Streamlit Documentation

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Documentation

The easiest way to learn how to use Streamlit is to try things out yourself. As you read through this guide, test each method. As long as your app is running, every time you add a new element to your script and save, Streamlit's UI will ask if you'd like to rerun the app and view the changes. This allows you to work in a fast interactive loop: you write some code, save it, review the output, write some more, and so on, until you're happy with the results. The goal is to use Streamlit to create an interactive app for your data or model and along the way to use Streamlit to review, debug, perfect, and share your code.

Use the links below to jump to a specific section:

CHAPTER 1

Prerequisites

Before you get started, you're going to need a few things:

- Your favorite IDE or text editor
- Python 3.6 or later
- PIP
- *Streamlit* — This one's kind of important, so don't forget to install.

If you haven't already, take a few minutes to read through *Main concepts* to understand Streamlit's data flow model.

CHAPTER 2

Set up your virtual environment

Regardless of which package management tool you're using, we recommend running these commands in a virtual environment. This ensures that the dependencies pulled in for Streamlit don't impact any other Python projects you're working on.

- pipenv
- venv
- virtualenv
- conda

CHAPTER 3

Install Streamlit

```
$ pip install streamlit
```

Now run the hello world app just to make sure everything it's working:

```
$ streamlit hello
```

CHAPTER 4

Import Streamlit

Now that everything's installed, let's create a new Python script and import Streamlit.

1. Create a new Python file named `first_app.py`, then open it with your IDE or text editor.
2. Next, import Streamlit.

```
import streamlit as st
# To make things easier later, we're also importing numpy and pandas for
# working with sample data.
import numpy as np
import pandas as pd
```

3. Run your app. A new tab will open in your default browser. It'll be blank for now. That's OK.

```
$ streamlit run first_app.py
```

Running a Streamlit app is no different than any other Python script. Whenever you need to view the app, you can use this command.

Tip: Did you know you can also pass a URL to *streamlit run*? This is great when combined with Github Gists. For example:

$ streamlit run https://raw.githubusercontent.com/streamlit/demo-uber-nyc-pickups/master/app.py

4. You can kill the app at any time by typing **Ctrl+c** in the terminal.

CHAPTER 5

Add text and data

5.1 Add a title

Streamlit has a number of ways to add text to your app. Check out our *API reference* for a complete list.

Let's add a title to test things out:

```
st.title('My first app')
```

That's it! Your app has a title. You can use specific text functions to add content to your app, or you can use `st.write()` and add your own markdown.

5.2 Write a data frame

Along with magic commands, `st.write()` is Streamlit's "Swiss Army knife". You can pass almost anything to `st.write()`: text, data, Matplotlib figures, Altair charts, and more. Don't worry, Streamlit will figure it out and render things the right way.

```
st.write("Here's our first attempt at using data to create a table:")
st.write(pd.DataFrame({
    'first column': [1, 2, 3, 4],
    'second column': [10, 20, 30, 40]
}))
```

There are other data specific functions like `st.dataframe()` and `st.table()` that you can also use for displaying data. Check our advanced guides on displaying data to understand when to use these features and how to add colors and styling to your data frames.

Tip: For this guide we're using small amounts of data so that we can move quickly. You can check out our Tutorial on creating a data explorer to see an example of how to load data from an API and use @st.cache to cache it.

CHAPTER 6

Use magic

If you're using Python 3, you can also write to your app without calling any Streamlit methods. Streamlit supports "magic commands," which means you don't have to use `st.write()` at all! Try replacing the code above with this snippet:

```
"""
# My first app
Here's our first attempt at using data to create a table:
"""

df = pd.DataFrame({
  'first column': [1, 2, 3, 4],
  'second column': [10, 20, 30, 40]
})

df
```

How it works is simple. Any time that Streamlit sees a variable or a literal value on its own line, it automatically writes that to your app using `st.write()`. For more information, refer to the documentation on magic commands.

CHAPTER 7

Draw charts and maps

Streamlit supports several popular data charting libraries like Matplotlib, Altair, deck.gl, and more. In this section, you'll add a bar chart, line chart, and a map to your app.

7.1 Draw a line chart

You can easily add a line chart to your app with `st.line_chart()`. We'll generate a random sample using Numpy and then chart it.

```
chart_data = pd.DataFrame(
     np.random.randn(20, 3),
     columns=['a', 'b', 'c'])

st.line_chart(chart_data)
```

7.2 Plot a map

With `st.map()` you can display data points on a map. Let's use Numpy to generate some sample data and plot it on a map of San Francisco.

```
map_data = pd.DataFrame(
    np.random.randn(1000, 2) / [50, 50] + [37.76, -122.4],
    columns=['lat', 'lon'])

st.map(map_data)
```

CHAPTER 8

Add interactivity with widgets

With widgets, Streamlit allows you to bake interactivity directly into your apps with checkboxes, buttons, sliders, and more. Check out our *API reference* for a full list of interactive widgets.

8.1 Use checkboxes to show/hide data

One use case for checkboxes is to hide or show a specific chart or section in an app. `st.checkbox()` takes a single argument, which is the widget label. In this sample, the checkbox is used to toggle a conditional statement.

```
if st.checkbox('Show dataframe'):
    chart_data = pd.DataFrame(
       np.random.randn(20, 3),
       columns=['a', 'b', 'c'])

    st.line_chart(chart_data)
```

8.2 Use a selectbox for options

Use `st.selectbox` to choose from a series. You can write in the options you want, or pass through an array or data frame column.

Let's use the `df` data frame we created earlier.

```
option = st.selectbox(
    'Which number do you like best?',
     df['first column'])

'You selected: ', option
```

8.3 Put widgets in a sidebar

For a cleaner look, you can move your widgets into a sidebar. This keeps your app central, while widgets are pinned to the left. Let's take a look at how you can use `st.sidebar` in your app.

```
option = st.sidebar.selectbox(
    'Which number do you like best?',
     df['first column'])

'You selected:', option
```

Most of the elements you can put into your app can also be put into a sidebar using this syntax: `st.sidebar.[element_name]()`. Here are a few examples that show how it's used: `st.sidebar.markdown()`, `st.sidebar.slider()`, `st.sidebar.line_chart()`.

The only exceptions right now are `st.write` (you should use `st.sidebar.markdown()` instead), `st.echo`, and `st.spinner`. Rest assured, though, we're currently working on adding support for those too!

CHAPTER 9

Show progress

When adding long running computations to an app, you can use `st.progress()` to display status in real time.

First, let's import time. We're going to use the `time.sleep()` method to simulate a long running computation:

```
import time
```

Now, let's create a progress bar:

```
'Starting a long computation...'

# Add a placeholder
latest_iteration = st.empty()
bar = st.progress(0)

for i in range(100):
  # Update the progress bar with each iteration.
  latest_iteration.text(f'Iteration {i+1}')
  bar.progress(i + 1)
  time.sleep(0.1)

'...and now we\'re done!'
```

CHAPTER 10

Record a screencast

After you've built a Streamlit app, you may want to discuss some of it with co-workers over email or Slack, or share it with the world on Twitter. A great way to do that is with Streamlit's built-in screencast recorder. With it, you can record, narrate, stop, save, and share with a few clicks.

To start a screencast, locate the menu in the upper right corner of your app (), select **Record a screencast**, and follow the prompts. Before the recording starts, you'll see a countdown — this means it's showtime.

To stop your screencast, go back to the menu () and select **Stop recording** (or hit the **ESC** key). Follow the prompts to preview your recording and save it to disk. That's it, you're ready to share your Streamlit app.

CHAPTER 11

Get help

That's it for getting started, now you can go and build your own apps! If you run into difficulties here are a few things you can do.

- Check out our community forum and post a question
- Quick help from command line with `$ streamlit --help`
- Read more documentation! Check out:
  - *Tutorials* to make an app
  - *Advanced concepts* for things like caching and inserting elements out of order
  - *API reference* for examples of every Streamlit command

CHAPTER 12

Main concepts

Working with Streamlit is simple. First you sprinkle a few Streamlit commands into a normal Python script, then you run it with `streamlit run`:

```
$ streamlit run your_script.py [-- script args]
```

As soon as you run the script as shown above, a local Streamlit server will spin up and your app will open in a new tab your default web browser. The app is your canvas, where you'll draw charts, text, widgets, tables, and more.

What gets drawn in the app is up to you. For example `st.text` writes raw text to your app, and `st.line_chart` draws — you guessed it — a line chart. Refer to our *API documentation* to see all commands that are available to you.

Note: When passing your script some custom arguments, they must be passed after two dashes. Otherwise the arguments get interpreted as arguments to Streamlit itself.

Tip: You can also pass a URL to *streamlit run*! This is great when combined with Github Gists. For example:

$ streamlit run https://raw.githubusercontent.com/streamlit/demo-uber-nyc-pickups/master/app.py

12.1 Development flow

Every time you want to update your app, just save the source file. When you do that, Streamlit detects if there is a change and asks you whether you want to rerun your app. Choose "Always rerun" at the top-right of your screen to automatically update your app every time you change its source code.

This allows you to work in a fast interactive loop: you type some code, save it, try it out live, then type some more code, save it, try it out, and so on until you're happy with the results. This tight loop between coding and viewing results live is one of the ways Streamlit makes your life easier.

Tip: While developing a Streamlit app, it's recommended to lay out your editor and browser windows side by side, so the code and the app can be seen at the same time. Give it a try!

12.2 Data flow

Streamlit's architecture allows you to write apps the same way you write plain Python scripts. To unlock this, Streamlit apps have a unique data flow: any time something must be updated on the screen, Streamlit just reruns your entire Python script from top to bottom.

This can happen in two situations:

- Whenever you modify your app's source code.
- Whenever a user interacts with widgets in the app. For example, when dragging a slider, entering text in an input box, or clicking a button.

And to make all of this fast and seamless, Streamlit does some heavy lifting for you behind the scenes. A big player in this story is the `@st.cache` decorator, which allows developers to skip certain costly computations when their apps rerun. We'll cover caching later in this page.

12.3 Drawing content

Writing to Streamlit apps is simple. Just call the appropriate API command:

```python
import streamlit as st
x = 4
st.write(x, 'squared is', x * x)
```

In the example above we used the `st.write()` command. Whenever you want to draw something to the screen `st.write()` is always a good first start! It tries to guess the best visual representation for its arguments based on their data types, so things like dataframes are drawn as beautiful tables, Matplotlib figures are drawn as charts, and so on.

And you can even use Streamlit magic to skip the `st.write()` command altogether:

```python
import streamlit as st
x = 4
x, 'squared is', x * x  # Magic!
```

If you want to do something more advanced like changing specific settings, drawing animations, or inserting content out of order, check out other available Streamlit commands in our *API documentation* and *Advanced Concepts* pages.

12.4 Widgets

When you've got the data or model into the state that you want to explore, you can add in widgets like `st.slider()`, `st.button()` or `st.selectbox()`. It's really straightforward — just treat widgets as variables:

```python
import streamlit as st
x = st.slider('x')  # this is a widget
st.write(x, 'squared is', x * x)
```

On first run, the app above should output the text "0 squared is 0". Then every time a user interacts with a widget, Streamlit simply reruns your script from top to bottom, assigning the current state of the widget to your variable in the process.

For example, if the user moves the slider to position `10`, Streamlit will rerun the code above and set `x` to `10` accordingly. So now you should see the text "10 squared is 100".

12.5 Sidebar

Streamlit makes it easy to organize your widgets in a left panel sidebar with `st.sidebar`. Each element that's passed to `st.sidebar` is pinned to the left, allowing users to focus on the content in your app while still having access to UI controls.

For example, if you want to add a selectbox and a slider to a sidebar, just use `st.sidebar.slider` and `st.siderbar.selectbox` instead of `st.slider` and `st.selectbox`:

```
import streamlit as st

# Add a selectbox to the sidebar:
add_selectbox = st.sidebar.selectbox(
    'How would you like to be contacted?',
    ('Email', 'Home phone', 'Mobile phone')
)

# Add a slider to the sidebar:
add_slider = st.sidebar.slider(
    'Select a range of values',
    0.0, 100.0, (25.0, 75.0)
)
```

Note: The following Streamlit commands are not currently supported in the sidebar: *st.write* (you should use *st.sidebar.markdown()* instead), *st.echo*, and *st.spinner*.

12.6 Caching

The Streamlit cache allows your app to execute quickly even when loading data from the web, manipulating large datasets, or performing expensive computations.

To use the cache, just wrap functions in the `@st.cache` decorator:

```
@st.cache  # This function will be cached
def my_slow_function(arg1, arg2):
    # Do something really slow in here!
    return the_output
```

When you mark a function with the `@st.cache` decorator, it tells Streamlit that whenever the function is called it needs to check a few things:

1. The input parameters that you called the function with
2. The value of any external variable used in the function
3. The body of the function

4. The body of any function used inside the cached function

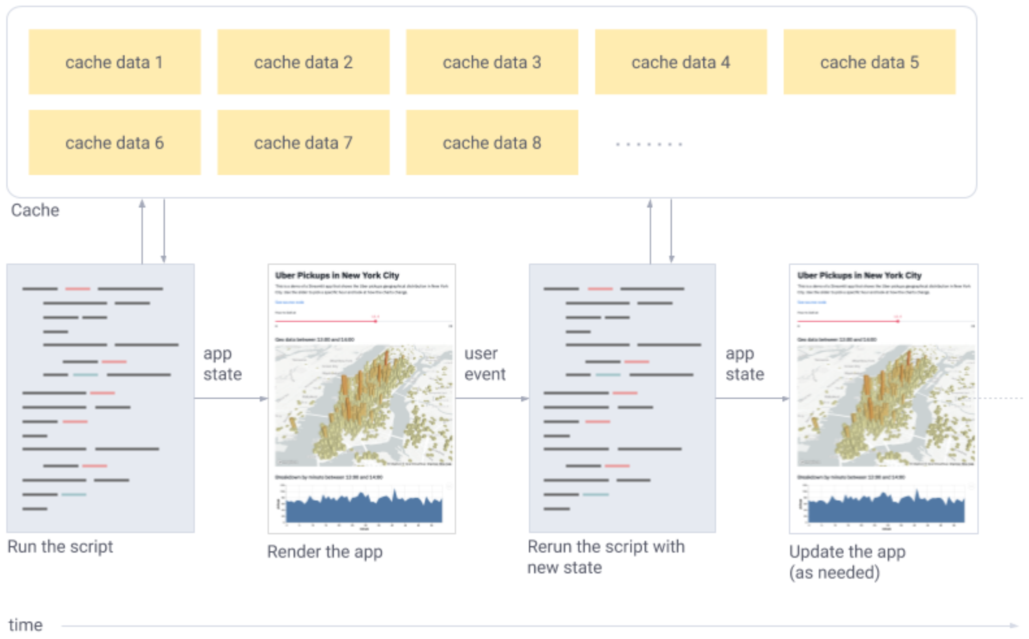
If this is the first time Streamlit has seen these four components with these exact values and in this exact combination and order, it runs the function and stores the result in a local cache. Then, next time the cached function is called, if none of these components changed, Streamlit will just skip executing the function altogether and, instead, return the output previously stored in the cache.

For more information about the Streamlit cache, its configuration parameters, and its limitations, see *Caching*.

12.7 App model

Now that you know a little more about all the individual pieces, let's close the loop and review how it works together:

1. Streamlit apps are Python scripts that run from top to bottom
2. Every time a user opens a browser tab pointing to your app, the script is re-executed
3. As the script executes, Streamlit draws its output live in a browser
4. Scripts use the Streamlit cache to avoid recomputing expensive functions, so updates happen very fast
5. Every time a user interacts with a widget, your script is re-executed and the output value of that widget is set to the new value during that run.



12.8 Next steps

- *Get started* with Streamlit
- Read up on *advanced concepts*
- *Build your first app*

CHAPTER 13

Tutorials

13.1 Tutorial: Create a data explorer app

If you've made it this far, chances are you've installed Streamlit and run through the basics in our *get started guide*. If not, now is a good time to take a look.

In this tutorial, you're going to use Streamlit's core features to create an interactive app; exploring a public Uber dataset for pickups and drop-offs in New York City. When you're finished, you'll know how to fetch and cache data, draw charts, plot information on a map, and use interactive widgets, like a slider, to filter results.

Tip: If you'd like to skip ahead and see everything at once, the *complete script is available below*.

13.1.1 Create an app

1. The first step is to create a new Python script. Let's call it `uber_pickups.py`.
2. Open `uber_pickups.py` in your favorite IDE or text editor, then add these lines:

   ```
   import streamlit as st
   import pandas as pd
   import numpy as np
   ```

3. Every good app has a title, so let's add one:

   ```
   st.title('Uber pickups in NYC')
   ```

4. Now it's time to run Streamlit from the command line:

   ```
   $ streamlit run uber_pickups.py
   ```

5. As usual, the app should automatically open in a new tab in your browser.

13.1.2 Fetch some data

Now that you have an app, the next thing you'll need to do is fetch the Uber dataset for pickups and drop-offs in New York City.

