Machine Learning 03 - Entering the Uncanny Valley of Speech

SLQ Wiki Fabrication Lab 2025/08/31 13:48

~~REVEAL~~

Machine Learning 03 - Entering the Uncanny Valley of Speech

With State Library closed to the public due to COVID-19, for this Machine Learning (ML) workshop we won't be able to use the Digital Media Lab at The Edge.

This online workshop recaps our previous workshops, and explores the world of Text To Speech (TTS), voice synthesisers and Speech To Text (STT) voice recognition nbuilt with ML. The workshop is not an introduction to coding or math, but we will give a of general overview of how ML is defined and where it is commonly used today.

We've chosen an approach that demonstrates the power and limitations of ML and leaves you with an understanding of how use an online ML environment, along with ideas on how to use State Library resources to explore ML further.

The first half of the workshop will cover

- a basic explanation of ML
- recap of previous ML workshops
- ML for speech

The second half of the workshop explore how to impliment ML research using Google's Colab platform

Outcomes

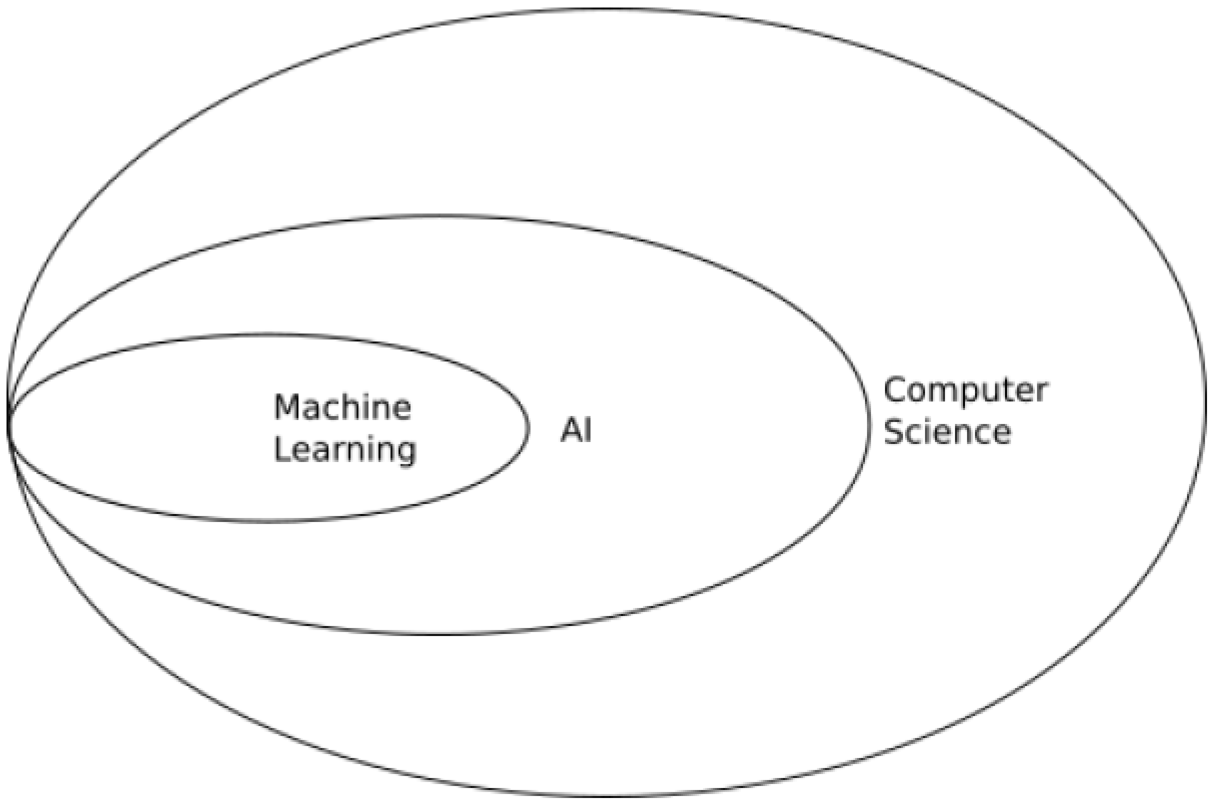
- A general basic ML background
  - ML for speech
- using Google Colab
  - Spleeter (audio source separation)
  - TTS (Mozilla TTS)
  - STT (Mozilla Deepspeech)

Requirements

All we need to get started for this workshop is a Google account to access Google Colab in the second half of the workshop. If you don't have one you can quickly sign up. If you don't want to create a Google account, you can always just follow along with the examples.

Background

Machine Learning(ML) is a subset of Artificial Intelligence (AI) which is is a fast moving field of computer science (CS). A good way to think about how these fields overlap is with a diagram.



Machine Learning - Why Now?

While many of the concepts are decades old, and the mathematical underpinnings have been around for centuries, the explosion in use and development of ML learning has been enabled by the creation and commercialisation of massively parallel processors. This specialised computer hardware most commonly found in Graphics Processing Units (GPUs) inside desktop and laptop computers and takes care of the display of 2D and 3D graphics. The same processing architecture that accelerates the rendering of 3D models onscreen is ideally suited to solve ML problems, resulting in specialised programming platforms, Application Programming Interfaces (APIs) and programming libraries for AI and ML.

Common Machine Learning Uses

One way to think of ML is as a *recommendation system*.

Based on input data (a lot of input data[1)])

- a machine learning system is trained

- a model is generated
- the model is used can make recommendations (is implimented) on *new* data.

:workshops:prototypes:machine_learning:ideepcolor:8725096366_d1fe677cc5_o.jpg

One extremely common application of this is image recognition.

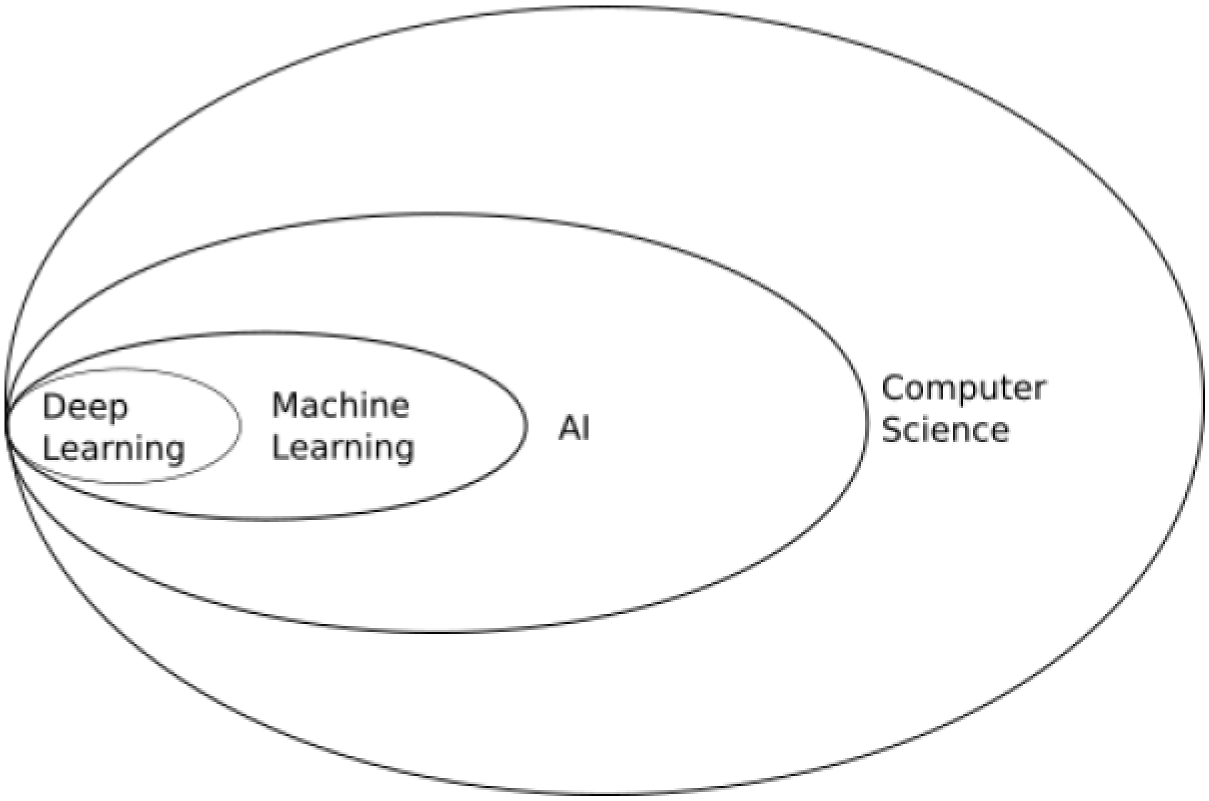
:workshops:prototypes:machine_learning:ideepcolor:2020-02-21_14_19_57-8725096366_d1fe677cc5_o_fb.jpg

When facebook asks you to tag a photo with names, you are providing them with a nicely annotated data set for **supervised learning**. They can then use this data set to train a model than then recognises (makes a recommendation) about other photos with you or your friend in it.

Snapchat filters use image recognition to make a map of your features, then applies masks and transformations in real-time.

Deep Learning

Today we are going to go a little “deeper” inside ML, exploring deep learning. Deep learning used multiple layers of algorithms, in an artificial neural network, inspired by the way the human neural networks inside all of us.



Interactive Deep Colorization

Lets take a look at the subject of our first ML workshop Real-Time User-Guided Image Colorization with Learned Deep Priors (ideepcolor), by Richard Zhang, Jun-Yan Zhu, Phillip Isola, Xinyang Geng, Angela S. Lin, Tianhe Yu and Alexei A. Efros.

Here is a talk about the details of their paper.

Video

I encourage you to watch the above talk in full....

but the TLDR version is that they have:

- trained a neural network on millions of images
- combined this with simulated human interaction
- produced a model that recommends an initial colourisation
- that takes user input to refine the colourisation.

The user input is provided through a Graphical User Interface (GUI), and the end result can be exported, along with information about how the model made its recommendations.

You can check out a video of the demo in action here.

ML - From Paper to Product

We'll be exploring a few ML ideas, but to start with lets follow "Real-Time User-Guided Image Colorization with Learned Deep Priors", by Richard Zhang, Jun-Yan Zhu, Phillip Isola, Xinyang Geng, Angela S. Lin, Tianhe Yu, Alexei A. Efros from paper to product. Its not a recent paper in ML terms where it seems every month brings another breakthrough, but we can follow this paper right through to its release in Adobe Photoshop Elements 2020.

