



# **Distributor2 Documentation**

## ***Release 3.0***

**/ELSA/MU-12016/V3.0**

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## PREAMBLE

This module provides functions to distribute blocks on a given number of processors. At the end of the process, each block will have a number corresponding to the processor it must be affected to for a balanced computation, depending on given criterias. This module doesn't perform splitting (see the Transform module for that).

This module is part of Cassiopee, a free open-source pre- and post-processor for CFD simulations.

For use with the array interface, you have to import Distributor2 module:

```
import Distributor2 as D2
```

For use with the pyTree interface:

```
import Distributor2.PyTree as D2
```



## LIST OF FUNCTIONS

### – Automatic load balance

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<code>Distributor2.distribute(arrays, NProc[, ...])</code>	Distribute zones over NProc processors.
<code>Distributor2.PyTree.distribute(t, NProc[, ...])</code>	Distribute a pyTree over processors.

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### – Various operations

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<code>Distributor2.PyTree.addProcNode(t, proc)</code>	Add a “proc” node to zones with the given proc value.
<code>Distributor2.PyTree.getProc(t)</code>	Return the value of proc node.
<code>Distributor2.PyTree.getProcDict(t[, ...])</code>	Return the proc of a zone in a dictionary <code>proc['zoneName']</code> .
<code>Distributor2.PyTree.getProcList(t[, NProc, sort])</code>	Return the list of zones for each proc.
<code>Distributor2.PyTree.copyDistribution(a, b)</code>	Copy distribution of a in b.
<code>Distributor2.PyTree.printProcStats(t[, ...])</code>	Print stats dictionary.
<code>Distributor2.Mpi.redispatch(t[, graph])</code>	

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## CONTENTS

Distributor2.**distribute**(*A*, *NProc*, *prescribed*=[], *perfo*=[], *weight*=[], *com*=[],  
*algorithm*='graph', *mode*='nodes', *nghost*=0)  
Distribute automatically the blocks amongst *NProc* processors.

- *prescribed* is a list of blocks that are forced to be on a given processor.

For instance, *prescribed*[2] = 0 means that block 2 MUST be affected to processor 0.

- *perfo* is a tuple or a tuple list for each processor.

Each tuple describes the relative weight of solver CPU time regarding the communication speed and latence (*solverWeight*, *latenceWeight*, *comSpeedWeight*).

- *weight* is a list of weight for each block indicating the relative cost for solving each block.
- *com* is a *ixj* matrix describing the volume of points exchanged between bloc *i* and bloc *j*.
- *algorithm* can be chosen in: 'gradient', 'genetic', 'fast', 'graph'
- *mode*='node', 'cells': optimize distribution of block considering node (cells) numbers.
- *nghost*: take into account ghost cells (only for structured grids)

### Parameters

- **a** ([array, list of arrays]) – Input data
- **N** (int) – number of processors
- **prescribed** (list of ints) – list of prescribed blocks
- **perfo** (list of tuples) – list of performance for each processor
- **weight** (list of ints) – list of weight for each block
- **algorithm** (string) – ['gradient', 'genetic', 'fast', 'graph']
- **nghost** (int) – number of ghost cells present in the mesh

The function output is a stats dictionary. `stat['distrib']` is a vector describing the attributed processor for each block, `stats['meanPtsPerProc']` is the mean number of points per proc, `stats['varMin']` is the minimum variation of number of points, `stats['varMax']` is the maximum variation of number of points, `stats['varRMS']` is the mean variation of number of points, `stats['nptsCom']` is the number of points exchanged between processors for communication, `stats['comRatio']` is the ratio between the number of points exchanged between processors in this configuration divided by the total number of matching/overlap boundary points, `stats['adaptation']` is the value of the optimized function.

