Designing Your Data:
The bread and butter of APL

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Functional Conf 2025, Inside the Matrix

Background

APL

APL

The language with all those funny symbols.

Background

APL

```
(2=+⌿0=X∘.|X)⌿X←1+⍳N                  ⍝ Prime Numbers up to N
⊃1 ⍵∨.∧3 4=+⌿,¯1 0 1∘.⌽¯1 0 1⊖¨⊂⍵ ⍝ Game of Life
0⌈(,[2+⍳3]{⍵}⌺3 3⊢⍵)+.×,[⍳3]⍺         ⍝ RelU, 3×3 Convolution
```

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with a **killer** syntax.

Beginners focus on the symbols (the “verbs”).

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They get stuck when the problem “doesn’t fit” arrays.

Experts focus on the data.

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Encode the data for simplicity and efficiency
using the Array Model.

How do they do it?

What are some tactics for data encoding in APL?

The Relational Model

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APL is an excellent extended relational algebra.

The Array Model

Foundations

$\mathbb{A}$: Array

Elements: $e_0\ e_1\ \ldots\ e_{n-1} \in \mathbb{A}$,A

Shape: $d_0\ \ldots\ d_{k-1} \in \mathbb{N}$ ρA

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⍴A	k	⟷	≢⍴A	Rank
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```
struct array {
      int rank;
      int shape[rank];
      struct array elements[n];
};
```

Slicing

Choice #1: Leverage inherent dimensionality

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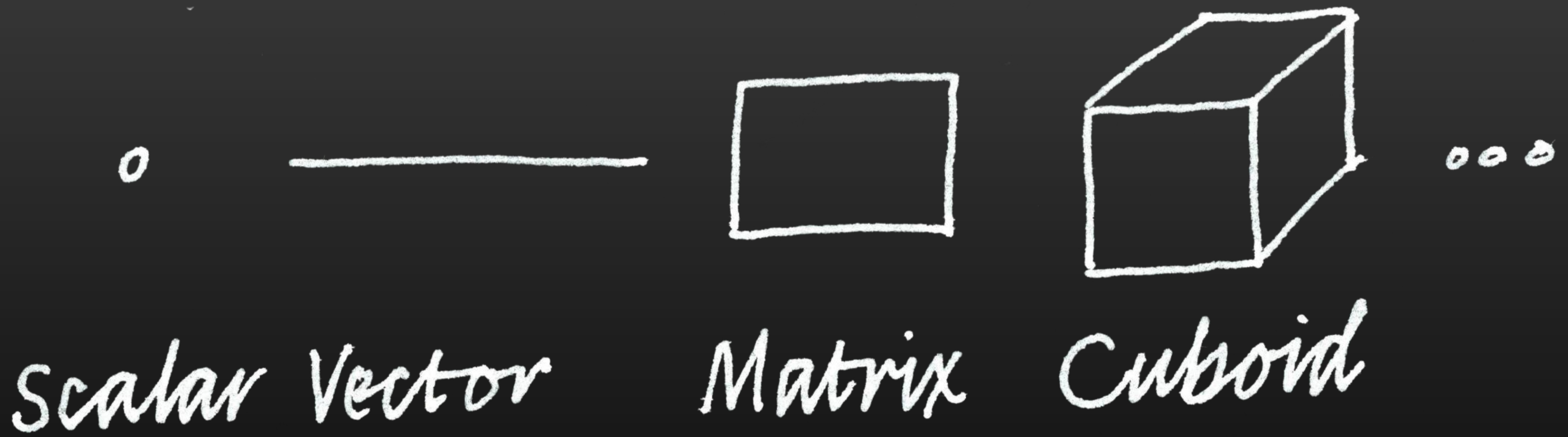

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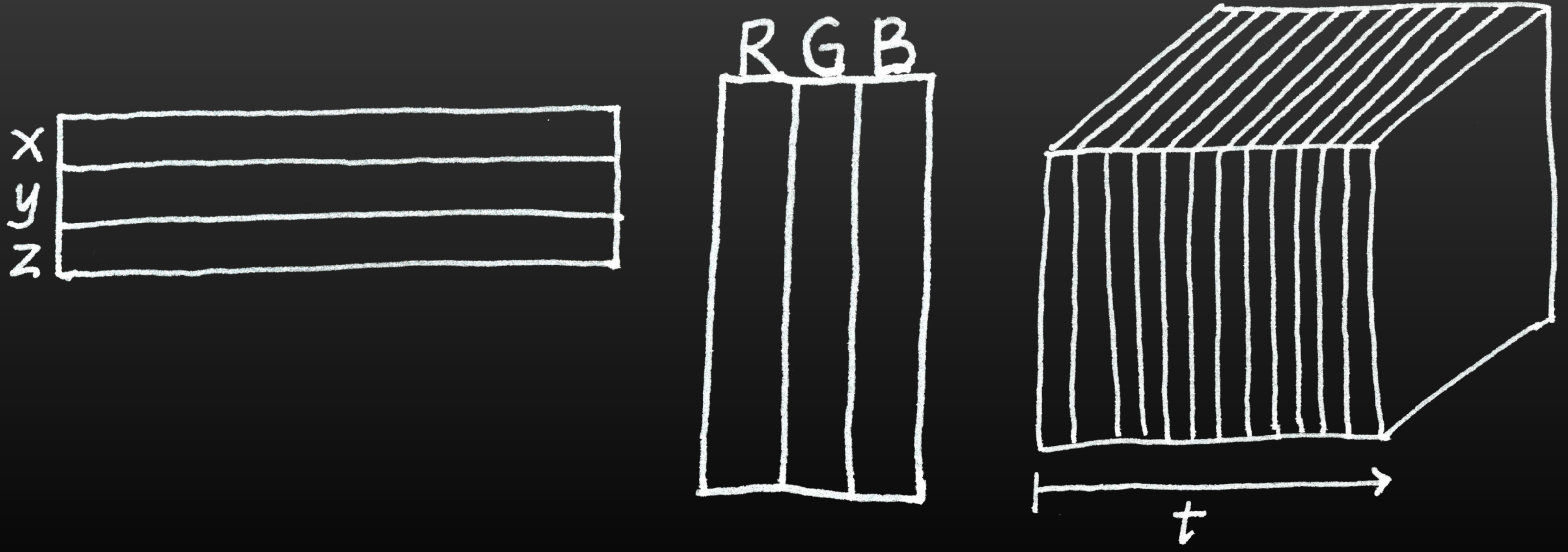

