PLSC 197 / SODA 197N: Social Data, Technology, and Artificial Intelligence

Christopher Zorn

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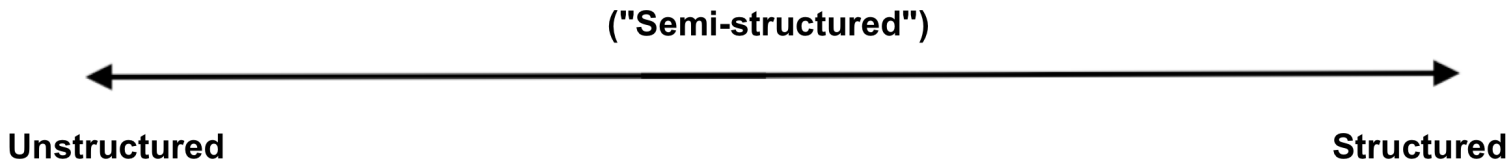
Data Structure



Key: The Data Model:

> *"...an abstract model that organizes elements of data and standardizes how they relate to one another and to the properties of real-world entities."*

Structured Data

Structured data (e.g., Ademola-Shanu 2025) has:

- A predefined *schema* (e.g., a "codebook")
- Consistent *formatting*
- Ease of *storage*
- High *searchability*

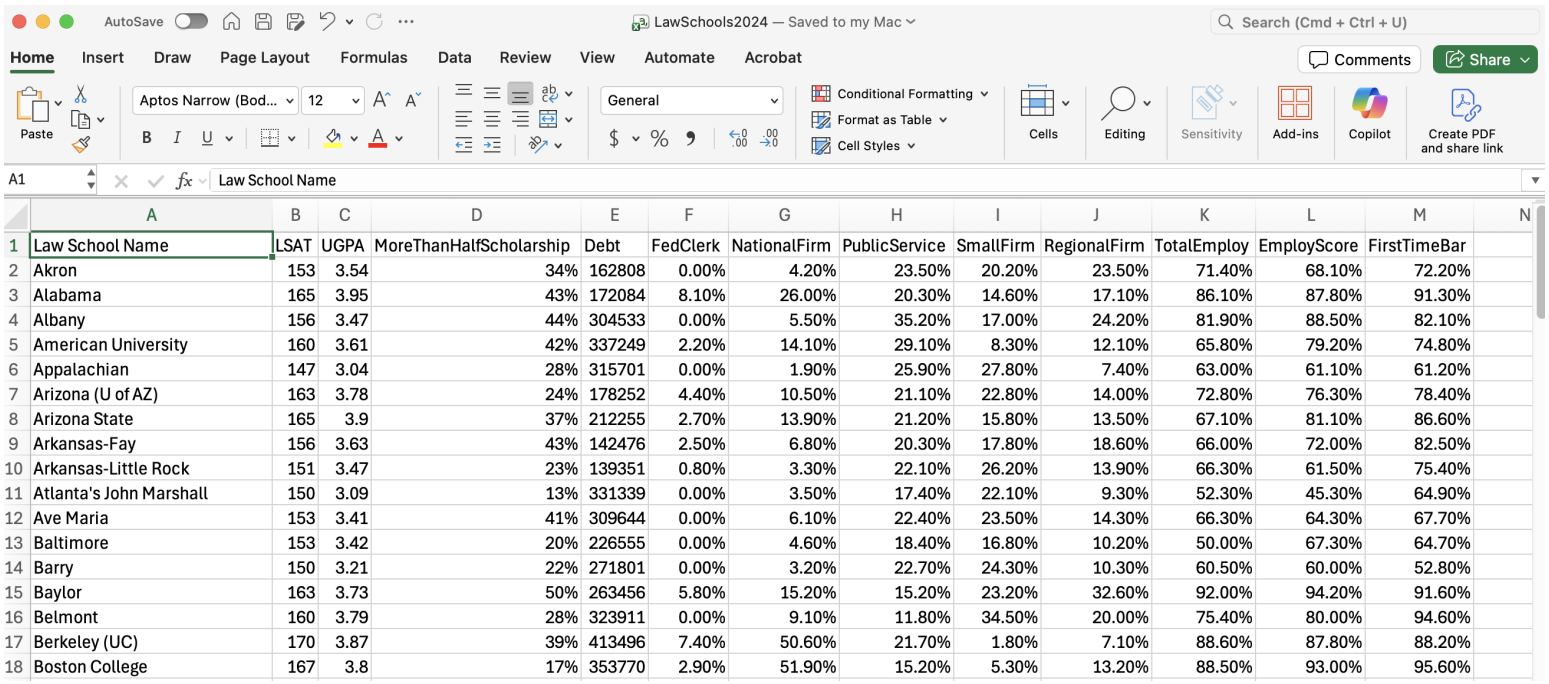
Characteristics:

- Intuitive / easy to use + understand
- Myriad tools for managing + analysis
- Central for machine learning