1. Let's start by writing a function to load the data. Add this code to your script:

```
DATE_COLUMN = 'date/time'
DATA_URL = ('https://s3-us-west-2.amazonaws.com/'
         'streamlit-demo-data/uber-raw-data-sep14.csv.gz')

def load_data(nrows):
    data = pd.read_csv(DATA_URL, nrows=nrows)
    lowercase = lambda x: str(x).lower()
    data.rename(lowercase, axis='columns', inplace=True)
    data[DATE_COLUMN] = pd.to_datetime(data[DATE_COLUMN])
    return data
```

   You'll notice that `load_data` is a plain old function that downloads some date, puts it in a Pandas dataframe, and converts the date column from text to datetime. The function accepts a single parameter (`nrows`), which specifies the number of rows that you want to load into the dataframe.

2. Now let's test the function and review the output. Below your function, add these lines:

```
# Create a text element and let the reader know the data is loading.
data_load_state = st.text('Loading data...')
# Load 10,000 rows of data into the dataframe.
data = load_data(10000)
# Notify the reader that the data was successfully loaded.
data_load_state.text('Loading data...done!')
```

   You'll see a few buttons in the upper-right corner of your app asking if you'd like to rerun the app. Choose **Always rerun**, and you'll see your changes automatically each time you save.

Ok, that's underwhelming…

It turns out that it takes a long time to download data, and load 10,000 lines into a dataframe. Converting the date column into datetime isn't a quick job either. You don't want to reload the data each time the app is updated – luckily Streamlit allows you to cache the data.

13.1.3 Effortless caching

1. Try adding `@st.cache` before the `load_data` declaration:

```
@st.cache
def load_data(nrows):
```

2. Then save the script, and Streamlit will automatically rerun your app. Since this is the first time you're running the script with `@st.cache`, you won't see anything change. Let's tweak your file a little bit more so that you can see the power of caching.

3. Replace the line `data_load_state.text('Loading data...done!')` with this:

```
data_load_state.text("Done! (using st.cache)")
```

4. Now save. See how the line you added appeared immediately? If you take a step back for a second, this is actually quite amazing. Something magical is happening behind the scenes, and it only takes one line of code to activate it.

How's it work?

Let's take a few minutes to discuss how `@st.cache` actually works.

When you mark a function with Streamlit's cache annotation, it tells Streamlit that whenever the function is called that it should check three things:

1. The actual bytecode that makes up the body of the function
2. Code, variables, and files that the function depends on
3. The input parameters that you called the function with

If this is the first time Streamlit has seen these items, with these exact values, and in this exact combination, it runs the function and stores the result in a local cache. The next time the function is called, if the three values haven't changed, then Streamlit knows it can skip executing the function altogether. Instead, it reads the output from the local cache and passes it on to the caller – like magic.

"But, wait a second," you're saying to yourself, "this sounds too good to be true. What are the limitations of all this awesomesauce?"

Well, there are a few:

1. Streamlit will only check for changes within the current working directory. This means that Streamlit only detects code updates inside installed Python libraries.
2. If your function is not deterministic (that is, its output depends on random numbers), or if it pulls data from an external time-varying source (for example, a live stock market ticker service) the cached value will be none-the-wiser.
3. Lastly, you should not mutate the output of a cached function since cached values are stored by reference (for performance reasons and to be able to support libraries such as TensorFlow). Note that, here, Streamlit is smart enough to detect these mutations and show a loud warning explaining how to fix the problem.

While these limitations are important to keep in mind, they tend not to be an issue a surprising amount of the time. Those times, this cache is really transformational.

Tip: Whenever you have a long-running computation in your code, consider refactoring it so you can use *@st.cache*, if possible.

Now that you know how caching with Streamlit works, let's get back to the Uber pickup data.

13.1.4 Inspect the raw data

It's always a good idea to take a look at the raw data you're working with before you start working with it. Let's add a subheader and a printout of the raw data to the app:

```
st.subheader('Raw data')
st.write(data)
```

In the *get started guide* you learned that `st.write` will render almost anything you pass to it. In this case, you're passing in a dataframe and it's rendering as an interactive table.

`st.write` tries to do the right thing based on the data type of the input. If it isn't doing what you expect you can use a specialized command like `st.dataframe` instead. For a full list, see *API reference*.

Alternatively, you could use a specialized statement, like `st.dataframe()`, to add a specific dataset to your app.

13.1.5 Draw a histogram

Now that you've had a chance to take a look at the dataset and observe what's available, let's take things a step further and draw a histogram to see what Uber's busiest hours are in New York City.

1. To start, let's add a subheader just below the raw data section:

```
st.subheader('Number of pickups by hour')
```

2. Use NumPy to generate a histogram that breaks down pickup times binned by hour:

```
hist_values = np.histogram(
    data[DATE_COLUMN].dt.hour, bins=24, range=(0,24))[0]
```

3. Now, let's use Streamlit's `st.bar_chart()` method to draw this histogram.

```
st.bar_chart(hist_values)
```

4. Save your script. This histogram should show up in your app right away. After a quick review, it looks like the busiest time is 17:00 (5 P.M.).

To draw this diagram we used Streamlit's native `bar_chart()` method, but it's important to know that Streamlit supports more complex charting libraries like Altair, Bokeh, Plotly, Matplotlib and more. For a full list, see supported charting libraries.

13.1.6 Plot data on a map

Using a histogram with Uber's dataset helped us determine what the busiest times are for pickups, but what if we wanted to figure out where pickups were concentrated throughout the city. While you could use a bar chart to show this data, it wouldn't be easy to interpret unless you were intimately familiar with latitudinal and longitudinal coordinates in the city. To show pickup concentration, let's use Streamlit `st.map()` function to overlay the data on a map of New York City.

1. Add a subheader for the section:

```
st.subheader('Map of all pickups')
```

2. Use the `st.map()` function to plot the data:

```
st.map(data)
```

3. Save your script. The map is fully interactive. Give it a try by panning or zooming in a bit.

After drawing your histogram, you determined that the busiest hour for Uber pickups was 17:00. Let's redraw the map to show the concentration of pickups at 17:00.

1. Locate the following code snippet:

```
st.subheader('Map of all pickups')
st.map(data)
```

2. Replace it with:

```
hour_to_filter = 17
filtered_data = data[data[DATE_COLUMN].dt.hour == hour_to_filter]
st.subheader(f'Map of all pickups at {hour_to_filter}:00')
st.map(filtered_data)
```

3. You should see the data update instantly.

To draw this map we used a simple map function that's built into Streamlit, but if you'd like to visualize complex map data, we encourage you to take a look at the `st.deckgl_chart`.

13.1.7 Filter results with a slider

In the last section, when you drew the map, the time used to filter results was hardcoded into the script, but what if we wanted to let a reader dynamically filter the data in real time? Using Streamlit's widgets you can. Let's add a slider to the app with the `st.slider()` method.

1. Locate `hour_to_filter` and replace it with this code snippet:

```
hour_to_filter = st.slider('hour', 0, 23, 17)  # min: 0h, max: 23h, default: 17h
```

2. Use the slider and watch the map update in real time.

13.1.8 Use a button to toggle data

Sliders are just one way to dynamically change the composition of your app. Let's use the `st.checkbox` function to add a checkbox to your app. We'll use this checkbox to show/hide the raw data table at the top of your app.

1. Locate these lines:

```
st.subheader('Raw data')
st.write(data)
```

2. Replace these lines with the following code:

```
if st.checkbox('Show raw data'):
    st.subheader('Raw data')
    st.write(data)
```

We're sure you've got your own ideas. When you're done with this tutorial, check out all the widgets that Streamlit exposes in our *API reference*.

13.1.9 Let's put it all together

That's it, you've made it to the end. Here's the complete script for our interactive app.

Tip: If you've skipped ahead, after you've created your script, the command to run Streamlit is *streamlit run [app name]*.

```
import streamlit as st
import pandas as pd
import numpy as np

st.title('Uber pickups in NYC')

DATE_COLUMN = 'date/time'
DATA_URL = ('https://s3-us-west-2.amazonaws.com/'
            'streamlit-demo-data/uber-raw-data-sep14.csv.gz')
```

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```
@st.cache
def load_data(nrows):
    data = pd.read_csv(DATA_URL, nrows=nrows)
    lowercase = lambda x: str(x).lower()
    data.rename(lowercase, axis='columns', inplace=True)
    data[DATE_COLUMN] = pd.to_datetime(data[DATE_COLUMN])
    return data

data_load_state = st.text('Loading data...')
data = load_data(10000)
data_load_state.text("Done! (using st.cache)")

if st.checkbox('Show raw data'):
    st.subheader('Raw data')
    st.write(data)

st.subheader('Number of pickups by hour')
hist_values = np.histogram(data[DATE_COLUMN].dt.hour, bins=24, range=(0,24))[0]
st.bar_chart(hist_values)

# Some number in the range 0-23
hour_to_filter = st.slider('hour', 0, 23, 17)
filtered_data = data[data[DATE_COLUMN].dt.hour == hour_to_filter]

st.subheader('Map of all pickups at %s:00' % hour_to_filter)
st.map(filtered_data)
```

13.2 Tutorial: Run Streamlit remotely

When you run Streamlit remotely you can still use your local web browser to see the results. Be it on AWS, GCS, a Docker instance, or some other remote machine, we got you covered! In this tutorial, we're going to show you how to set up remote operation with AWS. The steps are similar for other services.

13.2.1 Before we start

We assume that:

1. You have an EC2 instance up and running on AWS.
2. You know your AWS username, which we'll call `$USERNAME`. Often this is something like `ubuntu`, `admin` or `ec2-user`.
3. You know your instance's IP address, which we'll call `$IP_ADDRESS`. That's the "IPv4 Public IP" from this page.
4. Your Streamlit code is already on the remote machine, in a file called `my_script.py`.

13.2.2 SSH with port forwarding

To start with, let's SSH into your instance. But we won't just simply SSH. Instead we'll turn on port-forwarding, so the Streamlit server on the remote machine can be easily accessed on the local machine:

```
$ ssh -o logLevel=ERROR -L 8501:$IP_ADDRESS:8501 $USERNAME@$IP_ADDRESS
```

Note: You can avoid port-forwarding by configuring your instance to expose a port to the outside world. This is done by adding the following Inbound rule to the instance's Security Group:

- Protocol: TCP
- Port range: 8501
- Source: for security, put your IP address here. Or, if public: 0.0.0.0/0

13.2.3 Install Streamlit on the instance

Now that you're SSHed into the instance, make sure to install Streamlit on it. Using PIP, you can juse do:

```
$ pip install streamlit
```

To check that everything is working, run the Hello command:

```
$ streamlit hello
```

Ignore the URLs that print on your terminal. Instead, since you're using port-forwarding you should open your browser at http://localhost:8501.

If you see the Streamlit Hello page, everything is working! Otherwise, check out the *Troubleshooting page*.

13.2.4 Run your own code remotely

Now that you know Streamlit is working, let's try your actual code. First, press `Ctrl+C` to close the Hello program, and then type:

```
$ streamlit run my_script.py
```

And that's it! Now your browser should show your script at http://localhost:8501.

13.2.5 How to edit your remote script

When actively working on a Streamlit app remotely, there are three ways to edit your remote code:

1. If you use VS Code or the paid version of PyCharm, just point your IDE to your remote file using its SSH feature.
2. If you use some other editor, set up SSHFS as described below.
3. If you're a Vim or Emacs user, just start your editor directly inside the instance!

Optional: Install SSHFS

To get started, install SSHFS using one of the following methods:

- On a Mac:

```
$ brew cask install osxfuse
$ brew install sshfs
```

- On Ubuntu:

```
$ sudo apt-get update
$ sudo apt-get install sshfs
```

And then set it up:

1. Pick a folder on your remote machine that you would like to sync with your local machine. For this tutorial we'll assume it's called `~/sshfs-folder`.
2. Create a folder on your local machine where the remote folder will be mapped to. We'll call it `~/remote`, but you can name it whatever you like:

```
$ mkdir ~/remote
```

3. Open a terminal on your local machine and link the two folders using SSHFS:

```
$ sshfs [address of remote machine]:sshfs-folder ~/remote
```

That's it!

This should automatically open the file in your favorite local editor. Every time you save, it will save to the remote file directly.

CHAPTER 14

Caching

Streamlit provides a caching mechanism that allows your app to stay performant even when loading data from the web, manipulating large datasets, or performing expensive computations. This is done with the `@st.cache` decorator.

When you mark a function with the `@st.cache` decorator, it tells Streamlit that whenever the function is called it needs to check a few things:

1. The input parameters that you called the function with
2. The value of any external variable used in the function
3. The body of the function
4. The body of any function used inside the cached function

If this is the first time Streamlit has seen these four components with these exact values and in this exact combination and order, it runs the function and stores the result in a local cache. Then, next time the cached function is called, if none of these components changed, Streamlit will just skip executing the function altogether and, instead, return the output previously stored in the cache.

The way Streamlit keeps track of changes in these components is through hashing. Think of the cache as a simple in-memory key-value store, where the key is a hash of all of the above and the value is the actual output object passed by reference.

Finally, `@st.cache` supports arguments to configure the cache's behavior. You can find more information on those in our *API reference*.

Let's take a look at a few examples that illustrate how caching works in a Streamlit app.

14.1 Example 1: Basic usage

For starters, let's take a look at a sample app that has a function that performs an expensive, long-running computation. Without caching, this function is rerun each time the app is refreshed, leading to a poor user experience. Copy this code into a new app and try it out yourself:

```
import streamlit as st
import time

def expensive_computation(a, b):
    time.sleep(2)  #  This makes the function take 2s to run
    return a * b

a = 2
b = 21
res = expensive_computation(a, b)

st.write("Result:", res)
```

Try pressing **R** to rerun the app, and notice how long it takes for the result to show up. This is because `expensive_computation(a, b)` is being re-executed every time the app runs. This isn't a great experience.

Let's add the `@st.cache` decorator:

```
import streamlit as st
import time

@st.cache  #  Added this
def expensive_computation(a, b):
    time.sleep(2)  # This makes the function take 2s to run
    return a * b

a = 2
b = 21
res = expensive_computation(a, b)

st.write("Result:", res)
```

Now run the app again and you'll notice that it is much faster every time you press R to rerun. To understand what is happening, let's add an st.write inside the function:

```
import streamlit as st
import time

@st.cache(suppress_st_warning=True)  #  Changed this
def expensive_computation(a, b):
    #  Added this
    st.write("Cache miss: expensive_computation(", a, ",", b, ") ran")
    time.sleep(2)  # This makes the function take 2s to run
    return a * b

a = 2
b = 21
res = expensive_computation(a, b)

st.write("Result:", res)
```

Now when you rerun the app the text "Cache miss" appears on the first run, but not on any subsequent runs. That's because the cached function is only being executed once, and every time after that you're actually hitting the cache.

Note: You may have noticed that we've added the *suppress_st_warning* keyword to the *@st.cache* decorators. That's because the cached function above uses a Streamlit command itself (*st.write* in this case), and when Streamlit sees that, it shows a warning that your command will only execute when you get a cache hit. More often than not, when you see that warning it's because there's a bug in your code. However, in our case we're using the *st.write* command to demonstrate when the cache is being hit, so the behavior Streamlit is warning us about is exactly what we want. As a result, we are passing in *suppress_st_warning=True* to turn that warning off.

14.2 Example 2: When the function arguments change

Without stopping the previous app server, let's change one of the arguments to our cached function:

```
import streamlit as st
import time

@st.cache(suppress_st_warning=True)
def expensive_computation(a, b):
    st.write("Cache miss: expensive_computation(", a, ",", b, ") ran")
    time.sleep(2)  # This makes the function take 2s to run
    return a * b

a = 2
b = 210  #  Changed this
res = expensive_computation(a, b)

st.write("Result:", res)
```

Now the first time you rerun the app it's a cache miss. This is evidenced by the "Cache miss" text showing up and the app taking 2s to finish running. After that, if you press **R** to rerun, it's always a cache hit. That is, no such text shows up and the app is fast again.

This is because Streamlit notices whenever the arguments **a** and **b** change and determines whether the function should be re-executed and re-cached.

14.3 Example 3: When the function body changes

Without stopping and restarting your Streamlit server, let's remove the widget from our app and modify the function's code by adding a `+ 1` to the return value.

