

aliciously

$$F(mr^*a, mr^*b) \{$$

$$f(p, p)$$

$$f(p, p+10)$$

}

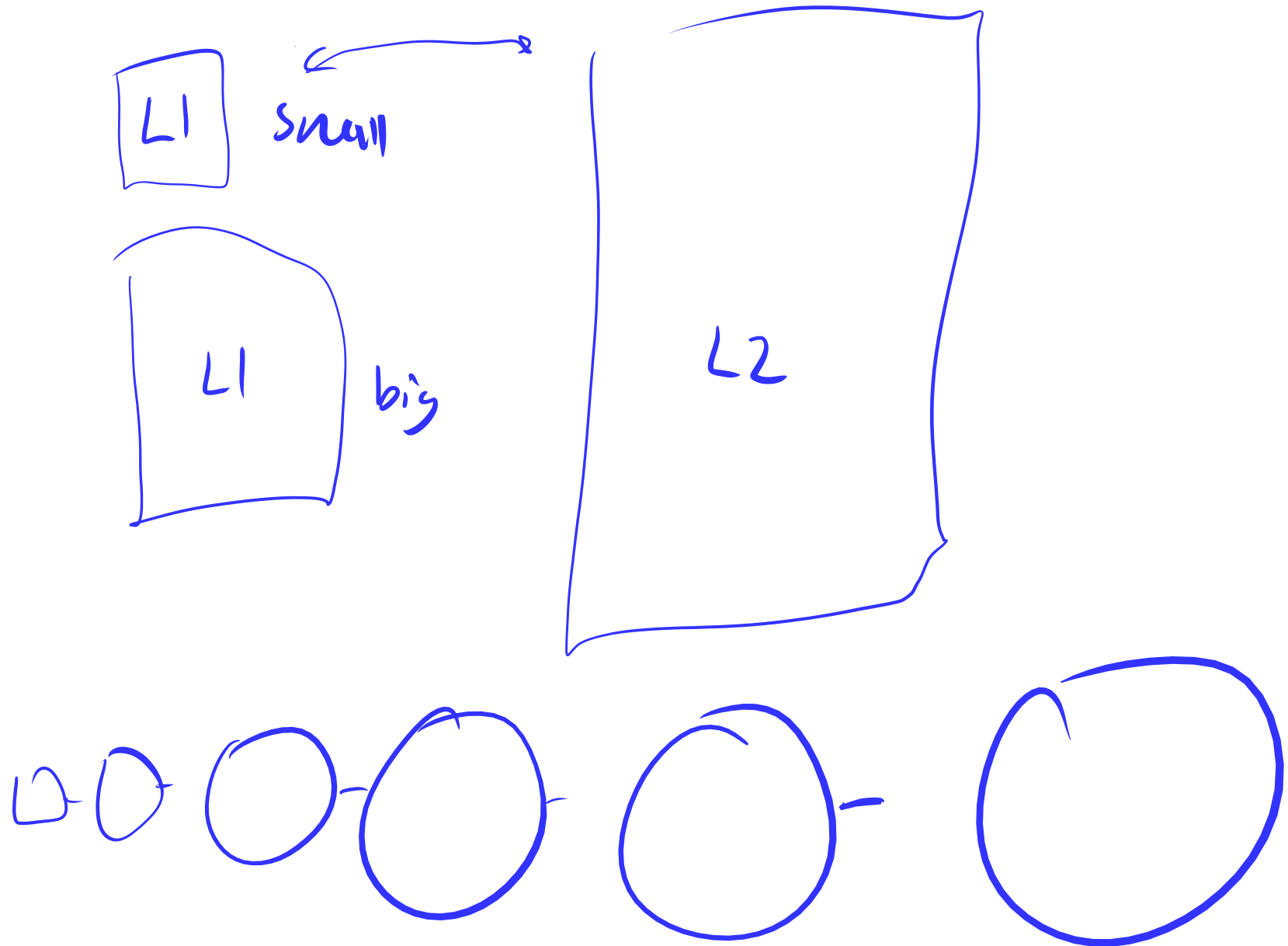
Cache

Pipe lining

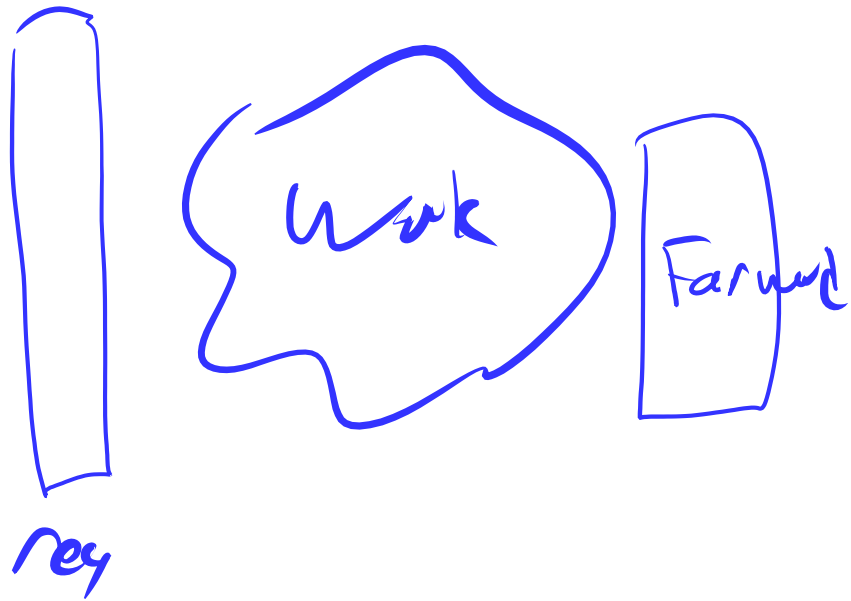
OOO/wrt issue

Cache

time \propto Size of cache



Pipelines

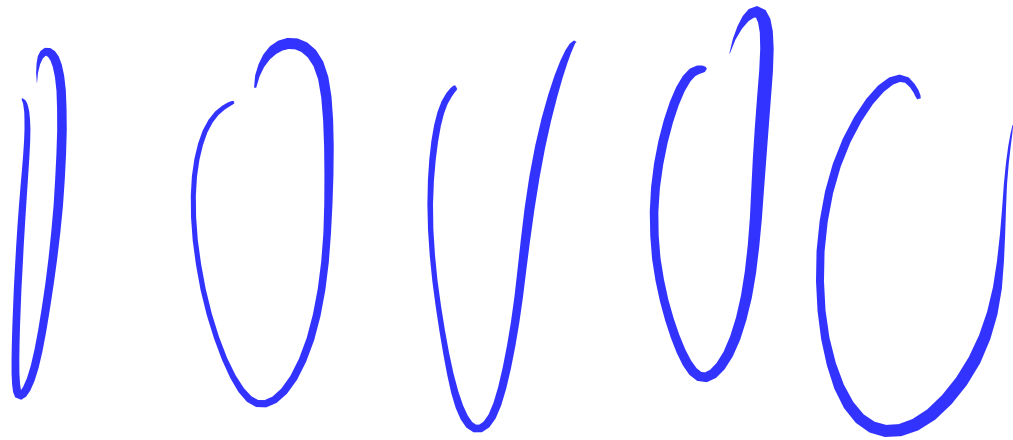


~ 10 Stages

M is predictions

