

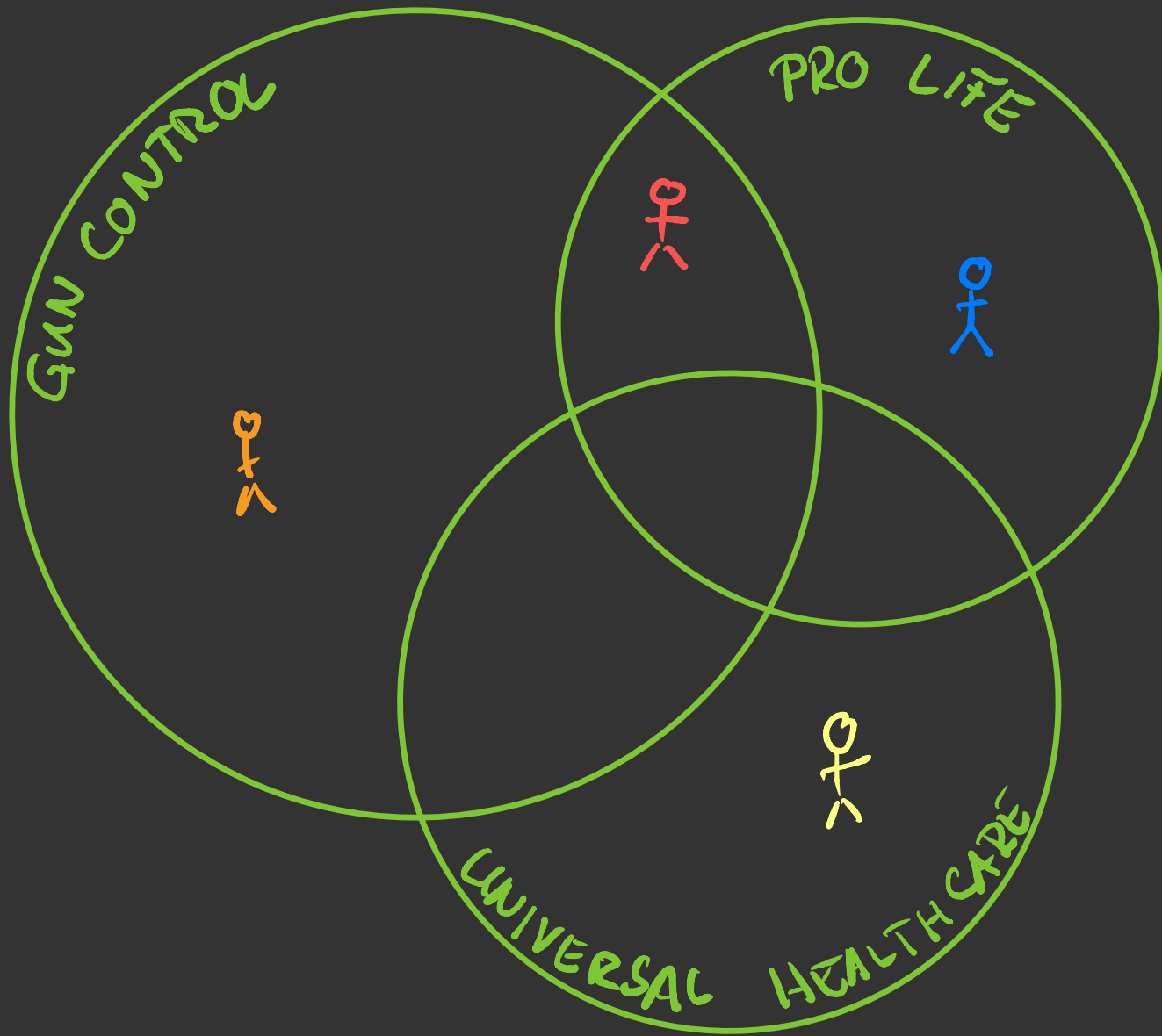
# ELECTION SECURITY

FROM BALLOTS TO TRUST

CARSTEN SCHÜRMAN

CENTER FOR INFORMATION SECURITY AND TRUST

IT UNIVERSITY OF COPENHAGEN



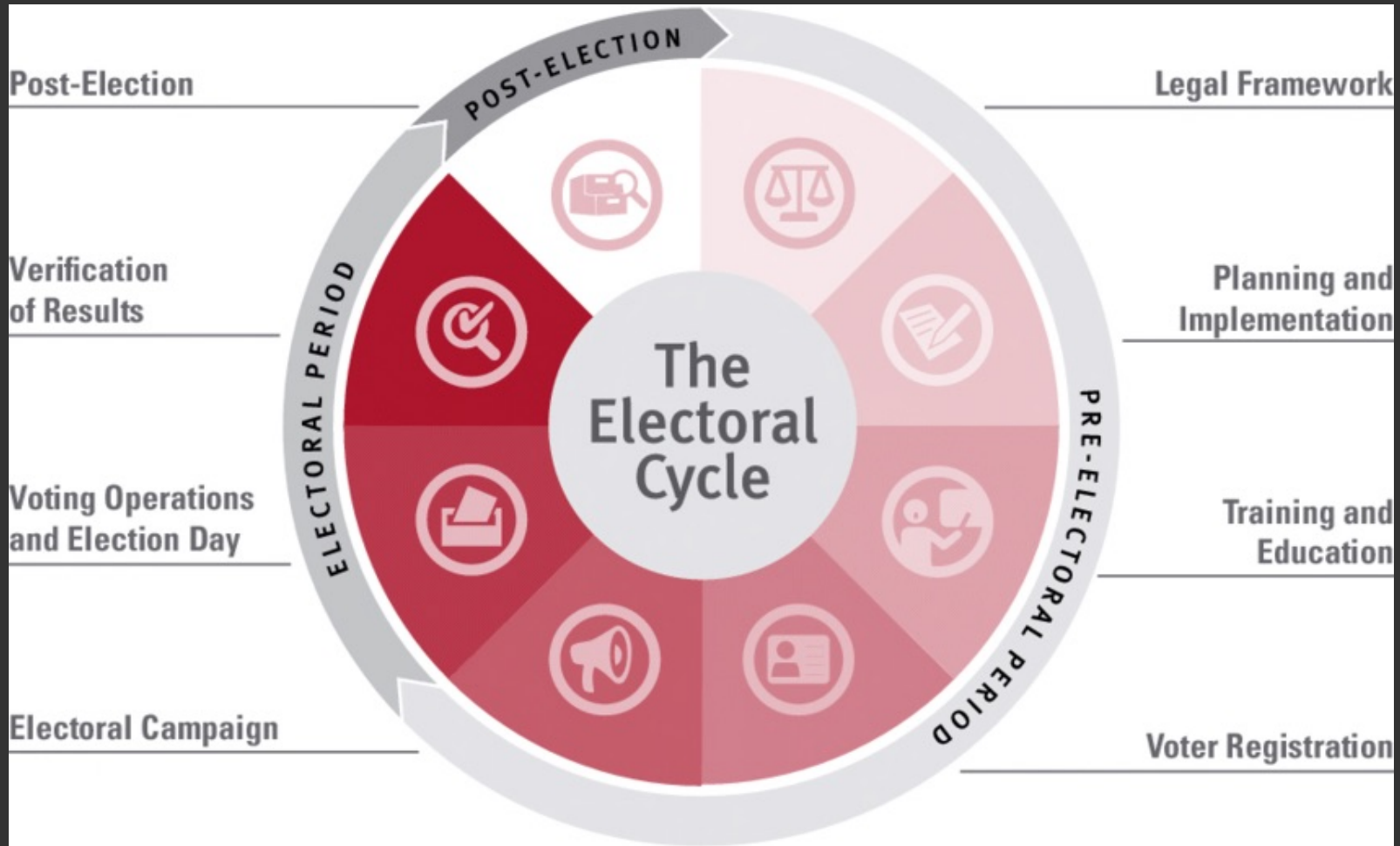
ELECTION  
PROCESS  
VOTING RULE



CIVIC BATTLE

GOVERNMENT

# THE ELECTORAL CYCLE



# PUBLIC CONFIDENCE

TRUST [SIMON '13]

"TO CONVINCe THE LOSER  
