

You can do RLAs for IRV: The Process Pilot of Risk-Limiting Audits for the San Francisco District Attorney 2019 Instant Runoff Vote

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EVOTE-ID 2020

Overview

- Primer on Risk Limiting Audits
- Instant Runoff Voting (IRV)
- RLAs for IRV
 - RAIRE – **R**isk limiting **A**udits for **IRV** **E**lections
 - Process and Tools
- San Francisco Pilot

Risk Limiting Audits

- Developed by Philip Stark from UC Berkeley, initially for first-past-the-post (FPTP) elections.
- The *risk limit* of the audit controls the degree of confidence attained, and influences auditing effort required.

In a nutshell

The probability that the audit fails to detect a wrong outcome is bounded by the risk limit. An RLA with a risk limit of 1%, for example, has at most a 1% chance of failing to detect that a reported election outcome is wrong.

- Randomly sample paper ballots, and maintain running statistics that indicate when the audit can stop.

Comparison Audits

- Pull a random sample of paper ballots;
- Compare paper ballots against electronic cast vote record (CVR);
- Any discrepancy (error) between the two is used to update (increase/decrease) our risk;
- A paper ballot expressing a vote for l , with a CVR expressing a vote for w represents a 2-vote overstatement;
- Requires a smaller sample size than a ballot polling audit.

Can run a ballot polling audit where CVRs are not available, or paper ballots cannot be matched with their associated (CVR).

Instant Runoff Voting (IRV)

- Each candidate is given the ballots on which they are ranked first (these are their 'first preference votes').
- We repeatedly *eliminate* (remove from consideration) the candidate with the smallest number of votes.
 - The ballots sitting in the eliminated candidates' tally are given to the next most-preferred candidate.
- We stop eliminated candidates once a candidate has the majority of votes – they are the winner.

IRV and San Francisco

- The City and County of San Francisco, CA, has used Instant Runoff Voting (IRV) for some elections since 2004.
- IRV is used widely in Australia (in the election of State and Federal governments, for example).

Our case study

The first ever process pilot of a Risk Limiting Audit for IRV was conducted for the San Francisco District Attorney's race in November 2019. The audit included only vote-by-mail ballots. Susan Loftus won the vote by mail ballots comfortably, though Chesa Boudin won the election overall. The audit tested the feasibility of the process, not the election result itself.

Auditing with Assertions

Create an *audit specification* consisting of a set of *assertions*.

Assertion

A winner vs. loser comparison in a context. The 'context' is a set of candidates that we assume have been eliminated.

- Each assertion represents a FPTP election that can be audited;
- Find a set of assertions that, if proven, rule out all outcomes in which the reported winner *does not win*.
- Find a set of such assertions that requires *the least estimated auditing effort*.

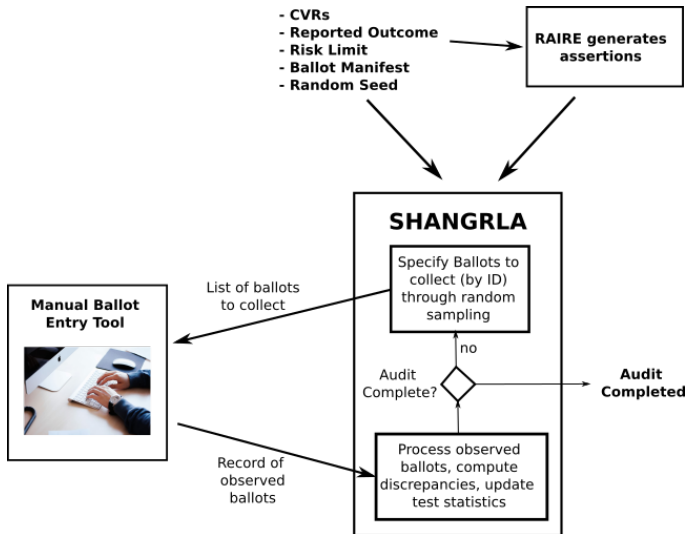
Summary of RAIRE

- We visualise the space of alternate outcomes for an IRV election as a tree – a tree of ‘alternate realities’.
- To audit the election, we want to generate assertions that will rule out all branches of this tree.
- RAIRE uses a branch-and-bound algorithm to find the ‘easiest to audit’ set of assertions.

