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
```

Background

APL is:

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A rich, economical vocabulary over arrays...

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with a **killer** syntax.

Challenge

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

Challenge

Experts focus on the data.

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

Challenge

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

A: Array

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

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

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```
struct array {
      int rank;
      int shape[rank];
      struct array elements[n];
};
```

Choice #1: Leverage inherent dimensionality

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Slicing

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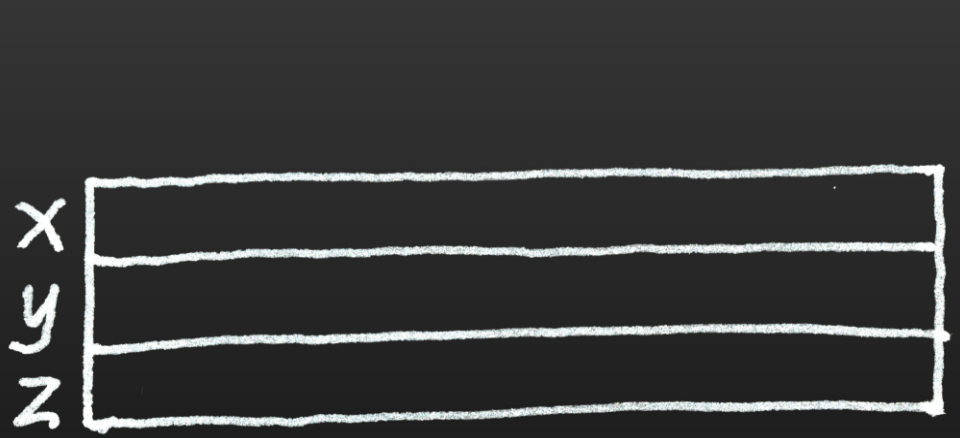

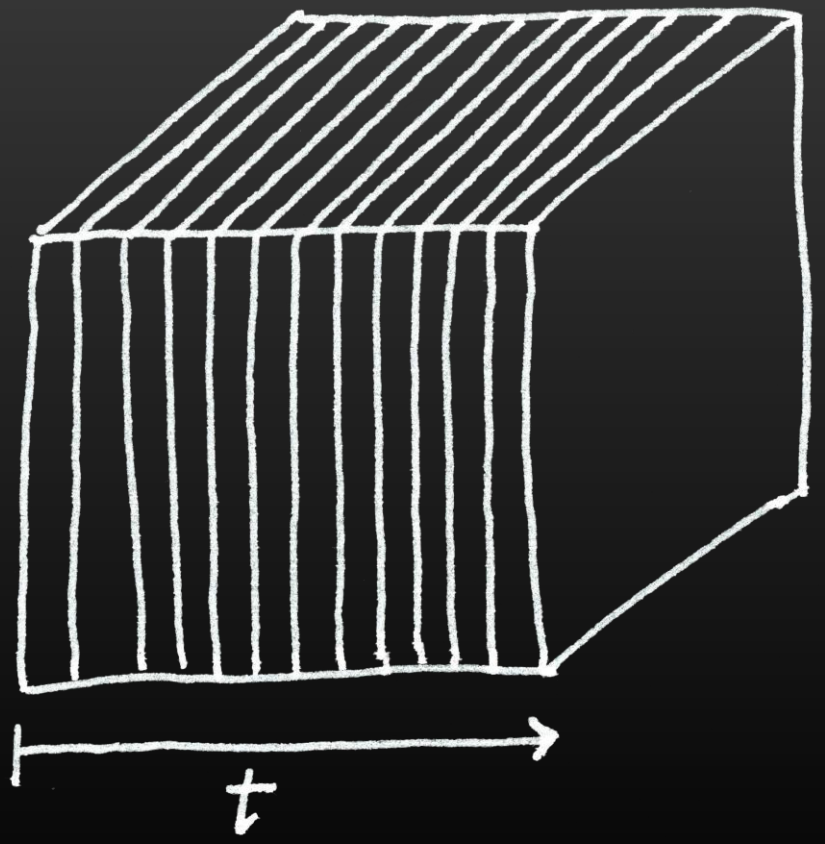

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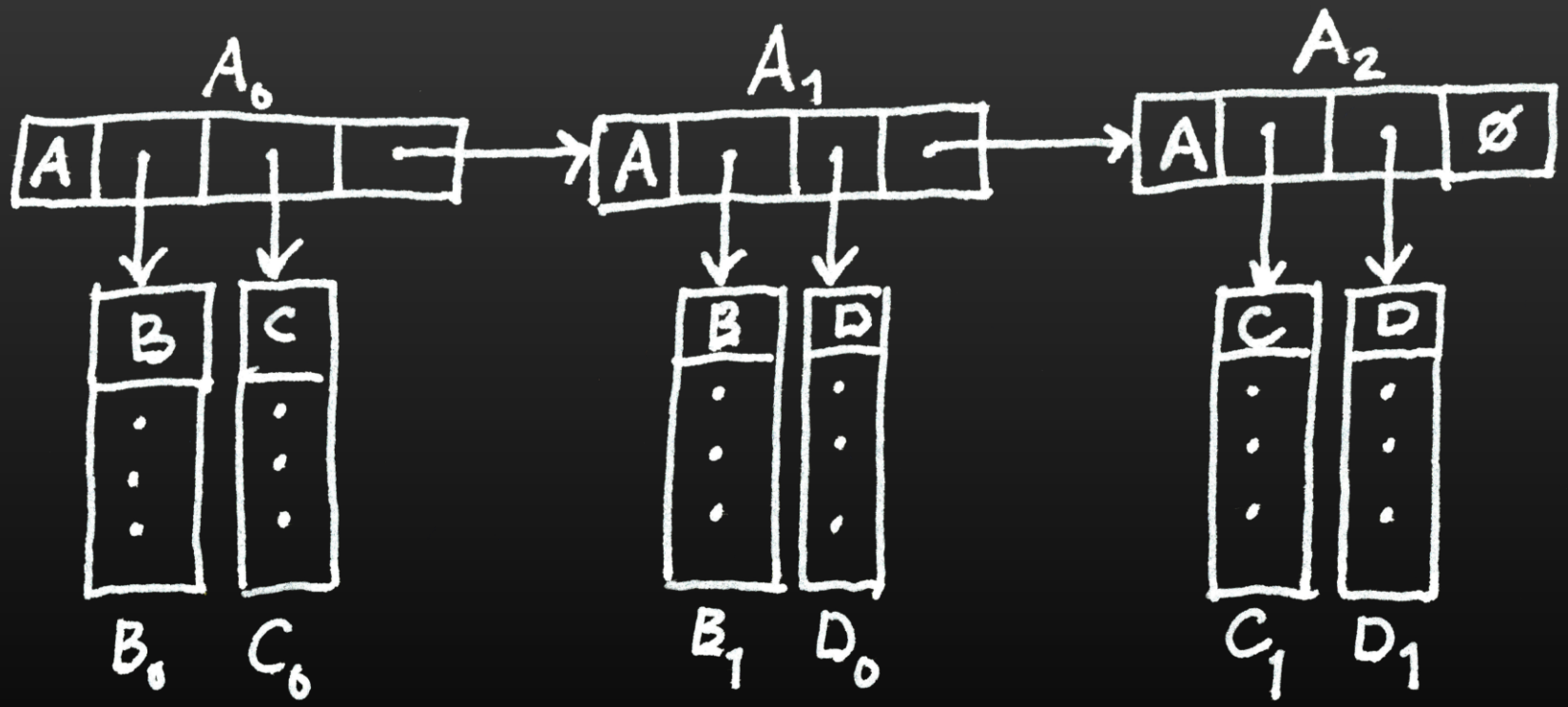