THAT HE OR SHE LOST"

DAN WALLACH

TEXAS SENATE HEARING, 2008

"TO GUARANTEe A PEACEFUL RESOLUTION  
OF THIS CIVIC BATTLE"

JORDI BARAT, 2018

PERSONAL COMMUNICATION

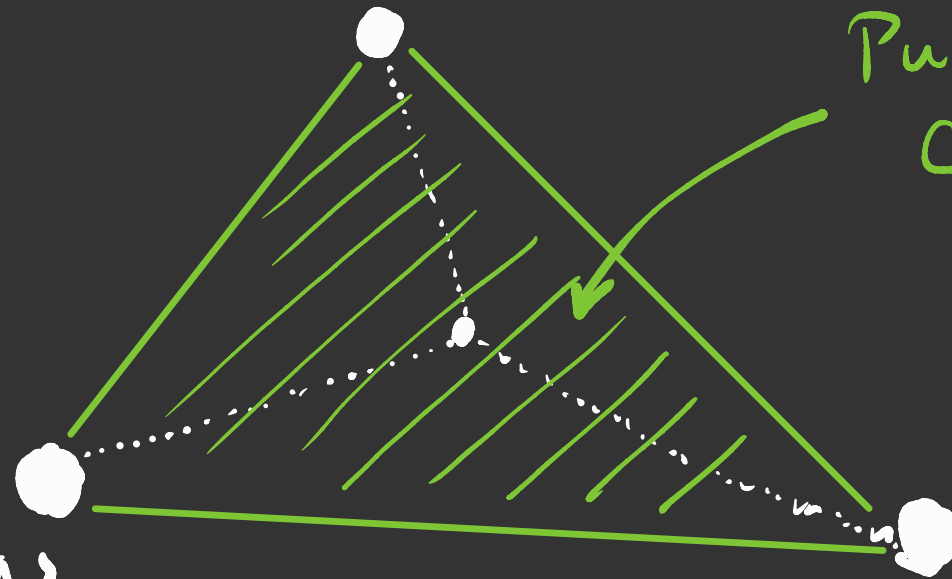
# THE ANATOMY OF PUBLIC CONFIDENCE

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- HAND-MARKED BALLOTS
- MACHINE MARKED
- PROOFS OF KNOWLEDGE
- DIGITAL SIGNATURES

