METODY NUMERYCZNE

ZADANIE 9

Artur Guniewicz

9 O. Skonstruować naturalny splajn kubiczny dla funkcji i węzłów z zadania 8. Sporządzić jego wykres.

Kod programu:

```
/*
************************************************************
*                                                          *
*               Artur Guniewicz - Zadanie 9                *
*                                                          *
************************************************************
*/

#include <iostream>
#include <stdio.h>
#include <stdlib.h>
#include <array>
#include <fstream>
#include <math.h>

using namespace std;

#define Vector array<long double, 65>

void fillXY(Vector &x, Vector &y);
long double newtonSymbol(int x, int y);
void calculateW(Vector &w, const int d);
void calculateResult(const Vector &x, const Vector &y, const Vector
&w);
long double factorial(int x);
void writeToFile(const Vector &x, const Vector &y, const char *f);
```

```cpp
int main()
{
    int d = 3;

    Vector x;       // x-y funkcji zmieniające się o 1/32
    Vector y;       // wartości funkcji 1/(1+5*x*x)
    Vector w = {}; // wektor wag

    // funkcja interpolowana
    fillXY(x, y);
    writeToFile(x, y, "Zadanie9_function.txt");

    // wielomian interpolacyjny
    calculateW(w, d);
    calculateResult(x, y, w);

    return 0;
}

// wypełnia wektory wartościami x i wartościami funkcji
void fillXY(Vector &x, Vector &y)
{
    int i = 0;

    for (long double j = -1; j <= 1; j = j + 1.0 / 32)
    {
        x[i] = j;
        y[i] = (1 / (1 + 5 * j * j));
        i++;
    }
}

// zapisuje wektor x i wartości funkcji y do pliku
void writeToFile(const Vector &x, const Vector &y, const char *f)
{
    ofstream file;
    file.open(f);

    for (int i = 0; i < x.size(); i++)
        file << x[i] << "       " << y[i] << endl;
```

```
    file.close();
}

// liczy wagi do algorytmu
void calculateW(Vector &w, const int d)
{
    long double sum;

    for (int k = 0; k < w.size(); k++)
    {
        w[k] = pow(-1, k - d);
        sum = 0;

        for (int i = k - d; i <= k; i++)
        {
            if (i < 0)
                continue;
            if (i == w.size() - d)
                break;

            sum += newtonSymbol(d, k - i);
        }

        w[k] = w[k] * sum;
    }
}

// oblicza symbol newtona
long double newtonSymbol(int x, int y)
{
    return factorial(x) / (factorial(y) * factorial(x - y));
}

// oblicza silnie
long double factorial(int x)
{
    if (x == 0)
        return 1;
```

```
    if (x < 2)
        return x;

    return x * factorial(x - 1);
}

// oblicza wartości y i zapisuje je do pliku
void calculateResult(const Vector &x, const Vector &y, const Vector &w)
{
    long double upperSum;
    long double lowerSum;
    long double temp;

    ofstream file;
    file.open("Zadanie9_splajn.txt");

    for (long double i = -1; i <= 1; i = i + 0.01)
    {
        upperSum = 0;
        lowerSum = 0;
        temp = 0;

        for (int k = 0; k < w.size(); k++)
        {
            temp = w[k] / (i - x[k]);
            upperSum += temp * y[k];
            lowerSum += temp;
        }

        file << i << "      " << upperSum / lowerSum << endl;
    }

    file.close();
}
```

Kompilacja:

g++ Zadanie9.cpp -o Zadanie9 && ./Zadanie9

Wyniki:

fragment pliku “Zadanie9_function.txt”:

```
-1        0.166667
-0.96875        0.175673
-0.9375         0.185373
-0.90625        0.195831
-0.875         0.20712
-0.84375        0.219319
-0.8125         0.232516
-0.78125        0.246806
-0.75          0.262295
-0.71875        0.279095
-0.6875         0.297329
-0.65625        0.317126
-0.625         0.338624
-0.59375        0.361965
-0.5625         0.387292
-0.53125        0.414743
-0.5          0.444444
-0.46875        0.476501
-0.4375         0.510978
-0.40625        0.547887
-0.375         0.587156
-0.34375        0.628607
-0.3125         0.671916
-0.28125        0.716585
-0.25          0.761905
-0.21875        0.806935
-0.1875         0.850498
-0.15625        0.89121
-0.125         0.927536
-0.09375        0.957905
-0.0625         0.980843
-0.03125        0.995141
0       1
0.03125         0.995141
0.0625         0.980843
0.09375         0.957905
0.125         0.927536
0.15625         0.89121
0.1875         0.850498
0.21875         0.806935
```

fragment pliku “Zadanie9_splajn.txt”:

```
-1      -nan
-0.99       0.169477
-0.98       0.172355
-0.97       0.1753
-0.96       0.178317
-0.95       0.181406
-0.94       0.18457
-0.93       0.187811
-0.92       0.191132
-0.91       0.194534
-0.9       0.19802
-0.89       0.201593
-0.88       0.205254
-0.87       0.209008
-0.86       0.212857
-0.85       0.216802
-0.84       0.220848
-0.83       0.224997
-0.82       0.229253
-0.81       0.233618
-0.8       0.238095
-0.79       0.242689
-0.78       0.247402
-0.77       0.252239
-0.76       0.257202
-0.75       0.262295
-0.74       0.267523
-0.73       0.272889
-0.72       0.278396
-0.71       0.284051
-0.7       0.289855
-0.69       0.295814
-0.68       0.301932
-0.67       0.308214
-0.66       0.314663
-0.65       0.321285
-0.64       0.328084
-0.63       0.335064
-0.62       0.342231
-0.61       0.349589
```

Wykres:

uruchomienie z terminalu: gnuplot --persist

skrypt do tworzenia wykresu:

gnuplot> set title “Wykres wielomianu interpolacyjnego i rzeczywistego”
gnuplot> set xlabel “x”
gnuplot> set ylabel “y”
gnuplot> set xrange [-1:1]
gnuplot> set yrange [0:1]
gnuplot> plot 'Zadanie9_splajn.txt' with lines title 'Wielomian interpolacyjny' ,
'Zadanie9_function.txt' title 'Wielomian rzeczywisty' with points pointtype 6

```
        G N U P L O T
        Version 5.2 patchlevel 2    last modified 2017-11-01

        Copyright (C) 1986-1993, 1998, 2004, 2007-2017
        Thomas Williams, Colin Kelley and many others

        gnuplot home:     http://www.gnuplot.info
        faq, bugs, etc:   type "help FAQ"
        immediate help:   type "help"  (plot window: hit 'h')

Terminal type is now 'qt'
gnuplot> set title "Wykres wielomianu interpolacyjnego i rzeczywistego"
gnuplot> set xlabel "x"
gnuplot> set ylabel "y"
gnuplot> set xrange [-1:1]
gnuplot> set yrange [0:1]
gnuplot> plot 'Zadanie9_splajn.txt' with lines title 'Wielomian interpolacyjny' , 'Zadanie9_function.txt' title 'Wielomian rzeczywisty' with points pointtype 6
```