

Practical Work Report - File Structures and Data Structures

Hierarchical Index with T1/T2 Trees

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1. Introduction

This practical work implements two file indexing structures: a two-level binary tree (T1/T2) and a B-Tree of order 5. The goal is to manage indexed file access with efficient search, insertion, and persistence mechanisms.

2. Key Implementation Approach

2.1 Index Loading and Saving

Loading Module

Sequentially reads data file blocks and inserts each record into the tree:

```
nBlocks ← getHeader(f, "Nblocks")
while i < nBlocks do
    Read block i+1 into Buf
    for j = 0 to Buf.Nrec - 1 do
        Insert into tree (Root, Buf.Tab[j].Key,
                        Buf.Tab[j].blkAddr,
                        Buf.Tab[j].recAddr)
    end for
end while
```

- Linear file scan → Tree construction
- Maintains block boundaries during load

Saving Module

Uses in-order traversal to write sorted records back to file:

Main control:

```
ProcessT1(f, Root, Nblocks)
setHeader(f, "Nblocks", Nblocks)
```

T1 traversal (in-order, recursively):

```

ProcessT1(f, Node.LC, Nblocks)    // Left subtree
ProcessT2(f, Node.R, Nblocks)     // T2 subtree
ProcessT1(f, Node.RC, Nblocks)    // Right subtree

```

T2 processing with block buffering:

```

// In-order traversal using stack
while current != NULL do
    Push current onto S
    current ← current.LC
end while

```

```

// Process node
Pop S to current
Add record to Buf

```

```

// Write when buffer full
if j > MAXTAB then
    Write Buf to block Nblocks
    Nblocks ← Nblocks + 1
    j ← 0
end if

```

Key techniques:

- **In-order traversal** → sorted output
- **Stack-based iteration** → handles deep trees
- **Block buffering** → efficient disk writes
- **Header update** → stores block count for reloading

2.2 Search Algorithm

The search follows the T1 routing logic, then performs BST search in T2:

```

Pointer to t_T1 current ← Root
while current != NULL AND NOT Found do
    if Key < current.V1 then
        current ← current.LC
    else if Key > current.V2 then
        current ← current.RC
    else
        // Search within T2 subtree
        Pointer to t_T2 currentT2 ← current.R
        while currentT2 != NULL AND NOT Found do
            // Binary search in T2

```

2.3 Insertion Mechanism

Insertion always occurs in T2 trees, with T1 nodes updated only when:

- A new key extends the current [V1, V2] range
- A new T1 leaf needs to be created

2.4 B-Tree Leaf Splitting

When a leaf node overflows (5 keys), it splits:

```
procedure SplitLeafNode(...)
    Create sorted array with new key
    middleValue ← tmpArr[2] // Median promoted to parent
    newLeftNode ← first 2 keys
    newRightNode ← last 2 keys
```

3. Conclusion

The implementation demonstrates:

1. **Efficient range-based indexing** through T1/T2 separation
2. **Persistent storage** with block-aware serialization
3. **Modular design** allowing B-Tree comparison
4. **Practical trade-offs**: T1/T2 simplifies certain range queries while B-Tree optimizes for disk I/O and balance

The pseudo-code provides a clear blueprint for implementing these structures in any programming language, emphasizing algorithmic logic over syntactic details.