000 / mult issue

↳ forwarding



add x8 + x9 → x10

issue + redundancy

add
○
○
○
○

clean
up

add2 x8 + x9 → x10
 x1 + x2 → x3

issue + redundancy

add

add

○

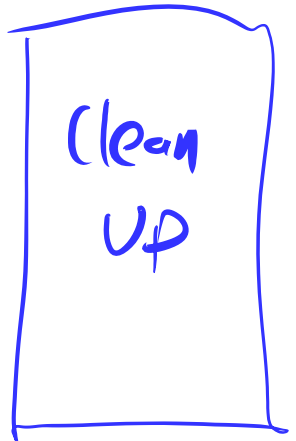
○

○

clean up

addZ x8 + x9 → x10
 y8 + y9 → y10

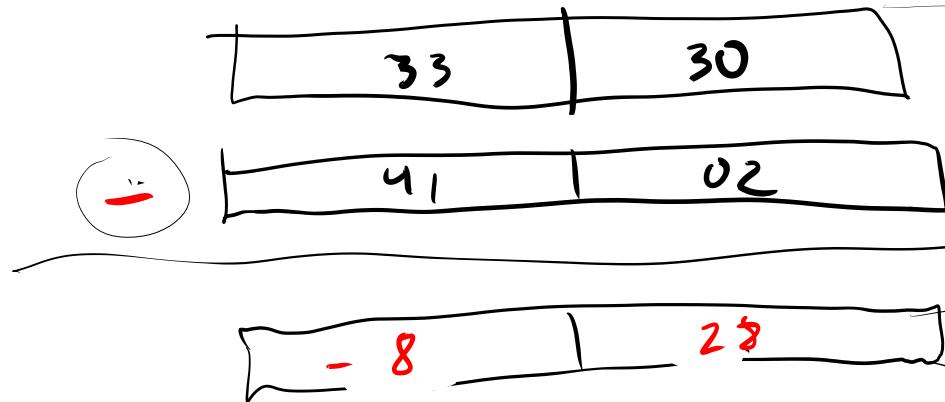
issue + recovery



addq(2)