*Example of use:*

- Distribute arrays (array):

```
# - distribute (array) -
import Generator as G
import Distributor2 as D2
import numpy

# Distribution sans communication entre blocs
N = 11
arrays = []
for i in range(N):
    a = G.cart( (0,0,0), (1,1,1), (10+i, 10, 10) )
    arrays.append(a)
out = D2.distribute(arrays, NProc=5); print(out)

# Distribution avec des perfos differentes pour chaque proc
out = D2.distribute(arrays, NProc=3, perfo=[(1,0,0), (1.2,0,0), (0.2,0,0)]);
↳print(out)

# Distribution avec forçage du bloc 0 sur le proc 1, du bloc 2 sur le proc 3
# -1 signifie que le bloc est a equilibrer
prescribed = [-1 for x in range(N)]
prescribed[0] = 1; prescribed[2] = 3
out = D2.distribute(arrays, NProc=5, prescribed=prescribed); print(out)

# Distribution avec communications entre blocs, perfos identique pour tous
# les procs
volCom = numpy.zeros( (N, N), numpy.int32 )
volCom[0,1] = 100; # Le bloc 0 echange 100 pts avec le bloc 1
out = D2.distribute(arrays, NProc=5, com=volCom, perfo=(1,0.,0.1)); print(out)

# Distribution avec des solveurs differentes pour les blocs (le solveur est 2
# fois plus couteux pour les bloc 2 et 4)
out = D2.distribute(arrays, weight=[1,2,1,2,1,1,1,1,1,1], NProc=3); print(out)
```

Distributor2.PyTree.**distribute**(A, NProc, prescribed={}, perfo=[], weight=[], useCom='match', algorithm='graph', mode='nodes', nghost=0)

Distribute automatically the blocks amongst NProc processors.

With the pyTree interface, the user-defined node .Solver#Param/proc is updated with the attributed processor number.

If useCom=0, only the grid number of points is taken into account. If useCom='match', only match connectivities are taken into account. if useCom='overlap', only overlap connectivities are taken into account. if useCom='bbox', overlap between zone bbox is taken into account. if useCom='ID', ID (interpolation or match) and IBCD (IBM points) are taken into account. If useCom='all', matching and overlap communications are taken into account.

When using distributed trees, prescribed must be a dictionary containing the zones names as key, and the prescribed proc as value. weight is also a dictionary where the keys are the zone names and the weight as the value. It is not mandatory to assign a weight to all the zones of the pyTree. Default value is assumed 1, only different weight values can be assigned to zones. t can be either a skeleton or a loaded skeleton pyTree for useCom=0 or useCom='match', but must be a loaded skeleton tree only for the other settings.

### Parameters

- **a** ([pyTree, base, zone, list of zones]) – Input data
- **N** (int) – number of processors
- **prescribed** (dictionary) – dictionary of prescribed block (optional)
- **perfo** (list of tuples) – list of perfo for each processor (optional)
- **weight** (dictionary) – dictionary of weights for block (optional)
- **useCom** (['0', 'all', 'match', 'overlap', 'bbox', 'ID']) – tell what to use to measure communication volumes
- **algorithm** (string) – ['gradient', 'genetic', 'fast', 'graph']
- **nghost** (int) – number of ghost cells present in the mesh

*Example of use:*

- Distribute zones (pyTree):

```
# - distribute (pyTree) -
import Generator.PyTree as G
import Distributor2.PyTree as D2
import Converter.PyTree as C
import Connector.PyTree as X
```

```
N = 11
t = C.newPyTree(['Base'])
pos = 0
for i in range(N):
    a = G.cart((pos,0,0), (1,1,1), (10+i, 10, 10))
    pos += 10 + i - 1
    t[2][1][2].append(a)
t = X.connectMatch(t)

# Distribute on 3 processors
t, stats = D2.distribute(t, 3)
C.convertPyTree2File(t, 'out.cgns')
```

## 3.1 Various operations

Distributor2.PyTree.**addProcNode**(a, NProc)

Add a “proc” node to all zones of a with given value. Exists also as in place version (`_addProcNode`) that modifies a and returns None.