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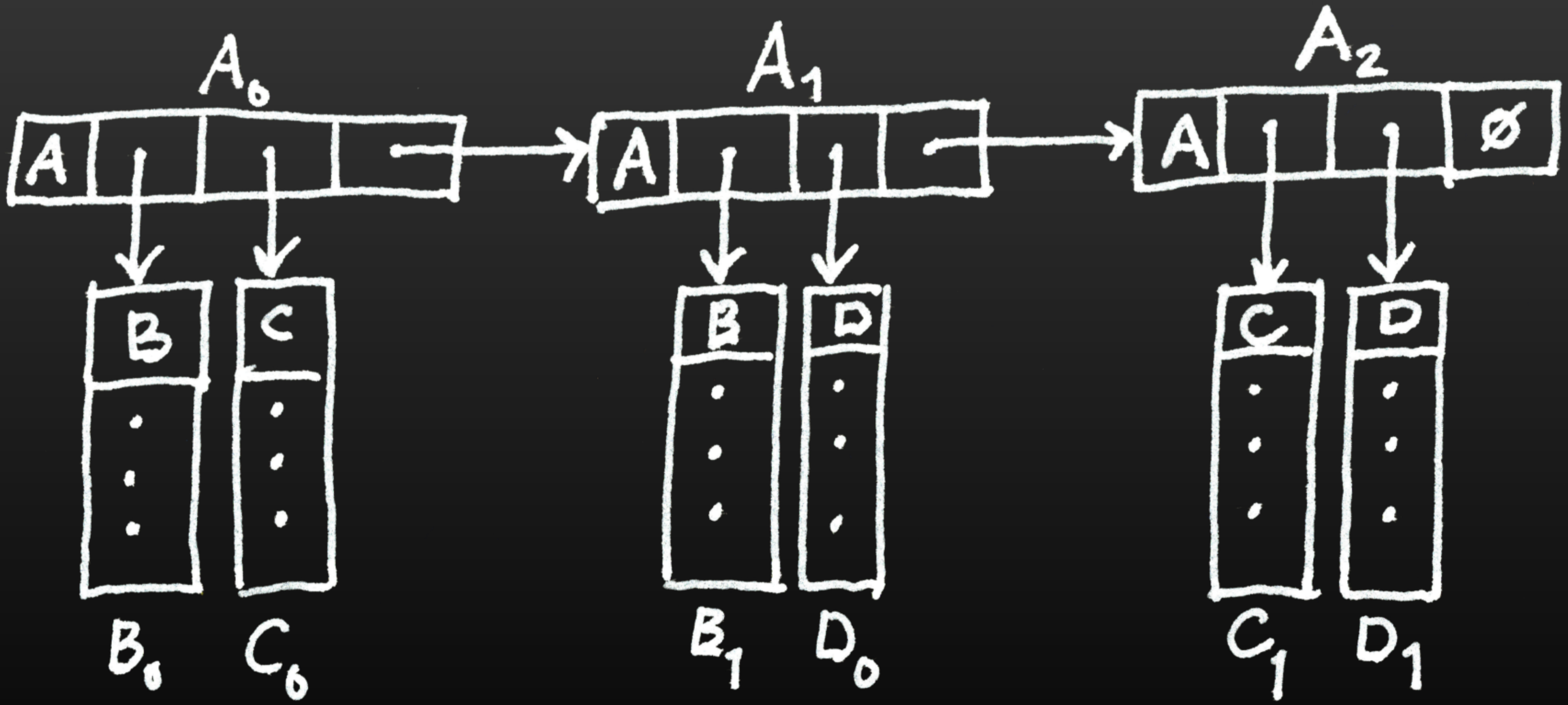

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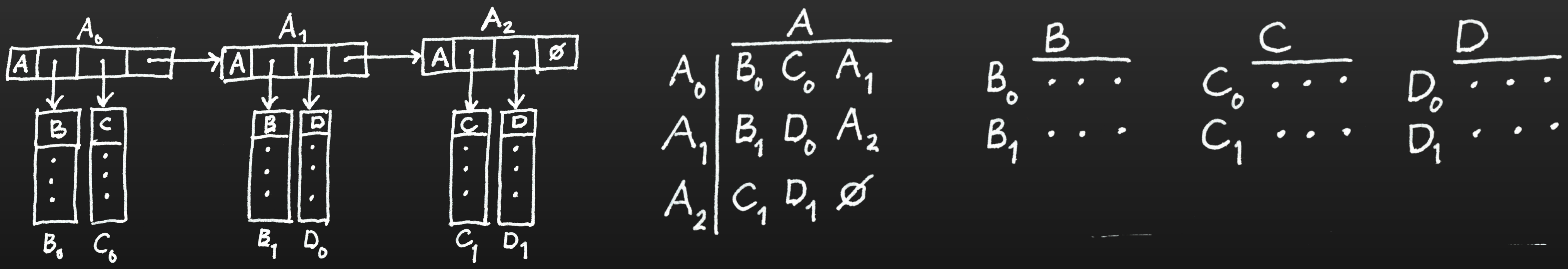

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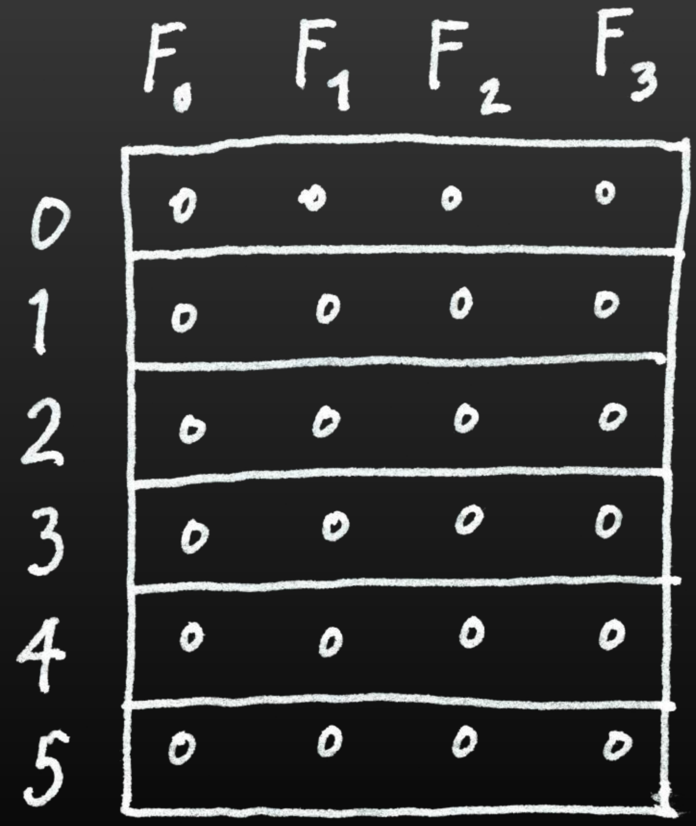

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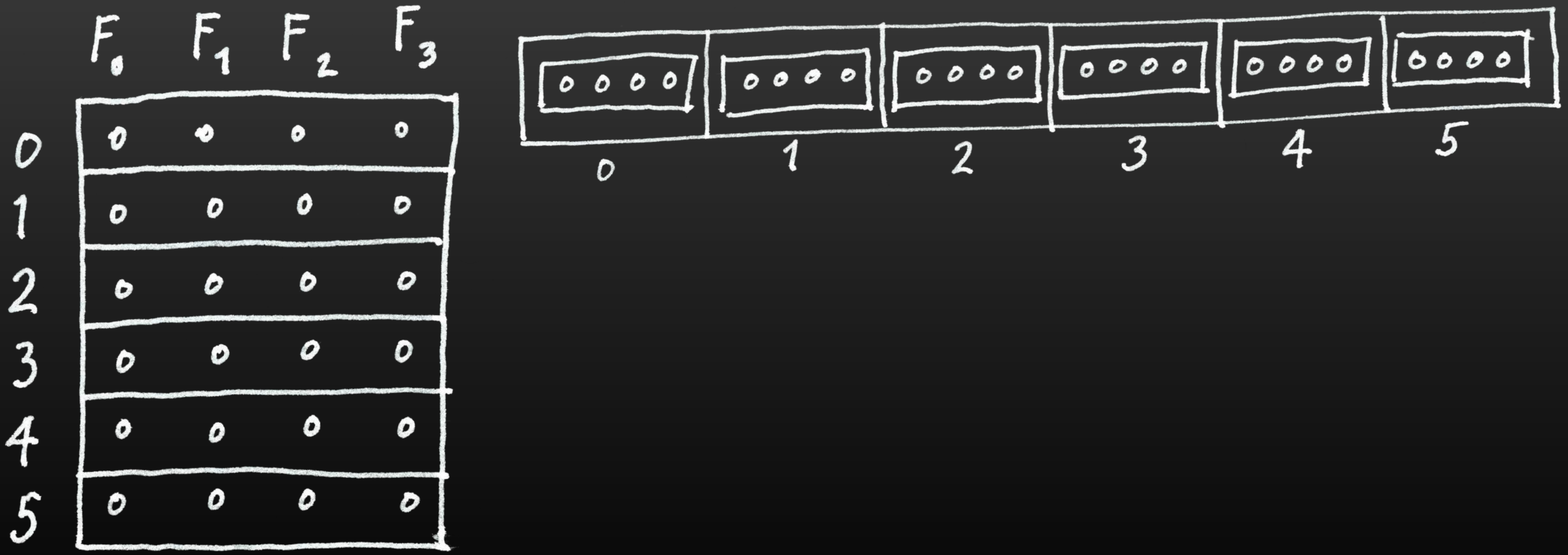

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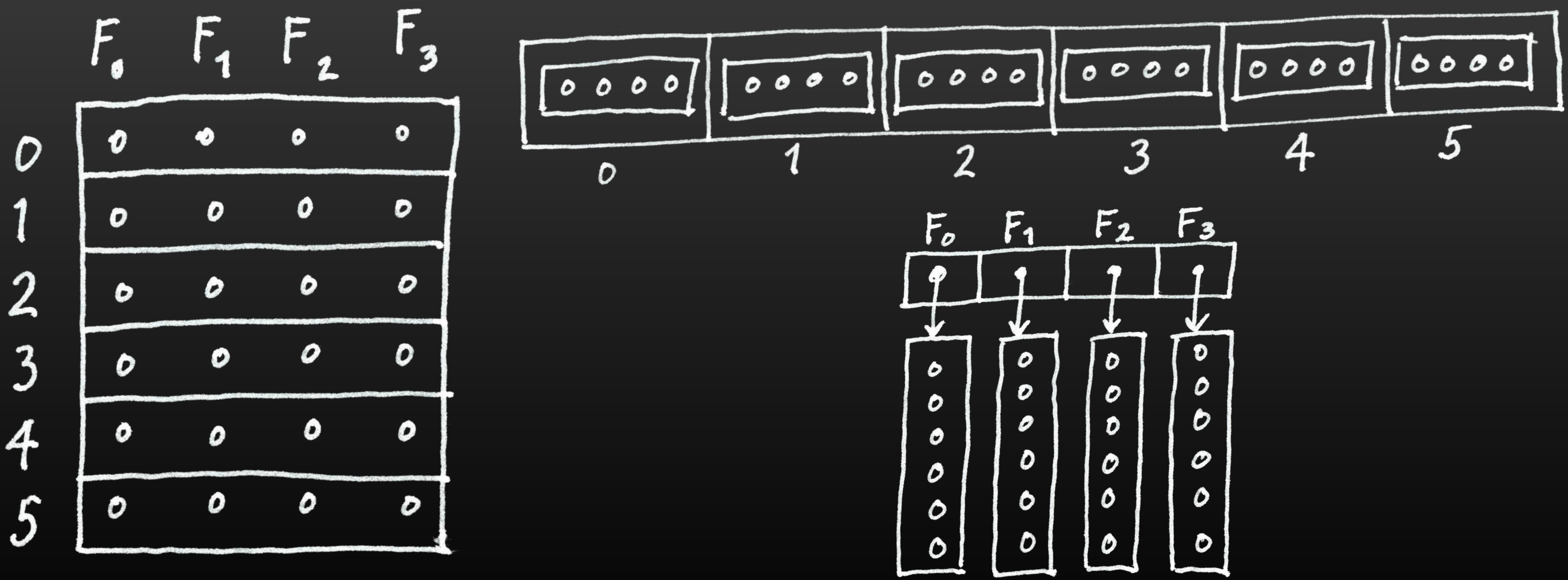

