Functional Encryption: Deterministic to Randomized Functions from Simple Assumptions

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The Olympic Games

Vinicius, Tom, and friends are competing at the Olympic games…

But…

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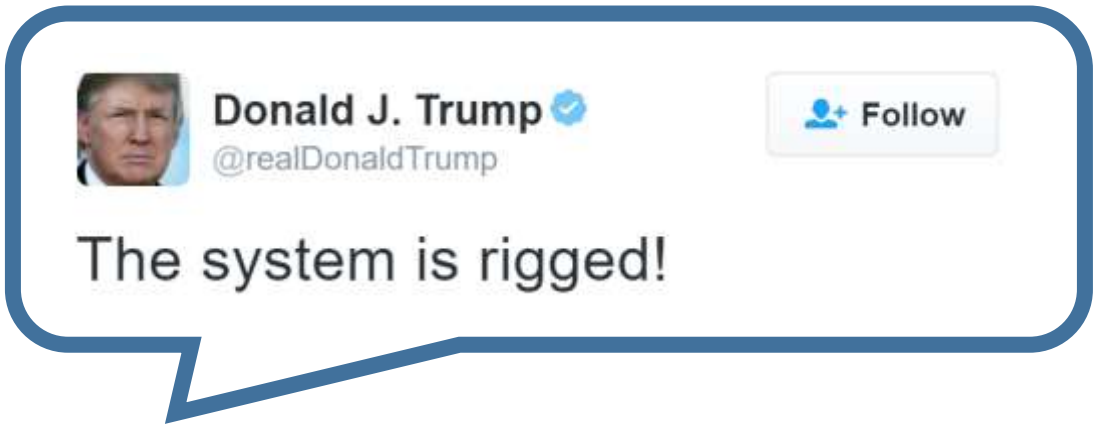
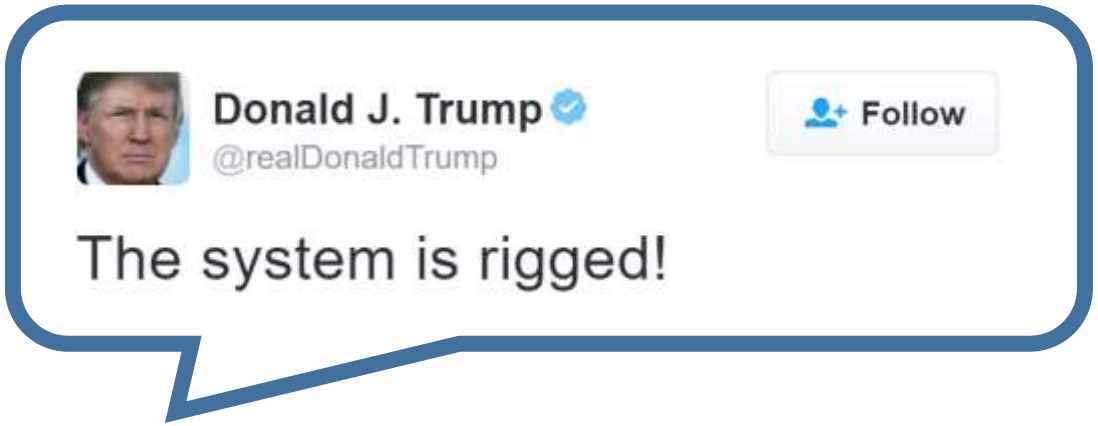


But… is it Rigged?

Vinicius, Tom, and friends are competing at the Olympic games…



Let’s Audit the Records!

Date: 01/09/2011

Date: 03/15/2012

Date: 06/11/2012

Weight: xxx
Blood Pressure: xxx
Performance: xxx
…

Solution: take each competitor’s health records, choose a couple at random and see if there is anything unusual

Let’s Audit the Records!

Date: 01/09/2011

Privacy?

ompetitor’s health records and
eck if there is anything unusual

Let’s Audit the Records!

