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Treść zadnia

Zadanie C15

Napisać program realizujący metodę różnicową dla zagadnienia

$$y'(t) = y(t) + y(t-1) - \frac{1}{4}y'(t-1)$$

$$y(t) = t\,,\ \ dla\ t \in [-1,0]$$

Rozwiązaniem jest

$$\bar{y}(t) = \begin{cases} -\frac{1}{4} + t + \frac{1}{4}\mathrm{e}^{\mathrm{t}}\,, dla\ t \in [0,1] \\ -\frac{5}{4} - 2(t-1) + \frac{5}{4}e^{t-1} + \frac{3}{16}(t-1)e^{t-1}, dla\ t \in [1,2] \end{cases}$$

Opis Metody

Metoda polega na pomiarze niewielkich różnic pomiędzy faktycznym wynikiem, a wynikiem uzyskanym z przekształcenia funkcji f(x) na układ równań różnicowych. Oznacza to, że można aproksymować pochodną danej funkcji f(x) za pomocą ilorazu różnicowego określonego wzorem

$$f'(x) \approx \frac{\mathrm{f(x+h)} - \mathrm{f(x)}}{\mathrm{h}}, gdzie\ h\ jest\ krokiem\ przybliżenia$$

Dokładność metody zależy od wyboru wielkości kroku tzn. jeżeli przedziałem x jest zbiór liczb naturalnych to najlepszym rozwiązaniem będzie wybranie kroku h=1. W większości przypadków im mniejszy krok tym dokładniejszy wynik.

W tym wypadku należało przekształcić funkcję w celu uzyskania y(t+h)

$$y'(t) = y(t) + y(t-1) - \frac{1}{4}y'(t-1)$$

$$\frac{\mathrm{y(t+h)} - \mathrm{y(t)}}{\mathrm{h}} = y(t) + y(t-1) - \frac{1}{4}\,\frac{\mathrm{y(t-1+h)} - \mathrm{y(t-1)}}{\mathrm{h}}$$

$$\mathrm{y(t+h)} - \mathrm{y(t)} = \left(y(t) + y(t-1) - \frac{1}{4}\,\frac{\mathrm{y(t-1+h)} - \mathrm{y(t-1)}}{\mathrm{h}}\right)\mathrm{h}$$

$$\mathrm{y(t+h)} = \left(y(t) + y(t-1) - \frac{1}{4}\,\frac{\mathrm{y(t-1+h)} - \mathrm{y(t-1)}}{\mathrm{h}}\right)\mathrm{h} + \mathrm{y(t)}$$

Dzięki tak przekształconej funkcji można obliczyć y(h) dla t=0 i kroku h=0,01.

$$\mathrm{y(0+0{,}01)} = \left(y(0) + y(0-1) - \frac{1}{4}\,\frac{\mathrm{y(0-1+0{,}01)} - \mathrm{y(0-1)}}{0{,}01}\right)0{,}01 + \mathrm{y(0)}$$

$$\mathrm{y}(0{,}01) = \left(y(0) + y(-1) - \frac{1}{4}\,\frac{\mathrm{y}(-0{,}99) - \mathrm{y}(-1)}{0{,}01}\right)0{,}01 + \mathrm{y}(0)$$

$$\mathrm{y}(0{,}01) = \left(0 - 1 - \frac{1}{4}\,\frac{-0{,}99 + 1}{0{,}01}\right)0{,}01 + 0$$

$$\mathrm{y}(0{,}01) = \left(-1 - \frac{1}{4}\,\frac{0{,}01}{0{,}01}\right)0{,}01$$

$$\mathrm{y}(0{,}01) = (-1{,}25)0{,}01$$

$$\mathrm{y}(0{,}01) = -0{,}0125$$

Tak samo postępuje się z pozostałymi punktami, z ty, że dla przedziału [0,1] dla funkcji

