STDinfo

Secure multiparty computation to infer transmission risk from 2 sexually transmitted diseases (STDs) test reports

Secure computation

Secure computation is part of information theoretic cryptography

Compute a function F(a,b) that takes input a from Alice and b from Bob, without revealing b to Alice or a to Bob?

Bob encrypts b and send enc(b) to Alice. Alice computes F(a,enc(b)) sends it to Bob. Bob can compute F(a,b) without knowing b, because F is a special function that allows that using garbled circuits, finite field arithmetic, or Shamir secret sharing.

Applications in privacy-preserving data analytics, quantum-resistant cryptography.

STDinfo problem set up

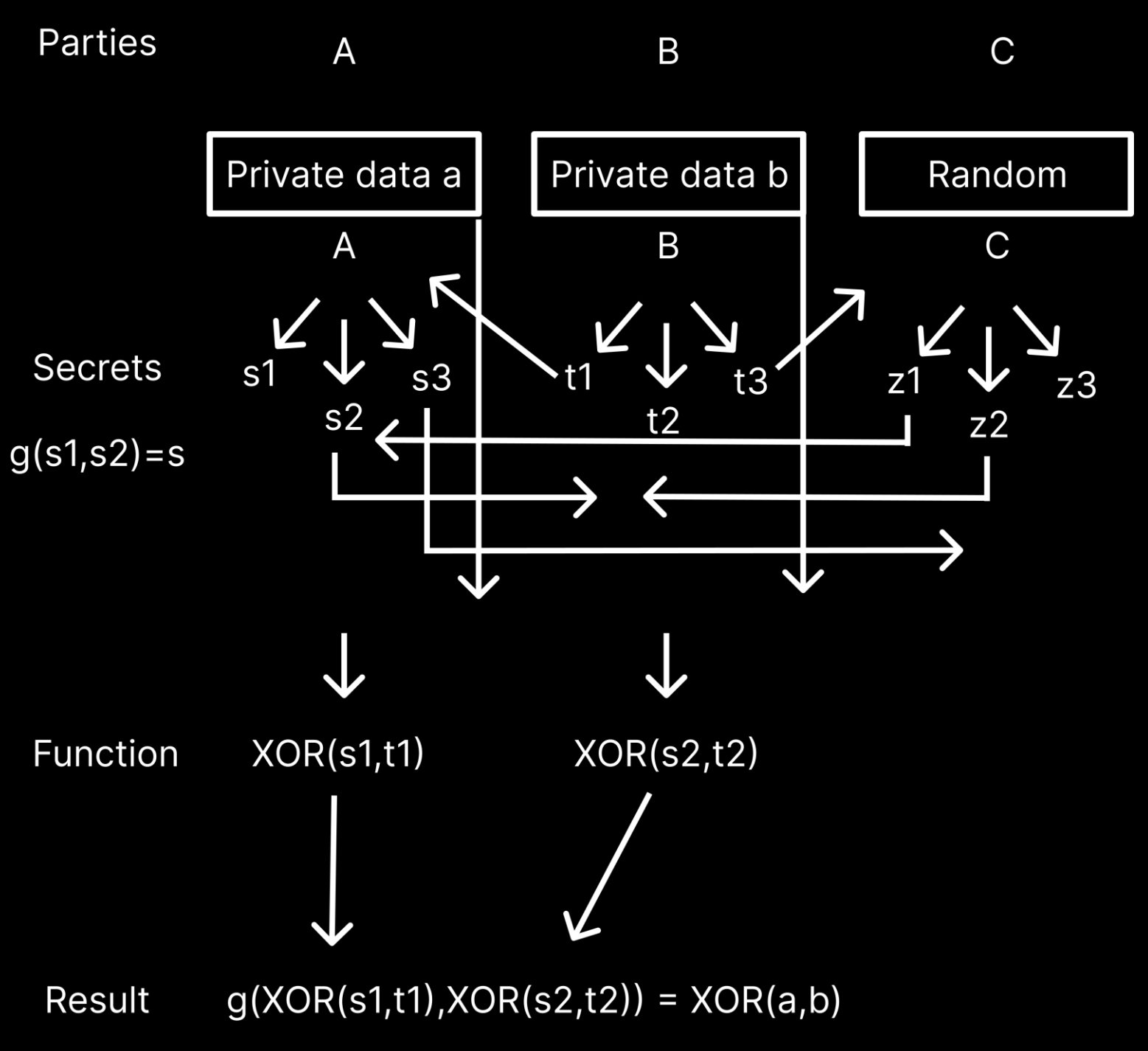
Alice and Bob have 2 private strings.

A = 010001

B = 010000

Compute bitwise XOR and modulo-2 sum. 0+0+0+0+0+1 = 1.

Bit strings are medical reports. Bitwise XOR and modulo-2 sum returns False (1) if A has a sexually transmitted disease that B doesn’t, and True (0) if both can have safe sex because they either have no diseases or share the same diseases.



3 parties A,B,C. A and B have private data ‘a’ and ‘b’.

A generates shares s1,s2,s3 from ‘a’ with the property that any 2 can be used in a public function g() to get a. This property is called Shamir secret sharing. B similarly generates shares t1,t2,t3 from ‘b’.

A sends s2,s3 to B and C respectively. B sends t1,t3 to A and C respectively.

A calculates XOR(s1,t1) and sends it to B. B calculates XOR(s2,t2) and sends it to A.

A and B calculate XOR(a,b) using XOR(s1,t1) and XOR(s2,t2) because XOR(s1,t1) and (s2 XOR t2) are shares of XOR(a,b). (from g(s1,s2)=s). This is called 2-reconstruction property.

Privacy-preserving data analytics

Instead of bitwise XOR and modulo-sum, other operations such as multiplication can be done, opening the machine learning toolkit for implementation.

Lasso is a regression algorithm that ignores features having low correlation with target. This was used to find important features from a combination of 2 private datasets without the parties revealing datasets to each other.

Applications in semiconductor fab optimization, healthcare data analytics, privacy for large language models.

Future work

Extending functions beyond XOR

Computer vision integration to convert PDF test reports into bit strings

Library for secure computation on Android and iOS

References

Privacy preserving dataset combination and Lasso regression for healthcare predictions

MPyC: Library in Python for secure multiparty computation

STDinfo: Github repository for Python implementation of secure multiparty computation to find disease transmission risk from medical test reports