# Dataset-JSON: SAS© implementation

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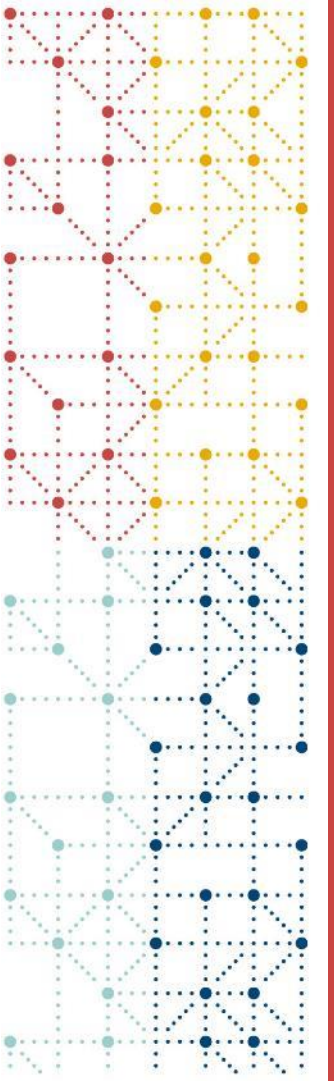
**CDISC Q3 COSA Quarterly Spotlight Webinar - 2023-10-05**

# About your presenter

- 16 years in an IT/Standards role in Biostatistics at Organon
- 4 years as a consultant to help companies implement CDISC
- 11 years at **SAS**.
  - 8 years as a **Principal Software Developer working on SAS Clinical Standards Toolkit** (implementing mostly XML based standards (Define-XML, ODM, Dataset-XML)) and SAS Life Science Analytics Framework (Java)
  - 3 years as Principal Solution Consultant at SAS implementing Life Science Analytics Framework

- Since Nov 2021 Senior Director, Data Science Development at **CDISC** (contractor)
- Core member of the CDISC Data Exchange Standards team since 2008.
  (co-lead since Nov 2021)
- Core member of the CDISC Define-XML development team.
  - One of the main Define-XML v2 developers.
  - Developer of CDISC/PhUSE Define-XML v2 stylesheet.
  - One of the main developers of the Analysis Results Metadata v1.0 for Define-XML v2.0 extension



# Agenda

1. Dataset-JSON Document Structure
2. SAS and JSON
3. Writing Dataset-JSON with SAS
4. Reading Dataset-JSON with SAS
5. Comparing SAS datasets / Dataset-JSON files
6. Validating Dataset-JSON files
7. Demo

# Dataset-JSON Document Structure

# Dataset-JSON Document Structure

- Dataset-JSON was adapted from the Dataset-XML specification, but uses JSON format instead of XML
- Each Dataset-JSON file is connected with a Define-XML file, containing **detailed** metadata
- Each Dataset-JSON files contains **basic** information about dataset variables, so that it is possible to have a simple view of the contents of a dataset without the need of a Define-XML document
- Dataset-JSON Specification:
  - https://www.cdisc.org/dataset-json
  - https://wiki.cdisc.org/display/PUB/Dataset-JSON
- GitHub repository with JSON Schema and examples: https://github.com/cdisc-org/DataExchange-DatasetJson

# Dataset-JSON Document Structure

- At the top level of the Dataset-JSON object, there are some required attributes (**creationDateTime** and **datasetJSONVersion**)*, and one of two optional attributes: **clinicalData** or **referenceData**.
- Subject data is stored in **clinicalData** and non-subject data is stored in **referenceData**.


```
{
    "creationDateTime": "2023-06-28T15:38:43",
    "datasetJSONVersion": "1.0.0",
    "clinicalData": {
        "studyOID": "cdisc.com/CDISCPILOT01",
        "metaDataVersionOID": "MDV.MSGv2.0.SDTMIG.3.3.SDTM.1.7",
        "itemGroupData": {
            "IG.DM": {…
            }
        }
    }
}
```



```
{
    "creationDateTime": "2023-06-28T15:38:44",
    "datasetJSONVersion": "1.0.0",
    "referenceData": {
        "studyOID": "cdisc.com/CDISCPILOT01",
        "metaDataVersionOID": "MDV.MSGv2.0.SDTMIG.3.3.SDTM.1.7",
        "itemGroupData": {
            "IG.TS": {…
            }
        }
    }
}
```

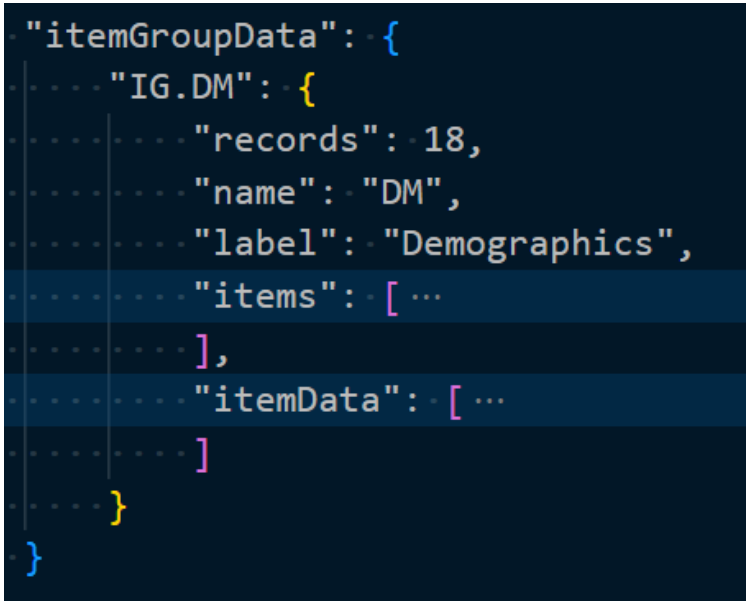

- **studyOID** and **metaDataVersionOID** must match corresponding values in Define-XML