```
import streamlit as st
import time

@st.cache(suppress_st_warning=True)
def expensive_computation(a, b):
    st.write("Cache miss: expensive_computation(", a, ",", b, ") ran")
    time.sleep(2)  # This makes the function take 2s to run
    return a * b + 1  #  Added a +1 at the end here

a = 2
b = 210
res = expensive_computation(a, b)

st.write("Result:", res)
```

The first run is a "Cache miss", but when you press **R** each subsequent run is a cache hit. This is because on first run, Streamlit detected that the function body changed, reran the function, and put the result in the cache.

Tip: If you change the function back the result will already be in the Streamlit cache from a previous run. Try it out!

14.4 Example 4: When an inner function changes

Let's make our cached function depend on another function internally:

```python
import streamlit as st
import time

def inner_func(a, b):
    st.write("inner_func(", a, ",", b, ") ran")
    return a * b

@st.cache(suppress_st_warning=True)
def expensive_computation(a, b):
    st.write("Cache miss: expensive_computation(", a, ",", b, ") ran")
    time.sleep(2)  # This makes the function take 2s to run
    return inner_func(a, b) + 1

a = 2
b = 210
res = expensive_computation(a, b)

st.write("Result:", res)
```

What you see is the usual:

1. The first run results in a cache miss.
2. Every subsequent rerun results in a cache hit.

But now let's try modifying the `inner_func()`:

```python
import streamlit as st
import time

def inner_func(a, b):
    st.write("inner_func(", a, ",", b, ") ran")
    return a ** b  #  Changed the * to ** here

@st.cache(suppress_st_warning=True)
def expensive_computation(a, b):
    st.write("Cache miss: expensive_computation(", a, ",", b, ") ran")
    time.sleep(2)  # This makes the function take 2s to run
    return inner_func(a, b) + 1

a = 2
b = 21
res = expensive_computation(a, b)

st.write("Result:", res)
```

Even though `inner_func()` is not annotated with `@st.cache`, when we edit its body we cause a "Cache miss" in the outer `expensive_computation()`.

That's because Streamlit always traverses your code and its dependencies to verify that the cached values are still valid. This means that while developing your app you can edit your code freely without worrying about the cache. Any change you make to your app, Streamlit should do the right thing!

Streamlit is also smart enough to only traverse dependencies that belong to your app, and skip over any dependency that comes from an installed Python library.

14.5 Example 5: Use caching to speed up your app across users

Going back to our original function, let's add a widget to control the value of `b`:

```python
import streamlit as st
import time

@st.cache(suppress_st_warning=True)
def expensive_computation(a, b):
    st.write("Cache miss: expensive_computation(", a, ",", b, ") ran")
    time.sleep(2)  # This makes the function take 2s to run
    return a * b

a = 2
b = st.slider("Pick a number", 0, 10)  #  Changed this
res = expensive_computation(a, b)

st.write("Result:", res)
```

What you'll see:

- If you move the slider to a number Streamlit hasn't seen before, you'll have a cache miss again. And every subsequent rerun with the same number will be a cache hit, of course.
- If you move the slider back to a number Streamlit has seen before, the cache is hit and the app is fast as expected.

In computer science terms, what is happening here is that `@st.cache` is memoizing `expensive_computation(a, b)`.

But now let's go one step further! Try the following:

1. Move the slider to a number you haven't tried before, such as 9.
2. Pretend you're another user by opening another browser tab pointing to your Streamlit app (usually at http://localhost:8501)
3. In the new tab, move the slider to 9.

Notice how this is actually a cache hit! That is, you don't actually see the "Cache miss" text on the second tab even though that second user never moved the slider to 9 at any point prior to this.

This happens because the Streamlit cache is global to all users. So everyone contributes to everyone else's performance.

14.6 Example 6: Mutating cached values

As mentioned in the *overview* section, the Streamlit cache stores items by reference. This allows the Streamlit cache to support structures that aren't memory-managed by Python, such as TensorFlow objects. However, it can also lead to unexpected behavior — which is why Streamlit has a few checks to guide developers in the right direction. Let's look into those checks now.

Let's write an app that has a cached function which returns a mutable object, and then let's follow up by mutating that object:

```
import streamlit as st
import time

@st.cache(suppress_st_warning=True)
def expensive_computation(a, b):
    st.write("Cache miss: expensive_computation(", a, ",", b, ") ran")
    time.sleep(2)  # This makes the function take 2s to run
    return {"output": a * b}  #  Mutable object

a = 2
b = 21
res = expensive_computation(a, b)

st.write("Result:", res)

res["output"] = "result was manually mutated"  #  Mutated cached value

st.write("Mutated result:", res)
```

When you run this app for the first time, you should see three messages on the screen:

- Cache miss (. . .)
- Result: {output: 42}
- Mutated result: {output: "result was manually mutated"}

No surprises here. But now notice what happens when you rerun you app (i.e. press **R**):

- Result: {output: "result was manually mutated"}
- Mutated result: {output: "result was manually mutated"}
- Cached object mutated. (. . .)

So what's up?

What's going on here is that Streamlit caches the output `res` by reference. When you mutated `res["output"]` outside the cached function you ended up inadvertently modifying the cache. This means every subsequent call to `expensive_computation(2, 21)` will return the wrong value!

Since this behavior is usually not what you'd expect, Streamlit tries to be helpful and show you a warning, along with some ideas about how to fix your code.

In this specific case, the fix is just to not mutate `res["output"]` outside the cached function. There was no good reason for us to do that anyway! Another solution would be to clone the result value with `res = deepcopy(expensive_computation(2, 21))`. Check out the section entitled *Fixing caching issues* for more information on these approaches and more.

14.7 Next steps

- *Advanced caching*

CHAPTER 15

Advanced caching

In *caching*, you learned about the Streamlit cache, which is accessed with the `@st.cache` decorator. In this article you'll see how Streamlit's caching functionality is implemented, so that you can use it to improve the performance of your Streamlit apps.

The cache is a key-value store, where the key is a hash of:

1. The input parameters that you called the function with
2. The value of any external variable used in the function
3. The body of the function
4. The body of any function used inside the cached function

And the value is a tuple of:

- The cached output
- A hash of the cached output (you'll see why soon)

For both the key and the output hash, Streamlit uses a specialized hash function that knows how to traverse code, hash special objects, and can have its *behavior customized by the user*.

For example, when the function `expensive_computation(a, b)`, decorated with `@st.cache`, is executed with `a=2` and `b=21`, Streamlit does the following:

1. Computes the cache key
2. If the key is found in the cache, then:
    - Extracts the previously-cached (output, output_hash) tuple.
    - Performs an **Output Mutation Check**, where a fresh hash of the output is computed and compared to the stored `output_hash`.
        - If the two hashes are different, shows a **Cached Object Mutated** warning. (Note: Setting `allow_output_mutation=True` disables this step).
3. If the input key is not found in the cache, then:
    - Executes the cached function (i.e. output = `expensive_computation(2, 21)`).

   - Calculates the output_hash from the function's output.
   - Stores key → (output, output_hash) in the cache.

4. Returns the output.

If an error is encountered an exception is raised. If the error occurs while hashing either the key or the output an UnhashableTypeError error is thrown. If you run into any issues, see *fixing caching issues*.

15.1 The hash_funcs parameter

As described above, Streamlit's caching functionality relies on hashing to calculate the key for cached objects, and to detect unexpected mutations in the cached result.

For added expressive power, Streamlit lets you override this hashing process using the hash_funcs argument. Suppose you define a type called FileReference which points to a file in the filesystem:

```python
class FileReference:
    def __init__(self, filename):
        self.filename = filename


@st.cache
def func(file_reference):
    ...
```

By default, Streamlit hashes custom classes like FileReference by recursively navigating their structure. In this case, its hash is the hash of the filename property. As long as the file name doesn't change, the hash will remain constant.

However, what if you wanted to have the hasher check for changes to the file's modification time, not just its name? This is possible with @st.cache's hash_funcs parameter:

```python
class FileReference:
    def __init__(self, filename):
        self.filename = filename

def hash_file_reference(file_reference):
    filename = file_reference.filename
    return (filename, os.path.getmtime(filename))

@st.cache(hash_funcs={FileReference: hash_file_reference})
def func(file_reference):
    ...
```

Additionally, you can hash FileReference objects by the file's contents:

```python
class FileReference:
    def __init__(self, filename):
        self.filename = filename

def hash_file_reference(file_reference):
    with open(file_reference.filename) as f:
      return f.read()

@st.cache(hash_funcs={FileReference: hash_file_reference})
```

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```
def func(file_reference):
    ...
```

Note: Because Streamlit's hash function works recursively, you don't have to hash the contents inside *hash_file_reference* Instead, you can return a primitive type, in this case the contents of the file, and Streamlit's internal hasher will compute the actual hash from it.

15.2 Typical hash functions

While it's possible to write custom hash functions, let's take a look at some of the tools that Python provides out of the box. Here's a list of some hash functions and when it makes sense to use them.

Python's `id` function | *Example*

- Speed: Fast
- Use case: If you're hashing a singleton object, like an open database connection or a TensorFlow session. These are objects that will only be instantiated once, no matter how many times your script reruns.

`lambda _: None` | *Example*

- Speed: Fast
- Use case: If you want to turn off hashing of this type. This is useful if you know the object is not going to change.

Python's `hash()` function | *Example*

- Speed: Can be slow based the size of the object being cached
- Use case: If Python already knows how to hash this type correctly.

Custom hash function | *Example*

- Speed: N/a
- Use case: If you'd like to override how Streamlit hashes a particular type.

15.3 Example 1: Pass a database connection around

Suppose we want to open a database connection that can be reused across multiple runs of a Streamlit app. For this you can make use of the fact that cached objects are stored by reference to automatically initialize and reuse the connection:

```
@st.cache(allow_output_mutation=True)
def get_database_connection():
    return db.get_connection()
```

With just 3 lines of code, the database connection is created once and stored in the cache. Then, every subsequent time `get_database_conection` is called, the already-created connection object is reused automatically. In other words, it becomes a singleton.

Tip: Use the *allow_output_mutation=True* flag to suppress the immutability check. This prevents Streamlit from trying to hash the output connection, and also turns off Streamlit's mutation warning in the process.

What if you want to write a function that receives a database connection as input? For that, you'll use hash_funcs:

```
@st.cache(hash_funcs={DBConnection: id})
def get_users(connection):
    # Note: We assume that connection is of type DBConnection.
    return connection.execute_sql('SELECT * from Users')
```

Here, we use Python's built-in id function, because the connection object is coming from the Streamlit cache via the get_database_conection function. This means that the same connection instance is passed around every time, and therefore it always has the same id. However, if you happened to have a second connection object around that pointed to an entirely different database, it would still be safe to pass it to get_users because its id is guaranteed to be different than the first id.

These design patterns apply any time you have an object that points to an external resource, such as a database connection or Tensorflow session.

15.4 Example 2: Turn off hashing for a specific type

You can turn off hashing entirely for a particular type by giving it a custom hash function that returns a constant. One reason that you might do this is to avoid hashing large, slow-to-hash objects that you know are not going to change. For example:

```
@st.cache(hash_funcs={pd.DataFrame: lambda _: None})
def func(huge_constant_dataframe):
    ...
```

When Streamlit encounters an object of this type, it always converts the object into None, no matter which instance of FooType its looking at. This means all instances are hash to the same value, which effectively cancels out the hashing mechanism.

15.5 Example 3: Use Python's hash() function

Sometimes, you might want to use Python's default hashing instead of Streamlit's. For example, maybe you've encountered a type that Streamlit is unable to hash, but it's hashable with Python's built-in hash() function. In that case, the solution is quite simple:

```
@st.cache(hash_funcs={FooType: hash})
def func(...):
    ...
```

15.6 Next steps

- *Advanced concepts*

CHAPTER 16

Advanced concepts

Now that you've mastered Streamlit's main concepts, let's take a look at some advanced functionality, like styling data, adjusting the order of elements in a report, and adding animations.

Note: We're adding these sections as quickly as we can, but please let us know what's important to you. Ping us in the community forum.

16.1 Display and style data

There are a few ways to display data (tables, arrays, data frames) in Streamlit apps. In *getting started*, you were introduced to *magic* and `st.write()`, which can be used to write anything from text to tables. Now let's take a look at methods designed specifically for visualizing data.

You might be asking yourself, "why wouldn't I always use st.write()?" There are a few reasons:

1. *Magic* and `st.write()` inspect the type of data that you've passed in, and then decide how to best render it in the app. Sometimes you want to draw it another way. For example, instead of drawing a dataframe as an interactive table, you may want to draw it as a static table by using st.table(df).
2. The second reason is that other methods return an object that can be used and modified, either by adding data to it or replacing it.
3. Finally, if you use a more specific Streamlit method you can pass additional arguments to customize its behavior.

For example, let's create a data frame and change its formatting with a Pandas `Styler` object. In this example, you'll use Numpy to generate a random sample, and the `st.dataframe()` method to draw an interactive table.

Note: This example uses Numpy to generate a random sample, but you can use Pandas DataFrames, Numpy arrays, or plain Python arrays.

```
dataframe = np.random.randn(10, 20)
st.dataframe(dataframe)
```

Let's expand on the first example using the Pandas `Styler` object to highlight some elements in the interactive table.

Note: If you used PIP to install Streamlit, you'll need to install Jinja2 to use the Styler object. To install Jinja2, run: pip install jinja2.

```
dataframe = pd.DataFrame(
    np.random.randn(10, 20),
    columns=('col %d' % i for i in range(20)))

st.dataframe(dataframe.style.highlight_max(axis=0))
```

Streamlit also has a method for static table generation: `st.table()`.

```
dataframe = pd.DataFrame(
    np.random.randn(10, 20),
    columns=('col %d' % i for i in range(20)))
st.table(dataframe)
```

16.2 Insert elements out of order

You can use the `st.empty` method as a placeholder, to "save" a slot in your app that you can use later.

```
st.text('This will appear first')
# Appends some text to the app.

my_slot1 = st.empty()
# Appends an empty slot to the app. We'll use this later.

my_slot2 = st.empty()
# Appends another empty slot.

st.text('This will appear last')
# Appends some more text to the app.

my_slot1.text('This will appear second')
# Replaces the first empty slot with a text string.

my_slot2.line_chart(np.random.randn(20, 2))
# Replaces the second empty slot with a chart.
```

16.3 Animate elements

Let's combine some of the things you've learned to create compelling animations in your app.

```
progress_bar = st.progress(0)
status_text = st.empty()
chart = st.line_chart(np.random.randn(10, 2))
```

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```
for i in range(100):
    # Update progress bar.
    progress_bar.progress(i + 1)

    new_rows = np.random.randn(10, 2)

    # Update status text.
    status_text.text(
        'The latest random number is: %s' % new_rows[-1, 1])

    # Append data to the chart.
    chart.add_rows(new_rows)

    # Pretend we're doing some computation that takes time.
    time.sleep(0.1)

status_text.text('Done!')
st.balloons()
```

16.4 Append data to a table or chart

In Streamlit, you can not only replace entire elements in your app, but also modify the data behind those elements. Here is how:

```
import numpy as np
import time

# Get some data.
data = np.random.randn(10, 2)

# Show the data as a chart.
chart = st.line_chart(data)

# Wait 1 second, so the change is clearer.
time.sleep(1)

# Grab some more data.
data2 = np.random.randn(10, 2)

# Append the new data to the existing chart.
chart.add_rows(data2)
```

16.5 Return the value of a Streamlit call

Coming soon! Ping us in the community forum if you just can't wait and have to have this info immediately.

CHAPTER 17

API reference

Streamlit makes it easy for you to visualize, mutate, and share data. The API reference is organized by activity type, like displaying data or optimizing performance. Each section includes methods associated with the activity type, including examples.

Know what you're looking for? Use these links or the left nav to move through this API reference.

- *Magic commands*
- *Display text*
- *Display data*
- *Display charts*
- *Display media*
- *Display interactive widgets*
- *Add widgets to sidebar*
- *Display code*
- *Display progress and status*
- *Placeholders, help, and options*
- *Mutate data*
- *Optimize performance*

17.1 Magic commands

Magic commands are a feature in Streamlit that allows you to write markdown and data to your app with very few keypresses. Here's an example:

```
# Draw a title and some text to the app:
'''
# This is the document title

This is some _markdown_.
'''

df = pd.DataFrame({'col1': [1,2,3]})
df  # <-- Draw the dataframe

x = 10
'x', x  # <-- Draw the string 'x' and then the value of x
```

How it works is simple: any time Streamlit sees either a variable or literal value on its own line, it automatically writes that to your app using `st.write` (which you'll learn about later).

Also, magic is smart enough to ignore docstrings. That is, it ignores the strings at the top of files and functions.

If you prefer to call Streamlit commands more explicitly, you can always turn magic off in your `~/.streamlit/config.toml` with the following setting:

```
[runner]
magicEnabled = false
```

Important: Right now, Magic only works in the main Python app file, not in imported files. See GitHub issue #288 for a discussion of the issues.

17.2 Display text

Streamlit apps usually start with a call to `st.title` to set the app's title. After that, there are 2 heading levels you can use: `st.header` and `st.subheader`.

Pure text is entered with `st.text`, and Markdown with `st.markdown`.

We also offer a "swiss-army knife" command called `st.write`, which accepts multiple arguments, and multiple data types. And as described above, you can also use magic commands in place of `st.write`.

`streamlit.`**`text`**`(`*body*`)`

Write fixed-width and preformatted text.

Parameters **body** (*str*) – The string to display.

Example

```
>>> st.text('This is some text.')
```

`streamlit.`**`markdown`**`(`*body*, *unsafe_allow_html=False*`)`

Display string formatted as Markdown.

Parameters

- **body** (*str*) – The string to display as Github-flavored Markdown. Syntax information can be found at: https://github.github.com/gfm.

  This also supports:

  - Emoji shortcodes, such as *:+1:* and *:sunglasses:*. For a list of all supported codes, see https://raw.githubusercontent.com/omnidan/node-emoji/master/lib/emoji.json.
  - LaTeX expressions, by just wrapping them in "$" or "$$" (the "$$" must be on their own lines). Supported LaTeX functions are listed at https://katex.org/docs/supported.html.

- **unsafe_allow_html** (*bool*) – By default, any HTML tags found in the body will be escaped and therefore treated as pure text. This behavior may be turned off by setting this argument to True.

  That said, we *strongly advise against it*. It is hard to write secure HTML, so by using this argument you may be compromising your users' security. For more information, see:

  https://github.com/streamlit/streamlit/issues/152

  Also note that 'unsafe_allow_html' is a temporary measure and may be removed from Streamlit at any time.

  If you decide to turn on HTML anyway, we ask you to please tell us your exact use case here:

  https://discuss.streamlit.io/t/96

  This will help us come up with safe APIs that allow you to do what you want.

Example

