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//#############################################################################################
//
// Copyright, 2013, Wang Xian, Xi'an Jiaotong university
// -- stability.c (Feb.2009)

// -- LAX & FTCS for one-order wave equation

//#############################################################################################


     #include <stdio.h>
     #include <stdlib.h>
     #include <malloc.h>
     #include <assert.h> //what is this?
     #include <math.h>
     #include <string.h>



int main(int argc, char *argv[])
{

//------------------------------ define varaibles ---------------------------------------------

      int   nx;                  /* number of nodes in the profile */  //波形部分的网格数
      int   nxx;                 /* total number of grid */            //求解区域总网格数

      int   i;                   /* variable for loop */

      int   method;              /* method=1: LAX; method=2: FTCS */
      int   ifun;                /* ifun=1: square wave; ifun=2: smooth wave */

      double dt;                 /* time step */
      double dx;                 /* cell dimension */
      double time_max;           /* maxium time  */                          //input data
    (time_max)
      double t;

      double aspeed;             /* speed of wave */                                 //input data
      double CFL;                /* CFL number = aspeed*dt/dx  */                    //input data

      double *x;                 /* x[i] coordinate */
      double *u;                 /* u[i] at t */
      double *un;                /* un[i] at t+dt */


//---------------------------  read input data ----------------------------------------------------
    FILE *in_data;
    FILE  * file_dat;
   char input[20];

     file_dat=fopen("result.plt","w");
     in_data=fopen("INPUT.dat","r");

     fscanf(in_data,"%s%d\n",input,&nx);
     fscanf(in_data,"%s%lf\n",input,&time_max);
     fscanf(in_data,"%s%lf\n",input,&CFL);
     fscanf(in_data,"%s%lf\n",input,&aspeed);
     fscanf(in_data,"%s%d\n",input,&method);
     fscanf(in_data,"%s%d\n",input,&ifun);


     fclose(in_data);
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     nxx=4*nx;       //求解总区域

//-------------------------------------------------------------------------------
    u = (double *) malloc(nxx*sizeof(double));
    un = (double *) malloc(nxx*sizeof(double));
    x = (double *) malloc(nxx*sizeof(double));
  //-------------------------------------------------

    x[0]=0.0;       //波形原始起点
    x[nx-1]=1.0;    //波形原始终点


    dx=1.0/(double)(nx-1);

    for(i=0;i<nxx;i++)
    {
       if(i>0) x[i]=x[i-1]+dx;
       u[i]=0.0;
       un[i]=0.0;
    }

//-------------initialize-----------------------------------------

    for(i=0;i<nx;i++)
    {

       if(ifun==1)
        {
            u[i]=1.0;

       }
        else
        {
            u[i]=-64.0*x[i]*x[i]*x[i]*(x[i]-1.0)*(x[i]-1.0)*(x[i]-1.0)*exp(-16.0*(x[i]-0.5)*(x[i]-0. ↙
    5));
        }
    }




    //-------------start computation---------------------------------
        dt = CFL * dx / aspeed ;
        printf("---------dt = %f-------------\n",dt);

        for(t=0.0;t<time_max;t=t+dt)
        {
            for(i=1;i<nxx-1;i++)
            {
              if (method ==1 ) // Lax
              {
                  un[i] = ( u[i+1] + u[i-1] )/2.0 - CFL * ( u[i+1] - u[i-1] )/2.0;
              }

              else   // FTCS
              {
                  un[i] = u[i] - CFL * ( u[i+1] - u[i-1] )/2.0;
              }

            }

           for(i=1;i<nxx-1;i++)
           {
             u[i]=un[i];
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           }

        }

//-----------------output-----------------------------------------------



        fputs("VARIABLES=X,U\n",file_dat);
    fprintf(file_dat, "ZONE I=%6d, F=POINT\n",nxx-1);

         for (i=0; i<nxx; i++)
          {
            fprintf(file_dat,"%15.9f %15.9f\n",x[i],u[i]);
          }

    fclose(file_dat);




    return 0;


}/***** end main *****/
```