Structured Data: Examples

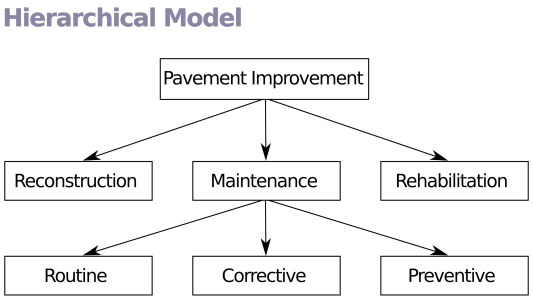
Rectangular / "linear" data:

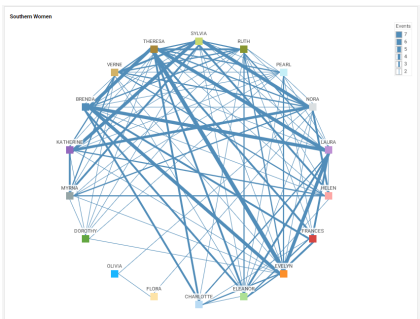
- Rows are *cases* / *observations* (units / "things")
- Columns are *variables* / *features* (characteristics of units)

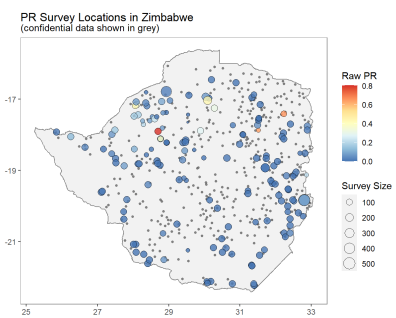


	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Law School Name	LSAT	UGPA	MoreThanHalfScholarship	Debt	FedClerk	NationalFirm	PublicService	SmallFirm	RegionalFirm	TotalEmploy	EmployScore	FirstTimeBar	
2	Akron	153	3.54	34%	162808	0.00%	4.20%	23.50%	20.20%	23.50%	71.40%	68.10%	72.20%	
3	Alabama	165	3.95	43%	172084	8.10%	26.00%	20.30%	14.60%	17.10%	86.10%	87.80%	91.30%	
4	Albany	156	3.47	44%	304533	0.00%	5.50%	35.20%	17.00%	24.20%	81.90%	88.50%	82.10%	
5	American University	160	3.61	42%	337249	2.20%	14.10%	29.10%	8.30%	12.10%	65.80%	79.20%	74.80%	
6	Appalachian	147	3.04	28%	315701	0.00%	1.90%	25.90%	27.80%	7.40%	63.00%	61.10%	61.20%	
7	Arizona (U of AZ)	163	3.78	24%	178252	4.40%	10.50%	21.10%	22.80%	14.00%	72.80%	76.30%	78.40%	
8	Arizona State	165	3.9	37%	212255	2.70%	13.90%	21.20%	15.80%	13.50%	67.10%	81.10%	86.60%	
9	Arkansas-Fay	156	3.63	43%	142476	2.50%	6.80%	20.30%	17.80%	18.60%	66.00%	72.00%	82.50%	
10	Arkansas-Little Rock	151	3.47	23%	139351	0.80%	3.30%	22.10%	26.20%	13.90%	66.30%	61.50%	75.40%	
11	Atlanta's John Marshall	150	3.09	13%	331339	0.00%	3.50%	17.40%	22.10%	9.30%	52.30%	45.30%	64.90%	
12	Ave Maria	153	3.41	41%	309644	0.00%	6.10%	22.40%	23.50%	14.30%	66.30%	64.30%	67.70%	
13	Baltimore	153	3.42	20%	226555	0.00%	4.60%	18.40%	16.80%	10.20%	50.00%	67.30%	64.70%	
14	Barry	150	3.21	22%	271801	0.00%	3.20%	22.70%	24.30%	10.30%	60.50%	60.00%	52.80%	
15	Baylor	163	3.73	50%	263456	5.80%	15.20%	15.20%	23.20%	32.60%	92.00%	94.20%	91.60%	
16	Belmont	160	3.79	28%	323911	0.00%	9.10%	11.80%	34.50%	20.00%	75.40%	80.00%	94.60%	
17	Berkeley (UC)	170	3.87	39%	413496	7.40%	50.60%	21.70%	1.80%	7.10%	88.60%	87.80%	88.20%	
18	Boston College	167	3.8	17%	353770	2.90%	51.90%	15.20%	5.30%	13.20%	88.50%	93.00%	95.60%	

