

Implementation of new features in Numjuggler

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Outline



- For request of F4E new capabilities have been implemented in the last version of numjuggler tool.
- The features requested were:
 - Remove complementary operators in MCNP cell definition
 - Remove redundant parentheses in MCNP cell definition
 - Provide information relative the memory consumption of the geometry definition in MCNP

Numjuggler modifications



- A new numjuggler module has been developed independently of original numjuggler module (only main.py module has been modified to integrate new capabilities in the tool)
- The original numjuggler capabilities haven't been changed.
- The syntax for calling new capabilities is identical to original numjuggler syntax.
- In line help of new features has been added in numjuggler help.

Removing complementary operator

- Command line : *remh* keyword

```
numjuggler --mode remh input > output
```

- Information on substituted operator can be obtain with the option *--log filename*

```
numjuggler --mode remh --log remhlog input > output
```

Log file example



```
-----
Cell      43055 :

    Complementary cell definition :
1:      ((43274 43527 -42725 -43273))
-----
Cell      47050 :

    Complementary cell definition :
1:      ((47271 47451 -46723 -47270))
-----
Cell      50712 :

    Complementary cell number :
1:      50926
-----
Cell      50864 :

    Complementary cell number :
1:      50857
2:      50860
-----
```

Removing complementary operator



- A complementary operator is removed only if the complementary cell is not a transformed cell

```
1 0  (3 :-4) 5  #10
...
10 0  like 9 but  trcl=3
```

Operator #10 in cell 1 is not removed

- Nested complementary operators are removed.

```
1 0  (3 :-4) 5  #2
2 0  6 -5 -7  #3
3 0  -6 :-8
```

Removing complementary operator

- Complementary cell algorithm: e.g.

1. Bracket the cell ()

2. Change cell sign

3. Subs ":" → ")("

" " → " : "

4. Remove redundant parentheses

3 -4 : 5 9 (1 : 6)

(3 -4 : 5 9 (1 : 6))

(-3 4 : -5 -9 (-1 : -6))

(-3 : 4)(-5 : -9 (-1)(-6))

(-3 : 4)(-5 : -9 -1 -6)

The algorithm is taken from MCNP(vol. I) manual

Removing redundant parentheses




- Command line : *remrp* keyword

```
numjuggler --mode remrp input > output
```


- Information on number of parentheses removed in each cell can be obtain with the option *--log filename*

```
numjuggler --mode remrp --log remrplog input > output
```

Log file example



Cell	:	Parentheses removed
1	:	-2
2	:	-1
3	:	-1
4	:	-4
5	:	-6
6	:	-4
7	:	-4
8	:	-6
9	:	-4
10	:	-4
11	:	-6
12	:	-4
13	:	-4



One
parenthesis is
the couple ()

Removing redundant parentheses



- In MCNP the presence of parenthesis in the cell definition make it complex (complex cells are treated differently vs simple cells in MCNP during transport)

2 -4 5 : simple cell
(2 -4 5) : complex cell
2 : 4 : complex cell

- Due to geometry error / MCNP bug with coincident surfaces, the transport is not exactly the same if cells are considered simple or complex.

Removing redundant parentheses



- remrp mode has options to define how the user wants to remove the parentheses
 - “nochg” (default) : the characteristic (simple/complex) of the cell is preserved
 - “cc” : All cells are considered as complex (extra parentheses are added if needed).
 - “all” : All redundant parentheses are removed independently of preserving cell characteristics.

```
numjuggler --mode remrp -opt all input > output
```

Redundant parentheses



- Redundant parentheses have the following pattern:

- ((anything) : ; : (anything) : ; : (anything))

The diagram shows the expression ((anything) : ; : (anything) : ; : (anything)). Blue arrows point from a central point labeled 'Redundant' to the opening and closing parentheses of each of the three inner expressions: (anything), (anything), and (anything).

- (A B ... only intersection ...) with A, B = (anything) or number

The diagram shows the expression (A B ... only intersection ...). Blue arrows point from a central point labeled 'Redundant' to the opening and closing parentheses of the entire expression.

