LAPORAN

ALGORITMA DAN PEMROGRAMAN 2

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Oleh :

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03TPLP029

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Jawaban

1. String Compression with Huffman Encoding

1. Hitung frekuensi setiap karakter dalam string menggunakan unordered_map.
2. Bangun pohon Huffman menggunakan *priority queue* berdasarkan frekuensi karakter.
3. Traversal pohon untuk menghasilkan kode Huffman untuk setiap karakter.
4. Encode string dengan mengganti karakter menggunakan kode Huffman.
5. Decode string dengan traversal pohon berdasarkan bit dalam string terenkripsi.

Source Code:

```
/*
   Program String Compression using Huffman Encoding
   Nama: Ridho Kurniawan
   NIM: 231011401209
*/

#include <iostream>
#include <queue>
#include <unordered_map>
#include <vector>
using namespace std;

struct Node {
   char ch;
   int freq;
   Node *left, *right;
   Node(char c, int f) : ch(c), freq(f), left(nullptr), right(nullptr) {}
};

// Comparator for priority queue
struct Compare {
   bool operator()(Node* a, Node* b) {
      return a->freq > b->freq;
   }
};

// Traverse Huffman Tree to generate codes
void buildCodes(Node* root, string code, unordered_map<char, string>& huffmanCode) {
   if (!root) return;
   if (!root->left && !root->right) {
      huffmanCode[root->ch] = code;
   }
   buildCodes(root->left, code + "0", huffmanCode);
   buildCodes(root->right, code + "1", huffmanCode);
}
```

```
// Build Huffman Tree
Node* buildHuffmanTree(const string& text) {
    unordered_map<char, int> freq;
    for (char ch : text) freq[ch]++;

    priority_queue<Node*, vector<Node*>, Compare> pq;
    for (auto pair : freq) {
        pq.push(new Node(pair.first, pair.second));
    }

    while (pq.size() > 1) {
        Node* left = pq.top(); pq.pop();
        Node* right = pq.top(); pq.pop();
        Node* merged = new Node('\0', left->freq + right->freq);
        merged->left = left;
        merged->right = right;
        pq.push(merged);
    }

    return pq.top();
}

// Encode string
string encode(const string& text, unordered_map<char, string>& huffmanCode) {
    string encoded = "";
    for (char ch : text) {
        encoded += huffmanCode[ch];
    }
    return encoded;
}

// Decode string
string decode(const string& encodedStr, Node* root) {
    string decoded = "";
    Node* curr = root;
    for (char bit : encodedStr) {
        curr = (bit == '0') ? curr->left : curr->right;
        if (!curr->left && !curr->right) {
            decoded += curr->ch;
            curr = root;
        }
    }
    return decoded;
}

// Main function
```

```
int main() {
    string text;
    cout << "Enter text: ";
    cin >> text;

    Node* root = buildHuffmanTree(text);
    unordered_map<char, string> huffmanCode;
    buildCodes(root, "", huffmanCode);

    cout << "Huffman Codes:\n";
    for (auto pair : huffmanCode) {
        cout << pair.first << ": " << pair.second << "\n";
    }

    string encodedStr = encode(text, huffmanCode);
    cout << "Encoded string: " << encodedStr << "\n";

    string decodedStr = decode(encodedStr, root);
    cout << "Decoded string: " << decodedStr << "\n";

    return 0;
}
```

2. Find Pairs with Sum K

Langkah-langkah:

1. **Baca Input:**
    - Masukkan dua array dan nilai KKK dari pengguna.
2. **Simpan Elemen dari Array Pertama:**
    - Gunakan unordered_set untuk menyimpan elemen dari array pertama.
3. **Cari Pasangan dari Array Kedua:**
    - Untuk setiap elemen di array kedua, periksa apakah pelengkapnya (K−elemenK - \text{elemen}K−elemen) ada di *set*. Jika ya, tambahkan pasangan tersebut ke hasil.
4. **Tampilkan Hasil:**
    - Cetak semua pasangan bilangan yang jumlahnya sama dengan KKK.

