

CS 230: Deep Learning

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Part I

Neural Networks and Deep Learning

Chapter 1

Introduction

Why it matters?

- AI is the new Electricity.
- Electricity had once transformed countless industries: transportation, manufacturing, healthcare, communications, and more.
- AI will now bring about an equally big transformation.

Courses in this sequence (Specialization):

1. Neural Networks and Deep Learning
2. Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization
3. Structuring your Machine Learning project
4. Convolutional Neural Networks (CNNs)
5. Natural Language Processing: Building sequence models (RNNs, LSTM)

1.1 What is a Neural Network?

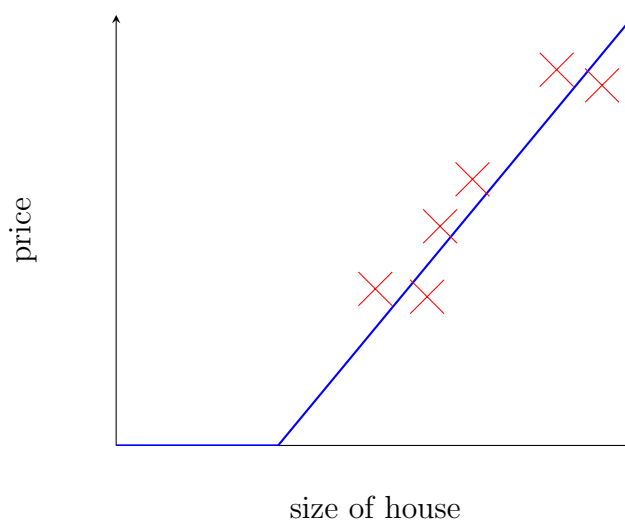


Figure 1.1: Housing Price Prediction

In the neural network literature, this function appears by a lot. This function is called a ReLU function, which stands for rectified linear units.

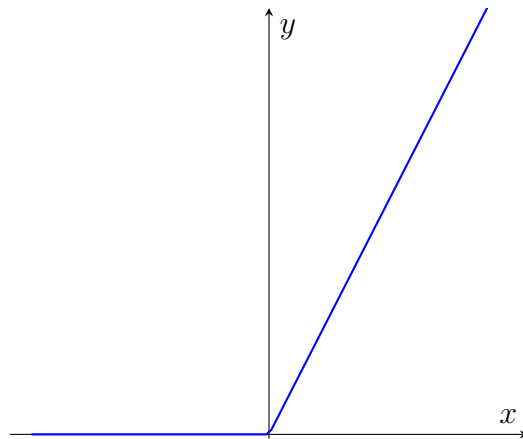


Figure 1.2: ReLU function: $\max\{0, x\}$

With the size of houses in square feet or square meters and the price of the house, we can fit a function to predict the price of a house as a function of its size.

This is the simplest neural network. We have the size of a house as input x , which goes into a node (a single "neuron"), and outputs the price y .

