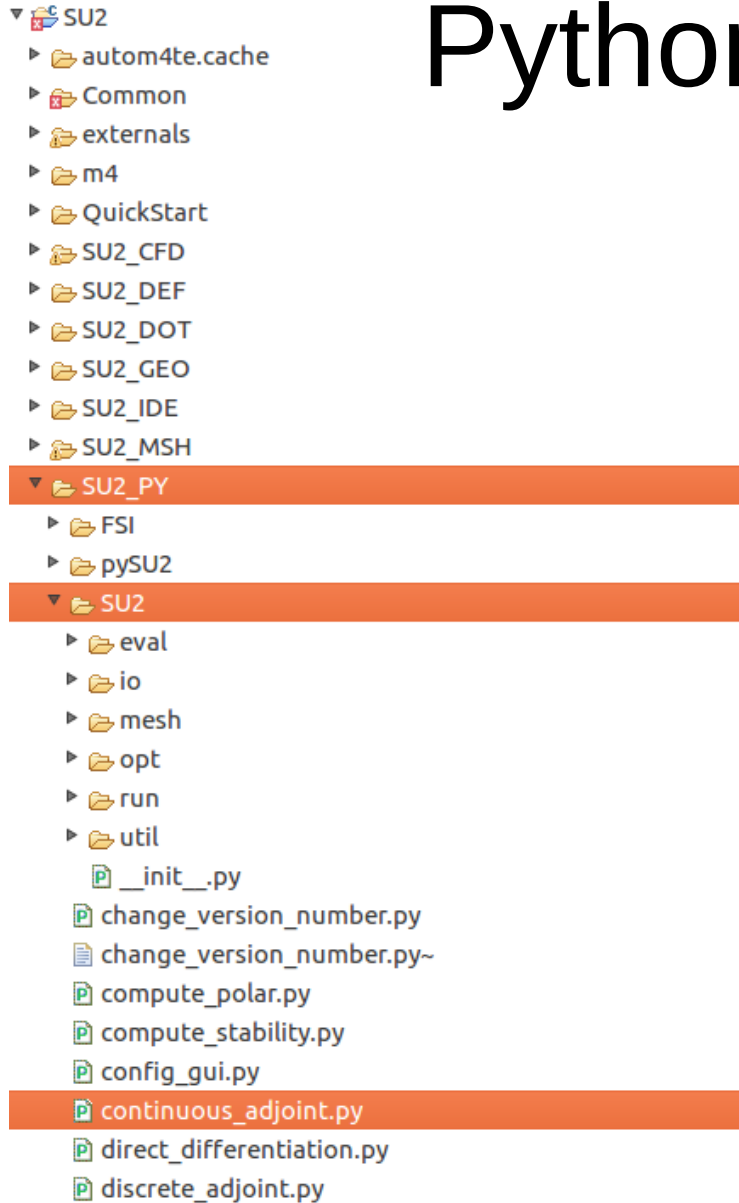


Interactive Python Exercise

Modifying the Python Scripts

SU2 Workshop Feb 3rd 2017
Heather Kline



Python Scripts

- Source code location:
SU2/SU2_PY/
- Installed location: SU2/bin/
- Dependencies: SU2/bin/SU2/
(source: SU2/SU2_PY/SU2/)
- To run a local version:
`$./python_script.py`
- To run version installed in the
bin/ directory:
`$ python_script.py`

```
1 #!/usr/bin/env python
2
3 ## \file Compute_Mpolar.py
4 # \brief Python script for performing polar sweep of Mach number.
5 # \author H. Kline (E. Arad compute_polar script)
6 # \version 5.0.0 "Raven"
7 #
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10 #
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13 # Prof. Alberto Guardone's group at Polytechnic University of Milan.
14 # Prof. Rafael Palacios' group at Imperial College London.
15 #
16 #
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31 #
32 # imports
33 import numpy as np
34 import matplotlib.pyplot as plt
35 from optparse import OptionParser
36 import os, sys, shutil, copy, os.path
37 sys.path.append(os.environ['SU2_RUN'])
38 import SU2
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1 #!/usr/bin/env python
2
3 ## \file Compute_Mpolar.py
4 # \brief Python script for performing polar sweep of Mach number.
5 # \author H. Kline (E. Arad compute_polar script)
6 # \version 5.0.0 "Raven"
7 #
8 # SU2 Lead Developers: Dr. Francisco Palacios (Francisco.D.Palacios@boeing.com).
9 #                      Dr. Thomas D. Economou (economou@stanford.edu).
10 #
11 #   The SU2 code is based on the work of:
12 #   Prof. Piero Colonna's group at Delft University of Technology.
13 #   Prof. Nicolas R. Gauger's group at Kaiserslautern University of Technology.
14 #   Prof. Alberto Guardone's group at Polytechnic University of Milan.
15 #   Prof. Rafael Palacios' group at Imperial College London.
16 #
17 # Copyright (C) 2012-2017 SU2, the open-source CFD code.
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22 # version 2.1 of the License, or (at your option) any later version.
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24 # SU2 is distributed in the hope that it will be useful,
25 # but WITHOUT ANY WARRANTY; without even the implied warranty of
26 # MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU
27 # Lesser General Public License for more details.
28 #
29 # You should have received a copy of the GNU Lesser General Public
30 # License along with SU2. If not, see <http://www.gnu.org/licenses/>.
31 # imports
32
33 import numpy as np
34 import matplotlib.pyplot as plt
35 from optparse import OptionParser
36 import os, sys, shutil, copy, os.path
37 sys.path.append(os.environ['SU2_RUN'])
38 import SU2
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40 def main():
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```
1 #!/usr/bin/env python
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3 ## \file Compute_Mpolar.py
4 # \brief Python script for performing polar sweep of Mach number.
5 # \author H. Kline (E. Arad compute_polar script)
6 # \version 5.0.0 "Raven"
7 #
8 # SU2 Lead Developers: Dr. Francisco Palacios (Francisco.D.Palacios@boeing.com).
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12 # Prof. Nicolas R. Gauger's group at Kaiserslautern University of Technology.
13 # Prof. Alberto Guardone's group at Polytechnic University of Milan.