Kompleksitas:

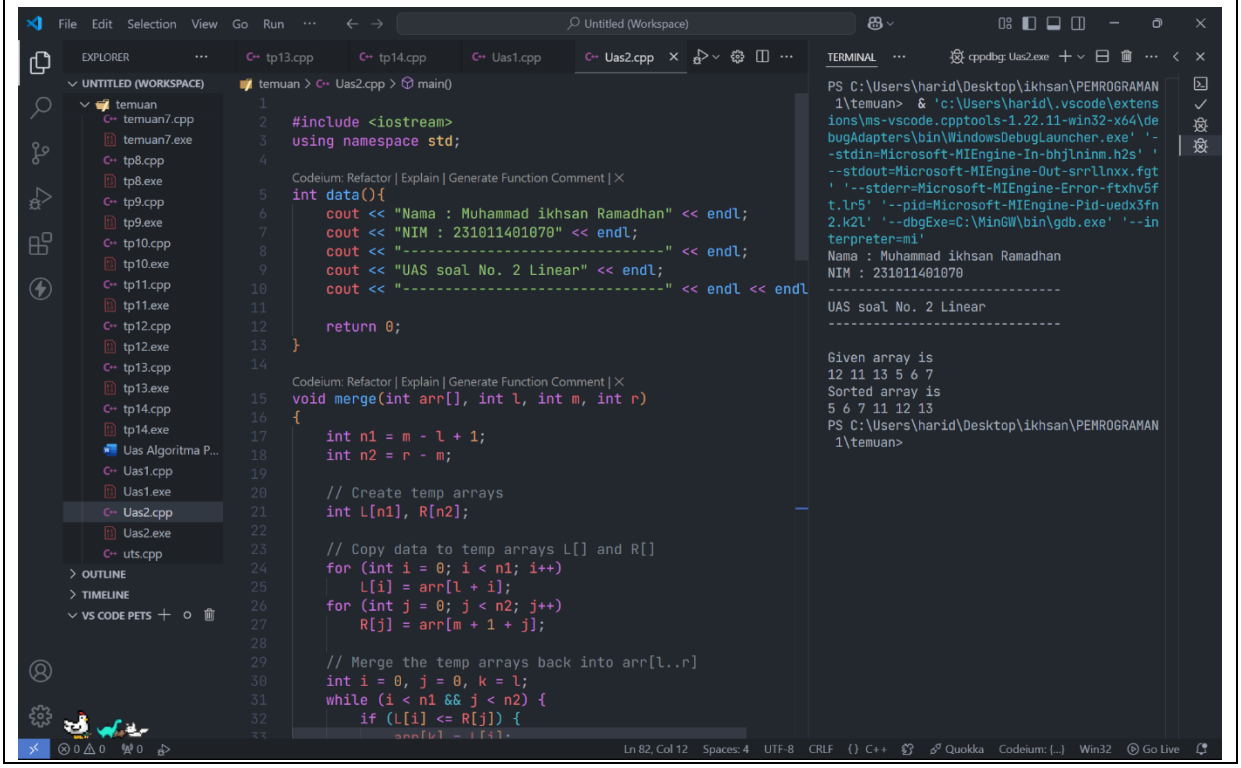
- Waktu: O(n+m)O(n + m)O(n+m), dengan nnn dan mmm adalah panjang array.
- Ruang: O(n)O(n)O(n) untuk *set*.

