

BME1901 – Introductory Computer Sciences

Laboratory Handout – 9

OBJECTIVES

Learn about,

- Cells and cell arrays
- Structures and structure arrays
- Opening, closing and reading files
- Built-in functions [isempty(), ischar(), strcmp(), input()]
- Solving various questions

TOOLS

Cells and cell arrays^{1,2,3,4}

A cell array is a data type with indexed data containers called cells, where each cell can contain any type of data. Cell arrays commonly contain either lists of character vectors of different lengths, or mixes of strings and numbers, or numeric arrays of different sizes. Refer to sets of cells by enclosing indices in smooth parentheses, (). Access the contents of cells by indexing with curly braces, {}.

Data can be put into a cell array using the cell array construction operator, {}.

```
>> C = {1, 2, 3; 'text', rand(3,2), {11; 22; 33}}  
  
C =  
  
    2×3 cell array  
  
    {[    1]}    {[    2]}    {[    3]}  
    {'text'}    {3×2 double}    {3×1 cell}
```

There are two ways to refer to the elements of a cell array. Enclose indices in smooth parentheses, (), to refer to sets of cells--for example, to define a subset of the array. Enclose indices in curly braces, {}, to refer to the text, numbers, or other data within individual cells.

D = C(1:2,1:2)	E = C(2,2)	F = C{2,2}
D =	E =	F =
2×2 cell array	1×1 cell array	0.1622 0.5285
{[1]} {[2]}	{3×2 double}	0.7943 0.1656
{'text'} {3×2 double}		0.3112 0.6020

¹ <https://www.mathworks.com/help/matlab/cell-arrays.html>

² <https://www.mathworks.com/help/matlab/ref/cell.html>

³ https://www.mathworks.com/help/matlab/matlab_prog/create-a-cell-array.html

⁴ https://www.mathworks.com/help/matlab/matlab_prog/access-data-in-a-cell-array.html

BME1901 – Introductory Computer Sciences

Laboratory Handout – 9

Structures and structure arrays^{5, 6, 7, 8, 9, 10}

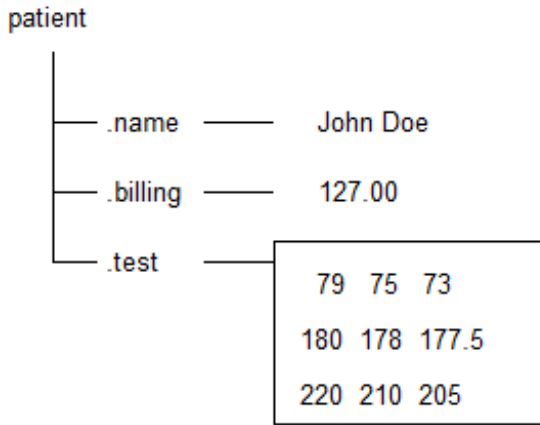
A structure array is a data type that groups related data using data containers called fields. Each field can contain any type of data. Access data in a structure using dot notation of the form “structName.fieldName”.

Data can be put into a new structure by creating the structure using dot notation to name its fields one at a time.

Data can be accessed from a structure using the same dot notation.

<pre>>> st.aa = [1 2 3; 4 5 6]; >> st.bb = 'Hello World'; >> st.cc = 3; >> st st = struct with fields: aa: [2x3 double] bb: 'Hello World' cc: 3</pre>	<pre>>> A = st.aa A = 1 2 3 4 5 6 >> disp(st.bb) Hello World >> B = 2 + st.cc B = 5</pre>
---	--

Example: How to store a patient record in a scalar structure with fields name, billing, and test.