*See the specification for other optional attributes

# Dataset-JSON Document Structure - top level attributes

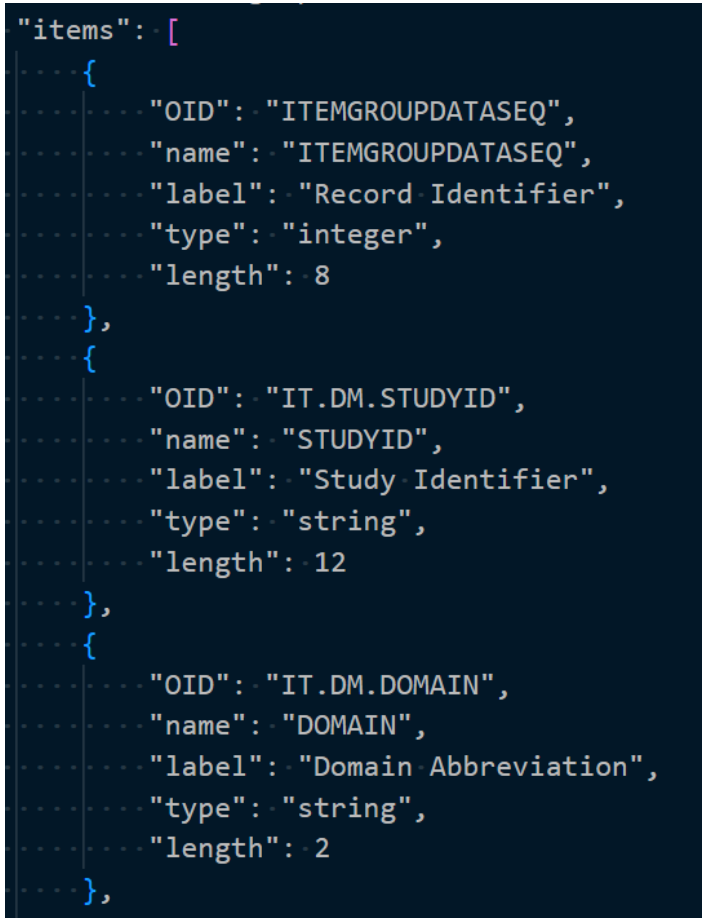
| Attribute | Usage | Description |
|---|---|---|
| creationDateTime | Required | Time of creation of the file containing the document. |
| datasetJSONVersion | Required | Version of Dataset-JSON standard |
| fileOID | Optional | A unique identifier for this file. |
| asOfDateTime | Optional | The date/time at which the source database was queried in order to create this document. |
| originator | Optional | The organization that generated the Dataset-JSON file. |
| sourceSystem | Optional | The computer system or database management system that is the source of the information in this file. |
| sourceSystemVersion | Optional | The version of the "SourceSystem" above. |
| clinicalData | Optional | Contains datasets for clinical data across multiple subjects. |
| referenceData | Optional | Contains datasets for non-subject data domains. |

# Dataset-JSON Document Structure




- **itemGroupData** is an object with attributes corresponding to individual datasets.
- The attribute name (IG.DM) is the OID of a described dataset, which must be the same as the OID of the corresponding itemGroup in the Define-XML file
- **records**, **name**, **label**:
  basic dataset information (all required)
- **items** - basic information about variables
- **itemData** - dataset data

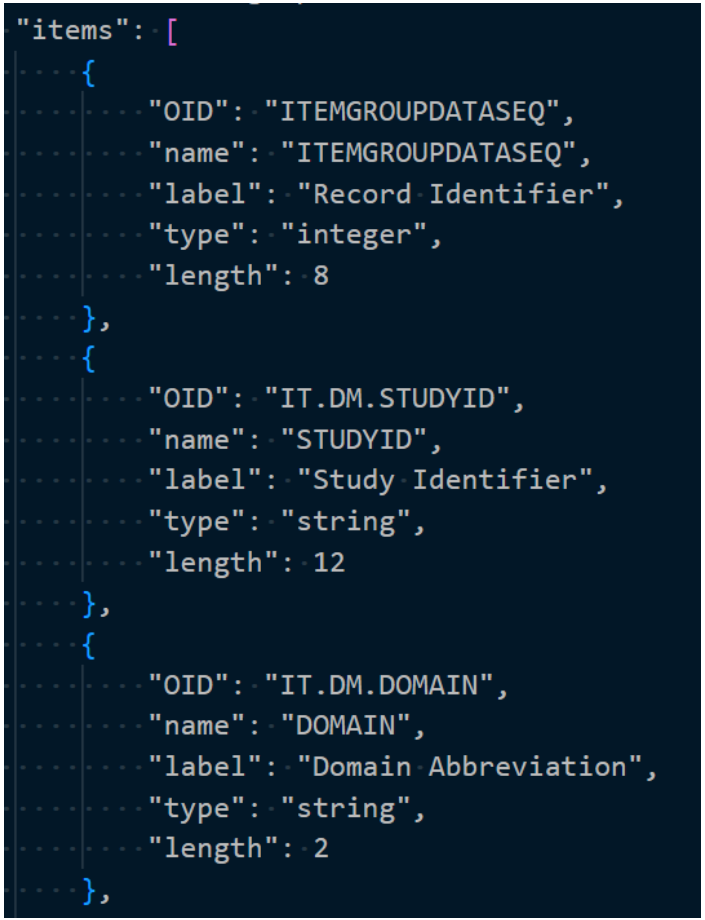
# Dataset-JSON Document Structure



```
"items": [
    {
        "OID": "ITEMGROUPDATASEQ",
        "name": "ITEMGROUPDATASEQ",
        "label": "Record Identifier",
        "type": "integer",
        "length": 8
    },
    {
        "OID": "IT.DM.STUDYID",
        "name": "STUDYID",
        "label": "Study Identifier",
        "type": "string",
        "length": 12
    },
    {
        "OID": "IT.DM.DOMAIN",
        "name": "DOMAIN",
        "label": "Domain Abbreviation",
        "type": "string",
        "length": 2
    },
```

