


Chapter 1: Getting Started with Keras

 Keras Documentation

Home

Keras: The Python Deep Learning library

You have just found Keras.

Guiding principles

Getting started: 30 seconds to Keras

Installation

Configuring your Keras backend

Support

Why this name, Keras?

Why use Keras

Getting started

Guide to the Sequential model

Guide to the Functional API

FAQ

Models

About Keras models


Sequential

Model (functional API)


Layers

About Keras layers

Docs » Home

 Edit on GitHub

Keras: The Python Deep Learning library

 Keras

You have just found Keras.

Keras is a high-level neural networks API, written in Python and capable of running on top of [TensorFlow](#), [CNTK](#), or [Theano](#). It was developed with a focus on enabling fast experimentation. *Being able to go from idea to result with the least possible delay is key to doing good research.*

Use Keras if you need a deep learning library that:

- Allows for easy and fast prototyping (through user friendliness, modularity, and extensibility).
- Supports both convolutional networks and recurrent networks, as well as combinations of the two.
- Runs seamlessly on CPU and GPU.

Read the documentation at [Keras.io](#).

Keras is compatible with: **Python 2.7-3.6**.

An open source machine learning
framework for everyone

[GET STARTED](#)

Get started with TensorFlow

There are new tutorials to get started with Tensorflow using tf.keras and eager execution. Run the Colab notebooks directly in the browser.

[GET STARTED](#)

TensorFlow 1.10 is here!

TensorFlow 1.10 is available, see the release notes for the latest updates.

[LEARN MORE](#)

Announcing TensorFlow.js

Learn about our JavaScript library for machine learning in the browser.

[LEARN MORE](#)

Welcome

Theano is a Python library that allows you to define, optimize, and evaluate mathematical expressions involving multi-dimensional arrays efficiently. Theano features:

- **tight integration with NumPy** – Use `numpy.ndarray` in Theano-compiled functions.
- **transparent use of a GPU** – Perform data-intensive computations much faster than on a CPU.
- **efficient symbolic differentiation** – Theano does your derivatives for functions with one or many inputs.
- **speed and stability optimizations** – Get the right answer for `log(1+x)` even when `x` is really tiny.
- **dynamic C code generation** – Evaluate expressions faster.
- **extensive unit-testing and self-verification** – Detect and diagnose many types of errors.

Theano has been powering large-scale computationally intensive scientific investigations since 2007. But it is also approachable enough to be used in the classroom (University of Montreal's [deep learning/machine learning](#) classes).

News

- 2017/11/15: Release of Theano 1.0.0. Everybody is encouraged to update.
- 2017/10/30: Release of Theano 1.0.0rc1, new features and many bugfixes, final release to coming.
- 2017/10/16: Release of Theano 0.10.0beta4, new features and many bugfixes, release candidate to coming.

The Microsoft Cognitive Toolkit

A free, easy-to-use, open-source, commercial-grade toolkit that trains deep learning algorithms to learn like the human brain.

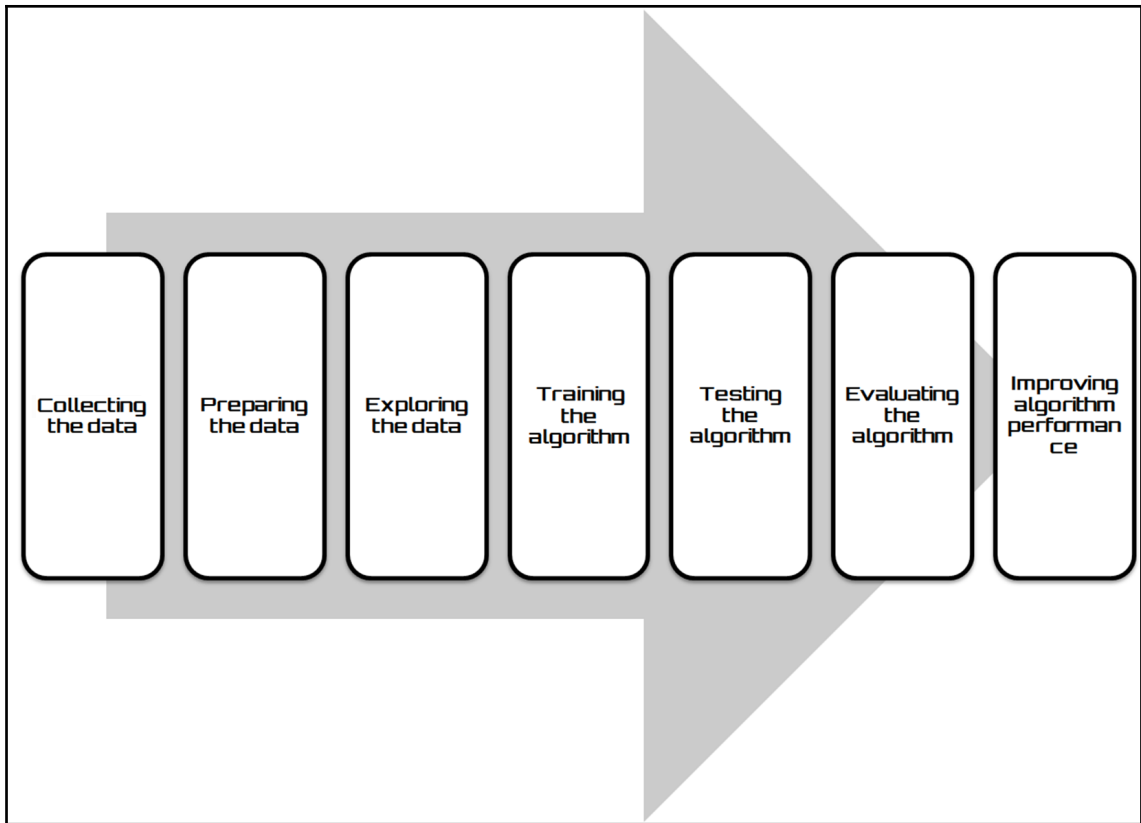
[GET STARTED >](#)

Unlock deeper learning with the new Microsoft Cognitive Tool... ➔



Unlock deeper learning with the new Microsoft Cognitive Toolkit

The Microsoft Cognitive Toolkit—previously known as CNTK—empowers you to harness the intelligence within massive datasets through deep learning by providing uncompromised scaling, speed, and accuracy with commercial-grade quality and compatibility with the programming languages and algorithms you already use. Hear about the team that developed the Cognitive Toolkit, or read more below.



Layer (type)	Output Shape	Param #
dense_1 (Dense)	(None, 32)	3232
dense_2 (Dense)	(None, 1)	33
Total params: 3,265		
Trainable params: 3,265		
Non-trainable params: 0		

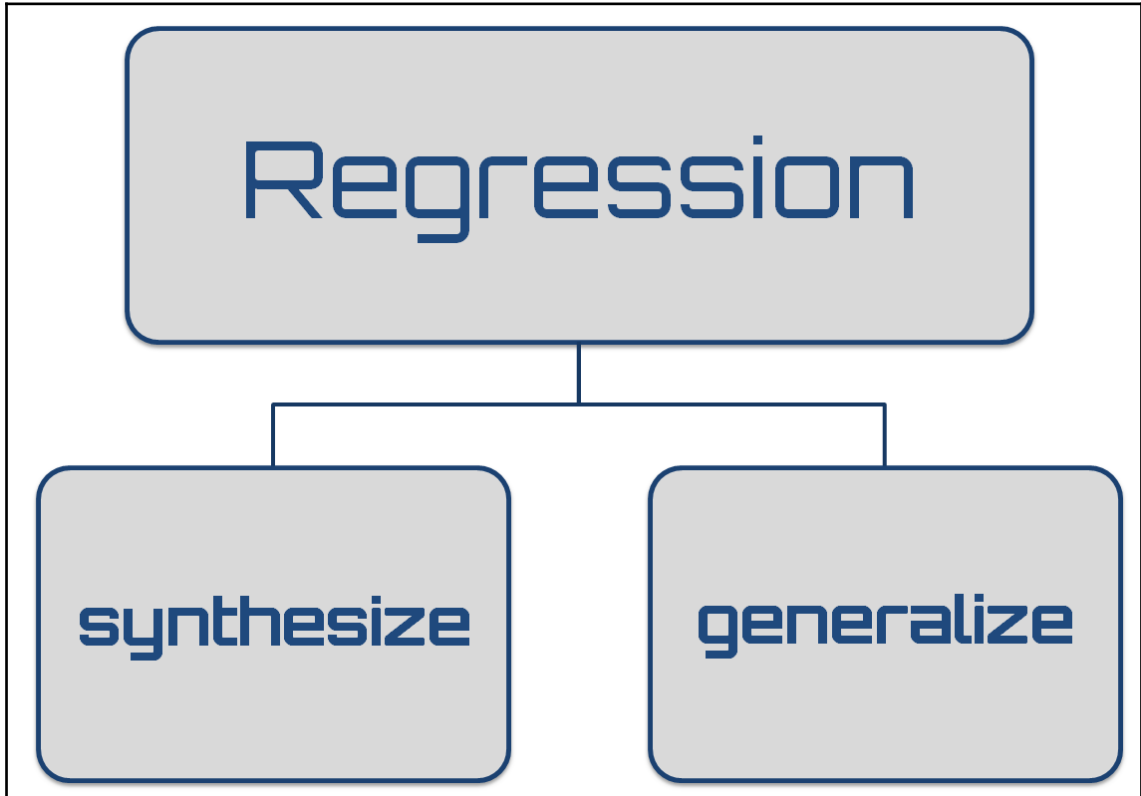
Layer (type)	Output Shape	Param #
=====		
input_1 (InputLayer)	(None, 100)	0

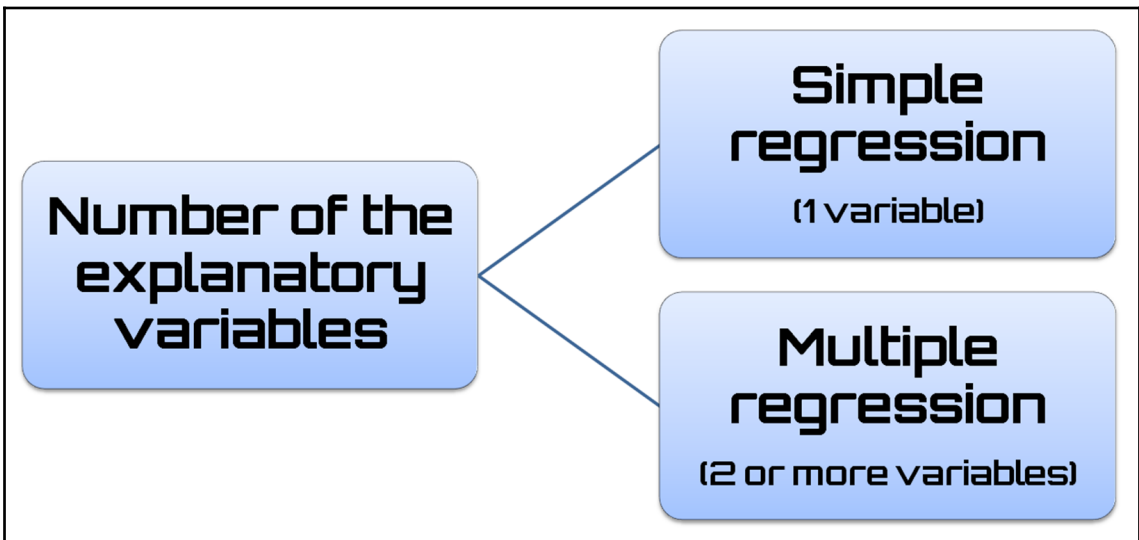
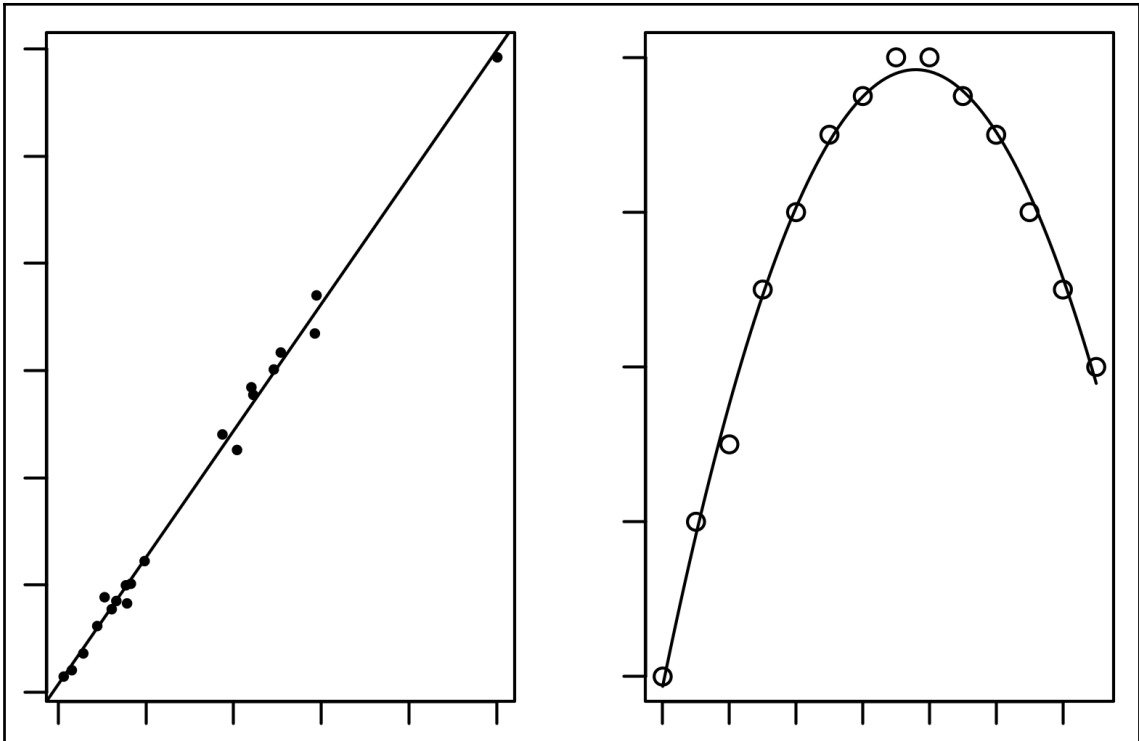
dense_1 (Dense)	(None, 10)	1010

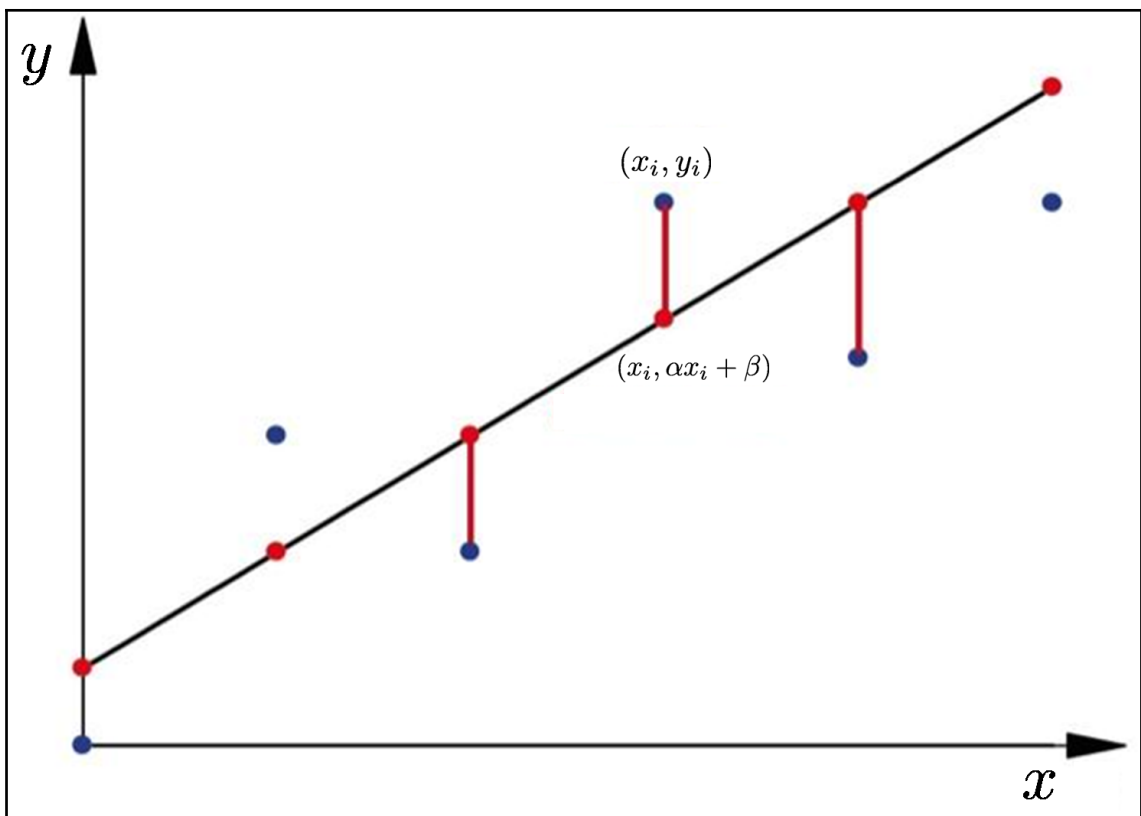
dense_2 (Dense)	(None, 20)	220

dense_3 (Dense)	(None, 1)	21
=====		
Total params: 1,251		
Trainable params: 1,251		
Non-trainable params: 0		

Chapter 2: Modeling Real Estate Using Regression Analysis



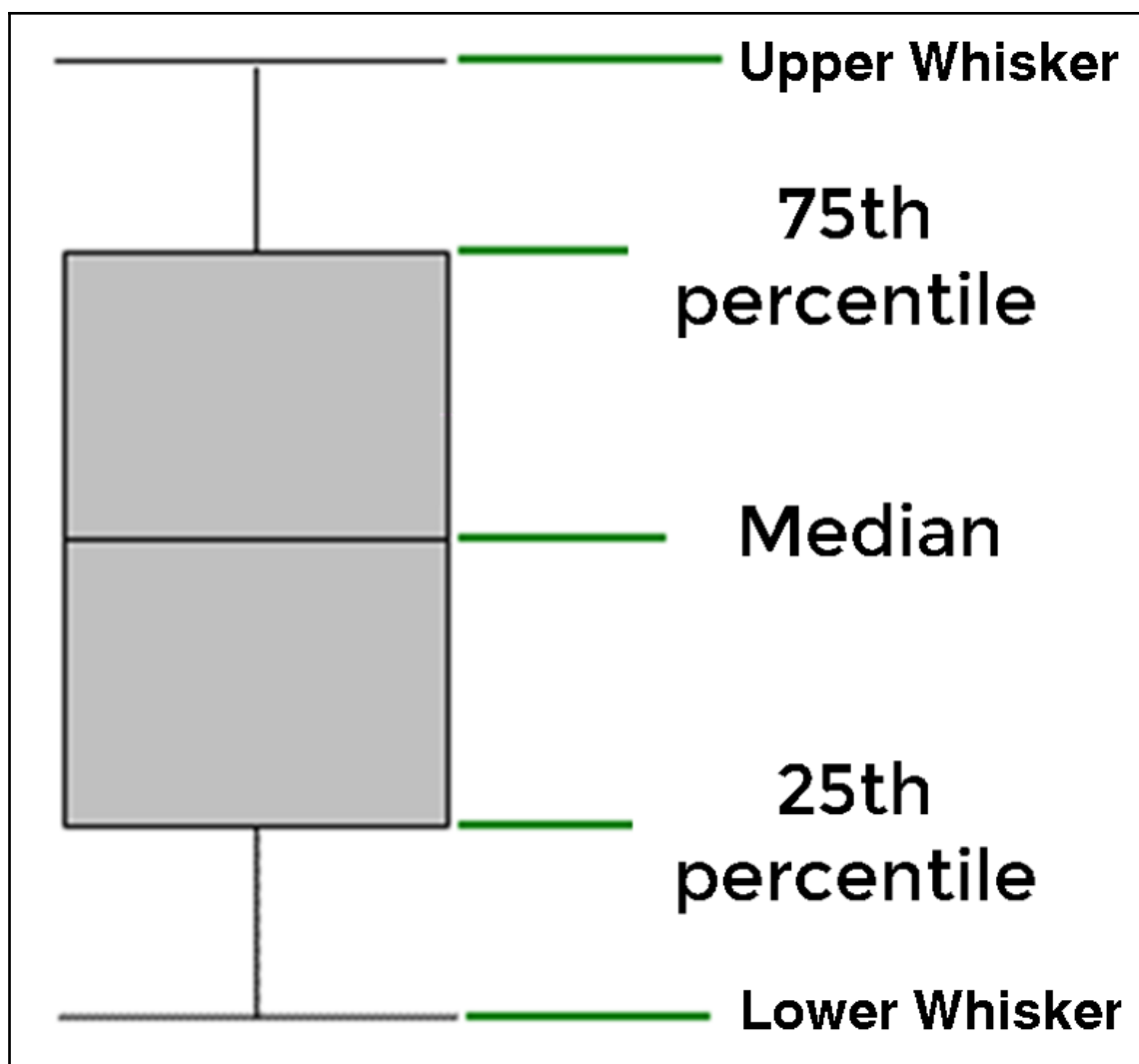


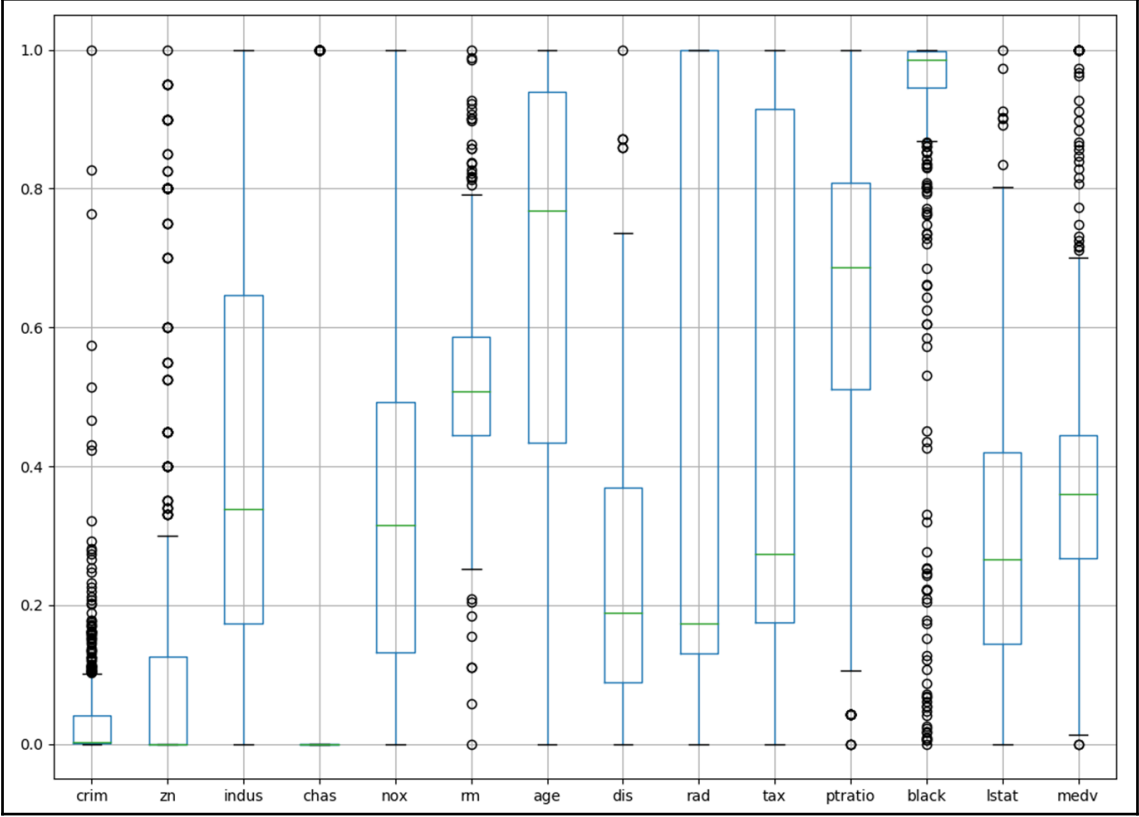


	crim	zn	indus	chas	nox	rm	age	dis	rad	tax	ptratio	black	lstat	medv
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	24.0
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242.0	17.8	396.90	9.14	21.6
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242.0	17.8	392.83	4.03	34.7
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222.0	18.7	394.63	2.94	33.4
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	36.2
5	0.02985	0.0	2.18	0	0.458	6.430	58.7	6.0622	3	222.0	18.7	394.12	5.21	28.7
6	0.08829	12.5	7.87	0	0.524	6.012	66.6	5.5605	5	311.0	15.2	395.60	12.43	22.9
7	0.14455	12.5	7.87	0	0.524	6.172	96.1	5.9505	5	311.0	15.2	396.90	19.15	27.1
8	0.21124	12.5	7.87	0	0.524	5.631	100.0	6.0821	5	311.0	15.2	386.63	29.93	16.5
9	0.17004	12.5	7.87	0	0.524	6.004	85.9	6.5921	5	311.0	15.2	386.71	17.10	18.9
10	0.22489	12.5	7.87	0	0.524	6.377	94.3	6.3467	5	311.0	15.2	392.52	20.45	15.0
11	0.11747	12.5	7.87	0	0.524	6.009	82.9	6.2267	5	311.0	15.2	396.90	13.27	18.9
12	0.09378	12.5	7.87	0	0.524	5.889	39.0	5.4509	5	311.0	15.2	390.50	15.71	21.7
13	0.62976	0.0	8.14	0	0.538	5.949	61.8	4.7075	4	307.0	21.0	396.90	8.26	20.4
14	0.63796	0.0	8.14	0	0.538	6.096	84.5	4.4619	4	307.0	21.0	380.02	10.26	18.2
15	0.62739	0.0	8.14	0	0.538	5.834	56.5	4.4986	4	307.0	21.0	395.62	8.47	19.9
16	1.05393	0.0	8.14	0	0.538	5.935	29.3	4.4986	4	307.0	21.0	386.85	6.58	23.1
17	0.78420	0.0	8.14	0	0.538	5.990	81.7	4.2579	4	307.0	21.0	386.75	14.67	17.5
18	0.80271	0.0	8.14	0	0.538	5.456	36.6	3.7965	4	307.0	21.0	288.99	11.69	20.2
19	0.72580	0.0	8.14	0	0.538	5.727	69.5	3.7965	4	307.0	21.0	390.95	11.28	18.2

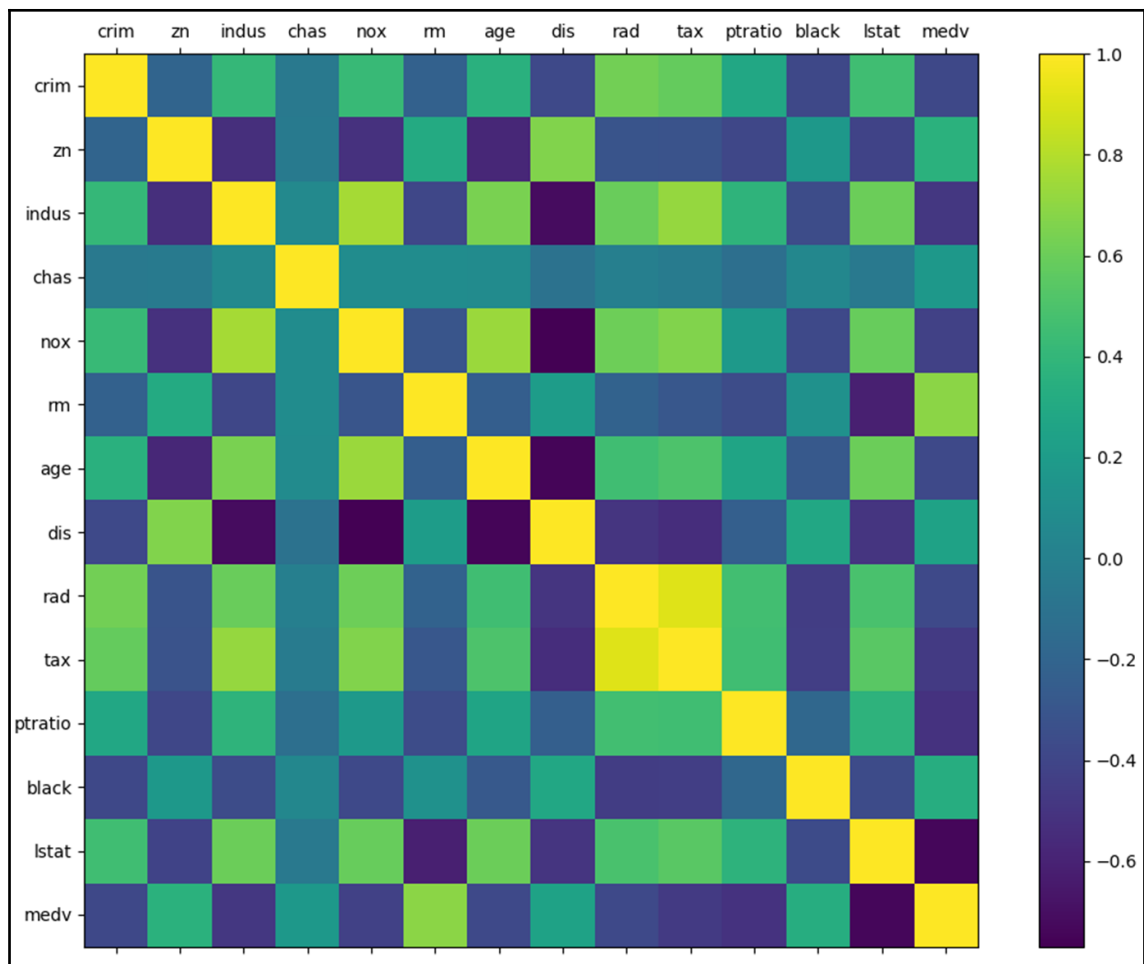
	count	mean	std	min	25%	50%	75%	max
crim	506.0	3.613524	8.601545	0.00632	0.082045	0.25651	3.677082	88.9762
zn	506.0	11.363636	23.322453	0.00000	0.000000	0.00000	12.500000	100.0000
indus	506.0	11.136779	6.860353	0.46000	5.190000	9.69000	18.100000	27.7400
chas	506.0	0.069170	0.253994	0.00000	0.000000	0.00000	0.000000	1.0000
nox	506.0	0.554695	0.115878	0.38500	0.449000	0.53800	0.624000	0.8710
rm	506.0	6.284634	0.702617	3.56100	5.885500	6.20850	6.623500	8.7800
age	506.0	68.574901	28.148861	2.90000	45.025000	77.50000	94.075000	100.0000
dis	506.0	3.795043	2.105710	1.12960	2.100175	3.20745	5.188425	12.1265
rad	506.0	9.549407	8.707259	1.00000	4.000000	5.00000	24.000000	24.0000
tax	506.0	408.237154	168.537116	187.00000	279.000000	330.00000	666.000000	711.0000
ptratio	506.0	18.455534	2.164946	12.60000	17.400000	19.05000	20.200000	22.0000
black	506.0	356.674032	91.294864	0.32000	375.377500	391.44000	396.225000	396.9000
lstat	506.0	12.653063	7.141062	1.73000	6.950000	11.36000	16.955000	37.9700
medv	506.0	22.532806	9.197104	5.00000	17.025000	21.20000	25.000000	50.0000

