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FontGen

Generating fonts using a neural net

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In[1]:=
```
ClearAll["Global`*"]
SetDirectory[NotebookDirectory[]];
```

I spend a lot of time trying to identify and download fonts, so a program that could do it for me would be wonderful. There are many academic papers on the subject, but none of them have published their code, so I decided to implement it myself and learn more about deep learning along the way.

Data

The data is a whopping 13+ gigabytes and was scraped from the internet by someone else. It can be downloaded here.

```
Import["fonts.hdf5", {"Dimensions"}]
```

```
⟨|/fonts → {56443, 62, 64, 64}|⟩
```

I debugged the neural net using a much smaller dataset, consisting of my personal collection of fonts. The smaller dataset was created by running a script written by the same guy who got the original data.

```
Import["fonts.small.hdf5", {"Dimensions"}]
f = Import["fonts.small.hdf5", {"Datasets", "fonts"}];
(* Show an example character. *)
Image[f[[1]][[1]]]
```

```
⟨|/fonts → {21, 62, 64, 64}|⟩
```

Network

Each letter is 64x64 pixels.

```
(* We use 4 letters as input... *)
4 * 64^2
(* ... and get 62 letters as output. *)
62 * 64^2
```

```
16 384
```

```
253 952
```

There are $4*64^2 = 16,384$ input neurons, and $62*64^2 = 253,952$ output neurons. The letters chosen for the inputs are “B”, “A”, “S”, and “Q”.

```
(* http://bit.ly/2oeHyZX *)
Range[0, 25];
letters = AssociationThread[ToUpperCase[#] & /@ Alphabet[], %];
Lookup[letters, {"B", "A", "S", "Q"}]
Image[f[[1]][[# + 1]]] & /@ %
```

```
{1, 0, 18, 16}
```

Architecture

Here is the architecture that I used for the model. Many of the parameters were determined through tedious trial-and-error.

```
(* Created using Keras's `plot_model` function: https://
 keras.io/visualization/ *)
Import["img/model.png"]
```

After training is complete, running `model.save_weights()` saves the weights of the model to an HDF5 file, which can be loaded to recreate the model (see the documentation).

```
(* The architecture is stored in `model.json`. *)
Import["model.hdf5", {"Dimensions"}]
```

```
⟨| /batch_normalization_1/batch_normalization_1/beta:0 → {253 952},
 /batch_normalization_1/batch_normalization_1/gamma:0 → {253 952},
 /batch_normalization_1/batch_normalization_1/moving_mean:0 → {253 952},
 /batch_normalization_1/batch_normalization_1/moving_variance:0 → {253 952},
 /conv2d_1/conv2d_1/bias:0 → {8}, /conv2d_1/conv2d_1/kernel:0 → {4, 4, 1, 8},
 /conv2d_2/conv2d_2/bias:0 → {8}, /conv2d_2/conv2d_2/kernel:0 → {4, 4, 1, 8},
 /conv2d_3/conv2d_3/bias:0 → {8}, /conv2d_3/conv2d_3/kernel:0 → {4, 4, 1, 8},
 /conv2d_4/conv2d_4/bias:0 → {8}, /conv2d_4/conv2d_4/kernel:0 → {4, 4, 1, 8},
 /conv2d_5/conv2d_5/bias:0 → {10}, /conv2d_5/conv2d_5/kernel:0 → {4, 4, 32, 10},
 /dense_1/dense_1/bias:0 → {253 952}, /dense_1/dense_1/kernel:0 → {10, 253 952} |⟩
```

Evaluation

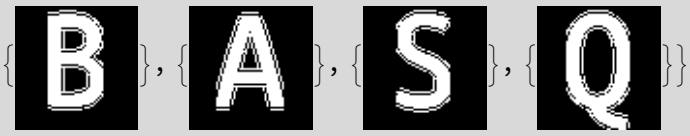
In[44]:=
```
(* A function which transforms a list of image arrays to a list of images. *)
displayFont[f_]:=Map[Map[Image,#]&,f];
```

I tested the model on the font Ubuntu Mono, which is available for download here.

