CS 220 / CS319
Tabular Data
(CSV and Spreadsheets)

Department of Computer Sciences
University of Wisconsin-Madison

Learning Objectives Today

CSV format

- purpose
- syntax
- comparison to spreadsheets

Reading CSV files

- without header
- with header
- type casting

Chapter 16 of Sweigart, to (and including) “Reading Data from Reader Objects in a for Loop”

https://automatetheboringstuff.com/2e/chapter16/

Today's Outline

Spreadsheets

CSVs

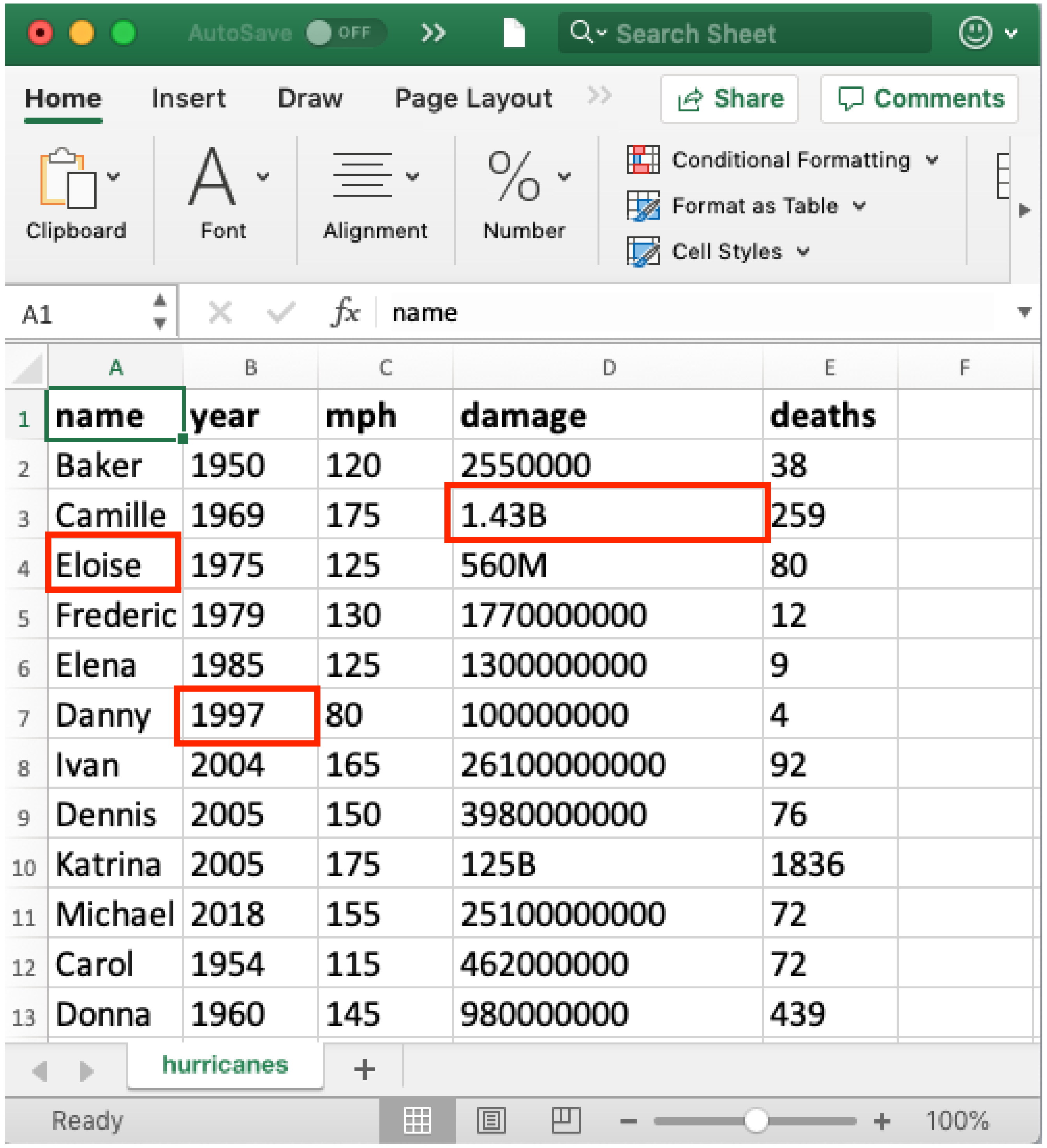
Reading a CSV to a list of lists

Coding examples

Spreadsheets (e.g., Excel)

Spreadsheets are tables of cells, organized by rows and columns

cells



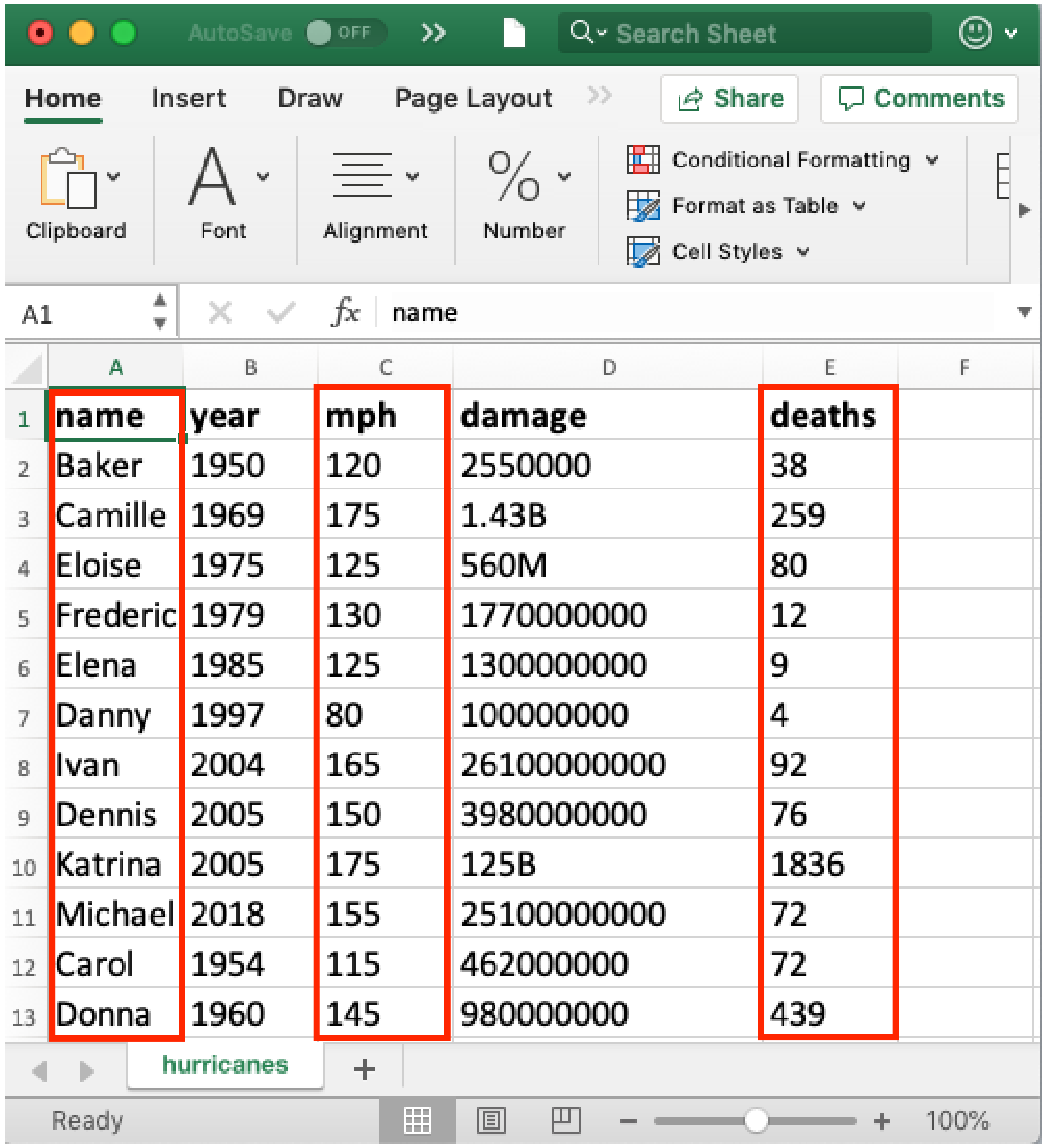
fx name

	A	B	C	D	E	F
1	name	year	mph	damage	deaths	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
5	Frederic	1979	130	1770000000	12	
6	Elena	1985	125	1300000000	9	
7	Danny	1997	80	100000000	4	
8	Ivan	2004	165	26100000000	92	
9	Dennis	2005	150	3980000000	76	
10	Katrina	2005	175	125B	1836	
11	Michael	2018	155	25100000000	72	
12	Carol	1954	115	462000000	72	
13	Donna	1960	145	980000000	439	