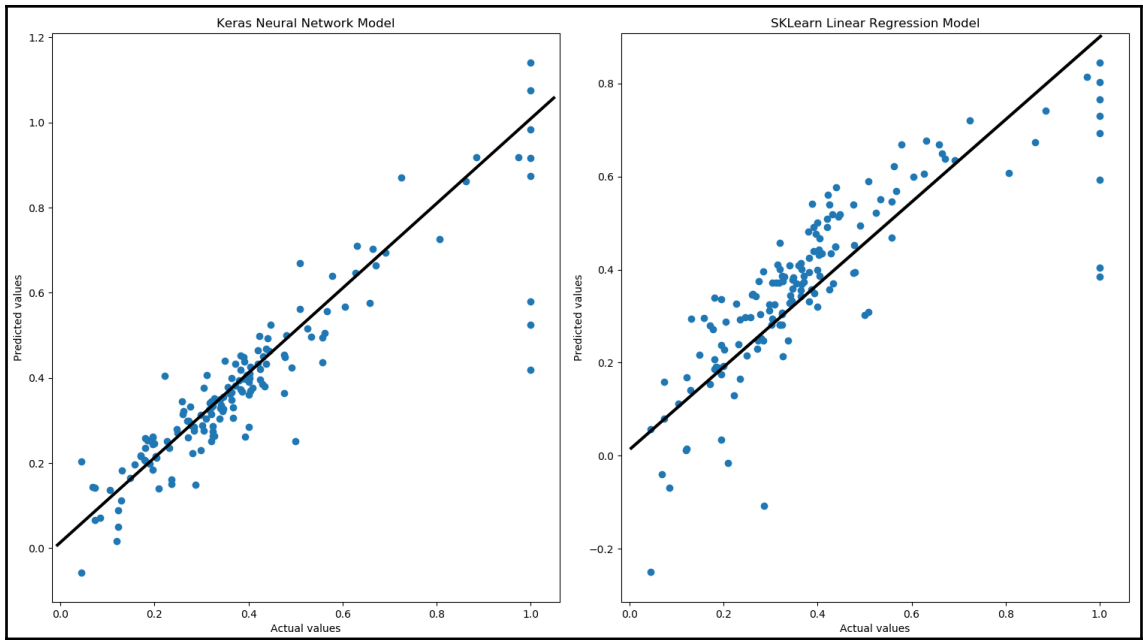
	count	mean	std	min	25%	50%	75%	max
crim	506.0	0.040544	0.096679	0.0	0.000851	0.002812	0.041258	1.0
zn	506.0	0.113636	0.233225	0.0	0.000000	0.000000	0.125000	1.0
indus	506.0	0.391378	0.251479	0.0	0.173387	0.338343	0.646628	1.0
chas	506.0	0.069170	0.253994	0.0	0.000000	0.000000	0.000000	1.0
nox	506.0	0.349167	0.238431	0.0	0.131687	0.314815	0.491770	1.0
rm	506.0	0.521869	0.134627	0.0	0.445392	0.507281	0.586798	1.0
age	506.0	0.676364	0.289896	0.0	0.433831	0.768280	0.938980	1.0
dis	506.0	0.242381	0.191482	0.0	0.088259	0.188949	0.369088	1.0
rad	506.0	0.371713	0.378576	0.0	0.130435	0.173913	1.000000	1.0
tax	506.0	0.422208	0.321636	0.0	0.175573	0.272901	0.914122	1.0
ptratio	506.0	0.622929	0.230313	0.0	0.510638	0.686170	0.808511	1.0
black	506.0	0.898568	0.230205	0.0	0.945730	0.986232	0.998298	1.0
lstat	506.0	0.301409	0.197049	0.0	0.144040	0.265728	0.420116	1.0
medv	506.0	0.389618	0.204380	0.0	0.267222	0.360000	0.444444	1.0



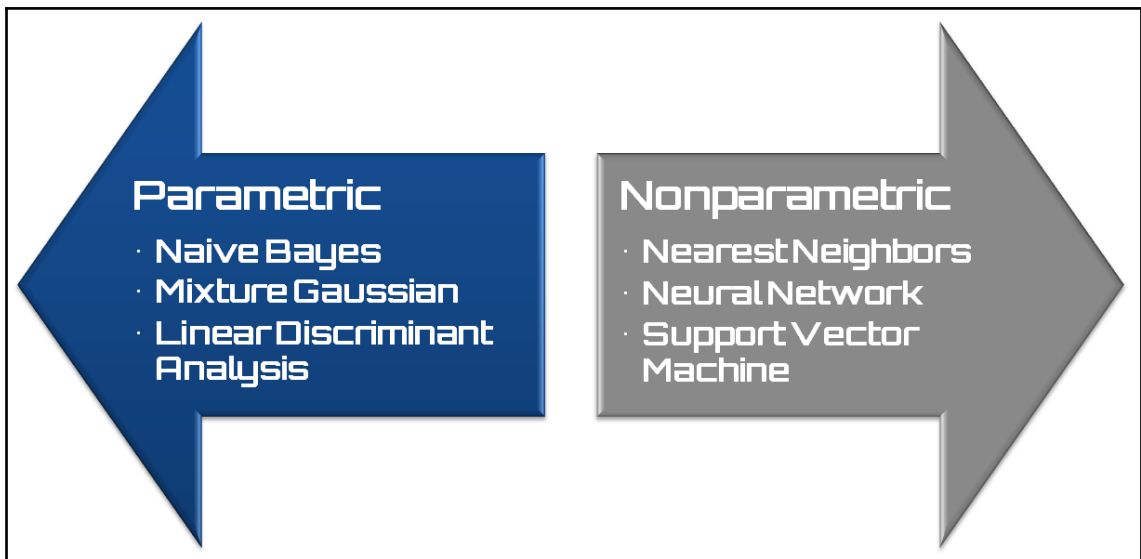
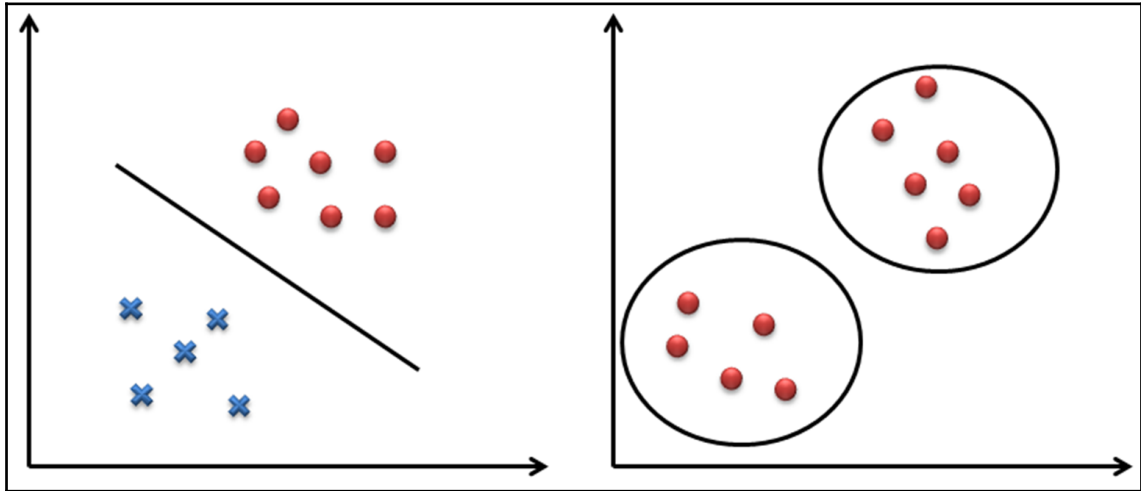


	crim	zn	indus	chas	nox	rm	age	\
crim	1.000000	-0.200469	0.406583	-0.055892	0.420972	-0.219247	0.352734	
zn	-0.200469	1.000000	-0.533828	-0.042697	-0.516604	0.311991	-0.569537	
indus	0.406583	-0.533828	1.000000	0.062938	0.763651	-0.391676	0.644779	
chas	-0.055892	-0.042697	0.062938	1.000000	0.091203	0.091251	0.086518	
nox	0.420972	-0.516604	0.763651	0.091203	1.000000	-0.302188	0.731470	
rm	-0.219247	0.311991	-0.391676	0.091251	-0.302188	1.000000	-0.240265	
age	0.352734	-0.569537	0.644779	0.086518	0.731470	-0.240265	1.000000	
dis	-0.379670	0.664408	-0.708027	-0.099176	-0.769230	0.205246	-0.747881	
rad	0.625505	-0.311948	0.595129	-0.007368	0.611441	-0.209847	0.456022	
tax	0.582764	-0.314563	0.720760	-0.035587	0.668023	-0.292048	0.506456	
ptratio	0.289946	-0.391679	0.383248	-0.121515	0.188933	-0.355501	0.261515	
black	-0.385064	0.175520	-0.356977	0.048788	-0.380051	0.128069	-0.273534	
lstat	0.455621	-0.412995	0.603800	-0.053929	0.590879	-0.613808	0.602339	
medv	-0.388305	0.360445	-0.483725	0.175260	-0.427321	0.695360	-0.376955	
	dis	rad	tax	ptratio	black	lstat	medv	
crim	-0.379670	0.625505	0.582764	0.289946	-0.385064	0.455621	-0.388305	
zn	0.664408	-0.311948	-0.314563	-0.391679	0.175520	-0.412995	0.360445	
indus	-0.708027	0.595129	0.720760	0.383248	-0.356977	0.603800	-0.483725	
chas	-0.099176	-0.007368	-0.035587	-0.121515	0.048788	-0.053929	0.175260	
nox	-0.769230	0.611441	0.668023	0.188933	-0.380051	0.590879	-0.427321	
rm	0.205246	-0.209847	-0.292048	-0.355501	0.128069	-0.613808	0.695360	
age	-0.747881	0.456022	0.506456	0.261515	-0.273534	0.602339	-0.376955	
dis	1.000000	-0.494588	-0.534432	-0.232471	0.291512	-0.496996	0.249929	
rad	-0.494588	1.000000	0.910228	0.464741	-0.444413	0.488676	-0.381626	
tax	-0.534432	0.910228	1.000000	0.460853	-0.441808	0.543993	-0.468536	
ptratio	-0.232471	0.464741	0.460853	1.000000	-0.177383	0.374044	-0.507787	
black	0.291512	-0.444413	-0.441808	-0.177383	1.000000	-0.366087	0.333461	
lstat	-0.496996	0.488676	0.543993	0.374044	-0.366087	1.000000	-0.737663	
medv	0.249929	-0.381626	-0.468536	-0.507787	0.333461	-0.737663	1.000000	





Chapter 3: Heart Disease Classification with Neural Networks



	age	sex	cp	trestbps	chol	fb	restecg	thalach	exang	oldpeak	slope	ca	hal	HeartDisease
0	67	1	4	160	286	0	2	108	1	1.5	2	3	3	1
1	67	1	4	120	229	0	2	129	1	2.6	2	2	7	1
2	37	1	3	130	250	0	0	187	0	3.5	3	0	3	0
3	41	0	2	130	204	0	2	172	0	1.4	1	0	3	0
4	56	1	2	120	236	0	0	178	0	0.8	1	0	3	0
5	62	0	4	140	268	0	2	160	0	3.6	3	2	3	1
6	57	0	4	120	354	0	0	163	1	0.6	1	0	3	0
7	63	1	4	130	254	0	2	147	0	1.4	2	1	7	1
8	53	1	4	140	203	1	2	155	1	3.1	3	0	7	1
9	57	1	4	140	192	0	0	148	0	0.4	2	0	6	0
10	56	0	2	140	294	0	2	153	0	1.3	2	0	3	0
11	56	1	3	130	256	1	2	142	1	0.6	2	1	6	1
12	44	1	2	120	263	0	0	173	0	0.0	1	0	7	0
13	52	1	3	172	199	1	0	162	0	0.5	1	0	7	0
14	57	1	3	150	168	0	0	174	0	1.6	1	0	3	0
15	48	1	2	110	229	0	0	168	0	1.0	3	0	7	1
16	54	1	4	140	239	0	0	160	0	1.2	1	0	3	0
17	48	0	3	130	275	0	0	139	0	0.2	1	0	3	0
18	49	1	2	130	266	0	0	171	0	0.6	1	0	3	0
19	64	1	1	110	211	0	2	144	1	1.8	2	0	3	0

	age	sex	cp	trestbps	chol	fbs	\
count	302.000000	302.000000	302.000000	302.000000	302.000000	302.000000	
mean	54.410596	0.678808	3.165563	131.645695	246.738411	0.145695	
std	9.040163	0.467709	0.953612	17.612202	51.856829	0.353386	
min	29.000000	0.000000	1.000000	94.000000	126.000000	0.000000	
25%	48.000000	0.000000	3.000000	120.000000	211.000000	0.000000	
50%	55.500000	1.000000	3.000000	130.000000	241.500000	0.000000	
75%	61.000000	1.000000	4.000000	140.000000	275.000000	0.000000	
max	77.000000	1.000000	4.000000	200.000000	564.000000	1.000000	
	restecg	thalach	exang	oldpeak	slope		\
count	302.000000	302.000000	302.000000	302.000000	302.000000		
mean	0.986755	149.605960	0.327815	1.035430	1.596026		
std	0.994916	22.912959	0.470196	1.160723	0.611939		
min	0.000000	71.000000	0.000000	0.000000	1.000000		
25%	0.000000	133.250000	0.000000	0.000000	1.000000		
50%	0.500000	153.000000	0.000000	0.800000	2.000000		
75%	2.000000	166.000000	1.000000	1.600000	2.000000		
max	2.000000	202.000000	1.000000	6.200000	3.000000		
	HeartDisease						
count	302.000000						
mean	0.460265						
std	0.499246						
min	0.000000						
25%	0.000000						
50%	0.000000						
75%	1.000000						
max	1.000000						

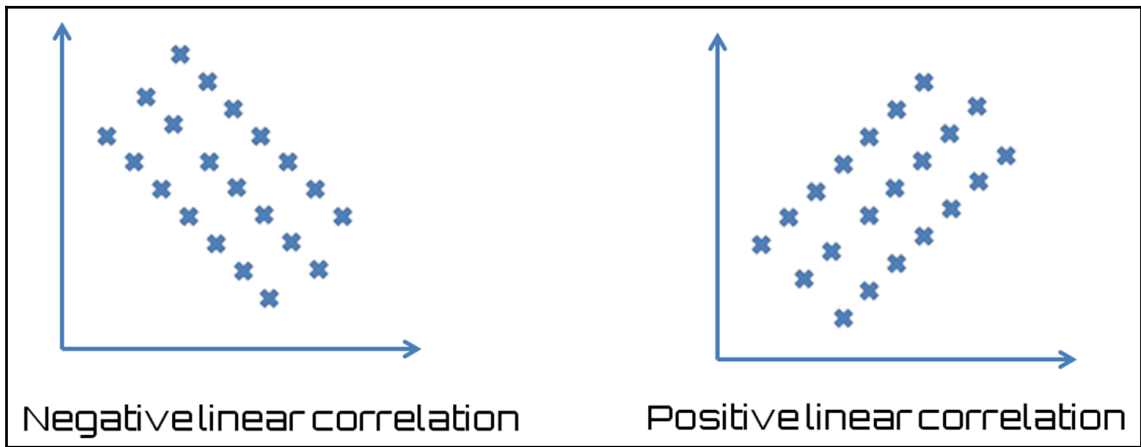
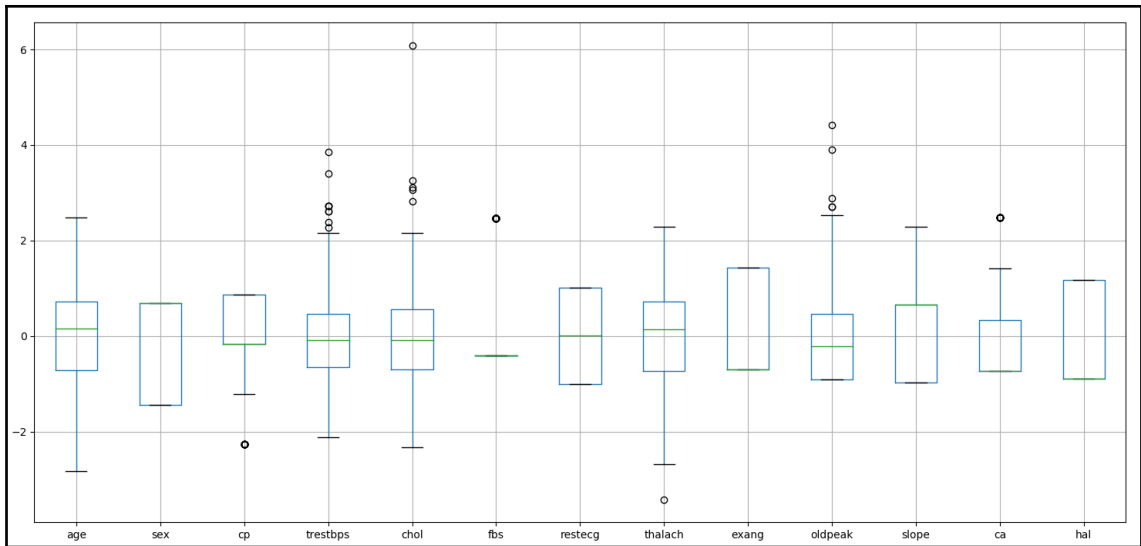
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
264	44	1	3	120	226	0	0	169	0	0	1	0	3	0						
265	61	1	4	138	166	0	2	125	1	3,6	2	1	3	1						
266	42	1	4	136	315	0	0	125	1	1,8	2	0	6	1						
267	52	1	4	128	204	1	0	156	1	1	2	0	1							
268	59	1	3	126	218	1	0	134	0	2,2	2	1	6	1						
269	40	1	4	152	223	0	0	181	0	0	1	0	7	1						
270	42	1	3	130	180	0	0	150	0	0	1	0	3	0						
271	61	1	4	140	207	0	2	138	1	1,9	1	1	7	1						
272	66	1	4	160	228	0	2	138	0	2,3	1	0	6	0						
273	46	1	4	140	311	0	0	120	1	1,8	2	2	7	1						
274	71	0	4	112	149	0	0	125	0	1,6	2	0	3	0						
275	59	1	1	134	204	0	0	162	0	0,8	1	2	3	1						
276	64	1	1	170	227	0	2	155	0	0,6	2	0	7	0						
277	66	0	3	146	278	0	2	152	0	0	2	1	3	0						
278	39	0	3	138	220	0	0	152	0	0	2	0	3	0						
279	57	1	2	154	232	0	2	164	0	0	1	1	3	1						
280	58	0	4	130	197	0	0	131	0	0,6	2	0	3	0						
281	57	1	4	110	335	0	0	143	1	3	2	1	7	1						
282	47	1	3	130	253	0	0	179	0	0	1	0	3	0						
283	55	0	4	128	205	0	1	130	1	2	2	1	7	1						
284	35	1	2	122	192	0	0	174	0	0	1	0	3	0						
285	61	1	4	148	203	0	0	161	0	0	1	1	7	1						
286	58	1	4	114	318	0	1	140	0	4,4	3	3	6	1						
287	58	0	4	170	225	1	2	146	1	2,8	2	2	6	1						
288	58	1	2	125	220	0	0	144	0	0,4	2	?	7	0						
289	56	1	2	130	221	0	2	163	0	0	1	0	7	0						
290	56	1	2	120	240	0	0	169	0	0	3	0	3	0						
291	67	1	3	152	212	0	2	150	0	0,8	2	0	7	1						

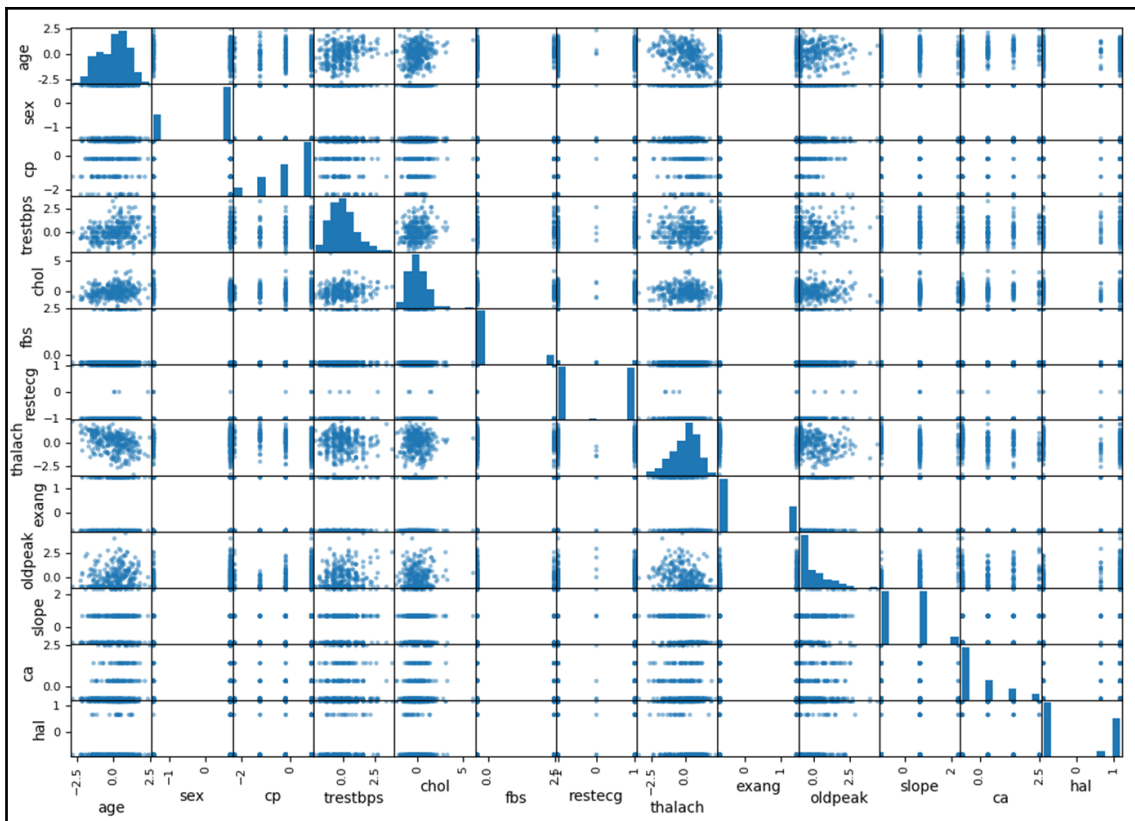
	age	sex	cp	trestbps	chol	fbs	\
count	302.000000	302.000000	302.000000	302.000000	302.000000	302.000000	
mean	54.410596	0.678808	3.165563	131.645695	246.738411	0.145695	
std	9.040163	0.467709	0.953612	17.612202	51.856829	0.353386	
min	29.000000	0.000000	1.000000	94.000000	126.000000	0.000000	
25%	48.000000	0.000000	3.000000	120.000000	211.000000	0.000000	
50%	55.500000	1.000000	3.000000	130.000000	241.500000	0.000000	
75%	61.000000	1.000000	4.000000	140.000000	275.000000	0.000000	
max	77.000000	1.000000	4.000000	200.000000	564.000000	1.000000	

	restecg	thalach	exang	oldpeak	slope	ca	\
count	302.000000	302.000000	302.000000	302.000000	302.000000	298.000000	
mean	0.986755	149.605960	0.327815	1.035430	1.596026	0.674497	
std	0.994916	22.912959	0.470196	1.160723	0.611939	0.938202	
min	0.000000	71.000000	0.000000	0.000000	1.000000	0.000000	
25%	0.000000	133.250000	0.000000	0.000000	1.000000	0.000000	
50%	0.500000	153.000000	0.000000	0.800000	2.000000	0.000000	
75%	2.000000	166.000000	1.000000	1.600000	2.000000	1.000000	
max	2.000000	202.000000	1.000000	6.200000	3.000000	3.000000	

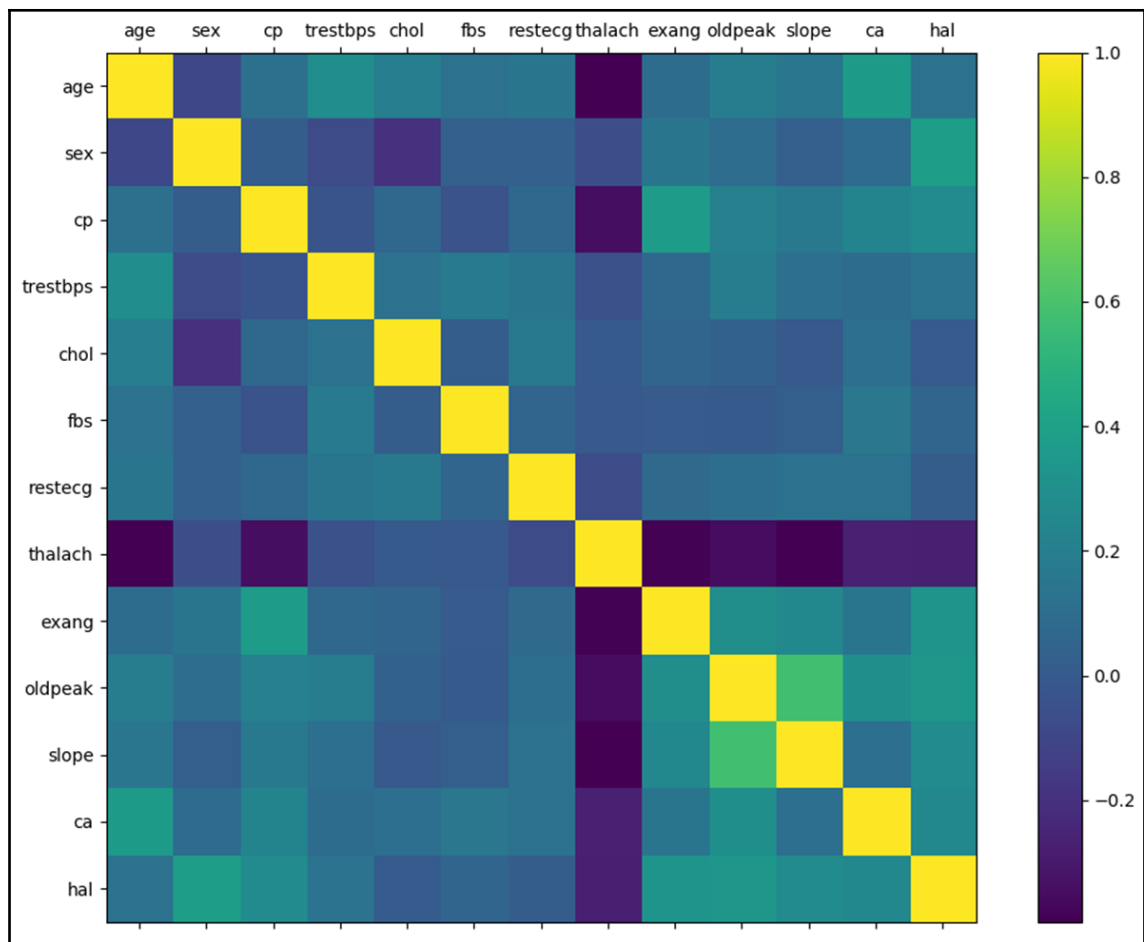
	hal	HeartDisease
count	300.000000	302.000000
mean	4.730000	0.460265
std	1.941563	0.499246
min	3.000000	0.000000
25%	3.000000	0.000000
50%	3.000000	0.000000
75%	7.000000	1.000000
max	7.000000	1.000000

	count	mean	std	min	25%	50%	75%	max
age	296.0	-2.550512e-16	1.001693	-2.823438	-0.720814	0.164501	0.717823	2.488454
sex	296.0	6.001206e-18	1.001693	-1.443376	-1.443376	0.692820	0.692820	0.692820
cp	296.0	1.860374e-16	1.001693	-2.263690	-0.173043	-0.173043	0.872280	0.872280
trestbps	296.0	1.920386e-16	1.001693	-2.121540	-0.656413	-0.092903	0.470607	3.851669
chol	296.0	6.601326e-17	1.001693	-2.334999	-0.700097	-0.084604	0.554931	6.089557
fbs	296.0	2.700542e-17	1.001693	-0.406638	-0.406638	-0.406638	-0.406638	2.459191
restecg	296.0	-4.800964e-17	1.001693	-1.000046	-1.000046	0.006803	1.013652	1.013652
thalach	296.0	2.160434e-16	1.001693	-3.426010	-0.723490	0.148291	0.714949	2.284154
exang	296.0	1.342770e-16	1.001693	-0.698167	-0.698167	-0.698167	1.432322	1.432322
oldpeak	296.0	6.001206e-17	1.001693	-0.903324	-0.903324	-0.215962	0.471400	4.423733
slope	296.0	-6.901386e-17	1.001693	-0.975788	-0.975788	0.656038	0.656038	2.287865
ca	296.0	1.200241e-17	1.001693	-0.723832	-0.723832	-0.723832	0.342110	2.473994
hal	296.0	-1.800362e-16	1.001693	-0.891149	-0.891149	-0.891149	1.173666	1.173666



