Data Structure Week 5

김재용 | 2024.08.07

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2. B Tree
3. B+ Tree

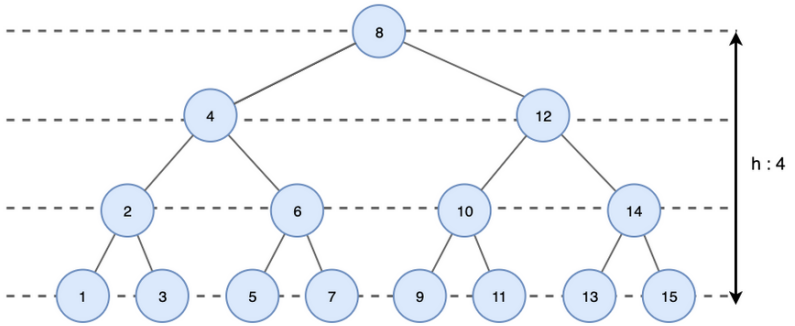
Multiway Search Tree

Binary Search Tree와의 차이점

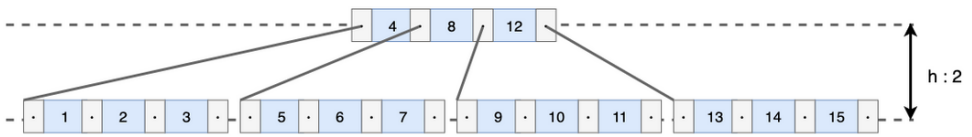
Binary Search Tree는 한 node 당 최대 2개의 child node를 갖게 됨
Tree의 높이가 최소로 잡아도 $log_2 n$이 될 수밖에 없음

-> 한 node에서 여러 갈래로 Child Node를 가질 수 있는 Tree를 제안

주로 C++ STL <map>을 사용해서 구현



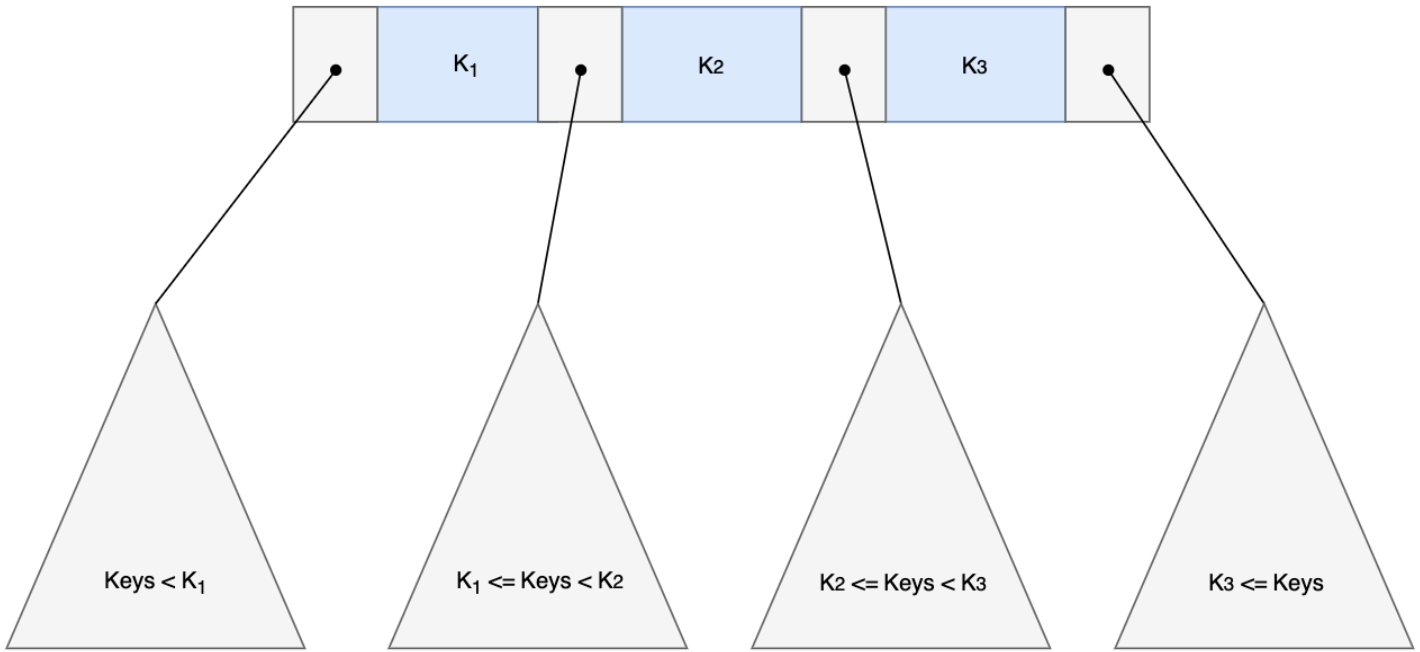
이진 탐색 트리 (Binary Search Tree)



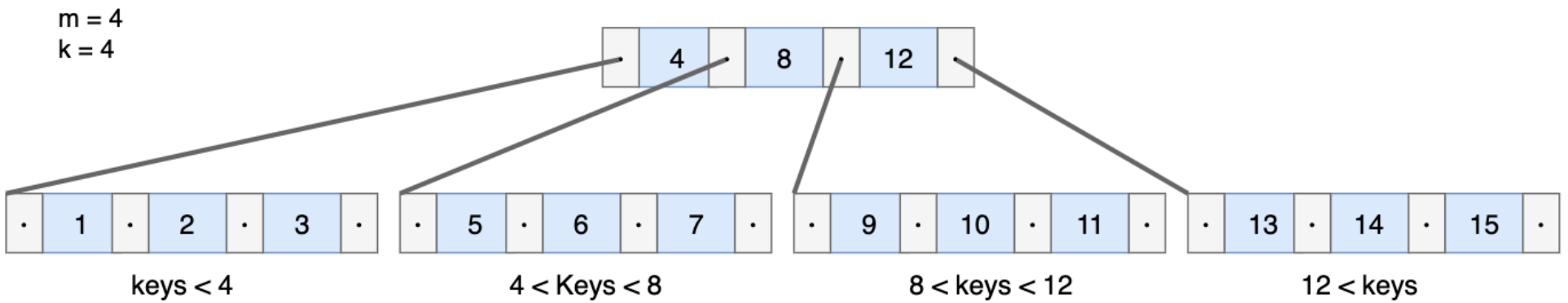
다원 탐색 트리 (m-way Search Tree)

