

## ▼ Лабораторная работа 5. Простые функции в R.

### Задание 1.

Напишите функции `Fun1a` и `Fun1b` такие, что для вектора `xVec` вида  $(x_1, x_2, \dots, x_n)$  функция `Fun1a` возвращает вектор  $(x_1, x_2^2, x_3^3, \dots, x_n^n)$ , а функция `Fun1b` возвращает вектор  $(x_1, \frac{x_2^2}{2}, \dots, \frac{x_n^n}{n})$ .

```
Fun1a <- function(xVec){
```

```
  vec_out <- c()
  for (i in 1:length(xVec)){
    vec_out[i] <- xVec[i]^i
  }
  return(vec_out)
```

```
}
```

```
Fun1a(c(1, 2, 3, 4))
```

```
1 · 4 · 27 · 256
```

```
Fun1b <- function (xVec) {
```

```
  vec_out <- numeric(length = length(xVec))
  for (i in seq_len(length(xVec))) {
    vec_out[i] <- (xVec[i])^i / i
  }
  return(vec_out)
```

```
}
```

```
Fun1b(c(1, 2, 3, 4))
```

```
1 · 2 · 9 · 64
```

### Задание 2.

Напишите функцию `Fun2` двух аргументов `x` и `n`, где `n` - строго положительное целое число. Эта функция должна возвращать значение:  $1 + \frac{x}{1} + \frac{x^2}{2} + \frac{x^3}{3} + \dots + \frac{x^n}{n}$ .

```
Fun2 <- function(x, n) {
```

```
  res <- 0
  for (i in 1:n) {
    res <- res + (x^i) / (i)
  }
  return(res + 1)
```

```
}
```

```
Fun2(3, 3)
```

17.5

**Задание 3.**

Напишите функцию `Fun3(xVec)` такую, что для вектора `xVec` вида  $(x_1, x_2, \dots, x_n)$  функция возвращает вектор скользящих

средних:  $\frac{x_1+x_2+x_3}{3}, \frac{x_2+x_3+x_4}{3}, \dots, \frac{x_{n-2}+x_{n-1}+x_n}{3}$ .

```
Fun3 <- function(xVec, w=3) {
  output <- c()
  for(i in 3:length(xVec)) {
    window <- xVec[i-w+1:i]
    output[i-w+1] <- mean(window, na.rm = TRUE)
  }
  return(output)
}
```

```
Fun3(c(1, 2, 3, 4))
```

```
2 3
```

**Задание 4.**

Рассмотрим непрерывную функцию  $f(x)$  числового аргумента  $x$ :

$$f(x) = \begin{cases} x^2 + 2x + 3, & \text{если } x < 0 \\ x + 3, & \text{если } 0 \leq x < 2 \\ x^2 + 4x - 7, & \text{если } x \geq 2 \end{cases}.$$

Напишите функцию `Fun4` аргумента `xVec`, которая возвращает вектор значений функции  $f(x)$ , вычисленных в точках `xVec`.

Постройте график функции  $f(x)$  для  $-3 < x < 3$ .

```
Fun4 <- function(xVec){
  f <- function(x){
    if(x < 0) { return(x^2 + 2*x + 3) }
    else if(x >= 0 & x < 2) { return(x + 3) }
    else { return(x^2 + 4*x - 7) }
  }
  res <- sapply(xVec, f)
  return(res)
}

xVec <- seq(-3, 3, by = 0.5)
Fun4(xVec)
plot(xVec, Fun4(xVec), type = 'l', col = 'red', lwd = 3)
```

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](#).

**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

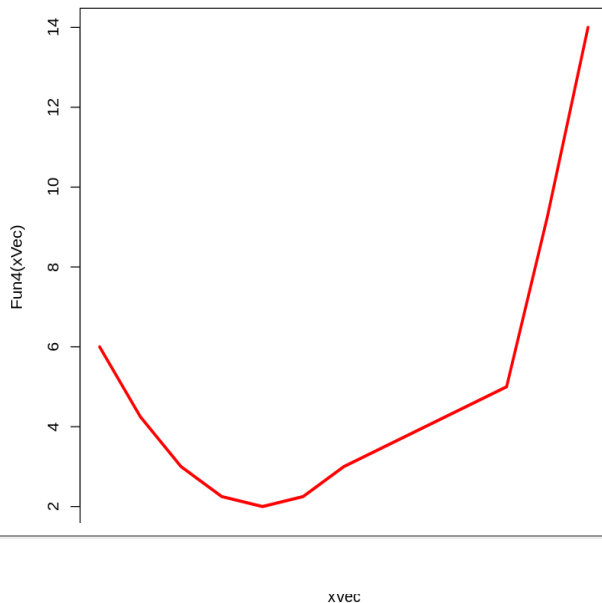
**2023-10-23**

- 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
  - 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