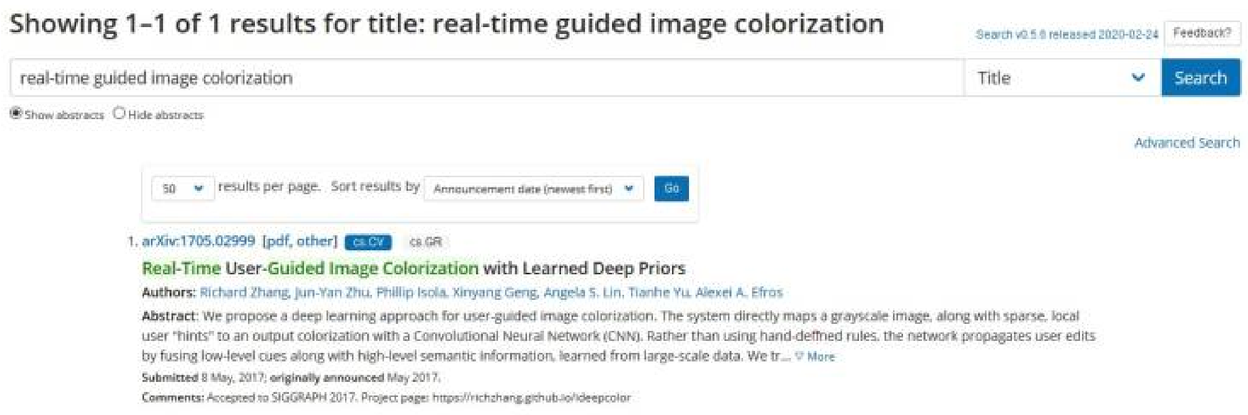
Research Papers on arXiv.org

arXiv.org is probably the worlds biggest and fastest growing collection of preprint electronic scientific papers from mathematics, physics, astronomy, electrical engineering, computer science, quantitative biology, statistics, mathematical finance and economics. All of the ML ideas we will be looking are either first published on arXiv.org, or reference papers on the site.

Finding a Paper

Papers on arXiv.org are moderated but not peer-reviewed, which means the speed and volume of publishing on this open-access repository is overwhelming. But to get started, lets say we are interested in re-colourisation of black and white images of our grandparents at their wedding, but we don't want to do all the work ourselves. We'd also like to interact in real-time and guide the process, so we can get the colour of grandad's suit and grandma's bouquet just right.

So lets search for “real-time guided image colourisation” but we'll use the American English spelling “ colorization”. Searching for “real-time guided image colorization” brings up our paper straight away, with handy PDF link[2].


Showing 1–1 of 1 results for title: real-time guided image colorization

Search v0.5.6 released 2020-02-24 Feedback?

real-time guided image colorization | Title | Search

[✓ Show abstracts] Hide abstracts

Advanced Search

50 results per page. Sort results by Announcement date (newest first) Go

1. arXiv:1705.02999 [pdf, other] cs.CV cs.GR

Real-Time User-Guided Image Colorization with Learned Deep Priors

Authors: Richard Zhang, Jun-Yan Zhu, Phillip Isola, Xinyang Geng, Angela S. Lin, Tianhe Yu, Alexei A. Efros

Abstract: We propose a deep learning approach for user-guided image colorization. The system directly maps a grayscale image, along with sparse, local user "hints" to an output colorization with a Convolutional Neural Network (CNN). Rather than using hand-defined rules, the network propagates user edits by fusing low-level cues along with high-level semantic information, learned from large-scale data. We tr… ▽ More

Submitted 8 May, 2017; **originally announced** May 2017.

Comments: Accepted to SIGGRAPH 2017. Project page: https://richzhang.github.io/ideepcolor

Examining the Abstract

All research papers begin with an abstract, and a well written abstract will tell us all we need to know about whether the paper is relevant for you, particularly if we are looking for working demonstration. This time we are in luck - there is a link to a an ideepcolor demo site at the end of the abstract.

Check out the Demo

The demo for ideepcolor looks great and we've got a link at the top of the page, where ideepcolor is implemented on github.

Code Implementation on github.com

Github.com is a website used by software developers to create, collaborate and share source code, and is most likely the largest repository of source code in the world. Github is named after git, a free and open-source(FOSS) distributed version-control system for tracking changes in source code during software development. Git means that developers from all over the world can work on the same code and if the project is open source, build on, expand and re-purpose shared codes[3]. But lets back up a bit and cover off on what source code is.

Using the Source

source code is the instructions for a computer program contained in a simple text document.

For a computer to run a program, the source code either has to be

***compiled** into binary machine code by a compiler:

- his file is executable - in this case execute just means can be read, understood and acted on by the computer, or
- **interpreted** by another program, which directly executes the code

Here is a example of source code. in this case its a simple program in the C programming language that shows on the screen “Hello, World”

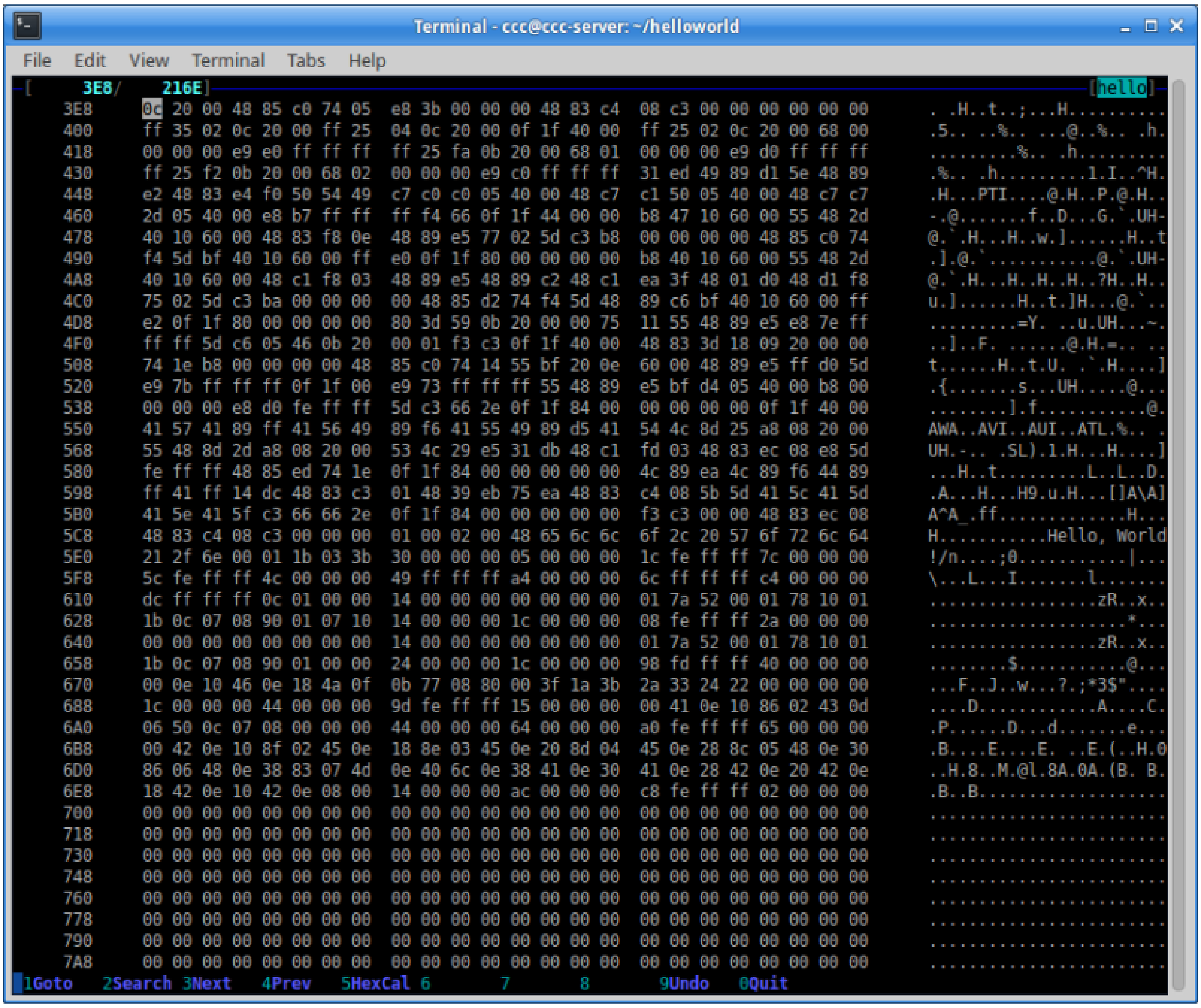
```
 #include <stdio.h>

 int main(void)
{
 printf("Hello, world!\n");
 return 0;
}
```

Despite the strange symbols, if you know how the C language is written, this program is **human readable**.

Once this code is run through a compiler, we get a binary executable file - which is **machine readable**.

But with the right tools (like a HEX editor) we can still open the file and edit it.

Here is the binary for our “Hello World!” program.


