Lecture 2

# DD 324:
# Data Visualisation

## Why ———— visualise?

14 Jan 2025 · Gyan Lakhwani · gyanlakhwani@gmail.com · Department of Design, DTU

DD 324

# Course Objective

Learn to use data as a design material to exhibit, explore, explain, experience and enable.

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# What can we do with data?

## Exhibit

Show raw data

List, Table, Infographic

## Explain

Answer Questions

Data journalism, report

## Explore

Finding what to ask

Dashboards, simulations

## Experience

Finding meaning in data

Data art piece, New media installation

## Enable

Building tools to visualise specific use cases

Software for data viz

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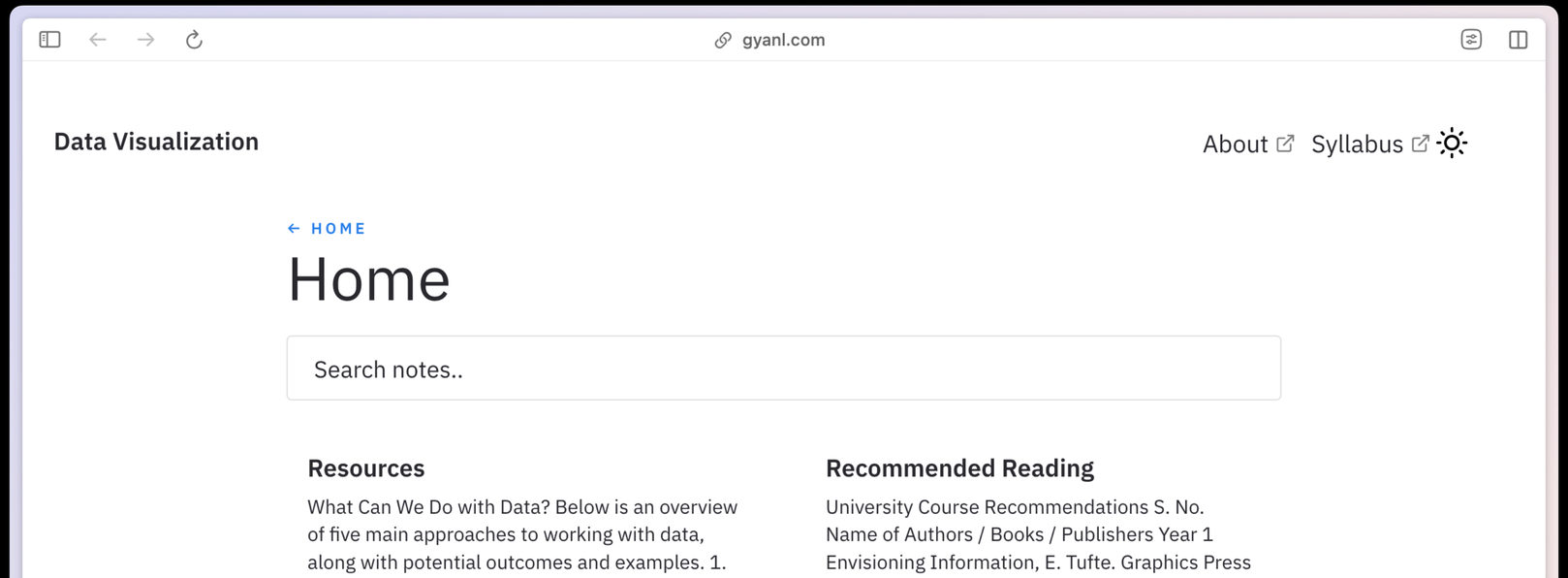
## Course Website

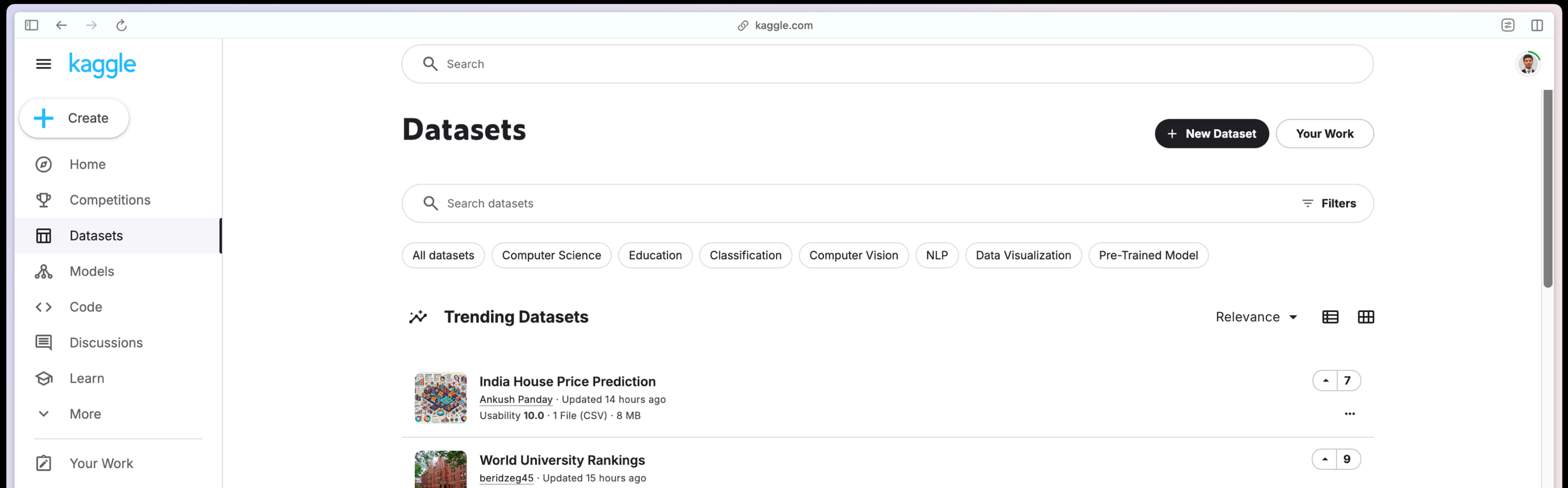
# gyanl.com/dv

(Work in progress)



While we wait...

# kaggle.com/datasets



# Data —— Information

Data —— Information

# Card PINs

3.5 million PINs that were hacked from a bank.

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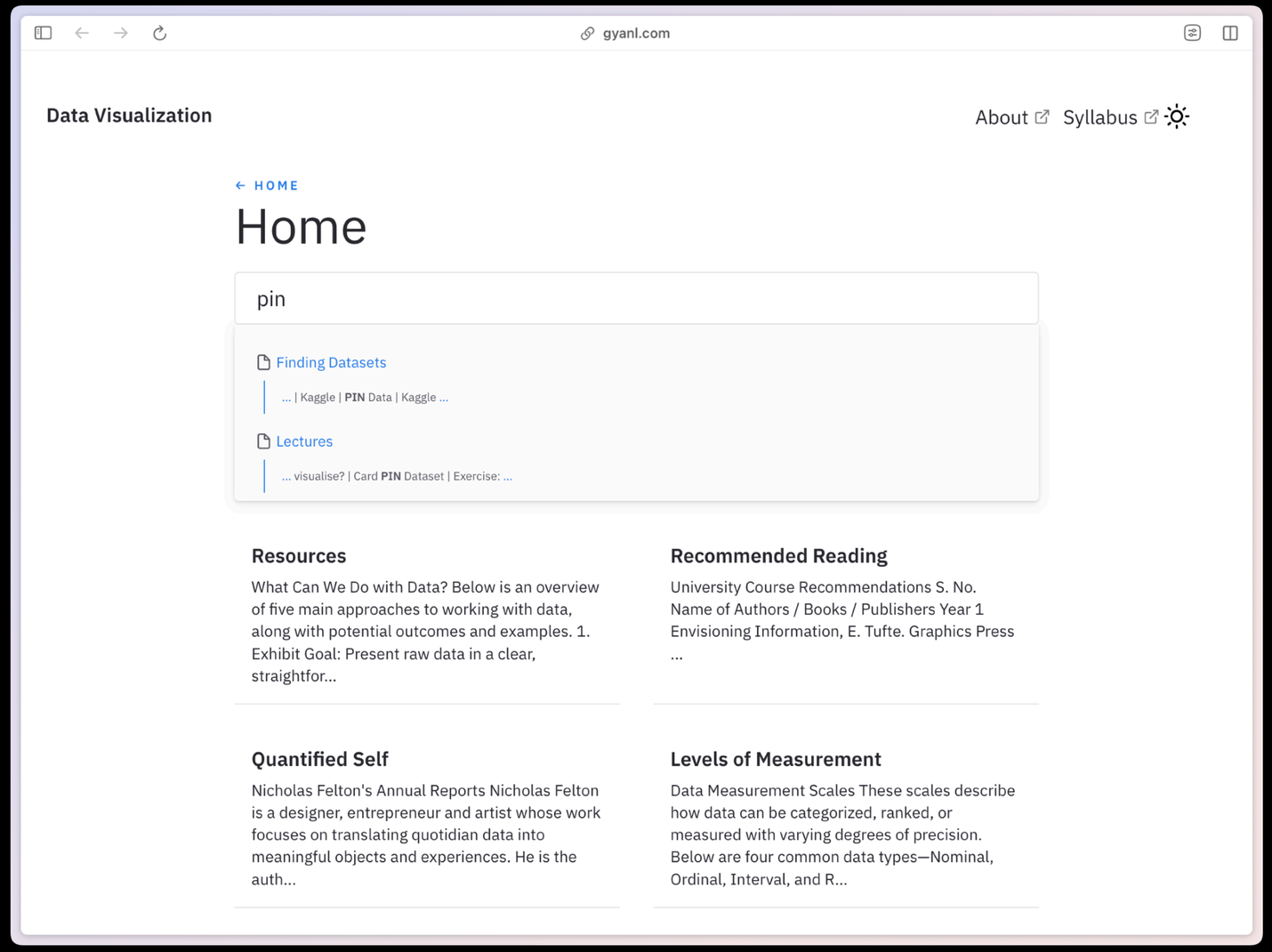

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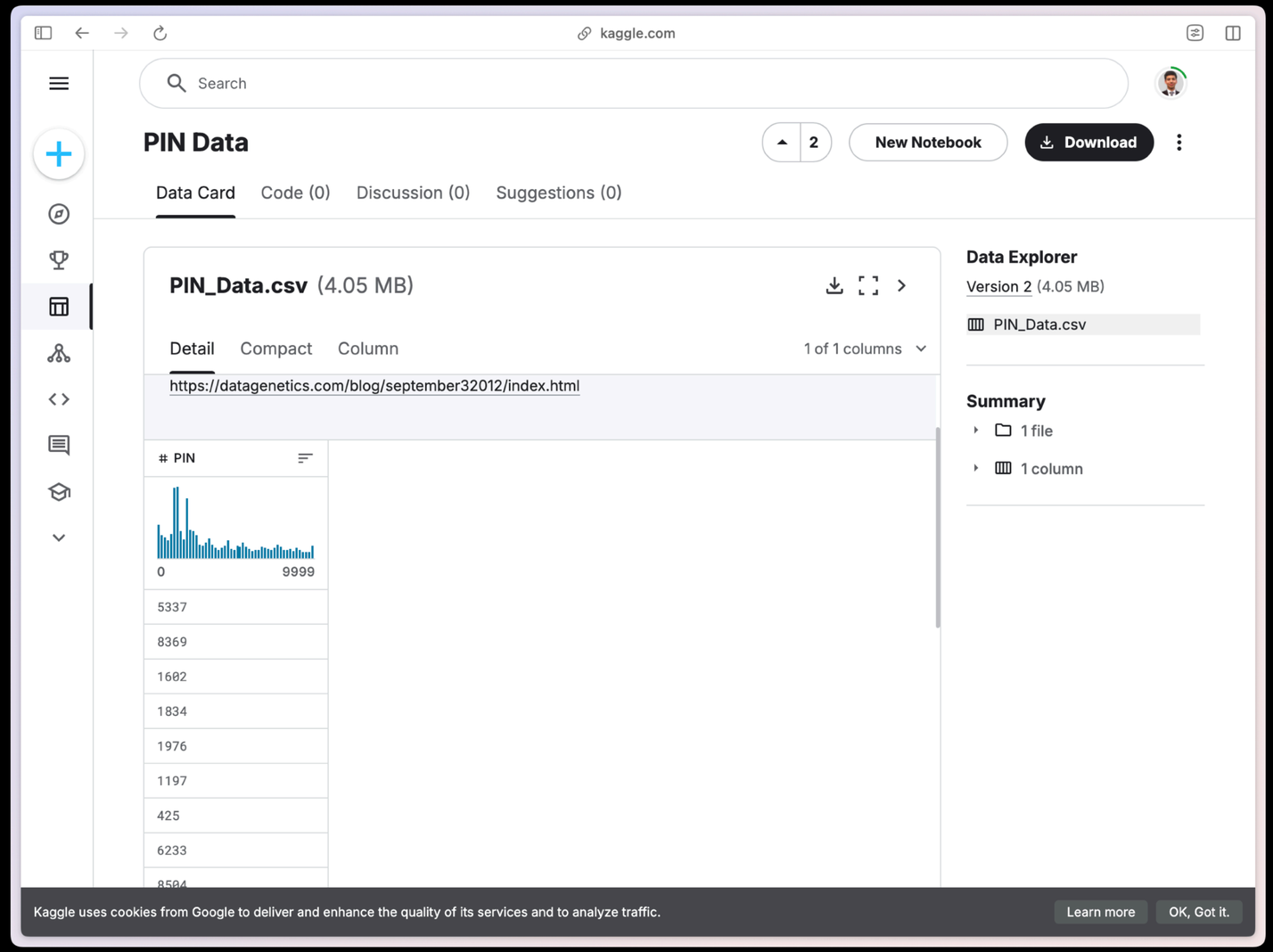