Spreadsheets (e.g., Excel)

Spreadsheets are tables of cells, organized by rows and columns

columns



	A	B	C	D	E	F
1	**name**	**year**	**mph**	**damage**	**deaths**	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
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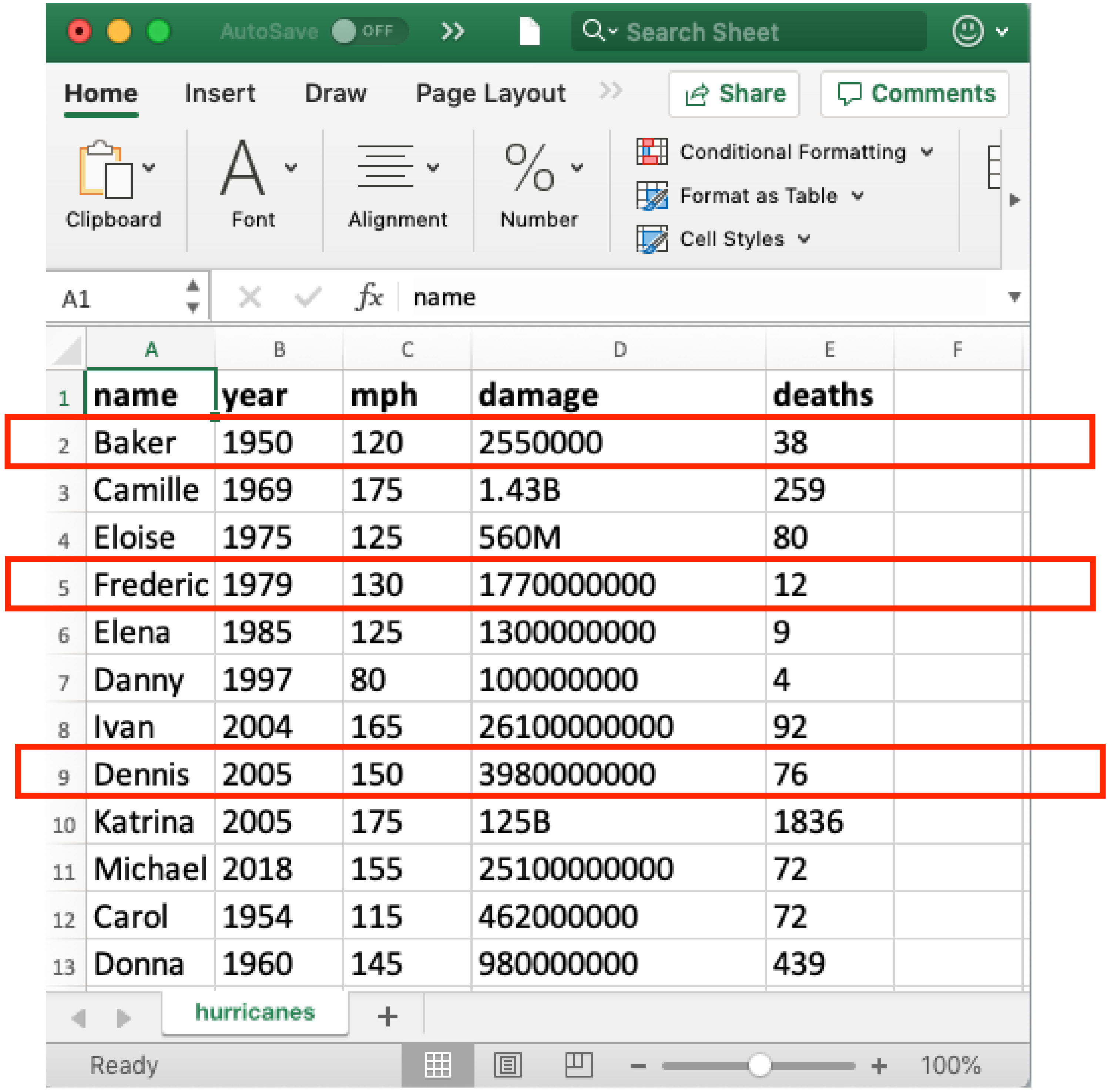
Spreadsheets (e.g., Excel)

Spreadsheets are tables of cells, organized by rows and columns

rows



	A	B	C	D	E	F
1	name	year	mph	damage	deaths	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
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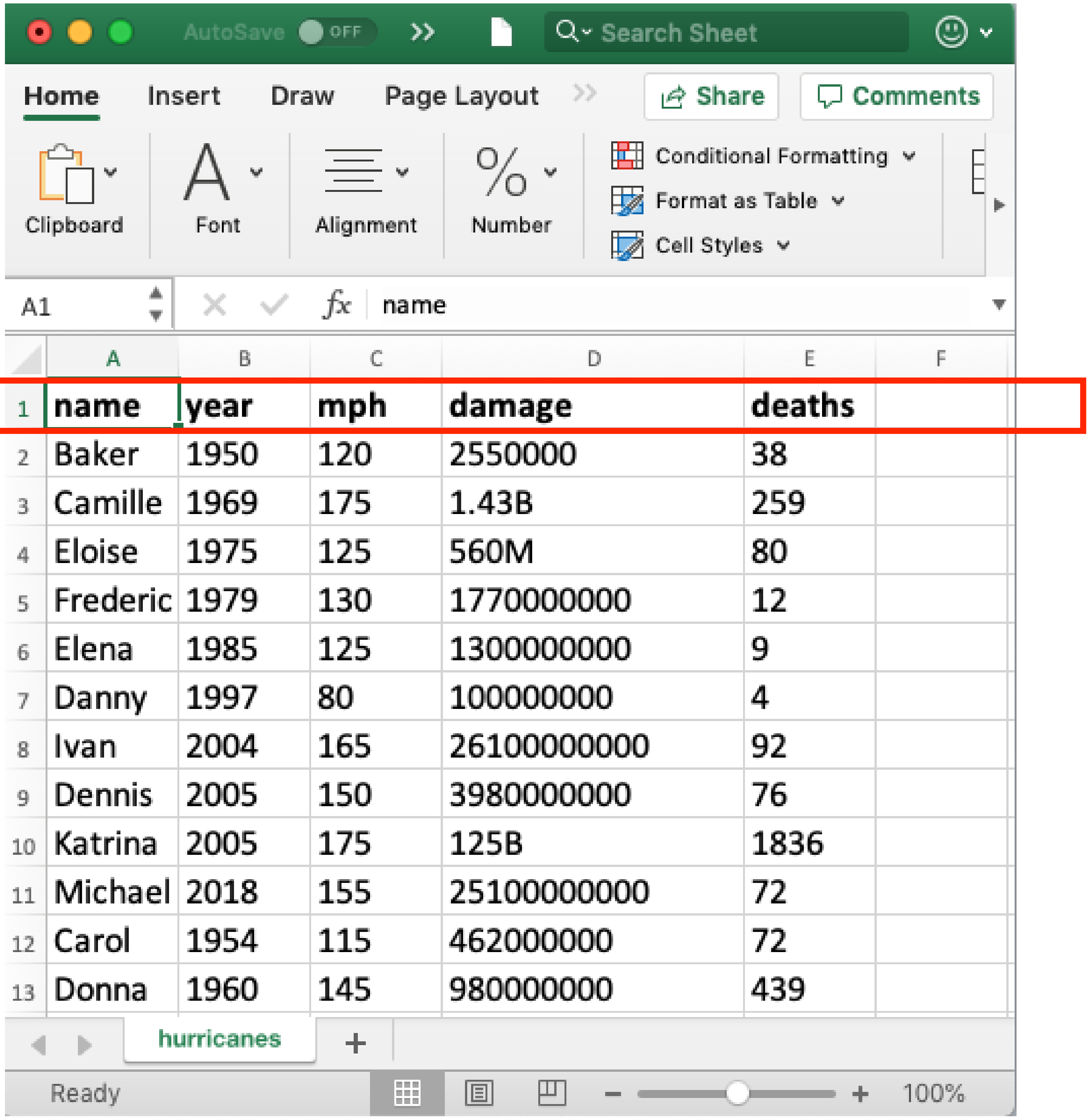
Spreadsheets (e.g., Excel)

