CMPU 101 § 53 · Computer Science I

Tables

30 January 2024

VASSAR COLLEGE

A·D·1861

Assignment 1	Due Wednesday
Assignment 2	Out on Thursday
Lab 2	Due Friday

Where are we?

Here are some data that can be represented with what we’ve seen so far:

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A picture of a dog	*Image*

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The population of NYC	*Number*

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A picture of a dog	*Image*
The population of NYC	*Number*
The complete text of *Beowulf*	*String*

Here are some data that can be represented with what we've seen so far:

A picture of a dog	*Image*
The population of NYC	*Number*
The complete text of *Beowulf*	*String*
Whether or not I ate breakfast this morning	*Boolean*

What if we wanted to write a program to look up the population of any town in New York?

We can consider the last two census years – 2010 and 2020.

```
fun population(municipality :: String, year :: Number) -> Number:
  doc: "Return population of the municipality for the given year"
  if municipality == "New York":
    if year == 2010:
      8175133
    else if year == 2020:
      8804190
    else:
      raise("Bad year")
    end
  else if municipality == "Poughkeepsie":
    if year == 2010:
      43341
    else if year == 2020:
      45471
    else:
      raise("Bad year")
    end
  else:
    raise("Bad municipality")
  end
end
```

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end
```

We can nest `if` expressions!

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end
```

Report an error that prevents the function from returning an answer

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```

This isn't a great way to do this. Why not?

```
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    raise("Bad municipality")
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end
```

What about the rest of the state?

```
fun population(municipality :: String, year :: Number) -> Number:
  doc: "Return population of the municipality for the given year"
  if municipality == "New York":
    if year == 2010:
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    else:
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    end
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    raise("Bad municipality")
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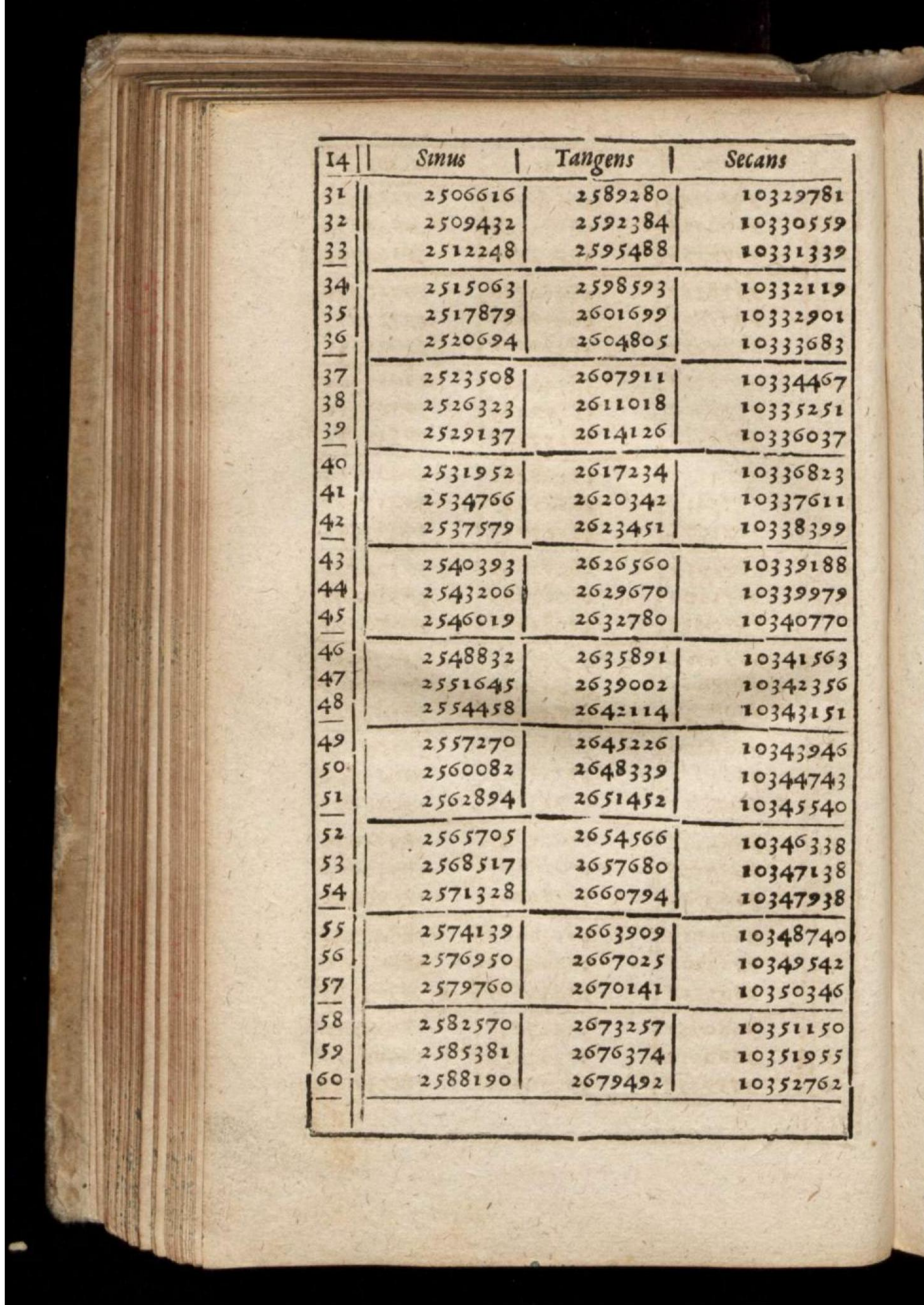
end
```

KEY IDEA Separate data from computation.

