LAPORAN PRAKTIKUM
ANALISIS ALGORITMA

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PROGRAM STUDI TEKNIK INFORMATIKA
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
UNIVERSITAS PADJADJARAN
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Studi Kasus 5

1. Program Closest Pair of Points C++

```
/*
    Nama        : Gede Bagus Darmagita
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    Deskripsi   : Closest Pair of Points
*/

#include <bits/stdc++.h>
using namespace std;

class Point
{
public:
    int x, y;
};

int compareX(const void *a, const void *b)
{
    Point *p1 = (Point *)a, *p2 = (Point *)b;
    return (p1->x - p2->x);
}

int compareY(const void *a, const void *b)
{
    Point *p1 = (Point *)a, *p2 = (Point *)b;
    return (p1->y - p2->y);
}

float dist(Point p1, Point p2)
{
    return sqrt((p1.x - p2.x) * (p1.x - p2.x) +
                (p1.y - p2.y) * (p1.y - p2.y));
}

float bruteForce(Point P[], int n)
{
    float min = FLT_MAX;
    for (int i = 0; i < n; ++i)
        for (int j = i + 1; j < n; ++j)
            if (dist(P[i], P[j]) < min)
                min = dist(P[i], P[j]);
    return min;
}
```

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```
float min(float x, float y)
{
    return (x < y) ? x : y;
}

float stripClosest(Point strip[], int size, float d)
{
    float min = d; // Initialize the minimum distance as d

    qsort(strip, size, sizeof(Point), compareY);

    for (int i = 0; i < size; ++i)
        for (int j = i + 1; j < size && (strip[j].y - strip[i].y) < min; ++j)
            if (dist(strip[i], strip[j]) < min)
                min = dist(strip[i], strip[j]);

    return min;
}

float closestUtil(Point P[], int n)
{
    // If there are 2 or 3 points, then use brute force
    if (n <= 3)
        return bruteForce(P, n);

    // Find the middle point
    int mid = n / 2;
    Point midPoint = P[mid];

    float dl = closestUtil(P, mid);
    float dr = closestUtil(P + mid, n - mid);

    // Find the smaller of two distances
    float d = min(dl, dr);

    Point strip[n];
    int j = 0;
    for (int i = 0; i < n; i++)
        if (abs(P[i].x - midPoint.x) < d)
            strip[j] = P[i], j++;

    return min(d, stripClosest(strip, j, d));
}
```

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```
float closest(Point P[], int n)
{
    qsort(P, n, sizeof(Point), compareX);

    return closestUtil(P, n);
}

// Driver code
int main()
{
    Point P[] = {{12, 1}, {33, 21}, {54, 36}};
    int n = sizeof(P) / sizeof(P[0]);
    cout << "The smallest distance is " << closest(P, n);
    return 0;
}
```

```
PS D:\MegaSync\Semester 4\Praktikum\Analisis Algoritma\Analgoku5> .\closest.exe
The smallest distance is 25.807
```

2. Kompleksitas Waktu
   T (n) = 2T (n / 2) + O (n) + O (n Log n) + O (n)
   T (n) = 2T (n / 2) + O (n Log n)
   T (n) = T (n * Log n * Log n)

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Studi Kasus 6

1. Program Karatsuba C++

```
/*
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    Deskripsi   : Karatsuba Fast Multiplication Algorithm
*/
#include <iostream>
#include <stdio.h>

using namespace std;

int makeEqualLength(string &str1, string &str2)
{
    int len1 = str1.size();
    int len2 = str2.size();
    if (len1 < len2)
    {
        for (int i = 0; i < len2 - len1; i++)
            str1 = '0' + str1;
        return len2;
    }
    else if (len1 > len2)
    {
        for (int i = 0; i < len1 - len2; i++)
            str2 = '0' + str2;
    }
    return len1; // If len1 >= len2
}

// The main function that adds two bit sequences and returns the addition
string addBitStrings(string first, string second)
{
    string result; // To store the sum bits

    // make the lengths same before adding
    int length = makeEqualLength(first, second);
    int carry = 0; // Initialize carry

    // Add all bits one by one
    for (int i = length - 1; i >= 0; i--)
    {
        int firstBit = first.at(i) - '0';
        int secondBit = second.at(i) - '0';
```

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```
        // boolean expression for sum of 3 bits
        int sum = (firstBit ^ secondBit ^ carry) + '0';

        result = (char)sum + result;

        // boolean expression for 3-bit addition
        carry = (firstBit & secondBit) | (secondBit & carry) | (firstBit & carry)
;
    }

    // if overflow, then add a leading 1
    if (carry)
        result = '1' + result;

    return result;
}

// A utility function to multiply single bits of strings a and b
int multiplyiSingleBit(string a, string b)
{
    return (a[0] - '0') * (b[0] - '0');
}

// The main function that multiplies two bit strings X and Y and returns
// result as long integer
long int multiply(string X, string Y)
{
    // Find the maximum of lengths of x and Y and make length
    // of smaller string same as that of larger string
    int n = makeEqualLength(X, Y);

