Tensorflow Unet Documentation

Release 0.1.1

Joel Akeret

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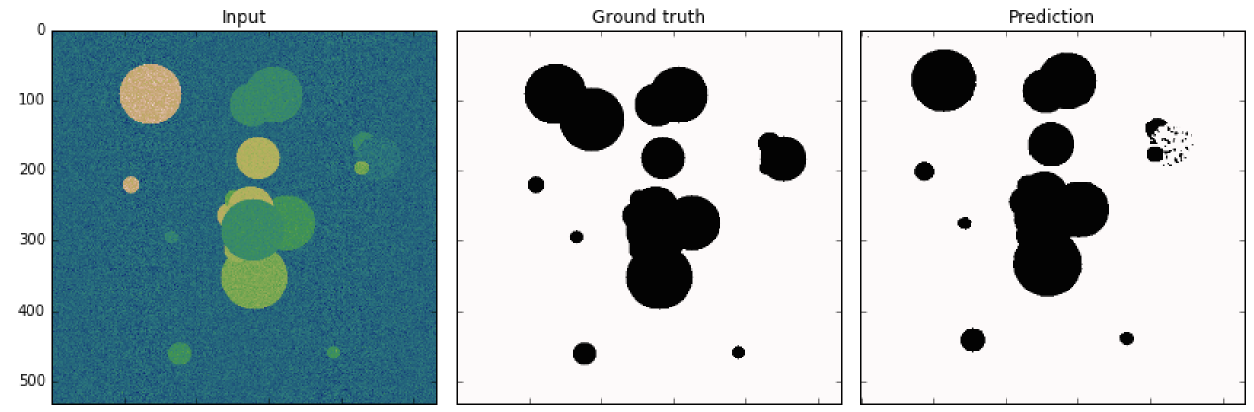
Contents

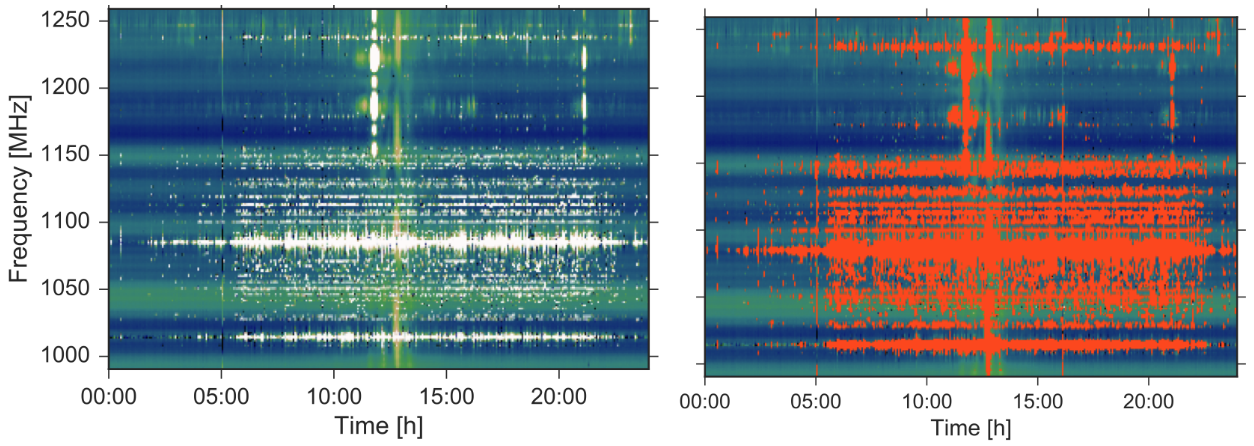
This is a generic **U-Net** implementation as proposed by Ronneberger et al. developed with **Tensorflow**. The code has been developed and used for Radio Frequency Interference mitigation using deep convolutional neural networks .

The network can be trained to perform image segmentation on arbitrary imaging data. Checkout the Usage section or the included Jupyter notebooks for a toy problem or the Radio Frequency Interference mitigation discussed in our paper.

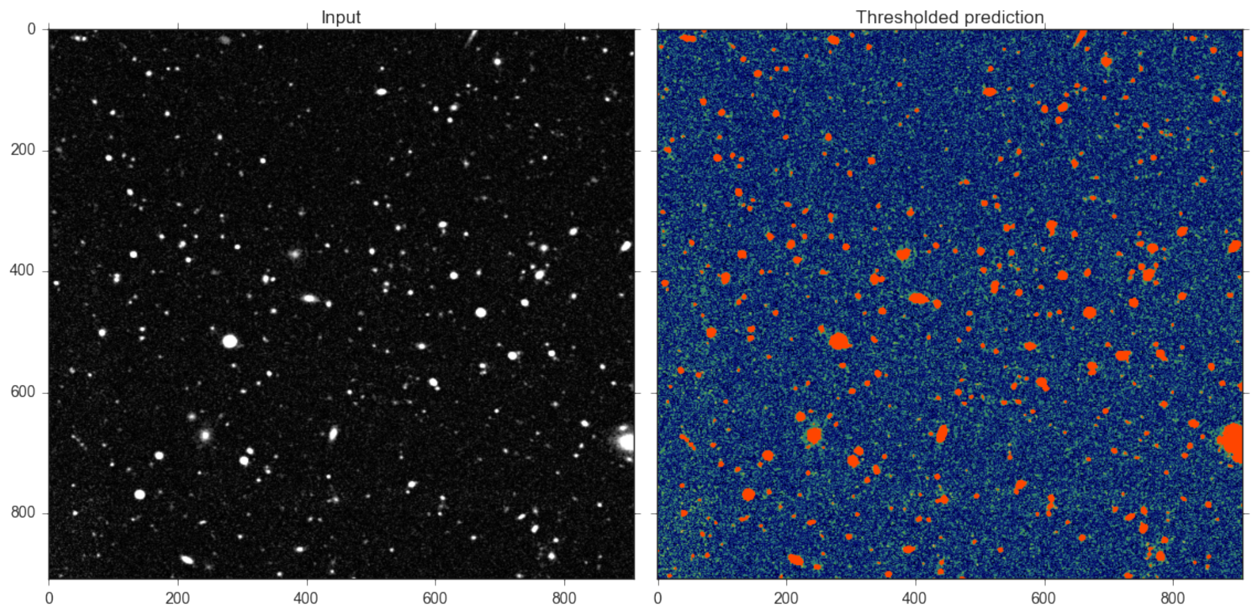
The code is not tied to a specific segmentation such that it can be used in a toy problem to detect circles in a noisy image.



To more complex application such as the detection of radio frequency interference (RFI) in radio astronomy.



Or to detect galaxies and star in wide field imaging data.



As you use **tf_unet** for your exciting discoveries, please cite the paper that describes the package:

```
@article{akeret2017radio,
  title={Radio frequency interference mitigation using deep convolutional neural␣
↪networks},
  author={Akeret, Joel and Chang, Chihway and Lucchi, Aurelien and Refregier,␣
↪Alexandre},
  journal={Astronomy and Computing},
  volume={18},
  pages={35--39},
  year={2017},
  publisher={Elsevier}
}
```

CHAPTER 1

Contents:

1.1 Installation

The project is hosted on GitHub. Get a copy by running:

```
$ git clone https://github.com/jakeret/tf_unet.git
```

Install the package like this:

```
$ cd tf_unet
$ pip install -r requirements.txt
$ python setup.py install --user
```

Alternatively, if you want to develop new features:

```
$ cd tf_unet
$ python setup.py develop --user
```

Make sure *TensorFlow* is installed on your system. Installation instruction can be found here

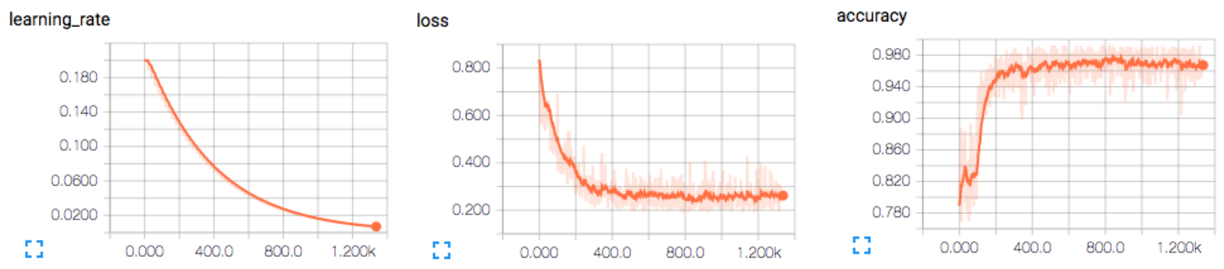
1.2 Usage

To use Tensorflow Unet in a project:

```
from tf_unet import unet, util, image_util

#preparing data loading
data_provider = image_util.ImageDataProvider("fishes/train/*.tif")

#setup & training
net = unet.Unet(layers=3, features_root=64, channels=1, n_class=2)
trainer = unet.Trainer(net)
```

```
path = trainer.train(data_provider, output_path, training_iters=32, epochs=100)

#verification
...

prediction = net.predict(path, data)

unet.error_rate(prediction, util.crop_to_shape(label, prediction.shape))

img = util.combine_img_prediction(data, label, prediction)
util.save_image(img, "prediction.jpg")
```

Keep track of the learning progress using *Tensorboard*. **tf_unet** automatically outputs relevant summaries.



More examples can be found in the Jupyter notebooks for a toy problem or for a RFI problem. Further code is stored in the scripts folder.

1.3 tf_unet Package

1.3.1 unet Module

Created on Jul 28, 2016

author: jakeret

class tf_unet.unet.**Trainer**(*net*, *batch_size=1*, *norm_grads=False*, *optimizer=u'momentum'*, *opt_kwargs={}*)

Bases: object

Trains a unet instance

Parameters

- **net** – the unet instance to train
- **batch_size** – size of training batch
- **norm_grads** – (optional) true if normalized gradients should be added to the summaries
- **optimizer** – (optional) name of the optimizer to use (momentum or adam)
- **opt_kwargs** – (optional) kwargs passed to the learning rate (momentum opt) and to the optimizer

output_epoch_stats(*epoch*, *total_loss*, *training_iters*, *lr*)

output_minibatch_stats(*sess*, *summary_writer*, *step*, *batch_x*, *batch_y*)

store_prediction(*sess*, *batch_x*, *batch_y*, *name*)

train (*data_provider*, *output_path*, *training_iters=10*, *epochs=100*, *dropout=0.75*, *display_step=1*, *restore=False*, *write_graph=False*, *prediction_path=u'prediction'*)
Lauches the training process

Parameters

- **data_provider** – callable returning training and verification data
- **output_path** – path where to store checkpoints
- **training_iters** – number of training mini batch iteration
- **epochs** – number of epochs
- **dropout** – dropout probability
- **display_step** – number of steps till outputting stats
- **restore** – Flag if previous model should be restored
- **write_graph** – Flag if the computation graph should be written as protobuf file to the output path
- **prediction_path** – path where to save predictions on each epoch

verification_batch_size = 4

class `tf_unet.unet.`**Unet** (*channels=3*, *n_class=2*, *cost=u'cross_entropy'*, *cost_kwargs={}*, ***kwargs*)
Bases: `object`

A unet implementation

Parameters

- **channels** – (optional) number of channels in the input image
- **n_class** – (optional) number of output labels
- **cost** – (optional) name of the cost function. Default is 'cross_entropy'
- **cost_kwargs** – (optional) kwargs passed to the cost function. See Unet._get_cost for more options

predict (*model_path*, *x_test*)
Uses the model to create a prediction for the given data

Parameters

- **model_path** – path to the model checkpoint to restore
- **x_test** – Data to predict on. Shape [n, nx, ny, channels]

Returns prediction The unet prediction Shape [n, px, py, labels] (px=nx-self.offset/2)

restore (*sess*, *model_path*)
Restores a session from a checkpoint

Parameters

- **sess** – current session instance
- **model_path** – path to file system checkpoint location

save (*sess*, *model_path*)
Saves the current session to a checkpoint

Parameters

- **sess** – current session
- **model_path** – path to file system location

`tf_unet.unet.`**create_conv_net**(*x*, *keep_prob*, *channels*, *n_class*, *layers=3*, *features_root=16*, *filter_size=3*, *pool_size=2*, *summaries=True*)

Creates a new convolutional unet for the given parametrization.

Parameters

- **x** – input tensor, shape [?,nx,ny,channels]
- **keep_prob** – dropout probability tensor
- **channels** – number of channels in the input image
- **n_class** – number of output labels
- **layers** – number of layers in the net
- **features_root** – number of features in the first layer
- **filter_size** – size of the convolution filter
- **pool_size** – size of the max pooling operation
- **summaries** – Flag if summaries should be created

`tf_unet.unet.`**error_rate**(*predictions*, *labels*)

Return the error rate based on dense predictions and 1-hot labels.

`tf_unet.unet.`**get_image_summary**(*img*, *idx=0*)

Make an image summary for 4d tensor image with index idx

1.3.2 `image_util` Module

author: jakeret

class `tf_unet.image_util.`**BaseDataProvider**(*a_min=None*, *a_max=None*)

Bases: `object`

Abstract base class for DataProvider implementation. Subclasses have to overwrite the *_next_data* method that load the next data and label array. This implementation automatically clips the data with the given min/max and normalizes the values to (0,1]. To change this behavoir the *_process_data* method can be overwritten. To enable some post processing such as data augmentation the *_post_process* method can be overwritten.

Parameters

- **a_min** – (optional) min value used for clipping
- **a_max** – (optional) max value used for clipping

channels = 1

n_class = 2

class `tf_unet.image_util.`**ImageDataProvider**(*search_path*, *a_min=None*, *a_max=None*, *data_suffix=u'.tif'*, *mask_suffix=u'_mask.tif'*, *shuffle_data=True*, *n_class=2*)

Bases: *`tf_unet.image_util.BaseDataProvider`*

Generic data provider for images, supports gray scale and colored images. Assumes that the data images and label images are stored in the same folder and that the labels have a different file suffix e.g. 'train/fish_1.tif' and 'train/fish_1_mask.tif'

Usage: data_provider = ImageDataProvider("..fishes/train/*.tif")

Parameters

- **`search_path`** – a glob search pattern to find all data and label images
- **`a_min`** – (optional) min value used for clipping
- **`a_max`** – (optional) max value used for clipping
- **`data_suffix`** – suffix pattern for the data images. Default '.tif'
- **`mask_suffix`** – suffix pattern for the label images. Default '_mask.tif'
- **`shuffle_data`** – if the order of the loaded file path should be randomized. Default 'True'
- **`channels`** – (optional) number of channels, default=1
- **`n_class`** – (optional) number of classes, default=2

`class` `tf_unet.image_util.`**`SimpleDataProvider`**(*data*, *label*, *a_min=None*, *a_max=None*, *channels=1*, *n_class=2*)

Bases: `tf_unet.image_util.BaseDataProvider`

A simple data provider for numpy arrays. Assumes that the data and label are numpy array with the dimensions data *[n, X, Y, channels]*, label *[n, X, Y, classes]*. Where *n* is the number of images, *X*, *Y* the size of the image.

Parameters

- **`data`** – data numpy array. Shape=[n, X, Y, channels]
- **`label`** – label numpy array. Shape=[n, X, Y, classes]
- **`a_min`** – (optional) min value used for clipping
- **`a_max`** – (optional) max value used for clipping
- **`channels`** – (optional) number of channels, default=1
- **`n_class`** – (optional) number of classes, default=2

1.3.3 `util` Module

Created on Aug 10, 2016

author: jakeret

`tf_unet.util.`**`combine_img_prediction`**(*data*, *gt*, *pred*)

Combines the data, grouth thruth and the prediction into one rgb image

Parameters

- **`data`** – the data tensor
- **`gt`** – the ground thruth tensor
- **`pred`** – the prediction tensor

Returns img the concatenated rgb image

`tf_unet.util.`**`crop_to_shape`**(*data*, *shape*)

Crops the array to the given image shape by removing the border (expects a tensor of shape [batches, nx, ny, channels].

