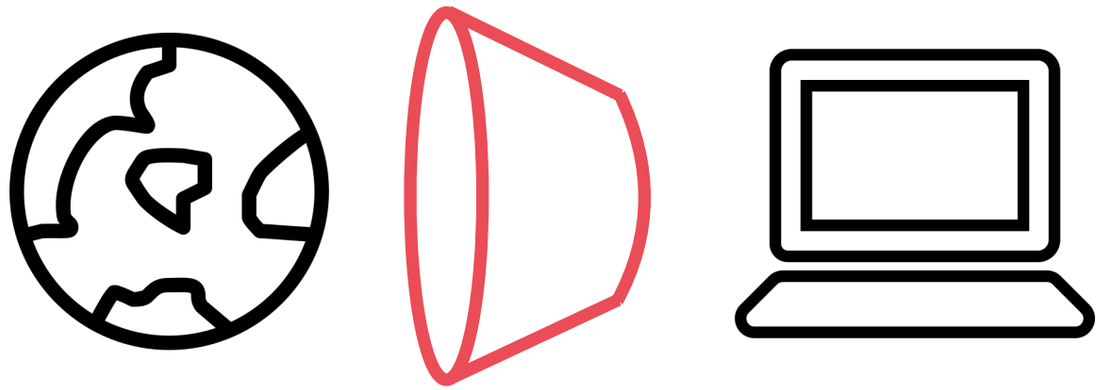
Making Data Make Sense

RACHAEL MILLER

ATOMIC OBJECT

I want to tell you why I care about this.

We added a whole new dimension of understanding.



DATA

- All of our observations, quantified
- Usually comes in numbers
- High-dimensional
- Noisy

DATA — EXAMPLE

ELEVATION	LATITUDE	LONGITUDE	DATE	reportType	HourlySkyCo	HourlyVisibi	HourlyPresen	HourlyDryBu	HourlyDryBu	HourlyWetBu	HourlyWetBu	HourlyDewPo	HourlyDewPo	HourlyRelati	HourlyWindS	HourlyWindD	HourlyWindG	HourlyStatio	HourlyPressu	HourlyPressu	HourlySeaLe	H
201.8	41.995	-87.9336	3/1/14 0:51	FM-15	SCT:04 70 O	10		30	-1.1	26	-3.4	16	-8.9	56	9	330		29.28			30.02	
201.8	41.995	-87.9336	3/1/14 1:51	FM-15	OVC:08 50	10		30	-1.1	26	-3.3	17	-8.3	58	0	0		29.27			30.02	
201.8	41.995	-87.9336	3/1/14 2:51	FM-15	OVC:08 29	6	-SN:03	SN:7	29	-1.7	26	-3.2	21	-6.1	72	8	330		29.28	1	-0.03	30.02	0.
201.8	41.995	-87.9336	3/1/14 3:51	FM-15	VV:09 9	0.75	-SN:03	SN:7	28	-2.2	26	-3.3	23	-5	81	0	0		29.29			30.04	
201.8	41.995	-87.9336	3/1/14 4:51	FM-15	OVC:08 8	10			26	-3.3	24	-4.5	20	-6.7	78	11	350		29.32			30.06	
201.8	41.995	-87.9336	3/1/14 5:51	FM-15	BKN:07 10 C	10			25	-3.9	22	-5.3	17	-8.3	72	11	360		29.35	3	-0.07	30.09	
201.8	41.995	-87.9336	3/1/14 6:51	FM-15	BKN:07 12 C	5	HZ:7	FU:05	23	-5	21	-6.4	15	-9.4	72	7	360		29.37			30.12	
201.8	41.995	-87.9336	3/1/14 7:51	FM-15	BKN:07 14 C	10			21	-6.1	18	-7.5	12	-11.1	68	11	360		29.42			30.17	
201.8	41.995	-87.9336	3/1/14 8:51	FM-15	OVC:08 27	9			21	-6.1	18	-7.6	11	-11.7	65	9	360		29.45	2	-0.09	30.19	
201.8	41.995	-87.9336	3/1/14 9:51	FM-15	SCT:04 27 O	10			21	-6.1	18	-7.7	10	-12.2	62	9	360		29.46			30.21	
201.8	41.995	-87.9336	3/1/14 10:51	FM-15	BKN:07 35 C	10			21	-6.1	18	-7.8	9	-12.8	59	11	340		29.49			30.24	
201.8	41.995	-87.9336	3/1/14 11:51	FM-15	SCT:04 45 B	10			21	-6.1	18	-8	7	-13.9	54	9	360		29.49	1	-0.04	30.24	T
201.8	41.995	-87.9336	3/1/14 12:51	FM-15	BKN:07 45 I	10			22	-5.6	18	-7.6	6	-14.4	50	10	340		29.5			30.25	T
201.8	41.995	-87.9336	3/1/14 13:51	FM-15	BKN:07 55 I	10			22	-5.6	19	-7.5	8	-13.3	55	8	10		29.47			30.22	
201.8	41.995	-87.9336	3/1/14 14:51	FM-15	FEW:02 25 I	10	-SN:03	SN:7	20	-6.7	17	-8.2	10	-12.2	65	13	350		29.51	3	-0.01	30.26	T
201.8	41.995	-87.9336	3/1/14 15:51	FM-15	BKN:07 18 C	6	-SN:03	SN:7	18	-7.8	16	-9.1	9	-12.8	68	14	360		29.5			30.25	T
201.8	41.995	-87.9336	3/1/14 16:51	FM-15	SCT:04 12 B	5	-SN:03	SN:7	16	-8.9	14	-9.9	9	-12.8	74	9	360		29.53			30.29	
201.8	41.995	-87.9336	3/1/14 17:51	FM-15	VV:09 10	0.5	SN:03	SN:72	15	-9.4	13	-10.5	8	-13.3	74	9	10		29.54	0	-0.01	30.3	
201.8	41.995	-87.9336	3/1/14 18:51	FM-15	VV:09 11	1	-SN:03	SN:7	14	-10	12	-10.9	8	-13.3	77	9	350		29.56			30.32	
201.8	41.995	-87.9336	3/1/14 19:51	FM-15	OVC:08 17	1.5	-SN:03	SN:7	13	-10.6	11	-11.5	6	-14.4	74	9	360		29.56			30.32	
201.8	41.995	-87.9336	3/1/14 20:51	FM-15	OVC:08 25	2	-SN:03	SN:7	12	-11.1	11	-11.9	6	-14.4	77	11	350		29.59	3	-0.04	30.35	
201.8	41.995	-87.9336	3/1/14 21:51	FM-15	VV:09 15	0.75	-SN:03	SN:7	11	-11.7	10	-12.5	5	-15	77	13	350		29.59			30.35	
201.8	41.995	-87.9336	3/1/14 22:51	FM-15	BKN:07 20 C	2	-SN:03	SN:7	11	-11.7	9	-12.6	4	-15.6	73	10	350		29.57			30.34	
201.8	41.995	-87.9336	3/1/14 23:51	FM-15	OVC:08 34	2.5	-SN:03	SN:7	11	-11.7	9	-12.7	3	-16.1	70	11	360		29.57	8	0.01	30.33	0.
201.8	41.995	-87.9336	3/1/14 23:59	SOD																			
201.8	41.995	-87.9336	3/2/14 0:51	FM-15	OVC:08 15	1.5	-SN:03	SN:7	10	-12.2	8	-13.1	3	-16.1	73	10	340		29.62			30.38	
201.8	41.995	-87.9336	3/2/14 1:51	FM-15	FEW:02 18 5	4	-SN:03	SN:7	10	-12.2	8	-13.2	2	-16.7	69	9	10		29.59			30.35	
201.8	41.995	-87.9336	3/2/14 2:51	FM-15	SCT:04 23 O	2	-SN:03	SN:7	10	-12.2	8	-13.1	3	-16.1	73	8	360		29.59	6	0.03	30.35	
201.8	41.995	-87.9336	3/2/14 3:51	FM-15	OVC:08 45	4	-SN:03	SN:7	9	-12.8	7	-13.7	1	-17.2	70	14	350		29.59			30.36	
201.8	41.995	-87.9336	3/2/14 4:51	FM-15	FEW:02 25 C	9	-SN:03	SN:7	9	-12.8	7	-14	-3	-19.4	58	10	350		29.6			30.37	T
201.8	41.995	-87.9336	3/2/14 5:51	FM-15	OVC:08 60	9			8	-13.3	6	-14.5	-4	-20	57	10	350		29.6	0	-0.01	30.37	T
201.8	41.995	-87.9336	3/2/14 6:51	FM-15	OVC:08 65	10			7	-13.9	5	-15	-5	-20.6	57	13	340		29.6			30.38	
201.8	41.995	-87.9336	3/2/14 7:51	FM-15	OVC:08 65	10			7	-13.9	5	-15	-5	-20.6	57	14	350	21	29.62			30.39	
201.8	41.995	-87.9336	3/2/14 8:51	FM-15	OVC:08 60	10			8	-13.3	6	-14.5	-4	-20	57	14	330	22	29.63	3	-0.04	30.4	
201.8	41.995	-87.9336	3/2/14 9:51	FM-15	OVC:08 60	10			9	-12.8	7	-14	-4	-20	55	10	330		29.63			30.41	
201.8	41.995	-87.9336	3/2/14 10:51	FM-15	BKN:07 60	10			10	-12.2	8	-13.5	-3	-19.4	55	13	340		29.63			30.4	
201.8	41.995	-87.9336	3/2/14 11:51	FM-15	SCT:04 60 B	10			12	-11.1	10	-12.5	-1	-18.3	56	8	350		29.63	8	0	30.4	
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201.8	41.995	-87.9336	3/2/14 13:51	FM-15	FEW:02 30 5	10			12	-11.1	9	-12.5	-2	-18.9	53	11	330		29.6			30.37	
201.8	41.995	-87.9336	3/2/14 14:51	FM-15	FEW:02 30 5	10			12	-11.1	9	-12.5	-2	-18.9	53	14	340		29.6	5	0.02	30.38	
201.8	41.995	-87.9336	3/2/14 15:51	FM-15	FEW:02 30 5	10			11	-11.7	8	-13.1	-4	-20	51	9	350		29.6			30.38	
201.8	41.995	-87.9336	3/2/14 16:51	FM-15	FEW:02 29 5	10			9	-12.8	7	-14.1	-5	-20.6	52	11	330		29.62			30.39	
201.8	41.995	-87.9336	3/2/14 17:51	FM-15	FEW:02 30 I	10			7	-13.9	5	-15.1	-8	-22.2	50	13	330		29.62	3	-0.02	30.4	
201.8	41.995	-87.9336	3/2/14 18:51	FM-15	FEW:02 30 I	10			6	-14.4	4	-15.6	-11	-23.9	45	13	340		29.64			30.42	
201.8	41.995	-87.9336	3/2/14 19:51	FM-15	BKN:07 250	10			5	-15	3	-16.1	-13	-25	42	14	340		29.65			30.43	
201.8	41.995	-87.9336	3/2/14 20:51	FM-15	BKN:07 250	10			4	-15.6	2	-16.7	-15	-26.1	40	9	330		29.65	1	-0.01	30.43	

