TVB-Framework command initialisation

In [1]:
```
import os
from collections import OrderedDict
import time
import numpy as np

from tvb.basic.profile import TvbProfile
TvbProfile.set_profile(TvbProfile.LIBRARY_PROFILE)

from tvb_multiscale.tvb_nest.config import *

work_path = os.getcwd()
data_path = work_path
tvb_conn_filepath = os.path.join(data_path, "Connectivity_res100_596_regions
outputs_path = os.path.join(work_path, "outputs/cereb")
config = Config(output_base=outputs_path)

config.figures.SHOW_FLAG = True
config.figures.SAVE_FLAG = True
config.figures.FIG_FORMAT = 'png'
config.figures.DEFAULT_SIZE= config.figures.NOTEBOOK_SIZE
FIGSIZE = config.figures.DEFAULT_SIZE

from tvb_multiscale.core.plot.plotter import Plotter
plotter = Plotter(config.figures)

WEIGHTED_AVERAGE_CENTRES = True

TRACT_LENGTHS_MODE = "weighted_average"  # "weighted_average", "euclidean"
# "average" is not correct at all for tract lenghts,
# because we are merging recursively one major structure after the other,
# which could work only if the merged regions have a larger weights in a wei
# for subsequent mergings of other regions.

FORCE_MERGED_ZERO_DIAGONAL = True

# For interactive plotting:
# %matplotlib notebook

# Otherwise:
%matplotlib inline
```

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2023-01-30 11:32:13,009 - INFO - tvb_multiscale.tvb_nest.config - Loading a
NEST instance...
2023-01-30 11:32:13,009 - INFO - tvb_multiscale.tvb_nest.config - Loading a
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l/lib/python3.9/site-packages', '/usr/local/lib/python3.9/dist-packages',
'/usr/lib/python3/dist-packages']
```

This loads the just-prepared data:

In [2]:

```
import h5py
from tvb.datatypes.connectivity import Connectivity

# Load connnectivity from file:
f = h5py.File(tvb_conn_filepath)
# We have to transpose the square connectivity matrices for TVB, because of
result_connectivity = Connectivity(weights=np.array(f["weights"][()]).T,
                                   tract_lengths=np.array(f["tract_lengths"]
                                   centres=np.array(f["centres"][()]), # hem
                                   region_labels=np.array(f["region_labels"]
f.close()

# For the full connectome, self-connections are meaningless:
np.fill_diagonal(result_connectivity.weights, 0.0)
np.fill_diagonal(result_connectivity.tract_lengths, 0.0)
result_connectivity.tract_lengths[result_connectivity.weights == 0.0] = 0.0

result_connectivity.configure()

print('number_of_regions:\n', result_connectivity.number_of_regions)
print('\nweights.shape:\n', result_connectivity.weights.shape)
print('\ntract_lengths.shape:\n', result_connectivity.tract_lengths.shape)
print('\nregion_labels:\n', result_connectivity.region_labels)
print('\nweights:\n', result_connectivity.weights)
```

```
number_of_regions:
 596

weights.shape:
 (596, 596)

tract_lengths.shape:
 (596, 596)

region_labels:
 ['Right Frontal pole, cerebral cortex' 'Right Primary motor area'
 'Right Secondary motor area' 'Right Primary somatosensory area, nose'
 'Right Primary somatosensory area, barrel field'
 'Right Primary somatosensory area, lower limb'
 'Right Primary somatosensory area, mouth'
 'Right Primary somatosensory area, upper limb'
 'Right Primary somatosensory area, trunk'
 'Right Primary somatosensory area, unassigned'
 'Right Supplemental somatosensory area' 'Right Gustatory areas'
 'Right Visceral area' 'Right Dorsal auditory area'
 'Right Primary auditory area' 'Right Posterior auditory area'
 'Right Ventral auditory area' 'Right Anterolateral visual area'
 'Right Anteromedial visual area' 'Right Lateral visual area'
 'Right Primary visual area' 'Right Posterolateral visual area'
 'Right posteromedial visual area' 'Right Laterointermediate area'
 'Right Postrhinal area' 'Right Anterior cingulate area, dorsal part'
 'Right Anterior cingulate area, ventral part' 'Right Prelimbic area'
 'Right Infralimbic area' 'Right Orbital area, lateral part'
 'Right Orbital area, medial part'
 'Right Orbital area, ventrolateral part'
 'Right Agranular insular area, dorsal part'
 'Right Agranular insular area, posterior part'
 'Right Agranular insular area, ventral part'
 'Right Retrosplenial area, lateral agranular part'
 'Right Retrosplenial area, dorsal part'
 'Right Retrosplenial area, ventral part' 'Right Anterior area'
 'Right Rostrolateral visual area' 'Right Temporal association areas'
 'Right Perirhinal area' 'Right Ectorhinal area'
 'Right Main olfactory bulb' 'Right Accessory olfactory bulb'
 'Right Anterior olfactory nucleus' 'Right Taenia tecta'
 'Right Dorsal peduncular area' 'Right Piriform area'
 'Right Nucleus of the lateral olfactory tract'
 'Right Cortical amygdalar area, anterior part'
 'Right Cortical amygdalar area, posterior part'
 'Right Piriform–amygdalar area' 'Right Postpiriform transition area'
 'Right Field CA1' 'Right Field CA2' 'Right Field CA3'
 'Right Dentate gyrus' 'Right Induseum griseum'
 'Right Entorhinal area, lateral part'
 'Right Entorhinal area, medial part, dorsal zone' 'Right Parasubiculum'
 'Right Postsubiculum' 'Right Presubiculum' 'Right Subiculum'
 'Right Prosubiculum' 'Right Area prostriata' 'Right Claustrum'
 'Right Endopiriform nucleus, dorsal part'
 'Right Endopiriform nucleus, ventral part'
 'Right Lateral amygdalar nucleus' 'Right Basolateral amygdalar nucleus'
 'Right Basomedial amygdalar nucleus' 'Right Posterior amygdalar nucleus'
 'Right Caudoputamen' 'Right Nucleus accumbens' 'Right Fundus of striatum'
 'Right Olfactory tubercle'
 'Right Lateral septal nucleus, caudal (caudodorsal) part'
 'Right Lateral septal nucleus, rostral (rostroventral) part'
 'Right Lateral septal nucleus, ventral part'
 'Right Septofimbrial nucleus' 'Right Anterior amygdalar area'
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'Right Bed nucleus of the accessory olfactory tract'
'Right Central amygdalar nucleus' 'Right Intercalated amygdalar nucleus'
'Right Medial amygdalar nucleus'
'Right Globus pallidus, external segment'
'Right Globus pallidus, internal segment' 'Right Substantia innominata'
'Right Magnocellular nucleus' 'Right Medial septal nucleus'
'Right Diagonal band nucleus' 'Right Triangular nucleus of septum'
'Right Bed nuclei of the stria terminalis'
'Right Bed nucleus of the anterior commissure'
'Right Ventral anterior-lateral complex of the thalamus'
'Right Ventral medial nucleus of the thalamus'
'Right Ventral posterolateral nucleus of the thalamus'
'Right Ventral posterolateral nucleus of the thalamus, parvicellular part'
'Right Ventral posteromedial nucleus of the thalamus'
'Right Ventral posteromedial nucleus of the thalamus, parvicellular part'
'Right Posterior triangular thalamic nucleus'
'Right Subparafascicular nucleus, magnocellular part'
'Right Subparafascicular nucleus, parvicellular part'
'Right Subparafascicular area' 'Right Peripeduncular nucleus'
'Right Medial geniculate complex'
'Right Dorsal part of the lateral geniculate complex'
'Right Lateral posterior nucleus of the thalamus'
'Right Posterior complex of the thalamus'
'Right Posterior limiting nucleus of the thalamus'
'Right Suprageniculate nucleus' 'Right Anteroventral nucleus of thalamus'
'Right Anteromedial nucleus' 'Right Anterodorsal nucleus'
'Right Interanteromedial nucleus of the thalamus'
'Right Interanterodorsal nucleus of the thalamus'
'Right Lateral dorsal nucleus of thalamus'
'Right Intermediodorsal nucleus of the thalamus'
'Right Mediodorsal nucleus of thalamus'
'Right Submedial nucleus of the thalamus' 'Right Perireunensis nucleus'
'Right Paraventricular nucleus of the thalamus'
'Right Parataenial nucleus' 'Right Nucleus of reuniens'
'Right Xiphoid thalamic nucleus' 'Right Rhomboid nucleus'
'Right Central medial nucleus of the thalamus'
'Right Paracentral nucleus'
'Right Central lateral nucleus of the thalamus'
'Right Parafascicular nucleus'
'Right Posterior intralaminar thalamic nucleus'
'Right Reticular nucleus of the thalamus'
'Right Intergeniculate leaflet of the lateral geniculate complex'
'Right Intermediate geniculate nucleus'
'Right Ventral part of the lateral geniculate complex'
'Right Medial habenula' 'Right Lateral habenula'
'Right Accessory supraoptic group'
'Right Paraventricular hypothalamic nucleus'
'Right Periventricular hypothalamic nucleus, anterior part'
'Right Periventricular hypothalamic nucleus, intermediate part'
'Right Arcuate hypothalamic nucleus'
'Right Anterodorsal preoptic nucleus'
'Right Anteroventral preoptic nucleus'
'Right Anteroventral periventricular nucleus'
'Right Dorsomedial nucleus of the hypothalamus'
'Right Median preoptic nucleus' 'Right Medial preoptic area'
'Right Vascular organ of the lamina terminalis'
'Right Posterodorsal preoptic nucleus' 'Right Parastrial nucleus'
'Right Periventricular hypothalamic nucleus, posterior part'
'Right Periventricular hypothalamic nucleus, preoptic part'
'Right Subparaventricular zone' 'Right Suprachiasmatic nucleus'
'Right Ventromedial preoptic nucleus'
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'Right Ventrolateral preoptic nucleus'
'Right Anterior hypothalamic nucleus' 'Right Lateral mammillary nucleus'
'Right Medial mammillary nucleus' 'Right Supramammillary nucleus'
'Right Tuberomammillary nucleus, dorsal part'
'Right Tuberomammillary nucleus, ventral part'
'Right Medial preoptic nucleus' 'Right Dorsal premammillary nucleus'
'Right Ventral premammillary nucleus'
'Right Paraventricular hypothalamic nucleus, descending division'
'Right Ventromedial hypothalamic nucleus'
'Right Posterior hypothalamic nucleus' 'Right Lateral hypothalamic area'
'Right Lateral preoptic area' 'Right Preparasubthalamic nucleus'
'Right Parasubthalamic nucleus' 'Right Perifornical nucleus'
'Right Retrochiasmatic area' 'Right Subthalamic nucleus'
'Right Tuberal nucleus' 'Right Zona incerta'
'Right Superior colliculus, sensory related' 'Right Inferior colliculus'
'Right Nucleus of the brachium of the inferior colliculus'
'Right Nucleus sagulum' 'Right Parabigeminal nucleus'
'Right Midbrain trigeminal nucleus' 'Right Subcommissural organ'
'Right Substantia nigra, reticular part' 'Right Ventral tegmental area'
'Right Paranigral nucleus'
'Right Midbrain reticular nucleus, retrorubral area'
'Right Midbrain reticular nucleus'
'Right Superior colliculus, motor related' 'Right Periaqueductal gray'
'Right Anterior pretectal nucleus' 'Right Medial pretectal area'
'Right Nucleus of the optic tract'
'Right Nucleus of the posterior commissure'
'Right Olivary pretectal nucleus' 'Right Posterior pretectal nucleus'
'Right Cuneiform nucleus' 'Right Red nucleus' 'Right Oculomotor nucleus'
'Right Medial accesory oculomotor nucleus'
'Right Edinger-Westphal nucleus' 'Right Trochlear nucleus'
'Right Paratrochlear nucleus' 'Right Ventral tegmental nucleus'
'Right Anterior tegmental nucleus'
'Right Lateral terminal nucleus of the accessory optic tract'
'Right Dorsal terminal nucleus of the accessory optic tract'
'Right Medial terminal nucleus of the accessory optic tract'
'Right Substantia nigra, compact part' 'Right Pedunculopontine nucleus'
'Right Interfascicular nucleus raphe' 'Right Interpeduncular nucleus'
'Right Rostral linear nucleus raphe' 'Right Central linear nucleus raphe'
'Right Dorsal nucleus raphe' 'Right Nucleus of the lateral lemniscus'
'Right Principal sensory nucleus of the trigeminal'
'Right Parabrachial nucleus' "Right Barrington's nucleus"
'Right Dorsal tegmental nucleus' 'Right Posterodorsal tegmental nucleus'
'Right Pontine central gray' 'Right Pontine gray'
'Right Pontine reticular nucleus, caudal part'
'Right Supratrigeminal nucleus' 'Right Tegmental reticular nucleus'
'Right Motor nucleus of trigeminal' 'Right Peritrigeminal zone'
'Right Intertrigeminal nucleus' 'Right Superior central nucleus raphe'
'Right Locus ceruleus' 'Right Laterodorsal tegmental nucleus'
'Right Nucleus incertus' 'Right Pontine reticular nucleus'
'Right Nucleus raphe pontis' 'Right Subceruleus nucleus'
'Right Sublaterodorsal nucleus' 'Right Dorsal cochlear nucleus'
'Right Ventral cochlear nucleus' 'Right Cuneate nucleus'
'Right Gracile nucleus' 'Right Nucleus of the trapezoid body'
'Right Nucleus of the solitary tract'
'Right Spinal nucleus of the trigeminal, caudal part'
'Right Spinal nucleus of the trigeminal, interpolar part'
'Right Spinal nucleus of the trigeminal, oral part'
'Right Paratrigeminal nucleus' 'Right Abducens nucleus'
'Right Facial motor nucleus' 'Right Nucleus ambiguus'
'Right Dorsal motor nucleus of the vagus nerve'
'Right Gigantocellular reticular nucleus'
```

```
'Right Inferior olivary complex' 'Right Intermediate reticular nucleus'
'Right Inferior salivatory nucleus' 'Right Linear nucleus of the medulla'
'Right Lateral reticular nucleus' 'Right Magnocellular reticular nucleus'
'Right Medullary reticular nucleus'
'Right Medullary reticular nucleus, dorsal part'
'Right Medullary reticular nucleus, ventral part'
'Right Parvicellular reticular nucleus'
'Right Paragigantocellular reticular nucleus, dorsal part'
'Right Paragigantocellular reticular nucleus, lateral part'
'Right Nucleus of Roller' 'Right Nucleus prepositus'
'Right Parapyramidal nucleus' 'Right Lateral vestibular nucleus'
'Right Medial vestibular nucleus' 'Right Spinal vestibular nucleus'
'Right Superior vestibular nucleus' 'Right Nucleus x'
'Right Hypoglossal nucleus' 'Right Nucleus y'
'Right Nucleus raphe magnus' 'Right Nucleus raphe obscurus'
'Right Lingula (I)' 'Right Central lobule' 'Right Culmen'
'Right Declive (VI)' 'Right Folium-tuber vermis (VII)'
'Right Pyramus (VIII)' 'Right Uvula (IX)' 'Right Nodulus (X)'
'Right Simple lobule' 'Right Ansiform lobule' 'Right Paramedian lobule'
'Right Copula pyramidis' 'Right Paraflocculus' 'Right Flocculus'
'Right Fastigial nucleus' 'Right Interposed nucleus'
'Right Dentate nucleus' 'Right Vestibulocerebellar nucleus'
'Left Frontal pole, cerebral cortex' 'Left Primary motor area'
'Left Secondary motor area' 'Left Primary somatosensory area, nose'
'Left Primary somatosensory area, barrel field'
'Left Primary somatosensory area, lower limb'
'Left Primary somatosensory area, mouth'
'Left Primary somatosensory area, upper limb'
'Left Primary somatosensory area, trunk'
'Left Primary somatosensory area, unassigned'
'Left Supplemental somatosensory area' 'Left Gustatory areas'
'Left Visceral area' 'Left Dorsal auditory area'
'Left Primary auditory area' 'Left Posterior auditory area'
'Left Ventral auditory area' 'Left Anterolateral visual area'
'Left Anteromedial visual area' 'Left Lateral visual area'
'Left Primary visual area' 'Left Posterolateral visual area'
'Left posteromedial visual area' 'Left Laterointermediate area'
'Left Postrhinal area' 'Left Anterior cingulate area, dorsal part'
'Left Anterior cingulate area, ventral part' 'Left Prelimbic area'
'Left Infralimbic area' 'Left Orbital area, lateral part'
'Left Orbital area, medial part' 'Left Orbital area, ventrolateral part'
'Left Agranular insular area, dorsal part'
'Left Agranular insular area, posterior part'
'Left Agranular insular area, ventral part'
'Left Retrosplenial area, lateral agranular part'
'Left Retrosplenial area, dorsal part'
'Left Retrosplenial area, ventral part' 'Left Anterior area'
'Left Rostrolateral visual area' 'Left Temporal association areas'
'Left Perirhinal area' 'Left Ectorhinal area' 'Left Main olfactory bulb'
'Left Accessory olfactory bulb' 'Left Anterior olfactory nucleus'
'Left Taenia tecta' 'Left Dorsal peduncular area' 'Left Piriform area'
'Left Nucleus of the lateral olfactory tract'
'Left Cortical amygdalar area, anterior part'
'Left Cortical amygdalar area, posterior part'
'Left Piriform-amygdalar area' 'Left Postpiriform transition area'
'Left Field CA1' 'Left Field CA2' 'Left Field CA3' 'Left Dentate gyrus'
'Left Induseum griseum' 'Left Entorhinal area, lateral part'
'Left Entorhinal area, medial part, dorsal zone' 'Left Parasubiculum'
'Left Postsubiculum' 'Left Presubiculum' 'Left Subiculum'
'Left Prosubiculum' 'Left Area prostriata' 'Left Claustrum'
'Left Endopiriform nucleus, dorsal part'
```

```
'Left Endopiriform nucleus, ventral part'
'Left Lateral amygdalar nucleus' 'Left Basolateral amygdalar nucleus'
'Left Basomedial amygdalar nucleus' 'Left Posterior amygdalar nucleus'
'Left Caudoputamen' 'Left Nucleus accumbens' 'Left Fundus of striatum'
'Left Olfactory tubercle'
'Left Lateral septal nucleus, caudal (caudodorsal) part'
'Left Lateral septal nucleus, rostral (rostroventral) part'
'Left Lateral septal nucleus, ventral part' 'Left Septofimbrial nucleus'
'Left Anterior amygdalar area'
'Left Bed nucleus of the accessory olfactory tract'
'Left Central amygdalar nucleus' 'Left Intercalated amygdalar nucleus'
'Left Medial amygdalar nucleus' 'Left Globus pallidus, external segment'
'Left Globus pallidus, internal segment' 'Left Substantia innominata'
'Left Magnocellular nucleus' 'Left Medial septal nucleus'
'Left Diagonal band nucleus' 'Left Triangular nucleus of septum'
'Left Bed nuclei of the stria terminalis'
'Left Bed nucleus of the anterior commissure'
'Left Ventral anterior-lateral complex of the thalamus'
'Left Ventral medial nucleus of the thalamus'
'Left Ventral posterolateral nucleus of the thalamus'
'Left Ventral posterolateral nucleus of the thalamus, parvicellular part'
'Left Ventral posteromedial nucleus of the thalamus'
'Left Ventral posteromedial nucleus of the thalamus, parvicellular part'
'Left Posterior triangular thalamic nucleus'
'Left Subparafascicular nucleus, magnocellular part'
'Left Subparafascicular nucleus, parvicellular part'
'Left Subparafascicular area' 'Left Peripeduncular nucleus'
'Left Medial geniculate complex'
'Left Dorsal part of the lateral geniculate complex'
'Left Lateral posterior nucleus of the thalamus'
'Left Posterior complex of the thalamus'
'Left Posterior limiting nucleus of the thalamus'
'Left Suprageniculate nucleus' 'Left Anteroventral nucleus of thalamus'
'Left Anteromedial nucleus' 'Left Anterodorsal nucleus'
'Left Interanteromedial nucleus of the thalamus'
'Left Interanterodorsal nucleus of the thalamus'
'Left Lateral dorsal nucleus of thalamus'
'Left Intermediodorsal nucleus of the thalamus'
'Left Mediodorsal nucleus of thalamus'
'Left Submedial nucleus of the thalamus' 'Left Perireunensis nucleus'
'Left Paraventricular nucleus of the thalamus' 'Left Parataenial nucleus'
'Left Nucleus of reuniens' 'Left Xiphoid thalamic nucleus'
'Left Rhomboid nucleus' 'Left Central medial nucleus of the thalamus'
'Left Paracentral nucleus' 'Left Central lateral nucleus of the thalamus'
'Left Parafascicular nucleus'
'Left Posterior intralaminar thalamic nucleus'
'Left Reticular nucleus of the thalamus'
'Left Intergeniculate leaflet of the lateral geniculate complex'
'Left Intermediate geniculate nucleus'
'Left Ventral part of the lateral geniculate complex'
'Left Medial habenula' 'Left Lateral habenula'
'Left Accessory supraoptic group'
'Left Paraventricular hypothalamic nucleus'
'Left Periventricular hypothalamic nucleus, anterior part'
'Left Periventricular hypothalamic nucleus, intermediate part'
'Left Arcuate hypothalamic nucleus' 'Left Anterodorsal preoptic nucleus'
'Left Anteroventral preoptic nucleus'
'Left Anteroventral periventricular nucleus'
'Left Dorsomedial nucleus of the hypothalamus'
'Left Median preoptic nucleus' 'Left Medial preoptic area'
'Left Vascular organ of the lamina terminalis'
```

```
'Left Posterodorsal preoptic nucleus' 'Left Parastrial nucleus'
'Left Periventricular hypothalamic nucleus, posterior part'
'Left Periventricular hypothalamic nucleus, preoptic part'
'Left Subparaventricular zone' 'Left Suprachiasmatic nucleus'
'Left Ventromedial preoptic nucleus'
'Left Ventrolateral preoptic nucleus'
'Left Anterior hypothalamic nucleus' 'Left Lateral mammillary nucleus'
'Left Medial mammillary nucleus' 'Left Supramammillary nucleus'
'Left Tuberomammillary nucleus, dorsal part'
'Left Tuberomammillary nucleus, ventral part'
'Left Medial preoptic nucleus' 'Left Dorsal premammillary nucleus'
'Left Ventral premammillary nucleus'
'Left Paraventricular hypothalamic nucleus, descending division'
'Left Ventromedial hypothalamic nucleus'
'Left Posterior hypothalamic nucleus' 'Left Lateral hypothalamic area'
'Left Lateral preoptic area' 'Left Preparasubthalamic nucleus'
'Left Parasubthalamic nucleus' 'Left Perifornical nucleus'
'Left Retrochiasmatic area' 'Left Subthalamic nucleus'
'Left Tuberal nucleus' 'Left Zona incerta'
'Left Superior colliculus, sensory related' 'Left Inferior colliculus'
'Left Nucleus of the brachium of the inferior colliculus'
'Left Nucleus sagulum' 'Left Parabigeminal nucleus'
'Left Midbrain trigeminal nucleus' 'Left Subcommissural organ'
'Left Substantia nigra, reticular part' 'Left Ventral tegmental area'
'Left Paranigral nucleus'
'Left Midbrain reticular nucleus, retrorubral area'
'Left Midbrain reticular nucleus'
'Left Superior colliculus, motor related' 'Left Periaqueductal gray'
'Left Anterior pretectal nucleus' 'Left Medial pretectal area'
'Left Nucleus of the optic tract'
'Left Nucleus of the posterior commissure'
'Left Olivary pretectal nucleus' 'Left Posterior pretectal nucleus'
'Left Cuneiform nucleus' 'Left Red nucleus' 'Left Oculomotor nucleus'
'Left Medial accesory oculomotor nucleus' 'Left Edinger-Westphal nucleus'
'Left Trochlear nucleus' 'Left Paratrochlear nucleus'
'Left Ventral tegmental nucleus' 'Left Anterior tegmental nucleus'
'Left Lateral terminal nucleus of the accessory optic tract'
'Left Dorsal terminal nucleus of the accessory optic tract'
'Left Medial terminal nucleus of the accessory optic tract'
'Left Substantia nigra, compact part' 'Left Pedunculopontine nucleus'
'Left Interfascicular nucleus raphe' 'Left Interpeduncular nucleus'
'Left Rostral linear nucleus raphe' 'Left Central linear nucleus raphe'
'Left Dorsal nucleus raphe' 'Left Nucleus of the lateral lemniscus'
'Left Principal sensory nucleus of the trigeminal'
'Left Parabrachial nucleus' "Left Barrington's nucleus"
'Left Dorsal tegmental nucleus' 'Left Posterodorsal tegmental nucleus'
'Left Pontine central gray' 'Left Pontine gray'
'Left Pontine reticular nucleus, caudal part'
'Left Supratrigeminal nucleus' 'Left Tegmental reticular nucleus'
'Left Motor nucleus of trigeminal' 'Left Peritrigeminal zone'
'Left Intertrigeminal nucleus' 'Left Superior central nucleus raphe'
'Left Locus ceruleus' 'Left Laterodorsal tegmental nucleus'
'Left Nucleus incertus' 'Left Pontine reticular nucleus'
'Left Nucleus raphe pontis' 'Left Subceruleus nucleus'
'Left Sublaterodorsal nucleus' 'Left Dorsal cochlear nucleus'
'Left Ventral cochlear nucleus' 'Left Cuneate nucleus'
'Left Gracile nucleus' 'Left Nucleus of the trapezoid body'
'Left Nucleus of the solitary tract'
'Left Spinal nucleus of the trigeminal, caudal part'
'Left Spinal nucleus of the trigeminal, interpolar part'
'Left Spinal nucleus of the trigeminal, oral part'
```