EVIDENCE

PUBLIC CONFIDENCE



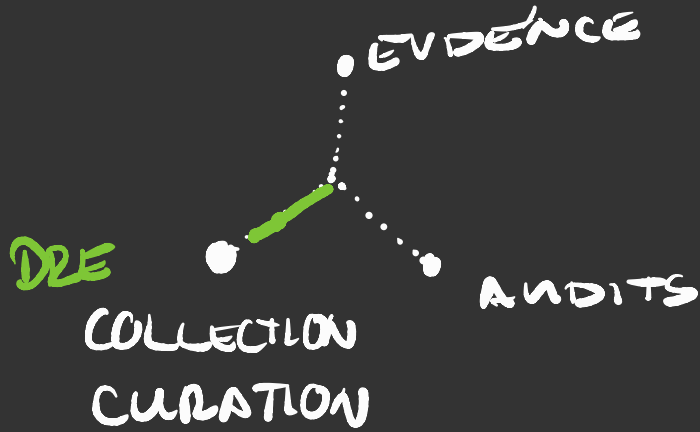
COLLECTION  
CURATION

AUDIT

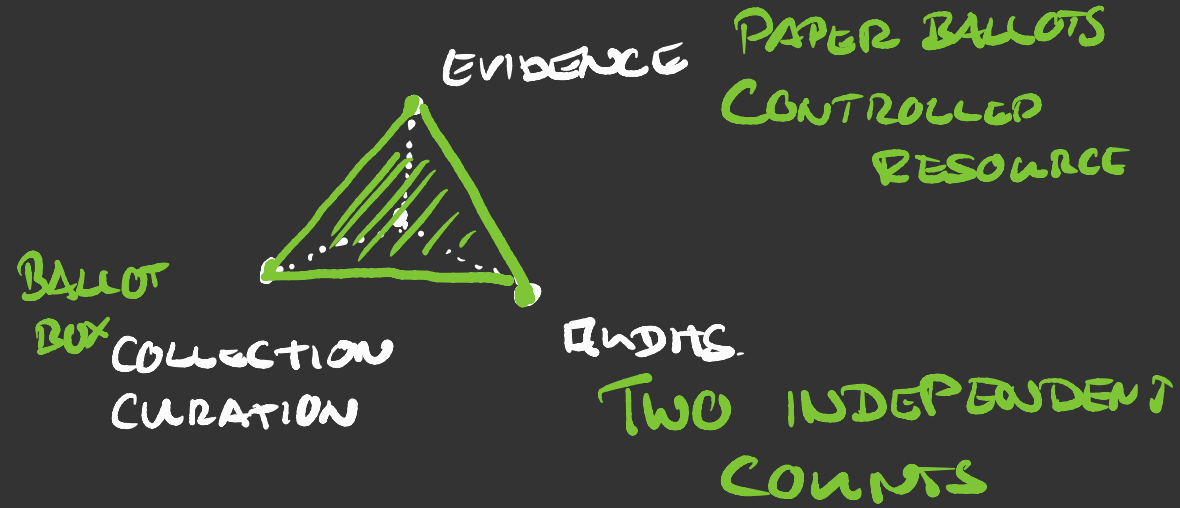
- STORAGE & PROTECTION
- TEMPER-PROOFING
- TRANSPORT

- RISK LIMITING AUDIT
- RECOUNTS
- POST ELECTION AUDITS

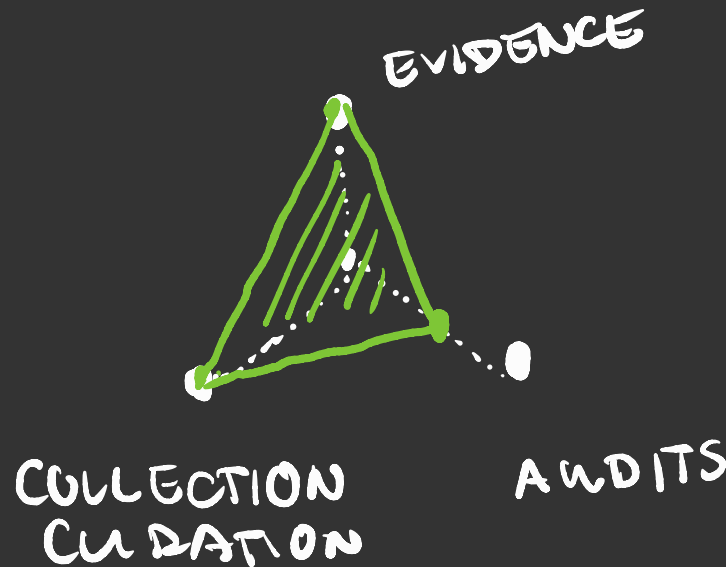
# USA [GEORGIA 2018]



