

## MATLAB Tutorial

### Chapter 7. Data structures and input assertion

#### 7.1. User-defined data structures

Vectors and matrices are not the only means that MATLAB offers for grouping data into a single entity. User defined data structures are also available that enable the programmer to create variable types that mix numbers, strings, and arrays. As an example, let us create a data structure that contains the information for a single student.

We will store the name, status (year and department), the homework and exam grades, and the final class grade.

First, we can define a NameData structure to contain the name. Here, the "." operator, used in the case of Structure.Field tells MATLAB to access the field named "Field" in the structure "Structure".

```
NameData.First = 'John';  
NameData.MI = 'J';  
NameData.Last = 'Doe';
```

We now create a StudentData structure with a name field.

```
StudentData.Name = NameData;
```

We now initialize the rest of the structure.

```
StudentData.Status = 'ChE grad 1';  
StudentData.HW = 10;  
StudentData.Exam = linspace(100,100,3);
```

We can now view the contents of the structure

```
StudentData  
StudentData.Name  
StudentData.Exam
```

We can operate on the elements of a structure.

```
StudentData.Exam(3) = 0;  
StudentData.Exam  
StudentData.Name.First = 'Jane';  
StudentData.Name
```

We can also create arrays of structures

```
num_students = 5;  
for i=1:num_students  
ClassData(i) = StudentData;  
end  
ClassData  
ClassData(2)
```

Structures can be passed as arguments to functions in the same manner as scalars, vectors, and matrices. In this case, we use the function pass\_or\_fail listed below.

```
message = pass_or_fail(ClassData(2));  
message
```

**File pass\_or\_fail.m**

```

function message = pass_or_fail(StudentData)
Exam_avg = mean(StudentData.Exam);

if(Exam_avg >= 70)
message = 'You pass!';
else
message = 'You fail!';
end

return;

```

## 7.2. Input assertion routines

Good programming style dictates the practice of defensive programming, that is, anticipating and detecting possible errors before they cause a run-time error that results in a halt to the program execution or a crash. This allows one to save the current data to the disk or take corrective action to avoid a catastrophic failure. One common source of errors can be avoided by having each subroutine make sure that the data that it has been fed through its argument list is of the appropriate type, e.g. argument 1 should be a real, positive, scalar integer and argument 2 should be a real, non-negative column vector of length N. The following m-files are useful for automating this checking process, and a scalar input function is provided to allow the robust entry of data from the keyboard.

### assert\_scalar.m

```

function [iflag_assert,message] = assert_scalar( ...
i_error,value,name,func_name, ...
check_real,check_sign,check_int,i_error);

```

This m-file contains logical checks to assert that an input value is a type of scalar number. This function is passed the value and name of the variable, the name of the function making the assertion, and four integer flags that have the following usage :

**i\_error** : controls what to do if test fails  
if i\_error is non-zero, then use error()  
MATLAB command to stop execution, otherwise just return the appropriate negative number.  
if i\_error > 1, then dump current state to dump\_error.mat before calling error().

**check\_real** : check to examine whether input number is real or not. See table after function header for set values of these case flags  
check\_real = i\_real (make sure that input is real)  
check\_real = i\_imag (make sure that input is purely imaginary)  
any other value of check\_real (esp. 0) results in no check

```

check_real
i_real = 1;
i_imag = -1;

```

**check\_sign** : check to examine sign of input value see table after function header for set values  
of these case flags  
check\_sign = i\_pos (make sure input is positive)  
check\_sign = i\_nonneg (make sure input is non-negative)  
check\_sign = i\_neg (make sure input is negative)  
check\_sign = i\_nonpos (make sure input is non-positive)  
check\_sign = i\_nonzero (make sure input is non-zero)  
check\_sign = i\_zero (make sure input is zero)

any other value of check\_sign (esp. 0) results in no check

```
check_sign
i_pos = 1;
i_nonneg = 2;
i_neg = -1;
i_nonpos = -2;
i_nonzero = 3;
i_zero = -3;
```

check\_int : check to see if input is an integer  
if = 1, then check to make sure input is an integer  
any other value, perform no check

Kenneth Beers  
Massachusetts Institute of Technology  
Department of Chemical Engineering

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```
function [iflag_assert,message] = assert_scalar( ...  
i_error,value,name,func_name, ...  
check_real,check_sign,check_int);
```

```
iflag_assert = 0;  
message = 'false';
```

First, set case values of check integer flags.

