EpiGRAM

Practical Garbled RAM

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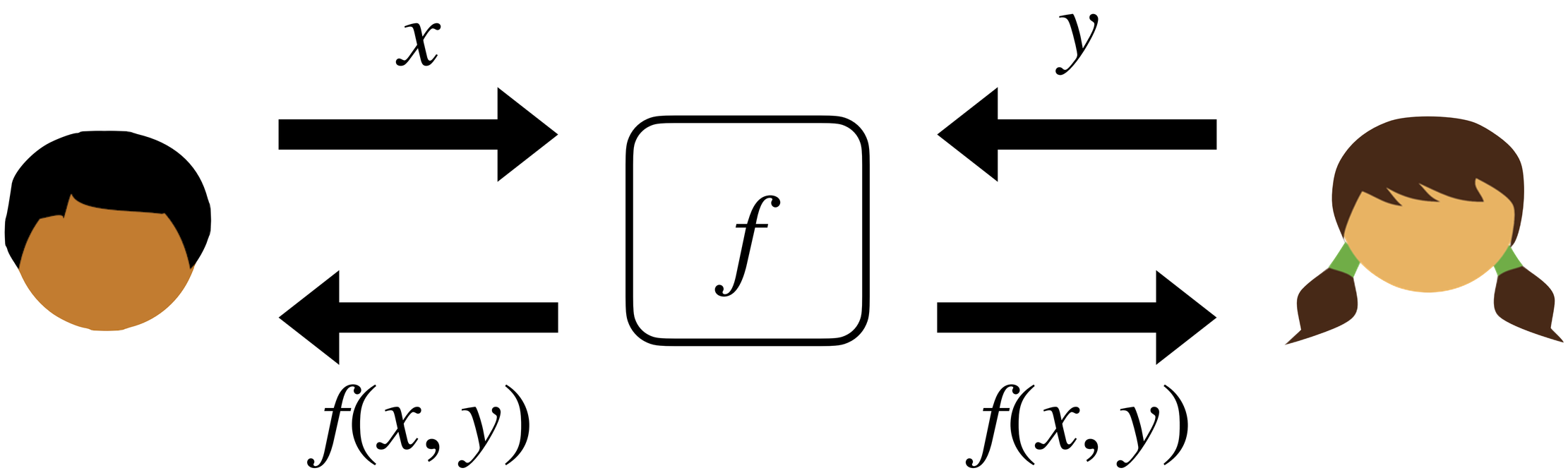
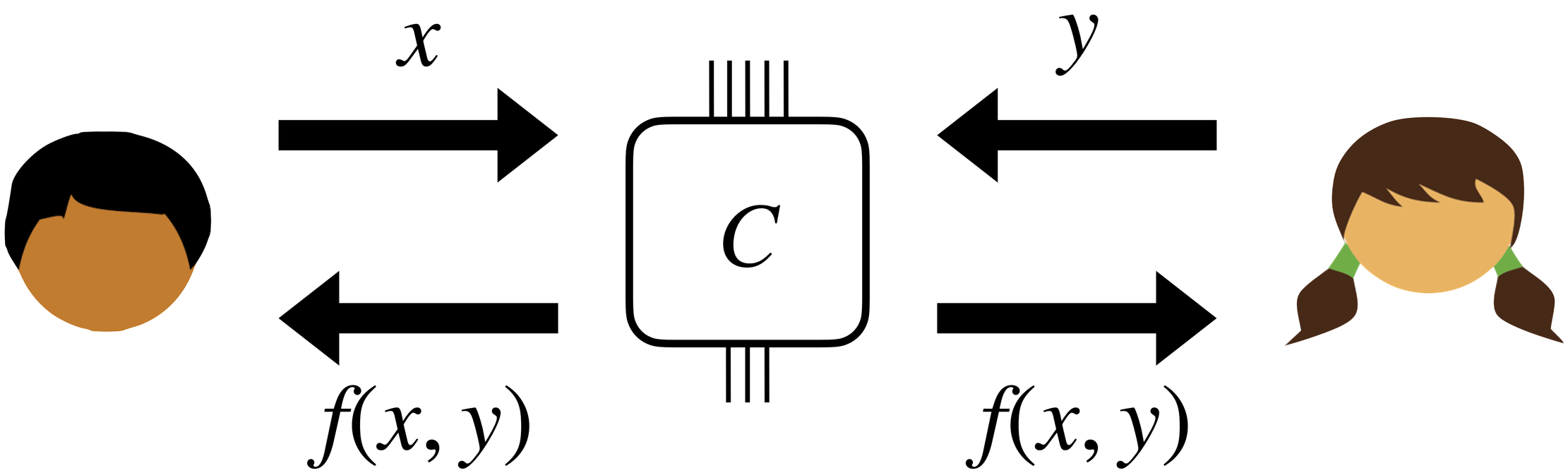
Secure 2PC



Garbled Circuits



Garbled Circuits

Constant Round ✓

Garbled Circuits

Constant Round ✓

Symmetric Key Primitives ✓

Garbled Circuits

Constant Round ✓

Symmetric Key Primitives ✓

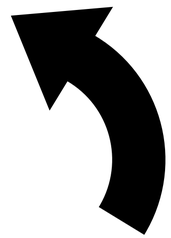
Circuits ✗

Garbled Circuits

Constant Round ✓

Symmetric Key Primitives ✓

Circuits ✗



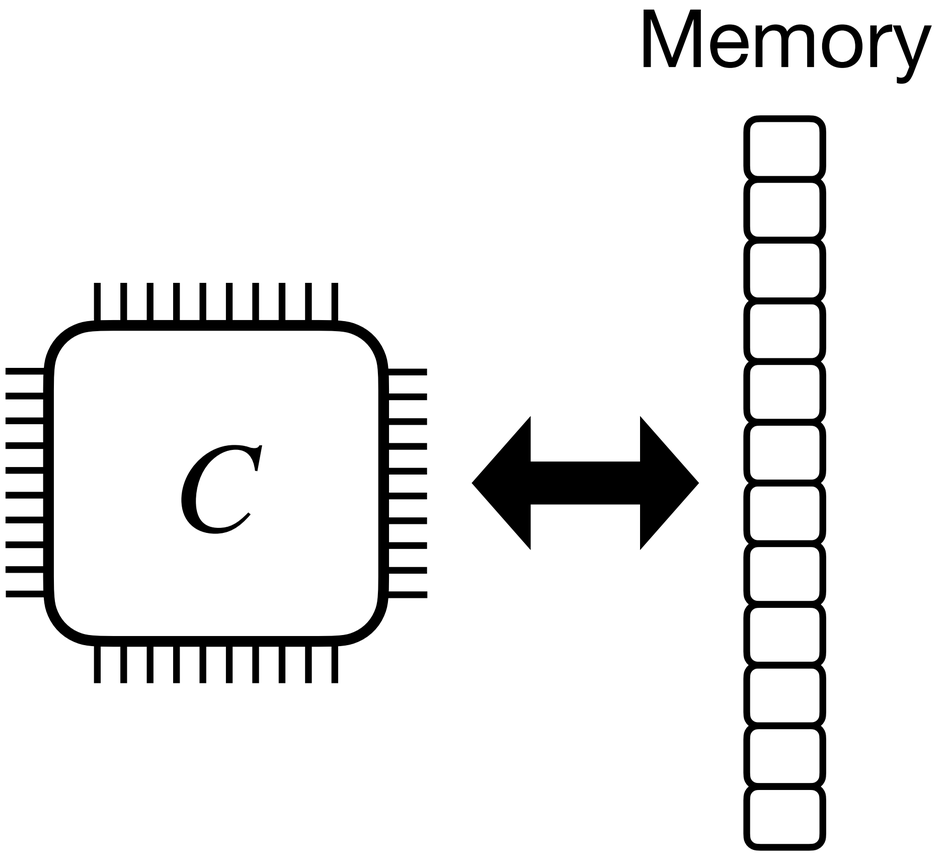
Cost scales w/ # gates

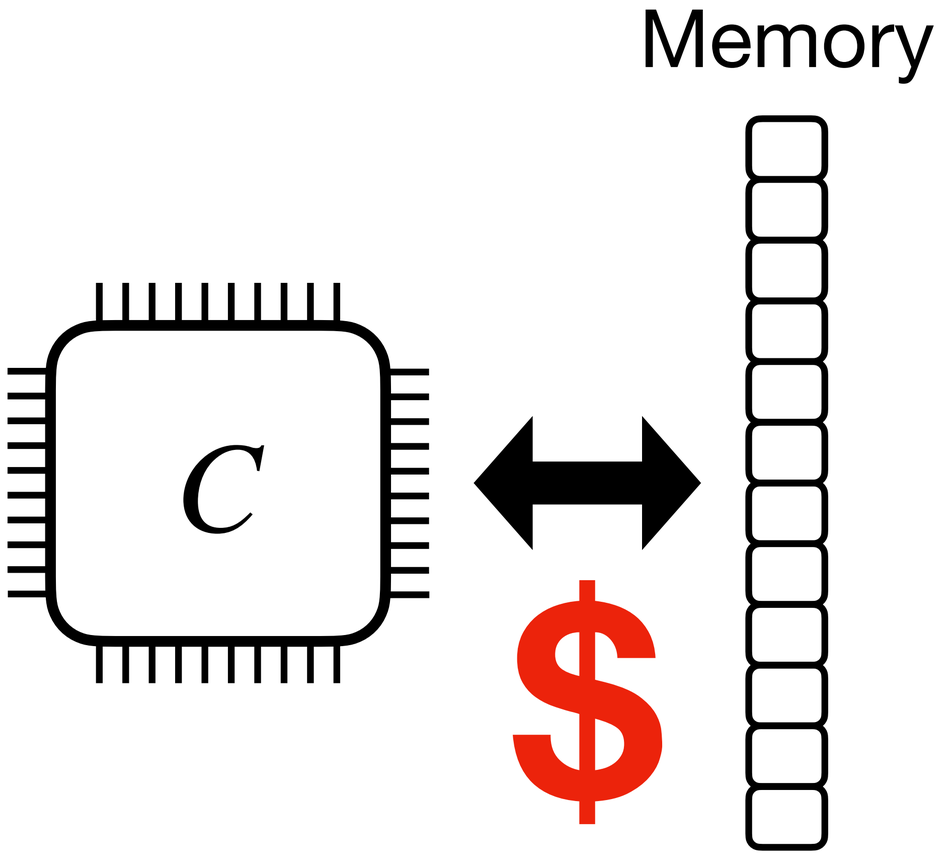
[LO13] Garbled Circuits RAM

Constant Round ✓

Symmetric Key Primitives ✓

Circuits ✗


Memory
C



Goal: Amortized $O(\text{poly}(\log n))$

[LO13] Garbled Circuits RAM

Constant Round ✓

Symmetric Key Primitives ✓

RAM Machines ~~Circuits~~ ✓

[LO13] Garbled Circuits ~~Garbled Circuits~~ RAM

Constant Round ✓

Symmetric Key Primitives ✓

RAM Machines ~~Circuits~~ ✓

Non-BB Crypto

Non-Standard Assumptions ✗

High Concrete Overhead ✗

Garbled Circuits RAM

Constant Round ✓

Symmetric Key Primitives ✓

RAM Machines ~~Circuits~~ ✓

Non-Standard Assumptions ✗

High Concrete Overhead ✗

Non-BB Crypto

[GHL+14, GLO15, ...]

