Brief Introduction to Deep Learning and TensorFlow

Deep Learning in Earth Science
Lecture 1
By Xiao Zhuowei

For researchers interested in studying Earth science with deep learning.

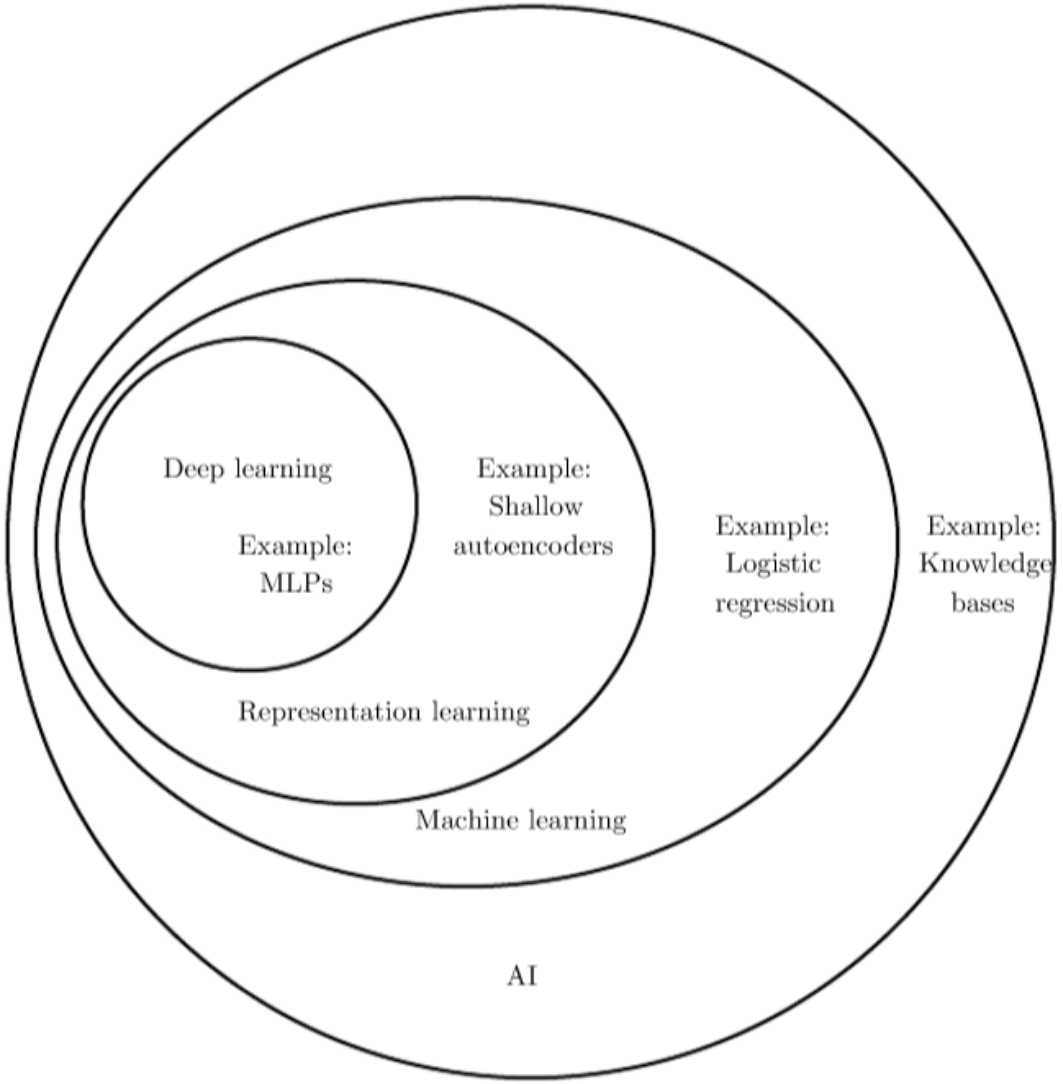
All resources in lectures are available at https://github.com/MrXiaoXiao/DLiES

OUTLINES

1. Brief Introduction to Deep Learning
2. TensorFlow Basics
3. Classifying Stability of Mantle with Neural Networks: An Example
4. Discussions

Brief Introduction to Deep Learning

Deep Learning is about automatically obtaining ***representation of input*** and ***mapping (from representation) to output*** with deep neural network architectures.