%rax, %rax

Vector



Spec. reg. w/ multiple numbers "vectors"

Spec. inst use vector args

SIMD

Single instruction Multiple data

CPU — vector type (in asm)
 \ vector operands

GPU

big vectors of data

write code for 1 value

→ fancy vector creation

float 4

float 3

int 3

int 4

max 4

almost any code

if ($x[i] > 0$) { $x[i] += 1$; } foo

~~vector of bool~~

Warp

bool

0
0
-
-
0
-
0
-
-
-
0

Cond

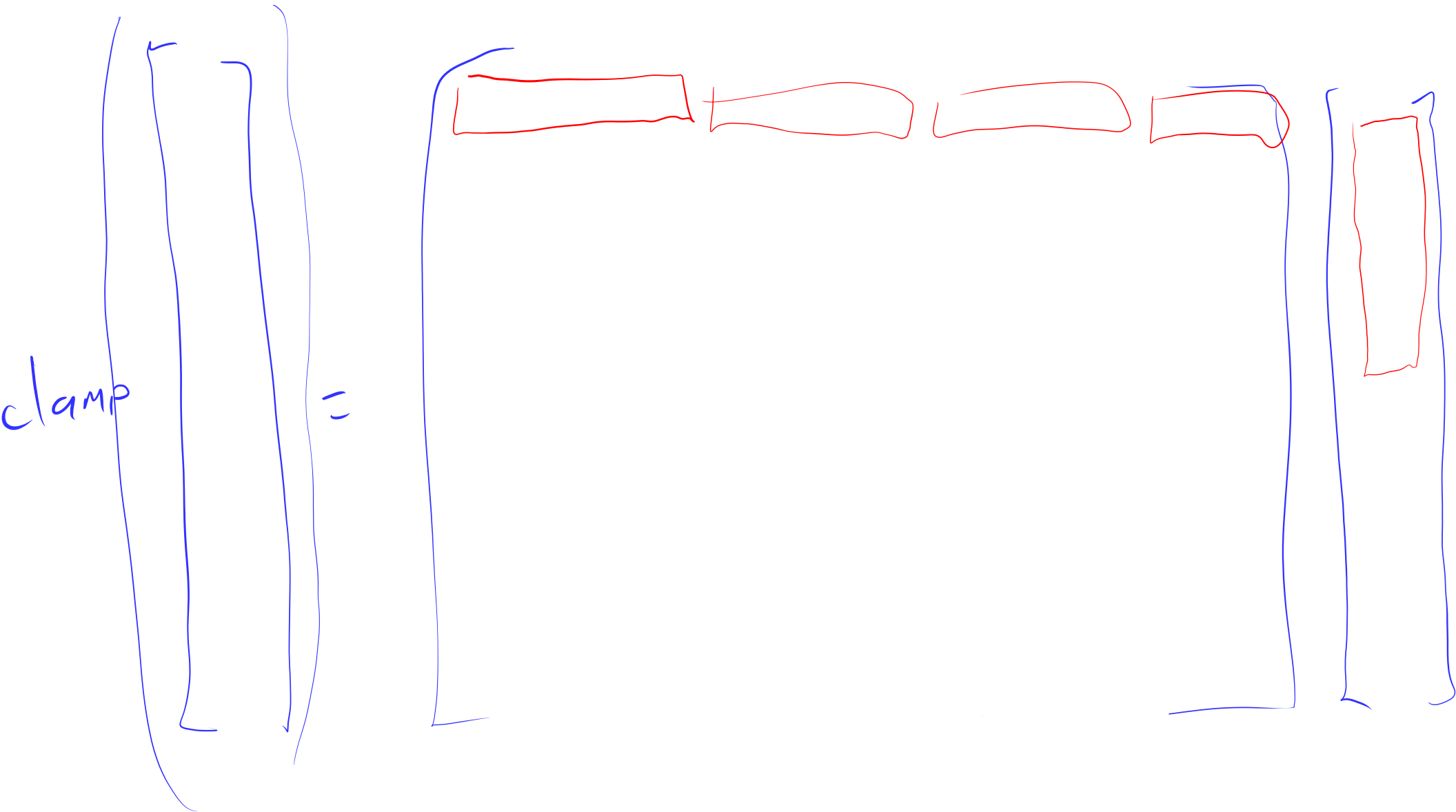
cond[i], #, x[i]

Cell

foo

⋮

Neural Net



Map-Reduce

vector \leftarrow map (func, vector)

value \leftarrow reduce (func, vector)

+