Release notes ×

```
!pip install tensorflow
```

```
Requirement already satisfied: tensorflow in /usr/
Requirement already satisfied: absl-py>=1.0.0 in /
Requirement already satisfied: astunparse>=1.6.0 i
Requirement already satisfied: flatbuffers>=23.5.2
Requirement already satisfied: gast!=0.5.0,!=0.5.1
Requirement already satisfied: google-pasta>=0.1.1
Requirement already satisfied: h5py>=2.9.0 in /usr
Requirement already satisfied: libclang>=13.0.0 ir
Requirement already satisfied: ml-dtypes~=0.2.0 ir
Requirement already satisfied: numpy<2.0.0,>=1.23.
Requirement already satisfied: opt-einsum>=2.3.2 i
Requirement already satisfied: packaging in /usr/l
Requirement already satisfied: protobuf!=4.21.0,!=
Requirement already satisfied: setuptools in /usr/
Requirement already satisfied: six>=1.12.0 in /usr
Requirement already satisfied: termcolor>=1.1.0 ir
Requirement already satisfied: typing-extensions>=
Requirement already satisfied: wrapt<1.15,>=1.11.0
Requirement already satisfied: tensorflow-io-gcs-f
Requirement already satisfied: grpcio<2.0,>=1.24.3
Requirement already satisfied: tensorboard<2.16,>=
Requirement already satisfied: tensorflow-estimato
Requirement already satisfied: keras<2.16,>=2.15.0
Requirement already satisfied: wheel<1.0,>=0.23.0
Requirement already satisfied: google-auth<3,>=1.6
Requirement already satisfied: google-auth-oauthli
Requirement already satisfied: markdown>=2.6.8 in
Requirement already satisfied: requests<3,>=2.21.0
Requirement already satisfied: tensorboard-data-se
Requirement already satisfied: werkzeug>=1.0.1 in
Requirement already satisfied: cachetools<6.0,>=2.
Requirement already satisfied: pyasn1-modules>=0.2
Requirement already satisfied: rsa<5,>=3.1.4 in /u
Requirement already satisfied: requests-oauthlib>=
Requirement already satisfied: charset-normalizer<
Requirement already satisfied: idna<4,>=2.5 in /us
Requirement already satisfied: urllib3<3,>=1.21.1
Requirement already satisfied: certifi>=2017.4.17
Requirement already satisfied: MarkupSafe>=2.1.1 i
Requirement already satisfied: pyasn1<0.6.0,>=0.4.
Requirement already satisfied: oauthlib>=3.0.0 in
```

```
!pip install keras
```

```
Requirement already satisfied: keras in /usr/local
```

```
from tensorflow.keras.datasets import imdb
(train_data, train_labels), (test_data, test_labels) =
    num_words=10000)
```

```
Downloading data from https://storage.googleapis.c
17464789/17464789 [==============================]
```

```
train_data[0]
```

Please follow our blog to see more information about new features, tips and tricks, and featured notebooks such as Analyzing a Bank Failure with Colab.

2024-01-29

- New Kaggle Notebooks <> Colab updates! Now you can:
  - Import directly from Colab without having to download/re-upload
  - Upload via link, by pasting Google Drive or Colab URLs
  - Export & run Kaggle Notebooks on Colab with 1 click
- Try these notebooks that talk to Gemini:
  - Gemini and Stable Diffusion
  - Learning with Gemini and ChatGPT
  - Talk to Gemini with Google's Speech to Text API
  - Sell lemonade with Gemin and Sheets
  - Generate images with Gemini and Vertex
- Python package upgrades
  - google-cloud-aiplatform 1.38.1 -> 1.39.0
  - bigframes 0.18.0 -> 0.19.2
  - polars 0.17.3 -> 0.20.2
  - gdown 4.6.6 -> 4.7.3 (GitHub issue)
  - tensorflow-hub 0.15.0 -> 0.16.0
  - flax 0.7.5 -> 0.8.0
- Python package inclusions
  - sentencepiece 0.1.99

2024-01-08

- Avoid nested scrollbars for large outputs by using `google.colab.output.no_ver` Example notebook
- Fix bug where downloading models from Hugging Face could freeze
- Python package upgrades
  - huggingface-hub 0.19.4 -> 0.20.2

```
 19,
 178,
 32]
```

```
train_labels[0]
```

```
1
```

```
max([max(sequence) for sequence in train_data])
```

```
9999
```

```
word_index = imdb.get_word_index()
reverse_word_index = dict(
    [(value, key) for (key, value) in word_index.items
decoded_review = " ".join(
    [reverse_word_index.get(i - 3, "?") for i in trair
```

```
Downloading data from https://storage.googleapis.c
1641221/1641221 [==============================] -
```

```
import numpy as np
def vectorize_sequences(sequences, dimension=10000):
    results = np.zeros((len(sequences), dimension))
    for i, sequence in enumerate(sequences):
        for j in sequence:
            results[i, j] = 1.
    return results
x_train = vectorize_sequences(train_data)
x_test = vectorize_sequences(test_data)
```

```
x_train[0]
```

```
array([0., 1., 1., ..., 0., 0., 0.])
```

```
y_train = np.asarray(train_labels).astype("float32")
y_test = np.asarray(test_labels).astype("float32")
```

```
x_val = x_train[:10000]
partial_x_train = x_train[10000:]
y_val = y_train[:10000]
partial_y_train = y_train[10000:]
```

Step 1 :

1. Sequential Three layered approach
2. Replaced relu with tanh

- bigframes 0.17.0 -> 0.18.0

2023-12-18

- Expanded access to AI coding has arrived in Colab across 175 locales for all tiers of Colab users
- Improvements to display of ML-based inline completions (for eligible Pro/Pro+ users)
- Started a series of notebooks highlighting Gemini API capabilities
- Enable ⌘/Ctrl+L to select the full line in an editor
- Fixed bug where we weren't correctly formatting output from multiple execution results
- Python package upgrades
  - CUDA 11.8 to CUDA 12.2
  - tensorflow 2.14.0 -> 2.15.0
  - tensorboard 2.14.0 -> 2.15.0
  - keras 2.14.0 -> 2.15.0
  - Nvidia drivers 525.105.17 -> 535.104.05
  - tensorflow-gcs-config 2.14.0 -> 2.15.0
  - bigframes 0.13.0 -> 0.17.0
  - geemap 0.28.2 -> 0.29.6
  - pyarrow 9.0.0 -> 10.0.1
  - google-generativeai 0.2.2 -> 0.3.1
  - jax 0.4.20 —> 0.4.23
  - jaxlib 0.4.20 —> 0.4.23
- Python package inclusions
  - kagglehub 0.1.4
  - google-cloud-aiplatform 1.38.1