Garbled Circuits RAM

Constant Round ✓

Symmetric Key Primitives ✓

RAM Machines ~~Circuits~~ ✓

~~Non-BB Crypto~~ ~~Non-Standard Assumptions~~ ✗

High Concrete Overhead ✗

[GHL+14, GLO15, ...]

Garbled Circuits RAM

Constant Round ✓

Symmetric Key Primitives ✓

RAM Machines ~~Circuits~~ ✓

Standard Assumptions ✓

High Concrete Overhead ✗

[GLO15] $\tilde{O}(\kappa^2 \cdot \log^4 n \cdot (w + \log^2 n))$

Hidden $\mathrm{poly}(\log \log n)$ factors

Analysis due to [PLS22]

Ours $O(\kappa \cdot \log^2 n \cdot (w + \log^2 n))$

κ Security parameter

w Size of RAM elements

n Number of RAM elements

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Hidden $\mathrm{poly}(\log \log n)$ factors

Ours $O(\kappa \cdot \log^2 n \cdot (w + \log^2 n))$

κ	Security parameter
w	Size of RAM elements
n	Number of RAM elements

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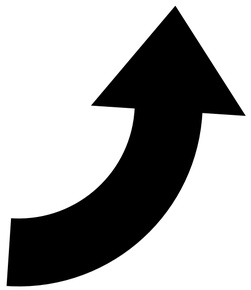
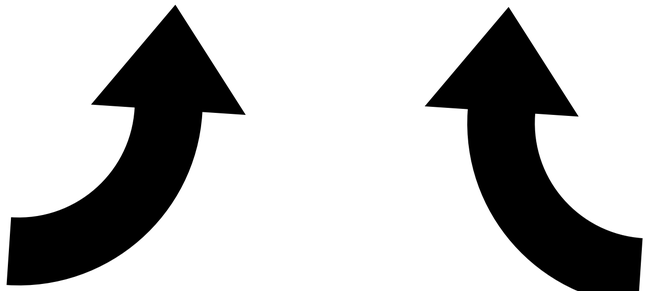


Improved GC
encoding of GC labels

[GLO15] $\tilde{O}(\kappa^2 \cdot \log^4 n \cdot (w + \log^2 n))$

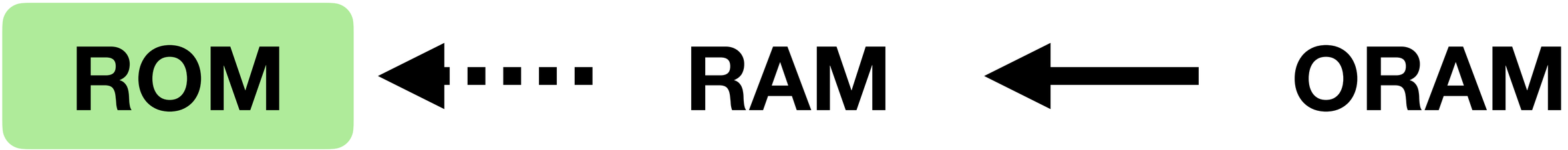
Ours $O(\kappa \cdot \log^2 n \cdot (w + \log^2 n))$



Improved GC encoding of GC labels

Clean GC data structure

Core Technical Challenge



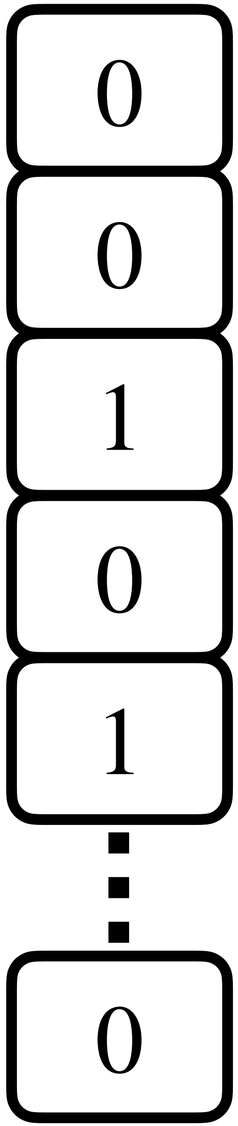
See paper

[GO96,…]

Core Technical Challenge

Read <u>once</u> only memory ◀⋯⋯ **RAM** ◀— **ORAM**

See paper [GO96,…]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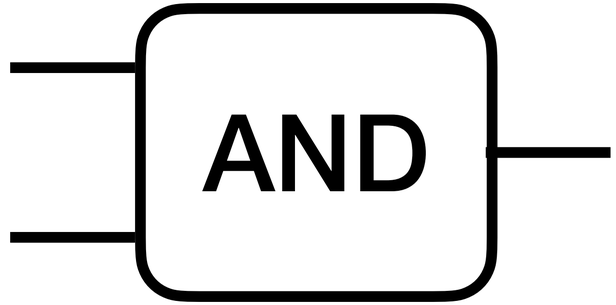
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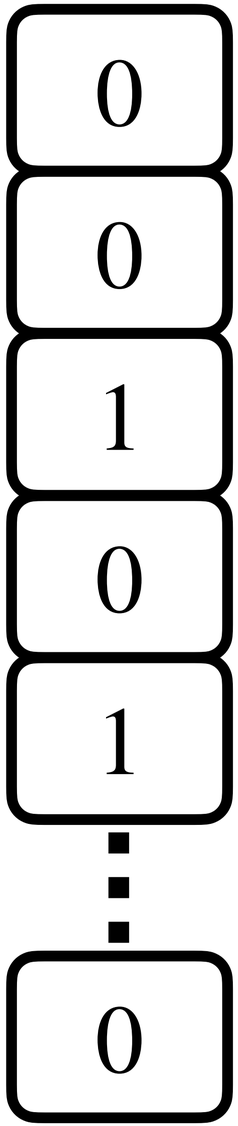
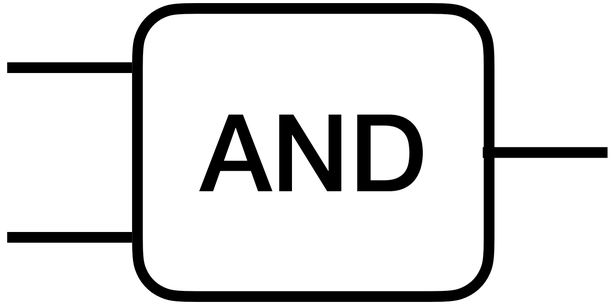
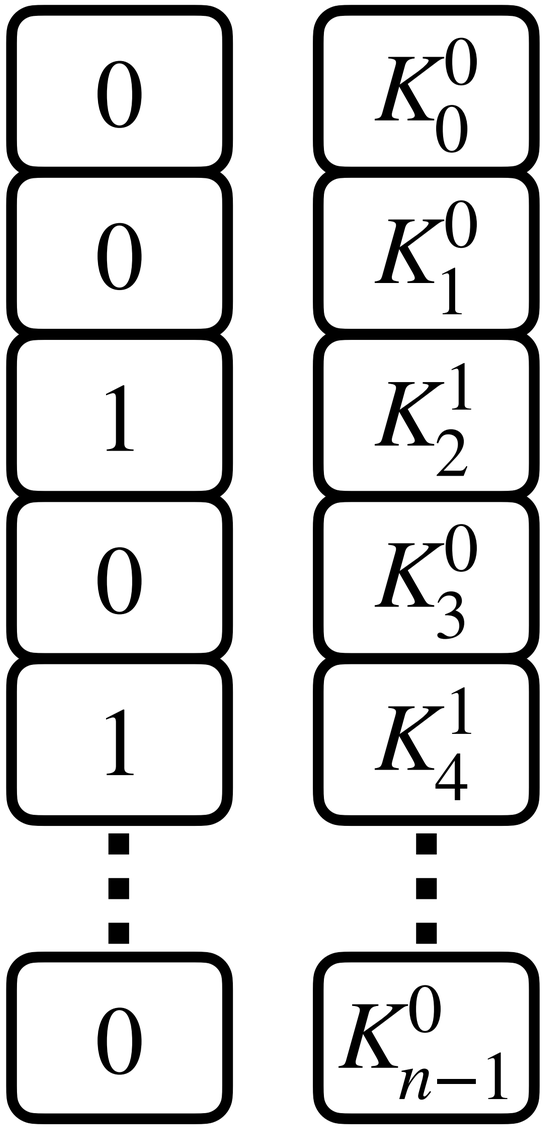