- **items** - array of basic information about dataset variables.
- The **order of elements** in the array must be the same as the **order of variables** in the described dataset.
- The first element always describes the Record Identifier (**ITEMGROUPDATASEQ**)

# Dataset-JSON Document Structure



```
"items": [
    {
        "OID": "ITEMGROUPDATASEQ",
        "name": "ITEMGROUPDATASEQ",
        "label": "Record Identifier",
        "type": "integer",
        "length": 8
    },
    {
        "OID": "IT.DM.STUDYID",
        "name": "STUDYID",
        "label": "Study Identifier",
        "type": "string",
        "length": 12
    },
    {
        "OID": "IT.DM.DOMAIN",
        "name": "DOMAIN",
        "label": "Domain Abbreviation",
        "type": "string",
        "length": 2
    },
```

- **OID** - OID of a variable (must correspond to the variable OID in the Define-XML file)
- **name** - variable name
- **label** - variable description
- **type** - type of the variable.
  'string', 'integer', 'decimal', 'float', 'double', 'boolean'
- **length** - variable length - most useful for the string type
- **displayFormat** - supports data visualization of numeric float and date values
- **keySequence** - indicates that this item is a key variable in the dataset structure

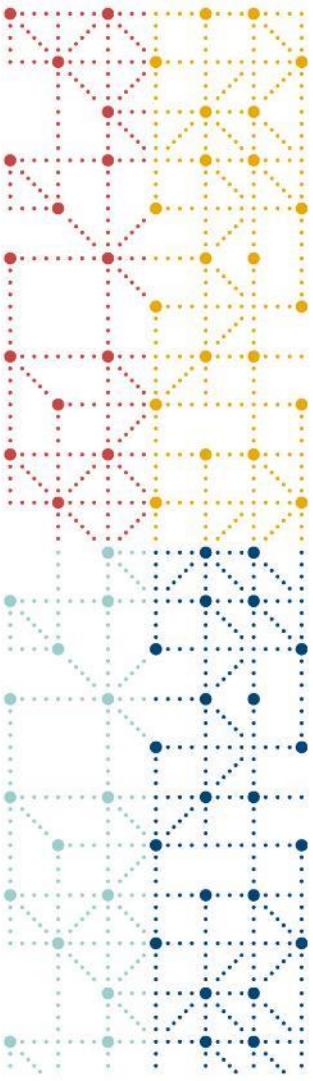
The last 3 attributes are optional

# Dataset-JSON Document Structure

- **itemData** is an array of records with variables values
- Each record itself is represented as an array of variables values
- The first value is a unique sequence number for each record in the dataset
- Missing values are represented by **null** in the case of numeric variables, and an **empty string** in case of character variables:

```
[1, "MyStudy", "", "DM", null]
```

```
"itemData": [
  [1,"CDISCPILOT01","DM","CDISC001","1115","","","701","1928",84,"YEARS","M","WHITE","NOT HIS
  [2,"CDISCPILOT01","DM","CDISC002","1211","2013-01-14","Y","701","1936",76,"YEARS","F","WHIT
  [3,"CDISCPILOT01","DM","CDISC003","1302","","","701","1951",61,"YEARS","M","WHITE","NOT HIS
  ...
]
```

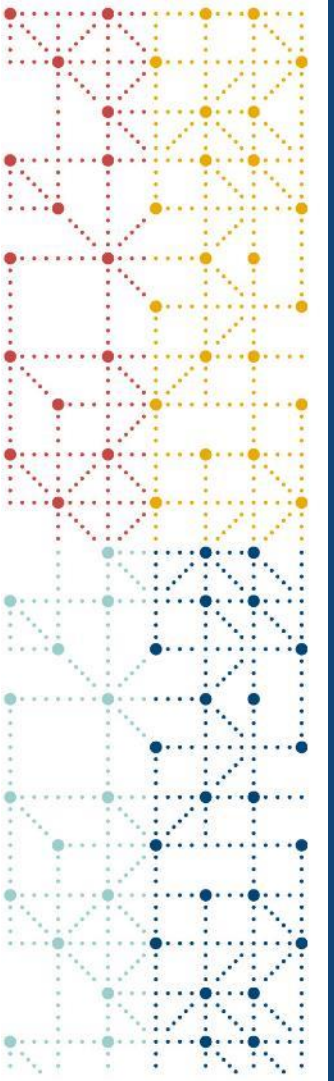


# SAS and JSON

# SAS and JSON

- Starting in SAS© 9.4, you can use **PROC JSON to** write SAS data sets to JSON files

- Starting in SAS© 9.4TS1M4, you can use the **JSON engine** to read JSON files into SAS data sets



# Writing Dataset-JSON with SAS

# Writing Dataset-JSON with SAS

- PROC JSON in SAS© gives the user control over the JSON output:
  - through the utilization of options
  - through the ability to control containers (objects or arrays)
  - by writing directly to the output file
  - by choosing exactly what to include or not include in the resulting JSON file

```
PROC JSON OUT=fileref | "external-file" <options>;
  EXPORT <libref.>SAS-data-set <(data-set-options)> </options>;
  WRITE VALUES value(s) </options>;
  WRITE OPEN type;
  WRITE CLOSE;
RUN;
```

