Homomorphic Voting Scheme

By Raj Thimmiah

Goal

- To understand the importance of privacy and integrity in a fair voting scheme
- Illustrate a basic working example of a homomorphic voting scheme which solves the two aforementioned issues
- To understand that no voting scheme is perfect

Why is privacy important in general?

- Access to someone's personal information can be used to:
  - Threaten
  - Influence
  - Damage reputations
  - Violate freedoms in thinking, beliefs, daily actions

Why is privacy critical for voting?

- Privacy can be implemented by service providers
- Usage of privacy is optional
  - Users can violate privacy by sharing their own data
- In voting, **violating your own privacy cannot be allowed for a fair vote!**

Do you like Python or Java better?

Why was lack of privacy harmful?

- Group think/peer pressure
- Discrimination and retribution
- Bribery

All of these issues violate the sanctity and trustability of the results of the vote

Do you like Python or Java better?

Did we have the same privacy issues?

- Group think/peer pressure
  - No risk of someone judging you or you seeing what everyone else thinks
- Discrimination and retribution
  - No one can prove you voted a certain way (except me) and thus no risk of discrimination or retribution
- Bribery
  - You could accept Martin's bribe, vote for Java and lie to him about the result
  - There is no "receipt" that could prove you voted a certain way

The authorities in charge of the vote can still violate privacy

Was the vote really added up correctly?

Verifiability

- Cast-as-intended (important for digital systems):
  - The voting system marked the choice correctly
- Recorded-as-cast
  - The vote that was cast was also recorded by the system correctly
- Tallied-as-recorded
  - The vote was added correctly

Verifiability

- Eligibility verification
- Accountability
  - Ability to prove failure of the system and to re-submit a vote
- Robustness
- Usability
- Accessibility

