1a) $M = 5$ buffers $\quad N = 200$ blocks

$$I/Os = 2N(1 + \log_{M-1} N/M)$$
$$= 2(200)(1 + \log_4 200/5)$$
$$= 400(1 + \log_4 40)$$
$$= 400(1+3) = \boxed{1600\ I/Os}$$

$200/5 =$ 40 sorted runs after 1st merge

$40/4 =$ 10 sorted runs after 2nd merge

1b) $M = 8$ buffers $\quad N = 200$ blocks

$$I/Os = 2N(1 + \log_{M-1} N/M)$$
$$= 2(200)(1 + \log_7 200/8)$$
$$= 400(1 + \log_7 25)$$
$$= 400(1+2) = \boxed{1200\ I/Os}$$

$200/8 =$ 25 sorted runs after 1st merge

$25/7 \approx 3.57 \rightarrow$ 4 sorted runs after 2nd merge

2.1) Yes

20×10^6 entries

292 entries / block $\rightarrow$ $20 \times 10^6 \text{ entries} \cdot \dfrac{\text{block}}{292 \text{ entries}}$

$\approx 68493.15 \rightarrow \boxed{68494 \text{ blocks}}$

2.2) Yes

10^6 entries (1 entry for each block)

292 entries / block → $10^6 \text{ entries} \cdot \frac{\text{block}}{292 \text{ entries}}$

$\approx 3424.66 \rightarrow \boxed{3425 \text{ blocks}}$

2.3) Yes

20×10^6 entries

292 entries / block → $20 \times 10^6 \text{ entries} \cdot \frac{\text{block}}{292 \text{ entries}}$

$\approx 68493.15 \rightarrow \boxed{68494 \text{ blocks}}$

2.4) No, you can't build a sparse sequential index on unsorted data

2.5) Yes

2nd level index size:

$68494 \text{ entries} \cdot \frac{\text{block}}{292 \text{ entries}}$

$\approx 234.57 \rightarrow \boxed{235 \text{ blocks}}$

Total index size:

$68494 + 235 = \boxed{68729 \text{ blocks}}$

2.6) Yes

2nd level index size:

$3425 \text{ entries} \cdot \frac{\text{block}}{292 \text{ entries}}$

$\approx 11.73 \rightarrow \boxed{12 \text{ blocks}}$

Total index size:

$3425 + 12 = \boxed{3437 \text{ blocks}}$

3.1) N1, N3, N8

3.2) N1, N2, N5, N6, N7

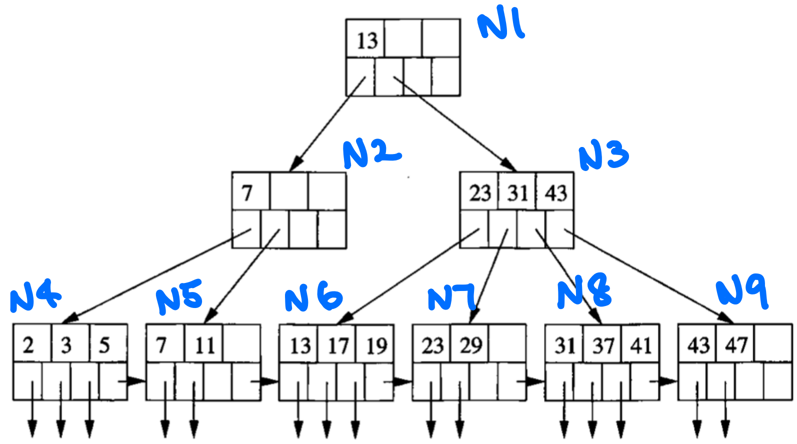
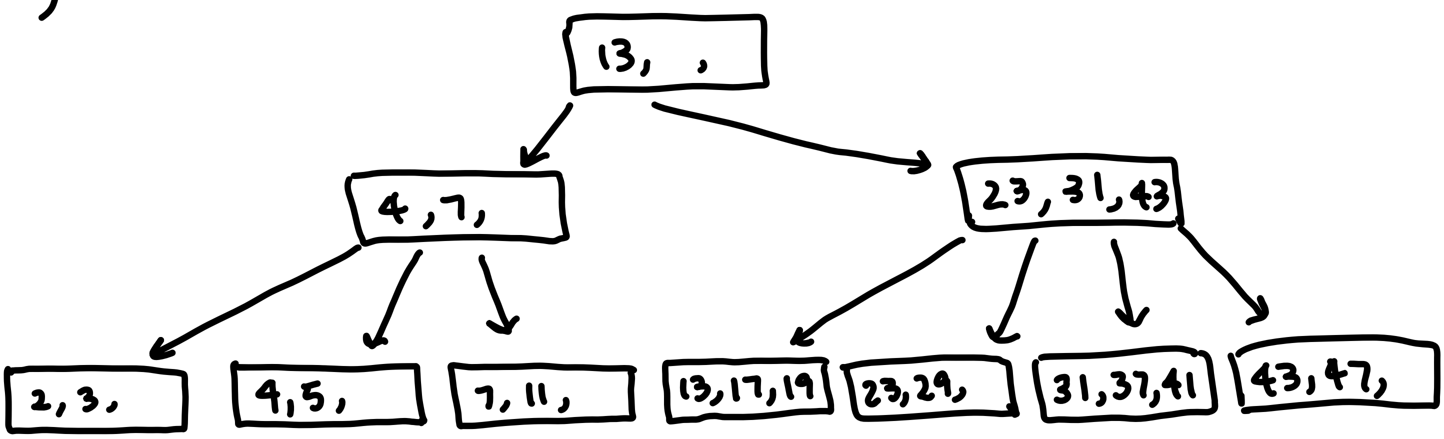
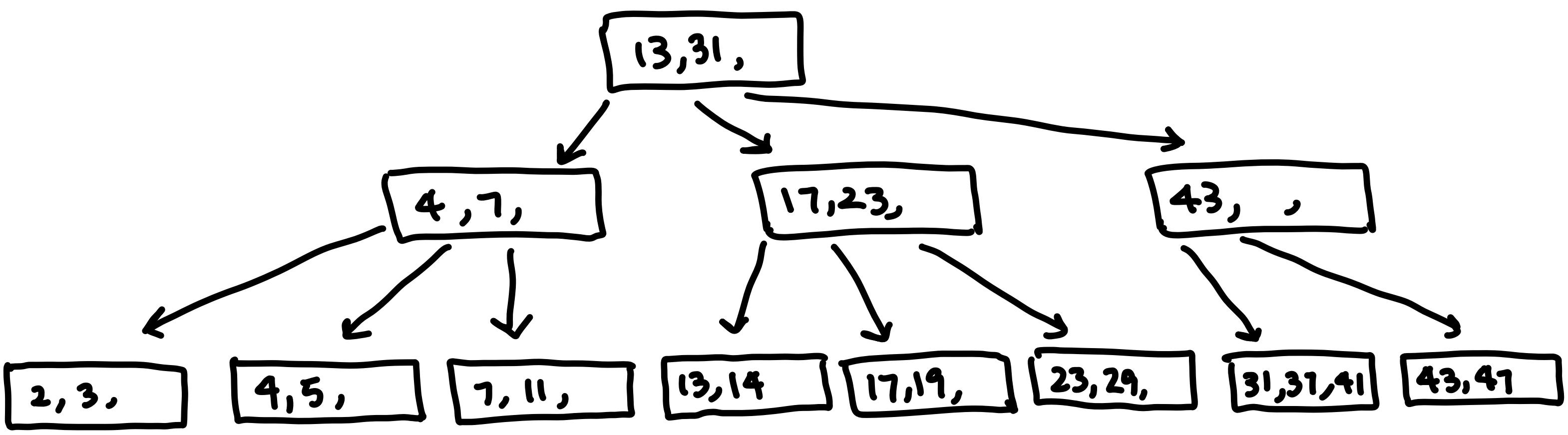


