CMPU 101 § 52 · Computer Science I

# Tables

30 January 2023

VASSAR COLLEGE A·D·1861

Lab 2

- Due Friday

Assignment 2

- Due Wednesday

# Where are we?

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

| | |
|---|---|
| A picture of a dog | *Image* |
| The population of Azerbaijan | *Number* |
| The complete text of the *Baghavad Gita* | *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" statements!*

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This is not a great way to do this.

Why not?

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end
```

*What about the rest of the state?*

```
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  if municipality == "New York":
    if year == 2010:
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    end
  else if municipality == "Poughkeepsie":
    if year == 2010:
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    else if year == 2020:
      45471
    else:
      raise("Bad year")
    end
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    raise("Bad municipality")
  end
end
```
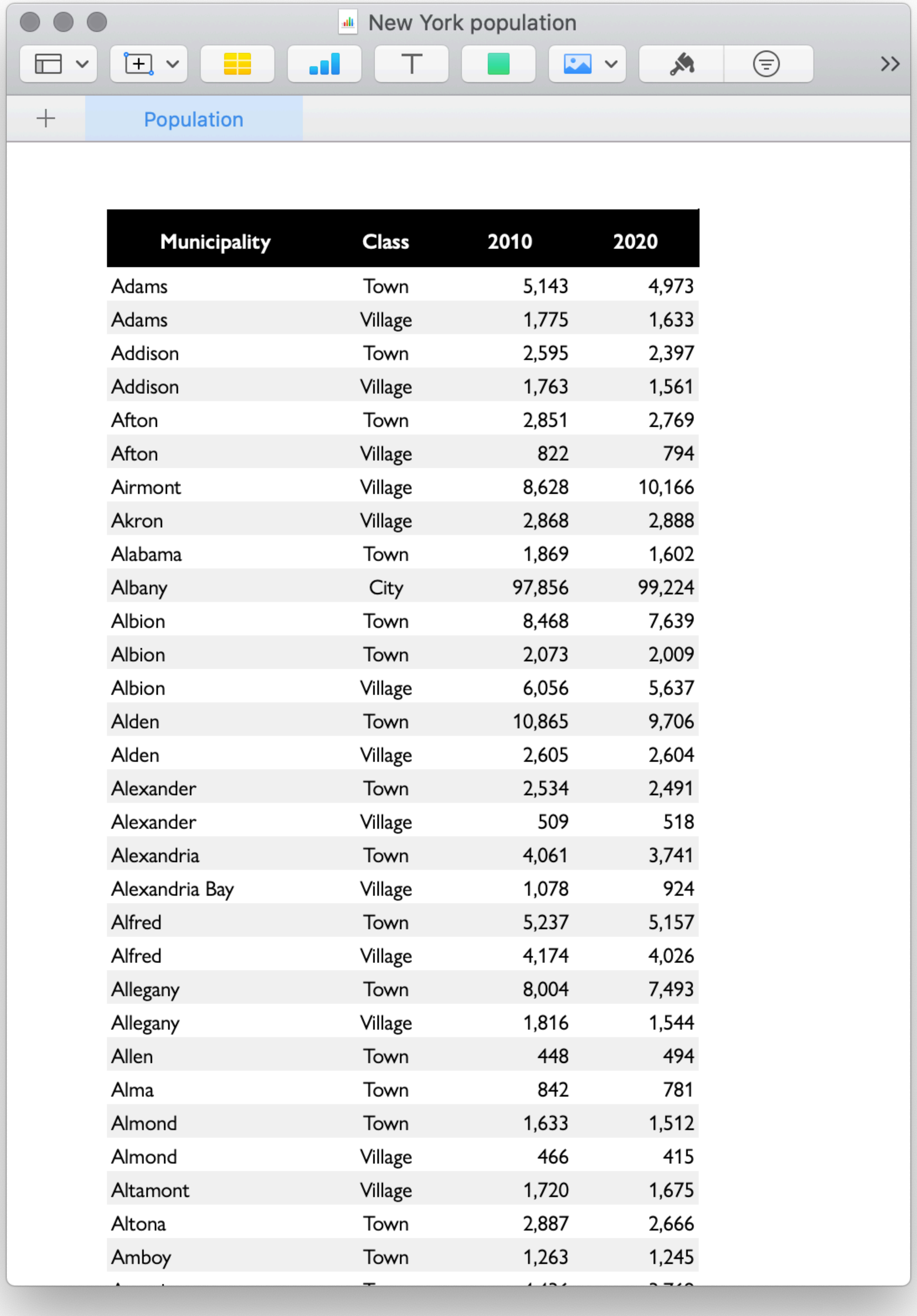

KEY IDEA Separate data from computations.

# Tables

*Tables* are used for tabular data, like you might find in a spreadsheet.



| 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
```