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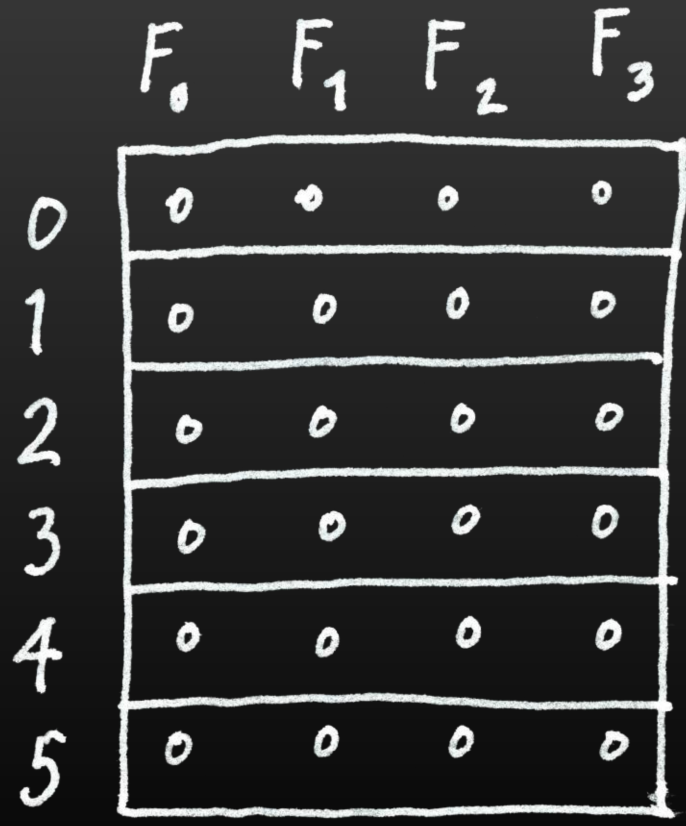

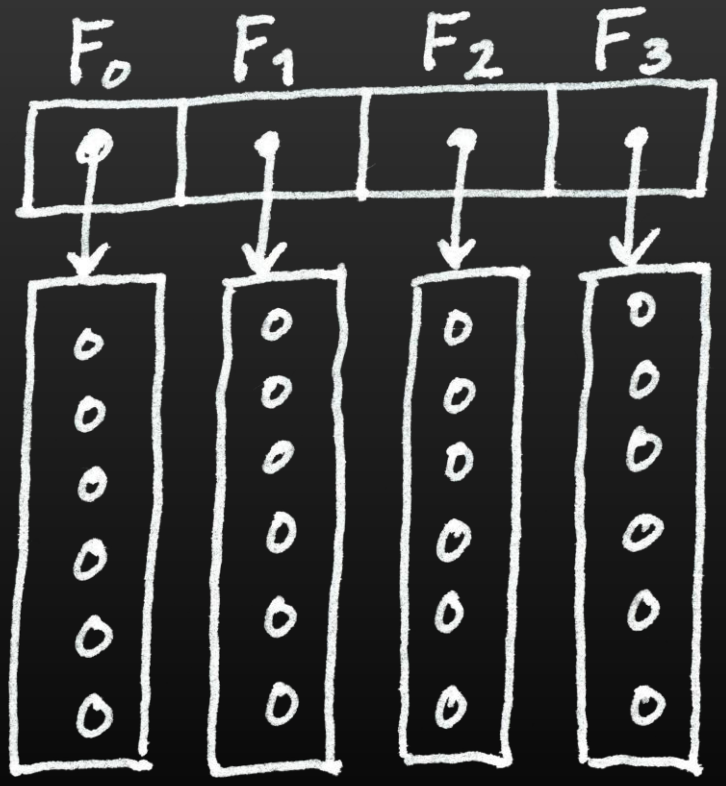

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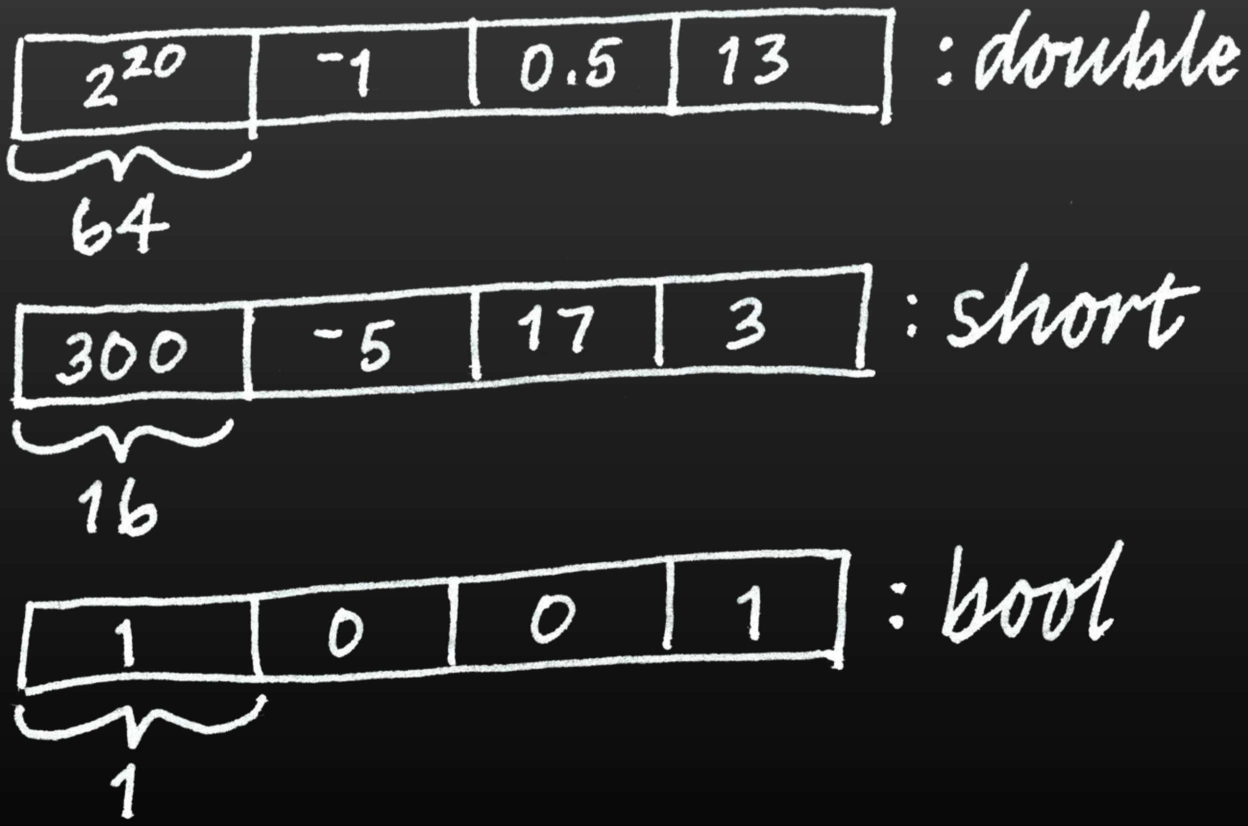

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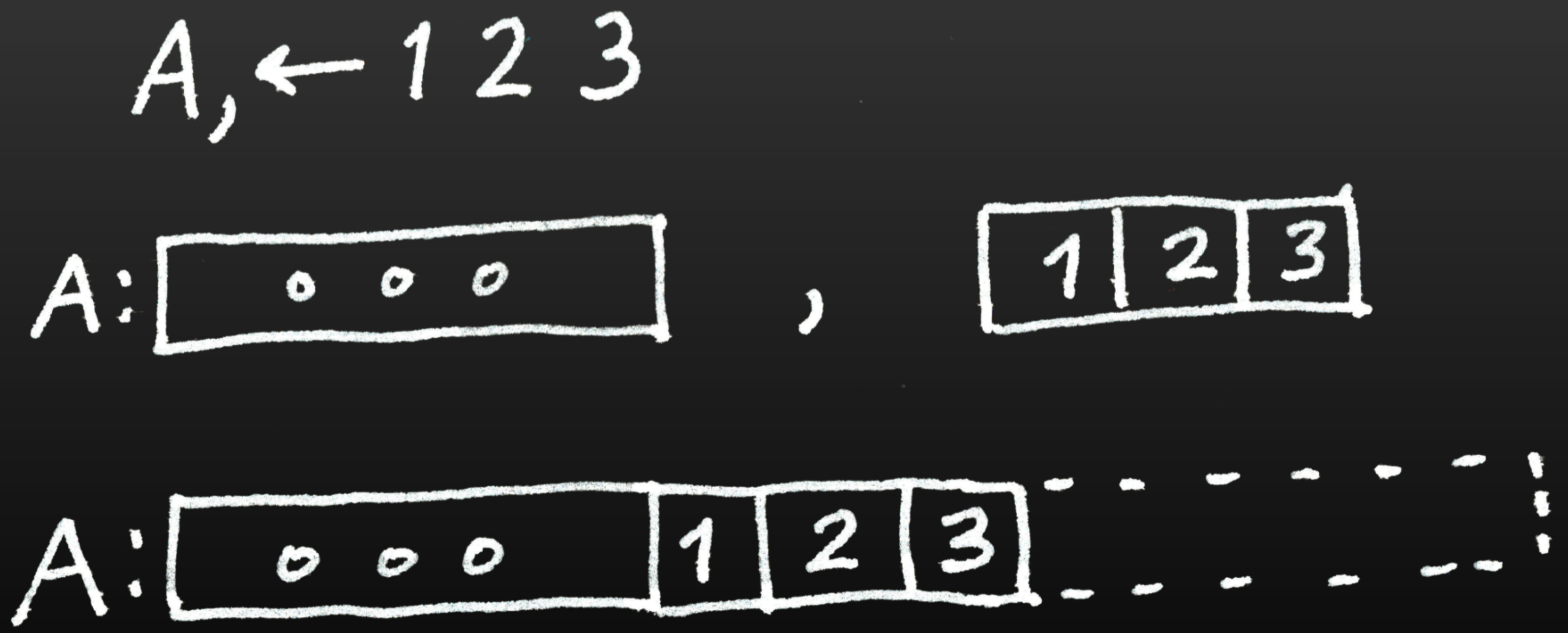

Implicit Structures

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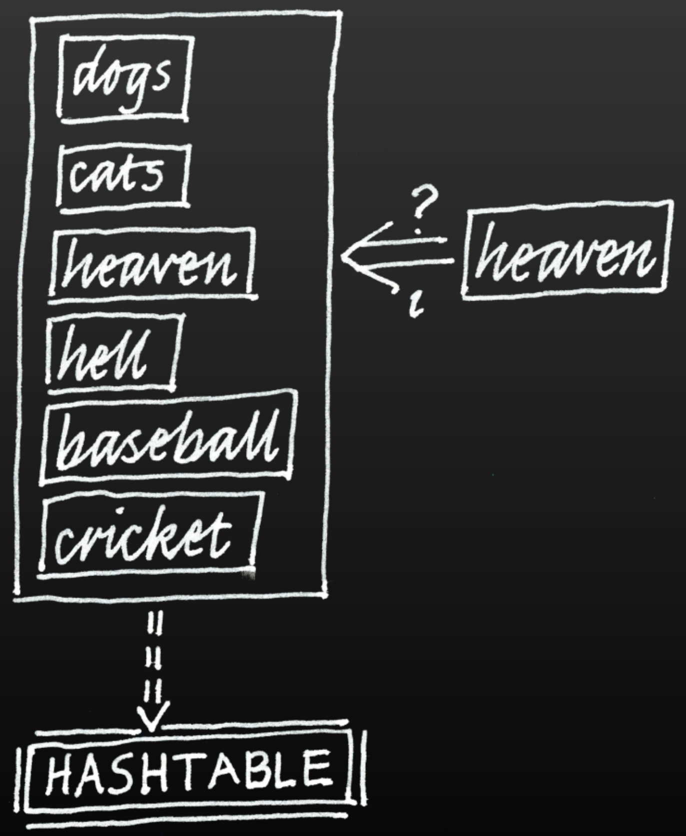

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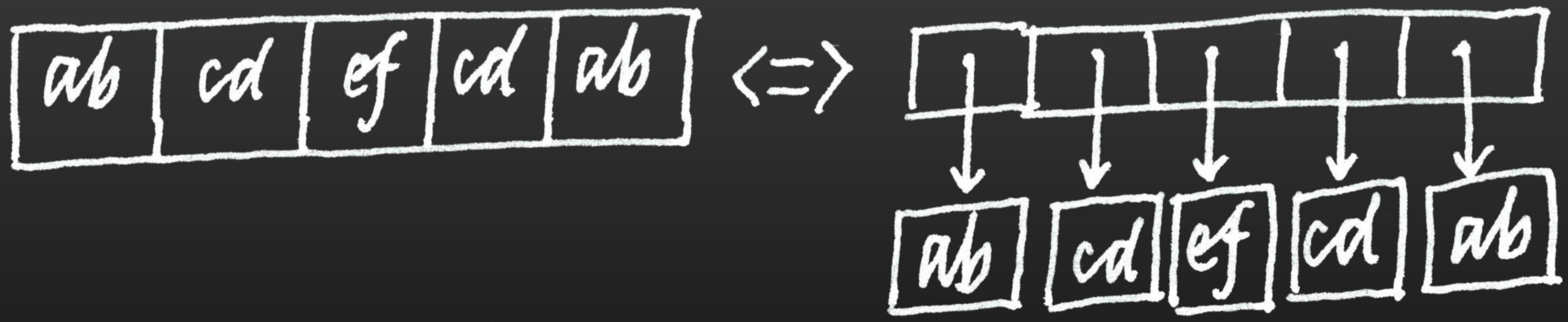