Multiway Search Tree

K: key
m = 4



Multiway Search Tree

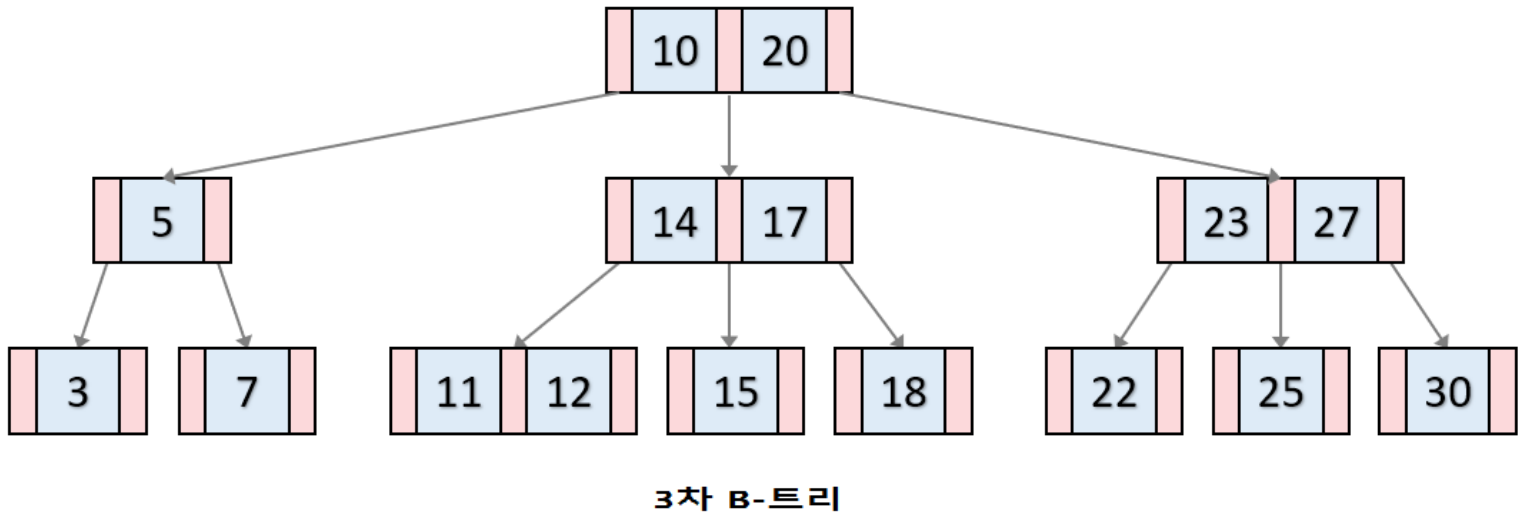


B Tree

Multiway Search Tree의 한 종류

최대 M개의 자식 노드를 가질 수 있는 B Tree를 M차 B Tree라고 함

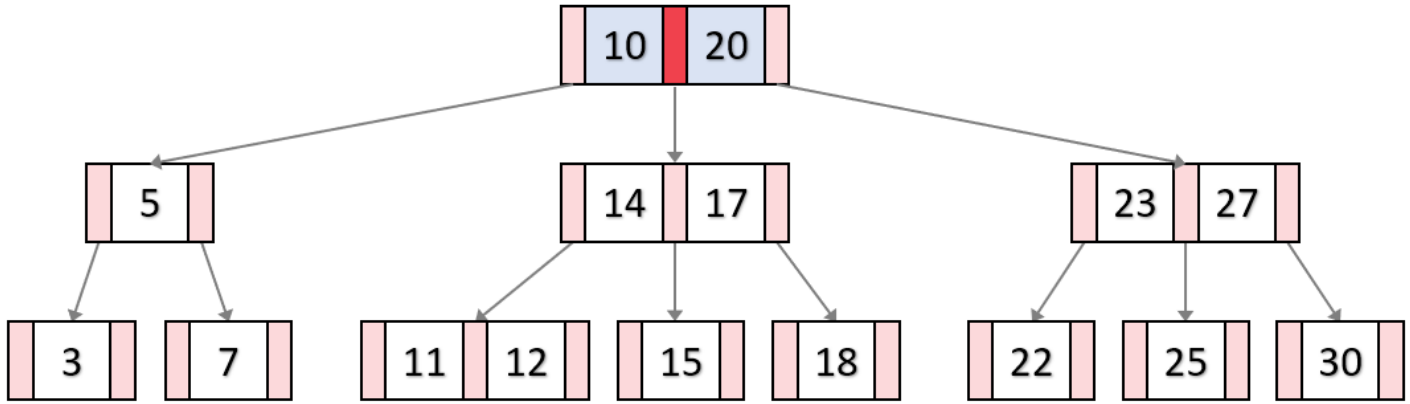
M차 B Tree는 M-1개의 Data를 갖고 있을 수 있음



3차 B-트리

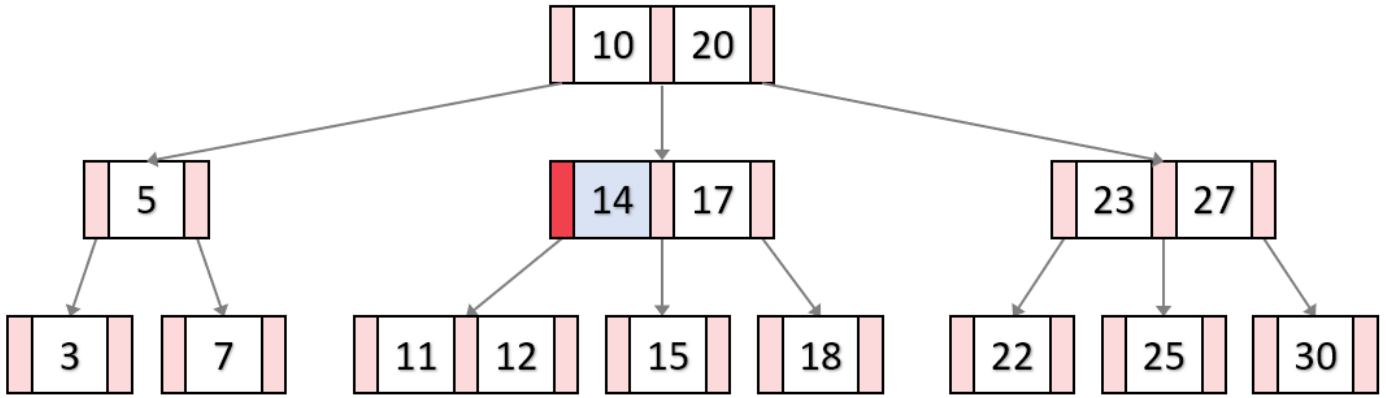
B Tree

1 13 삽입 시작, 루트노드의 key 중 10보다 크고 20보다 작기 때문에 중간 자식노드로 이동



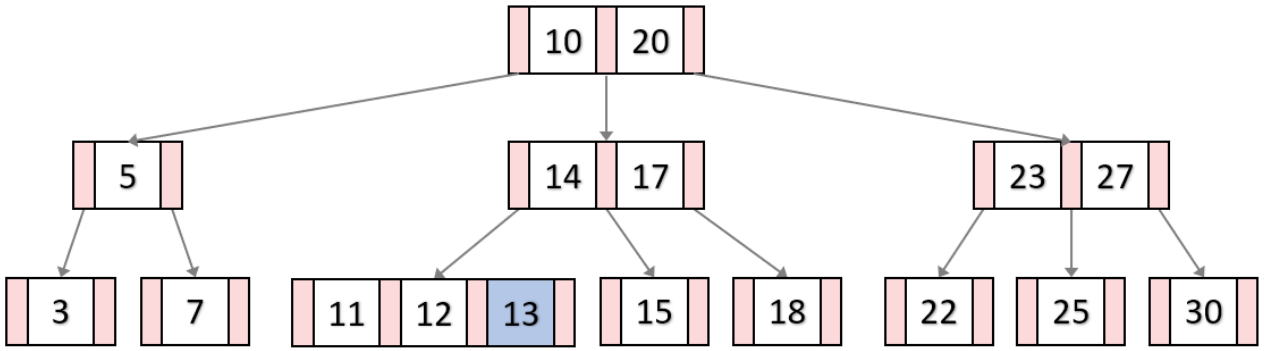
B Tree

2 13은 14보다 작기 때문에, 가장 왼쪽 자식노드로 이동



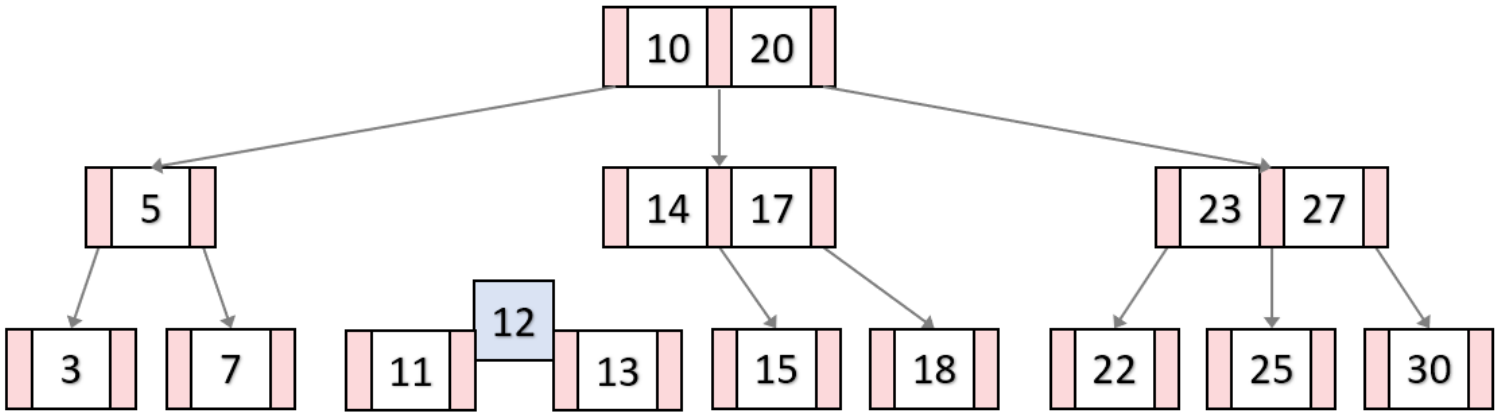
B Tree

3 13은 12보다 크기 때문에 가장 마지막에 삽입. 해당 노드가 최대로 가질 수 있는 key의 개수를 초과했기 때문에 분할을 수행



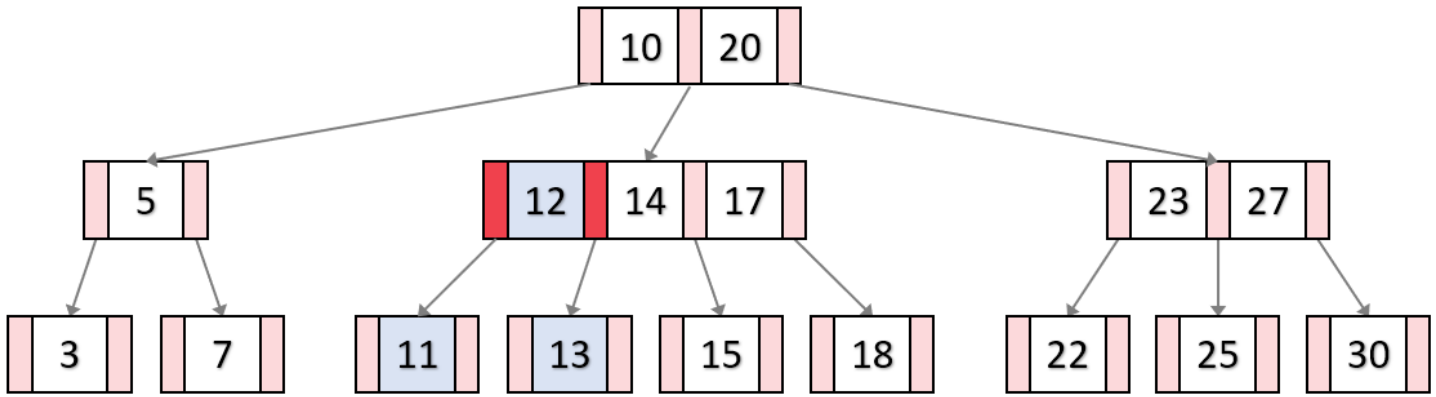
B Tree

4 중앙값 12를 기준으로 분할을 수행