```
check_real  
i_real = 1;  
i_imag = -1;  
check_sign  
i_pos = 1;  
i_nonneg = 2;  
i_neg = -1;  
i_nonpos = -2;  
i_nonzero = 3;  
i_zero = -3;
```

Check to make sure input is numerical and not a string.

```
if(~isnumeric(value))  
message = [ func_name, ': ', ...  
name, ' is not numeric'];  
iflag_assert = -1;  
if(i_error ~= 0)  
if(i_error > 1)  
save dump_error.mat;  
end  
error(message);  
else  
return;  
end  
end
```

Check to see if it is a scalar.

```
if(max(size(value)) ~= 1)
message = [ func_name, ': ', ...
name, ' is not scalar'];
iflag_assert = -2;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

Then, check to see if it is real.

```
switch check_real;
```

```
case {i_real}
if(~isreal(value))
message = [ func_name, ': ', ...
name, ' is not real'];
iflag_assert = -3;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_imag}
if(real(value))
message = [ func_name, ': ', ...
name, ' is not imaginary'];
iflag_assert = -3;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
```

Next, check sign.

```
switch check_sign;
```

```
case {i_pos}
if(value <= 0)
message = [ func_name, ': ', ...
name, ' is not positive'];
iflag_assert = -4;
```

```
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_nonneg}
if(value < 0)
message = [ func_name, ': ', ...
name, ' is not non-negative'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_neg}
if(value >= 0)
message = [ func_name, ': ', ...
name, ' is not negative'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_nonpos}
if(value > 0)
message = [ func_name, ': ', ...
name, ' is not non-positive'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_nonzero}
if(value == 0)
message = [ func_name, ': ', ...
```

```

name, ' is not non-zero'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end

case {i_zero}
if(value ~= 0)
message = [ func_name, ': ', ...
name, ' is not zero'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
end

```

Finally, check to make sure it is an integer.

```

if(check_int == 1)
if(round(value) ~= value)
message = [ func_name, ': ', ...
name, ' is not an integer'];
iflag_assert = -5;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
end

```

set flag for succesful passing of all checks

```

iflag_assert = 1;
message = 'true';

return;

```

### **assert\_vector.m**

```

function [iflag_assert, message] = ...
assert_vector( ...
i_error,value,name,func_name,num_dim, ...

```

check\_real,check\_sign,check\_int,check\_column);

This m-file contains logical checks to assert that an input value is a vector of a given type. This function is passed the value and name of the variable, the name of the function making the assertion, the dimension that the vector is supposed to be, and five integer flags that have the following usage :

i\_error : controls what to do if test fails  
if i\_error is non-zero, then use error()  
MATLAB command to stop execution, otherwise  
just return the appropriate negative number.  
if i\_error > 1, create file dump\_error.mat  
before calling error()

check\_real : check to examine whether input is real  
see table after function header for set  
values of these case flags  
check\_real = i\_real (make sure that input is real)  
check\_real = i\_imag (make sure that input  
is purely imaginary)  
any other value of check\_real (esp. 0)  
results in no check

check\_real  
i\_real = 1;  
i\_imag = -1;

check\_sign : check to examine sign of input see table after function header for set  
values of these case flags  
check\_sign = i\_pos (make sure input is positive)  
check\_sign = i\_nonneg (make sure input is non-negative)  
check\_sign = i\_neg (make sure input is negative)  
check\_sign = i\_nonpos (make sure input is non-positive)  
check\_sign = i\_nonzero (make sure input is non-zero)  
check\_sign = i\_zero (make sure input is zero)  
any other value of check\_sign (esp. 0)  
results in no check

check\_sign  
i\_pos = 1;  
i\_nonneg = 2;  
i\_neg = -1;  
i\_nonpos = -2;  
i\_nonzero = 3;  
i\_zero = -3;

check\_int : check to see if input is an integer  
if = 1, then check to make sure input is an integer  
any other value, perform no check

check\_column : check to see if input is a column or row vector  
check\_column = i\_column (make sure input is  
column vector)  
check\_column = i\_row (make sure input is row vector)  
any other value, perform no check

check\_column  
i\_column = 1;

```
i_row = -1;
```

if the dimension num\_dim is set to zero, no check as to the dimension of the vector is made.