Let’s use CRYPTO!
I’ll just encrypt
my records!

Date: 01/09/2011

Date: 03/15/2012

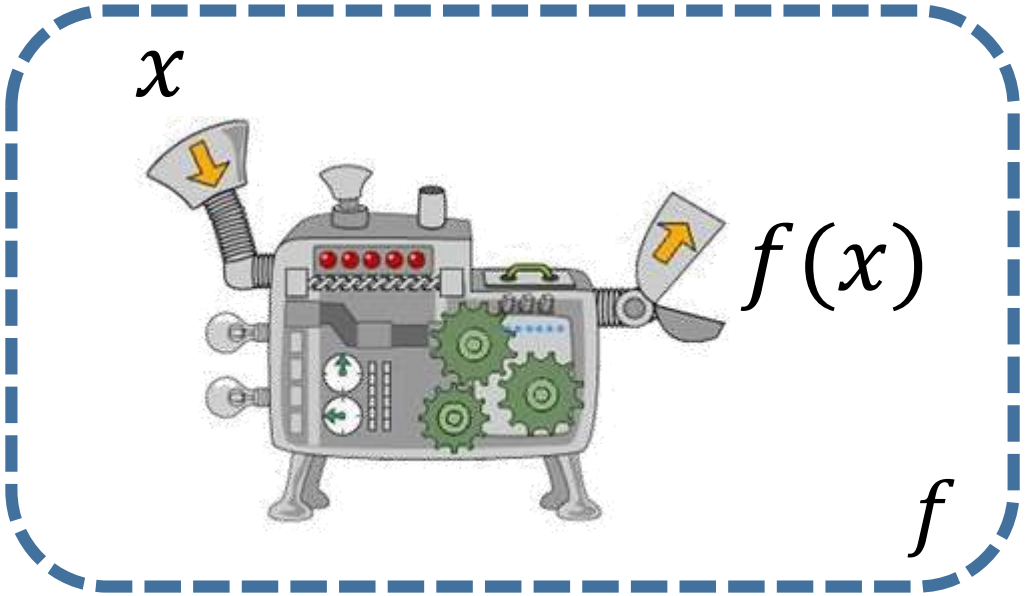
Date: 06/11/2012

Weight: xxx
Blood Pressure: xxx
Performance: xxx

But How Do We Audit?

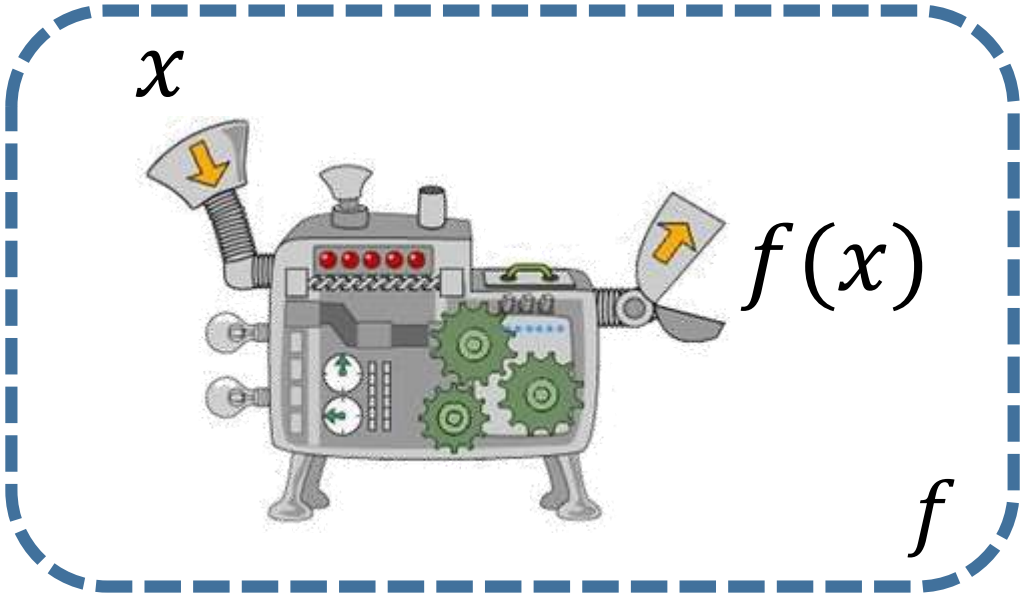
Abstract problem: sample a random record from an encrypted database

