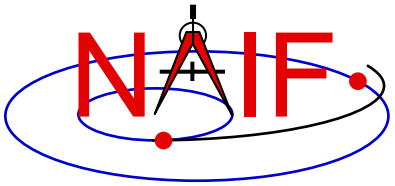
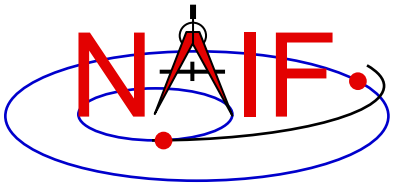


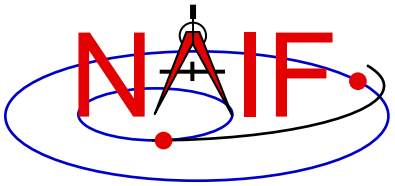
Other Useful Functions

April 2023



Topics

- Overview
- Language-specific status
- File Operations
- String Manipulation
- Searching, Sorting and Other Array Manipulations
- Windows
- Symbol Tables
- Sets and Cells
- Constants and Unit Conversion
- Numerical Functions



Overview

Navigation and Ancillary Information Facility

- The routines described in this tutorial originated in the Fortran version of the the SPICE Toolkit.
- Many, but not all, of these routines have implementations in the C, IDL, and MATLAB Toolkits.
- The descriptions include a language "identifier" or set of identifiers prefixed to the routine's name to indicate which Toolkit language(s) include that routine.
  - [F] available in Fortran (SPICELIB)
  - [C] available in C (CSPICE)
  - [I] available in IDL (Icy)
  - [M] available in MATLAB (Mice)
- NAIF adds interfaces to the CSPICE, Icy and Mice Toolkits as needed or when requested by a customer.
- CSPICE, Icy and Mice do not need all of the functionality implemented in the Fortran Toolkit.
- NAIF does not attempt to keep track of which functions are implemented in 3rd party toolkits such as SpiceyPy.

Text I/O (1)

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- **Text files provide a simple, human readable mechanism for sharing data.**

- **The Toolkit contains several utility routines to assist with the creation and parsing of text, and with the reading and writing of text files.**

  - **[F,C] RDTEXT: read a line of text from a text file***
  - **[F] TOSTDO: write a line of text to standard output**
  - **[F,C] PROMPT: display a prompt, wait for and return user's response**
  - **[F] TXTOPN: open a new text file returning a logical unit**
  - **[F] WRITLN: write a line of text to the file attached to a logical unit.**

* The text file must be in native text format for your computer

Text I/O (2)