2023-11-27

- Removed warning when calling `await` to make it render as code
- Added "Run selection" to the cell context menu
- Added highlighting for the `%%python` cell magic
- Launched AI coding features for Pro/Pro+ users in more locales
- Python package upgrades
  - bigframes 0.12.0 -> 0.13.0
- Python package inclusions

3. optimizers changed to adam and loss to mse and metrics == accuracy

```
from tensorflow import keras
from tensorflow.keras import layers
from tensorflow.keras.layers import Dense

model = keras.Sequential()
model.add(Dense(16, activation="tanh"))
model.add(Dense(16, activation="tanh"))
model.add(Dense(1, activation="sigmoid"))


model.compile(optimizer="adam",
              loss="mean_squared_error",
              metrics=["accuracy"])
```

```
history = model.fit(partial_x_train,
                    partial_y_train,
                    epochs=20,
                    batch_size=512,
                    validation_data=(x_val, y_val))
```

```
Epoch 1/20
30/30 [==============================] - 6s 123ms/
Epoch 2/20
30/30 [==============================] - 2s 53ms/s
Epoch 3/20
30/30 [==============================] - 2s 52ms/s
Epoch 4/20
30/30 [==============================] - 1s 35ms/s
Epoch 5/20
30/30 [==============================] - 1s 34ms/s
Epoch 6/20
30/30 [==============================] - 1s 48ms/s
Epoch 7/20
30/30 [==============================] - 1s 36ms/s
Epoch 8/20
30/30 [==============================] - 1s 35ms/s
Epoch 9/20
30/30 [==============================] - 1s 34ms/s
Epoch 10/20
30/30 [==============================] - 1s 33ms/s
Epoch 11/20
30/30 [==============================] - 1s 34ms/s
Epoch 12/20
30/30 [==============================] - 1s 32ms/s
Epoch 13/20
30/30 [==============================] - 2s 53ms/s
Epoch 14/20
30/30 [==============================] - 1s 48ms/s
Epoch 15/20
30/30 [==============================] - 1s 35ms/s
Epoch 16/20
30/30 [==============================] - 1s 35ms/s
```

- transformers 4.35.2
- google-generativeai 0.2.2

2023-11-08

- Launched Secrets, for safe storage of private keys on Colab (tweet)
- Fixed issue where TensorBoard would not load (#3990)
- Python package upgrades
  - lightgbm 4.0.0 -> 4.1.0
  - bigframes 0.10.0 -> 0.12.0
  - bokeh 3.2.2 -> 3.3.0
  - duckdb 0.8.1 -> 0.9.1
  - numba 0.56.4 -> 0.58.1
  - tweepy 4.13.0 -> 4.14.0
  - jax 0.4.16 -> 0.4.20
  - jaxlib 0.4.16 -> 0.4.20

2023-10-23

- Updated the **Open notebook** dialog for better usability and support for smaller screen sizes
- Added smart paste support for data from Google Sheets for R notebooks
- Enabled showing release notes in a tab
- Launched AI coding features for Pro/Pro+ users in Australia AU Canada CA India IN and Japan JP (tweet)
- Python package upgrades
  - earthengine-api 0.1.357 -> 0.1.375
  - flax 0.7.2 -> 0.7.4
  - geemap 0.27.4 -> 0.28.2
  - jax 0.4.14 -> 0.4.16
  - jaxlib 0.4.14 -> 0.4.16
  - keras 2.13.1 -> 2.14.0
  - tensorboard 2.13.0 -> 2.14.1
  - tensorflow 2.13.0 -> 2.14.0
  - tensorflow-gcs-config 2.13.0 -> 2.14.0
  - tensorflow-hub 0.14.0 -> 0.15.0
  - tensorflow-probability 0.20.1 -> 0.22.0
  - torch 2.0.1 -> 2.1.0
  - torchaudio 2.0.2 -> 2.1.0
  - torchtext 0.15.2 -> 0.16.0
  - torchvision 0.15.2 -> 0.16.0

```
Epoch 17/20
30/30 [==============================] - 1s 35ms/s
Epoch 18/20
30/30 [==============================] - 1s 36ms/s
Epoch 19/20
30/30 [==============================] - 1s 35ms/s
Epoch 20/20
30/30 [==============================] - 1s 36ms/s
```

```
# Step 2

### implement dropouts and Regularizers
### check performance by changing the dense layers to

from tensorflow.keras.layers import Dropout
from tensorflow.keras import regularizers


model = keras.Sequential()
model.add(Dense(64, activation="tanh"))
model.add(Dropout(0.5))
model.add(Dense(64, activation="tanh"))
model.add(Dropout(0.5))
model.add(Dense(64, activation="tanh"))
model.add(Dense(1, activation="sigmoid",activity_regul


model.compile(optimizer="adam",
              loss="mean_squared_error",
              metrics=["accuracy"])

history = model.fit(partial_x_train,
                    partial_y_train,
                    epochs=30,
                    batch_size=512,
                    validation_data=(x_val, y_val))
```

```
30/30 [==============================] - 2s 70m
Epoch 3/30
30/30 [==============================] - 2s 62m
Epoch 4/30
30/30 [==============================] - 2s 70m
Epoch 5/30
30/30 [==============================] - 3s 102
Epoch 6/30
30/30 [==============================] - 2s 72m
Epoch 7/30
30/30 [==============================] - 2s 70m
Epoch 8/30
30/30 [==============================] - 2s 70m
Epoch 9/30
30/30 [==============================] - 2s 63m
```

- xgboost 1.7.6 -> 2.0.0

- Python package inclusions
  - bigframes 0.10.0
  - malloy 2023.1056

2023-09-22

- Added the ability to scope an AI generated suggestion to a specific Pandas dataframe (tweet)
- Added Colab link previews to Docs (tweet)
- Added smart paste support for data from Google Sheets
- Increased font size of dropdowns in interactive forms
- Improved rendering of the notebook when printing
- Python package upgrades
  - tensorflow 2.12.0 -> 2.13.0
  - tensorboard 2.12.3 -> 2.13.0
  - keras 2.12.0 -> 2.13.1
  - tensorflow-gcs-config 2.12.0 -> 2.13.
  - scipy 1.10.1-> 1.11.2
  - cython 0.29.6 -> 3.0.2
- Python package inclusions
  - geemap 0.26.0