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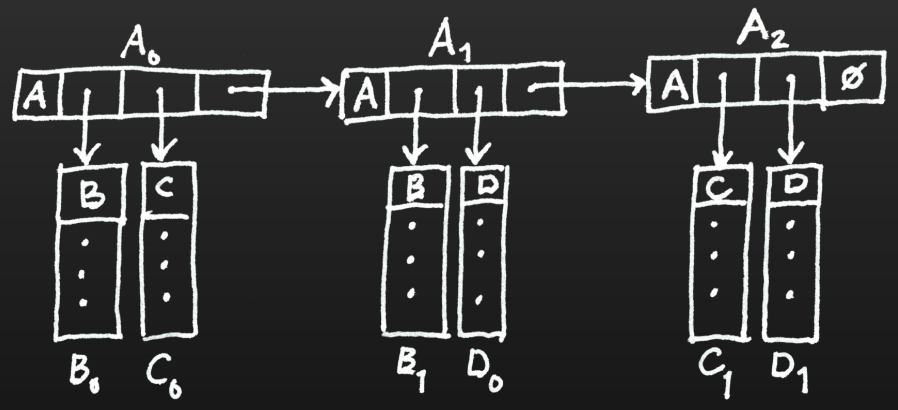

	A		
A_0	B_0	C_0	A_1
A_1	B_1	D_0	A_2
A_2	C_1	D_1	ø

B	
B_0	. . .
B_1	. . .

C	
C_0	. . .
C_1	. . .

D	
D_0	. . .
D_1	. . .

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Use inverted tables to represent relations, complex objects.

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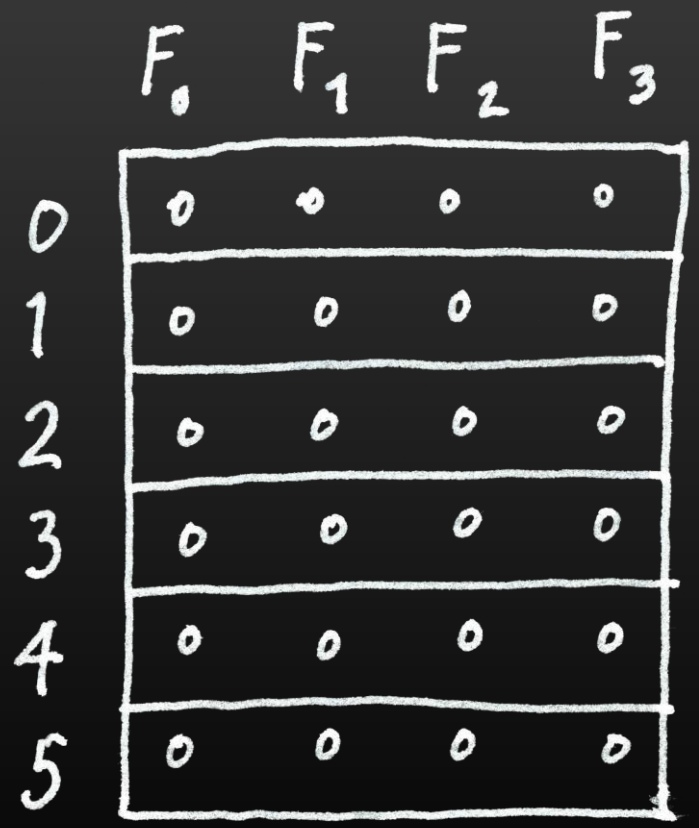

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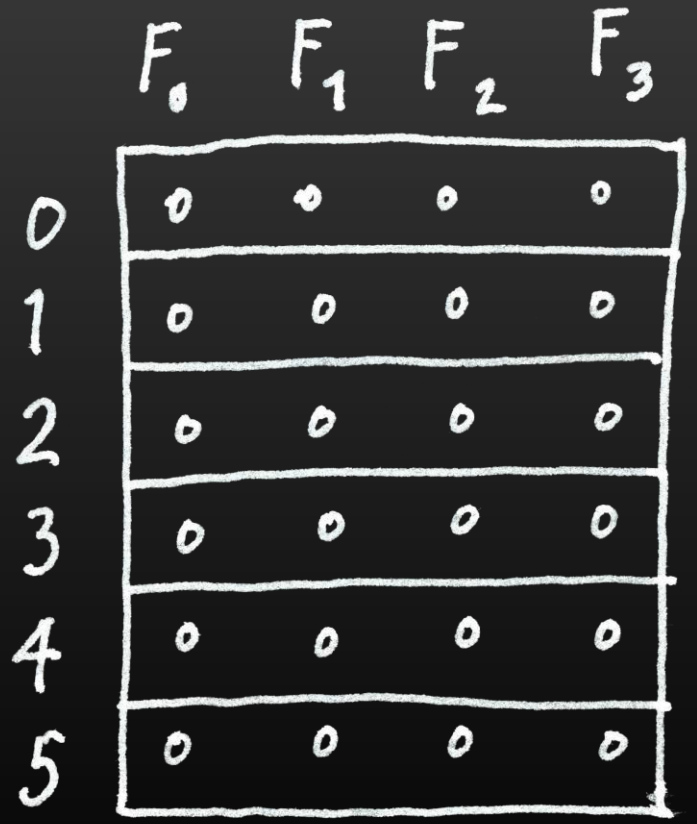