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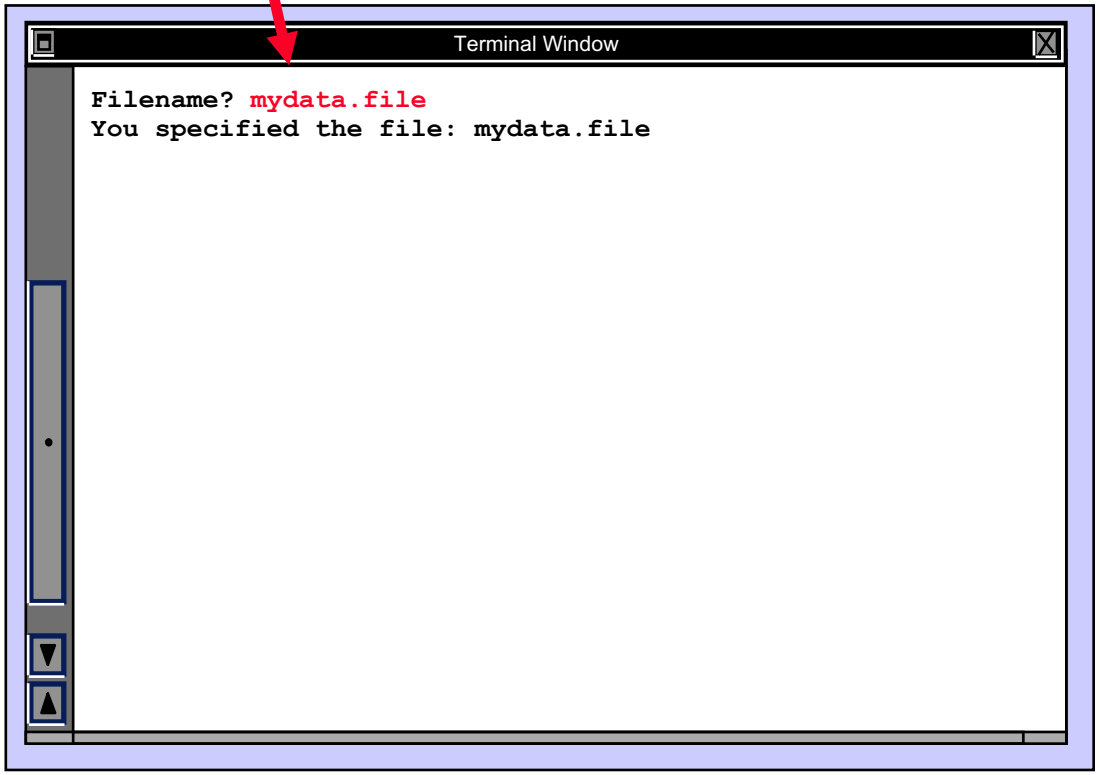
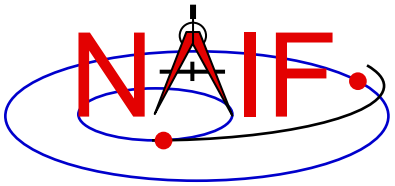
```
CALL PROMPT ( 'Filename? ', NAME )
CALL TOSTDO ( 'You specified the file: '// NAME )
```

Now that we have the filename, read and process its contents

```
CALL RDTEXT ( NAME, LINE, EOF )

DO WHILE ( .NOT. EOF )

   process the line just read

   CALL RDTEXT ( NAME, LINE, EOF )

END DO
```





File Operations

- Logical unit management - Fortran specific
  - [F] RESLUN: (reserve logical unit) prohibits SPICE systems from using specified units.
  - [F] FRELUN: (free logical unit) places “reserved” units back into service for SPICE.
  - [F] GETLUN: (get logical unit) locates an unused, unreserved logical unit.
- Determine whether or not a file exists
  - [F,C,I] EXISTS
- Delete an existing file
  - [F] DELFIL

String Manipulation - Parsing (1)

- Breaking apart a list
  - [F,C,I] LPARSE: parses a list of items delimited by a single character.
  - [F,C] LPARSM: parses a list of items separated by multiple delimiters.
  - [F,C,I,M] NEXTWD: returns the next word in a given character string.
  - [F,C,I,M] NTHWD: returns the nth word in a string and the location of the word in the string.
  - [F,C] KXTRCT: extracts a substring starting with a keyword.
- Removing unwanted parts of a string
  - [F,C,I] CMPRSS: compresses a character string by removing instances of more than N consecutive occurrences of a specified character.
  - [F] ASTRIP: removes a set ASCII characters from a string.
  - [F] REMSUB: removes a substring from a string.

String Manipulation - Parsing (2)

- Locating substrings
  - [F] LTRIM, RTRIM: return the location of the leftmost or rightmost non-blank character.
  - [F,C] POS, CPOS, POSR, CPOSR, NCPOS, NCPOSR: locate substring or member of specified character set searching forward or backward.
- Pattern matching
  - [F,C,I] MATCHI: matches a string against a wildcard template, case insensitive.
  - [F,C,I] MATCHW: matches a string against a wildcard template, case sensitive.
- Extracting numeric and time data
  - [F] NPARSD, NPARSI, DXTRCT, TPARTV
  - [F,C,I] PRSDP, PRSINT,
  - [F,C,I,M] TPARSE
- Heavy duty parsing
  - [F] SCANIT