2023-08-18

- Added "Change runtime type" to the menu in the connection button
- Improved auto-reconnection to an already running notebook (#3764)
- Increased the specs of our highmem machines for Pro users
- Fixed `add-apt-repository` command on Ubuntu 22.04 runtime (#3867)
- Python package upgrades
  - bokeh 2.4.3 -> 3.2.2
  - cmake 3.25.2 -> 3.27.2
  - cryptography 3.4.8 -> 41.0.3
  - dask 2022.12.1 -> 2023.8.0
  - distributed 2022.12.1 -> 2023.8.0
  - earthengine-api 0.1.358 -> 0.1.364
  - flax 0.7.0 -> 0.7.2

```
30/30 [==============================] - 3s 99m
Epoch 12/30
30/30 [==============================] - 2s 65m
Epoch 13/30
30/30 [==============================] - 2s 69m
Epoch 14/30
30/30 [==============================] - 2s 69m
Epoch 15/30
30/30 [==============================] - 2s 64m
Epoch 16/30
30/30 [==============================] - 2s 67m
Epoch 17/30
30/30 [==============================] - 3s 94m
Epoch 18/30
30/30 [==============================] - 2s 71m
Epoch 19/30
30/30 [==============================] - 2s 70m
Epoch 20/30
30/30 [==============================] - 2s 70m
Epoch 21/30
30/30 [==============================] - 2s 71m
Epoch 22/30
30/30 [==============================] - 3s 97m
Epoch 23/30
30/30 [==============================] - 4s 120
Epoch 24/30
30/30 [==============================] - 2s 72m
Epoch 25/30
30/30 [==============================] - 2s 71m
Epoch 26/30
30/30 [==============================] - 2s 69m
Epoch 27/30
30/30 [==============================] - 3s 108
Epoch 28/30
30/30 [==============================] - 2s 64m
Epoch 29/30
30/30 [==============================] - 2s 66m
Epoch 30/30
30/30 [==============================] - 2s 75m
```

```
history_dict = history.history
history_dict.keys()
```

```
dict_keys(['loss', 'accuracy', 'val_loss',
'val_accuracy'])
```

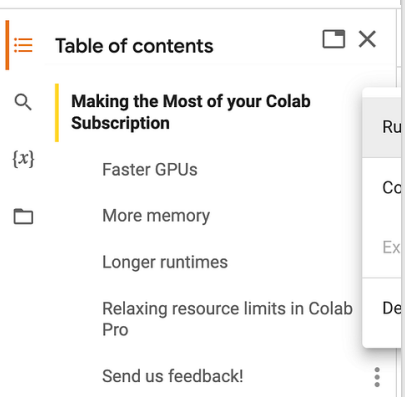
- ipython-sql 0.4.0 -> 0.5.0
- jax 0.4.13 -> 0.4.14
- jaxlib 0.4.13 -> 0.4.14
- lightgbm 3.3.5 -> 4.0.0
- mkl 2019.0 -> 2023.2.0
- notebook 6.4.8 -> 6.5.5
- numpy 1.22.4 -> 1.23.5
- opencv-python 4.7.0.72 -> 4.8.0.76
- pillow 8.4.0 -> 9.4.0
- plotly 5.13.1 -> 5.15.0
- prettytable 0.7.2 -> 3.8.0
- pytensor 2.10.1 -> 2.14.2
- spacy 3.5.4 -> 3.6.1
- statsmodels 0.13.5 -> 0.14.0
- xarray 2022.12.0 -> 2023.7.0

- Python package inclusions
  - PyDrive2 1.6.3

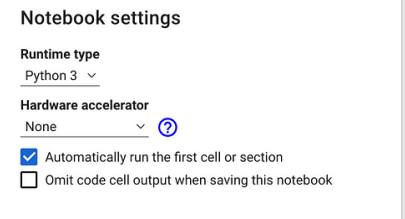
2023-07-21

- Launched auto-plotting for dataframes, available using the chart button that shows up alongside datatables (post)

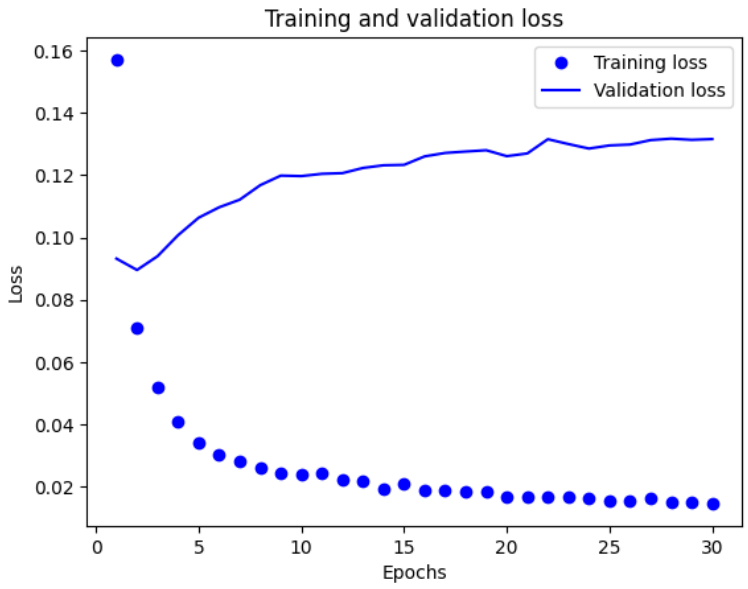
- Added a menu to the table of contents to support running a section or collapsing/expanding sections (post)



- Added an option to automatically run the first cell or section, available under Edit -> Notebook settings (post)



```
import matplotlib.pyplot as plt
history_dict = history.history
loss_values = history_dict["loss"]
val_loss_values = history_dict["val_loss"]
epochs = range(1, len(loss_values) + 1)
plt.plot(epochs, loss_values, "bo", label="Training lc
plt.plot(epochs, val_loss_values, "b", label="Validati
plt.title("Training and validation loss")
plt.xlabel("Epochs")
plt.ylabel("Loss")
plt.legend()
plt.show()
```

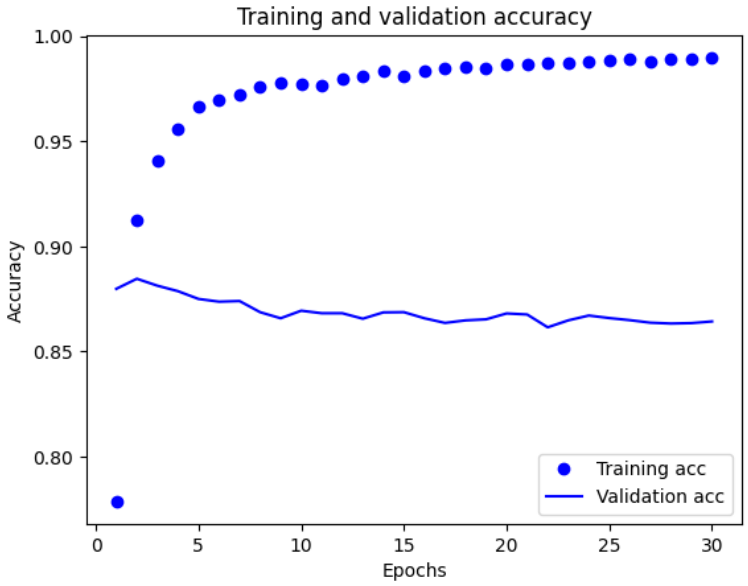



```
plt.clf()
acc = history_dict["accuracy"]
val_acc = history_dict["val_accuracy"]
plt.plot(epochs, acc, "bo", label="Training acc")
plt.plot(epochs, val_acc, "b", label="Validation acc")
plt.title("Training and validation accuracy")
plt.xlabel("Epochs")
plt.ylabel("Accuracy")
plt.legend()
plt.show()
```