Kenneth Beers  
Massachusetts Institute of Technology  
Department of Chemical Engineering

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```
function [iflag_assert,message] = ...  
assert_vector( ...  
i_error,value,name,func_name,num_dim, ...  
check_real,check_sign,check_int,check_column);
```

First, set case values of check integer flags.

```
check_real  
i_real = 1;  
i_imag = -1;  
check_sign  
i_pos = 1;  
i_nonneg = 2;  
i_neg = -1;  
i_nonpos = -2;  
i_nonzero = 3;  
i_zero = -3;  
check_column  
i_column = 1;  
i_row = -1;
```

```
iflag_assert = 0;  
message = 'false';
```

Check to make sure input is numerical and not a string.

```
if(~isnumeric(value))  
message = [ func_name, ': ', ...  
name, 'is not numeric'];  
iflag_assert = -1;  
if(i_error ~= 0)  
if(i_error > 1)  
save dump_error.mat;  
end  
error(message);  
else  
return;  
end  
end
```

Check to see if it is a vector of the proper length.

```
num_rows = size(value,1);  
num_columns = size(value,2);  
if it is a multidimensional array  
if(length(size(value)) > 2)  
message = [ func_name, ': ', ...  
name, 'has too many subscripts'];
```



```

iflag_assert = -2;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end

```

if both the number of rows and number of columns are not equal to 1, then value is a matrix instead of a vector.

```

if(and((num_rows ~= 1),(num_columns ~= 1)))
message = [ func_name, ': ', ...
name, 'is not a vector'];
iflag_assert = -2;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end

```

if the dimension of the vector is incorrect

```

if(num_dim ~= 0)
if(length(value) ~= num_dim)
message = [ func_name, ': ', ...
name, 'is not of the proper length'];
iflag_assert = -2;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end

```

check to make sure that the vector is of the correct type (e.g. column)

```

switch check_column;

```

```

case {i_column}

```

check to make sure that it is a column vector

```

if(num_columns > 1)
message = [ func_name, ': ', ...
name, 'is not a column vector'];
iflag_assert = -2;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);

```

```

else
return;
end
end

case {i_row}
if(num_rows > 1)
message = [ func_name, ': ', ...
name, 'is not a row vector'];
iflag_assert = -2;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end

```

Then, check to see if all elements are of the proper complex type.  
**switch check\_real;**

```

case {i_real}
if any element of value is not real
if(any(~isreal(value)))
message = [ func_name, ': ', ...
name, ' is not real'];
iflag_assert = -3;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end

```

```

case {i_imag}
if any element of value is not purely imaginary
if(any(real(value)))
message = [ func_name, ': ', ...
name, ' is not imaginary'];
iflag_assert = -3;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
end

```

Next, check sign.

```
switch check_sign;
```

```
case {i_pos}
```

```
if any element of value is not positive
```

```
if(any(value <= 0))
```

```
message = [ func_name, ': ', ...
```

```
name, ' is not positive'];
```

```
iflag_assert = -4;
```

```
if(i_error ~= 0)
```

```
if(i_error > 1)
```

```
save dump_error.mat;
```

```
end
```

```
error(message);
```

```
else
```

```
return;
```

```
end
```

```
end
```

```
case {i_nonneg}
```

```
if any element of value is negative
```

```
if(any(value < 0))
```

```
message = [ func_name, ': ', ...
```

```
name, ' is not non-negative'];
```

```
iflag_assert = -4;
```

```
if(i_error ~= 0)
```

```
if(i_error > 1)
```

```
save dump_error.mat;
```

```
end
```

```
error(message);
```

```
else
```

```
return;
```

```
end
```

```
end
```

```
case {i_neg}
```

```
if any element of value is not negative
```

```
if(any(value >= 0))
```

```
message = [ func_name, ': ', ...
```

```
name, ' is not negative'];
```

```
iflag_assert = -4;
```

```
if(i_error ~= 0)
```

```
if(i_error > 1)
```

```
save dump_error.mat;
```

```
end
```

```
error(message);
```

```
else
```

```
return;
```

```
end
```

```
end
```

```
case {i_nonpos}
```

```
if any element of value is positive
```

```
if(any(value > 0))
```

```
message = [ func_name, ': ', ...
```

```
name, ' is not non-positive'];
```

```
iflag_assert = -4;
```

```
if(i_error ~= 0)
```

```
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_nonzero}
if any element of value is zero
if(any(value == 0))
message = [ func_name, ': ', ...
name, 'is not non-zero'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_zero}
if any element of value is non-zero
if(any(value ~= 0))
message = [ func_name, ': ', ...
name, ' is not zero'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
```

Finally, check to make sure it is an integer.