```
>>> st.markdown('Streamlit is **_really_ cool**.')
```

`streamlit.`**`latex`**(*body*)

Display mathematical expressions formatted as LaTeX.

Supported LaTeX functions are listed at https://katex.org/docs/supported.html.

Parameters **body** (*str or SymPy expression*) – The string or SymPy expression to display as LaTeX. If str, it's a good idea to use raw Python strings since LaTeX uses backslashes a lot.

Example

```
>>> st.latex(r'''
...     a + ar + a r^2 + a r^3 + \cdots + a r^{n-1} =
...     \sum_{k=0}^{n-1} ar^k =
...     a \left(\frac{1-r^{n}}{1-r}\right)
...     ''')
```

`streamlit.`**`write`**(**args*, ***kwargs*)

Write arguments to the app.

This is the Swiss Army knife of Streamlit commands: it does different things depending on what you throw at it. Unlike other Streamlit commands, write() has some unique properties:

1. You can pass in multiple arguments, all of which will be written.
2. Its behavior depends on the input types as follows.
3. It returns None, so it's "slot" in the App cannot be reused.

Parameters

- ***args** (*any*) – One or many objects to print to the App.

  Arguments are handled as follows:

  - **write(string)** [Prints the formatted Markdown string, with] support for LaTeX expression and emoji shortcodes. See docs for st.markdown for more.
  - write(data_frame) : Displays the DataFrame as a table.
  - write(error) : Prints an exception specially.
  - write(func) : Displays information about a function.
  - write(module) : Displays information about the module.
  - write(dict) : Displays dict in an interactive widget.
  - write(obj) : The default is to print str(obj).
  - write(mpl_fig) : Displays a Matplotlib figure.
  - write(altair) : Displays an Altair chart.
  - write(keras) : Displays a Keras model.
  - write(graphviz) : Displays a Graphviz graph.
  - write(plotly_fig) : Displays a Plotly figure.
  - write(bokeh_fig) : Displays a Bokeh figure.
  - write(sympy_expr) : Prints SymPy expression using LaTeX.

- **unsafe_allow_html** (*bool*) – This is a keyword-only argument that defaults to False.

  By default, any HTML tags found in strings will be escaped and therefore treated as pure text. This behavior may be turned off by setting this argument to True.

  That said, *we strongly advise* against it*. It is hard to write secure HTML, so by using this argument you may be compromising your users' security. For more information, see:

  https://github.com/streamlit/streamlit/issues/152

  Also note that 'unsafe_allow_html' is a temporary measure and may be removed from Streamlit at any time.

  If you decide to turn on HTML anyway, we ask you to please tell us your exact use case here: https://discuss.streamlit.io/t/96 .

  This will help us come up with safe APIs that allow you to do what you want.

Example

Its simplest use case is to draw Markdown-formatted text, whenever the input is a string:

```
>>> write('Hello, *World!* :sunglasses:')
```

As mentioned earlier, *st.write()* also accepts other data formats, such as numbers, data frames, styled data frames, and assorted objects:

```
>>> st.write(1234)
>>> st.write(pd.DataFrame({
...     'first column': [1, 2, 3, 4],
...     'second column': [10, 20, 30, 40],
... }))
```

Finally, you can pass in multiple arguments to do things like:

```
>>> st.write('1 + 1 = ', 2)
>>> st.write('Below is a DataFrame:', data_frame, 'Above is a dataframe.')
```

Oh, one more thing: *st.write* accepts chart objects too! For example:

```
>>> import pandas as pd
>>> import numpy as np
>>> import altair as alt
>>>
>>> df = pd.DataFrame(
...     np.random.randn(200, 3),
...     columns=['a', 'b', 'c'])
...
>>> c = alt.Chart(df).mark_circle().encode(
...     x='a', y='b', size='c', color='c', tooltip=['a', 'b', 'c'])
>>>
>>> st.write(c)
```

`streamlit.`**`title`**(*body*)

Display text in title formatting.

Each document should have a single *st.title()*, although this is not enforced.

Parameters **body** (*str*) – The text to display.

Example

```
>>> st.title('This is a title')
```

`streamlit.`**`header`**(*body*)

Display text in header formatting.

Parameters **body** (*str*) – The text to display.

Example

```
>>> st.header('This is a header')
```

`streamlit.`**`subheader`**(*body*)

Display text in subheader formatting.

Parameters **body** (*str*) – The text to display.

Example

```
>>> st.subheader('This is a subheader')
```

`streamlit.`**`code`**(*body*, *language='python'*)

Display a code block with optional syntax highlighting.

(This is a convenience wrapper around *st.markdown()*)

Parameters

- **body** (*str*) – The string to display as code.
- **language** (*str*) – The language that the code is written in, for syntax highlighting. If omitted, the code will be unstyled.

Example

```
>>> code = '''def hello():
...     print("Hello, Streamlit!")'''
>>> st.code(code, language='python')
```

17.3 Display data

When you're working with data, it is extremely valuable to visualize that data quickly, interactively, and from multiple different angles. That's what Streamlit is actually built and optimized for.

You can display data via *charts*, and you can display it in raw form. These are the Streamlit commands you can use to display raw data.

streamlit.**dataframe**(*data=None*, *width=None*, *height=None*)

Display a dataframe as an interactive table.

Parameters

- **data** (*pandas.DataFrame, pandas.Styler, numpy.ndarray, Iterable, dict,*) – or None The data to display.

  If 'data' is a pandas.Styler, it will be used to style its underying DataFrame. Streamlit supports custom cell values and colors. (It does not support some of the more exotic pandas styling features, like bar charts, hovering, and captions.) Styler support is experimental!
- **width** (*int or None*) – Desired width of the UI element expressed in pixels. If None, a default width based on the page width is used.
- **height** (*int or None*) – Desired height of the UI element expressed in pixels. If None, a default height is used.

Examples

```
>>> df = pd.DataFrame(
...    np.random.randn(50, 20),
...    columns=('col %d' % i for i in range(20)))
...
>>> st.dataframe(df)  # Same as st.write(df)
```

```
>>> st.dataframe(df, 200, 100)
```

You can also pass a Pandas Styler object to change the style of the rendered DataFrame:

```
>>> df = pd.DataFrame(
...    np.random.randn(10, 20),
...    columns=('col %d' % i for i in range(20)))
...
>>> st.dataframe(df.style.highlight_max(axis=0))
```

`streamlit.`**`table`**`(`*data=None*`)`

Display a static table.

This differs from *st.dataframe* in that the table in this case is static: its entire contents are just laid out directly on the page.

Parameters **`data`** (*`pandas.DataFrame, pandas.Styler, numpy.ndarray, Iterable, dict,`*) – or None The table data.

Example

```
>>> df = pd.DataFrame(
...     np.random.randn(10, 5),
...     columns=('col %d' % i for i in range(5)))
...
>>> st.table(df)
```

`streamlit.`**`json`**`(`*body*`)`

Display object or string as a pretty-printed JSON string.

Parameters **`body`** (*`Object or str`*) – The object to print as JSON. All referenced objects should be serializable to JSON as well. If object is a string, we assume it contains serialized JSON.

Example

```
>>> st.json({
...     'foo': 'bar',
...     'baz': 'boz',
...     'stuff': [
...         'stuff 1',
...         'stuff 2',
...         'stuff 3',
...         'stuff 5',
...     ],
... })
```

17.4 Display charts

Streamlit supports several different charting libraries, and our goal is to continually add support for more. Right now, the most basic library in our arsenal is Matplotlib. Then there are also interactive charting libraries like Vega Lite (2D charts) and deck.gl (maps and 3D charts). And finally we also provide a few chart types that are "native" to Streamlit, like `st.line_chart` and `st.area_chart`.

`streamlit.`**`line_chart`**`(`*data=None*, *width=0*, *height=0*, *use_container_width=True*`)`

Display a line chart.

This is just syntax-sugar around st.altair_chart. The main difference is this command uses the data's own column and indices to figure out the chart's spec. As a result this is easier to use for many "just plot this" scenarios, while being less customizable.

Parameters

- **`data`** (*`pandas.DataFrame, pandas.Styler, numpy.ndarray, Iterable, dict`*) – or None Data to be plotted.

- **width** (*int*) – The chart width in pixels. If 0, selects the width automatically.
- **height** (*int*) – The chart width in pixels. If 0, selects the height automatically.
- **use_container_width** (*bool*) – If True, set the chart width to the column width. This takes precedence over the width argument.

Example

```
>>> chart_data = pd.DataFrame(
...     np.random.randn(20, 3),
...     columns=['a', 'b', 'c'])
...
>>> st.line_chart(chart_data)
```

`streamlit.`**`area_chart`**(*data=None*, *width=0*, *height=0*, *use_container_width=True*)

Display a area chart.

This is just syntax-sugar around st.altair_chart. The main difference is this command uses the data's own column and indices to figure out the chart's spec. As a result this is easier to use for many "just plot this" scenarios, while being less customizable.

Parameters

- **data** (*pandas.DataFrame, pandas.Styler, numpy.ndarray, Iterable, or dict*) – Data to be plotted.
- **width** (*int*) – The chart width in pixels. If 0, selects the width automatically.
- **height** (*int*) – The chart width in pixels. If 0, selects the height automatically.
- **use_container_width** (*bool*) – If True, set the chart width to the column width. This takes precedence over the width argument.

Example

```
>>> chart_data = pd.DataFrame(
...     np.random.randn(20, 3),
...     columns=['a', 'b', 'c'])
...
>>> st.area_chart(chart_data)
```

`streamlit.`**`bar_chart`**(*data=None*, *width=0*, *height=0*, *use_container_width=True*)

Display a bar chart.

This is just syntax-sugar around st.altair_chart. The main difference is this command uses the data's own column and indices to figure out the chart's spec. As a result this is easier to use for many "just plot this" scenarios, while being less customizable.

Parameters

- **data** (*pandas.DataFrame, pandas.Styler, numpy.ndarray, Iterable, or dict*) – Data to be plotted.
- **width** (*int*) – The chart width in pixels. If 0, selects the width automatically.
- **height** (*int*) – The chart width in pixels. If 0, selects the height automatically.
- **use_container_width** (*bool*) – If True, set the chart width to the column width. This takes precedence over the width argument.

Example

```
>>> chart_data = pd.DataFrame(
...     np.random.randn(50, 3),
...     columns=["a", "b", "c"])
...
>>> st.bar_chart(chart_data)
```

`streamlit.`**`pyplot`**(*fig=None*, *clear_figure=None*, ***kwargs*)

Display a matplotlib.pyplot figure.

Parameters

- **`fig`** (*`Matplotlib Figure`*) – The figure to plot. When this argument isn't specified, which is the usual case, this function will render the global plot.
- **`clear_figure`** (*`bool`*) – If True, the figure will be cleared after being rendered. If False, the figure will not be cleared after being rendered. If left unspecified, we pick a default based on the value of *fig*.
  - If *fig* is set, defaults to *False*.
  - If *fig* is not set, defaults to *True*. This simulates Jupyter's approach to matplotlib rendering.
- **`**kwargs`** (*`any`*) – Arguments to pass to Matplotlib's savefig function.

Example

```
>>> import matplotlib.pyplot as plt
>>> import numpy as np
>>>
>>> arr = np.random.normal(1, 1, size=100)
>>> plt.hist(arr, bins=20)
>>>
>>> st.pyplot()
```

Notes

Matplotlib support several different types of "backends". If you're getting an error using Matplotlib with Streamlit, try setting your backend to "TkAgg":

```
echo "backend: TkAgg" >> ~/.matplotlib/matplotlibrc
```

For more information, see https://matplotlib.org/faq/usage_faq.html.

`streamlit.`**`altair_chart`**(*altair_chart*, *width=0*, *use_container_width=False*)

Display a chart using the Altair library.

Parameters

- **`altair_chart`** (*`altair.vegalite.v2.api.Chart`*) – The Altair chart object to display.
- **`width`** (*`number`*) – Deprecated. If != 0 (default), will show an alert. From now on you should set the width directly in the Altair spec. Please refer to the Altair documentation for details.

- **use_container_width** (*bool*) – If True, set the chart width to the column width. This takes precedence over Altair's native *width* value.

Example

```
>>> import pandas as pd
>>> import numpy as np
>>> import altair as alt
>>>
>>> df = pd.DataFrame(
...     np.random.randn(200, 3),
...     columns=['a', 'b', 'c'])
...
>>> c = alt.Chart(df).mark_circle().encode(
...     x='a', y='b', size='c', color='c', tooltip=['a', 'b', 'c'])
>>>
>>> st.altair_chart(c, use_container_width=True)
```

Examples of Altair charts can be found at https://altair-viz.github.io/gallery/.

`streamlit.`**`vega_lite_chart`**(*data=None, spec=None, width=0, use_container_width=False, **kwargs*)

Display a chart using the Vega-Lite library.

Parameters

- **data** (*pandas.DataFrame, pandas.Styler, numpy.ndarray, Iterable, dict,*) – or None Either the data to be plotted or a Vega-Lite spec containing the data (which more closely follows the Vega-Lite API).
- **spec** (*dict or None*) – The Vega-Lite spec for the chart. If the spec was already passed in the previous argument, this must be set to None. See https://vega.github.io/vega-lite/docs/ for more info.
- **width** (*number*) – Deprecated. If != 0 (default), will show an alert. From now on you should set the width directly in the Vega-Lite spec. Please refer to the Vega-Lite documentation for details.
- **use_container_width** (*bool*) – If True, set the chart width to the column width. This takes precedence over Vega-Lite's native *width* value.
- ****kwargs** (*any*) – Same as spec, but as keywords.

Example

```
>>> import pandas as pd
>>> import numpy as np
>>>
>>> df = pd.DataFrame(
...     np.random.randn(200, 3),
...     columns=['a', 'b', 'c'])
>>>
>>> st.vega_lite_chart(df, {
...     'mark': {'type': 'circle', 'tooltip': True},
...     'encoding': {
...         'x': {'field': 'a', 'type': 'quantitative'},
...         'y': {'field': 'b', 'type': 'quantitative'},
```

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```
...         'size': {'field': 'c', 'type': 'quantitative'},
...         'color': {'field': 'c', 'type': 'quantitative'},
...     },
... })
```

Examples of Vega-Lite usage without Streamlit can be found at https://vega.github.io/vega-lite/examples/. Most of those can be easily translated to the syntax shown above.

`streamlit.`**`plotly_chart`**(*figure_or_data*, *width=0*, *height=0*, *use_container_width=False*, *sharing='streamlit'*, ***kwargs*)

Display an interactive Plotly chart.

Plotly is a charting library for Python. The arguments to this function closely follow the ones for Plotly's *plot()* function. You can find more about Plotly at https://plot.ly/python.

Parameters

- **`figure_or_data`** (*`plotly.graph_objs.Figure, plotly.graph_objs.Data,`*) – dict/list of plotly.graph_objs.Figure/Data, or matplotlib.figure.Figure

  See https://plot.ly/python/ for examples of graph descriptions.

  If a Matplotlib Figure, converts it to a Plotly figure and displays it.

- **`width`** (*`int`*) – Deprecated. If != 0 (default), will show an alert. From now on you should set the width directly in the figure. Please refer to the Plotly documentation for details.

- **`height`** (*`int`*) – Deprecated. If != 0 (default), will show an alert. From now on you should set the height directly in the figure. Please refer to the Plotly documentation for details.

- **`use_container_width`** (*`bool`*) – If True, set the chart width to the column width. This takes precedence over the figure's native *width* value.

- **`sharing`** (*`{'streamlit', 'private', 'secret', 'public'}`*) – Use 'streamlit' to insert the plot and all its dependencies directly in the Streamlit app, which means it works offline too. This is the default. Use any other sharing mode to send the app to Plotly's servers, and embed the result into the Streamlit app. See https://plot.ly/python/privacy/ for more. Note that these sharing modes require a Plotly account.

- **`**kwargs`** – Any argument accepted by Plotly's *plot()* function.

To show Plotly charts in Streamlit, just call *st.plotly_chart* wherever you would call Plotly's *py.plot* or *py.iplot*.