Parameters

- **`data`** – the array to crop

- **shape** – the target shape

`tf_unet.util.`**`plot_prediction`**(*x_test*, *y_test*, *prediction*, *save=False*)

`tf_unet.util.`**`save_image`**(*img*, *path*)
Writes the image to disk

Parameters

- **img** – the rgb image to save
- **path** – the target path

`tf_unet.util.`**`to_rgb`**(*img*)
Converts the given array into a RGB image. If the number of channels is not 3 the array is tiled such that it has 3 channels. Finally, the values are rescaled to [0,255)

Parameters **img** – the array to convert [nx, ny, channels]

Returns img the rgb image [nx, ny, 3]

1.3.4 `layers` Module

Created on Aug 19, 2016

author: jakeret

`tf_unet.layers.`**`bias_variable`**(*shape*)

`tf_unet.layers.`**`conv2d`**(*x*, *W*, *keep_prob_*)

`tf_unet.layers.`**`crop_and_concat`**(*x1*, *x2*)

`tf_unet.layers.`**`cross_entropy`**(*y_*, *output_map*)

`tf_unet.layers.`**`deconv2d`**(*x*, *W*, *stride*)

`tf_unet.layers.`**`max_pool`**(*x*, *n*)

`tf_unet.layers.`**`pixel_wise_softmax`**(*output_map*)

`tf_unet.layers.`**`pixel_wise_softmax_2`**(*output_map*)

`tf_unet.layers.`**`weight_variable`**(*shape*, *stddev=0.1*)

`tf_unet.layers.`**`weight_variable_devonc`**(*shape*, *stddev=0.1*)

1.4 Contributing

Contributions are welcome, and they are greatly appreciated! Every little bit helps, and credit will always be given.

You can contribute in many ways:

1.4.1 Types of Contributions

Report Bugs

If you are reporting a bug, please include:

- Your operating system name and version.

- Any details about your local setup that might be helpful in troubleshooting.
- Detailed steps to reproduce the bug.

Fix Bugs

Implement Features

Write Documentation

Tensorflow Unet could always use more documentation, whether as part of the official Tensorflow Unet docs, in docstrings, or even on the web in blog posts, articles, and such.

Submit Feedback

If you are proposing a feature:

- Explain in detail how it would work.
- Keep the scope as narrow as possible, to make it easier to implement.
- Remember that this is a volunteer-driven project, and that contributions are welcome :)

1.4.2 Pull Request Guidelines

Before you submit a pull request, check that it meets these guidelines:

1. The pull request should include tests.
2. If the pull request adds functionality, the docs should be updated. Put your new functionality into a function with a docstring, and add the feature to the list in README.rst.
3. The pull request should work for Python 2.6, 2.7, and 3.3, and for PyPy. make sure that the tests pass for all supported Python versions.

1.4.3 Tips

To run a subset of tests:

```
$ py.test test/test_tf_unet.py
```

1.5 Credits

1.5.1 Development Lead

- @jakeret

1.5.2 Contributors

- @FelixGruen
- @ameya005
- @agrafix
- @AlessioM
- @FiLeonard
- @nikkou

1.5.3 Citations

As you use **tf_unet** for your exciting discoveries, please cite the paper that describes the package:

J. Akeret, C. Chang, A. Lucchi, A. Refregier, Published in Astronomy and Computing (2017)

1.6 History

1.6.1 0.1.1 (2017-12-29)

- Support for Tensorflow > 1.0.0
- Clean package structure
- Integration into mybinder

1.6.2 0.1.0 (2016-08-18)

- First release to GitHub.

CHAPTER 2

Feedback

If you have any suggestions or questions about **Tensorflow Unet** feel free to contact me on GitHub.

If you encounter any errors or problems with **Tensorflow Unet**, please let me know!

Python Module Index

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