A Robust and Sponge–Like PRNG With Improved Efficiency

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ToC

1. Preliminaries
2. Security notions
3. Designs
4. Conclusions

Randomness

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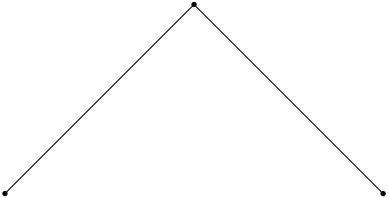
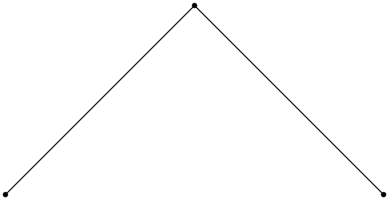
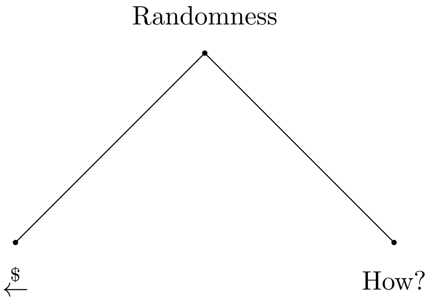
Randomness



Randomness



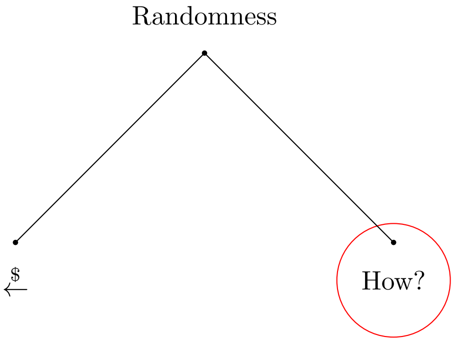
$\overset{\$}{\leftarrow}$



Randomness

$\xleftarrow{\$}$

How?



Randomness

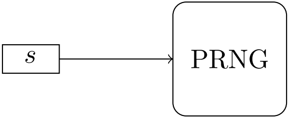
$\xleftarrow{\$}$

How?

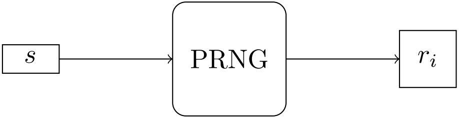
PRNG with Input

PRNG

PRNG with Input



PRNG with Input



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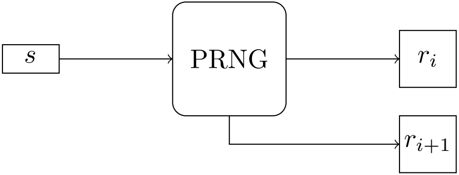

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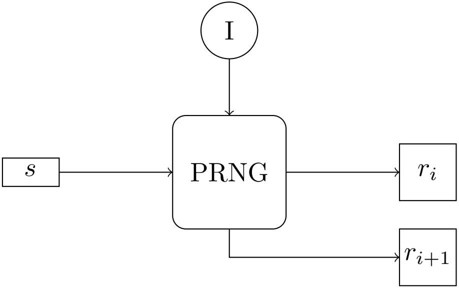
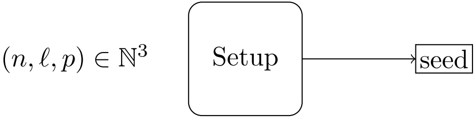


PRNG with Input

WARNING

Seed in this definition is public, NOT the initial state.