5337, 8369, 1602, 1834, 1976, 1197, 425, 6233,
8504, 9305, 1497, 1222, 2118, 8650, 4001, 6555,
1760, 8266, 1888, 9703, 1120, 6942, 622, 704,
8976, 9229, 9191, 9055, 2606, 5263, 1236, 103,
287, 5768, 2421, 7942, 7412, 829, 9232, 9790,
8440, 27, 102, 909, 208, 54, 7543, 7601,
3949, 3315, 2215, 3455, 1988, 16, 3207, 2107,
4308, 502, 3333, 9406, 4646, 7774, 3838, 2441,
8073, 6169, 4202, 2751, 1123, 1963, 563, 4242,
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# Data is not always available exactly how you want it.

Sometimes you will need to clean up your data to make it work for your needs.

# Do you notice any trends?

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1760, 8266, 1888, 9703, 1120, 6942, 0622, 0704,
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Data ——— Information

# What could we look for?

**Unique PINs**

Which all PINs are people using?

**Average (mean)**

Find the arithmetic mean of the numbers

Data —— Information

# What could we look for?

**Unique PINs**
Which all PINs are people using?

0000, 0001, 0002, 0003…

**Average (mean)**
Find the arithmetic mean of the numbers

Data —— Information

# What could we look for?

**Unique PINs**
Which all PINs are people using?

0000, 0001, 0002, 0003…

**Average (mean)**
Find the arithmetic mean of the numbers

3954

Data —— Information

# What could we look for?

**Unique PINs**
Which all PINs are people using?

**Average (mean)**
Find the arithmetic mean of the numbers

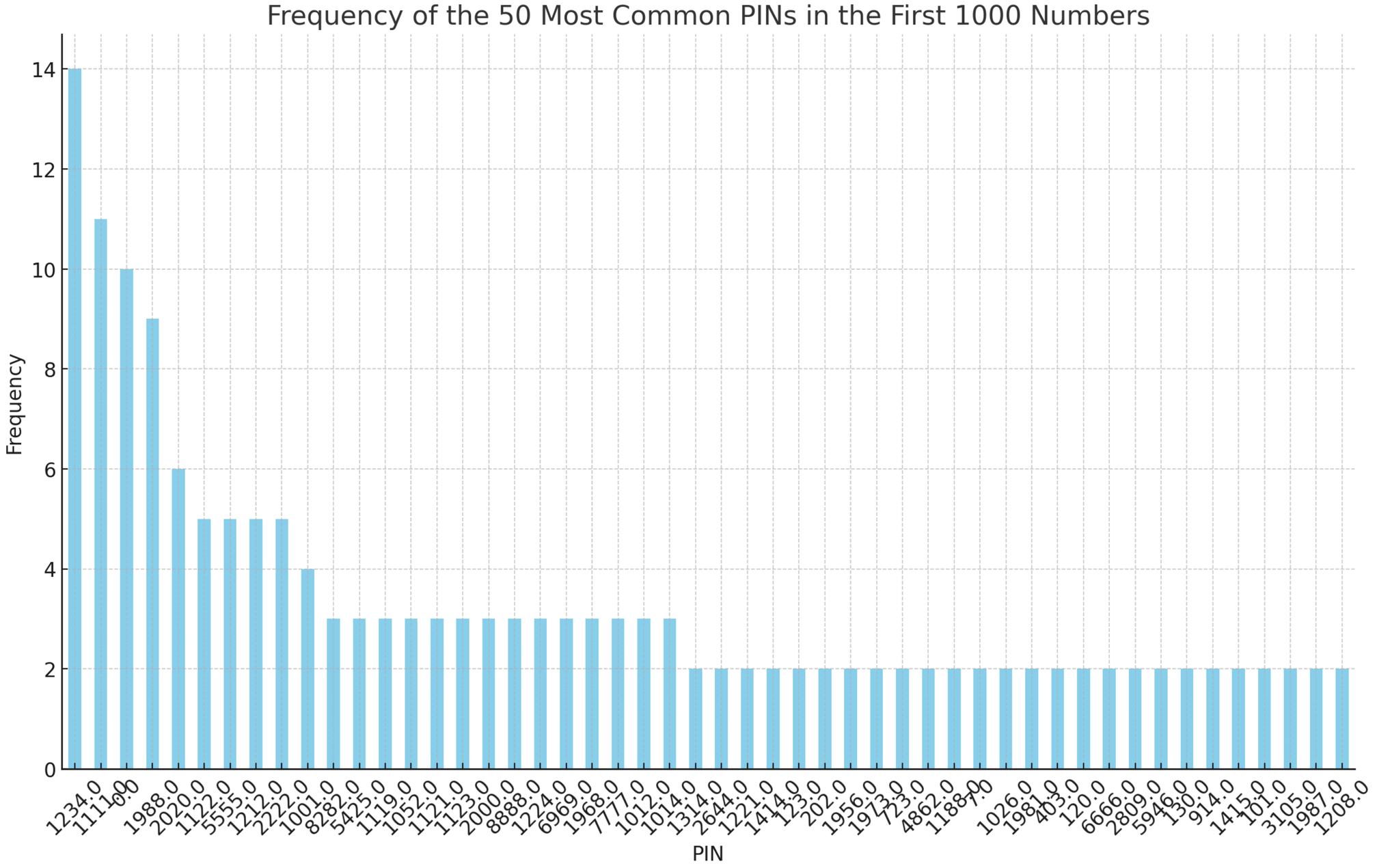
**Frequency**
Count every time each PIN shows up

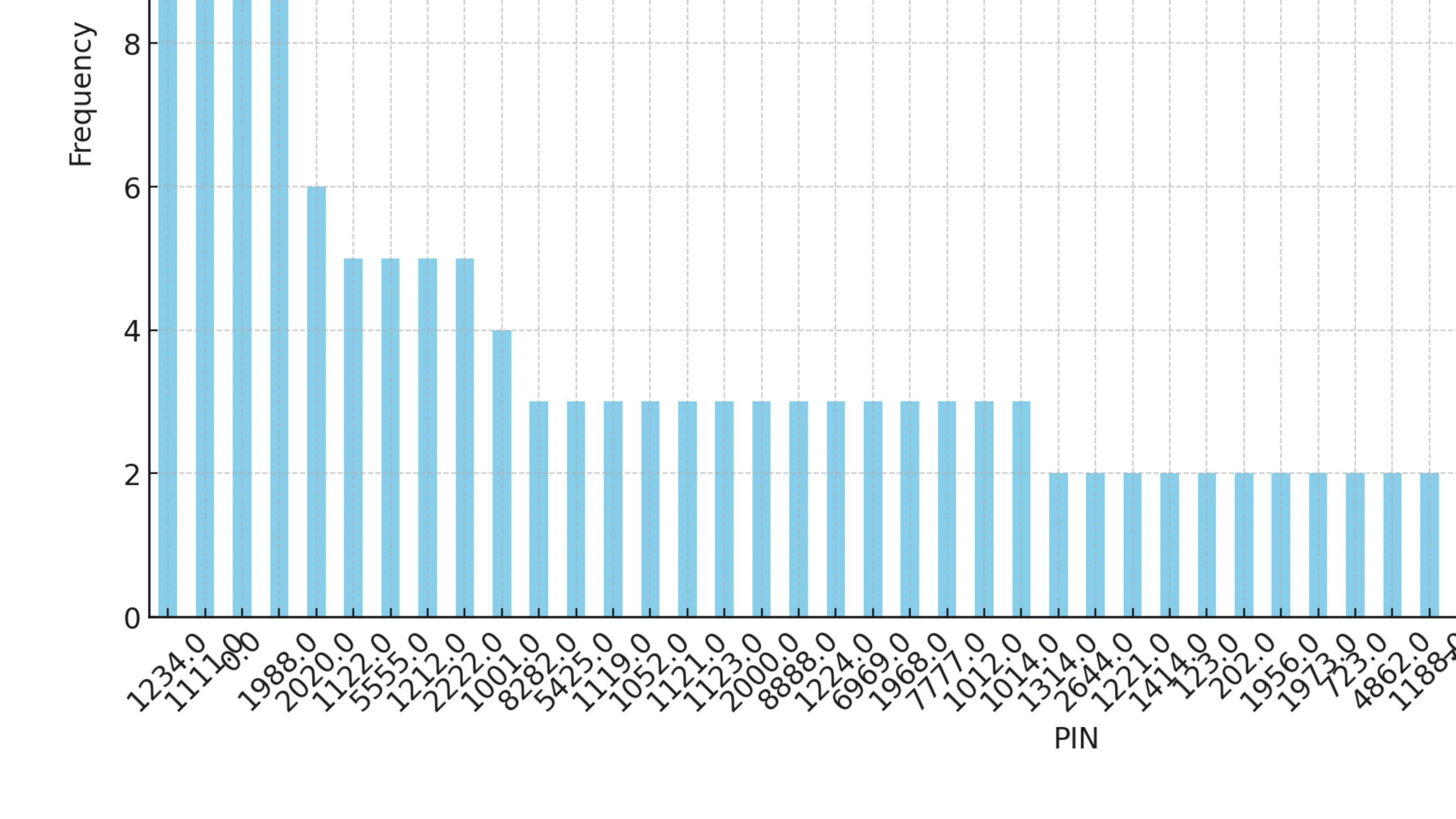
**Number frequency**
How many times 1,2,3,4... show up

**Most common first/last digit?**
Is 0xxx or 1xxx or xxx0 very common?

**Sequences**
How many people use 1234, 9876, etc?

**Repeated Digits**
How many people use 1111, 2424, etc?


Frequency of the 50 Most Common PINs in the First 1000 Numbers
Frequency
PIN
0
2
4
6
8
10
12
14
1234.0
1111.0
0.0
1988.0
2020.0
1122.0
5555.0
1212.0
2222.0
1001.0
8282.0
5425.0
1119.0
1052.0
1121.0
1123.0
2000.0
8888.0
1224.0
6969.0
1968.0
7777.0
1012.0
1014.0
1314.0
2644.0
1221.0
1414.0
123.0
202.0
1956.0
1973.0
723.0
4862.0
1188.0
7.0
1026.0
1981.0
403.0
120.0
6666.0
2809.0
5946.0
130.0
914.0
1415.0
101.0
3105.0
1987.0
1208.0