```
 'Left Paratrigeminal nucleus' 'Left Abducens nucleus'
 'Left Facial motor nucleus' 'Left Nucleus ambiguus'
 'Left Dorsal motor nucleus of the vagus nerve'
 'Left Gigantocellular reticular nucleus' 'Left Inferior olivary complex'
 'Left Intermediate reticular nucleus' 'Left Inferior salivatory nucleus'
 'Left Linear nucleus of the medulla' 'Left Lateral reticular nucleus'
 'Left Magnocellular reticular nucleus' 'Left Medullary reticular nucleus'
 'Left Medullary reticular nucleus, dorsal part'
 'Left Medullary reticular nucleus, ventral part'
 'Left Parvicellular reticular nucleus'
 'Left Paragigantocellular reticular nucleus, dorsal part'
 'Left Paragigantocellular reticular nucleus, lateral part'
 'Left Nucleus of Roller' 'Left Nucleus prepositus'
 'Left Parapyramidal nucleus' 'Left Lateral vestibular nucleus'
 'Left Medial vestibular nucleus' 'Left Spinal vestibular nucleus'
 'Left Superior vestibular nucleus' 'Left Nucleus x'
 'Left Hypoglossal nucleus' 'Left Nucleus y' 'Left Nucleus raphe magnus'
 'Left Nucleus raphe obscurus' 'Left Lingula (I)' 'Left Central lobule'
 'Left Culmen' 'Left Declive (VI)' 'Left Folium-tuber vermis (VII)'
 'Left Pyramus (VIII)' 'Left Uvula (IX)' 'Left Nodulus (X)'
 'Left Simple lobule' 'Left Ansiform lobule' 'Left Paramedian lobule'
 'Left Copula pyramidis' 'Left Paraflocculus' 'Left Flocculus'
 'Left Fastigial nucleus' 'Left Interposed nucleus' 'Left Dentate nucleus'
 'Left Vestibulocerebellar nucleus']

weights:
 [[0.00000000e+00 3.63441680e-02 8.47970561e-02 ... 8.07329172e-07
  8.07329172e-07 1.02162597e-04]
 [3.32728901e-02 0.00000000e+00 5.49682272e-02 ... 2.73112949e-05
  2.85348052e-05 2.77993498e-05]
 [9.89313689e-02 6.43270451e-02 0.00000000e+00 ... 3.36029153e-05
  3.54584335e-05 9.15227954e-06]
 ...
 [1.36803986e-06 6.32084139e-05 2.99611362e-05 ... 0.00000000e+00
  1.00408312e-01 1.37087573e-02]
 [1.95515882e-07 5.04100941e-05 4.17897432e-05 ... 5.17439950e-02
  0.00000000e+00 2.65998675e-03]
 [2.71852623e-05 4.45484959e-04 2.03744779e-04 ... 3.86534058e-02
  3.67525396e-02 0.00000000e+00]]
```

Summarize the major structures, except for the cerebellum

In [3]:

```
# Open the xls file and create a mapping between all regions and the major s

#pip install xlrd
try:
    import xlrd
except:
    import sys
    !{sys.executable} -m pip install xlrd
    import xlrd

sheet_data = []
wb = xlrd.open_workbook(os.path.join(data_path, 'oh_table1.xls'))
p = wb.sheet_names()
#p[1]
#for y in p:
sh = wb.sheet_by_name(p[1])
```

```
print(sh)
for rownum in range(sh.nrows):
    sheet_data.append((sh.row_values(rownum)))

found_list = []
voxel_count = []
rows_to_be_saved = []
regions_missing = []
cc=0

for j in result_connectivity.region_labels: #go over the region labels
    j=j.split(" ",1)[1]
    #let us get rid of the left or right
    a=len(found_list)
    for i in sheet_data:
        if i[3] == j: #or i[2] == "string2" or i[2] == "string3" or i[2] ==
            found_list.append(i[4])
            if i[5]:
                voxel_count.append(int(i[5]))
            else:
                voxel_count.append(-1)
        else:
            rows_to_be_saved.append(i)

    b=len(found_list)
    if a == b:
        regions_missing.append(j)
        found_list.append('X')
        voxel_count.append(-1)
        print(a,b)

    b=len(found_list)
    cc+=1
    if b != cc:
        print(b,cc)
print("Regions missing:\n%s" % str(regions_missing))
n_regs = len(found_list)
print("Number of regions: %d" % n_regs)
n_regs2 = n_regs/2
major_structures_labels = ["Right " + msl if iL <n_regs2 else "Left " + msl
                           for iL, msl in enumerate(found_list)]
voxel_count = np.array(voxel_count).astype('i')
major_structures = np.unique(major_structures_labels)
print("\nmajor_structures:\n", major_structures)
```

```
Collecting xlrd
  Downloading xlrd-2.0.1-py2.py3-none-any.whl (96 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 96.5/96.5 kB 3.8 MB/s eta 0:0
0:00
Installing collected packages: xlrd
Successfully installed xlrd-2.0.1
WARNING: There was an error checking the latest version of pip.
Sheet  1:<Voxel Count_295 Structures>
Regions missing:
[]
Number of regions: 596

major_structures:
 ['Left Cerebellar Cortex' 'Left Cerebellar Nuclei'
 'Left Cortical Subplate' 'Left Hippocampal Formation' 'Left Hypothalamus'
 'Left Isocortex' 'Left Medulla' 'Left Midbrain'
 'Left Nonspecific Thalamus' 'Left Olfactory Areas' 'Left Pallidum'
 'Left Pons Behavioral' 'Left Pons Motor' 'Left Pons Sensory'
 'Left Spinal nucleus of the trigeminal' 'Left Striatum' 'Left Thalamus'
 'Right Cerebellar Cortex' 'Right Cerebellar Nuclei'
 'Right Cortical Subplate' 'Right Hippocampal Formation'
 'Right Hypothalamus' 'Right Isocortex' 'Right Medulla' 'Right Midbrain'
 'Right Nonspecific Thalamus' 'Right Olfactory Areas' 'Right Pallidum'
 'Right Pons Behavioral' 'Right Pons Motor' 'Right Pons Sensory'
 'Right Spinal nucleus of the trigeminal' 'Right Striatum'
 'Right Thalamus']
```

Find the connections FROM Isocortex nodes TO the Reticular Thalamic Nucleus and store them:

In [4]:
```
crtx_inds = np.where(["Isocortex" in lbl for lbl in major_structures_labels]
rtn_inds = np.where(["Reticular nucleus of the thalamus" in reg for reg in r

crtx_to_rtn_conns = result_connectivity.weights[rtn_inds][:, crtx_inds]
print("crtx_to_rtn_conns.shape: ", crtx_to_rtn_conns.shape)
# print("\ncrtx_to_rtn_conns:\n","crtx_to_rtn_conns)
```

```
crtx_to_rtn_conns.shape:  (2, 86)
```

Some functions to use for merging regions to larger structures

In [5]:
```
from copy import deepcopy


def voxel_count_sum(arr, axis=0, **kwargs):
    voxel_count_sum = np.sum(arr[arr>0], axis=axis)
    print("Voxel count sum: %s" % str(voxel_count_sum))
    return voxel_count_sum


def weighted_average(arr, axis=0, **kwargs):
    weights = kwargs.pop('weights', 1.0)
    if weights.ndim < arr.ndim:
```

```
        weights = np.expand_dims(weights, 1-axis)
    assert np.nansum(weights) > 0.0
    wav = np.nansum(arr * weights, axis=axis, **kwargs) / np.nansum(weights,
    return wav


def repeat(arr, sub, axis=0, **kwargs):
    """This function will tile a subarray
       to create an array of shape similar to the input array's arr,
       except for the axis given in the input, where size will be 1.
       It is used to substitute many labels by a single one."""
    shape = list(arr.shape)
    shape[axis] = 1
    return np.tile(sub, tuple(shape))


def delete(arr, axis=0, **kwargs):
    """This function returns an empty array
       of shape similar to the input array's arr,
       except for the axis given in the input, where size will be 0.
       It is used to delete a subarray."""
    shape = list(arr.shape)
    shape[axis] = 0
    return np.empty(tuple(shape))


def insert_axis(arr, arr_to_insert=None, inds=None, axis=0, def_value=0.0):
    if inds is None:
        inds = [arr.shape[axis]]
    if arr_to_insert is None:
        arr_to_insert = np.tile(def_value, np.take(arr, [-1], axis=axis).sha
    return np.insert(arr, inds, arr_to_insert, axis=axis)


def merge_axis(inds, arr, axis=0, fun=np.nansum, **funkwargs):
    """This function will merge a subarray of the input array arr,
       as defined by the input indices inds, along the input axis,
       applying the function fun, in order to summarize the values."""
    new_arr = np.delete(arr, inds, axis)
    array_to_be_merged = np.take(arr, inds, axis)
    if funkwargs.get('weights', None) is not None:
        # we need to reduce weights just like arr
        funkwargs['weights'] = np.take(funkwargs['weights'], inds, axis=axis
    merged_arr = fun(array_to_be_merged, axis, keepdims=True, **funkwargs)
    return insert_axis(new_arr, merged_arr, [np.minimum(inds[0], new_arr.sha
    # return np.insert(new_arr, [np.minimum(inds[0], new_arr.shape[axis])],


def merge_nD(inds, arr, fun=np.nansum, weights=None, **funkwargs):
    """This function will merge a subarray of the input array arr,
       as defined by the input indices inds,
       along all the axes of arr (assuming same dimensionality along all axe
       applying the function fun, in order to summarize the values."""
    new_arr = arr.copy()
    for ax in range(arr.ndim):
        if weights is not None:
            new_arr = merge_axis(inds, new_arr, axis=ax, fun=fun, weights=we
            # we need to reduce weights just like arr
            weights = merge_axis(inds, weights, axis=ax, fun=np.nansum)
        else:
            new_arr = merge_axis(inds, new_arr, axis=ax, fun=fun, **funkwarg
```

```
    return new_arr


def euclidean_distance(p1, p2, mask=None, axis=1):
    return np.sqrt(np.sum(np.square(p1 - p2),  axis=axis))


def compute_euclidean_tract_lengths(centres, weights):
    N = centres.shape[0]
    tl = np.zeros((N, N))
    for iR1 in range(N-1):
        for iR2 in range(iR1+1, N):
            if weights[iR1, iR2] > 0.0:
                tl[iR1, iR2] = euclidean_distance(centres[iR1][np.newaxis],
            else:
                tl[iR1, iR2] = 0.0
            tl[iR2, iR1] = tl[iR1, iR2]
    return tl


def merge_conn(conn, regions, new_label, voxel_count,
               weight_fun=np.nansum, configure=False):
    """This function will merge an input TVB connectivity conn,
       for the input regions (indices or labels),
       substituting them with a summarized region of label new_label,
       applying the summary function for the connectivity weights weight_fun
       If configure is True, the new connectivity will also be configured."""
    if np.issubdtype(regions.dtype, np.integer):
        inds = regions
    else:
        inds = []
        for iR, region in conn.region_labels:
            if region in regions:
                inds.append(iR)
    new_conn = deepcopy(conn)
    repeat_fun = lambda arr, axis=0, **kwargs: repeat(arr, new_label, axis,
    new_conn.region_labels = merge_axis(inds, conn.region_labels, axis=0, fu
    new_conn.weights = merge_nD(inds, conn.weights, fun=weight_fun)
    if FORCE_MERGED_ZERO_DIAGONAL:
        np.fill_diagonal(new_conn.weights, 0.0)
    # If WEIGHTED_AVERAGE_CENTRES...
    if WEIGHTED_AVERAGE_CENTRES:
        # ...compute merged regions' centres as weighted averages of the com
        # weighted by the relative volume (i.e., voxel count) of each region
        new_conn.centres = merge_axis(inds, conn.centres, axis=0, fun=weight
    else: # ...otherwise...
        # ...approximate merged regions' centres as simple averages of the c
        new_conn.centres = merge_axis(inds, conn.centres, axis=0, fun=np.nan
    if TRACT_LENGTHS_MODE == "euclidean":
        # Compute tract lengths as euclidean distances from the newly formed
        new_conn.tract_lengths = compute_euclidean_tract_lengths(new_conn.ce
    else:
        # Compute tract lengths as weighted averages of the tract lengths
        # of all connections referring to/from a merged region,
        # weighted by corresponding tracts' weights:
        new_conn.tract_lengths = merge_nD(inds, conn.tract_lengths, fun=weig
    if FORCE_MERGED_ZERO_DIAGONAL:
        np.fill_diagonal(new_conn.tract_lengths, 0.0)
    new_conn.tract_lengths[new_conn.weights == 0.0] = 0.0
    if configure:
        new_conn.configure()
```

```
    return new_conn


def merge_major_structure(conn, major_struct_to_merge, major_structs_labels,
                          exclude_regions=[], weight_fun=np.nansum, configur
    """This function will merge an input TVB connectivity conn,
       for the input major structure label major_struct_to_merge,
       assuming an input vector major_structs_labels, mapping all regions to
       substituting merged regions with a summarized region of the major str
       and applying the summary function for the connectivity weights weight
       If configure is True, the new connectivity will also be configured."""
    regions_inds = np.where([major_structs_label == major_struct_to_merge an
                             region not in exclude_regions
                             for region, major_structs_label in zip(conn.reg
    print("...%d regions' indices of %s:\n%s" % (len(regions_inds), major_st
    repeat_fun = lambda arr, axis=0, **kwargs: repeat(arr, major_struct_to_m
    return merge_conn(conn, regions_inds, major_struct_to_merge, voxel_count
                      weight_fun=weight_fun, configure=configure), \
           merge_axis(regions_inds, major_structs_labels, axis=0, fun=repeat
           merge_axis(regions_inds, voxel_count, axis=0, fun=voxel_count_sum


def merge_major_structures(conn, major_structs_to_merge, major_structs_label
                           exclude_regions={}, weight_fun=np.nansum):
    """This function will merge an input TVB connectivity conn,
       for the input major structures labels major_structs_to_merge,
       assuming an input vector major_structs_labels, mapping all regions to
       substituting merged regions with a summarized region of the respectiv
       and applying the summary function for the connectivity weights weight
       If configure is True, the new connectivity will also be configured."""
    new_conn = deepcopy(conn)
    new_major_structs_labels = major_structs_labels.copy()
    new_voxel_count = voxel_count.copy()
    for major_struct_to_merge in major_structs_to_merge:
        print("Merging %s ..." % major_struct_to_merge)
        new_conn, new_major_structs_labels, new_voxel_count = \
            merge_major_structure(new_conn, major_struct_to_merge,
                                  new_major_structs_labels, new_voxel_count,
                                  exclude_regions=exclude_regions.get(major_
                                  weight_fun=weight_fun)

    new_conn.configure()
    return new_conn, new_major_structs_labels, new_voxel_count
```

In [6]:

```
def unilateral_to_bilateral_exclude_regions(major_structure, hemi, exclude_r
    new_exclude_regions = []
    if len(exclude_regions):
        if hemi == "Left":
            hemistr = "Left "
            hemidel = "Right "
        else:
            hemistr = "Right "
            hemidel = "Left "
        for reg in exclude_regions:
            if hemistr in reg:
                new_exclude_regions.append(reg)
            elif hemidel in reg:
                pass
            else:
                new_exclude_regions.append(hemistr + reg)
    return new_exclude_regions
```

```
def unilateral_to_bilateral(major_structures_to_merge, exclude_regions):
    # For bilateral merge:
    new_major_structures_to_merge = []
    new_exclude_regions = {}
    for mstm in major_structures_to_merge:
        if "Left " not in mstm and "Right " not in mstm:
            left = "Left " + mstm
            new_major_structures_to_merge.append("Left " + mstm)
            new_major_structures_to_merge.append("Right " + mstm)
        else:
            new_major_structures_to_merge.append(mstm)
    new_major_structures_to_merge = np.unique(new_major_structures_to_merge)
    for hemimstm in new_major_structures_to_merge:
        if "Left " in hemimstm:
            hemi = "Left"
            mstm = hemimstm.split("Left ")[-1]
        else:
            hemi = "Right"
            mstm = hemimstm.split("Right ")[-1]
        new_exclude_regions[hemimstm] = \
            exclude_regions.get(hemimstm,
                                unilateral_to_bilateral_exclude_regions(mstm
    return new_major_structures_to_merge, new_exclude_regions
```

Determine regions and structures to be merged, uni- and/or bi-laterally

In [7]:

```
# Summarize all subcortical major structures except for the Cerebellar Corti
# for _SummedSubcortical connectomes.
# Specific Thalami have to be merged and then distributed to the Isocortex r
major_structures_to_merge = ['Thalamus',
                             'Cortical Subplate', 'Hippocampal Formation',
                             'Medulla','Spinal nucleus of the trigeminal',
                             'Midbrain', 'Olfactory Areas', 'Pallidum',
                             'Pons Motor', 'Pons Sensory', 'Pons Behavioral'
                             'Striatum', 'Cerebellar Cortex', 'Cerebellar Nu
                            ]

exclude_regions = {'Cerebellar Cortex': ["Ansiform lobule"],
                   #  !!! Final decision to merge all Cerebellar Nuclei toge
                   # 'Cerebellar Nuclei': ["Interposed nucleus"]
                   'Medulla': ["Inferior olivary complex", "Facial motor nuc
                   'Pons Sensory': ["Principal sensory nucleus of the trigem
                   'Midbrain': ["Superior colliculus, motor related"]}

# For bilateral merging:
major_structures_to_merge, exclude_regions = unilateral_to_bilateral(major_s

print('major_structures_to_merge:\n', major_structures_to_merge)
print('\nexclude_regions from mergin:\n', exclude_regions)
```

```
major_structures_to_merge:
 ['Left Cerebellar Cortex' 'Left Cerebellar Nuclei'
 'Left Cortical Subplate' 'Left Hippocampal Formation' 'Left Hypothalamus'
 'Left Medulla' 'Left Midbrain' 'Left Nonspecific Thalamus'
 'Left Olfactory Areas' 'Left Pallidum' 'Left Pons Behavioral'
 'Left Pons Motor' 'Left Pons Sensory'
 'Left Spinal nucleus of the trigeminal' 'Left Striatum' 'Left Thalamus'
 'Right Cerebellar Cortex' 'Right Cerebellar Nuclei'
 'Right Cortical Subplate' 'Right Hippocampal Formation'
 'Right Hypothalamus' 'Right Medulla' 'Right Midbrain'
 'Right Nonspecific Thalamus' 'Right Olfactory Areas' 'Right Pallidum'
 'Right Pons Behavioral' 'Right Pons Motor' 'Right Pons Sensory'
 'Right Spinal nucleus of the trigeminal' 'Right Striatum'
 'Right Thalamus']

exclude_regions from mergin:
 {'Left Cerebellar Cortex': ['Left Ansiform lobule'], 'Left Cerebellar Nucl
ei': [], 'Left Cortical Subplate': [], 'Left Hippocampal Formation': [], 'L
eft Hypothalamus': [], 'Left Medulla': ['Left Inferior olivary complex', 'L
eft Facial motor nucleus'], 'Left Midbrain': ['Left Superior colliculus, mo
tor related'], 'Left Nonspecific Thalamus': [], 'Left Olfactory Areas': [],
'Left Pallidum': [], 'Left Pons Behavioral': [], 'Left Pons Motor': [], 'Le
ft Pons Sensory': ['Left Principal sensory nucleus of the trigeminal'], 'Le
ft Spinal nucleus of the trigeminal': [], 'Left Striatum': [], 'Left Thalam
us': [], 'Right Cerebellar Cortex': ['Right Ansiform lobule'], 'Right Cereb
ellar Nuclei': [], 'Right Cortical Subplate': [], 'Right Hippocampal Format
ion': [], 'Right Hypothalamus': [], 'Right Medulla': ['Right Inferior oliva
ry complex', 'Right Facial motor nucleus'], 'Right Midbrain': ['Right Super
ior colliculus, motor related'], 'Right Nonspecific Thalamus': [], 'Right O
lfactory Areas': [], 'Right Pallidum': [], 'Right Pons Behavioral': [], 'Ri
ght Pons Motor': [], 'Right Pons Sensory': ['Right Principal sensory nucleu
s of the trigeminal'], 'Right Spinal nucleus of the trigeminal': [], 'Right
Striatum': [], 'Right Thalamus': []}
```

Execute merging

In [8]:
```
new_conn, new_major_structs_labels, new_voxel_count = \
    merge_major_structures(result_connectivity,
                           major_structures_to_merge,
                           major_structures_labels, voxel_count,
                           exclude_regions=exclude_regions, weight_fun=np.na
sum_conn_new = new_conn.weights
print("\nMerged major structures and their voxel counts:\n",
      np.array(list(zip(new_conn.region_labels, new_major_structs_labels, ne
```

```
Merging Left Cerebellar Cortex ...
...13 regions' indices of Left Cerebellar Cortex:
[578 579 580 581 582 583 584 585 586 588 589 590 591]
Voxel count sum: 33696
Merging Left Cerebellar Nuclei ...
...4 regions' indices of Left Cerebellar Nuclei:
[580 581 582 583]
Voxel count sum: 1116
Merging Left Cortical Subplate ...
...7 regions' indices of Left Cortical Subplate:
[365 366 367 368 369 370 371]
Voxel count sum: 6669
Merging Left Hippocampal Formation ...
...13 regions' indices of Left Hippocampal Formation:
[352 353 354 355 356 357 358 359 360 361 362 363 364]
Voxel count sum: 34819
Merging Left Hypothalamus ...
...41 regions' indices of Left Hypothalamus:
[419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436
 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454
 455 456 457 458 459]
Voxel count sum: 13871
Merging Left Medulla ...
...34 regions' indices of Left Medulla:
[481 482 483 484 485 486 490 491 493 494 495 497 498 499 500 501 502 503
 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519]
Voxel count sum: 17303
Merging Left Midbrain ...
...38 regions' indices of Left Midbrain:
[420 421 422 423 424 425 426 427 428 429 430 431 433 434 435 436 437 438
 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456
 457 458]
Voxel count sum: 19804
Merging Left Nonspecific Thalamus ...
...9 regions' indices of Left Nonspecific Thalamus:
[403 404 406 407 408 409 410 411 412]
Voxel count sum: 2324
Merging Left Olfactory Areas ...
...11 regions' indices of Left Olfactory Areas:
[341 342 343 344 345 346 347 348 349 350 351]
Voxel count sum: 41043
Merging Left Pallidum ...
...9 regions' indices of Left Pallidum:
[357 358 359 360 361 362 363 364 365]
Voxel count sum: 9308
Merging Left Pons Behavioral ...
...8 regions' indices of Left Pons Behavioral:
[410 411 412 413 414 415 416 417]
Voxel count sum: 3890
Merging Left Pons Motor ...
...11 regions' indices of Left Pons Motor:
[399 400 401 402 403 404 405 406 407 408 409]
Voxel count sum: 5971
Merging Left Pons Sensory ...
...2 regions' indices of Left Pons Sensory:
[396 398]
Voxel count sum: 1585
Merging Left Spinal nucleus of the trigeminal ...
...3 regions' indices of Left Spinal nucleus of the trigeminal:
[401 402 403]
Voxel count sum: 3107
```