$$y'(t) = y(t) + y(t-1) - \frac{1}{4}y'(t-1)$$

y(t-1) wylicza się z $y(t) = t\,,\ \ dla\ t \in [-1{,}0]$

a dla przedziału [1,2] z już obliczonych wartości funkcji

$$y'(t) = y(t) + y(t-1) - \frac{1}{4}y'(t-1)$$

Następnie wykonuje się obliczenia dla rozwiązania, czyli dla układu równań

$$\bar{y}(t) = \begin{cases} -\frac{1}{4} + t + \frac{1}{4}\mathrm{e}^{\mathrm{t}}\,, dla\ t \in [0{,}1] \\ -\frac{5}{4} - 2(t-1) + \frac{5}{4}e^{t-1} + \frac{3}{16}(t-1)e^{t-1}, dla\ t \in [1{,}2] \end{cases}$$

Aby uzyskać tabelę błędów należy odjąć wynik oczekiwany od wyniku przybliżonego lub odwrotnie.

Kod programu

```
#include <stdio.h>
#include <stdlib.h>
#include<math.h>
#define h 0.001

int main(void) {
        double t1[1001];
        double t[2001];
        double w2[2001];
        double w1[2001];
        int i;
        t1[0] = -1;
        for (i = 1; i < 1001; i++) {
                t1[i] = t1[i - 1] + 0.001;
        }

        for (i = 0; i < 2001; i++) {
                t[i] = i * 0.001;
                w2[i] = 0;
                w1[i] = 0;
        }
        for (i = 0; i < 1001; i++) {
                w2[i] = (-1)*((-0.25) + t[i] + (0.25 * exp(t[i])));
        }
        for (i = 1000; i < 2001; i++) {
                w2[i] = (-1.25) - (2 * (t[i - 1000])) + (1.25 * exp(t[i - 1000]))
                                + (0.1875 * (t[i - 1000]) * exp(t[i - 1000]));
        }
        for (i = 0; i < 1001; i++) {
                w1[i + 1] = w1[i] + h * w1[i] + h * t1[i] - 0.25 * (t1[i+1] - t1[i]);
        }
        for (i = 1000; i < 2001; i++) {
                w1[i + 1] = w1[i] + h * w1[i] + h * w1[i - 1000] - 0.25 * (w1[i - 999] - w1[i - 1000]);
        }
        printf("\n");

         for (i = 1; i < 2001; i++) {
         printf("%3.3lf: %6.5lf \n", i*0.001,fabs(w1[i] - w2[i]));
         //printf("%3.3lf:( %9.5lf  |%9.5lf ): %6.5lf \n", i*0.001, w1[i], w2[i], fabs(-w1[i] - w2[i]));
         }
         printf("\n");

        return EXIT_SUCCESS;
}
```

