HELMHOLTZ
Metadata Collaboration

Metadata for Beginners

Dr. Özlem ÖZKAN

Helmholtz Metadata Collaboration (HMC) Hub Matter

Who am I?

Dr. Özlem Özkan

BSc: Computer Education

MSc & PhD: Medical Informatics

Experience:

- METU Research Assistant,
- KPMG Data Scientist,
- MDC Research Data Manager,
- HMC Data Policy Expert &
- Training Officer

Creator

Gerlich, Silke. C., Strupp, A., Hofmann, V., & Sandfeld, S. (2023). Fundamentals of Scientific Metadata (1.0.0). Zenodo. https://doi.org/10.5281/zenodo.10091847

Helmholtz Metadata Collaboration - Mission

Making Helmholtz data treasures visible!

- help researchers describe their data with high-quality metadata
- enable researchers to reuse of Helmholtz research data
- provide advice, information & tools

There are 6 domain specific hubs for each research field:

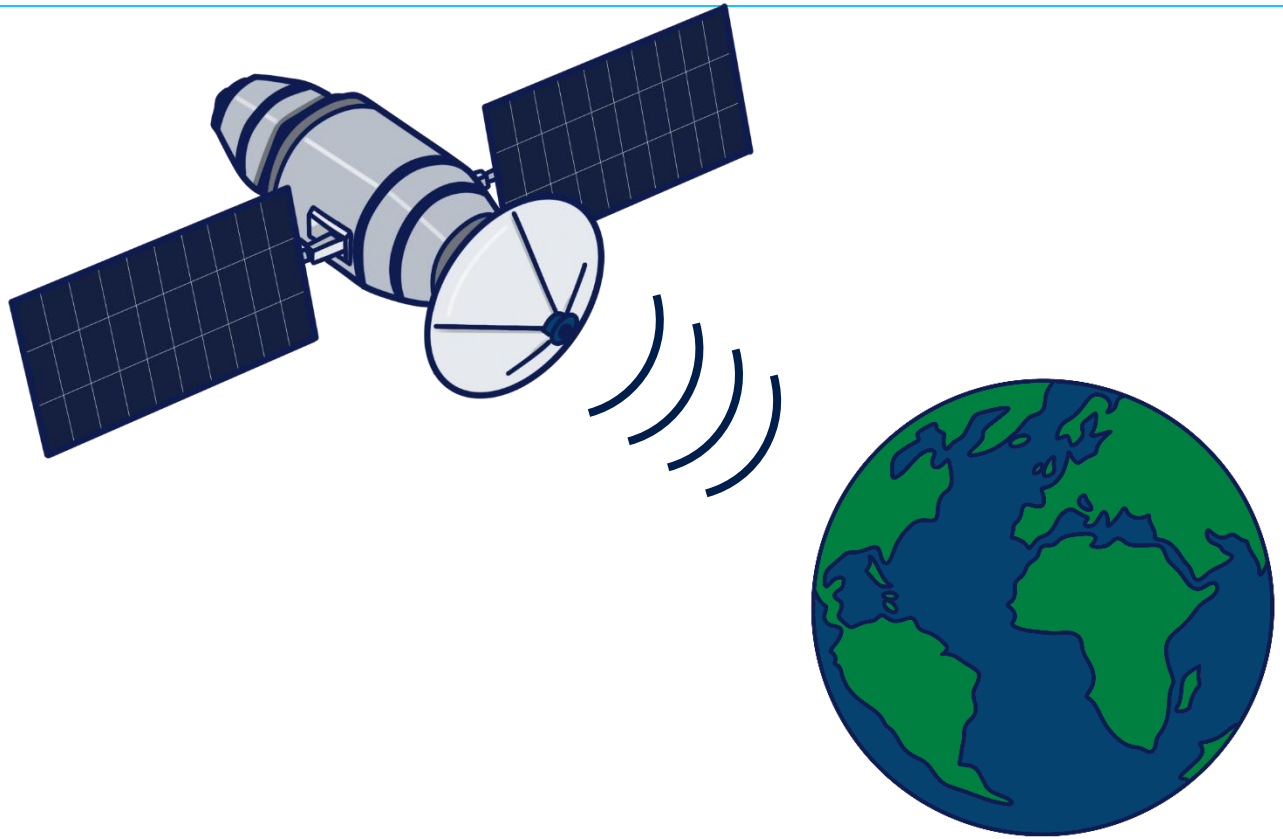
- **Matter**
- Energy
- Earth and Environment
- Health
- Aeronautics, Space and Transport
- Information

What can you say about this data?

	A	B	C	D	E
1	t	ax	ay	az	scr
2	0	0.3931848	-0.1593144	-0.4178079	0
3	0.01	0.3957354	-0.15696	-0.4242825	0
4	0.04	0.4138839	-0.1547037	-0.429678	0
5	0.05	0.4415481	-0.1512702	-0.4325229	0
6	0.06	0.4741173	-0.1488177	-0.434583	0
7	0.08	0.5021739	-0.1521531	-0.4285008	0
8	0.1	0.5247369	-0.1669662	-0.420849	0
9	0.11	0.5421987	-0.1813869	-0.4160421	0
10	0.14	0.5506353	-0.1947285	-0.4094694	0
11	0.15	0.5538726	-0.203067	-0.4057416	0
12	0.16	0.5534802	-0.2035575	-0.4056435	0
13	0.17	0.5527935	-0.1961019	-0.4098618	0
14	0.2	0.558189	-0.1908045	-0.4121181	0
15	0.21	0.5764356	-0.1865862	-0.4162383	0
16	0.22	0.589581	-0.18639	-0.4258521	0
17	0.25	0.6049827	-0.1941399	-0.4243806	0
18	0.26	0.619992	-0.206991	-0.4192794	0
19	0.27	0.6320583	-0.2191554	-0.4092732	0
20	0.3	0.6392196	-0.2279844	-0.3975993	0
21	0.31	0.6465771	-0.2317122	-0.3908304	0
22	0.32	0.6583491	-0.2291616	-0.3950487	0
23	0.34	0.6725736	-0.2220984	-0.4050549	0

What is Data?

What is data?



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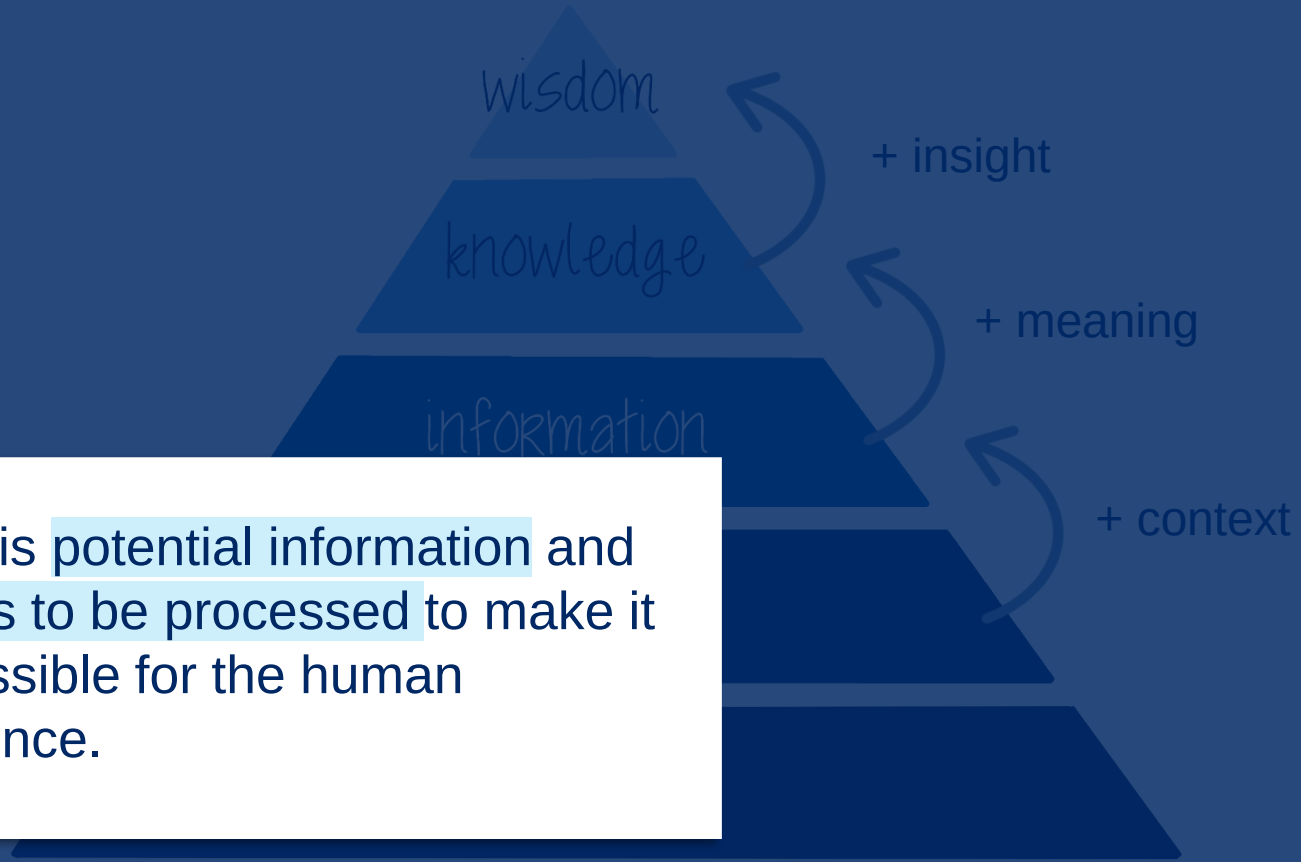
This is data

This is data

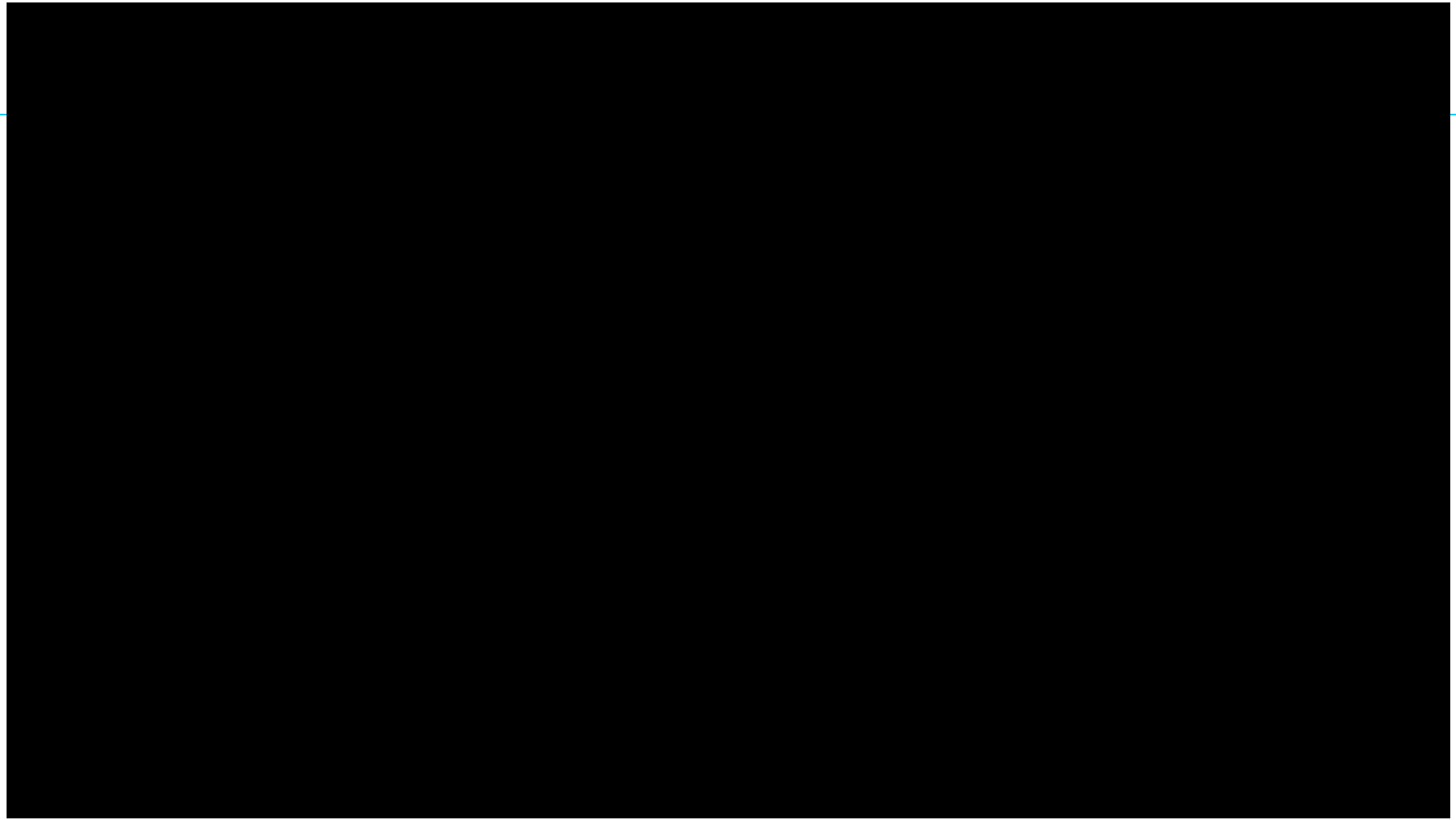
Information – the human-readable data

Knowledge – Where is the cathedral?

Information pyramid



Data is potential information and needs to be processed to make it accessible for the human audience.



Example data - What it really shows

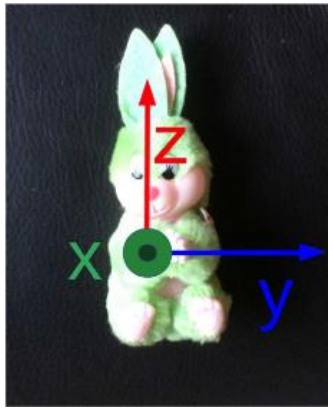
Time

	A	B	C	D	E
1	t	ax	ay	az	scr
2	0	0.3931848	-0.1593144	-0.4178079	0
3	0.01	0.3957354	-0.15696	-0.4242825	0
4	0.04	0.4138839	-0.1547037	-0.429678	0
5	0.05	0.4415481	-0.1512702	-0.4325229	0
6	0.06	0.4741173	-0.1488177	-0.434583	0
7	0.08	0.5021739	-0.1521531	-0.4285008	0
8	0.1	0.5247369	-0.1669662	-0.420849	0
9	0.11	0.5421987	-0.1813869	-0.4160421	0
10	0.14	0.5506353	-0.1947285	-0.4094694	0
11	0.15	0.5538726	-0.203067	-0.4057416	0
12	0.16	0.5534802	-0.2035575	-0.4056435	0
13	0.17	0.5527935	-0.1961019	-0.4098618	0
14	0.2	0.558189	-0.1908045	-0.4121181	0
15	0.21	0.5764356	-0.1865862	-0.4162383	0
16	0.22	0.589581	-0.18639	-0.4258521	0
17	0.25	0.6049827	-0.1941399	-0.4243806	0
18	0.26	0.619992	-0.206991	-0.4192794	0
19	0.27	0.6320583	-0.2191554	-0.4092732	0
20	0.3	0.6392196	-0.2279844	-0.3975993	0
21	0.31	0.6465771	-0.2317122	-0.3908304	0
22	0.32	0.6583491	-0.2291616	-0.3950487	0
23	0.34	0.6725736	-0.2220984	-0.4050549	0

Example data - What it really shows

Time

Biomechanical acceleration



Pendrill, A.-M., Eager, D.(2020). "Velocity, acceleration, jerk, snap and vibration: forces in our bodies during a roller coaster ride." *Phys. Educ.* **55** 065012

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23	0.34	0.6725736	-0.2220984	-0.4050549	0

https://apparentlysew.weebly.com/stem-blog/category/roller-coaster

Example data - What it really shows

Time

Biomechanical acceleration

Scream detected

	A	B	C	D	E
1	t	ax	ay	az	scr
2	0	0.3931848	-0.1593144	-0.4178079	0
3	0.01	0.3957354	-0.15696	-0.4242825	0
4	0.04	0.4138839	-0.1547037	-0.429678	0
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18	0.26	0.619992	-0.206991	-0.4192794	0
19	0.27	0.6320583	-0.2191554	-0.4092732	0
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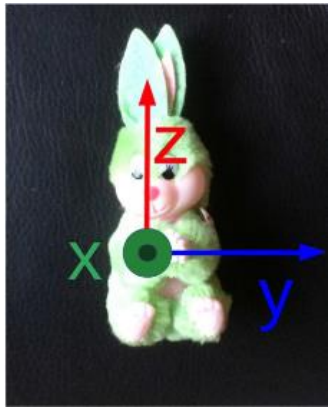