Spreadsheets are tables of cells, organized by rows and columns

header

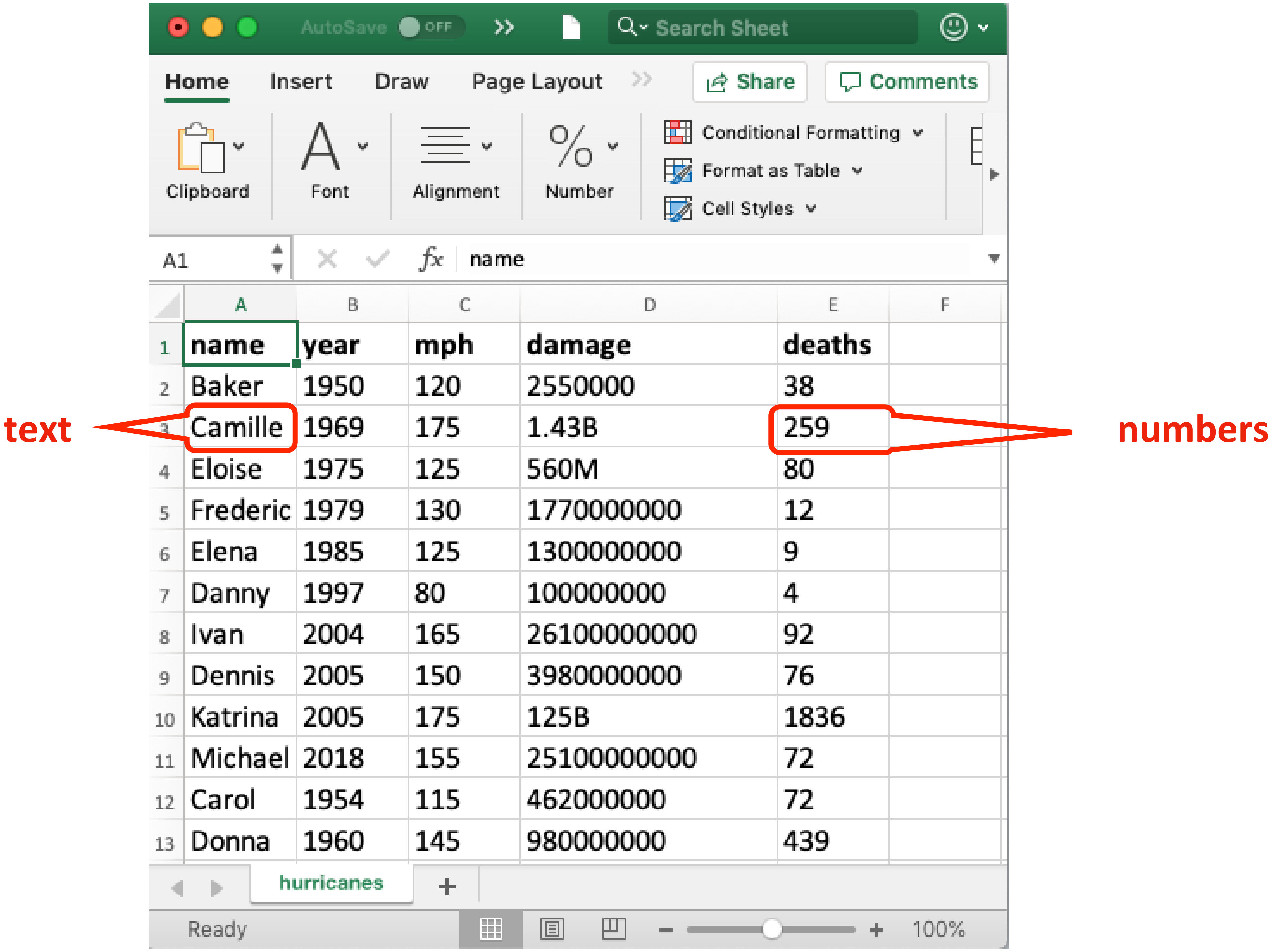


	A	B	C	D	E	F
1	**name**	**year**	**mph**	**damage**	**deaths**	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
5	Frederic	1979	130	1770000000	12	
6	Elena	1985	125	1300000000	9	
7	Danny	1997	80	100000000	4	
8	Ivan	2004	165	26100000000	92	
9	Dennis	2005	150	3980000000	76	
10	Katrina	2005	175	125B	1836	
11	Michael	2018	155	25100000000	72	
12	Carol	1954	115	462000000	72	
13	Donna	1960	145	980000000	439	

hurricanes

Spreadsheets (e.g., Excel)

Spreadsheets often allow different data types



	A	B	C	D	E	F
1	name	year	mph	damage	deaths	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
5	Frederic	1979	130	1770000000	12	
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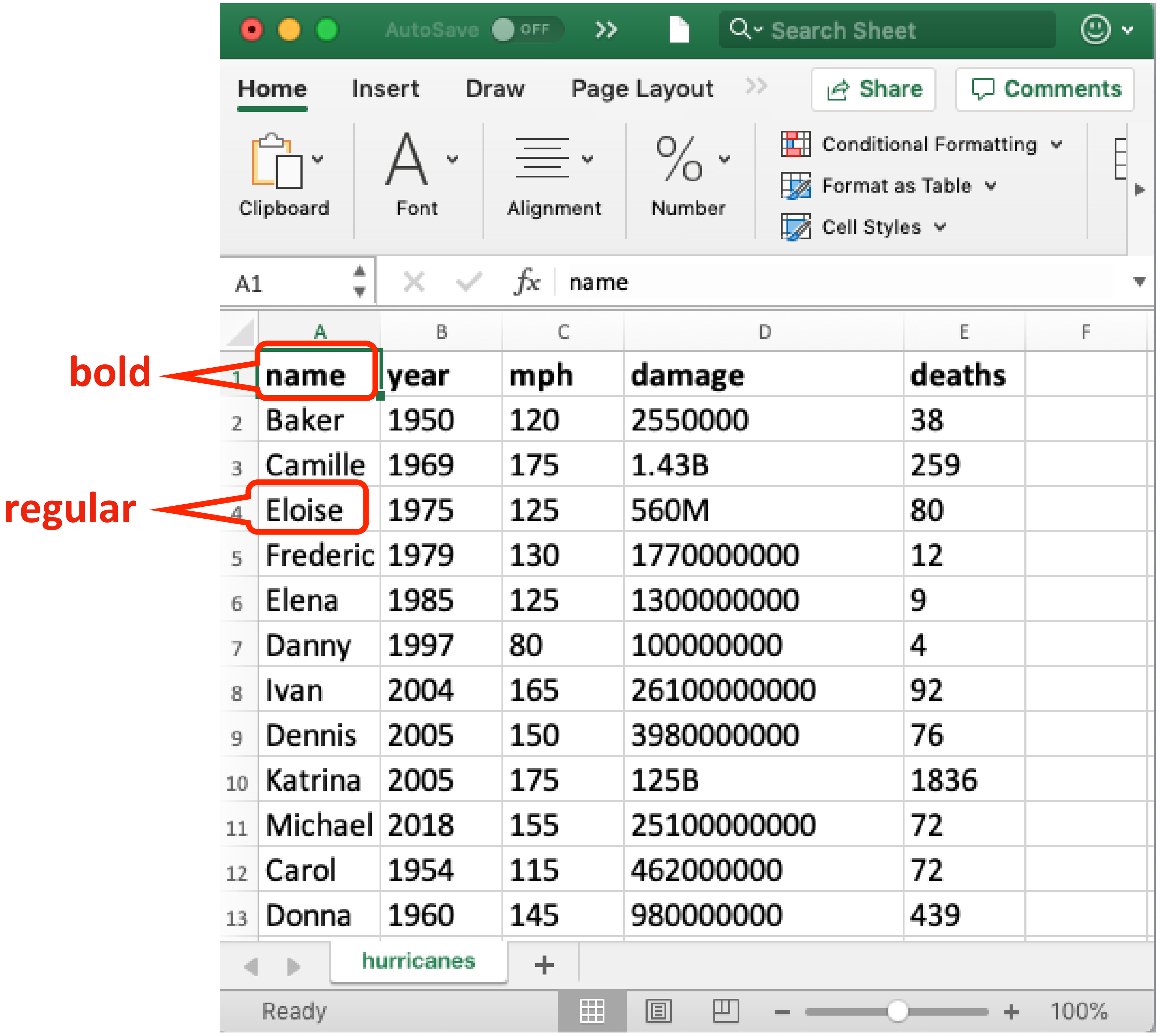
13	Donna	1960	145	980000000	439	