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

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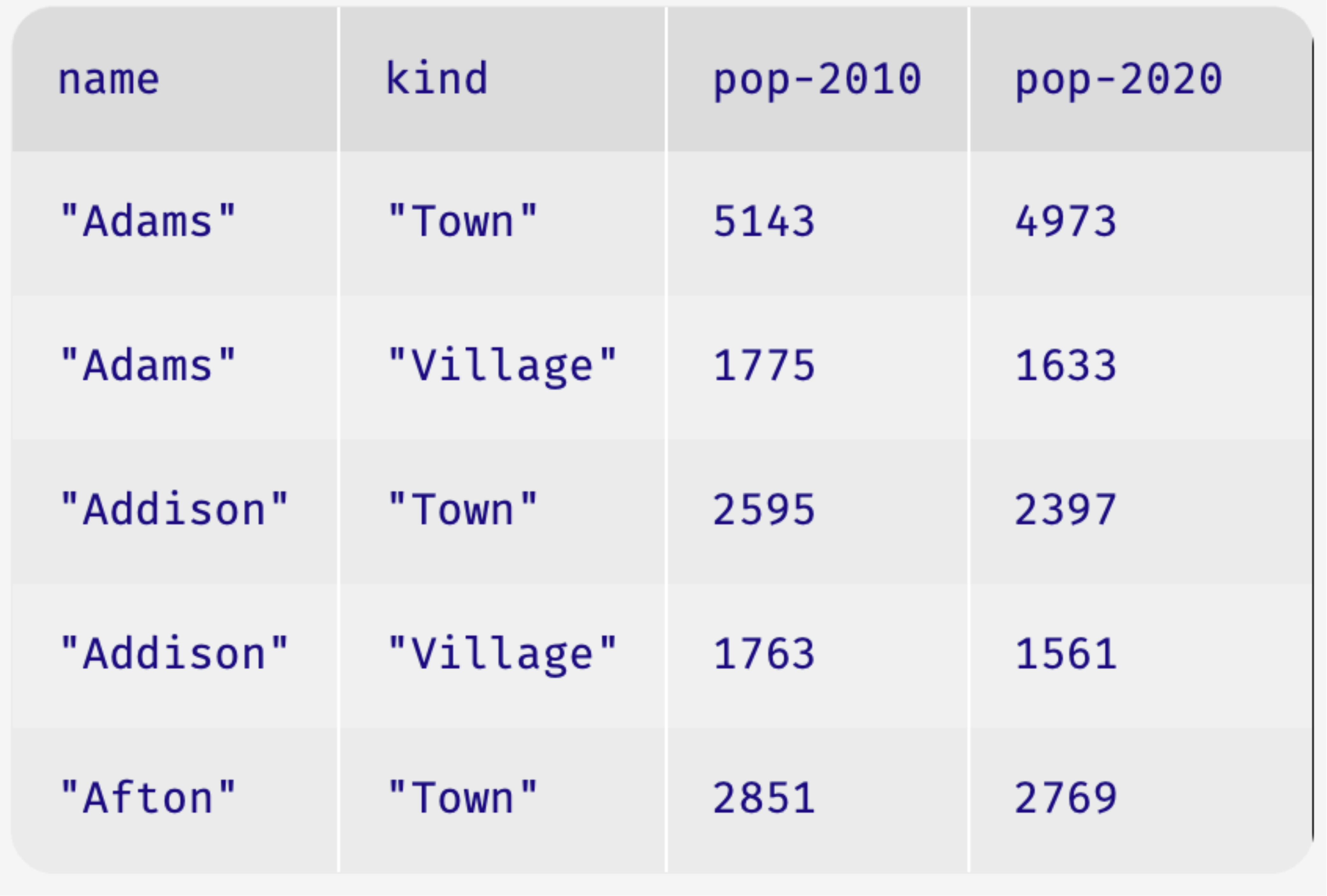

*As with functions, we can specify the types for parts of a table.*

```
>>> municipalities
```