    // Base cases
    if (n == 0)
        return 0;
    if (n == 1)
        return multiplyiSingleBit(X, Y);

    int fh = n / 2;    // First half of string, floor(n/2)
    int sh = (n - fh); // Second half of string, ceil(n/2)

    // Find the first half and second half of first string.
    // Refer http://goo.gl/lLmgn for substr method
    string Xl = X.substr(0, fh);
    string Xr = X.substr(fh, sh);
```

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```
    // Find the first half and second half of second string
    string Yl = Y.substr(0, fh);
    string Yr = Y.substr(fh, sh);

    // Recursively calculate the three products of inputs of size n/2
    long int P1 = multiply(Xl, Yl);
    long int P2 = multiply(Xr, Yr);
    long int P3 = multiply(addBitStrings(Xl, Xr), addBitStrings(Yl, Yr));

    // Combine the three products to get the final result.
    return P1 * (1 << (2 * sh)) + (P3 - P1 - P2) * (1 << sh) + P2;
}

// Driver program to test aboev functions
int main()
{
    printf("%ld\n", multiply("1001", "0110"));
    printf("%ld\n", multiply("1100", "0011"));
    printf("%ld\n", multiply("1101", "0010"));
    printf("%ld\n", multiply("1001", "1110"));
    printf("%ld\n", multiply("0000", "1011"));
    printf("%ld\n", multiply("0111", "1111"));
    printf("%ld\n", multiply("0011", "1101"));
}
```

```
PS D:\MegaSync\Semester 4\Praktikum\Analisis Algoritma\Analgoku5> .\karatsuba.exe
54
36
26
126
0
105
39
```

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2. Komplesitas Waktu

- Let's try divide and conquer.
  - Divide each number into two halves.
    - $x = x_H r^{n/2} + x_L$
    - $y = y_H r^{n/2} + y_L$
  - Then:

    $xy = (x_H r^{n/2} + x_L)\, y_H r^{n/2} + y_L$

    $= x_H y_H r^n + (x_H y_L + x_L y_H) r^{n/2} + x_L y_L$
  - Runtime?
    - T(n) = 4 T(n/2) + O(n)
    - T(n) = O(n^2)
- Instead of 4 subproblems, we only need 3 (with the help of clever insight).
- Three subproblems:
  - $a = x_H y_H$
  - $d = x_L y_L$
  - $e = (x_H + x_L)(y_H + y_L) - a - d$
- Then $xy = a r^n + e r^{n/2} + d$
- T(n) = 3 T(n/2) + O(n)
- $T(n) = O(n^{\log 3}) = O(n^{1.584\ldots})$

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Studi Kasus 7

1. Program Tilling C++

```
/*
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    Deskripsi   : Tilling Problem
*/
#include <bits/stdc++.h>

using namespace std;

// function to count the total number of ways
int countWays(int n, int m)
{

    // table to store values
    // of subproblems
    int count[n + 1];
    count[0] = 0;

    // Fill the table upto value n
    for (int i = 1; i <= n; i++)
    {
        // recurrence relation
        if (i > m)
            count[i] = count[i - 1] + count[i - m];

        // base cases
        else if (i < m)
            count[i] = 1;

        // i = = m
        else
            count[i] = 2;
    }

    // required number of ways
    return count[n];
}

// Driver program to test above
int main()
{
```

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```
    int n = 9, m = 1;
    cout << "Number of ways = "
         << countWays(n, m);
    return 0;
}
```

```
PS D:\MegaSync\Semester 4\Praktikum\Analisis Algoritma\Analgoku5> .\tilling.exe
Number of ways = 512
```

2. Kompleksitas Waktu

   Relasi perulangan untuk algoritma rekursif di atas dapat ditulis seperti di bawah ini. C adalah konstanta.
   T (n) = 4T (n / 2) + C
   Rekursi di atas dapat diselesaikan dengan menggunakan Metode Master dan kompleksitas waktu adalah O (n2)

   Bagaimana cara kerjanya?
   Pengerjaan algoritma Divide and Conquer dapat dibuktikan menggunakan Mathematical Induction. Biarkan kuadrat input berukuran 2k x 2k di mana k> = 1.

   Kasus Dasar: Kita tahu bahwa masalahnya dapat diselesaikan untuk k = 1. Kami memiliki 2 x 2 persegi dengan satu sel hilang.

   Hipotesis Induksi: Biarkan masalah dapat diselesaikan untuk k-1.
   Sekarang perlu dibuktikan untuk membuktikan bahwa masalah dapat diselesaikan untuk k jika dapat diselesaikan untuk k-1. Untuk k, ditempatkan ubin berbentuk L di tengah dan memiliki empat subsqure dengan dimensi 2k-1 x 2k-1 seperti yang ditunjukkan pada gambar 2 di atas. Jadi jika dapat menyelesaikan 4 subskuares, dapat menyelesaikan kuadrat lengkap.