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# HDMF-common Specification

*Release v1.8.0*

**unknown**

**Aug 09, 2023**



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## **Part I**

# **Introduction**



## OVERVIEW OF HDMF-COMMON

hdmf-common defines common data structures to be used across applications.

### 1.1 DynamicTable

The `DynamicTable` type is used to store tabular data. The tables are created in a columnar fashion with each column stored in its own `VectorData` object. Rows of the table are assigned unique ids with the required `id` column of type `ElementIdentifier`. The `colnames` attribute indicates the order of the columns.

### 1.2 VectorData

`VectorData` is the datatype used to store a column in a `DynamicTable`. If unpaired with a `VectorIndex` object the first dimension is the row dimension, which must be the same across all of the columns in that `DynamicTable`.

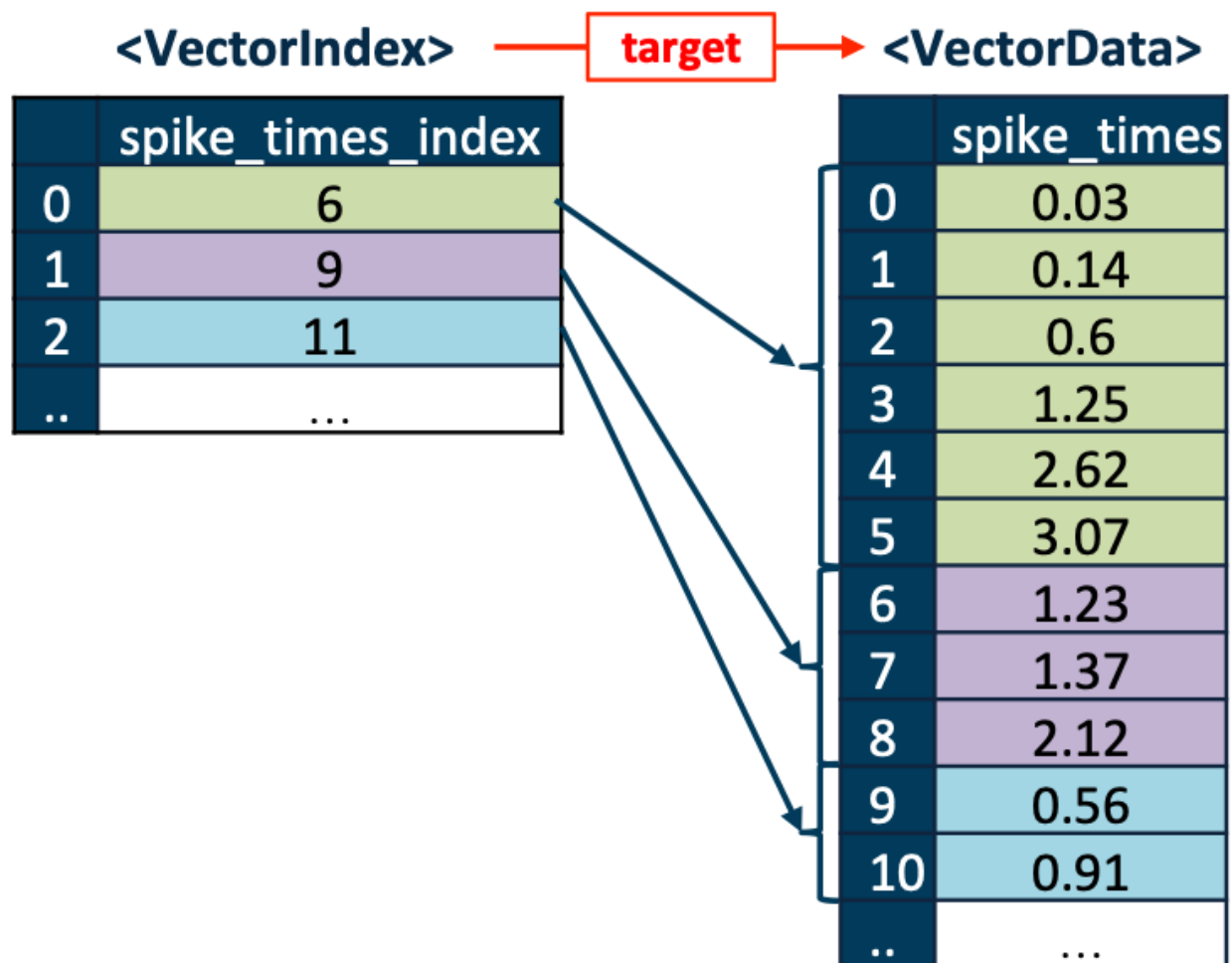
### 1.3 Ragged Arrays

(also known as Jagged Arrays)

Sometimes, you want to have a 2-d array where each row of the array has a different number of elements. For instance, in neuroscience, when storing the action potential times of sorted neurons, you might want to store them as a neuron x times matrix, but the problem is that each neuron will have a different number of spikes, so the second dimension will be inconsistent.

0	0.03	0.14	0.6	1.25	2.62	3.07
1	1.23	1.37	2.12			
2	0.56	0.91				
..	..	..	..	..		

There are a number of possible solutions to this problem. Some solve it by NaN-padding the array. You might want to store the spike times of each neuron in a separate dataset, but that will not scale well if you have many neurons. In HDMF, you would store this using a pair of objects a `VectorData` and a `VectorIndex` object. The `VectorData` array





holds all of the data concatenated as a 1-d array, and it is paired with a link to a `VectorIndex` object that indexes the data, forming a map between the rows of the ragged array and the indices of `VectorData`.

These objects are generally stored inside a `DynamicTable`, and the elements of `VectorIndex` map onto the rows of the table. The `VectorData` object may be n-dimensional, but only the first dimension is ragged.



## EXPERIMENTAL DATA STRUCTURES

The following data structures are currently available under the HDMF-experimental schema. These are subject to change! They are not guaranteed to exist in the future nor maintain backward compatibility.

### 2.1 ExternalResources

The [ExternalResources](#) type is used to store references to data stored in external, web-accessible databases. This information is maintained using four row-based tables.