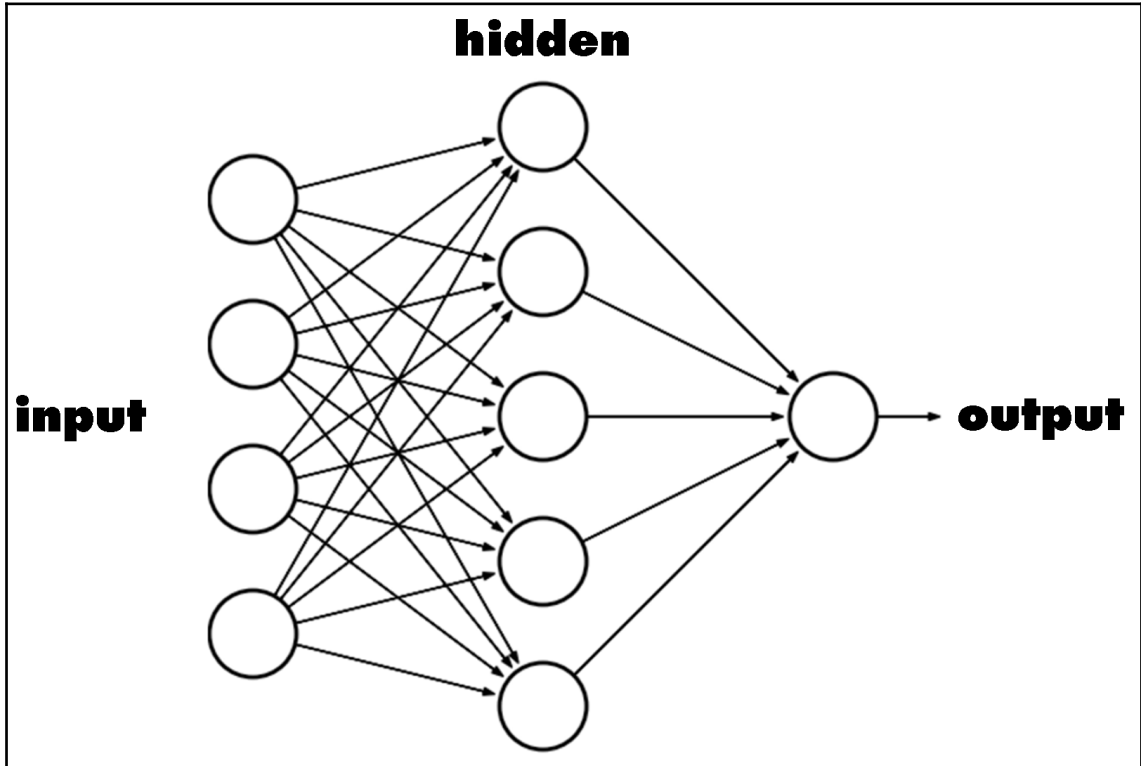


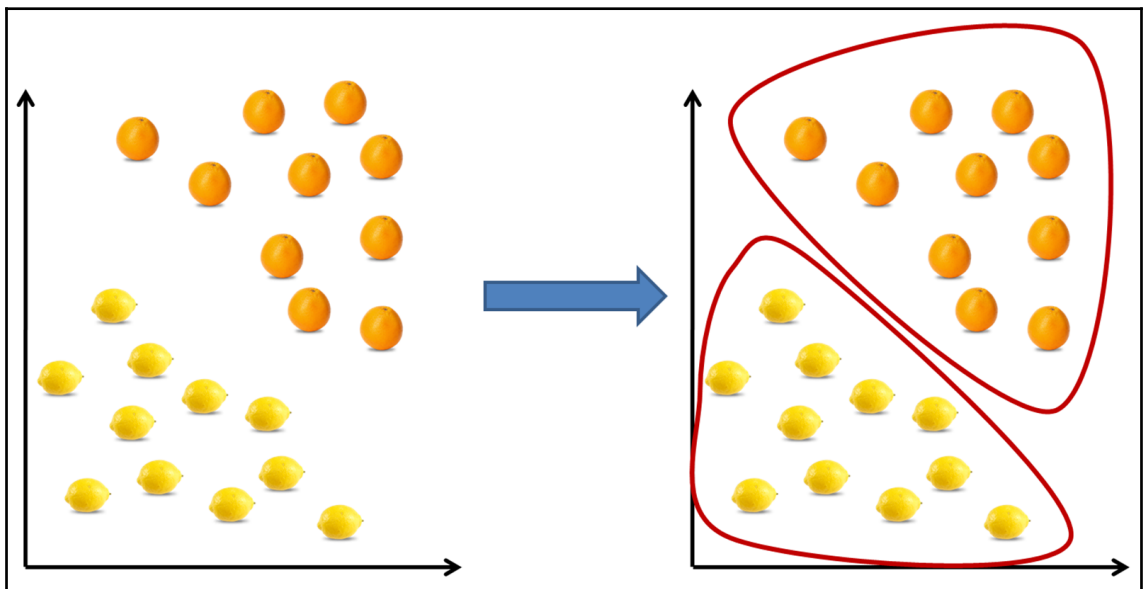
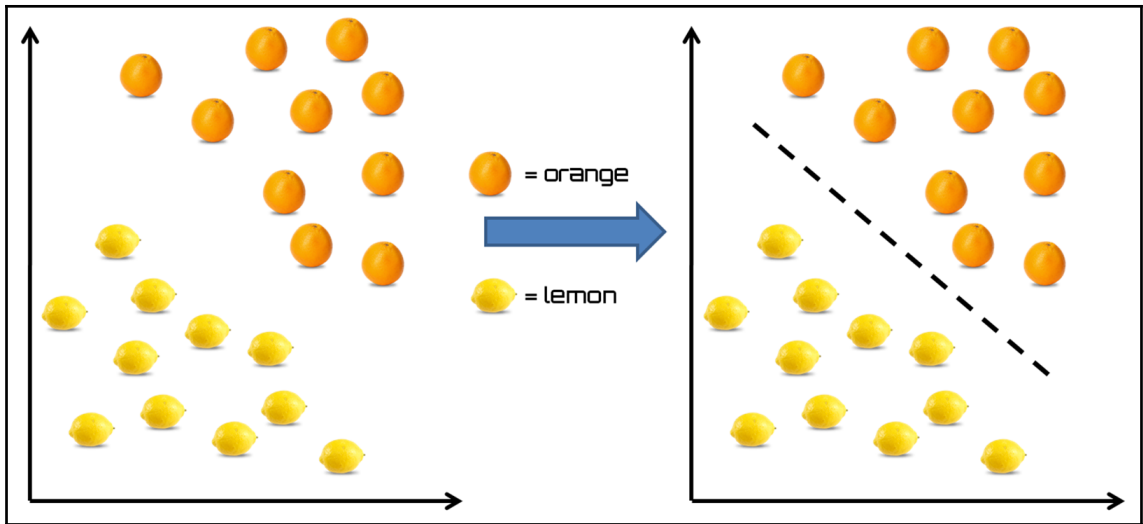
	age	sex	cp	trestbps	chol	fbs	\
age	1.000000	-0.094802	0.118743	0.288805	0.203846	0.125821	
sex	-0.094802	1.000000	0.014272	-0.068212	-0.197629	0.033539	
cp	0.118743	0.014272	1.000000	-0.031599	0.070606	-0.040004	
trestbps	0.288805	-0.068212	-0.031599	1.000000	0.132380	0.176636	
chol	0.203846	-0.197629	0.070606	0.132380	1.000000	0.015132	
fbs	0.125821	0.033539	-0.040004	0.176636	0.015132	1.000000	
restecg	0.147193	0.031618	0.072291	0.147075	0.166298	0.061255	
thalach	-0.395204	-0.060586	-0.342089	-0.049199	-0.000058	-0.008067	
exang	0.098919	0.145444	0.375759	0.068578	0.058744	0.004878	
oldpeak	0.194405	0.104357	0.213564	0.189078	0.039676	-0.000472	
slope	0.153807	0.028328	0.171151	0.116556	-0.007164	0.029783	
ca	0.365356	0.093769	0.232361	0.099967	0.115387	0.159755	
hal	0.124787	0.382707	0.276014	0.136750	0.011481	0.057441	
	restecg	thalach	exang	oldpeak	slope	ca	hal
age	0.147193	-0.395204	0.098919	0.194405	0.153807	0.365356	0.124787
sex	0.031618	-0.060586	0.145444	0.104357	0.028328	0.093769	0.382707
cp	0.072291	-0.342089	0.375759	0.213564	0.171151	0.232361	0.276014
trestbps	0.147075	-0.049199	0.068578	0.189078	0.116556	0.099967	0.136750
chol	0.166298	-0.000058	0.058744	0.039676	-0.007164	0.115387	0.011481
fbs	0.061255	-0.008067	0.004878	-0.000472	0.029783	0.159755	0.057441
restecg	1.000000	-0.072474	0.084466	0.110482	0.128753	0.131828	0.016598
thalach	-0.072474	1.000000	-0.384642	-0.348376	-0.392858	-0.268921	-0.275070
exang	0.084466	-0.384642	1.000000	0.292629	0.258355	0.146783	0.328979
oldpeak	0.110482	-0.348376	0.292629	1.000000	0.576984	0.297897	0.343520
slope	0.128753	-0.392858	0.258355	0.576984	1.000000	0.116398	0.277282
ca	0.131828	-0.268921	0.146783	0.297897	0.116398	1.000000	0.258398
hal	0.016598	-0.275070	0.328979	0.343520	0.277282	0.258398	1.000000

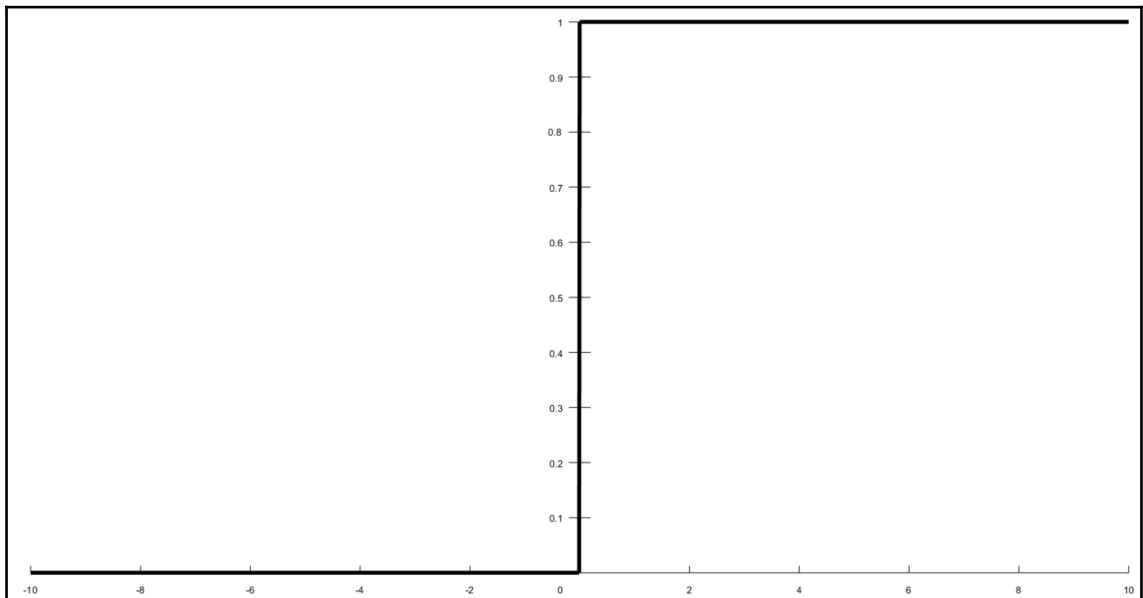
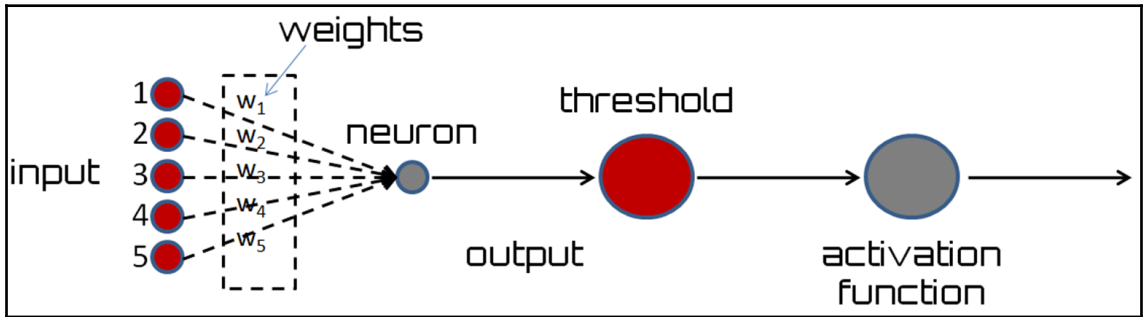
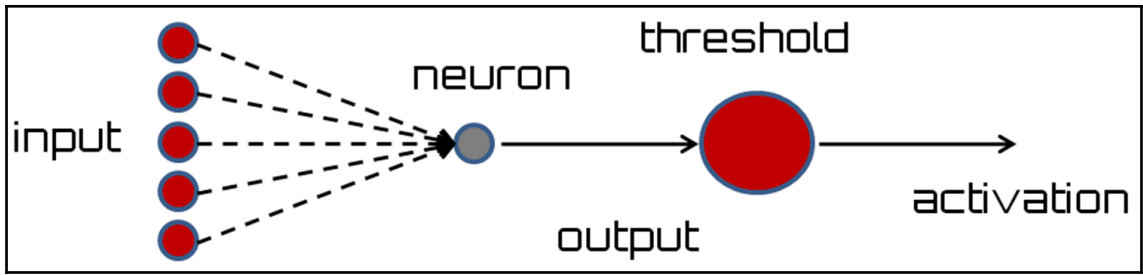