6 · 4.25 · 3 · 2.25 · 2 · 2.25 · 3 · 3.5 · 4 · 4.5 · 5 · 9.25 · 14



### Задание 5.

Напишите функцию `Fun5`, аргументом которой является матрица. Функция должна возвращать матрицу, равную исходной, но каждый нечетный элемент которой удваивается.

```
Fun5 <- function(mat){
  for(i in 1:nrow(mat)){
    for(j in 1:ncol(mat)){
      if((i + j) %% 2 != 1){
        mat[i,j] <- mat[i, j] * 2
      }
    }
  }
  return(mat)
}
```

```
Fun5(matrix(data = c(1:12), nrow = 3, ncol = 4))
```

A matrix: 3 × 4 of  
type dbl

```
2  4 14 10
2 10  8 22
6  6 18 12
```

### Задание 6.

Напишите функцию `Fun6` двух положительных целых аргументов `n` и `k`. Эта функция должна возвращать матрицу размерности

- 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

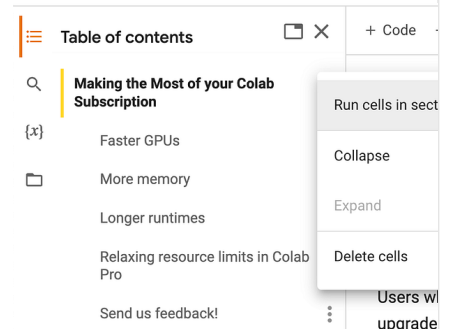
- Added "Change runtime type" to the menu in the connection button
- Improved auto-reconnection to an already running notebook ([#3764](#))
- Increased the specs of our highmem machines for Pro users
- Fixed add-apt-repository command on Ubuntu 22.04 runtime ([#3867](#))
- Python package upgrades
  - 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
  - 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](#))



$n \times n$  вида:

$$\begin{bmatrix} k & 1 & 0 & 0 & \dots & 0 & 0 \\ 1 & k & 1 & 0 & \dots & 0 & 0 \\ 0 & 1 & k & 1 & \dots & 0 & 0 \\ 0 & 0 & 1 & k & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & 0 & \dots & k & 1 \\ 0 & 0 & 0 & 0 & \dots & 1 & k \end{bmatrix}.$$

```
Fun6 <- function(n, k) {
  if(n>0 & k>0 & n%%1==0 & k%%1==0){
    mat <- matrix(0, n, n)
    diag(mat) <- k
    for (i in 1:(n-1)) {
      mat[i,i+1] <- 1
      mat[i+1,i] <- 1
    }
    return(mat)
  }
}
```

```
Fun6(4, 2)
```

```
A matrix: 4 ×
4 of type dbl
 2  1  0  0
 1  2  1  0
 0  1  2  1
 0  0  1  2
```

**Задание 7.** Пусть угол  $\alpha$  задается как положительное действительное число (в градусах). Напишите функцию `Fun7(alfa)`, которая для заданного угла  $\alpha$  определяет, к какому квадранту он принадлежит. То есть: если  $0 \leq \alpha < 90$ , то это первый квадрант, если  $90 \leq \alpha < 180$  - второй квадрант, если  $180 \leq \alpha < 270$  - третий квадрант, если  $270 \leq \alpha < 360$  - четвертый квадрант, и т.д.

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

#### Notebook settings

Runtime type  
Python 3

Hardware accelerator  
None

☒ Automatically run the first cell or section  
☐ Omit code cell output when saving this notebook

Cancel

- 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
  - gsread-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](#))
- 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

```
Fun7 <- function(alpha) {

  if(alpha < 0){
    print('alpha < 0')
  }
  else{
    quad <- floor((alpha%%360)%/%90) + 1
    return(quad)
  }

}

Fun7(110)

2
```

**Задание 8.** (а) Пусть  $x_0 = 1$ ,  $x_1 = 2$  и  $x_j = x_{j-1} + \frac{2}{x_{j-1}}$  для  $j = 1, 2, \dots$ . Напишите функцию Loop одного аргумента  $n$ , которая возвращает первые  $n - 1$  значений последовательности  $\{x_j\}_{j \geq 0}$ , т.е. значения  $x_0, x_1, x_2, \dots, x_{n-2}$ .

(б) Напишите функцию Loop2, аргументом которой является вектор yVec, возвращающую значение  $\sum_{j=1}^n e^j$ , где  $n$  - длина вектора yVec.

```
Loop <- function(n) {

  x <- c(1, 2)
  for (i in 3:n) {
    x[i] <- x[i-1] + 2 / x[i-1]
  }
  return(x[1:(n-1)])

}

Loop(7)

1 · 2 · 3 · 3.666666666666667 · 4.21212121212121 · 4.6869413560061

Loop2 <- function(yVec) {

  n <- length(yVec)
  return(sum(exp(1:n)))

}

Loop2(c(1, 2, 3))

30.1928748505774
```

- 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](https://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
- 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 -> 23.1.0
  - earthengine-api 0.1.349 -> 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
  - 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
- 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

## 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
- tiff file 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
  - tiff file 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-http2 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 tcclib 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.authenticate\\_service\\_account\\_keys](#) 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