

---

# Table of Contents

<b>Preface</b> .....	<b>ix</b>
<b>1. The Neural Network</b> .....	<b>1</b>
Building Intelligent Machines	1
The Limits of Traditional Computer Programs	2
The Mechanics of Machine Learning	3
The Neuron	7
Expressing Linear Perceptrons as Neurons	8
Feed-Forward Neural Networks	9
Linear Neurons and Their Limitations	12
Sigmoid, Tanh, and ReLU Neurons	13
Softmax Output Layers	15
Looking Forward	15
<b>2. Training Feed-Forward Neural Networks</b> .....	<b>17</b>
The Fast-Food Problem	17
Gradient Descent	19
The Delta Rule and Learning Rates	21
Gradient Descent with Sigmoidal Neurons	22
The Backpropagation Algorithm	23
Stochastic and Minibatch Gradient Descent	25
Test Sets, Validation Sets, and Overfitting	27
Preventing Overfitting in Deep Neural Networks	34
Summary	37
<b>3. Implementing Neural Networks in TensorFlow</b> .....	<b>39</b>
What Is TensorFlow?	39
How Does TensorFlow Compare to Alternatives?	40

Installing TensorFlow	41
Creating and Manipulating TensorFlow Variables	43
TensorFlow Operations	45
Placeholder Tensors	45
Sessions in TensorFlow	46
Navigating Variable Scopes and Sharing Variables	48
Managing Models over the CPU and GPU	51
Specifying the Logistic Regression Model in TensorFlow	52
Logging and Training the Logistic Regression Model	55
Leveraging TensorBoard to Visualize Computation Graphs and Learning	58
Building a Multilayer Model for MNIST in TensorFlow	59
Summary	62
<b>4. Beyond Gradient Descent.....</b>	<b>63</b>
The Challenges with Gradient Descent	63
Local Minima in the Error Surfaces of Deep Networks	64
Model Identifiability	65
How Pesky Are Spurious Local Minima in Deep Networks?	66
Flat Regions in the Error Surface	69
When the Gradient Points in the Wrong Direction	71
Momentum-Based Optimization	74
A Brief View of Second-Order Methods	77
Learning Rate Adaptation	78
AdaGrad—Accumulating Historical Gradients	79
RMSProp—Exponentially Weighted Moving Average of Gradients	80
Adam—Combining Momentum and RMSProp	81
The Philosophy Behind Optimizer Selection	83
Summary	83
<b>5. Convolutional Neural Networks.....</b>	<b>85</b>
Neurons in Human Vision	85
The Shortcomings of Feature Selection	86
Vanilla Deep Neural Networks Don't Scale	89
Filters and Feature Maps	90
Full Description of the Convolutional Layer	95
Max Pooling	98
Full Architectural Description of Convolution Networks	99
Closing the Loop on MNIST with Convolutional Networks	101
Image Preprocessing Pipelines Enable More Robust Models	103
Accelerating Training with Batch Normalization	104
Building a Convolutional Network for CIFAR-10	107
Visualizing Learning in Convolutional Networks	109

Leveraging Convolutional Filters to Replicate Artistic Styles	113
Learning Convolutional Filters for Other Problem Domains	114
Summary	115
<b>6. Embedding and Representation Learning.....</b>	<b>117</b>
Learning Lower-Dimensional Representations	117
Principal Component Analysis	118
Motivating the Autoencoder Architecture	120
Implementing an Autoencoder in TensorFlow	121
Denoising to Force Robust Representations	134
Sparsity in Autoencoders	137
When Context Is More Informative than the Input Vector	140
The Word2Vec Framework	143
Implementing the Skip-Gram Architecture	146
Summary	152
<b>7. Models for Sequence Analysis.....</b>	<b>153</b>
Analyzing Variable-Length Inputs	153
Tackling seq2seq with Neural N-Grams	155
Implementing a Part-of-Speech Tagger	156
Dependency Parsing and SyntaxNet	164
Beam Search and Global Normalization	168
A Case for Stateful Deep Learning Models	172
Recurrent Neural Networks	173
The Challenges with Vanishing Gradients	176
Long Short-Term Memory (LSTM) Units	178
TensorFlow Primitives for RNN Models	183
Implementing a Sentiment Analysis Model	185
Solving seq2seq Tasks with Recurrent Neural Networks	189
Augmenting Recurrent Networks with Attention	191
Dissecting a Neural Translation Network	194
Summary	217
<b>8. Memory Augmented Neural Networks.....</b>	<b>219</b>
Neural Turing Machines	219
Attention-Based Memory Access	221
NTM Memory Addressing Mechanisms	223
Differentiable Neural Computers	226
Interference-Free Writing in DNCs	229
DNC Memory Reuse	230
Temporal Linking of DNC Writes	231
Understanding the DNC Read Head	232

The DNC Controller Network	232
Visualizing the DNC in Action	234
Implementing the DNC in TensorFlow	237
Teaching a DNC to Read and Comprehend	242
Summary	244
<b>9. Deep Reinforcement Learning.....</b>	<b>245</b>
Deep Reinforcement Learning Masters Atari Games	245
What Is Reinforcement Learning?	247
Markov Decision Processes (MDP)	248
Policy	249
Future Return	250
Discounted Future Return	251
Explore Versus Exploit	251
Policy Versus Value Learning	253
Policy Learning via Policy Gradients	254
Pole-Cart with Policy Gradients	254
OpenAI Gym	254
Creating an Agent	255
Building the Model and Optimizer	257
Sampling Actions	257
Keeping Track of History	257
Policy Gradient Main Function	258
PGAgent Performance on Pole-Cart	260
Q-Learning and Deep Q-Networks	261
The Bellman Equation	261
Issues with Value Iteration	262
Approximating the Q-Function	262
Deep Q-Network (DQN)	263
Training DQN	263
Learning Stability	263
Target Q-Network	264
Experience Replay	264
From Q-Function to Policy	264
DQN and the Markov Assumption	265
DQN's Solution to the Markov Assumption	265
Playing Breakout wth DQN	265
Building Our Architecture	268
Stacking Frames	268
Setting Up Training Operations	268
Updating Our Target Q-Network	269
Implementing Experience Replay	269

DQN Main Loop	270
DQNAgent Results on Breakout	272
Improving and Moving Beyond DQN	273
Deep Recurrent Q-Networks (DRQN)	273
Asynchronous Advantage Actor-Critic Agent (A3C)	274
UNsupervised REinforcement and Auxiliary Learning (UNREAL)	275
Summary	276
<b>Index.....</b>	<b>277</b>