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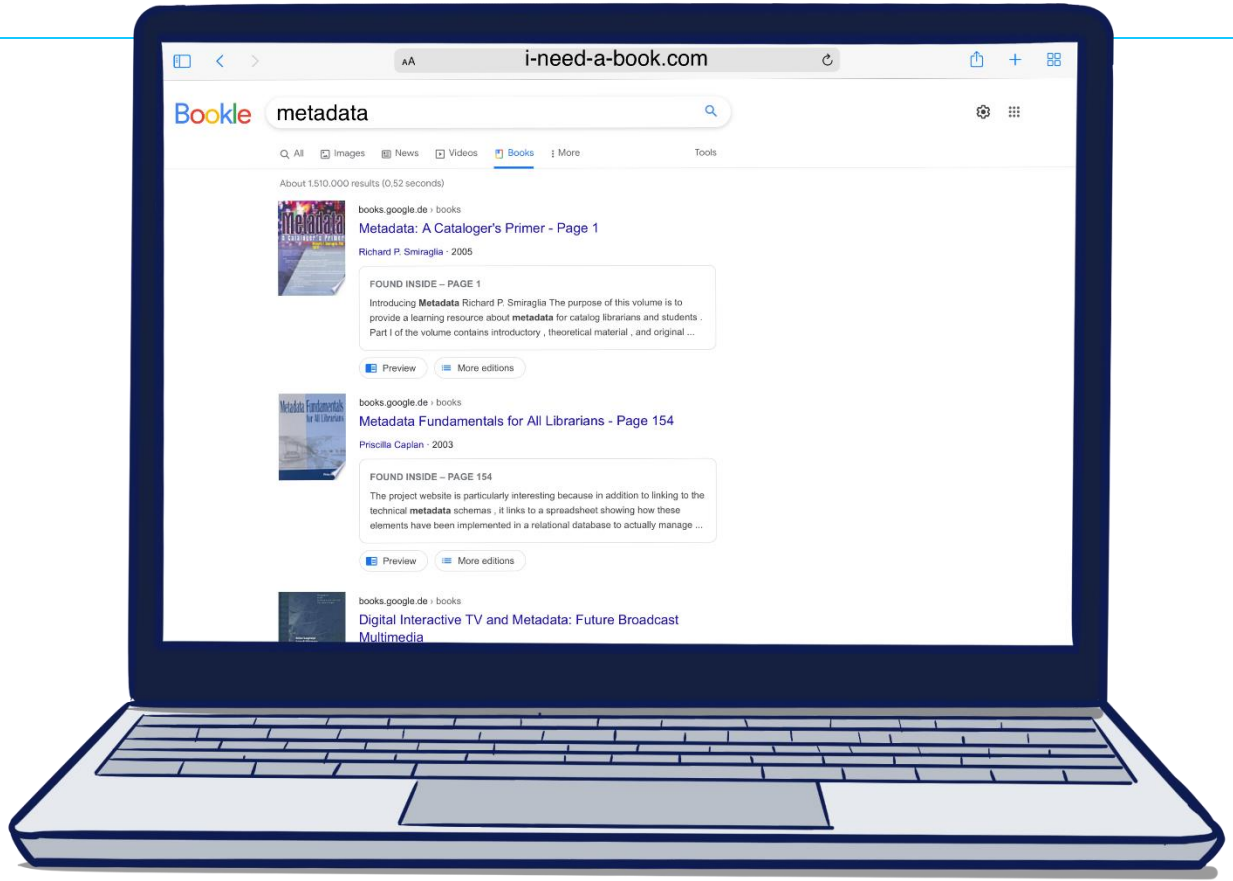
What is Metadata?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Richard P. Smiraglia · 2005
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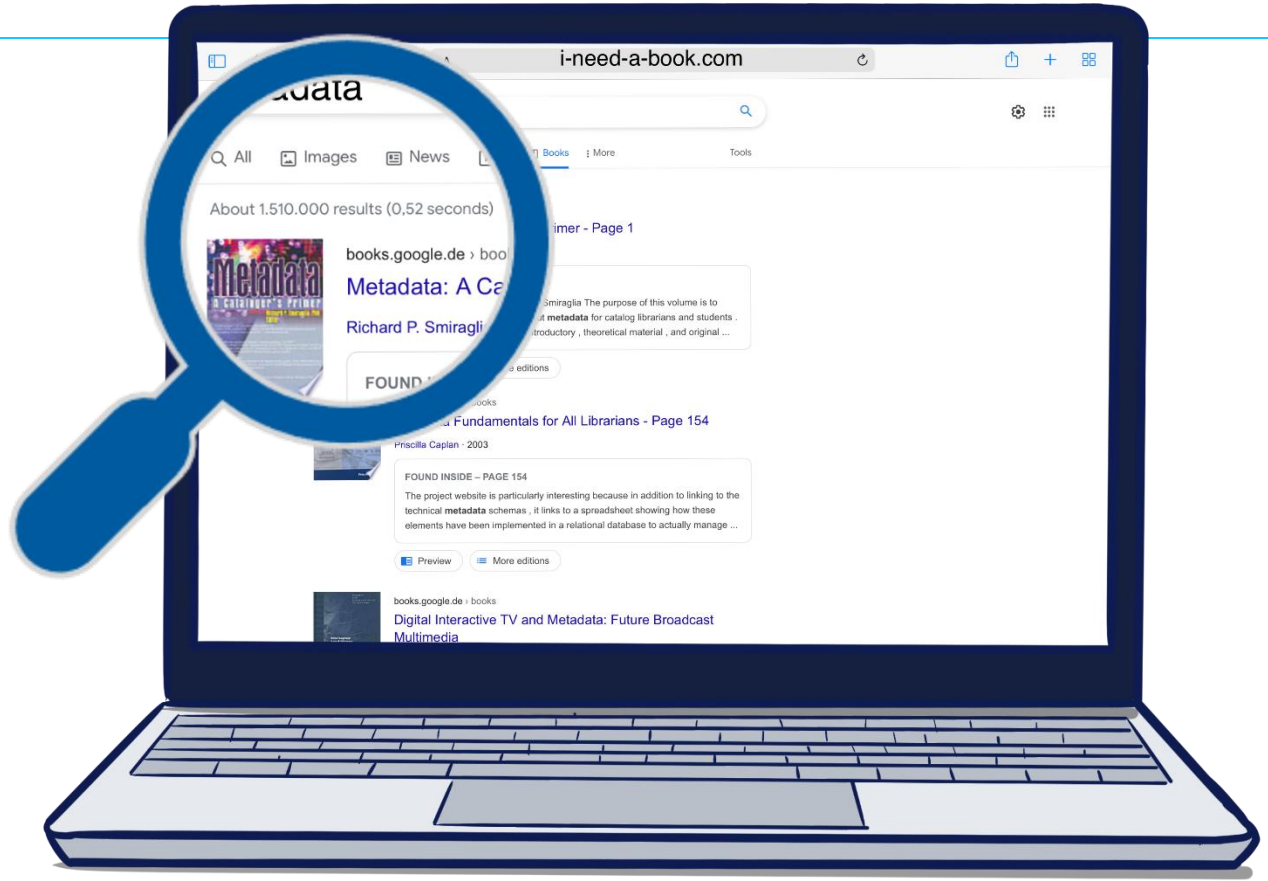
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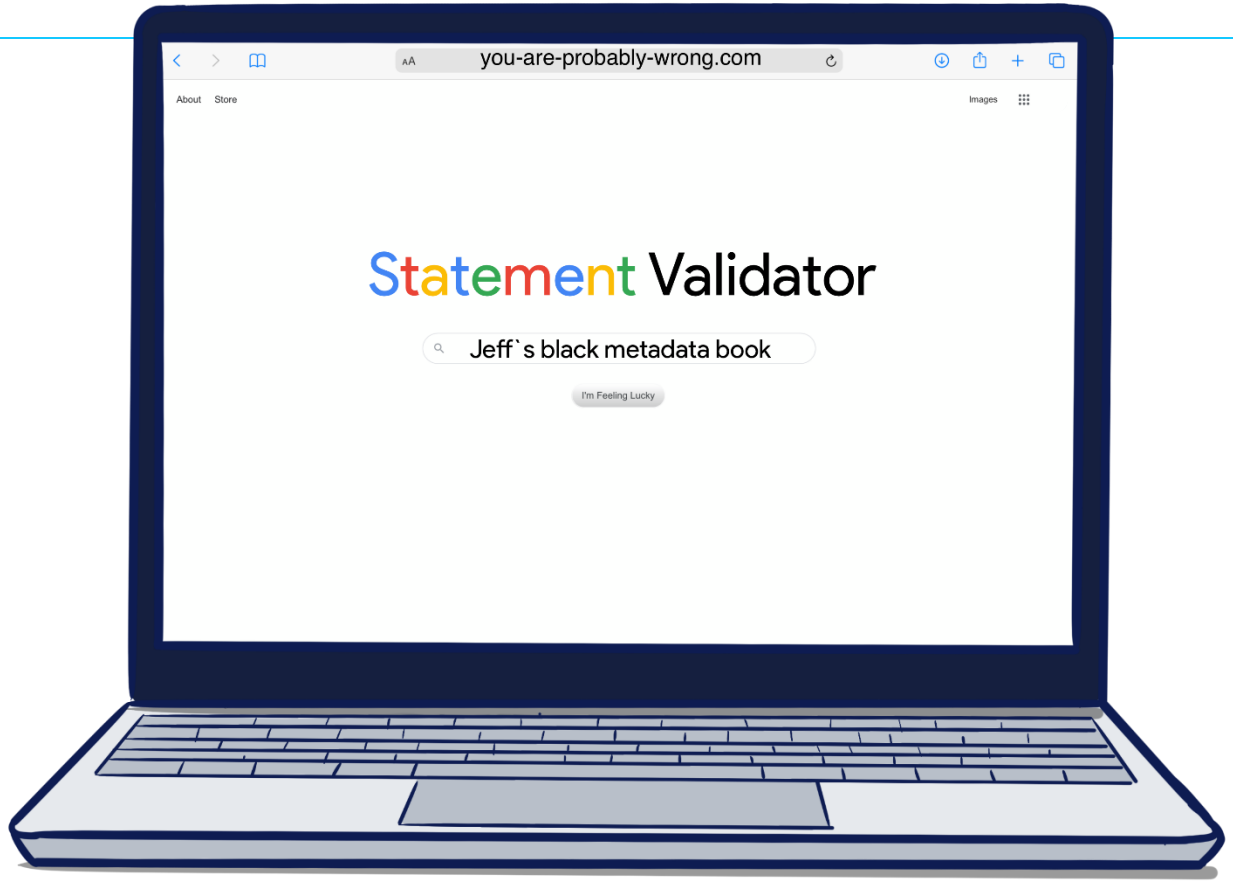
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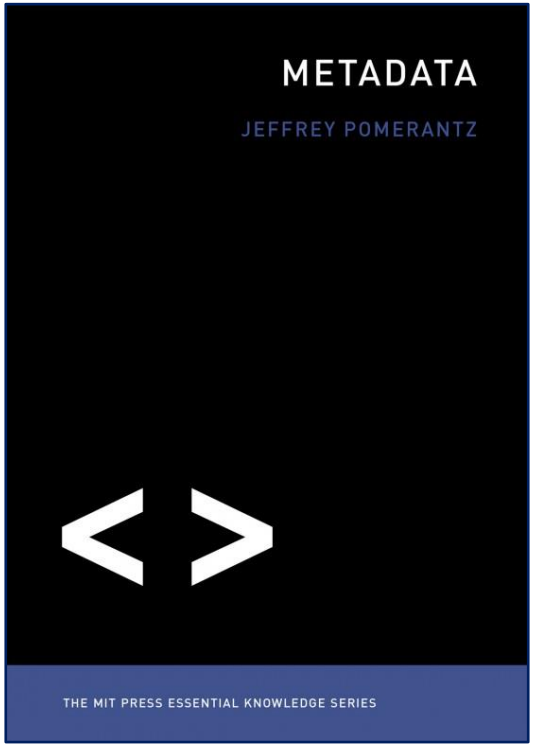
METADATA
JEFFREY POMERANTZ
THE MIT PRESS ESSENTIAL KNOWLEDGE SERIES

Descriptive, administrative, structural metadata

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025.3—dc23

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CONTENTS

Preface ix

1 Introduction 1
2 Definitions 19
3 Descriptive Metadata 65
4 Administrative Metadata 93
5 Use Metadata 117
6 Enabling Technologies for Metadata 133
7 The Semantic Web 153
8 The Future of Metadata 187

Glossary 209
Further Readings 215
Figure Credits 223
Bibliography 225
Index 233

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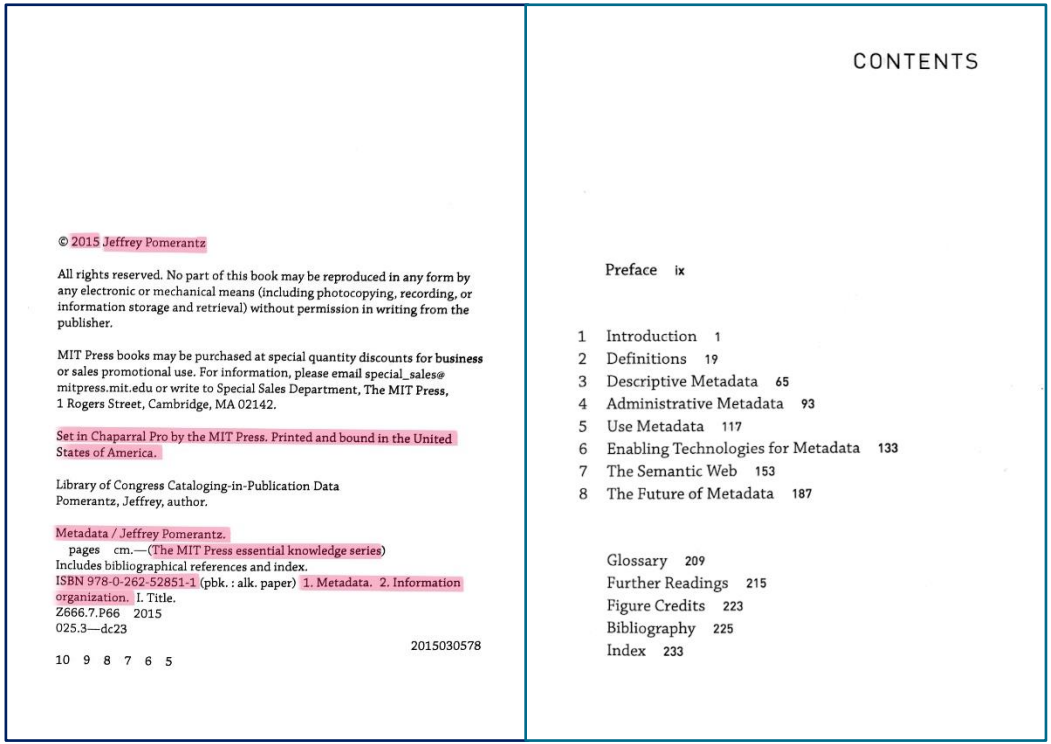

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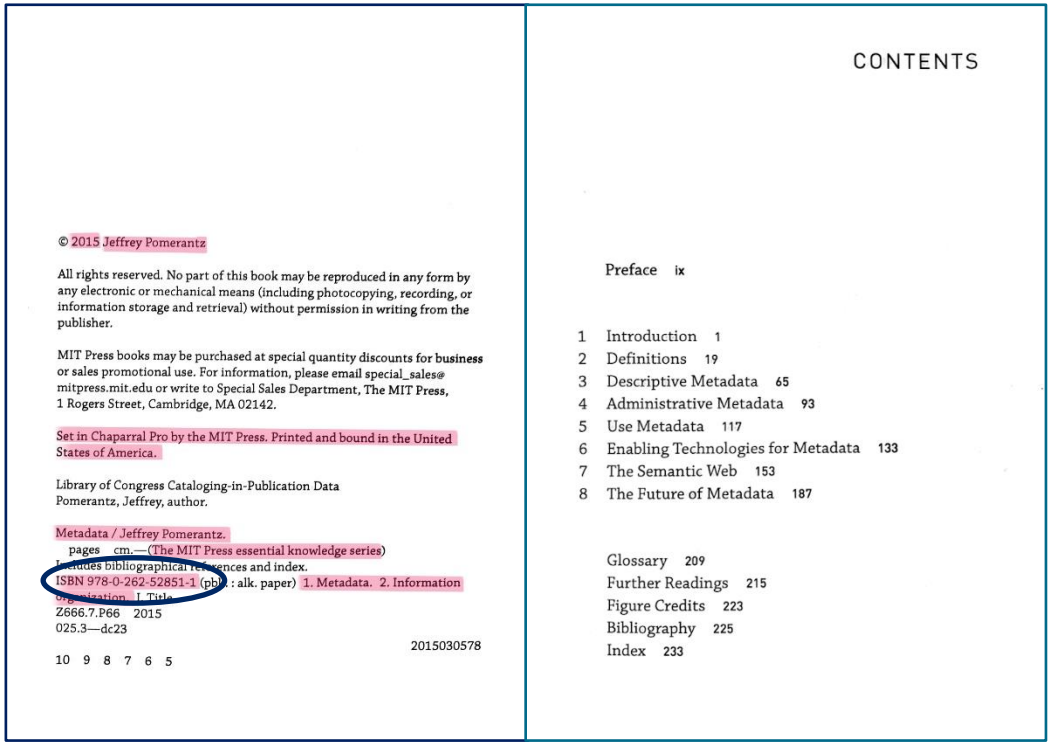

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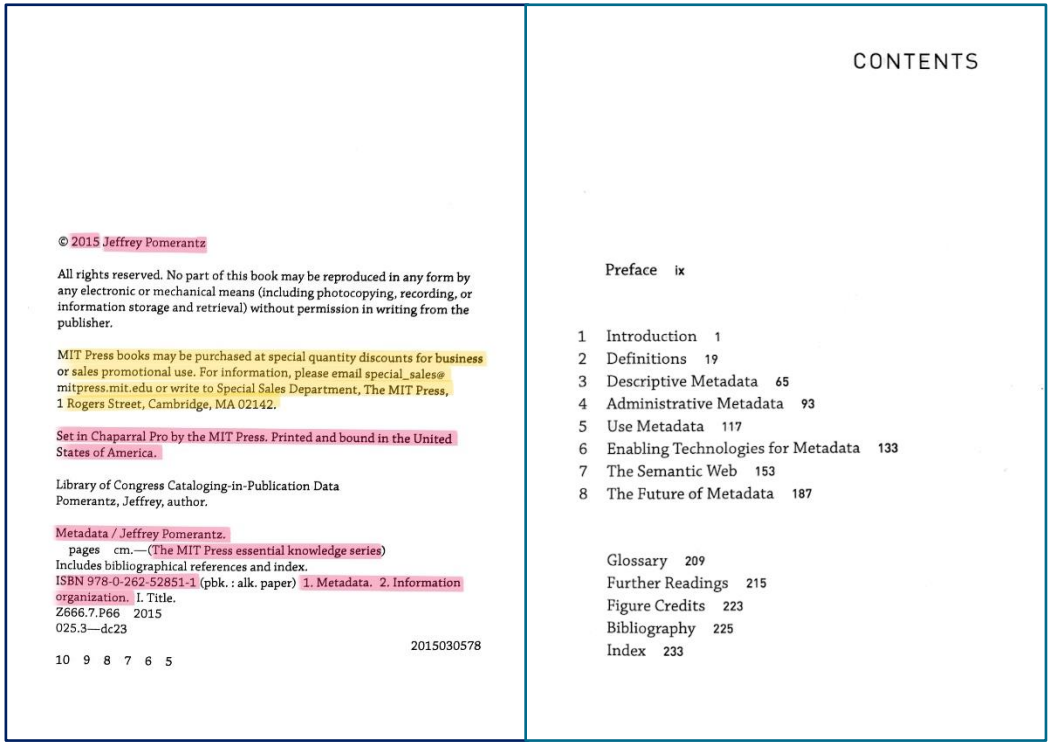

