Discussion386

November 23, 2022

1 Discussion #386

1.1 Packages version

[ ]:
```
import andes
import numpy as np
```

[ ]:
```
print(andes.__version__)
print(np.__version__)
```

```
1.8.3.post8+ge180c540
1.22.3
```

[ ]:
```
andes.config_logger(stream_level=50)
```

1.2 Load case

[ ]:
```
case0 = andes.get_case('ieee14/ieee14_full.xlsx')

case_path = '/Users/jinningwang/Documents/work/andes/icebar/discussion386/'

case1 = case_path + 'ieee14_1.00_Line_12_0.80_1.00_1.30.xlsx'

case2 = case_path + 'ieee14_1.00_Line_12_0.90_1.00_1.30.xlsx'

case3 = case_path + 'ieee14_1.00_Line_12_0.95_1.00_1.30.xlsx'
```

[ ]:
```
ss0 = andes.load(case0,
                 default_config=True,
                 no_output=True)

ss1 = andes.load(case1,
                 default_config=True,
                 no_output=True)

ss2 = andes.load(case2,
                 default_config=True,
                 no_output=True)
```

```
ss3 = andes.load(case3,
                 default_config=True,
                 no_output=True)
```

```
Generating code for 1 models on 8 processes.
Generating code for 1 models on 8 processes.
Generating code for 1 models on 8 processes.
Generating code for 1 models on 8 processes.
```

[ ]:
```
andes.config_logger(stream_level=20)
```

1.3 Case0

[ ]:
```
ss0.PFlow.run()
```

```
-> System connectivity check results:
  No islanded bus detected.
  System is interconnected.
  Each island has a slack bus correctly defined and enabled.

-> Power flow calculation
           Numba: Off
   Sparse solver: KLU
 Solution method: NR method
Power flow initialized in 0.0051 seconds.
0: |F(x)| = 0.5605182134
1: |F(x)| = 0.006202200332
2: |F(x)| = 5.819382825e-06
3: |F(x)| = 6.957087684e-12
Converged in 4 iterations in 0.0055 seconds.
```

[ ]:
```
True
```

[ ]:
```
ss0i = ss0.TDS.init()
```

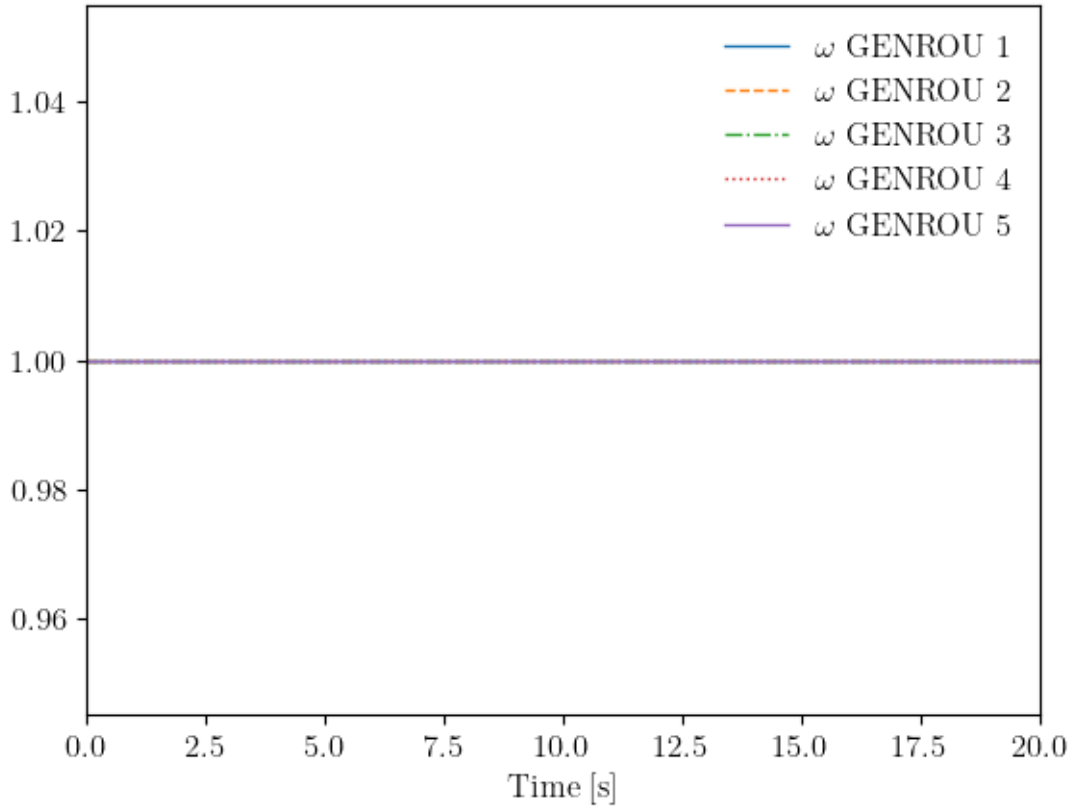
```
Initialization for dynamics completed in 0.0358 seconds.
Initialization was successful.
```