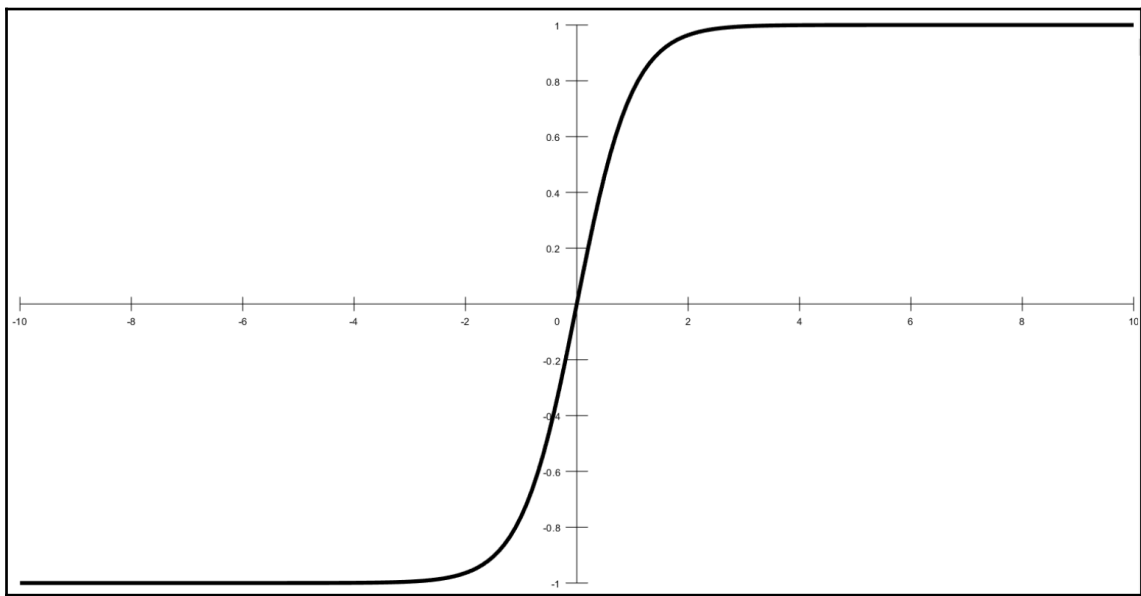
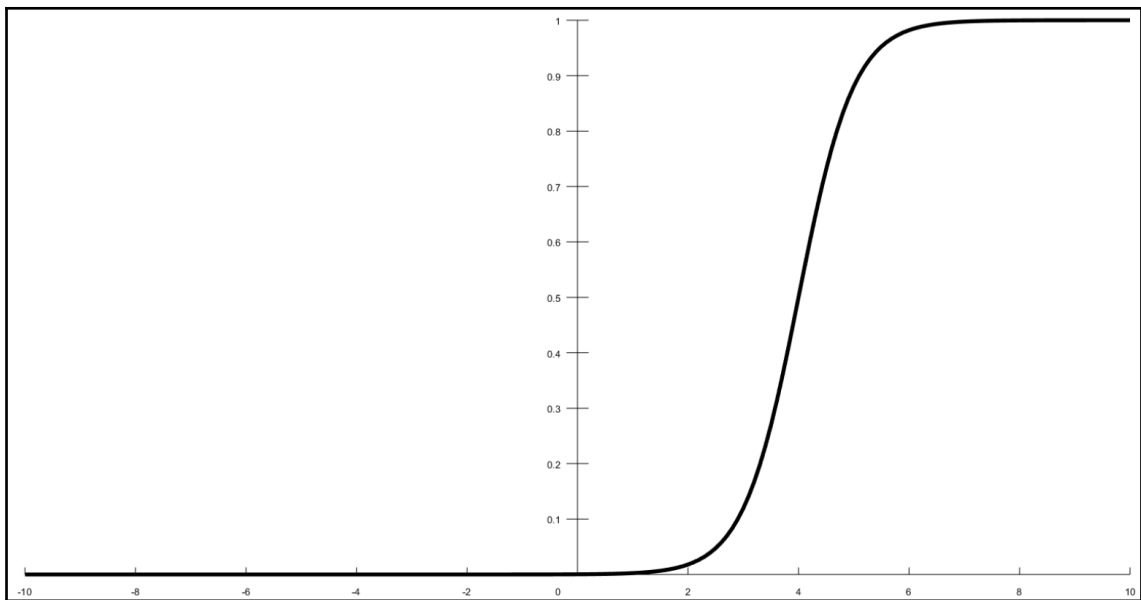
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Epoch 990/1000
207/207 [=====] - 0s 101us/step - loss: 2.0041e-04 - acc: 1.0000
Epoch 991/1000
207/207 [=====] - 0s 106us/step - loss: 1.9977e-04 - acc: 1.0000
Epoch 992/1000
207/207 [=====] - 0s 97us/step - loss: 1.9886e-04 - acc: 1.0000
Epoch 993/1000
207/207 [=====] - 0s 97us/step - loss: 1.9743e-04 - acc: 1.0000
Epoch 994/1000
207/207 [=====] - 0s 97us/step - loss: 1.9678e-04 - acc: 1.0000
Epoch 995/1000
207/207 [=====] - 0s 87us/step - loss: 1.9598e-04 - acc: 1.0000
Epoch 996/1000
207/207 [=====] - 0s 97us/step - loss: 1.9558e-04 - acc: 1.0000
Epoch 997/1000
207/207 [=====] - 0s 101us/step - loss: 1.9407e-04 - acc: 1.0000
Epoch 998/1000
207/207 [=====] - 0s 82us/step - loss: 1.9327e-04 - acc: 1.0000
Epoch 999/1000
207/207 [=====] - 0s 97us/step - loss: 1.9223e-04 - acc: 1.0000
Epoch 1000/1000
207/207 [=====] - 0s 87us/step - loss: 1.9132e-04 - acc: 1.0000
```

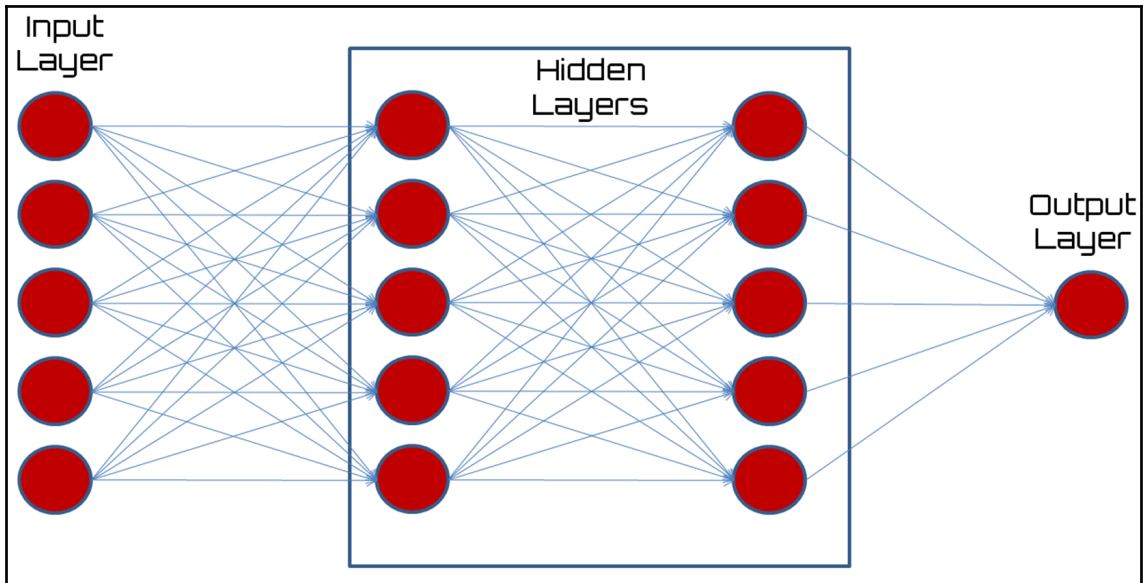
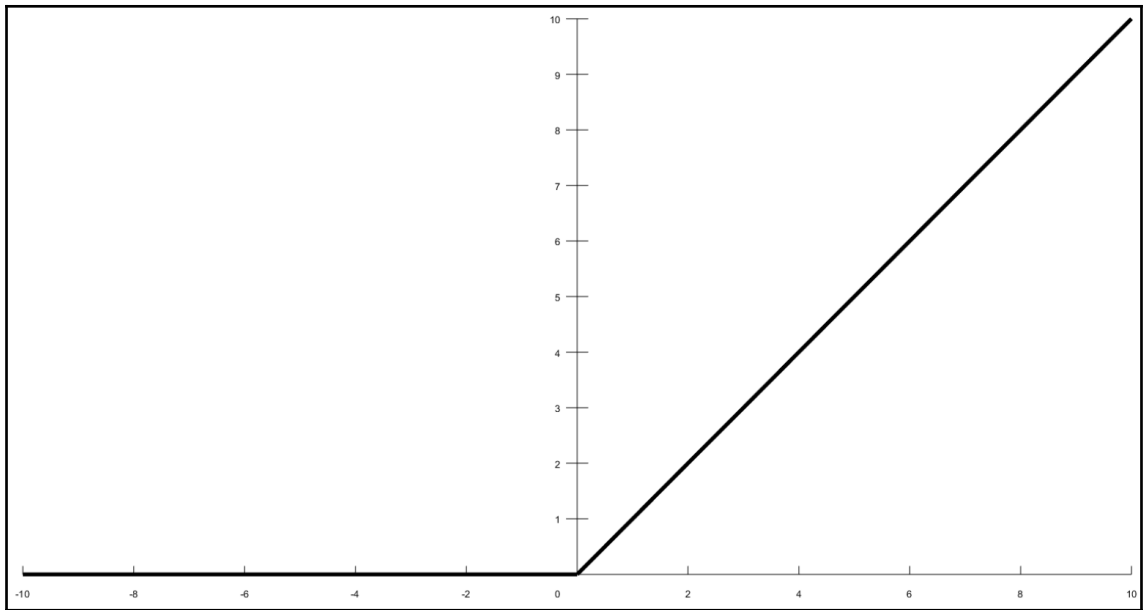

Chapter 4: Concrete Quality Prediction Using Deep Neural Networks

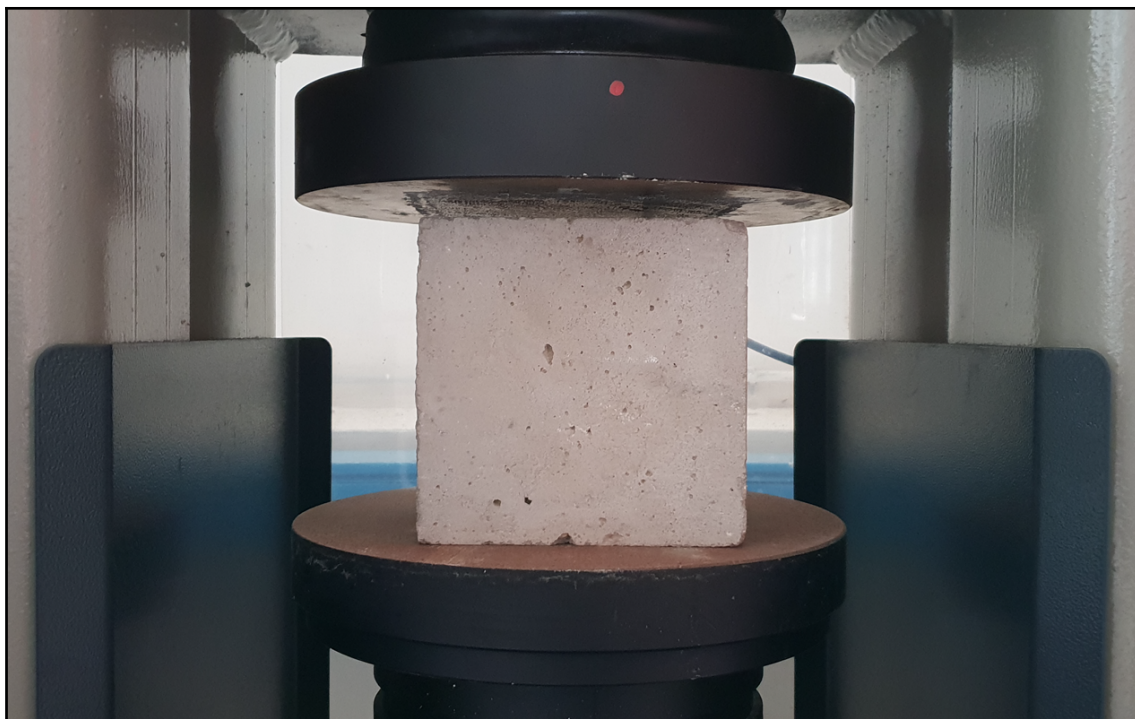








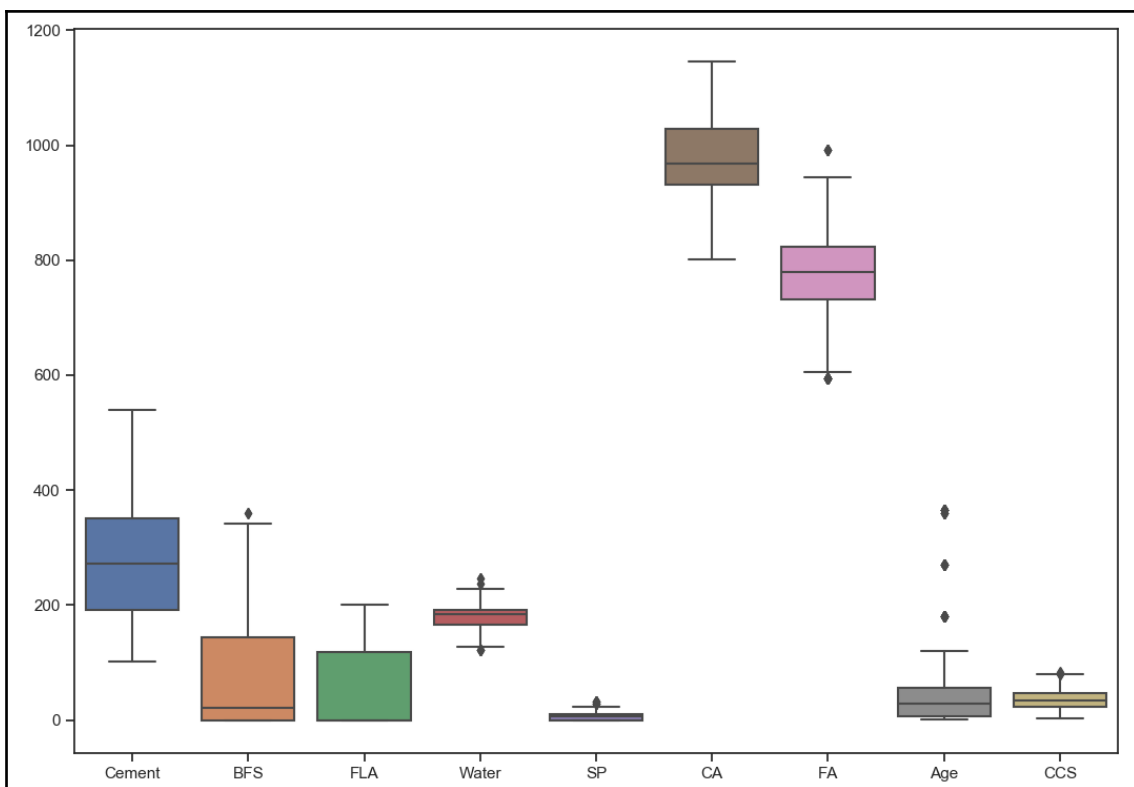


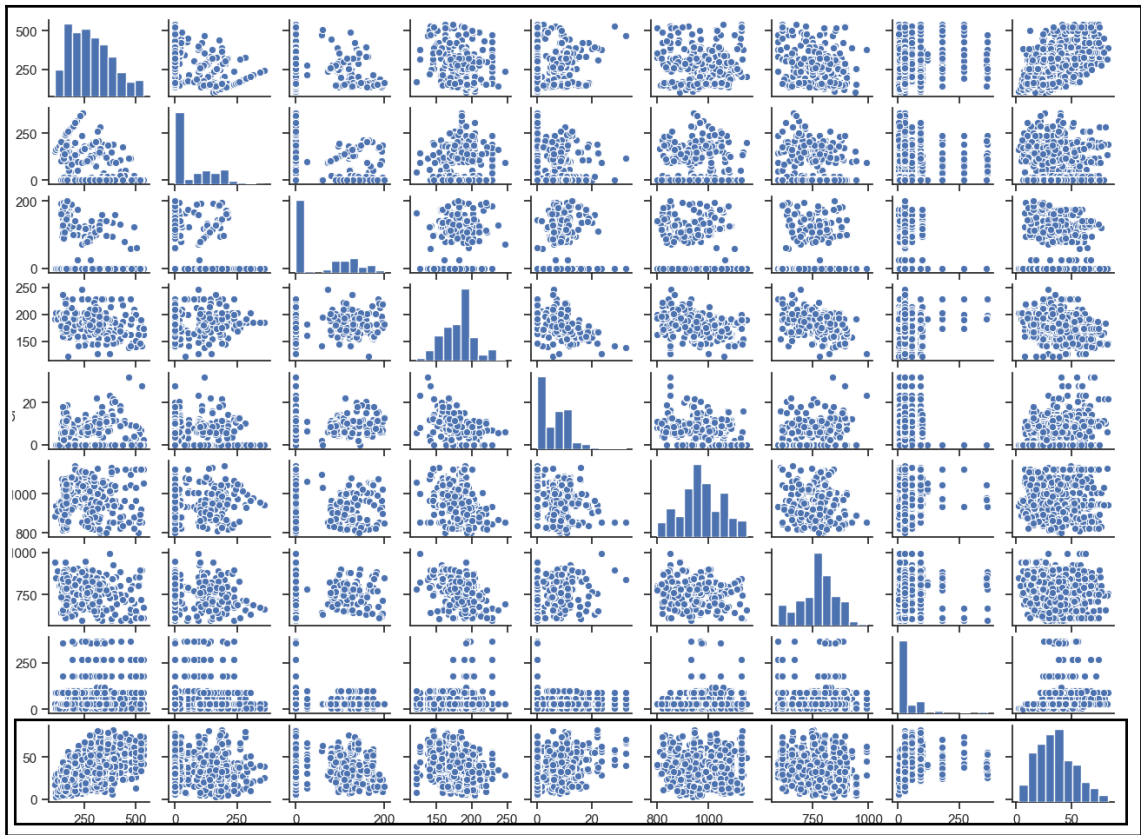


	Cement	BFS	FLA	Water	SP	CA	FA	Age	CCS
0	540.0	0.0	0.0	162.0	2.5	1055.0	676.0	28	61.887366
1	332.5	142.5	0.0	228.0	0.0	932.0	594.0	270	40.269535
2	332.5	142.5	0.0	228.0	0.0	932.0	594.0	365	41.052780
3	198.6	132.4	0.0	192.0	0.0	978.4	825.5	360	44.296075
4	266.0	114.0	0.0	228.0	0.0	932.0	670.0	90	47.029847
5	380.0	95.0	0.0	228.0	0.0	932.0	594.0	365	43.698299
6	380.0	95.0	0.0	228.0	0.0	932.0	594.0	28	36.447770
7	266.0	114.0	0.0	228.0	0.0	932.0	670.0	28	45.854291
8	475.0	0.0	0.0	228.0	0.0	932.0	594.0	28	39.289790
9	198.6	132.4	0.0	192.0	0.0	978.4	825.5	90	38.074244
10	198.6	132.4	0.0	192.0	0.0	978.4	825.5	28	28.021684
11	427.5	47.5	0.0	228.0	0.0	932.0	594.0	270	43.012960
12	190.0	190.0	0.0	228.0	0.0	932.0	670.0	90	42.326932
13	304.0	76.0	0.0	228.0	0.0	932.0	670.0	28	47.813782
14	380.0	0.0	0.0	228.0	0.0	932.0	670.0	90	52.908320
15	139.6	209.4	0.0	192.0	0.0	1047.0	806.9	90	39.358048
16	342.0	38.0	0.0	228.0	0.0	932.0	670.0	365	56.141962
17	380.0	95.0	0.0	228.0	0.0	932.0	594.0	90	40.563252
18	475.0	0.0	0.0	228.0	0.0	932.0	594.0	180	42.620648
19	427.5	47.5	0.0	228.0	0.0	932.0	594.0	180	41.836714

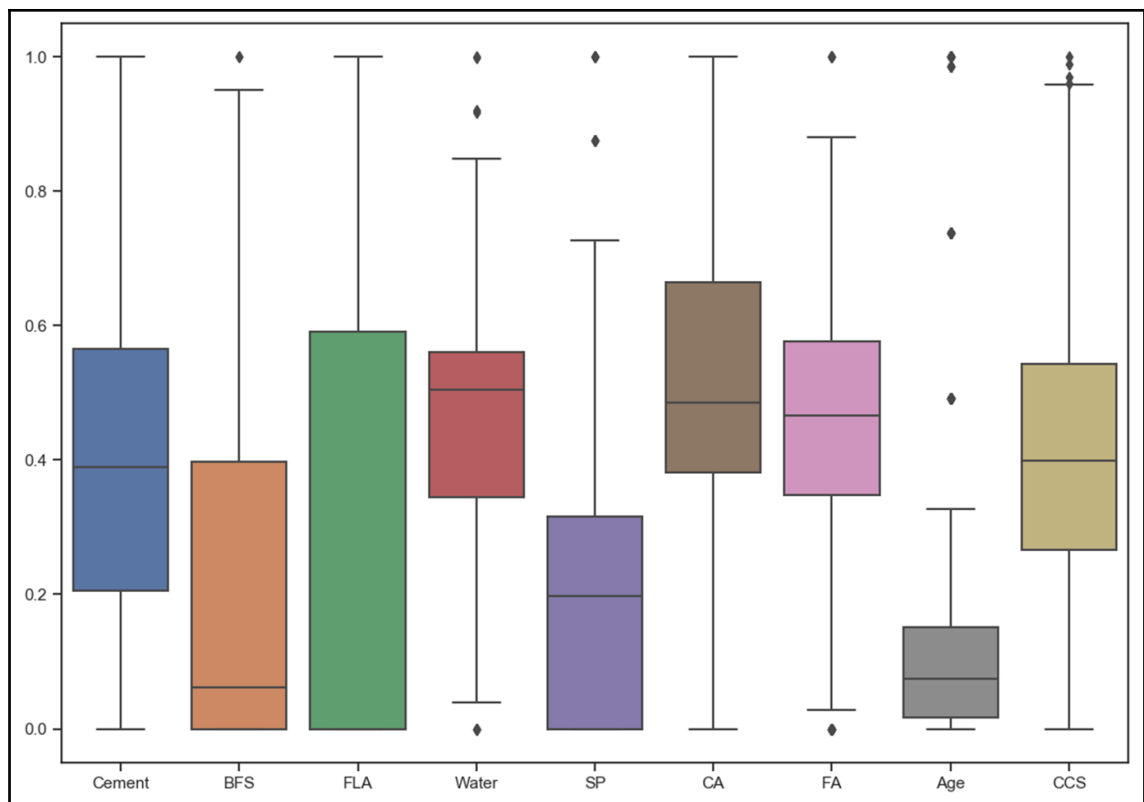
	Cement	BFS	FLA	Water	SP
count	1029.000000	1029.000000	1029.000000	1029.000000	1029.000000
mean	280.914091	73.967298	54.239796	181.585374	6.206710
std	104.245542	86.290255	64.005258	21.357226	5.975279
min	102.000000	0.000000	0.000000	121.750000	0.000000
25%	192.000000	0.000000	0.000000	164.900000	0.000000
50%	272.800000	22.000000	0.000000	185.000000	6.350000
75%	350.000000	143.000000	118.270000	192.000000	10.160000
max	540.000000	359.400000	200.100000	247.000000	32.200000

	CA	FA	Age	CCS
count	1029.000000	1029.000000	1029.000000	1029.000000
mean	972.853401	773.673712	45.679300	35.774912
std	77.763459	80.156602	63.198226	16.656880
min	801.000000	594.000000	1.000000	2.331808
25%	932.000000	732.600000	7.000000	23.696601
50%	968.000000	779.700000	28.000000	34.397958
75%	1029.400000	824.000000	56.000000	45.939786
max	1145.000000	992.600000	365.000000	82.599225





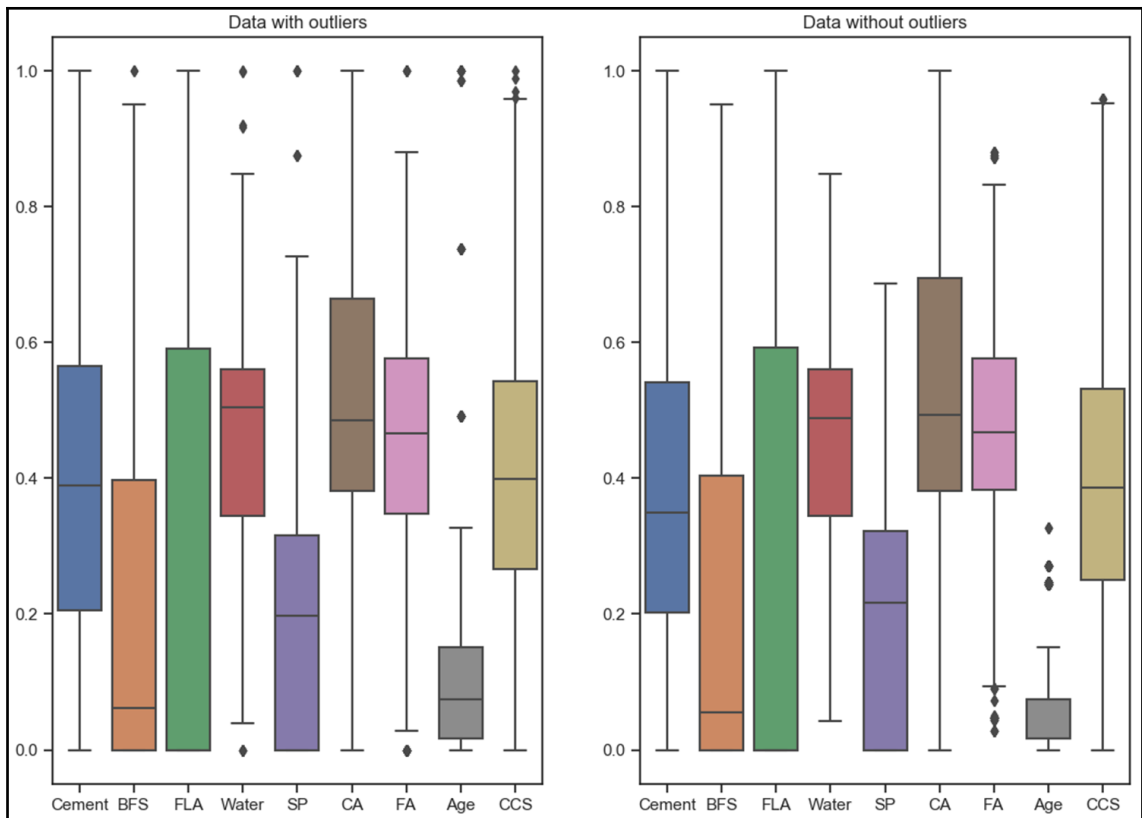
	Cement	BFS	FLA	Water	SP \
count	1029.000000	1029.000000	1029.000000	1029.000000	1029.000000
mean	0.408480	0.205808	0.271063	0.477728	0.192755
std	0.238004	0.240095	0.319866	0.170517	0.185568
min	0.000000	0.000000	0.000000	0.000000	0.000000
25%	0.205479	0.000000	0.000000	0.344511	0.000000
50%	0.389954	0.061213	0.000000	0.504990	0.197205
75%	0.566210	0.397885	0.591054	0.560878	0.315528
max	1.000000	1.000000	1.000000	1.000000	1.000000
	CA	FA	Age	CCS	
count	1029.000000	1029.000000	1029.000000	1029.000000	
mean	0.499574	0.450762	0.122745	0.416646	
std	0.226057	0.201095	0.173621	0.207517	
min	0.000000	0.000000	0.000000	0.000000	
25%	0.380814	0.347717	0.016484	0.266170	
50%	0.485465	0.465881	0.074176	0.399491	
75%	0.663953	0.577020	0.151099	0.543284	
max	1.000000	1.000000	1.000000	1.000000	



```

Epoch 990/1000
720/720 [=====] - 0s 68us/step - loss: 0.0024 - acc: 0.0014
Epoch 991/1000
720/720 [=====] - 0s 65us/step - loss: 0.0025 - acc: 0.0014
Epoch 992/1000
720/720 [=====] - 0s 69us/step - loss: 0.0024 - acc: 0.0014
Epoch 993/1000
720/720 [=====] - 0s 69us/step - loss: 0.0025 - acc: 0.0014
Epoch 994/1000
720/720 [=====] - 0s 68us/step - loss: 0.0024 - acc: 0.0014
Epoch 995/1000
720/720 [=====] - 0s 69us/step - loss: 0.0024 - acc: 0.0014
Epoch 996/1000
720/720 [=====] - 0s 68us/step - loss: 0.0025 - acc: 0.0014
Epoch 997/1000
720/720 [=====] - 0s 67us/step - loss: 0.0024 - acc: 0.0014
Epoch 998/1000
720/720 [=====] - 0s 71us/step - loss: 0.0025 - acc: 0.0014
Epoch 999/1000
720/720 [=====] - 0s 68us/step - loss: 0.0025 - acc: 0.0014
Epoch 1000/1000
720/720 [=====] - 0s 67us/step - loss: 0.0025 - acc: 0.0014

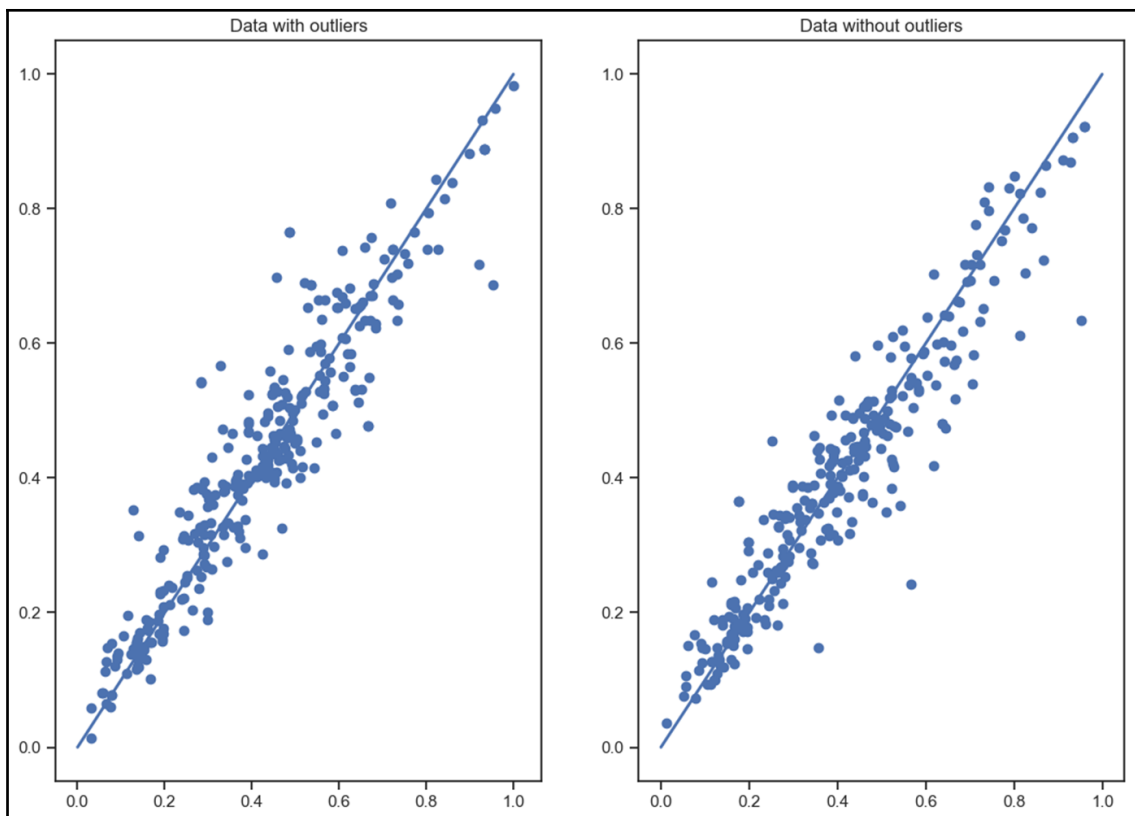
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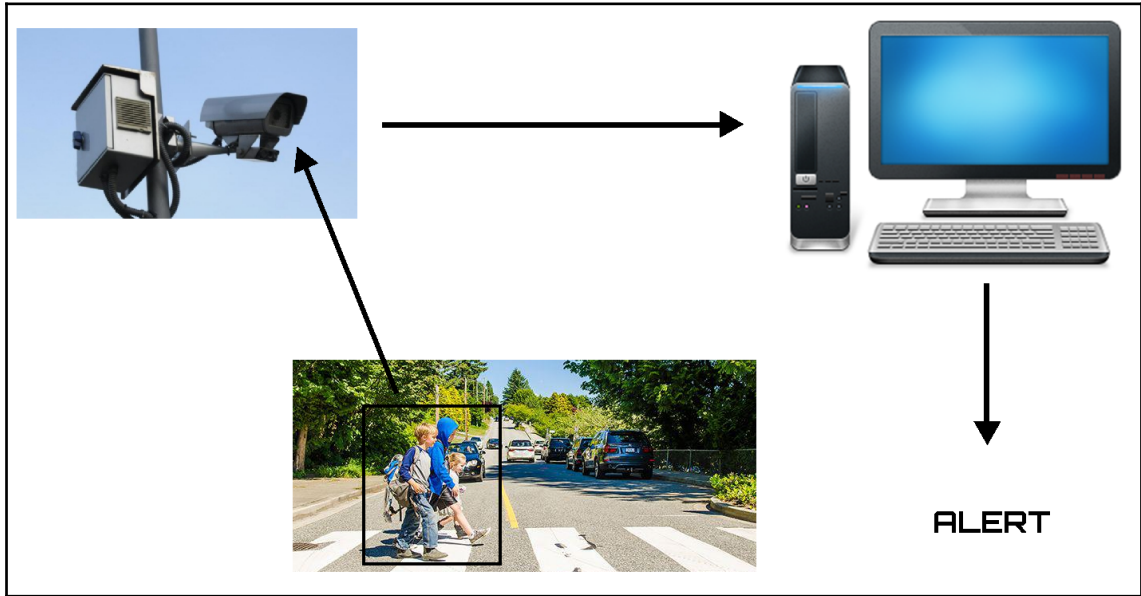
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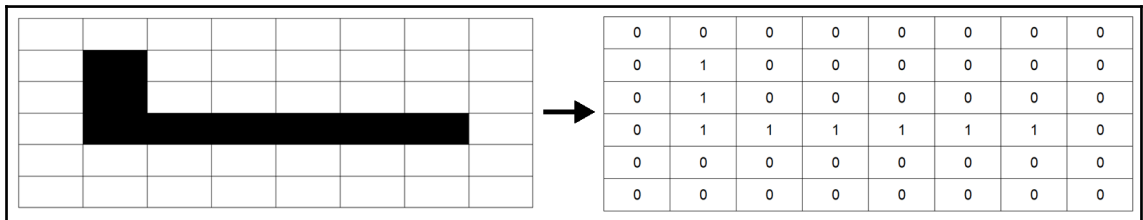
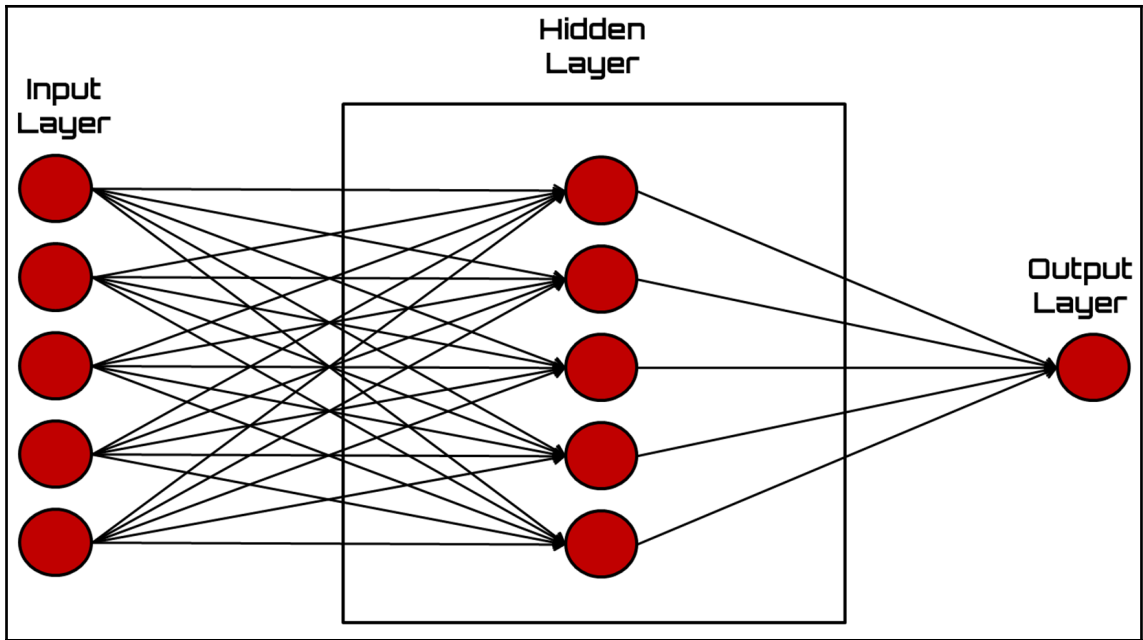
Epoch 990/1000
647/647 [=====] - 0s 70us/step - loss: 0.0022 - acc: 0.0015
Epoch 991/1000
647/647 [=====] - 0s 70us/step - loss: 0.0022 - acc: 0.0015
Epoch 992/1000
647/647 [=====] - 0s 65us/step - loss: 0.0021 - acc: 0.0015
Epoch 993/1000
647/647 [=====] - 0s 71us/step - loss: 0.0021 - acc: 0.0015
Epoch 994/1000
647/647 [=====] - 0s 66us/step - loss: 0.0022 - acc: 0.0015
Epoch 995/1000
647/647 [=====] - 0s 65us/step - loss: 0.0022 - acc: 0.0015
Epoch 996/1000
647/647 [=====] - 0s 68us/step - loss: 0.0023 - acc: 0.0015
Epoch 997/1000
647/647 [=====] - 0s 65us/step - loss: 0.0023 - acc: 0.0015
Epoch 998/1000
647/647 [=====] - 0s 71us/step - loss: 0.0022 - acc: 0.0015
Epoch 999/1000
647/647 [=====] - 0s 65us/step - loss: 0.0021 - acc: 0.0015
Epoch 1000/1000
647/647 [=====] - 0s 63us/step - loss: 0.0022 - acc: 0.0015

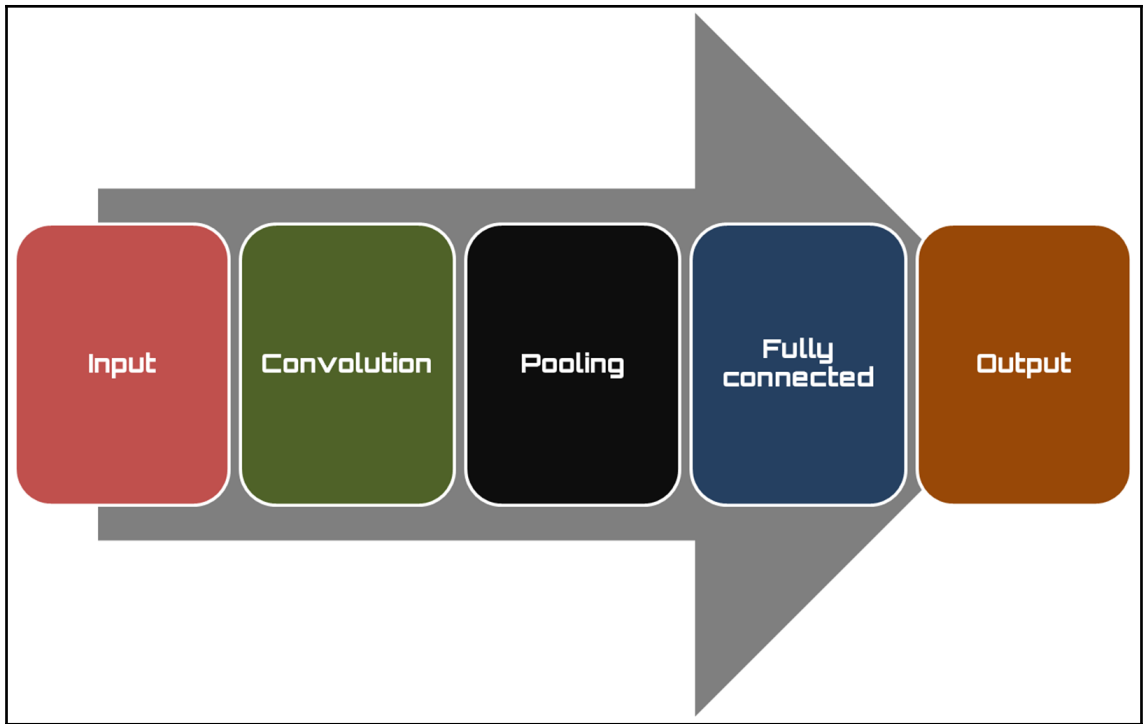
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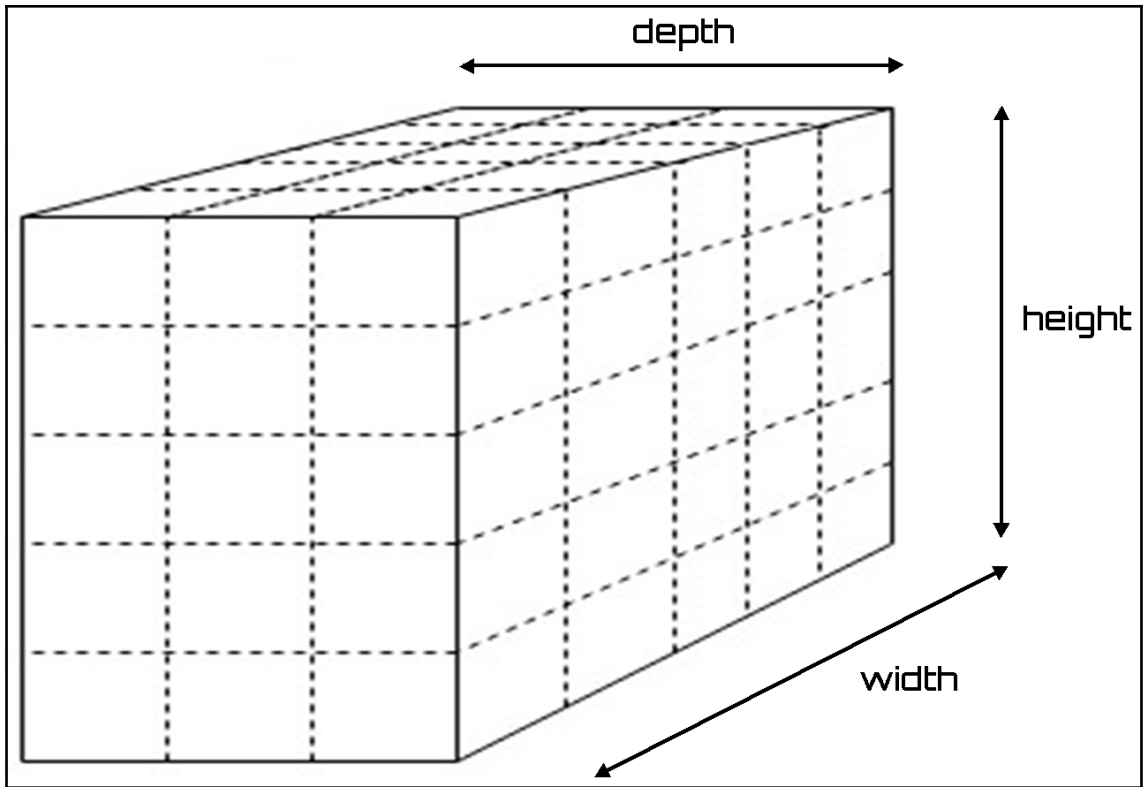