14 # Prof. Rafael Palacios' group at Imperial College London.
15 #
16 #
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26 # MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU
27 # Lesser General Public License for more details.
28 #
29 # You should have received a copy of the GNU Lesser General Public
30 # License along with SU2. If not, see <http://www.gnu.org/licenses/>.
31 #
32 # imports
33 import numpy as np
34 import matplotlib.pyplot as plt
35 from optparse import OptionParser
36 import os, sys, shutil, copy, os.path
37 sys.path.append(os.environ['SU2_RUN'])
38 import SU2
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40 def main():
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wget

su2.stanford.edu/documents/
WorkshopFeb2017/compute_
Mpolar.py

```
40 def main():
41     # Command Line Options
42     parser = OptionParser()
43     parser.add_option("-f", "--file", dest="filename",
44                     help="read config from FILE", metavar="FILE")
45     parser.add_option("-n", "--partitions", dest="partitions", default=2,
46                     help="number of PARTITIONS", metavar="PARTITIONS")
47     parser.add_option("-i", "--iterations", dest="iterations", default=99999,
48                     help="number of ITERATIONS", metavar="ITERATIONS")
49
50     (options, args)=parser.parse_args()
51     options.partitions = int( options.partitions )
52     options.iterations = int( options.iterations )
53
54     # load config, start state
55     config = SU2.io.Config(options.filename)
56     state = SU2.io.State()
57
58     # find solution files if they exist
59     state.find_files(config)
60
61     # prepare config
62     config.NUMBER_PART = options.partitions
63     config.EXT_ITER   = options.iterations
64
65     # Initialize results arrays
66     nMach = 5
67     MachList=np.linspace(0.5,0.6,nMach)
68     LiftList=[]
69     DragList=[]
70
71     # Output file
72     outFile='Polar M' + str(MachList[0]) + '.dat'
73     f = open(outFile, 'w')
74     f.write('% Mach, CL, CD, \n')
75
76     # iterate on Mach number
77     for MachNumber in MachList:
78
79         # local config and state
80         konfig = copy.deepcopy(config)
81         ztate  = copy.deepcopy(state)
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83         # set config options
84         konfig.MACH_NUMBER = MachNumber
85         caseName='DIRECT_M_'+str(MachNumber)
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87         # run su2
88         drag = SU2.eval.func('DRAG',konfig,ztate)
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91         LiftList.append(lift)
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93
94         output = str(MachNumber)+", "+ str(lift) + ", " + str(drag)+"\n"
95         f.write(output)
96
97         # Store result in a subdirectory
98         if os.path.isdir(caseName):
99             os.system('rm -R '+caseName)
100            command='mv DIRECT '+caseName
101            os.system(command)
102
103     # Close open file
104     f.close()
105
106     # plotting
107     plt.figure()
108     plt.plot( MachList, LiftList )
109     plt.xlabel('Mach')
110     plt.ylabel('Lift Coefficient')
111     plt.show()
112
113
114 if __name__ == "__main__":
115     main()
```

Define and parse command line options (-f filename, etc)