[ ]:
```
ss0.TDS.run()
```

```
-> Time Domain Simulation Summary:
Sparse Solver: KLU
Simulation time: 0.0-20.0 s.
Fixed step size: h=33.33 ms. Shrink if not converged.
  0%|          | 0/100 [00:00<?, ?%/s]
Simulation to t=20.00 sec completed in 0.5282 seconds.
```

[ ]: True

[ ]:
```
ss0.TDS.plt.plot(ss0.GENROU.omega)
```



[ ]:
```
(<Figure size 640x480 with 1 Axes>, <AxesSubplot:xlabel='Time [s]'>)
```

Base case is okay.

1.4 Case1

[ ]:
```
ss1.PFlow.run()
```

```
-> System connectivity check results:
  No islanded bus detected.
  System is interconnected.
  Each island has a slack bus correctly defined and enabled.

-> Power flow calculation
           Numba: Off
   Sparse solver: KLU
 Solution method: NR method
Power flow initialized in 0.0077 seconds.
```

```
0: |F(x)| = 8.6568834
1: |F(x)| = 7.007197233
2: |F(x)| = 1.365637093
3: |F(x)| = 0.1659350293
4: |F(x)| = 0.003034072009
5: |F(x)| = 9.897107155e-07
Converged in 6 iterations in 0.0100 seconds.
```

[ ]:
```
True
```

Power flow solved.

[ ]:
```
ss1i = ss1.TDS.init()
```

```
Initialization for dynamics completed in 0.0413 seconds.
Initialization was successful.
```

TDS initialized.

1.5 Case2

[ ]:
```
ss2.PFlow.run()
```

```
-> System connectivity check results:
  No islanded bus detected.
  System is interconnected.
  Each island has a slack bus correctly defined and enabled.

-> Power flow calculation
           Numba: Off
   Sparse solver: KLU
 Solution method: NR method
Power flow initialized in 0.0056 seconds.
0: |F(x)| = 15.44601457
1: |F(x)| = 87.13552781
2: |F(x)| = 51.0391057
3: |F(x)| = 14.27050865
4: |F(x)| = 3.188620159
5: |F(x)| = 0.5200860572
6: |F(x)| = 0.1319546069
7: |F(x)| = 0.02833026213
8: |F(x)| = 0.007088256276
9: |F(x)| = 0.001772020979
10: |F(x)| = 0.0004430050393
11: |F(x)| = 0.0001107512598
12: |F(x)| = 2.768781496e-05
13: |F(x)| = 6.92195374e-06
14: |F(x)| = 1.730488435e-06
15: |F(x)| = 4.326221087e-07
Converged in 16 iterations in 0.0215 seconds.
```

[ ]: True

Power flow solved.

