

Pmerge(L)

引数を
merge-insertion sort



(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

pair 作って大小に分ける
(この pair は変わらない。
L1 が sort される過程で S1 も並び替わる)

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

pair 作って大小に分ける
(この pair は変わらない。
L1 が sort される過程で S1 も並び替わる)

Pmerge(L)

引数を
merge-insertion sort



(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)



(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

pair 作って大小に分ける
(この pair も以下同文)
(奇数個なら余りは下の1 番右)

Pmerge(L)

引数を
merge-insertion sort



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

pair 作って大小に分ける
(この pair は変わらない。
L1 が sort される過程でS1 も並び替わる)

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L2)

大のグループだけ
merge-insertion sort (再帰)



(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

pair 作って大小に分ける
(この pair も以下同文)
(奇数個なら余りは下の1 番右)

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

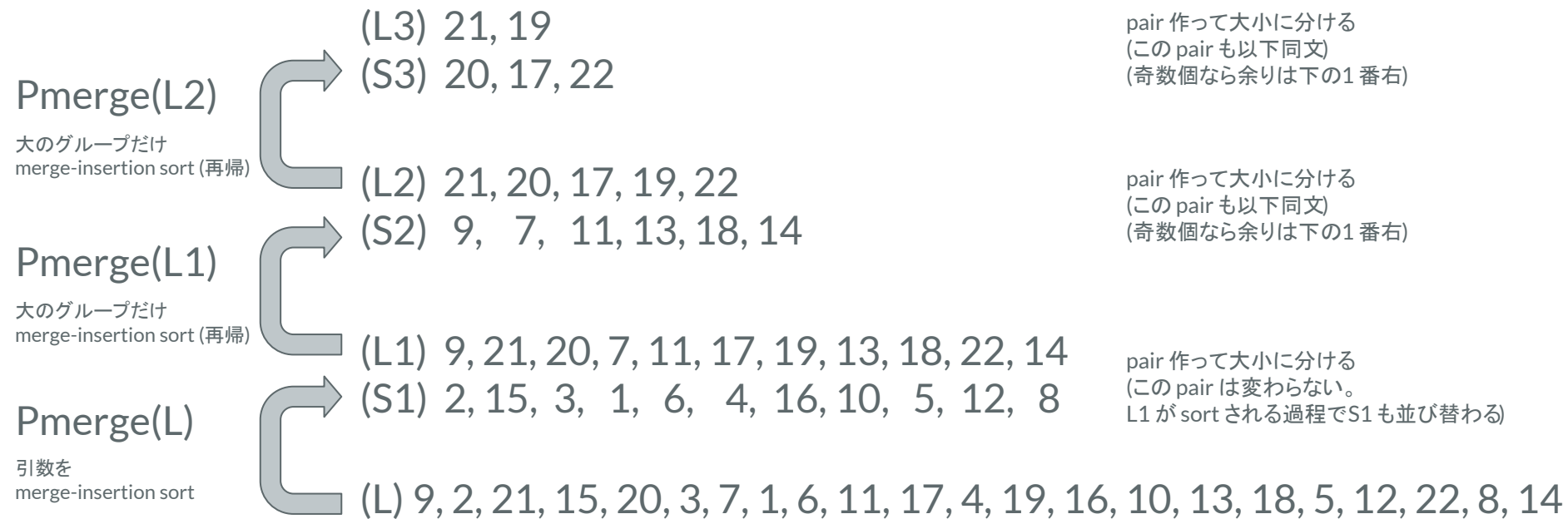
pair 作って大小に分ける
(この pair は変わらない。
L1 が sort される過程でS1 も並び替わる)

Pmerge(L)

引数を
merge-insertion sort



(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14



Pmerge(L3)

大のグループだけ
merge-insertion sort (再帰)



(L3) 21, 19
(S3) 20, 17, 22

pair 作って大小に分ける
(この pair も以下同文)
(奇数個なら余りは下の1 番右)

Pmerge(L2)

大のグループだけ
merge-insertion sort (再帰)



(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

pair 作って大小に分ける
(この pair も以下同文)
(奇数個なら余りは下の1 番右)

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

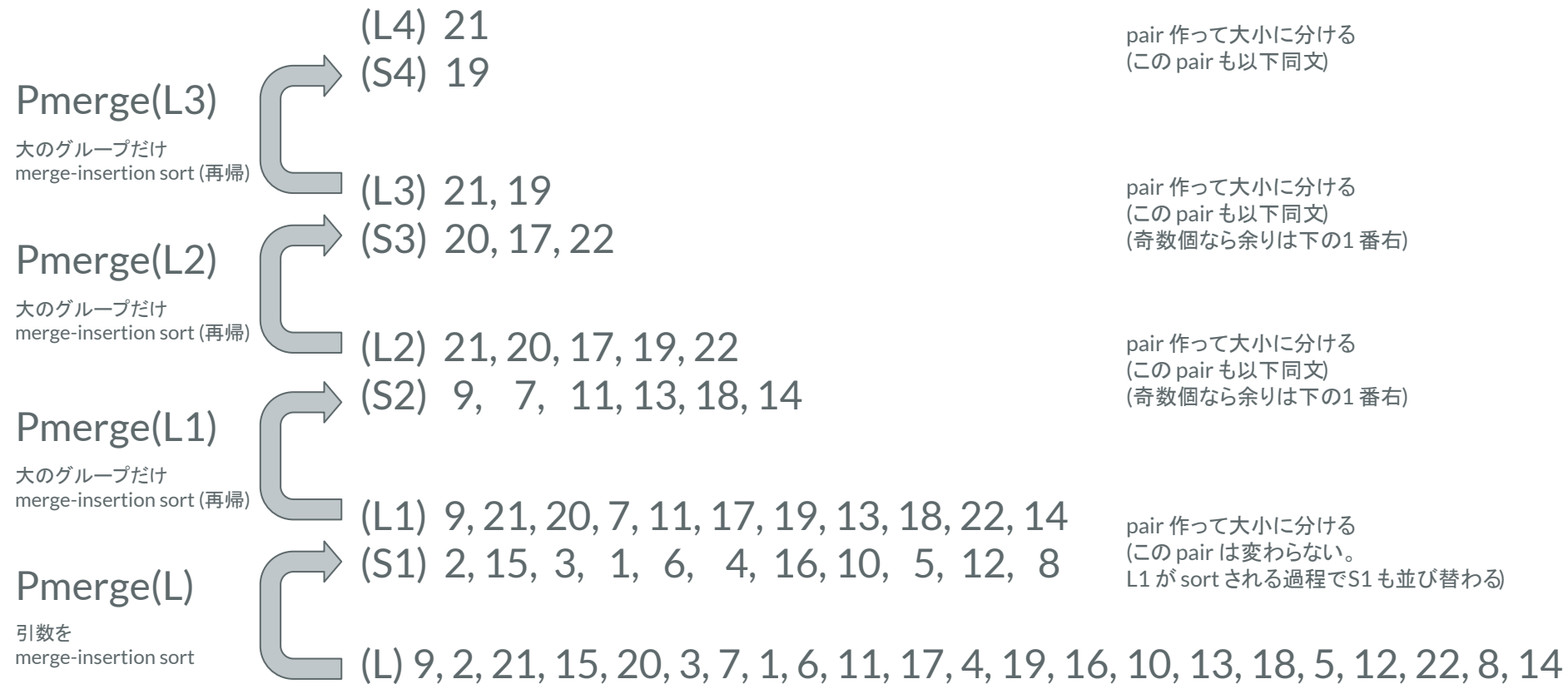
pair 作って大小に分ける
(この pair は変わらない。
L1 が sort される過程でS1 も並び替わる)