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Index 233

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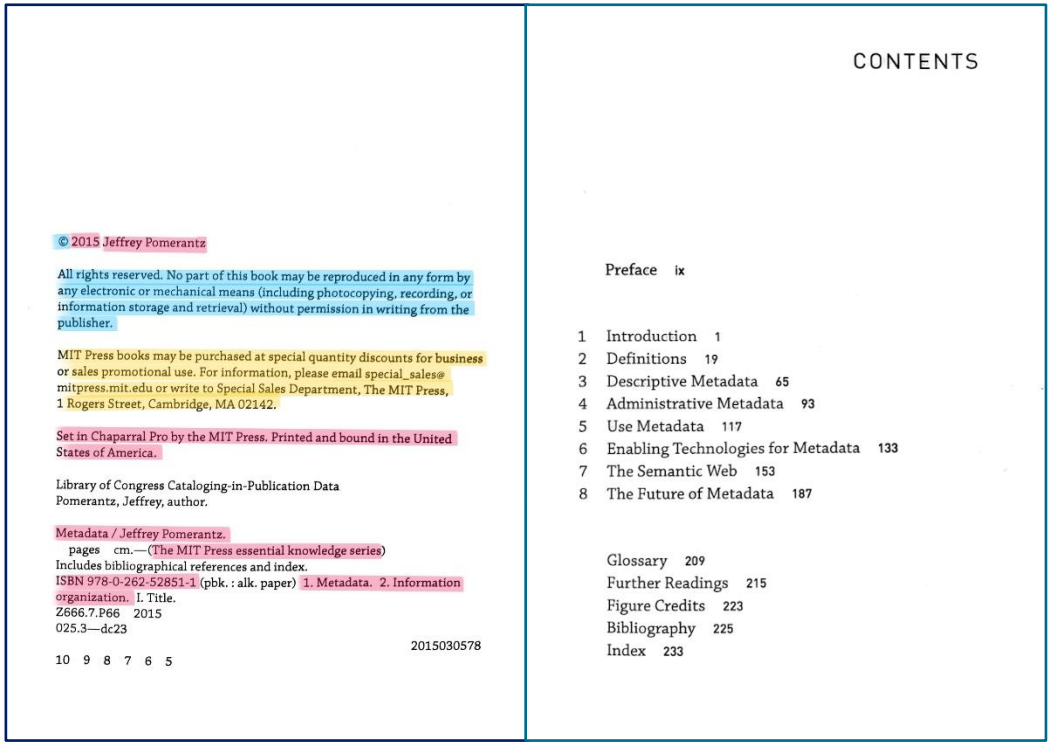

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CONTENTS

Preface ix

1 Introduction 1
2 Definitions 19
3 Descriptive Metadata 65
4 Administrative Metadata 93
5 Use Metadata 117
6 Enabling Technologies for Metadata 133
7 The Semantic Web 153
8 The Future of Metadata 187

Glossary 209
Further Readings 215
Figure Credits 223
Bibliography 225
Index 233

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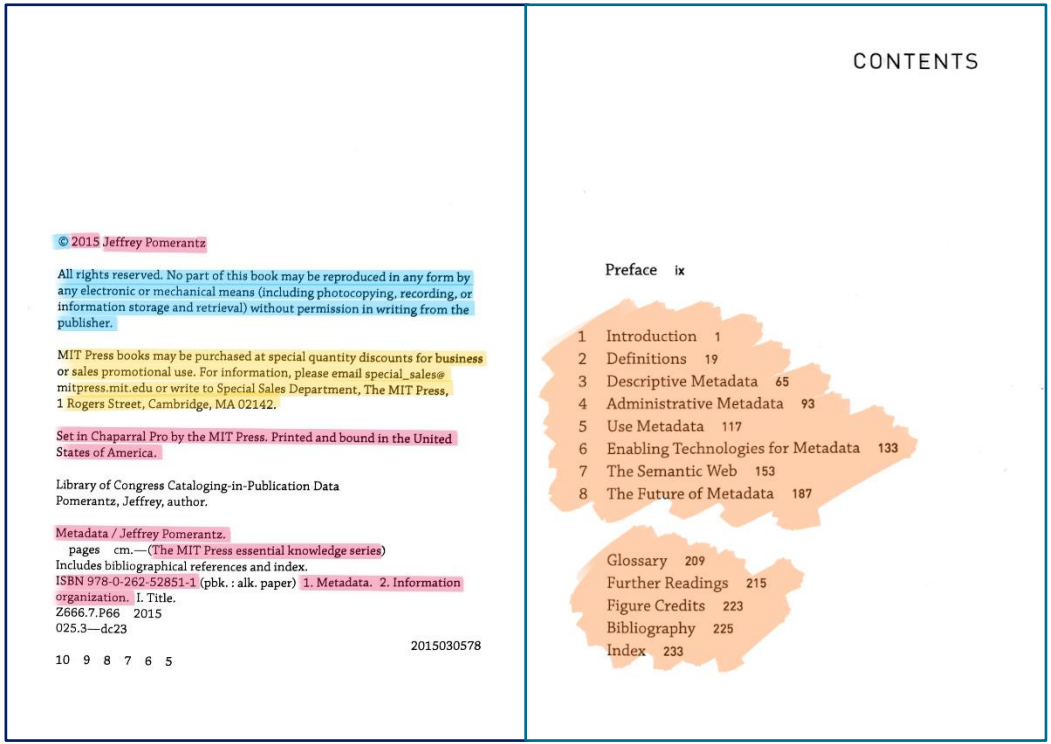

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Structure

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- Chapters
- Pages

Descriptive Metadata:

Metadata that provides information to identify and describe a resource, such as its title, author, and keywords.

Administrative Metadata:

Metadata used to manage a resource, including details like rights, licensing, and file creation dates.

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- Keywords
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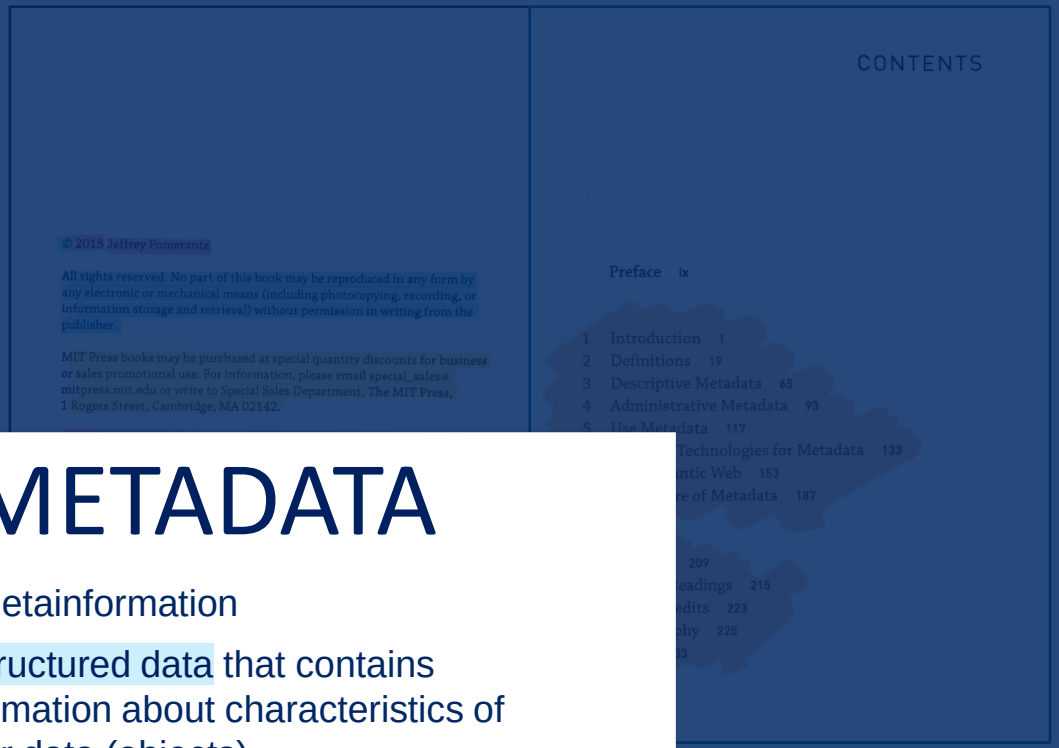

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- Pages

METADATA

or metainformation

is structured data that contains information about characteristics of other data (objects).

Questions?

Metadata in a paper

Demonstration

HELMHOLTZ
Metadata Collaboration

Metadata Annotation in the Scientific Context

You should start your project with **repeating** your collaborator's results

You should start your project with **repeating** your collaborator's results

The Publication

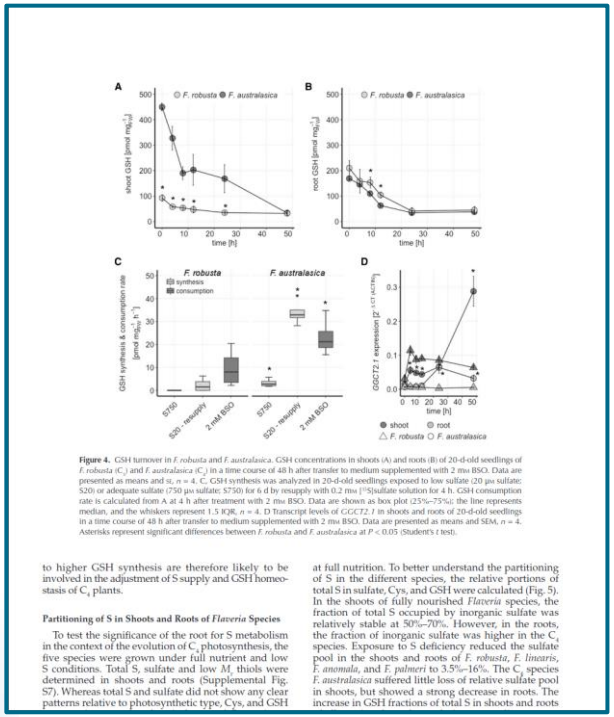


Figure 4. GSH turnover in *F. robusta* and *F. australasica*. GSH concentrations in shoots (A) and roots (B) of 20-d-old seedlings of *F. robusta* (C_3) and *F. australasica* (C_3) in a time course of 48 h after transfer to medium supplemented with 2 mM BSO. Data are presented as means and SE, $n = 4$. C, GSH synthesis was analyzed in 20-d-old seedlings exposed to low sulfate (20 µM sulfate; S20) or adequate sulfate (750 µM sulfate; S750) for 6 d by resupply with 0.2 mM [^{34}S]sulfate solution for 4 h. GSH consumption rate is calculated from A at 4 h after treatment with 2 mM BSO. Data are shown as box plot (25%–75%; the line represents median, and the whiskers represent 1.5 IQR, $n = 4$. D Transcript levels of *GGCT2.1* in shoots and roots of 20-d-old seedlings in a time course of 48 h after transfer to medium supplemented with 2 mM BSO. Data are presented as means and SEM, $n = 4$. Asterisks represent significant differences between *F. robusta* and *F. australasica* at $P < 0.05$ (Student's *t* test).

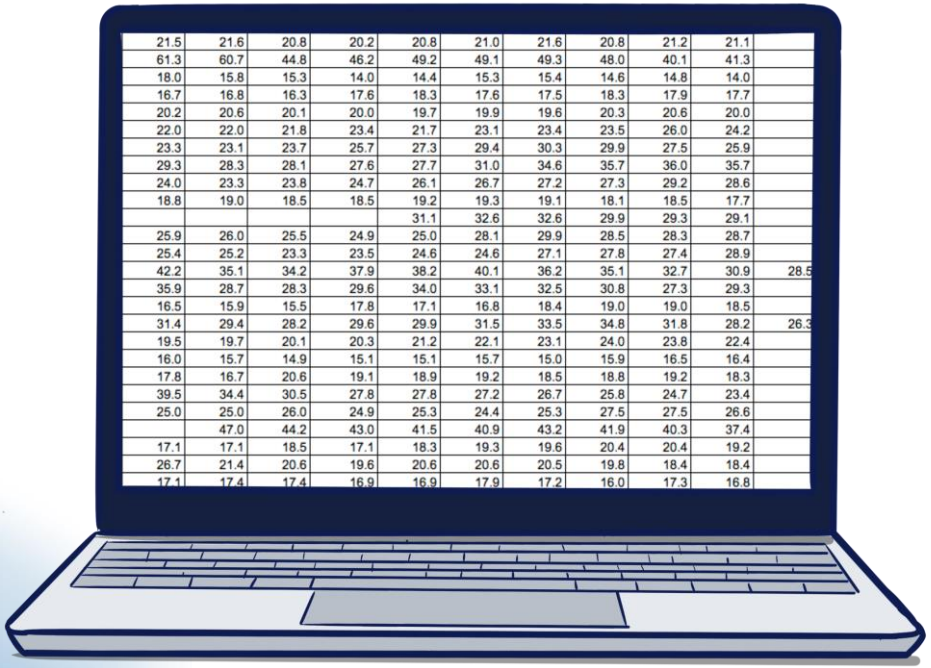
to higher GSH synthesis are therefore likely to be involved in the adjustment of S supply and GSH homeostasis of C_4 plants.

Partitioning of S in Shoots and Roots of *Flaveria* Species

To test the significance of the root for S metabolism in the context of the evolution of C_4 photosynthesis, the five species were grown under full nutrient and low S conditions. Total S, sulfate and low M_r thiols were determined in shoots and roots (Supplemental Fig. S7). Whereas total S and sulfate did not show any clear patterns relative to photosynthetic type, Cys, and GSH at full nutrition. To better understand the partitioning of S in the different species, the relative portions of total S in sulfate, Cys, and GSH were calculated (Fig. 5). In the shoots of fully nourished *Flaveria* species, the fraction of total S occupied by inorganic sulfate was relatively stable at 50%–70%. However, in the roots, the fraction of inorganic sulfate was higher in the C_4 species. Exposure to S deficiency reduced the sulfate pool in the shoots and roots of *F. robusta*, *F. linearis*, *F. anomala*, and *F. palmeri* to 3.5%–16%. The C_4 species *F. australasica* suffered little loss of relative sulfate pool in shoots, but showed a strong decrease in roots. The increase in GSH fractions of total S in shoots and roots

You should start your project with **repeating** your collaborator's results

The Data



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18.0	15.8	15.3	14.0	14.4	15.3	15.4	14.6	14.8	14.0	
16.7	16.8	16.3	17.6	18.3	17.6	17.5	18.3	17.9	17.7	
20.2	20.6	20.1	20.0	19.7	19.9	19.6	20.3	20.6	20.0	
22.0	22.0	21.8	23.4	21.7	23.1	23.4	23.5	26.0	24.2	
23.3	23.1	23.7	25.7	27.3	29.4	30.3	29.9	27.5	25.9	
29.3	28.3	28.1	27.6	27.7	31.0	34.6	35.7	36.0	35.7	
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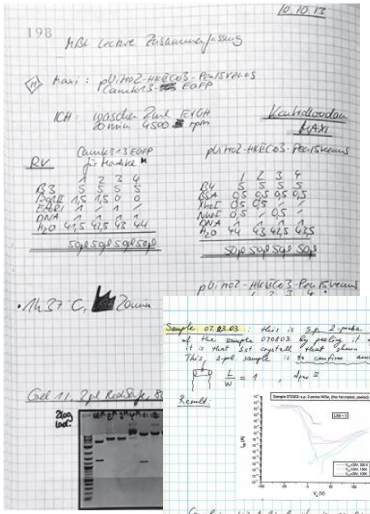
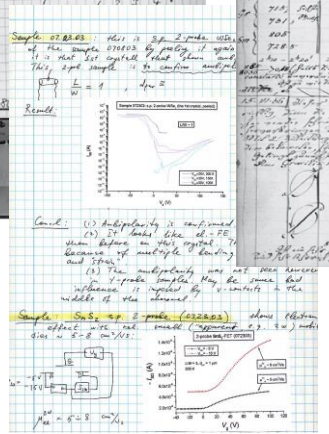
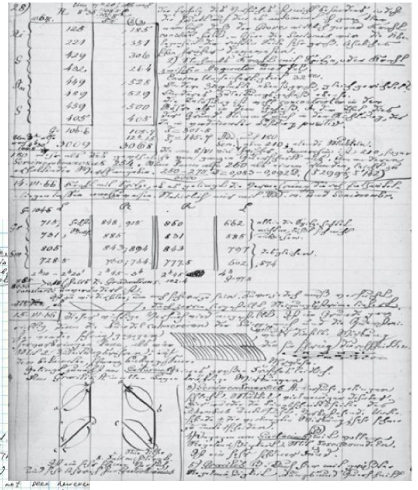
25.0	25.0	26.0	24.9	25.3	24.4	25.3	27.5	27.5	26.6	
	47.0	44.2	43.0	41.5	40.9	43.2	41.9	40.3	37.4	
17.1	17.1	18.5	17.1	18.3	19.3	19.6	20.4	20.4	19.2	
26.7	21.4	20.6	19.6	20.6	20.6	20.5	19.8	18.4	18.4	
17.1	17.4	17.4	16.9	16.9	17.9	17.2	16.0	17.3	16.8	

The Documentation







Monya Baker

„More than 70 % of researchers have tried and failed to reproduce another scientist's experiments.