Example

The example below comes straight from the examples at https://plot.ly/python:

```
>>> import streamlit as st
>>> import plotly.figure_factory as ff
>>> import numpy as np
>>>
>>> # Add histogram data
>>> x1 = np.random.randn(200) - 2
>>> x2 = np.random.randn(200)
>>> x3 = np.random.randn(200) + 2
>>>
>>> # Group data together
>>> hist_data = [x1, x2, x3]
```

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```
>>>
>>> group_labels = ['Group 1', 'Group 2', 'Group 3']
>>>
>>> # Create distplot with custom bin_size
>>> fig = ff.create_distplot(
...         hist_data, group_labels, bin_size=[.1, .25, .5])
>>>
>>> # Plot!
>>> st.plotly_chart(fig, use_container_width=True)
```

`streamlit.`**`bokeh_chart`**(*figure*, *use_container_width=False*)

Display an interactive Bokeh chart.

Bokeh is a charting library for Python. The arguments to this function closely follow the ones for Bokeh's *show* function. You can find more about Bokeh at https://bokeh.pydata.org.

Parameters

- **`figure`** (*`bokeh.plotting.figure.Figure`*) – A Bokeh figure to plot.
- **`use_container_width`** (*`bool`*) – If True, set the chart width to the column width. This takes precedence over Bokeh's native *width* value.
- **`show Bokeh charts in Streamlit, just call st.bokeh_chart`** (*`To`*) –
- **`you would call Bokeh's show.`** (*`wherever`*) –

Example

```
>>> import streamlit as st
>>> from bokeh.plotting import figure
>>>
>>> x = [1, 2, 3, 4, 5]
>>> y = [6, 7, 2, 4, 5]
>>>
>>> p = figure(
...     title='simple line example',
...     x_axis_label='x',
...     y_axis_label='y')
...
>>> p.line(x, y, legend='Trend', line_width=2)
>>>
>>> st.bokeh_chart(p, use_container_width=True)
```

`streamlit.`**`pydeck_chart`**(*pydeck_obj=None*, *use_container_width=False*)

Draw a chart using the PyDeck library.

This supports 3D maps, point clouds, and more! More info about PyDeck at https://deckgl.readthedocs.io/en/latest/.

These docs are also quite useful:

- DeckGL docs: https://github.com/uber/deck.gl/tree/master/docs
- DeckGL JSON docs: https://github.com/uber/deck.gl/tree/master/modules/json

When using this command, we advise all users to use a personal Mapbox token. This ensures the map tiles used in this chart are more robust. You can do this with the mapbox.token config option.

To get a token for yourself, create an account at https://mapbox.com. It's free! (for moderate usage levels) See https://docs.streamlit.io/en/latest/cli.html#view-all-config-options for more info on how to set config options.

Parameters **spec** (*pydeck.Deck or None*) – Object specifying the PyDeck chart to draw.

Example

Here's a chart using a HexagonLayer and a ScatterplotLayer on top of the light map style:

```
>>> df = pd.DataFrame(
...    np.random.randn(1000, 2) / [50, 50] + [37.76, -122.4],
...    columns=['lat', 'lon'])
>>>
>>> st.pydeck_chart(pdk.Deck(
...     map_style='mapbox://styles/mapbox/light-v9',
...     initial_view_state=pdk.ViewState(
...         latitude=37.76,
...         longitude=-122.4,
...         zoom=11,
...         pitch=50,
...     ),
...     layers=[
...         pdk.Layer(
...            'HexagonLayer',
...            data=df,
...            get_position='[lon, lat]',
...            radius=200,
...            elevation_scale=4,
...            elevation_range=[0, 1000],
...            pickable=True,
...            extruded=True,
...         ),
...         pdk.Layer(
...             'ScatterplotLayer',
...             data=df,
...             get_position='[lon, lat]',
...             get_color='[200, 30, 0, 160]',
...             get_radius=200,
...         ),
...     ],
... ))
```

streamlit.**deck_gl_chart**(*spec=None*, *use_container_width=False*, ***kwargs*)

Draw a map chart using the Deck.GL library.

This API closely follows Deck.GL's JavaScript API (https://deck.gl/#/documentation), with a few small adaptations and some syntax sugar.

When using this command, we advise all users to use a personal Mapbox token. This ensures the map tiles used in this chart are more robust. You can do this with the mapbox.token config option.

To get a token for yourself, create an account at https://mapbox.com. It's free! (for moderate usage levels) See https://docs.streamlit.io/en/latest/cli.html#view-all-config-options for more info on how to set config options.

Parameters

- **spec** (*dict*) – Keys in this dict can be:
  - Anything accepted by Deck.GL's top level element, such as "viewport", "height", "width".

- ”layers”: a list of dicts containing information to build a new Deck.GL layer in the map. Each layer accepts the following keys:
  - ”data” : DataFrame The data for the current layer.
  - ”type” : str One of the Deck.GL layer types that are currently supported by Streamlit: ArcLayer, GridLayer, HexagonLayer, LineLayer, PointCloudLayer, ScatterplotLayer, ScreenGridLayer, TextLayer.
  - Plus anything accepted by that layer type. The exact keys that are accepted depend on the “type” field, above. For example, for ScatterplotLayer you can set fields like “opacity”, “filled”, “stroked”, and so on.

    In addition, Deck.GL”s documentation for ScatterplotLayer shows you can use a “getRadius” field to individually set the radius of each circle in the plot. So here you would set “getRadius”: “my_column” where “my_column” is the name of the column containing the radius data.

    For things like “getPosition”, which expect an array rather than a scalar value, we provide alternates that make the API simpler to use with dataframes:
    - Instead of “getPosition” : use “getLatitude” and “getLongitude”.
    - Instead of “getSourcePosition” : use “getLatitude” and “getLongitude”.
    - Instead of “getTargetPosition” : use “getTargetLatitude” and “getTargetLongitude”.
    - Instead of “getColor” : use “getColorR”, “getColorG”, “getColorB”, and (optionally) “getColorA”, for red, green, blue and alpha.
    - Instead of “getSourceColor” : use the same as above.
    - Instead of “getTargetColor” : use “getTargetColorR”, etc.

- **use_container_width** (*bool*) – If True, set the chart width to the column width. This takes precedence over the figure’s native *width* value.
- ****kwargs** (*any*) – Same as spec, but as keywords. Keys are “unflattened” at the underscore characters. For example, foo_bar_baz=123 becomes foo={‘bar’: {‘bar’: 123}}.

Example

```
>>> st.deck_gl_chart(
...     viewport={
...         'latitude': 37.76,
...         'longitude': -122.4,
...         'zoom': 11,
...         'pitch': 50,
...     },
...     layers=[{
...         'type': 'HexagonLayer',
...         'data': df,
...         'radius': 200,
...         'elevationScale': 4,
...         'elevationRange': [0, 1000],
...         'pickable': True,
...         'extruded': True,
...     }, {
...         'type': 'ScatterplotLayer',
...         'data': df,
```

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```
...     }])
...
```

streamlit.**graphviz_chart**(*figure_or_dot*, *width=0*, *height=0*, *use_container_width=False*)

Display a graph using the dagre-d3 library.

Parameters

- **figure_or_dot** (*graphviz.dot.Graph, graphviz.dot.Digraph, str*) – The Graphlib graph object or dot string to display
- **width** (*number*) – Deprecated. If != 0 (default), will show an alert. From now on you should set the width directly in the Graphviz spec. Please refer to the Graphviz documentation for details.
- **height** (*number*) – Deprecated. If != 0 (default), will show an alert. From now on you should set the height directly in the Graphviz spec. Please refer to the Graphviz documentation for details.
- **use_container_width** (*bool*) – If True, set the chart width to the column width. This takes precedence over the figure's native *width* value.

Example

```
>>> import streamlit as st
>>> import graphviz as graphviz
>>>
>>> # Create a graphlib graph object
>>> graph = graphviz.Digraph()
>>> graph.edge('run', 'intr')
>>> graph.edge('intr', 'runbl')
>>> graph.edge('runbl', 'run')
>>> graph.edge('run', 'kernel')
>>> graph.edge('kernel', 'zombie')
>>> graph.edge('kernel', 'sleep')
>>> graph.edge('kernel', 'runmem')
>>> graph.edge('sleep', 'swap')
>>> graph.edge('swap', 'runswap')
>>> graph.edge('runswap', 'new')
>>> graph.edge('runswap', 'runmem')
>>> graph.edge('new', 'runmem')
>>> graph.edge('sleep', 'runmem')
>>>
>>> st.graphviz_chart(graph)
```

Or you can render the chart from the graph using GraphViz's Dot language:

```
>>> st.graphviz_chart('''
    digraph {
        run -> intr
        intr -> runbl
        runbl -> run
        run -> kernel
        kernel -> zombie
        kernel -> sleep
        kernel -> runmem
```

(continues on next page)

(continued from previous page)

```
        sleep -> swap
        swap -> runswap
        runswap -> new
        runswap -> runmem
        new -> runmem
        sleep -> runmem
    }
''')
```

`streamlit.`**map**(*data=None*, *zoom=None*, *use_container_width=True*)

Display a map with points on it.

This is a wrapper around st.pydeck_chart to quickly create scatterplot charts on top of a map, with auto-centering and auto-zoom.

When using this command, we advise all users to use a personal Mapbox token. This ensures the map tiles used in this chart are more robust. You can do this with the mapbox.token config option.

To get a token for yourself, create an account at https://mapbox.com. It's free! (for moderate usage levels) See https://docs.streamlit.io/en/latest/cli.html#view-all-config-options for more info on how to set config options.

Parameters

- **data** (*pandas.DataFrame, pandas.Styler, numpy.ndarray, Iterable, dict,*) – or None The data to be plotted. Must have columns called 'lat', 'lon', 'latitude', or 'longitude'.
- **zoom** (*int*) – Zoom level as specified in https://wiki.openstreetmap.org/wiki/Zoom_levels

Example

```
>>> import pandas as pd
>>> import numpy as np
>>>
>>> df = pd.DataFrame(
...     np.random.randn(1000, 2) / [50, 50] + [37.76, -122.4],
...     columns=['lat', 'lon'])
>>>
>>> st.map(df)
```

17.5 Display media

It's easy to embed images, videos, and audio files directly into your Streamlit apps.

`streamlit.`**image**(*image*, *caption=None*, *width=None*, *use_column_width=False*, *clamp=False*, *channels='RGB'*, *format='JPEG'*)

Display an image or list of images.

Parameters

- **image** (*numpy.ndarray, [numpy.ndarray], BytesIO, str, or [str]*) – Monochrome image of shape (w,h) or (w,h,1) OR a color image of shape (w,h,3) OR an RGBA image of shape (w,h,4) OR a URL to fetch the image from OR a list of one of the above, to display multiple images.

- **caption** (*str or list of str*) – Image caption. If displaying multiple images, caption should be a list of captions (one for each image).
- **width** (*int or None*) – Image width. None means use the image width.
- **use_column_width** (*bool*) – If True, set the image width to the column width. This takes precedence over the *width* parameter.
- **clamp** (*bool*) – Clamp image pixel values to a valid range ([0-255] per channel). This is only meaningful for byte array images; the parameter is ignored for image URLs. If this is not set, and an image has an out-of-range value, an error will be thrown.
- **channels** (*'RGB' or 'BGR'*) – If image is an nd.array, this parameter denotes the format used to represent color information. Defaults to 'RGB', meaning *image[:, :, 0]* is the red channel, *image[:, :, 1]* is green, and *image[:, :, 2]* is blue. For images coming from libraries like OpenCV you should set this to 'BGR', instead.
- **format** (*'JPEG' or 'PNG'*) – This parameter specifies the image format to use when transferring the image data. Defaults to 'JPEG'.

Example

```
>>> from PIL import Image
>>> image = Image.open('sunrise.jpg')
>>>
>>> st.image(image, caption='Sunrise by the mountains',
...          use_column_width=True)
```

streamlit.**audio**(*data*, *format='audio/wav'*, *start_time=0*)

Display an audio player.

Parameters

- **data** (*str, bytes, BytesIO, numpy.ndarray, or file opened with*) – io.open(). Raw audio data, filename, or a URL pointing to the file to load. Numpy arrays and raw data formats must include all necessary file headers to match specified file format.
- **start_time** (*int*) – The time from which this element should start playing.
- **format** (*str*) – The mime type for the audio file. Defaults to 'audio/wav'. See https://tools.ietf.org/html/rfc4281 for more info.

Example

```
>>> audio_file = open('myaudio.ogg', 'rb')
>>> audio_bytes = audio_file.read()
>>>
>>> st.audio(audio_bytes, format='audio/ogg')
```

streamlit.**video**(*data*, *format='video/mp4'*, *start_time=0*)

Display a video player.

Parameters

- **data** (*str, bytes, BytesIO, numpy.ndarray, or file opened with*) – io.open(). Raw video data, filename, or URL pointing to a video to load.

Includes support for YouTube URLs. Numpy arrays and raw data formats must include all necessary file headers to match specified file format.

- **format** (*str*) – The mime type for the video file. Defaults to 'video/mp4'. See https://tools.ietf.org/html/rfc4281 for more info.
- **start_time** (*int*) – The time from which this element should start playing.

Example

```
>>> video_file = open('myvideo.mp4', 'rb')
>>> video_bytes = video_file.read()
>>>
>>> st.video(video_bytes)
```

17.6 Display interactive widgets

With widgets, Streamlit allows you to bake interactivity directly into your apps with buttons, sliders, text inputs, and more.

streamlit.**button**(*label*, *key=None*)

Display a button widget.

Parameters

- **label** (*str*) – A short label explaining to the user what this button is for.
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns If the button was clicked on the last run of the app.

Return type bool

Example

```
>>> if st.button('Say hello'):
...     st.write('Why hello there')
... else:
...     st.write('Goodbye')
```

streamlit.**checkbox**(*label*, *value=False*, *key=None*)

Display a checkbox widget.

Parameters

- **label** (*str*) – A short label explaining to the user what this checkbox is for.
- **value** (*bool*) – Preselect the checkbox when it first renders. This will be cast to bool internally.
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns Whether or not the checkbox is checked.

Return type bool

Example

```
>>> agree = st.checkbox('I agree')
>>>
>>> if agree:
...     st.write('Great!')
```

`streamlit.`**`radio`**(*label*, *options*, *index=0*, *format_func=<class 'str'>*, *key=None*)

Display a radio button widget.

Parameters

- **`label`** (*`str`*) – A short label explaining to the user what this radio group is for.
- **`options`** (*`list, tuple, numpy.ndarray, or pandas.Series`*) – Labels for the radio options. This will be cast to str internally by default.
- **`index`** (*`int`*) – The index of the preselected option on first render.
- **`format_func`** (*`function`*) – Function to modify the display of radio options. It receives the raw option as an argument and should output the label to be shown for that option. This has no impact on the return value of the radio.
- **`key`** (*`str`*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns The selected option.

Return type any

Example

```
>>> genre = st.radio(
...     "What's your favorite movie genre",
...     ('Comedy', 'Drama', 'Documentary'))
>>>
>>> if genre == 'Comedy':
...     st.write('You selected comedy.')
... else:
...     st.write("You didn't select comedy.")
```

`streamlit.`**`selectbox`**(*label*, *options*, *index=0*, *format_func=<class 'str'>*, *key=None*)

Display a select widget.

Parameters

- **`label`** (*`str`*) – A short label explaining to the user what this select widget is for.
- **`options`** (*`list, tuple, numpy.ndarray, or pandas.Series`*) – Labels for the select options. This will be cast to str internally by default.
- **`index`** (*`int`*) – The index of the preselected option on first render.
- **`format_func`** (*`function`*) – Function to modify the display of the labels. It receives the option as an argument and its output will be cast to str.

- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns The selected option

Return type any

Example

```
>>> option = st.selectbox(
...     'How would you like to be contacted?',
...     ('Email', 'Home phone', 'Mobile phone'))
>>>
>>> st.write('You selected:', option)
```

`streamlit.`**`multiselect`**(*label*, *options*, *default=None*, *format_func=<class 'str'>*, *key=None*)

Display a multiselect widget. The multiselect widget starts as empty.

Parameters

- **label** (*str*) – A short label explaining to the user what this select widget is for.
- **options** (*list, tuple, numpy.ndarray, or pandas.Series*) – Labels for the select options. This will be cast to str internally by default.
- **default** (*[str] or None*) – List of default values.
- **format_func** (*function*) – Function to modify the display of selectbox options. It receives the raw option as an argument and should output the label to be shown for that option. This has no impact on the return value of the selectbox.
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns A list with the selected options

Return type [str]

Example

```
>>> options = st.multiselect(
...     'What are your favorite colors',
...     ['Green', 'Yellow', 'Red', 'Blue'],
...     ['Yellow', 'Red'])
>>>
>>> st.write('You selected:', options)
```

`streamlit.`**`slider`**(*label*, *min_value=None*, *max_value=None*, *value=None*, *step=None*, *format=None*, *key=None*)

Display a slider widget.

This also allows you to render a range slider by passing a two-element tuple or list as the *value*.

Parameters

- **label** (*str or None*) – A short label explaining to the user what this slider is for.

- **min_value** (*int/float or None*) – The minimum permitted value. Defaults to 0 if the value is an int, 0.0 otherwise.
- **max_value** (*int/float or None*) – The maximum permitted value. Defaults 100 if the value is an int, 1.0 otherwise.
- **value** (*int/float or a tuple/list of int/float or None*) – The value of the slider when it first renders. If a tuple/list of two values is passed here, then a range slider with those lower and upper bounds is rendered. For example, if set to *(1, 10)* the slider will have a selectable range between 1 and 10. Defaults to min_value.
- **step** (*int/float or None*) – The stepping interval. Defaults to 1 if the value is an int, 0.01 otherwise.
- **format** (*str or None*) – A printf-style format string controlling how the interface should display numbers. This does not impact the return value. Valid formatters: %d %e %f %g %i
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns The current value of the slider widget. The return type will match the data type of the value parameter.

