Spazi di pattern

concurrency
algorithm
Support structure
meccanismi

} skeleton
template
building blocks

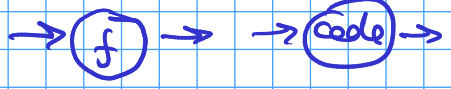
{ Building block } = { Wrapper } ∪
{ funzionali } ∪ { combinatori }

WRAPPER

costruttori : codice → "componente building block"

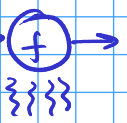
Wrapper di codice seq ((code)) ((f))

*) 1 ingresso e 1 uscita
*) stateless



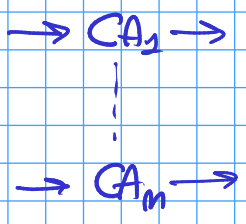
Wrapper di codice parallelo (| f |)

*) 1 ingresso e 1 uscita
*) stateless



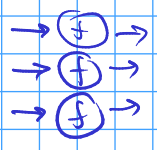
⇒ riuso di codice

Funzionali (sono "quelli che calcolano" (in parallelo))



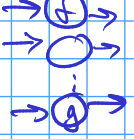
PAR f

[[CA]]n

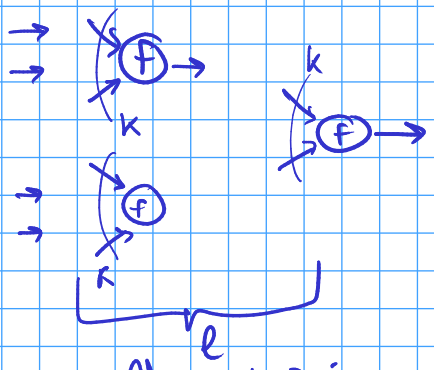


MISD

[[CA1, ..., CAn]]
f g

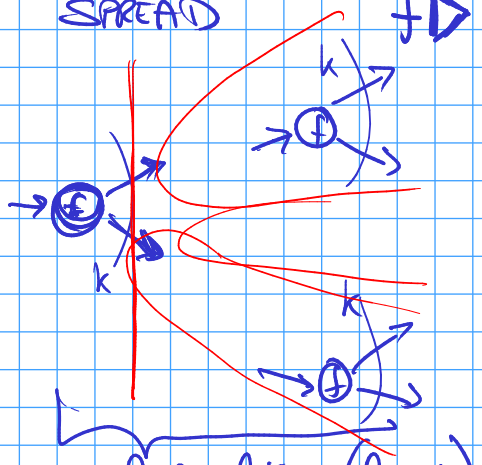


REDUCE $f\blacktriangleleft$

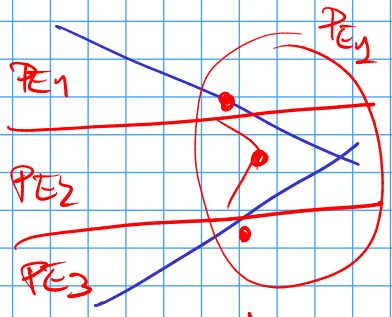


albero k-ario profondità ℓ ($\ell \geq 1$)

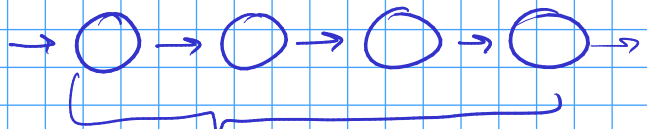
SPREAD $f\blacktriangleright$



ℓ livelli ($\ell \geq 1$)



Se f è comm e associativa



PIPELINE

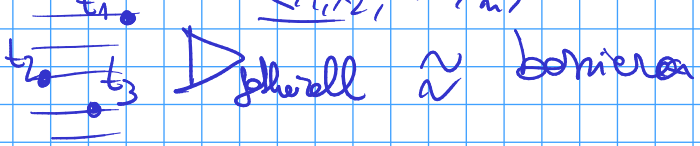
COMBINATORI

1-to-N $\blacktriangleleft_{Pol}$ $Pol \in \{$ Scatter, Broadcast, Unicast(P) $\}$ P = auto, RR, ...