Memory information



Command line : minfo keyword

```
numjuggler --mode minfo input
```

Return information on the number of words and # operator present in the input and memory required by MCNP to store the geometry.

```
Total words      : 8304762
Total hash       : 340
Hashcel         : 260
Hashsurf        : 80
Longest cell     : 131
Words in longest cell : 1090

MCNP estimation :
  mlja          : 70778854
  Estimated memory requirement : 1.1GB
  %cell length, %number #    : 82.2% 17.8%

Cell name  total #  cell #  surf #
10290      1       0       1
10291      1       0       1
28833      1       1       0
40706      1       1       0
43055      1       0       1
47050      1       0       1
50712      1       1       0
50864      2       2       0
50927      1       1       0
51012      1       1       0
```

Verification



Two kinds of verification were performed.

- The MCNP lja array (which store the MCNP geometry) has been written in a file after MCNP geometry processing. Arrays produced by original input file and input file processed by numjuggler were compared. **Arrays were identical.**
- Statistical volume evaluation has been performed on the geometry of the original and modified input files. **Both simulations give identical results.**

These test have been applied successfully to Clite-R131031, Cmodel-R2.1-161214, and Cmodel-R171031 models.

Model performances



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Model performances



C-lite_R131031

Run_time	less < 1min	Removal of Hash		Removal of Hash + Brackets	
		No dump file exists	No dump file exists	No dump file exists	No dump file exists
Total words	191540	Total words	192818	Total words	162172
Total hash	41	Total hash	0	Total hash	0
Hashcel	32	Hashcel	0	Hashcel	0
Hashsurf	9	Hashsurf	0	Hashsurf	0
Longest cell	131	Longest cell	131	Longest cell	122
Words in longest cell	1090	Words in longest cell	1090	Words in longest cell	922
MCNP estimation		MCNP estimation		MCNP estimation	
mlja	2873960	mlja	1363446	mlja	1146524
Estimated memory requirement	43.9MB	Estimated memory requirement	20.8MB	Estimated memory requirement	17.5MB
Memory % --> Words	47,10%	Memory % --> Words	100,00%	Memory % --> Words	100,00%
Memory % --> #	52,90%	Memory % --> #	0,00%	Memory % --> #	0,00%
cp0 w-MCNP6.1	1,1 min	cp0 w-MCNP6.1	1,05	cp0 w-MCNP6.1	0,95

**Saving
memory
52,56%
Time
4,55%**

**Saving
Time
60,11%
Time
13,64%**

C-Model_2016_v1_R2.1

Run time	less < 5min	Removal of Hash		Removal of Hash + Brakets	
	No dump file exists	No dump file exists		No dump file exists	
Total words	6253646	Total words	6267600	Total words	5483493
Total hash	689	Total hash	0	Total hash	0
Hashcel	594	Hashcel	0	Hashcel	0
Hashsurf	95	Hashsurf	0	Hashsurf	0
Longest cell	131	Longest cell	131	Longest cell	122
Words in longest cell	1090	Words in longest cell	1090	Words in longest cell	922
			Saving memory		Saving memory
MCNP estimation		MCNP estimation		MCNP estimation	
mlja	69354982	mlja	43918320	mlja	38420171
			36,68%		44,60%
Estimated memory requirement	1.0GB	Estimated memory requirement	670.1MB	Estimated memory requirement	586.2MB
Memory % --> Words	63,20%		0,00%		0,00%
Memory % -->#	36,80%		100,00%		100,00%
			Time		Time
cp0 w-MCNP6.1	203 min		225		94
			-10,84%		53,69%

Model performances



C-Model_R171031

Run time	less < 5min	Removal of Hash		Removal of Hash + Brackets	
	No dump file exists	No dump file exists		No dump file exists	
Total words	8304762	Total words	8316434	Total words	7209386
Total hash	340	Total hash	0	Total hash	0
Hashcel	260	Hashcel	0	Hashcel	0
Hashsurf	80	Hashsurf	0	Hashsurf	0
Longest cell	131	Longest cell	131	Longest cell	122
Words in longest cell	1090	Words in longest cell	1090	Words in longest cell	922
MCNP estimation		MCNP estimation		MCNP estimation	
mlja	70778854	mlja	58260158	mlja	50501422
Estimated memory requirement	1.1GB	Estimated memory requirement	889.0MB	Estimated memory requirement	770.6MB
Memory % --> Words	82,20%		100,00%		100,00%
Memory % --> #	17,80%		0,00%		0,00%
cp0 w-MCNP6.1	320 min		345		127,5
			-7,81%		60,16%