End to End Verifiability

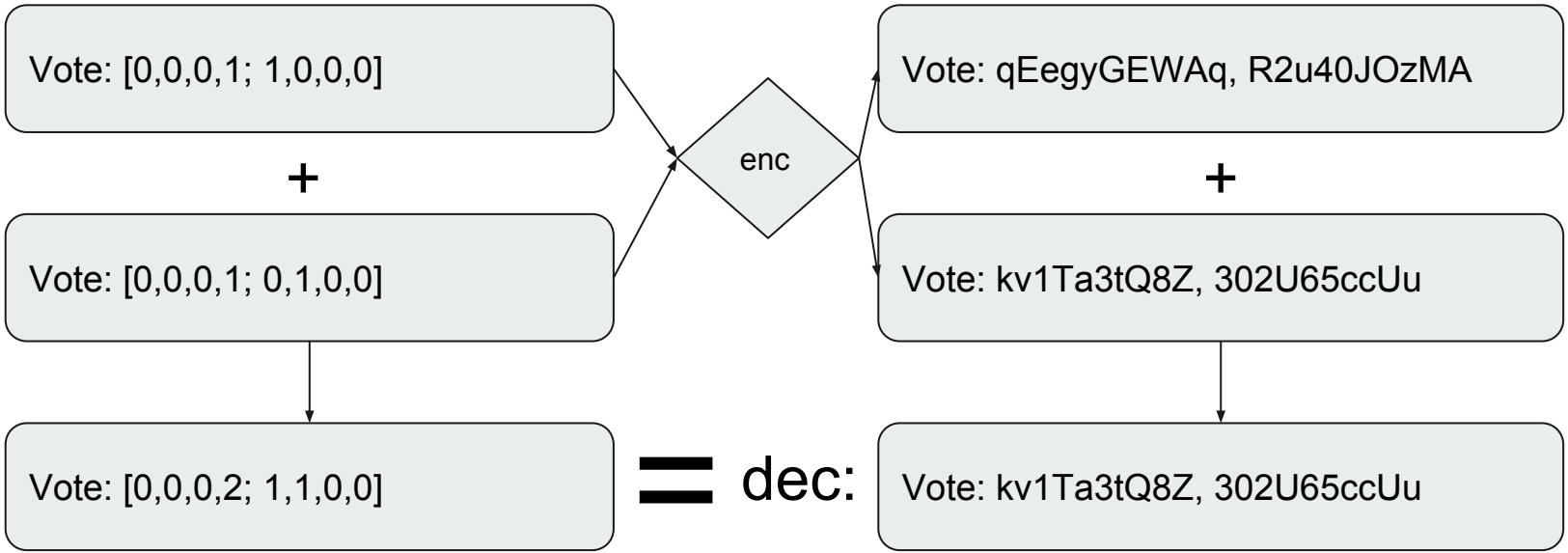
Raj	Java
Martin	Python
Adel	Python

Python	2
Java	1

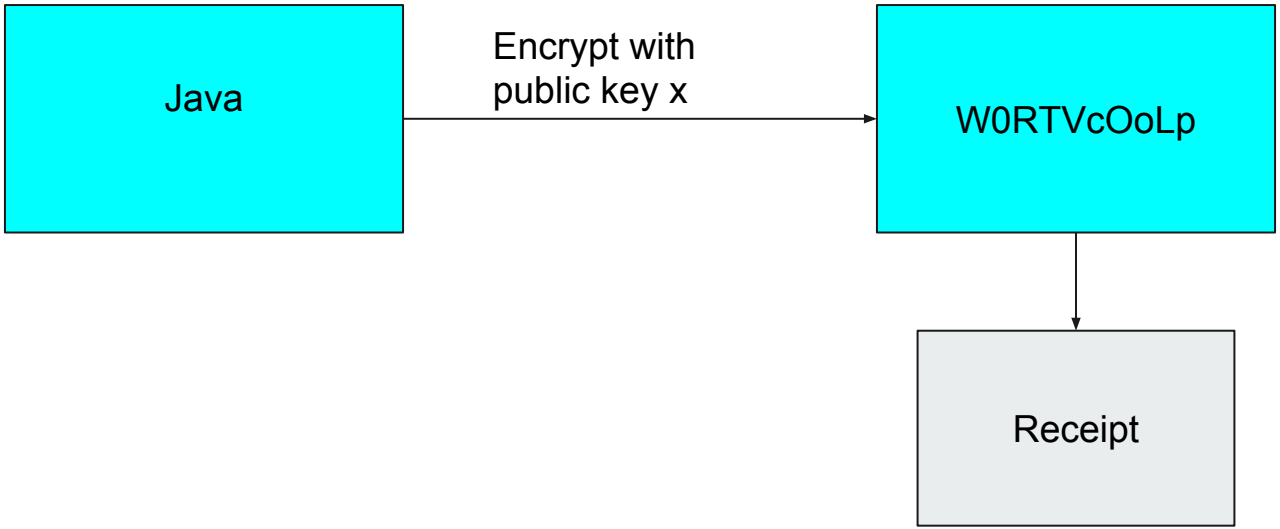
Homomorphic Encryption

- Additively Homomorphic Scheme:
  - X + Y
  - ENC(X) + ENX(Y) = ENC(X + Y)

Homomorphic Encryption



Vote



End to End Verifiability

Raj	W0RTVcOoLp
Martin	56LjKngjOk
Adel	g4k23fsCom

Python	uGYHrEnVNT
Java	kgKoepq8L0

Public/Private Key Encryption

- Public key is shared with everyone
  - Can be used to encrypt data
- Private key is hidden
  - Can be used to decrypt data encrypted with a corresponding public key

Threshold Encryption

- Split private key into n shares
- N shares are given to people
- X out of N shares are needed to decrypt
- Until X nodes are malicious and collude, individual privacy is guaranteed

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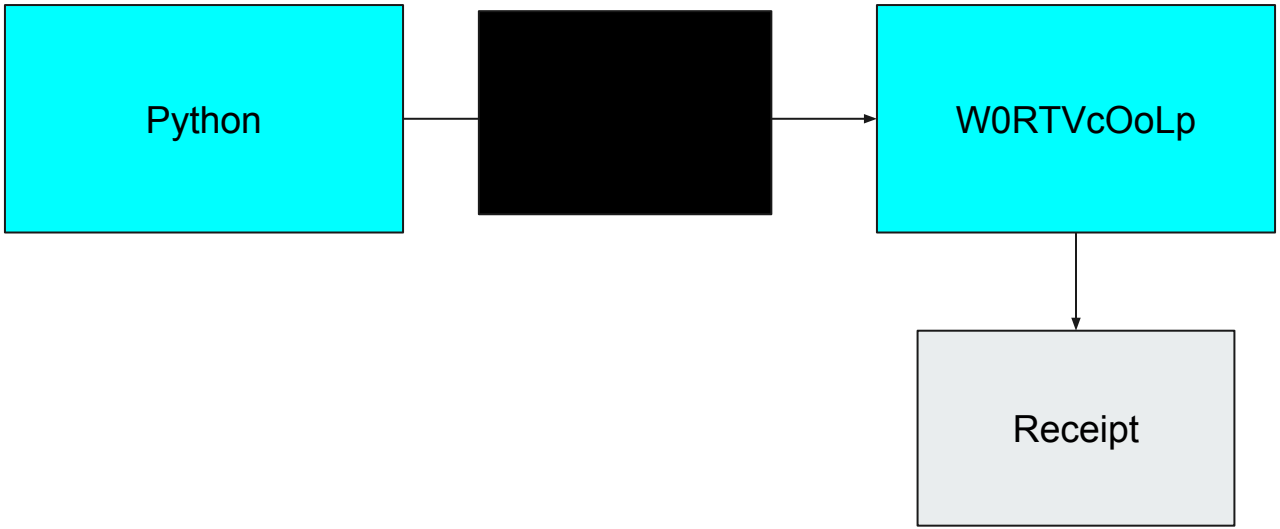
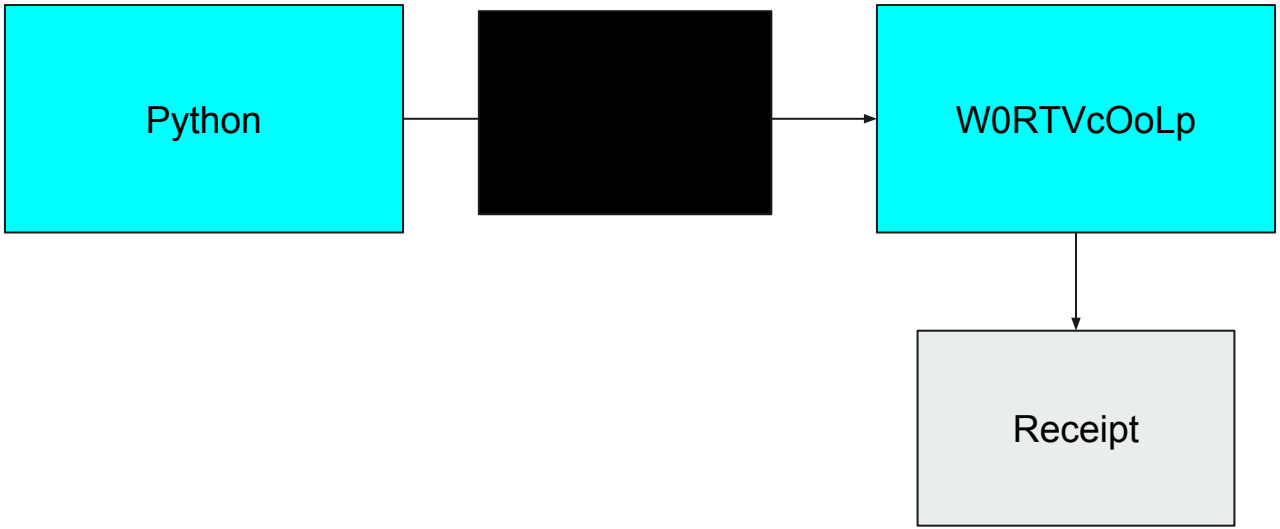
Voting Machines are Black Boxes