# Writing Dataset-JSON with SAS

```
PROC JSON OUT=jsonfout PRETTY;
  WRITE OPEN OBJECT;
  WRITE VALUES "creationDateTime" "&CurrentDateTime";
  WRITE VALUES "datasetJSONVersion" "1.0.0";
  WRITE VALUES "clinicalData";
  WRITE OPEN OBJECT;
  WRITE VALUES "studyOID" "<study OID>";
  WRITE VALUES "metaDataVersionOID" "<MDV OID>";
  WRITE VALUES "itemGroupData";
  WRITE OPEN OBJECT;
  WRITE VALUES "IG.DM";
  WRITE OPEN OBJECT;
  WRITE VALUES "records" 18;
  WRITE VALUES "name" "DM";
  WRITE VALUES "label" "Demographics";
  WRITE VALUES "items";
  WRITE OPEN ARRAY;
    EXPORT work.column_metadata / KEYS;
  WRITE CLOSE;
  WRITE VALUES "itemData";
  WRITE OPEN ARRAY;
    EXPORT work.column_data / NOKEYS;
  WRITE CLOSE;
  WRITE CLOSE;
  WRITE CLOSE;
  WRITE CLOSE;
  WRITE CLOSE;
RUN;
```

```
{
  "creationDateTime": "2023-06-28T15:38:43",
  "datasetJSONVersion": "1.0.0",
  "clinicalData": {
    "studyOID": "<study OID>",
    "metaDataVersionOID": "<MDV OID>",
    "itemGroupData": {
      "IG.DM": {
        "records": 18,
        "name": "DM",
        "label": "Demographics",
        "items": [
          column metadata
        ],
        "itemData": [
          Column data
        ]
      }
    }
  }
}
```

**EXPORT** creates empty strings or null with missing data..

# Writing Dataset-JSON with SAS

```
PROC JSON OUT=jsonfout PRETTY;
  WRITE OPEN OBJECT;
  WRITE VALUES "creationDateTime" "&CurrentDateTime";
  WRITE VALUES "datasetJSONVersion" "1.0.0";
  WRITE VALUES "clinicalData";
  WRITE OPEN OBJECT;
  WRITE VALUES "studyOID" "<study OID>";
  WRITE VALUES "metaDataVersionOID" "<MDV OID>";
  WRITE VALUES "itemGroupData";
  WRITE OPEN OBJECT;
  WRITE VALUES "IG.DM";
  WRITE OPEN OBJECT;
  WRITE VALUES "records" 18;
  WRITE VALUES "name" "DM";
  WRITE VALUES "label" "Demographics";
  WRITE VALUES "items";
  WRITE OPEN ARRAY;
    %write_json_metadata_array(work.column_metadata);
  WRITE CLOSE;
  WRITE VALUES "itemData";
  WRITE OPEN ARRAY;
    EXPORT work.column_data / NOKEYS;
  WRITE CLOSE;
  WRITE CLOSE;
  WRITE CLOSE;
  WRITE CLOSE;
  WRITE CLOSE;
RUN;
```

```
{
  "creationDateTime": "2023-06-28T15:38:43",
  "datasetJSONVersion": "1.0.0",
  "clinicalData": {
    "studyOID": "<study OID>",
    "metaDataVersionOID": "<MDV OID>",
    "itemGroupData": {
      "IG.DM": {
        "records": 18,
        "name": "DM",
        "label": "Demographics",
        "items": [
          column metadata
        ],
        "itemData": [
          Column data
        ]
      }
    }
  }
}
```

The **%write_json_metadata_array** macro does not write key-value pairs when the value is null.

# Using Define-XML metadata when creating Dataset-JSON

- Get OIDs from Define-XML when creating Dataset-JSON
- Use pre-specified metadata from Define-XML (label, datatype, length, and KeySequence) for creating Dataset-JSON
- Get variable display formats from Define-XML when creating SAS datasets from Dataset-JSON (especially for numeric date/time variables)
- Important to check that Define-XML is consistent with the data!

```
/* Create metadata from Define-XML for ADaM */
%CreateMetadataFromDefineXML(
   definexml=&root/json/adam/define.xml,
   metadatalib=metaadam
   );

/* Some manual data type updates */
data metaadam.metadata_columns;
  set metaadam.metadata_columns;
  if xml_datatype='float' and index(name, 'VISIT')
    then json_datatype='decimal';
run;


/* Create metadata from Define-XML for SDTM */
%CreateMetadataFromDefineXML(
   definexml=&root/json/sdtm/define.xml,
   metadatalib=metasdtm
   );

/* Some manual data type updates */
data metasdtm.metadata_columns;
  set metasdtm.metadata_columns;
  if xml_datatype='float' and name ne 'LBSTRESN'
    then json_datatype='decimal';
run;
```

# Writing Dataset-JSON - %write_datasetjson()

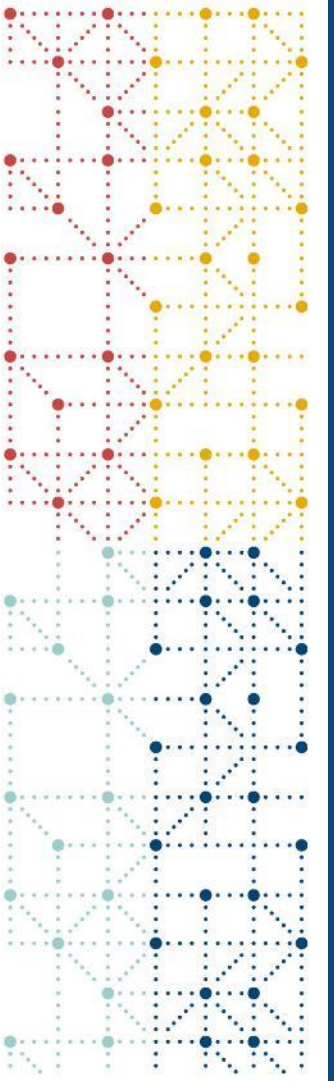
```
%write_datasetjson(
    dataset=                    /* (libname.)memname of the data set  */
    xptpath=,                   /* Path to XPT file                   */
    jsonpath=,                  /* Path to Dataset-JSON file          */
    usemetadata=N,              /* Use Define-XML metadata? (Y/N      */
    metadatalib=,               /* Define-XML metadata library        */
    datasetJSONVersion=1.0.0,
    fileOID=,
    asOfDateTime=,
    originator=,
    sourceSystem=,
    sourceSystemVersion=,
    studyOID=,
    metaDataVersionOID=,
    metaDataRef=,
    pretty=NOPRETTY);
```