### Parameters

- a ([pyTree, base, zone, list of zones]) – input data
- NProc (int) – proc to be set

**Returns** reference copy of a

**Return type** identical to input

*Example of use:*

- Add a proc node (pyTree):

```
# - addProcNode (pyTree) -
import Converter.PyTree as C
import Generator.PyTree as G
import Distributor2.PyTree as D2

a = G.cart((0,0,0), (1,1,1), (10,10,10))
a = D2.addProcNode(a, 12)
C.convertPyTree2File(a, 'out.cgns')
```

Distributor2.PyTree.**getProc**(a)

Return the proc value of a zone or a list of zones.

**Parameters** *a* ([pyTree, base, zone, list of zones]) – input data

**Returns** the affected proc of zone

**Return type** int or list of ints (for multiple zones)

*Example of use:*

- Get proc of a zone (pyTree):

```
# - getProc (pyTree) -
import Generator.PyTree as G
import Distributor2.PyTree as D2

a = G.cart((0,0,0), (1,1,1), (10,10,10))
a = D2.addProcNode(a, 12)
proc = D2.getProc(a); print(proc)
#>> 12
```

Distributor2.PyTree.**getProcDict**(*a*, *prefixByBase=False*)

Return a dictionary where `procDict['zoneName']` is the no of proc affected to zone 'zoneName'.

**Parameters**

- *a* ([pyTree, base, zone, list of zones]) – input data
- **prefixByBase** (boolean) – if true, add base prefix to zone name

**Returns** the dictionary of zone/proc.

**Return type** dictionary

*Example of use:*

- Return the dictionary of zones/proc (pyTree):

```
# - getProcDict (pyTree) -
import Generator.PyTree as G
import Distributor2.PyTree as D2
import Converter.PyTree as C
import Connector.PyTree as X

N = 11
t = C.newPyTree(['Base'])
pos = 0
for i in range(N):
    a = G.cart((pos,0,0), (1,1,1), (10+i, 10, 10))
    pos += 10 + i - 1
    t[2][1][2].append(a)
```

```
t = X.connectMatch(t)
t, stats = D2.distribute(t, 3)

proc = D2.getProcDict(t)
zoneNames = C.getZoneNames(t, prefixByBase=False)
for z in zoneNames: print(z[0], proc[z])

# - or with base prefix -
proc = D2.getProcDict(t, prefixByBase=True)
zoneNames = C.getZoneNames(t, prefixByBase=True)
for z in zoneNames: print(z[0], proc[z])
```

Distributor2.PyTree.**getProcList**(a, NProc=None)

Return procList where procList[proc] is a list of zone names attributed to the proc processor.

**Parameters** a ([pyTree, base, zone, list of zones]) – input data

**Returns** the affected proc of zone

**Return type** int or list of ints

*Example of use:*

- Return the list of zones affected to a proc (pyTree):

```
# - getProcList (pyTree) -
import Generator.PyTree as G
import Distributor2.PyTree as D2
import Converter.PyTree as C
import Connector.PyTree as X

N = 11
t = C.newPyTree(['Base'])
pos = 0
for i in range(N):
    a = G.cart((pos,0,0), (1,1,1), (10+i, 10, 10))
    pos += 10 + i - 1
    t[2][1][2].append(a)

t = X.connectMatch(t)
t, stats = D2.distribute(t, 3)

procList = D2.getProcList(t)
print(procList)
```

Distributor2.PyTree.**copyDistribution**(a, b)

Copy the distribution from b to a matching zones by their name. Exists also as in place version (`_copyDistribution`) that modifies a and returns None.