- Launched Pro/Pro+ to Algeria, Argentina, Chile, Ecuador, Egypt, Ghana, Kenya, Malaysia, Nepal, Nigeria, Peru, Rwanda, Saudi Arabia, South Africa, Sri Lanka, Tunisia, and Ukraine (tweet)
- Added a command, "Toggle tab moves focus" for toggling tab trapping in the editor (Tools -> Command palette, "Toggle tab moves focus")
- Fixed issue where `files.upload()` was sometimes returning an incorrect filename (#1550)
- Fixed f-string syntax highlighting bug (#3802)
- Disabled ambiguous characters highlighting for commonly used LaTeX characters (#3648)
- Upgraded Ubuntu from 20.04 LTS to 22.04 LTS
- Updated the Colab Marketplace VM image
- Python package upgrades:
  - autograd 1.6.1 -> 1.6.2
  - drivefs 76.0 -> 77.0
  - flax 0.6.11 -> 0.7.0
  - earthengine-api 0.1.357 -> 0.1.358
  - GDAL 3.3.2->3.4.3
  - google-cloud-bigquery-storage 2.20.0 -> 2.22.2
  - gspread-dataframe 3.0.8 -> 3.3.1
  - holidays 0.27.1 -> 0.29
  - jax 0.4.10 -> jax 0.4.13
  - jaxlib 0.4.10 -> jax 0.4.13
  - jupyterlab-widgets 3.0.7 -> 3.0.8
  - nbformat 5.9.0 -> 5.9.1
  - opencv-python-headless 4.7.0.72 -> 4.8.0.74
  - pygame 2.4.0 -> 2.5.0
  - spacy 3.5.3 -> 3.5.4
  - SQLAlchemy 2.0.16 -> 2.0.19
  - tabulate 0.8.10 -> 0.9.0
  - tensorflow-hub 0.13.0 -> 0.14.0

2023-06-23

- Launched AI coding features to subscribed users starting with Pro+ users in the US (tweet, post)



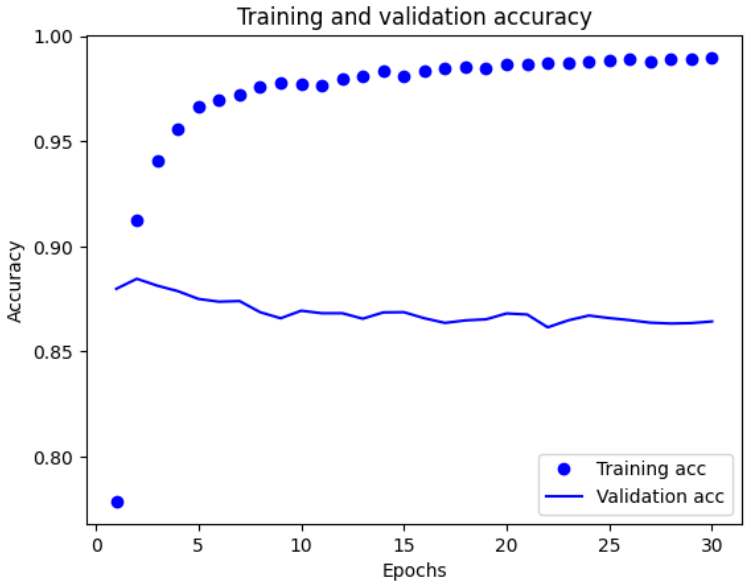

```
import matplotlib.pyplot as plt

plt.clf()
acc = history_dict["accuracy"]
val_acc = history_dict["val_accuracy"]
plt.plot(epochs, acc, "bo", label="Training acc")
plt.plot(epochs, val_acc, "b", label="Validation acc")
plt.title("Training and validation accuracy")
plt.xlabel("Epochs")
plt.ylabel("Accuracy")
plt.legend()
plt.show()
```

- Added the Kernel Selector in the Notebook Settings (tweet)
- Fixed double space trimming issue in markdown #3766
- Fixed run button indicator not always centered #3609
- Fixed inconsistencies for automatic indentation on multi-line #3697
- Upgraded Python from 3.10.11 to 3.10.12
- Python package updates:
  - duckdb 0.7.1 -> 0.8.1
  - earthengine-api 0.1.350 -> 0.1.357
  - flax 0.6.9 -> 0.6.11
  - google-cloud-bigquery 3.9.0 -> 3.10.0
  - google-cloud-bigquery-storage 2.19.1 -> 2.20.0
  - grpcio 1.54.0 -> 1.56.0
  - holidays 0.25 -> 0.27.1
  - nbformat 5.8.0 -> 5.9.0
  - prophet 1.1.3 -> 1.1.4
  - pydata-google-auth 1.7.0 -> 1.8.0
  - spacy 3.5.2 -> 3.5.3
  - tensorboard 2.12.2 -> 2.12.3
  - xgboost 1.7.5 -> 1.7.6
- Python package inclusions:
  - gcsfs 2023.6.0
  - geopandas 0.13.2
  - google-cloud-bigquery-connection 1.12.0
  - google-cloud-functions 1.13.0
  - grpc-google-iam-v1 0.12.6
  - multidict 6.0.4
  - tensorboard-data-server 0.7.1

2023-06-02

- Released the new site colab.google
- Published Colab's Docker runtime image to us-docker.pkg.dev/colab-images/public/runtime (tweet, instructions)
- Launched support for Google children accounts (tweet)
- Launched DagsHub integration (tweet, post)
- Upgraded to Monaco Editor Version 0.37.1
- Fixed various Vim keybinding bugs




```
from tensorflow.keras.layers import Dropout
from tensorflow.keras import regularizers


model = keras.Sequential()
model.add(Dense(64, activation="tanh"))
model.add(Dropout(0.5))
model.add(Dense(64, activation="tanh"))
model.add(Dense(64, activation="tanh"))
model.add(Dense(64, activation="tanh",activity_regular
model.add(Dropout(0.5))
model.add(Dense(64, activation="tanh"))
model.add(Dense(64, activation="tanh"))
model.add(Dense(1, activation="sigmoid"))


model.compile(optimizer="adam",
              loss="mean_squared_error",
              metrics=["accuracy"])

history = model.fit(partial_x_train,
                    partial_y_train,
                    epochs=30,
                    batch_size=512,
                    validation_data=(x_val, y_val))
```