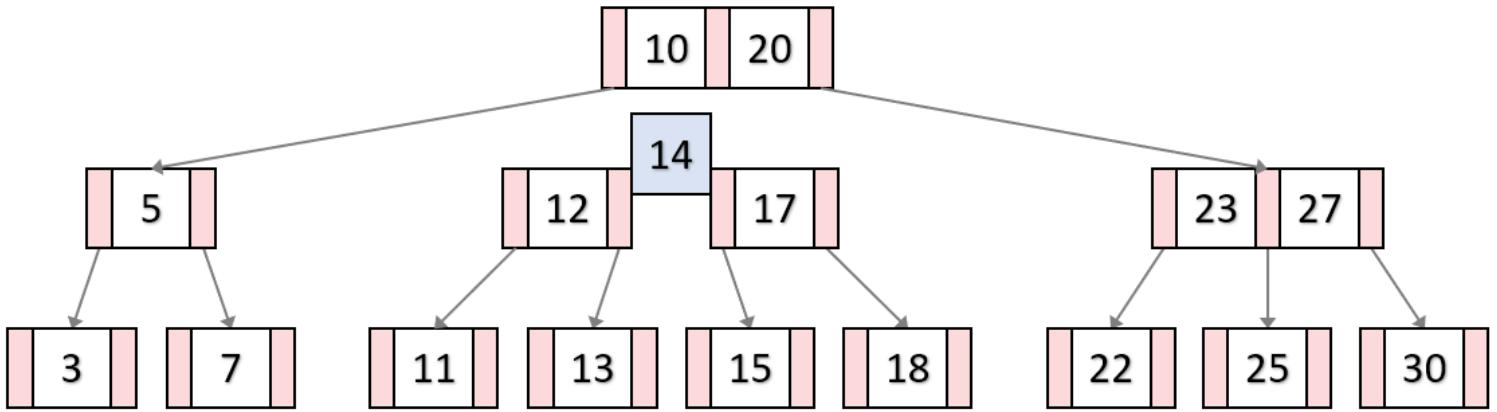
B Tree

5 12는 부모노드에 오름차순으로 삽입, 11과 13은 12의 왼쪽자식, 오른쪽 자식으로 설정



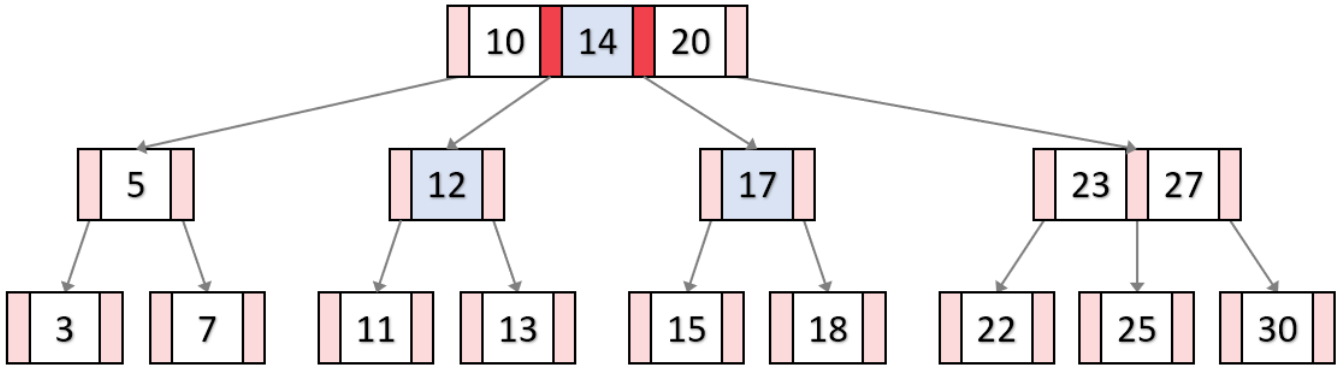
B Tree

6 12가 병합된 노드가 최대로 가질 수 있는 key의 개수를 초과, 중앙값 14를 기준으로 분할을 수행



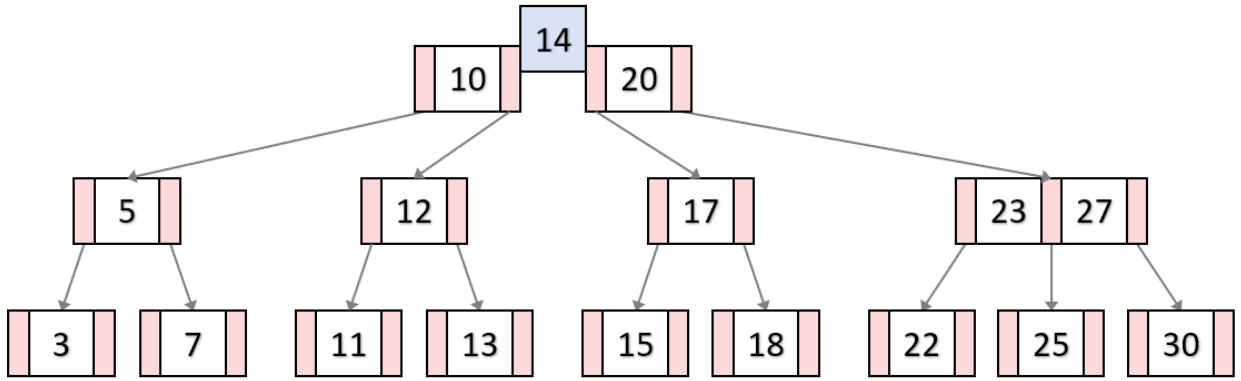
B Tree

7 14는 부모노드에 오름차순으로 삽입, 12과 17은 14의 왼쪽자식, 오른쪽 자식으로 설정



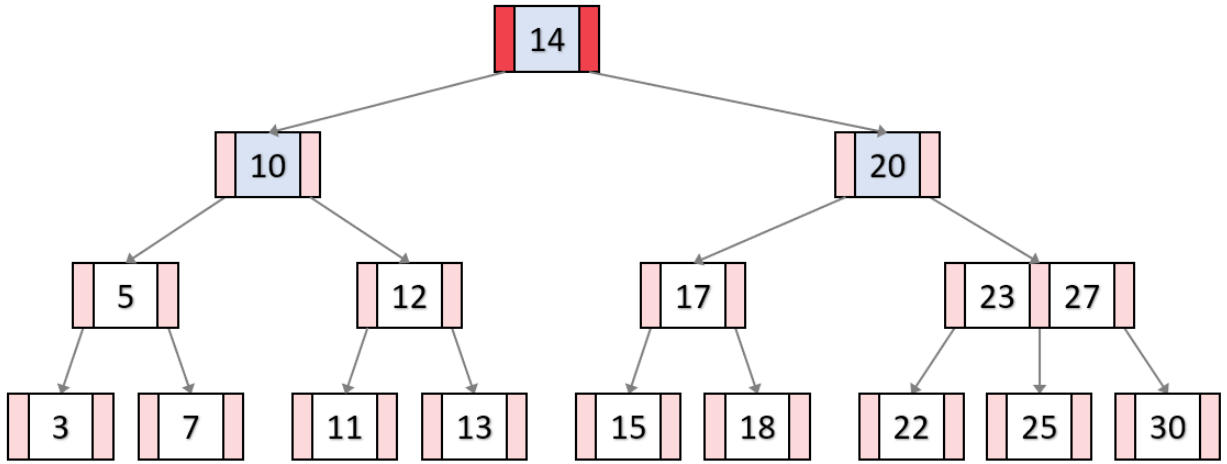
B Tree

8 14가 병합된 노드가 최대로 가질 수 있는 key의 개수를 초과, 중앙값 14를 기준으로 분할을 수행



B Tree

9 14가 새로운 루트노드가 되고, 10과 20은 14의 왼쪽자식, 오른쪽 자식으로 설정. 삽입과정 완료

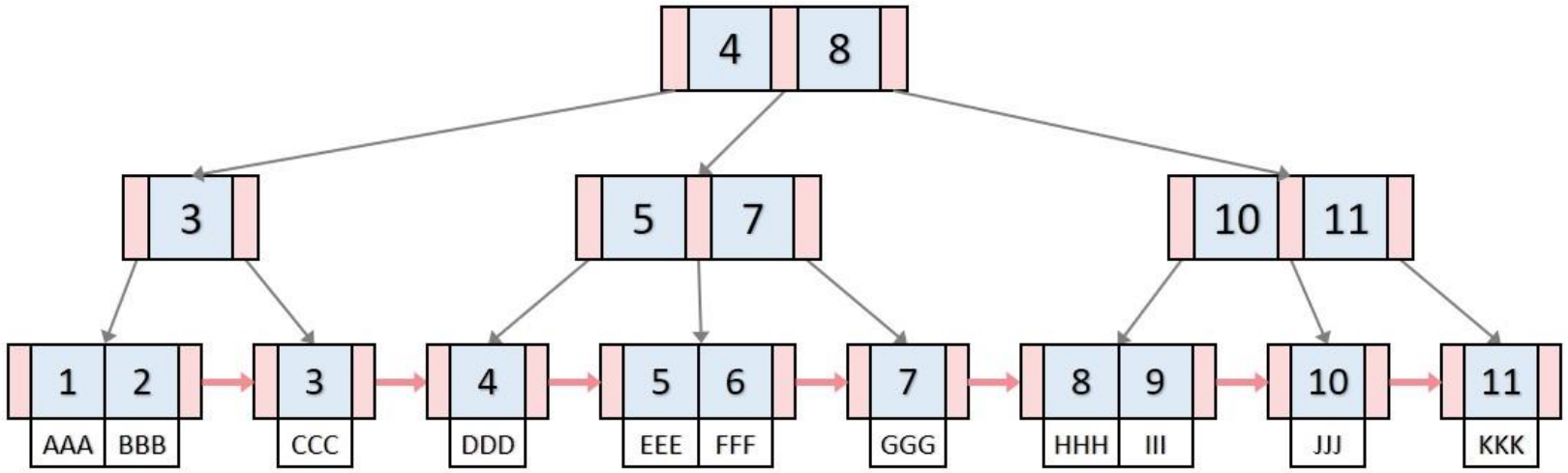


B Tree & B+ Tree

데이터를 저장하는 방식이 다른 Tree들과 다른 점이 있음

한 노드의 1개의 데이터를 저장하는 이전의 방식들과 달리 여러 개의 데이터를 저장해야 하므로 노드에 key-value 쌍으로 데이터를 저장하는 map을 갖고 있음