**Parameters**

- **a** ([pyTree, base, zone, list of zones]) – input data
- **b** ([pyTree, base, zone, list of zones]) – original data

**Returns** modify reference copy of a

**Return type** same as input data

*Example of use:*

- Copy proc distribution from one tree to another (pyTree):

```
# - copyDistribution (pyTree) -
import Converter.PyTree as C
import Distributor2.PyTree as D2
import Generator.PyTree as G

# Case
N = 11
t = C.newPyTree(['Base'])
pos = 0
for i in range(N):
    a = G.cart((pos,0,0), (1,1,1), (10+i, 10, 10))
    a[0] = 'cart%d'%i
    pos += 10 + i - 1
    D2._addProcNode(a, i)
    t[2][1][2].append(a)

t2 = C.newPyTree(['Base'])
for i in range(N):
    a = G.cart((pos,0,0), (1,1,1), (10+i, 10, 10))
    a[0] = 'cart%d'%i
    pos += 10 + i - 1
    t2[2][1][2].append(a)
t2 = D2.copyDistribution(t2, t)
C.convertPyTree2File(t2, 'out.cgns')
```

Distributor2.Mpi.**redispatch**(a)

Redispatch a tree where a new distribution is defined in the node 'proc'.

**Parameters** **a** ([pyTree, base, zone, list of zones]) – input data

**Returns** modify reference copy of a

**Return type** same as input data

*Example of use:*

- Redispatch a tree (pyTree):

```
# - redispatch (pyTree) -
import Converter.PyTree as C
import Distributor2.PyTree as D2
import Distributor2.Mpi as D2mpi
import Converter.Mpi as Cmpi
import Connector.PyTree as X
import Converter.Internal as Internal
import Generator.PyTree as G

# Case
N = 11
t = C.newPyTree(['Base'])
pos = 0
for i in range(N):
    a = G.cart((pos,0,0), (1,1,1), (10+i, 10, 10))
    pos += 10 + i - 1
    t[2][1][2].append(a)
t = X.connectMatch(t)
if Cmpi.rank == 0: C.convertPyTree2File(t, 'in.cgns')
Cmpi.barrier()

# lecture du squelette
a = Cmpi.convertFile2SkeletonTree('in.cgns')

# equilibrage 1
(a, dic) = D2.distribute(a, NProc=Cmpi.size, algorithm='fast', useCom=0)

# load des zones locales dans le squelette
a = Cmpi.readZones(a, 'in.cgns', rank=Cmpi.rank)

# equilibrage 2 (a partir d'un squelette charge)
(a, dic) = D2.distribute(a, NProc=Cmpi.size, algorithm='gradient1',
                        useCom='match')

a = D2mpi.redispatch(a)

# force toutes les zones sur 0
zones = Internal.getNodesFromType(a, 'Zone_t')
for z in zones:
    nodes = Internal.getNodesFromName(z, 'proc')
    Internal.setValue(nodes[0], 0)
```



```
a = D2mpi.redispatch(a)

# Reconstitue l'arbre complet a l'ecriture
Cmpi.convertPyTree2File(a, 'out.cgns')
```

`Distributor2.PyTree.printProcStats(a, stats=None, NProc=None)`

Print statistics for each processor: number of points and list of zones names.

#### Parameters

- **a** ([pyTree, base, zone, list of zones]) – input data
- **stats** (Python dictionary) – dictionary obtained from `Distributor2.distribute`
- **NProc** (integer) – number of processors

**Returns** None

*Example of use:*

- Print procs statistics after distribution of a tree (pyTree):

```
# - printProcStats (pyTree) -
import Generator.PyTree as G
import Distributor2.PyTree as D2
import Converter.PyTree as C
import Connector.PyTree as X

N = 11
t = C.newPyTree(['Base'])
pos = 0
for i in range(N):
    a = G.cart((pos,0,0), (1,1,1), (10+i, 10, 10))
    pos += 10 + i - 1
    t[2][1][2].append(a)
t = X.connectMatch(t)

# Distribute on 3 processors
t, stats = D2.distribute(t, 3)

# With stats and NProc
D2.printProcStats(t, stats, NProc=3)
# NProc is guessed from stats
D2.printProcStats(t, stats)
# All are guessed from t
D2.printProcStats(t)

C.convertPyTree2File(t, 'out.cgns')
```

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**Note:** new in version 2.7.

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CHAPTER  
**FOUR**

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