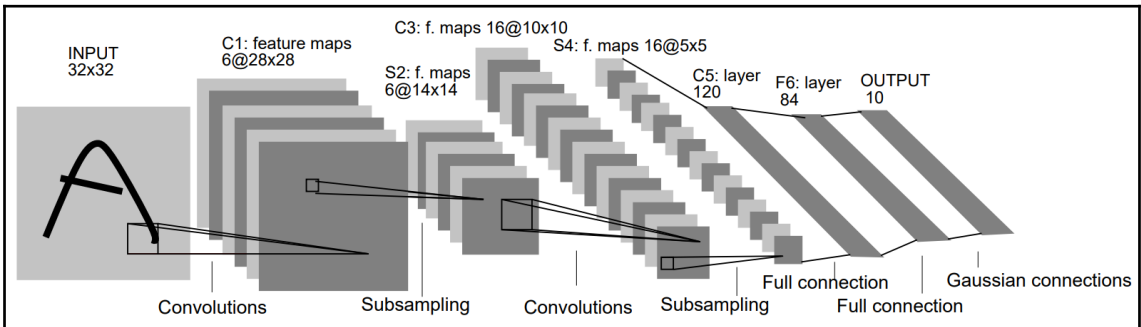
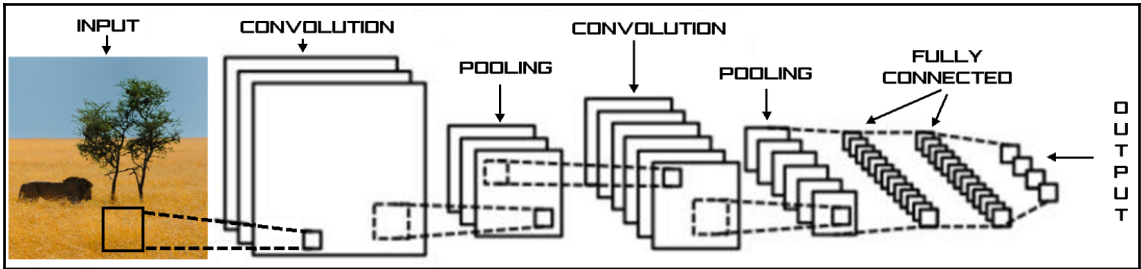
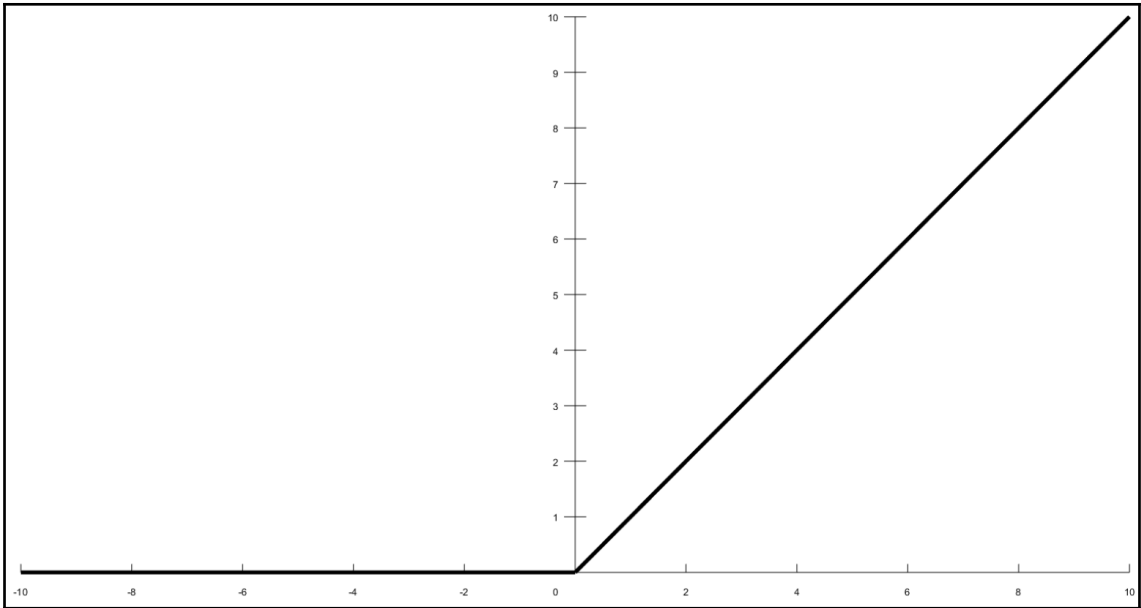
Chapter 5: Fashion Article Recognition Using Convolutional Neural Networks

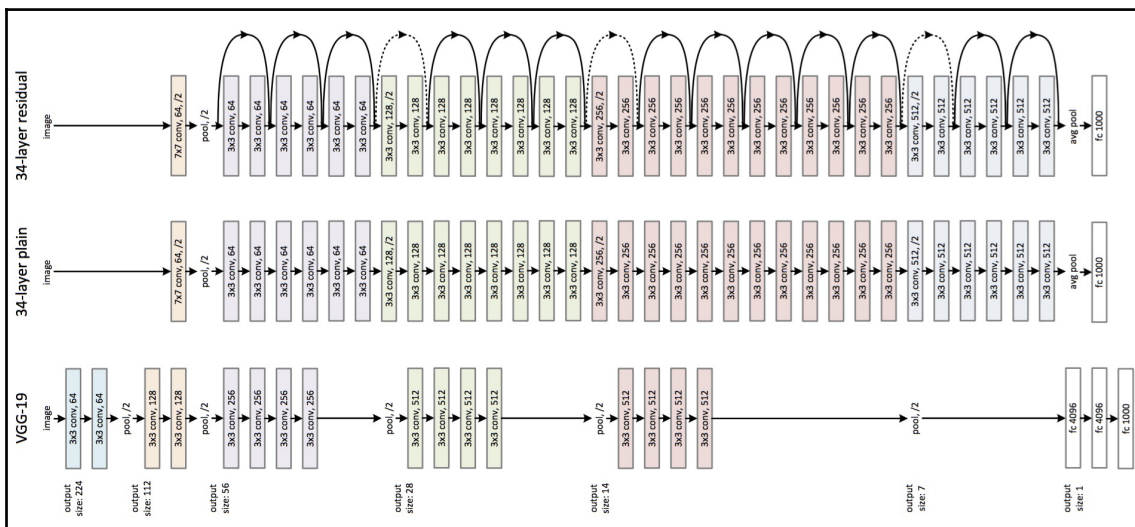
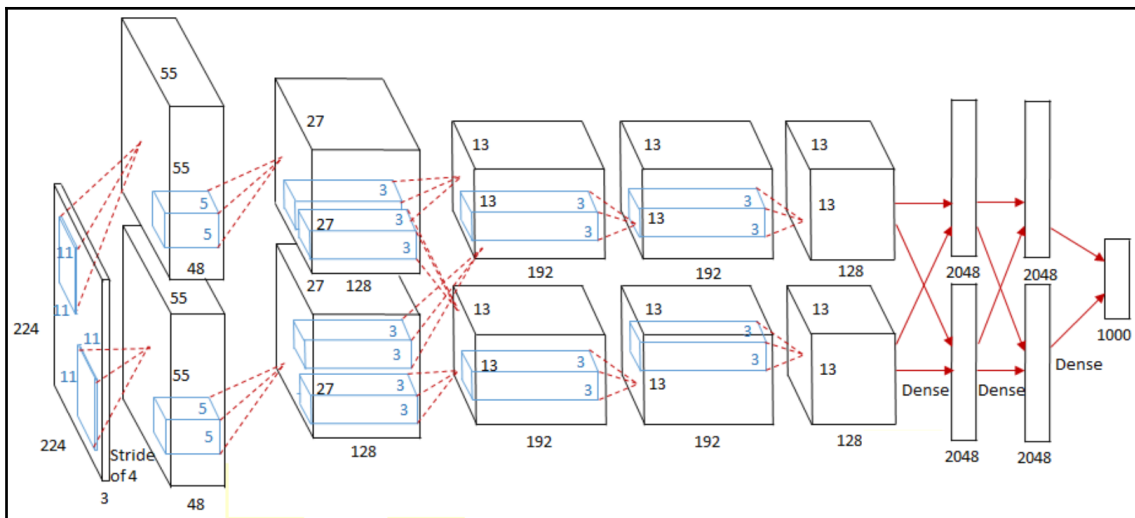


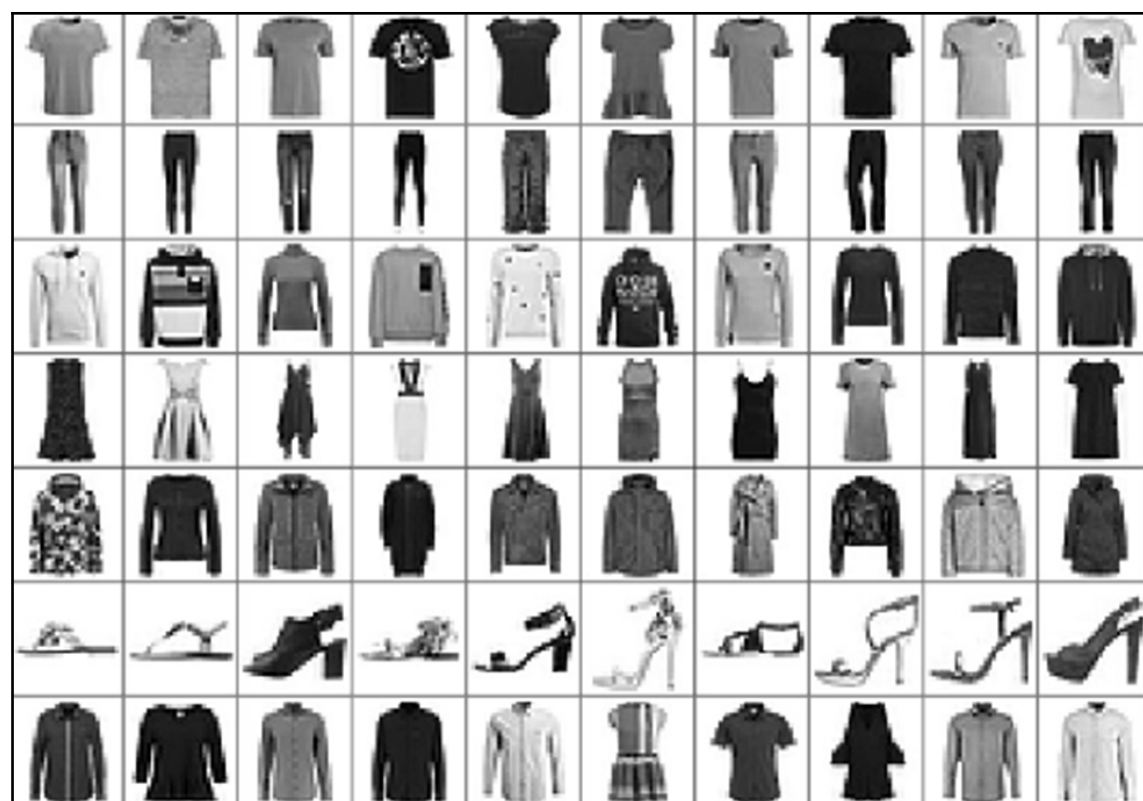


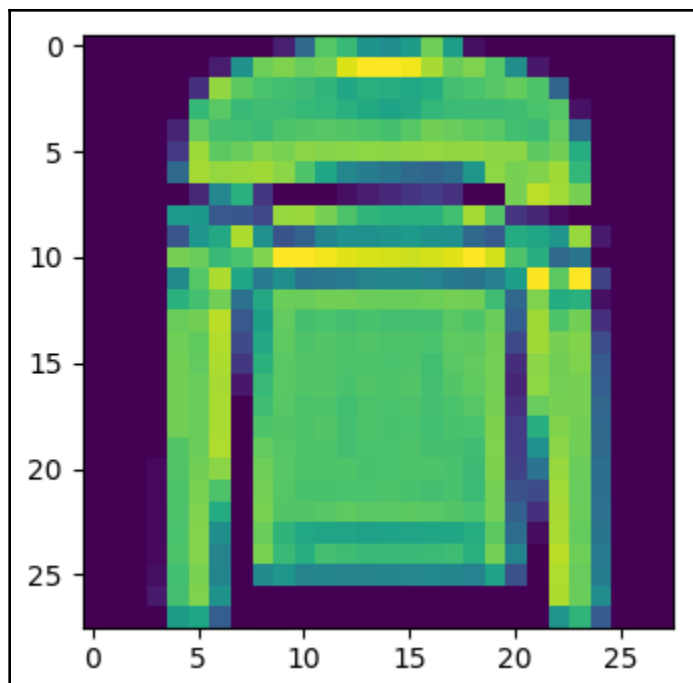


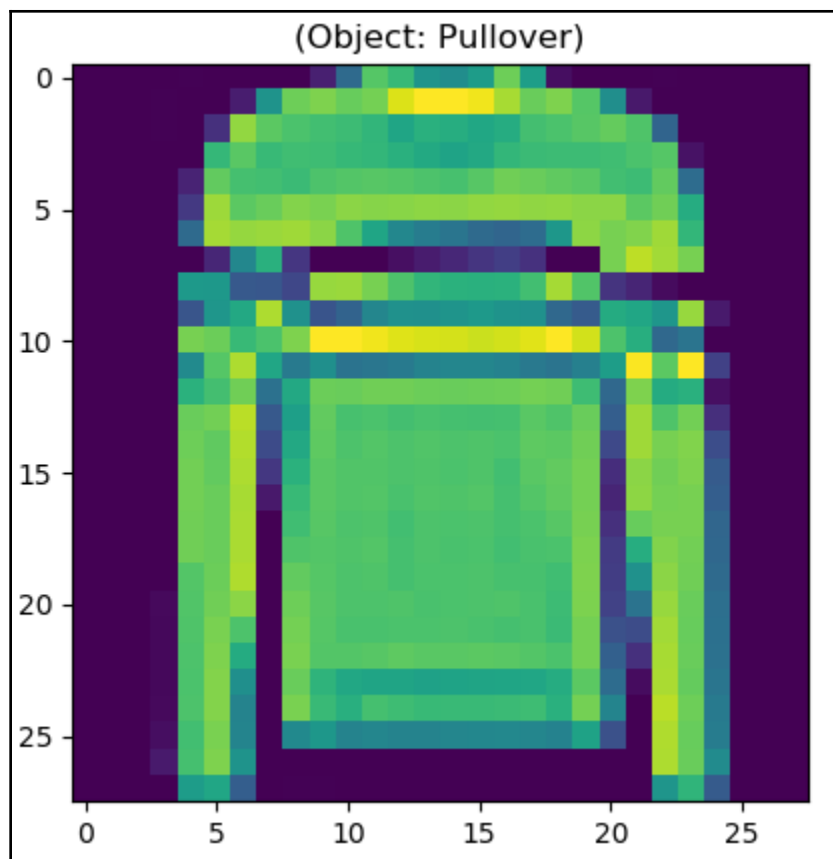












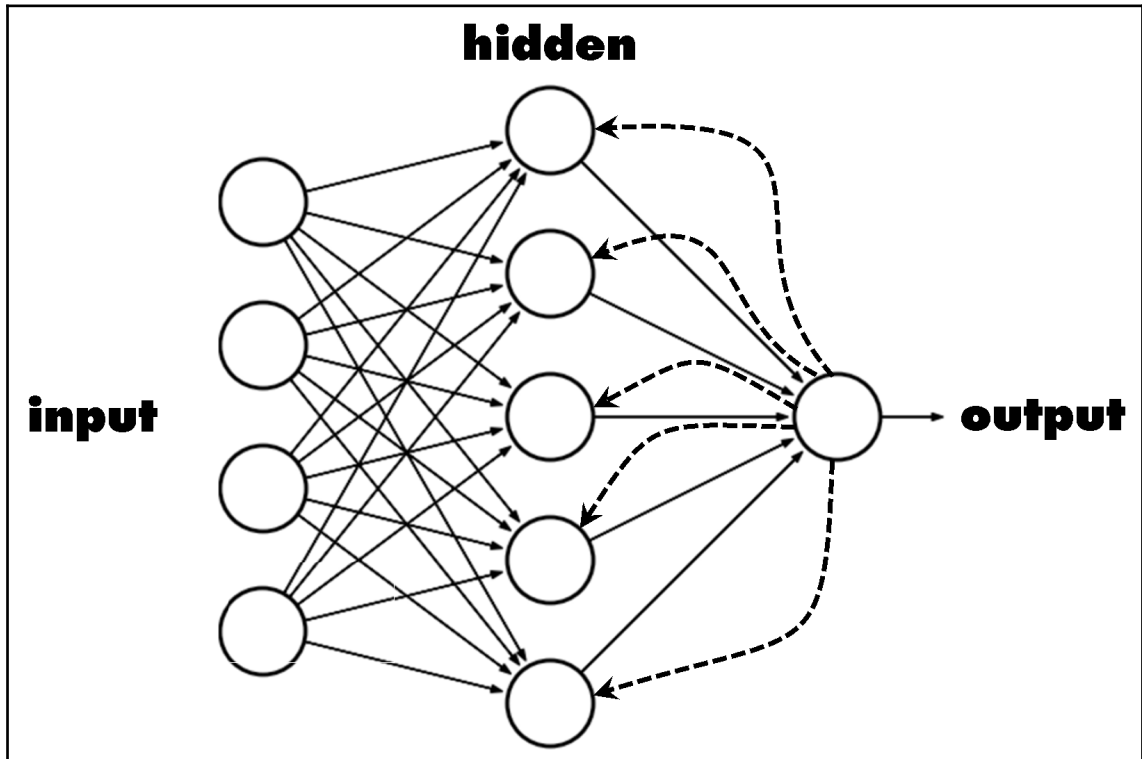
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
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1	0	0	0	1	0	0	20	131	199	206	196	202	242	255	255	250	222	197	206	188	126	17	0	0	0	0	0	0
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4	0	0	0	0	25	194	180	178	174	184	187	189	187	184	181	189	200	197	193	190	178	175	194	90	0	0	0	0
5	0	0	0	0	42	218	191	197	208	204	211	209	210	212	211	214	215	213	214	211	211	191	200	158	0	0	0	0
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7	0	0	0	0	0	27	118	162	40	0	0	0	10	19	28	39	47	36	0	0	203	230	220	203	0	0	0	0
8	0	0	0	0	138	136	71	69	54	216	217	203	184	168	163	162	163	178	221	186	38	26	7	0	0	0	0	0
9	0	0	0	0	67	134	154	224	129	66	81	117	129	128	132	137	131	129	86	73	157	151	134	216	18	0	0	0
10	0	0	0	0	203	198	172	183	206	255	255	250	243	240	239	235	238	244	255	238	184	160	86	98	0	0	0	0
11	0	0	0	0	122	188	224	151	105	127	97	100	105	114	117	117	113	103	98	111	142	254	191	255	49	0	0	0
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15	0	0	0	0	201	194	224	41	163	190	186	186	184	185	183	185	178	190	194	202	33	211	200	206	73	0	0	0
16	0	0	0	0	201	197	222	17	172	190	186	187	182	186	185	187	180	187	193	202	26	212	202	203	76	0	0	0
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19	0	0	0	0	187	198	225	0	194	188	184	185	180	183	183	184	181	181	177	206	46	129	211	200	88	0	0	0
20	0	0	0	6	186	200	211	0	199	189	184	184	185	182	183	184	185	182	175	205	50	97	216	197	93	0	0	0
21	0	0	0	5	185	204	184	0	202	188	182	182	183	183	184	182	180	182	174	202	63	59	220	196	94	0	0	0
22	0	0	0	5	184	206	157	0	204	187	187	189	192	190	190	191	190	187	183	202	78	35	222	197	95	0	0	0
23	0	0	0	5	183	208	127	0	197	166	153	149	149	146	148	149	150	151	158	191	90	8	223	195	99	0	0	0
24	0	0	0	6	184	208	114	0	204	173	161	180	176	172	173	173	174	176	162	202	115	0	229	199	105	0	0	0
25	0	0	0	9	178	204	115	0	121	135	114	117	114	114	117	118	119	117	113	147	63	0	225	196	107	0	0	0
26	0	0	0	18	180	206	131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	224	197	123	0	0	0
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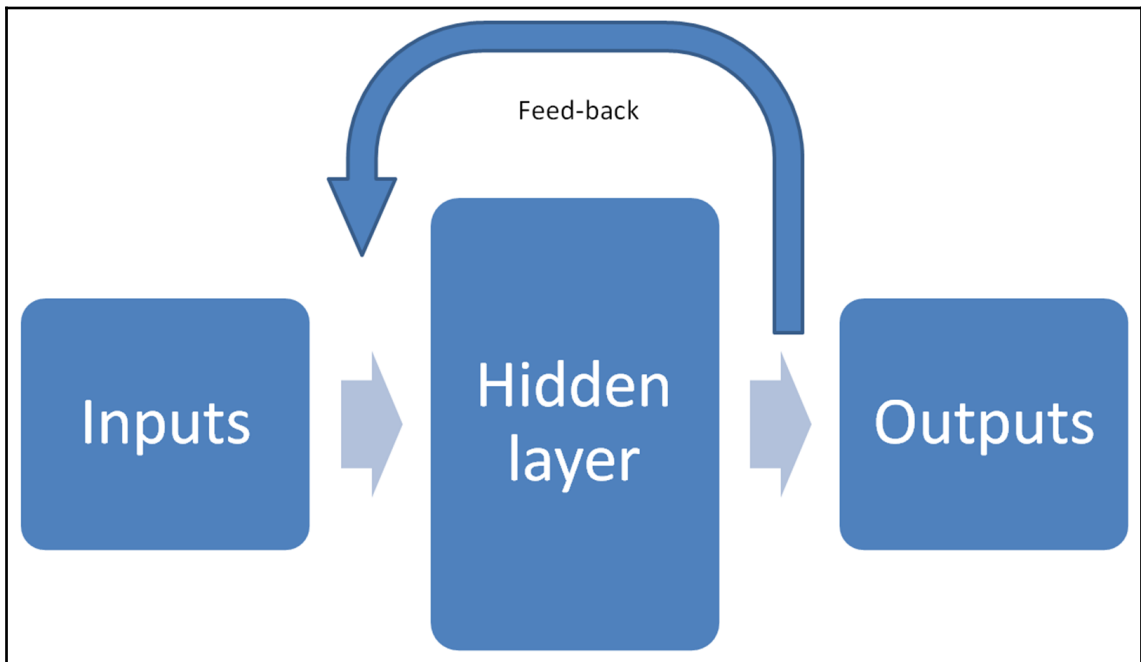
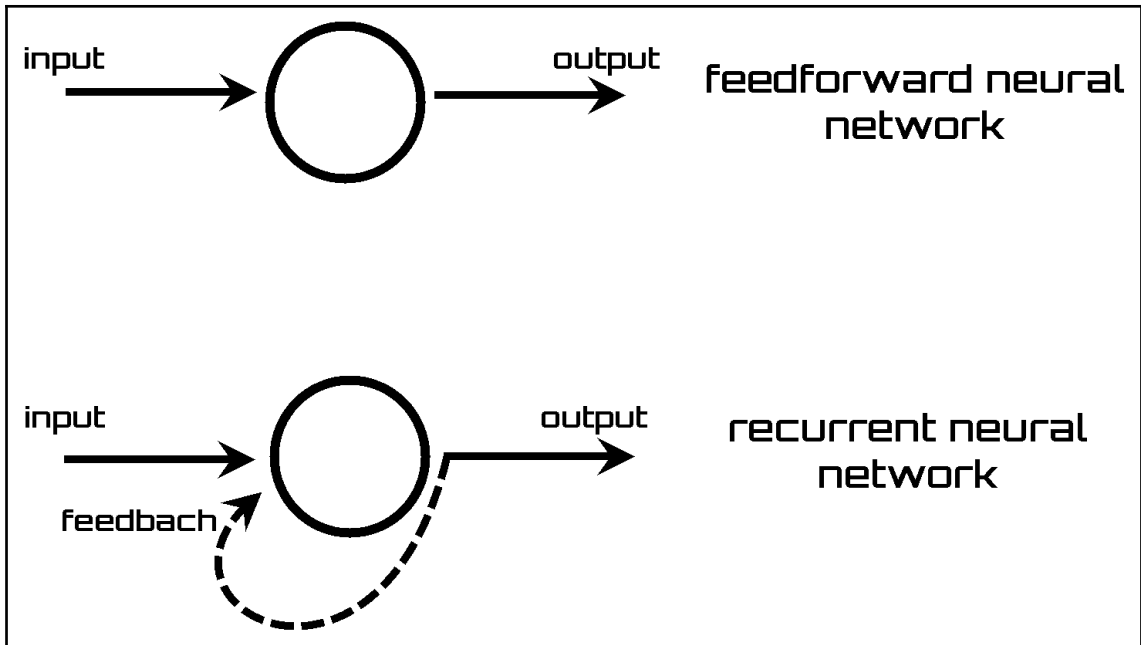


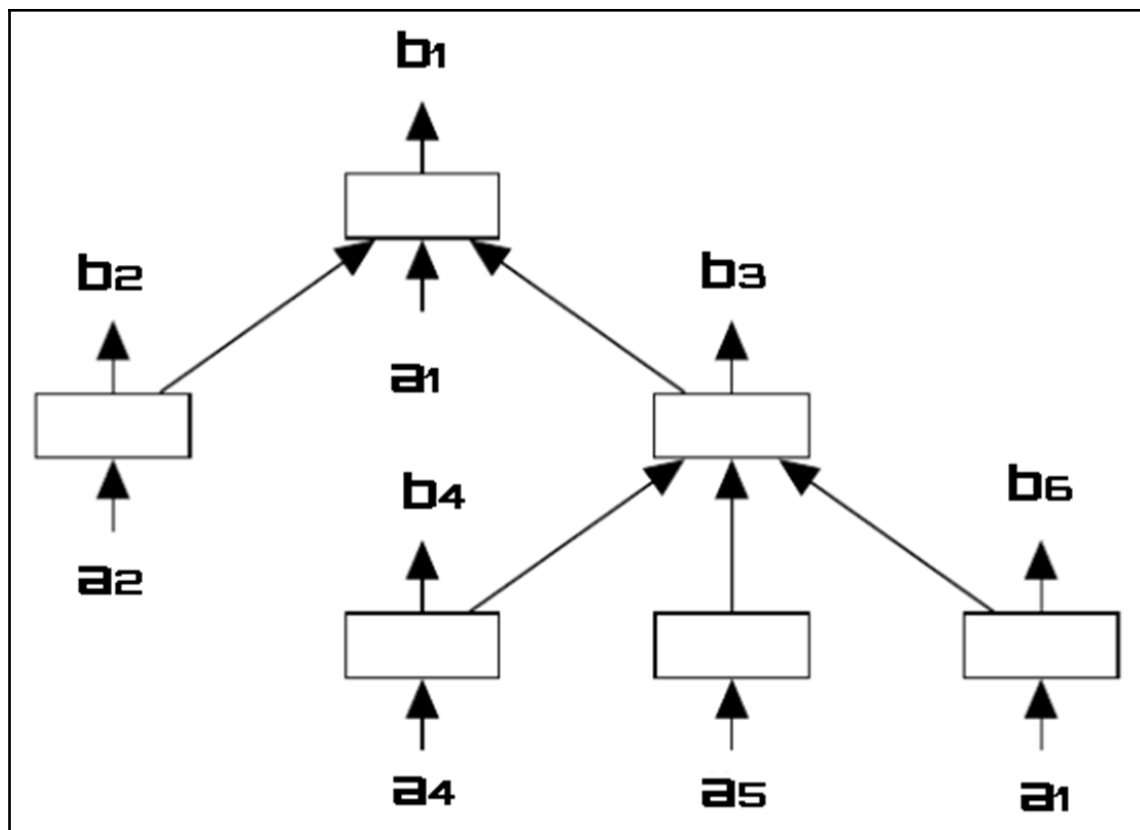
Layer (type)	Output Shape	Param #
conv2d_20 (Conv2D)	(None, 1, 28, 32)	3616
activation_6 (Activation)	(None, 1, 28, 32)	0
max_pooling2d_14 (MaxPooling)	(None, 1, 14, 32)	0
conv2d_21 (Conv2D)	(None, 1, 14, 64)	8256
activation_7 (Activation)	(None, 1, 14, 64)	0
max_pooling2d_15 (MaxPooling)	(None, 1, 7, 64)	0
flatten_7 (Flatten)	(None, 448)	0
dense_13 (Dense)	(None, 128)	57472
dense_14 (Dense)	(None, 10)	1290
=====		
Total params: 70,634		
Trainable params: 70,634		
Non-trainable params: 0		