Structured Data: Other Examples







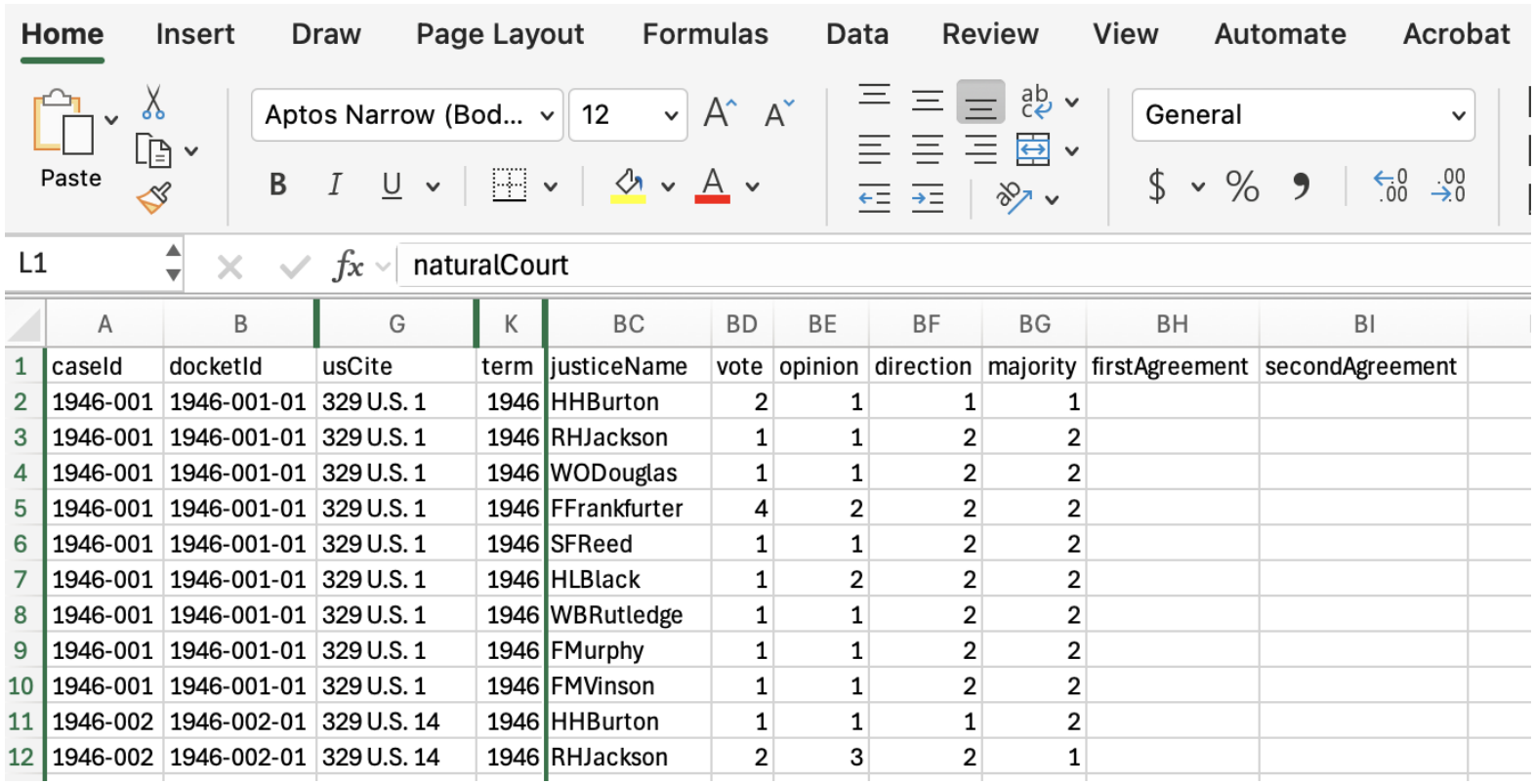
- Hierarchical Data (nested)
- Network Data (nodes + edges)
- Spatial Data (geolocated)

Structured Data: Formats

Rectangular formats:

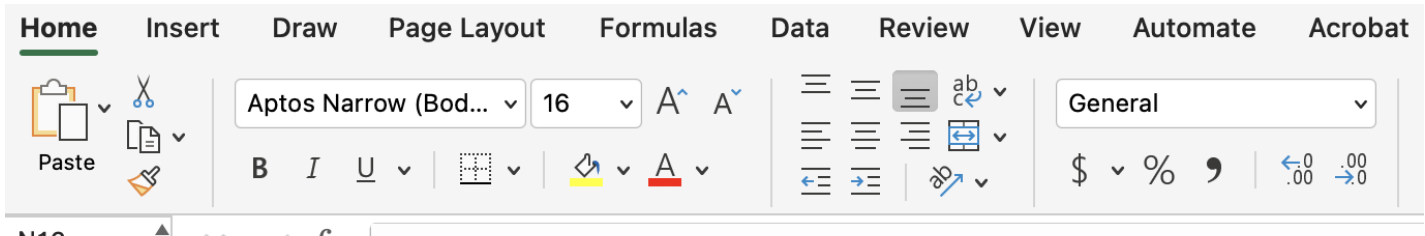
- `.csv` (Comma-separated values)
- `.xlsx` (Microsoft Excel)
- `.parquet` (Parquet)
- SQL tables (see below)
- Others (`.tsv`, `.txt`, etc.)

