User's Manual for the Function `matfd`. A MATlab function for the Finite Differences method

The MatMOL Group (2009)

The Function `matfd`

This function allows the user to call, in a systematic way, the different finite differences shcemes implemented in the MatMOL toolbox.

```
[fd_im] = matfd (z, grid, der_ord, ns, mth, v)
```

where the input and output parameters are

```
Input parameters:
z:        Coordinates of the spatial discretization points.
grid:     Set this parameter to 'uni' if the grid is uniform,
          otherwise, set it to 'non_uni'.
der_ord:  Order of the derivative. The possibilities are '1st',
          '2nd'and '3rd'.
ns:       Number of points in the stencil.
mth:      Finite differences scheme. The possibilities are
          'centered', 'upwind', 'upwind_biased'.
v:        Fluid velocity. It is necessary in the cases of upwind
          and upwind biased methods

Output parameters:
fd_im:    Finite difference approximation of the derivative
          operator of order indicated in the input parameter
          der_ord.
```

A simple example

Compute the first order finite difference matrix with uniform grid using 7 points in the stencil and a centered finite difference scheme

```
xe   = linspace(0,pi,21);
[D1] = matfd (xe, 'uni', '1st', 7, 'centered')
```

Note: Some of the different possibilities were not included either because they do not exist (like the case of a centered scheme with four points in the stencil) or because the authors decided not to include them in this version of the MatMOL toolbox. Future versions will include new possibilities.

The available schemes are indicated in Table 1 for uniform grids and in Table 2 for non uniform grids.

		Number of points in the stencil						
Scheme	Der. Order	11	9	7	5	4	3	2
Centered	1^{st}	X	X	X	X	-	X	-
	2^{nd}	-	-	-	X	-	X	-
	3^{rd}	-	-	-	-	-	-	-
Upwind	1^{st}	-	-	-	-	X	X	X
	2^{nd}	-	-	-	-	-	-	-
	3^{rd}	-	-	-	-	-	-	-
Upwind biased	1^{st}	-	-	-	X	X	-	-
	2^{nd}	-	-	-	-	-	-	-
	3^{rd}	-	-	-	-	-	-	-

Table 1: Available finite differences schemes for uniform grids

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		Number of points in the stencil						
Scheme	Der. Order	11	9	7	5	4	3	2
Centered	1^{st}	X	X	X	X	-	X	-
	2^{nd}	-	-	-	X	-	X	-
	3^{rd}	-	-	X	-	-	-	-
Upwind	1^{st}	-	-	-	-	X	X	X
	2^{nd}	-	-	-	-	-	-	-
	3^{rd}	-	-	-	-	-	-	-
Upwind biased	1^{st}	-	-	-	X	X	-	-
	2^{nd}	-	-	-	-	-	-	-
	3^{rd}	-	-	-	-	-	-	-

Table 2: Available finite differences schemes for non uniform grids