Source Code:

```
/*
   Program Find Pairs with Sum K
   Nama: Ridho Kurniawan
   NIM: 231011401209
*/

#include <iostream>
#include <vector>
#include <unordered_set>
using namespace std;

vector<pair<int, int>> findPairsWithSumK(const vector<int>& arr1, const vector<int>&
arr2, int K) {
   unordered_set<int> elements;
   vector<pair<int, int>> result;

   // Insert elements of arr1 into set
   for (int num : arr1) {
      elements.insert(num);
   }

   // Check for complement in arr2
   for (int num : arr2) {
      if (elements.count(K - num)) {
         result.emplace_back(K - num, num);
      }
   }
   return result;
}
```

```
int main() {
    vector<int> arr1 = {1, 2, 3, 4, 5};
    vector<int> arr2 = {6, 7, 8, 9};
    int K = 10;

    auto pairs = findPairsWithSumK(arr1, arr2, K);
    cout << "Pairs with sum " << K << ":\n";
    for (auto& p : pairs) {
        cout << "(" << p.first << ", " << p.second << ")\n";
    }
    return 0;
}
```

Screennshot:



3. Functional Style Quick Sort

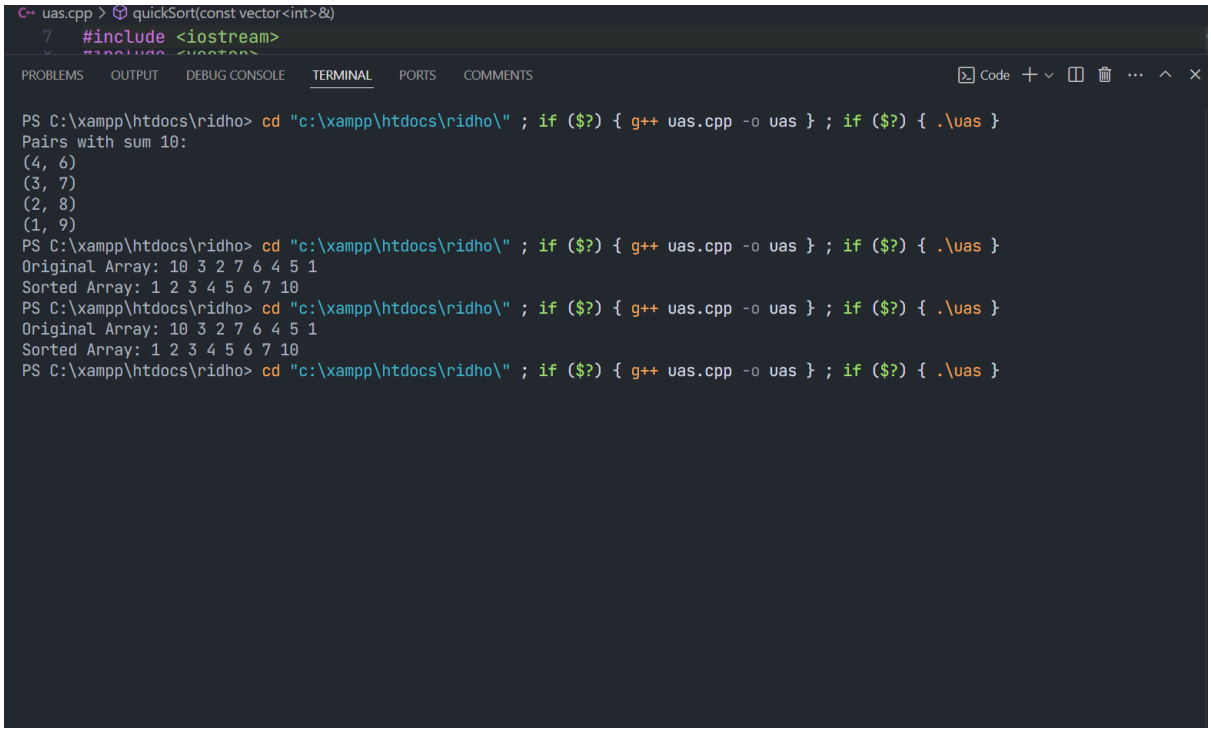
1. Pilih elemen pertama sebagai pivot.
2. Partisi array menjadi elemen < pivot, == pivot, dan > pivot.
3. Rekursif urutkan bagian < pivot dan > pivot.
4. Gabungkan hasil partisi menjadi array yang diurutkan.