Frequency
0
2
4
6
8
1234.0
1111.0
0.0
1988.0
2020.0
1122.0
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2222.0
1001.0
8282.0
5425.0
1119.0
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8888.0
1224.0
6969.0
1968.0
7777.0
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2644.0
1221.0
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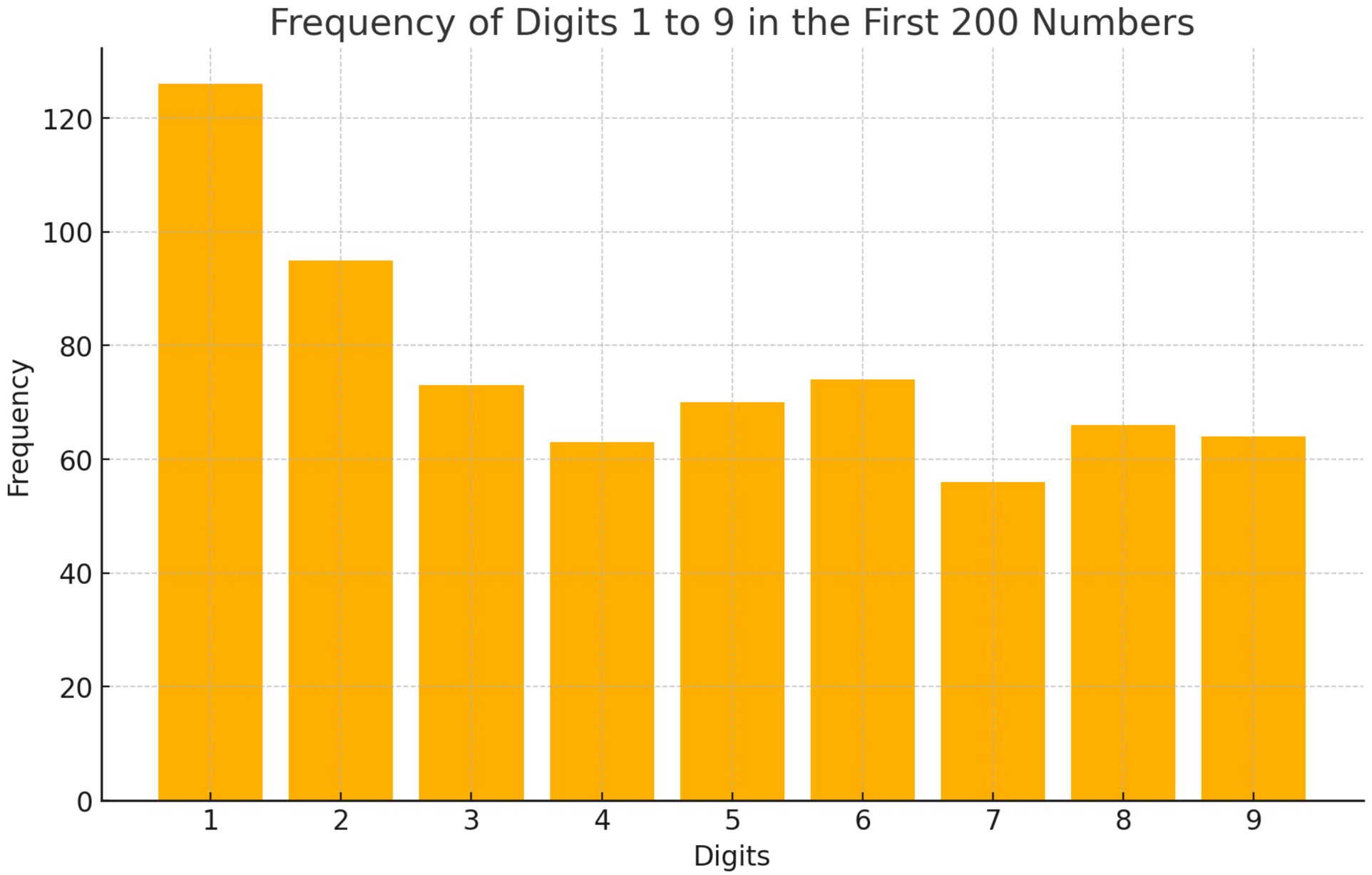
202.0
1956.0
1973.0
723.0
4862.0
PIN


Frequency of Digits 1 to 9 in the First 200 Numbers
Frequency
0
20
40
60
80
100
120
1
2
3
4
5
6
7
8
9
Digits

Data —— Information

# Card PINs

3.5 million PINs that were hacked from a bank.

| | PIN | Freq |
|---|---|---|
| #1 | 1234 | 10.713% |
| #2 | 1111 | 6.016% |
| #3 | 0 | 1.881% |
| #4 | 1212 | 1.197% |
| #5 | 7777 | 0.745% |
| #6 | 1004 | 0.616% |
| #7 | 2000 | 0.613% |
| #8 | 4444 | 0.526% |
| #9 | 2222 | 0.516% |
| #10 | 6969 | 0.512% |

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Total: **23.34%**

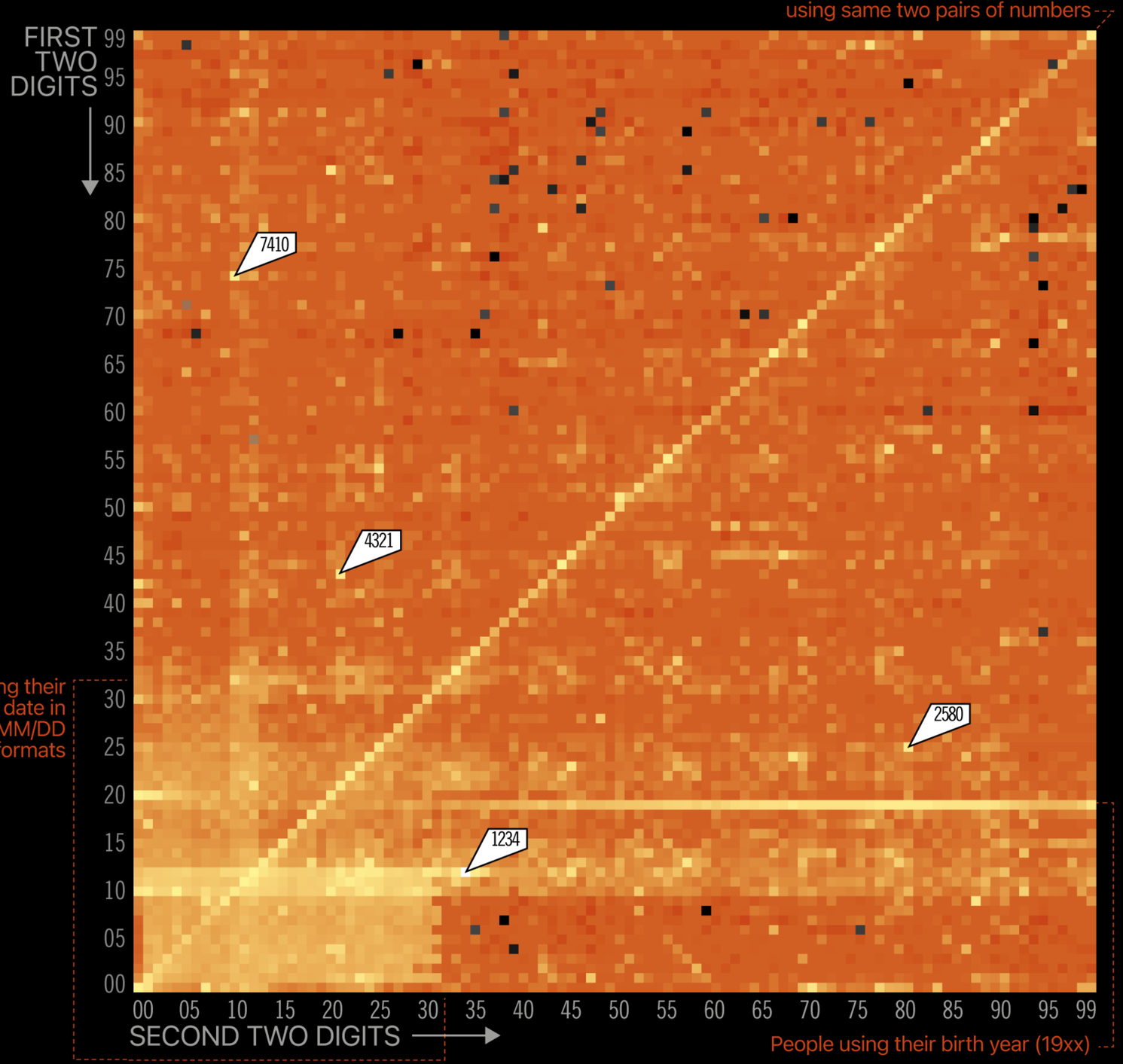
# Visualisation

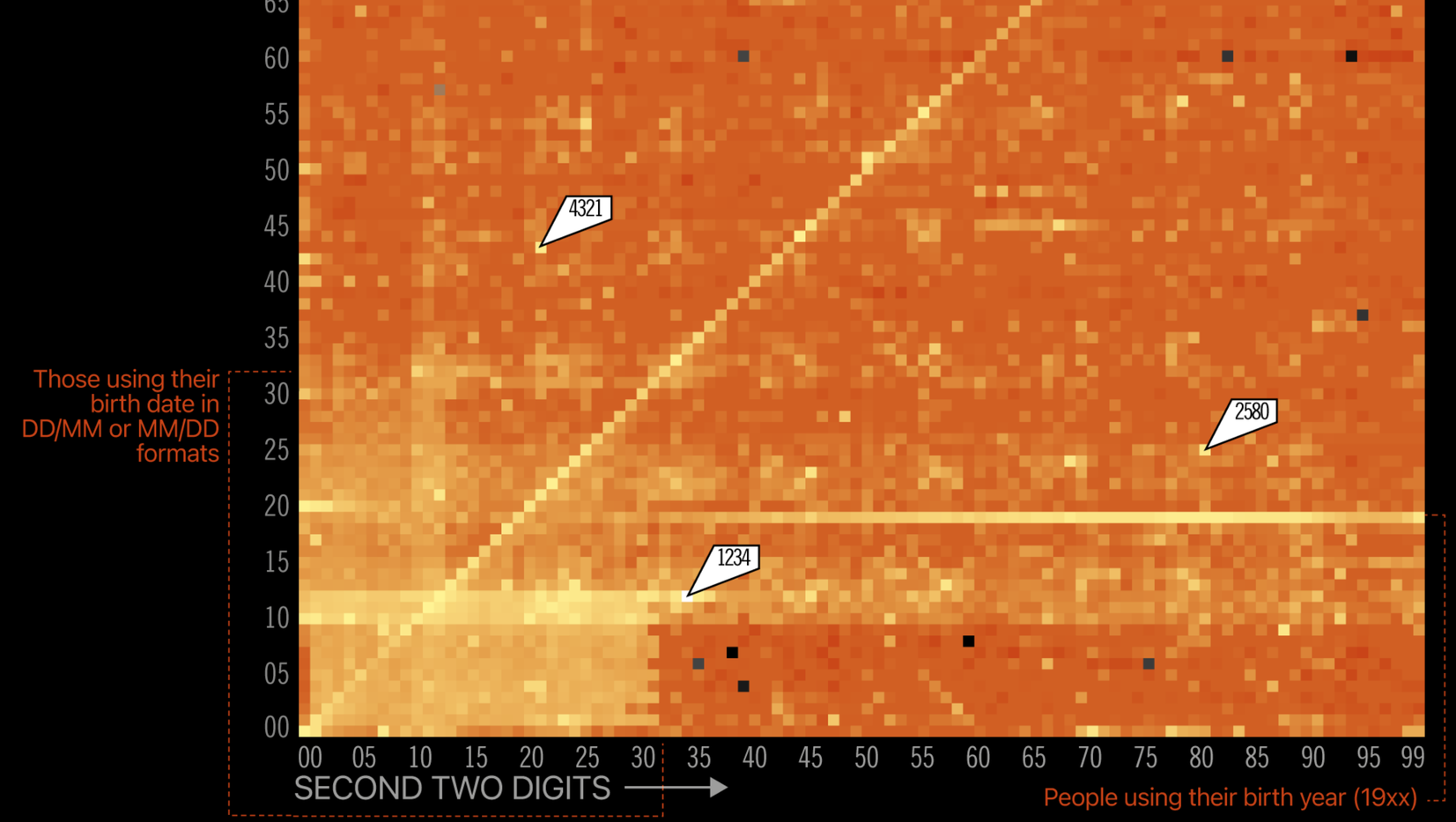
informationisbeautiful.net

# Pin Point

## The most common 4-digit PIN numbers

most common — least






## most common

1234 0000 7777 2000 2222 9999 5555 1122 8888 2001
1111 1212 1004 4444 6969 3333 6666 1313 4321 1010

27% of all PIN numbers

## least common

8557 8438 9539 7063 6827 0859 6793 0738 6835 8093
9047 0439 8196 6093 7394 9480 8398 7637 9629 8068

sources: 3.4 million PIN codes from several data breaches

Data ——— Information

# Did we learn something?

Data —— Information

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It’s really bad to use 1234, 1111 or 0000 as your PIN.