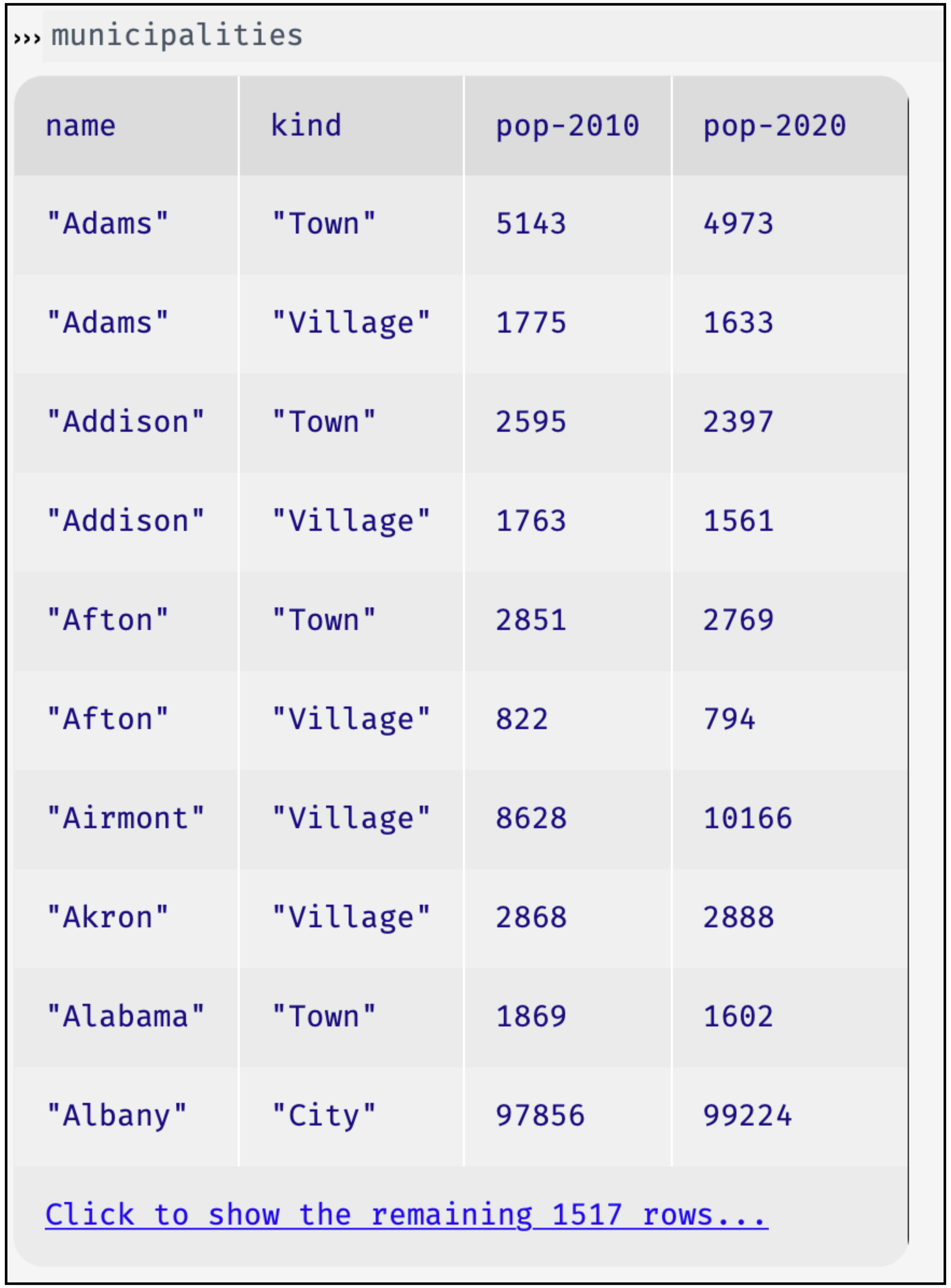


| name | kind | pop-2010 | pop-2020 |
|---|---|---|---|
| "Adams" | "Town" | 5143 | 4973 |
| "Adams" | "Village" | 1775 | 1633 |
| "Addison" | "Town" | 2595 | 2397 |
| "Addison" | "Village" | 1763 | 1561 |
| "Afton" | "Town" | 2851 | 2769 |

A bit later, we’ll see how we can load tabular data from outside Pyret so we don’t need to enter it all into our program.

I’ve already made a Pyret file that has the full municipality data, which we can load:

```
include shared-gdrive(“municipalities.arr”,
  "10LyywS8KYe0bfEHebDzCBYYq7XxDrvQn")
```



››› municipalities

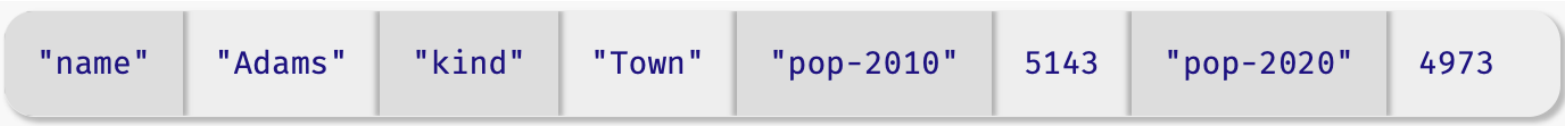
| name | kind | pop-2010 | pop-2020 |
|---|---|---|---|
| "Adams" | "Town" | 5143 | 4973 |
| "Adams" | "Village" | 1775 | 1633 |
| "Addison" | "Town" | 2595 | 2397 |
| "Addison" | "Village" | 1763 | 1561 |
| "Afton" | "Town" | 2851 | 2769 |
| "Afton" | "Village" | 822 | 794 |
| "Airmont" | "Village" | 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 with 0:

```
>>> 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
```

# 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)
```

*This means sort descending; 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 out the cities
- Calculating percentage change in population
- Building a column for percentage change
- Sorting on that column in *descending* order

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

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

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
```

# Acknowledgments

This class incorporates material from:

Kathi Fisler, Brown University

Doug Woos, Brown University