0.001: 0.00000	0.089: 0.00001	0.177: 0.00003	0.265: 0.00004	0.353: 0.00006
0.002: 0.00000	0.090: 0.00001	0.178: 0.00003	0.266: 0.00004	0.354: 0.00006
0.003: 0.00000	0.091: 0.00001	0.179: 0.00003	0.267: 0.00004	0.355: 0.00006
0.004: 0.00000	0.092: 0.00001	0.180: 0.00003	0.268: 0.00004	0.356: 0.00006
0.005: 0.00000	0.093: 0.00001	0.181: 0.00003	0.269: 0.00004	0.357: 0.00006
0.006: 0.00000	0.094: 0.00001	0.182: 0.00003	0.270: 0.00004	0.358: 0.00006
0.007: 0.00000	0.095: 0.00001	0.183: 0.00003	0.271: 0.00004	0.359: 0.00006
0.008: 0.00000	0.096: 0.00001	0.184: 0.00003	0.272: 0.00004	0.360: 0.00006
0.009: 0.00000	0.097: 0.00001	0.185: 0.00003	0.273: 0.00004	0.361: 0.00006
0.010: 0.00000	0.098: 0.00001	0.186: 0.00003	0.274: 0.00005	0.362: 0.00006
0.011: 0.00000	0.099: 0.00001	0.187: 0.00003	0.275: 0.00005	0.363: 0.00007
0.012: 0.00000	0.100: 0.00001	0.188: 0.00003	0.276: 0.00005	0.364: 0.00007
0.013: 0.00000	0.101: 0.00001	0.189: 0.00003	0.277: 0.00005	0.365: 0.00007
0.014: 0.00000	0.102: 0.00001	0.190: 0.00003	0.278: 0.00005	0.366: 0.00007
0.015: 0.00000	0.103: 0.00001	0.191: 0.00003	0.279: 0.00005	0.367: 0.00007
0.016: 0.00000	0.104: 0.00001	0.192: 0.00003	0.280: 0.00005	0.368: 0.00007
0.017: 0.00000	0.105: 0.00001	0.193: 0.00003	0.281: 0.00005	0.369: 0.00007
0.018: 0.00000	0.106: 0.00001	0.194: 0.00003	0.282: 0.00005	0.370: 0.00007
0.019: 0.00000	0.107: 0.00001	0.195: 0.00003	0.283: 0.00005	0.371: 0.00007
0.020: 0.00000	0.108: 0.00002	0.196: 0.00003	0.284: 0.00005	0.372: 0.00007
0.021: 0.00000	0.109: 0.00002	0.197: 0.00003	0.285: 0.00005	0.373: 0.00007
0.022: 0.00000	0.110: 0.00002	0.198: 0.00003	0.286: 0.00005	0.374: 0.00007
0.023: 0.00000	0.111: 0.00002	0.199: 0.00003	0.287: 0.00005	0.375: 0.00007
0.024: 0.00000	0.112: 0.00002	0.200: 0.00003	0.288: 0.00005	0.376: 0.00007
0.025: 0.00000	0.113: 0.00002	0.201: 0.00003	0.289: 0.00005	0.377: 0.00007
0.026: 0.00000	0.114: 0.00002	0.202: 0.00003	0.290: 0.00005	0.378: 0.00007
0.027: 0.00000	0.115: 0.00002	0.203: 0.00003	0.291: 0.00005	0.379: 0.00007
0.028: 0.00000	0.116: 0.00002	0.204: 0.00003	0.292: 0.00005	0.380: 0.00007
0.029: 0.00000	0.117: 0.00002	0.205: 0.00003	0.293: 0.00005	0.381: 0.00007
