Object-Oriented Interactive Access to JET Database
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Object-Oriented Interactive Access to JET Database

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ABSTRACT.
Some preliminary classes have been developed in MATLAB to interface with the JET PPF system which stores the data elaborated after the discharge. These classes simplify the most common operations required during an interactive analysis and visualization of JET data, while keeping all the power of a full programming language. The first class is ppfs which given a shot number retrieves a list of all the main family (DDAs) related to that shot, the second is ddas which lists all the DTYPEs belonging to a DDA. The last two classes are used for retrieving the actual data and perform the most common operation, such as basic plotting, slicing, and arithmetic operation.

1. INTRODUCTION
Object Oriented (OO) languages are widely used as they permit to write large codes in a more natural and easy way. Many languages have been changed in order to support a form or another of objects [1].

An interactive environment, and language, as MATLAB† has the possibility to manipulate natively arrays and, with OO features, other kind of data while retaining all the strength of a full programming language. In the following MATLAB has been used to develop four classes to retrieve data from the JET PPF (Processed Pulse File) system, a porting of these classes to other interactive environment is also under way. The jet PPF system [2] stores data elaborated after every discharge. Every signal stored there is characterized by its family name DDA (Diagnostic Data Areas) and its proper name DTYPE (Data Type), each of them of four characters. They are also characterized by the owner (in the case of private PPFs) and a sequence number (we are not caring about the sequence number now, but we are assuming to be interested only in the last written sequence number). An owner (by default JETPPF), a DDA and a DTYPE is all that is required to get the proper data. All the data are basically bi-dimensional, matrices with a time and a radial coordinate, even though one of them could be missing if one is interested in one-dimensional data. A short description of the data is also stored in the archive. There are three basic operations that the interactive user might want to do, the first is to retrieve the correct name of a given measurable quantity, the second to make slices and plot them, third to make operations between different data. This has been achieved with four classes. The first two are directly related to the DDA and DTYPE parameters, the first class called ppfs give a list of the DDAs, while the second class called ddas gives a list of a DTYPE inside a DDA. The second two classes are more related to the data itself, a first class to deal with the bi-dimensional data, the second to deal with the slices. A single class could have been used instead of two different classes, and in the future they may be combined together.

2. PPFS AND DDAS CLASSES
These two classes are quite similar and in the following the ppfs class is described first. From the user point of view, a ppfs object appears as a structure where its fields are the DDAs, and consequently the DTYPEs appear as fields of DDAs. This has been obtained overloading the field operator (the function subsref of the object). Even though there is strict separation in MATLAB
among input and output parameter of a function, it is possible, with a perfectly legal trick (using only documented functions), to change an input parameter. This is specially important with OO programming for interactive use as it is more natural and fast to have objects that can change there status depending on the methods called. Even if the access to JET archive is quite fast the retrieved data are stored in memory changing the ddas or the ppfs objects accordingly.

The two main attributes of the ppfs class are two arrays, one is a character array with the names of all the DDAs, the second is a cell array where the ddas object would be stored. There are other attributes like the shot number or the userid for private PPFs. The ddas class is similar, with corresponding arrays for storing the DTYPE names and objects.

The main constructor fetches the DDA names from JET archive and returns to the caller. No ddas object is stored in the second array. This is the aim of the subsref method. When a complete field is referenced, the subsref method calls a constructor for the corresponding DDA, which in turn fetches the list of the DTYPE. The subsref function would then modify the original ppfs object, so that a following reference to the same field does not result in a new access to the database. The subsref method would then return a ddas object (that accordingly shows the list of its DTYPE). If one asks an incomplete field then a ppfs object, with only the DDAs beginning with that initials is returned (that would then display on the screen only the selected DTYPE). The ddas objects have a similar behaviour to the ppfs objects with v2d objects in place of ddas objects. The other two methods are: the display method which display on the screen the list of DDA (DTYPE) belonging to the ppfs(ddas) object; and a list method to convert a ppfs(ddas) object to a list of names.

3. V2D CLASS
The data in the PPF system are basically bidimensional, with the first dimension being a spatial dimension and the second one a temporal dimension. One of the two dimensions could be absent, in this case the data depend only on time (by far the most frequent case), or on spatial position. The v2d class has been written in order to resemble as much as possible this situation.

There are three fields: the first is r, a spatial coordinate, the second is t, a time coordinate and the third is v, the value of the data at the specific time and radius. The radial coordinates could be a matrix, while the time coordinates is always a vector. This way is possible to model a situation (for example the ECE temperature) where the detectors measure the temperature at a position which depends on the magnetic field.

