2. external sorting

Note that we need 2 dummy runs (run length is zero)
for optimal 4-way merge which must merged first to be optimal.

* 4-way merge sequence :
  step 1: (0,0,100,200) ==> 300
  step 2: (300,300,400,500) ==> 1500
  step 3: (1500,600,700,800) ==> 3600

* 8-way merge :
  (100,200,300,400,500,600,700,800) ==> 3600

1) # comparisons
  o 4-way scheme:
    For each step,
    loser tree initialization needs 3 comparisons (one record produced)
    and then each record needs 2 comparisons to output.

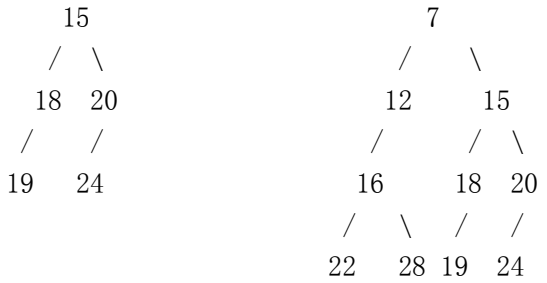
    So, the total # cmps in the 4-way scheme is
    3+(300-1)*2 + 3+(1500-1)*2 + 3+(3600-1)*2 = 10803

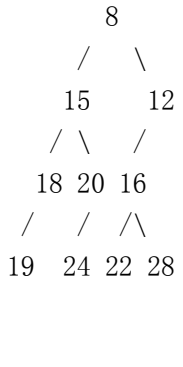
  o 8-way scheme:
    7 + (3600-1)*3 = 10804.

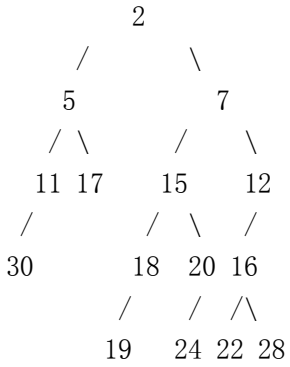
2) # disk IOs
 : Each merge step need 2 disk IOs: one for input and one for output.
 o 4-way scheme: 3*2 + 15*2 + 36*2 = 108.
 o 8-way scheme: 36*2 = 72.

3) 8-way merge is better scheme than 4-way merge scheme
   due to the number of disk IOs.

3.

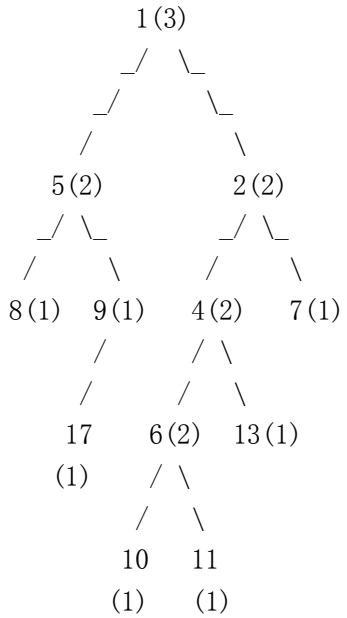






4.

(a)



(b) label S(r)

1	3
2	7
3	15

S(r) = 2*S(r-1) + 1

S(1) = 3.

Solve by repeated substitution

S(r) = 2*S(r-1) + 1

= 2(2*S(r-2)+1) +1

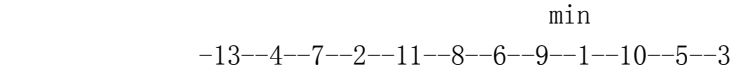
.....

= 2^(r-1) (3) + 2^(r-2) + ... + 2 + 1
> 2^r

then S(r) = n > 2^r
=> log n > r
=> floor(log n) >= r

5. min bionomial heap (omitted steps)

(a) insert keys



(b) DeleteMin
- delete 1
- merge each min bionomial heaps with single element