For further details on algorithmic aspects, see:

- The paper (You Can Do RLAs for IRV).
- M. Blom, P. Stuckey, V. Teague. RAIRE: Risk-Limiting Audits for IRV Elections, on ARXIV.
- M. Blom, P. Stuckey, V. Teague. Ballot-polling Risk Limiting Audits for IRV Elections. EVOTE-ID 2018.
- P. Stark. Sets of Half-Average Nulls Generate Risk-Limiting Audits: SHANGRLA, on ARXIV.

Tools & Process



Contest: WYOMING DNC PRIMARY

Reviewer #1 - Enter imprinted id and choices as marked on paper ballot

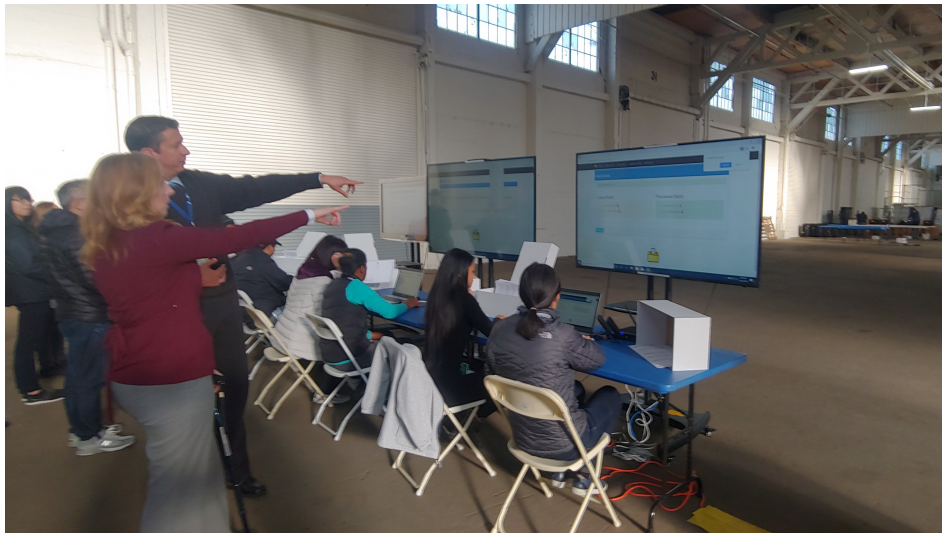
Imprinted ID: Select Imprinted ID from remaining list of 20:

| | 1st Choice | 2nd Choice | 3rd Choice | 4th Choice | 5th Choice | 6th Choice | 7th Choice | 8th Choice | 9th Choice |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|  Tulsi Gabbard | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|  Pete Buttigieg | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|  Joseph R. Biden | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|  Michael R. Bloomberg | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|  Elizabeth Warren | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|  Amy Klobuchar | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|  Bernie Sanders | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|  Tom Steyer | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|  (undeclared) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

 Contest Not On Ballot Clear Ballot Submit For Verification

Performing the Audit – in San Francisco

[Photo by Vanessa Teague]



Performing the Audit – the Stats

- 293,555 ballots involved in the audit;
- A sample of 200 ballots was required to complete the audit;
- 11 assertions;
- An overall risk of 3% was attained.



The Future – Auditing STV

- Single Transferable Vote (STV) is how candidates are elected to our Federal Senate, and all upper houses of State Parliaments.
- Ballot scanning, data entry, and software used for tabulating votes and determining the outcome.
- Auditing needed – especially as OCR is used in ballot scanning.
- STV is hideously complex, and we don't know how to audit it!
- Should be of interest to Australian elections.

In the paper ...

- Details on the types of assertions RAIRE forms;
- More detail on how RAIRE and SHANGRLA work;
- Description and location of each tool used to perform an RLA for an IRV election. All tools are open source.

Questions?

Via provided chat (or email: michelle.blom@unimelb.edu.au)