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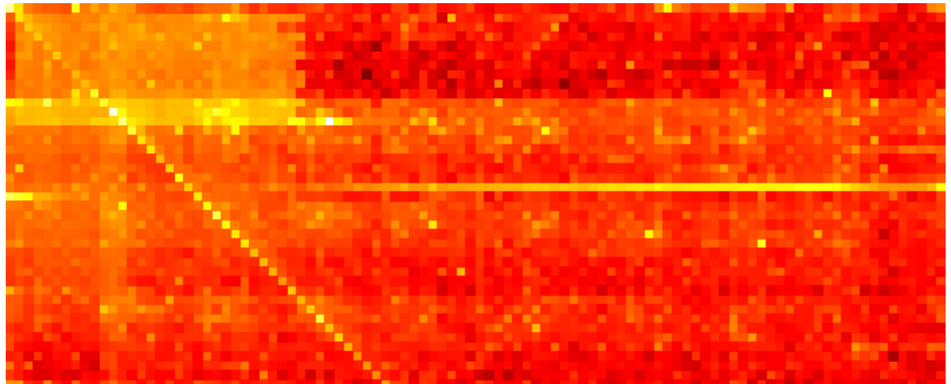
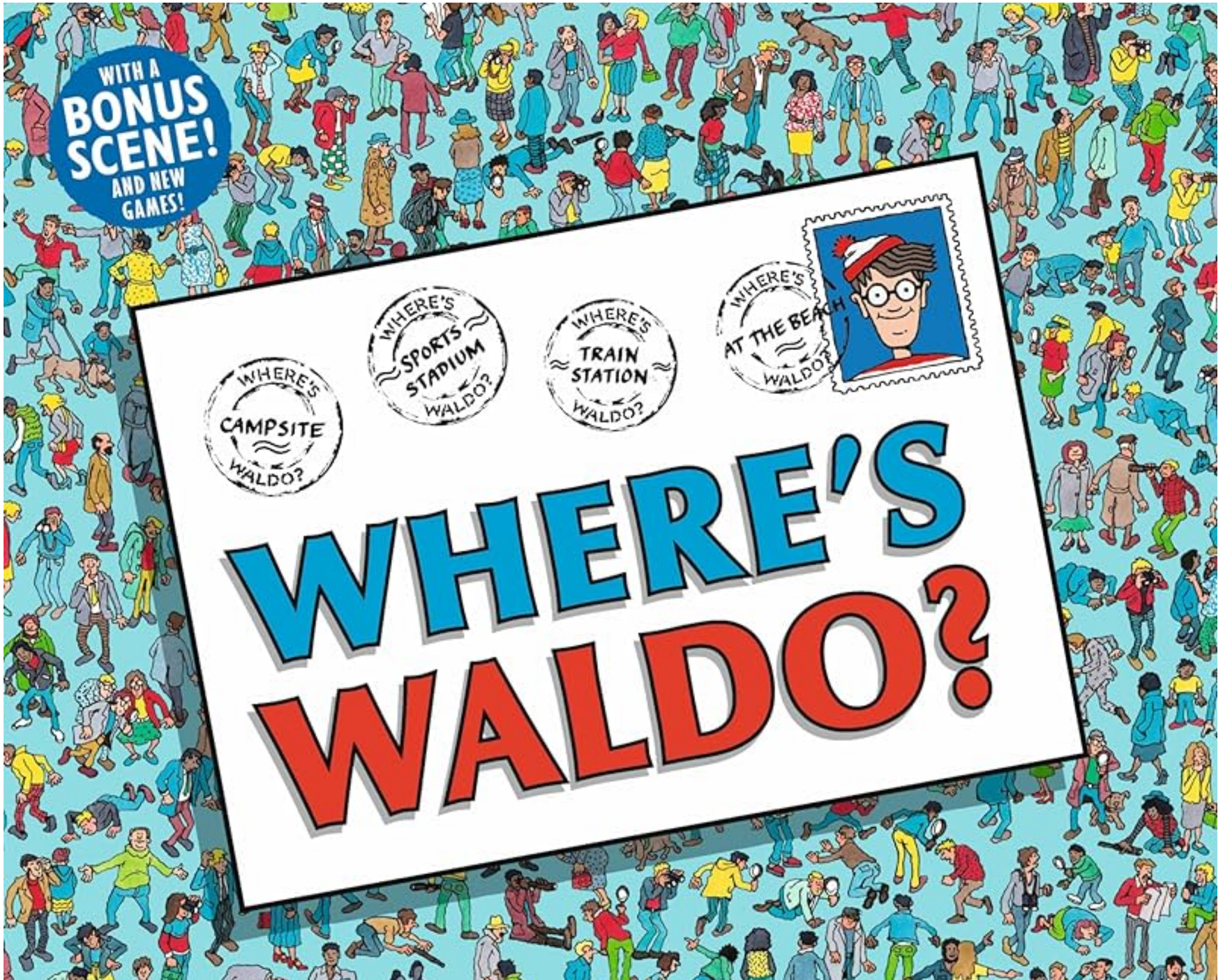
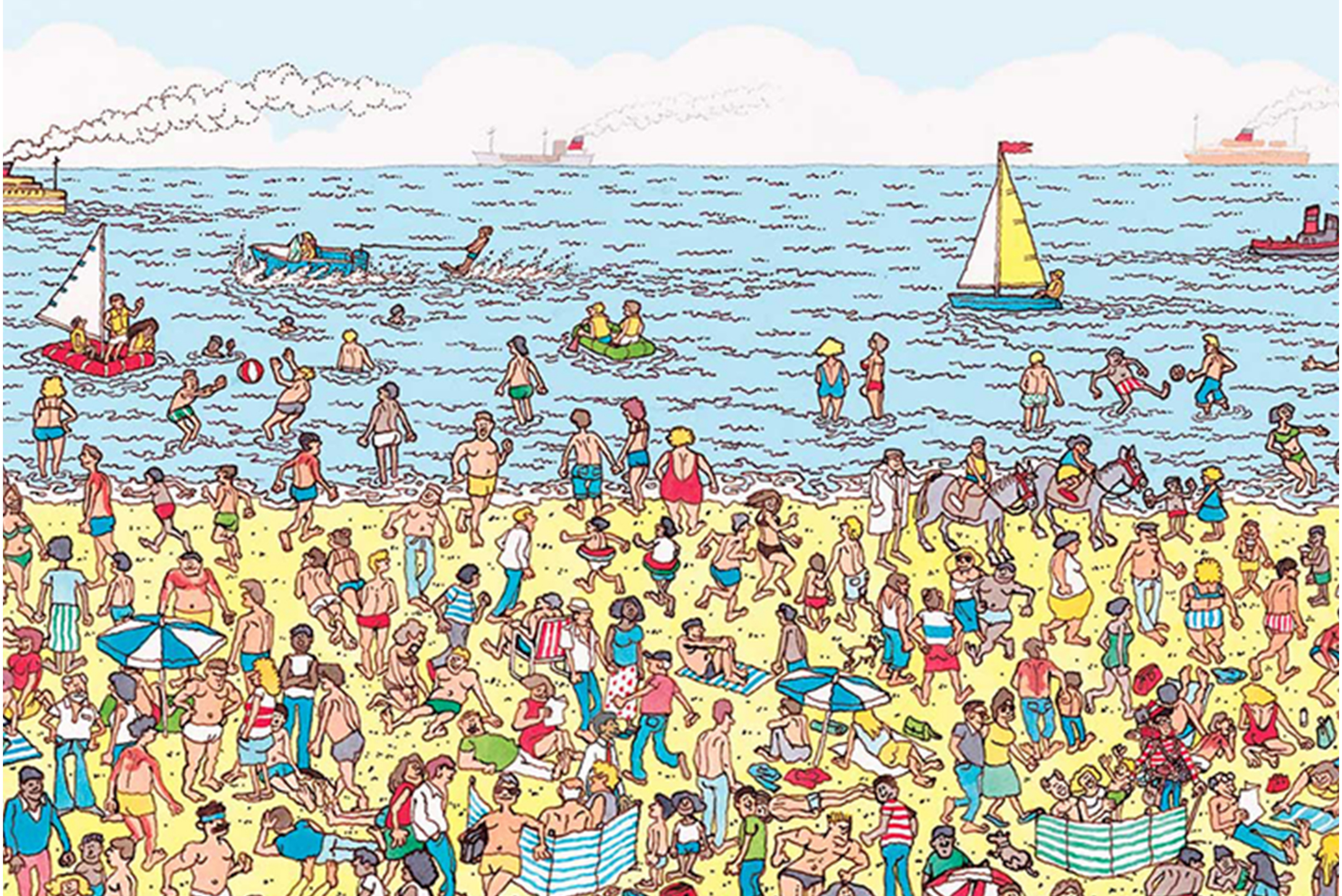
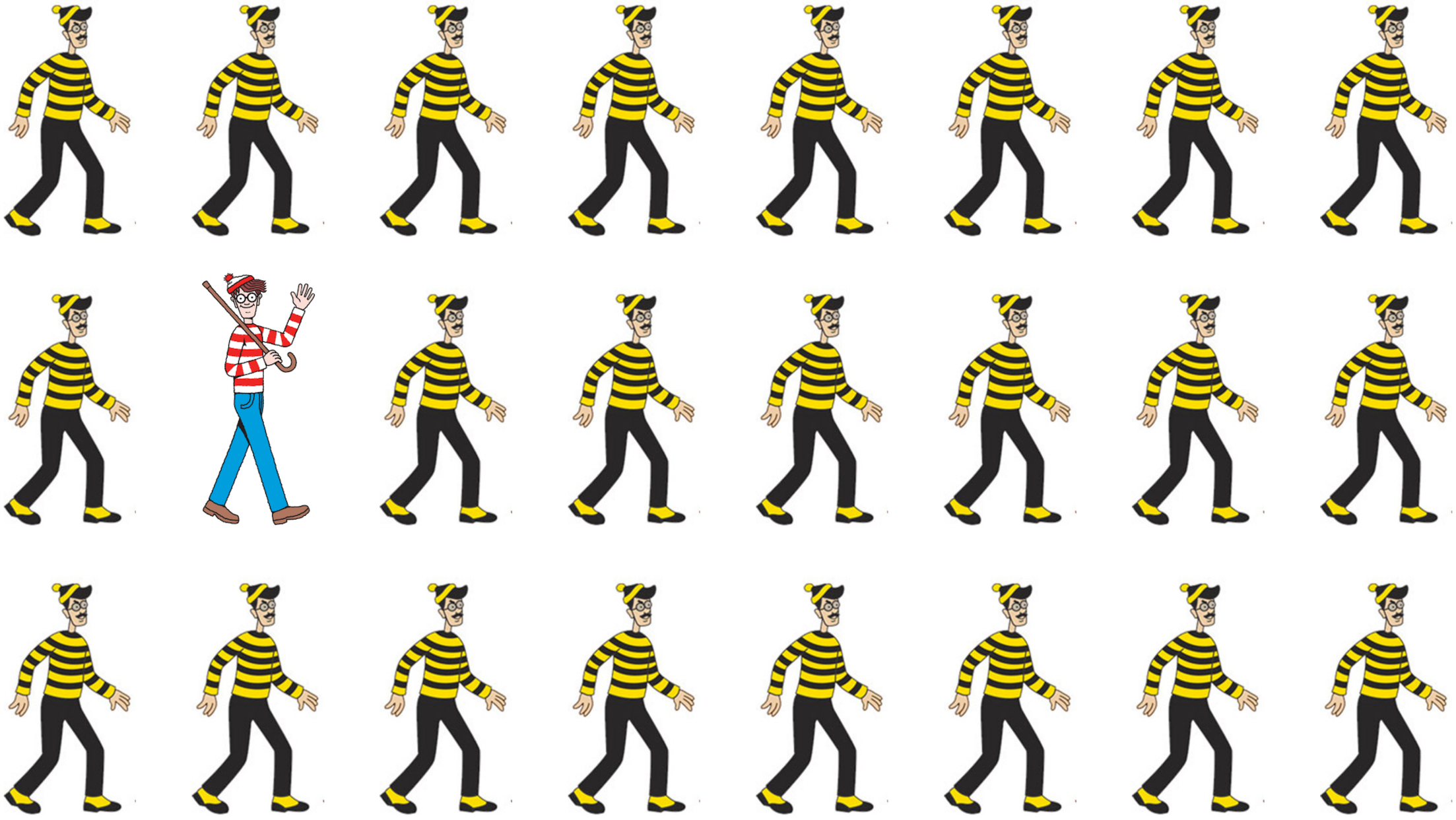