	<pre>>> patient.name = 'John Doe'; >> patient.billing = 127.00; >> patient.test = [79, 75, 73; 180, 178, 177.5; 220, 210, 205]; >> patient patient = struct with fields: name: 'John Doe' billing: 127 test: [3x3 double]</pre>
---	---

⁵ <https://www.mathworks.com/help/matlab/structures.html>

⁶ <https://www.mathworks.com/help/matlab/ref/struct.html>

⁷ https://www.mathworks.com/help/matlab/matlab_prog/create-a-structure-array.html

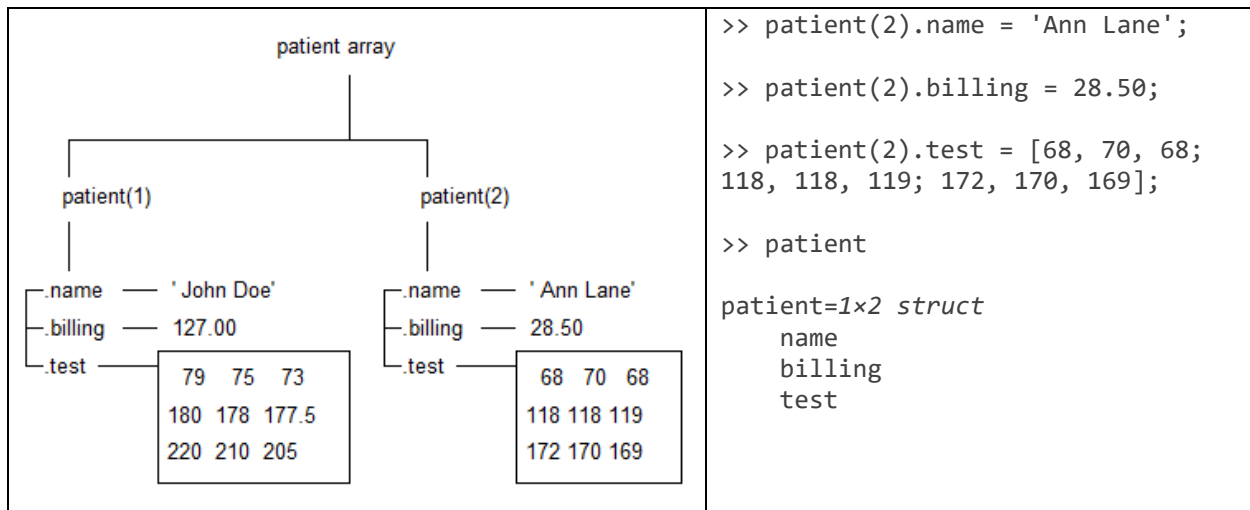
⁸ https://www.mathworks.com/help/matlab/matlab_prog/access-data-in-a-structure-array.html

⁹ https://www.mathworks.com/help/matlab/matlab_prog/access-data-in-nested-structures.html

¹⁰ https://www.mathworks.com/help/matlab/matlab_prog/ways-to-organize-data-in-structure-arrays.html

BME1901 – Introductory Computer Sciences Laboratory Handout – 9

Example: How to add new patient records to the array by including subscripts after the array name.



Each patient record in the array is a structure of class struct. An array of structures is often referred to as a struct array. Like other MATLAB arrays, a struct array can have any dimensions.

A struct array has the following properties:

- All structs in the array have the same number of fields.
- All structs have the same field names.
- Fields of the same name in different structs can contain different types or sizes of data.

Example: How to find the average of the test results of first and second patients.

<pre> >> aveResultsP1 = mean(patient(1).test) aveResultsP1 = 159.6667 154.3333 151.8333 >> aveResultsP2 = mean(patient(2).test) aveResultsP2 = 119.3333 119.3333 118.6667 </pre>	<pre> for i = 1:size(patient, 2); aveResults(i,:) = mean(patient(i).test); end >> aveResults aveResults = 159.6667 154.3333 151.8333 119.3333 119.3333 118.6667 </pre>
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BME1901 – Introductory Computer Sciences
Laboratory Handout – 9