PRNG with Input



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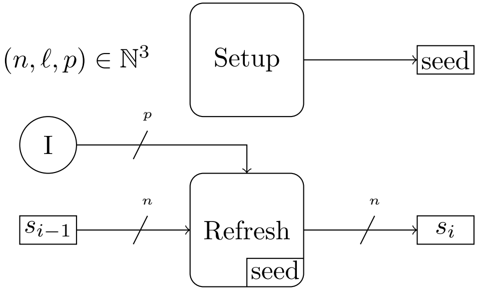
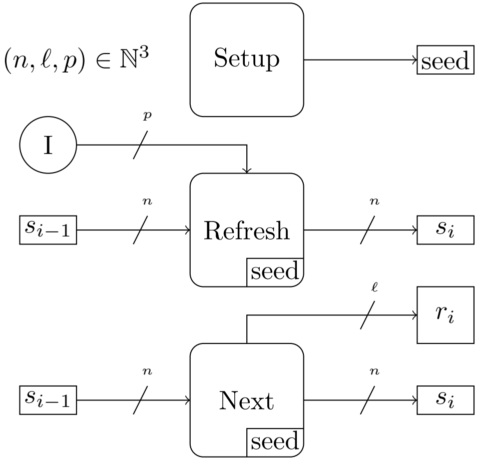


PRNG with Input



Security notions for PRNGs with input[1]

- Resilience - RES ←Weakest notion
  Basic security, no compromise of state, looks random.
- Forward security - FWD
  Output still random even if state is compromised afterwards.
- Backward security - BWD
  Output looks random even if state is compromised previously, but enough entropy has been input since then.
- Robustness - ROB ←Strongest notion
  Combination of the above; adversary can tamper with state.

[1] Yevgeniy Dodis et al. (2013). *Security Analysis of Pseudo-Random Number Generators with Input: /dev/random is not Robust*.

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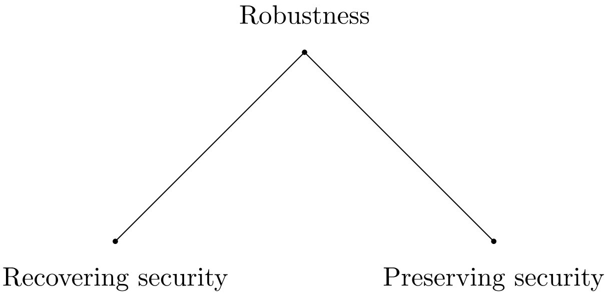
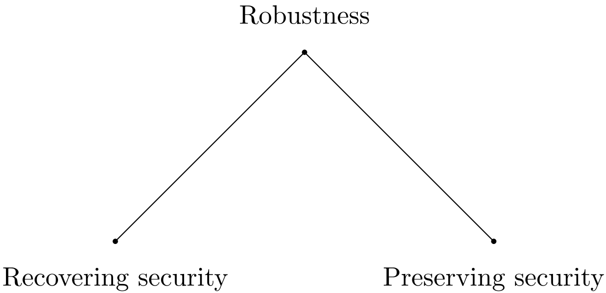
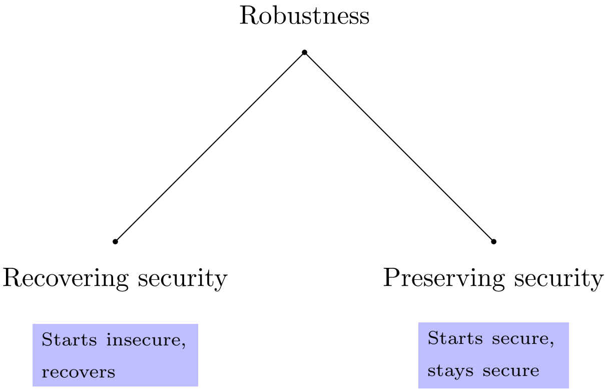
Robustness