[ ]:
```
ss2i = ss2.TDS.init()
```

```
GENROU (vf range) out of typical upper limit.

   idx    | values | limit
----------+--------+------
 GENROU_1 | 7.000  | 5
 GENROU_2 | 11.206 | 5
 GENROU_3 | 5.413  | 5
 GENROU_4 | 36.426 | 5
 GENROU_5 | 12.359 | 5


ESST3A.VG_lim: adjusted limit <VGMAX>

   Idx    | Input  | Old Limit
----------+--------+----------
 ESST3A_2 | 7.000  | 3.860
 ESST3A_3 | 5.413  | 3.860
 ESST3A_4 | 36.426 | 3.860
 ESST3A_5 | 12.359 | 3.860


ESST3A.VB_lim: adjusted limit <VBMAX>

   Idx    | Input | Old Limit
----------+-------+----------
 ESST3A_4 | 7.352 | 5.480


PQ.vcmp out of limits <vmin>

 idx   | Flag | Input Value | Limit
-------+------+-------------+------
 PQ_3  | zl   | 0.772       | 0.800
 PQ_4  | zl   | 0.782       | 0.800
 PQ_6  | zl   | -0.000      | 0.800
 PQ_7  | zl   | -0.000      | 0.800
 PQ_8  | zl   | 0.000       | 0.800
 PQ_11 | zl   | 0.369       | 0.800


ESST3A.HLI out of limits <VIMAX>
```

```
   idx    | Flag | Input Value | Limit
----------+------+-------------+------
 ESST3A_2 | zu   | 0.360       | 0.200
 ESST3A_3 | zu   | 0.278       | 0.200
 ESST3A_4 | zu   | 1.852       | 0.200
 ESST3A_5 | zu   | 0.633       | 0.200


Suspect initialization issue! Simulation may crash!

    Name      | Var. Value | Eqn. Mismatch
--------------+------------+--------------
 LL_y TGOV1 1 | 3.454      | -2.404
 vil ESST3A 2 | 0.360      | -0.160
 vil ESST3A 3 | 0.278      | -0.078
 vil ESST3A 4 | 1.852      | -1.652
 vil ESST3A 5 | 0.633      | -0.433


Initialization for dynamics completed in 0.0459 seconds.
Initialization failed!!
If you are developing a new model, check the initialization with
   andes -v 10 run -r tds --init /Users/jinningwang/Documents/work/andes/icebar/
discussion386/ieee14_1.00_Line_12_0.90_1.00_1.30.xlsx
Otherwise, check the variables that are initialized out of limits.
```

TDS initialization failed.

The Eqn. Mismatch items are associated with `LL_y TGOV1` and `vil ESST3A`. In the Model Reference or the model source code, it can be noticed that:

1. `LL_y TGOV1` is associated with function `LAG`, and `LAG` is limited by `VMIN` and `VMAX`.
2. `vil ESST3A` is associated with `HIL`, and `HIL` is limited by `VIMIN` and `VIMAX`.

Usually, the failed initialization is caused by the inapproriate limiter range, and it can be addressed by adjusting the range.

[ ]:
```
ss2.TGOV1.as_df()
```

[ ]:
```
          idx    u     name       syn   Tn  wref0     R  VMAX  VMIN    T1   T2  \
uid
0    TGOV1_1  1.0  TGOV1_1  GENROU_1  0.0    1.0  0.05  1.05   0.3  0.05  1.0
1    TGOV1_2  1.0  TGOV1_2  GENROU_2  0.0    1.0  0.05  1.20   0.0  0.10  1.0
2    TGOV1_3  1.0  TGOV1_3  GENROU_3  0.0    1.0  0.05  1.20   0.0  0.10  1.0
3    TGOV1_4  1.0  TGOV1_4  GENROU_4  0.0    1.0  0.05  1.05   0.3  0.05  1.0
4    TGOV1_5  1.0  TGOV1_5  GENROU_5  0.0    1.0  0.05  1.05   0.3  0.05  1.0

      T3   Dt
uid
```

```
0    2.1  0.0
1    2.1  0.0
2    2.1  0.0
3    2.1  0.0
4    2.1  0.0
```

