How (not) to Fuzzy Vault?

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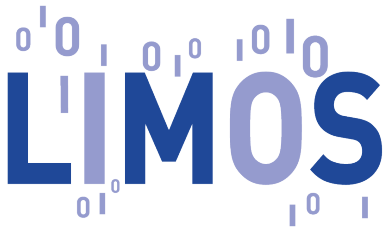

Biometric?

Biometric

Definition (CNIL)

"Biometrics groups all the computer techniques that make possible to automatically recognize a person based on his physical, biological or behavioral characteristics. Most of them have the particularity of being unique and permanent (DNA, fingerprints, etc.)."

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Biometric Protocol

Enrollement

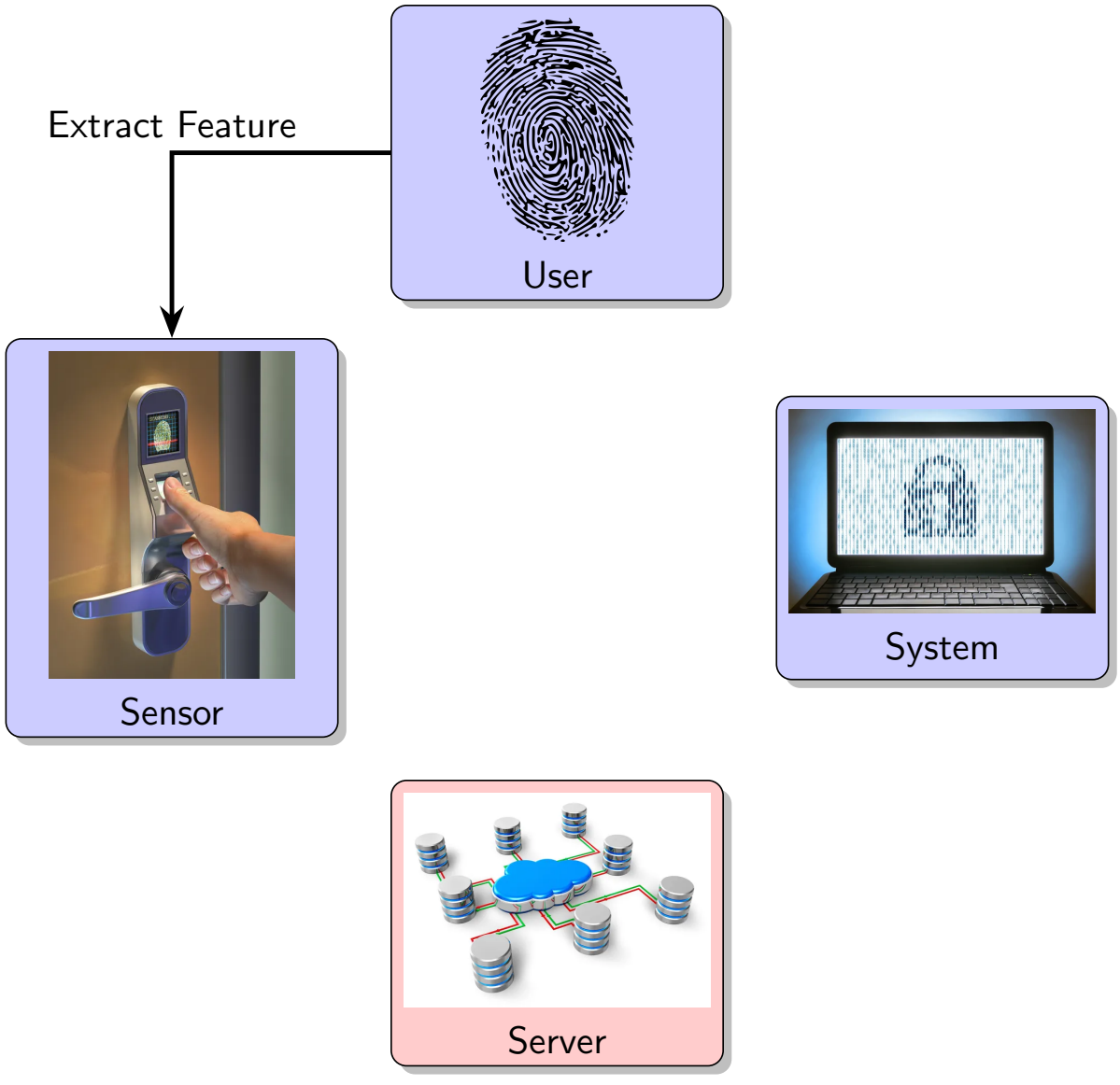
User

Sensor

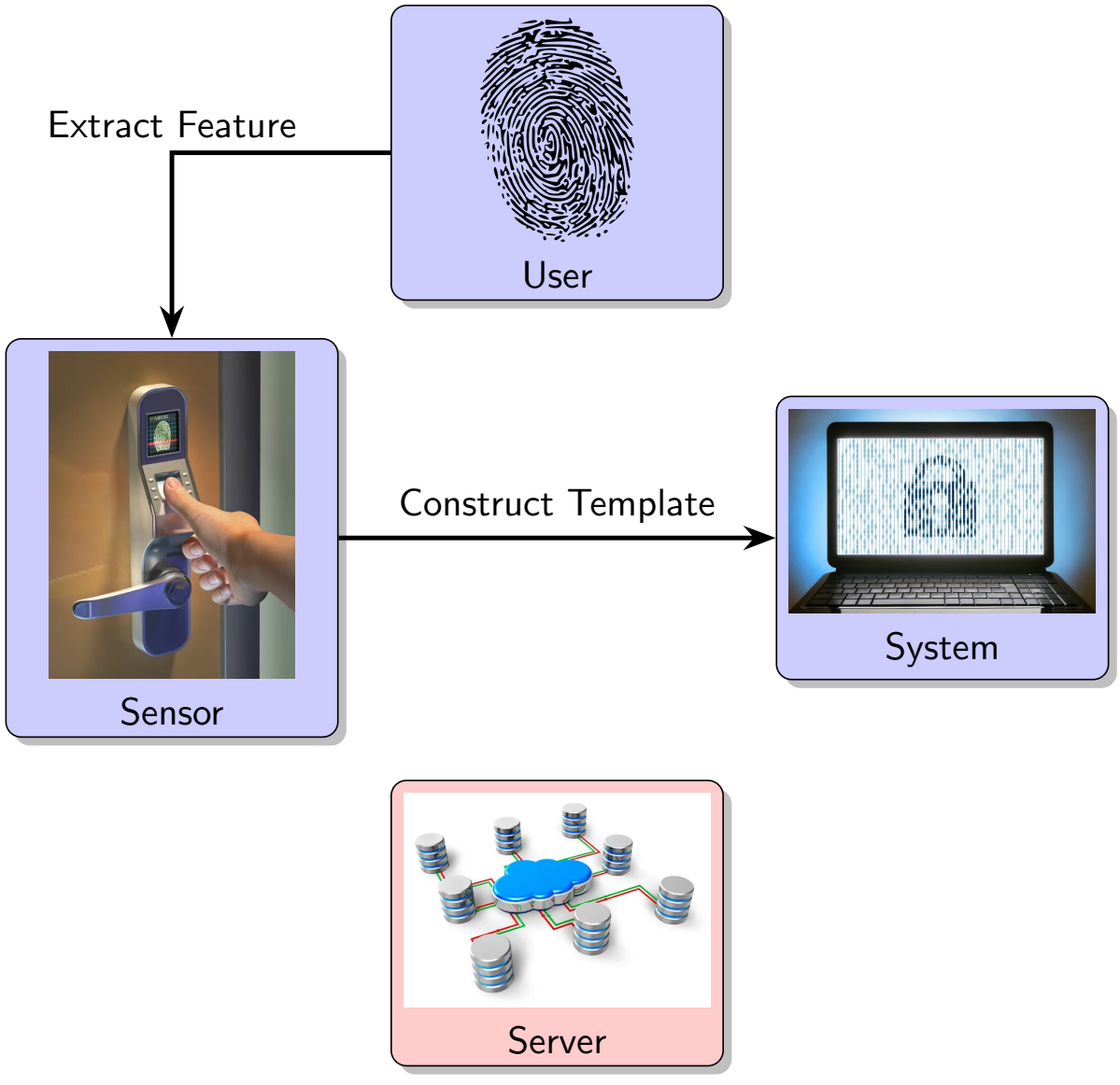
System

Server

Enrollement



Enrollement



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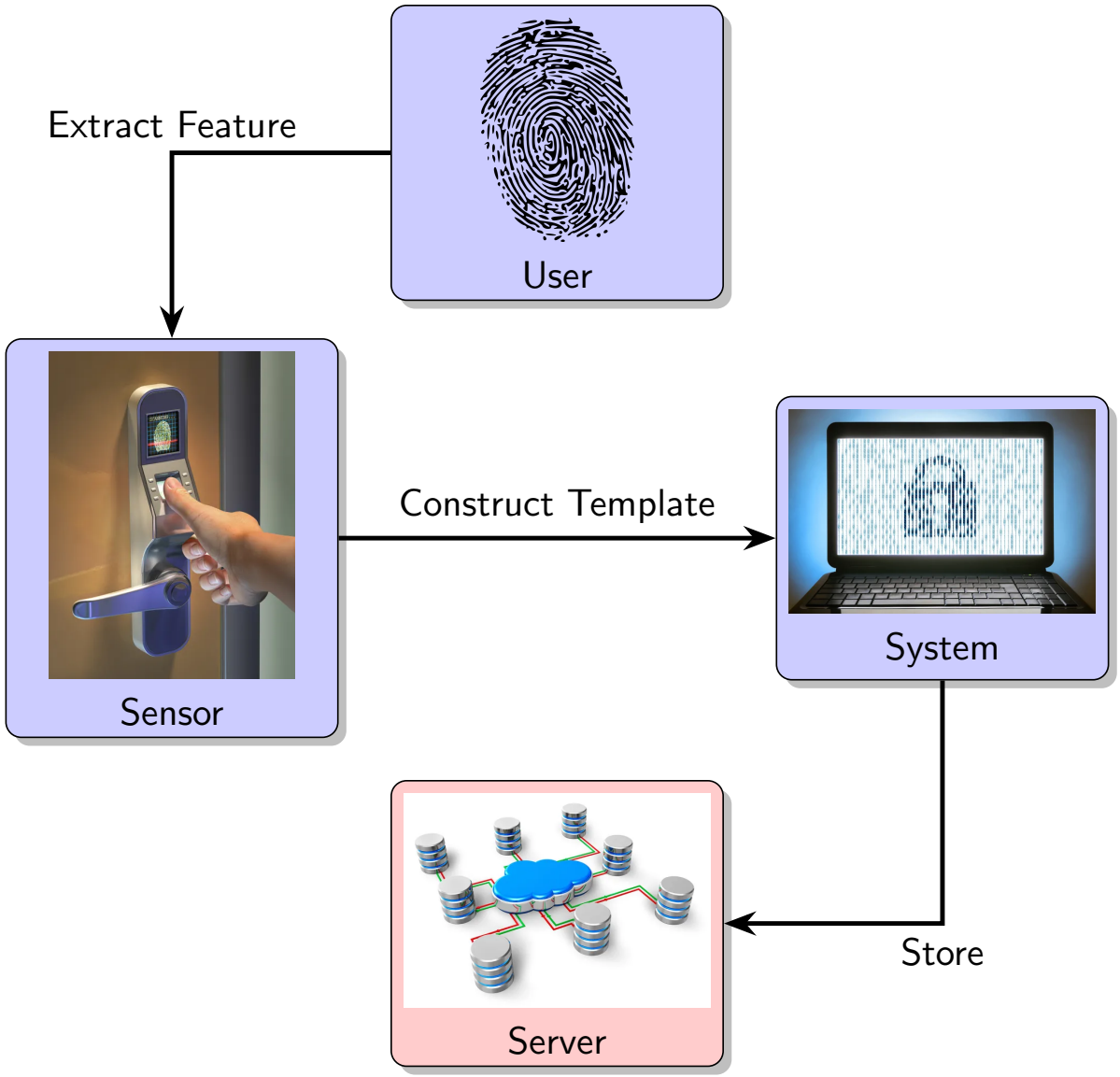
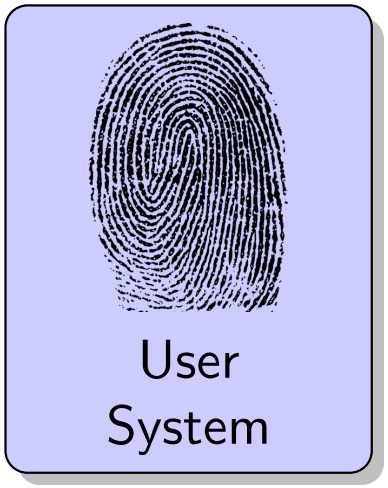


