Survey

Introductory Intermediat Advanced

Playground

Hardware

Software

Shallow Net

The Unreasonable Effectiveness of Deep Learning

Deep Learning — Unit 1

Dr. Jon Krohn
jon@untapt.com

October 14th, 2017



1 Name



Playground

Hardware

- Name
- 2 Relevant background, e.g., programming, stats, machine learning
- Interest in Deep Learning
- What you'd like to take away from this course



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Shallow No

- 1 An Introduction to Neural Networks and Deep Learning
- 2 Course Survey
 Introductory Units (1-3)
 Intermediate Units (4-6)
 Advanced Units (7-10)
- 3 Interactive Visualization of an Artificial Neural Network
- 4 Hardware Options for DL
- 5 TensorFlow Jupyter Notebooks within a Docker Container
 - 6 A Shallow Artificial Neural Network



TF Playground

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Shallow N

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Course Survey

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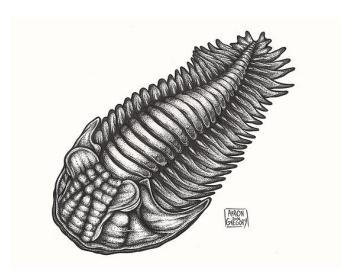
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Hardware

Software

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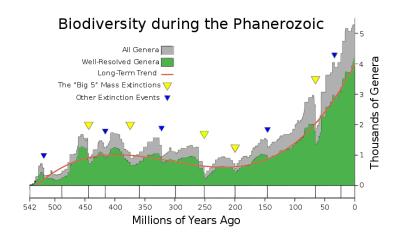


Course Survey

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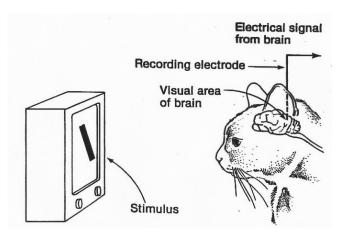
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Hardware





Hubel & Wiesel (1959)





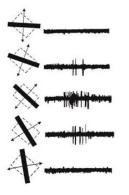
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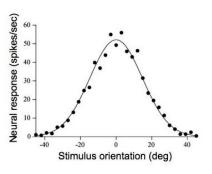
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Hubel & Wiesel, 1968



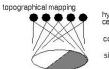
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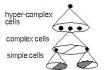
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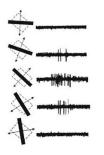
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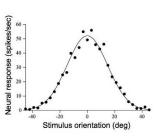
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Hubel & Wiesel, 1968



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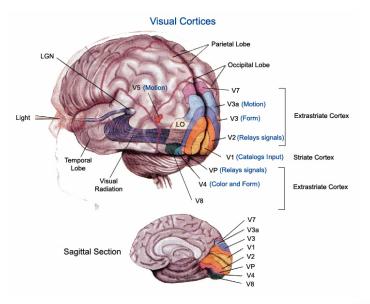
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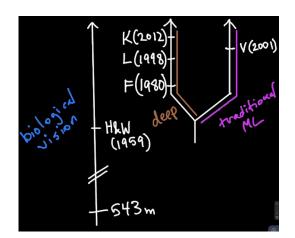
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Software

Shallow Net



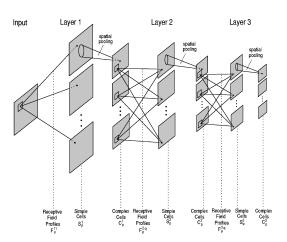




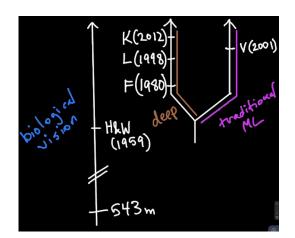




Neurocognitron Fukushima (1980)











Unit 1

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Course Survey

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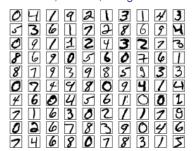
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MNIST Digits & LeNet-5

LeCun, Boutou, Bengio & Haffner (1998)





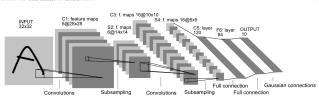
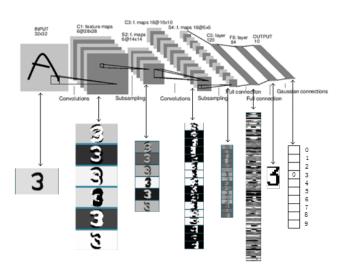


Fig. 2. Architecture of LeNet-5, a Convolutional Neural Network, here for digits recognition. Each plane is a feature map, i.e. a set of units whose weights are constrained to be identical.