# Writing Dataset-JSON - %write_datasetjson() - loop

```
data _null_;
  length datasetname $64 jsonpath $512 fileoid $128 code $2048;
  set work.dirtree_adam;
    datasetname=scan(filename, 1, ".");
    jsonpath=cats("&project_folder/json_out/adam/", datasetname, ".json");
    fileoid=cats("&_fileOID", "/", "%sysfunc(date(), is8601da.)", "/", datasetname);
    code=cats('%nrstr(%write_datasetjson('
      , 'dataset=dataadam.', datasetname, ','
      /* , 'xptpath=', fullpath,',' */
      , 'jsonpath=', jsonpath, ','
      , 'usemetadata=N,'
      , 'metadatalib=metaadam,'
      , "fileOID=", fileoid, ","
      , "asOfDateTime=2023-05-31T00:00:00, "
      , "originator=CDISC ADaM MSG Team", ","
      , "sourceSystem=Sponsor System,"
      , "sourceSystemVersion=1.0,"
      , "studyOID=&_studyOID,"
      , "metaDataVersionOID=&_metaDataVersionOID,"
      , "metaDataRef=define.xml"
    ,');)');
    call execute(code);
run;
```

# Writing Dataset-JSON - %write_datasetjson() - loop

```
data _null_;
  length datasetname $64 jsonpath $512 fileoid $128 code $2048;
  set dirtree_sdtm;
    datasetname=scan(filename, 1, ".");
    jsonpath=cats("&project_folder/json_out/sdtm/", datasetname, ".json");
    fileoid=cats("&_fileOID", "/", "%sysfunc(date(), is8601da.)", "/", datasetname);
    code=cats('%nrstr(%write_datasetjson('
      /* , 'dataset=datasdtm.', name, ',' */
      , 'xptpath=', fullpath,','
      , 'jsonpath=', jsonpath, ','
      , 'usemetadata=Y,'
      , 'metadatalib=metasdtm,'
      , "fileOID=", fileoid, ","
      , "asOfDateTime=2023-05-31T00:00:00, "
      , "originator=CDISC SDTM MSG Team,"
      , "sourceSystem=Sponsor System,"
      , "sourceSystemVersion=1.0,"
      /*
      , "studyOID=&_studyOID,"
      , "metaDataVersionOID=&_metaDataVersionOID,"
      */
      , "metaDataRef=define.xml"
    ,');)');
    call execute(code);
run;
```



# Reading Dataset-JSON with SAS

# Reading Dataset-JSON with SAS

- Starting in SAS© 9.4TS1M4, you can use the **JSON engine** to read JSON files into SAS data sets
- A **JSON map** is a file that the JSON engine uses to define the data set structures that are created when reading JSON

# Reading Dataset-JSON with SAS

```
FILENAME jsonfile "<path to the JSON file>";
FILENAME mapfile "<path to the MAP file to be created>";
LIBNAME data_out "<path to the output folder>";

LIBNAME jsonfile JSON FILEREF=jsonfile MAP=mapfile
        AUTOMAP=CREATE NOALLDATA ORDINALCOUNT=NONE;
PROC COPY IN=jsonfile OUT=data_out;
RUN;
```

# Reading Dataset-JSON with SAS

```
{
  "creationDateTime": "<yyyy-mm-ddThh:mm:ss>",
  "datasetJSONVersion": "1.0.0",
  "clinicalData": {
    "studyOID": "<study OID>",
    "metaDataVersionOID": "<MDV OID>",
    "itemGroupData": {
      "IG.DM": {
        "records": 18,
        "name": "DM",
        "label": "Demographics",
        "items": [

        ]

        "itemData": [

        ]
      }
    }
  }
}
```

column metadata

column data

Creates 6 data sets:

- **ALLDATA**
- **CLINICALDATA**
  - studyOID, metaDataVersionOID
- **ITEMGROUPDATA_IG_DM**
  - records, name, label
- **IG_DM_ITEMS**
  - contains column metadata (OID, name, label, type, length, displayFormat, keySequence)
- **IG_DM_ITEMDATA**
  - contains column data (element1, element2, element3, …)
- **ROOT**
  - contains creationDateTime, datasetJSONVersion

# Reading Dataset-JSON with SAS

## ITEMGROUPDATA_IG_DM

| | records | name | label |
|---|---|---|---|
| 1 | 18 | DM | Demographics |

## IG_DM_ITEMS

| | OID | name | label | type | length | keySequence |
|---|---|---|---|---|---|---|
| 1 | ITEMGROUPDATASEQ | ITEMGROUPDATASEQ | Record Identifier | integer | . | . |
| 2 | IT.DM.STUDYID | STUDYID | Study Identifier | string | 12 | 1 |
| 3 | IT.DM.DOMAIN | DOMAIN | Domain Abbreviation | string | 2 | . |
| 4 | IT.DM.USUBJID | USUBJID | Unique Subject Identifier | string | 8 | 2 |
| 5 | IT.DM.SUBJID | SUBJID | Subject Identifier for the Study | string | 4 | . |
| 6 | IT.DM.RFSTDTC | RFSTDTC | Subject Reference Start Date/Time | string | . | . |
| 7 | IT.DM.RFENDTC | RFENDTC | Subject Reference End Date/Time | string | . | . |
| 8 | IT.DM.RFXSTDTC | RFXSTDTC | Date/Time of First Study Treatment | string | . | . |
| 9 | IT.DM.RFXENDTC | RFXENDTC | Date/Time of Last Study Treatment | string | . | . |