# **Part II**

## **Format Specification**



**Version** v1.8.0 Aug 09, 2023





## FORMAT OVERVIEW

### 3.1 Namespace – HDMF Common

- **Description:** Common data structures provided by HDMF
- **Name:** hdmf-common
- **Full Name:** HDMF Common
- **Version:** 1.8.0
- **Authors:**
  - Andrew Tritt
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  - [bdichter@lbl.gov](mailto:bdichter@lbl.gov)
- **Schema:**
  - **doc:** base data types
  - **source:** base.yaml
  - **title:** Base data types
  - **doc:** data types for a column-based table
  - **source:** table.yaml
  - **title:** Table data types
  - **doc:** data types for different types of sparse matrices
  - **source:** sparse.yaml
  - **title:** Sparse data types



## TYPE SPECIFICATIONS

### 4.1 Base data types

base data types

#### 4.1.1 Data

**Overview:** An abstract data type for a dataset.

- **Primitive Type:** Dataset
- **Subtypes:** *ElementIdentifiers*, *DynamicTableRegion*, *VectorIndex*, *VectorData*
- **Source filename:** base.yaml
- **Source Specification:** see [Section 5.2.1](#)

### 4.1.2 Container

**Overview:** An abstract data type for a group storing collections of data and metadata. Base type for all data and metadata containers.

- **Primitive Type:** Group
- **Subtypes:** *SimpleMultiContainer*, *DynamicTable*, *AlignedDynamicTable*, *CSRMatrix*
- **Source filename:** base.yaml
- **Source Specification:** see [Section 5.2.2](#)

### 4.1.3 SimpleMultiContainer

**Overview:** A simple Container for holding onto multiple containers.

SimpleMultiContainer extends Container and includes all elements of *Container* with the following additions or changes.

- **Extends:** *Container*
- **Primitive Type:** Group
- **Inherits from:** *Container*
- **Source filename:** base.yaml
- **Source Specification:** see Section 5.2.3

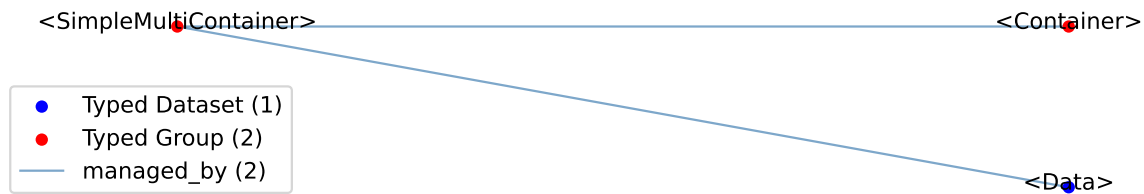


Table 4.1: Datasets, Links, and Attributes contained in <SimpleMultiContainer>

Id	Type	Description
<SimpleMultiContainer>	Group	Top level Group for <SimpleMultiContainer> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> <i>SimpleMultiContainer</i></li> <li>• <b>Extends:</b> <i>Container</i></li> </ul>
.<Data>	Dataset	Data objects held within this SimpleMultiContainer. <ul style="list-style-type: none"> <li>• <b>Extends:</b> <i>Data</i></li> <li>• <b>Quantity:</b> 0 or more</li> </ul>

Table 4.2: Groups contained in <SimpleMultiContainer>

Id	Type	Description
<SimpleMultiContainer>	Group	Top level Group for <SimpleMultiContainer> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> <i>SimpleMultiContainer</i></li> <li>• <b>Extends:</b> <i>Container</i></li> </ul>
.<Container>	Group	Container objects held within this SimpleMultiContainer. <ul style="list-style-type: none"> <li>• <b>Extends:</b> <i>Container</i></li> <li>• <b>Quantity:</b> 0 or more</li> </ul>

#### 4.1.3.1 Groups: <Container>

Container objects held within this SimpleMultiContainer.

- **Extends:** *Container*
- **Quantity:** 0 or more

## 4.2 Table data types

data types for a column-based table

### 4.2.1 VectorData

**Overview:** An n-dimensional dataset representing a column of a DynamicTable. If used without an accompanying VectorIndex, first dimension is along the rows of the DynamicTable and each step along the first dimension is a cell of the larger table. VectorData can also be used to represent a ragged array if paired with a VectorIndex. This allows for storing arrays of varying length in a single cell of the DynamicTable by indexing into this VectorData. The first vector is at VectorData[0:VectorIndex[0]]. The second vector is at VectorData[VectorIndex[0]:VectorIndex[1]], and so on.

VectorData extends Data and includes all elements of *Data* with the following additions or changes.

- **Extends:** *Data*
- **Primitive Type:** Dataset
- **Dimensions:** [['dim0'], ['dim0', 'dim1'], ['dim0', 'dim1', 'dim2'], ['dim0', 'dim1', 'dim2', 'dim3']]
- **Shape:** [[None], [None, None], [None, None, None], [None, None, None, None]]
- **Inherits from:** *Data*
- **Subtypes:** *DynamicTableRegion*, *VectorIndex*
- **Source filename:** table.yaml
- **Source Specification:** see [Section 5.3.1](#)

Table 4.3: Datasets, Links, and Attributes contained in <VectorData>

Id	Type	Description
<VectorData>	Dataset	Top level Dataset for <VectorData> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> VectorData</li> <li>• <b>Extends:</b> <i>Data</i></li> <li>• <b>Dimensions:</b> [['dim0'], ['dim0', 'dim1'], ['dim0', 'dim1', 'dim2'], ['dim0', 'dim1', 'dim2', 'dim3']]</li> <li>• <b>Shape:</b> [[None], [None, None], [None, None, None], [None, None, None, None]]</li> </ul>
.description	At-tribute	Description of what these vectors represent. <ul style="list-style-type: none"> <li>• <b>Data Type:</b> text</li> <li>• <b>Name:</b> description</li> </ul>

## 4.2.2 VectorIndex

**Overview:** Used with `VectorData` to encode a ragged array. An array of indices into the first dimension of the target `VectorData`, and forming a map between the rows of a `DynamicTable` and the indices of the `VectorData`. The name of the `VectorIndex` is expected to be the name of the target `VectorData` object followed by “\_index”.

`VectorIndex` extends `VectorData` and includes all elements of *VectorData* with the following additions or changes.