Terminal - ccc@ccc-server: ~/helloworld
File Edit View Terminal Tabs Help

```
[      3E8/    216E]                                                                              [hello]
     3E8     0c 20 00 48 85 c0 74 05  e8 3b 00 00 00 48 83 c4  08 c3 00 00 00 00 00 00     . .H..t..;...H.........
     400     ff 35 02 0c 20 00 ff 25  04 0c 20 00 0f 1f 40 00  ff 25 02 0c 20 00 68 00     .5.. ..%.. ...@..%.. .h.
     418     00 00 00 e9 e0 ff ff ff  ff 25 fa 0b 20 00 68 01  00 00 00 e9 d0 ff ff ff     .........%.. .h.........
     430     ff 25 f2 0b 20 00 68 02  00 00 00 e9 c0 ff ff ff  31 ed 49 89 d1 5e 48 89     .%.. .h.........1.I..^H.
     448     e2 48 83 e4 f0 50 54 49  c7 c0 c0 05 40 00 48 c7  c1 50 05 40 00 48 c7 c7     .H...PTI....@.H..P.@.H..
     460     2d 05 40 00 e8 b7 ff ff  ff f4 66 0f 1f 44 00 00  b8 47 10 60 00 55 48 2d     -.@.......f..D...G.`.UH-
     478     40 10 60 00 48 83 f8 0e  48 89 e5 77 02 5d c3 b8  00 00 00 00 48 85 c0 74     @.`.H...H..w.]......H..t
     490     f4 5d bf 40 10 60 00 ff  e0 0f 1f 80 00 00 00 00  b8 40 10 60 00 55 48 2d     .].@.`...........@.`.UH-
     4A8     40 10 60 00 48 c1 f8 03  48 89 e5 48 89 c2 48 c1  ea 3f 48 01 d0 48 d1 f8     @.`.H...H..H..H..?H..H..
     4C0     75 02 5d c3 ba 00 00 00  00 48 85 d2 74 f4 5d 48  89 c6 bf 40 10 60 00 ff     u.]......H..t.]H...@.`..
     4D8     e2 0f 1f 80 00 00 00 00  80 3d 59 0b 20 00 00 75  11 55 48 89 e5 e8 7e ff     .........=Y. ..u.UH...~.
     4F0     ff ff 5d c6 05 46 0b 20  00 01 f3 c3 0f 1f 40 00  48 83 3d 18 09 20 00 00     ..]..F. ......@.H.=.. ..
     508     74 1e b8 00 00 00 00 48  85 c0 74 14 55 bf 20 0e  60 00 48 89 e5 ff d0 5d     t......H..t.U. .`.H....]
     520     e9 7b ff ff ff 0f 1f 00  e9 73 ff ff ff 55 48 89  e5 bf d4 05 40 00 b8 00     .{.......s...UH.....@...
     538     00 00 00 e8 d0 fe ff ff  5d c3 66 2e 0f 1f 84 00  00 00 00 00 0f 1f 40 00     ........].f...........@.
     550     41 57 41 89 ff 41 56 49  89 f6 41 55 49 89 d5 41  54 4c 8d 25 a8 08 20 00     AWA..AVI..AUI..ATL.%.. .
     568     55 48 8d 2d a8 08 20 00  53 4c 29 e5 31 db 48 c1  fd 03 48 83 ec 08 e8 5d     UH.-.. .SL).1.H...H....]
     580     fe ff ff 48 85 ed 74 1e  0f 1f 84 00 00 00 00 00  4c 89 ea 4c 89 f6 44 89     ...H..t.........L..L..D.
     598     ff 41 ff 14 dc 48 83 c3  01 48 39 eb 75 ea 48 83  c4 08 5b 5d 41 5c 41 5d     .A...H...H9.u.H...[]A\A]
     5B0     41 5e 41 5f c3 66 66 2e  0f 1f 84 00 00 00 00 00  f3 c3 00 00 48 83 ec 08     A^A_.ff.............H...
     5C8     48 83 c4 08 c3 00 00 00  01 00 02 00 48 65 6c 6c  6f 2c 20 57 6f 72 6c 64     H...........Hello, World
     5E0     21 2f 6e 00 01 1b 03 3b  30 00 00 00 05 00 00 00  1c fe ff ff 7c 00 00 00     !/n....;0...........|...
     5F8     5c fe ff ff 4c 00 00 00  49 ff ff ff a4 00 00 00  6c ff ff ff c4 00 00 00     \...L...I.......l.......
     610     dc ff ff ff 0c 01 00 00  14 00 00 00 00 00 00 00  01 7a 52 00 01 78 10 01     .................zR..x..
     628     1b 0c 07 08 90 01 07 10  14 00 00 00 1c 00 00 00  08 fe ff ff 2a 00 00 00     ....................*...
     640     00 00 00 00 00 00 00 00  14 00 00 00 00 00 00 00  01 7a 52 00 01 78 10 01     .................zR..x..
     658     1b 0c 07 08 90 01 00 00  24 00 00 00 1c 00 00 00  98 fd ff ff 40 00 00 00     ........$...........@...
     670     00 0e 10 46 0e 18 4a 0f  0b 77 08 80 00 3f 1a 3b  2a 33 24 22 00 00 00 00     ...F..J..w...?.;*3$"....
     688     1c 00 00 00 44 00 00 00  9d fe ff ff 15 00 00 00  00 41 0e 10 86 02 43 0d     ....D............A....C.
     6A0     06 50 0c 07 08 00 00 00  44 00 00 00 64 00 00 00  a0 fe ff ff 65 00 00 00     .P......D...d.......e...
     6B8     00 42 0e 10 8f 02 45 0e  18 8e 03 45 0e 20 8d 04  45 0e 28 8c 05 48 0e 30     .B....E....E. ..E.(..H.0
     6D0     86 06 48 0e 38 83 07 4d  0e 40 6c 0e 38 41 0e 30  41 0e 28 42 0e 20 42 0e     ..H.8..M.@l.8A.0A.(B. B.
     6E8     18 42 0e 10 42 0e 08 00  14 00 00 00 ac 00 00 00  c8 fe ff ff 02 00 00 00     .B..B...................
     700     00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00     ........................
     718     00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00     ........................
     730     00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00     ........................
     748     00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00     ........................
     760     00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00     ........................
     778     00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00     ........................
     790     00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00     ........................
     7A8     00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00     ........................
 1Goto   2Search 3Next   4Prev   5HexCal 6       7       8       9Undo   0Quit
```

Open Source

Dokuwiki (the software we are using for this wiki) is open source, and developed publicly, and freely available on the internet. Anyone is able to grab the source code and run it, modify it or redistribute it.

Below is and example of the **open source** code for this wiki, which is written in a language called php.

```
  // define all DokuWiki globals here (needed within test requests but also
helps to keep track)
  global $ACT, $INPUT, $QUERY, $ID, $REV, $DATE_AT, $IDX,
  $DATE, $RANGE, $HIGH, $TEXT, $PRE, $SUF, $SUM, $INFO, $JSINFO;
  if(isset($_SERVER['HTTP_X_DOKUWIKI_DO'])) {
  $ACT = trim(strtolower($_SERVER['HTTP_X_DOKUWIKI_DO']));
  } elseif(!empty($_REQUEST['idx'])) {
```

```
$ACT = 'index';
} elseif(isset($_REQUEST['do'])) {
$ACT = $_REQUEST['do'];
} else {
$ACT = 'show';
}
```

How did we get hold of the source code for this wiki? In this case all we did was look in the dokuwiki source found on github pick bit of code at random and throw it in our wiki.

So, finding the source for open software is easy. but to do the same thing with closed source program is usually difficult or impossible. Either you purchase or are given access to the code. Any other method may break all manner of licenses and laws.

ideepcolor on Github

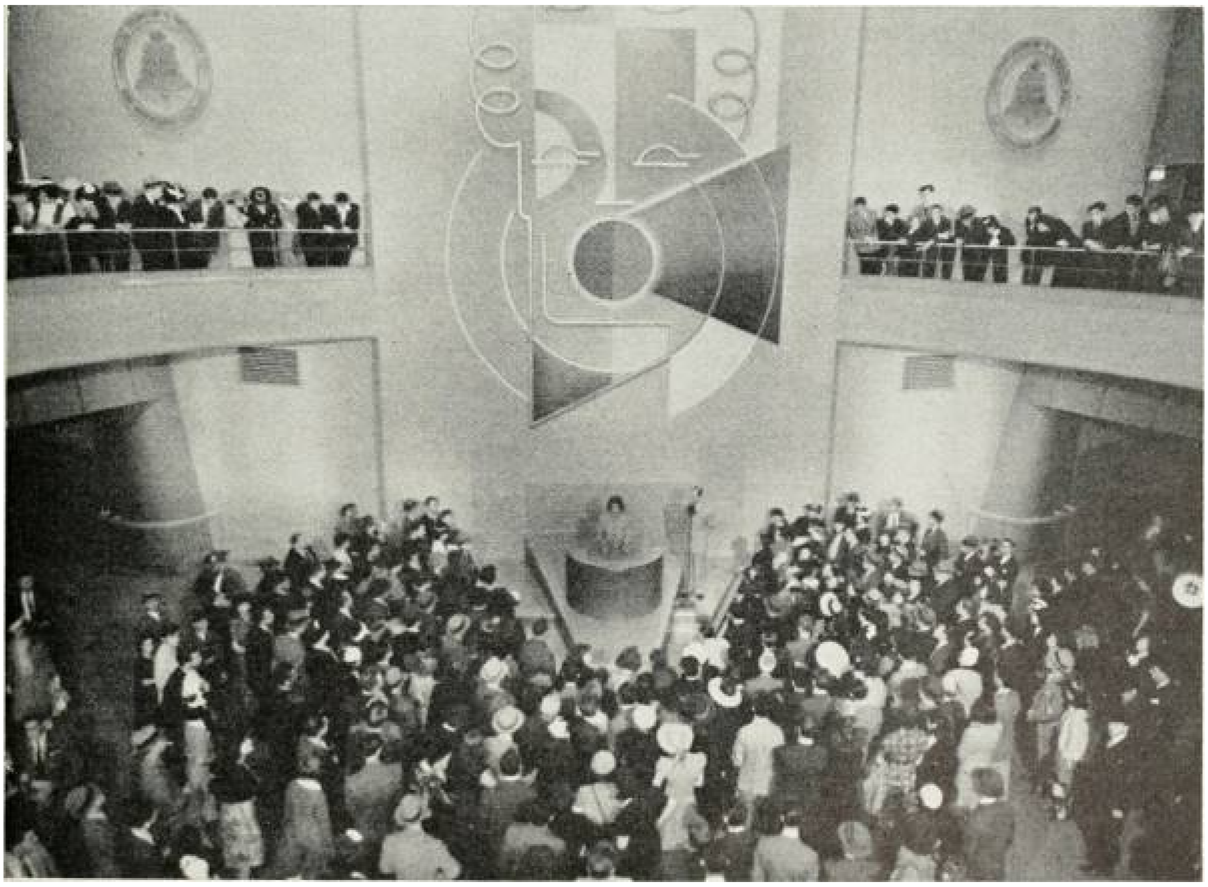
For a project like ideepcolor, Github is where researchers and developers describe how they achieved their results with real, working code. There is generally an introduction, which should contain any major updates to the project, then we go through the prerequisites, setting up or getting started, installation, training and (hopefully) application. There are number of ways to demonstrate application of a model, ideepcolor has built a custom Graphical User Interface (GUI), which we demonstrated this project in our first ML workshop. More commonly demos are done with a jupyter notebook or Google Colab notebook. Now, lets look at the updates at the top of the ideepcolor repository - which tell us:

> 10/3/2019 Update: Our technology is also now available in Adobe Photoshop Elements 2020. See this blog and video for more details.

So it looks like this project has moved to the next stage - integrating ideepcolor into a commercial product.