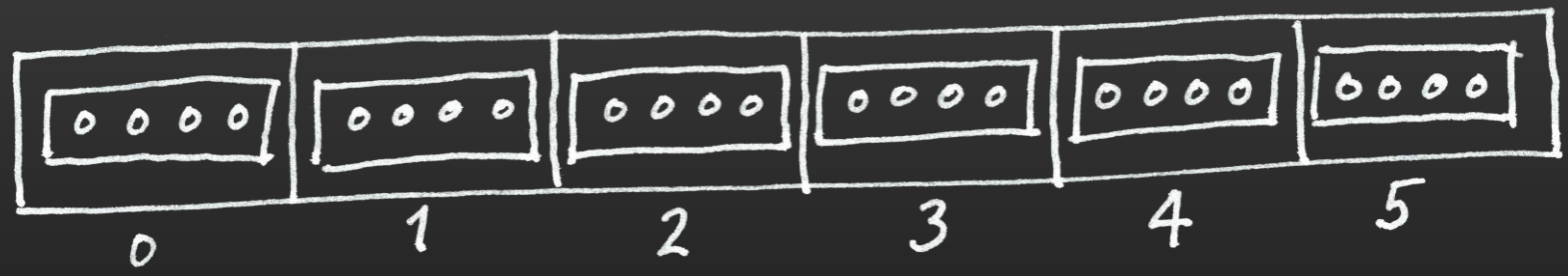

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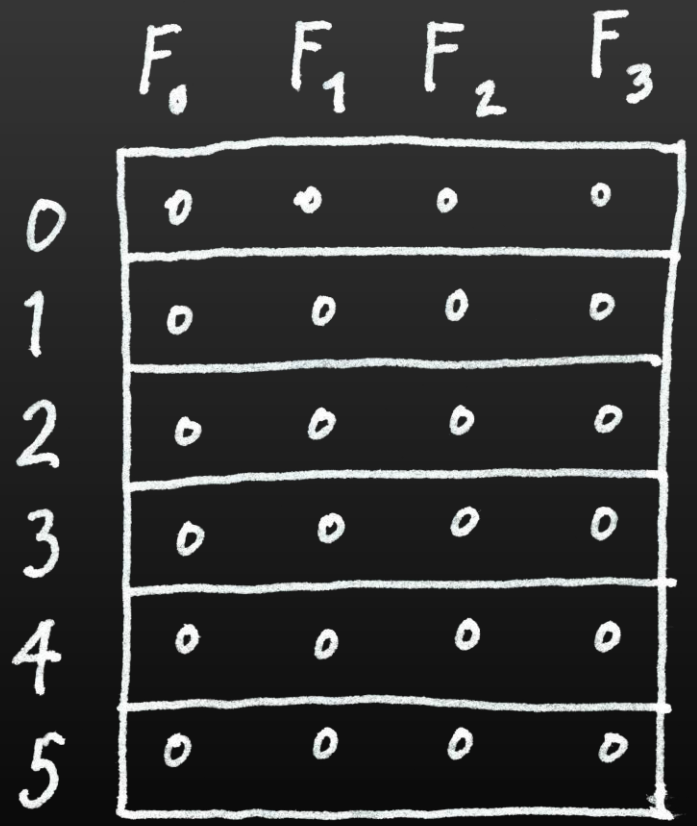

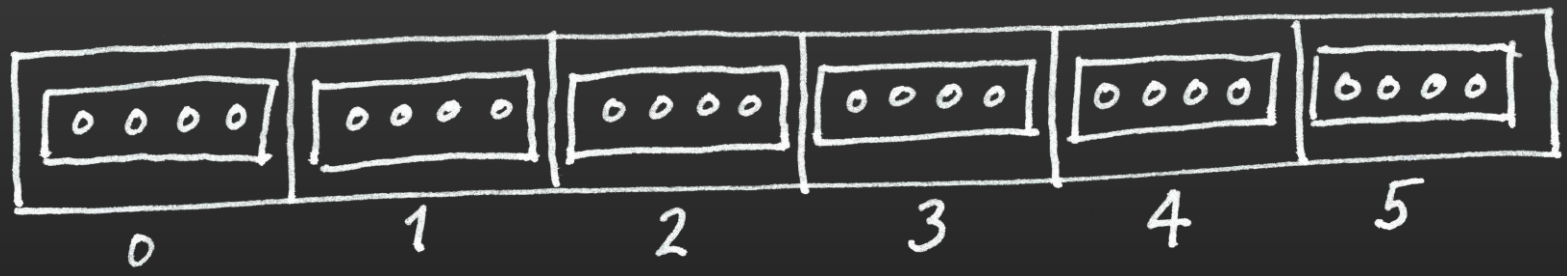

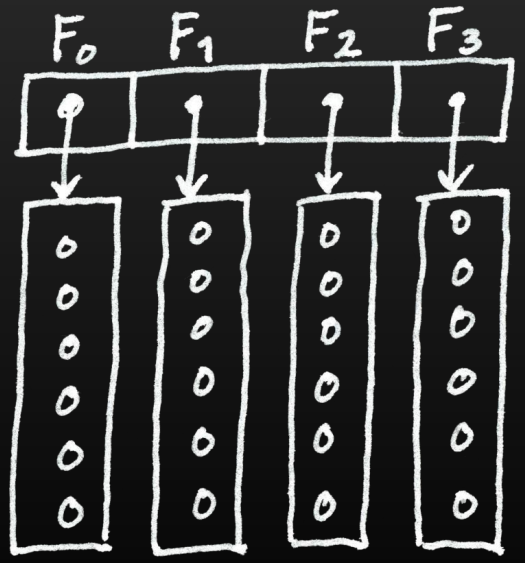

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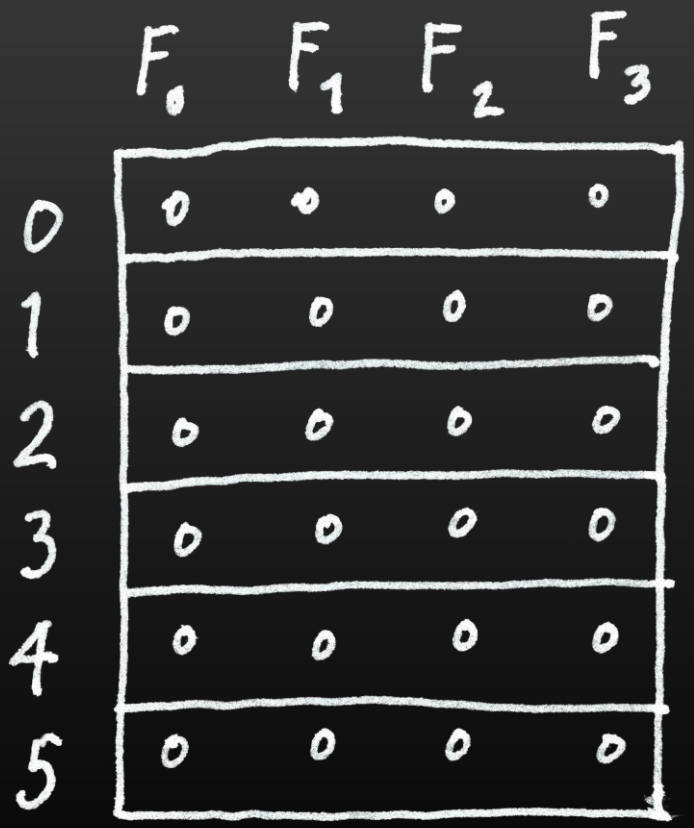