Tables

Tables are used for tabular data, like you might find printed in a book or in a spreadsheet on a computer.



14	Sinus	Tangens	Secans
31	2506616	2589280	10329781
32	2509432	2592384	10330559
33	2512248	2595488	10331339
34	2515063	2598593	10332119
35	2517879	2601699	10332901
36	2520694	2604805	10333683
37	2523508	2607911	10334467
38	2526323	2611018	10335251
39	2529137	2614126	10336037
40	2531952	2617234	10336823
41	2534766	2620342	10337611
42	2537579	2623451	10338399
43	2540393	2626560	10339188
44	2543206	2629670	10339979
45	2546019	2632780	10340770
46	2548832	2635891	10341563
47	2551645	2639002	10342356
48	2554458	2642114	10343151
49	2557270	2645226	10343946
50	2560082	2648339	10344743
51	2562894	2651452	10345540
52	2565705	2654566	10346338
53	2568517	2657680	10347138
54	2571328	2660794	10347938
55	2574139	2663909	10348740
56	2576950	2667025	10349542
57	2579760	2670141	10350346
58	2582570	2673257	10351150
59	2585381	2676374	10351955
60	2588190	2679492	10352762

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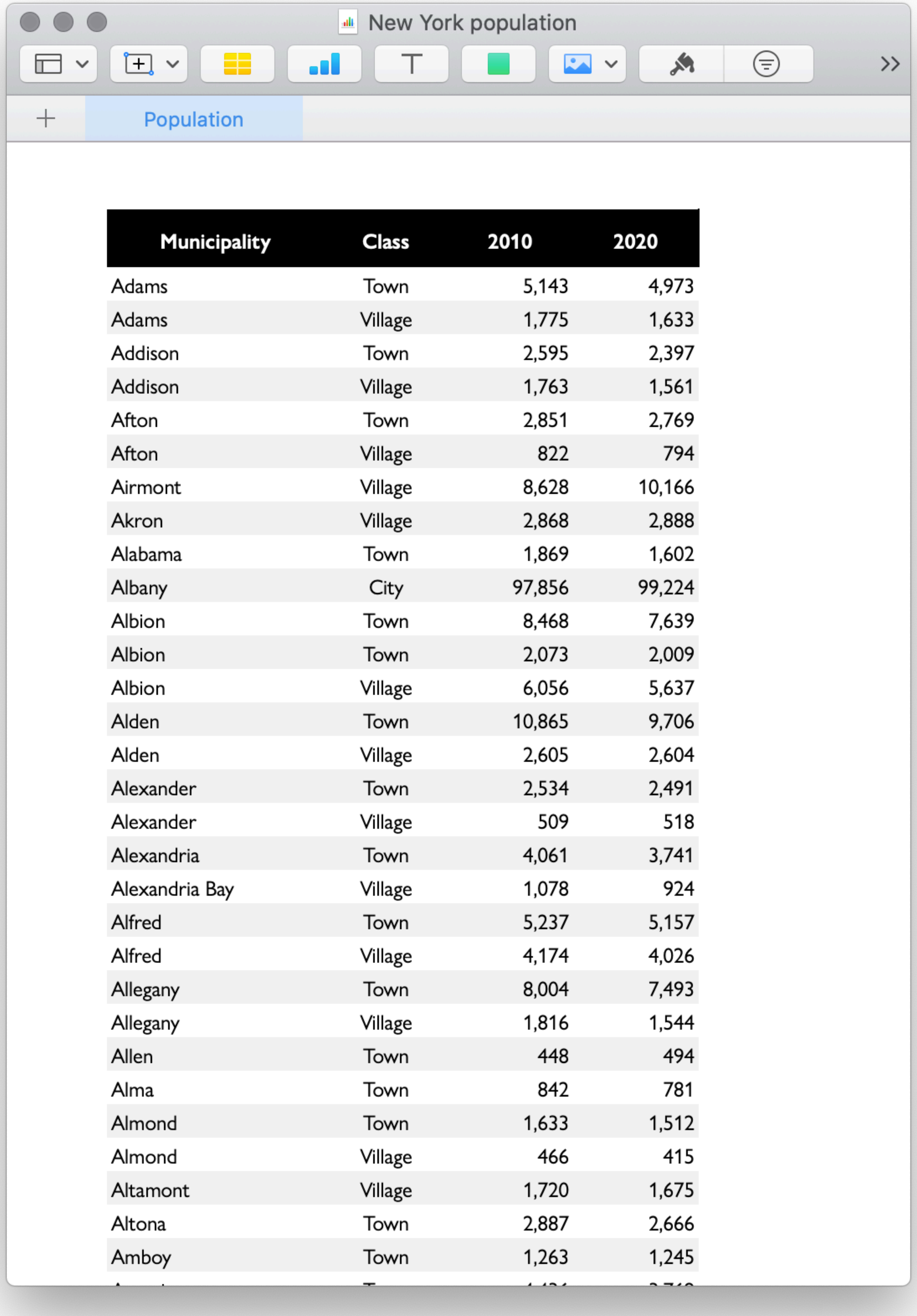
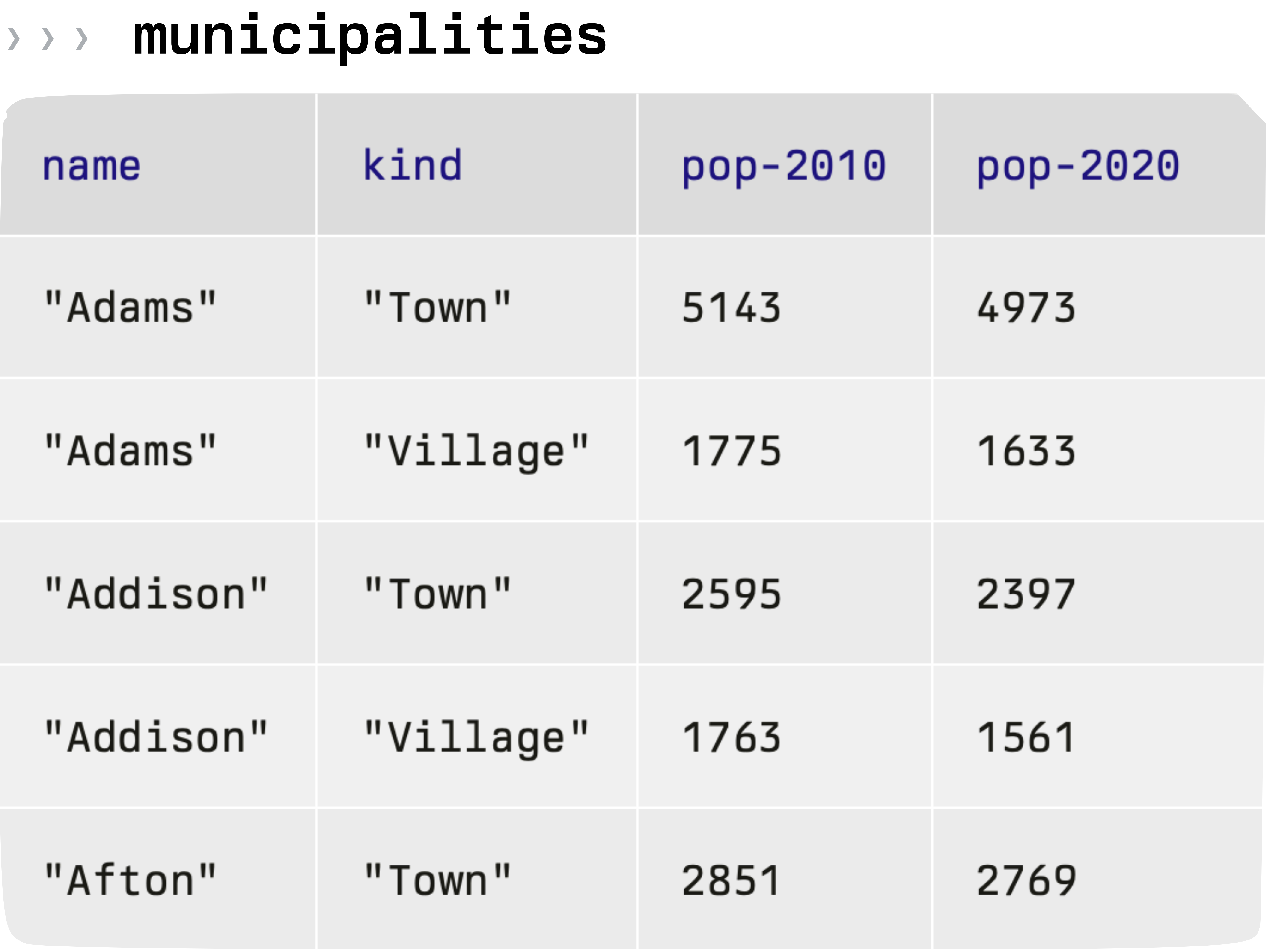


Municipality	Class	2010	2020
Adams	Town	5,143	4,973
Adams	Village	1,775	1,633
Addison	Town	2,595	2,397
Addison	Village	1,763	1,561
Afton	Town	2,851	2,769
Afton	Village	822	794
Airmont	Village	8,628	10,166
Akron	Village	2,868	2,888
Alabama	Town	1,869	1,602
Albany	City	97,856	99,224
Albion	Town	8,468	7,639
Albion	Town	2,073	2,009
Albion	Village	6,056	5,637
Alden	Town	10,865	9,706
Alden	Village	2,605	2,604
Alexander	Town	2,534	2,491
Alexander	Village	509	518
Alexandria	Town	4,061	3,741
Alexandria Bay	Village	1,078	924
Alfred	Town	5,237	5,157
Alfred	Village	4,174	4,026
Allegany	Town	8,004	7,493
Allegany	Village	1,816	1,544
Allen	Town	448	494
Alma	Town	842	781
Almond	Town	1,633	1,512
Almond	Village	466	415
Altamont	Village	1,720	1,675
Altona	Town	2,887	2,666
Amboy	Town	1,263	1,245