Hierarchical Data: Excel



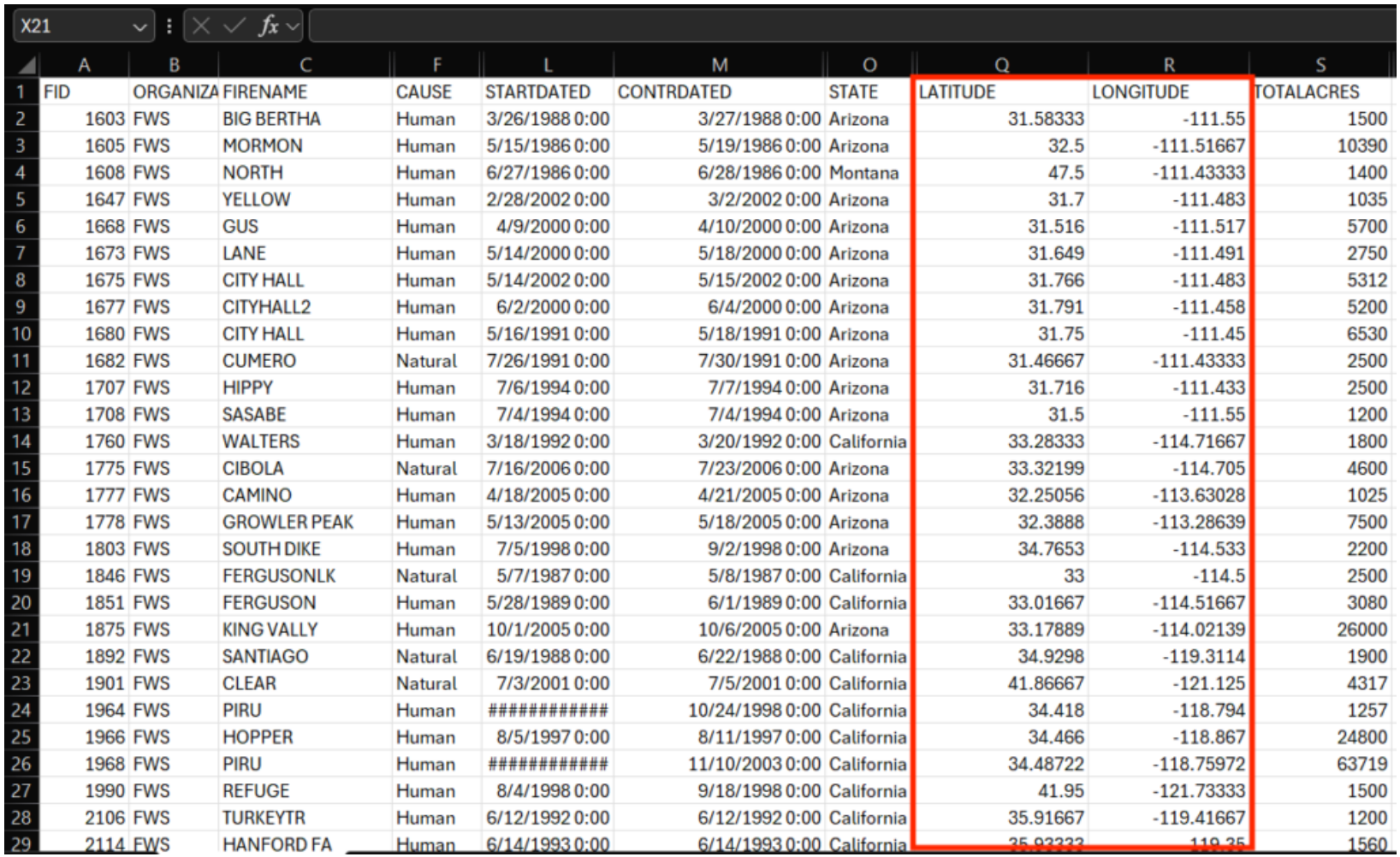
	A	B	G	K	BC	BD	BE	BF	BG	BH	BI
1	caseId	docketId	usCite	term	justiceName	vote	opinion	direction	majority	firstAgreement	secondAgreement
2	1946-001	1946-001-01	329 U.S. 1	1946	HHBurton	2	1	1	1		
3	1946-001	1946-001-01	329 U.S. 1	1946	RHJackson	1	1	2	2		
4	1946-001	1946-001-01	329 U.S. 1	1946	WODouglas	1	1	2	2		
5	1946-001	1946-001-01	329 U.S. 1	1946	FFrankfurter	4	2	2	2		
6	1946-001	1946-001-01	329 U.S. 1	1946	SFReed	1	1	2	2		
7	1946-001	1946-001-01	329 U.S. 1	1946	HLBlack	1	2	2	2		
8	1946-001	1946-001-01	329 U.S. 1	1946	WBRutledge	1	1	2	2		
9	1946-001	1946-001-01	329 U.S. 1	1946	FMurphy	1	1	2	2		
10	1946-001	1946-001-01	329 U.S. 1	1946	FMVinson	1	1	2	2		
11	1946-002	1946-002-01	329 U.S. 14	1946	HHBurton	1	1	1	2		
12	1946-002	1946-002-01	329 U.S. 14	1946	RHJackson	2	3	2	1		