## IG_DM_ITEMDATA

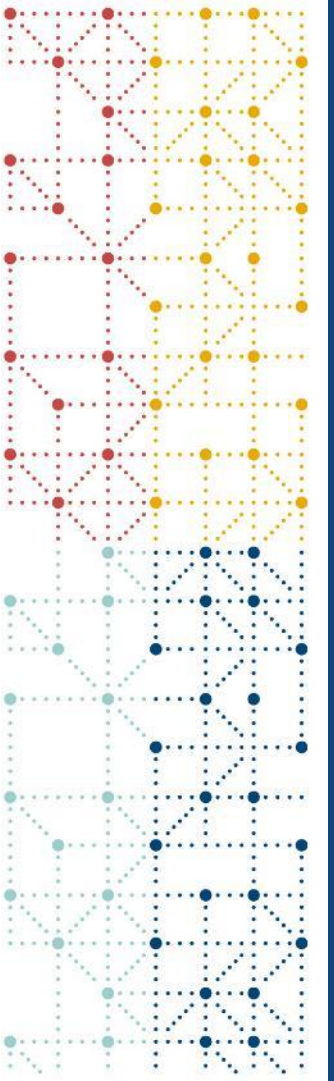
| | element1 | element2 | element3 | element4 | element5 | element6 | element7 | element8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | CDISCPILOT01 | DM | CDISC001 | 1115 | 2012-11-30 | 2013-01-23 | 2012-11-30 |
| 2 | 2 | CDISCPILOT01 | DM | CDISC002 | 1211 | 2012-11-15 | 2013-01-14 | 2012-11-15 |
| 3 | 3 | CDISCPILOT01 | DM | CDISC003 | 1302 | 2013-08-29 | 2013-11-05 | 2013-08-29 |
| 4 | 4 | CDISCPILOT01 | DM | CDISC004 | 1345 | 2013-10-08 | 2014-03-18 | 2013-10-08 |
| 5 | 5 | CDISCPILOT01 | DM | CDISC005 | 1383 | 2013-02-04 | 2013-08-06 | 2013-02-04 |
| 6 | 6 | CDISCPILOT01 | DM | CDISC006 | 1429 | 2013-03-19 | 2013-04-30 | 2013-03-19 |
| 7 | 7 | CDISCPILOT01 | DM | CDISC007 | 1444 | 2013-01-05 | 2013-02-13 | 2013-01-05 |
| 8 | 8 | CDISCPILOT01 | DM | CDISC008 | 1445 | 2014-05-11 | 2014-11-01 | 2014-05-11 |
| 9 | 9 | CDISCPILOT01 | DM | CDISC009 | 1087 | 2012-10-22 | 2013-04-28 | 2012-10-22 |

# Reading Dataset-JSON - %read_datasetjson()

```
%read_datasetjson(
    jsonpath=,              /* Path to Dataset-JSON file              */
    datalib=                /* Library to save SAS dataset            */
    dropseqvar=N,           /* Drop ITEMGROUPDATASEQ variable? (Y/N)  */
    savemetadata=N,         /* Save Dataset-JSON metadata? (Y/N)      */
    metadatalib=            /* Library to save Dataset-JSON metadata  */
);
```

# Reading Dataset-JSON - %read_datasetjson() - loop

```
%util_gettree(
  dir=&project_folder/json_out/adam,
  outds=work.dirtree_adam,
  where=%str(ext="json" and dir=0)
);

data _null_;
  length code $2048;
  set work.dirtree_adam;
    code=cats('%nrstr(%read_datasetjson(',
                'jsonpath=', fullpath, ', ',
                'datalib=outadam, ',
                'dropseqvar=Y, ',
                'savemetadata=Y, ',
                'metadatalib=metainad',
              ');)');
    call execute(code);
run;
```



# Comparing SAS datasets / Dataset-JSON files

# Comparing SAS datasets

- Compare results in a summary
- Details for datasets that had differences

```
%macro util_comparedata(
  baselib=,
  complib=,
  dsname=,
  compareoptions=%str(listall criterion=0.00000001 method=absolute),
  resultds=,
  detailall=N
  );
```