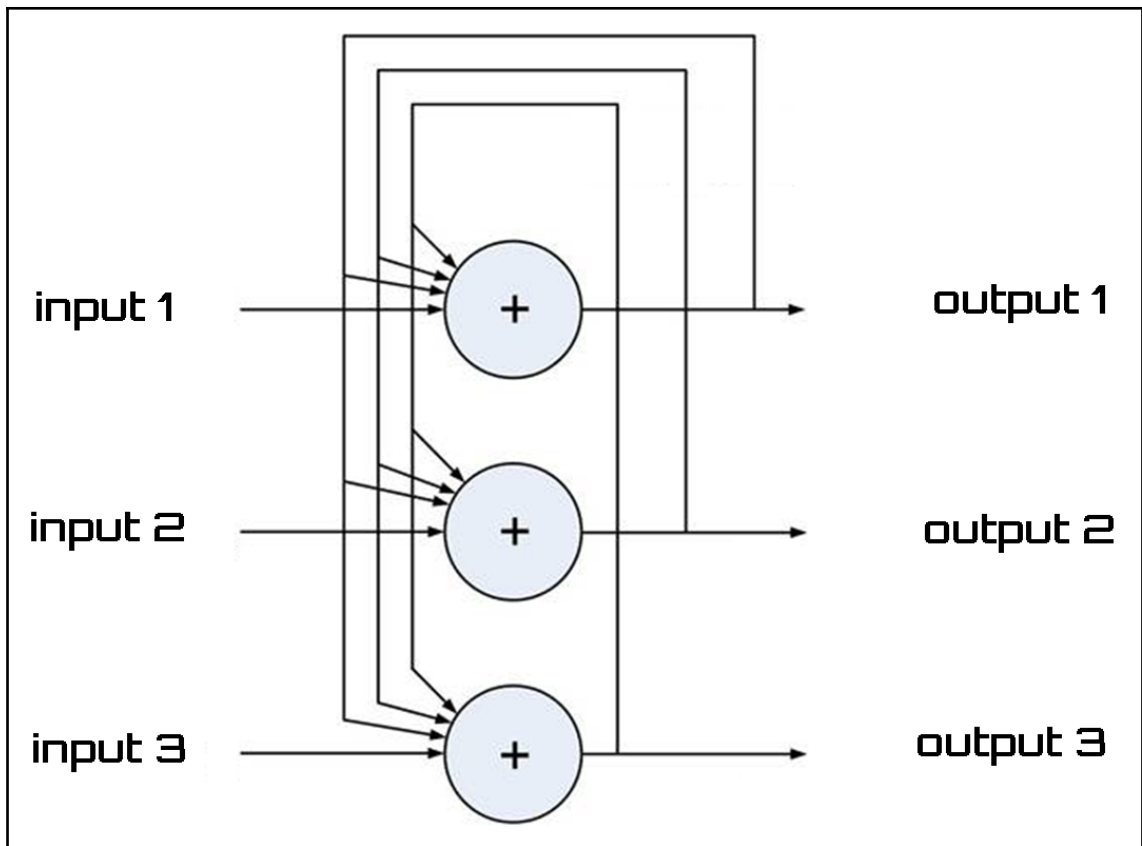
```
Epoch 990/1000
60000/60000 [=====] - 17s 275us/step - loss: 0.0200 - acc: 0.9955
Epoch 991/1000
60000/60000 [=====] - 17s 277us/step - loss: 0.0220 - acc: 0.9951
Epoch 992/1000
60000/60000 [=====] - 17s 277us/step - loss: 0.0231 - acc: 0.9949
Epoch 993/1000
60000/60000 [=====] - 16s 275us/step - loss: 0.0220 - acc: 0.9949
Epoch 994/1000
60000/60000 [=====] - 17s 276us/step - loss: 0.0248 - acc: 0.9944
Epoch 995/1000
60000/60000 [=====] - 17s 276us/step - loss: 0.0177 - acc: 0.9958
Epoch 996/1000
60000/60000 [=====] - 17s 276us/step - loss: 0.0230 - acc: 0.9946
Epoch 997/1000
60000/60000 [=====] - 16s 275us/step - loss: 0.0242 - acc: 0.9950
Epoch 998/1000
60000/60000 [=====] - 16s 275us/step - loss: 0.0261 - acc: 0.9944
Epoch 999/1000
60000/60000 [=====] - 17s 275us/step - loss: 0.0208 - acc: 0.9954
Epoch 1000/1000
60000/60000 [=====] - 17s 276us/step - loss: 0.0245 - acc: 0.9948
```

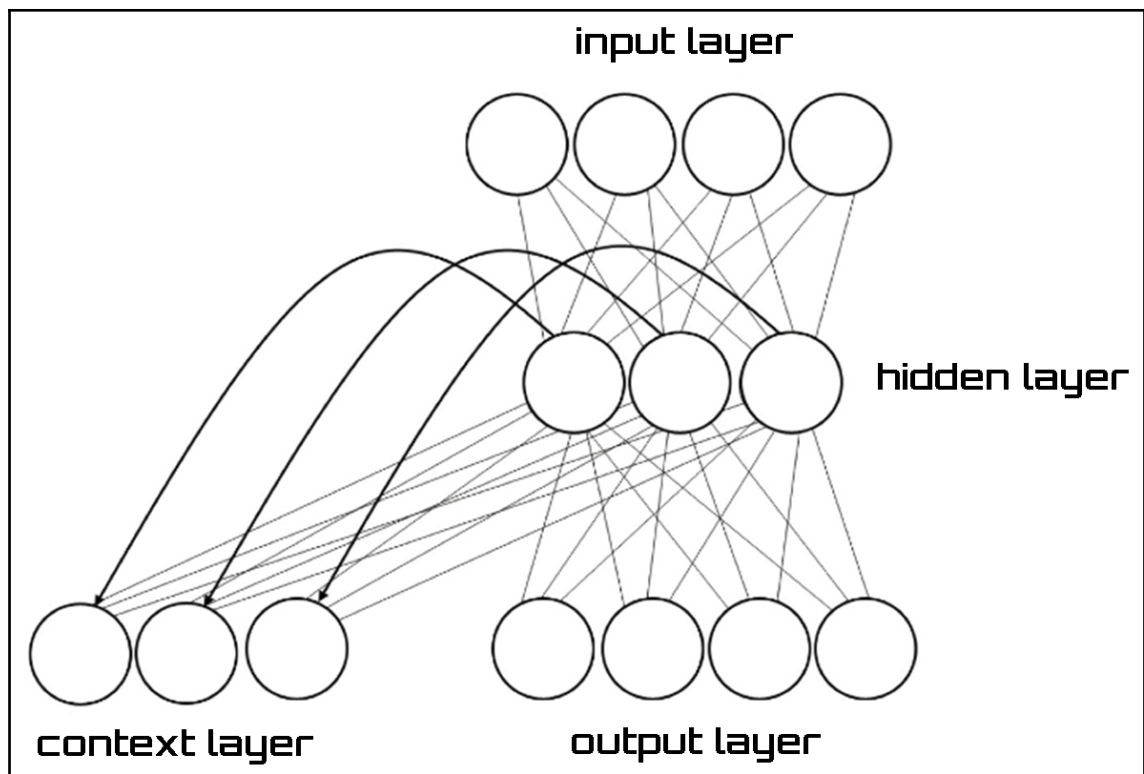
Chapter 6: Movie Reviews Sentiment Analysis Using Recurrent Neural Networks

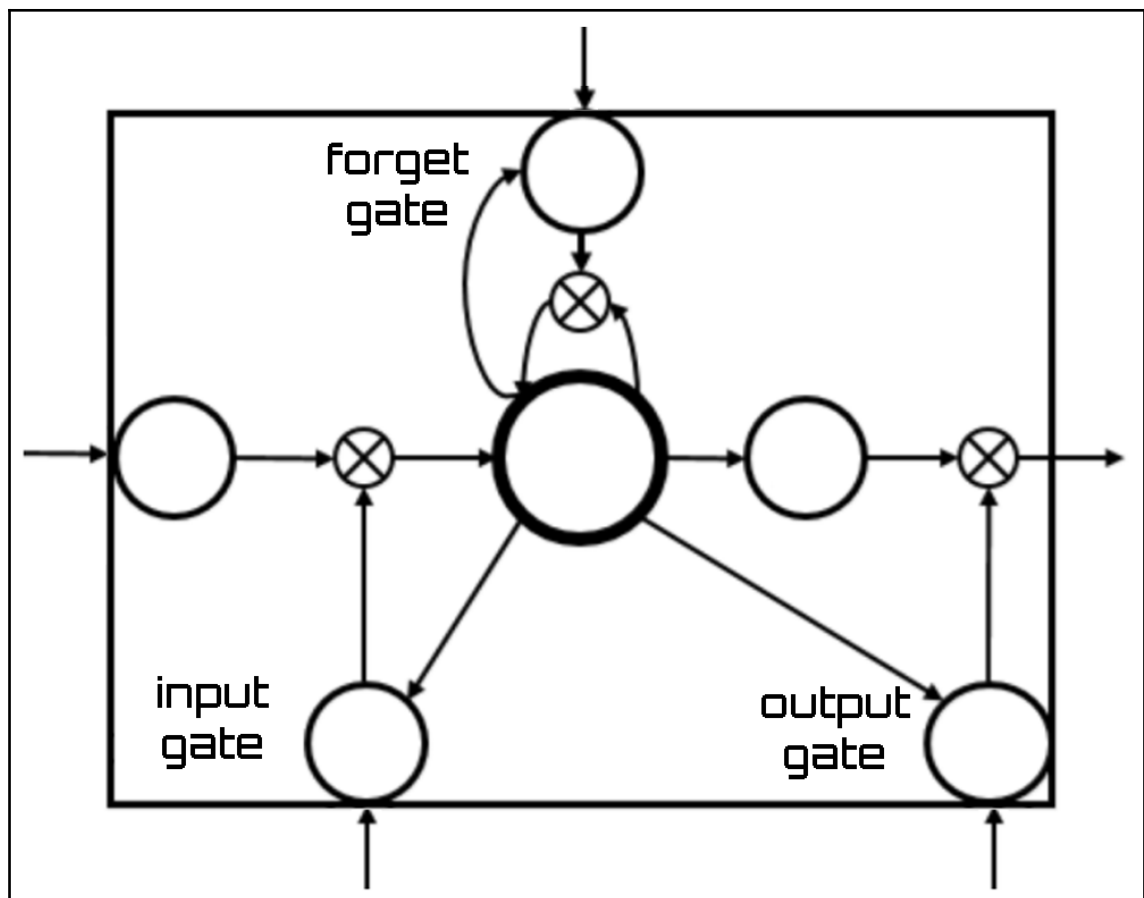


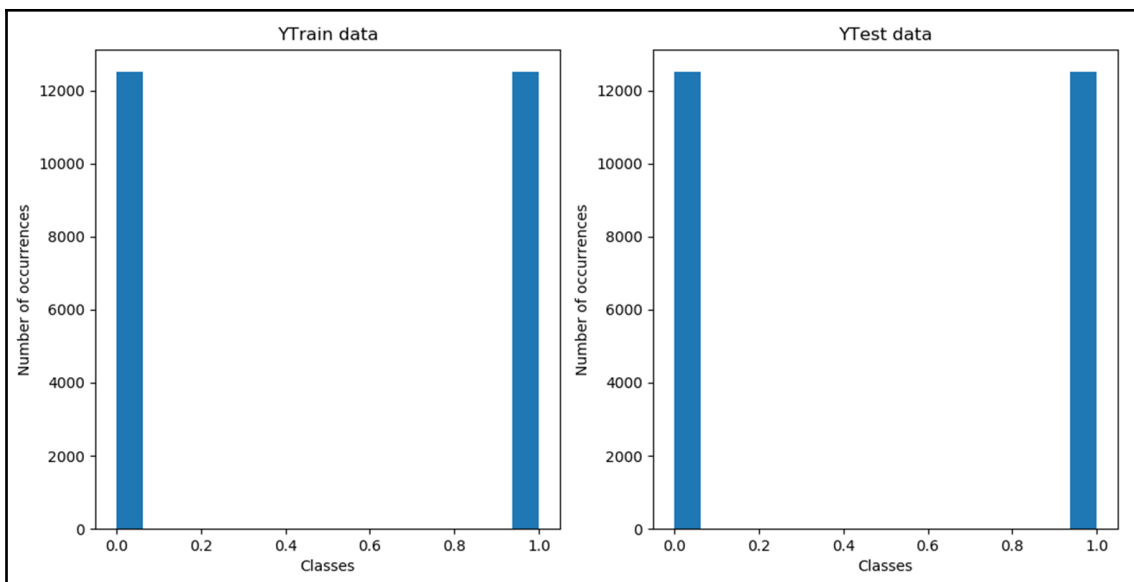












```
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38, 1334, 88, 12, 16, 283, 5, 16, 4472, 113, 103, 32, 15, 16, 5345, 19, 178, 32]
```


Layer (type)	Output Shape	Param #
=====	=====	=====
embedding_15 (Embedding)	(None, 100, 32)	320000
simple_rnn_15 (SimpleRNN)	(None, 32)	2080
dense_22 (Dense)	(None, 1)	33
=====	=====	=====
Total params: 322,113		
Trainable params: 322,113		
Non-trainable params: 0		

Train on 25000 samples, validate on 25000 samples

Epoch 1/3

25000/25000 [=====] - 13s 538us/step - loss: 0.5606 - acc: 0.6901
- val_loss: 0.4697 - val_acc: 0.7800

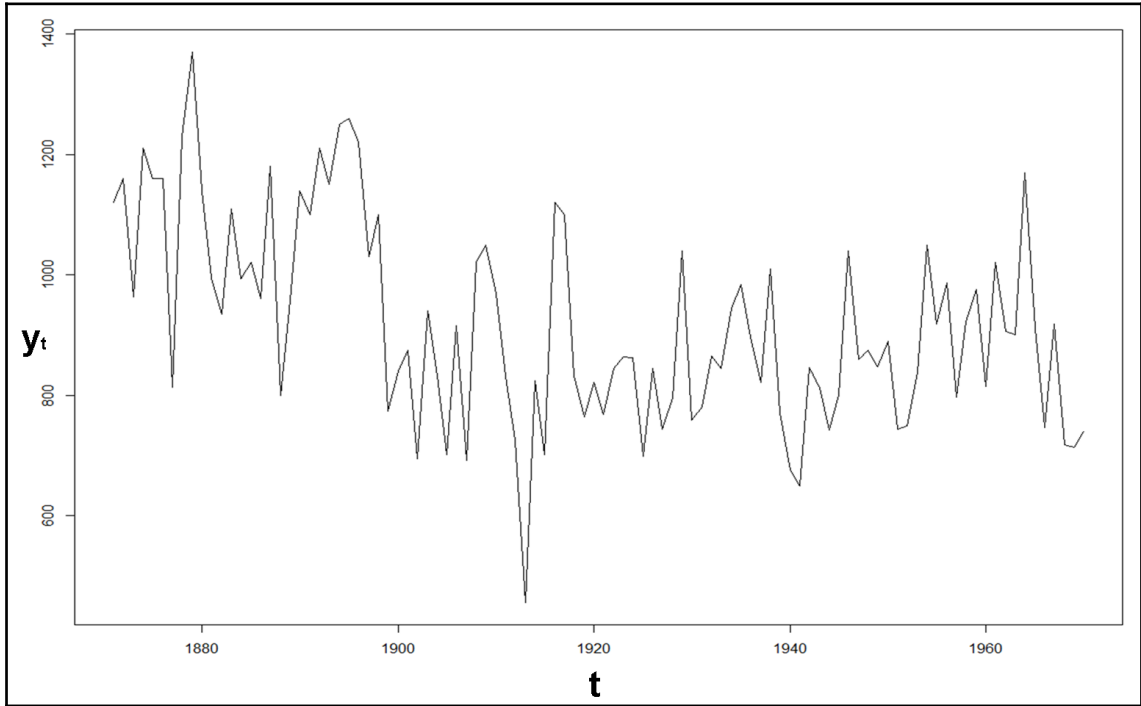
Epoch 2/3

25000/25000 [=====] - 12s 465us/step - loss: 0.3440 - acc: 0.8558
- val_loss: 0.3983 - val_acc: 0.8194

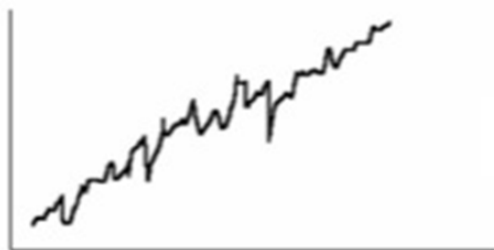
Epoch 3/3

25000/25000 [=====] - 12s 470us/step - loss: 0.2659 - acc: 0.8933
- val_loss: 0.3938 - val_acc: 0.8435

Chapter 7: Stock Volatility Forecasting Using Long Short-Term Memory



time series



trend

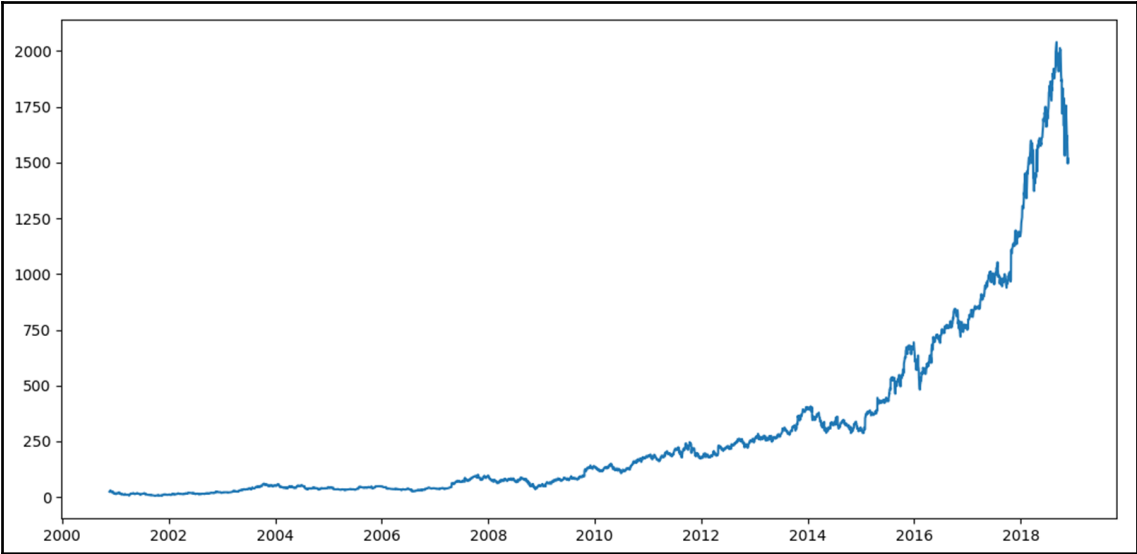
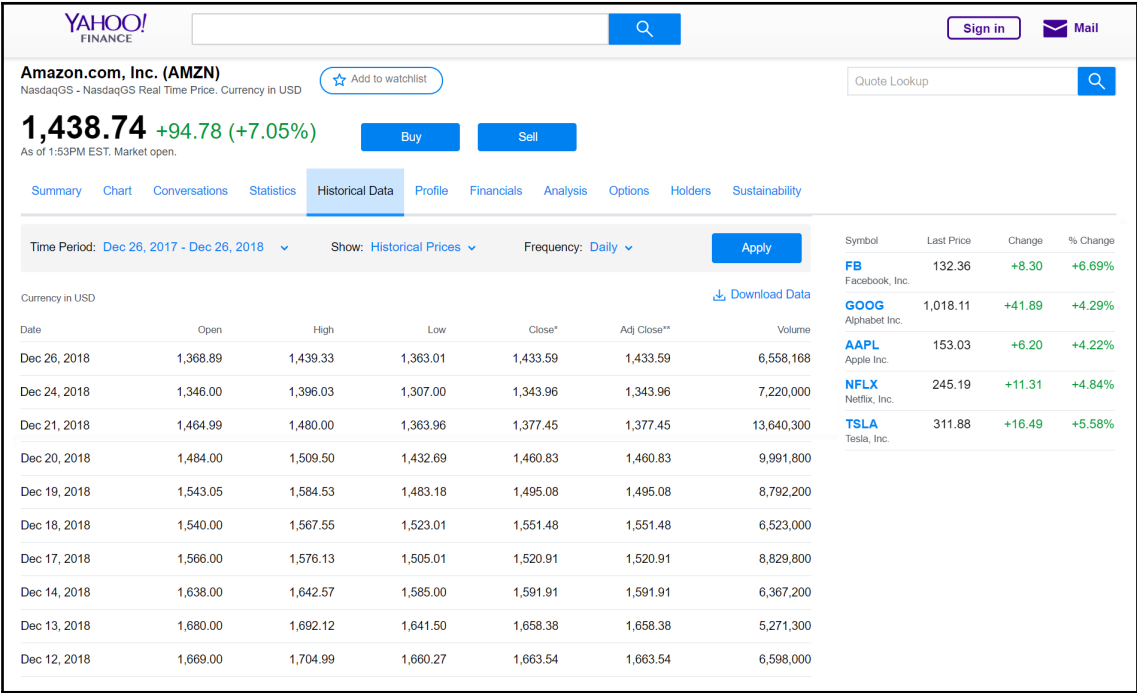


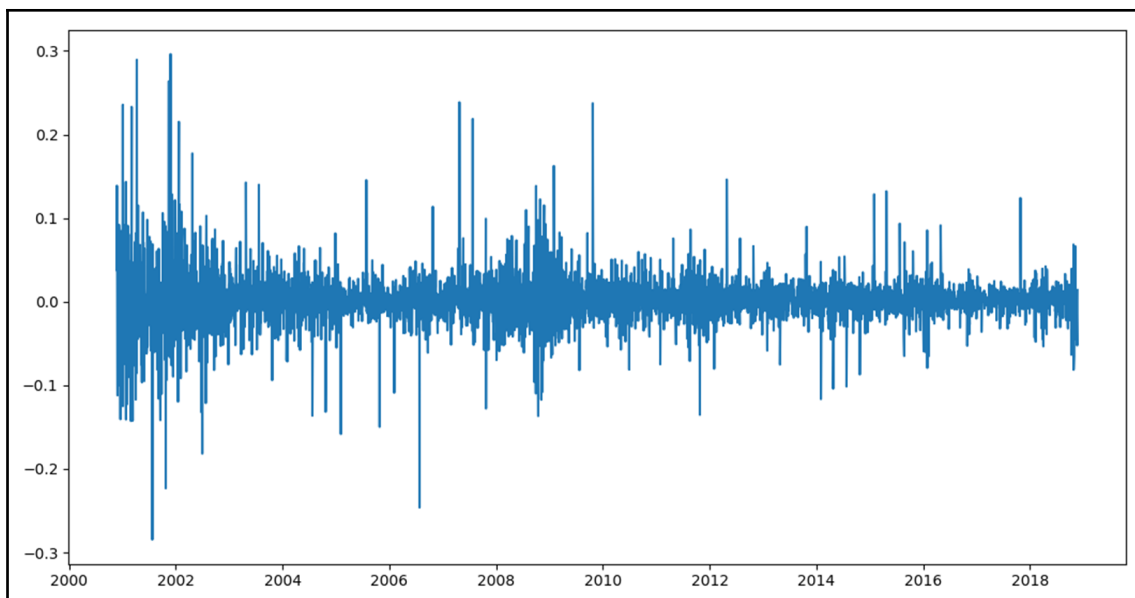
Seasonal



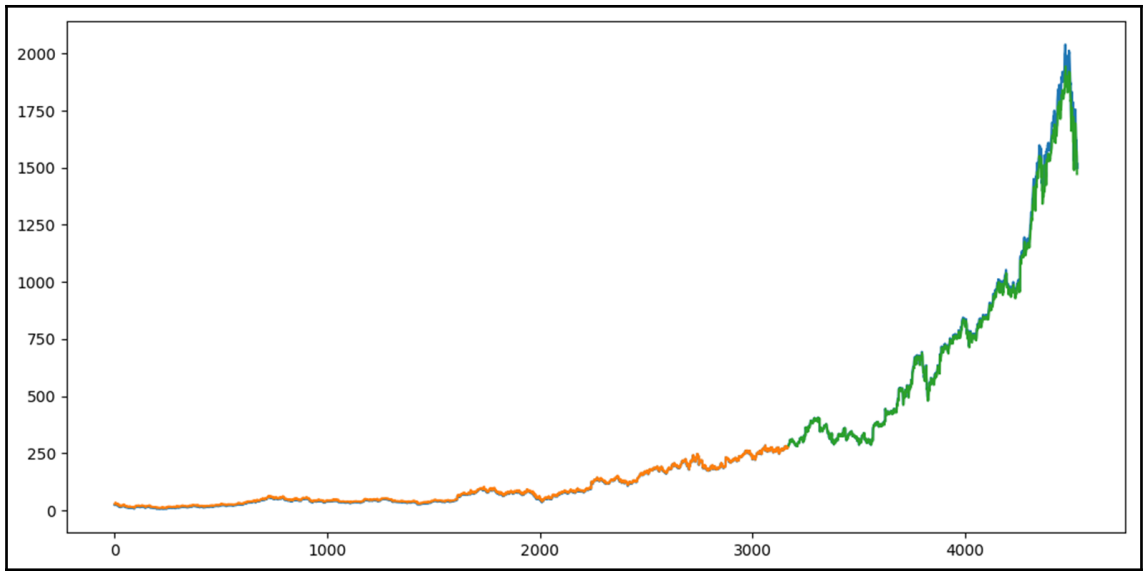
residual



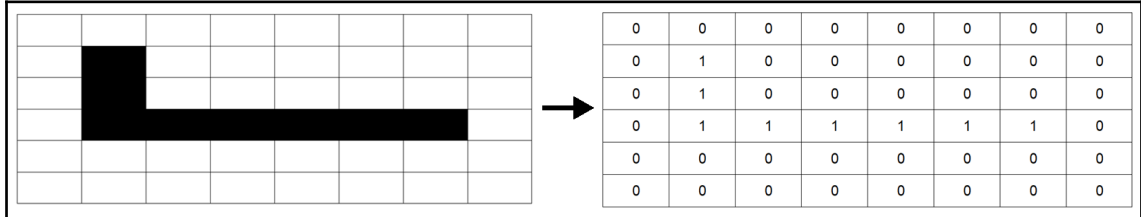


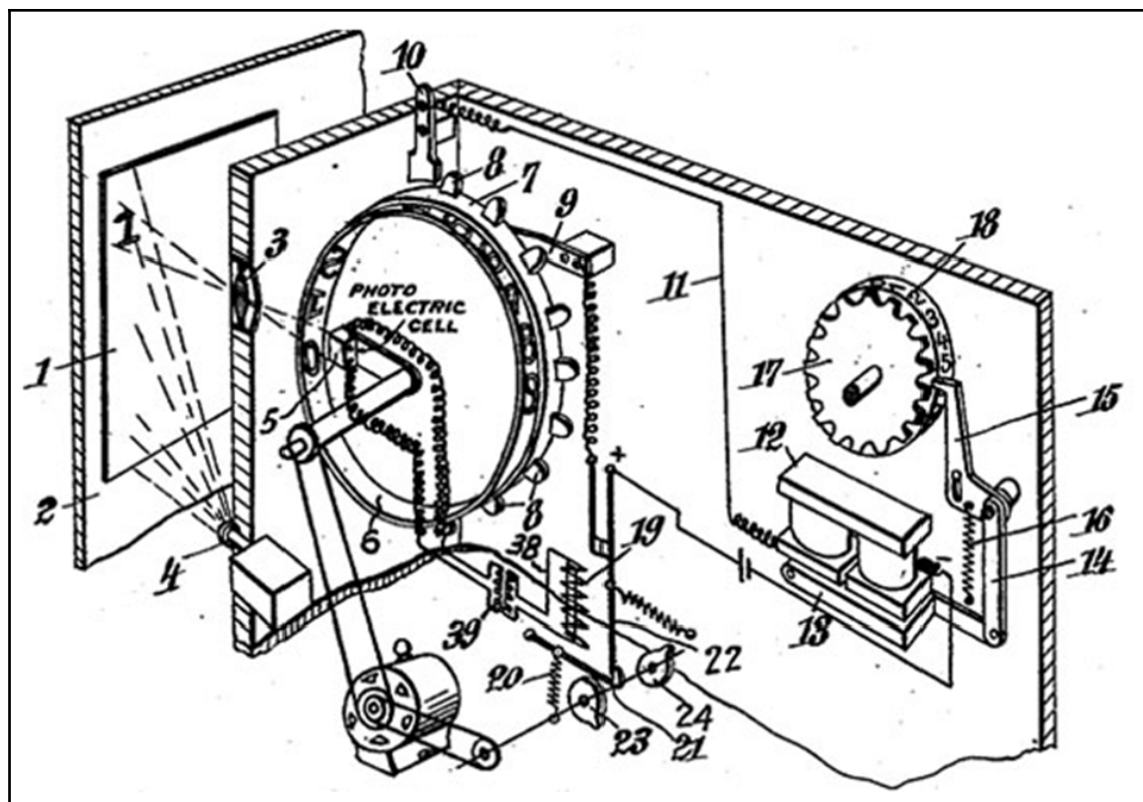


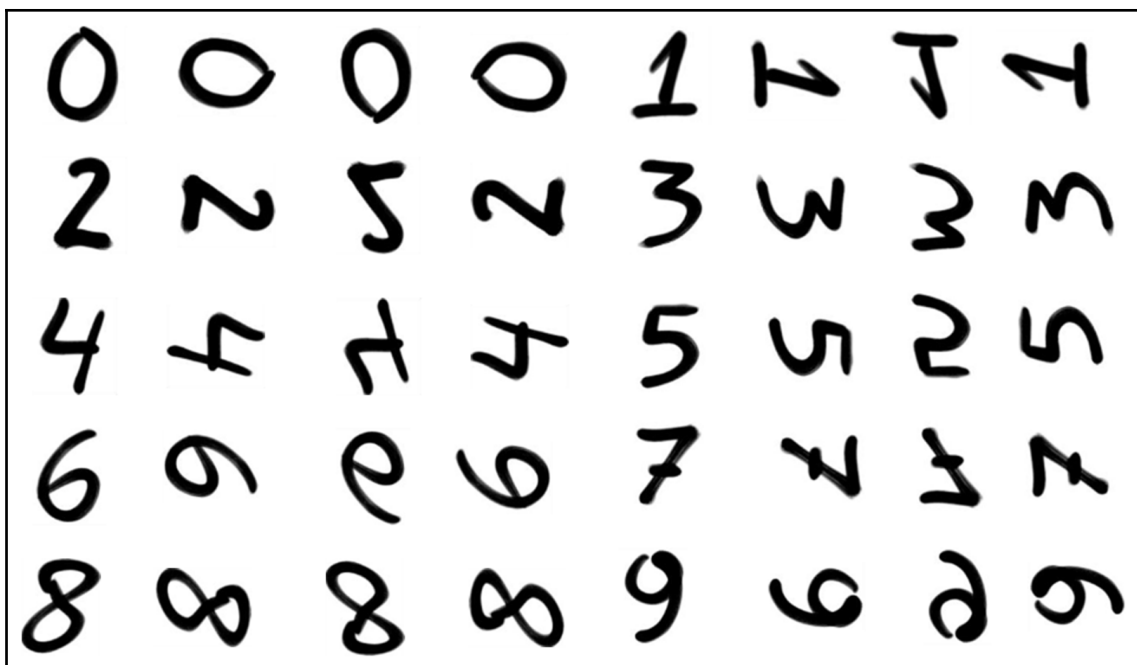
Layer (type)	Output Shape	Param #
lstm_9 (LSTM)	(None, 256)	264192
dense_10 (Dense)	(None, 1)	257
Total params: 264,449		
Trainable params: 264,449		
Non-trainable params: 0		