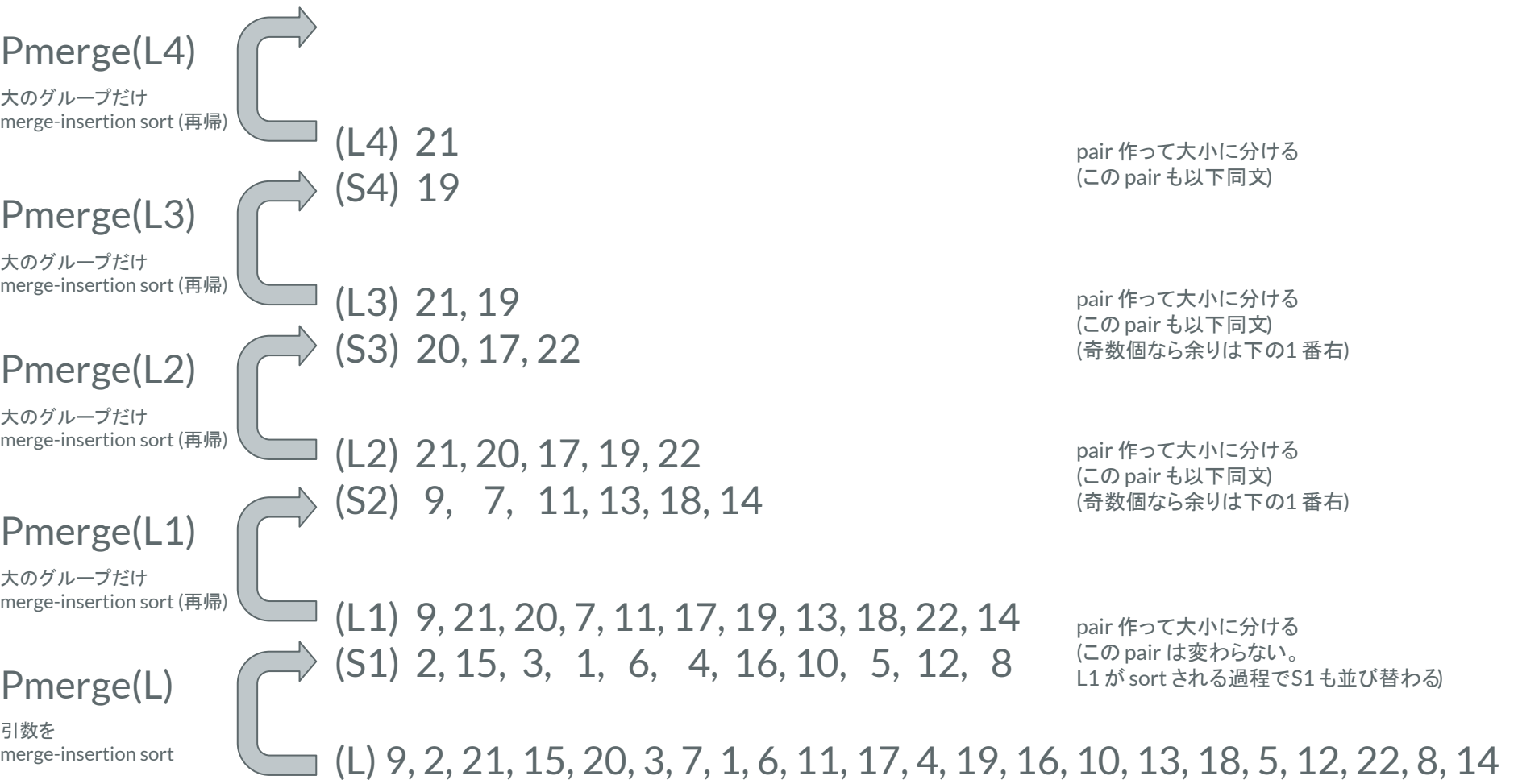
Pmerge(L)