$$(5 \times 64) + (5 \times 2 \times 8) \longleftrightarrow 400$$

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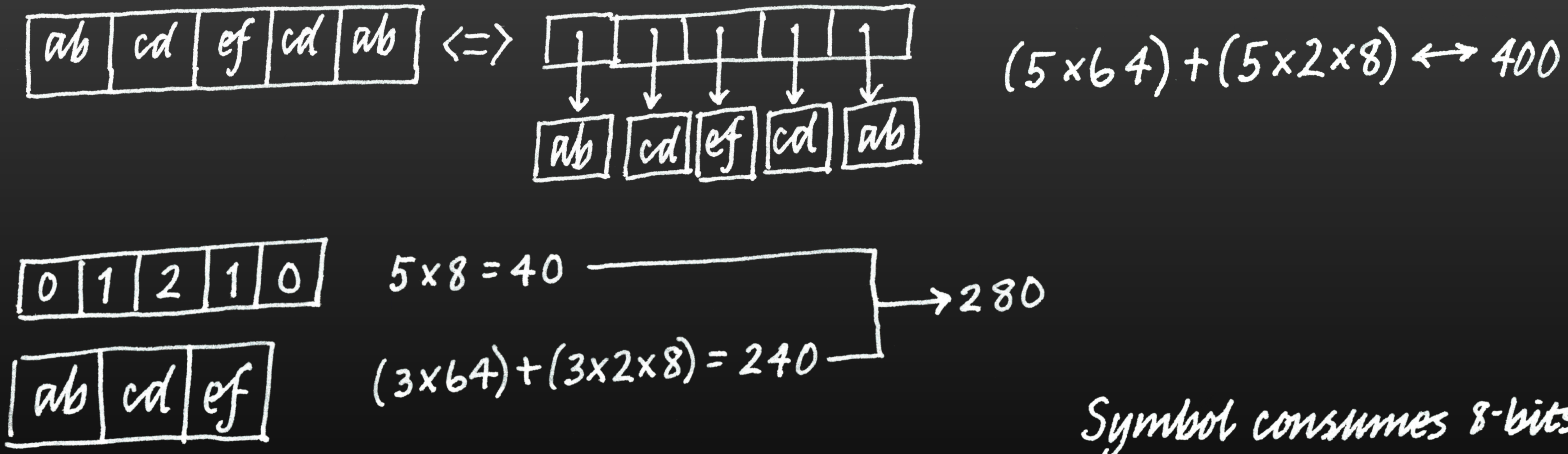

Symbol consumes 8-bits, not 64!

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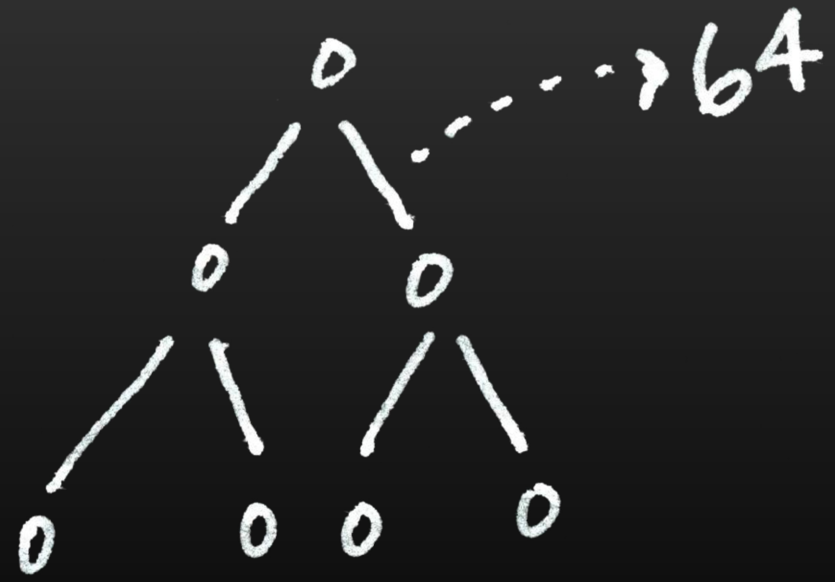

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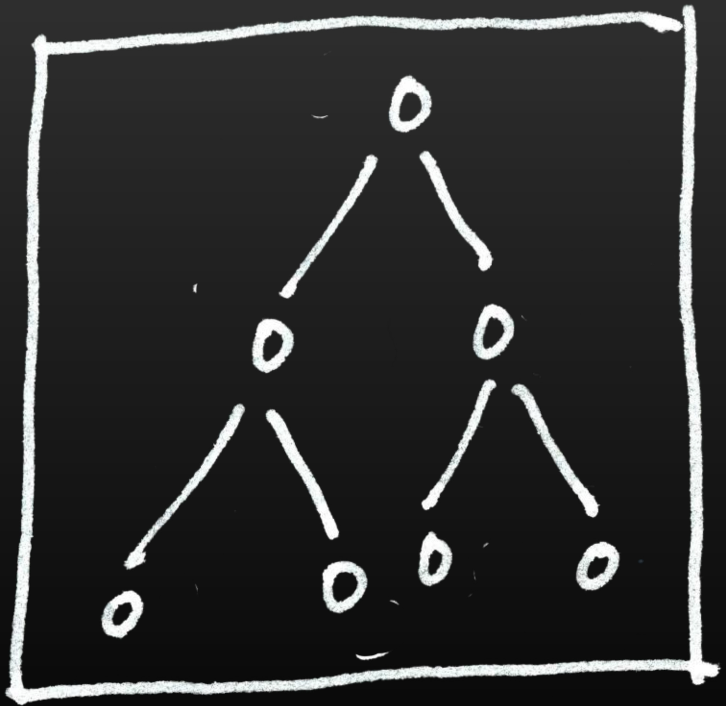

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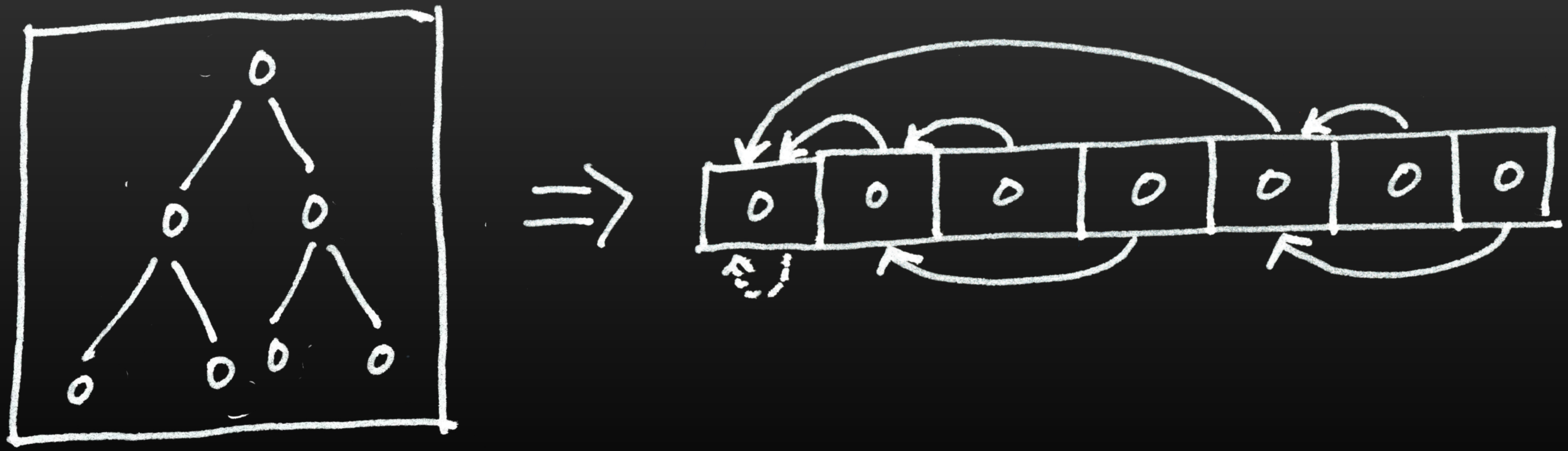

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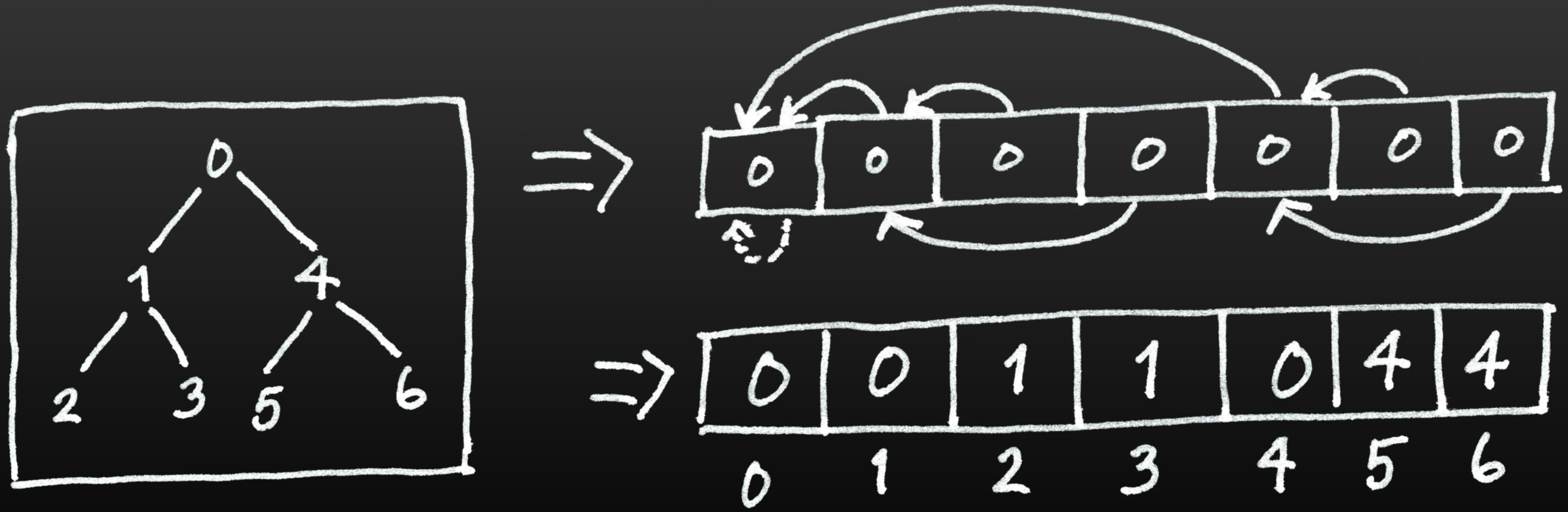