LeNet-5

LeCun, Boutou, Bengio & Haffner (1998)





Course Survey

Introductory
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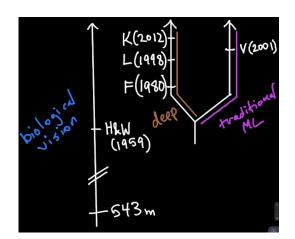
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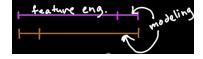
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Viola & Jones (2001)

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Playground

Hardware

Sollware

Shallow Net



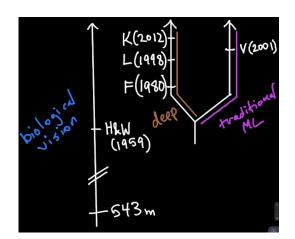


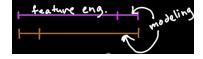














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TF Playgroup

Hardware

Software

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ImageNet

Fei-Fei Li et al. (2009), 14m images, 22k categories



gill fungus ffordshire bullterrier

currant

dead-man's-fingers

beach wagon

fire engine



indri

howler monkey

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Introductory
Intermediate

Playground

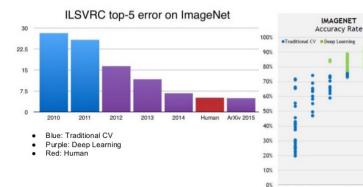
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ImageNet Classification Error

ILSVRC: 1.4m, 1k object classes

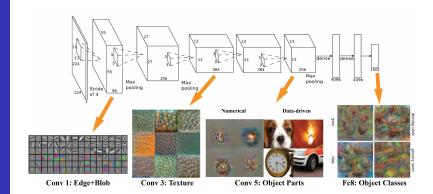




2010 2011 2012 2013 2014 2015

AlexNet

Krizhevsky, Sutskever & Hinton (2012)





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I just sent them to you.

No plans yet.



I'm working on them.









Course Survey

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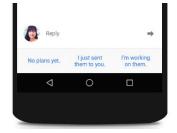
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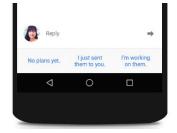
Playground

Sollware

Shallow Net













Playgroun

Hardware

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Intermediat

TF

Hardware

Software

← → C ① nycdatascience.com/courses/deep-learning/

Syllabus

Unit 1: The Unreasonable Effectiveness of Deep Learning

- An Introduction to Neural Networks and Deep Learning
- Course Survey
- · Interactive Visualization of an Artificial Neural Network
- Hardware Options for Deep Learning, including How to Build a Deep Learning Server
- Running a TensorFlow Jupyter Notebook within a Docker Container
- A Shallow Artificial Neural Network

Unit 2: How Deep Learning Works

- . Essential Theory I: Neural Units
- · Interactive Visualization of Neural Units
- Essential Theory II: Cost Functions, Gradient Descent, and Backpropagation
- · Interactive Visualization of a Deep Neural Network
- · An Intermediate Neural Network
- · Data Sets for Deep Learning
- Your Deep Learning Project: Ideating

Unit 3: Ruilding and Training a Deen Learning Network



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Shallow N

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 Introductory Units (1-3)
 Intermediate Units (4-6)
 Advanced Units (7-10)
- 3 Interactive Visualization of an Artificial Neural Network
- 4 Hardware Options for DL
- TensorFlow Jupyter Notebooks within a Docker Container
 - 6 A Shallow Artificial Neural Network



Introduction

Introduction

Introductory

Intermedia Advanced

Playgroun

Hardware

Software

Shallow Net

The Unreasonable Effectiveness of Deep Learning

Unit 1: right now!