```
Merging Left Striatum ...
...13 regions' indices of Left Striatum:
[344 345 346 347 348 349 350 351 352 353 354 355 356]
Voxel count sum: 40219
Merging Left Thalamus ...
...34 regions' indices of Left Thalamus:
[346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363
 364 365 366 367 368 369 370 371 372 374 375 376 377 378 379 380]
Voxel count sum: 13346
Merging Right Cerebellar Cortex ...
...13 regions' indices of Right Cerebellar Cortex:
[280 281 282 283 284 285 286 287 288 290 291 292 293]
Voxel count sum: 33696
Merging Right Cerebellar Nuclei ...
...4 regions' indices of Right Cerebellar Nuclei:
[282 283 284 285]
Voxel count sum: 1116
Merging Right Cortical Subplate ...
...7 regions' indices of Right Cortical Subplate:
[67 68 69 70 71 72 73]
/tmp/ipykernel_110/2251895505.py:15: RuntimeWarning: invalid value encounte
red in true_divide
  wav = np.nansum(arr * weights, axis=axis, **kwargs) / np.nansum(weights,
axis=axis, **kwargs)
```

```
Voxel count sum: 6669
Merging Right Hippocampal Formation ...
...13 regions' indices of Right Hippocampal Formation:
[54 55 56 57 58 59 60 61 62 63 64 65 66]
Voxel count sum: 34819
Merging Right Hypothalamus ...
...41 regions' indices of Right Hypothalamus:
[121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138
 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156
 157 158 159 160 161]
Voxel count sum: 13871
Merging Right Medulla ...
...34 regions' indices of Right Medulla:
[183 184 185 186 187 188 192 193 195 196 197 199 200 201 202 203 204 205
 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221]
Voxel count sum: 17303
Merging Right Midbrain ...
...38 regions' indices of Right Midbrain:
[122 123 124 125 126 127 128 129 130 131 132 133 135 136 137 138 139 140
 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158
 159 160]
Voxel count sum: 19804
Merging Right Nonspecific Thalamus ...
...9 regions' indices of Right Nonspecific Thalamus:
[105 106 108 109 110 111 112 113 114]
Voxel count sum: 2324
Merging Right Olfactory Areas ...
...11 regions' indices of Right Olfactory Areas:
[43 44 45 46 47 48 49 50 51 52 53]
Voxel count sum: 41043
Merging Right Pallidum ...
...9 regions' indices of Right Pallidum:
[59 60 61 62 63 64 65 66 67]
Voxel count sum: 9308
Merging Right Pons Behavioral ...
...8 regions' indices of Right Pons Behavioral:
[112 113 114 115 116 117 118 119]
Voxel count sum: 3890
Merging Right Pons Motor ...
...11 regions' indices of Right Pons Motor:
[101 102 103 104 105 106 107 108 109 110 111]
Voxel count sum: 5971
Merging Right Pons Sensory ...
...2 regions' indices of Right Pons Sensory:
[ 98 100]
Voxel count sum: 1585
Merging Right Spinal nucleus of the trigeminal ...
...3 regions' indices of Right Spinal nucleus of the trigeminal:
[103 104 105]
Voxel count sum: 3107
Merging Right Striatum ...
...13 regions' indices of Right Striatum:
[46 47 48 49 50 51 52 53 54 55 56 57 58]
Voxel count sum: 40219
Merging Right Thalamus ...
...34 regions' indices of Right Thalamus:
[48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71
 72 73 74 76 77 78 79 80 81 82]
Voxel count sum: 13346

Merged major structures and their voxel counts:
```

```
[['Right Frontal pole, cerebral cortex' 'Right Isocortex' '514']
['Right Primary motor area' 'Right Isocortex' '11760']
['Right Secondary motor area' 'Right Isocortex' '10098']
['Right Primary somatosensory area, nose' 'Right Isocortex' '1358']
['Right Primary somatosensory area, barrel field' 'Right Isocortex'
 '10306']
['Right Primary somatosensory area, lower limb' 'Right Isocortex' '3254']
['Right Primary somatosensory area, mouth' 'Right Isocortex' '2924']
['Right Primary somatosensory area, upper limb' 'Right Isocortex' '5406']
['Right Primary somatosensory area, trunk' 'Right Isocortex' '4799']
['Right Primary somatosensory area, unassigned' 'Right Isocortex' '2958']
['Right Supplemental somatosensory area' 'Right Isocortex' '5729']
['Right Gustatory areas' 'Right Isocortex' '2104']
['Right Visceral area' 'Right Isocortex' '1793']
['Right Dorsal auditory area' 'Right Isocortex' '2556']
['Right Primary auditory area' 'Right Isocortex' '2689']
['Right Posterior auditory area' 'Right Isocortex' '191']
['Right Ventral auditory area' 'Right Isocortex' '2554']
['Right Anterolateral visual area' 'Right Isocortex' '1981']
['Right Anteromedial visual area' 'Right Isocortex' '1795']
['Right Lateral visual area' 'Right Isocortex' '880']
['Right Primary visual area' 'Right Isocortex' '6227']
['Right Posterolateral visual area' 'Right Isocortex' '679']
['Right posteromedial visual area' 'Right Isocortex' '1265']
['Right Laterointermediate area' 'Right Isocortex' '-1']
['Right Postrhinal area' 'Right Isocortex' '-1']
['Right Anterior cingulate area, dorsal part' 'Right Isocortex' '2789']
['Right Anterior cingulate area, ventral part' 'Right Isocortex' '2418']
['Right Prelimbic area' 'Right Isocortex' '1790']
['Right Infralimbic area' 'Right Isocortex' '1764']
['Right Orbital area, lateral part' 'Right Isocortex' '1853']
['Right Orbital area, medial part' 'Right Isocortex' '1024']
['Right Orbital area, ventrolateral part' 'Right Isocortex' '1556']
['Right Agranular insular area, dorsal part' 'Right Isocortex' '2364']
['Right Agranular insular area, posterior part' 'Right Isocortex' '1348']
['Right Agranular insular area, ventral part' 'Right Isocortex' '1120']
['Right Retrosplenial area, lateral agranular part' 'Right Isocortex'
 '937']
['Right Retrosplenial area, dorsal part' 'Right Isocortex' '2738']
['Right Retrosplenial area, ventral part' 'Right Isocortex' '3997']
['Right Anterior area' 'Right Isocortex' '-1']
['Right Rostrolateral visual area' 'Right Isocortex' '-1']
['Right Temporal association areas' 'Right Isocortex' '3773']
['Right Perirhinal area' 'Right Isocortex' '1412']
['Right Ectorhinal area' 'Right Isocortex' '3390']
['Right Olfactory Areas' 'Right Olfactory Areas' '41043']
['Right Hippocampal Formation' 'Right Hippocampal Formation' '34819']
['Right Cortical Subplate' 'Right Cortical Subplate' '6669']
['Right Striatum' 'Right Striatum' '40219']
['Right Pallidum' 'Right Pallidum' '9308']
['Right Thalamus' 'Right Thalamus' '13346']
['Right Nonspecific Thalamus' 'Right Nonspecific Thalamus' '2324']
['Right Hypothalamus' 'Right Hypothalamus' '13871']
['Right Midbrain' 'Right Midbrain' '19804']
['Right Superior colliculus, motor related' 'Right Midbrain' '6779']
['Right Pons Sensory' 'Right Pons Sensory' '1585']
['Right Principal sensory nucleus of the trigeminal'
 'Right Pons Sensory' '1093']
['Right Pons Motor' 'Right Pons Motor' '5971']
['Right Pons Behavioral' 'Right Pons Behavioral' '3890']
['Right Medulla' 'Right Medulla' '17303']
```

```
['Right Spinal nucleus of the trigeminal'
 'Right Spinal nucleus of the trigeminal' '3107']
['Right Facial motor nucleus' 'Right Medulla' '660']
['Right Inferior olivary complex' 'Right Medulla' '567']
['Right Cerebellar Cortex' 'Right Cerebellar Cortex' '33696']
['Right Ansiform lobule' 'Right Cerebellar Cortex' '9044']
['Right Cerebellar Nuclei' 'Right Cerebellar Nuclei' '1116']
['Left Frontal pole, cerebral cortex' 'Left Isocortex' '514']
['Left Primary motor area' 'Left Isocortex' '11760']
['Left Secondary motor area' 'Left Isocortex' '10098']
['Left Primary somatosensory area, nose' 'Left Isocortex' '1358']
['Left Primary somatosensory area, barrel field' 'Left Isocortex'
 '10306']
['Left Primary somatosensory area, lower limb' 'Left Isocortex' '3254']
['Left Primary somatosensory area, mouth' 'Left Isocortex' '2924']
['Left Primary somatosensory area, upper limb' 'Left Isocortex' '5406']
['Left Primary somatosensory area, trunk' 'Left Isocortex' '4799']
['Left Primary somatosensory area, unassigned' 'Left Isocortex' '2958']
['Left Supplemental somatosensory area' 'Left Isocortex' '5729']
['Left Gustatory areas' 'Left Isocortex' '2104']
['Left Visceral area' 'Left Isocortex' '1793']
['Left Dorsal auditory area' 'Left Isocortex' '2556']
['Left Primary auditory area' 'Left Isocortex' '2689']
['Left Posterior auditory area' 'Left Isocortex' '191']
['Left Ventral auditory area' 'Left Isocortex' '2554']
['Left Anterolateral visual area' 'Left Isocortex' '1981']
['Left Anteromedial visual area' 'Left Isocortex' '1795']
['Left Lateral visual area' 'Left Isocortex' '880']
['Left Primary visual area' 'Left Isocortex' '6227']
['Left Posterolateral visual area' 'Left Isocortex' '679']
['Left posteromedial visual area' 'Left Isocortex' '1265']
['Left Laterointermediate area' 'Left Isocortex' '-1']
['Left Postrhinal area' 'Left Isocortex' '-1']
['Left Anterior cingulate area, dorsal part' 'Left Isocortex' '2789']
['Left Anterior cingulate area, ventral part' 'Left Isocortex' '2418']
['Left Prelimbic area' 'Left Isocortex' '1790']
['Left Infralimbic area' 'Left Isocortex' '1764']
['Left Orbital area, lateral part' 'Left Isocortex' '1853']
['Left Orbital area, medial part' 'Left Isocortex' '1024']
['Left Orbital area, ventrolateral part' 'Left Isocortex' '1556']
['Left Agranular insular area, dorsal part' 'Left Isocortex' '2364']
['Left Agranular insular area, posterior part' 'Left Isocortex' '1348']
['Left Agranular insular area, ventral part' 'Left Isocortex' '1120']
['Left Retrosplenial area, lateral agranular part' 'Left Isocortex'
 '937']
['Left Retrosplenial area, dorsal part' 'Left Isocortex' '2738']
['Left Retrosplenial area, ventral part' 'Left Isocortex' '3997']
['Left Anterior area' 'Left Isocortex' '-1']
['Left Rostrolateral visual area' 'Left Isocortex' '-1']
['Left Temporal association areas' 'Left Isocortex' '3773']
['Left Perirhinal area' 'Left Isocortex' '1412']
['Left Ectorhinal area' 'Left Isocortex' '3390']
['Left Olfactory Areas' 'Left Olfactory Areas' '41043']
['Left Hippocampal Formation' 'Left Hippocampal Formation' '34819']
['Left Cortical Subplate' 'Left Cortical Subplate' '6669']
['Left Striatum' 'Left Striatum' '40219']
['Left Pallidum' 'Left Pallidum' '9308']
['Left Thalamus' 'Left Thalamus' '13346']
['Left Nonspecific Thalamus' 'Left Nonspecific Thalamus' '2324']
['Left Hypothalamus' 'Left Hypothalamus' '13871']
['Left Midbrain' 'Left Midbrain' '19804']
```

```
['Left Superior colliculus, motor related' 'Left Midbrain' '6779']
['Left Pons Sensory' 'Left Pons Sensory' '1585']
['Left Principal sensory nucleus of the trigeminal' 'Left Pons Sensory'
 '1093']
['Left Pons Motor' 'Left Pons Motor' '5971']
['Left Pons Behavioral' 'Left Pons Behavioral' '3890']
['Left Medulla' 'Left Medulla' '17303']
['Left Spinal nucleus of the trigeminal'
 'Left Spinal nucleus of the trigeminal' '3107']
['Left Facial motor nucleus' 'Left Medulla' '660']
['Left Inferior olivary complex' 'Left Medulla' '567']
['Left Cerebellar Cortex' 'Left Cerebellar Cortex' '33696']
['Left Ansiform lobule' 'Left Cerebellar Cortex' '9044']
['Left Cerebellar Nuclei' 'Left Cerebellar Nuclei' '1116']]
```

Testing merging

In [9]:

```
# Testing that everything went well:
print("Testing merging, voxel counts, sum of (self/from/to) weights, and sel
for iR, (reg, msl, vc) in enumerate(zip(new_conn.region_labels, new_major_st
    print("\n%s - %s:" % (reg, msl))
    if reg in result_connectivity.region_labels:
        iR2 = np.where([reg == reg2 for reg2 in result_connectivity.region_l
        print("...%d = %d voxels" % (vc, voxel_count[iR2]))
        assert voxel_count[iR2] - vc == 0
        print("...centres: %s = %s" % (new_conn.centres[iR], result_connecti
        assert np.allclose(new_conn.centres[iR], result_connectivity.centres
        ws = np.nansum(new_conn.weights[iR])
        ws2 = np.nansum(result_connectivity.weights[iR2])
        print("...weights to: %g = %g" % (ws, ws2))
        assert np.abs(ws - ws2) < 1e-6
        ws = np.nansum(new_conn.weights[:, iR])
        ws2 = np.nansum(result_connectivity.weights[:, iR2])
        print("...weights from: %g = %g" % (ws, ws2))
        assert np.abs(ws - ws2) < 1e-6
        print("...self tract_lengths: %g = %g" % (new_conn.tract_lengths[iR,
        assert np.abs(new_conn.tract_lengths[iR, iR] - result_connectivity.t
    else:
        excl_regs = exclude_regions.get(reg, [])
        iR2s = np.where([msl == msl2 and reg2 not in excl_regs
                         for reg2, msl2 in zip(result_connectivity.region_la
        old_vc = voxel_count[iR2s]
        old_vc = old_vc[old_vc >= 0]
        old_vc_sum = old_vc.sum()
        print("...%d voxels" % old_vc_sum)
        assert old_vc_sum - vc == 0
        if WEIGHTED_AVERAGE_CENTRES:
            assert np.allclose(new_conn.centres[iR],
                               np.average(result_connectivity.centres[iR2s,
                                          axis=0, weights=voxel_count[iR2s])
        else:
            oldcntrs = np.nanmean(result_connectivity.centres[iR2s], axis=0)
            print("...centres: %s = %s" % (new_conn.centres[iR], oldcntrs))
            assert np.allclose(new_conn.centres[iR], oldcntrs)
        ws = np.nansum(new_conn.weights[iR])
        ws2 = np.nansum(result_connectivity.weights[iR2s])
        print("...weights to: %g = %g" % (ws, ws2))
        if not FORCE_MERGED_ZERO_DIAGONAL:
            assert np.abs(ws - ws2) < 1e-6
```

```
        ws = np.nansum(new_conn.weights[:, iR])
        ws2 = np.nansum(result_connectivity.weights[:, iR2s])
        print("...weights from: %g = %g" % (ws, ws2))
        if not FORCE_MERGED_ZERO_DIAGONAL:
            assert np.abs(ws - ws2) < 1e-6
        ws2 = np.nansum(result_connectivity.weights[iR2s][:, iR2s])
        print("...self weights: %g = %g" % (new_conn.weights[iR, iR], ws2))
        # assert np.abs(new_conn.weights[iR, iR] - ws2) < 1e-6
        if TRACT_LENGTHS_MODE == "euclidean":
            tl = new_conn.tract_lengths[iR, :]
            weights = new_conn.weights[iR, :] > 0.0
            tl2 = weights*euclidean_distance(new_conn.centres[iR, :], new_co
            print("...average tract_lengths to/from: %g = %g" % (tl.mean(),
            assert np.allclose(tl, tl2)
        # TODO: Think of a test for weigthed average!!!
```

```
Testing merging, voxel counts, sum of (self/from/to) weights, and self-trac
t lengths:

Right Frontal pole, cerebral cortex - Right Isocortex:
...514 = 514 voxels
...centres: [45.5942029  22.72256729 51.2484472 ] = [[45.5942029  22.722567
29 51.2484472 ]]
...weights to: 3.14868 = 3.14868
...weights from: 6.36079 = 6.36079
...self tract_lengths: 0 = 0

Right Primary motor area - Right Isocortex:
...11760 = 11760 voxels
...centres: [35.30080448 42.96502274 55.40433718] = [[35.30080448 42.965022
74 55.40433718]]
...weights to: 1.87382 = 1.87382
...weights from: 6.37274 = 6.37274
...self tract_lengths: 0 = 0

Right Secondary motor area - Right Isocortex:
...10098 = 10098 voxels
...centres: [43.65873016 36.05326618 57.91804029] = [[43.65873016 36.053266
18 57.91804029]]
...weights to: 2.33534 = 2.33534
...weights from: 6.99391 = 6.99391
...self tract_lengths: 0 = 0

Right Primary somatosensory area, nose - Right Isocortex:
...1358 = 1358 voxels
...centres: [21.02302632 56.74407895 54.42039474] = [[21.02302632 56.744078
95 54.42039474]]
...weights to: 1.20136 = 1.20136
...weights from: 5.39897 = 5.39897
...self tract_lengths: 0 = 0

Right Primary somatosensory area, barrel field - Right Isocortex:
...10306 = 10306 voxels
...centres: [23.73700988 67.39846988 61.48453937] = [[23.73700988 67.398469
88 61.48453937]]
...weights to: 1.37367 = 1.37367
...weights from: 6.26508 = 6.26508
...self tract_lengths: 0 = 0

Right Primary somatosensory area, lower limb - Right Isocortex:
...3254 = 3254 voxels
...centres: [39.3573854  59.67402377 66.73344652] = [[39.3573854  59.674023
77 66.73344652]]
...weights to: 1.83371 = 1.83371
...weights from: 5.63341 = 5.63341
...self tract_lengths: 0 = 0

Right Primary somatosensory area, mouth - Right Isocortex:
...2924 = 2924 voxels
...centres: [22.99775281 46.18266453 48.86420546] = [[22.99775281 46.182664
53 48.86420546]]
...weights to: 1.3537 = 1.3537
...weights from: 5.09649 = 5.09649
...self tract_lengths: 0 = 0

Right Primary somatosensory area, upper limb - Right Isocortex:
...5406 = 5406 voxels
```

```
...centres: [32.6544196  54.61182109 61.69755059] = [[32.6544196  54.611821
09 61.69755059]]
...weights to: 1.39079 = 1.39079
...weights from: 2.70357 = 2.70357
...self tract_lengths: 0 = 0

Right Primary somatosensory area, trunk - Right Isocortex:
...4799 = 4799 voxels
...centres: [38.95590327 66.81507824 69.51920341] = [[38.95590327 66.815078
24 69.51920341]]
...weights to: 2.32431 = 2.32431
...weights from: 4.8304 = 4.8304
...self tract_lengths: 0 = 0

Right Primary somatosensory area, unassigned - Right Isocortex:
...2958 = 2958 voxels
...centres: [29.06161137 58.57661927 61.72827804] = [[29.06161137 58.576619
27 61.72827804]]
...weights to: 1.71146 = 1.71146
...weights from: 3.56411 = 3.56411
...self tract_lengths: 0 = 0

Right Supplemental somatosensory area - Right Isocortex:
...5729 = 5729 voxels
...centres: [15.35346359 61.09413854 45.52775311] = [[15.35346359 61.094138
54 45.52775311]]
...weights to: 2.45012 = 2.45012
...weights from: 7.48341 = 7.48341
...self tract_lengths: 0 = 0

Right Gustatory areas - Right Isocortex:
...2104 = 2104 voxels
...centres: [19.56851642 46.67610419 34.30124575] = [[19.56851642 46.676104
19 34.30124575]]
...weights to: 3.59145 = 3.59145
...weights from: 8.43749 = 8.43749
...self tract_lengths: 0 = 0

Right Visceral area - Right Isocortex:
...1793 = 1793 voxels
...centres: [12.67567568 62.97043919 34.46706081] = [[12.67567568 62.970439
19 34.46706081]]
...weights to: 4.12891 = 4.12891
...weights from: 9.98387 = 9.98387
...self tract_lengths: 0 = 0

Right Dorsal auditory area - Right Isocortex:
...2556 = 2556 voxels
...centres: [14.68144499 75.45812808 54.78981938] = [[14.68144499 75.458128
08 54.78981938]]
...weights to: 3.36174 = 3.36174
...weights from: 4.9361 = 4.9361
...self tract_lengths: 0 = 0

Right Primary auditory area - Right Isocortex:
...2689 = 2689 voxels
...centres: [11.802595   79.33920297 50.82205746] = [[11.802595   79.339202
97 50.82205746]]
...weights to: 3.70985 = 3.70985
...weights from: 3.86101 = 3.86101
...self tract_lengths: 0 = 0
```

```
Right Posterior auditory area - Right Isocortex:
...191 = 191 voxels
...centres: [14.58333333 84.17       56.06666667] = [[14.58333333 84.17
56.06666667]]
...weights to: 4.81068 = 4.81068
...weights from: 4.55941 = 4.55941
...self tract_lengths: 0 = 0

Right Ventral auditory area - Right Isocortex:
...2554 = 2554 voxels
...centres: [10.50774336 78.00110619 45.04535398] = [[10.50774336 78.001106
19 45.04535398]]
...weights to: 3.64962 = 3.64962
...weights from: 7.59361 = 7.59361
...self tract_lengths: 0 = 0

Right Anterolateral visual area - Right Isocortex:
...1981 = 1981 voxels
...centres: [19.92327366 82.52173913 62.23529412] = [[19.92327366 82.521739
13 62.23529412]]
...weights to: 3.36884 = 3.36884
...weights from: 6.11907 = 6.11907
...self tract_lengths: 0 = 0

Right Anteromedial visual area - Right Isocortex:
...1795 = 1795 voxels
...centres: [40.48704663 76.65025907 71.68911917] = [[40.48704663 76.650259
07 71.68911917]]
...weights to: 3.6538 = 3.6538
...weights from: 7.05138 = 7.05138
...self tract_lengths: 0 = 0

Right Lateral visual area - Right Isocortex:
...880 = 880 voxels
...centres: [21.07281553 91.04530744 60.5566343 ] = [[21.07281553 91.045307
44 60.5566343 ]]
...weights to: 3.31325 = 3.31325
...weights from: 5.33257 = 5.33257
...self tract_lengths: 0 = 0

Right Primary visual area - Right Isocortex:
...6227 = 6227 voxels
...centres: [31.24740533 90.72734923 66.94922861] = [[31.24740533 90.727349
23 66.94922861]]
...weights to: 2.40566 = 2.40566
...weights from: 4.65915 = 4.65915
...self tract_lengths: 0 = 0

Right Posterolateral visual area - Right Isocortex:
...679 = 679 voxels
...centres: [ 24.43859649 100.0726817   56.95989975] = [[ 24.43859649 100.0
726817   56.95989975]]
...weights to: 2.98092 = 2.98092
...weights from: 5.24074 = 5.24074
...self tract_lengths: 0 = 0

Right posteromedial visual area - Right Isocortex:
...1265 = 1265 voxels
...centres: [40.06730769 83.88076923 71.89615385] = [[40.06730769 83.880769
23 71.89615385]]
```

```
...weights to: 3.1971 = 3.1971
...weights from: 9.94985 = 9.94985
...self tract_lengths: 0 = 0

Right Laterointermediate area - Right Isocortex:
...-1 = -1 voxels
...centres: [17.85185185 90.53497942 57.65432099] = [[17.85185185 90.534979
42 57.65432099]]
...weights to: 3.73671 = 3.73671
...weights from: 6.57665 = 6.57665
...self tract_lengths: 0 = 0

Right Postrhinal area - Right Isocortex:
...-1 = -1 voxels
...centres: [15.60658307 95.63793103 51.69435737] = [[15.60658307 95.637931
03 51.69435737]]
...weights to: 4.35521 = 4.35521
...weights from: 6.61262 = 6.61262
...self tract_lengths: 0 = 0