INFORMATION

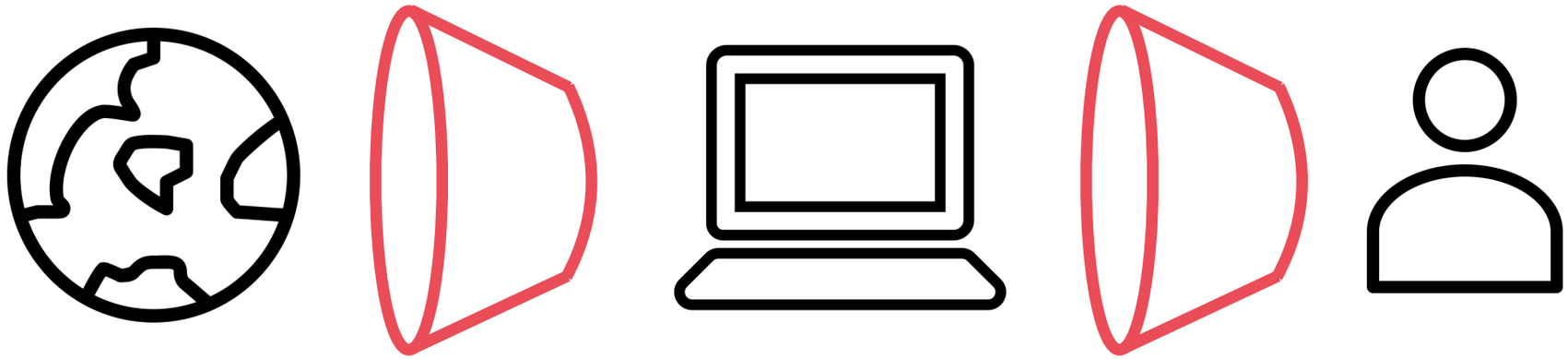
- Data, but only the accurate and interesting parts
- Comes as a collection of facts
- Extraneous detail removed

Anchorage	50°F
Phoenix	84°F
Los Angeles	72°F
San Francisco	70°F
Denver	34°F
Washington DC	86°F
Miami	77°F
Atlanta	85°F
Honolulu	84°F
Chicago	78°F
Indianapolis	83°F
New Orleans	82°F
Boston	92°F
Detroit	87°F
Minneapolis	52°F
Las Vegas	69°F
New York	87°F
Philadelphia	89°F
Dallas	90°F
Houston	84°F
Salt Lake City	51°F