Language

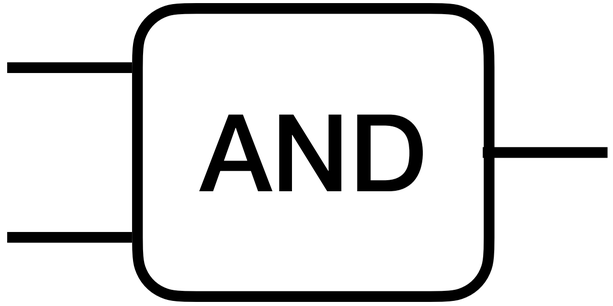
K^0, K^1

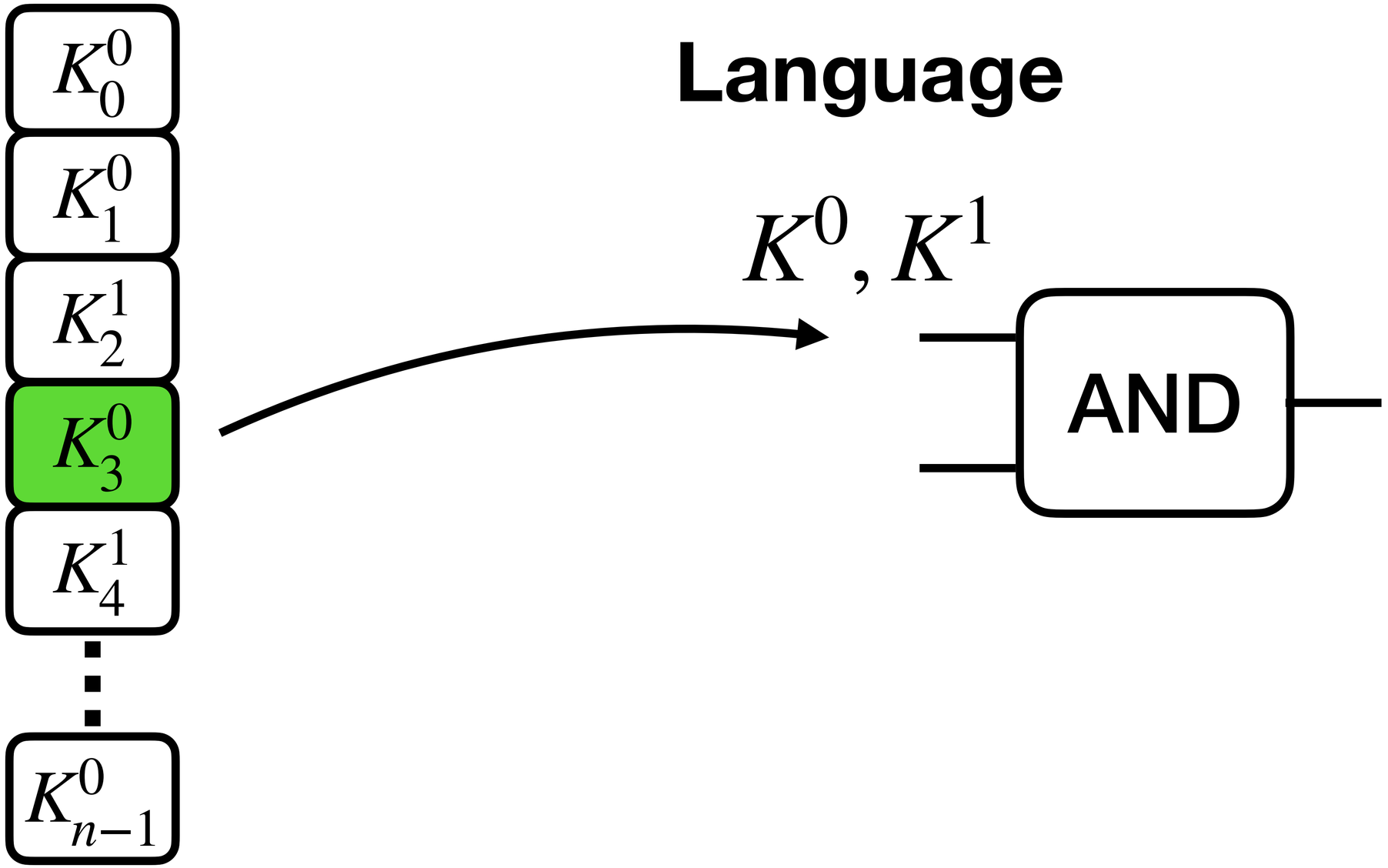


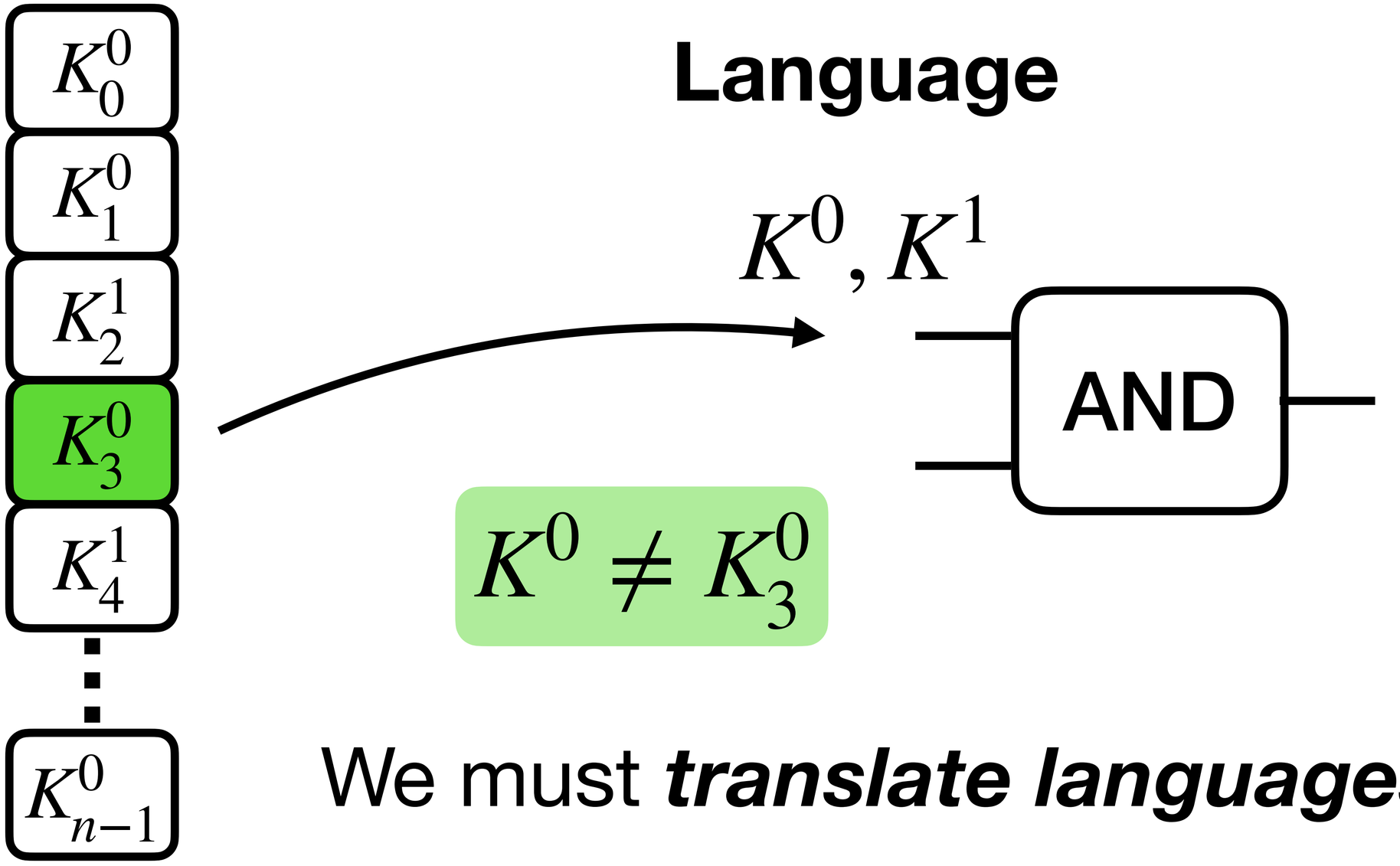


Language

K^0, K^1



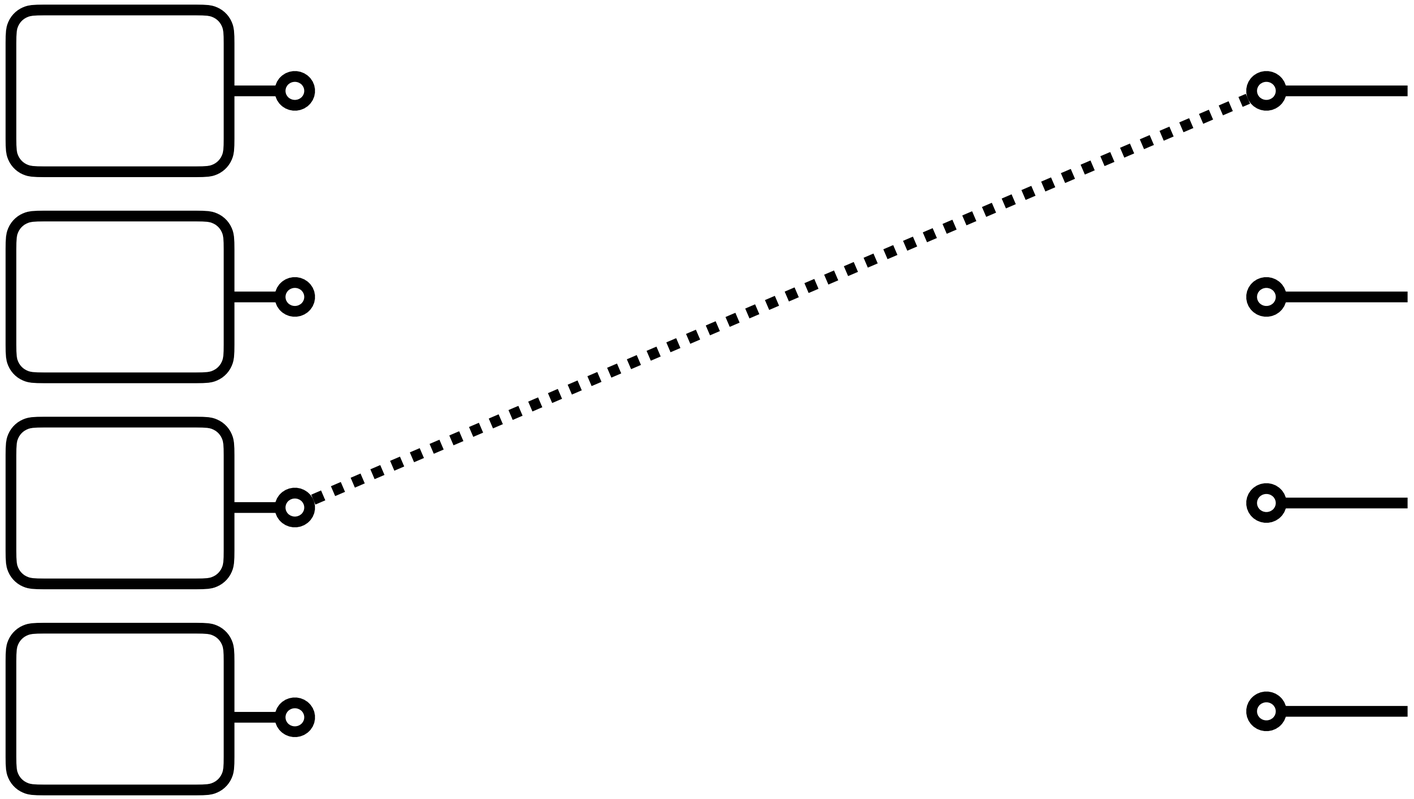

K_0^0
K_1^0
K_2^1
K_3^0
K_4^1
K_{n-1}^0
Language
K^0, K^1
AND



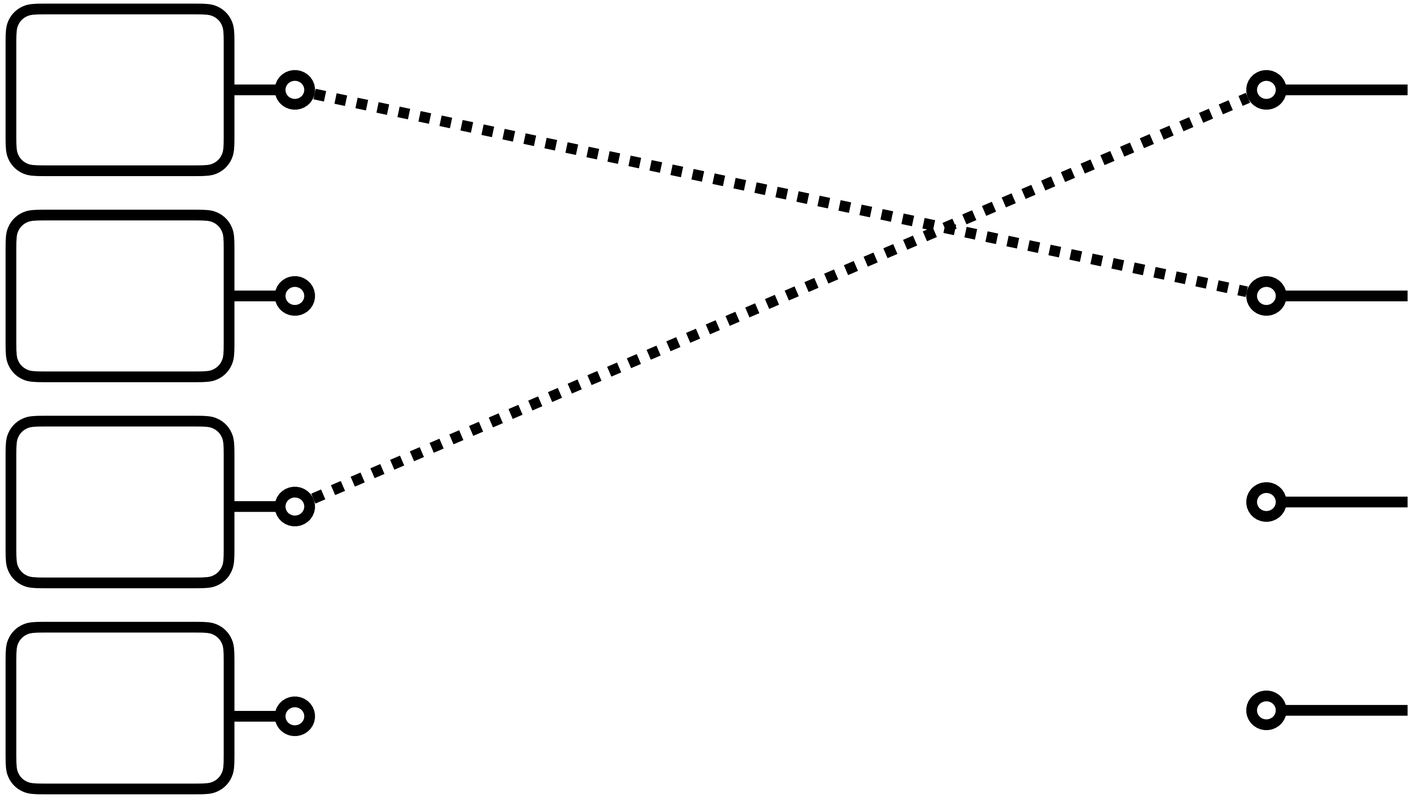