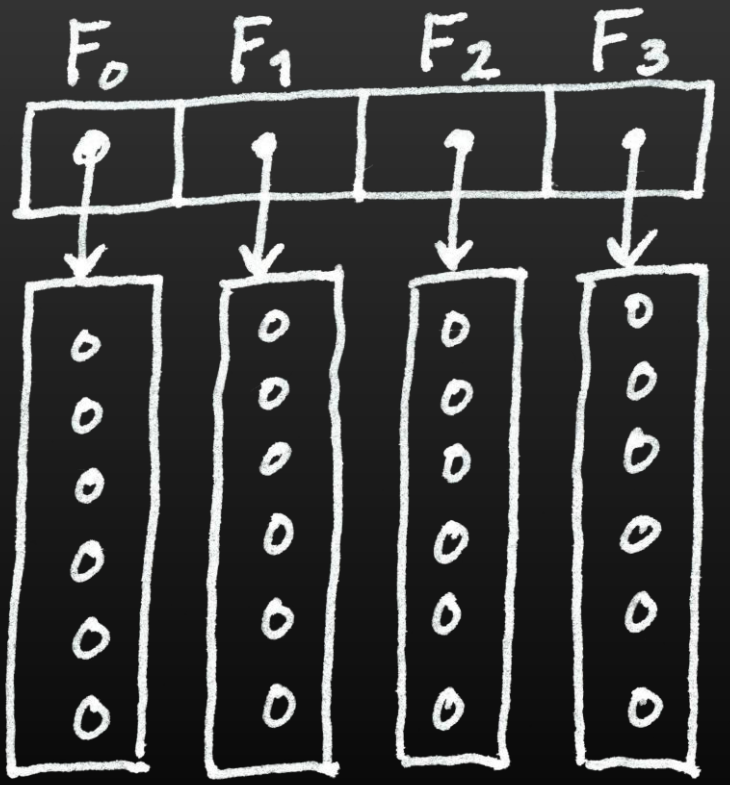

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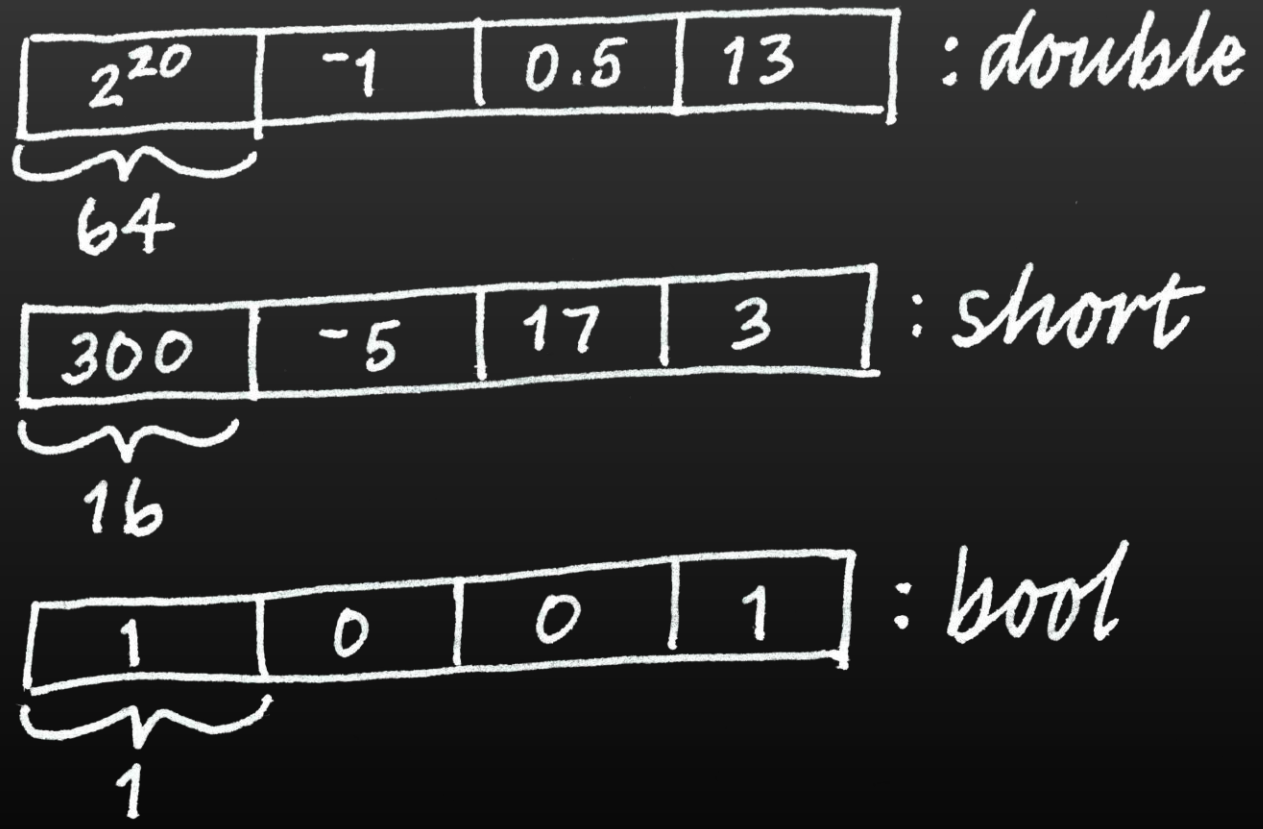

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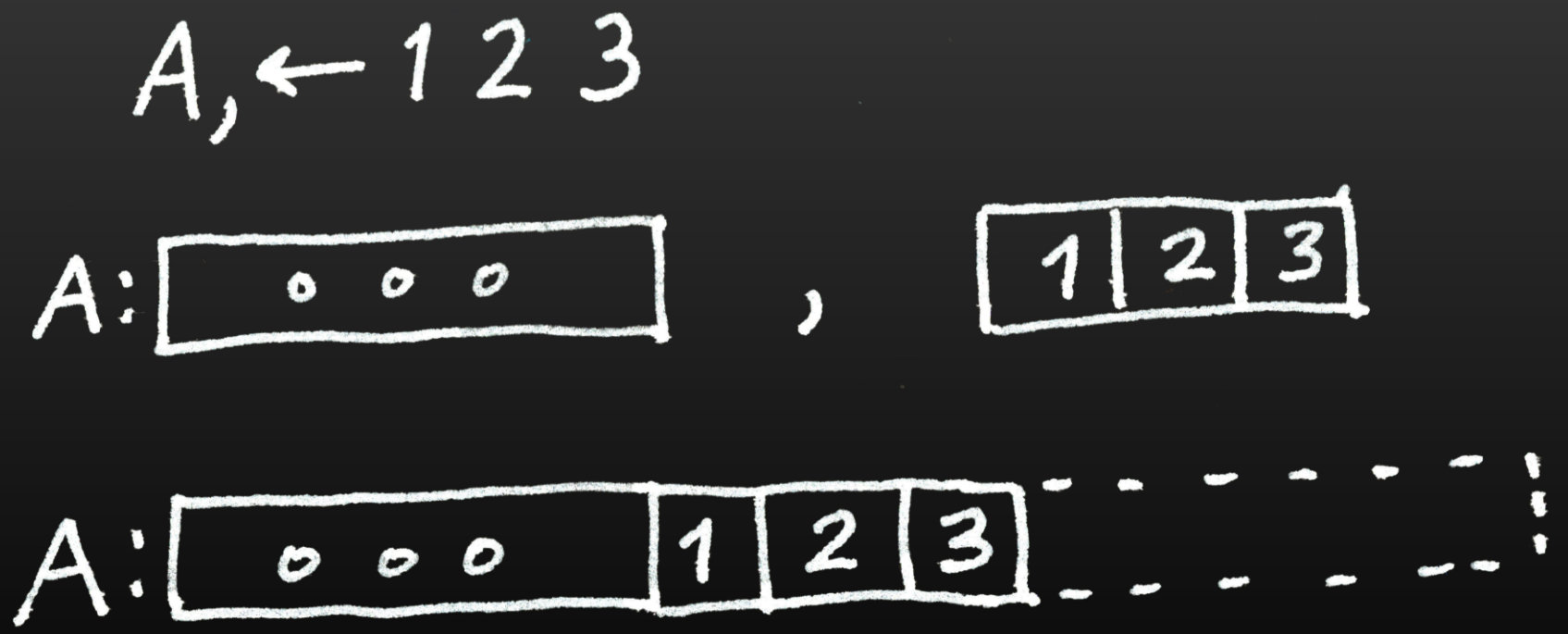