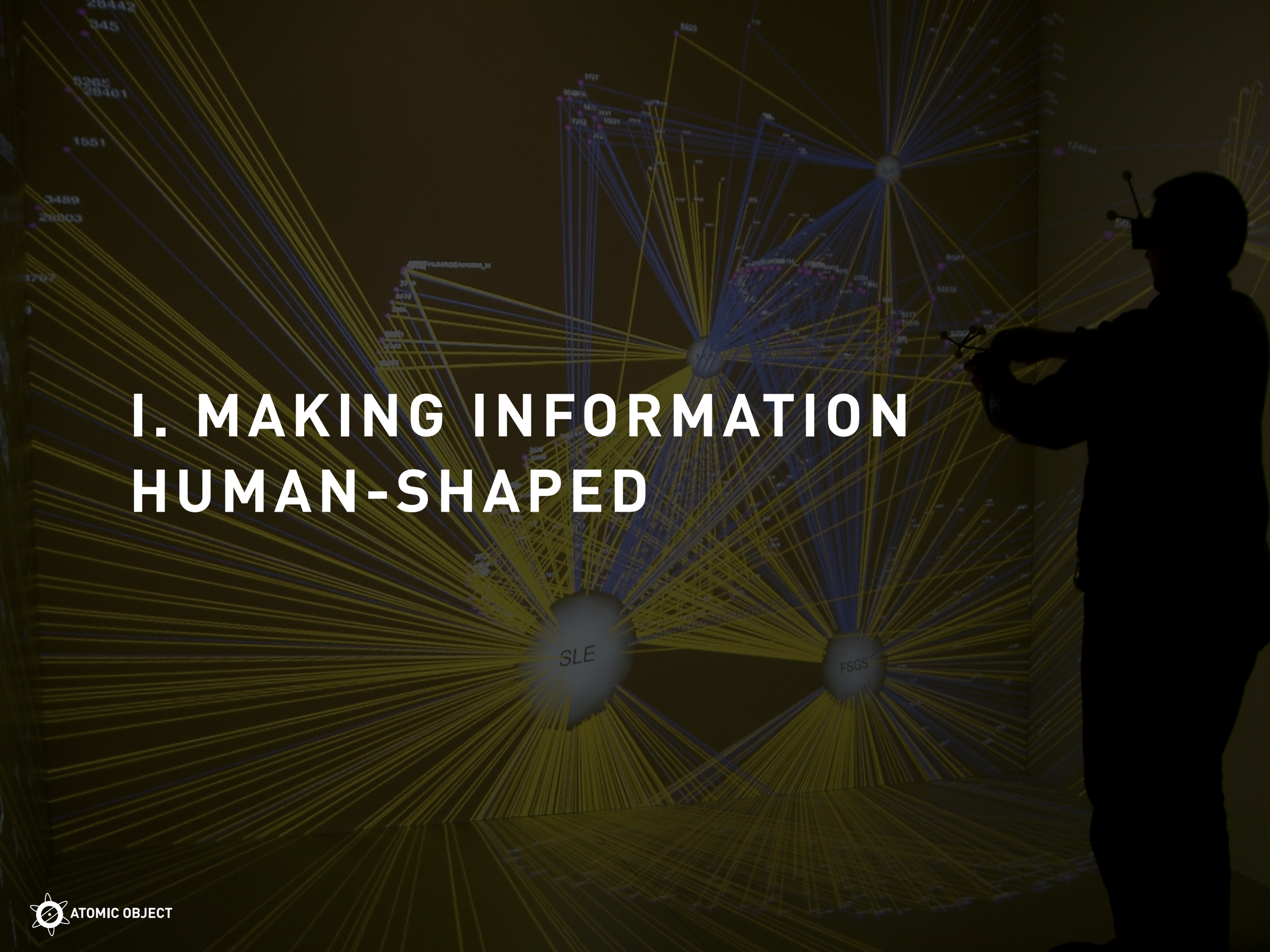
KNOWLEDGE

- Information, but only the useful parts
- Not very easy to quantify
- Comes in the form of an answer to a question

“IT’S COLD OUTSIDE.”