# DENMARK



# PHILIPPINES



# CHALLENGES TO PUBLIC CONFIDENCE

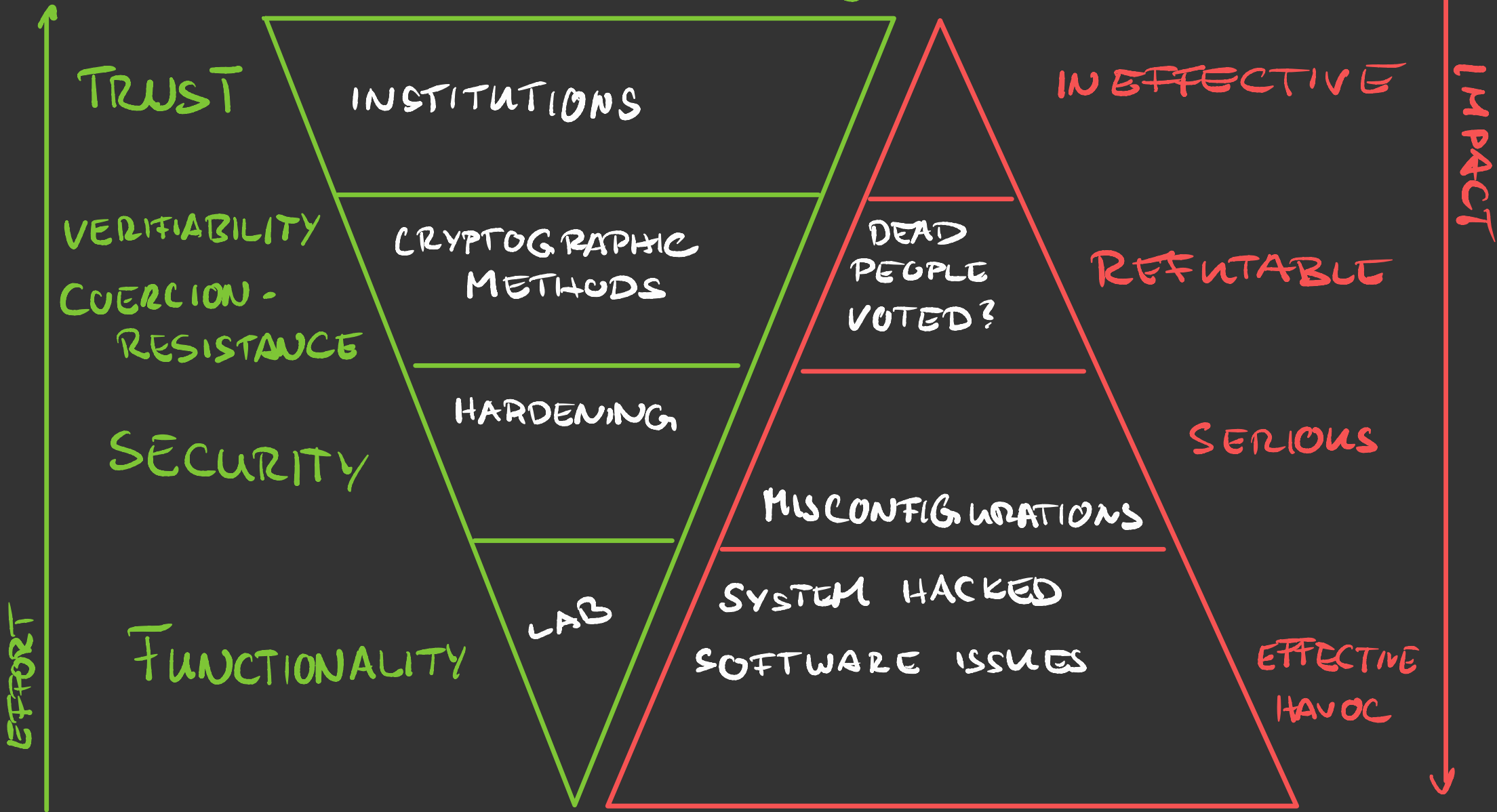
## 1) ELECTION TECHNOLOGIES

- COMPLEX
- UNOBSERVABLE

## 2) DISINFORMATION CAMPAIGNS

- POLITICALLY MOTIVATED
- NEW MEDIA
- GLOBAL INSTANTANEOUS DISTRIBUTION

# ELECTION TECHNOLOGIES



TRUST

INSTITUTIONS

INEFFECTIVE

VERIFIABILITY

CRYPTOGRAPHIC  
METHODS

DEAD  
PEOPLE  
VOTED?

