Data Formats

CMSE 890-602

What is data?

What is data?

- Text
- Tables
- Time series

- Images - tables of color information
- Videos - time series of images
- Sound - time series of frequencies
- etc

Human vs Machine-readable

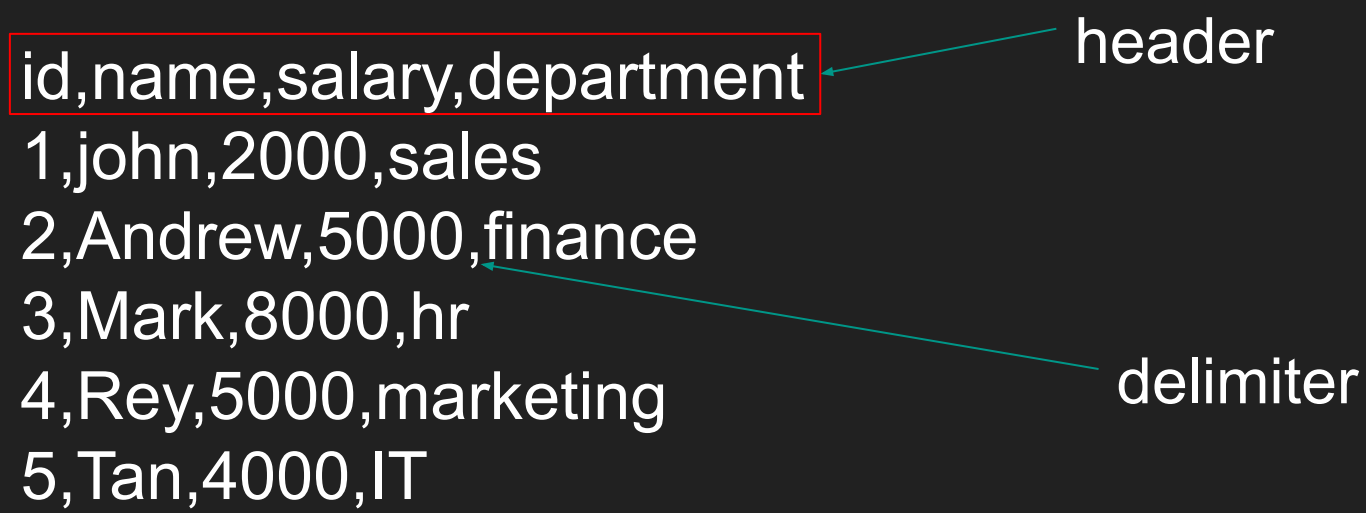
- Humans typically prefer whitespace or lines as a delimiter for tables
- Computers work best with specific characters
- Special characters in text (especially from non-English languages) may be difficult to handle

A bad but human-readable format

WR134 - time sequence polarimetry (Crimea 1989, values plus errors)

JD-2447700	U				B				V				R				I			
	q		u		q		u		q		u		q		u					
59.3018	1.204	.048	0.358	.079	0.946	.032	0.218	.048	1.091	.062	0.303	.068	0.839	.028	0.190	.059	0.777	.023	0.155	.053
60.4033	1.051	.034	0.265	.025	0.872	.039	0.179	.028	0.912	.040	0.203	.026	0.717	.021	0.114	.039	0.621	.037	0.168	.021
60.4692	0.946	.070	0.395	.060	0.790	.050	0.229	.054	0.858	.046	0.268	.068	0.738	.064	0.215	.045	0.622	.048	0.204	.043
61.2734	1.182	.059	0.441	.104	0.990	.034	0.256	.077	1.015	.039	0.275	.081	0.793	.029	0.245	.072	0.739	.045	0.175	.053
61.3306	1.360	.108	0.340	.089	1.145	.044	0.244	.065	1.261	.051	0.176	.071	0.920	.081	0.167	.054	0.859	.050	0.115	.056
61.4160	1.284	.082	0.468	.086	1.051	.032	0.331	.041	1.161	.060	0.398	.057	0.995	.077	0.200	.073	0.897	.050	0.225	.056
61.5273	1.500	.097	0.340	.107	1.009	.047	0.277	.019	1.148	.041	0.292	.034	0.960	.062	0.214	.059	0.889	.075	0.176	.061
62.3887	1.106	.063	0.191	.053	0.978	.034	0.070	.031	1.035	.039	0.162	.058	0.783	.033	0.033	.039	0.689	.018	0.002	.033