I. MAKING INFORMATION HUMAN-SHAPED

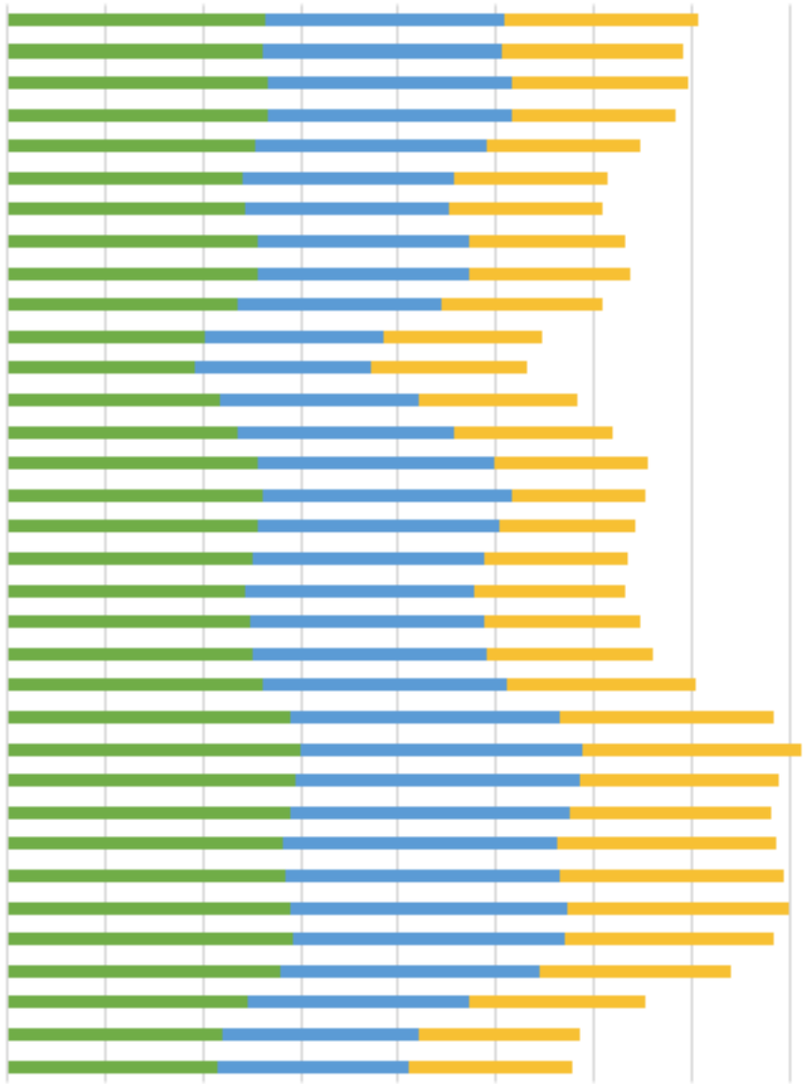


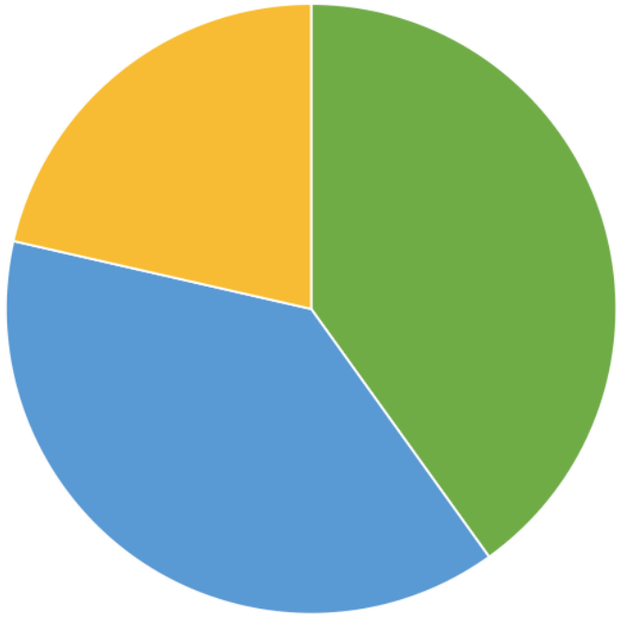
ATOMIC OBJECT

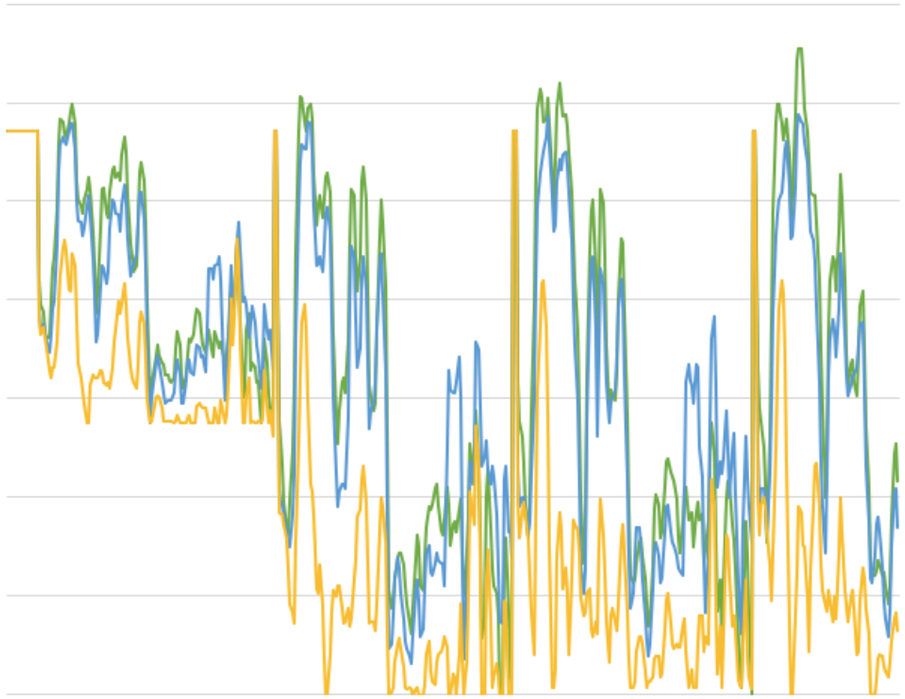
ENCODING INFORMATION

- How much
- How big
- Which one
- When
- Where
- …What?