- **Extends:** *VectorData*
- **Primitive Type:** Dataset
- **Data Type:** uint8
- **Dimensions:** ['num\_rows']
- **Shape:** [None]
- **Inherits from:** *VectorData*, *Data*
- **Source filename:** table.yaml
- **Source Specification:** see [Section 5.3.2](#)

Table 4.4: Datasets, Links, and Attributes contained in <VectorIndex>

Id	Type	Description
<VectorIndex>	Dataset	Top level Dataset for <VectorIndex> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> VectorIndex</li> <li>• <b>Extends:</b> <i>VectorData</i></li> <li>• <b>Data Type:</b> uint8</li> <li>• <b>Dimensions:</b> ['num_rows']</li> <li>• <b>Shape:</b> [None]</li> </ul>
.target	At-tribute	Reference to the target dataset that this index applies to. <ul style="list-style-type: none"> <li>• <b>Data Type:</b> object reference to <i>VectorData</i></li> <li>• <b>Name:</b> target</li> </ul>



### 4.2.3 ElementIdentifiers

**Overview:** A list of unique identifiers for values within a dataset, e.g. rows of a DynamicTable.

ElementIdentifiers extends Data and includes all elements of *Data* with the following additions or changes.

- **Extends:** *Data*
- **Primitive Type:** Dataset
- **Data Type:** int
- **Dimensions:** ['num\_elements']
- **Shape:** [None]
- **Default Name:** element\_id
- **Inherits from:** *Data*
- **Source filename:** table.yaml
- **Source Specification:** see [Section 5.3.3](#)

## 4.2.4 DynamicTableRegion

**Overview:** `DynamicTableRegion` provides a link from one table to an index or region of another. The `table` attribute is a link to another `DynamicTable`, indicating which table is referenced, and the data is `int(s)` indicating the row(s) (0-indexed) of the target array. `DynamicTableRegion`'s can be used to associate rows with repeated meta-data without data duplication. They can also be used to create hierarchical relationships between multiple `DynamicTable`'s. `DynamicTableRegion` objects may be paired with a `VectorIndex` object to create ragged references, so a single cell of a `DynamicTable` can reference many rows of another `DynamicTable`.

`DynamicTableRegion` extends `VectorData` and includes all elements of `VectorData` with the following additions or changes.

- **Extends:** `VectorData`
- **Primitive Type:** Dataset
- **Data Type:** `int`
- **Dimensions:** `['num_rows']`
- **Shape:** `[None]`
- **Inherits from:** `VectorData`, `Data`
- **Source filename:** `table.yaml`
- **Source Specification:** see [Section 5.3.4](#)

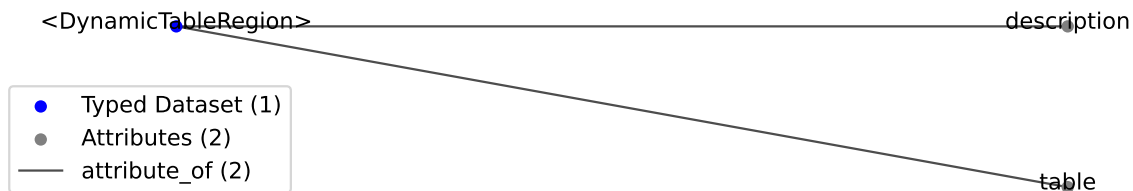


Table 4.5: Datasets, Links, and Attributes contained in `<DynamicTableRegion>`

Id	Type	Description
<code>&lt;DynamicTableRegion&gt;</code>	Dataset	Top level Dataset for <code>&lt;DynamicTableRegion&gt;</code> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> <code>DynamicTableRegion</code></li> <li>• <b>Extends:</b> <code>VectorData</code></li> <li>• <b>Data Type:</b> <code>int</code></li> <li>• <b>Dimensions:</b> <code>['num_rows']</code></li> <li>• <b>Shape:</b> <code>[None]</code></li> </ul>
<code>.table</code>	Attribute	Reference to the <code>DynamicTable</code> object that this region applies to. <ul style="list-style-type: none"> <li>• <b>Data Type:</b> object reference to <code>DynamicTable</code></li> <li>• <b>Name:</b> <code>table</code></li> </ul>
<code>.description</code>	Attribute	Description of what this table region points to. <ul style="list-style-type: none"> <li>• <b>Data Type:</b> <code>text</code></li> <li>• <b>Name:</b> <code>description</code></li> </ul>

### 4.2.5 DynamicTable

**Overview:** A group containing multiple datasets that are aligned on the first dimension (Currently, this requirement is left up to APIs to check and enforce). These datasets represent different columns in the table. Apart from a column that contains unique identifiers for each row, there are no other required datasets. Users are free to add any number of custom VectorData objects (columns) here. DynamicTable also supports ragged array columns, where each element can be of a different size. To add a ragged array column, use a VectorIndex type to index the corresponding VectorData type. See documentation for VectorData and VectorIndex for more details. Unlike a compound data type, which is analogous to storing an array-of-structs, a DynamicTable can be thought of as a struct-of-arrays. This provides an alternative structure to choose from when optimizing storage for anticipated access patterns. Additionally, this type provides a way of creating a table without having to define a compound type up front. Although this convenience may be attractive, users should think carefully about how data will be accessed. DynamicTable is more appropriate for column-centric access, whereas a dataset with a compound type would be more appropriate for row-centric access. Finally, data size should also be taken into account. For small tables, performance loss may be an acceptable trade-off for the flexibility of a DynamicTable.

DynamicTable extends Container and includes all elements of *Container* with the following additions or changes.