Right Anterior cingulate area, dorsal part - Right Isocortex:
...2789 = 2789 voxels
...centres: [52.53279243 44.29952671 59.43002028] = [[52.53279243 44.299526
71 59.43002028]]
...weights to: 3.40323 = 3.40323
...weights from: 7.78532 = 7.78532
...self tract_lengths: 0 = 0

Right Anterior cingulate area, ventral part - Right Isocortex:
...2418 = 2418 voxels
...centres: [53.40868794 48.55319149 54.30141844] = [[53.40868794 48.553191
49 54.30141844]]
...weights to: 4.55297 = 4.55297
...weights from: 10.0158 = 10.0158
...self tract_lengths: 0 = 0

Right Prelimbic area - Right Isocortex:
...1790 = 1790 voxels
...centres: [52.33045729 31.06039689 51.18205349] = [[52.33045729 31.060396
89 51.18205349]]
...weights to: 4.54218 = 4.54218
...weights from: 10.5647 = 10.5647
...self tract_lengths: 0 = 0

Right Infralimbic area - Right Isocortex:
...1764 = 1764 voxels
...centres: [53.15632754 34.98759305 41.86848635] = [[53.15632754 34.987593
05 41.86848635]]
...weights to: 7.0478 = 7.0478
...weights from: 7.95842 = 7.95842
...self tract_lengths: 0 = 0

Right Orbital area, lateral part - Right Isocortex:
...1853 = 1853 voxels
...centres: [41.75661765 29.64191176 40.67426471] = [[41.75661765 29.641911
76 40.67426471]]
...weights to: 4.16078 = 4.16078
...weights from: 6.72122 = 6.72122
...self tract_lengths: 0 = 0

Right Orbital area, medial part - Right Isocortex:
```

```
...1024 = 1024 voxels
...centres: [53.2739726  28.0456621  43.21613394] = [[53.2739726  28.045662
1  43.21613394]]
...weights to: 5.11325 = 5.11325
...weights from: 7.6126 = 7.6126
...self tract_lengths: 0 = 0

Right Orbital area, ventrolateral part - Right Isocortex:
...1556 = 1556 voxels
...centres: [49.09438202 27.48539326 42.88426966] = [[49.09438202 27.485393
26 42.88426966]]
...weights to: 4.6912 = 4.6912
...weights from: 7.00555 = 7.00555
...self tract_lengths: 0 = 0

Right Agranular insular area, dorsal part - Right Isocortex:
...2364 = 2364 voxels
...centres: [29.77396893 34.61810391 36.22656668] = [[29.77396893 34.618103
91 36.22656668]]
...weights to: 4.4157 = 4.4157
...weights from: 11.3421 = 11.3421
...self tract_lengths: 0 = 0

Right Agranular insular area, posterior part - Right Isocortex:
...1348 = 1348 voxels
...centres: [15.16350124 59.63996697 27.96944674] = [[15.16350124 59.639966
97 27.96944674]]
...weights to: 5.1191 = 5.1191
...weights from: 8.72044 = 8.72044
...self tract_lengths: 0 = 0

Right Agranular insular area, ventral part - Right Isocortex:
...1120 = 1120 voxels
...centres: [29.87514318 37.21076747 30.        ] = [[29.87514318 37.210767
47 30.        ]]
...weights to: 5.56127 = 5.56127
...weights from: 5.79887 = 5.79887
...self tract_lengths: 0 = 0

Right Retrosplenial area, lateral agranular part - Right Isocortex:
...937 = 937 voxels
...centres: [44.0636833  81.13253012 70.83390706] = [[44.0636833  81.132530
12 70.83390706]]
...weights to: 2.48287 = 2.48287
...weights from: 4.5897 = 4.5897
...self tract_lengths: 0 = 0

Right Retrosplenial area, dorsal part - Right Isocortex:
...2738 = 2738 voxels
...centres: [48.19167983 80.32490785 70.98683518] = [[48.19167983 80.324907
85 70.98683518]]
...weights to: 1.95983 = 1.95983
...weights from: 4.54976 = 4.54976
...self tract_lengths: 0 = 0

Right Retrosplenial area, ventral part - Right Isocortex:
...3997 = 3997 voxels
...centres: [51.74832536 78.26985646 66.47607656] = [[51.74832536 78.269856
46 66.47607656]]
...weights to: 2.52084 = 2.52084
...weights from: 7.47747 = 7.47747
```

```
...self tract_lengths: 0 = 0

Right Anterior area - Right Isocortex:
...-1 = -1 voxels
...centres: [36.72853186 72.52493075 70.37257618] = [[36.72853186 72.524930
75 70.37257618]]
...weights to: 2.75957 = 2.75957
...weights from: 5.86238 = 5.86238
...self tract_lengths: 0 = 0

Right Rostrolateral visual area - Right Isocortex:
...-1 = -1 voxels
...centres: [26.21960784 77.9745098  66.57254902] = [[26.21960784 77.974509
8  66.57254902]]
...weights to: 2.27166 = 2.27166
...weights from: 6.42253 = 6.42253
...self tract_lengths: 0 = 0

Right Temporal association areas - Right Isocortex:
...3773 = 3773 voxels
...centres: [11.30600387 82.74112331 44.43124597] = [[11.30600387 82.741123
31 44.43124597]]
...weights to: 4.7417 = 4.7417
...weights from: 6.0477 = 6.0477
...self tract_lengths: 0 = 0

Right Perirhinal area - Right Isocortex:
...1412 = 1412 voxels
...centres: [10.31155779 82.23366834 33.93467337] = [[10.31155779 82.233668
34 33.93467337]]
...weights to: 4.78609 = 4.78609
...weights from: 8.2565 = 8.2565
...self tract_lengths: 0 = 0

Right Ectorhinal area - Right Isocortex:
...3390 = 3390 voxels
...centres: [11.0908046  80.43908046 36.10689655] = [[11.0908046  80.439080
46 36.10689655]]
...weights to: 5.28341 = 5.28341
...weights from: 7.69002 = 7.69002
...self tract_lengths: 0 = 0

Right Olfactory Areas - Right Olfactory Areas:
...41043 voxels
...weights to: 39.4701 = 48.8479
...weights from: 53.8398 = 63.2176
...self weights: 0 = 9.37775

Right Hippocampal Formation - Right Hippocampal Formation:
...34819 voxels
...weights to: 34.0178 = 43.4767
...weights from: 48.5659 = 58.0249
...self weights: 0 = 9.45896

Right Cortical Subplate - Right Cortical Subplate:
...6669 voxels
...weights to: 44.7184 = 50.8921
...weights from: 44.4496 = 50.6234
...self weights: 0 = 6.17378

Right Striatum - Right Striatum:
```

```
...40219 voxels
...weights to: 98.9072 = 109.003
...weights from: 88.2897 = 98.3856
...self weights: 0 = 10.0959

Right Pallidum - Right Pallidum:
...9308 voxels
...weights to: 84.9946 = 89.3808
...weights from: 75.5767 = 79.9628
...self weights: 0 = 4.38613

Right Thalamus - Right Thalamus:
...13346 voxels
...weights to: 280.134 = 326.04
...weights from: 186.091 = 231.998
...self weights: 0 = 45.906

Right Nonspecific Thalamus - Right Nonspecific Thalamus:
...2324 voxels
...weights to: 115.961 = 118.485
...weights from: 61.0322 = 63.5561
...self weights: 0 = 2.5239

Right Hypothalamus - Right Hypothalamus:
...13871 voxels
...weights to: 354.926 = 630.732
...weights from: 366.33 = 642.136
...self weights: 0 = 275.806

Right Midbrain - Right Midbrain:
...19804 voxels
...weights to: 338.668 = 429.195
...weights from: 286.757 = 377.284
...self weights: 0 = 90.5271

Right Superior colliculus, motor related - Right Midbrain:
...6779 = 6779 voxels
...centres: [47.53567587 91.42129796 55.60666906] = [[47.53567587 91.421297
96 55.60666906]]
...weights to: 9.62674 = 9.62674
...weights from: 7.67702 = 7.67702
...self tract_lengths: 0 = 0

Right Pons Sensory - Right Pons Sensory:
...1585 voxels
...weights to: 13.202 = 13.3324
...weights from: 19.1642 = 19.2947
...self weights: 0 = 0.130488

Right Principal sensory nucleus of the trigeminal - Right Pons Sensory:
...1093 = 1093 voxels
...centres: [ 36.33636364 101.84        22.50363636] = [[ 36.33636364 101.8
4        22.50363636]]
...weights to: 3.14049 = 3.14049
...weights from: 9.72171 = 9.72171
...self tract_lengths: 0 = 0

Right Pons Motor - Right Pons Motor:
...5971 voxels
...weights to: 102.516 = 111.275
...weights from: 99.5803 = 108.339
```

```
...self weights: 0 = 8.75894

Right Pons Behavioral - Right Pons Behavioral:
...3890 voxels
...weights to: 115.281 = 126.613
...weights from: 81.4818 = 92.8137
...self weights: 0 = 11.3319

Right Medulla - Right Medulla:
...17303 voxels
...weights to: 162.776 = 241.373
...weights from: 187.547 = 266.144
...self weights: 0 = 78.5974

Right Spinal nucleus of the trigeminal - Right Spinal nucleus of the trigem
inal:
...3107 voxels
...weights to: 7.41493 = 7.94454
...weights from: 18.6598 = 19.1894
...self weights: 0 = 0.529612

Right Facial motor nucleus - Right Medulla:
...660 = 660 voxels
...centres: [ 43.41327623 108.59100642  11.23768737] = [[ 43.41327623 108.5
9100642  11.23768737]]
...weights to: 9.15874 = 9.15874
...weights from: 11.0785 = 11.0785
...self tract_lengths: 0 = 0

Right Inferior olivary complex - Right Medulla:
...567 = 567 voxels
...centres: [ 52.98765432 120.24279835   8.0617284 ] = [[ 52.98765432 120.2
4279835   8.0617284 ]]
...weights to: 4.99518 = 4.99518
...weights from: 10.4086 = 10.4086
...self tract_lengths: 0 = 0

Right Cerebellar Cortex - Right Cerebellar Cortex:
...33696 voxels
...weights to: 14.3996 = 16.6808
...weights from: 23.8543 = 26.1355
...self weights: 0 = 2.28123

Right Ansiform lobule - Right Cerebellar Cortex:
...9044 = 9044 voxels
...centres: [ 27.33283859 118.267718    49.59369202] = [[ 27.33283859 118.2
67718    49.59369202]]
...weights to: 0.843584 = 0.843584
...weights from: 0.209096 = 0.209096
...self tract_lengths: 0 = 0

Right Cerebellar Nuclei - Right Cerebellar Nuclei:
...1116 voxels
...weights to: 6.58665 = 7.09595
...weights from: 22.0603 = 22.5696
...self weights: 0 = 0.5093

Left Frontal pole, cerebral cortex - Left Isocortex:
...514 = 514 voxels
...centres: [68.4057971  22.72256729 51.2484472 ] = [[68.4057971  22.722567
29 51.2484472 ]]
```

```
...weights to: 3.14868 = 3.14868
...weights from: 6.36079 = 6.36079
...self tract_lengths: 0 = 0

Left Primary motor area - Left Isocortex:
...11760 = 11760 voxels
...centres: [78.69919552 42.96502274 55.40433718] = [[78.69919552 42.965022
74 55.40433718]]
...weights to: 1.87382 = 1.87382
...weights from: 6.37274 = 6.37274
...self tract_lengths: 0 = 0

Left Secondary motor area - Left Isocortex:
...10098 = 10098 voxels
...centres: [70.34126984 36.05326618 57.91804029] = [[70.34126984 36.053266
18 57.91804029]]
...weights to: 2.33534 = 2.33534
...weights from: 6.99391 = 6.99391
...self tract_lengths: 0 = 0

Left Primary somatosensory area, nose - Left Isocortex:
...1358 = 1358 voxels
...centres: [92.97697368 56.74407895 54.42039474] = [[92.97697368 56.744078
95 54.42039474]]
...weights to: 1.20136 = 1.20136
...weights from: 5.39897 = 5.39897
...self tract_lengths: 0 = 0

Left Primary somatosensory area, barrel field - Left Isocortex:
...10306 = 10306 voxels
...centres: [90.26299012 67.39846988 61.48453937] = [[90.26299012 67.398469
88 61.48453937]]
...weights to: 1.37367 = 1.37367
...weights from: 6.26508 = 6.26508
...self tract_lengths: 0 = 0

Left Primary somatosensory area, lower limb - Left Isocortex:
...3254 = 3254 voxels
...centres: [74.6426146  59.67402377 66.73344652] = [[74.6426146  59.674023
77 66.73344652]]
...weights to: 1.83371 = 1.83371
...weights from: 5.63341 = 5.63341
...self tract_lengths: 0 = 0

Left Primary somatosensory area, mouth - Left Isocortex:
...2924 = 2924 voxels
...centres: [91.00224719 46.18266453 48.86420546] = [[91.00224719 46.182664
53 48.86420546]]
...weights to: 1.3537 = 1.3537
...weights from: 5.09649 = 5.09649
...self tract_lengths: 0 = 0

Left Primary somatosensory area, upper limb - Left Isocortex:
...5406 = 5406 voxels
...centres: [81.3455804  54.61182109 61.69755059] = [[81.3455804  54.611821
09 61.69755059]]
...weights to: 1.39079 = 1.39079
...weights from: 2.70357 = 2.70357
...self tract_lengths: 0 = 0

Left Primary somatosensory area, trunk - Left Isocortex:
```

```
...4799 = 4799 voxels
...centres: [75.04409673 66.81507824 69.51920341] = [[75.04409673 66.815078
24 69.51920341]]
...weights to: 2.32431 = 2.32431
...weights from: 4.8304 = 4.8304
...self tract_lengths: 0 = 0

Left Primary somatosensory area, unassigned - Left Isocortex:
...2958 = 2958 voxels
...centres: [84.93838863 58.57661927 61.72827804] = [[84.93838863 58.576619
27 61.72827804]]
...weights to: 1.71146 = 1.71146
...weights from: 3.56411 = 3.56411
...self tract_lengths: 0 = 0

Left Supplemental somatosensory area - Left Isocortex:
...5729 = 5729 voxels
...centres: [98.64653641 61.09413854 45.52775311] = [[98.64653641 61.094138
54 45.52775311]]
...weights to: 2.45012 = 2.45012
...weights from: 7.48341 = 7.48341
...self tract_lengths: 0 = 0

Left Gustatory areas - Left Isocortex:
...2104 = 2104 voxels
...centres: [94.43148358 46.67610419 34.30124575] = [[94.43148358 46.676104
19 34.30124575]]
...weights to: 3.59145 = 3.59145
...weights from: 8.43749 = 8.43749
...self tract_lengths: 0 = 0

Left Visceral area - Left Isocortex:
...1793 = 1793 voxels
...centres: [101.32432432  62.97043919  34.46706081] = [[101.32432432  62.9
7043919  34.46706081]]
...weights to: 4.12891 = 4.12891
...weights from: 9.98387 = 9.98387
...self tract_lengths: 0 = 0

Left Dorsal auditory area - Left Isocortex:
...2556 = 2556 voxels
...centres: [99.31855501 75.45812808 54.78981938] = [[99.31855501 75.458128
08 54.78981938]]
...weights to: 3.36174 = 3.36174
...weights from: 4.9361 = 4.9361
...self tract_lengths: 0 = 0

Left Primary auditory area - Left Isocortex:
...2689 = 2689 voxels
...centres: [102.197405    79.33920297  50.82205746] = [[102.197405    79.3
3920297  50.82205746]]
...weights to: 3.70985 = 3.70985
...weights from: 3.86101 = 3.86101
...self tract_lengths: 0 = 0

Left Posterior auditory area - Left Isocortex:
...191 = 191 voxels
...centres: [99.41666667 84.17       56.06666667] = [[99.41666667 84.17
56.06666667]]
...weights to: 4.81068 = 4.81068
...weights from: 4.55941 = 4.55941
```

```
...self tract_lengths: 0 = 0

Left Ventral auditory area - Left Isocortex:
...2554 = 2554 voxels
...centres: [103.49225664  78.00110619  45.04535398] = [[103.49225664  78.0
0110619  45.04535398]]
...weights to: 3.64962 = 3.64962
...weights from: 7.59361 = 7.59361
...self tract_lengths: 0 = 0

Left Anterolateral visual area - Left Isocortex:
...1981 = 1981 voxels
...centres: [94.07672634 82.52173913 62.23529412] = [[94.07672634 82.521739
13 62.23529412]]
...weights to: 3.36884 = 3.36884
...weights from: 6.11907 = 6.11907
...self tract_lengths: 0 = 0

Left Anteromedial visual area - Left Isocortex:
...1795 = 1795 voxels
...centres: [73.51295337 76.65025907 71.68911917] = [[73.51295337 76.650259
07 71.68911917]]
...weights to: 3.6538 = 3.6538
...weights from: 7.05138 = 7.05138
...self tract_lengths: 0 = 0

Left Lateral visual area - Left Isocortex:
...880 = 880 voxels
...centres: [92.92718447 91.04530744 60.5566343 ] = [[92.92718447 91.045307
44 60.5566343 ]]
...weights to: 3.31325 = 3.31325
...weights from: 5.33257 = 5.33257
...self tract_lengths: 0 = 0

Left Primary visual area - Left Isocortex:
...6227 = 6227 voxels
...centres: [82.75259467 90.72734923 66.94922861] = [[82.75259467 90.727349
23 66.94922861]]
...weights to: 2.40566 = 2.40566
...weights from: 4.65915 = 4.65915
...self tract_lengths: 0 = 0

Left Posterolateral visual area - Left Isocortex:
...679 = 679 voxels
...centres: [ 89.56140351 100.0726817   56.95989975] = [[ 89.56140351 100.0
726817   56.95989975]]
...weights to: 2.98092 = 2.98092
...weights from: 5.24074 = 5.24074
...self tract_lengths: 0 = 0

Left posteromedial visual area - Left Isocortex:
...1265 = 1265 voxels
...centres: [73.93269231 83.88076923 71.89615385] = [[73.93269231 83.880769
23 71.89615385]]
...weights to: 3.1971 = 3.1971
...weights from: 9.94985 = 9.94985
...self tract_lengths: 0 = 0

Left Laterointermediate area - Left Isocortex:
...-1 = -1 voxels
...centres: [96.14814815 90.53497942 57.65432099] = [[96.14814815 90.534979
```

```
42 57.65432099]]
...weights to: 3.73671 = 3.73671
...weights from: 6.57665 = 6.57665
...self tract_lengths: 0 = 0

Left Postrhinal area - Left Isocortex:
...-1 = -1 voxels
...centres: [98.39341693 95.63793103 51.69435737] = [[98.39341693 95.637931
03 51.69435737]]
...weights to: 4.35521 = 4.35521
...weights from: 6.61262 = 6.61262
...self tract_lengths: 0 = 0

Left Anterior cingulate area, dorsal part - Left Isocortex:
...2789 = 2789 voxels
...centres: [61.46720757 44.29952671 59.43002028] = [[61.46720757 44.299526
71 59.43002028]]
...weights to: 3.40323 = 3.40323
...weights from: 7.78532 = 7.78532
...self tract_lengths: 0 = 0

Left Anterior cingulate area, ventral part - Left Isocortex:
...2418 = 2418 voxels
...centres: [60.59131206 48.55319149 54.30141844] = [[60.59131206 48.553191
49 54.30141844]]
...weights to: 4.55297 = 4.55297
...weights from: 10.0158 = 10.0158
...self tract_lengths: 0 = 0

Left Prelimbic area - Left Isocortex:
...1790 = 1790 voxels
...centres: [61.66954271 31.06039689 51.18205349] = [[61.66954271 31.060396
89 51.18205349]]
...weights to: 4.54218 = 4.54218
...weights from: 10.5647 = 10.5647
...self tract_lengths: 0 = 0

Left Infralimbic area - Left Isocortex:
...1764 = 1764 voxels
...centres: [60.84367246 34.98759305 41.86848635] = [[60.84367246 34.987593
05 41.86848635]]
...weights to: 7.0478 = 7.0478
...weights from: 7.95842 = 7.95842
...self tract_lengths: 0 = 0

Left Orbital area, lateral part - Left Isocortex:
...1853 = 1853 voxels
...centres: [72.24338235 29.64191176 40.67426471] = [[72.24338235 29.641911
76 40.67426471]]
...weights to: 4.16078 = 4.16078
...weights from: 6.72122 = 6.72122
...self tract_lengths: 0 = 0

Left Orbital area, medial part - Left Isocortex:
...1024 = 1024 voxels
...centres: [60.7260274  28.0456621  43.21613394] = [[60.7260274  28.045662
1  43.21613394]]
...weights to: 5.11325 = 5.11325
...weights from: 7.6126 = 7.6126
...self tract_lengths: 0 = 0
```

```
Left Orbital area, ventrolateral part - Left Isocortex:
...1556 = 1556 voxels
...centres: [64.90561798 27.48539326 42.88426966] = [[64.90561798 27.485393
26 42.88426966]]
...weights to: 4.6912 = 4.6912
...weights from: 7.00555 = 7.00555
...self tract_lengths: 0 = 0

Left Agranular insular area, dorsal part - Left Isocortex:
...2364 = 2364 voxels
...centres: [84.22603107 34.61810391 36.22656668] = [[84.22603107 34.618103
91 36.22656668]]
...weights to: 4.4157 = 4.4157
...weights from: 11.3421 = 11.3421
...self tract_lengths: 0 = 0

Left Agranular insular area, posterior part - Left Isocortex:
...1348 = 1348 voxels
...centres: [98.83649876 59.63996697 27.96944674] = [[98.83649876 59.639966
97 27.96944674]]
...weights to: 5.1191 = 5.1191
...weights from: 8.72044 = 8.72044
...self tract_lengths: 0 = 0

Left Agranular insular area, ventral part - Left Isocortex:
...1120 = 1120 voxels
...centres: [84.12485682 37.21076747 30.        ] = [[84.12485682 37.210767
47 30.        ]]
...weights to: 5.56127 = 5.56127
...weights from: 5.79887 = 5.79887
...self tract_lengths: 0 = 0

Left Retrosplenial area, lateral agranular part - Left Isocortex:
...937 = 937 voxels
...centres: [69.9363167  81.13253012 70.83390706] = [[69.9363167  81.132530
12 70.83390706]]
...weights to: 2.48287 = 2.48287
...weights from: 4.5897 = 4.5897
...self tract_lengths: 0 = 0

Left Retrosplenial area, dorsal part - Left Isocortex:
...2738 = 2738 voxels
...centres: [65.80832017 80.32490785 70.98683518] = [[65.80832017 80.324907
85 70.98683518]]
...weights to: 1.95983 = 1.95983
...weights from: 4.54976 = 4.54976
...self tract_lengths: 0 = 0

Left Retrosplenial area, ventral part - Left Isocortex:
...3997 = 3997 voxels
...centres: [62.25167464 78.26985646 66.47607656] = [[62.25167464 78.269856
46 66.47607656]]
...weights to: 2.52084 = 2.52084
...weights from: 7.47747 = 7.47747
...self tract_lengths: 0 = 0

Left Anterior area - Left Isocortex:
...-1 = -1 voxels
...centres: [77.27146814 72.52493075 70.37257618] = [[77.27146814 72.524930
75 70.37257618]]
...weights to: 2.75957 = 2.75957
```

```
...weights from: 5.86238 = 5.86238
...self tract_lengths: 0 = 0

Left Rostrolateral visual area - Left Isocortex:
...-1 = -1 voxels
...centres: [87.78039216 77.9745098  66.57254902] = [[87.78039216 77.974509
8  66.57254902]]
...weights to: 2.27166 = 2.27166
...weights from: 6.42253 = 6.42253
...self tract_lengths: 0 = 0

Left Temporal association areas - Left Isocortex:
...3773 = 3773 voxels
...centres: [102.69399613  82.74112331  44.43124597] = [[102.69399613  82.7
4112331  44.43124597]]
...weights to: 4.7417 = 4.7417
...weights from: 6.0477 = 6.0477
...self tract_lengths: 0 = 0

Left Perirhinal area - Left Isocortex:
...1412 = 1412 voxels
...centres: [103.68844221  82.23366834  33.93467337] = [[103.68844221  82.2
3366834  33.93467337]]
...weights to: 4.78609 = 4.78609
...weights from: 8.2565 = 8.2565
...self tract_lengths: 0 = 0