More than half have failed to reproduce their own experiments. "

Quote: Baker, M. 1,500 scientists lift the lid on reproducibility. *Nature* **533,** 452 – 454 (2016). https://doi.org/10.1038/533452a

Image: https://www.booksmith.com/event/bindery-launch-katie-burke-urban-playground-what-kids-say-about-living-san-francisco

Slightly better – lab notes

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1	t	ax	ay	az	scr
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3	0.01	0.3957354	-0.15696	-0.4242825	0
4	0.04	0.4138839	-0.1547037	-0.429678	0
5	0.05	0.4415481	-0.1512702	-0.4325229	0
6	0.06	0.4741173	-0.1488177	-0.434583	0
7	0.08	0.5021739	-0.1521531	-0.4285008	0
8	0.1	0.5247369	-0.1669662	-0.420849	0
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12	0.16	0.5534802	-0.2035575	-0.4056435	0
13	0.17	0.5527935	-0.1961019	-0.4098618	0
14	0.2	0.558189	-0.1908045	-0.4121181	0
15	0.21	0.5764356	-0.1865862	-0.4162383	0
16	0.22	0.589581	-0.18639	-0.4258521	0
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21	0.31	0.6465771	-0.2317122	-0.3908304	0
22	0.32	0.6583491	-0.2291616	-0.3950487	0
23	0.34	0.6725736	-0.2220984	-0.4050549	0

someRandomFileName.csv

Slightly better – lab notes

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1	t	ax	ay	az	scr
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23	0.34	0.6725736	-0.2220984	-0.4050549	0

csv 20220228_recordingData.csv

2022-02-28

Gotham City, New Jersey, USA

Flight of the bat

weather: more clouds than sun, 11°C, 74% humidity, 1023 mbar, SSW, 17 km/h

recording device strapped to upper arm

Slightly better – lab notes

	A	B	C	D	E
1	t	ax	ay	az	scr
2	0	0.3931848	-0.1593144	-0.4178079	0
3	0.01	0.3957354	-0.15696	-0.4242825	0
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23	0.34	0.6725736	-0.2220984	-0.4050549	0

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LAB NOTES IV
LAB NOTES III
LAB NOTES II
LAB NOTES I

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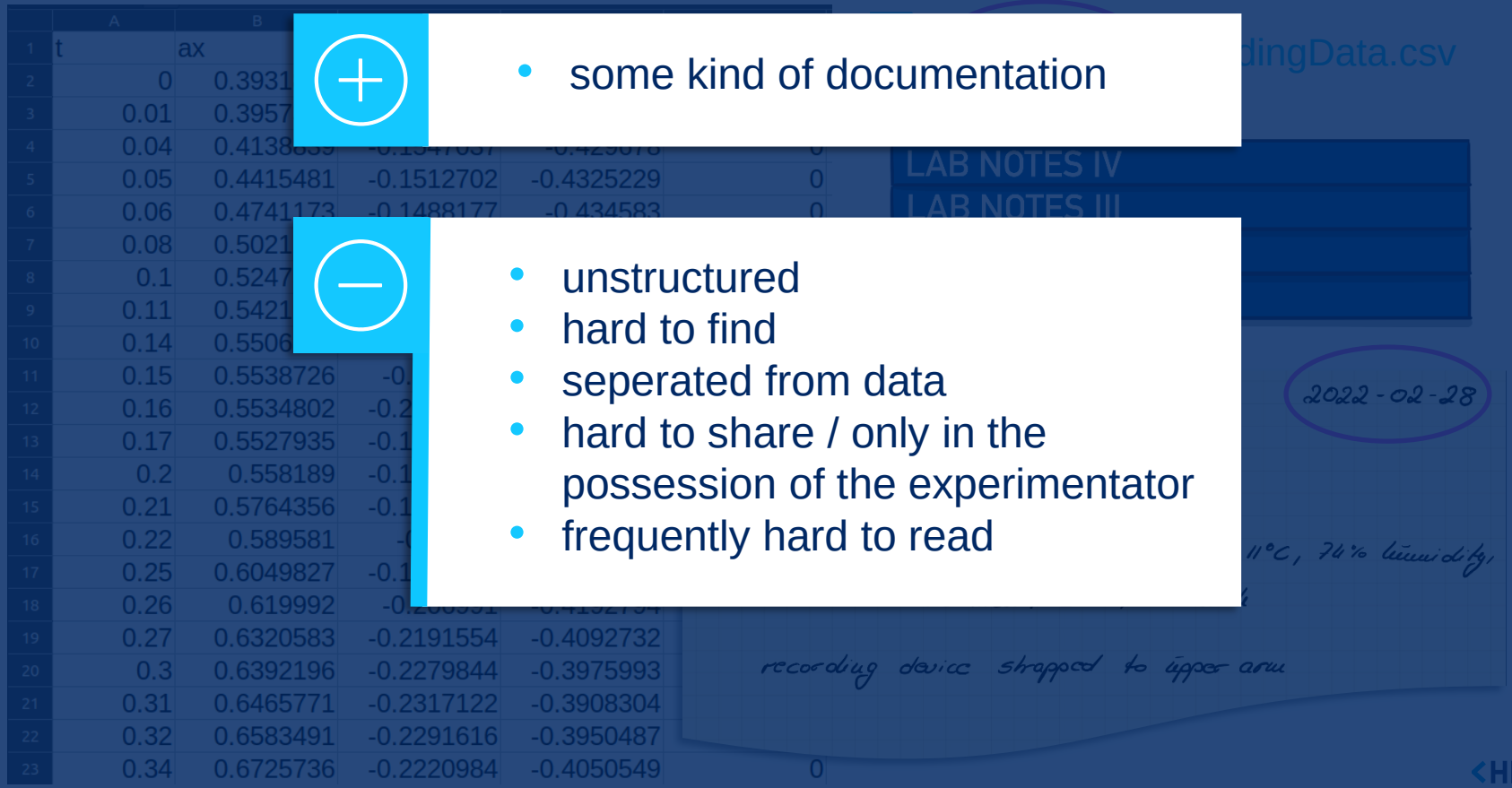


- some kind of documentation

- unstructured
- hard to find
- seperated from data
- hard to share / only in the possession of the experimentator
- frequently hard to read

Gregor Mendel, the father of genetics

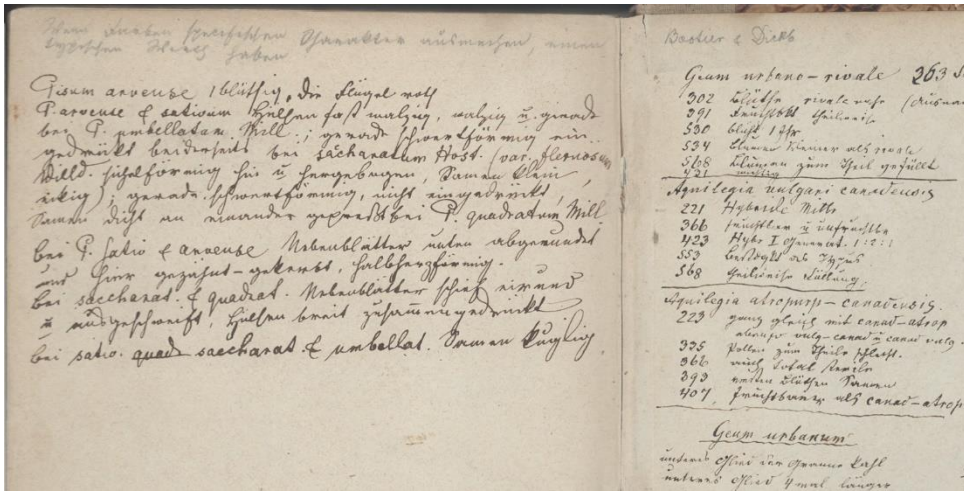
Do you know why Mendel’s work was largely **ignored** until 1900, **more than 30 years** after his death?

Other scientists couldn't **fully understand** and **validate** his findings

Mendel did not provide sufficient details in his notes about

- his experimental design or
- some of the intermediate steps in his calculations

Without this detailed "**metadata",** it was difficult for other scientists to **replicate his work** or even **fully appreciate its significance**.



https://www.nature.com/articles/s41588-022-01109-9/figures/1

Even better – Readme style metadata

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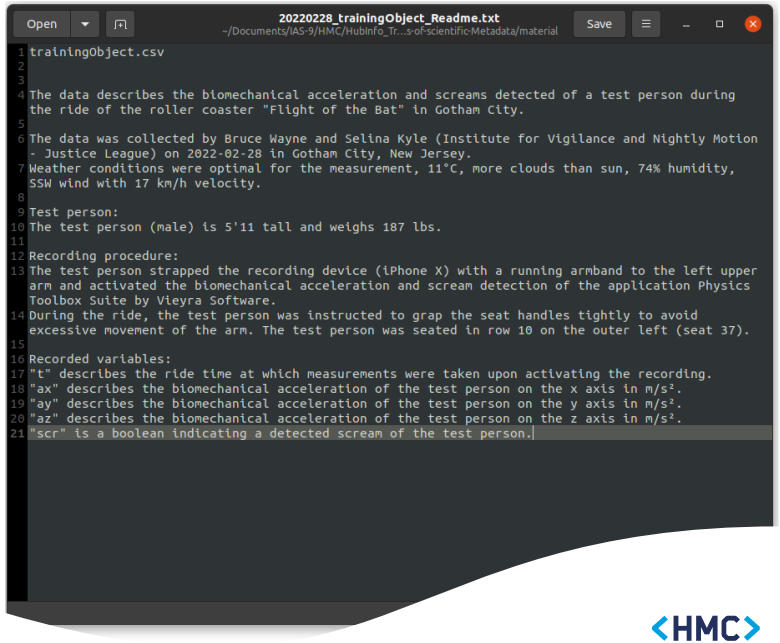
csv 20220228_recordingData.csv

txt 20220228_recordingData_Readme.txt



Even better – Readme style metadata

	A	B	C	D	E
1	t	ax	ay	az	scr
2	0	0.3931848	-0.1593144	-0.4178079	0
3	0.01	0.3957354	-0.15696	-0.4242825	0
4	0.04	0.4138839	-0.1547037	-0.429678	0
5	0.05	0.4415481	-0.1512702	-0.4325229	0
6	0.06	0.4741173	-0.1488177	-0.434583	0
7	0.08	0.5021739	-0.1521531	-0.4285008	0
8	0.1	0.5247369	-0.1669662	-0.420849	0
9	0.11	0.5421987	-0.1813869	-0.4160421	0
10	0.14	0.5506353	-0.1947285	-0.4094694	0
11	0.15	0.5538726	-0.203067	-0.4057416	0
12	0.16	0.5534802	-0.2035575	-0.4056435	0
13	0.17	0.5527935	-0.1961019	-0.4098618	0
14	0.2	0.558189	-0.1908045	-0.4121181	0
15	0.21	0.5764356	-0.1865862	-0.4162383	0
16	0.22	0.589581	-0.18639	-0.4258521	0
17	0.25	0.6049827	-0.1941399	-0.4243806	0
18	0.26	0.619992	-0.206991	-0.4192794	0
19	0.27	0.6320583	-0.2191554	-0.4092732	0
20	0.3	0.6392196	-0.2279844	-0.3975993	0
21	0.31	0.6465771	-0.2317122	-0.3908304	0
22	0.32	0.6583491	-0.2291616	-0.3950487	0
23	0.34	0.6725736	-0.2220984	-0.4050549	0

csv 20220228_recordingData.csv

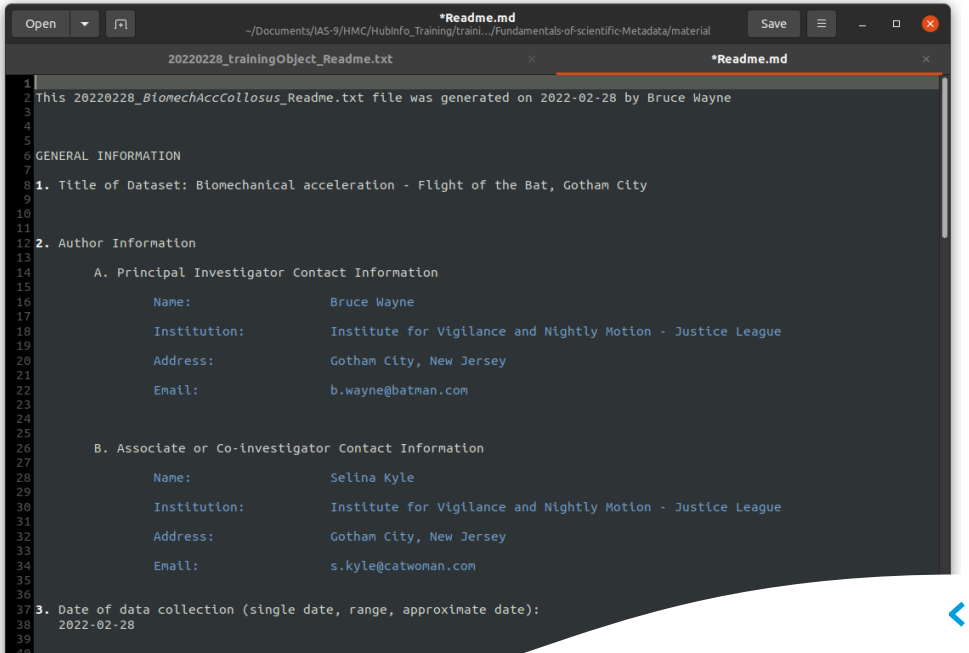
txt 20220228_recordingData_Readme.txt

Human readable metadata: README file

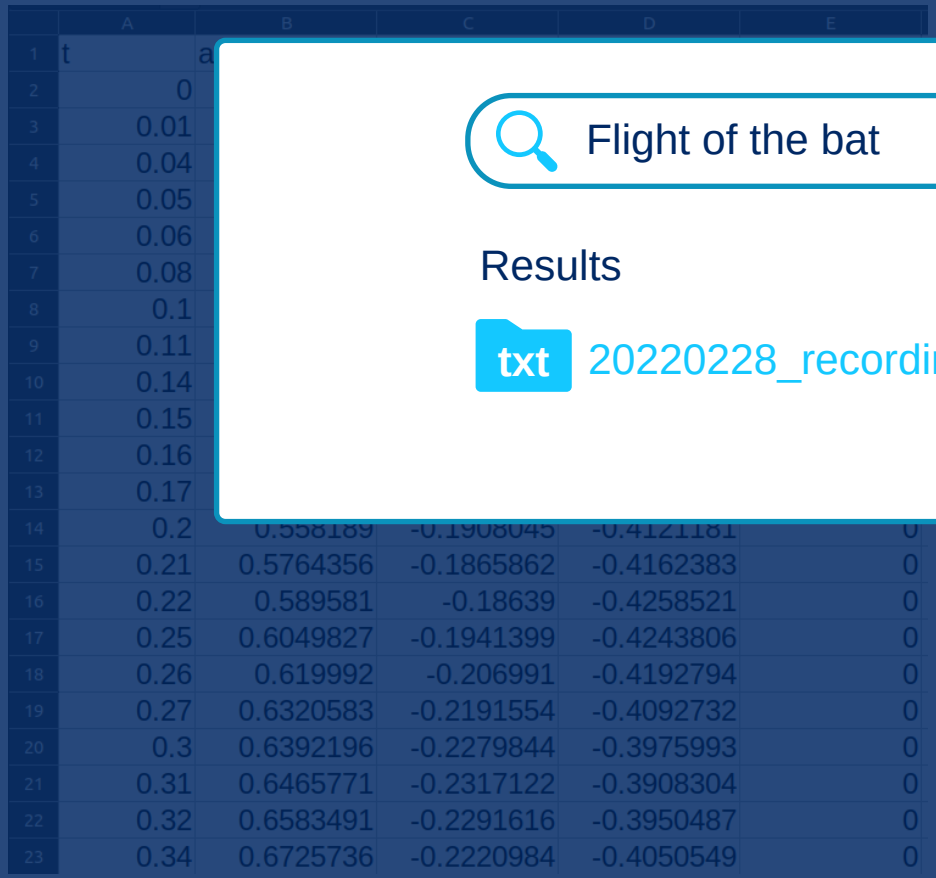
README files can be considered **a human-readable form of metadata recording.**

This information helps users understand **how to properly work with** or **reuse the data/code:**

- Name of the data document
- Title
- Author information
- The date the files were created
- Data fields/units
- PIDs
- Instrument info
- Sample info
- Date the files were last updated
- Version etc.



Even better – Readme style metadata



	A	B	C	D	E
1	t	a			
2	0				
3	0.01				
4	0.04				
5	0.05				
6	0.06				
7	0.08				
8	0.1				
9	0.11				
10	0.14				
11	0.15				
12	0.16				
13	0.17				
14	0.2	0.558189	-0.1908045	-0.4121181	0
15	0.21	0.5764356	-0.1865862	-0.4162383	0
16	0.22	0.589581	-0.18639	-0.4258521	0
17	0.25	0.6049827	-0.1941399	-0.4243806	0
18	0.26	0.619992	-0.206991	-0.4192794	0
19	0.27	0.6320583	-0.2191554	-0.4092732	0
20	0.3	0.6392196	-0.2279844	-0.3975993	0
21	0.31	0.6465771	-0.2317122	-0.3908304	0
22	0.32	0.6583491	-0.2291616	-0.3950487	0
23	0.34	0.6725736	-0.2220984	-0.4050549	0

Flight of the bat

Results

txt 20220228_recordingData_Readme.txt

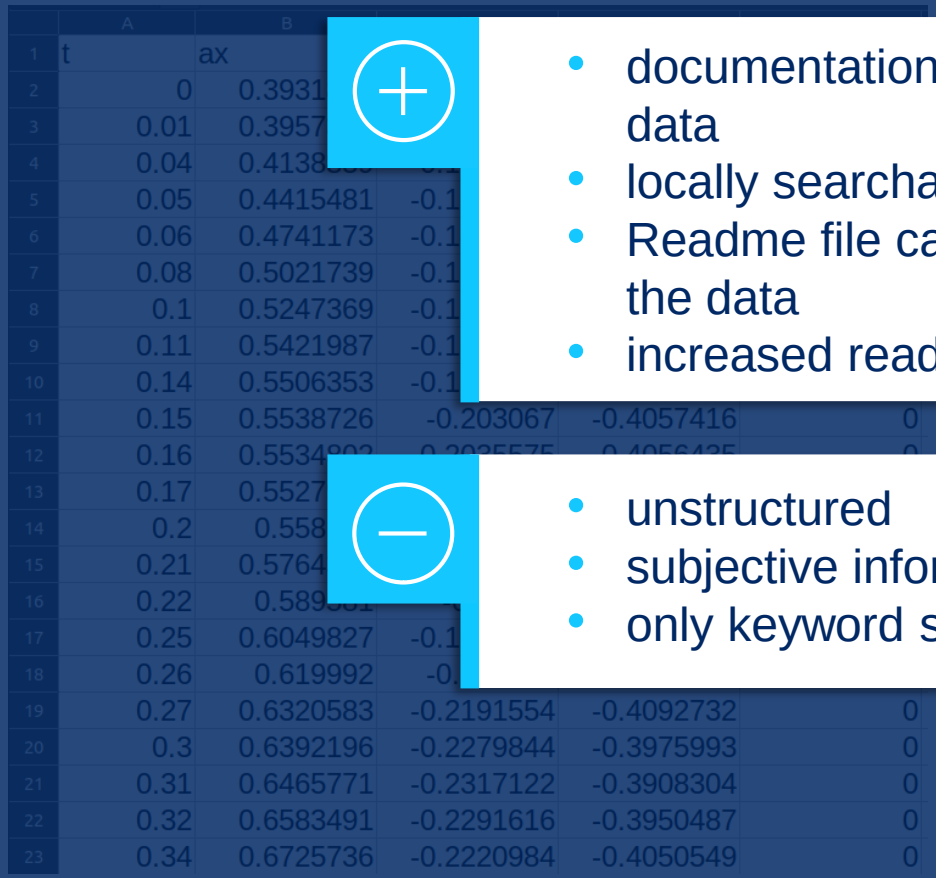
me.txt

Institution: Institute for Vigilance and Nightly Motion - Justice League
Address: Gotham City, New Jersey
Email: b.wayne@batman.com

B. Associate or Co-investigator Contact Information
Name: Selina Kyle
Institution: Institute for Vigilance and Nightly Motion - Justice League
Address: Gotham City, New Jersey
Email: s.kyle@catwoman.com