0.030: 0.00000	0.118: 0.00002	0.206: 0.00003	0.294: 0.00005	0.382: 0.00007
0.031: 0.00000	0.119: 0.00002	0.207: 0.00003	0.295: 0.00005	0.383: 0.00007
0.032: 0.00000	0.120: 0.00002	0.208: 0.00003	0.296: 0.00005	0.384: 0.00007
0.033: 0.00000	0.121: 0.00002	0.209: 0.00003	0.297: 0.00005	0.385: 0.00007
0.034: 0.00000	0.122: 0.00002	0.210: 0.00003	0.298: 0.00005	0.386: 0.00007
0.035: 0.00000	0.123: 0.00002	0.211: 0.00003	0.299: 0.00005	0.387: 0.00007
0.036: 0.00000	0.124: 0.00002	0.212: 0.00003	0.300: 0.00005	0.388: 0.00007
0.037: 0.00000	0.125: 0.00002	0.213: 0.00003	0.301: 0.00005	0.389: 0.00007
0.038: 0.00000	0.126: 0.00002	0.214: 0.00003	0.302: 0.00005	0.390: 0.00007
0.039: 0.00001	0.127: 0.00002	0.215: 0.00003	0.303: 0.00005	0.391: 0.00007
0.040: 0.00001	0.128: 0.00002	0.216: 0.00003	0.304: 0.00005	0.392: 0.00007
0.041: 0.00001	0.129: 0.00002	0.217: 0.00003	0.305: 0.00005	0.393: 0.00007
0.042: 0.00001	0.130: 0.00002	0.218: 0.00003	0.306: 0.00005	0.394: 0.00007
0.043: 0.00001	0.131: 0.00002	0.219: 0.00003	0.307: 0.00005	0.395: 0.00007
0.044: 0.00001	0.132: 0.00002	0.220: 0.00003	0.308: 0.00005	0.396: 0.00007
0.045: 0.00001	0.133: 0.00002	0.221: 0.00003	0.309: 0.00005	0.397: 0.00007
0.046: 0.00001	0.134: 0.00002	0.222: 0.00003	0.310: 0.00005	0.398: 0.00007
0.047: 0.00001	0.135: 0.00002	0.223: 0.00003	0.311: 0.00005	0.399: 0.00007
0.048: 0.00001	0.136: 0.00002	0.224: 0.00004	0.312: 0.00005	0.400: 0.00007
0.049: 0.00001	0.137: 0.00002	0.225: 0.00004	0.313: 0.00005	0.401: 0.00007
0.050: 0.00001	0.138: 0.00002	0.226: 0.00004	0.314: 0.00005	0.402: 0.00008
0.051: 0.00001	0.139: 0.00002	0.227: 0.00004	0.315: 0.00005	0.403: 0.00008
0.052: 0.00001	0.140: 0.00002	0.228: 0.00004	0.316: 0.00005	0.404: 0.00008
0.053: 0.00001	0.141: 0.00002	0.229: 0.00004	0.317: 0.00005	0.405: 0.00008
0.054: 0.00001	0.142: 0.00002	0.230: 0.00004	0.318: 0.00005	0.406: 0.00008
0.055: 0.00001	0.143: 0.00002	0.231: 0.00004	0.319: 0.00005	0.407: 0.00008
0.056: 0.00001	0.144: 0.00002	0.232: 0.00004	0.320: 0.00006	0.408: 0.00008
0.057: 0.00001	0.145: 0.00002	0.233: 0.00004	0.321: 0.00006	0.409: 0.00008
0.058: 0.00001	0.146: 0.00002	0.234: 0.00004	0.322: 0.00006	0.410: 0.00008
0.059: 0.00001	0.147: 0.00002	0.235: 0.00004	0.323: 0.00006	0.411: 0.00008