Left Ectorhinal area - Left Isocortex:
...3390 = 3390 voxels
...centres: [102.9091954   80.43908046  36.10689655] = [[102.9091954   80.4
3908046  36.10689655]]
...weights to: 5.28341 = 5.28341
...weights from: 7.69002 = 7.69002
...self tract_lengths: 0 = 0

Left Olfactory Areas - Left Olfactory Areas:
...41043 voxels
...weights to: 39.4701 = 48.8479
...weights from: 53.8398 = 63.2176
...self weights: 0 = 9.37775

Left Hippocampal Formation - Left Hippocampal Formation:
...34819 voxels
...weights to: 34.0178 = 43.4767
...weights from: 48.5659 = 58.0249
...self weights: 0 = 9.45896

Left Cortical Subplate - Left Cortical Subplate:
...6669 voxels
...weights to: 44.7184 = 50.8921
...weights from: 44.4496 = 50.6234
...self weights: 0 = 6.17378

Left Striatum - Left Striatum:
...40219 voxels
...weights to: 98.9072 = 109.003
...weights from: 88.2897 = 98.3856
...self weights: 0 = 10.0959

Left Pallidum - Left Pallidum:
...9308 voxels
```

```
...weights to: 84.9946 = 89.3808
...weights from: 75.5767 = 79.9628
...self weights: 0 = 4.38613

Left Thalamus - Left Thalamus:
...13346 voxels
...weights to: 280.134 = 326.04
...weights from: 186.091 = 231.998
...self weights: 0 = 45.906

Left Nonspecific Thalamus - Left Nonspecific Thalamus:
...2324 voxels
...weights to: 115.961 = 118.485
...weights from: 61.0322 = 63.5561
...self weights: 0 = 2.5239

Left Hypothalamus - Left Hypothalamus:
...13871 voxels
...weights to: 354.926 = 630.732
...weights from: 366.33 = 642.136
...self weights: 0 = 275.806

Left Midbrain - Left Midbrain:
...19804 voxels
...weights to: 338.668 = 429.195
...weights from: 286.757 = 377.284
...self weights: 0 = 90.5271

Left Superior colliculus, motor related - Left Midbrain:
...6779 = 6779 voxels
...centres: [66.46432413 91.42129796 55.60666906] = [[66.46432413 91.421297
96 55.60666906]]
...weights to: 9.62674 = 9.62674
...weights from: 7.67702 = 7.67702
...self tract_lengths: 0 = 0

Left Pons Sensory - Left Pons Sensory:
...1585 voxels
...weights to: 13.202 = 13.3324
...weights from: 19.1642 = 19.2947
...self weights: 0 = 0.130488

Left Principal sensory nucleus of the trigeminal - Left Pons Sensory:
...1093 = 1093 voxels
...centres: [ 77.66363636 101.84        22.50363636] = [[ 77.66363636 101.8
4        22.50363636]]
...weights to: 3.14049 = 3.14049
...weights from: 9.72171 = 9.72171
...self tract_lengths: 0 = 0

Left Pons Motor - Left Pons Motor:
...5971 voxels
...weights to: 102.516 = 111.275
...weights from: 99.5803 = 108.339
...self weights: 0 = 8.75894

Left Pons Behavioral - Left Pons Behavioral:
...3890 voxels
...weights to: 115.281 = 126.613
...weights from: 81.4818 = 92.8137
...self weights: 0 = 11.3319
```

```
Left Medulla - Left Medulla:
...17303 voxels
...weights to: 162.776 = 241.373
...weights from: 187.547 = 266.144
...self weights: 0 = 78.5974

Left Spinal nucleus of the trigeminal - Left Spinal nucleus of the trigemin
al:
...3107 voxels
...weights to: 7.41493 = 7.94454
...weights from: 18.6598 = 19.1894
...self weights: 0 = 0.529612

Left Facial motor nucleus - Left Medulla:
...660 = 660 voxels
...centres: [ 70.58672377 108.59100642  11.23768737] = [[ 70.58672377 108.5
9100642  11.23768737]]
...weights to: 9.15874 = 9.15874
...weights from: 11.0785 = 11.0785
...self tract_lengths: 0 = 0

Left Inferior olivary complex - Left Medulla:
...567 = 567 voxels
...centres: [ 61.01234568 120.24279835   8.0617284 ] = [[ 61.01234568 120.2
4279835   8.0617284 ]]
...weights to: 4.99518 = 4.99518
...weights from: 10.4086 = 10.4086
...self tract_lengths: 0 = 0

Left Cerebellar Cortex - Left Cerebellar Cortex:
...33696 voxels
...weights to: 14.3996 = 16.6808
...weights from: 23.8543 = 26.1355
...self weights: 0 = 2.28123

Left Ansiform lobule - Left Cerebellar Cortex:
...9044 = 9044 voxels
...centres: [ 86.66716141 118.267718    49.59369202] = [[ 86.66716141 118.2
67718    49.59369202]]
...weights to: 0.843584 = 0.843584
...weights from: 0.209096 = 0.209096
...self tract_lengths: 0 = 0

Left Cerebellar Nuclei - Left Cerebellar Nuclei:
...1116 voxels
...weights to: 6.58665 = 7.09595
...weights from: 22.0603 = 22.5696
...self weights: 0 = 0.5093
```

Plot merged connectome

In [10]:
```
# Plot the resulting connectivity weights at linear and log scale
import matplotlib.pyplot as plt

fig, axes = plt.subplots(2, 2, figsize=(15, 15))
cs_lin = axes[0, 0].imshow(new_conn.weights, cmap='jet', aspect='equal', int
axes[0, 0].set_title('Structural connectivity matrix', fontsize=12)
axcb_lin = plt.colorbar(cs_lin, ax=axes[0, 0])
```

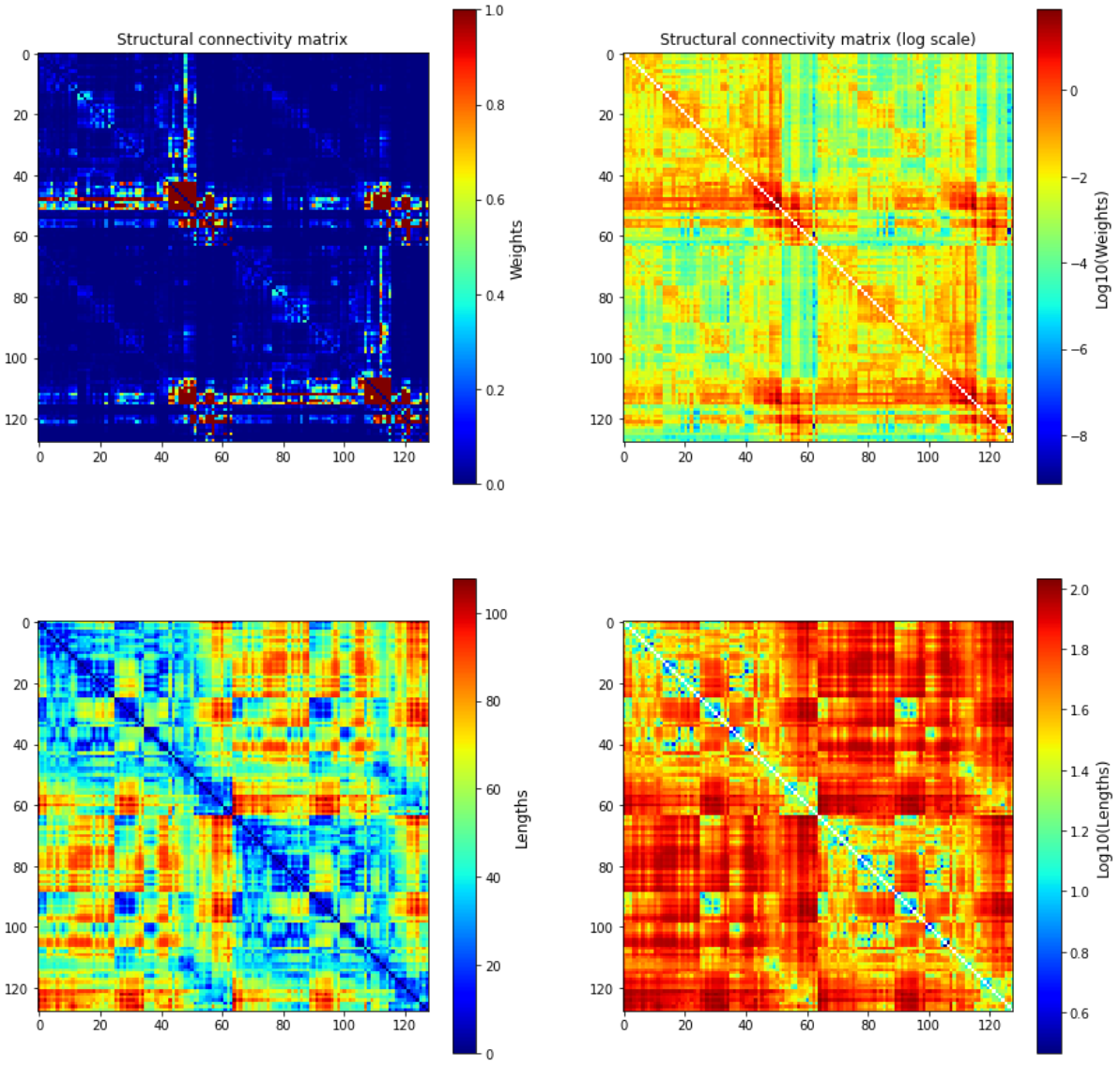
```
axcb_lin.set_label('Weights', fontsize=12)

cs_log = axes[0, 1].imshow(np.log10(new_conn.weights), cmap='jet', aspect='e
axes[0, 1].set_title('Structural connectivity matrix (log scale)', fontsize=
axcb_log = plt.colorbar(cs_log, ax=axes[0, 1])
axcb_log.set_label('Log10(Weights)', fontsize=12)


ls_lin = axes[1, 0].imshow(new_conn.tract_lengths, cmap='jet', aspect='equal
axcb_lin = plt.colorbar(ls_lin, ax=axes[1, 0])
axcb_lin.set_label('Lengths', fontsize=12)

ls_log = axes[1, 1].imshow(np.log10(new_conn.tract_lengths), cmap='jet', asp
axcb_log = plt.colorbar(ls_log, ax=axes[1, 1])
axcb_log.set_label('Log10(Lengths)', fontsize=12)
```

```
/tmp/ipykernel_110/2993400780.py:10: RuntimeWarning: divide by zero encount
ered in log10
  cs_log = axes[0, 1].imshow(np.log10(new_conn.weights), cmap='jet', aspect
='equal', interpolation='none')
/tmp/ipykernel_110/2993400780.py:20: RuntimeWarning: divide by zero encount
ered in log10
  ls_log = axes[1, 1].imshow(np.log10(new_conn.tract_lengths), cmap='jet',
aspect='equal', interpolation='none')
```



Construct useful indices

In [11]:
```
inds = {}
inds["crtx"] = []
inds["m1"] = []
inds["s1brl"] = []
inds["supcol"] = []
inds["facial"] = []
inds["trigeminal"] = []
inds["ponssens_trigeminal"] = []
inds["ponssens"] = []
inds["ponsmotor"] = []
inds["thal"] = []
inds["thalspec"] = []
inds["m1thal"] = []
inds["s1brlthal"] = []
inds["ansilob"] = []
inds["dentate"] = []
inds["interposed"] = []
inds["oliv"] = []
inds['cereb_nuclei'] = []
inds['cereb_crtx'] = []
for iR, (reg, lbl) in enumerate(zip(new_conn.region_labels, new_major_struct
    if "Isocortex" in lbl:
        inds["crtx"].append(iR)
    if "Primary motor area" in reg and "Specific" not in reg:
        inds["m1"].append(iR)
    if "barrel" in reg and "Specific" not in reg:
        inds["s1brl"].append(iR)
    if "Superior colliculus, motor related" in reg:
        inds["supcol"].append(iR)
    if "Primary motor area" in reg and "Specific" in reg:
        inds["m1thal"].append(iR)
    if "barrel" in reg and "Specific" in reg:
        inds["s1brlthal"].append(iR)
    if "Superior colliculus, motor related" in reg:
        inds["supcol"].append(iR)
    if "Facial" in reg:
        inds["facial"] .append(iR)
    if "Spinal nucleus of the trigeminal" in reg:
        inds["trigeminal"].append(iR)
    if "Principal sensory nucleus of the trigeminal" in reg:
        inds["ponssens_trigeminal"] .append(iR)
    if "Pons Sensory" in lbl:
        inds["ponssens"] .append(iR)
    if "Pons Motor" in lbl:
        inds["ponsmotor"].append(iR)
    if "Nonspecific Thalamus" in lbl:
        inds["thal"].append(iR)
    if "Thalamus" in lbl:
        inds["thalspec"].append(iR)
    if "Ansiform lobule" in reg:
        inds["ansilob"].append(iR)
    elif "Cerebellar Cortex" in lbl:
        inds['cereb_crtx'].append(iR)
    if "Dentate nucleus" in reg:
        inds["dentate"].append(iR)
    if "Interposed nucleus" in reg:
        inds["interposed"].append(iR)
    elif "Cerebellar Nuclei" in lbl:
        inds['cereb_nuclei'].append(iR)
    if "Inferior olivary complex" in reg:
```

```
        inds["oliv"].append(iR)
inds["m1s1brl"] = inds["m1"]  + inds["s1brl"]
inds["sens"] = inds["trigeminal"]  + inds["ponssens_trigeminal"] + inds["s1b
inds["motor"] = inds["m1thal"] + inds["facial"]  # inds["supcol"]  +
inds["cereb"] = inds["ansilob"] + inds["dentate"] + inds["interposed"] + ind
inds['cereb_merged'] = inds['cereb_nuclei'] + inds['cereb_crtx']
allspecial = inds["m1s1brl"] + inds["motor"] + inds["sens"] + inds["thal"] +
for key, val in inds.items():
    inds[key] = np.array(val)

print("ROIs:\n", new_conn.region_labels[allspecial])
```

```
ROIs:
 ['Right Primary motor area' 'Left Primary motor area'
 'Right Primary somatosensory area, barrel field'
 'Left Primary somatosensory area, barrel field'
 'Right Facial motor nucleus' 'Left Facial motor nucleus'
 'Right Spinal nucleus of the trigeminal'
 'Left Spinal nucleus of the trigeminal'
 'Right Principal sensory nucleus of the trigeminal'
 'Left Principal sensory nucleus of the trigeminal'
 'Right Nonspecific Thalamus' 'Left Nonspecific Thalamus' 'Right Thalamus'
 'Right Nonspecific Thalamus' 'Left Thalamus' 'Left Nonspecific Thalamus'
 'Right Ansiform lobule' 'Left Ansiform lobule'
 'Right Inferior olivary complex' 'Left Inferior olivary complex']
```

In [12]:

```
import h5py

# the method returns the tract lengths between the brain areas in the select
def construct_tract_lengths(centres):
    n_regions = len(centres)
    tracts = np.zeros((n_regions, n_regions), dtype=float)
    for i_ind, inj in enumerate(centres):
        for i_targ, targ in enumerate(centres):
            tracts[i_ind, i_targ] = np.sqrt(
                (inj[0] - targ[0]) ** 2 + (inj[1] - targ[1]) ** 2 + (inj[2]
    return tracts

def write_connectivity_to_h5_file(connectivity, filename):
    #save the structural conn matrix
    f = h5py.File(os.path.join(data_path, filename), "w")
    for attr in ["weights", "tract_lengths", "centres", "region_labels"]:
        if attr == "region_labels":
            f.create_dataset(attr, data=getattr(connectivity, attr).astype(h

        else:
            f.create_dataset(attr, data=getattr(connectivity, attr))
    f.close()



def write_all_files(connectivity, major_structs_labels, voxel_count, inds,
                    conn_name="Connectivity", conn_type=""):
    if WEIGHTED_AVERAGE_CENTRES:
        conn_name += "_wavCntrs"
    else:
        conn_name += "_avCntrs"
    if TRACT_LENGTHS_MODE == "euclidean":
        conn_name += "_TLed"
    else:
        conn_name += "_TLwav"
    # Write the resulting connectivity to .h5 TVB compatible file...
```

```
    print("Writing %s_%s.h5" % (conn_name, conn_type))
    write_connectivity_to_h5_file(connectivity, "%s_%s.h5" % (conn_name, cor
    # ... along with the corresponding mapping from regions to major structu
    print("Writing major_structs_labels_%s.npy..." % conn_type)
    np.save("major_structs_labels_%s.npy" % conn_type, major_structs_labels)
    print("Writing voxel_count_%s.npy..." % conn_type)
    np.save("voxel_count_%s.npy" % conn_type, voxel_count)
    print("Writing inds_%s.npy..." % conn_type)
    np.save("inds_%s.npy" % conn_type, inds)
```

In [13]:
```
print("Major structures:\n", np.unique(new_major_structs_labels))
```

```
Major structures:
 ['Left Cerebellar Cortex' 'Left Cerebellar Nuclei'
 'Left Cortical Subplate' 'Left Hippocampal Formation' 'Left Hypothalamus'
 'Left Isocortex' 'Left Medulla' 'Left Midbrain'
 'Left Nonspecific Thalamus' 'Left Olfactory Areas' 'Left Pallidum'
 'Left Pons Behavioral' 'Left Pons Motor' 'Left Pons Sensory'
 'Left Spinal nucleus of the trigeminal' 'Left Striatum' 'Left Thalamus'
 'Right Cerebellar Cortex' 'Right Cerebellar Nuclei'
 'Right Cortical Subplate' 'Right Hippocampal Formation'
 'Right Hypothalamus' 'Right Isocortex' 'Right Medulla' 'Right Midbrain'
 'Right Nonspecific Thalamus' 'Right Olfactory Areas' 'Right Pallidum'
 'Right Pons Behavioral' 'Right Pons Motor' 'Right Pons Sensory'
 'Right Spinal nucleus of the trigeminal' 'Right Striatum'
 'Right Thalamus']
```

Writing files for Connectivity with summarized subcortical structures

In [14]:
```
write_all_files(new_conn, new_major_structs_labels, new_voxel_count, inds,
                conn_name="Connectivity", conn_type="SummedSubcortical")
```

```
Writing Connectivity_wavCntrs_TLwav_SummedSubcortical.h5
Writing major_structs_labels_SummedSubcortical.npy...
Writing voxel_count_SummedSubcortical.npy...
Writing inds_SummedSubcortical.npy...
```

Splitting Thalamus to create specific thalamic nuclei

In [15]:
```
# Now we need to create the specific Thalamic nuclei, one for each Isocortex

# Thalamus indices:
iThR = np.where(["Right Thalamus" in lbl for lbl in new_major_structs_labels
iThL = np.where(["Left Thalamus" in lbl for lbl in new_major_structs_labels]
assert np.all(new_conn.region_labels[[iThR, iThL]] == ['Right Thalamus', 'Le


# Isocortex indices
crtx_inds = np.where(["Isocortex" in lbl for lbl in new_major_structs_labels
n_crtx = int(len(crtx_inds))
n_crtx2 = int(n_crtx/2)
crtx_inds_R = crtx_inds[:n_crtx2]
crtx_inds_L = crtx_inds[n_crtx2:]
```

```
# All the rest indices, subcortical but not specific thalamic, but including
subcrtx_inds = np.arange(len(new_major_structs_labels)).astype('i')
subcrtx_inds = np.delete(subcrtx_inds,
                         crtx_inds.tolist() + [iThR, iThL])

# Create new major_structs_labels
insert_inds_R = crtx_inds[n_crtx2-1]+1
final_major_structs_labels = insert_axis(new_major_structs_labels,
                                         arr_to_insert=np.tile('Right Specif
                                         inds=[insert_inds_R])
insert_inds_L = 1+ np.where(["Left Isocortex" in lbl for lbl in final_major_
final_major_structs_labels = insert_axis(final_major_structs_labels,
                                         arr_to_insert=np.tile('Left Specifi
                                         inds=[insert_inds_L])
# print(final_major_structs_labels)

# Get the new indices of major structures:
final_crtx_inds = np.where(["Isocortex" in lbl for lbl in final_major_struct
final_crtx_inds_R = final_crtx_inds[:n_crtx2]
final_crtx_inds_L = final_crtx_inds[n_crtx2:]
final_spec_thal_inds_R = final_crtx_inds[:n_crtx2] + n_crtx2
final_spec_thal_inds_L = final_crtx_inds[n_crtx2:] + n_crtx2
final_spec_thal_inds = final_spec_thal_inds_R.tolist() + final_spec_thal_ind
final_iThR = np.where(["Right Nonspecific Thalamus" in lbl for lbl in final_
final_iThL = np.where(["Left Nonspecific Thalamus" in lbl for lbl in final_m
final_n_regions = len(final_major_structs_labels)
# All the rest indices, subcortical but not thalamic:
final_subcrtx_inds = np.arange(final_n_regions).astype('i')
final_subcrtx_inds = np.delete(final_subcrtx_inds,
                               final_crtx_inds.tolist() +
                               final_spec_thal_inds_R.tolist() +
                               final_spec_thal_inds_L.tolist() +
                               [final_iThR, final_iThL])
assert final_n_regions == new_conn.number_of_regions + n_crtx
assert np.all(final_major_structs_labels[final_crtx_inds_R] == "Right Isocor
assert np.all(final_major_structs_labels[final_crtx_inds_L] == "Left Isocort
assert np.all(final_major_structs_labels[final_spec_thal_inds_R] == "Right S
assert np.all(final_major_structs_labels[final_spec_thal_inds_L] == "Left Sp
assert np.all(final_major_structs_labels[[final_iThR, final_iThL]] == ['Righ
                                                                       'Left

# Create new voxel counts:
# Thalamus voxel counts
voxel_count_th = new_voxel_count[iThL]
assert new_voxel_count[iThL] == new_voxel_count[iThR] == voxel_count_th
voxel_count_spec_th = int(voxel_count_th / n_crtx2)
final_voxel_count = insert_axis(new_voxel_count,
                                arr_to_insert=np.tile(voxel_count_spec_th, n
                                inds=[insert_inds_R])
final_voxel_count = insert_axis(final_voxel_count,
                                arr_to_insert=np.tile(voxel_count_spec_th, n
                                inds=[insert_inds_L])
assert np.all(final_voxel_count[final_spec_thal_inds_R] == voxel_count_spec_
assert np.all(final_voxel_count[final_spec_thal_inds_L] == voxel_count_spec_

# Create new region labels
final_region_labels = insert_axis(new_conn.region_labels,
                                  arr_to_insert=np.array(['Right Specific Th
                                                          for reg in new_con
                                  inds=[insert_inds_R])
```

```
final_region_labels = insert_axis(final_region_labels,
                                  arr_to_insert=np.array(['Left Specific Tha
                                                          for reg in new_cor
                                  inds=[insert_inds_L])
assert np.all(np.array([reg.split("Right ")[-1] for reg in final_region_labe
              np.array([reg.split("Right Specific Thalamus to ")[-1] for reg
assert np.all(np.array([reg.split("Left ")[-1] for reg in final_region_label
              np.array([reg.split("Left Specific Thalamus to ")[-1] for reg

# Create new centers:
final_centres = insert_axis(new_conn.centres,
                            arr_to_insert=np.repeat([new_conn.centres[iThR]]
                            inds=[insert_inds_R])
final_centres = insert_axis(final_centres,
                            arr_to_insert=np.repeat([new_conn.centres[iThL]]
                            inds=[insert_inds_L])


def expand_2D_with_zeros(arr, inds, nregs):
    new_arr = insert_axis(arr,
                          arr_to_insert=np.tile(0.0, (nregs, arr.shape[1])),
                          inds=[inds[0]], axis=0)
    new_arr = insert_axis(new_arr,
                          arr_to_insert=np.tile(0.0, (nregs, new_arr.shape[1
                          inds=[inds[1]], axis=0)
    new_arr = insert_axis(new_arr,
                          arr_to_insert=np.tile(0.0, (new_arr.shape[0], nreg
                          inds=[inds[0]], axis=1)
    new_arr = insert_axis(new_arr,
                          arr_to_insert=np.tile(0.0, (new_arr.shape[0], nreg
                          inds=[inds[1]], axis=1)
    return new_arr

# Create new weights:
final_weights = expand_2D_with_zeros(new_conn.weights, [insert_inds_R, inser
# Connections Specific Thalami -> Cortex = Specific Thalamus -> Cortex:
final_weights[final_crtx_inds_R, final_spec_thal_inds_R] = new_conn.weights[
final_weights[final_crtx_inds_L, final_spec_thal_inds_L] = new_conn.weights[
# Connections  Cortex -> Specific Thalami = Cortex -> Specific Thalamus:
final_weights[final_spec_thal_inds_R, final_crtx_inds_R] = new_conn.weights[
final_weights[final_spec_thal_inds_L, final_crtx_inds_L] = new_conn.weights[
# Connections Subcortex -> Specific Thalami = Subcortex -> Specific Thalamus
final_weights[final_spec_thal_inds_R[:, None], final_subcrtx_inds[None, :]]
final_weights[final_spec_thal_inds_L[:, None], final_subcrtx_inds[None, :]]
# Connections Specific Thalami -> Subcortex  =  Specific Thalamus -> Subcort
final_weights[final_subcrtx_inds[:, None], final_spec_thal_inds_R[None, :]]
final_weights[final_subcrtx_inds[:, None], final_spec_thal_inds_L[None, :]]
# No connections Specific Thalami <-> Specific Thalami!!!