- **Extends:** *Container*
- **Primitive Type:** Group
- **Inherits from:** *Container*
- **Subtypes:** *AlignedDynamicTable*
- **Source filename:** table.yaml
- **Source Specification:** see Section 5.3.5

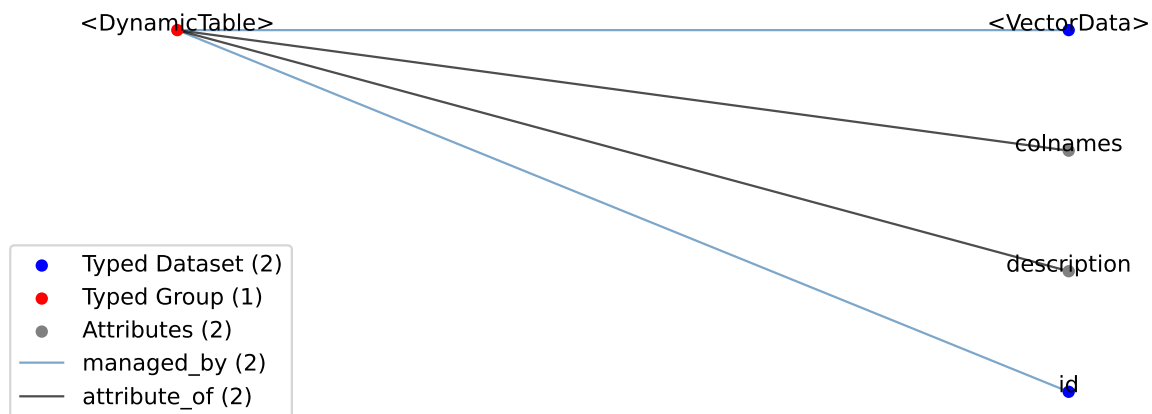


Table 4.6: Datasets, Links, and Attributes contained in <DynamicTable>

Id	Type	Description
<DynamicTable>	Group	Top level Group for <DynamicTable> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> <i>DynamicTable</i></li> <li>• <b>Extends:</b> <i>Container</i></li> </ul>

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Table 4.6 – continued from previous page

Id	Type	Description
.colnames	At-tribute	<p>The names of the columns in this table. This should be used to specify an order to the columns.</p> <ul style="list-style-type: none"> <li>• <b>Data Type:</b> text</li> <li>• <b>Dimensions:</b> ['num_columns']</li> <li>• <b>Shape:</b> [None]</li> <li>• <b>Name:</b> colnames</li> </ul>
.description	At-tribute	<p>Description of what is in this dynamic table.</p> <ul style="list-style-type: none"> <li>• <b>Data Type:</b> text</li> <li>• <b>Name:</b> description</li> </ul>
.id	Dataset	<p>Array of unique identifiers for the rows of this dynamic table.</p> <ul style="list-style-type: none"> <li>• <b>Extends:</b> <i>ElementIdentifiers</i></li> <li>• <b>Data Type:</b> int</li> <li>• <b>Dimensions:</b> ['num_rows']</li> <li>• <b>Shape:</b> [None]</li> <li>• <b>Name:</b> id</li> </ul>
.< <i>VectorData</i> >	Dataset	<p>Vector columns, including index columns, of this dynamic table.</p> <ul style="list-style-type: none"> <li>• <b>Extends:</b> <i>VectorData</i></li> <li>• <b>Quantity:</b> 0 or more</li> </ul>

## 4.2.6 AlignedDynamicTable

**Overview:** DynamicTable container that supports storing a collection of sub-tables. Each sub-table is a DynamicTable itself that is aligned with the main table by row index. I.e., all DynamicTables stored in this group MUST have the same number of rows. This type effectively defines a 2-level table in which the main data is stored in the main table implemented by this type and additional columns of the table are grouped into categories, with each category being represented by a separate DynamicTable stored within the group.

AlignedDynamicTable extends DynamicTable and includes all elements of *DynamicTable* with the following additions or changes.

- **Extends:** *DynamicTable*
- **Primitive Type:** Group
- **Inherits from:** *DynamicTable*, *Container*
- **Source filename:** table.yaml
- **Source Specification:** see Section 5.3.6

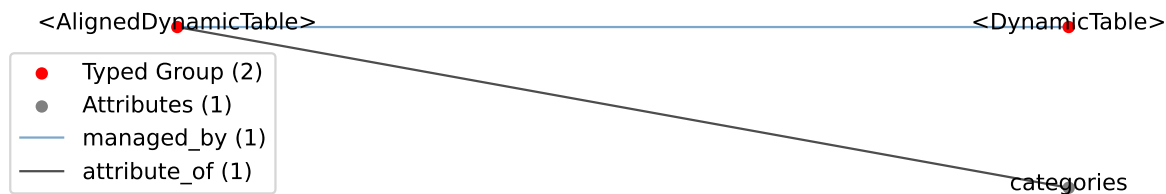


Table 4.7: Datasets, Links, and Attributes contained in <AlignedDynamicTable>

Id	Type	Description
<AlignedDynamicTable>	Group	Top level Group for <AlignedDynamicTable> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> <i>AlignedDynamicTable</i></li> <li>• <b>Extends:</b> <i>DynamicTable</i></li> </ul>
.categories	Attribute	The names of the categories in this AlignedDynamicTable. Each category is represented by one DynamicTable stored in the parent group. This attribute should be used to specify an order of categories and the category names must match the names of the corresponding DynamicTable in the group. <ul style="list-style-type: none"> <li>• <b>Data Type:</b> text</li> <li>• <b>Dimensions:</b> ['num_categories']</li> <li>• <b>Shape:</b> [None]</li> <li>• <b>Name:</b> categories</li> </ul>

Table 4.8: Groups contained in <AlignedDynamicTable>

Id	Type	Description
<AlignedDynamicTable>	Group	Top level Group for <AlignedDynamicTable> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> <i>AlignedDynamicTable</i></li> <li>• <b>Extends:</b> <i>DynamicTable</i></li> </ul>

continues on next page

Table 4.8 – continued from previous page

Id	Type	Description
.< <i>DynamicTable</i> >	Group	<p>A <i>DynamicTable</i> representing a particular category for columns in the <i>AlignedDynamicTable</i> parent container. The table <b>MUST</b> be aligned with (i.e., have the same number of rows) as all other <i>DynamicTables</i> stored in the <i>AlignedDynamicTable</i> parent container. The name of the category is given by the name of the <i>DynamicTable</i> and its description by the description attribute of the <i>DynamicTable</i>.</p> <ul style="list-style-type: none"><li>• <b>Extends:</b> <i>DynamicTable</i></li><li>• <b>Quantity:</b> 0 or more</li></ul>

#### 4.2.6.1 Groups: <*DynamicTable*>

A *DynamicTable* representing a particular category for columns in the *AlignedDynamicTable* parent container. The table **MUST** be aligned with (i.e., have the same number of rows) as all other *DynamicTables* stored in the *AlignedDynamicTable* parent container. The name of the category is given by the name of the *DynamicTable* and its description by the description attribute of the *DynamicTable*.