[ ]:
```
ss2.ESST3A.as_df()
```

[ ]:
```
          idx    u      name       syn    TR  VIMAX  VIMIN   KM   TC   TB  \
uid
0    ESST3A_2  1.0  ESST3A_2  GENROU_1  0.02    0.2   -0.2  8.0  1.0  5.0
1    ESST3A_3  1.0  ESST3A_3  GENROU_3  0.02    0.2   -0.2  8.0  1.0  5.0
2    ESST3A_4  1.0  ESST3A_4  GENROU_4  0.02    0.2   -0.2  8.0  1.0  5.0
3    ESST3A_5  1.0  ESST3A_5  GENROU_5  0.02    0.2   -0.2  8.0  1.0  5.0

     …    KP     KI     VBMAX    KC      XL      VGMAX  THETAP   TM  VMMAX  \
uid  …
0    …  3.67  0.435  5.480000  0.01  0.0098   7.000318    3.33  0.4   99.0
1    …  3.67  0.435  5.480000  0.01  0.0098   5.413357    3.33  0.4   99.0
2    …  3.67  0.435  7.352355  0.01  0.0098  36.425544    3.33  0.4   99.0
3    …  3.67  0.435  5.480000  0.01  0.0098  12.359430    3.33  0.4   99.0

     VMMIN
uid
0      0.0
1      0.0
2      0.0
3      0.0

[4 rows x 25 columns]
```

We can try to enlarge `VMAX` and `VMIN` of device `TGOV1_1`.

However, it should be noted that since `ss2` has been initialziaed, we need to re-instantiate a new one.

[ ]:
```
sc2 = andes.load(case2,
                 default_config=True,
                 no_output=True)
```

```
Working directory:
"/Users/jinningwang/Documents/work/andes/icebar/discussion386"
> Reloaded generated Python code of module "pycode".
Generated code for <PQ> is stale.
Numerical code generation (rapid incremental mode) started…

Generating code for 1 models on 8 processes.

Saved generated pycode to "/Users/jinningwang/.andes/pycode"
> Reloaded generated Python code of module "pycode".
```

```
Generated numerical code for 1 models in 0.1807 seconds.
Parsing input file "/Users/jinningwang/Documents/work/andes/icebar/discussion386
/ieee14_1.00_Line_12_0.90_1.00_1.30.xlsx"…
Input file parsed in 0.0650 seconds.
System internal structure set up in 0.0393 seconds.
```

[ ]:
```
sc2.TGOV1.set(idx='TGOV1_1', src='VMAX', attr='v', value=10)
sc2.TGOV1.set(idx='TGOV1_1', src='VMIN', attr='v', value=0)
```

[ ]:
```
True
```

Similarly, we can try to enlarge `VIMAX` and `VIMIN` of device `ESST3A_2` - `ESST3A_5`.

[ ]:
```
sc2.ESST3A.set(idx=['ESST3A_2', 'ESST3A_3', 'ESST3A_4', 'ESST3A_5'],
               src='VIMAX', attr='v',
               value=[10, 10, 10, 10])

sc2.ESST3A.set(idx=['ESST3A_2', 'ESST3A_3', 'ESST3A_4', 'ESST3A_5'],
               src='VIMIN', attr='v',
               value=[-10, -10, -10, -10])
```

[ ]:
```
True
```

[ ]:
```
sc2.PFlow.run()
```

```
-> System connectivity check results:
  No islanded bus detected.
  System is interconnected.
  Each island has a slack bus correctly defined and enabled.

-> Power flow calculation
           Numba: Off
   Sparse solver: KLU
 Solution method: NR method
Power flow initialized in 0.0060 seconds.
0: |F(x)| = 15.44601457
1: |F(x)| = 87.13552781
2: |F(x)| = 51.0391057
3: |F(x)| = 14.27050865
4: |F(x)| = 3.188620159
5: |F(x)| = 0.5200860572
6: |F(x)| = 0.1319546069
7: |F(x)| = 0.02833026213
8: |F(x)| = 0.007088256276
9: |F(x)| = 0.001772020979
10: |F(x)| = 0.0004430050393
11: |F(x)| = 0.0001107512598
12: |F(x)| = 2.768781496e-05
13: |F(x)| = 6.92195374e-06
```

```
14: |F(x)| = 1.730488435e-06
15: |F(x)| = 4.326221087e-07
Converged in 16 iterations in 0.0218 seconds.
```

[ ]:
```
True
```

Now, Case2 can be initialized successfully.