(Deep Learning, MIT Press, 2016)

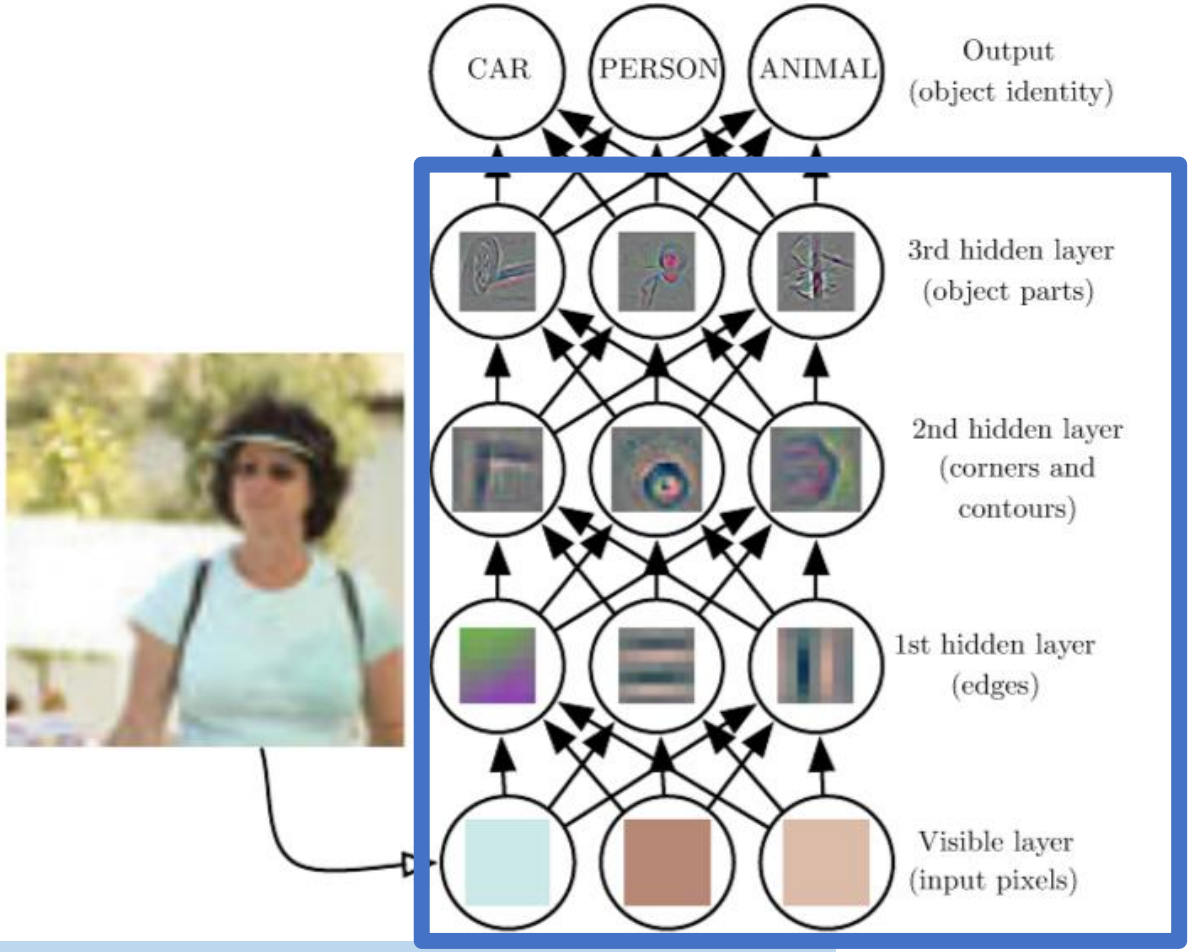
Brief Introduction to Deep Learning

Obtain the ***representation*** of input.