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Enums/Types

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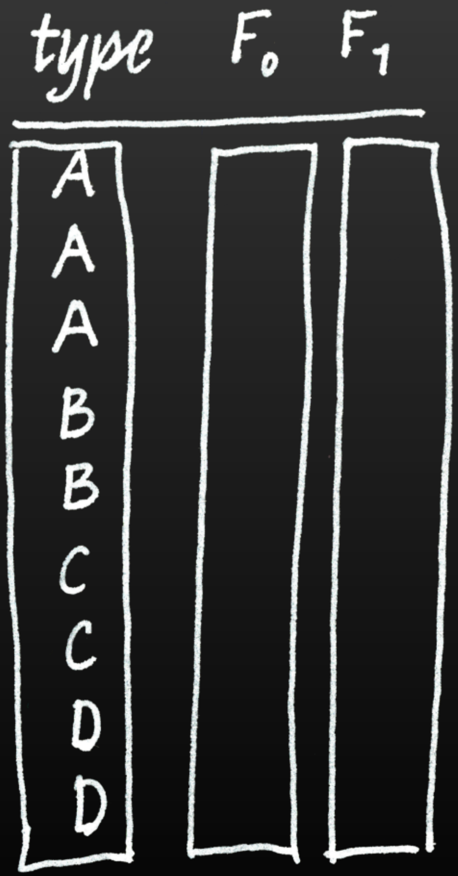

type=A

(type=A)∨(type=B)

type∊A B

{⍺(≢⍵)}⌸type

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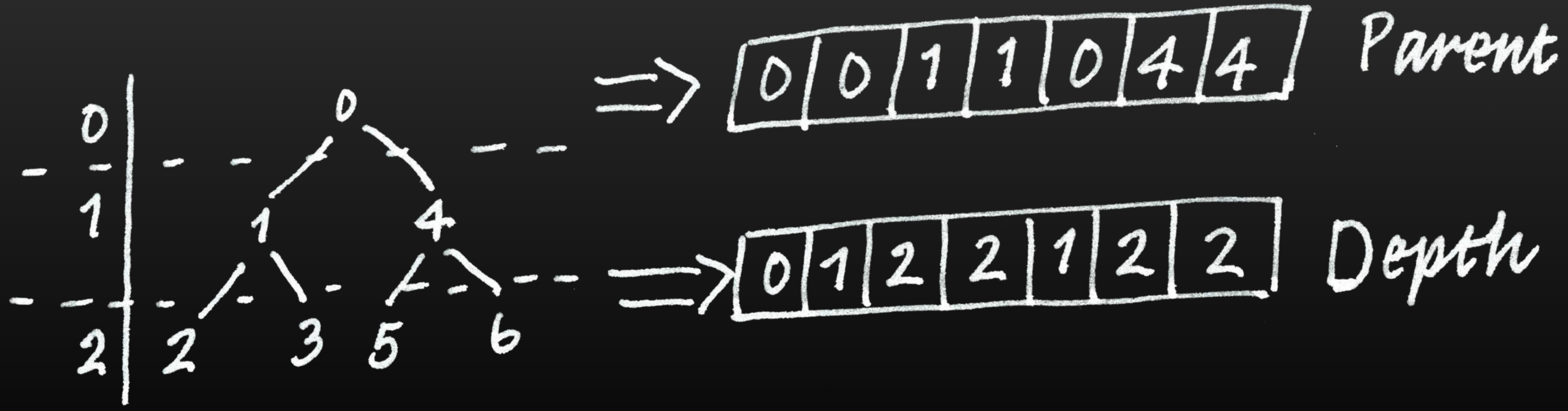

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The Quick Brown Fox

1000100000100000100

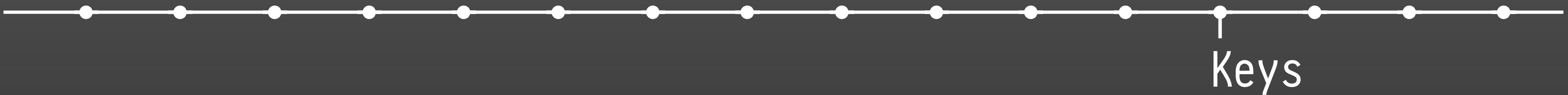
1110111110111110111

Boolean Masks

Take advantage of Bitvector masks.