Hardware Options for DL

Introduction

Introduction

Introductory

TF

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Introduction

introduction

Introductory

Intermedia

TF

Hardware

Software

Shallow Net

Jupyter Notebooks

+ Docker + Nvidia GPU + TensorFlow



A Shallow Neural Network

Introduction

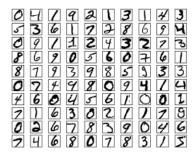
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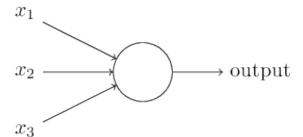
How Deep Learning Works

Unit 2: This Afternoon



Introductory

Essential Theory I Neural Units

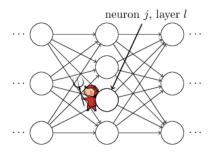


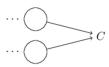


Introductory

Essential Theory II

Cost Functions, Gradient Descent, and Backpropagation







An Intermediate Neural Network

Introduction

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[intermediate notebook]



Data Sets for Deep Learning

Introduction

Course Survey Introductory Intermediate Advanced

TF Playground

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Dataset	Classes	Train Samples
AG's News	4	120,000
Sogou News	5	450,000
DBPedia	14	560,000
Yelp Review Polarity	2	560,000
Yelp Review Full	5	650,000
Yahoo! Answers	10	1,400,000
Amazon Review Full	5	3,000,000
Amazon Review Polarity	2	3,600,000



Data Sets for Deep Learning

Introduction

Course Survey Introductory Intermediate Advanced

TF Playground

Hardware

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Amazon Review Polarity	2	3,600,000



Data Sets for Deep Learning

Introduction

Course Survey Introductory Intermediate Advanced

TF Playground

Hardware

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Course Survey Introductory Intermediate Advanced

Playground

Hardware

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Jon Krohn, Cajoler of Datums

Home Resources

Posts Publications

Talks

Academia
Applications
Quotations
Contact

Open Data Sources

To train a powerful model, the larger the data set, the better -- if it's well-organised and open, that's ideal. The following repositories are standouts that meet all these criteria:

- Data.gov (home of >150k US government-related datasets),
- Govcode, a collection of government open source projects,
- the Open Data Stack Exchange, and
- · this curated list of 'awesome' public datasets
- this well-annotated list of data sets for natural language processing
- · for biomedical and health data specifically, check out:
 - this University of Minnesota resource
 - this Medical Data for Machine Learning GitHub repo

For machine learning models that require a lot of labelled data, check out:

- UC Irvine's repository
- · Yahoo's massive 13TB data set comprised of 100 billion user interactions with news items
- Google's image and video data sets
- · Luke de Oliveira's Greatest Public Datasets for Al blog post
- CrowdFlower's Data for Everyone

Finally, here are extensive pages on importing data from the Web into R, provided by CRAN and MRAN.



Introduction

Survey Introductory Intermediate

TF

Softwar

Shallow Net

Your Deep Learning Project I





Introduction

introduction

Introductory

Intermedia

Plavgroun

Hardware

Software

Shallow Net

Building & Training a Deep Network

Unit 3: October 28th AM



Introduction

introduction

Introductory

Intermedi

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Hardware

Software

Shallow Net

Essential Theory III

Weight Initialization and Mini-Batches

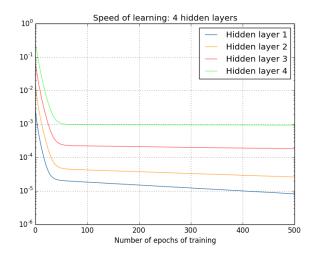
[neurons notebook]



Introductory

Essential Theory IV

Unstable Gradients and Avoiding Overfitting

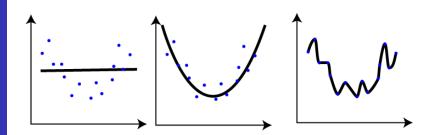




Introductory

Essential Theory IV

Unstable Gradients and Avoiding Overfitting





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Introduction

Introductory

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TF

Hardware

Software

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A Deep Neural Network

[deep notebook]



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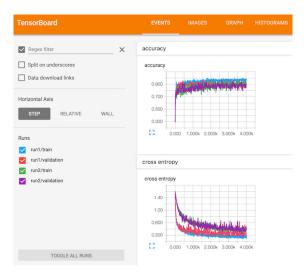
Hardware

Software

Shallow Net

TensorBoard

and the Interpretation of Model Outputs





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Hardware

Softwar

Shallow N

Outline

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 - 6 A Shallow Artificial Neural Network