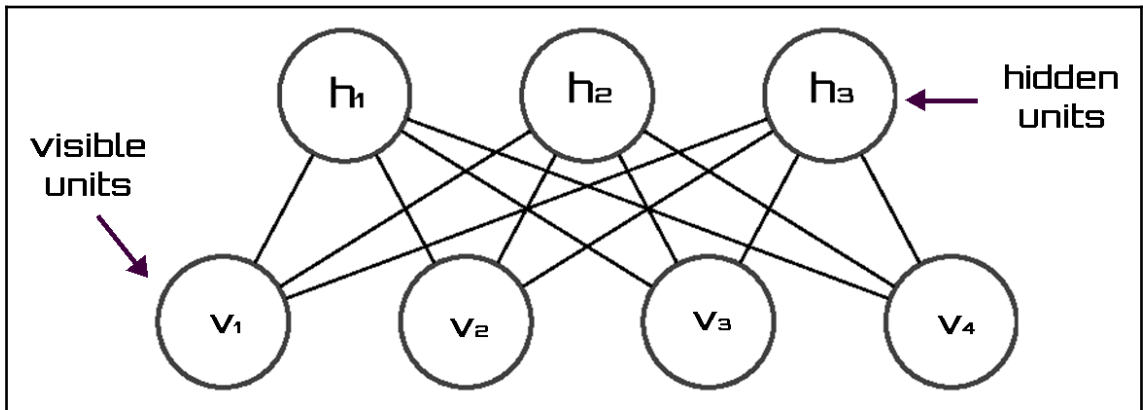
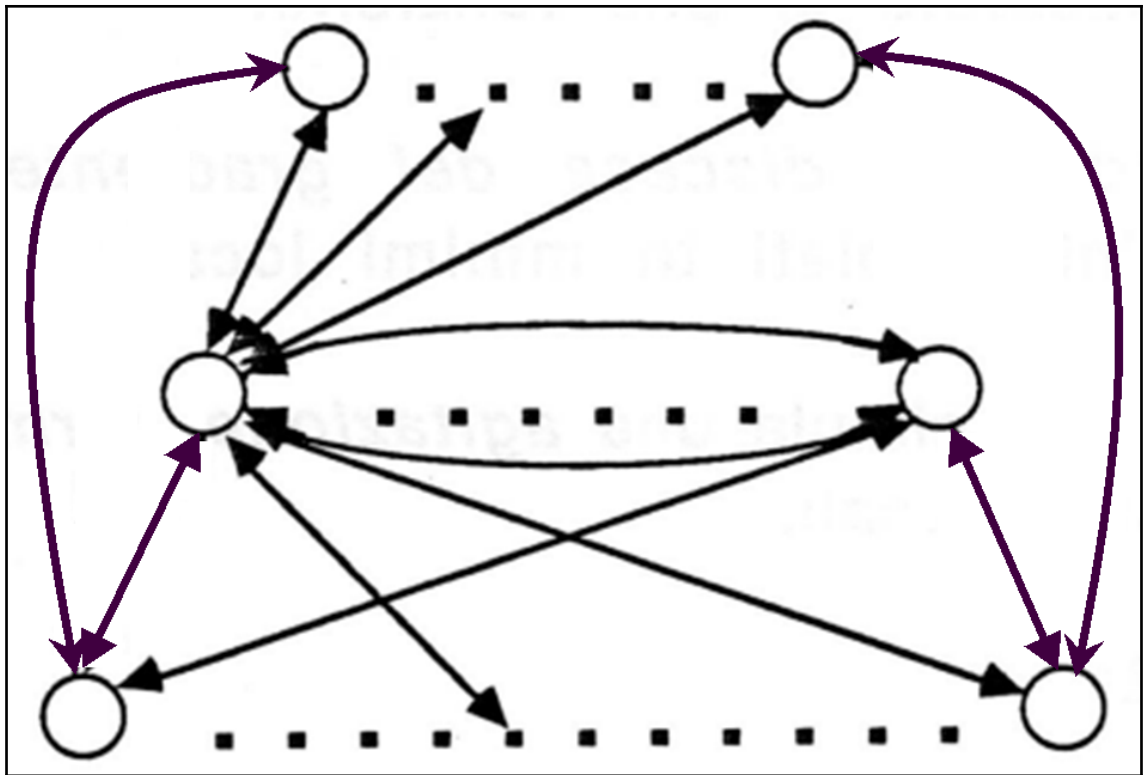


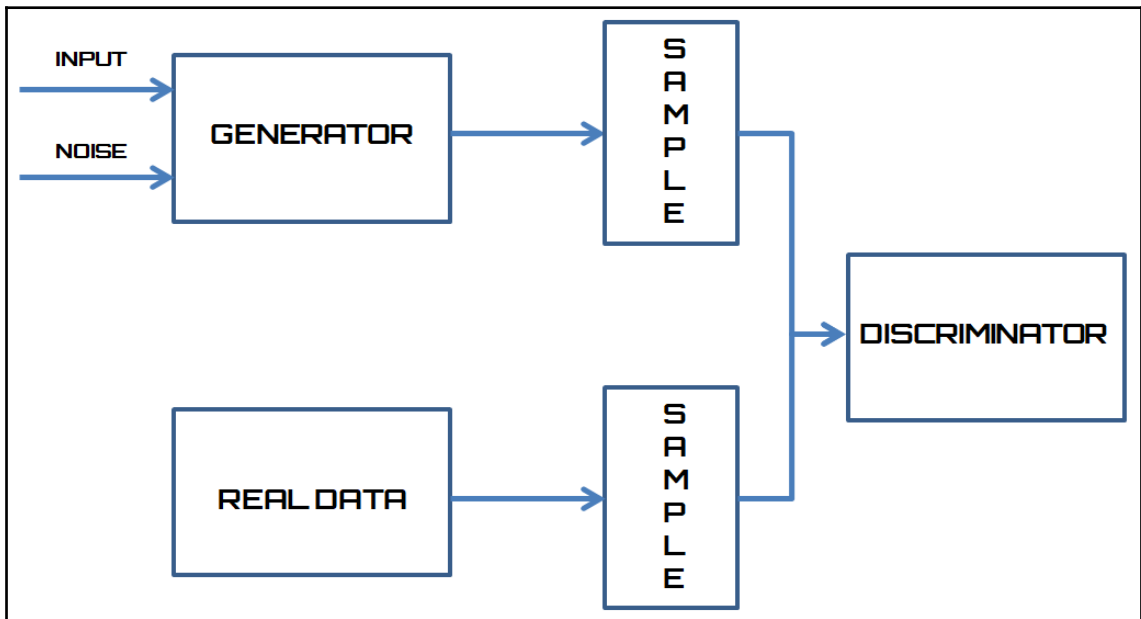
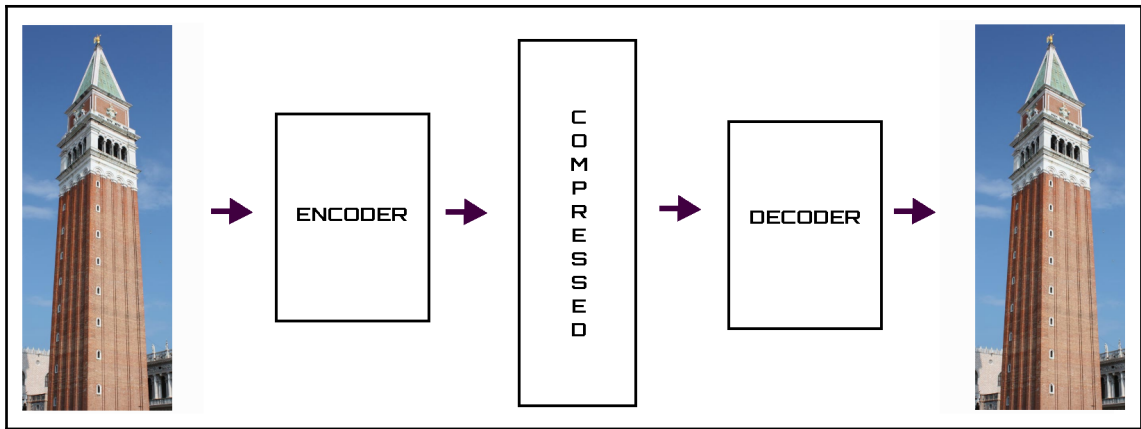
Chapter 8: Reconstruction of Handwritten Digit Images Using Autoencoders

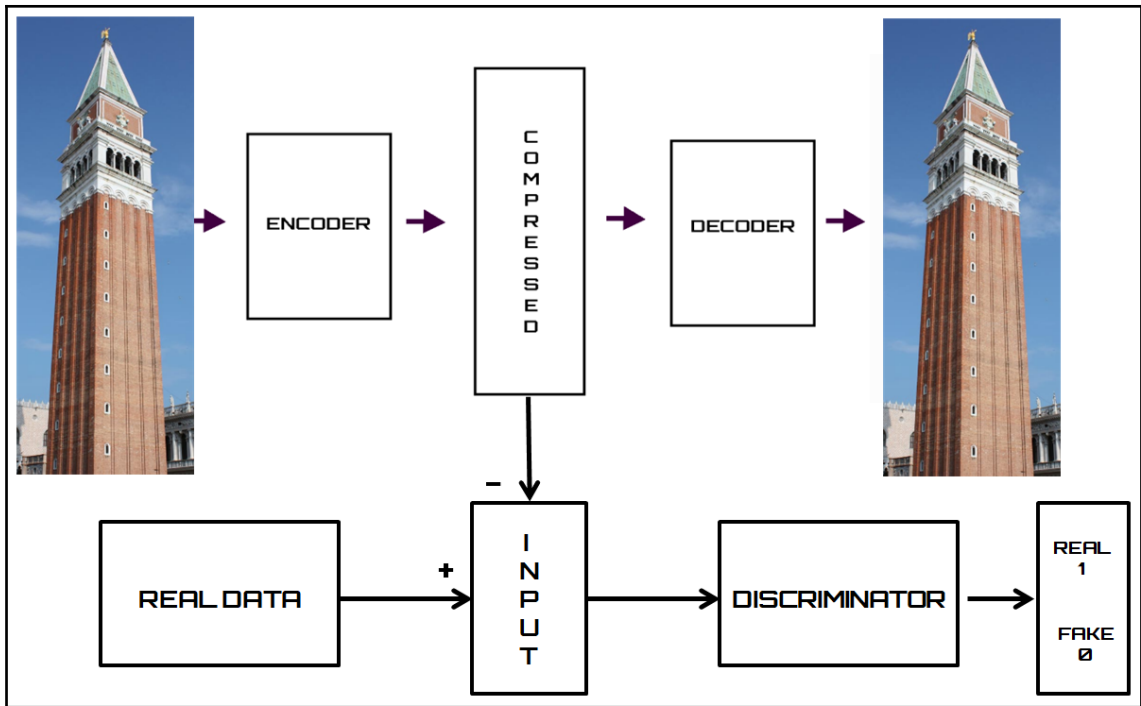


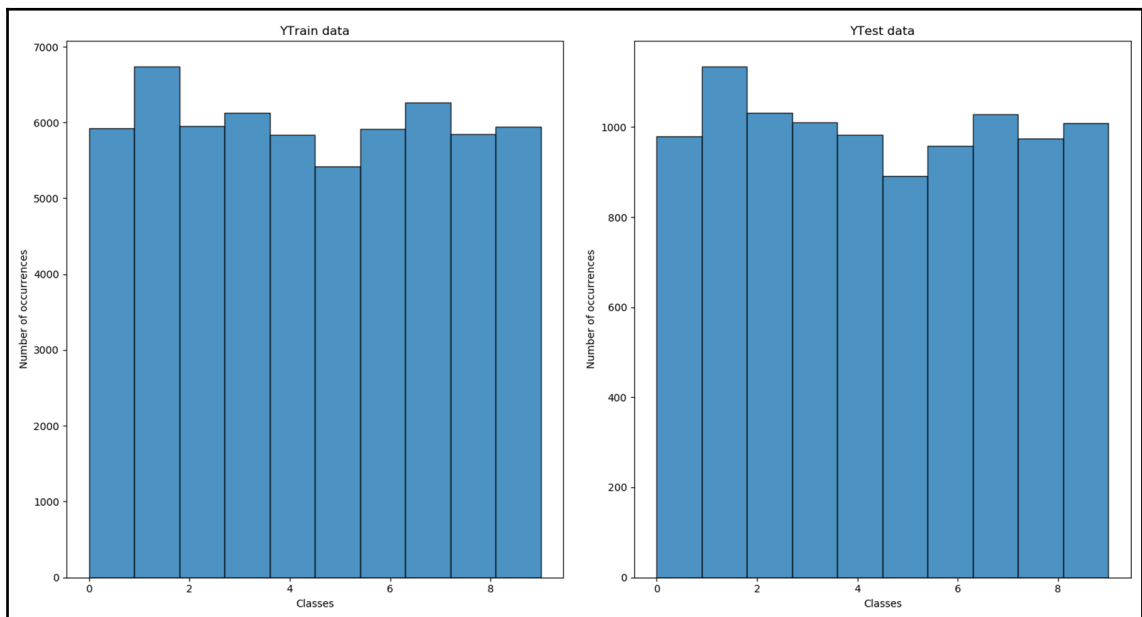
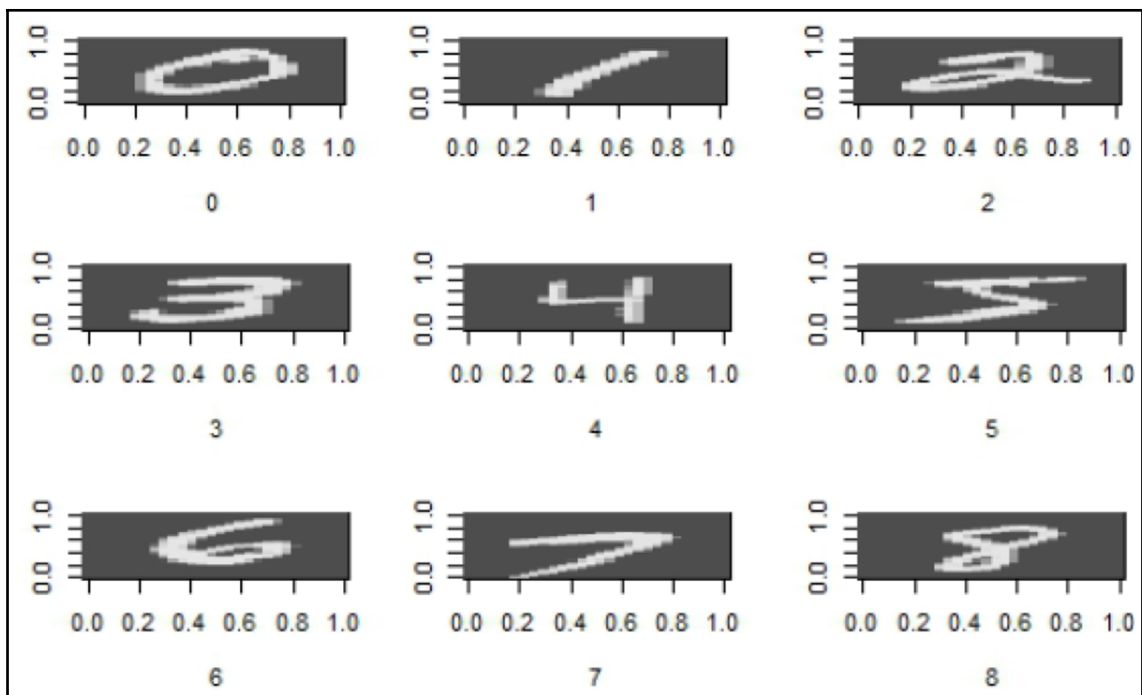










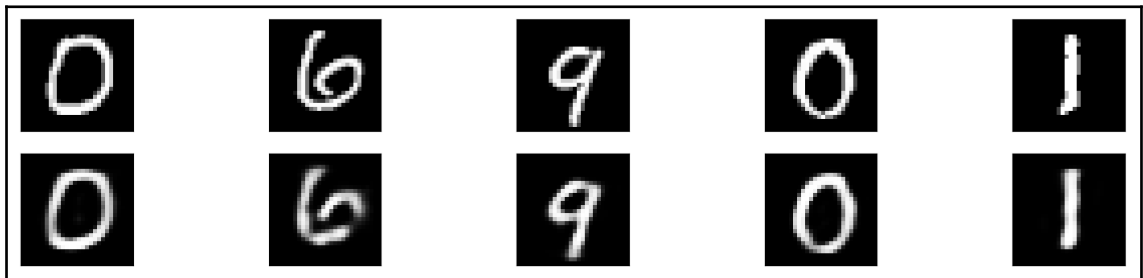
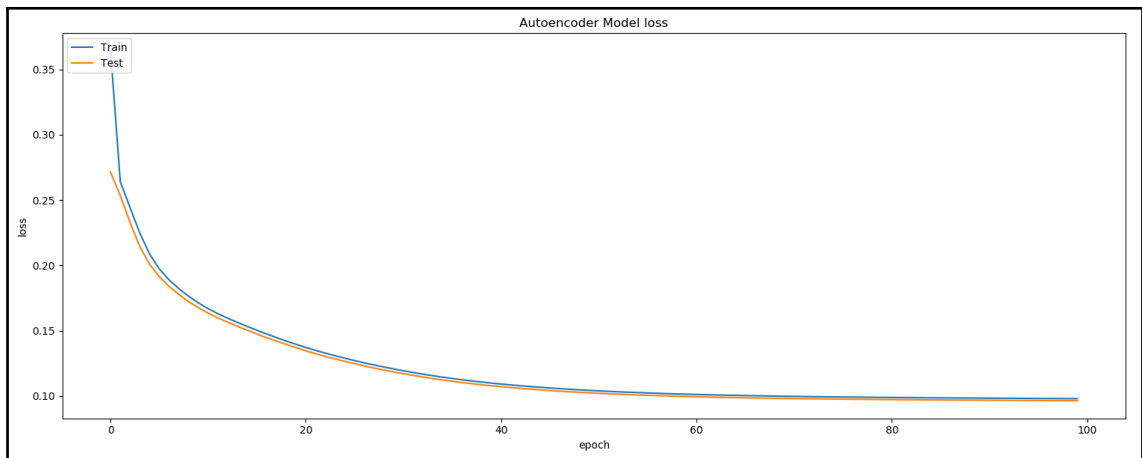


Layer (type)	Output Shape	Param #
input_1 (InputLayer)	(None, 784)	0
dense_1 (Dense)	(None, 32)	25120
dense_2 (Dense)	(None, 784)	25872
Total params: 50,992		
Trainable params: 50,992		
Non-trainable params: 0		

```

Epoch 90/100
60000/60000 [=====] - 4s 62us/step - loss: 0.0985 - val_loss: 0.0969
Epoch 91/100
60000/60000 [=====] - 4s 65us/step - loss: 0.0984 - val_loss: 0.0968
Epoch 92/100
60000/60000 [=====] - 4s 66us/step - loss: 0.0984 - val_loss: 0.0968
Epoch 93/100
60000/60000 [=====] - 4s 64us/step - loss: 0.0983 - val_loss: 0.0967
Epoch 94/100
60000/60000 [=====] - 4s 63us/step - loss: 0.0983 - val_loss: 0.0967
Epoch 95/100
60000/60000 [=====] - 4s 61us/step - loss: 0.0982 - val_loss: 0.0967
Epoch 96/100
60000/60000 [=====] - 4s 61us/step - loss: 0.0982 - val_loss: 0.0967
Epoch 97/100
60000/60000 [=====] - 4s 61us/step - loss: 0.0982 - val_loss: 0.0966
Epoch 98/100
60000/60000 [=====] - 4s 63us/step - loss: 0.0981 - val_loss: 0.0966
Epoch 99/100
60000/60000 [=====] - 4s 62us/step - loss: 0.0981 - val_loss: 0.0965
Epoch 100/100
60000/60000 [=====] - 4s 62us/step - loss: 0.0981 - val_loss: 0.0965

```

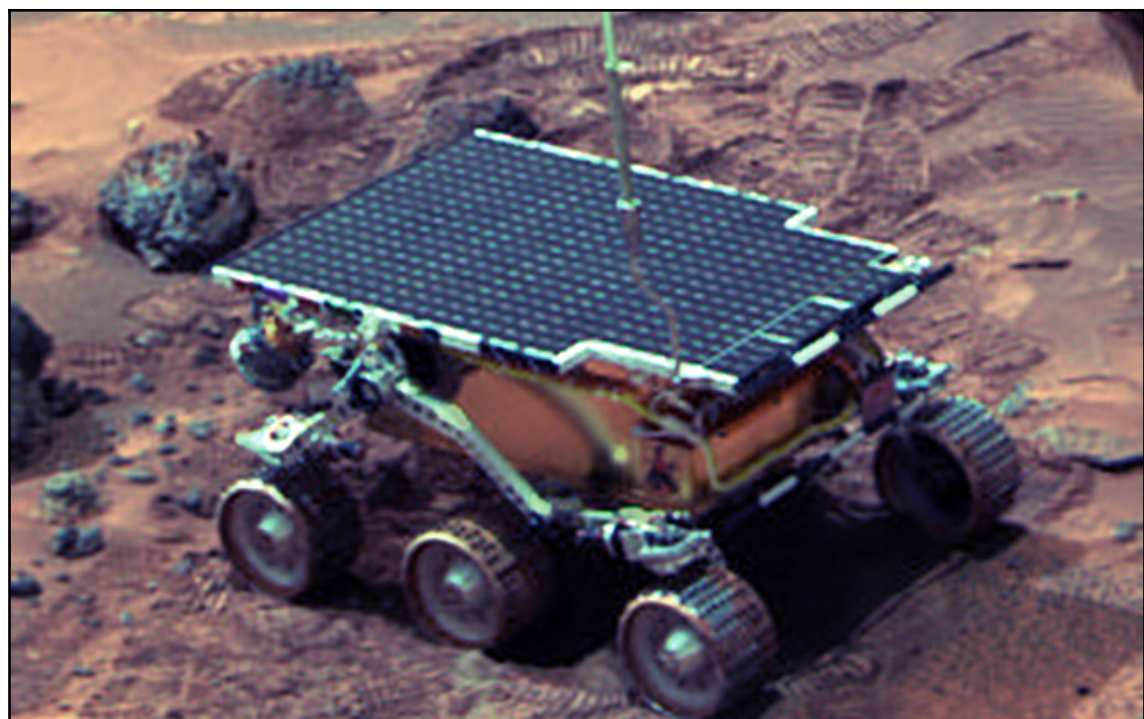


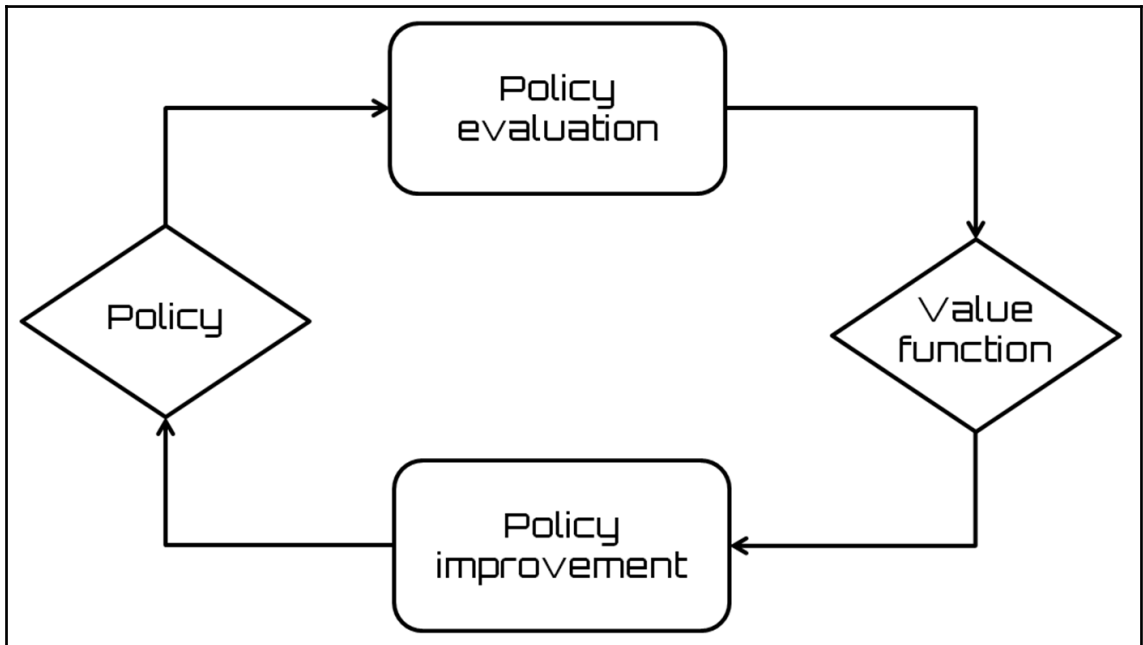
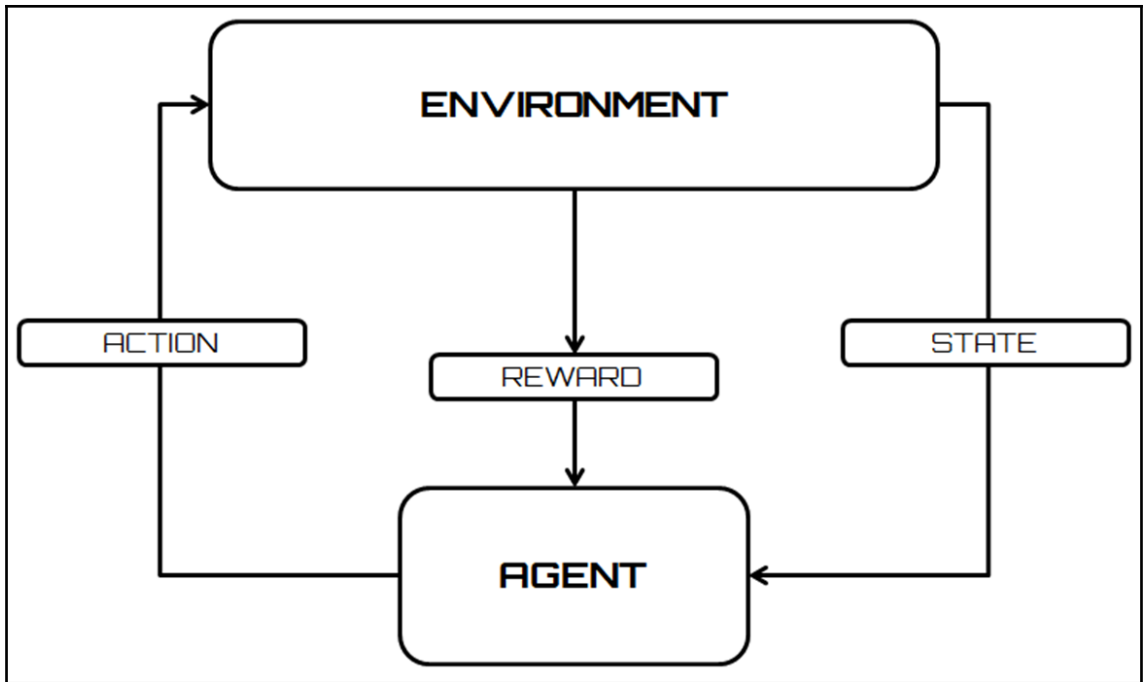
Chapter 9: Robot Control System Using Deep Reinforcement Learning

