Assignment 2

Quantum Information and Computing
AA 2022–23

James Chryssanthacopoulos
8 November 2022

UNIVERSITÀ
DEGLI STUDI
DI PADOVA

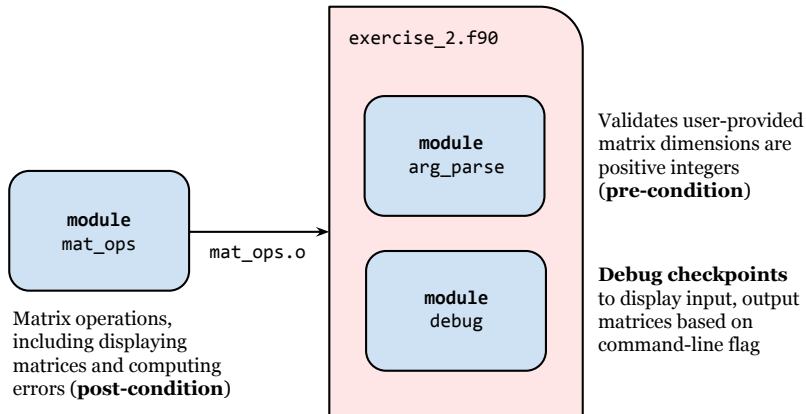Debug subroutine entered depending on flag

exercise_1 [-v/--verbose]

no flag

flag set

Nothing to print. Exiting ...

Entering checkpoint ...
Value of variable a is 10
Value of variable b is 20
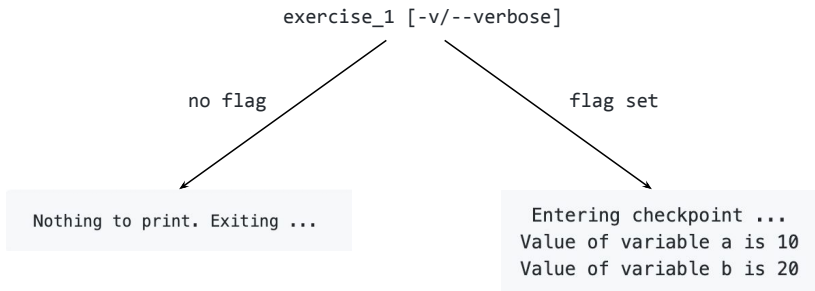
Matrix multiplication program enhanced to be
fault tolerant and easier to debug

exercise_2.f90

module
arg_parse

Validates user-provided
matrix dimensions are
positive integers
(**pre-condition**)

module
mat_ops

mat_ops.o

Matrix operations,
including displaying
matrices and computing
errors (**post-condition**)

module
debug

Debug checkpoints
to display input, output
matrices based on
command-line flag

Less room for error and more visibility into the results

```
 Running in verbose mode ...
 Matrix A =
   0.82   0.79
   0.80   0.99
 Matrix B =
   0.25   0.71
   0.48   0.96
 Product using matmul =
   0.58   1.35
   0.67   1.53
Elapsed time for matmul = 1.7000000000E-05
 Matrix using row-col-inner =
   0.58   1.35
   0.67   1.53
Max abs error for row-col-inner = 0.0000000000E+00
Elapsed time for row-col-inner = 3.0000000000E-06
 Matrix using inner-col-row =
   0.58   1.35
   0.67   1.53
Max abs error for inner-col-row = 0.0000000000E+00
Elapsed time for inner-col-row = 2.0000000000E-06
```

Verbose mode

```
# non-integers
$ compiled/exercise_2
 Enter number of rows, columns, and inner dimension:
a b c
 Dimensions need to be integers!

# non-positive integers
$ compiled/exercise_2
 Enter number of rows, columns, and inner dimension:
1, 2, -1
 Dimensions must be greater than zero!
```

Error checking

Exercise 3: Derived types (1)


```
module cmatrix

  type cmatrix
    N
    elems
    trace
  end type

  interface Trace
  interface operator (.Adj.)

contains
  function Init(nrows, ncols)
  subroutine Trace(M)
  function Adjoint(M)
  subroutine Del(M)

  + other utilities
```

cmatrix.o

```
exercise_3.f90

  User enters matrix dimensions

  Initialize and display matrix
  Save to file

  Compute adjoint
  Display and save

  Delete matrices
```

Program writes matrices to screen and files

```
 The original matrix is:
.3637 +.7254i   +.4593 +.8790i
.0378 +.9221i   +.5062 +.9254i
The trace of M is .8699 +1.6507i
 Saving to file mat.txt ...
 The adjoint matrix is:
.3637 −.7254i   +.0378 −.9221i
.4593 −.8790i   +.5062 −.9254i
The trace of M is .8699 −1.6507i
 Saving to file mat_adj.txt ...
 Deleting matrices ...
```

Program execution

```
mat_adj.txt

Size:          2 x          2

 Matrix ele
.3637 −.725
.4593 −.879
 Trace:
.8699 -1.6
```

```
mat.txt

Size:          2 x          2

 Matrix elements:
.3637 +.7254i  +.4593 +.8790i
.0378 +.9221i  +.5062 +.9254i
 Trace:
.8699 +1.6507i
```

Saved files