To define a table in Pyret, we specify its contents like so:

```
municipalities =
  table: name, kind, pop-2010, pop-2020
    row: "Adams", "Town", 5143, 4973
    row: "Adams", "Village", 1775, 1633
    row: "Addison", "Town", 2595, 2397
    row: "Addison", "Village", 1763, 1561
    row: "Afton", "Town", 2851, 2769
    ...
  end
```



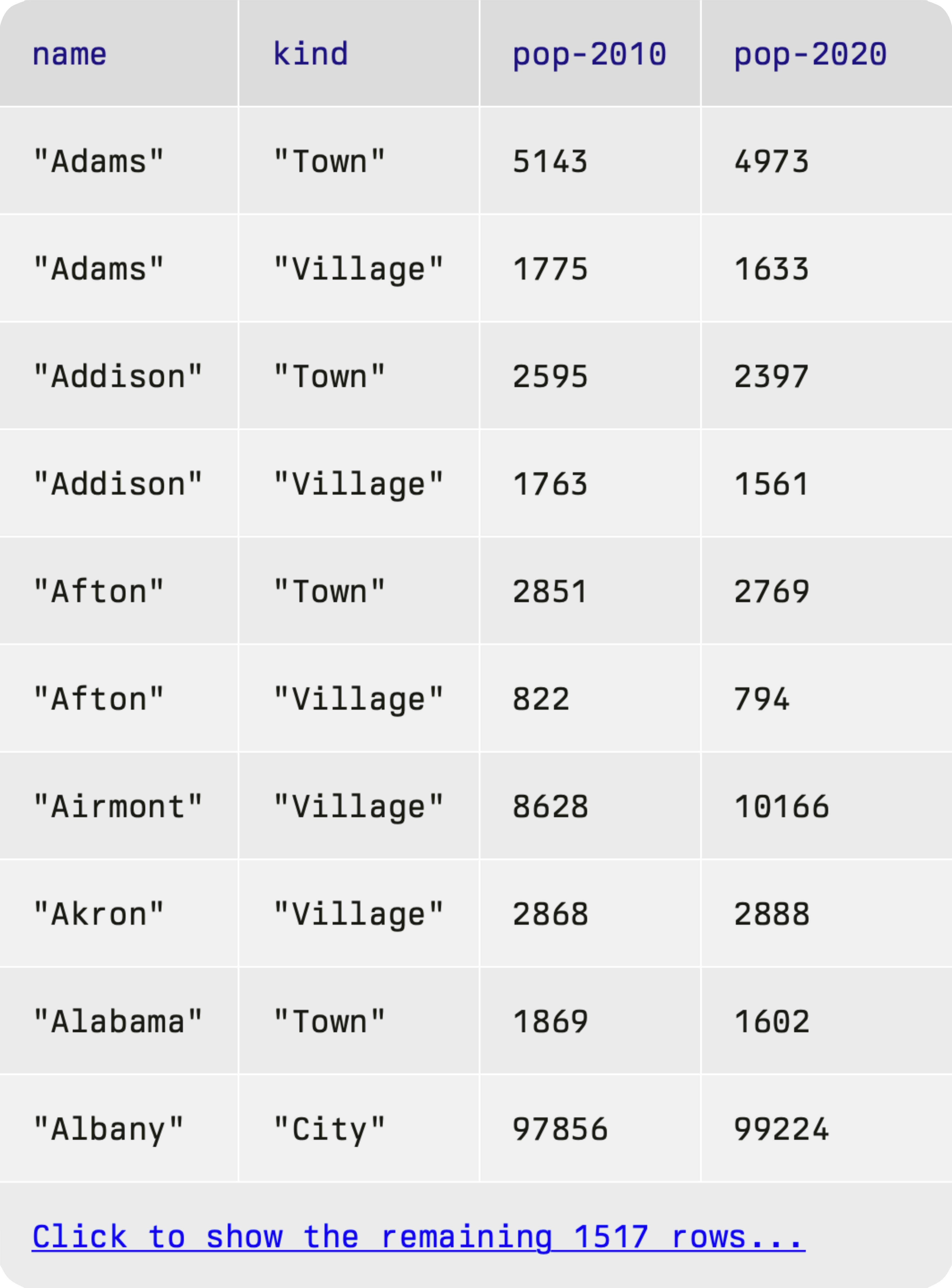
```
››› municipalities
```

name	kind	pop-2010	pop-2020
"Adams"	"Town"	5143	4973
"Adams"	"Village"	1775	1633
"Addison"	"Town"	2595	2397
"Addison"	"Village"	1763	1561
"Afton"	"Town"	2851	2769

Next class, we'll see how we can load tabular data from outside Pyret so we don't need to enter it all into our program.