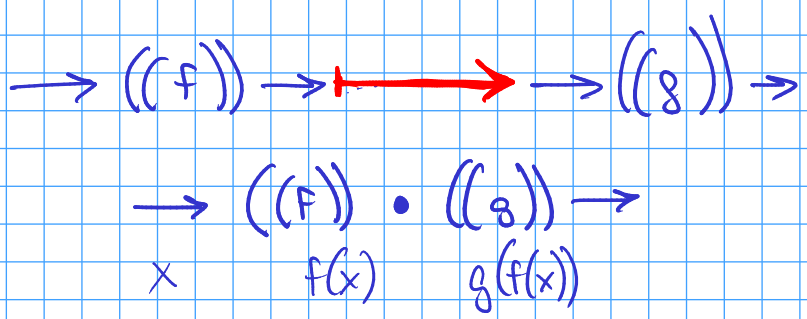
N-to-1 $\blacktriangleright_{Pol}$ $Pol = \{$ Gather, Gatherall, Reduce $\}$

feedback

building block = BB



Composizionalità • = pipeline (infixa)

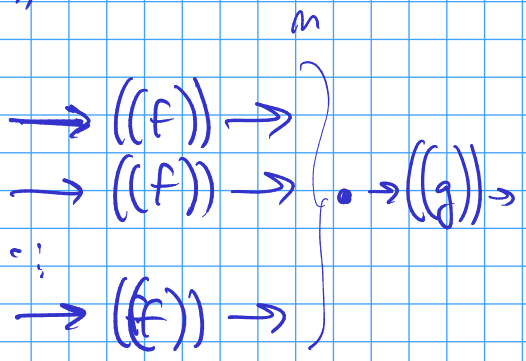


$$\rightarrow ((f)) \rightarrow \longrightarrow \rightarrow ((g)) \rightarrow$$

$$\rightarrow ((f)) \bullet ((g)) \rightarrow$$

$x \quad f(x) \quad g(f(x))$

$$[\![((f))]\!]_n \bullet ((g))$$



$$\rightarrow ((f)) \rightarrow$$
$$\rightarrow ((f)) \rightarrow \Big\}^{n} \bullet \rightarrow ((g)) \rightarrow$$
$$\rightarrow ((f)) \rightarrow$$

$$\Delta^n ::= [\![\Delta]\!] \mid [\![\Delta_1 \dots \Delta_n]\!] \mid \Delta^n_{caud} \mid \Delta^n \bullet \Delta^n$$

per

quanti ingressi

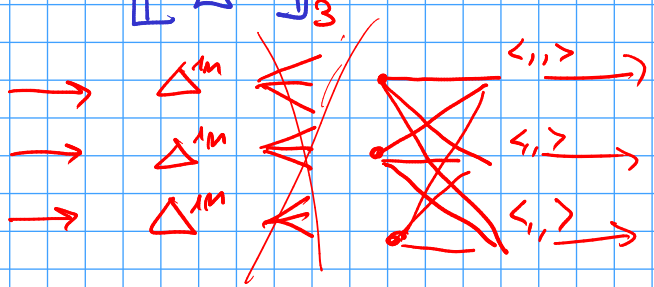
quante uscite

$\Delta^{1n} ::= \Delta_{Rel} \mid f\Delta$

$\Delta^{n1} ::= \nabla_{Rel} \mid g\nabla$

$\Delta^{11} ::= ((f)) \mid ((f\,g)) \mid \Delta\bullet\Delta \mid \Delta^{1n}\bullet\Delta^{n1} \mid \Delta^{1n}\bullet\Delta^{n}\bullet\Delta^{n1}$