```
40 def main():
41     # Command Line Options
42     parser = OptionParser()
43     parser.add_option("-f", "--file", dest="filename",
44                       help="read config from FILE", metavar="FILE")
45     parser.add_option("-n", "--partitions", dest="partitions", default=2,
46                       help="number of PARTITIONS", metavar="PARTITIONS")
47     parser.add_option("-i", "--iterations", dest="iterations", default=99999,
48                       help="number of ITERATIONS", metavar="ITERATIONS")
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51     options.partitions = int( options.partitions )
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89         lift = SU2.eval.func('LIFT',konfig,ztate)
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91         LiftList.append(lift)
92         DragList.append(drag)
93
94         output = str(MachNumber)+", "+ str(lift) + ", " + str(drag)+"\n"
95         f.write(output)
96
97         # Store result in a subdirectory
98         if os.path.isdir(caseName):
99             os.system('rm -R '+caseName)
100            command='mv DIRECT '+caseName
101            os.system(command)
102            |
103
104     # Close open file
105     f.close()
106
107     # plotting
108     plt.figure()
109     plt.plot( MachList, LiftList )
110     plt.xlabel('Mach')
111     plt.ylabel('Lift Coefficient')
112     plt.show()
113
114 if __name__ == "__main__":
115     main()
```

Initialize python objects that run SU2, modify options.

To modify config options from the python script:

```
config.EXT_ITER = options.iterations
```

```
40 def main():
41     # Command Line Options
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43     parser.add_option("-f", "--file", dest="filename",
44                     help="read config from FILE", metavar="FILE")
45     parser.add_option("-n", "--partitions", dest="partitions", default=2,
46                     help="number of PARTITIONS", metavar="PARTITIONS")
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48                     help="number of ITERATIONS", metavar="ITERATIONS")
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65     # initialize results arrays
66     nMach = 5
67     MachList=np.linspace(0.5,0.6,nMach)
68     LiftList=[]
69     DragList=[]
70
71     # Output file
72     outFile='Polar M' + str(MachList[0]) + '.dat'
73     f = open(outFile, 'w')
74     f.write('Mach Cl Co \n')
75
76
77
78     # local config and state
79     konfig = copy.deepcopy(config)
80     ztate = copy.deepcopy(state)
81
82
83     # set config options
84     konfig.MACH_NUMBER = MachNumber
85     caseName='DIRECT_M_'+str(MachNumber)
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88     drag = SU2.eval.func('DRAG',konfig,ztate)
89     lift = SU2.eval.func('LIFT',konfig,ztate)
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91     LiftList.append(lift)
92     DragList.append(drag)
93
94     output = str(MachNumber)+", "+ str(lift) + ", " + str(drag)+"\n"
95     f.write(output)
96
97     # Store result in a subdirectory
98     if os.path.isdir(caseName):
99         os.system('rm -R '+caseName)
100     command='mv DIRECT '+caseName
101     os.system(command)
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103     # Close open file
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107     plt.figure()
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109     plt.xlabel('Mach')
110     plt.ylabel('Lift Coefficient')
111     plt.show()
112
113
114 if __name__ == "__main__":
115     main()
```


Set up range of Mach numbers, open the output file, and start a for loop.