REFUTABLE

COERCION-  
RESISTANCE

HARDENING

SECURITY

SERIOUS

FUNCTIONALITY

LAB

SYSTEM HACKED  
SOFTWARE ISSUES

EFFECTIVE  
HAVOC

DIS/INFORMATION

EFFORT

IMPACT



# VOTING TECHNOLOGIES

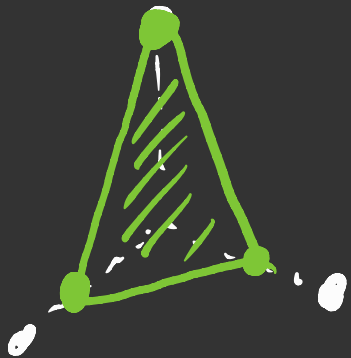
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OPTICAL  
SCANNERS

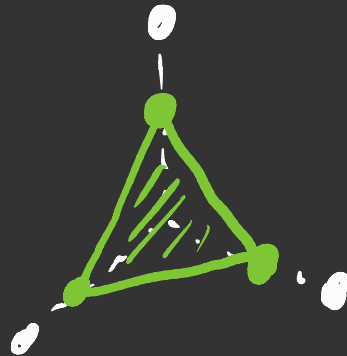
BALLOT  
MARKERS

INTERNET  
VOTING

COLORADO 2020



GEORGIA 2020



SWITZERLAND 2022

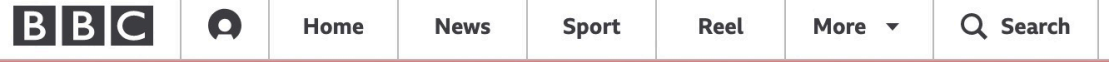


KENYA 2017

# REACTIONS OF THE WINNER / LOSER



[Oct 27]



## Kenya election 2017: Raila Odinga says election systems hacked

9 August 2017

Kenya general election 2017



Kenya's day of tension after polls

[Aug 6]