3. Date of data collection (single date, range, approximate date):
2022-02-28

Even better – Readme style metadata



	A	B	C	D	E
1	t	ax			
2	0	0.3931			
3	0.01	0.3957			
4	0.04	0.4138			
5	0.05	0.4415481	-0.1		
6	0.06	0.4741173	-0.1		
7	0.08	0.5021739	-0.1		
8	0.1	0.5247369	-0.1		
9	0.11	0.5421987	-0.1		
10	0.14	0.5506353	-0.1		
11	0.15	0.5538726	-0.203067	-0.4057416	0
12	0.16	0.5534			
13	0.17	0.5527			
14	0.2	0.558			
15	0.21	0.5764			
16	0.22	0.589			
17	0.25	0.6049827	-0.1		
18	0.26	0.619992	-0.		
19	0.27	0.6320583	-0.2191554	-0.4092732	0
20	0.3	0.6392196	-0.2279844	-0.3975993	0
21	0.31	0.6465771	-0.2317122	-0.3908304	0
22	0.32	0.6583491	-0.2291616	-0.3950487	0
23	0.34	0.6725736	-0.2220984	-0.4050549	0

dingData.csv

dingData_Readme.txt

- documentation linked to the data
- locally searchable
- Readme file can be shared with the data
- increased readability

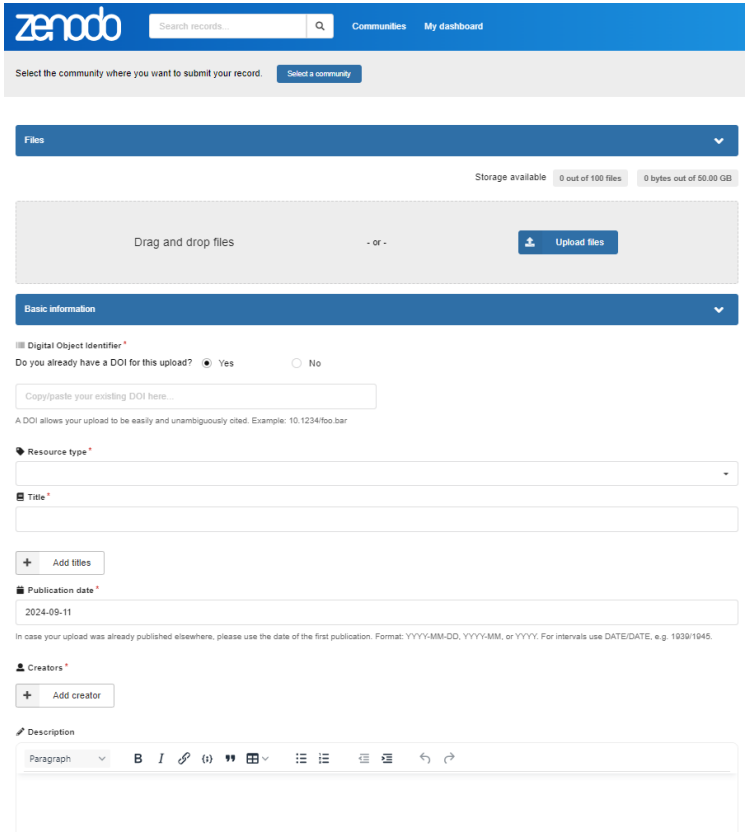
- unstructured
- subjective information
- only keyword search possible

Metadata in repositories

While uploading your data to a repository, **you also enter the metadata into the system**,

just like you would when using Zenodo>>>

But there might be no field to define the variables in the dataset so we can **include a readme** file along with the dataset!



Widely used formats for machine-readable metadata

XML

```
<example>
   <superhero>Wonder Woman</superhero>
   <publisher>DC Comics</publisher>
   <identities>
      <identity>Princess Diana</identity>
      <identity>Diana Prince</identity>
   </identities>
   <pet>
      <name>Jumpa</name>
      <species>kangaroo</species>
   </pet>
</example>
```

JSON

```
{
 "superhero": "Wonder Woman",
 "publisher": "DC Comics",
 "identities": [
  "Princess Diana",
  "Diana Prince"
 ],
 "pet": {
  "name": "Jumpa",
  "species": "kangaroo"
 }
}
```

YAML

```
---
superhero: Wonder Woman
publisher: DC Comics
identities:
- Princess Diana
- Diana Prince
pet:
 name: Jumpa
 species: kangaroo
```

if you are interested in YAML,
also see https://yaml.org/

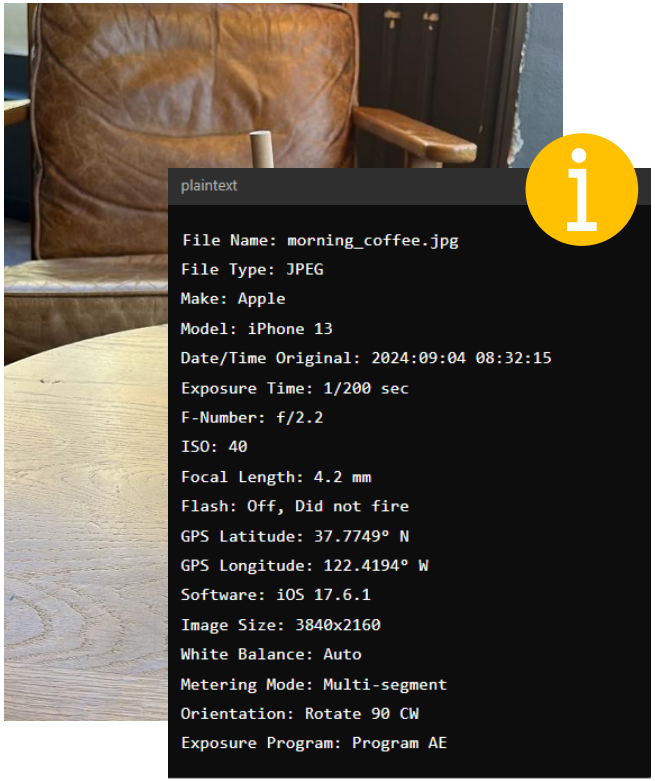
Questions?

Metadata Standard and Schema

Metadata Standards

This is a photo of my morning coffee >>>

- My phone also records the **metadata** attached to this photo.
- **Exchangeable image file format** (EXIF)
  - is most **widely used metadata standard** for images.
  - is embedded in image files by digital cameras and smartphones.
- These standards **ensure that metadata is structured** and used consistently across different platforms, software, and devices.



Metadata Standards

They are all in EXIF Metadata Standard:

plaintext Copy code

```
File Name: sunset_beach.jpg
File Type: JPEG
Make: Canon
Model: Canon EOS 5D Mark IV
Date/Time Original: 2024:08:25 19:05:12
Exposure Time: 1/400 sec
F-Number: f/5.6
ISO: 100
Focal Length: 24 mm
Flash: Off
GPS Latitude: 34.0195° N
GPS Longitude: 118.4912° W
Software: Adobe Photoshop 2024
Image Size: 6720x4480
White Balance: Auto
Metering Mode: Multi-segment
Orientation: Horizontal (normal)
Exposure Program: Aperture priority
```

plaintext Copy code

```
File Name: mountain_hike.jpg
File Type: JPEG
Make: Google
Model: Pixel 6 Pro
Date/Time Original: 2024:09:02 09:45:50
Exposure Time: 1/500 sec
F-Number: f/1.9
ISO: 50
Focal Length: 5.8 mm
Flash: Off
GPS Latitude: 39.7392° N
GPS Longitude: 104.9903° W
Software: Android 13
Image Size: 4032x3024
White Balance: Auto
Metering Mode: Center-weighted average
Orientation: Rotate 90 CW
Exposure Program: Auto
```

plaintext Copy code

```
File Name: morning_coffee.jpg
File Type: JPEG
Make: Apple
Model: iPhone 13
Date/Time Original: 2024:09:04 08:32:15
Exposure Time: 1/200 sec
F-Number: f/2.2
ISO: 40
Focal Length: 4.2 mm
Flash: Off, Did not fire
GPS Latitude: 37.7749° N
GPS Longitude: 122.4194° W
Software: iOS 17.6.1
Image Size: 3840x2160
White Balance: Auto
Metering Mode: Multi-segment
Orientation: Rotate 90 CW
Exposure Program: Program AE
```

Metadata Standards

XMP

plaintext Copy code

```
File Name: sunset_beach.jpg
File Type: JPEG
Creator: John Doe
Camera Model: Canon EOS 5D Mark IV
Lens: 24mm f/5.6
Date Created: 2024-08-25T19:05:12-07:00
Exposure: 1/400 sec
ISO: 100
Focal Length: 24 mm
Flash: Off
Scene Type: Directly Photographed
Software: Adobe Photoshop 2024
Image Size: 6720x4480
Location: GPS Latitude: 34.0195° N, GPS Longitude:
Copyright: © 2024 John Doe
Title: Sunset Beach
Description: A beautiful sunset at the beach with
Keywords: sunset, beach, landscape, water, nature
Editing History: Edited: 2024-08-26 10:30:00
```

IPTC

plaintext Copy code

```
File Name: mountain_hike.jpg
File Type: JPEG
Creator: Jane Smith
Title: Mountain Adventure
Description: A breathtaking view from the peak of
Keywords: mountain, hiking, nature, adventure
Date Created: 2024:09:02
Location: Rocky Mountains, Colorado, USA
Copyright Notice: © 2024 Jane Smith
Contact Info: janesmith@example.com
```

EXIF

plaintext Copy code

```
File Name: morning_coffee.jpg
File Type: JPEG
Make: Apple
Model: iPhone 13
Date/Time Original: 2024:09:04 08:32:15
Exposure Time: 1/200 sec
F-Number: f/2.2
ISO: 40
Focal Length: 4.2 mm
Flash: Off, Did not fire
GPS Latitude: 37.7749° N
GPS Longitude: 122.4194° W
Software: iOS 17.6.1
Image Size: 3840x2160
White Balance: Auto
Metering Mode: Multi-segment
Orientation: Rotate 90 CW
Exposure Program: Program AE
```

The Dublin Core

One of the best-known, generic, and widely used metadata standard for online resources, is the Dublin Core.

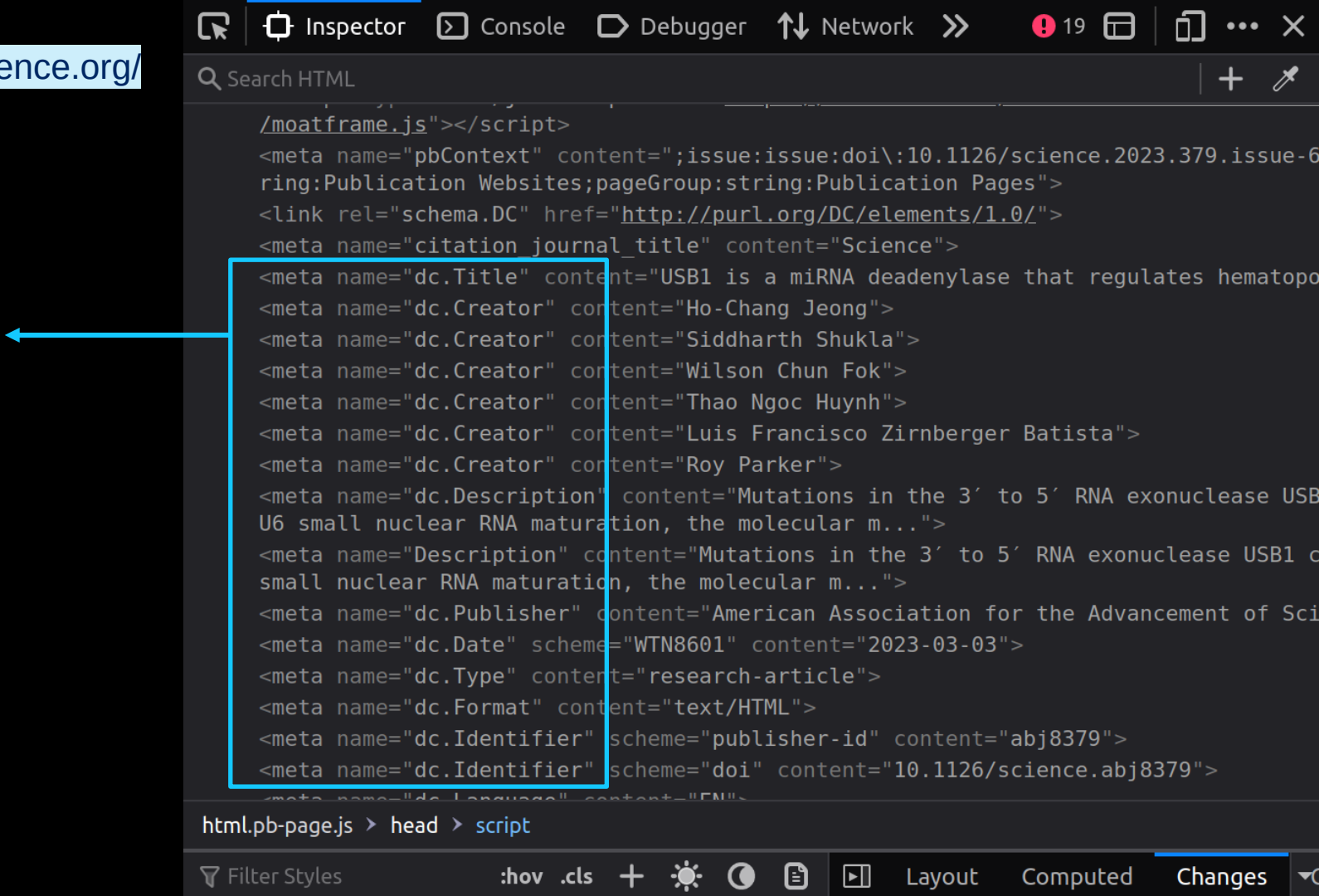
The Dublin Core was developed by a consortium of researchers, librarians, and web technologists in 1995, to address the need for a unified description of web resources.

- Creator
- Contributor
- Publisher
- Title
- Date
- Language
- Format
- Subject
- Description
- Identifier
- Relation

[1] https://www.dublincore.org/resources/metadata-basics/
[2] https://www.dublincore.org/specifications/dublin-core/dcmi-terms/#section-3
[3] https://www.dublincore.org/about/
[4] https://www.iso.org/standard/71339.html

https://www.science.org/

Dublin Core Elements



Metadata schemas

Metadata schemas define the structure and fields for metadata, often built on a standard.

Key Difference

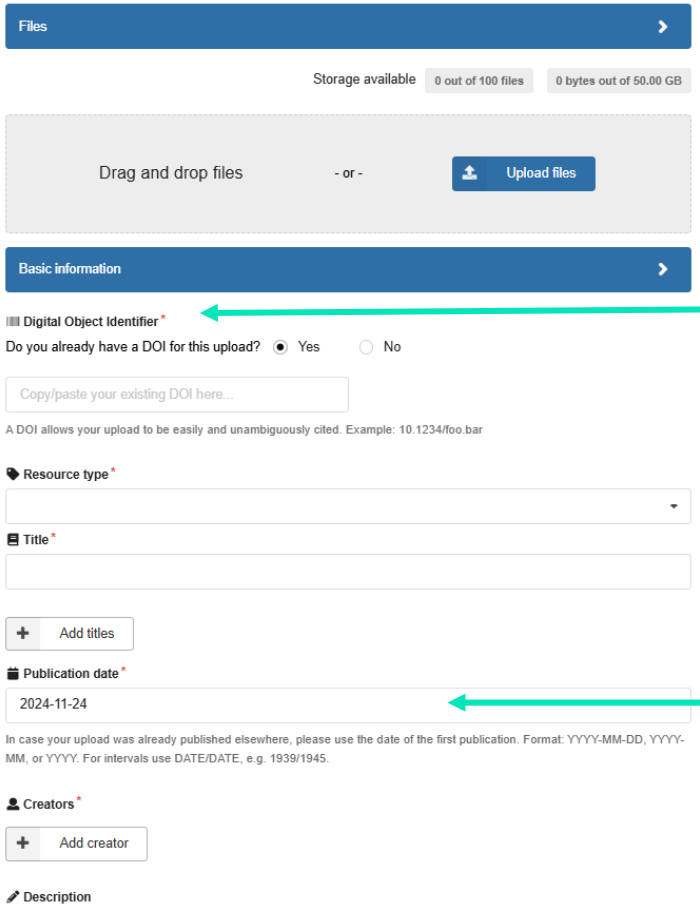
A standard defines what metadata to include:

- Dublin Core: Includes elements like title, creator, subject, date, description, etc,
- EXIF Metadata Schema: Includes fields like File Name, File Type, Model, Date/Time, etc.

A schema defines how the metadata is structured and formatted:

- Relationships between fields,
- Defining required or optional fields,
- Date: YYYY-MM-DD (ISO 8601 format),
- Name: Last Name, First Name,
- Keywords: A list separated by commas or semicolons.

Zenodo new upload form - **schemas** define the structure and fields for metadata

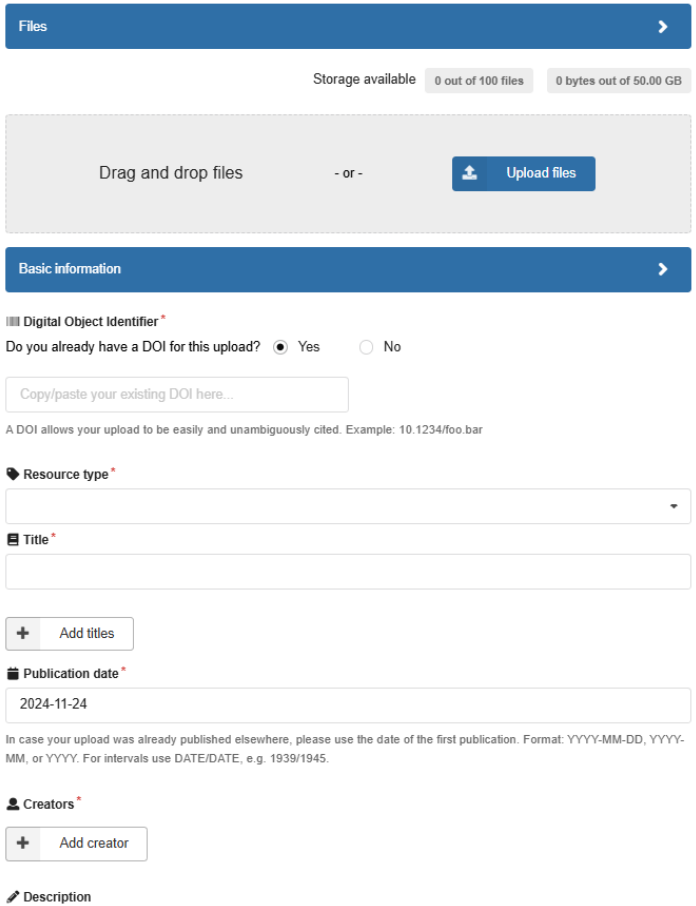


asterisks indicate mandatory entries

controlled list

entry format

Human-readable input (form fields) translates into machine-readable metadata



newdatasubmission.json


```
{
 “Files”: “metadatabeginners.pptx”,
 “Resource type”: “Presentation”,
 “Title”: “Metadata for Beginners”,
 “Publication date”: “2024-11-24”,
 “Creators”: “Dr. Özlem ÖZKAN”
}
```

Domain-relevant community standards

Data should meet **domain-relevant community standards!**

Many disciplines have created

- metadata standards for describing data,
- created lists of recommended file formats etc.