String Manipulation - Parsing (3)

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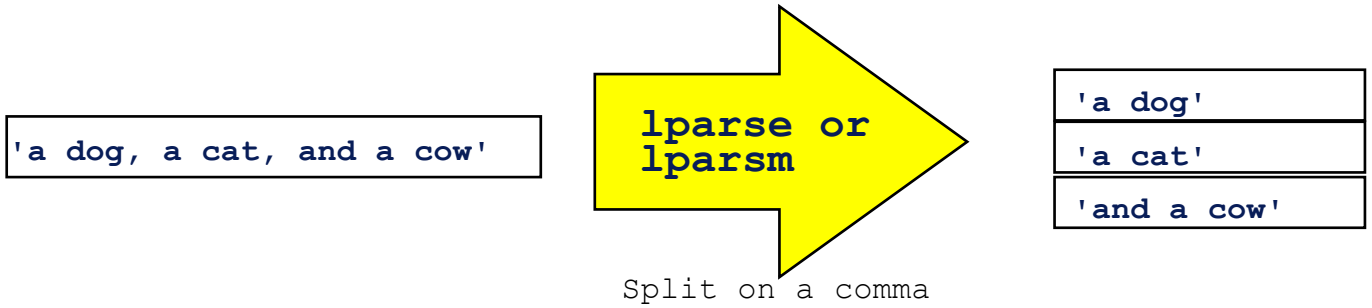

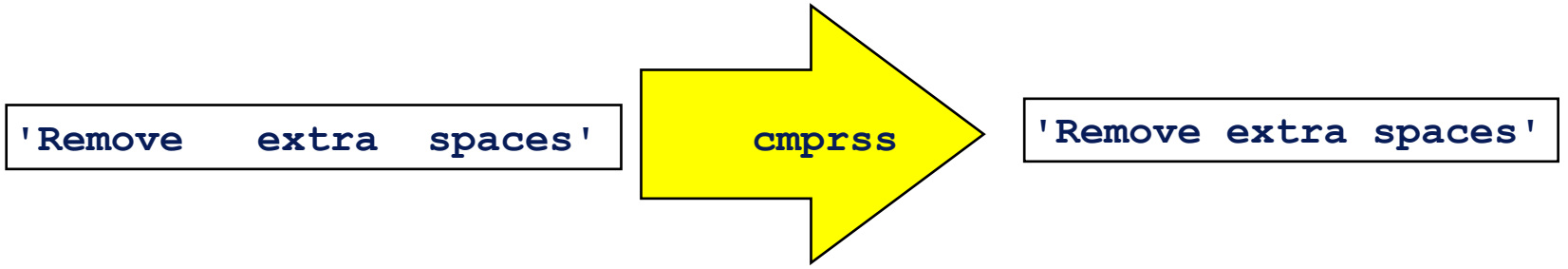

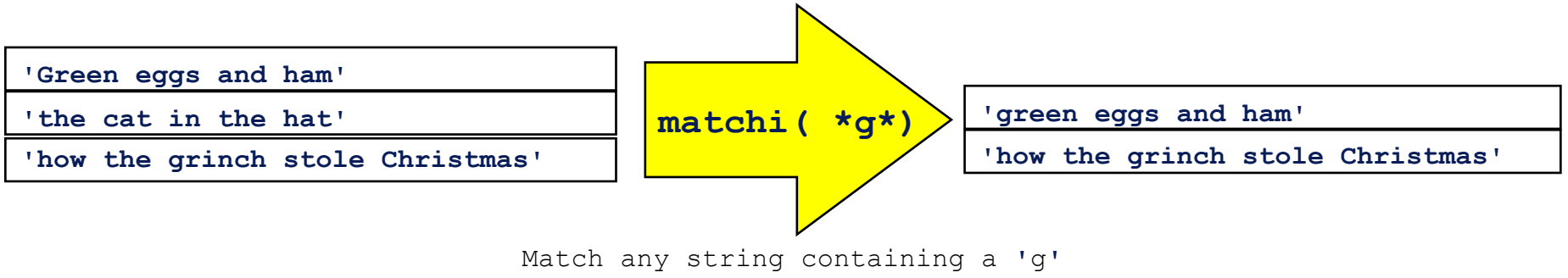

String Manipulation - Creating (1)