# IMPACT

2017

---

Aug 8: GENERAL ELECTIONS

Aug 28: SUPREME COURT HEARS ODINGA'S CASE

- SUSPICIOUS LOG FILES

- NO ACCESS TO SERVERS

Sep 1: SUPREME COURT NULLIFIED RESULT  
ORDERS FRESH ELECTION

Oct 26: FRESH PRESIDENTIAL ELECTION

# EVIDENCE

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MAINTENANCE  
KPMG 2017

- FINGERPRINT
- ID + FINGERPRINT
- FORM 32A

- IMAGE
- DIGITAL DATA



KIEMS



KIEMS

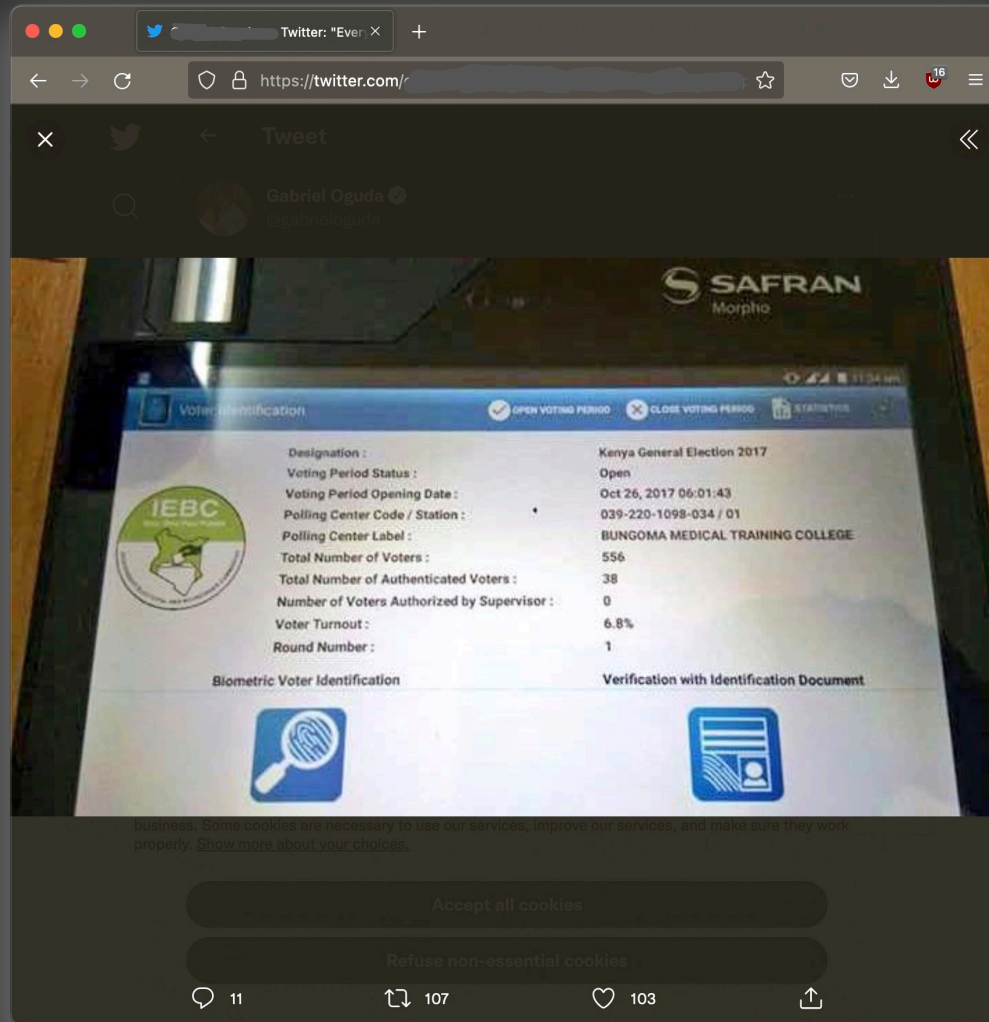
BIOMETRIC  
VOTER  
REGISTER

VOTER  
REGISTRATION

PAPER  
BALLOTS

RESULTS  
TRANSMISSION  
SYSTEM  
RTS

# KENYA INTEGRATED MANAGEMENT SYSTEM

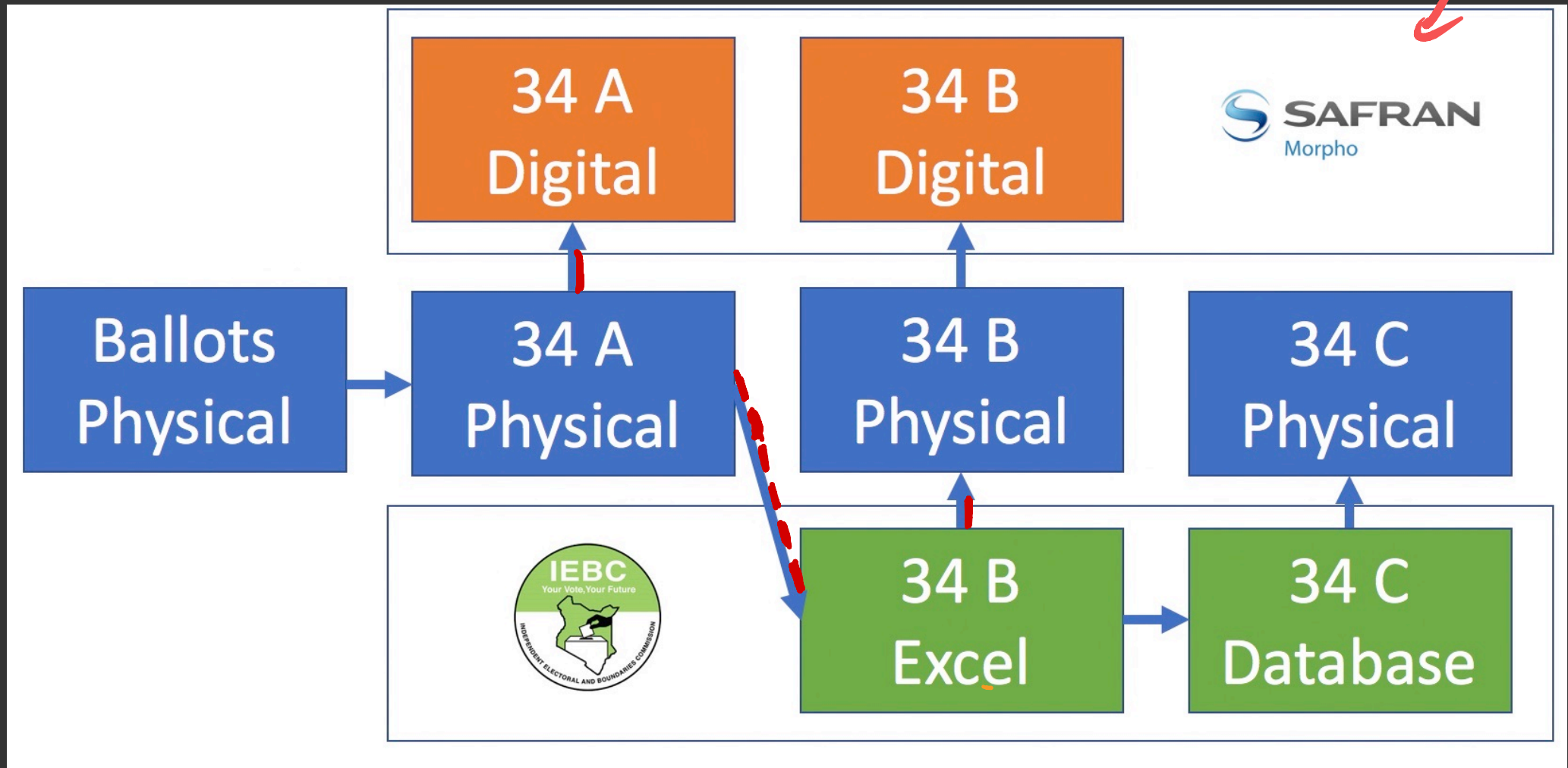


# KIEMS Kit



# FROM BALLOT TO RESULT

SERVERS IN FRANCE



FRESH PRESIDENTIAL ELECTION

OCT 26, 2017



## EVIDENCE

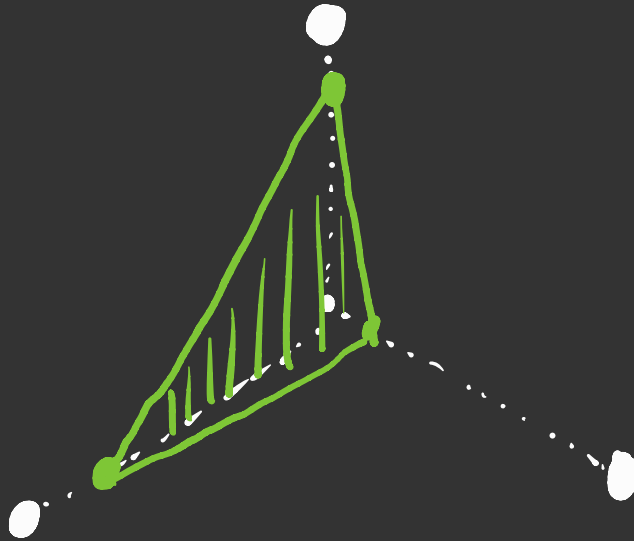
- BVR
- PAPER BALLOTS
- 34A, 34B, 34C FORMS
- RESULTS TRANSMISSIONS

DIGITAL



## COLLECTION CURATION

- VOTER STATION
- JURISDICTION  
WAREHOUSE
- SECURE CLEAR  
BALLOT BOXES



## AUDITS

- DIGITAL DATA  
VS  
PAPER TRAIL
- NO AUDIT OF BALLOTS

# RISK-LIMITING AUDITS

A BETTER WAY  
TO AUDIT

[LINDEMANN & STARK 2012]

# EVIDENCE

# RESULT



UHURU KEN YATTA	8.223.369