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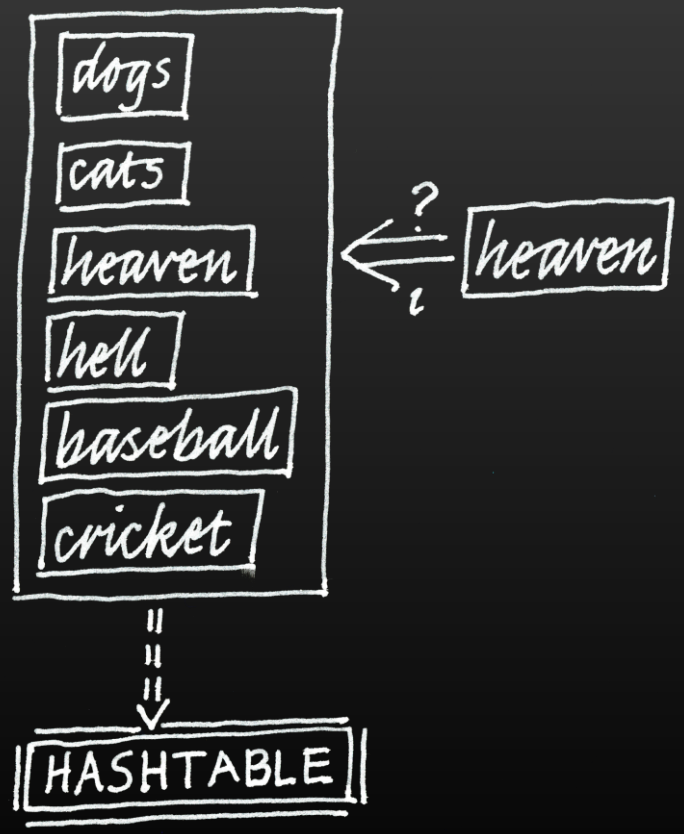

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Explicitly intern data using symbol tables.

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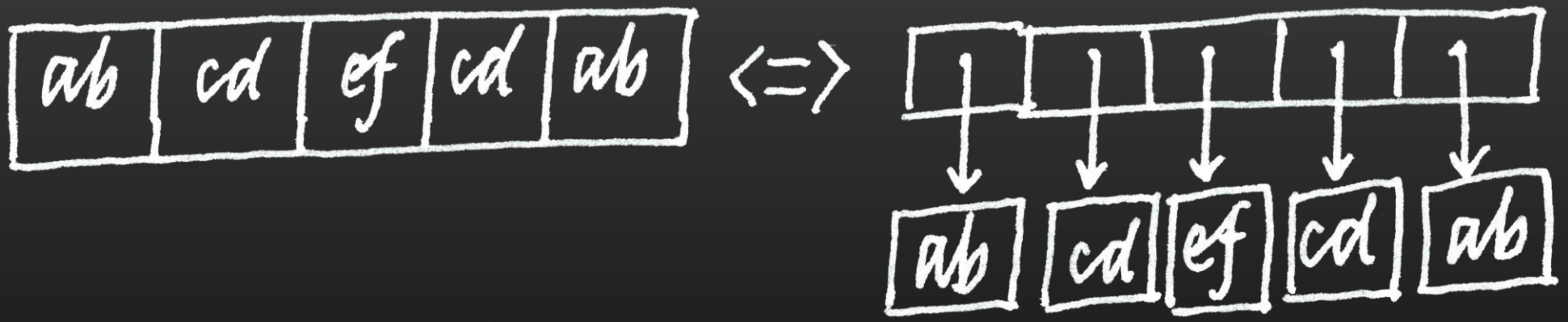

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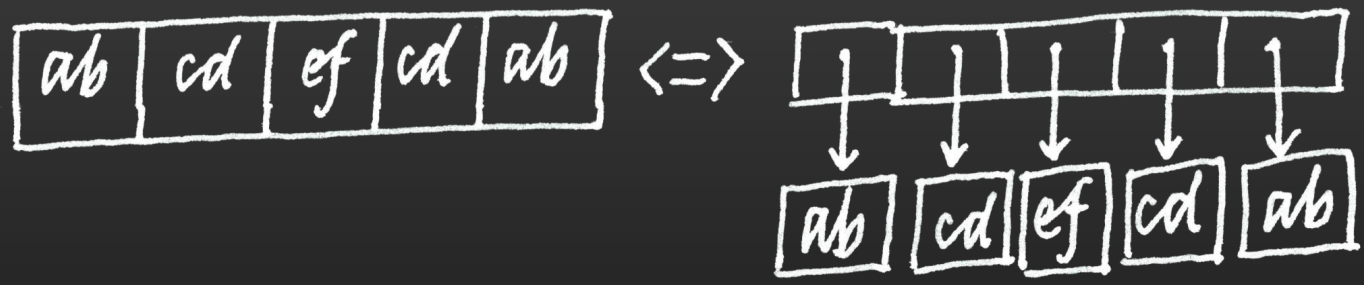

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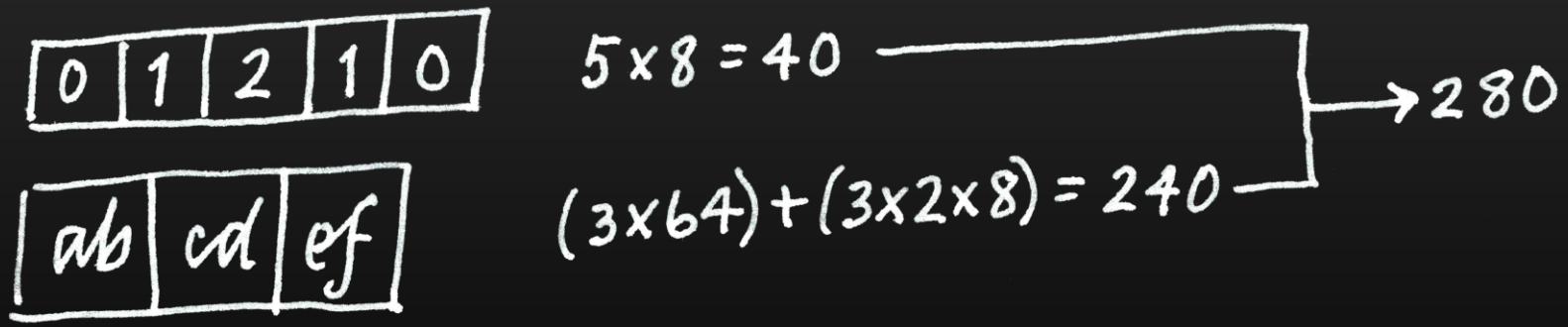

Symbol consumes 8-bits, not 64!