## Compare results for dataset ADADAS

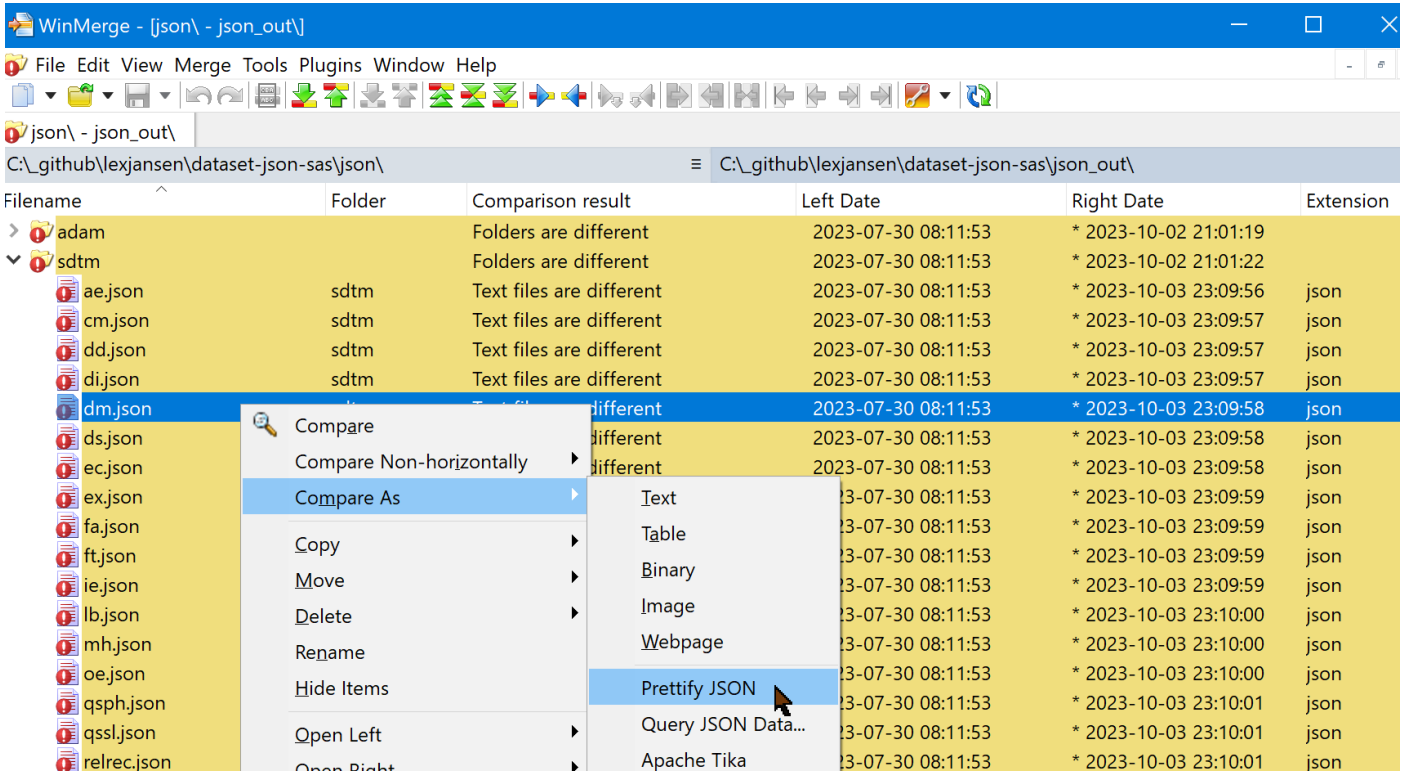
```
The COMPARE Procedure
Comparison of DATAADAM.ADADAS with OUTADAM.ADADAS
(Method=ABSOLUTE, Criterion=1.0E-08)

Data Set Summary

Dataset                   Created          Modified  NVar    NObs  Label

DATAADAM.ADADAS   02OCT23:22:29:17  02OCT23:22:29:17    40   12463  ADAS-COG Analysis Dataset
OUTADAM.ADADAS    03OCT23:23:04:27  03OCT23:23:04:27    40   12463  ADAS-Cog Analysis


Variables Summary

Number of Variables in Common: 40.
Number of Variables with Differing Attributes: 8.
```

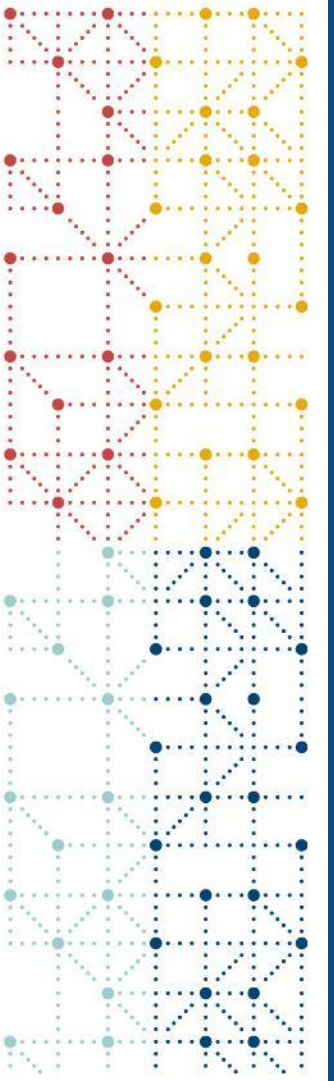
```
Listing of Common Variables with Differing Attributes

Variable  Dataset          Type  Length  Label

ITTFL     DATAADAM.ADADAS  Char       1  Intent-To-Treat Population Flag
          OUTADAM.ADADAS   Char       1  Intent-to-Treat Population Flag
AVISIT    DATAADAM.ADADAS  Char       8  Analysis Visit
          OUTADAM.ADADAS   Char      16  Analysis Visit
VISIT     DATAADAM.ADADAS  Char      17  Visit Name
          OUTADAM.ADADAS   Char      19  Visit Name
```

| resultc |
| --- |
| DSLABEL/LENGTH/LABEL |
| DSLABEL/LABEL |
| DSLABEL/FORMAT/LABEL |
| DSLABEL/LENGTH |
| DSLABEL/LENGTH |
| DSLABEL/LENGTH |
| DSLABEL/LENGTH |
| DSLABEL/LENGTH |
| DSLABEL/LENGTH/LABEL |