In[62]:=
```
(* The input to the neural net. *)
Import["test.hdf5", {"Dimensions"}]
testInput = Import["test.hdf5", {"input"}];
displayFont[testInput]
(* The output. *)
output = Import["test.hdf5", {"output"}];
displayFont[output]
```

Out[62]=
```
⟨| /input → {4, 1, 64, 64, 1}, /output → {1, 62, 64, 64} |⟩
```

Out[64]=



Out[66]=

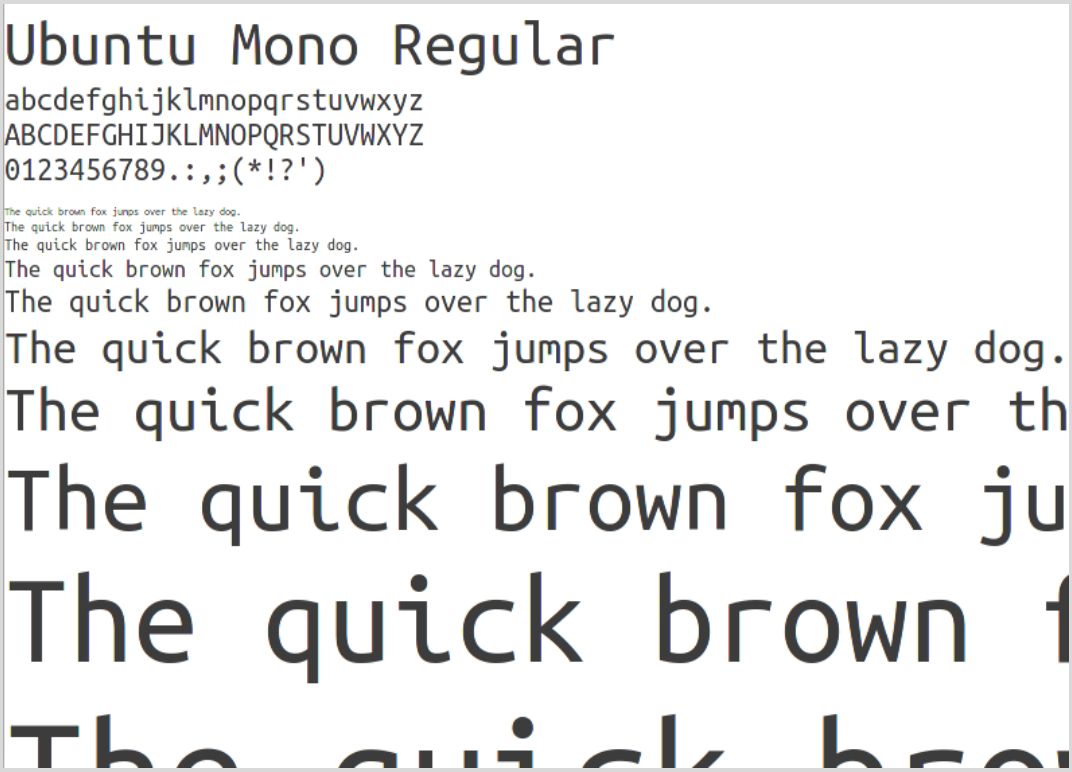
Training the model for 70 epochs resulted in the above characters. Training for more epochs resulted in the characters being sharper at the loss of the “holes” in some of the letters, such as “A”.

```
Import["img/overfitA.png"]
```

When we compare the output to a screenshot of the actual font, we see that the actual font is much skinnier and sharper (the inverted colors are a result of the encoding).

```
(* A screenshot of the actual font (viewed with Ubuntu Font Viewer). *)
Import["img/actual.png"]
```

Out[67]=



Unfortunately, actual TrueType fonts are stored as vectors, and not bitmaps like my neural net created, meaning that I can't create an actual usable font without a major refactoring.

References

In[68]:=
```
(* There is no better way to insert references on Mac/Linux. See http://
 bit.ly/2lo3Pkc *)
Import["sources.bib"]
```

Out[68]=
```
@inproceedings{paper,
    title = {Learning Typographic Style},
    author  = {Shumeet Baluja},
    year  = {2016},
    URL = {http://arxiv.org/abs/1603.04000},
    booktitle = {arXiv}
}

@misc{deepfont,
    url =
  {https://erikbern.com/2016/01/21/analyzing-50k-fonts-using-deep-neural-networks
  .html},
    title = {Analyzing 50k fonts using deep neural networks},
    author = {Erik Bernhardsson},
    year = {2016},
    month = JAN
}

@misc{keras,
    url = {https://keras.io/},
    title = {Keras},
    version = {2.1.2}
}

@misc{fonsi,
    author = {Fonsi Bonilla},
    howpublished = {Personal Correspondance},
    year = {2017},
    month = DEC
}
```