Evidence-Based Elections

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Evidence-Based Elections

- **Bold Claim**: Law should require LEOs to give convincing evidence outcomes are right.
- Certifying equipment isn’t enough: How was the equipment used?
- Election should generate hard evidence, checked for integrity.
- Audit trail is key. Needs to be created, curated, and scrutinized to confirm or correct the outcome.
- Why regulate equipment but not curation of the audit trail?
- Voting systems should make it easy—instead they make it hard.
What do we want Elections to do?

**Purpose of Elections (Wallach)**
Convince the loser he lost.

**Evidence-Based Elections (Stark & Wagner)**
Produce convincing qualitative and quantitative evidence that it found the right winners—or report that it cannot.

What’s the proper role of certification? Who benefits?
Evidence-Based Elections

Evidence = Auditability + Auditing

Strong Software Independence = VVPR + Compliance Audit

Evidence = Strong Software Independence + Risk-Limiting Audit

This approach has a large chance of correcting its own errors. If it can’t, it says so.
# Ingredients for Convincing Evidence

<table>
<thead>
<tr>
<th>Audit trail</th>
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<tbody>
<tr>
<td>Typically, VVPR.</td>
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<table>
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<tr>
<th>Compliance Audit</th>
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<tbody>
<tr>
<td>Is the system, as maintained &amp; used, strongly software independent? Was audit trail complete and accurate when generated, and curated adequately since?</td>
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<table>
<thead>
<tr>
<th>Risk-limiting Audit</th>
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<tr>
<td>To pass, need convincing evidence that full hand count would find the same outcome—or a full hand count. Large, known chance of requiring a full hand count if the outcome is wrong, no matter why.</td>
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*Risk* is biggest chance of not correcting a wrong outcome.
Risk-Limiting Audits

Required by Colorado Revised Statutes 1-7-515
Pilot mandated by California AB 2023.

- Doesn’t absolutely guarantee the electoral outcome is right, but guarantees a large chance of correcting the outcome if it is wrong.
- “Intelligent” incremental recount: stops only when there is convincing evidence that a full hand count won’t change the outcome.
- Until the evidence is strong, counting continues, possibly to a full hand count.
- Absent a full hand count, will not alter election outcomes: Can correct wrong outcomes, but can’t harm correct outcomes.
Pilot risk-limiting audits

- Simple measures, super-majority measures, simple contests, vote-for-$k$ contests. 200–121,000 ballots; burden 16–7,000 ballots.

- California pilots. Mix of voting technology, contest sizes, county sizes, contest types:
  - Alameda 4c, Humboldt 3c, Marin 2e2c, Merced 2c, Monterey 1c, Orange 1c, San Luis Obispo 2c, Santa Cruz 1c, Stanislaus 1c, Ventura 1c, Yolo 2e3c

- Boulder, CO; Cuyahoga, OH

- NM: “almost” risk-limiting.

- EAC funding for CA and CO; CA and CO laws

- 7/2012: Madera, Marin, Napa, Orange (entire ballot), Santa Cruz, Yolo...

- 11/2012: More. $\geq$ 20 counties in all under CA AB 2023
Friendly Tools for Risk-Limiting Audits

The rules are not hard, and the tools can be simple:

http://statistics.berkeley.edu/~stark/Vote/auditTools.htm
### auditTools in action

#### Contest Information

- **Ballots cast in all contests:** 7120
- **Smallest margin (votes):** 192
- **Diluted margin:** 2.7%

#### Contest 1: Merced Mayor

- **Contest name:** Merced Mayor
- **Votes for no more than:** 1

**Reported votes:**

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<thead>
<tr>
<th>Candidate 1 Name</th>
<th>Candidate 2 Name</th>
<th>Candidate 3 Name</th>
<th>Candidate 4 Name</th>
<th>Candidate 5 Name</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>THURSTON</td>
<td>GABRIELT-ACOSTA</td>
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#### Contest 2: Merced Councilmember