Keeping in line with these standards will lead new data out into the ecosystem of data that is easy and suitable for others to reuse.

Interoperability: NASA’s Mars Climate Orbiter Mishap

The failure of NASA's Mars Climate Orbiter in 1999

- The engineering team at Lockheed Martin used English units of measurement (**pounds-force**),
- while the NASA team expected data in metric units (**newtons**).

1 Newton ≈ 0.224809 pounds-force (lbf)

Consequence:

The orbiter entered the atmosphere at a much lower altitude than intended, leading to **its destruction** by atmospheric stresses and heat.

Loss: $327.6 million

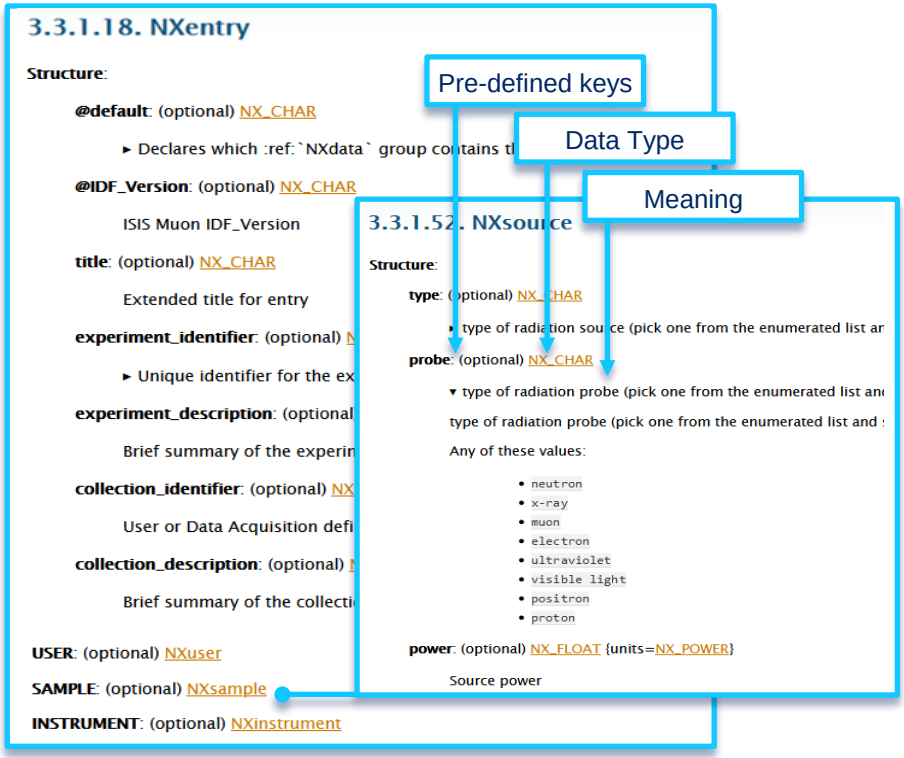
Remember the Mars Climate Orbiter incident from 1999?

What about research field matter?

NeXus is an **open community standard!**

[the **NeXus International Advisory Committee (NIAC) (**since **1994)**]

It functions both as a **data format** and a **metadata standard** particularly in **neutron, X-ray, and muon research.**



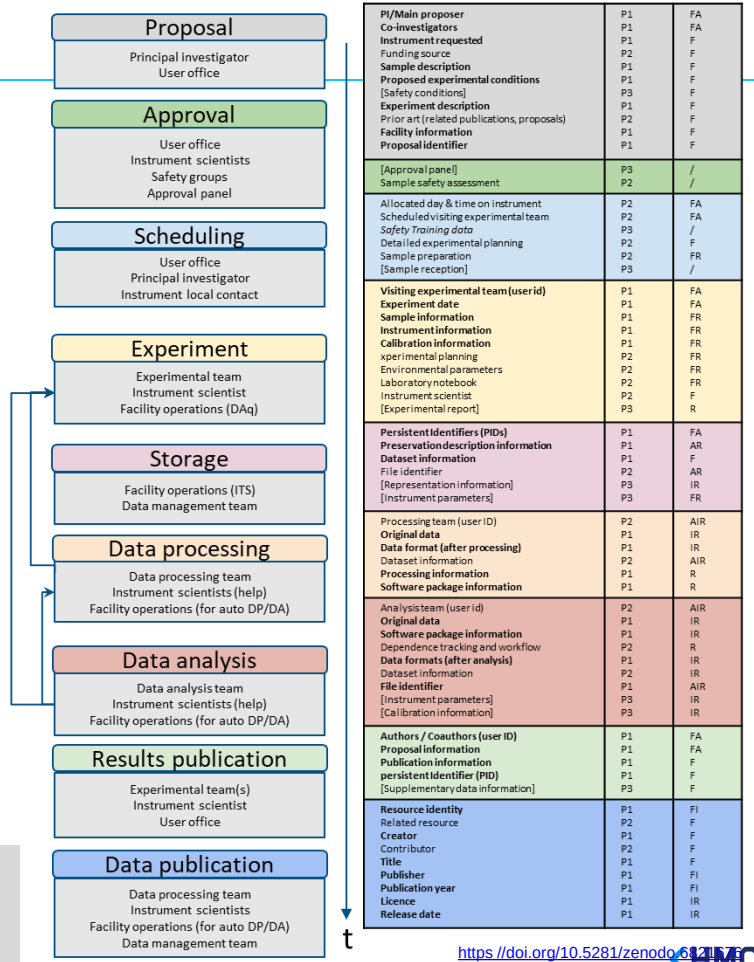
https://manual.nexusformat.org/classes/base_classes/NXsource.html

What about research field matter?

ExPaNDS project report (2022),

- defined **the necessary metadata elements** for Photon and Neutron (PaN) facilities >>>

(these elements are aligned with other open standards, like **NeXus)**



P1: essential
P2: important
P3: useful

https //doi.org/10.5281/zenodo.6815772

Metadata for nuclear physics experiments: NAPMIX

https://www.oscars-project.eu/projects/napmix-nuclear-astro-and-particle-metadata-integration-experiments

The NAPMIX project emerged to address a significant gap in nuclear physics: the lack of a unified metadata schema necessary for achieving FAIR datasets. This challenge extends to the fields of particle and astro-particle physics, highlighting the need for a collaborative European effort to create a common metadata schema with user-friendly infrastructure. By integrating expertise across these domains, NAPMIX aims to enhance data management practices.

The authors acknowledge the OSCARS project, which has received funding from the European Commission's Horizon Europe Research and Innovation programme under grant agreement No. 101129751

Funded by:

OSCARS Open Science Clusters' Action for Research & Society

Funded by the European Union

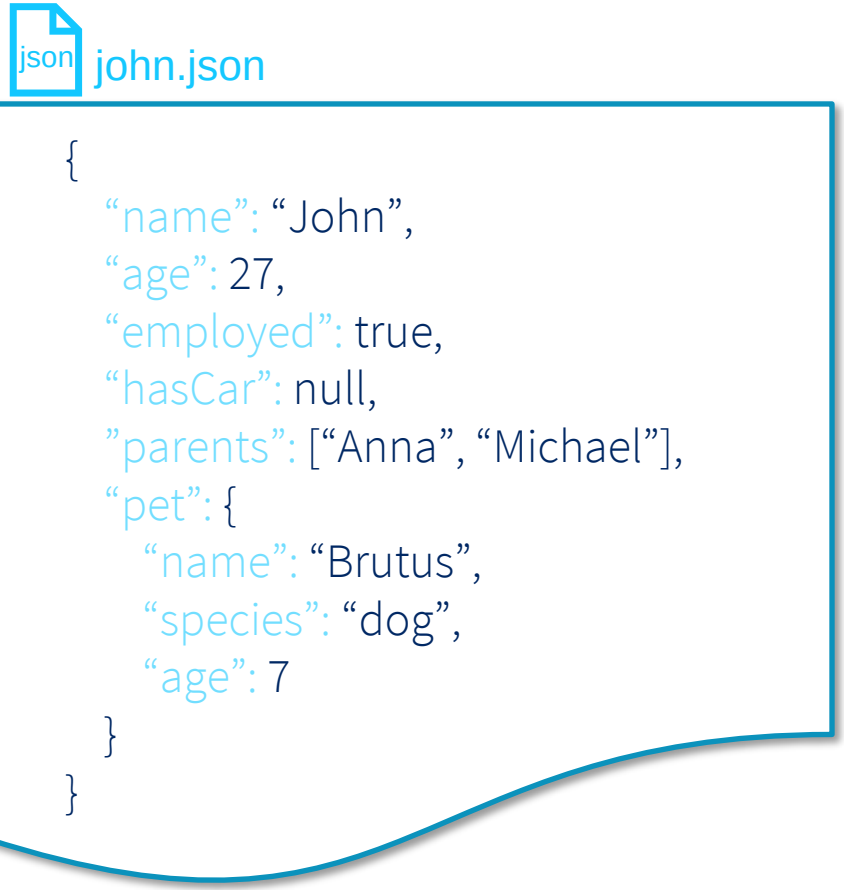
Questions?