We must ***translate languages***

Lazy Permutation

Lazy Permutation



Lazy Permutation



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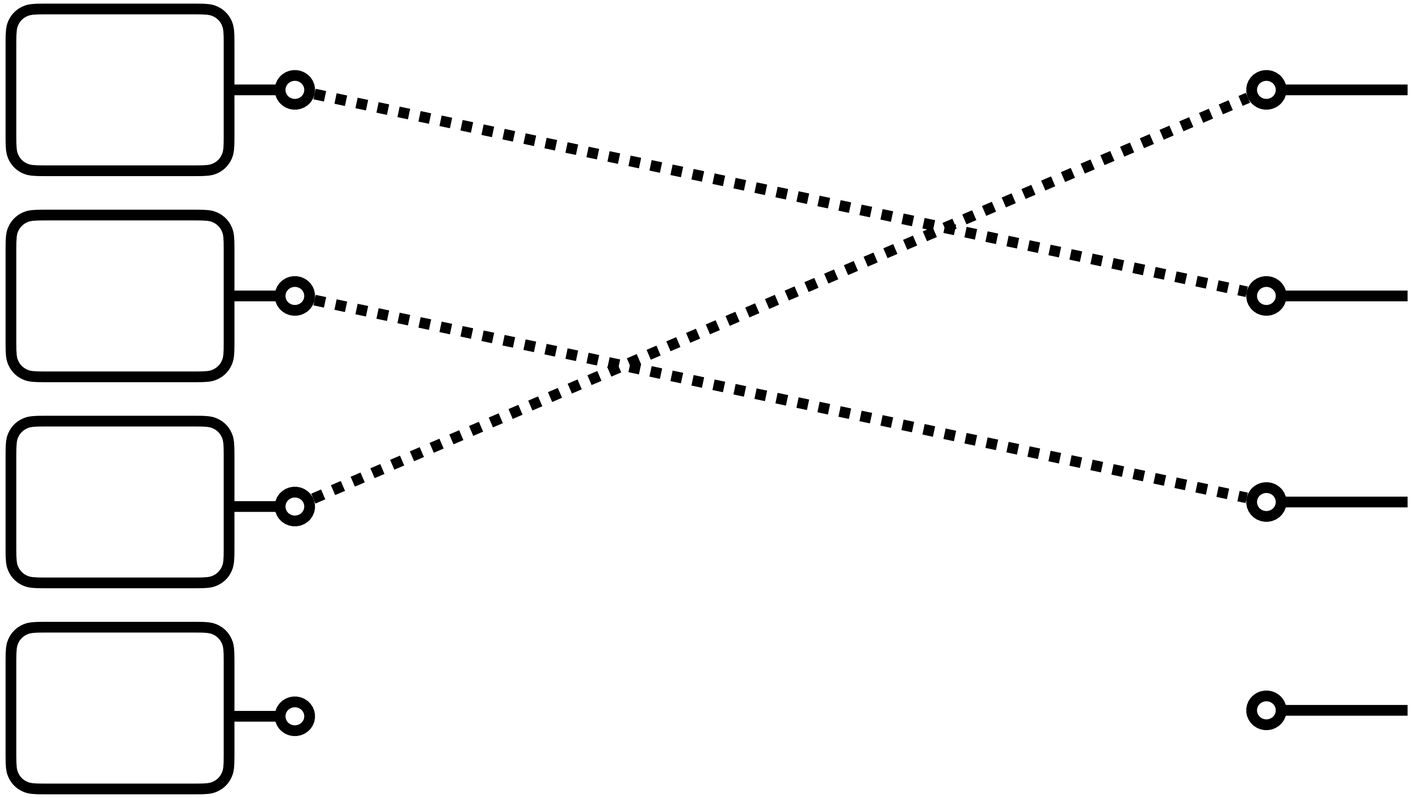

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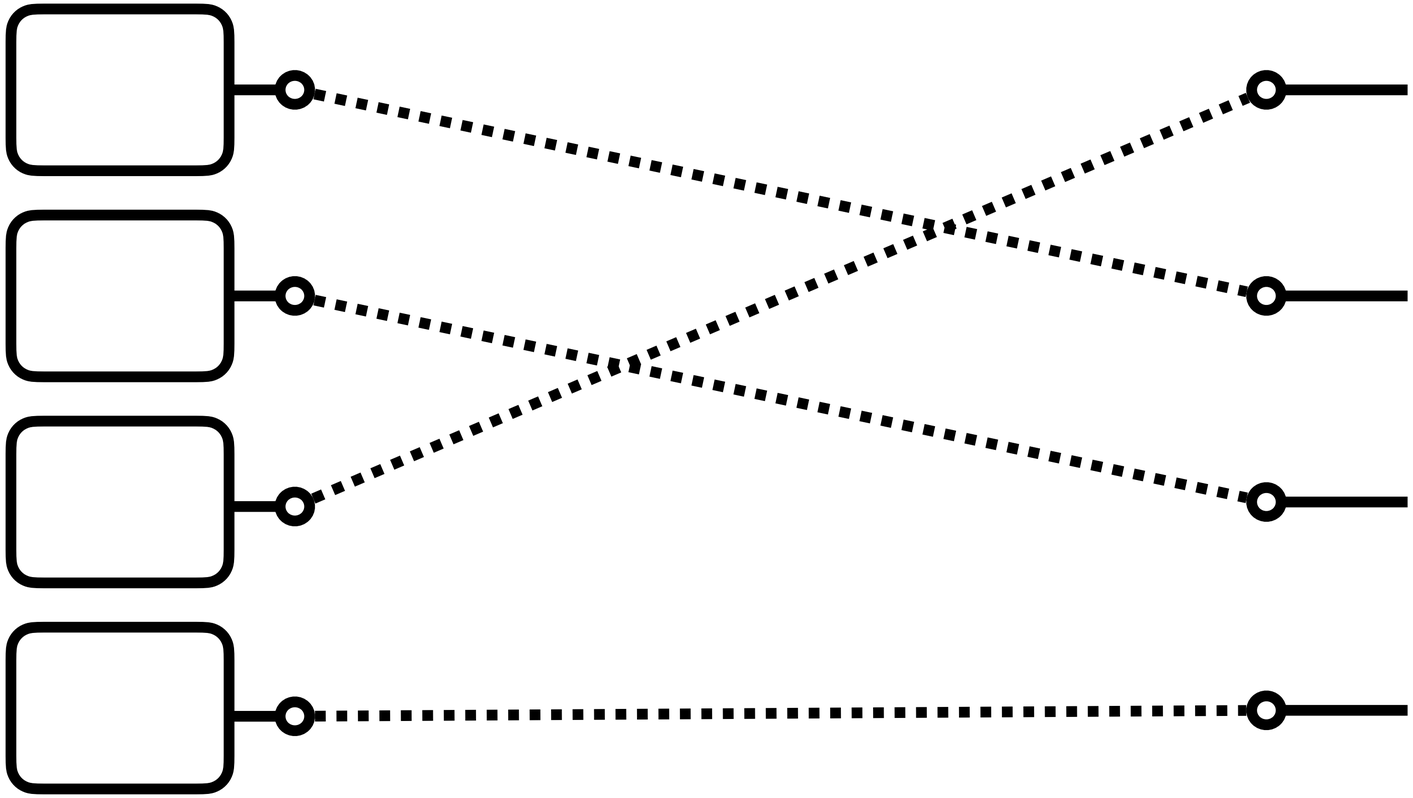
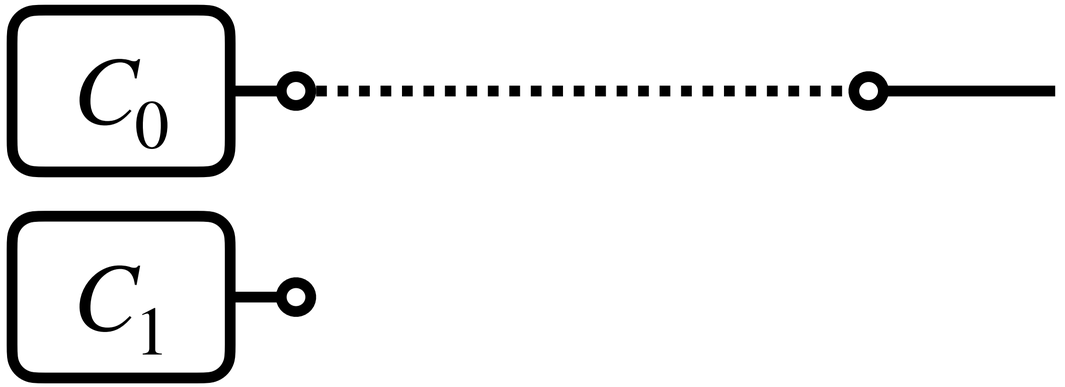