WITH A
BONUS
SCENE!
AND NEW
GAMES!
WHERE'S
CAMPSITE
WALDO?
WHERE'S
SPORTS
STADIUM
WALDO?
WHERE'S
TRAIN
STATION
WALDO?
WHERE'S
AT THE BEACH
WALDO?
WHERE'S
WALDO?





Data ——— Information

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(As long as you use an encoding that makes sense and keep human graphical perception in mind)

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Data ——— Information

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Visualising data can help generate an **Insight.**

Data ——— Information

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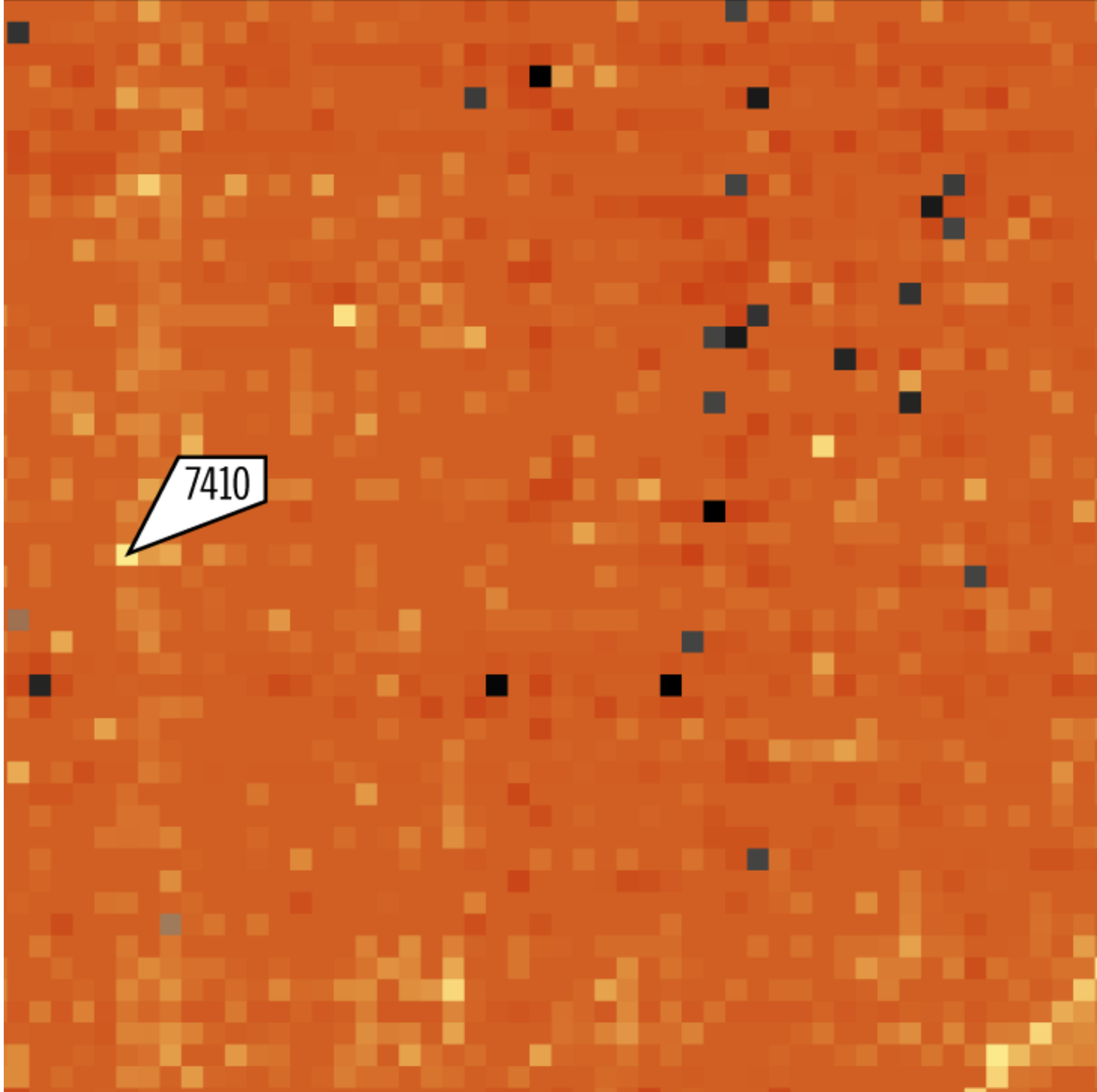
an understanding of cause and effect based on the identification of relationships and behaviors within a model, system, context, or scenario

Data —— Information

# Insight

An understanding of cause and effect based on the identification of relationships and behaviors within a model, system, context, or scenario



Data —— Information

# Insight

An understanding of cause and effect based on the identification of relationships and behaviors within a model, system, context, or scenario

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Lecture 2

# DD 324:
# Data Visualisation

## Looking at data

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What are

# Data Models?

a conceptual framework that defines how data is structured

## What are

# Data Models?

### Relational

Rows and columns in a table

### Hierarchical

Parent-child relationships

### Network

Complex connections

### Document

Semi-structured data

### Graph

Emphasizes relationships among data points

## What are

# Data Models?

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Emphasizes relationships among data points

These are more relevant for data science/database management.

## What are

# Data Models?

**Relational**

Rows and columns in a table

**Hierarchical**

Parent-child relationships

**Network**

Complex connections

**Document**

Semi-structured data

**Graph**

Emphasizes relationships among data points

We might talk about these later. For now, just be aware they exist.

Data Models

# Types of Data

Structured ——— Unstructured

# Structured

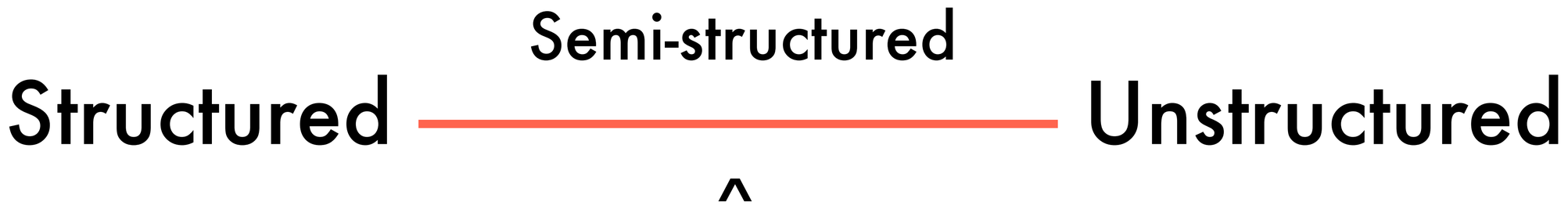
- Follows a **predefined format** and can be put in **rows and columns**.
- **Measurements of some sort**
  - Nominal
  - Ordinal
  - Interval
  - Ratio
- **For eg.** course attendance sheet, sales data for a company, feedback popup with star rating
- **Visualisation is straightforward**

# Unstructured

- Data that **doesn't fit neatly** into a tabular format.
- **Structure is not defined**
  - (Long) Text
  - Images
  - Audio
  - Video
- **For eg.** a moodboard for a project, social media posts, feedback form with a textbox
- **Could need NLP or creativity**

Data Models

# Types of Data



## Structured or Unstructured?

# 10 emails

Structured or Unstructured?

# 10 emails and a rating for spam/ham

Structured or Unstructured?

# Star rating popup

Structured or Unstructured?

# Star rating popup with a textbox for explaining why

Structured or Unstructured?

# Names of 10 songs

Structured or Unstructured?

# Contents of 10 emails

Structured or Unstructured?

# Contents of 10 emails, from, to and date

# Structured or Unstructured?

# Structured or Unstructured?

27 March 2020
1:07 PM

31 March 2020
3:27 PM

2 April 2020
4:58 PM

6 April 2020
6:07 PM

# What structured information could you extract from these?

27 March 2020
1:07 PM

31 March 2020
3:27 PM

2 April 2020
4:58 PM

6 April 2020
6:07 PM

Data Models

# Types of Data

Structured ——— Unstructured

Data Models

# Types of Data

Structured ——— Unstructured

Data Models

# Types of Data

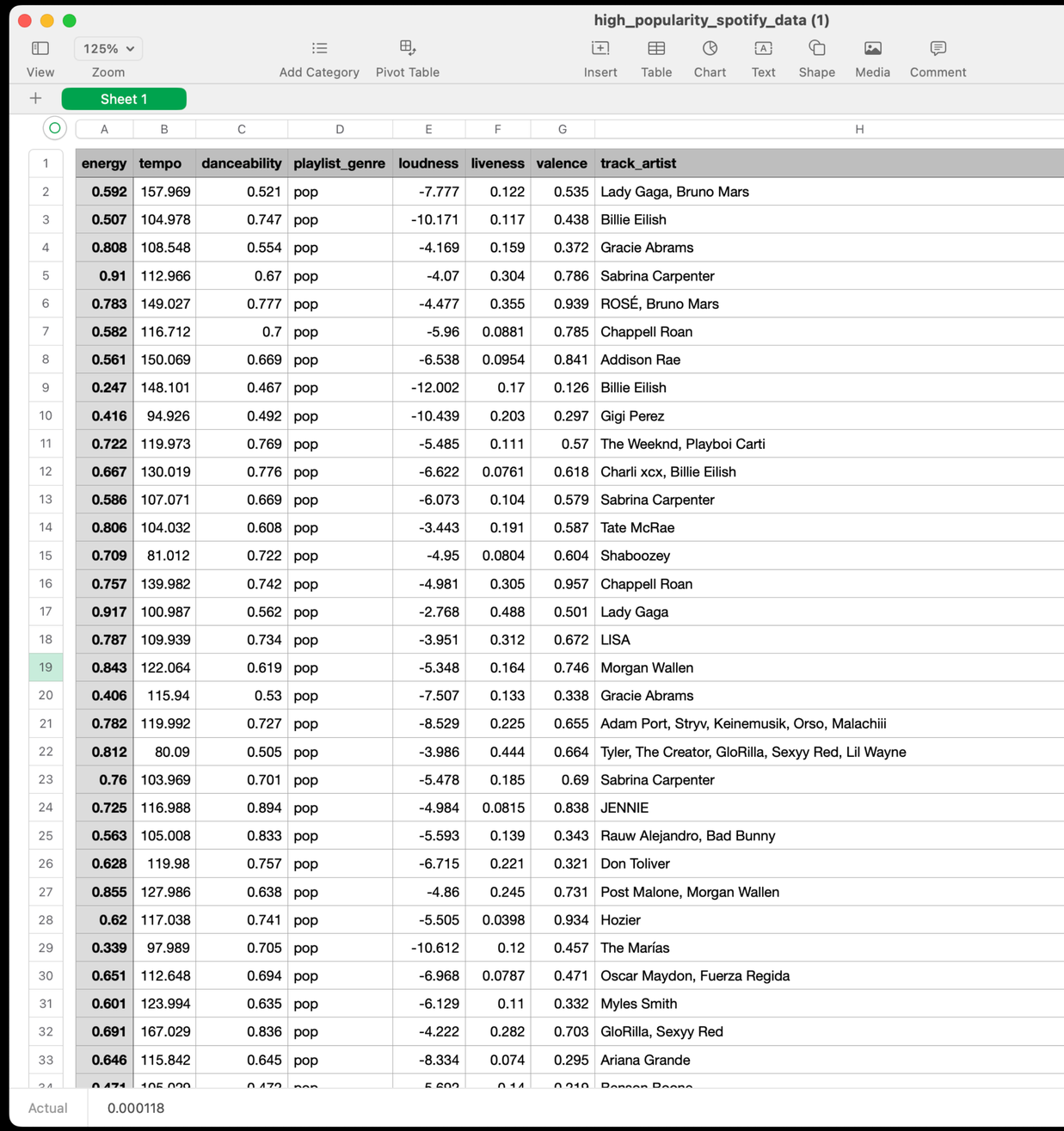
Structured ——— Unstructured

We will focus on structured data today.