For today, I've made a Pyret file that has the full NY municipality data, which we can load:

```
include shared-gdrive("municipalities",
  "1RfjMqyebrBnmdhS8H846flCzwz5gknyE")
```



name	kind	pop-2010	pop-2020
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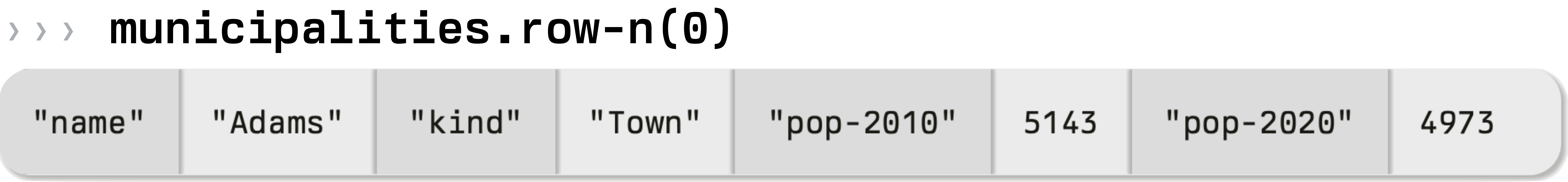
"Adams"	"Village"	1775	1633
"Addison"	"Town"	2595	2397
"Addison"	"Village"	1763	1561
"Afton"	"Town"	2851	2769
"Afton"	"Village"	822	794
"Airmont"	"Village"	8628	10166
"Akron"	"Village"	2868	2888
"Alabama"	"Town"	1869	1602
"Albany"	"City"	97856	99224

Click to show the remaining 1517 rows...

Now that we have the data in Pyret, we can write programs to answer questions.

To get a row out of a table, specify its number, beginning at zero:



```
››› municipalities.row-n(0)
"name"  "Adams"  "kind"  "Town"  "pop-2010"  5143  "pop-2020"  4973
```

The data type returned by `.row-n` is a *Row*.

We can access a value in the Row by specifying the name of a column:

```
  ››› municipalities.row-n(0)["name"]
  "Adams"
```

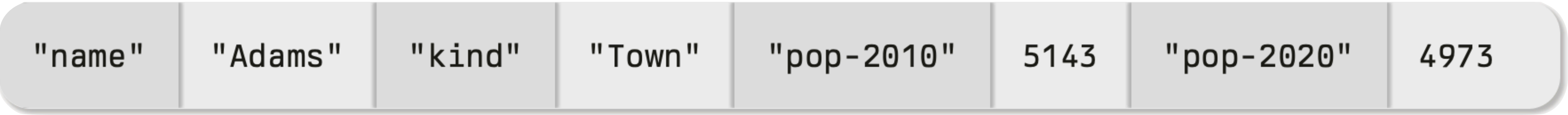
We can write a function that takes a row as input:

```
fun population-decreased(r :: Row) -> Boolean:
  doc: "Return true if the municipality's
population went down between 2010 and 2020"
  r["pop-2020"] < r["pop-2010"]
end
```

```
fun population-decreased(r :: Row) -> Boolean:
  doc: "Return true if the municipality's
population went down between 2010 and 2020"
  if r["pop-2020"] < r["pop-2010"]:
    true
  else:
    false
  end
end
```

*Why **don’t** we write it like this?*

Consider calling it on a particular input.



"name"	"Adams"	"kind"	"Town"	"pop-2010"	5143	"pop-2020"	4973

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fun population-decreased(r :: Row) -> Boolean:
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  if r["pop-2020"] < r["pop-2010"]:
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Consider calling it on a particular input.

r =

"name"	"Adams"	"kind"	"Town"	"pop-2010"	5143	"pop-2020"	4973

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if r["pop-2020"] < r["pop-2010"]:
  true
else:
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end
```

Consider calling it on a particular input.

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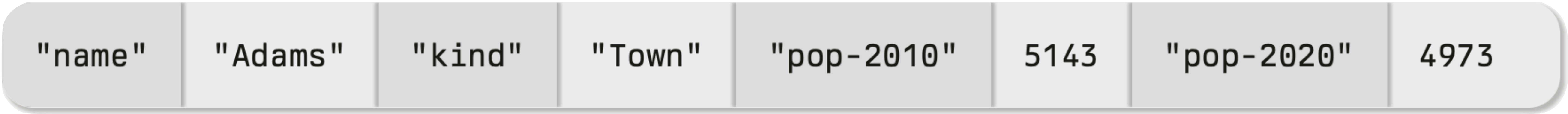

"name"	"Adams"	"kind"	"Town"	"pop-2010"	5143	"pop-2020"	4973

```
if 4973 < r["pop-2010"]:
  true
else:
  false
end
```

Consider calling it on a particular input.

r =

"name"	"Adams"	"kind"	"Town"	"pop-2010"	5143	"pop-2020"	4973