- Fixed issue where the N and P letters sometimes couldn't be typed (#3664)
- Fixed rendering support for compositional inputs (#3660, #3679)
- Fixed lag in notebooks with lots of cells (#3676)
- Improved support for R by adding a Runtime type notebook setting (Edit -> Notebook settings)
- Improved documentation for connecting to a local runtime (Connect -> Connect to a local runtime)
- Python package updates:
  - holidays 0.23 -> 0.25
  - jax 0.4.8 -> 0.4.10
  - jaxlib 0.4.8 -> 0.4.10
  - pip 23.0.1 -> 23.1.2
  - tensorflow-probability 0.19.0 -> 0.20.1
  - torch 2.0.0 -> 2.0.1
  - torchaudio 2.0.1 -> 2.0.2
  - torchdata 0.6.0 -> 0.6.1
  - torchtext 0.15.1 -> 0.15.2
  - torchvision 0.15.1 -> 0.15.2
  - tornado 6.2 -> 6.3.1

2023-05-05

- Released GPU type selection for paid users, allowing them to choose a preferred NVidia GPU
- Upgraded R from 4.2.3 to 4.3.0
- Upgraded Python from 3.9.16 to 3.10.11
- Python package updates:
  - attrs 22.2.0 -> attrs 23.1.0
  - earthengine-api 0.1.349 -> earthengine-api 0.1.350
  - flax 0.6.8 -> 0.6.9
  - grpcio 1.53.0 -> 1.54.0
  - nbclient 0.7.3 -> 0.7.4
  - tensorflow-datasets 4.8.3 -> 4.9.2
  - termcolor 2.2.0 -> 2.3.0
  - zict 2.2.0 -> 3.0.0

2023-04-14

- Python package updates:
  - google-api-python-client 2.70.0 -> 2.84.0
  - google-auth-oauthlib 0.4.6 -> 1.0.0

```
30/30 [==============================] - 2s 65m
Epoch 4/30
30/30 [==============================] - 2s 72m
Epoch 5/30
30/30 [==============================] - 2s 67m
Epoch 6/30
30/30 [==============================] - 3s 102
Epoch 7/30
30/30 [==============================] - 2s 66m
Epoch 8/30
30/30 [==============================] - 2s 72m
Epoch 9/30
30/30 [==============================] - 2s 72m
Epoch 10/30
30/30 [==============================] - 2s 72m
Epoch 11/30
30/30 [==============================] - 3s 93m
Epoch 12/30
30/30 [==============================] - 2s 77m
Epoch 13/30
30/30 [==============================] - 2s 73m
Epoch 14/30
30/30 [==============================] - 2s 71m
Epoch 15/30
30/30 [==============================] - 2s 71m
Epoch 16/30
30/30 [==============================] - 2s 70m
Epoch 17/30
30/30 [==============================] - 3s 118
Epoch 18/30
30/30 [==============================] - 2s 64m
Epoch 19/30
30/30 [==============================] - 2s 72m
Epoch 20/30
30/30 [==============================] - 2s 74m
Epoch 21/30
30/30 [==============================] - 2s 65m
Epoch 22/30
30/30 [==============================] - 3s 95m
Epoch 23/30
30/30 [==============================] - 3s 83m
Epoch 24/30
30/30 [==============================] - 2s 71m
Epoch 25/30
30/30 [==============================] - 2s 66m
Epoch 26/30
30/30 [==============================] - 2s 65m
Epoch 27/30
30/30 [==============================] - 2s 68m
Epoch 28/30
30/30 [==============================] - 3s 114
Epoch 29/30
30/30 [==============================] - 2s 67m
Epoch 30/30
30/30 [==============================] - 2s 70m
```

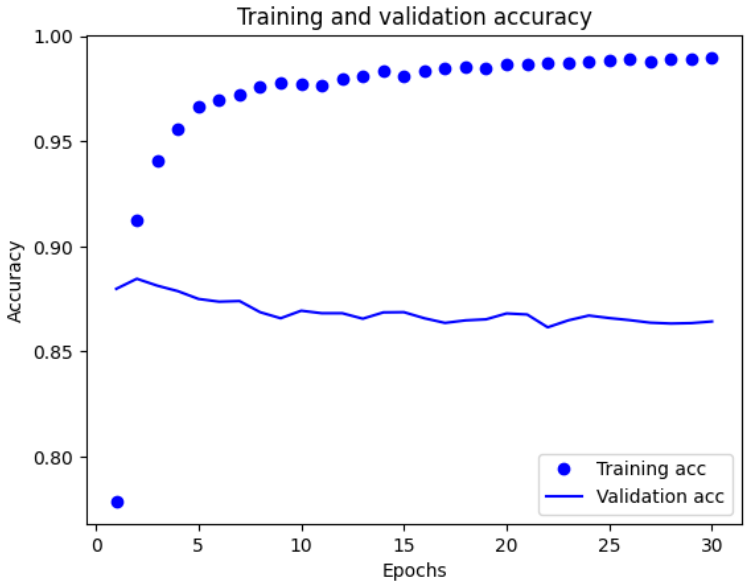
```
plt.clf()
acc = history_dict["accuracy"]
val_acc = history_dict["val_accuracy"]
```

- google-cloud-bigquery 3.4.2 -> 3.9.0
- google-cloud-datastore 2.11.1 -> 2.15.1
- google-cloud-firestore 2.7.3 -> 2.11.0
- google-cloud-language 2.6.1 -> 2.9.1
- google-cloud-storage 2.7.0 -> 2.8.0
- google-cloud-translate 3.8.4 -> 3.11.1
- networkx 3.0 -> 3.1
- notebook 6.3.0 -> 6.4.8
- jax 0.4.7 -> 0.4.8
- pandas 1.4.4 -> 1.5.3
- spacy 3.5.1 -> 3.5.2
- SQLAlchemy 1.4.47 -> 2.0.9
- xgboost 1.7.4 -> 1.7.5