Spreadsheets (e.g., Excel)

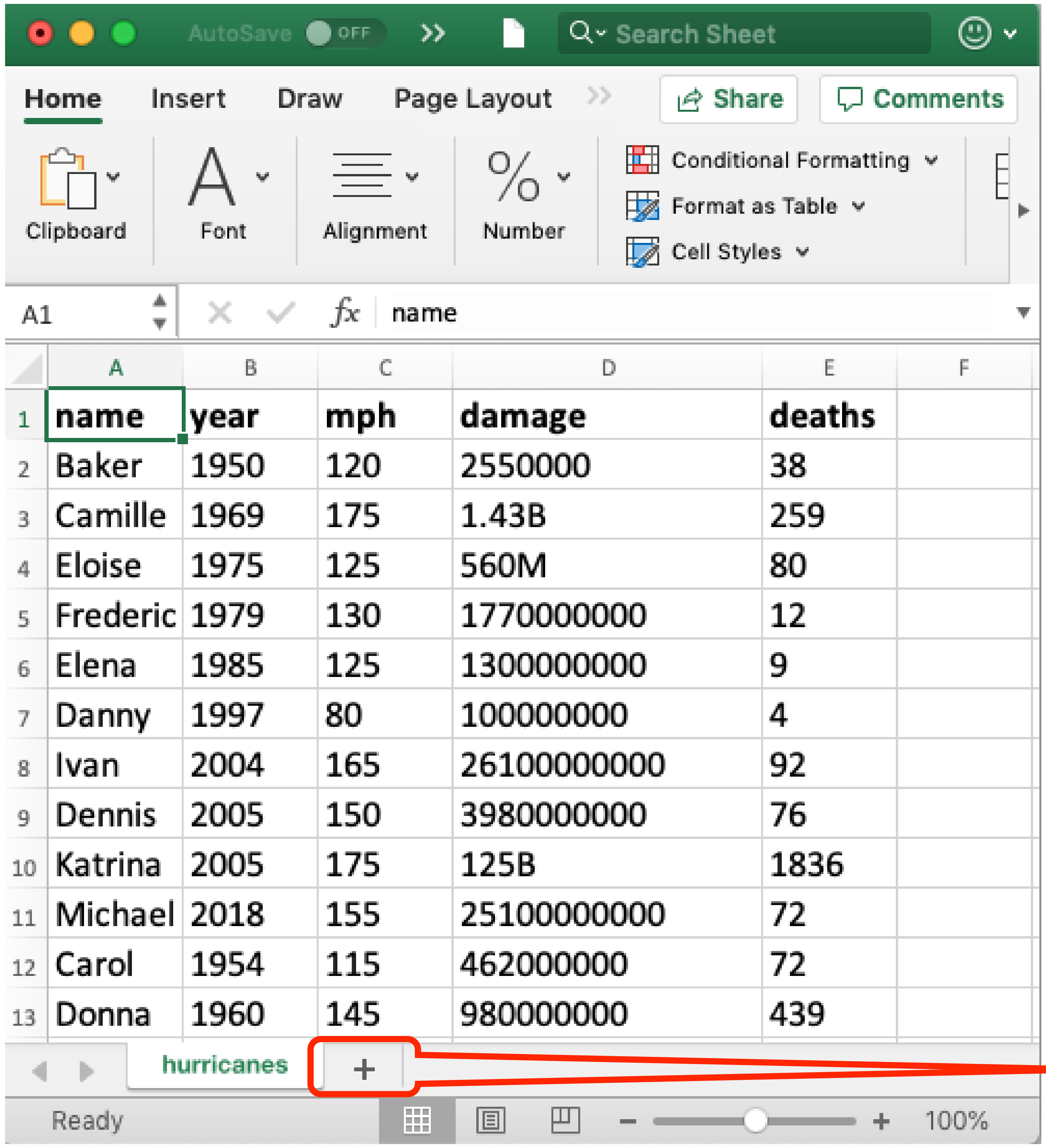
Spreadsheets often allow different fonts, text sizes, colors, highlighting



	A	B	C	D	E	F
1	**name**	**year**	**mph**	**damage**	**deaths**	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
5	Frederic	1979	130	1770000000	12	
6	Elena	1985	125	1300000000	9	
7	Danny	1997	80	100000000	4	
8	Ivan	2004	165	26100000000	92	
9	Dennis	2005	150	3980000000	76	
10	Katrina	2005	175	125B	1836	
11	Michael	2018	155	25100000000	72	
12	Carol	1954	115	462000000	72	
13	Donna	1960	145	980000000	439	

Spreadsheets (e.g., Excel)