# Create new tract_lengths:
final_tract_lengths = expand_2D_with_zeros(new_conn.tract_lengths, [insert_i
# Connections Specific Thalami -> Cortex = Specific Thalamus -> Cortex:
final_tract_lengths[final_crtx_inds_R, final_spec_thal_inds_R] = new_conn.tr
final_tract_lengths[final_crtx_inds_L, final_spec_thal_inds_L] = new_conn.tr
# Connections  Cortex -> Specific Thalami = Cortex -> Specific Thalamus:
final_tract_lengths[final_spec_thal_inds_R, final_crtx_inds_R] = new_conn.tr
final_tract_lengths[final_spec_thal_inds_L, final_crtx_inds_L] = new_conn.tr
# Connections Subcortex -> Specific Thalami = Subcortex -> Specific Thalamus

# Connections Subcortex -> Specific Thalami = Subcortex -> Specific Thalamus
final_tract_lengths[final_spec_thal_inds_R[:, None], final_subcrtx_inds[None
```

```
final_tract_lengths[final_spec_thal_inds_L[:, None], final_subcrtx_inds[None
# Connections Specific Thalami -> Subcortex  =  Specific Thalamus -> Subcort
final_tract_lengths[final_subcrtx_inds[:, None], final_spec_thal_inds_R[None
final_tract_lengths[final_subcrtx_inds[:, None], final_spec_thal_inds_L[None
# No connections Specific Thalami <-> Specific Thalami!!!

# Finally delete the merged Right/Left Thalamus:
iTh = []
iTh.append(np.where(["Right Thalamus" in lbl for lbl in final_region_labels]
iTh.append(np.where(["Left Thalamus" in lbl for lbl in final_region_labels])
iTh = np.unique(iTh)
final_major_structs_labels = np.delete(final_major_structs_labels, iTh)
final_voxel_count = np.delete(final_voxel_count, iTh)
final_region_labels = np.delete(final_region_labels, iTh)
final_centres = np.delete(final_centres, iTh)
final_weights = np.delete(final_weights, iTh, axis=0)
final_weights = np.delete(final_weights, iTh, axis=1)
final_tract_lengths = np.delete(final_tract_lengths, iTh, axis=0)
final_tract_lengths = np.delete(final_tract_lengths, iTh, axis=1)

final_connectivity = Connectivity(weights=final_weights,
                                  tract_lengths=final_tract_lengths,
                                  centres=final_centres,
                                  region_labels=final_region_labels)
```

Plot the connectivity with the specific thalami

In [16]:

```
# Plot the resulting connectivity weights at linear and log scale
import matplotlib.pyplot as plt

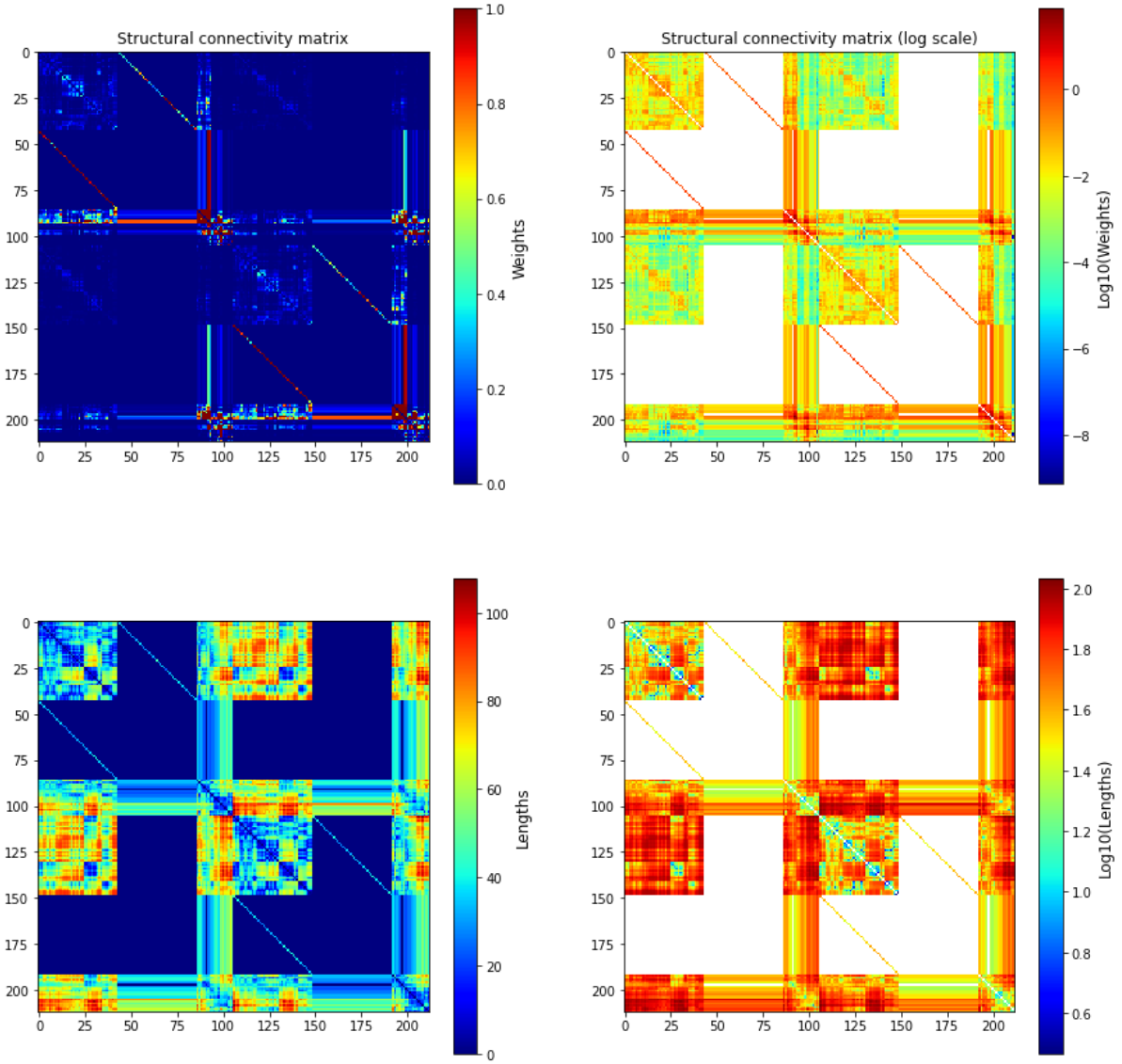
fig, axes = plt.subplots(2, 2, figsize=(15, 15))
cs_lin = axes[0, 0].imshow(final_connectivity.weights, cmap='jet', aspect='e
axes[0, 0].set_title('Structural connectivity matrix', fontsize=12)
axcb_lin = plt.colorbar(cs_lin, ax=axes[0, 0])
axcb_lin.set_label('Weights', fontsize=12)

cs_log = axes[0, 1].imshow(np.log10(final_connectivity.weights), cmap='jet',
axes[0, 1].set_title('Structural connectivity matrix (log scale)', fontsize=
axcb_log = plt.colorbar(cs_log, ax=axes[0, 1])
axcb_log.set_label('Log10(Weights)', fontsize=12)


ls_lin = axes[1, 0].imshow(final_connectivity.tract_lengths, cmap='jet', asp
axcb_lin = plt.colorbar(ls_lin, ax=axes[1, 0])
axcb_lin.set_label('Lengths', fontsize=12)

ls_log = axes[1, 1].imshow(np.log10(final_connectivity.tract_lengths), cmap=
axcb_log = plt.colorbar(ls_log, ax=axes[1, 1])
axcb_log.set_label('Log10(Lengths)', fontsize=12)
```

```
/tmp/ipykernel_110/2136995184.py:10: RuntimeWarning: divide by zero encount
ered in log10
  cs_log = axes[0, 1].imshow(np.log10(final_connectivity.weights), cmap='je
t', aspect='equal', interpolation='none')
/tmp/ipykernel_110/2136995184.py:20: RuntimeWarning: divide by zero encount
ered in log10
  ls_log = axes[1, 1].imshow(np.log10(final_connectivity.tract_lengths), cm
ap='jet', aspect='equal', interpolation='none')
```



Plot the resulting connectivity weights and tract lengths beween Isocortex and Specific Thalamic Nuclei

In [17]:
```
fig, axes = plt.subplots(2, 2, figsize=(15, 15))
cs_spec_R = axes[0, 0].plot(final_connectivity.weights[final_crtx_inds_R, fi
cs_spec_L = axes[0, 0].plot(final_connectivity.weights[final_crtx_inds_L, fi
axes[0, 0].set_title('Isocortex -> Specific Thalamic Nuclei', fontsize=12)
axes[0, 0].set_ylabel('Weights', fontsize=12)
axes[0, 0].legend()

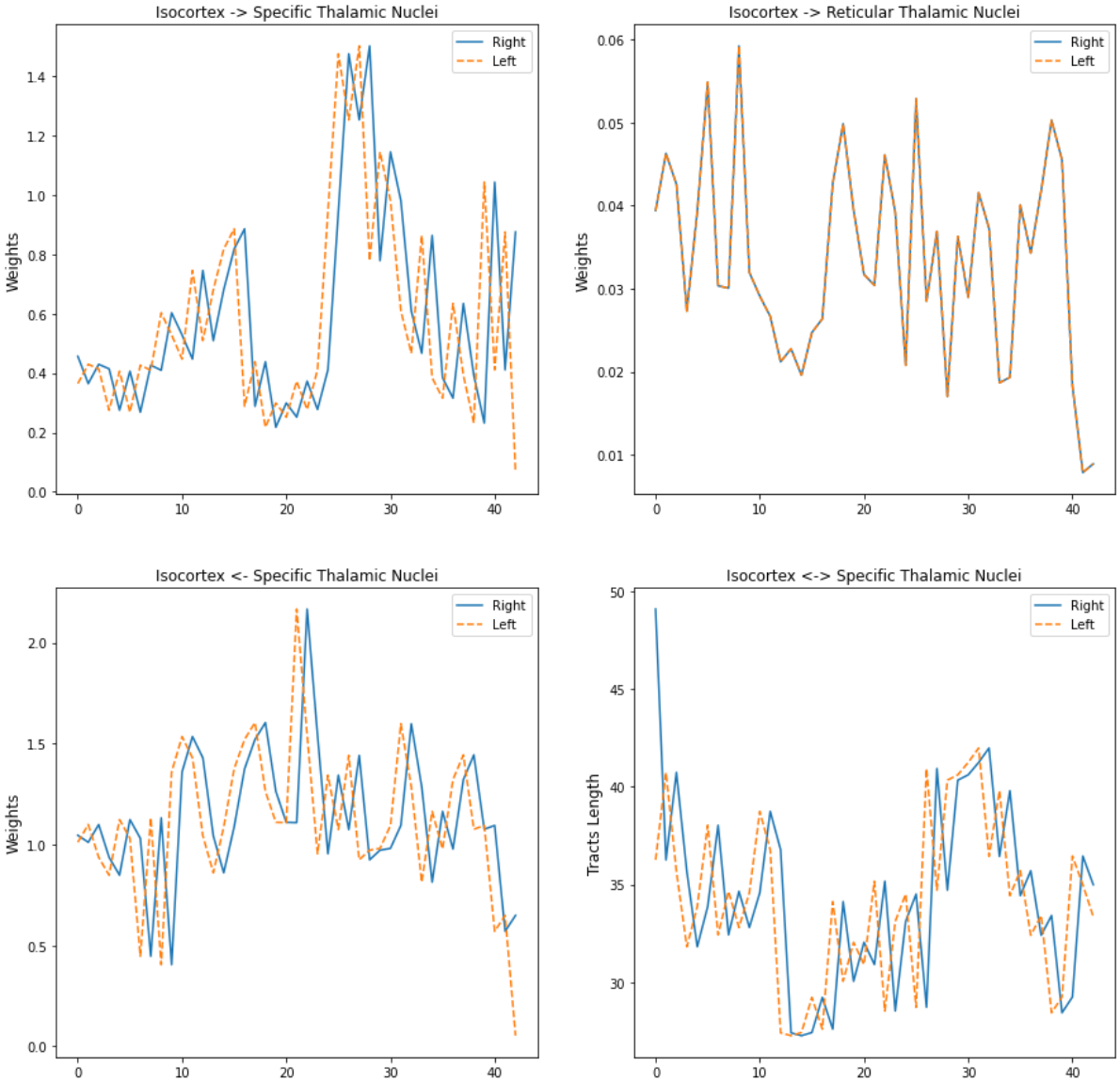
cs_rtn_R = axes[0, 1].plot(crtx_to_rtn_conns[0, :43], "-", label="Right")
cs_rtn_L = axes[0, 1].plot(crtx_to_rtn_conns[1, 43:], "--", label="Left")
axes[0, 1].set_title('Isocortex -> Reticular Thalamic Nuclei', fontsize=12)
axes[0, 1].set_ylabel('Weights', fontsize=12)
```

```
axes[0, 1].legend()

cs_lin_R = axes[1, 0].plot(final_connectivity.weights[final_spec_thal_inds_R
cs_lin_L = axes[1, 0].plot(final_connectivity.weights[final_spec_thal_inds_L
axes[1, 0].set_title('Isocortex <- Specific Thalamic Nuclei', fontsize=12)
axes[1, 0].set_ylabel('Weights', fontsize=12)
axes[1, 0].legend()


tl_lin_R = axes[1, 1].plot(final_connectivity.tract_lengths[final_spec_thal_
tl_lin_L = axes[1, 1].plot(final_connectivity.tract_lengths[final_spec_thal_
axes[1, 1].set_title('Isocortex <-> Specific Thalamic Nuclei', fontsize=12)
axes[1, 1].set_ylabel('Tracts Length', fontsize=12)
axes[1, 1].legend()
```

Out[17]: <matplotlib.legend.Legend at 0x7faa55f37b80>



Construct useful indices

In [18]:
```
inds = {}
inds["crtx"] = []
inds["m1"] = []
inds["s1brl"] = []
inds["supcol"] = []
inds["facial"] = []
```

```
inds["trigeminal"] = []
inds["ponssens_trigeminal"] = []
inds["ponssens"] = []
inds["ponsmotor"] = []
inds["thal"] = []
inds["thalspec"] = []
inds["m1thal"] = []
inds["s1brlthal"] = []
inds["ansilob"] = []
inds["dentate"] = []
inds["interposed"] = []
inds["oliv"] = []
inds['cereb_nuclei'] = []
inds['cereb_crtx'] = []
for iR, (reg, lbl) in enumerate(zip(final_connectivity.region_labels, final_
    if "Isocortex" in lbl:
        inds["crtx"].append(iR)
    if "Primary motor area" in reg and "Specific" not in reg:
        inds["m1"].append(iR)
    if "barrel" in reg and "Specific" not in reg:
        inds["s1brl"].append(iR)
    if "Superior colliculus, motor related" in reg:
        inds["supcol"].append(iR)
    if "Primary motor area" in reg and "Specific" in reg:
        inds["m1thal"].append(iR)
    if "barrel" in reg and "Specific" in reg:
        inds["s1brlthal"].append(iR)
    if "Superior colliculus, motor related" in reg:
        inds["supcol"].append(iR)
    if "Facial" in reg:
        inds["facial"] .append(iR)
    if "Spinal nucleus of the trigeminal" in reg:
        inds["trigeminal"].append(iR)
    if "Principal sensory nucleus of the trigeminal" in reg:
        inds["ponssens_trigeminal"] .append(iR)
    if "Pons Sensory" in lbl:
        inds["ponssens"] .append(iR)
    if "Pons Motor" in lbl:
        inds["ponsmotor"].append(iR)
    if "Nonspecific Thalamus" in lbl:
        inds["thal"].append(iR)
    if "Specific Thalamus" in lbl:
        inds["thalspec"].append(iR)
    if "Ansiform lobule" in reg:
        inds["ansilob"].append(iR)
    elif "Cerebellar Cortex" in lbl:
        inds['cereb_crtx'].append(iR)
    if "Dentate nucleus" in reg:
        inds["dentate"].append(iR)
    if "Interposed nucleus" in reg:
        inds["interposed"].append(iR)
    elif "Cerebellar Nuclei" in lbl:
        inds['cereb_nuclei'].append(iR)
    if "Inferior olivary complex" in reg:
        inds["oliv"].append(iR)

inds["m1s1brl"] = inds["m1"]  + inds["s1brl"]
inds["sens"] = inds["trigeminal"]  + inds["ponssens_trigeminal"] + inds["s1b
inds["motor"] = inds["m1thal"] + inds["facial"]  # inds["supcol"]  +
inds["cereb"] = inds["ansilob"] + inds["dentate"] + inds["interposed"] + ind
inds['cereb_merged'] = inds['cereb_nuclei'] + inds['cereb_crtx']
```

```
allspecial = inds["m1s1brl"] + inds["motor"] + inds["sens"] + inds["thal"] +
for key, val in inds.items():
    inds[key] = np.array(val)

print("ROIs:\n", final_connectivity.region_labels[allspecial])
```

```
ROIs:
 ['Right Primary motor area' 'Left Primary motor area'
 'Right Primary somatosensory area, barrel field'
 'Left Primary somatosensory area, barrel field'
 'Right Specific Thalamus to Primary motor area'
 'Left Specific Thalamus to Primary motor area'
 'Right Facial motor nucleus' 'Left Facial motor nucleus'
 'Right Spinal nucleus of the trigeminal'
 'Left Spinal nucleus of the trigeminal'
 'Right Principal sensory nucleus of the trigeminal'
 'Left Principal sensory nucleus of the trigeminal'
 'Right Specific Thalamus to Primary somatosensory area, barrel field'
 'Left Specific Thalamus to Primary somatosensory area, barrel field'
 'Right Nonspecific Thalamus' 'Left Nonspecific Thalamus'
 'Right Ansiform lobule' 'Left Ansiform lobule'
 'Right Inferior olivary complex' 'Left Inferior olivary complex']
```

In [19]:
```
print("Major structures:\n", np.unique(final_major_structs_labels))
```

```
Major structures:
 ['Left Cerebellar Cortex' 'Left Cerebellar Nuclei'
 'Left Cortical Subplate' 'Left Hippocampal Formation' 'Left Hypothalamus'
 'Left Isocortex' 'Left Medulla' 'Left Midbrain'
 'Left Nonspecific Thalamus' 'Left Olfactory Areas' 'Left Pallidum'
 'Left Pons Behavioral' 'Left Pons Motor' 'Left Pons Sensory'
 'Left Specific Thalamus' 'Left Spinal nucleus of the trigeminal'
 'Left Striatum' 'Right Cerebellar Cortex' 'Right Cerebellar Nuclei'
 'Right Cortical Subplate' 'Right Hippocampal Formation'
 'Right Hypothalamus' 'Right Isocortex' 'Right Medulla' 'Right Midbrain'
 'Right Nonspecific Thalamus' 'Right Olfactory Areas' 'Right Pallidum'
 'Right Pons Behavioral' 'Right Pons Motor' 'Right Pons Sensory'
 'Right Specific Thalamus' 'Right Spinal nucleus of the trigeminal'
 'Right Striatum']
```

Writing files for Connectivity with summarized subcortical structures and Specific Thalami

In [20]:
```
# Write the resulting connectivity to .h5 TVB compatible file...
write_all_files(final_connectivity, final_major_structs_labels, final_voxel_
                conn_name="Connectivity", conn_type="SummedSubcortical_Thals
```

```
Writing Connectivity_wavCntrs_TLwav_SummedSubcortical_Thals.h5
Writing major_structs_labels_SummedSubcortical_Thals.npy...
Writing voxel_count_SummedSubcortical_Thals.npy...
Writing inds_SummedSubcortical_Thals.npy...
```

Print out statistics of final regions' sizes and connectivity

In [21]:
```
from six import string_types
from collections import OrderedDict
from tvb.contrib.scripts.utils.data_structures_utils import is_integer, is_f
from examples.tvb_nest.notebooks.cerebellum.utils import print_conn


def _maxrow(maxrow, weights):
    if maxrow < 1:
        cum = np.maximum(maxrow, 0.1)
        maxrow_label = "%g%%" % (100*cum)
        weights_sum = 0.0
        weights_total = weights.sum()
        maxrow = 0
        for weight in weights:
            maxrow += 1
            weights_sum += weight
            if weights_sum / weights_total >= cum:
                break
    else:
        maxrow = int(maxrow)
        maxrow_label = "%d" % maxrow
    return maxrow, maxrow_label


def print_weights_from(label, inds, region_labels, weights, maxrow=0.9):
    for iH, hemi in enumerate(["Right", "Left"]):
        arginds = np.argsort(weights[inds[iH], :])[::-1]
        out_maxrow, maxrow_label = _maxrow(maxrow, weights[inds[iH], arginds
        d = OrderedDict()
        d[("Region", 55)] = ["%d.%s" % (iR, region_labels[iR]) for iR in arg
        d[("Weight", 30)] = weights[inds[iH], arginds]
        d[("Total weights to", 30)] = np.nansum(weights[arginds], axis=1)
        print_conn(d, prnt="\nStronger %s connections from %s %s to:\n" % (m
                   maxrow=out_maxrow, printit=True);


def print_weights_to(label, inds, region_labels, weights, maxrow=0.9):
    for iH, hemi in enumerate(["Right", "Left"]):
        arginds = np.argsort(weights[:, inds[iH]])[::-1]
        out_maxrow, maxrow_label = _maxrow(maxrow, weights[inds[iH], arginds
        d = OrderedDict()
        d[("Region", 55)] = ["%d.%s" % (iR, region_labels[iR]) for iR in arg
        d[("Weight", 30)] = weights[arginds, inds[iH]]
        d[("Total weights from", 30)] = np.nansum(weights[:, arginds], axis=
        print_conn(d, prnt="\nStronger %s connections to %s %s from:\n" % (m
                   maxrow=out_maxrow, printit=True);
```

In [22]:
```
d = OrderedDict()
d[("Region", 55)] = ["%d.%s" % (iR, reg[:50]) for iR, reg in enumerate(final
d[("Major Structure", 30)] = final_major_structs_labels
d[("Voxels", 10)] = final_voxel_count
d[("Total weights to/from", 21)] = np.array(["%0.3f/%0.3f" % ( wt, wf)
                                             for wt, wf in zip(np.nansum(fir
                                                               np.nansum(fir
print_conn(d, prnt="", printit=True);
```