Return type int/float or tuple of int/float

Examples

```
>>> age = st.slider('How old are you?', 0, 130, 25)
>>> st.write("I'm ", age, 'years old')
```

And here's an example of a range slider:

```
>>> values = st.slider(
...     'Select a range of values',
...     0.0, 100.0, (25.0, 75.0))
>>> st.write('Values:', values)
```

streamlit.**text_input**(*label*, *value=”*, *max_chars=None*, *key=None*, *type=’default’*)

Display a single-line text input widget.

Parameters

- **label** (*str*) – A short label explaining to the user what this input is for.
- **value** (*any*) – The text value of this widget when it first renders. This will be cast to str internally.
- **max_chars** (*int or None*) – Max number of characters allowed in text input.
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.
- **type** (*str*) – The type of the text input. This can be either “default” (for a regular text input), or “password” (for a text input that masks the user's typed value). Defaults to “default”.

Returns The current value of the text input widget.

Return type str

Example

```
>>> title = st.text_input('Movie title', 'Life of Brian')
>>> st.write('The current movie title is', title)
```

`streamlit.`**`number_input`**(*label*, *min_value=None*, *max_value=None*, *value=<streamlit.DeltaGenerator.NoValue object>*, *step=None*, *format=None*, *key=None*)

Display a numeric input widget.

Parameters

- **label** (*str or None*) – A short label explaining to the user what this input is for.
- **min_value** (*int or float or None*) – The minimum permitted value. If None, there will be no minimum.
- **max_value** (*int or float or None*) – The maximum permitted value. If None, there will be no maximum.
- **value** (*int or float or None*) – The value of this widget when it first renders. Defaults to min_value, or 0.0 if min_value is None
- **step** (*int or float or None*) – The stepping interval. Defaults to 1 if the value is an int, 0.01 otherwise. If the value is not specified, the format parameter will be used.
- **format** (*str or None*) – A printf-style format string controlling how the interface should display numbers. Output must be purely numeric. This does not impact the return value. Valid formatters: %d %e %f %g %i
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns The current value of the numeric input widget. The return type will match the data type of the value parameter.

Return type int or float

Example

```
>>> number = st.number_input('Insert a number')
>>> st.write('The current number is ', number)
```

`streamlit.`**`text_area`**(*label*, *value=''*, *height=None*, *max_chars=None*, *key=None*)

Display a multi-line text input widget.

Parameters

- **label** (*str*) – A short label explaining to the user what this input is for.
- **value** (*any*) – The text value of this widget when it first renders. This will be cast to str internally.
- **height** (*int or None*) – Desired height of the UI element expressed in pixels. If None, a default height is used.
- **max_chars** (*int or None*) – Maximum number of characters allowed in text area.

- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns The current value of the text input widget.

Return type str

Example

```
>>> txt = st.text_area('Text to analyze', '''
...     It was the best of times, it was the worst of times, it was
...     the age of wisdom, it was the age of foolishness, it was
...     the epoch of belief, it was the epoch of incredulity, it
...     was the season of Light, it was the season of Darkness, it
...     was the spring of hope, it was the winter of despair, (...)
...     ''')
>>> st.write('Sentiment:', run_sentiment_analysis(txt))
```

`streamlit.`**`date_input`**(*label, value=None, min_value=datetime.datetime(1, 1, 1, 0, 0), max_value=None, key=None*)

Display a date input widget.

Parameters

- **label** (*str*) – A short label explaining to the user what this date input is for.
- **value** (*datetime.date or datetime.datetime or list/tuple of datetime.date or datetime.datetime or None*) – The value of this widget when it first renders. If a list/tuple with 0 to 2 date/datetime values is provided, the datepicker will allow users to provide a range. Defaults to today as a single-date picker.
- **min_value** (*datetime.date or datetime.datetime*) – The minimum selectable date. Defaults to datetime.min.
- **max_value** (*datetime.date or datetime.datetime*) – The maximum selectable date. Defaults to today+10y.
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns The current value of the date input widget.

Return type datetime.date

Example

```
>>> d = st.date_input(
...     "When's your birthday",
...     datetime.date(2019, 7, 6))
>>> st.write('Your birthday is:', d)
```

`streamlit.`**`time_input`**(*label, value=None, key=None*)

Display a time input widget.

Parameters

- **label** (*str*) – A short label explaining to the user what this time input is for.
- **value** (*datetime.time/datetime.datetime*) – The value of this widget when it first renders. This will be cast to str internally. Defaults to the current time.
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns The current value of the time input widget.

Return type datetime.time

Example

```
>>> t = st.time_input('Set an alarm for', datetime.time(8, 45))
>>> st.write('Alarm is set for', t)
```

streamlit.**file_uploader**(*label*, *type=None*, *encoding='auto'*, *key=None*)

Display a file uploader widget.

By default, uploaded files are limited to 200MB. You can configure this using the *server.maxUploadSize* config option.

Parameters

- **label** (*str or None*) – A short label explaining to the user what this file uploader is for.
- **type** (*str or list of str or None*) – Array of allowed extensions. ['png', 'jpg'] By default, all extensions are allowed.
- **encoding** (*str or None*) – The encoding to use when opening textual files (i.e. non-binary). For example: 'utf-8'. If set to 'auto', will try to guess the encoding. If None, will assume the file is binary.
- **key** (*str*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns

If no file has been uploaded, returns None. Otherwise, returns the data for the uploaded file(s): - If the file is in a well-known textual format (or if the encoding parameter is set), the file data is a StringIO. - Otherwise the file data is BytesIO. - If multiple_files is True, a list of file data will be returned.

Note that BytesIO/StringIO are "file-like", which means you can pass them anywhere where a file is expected!

Return type BytesIO or StringIO or or list of BytesIO/StringIO or None

Examples

```
>>> uploaded_file = st.file_uploader("Choose a CSV file", type="csv")
>>> if uploaded_file is not None:
...     data = pd.read_csv(uploaded_file)
...     st.write(data)
```

`streamlit.`**`beta_color_picker`**`(`*label*, *value=None*, *key=None*`)`

Display a color picker widget.

Note: This is a beta feature. See https://docs.streamlit.io/en/latest/pre_release_features.html for more information.

Parameters

- **`label`** (*`str`*) – A short label explaining to the user what this input is for.
- **`value`** (*`str or None`*) – The hex value of this widget when it first renders. If None, defaults to black.
- **`key`** (*`str`*) – An optional string to use as the unique key for the widget. If this is omitted, a key will be generated for the widget based on its content. Multiple widgets of the same type may not share the same key.

Returns The selected color as a hex string.

Return type str

Example

```
>>> color = st.beta_color_picker('Pick A Color', '#00f900')
>>> st.write('The current color is', color)
```

17.7 Add widgets to sidebar

Not only can you add interactivity to your report with widgets, you can organize them into a sidebar with `st.sidebar.[element_name]`. Each element that's passed to `st.sidebar` is pinned to the left, allowing users to focus on the content in your app. The only elements that aren't supported are: `st.write` (you should use `st.sidebar.markdown()` instead), `st.echo`, and `st.spinner`.

Here's an example of how you'd add a selectbox to your sidebar.

```
import streamlit as st

add_selectbox = st.sidebar.selectbox(
    "How would you like to be contacted?",
    ("Email", "Home phone", "Mobile phone")
)
```

17.8 Display code

Sometimes you want your Streamlit app to contain *both* your usual Streamlit graphic elements *and* the code that generated those elements. That's where `st.echo()` comes in.

`streamlit.`**`echo`**`(`*code_location='above'*`)`

Use in a *with* block to draw some code on the app, then execute it.

Parameters **`code_location`** (*`"above" or "below"`*) – Whether to show the echoed code before or after the results of the executed code block.

Example

```
>>> with st.echo():
>>>     st.write('This code will be printed')
```

Ok so let's say you have the following file, and you want to make its app a little bit more self-explanatory by making that middle section visible in the Streamlit app:

```
import streamlit as st

def get_user_name():
    return 'John'

# ------------------------------------------------
# Want people to see this part of the code...

def get_punctuation():
    return '!!!'

greeting = "Hi there, "
user_name = get_user_name()
punctuation = get_punctuation()

st.write(greeting, user_name, punctuation)

# ...up to here
# ------------------------------------------------

foo = 'bar'
st.write('Done!')
```

The file above creates a Streamlit app containing the words "Hi there, `John`", and then "Done!".

Now let's use `st.echo()` to make that middle section of the code visible in the app:

```
import streamlit as st

def get_user_name():
    return 'John'

with st.echo():
    # Everything inside this block will be both printed to the screen
    # and executed.

    def get_punctuation():
        return '!!!'

    greeting = "Hi there, "
    value = get_user_name()
    punctuation = get_punctuation()

    st.write(greeting, value, punctuation)

# And now we're back to _not_ printing to the screen
foo = 'bar'
st.write('Done!')
```

It's *that* simple!

Note: You can have multiple *st.echo()* blocks in the same file. Use it as often as you wish!

17.9 Display progress and status

Streamlit provides a few methods that allow you to add animation to your apps. These animations include progress bars, status messages (like warnings), and celebratory balloons.

`streamlit.`**`progress`**(*value*)

Display a progress bar.

Parameters **`value`** (*`int`*) – The percentage complete: 0 <= value <= 100

Example

Here is an example of a progress bar increasing over time:

```
>>> import time
>>>
>>> my_bar = st.progress(0)
>>>
>>> for percent_complete in range(100):
...     time.sleep(0.1)
...     my_bar.progress(percent_complete + 1)
```

`streamlit.`**`spinner`**(*text='In progress...'*)

Temporarily displays a message while executing a block of code.

Parameters **`text`** (*`str`*) – A message to display while executing that block

Example

```
>>> with st.spinner('Wait for it...'):
>>>     time.sleep(5)
>>> st.success('Done!')
```

`streamlit.`**`balloons`**()

Draw celebratory balloons.

Example

```
>>> st.balloons()
```

. . . then watch your app and get ready for a celebration!

`streamlit.`**`error`**(*body*)

Display error message.

Parameters **`body`** (*`str`*) – The error text to display.

Example

```
>>> st.error('This is an error')
```

streamlit.**warning**(*body*)
Display warning message.

Parameters **body** (*str*) – The warning text to display.

Example

```
>>> st.warning('This is a warning')
```

streamlit.**info**(*body*)
Display an informational message.

Parameters **body** (*str*) – The info text to display.

Example

```
>>> st.info('This is a purely informational message')
```

streamlit.**success**(*body*)
Display a success message.

Parameters **body** (*str*) – The success text to display.

Example

```
>>> st.success('This is a success message!')
```

streamlit.**exception**(*exception*)
Display an exception.

Parameters **exception** (*Exception*) – The exception to display.

Example

```
>>> e = RuntimeError('This is an exception of type RuntimeError')
>>> st.exception(e)
```

17.10 Placeholders, help, and options

There are a handful of methods that allow you to create placeholders in your app, provide help using doc strings, and get and modify configuration options.

streamlit.**empty**()
Add a placeholder to the app.

The placeholder can be filled any time by calling methods on the return value.

Example

```
>>> my_placeholder = st.empty()
>>>
>>> # Now replace the placeholder with some text:
>>> my_placeholder.text("Hello world!")
>>>
>>> # And replace the text with an image:
>>> my_placeholder.image(my_image_bytes)
```

`streamlit.`**`help`**`(`*obj*`)`

Display object's doc string, nicely formatted.

Displays the doc string for this object.

Parameters **`obj`** (*`Object`*) – The object whose docstring should be displayed.

Example

Don't remember how to initialize a dataframe? Try this:

```
>>> st.help(pandas.DataFrame)
```

Want to quickly check what datatype is output by a certain function? Try:

```
>>> x = my_poorly_documented_function()
>>> st.help(x)
```

`streamlit.`**`get_option`**`(`*key*`)`

Return the current value of a given Streamlit config option.

Run *streamlit config show* in the terminal to see all available options.

Parameters **`key`** (*`str`*) – The config option key of the form "section.optionName". To see all available options, run *streamlit config show* on a terminal.

`streamlit.`**`set_option`**`(`*key*, *value*`)`

Set config option.

Currently, only two config options can be set within the script itself:

- client.caching
- client.displayEnabled

Calling with any other options will raise StreamlitAPIException.

Run *streamlit config show* in the terminal to see all available options.

Parameters

- **`key`** (*`str`*) – The config option key of the form "section.optionName". To see all available options, run *streamlit config show* on a terminal.
- **`value`** – The new value to assign to this config option.

17.11 Mutate data

With Streamlit you can modify the data within an existing element (chart, table, dataframe).

`DeltaGenerator.`**`add_rows`**(*data=None*, ***kwargs*)

Concatenate a dataframe to the bottom of the current one.

Parameters

- **`data`** (*`pandas.DataFrame, pandas.Styler, numpy.ndarray, Iterable, dict,`*) –
- **`None`** (*`or`*) – Table to concat. Optional.
- **`**kwargs`** (*`pandas.DataFrame, numpy.ndarray, Iterable, dict, or None`*) – The named dataset to concat. Optional. You can only pass in 1 dataset (including the one in the data parameter).

Example

```
>>> df1 = pd.DataFrame(
...    np.random.randn(50, 20),
...    columns=('col %d' % i for i in range(20)))
...
>>> my_table = st.table(df1)
>>>
>>> df2 = pd.DataFrame(
...    np.random.randn(50, 20),
...    columns=('col %d' % i for i in range(20)))
...
>>> my_table.add_rows(df2)
>>> # Now the table shown in the Streamlit app contains the data for
>>> # df1 followed by the data for df2.
```

You can do the same thing with plots. For example, if you want to add more data to a line chart:

```
>>> # Assuming df1 and df2 from the example above still exist...
>>> my_chart = st.line_chart(df1)
>>> my_chart.add_rows(df2)
>>> # Now the chart shown in the Streamlit app contains the data for
>>> # df1 followed by the data for df2.
```

And for plots whose datasets are named, you can pass the data with a keyword argument where the key is the name:

```
>>> my_chart = st.vega_lite_chart({
...     'mark': 'line',
...     'encoding': {'x': 'a', 'y': 'b'},
...     'datasets': {
...       'some_fancy_name': df1,  # <-- named dataset
...      },
...     'data': {'name': 'some_fancy_name'},
... }),
>>> my_chart.add_rows(some_fancy_name=df2)  # <-- name used as keyword
```

17.12 Optimize performance

When you mark a function with Streamlit's cache annotation, it tells Streamlit that whenever the function is called it should check three things:

1. The name of the function
2. The actual code that makes up the body of the function
3. The input parameters that you called the function with

If this is the first time Streamlit has seen those three items, with those exact values, and in that exact combination, it runs the function and stores the result in a local cache.

Then, next time the function is called, if those three values have not changed Streamlit knows it can skip executing the function altogether. Instead, it just reads the output from the local cache and passes it on to the caller.

The main limitation is that Streamlit's cache feature doesn't know about changes that take place outside the body of the annotated function.

For more information about the Streamlit cache, its configuration parameters, and its limitations, see *Caching*.

`streamlit.`**`cache`**(*func=None*, *persist=False*, *allow_output_mutation=False*, *show_spinner=True*, *suppress_st_warning=False*, *hash_funcs=None*, *max_entries=None*, *ttl=None*)

Function decorator to memoize function executions.

Parameters

- **`func`** (*`callable`*) – The function to cache. Streamlit hashes the function and dependent code.
- **`persist`** (*`boolean`*) – Whether to persist the cache on disk.
- **`allow_output_mutation`** (*`boolean`*) – Streamlit normally shows a warning when return values are not mutated, as that can have unintended consequences. This is done by hashing the return value internally.

  If you know what you're doing and would like to override this warning, set this to True.
- **`show_spinner`** (*`boolean`*) – Enable the spinner. Default is True to show a spinner when there is a cache miss.
- **`suppress_st_warning`** (*`boolean`*) – Suppress warnings about calling Streamlit functions from within the cached function.
- **`hash_funcs`** (*`dict or None`*) – Mapping of types or fully qualified names to hash functions. This is used to override the behavior of the hasher inside Streamlit's caching mechanism: when the hasher encounters an object, it will first check to see if its type matches a key in this dict and, if so, will use the provided function to generate a hash for it. See below for an example of how this can be used.
- **`max_entries`** (*`int or None`*) – The maximum number of entries to keep in the cache, or None for an unbounded cache. (When a new entry is added to a full cache, the oldest cached entry will be removed.) The default is None.
- **`ttl`** (*`float or None`*) – The maximum number of seconds to keep an entry in the cache, or None if cache entries should not expire. The default is None.