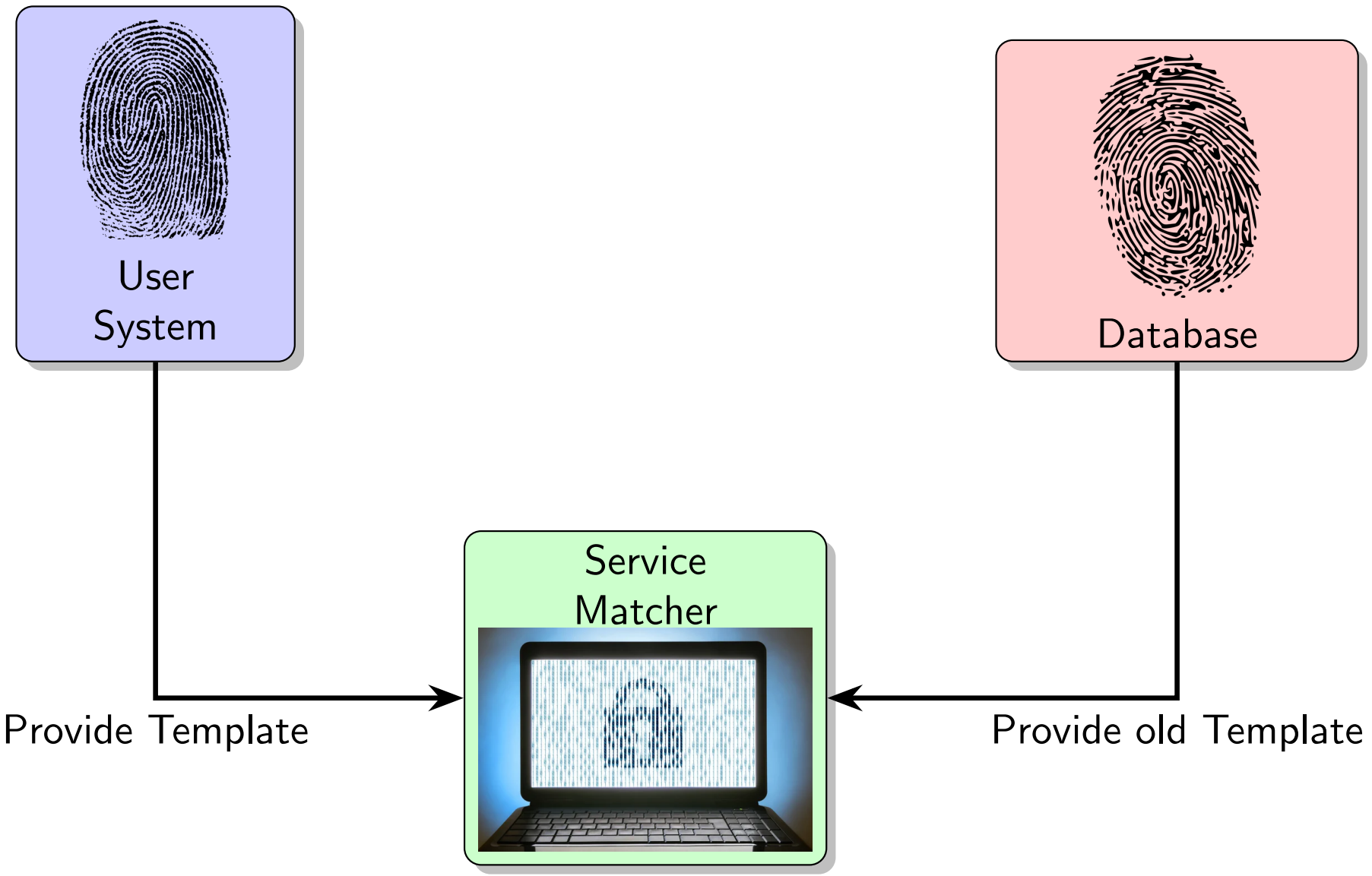
Login



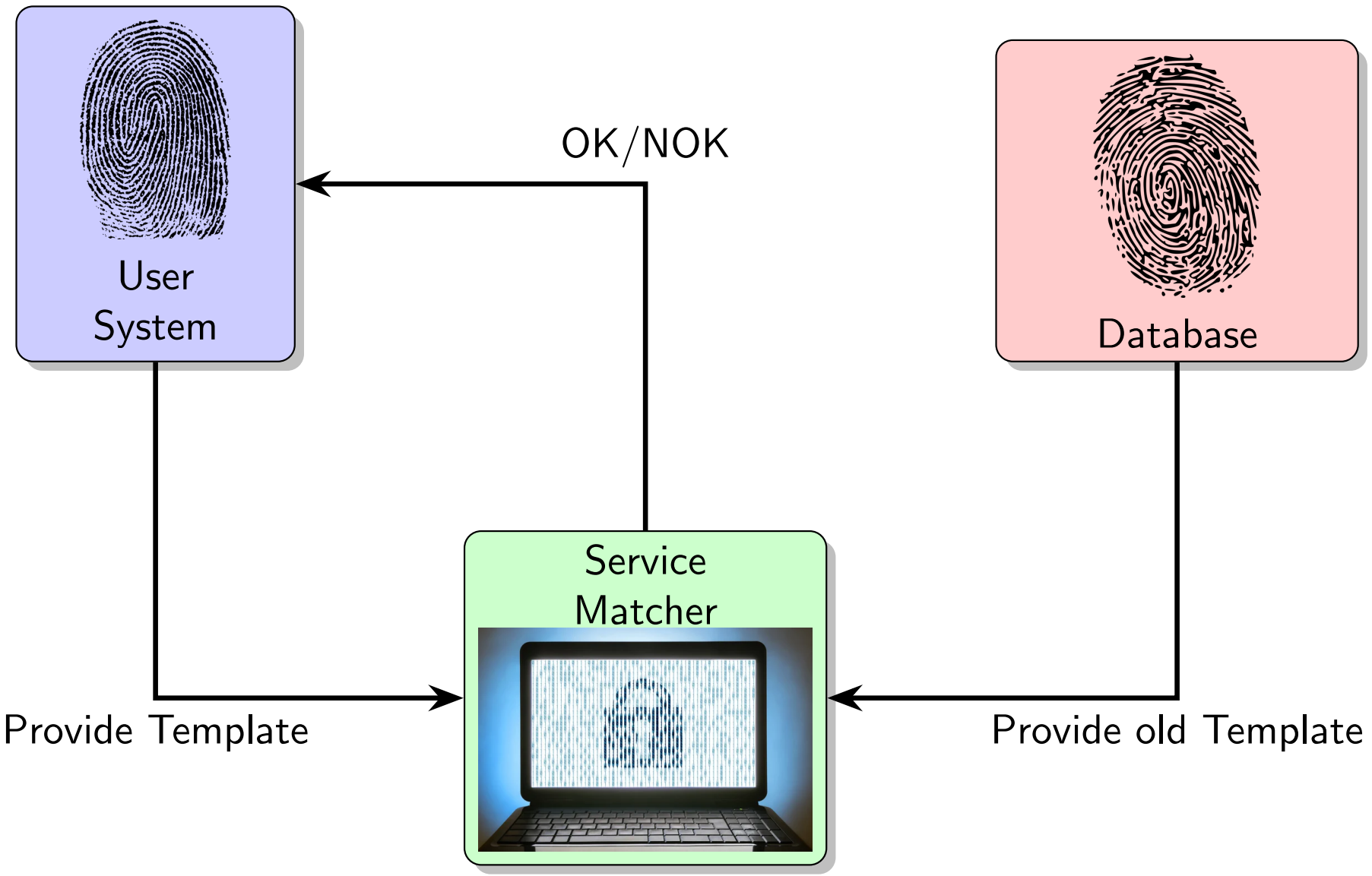
Login

Provide Template

Login


User
System
Database
Service
Matcher
Provide Template
Provide old Template

Login

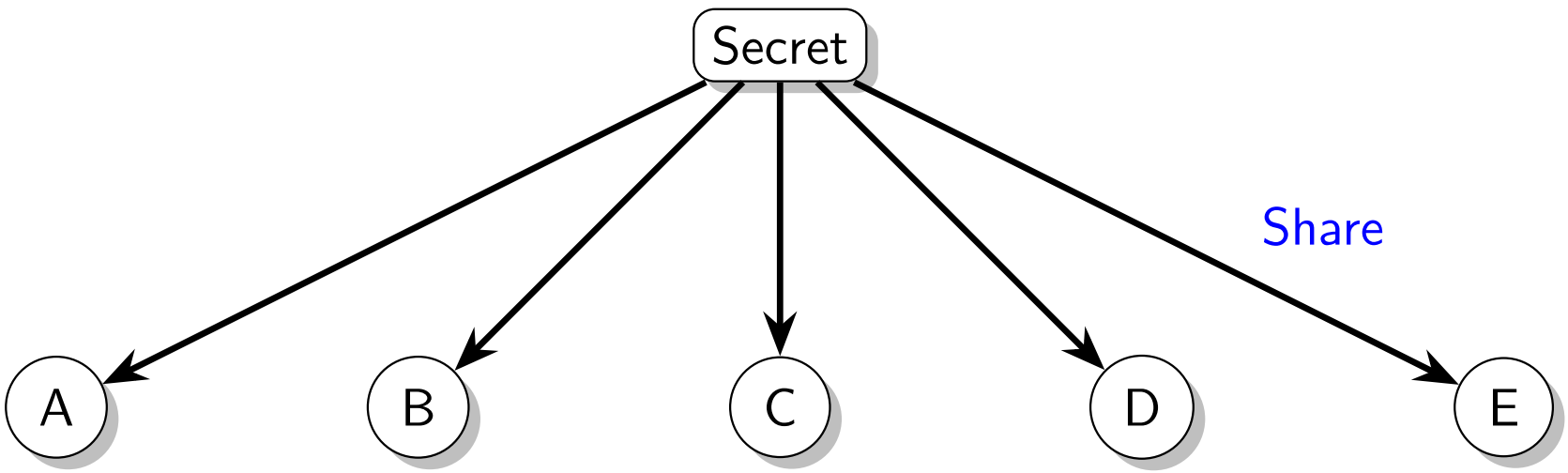

User
System
OK/NOK
Database
Service
Matcher
Provide Template
Provide old Template

Secret Sharing in a Nutshell

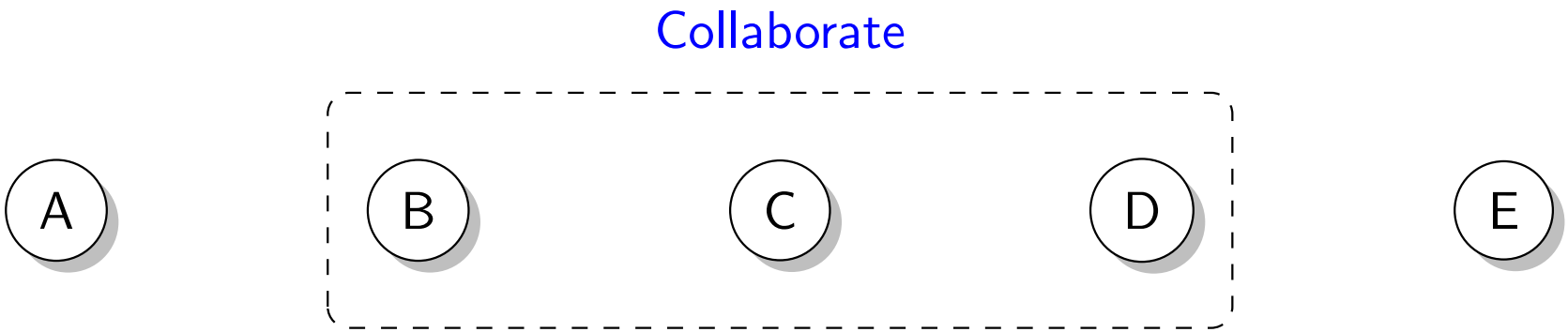
Secret Sharing in a Nutshell

Secret

Secret Sharing in a Nutshell



Secret Sharing in a Nutshell



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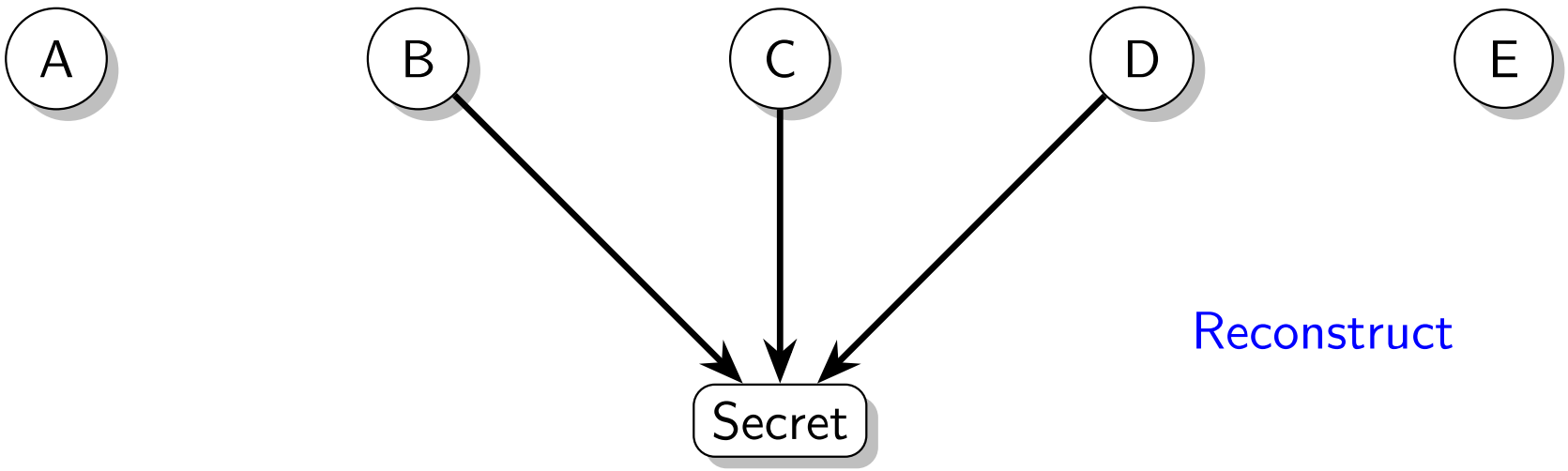