Figure 14.13: A B-tree

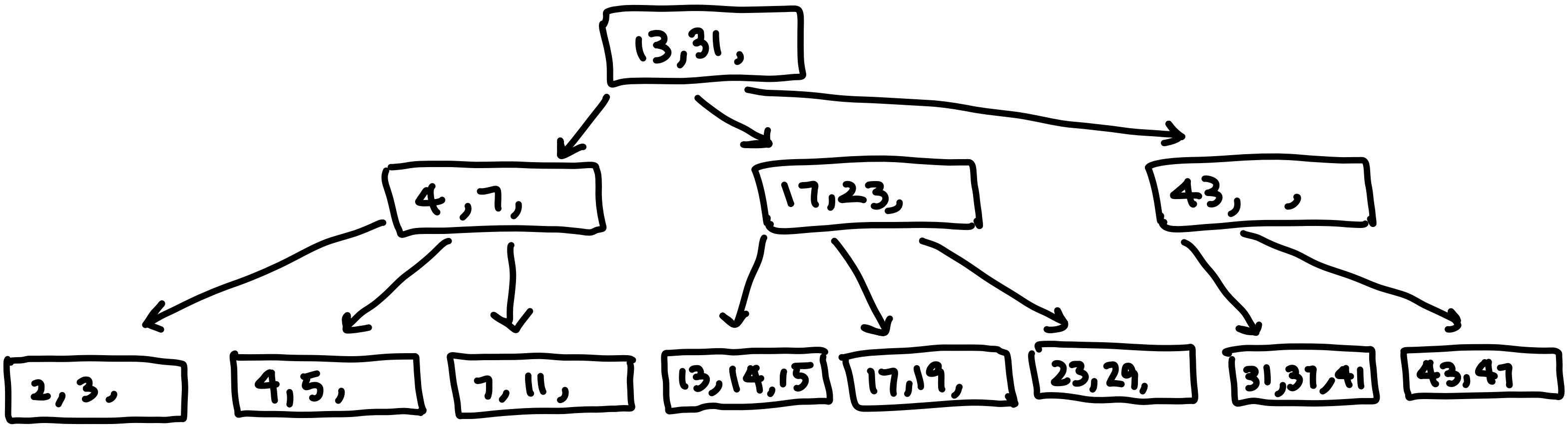
3.3)



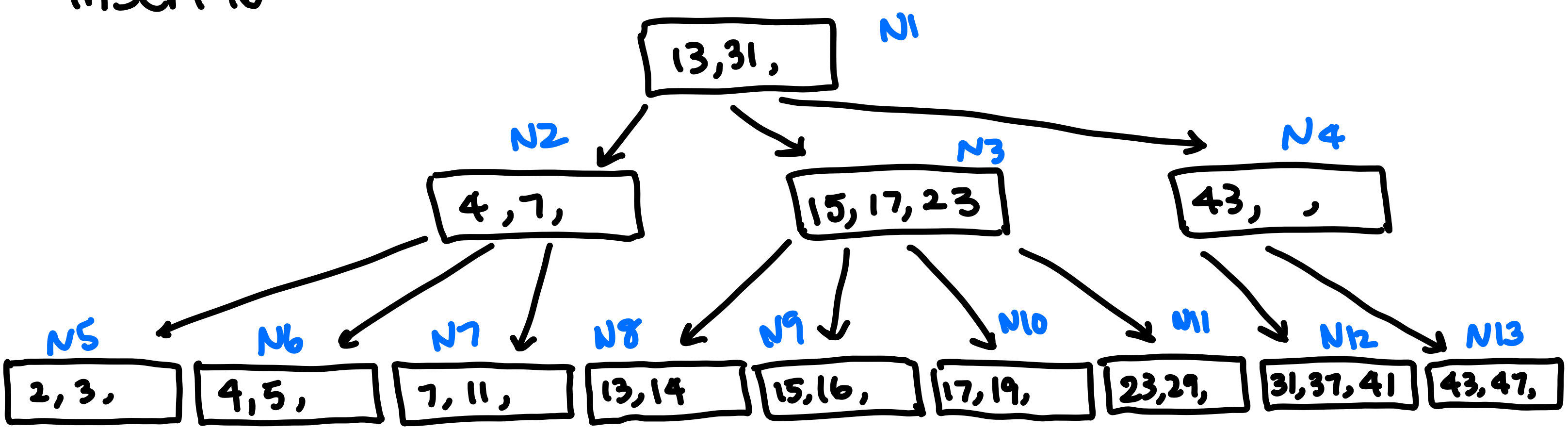
3.4) Insert 14



Insert 15



Insert 16



3.5) N1, N2, N6, N7, N8

3.6)