RAILA ODINGA	6.822.812
JOSEPH NYAGATH	38.029
ABDUBA DIDA	38.004
EKURU AMKOT	27.400
INVALID/BLANK	411.510
TOTAL	15.593.050
ELIGIBLE	19.611.423

# RISK LIMITING AUDIT (RLA)

PROCEDURE THAT HAS A LARGE PRE-SPECIFIED CHANCE OF CORRECTING AN ERRONEOUS RESULT

STEP 2: SIZE OF RANDOM SAMPLE

Initial sample size

Contest information

Ballots cast in all contests: 15593050 Smallest margin (votes): 1,400,557. Diluted margin: 8.98%.

Contest 1. Contest name:  
2017 Kenya Presidential Election August 8, 2017

Winners: 1

Reported votes:

Candidate 1 Name:	Uhuru Kenyatta	Votes:	8223369
Candidate 2 Name:	Raila Odinga	Votes:	6822812
Candidate 3 Name:	Joseph Nyagah	Votes:	38029
Candidate 4 Name:	Abduba Dida	Votes:	38004
Candidate 5 Name:	Ekuru Aukot	Votes:	27400
Candidate 6 Name:	Japheth Kaluyu	Votes:	11774
Candidate 7 Name:	Cyrus Jirongo	Votes:	11282
Candidate 8 Name:	Michael Wainaina	Votes:	8870

Add candidate to contest 1 Remove last candidate from contest 1

Add contest Remove last contest

Audit parameters

Risk limit: 0.1%

Expected rates of differences (as decimal numbers):

Overstatements. 1-vote:	0.001	2-vote:	0.0001
Understatements. 1-vote:	0.001	2-vote:	0.0001