2023-03-31

- Improve bash ! syntax highlighting (GitHub issue)
- Fix bug where VIM keybindings weren't working in the file editor
- Upgraded R from 4.2.2 to 4.2.3
- Python package updates:
  - arviz 0.12.1 --> 0.15.1
  - astropy 4.3.1 --> 5.2.2
  - dopamine-rl 1.0.5 --> 4.0.6
  - gensim 3.6.0 --> 4.3.1
  - ipykernel 5.3.4 -> 5.5.6
  - ipython 7.9.0 -> 7.34.0
  - jax 0.4.4 -> 0.4.7
  - jaxlib 0.4.4 -> 0.4.7
  - jupyter_core 5.2.0 -> 5.3.0
  - keras 2.11.0 -> 2.12.0
  - lightgbm 2.2.3 -> 3.3.5
  - matplotlib 3.5.3 -> 3.7.1
  - nltk 3.7 -> 3.8.1
  - opencv-python 4.6.0.66 -> 4.7.0.72
  - plotly 5.5.0 -> 5.13.1
  - pymc 4.1.4 -> 5.1.2
  - seaborn 0.11.2 -> 0.12.2
  - spacy 3.4.4 -> 3.5.1
  - sympy 1.7.1 -> 1.11.1
  - tensorboard 2.11.2 -> 2.12.0
  - tensorflow 2.11.0 -> 2.12.0
  - tensorflow-estimator 2.11.0 -> 2.12.0
  - tensorflow-hub 0.12.0 -> 0.13.0
  - torch 1.13.1 -> 2.0.0
  - torchaudio 0.13.1 -> 2.0.1

```
plt.plot(epochs, acc, "bo", label="Training acc")
plt.plot(epochs, val_acc, "b", label="Validation acc")
plt.title("Training and validation accuracy")
plt.xlabel("Epochs")
plt.ylabel("Accuracy")
plt.legend()
plt.show()
```



result.png

Summary

My strategy for solving the issue began with an appreciation of the importance of the Keras Sequential model, which functions as a stack of layers for building neural networks. To do this, you have to import the necessary TensorFlow.keras modules, including layers, Dense, Dropout, and Regularizers.

To measure performance, I experimented with creating neural networks with 2, 3, and 6 layers and varying the amount of hidden neurons (16, 64, and 64, respectively).

- torchtext 0.14.1 -> 0.15.1
- torchvision 0.14.1 -> 0.15.1

2023-03-10

- Added the Colab editor shortcuts example notebook
- Fixed triggering of @-mention and email autocomplete for large comments (GitHub issue)
- Added View Resources to the Runtime menu
- Made file viewer images fit the view by default, resizing to original size on click
- When in VIM mode, enable copy as well as allowing propagation to monaco-vim to escape visual mode (GitHub issue)
- Upgraded CUDA 11.6.2 -> 11.8.0 and cuDNN 8.4.0.27 -> 8.7.0.84
- Upgraded Nvidia drivers 525.78.01 -> 530.30.02
- Upgraded Python 3.8.10 -> 3.9.16
- Python package updates:
  - beautifulsoup4 4.6.3 -> 4.9.3
  - bokeh 2.3.3 -> 2.4.3
  - debugpy 1.0.0 -> 1.6.6
  - Flask 1.1.4 -> 2.2.3
  - jax 0.3.25 -> 0.4.4
  - jaxlib 0.3.25 -> 0.4.4
  - Jinja2 2.11.3 -> 3.1.2
  - matplotlib 3.2.2 -> 3.5.3
  - nbconvert 5.6.1 -> 6.5.4
  - pandas 1.3.5 -> 1.4.4
  - pandas-datareader 0.9.0 -> 0.10.0
  - pandas-profiling 1.4.1 -> 3.2.0
  - Pillow 7.1.2 -> 8.4.0
  - plotnine 0.8.0 -> 0.10.1
  - scikit-image 0.18.3 -> 0.19.3
  - scikit-learn 1.0.2 -> 1.2.2
  - scipy 1.7.3 -> 1.10.1
  - setuptools 57.4.0 -> 63.4.3
  - sklearn-pandas 1.8.0 -> 2.2.0
  - statsmodels 0.12.2 -> 0.13.5
  - urllib3 1.24.3 -> 1.26.14
  - Werkzeug 1.0.1 -> 2.2.3
  - wrapt 1.14.1 -> 1.15.0
  - xgboost 0.90 -> 1.7.4
  - xlrd 1.2.0 -> 2.0.1

An key finding was that performance peaked at a specific threshold, irrespective of the number of layers stacked.

The Sequential model is initialized using model = keras.Sequential() establishes the input, hidden, and output layer structure. In order to create 64 neurons in the layer to learn vector data, a hidden layer with 64 dense units and the tanh activation function (model.add(Dense(64, activation="tanh")) are added.

By randomly removing neurons, the Dropout layer (model.add(Dropout(0.5))) effectively prevents overfitting. Giving 0.5 indicates that 50% of the neurons should be removed.

I played around with L1 and L2 regularizers, but they didn't really help performance—in fact, they might have made it worse—which suggests the model might be saturated. The highest validation accuracy of 86–87% was attained.

Better performance metrics were obtained by substituting mean squared error (MSE) for binary_crossentropy in the loss evaluation process. MSE produced a smaller validation loss than binary_crossentropy.

ReLU's ability to mitigate the vanishing gradient problem made it the preferred activation function over sigmoid and tanh. Tanh, however, performed comparably to ReLU in this particular scenario.

2023-02-17

- Show graphs of RAM and disk usage in notebook toolbar
- Copy cell links directly to the clipboard instead of showing a dialog when clicking on the link icon in the cell toolbar
- Updated the Colab Marketplace VM image
- Upgraded CUDA to 11.6.2 and cuDNN to 8.4.0.27
- Python package updates:
    - tensorflow 2.9.2 -> 2.11.0
    - tensorboard 2.9.1 -> 2.11.2
    - keras 2.9.0 -> 2.11.0
    - tensorflow-estimator 2.9.0 -> 2.11.0
    - tensorflow-probability 0.17.0 -> 0.19.0
    - tensorflow-gcs-config 2.9.0 -> 2.11.0
    - earthengine-api 0.1.339 -> 0.1.341
    - flatbuffers 1.12 -> 23.1.21
    - platformdirs 2.6.2 -> 3.0.0
    - pydata-google-auth 1.6.0 -> 1.7.0
    - python-utils 3.4.5 -> 3.5.2
    - tenacity 8.1.0 -> 8.2.1
    - tifffile 2023.1.23.1 -> 2023.2.3
    - notebook 5.7.16 -> 6.3.0
    - tornado 6.0.4 -> 6.2
    - aiohttp 3.8.3 -> 3.8.4
    - charset-normalizer 2.1.1 -> 3.0.1
    - fastai 2.7.0 -> 2.7.1
    - soundfile 0.11.0 -> 0.12.1
    - typing-extensions 4.4.0 -> 4.5.0
    - widgetsnbextension 3.6.1 -> 3.6.2
    - pydantic 1.10.4 -> 1.10.5
    - zipp 3.12.0 -> 3.13.0
    - numpy 1.21.6 -> 1.22.4
    - drivefs 66.0 -> 69.0
    - gdal 3.0.4 -> 3.3.2 GitHub issue
- Added libudunits2-dev for smoother R package installs GitHub issue