-


Robustness
Recovering security
Preserving security



Starts insecure, recovers



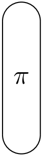
Robustness

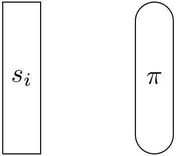
Recovering security

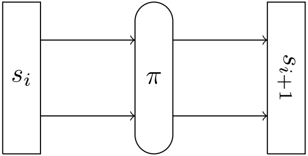
Starts insecure, recovers

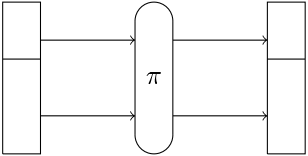
Preserving security

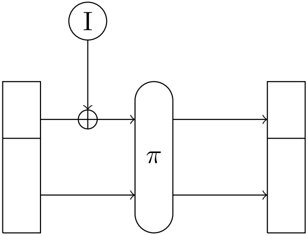
Starts secure, stays secure

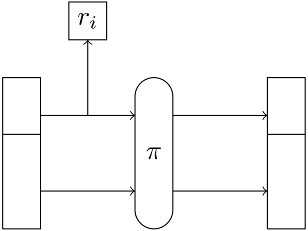

π

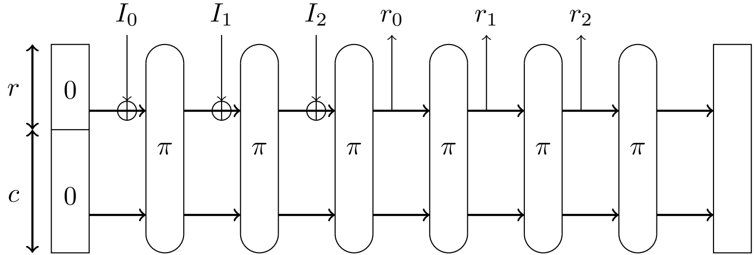

s_i
π


s_i
π
s_{i+1}

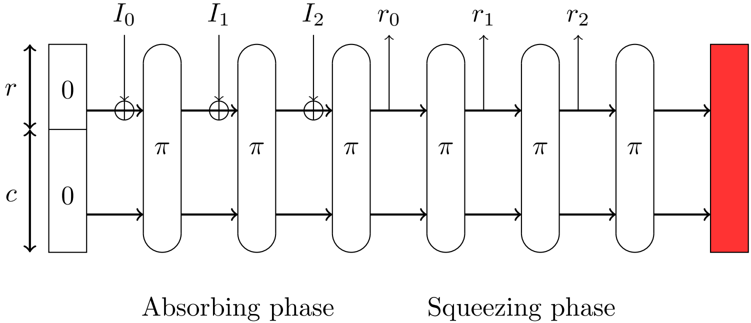

π

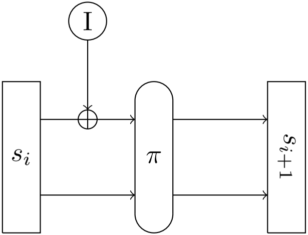

I
π


r_i
π

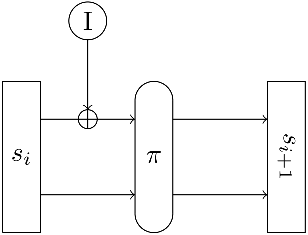


Absorbing phase Squeezing phase

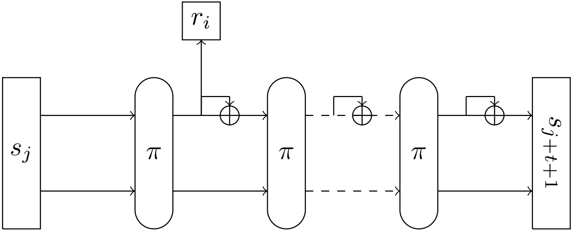

I_0
