CS3000: Algorithms & Data — Summer '25 — Laney Strange

Mergesort Algorithm

Mergesort is a divide-and-conquer recursive algorithm. It *divides* by making the input array smaller and smaller and smaller until it's trivially easy to sort (sorting the trivially easy is the *conquer* step). Then it merges together the smaller sorted subarrays – that's the final step, which we call *combine*.

```
MERGESORT(A, p, r)
1  if p < r
2       q = ⌊(p + r)/2⌋
3       MERGESORT(A, p, q)
4       MERGESORT(A, q + 1, r)
5       MERGE(A, p, q, r)
```

```
MERGE(A, p, q, r)
 1  n_L = q − p + 1
 2  n_R = r − q
 3  let L[1 : n_L] and R[1 : n_R] be new arrays
 4  for i = 1 to n_L
 5       L[i] = A[p + i − 1]
 6  for j = 1 to n_R
 7       R[j] = A[q + j]
 8  i = 1
 9  j = 1
10  k = p
11  while i ≤ n_L and j ≤ n_R
12       if L[i] ≤ R[j]
13            A[k] = L[i]
14            i = i + 1
15       else
16            A[k] = R[j]
17            j = j + 1
18       k = k + 1
19  while i ≤ n_L
20       A[k] = L[i]
21       i = i + 1
22       k = k + 1
23  while j ≤ n_R
24       A[k] = R[j]
25       j = j + 1
26       k = k + 1
```

Here's how we typeset the above functions in CLRS style:

```
\begin{codebox}
\Procname{$\proc{Mergesort}(A, p, r)$}
\li \If $p < r$
\Then
\li $q \gets \lfloor(p+r)/2\rfloor$
\li $\proc{Mergesort}(A, p, q)$
\li $\proc{Mergesort}(A, q+1, r)$
\li $\proc{Merge}(A, p, q, r)$
\end{codebox}

\medskip

\begin{codebox}
\Procname{$\proc{Merge}(A, p, q, r)$}
\li $n_L = q - p + 1$
\li $n_R = r-q$
\li let $L[1:n_L]$ and  $R[1:n_R]$ be new arrays
\li \For $i \gets 1 \To n_L$
\Do
\li $L[i] \gets A[p+i-1]$
\End
\li \For $j \gets 1 \To n_R$
\Do
\li $R[j] \gets A[q+j]$
\End
\li $i \gets 1$
\li $j \gets 1$
\li $k \gets p$
\li \While $i \le n_L$ and $j \le n_R$
\Do
\li \If $L[i] \le R[j]$
\Then
\li $A[k] \gets L[i]$
\li $i \gets i + 1$
\li \Else
\li $A[k] \gets R[j]$
\li $j \gets j + 1$
\End
\li $k \gets k + 1$
\End
\li \While $i \le n_L$
\Do
\li $A[k] \gets L[i]$
\li $i \gets i + 1$
\li $k \gets k + 1$
\End
\li \While $j \le n_R$
\Do
```

```
\li $A[k] \gets R[j]$
\li $j \gets j + 1$
\li $k \gets k + 1$
\End
\end{codebox}
```