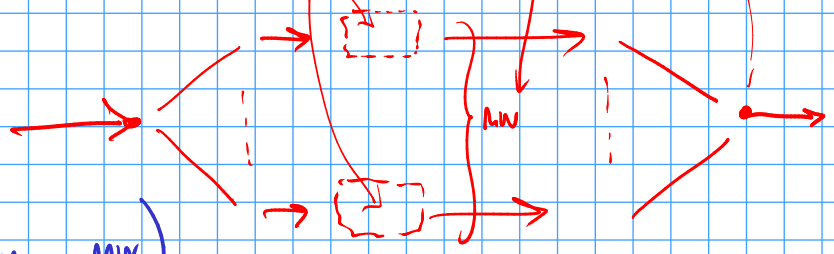
$[\![\Delta^{1n}]\!]_3$



EMBARRASSINGLY PARALLEL

FARM (worker, nw) =

$\triangleleft_{unicast(ec)} \bullet [\![\triangle_{worker}]\!]_{nw} \bullet \triangleright_{gather}$



MAP (worker, nw) =

$\triangleleft_{scatter} \bullet [\![\triangle_{worker}]\!]_{nw} \bullet \triangleright_{gatherall}$

STENCIL $(f, f_{intorno}, nw)$

$\forall$ elemento della collezione x : $y = f_{intorno}(x)$; $f(y)$

$\Rightarrow\Rightarrow [\![f_{intorno}]\!]_n \Rightarrow\Rightarrow [\![f]\!] \Rightarrow\Rightarrow$

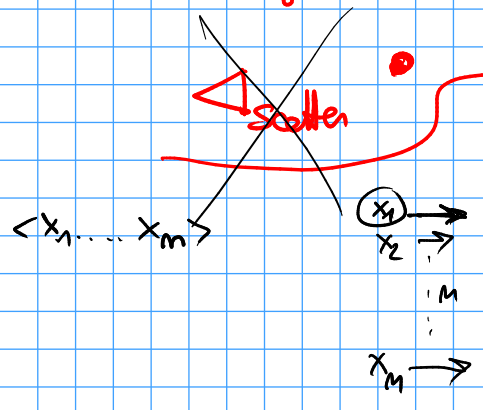
1 elemento della collezione x ingresso

1 intorno x uscita

1 nuovo elemento x uscita

$[\![f_{intorno}]\!]_n \bullet [\![f]\!]_n \bullet \triangleright_{gatherall}$

$\triangleleft_{scatter}$ •



$f_{intorno}(x_1)$

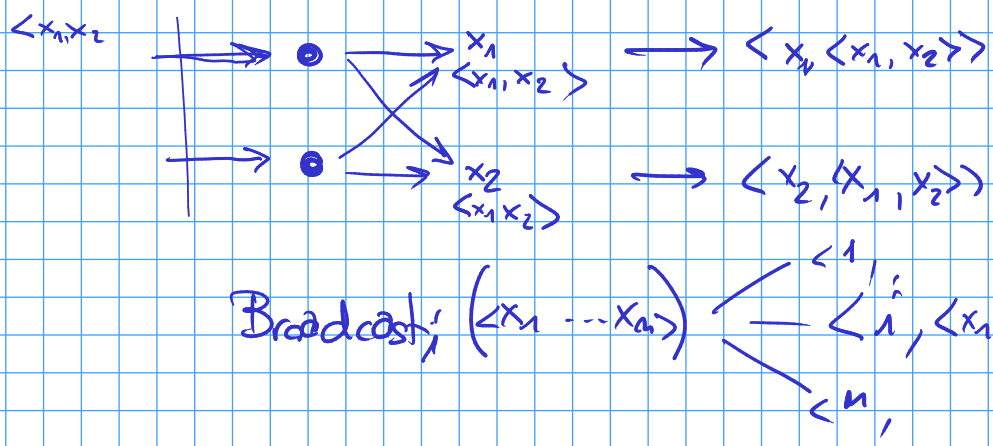
$intorno(x_i) = \{x_i, x_{i-1}, x_{i+1}\}$

$\triangleleft_{broadcast} \bullet [\![f_{intorno}]\!]_n$

$\langle x_n \dots x_1 \rangle$

$\langle x_1 \dots x_n \rangle$

$[\![\triangleleft_{scatter} , \triangleleft_{Broadcast}]\!]$



$Broadcast_i (\langle x_1 \dots x_m \rangle) \longrightarrow \langle 1, \langle i, \langle x_1 \dots x_m \rangle \rangle \rangle \dots \langle m, \langle i, \langle x_1 \dots x_m \rangle \rangle \rangle$