Challenge the machine!



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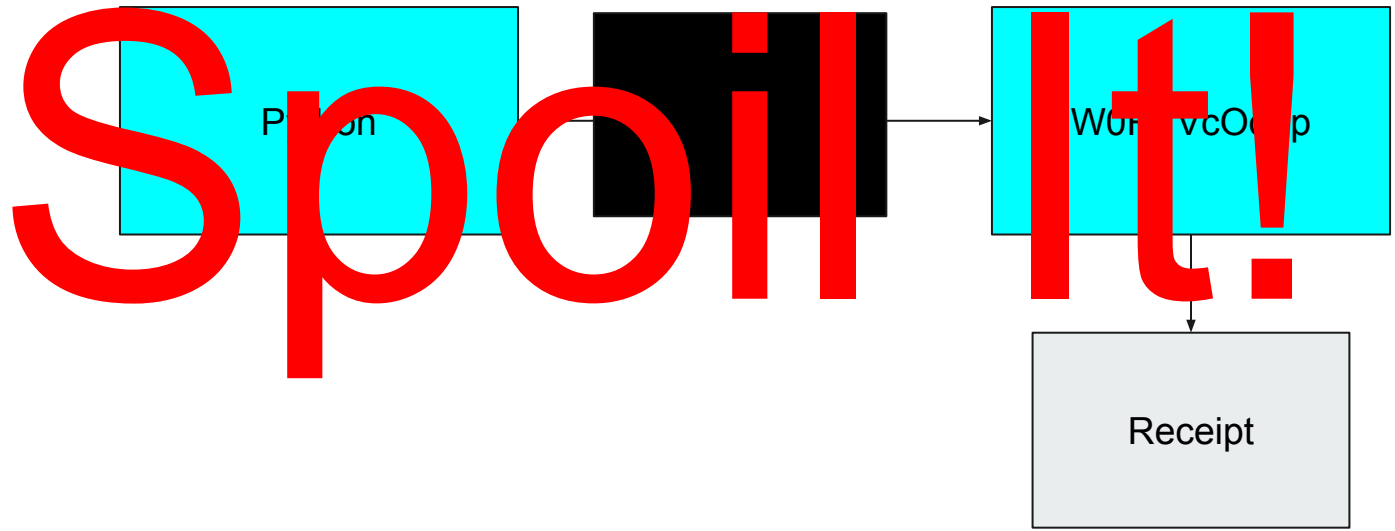

Spoiling Ballots

- When you want to challenge, you spoil the ballot
- Spoiled ballots are added in a separate section
- They are decrypted at the end and you can check that it was encoded correctly

End to End Verifiability

Raj	W0RTVcOoLp
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Java	kgKoepq8L0

Java	48giABRpkR (Spoiled Ballot)

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Why can’t we vote remotely?

- Can be coerced to vote a certain way more easily
- Malware can also cause issues
- Might be difficult to use for some voters

We can’t actually prevent coercion!

Coercion Resistance

- On site coercion should not be able to violate privacy
- Cannot be forced into submitting voting materials
- Cannot be forced to not vote
- Cannot be forced to randomly vote
- JCJ/Civitas

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- Accessibility

Star Vote

https://www.usenix.org/conference/evtwote13/workshop-program/presentation/bell

Please fill out this survey!

Citations

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