Dynamic Soldering and Evaluation



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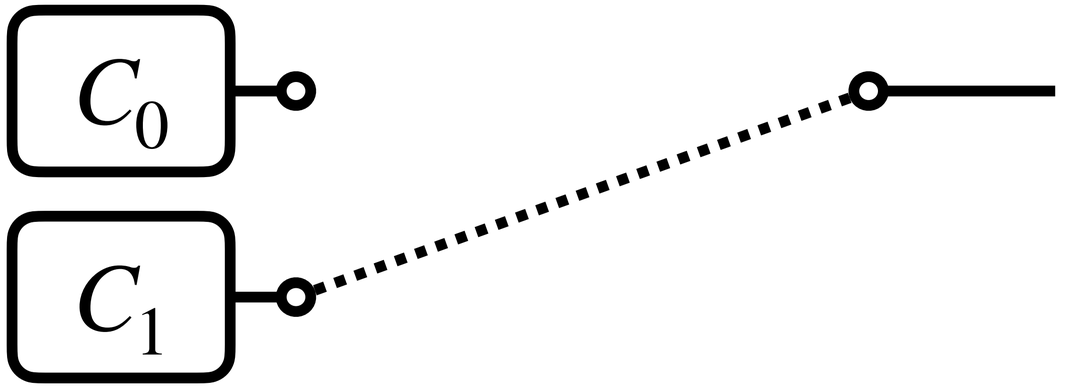

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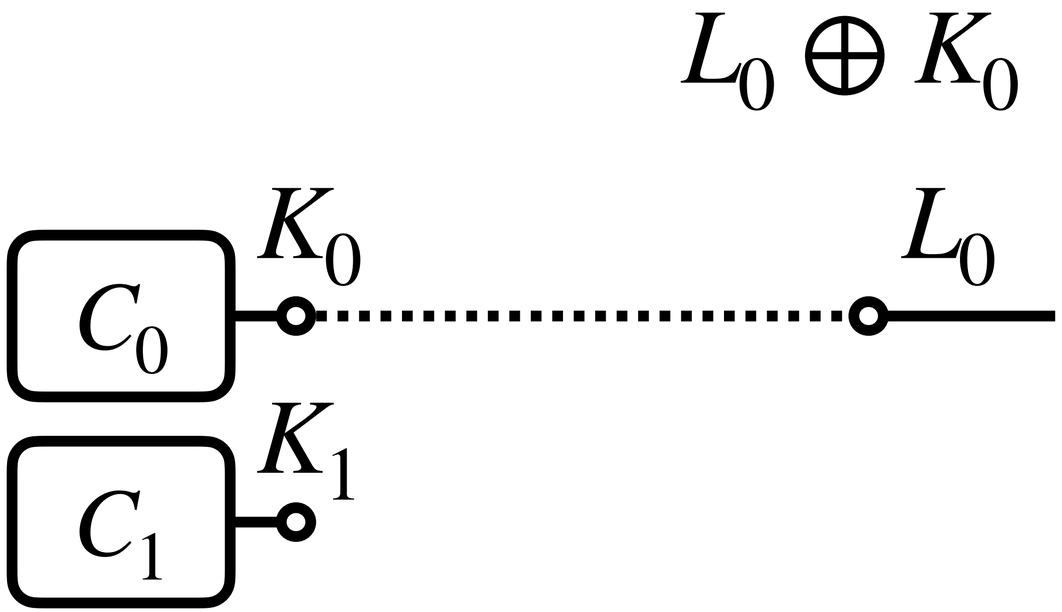

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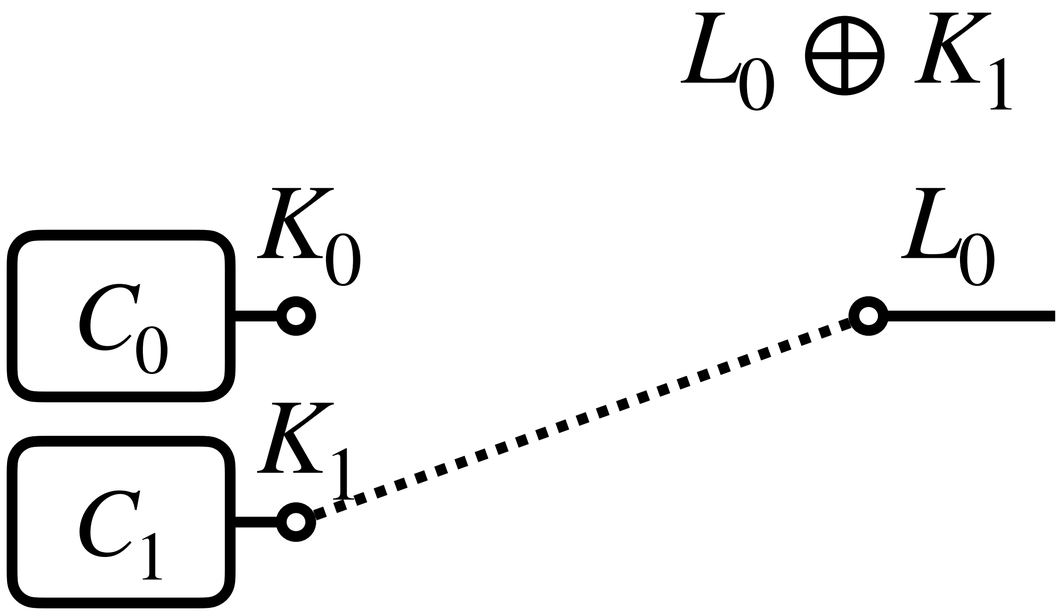

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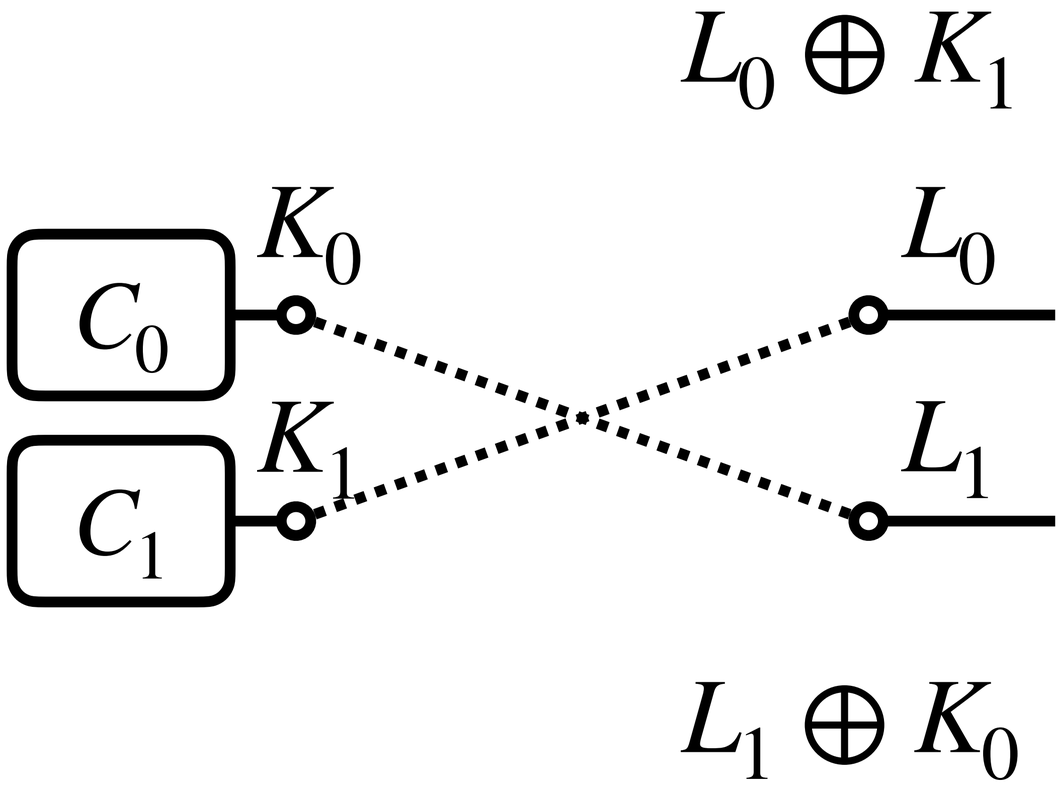