Introduction

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Introducto

Intermediate

TF

Hardware

Software

Shallow Net

Machine Vision

Unit 4: October 28th PM



Introduction

Introduction

Introducto

Intermediate

TF

Hardware

Software

Shallow Net

Intro to ConvNets

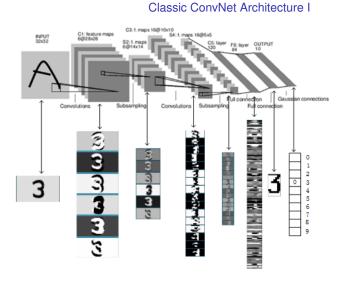
for Visual Recognition

[deepvis]



Intermediate

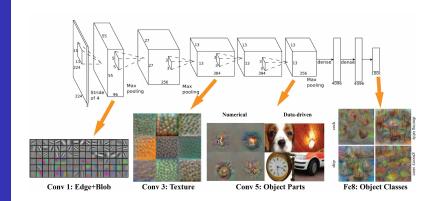
LeNet-5





Intermediate

AlexNet Classic ConvNet Architecture II



[notebook]



Transfer Learning

Introduction

Survey Introductory Intermediate

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Hardwar

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Your Deep Learning Project II Formulating





Introduction

Introduction

Introducto

Intermediate

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Software

Shallow Net

TensorFlow

Unit 5: November 18th AM



Course

Introductory Intermediate Advanced

Playground

Hardware

Continuit

Leading DL Libraries A Comparison

	Caffe	Torch	Theano	TensorFlow
language	Python, C++	Lua, PyTorch	Python	Python, Java, C, Go
pre-trained models	Model Zoo	ModelZoo	Lasagne	Inception, others
parallel GPUs: data	Yes	Yes	Yes	Yes
parallel GPUs: model		Yes		Yes
source code	Readable	Readable		
for RNNs			Good	Best
high-level APIs			Keras	Keras, TFLearn



TensorFlow Graphs

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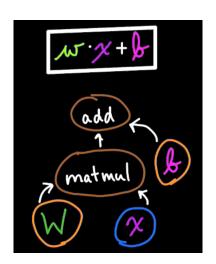
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Software

Shallow Net





Neurons in TensorFlow

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Introductory

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Software

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[LeNet-5 in TF]



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Introduction

Introducto

Intermedia

TF

Hardware

Software

Shallow Net

Deep Learning with TensorFlow

Unit 6: November 18th PM



Deep ConvNets in TensorFlow

Introduction

Course

Introductory

TF

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[LeNet-5 in TF]



Introduction

Introductor Intermedia Advanced

Playgroun

Hardware

Softwar

Shallow Ne

- Xavier Glorot initialization
- problem simplification
- 3 layer architecture
- 4 cost function
- 6 avoid overfitting
- **6** variable learning rate η
- epochs
- $oxed{8}$ regularization parameters, e.g., λ
- mini-batch size
- grid-search automation



Introduction

Introductory Intermediat Advanced

Playgroun

Hardware

Softwar

Shallow Ne

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Introduction

Introductory Intermediat Advanced

Playground

Hardware

Softwar

Shallow Ne

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Introduction

Introductor Intermediat Advanced

Playgroun

Hardware

Softwar

Shallow Ne

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Survey Introductory Intermediate

Playgroun

Hardware

Softwar

Shallow Ne

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Survey
Introductory
Intermediate

Playgroun

Hardware

Softwar

Shallow Ne

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Survey

TF Playgroun

Hardware

Softwar

Shallow Ne

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Survey
Introductory
Intermediate
Advanced

Playgroun

Hardware

Softwar

Shallow Ne

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Survey
Introductory
Intermediate

TF Playground

Hardware

Softwar

Shallow Ne

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- **6** variable learning rate η
- 7 epochs
- $oldsymbol{8}$ regularization parameters, e.g., λ
- 9 mini-batch size
- grid-search automation



Survey
Introductory
Intermediate
Advanced

Playgroun

Hardware

Softwar

Shallow Ne

- Xavier Glorot initialization
- 2 problem simplification
- 3 layer architecture
- 4 cost function
- 6 avoid overfitting
- **6** variable learning rate η
- epochs
- 8 regularization parameters, e.g., λ
- 9 mini-batch size
- grid-search automation