Network Data: Excel



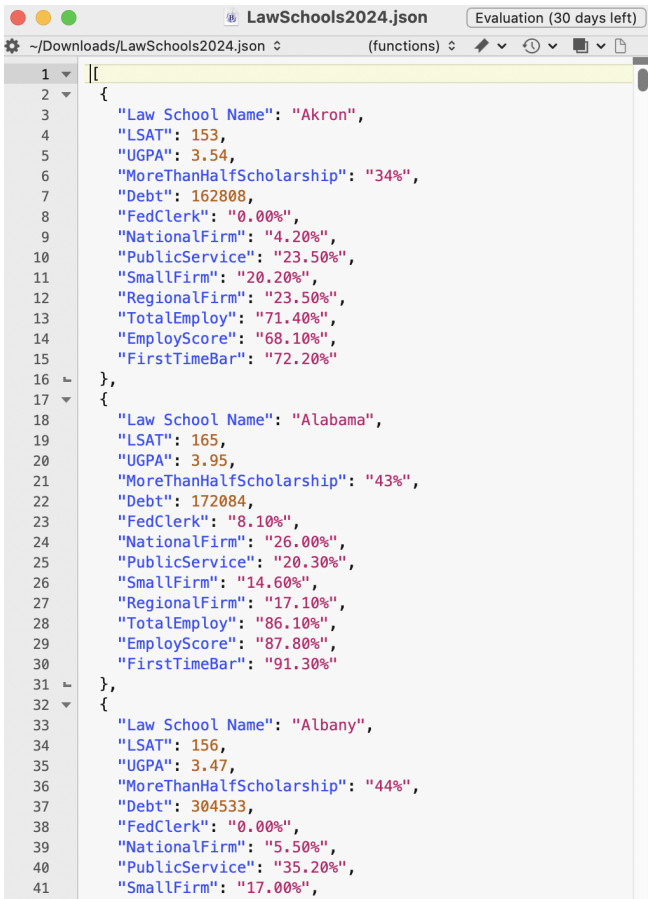
	A	B	C	D	E	F	G	H	I	J	K
1		Rehnquist	Stevens	OConnor	Scalia	Kennedy	Souter	Thomas	Ginsburg	Breyer	
2	Rehnquist	0	0	1	1	1	0	1	0	0	
3	Stevens	0	0	0	0	0	1	0	1	1	
4	OConnor	1	0	0	0	1	1	0	1	1	
5	Scalia	1	0	0	0	1	0	1	0	0	
6	Kennedy	1	0	1	1	0	1	1	1	1	
7	Souter	0	1	1	0	1	0	0	1	1	
8	Thomas	1	0	0	1	1	0	0	0	0	
9	Ginsburg	0	1	1	0	1	1	0	0	1	
10	Breyer	0	1	1	0	1	1	0	1	0	

Spatial Data: Excel



	A	B	C	F	L	M	O	Q	R	S
1	FID	ORGANIZA	FIRENAME	CAUSE	STARTDATED	CONTRDATED	STATE	LATITUDE	LONGITUDE	TOTALACRES
2	1603	FWS	BIG BERTHA	Human	3/26/1988 0:00	3/27/1988 0:00	Arizona	31.58333	-111.55	1500
3	1605	FWS	MORMON	Human	5/15/1986 0:00	5/19/1986 0:00	Arizona	32.5	-111.51667	10390
4	1608	FWS	NORTH	Human	6/27/1986 0:00	6/28/1986 0:00	Montana	47.5	-111.43333	1400
5	1647	FWS	YELLOW	Human	2/28/2002 0:00	3/2/2002 0:00	Arizona	31.7	-111.483	1035
6	1668	FWS	GUS	Human	4/9/2000 0:00	4/10/2000 0:00	Arizona	31.516	-111.517	5700
7	1673	FWS	LANE	Human	5/14/2000 0:00	5/18/2000 0:00	Arizona	31.649	-111.491	2750
8	1675	FWS	CITY HALL	Human	5/14/2002 0:00	5/15/2002 0:00	Arizona	31.766	-111.483	5312
9	1677	FWS	CITYHALL2	Human	6/2/2000 0:00	6/4/2000 0:00	Arizona	31.791	-111.458	5200
10	1680	FWS	CITY HALL	Human	5/16/1991 0:00	5/18/1991 0:00	Arizona	31.75	-111.45	6530
11	1682	FWS	CUMERO	Natural	7/26/1991 0:00	7/30/1991 0:00	Arizona	31.46667	-111.43333	2500
12	1707	FWS	HIPPY	Human	7/6/1994 0:00	7/7/1994 0:00	Arizona	31.716	-111.433	2500
13	1708	FWS	SASABE	Human	7/4/1994 0:00	7/4/1994 0:00	Arizona	31.5	-111.55	1200
14	1760	FWS	WALTERS	Human	3/18/1992 0:00	3/20/1992 0:00	California	33.28333	-114.71667	1800
15	1775	FWS	CIBOLA	Natural	7/16/2006 0:00	7/23/2006 0:00	Arizona	33.32199	-114.705	4600
16	1777	FWS	CAMINO	Human	4/18/2005 0:00	4/21/2005 0:00	Arizona	32.25056	-113.63028	1025
17	1778	FWS	GROWLER PEAK	Human	5/13/2005 0:00	5/18/2005 0:00	Arizona	32.3888	-113.28639	7500
18	1803	FWS	SOUTH DIKE	Human	7/5/1998 0:00	9/2/1998 0:00	Arizona	34.7653	-114.533	2200
19	1846	FWS	FERGUSONLK	Natural	5/7/1987 0:00	5/8/1987 0:00	California	33	-114.5	2500
20	1851	FWS	FERGUSON	Human	5/28/1989 0:00	6/1/1989 0:00	California	33.01667	-114.51667	3080
21	1875	FWS	KING VALLY	Human	10/1/2005 0:00	10/6/2005 0:00	Arizona	33.17889	-114.02139	26000
22	1892	FWS	SANTIAGO	Natural	6/19/1988 0:00	6/22/1988 0:00	California	34.9298	-119.3114	1900
23	1901	FWS	CLEAR	Natural	7/3/2001 0:00	7/5/2001 0:00	California	41.86667	-121.125	4317
24	1964	FWS	PIRU	Human	##########	10/24/1998 0:00	California	34.418	-118.794	1257
25	1966	FWS	HOPPER	Human	8/5/1997 0:00	8/11/1997 0:00	California	34.466	-118.867	24800
26	1968	FWS	PIRU	Human	##########	11/10/2003 0:00	California	34.48722	-118.75972	63719
27	1990	FWS	REFUGE	Human	8/4/1998 0:00	9/18/1998 0:00	California	41.95	-121.73333	1500
28	2106	FWS	TURKEYTR	Human	6/12/1992 0:00	6/12/1992 0:00	California	35.91667	-119.41667	1200
29	2114	FWS	HANFORD FA	Human	6/14/1993 0:00	6/14/1993 0:00	California	35.93333	119.35	1560