0.060: 0.00001	0.148: 0.00002	0.236: 0.00004	0.324: 0.00006	0.412: 0.00008
0.061: 0.00001	0.149: 0.00002	0.237: 0.00004	0.325: 0.00006	0.413: 0.00008
0.062: 0.00001	0.150: 0.00002	0.238: 0.00004	0.326: 0.00006	0.414: 0.00008
0.063: 0.00001	0.151: 0.00002	0.239: 0.00004	0.327: 0.00006	0.415: 0.00008
0.064: 0.00001	0.152: 0.00002	0.240: 0.00004	0.328: 0.00006	0.416: 0.00008
0.065: 0.00001	0.153: 0.00002	0.241: 0.00004	0.329: 0.00006	0.417: 0.00008
0.066: 0.00001	0.154: 0.00002	0.242: 0.00004	0.330: 0.00006	0.418: 0.00008
0.067: 0.00001	0.155: 0.00002	0.243: 0.00004	0.331: 0.00006	0.419: 0.00008
0.068: 0.00001	0.156: 0.00002	0.244: 0.00004	0.332: 0.00006	0.420: 0.00008
0.069: 0.00001	0.157: 0.00002	0.245: 0.00004	0.333: 0.00006	0.421: 0.00008
0.070: 0.00001	0.158: 0.00002	0.246: 0.00004	0.334: 0.00006	0.422: 0.00008
0.071: 0.00001	0.159: 0.00002	0.247: 0.00004	0.335: 0.00006	0.423: 0.00008
0.072: 0.00001	0.160: 0.00002	0.248: 0.00004	0.336: 0.00006	0.424: 0.00008
0.073: 0.00001	0.161: 0.00002	0.249: 0.00004	0.337: 0.00006	0.425: 0.00008
0.074: 0.00001	0.162: 0.00002	0.250: 0.00004	0.338: 0.00006	0.426: 0.00008
0.075: 0.00001	0.163: 0.00002	0.251: 0.00004	0.339: 0.00006	0.427: 0.00008
0.076: 0.00001	0.164: 0.00002	0.252: 0.00004	0.340: 0.00006	0.428: 0.00008
0.077: 0.00001	0.165: 0.00002	0.253: 0.00004	0.341: 0.00006	0.429: 0.00008
0.078: 0.00001	0.166: 0.00002	0.254: 0.00004	0.342: 0.00006	0.430: 0.00008
0.079: 0.00001	0.167: 0.00002	0.255: 0.00004	0.343: 0.00006	0.431: 0.00008
0.080: 0.00001	0.168: 0.00002	0.256: 0.00004	0.344: 0.00006	0.432: 0.00008
0.081: 0.00001	0.169: 0.00002	0.257: 0.00004	0.345: 0.00006	0.433: 0.00008
0.082: 0.00001	0.170: 0.00003	0.258: 0.00004	0.346: 0.00006	0.434: 0.00008
0.083: 0.00001	0.171: 0.00003	0.259: 0.00004	0.347: 0.00006	0.435: 0.00008
0.084: 0.00001	0.172: 0.00003	0.260: 0.00004	0.348: 0.00006	0.436: 0.00008
0.085: 0.00001	0.173: 0.00003	0.261: 0.00004	0.349: 0.00006	0.437: 0.00008
0.086: 0.00001	0.174: 0.00003	0.262: 0.00004	0.350: 0.00006	0.438: 0.00008
0.087: 0.00001	0.175: 0.00003	0.263: 0.00004	0.351: 0.00006	0.439: 0.00009
0.088: 0.00001	0.176: 0.00003	0.264: 0.00004	0.352: 0.00006	0.440: 0.00009