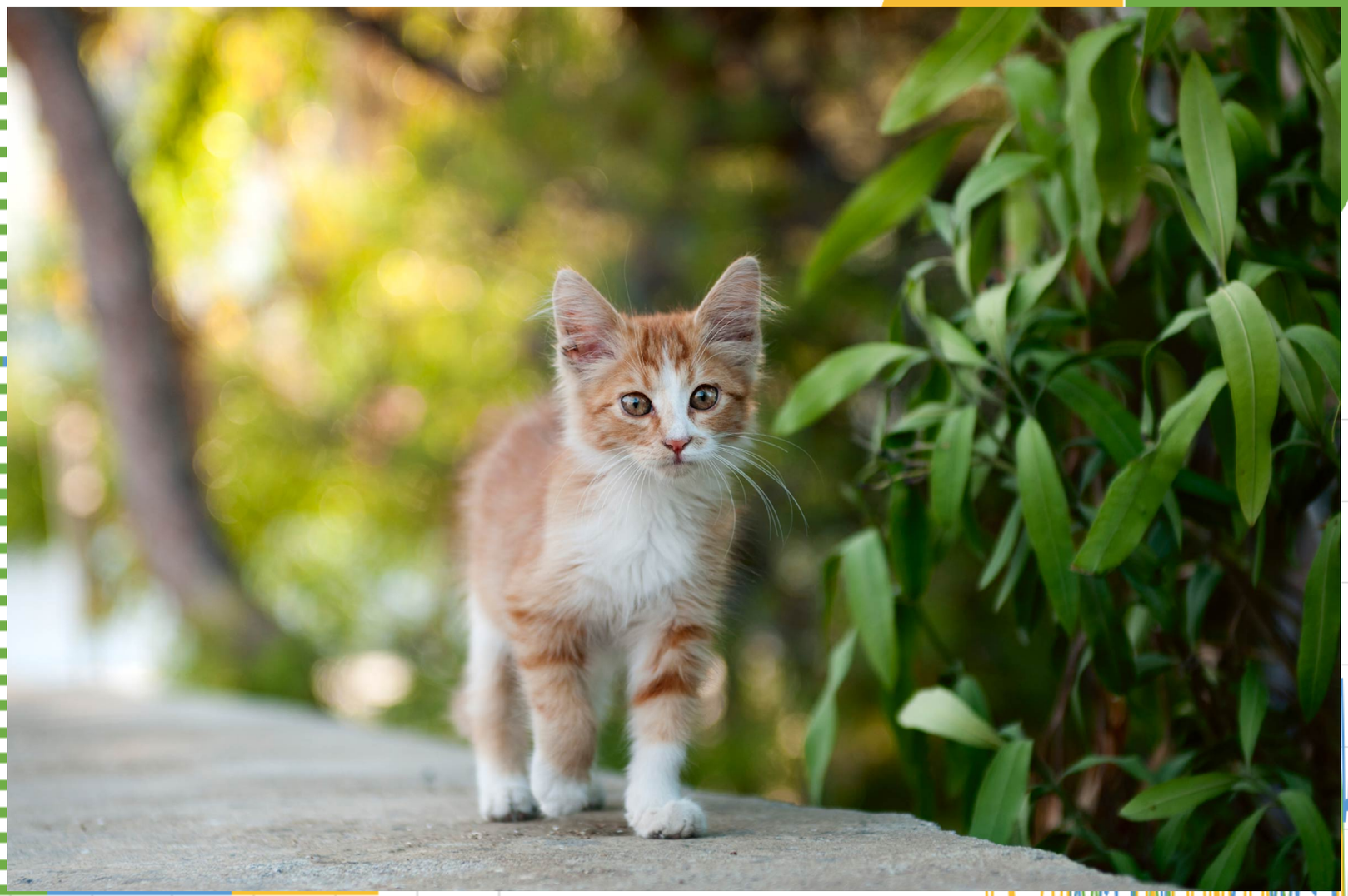
PATTERNFINDING







PATTERNFINDING

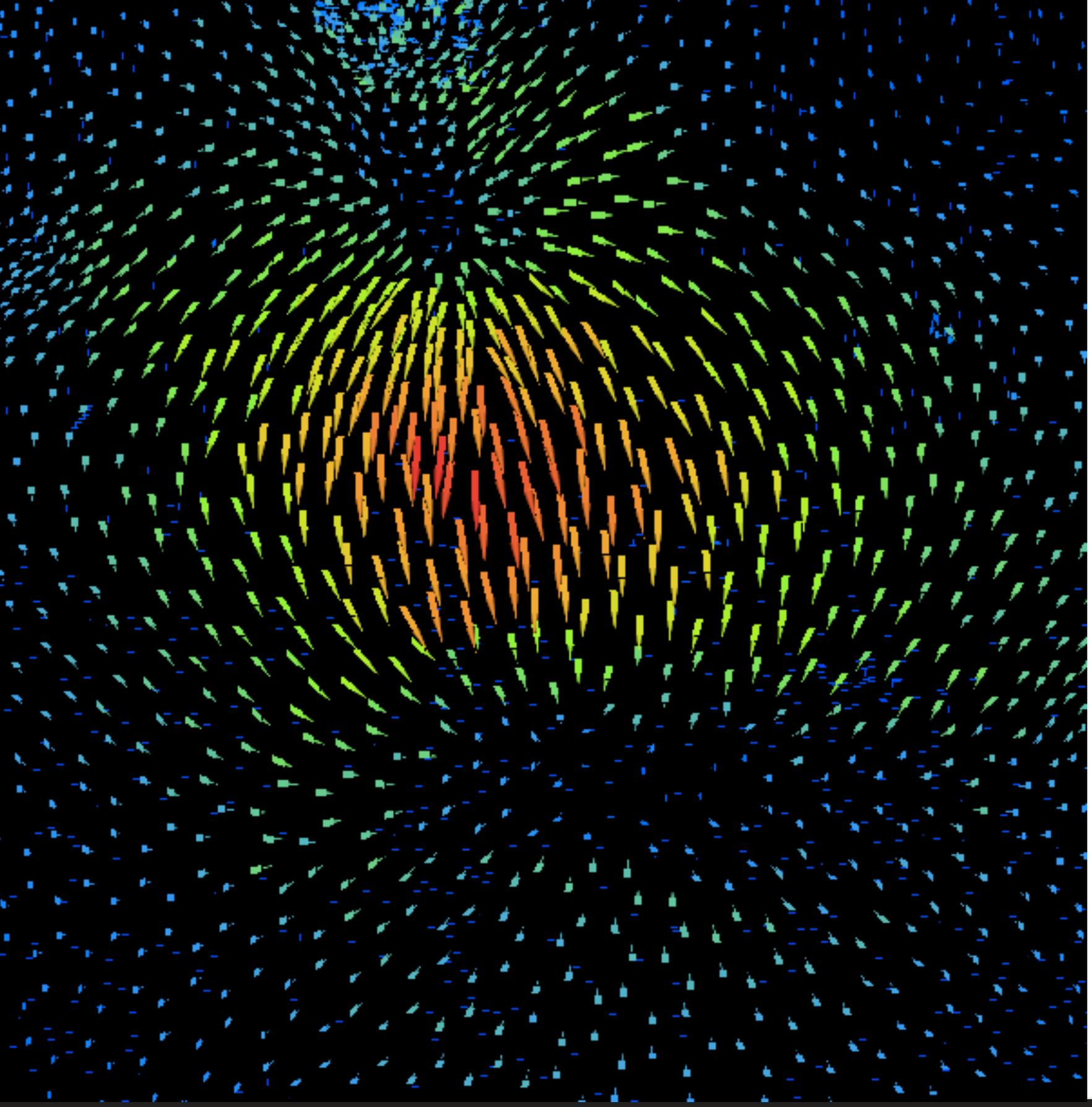


MAPPINGS

A mapping is the way the we encode information so that we can better spot patterns in it.