```
(A×M)+(B×~M) ⍝ Select A if M, B otherwise
M⍀f(M⌿A)     ⍝ Masked A modified by f
```

Combine Enums, Views, and Masks
by using “Keys” either explicitly or implicitly.



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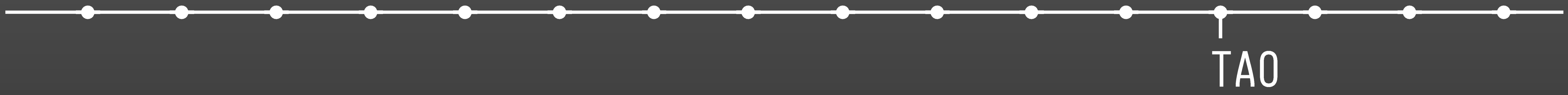
The Quick Brown Fox
1000100000100000100
1110111110111110111
1111222222333333444

xoFnworBkciuQehT
4443333322222111

ehTkciuQnworBxoF
1112222233333444

ehT kciuQ nworB xoF
1110111110111110111

Embrace the Total Array Ordering:
Leverage permutations and total array ordering
for knowledge embedding.



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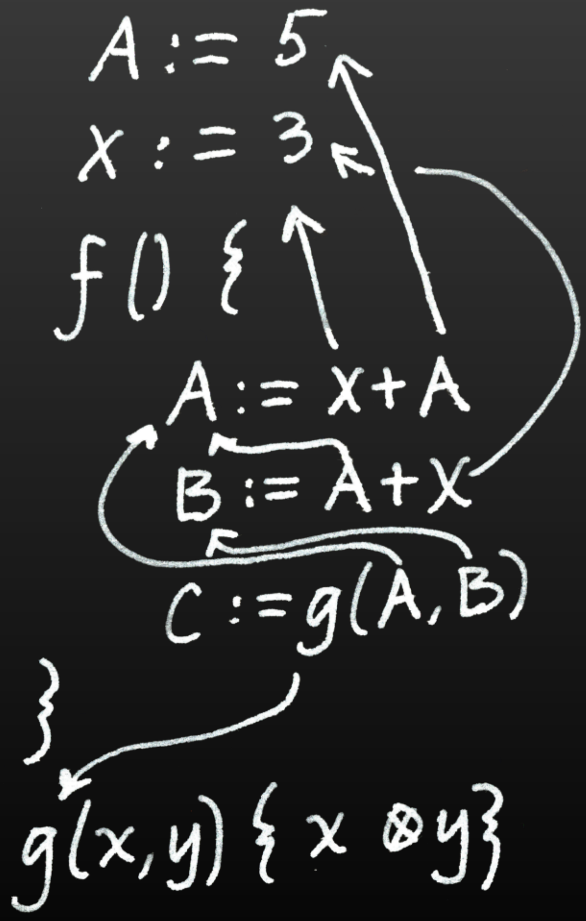

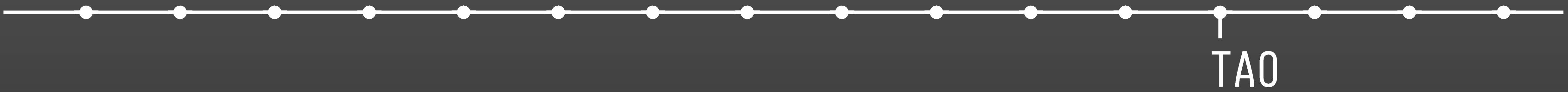

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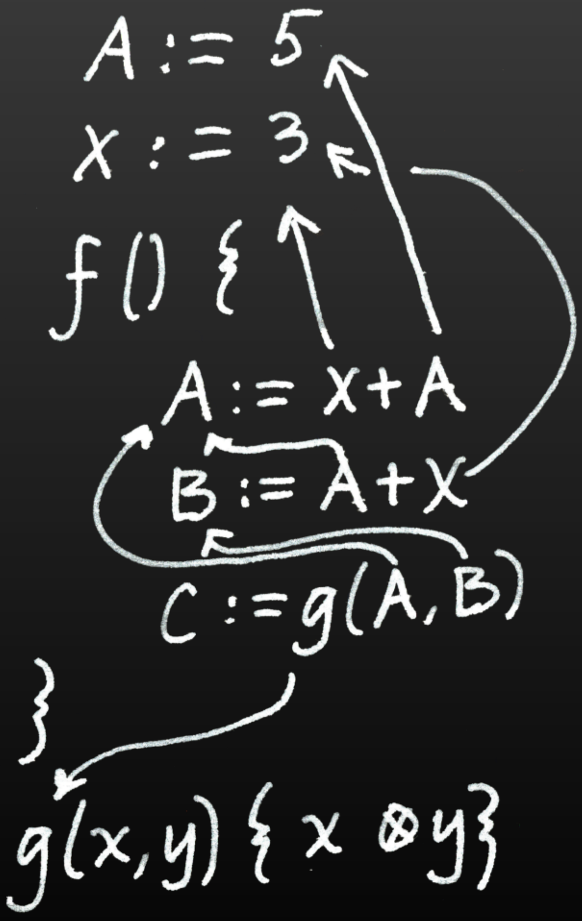

A	X	f	g	A	X	A	X	A	B	B	A	g	C
1	1	1	1	0	0	1	0	0	1	0	0	0	1
0	3	6	17	9	8	7	12	11	10	16	15	14	13

Related Work

Moseley, Ben, and Peter Marks. "Out of the tar pit." Software Practice Advancement (SPA) 2006 (2006). https://blog.royalsloth.eu/archive/outOfTheTarPit.pdf

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Thank you. Questions?

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