- **Extends:** *DynamicTable*
- **Quantity:** 0 or more

## 4.3 Sparse data types

data types for different types of sparse matrices

### 4.3.1 CSRMatrix

**Overview:** A compressed sparse row matrix. Data are stored in the standard CSR format, where column indices for row  $i$  are stored in `indices[indptr[i]:indptr[i+1]]` and their corresponding values are stored in `data[indptr[i]:indptr[i+1]]`.

CSRMatrix extends *Container* and includes all elements of *Container* with the following additions or changes.

- **Extends:** *Container*
- **Primitive Type:** Group
- **Inherits from:** *Container*
- **Source filename:** sparse.yaml
- **Source Specification:** see [Section 5.4.1](#)

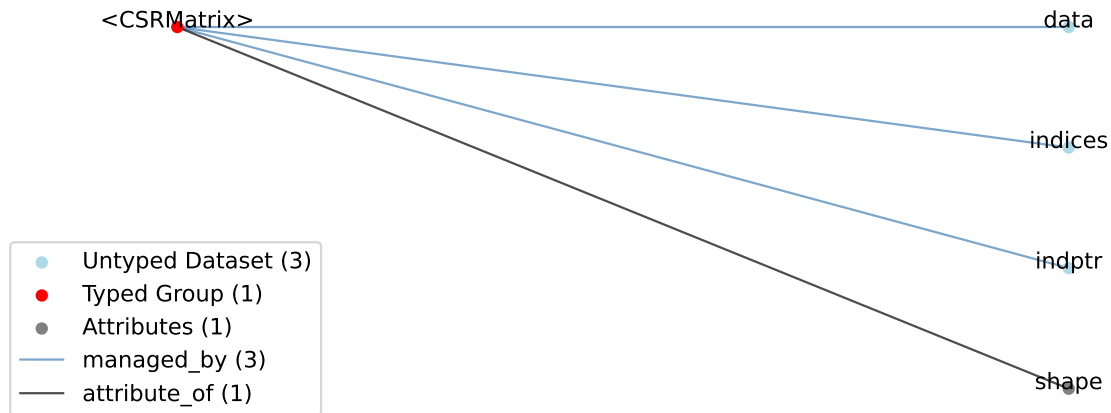


Table 4.9: Datasets, Links, and Attributes contained in `<CSRMatrix>`

Id	Type	Description
<code>&lt;CSRMatrix&gt;</code>	Group	Top level Group for <code>&lt;CSRMatrix&gt;</code> <ul style="list-style-type: none"> <li>• <b>Neurodata Type:</b> <i>CSRMatrix</i></li> <li>• <b>Extends:</b> <i>Container</i></li> </ul>
<code>.shape</code>	Attribute	The shape (number of rows, number of columns) of this sparse matrix. <ul style="list-style-type: none"> <li>• <b>Data Type:</b> <code>uint</code></li> <li>• <b>Dimensions:</b> ['number of rows, number of columns']</li> <li>• <b>Shape:</b> [2]</li> <li>• <b>Name:</b> <code>shape</code></li> </ul>
<code>.indices</code>	Dataset	The column indices. <ul style="list-style-type: none"> <li>• <b>Data Type:</b> <code>uint</code></li> <li>• <b>Dimensions:</b> ['number of non-zero values']</li> <li>• <b>Shape:</b> [None]</li> <li>• <b>Name:</b> <code>indices</code></li> </ul>

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Table 4.9 – continued from previous page

Id	Type	Description
.indptr	Dataset	The row index pointer. <ul style="list-style-type: none"><li>• <b>Data Type:</b> uint</li><li>• <b>Dimensions:</b> ['number of rows in the matrix + 1']</li><li>• <b>Shape:</b> [None]</li><li>• <b>Name:</b> indptr</li></ul>
.data	Dataset	The non-zero values in the matrix. <ul style="list-style-type: none"><li>• <b>Dimensions:</b> ['number of non-zero values']</li><li>• <b>Shape:</b> [None]</li><li>• <b>Name:</b> data</li></ul>



## SCHEMA SOURCES

**Source Specification:** see [Section 5.1](#)

## 5.1 Namespace – HDMF Common

**Description:** see [Section 3.1](#)

**YAML Specification:**

```
1 author:
2   - Andrew Tritt
3   - Oliver Ruebel
4   - Ryan Ly
5   - Ben Dichter
6 contact:
7   - ajtritt@lbl.gov
8   - oruebel@lbl.gov
9   - rly@lbl.gov
10  - bdichter@lbl.gov
11 doc: Common data structures provided by HDMF
12 full_name: HDMF Common
13 name: hdmf-common
14 schema:
15   - doc: base data types
16     source: base.yaml
17     title: Base data types
18   - doc: data types for a column-based table
19     source: table.yaml
20     title: Table data types
21   - doc: data types for different types of sparse matrices
22     source: sparse.yaml
23     title: Sparse data types
24 version: 1.8.0
```

## 5.2 Base data types

base data types

### 5.2.1 Data

**Description:** see [Section 4.1.1](#)

**YAML Specification:**

<pre>1 data_type_def: Data 2 doc: An abstract data type for a dataset.</pre>
--

## 5.2.2 Container

**Description:** see [Section 4.1.2](#)

**YAML Specification:**

<pre>1 <b>data_type_def:</b> Container 2 <b>doc:</b> An abstract data type for a group storing collections of data and metadata. Base 3   type for all data and metadata containers.</pre>
--

### 5.2.3 SimpleMultiContainer

**Extends:** *Container*

**Description:** see [Section 4.1.3](#)

**YAML Specification:**

```
1 data_type_def: SimpleMultiContainer
2 data_type_inc: Container
3 datasets:
4 - data_type_inc: Data
5   doc: Data objects held within this SimpleMultiContainer.
6   quantity: '*'
7 doc: A simple Container for holding onto multiple containers.
8 groups:
9 - data_type_inc: Container
10  doc: Container objects held within this SimpleMultiContainer.
11  quantity: '*'
```