Data —— Information

# Lets try and look at some datasets.

Songs from Spotify ▸


high_popularity_spotify_data (1)

125% View Zoom Add Category Pivot Table Insert Table Chart Text Shape Media Comment

Sheet 1

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | energy | tempo | danceability | playlist_genre | loudness | liveness | valence | track_artist |
| 2 | 0.592 | 157.969 | 0.521 | pop | -7.777 | 0.122 | 0.535 | Lady Gaga, Bruno Mars |
| 3 | 0.507 | 104.978 | 0.747 | pop | -10.171 | 0.117 | 0.438 | Billie Eilish |
| 4 | 0.808 | 108.548 | 0.554 | pop | -4.169 | 0.159 | 0.372 | Gracie Abrams |
| 5 | 0.91 | 112.966 | 0.67 | pop | -4.07 | 0.304 | 0.786 | Sabrina Carpenter |
| 6 | 0.783 | 149.027 | 0.777 | pop | -4.477 | 0.355 | 0.939 | ROSÉ, Bruno Mars |
| 7 | 0.582 | 116.712 | 0.7 | pop | -5.96 | 0.0881 | 0.785 | Chappell Roan |
| 8 | 0.561 | 150.069 | 0.669 | pop | -6.538 | 0.0954 | 0.841 | Addison Rae |
| 9 | 0.247 | 148.101 | 0.467 | pop | -12.002 | 0.17 | 0.126 | Billie Eilish |
| 10 | 0.416 | 94.926 | 0.492 | pop | -10.439 | 0.203 | 0.297 | Gigi Perez |
| 11 | 0.722 | 119.973 | 0.769 | pop | -5.485 | 0.111 | 0.57 | The Weeknd, Playboi Carti |
| 12 | 0.667 | 130.019 | 0.776 | pop | -6.622 | 0.0761 | 0.618 | Charli xcx, Billie Eilish |
| 13 | 0.586 | 107.071 | 0.669 | pop | -6.073 | 0.104 | 0.579 | Sabrina Carpenter |
| 14 | 0.806 | 104.032 | 0.608 | pop | -3.443 | 0.191 | 0.587 | Tate McRae |
| 15 | 0.709 | 81.012 | 0.722 | pop | -4.95 | 0.0804 | 0.604 | Shaboozey |
| 16 | 0.757 | 139.982 | 0.742 | pop | -4.981 | 0.305 | 0.957 | Chappell Roan |
| 17 | 0.917 | 100.987 | 0.562 | pop | -2.768 | 0.488 | 0.501 | Lady Gaga |
| 18 | 0.787 | 109.939 | 0.734 | pop | -3.951 | 0.312 | 0.672 | LISA |
| 19 | 0.843 | 122.064 | 0.619 | pop | -5.348 | 0.164 | 0.746 | Morgan Wallen |
| 20 | 0.406 | 115.94 | 0.53 | pop | -7.507 | 0.133 | 0.338 | Gracie Abrams |
| 21 | 0.782 | 119.992 | 0.727 | pop | -8.529 | 0.225 | 0.655 | Adam Port, Stryv, Keinemusik, Orso, Malachiii |
| 22 | 0.812 | 80.09 | 0.505 | pop | -3.986 | 0.444 | 0.664 | Tyler, The Creator, GloRilla, Sexyy Red, Lil Wayne |
| 23 | 0.76 | 103.969 | 0.701 | pop | -5.478 | 0.185 | 0.69 | Sabrina Carpenter |
| 24 | 0.725 | 116.988 | 0.894 | pop | -4.984 | 0.0815 | 0.838 | JENNIE |
| 25 | 0.563 | 105.008 | 0.833 | pop | -5.593 | 0.139 | 0.343 | Rauw Alejandro, Bad Bunny |
| 26 | 0.628 | 119.98 | 0.757 | pop | -6.715 | 0.221 | 0.321 | Don Toliver |
| 27 | 0.855 | 127.986 | 0.638 | pop | -4.86 | 0.245 | 0.731 | Post Malone, Morgan Wallen |
| 28 | 0.62 | 117.038 | 0.741 | pop | -5.505 | 0.0398 | 0.934 | Hozier |
| 29 | 0.339 | 97.989 | 0.705 | pop | -10.612 | 0.12 | 0.457 | The Marías |
| 30 | 0.651 | 112.648 | 0.694 | pop | -6.968 | 0.0787 | 0.471 | Oscar Maydon, Fuerza Regida |
| 31 | 0.601 | 123.994 | 0.635 | pop | -6.129 | 0.11 | 0.332 | Myles Smith |
| 32 | 0.691 | 167.029 | 0.836 | pop | -4.222 | 0.282 | 0.703 | GloRilla, Sexyy Red |
| 33 | 0.646 | 115.842 | 0.645 | pop | -8.334 | 0.074 | 0.295 | Ariana Grande |

Actual 0.000118

## Spotify Dataset

# A dataset can have many **features.**

Here are some of the features this dataset has: song name, artist, genre, popularity, energy, tempo, danceability...

| Feature | Description |
|---|---|
| **Energy** | A measure of intensity and activity. Typically, energetic tracks feel fast, loud, and noisy. |
| **Tempo** | The speed of a track, measured in beats per minute (BPM). |
| **Danceability** | A score describing how suitable a track is for dancing based on tempo, rhythm stability, beat strength and overall regularity. |
| **Loudness** | The overall loudness of a track in decibels (dB). Higher values indicate louder tracks overall. |
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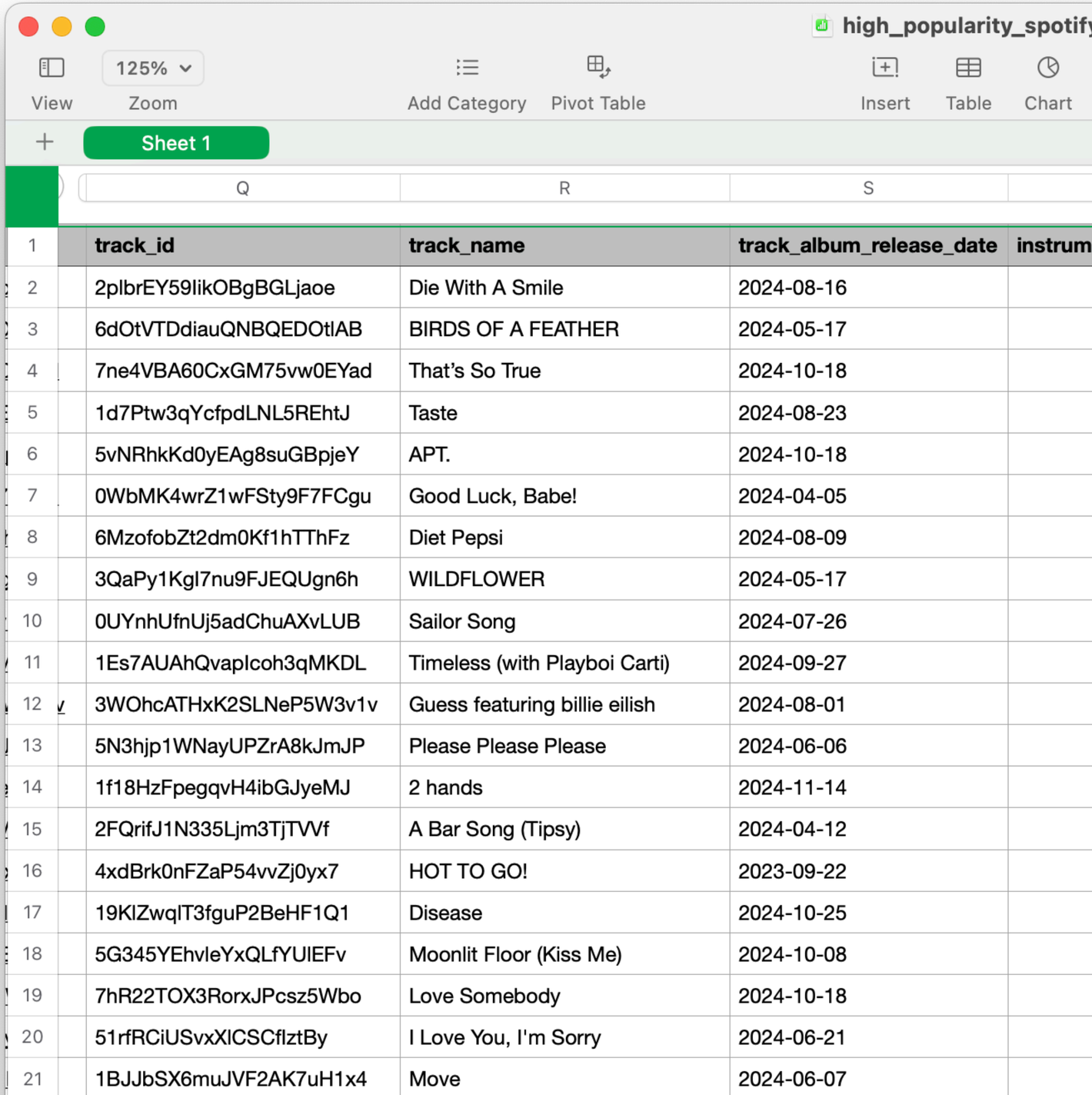
| **Speechiness** | Measures the presence of spoken words. |
| **Instrumentalness** | The likelihood a track contains no vocals. Values closer to 1.0 suggest solely instrumental tracks. |
| **Mode** | Indicates the modality of the track. |

Features

# Usually the title of each column in a table is the feature name.

At least one feature should have unique values.