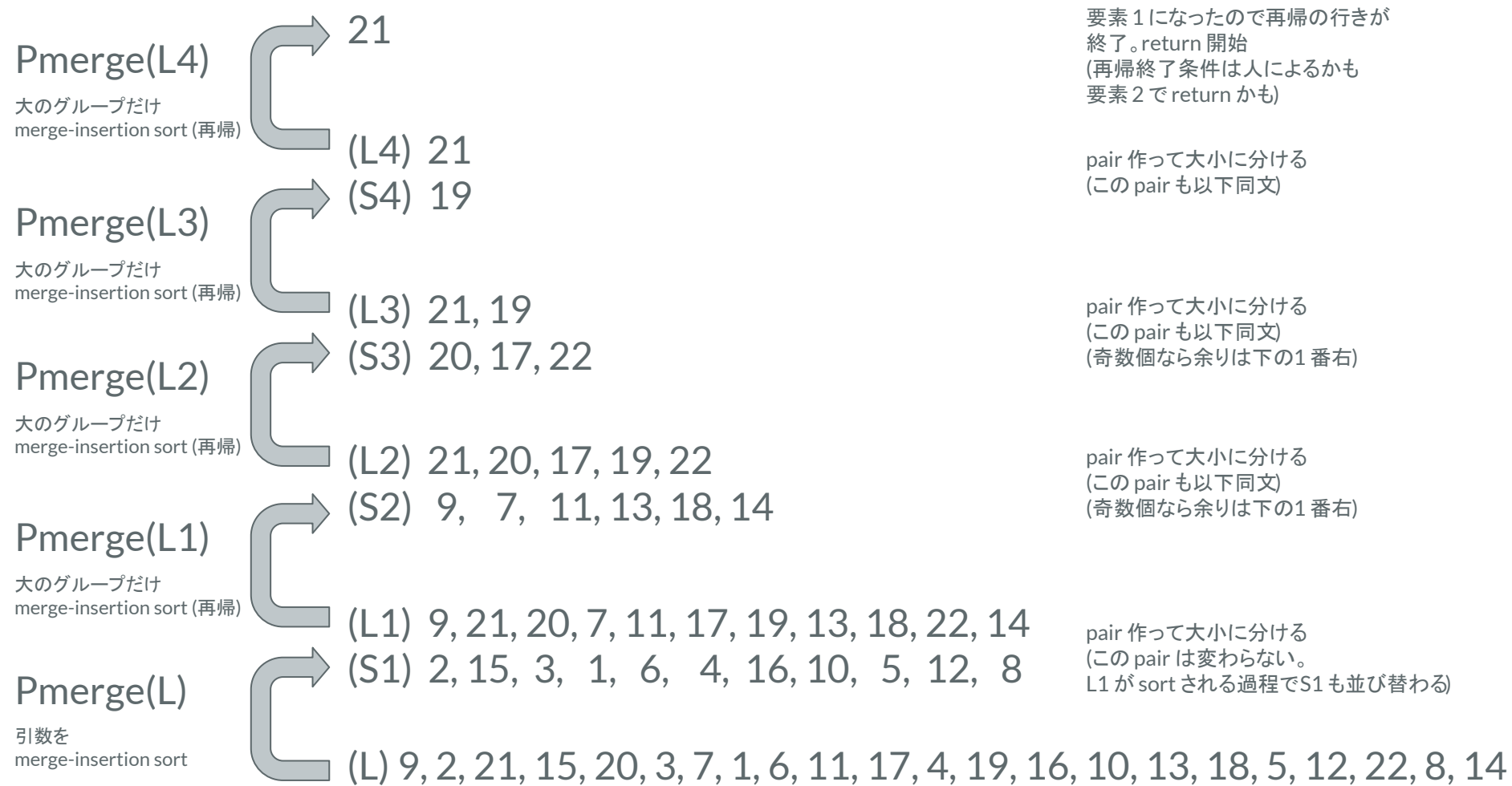
引数を
merge-insertion sort

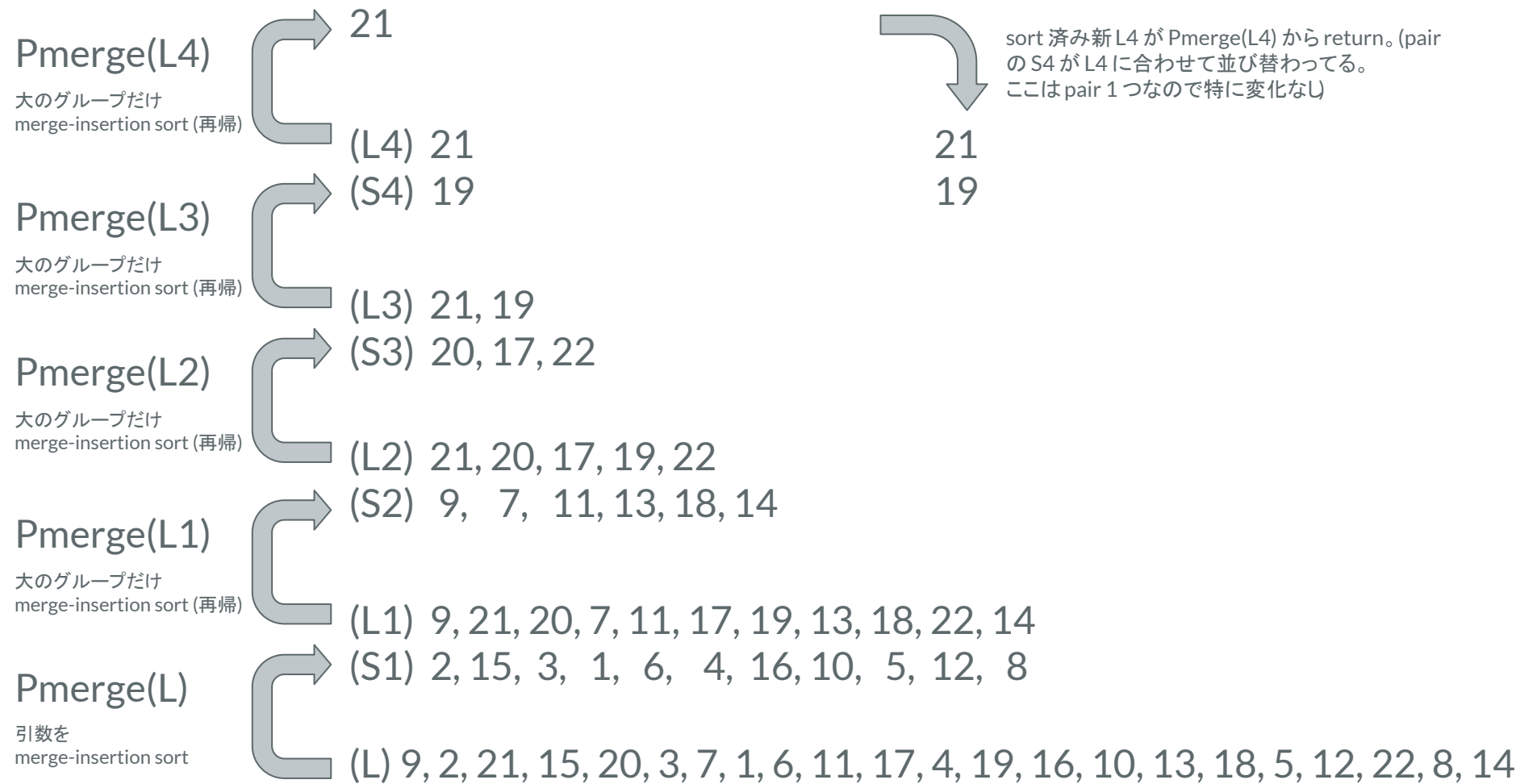


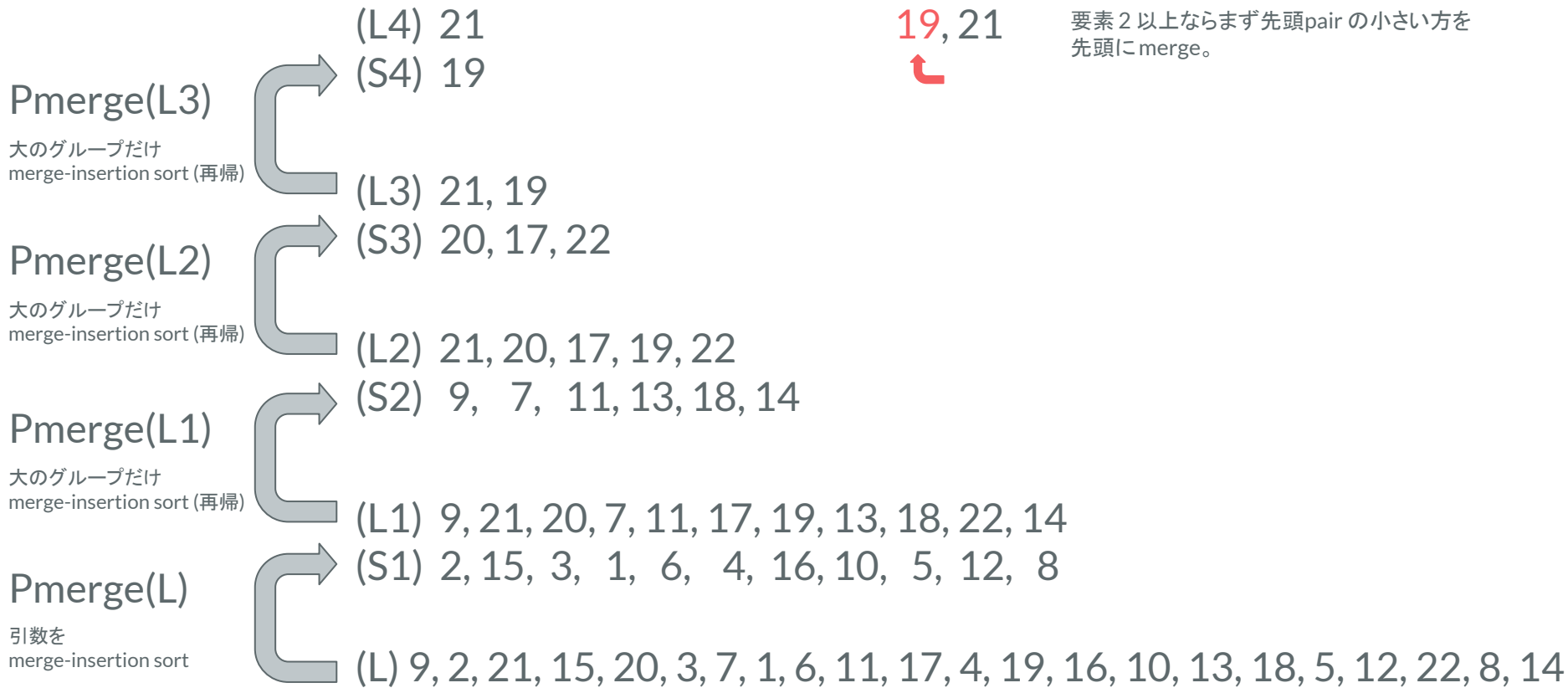
(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