Spreadsheets often support multiple sheets



	A	B	C	D	E	F
1	name	year	mph	damage	deaths	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
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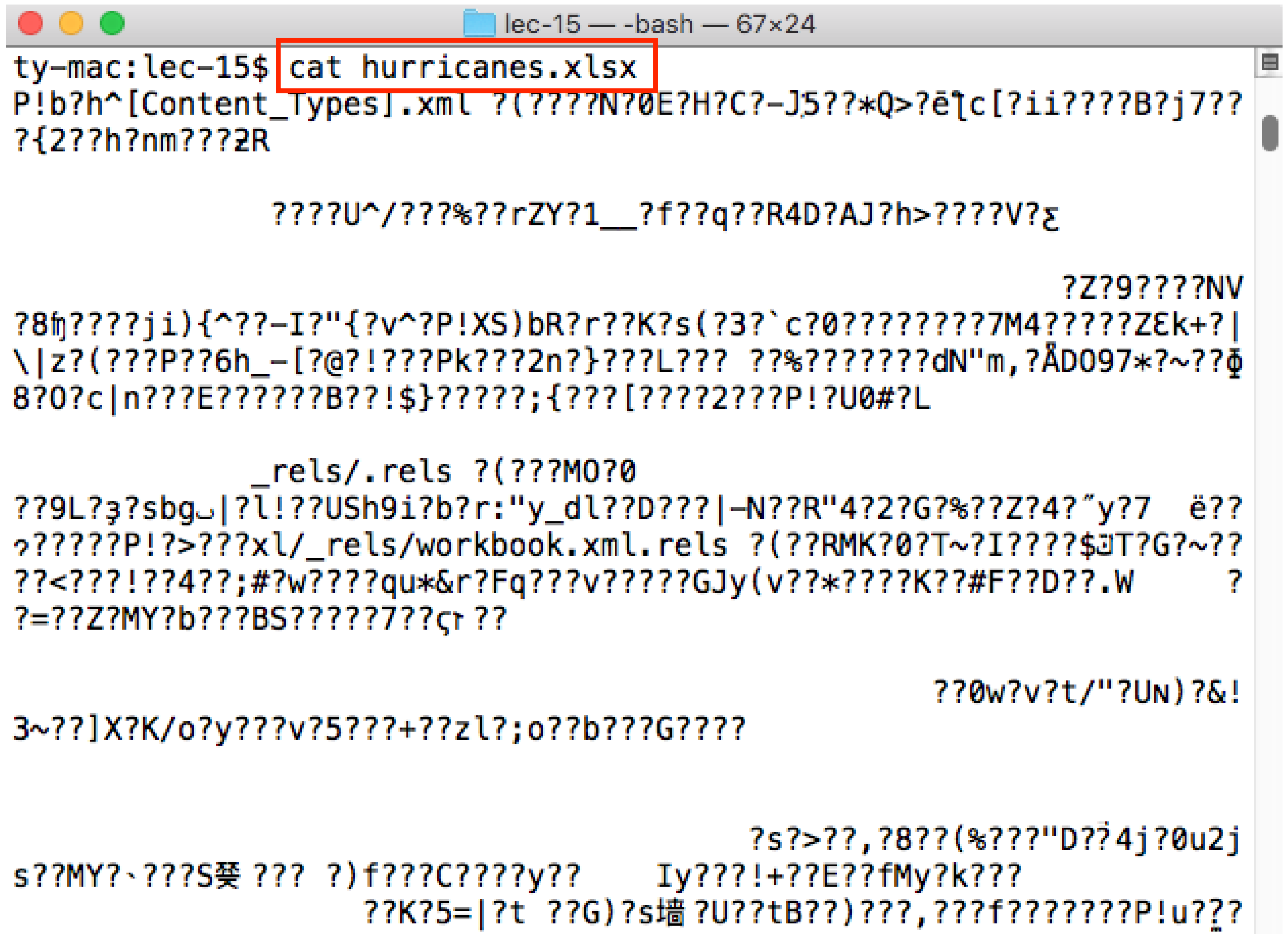
more tables of data

Excel Files

Extension: .xlsx

Format: binary

just 0's and 1's, not human-readable characters.
Need special software...



```
lec-15 — -bash — 67×24
ty-mac:lec-15$ cat hurricanes.xlsx
P!b?h^[Content_Types].xml ?(????N?0E?H?C?-J5??*Q>?ě[c[?ii????B?j7??
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                                             ??0w?v?t/"?Uɴ)?&!
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                                     ?s?>??,?8??(%???"D??4j?0u2j
s??MY?ˎ???S癸 ??? ?)f???C????y??    Iy???!+??E??fMy?k???
              ??K?5=|?t ??G)?s墙?U??tB??)???,???f???????P!u???
```

Writing code to read data from Excel files is tricky, unless you use special modules

Today's Outline

Spreadsheets

CSVs

Reading a CSV to a list of lists

Coding examples

CSVs

CSV is a simple data format that stands for
Comma-**S**eparated **V**alues

CSVs are like simple spreadsheets

- organize cells of data into rows and columns
- only one sheet per file
- only holds strings
- no way to specify font, borders, cell size, etc

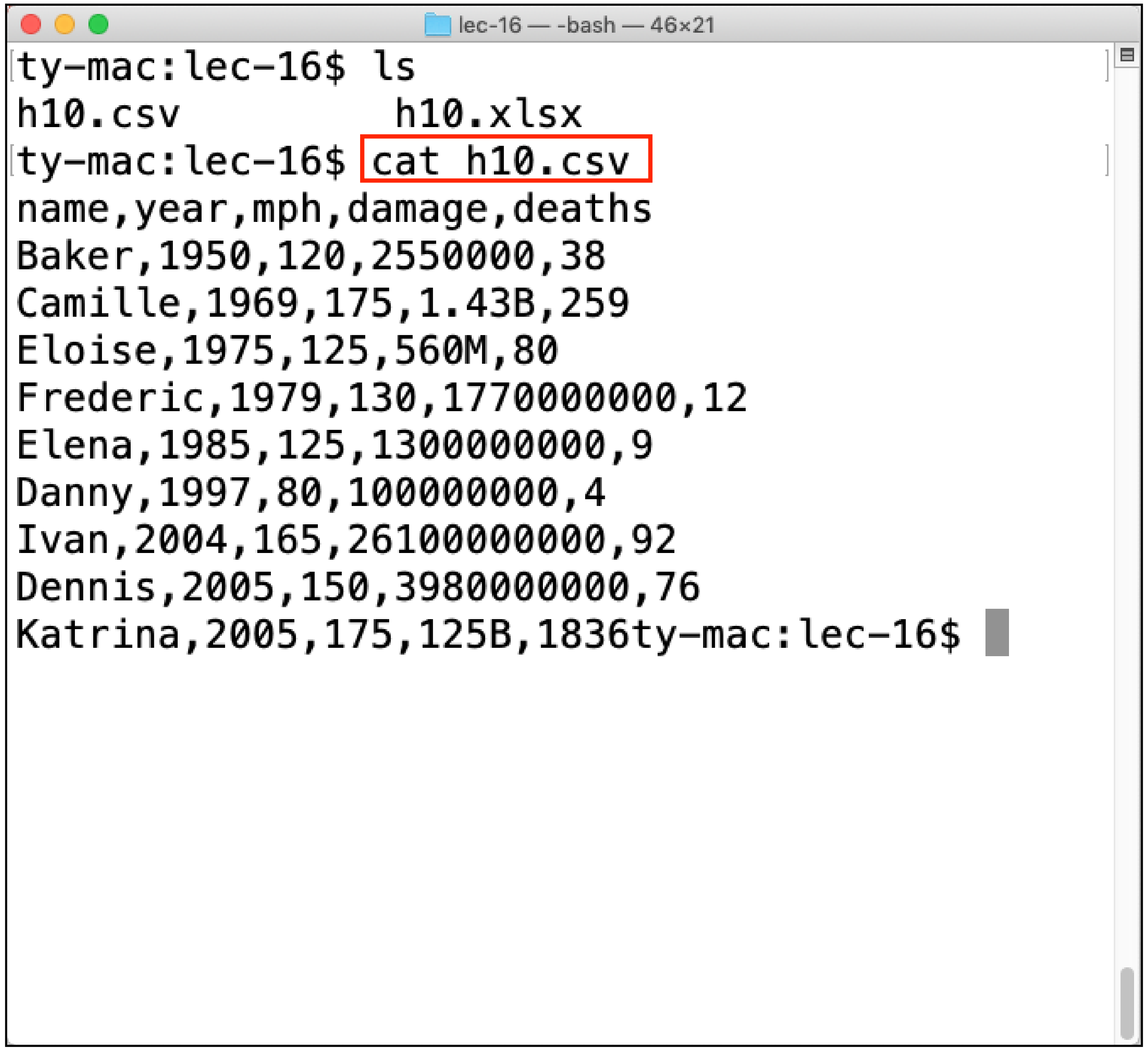
we'll do lots of type casting/conversion!