Speech Synthesis

Like many of the 20th century's technological inovations, the frst modern speech synthesiser can be traced back to the invention of the vocoder at Bell Labs. Derived from this, the Voder was demonstrated at the 1939 World Fair.



4)

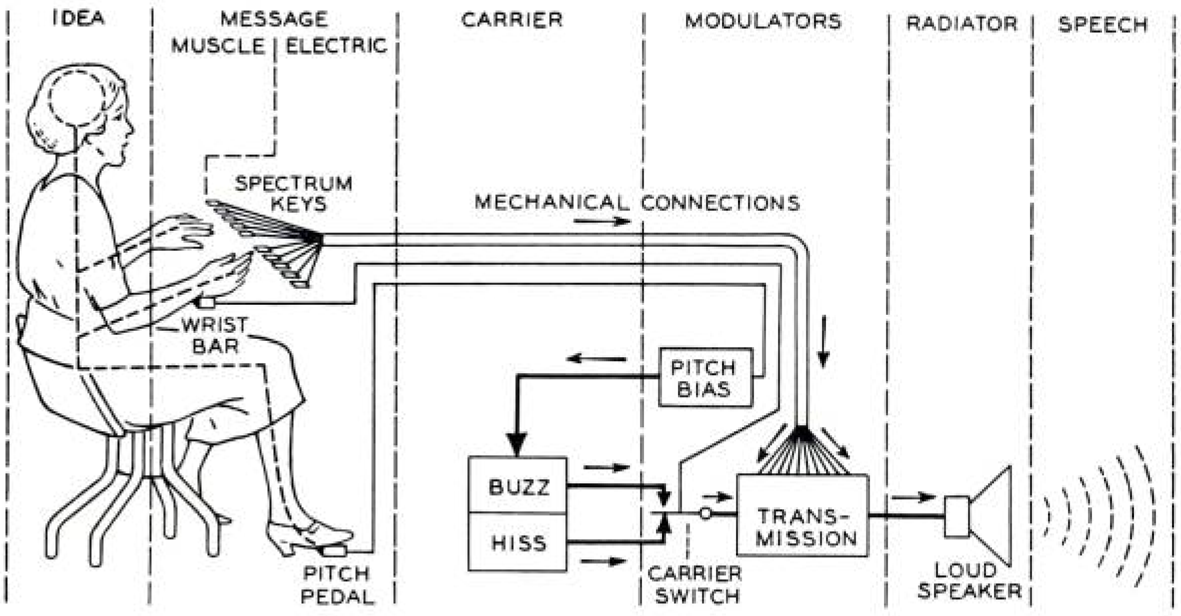


Fig. 8—Schematic circuit of the voder.

Historical Audio Examples

Here is a playlist of various historical TTS methods.

https://soundcloud.com/user-552764043

Modern State of the Art TTS

Now - it time to have some fun with TTS - check out the man holding the frog below…

https://vo.codes/#speak

And have a listen to some interesting examples from pop/meme culture.

https://fifteen.ai/examples

https://www.youtube.com/watch?v=drirw-XvzzQ

Wavenet

Modern deep learning based synthesis started with the release of Wavenet in 2016 by Google's Deepmind.

WaveNet changes this paradigm by directly modelling the raw waveform of the audio signal, one sample at a time. As well as yielding more natural-sounding speech, using raw waveforms means that WaveNet can model any kind of audio, including music.[5)]

Tacotron and Tacotron2

Wavenet was followed by Tacoctron (also from Google) in 2017.

https://google.github.io/tacotron/publications/tacotron/index.html

Then Tacotron2

https://ai.googleblog.com/2017/12/tacotron-2-generating-human-like-speech.html

Google Colab

Google's Colaboratory[6)], or “Colab” for short, allows you to write and execute Python in your browser, with

- Zero configuration required

- Free access to GPUs
- Easy sharing

Python

Python is an open source programming language that was made to be easy-to-read and powerful[7]). Python is:

- a high-level language, (Meaning programmer can focus on what to do instead of how to do it.)
- an interpreted language (Interpreted languages do not need to be compiled to run.)
- is often described as a “batteries included” language due to its comprehensive standard library.

A program called an interpreter runs Python code on almost any kind of computer. In our case python will be interpreted by google colab, which is based on Jupyter notebooks.

Jupyter Notebooks

Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text[8]. Usually Jupyter notebooks require set-up for a specific purpose, but Colab takes care of all this for us.

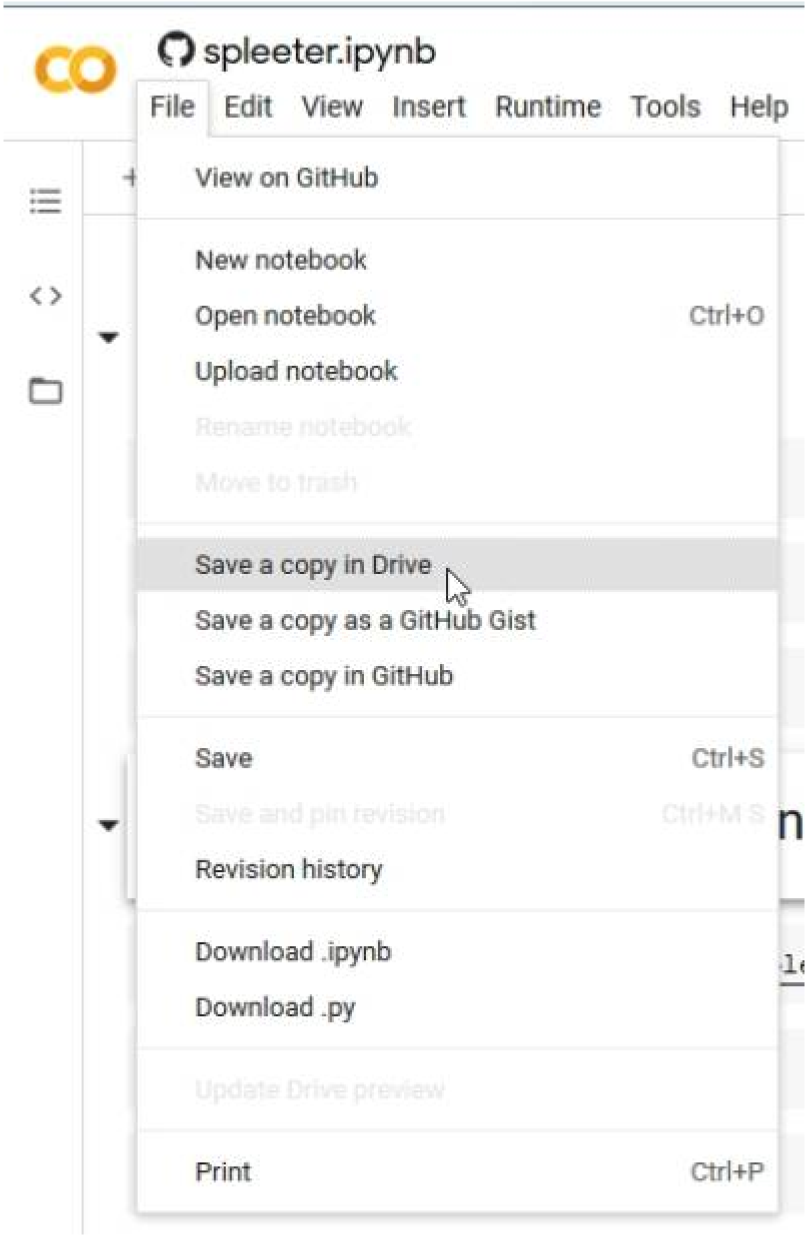
Getting Started with Colab

The only requirment for using Colab is (unsurprisingly) a Google account. Once you have a google account, lets jump into our first ML example - Spleeter - that we mentioned earlier. Go to the Colab here:

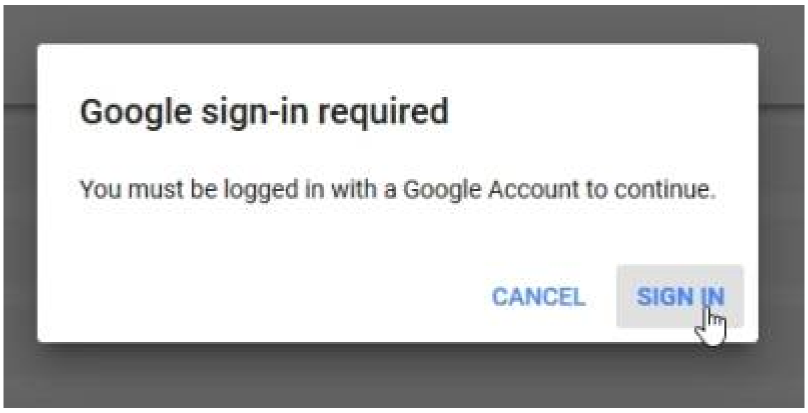
https://colab.research.google.com/github/deezer/spleeter/blob/master/spleeter.ipynb

Making a Colab Copy

The first step is make a copy of the notebook to our Google drive - this means we can save any changes we like.



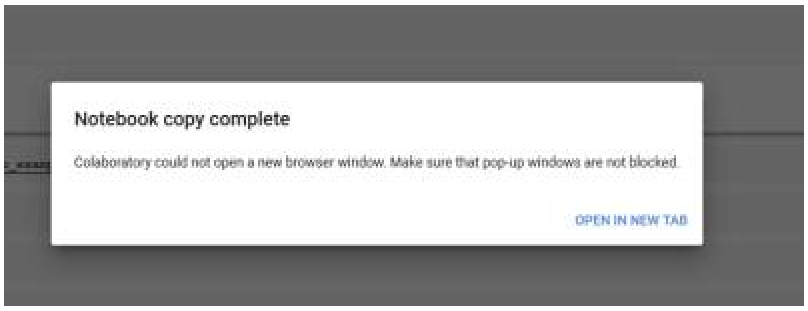
This will trigger a google sign-in



Google sign-in required

You must be logged in with a Google Account to continue.

and the your copy will open in a new tab.