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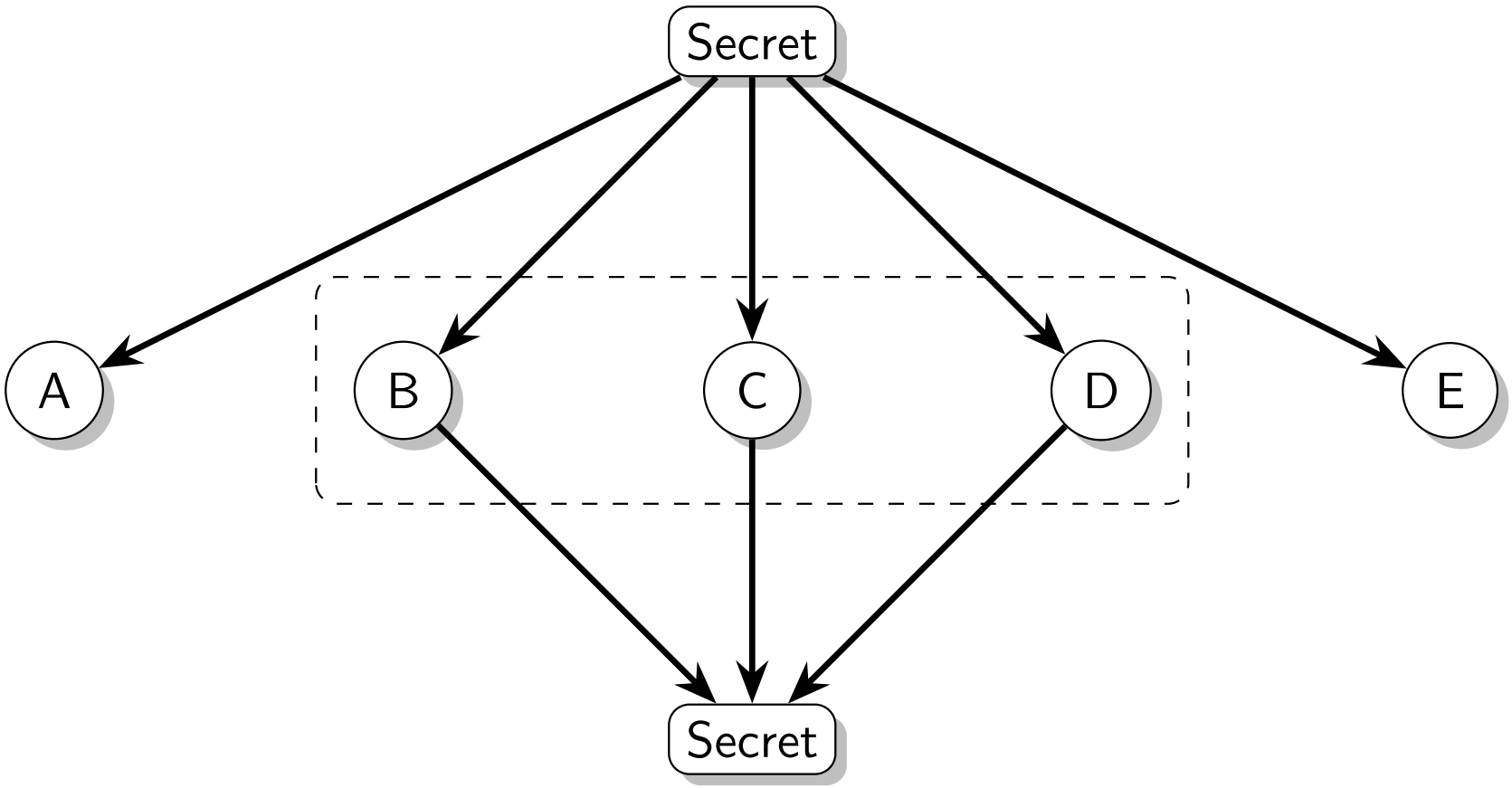
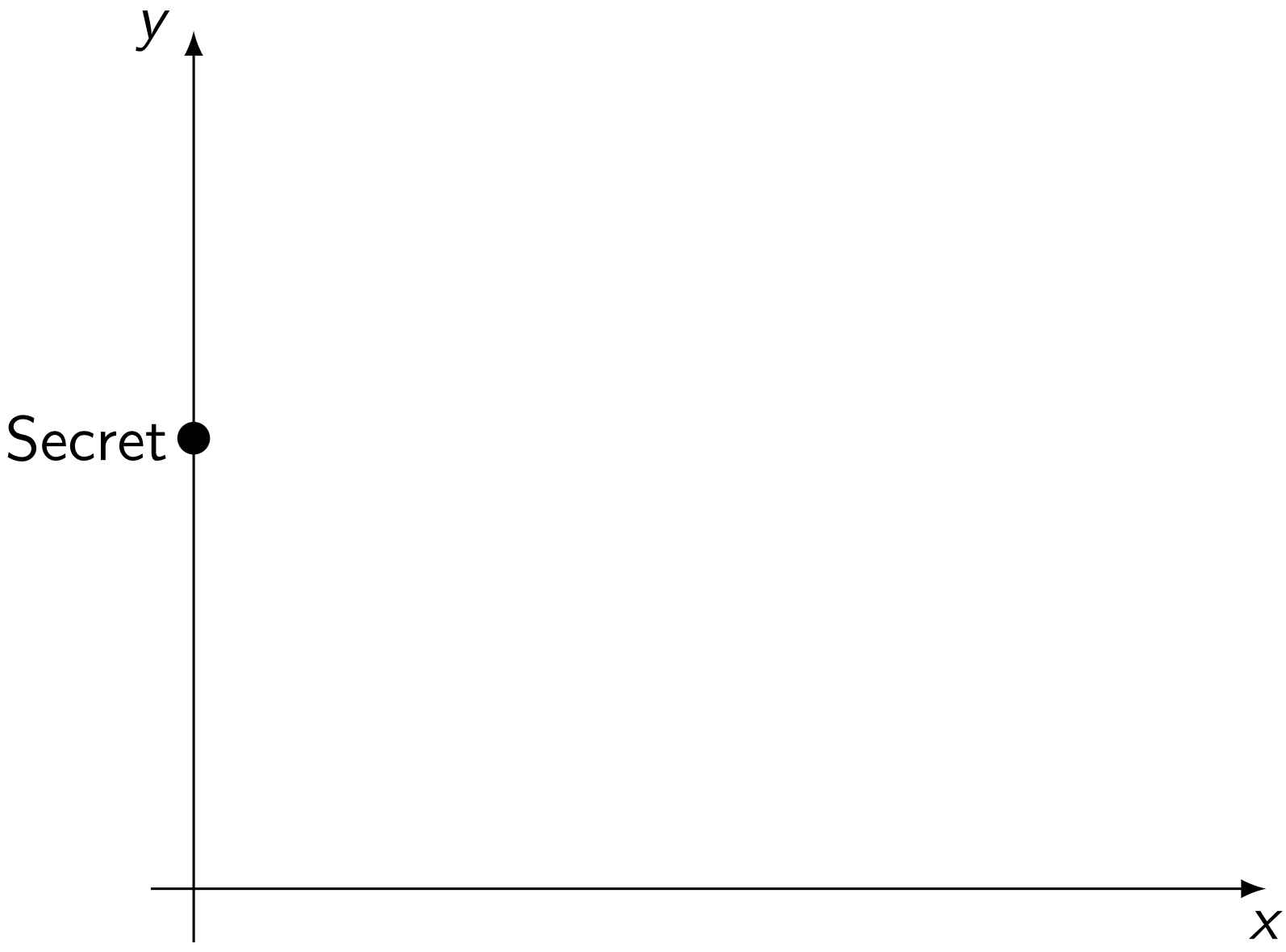
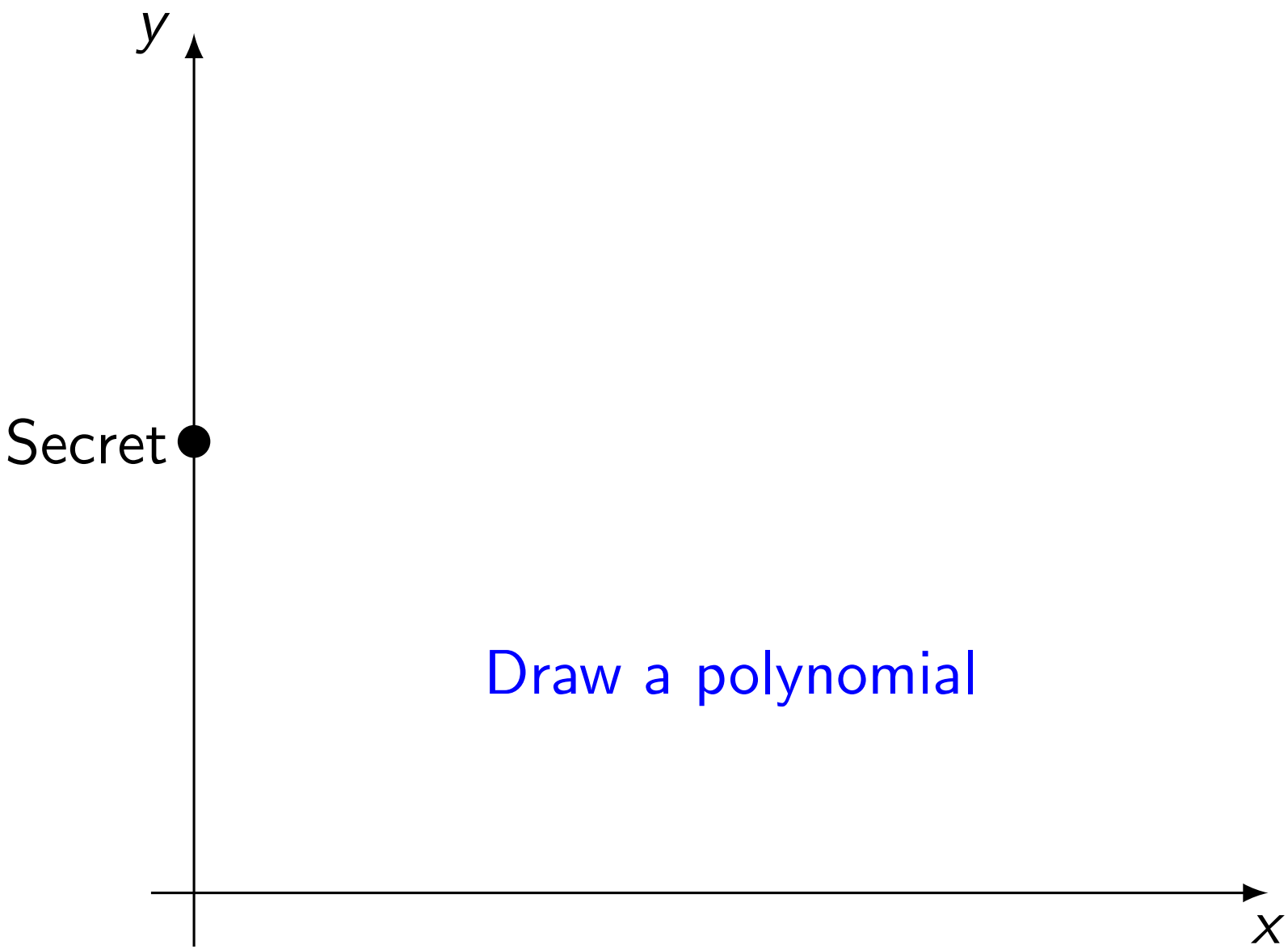