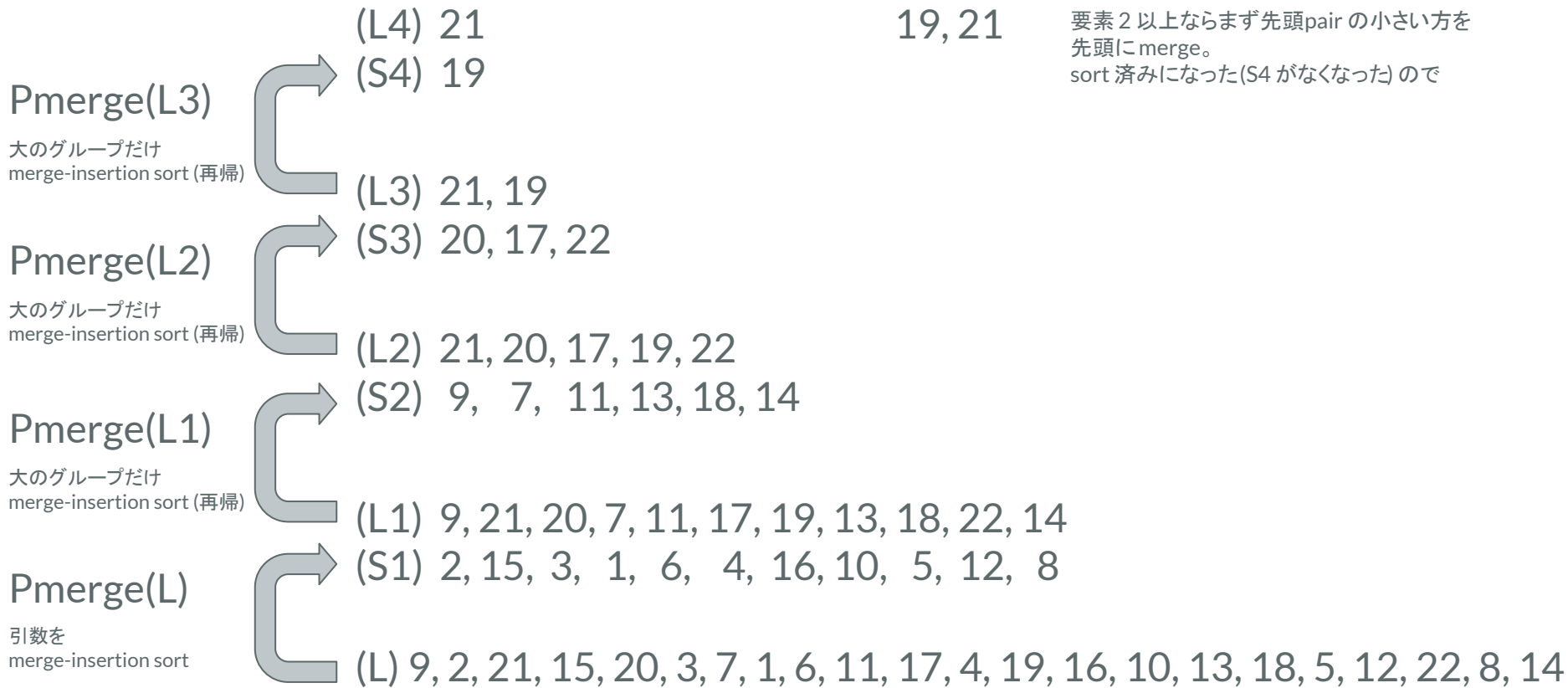


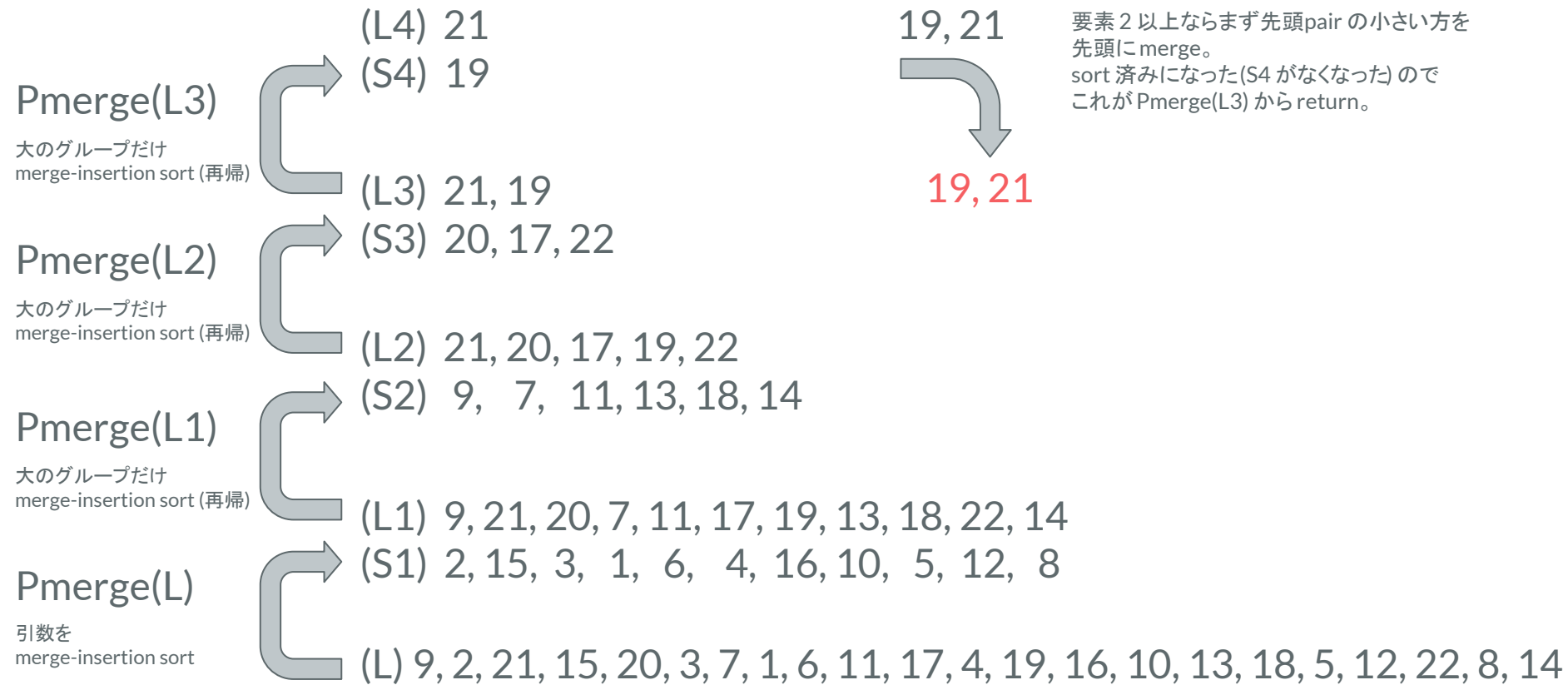


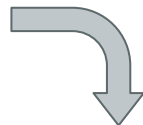










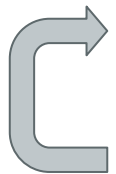


19, 21
17, 20, 22

S3 が元々の pair の順に並び替わってる

Pmerge(L2)

大のグループだけ
merge-insertion sort (再帰)



(L3) 21, 19
(S3) 20, 17, 22

(L2) 21, 20, 17, 19, 22

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)



(S2) 9, 7, 11, 13, 18, 14

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

Pmerge(L)