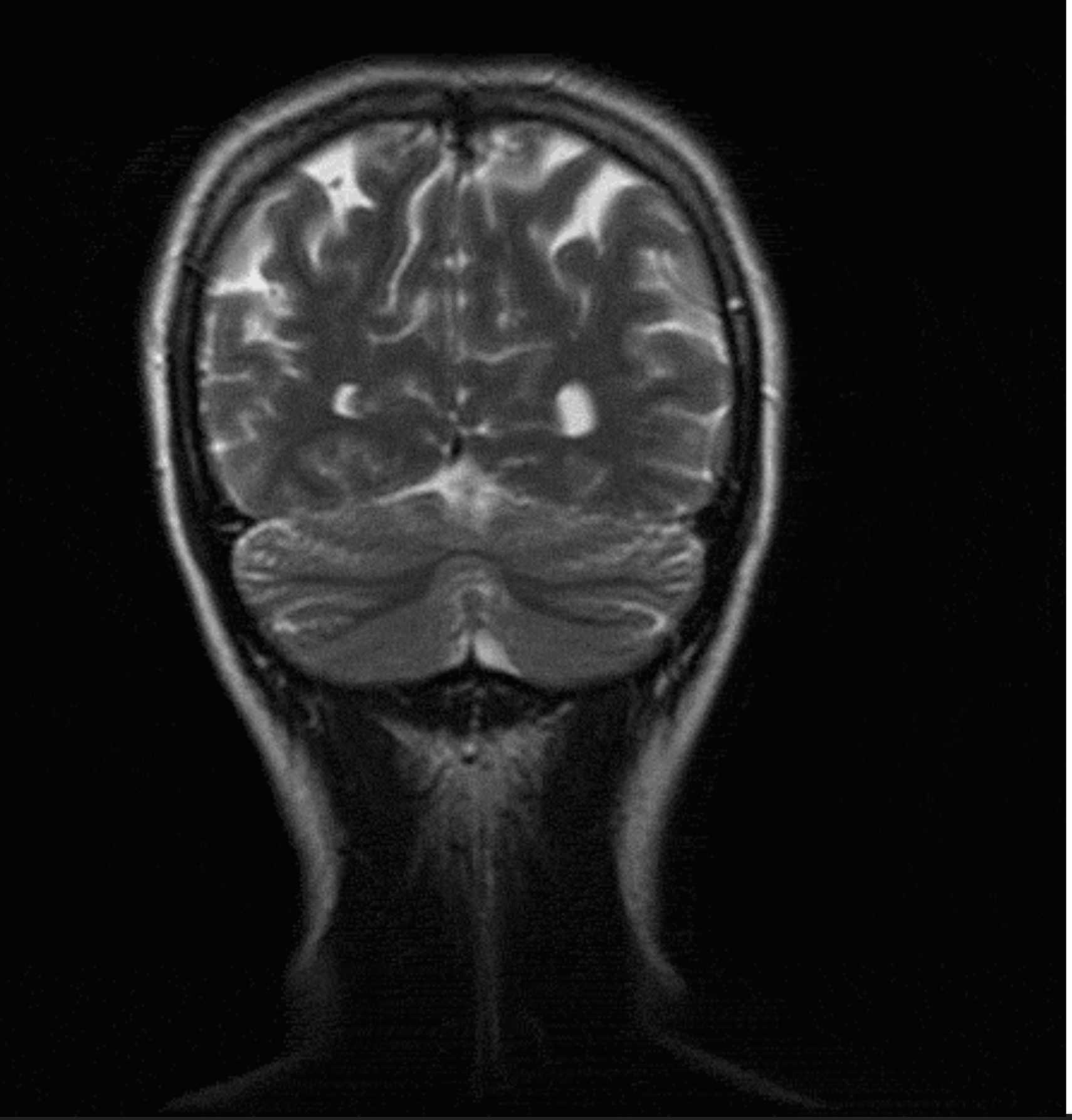
COLOR

CONTINUOUS
CHANGE
BETWEEN
EXTREMES



GLYPHS

MOVEMENT, ENUMERATED TYPES



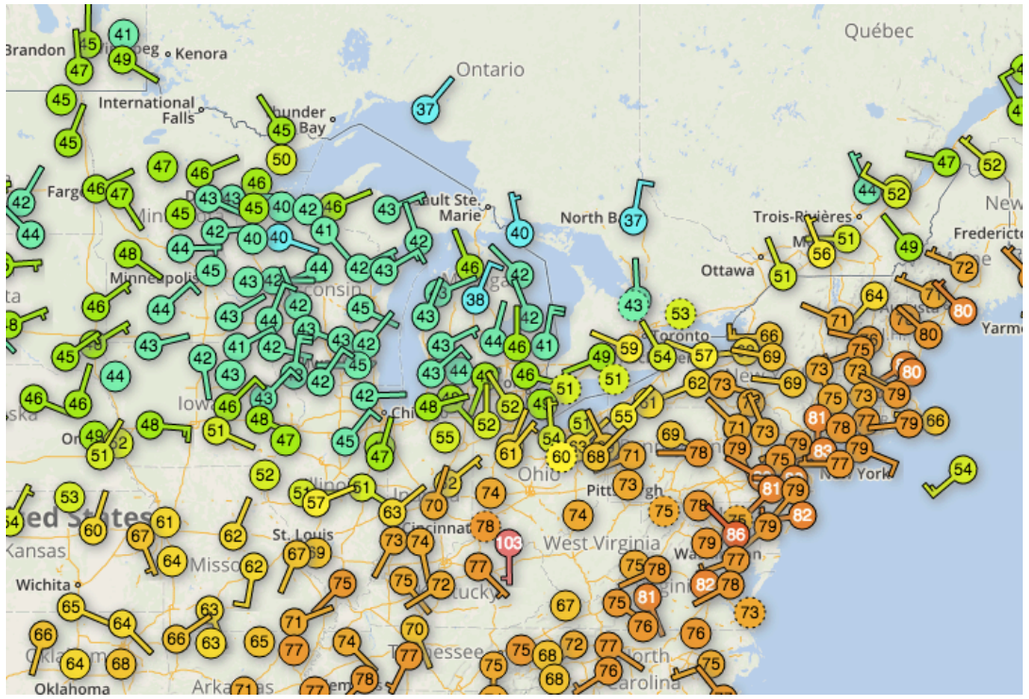
ANIMATION

TEMPORAL CHANGES, EXTRA DIMENSIONS

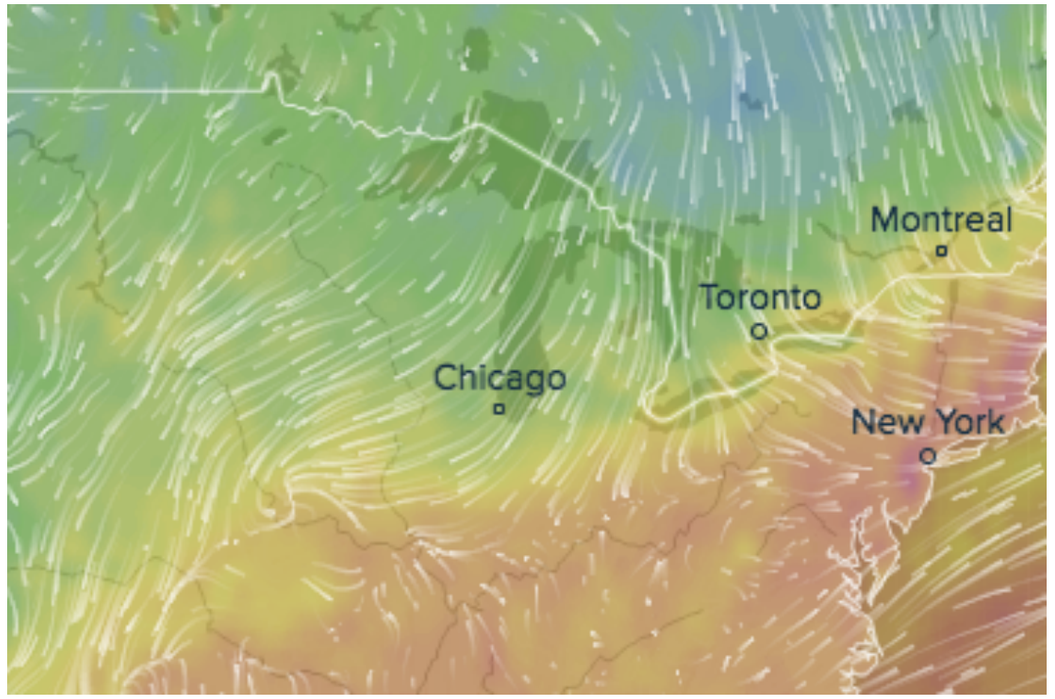
MENTAL LEAPS

How many transformations does the viewer need to make to get the information?

Shape -> Flag type -> Key -> Speed -> Intensity



Opacity -> Intensity



DIMENSIONS

There’s a whole lot more to data than just the x and the y.

II. CRAMMING INFORMATION INTO YOUR BRAIN

ATOMIC OBJECT

PATTERNFINDING [AGAIN]

INFORMATION CHANNELS

Information channels are the way that information gets from one “brain” to another.

