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1  /* Another online mathematics problem (c)
2   * August 9, 2024 by James Pate Williams, Jr.
3   * find the root of  $f(x) = x^{(x^8)} - 8 = 0$ 
4   *  $x = 1.2968395547$ 
5   *  $f(x) = -2.6645353e-15$ 
6   */
7
8  #include <math.h>
9  #include <stdio.h>
10
11  typedef long double real;
12
13  real f(real x) {
14      return powl(x, 8.0);
15  }
16
17  real g(real x) {
18      return powl(x, f(x)) - 8.0;
19  }
20
21  real CentralDifference(
22      real x, real h, real (*gx)(real)) {
23      return (gx(x + h) - gx(x - h)) / (2.0 * h);
24  }
25
26  real NewtonRaphson(
27      real x0, real ftolerance, real xtolerance,
28      real (*fx)(real), real (*deriv)(real, real,
29          real (*fx)(real))) {
30      real h = 2.0 / 10000.0, x1 = 0.0;
31
32      while (1) {
33          real f = fx(x0);
34          real dfdx = deriv(x0, h, fx);
35          x1 = x0 - f / dfdx;
36
37          if (fabsl(x1 - x0) < xtolerance ||
38              fabsl(f) < ftolerance)
39              break;
40
41          x0 = x1;
42      }
43
44      return x1;
45  }
46
47  int main(void) {
48      real ftolerance = 1.0e-15, xtolerance = 1.0e-15, x = 0, y = 0;
49
50      x = NewtonRaphson(
51          2.0, ftolerance, xtolerance, g, CentralDifference);
52      printf_s("x = %12.10Lf\n", x);
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53     printf_s("f(x) = %13.7e\n", g(x));  
54     return 0;  
55 }
```