2023-02-03

- Improved tooltips for pandas series to show common statistics about the series object

- Made the forms dropdown behave like an autocomplete box when it allows input
- Updated the nvidia driver from 460.32.03 to 510.47.03
- Python package updates:
  - absl-py 1.3.0 -> 1.4.0
  - bleach 5.0.1 -> 6.0.0
  - cachetools 5.2.1 -> 5.3.0
  - cmdstanpy 1.0.8 -> 1.1.0
  - dnspython 2.2.1 -> 2.3.0
  - fsspec 2022.11.0 -> 2023.1.0
  - google-cloud-bigquery-storage 2.17.0 -> 2.18.1
  - holidays 0.18 -> 0.19
  - jupyter-core 5.1.3 -> 5.2.0
  - packaging 21.3 -> 23.0
  - prometheus-client 0.15.0 -> 0.16.0
  - pyct 0.4.8 -> 0.5.0
  - pydata-google-auth 1.5.0 -> 1.6.0
  - python-slugify 7.0.0 -> 8.0.0
  - sqlalchemy 1.4.46 -> 2.0.0
  - tensorflow-io-gcs-filesystem 0.29.0 -> 0.30.0
  - tifffile 2022.10.10 -> 2023.1.23.1
  - zipp 3.11.0 -> 3.12.0
  - Pinned sqlalchemy to version 1.4.46

2023-01-12

- Added support for @-mention and email autocomplete in comments
- Improved errors when GitHub notebooks can't be loaded
- Increased color contrast for colors used for syntax highlighting in the code editor
- Added terminal access for custom GCE VM runtimes
- Upgraded Ubuntu from 18.04 LTS to 20.04 LTS (GitHub issue)
- Python package updates:
  - GDAL 2.2.2 -> 2.2.3.
  - NumPy from 1.21.5 to 1.21.6.
  - attrs 22.1.0 -> 22.2.0
  - chardet 3.0.4 -> 4.0.0
  - cloudpickle 1.6.0 -> 2.2.0
  - filelock 3.8.2 -> 3.9.0
  - google-api-core 2.8.2 -> 2.11.0

- google-api-python-client 1.12.11 -> 2.70.0
- google-auth-httplib2 0.0.3 -> 0.1.0
- google-cloud-bigquery 3.3.5 -> 3.4.1
- google-cloud-datastore 2.9.0 -> 2.11.0
- google-cloud-firestore 2.7.2 -> 2.7.3
- google-cloud-storage 2.5.0 -> 2.7.0
- holidays 0.17.2 -> holidays 0.18
- importlib-metadata 5.2.0 -> 6.0.0
- networkx 2.8.8 -> 3.0
- opencv-python-headless 4.6.0.66 -> 4.7.0.68
- pip 21.1.3 -> 22.04
- pip-tools 6.2.0 -> 6.6.2
- prettytable 3.5.0 -> 3.6.0
- requests 2.23.0 -> 2.25.1
- termcolor 2.1.1 -> 2.2.0
- torch 1.13.0 -> 1.13.1
- torchaudio 0.13.0 -> 0.13.1
- torchtext 0.14.0-> 0.14.1
- torchvision 0.14.0 -> 0.14.1

2022-12-06

- Made fallback runtime version available until mid-December (GitHub issue)
- Upgraded to Python 3.8 (GitHub issue)
- Python package updates:
  - jax from 0.3.23 to 0.3.25, jaxlib from 0.3.22 to 0.3.25
  - pyarrow from 6.0.1 to 9.0.0
  - torch from 1.12.1 to 1.13.0
  - torchaudio from 0.12.1 to 0.13.0
  - torchvision from 0.13.1 to 0.14.0
  - torchtext from 0.13.1 to 0.14.0
  - xlrd from 1.1.0 to 1.2.0
  - DriveFS from 62.0.1 to 66.0.3
- Made styling of markdown tables in outputs match markdown tables in text cells

- Improved formatting for empty interactive table rows
- Fixed syntax highlighting for variables with names that contain Python keywords (GitHub issue)

2022-11-11

- Added more dark editor themes for Monaco (when in dark mode, "Editor colorization" appears as an option in the Editor tab of the Tools → Settings dialog)
- Fixed bug where collapsed forms were deleted on mobile GitHub issue
- Python package updates:
  - rpy2 from 3.4.0 to 3.5.5 (GitHub issue)
  - notebook from 5.5.0 to 5.7.16
  - tornado from 5.1.1 to 6.0.4
  - tensorflow_probability from 0.16.0 to 0.17.0
  - pandas-gbq from 0.13.3 to 0.17.9
  - protobuf from 3.17.3 to 3.19.6
  - google-api-core[grpc] from 1.31.5 to 2.8.2
  - google-cloud-bigquery from 1.21.0 to 3.3.5
  - google-cloud-core from 1.0.1 to 2.3.2
  - google-cloud-datastore from 1.8.0 to 2.9.0
  - google-cloud-firestore from 1.7.0 to 2.7.2
  - google-cloud-language from 1.2.0 to 2.6.1
  - google-cloud-storage from 1.18.0 to 2.5.0
  - google-cloud-translate from 1.5.0 to 3.8.4

2022-10-21

- Launched a single-click way to get from BigQuery to Colab to further explore query results (announcement)
- Launched Pro, Pro+, and Pay As You Go to 19 additional countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, Greece, Hungary, Latvia, Lithuania, Norway, Portugal,

Romania, Slovakia, Slovenia, and Sweden (tweet)
- Updated jax from 0.3.17 to 0.3.23, jaxlib from 0.3.15 to 0.3.22, TensorFlow from 2.8.2 to 2.9.2, CUDA from 11.1 to 11.2, and cuDNN from 8.0 to 8.1 (backend-info)
- Added a `readonly` option to `drive.mount`
- Fixed bug where Xarray was not working (GitHub issue)
- Modified Markdown parsing to ignore block quote symbol within MathJax (GitHub issue)

2022-09-30

- Launched Pay As You Go, allowing premium GPU access without requiring a subscription
- Added vim and tcllib to our runtime image
- Fixed bug where open files were closed on kernel disconnect (GitHub issue)
- Fixed bug where the play button/execution indicator was not clickable when scrolled into the cell output (GitHub issue)
- Updated the styling for form titles so that they avoid obscuring the code editor
- Created a GitHub repo, backend-info, with the latest apt-list.txt and pip-freeze.txt files for the Colab runtime (GitHub issue)
- Added `files.upload_file(filename)` to upload a file from the browser to the runtime with a specified filename