Opening, closing and reading files

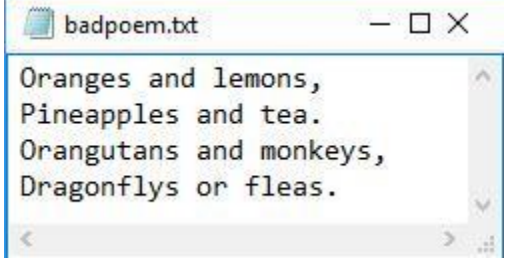
fopen()¹¹: fileID = fopen(filename) opens the file, filename, for binary read access. If fopen cannot open the file, then fileID is -1.

fileID = fopen(filename, permission) opens the file with the type of access specified by permission. File access type, specified as a character vector or a string scalar. You can open a file in binary mode or in text mode. To open a file in binary mode, specify one of the following.

'r'	Open file for reading. (default)
'w'	Open or create new file for writing. Discard existing contents, if any.
'a'	Open or create new file for writing. Append data to the end of the file.
'r+'	Open file for reading and writing.
'w+'	Open or create new file for reading and writing. Discard existing contents, if any.
'a+'	Open or create new file for reading and writing. Append data to the end of the file.
'A'	Open file for appending without automatic flushing of the current output buffer.
'W'	Open file for writing without automatic flushing of the current output buffer.

fgetl()¹²: tline = fgetl(fileID) returns the next line of the specified file, removing the newline characters. Consecutive calls of the fgetl() function returns consecutive lines of characters. If the file is nonempty, then fgetl returns tline as a character vector. If the file is empty and contains only the end-of-file marker, then fgetl returns tline as a numeric value -1.

fclose()¹³: fclose(fileID) closes an open file identified with fileID.

	<pre>>> fid = fopen('badpoem.txt'); >> fgetl(fid) ans = 'Oranges and lemons,' >> fgetl(fid) ans = 'Pineapples and tea.' >> fgetl(fid) ans = 'Orangutans and monkeys,' >> fclose(fid);</pre>
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¹¹ <https://www.mathworks.com/help/matlab/ref/fopen.html>

¹² <https://www.mathworks.com/help/matlab/ref/fgetl.html>

¹³ <https://www.mathworks.com/help/matlab/ref/fclose.html>

BME1901 – Introductory Computer Sciences
Laboratory Handout – 9

Built-in functions

isempty()¹⁴: TF = isempty(A) returns logical 1 (true) if A is empty, and logical 0 (false) otherwise. An empty array, table, or timetable has at least one dimension with length 0, such as 0-by-0 or 0-by-5.

<pre>>> A = zeros(0,5); >> TF = isempty(A) TF = logical 1</pre>	<pre>>> B = zeros(2,5); >> TF = isempty(B) TF = logical 0</pre>
--	--

ischar()¹⁵: tf = ischar(A) returns logical 1 (true) if A is a character array and logical 0 (false) otherwise.

<pre>>> A = 'Mary Jones'; >> tf = ischar(A) tf = logical 1</pre>	<pre>>> B = rand(1,3); >> tf = ischar(B) tf = logical 0</pre>
---	--

strcmp()¹⁶: tf = strcmp(s1, s2) compares character vectors s1 and s2 and returns 1 (true) if the two are identical and 0 (false) otherwise. Text is considered identical if the size and content of each are the same. The return result tf is of data type logical. The input arguments can be any combination of string arrays, character vectors, and cell arrays of character vectors.