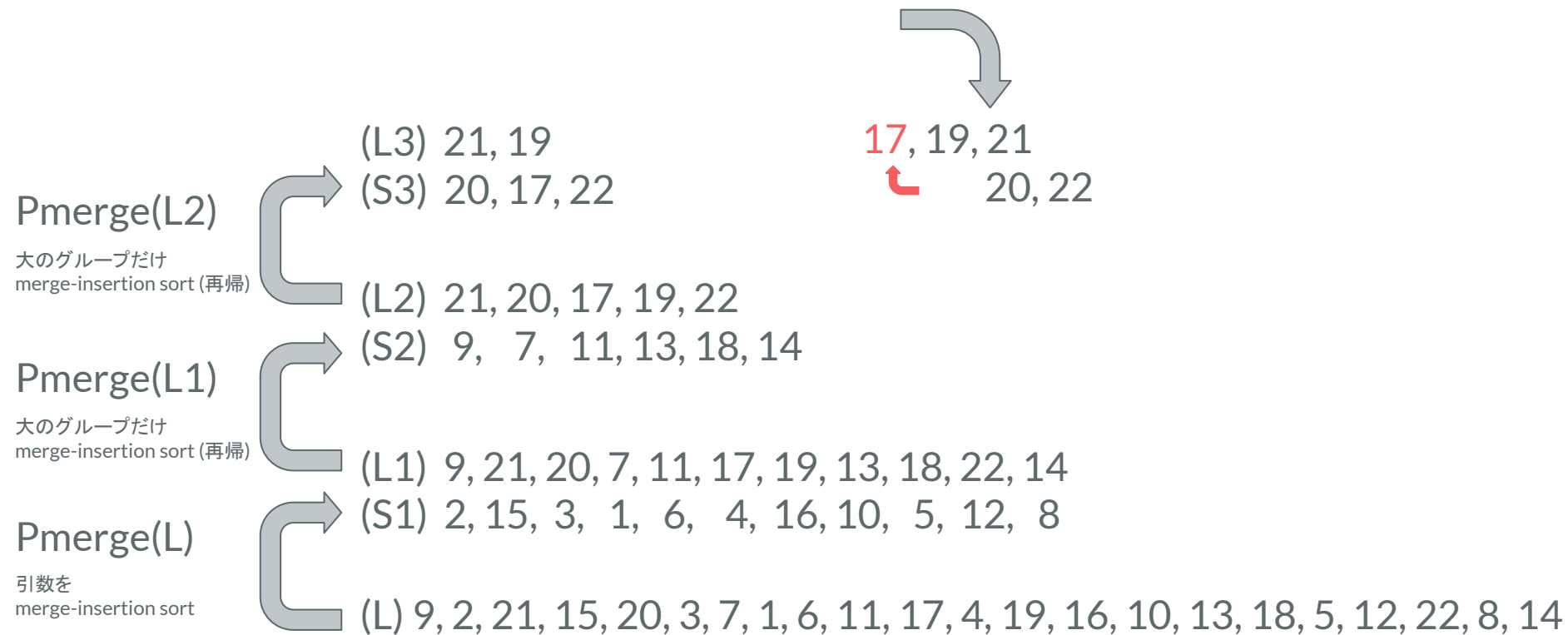
引数を
merge-insertion sort



(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

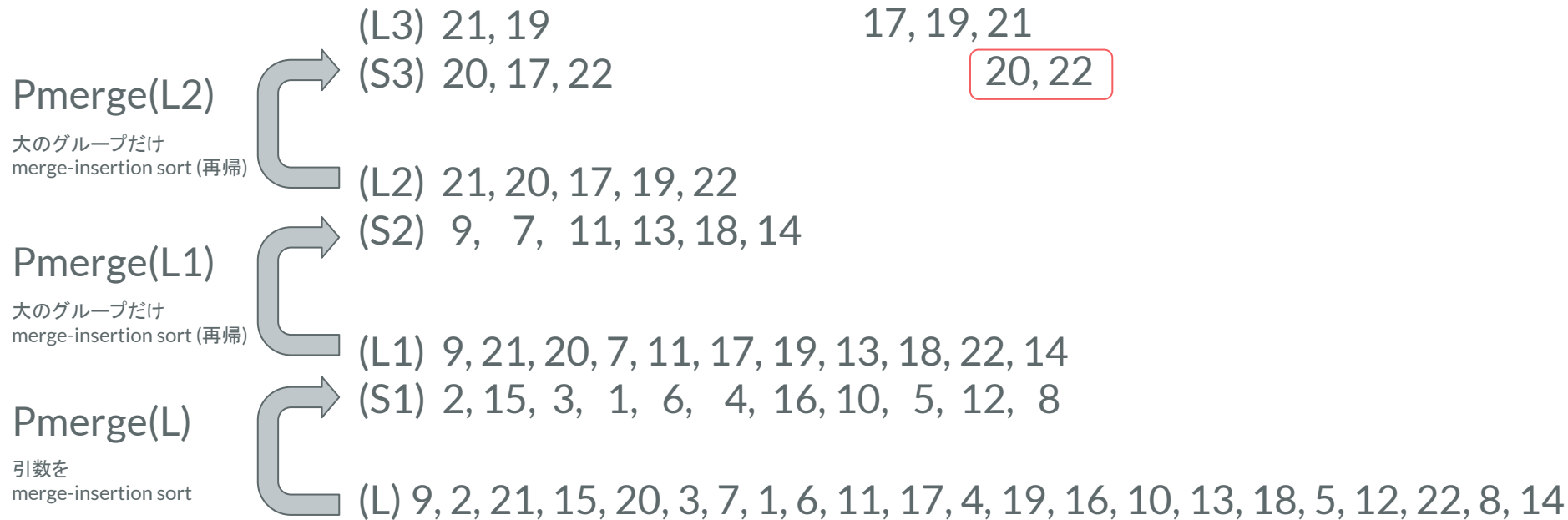
(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

- ・要素2以上なのでまず先頭pairの小さい方を先頭にmerge。



- ・要素 2 以上なのでまず先頭pair の小さい方を先頭にmerge。
- ・S グループを 2, 2, 6, 10, 22, 42, ...
(Jacobsthal number の 2 倍...? wiki にも書いてある) のグループに分割

17, 19, 21
20, 22



- ・要素 2 以上なのでまず先頭pair の小さい方を先頭にmerge。
- ・S グループを 2, 2, 6, 10, 22, 42, ...
(Jacobsthal number の 2 倍...? wiki にも書いてある) のグループに分割
- ・グループ内で右から左の順(22 → 20 の順)で L3 に二分探索して挿入していく
二分探索の範囲は L3 の先頭 ~ pair の前まで



17, 19, 21

20, 22

(L3) 21, 19

(S3) 20, 17, 22

Pmerge(L2)

大のグループだけ
merge-insertion sort (再帰)

(L2) 21, 20, 17, 19, 22

(S2) 9, 7, 11, 13, 18, 14

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

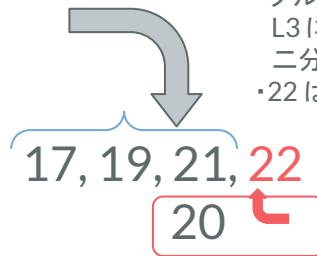
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

Pmerge(L)

引数を
merge-insertion sort

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

- ・要素 2 以上なのでまず先頭pair の小さい方を先頭にmerge。
- ・S グループを 2, 2, 6, 10, 22, 42, ...
(Jacobsthal number の 2 倍...? wiki にも書いてある) のグループに分割
- ・グループ内で右から左の順(22 → 20 の順)で L3 に二分探索して挿入していく
二分探索の範囲は L3 の先頭 ~ pair の前まで
- ・22 は 17 ~ 21 の範囲を二分探索(偶然最大...)



Pmerge(L2)

(L3) 21, 19
(S3) 20, 17, 22

大のグループだけ
merge-insertion sort (再帰)

Pmerge(L1)

(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

大のグループだけ
merge-insertion sort (再帰)

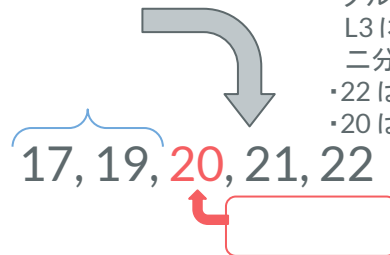
Pmerge(L)

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

引数を
merge-insertion sort

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

- ・要素 2 以上なのでまず先頭pair の小さい方を先頭にmerge。
- ・S グループを 2, 2, 6, 10, 22, 42, ...
(Jacobsthal number の 2 倍... ? wiki にも書いてある) のグループに分割
- ・グループ内で右から左の順(22 → 20 の順)で L3 に二分探索して挿入していく
二分探索の範囲は L3 の先頭 ~ pair の前まで
- ・22 は 17 ~ 21 の範囲を二分探索(偶然最大...)
- ・20 は 17 ~ 19 の範囲を二分探索(偶然最大...)