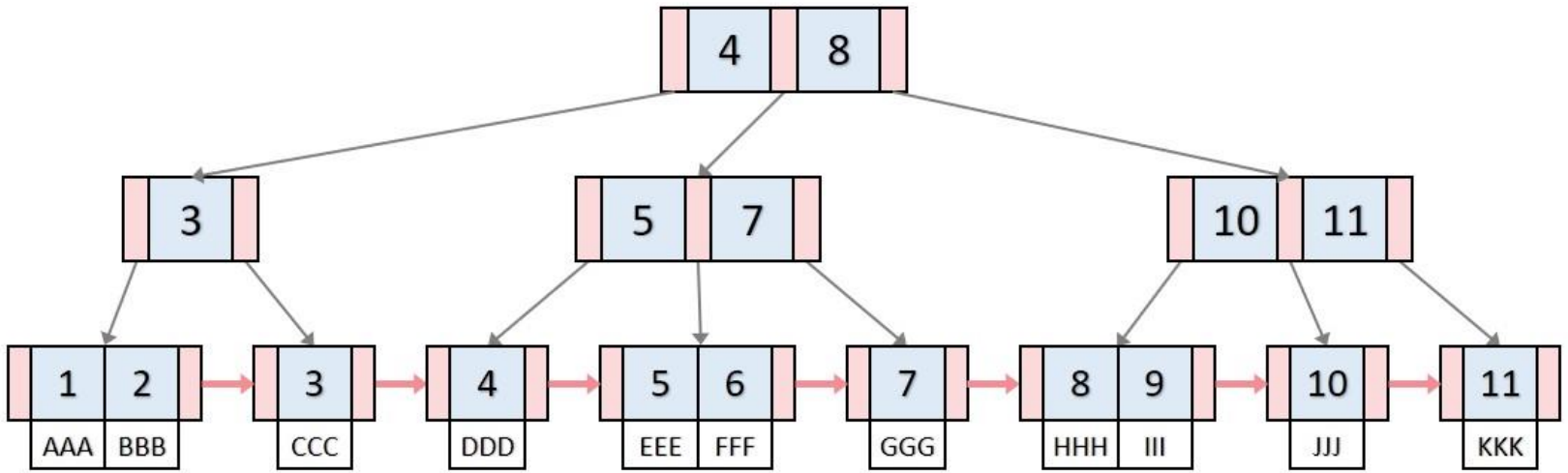
Map: {key, value} 형태로 데이터를 저장하는 컨테이너



B+ Tree

B Tree에서 데이터의 구간 Search를 용이하게 만든 트리

노드가 index node와 data node로 나뉨



B+ Tree

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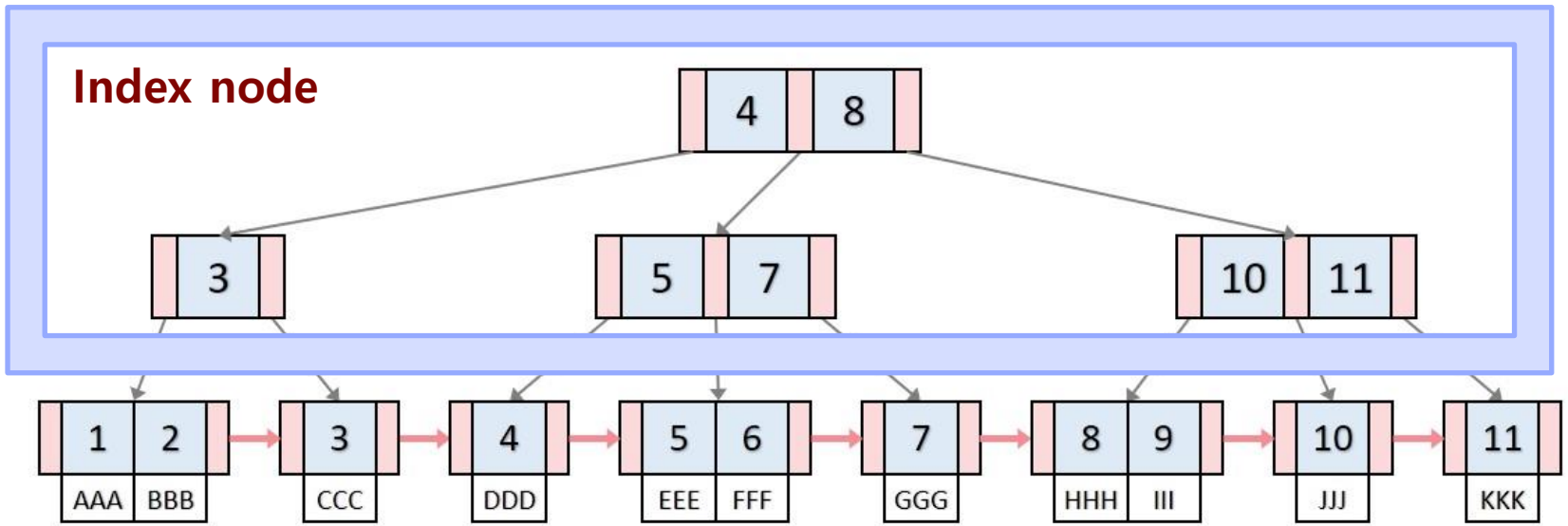
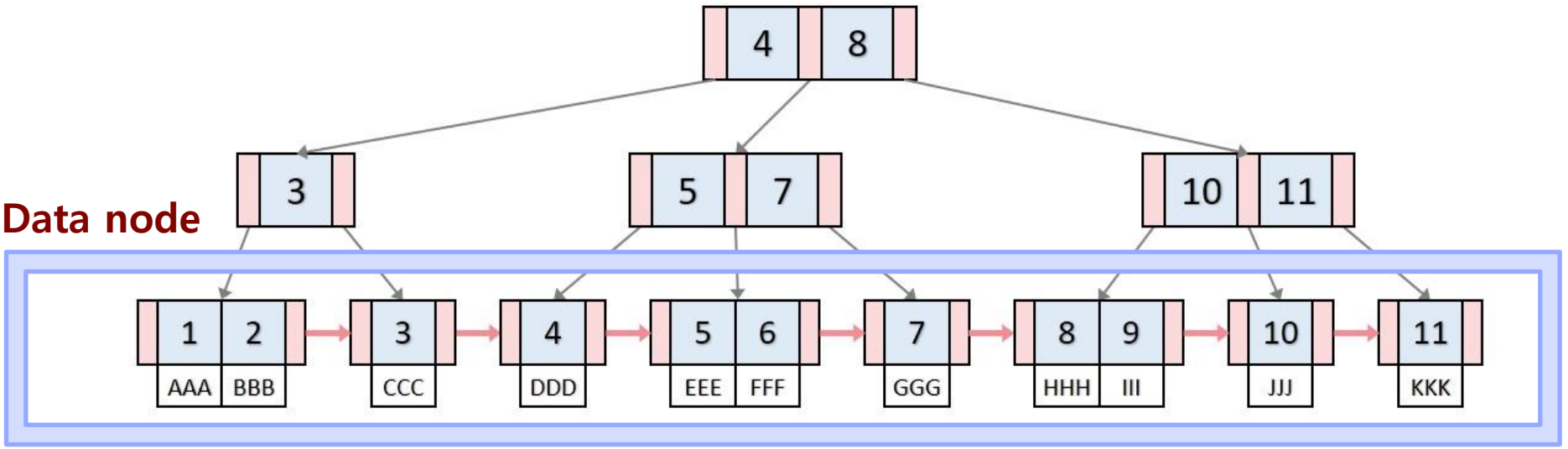


B+ Tree

B Tree에서 데이터의 구간 Search를 용이하게 만든 트리

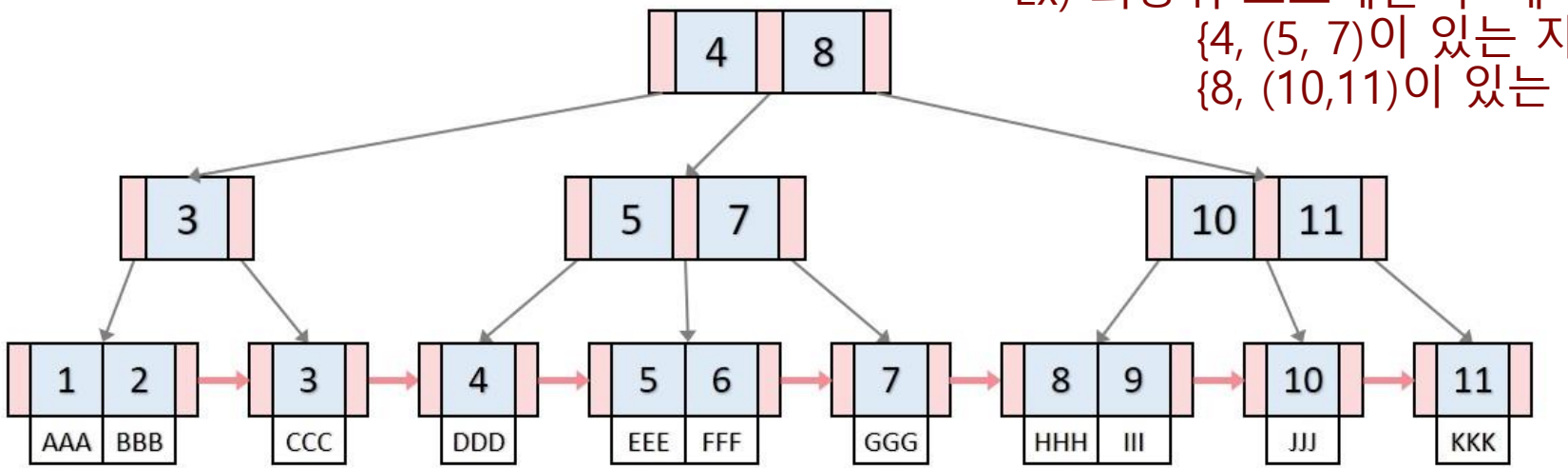
노드가 index node와 data node로 나뉨



B+ Tree

Index Node
리프 노드가 아닌 모든 노드, 실질적으로 데이터를 저장하고 있는 것이 아니고 그 데이터에 접근할 수 있는 주소를 갖고 있음.
Map에 들어갈 데이터의 Key값은 크기 비교를 할 숫자, Value 값은 자식 노드의 주소