Functional Encryption



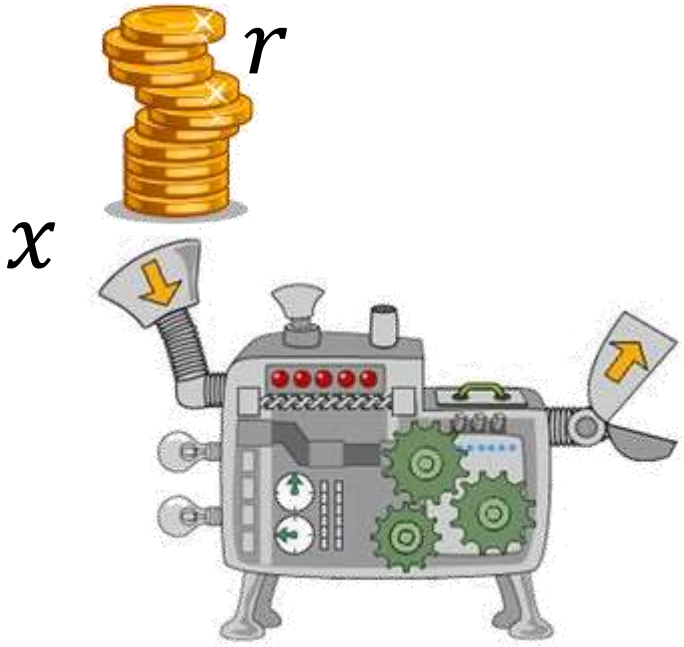
Keys associated with functions f

Functional Encryption



Keys associated with functions f

Randomized Functional Encryption [GJKS15]