Pmerge(L2)

(L3) 21, 19
(S3) 20, 17, 22

大のグループだけ
merge-insertion sort (再帰)

Pmerge(L1)

(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

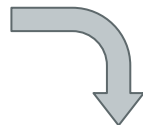
大のグループだけ
merge-insertion sort (再帰)

Pmerge(L)

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

引数を
merge-insertion sort

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14



17, 19, 20, 21, 22



sort 済みになった(S3 がなくなった) ので

(L3) 21, 19

(S3) 20, 17, 22

Pmerge(L2)

大のグループだけ
merge-insertion sort (再帰)



(L2) 21, 20, 17, 19, 22

(S2) 9, 7, 11, 13, 18, 14

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

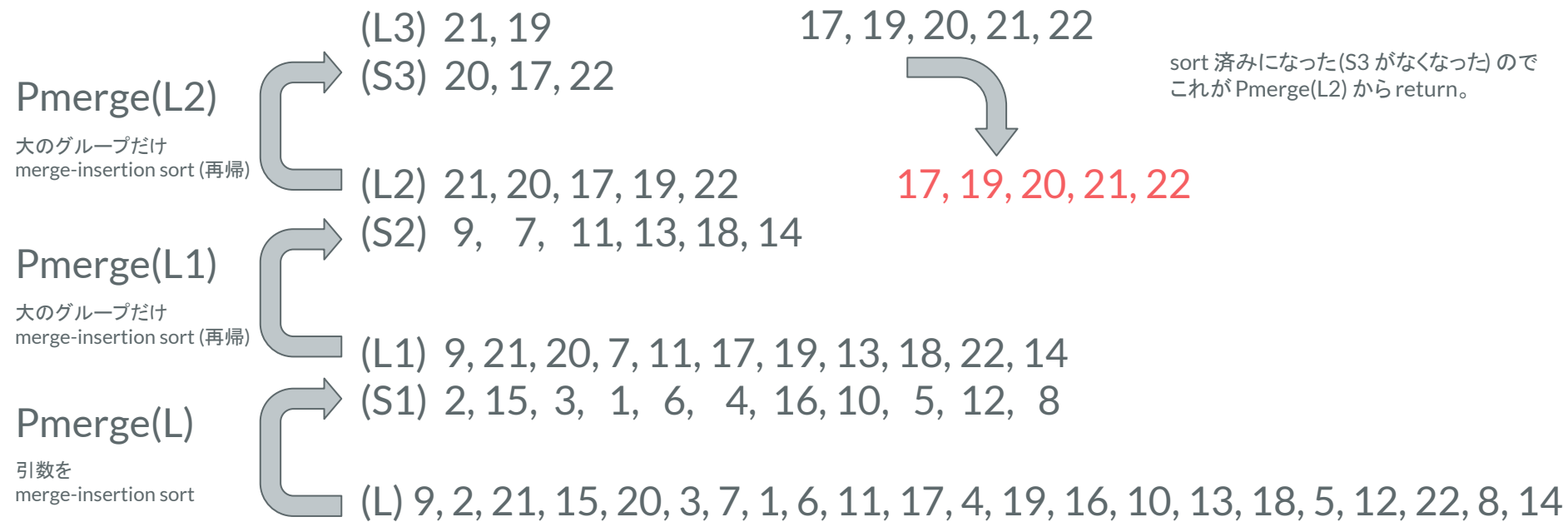
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

Pmerge(L)

引数を
merge-insertion sort



(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14





17, 19, 20, 21, 22

(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14



Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8



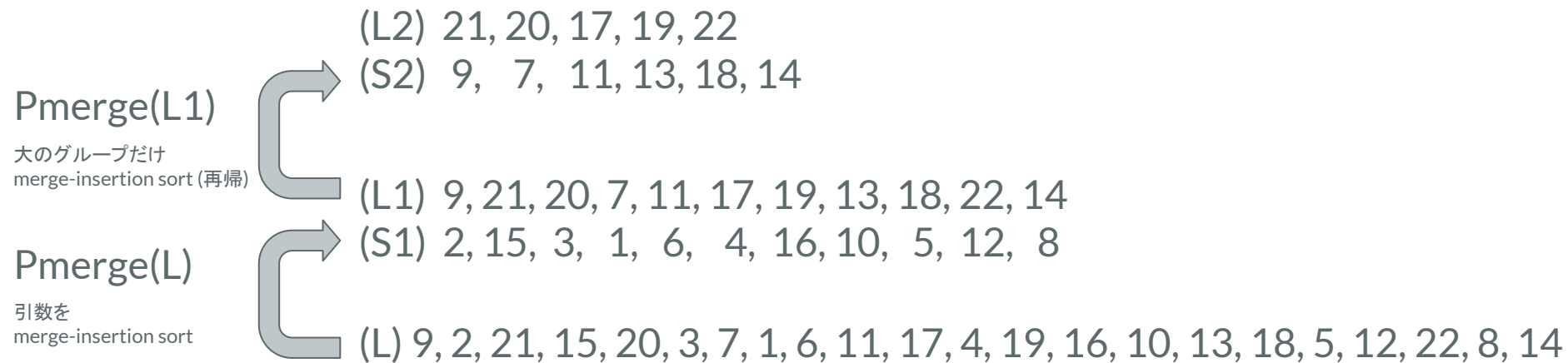
Pmerge(L)

引数を
merge-insertion sort

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14



17, 19, 20, 21, 22





17, 19, 20, 21, 22

11, 13, 7, 9, 18, 14

(L2) 21, 20, 17, 19, 22

(S2) 9, 7, 11, 13, 18, 14

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)

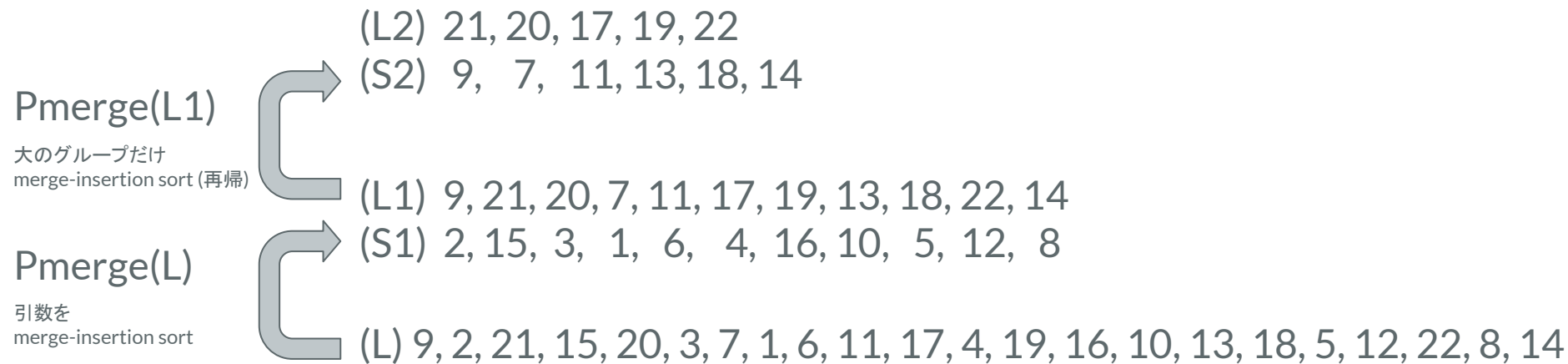
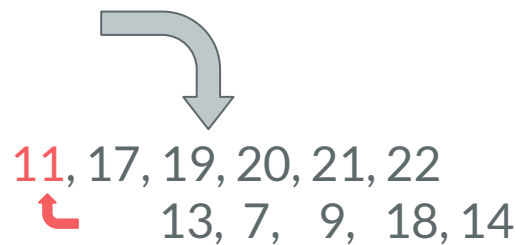
(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