- Images
- Video
- Presentations
- Sound
- Interactive systems

ATTRIBUTES OF A CHANNEL

- Resolution
- Bandwidth
- Distance

ATTRIBUTES OF A CHANNEL

- **Resolution**
- Bandwidth
- Distance

How much detail this channel can capture

ATTRIBUTES OF A CHANNEL

- Resolution
- **Bandwidth**
- Distance

The amount of information that can be encoded in this channel at once

ATTRIBUTES OF A CHANNEL

- Resolution
- Bandwidth
- **Distance**

How many mental leaps it takes to absorb information on this channel

III. SQUEEZING KNOWLEDGE OUT OF INFORMATION

ATOMIC OBJECT

TURNING INFORMATION INTO KNOWLEDGE

- Ask a question
- Identify the information needed
- Find & consume a piece of information
- Contextualize it with regard to your environment
- Answer the question

EXAMPLE: WEATHER

- Question: What should I wear today?
- Data source: NOAA
- Data: …

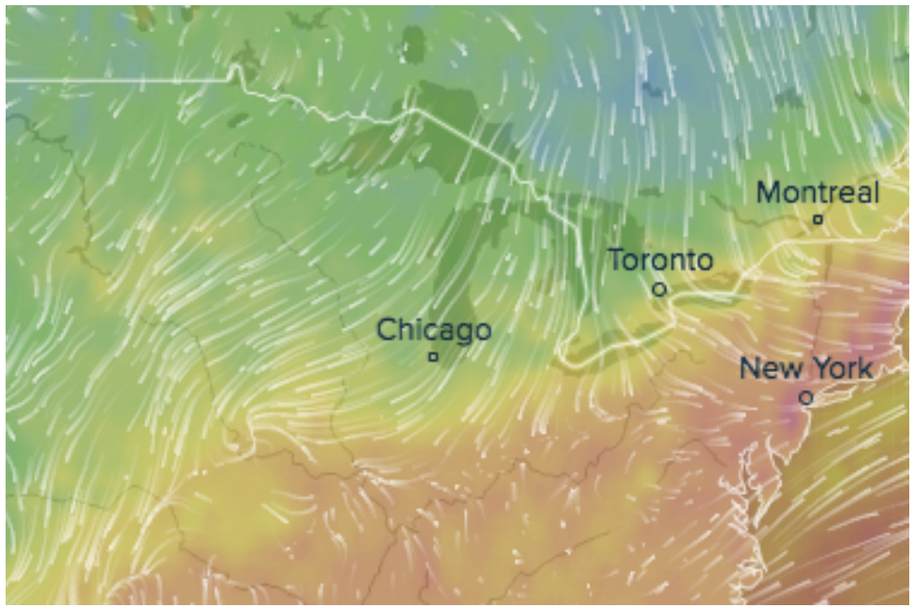
TURNING INFORMATION INTO KNOWLEDGE

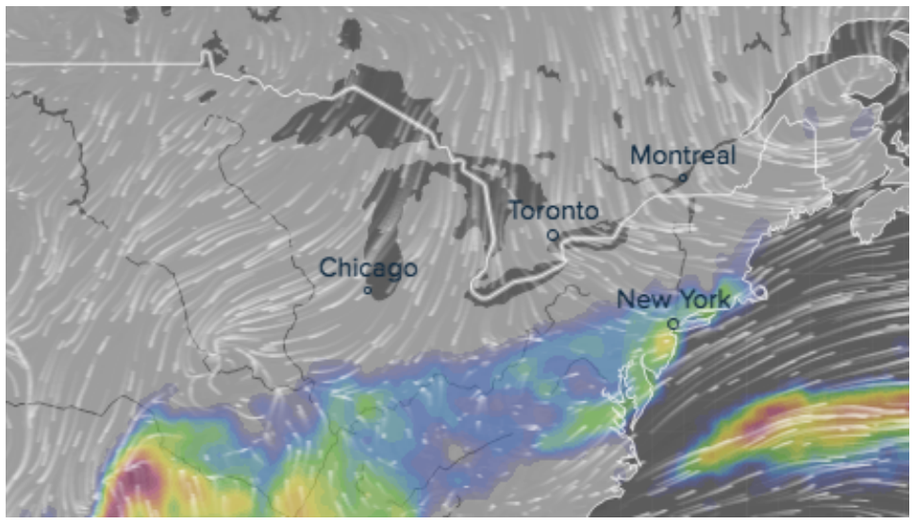
- Ask a question
- **Identify the information needed**
- Find & consume a piece of information
- Contextualize it with regard to your environment
- Answer the question

EXPLORING

"What's interesting about the weather today?"

- **Resolution** – Low
- **Bandwidth** – High
- **Distance** – Low
- Interactive, ideally low-latency
- Explorable





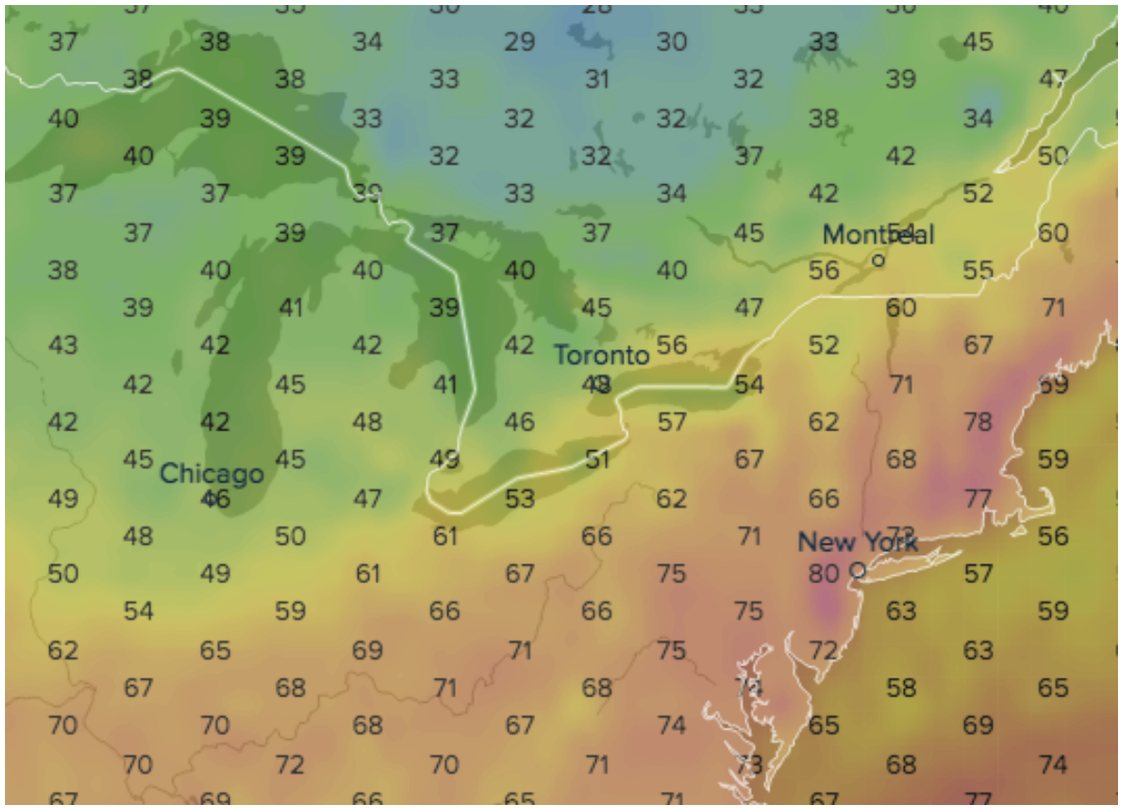
TURNING INFORMATION INTO KNOWLEDGE

- Ask a question
- Identify the information needed
- **Find & consume a piece of information**
- Contextualize it with regard to your environment
- Answer the question

INTERPRETING

"How cold is it? How windy? Will that change?"