```
if(check_int == 1)
if(any(round(value) ~= value))
message = [ func_name, ': ', ...
name, ' is not an integer'];
iflag_assert = -5;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
```

set flag for succesful passing of all checks

```
iflag_assert = 1;  
message = 'true';
```

```
return;
```

### **assert\_matrix.m**

```
function [iflag_assert,message] = assert_matrix( ...  
i_error,value,name,func_name, ...  
num_rows,num_columns, ...  
check_real,check_sign,check_int);
```

This m-file contains logical checks to assert than an input value is a matrix of a given type. This function is passed the value and name of the variable, the name of the function making the assertion, the dimension that the matrix is supposed to be, and four integer flags that have the following usage :

**i\_error** : controls what to do if test fails  
if **i\_error** is non-zero, then use `error()`  
MATLAB command to stop execution, otherwise just return the appropriate negative number.  
if **i\_error** > 1, create file `dump_error.mat`  
before calling `error()`

**check\_real** : check to examine whether input is real see table after function header for set values of these case flags

**check\_real** = **i\_real** (make sure that input is real)  
**check\_real** = **i\_imag** (make sure that input is purely imaginary)  
any other value of **check\_real** (esp. 0)  
results in no check

```
check_real  
i_real = 1;  
i_imag = -1;
```

**check\_sign** : check to examine sign of input  
see table after function header for set values of these case flags

**check\_sign** = **i\_pos** (make sure input is positive)  
**check\_sign** = **i\_nonneg** (make sure input is non-negative)  
**check\_sign** = **i\_neg** (make sure input is negative)  
**check\_sign** = **i\_nonpos** (make sure input is non-positive)  
**check\_sign** = **i\_nonzero** (make sure input is non-zero)  
**check\_sign** = **i\_zero** (make sure input is zero)  
any other value of **check\_sign** (esp. 0)  
results in no check

```
check_sign  
i_pos = 1;  
i_nonneg = 2;  
i_neg = -1;  
i_nonpos = -2;  
i_nonzero = 3;  
i_zero = -3;
```

**check\_int** : check to see if input value is an integer

if = 1, then check to make sure input is an integer  
any other value, perform no check

if the dimensions num\_rows or num\_columns  
are set to zero, no check as to that dimension of the matrix is made.

Kenneth Beers  
Massachusetts Institute of Technology  
Department of Chemical Engineering

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```
function [iflag_assert,message] = assert_matrix( ...  
i_error,value,name,func_name, ...  
num_rows,num_columns, ...  
check_real,check_sign,check_int);
```

First, set case values of check integer flags.

```
check_real  
i_real = 1;  
i_imag = -1;  
check_sign  
i_pos = 1;  
i_nonneg = 2;  
i_neg = -1;  
i_nonpos = -2;  
i_nonzero = 3;  
i_zero = -3;
```

```
iflag_assert = 0;  
message = 'false';
```

Check to make sure input is numerical and not a string.

```
if(~isnumeric(value))  
message = [ func_name, ': ', ...  
name, ' is not numeric'];  
iflag_assert = -1;  
if(i_error ~= 0)  
if(i_error > 1)  
save dump_error.mat;  
end  
error(message);  
else  
return;  
end  
end
```

Check to see if it is a matrix of the proper length.

```
if it is a multidimensional array  
if(length(size(value)) > 2)  
message = [ func_name, ': ', ...  
name, ' has too many subscripts'];  
iflag_assert = -2;  
if(i_error ~= 0)  
if(i_error > 1)
```

```
save dump_error.mat;
end
error(message);
else
return;
end
end
```

check that value has the proper number of rows

```
if(num_rows ~= 0)
if(size(value,1) ~= num_rows)
message = [ func_name, ': ', ...
name, ' has the wrong number of rows!'];
iflag_assert = -2;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
```

check that value has the proper number of columns

```
if(num_columns ~= 0)
if(size(value,2) ~= num_columns)
message = [ func_name, ': ', ...
name, ' has the wrong number of columns!'];
iflag_assert = -2;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
```