The most common operation required is slicing the data along a dimension, and two methods have been written to slice the data along time or space. These methods accept a parameter for selecting the position of the slice. For example, to get a slice along time, a parameter with the radial position should be supplied. There are two kinds of slicing: in the first one the closest profile to the given position or time is returned, in the second one an interpolation is performed. This kind of slicing is mostly useful when an object v2d has got an r coordinate which is a matrix, the first kind of slicing would give jumps when a different detector is selected. As an option for the first kind of slicing there is the possibility to follow one detector even if its position is changing.
The first kind of slicing could also return all the possible slices if no parameter is given, or an array of slices if the supplied parameter is a vector. The slices are objects of \textit{vxy} class. Array of \textit{vxy} objects can be created and a multiple slice produces an array of \textit{vxy} object.

Actually it would have been possible to use a single class instead of two classes but in this preliminary version of the code two classes were written as the \textit{vxy} class was already present (it was used to access experimental data in FTU which are mostly one-dimensional); moreover there are simple methods in the \textit{vxy} class that would have required a different design if they had to be applied to bidimensional data.

4. VXY CLASS

The data of a \textit{vxy} object are one-dimensional, with two arrays \textit{x}, \textit{y}. A further field ud is used to store additional data. Even if it is not required the \textit{x} being in ascending or descending order, many methods that imply an interpolation work only for monotonic \textit{x} data. There are four main methods:

- Methods that perform an unary or a binary operation between two \textit{vxy} objects mostly implemented as operators, or simple function.
- Methods that change the object, like swapping the \textit{x} and the \textit{y} field or restricting the \textit{x} between two given values, or getting interpolated value at a given coordinate.
- Methods to get the \textit{x} and the \textit{y} array or the ud field.
- Method \texttt{plot} which plots arrays of \textit{vxy} object.

Some of the methods are implemented as pseudo-fields overloading the \texttt{subsref} method, for example the method which get the \textit{x} or \textit{y} array. They appear to the user as fields of a structure, while the \texttt{subsref} is actually called. This is useful as it hides the true fields from the user. The methods that combine two different \textit{vxy} objects need a common \textit{x} base where to interpolate the data. The default choice is to get the union of the two \textit{x} bases in the zone where both were defined. The interpolation is linear but other kind of interpolation and \textit{x} base choice could be selected.

5. EXAMPLES

This is a simple example showing from the user point of view the interaction with the system. First the list of all the public DDA belonging to the Pulse No: 57941 is printed on the screen (only few of them are shown here).

\begin{verbatim}
>> w = ppfs(57941)
   w =
       Shot: 57941
          uid: JETPPF
        n.DDA: 106
          bol4:  - 7
          bolo:  - 7
          ...
\end{verbatim}
Then the list of all the DTYPE belonging to the \texttt{nft2} DDA and starting with \texttt{pr} is shown on the screen. A small comment attached to the DTYPE is also shown, so the users can quickly find what they are searching for.

\begin{verbatim}
>> w.nft2.pr
ans =
    Shot: 57941
    dda: nft2
    uid: JETPPF
n. DT: 3
    prhi: 21 x 145 - ne(sqrt(psi)) Hi Limit
    prlo: 21 x 145 - ne(sqrt(psi)) Low Limit
    prof: 21 x 145 - ne(sqrt(psi)) on C2 Grid
\end{verbatim}

The radial coordinate of the density profile is the square root of \texttt{psi}. The \texttt{psi} can be found in the \texttt{efit} DDA.

\begin{verbatim}
>> w.efit.psn
ans =
    Shot: 57941
    dda: efit
    uid: JETPPF
n. DT: 3
    psni: 33 x 149 - PSI_NORM (RAD_NORM_IN)
    psnm: 33 x 149 - PSI_NORM(R) ON Z=ZMAG
    psno: 33 x 149 - PSI_NORM (RAD_NORM_OUT)
\end{verbatim}

The correct DTYPE is \texttt{psnm}. Then we can slice the data at for example 50s. The ECE temperature is also read. The data are also normalized.

\begin{verbatim}
ne = w.nft2.prof.ct(50) / 1e19;
psi = w.efit.psnm.ct(50);
te = w.ecm1.prfl.ct(50) / 1e3;
\end{verbatim}

In order to get the density as function of \texttt{R} instead of \texttt{psi} it is possible to use the pseudo-field \texttt{f} which realizes a sort of functional composition.

\begin{verbatim}
ner = ne.f(sqrt(psi),'extreme');
\end{verbatim}

Then we plot the \texttt{psi}, the density as function of the \texttt{psi} and as function of the radius, and the temperature and pressure. Note that the temperature and the density are multiplied together even if they have a different spatial base, and in two plots the radial coordinate is restricted between 2 and 4 with the : operator (Fig.1).
CONCLUSION
The use of OO features of MATLAB has greatly simplified the use of this interactive environment. Four classes have been developed, their main methods have been shown together with some examples.

REFERENCES

Figure 1: The plots produced by the methods plot as shown in the text. The labels on the x and y axes and the legend have been added later for clarity. (a) the psi as function of the radius; (b) the density as function of the psi; (c) the density as function of the radius obtained combining ne(sqrt(psi)) and psi(R); (d) the temperature and the pressure (in arbitrary units), the latter obtained multiplying temperature and density.