$\triangleleft_{Broadcast_i} \bullet [\![f_{intero}]\!]_m \bullet [\![f]\!]_m \bullet \triangleright_{gatherall}$

Shared memory multicore

$\triangleleft_{Broadcast_i}$: manda a ogni worker
struct { int indice; float *x }

codice "a mano" for ; for ;

struct { float, float, float }
$i-1$ i $i+1$

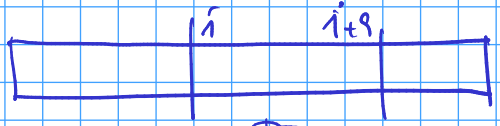
COW / NOW

PE_0 PE_1 PE_{MW}

$\frac{n}{MW} = 10$

$\triangleleft_{Broadcast_i} \bullet [\![f_{intero}]\!]$

$MW << n$



PE_1

$\{ (i-1, i, i+1), (i, i+1, i+2) \dots (i+8, i+9, i+10) \}$

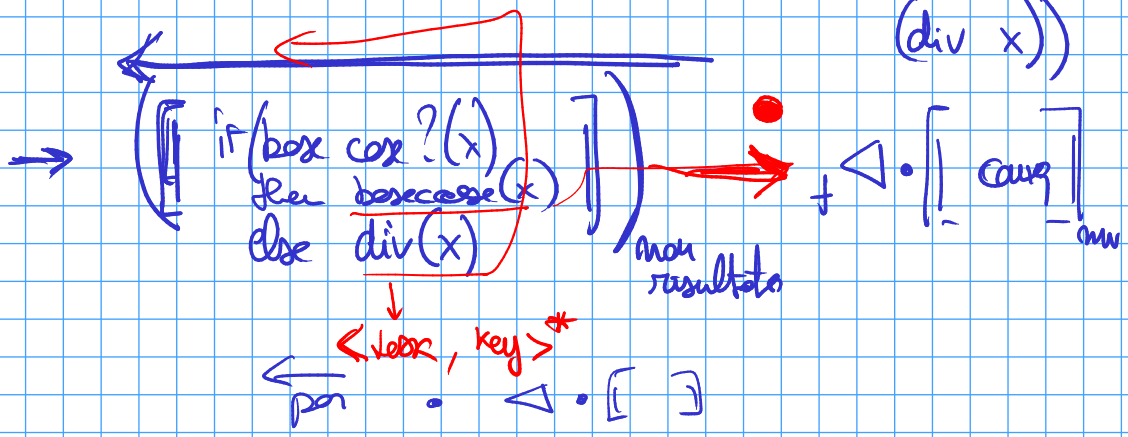
$\{ [i-1] \dots [i+10] \}$

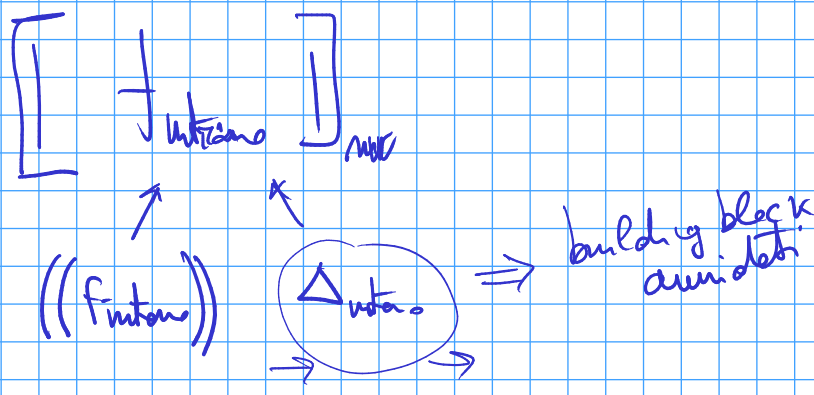
Divide & conquer

div basecase?