What We See

What Computers See

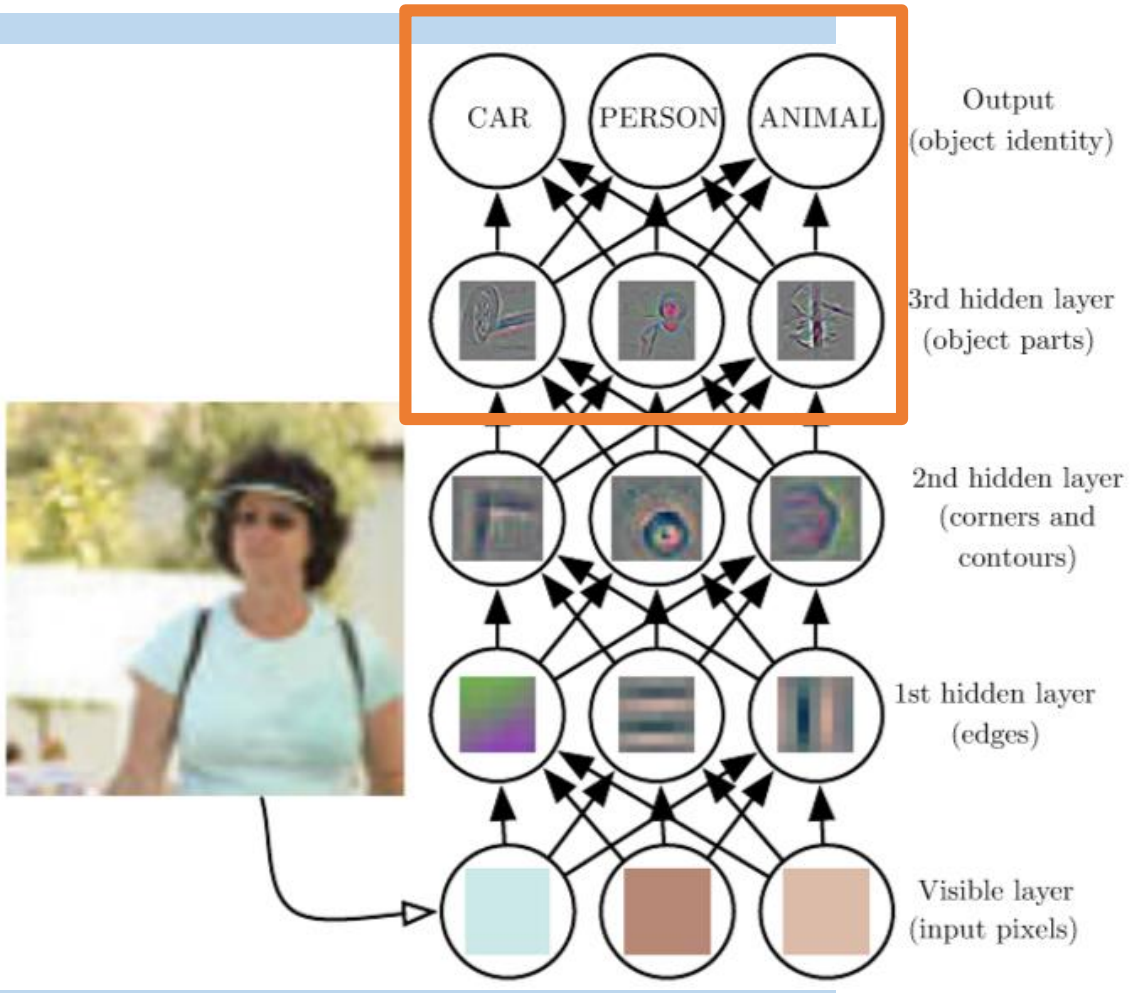
(https://adeshpande3.github.io)



(Deep Learning, MIT Press, 2016)

Brief Introduction to Deep Learning

Obtain ***mapping*** from representation to output.

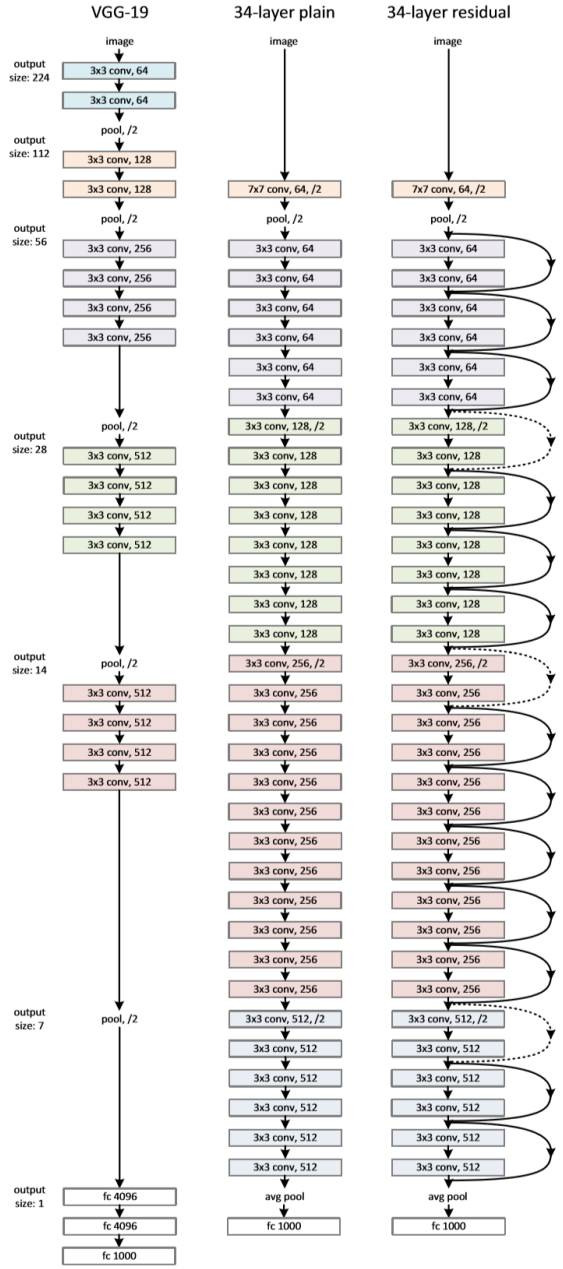


(Deep Learning, MIT Press, 2016)

Brief Introduction to Deep Learning

Complicated representations are built out of simpler ones.