Pointers

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use type-constrained explicit pointers with restricted range.

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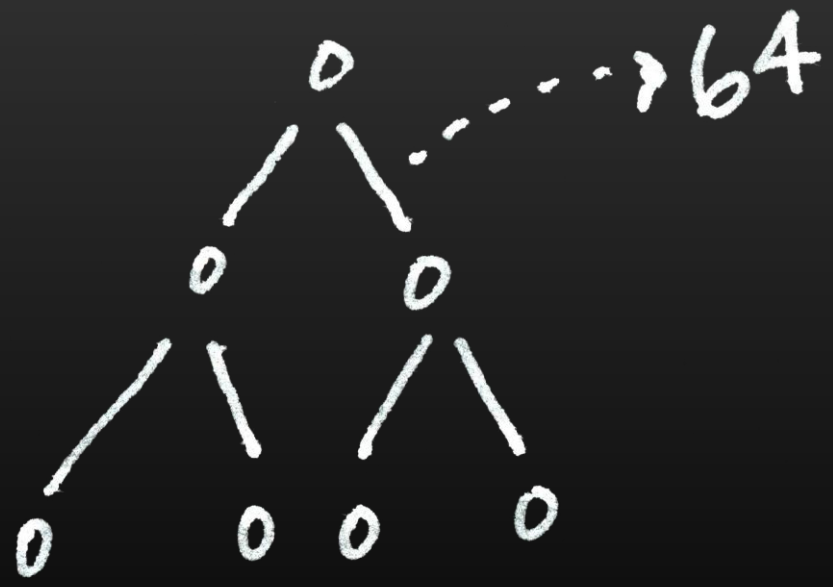

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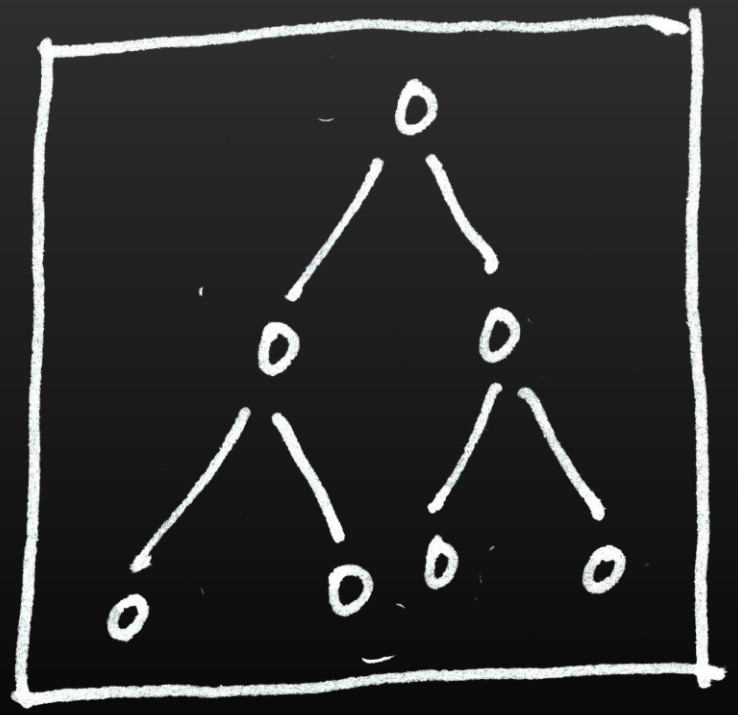

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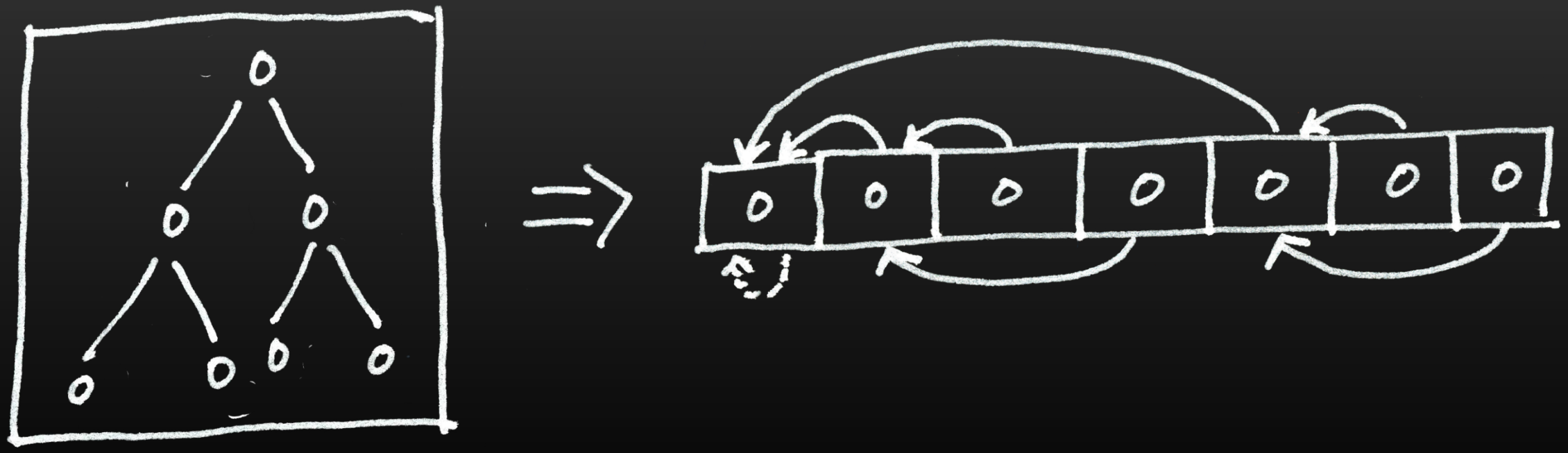