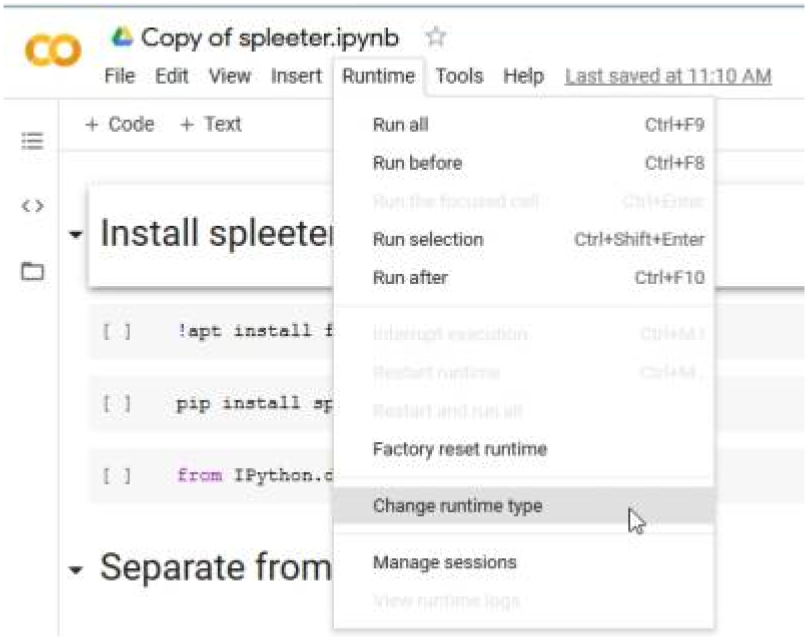

Notebook copy complete

Colaboratory could not open a new browser window. Make sure that pop-up windows are not blocked.

OPEN IN NEW TAB

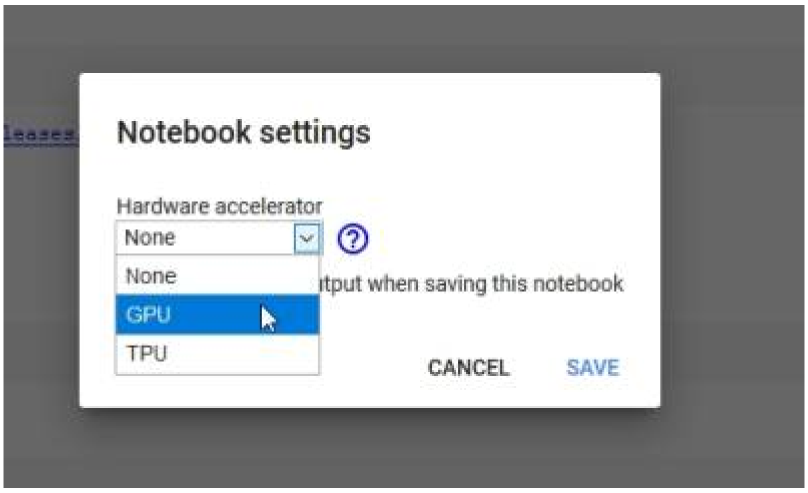
Select a Runtime

Next we change our runtime (the kind or processor we use)



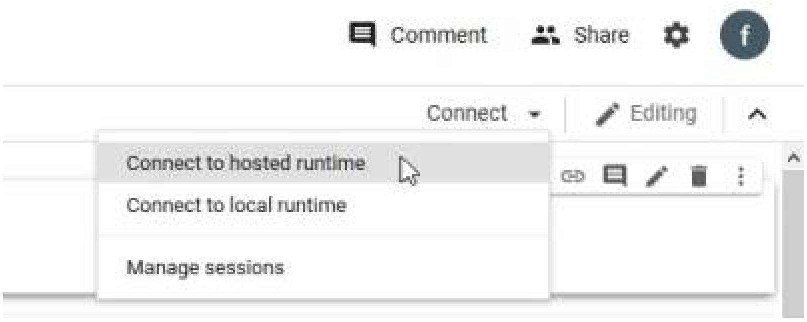
```
[ ] !apt install f
[ ] pip install sp
[ ] from IPython.c
```

to a GPU to take advantage of Googles free GPU offer.

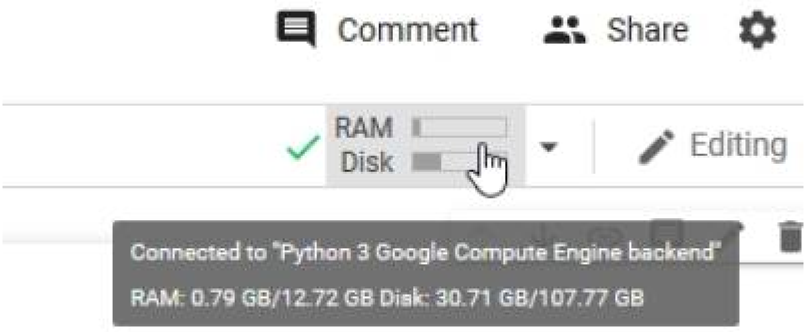


Hardware accelerator: GPU

Now lets connect to our hosted runtime



and check the specs…



Connected to "Python 3 Google Compute Engine backend"
RAM: 0.79 GB/12.72 GB Disk: 30.71 GB/107.77 GB

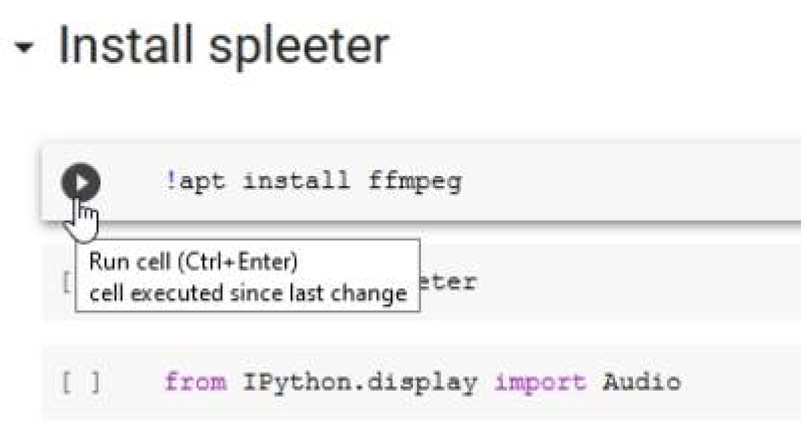
Step Through the Notebook

Now its time to actually use the notebook! Before we start, lets go over how the notebooks work:

- The notebook is divided into sections, with each section made up of cells.
- These cells have code pre-entered into them,
- A play button on the runs (executes) the code in the cell.
- The output of the cell is printed (or displayed) directly below each cell.
- The output could be text, pictures, audio or video.

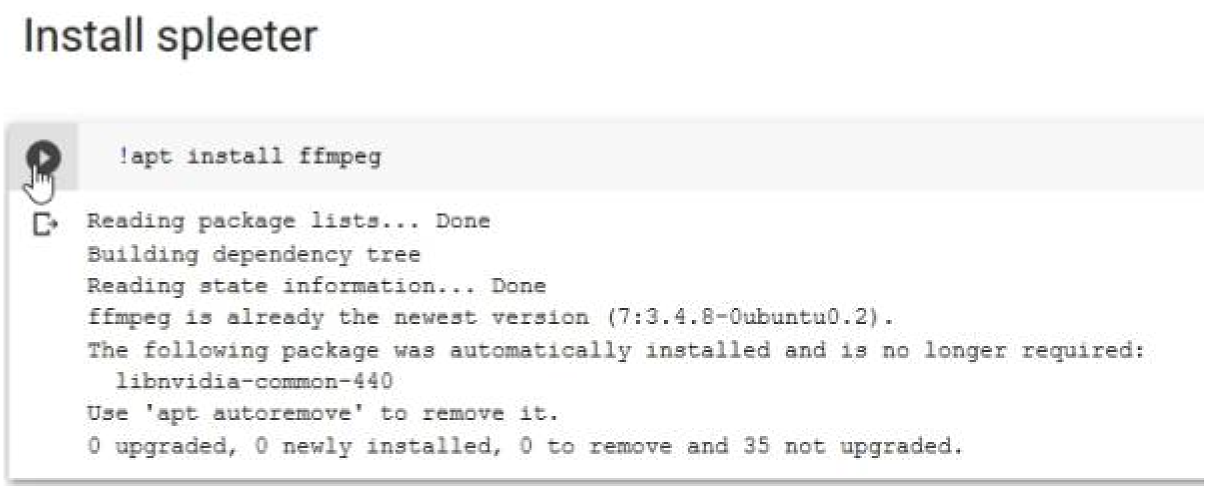
Cells usually contain python code, but can also be coded in bash - the UNIX command line shell. Cells containing bash commands start with an exclamation mark !

Our first section is called "Install Spleeter" and contains the bash command `apt install ffmeg` . This installs ffmeg in our runtime, which is used to process audio. Press the go button..



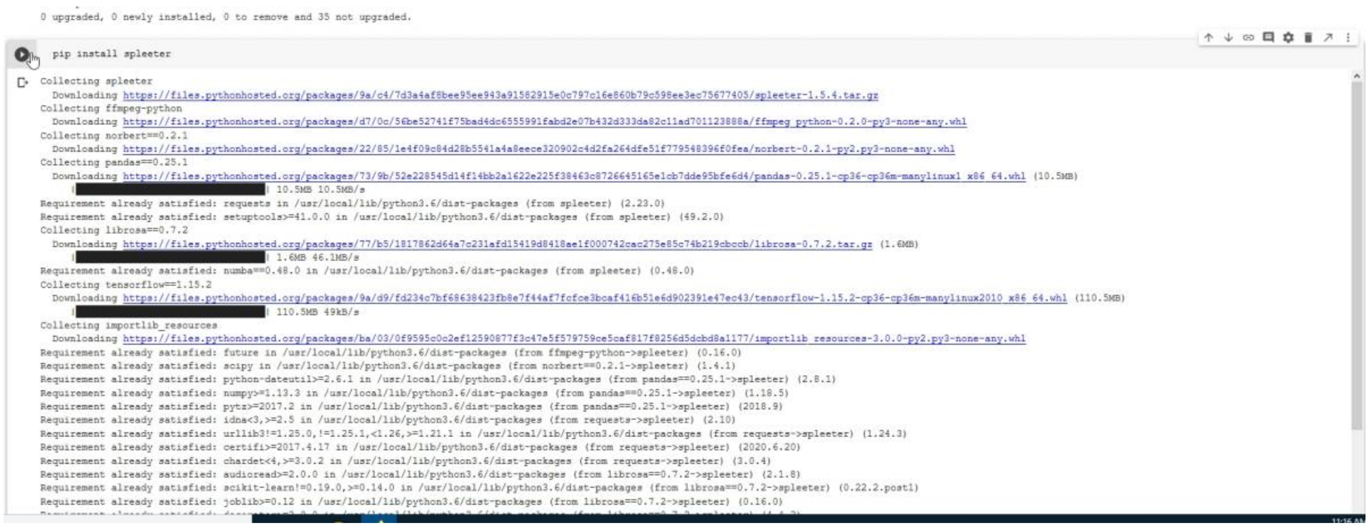
```
▾ Install spleeter

!apt install ffmpeg

[ ]                                      eter

[ ]   from IPython.display import Audio
```

ffmpeg will be downloaded and installed to our runtime.