The graph of deep learning architecture is deep, with many layers.



Example network architectures (He et al., 2015)

Brief Introduction to Deep Learning

Considering deep learning as algorithm for non-linear function approximation

$$Ideal\ Output = Ideal\ Function(Input + Noise)$$

$$Approximation\ of\ Ideal\ Output = DL\ Model(Input + Noise)$$

Brief Introduction to Deep Learning

What can deep learning do in Earth science?

Classification

Denoising

Forward Modeling

Inversion

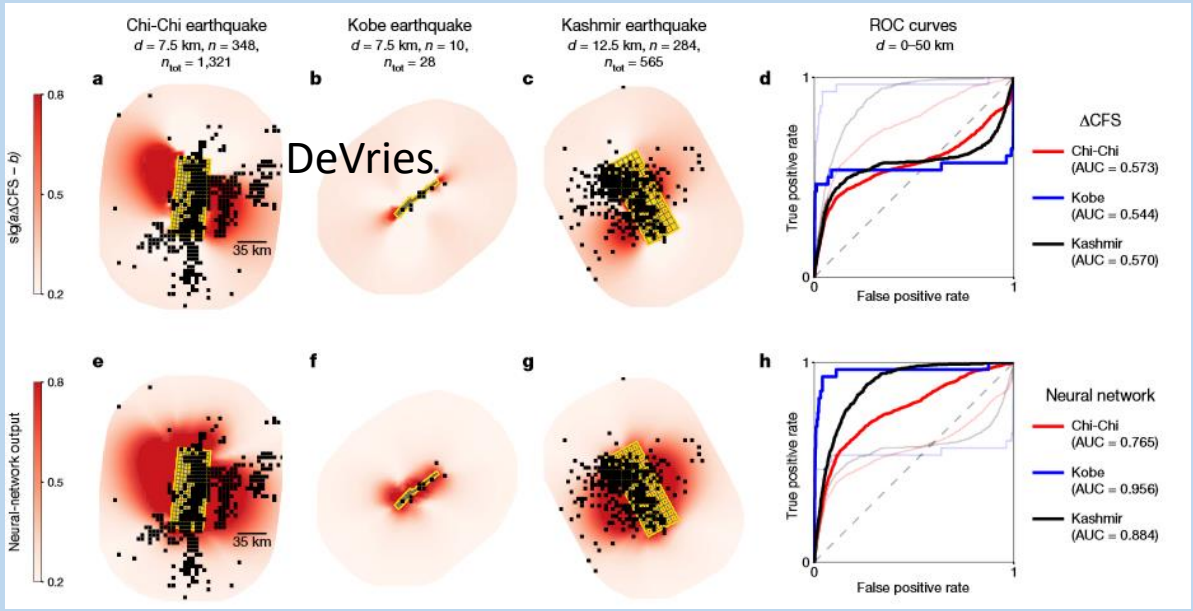
…

Brief Introduction to Deep Learning

What can deep learning do in Earth science?

Classification

Predicting aftershocks following large earthquakes



DeVries

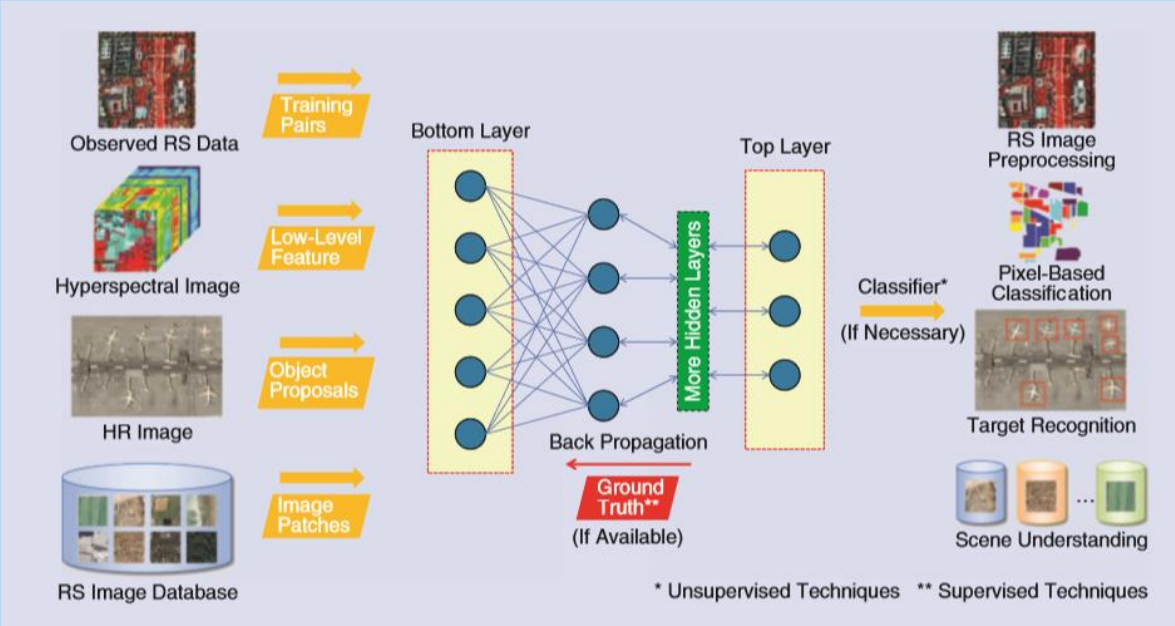
(DeVries et al., 2018)