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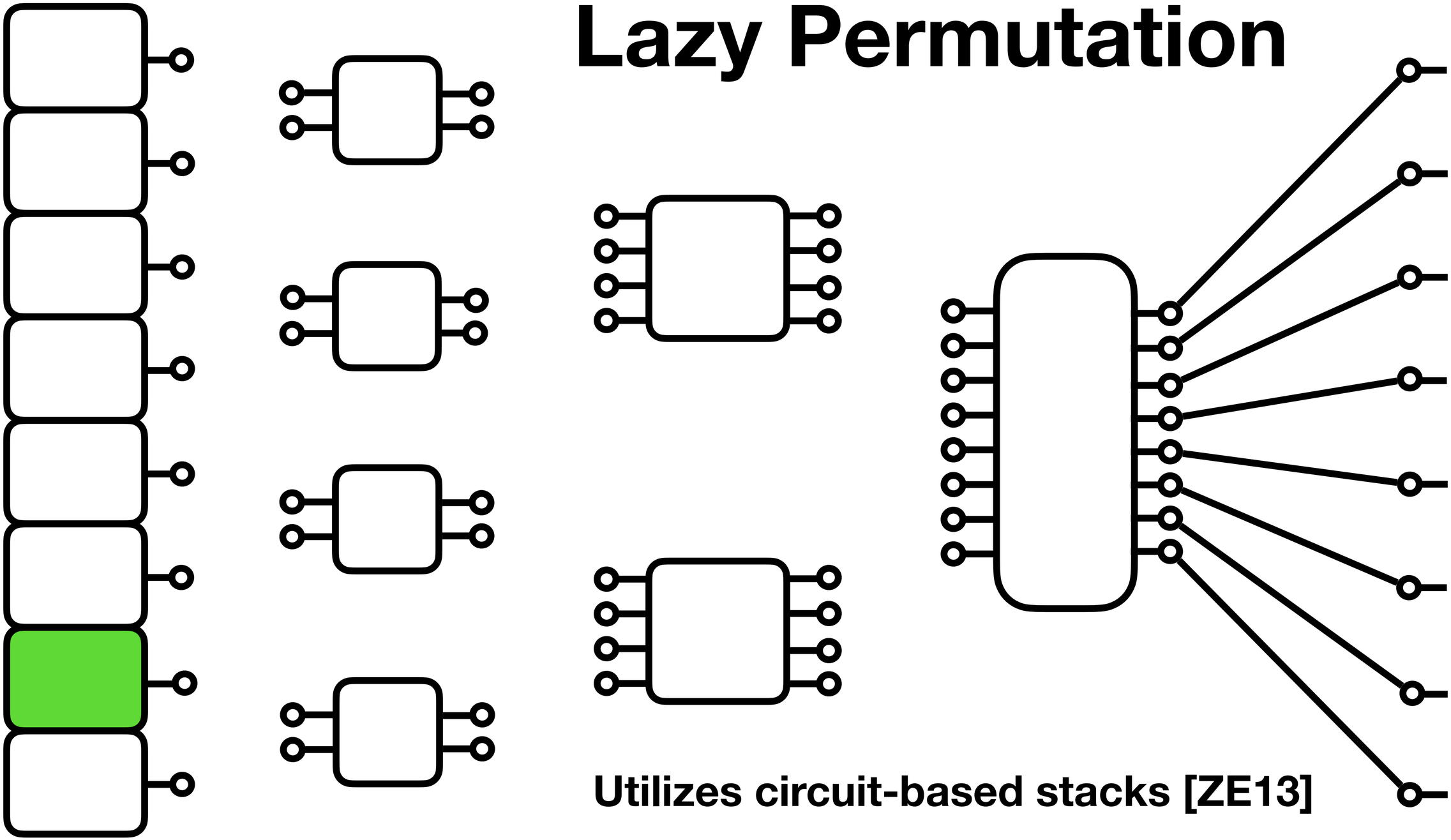
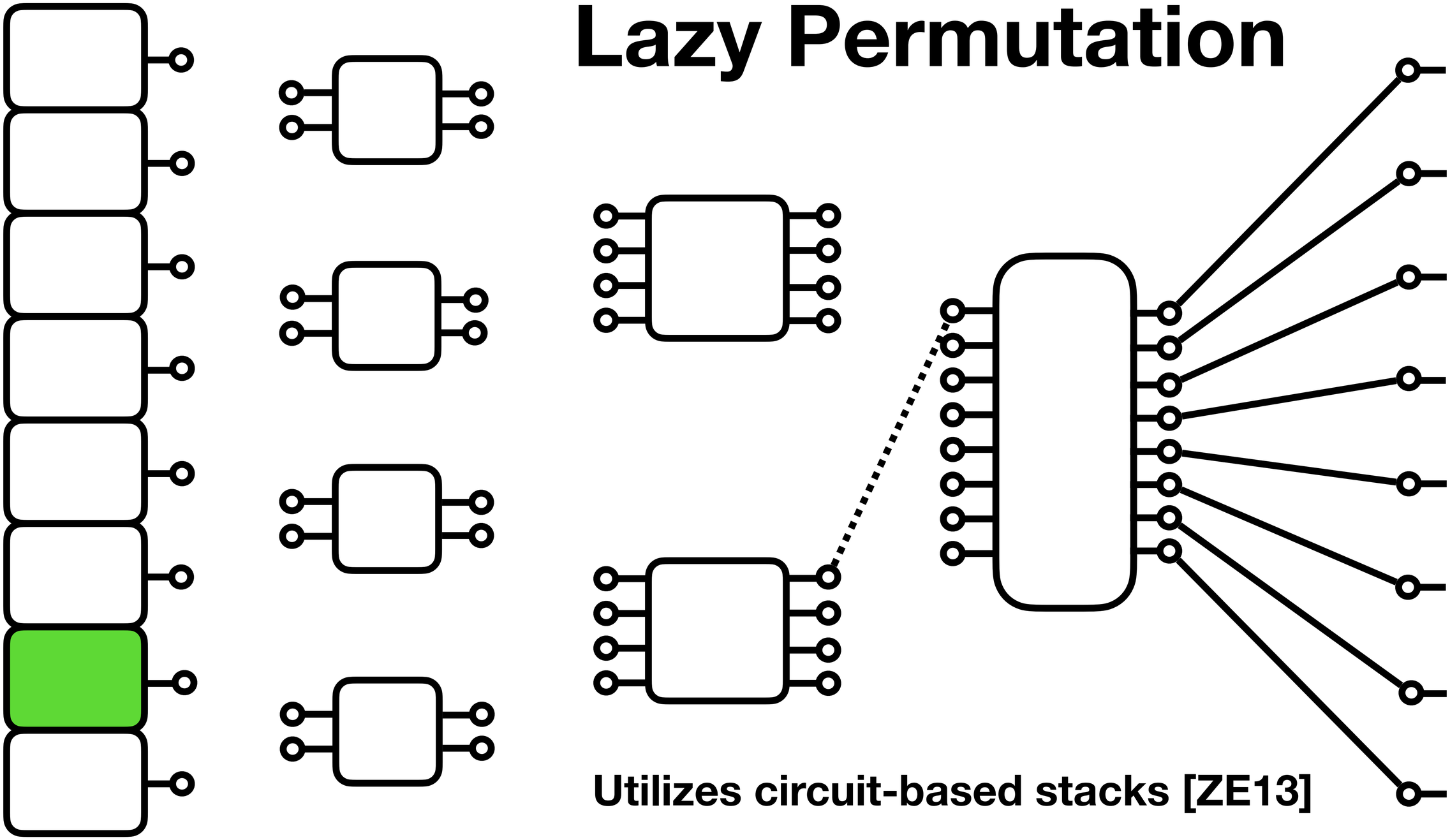


Utilizes circuit-based stacks [ZE13]

Lazy Permutation



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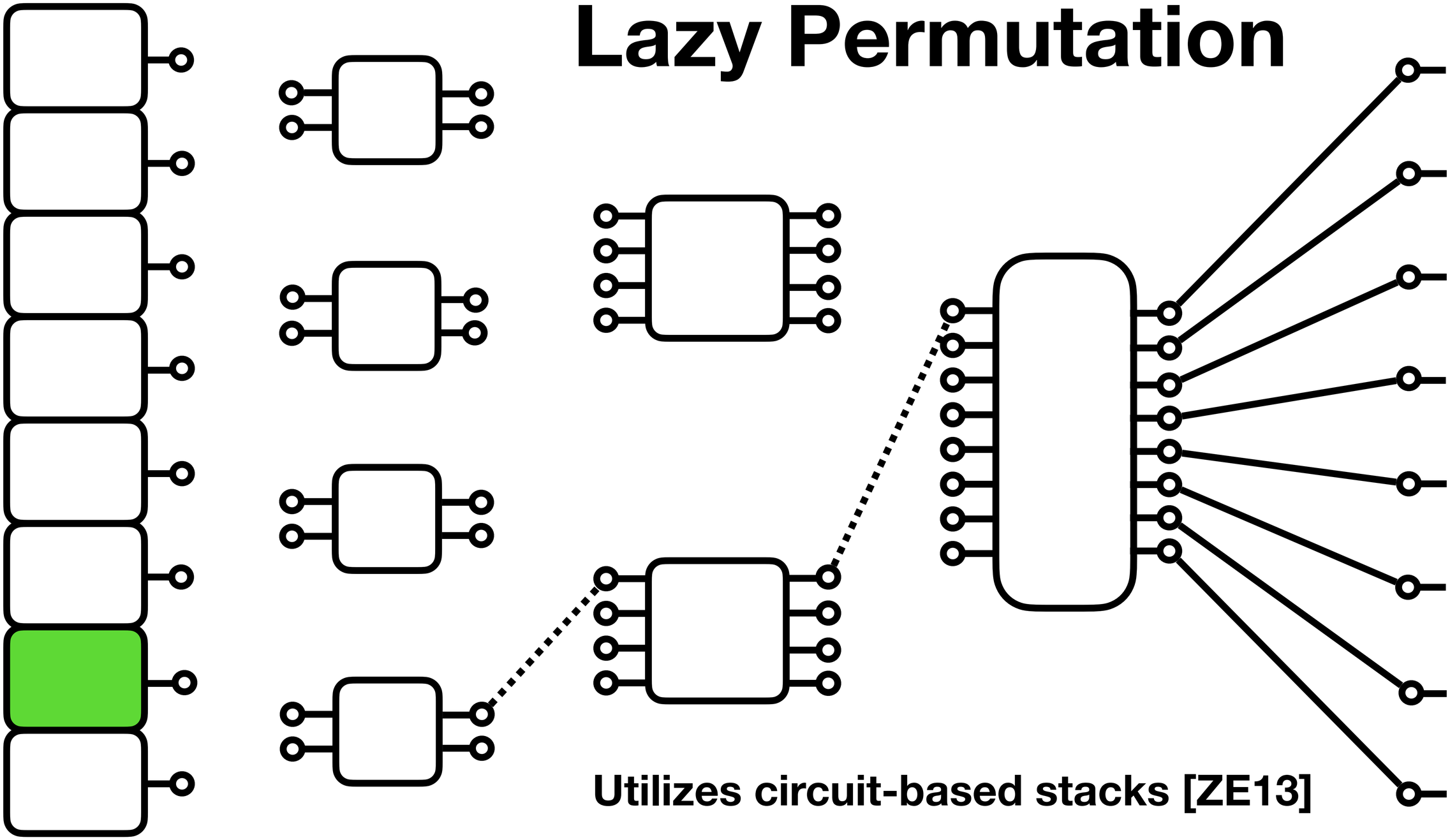