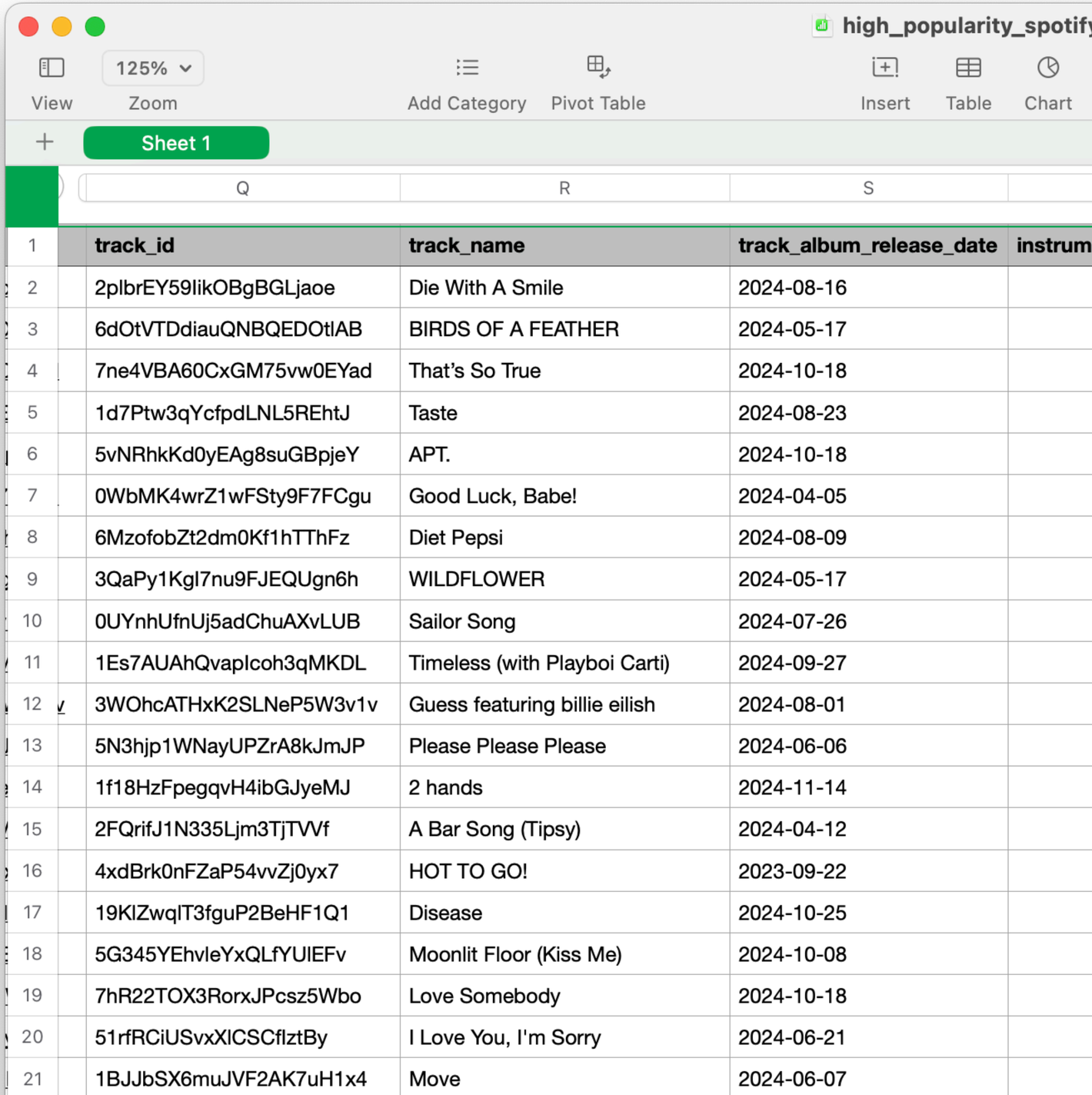



| | Q | R | S |
|---|---|---|---|
| 1 | track_id | track_name | track_album_release_date |
| 2 | 2plbrEY59IikOBgBGLjaoe | Die With A Smile | 2024-08-16 |
| 3 | 6dOtVTDdiauQNBQEDOtlAB | BIRDS OF A FEATHER | 2024-05-17 |
| 4 | 7ne4VBA60CxGM75vw0EYad | That's So True | 2024-10-18 |
| 5 | 1d7Ptw3qYcfpdLNL5REhtJ | Taste | 2024-08-23 |
| 6 | 5vNRhkKd0yEAg8suGBpjeY | APT. | 2024-10-18 |
| 7 | 0WbMK4wrZ1wFSty9F7FCgu | Good Luck, Babe! | 2024-04-05 |
| 8 | 6MzofobZt2dm0Kf1hTThFz | Diet Pepsi | 2024-08-09 |
| 9 | 3QaPy1Kgl7nu9FJEQUgn6h | WILDFLOWER | 2024-05-17 |
| 10 | 0UYnhUfnUj5adChuAXvLUB | Sailor Song | 2024-07-26 |
| 11 | 1Es7AUAhQvapIcoh3qMKDL | Timeless (with Playboi Carti) | 2024-09-27 |
| 12 | 3WOhcATHxK2SLNeP5W3v1v | Guess featuring billie eilish | 2024-08-01 |
| 13 | 5N3hjp1WNayUPZrA8kJmJP | Please Please Please | 2024-06-06 |
| 14 | 1f18HzFpegqvH4ibGJyeMJ | 2 hands | 2024-11-14 |
| 15 | 2FQrifJ1N335Ljm3TjTVVf | A Bar Song (Tipsy) | 2024-04-12 |
| 16 | 4xdBrk0nFZaP54vvZj0yx7 | HOT TO GO! | 2023-09-22 |
| 17 | 19KlZwqlT3fguP2BeHF1Q1 | Disease | 2024-10-25 |
| 18 | 5G345YEhvleYxQLfYUlEFv | Moonlit Floor (Kiss Me) | 2024-10-08 |
| 19 | 7hR22TOX3RorxJPcsz5Wbo | Love Somebody | 2024-10-18 |
| 20 | 51rfRCiUSvxXlCSCflztBy | I Love You, I'm Sorry | 2024-06-21 |
| 21 | 1BJJbSX6muJVF2AK7uH1x4 | Move | 2024-06-07 |

Features

# Usually the title of each column in a table is the feature name.

# At least one feature should have unique values... why?

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| 6 | 5vNRhkKd0yEAg8suGBpjeY | APT. | 2024-10-18 |
| 7 | 0WbMK4wrZ1wFSty9F7FCgu | Good Luck, Babe! | 2024-04-05 |
| 8 | 6MzofobZt2dm0Kf1hTThFz | Diet Pepsi | 2024-08-09 |
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| 14 | 1f18HzFpegqvH4ibGJyeMJ | 2 hands | 2024-11-14 |
| 15 | 2FQrifJ1N335Ljm3TjTVVf | A Bar Song (Tipsy) | 2024-04-12 |
| 16 | 4xdBrk0nFZaP54vvZj0yx7 | HOT TO GO! | 2023-09-22 |
| 17 | 19KlZwqlT3fguP2BeHF1Q1 | Disease | 2024-10-25 |
| 18 | 5G345YEhvleYxQLfYUlEFv | Moonlit Floor (Kiss Me) | 2024-10-08 |
| 19 | 7hR22TOX3RorxJPcsz5Wbo | Love Somebody | 2024-10-18 |
| 20 | 51rfRCiUSvxXlCSCflztBy | I Love You, I'm Sorry | 2024-06-21 |
| 21 | 1BJJbSX6muJVF2AK7uH1x4 | Move | 2024-06-07 |

| | | | | |
|---|---|---|---|---|
| Lover<br>Diljit Dosanjh | 14,35,53,214 | ✓ | 3:10 |

| | | | | |
|---|---|---|---|---|
| Lover<br>Diljit Dosanjh | 14,35,53,214 | ✓ | 3:10 |
| Lover<br>Taylor Swift | 1,65,05,10,116 | | 3:41 |

Spotify Dataset

# What are some Features that might impact each other?

| Feature | Description |
| --- | --- |
| **Energy** | A measure of intensity and activity. Typically, energetic tracks feel fast, loud, and noisy. |
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## Spotify Dataset

# What are some Features that might impact each other?

## Hypothesis

# High energy tracks are Louder.

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Data ——— Information

# You can use data to prove or disprove a hypothesis.

Data ——— Information

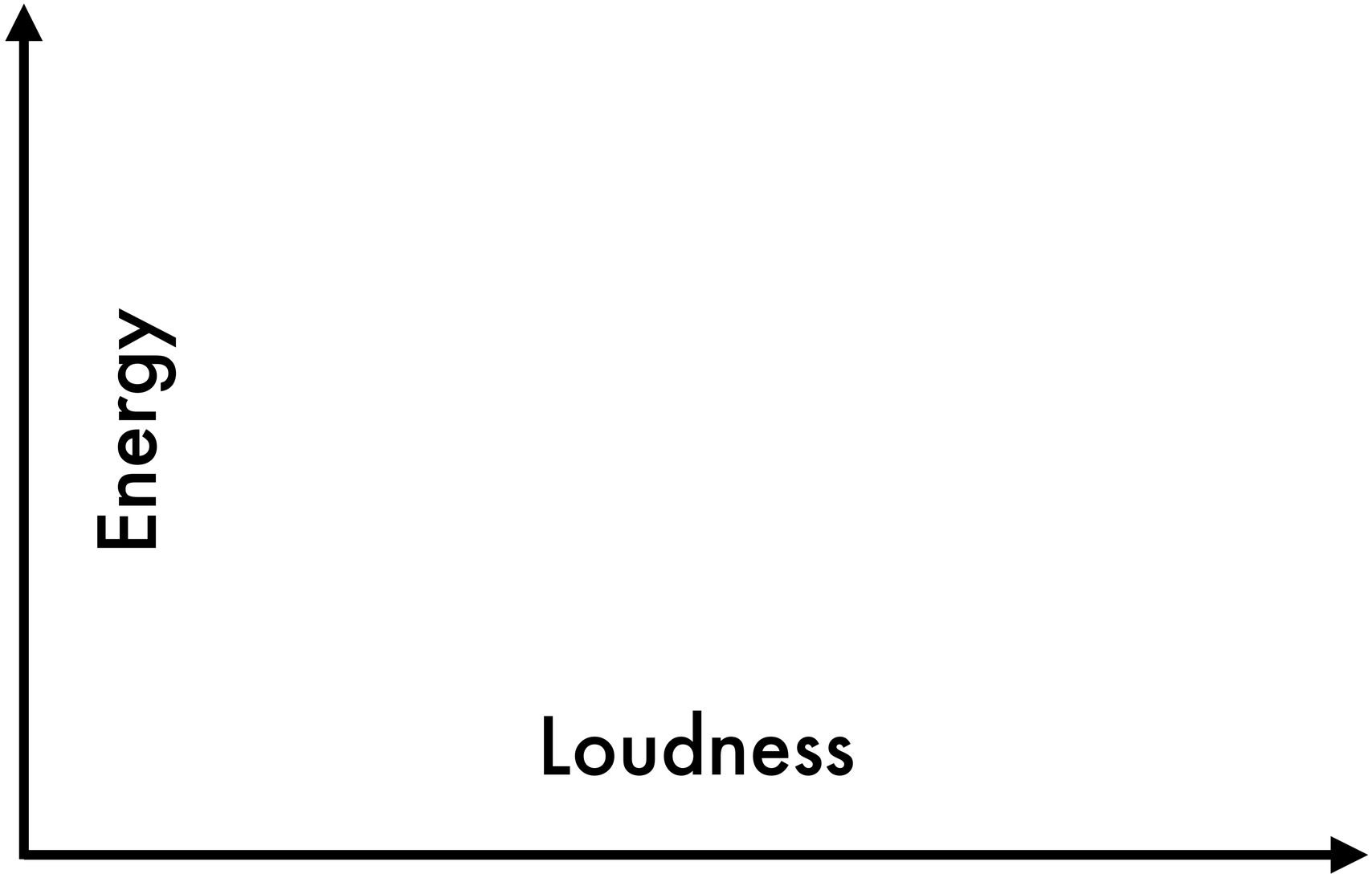
# You can use data visualisation to prove or disprove a hypothesis.

**Hypothesis**

High energy tracks are Louder.

