consider using RFIDs to ease pressure on chain-of-custody.

General Procedures for CA

http://josephhall.org/procedures/ ca_tally_procedures-2008.pdf

6 November 2008