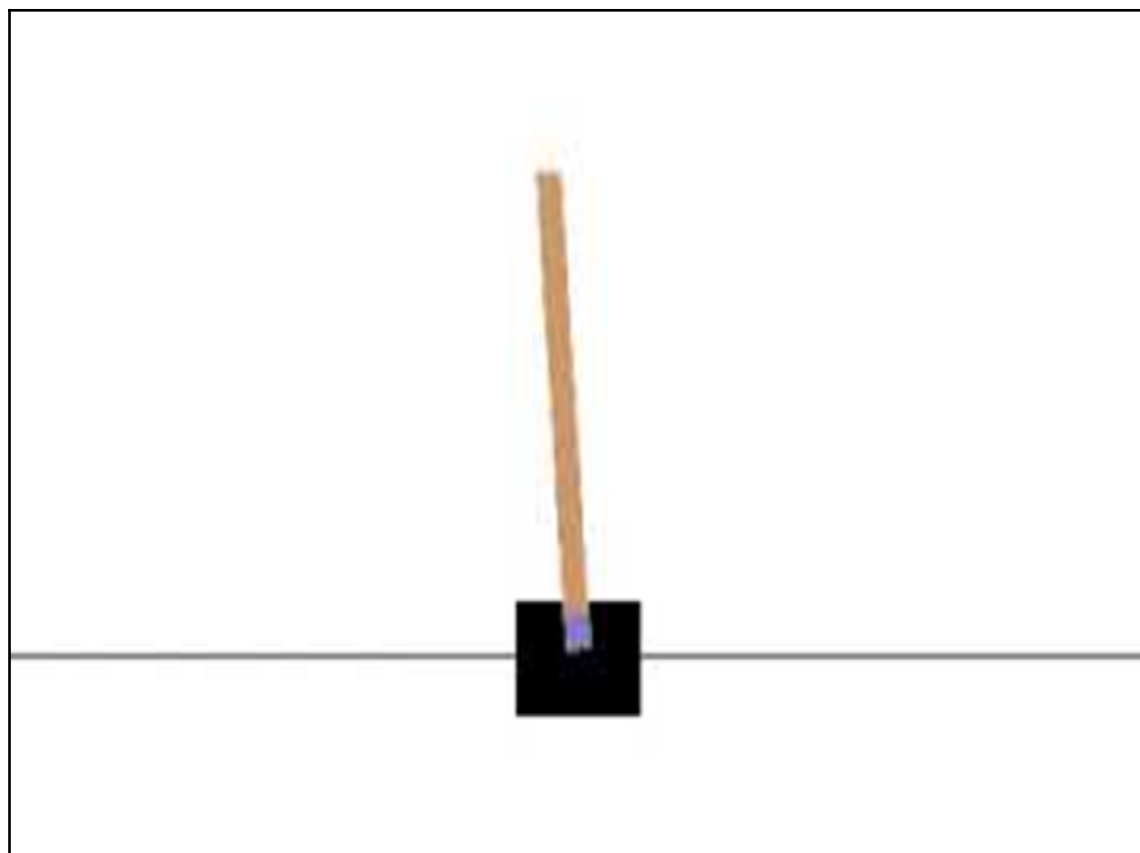












Layer (type)	Output Shape	Param #
=====	=====	=====
flatten_3 (Flatten)	(None, 4)	0
dense_9 (Dense)	(None, 16)	80
activation_9 (Activation)	(None, 16)	0
dense_10 (Dense)	(None, 16)	272
activation_10 (Activation)	(None, 16)	0
dense_11 (Dense)	(None, 16)	272
activation_11 (Activation)	(None, 16)	0
dense_12 (Dense)	(None, 2)	34
activation_12 (Activation)	(None, 2)	0
=====	=====	=====
Total params: 658		
Trainable params: 658		
Non-trainable params: 0		
=====		

Chapter 10: Reuters Newswire Topics Classifier in Keras

```

C:\pythonscript\KDL>pip install nltk
Collecting nltk
  Downloading https://files.pythonhosted.org/packages/6f/ed/9c755d357d33bc1931e157f537721efb5b88d2c583fe593cc09603076cc3/nltk-3.4.zip (1.4MB)
    100% |████████████████████████████████████████| 1.4MB 1.3MB/s
Requirement already satisfied: six in c:\python36\lib\site-packages (from nltk) (1.11.0)
Collecting singledispatch (from nltk)
  Downloading https://files.pythonhosted.org/packages/c5/10/369f50bcd4621b263927b0a1519987a04383d4a98fb10438042ad410cf88/singledispatch-3.4.0.3-py2.py3-none-any.whl
Building wheels for collected packages: nltk
  Running setup.py bdist_wheel for nltk ... done
  Stored in directory: C:\Users\lavoro\AppData\Local\pip\Cache\wheels\4b\c8\24\b2343664bccb7147efeb21c0b23703a05b23fcfeaceaa2a1e
Successfully built nltk
Installing collected packages: singledispatch, nltk
Successfully installed nltk-3.4 singledispatch-3.4.0.3

C:\pythonscript\KDL>

```

NLTK Downloader
File View Sort Help

Collections
Corpora
Models
All Packages

Identifier	Name	Size	Status
all	All packages	n/a	not installed
all-corpora	All the corpora	n/a	not installed
all-nltk	All packages available on nltk_data gh-pages branch	n/a	not installed
book	Everything used in the NLTK Book	n/a	not installed
popular	Popular packages	n/a	not installed
tests	Packages for running tests	n/a	not installed
third-party	Third-party data packages	n/a	not installed

Download
Refresh

Server Index: https://raw.githubusercontent.com/nltk/nltk_data/gh-pages/index.xml

Download Directory: C:\Users\lavoro\AppData\Roaming\nltk_data

WPS+BEZ: WH-pronoun, nominative + verb 'to be', present, 3rd person singular
that's who's

WPS+HVD: WH-pronoun, nominative + verb 'to have', past tense
who'd

WPS+HVZ: WH-pronoun, nominative + verb 'to have', present tense, 3rd person singular
who's that's

WPS+MD: WH-pronoun, nominative + modal auxillary
who'll that'd who'd that'll

WQL: WH-qualifier
however how

WRB: WH-adverb
however when where why whereby wherever how whenever whereon wherein
wherewith wheare wherefore whereof howsabout

WRB+BER: WH-adverb + verb 'to be', present, 2nd person singular or all persons plural
where're

WRB+BEZ: WH-adverb + verb 'to be', present, 3rd person singular
how's where's

WRB+DO: WH-adverb + verb 'to do', present, not 3rd person singular
howda

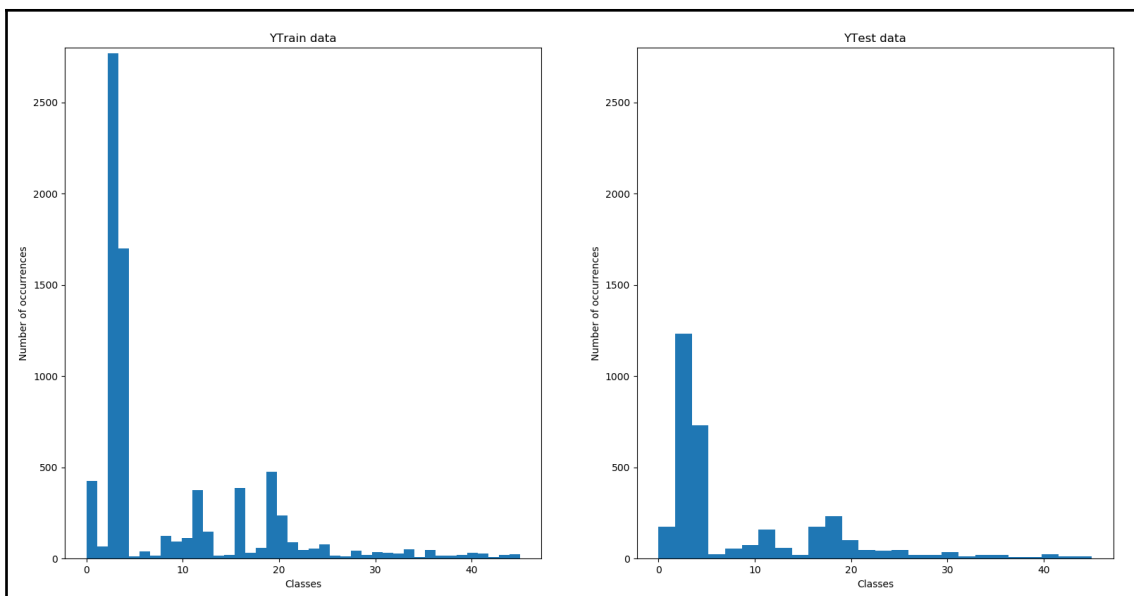
WRB+DOD: WH-adverb + verb 'to do', past tense
where'd how'd

WRB+DOD*: WH-adverb + verb 'to do', past tense, negated
whyn't

WRB+DOZ: WH-adverb + verb 'to do', present tense, 3rd person singular
how's

WRB+IN: WH-adverb + preposition
why'n

WRB+MD: WH-adverb + modal auxillary
where'd



Layer (type)	Output Shape	Param #
=====	=====	=====
dense_1 (Dense)	(None, 512)	5120512
activation_1 (Activation)	(None, 512)	0
dropout_1 (Dropout)	(None, 512)	0
dense_2 (Dense)	(None, 46)	23598
activation_2 (Activation)	(None, 46)	0
=====	=====	=====
Total params: 5,144,110		
Trainable params: 5,144,110		
Non-trainable params: 0		
=====		

Train on 7859 samples, validate on 3369 samples

Epoch 1/10

7859/7859 [=====] - 19s 2ms/step - loss: 1.4667 - acc: 0.6894 - val_loss: 0.9782 - val_acc: 0.7815

Epoch 2/10

7859/7859 [=====] - 18s 2ms/step - loss: 0.5885 - acc: 0.8717 - val_loss: 0.8391 - val_acc: 0.8088

Epoch 3/10

7859/7859 [=====] - 17s 2ms/step - loss: 0.3219 - acc: 0.9284 - val_loss: 0.8517 - val_acc: 0.8071

Epoch 4/10

7859/7859 [=====] - 16s 2ms/step - loss: 0.2250 - acc: 0.9471 - val_loss: 0.8998 - val_acc: 0.8020

Epoch 5/10

7859/7859 [=====] - 18s 2ms/step - loss: 0.1814 - acc: 0.9542 - val_loss: 0.9417 - val_acc: 0.7985

Epoch 6/10

7859/7859 [=====] - 18s 2ms/step - loss: 0.1648 - acc: 0.9550 - val_loss: 0.9280 - val_acc: 0.8059

Epoch 7/10

7859/7859 [=====] - 17s 2ms/step - loss: 0.1618 - acc: 0.9588 - val_loss: 0.9567 - val_acc: 0.8017

Epoch 8/10

7859/7859 [=====] - 17s 2ms/step - loss: 0.1544 - acc: 0.9580 - val_loss: 0.9763 - val_acc: 0.8014

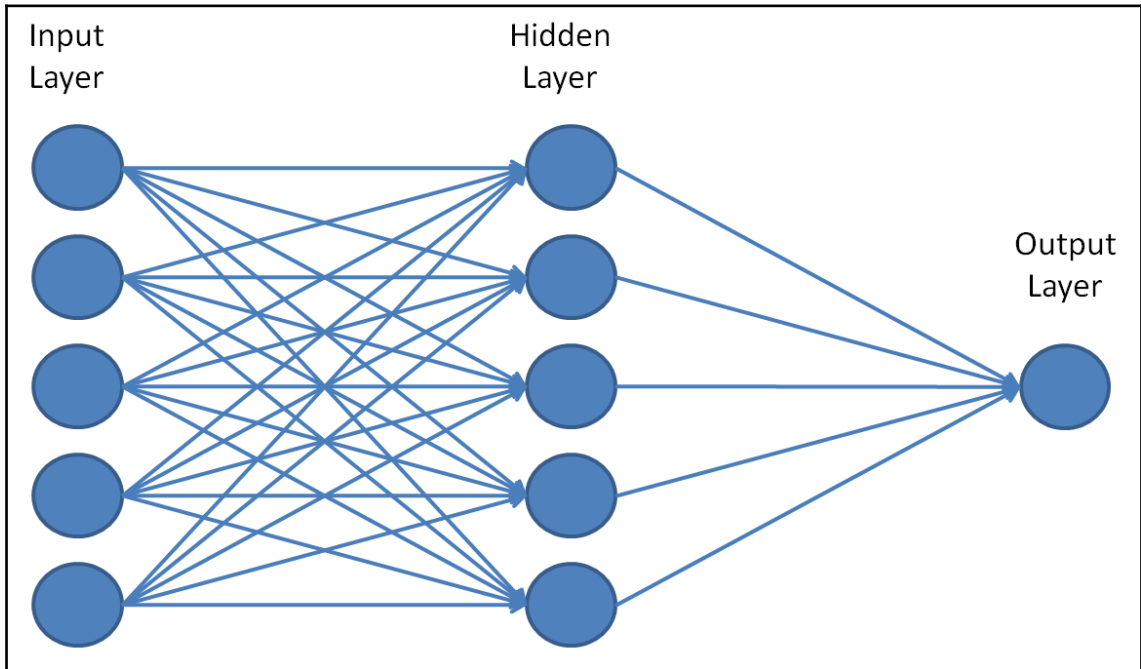
Epoch 9/10

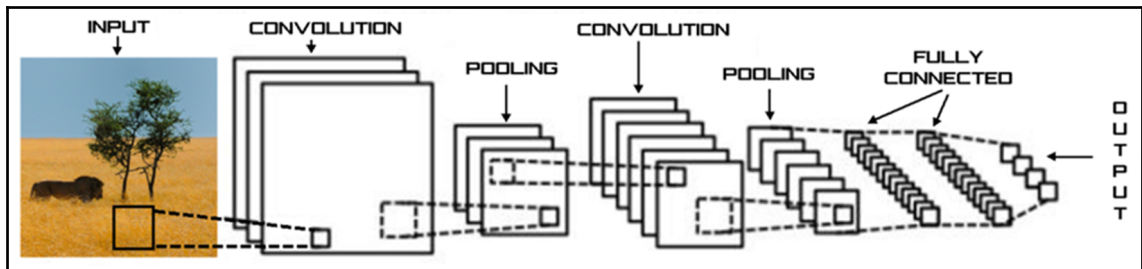
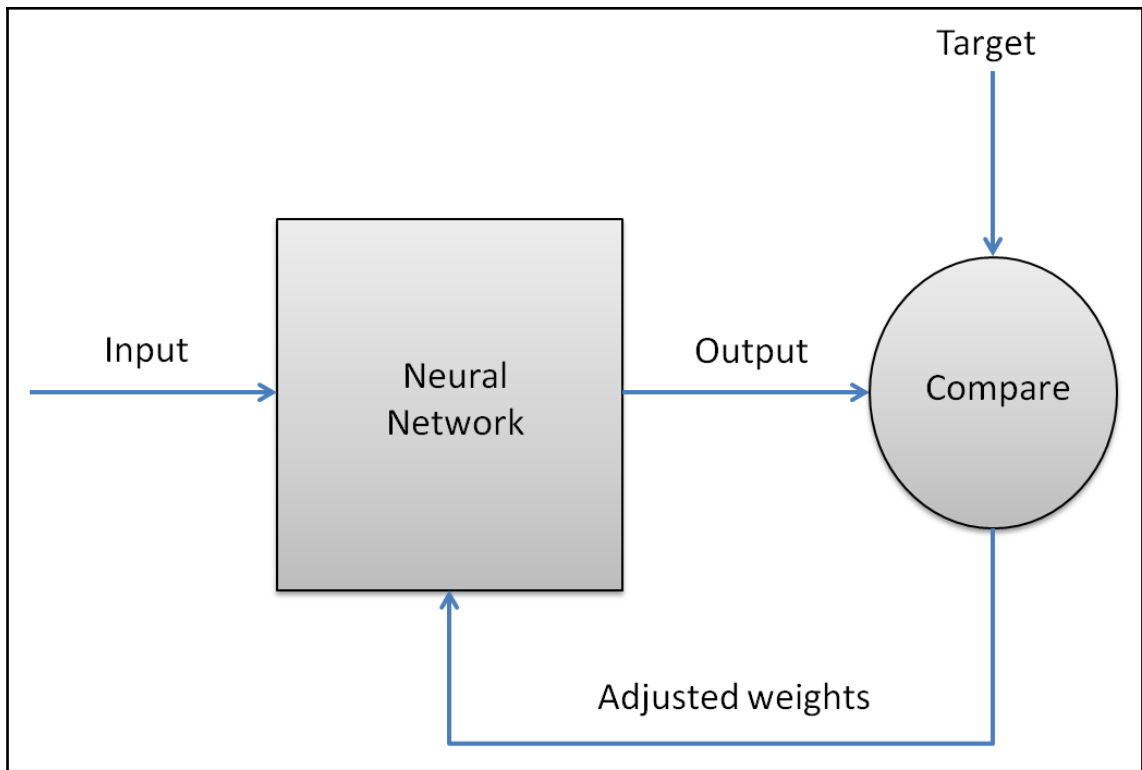
7859/7859 [=====] - 18s 2ms/step - loss: 0.1580 - acc: 0.9578 - val_loss: 0.9762 - val_acc: 0.8074

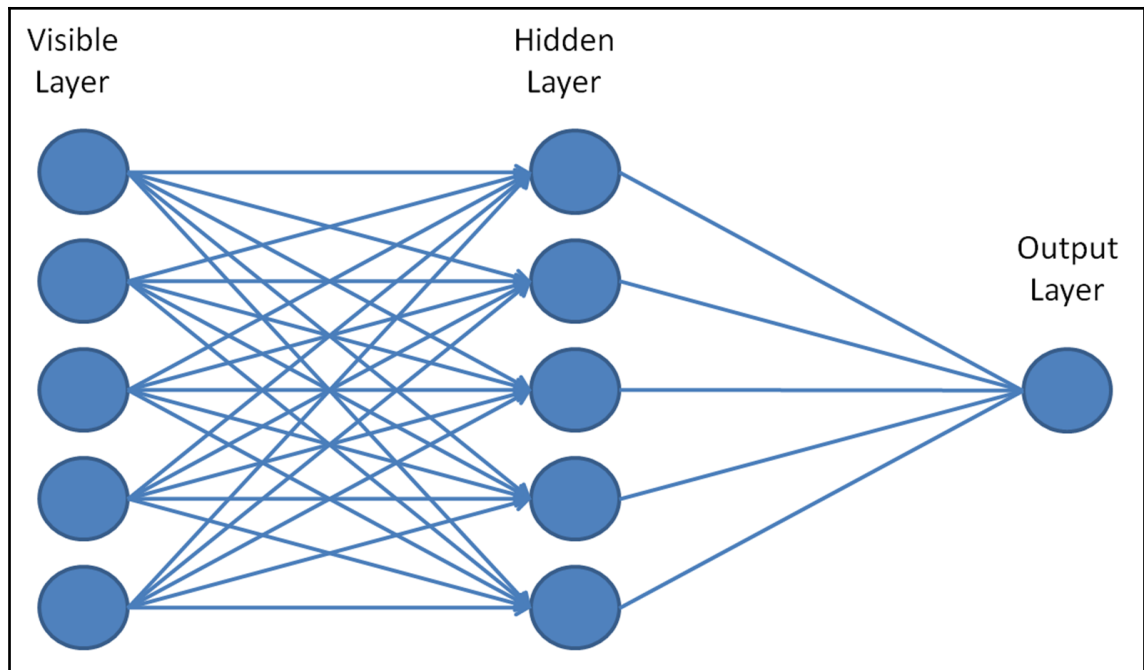
Epoch 10/10

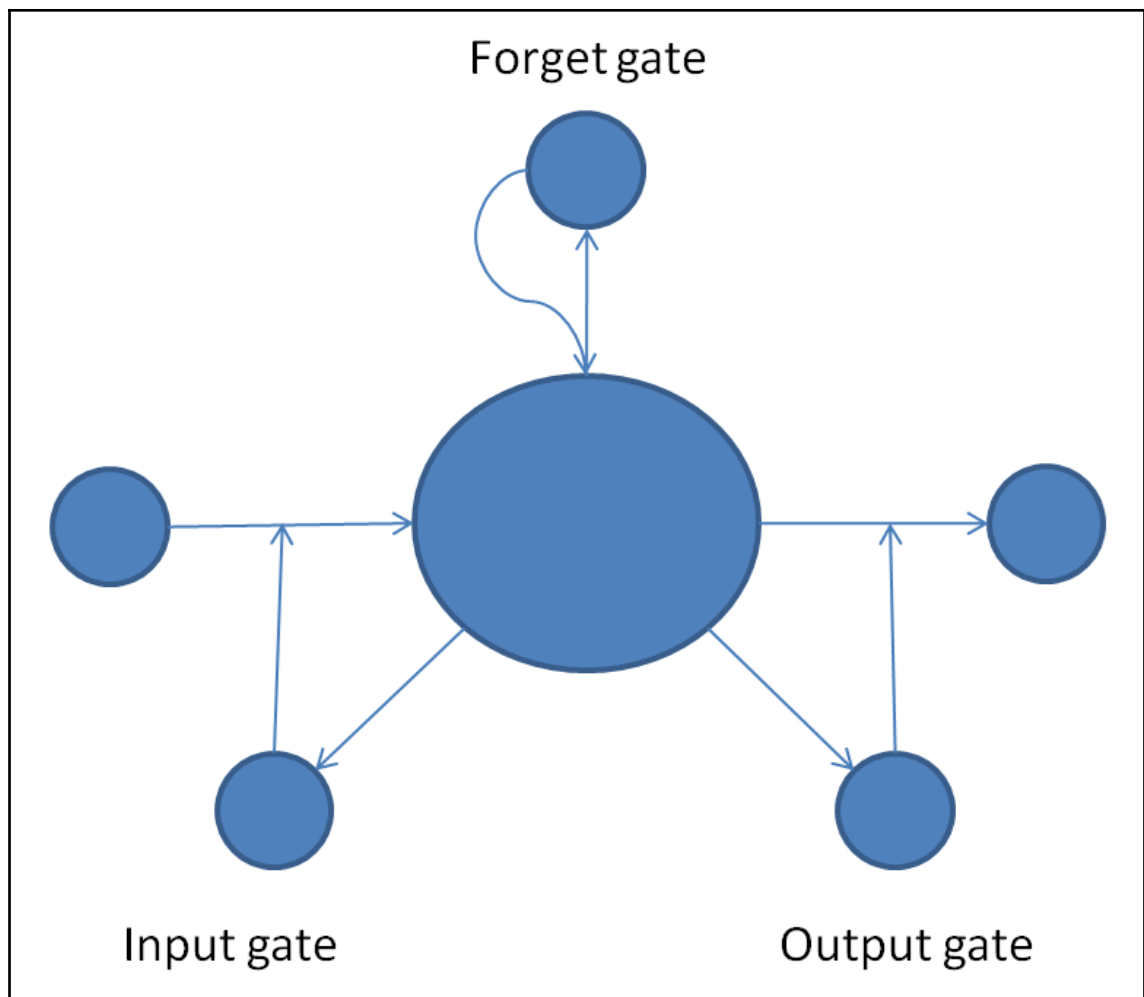
7859/7859 [=====] - 17s 2ms/step - loss: 0.1487 - acc: 0.9588 - val_loss: 1.0146 - val_acc: 0.7991

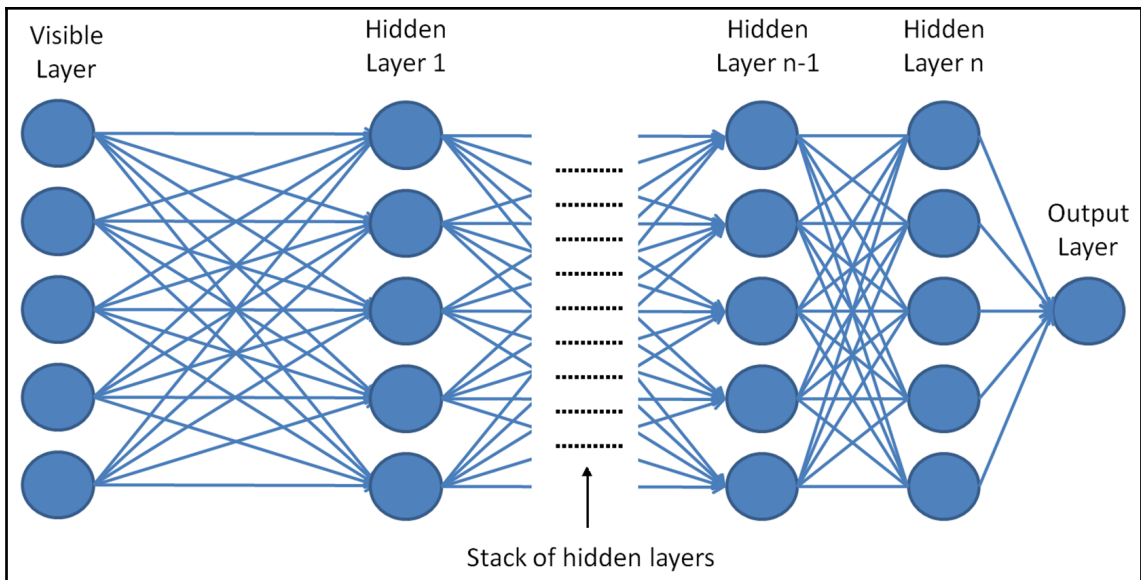
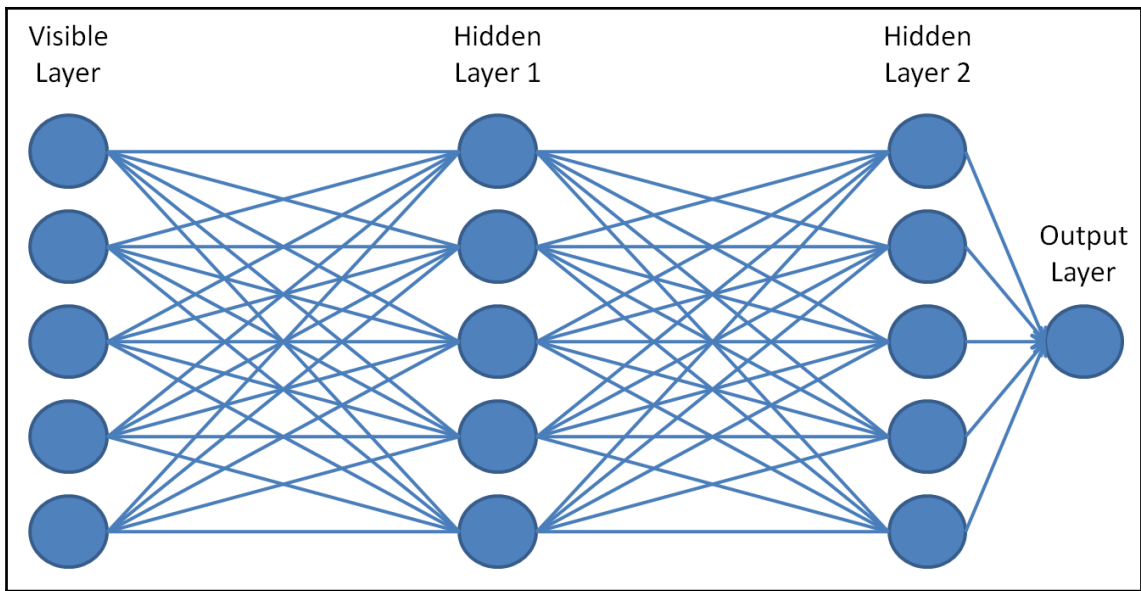
Chapter 11: What is Next?














 Auto-Keras

 Search

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Auto-Keras

Home

Getting Started


Getting Started with Docker

Contributing Guide

Documentation ▾

About

Home

 **AUTO KERAS**

build

passing

coverage 94%

pypi package 0.3.5

Auto-Keras is an open source software library for automated machine learning (AutoML). It is developed by [DATA Lab](#) at Texas A&M University and community contributors. The ultimate goal of AutoML is to provide easily accessible deep learning tools to domain experts with limited data science or machine learning background. Auto-Keras provides functions to automatically search for architecture and hyperparameters of deep learning models.

Table of contents

Installation

Example


Community

Citing this work


Support Auto-Keras





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Acknowledgements

 Google Cloud Platform


MainProject ▾




DASHBOARD

ACTIVITY

 CUSTOMIZE

 **Project info**

Project name

MainProject

Project ID


progetto-1-191608


Project number

864125566776

→

Go to project settings


 **Resources**

 Storage

4 buckets


APIs

Requests (requests/sec)



→


Go to APIs overview

 **Google Cloud Platform status**

All services normal

→

Go to Cloud status dashboard

 **Billing**


Estimated charges





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EUR €0.00

→

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View Dashboard