Brief Introduction to Deep Learning

What can deep learning do in Earth science?

Classification

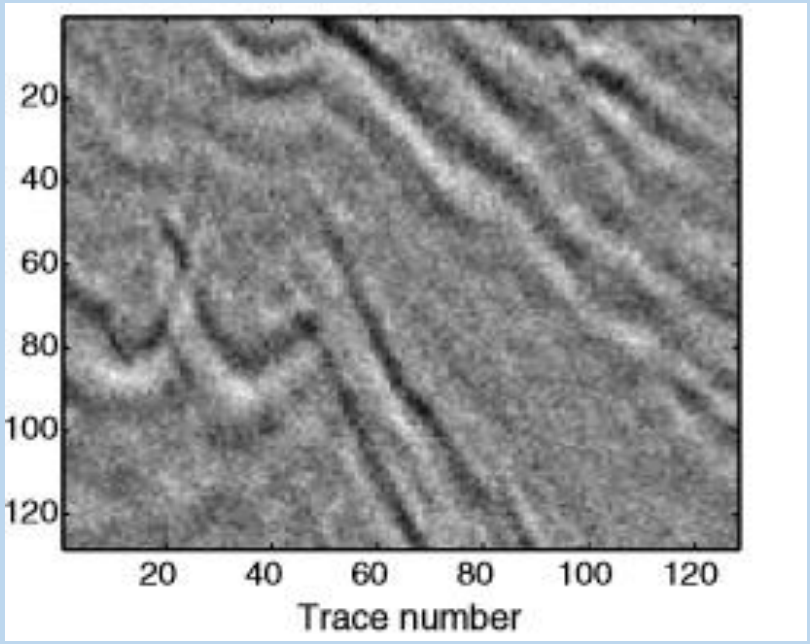
Processing remote sensing data



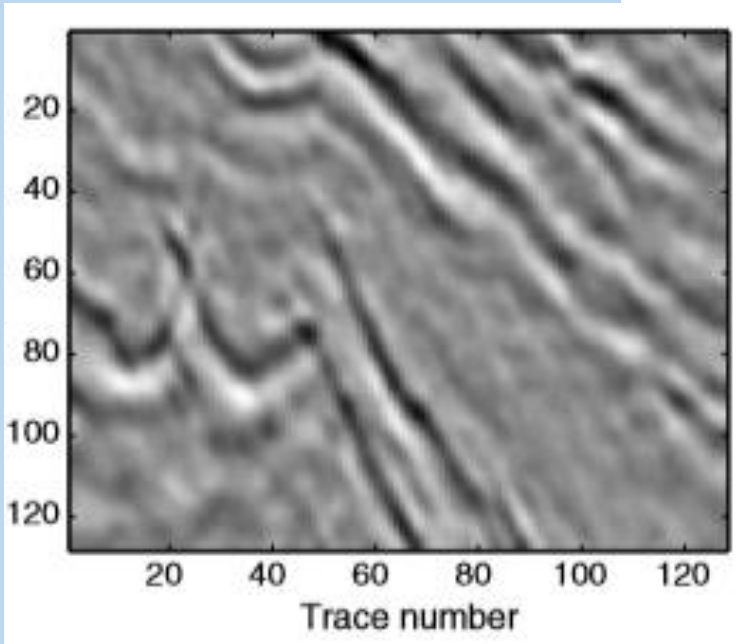
(Zhang et al., 2016)

What can deep learning do in Earth science?