Starting size

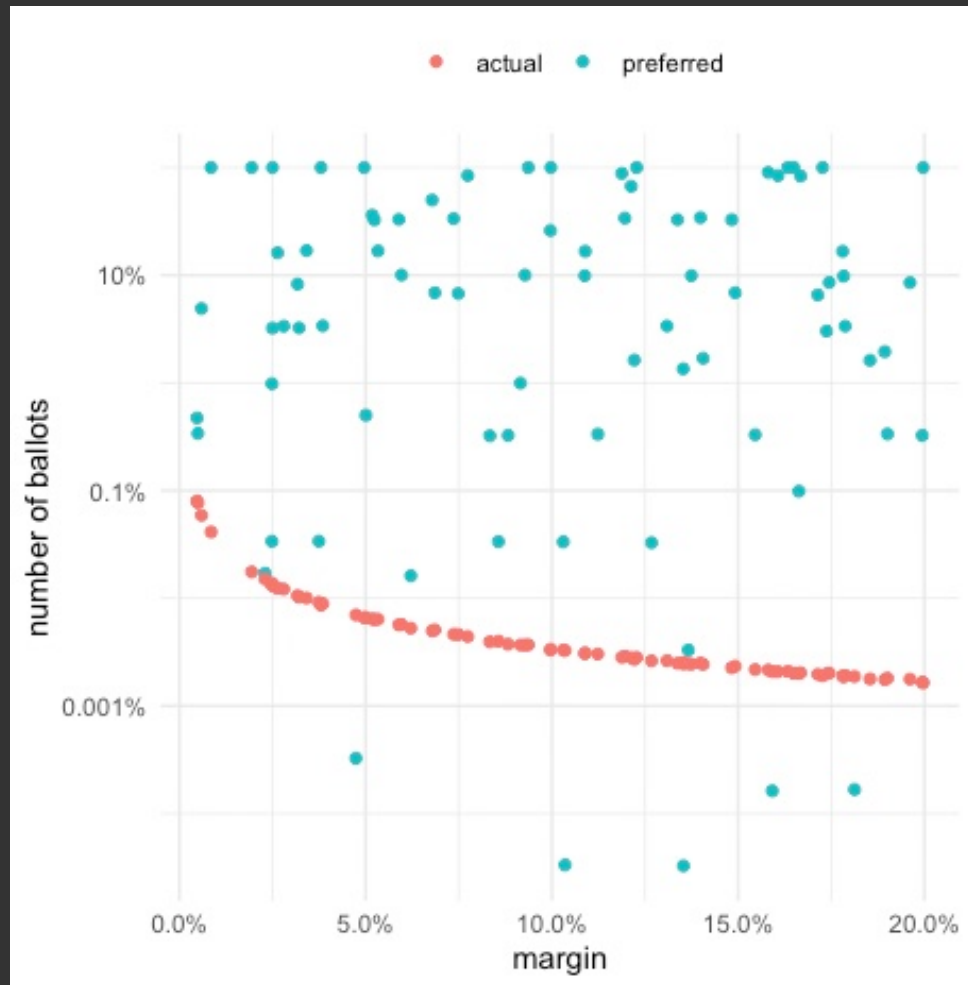
Round up 1-vote differences.  Round up 2-vote differences. Calculate size: 166.

Step 1

SET THE CHANCE (RISK-LIMIT)

99.9% CERTAINTY

# RLAs & DISINFORMATION



- PROLIFIC PLATFORM
- US DEMOGRAPHIC
- 105 PARTICIPANTS

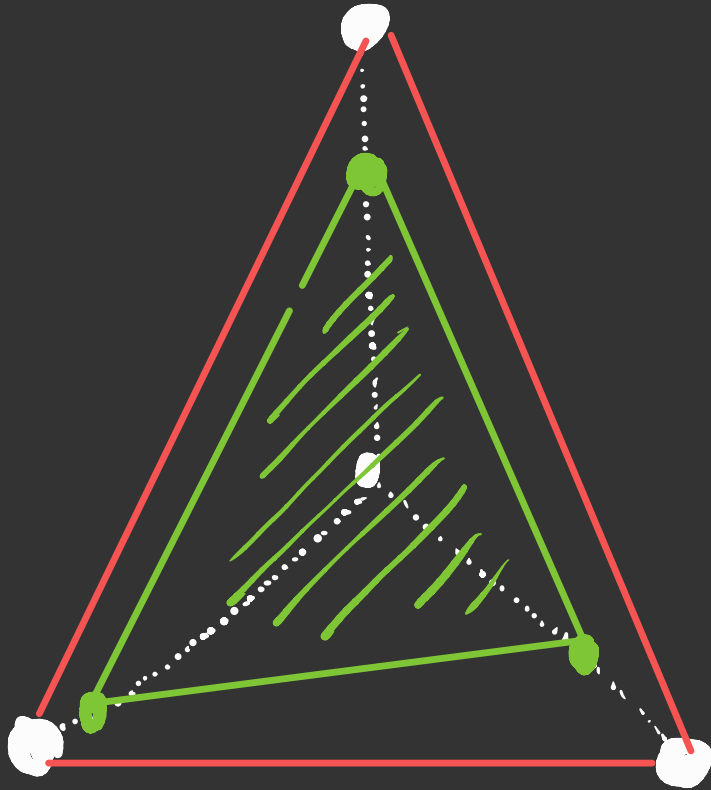
## HYPOTHESIS:

WHEN ASKED ABOUT # BALLOTS TO AUDIT PARTICIPANTS ANSWER HIGHER THAN RLA.

[DALELA, KULYK, CS'21]

CONCLUSIONS

EVIDENCE



DISINFORMATION

PUBLIC CONFIDENCE

COLLECTION

CURATION

AUDIT

#1 BAD ELECTION TECHNOLOGY  
IMPLIES HIGHER RISK OF  
DISINFORMATION

#2 UNDERESTIMATING RISKS OF  
ELECTION TECHNOLOGIES  
CAN DESTABILIZE  
DEMOCRACIES