```
Region.....................................................Major Structur
e..............Voxels....Total weights to/from
--------------------------------------------------------------------------
-----------------------------------------
0.Right Frontal pole, cerebral cortex.................Right Isocorte
x..............514.......3.107/5.948..........
1.Right Primary motor area............................Right Isocorte
x..............11760.....1.855/6.174..........
2.Right Secondary motor area..........................Right Isocorte
x..............10098.....2.315/6.759..........
3.Right Primary somatosensory area, nose..............Right Isocorte
x..............1358......1.197/5.138..........
4.Right Primary somatosensory area, barrel field.......Right Isocorte
x..............10306.....1.371/6.229..........
5.Right Primary somatosensory area, lower limb.........Right Isocorte
x..............3254......1.829/5.456..........
6.Right Primary somatosensory area, mouth..............Right Isocorte
x..............2924......1.342/4.833..........
7.Right Primary somatosensory area, upper limb.........Right Isocorte
x..............5406......1.388/2.691..........
8.Right Primary somatosensory area, trunk..............Right Isocorte
x..............4799......2.315/4.736..........
9.Right Primary somatosensory area, unassigned.........Right Isocorte
x..............2958......1.709/3.534..........
10.Right Supplemental somatosensory area..............Right Isocorte
x..............5729......2.436/7.186..........
11.Right Gustatory areas..............................Right Isocorte
x..............2104......3.481/7.911..........
12.Right Visceral area................................Right Isocorte
x..............1793......4.021/9.503..........
13.Right Dorsal auditory area.........................Right Isocorte
x..............2556......3.358/4.931..........
14.Right Primary auditory area........................Right Isocorte
x..............2689......3.708/3.858..........
15.Right Posterior auditory area......................Right Isocorte
x..............191.......4.806/4.555..........
16.Right Ventral auditory area........................Right Isocorte
x..............2554......3.647/7.515..........
17.Right Anterolateral visual area....................Right Isocorte
x..............1981......3.365/6.113..........
18.Right Anteromedial visual area.....................Right Isocorte
x..............1795......3.629/6.890..........
19.Right Lateral visual area..........................Right Isocorte
x..............880.......3.308/5.298..........
20.Right Primary visual area..........................Right Isocorte
x..............6227......2.396/4.574..........
21.Right Posterolateral visual area...................Right Isocorte
x..............679.......2.945/5.238..........
22.Right posteromedial visual area....................Right Isocorte
x..............1265......3.178/9.601..........
23.Right Laterointermediate area......................Right Isocorte
x..............-1........3.731/6.566..........
24.Right Postrhinal area..............................Right Isocorte
x..............-1........4.321/6.548..........
25.Right Anterior cingulate area, dorsal part..........Right Isocorte
x..............2789......3.355/7.577..........
26.Right Anterior cingulate area, ventral part.........Right Isocorte
x..............2418......4.413/9.728..........
27.Right Prelimbic area...............................Right Isocorte
x..............1790......4.390/9.983..........
28.Right Infralimbic area.............................Right Isocorte
```

```
x..............1764......6.726/7.545.........
29.Right Orbital area, lateral part...................Right Isocorte
x..............1853......4.088/6.327.........
30.Right Orbital area, medial part....................Right Isocorte
x..............1024......4.926/7.284.........
31.Right Orbital area, ventrolateral part.............Right Isocorte
x..............1556......4.611/6.571.........
32.Right Agranular insular area, dorsal part..........Right Isocorte
x..............2364......4.273/10.528........
33.Right Agranular insular area, posterior part........Right Isocorte
x..............1348......5.005/8.246.........
34.Right Agranular insular area, ventral part.........Right Isocorte
x..............1120......5.441/5.439.........
35.Right Retrosplenial area, lateral agranular part...Right Isocorte
x..............937.......2.446/4.479.........
36.Right Retrosplenial area, dorsal part..............Right Isocorte
x..............2738......1.937/4.418.........
37.Right Retrosplenial area, ventral part.............Right Isocorte
x..............3997......2.476/7.241.........
38.Right Anterior area................................Right Isocorte
x..............-1........2.749/5.801.........
39.Right Rostrolateral visual area....................Right Isocorte
x..............-1........2.267/6.416.........
40.Right Temporal association areas...................Right Isocorte
x..............3773......4.724/5.975.........
41.Right Perirhinal area..............................Right Isocorte
x..............1412......4.662/8.128.........
42.Right Ectorhinal area..............................Right Isocorte
x..............3390......5.197/7.544.........
43.Right Specific Thalamus to Frontal pole, cerebral ..Right Specific Thala
mus.......310.......5.630/3.463.........
44.Right Specific Thalamus to Primary motor area.......Right Specific Thala
mus.......310.......5.595/3.371.........
45.Right Specific Thalamus to Secondary motor area.....Right Specific Thala
mus.......310.......5.683/3.436.........
46.Right Specific Thalamus to Primary somatosensory a..Right Specific Thala
mus.......310.......5.521/3.421.........
47.Right Specific Thalamus to Primary somatosensory a..Right Specific Thala
mus.......310.......5.432/3.282.........
48.Right Specific Thalamus to Primary somatosensory a..Right Specific Thala
mus.......310.......5.707/3.413.........
49.Right Specific Thalamus to Primary somatosensory a..Right Specific Thala
mus.......310.......5.615/3.275.........
50.Right Specific Thalamus to Primary somatosensory a..Right Specific Thala
mus.......310.......5.031/3.433.........
51.Right Specific Thalamus to Primary somatosensory a..Right Specific Thala
mus.......310.......5.716/3.416.........
52.Right Specific Thalamus to Primary somatosensory a..Right Specific Thala
mus.......310.......4.989/3.610.........
53.Right Specific Thalamus to Supplemental somatosens..Right Specific Thala
mus.......310.......5.943/3.535.........
54.Right Specific Thalamus to Gustatory areas.........Right Specific Thala
mus.......310.......6.119/3.454.........
55.Right Specific Thalamus to Visceral area...........Right Specific Thala
mus.......310.......6.013/3.752.........
56.Right Specific Thalamus to Dorsal auditory area.....Right Specific Thala
mus.......310.......5.627/3.516.........
57.Right Specific Thalamus to Primary auditory area...Right Specific Thala
mus.......310.......5.444/3.687.........
58.Right Specific Thalamus to Posterior auditory area..Right Specific Thala
mus.......310.......5.671/3.824.........
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59.Right Specific Thalamus to Ventral auditory area....Right Specific Thala
mus.......310.......5.959/3.893..........
60.Right Specific Thalamus to Anterolateral visual ar..Right Specific Thala
mus.......310.......6.105/3.295..........
61.Right Specific Thalamus to Anteromedial visual are..Right Specific Thala
mus.......310.......6.188/3.445..........
62.Right Specific Thalamus to Lateral visual area......Right Specific Thala
mus.......310.......5.847/3.224..........
63.Right Specific Thalamus to Primary visual area......Right Specific Thala
mus.......310.......5.694/3.306..........
64.Right Specific Thalamus to Posterolateral visual a..Right Specific Thala
mus.......310.......5.693/3.259..........
65.Right Specific Thalamus to posteromedial visual ar..Right Specific Thala
mus.......310.......6.751/3.380..........
66.Right Specific Thalamus to Laterointermediate area..Right Specific Thala
mus.......310.......6.127/3.284..........
67.Right Specific Thalamus to Postrhinal area..........Right Specific Thala
mus.......310.......5.538/3.418..........
68.Right Specific Thalamus to Anterior cingulate area..Right Specific Thala
mus.......310.......5.928/3.951..........
69.Right Specific Thalamus to Anterior cingulate area..Right Specific Thala
mus.......310.......5.658/4.482..........
70.Right Specific Thalamus to Prelimbic area...........Right Specific Thala
mus.......310.......6.026/4.259..........
71.Right Specific Thalamus to Infralimbic area.........Right Specific Thala
mus.......310.......5.508/4.508..........
72.Right Specific Thalamus to Orbital area, lateral p..Right Specific Thala
mus.......310.......5.556/3.785..........
73.Right Specific Thalamus to Orbital area, medial pa..Right Specific Thala
mus.......310.......5.565/4.152..........
74.Right Specific Thalamus to Orbital area, ventrolat..Right Specific Thala
mus.......310.......5.679/3.987..........
75.Right Specific Thalamus to Agranular insular area,..Right Specific Thala
mus.......310.......6.182/3.616..........
76.Right Specific Thalamus to Agranular insular area,..Right Specific Thala
mus.......310.......5.870/3.474..........
77.Right Specific Thalamus to Agranular insular area,..Right Specific Thala
mus.......310.......5.398/3.870..........
78.Right Specific Thalamus to Retrosplenial area, lat..Right Specific Thala
mus.......310.......5.748/3.391..........
79.Right Specific Thalamus to Retrosplenial area, dor..Right Specific Thala
mus.......310.......5.562/3.322..........
80.Right Specific Thalamus to Retrosplenial area, ven..Right Specific Thala
mus.......310.......5.906/3.641..........
81.Right Specific Thalamus to Anterior area............Right Specific Thala
mus.......310.......6.028/3.399..........
82.Right Specific Thalamus to Rostrolateral visual ar..Right Specific Thala
mus.......310.......5.660/3.239..........
83.Right Specific Thalamus to Temporal association ar..Right Specific Thala
mus.......310.......5.679/4.050..........
84.Right Specific Thalamus to Perirhinal area..........Right Specific Thala
mus.......310.......5.154/3.418..........
85.Right Specific Thalamus to Ectorhinal area..........Right Specific Thala
mus.......310.......5.233/3.882..........
86.Right Olfactory Areas..............................Right Olfactory Area
s.........41043.....39.470/53.840.........
87.Right Hippocampal Formation........................Right Hippocampal Fo
rmation...34819.....34.018/48.566........
88.Right Cortical Subplate............................Right Cortical Subpl
ate.......6669......44.718/44.450........
89.Right Striatum.....................................Right Striatu
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m.............40219.....98.907/88.290........
90.Right Pallidum.....................................Right Pallidu
m.............9308......84.995/75.577........
91.Right Nonspecific Thalamus.........................Right Nonspecific Th
alamus....2324......97.939/46.910........
92.Right Hypothalamus.................................Right Hypothalamu
s............13871.....354.926/366.330......
93.Right Midbrain.....................................Right Midbrai
n.............19804.....338.668/286.757......
94.Right Superior colliculus, motor related............Right Midbrai
n.............6779......9.627/7.677..........
95.Right Pons Sensory.................................Right Pons Sensor
y............1585......13.202/19.164........
96.Right Principal sensory nucleus of the trigeminal...Right Pons Sensor
y............1093......3.140/9.722..........
97.Right Pons Motor....................................Right Pons Moto
r.............5971......102.516/99.580.......
98.Right Pons Behavioral..............................Right Pons Behaviora
l.........3890......115.281/81.482.......
99.Right Medulla......................................Right Medull
a.............17303.....162.776/187.547......
100.Right Spinal nucleus of the trigeminal.............Right Spinal nucleus
of the trigeminal3107......7.415/18.660.........
101.Right Facial motor nucleus.........................Right Medull
a.............660.......9.159/11.078.........
102.Right Inferior olivary complex.....................Right Medull
a.............567.......4.995/10.409.........
103.Right Cerebellar Cortex............................Right Cerebellar Cor
tex.......33696.....14.400/23.854........
104.Right Ansiform lobule..............................Right Cerebellar Cor
tex.......9044......0.844/0.209..........
105.Right Cerebellar Nuclei...........................Right Cerebellar Nuc
lei.......1116......6.587/22.060.........
106.Left Frontal pole, cerebral cortex.................Left Isocorte
x.............514.......3.107/5.948..........
107.Left Primary motor area...........................Left Isocorte
x.............11760.....1.855/6.174..........
108.Left Secondary motor area.........................Left Isocorte
x.............10098.....2.315/6.759..........
109.Left Primary somatosensory area, nose..............Left Isocorte
x.............1358......1.197/5.138..........
110.Left Primary somatosensory area, barrel field......Left Isocorte
x.............10306.....1.371/6.229..........
111.Left Primary somatosensory area, lower limb........Left Isocorte
x.............3254......1.829/5.456..........
112.Left Primary somatosensory area, mouth.............Left Isocorte
x.............2924......1.342/4.833..........
113.Left Primary somatosensory area, upper limb........Left Isocorte
x.............5406......1.388/2.691..........
114.Left Primary somatosensory area, trunk.............Left Isocorte
x.............4799......2.315/4.736..........
115.Left Primary somatosensory area, unassigned........Left Isocorte
x.............2958......1.709/3.534..........
116.Left Supplemental somatosensory area..............Left Isocorte
x.............5729......2.436/7.186..........
117.Left Gustatory areas..............................Left Isocorte
x.............2104......3.481/7.911..........
118.Left Visceral area................................Left Isocorte
x.............1793......4.021/9.503..........
119.Left Dorsal auditory area.........................Left Isocorte
x.............2556......3.358/4.931..........
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120.Left Primary auditory area.....................Left Isocorte
x.............2689......3.708/3.858.........
121.Left Posterior auditory area...................Left Isocorte
x.............191.......4.806/4.555.........
122.Left Ventral auditory area.....................Left Isocorte
x.............2554......3.647/7.515.........
123.Left Anterolateral visual area.................Left Isocorte
x.............1981......3.365/6.113.........
124.Left Anteromedial visual area..................Left Isocorte
x.............1795......3.629/6.890.........
125.Left Lateral visual area.......................Left Isocorte
x.............880.......3.308/5.298.........
126.Left Primary visual area.......................Left Isocorte
x.............6227......2.396/4.574.........
127.Left Posterolateral visual area................Left Isocorte
x.............679.......2.945/5.238.........
128.Left posteromedial visual area.................Left Isocorte
x.............1265......3.178/9.601.........
129.Left Laterointermediate area...................Left Isocorte
x.............-1........3.731/6.566.........
130.Left Postrhinal area...........................Left Isocorte
x.............-1........4.321/6.548.........
131.Left Anterior cingulate area, dorsal part.......Left Isocorte
x.............2789......3.355/7.577.........
132.Left Anterior cingulate area, ventral part.....Left Isocorte
x.............2418......4.413/9.728.........
133.Left Prelimbic area...........................Left Isocorte
x.............1790......4.390/9.983.........
134.Left Infralimbic area..........................Left Isocorte
x.............1764......6.726/7.545.........
135.Left Orbital area, lateral part................Left Isocorte
x.............1853......4.088/6.327.........
136.Left Orbital area, medial part.................Left Isocorte
x.............1024......4.926/7.284.........
137.Left Orbital area, ventrolateral part..........Left Isocorte
x.............1556......4.611/6.571.........
138.Left Agranular insular area, dorsal part.......Left Isocorte
x.............2364......4.273/10.528........
139.Left Agranular insular area, posterior part....Left Isocorte
x.............1348......5.005/8.246.........
140.Left Agranular insular area, ventral part......Left Isocorte
x.............1120......5.441/5.439.........
141.Left Retrosplenial area, lateral agranular part...Left Isocorte
x.............937.......2.446/4.479.........
142.Left Retrosplenial area, dorsal part...........Left Isocorte
x.............2738......1.937/4.418.........
143.Left Retrosplenial area, ventral part..........Left Isocorte
x.............3997......2.476/7.241.........
144.Left Anterior area............................Left Isocorte
x.............-1........2.749/5.801.........
145.Left Rostrolateral visual area.................Left Isocorte
x.............-1........2.267/6.416.........
146.Left Temporal association areas................Left Isocorte
x.............3773......4.724/5.975.........
147.Left Perirhinal area..........................Left Isocorte
x.............1412......4.662/8.128.........
148.Left Ectorhinal area..........................Left Isocorte
x.............3390......5.197/7.544.........
149.Left Specific Thalamus to Frontal pole, cerebral c.Left Specific Thalam
us........310.......5.630/3.463.........
150.Left Specific Thalamus to Primary motor area.....Left Specific Thalam
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us........310.......5.595/3.371..........
151.Left Specific Thalamus to Secondary motor area.....Left Specific Thalam
us........310.......5.683/3.436..........
152.Left Specific Thalamus to Primary somatosensory ar.Left Specific Thalam
us........310.......5.521/3.421..........
153.Left Specific Thalamus to Primary somatosensory ar.Left Specific Thalam
us........310.......5.432/3.282..........
154.Left Specific Thalamus to Primary somatosensory ar.Left Specific Thalam
us........310.......5.707/3.413..........
155.Left Specific Thalamus to Primary somatosensory ar.Left Specific Thalam
us........310.......5.615/3.275..........
156.Left Specific Thalamus to Primary somatosensory ar.Left Specific Thalam
us........310.......5.031/3.433..........
157.Left Specific Thalamus to Primary somatosensory ar.Left Specific Thalam
us........310.......5.716/3.416..........
158.Left Specific Thalamus to Primary somatosensory ar.Left Specific Thalam
us........310.......4.989/3.610..........
159.Left Specific Thalamus to Supplemental somatosenso.Left Specific Thalam
us........310.......5.943/3.535..........
160.Left Specific Thalamus to Gustatory areas..........Left Specific Thalam
us........310.......6.119/3.454..........
161.Left Specific Thalamus to Visceral area............Left Specific Thalam
us........310.......6.013/3.752..........
162.Left Specific Thalamus to Dorsal auditory area.....Left Specific Thalam
us........310.......5.627/3.516..........
163.Left Specific Thalamus to Primary auditory area....Left Specific Thalam
us........310.......5.444/3.687..........
164.Left Specific Thalamus to Posterior auditory area..Left Specific Thalam
us........310.......5.671/3.824..........
165.Left Specific Thalamus to Ventral auditory area....Left Specific Thalam
us........310.......5.959/3.893..........
166.Left Specific Thalamus to Anterolateral visual are.Left Specific Thalam
us........310.......6.105/3.295..........
167.Left Specific Thalamus to Anteromedial visual area.Left Specific Thalam
us........310.......6.188/3.445..........
168.Left Specific Thalamus to Lateral visual area......Left Specific Thalam
us........310.......5.847/3.224..........
169.Left Specific Thalamus to Primary visual area......Left Specific Thalam
us........310.......5.694/3.306..........
170.Left Specific Thalamus to Posterolateral visual ar.Left Specific Thalam
us........310.......5.693/3.259..........
171.Left Specific Thalamus to posteromedial visual are.Left Specific Thalam
us........310.......6.751/3.380..........
172.Left Specific Thalamus to Laterointermediate area..Left Specific Thalam
us........310.......6.127/3.284..........
173.Left Specific Thalamus to Postrhinal area..........Left Specific Thalam
us........310.......5.538/3.418..........
174.Left Specific Thalamus to Anterior cingulate area,.Left Specific Thalam
us........310.......5.928/3.951..........
175.Left Specific Thalamus to Anterior cingulate area,.Left Specific Thalam
us........310.......5.658/4.482..........
176.Left Specific Thalamus to Prelimbic area...........Left Specific Thalam
us........310.......6.026/4.259..........
177.Left Specific Thalamus to Infralimbic area.........Left Specific Thalam
us........310.......5.508/4.508..........
178.Left Specific Thalamus to Orbital area, lateral pa.Left Specific Thalam
us........310.......5.556/3.785..........
179.Left Specific Thalamus to Orbital area, medial par.Left Specific Thalam
us........310.......5.565/4.152..........
180.Left Specific Thalamus to Orbital area, ventrolate.Left Specific Thalam
us........310.......5.679/3.987..........
```

```
181.Left Specific Thalamus to Agranular insular area, .Left Specific Thalam
us........310.......6.182/3.616..........
182.Left Specific Thalamus to Agranular insular area, .Left Specific Thalam
us........310.......5.870/3.474..........
183.Left Specific Thalamus to Agranular insular area, .Left Specific Thalam
us........310.......5.398/3.870..........
184.Left Specific Thalamus to Retrosplenial area, late.Left Specific Thalam
us........310.......5.748/3.391..........
185.Left Specific Thalamus to Retrosplenial area, dors.Left Specific Thalam
us........310.......5.562/3.322..........
186.Left Specific Thalamus to Retrosplenial area, vent.Left Specific Thalam
us........310.......5.906/3.641..........
187.Left Specific Thalamus to Anterior area............Left Specific Thalam
us........310.......6.028/3.399..........
188.Left Specific Thalamus to Rostrolateral visual are.Left Specific Thalam
us........310.......5.660/3.239..........
189.Left Specific Thalamus to Temporal association are.Left Specific Thalam
us........310.......5.679/4.050..........
190.Left Specific Thalamus to Perirhinal area..........Left Specific Thalam
us........310.......5.154/3.418..........
191.Left Specific Thalamus to Ectorhinal area..........Left Specific Thalam
us........310.......5.233/3.882..........
192.Left Olfactory Areas..............................Left Olfactory Area
s..........41043.....39.470/53.840........
193.Left Hippocampal Formation........................Left Hippocampal For
mation....34819.....34.018/48.566........
194.Left Cortical Subplate............................Left Cortical Subpla
te........6669......44.718/44.450........
195.Left Striatum.....................................Left Striatu
m.................40219.....98.907/88.290........
196.Left Pallidum.....................................Left Pallidu
m.................9308......84.995/75.577........
197.Left Nonspecific Thalamus.........................Left Nonspecific Tha
lamus.....2324......97.939/46.910........
198.Left Hypothalamus.................................Left Hypothalamu
s.............13871.....354.926/366.330......
199.Left Midbrain.....................................Left Midbrai
n.................19804.....338.668/286.757......
```

In [23]:

```
print("SENSORY PATHWAY:\n")
print_weights_from("Spinal nucleus of the trigeminal", inds["trigeminal"],
                   final_connectivity.region_labels, final_connectivity.weig
print_weights_to("Principal sensory nucleus of the trigeminal", inds["ponsse
                  final_connectivity.region_labels, final_connectivity.weight
print_weights_from("Principal sensory nucleus of the trigeminal", inds["pons
                   final_connectivity.region_labels, final_connectivity.weig
print_weights_to("Ansiform lobule", inds["ansilob"],
                 final_connectivity.region_labels, final_connectivity.weights

print("\n\n\nMOTOR PATHWAY:\n")
print_weights_from("Primary motor area", inds["m1"], final_connectivity.regi
# print_weights_to("Superior colliculus, motor related", inds["supcol"], fin
# print_weights_from("Superior colliculus, motor related", inds["supcol"], f
print_weights_to("Facial motor nucleus", inds["facial"], final_connectivity.
```

```
SENSORY PATHWAY:


Stronger 90% connections from Right Spinal nucleus of the trigeminal to:
Region.....................................................Weigh
t.......................Total weights to..............
--------------------------------------------------------------------------
----------------------------------------
99.Right Medulla.....................................3.8854
5.......................162.776.......................
205.Left Medulla.....................................1.1178
8.......................162.776.......................
97.Right Pons Motor..................................0.29671
9.......................102.516.......................
199.Left Midbrain....................................0.27801
5.......................338.668.......................
203.Left Pons Motor..................................0.13614
3.......................102.516.......................
206.Left Spinal nucleus of the trigeminal..............0.13320
2.......................7.41493.......................
102.Right Inferior olivary complex.....................0.12800
7.......................4.99518.......................
101.Right Facial motor nucleus.........................0.10647
4.......................9.15874.......................
93.Right Midbrain....................................0.10354
2.......................338.668.......................
95.Right Pons Sensory.................................0.095514
9.......................13.202.......................
96.Right Principal sensory nucleus of the trigeminal...0.094956
1.......................3.14049.......................
204.Left Pons Behavioral..............................0.075833
3.......................115.281.......................
98.Right Pons Behavioral..............................0.070241
1.......................115.281.......................
112.Left Primary somatosensory area, mouth.............0.066440
1.......................1.34163.......................
208.Left Inferior olivary complex.....................0.047695
2.......................4.99518.......................
117.Left Gustatory areas..............................0.046155
6.......................3.481........................

Stronger 90% connections from Left Spinal nucleus of the trigeminal to:
Region.....................................................Weigh
t.......................Total weights to..............
--------------------------------------------------------------------------
----------------------------------------
205.Left Medulla.....................................3.8854
5.......................162.776.......................
99.Right Medulla.....................................1.1178
8.......................162.776.......................
203.Left Pons Motor..................................0.29671
9.......................102.516.......................
93.Right Midbrain....................................0.27801
5.......................338.668.......................
97.Right Pons Motor..................................0.13614
3.......................102.516.......................
100.Right Spinal nucleus of the trigeminal.............0.13320
2.......................7.41493.......................
208.Left Inferior olivary complex.....................0.12800
7.......................4.99518.......................
207.Left Facial motor nucleus.........................0.10647
```

```
4.....................9.15874.....................
199.Left Midbrain.....................................0.10354
2.....................338.668.....................
201.Left Pons Sensory.................................0.095514
9.....................13.202.....................
202.Left Principal sensory nucleus of the trigeminal...0.094956
1.....................3.14049.....................
98.Right Pons Behavioral..............................0.075833
3.....................115.281.....................
204.Left Pons Behavioral..............................0.070241
1.....................115.281.....................
6.Right Primary somatosensory area, mouth..............0.066440
1.....................1.34163.....................
102.Right Inferior olivary complex.....................0.047695
2.....................4.99518.....................
11.Right Gustatory areas..............................0.046155
6.....................3.481.....................