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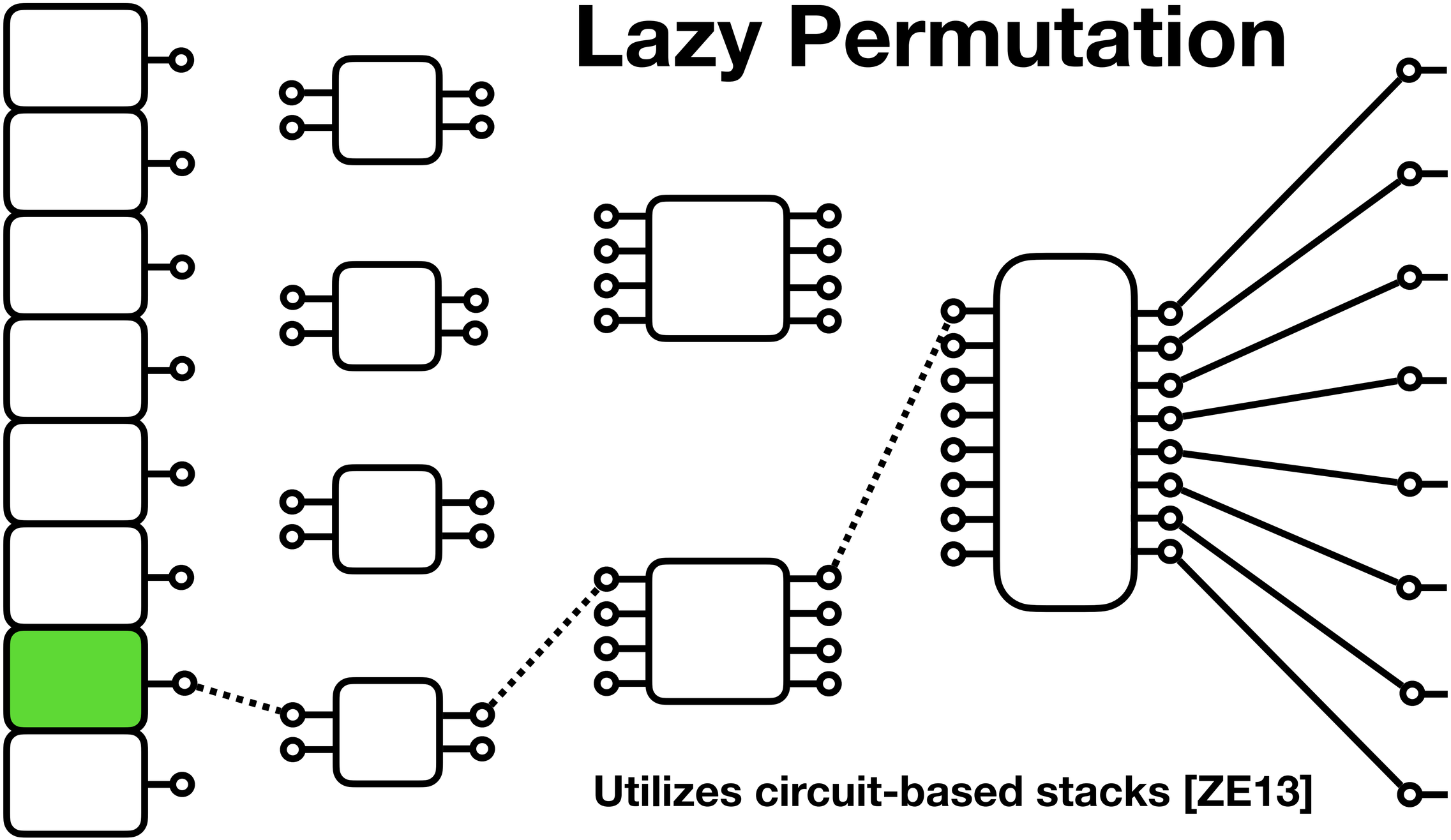

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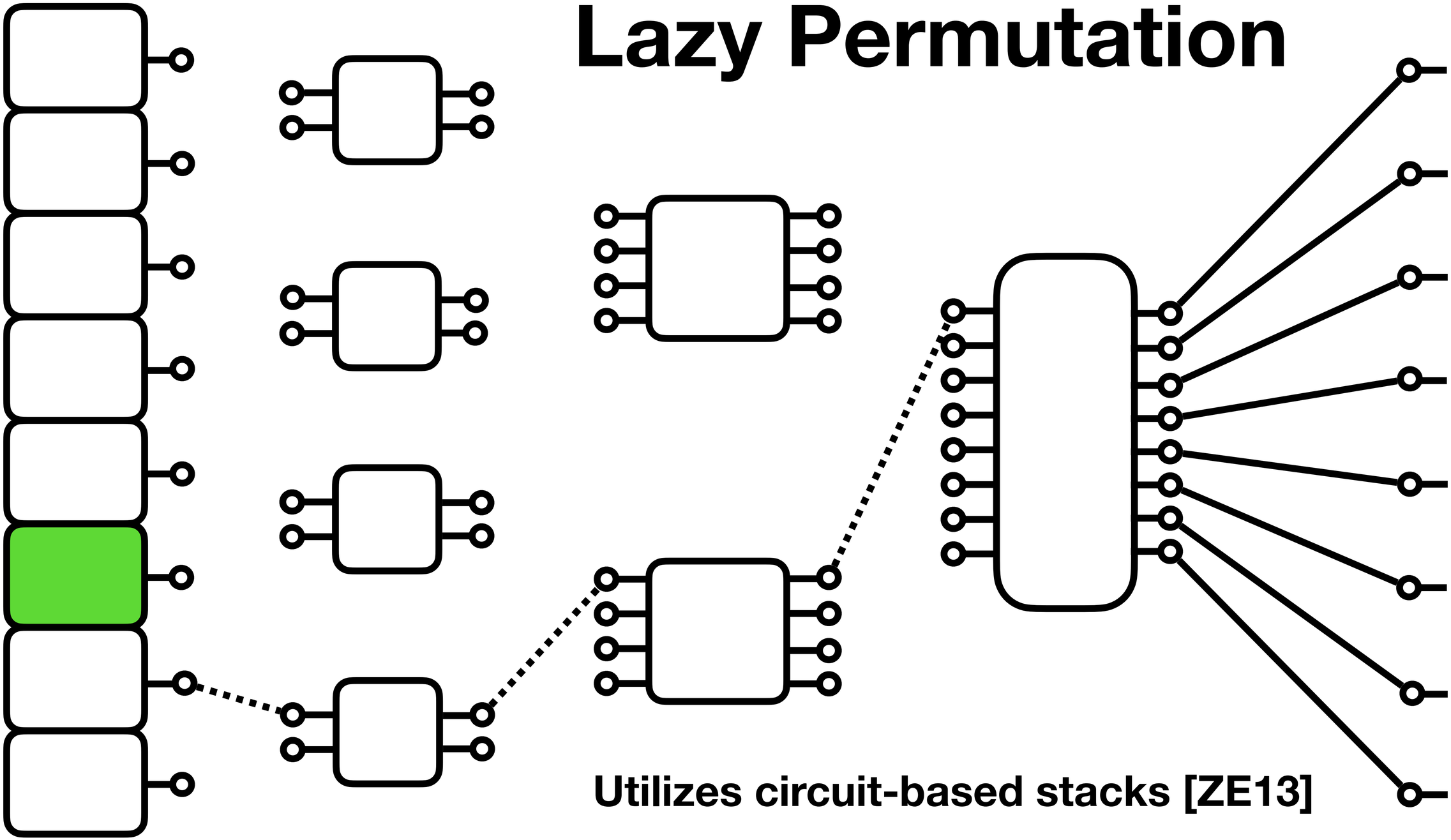

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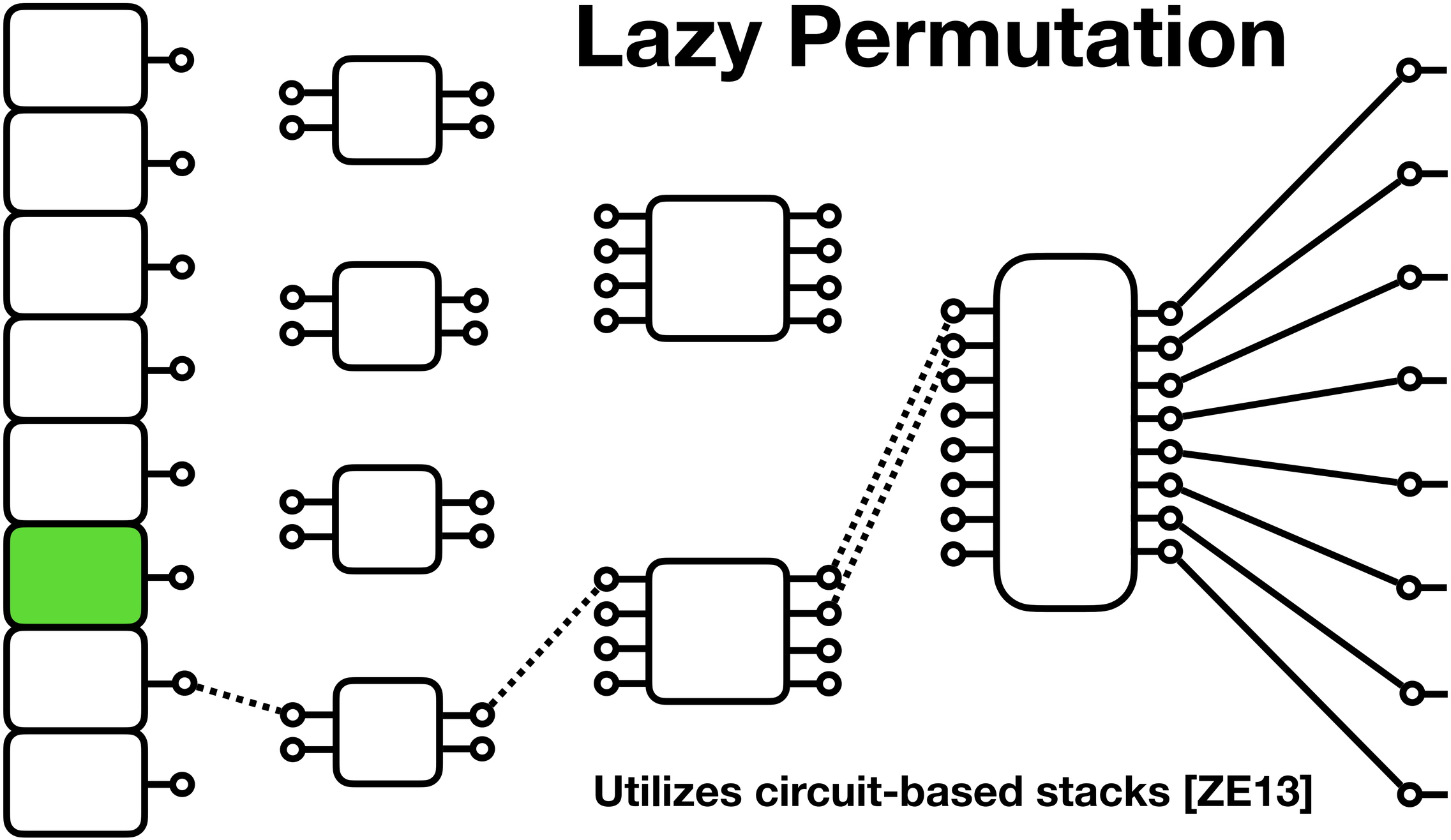

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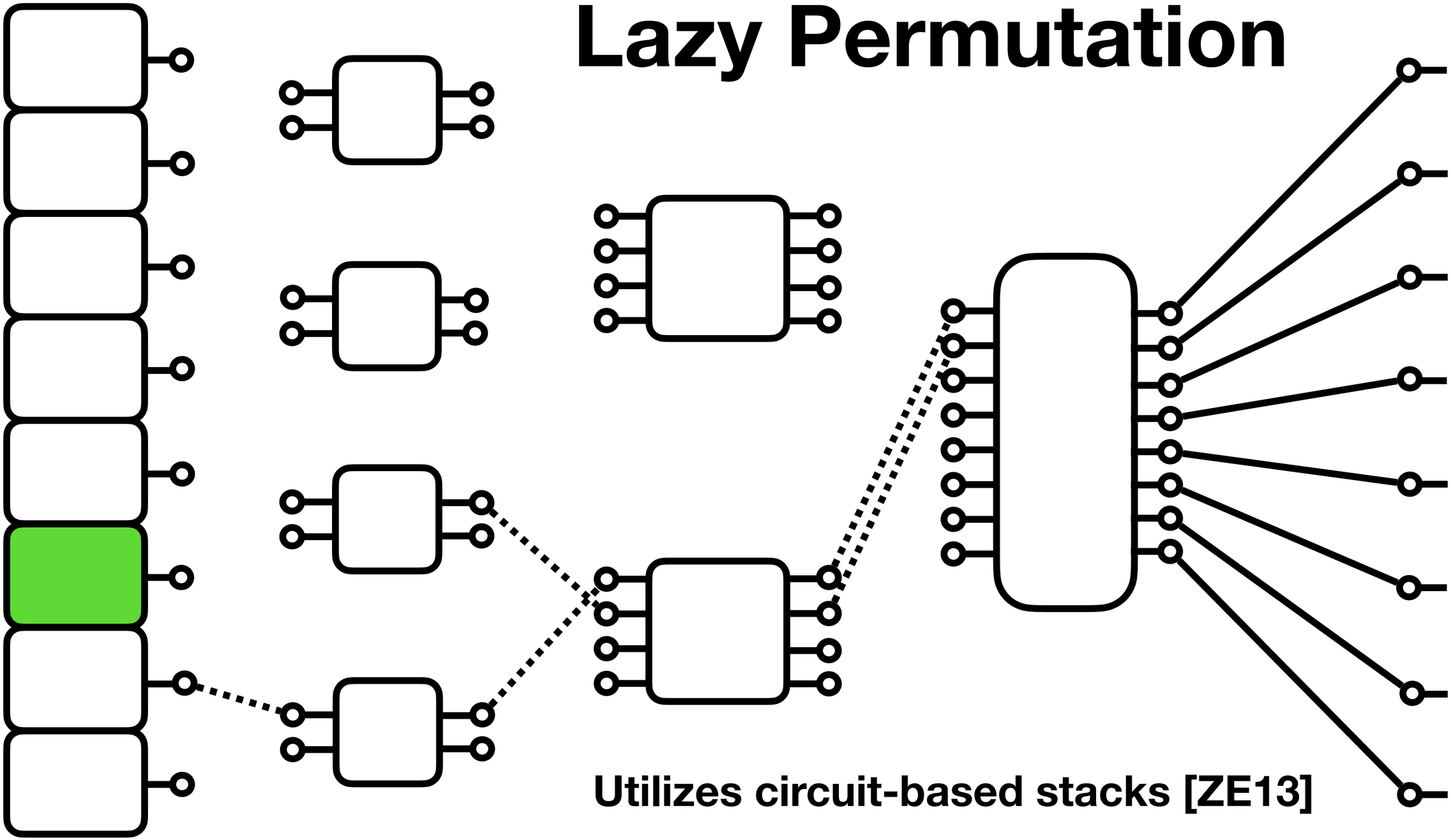

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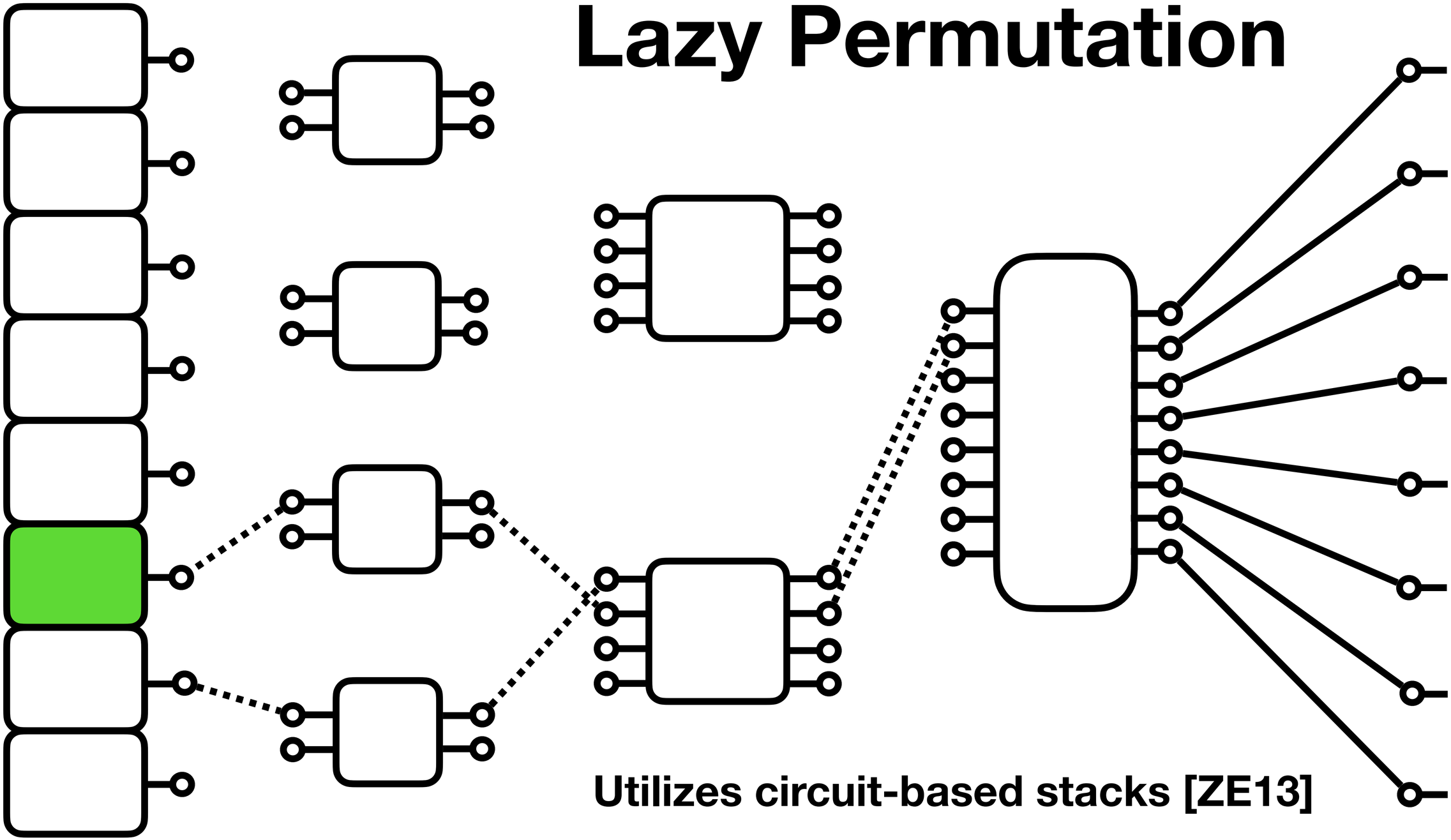

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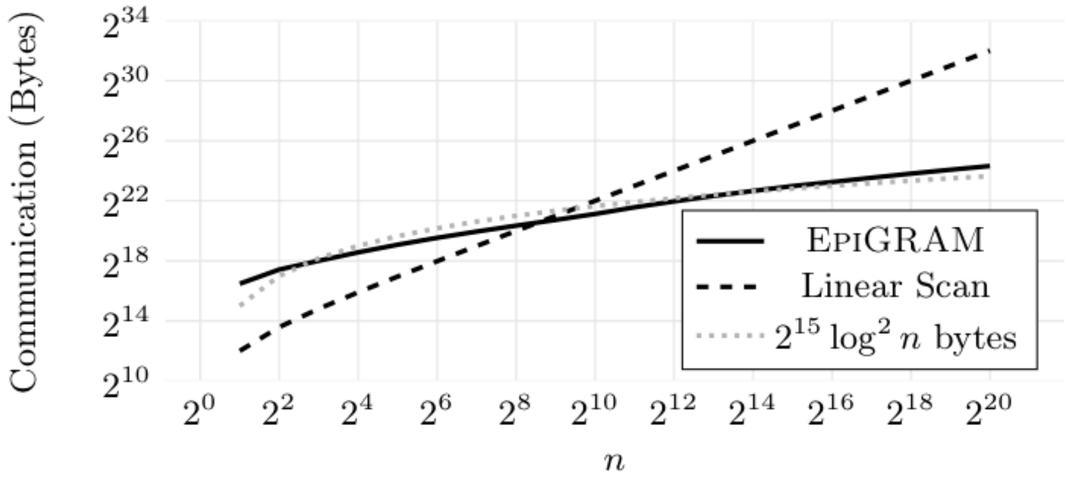
EpiGRAM



$$O(\kappa \cdot \log^2 n \cdot (w + \log^2 n))$$

Achieves $O(\log^2 n)$ overhead

Opens the door to handling high level programs inside GC