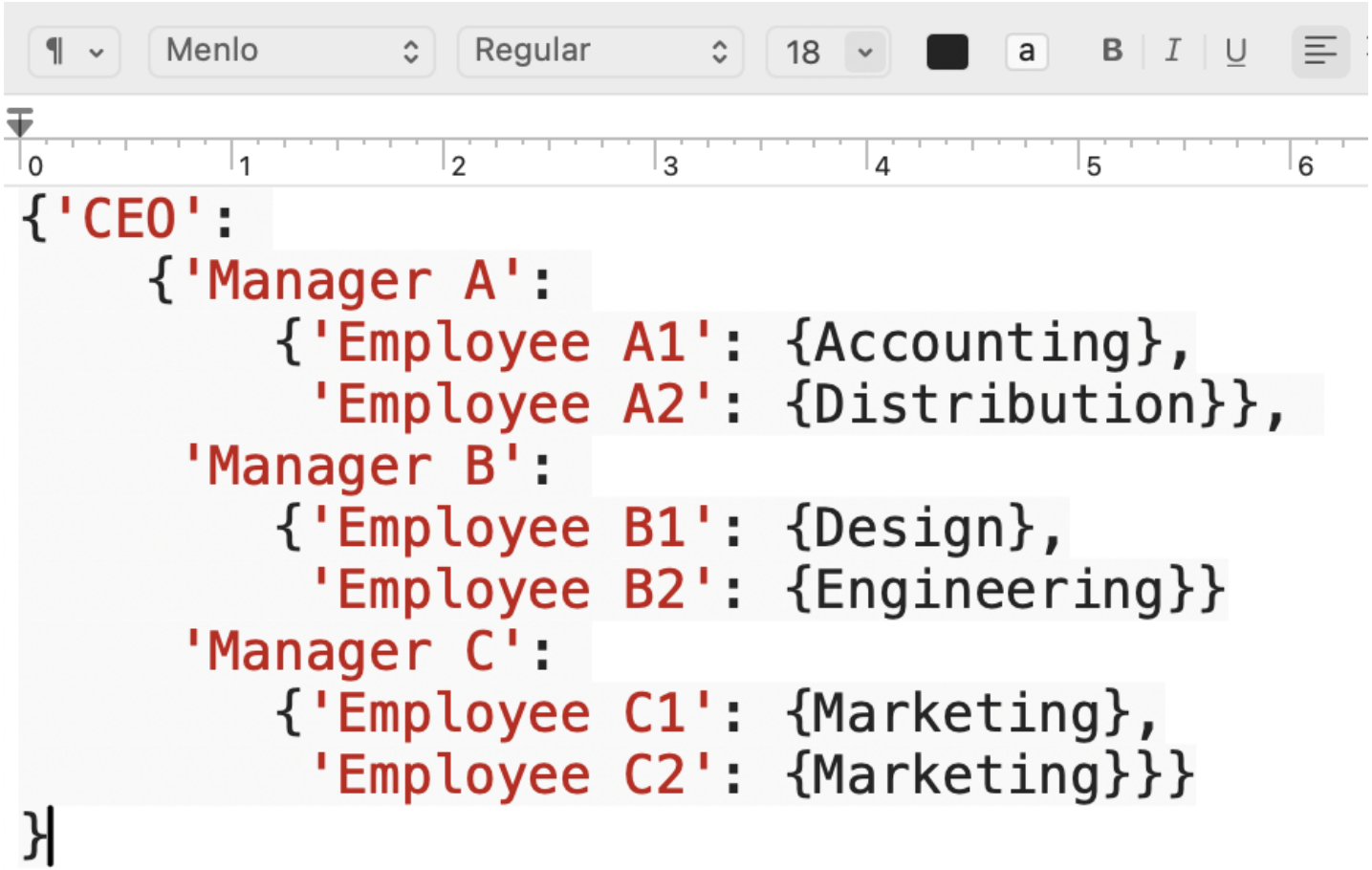
Structured Data: JSON



JavaScript Object Notation (JSON) is:

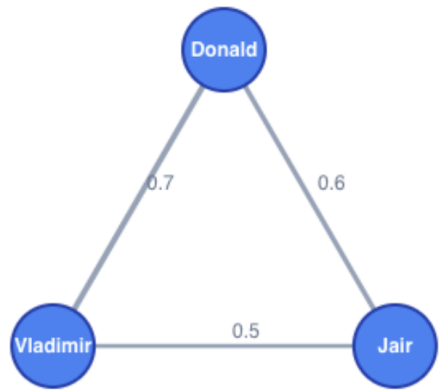
- Lightweight (little extra formatting)
- Text-based
- Human-readable
- Language-independent
- Simple / fast
- Widely used for web/cloud-based applications

Hierarchical Data: JSON



Network Data: JSON

```json
{
  "nodes": [
    {
      "id": "1",
      "label": "Donald"
    },
    {
      "id": "2",
      "label": "Vladimir"
    },
    {
      "id": "3",
      "label": "Jair"
    }
  ],
  "edges": [
    {
      "source": "1",
      "target": "2",
      "value": 0.7
    },
    {
      "source": "2",
      "target": "3",
      "value": 0.5
    },
    {
      "source": "1",
      "target": "3",
      "value": 0.6
    }
  ]
}
```



Databases

Databases are collections of structured data:

- Managed / analyzed using a "database management system (DBMS)
- Original "navigational;" later primarily "relational" (SQL)
- More recently: "NewSQL" (relational 2.0)

Relational Databases

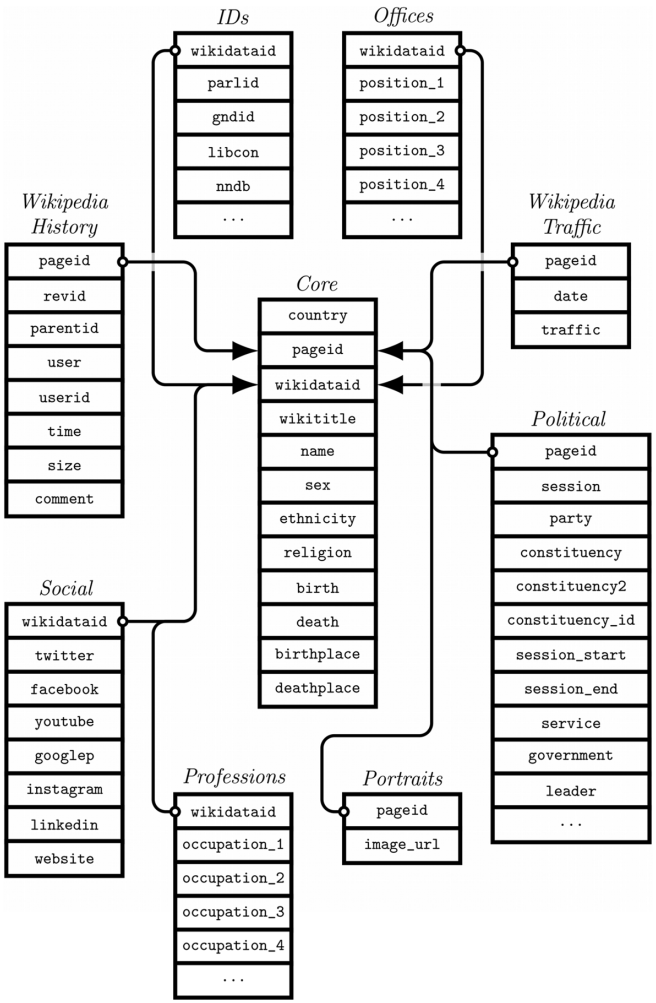
The primary form of structured database in use in AI is the *relational database*:

- Typically *rectangular tables* ("flat files") with identifying *keys* in each row
- Each table has a unique unit / item type that it stores
- Tables are connected by *relationships*
- Changes to one table leave others intact
- Interface: Structured Query Language (SQL)

Example: Comparative Legislators Database

- Over 67,000 contemporary and historical legislators
- 16 countries
- (As far back as) 1789 - 2022
- Includes sociodemographic, political, historical, occupational, and social network data, plus Wikipedia traffic
- Also: `LegislatoR` R package
- Website: `https://complegdatabase.com/`

Comparative Legislators Database



- Each legislature = 9 tables
- Each table is a "flat file" (think: Excel sheet)
- Each legislator's characteristics are connected to data on their country, occupations, web presence, Wikipedia page(s), etc.

Unstructured Data

Data that do not fit the above-referenced structure(s).

Most data is unstructured...