CSV Files

Extension: .csv

Format: plain text

just open in any editor (notepad, textedit, idle, etc) and you'll be able to read it



```
ty-mac:lec-16$ ls
h10.csv             h10.xlsx
ty-mac:lec-16$ cat h10.csv
name,year,mph,damage,deaths
Baker,1950,120,2550000,38
Camille,1969,175,1.43B,259
Eloise,1975,125,560M,80
Frederic,1979,130,1770000000,12
Elena,1985,125,1300000000,9
Danny,1997,80,100000000,4
Ivan,2004,165,26100000000,92
Dennis,2005,150,3980000000,76
Katrina,2005,175,125B,1836ty-mac:lec-16$
```

Writing code that understands CSV files is easy

Basic Syntax

Table

Name	**Date**	**Time**	**Status**	**Latitude**	**Longitude**	**WindSpeed**	**Ocean**
HEIDI	19671019	1200	TD	20.5N	54.0W	25	Atlantic
OLAF	19850822	0	TD	12.9N	102.2W	25	Pacific
TINA	19920917	1200	TD	10.4N	98.5W	25	Pacific
EMMY	19760820	1200	TD	14.0N	48.0W	20	Atlantic

Corresponding CSV

```
Name,Date,Time,Status,Latitude,Longitude,WindSpeed,Ocean
HEIDI,19671019,1200,TD,20.5N,54.0W,25,Atlantic
OLAF,19850822,0,TD,12.9N,102.2W,25,Pacific
TINA,19920917,1200,TD,10.4N,98.5W,25,Pacific
EMMY,19760820,1200,TD,14.0N,48.0W,20,Atlantic
```

Each row is a line of the file

Basic Syntax

Table

Name	Date	Time	Status	Latitude	Longitude	WindSpeed	Ocean
HEIDI	19671019	1200	TD	20.5N	54.0W	25	Atlantic
OLAF	19850822	0	TD	12.9N	102.2W	25	Pacific
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EMMY	19760820	1200	TD	14.0N	48.0W	20	Atlantic

Corresponding CSV

```
Name,Date,Time,Status,Latitude,Longitude,WindSpeed,Ocean
HEIDI,19671019,1200,TD,20.5N,54.0W,25,Atlantic
OLAF,19850822,0,TD,12.9N,102.2W,25,Pacific
TINA,19920917,1200,TD,10.4N,98.5W,25,Pacific
EMMY,19760820,1200,TD,14.0N,48.0W,20,Atlantic
```

Cells…

Basic Syntax

Table

Name	Date	Time	Status	Latitude	Longitude	WindSpeed	Ocean
HEIDI	19671019	1200	TD	20.5N	54.0W	25	Atlantic
OLAF	19850822	0	TD	12.9N	102.2W	25	Pacific
TINA	19920917	1200	TD	10.4N	98.5W	25	Pacific
EMMY	19760820	1200	TD	14.0N	48.0W	20	Atlantic

Corresponding CSV

```
Name,Date,Time,Status,Latitude,Longitude,WindSpeed,Ocean
HEIDI,19671019,1200,TD,20.5N,54.0W,25,Atlantic
OLAF,19850822,0,TD,12.9N,102.2W,25,Pacific
TINA,19920917,1200,TD,10.4N,98.5W,25,Pacific
EMMY,19760820,1200,TD,14.0N,48.0W,20,Atlantic
```

… are separated by commas

Basic Syntax

Table

Name	Date	Time	Status	Latitude	Longitude	WindSpeed	Ocean
HEIDI	19671019	1200	TD	20.5N	54.0W	25	Atlantic
OLAF	19850822	0	TD	12.9N	102.2W	25	Pacific
TINA	19920917	1200	TD	10.4N	98.5W	25	Pacific
EMMY	19760820	1200	TD	14.0N	48.0W	20	Atlantic

Cor We call characters that act a separators “**delimiters**”

Nar

HEI Newlines delimit rows

OL/

TIN The comma is a delimiter between cells in a row

EMMY,19760820,1200, TD,14.0N,48.0W,20,Atlantic

… are separated by commas

Advanced Syntax

We won’t go into details here, but there are some complexities

Motivation for more complicated syntax

- *what if* a cell contains a newline?
- *what if* we want a comma inside a cell?
- *what if* a cell contains a quote?
- *what if* we want to use different delimiters between rows/cells?

usually better to use a general CSV module than write our own

Today's Outline

Spreadsheets

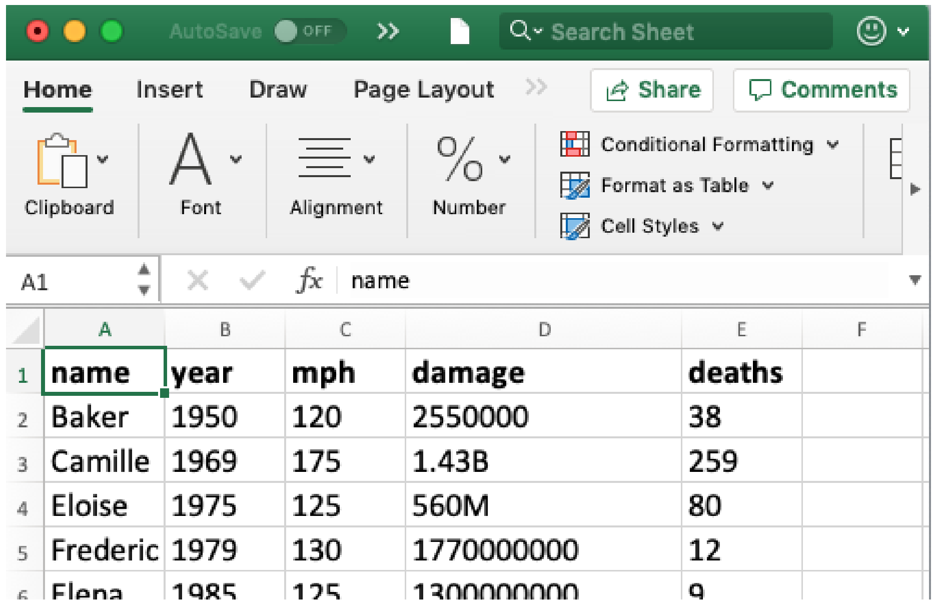
CSVs

Reading a CSV to a list of lists

Coding examples

Data Management

1. spreadsheet in Excel



	A	B	C	D	E	F
1	**name**	**year**	**mph**	**damage**	**deaths**	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
5	Frederic	1979	130	1770000000	12	
6	Elena	1985	125	1300000000	9	

Save As .CSV

2. CSV file saved somewhere

```
name,year,mph,damage,deaths
Baker,1950,120,2550000,38
Camille,1969,175,1.43B,259
Eloise,1975,125,560M,80
Frederic,1979,130,1770000000,12
```

3. Python Program

Parsing Code

list of lists

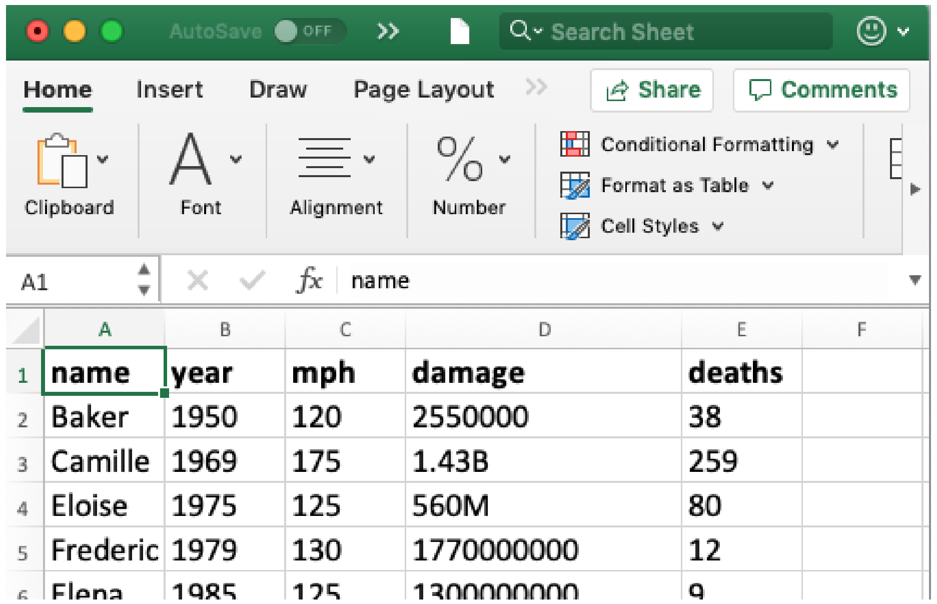
```
[
  ["name", "year", ...],
  ["Baker", "1950", ...],
  ...
]
```