## 5.3 Table data types

data types for a column-based table

### 5.3.1 VectorData

**Extends:** *Data*

**Description:** see [Section 4.2.1](#)

**YAML Specification:**

```

1 attributes:
2 - doc: Description of what these vectors represent.
3   dtype: text
4   name: description
5 data_type_def: VectorData
6 data_type_inc: Data
7 dims:
8 - - dim0
9 - - dim0
10 - - dim1
11 - - dim0
12 - - dim1
13 - - dim2
14 - - dim0
15 - - dim1
16 - - dim2
17 - - dim3
18 doc: An n-dimensional dataset representing a column of a DynamicTable. If used without
19 an accompanying VectorIndex, first dimension is along the rows of the DynamicTable
20 and each step along the first dimension is a cell of the larger table. VectorData
21 can also be used to represent a ragged array if paired with a VectorIndex. This
22 allows for storing arrays of varying length in a single cell of the DynamicTable
23 by indexing into this VectorData. The first vector is at VectorData[0:VectorIndex[0]].
24 The second vector is at VectorData[VectorIndex[0]:VectorIndex[1]], and so on.
25 shape:
26 - - null
27 - - null
28 - - null
29 - - null
30 - - null
31 - - null
32 - - null
33 - - null
34 - - null
35 - - null

```

### 5.3.2 VectorIndex

**Extends:** *VectorData*

**Description:** see [Section 4.2.2](#)

**YAML Specification:**

```
1 attributes:
2 - doc: Reference to the target dataset that this index applies to.
3   dtype:
4     reftype: object
5     target_type: VectorData
6   name: target
7 data_type_def: VectorIndex
8 data_type_inc: VectorData
9 dims:
10 - num_rows
11 doc: Used with VectorData to encode a ragged array. An array of indices into the first
12     dimension of the target VectorData, and forming a map between the rows of a
13     ↪DynamicTable
14     and the indices of the VectorData. The name of the VectorIndex is expected to be
15     the name of the target VectorData object followed by "_index".
16 dtype: uint8
17 shape:
18 - null
```

### 5.3.3 ElementIdentifiers

**Extends:** *Data*

**Description:** see [Section 4.2.3](#)

**YAML Specification:**

```
1 data_type_def: ElementIdentifiers
2 data_type_inc: Data
3 default_name: element_id
4 dims:
5   - num_elements
6 doc: A list of unique identifiers for values within a dataset, e.g. rows of a
   ↪ DynamicTable.
7 dtype: int
8 shape:
9   - null
```

### 5.3.4 DynamicTableRegion

**Extends:** *VectorData*

**Description:** see [Section 4.2.4](#)

**YAML Specification:**

```
1 attributes:
2 - doc: Reference to the DynamicTable object that this region applies to.
3   dtype:
4     reftype: object
5     target_type: DynamicTable
6   name: table
7 - doc: Description of what this table region points to.
8   dtype: text
9   name: description
10 data_type_def: DynamicTableRegion
11 data_type_inc: VectorData
12 dims:
13 - num_rows
14 doc: DynamicTableRegion provides a link from one table to an index or region of another.
15   The `table` attribute is a link to another `DynamicTable`, indicating which table
16   is referenced, and the data is int(s) indicating the row(s) (0-indexed) of the target
17   array. `DynamicTableRegion`s can be used to associate rows with repeated meta-data
18   without data duplication. They can also be used to create hierarchical relationships
19   between multiple `DynamicTable`s. `DynamicTableRegion` objects may be paired with
20   a `VectorIndex` object to create ragged references, so a single cell of a
21   ↪ `DynamicTable`
22   can reference many rows of another `DynamicTable`.
23 dtype: int
24 shape:
25 - null
```



### 5.3.5 DynamicTable

**Extends:** *Container*

**Description:** see [Section 4.2.5](#)

**YAML Specification:**

```

1 attributes:
2   - dims:
3     - num_columns
4   doc: The names of the columns in this table. This should be used to specify an order
5     to the columns.
6   dtype: text
7   name: colnames
8   shape:
9     - null
10  - doc: Description of what is in this dynamic table.
11    dtype: text
12    name: description
13 data_type_def: DynamicTable
14 data_type_inc: Container
15 datasets:
16  - data_type_inc: ElementIdentifiers
17    dims:
18      - num_rows
19    doc: Array of unique identifiers for the rows of this dynamic table.
20    dtype: int
21    name: id
22    shape:
23      - null
24  - data_type_inc: VectorData
25    doc: Vector columns, including index columns, of this dynamic table.
26    quantity: '*'
27 doc: A group containing multiple datasets that are aligned on the first dimension
28 (Currently, this requirement is left up to APIs to check and enforce). These datasets
29 represent different columns in the table. Apart from a column that contains unique
30 identifiers for each row, there are no other required datasets. Users are free to
31 add any number of custom VectorData objects (columns) here. DynamicTable also supports
32 ragged array columns, where each element can be of a different size. To add a ragged
33 array column, use a VectorIndex type to index the corresponding VectorData type.
34 See documentation for VectorData and VectorIndex for more details. Unlike a compound
35 data type, which is analogous to storing an array-of-structs, a DynamicTable can
36 be thought of as a struct-of-arrays. This provides an alternative structure to choose
37 from when optimizing storage for anticipated access patterns. Additionally, this
38 type provides a way of creating a table without having to define a compound type
39 up front. Although this convenience may be attractive, users should think carefully
40 about how data will be accessed. DynamicTable is more appropriate for column-centric
41 access, whereas a dataset with a compound type would be more appropriate for row-
42 centric
43 access. Finally, data size should also be taken into account. For small tables,
44 performance loss may be an acceptable trade-off for the flexibility of a DynamicTable.

