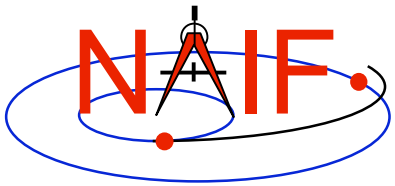
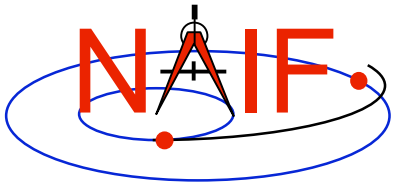


Navigation and Ancillary Information Facility

Matlab Interface to CSPICE "Mice"

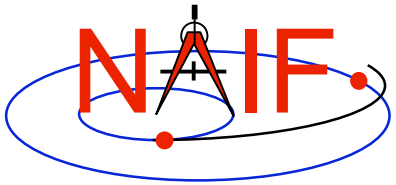
How to Access the CSPICE library Using Matlab©

January 2009



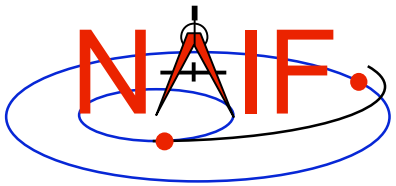
Topics

- Mice Benefits
- How does it work?
- Distribution
- Mice Operation
- Vectorization
- Simple Mice Example



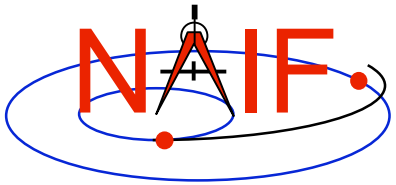
Mice Benefits

- Mice operates as an extension to the Matlab environment.
- All Mice calls are functions regardless of the call format of the underlying CSPICE routine, returning Matlab native data types.
- Mice has some capability not available in CSPICE such as vectorization.
- CSPICE error messages return to Matlab in the form usable by the *try...catch* construct.



How Does It Work? (1)

- **The Matlab environment includes an intrinsic capability to use external routines.**
  - **Mice functions as a Matlab Executable, MEX, consisting of the Mice MEX shared object library and a set of .m wrapper files.**
    - » **The Mice library contains the Matlab callable C interface routines that wrap a subset of CSPICE wrapper calls.**
    - » **The wrapper files, named cspice_*.m and mice_*.m, provide the Matlab calls to the interface functions.**
      - » **A function prefixed with 'cspice_' retains essentially the same argument list as the CSPICE counterpart.**
      - » **An interface prefixed with 'mice_' returns a structure, with the fields of the structure corresponding to the output arguments of the CSPICE counterpart.**
    - » **The wrappers include a header section describing the function call, displayable by the Matlab *help* command.**

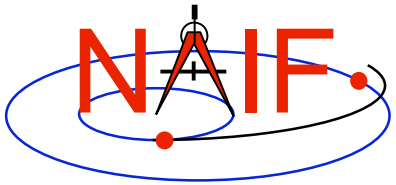


How Does It Work? (2)

When a user invokes a call to a Mice function:

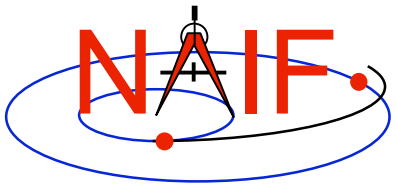
1. Matlab calls…
   2. the function's wrapper, which calls…
      3. the Mice MEX shared object library, which performs its function then returns the result…
         4. to the wrapper, which…
            5. returns the result to the user

… transparent from the user's perspective.



Mice Distribution

- NAIF distributes Mice as a complete, standalone package.
- The package includes:
  - the CSPICE source files
  - the Mice interface source code
  - platform specific build scripts for Mice and CSPICE
  - Matlab versions of the SPICE cookbook programs, *states*, *tictoc*, *subpt*, and *simple*
  - an HTML based help system for both Mice and CSPICE, with the Mice help cross-linked to CSPICE
  - the Mice MEX shared library and the M wrapper files. The system is ready for use after installation of the the library and wrapper files.
- Note: You do not need a C compiler to use Mice.