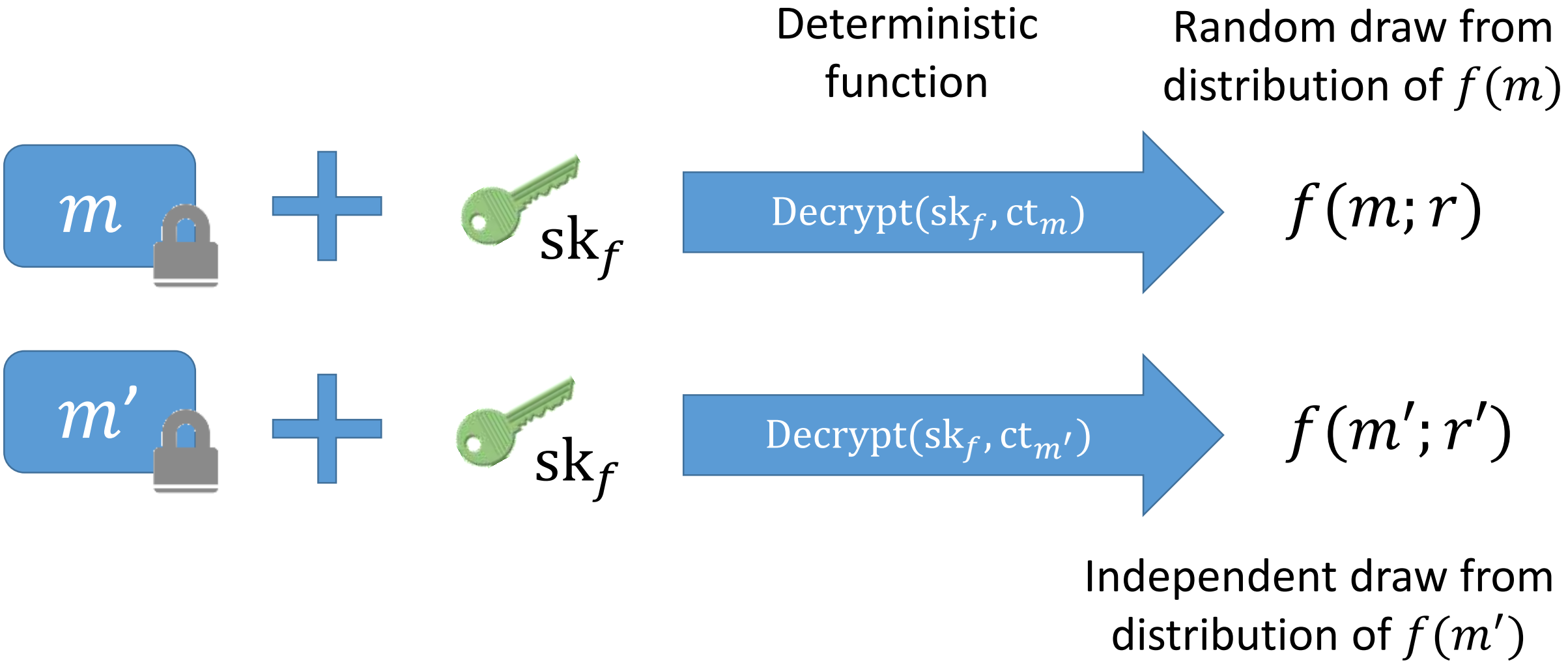
$f(x\,;r)$

But what if f is *randomized*?

Auditing an encrypted database reduces to sampling a **random** element.

Randomized Functional Encryption

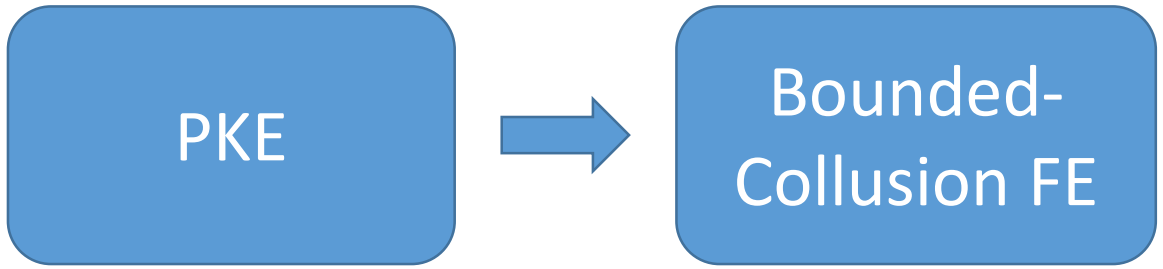
Randomized Functional Encryption



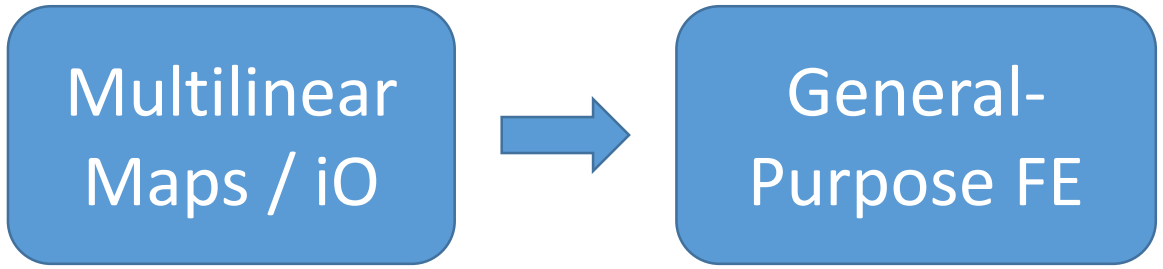
The State of (Public-Key) Functional Encryption

deterministic functionalities

[SS10, GVW12, …]