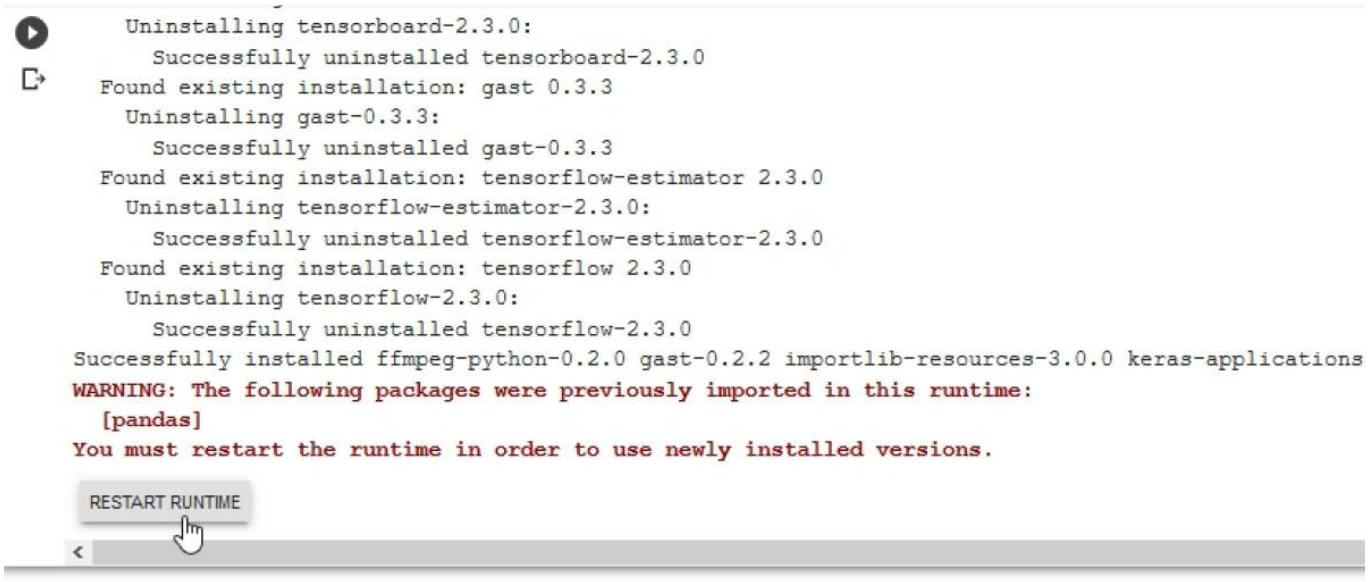
```
Install spleeter

!apt install ffmpeg

Reading package lists... Done
Building dependency tree
Reading state information... Done
ffmpeg is already the newest version (7:3.4.8-0ubuntu0.2).
The following package was automatically installed and is no longer required:
  libnvidia-common-440
Use 'apt autoremove' to remove it.
0 upgraded, 0 newly installed, 0 to remove and 35 not upgraded.
```

Next we will run a python command `pip`to use the python package manager to install the spleeter python package.



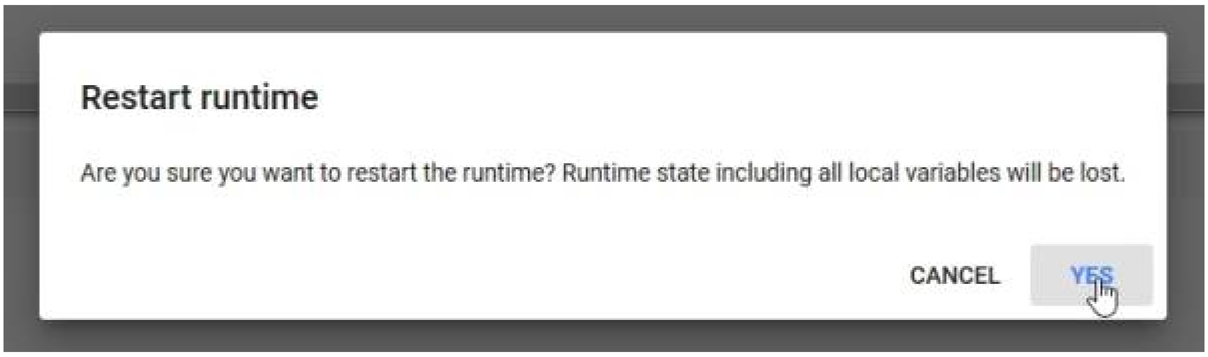
```
0 upgraded, 0 newly installed, 0 to remove and 35 not upgraded.

pip install spleeter

Collecting spleeter
  Downloading https://files.pythonhosted.org/packages/9a/c4/7d3a4af8bee95ee943a91582915e0c797c16e860b79c598ee3ec75677405/spleeter-1.5.4.tar.gz
Collecting ffmpeg-python
  Downloading https://files.pythonhosted.org/packages/d7/0c/56be52741f75bad4dc6555991fabd2e07b432d333da82c11ad701123888a/ffmpeg_python-0.2.0-py3-none-any.whl
Collecting norbert==0.2.1
  Downloading https://files.pythonhosted.org/packages/22/85/1e4f09c84d28b5541a4a8eece320902c4d2fa264dfe51f779548396f0fea/norbert-0.2.1-py2.py3-none-any.whl
Collecting pandas==0.25.1
  Downloading https://files.pythonhosted.org/packages/73/9b/52e228545d14f14bb2a1622e225f38463c8726645165e1cb7dde95bfe6d4/pandas-0.25.1-cp36-cp36m-manylinux1_x86_64.whl (10.5MB)
     |████████████████████████████████| 10.5MB 10.5MB/s
Requirement already satisfied: requests in /usr/local/lib/python3.6/dist-packages (from spleeter) (2.23.0)
Requirement already satisfied: setuptools>=41.0.0 in /usr/local/lib/python3.6/dist-packages (from spleeter) (49.2.0)
Collecting librosa==0.7.2
  Downloading https://files.pythonhosted.org/packages/77/b5/1817862d64a7c231afd15419d8418ae1f000742cac275e85c74b219cbccb/librosa-0.7.2.tar.gz (1.6MB)
     |████████████████████████████████| 1.6MB 46.1MB/s
Requirement already satisfied: numba==0.48.0 in /usr/local/lib/python3.6/dist-packages (from spleeter) (0.48.0)
Collecting tensorflow==1.15.2
  Downloading https://files.pythonhosted.org/packages/9a/d9/fd234c7bf68638423fb8e7f44af7fcfce3bcaf416b51e6d902391e47ec43/tensorflow-1.15.2-cp36-cp36m-manylinux2010_x86_64.whl (110.5MB)
     |████████████████████████████████| 110.5MB 49kB/s
Collecting importlib_resources
  Downloading https://files.pythonhosted.org/packages/ba/03/0f9595c0c2ef12590877f3c47e5f579759ce5caf817f8256d5dcbd8a1177/importlib_resources-3.0.0-py2.py3-none-any.whl
Requirement already satisfied: future in /usr/local/lib/python3.6/dist-packages (from ffmpeg-python->spleeter) (0.16.0)
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from norbert==0.2.1->spleeter) (1.4.1)
Requirement already satisfied: python-dateutil>=2.6.1 in /usr/local/lib/python3.6/dist-packages (from pandas==0.25.1->spleeter) (2.8.1)
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib/python3.6/dist-packages (from pandas==0.25.1->spleeter) (1.18.5)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.6/dist-packages (from pandas==0.25.1->spleeter) (2018.9)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.6/dist-packages (from requests->spleeter) (2.10)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local/lib/python3.6/dist-packages (from requests->spleeter) (1.24.3)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.6/dist-packages (from requests->spleeter) (2020.6.20)
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.6/dist-packages (from requests->spleeter) (3.0.4)
Requirement already satisfied: audioread>=2.0.0 in /usr/local/lib/python3.6/dist-packages (from librosa==0.7.2->spleeter) (2.1.8)
Requirement already satisfied: scikit-learn!=0.19.0,>=0.14.0 in /usr/local/lib/python3.6/dist-packages (from librosa==0.7.2->spleeter) (0.22.2.post1)
Requirement already satisfied: joblib>=0.12 in /usr/local/lib/python3.6/dist-packages (from librosa==0.7.2->spleeter) (0.16.0)
```

This will take a while - and at the end we will get a message saying we need to restart our runtime due to some compatibilty issues [9)]



```
    Uninstalling tensorboard-2.3.0:
      Successfully uninstalled tensorboard-2.3.0
  Found existing installation: gast 0.3.3
    Uninstalling gast-0.3.3:
      Successfully uninstalled gast-0.3.3
  Found existing installation: tensorflow-estimator 2.3.0
    Uninstalling tensorflow-estimator-2.3.0:
      Successfully uninstalled tensorflow-estimator-2.3.0
  Found existing installation: tensorflow 2.3.0
    Uninstalling tensorflow-2.3.0:
      Successfully uninstalled tensorflow-2.3.0
Successfully installed ffmpeg-python-0.2.0 gast-0.2.2 importlib-resources-3.0.0 keras-applications
WARNING: The following packages were previously imported in this runtime:
  [pandas]
You must restart the runtime in order to use newly installed versions.
```

Go ahead and restart



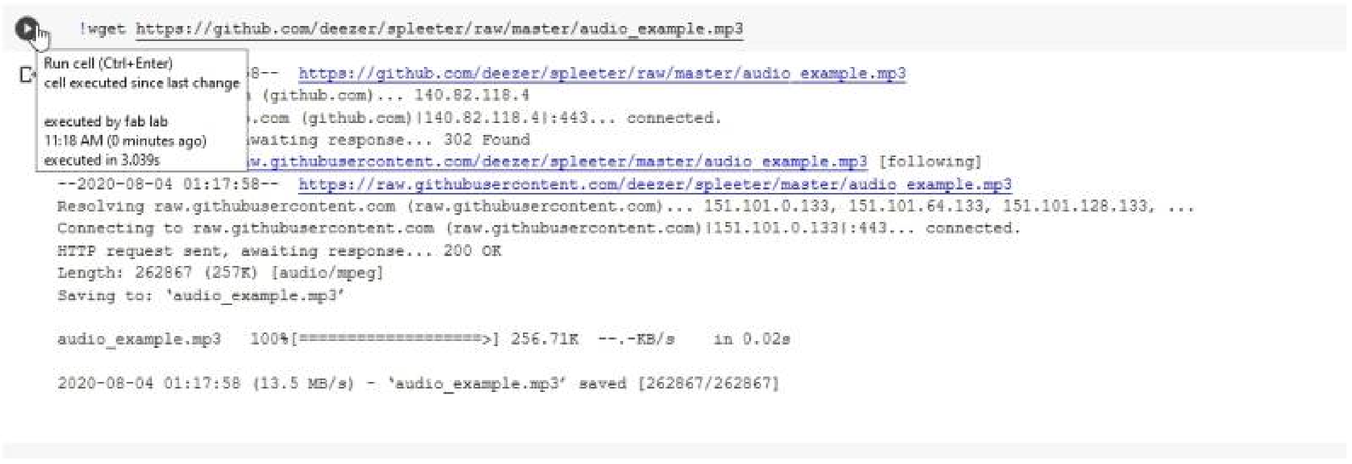
Restart runtime

Are you sure you want to restart the runtime? Runtime state including all local variables will be lost.

