Map Reduce

Map: square each item

- list L=[0,1,2,3]
- Compute the square of each item
- output: [0,1,4,9]

Traditional

```
## For Loop
O=[]
for i in L:
    O.append(i*i)

## List Comprehension
[i*i for i in L]
```

Map-Reduce

```
map(lambda x:x*x, L)
```

Reduce: compute the sum

- A list L=[3,1,5,7]
- Find the sum (16)

Traditional

```
## Use Builtin
sum(L)

## for loop
s=0
for i in L:
    s+=i
```

Map-Reduce

```
reduce(lambda (x,y): x+y, L)
```

Map + Reduce

- list L=[0,1,2,3]
- Compute the sum of the squares
- Note the differences

Traditional

```
## For Loop
s=0
for i in L:
   s+= i*i
## List comprehension
sum([i*i for i in L])
```

Map-Reduce

```
reduce(lambda x,y:x+y, \\
         map(lambda i:i*i,L))
```

The Wrong way

```
reduce(lambda x,y:x+y*y)
```

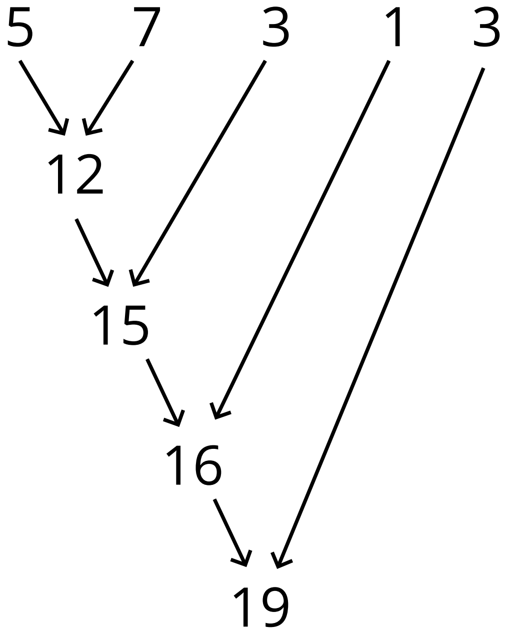
- Map, Reduce operations should not depend on:
    - Order of items in the list (commutativity)
    - Order of operations (Associativity)
- It is this independence that allows parallel computation.

Order independence

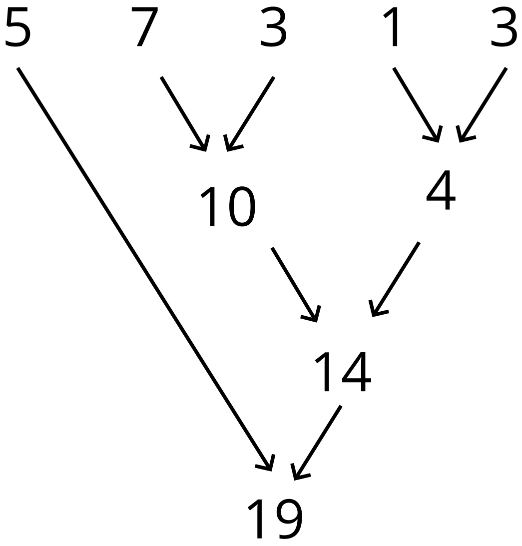
- The result of map or reduce does not depend on the order

computation order of a sum

For loop order



parallel order



Result should not depend on order

Why Order Independence?

- Computation order can be chosen by compiler/optimizer.
- Allows for **parallel computation** of sums of subsets.
    - Modern hardware calls for parallel computation but parallel computation is very hard to program.
- Using map-reduce programmer **exposes** to the compiler opportunities for parallel computation.