```

### 5.3.6 AlignedDynamicTable

**Extends:** *DynamicTable*

**Description:** see Section 4.2.6

**YAML Specification:**

```

1 attributes:
2 - dims:
3   - num_categories
4   doc: The names of the categories in this AlignedDynamicTable. Each category is
5   ↪represented
6     by one DynamicTable stored in the parent group. This attribute should be used
7     to specify an order of categories and the category names must match the names
8     of the corresponding DynamicTable in the group.
9   dtype: text
10  name: categories
11  shape:
12    - null
13 data_type_def: AlignedDynamicTable
14 data_type_inc: DynamicTable
15 doc: DynamicTable container that supports storing a collection of sub-tables. Each
16     sub-table is a DynamicTable itself that is aligned with the main table by row index.
17     I.e., all DynamicTables stored in this group MUST have the same number of rows.
18     This type effectively defines a 2-level table in which the main data is stored in
19     the main table implemented by this type and additional columns of the table are
20     grouped into categories, with each category being represented by a separate
21     ↪DynamicTable
22     stored within the group.
23 groups:
24 - data_type_inc: DynamicTable
25   doc: A DynamicTable representing a particular category for columns in the
26   ↪AlignedDynamicTable
27     parent container. The table MUST be aligned with (i.e., have the same number of
28     rows) as all other DynamicTables stored in the AlignedDynamicTable parent container.
29     The name of the category is given by the name of the DynamicTable and its description
30     by the description attribute of the DynamicTable.
31   quantity: '*'

```

## 5.4 Sparse data types

data types for different types of sparse matrices

### 5.4.1 CSRMatrix

**Extends:** *Container*

**Description:** see [Section 4.3.1](#)

**YAML Specification:**

```

1  attributes:
2  - dims:
3    - number of rows, number of columns
4    doc: The shape (number of rows, number of columns) of this sparse matrix.
5    dtype: uint
6    name: shape
7    shape:
8      - 2
9  data_type_def: CSRMatrix
10 data_type_inc: Container
11 datasets:
12 - dims:
13   - number of non-zero values
14   doc: The column indices.
15   dtype: uint
16   name: indices
17   shape:
18     - null
19 - dims:
20   - number of rows in the matrix + 1
21   doc: The row index pointer.
22   dtype: uint
23   name: indptr
24   shape:
25     - null
26 - dims:
27   - number of non-zero values
28   doc: The non-zero values in the matrix.
29   name: data
30   shape:
31     - null
32 doc: A compressed sparse row matrix. Data are stored in the standard CSR format, where
33 column indices for row i are stored in indices[indptr[i]:indptr[i+1]] and their
34 corresponding values are stored in data[indptr[i]:indptr[i+1]].

```



## **Part III**

# **Resources**



## MAKING A PULL REQUEST

Actions to take on each PR that modifies the schema and does not prepare the schema for a public release (this is also in the [GitHub PR template](#)):

If the current schema version on “main” is a public release, then:

1. Update the version string in `docs/source/conf.py` and `common/namespace.yaml` to the next version with the suffix “-alpha”
2. Add a new section in the release notes for the new version with the date “Upcoming”

Always:

1. Add release notes for the PR to `docs/source/hdmf_common_release_notes.rst` and/or `docs/source/hdmf_experimental_release_notes.rst`

Documentation or internal changes to the repo (i.e., changes that do not affect the schema files) do not need to be accompanied with a version bump or addition to the release notes.





## MERGING PRS AND MAKING RELEASES

**Public release:** a tagged release of the schema. The version string **MUST NOT** have a suffix indicating a pre-release, such as “-alpha”. The current “dev” branch of HDMF and all HDMF releases **MUST** point to a public release of hdmf-common-schema. All schema that use hdmf-common-schema as a submodule **MUST** also point only to public releases.

**Internal release:** a state of the schema “main” branch where the version string ends with “-alpha”.

The default branch of hdmf-common-schema is “main”. **The “main” branch holds the bleeding edge version of the hdmf-common schema specification.**

PRs should be made to “main”. Every PR should include an update to the namespace release notes (docs/source/hdmf\_common\_release\_notes.rst and/or docs/source/hdmf\_experimental\_release\_notes.rst). If the current version is a public release, then the PR should also update the version of the schema in two places: docs/source/conf.py and common/namespace.yaml. The new version should be the next bugfix/minor/major version of the schema with the suffix “-alpha”. For example, if the current schema on “main” has version “2.2.0”, then a PR implementing a bug fix should update the schema version from “2.2.0” to “2.2.1-alpha”. Appending the “-alpha” suffix ensures that any person or API accessing the default “main” branch of the repo containing an internal release of the schema receives the schema with a version string that is distinct from public releases of the schema. If the current schema on “main” is already an internal release, then the version string does not need to be updated unless the PR requires an upgrade in the version (e.g., from bugfix to minor).

HDMF should contain a branch and PR that tracks the “main” branch of hdmf-common-schema. Before a public release of hdmf-common-schema is made, this HDMF branch should be checked to ensure that when the new release is made, the branch can be merged without issue.

Immediately prior to making a new public release, the version of the schema should be updated to remove the “-alpha” suffix and the documentation and release notes should be updated as needed (see next section).

The current “dev” branch of HDMF and all HDMF releases **MUST** always point to a public release of hdmf-common-schema. If a public release contains an internally released version of hdmf-common-schema, e.g., from an untagged commit on the “main” branch, then it will be difficult to find the version (commit) of hdmf-common-schema that was used to create an HDMF file when the schema is not cached.



## MAKING A RELEASE CHECKLIST

Before merging:

1. Update requirements versions as needed
2. Update legal file dates and information in `Legal.txt`, `license.txt`, `README.md`, `docs/source/conf.py`, and any other locations as needed
3. Update `README.md` as needed
4. Update the version string in `docs/source/conf.py` and `common/namespace.yaml` (remove “-alpha” suffix)
5. Update `docs/source/conf.py` as needed
6. Update release notes (set release date) in `docs/source/hdmf_common_release_notes.rst`, `docs/source/hdmf_experimental_release_notes.rst`, and any other docs as needed
7. Test docs locally (`cd docs; make fulldoc`) where the hdmf-common-schema submodule in the local version of HDMF is fully up-to-date with the head of the main branch.
8. Push changes to a new PR and make sure all PRs to be included in this release have been merged. Add `?template=release.md` to the PR URL to auto-populate the PR with this checklist.
9. Check that the readthedocs build for this PR succeeds (build latest to pull the new branch, then activate and build docs for new branch): <https://readthedocs.org/projects/hdmf-common-schema/builds/>

After merging:

1. Create a new git tag. Pull the latest main branch locally, run `git tag [version] --sign`, copy and paste the release notes into the tag message, and run `git push --tags`.
2. On the [GitHub tags](#) page, click “...” -> “Create release” for the new tag on the right side of the page. Copy and paste the release notes into the release message, update the formatting if needed (reST to Markdown), and set the title to the version string.
3. Check that the readthedocs “latest” and “stable” builds run and succeed. Delete the readthedocs build for the merged PR. <https://readthedocs.org/projects/hdmf-common-schema/builds/>
4. Update the HDMF submodule in the HDMF branch corresponding to this schema version to point to the tagged commit.

