DoGPack Documentation File

Directory: `apps/2d/advection/smooth_example`
Equation: $q_{,t} + u\,q_{,x} + v\,q_{,y} = 0$

Mathematics

Consider the space-time domain $[0,T] \times \Omega$, where $\Omega \subseteq \mathbb{R}^2$, and let $t \in [0,T]$ and $(x,y) \in \Omega$. The dependent variable is the concentration of a passive tracer, denoted by $q\colon \mathbb{R} \times \Omega \to \mathbb{R}$, which is advected by the velocity field (u,v), where $u\colon \Omega \to \mathbb{R}$ is the x-component of the velocity field and $v\colon \Omega \to \mathbb{R}$ is the y-component of the velocity field. The concentration then satisfies the following time-dependent advection equation:

$$q_{,t} + u\,q_{,x} + v\,q_{,y} = 0.$$

From the method of characteristics, we find that $q(t,x,y)$ is constant along the characteristics that are defined by the velocity field:

$$q(t,x,y) = q(0,\xi,\eta), \quad \text{where} \quad \frac{d\xi}{dt} = u(\xi,\eta), \quad \frac{d\eta}{dt} = v(\xi,\eta) \quad \text{with} \quad \xi(0) = x, \quad \eta(0) = y.$$

The affect of boundary conditions can also be readily incorporated into the method of characteristics.

Editing Basic Application Files

Below we describe all the basic files that can be edited to change basi

1. The initial conditions can be changed in the following file:

   ```
   Shell] open $DOGPACK/apps/2d/advection/smooth_example/QinitFunc.cpp
   Shell]
   ```

2. The velocity field can be changed in the following file:

   ```
   Shell] open $DOGPACK/apps/2d/advection/smooth_example/AuxFunc.cpp
   Shell]
   ```

3. The boundary conditions can be changed in the following file:

   ```
   Shell] open $DOGPACK/apps/2d/advection/smooth_example/SetBndValues.cpp
   Shell]
   ```

4. The flux function can be changed in the following file:

   ```
   Shell] open $DOGPACK/apps/2d/advection/smooth_example/FluxFunc.cpp
   Shell]
   ```

5. The wave speeds needed to determine the time-step can be changed in the following file:

   ```
   Shell] open $DOGPACK/apps/2d/advection/smooth_example/SetWaveSpd.cpp
   Shell]
   ```

6. The projection onto the left and right eigenvectors can be done in the following two files (these are only needed if moment-limiters are used):

```
Shell] open $DOGPACK/apps/2d/advection/smooth_example/ProjectLeftEig.cpp
Shell] open $DOGPACK/apps/2d/advection/smooth_example/ProjectRightEig.cpp
Shell]
```

Compilation

The example in this directory can be compiled as follows:

```
   Shell session inside TeXmacs pid = 5559
Shell] cd $DOGPACK/apps/2d/advection/smooth_example/
Shell] make >/dev/null 2>&1
Shell] ls dog.exe
   dog.exe
Shell]
```

Editing parameter file

The example parameters can be changed in the parameter file:

```
Shell] open $DOGPACK/apps/2d/advection/smooth_example/parameters.ini
Shell]
```

Running the example

To run the example simply type:

```
Shell] cd $DOGPACK/apps/2d/advection/smooth_example/
Shell] dog.exe >/dev/null 2>&1
Shell]
```

Plotting in Python

To plot the solution results in Python type the following:

```
Python] import os
Python] DOG = os.environ["DOGPACK"];
Python] wdir = "".join((DOG,"/apps/2d/advection/smooth_example"));
Python] os.chdir(wdir);
Python] import plotdog2np as pd
Python] pd.plotdog2np(4,'output',1,1);
   GridType =  Cartesian
           points_per_dir =  4
               point_type =  1
                outputdir =  output
    component_of_solution =  1
```

```
    Finished creating file for FRAME =  0   filename =  figure0000.jpg
    Finished creating file for FRAME =  1   filename =  figure0001.jpg
    Finished creating file for FRAME =  2   filename =  figure0002.jpg
    Finished creating file for FRAME =  3   filename =  figure0003.jpg
    Finished creating file for FRAME =  4   filename =  figure0004.jpg
    Finished creating file for FRAME =  5   filename =  figure0005.jpg
    Finished creating file for FRAME =  6   filename =  figure0006.jpg
    Finished creating file for FRAME =  7   filename =  figure0007.jpg
    Finished creating file for FRAME =  8   filename =  figure0008.jpg
    Finished creating file for FRAME =  9   filename =  figure0009.jpg
    Finished creating file for FRAME =  10   filename =  figure0010.jpg
Python]
```

Sample Output (JPEG)