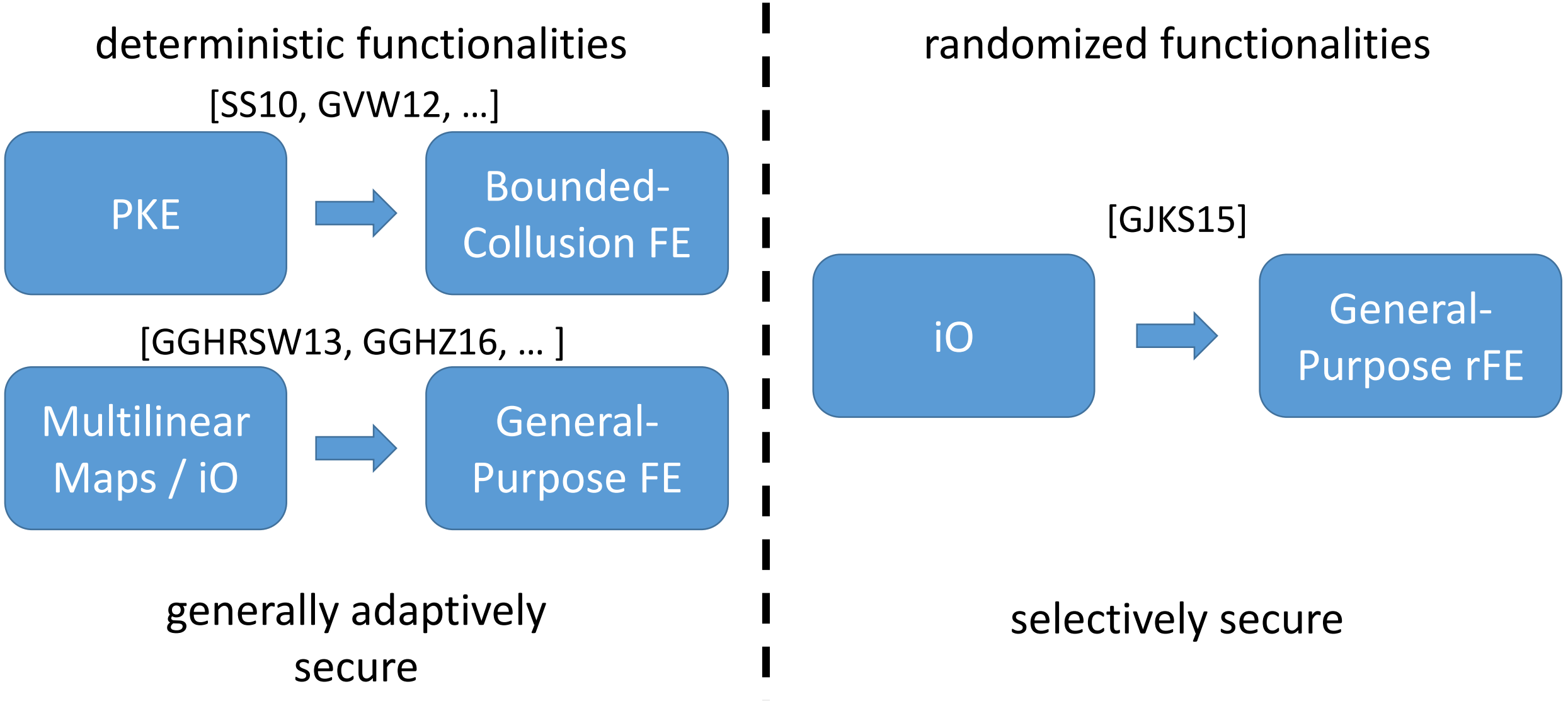


[GGHRSW13, GGHZ16, …]