Overview

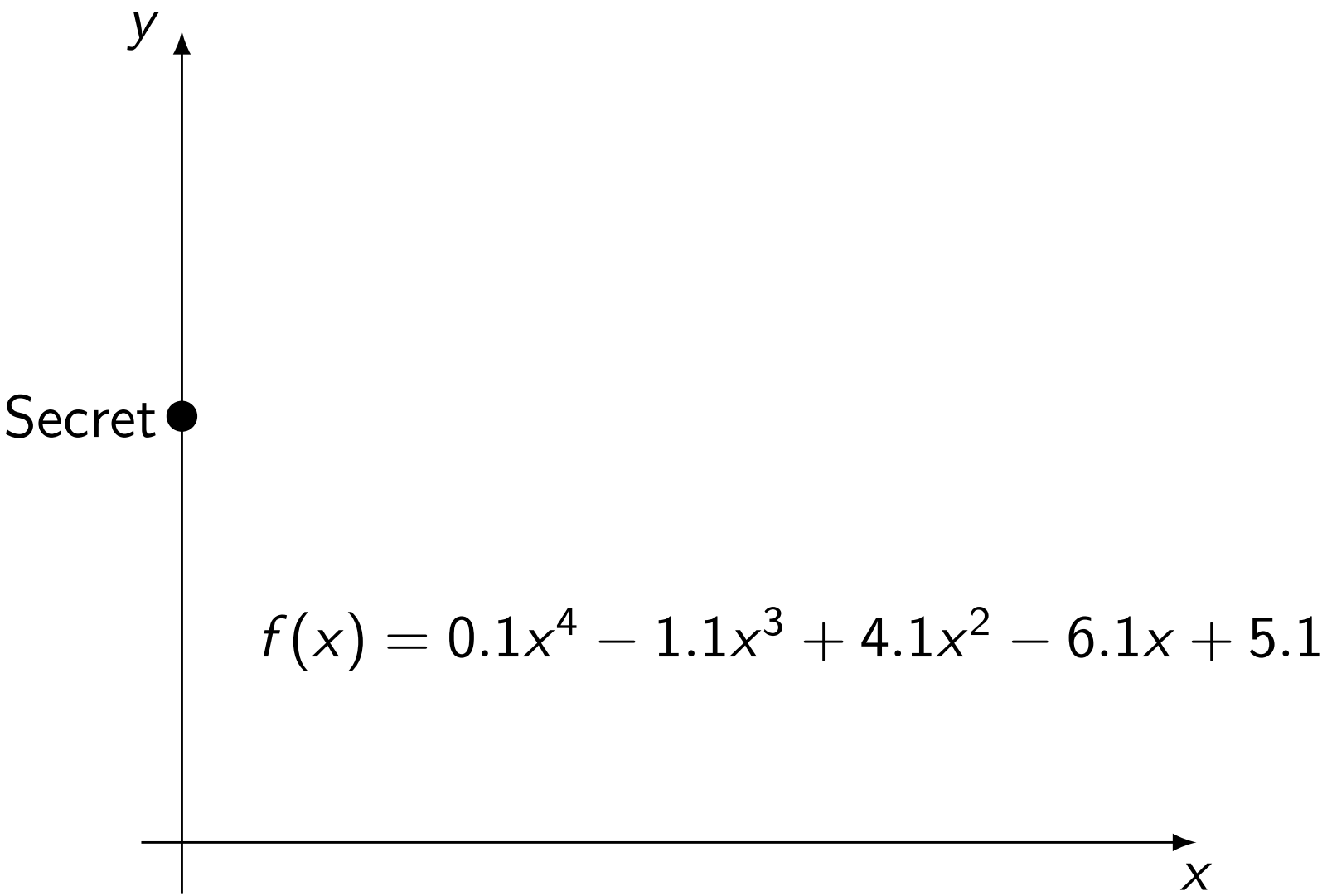
Shamir's Secret Sharing



Shamir's Secret Sharing

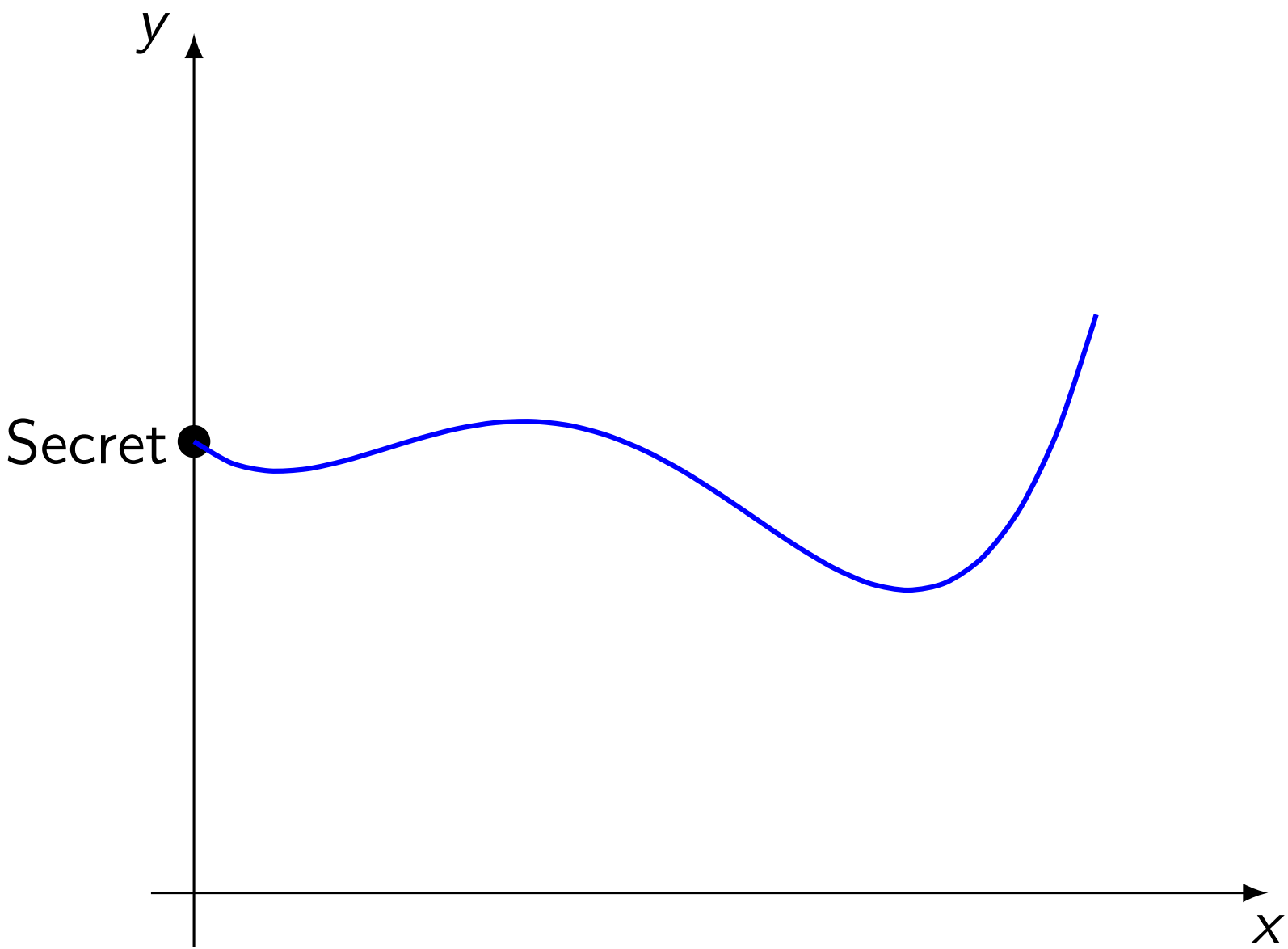


Shamir's Secret Sharing



$$f(x) = 0.1x^4 - 1.1x^3 + 4.1x^2 - 6.1x + 5.1$$

Shamir's Secret Sharing



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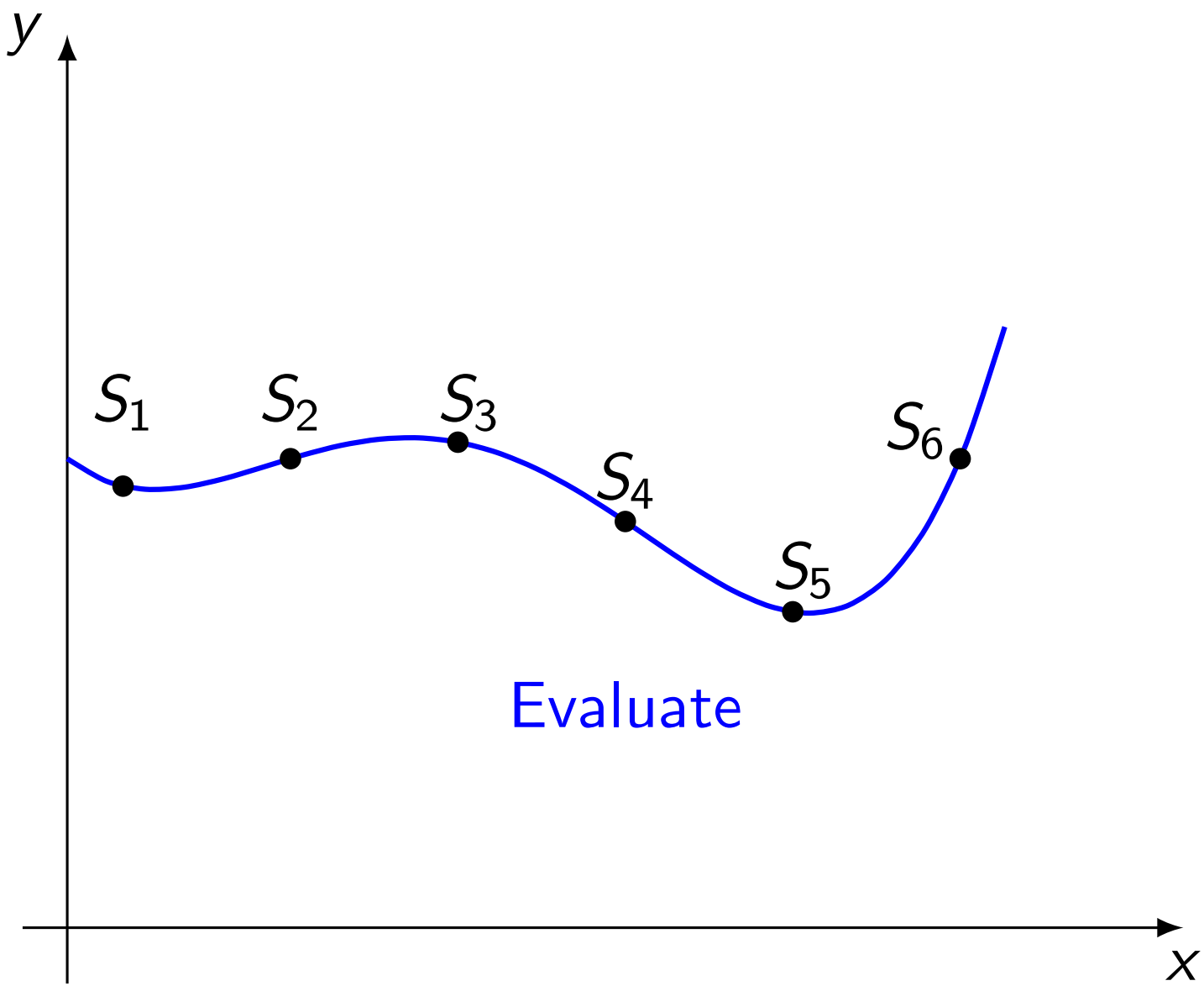

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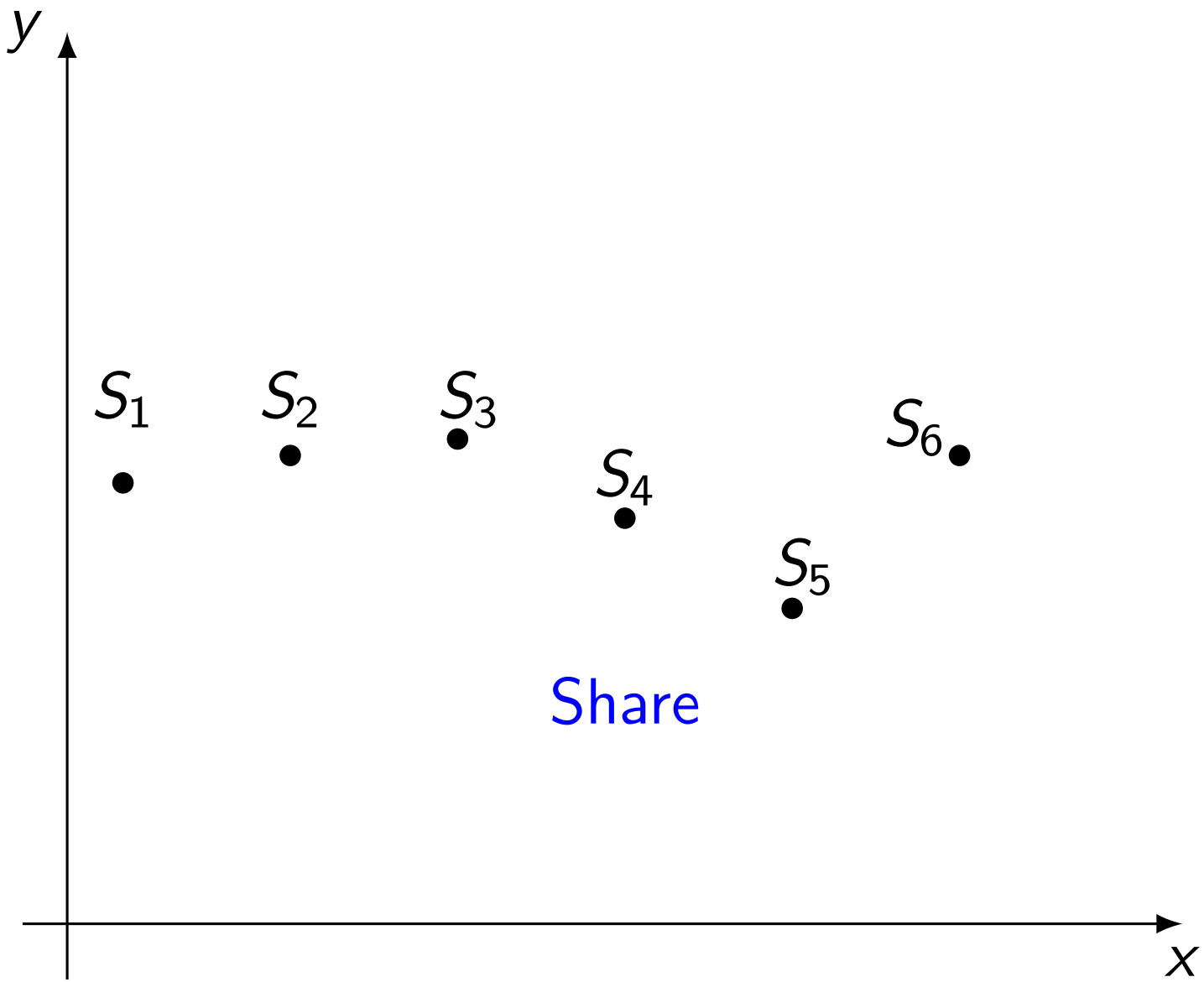