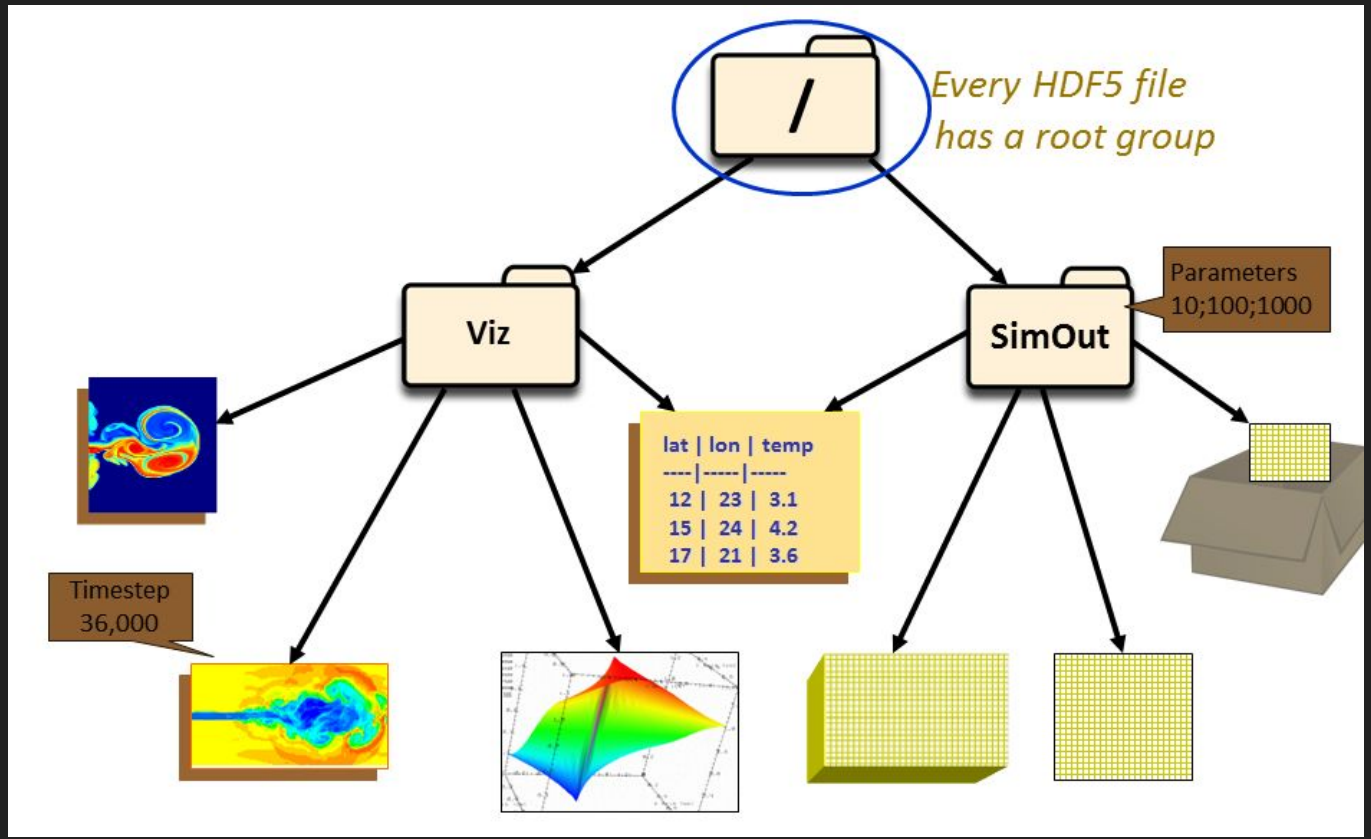
CSV format


id,name,salary,department
1,john,2000,sales
2,Andrew,5000,finance
3,Mark,8000,hr
4,Rey,5000,marketing
5,Tan,4000,IT
header
delimiter