0.441: 0.00009	0.529: 0.00011	0.617: 0.00014	0.705: 0.00018	0.793: 0.00022
0.442: 0.00009	0.530: 0.00011	0.618: 0.00014	0.706: 0.00018	0.794: 0.00022
0.443: 0.00009	0.531: 0.00011	0.619: 0.00014	0.707: 0.00018	0.795: 0.00022
0.444: 0.00009	0.532: 0.00011	0.620: 0.00014	0.708: 0.00018	0.796: 0.00022
0.445: 0.00009	0.533: 0.00011	0.621: 0.00014	0.709: 0.00018	0.797: 0.00022
0.446: 0.00009	0.534: 0.00011	0.622: 0.00014	0.710: 0.00018	0.798: 0.00022
0.447: 0.00009	0.535: 0.00011	0.623: 0.00015	0.711: 0.00018	0.799: 0.00022
0.448: 0.00009	0.536: 0.00011	0.624: 0.00015	0.712: 0.00018	0.800: 0.00022
0.449: 0.00009	0.537: 0.00011	0.625: 0.00015	0.713: 0.00018	0.801: 0.00022
0.450: 0.00009	0.538: 0.00012	0.626: 0.00015	0.714: 0.00018	0.802: 0.00022
0.451: 0.00009	0.539: 0.00012	0.627: 0.00015	0.715: 0.00018	0.803: 0.00022
0.452: 0.00009	0.540: 0.00012	0.628: 0.00015	0.716: 0.00018	0.804: 0.00022
0.453: 0.00009	0.541: 0.00012	0.629: 0.00015	0.717: 0.00018	0.805: 0.00022
0.454: 0.00009	0.542: 0.00012	0.630: 0.00015	0.718: 0.00018	0.806: 0.00023
0.455: 0.00009	0.543: 0.00012	0.631: 0.00015	0.719: 0.00018	0.807: 0.00023
0.456: 0.00009	0.544: 0.00012	0.632: 0.00015	0.720: 0.00018	0.808: 0.00023
0.457: 0.00009	0.545: 0.00012	0.633: 0.00015	0.721: 0.00019	0.809: 0.00023
0.458: 0.00009	0.546: 0.00012	0.634: 0.00015	0.722: 0.00019	0.810: 0.00023
0.459: 0.00009	0.547: 0.00012	0.635: 0.00015	0.723: 0.00019	0.811: 0.00023
0.460: 0.00009	0.548: 0.00012	0.636: 0.00015	0.724: 0.00019	0.812: 0.00023
0.461: 0.00009	0.549: 0.00012	0.637: 0.00015	0.725: 0.00019	0.813: 0.00023
0.462: 0.00009	0.550: 0.00012	0.638: 0.00015	0.726: 0.00019	0.814: 0.00023
0.463: 0.00009	0.551: 0.00012	0.639: 0.00015	0.727: 0.00019	0.815: 0.00023
0.464: 0.00009	0.552: 0.00012	0.640: 0.00015	0.728: 0.00019	0.816: 0.00023
0.465: 0.00009	0.553: 0.00012	0.641: 0.00015	0.729: 0.00019	0.817: 0.00023
0.466: 0.00009	0.554: 0.00012	0.642: 0.00015	0.730: 0.00019	0.818: 0.00023
0.467: 0.00009	0.555: 0.00012	0.643: 0.00015	0.731: 0.00019	0.819: 0.00023
0.468: 0.00009	0.556: 0.00012	0.644: 0.00015	0.732: 0.00019	0.820: 0.00023
0.469: 0.00009	0.557: 0.00012	0.645: 0.00015	0.733: 0.00019	0.821: 0.00023
0.470: 0.00009	0.558: 0.00012	0.646: 0.00015	0.734: 0.00019	0.822: 0.00023
0.471: 0.00009	0.559: 0.00012	0.647: 0.00015	0.735: 0.00019	0.823: 0.00023
0.472: 0.00009	0.560: 0.00012	0.648: 0.00015	0.736: 0.00019	0.824: 0.00023
0.473: 0.00009	0.561: 0.00012	0.649: 0.00016	0.737: 0.00019	0.825: 0.00024
0.474: 0.00010	0.562: 0.00012	0.650: 0.00016	0.738: 0.00019	0.826: 0.00024
0.475: 0.00010	0.563: 0.00012	0.651: 0.00016	0.739: 0.00019	0.827: 0.00024
0.476: 0.00010	0.564: 0.00012	0.652: 0.00016	0.740: 0.00019	0.828: 0.00024
0.477: 0.00010	0.565: 0.00012	0.653: 0.00016	0.741: 0.00019	0.829: 0.00024
0.478: 0.00010	0.566: 0.00012	0.654: 0.00016	0.742: 0.00019	0.830: 0.00024
0.479: 0.00010	0.567: 0.00012	0.655: 0.00016	0.743: 0.00020	0.831: 0.00024
0.480: 0.00010	0.568: 0.00013	0.656: 0.00016	0.744: 0.00020	0.832: 0.00024
0.481: 0.00010	0.569: 0.00013	0.657: 0.00016	0.745: 0.00020	0.833: 0.00024
0.482: 0.00010	0.570: 0.00013	0.658: 0.00016	0.746: 0.00020	0.834: 0.00024
0.483: 0.00010	0.571: 0.00013	0.659: 0.00016	0.747: 0.00020	0.835: 0.00024
0.484: 0.00010	0.572: 0.00013	0.660: 0.00016	0.748: 0.00020	0.836: 0.00024
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