Tuning Hyperparameters

...in lenet in keras.ipynb:

```
model = Sequential()
model.add(Conv2D(32, kernel size=(3, 3), activation='relu', input shape=(28, 28, 1)))
model.add(Conv2D(64, kernel size=(3, 3), activation='relu'))
model.add(MaxPooling2D(pool size=(2, 2)))
model.add(Dropout(0.25)
model.add(Flatten())
model.add(Dense(128. activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(n classes, activation='softmax'))
```

...in lenet in tensorflow.ipynb:

```
# convolutional and max-pooling layers:
                                conv 1 = conv2d(square x, weights['W cl'], biases['b cl'])
# max pooling laver:
                                conv 2 = conv2d(conv 1, weights['W c2'], biases['b c2'])
pool size = 2
                                pool 1 = maxpooling2d(conv 2, mp psize)
mp laver dropout = 0.25
                                pool 1 = tf.nn.dropout(pool 1, 1-mp dropout)
# dense laver:
                                # dense laver:
n dense = 128
                                flat = tf.reshape(pool 1, [-1, weights['W dl'].get shape().as list()[0]])
dense laver dropout = 0.5
                                dense 1 = dense(flat, weights['W dl'], biases['b dl'])
                                dense 1 = tf.nn.dropout(dense 1, 1-dense dropout)
```



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Introduction

Introductory

Advanced

Diegonaria

Hardwar

Software

Shallow Ne

Your Deep Learning Project III Assessing





Playgroun

Hardware

Softwar

Shallow N

Outline

- 1 An Introduction to Neural Networks and Deep Learning
- 2 Course Survey
 Introductory Units (1-3)
 Intermediate Units (4-6)
 Advanced Units (7-10)
- 3 Interactive Visualization of an Artificial Neural Network
- 4 Hardware Options for DL
- 5 TensorFlow Jupyter Notebooks within a Docker Container
 - 6 A Shallow Artificial Neural Network



Natural Language Processing

Units 7 & 8: December 2nd



Advanced

A history of language technologies

Scientists from IBM and Georgetown demonstrate a limited machinetranslation system

 John Pierce's highly critical report on language technologies published. Funding languishes for decades

70

"2001: A Space Odyssey" released

Microsoft

Microsoft speech-recognition system reaches human parity

Google

Google releases neural-net machine translation for eight language pairs

> Siri debuts on iPhone "Hev Siri"

No US government research funding for machine translation or speech recognition

Pawn of "common

Researchers share

common methods

task" method.

data, agree on

of evaluation

Statistics-based version of Google Translate launched

2000

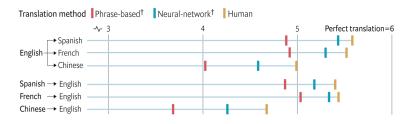


Introductory
Intermediate
Advanced

Playground

Hardware

Software





Sunspring

Introduction

Course

Introductor

Intermediate Advanced

TF

Literature and

~ ..

Shallow Net





Introduction

Course Survey

Introductory

Advanced

Playgroun

Hardware

Software

Shallow Ne

Sunspring

He is standing in the stars and sitting on the floor. He hades a seat on the counters and guilz fine course, over 50 Mes back. He stars at it, we is on the phone, He cuts the shortum from the edge of the room and potat it in his mouth, He sees a black hole in the floor leading to the man on the roof. I know that it's a consequence. Whatever you want to know about the presence of the story, I'm a little bit of a boy on the floor. We see H pull a book from a shelf, flip through it while speaking, and then put it back. I don't know. I don't know what you're talking about. In a future with mass unemployment, young people are forced to sell blood. That's the first thins I can H I don't know. I just have to ask you to explain to me what you say. H12 What do you mean? He looks through the door and the door closes. He looks at the beg from his backpack, and starts to cry. No should see the boys and shat up. I was the one who was going to be a hundred years old. So what are you doing? Well, there's the situation with me and the light on the ship. The yoy mea trying to stop me. He was like a body and he was so so so the second was like a body and he was so was the would have does it all. He could not come any more. I didn't mean to be to the was to be to the way of the was cased to the was cased to the was cased to the was cased to take it out, it was a long time ago, He was a little H Decause I don't know what you're talking about. I don't want to be beneat with you. I saw him again. The way you were sent to me... that was a big honest idea. I am not a bright light. He looks at him for a moment, then omiles at him. That was all the time You don't have to be a doctor. I know that. Well, I have to go to the skull. I don't know. E2 I am not sure. I don't know what you're talking about. He picks up a light screen and fights the security force of the particles of a transmission on his face. I want to see you too. (angry)
It would be a good time. I think I could have been my life. What do you mean? He starts to shake. (smiles)
I don't know anything about any of this. H (CONT'D)
It may never be forgiven, but that
is just too bed. I have to leave,
but I'm not free of the world. H (to Mark, taking his eyes from his mouth) Then what? Yes. Perhaps I should take it from here. I'm not going to do something. If the principle is completely constructed for the same time. There's no answer. You can't afford to take this anywhere. It's not a dream. But I've got a good time to stay there. (smiling)
It was all about you to be true. (frowning)
We're going to see the money. Well, I think you can still be back on the table. Steps back. Coffey is still going through.