- **Fill in the "Blank"**
  - **[F,C,I,M] REPMC: Replace a marker with a character string.**

```
CALL REPMC ( 'The file was: #', '#', 'foo.bar', OUT )
```

    OUT has the value "The file was: foo.bar"
  - **[F,C,I,M] REPMI: Replace a marker with an integer.**

```
CALL REPMI ( 'The value is: #', '#', 7, OUT )
```

    OUT has the value "The value is: 7"
  - **[F,C,I,M] REPMD: Replace a marker with a DP number.**

```
CALL REPMD ( 'The value is: #', '#', 3.141592654D0, 10, OUT )
```

    OUT has the value "The value is: 3.141592654E+00"
  - **[F,C,I,M] REPMF: Replace a marker with a formatted DP number.**

```
CALL REPMF ( 'The value is: #', '#', 3.1415D0, 'F', 3, OUT )
```

    OUT has the value "The value is: 3.14"
  - **[F,C,I,M] REPML: Replace a marker with a logical value.**

```
CALL REPML ( 'The value is: #', '#', .TRUE., 'u', OUT )
```

    OUT has the value "The value is: TRUE"

String Manipulation - Creating (2)

- **Fill in the "Blank" (cont.)**
  - **[F,C,I,M] REPMOT: Replace a marker with the text representation of an ordinal number.**

```
CALL REPMOT ( 'It was the # term.', '#', 'L', 2, OUT )
```

    OUT has the value "It was the second term."
  - **[F,C,I,M] REPMCT: Replace a marker with the text representation of a cardinal number.**

```
CALL REPMCT ( 'Hit # errors.', '#', 6, 'L', OUT )
```

    OUT becomes 'Hit six errors.'
- **Numeric Formatting**
  - **[F] DPFMT: Using a format template, create a formatted string that represents a double precision number**

```
CALL DPFMT ( PI(), 'xxx.yyyy', OUT )
```

    OUT becomes ' 3.1416'
  - **[F] DPSTR, INTSTR, INTTXT, INTORD**

String Manipulation - Creating (3)

- Time formatting
  - [F,C,I,M] TPICTR: Given a sample time string, create a time format picture suitable for use by the routine TIMOUT.
  - [F,C,I,M] TIMOUT: Converts an input epoch to a character string formatted to the specifications of a user's format picture.
- Changing case
  - [F,C,I] UCASE: Convert all characters in string to uppercase.
  - [F,C,I] LCASE: Convert all characters in string to lowercase.
- Building strings
  - [F] SUFFIX: add a suffix to a string
  - [F] PREFIX: add a prefix to a string
  - [F] LJUCRS: left-justify, upper-case and compress

Searching, Sorting and Other Array Manipulations (1)

- Sorting arrays
  - [F,C] SHELLC, SHELLI, SHELLD, ORDERI, ORDERC, ORDERD, REORDC, REORDI, REORDD, REORDL
- Searching ordered arrays
  - [F,C] BSRCHC, BSRCHI, BSRCHD, LSTLEC, LSTLEI, LSTLED, LSTLTC, LSTLTI, LSTLTD, BSCHOI
- Searching unordered arrays
  - [F,C] ISRCHC, ISRCHI, ISRCHD, ESRCHC
- Moving portions of arrays
  - [F] CYCLAC, CYCLAD, CYCLAI
- Inserting and removing array elements
  - [F] INSLAC, INSLAD, INSLAI, REMLAC, REMLAD, REMLAI

Searching, Sorting and Other Array Manipulations (2)

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Body	A.U.[1]
sun	00.0
mercury	00.455
venus	00.720
earth	00.983
mars	01.531
jupiter	05.440
saturn	09.107
uranus	20.74
neptune	30.091
pluto	31.052

orderc

04
06
05
02
09
10
07
01
08
03

reordc,d

Sorted Body	A.U.[1]
earth	00.983
jupiter	05.440
mars	01.531
mercury	00.455
neptune	30.091
pluto	31.052
saturn	09.107
sun	00.000
uranus	20.74
venus	00.720

Vector of “Body” indices representing the list sorted in alphabetical order.