```
if 4973 < 5143:
  true
else:
  false
end
```

```
if true:
  true
else:
  false
end
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if true:
  true
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end
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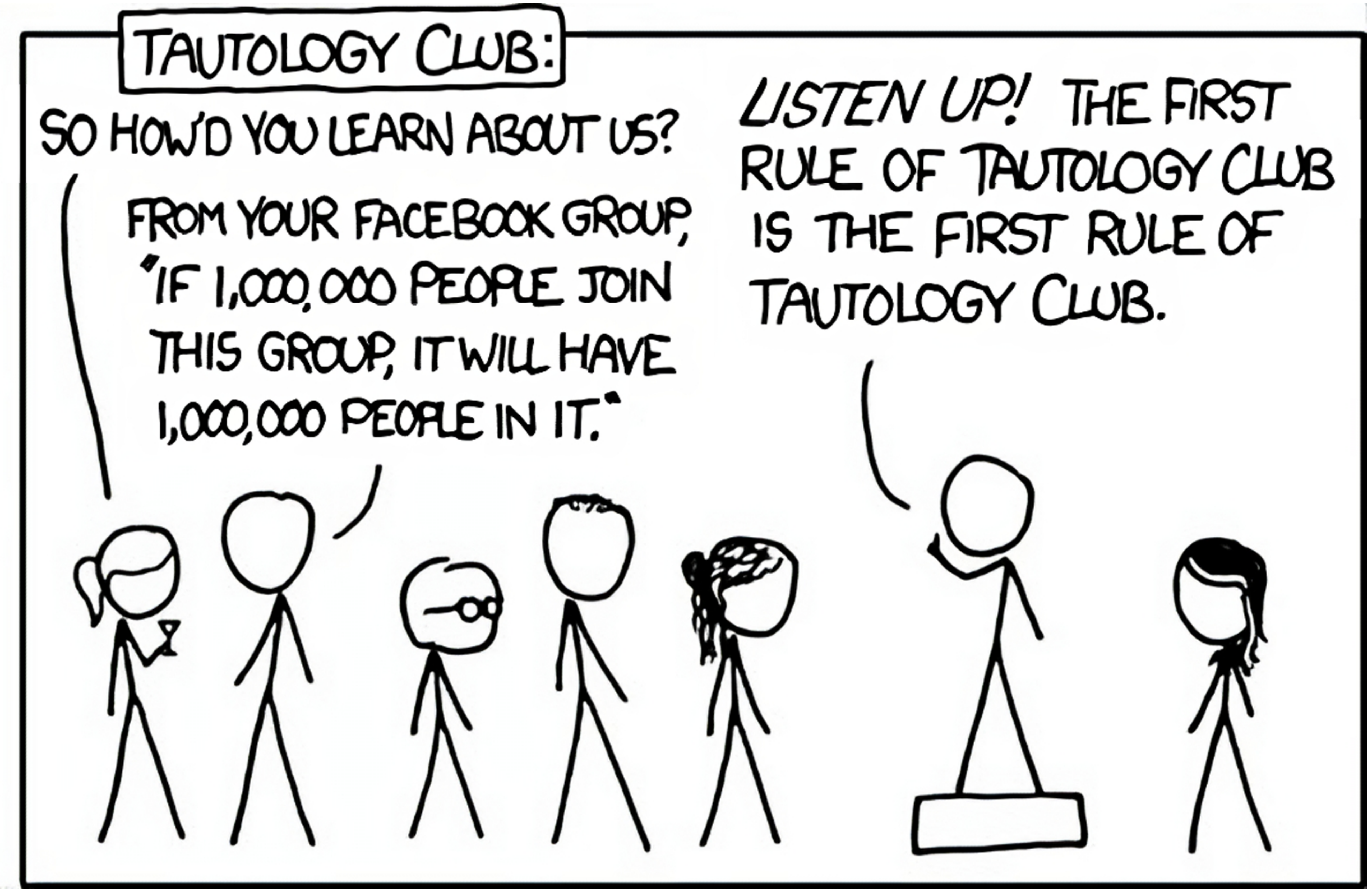
TAUTOLOGY CLUB:
SO HOW'D YOU LEARN ABOUT US?
FROM YOUR FACEBOOK GROUP, "IF 1,000,000 PEOPLE JOIN THIS GROUP, IT WILL HAVE 1,000,000 PEOPLE IN IT."
LISTEN UP! THE FIRST RULE OF TAUTOLOGY CLUB IS THE FIRST RULE OF TAUTOLOGY CLUB.

xkcd.com/703

```
if true:
  true
else:
  false
end
```

This is equivalent to just writing **`true`**

```
if 4973 < 5143:
  true
else:
  false
end
```

This is equivalent to just writing **`4973 < 5143`** *r* =

"name"	"Adams"	"kind"	"Town"	"pop-2010"	5143	"pop-2020"	4973

```
if r["pop-2020"] < r["pop-2010"]:
  true
else:
  false
end
```