Shamir's Secret Sharing: Recover by solving a system

The users know:

- Some values $(x, f(x))$
- $f(x) = \sum_{i=1}^{n} a_i X^i + Secret$

Solve system with n-unknowns and n-equations system:

$$\begin{cases} f(x_1) & = \sum_{i=1}^{n-1} a_i x_1^i + Secret \\ & \vdots \\ f(x_n) & = \sum_{i=1}^{n-1} a_i x_n^i + Secret \end{cases}$$

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Set Intersection in a Nutshell

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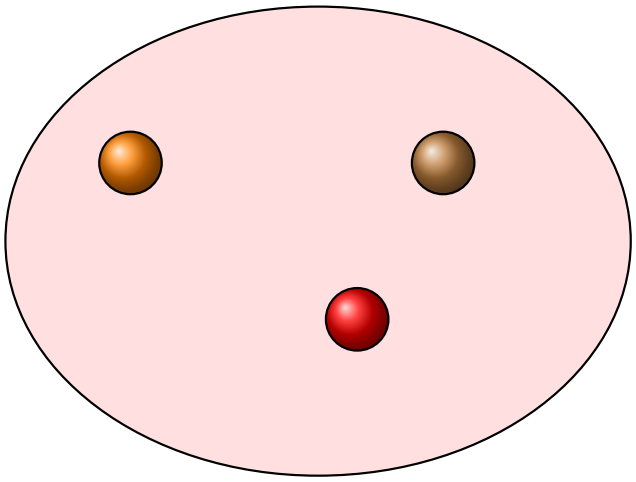
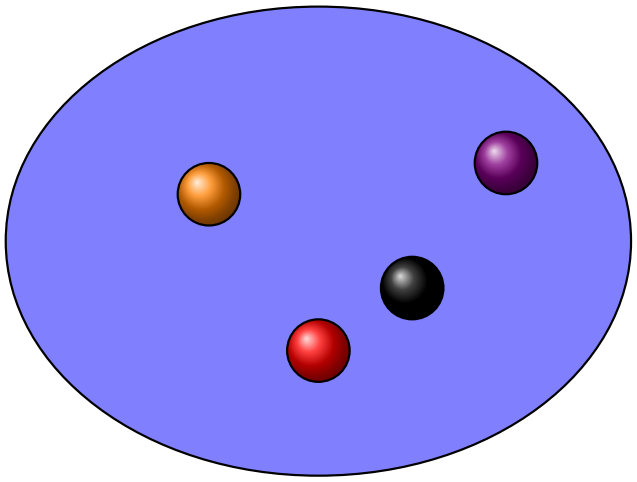
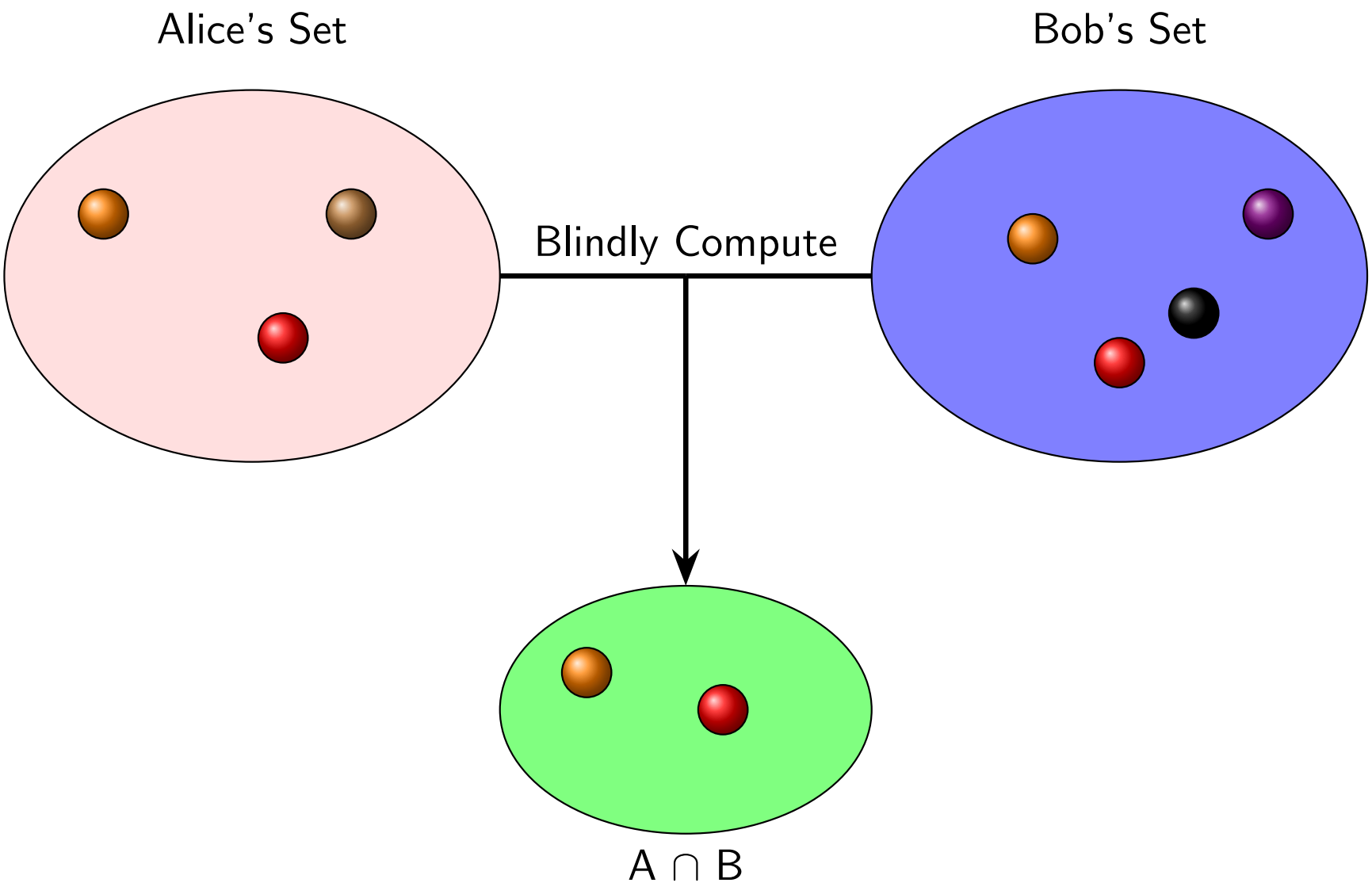
Alice's Set