Example

```
>>> @st.cache
... def fetch_and_clean_data(url):
...     # Fetch data from URL here, and then clean it up.
...     return data
...
>>> d1 = fetch_and_clean_data(DATA_URL_1)
```

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```
>>> # Actually executes the function, since this is the first time it was
>>> # encountered.
>>>
>>> d2 = fetch_and_clean_data(DATA_URL_1)
>>> # Does not execute the function. Just returns its previously computed
>>> # value. This means that now the data in d1 is the same as in d2.
>>>
>>> d3 = fetch_and_clean_data(DATA_URL_2)
>>> # This is a different URL, so the function executes.
```

To set the *persist* parameter, use this command as follows:

```
>>> @st.cache(persist=True)
... def fetch_and_clean_data(url):
...     # Fetch data from URL here, and then clean it up.
...     return data
```

To disable hashing return values, set the *allow_output_mutation* parameter to *True*:

```
>>> @st.cache(allow_output_mutation=True)
... def fetch_and_clean_data(url):
...     # Fetch data from URL here, and then clean it up.
...     return data
```

To override the default hashing behavior, pass a custom hash function. You can do that by mapping a type (e.g. *MongoClient*) to a hash function (*id*) like this:

```
>>> @st.cache(hash_funcs={MongoClient: id})
... def connect_to_database(url):
...     return MongoClient(url)
```

Alternatively, you can map the type's fully-qualified name (e.g. *"pymongo.mongo_client.MongoClient"*) to the hash function instead:

```
>>> @st.cache(hash_funcs={"pymongo.mongo_client.MongoClient": id})
... def connect_to_database(url):
...     return MongoClient(url)
```

CHAPTER 18

Command-line interface

When you install Streamlit, the Streamlit command-line CLI tool gets installed as well. The main purpose of this tool is to help you diagnose and fix issues.

You can find docs for our CLI tool as usual:

```
$ streamlit --help
```

Below are a few of the most useful commands accepted by Streamlit CLI:

18.1 Run Streamlit apps

```
$ streamlit run your_script.py [-- script args]
```

Runs your app. At any time you can kill the server with **Ctrl+c**.

Note: When passing your script some custom arguments, **they must be passed after two dashes**. Otherwise the arguments get interpreted as arguments to Streamlit itself.

You can also pass in config options to `streamlit run`. These allow you to do things like change the port the app is served from, disable run-on-save, and more. To see all options, run:

```
$ streamlit run --help
```

Tip: If you want to permanently set certain config options, just add them to *$CWD/.streamlit/config.toml* or to a global *~/.streamlit/config.toml* (in Windows this would be *%userprofile%/.streamlit/config.toml*). More info below.

18.2 Run a cool demo

```
$ streamlit hello
```

Opens Streamlit's Hello World app in a web browser. This is useful for testing Streamlit.

18.3 View all config options

```
$ streamlit config show
```

Shows all config options available for Streamlit, including their current values. You can set these options in four different ways:

- **In a global config file at `~/.streamlit/config.toml`.** For instance:

  ```
  [server]
  port = 80
  ```

- **In a per-project config file at `$CWD/.streamlit/config.toml`,** where `$CWD` is the folder you're running Streamlit from.
- **Through `STREAMLIT_*` environment variables,** such as:

  ```
  $ export STREAMLIT_SERVER_PORT=80
  ```

- **As flags in the command line** when running `streamlit run`. For example:

  ```
  $ streamlit run your_script.py --server.port 80
  ```

18.4 Clear the cache

```
$ streamlit cache clear
```

Clears persisted files from the Streamlit cache, if any.

18.5 View documentation

```
$ streamlit docs
```

Opens Streamlit's documentation (i.e. this website) in a web browser.

18.6 Print Streamlit's version

```
$ streamlit --version
```

Shows the version of Streamlit in your current Python environment.

CHAPTER 19

Try pre-release features

At Streamlit, we like to move quick while keeping things stable. In our latest effort to move even faster without sacrificing stability, we're offering our bold and fearless users two ways to try out Streamlit's most bleeding edge features:

1. *Nightly releases*
2. *Beta and experimental namespaces*

19.1 Nightly releases

At the end of each day (at night), our bots run automated tests against the latest Streamlit code and, if everything looks good, it publishes them as the `streamlit-nightly` package. This means the nightly build includes all our latest features, bug fixes, and other enhancements on the same day they land on our codebase.

How does this differ from official releases?

Official Streamlit releases go not only through both automated tests but also rigorous manual testing, while nightly releases only have automated tests. It's important to keep in mind that new features introduced in nightly releases often lack polish. In our official releases, we always make double-sure all new features are ready for prime time.

How do I use the nightly release?

All you need to do is install the `streamlit-nightly` package:

```
pip uninstall streamlit
pip install streamlit-nightly --upgrade
```

Warning: You should never have both *streamlit* and *streamlit-nightly* installed in the same environment!

Why should I use the nightly release?

Because you can't wait for official releases, and you want to help us find bugs early!

Why shouldn't I use the nightly release?

While our automated tests have high coverage, there's still a significant likelihood that there will be some bugs in the nightly code.

Can I choose which nightly release I want to install?

If you'd like to use a specific version, you can find the version number in our Release history. Just specify the desired version using `pip` as usual: `pip install streamlit-nightly==x.yy.zz-123456`.

Can I compare changes between releases?

If you'd like to review the changes for a nightly release, you can use the comparison tool on GitHub.

19.2 Beta and Experimental Namespaces

In addition to nightly releases, we're also introducing two new namespaces for Streamlit features: `st.beta` and `st.experimental`. These are basically prefixes we attach to our function names to make sure their status is clear to everyone.

Here's a quick rundown of what you get from each namespace:

- **st**: this is where our core features like `st.write` and `st.dataframe` live. If we ever make backward-incompatible changes to these, they will take place gradually and with months of announcements and warnings.
- **st.beta**: this is where all new features land before they find their way to `st`. This gives you a chance to try the next big thing we're cooking up weeks or months before we're ready to stabilize its API.
- **st.experimental**: this is where we'll put features that may or may not ever make it into `st`. We don't know whether these features have a future, but we want you to have access to everything we're trying, and work with us to figure them out.

The main difference between `st.beta` and `st.experimental` is that beta features are expected to make it into the `st` namespace at some point soon, while experimental features may never make it.

19.2.1 Beta

Features in the beta namespace are all scheduled to become part of `st`, or core Streamlit. While in beta, a feature's API and behaviors may not be stable, and it's possible they could change in ways that aren't backward-compatible.

The lifecycle of a beta feature

1. A feature is added to the beta namespace.
2. The feature's API stabilizes and the feature is *cloned* into the `st` namespace, so it exists in both st and `st.beta`. At this point, users will see a warning when using the version of the feature that lives in the beta namespace – but the `st.beta` feature will still work.
3. At some point, the feature is *removed* from the `st.beta` namespace, but there will still be a stub in `st.beta` that shows an error with appropriate instructions.
4. Finally, at a later date the stub in `st.beta` is removed.

19.2.2 Experimental

Features in the experimental namespace are things that we're still working on or trying to understand. If these features are successful, at some point they'll become part of core Streamlit, by moving to the `st.beta` namespace and then to `st`. If unsuccessful, these features are removed without much notice.

Warning: Experimental features and their APIs may change or be removed at any time.

The lifecycle of an experimental feature

1. A feature is added to the experimental namespace.
2. The feature is potentially tweaked over time, with possible API/behavior breakages.
3. At some point, we either move the feature into `st.beta` or remove it from `st.experimental`. Either way, we leave a stub in `st.experimental` that shows an error with instructions.

Let us know if you have any questions or feedback about the new namespaces!

CHAPTER 20

Changelog

This page lists highlights, bug fixes, and known issues for official Streamlit releases. If you're looking for information about nightly releases, beta features, or experimental features, see *Try pre-release features*.

Tip: To upgrade to the latest version of Streamlit, run:

```
$ pip install --upgrade streamlit
```

20.1 Version 0.61.0

Release date: June 2, 2020

Highlights:

- Support for date ranges in `st.date_picker`. See docs for more info, but the TLDR is: just pass a list/tuple as the default date and it will be interpreted as a range.
- You can now choose whether `st.echo` prints the code above or below the output of the echoed block. To learn more, refer to the `code_location` argument in the docs.
- Improved `@st.cache` support for Keras models and Tensorflow `saved_models`.

20.2 Version 0.60.0

Release date: May 18, 2020

Highlights:

- Ability to set the height of an `st.text_area` with the `height` argument (expressed in pixels). See docs for more.

- Ability to set the maximimum number of characters allowed in `st.text_area` or `st.text_input`. Check out the `max_chars` argument in the docs.
- Better DeckGL support for the H3 geospatial indexing system. So now you can use things like `H3HexagonLayer` in `st.pydeck_chart`.
- Improved `@st.cache` support for PyTorch TensorBase and Model.

20.3 Version 0.59.0

Release date: May 05, 2020

Highlights:

- New color-picker widget! Use it with `st.beta_color_picker()`
- Introducing `st.beta_*` and `st.experimental_*` function prefixes, for faster Streamlit feature releases. See docs for more info.
- Improved `@st.cache` support for SQL Alchemy objects, CompiledFFI, PyTorch Tensors, and `builtins.mappingproxy`.

20.4 Version 0.58.0

Release date: April 22, 2020

Highlights:

- Made `st.selectbox` filtering case-insensitive.
- Better support for Tensorflow sessions in `@st.cache`.
- Changed behavior of `st.pyplot` to auto-clear the figure only when using the global Matplotlib figure (i.e. only when calling `st.pyplot()` rather than `st.pyplot(fig)`).

20.5 Version 0.57.0

Release date: March 26, 2020

Highlights:

- Ability to set expiration options for `@st.cache`'ed functions by setting the `max_entries` and `ttl` arguments. See docs.
- Improved the machinery behind `st.file_uploader`, so it's much more performant now! Also increased the default upload limit to 200MB (configurable via `server.max_upload_size`).
- The `server.address` config option now *binds* the server to that address for added security.
- Even more details added to error messages for `@st.cache` for easier debugging.

20.6 Version 0.56.0

Release date: February 15, 2020

Highlights:

- Improved error messages for st.cache. The errors now also point to the new caching docs we just released. Read more here!

Breaking changes:

- As announced last month, **Streamlit no longer supports Python 2.** To use Streamlit you'll need Python 3.5 or above.

20.7 Version 0.55.0

Release date: February 4, 2020

Highlights:

- **Ability to record screencasts directly from Streamlit!** This allows you to easily record and share explanations about your models, analyses, data, etc. Just click then "Record a screencast". Give it a try!

20.8 Version 0.54.0

Release date: January 29, 2020

Highlights:

- Support for password fields! Just pass `type="password"` to `st.text_input()`.

Notable fixes:

- Numerous st.cache improvements, including better support for complex objects.
- Fixed cross-talk in sidebar between multiple users.

Breaking changes:

- If you're using the SessionState hack Gist, you should re-download it! Depending on which hack you're using, here are some links to save you some time:
  - SessionState.py
  - st_state_patch.py

20.9 Version 0.53.0

Release date: January 14, 2020

Highlights:

- Support for all DeckGL features! Just use Pydeck instead of `st.deck_gl_chart`. To do that, simply pass a PyDeck object to `st.pydeck_chart`, `st.write`, or magic.

  *Note that as a **preview release** things may change in the near future. Looking forward to hearing input from the community before we stabilize the API!*

The goals is for this to replace `st.deck_gl_chart`, since it is does everything the old API did *and much more!*

- Better handling of Streamlit upgrades while developing. We now auto-reload the browser tab if the app it is displaying uses a newer version of Streamlit than the one the tab is running.
- New favicon, with our new logo!

Notable fixes:

- Magic now works correctly in Python 3.8. It no longer causes docstrings to render in your app.

Breaking changes:

- Updated how we calculate the default width and height of all chart types. We now leave chart sizing up to your charting library itself, so please refer to the library's documentation.

  As a result, the `width` and `height` arguments have been deprecated from most chart commands, and `use_container_width` has been introduced everywhere to allow you to make charts fill as much horizontal space as possible (this used to be the default).

20.10 Version 0.52.0

Release date: December 20, 2019

Highlights:

- Preview release of the file uploader widget. To try it out just call `st.file_uploader`!

  Note that as a ***preview release*** *things may change in the near future. Looking forward to hearing input from the community before we stabilize the API!*
- Support for emoji codes in `st.write` and `st.markdown`! Try it out with `st.write("Hello :wave:")`.

Breaking changes:

- `st.pyplot` now clears figures by default, since that's what you want 99% of the time. This allows you to create two or more Matplotlib charts without having to call `pyplot.clf` every time. If you want to turn this behavior off, use `st.pyplot(clear_figure=False)`
- `st.cache` no longer checks for input mutations. This is the first change of our ongoing effort to simplify the caching system and prepare Streamlit for the launch of other caching primitives like Session State!

20.11 Version 0.51.0

Release date: November 30, 2019

Highlights:

- You can now tweak the behavior of the file watcher with the config option `server.fileWatcherType`. Use it to switch between:
  - `auto` (default) : Streamlit will attempt to use the watchdog module, and falls back to polling if watchdog is not available.
  - `watchdog` : Force Streamlit to use the watchdog module.
  - `poll` : Force Streamlit to always use polling.
  - `none` : Streamlit will not watch files.

Notable bug fixes:

- Fix the “keyPrefix” option in static report sharing #724
- Add support for getColorX and getTargetColorX to DeckGL Chart #718
- Fixing Tornado on Windows + Python 3.8 #682
- Fall back on webbrowser if xdg-open is not installed on Linux #701
- Fixing number input spin buttons for Firefox #683
- Fixing CTRL+ENTER on Windows #699
- Do not automatically create credential file when in headless mode #467

20.12 Version 0.50.1

Release date: November 10, 2019

Highlights:

- SymPy support and ability to draw mathematical expressions using LaTeX! See `st.latex`, `st.markdown`, and `st.write`.
- You can now set config options using environment variables. For example, `export STREAMLIT_SERVER_PORT=9876`.
- Ability to call `streamlit run` directly with Github and Gist URLs. No need to grab the “raw” URL first!
- Cleaner exception stack traces. We now remove all Streamlit-specific code from stack traces originating from the user’s app.

20.13 Version 0.49.0

Release date: October 23, 2019

Highlights:

- New input widget for entering numbers with the keyboard: `st.number_input()`
- Audio/video improvements: ability to load from a URL, to embed YouTube videos, and to set the start position.
- You can now (once again) share static snapshots of your apps to S3! See the S3 section of `streamlit config show` to set it up. Then share from top-right menu.
- Use `server.baseUrlPath` config option to set Streamlit’s URL to something like `http://domain.com/customPath`.

Notable bug fixes:

- Fixes numerous Windows bugs, including Issues #339 and #401.

20.14 Version 0.48.0

Release date: October 12, 2019

Highlights:

- Ability to set config options as command line flags or in a local config file.
- You can now maximize charts and images!
- Streamlit is now much faster when writing data in quick succession to your app.
- Ability to blacklist folder globs from "run on save" and `@st.cache` hashing.
- Improved handling of widget state when Python file is modified.
- Improved HTML support in `st.write` and `st.markdown`. HTML is still unsafe, though!

Notable bug fixes:

- Fixes `@st.cache` bug related to having your Python environment on current working directory. Issue #242
- Fixes loading of root url `/` on Windows. Issue #244

20.15 Version 0.47.0

Release date: October 1, 2019

Highlights:

- New hello.py showing off 4 glorious Streamlit apps. Try it out!
- Streamlit now automatically selects an unused port when 8501 is already in use.
- Sidebar support is now out of beta! Just start any command with `st.sidebar.` instead of `st.`
- Performance improvements: we added a cache to our websocket layer so we no longer re-send data to the browser when it hasn't changed between runs
- Our "native" charts `st.line_chart`, `st.area_chart` and `st.bar_chart` now use Altair behind the scenes
- Improved widgets: custom st.slider labels; default values in multiselect
- The filesystem watcher now ignores hidden folders and virtual environments
- Plus lots of polish around caching and widget state management

Breaking change:

- We have temporarily disabled support for sharing static "snapshots" of Streamlit apps. Now that we're no longer in a limited-access beta, we need to make sure sharing is well thought through and abides by laws like the DMCA. But we're working on a solution!

20.16 Version 0.46.0

Release date: September 19, 2019

Highlights:

- Magic commands! Use `st.write` without typing `st.write`. See https://docs.streamlit.io/en/latest/api.html#magic-commands
- New `st.multiselect` widget.
- Fixed numerous install issues so now you can use `pip install streamlit` even in Conda! We've therefore deactivated our Conda repo.
- Multiple bug fixes and additional polish in preparation for our launch!

Breaking change:

- HTML tags are now blacklisted in `st.write`/`st.markdown` by default. More information and a temporary work-around at: https://github.com/streamlit/streamlit/issues/152

20.17 Version 0.45.0

Release date: August 28, 2019

Highlights:

- Experimental support for *sidebar*! Let us know if you want to be a beta tester.
- Completely redesigned `st.cache`! Much more performant, has a cleaner API, support for caching functions called by `@st.cached` functions, user-friendly error messages, and much more!
- Lightning fast `st.image`, ability to choose between JPEG and PNG compression, and between RGB and BGR (for OpenCV).
- Smarter API for `st.slider`, `st.selectbox`, and `st.radio`.
- Automatically fixes the Matplotlib backend – no need to edit .matplotlibrc

20.18 Version 0.44.0

Release date: July 28, 2019

Highlights:

- Lightning-fast reconnect when you do a ctrl-c/rerun on your Streamlit code
- Useful error messages when the connection fails
- Fixed multiple bugs and improved polish of our newly-released interactive widgets

20.19 Version 0.43.0

Release date: July 9, 2019

Highlights:

- Support for interactive widgets!

20.20 Version 0.42.0

Release date: July 1, 2019

Highlights:

- Ability to save Vega-Lite and Altair charts to SVG or PNG
- We now cache JS files in your browser for faster loading
- Improvements to error-handling inside Streamlit apps

20.21 Version 0.41.0

Release date: June 24, 2019

Highlights:

- Greatly improved our support for named datasets in Vega-Lite and Altair
- Added ability to ignore certain folders when watching for file changes. See the `server.folderWatchBlacklist` config option.
- More robust against syntax errors on the user's script and imported modules

20.22 Version 0.40.0

Release date: June 10, 2019

Highlights:

- Streamlit is more than 10x faster. Just save and watch your analyses update instantly.
- We changed how you run Streamlit apps: `$ streamlit run your_script.py [script args]`
- Unlike the previous versions of Streamlit, `streamlit run [script] [script args]` creates a server (now you don't need to worry if the proxy is up). To kill the server, all you need to do is hit **Ctrl+c**.

Why is this so much faster?

Now, Streamlit keeps a single Python session running until you kill the server. This means that Streamlit can re-run your code without kicking off a new process; imported libraries are cached to memory. An added bonus is that `st.cache` now caches to memory instead of to disk.

What happens if I run Streamlit the old way?

If you run `$ python your_script.py` the script will execute from top to bottom, but won't produce a Streamlit app.

What are the limitations of the new architecture?

- To switch Streamlit apps, first you have to kill the Streamlit server with **Ctrl-c**. Then, you can use `streamlit run` to generate the next app.
- Streamlit only works when used inside Python files, not interactively from the Python REPL.

What else do I need to know?

- The strings we print to the command line when **liveSave** is on have been cleaned up. You may need to adjust any RegEx that depends on those.
- A number of config options have been renamed:

Old config	New config
proxy.isRemote	server.headless
proxy.liveSave	server.liveSave
proxy.runOnSave, proxy.watchFileSystem	server.runOnSave
proxy.enableCORS	server.enableCORS
proxy.port	server.port
browser.proxyAddress	browser.serverAddress
browser.proxyPort	browser.serverPort
client.waitForProxySecs	n/a
client.throttleSecs	n/a
client.tryToOutliveProxy	n/a
client.proxyAddress	n/a
client.proxyPort	n/a
proxy.autoCloseDelaySecs	n/a
proxy.reportExpirationSecs	n/a

What if something breaks?

If the new Streamlit isn't working, please let us know by Slack or email. You can downgrade at any time with these commands:

```
$ pip install --upgrade streamlit==0.37
```

```
$ conda install streamlit=0.37
```

What's next?

Thank you for staying with us on this journey! This version of Streamlit lays the foundation for interactive widgets, a new feature of Streamlit we're really excited to share with you in the next few months.

20.23 Version 0.36.0

Release date: May 03, 2019

Highlights

- `st.progress()` now also accepts floats from 0.0–1.0
- Improved rendering of long headers in DataFrames
- Shared apps now default to HTTPS

20.24 Version 0.35.0

Release date: April 26, 2019

Highlights

- Bokeh support! Check out docs for `st.bokeh_chart`
- Improved the size and load time of saved apps
- Implemented better error-catching throughout the codebase

CHAPTER 21

Troubleshooting

These articles are designed to get you "unstuck" when something goes wrong. If you have questions, feature requests, or want to report an issue, please use our community forum or GitHub issues.

21.1 Sanity checks

If you're having problems running your Streamlit app, here are a few "obvious" things to try out.

21.1.1 Check #1: Is Streamlit running?

On a Mac or Linux machine, just type this on the terminal:

```
$ ps -Al | grep streamlit
```

If you don't see `streamlit run` in the output (or `streamlit hello`, if that's the command you ran) then the Streamlit server is actually not running for some reason. So just run it and see if the bug goes away.

21.1.2 Check #2: Is this an already-fixed Streamlit bug?

We try to fix bugs quickly, so many times a problem will go away when you upgrade Streamlit. So the first thing to try when having an issue is upgrading to the latest version of Streamlit:

```
$ pip install --upgrade streamlit
$ streamlit version
```

. . . and then verify that the version number printed is `0.61.0`.

Try reproducing the issue now. If not fixed, keep reading on.

21.1.3 Check #3: Are you running the correct Streamlit binary?

Let's check whether your Python environment is set up correctly. Edit the Streamlit script where you're experiencing your issue, **comment everything out, and add these lines instead:**

```
import streamlit as st
st.write(st.__version__)
```

. . . then call `streamlit run` on your script and make sure it says the same version as above. If not the same version, check out these instructions for some sure-fire ways to set up your environment.

21.1.4 Check #4: Is your browser caching your app too aggressively?

There are two easy ways to check this:

1. Load your app in a browser then press `Ctrl-Shift-R` or `-Shift-R` to do a hard refresh (Chrome/Firefox).
2. As a test, run Streamlit on another port. This way the browser starts the page with a brand new cache. For that, just pass the `--server.port` argument to Streamlit on the command line:

   ```
   $ streamlit run my_app.py --server.port=9876
   ```

21.1.5 Check #5: Is this a Streamlit regression?

If you've upgraded to the latest version of Streamlit and things aren't working, you can downgrade at any time using this command:

```
$ pip install --upgrade streamlit==0.50
```

. . . where `0.50` is the version you'd like to downgrade to. See *Changelog* for a complete list of Streamlit versions.

21.2 App is not loading when running remotely

Below are a few common errors that occur when users spin up their own solution to host a Streamlit app remotely.

To learn about a deceptively simple way to host Streamlit apps that avoids all the issues below, check out Streamlit for Teams.

21.2.1 Symptom #1: The app never loads

When you enter the app's URL in a browser and all you see is a **blank page, a "Page not found" error, a "Conection refused" error**, or anything like that, first check that Streamlit is actually running on the remote server. On a Linux server you can SSH into it and then run:

```
$ ps -Al | grep streamlit
```

If you see Streamlit running, the most likely culprit is the Streamlit port not being exposed. The fix depends on your exact setup. Below are three example fixes:

- **Try port 80:** Some hosts expose port 80 by default. To set Streamlit to use that port, just run it with the `--server.port` option:

```
$ streamlit run my_app.py --server.port=80
```

- **AWS EC2 server**: First, click on your instance in the AWS Console. Then scroll down and click on *Security Groups* → *Inbound* → *Edit*. Next, add a *Custom TCP* rule that allows the *Port Range* `8501` with *Source* `0.0.0.0/0`.
- **Other types of server**: Check the firewall settings.

If that still doesn't solve the problem, try running a simple HTTP server instead of Streamlit, and seeing if *that* works correctly. If it does, then you know the problem lies somewhere in your Streamlit app or configuration (in which case you should ask for help in our forums!) If not, then it's definitely unrelated to Streamlit.

How to start a simple HTTP server:

- Python 3:

```
$ python -m http.server [port]
```

21.2.2 Symptom #2: The app says "Please wait…" forever

If when you try to load your app in a browser you see a blue box in the center of the page with the text "Please wait…", the underlying cause is most likely CORS.

To diagnose the issue, try temporarily disabling CORS by running Streamlit with the `--server.enableCORS` flag set to false:

```
$ streamlit run my_app.py --server.enableCORS=false
```

If this fixes your issue, **you should re-enable CORS** and then set `browser.serverPort` and `browser.serverAddress` to the URL and port of your Streamlit app.

21.3 How to clean install Streamlit

If you run into any issues while installing Streamlit or if you just want to do a clean install, don't worry, we've got you covered. In this guide, we'll show you how to clean install Streamlit for Windows, macOS, and Linux.

21.3.1 Install Streamlit on Windows

Streamlit's officially-supported environment manager on Windows is Anaconda Navigator.

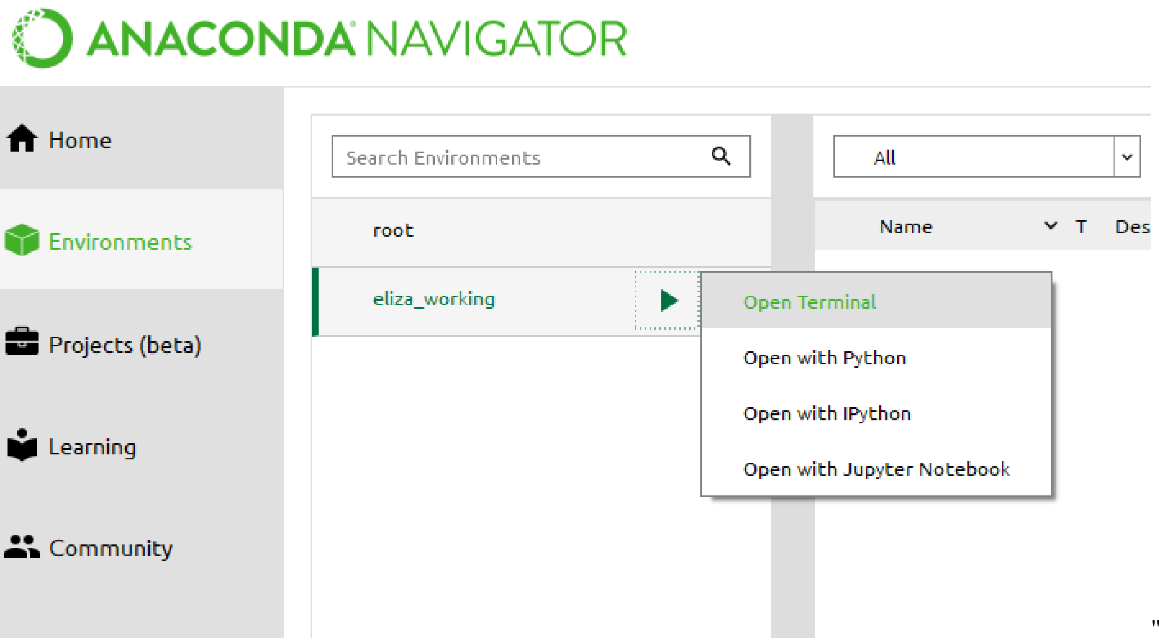
Install Anaconda

If you don't have Anaconda install yet, follow the steps provided on the Anaconda installation page.

Create a new environment with Streamlit

Next you'll need to set up your environment.

1. Follow the steps provided by Anaconda to set up and manage your environment using the Anaconda Navigator.
2. Select the "" icon next to your new environment. Then select "Open terminal":



"Open terminal" in Anaconda Navigator

3. In the terminal that appears, type:

```
pip install streamlit
```

4. Test that the installation worked:

```
streamlit hello
```

Streamlit's Hello app should appear in a new tab in your web browser!

Use your new environment

1. In Anaconda Navigator, open a terminal in your environment (see step 2 above).
2. In the terminal that appears, use Streamlit as usual:

```
streamlit run myfile.py
```

21.3.2 Install Streamlit on macOS/Linux

Streamlit's officially-supported environment manager for macOS and Linux is Pipenv. See instructions on how to install and use it below.

Install Pipenv

1. Install `pip`.

   On a macOS:

   ```
   sudo easy_install pip
   ```

   On Ubuntu with Python 3:

   ```
   sudo apt-get install python3-pip
   ```

   For other Linux distributions, see How to install PIP for Python.

2. Install `pipenv`.

   ```
   pip3 install pipenv
   ```

Create a new environment with Streamlit

1. Navigate to your project folder:

   ```
   cd myproject
   ```

2. Create a new Pipenv environment in that folder and activate that environment:

   ```
   pipenv shell
   ```

   When you run the command above, a file called `Pipfile` will appear in `myprojects/`. This file is where your Pipenv environment and its dependencies are declared.

3. Install Streamlit in your environment:

   ```
   pip install streamlit
   ```

   Or if you want to create an easily-reproducible environment, replace `pip` with `pipenv` every time you install something:

   ```
   pipenv install streamlit
   ```

4. Test that the installation worked:

   ```
   streamlit hello
   ```

   Streamlit's Hello app should appear in a new tab in your web browser!

Use your new environment

1. Any time you want to use the new environment, you first need to go to your project folder (where the `Pipenv` file lives) and run:

   ```
   pipenv shell
   ```

2. Now you can use Python and Streamlit as usual:

```
streamlit run myfile.py
```

3. When you're done using this environment, just type `exit` or press `ctrl-D` to return to your normall shell.

21.4 Caching issues

While developing an app, if you see an error or warning that stems from a cached function, it's probably related to the hashing procedure described in the *Advanced caching*. In this article, we'll provide solutions to common issues encountered when using caching. If you have an issue that's not covered in this article, please let us know in the community forum.

21.4.1 How to debug a cached function that isn't executing

If you believe your cached function isn't executing even though its inputs are a "Cache miss", a simple way to debug is to add `st.write` statements inside and outside of your function like this:

```
@st.cache
def my_cached_func(a, b):
    st.write("Cache miss: my_cached_func(", a, ", ", b, ") ran")
    ...

st.write("Calling my_cached_func(", a, ", ", b, ")")
my_cached_func(2, 21)
```

21.4.2 How to fix an `UnhashableTypeError`

Streamlit raises this error whenever it encounters a type it doesn't know how to hash. This could be either when hashing the inputs to generate the cache key or when hashing the output to verify whether it changed. To address it, you'll need to help Streamlit understand how to hash that type by using the `hash_funcs` argument:

```
@st.cache(hash_funcs={FooType: hash_foo_type})
def my_cached_func(a, b):
    ...
```

Here, `FooType` is the type Streamlit was unable to hash, and `hash_foo_type` is a function that can be used to properly hash `FooType` objects.

For example, if you'd like to make Streamlit ignore a specific type of object when hashing, you can pass a constant function to `hash_funcs`, like this:

```
@st.cache(hash_funcs={FooType: lambda _: None})
def my_cached_func(a, b):
    ...
```

For more information, see Advanced caching.

21.4.3 How to fix the Cached Object Mutated warning

By default Streamlit expects its cached values to be treated as immutable – that cached objects remain constant. You received this warning if your code modified a cached object (see Example 5 in Caching). When this happens, you have a few options:

1. If you don't understand why you're seeing this error, it's very likely that you didn't mean to mutate the cached value in the first place. So you should either:

- **Preferred:** rewrite your code to remove that mutation
- Clone the output of the cached function before mutating it. For example:

```
import copy
cloned_output = copy.deepcopy(my_cached_function(...))
```

1. If you wanted to allow the cached object to mutate, you can disable this check by setting `allow_output_mutation=True` like this:

```
@st.cache(allow_output_mutation=True)
def my_cached_func(...):
    ...
```

For examples, see *Advanced caching*.

Note: If your function returns multiple objects and you only want to allow a subset of them to mutate between runs, you can do that with the *hash_funcs* option.

2. If Streamlit is incorrectly hashing the cached object, you can override this by using `hash_funcs`. For example, if your function returns an object of type `FooType` then you could write:

```
@st.cache(hash_funcs={FooType: hash_func_for_foo_type})
def my_cached_func(...):
    ...
```

For more information, see Advanced caching.

By the way, the scenario above is fairly unlikely — unless `FooType` does something particularly tricky internally. This is the case with some `SpaCY` objects, which can automatically mutate behind the scenes for better performance, while keeping their semantics constant. That means Streamlit will correctly detect a mutation in the object's internal structure, even though semantically that mutation makes no difference.

21.4.4 If all else fails

If the proposed fixes above don't work for you, or if you have an idea on how to further improve `@st.cache` – let us know by asking questions in the community forum, filing a bug, or submitting a feature request. We love hearing back from the community!

CHAPTER 22

Welcome to Streamlit

Streamlit is an open-source Python library that makes it easy to build beautiful custom web-apps for machine learning and data science.

To use it, just `pip install streamlit`, then import it, write a couple lines of code, and run your script with `streamlit run [filename]`. Streamlit watches for changes on each save and updates the app live while you're coding. Code runs from top to bottom, always from a clean state, and with no need for callbacks. It's a simple and powerful app model that lets you build rich UIs incredibly quickly. To learn more about how Streamlit works, see *Main concepts*.

You may also want to check out this four-part video recorded at our PyData talk on December 2019. In it we describe the motivation behind Streamlit, then go over how to install and create apps with it.

22.1 Install Streamlit

Follow these steps and to get a sample app running in less than 5 minutes.

1. Make sure that you have Python 3.6 or greater installed.
2. Install Streamlit using PIP:

   ```
   $ pip install streamlit
   ```

3. Run the hello world app:

   ```
   $ streamlit hello
   ```

4. That's it! In the next few seconds the sample app will open in a new tab in your default browser.

22.2 Get started

The easiest way to learn how to use Streamlit is to actually try it out. Our *get started guide* walks you through the basics of building a Streamlit app.

22.3 Build your first app

Create an app to explore a dataset of Uber ride pickups in New York City. You'll learn about caching, drawing charts, plotting data on a map, and how to use interactive widgets.

22.4 Join the community

The quickest way to get help is to reach out on our community forum. We love to hear our users' questions, ideas, and bugs — please share!

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