Analysis Code

rows[1][0] $\longrightarrow$ "Baker"

Data Management

1. spreadsheet in Excel



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Save As .CSV

2. CSV file saved somewhere

```
name,year,mph,damage,deaths
Baker,1950,120,2550000,38
Camille,1969,175,1.43B,259
Eloise,1975,125,560M,80
Frederic,1979,130,1770000000,12
```

3. Python Program

Parsing Code

list of lists

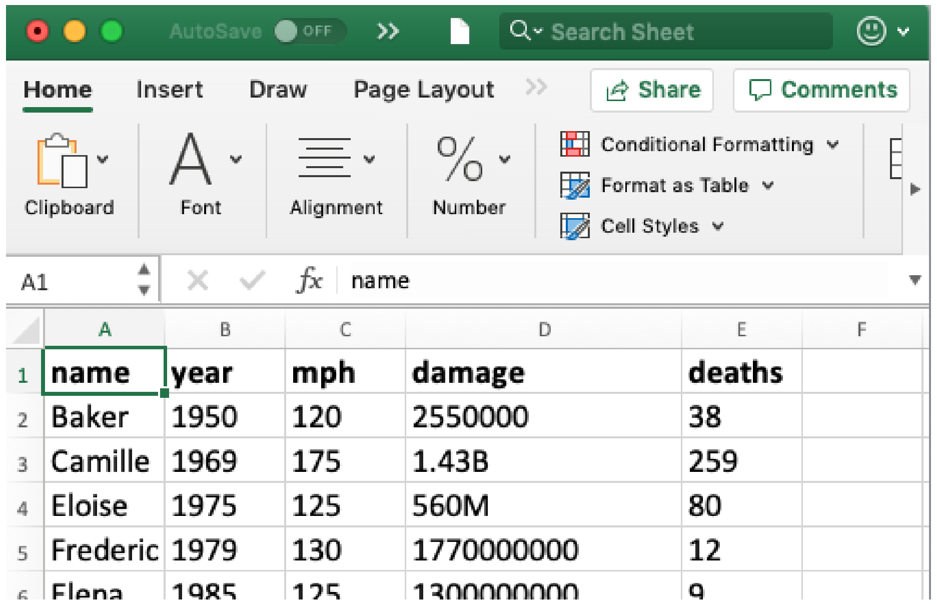
```
[
  ["name", "year", ...],
  ["Baker", "1950", ...],
  ...
]
```

Analysis Code

rows[3][1] → "1975"

Data Management

1. spreadsheet in Excel



	A	B	C	D	E	F
1	name	year	mph	damage	deaths	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
5	Frederic	1979	130	1770000000	12	
6	Elena	1985	125	1300000000	9	

Save As .CSV

2. CSV file saved somewhere

```
name,year,mph,damage,deaths
Baker,1950,120,2550000,38
Camille,1969,175,1.43B,259
Eloise,1975,125,560M,80
Frederic,1979,130,1770000000,12
```

3. Python Program

Analysis Code

rows[1][-1] $\longrightarrow$ "38"

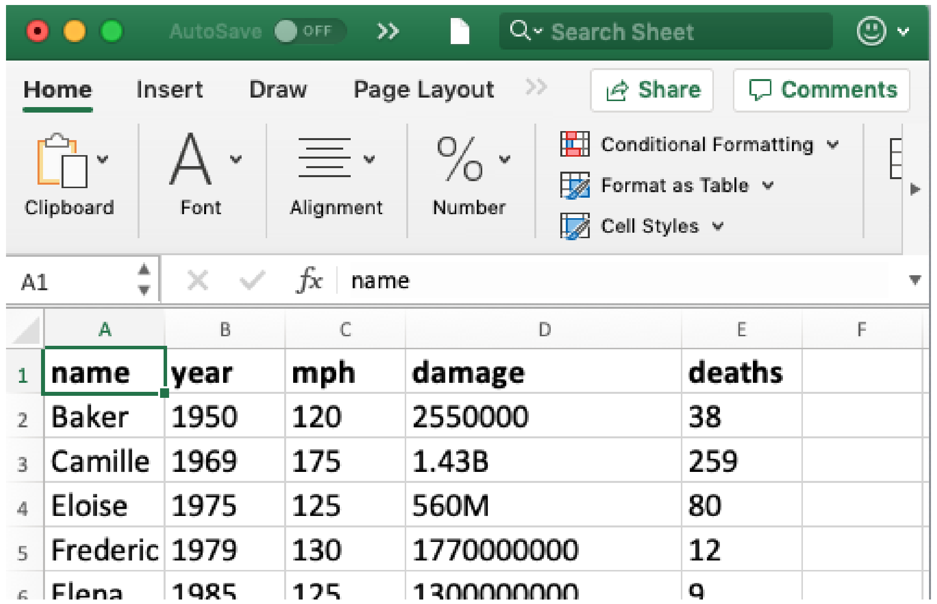
list of lists

```
[
  ["name", "year", ...],
  ["Baker", "1950", ...],
  ...
]
```

Parsing Code

Data Management

1. spreadsheet in Excel



	A	B	C	D	E	F
1	**name**	**year**	**mph**	**damage**	**deaths**	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
5	Frederic	1979	130	1770000000	12	
6	Elena	1985	125	1300000000	9	

Save As .CSV

2. CSV file saved somewhere

```
name,year,mph,damage,deaths
Baker,1950,120,2550000,38
Camille,1969,175,1.43B,259
Eloise,1975,125,560M,80
Frederic,1979,130,1770000000,12
```

3. Python Program

Parsing Code

list of lists

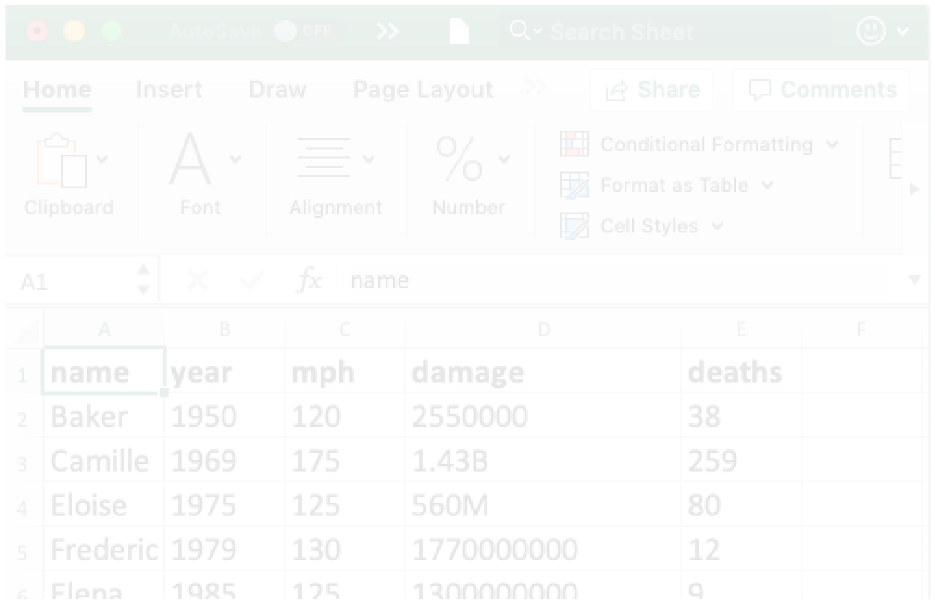
```
[
  ["name", "year", ...],
  ["Baker", "1950", ...],
  ...
]
```

Analysis Code

rows[0][-2] → "damage"

Data Management

1. spreadsheet in Excel



	A	B	C	D	E	F
1	name	year	mph	damage	deaths	
2	Baker	1950	120	2550000	38	
3	Camille	1969	175	1.43B	259	
4	Eloise	1975	125	560M	80	
5	Frederic	1979	130	1770000000	12	
6	Elena	1985	125	1300000000	9	

Save As .CSV

2. CSV file saved somewhere

```
name,year,mph,damage,deaths
Baker,1950,120,2550000,38
Camille,1969,175,1.43B,259
Eloise,1975,125,560M,80
Frederic,1979,130,1770000000,12
```

3. Python Program

Analysis Code

`rows[0][-2]` $\longrightarrow$ "damage"

list of lists

```
[
   ["name", "year", …],
   ["Baker", "1950", …],
   …
]
```

Parsing Code

What does this look like?