Bob's Set



Set Intersection in a Nutshell



Fuzzy Vault For Beginners

FV_{Gen}


Chaff Fingerprint

Parameters


Genuine Fingerprint


Secret

polynomial

Genuine Minutiae

Chaff Minutiae

Random number generator

Permutation

Store on the server

FV_{Gen}


Chaff Fingerprint

Parameters


Genuine Fingerprint

1


Secret

polynomial

Genuine Minutiae

Chaff Minutiae

Random number generator

Permutation

Store on the server

FV_{Gen}


Chaff Fingerprint

Parameters

2


Genuine Fingerprint

1


Secret

2

polynomial

Genuine Minutiae

Chaff Minutiae

Random number generator

Permutation

Store on the server

FV_{Gen}


Chaff Fingerprint

Parameters


Genuine Fingerprint

2

1


Secret

2

polynomial

3

Genuine Minutiae

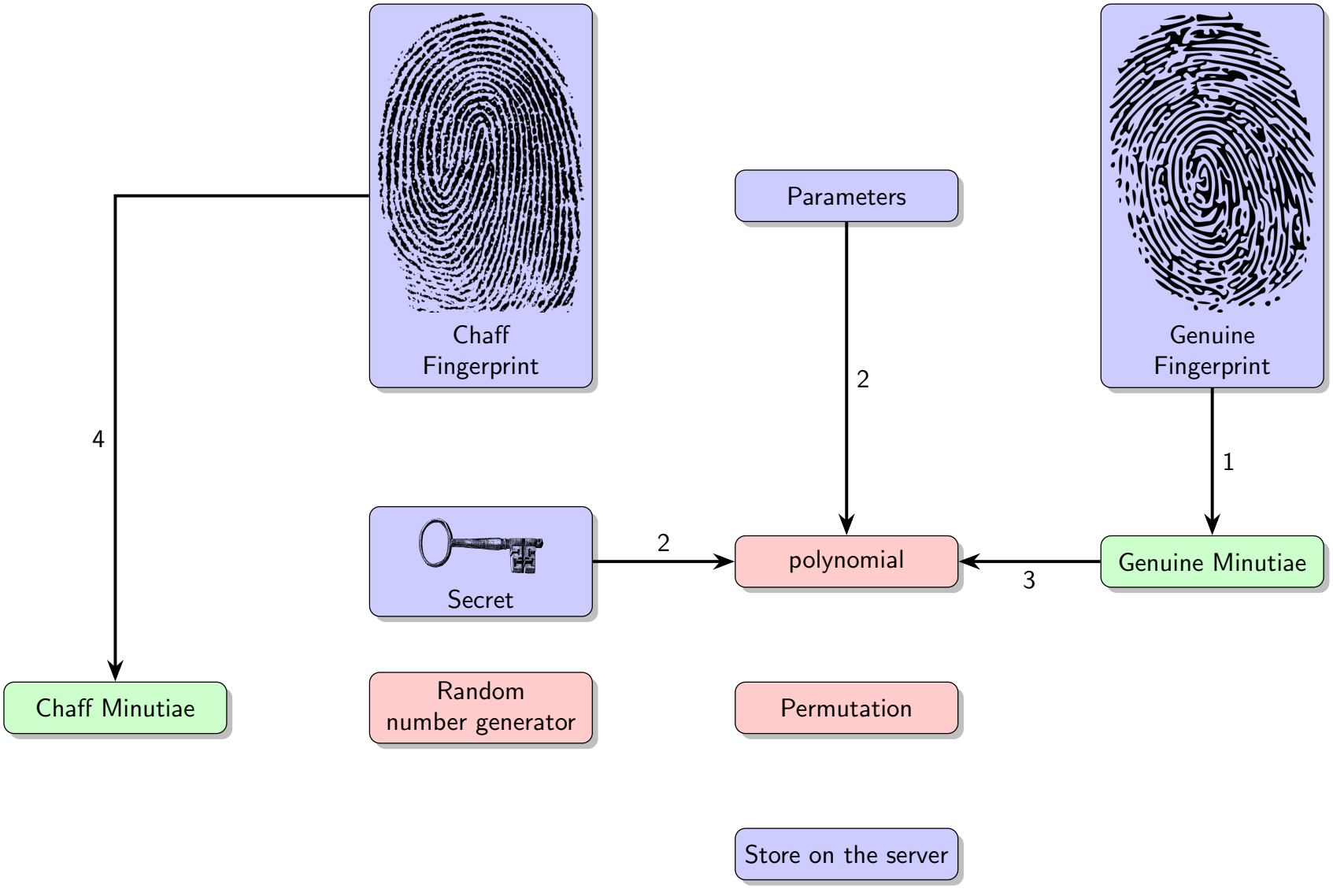
Chaff Minutiae

Random number generator

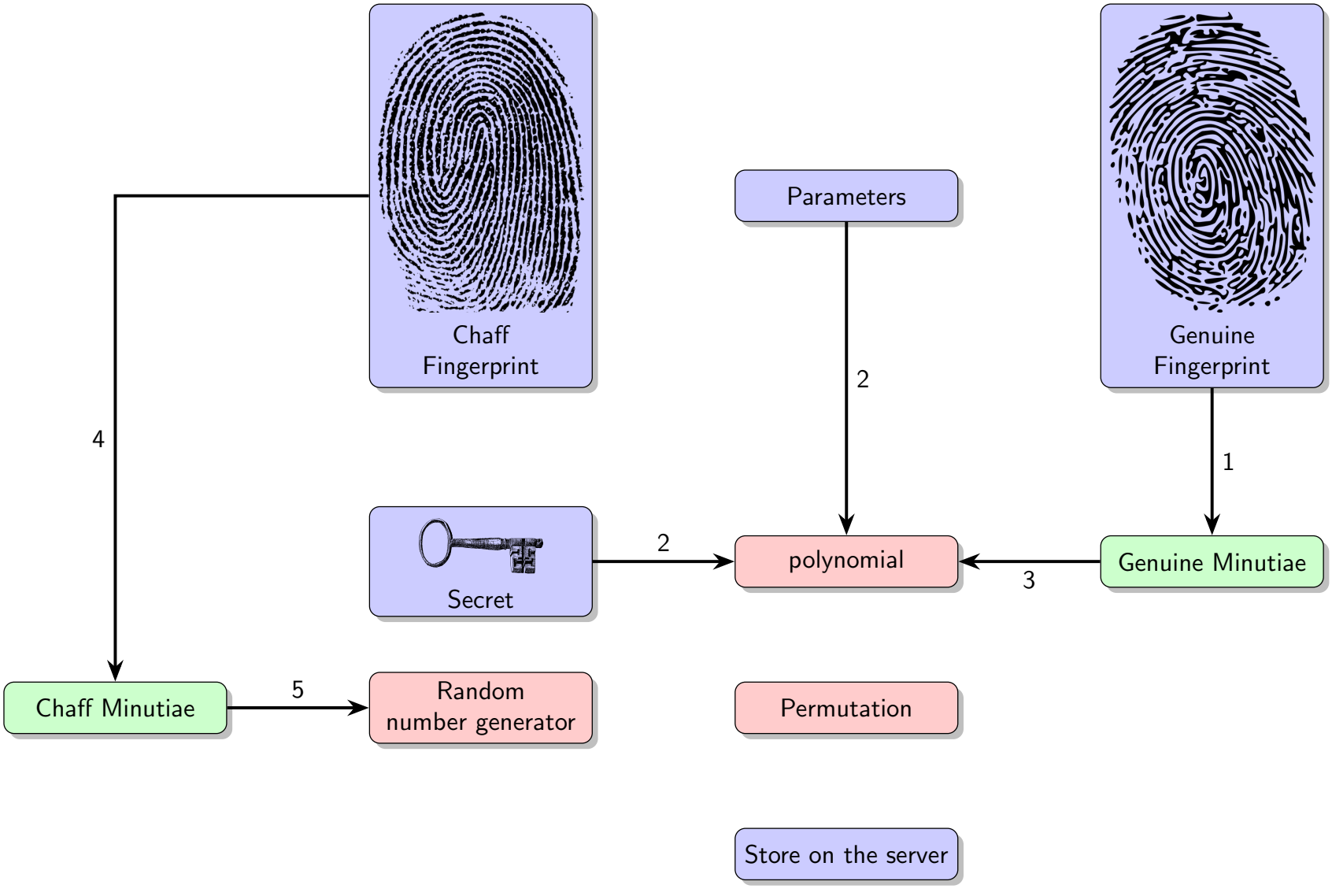
Permutation

Store on the server

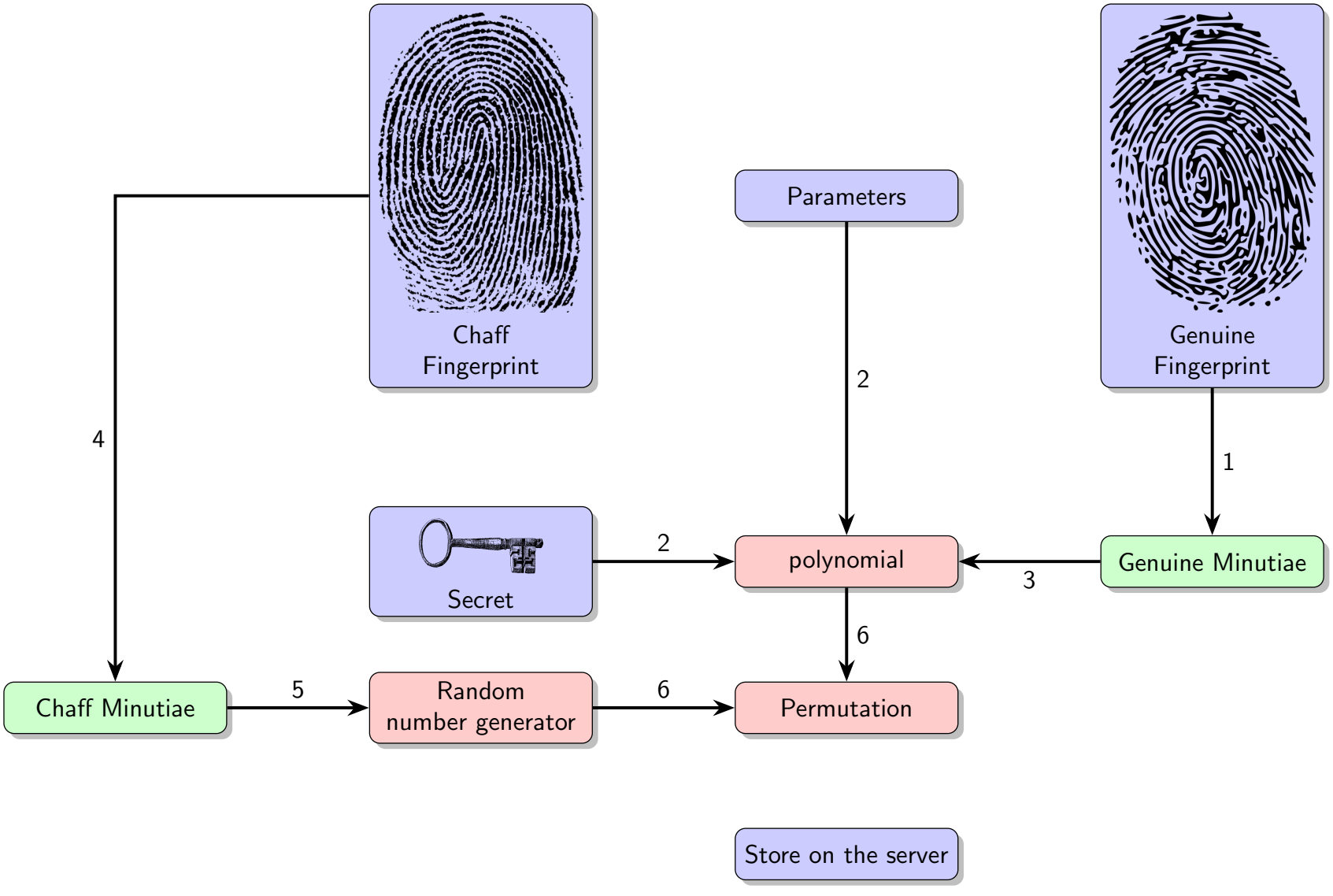
FV_{Gen}


Chaff Fingerprint
Parameters
Genuine Fingerprint
4
2
1
Secret
2
polynomial
3
Genuine Minutiae
Chaff Minutiae
Random number generator
Permutation
Store on the server

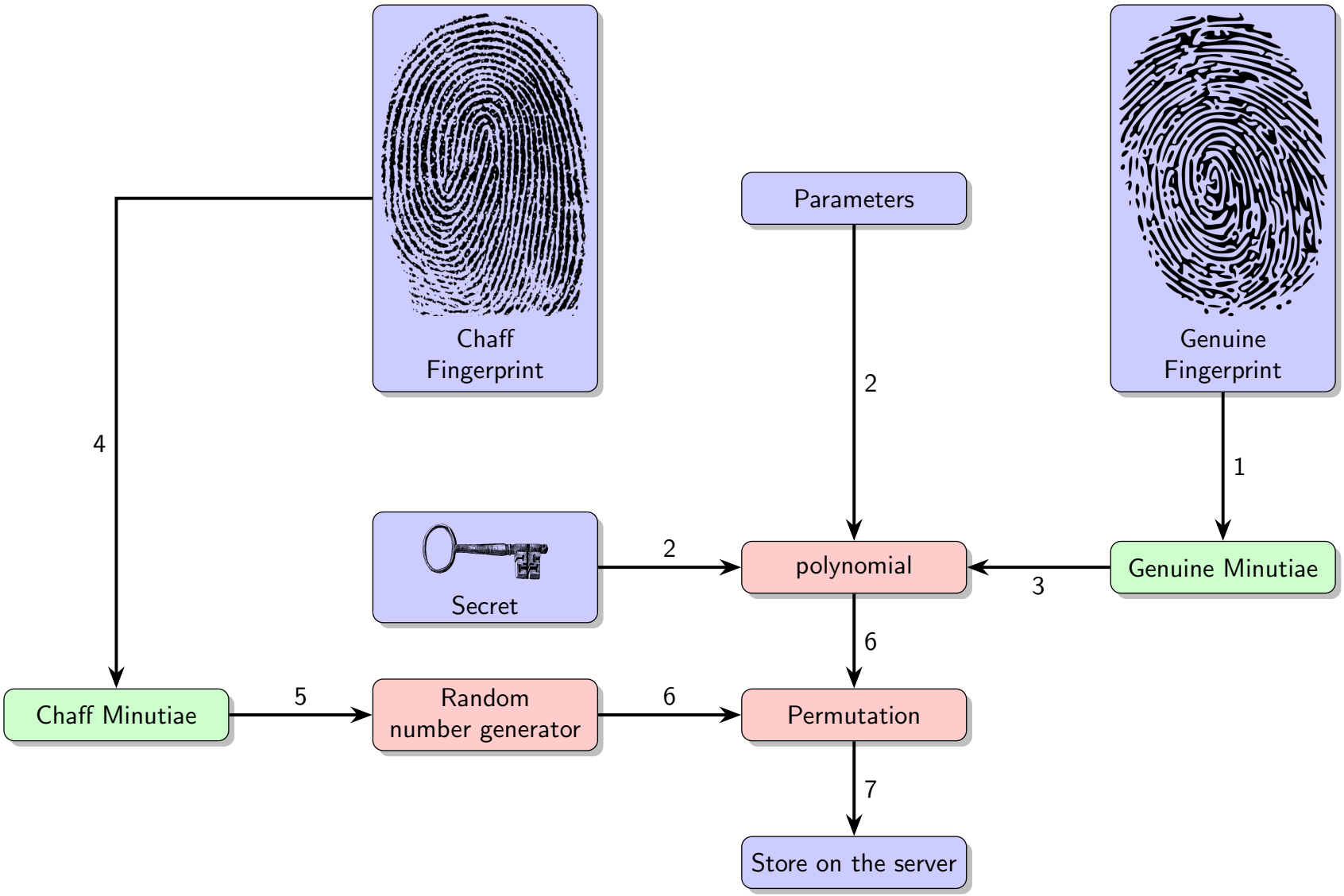
FV_{Gen}


Chaff Fingerprint
Parameters
Genuine Fingerprint
4
2
1
Secret
2
polynomial
3
Genuine Minutiae
Chaff Minutiae
5
Random number generator
Permutation
Store on the server

FV_{Gen}


Chaff Fingerprint
Parameters
Genuine Fingerprint
4
2
1
Secret
2
polynomial
3
Genuine Minutiae
6
Chaff Minutiae
5
Random number generator
6
Permutation
Store on the server

FV_{Gen}


Chaff Fingerprint
Parameters
Genuine Fingerprint
4
2
1
Secret
2
polynomial
3
Genuine Minutiae
6
Chaff Minutiae
5
Random number generator
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7
Store on the server