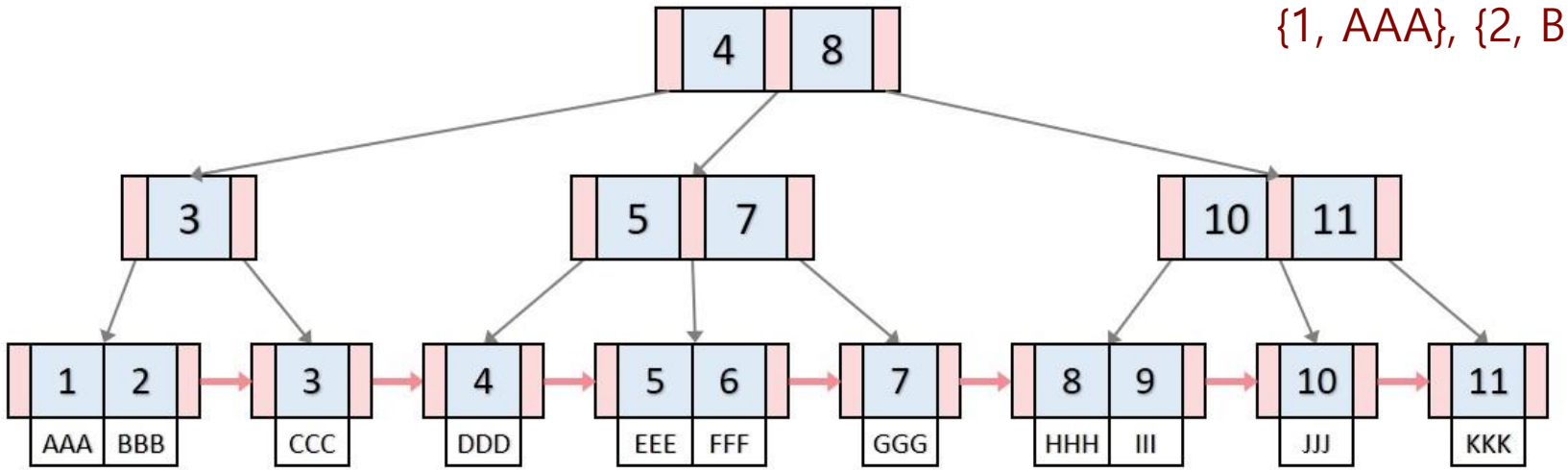
Ex) 최상위 노드에는 두 데이터 존재
{4, (5, 7)이 있는 자식 노드}
{8, (10,11)이 있는 자식 노드}



B+ Tree

Data Node
리프 노드에 있는 노드, 리프 노드에 있는 모든 데이터는 Linked List로 연결되어 있어야 함
Map에 들어갈 데이터의 Key값은 크기 비교를 할 숫자, Value 값은 실제 데이터

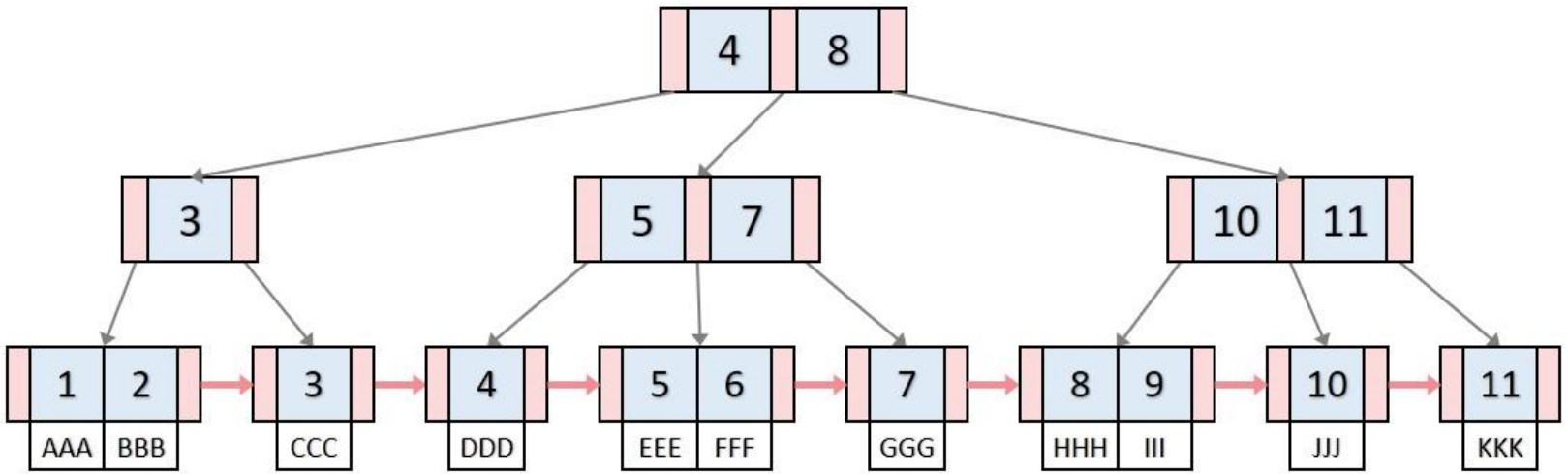
Ex) 맨 왼쪽 Leaf 노드에 두 데이터 존재
{1, AAA}, {2, BBB}



B+ Tree

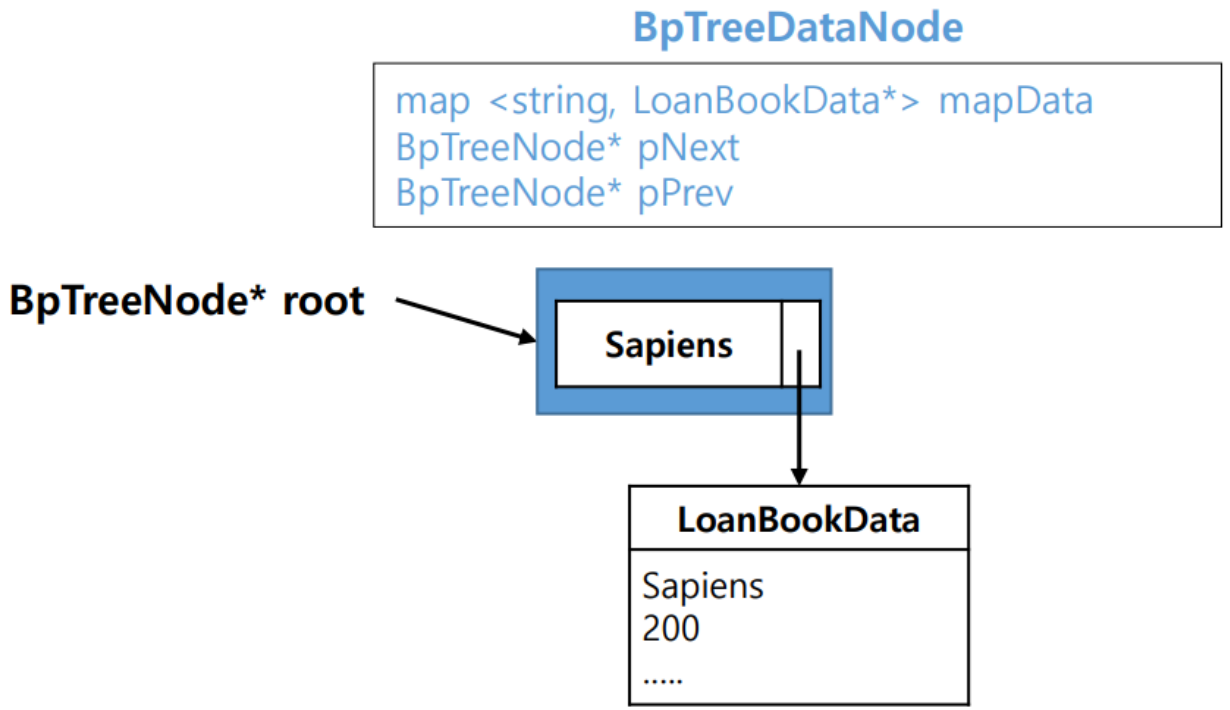
B+ Tree의 장점
B Tree는 한 데이터만 검색할 때는 효율적이지만, 모든 데이터를 순회할 때는 트리 안의 모든 노드를 순회해야 하므로 비효율적임