# Comparing JSON files

**WinMerge** (https://winmerge.org) can compare JSON files in 'pretty' mode





# Validating Dataset-JSON files

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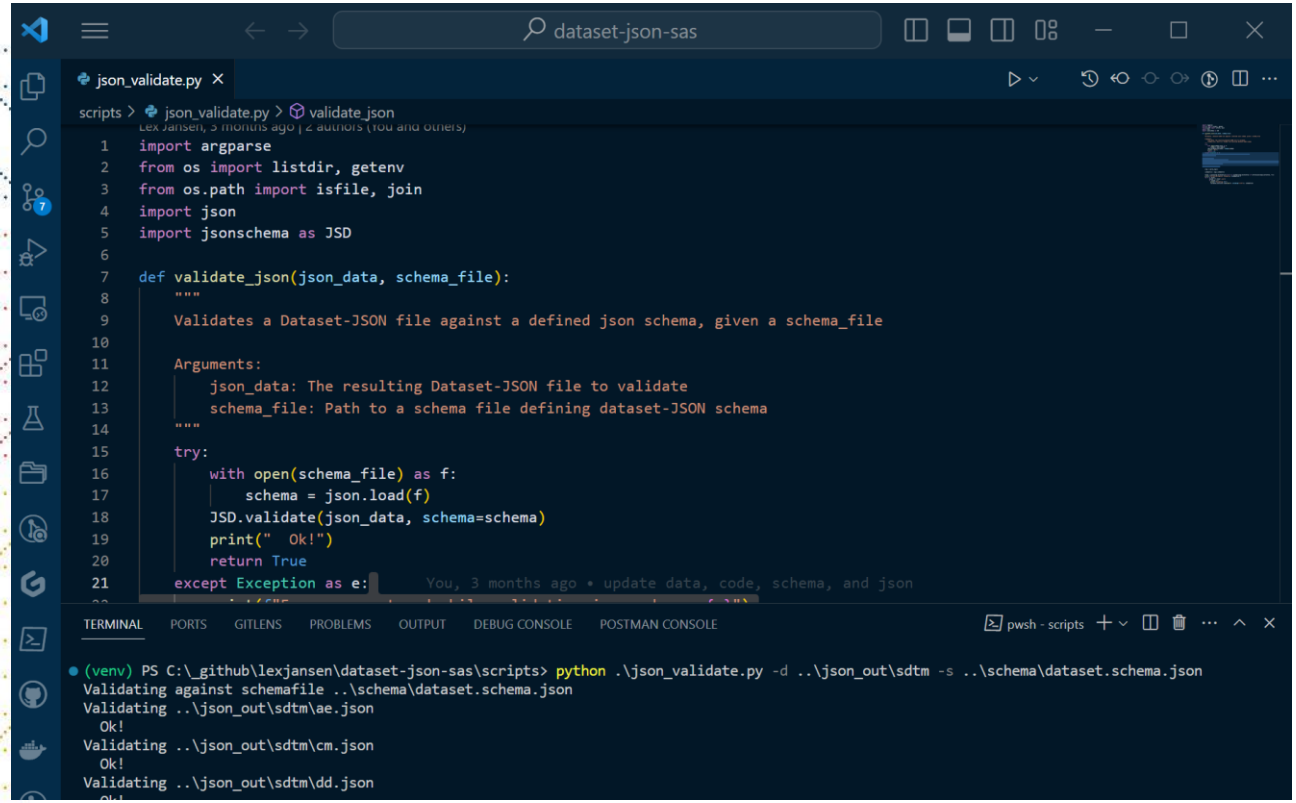
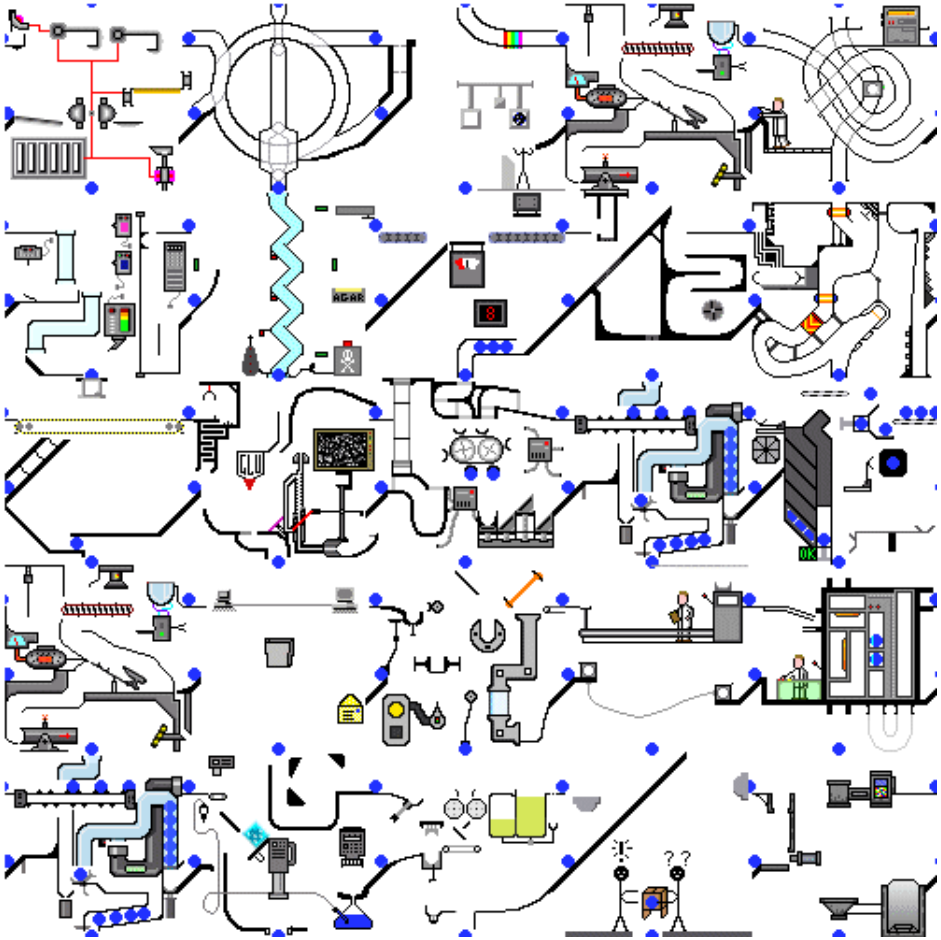



**python .\json_validate.py -d <folder> -s ..\schema\dataset.schema.json**

# Demo




**GitHub**: https://github.com/lexjansen/dataset-json-sas

**open issues at**: https://github.com/lexjansen/dataset-json-sas/issues

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