FORTH in Zig

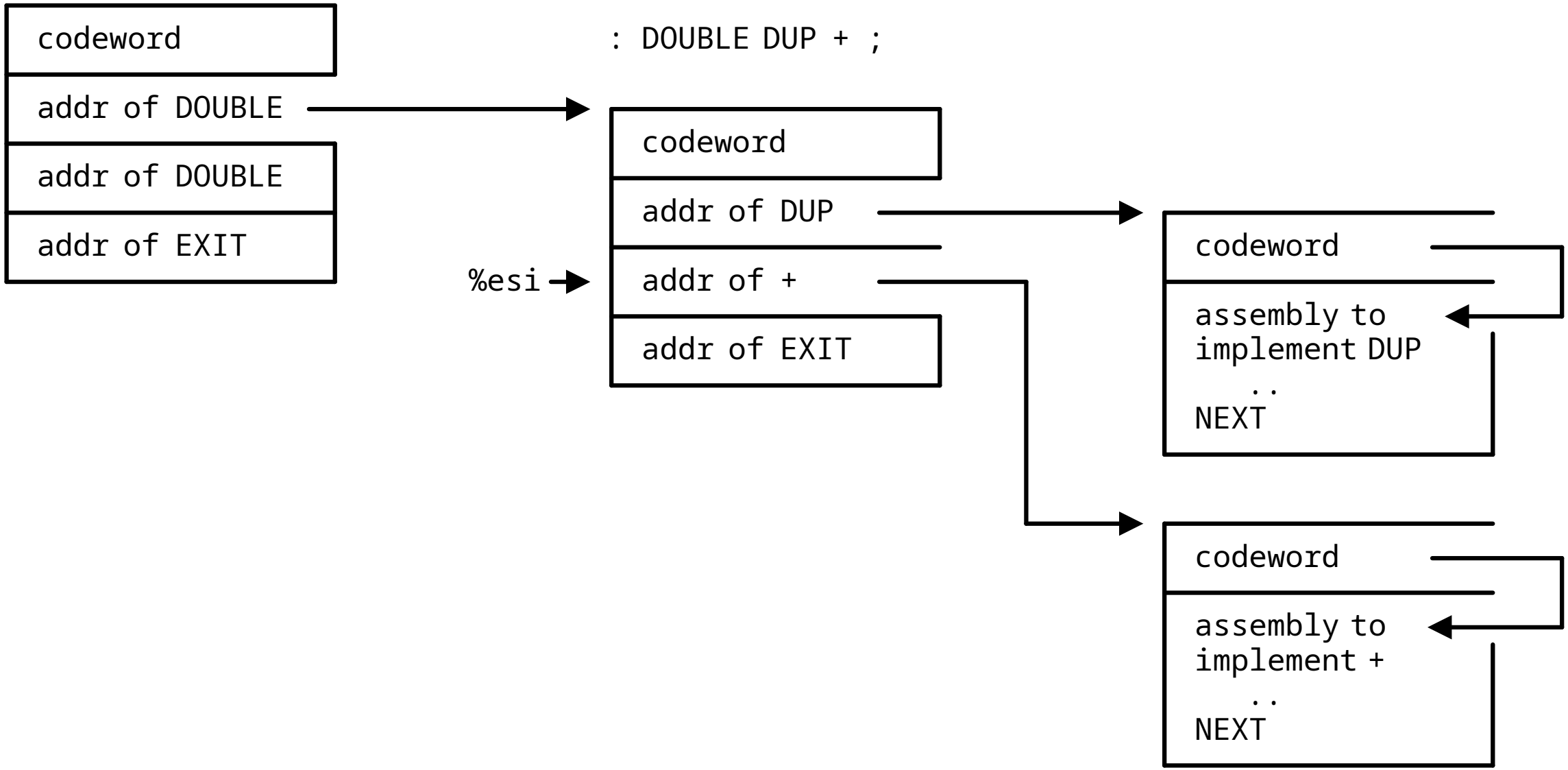
Mixing old and new

What is FORTH?

- append-only linked list of
- code fragments (flexible array members)
- with threaded interpreter to jump around

```
: DOUBLE ( n -- n ) DUP + ;
: QUADRUPLE ( n -- n ) DOUBLE DOUBLE ;
10 QUADRUPLE 2 + .
42
```

: QUADRUPLE DOUBLE DOUBLE ;



Successive approaches

- `jonesforth.S`: `lodsl; jmp *(%eax)`
- `4th.c`: `target = *ip++; goto **target`
- `5th.c`: `__attribute__((musttail)) return ...`
- `5th.zig`: `return @call(.always_tail, ...`

How does it work?

Ideally

```
const Instr = packed union {
    code: *const fn (...) void,
    literal: isize,
    word: [*]const Instr,
};

const Word = extern struct {
    link: ?*const Word,
    flag: u8,
    name: [F_LENMASK]u8 align(1),
    code: []Instr,  # NOT CONTIGUOUS!
};
```

Practically

Helper emulates flexible array member with

```
var instrs: [n + 5]Instr;
const p: *Word = @ptrCast(&instrs[0]);
```

zig < ZORTH < python 3.12

```
$ hyperfine -N 'python fibonacci.py'
Benchmark 1: python fibonacci.py
  Time (mean ± σ):      58.5 ms ±  18.8 ms    [User: 39.9 ms, System: 11.6 ms]
  Range (min … max):    34.9 ms … 116.0 ms    25 runs

$ hyperfine -N './zig-out/bin/5th < ./fibonacci.fs'
Benchmark 1: ./zig-out/bin/5th < ./fibonacci.fs
  Time (mean ± σ):       3.1 ms ±   3.5 ms    [User: 0.5 ms, System: 0.6 ms]
  Range (min … max):     0.4 ms …  53.2 ms    6452 runs

$ hyperfine -N ./fibonacci
Benchmark 1: ./fibonacci
  Time (mean ± σ):       2.6 ms ±   2.5 ms    [User: 0.4 ms, System: 0.7 ms]
  Range (min … max):     0.5 ms …  22.2 ms    541 runs
```

References

- jonesforth for the origin story
- Forth: The programming language that writes itself
- Why not try Zig next? (shameless plug)
- Starting FORTH to go deeper
- Discord conversations 1, 2, and 3