I_1
I_2
r_0
r_1
r_2
r
c
0
0
π
π
π
π
π
π
Absorbing phase
Squeezing phase



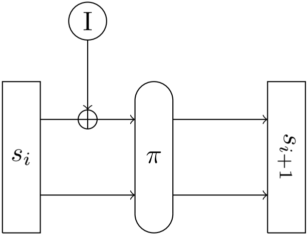
spongeprng.refresh



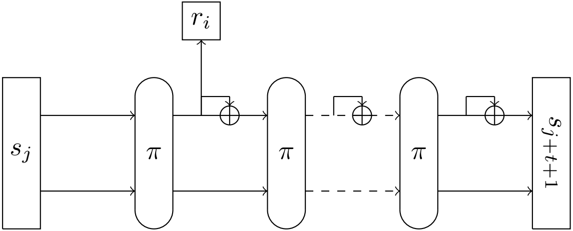
spongeprng.refresh



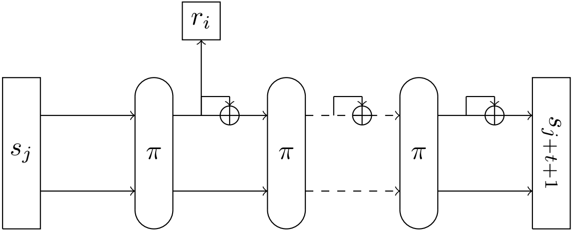
spongeprng.next



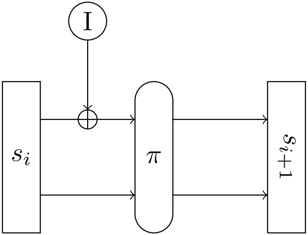
spongeprng.refresh



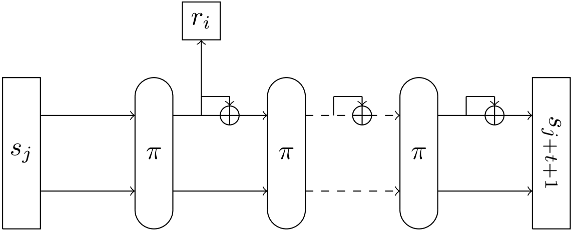
spongeprng.next



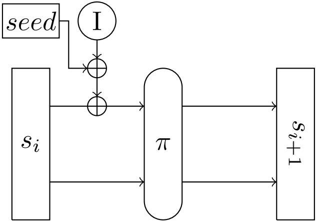
SPRG.next $\boxed{\text{IPM}}$



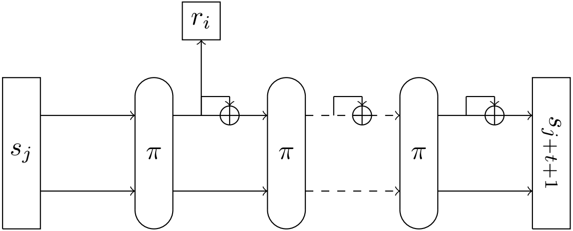
spongeprng.refresh



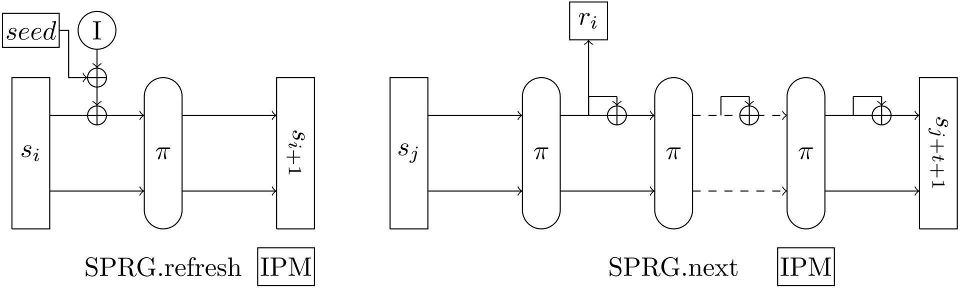
spongeprng.next

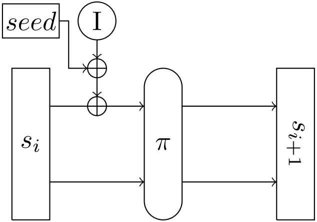


SPRG.refresh $\boxed{\text{IPM}}$

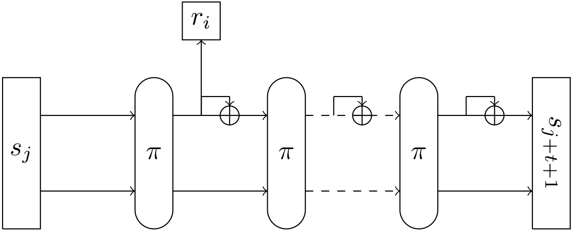


SPRG.next $\boxed{\text{IPM}}$

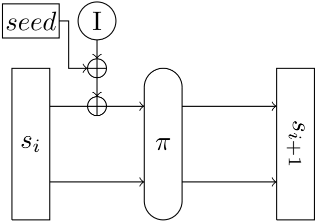

$seed$
I
s_i
π
s_{i+1}
SPRG.refresh
IPM
r_i
s_j
π
π
π
s_{j+t+1}
SPRG.next
IPM



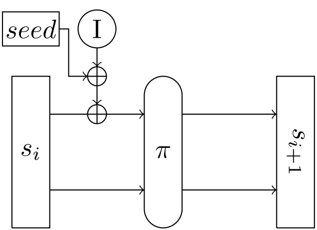
SPRG.refresh $\boxed{\text{IPM}}$



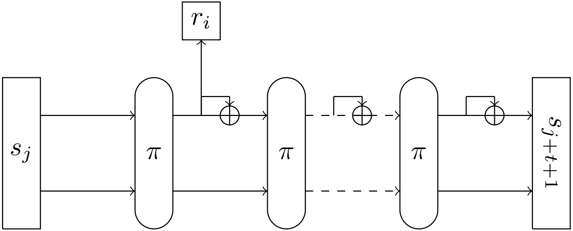
SPRG.next $\boxed{\text{IPM}}$



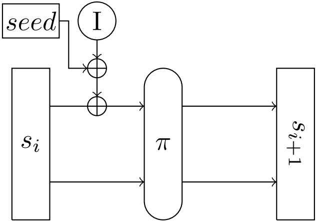
Reverie.refresh $\boxed{\text{IPM}}$



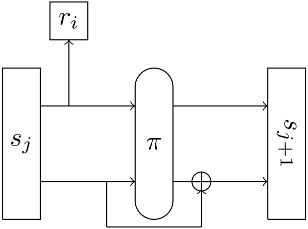
SPRG.refresh IPM



SPRG.next IPM



Reverie.refresh IPM



Reverie.next IPM

Patarin's H-coefficient technique

- Two experiments, real and ideal.

Patarin's H-coefficient technique

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- An experiment is described by an oracle ω together with a transcript τ obtained by interacting with ω.

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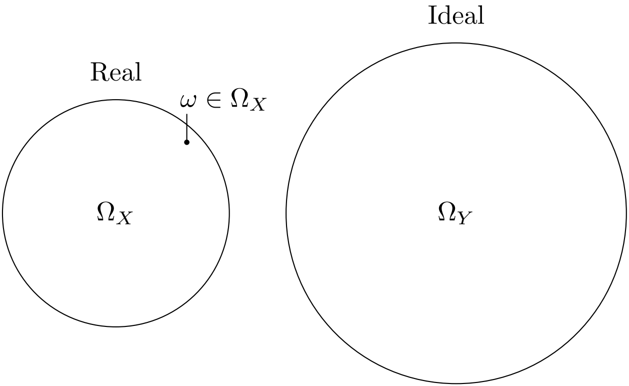
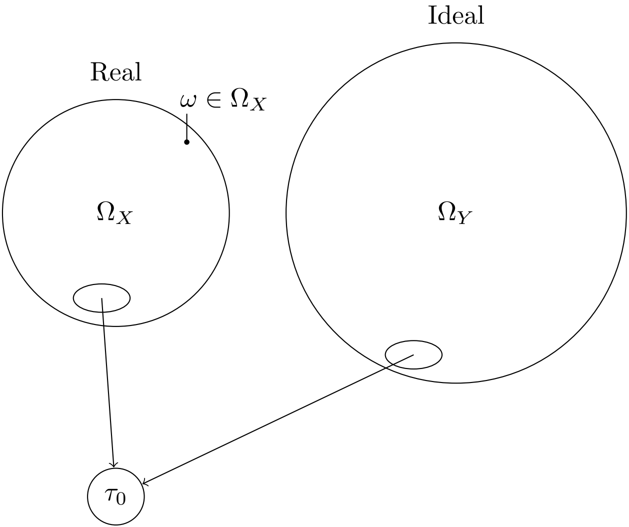
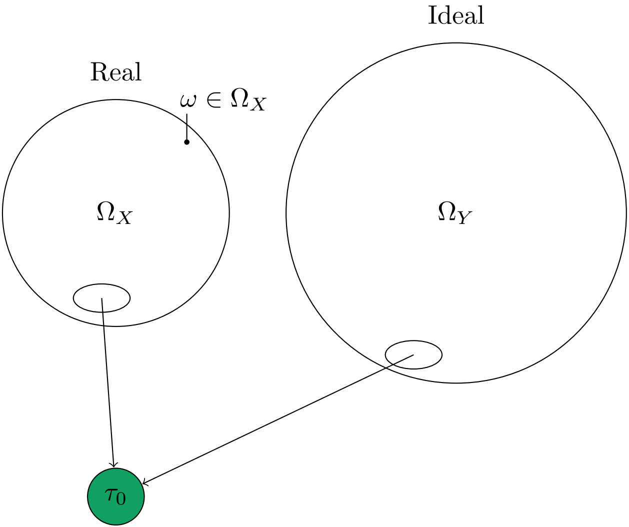
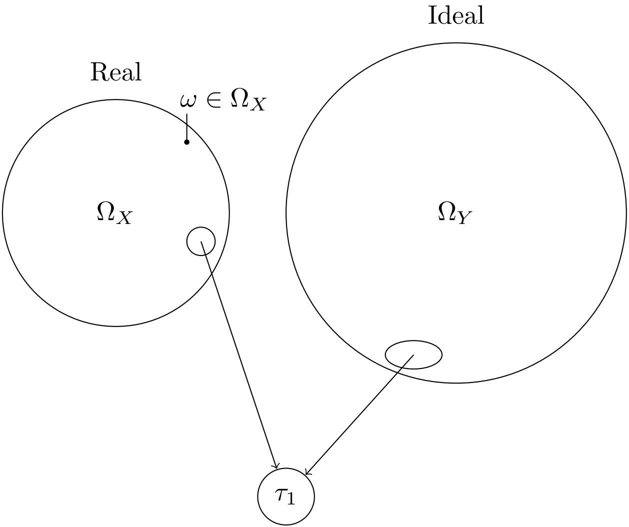
Patarin's H-coefficient technique

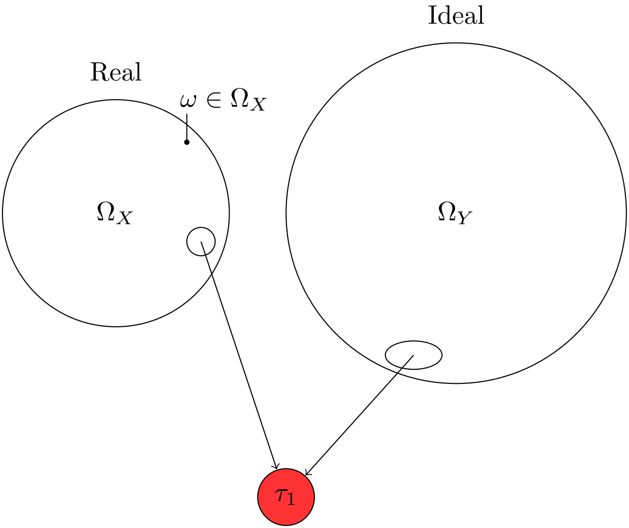
- Two experiments, real and ideal.
- An experiment is described by an oracle ω together with a transcript τ obtained by interacting with ω.
- Ω_X the space of real oracles, while Ω_Y is the space of ideal oracles.
- Transcripts are partitioned into two sets; good or bad.