Source Code:

```
/*
   Program Functional Style Quick Sort
   Nama: Ridho Kurniawan
   NIM: 231011401209
*/

#include <iostream>
#include <vector>
using namespace std;

vector<int> quickSort(const vector<int>& arr) {
   if (arr.size() <= 1) return arr;

   // Select pivot
   int pivot = arr[0];
   vector<int> less, equal, greater;

   // Partitioning
   for (int num : arr) {
      if (num < pivot) less.push_back(num);
      else if (num == pivot) equal.push_back(num);
      else greater.push_back(num);
   }

   // Recursive sort and combine results
   vector<int> sortedLess = quickSort(less);
   vector<int> sortedGreater = quickSort(greater);

   // Combine sorted arrays
   sortedLess.insert(sortedLess.end(), equal.begin(), equal.end());
   sortedLess.insert(sortedLess.end(), sortedGreater.begin(), sortedGreater.end());
   return sortedLess;
}

int main() {
   vector<int> arr = {10, 3, 2, 7, 6, 4, 5, 1};
   cout << "Original Array: ";
   for (int num : arr) cout << num << " ";
   cout << "\n";
```

```
    vector<int> sortedArr = quickSort(arr);
    cout << "Sorted Array: ";
    for (int num : sortedArr) cout << num << " ";
    cout << "\n";

    return 0;
}
```

Screenshot:



4. Radix Sort, Quick Sort, and Merge Sort Comparison

1. Implementasikan tiga algoritma:
    - **Radix Sort**: Urutkan digit demi digit.
    - **Quick Sort**: Gunakan rekursi dan partisi.
    - **Merge Sort**: Rekursif membagi array dan gabungkan hasil.
2. Jalankan ketiga algoritma pada array yang sama.
3. Bandingkan hasil dan kinerja:
    - Radix unggul jika rentang elemen kecil.