Text vs Binary

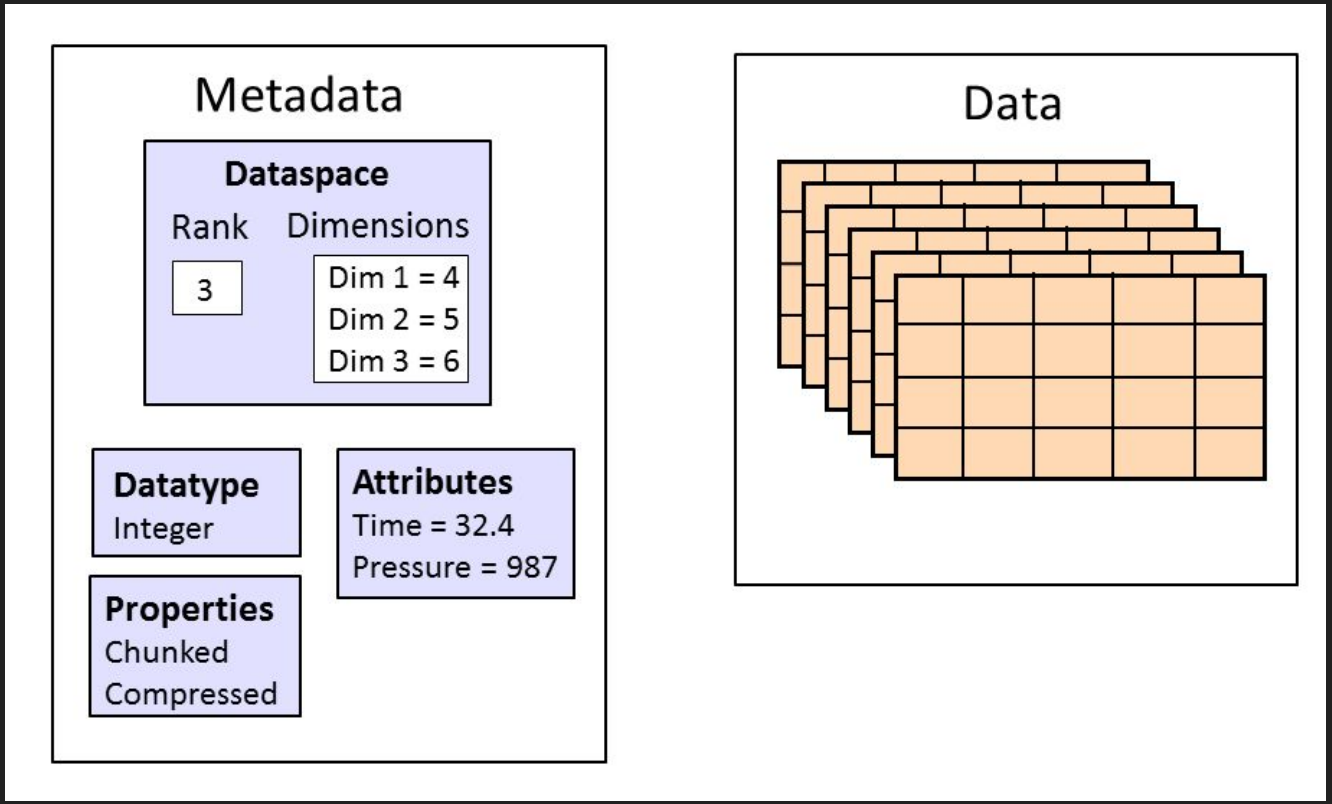
- Text is stored as characters
  - Easy to version control
  - Easy to read
  - Potentially human readable
  - Large file sizes
- Binary data is stored as a direct binary representation
  - Not human readable
  - Difficult to version control
  - Potentially smaller file sizes

HDF: a common binary format



https://hdfgroup.github.io/hdf5/_intro_h_d_f5.html

Metadata example with HDF



https://hdfgroup.github.io/hdf5/_intro_h_d_f5.html

Compression

- Converts data to a binary representation
- Reduces file size by reducing duplication of information
- More redundant data = better compression
- Typically data must be decompressed in its entirety to be read
- Some compressed formats can be decompressed into memory for access

FAIR data

- Findability
- Accessibility
- Interoperability
- Reusability

https://www.go-fair.org/fair-principles/

Findability

- Data is searchable and can be searched for
- This requires *metadata* (data about data!)
  - Labels
  - References
  - Provenance (where did it come from?)
  - Uniqueness
- Data should be stored in a location that can be searched

Accessibility

- The data can be read by both humans and machines
- The metadata includes clear format information
- Examples of how to read the data may be provided
- Metadata can always be read even if the data is gone

Interoperability

- The data works with multiple machine types
  - Operating systems
  - Programming languages
- Reference other data where necessary

Reusability

- Data are clearly described
- Data are clearly licensed
- Relevant community standards are met

Storage locations for data

- Data Dryad
- Zenodo
- ACCESS long-term storage
- REDCap
- MSU digital commons
- All are searchable and handle metadata
- Some include automatic DOI minting

Tables

- Straightforward storage of related data
- Columns define the content
- Rows store the content
- Index accesses rows

Index	Column 1	Column 2	Column 3
0	Data	Data	
1		Data	
2	Data		

Common table operations

- Index a row or selection of rows
- Select a column or selection of columns
- Compute summary statistics
  - Row or column direction
- Create new rows or columns
- Transpose the table (swap rows and columns)

Index	Column 1	Column 2	Column 3	
0	Data	Data		Summary row 0
1		Data		
2	Data			
		Summary Column 2		

Activity

- On D2L access the in-class assignment and follow the instructions
- PDF of instructions will be posted to the class repository as well

Homework

https://classroom.github.com/a/OV0NXygu

1. Create or load a Python environment containing pandas and jupyter
2. Open the notebook pandas-and-uci-adult-dataset.ipynb in VSCode or your preferred notebook editor
3. Complete the empty code cells by answering the questions. Refer to the file exploratory-data-analysis-with-pandas.html (open it in a web browser) for help. There are many helpful links in the document.
4. You can cheat and find the assignment solutions if you want, but it will be obvious.
5. Commit the notebook back into the GitHub classroom repository

Pre-class 9: Databases

- Go to https://www.w3schools.com/sql/ and learn about SQL
- Try to complete the first 12 exercises at https://www.w3schools.com/sql/exercise.asp
- Post a screenshot of your results on D2L