[1] Distance in A.U. at Jan 01, 2006.

Windows

- A SPICE window is a list of disjoint intervals arranged in ascending order.

  - An interval is specified by a pair of double precision numbers, with the second greater than or equal to the first.
- The Toolkit contains a family of routines for creating windows and performing "set arithmetic" on them.
- SPICE windows are frequently used to specify intervals of time when some set of user constraints are satisfied.
  - Let window ***NotBehind*** contain intervals of time when Cassini is not behind Saturn as seen from earth.
  - Let window ***Goldstone*** contain intervals of time when Cassini is above the Goldstone horizon.
  - Cassini can be tracked from Goldstone during the intersection of these two windows (*Track* = *NotBehind* * *Goldstone*).
- See *windows.req* for more information.

Windows Math

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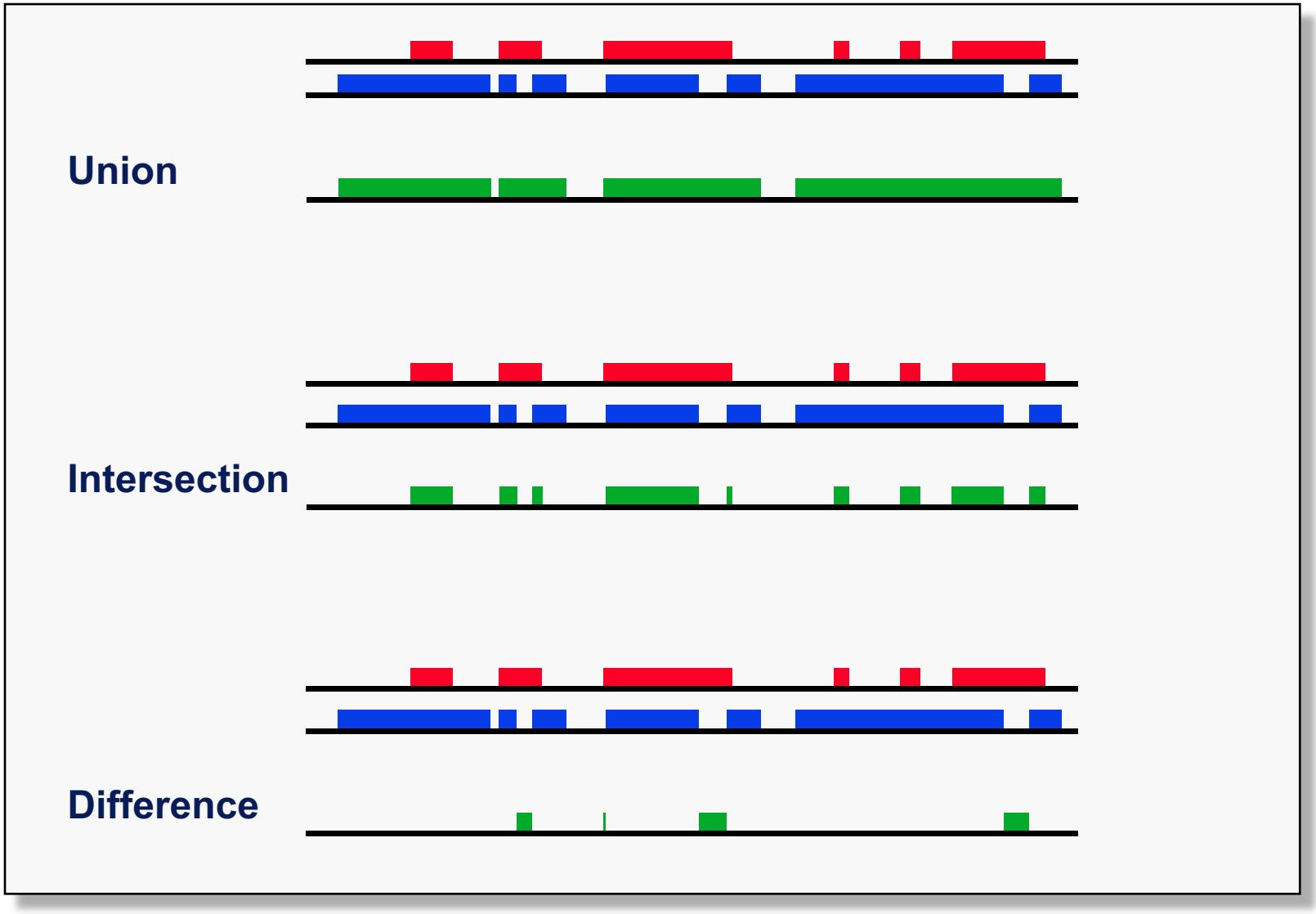
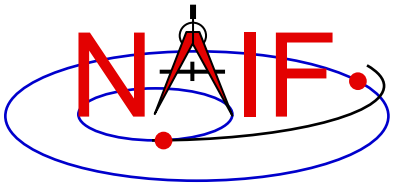
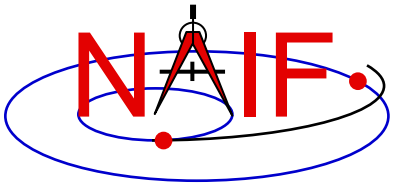




Symbol Tables

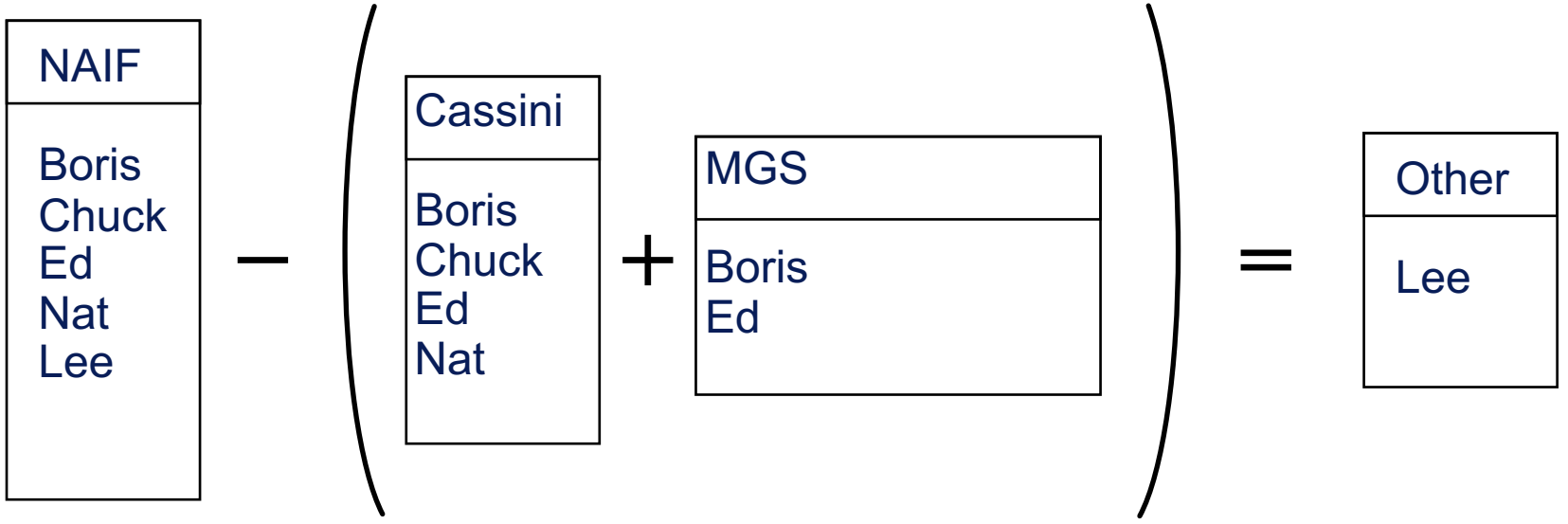
- SPICELIB (Fortran) supports the use of associative arrays/hashes through the use of an abstract data type called symbol tables.
  - These are used to associate a set of names with collections of associated values.
  - Values associated with a name are exclusively character, exclusively integer or exclusively double precision.
  - Routines to manipulate a symbol table have the form SY***<*T*> where <*T*> is the data type of the values (C, D, or I).
- Operations include:
  - Insert a symbol
  - Remove a symbol
  - Push/Pop a value onto/off of the list of values associated with a symbol
  - Fetch/Sort values associated with a symbol
- See *symbols.req* for more information.



Sets and Cells (1)

- Cells are arrays that "know" how many addresses are available for use and how many are currently used.
  - Routines that use cells typically have simpler interfaces than routines that use arrays.
  - See *cells.req* for more information.
- Sets are cells that contain no duplicate elements and whose elements are ordered in ascending order.
  - Two Sets can be: intersected, unioned, differenced, differenced symmetrically (union - intersection)
  - See *sets.req* for more information.
- Language support for sets and cells
  - Double Precision, Integer, and Character string cell types are supported in the Fortran and C Toolkits.
  - Double Precision and Integer cell types are supported in the IDL Toolkits (Icy).
  - Sets and cells aren't currently needed in the MATLAB Toolkits (Mice) since MATLAB itself supports set math.

Sets and Cells (2)




```
CALL UNIONC ( CASSINI, MGS,       PROJECTS)
CALL DIFFC  ( NAIF,    PROJECTS,  OTHER    )
```

Constants and Unit Conversion

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- Constants are implemented in the Toolkit as functions.
  - Thus the changing of a constant by NAIF requires only relinking by the Toolkit user–not recompiling.
    - » Users should NOT change constant functions in the Toolkit.
- System Constants
  - [F,C,I,M] DPMIN, DPMAX, INTMIN, INTMAX
- Numeric Constants
  - [F,C,I,M] PI, HALFPI, TWOPI, RPD (radians/degree), DPR(degrees/radian)
- Physical Constants
  - [F,C,I,M] CLIGHT, SPD, TYEAR, JYEAR
- Epochs
  - [F,C,I,M] J2000,J1950, J1900, J2100, B1900, B1950
- Simple Conversion of Units
  - [F,C,I,M] CONVRT

Numerical Functions (1)

- Several routines are provided to assist with numeric computations and comparisons.
- Functions
  - [F] DCBRT: cube root
  - Hyperbolic Functions:
    - » [F] DACOSH, DATANH
  - Polynomial Interpolation and Evaluation:
    - » [F,C,I,M] LGRESP, LGRINT, LGRIND, POLYDS, HRMESP, HRMINT
  - Chebyshev Polynomial Evaluation:
    - » [F,C,I,M] CHBDER, CHBVAL, CHBINT, CHBIGR

Numerical Functions (2)

- **Numerical Decisions**
  - **Same or opposite sign (Boolean):**
    - » **[F] SMSGND, SMSGNI, OPSGND, OPSGNI**
  - **Force a value into a range (bracket):**
    - » **[F,C] BRCKTD, BRCKTI**
  - **Determine parity of integers (Boolean):**
    - » **[F] ODD, EVEN**
  - **Truncate conditionally:**
    - » **[F] EXACT**
- **Arithmetic**
  - **Greatest common divisor:**
    - » **[F] GCD**
  - **Positive remainder:**
    - » **[F] RMAINI, RMAIND**