

# Worksheet solution: Associativity and Commutativity

Recap:

A binary function  $f$  is *associative* if  $f(f(x,y),z) = f(x,f(y,z))$ .

A binary function  $f$  is *commutative* if  $f(x,y) = f(y,x)$ .

Worksheet problems:

1) Claim: a Finish Accumulator (FA) can only be used with operators that are *associative and commutative*.

Why? What can go wrong with accumulators if the operator is non-associative or non-commutative?

You may get different answers in different executions if the operator is non-associative or non-commutative e.g., an accumulator can be implemented using one “partial accumulator” per processor core.

2) For each of the following functions, indicate if it is associative and/or commutative.

a)  $f(x,y) = x+y$ , for integers  $x, y$ , is associative and commutative

b)  $g(x,y) = (x+y)/2$ , for integers  $x, y$ , is commutative but not associative

c)  $h(s1,s2) = \text{concat}(s1, s2)$  for strings  $s1, s2$ , e.g.,  $h(\text{“ab”}, \text{“cd”}) = \text{“abcd”}$ , is associative but not commutative