Stronger 90% connections to Right Principal sensory nucleus of the trigemin
al from:
Region.................................................Weigh
t.....................Total weights from...........
------------------------------------------------------------------------
----------------------------------------
99.Right Medulla.....................................1.9306
3.....................187.547.....................
93.Right Midbrain.....................................1.1311
5.....................286.757.....................
97.Right Pons Motor...................................0.9280
4.....................99.5803.....................
98.Right Pons Behavioral..............................0.82995
9.....................81.4818.....................
199.Left Midbrain.....................................0.81668
2.....................286.757.....................
205.Left Medulla......................................0.78760
8.....................187.547.....................
204.Left Pons Behavioral..............................0.51320
2.....................81.4818.....................
203.Left Pons Motor...................................0.3040
9.....................99.5803.....................
95.Right Pons Sensory.................................0.20954
4.....................19.1642.....................
103.Right Cerebellar Cortex...........................0.16389
2.....................23.8543.....................
198.Left Hypothalamus.................................0.15884
4.....................366.33.....................
91.Right Nonspecific Thalamus.........................0.13078
9.....................46.91.....................
197.Left Nonspecific Thalamus.........................0.10733
8.....................46.91.....................
92.Right Hypothalamus.................................0.095162
8.....................366.33.....................
100.Right Spinal nucleus of the trigeminal.............0.094956
1.....................18.6598.....................
201.Left Pons Sensory.................................0.093251
3.....................19.1642.....................

Stronger 90% connections to Left Principal sensory nucleus of the trigemina
l from:
Region.................................................Weigh
t.....................Total weights from...........
```

```
--------------------------------------------------------------------------------
----------------------------------------
205.Left Medulla.....................................1.9306
3.....................187.547.....................
199.Left Midbrain....................................1.1311
5.....................286.757.....................
203.Left Pons Motor..................................0.9280
4.....................99.5803.....................
204.Left Pons Behavioral.............................0.82995
9.....................81.4818.....................
93.Right Midbrain....................................0.81668
2.....................286.757.....................
99.Right Medulla.....................................0.78760
8.....................187.547.....................
98.Right Pons Behavioral.............................0.51320
2.....................81.4818.....................
97.Right Pons Motor..................................0.3040
9.....................99.5803.....................
201.Left Pons Sensory................................0.20954
4.....................19.1642.....................
209.Left Cerebellar Cortex...........................0.16389
2.....................23.8543.....................
92.Right Hypothalamus................................0.15884
4.....................366.33.....................
197.Left Nonspecific Thalamus........................0.13078
9.....................46.91.....................
91.Right Nonspecific Thalamus........................0.10733
8.....................46.91.....................
198.Left Hypothalamus................................0.095162
8.....................366.33.....................
206.Left Spinal nucleus of the trigeminal.............0.094956
1.....................18.6598.....................
95.Right Pons Sensory................................0.093251
3.....................19.1642.....................

Stronger 90% connections from Right Principal sensory nucleus of the trigem
inal to:
Region.....................................................Weigh
t.....................Total weights to.............
--------------------------------------------------------------------------------
----------------------------------------
99.Right Medulla.....................................1.10
9.....................162.776.....................
97.Right Pons Motor..................................0.39751
3.....................102.516.....................
205.Left Medulla.....................................0.33570
8.....................162.776.....................
100.Right Spinal nucleus of the trigeminal............0.24210
7.....................7.41493.....................
203.Left Pons Motor..................................0.23626
3.....................102.516.....................
95.Right Pons Sensory................................0.12026
3.....................13.202.....................
93.Right Midbrain....................................0.10825
4.....................338.668.....................
199.Left Midbrain....................................0.094143
7.....................338.668.....................
204.Left Pons Behavioral.............................0.053991
4.....................115.281.....................
103.Right Cerebellar Cortex..........................0.049105
8.....................14.3996.....................
```

```
98.Right Pons Behavioral.............................0.048010
9.....................115.281.......................
206.Left Spinal nucleus of the trigeminal.............0.038664
7.....................7.41493.......................

Stronger 90% connections from Left Principal sensory nucleus of the trigemi
nal to:
Region...................................................Weigh
t........................Total weights to..............
------------------------------------------------------------------------------
----------------------------------------
205.Left Medulla.....................................1.10
9.........................162.776.......................
203.Left Pons Motor..................................0.39751
3.......................102.516.......................
99.Right Medulla.....................................0.33570
8.......................162.776.......................
206.Left Spinal nucleus of the trigeminal.............0.24210
7.......................7.41493.......................
97.Right Pons Motor..................................0.23626
3.......................102.516.......................
201.Left Pons Sensory................................0.12026
3.......................13.202........................
199.Left Midbrain....................................0.10825
4.......................338.668.......................
93.Right Midbrain....................................0.094143
7.......................338.668.......................
98.Right Pons Behavioral.............................0.053991
4.....................115.281.......................
209.Left Cerebellar Cortex...........................0.049105
8.....................14.3996.......................
204.Left Pons Behavioral.............................0.048010
9.....................115.281.......................
100.Right Spinal nucleus of the trigeminal.............0.038664
7.....................7.41493.......................

Stronger 95% connections to Right Ansiform lobule from:
Region...................................................Weigh
t........................Total weights from............
------------------------------------------------------------------------------
----------------------------------------
103.Right Cerebellar Cortex..........................0.072371
4.....................23.8543.......................
105.Right Cerebellar Nuclei..........................0.050667
1.....................22.0603.......................
203.Left Pons Motor..................................0.034214
7.....................99.5803.......................
97.Right Pons Motor..................................0.018549
9.....................99.5803.......................
99.Right Medulla.....................................0.0070936
4.....................187.547.......................
199.Left Midbrain....................................0.0043502
1.....................286.757.......................
93.Right Midbrain....................................0.003581
7.....................286.757.......................
87.Right Hippocampal Formation.......................0.0024682
1.....................48.5659.......................
98.Right Pons Behavioral.............................0.0017793
8.....................81.4818.......................
193.Left Hippocampal Formation.......................0.0017001
4.....................48.5659.......................
```

```
204.Left Pons Behavioral.............................0.001391
5.....................81.4818.......................
209.Left Cerebellar Cortex...........................0.0012268
4.....................23.8543.......................
95.Right Pons Sensory................................0.00098330
9.....................19.1642.......................
205.Left Medulla.....................................0.00093713
1.....................187.547.......................
198.Left Hypothalamus................................0.00085860
6.....................366.33........................
96.Right Principal sensory nucleus of the trigeminal...0.00064591
4.....................9.72171.......................
100.Right Spinal nucleus of the trigeminal.............0.00055884
9.....................18.6598.......................

Stronger 95% connections to Left Ansiform lobule from:
Region.................................................Weigh
t.........................Total weights from............
------------------------------------------------------------------------------
----------------------------------------
209.Left Cerebellar Cortex...........................0.072371
4.....................23.8543.......................
211.Left Cerebellar Nuclei...........................0.050667
1.....................22.0603.......................
97.Right Pons Motor..................................0.034214
7.....................99.5803.......................
203.Left Pons Motor..................................0.018549
9.....................99.5803.......................
205.Left Medulla.....................................0.0070936
4.....................187.547.......................
93.Right Midbrain...................................0.0043502
1.....................286.757.......................
199.Left Midbrain....................................0.003581
7.....................286.757.......................
193.Left Hippocampal Formation.......................0.0024682
1.....................48.5659.......................
204.Left Pons Behavioral.............................0.0017793
8.....................81.4818.......................
87.Right Hippocampal Formation.......................0.0017001
4.....................48.5659.......................
98.Right Pons Behavioral.............................0.001391
5.....................81.4818.......................
103.Right Cerebellar Cortex...........................0.0012268
4.....................23.8543.......................
201.Left Pons Sensory................................0.00098330
9.....................19.1642.......................
99.Right Medulla.....................................0.00093713
1.....................187.547.......................
92.Right Hypothalamus................................0.00085860
6.....................366.33........................
202.Left Principal sensory nucleus of the trigeminal...0.00064591
4.....................9.72171.......................
206.Left Spinal nucleus of the trigeminal.............0.00055884
9.....................18.6598.......................



MOTOR PATHWAY:


Stronger 90% connections from Right Primary motor area to:
```

```
Region.....................................................Weigh
t.......................Total weights to..............
--------------------------------------------------------------------------------
----------------------------------------
44.Right Specific Thalamus to Primary motor area.......0.36461
2.....................5.5953.........................
6.Right Primary somatosensory area, mouth..............0.083217
4.....................1.34163........................
32.Right Agranular insular area, dorsal part...........0.082830
8.....................4.27312........................
11.Right Gustatory areas...............................0.080676
5.....................3.481..........................
92.Right Hypothalamus..................................0.078066
6.....................354.926........................
88.Right Cortical Subplate.............................0.066693
8.....................44.7184........................
10.Right Supplemental somatosensory area...............0.060542
4.....................2.43609........................
91.Right Nonspecific Thalamus..........................0.059579
3.....................97.9386........................
12.Right Visceral area.................................0.058169
1.....................4.02148........................
2.Right Secondary motor area...........................0.054968
2.....................2.31489........................
3.Right Primary somatosensory area, nose...............0.054398
5.....................1.19654........................
33.Right Agranular insular area, posterior part........0.054055
4.....................5.00549........................
107.Left Primary motor area............................0.047729
3.....................1.85526........................
5.Right Primary somatosensory area, lower limb.........0.045473
4.....................1.82863........................
7.Right Primary somatosensory area, upper limb.........0.040928
2.....................1.38802........................
138.Left Agranular insular area, dorsal part...........0.036374
3.....................4.27312........................
0.Right Frontal pole, cerebral cortex..................0.033272
9.....................3.1065.........................
108.Left Secondary motor area..........................0.029602
6.....................2.31489........................
8.Right Primary somatosensory area, trunk..............0.025778
8.....................2.31494........................
89.Right Striatum.....................................0.02563
3.....................98.9072........................
4.Right Primary somatosensory area, barrel field.......0.024229
5.....................1.37111........................
86.Right Olfactory Areas...............................0.02241
8.....................39.4701........................
9.Right Primary somatosensory area, unassigned.........0.021958
5.....................1.70905........................
93.Right Midbrain.....................................0.020156
5.....................338.668........................
87.Right Hippocampal Formation.........................0.017704
4.....................34.0178........................
25.Right Anterior cingulate area, dorsal part..........0.016782
6.....................3.35503........................
117.Left Gustatory areas...............................0.016399
9.....................3.481..........................
34.Right Agranular insular area, ventral part..........0.015923
4.....................5.44112........................
112.Left Primary somatosensory area, mouth..............0.015613
```

```
6.....................1.34163.....................
106.Left Frontal pole, cerebral cortex.................0.013729
2.....................3.1065......................
29.Right Orbital area, lateral part...................0.013663
9.....................4.08821.....................
111.Left Primary somatosensory area, lower limb........0.013589
2.....................1.82863.....................
38.Right Anterior area................................0.012594
1.....................2.74865.....................
194.Left Cortical Subplate............................0.01046
7.....................44.7184.....................
118.Left Visceral area................................0.010141
9.....................4.02148.....................
90.Right Pallidum.....................................0.010135
6.....................84.9946.....................
37.Right Retrosplenial area, ventral part..............0.0099800
6.....................2.47556.....................
35.Right Retrosplenial area, lateral agranular part....0.0097695
3.....................2.44595.....................
31.Right Orbital area, ventrolateral part..............0.0096894
2.....................4.6111......................
139.Left Agranular insular area, posterior part........0.0095774
7.....................5.00549.....................

Stronger 90% connections from Left Primary motor area to:
Region.................................................Weigh
t.......................Total weights to..............
--------------------------------------------------------------------------------
----------------------------------------
150.Left Specific Thalamus to Primary motor area.......0.36461
2.....................5.5953......................
112.Left Primary somatosensory area, mouth.............0.083217
4.....................1.34163.....................
138.Left Agranular insular area, dorsal part...........0.082830
8.....................4.27312.....................
117.Left Gustatory areas..............................0.080676
5.....................3.481.......................
198.Left Hypothalamus.................................0.078066
6.....................354.926.....................
194.Left Cortical Subplate............................0.066693
8.....................44.7184.....................
116.Left Supplemental somatosensory area..............0.060542
4.....................2.43609.....................
197.Left Nonspecific Thalamus.........................0.059579
3.....................97.9386.....................
118.Left Visceral area................................0.058169
1.....................4.02148.....................
108.Left Secondary motor area.........................0.054968
2.....................2.31489.....................
109.Left Primary somatosensory area, nose..............0.054398
5.....................1.19654.....................
139.Left Agranular insular area, posterior part........0.054055
4.....................5.00549.....................
1.Right Primary motor area............................0.047729
3.....................1.85526.....................
111.Left Primary somatosensory area, lower limb........0.045473
4.....................1.82863.....................
113.Left Primary somatosensory area, upper limb........0.040928
2.....................1.38802.....................
32.Right Agranular insular area, dorsal part...........0.036374
3.....................4.27312.....................
```

```
106.Left Frontal pole, cerebral cortex.................0.033272
9.....................3.1065.........................
2.Right Secondary motor area...........................0.029602
6.....................2.31489........................
114.Left Primary somatosensory area, trunk.............0.025778
8.....................2.31494........................
195.Left Striatum......................................0.02563
3.....................98.9072........................
110.Left Primary somatosensory area, barrel field......0.024229
5.....................1.37111........................
192.Left Olfactory Areas...............................0.02241
8.....................39.4701........................
115.Left Primary somatosensory area, unassigned........0.021958
5.....................1.70905........................
199.Left Midbrain......................................0.020156
5.....................338.668........................
193.Left Hippocampal Formation.........................0.017704
4.....................34.0178........................
131.Left Anterior cingulate area, dorsal part..........0.016782
6.....................3.35503........................
11.Right Gustatory areas...............................0.016399
9.....................3.481..........................
140.Left Agranular insular area, ventral part..........0.015923
4.....................5.44112........................
6.Right Primary somatosensory area, mouth..............0.015613
6.....................1.34163........................
0.Right Frontal pole, cerebral cortex..................0.013729
2.....................3.1065.........................
135.Left Orbital area, lateral part....................0.013663
9.....................4.08821........................
5.Right Primary somatosensory area, lower limb.........0.013589
2.....................1.82863........................
144.Left Anterior area.................................0.012594
1.....................2.74865........................
88.Right Cortical Subplate.............................0.01046
7.....................44.7184........................
12.Right Visceral area.................................0.010141
9.....................4.02148........................
196.Left Pallidum......................................0.010135
6.....................84.9946........................
143.Left Retrosplenial area, ventral part..............0.0099800
6.....................2.47556........................
141.Left Retrosplenial area, lateral agranular part....0.0097695
3.....................2.44595........................
137.Left Orbital area, ventrolateral part..............0.0096894
2.....................4.6111.........................
33.Right Agranular insular area, posterior part........0.0095774
7.....................5.00549........................

Stronger 90% connections to Right Facial motor nucleus from:
Region.................................................Weigh
t.......................Total weights from............
--------------------------------------------------------------------------------
----------------------------------------
99.Right Medulla.......................................3.3347
8.....................187.547........................
205.Left Medulla.......................................1.9811
9.....................187.547........................
97.Right Pons Motor....................................0.80366
7.....................99.5803........................
93.Right Midbrain......................................0.70427
```

```
5.....................286.757.....................
199.Left Midbrain.....................................0.64889
4.....................286.757.....................
98.Right Pons Behavioral..............................0.60712
8.....................81.4818.....................
203.Left Pons Motor...................................0.48457
2.....................99.5803.....................
92.Right Hypothalamus.................................0.373
3.....................366.33.....................
198.Left Hypothalamus.................................0.35900
2.....................366.33.....................
204.Left Pons Behavioral..............................0.33517
6.....................81.4818.....................
197.Left Nonspecific Thalamus.........................0.12935
2.....................46.91.....................
100.Right Spinal nucleus of the trigeminal.............0.10647
4.....................18.6598.....................
95.Right Pons Sensory.................................0.098580
6.....................19.1642.....................
91.Right Nonspecific Thalamus.........................0.096596
3.....................46.91.....................
201.Left Pons Sensory.................................0.061033
2.....................19.1642.....................
207.Left Facial motor nucleus..........................0.058178
5.....................11.0785.....................

Stronger 90% connections to Left Facial motor nucleus from:
Region.....................................................Weigh
t.....................Total weights from............
------------------------------------------------------------------------------
----------------------------------------
205.Left Medulla.....................................3.3347
8.....................187.547.....................
99.Right Medulla.....................................1.9811
9.....................187.547.....................
203.Left Pons Motor...................................0.80366
7.....................99.5803.....................
199.Left Midbrain.....................................0.70427
5.....................286.757.....................
93.Right Midbrain.....................................0.64889
4.....................286.757.....................
204.Left Pons Behavioral..............................0.60712
8.....................81.4818.....................
97.Right Pons Motor...................................0.48457
2.....................99.5803.....................
198.Left Hypothalamus.................................0.373
3.....................366.33.....................
92.Right Hypothalamus.................................0.35900
2.....................366.33.....................
98.Right Pons Behavioral..............................0.33517
6.....................81.4818.....................
91.Right Nonspecific Thalamus.........................0.12935
2.....................46.91.....................
206.Left Spinal nucleus of the trigeminal.............0.10647
4.....................18.6598.....................
201.Left Pons Sensory.................................0.098580
6.....................19.1642.....................
197.Left Nonspecific Thalamus.........................0.096596
3.....................46.91.....................
95.Right Pons Sensory.................................0.061033
2.....................19.1642.....................
```

```
101.Right Facial motor nucleus.....................0.058178
5.....................11.0785.....................
```

Brain network graph

In [24]:
```
# import networkx as nx  # https://networkx.org/
# from mpl_toolkits.mplot3d import Axes3D


# def conn_to_graph(conn, major_structs_labels, voxel_count):

#     G = nx.DiGraph()
#     # G.add_edge('A', 'B', weight=4)
#     nodes = []
#     for iR, (reg, centre, msl, vc) in enumerate(zip(conn.region_labels, co
#                                                     major_structs_labels,
#         nodes.append(reg)
#         G.add_node(nodes[-1], ind=iR, centre=centre, major_structure_label

#     for iR1, reg1 in enumerate(nodes):
#         for iR2, reg2 in enumerate(nodes):
#             G.add_edge(reg1, reg2,
#                        weight=conn.weights[iR2, iR1],
#                        distance=1.0/conn.weights[iR2, iR1] if conn.weights
#                        tract_length=conn.tract_lengths[iR2, iR1])

#     return G



# def plot_G_conn_3D(G, nodes_kwgs={'s': 100, 'ec':"w"},
#                    edges_kwgs={'color':"tab:gray", 'alpha': 0.01}, show=Tr

#     node_centres = nx.get_node_attributes(G, "centre")

#     # 3d layout
#     pos = nx.rescale_layout_dict(node_centres)

#     # Extract node and edge positions from the layout
#     node_xyz = np.array([pos[v] for v in sorted(G)])
#     edge_xyz = np.array([(pos[u], pos[v]) for u, v in G.edges()])

#     # Create the 3D figure
#     fig = plt.figure(figsize=(15, 15))
#     ax = fig.add_subplot(111, projection="3d")

#     # Plot the nodes - alpha is scaled by "depth" automatically
#     ax.scatter(*node_xyz.T, **nodes_kwgs)

#     # Plot the edges
#     for vizedge in edge_xyz:
#         ax.plot(*vizedge.T, **edges_kwgs)


#     def _format_axes(ax):
#         """Visualization options for the 3D axes."""
#         # Turn gridlines off
#         ax.grid(False)
#         # Suppress tick labels
```

```
#         for dim in (ax.xaxis, ax.yaxis, ax.zaxis):
#             dim.set_ticks([])
#         # Set axes labels
#         ax.set_xlabel("x")
#         ax.set_ylabel("y")
#         ax.set_zlabel("z")


#     _format_axes(ax)
#     fig.tight_layout()

#     if show:
#         plt.show()

#     return fig, ax
```

In [25]:
```
# G = conn_to_graph(final_connectivity, final_major_structs_labels, final_vo
# source = "Right Spinal nucleus of the trigeminal"
# target = 'Right Ansiform lobule'

# print(G.nodes())

# sp = nx.shortest_path(G, source, target, weight='distance')  # distance =
# print("Shortest Path:\n", sp)

# spl = nx.shortest_path_length(G, source, target, weight='distance')
# print("Shortest Path Length:\n", spl)

# w = 1.0 / spl / (len(sp) - 1)
# print("Shortest Path Weight = 1.0 / ShortestPathLength / (len(ShortestPath


# # For interactive plotting:
# %matplotlib notebook

# plot_G_conn_3D(G)
```

In [26]:
```
# # Summarize also the Cerebellar Cortices and Nuclei:
# major_structures_to_merge = ['Cerebellar Cortex', "Cerebellar Nuclei"]
# exclude_regions={}

# # For bilateral merging:
# major_structures_to_merge, exclude_regions = unilateral_to_bilateral(major

# merged_cereb_conn, merged_cereb_major_structs_labels, merged_cereb_voxel_c
#     merge_major_structures(final_connectivity,
#                            major_structures_to_merge,
#                            final_major_structs_labels, final_voxel_count,
#                            exclude_regions=exclude_regions, weight_fun=np.

# inds = {}
# inds["crtx"] = []
# inds["m1"] = []
# inds["s1brl"] = []
# inds["supcol"] = []
# inds["facial"] = []
# inds["trigeminal"] = []
# inds["ponssens_trigeminal"] = []
# inds["ponssens"] = []
# inds["ponsmotor"] = []
# inds["thal"] = []
```

```
# inds["thalspec"] = []
# inds["m1thal"] = []
# inds["s1brlthal"] = []
# inds["cerebcrtx"] = []
# inds["cerebnucleus"] = []
# inds["oliv"] = []
# for iR, (reg, lbl) in enumerate(zip(merged_cereb_conn.region_labels, merge
#     if "Isocortex" in lbl:
#         inds["crtx"].append(iR)
#     if "Primary motor area" in reg and "Specific" not in reg:
#         inds["m1"].append(iR)
#     if "barrel" in reg and "Specific" not in reg:
#         inds["s1brl"].append(iR)
#     if "Superior colliculus, motor related" in reg:
#         inds["supcol"].append(iR)
#     if "Primary motor area" in reg and "Specific" in reg:
#         inds["m1thal"].append(iR)
#     if "barrel" in reg and "Specific" in reg:
#         inds["s1brlthal"].append(iR)
#     if "Superior colliculus, motor related" in reg:
#         inds["supcol"].append(iR)
#     if "Facial" in reg:
#         inds["facial"] .append(iR)
#     if "Spinal nucleus of the trigeminal" in reg:
#         inds["trigeminal"].append(iR)
#     if "Principal sensory nucleus of the trigeminal" in reg:
#         inds["ponssens_trigeminal"] .append(iR)
#     if "Pons Sensory" in lbl:
#         inds["ponssens"] .append(iR)
#     if "Pons Motor" in lbl:
#         inds["ponsmotor"].append(iR)
#     if "Nonspecific Thalamus" in lbl:
#         inds["thal"].append(iR)
#     if "Specific Thalamus" in lbl:
#         inds["thalspec"].append(iR)
#     if "Cerebellar Cortex" in reg:
#         inds["cerebcrtx"].append(iR)
#     if "Cerebellar Nuclei" in reg:
#         inds["cerebnucleus"].append(iR)
#     if "Inferior olivary complex" in reg:
#         inds["oliv"].append(iR)
# inds["m1s1brl"] = inds["m1"]  + inds["s1brl"]
# inds["sens"] = inds["trigeminal"]  + inds["ponssens_trigeminal"] + inds["s
# inds["motor"] = inds["m1thal"] + inds["facial"]  # inds["supcol"]  +
# inds["cereb"] = inds["cerebcrtx"] + inds["cerebnucleus"] + inds["oliv"]
# allspecial = inds["m1s1brl"] + inds["motor"] + inds["sens"] + inds["thal"]
# for key, val in inds.items():
#     inds[key] = np.array(val)
# print(merged_cereb_conn.region_labels[allspecial])
```

In [27]:
```
# # Write the resulting connectivity to .h5 TVB compatible file...
# write_connectivity_to_h5_file(merged_cereb_conn, "Connectivity_SummedSubco
# # ... along with the corresponding mapping from regions to major structure
# np.save("major_structs_labels_SummedSubcortical_Thals_SummedCereb.npy", me
# np.save("voxel_count_SummedSubcortical_Thals_SummedCereb.npy", merged_cere
# np.save("inds_SummedSubcortical_Thals_SummedCereb.npy", inds)
```

In [ ]:
```
```