generally adaptively secure

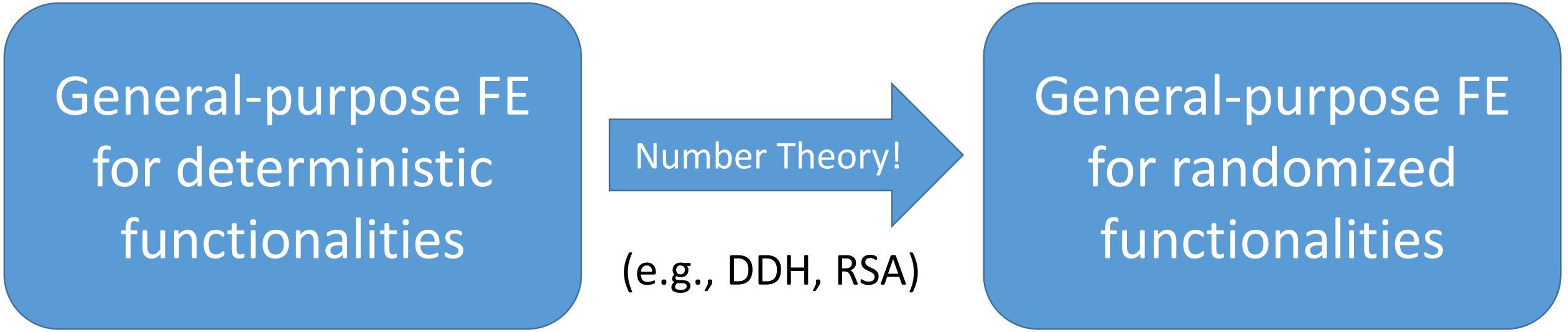
The State of (Public-Key) Functional Encryption



The State of (Public-Key) Functional Encryption

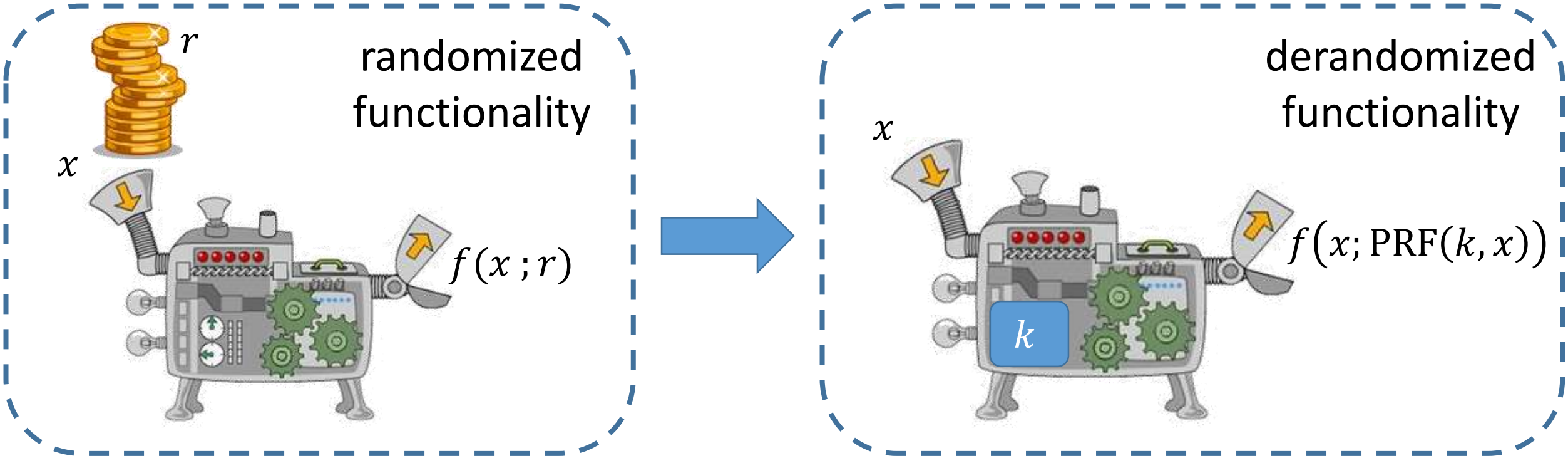
Does extending FE to support randomized functionalities require much stronger tools?