B+ Tree는 Data Node만 순회하면 모든 데이터를 찾을 수 있으므로 효율적임
특히, 특정 구간을 탐색할 때 효율적임



Ex) 4~8까지 데이터를 탐색하고 싶으면
4를 탐색한 후 Linked List로 이어진 데이터를 따라가서 8까지 탐색

B+ Tree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BpTreeNode* pNext
BpTreeNode* pPrev
BpTreeNode* root
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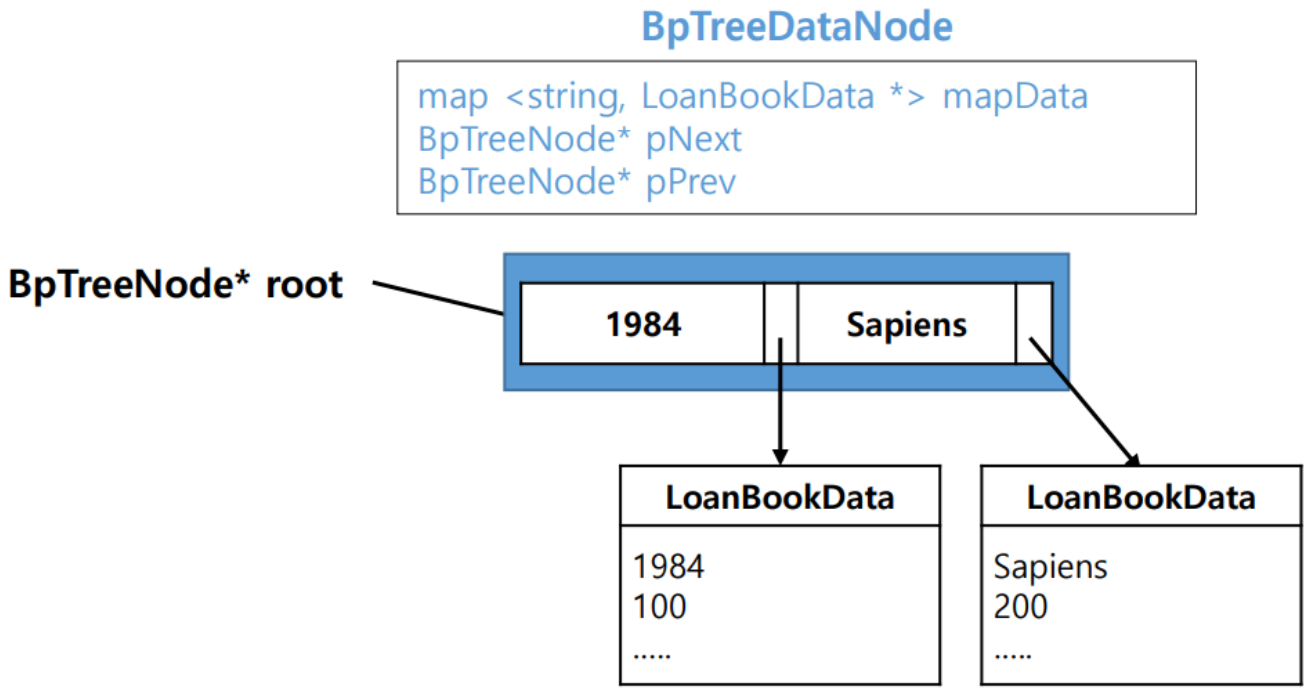