Denoising



Noisy input



DL output

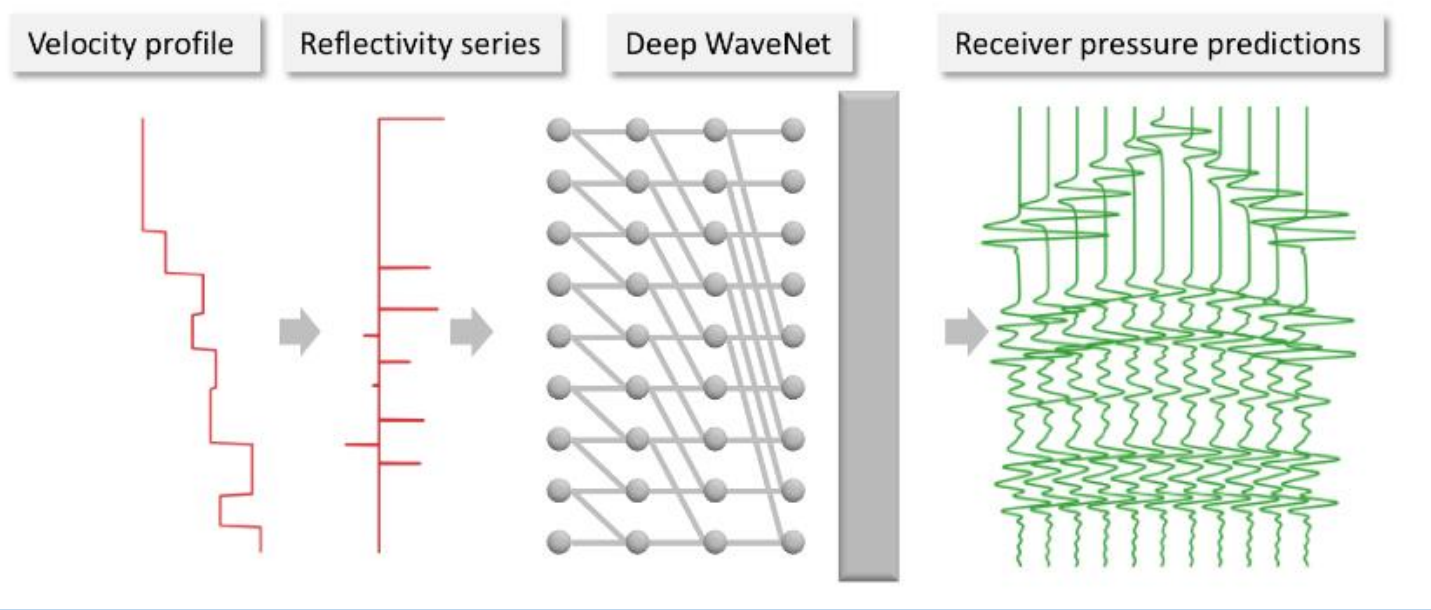
(Beckouche and Ma, 2014)

Brief Introduction to Deep Learning

What can deep learning do in Earth science?

Forward Modeling

Fast approximate simulation of seismic waves with deep learning

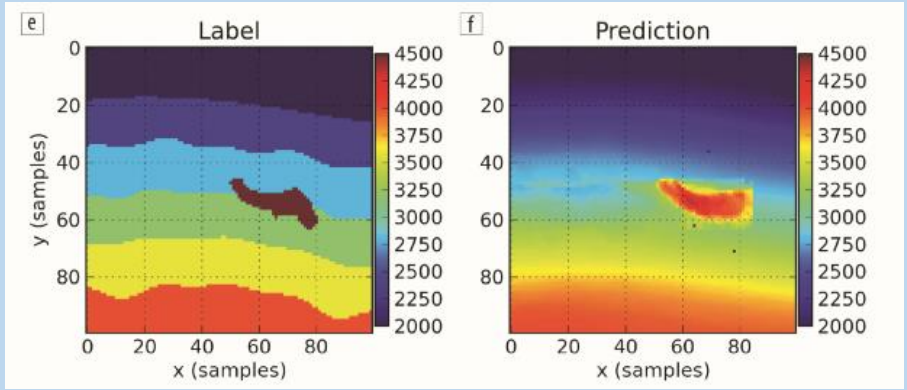


(Moseley et al., 2018)

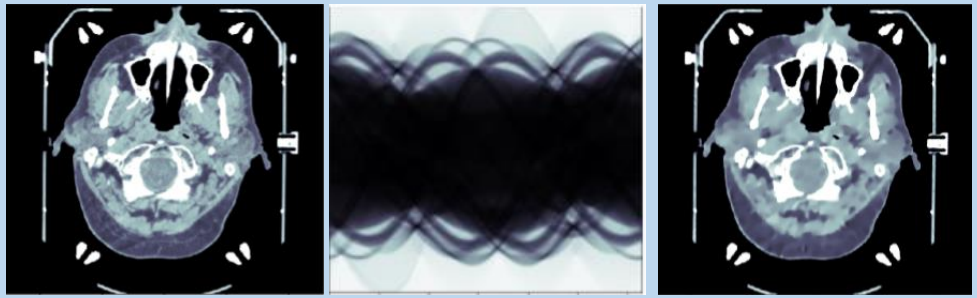
Brief Introduction to Deep Learning

What can deep learning do in Earth science?