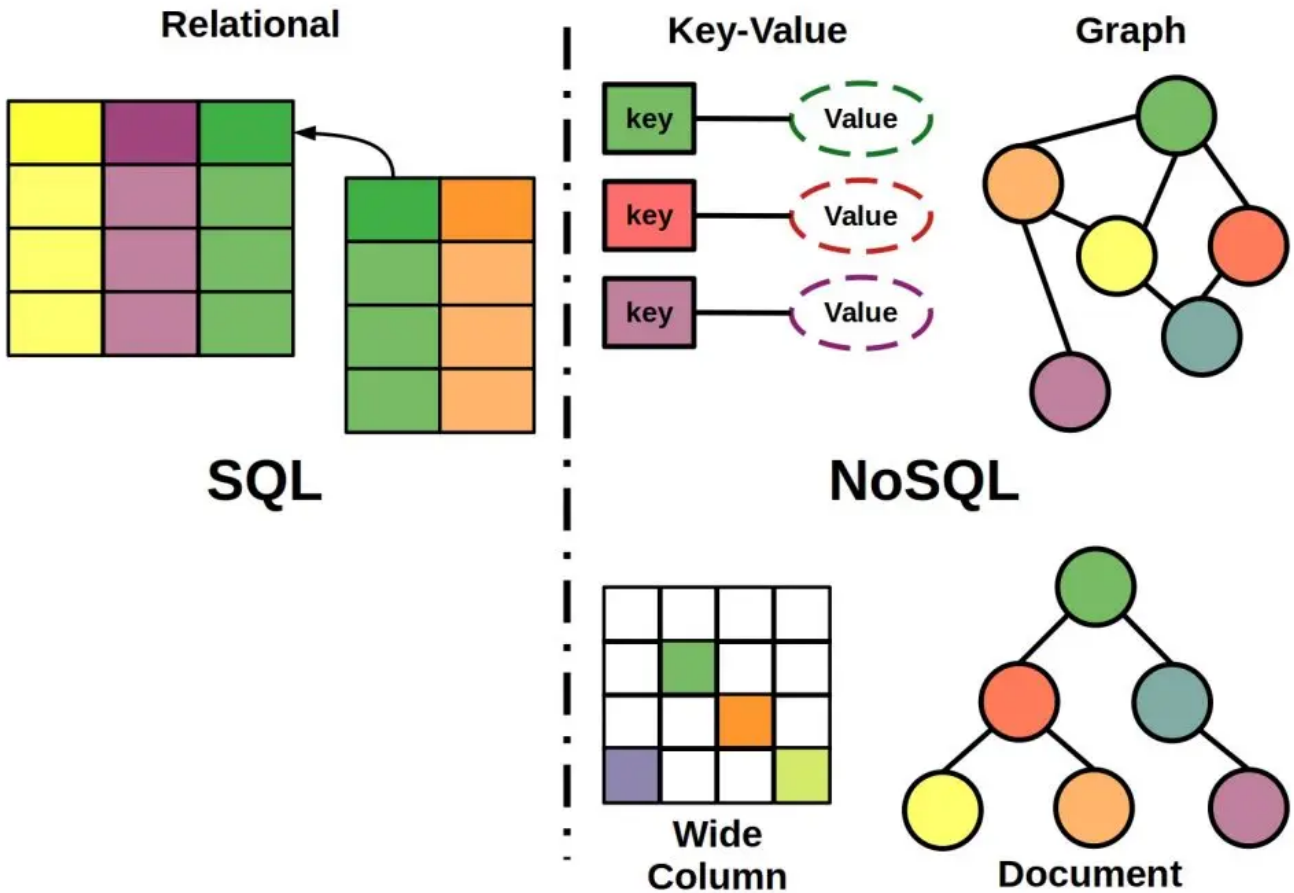
- Much text (social media, documents, etc.)
- Images, audio, video files
- Web content (blends of the above)

Semi-Structured Data

Semi-structured data...

- ...doesn't have a structured schema, but
- ...contains tags/markers that enforce types and hierarchies across objects.
- Data and schema are *integrated* ("self-describing")
- Formats: XML, JSON, YAML, etc.
- Interface: NoSQL

SQL vs. NoSQL



(Source)

Semi- vs. Structured Data

Characteristic	Structured/SQL	Semi-Structured/NoSQL
Data Model	Relational	Varies*
Schema	Predefined	Dynamic / Schema-on-read
Scales	Vertically	Horizontally
ACID**	Yes	No

* Relational, network, etc.

** Atomicity, Consistency, Isolation, Durability

Digression: ACID

ACID means:

1. **Atomicity**: All transactions must succeed or fail completely and cannot be left partially complete, even in the case of system failure.
2. **Consistency**: The database must follow rules that validate and prevent corruption at every step.
3. **Isolation**: Concurrent transactions cannot affect each other.
4. **Durability**: Transactions are final, and even system failure cannot "roll back" a complete transaction.

Schöch (2013): Data in the Humanities

Key points:

- "Big data" (volume, velocity, variety) vs. "smart data"
  - Which does he seem to prefer, and why?
  - Is it an accurate / fair description?
- Challenge: Make big data smarter, or smart data bigger... how?
- Compare to physical / natural sciences?
- Social / behavioral sciences?