Example Copied From Sweigart Ch 16

Code

```
import csv
exampleFile = open('example.csv')
exampleReader = csv.reader(exampleFile)
exampleData = list(exampleReader)
```

example.csv

```
4/5/2015 13:34,Apples,73
4/5/2015 3:41,Cherries,85
4/6/2015 12:46,Pears,14
4/8/2015 8:59,Oranges,52
4/10/2015 2:07,Apples,152
4/10/2015 18:10,Bananas,23
4/10/2015 2:40,Strawberries,98
```

Example Copied From Sweigart Ch 16

Code

```
import csv
exampleFile = open('example.csv')
exampleReader = csv.reader(exampleFile)
exampleData = list(exampleReader)
exampleData
```

list of lists

```
[['4/5/2015 13:34', 'Apples', '73'], ['4/5/2015 3:41', 'Cherries', '85'],
['4/6/2015 12:46', 'Pears', '14'], ['4/8/2015 8:59', 'Oranges', '52'],
['4/10/2015 2:07', 'Apples', '152'], ['4/10/2015 18:10', 'Bananas', '23'],
['4/10/2015 2:40', 'Strawberries', '98']]
```

Example Copied From Sweigart Ch 16

```
import csv
exampleFile = open('example.csv')
exampleReader = csv.reader(exampleFile)
exampleData = list(exampleReader)
exampleData
```

let's generalize this to a function
(don't need to know exactly how the code works, though we will eventually)

Example Copied From Sweigart Ch 16

input

```
import csv
exampleFile = open('example.csv')
exampleReader = csv.reader(exampleFile)
exampleData = list(exampleReader)
exampleData
```

output

let's generalize this to a function
(don't need to know exactly how the code works, though we will eventually)

Example Copied From Sweigart Ch 16

```
def process_csv():
    import csv
    exampleFile = open('example.csv')
    exampleReader = csv.reader(exampleFile)
    exampleData = list(exampleReader)
    exampleData
```

1. move code to a function

Example Copied From Sweigart Ch 16

```
import csv

def process_csv():
  ~~import csv~~
  exampleFile = open('example.csv')
  exampleReader = csv.reader(exampleFile)
  exampleData = list(exampleReader)
  exampleData
```

2. move out imports

Example Copied From Sweigart Ch 16

```
import csv

def process_csv():
   ~~import csv~~
   exampleFile = open('example.csv')
   exampleReader = csv.reader(exampleFile)
   exampleData = list(exampleReader)
   exampleFile.close()
   return exampleData
```

3. return data to get it out of the function

Example Copied From Sweigart Ch 16

```
import csv

def process_csv():
  ~~import csv~~
  exampleFile = open(~~'example.csv'~~)
  exampleReader = csv.reader(exampleFile)
  exampleData = list(exampleReader)
  return exampleData
```

4. generalize input

Example Copied From Sweigart Ch 16

```
import csv

def process_csv(filename):
  ~~import csv~~
  exampleFile = open(filename)
  exampleReader = csv.reader(exampleFile)
  exampleData = list(exampleReader)
  return exampleData
```

4. generalize input

Example Copied From Sweigart Ch 16

```
import csv

# copied from https://automatetheboringstuff.com/2e/chapter16/
def process_csv(filename):
  ~~import csv~~
  exampleFile = open(filename)
  exampleReader = csv.reader(exampleFile)
  exampleData = list(exampleReader)
  return exampleData
```

Reminder!
cite code
copied online

5. cite the code

Example Copied From Sweigart Ch 16

```
import csv

# inspired by https://automatetheboringstuff.com/2e/chapter16/
def process_csv(filename):
    example_file = open(filename, encoding="utf-8")
    example_reader = csv.reader(example_file)
    example_data = list(example_reader)
    example_file.close()
    return example_data
```

keep this handy for copy/paste

Encoding required for international computers
We use this file format for all csv files for the class

Remember to close your files

Today's Outline

Spreadsheets

CSVs

Reading a CSV to a list of lists

Coding examples

Example: Student Information Survey

Goal: find the average age of the students, for each lecture

Input:

- Student data (a CSV file)

Output:

- Average student age for a given lecture

Goal: column name, print that data for all hurricanes

Example:

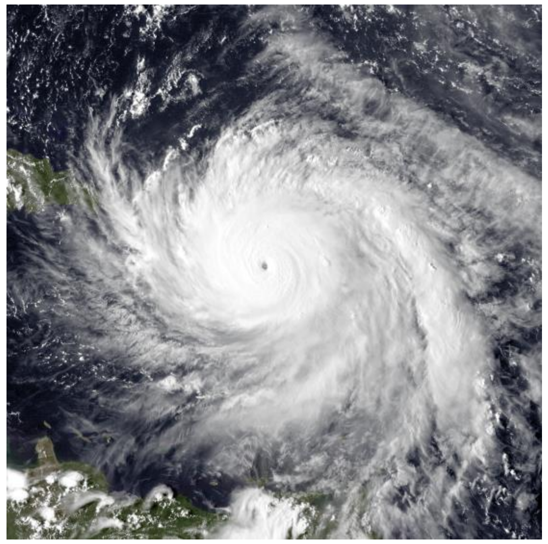
```
LEC001: 18.5
LEC002: 18.2
LEC003: 18.6
…
```

Challenge: Hurricane Column Dump

Goal: column name, print that data for all hurricanes

Input:
- column name (and a CSV file)

Output:
- data in given column, associated with name



Example:

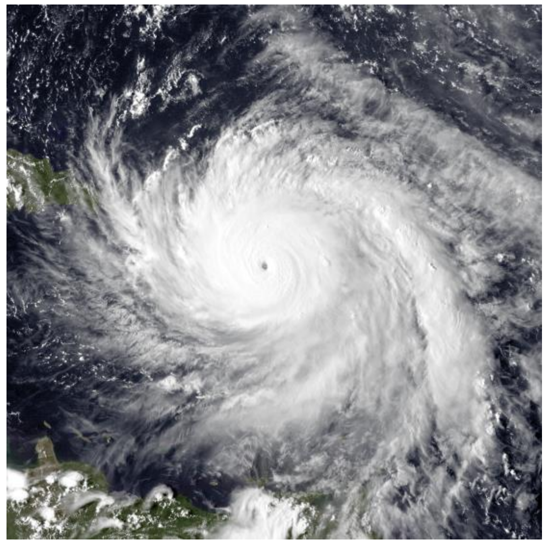
```
Baker: 1950
Camille: 1969
Eloise: 1975
…
```

Challenge: Hurricanes per Year

Goal: column name, print that data for all hurricanes

Input:
- none typed (only a CSV file)

Output:
- the number of hurricanes in each year



Example:

```
1967: 23
1968: 29
2969: 15
…
```