2022-09-16

- Upgraded pymc from 3.11.0 to 4.1.4, jax from 0.3.14 to 0.3.17, jaxlib from 0.3.14 to 0.3.15, fsspec from 2022.8.1 to 2022.8.2
- Modified our save flow to avoid persisting Drive filenames as titles in notebook JSON
- Updated our Terms of Service
- Modified the `Jump to Cell` command to locate the cursor at the end of the command palette input (`Jump to cell` in Tools → Command palette in a notebook with section headings)

- Updated the styling of the Drive notebook comment UI
- Added support for terminating your runtime from code: `python from google.colab import runtime runtime.unassign()`
- Added regex filter support to the Recent notebooks dialog
- Inline google.colab.files.upload JS to fix `files.upload()` not working (GitHub issue)

2022-08-26

- Upgraded PyYAML from 3.13 to 6.0 (GitHub issue), drivefs from 61.0.3 to 62.0.1
- Upgraded TensorFlow from 2.8.2 to 2.9.1 and ipywidgets from 7.7.1 to 8.0.1 but rolled both back due to a number of user reports (GitHub issue, GitHub issue)
- Stop persisting inferred titles in notebook JSON (GitHub issue)
- Fix bug in background execution which affected some Pro+ users (GitHub issue)
- Fix bug where `Download as .py` incorrectly handled text cells ending in a double quote
- Fix bug for Pro and Pro+ users where we weren't honoring the preference (Tools → Settings) to use a temporary scratch notebook as the default landing page
- Provide undo/redo for scratch cells
- When writing ipynb files, serialize empty multiline strings as `[]` for better consistency with JupyterLab

2022-08-11

- Upgraded ipython from 5.5.0 to 7.9.0, fbprophet 0.7 to prophet 1.1, tensorflow-datasets from 4.0.1 to 4.6.0, drivefs from 60.0.2 to 61.0.3, pytorch from 1.12.0 to 1.12.1, numba from 0.51 to 0.56, and lxml from 4.2.0 to 4.9.1
- Loosened our `requests` version requirement (GitHub issue)
- Removed support for TensorFlow 1
- Added Help → Report Drive abuse for Drive notebooks

- Fixed indentation for Python lines ending in [
- Modified styling of tables in Markdown to left-align them rather than centering them
- Fixed special character replacement when copying interactive tables as Markdown
- Fixed ansi 8-bit color parsing (GitHub issue)
- Configured logging to preempt transitive imports and other loading from implicitly configuring the root logger
- Modified forms to use a value of `None` instead of causing a parse error when clearing raw and numeric-typed form fields

2022-07-22

- Update scipy from 1.4.1 to 1.7.3, drivefs from 59.0.3 to 60.0.2, pytorch from 1.11 to 1.12, jax & jaxlib from 0.3.8 to 0.3.14, opencv-python from 4.1.2.30 to 4.6.0.66, spaCy from 3.3.1 to 3.4.0, and dlib from 19.18.0 to 19.24.0
- Fix `Open in tab` doc link which was rendering incorrectly (GitHub issue)
- Add a preference for the default tab orientation to the Site section of the settings menu under Tools → Settings
- Show a warning for `USE_AUTH_EPHEM` usage when running authenticate_user on a TPU runtime (code)

2022-07-01

- Add a preference for code font to the settings menu under Tools → Settings
- Update drivefs from 58.0.3 to 59.0.3 and spacy from 2.2.4 to 3.3.1
- Allow display_data and execute_result text outputs to wrap, matching behavior of JupyterLab (does not affect stream outputs/print statements).
- Improve LSP handling of some magics, esp. %%writefile (GitHub issue).
- Add a FAQ entry about the mount Drive button behavior and

include link buttons for each FAQ entry.
- Fix bug where the notebook was sometimes hidden behind other tabs on load when in single pane view.
- Fix issue with inconsistent scrolling when an editor is in multi-select mode.
- Fix bug where clicking on a link in a form would navigate away from the notebook
- Show a confirmation dialog before performing Replace all from the Find and replace pane.

2022-06-10

- Update drivefs from 57.0.5 to 58.0.3 and tensorflow from 2.8.0 to 2.8.2
- Support more than 100 repos in the GitHub repo selector shown in the open dialog and the clone to GitHub dialog
- Show full notebook names on hover in the open dialog
- Improve the color contrast for links, buttons, and the `ipywidgets.Accordion` widget in dark mode

2022-05-20

- Support URL params for linking to some common pref settings: force_theme=dark, force_corgi_mode=1, force_font_size=14. Params forced by URL are not persisted unless saved using Tools → Settings.
- Add a class `markdown-google-sans` to allow Markdown to render in Google Sans
- Update monaco-vim from 0.1.19 to 0.3.4
- Update drivefs from 55.0.3 to 57.0.5, jax from 0.3.4 to 0.3.8, and jaxlib from 0.3.2 to 0.3.7

2022-04-29

- Added 🦀 mode (under Miscellaneous in Tools → Settings)
- Added "Disconnect and delete runtime" option to the menu next to the Connect button
- Improved rendering of filter options in an interactive table

- Added git-lfs to the base image
- Updated torch from 1.10.0 to 1.11.0, jupyter-core from 4.9.2 to 4.10.0, and cmake from 3.12.0 to 3.22.3
- Added more details to our FAQ about unsupported uses (using proxies, downloading torrents, etc.)
- Fixed issue with apt-get dependencies

2022-04-15

- Add an option in the file browser to show hidden files.
- Upgrade gdown from 4.2.0 to 4.4.0, google-api-core[grpc] from 1.26.0 to 1.31.5, and pytz from 2018.4 to 2022.1

2022-03-25

- Launched Pro/Pro+ to 12 additional countries: Australia, Bangladesh, Colombia, Hong Kong, Indonesia, Mexico, New Zealand, Pakistan, Philippines, Singapore, Taiwan, and Vietnam
- Added `google.colab.auth.authenti` to support using Service Account keys
- Update jax from 0.3.1 to 0.3.4 & jaxlib from 0.3.0 to 0.3.2
- Fixed an issue with Twitter previews of notebooks shared as Github Gists

2022-03-10

- Launched Pro/Pro+ to 10 new countries: Ireland, Israel, Italy, Morocco, the Netherlands, Poland, Spain, Switzerland, Turkey, and the United Arab Emirates
- Launched support for scheduling notebooks for Pro+ users
- Fixed bug in interactive datatables where filtering by number did not work
- Finished removing the python2 kernelspec