B+ Tree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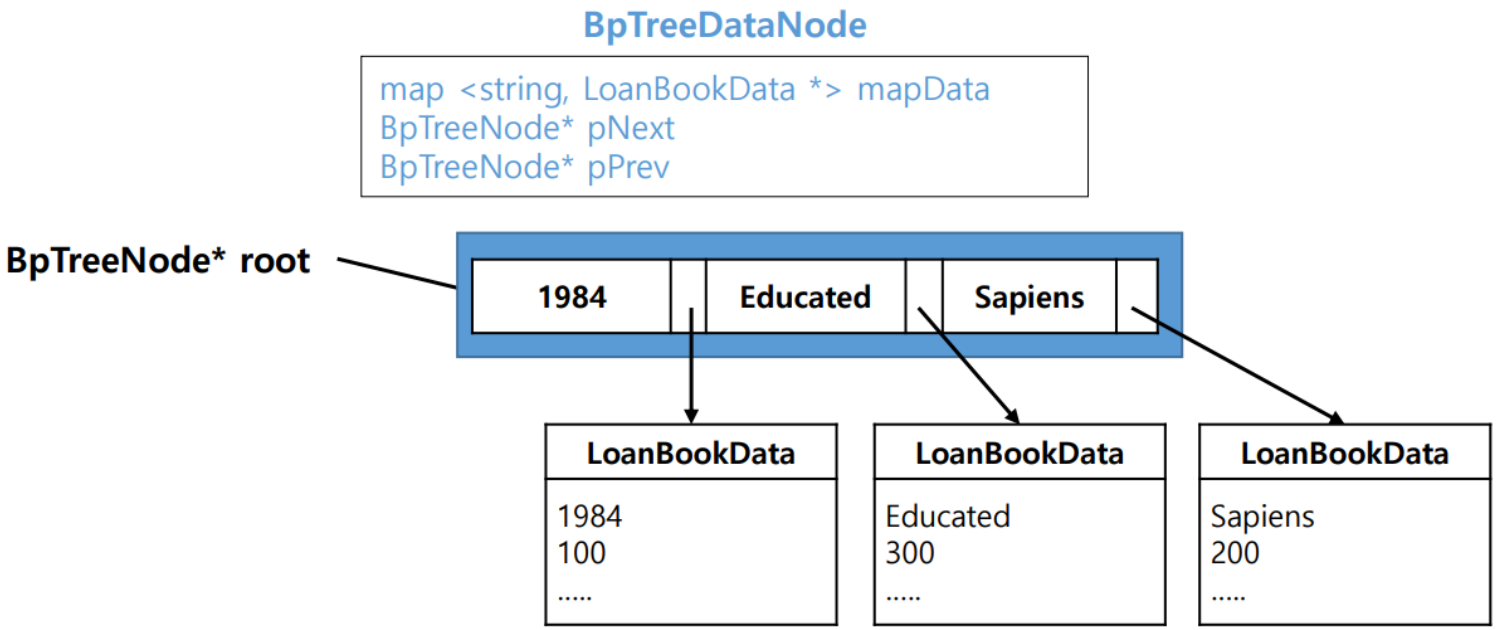
B+ Tree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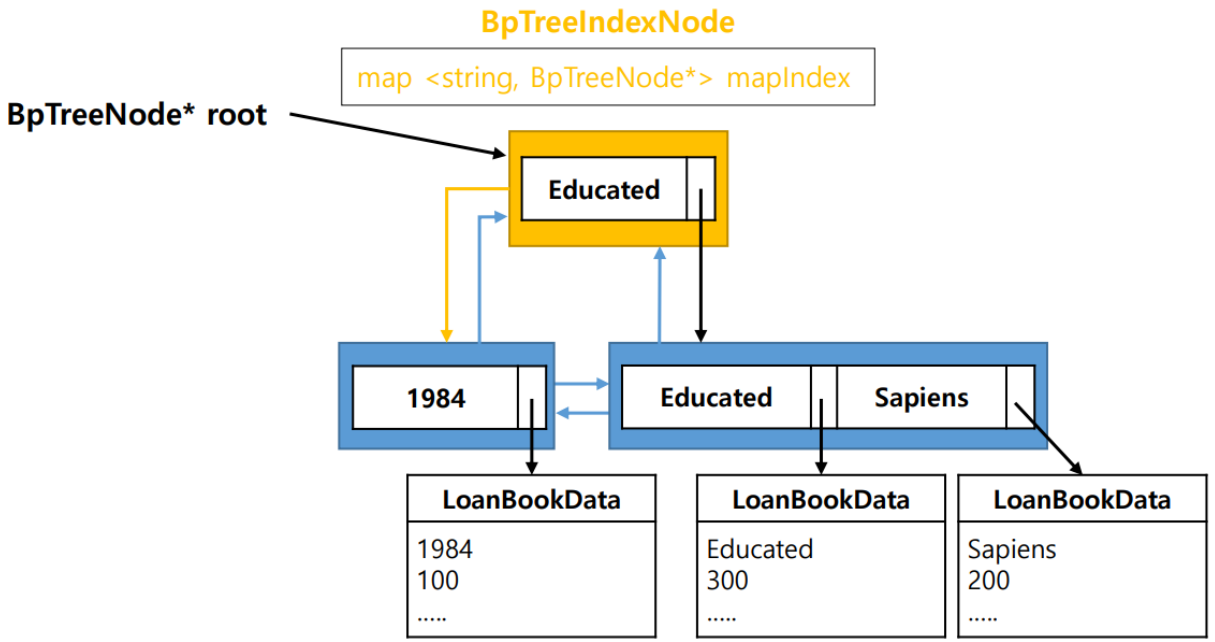
B+ Tree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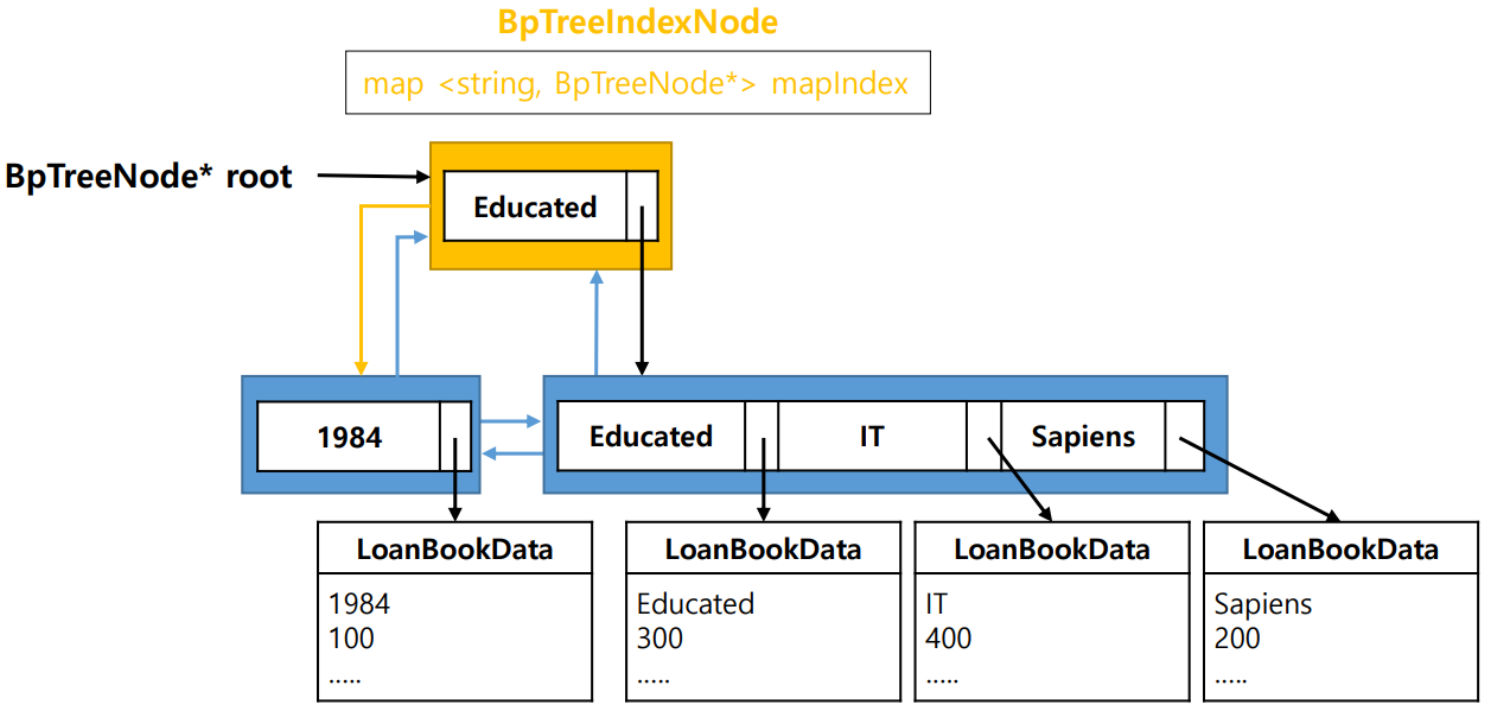
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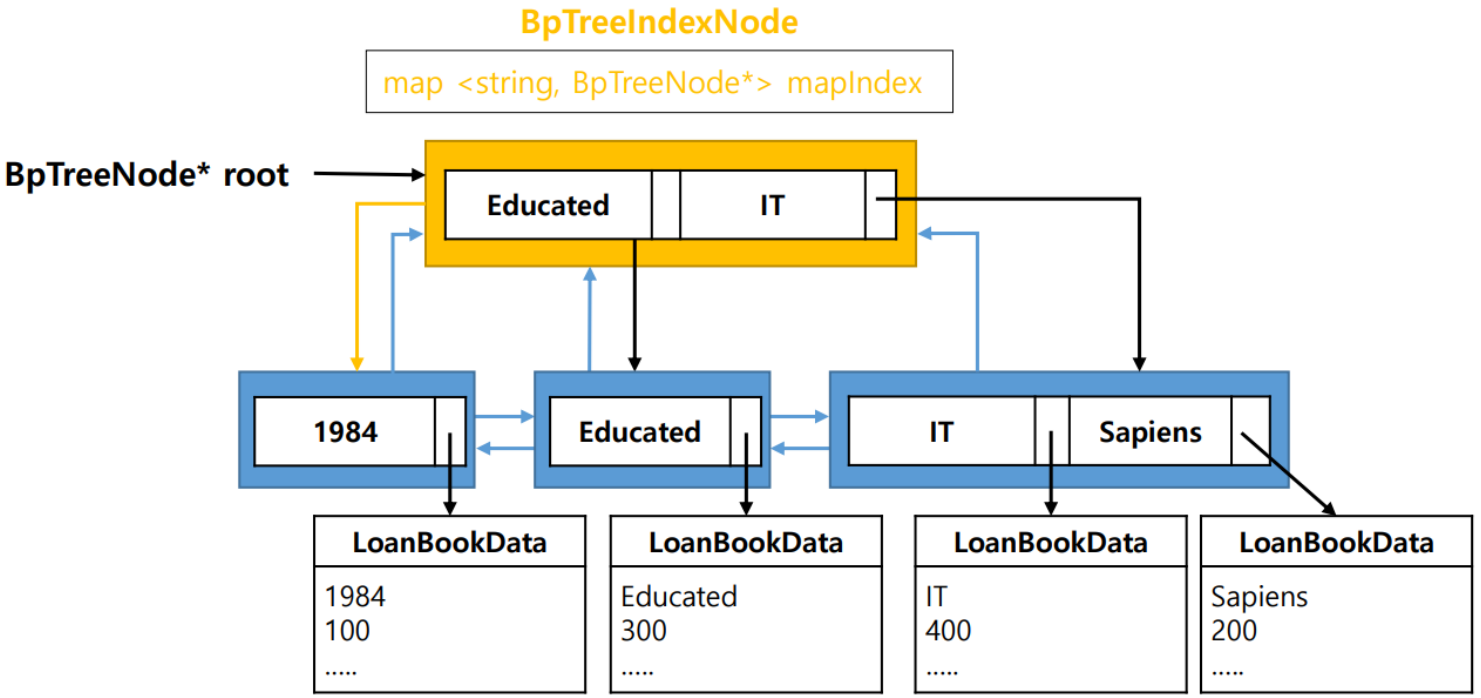
B+ Tree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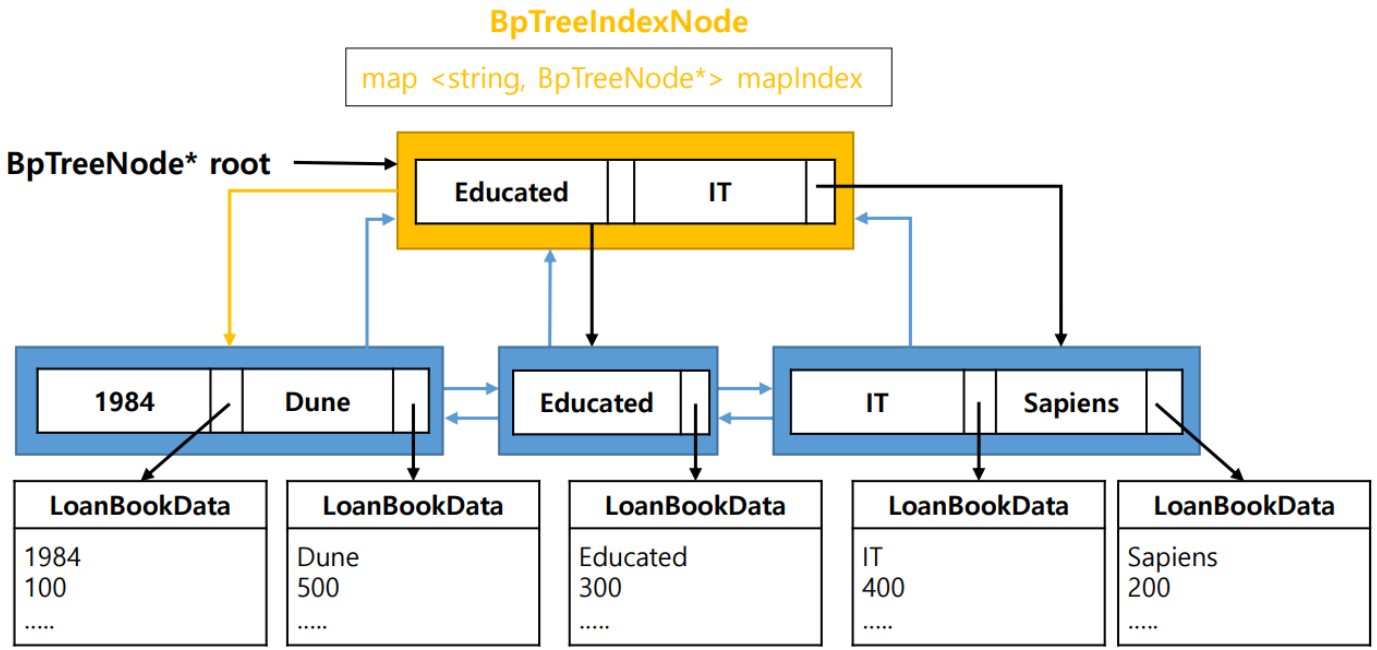