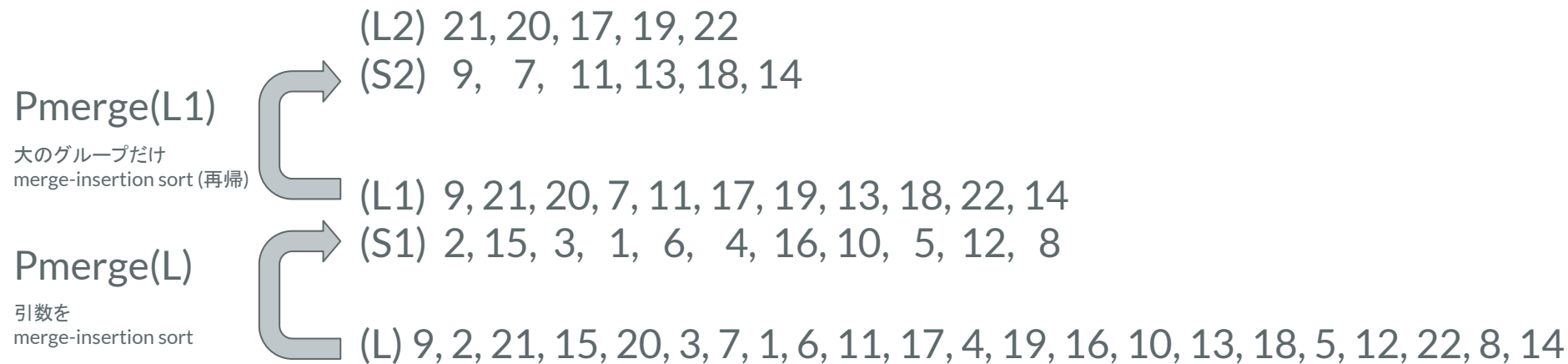
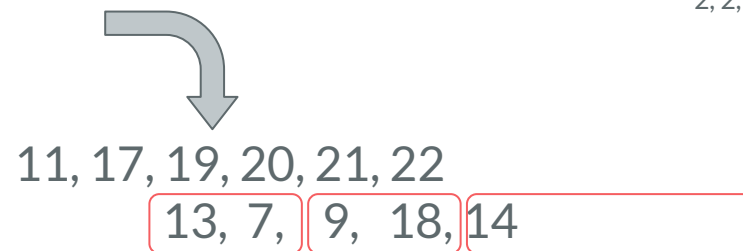
Pmerge(L)

引数を
merge-insertion sort

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14



グループ分け
2, 2, 6, ...



先頭グループから順に。
グループ内は右から。
二分探索の範囲は先頭からpair 前まで



Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)

(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

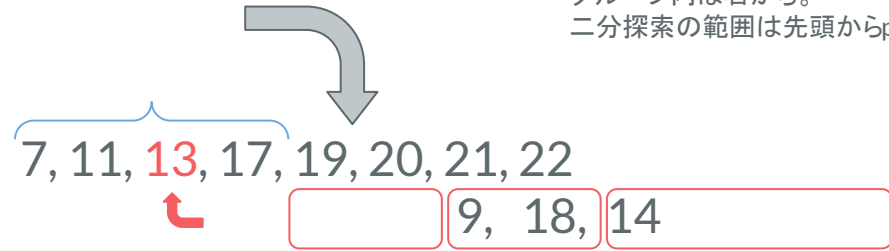
Pmerge(L)

引数を
merge-insertion sort

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

先頭グループから順に。
グループ内は右から。
二分探索の範囲は先頭からpair 前まで



(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

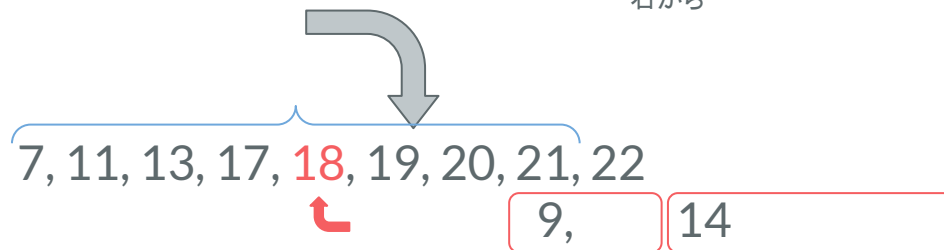
Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)

Pmerge(L)

引数を
merge-insertion sort

次のグループ
右から



Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)

(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

Pmerge(L)

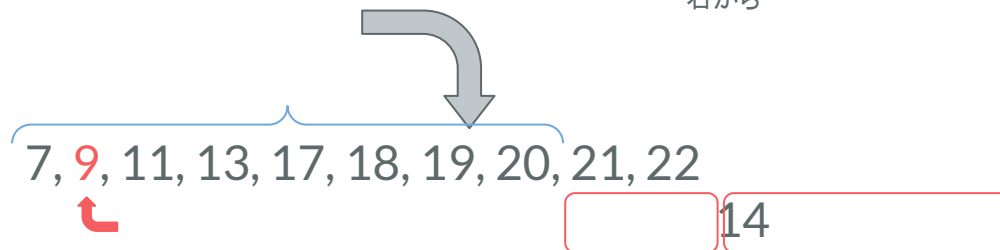
引数を
merge-insertion sort

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

次のグループ
右から



Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)

(L2) 21, 20, 17, 19, 22
(S2) 9, 7, 11, 13, 18, 14

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

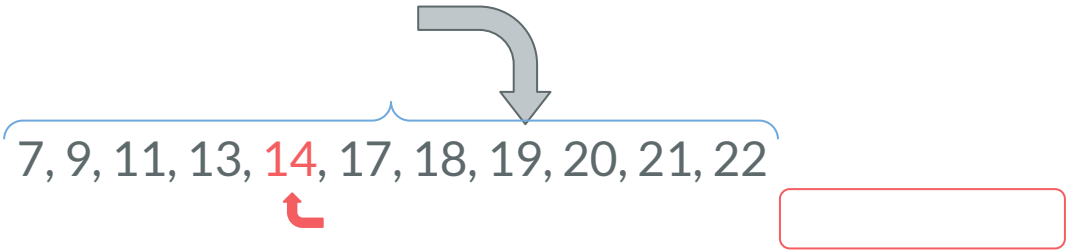
Pmerge(L)

引数を
merge-insertion sort

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

次のグループ



Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)



- (L2) 21, 20, 17, 19, 22
- (S2) 9, 7, 11, 13, 18, 14

Pmerge(L)

引数を
merge-insertion sort



- (S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8
- (L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

sort done.
return from Pmerge(L1).

7, 9, 11, 13, 14, 17, 18, 19, 20, 21, 22

Pmerge(L1)

大のグループだけ
merge-insertion sort (再帰)



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

Pmerge(L)

引数を
merge-insertion sort



(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14



7, 9, 11, 13, 14, 17, 18, 19, 20, 21, 22
 1, 2, 6, 10, 8, 4, 5, 16, 3, 15, 12



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8



(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort

先頭

1, 7, 9, 11, 13, 14, 17, 18, 19, 20, 21, 22
2, 6, 10, 8, 4, 5, 16, 3, 15, 12



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

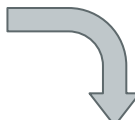


(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort

group 2, 2, 6, 10, ...



1, 7, 9, 11, 13, 14, 17, 18, 19, 20, 21, 22
2, 6, 10, 8, 4, 5, 16, 3, 15, 12

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

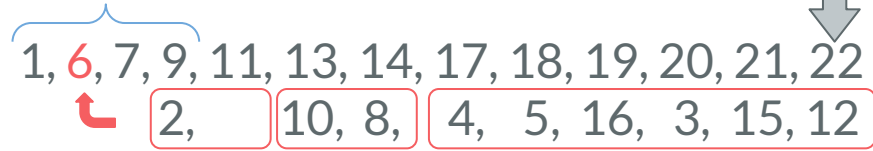
(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort



insert



1, 6, 7, 9, 11, 13, 14, 17, 18, 19, 20, 21, 22
2, 10, 8, 4, 5, 16, 3, 15, 12



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

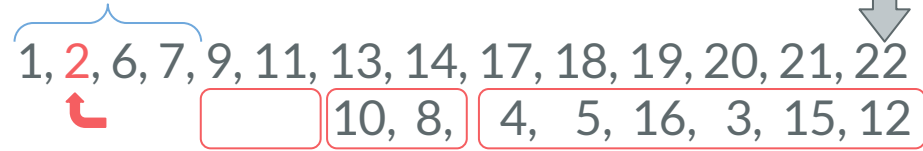
(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort



insert



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

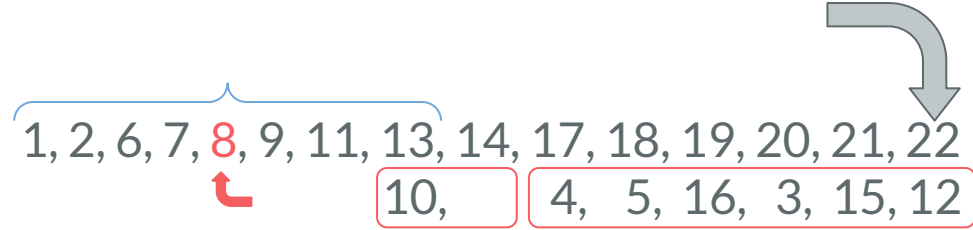
(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort



insert



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort



insert

1, 2, 6, 7, 8, 9, 10, 11, 13, 14, 17, 18, 19, 20, 21, 22
4, 5, 16, 3, 15, 12

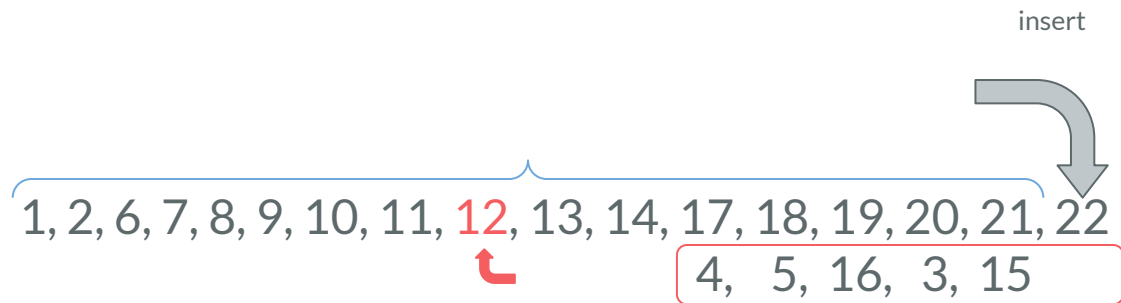
(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort



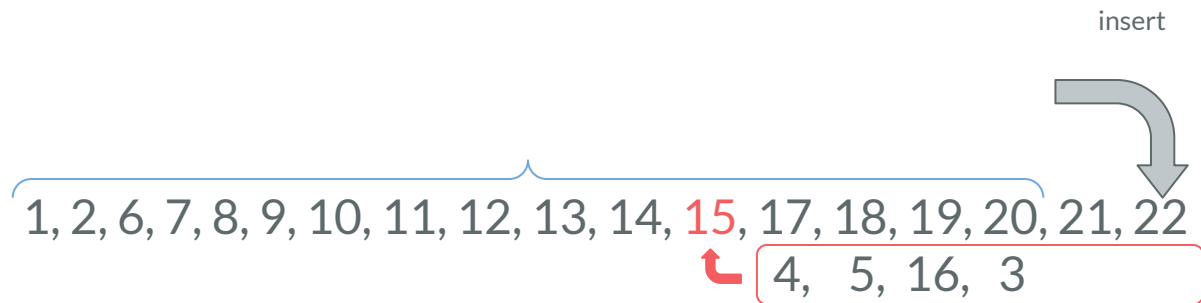
(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort



Pmerge(L)

引数を
merge-insertion sort



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

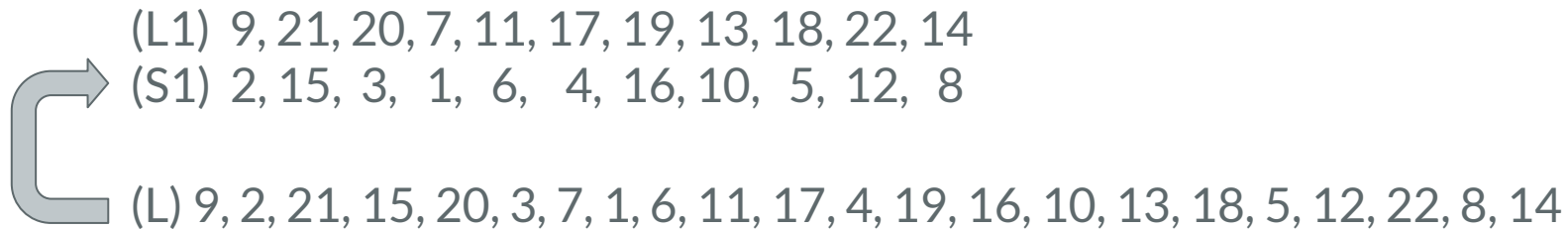
(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14



Pmerge(L)

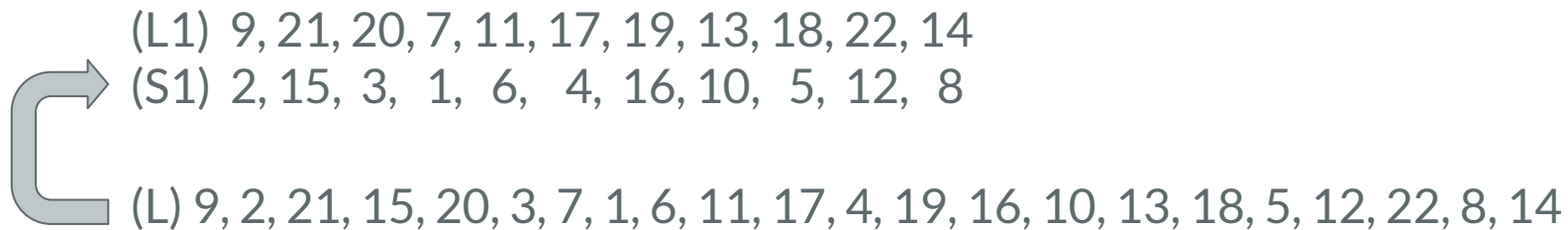
引数を
merge-insertion sort





Pmerge(L)

引数を
merge-insertion sort



insert

1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
4,

(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

引数を
merge-insertion sort

insert

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22



(L1) 9, 21, 20, 7, 11, 17, 19, 13, 18, 22, 14

(S1) 2, 15, 3, 1, 6, 4, 16, 10, 5, 12, 8

(L) 9, 2, 21, 15, 20, 3, 7, 1, 6, 11, 17, 4, 19, 16, 10, 13, 18, 5, 12, 22, 8, 14

Pmerge(L)

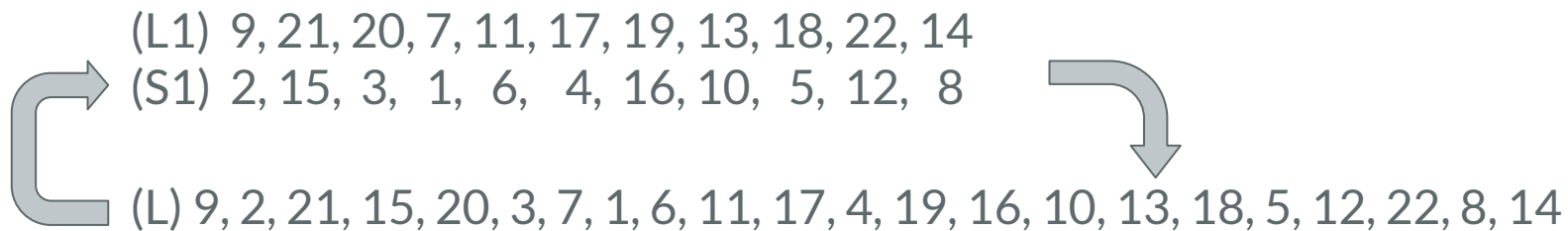
引数を
merge-insertion sort

done.
return from Pmerge(L).

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

Pmerge(L)

引数を
merge-insertion sort



merge-insertion sort done.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22