```
40 def main():
41     # Command Line Options
42     parser = OptionParser()
43     parser.add_option("-f", "--file", dest="filename",
44                     help="read config from FILE", metavar="FILE")
45     parser.add_option("-n", "--partitions", dest="partitions", default=2,
46                     help="number of PARTITIONS", metavar="PARTITIONS")
47     parser.add_option("-i", "--iterations", dest="iterations", default=99999,
48                     help="number of ITERATIONS", metavar="ITERATIONS")
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50     (options, args)=parser.parse_args()
51     options.partitions = int( options.partitions )
52     options.iterations = int( options.iterations )
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68     LiftList=[]
69     DragList=[]
70
71     # Output file
72     outFile='Polar M' + str(MachList[0]) + '.dat'
73     f = open(outFile, 'w')
74     f.write('% Mach, CL, CD, \n')
75
76     # iterate on Mach number
77     for MachNumber in MachList:
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84         konfig.MACH_NUMBER = MachNumber
85         caseName='DIRECT_M_'+str(MachNumber)
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87         # run su2
88         drag = SU2.eval.func('DRAG',konfig,ztate)
89         lift = SU2.eval.func('LIFT',konfig,ztate)
90
91         LiftList.append(lift)
92         DragList.append(drag)
93
94         output = str(MachNumber)+", " + str(lift) + ", " + str(drag)+"\n"
95         f.write(output)
96
97         # Store result in a subdirectory
98         if os.path.isdir(caseName):
99             os.system('rm -R '+caseName)
100            command='mv DIRECT '+caseName
101            os.system(command)
102
103     # Close open file
104     f.close()
105
106     # plotting
107     plt.figure()
108     plt.plot( MachList, LiftList )
109     plt.xlabel('Mach')
110     plt.ylabel('Lift Coefficient')
111     plt.show()
112
113
114 if __name__ == "__main__":
115     main()
```

Copy the config and state objects using copy.deepcopy and set the Mach number

```
40 def main():
41     # Command Line Options
42     parser = OptionParser()
43     parser.add_option("-f", "--file", dest="filename",
44                     help="read config from FILE", metavar="FILE")
45     parser.add_option("-n", "--partitions", dest="partitions", default=2,
46                     help="number of PARTITIONS", metavar="PARTITIONS")
47     parser.add_option("-i", "--iterations", dest="iterations", default=99999,
48                     help="number of ITERATIONS", metavar="ITERATIONS")
49
50     (options, args)=parser.parse_args()
51     options.partitions = int( options.partitions )
52     options.iterations = int( options.iterations )
53
54     # load config, start state
55     config = SU2.io.Config(options.filename)
56     state = SU2.io.State()
57
58     # find solution files if they exist
59     state.find_files(config)
60
61     # prepare config
62     config.NUMBER_PART = options.partitions
63     config.EXT_ITER   = options.iterations
64
65     # Initialize results arrays
66     nMach = 5
67     MachList=np.linspace(0.5,0.6,nMach)
68     LiftList=[]
69     DragList=[]
70
71     # Output file
72     outFile='Polar M' + str(MachList[0]) + '.dat'
73     f = open(outFile, 'w')
74     f.write('% Mach, CL, CD, \n')
75
76     # iterate on Mach number
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79         # local config and state
80         konfig = copy.deepcopy(config)
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84         konfig.MACH_NUMBER = MachNumber
85         caseName='DIRECT_M_'+str(MachNumber)
86
87         # run su2
88         drag = SU2.eval.func('DRAG',konfig,ztate)
89         lift = SU2.eval.func('LIFT',konfig,ztate)
90
91         LiftList.append(lift)
92         DragList.append(drag)
93
94         output = str(MachNumber)+", "+ str(lift) + ", " + str(drag)+"\n"
95         f.write(output)
96
97         # Store result in a subdirectory
98         if os.path.isdir(caseName):
99             os.system('rm -R '+caseName)
100             command='mv DIRECT '+caseName
101             os.system(command)
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103     # Close open file
104     f.close()
105
106     # plotting
107     plt.figure()
108     plt.plot( MachList, LiftList )
109     plt.xlabel('Mach')
110     plt.ylabel('Lift Coefficient')
111     plt.show()
112
113
114 if __name__ == "__main__":
115     main()
```

Evaluate lift and drag using
`SU2.eval.func('DRAG',konfig,ztate)`

Note that only the first 'eval' runs
SU2_CFD, after that the output
values are stored in the state
object.