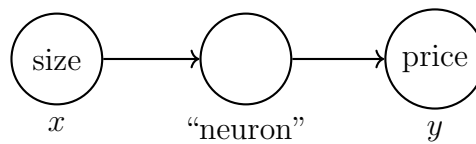


Figure 1.3: Simple Neural Network of Housing Example

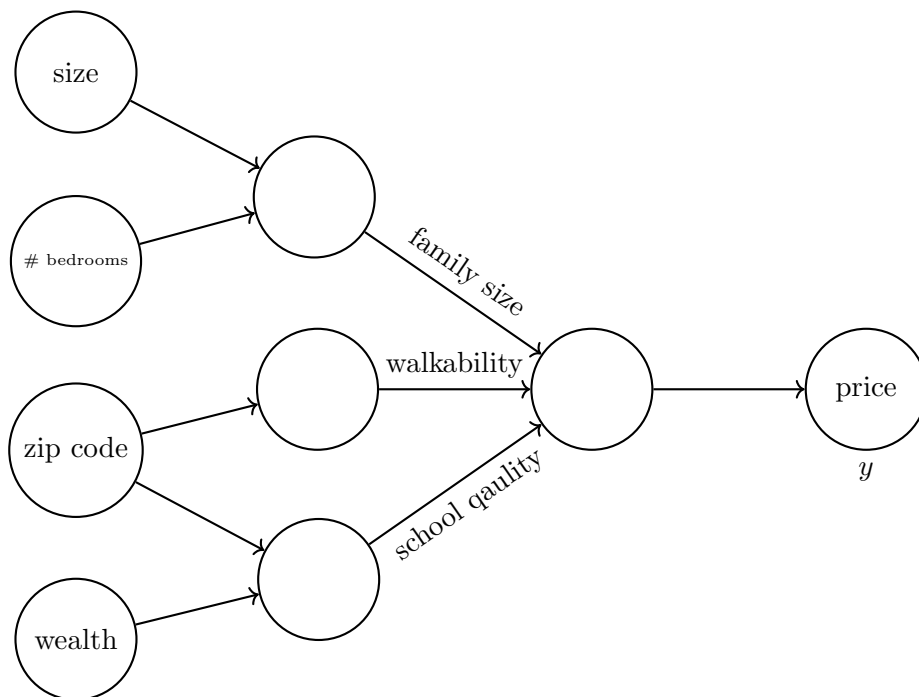


Figure 1.4: Slightly Larger Neural Network

Suppose that, instead of predicting the price of a house just from the size, we also have other features, such as the number of bedrooms, zip code, and wealth. The number of bedrooms determines whether or not a house can fit one's family size; Zip code tells walkability; and zip code and wealth tells how good the school quality is. Each of the circle could be ReLU or other nonlinear function.

We need to give the neural network the input x and the output y for a number of examples in the training set and, for all the things in the middle, neural network will figure out by itself.

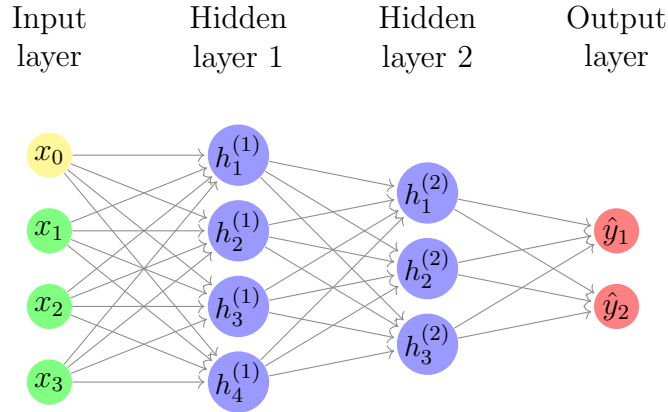


Figure 1.5: General Picture of Neural Network

1.2 Supervised Learning with Neural Networks

Supervised Learning Examples.

Input(x)	Output(y)	Application	Type of NN
Home features	Price	Real Estate	Standard
Ad, user info	Click on ad? (0/1)	Online Advertising	Standard
Image	Object (1, ..., 1000)	Photo tagging	CNN
Audio	Text transcript	Speech recognition	RNN
English	Chinese	Machine translation	RNN
Image, Radar info	Position of other cars	Autonomous driving	Custom

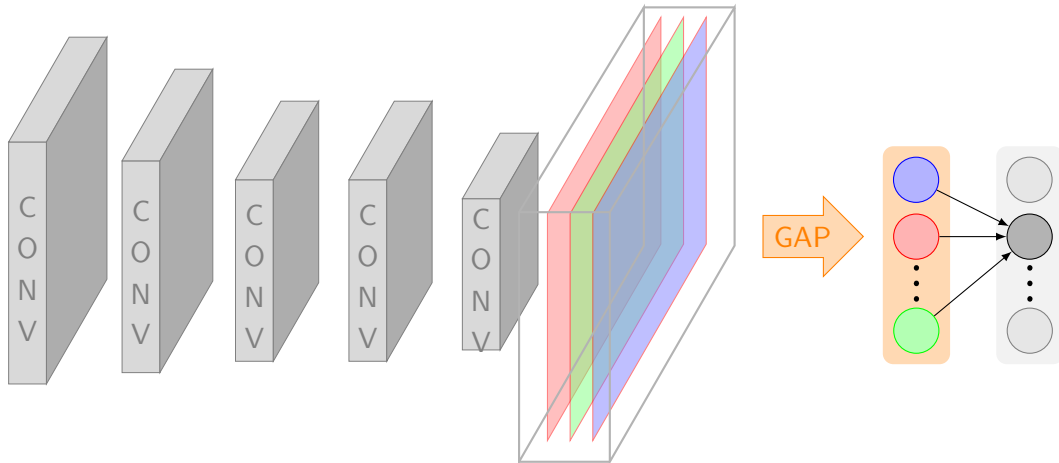


Figure 1.6: Convolutional Neural Network

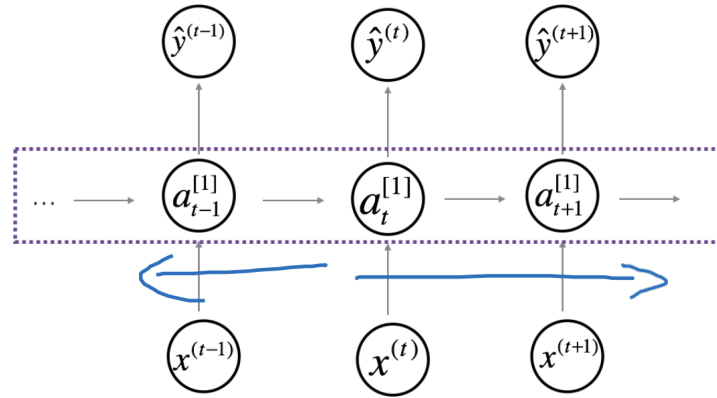
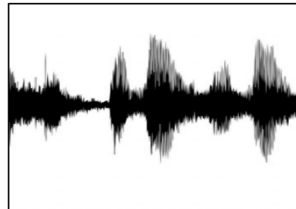


Figure 1.7: Recurrent Neural Network

There are two types of data: Structured Data and Unstructured Data. We could have the following examples for each.

Size	#bedrooms	...	Price(1000\$)	User Age	Ad ID	...	Click
2104	3		400	41	93242		1
1600	3		330	80	93287		0
2400	3		369	18	87312		1
⋮	⋮		⋮	⋮	⋮		⋮
3000	4		540	27	71244		1

Table 1.1: Structured Data



Audio



Image

Four scores and seven
years ago...

Text

Figure 1.8: Unstructured Data

Historically, it has been much harder for computers to make sense of unstructured data compared to structured data. Thanks to the neural networks, computers are better at interpreting unstructured data as well, compared to just a few years ago.

1.3 Why is Deep Learning Taking off?

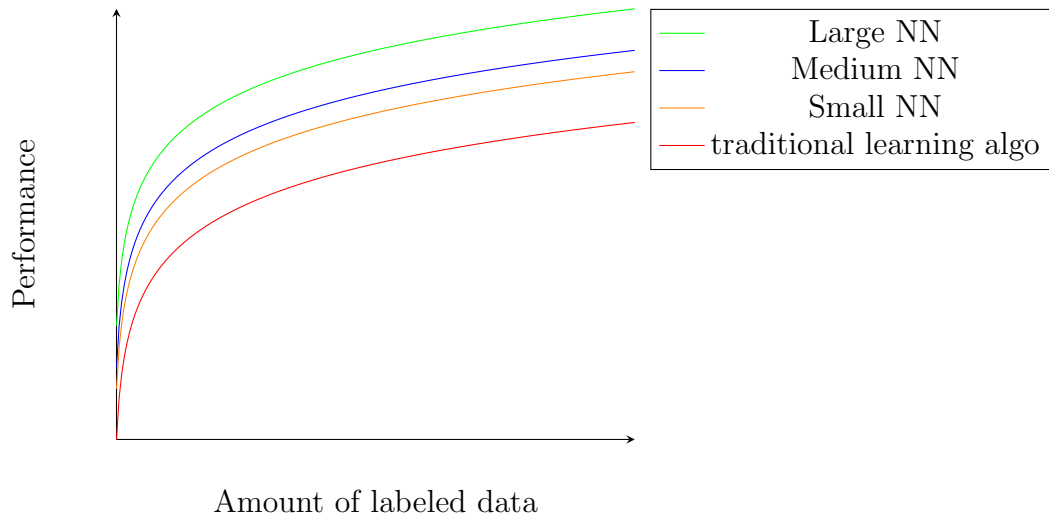


Figure 1.9: Scale drives deep learning progress

In the regime of small number of training sets, the relative ordering of the algorithms is not very well defined. If you don't have a lot of training data, it is often up to your skill at hand engineering features that determines performance. When we have large training sets – large labeled data regime in the right, we more consistently see large neural networks dominating the other approaches.