Then, check to see if all elements are of the proper complex type.

```
switch check_real;
```

```
case {i_real}
```

if any element of value is not real

```
if(any(~isreal(value)))
message = [ func_name, ': ', ...
name, ' is not real!'];
iflag_assert = -3;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
```

```
end
end
```

```
case {i_imag}
if any element of value is not purely imaginary
if(any(real(value)))
message = [ func_name, ': ', ...
name, ' is not imaginary'];
iflag_assert = -3;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
```

Next, check sign.  
switch check\_sign;

```
case {i_pos}
if any element of value is not positive
if(any(value <= 0))
message = [ func_name, ': ', ...
name, ' is not positive'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
```

```
case {i_nonneg}
if any element of value is negative
if(any(value < 0))
message = [ func_name, ': ', ...
name, ' is not non-negative'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end
```

```
case {i_neg}
if any element of value is not negative
```



```
if(any(value >= 0))
message = [ func_name, ': ', ...
name, ' is not negative'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_nonpos}
if any element of value is positive
if(any(value > 0))
message = [ func_name, ': ', ...
name, ' is not non-positive'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_nonzero}
if any element of value is zero
if(any(value == 0))
message = [ func_name, ': ', ...
name, 'is not non-zero'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
```

```
case {i_zero}
if any element of value is non-zero
if(any(value ~= 0))
message = [ func_name, ': ', ...
name, ' is not zero'];
iflag_assert = -4;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
```

```

return;
end
end
end

```

Finally, check to make sure it is an integer.

```

if(check_int == 1)
if(any(round(value) ~= value))
message = [ func_name, ': ', ...
name, ' is not an integer'];
iflag_assert = -5;
if(i_error ~= 0)
if(i_error > 1)
save dump_error.mat;
end
error(message);
else
return;
end
end
end

```

set flag for succesful passing of all checks

```

iflag_assert = 1;
message = 'true';

```

```

return;

```

### **assert\_structure.m**

```

function [iflag_assert,message] = assert_structure(...
i_error,Struct,struct_name,func_name,StructType);

```

This MATLAB m-file performs assertions on a data structure. It makes use of `assert_scalar`, `assert_vector`, and `assert_matrix` for the fields.

INPUT :

=====

`i_error` controls what to do if test fails

if `i_error` is non-zero, then use `error()`

MATLAB command to stop execution, otherwise just return the appropriate negative number.

if `i_error > 1`, then dump current state to `dump_error.mat` before calling `error()`.

`Struct` This is the structure to be checked

`struct_name` the name of the structure

`func_name` the name of the function making the assertion

`StructType` this is a structure that contains the typing data for each field.

`.num_fields` is the total number of fields

Then, for `i = 1,2, ..., StructType.num_fields`, we have :

`.field(i).name` the name of the field

`.field(i).is_numeric` if non-zero, then field is numeric

`.field(i).num_rows` # of rows in field

`.field(i).num_columns` # of columns in field

`.field(i).check_real` value of `check_real` passed to assertion

`.field(i).check_sign` value of `check_sign` passed to assertion

`.field(i).check_int` value of `check_int` passed to assertion

OUTPUT :

=====

iflag\_assert an integer flag telling of outcome message a message passed that describes the result of making the assertion

Kenneth Beers  
Massachusetts Institute of Technology  
Department of Chemical Engineering

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```
function [iflag_assert,message] = assert_structure(...  
i_error,Struct,struct_name,func_name,StructType);
```

```
iflag_assert = 0;  
message = 'false';
```

first, check to make sure Struct is a structure

```
if(~isstruct(Struct))  
iflag_assert = -1;  
message = [func_name, ': ', struct_name, ...  
' is not a structure'];  
if(i_error ~= 0)  
if(i_error > 1);  
save dump_error.mat;  
end  
error(message);  
else  
return;  
end  
end
```

Now, for each field, perform the required assertion.