fairsharing.org

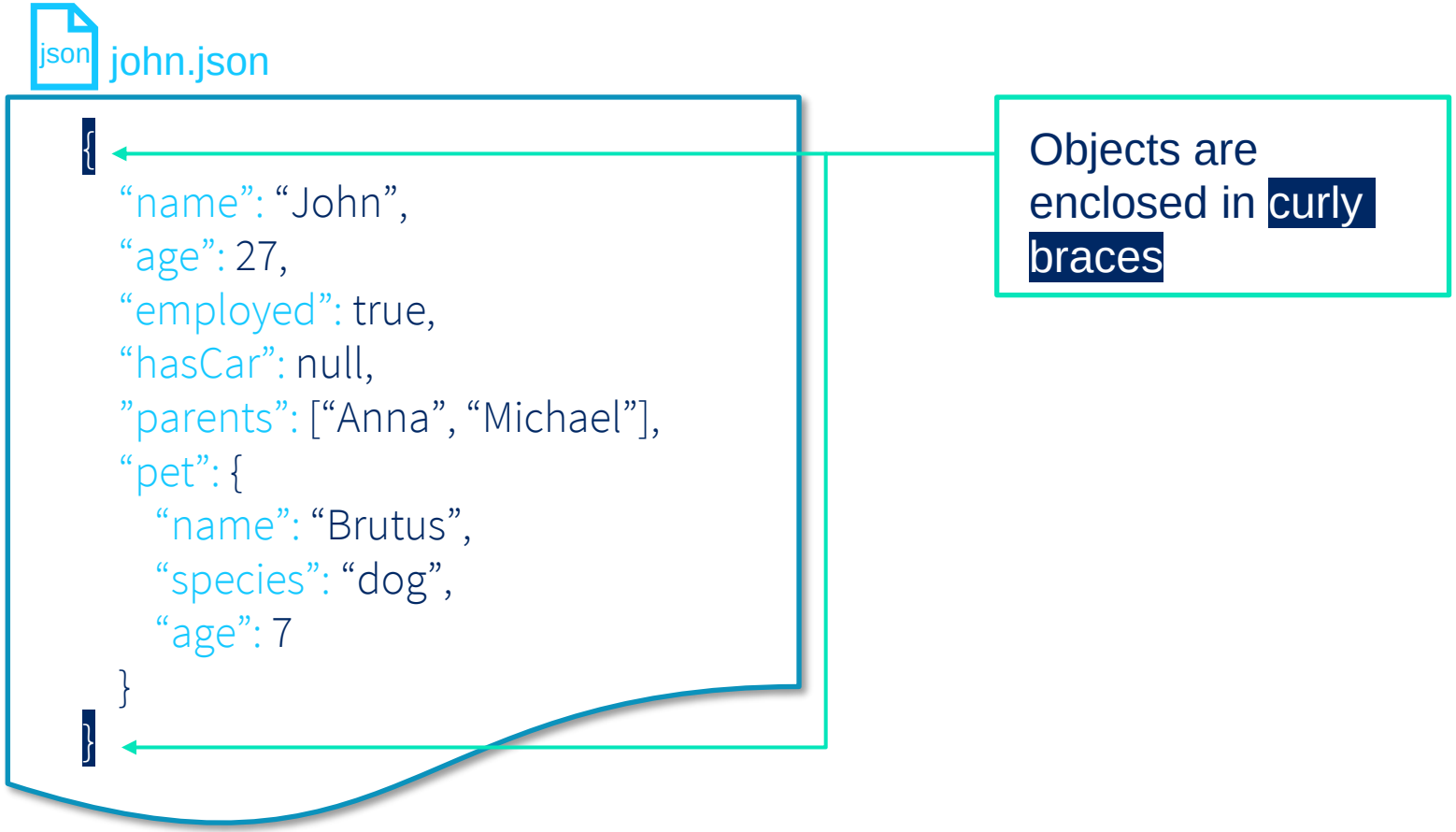
JSON

step-by-step

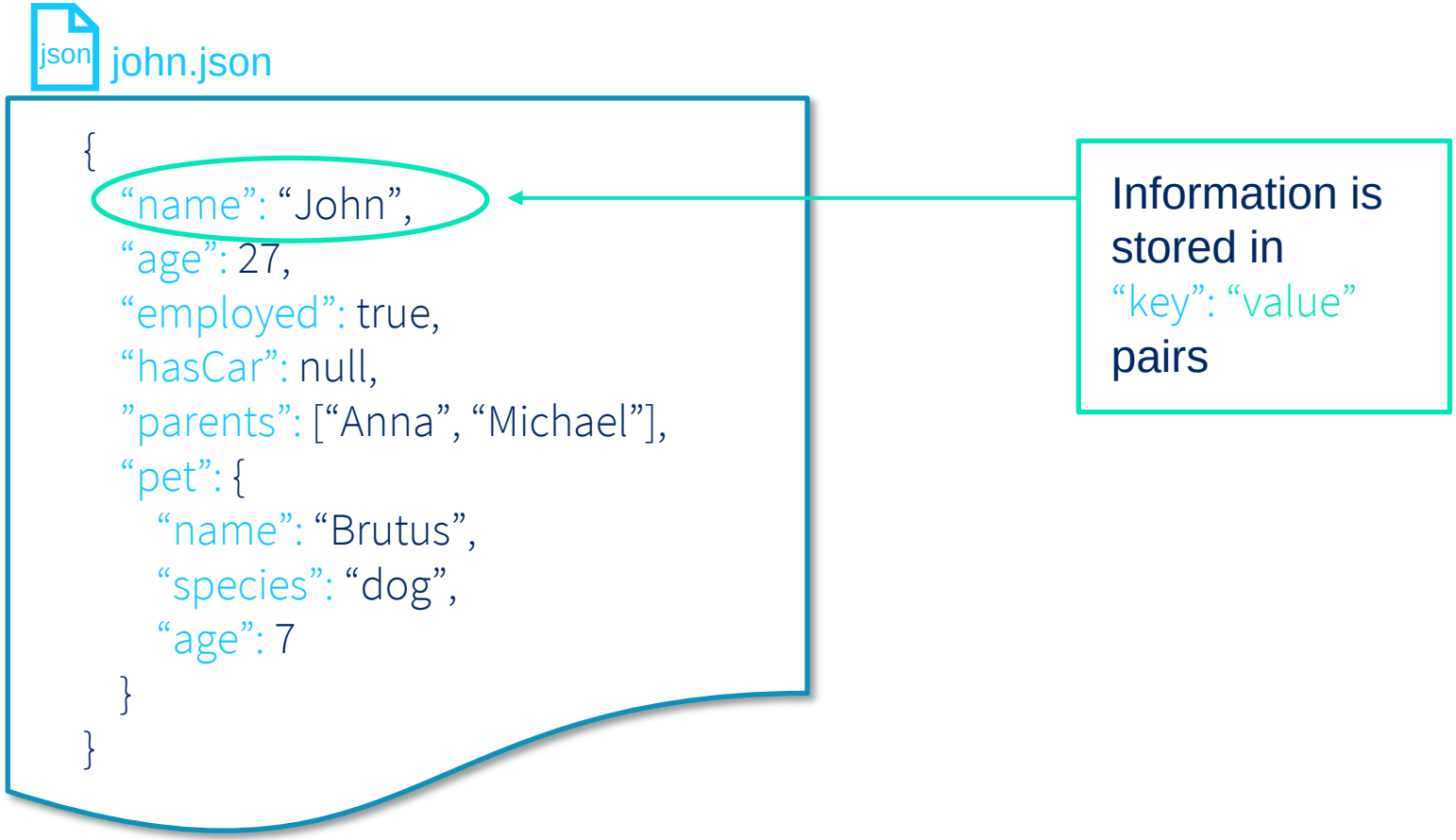
The JSON object



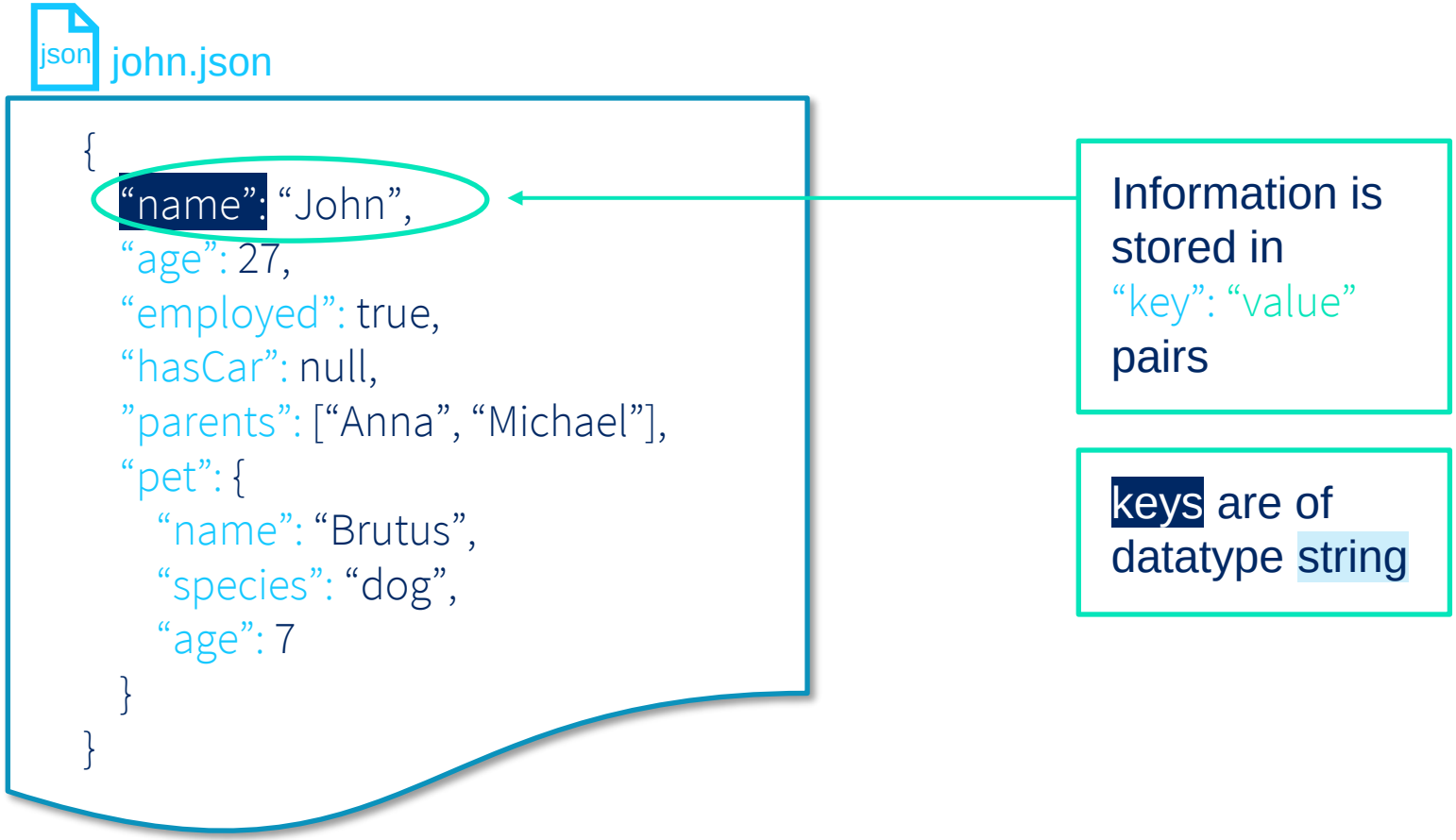
The JSON object



The JSON object



The JSON object



The JSON object

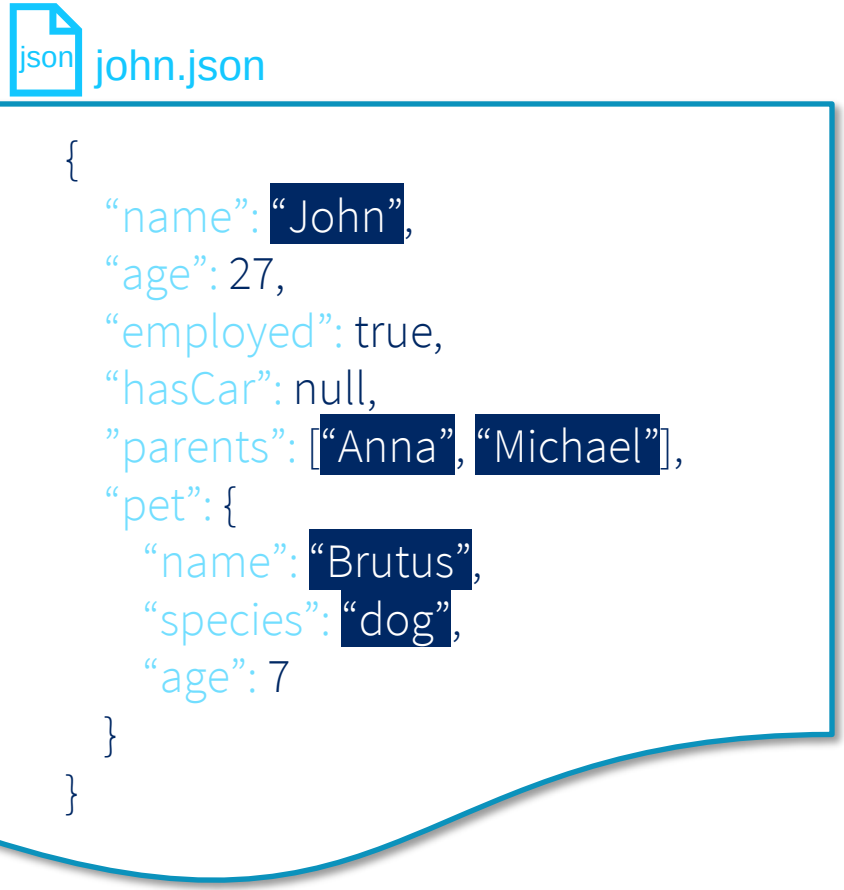
john.json

```
{
  “name”: “John”,
  “age”: 27,
  “employed”: true,
  “hasCar”: null,
  ”parents”: [“Anna”, “Michael”],
  “pet”: {
    “name”: “Brutus”,
    “species”: “dog”,
    “age”: 7
  }
}
```

values must be one of the following data types:

string
number
boolean
null
array
object

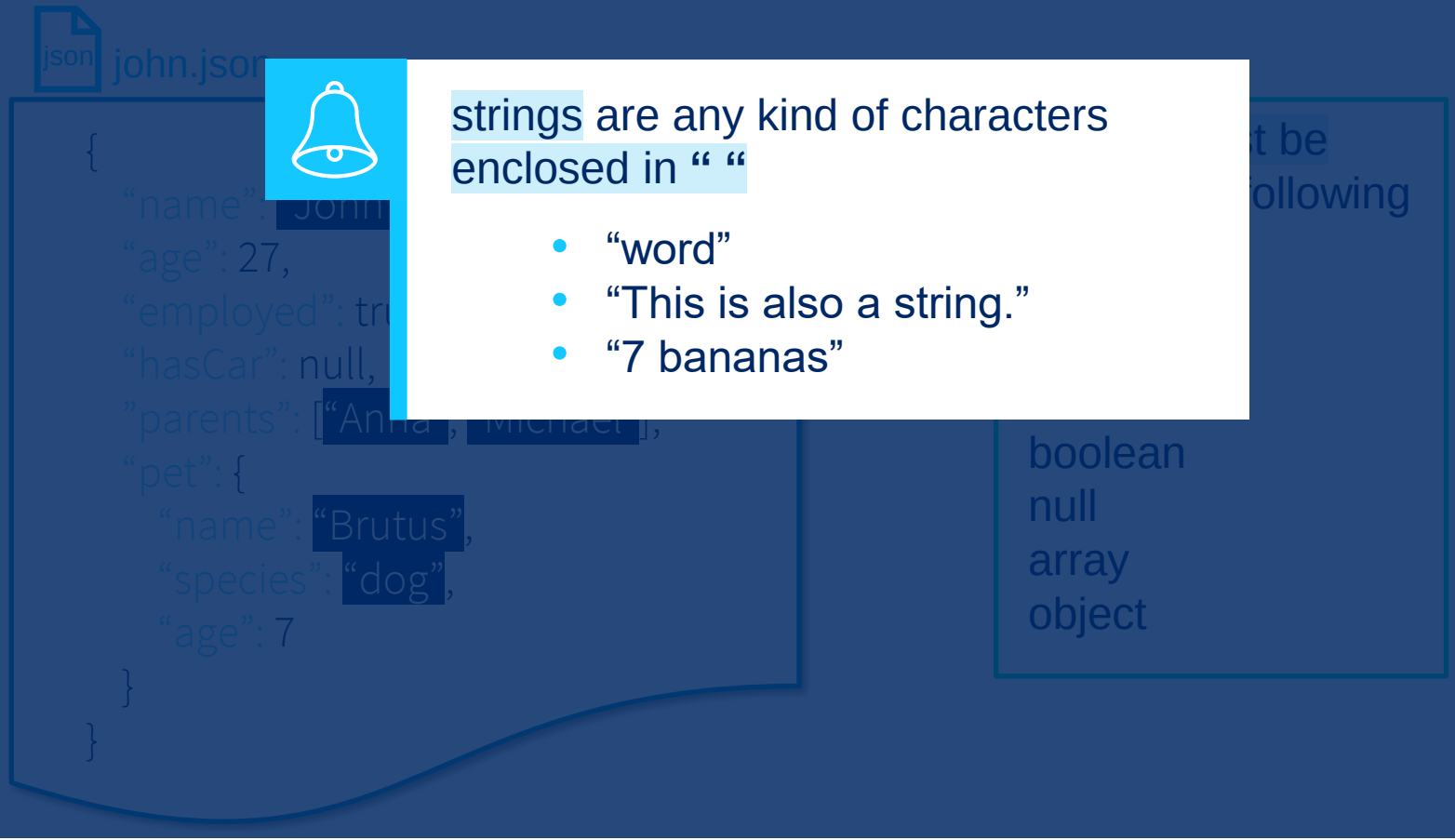
The JSON object



values must be one of the following data types:

string
number
boolean
null
array
object

The JSON object



strings are any kind of characters enclosed in “ “

- “word”
- “This is also a string.”
- “7 bananas”

The JSON object

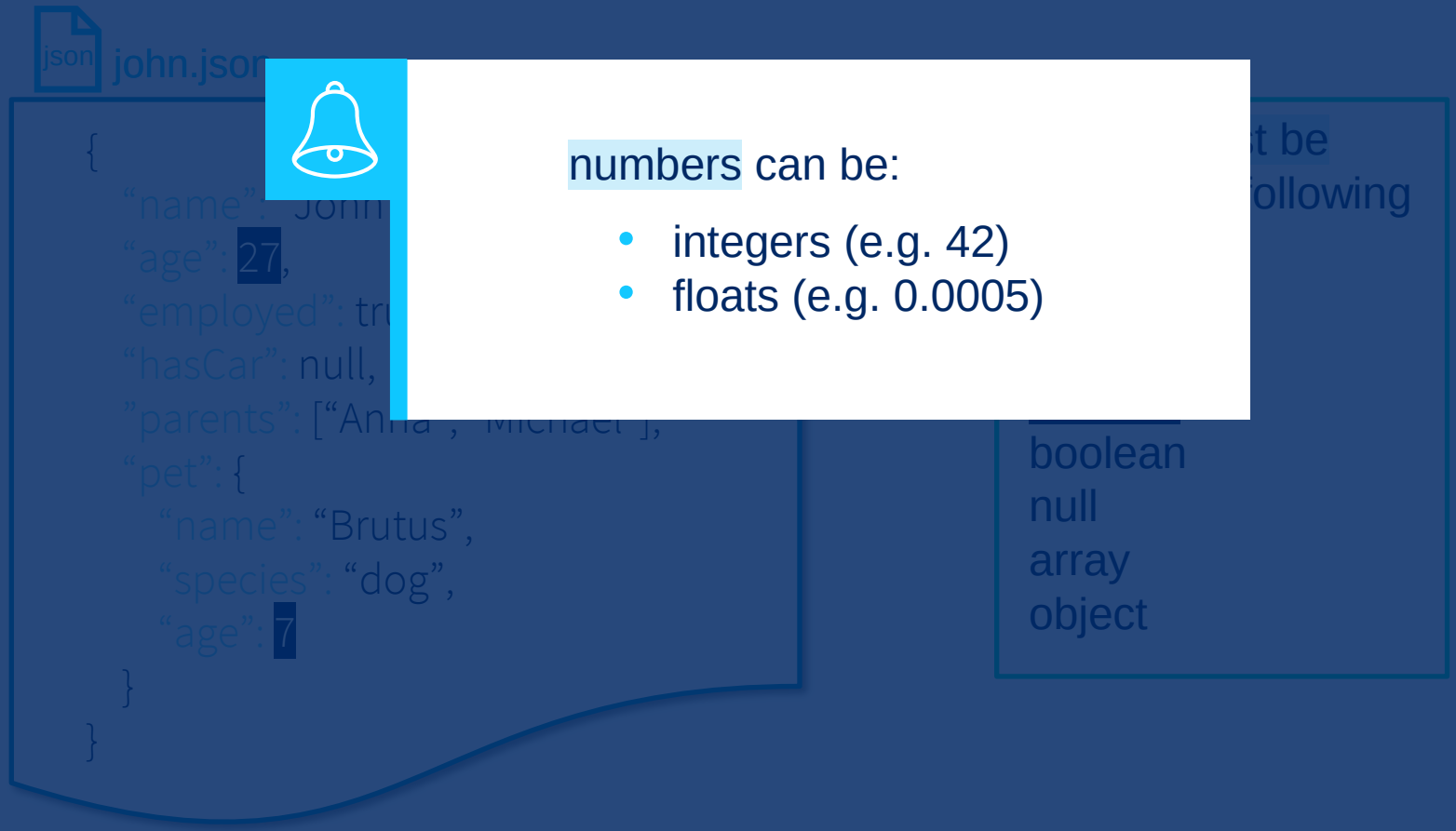
john.json

```
{
  “name”: “John”,
  “age”: 27,
  “employed”: true,
  “hasCar”: null,
  ”parents”: [“Anna”, “Michael”],
  “pet”: {
    “name”: “Brutus”,
    “species”: “dog”,
    “age”: 7
  }
}
```

values must be one of the following data types:

string
number
boolean
null
array
object

The JSON object



numbers can be:

- integers (e.g. 42)
- floats (e.g. 0.0005)

The JSON object

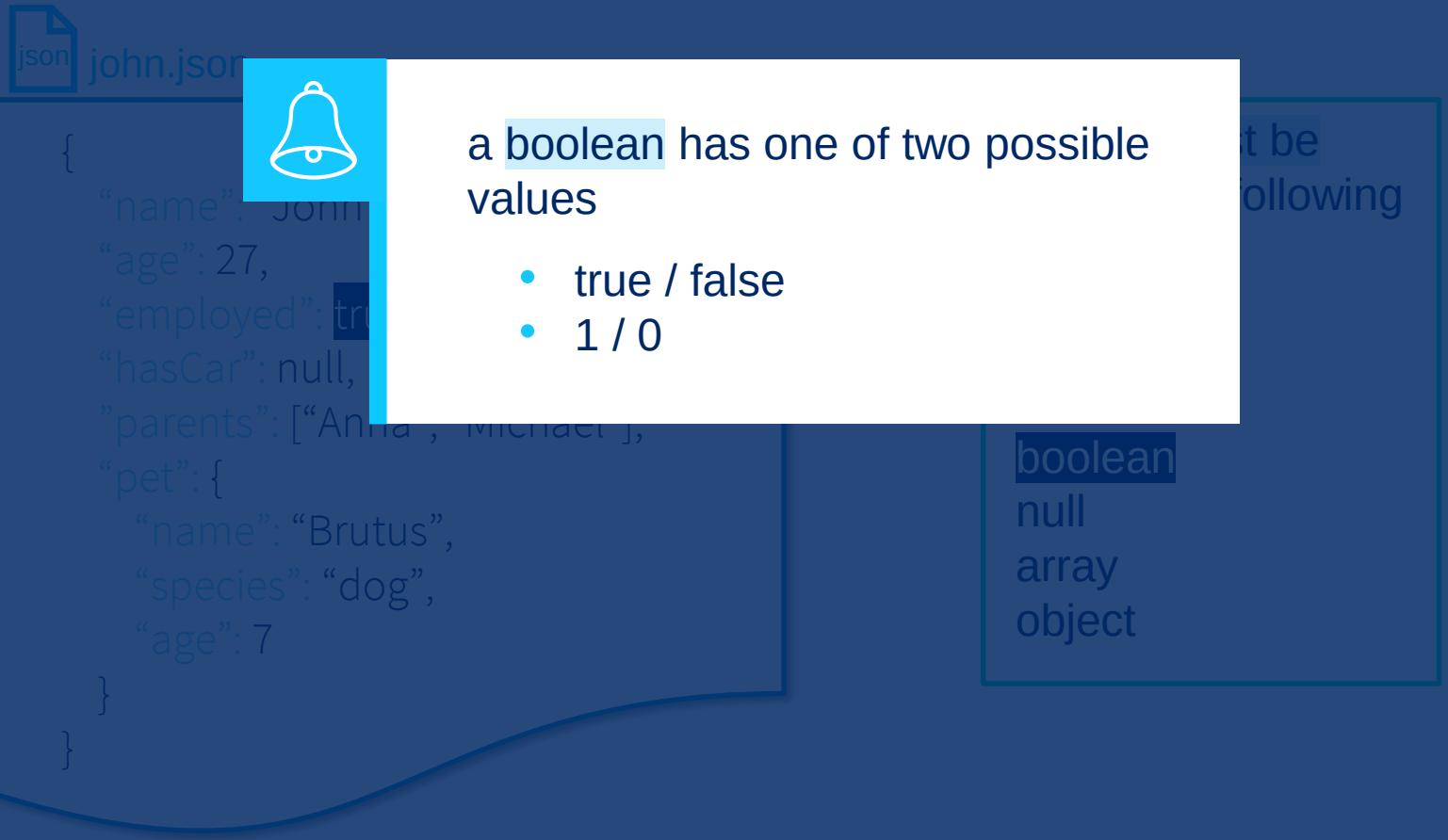
john.json

```
{
  “name”: “John”,
  “age”: 27,
  “employed”: true,
  “hasCar”: null,
  ”parents”: [“Anna”, “Michael”],
  “pet”: {
    “name”: “Brutus”,
    “species”: “dog”,
    “age”: 7
  }
}
```

values must be one of the following data types:

string
number
boolean
null
array
object

The JSON object



a boolean has one of two possible values

- true / false
- 1 / 0

The JSON object

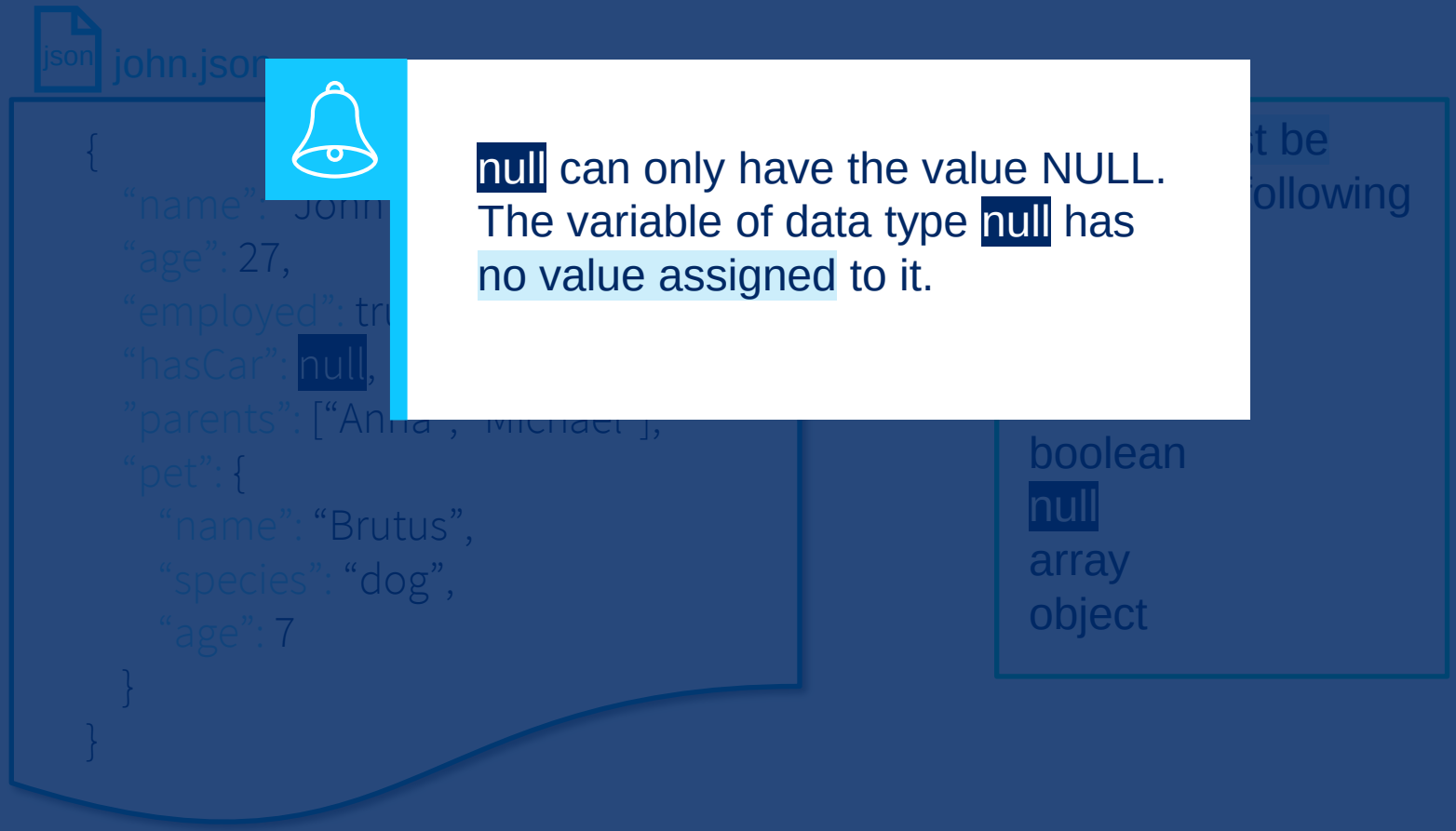
john.json

```
{
  “name”: “John”,
  “age”: 27,
  “employed”: true,
  “hasCar”: null,
  ”parents”: [“Anna”, “Michael”],
  “pet”: {
    “name”: “Brutus”,
    “species”: “dog”,
    “age”: 7
  }
}
```

values must be one of the following data types:

string
number
boolean
null
array
object

The JSON object



null can only have the value NULL.
The variable of data type **null** has no value assigned to it.

The JSON object

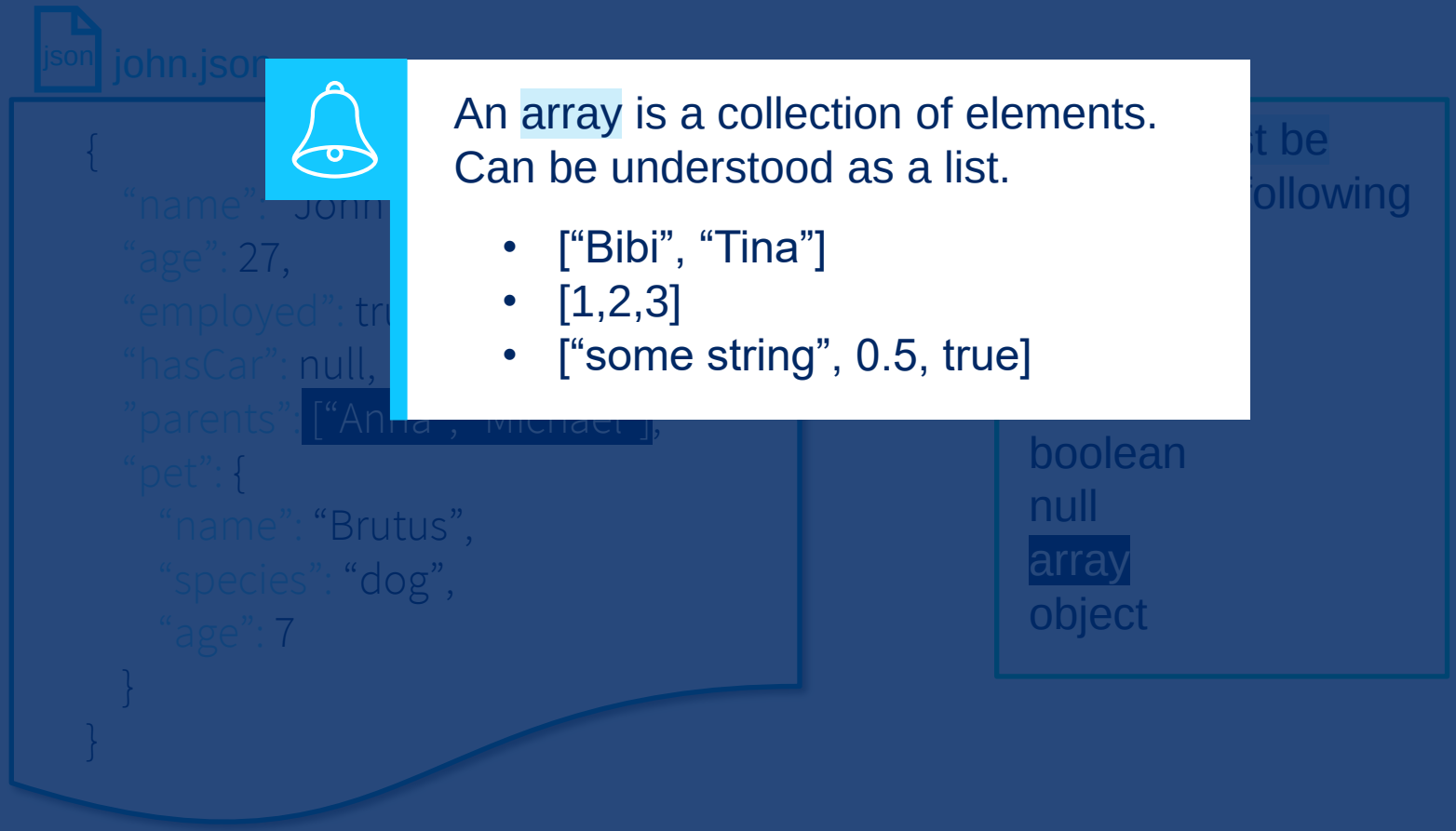
john.json

```
{
  “name”: “John”,
  “age”: 27,
  “employed”: true,
  “hasCar”: null,
  ”parents”: [“Anna”, “Michael”],
  “pet”: {
    “name”: “Brutus”,
    “species”: “dog”,
    “age”: 7
  }
}
```

values must be one of the following data types:

string
number
boolean
null
array
object

The JSON object



An array is a collection of elements.
Can be understood as a list.

- [“Bibi”, “Tina”]
- [1,2,3]
- [“some string”, 0.5, true]

The JSON object

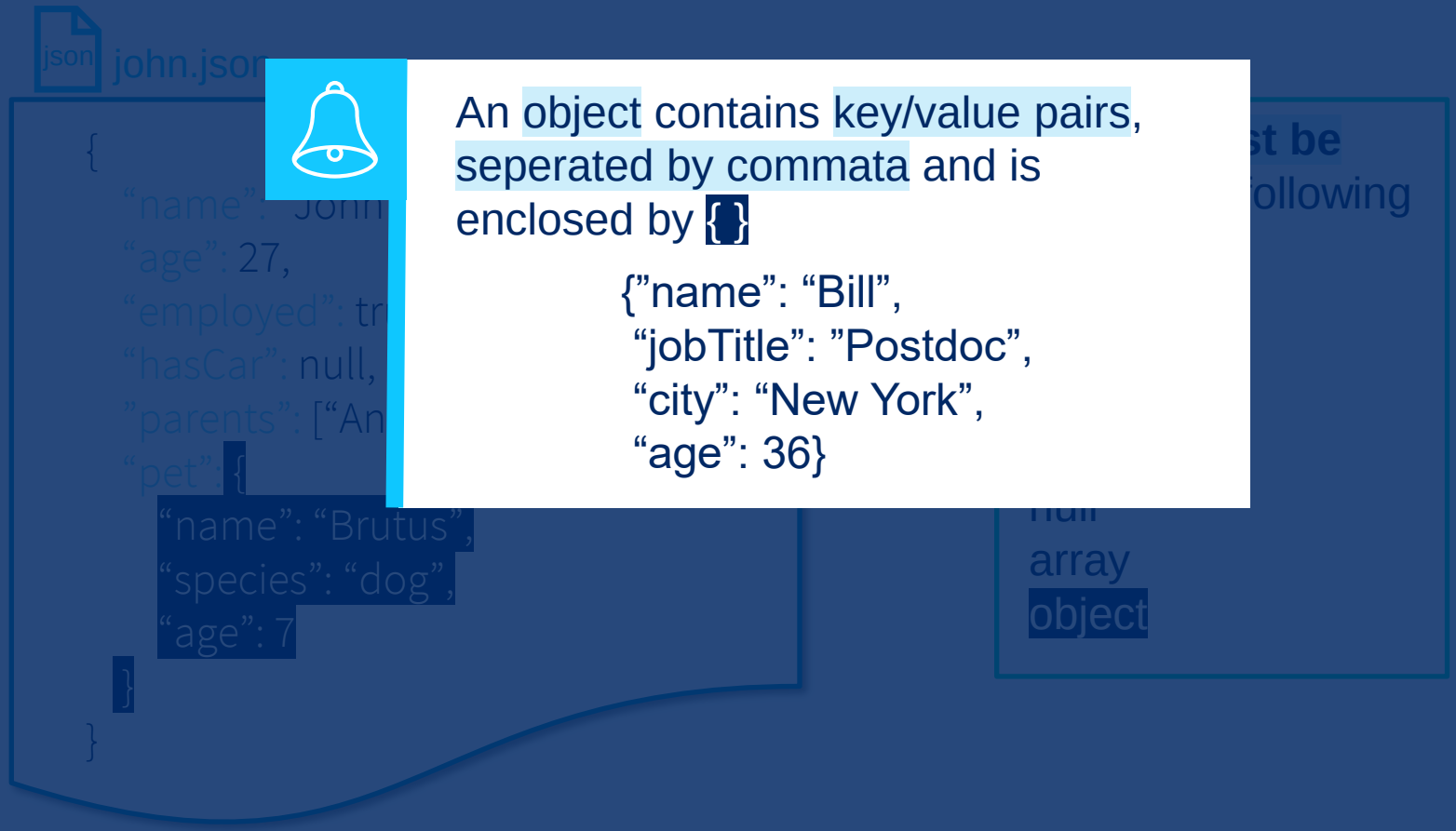
john.json

```
{
   “name”: “John”,
   “age”: 27,
   “employed”: true,
   “hasCar”: null,
   ”parents”: [“Anna”, “Michael”],
   “pet”: {
      “name”: “Brutus”,
      “species”: “dog”,
      “age”: 7
   }
}
```

values **must be** one of the following data types:

string
number
boolean
null
array
object

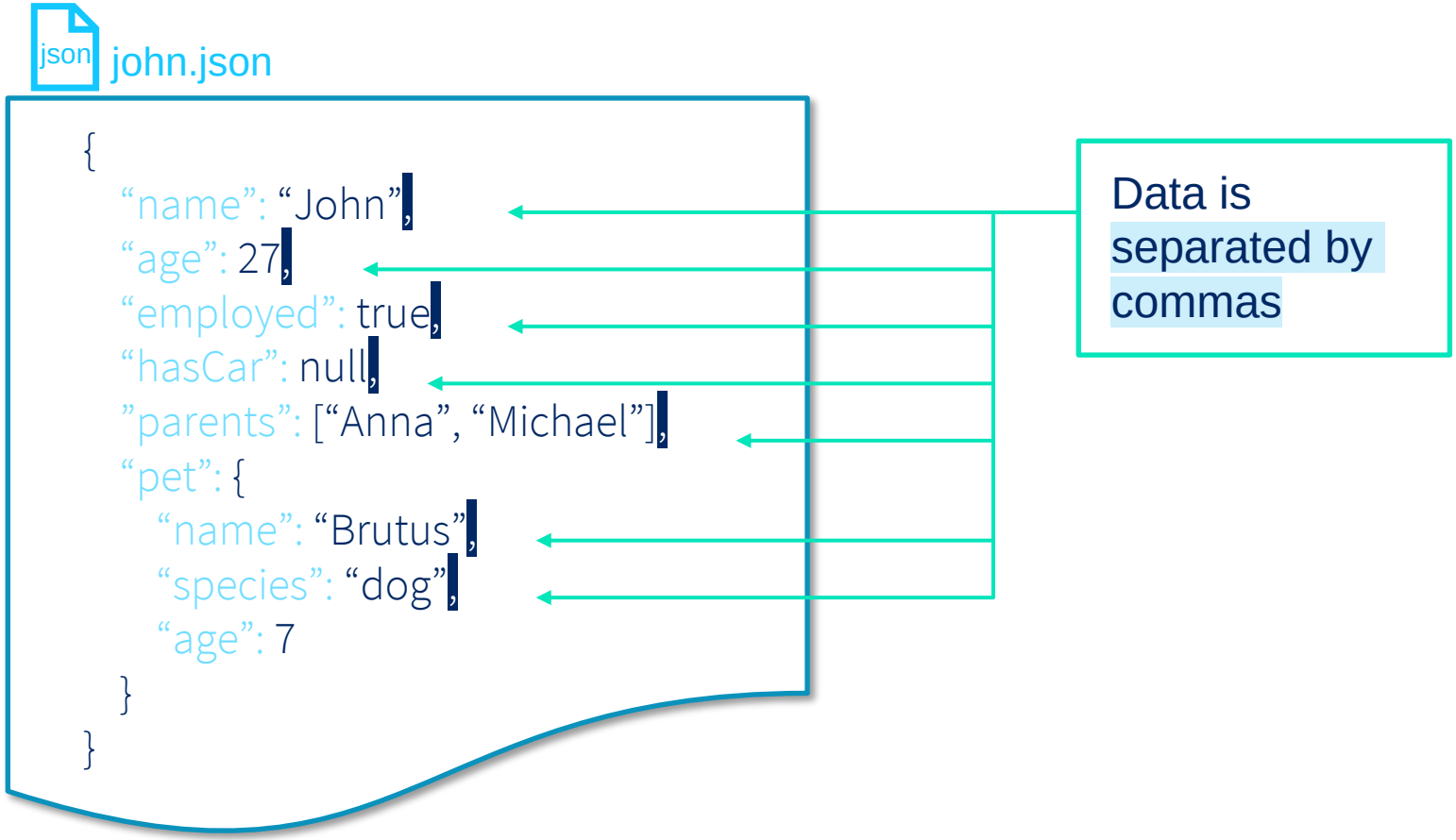
The JSON object



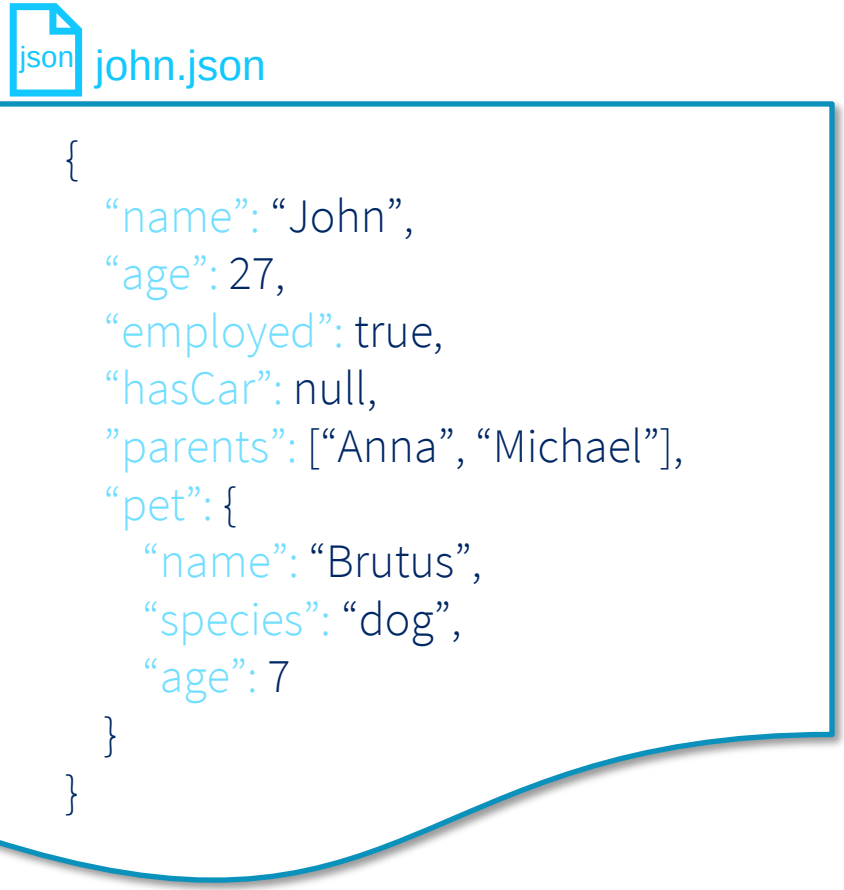
An object contains key/value pairs, seperated by commata and is enclosed by {}

{"name": "Bill",
"jobTitle": "Postdoc",
"city": "New York",
"age": 36}

The JSON object



The JSON object - indentation



Structured metadata: JSON vs. XML

json john.json

```
{
   “name”: “John”,
   “age”: 27,
   “employed”: true,
   “hasCar”: null,
   ”parents”: [“Anna”, “Michael”],
   “pet”: {
      “name”: “Brutus”,
      “species”: “dog”,
      “age”: 7
   }
}
```

xml john.xml

```
<name>John</name>
<age>27</age>
<employed>TRUE</employed>
<hasCar>NULL</hasCar>
<parents>Anna</parents>
<parents>Michael</parents>
<pet>
   <name>Brutus</name>
   <species>dog</species>
   <age>7</age>
</pet>
```

Coding

Example:

```
{
  "firstName": "value",
  "ORCID": "value",
  "favoriteCake": "value",
  "hobbies": ["value", "value"],
  "city": {
    "name": "value",
    "url": "value"
  }
}
```

Thanks