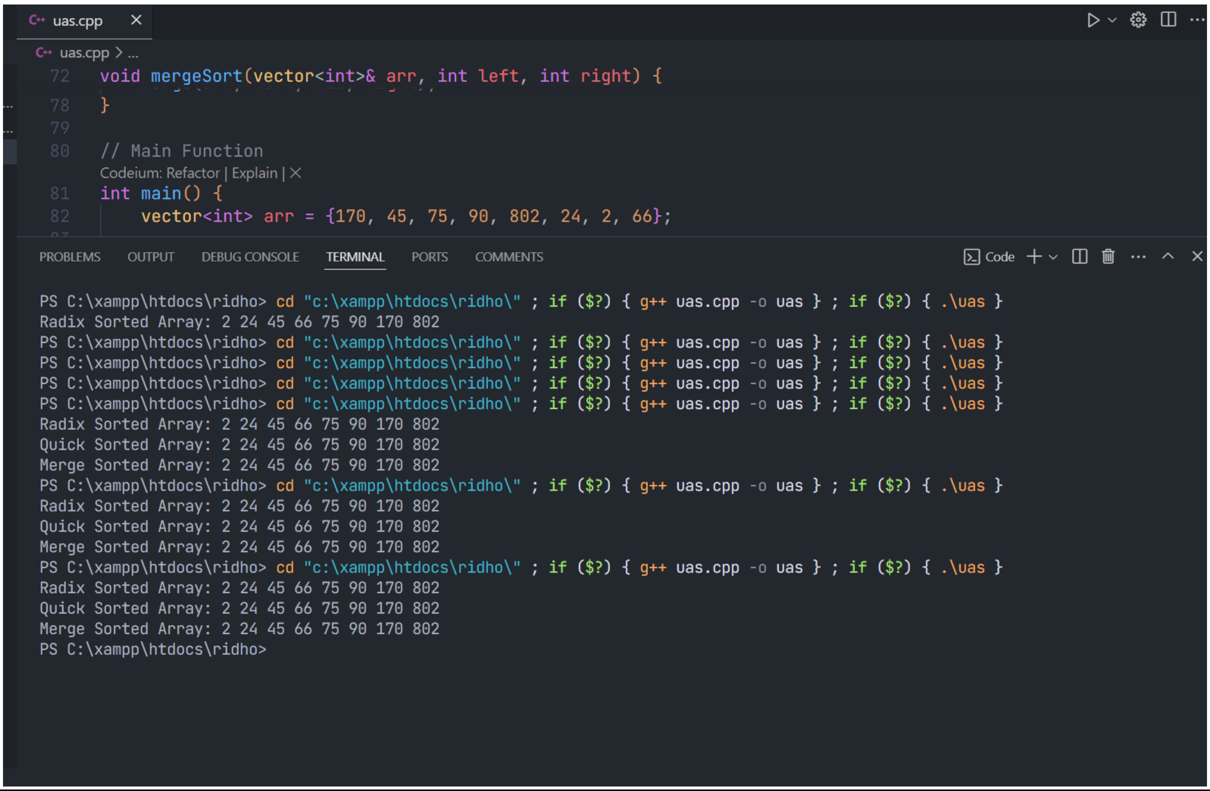
Source Code:

```
/*
   Program Sorting Comparison: Radix, Quick, and Merge Sort
   Nama: Ridho Kurniawan
   NIM: 231011401209
*/

#include <iostream>
#include <vector>
#include <algorithm>
#include <queue>
using namespace std;

// Radix Sort
void radixSort(vector<int>& arr) {
   int maxNum = *max_element(arr.begin(), arr.end());
   for (int exp = 1; maxNum / exp > 0; exp *= 10) {
      vector<int> output(arr.size());
      int count[10] = {0};

      // Count occurrences
      for (int num : arr) count[(num / exp) % 10]++;

      // Accumulate counts
      for (int i = 1; i < 10; i++) count[i] += count[i - 1];

      // Build output array
      for (int i = arr.size() - 1; i >= 0; i--) {
         int digit = (arr[i] / exp) % 10;
         output[--count[digit]] = arr[i];
      }

      // Copy output to arr
      arr = output;
   }
}
```

```
// Quick Sort
vector<int> quickSort(const vector<int>& arr) {
    if (arr.size() <= 1) return arr;

    int pivot = arr[0];
    vector<int> less, equal, greater;

    for (int num : arr) {
        if (num < pivot) less.push_back(num);
        else if (num == pivot) equal.push_back(num);
        else greater.push_back(num);
    }

    vector<int> sortedLess = quickSort(less);
    vector<int> sortedGreater = quickSort(greater);

    sortedLess.insert(sortedLess.end(), equal.begin(), equal.end());
    sortedLess.insert(sortedLess.end(), sortedGreater.begin(), sortedGreater.end());
    return sortedLess;
}

// Merge Sort
void merge(vector<int>& arr, int left, int mid, int right) {
    vector<int> temp;
    int i = left, j = mid + 1;
    while (i <= mid && j <= right) {
        if (arr[i] <= arr[j]) temp.push_back(arr[i++]);
        else temp.push_back(arr[j++]);
    }
    while (i <= mid) temp.push_back(arr[i++]);
    while (j <= right) temp.push_back(arr[j++]);

    for (int k = left; k <= right; k++) arr[k] = temp[k - left];
}

void mergeSort(vector<int>& arr, int left, int right) {
    if (left >= right) return;
    int mid = left + (right - left) / 2;
    mergeSort(arr, left, mid);
    mergeSort(arr, mid + 1, right);
    merge(arr, left, mid, right);
}

// Main Function
int main() {
    vector<int> arr = {170, 45, 75, 90, 802, 24, 2, 66};
```

```
    vector<int> arrRadix = arr;
    vector<int> arrQuick = arr;
    vector<int> arrMerge = arr;

    radixSort(arrRadix);
    cout << "Radix Sorted Array: ";
    for (int num : arrRadix) cout << num << " ";
    cout << "\n";

    vector<int> quickSorted = quickSort(arrQuick);
    cout << "Quick Sorted Array: ";
    for (int num : quickSorted) cout << num << " ";
    cout << "\n";

    mergeSort(arrMerge, 0, arrMerge.size() - 1);
    cout << "Merge Sorted Array: ";
    for (int num : arrMerge) cout << num << " ";
    cout << "\n";

    return 0;
}
```