FV_{Open}

Minutiae

Private Set
Intersection

Server

System
Solve

FV_{Open}

1

Minutiae

Private Set
Intersection

Server

System
Solve

Secret

FV_{Open}

1

Minutiae

2

Private Set
Intersection

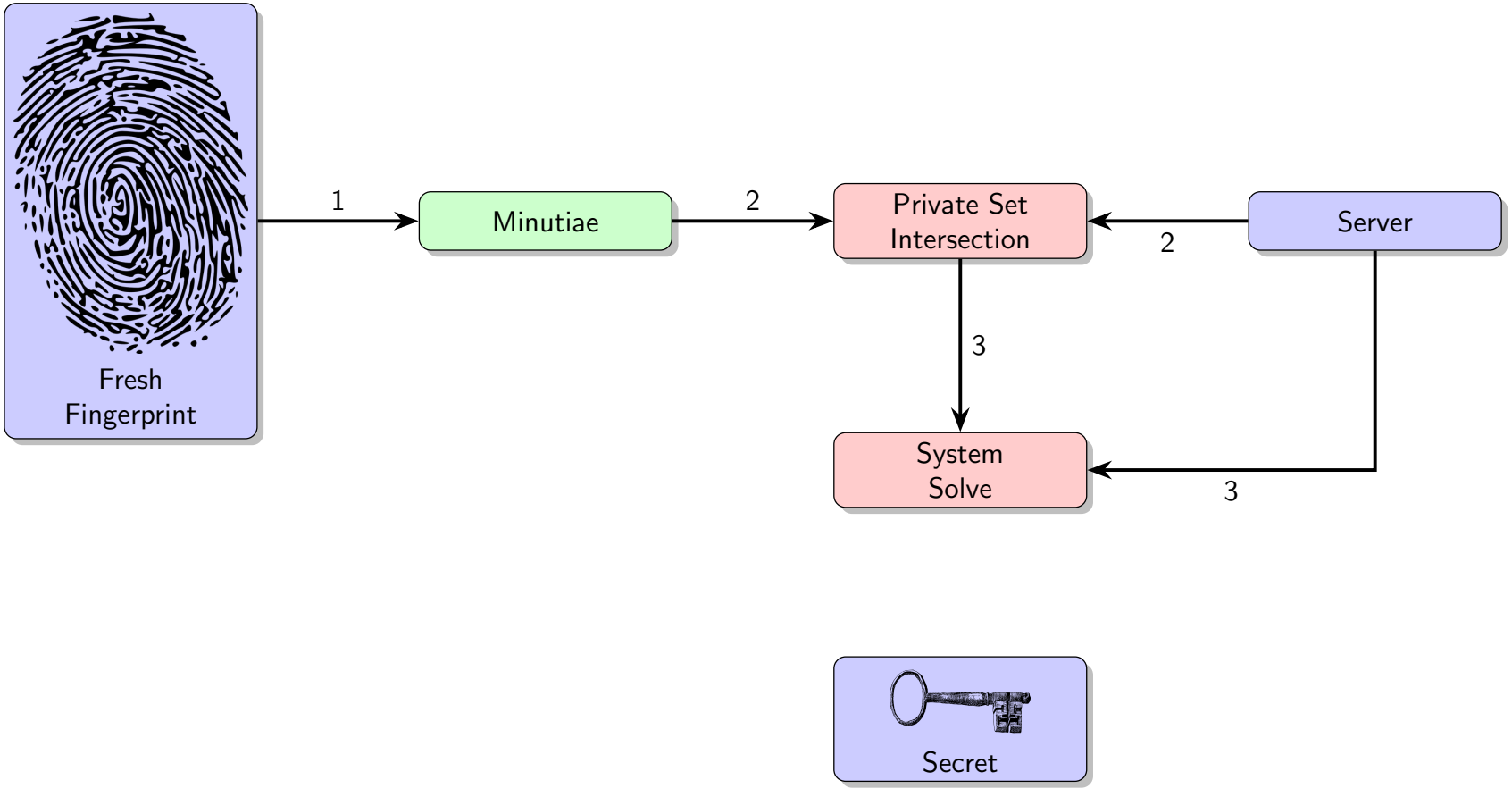
2

Server

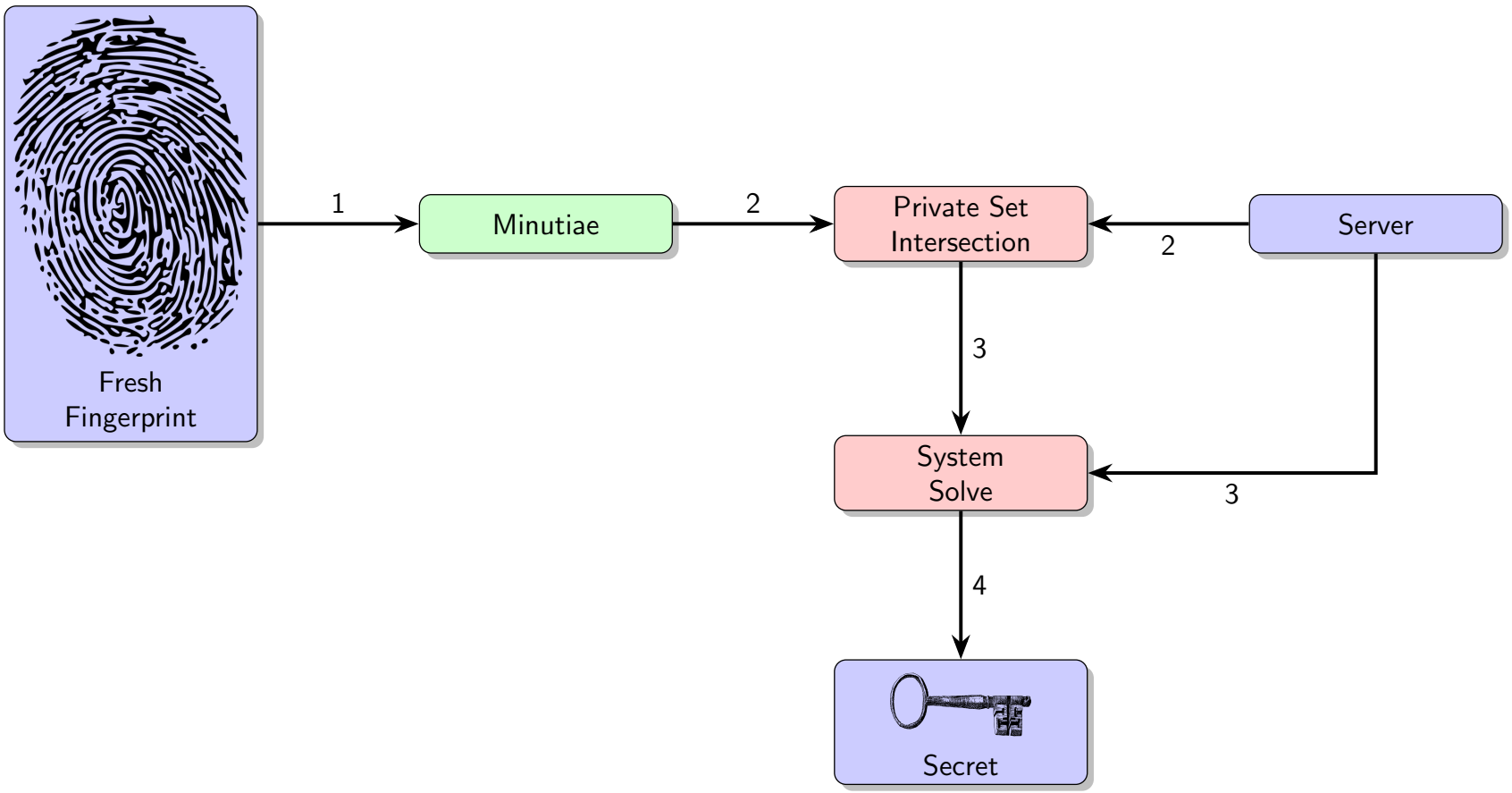
System
Solve

Secret

FV_{Open}

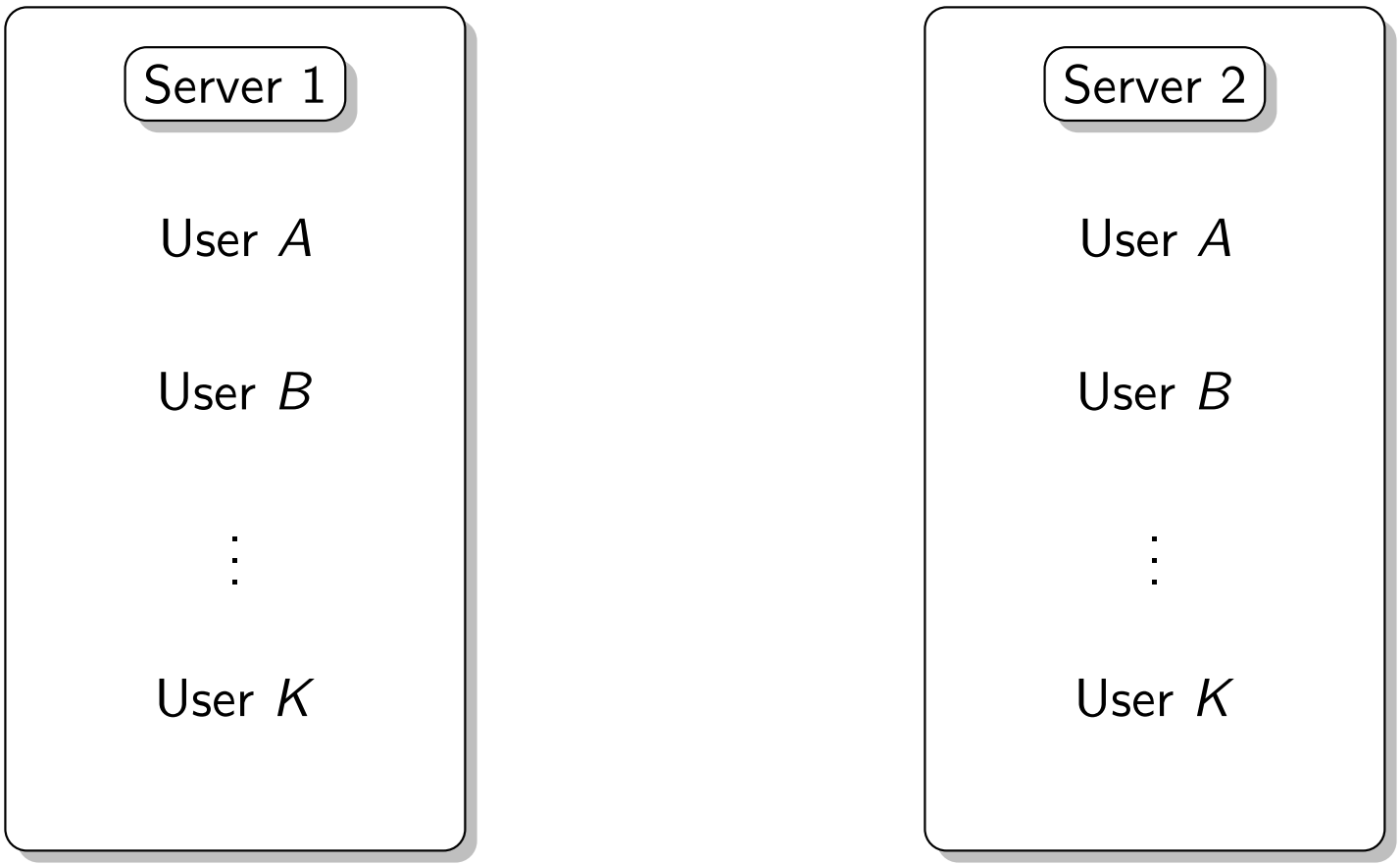

Fresh
Fingerprint
1
Minutiae
2
Private Set
Intersection
2
Server
3
System
Solve
3
Secret

FV_{Open}


Fresh
Fingerprint
1
Minutiae
2
Private Set
Intersection
2
Server
3
System
Solve
3
4
Secret