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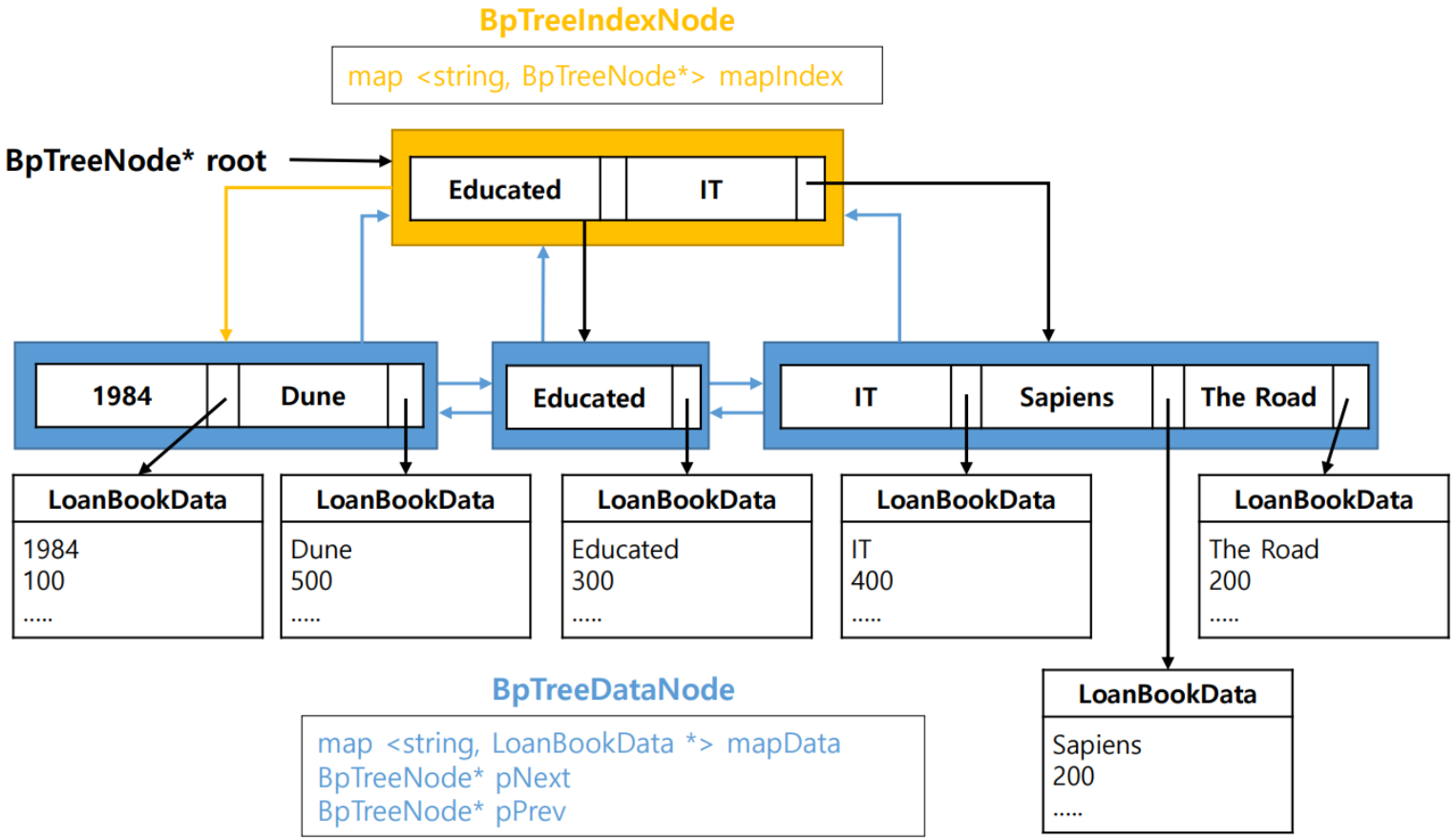
B+ Tree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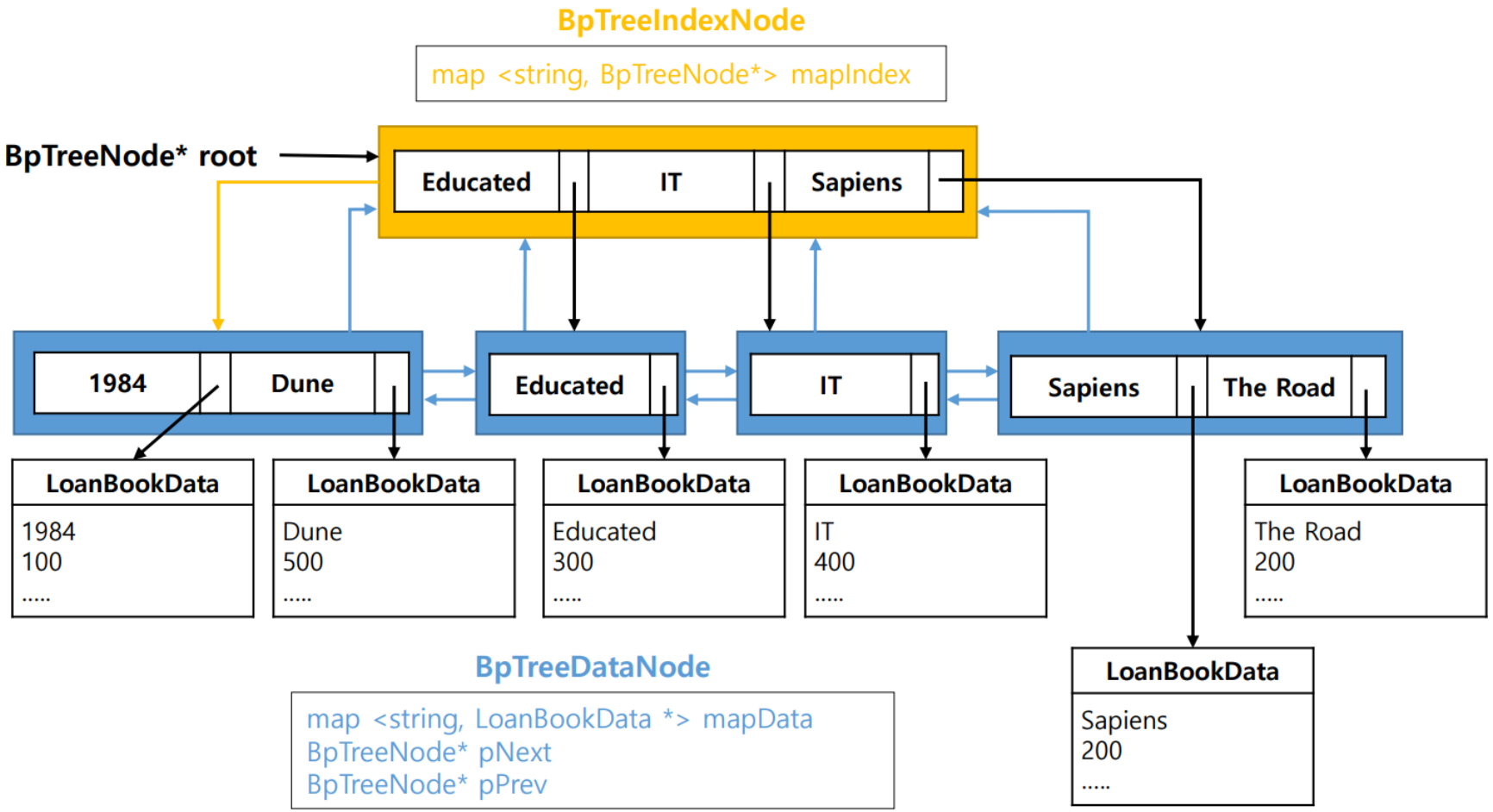
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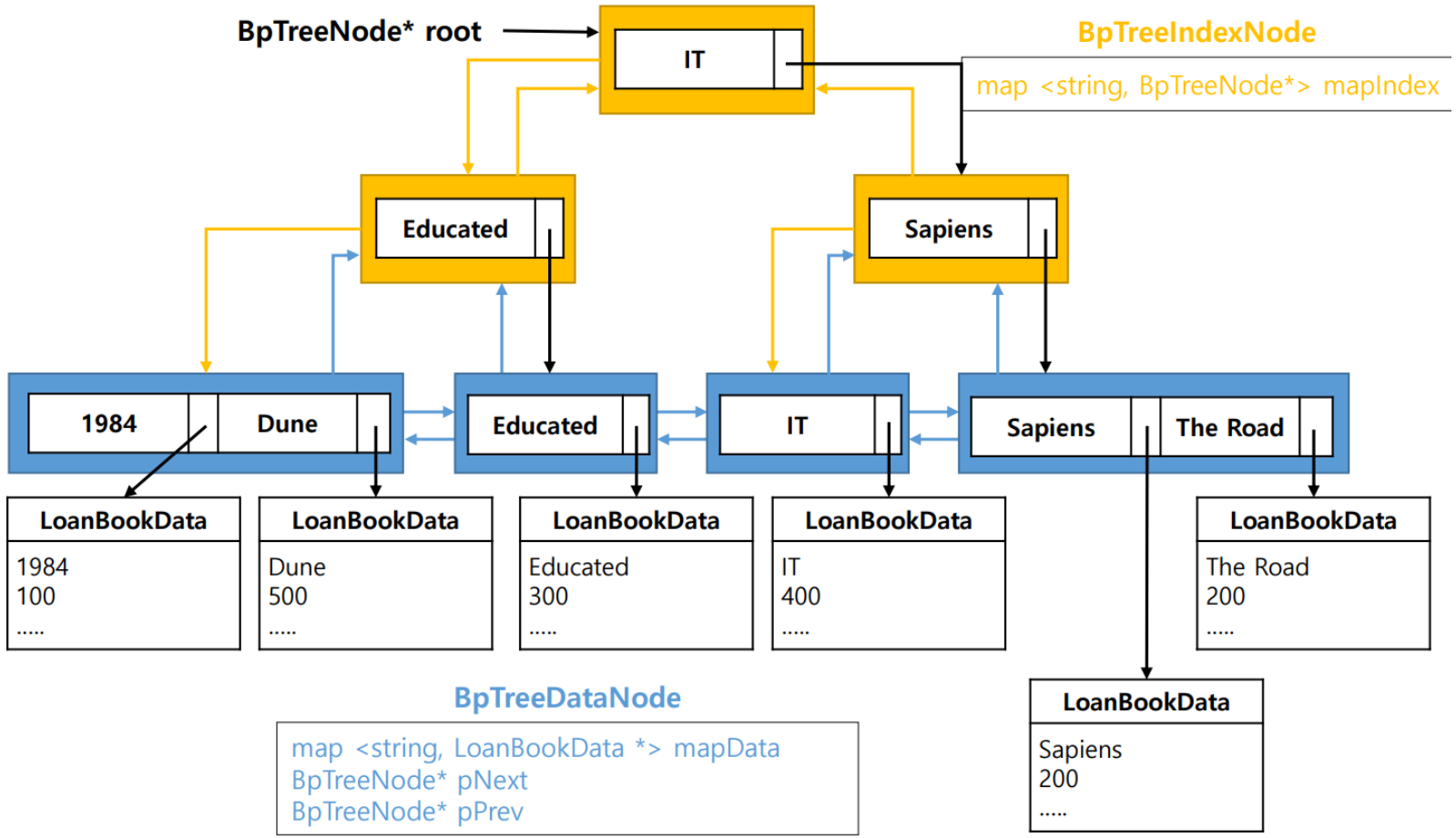
B+ Tree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