Mice Operation (1)

- **A possible irritant exists in loading kernels using the `cspice_furnsh` function.**
  - **Kernels load into your Matlab session, not into your Matlab scripts. This means:**
    - » **loaded binary kernels remain accessible ("active") throughout your Matlab session**
    - » **data from loaded text kernels remain in the kernel pool (in the memory space used by CSPICE) throughout your Matlab session**
  - **Consequence: some kernel data may be available to one of your scripts even though not intended to be so.**
    - » **You could get incorrect results!**
    - » **If you run only one script during your Matlab session, there's no problem.**

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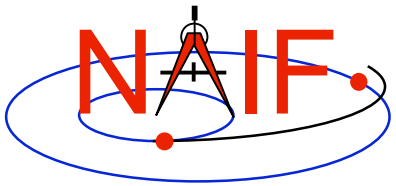
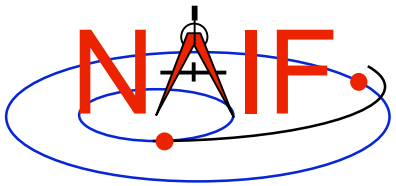


Mice Operation (2)

- **Mitigation: two approaches**
  - **Load all needed SPICE kernels for your Matlab session at the beginning of the session, paying careful attention to the files loaded and the loading order (loading order affects precedence)**
    - » **Convince yourself that this approach will provide ALL of the scripts you will run during this Matlab session with the appropriate SPICE data**
  - **At or near the end of every Matlab script:**
    - » **include a call to** `cspice_unload` **for each kernel loaded using** `cspice_furnsh`
    - » **or include a call to** `cspice_kclear` **to remove ALL kernel data from the kernel pool loaded using** `cspice_furnsh`



Mice Vectorization (1)

- **Most Mice functions include use of vectorized arguments, a capability not available in C or Fortran toolkits.**
- **Example: use Mice to retrieve state vectors and light-time values for 1000 ephemeris times.**
  - **Create the array of 1000 ephemeris times in steps of 10 hours, keyed on July 1, 2005:**

```
start = cspice_str2et('July 1 2005');
et    = (0:999)*36000 + start;
```

  - **Retrieve the state vectors and corresponding light times from Mars to earth at each `et` in the J2000 frame with LT+S aberration correction:**

```
[state, ltime] = cspice_spkezr( 'Earth', et, 'J2000', 'LT+S', 'MARS');
```

or

```
starg = mice_spkezr( 'Earth', et, 'J2000', 'LT+S', 'MARS');
```

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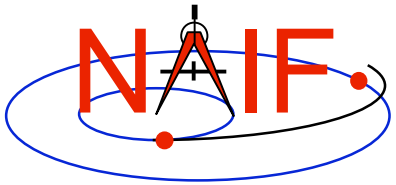

Mice Vectorization (2)

– **Access the *ith* state 6-vector (6x1 array) corresponding to the *ith* ephemeris time with the expression**

```
state_i = state(:,i)
```

or

```
state_i = starg(i).state
```

- **Convert the ephemeris time vector `et` from the previous example to UTC calendar strings with three decimal places of precision in the seconds field.**

```
format = 'C';
prec   = 3;
utcstr = cspice_et2utc( et, format, prec );
```

– **The call returns `utcstr`, an array of 1000 strings (dimensioned 1000x24), where each *ith* string is the calendar date corresponding to `et(i)`.**

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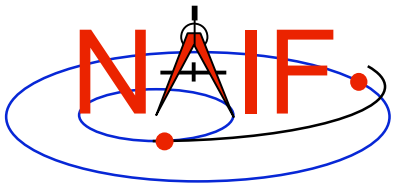


Mice Vectorization (3)

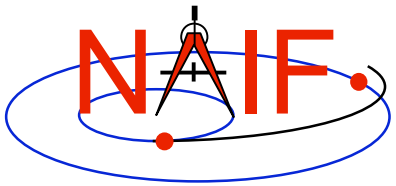
– **Access the *ith* string of utcstr corresponding to the *ith* ephemeris time with the expression**

```
utcstr_i = utcstr(i,:)
```

- **Convert the position components (the first three components in a state vector) of the N state vectors returned in `state` by the `cspice_spkezr` function to latitudinal coordinates.**

```
[radius, latitude, longitude] = cspice_reclat( state(1:3,:) );
```

– **The call returns three double precision 1x1000 arrays (vectorized scalars):** `radius, latitude, longitude.`



Simple Mice Example (1)

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- **As an example of Mice use, calculate and plot the trajectory in the J2000 inertial frame of the Cassini spacecraft from June 20, 2004 to December 1, 2005. This example uses the `cspice_spkpos` function to retrieve position data.**

```
% Define the number of divisions of the time interval and the time interval.
STEP = 1000;

% Load the needed kernels. Use a meta kernel "standard.ker" to load the kernels
% "naif0009.tls," "de405_2000-2050.bsp," "pck00008.tpc."

cspice_furnsh( { 'standard.tm', '/kernels/cassini/spk/T18-5TDJ5.bsp'} )

et         = cspice_str2et( {'Jun 20, 2004', 'Dec 1, 2005'} );
times      = (0:STEP-1) * ( et(2) - et(1) )/STEP + et(1);

[pos,ltime]= cspice_spkpos( 'Cassini', times, 'J2000', 'NONE', 'SATURN BARYCENTER' );

% Plot the resulting trajectory.
x = pos(1,:);
y = pos(2,:);
z = pos(3,:);

plot3(x,y,z)

cspice_kclear
```