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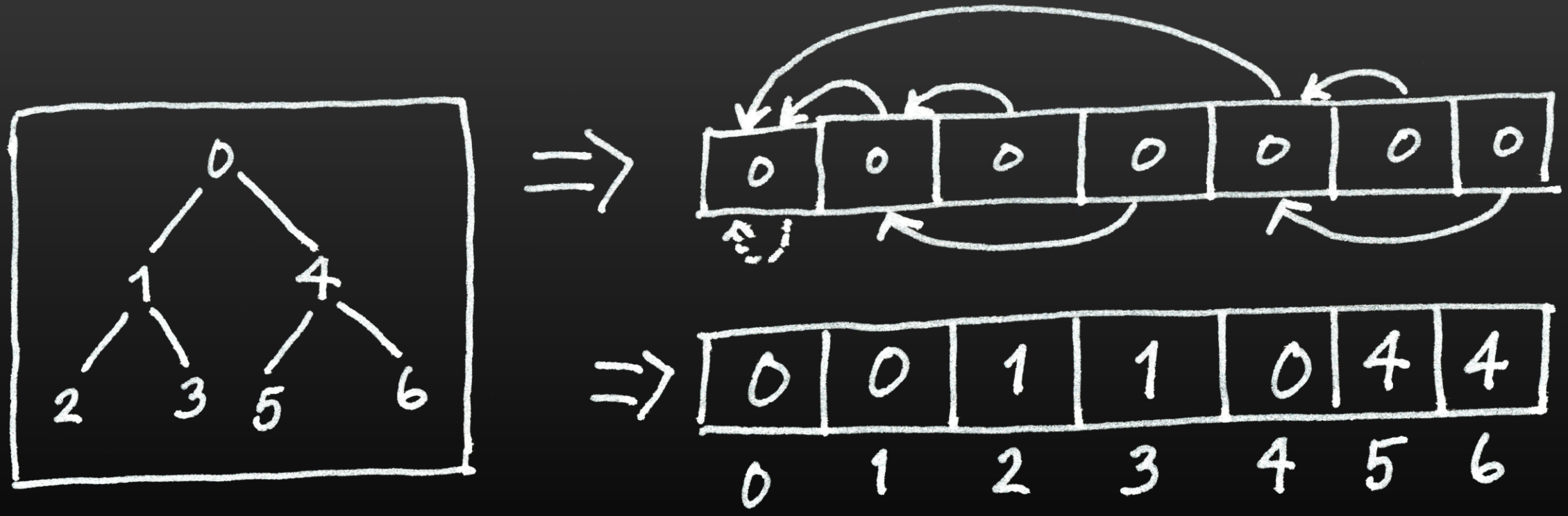

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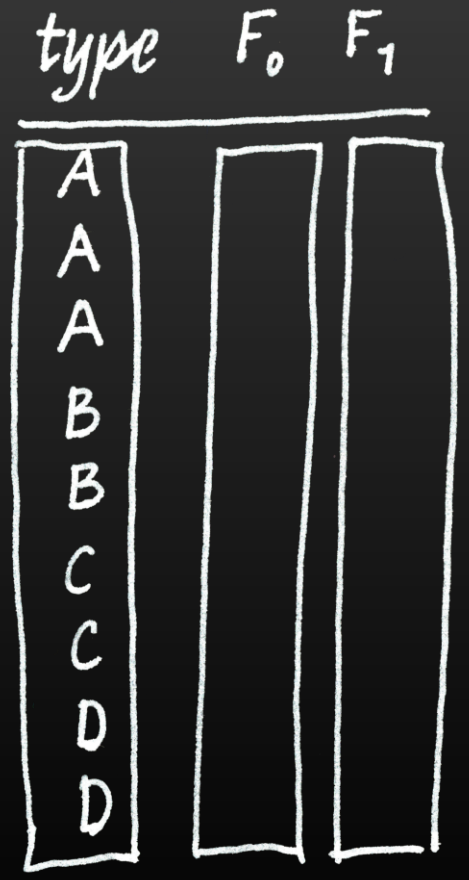

$type = A$

$(type = A) \vee (type = B)$

$type \in A\ B$

$\{\alpha (\neq \omega)\} \ni type$

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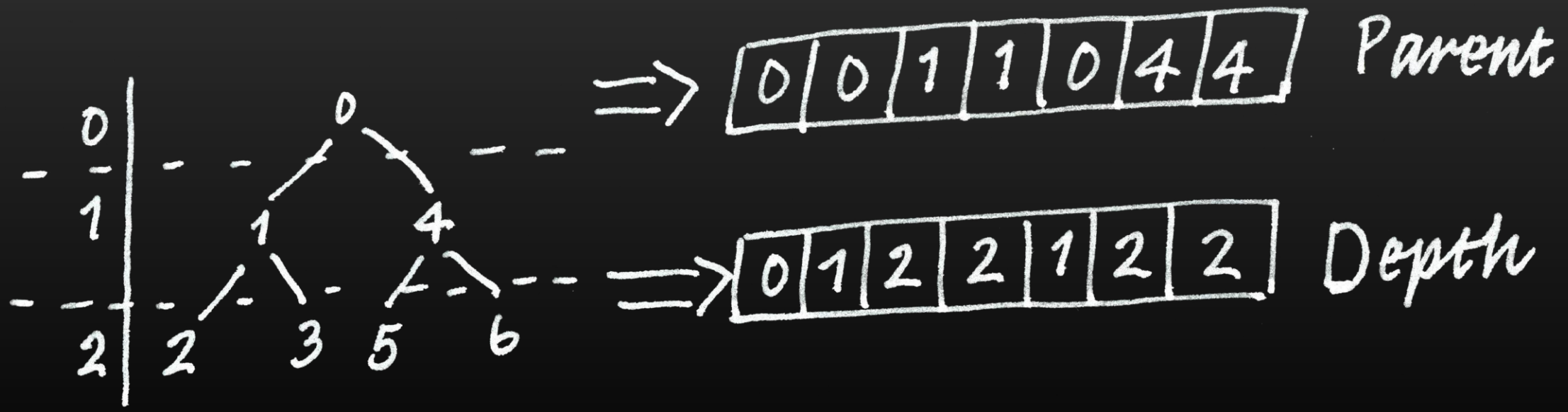