Next is another bash command

```
wget
```

we use to (web)get our example audio file.



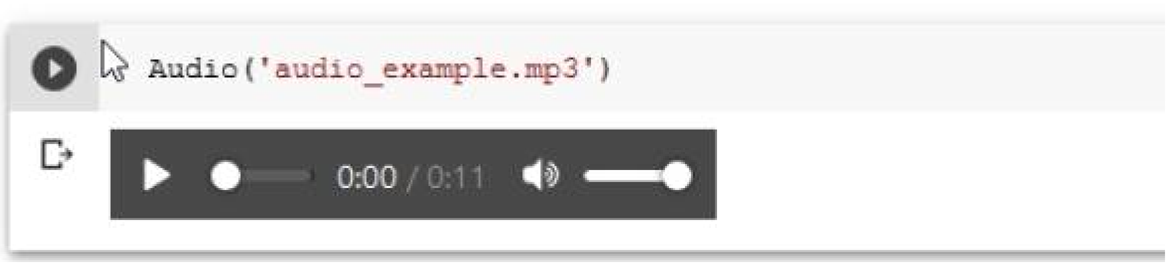
```
!wget https://github.com/deezer/spleeter/raw/master/audio_example.mp3
```

Run cell (Ctrl+Enter)
cell executed since last change

executed by fab lab
11:18 AM (0 minutes ago)
executed in 3.039s

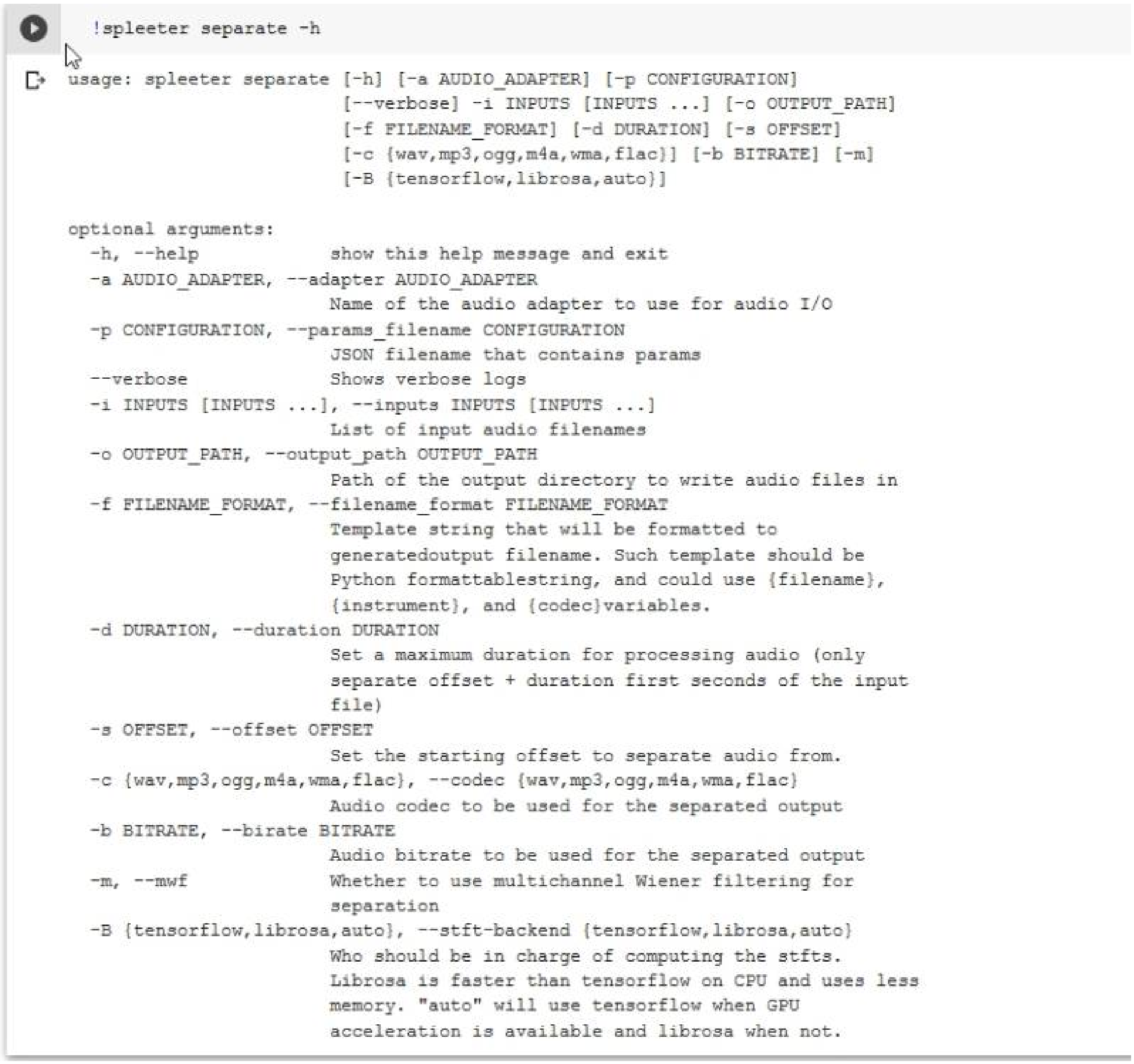
```
8--  https://github.com/deezer/spleeter/raw/master/audio_example.mp3
 (github.com)... 140.82.118.4
.com (github.com)|140.82.118.4|:443... connected.
waiting response... 302 Found
w.githubusercontent.com/deezer/spleeter/master/audio_example.mp3 [following]
--2020-08-04 01:17:58--  https://raw.githubusercontent.com/deezer/spleeter/master/audio_example.mp3
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 151.101.0.133, 151.101.64.133, 151.101.128.133, ...
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|151.101.0.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 262867 (257K) [audio/mpeg]
Saving to: 'audio_example.mp3'

audio_example.mp3   100%[===================>] 256.71K  --.-KB/s    in 0.02s

2020-08-04 01:17:58 (13.5 MB/s) - 'audio_example.mp3' saved [262867/262867]
```

And the next cell uses the python `Audio` command to give us a nice little audio player so we can hear our example.



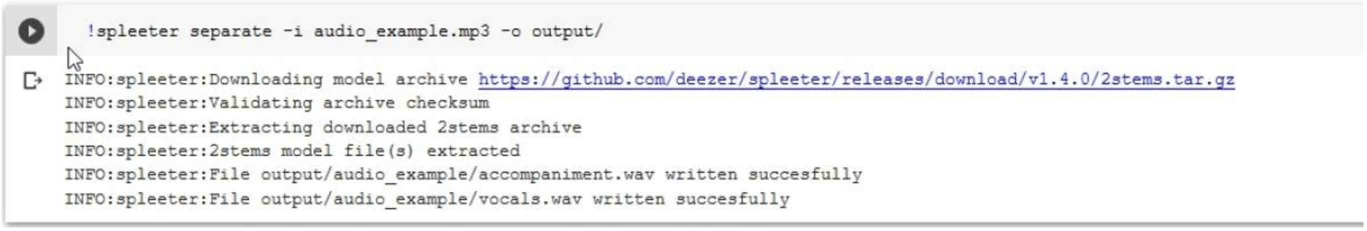
```
Audio('audio_example.mp3')
```

Now its finally time to use the spleeter tool with the `separate` command [10] as `!spleeter separate` , and lets pass the `-h` flag [11] to show us the built in help for the command.



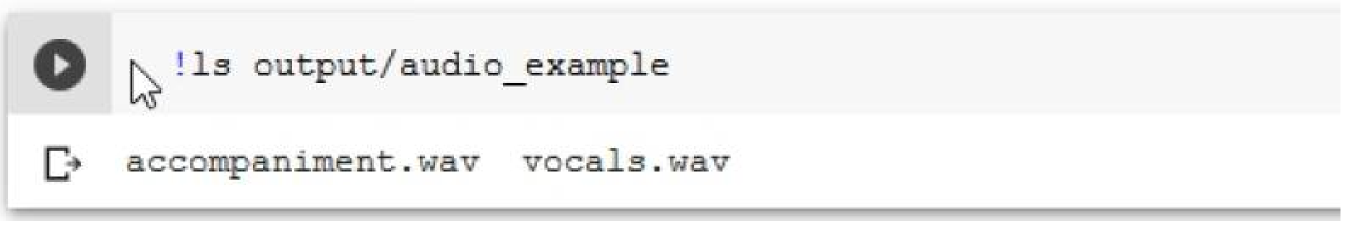
```
!spleeter separate -h

usage: spleeter separate [-h] [-a AUDIO_ADAPTER] [-p CONFIGURATION]
                         [--verbose] -i INPUTS [INPUTS ...] [-o OUTPUT_PATH]
                         [-f FILENAME_FORMAT] [-d DURATION] [-s OFFSET]
                         [-c {wav,mp3,ogg,m4a,wma,flac}] [-b BITRATE] [-m]
                         [-B {tensorflow,librosa,auto}]

optional arguments:
  -h, --help            show this help message and exit
  -a AUDIO_ADAPTER, --adapter AUDIO_ADAPTER
                        Name of the audio adapter to use for audio I/O
  -p CONFIGURATION, --params_filename CONFIGURATION
                        JSON filename that contains params
  --verbose             Shows verbose logs
  -i INPUTS [INPUTS ...], --inputs INPUTS [INPUTS ...]
                        List of input audio filenames
  -o OUTPUT_PATH, --output_path OUTPUT_PATH
                        Path of the output directory to write audio files in
  -f FILENAME_FORMAT, --filename_format FILENAME_FORMAT
                        Template string that will be formatted to
                        generatedoutput filename. Such template should be
                        Python formattablestring, and could use {filename},
                        {instrument}, and {codec}variables.
  -d DURATION, --duration DURATION
                        Set a maximum duration for processing audio (only
                        separate offset + duration first seconds of the input
                        file)
  -s OFFSET, --offset OFFSET
                        Set the starting offset to separate audio from.
  -c {wav,mp3,ogg,m4a,wma,flac}, --codec {wav,mp3,ogg,m4a,wma,flac}
                        Audio codec to be used for the separated output
  -b BITRATE, --birate BITRATE
                        Audio bitrate to be used for the separated output
  -m, --mwf             Whether to use multichannel Wiener filtering for
                        separation
  -B {tensorflow,librosa,auto}, --stft-backend {tensorflow,librosa,auto}
                        Who should be in charge of computing the stfts.
                        Librosa is faster than tensorflow on CPU and uses less
                        memory. "auto" will use tensorflow when GPU
                        acceleration is available and librosa when not.
```

Now that we know what we are doing - we run the tool for real, and will use the `-i` flag to define the input as our downloaded example, and the `-o` flag to define our output destination as the directory (folder) `output`. By default spleeter will download and use the2stems model.