[ ]:
```
sc2i = sc2.TDS.init()
```

```
GENROU (vf range) out of typical upper limit.

   idx    | values | limit
----------+--------+------
 GENROU_1 | 7.000  | 5
 GENROU_2 | 11.206 | 5
 GENROU_3 | 5.413  | 5
 GENROU_4 | 36.426 | 5
 GENROU_5 | 12.359 | 5


ESST3A.VG_lim: adjusted limit <VGMAX>

   Idx    | Input  | Old Limit
----------+--------+----------
 ESST3A_2 | 7.000  | 3.860
 ESST3A_3 | 5.413  | 3.860
 ESST3A_4 | 36.426 | 3.860
 ESST3A_5 | 12.359 | 3.860


ESST3A.VB_lim: adjusted limit <VBMAX>

   Idx    | Input | Old Limit
----------+-------+----------
 ESST3A_4 | 7.352 | 5.480


PQ.vcmp out of limits <vmin>

 idx   | Flag | Input Value | Limit
-------+------+-------------+------
 PQ_3  | zl   | 0.772       | 0.800
 PQ_4  | zl   | 0.782       | 0.800
 PQ_6  | zl   | -0.000      | 0.800
 PQ_7  | zl   | -0.000      | 0.800
 PQ_8  | zl   | 0.000       | 0.800
 PQ_11 | zl   | 0.369       | 0.800
```

```
Initialization for dynamics completed in 0.0421 seconds.
Initialization was successful.
```

1.6 Case3

[ ]:
```
ss3.PFlow.run()
```

```
-> System connectivity check results:
  No islanded bus detected.
  System is interconnected.
  Each island has a slack bus correctly defined and enabled.

-> Power flow calculation
           Numba: Off
   Sparse solver: KLU
 Solution method: NR method
Power flow initialized in 0.0065 seconds.
0: |F(x)| = 29.31915012
1: |F(x)| = 740.0002552
2: |F(x)| = 184.73335
3: |F(x)| = 45.4526586
4: |F(x)| = 12.50794975
5: |F(x)| = 15.21453025
6: |F(x)| = 10.05942972
7: |F(x)| = 13.61984299
8: |F(x)| = 35.59466317
9: |F(x)| = 8.482561041
10: |F(x)| = 10.18377093
11: |F(x)| = 3.30210519
12: |F(x)| = 29.83519301
13: |F(x)| = 37.76487849
14: |F(x)| = 12.23775322
15: |F(x)| = 3.856617645
16: |F(x)| = 2901.501366
17: |F(x)| = 729.7337025
18: |F(x)| = 180.6417168
19: |F(x)| = 2184.801181
20: |F(x)| = 547.8476025
21: |F(x)| = 1230.613562
22: |F(x)| = 64.12087458
23: |F(x)| = 13.02606755
24: |F(x)| = 46.98123
25: |F(x)| = 94.82327295
26: |F(x)| = 29.99344683
Power flow failed after 27 iterations for "/Users/jinningwang/Documents/work/and
es/icebar/discussion386/ieee14_1.00_Line_12_0.95_1.00_1.30.xlsx".
```

[ ]:
```
False
```

Power flow failed.