Our Compiler



Implication: *Randomized FE is not much more difficult to construct than standard FE.*

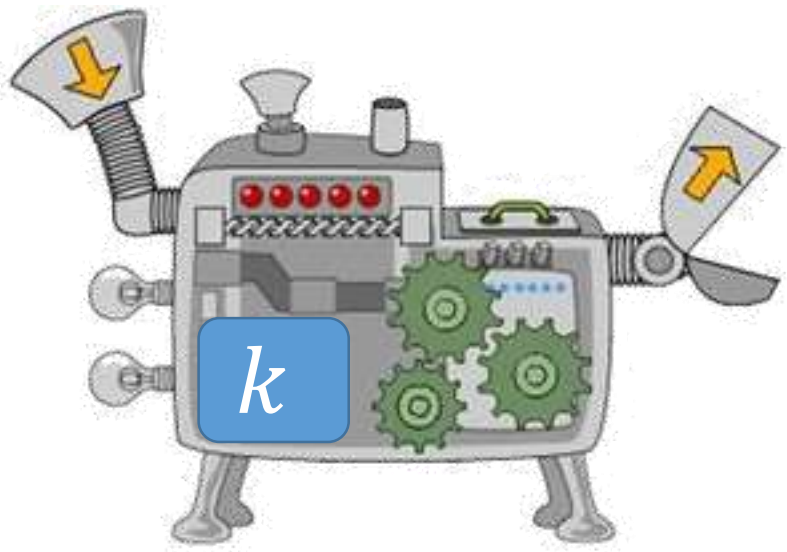
First Attempt



Starting point: Construct "derandomized function" where randomness for f derived from outputs of a PRF