- **Resolution** – High
- **Bandwidth** – Low
- **Distance** – Medium
- Precision and detail



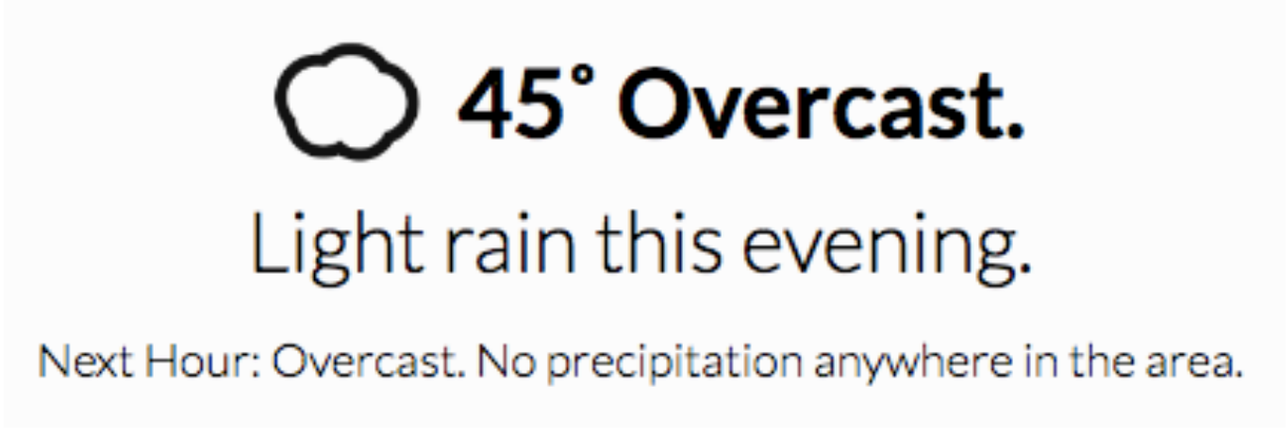
TURNING INFORMATION INTO KNOWLEDGE

- Ask a question
- Identify the information needed
- Find & consume a piece of information
- **Contextualize it with regard to your environment**
- Answer the question

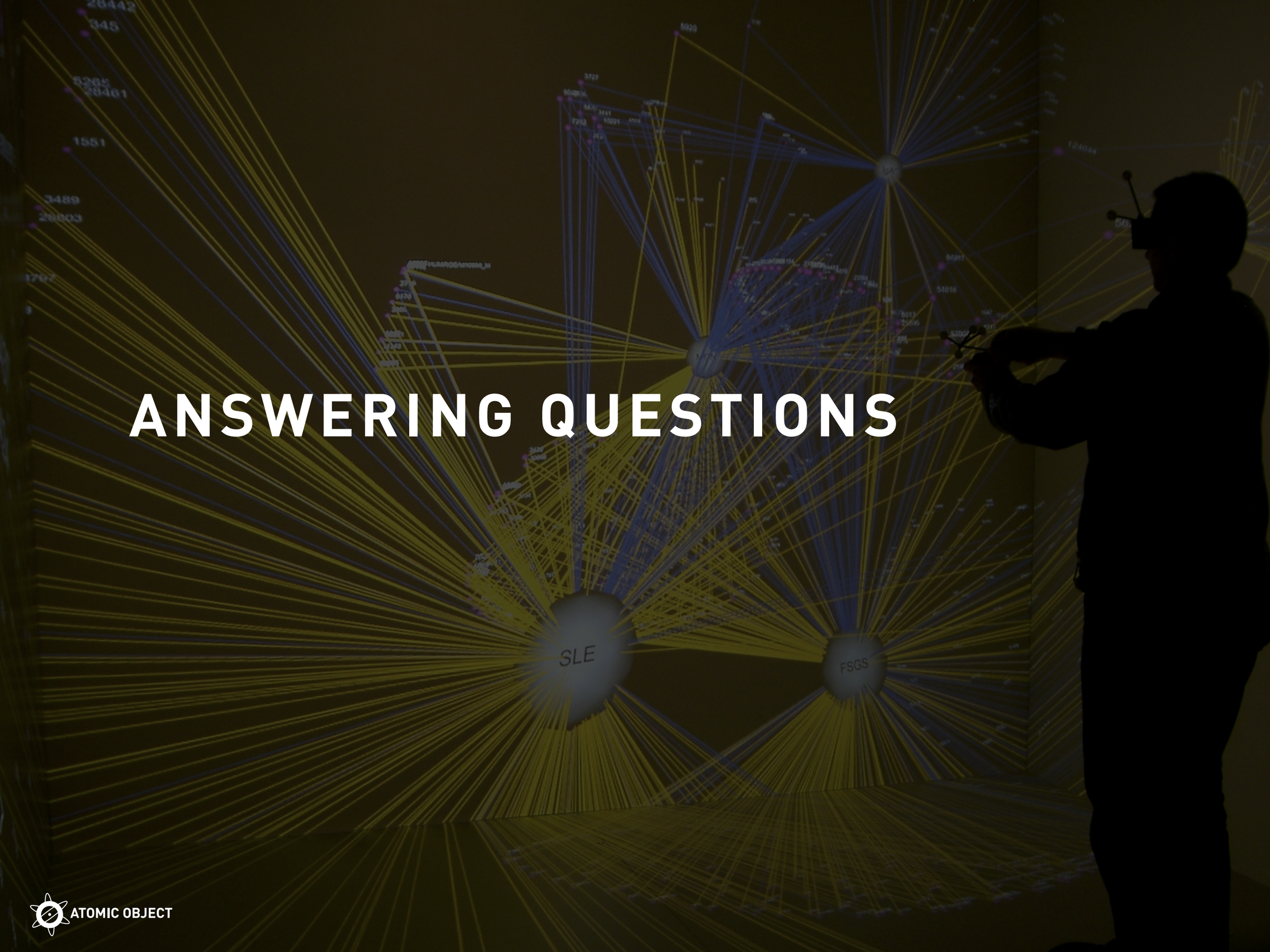
PRESENTING

"What should I wear?"

- **Resolution** – Low
- **Bandwidth** – Low
- **Distance** – Medium
- Minimal detail
- As close to knowledge as possible



ANSWERING QUESTIONS



ATOMIC OBJECT


ATOMIC OBJECT

SOURCES

http://um3d.dc.umich.edu/new-discoveries-exploring-renal-gene-clusters/

https://68.media.tumblr.com/0b8038b1469ad0148be57709f637bbce/

tumblr_nkfuy7DTfd1saxfomo1_500.gif

http://www.sci.utah.edu/~bburton/Images/Gallery/T_2yoTorsoVectorsFrontZoom.png

http://3-byte.com/blog/2013/3/29/kinect-cheap-key

Kelleher, C., Wagener, T., Ten guidelines for effective data visualization in scientific publications,

Environmental Modelling & Software (2011), doi: 10.1016/j.en- vsoft.2010.12.006

planet earth by Amiryshakiel from the Noun Project