<pre>>> s1 = 'Yes'; >> s2 = 'No'; >> tf = strcmp(s1,s2) tf = logical 0</pre>	<pre>>> s1 = 'Yes'; >> s2 = 'Yes'; >> tf = strcmp(s1,s2) tf = logical 1</pre>	<pre>>> s1 = 'upon'; >> s2 = {'Once', 'upon'; 'a', 'time'}; >> tf = strcmp(s1,s2) tf = 2x2 logical array 0 1 0 0</pre>
--	---	---

¹⁴ <https://www.mathworks.com/help/matlab/ref/isempty.html>

¹⁵ <https://www.mathworks.com/help/matlab/ref/ischar.html>

¹⁶ <https://www.mathworks.com/help/matlab/ref/strcmp.html>

BME1901 – Introductory Computer Sciences

Laboratory Handout – 9

input()¹⁷: `str = input(prompt,'s')` displays the text in prompt and waits for the user to input a value and press the Enter key. This expression returns the entered text, without evaluating the input as an expression.

<pre>>> x = input('What is your name? ') What is your name? John Error using input Undefined function or variable 'John'.</pre>	<pre>>> x = input('What is your name? ', 's') What is your name? John x = 'John'</pre>
---	--

¹⁷ <https://www.mathworks.com/help/matlab/ref/input.html>

BME1901 – Introductory Computer Sciences
Laboratory Handout – 9

PROBLEMS

1. You are working in a software development team for a hospital and your team is assigned with the development of a patient check-in and check-out program. You are given the base part of the program as in the box below. Using indexed structure arrays write the functions shown in **bold text** with the given instructions.
 - a. For the “checkIn()” function there should be an input and an output both being the structName called “patients” (i.e.: database). Under this structName, there should be fieldNames called “name, gender, age, blood_type, days_in_hospital, mobile_phone, intensive_care, ambulance_come. For each patient checking in, these fields should be requested as an input from the user. (Note: this function should add new patients while keeping the data from before.)
 - “name” should be a character array user input.
 - “gender” should be a character array user input.
 - “age” should be a numeric user input.
 - “blood_type” should be a character array user input.
 - “days_in_hospital” should be a numeric user input.
 - “mobile_phone” should be a character array user input.
 - “intensive_care” should be a character array user input, asking the user to input “IC” for intensive care patients and “NIC” for non-intensive care patients.
 - “ambulance_come” should be a character array user input, asking the user to input “WA” for the patients coming in with an ambulance and “NA” for the patients do not come with an ambulance.
 - b. For the “checkOut()” function there should be two inputs and two outputs. The inputs should be the structName “patients” and a single patient name who is checking out. The outputs should be the structName “patients” and the bill of the patient.
 - The code should search for the patient checking out in the list of patients. If the patient is not on the list, then the program should exit this function with an error.
 - If the patient is present, then the program should calculate their bill.
 - Each day in the hospital costs 1000 TL.
 - If the patient stayed in intensive care, their bill should be doubled.
 - If the patient came to the hospital with an ambulance, their bill should be halved.
 - At the end that patient and their information should be deleted from the database (i.e.: structName “patients”).
 - c. For the function “printInventory()” the input should be the structName “patients”, and there should be no output. The program should display the names of the patients in the database (i.e.: structName “patients”) on the screen individually.

BME1901 – Introductory Computer Sciences
Laboratory Handout – 9

```
function patients = patientHospital()

disp('Generating a structure for storing patients hospital information');

patients = [];

while(1)

    choice = input('Press I for check-In, O for Check-Out and Q to quit: ', 's');

    if choice == 'I'

        patients = checkIn(patients);

    elseif choice == 'O'

        patient_name = input('Enter the name of the patient for check-out: ', 's');

        [patients, bill] = checkOut(patients, patient_name);

        disp(['The bill is ', num2str(bill), ' TL']);

    elseif choice == 'Q'

        return;

    end

    printInventory(patients);

end

end
```

2. Write a function file called “copyText()” that request and returns no output. The first input should be the txt file to be read and the second input should be the txt file to be written. The code should scan the first file line by line and should print the same text to the second file. Create a txt file called “Poem.txt” and put the poem below Beklenen – Necip Fazıl KISAKÜREK in it.

Ne hasta bekler sabahi,
Ne taze oluyu mezar.
Ne de seytan, bir gunahi,
Seni bekledigim kadar.