Introduction

Introducto

Intermedia Advanced

TF

Hardwaro

Software

Shallow Net

Word Vectors

word2vec & Vector-Space Embedding

[vse 2000]

[word2viz]



Introduction

Introduction

Introducto

Introducto

Intermedia

Playgroun

Hardware

Software

Shallow Not

Recurrent Neural Networks GRUs and LSTMs

[BiLSTM notebook]



Introduction

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Introducto

Intermedia

TF

Software

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Advanced Architectures

[multi-ConvNet notebook]



Course Survey Introductor Intermedia Advanced

TF Playgroup

Hardwar

Software

Shallow Not

Your Deep Learning Project IV





Introduction

introduction

Introductor

Intermedia

Advanced

Playgrour

Hardware

Software

Shallow Net

Generative Adversarial Networks

Unit 9: December 16th AM



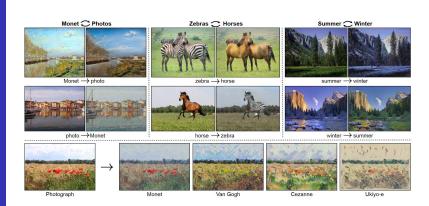
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Hardware

Software

Shallow N





Advanced







with glasses



man without glasses

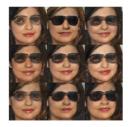












woman with glasses















Results of doing the same arithmetic in pixel space



Introductio

Course

Introductor

Intermedia Advanced

TF

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Hardware

Software

Shallow Net

[Quick, Draw!]



Introduction

Course

Introductory

Advanced

Playgroun

Hardware

Software

Shallow Net



Introduction

Introduction

Introducto

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Intermedia

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Deep Reinforcement Learning

Unit 10: December 16th PM



Introductio

Introductor

Advanced TF

Playground

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Software

Shallow Net

AlphaGO Silver et al. (2016)



Survey Introductor

Advanced
TF

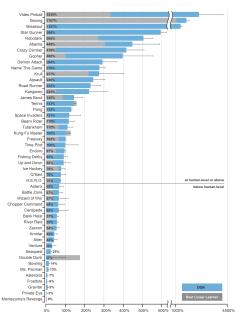
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Mnih et al. (2015)



[Atari Games]



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Advanced
TF

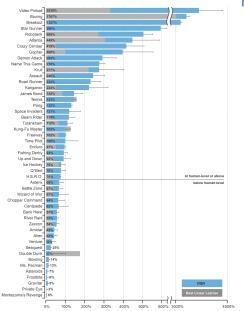
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Mnih et al. (2015)



[Atari Games]



Video Pinball 25395

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Advanced
TF
Playgroup

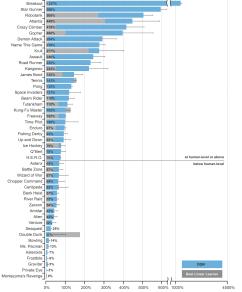
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Software

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Mnih et al. (2015)



[Atari Games]



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Introductor

Intermedia Advanced

Playgrour

Hardware

Software

Shallow Net

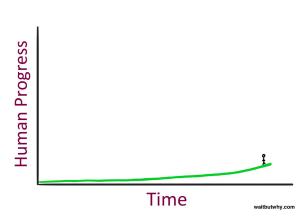
[OpenAl Universe]