- **Contest name:** Merced Councilmember
- **Votes for no more than:** 3

**Reported votes:**

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<th>Candidate 3 Name</th>
<th>Candidate 4 Name</th>
<th>Candidate 5 Name</th>
<th>Candidate 6 Name</th>
<th>Candidate 7 Name</th>
<th>Candidate 8 Name</th>
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#### Audit Parameters

- **Risk limit:** 10%
- **Expected rate of 1-vote overstatements (decimal number):** 0.001
- **Expected rate of 2-vote overstatements (decimal number):** 0.001
- **Expected rate of 1-vote understatements (decimal number):** 0.0001
- **Expected rate of 2-vote understatements (decimal number):** 0.0001

**Starting size:** 198

- **Round up 1-vote differences.**
- **Round up 2-vote differences.**
Should more ballots be audited?

Stopping sample size and escalation

Ballots audited so far: 198

1-vote overstatements: 0  Rate: 0
2-vote overstatements: 0  Rate: 0
1-vote understatements: 0  Rate: 0
2-vote understatements: 0  Rate: 0

Estimated stopping size

Audit complete

If no more differences are observed: 178.
If differences continue at the same rates: 178.
Estimated additional ballots if difference rates stay the same: 0.
Four Options to Move Forward

Assume jurisdiction has VVPRs and a “ballot manifest.”

1. Ballot-polling audits: no export from VTS required. Not as efficient as possible, but surprisingly economical.
2. Upgrade voting systems to next-next. (Systems currently in review for certification won’t do it). Expensive. Many jurisdictions can’t afford to replace current systems.
3. “Parallel” audit: Re-scan ballots or export images (e.g., Hart). Base the audit on CVRs extracted from scans by unofficial software. Time-consuming. Have to touch ballots twice.
4. Replace the system with one that makes auditing easy: Travis County approach. Re-visit the role of certification.
VTS Certification and Risk-Limiting Audits

**Question 1**
In the lab, can the vote-tabulation system—as delivered from the manufacturer—count votes with a specified level of accuracy?

**Question 2**
As maintained, deployed, and used in the current election, did the vote-tabulation system find the true winners?

Only care about Q1 insofar as it matters for Q2.

Certification addresses Q1. Risk-limiting audits address Q2.
Advantages of a Current Unofficial System (Wagner et al.)

- Makes ballot-level auditing easy.
- Drastically reduces costs: much cheaper to buy & maintain than any commercial system.
- Can be based on COTS scanners—cheap to lease or buy.
- Not locked into contracts, maintenance, etc.; easy upgrades: “agile.”
- Speeds development/improvement cycle.
- Can capture voter intent better, improve accuracy. (cf Merced, San Luis Obispo, Stanislaus, Ventura).
- Requiring convincing evidence aligns incentives: more accurate CVRs means less hand counting in the audit. LEOs gain by using the most accurate and economical system.
Simplest incarnation

- Paper ballots designed by current EMSs.
- CCOS using COTS high speed scanners. $16k scanner can image about 3,500 ballots per hour.
- Scanner prints identifier on the ballots as they are scanned.
- Open-source software interprets images.
- Open-source software lets LEOs inspect images, resolve hard cases. (Sort on mark density, undervotes, over votes, etc.; images could be deleted after this step.)
- Post results at whatever level of geography statutes require.
- “Commit” cast vote record for each ballot.
- Compliance audit to ensure audit trail is complete.
- Risk-limiting audit at the ballot level using simple tools.
Paths to Economical Evidence-Based Elections

• Strong evidence doesn’t require radical transparency, just observing a few key processes
• VVPR, preferably “accessible” VMPB
• Systems that export CVRs linked to the physical ballots.
• Certify things that have to work on election day—not tabulation accuracy
• Laws/regs to provide affirmative evidence outcome is right: Security, custody, compliance audits, risk-limiting audits (group is drafting model legislation for risk-limiting audits)
• Functional requirements, not dictating equipment or procedures
• Align incentives with need for evidence