

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.

	$3 -4 : 5 \ 9 \ (1 : 6)$
1. Bracket the cell ()	$(3 -4 : 5 \ 9 \ (1 : 6))$
2. Change cell sign	$(-3 \ 4 : -5 \ -9 \ (-1 : -6))$
3. Subs “:” → “)(“ “ “ → “ : “	$(-3 : 4)(-5 : -9 (-1)(-6))$
4. Remove redundant parentheses	$(-3 : 4)(-5 : -9 -1 -6)$

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 obtained 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



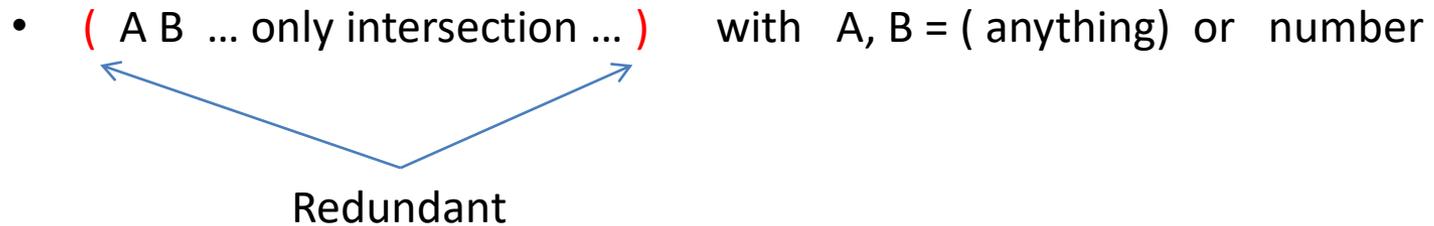
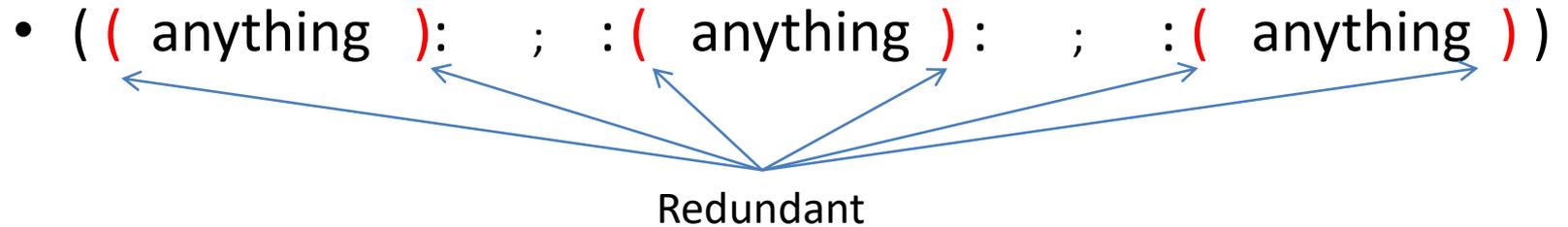
- remrp mode has options to define how the user wants to remove the parentheses
 - “nochg” (default) : the characteristic (simple/complex) of the cell is preserved
 - “cc” : All cells are considered as complex (extra parentheses are added if needed).
 - “all” : All redundant parentheses are removed independently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

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

Redundant parentheses



- Redundant parentheses have the following pattern:





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

Memory Saving	Time Saving
52,56%	60,11%
4,55%	13,64%

Model performances



C-Model_2016_v1_R2.1

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	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
MCNP estimation		MCNP estimation	MCNP estimation
mlja	69354982	mlja 43918320	mlja 38420171
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%
cp0 w-MCNP6.1	203 min	225	94

Saving memory

36,68%

44,60%

Time

-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

Saving memory
17,69%
Time
-7,81%

Saving memory
28,65%
Time
60,16%