[ ]:
```
sc3 = andes.load(case3,
                 default_config=True,
                 no_output=True)
```

```
Working directory:
"/Users/jinningwang/Documents/work/andes/icebar/discussion386"
> Reloaded generated Python code of module "pycode".
Generated code for <PQ> is stale.
Numerical code generation (rapid incremental mode) started…

Generating code for 1 models on 8 processes.

Saved generated pycode to "/Users/jinningwang/.andes/pycode"
> Reloaded generated Python code of module "pycode".
Generated numerical code for 1 models in 0.1957 seconds.
Parsing input file "/Users/jinningwang/Documents/work/andes/icebar/discussion386
/ieee14_1.00_Line_12_0.95_1.00_1.30.xlsx"…
Input file parsed in 0.0597 seconds.
System internal structure set up in 0.0368 seconds.
```

[ ]:
```
sc3.Bus.as_df()
```

[ ]:

uid	idx	u	name	Vn	vmax	vmin	v0	a0	xcoord	ycoord	area	zone	owner
0	1	1.0	BUS1	69.0	1.1	0.9	1.03000	0.000000	0	0	1.0	1.0	1.0
1	2	1.0	BUS2	69.0	1.1	0.9	1.01970	-0.027981	0	0	1.0	1.0	1.0
2	3	1.0	BUS3	69.0	1.1	0.9	1.00042	-0.060097	0	0	1.0	1.0	1.0
3	4	1.0	BUS4	69.0	1.1	0.9	0.99858	-0.074721	0	0			
4	5	1.0	BUS5	69.0	1.1	0.9	1.00443	-0.064315	0	0			
5	6	1.0	BUS6	138.0	1.1	0.9	0.99871	-0.109998	0	0			
6	7	1.0	BUS7	138.0	1.1	0.9	1.00682	-0.084285	0	0			
7	8	1.0	BUS8	69.0	1.1	0.9	1.01895	-0.024339	0	0			
8	9	1.0	BUS9	138.0	1.1	0.9	1.00193	-0.127502	0	0			
9	10	1.0	BUS10	138.0	1.1	0.9	0.99351	-0.130202	0	0			
10	11	1.0	BUS11	138.0	1.1	0.9	0.99245	-0.122948	0	0			
11	12	1.0	BUS12	138.0	1.1	0.9	0.98639	-0.128934	0	0			
12	13	1.0	BUS13	138.0	1.1	0.9	0.98403	-0.133786	0	0			
13	14	1.0	BUS14	138.0	1.1	0.9	0.99063	-0.166916	0	0			
14	15	1.0	BUS15	138.0	1.1	0.9	1.00000	0.000000	0	0			

```
3     1.0   1.0    1.0
4     1.0   1.0    1.0
5     2.0   2.0    2.0
6     2.0   2.0    2.0
7     2.0   2.0    2.0
8     2.0   2.0    2.0
9     2.0   2.0    2.0
10    2.0   2.0    2.0
11    2.0   2.0    2.0
12    2.0   2.0    2.0
13    2.0   2.0    2.0
14    NaN   NaN    NaN
```

We can notice that there is a newly added device `BUS15` with `v0` and `a0` being set as default values.

This might be the reason why the power flow failed.

[ ]:
```
sc3.Bus.set(idx=15, src='v0', attr='v', value=0.99)
sc3.Bus.set(idx=15, src='a0', attr='v', value=-0.1)
```

[ ]:
```
True
```

[ ]:
```
sc3.PFlow.run()
```

```
-> System connectivity check results:
  No islanded bus detected.
  System is interconnected.
  Each island has a slack bus correctly defined and enabled.

-> Power flow calculation
           Numba: Off
   Sparse solver: KLU
 Solution method: NR method
Power flow initialized in 0.0054 seconds.
0: |F(x)| = 6.171679059
1: |F(x)| = 0.8778049877
2: |F(x)| = 0.05516065719
3: |F(x)| = 0.0001907369157
4: |F(x)| = 2.026405849e-09
Converged in 5 iterations in 0.0067 seconds.
```

[ ]:
```
True
```

[ ]:
```
sc3i = sc3.TDS.init()
```

```
Initialization for dynamics completed in 0.0401 seconds.
Initialization was successful.
```

Now the power flow can be solved and the TDS can be initialized successfully.