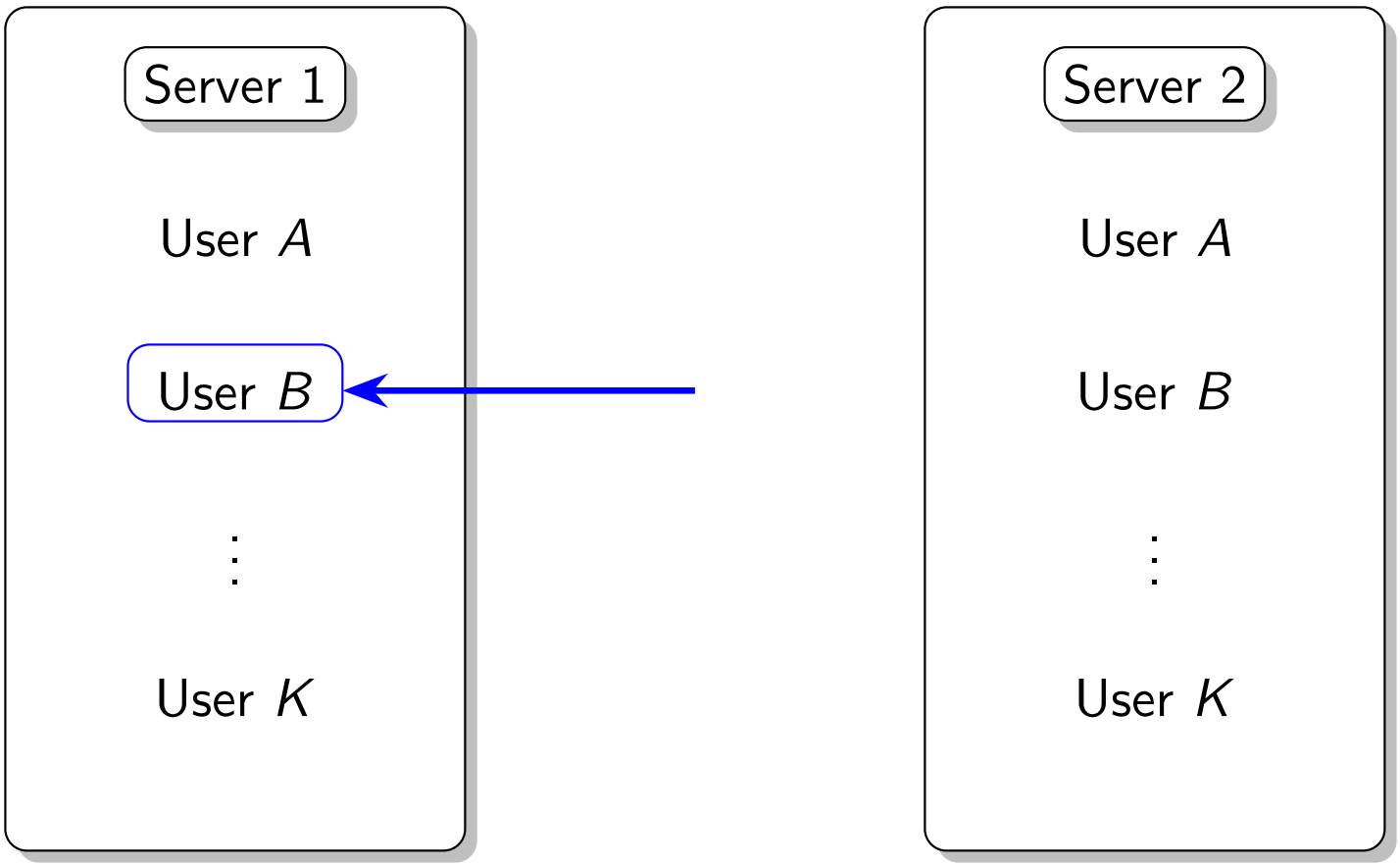
Intersection Attack

Intersection Attack



Pick a target

Intersection Attack

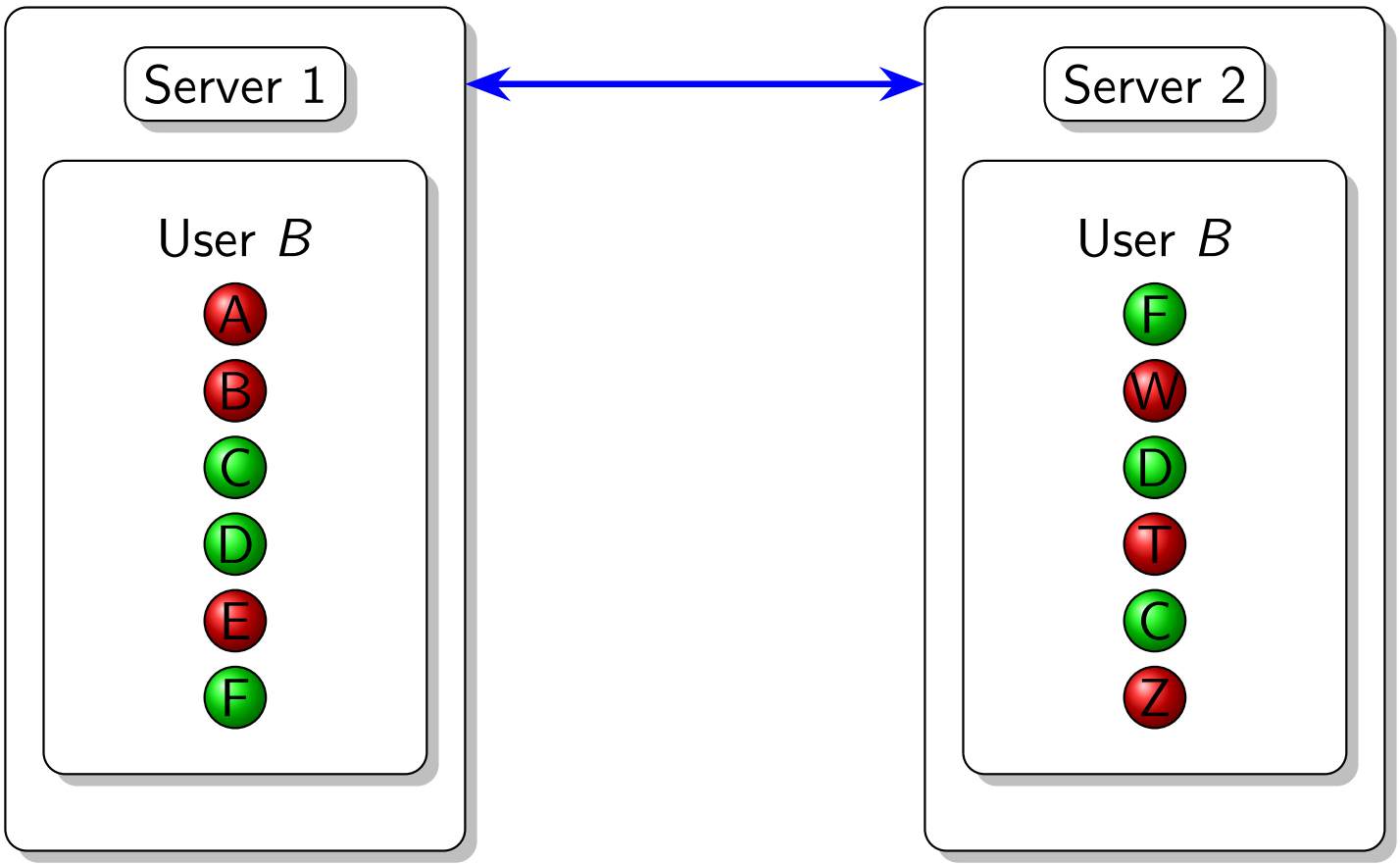


Pick a target

Intersection Attack

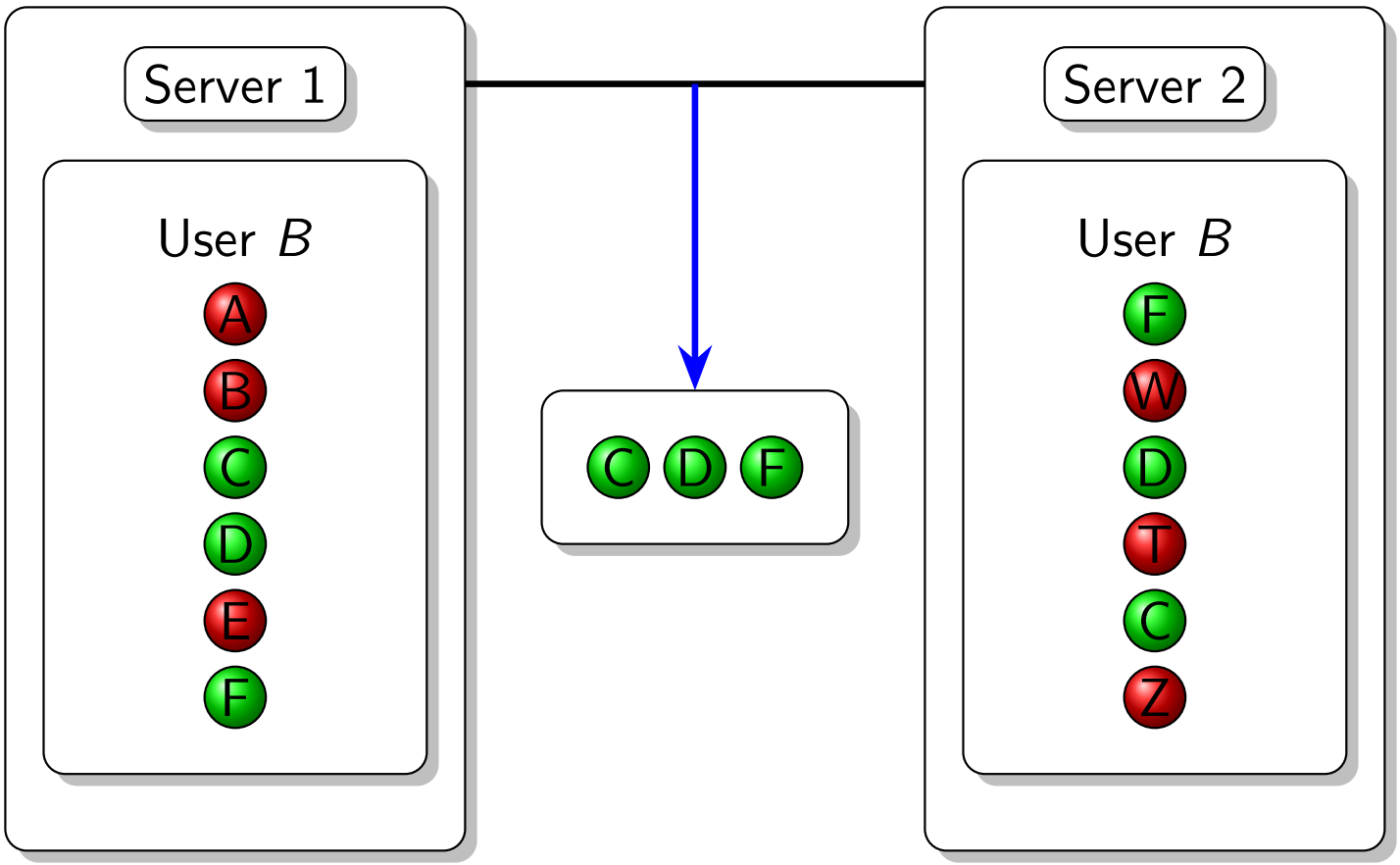
Content of the user B

Intersection Attack



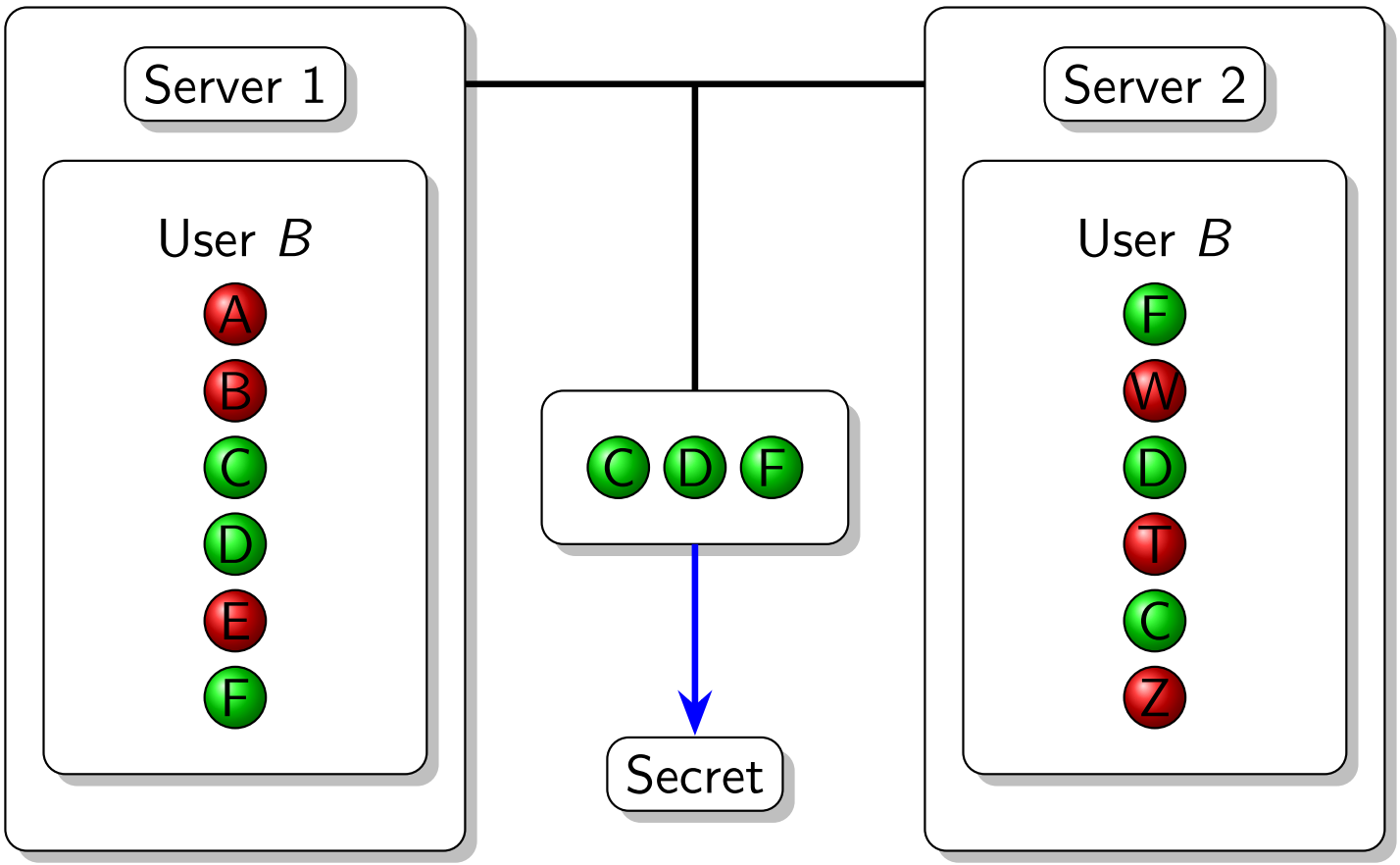
Collaboration

Intersection Attack



Gets the real points

Intersection Attack



Retrieve the secret

Conclusion

Question time