This is equivalent to just writing

`r["pop-2020"] < r["pop-2010"]`

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fun population-decreased(r :: Row) -> Boolean:
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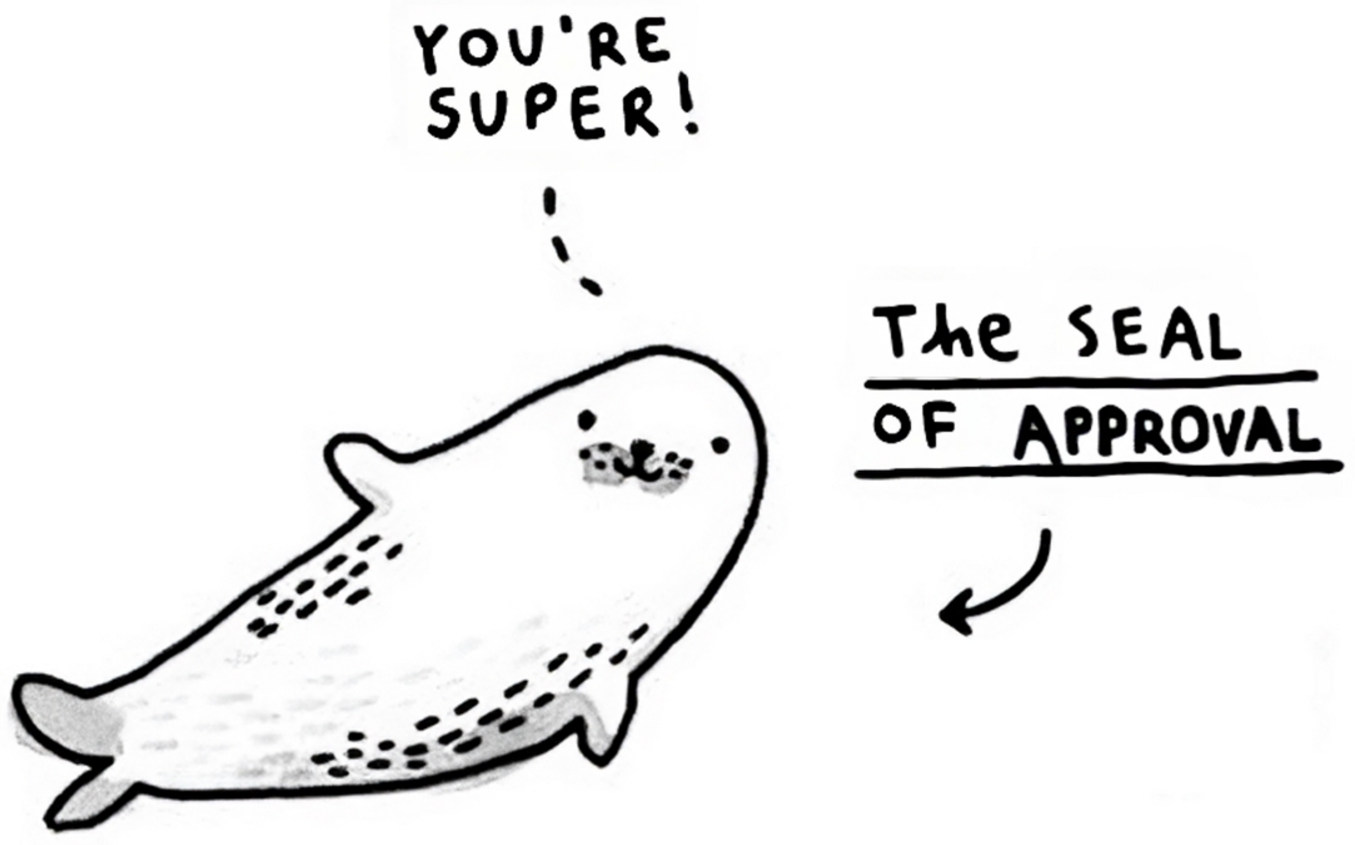

Illustration by Gemma Correll

```
fun population-decreased(r :: Row) -> Boolean:
  doc: "Return true if the municipality's
population went down between 2010 and 2020"
  if r["pop-2020"] < r["pop-20
    true
  else:
    false
  end
end
```