Inversion



(Araya-Polo et al., 2018)



Model Observation Inversion by DL

(Adler and Öktem, 2017)

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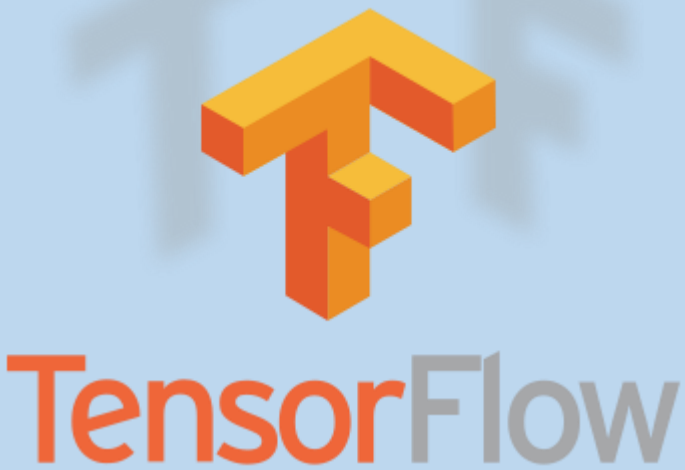
TensorFlow Basics

TensorFlow™ is an open source software library for high performance numerical computation.

https://www.tensorflow.org/

or

https://tensorflow.google.cn/



Install TensorFlow via Anaconda

Anaconda Distribution is a free, easy-to-install package manager, environment manager and Python distribution with a collection of 1,000+ open source packages with free community support.

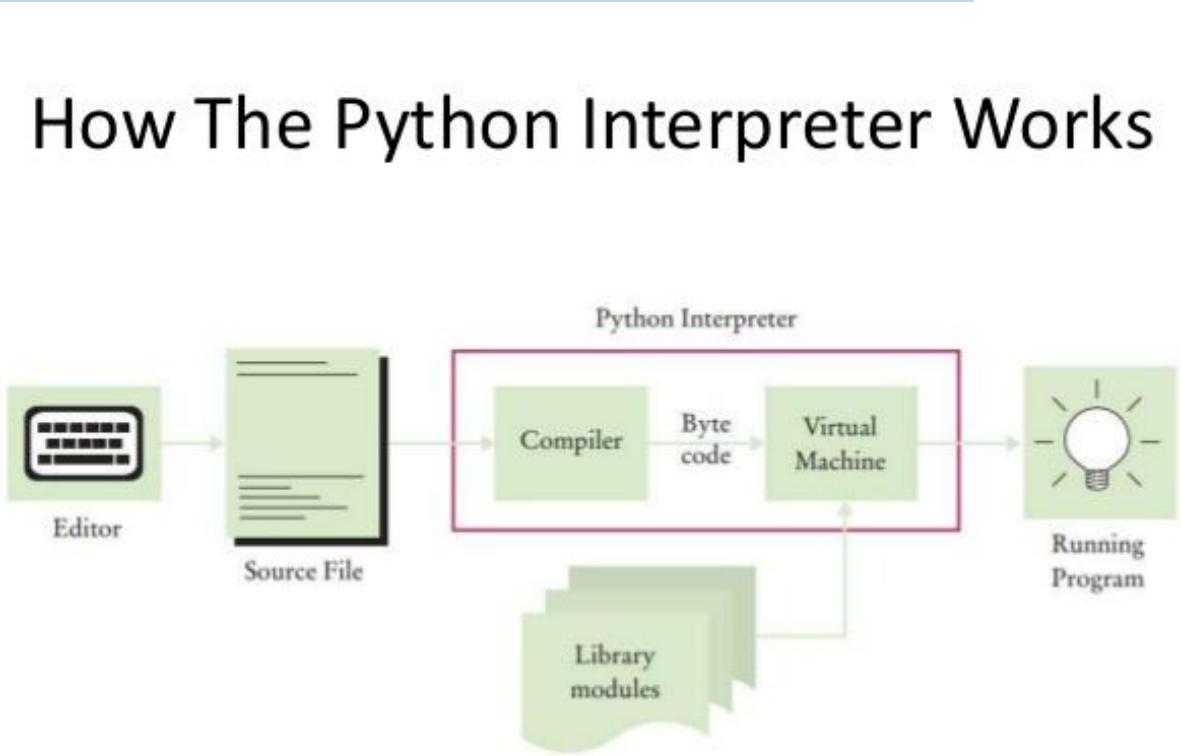
Anaconda Download (https://www.anaconda.com/download/)

Tensorflow-in-Anaconda
(https://www.anaconda.com/blog/developer-blog/tensorflow-in-anaconda/)

TensorFlow Basics

Python is an interpreted high-level programming language for general-purpose programming.

(https://www.python.org/)



(http://opensourceforgeeks.blogspot.com/2015/10/how-python-works.html)

TensorFlow Basics

The 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.

https://jupyter.org/

Image Manipulation with skimage

This example builds a simple UI for performing basic image manipulation with scikit-image.

In [21]:
```
from ipywidgets import interact, interactive, fixed
from IPython.display import display
```

In [22]:
```
import skimage
from skimage import data, filter, io
```

In [23]:
```
i = data.coffee()
```

In [24]:
```
io.Image(i)
```

Out[24]:

In [25]:
```
def edit_image(image, sigma=0.1, r=1.0, g=1.0, b=1.0):
    new_image = filter.gaussian_filter(image, sigma=sigma, multichannel=True)
    new_image[:,:,0] = r*new_image[:,:,0]
    new_image[:,:,1] = g*new_image[:,:,1]
    new_image[:,:,2] = b*new_image[:,:,2]
    new_image = io.Image(new_image)
    display(new_image)
    return new_image
```

In [26]:
```
lims = (0.0,1.0,0.01)
w = interactive(edit_image, image=fixed(i), sigma=(0.0,10.0,0.1), r=lims, g=lims, b=lims)
display(w)
```

TensorFlow Basics

TensorFlow Hello World

TensorFlow Basics

TensorFlow Multiply Matrices

TensorFlow Basics

TensorFlow Approximate curve
with gradient decent

TensorFlow Basics

https://github.com/vahidk/EffectiveTensorflow

TensorFlow Basics

TensorFlow Basics

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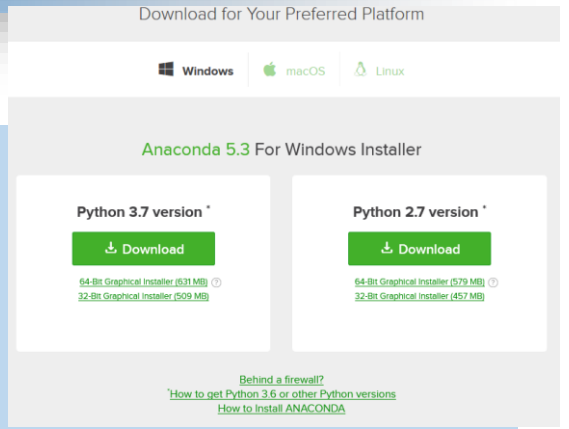
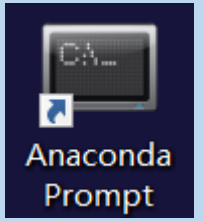
Discussions

TensorFlow Installation via Anaconda

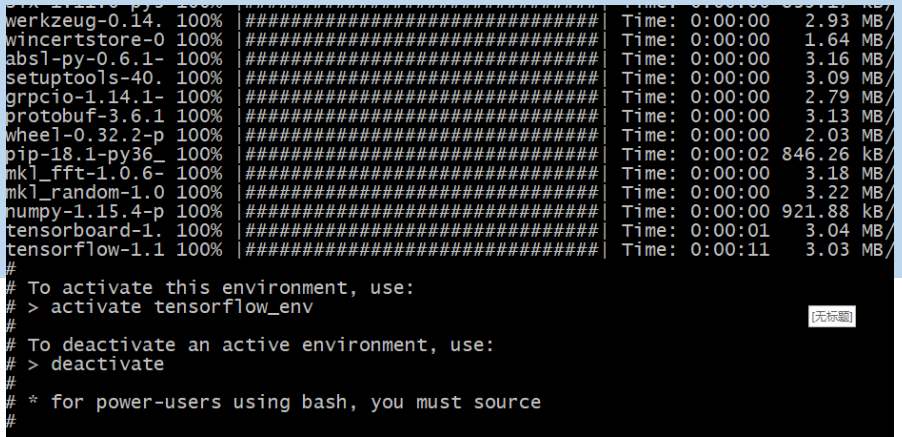


Step 1. Install Anaconda from (https://www.anaconda.com/download/)

Step 2. Create a new conda environment containing TensorFlow. Open Anaconda Prompt and run
‘conda create -n tensorflow_env tensorflow python=3.6’
or
‘conda create -n tensorflow_gpuenv tensorflow-gpu python=3.6’
for GPU version



Congratulations…



References