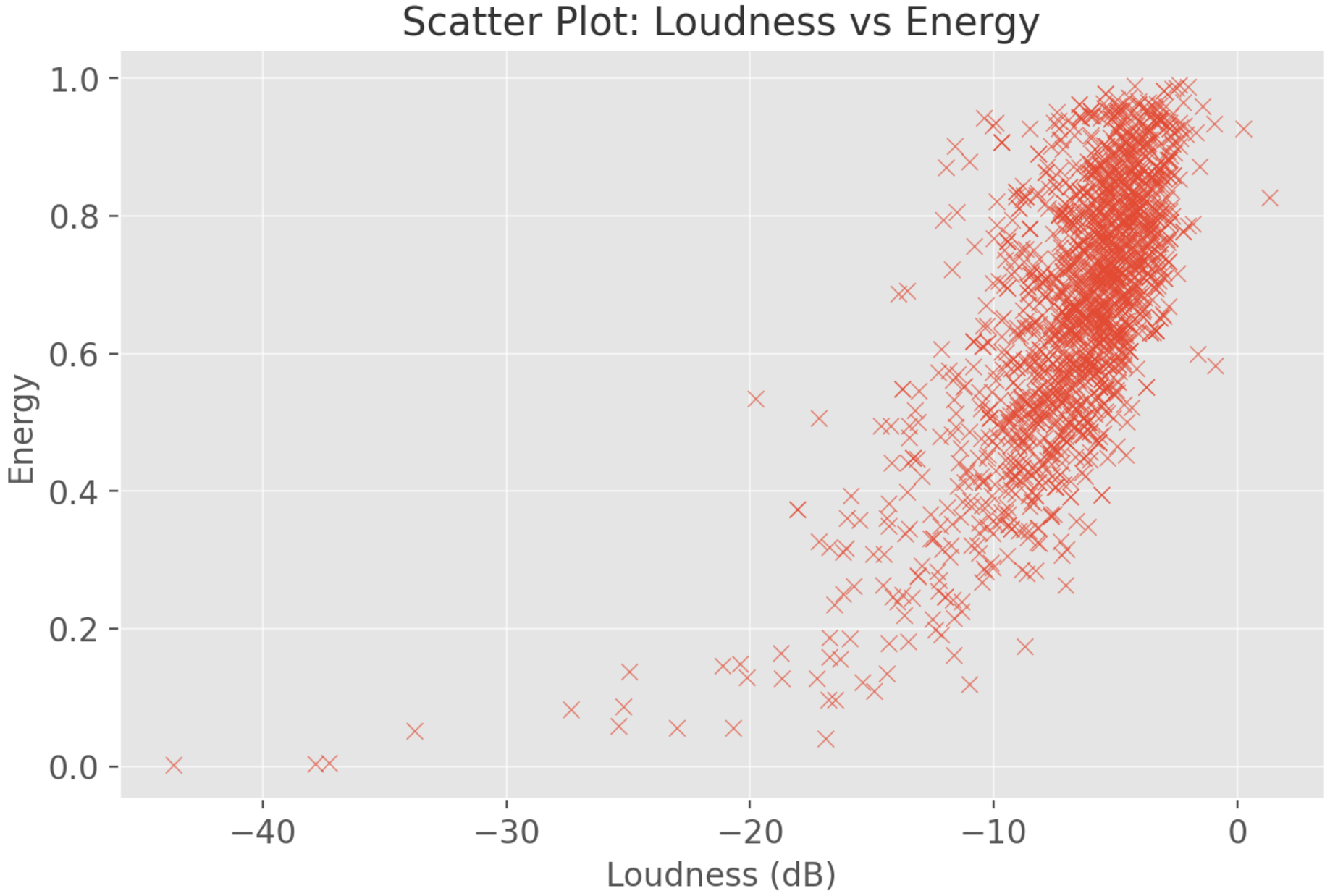
**Hypothesis**

High energy tracks are Louder.



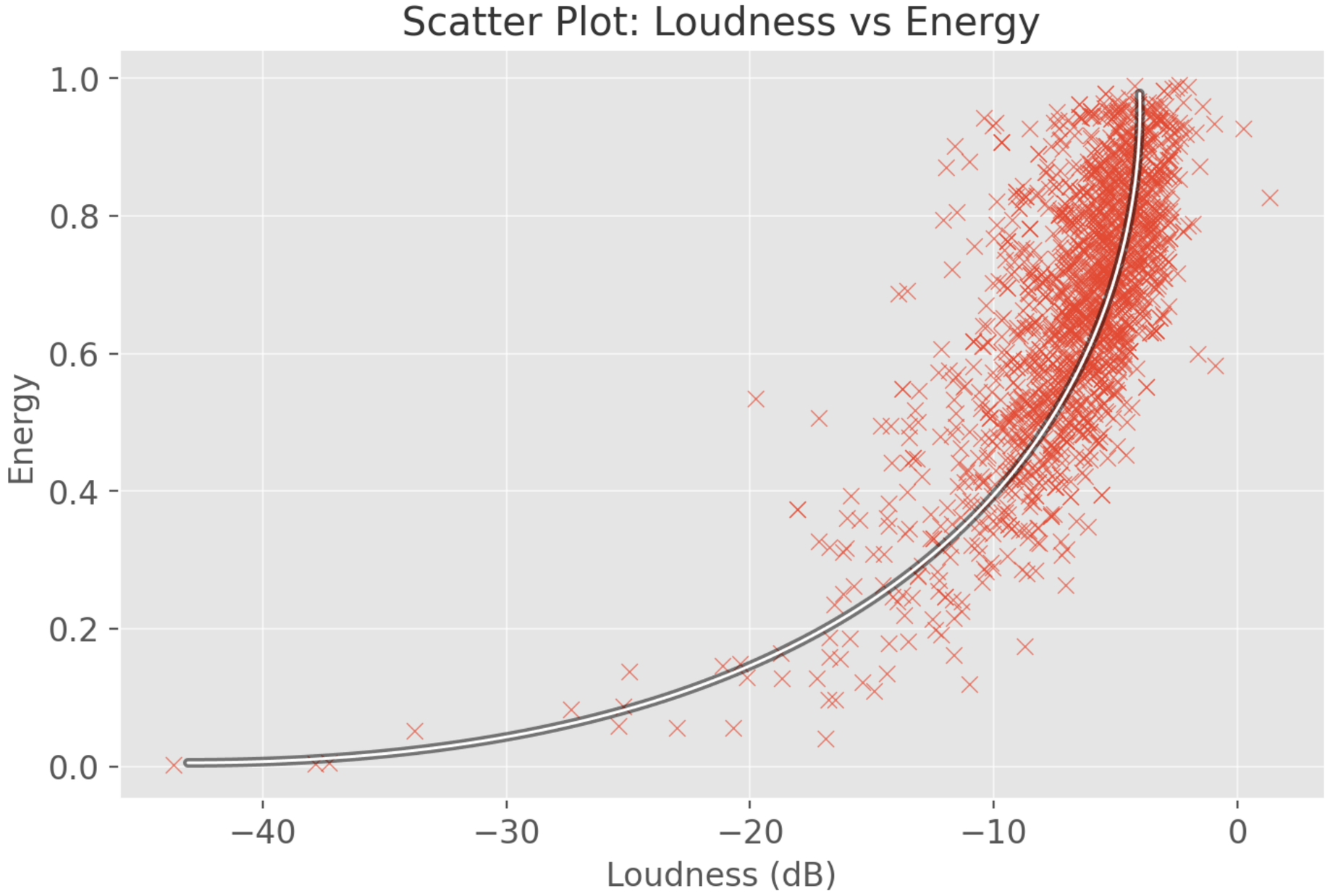
**Hypothesis**

# High energy tracks are Louder.



**Hypothesis**

# High energy tracks are Louder.



Exercise

# Explore a Dataset

## ✅ Dataset with 4+ features

| Date<br>The date when the stock data was recorded. Represents each trading day. | # Adj_Close<br>The adjusted closing price accounting for corporate actions like dividends. | # Close<br>The final price at which the stock was traded on that day. | # High<br>The highest price that Adobe's stock reached on a given day. | # Low<br>The lowest price Adobe's stock reached during a trading day. |
|---|---|---|---|---|
| <br>1986-08-13 2024-12-27 | <br>0.19 688 | <br>0.21 688 | <br>0.22 700 | <br>0.21 679 |
| 1986-08-13 | 0.19805713 | 0.210938007 | 0.21875 | 0.210938007 |
| 1986-08-14 | 0.209059551 | 0.222655997 | 0.230469003 | 0.222655997 |
| 1986-08-15 | 0.205392078 | 0.21875 | 0.222655997 | 0.21875 |

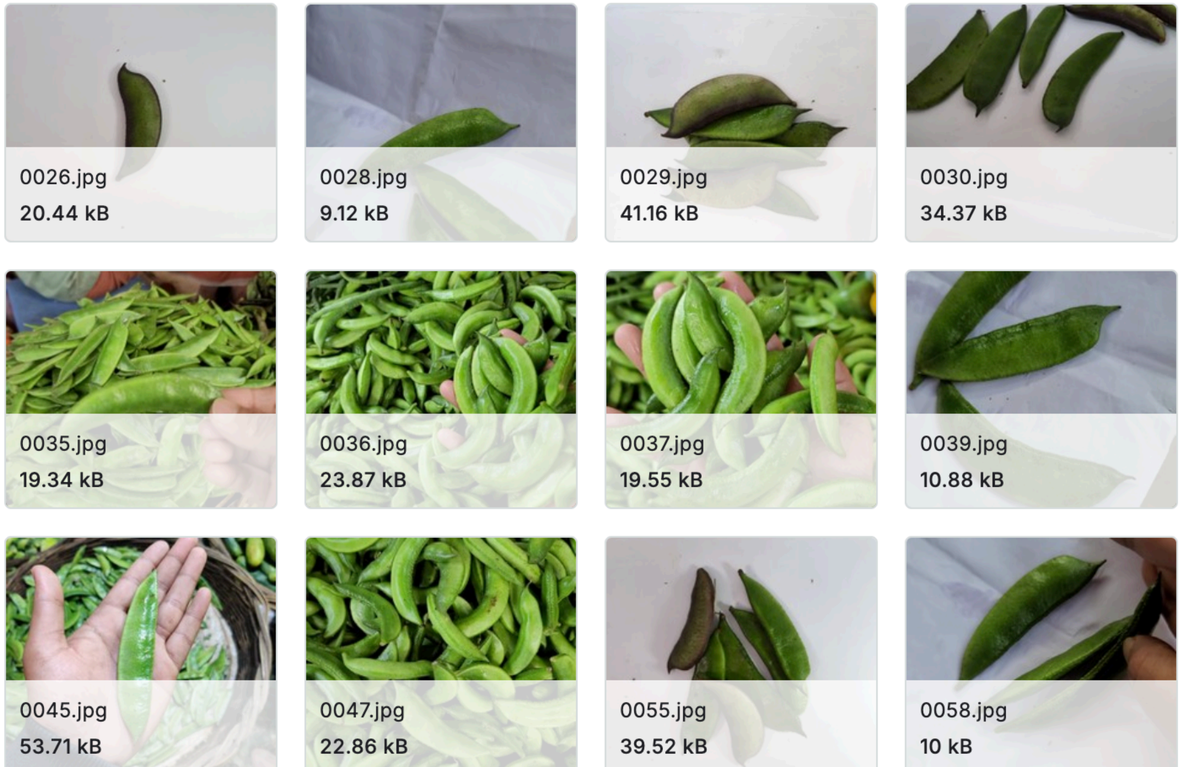
Exercise

# Explore a Dataset

## ❌ Unstructured Text

| Category<br>Label | Message<br>Text |
| --- | --- |
| ham 87%<br>spam 13%<br>Other (1) 0% | 5158<br>unique values |
| | work a... |
| spam | Your free ringtone is waiting to be collected. Simply text the password "MIX" to 85069 to verify. Ge... |
| ham | Watching telugu movie..wat abt u? |
| ham | i see. When we finish we have loads |

## ❌ Images



Exercise

# Explore a Dataset

- Find a dataset in an area you are interested in. Sports, politics, health, music, etc.
- Spend some time looking at it in a tabular format. Try some spreadsheet operations.
- Come up with 3 statements about it that you think might be true.

14 Jan 2025 · Gyan Lakhwani · gyanlakhwani@gmail.com · Department of Design, DTU

Exercise

# Explore a Dataset

- Find a dataset in a
  Spe
  operations.
  p with 3 statements about it that you think might be true.

WITH AI!!!!

14 Jan 2025 · Gyan Lakhwani · gyanlakhwani@gmail.com · Department of Design, DTU