

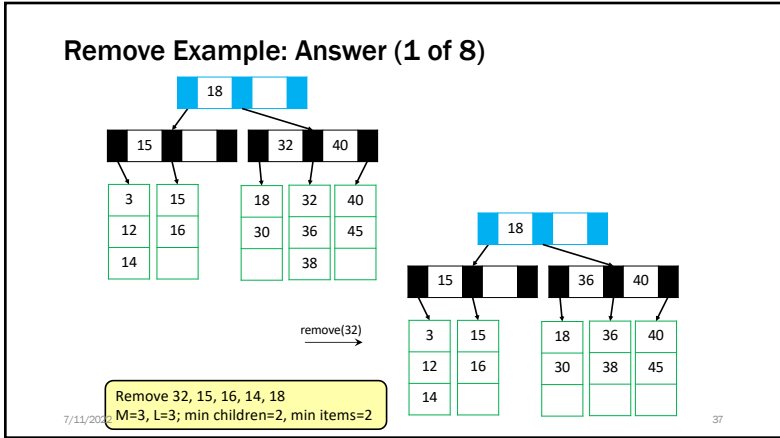
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### B+ Tree Add: Efficiency (1 of 2)

- Find correct **leaf**:  $O(\log_2 M \log_M n)$
- Add (key, value) pair to **leaf**:  $O(L)$ 
  - Why?
- Possibly split **leaf**:  $O(L)$ 
  - Why?
- Possibly split parents all the way up to **root**:  $O(M \log_M n)$ 
  - Why?
- Total:  $O(L + M \log_M n)$

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### B+ Tree Remove: Efficiency (1 of 2)

- Find correct **leaf**:  $O(\log_2 M \log_M n)$
- Remove item from **leaf**:  $O(L)$ 
  - Why?
- Possibly adopt from or merge with neighbor **leaf**:  $O(L)$ 
  - Why?
- Possibly adopt or merge **parent node** up to **root**:  $O(M \log_M n)$ 
  - Why?
- Total:  $O(L + M \log_M n)$

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