First Attempt

x

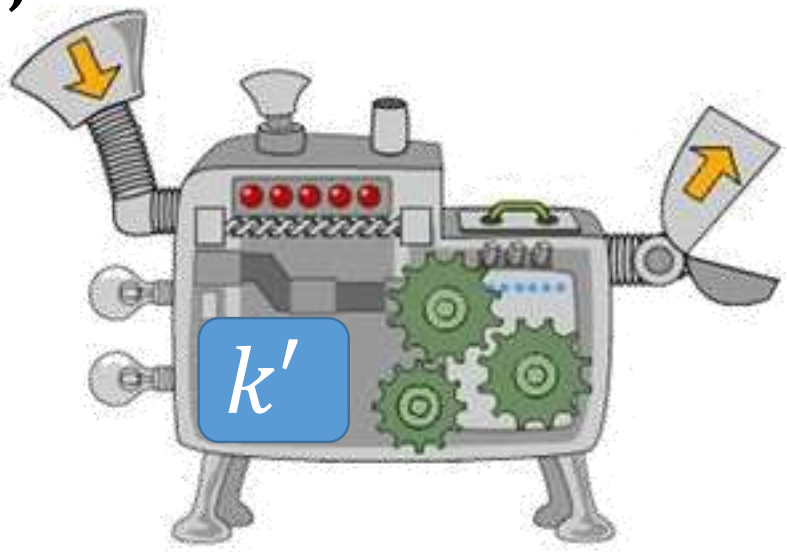


$f\left(x; \mathrm{PRF}(k, x)\right)$

But… function keys do not hide the function…

Second Attempt

k, x



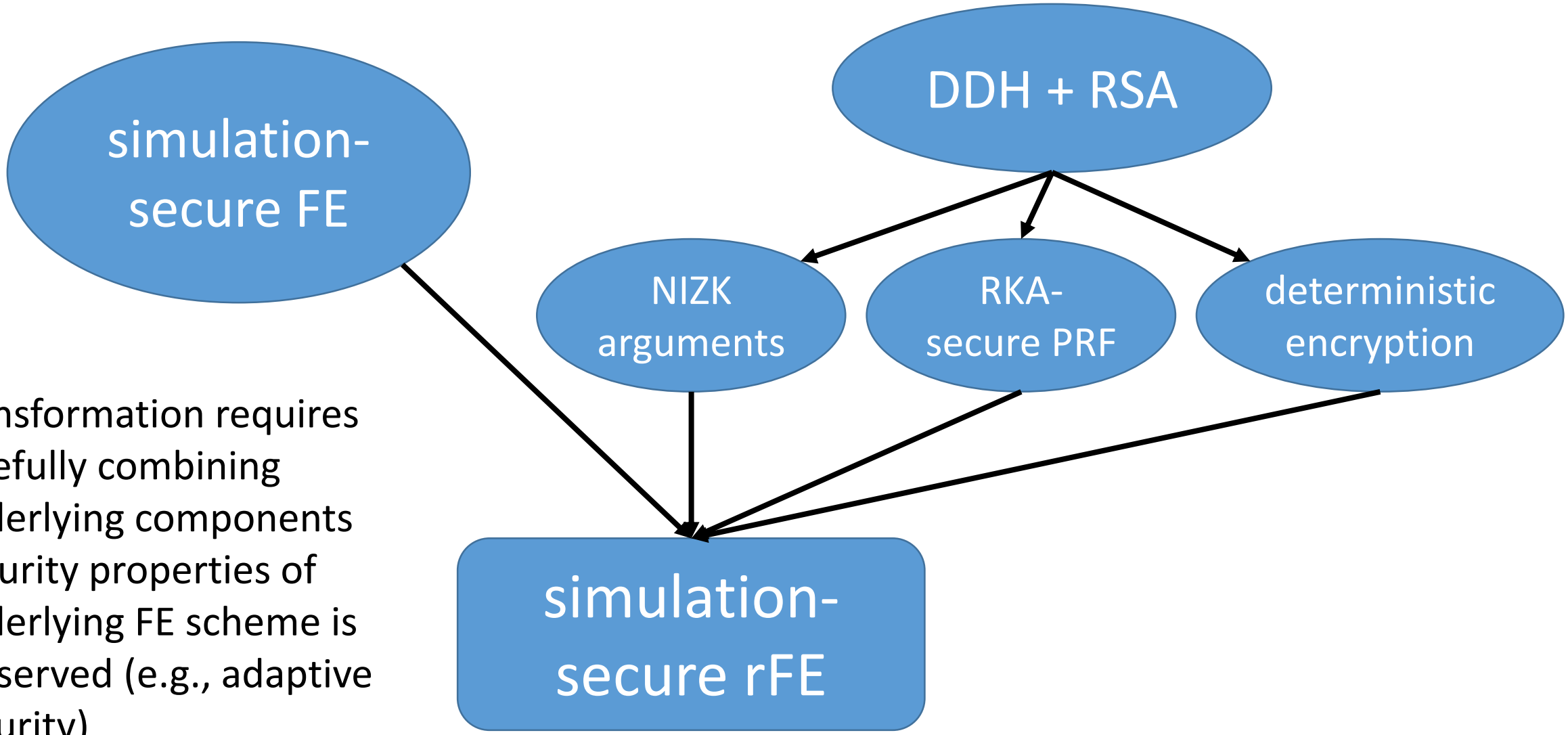
$$f\left(x; \mathrm{PRF}(k \oplus k', x)\right)$$

So split (secret share) the PRF key!

But Remember, it's Rigged…

Encrypter can misbehave! Can influence key-share for PRF and encryption randomness to induce bad distributions

Our Transformation



- Transformation requires carefully combining underlying components
- Security properties of underlying FE scheme is preserved (e.g., adaptive security)

Thanks!

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