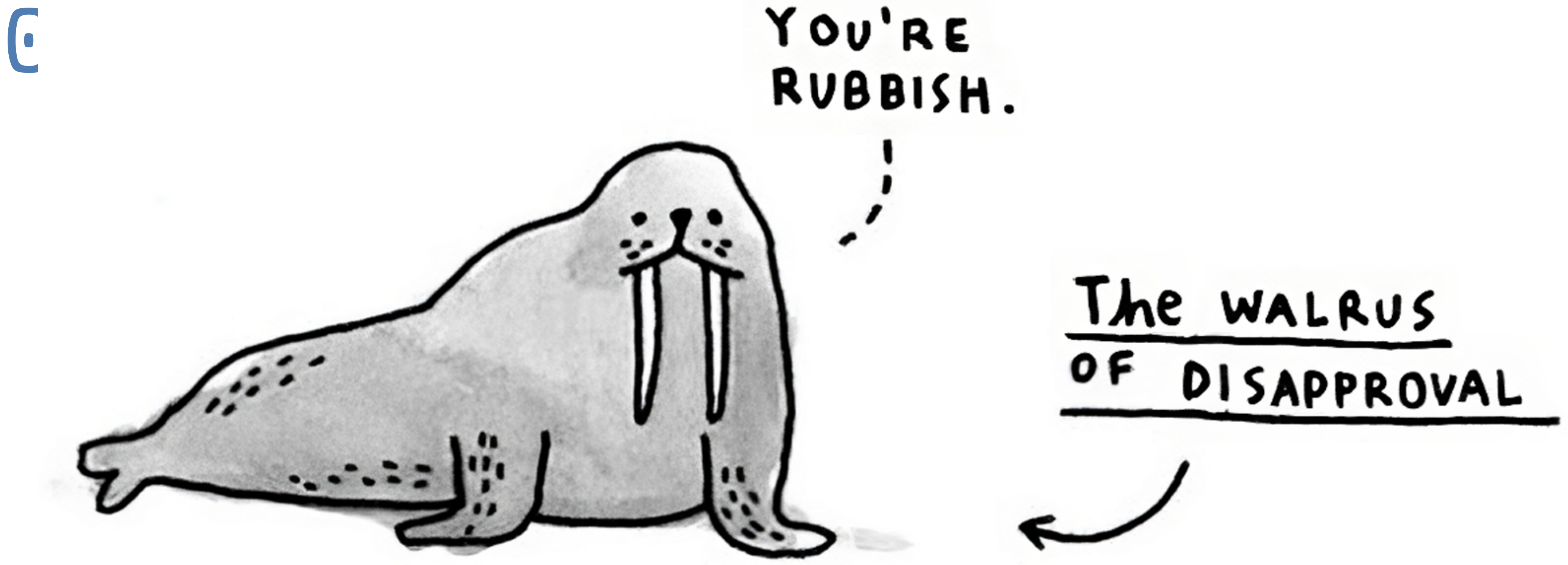

Illustration by Gemma Correll

Filtering and ordering tables

To work with tables, we'll use a library that goes with the textbook.

We need to tell Pyret to load it:

```
include shared-gdrive("dcic-2021",
  "1wyQZj_L0qqV9Ekgr9au6RX2iqt2Ga8Ep")
```

One thing we might want to do is to get a version of the table that only has cities where the population has decreased.

```
fun filter-population-decreased(t :: Table) -> Table:
  if population-decreased(t.row-n(0)):
    ...  # Keep row 0
    if population-decreased(t.row-n(1)):
      ...  # Keep row 1
    else:
      ...  # Don't keep row 1
    end
  else:
    ...  # Don't keep row 0
  end
end
```

We can use **`filter-with`** to return a new table of just the rows where **`population-decreased`** evaluates to `true`:

```
filter-with(municipalities, population-decreased)
```

We can also use **`filter-with`** to get just the towns:

```
fun is-town(r :: Row) -> Boolean:
  doc: "Check if a row is for a town"
  r["kind"] == "Town"
end

filter-with(municipalities, is-town)
```

We can also order the data by the values in one column:

```
order-by(municipalities, "pop-2020", false)
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order-by(municipalities, "pop-2020", false)
```

This means we want to sort in ***descending*** *order;* **`true`** *means* ***ascending.***

And we can combine all of these operations.

How would we get the town with the smallest population?

```
order-by(
  filter-with(municipalities, is-town),
  "pop-2020",
  true
).row-n(0)
```

Example: Population change

PROBLEM Figure out what the fastest-growing *towns* are in New York.

Subtasks:

- Filtering to just towns
- Calculating percentage change in population
- Building a column for percentage change
- Sorting on that column in *descending* order

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- Calculating percentage change in population
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- Sorting on that column in *descending* order

```
towns = filter-with(municipalities, is-town)
```

Subtasks:

- Filtering to just towns
- Calculating percentage change in population
- Building a column for percentage change
- Sorting on that column in *descending* order

```
towns = filter-with(municipalities, is-town)

fun percent-change(r :: Row) -> Number:
  doc: "Compute the percentage change for the
population of a municipality between 2010 and 2020"
  (r["pop-2020"] - r["pop-2010"]) / r["pop-2010"]
end
```

We can write a function that takes a row as input and returns any kind of value, not just a Boolean.

Subtasks:

- Filtering to just towns
- Calculating percentage change in population
- Building a column for percentage change
- Sorting on that column in *descending* order

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  (r["pop-2020"] - r["pop-2010"]) / r["pop-2010"]
end

towns-with-percent-change =
  build-column(towns, "percent-change",
    percent-change)
```

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  (r["pop-2020"] - r["pop-2010"]) / r["pop-2010"]
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towns-with-percent-change =
  build-column(towns, "percent-change",
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```

Name of the new column

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end

towns-with-percent-change =
  build-column(towns, "percent-change",
    percent-change)
```

Name of the new column

Name of the function to use

Subtasks:

- Filtering to just towns
- Calculating percentage change in population
- Building a column for percentage change
- Sorting on that column in *descending* order

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towns = filter-with(municipalities, is-town)

fun percent-change(r :: Row) -> Number:
  doc: "Compute the percentage change for the
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  (r["pop-2020"] - r["pop-2010"]) / r["pop-2010"]
end

towns-with-percent-change =
  build-column(towns, "percent-change",
    percent-change)

fastest-growing-towns =
  order-by(towns-with-percent-change,
    "percent-change", false)

fastest-growing-towns
```

Pyret code from class:

`tinyurl.com/101-2024-01-30`

Acknowledgments

This class incorporates material from:

Kathi Fisler, Brown University

Doug Woos, Brown University