Screenshot:



5. Sierpinski Triangle Fractal

1. Gambar segitiga besar menggunakan tiga garis.
2. Rekursif gambar tiga segitiga lebih kecil di dalam segitiga besar.
3. Hentikan rekursi jika kedalaman mencapai 0.
4. Gunakan pustaka grafis untuk menggambar.

Source Code:

```
/*
   Program Sorting Comparison: Radix, Quick, and Merge Sort
   Nama: Ridho Kurniawan
   NIM: 231011401209
*/

#include <iostream>
#include <vector>
#include <algorithm>
#include <queue>
using namespace std;

// Radix Sort
void radixSort(vector<int>& arr) {
   int maxNum = *max_element(arr.begin(), arr.end());
   for (int exp = 1; maxNum / exp > 0; exp *= 10) {
      vector<int> output(arr.size());
      int count[10] = {0};

      // Count occurrences
      for (int num : arr) count[(num / exp) % 10]++;

      // Accumulate counts
      for (int i = 1; i < 10; i++) count[i] += count[i - 1];

      // Build output array
      for (int i = arr.size() - 1; i >= 0; i--) {
         int digit = (arr[i] / exp) % 10;
         output[--count[digit]] = arr[i];
      }

      // Copy output to arr
      arr = output;
   }
}

// Quick Sort
vector<int> quickSort(const vector<int>& arr) {
   if (arr.size() <= 1) return arr;
```

```
    int pivot = arr[0];
    vector<int> less, equal, greater;

    for (int num : arr) {
        if (num < pivot) less.push_back(num);
        else if (num == pivot) equal.push_back(num);
        else greater.push_back(num);
    }

    vector<int> sortedLess = quickSort(less);
    vector<int> sortedGreater = quickSort(greater);

    sortedLess.insert(sortedLess.end(), equal.begin(), equal.end());
    sortedLess.insert(sortedLess.end(), sortedGreater.begin(), sortedGreater.end());
    return sortedLess;
}

// Merge Sort
void merge(vector<int>& arr, int left, int mid, int right) {
    vector<int> temp;
    int i = left, j = mid + 1;
    while (i <= mid && j <= right) {
        if (arr[i] <= arr[j]) temp.push_back(arr[i++]);
        else temp.push_back(arr[j++]);
    }
    while (i <= mid) temp.push_back(arr[i++]);
    while (j <= right) temp.push_back(arr[j++]);

    for (int k = left; k <= right; k++) arr[k] = temp[k - left];
}

void mergeSort(vector<int>& arr, int left, int right) {
    if (left >= right) return;
    int mid = left + (right - left) / 2;
    mergeSort(arr, left, mid);
    mergeSort(arr, mid + 1, right);
    merge(arr, left, mid, right);
}

// Main Function
int main() {
    vector<int> arr = {170, 45, 75, 90, 802, 24, 2, 66};

    vector<int> arrRadix = arr;
    vector<int> arrQuick = arr;
```

```
    vector<int> arrMerge = arr;

    radixSort(arrRadix);
    cout << "Radix Sorted Array: ";
    for (int num : arrRadix) cout << num << " ";
    cout << "\n";

    vector<int> quickSorted = quickSort(arrQuick);
    cout << "Quick Sorted Array: ";
    for (int num : quickSorted) cout << num << " ";
    cout << "\n";

    mergeSort(arrMerge, 0, arrMerge.size() - 1);
    cout << "Merge Sorted Array: ";
    for (int num : arrMerge) cout << num << " ";
    cout << "\n";

    return 0;
}
```

Sreenshot: