

Sets in Matlab

A small detour to learn some usefull things in Matlab

Sets of words and Matlab

- We need to know how to have sets of words in Matlab
 - Sets of different sizes
 - Words in each set with different sizes

Storing More Than Numbers

- MATLAB matrices store numeric results
- What about words, names, strings?
- What about arrays of arrays?
- What about Sets ?
- MATLAB provides more containers to store data
 - Character arrays
 - Cell arrays
 - Structures

Character Arrays

■ Examples:

```
» C = 'Hello';           %C is a 1x5 character array.  
» D = 'Hello there';     %D is a 1x11 character array.  
» A = 43;                %A is a 1x1 double array.  
» T = 'How about this character string?'
```

```
» size(T)  
ans =
```

```
1      32
```

How are Characters Stored?

- Character arrays are similar to vectors, except:
 - Each cell contains a single digit

- **Example**

```
» u = double(T)    % double is a dedicated function.  
» char(u)          % performs the opposite function.
```

- **Exercise**

```
» a = double('a')  
» char(a)
```

- **Questions:** What is the numerical value of 'a' and what does it mean?

Manipulating Strings

- Strings can be manipulated like arrays.

- **Examples**

```
» u = T(16:24)
» u = T(24:-1:16)
» u = T(16:24) '
» v = 'I can''t find the manual!' % Note quote in
    string
» u = 'If a woodchuck could chuck wood, ' ;
» v = 'how much wood could a woodchuck chuck? ' ;
» w = [u, ' ', v] % string concatenation in Matlab
» disp(w) % works just like for arrays
```

Cell Arrays

- Cell arrays are containers for “collections” of data of any type stored in a common container.
- Cell arrays are like a wall of PO boxes, with each PO box containing its own type of information.
- When mail is sent to a PO box the PO box number is given. Similarly, each cell in a cell array is indexed.
- Cell arrays are created using cell indexing in the same way that data in a table or an array is created and referenced
- **The difference is the use of curly braces { }.**

Matrix of matrices

- Cell arrays are matrix of matrices

- Example:

```
x=[1:5]; y = floor(2.*randn(1,5));  
z = [100:-20:20];  
M = [x; y; z]
```

```
c = {M M+M; M(:,1) M(3,:) }
```

```
c =  
2×2 cell array
```

```
{3×5 double} {3×5 double}  
{3×1 double} {1×5 double}
```


Cell array example

- create in the same way as arrays but use (curly) braces

```
>> a = { i 5:-1:2 'carrots'; magic(2) 77 NaN }
```

```
a =
```

```
 [0 + 1.0000i] [1x4 double] 'carrots'  
 [2x2 double] [    77] [ NaN]
```

Create **empty cell array**

Using `cell()` function:

```
a = cell( rows, columns)
```

```
a = cell( 3, 6 )
```

```
a =
```

```
    []    []    []    []    []    []  
    []    []    []    []    []    []  
    []    []    []    []    []    []
```

```
whos a
```

Name	Size	Bytes	Class
a	3x6	72	cell

Cell Array Access

- Cell arrays look a lot like arrays but they cannot generally be manipulated the same way.
- Cell arrays should be considered more as data “containers” and must be manipulated accordingly.
 - *Cell arrays cannot be used in arithmetic computations like arrays can, e.g., $+ - * / ^$*

Addressing Cell Arrays

- $A(i,j) = \{x\}$

this is called CELL INDEXING

- $A\{i,j\} = x$

this is called CONTENT ADDRESSING

- either can be used, but be careful...

Examples

```
first = 'Hello';  
second = {'hello', 'world', 'from', 'me'};  
  
third(1,1) = {'happy'}; % Cell indexing  
third{2,1} = 'birthday'; % Content addressing  
third{3,1} = 40;
```

■ What will we obtain from ?

```
>> third  
>> third(1,1), third{1,1}  
>> third(2,1), third{2,1}  
>> third(3,1), third{3,1}
```

Cell Arrays of Strings

- All rows in a string array **MUST** have the same number of columns ... this is a problem for representing our sets of words
 - An many other problems
- Solution?
- **Cell arrays**

Exercise

```
C = {'How'; 'about'; 'this for a'; 'cell array of strings?'}
```

```
size(C)
```

```
C(2:3)
```

```
C([4,3,2,1])
```

```
[a,b,c,d] = deal(C{:})
```

Examples

```
» C = cell(2,3) % Defines C to be a cell array
» C(1,1) = {'This does work'} % ( ) refer to PO Box
» C{2,3} = 'This works too' % { } refers to
    contents
```

Try:

```
» A = cell(1,3) % Note 1 x 3
» A = {'My' , 'name', 'is' , 'Burdell'} % Note 1 x 4
» A = {'My'; 'name'; 'is' ; 'Burdell'}
```

Get more info:

```
» help lists
```


Set Operations

- Matlab provides several functions for set operations

<u>intersect</u>	Set intersection of two arrays
<u>ismember</u>	Array elements that are members of set array
<u>setdiff</u>	Set difference of two arrays
<u>setxor</u>	Set exclusive OR of two arrays
<u>union</u>	Set union of two arrays
<u>unique</u>	Unique values in array
<u>ismembertol</u>	Members of set within tolerance
<u>uniquetol</u>	Unique values within tolerance
<u>join</u>	Combine two tables or timetables by rows using key variables
<u>innerjoin</u>	Inner join between two tables or timetables
<u>outerjoin</u>	Outer join between two tables or timetables

join

Example

```
A={'a' 'e' 'i' 'o' 'u'}
```

```
B={'a','b','c','d','e'}
```

```
C=intersect(A,B) % o que dará ?
```

```
D=union(A,B)
```

```
ismember(A(1),C)
```

```
ismember(A,D) % o que dará ?
```

```
ans =  
    1    1    1    1    1
```

Some Useful functions

- » `iscellstr(A)` % logical test for a cell array of strings
- » `ischar(A)` % logical test for a string array
- » **`celldisp(B)`** % recursively displays cell array, i.e., if content a cell array, also displays its content
- » `cellstr(B)`

Use `help` to get information on each of these functions ...

Some Useful functions

- » **cellplot(B)** % displays in figure window drawing of 1D or 2D cell array
- » **cell2mat(B)** % convert a cell array of numbers to a numerical array
- » **num2cell(A)** % convert an array of numbers to a cell array
- » **cellfun(A)** % applies a specified function to the content of every element of a cell array

Structures

- Numeric, character and cell arrays all reference the individual elements by number
- Structures reference individual elements within each row (called “fields”) by name.
- To access these fields, the dot “.” notation is used.
- Assignment is as follows:
`structurename.fieldname =
datatype;`

Creating a Structure...

- Let's create a simple structure:

```
person.firstname = 'António';  
person.lastname = 'Teixeira';  
person.address1 = 'DETI/IEETA,  
University of Aveiro';  
person.city = 'Aveiro';  
person.zip = '3810-193 AVEIRO';
```

■ ■ ■

person =

firstname: 'António'

lastname: 'Teixeira'

address1: [1x32 char]

city: 'Aveiro'

zip: '3810-193 AVEIRO'

More on Structures...

- A structure can have a field that is a structure itself.
- A structure array is that which contains more than one record for each field name.
- As the structure array is expanded (more records are created), all unassigned fields are filled with an empty matrix.
- All structures have the same number of fields and elements in each field.

Example

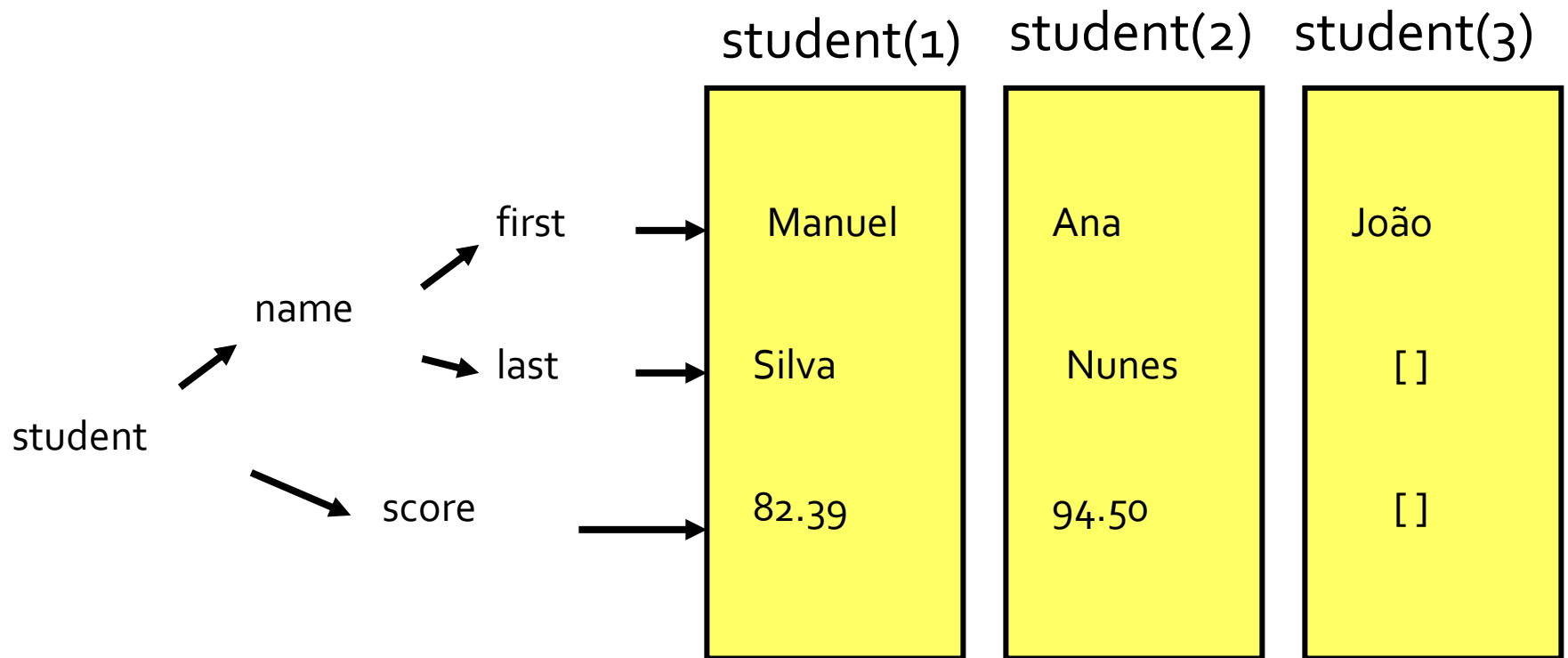
```
student(1).name.first = 'Manuel';  
student(1).name.last = 'Silva';  
Student(1).score = 82.39;
```

```
student(2).name.first = 'Ana';  
student(2).name.last = 'Nunes';  
student(2).score = 94.50;
```

```
student(3).name.first = 'João';
```

...

Example (cont.)



Sources used

- PPT on “Strings, Cell Arrays and Structures” of AE6382-9 Design Computing course, Georgia Tech, 2006
- PPT “Matlab Cell Arrays” by Greg Reese, Miami University, 2011
- Chapters 7 and 8 of Duane Hanselman and Bruce Littlefield (2003), “Matlab 6 Curso Completo”, Prentice Hall