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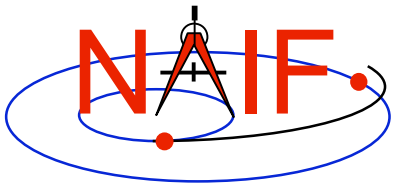

Simple Mice Example (2)

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- **The example script using the `mice_spkezr` function.**

```
% Define the number of divisions of the time interval and the time interval.
STEP = 1000;

% Load the needed kernels. Use a meta kernel "standard.ker" to load the kernels
% "naif0000.tls," "de405_2000-2050.bsp," "pck00008.tpc."

cspice_furnsh( { 'standard.tm', '/kernels/cassini/spk/T18-5TDJ5.bsp'} )

et    = cspice_str2et( {'Jun 20, 2004', 'Dec 1, 2005'} );
times = (0:STEP-1) * ( et(2) - et(1) )/STEP + et(1);

ptarg = mice_spkpos( 'Cassini', times, 'J2000', 'NONE', 'SATURN BARYCENTER' );
pos   = [ptarg.pos];

% Plot the resulting trajectory.
x = pos(1,:);
y = pos(2,:);
z = pos(3,:);

plot3(x,y,z)

cspice_kclear
```

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Mice Example Graphic Output

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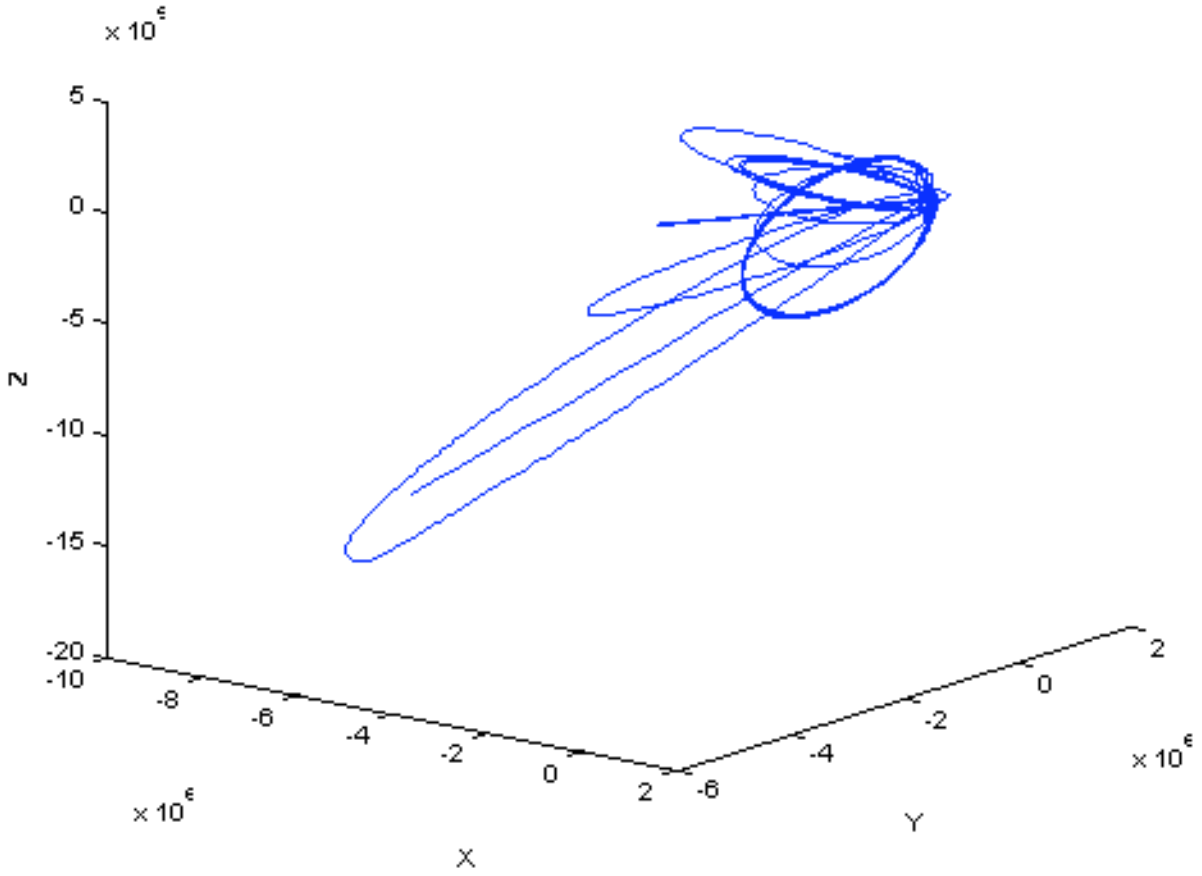

Trajectory of the Cassini vehicle in the J2000 frame, for June 20, 2004 to Dec 1, 2005