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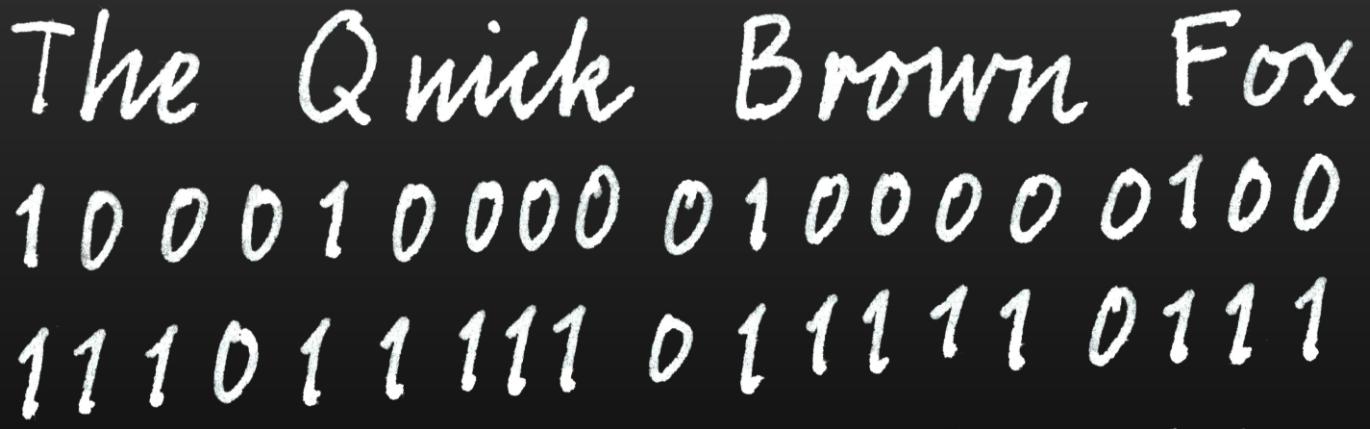

Boolean Masks

Take advantage of Bitvector masks.

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

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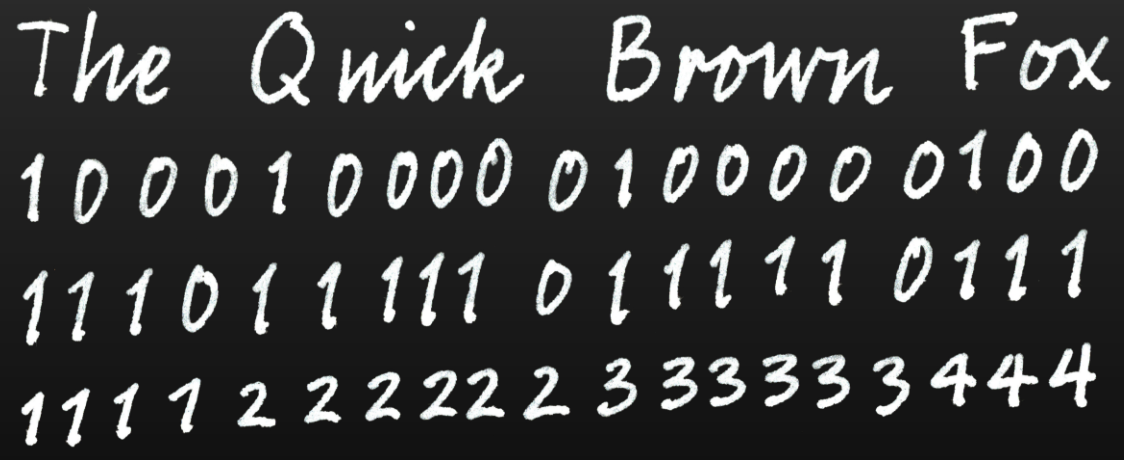


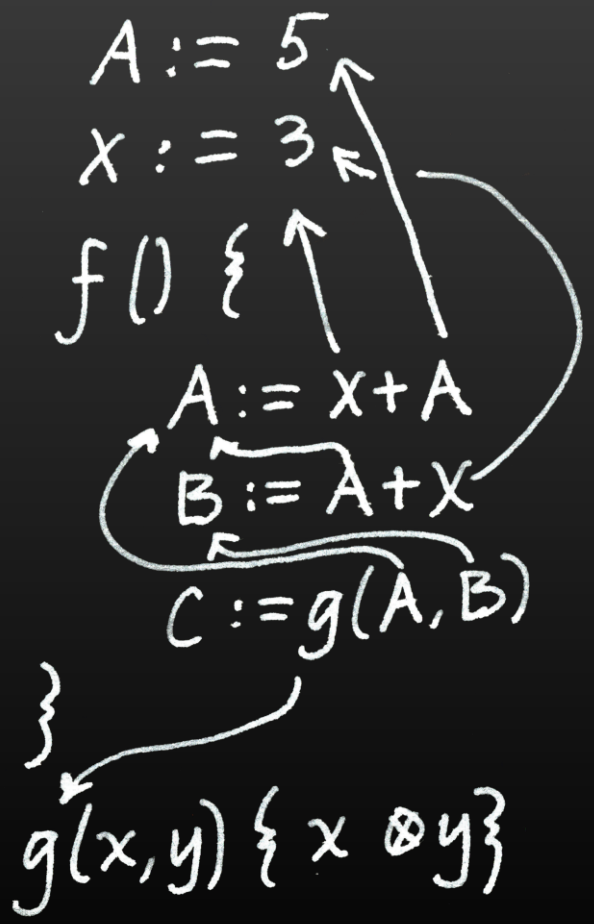
xoFnworBkciuQehT
444333322222111

ehTkciuQnworBxoF
1112222233333444

ehT kciuQ nworB xoF
11101111101111110111

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

Embrace the TAO:



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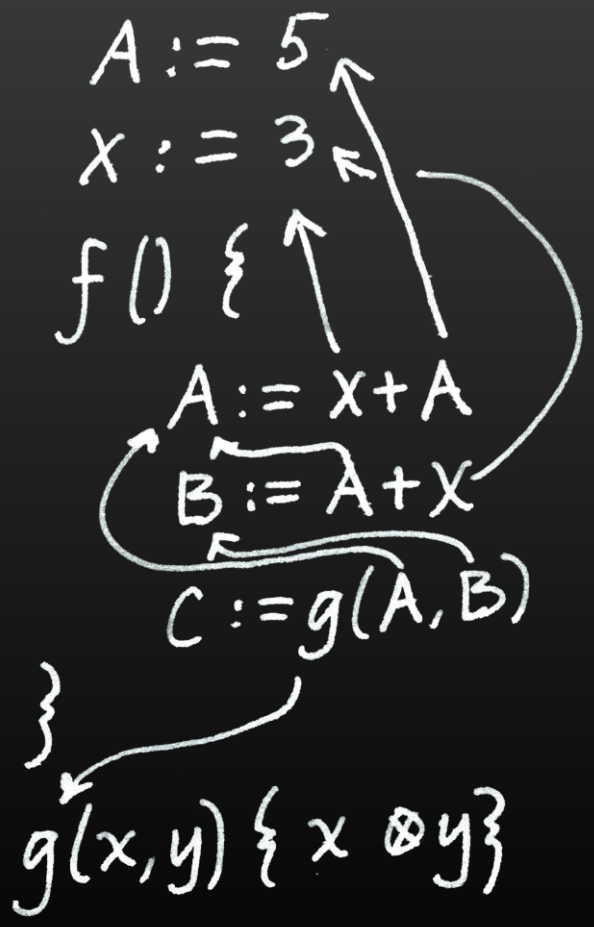

A	X	f	g	A	X	A	X	A	B	B	A	g	C
1	1	1	1	0	0	1	0	0	1	0	0	0	1
0	3	6	17	9	8	7	12	11	10	16	15	14	13

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

Lessons

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Thank you. Questions?

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