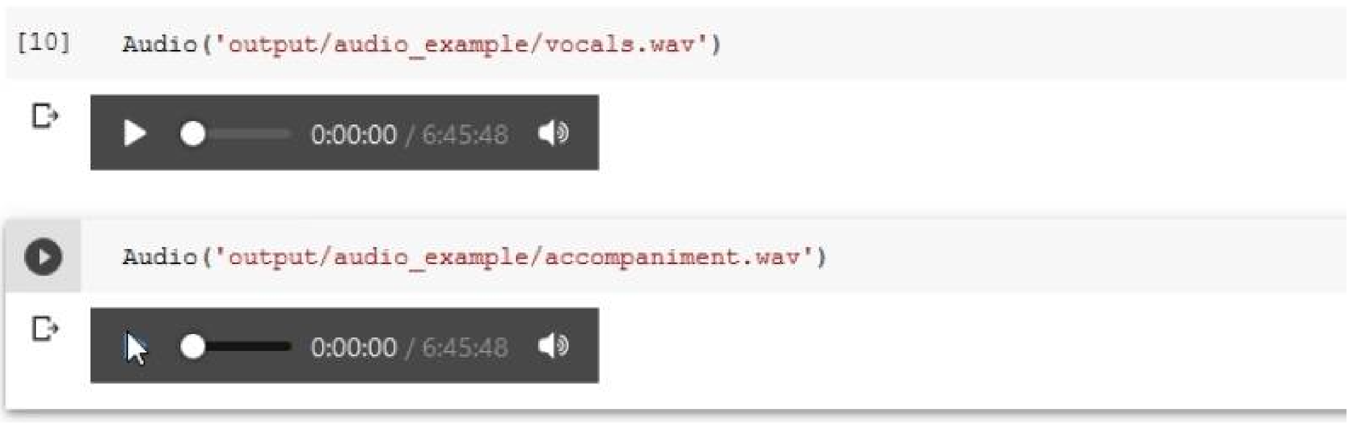
```
!spleeter separate -i audio_example.mp3 -o output/

INFO:spleeter:Downloading model archive https://github.com/deezer/spleeter/releases/download/v1.4.0/2stems.tar.gz
INFO:spleeter:Validating archive checksum
INFO:spleeter:Extracting downloaded 2stems archive
INFO:spleeter:2stems model file(s) extracted
INFO:spleeter:File output/audio_example/accompaniment.wav written succesfully
INFO:spleeter:File output/audio_example/vocals.wav written succesfully
```

Another bash command `ls` (list) shows us the contents of our output directory



```
!ls output/audio_example
accompaniment.wav  vocals.wav
```

And finally onother couple of `audio` commands to hear our result!



```
[10] Audio('output/audio_example/vocals.wav')
```

```
Audio('output/audio_example/accompaniment.wav')
```

Things to try

Check out the usage instructions for the separate tool on the Github site and try your own 4stem and 5stem separations. Use your own audio files to test the separation.

Speech to Text with Mozilla Deepspeech

Our next challenge will be to adapt the latest version of Mozilla's Deepspeech for use in Google Colab.

We will be using the documentation here:

https://deepspeech.readthedocs.io/en/v0.8.0/USING.html#getting-the-pre-trained-model

To adapt this colab notebook to run the latest version of Mozilla Deepspeech:

https://colab.research.google.com/github/tugstugi/dl-colab-notebooks/blob/master/notebooks/MozillaDeepSpeech.ipynb#scrollTo=4OAYywPHApuz

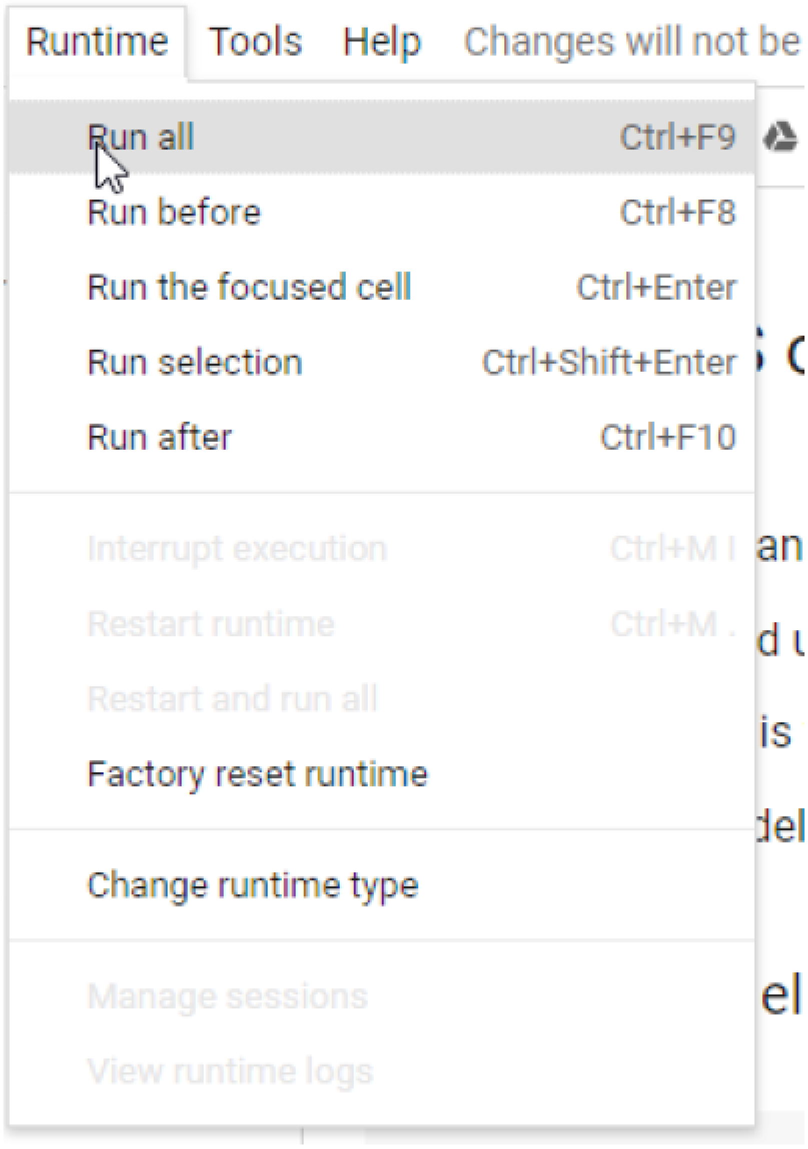
Text to Speech with Mozilla TTS

Our final example is TTS with Mozilla TTS:

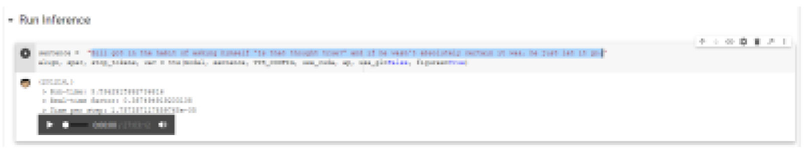
https://colab.research.google.com/drive/1u_16ZzHjKYFn1HNVuA4Qf_i2MMFB9olY?usp=sharing#scrollTo=6LWsNd3_M3MP

You can dive straight into this and use it to generate speech. This example usesTacotron2 and MultiBand-Melgan models and LJSpeech dataset.

Run All Cells



Generate Speech



```
[illegible]
```

Going Further

ML is such a big and fast moving area of research there are countless other ways to explore and learn, here are a few two-minute videos to pique your interest:

- Video restoration
- OpenAI Plays Hide and Seek

Make sure you check out the resources in Lynda, which you will have free access to as a State Library of Queensland member

Links

https://machinelearningforkids.co.uk/#!/links#top

https://experiments.withgoogle.com/collection/ai

https://openai.com/blog/

1)
the ideepcolor training set is 1.3 million images
2)
this is obviously a contrived example of course, but the principle applies regardless
3)
if made available under an appropriate license
4)
By Internet Archive Book Images - https://www.flickr.com/photos/internetarchivebookimages/14776509983/Source book page:
https://archive.org/stream/belltelephonemag19amerrich/belltelephonemag19amerrich#page/n78/mode/1upReference[Fig.4] The Voder Fascinates the Crowds from: Williams, Thomas W. (January 1940) I. At the New York World&#039;s Fair. &quot;Our Exhibits at Two Fairs&quot;. Bell Telephone Quarterly XIX (1): 65.&quot;The Voder Fascinates the Crowds - The manipulative skill of the operator s fingers makes the Voders voice almost loo good to be true &quot;, No restrictions, https://commons.wikimedia.org/w/index.php?curid=43343073
5)
https://deepmind.com/blog/article/wavenet-generative-model-raw-audio
6)
https://colab.research.google.com/notebooks/intro.ipynb
7)
https://simple.wikipedia.org/wiki/Python_(programming_language
8)
https://jupyter.org/
9)
this is not unusual when using a hosted runtime
10)
confusingly we need to call it from bash (with the exclamation
11)
a fancy way of saying option