```
for ifield = 1:StructType.num_fields
```

set shortcut to current field type

```
FieldType = StructType.field(ifield);
```

check if it exists in Struct

```
if(~isfield(Struct,FieldType.name))  
iflag_assert = -2;  
message = [func_name, ': ', struct_name, ...  
' does not contain ', FieldType.name];  
if(i_error ~= 0)  
if(i_error > 1)  
save dump_error.mat;  
end  
error(message);  
else  
return;  
end  
end
```

extract value of field

```
value = getfield(Struct,FieldType.name);
```

if the field is supposed to be numeric  
**if(FieldType.is\_numeric ~= 0)**

check to make sure field is numeric  
**if(~isnumeric(value))**  
**iflag\_assert = -3;**  
**message = [func\_name, ': ', ...**  
**struct\_name, '.', FieldType.name, ...**  
**' is not numeric'];**  
**if(i\_error ~= 0)**  
**if(i\_error > 1)**  
**save dump\_error.mat;**  
**end**  
**error(message);**  
**else**  
**return;**  
**end**  
**end**

decide which assertion statement to use based on array dimension of field value  
If both num\_rows and num\_columns are set equal to zero, then no check of the dimension of this field is made.

**if(and((FieldType.num\_rows == 0), ...**  
**(FieldType.num\_columns == 0)))**

**message = [func\_name, ': ', ...**  
**struct\_name, '.', FieldType.name, ...**  
**' is not checked for dimension'];**  
**if(i\_error ~= 0)**  
**disp(message);**  
**end**

else, perform check of dimension to make sure it is a scalar, vector, or matrix (i.e. a two dimensional array).

**else**

check that it is not a multidimensional array

**if(length(size(value)) > 2)**  
**iflag\_assert = -4;**  
**message = [func\_name, ': ', ...**  
**struct\_name, '.', FieldType.name, ...**  
**' is multidimensional array'];**  
**if(i\_error ~= 0)**  
**if(i\_error > 1)**  
**save dump\_error.mat;**  
**end**  
**error(message);**  
**else**  
**return;**  
**end**

else if scalar

**elseif(and((FieldType.num\_rows == 1), ...**  
**(FieldType.num\_columns == 1)))**  
**assert\_scalar(i\_error,value, ...**  
**[struct\_name, '.', FieldType.name], ...**

```
func_name,FieldType.check_real, ...
FieldType.check_sign,FieldType.check_int);
```

else if a column vector

```
elseif (and((FieldType.num_rows > 1), ...
(FieldType.num_columns == 1)))
dim = FieldType.num_rows;
check_column = 1;
assert_vector(i_error,value, ...
[struct_name, '.',FieldType.name], ...
func_name,dim,FieldType.check_real, ...
FieldType.check_sign,FieldType.check_int, ...
check_column);
```

else if a row vector

```
elseif (and((FieldType.num_rows == 1), ...
(FieldType.num_columns > 1)))
dim = FieldType.num_columns;
check_column = -1;
assert_vector(i_error,value, ...
[struct_name, '.',FieldType.name], ...
func_name,dim,FieldType.check_real, ...
FieldType.check_sign,FieldType.check_int, ...
check_column);
```

otherwise, a matrix

```
else
assert_matrix(i_error,value, ...
[struct_name, '.',FieldType.name], ...
func_name, ...
FieldType.num_rows,FieldType.num_columns, ...
FieldType.check_real,FieldType.check_sign, ...
FieldType.check_int);
```

```
end selection of assertion routine
end if perform check of dimension
end if (FieldType.is_numeric ~= 0)
end for loop over fields
```

set return results for succesful assertion

```
iflag_assert = 1;
message = 'true';
```

```
return;
```

### **get\_input\_scalar.m**

```
function value = get_input_scalar(prompt, ...
check_real,check_sign,check_int);
```

This MATLAB m-file gets from the user an input scalar value of the appropriate type. It asks for input over and over again until a correctly typed input value is entered.

Kenneth Beers  
Massachusetts Institute of Technology  
Department of Chemical Engineering

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```
function value = get_input_scalar(prompt, ...  
check_real,check_sign,check_int);
```

```
func_name = 'get_input_scalar';  
name = 'trial_value';
```

```
input_OK = 0;
```

```
while (input_OK ~= 1)  
trial_value = input(prompt);  
[iflag_assert,message] = ...  
assert_scalar(0,trial_value, ...  
name,func_name, ...  
check_real,check_sign,check_int);  
if(iflag_assert == 1)  
input_OK = 1;  
value = trial_value;  
else  
disp(message);  
end  
end
```

```
return;
```