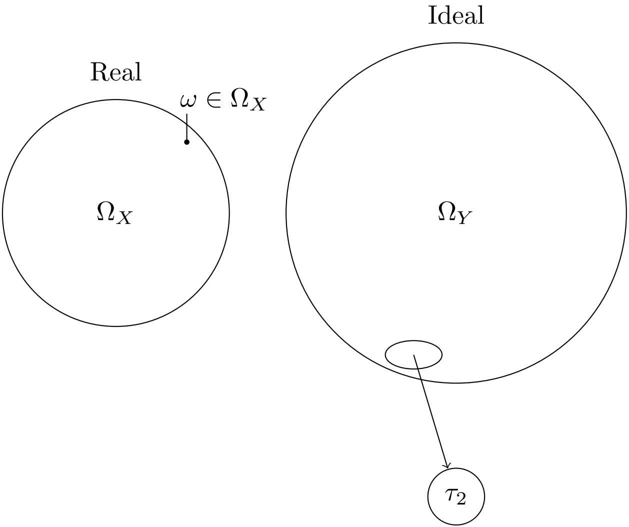

Real
$\omega \in \Omega_X$
Ω_X
Ideal
Ω_Y

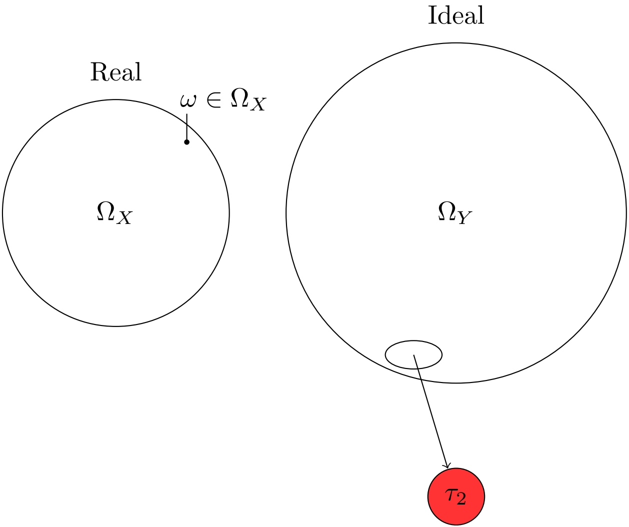

Ideal
Real
$\omega \in \Omega_X$
Ω_X
Ω_Y
τ_0

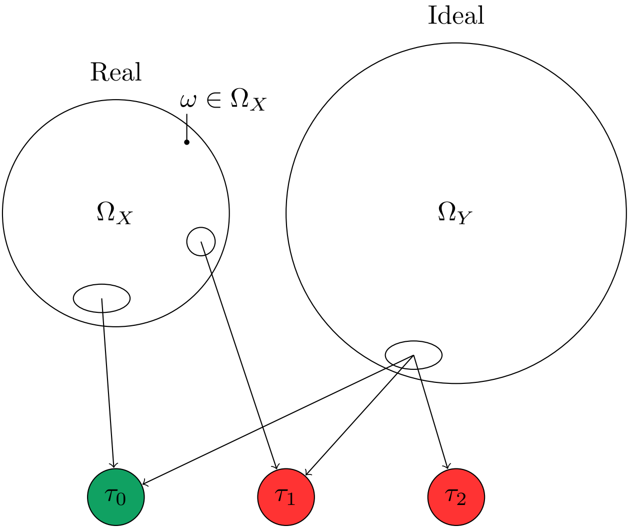

Real
$\omega \in \Omega_X$
Ω_X
Ideal
Ω_Y
τ_0


Ideal
Real
$\omega \in \Omega_X$
Ω_X
Ω_Y
τ_1


Ideal
Real
$\omega \in \Omega_X$
Ω_X
Ω_Y
τ_1


Real
$\omega \in \Omega_X$
Ω_X
Ideal
Ω_Y
τ_2


Real
$\omega \in \Omega_X$
Ω_X
Ideal
Ω_Y
τ_2


Ideal
Real
$\omega \in \Omega_X$
Ω_X
Ω_Y
τ_0
τ_1
τ_2

Conclusions

- Provably robust PRNG design using the H-coefficient technique

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- Design is more efficient than other offerings

Questions

Thank you for listening.

Any Questions?

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