This checklist can also be found in the [GitHub release PR template](#).

The time between merging this PR and creating a new public release should be minimized.



## **Part IV**

# **History and Legal**



## HDMF-COMMON RELEASE NOTES

### 9.1 1.8.0 (August 4, 2023)

- No change in the hdmf-common namespace. See [here](#) for changes to the hdmf-experimental namespace.

### 9.2 1.7.0 (June 22, 2023)

- No change in the hdmf-common namespace. See [here](#) for changes to the hdmf-experimental namespace.

### 9.3 1.6.0 (May 3, 2023)

- No change in the hdmf-common namespace. See [here](#) for changes to the hdmf-experimental namespace.

### 9.4 1.5.1 (January 10, 2022)

- No change in the hdmf-common namespace. See [here](#) for changes to the hdmf-experimental namespace.

### 9.5 1.5.0 (April 19, 2021)

- Added `AlignedDynamicTable`, which defines a `DynamicTable` that supports storing a collection of sub-tables. Each sub-table is itself a `DynamicTable` that is aligned with the main table by row index. Each sub-table defines a sub-category in the main table effectively creating a table with sub-headings to organize columns.

### 9.6 1.4.0 (March 29, 2021)

Summary: In 1.4.0, the HDMF-experimental namespace was added, which includes the `ExternalResources` and `EnumData` data types. Schema in the HDMF-experimental namespace are experimental and subject to breaking changes at any time. `ExternalResources` was changed to support storing both names and URIs for resources. The `VocabData` data type was replaced by `EnumData` to provide more flexible support for data from a set of fixed values.

- Added `EnumData` for storing data that comes from a set of fixed values. This replaces `VocabData` which could hold only string values. Also, `VocabData` could hold only a limited number of elements (~64k) when used with

the HDF5 storage backend. `EnumData` gets around these restrictions by using an untyped dataset (`VectorData`) instead of a string attribute to hold the enumerated values.

- Removed `VocabData`.
- Renamed the “resources” table in `ExternalResources` to “entities”.
- Created a new “resources” table to store the name and URI of the ontology / external resource used by the “entities” table in `ExternalResources`.
- Renamed fields in `ExternalResources`.
- Added “entities” dataset to `ExternalResources`. This is a row-based table dataset to replace the functionality of the “resources” dataset in `ExternalResources`.
- Changed the “resources” dataset in `ExternalResources` to store the name and URI of the ontology / external resource used by the “entities” dataset in `ExternalResources`.
- Added HDMF-experimental namespace.
- Moved `ExternalResources` and `EnumData` to HDMF-experimental.

### 9.7 1.3.0 (December 2, 2020)

- Add data type `ExternalResources` for storing ontology information / external resource references. NOTE: this data type is in beta testing and is subject to change in a later version.
- Changed dtype for datasets within `CSRMatrix` from ‘int’ to ‘uint’. Negative values do not make sense for these datasets.

### 9.8 1.2.1 (November 4, 2020)

- Update software process documentation for maintainers.
- Fix missing `data_type_inc` for `CSRMatrix`. It now has `data_type_inc: Container`.
- Add `hdmf-schema-language` comment at the top of each yaml file.
- Add `SimpleMultiContainer`, a `Container` for storing other `Container` and `Data` objects together

### 9.9 1.2.0 (July 10, 2020)

- Add software process documentation.
- Fix missing dtype for `VectorIndex`.
- Add new `VocabData` data type.
- Move `Data`, `Index`, and `Container` to `base.yaml`. This change does not functionally change the schema.
- `VectorIndex` now extends `VectorData` instead of `Index`. This change allows `VectorIndex` to index other `VectorIndex` types.
- The `Index` data type is now unused and has been removed.
- Fix documentation for ragged arrays.



## 9.10 1.1.3 (January 21, 2020)

- Fix missing ‘shape’ and ‘dims’ key for types `VectorData`, `VectorIndex`, and `DynamicTableRegion`.

## 9.11 1.1.2 (January 9, 2020)

- Fix version number in `namespace.yaml` and docs

## 9.12 1.1.1 (January 9, 2020)

- Support for ReadTheDocs continuous documentation was added, and legal/license documents were also added. The schema is unchanged.

## 9.13 1.1.0 (January 3, 2020)

- The ‘colnames’ attribute of `DynamicTable` changed from data type ‘ascii’ to ‘text’.
- Improved documentation and type docstrings.

## 9.14 1.0.0 (September 26, 2019)

Initial release.



## HDMF-EXPERIMENTAL RELEASE NOTES

### 10.1 0.5.0 (August 4, 2023)

- Updates `ExternalResources` to have a uniform name throughout the codebase and the literature, which is now HERD (HDMF External Resources Data).
- Fixed schema bug regarding the missing quote.

### 10.2 0.4.0 (June 22, 2023)

- In the experimental `ExternalResources`, added a `entity_keys` table and removed `keys_idx` from the `entities` table.

### 10.3 0.3.0 (May 3, 2023)

- In the experimental `ExternalResources`, added a `files` table, removed the `resources` table, and adjusted existing columns.

### 10.4 0.2.0 (January 10, 2022)

- In the experimental `ExternalResources`, added `relative_path` field to the “objects” table dtype. This is used in place of the previous `field` field representing the relative path to get to the dataset/attribute from the object. The previous `field` field will be used to represent a compound type field name if the dataset/attribute is a compound dtype.
- Updated contributors.

## 10.5 0.1.0 (March 29, 2021)

- See the release notes for *hdmf-common 1.4.0* for details.

## **11.1 Authors**

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