```
40 def main():
41 # Command Line Options
42 parser = OptionParser()
43 parser.add_option("-f", "--file", dest="filename",
44                 help="read config from FILE", metavar="FILE")
45 parser.add_option("-n", "--partitions", dest="partitions", default=2,
46                 help="number of PARTITIONS", metavar="PARTITIONS")
47 parser.add_option("-i", "--iterations", dest="iterations", default=99999,
48                 help="number of ITERATIONS", metavar="ITERATIONS")
49
50 (options, args)=parser.parse_args()
51 options.partitions = int( options.partitions )
52 options.iterations = int( options.iterations )
53
54 # load config, start state
55 konfig = SU2.io.Config(options.filename)
56 state = SU2.io.State()
57
58 # find solution files if they exist
59 state.find_files(konfig)
60
61 # prepare config
62 konfig.NUMBER_PART = options.partitions
63 konfig.EXT_ITER   = options.iterations
64
65 # Initialize results arrays
66 nMach = 5
67 MachList=np.linspace(0.5,0.6,nMach)
68 LiftList=[]
69 DragList=[]
70
71 # Output file
72 outFile='Polar M' + str(MachList[0]) + '.dat'
73 f = open(outFile, 'w')
74 f.write('% Mach, CL, CD, \n')
75
76 # iterate on Mach number
77 for MachNumber in MachList:
78
79     # local config and state
80     konfig = copy.deepcopy(konfig)
81     ztate = copy.deepcopy(state)
82
83     # set config options
84     konfig.MACH_NUMBER = MachNumber
85     caseName='DIRECT_M_'+str(MachNumber)
86
87     # run SU2
88     drag = SU2.eval.func('DRAG',konfig,ztate)
89     lift = SU2.eval.func('LIFT',konfig,ztate)
90
91     LiftList.append(lift)
92     DragList.append(drag)
93
94     output = str(MachNumber)+" "+str(lift)+" "+str(drag)+"\n"
95     f.write(output)
96
97     # Store result in a subdirectory
98     if os.path.isdir(caseName):
99         os.system('rm -R '+caseName)
100     command='mv DIRECT '+caseName
101     os.system(command)
102
103 # Close open file
104 f.close()
105
106 # plotting
107 plt.figure()
108 plt.plot( MachList, LiftList )
109 plt.xlabel('Mach')
110 plt.ylabel('Lift Coefficient')
111 plt.show()
112
113
114 if __name__ == "__main__":
115     main()
```

Store results, close output file, and plot results

```
40 def main():
41     # Command Line Options
42     parser = OptionParser()
43     parser.add_option("-f", "--file", dest="filename",
44                       help="read config from FILE", metavar="FILE")
45     parser.add_option("-n", "--partitions", dest="partitions", default=2,
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112
113
114 if __name__ == "__main__":
115     main()
```

Run, and modify compute_Mpolar.py

- What do we need to change to plot an additional output (ie, C_l/C_d , C_{mz})?

Mini-project: N minutes to modify a python script

- Goal: execute a problem that requires several CFD simulations (10-20).
- Use the Quickstart input files
- Suggested mini-projects:
 - Sweep through angle of attack and output the lift coefficients.
 - Estimate the standard deviation of lift with respect to an input distribution of Mach number.
- Resources:
 - Plotting with python: http://matplotlib.org/faq/howto_faq.html
 - Numpy (arrays, random numbers, etc):
<https://docs.scipy.org/doc/numpy/reference/index.html>
 - File I/O with Python:
<https://docs.python.org/2/tutorial/inputoutput.html#reading-and-writing-files>
 - Output function names: SU2_PY/SU2/io/tools.py → get_headerMap()