[Google DeepMind Lab]



Advanced

The Al Revolution





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Introduction

Introducto

Intermedia Advanced

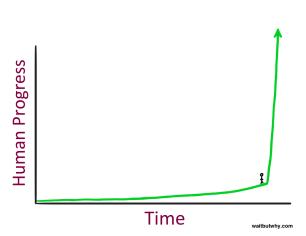
TF

Hardwaro

Software

Shallow Not

The Al Revolution





Your Deep Learning Project V Presentations in January



Playground

Hardware

Softwar

Shallow N

- 1 An Introduction to Neural Networks and Deep Learning
- 2 Course Survey
 Introductory Units (1-3)
 Intermediate Units (4-6)
 Advanced Units (7-10)
- 3 Interactive Visualization of an Artificial Neural Network
- 4 Hardware Options for DL
- 5 TensorFlow Jupyter Notebooks within a Docker Container
 - 6 A Shallow Artificial Neural Network



Introduction

Introduction

Introducto

TF Playground

Hardware

Software

Shallow Net

TensorFlow Playground

Interactive ANN Visualization

[TensorFlow Playground]



Hardware

Softwar

Shallow N

Outline

- 1 An Introduction to Neural Networks and Deep Learning
- 2 Course Survey
 Introductory Units (1-3)
 Intermediate Units (4-6)
 Advanced Units (7-10)
- 3 Interactive Visualization of an Artificial Neural Network
- 4 Hardware Options for DL
- 5 TensorFlow Jupyter Notebooks within a Docker Container
- 6 A Shallow Artificial Neural Network



Hardware

Hardware Options for DL

incl. how to build a DL server

- local machine
- (Tesla K80) cloud instance
- (GTX 1080ti) monster box



Hardware

Hardware Options for DL

incl. how to build a DL server

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Hardware

Hardware Options for DL

incl. how to build a DL server

- local machine
- (Tesla K80) cloud instance
- (GTX 1080ti) monster box



Survey Introductory Intermediat

TF

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Hardware

Software

Shallow Net

Local Machine





Introduction

Introducto

TF

Hardware

Software

Shallow Not

Remote Cloud Instance

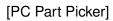
[GCP Ubuntu Instance]



Build Your Own Monster Box

Hardware







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TF

Playgroung

Hardware

Software

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Course

Introductory Intermediate

TF

Playground

Hardware

Software

Shallow No





Introduction

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Hardware

Software

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Course

Intermediat

TF

Playground

Hardware

Software

Shallow Net





Course

Introductory

TF

Hardware

Software

Shallow Net





Playground

Hardware

Software

Shallow No

Outline

- An Introduction to Neural Networks and Deep Learning
- 2 Course Survey
 Introductory Units (1-3)
 Intermediate Units (4-6)
 Advanced Units (7-10)
- 3 Interactive Visualization of an Artificial Neural Network
- 4 Hardware Options for DL
- 5 TensorFlow Jupyter Notebooks within a Docker Container
 - 6 A Shallow Artificial Neural Network



Software

Software Installation

How did everyone get on?

[installation instructions]



Introduction

Introduction

Introducto

TF

Software

Shallow Not

Jupyter Notebooks

+ Docker + Nvidia GPU

[Dockerfile]



Introduction

Introduction

Introducto

TE

Playground

паниман

Software

Shallow Net

Jupyter Notebooks

+ Docker + Nvidia GPU + TensorFlow

[Dockerfile]



Hardware

Softwar

Shallow Net

Outline

- An Introduction to Neural Networks and Deep Learning
- 2 Course Survey
 Introductory Units (1-3)
 Intermediate Units (4-6)
 Advanced Units (7-10)
- 3 Interactive Visualization of an Artificial Neural Network
- 4 Hardware Options for DL
- 5 TensorFlow Jupyter Notebooks within a Docker Container
- 6 A Shallow Artificial Neural Network



A Shallow Neural Network

Introduction

Survey

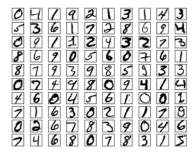
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Playgroun

Hardwar

Software

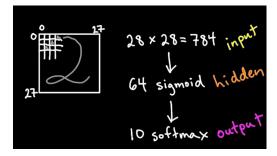
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A Shallow Neural Network

Shallow Net



[shallow notebook]