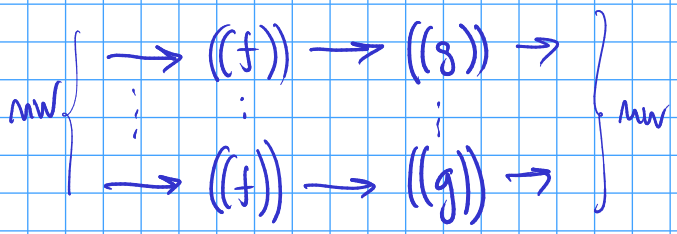
conq basecase

if (basecase?(x))
then basecase(x);
else conq(applyToAll
(div x))

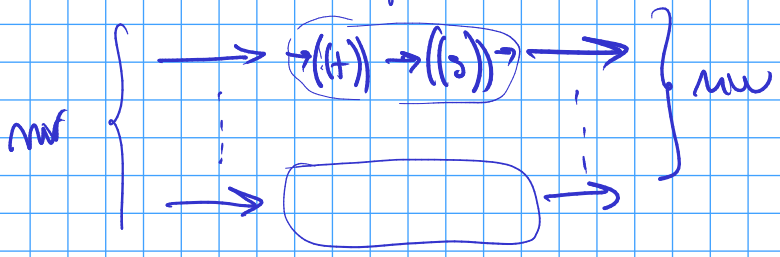




$$[\![((f))]\!]_{nw} \bullet [\![((g))]\!]_{nw} =$$

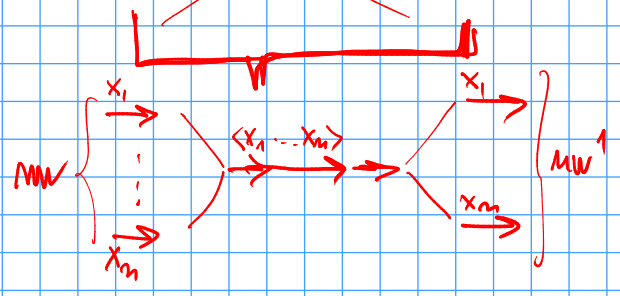


$$= [\![((f)) \bullet ((g))]\!]_{nw}$$



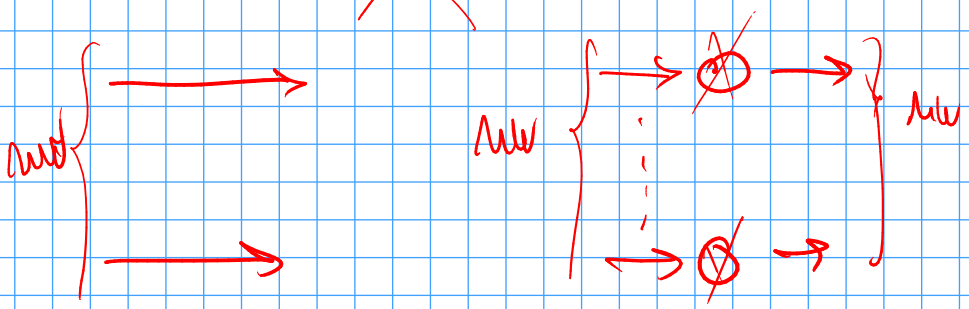
$$\mathrm{map}(f) \circ \mathrm{map}(g) = \mathrm{map}(f \circ g)$$

$$\triangleleft_{\mathrm{scatter}} \cdot [\![((f))]\!]_{nw} \cdot \triangleright_{\mathrm{gather}} \cdot \triangleleft_{\mathrm{scatter}} \cdot [\![((g))]\!]_{nw'} \cdot \triangleright_{\mathrm{gather}}$$



$$nw = n \times nw'$$

$$((f)) \quad [\![((f))]\!]_{nw}$$



$$\triangleleft_{\mathrm{scatter}} \cdot [\![((f))]\!]_{nw} \cdot [\![((g))]\!]_{nw} \cdot \triangleright_{\mathrm{gather}}$$

$$\mathrm{map}(f \circ g)$$