

| Level                      | Morphology type            | Scale           | Morpho-features  | Whole-brain registration needed?              | Data                                    | Previous knowledge   | Previous major literatures   | Our key findings  | Major location of our results in Figures / Tables | Our data sharable? | Shared results data volume / size |
|----------------------------|----------------------------|-----------------|--|---|---|--|--|---|---|--------------------|-----------------------------------|
| Whole brain                | Cross-scale                | 1μm - 10000+ μm | Multiscale features from neuron-population to axonal varicosity  | Yes   | Petavoxels                              | NO existing systematic cross-scale study   | NO   | 1. Highly-modularized neuroanatomical organizations are observed in the central nervous system (CNS) neurons, with respect to brain regions, cortical laminations, and projection types of cortical neurons.<br>2. Morphometry at different scales complements the classification of neurons in the central nervous system. | Figure 1; Figure 8                                | Yes                | 3.7 Petavoxels                    |
| Neuron-population (global) | Neuron-population          | 1000μm-10000μm  | Number of neurite voxels across all brain regions  | Yes   | Petavoxels                              | Some whole-brain modularity of mammalian brains have been analyzed at macro- or meso-scales  | 1. Bertolero et al., PNAS, 2015, doi: 10.1073/pnas.1510619112<br>2. Wang et al., J Neurosci, 2012, doi: 10.1523/JNEUROSCI.6063-11.2012<br>3. Oh et al., Nature, 2014, doi: 10.1038/nature13186   | We identified 18 new modules from the complete set of 314 brain regions at a submicron resolution.  | Figure 2D; Supplementary Table S5                 | Yes                | 3.7 Petavoxels                    |
| Neuron population (local)  | Dendritic microenvironment | 30 million μm³  | Spatially enhanced morphological features  | Yes   | Thousands to millions microenvironments | Parcellations reported in low resolution, incapable of differentiating subregions that containing neurons with different morphology and function.  | 1. Lein et al., Nature, 2007, doi: 10.1038/nature05453<br>2. Oh et al., Nature, 2014, doi: 10.1038/nature13186<br>3. Dong et al., Wiley, 2008<br>4. Paxinos et al., Elsevier, 2001, 2012<br>5. Wang et al., 2020, doi: 10.1016/j.cell.2020.04.007  | Microenvironment representation of neighoring neurons discriminates sub-regional parcellation   | Figure 3  | Yes                | 15441                             |
| Single-neuron              | Full morphology            | 500μm-5000μm    | Spatially enhanced Morphological features  | Yes   | Hundreds to thousands neurons           | Single neurons could not be classified into discrete clusters, based on conventional features of projection or morphology.   | 1. Peng et al., Nature, 2021, doi: 10.1038/s41586-021-03941-1<br>2. Winnubst et al., Cell, 2019, doi: 10.1016/j.cell.2019.07.042   | We identified 4 discrete cross-areal single neuron clusters from 1,876 single neurons, covering 94 brain regions. This is the first time such clear clustering has been shown, and is only possible with our enhanced analysis  | Figure 4  | Yes                | 1876                              |
| Sub-neuronal               | Sub-neuronal arbor         | 100μm-2000μm    | Morphological features (e.g., volume and path length)  | No for sub-areas, yes for comparative studies | Thousands arbors                        | NO previous study  | NO   | Neuronal arborization pattern characterizes cortical, striatal, and thalamic neurons in mouse.  | Figure 5  | Yes                | 3776                              |
|                            | Primary axonal tracts      | 100μm-2000μm    | Volume, length, and coordinates  | Yes   | Hundreds to thousands tracts            | Projection patterns were experimentally estimated through various labeling techniques or transcriptome profiling, however quantifying the relationship between sources (somas) and targets (terminal axons) has been challenging due to their imbalanced scales. | 1. Li et al., Brain Structure and Function, 2021, doi:10.1007/s00429-021-02289-6; Oh et al., Nature, 2014, doi: 10.1038/nature13186<br>2. Fernández-Nogales, Advanced Science, 2023, doi:10.1002/advs.202200615<br>3. Wang et al., Neurosci Bull, 2021, doi: 10.1007/s12264-020-00616-1<br>4. Peng et al., Nature, 2021, doi: 10.1038/s41586-021-03941-1 | Confirmed quantitatively the convergent projection patterns for CP neurons, and divergent patterns for cortical and thalamic neurons.   | Figure 6  | Yes                | 1876                              |
|                            | Axonal varicosity          | 1μm-3μm         | Customized features (see Figure 1E)  | No for sub-areas, yes for comparative studies | Millions [predicted] boutons            | Comparative analyses of the spatial preference of varicosities across the whole brain have not been found, and the distribution of local varicosities was evaluated only in small datasets, never at the whole brain scale                                       | 1. Julian et al., PLoS Computational Biology, 2010, doi: 10.1371/journal.pcbi.1000711<br>2. Karube et al., J Neurosci, 2004, doi: 10.1523/JNEUROSCI.4814-03.2004   | 1. Stereotyped axonal varicosity features are observed among neurons from the same brain structures (e.g., cortex, thalamus, and cerebral nuclei), while diverse across different structures.<br>2. Axonal branches successive to a varicosity-containing branch (near the soma) always contain varicosities                | Figure 7  | Yes                | 3.63 millions                     |
|                            |                            |                 |  |   |   |  |  |   |   |                    |                                   |
|                            |                            |                 | Red color: key novelties. See the main text and Supplementary Figures / Tables for details. See video demos etc at <a href="https://sd-jiang.github.io/full_spectrum/">https://sd-jiang.github.io/full_spectrum/</a> |   |   |  |  |   |   |                    |                                   |