Deep Learning for Image Classification and Segmentation

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Background

Education

Ph.D., Department of Applied Mathematics, National Chung Hsing University, 1997

M.S., Department of Applied Mathematics, National Chung Hsing University, 1993

B.S., Department of Mechanical Engineering, National Chiao Tung University, 1985

Research Interests

My research interest is using numerical methods to solve partial differential equations (P.D.E.) and machine learning algorithm applied on image processing and analysis.

DAAD Information

- German Academic Exchange Service (DAAD)
- Support German/Taiwanese students and university teachers during their stay in Taiwan/Germany .
- https://www.daad.org.tw/en/about-us/daad-information-centre-in-taipei/
- https://www.daad.de/laenderinformationen/taiwan/de/

Quote

In the age of AI, the role of teacher must be changed from the instructor to the coach because there are a huge free online learning resource.

Learning Objective

- First getting you acquainted with the basics of Tensorflow framework and ready to work.
- The contents focus on Deep learning theory and application together.
- You will learn things from the fundamentals and implement them throughout this course.
- Dive deeper into the word of Deep Learning with exciting and practical examples.

The study plan

- Unit 1: What is Tensorflow and how to solve linear regression problem in Python and Tensorflow?
- Unit 2: What is image classification and how to implement a solution?
- Unit 3: What is Neural Networks and how to apply on image classification?
- Unit 4: What is Convolutional Neural Networks and Deep Neural Networks?
- Unit 5: What is image segmentation and how to implement a solution?

Unit 6: How to improve Deep Neural Networks?

Short-Term Project Report Presentation

The study plan

- Unit 1: What is Tensorflow and how to solve linear regression problem in Python and Tensorflow?

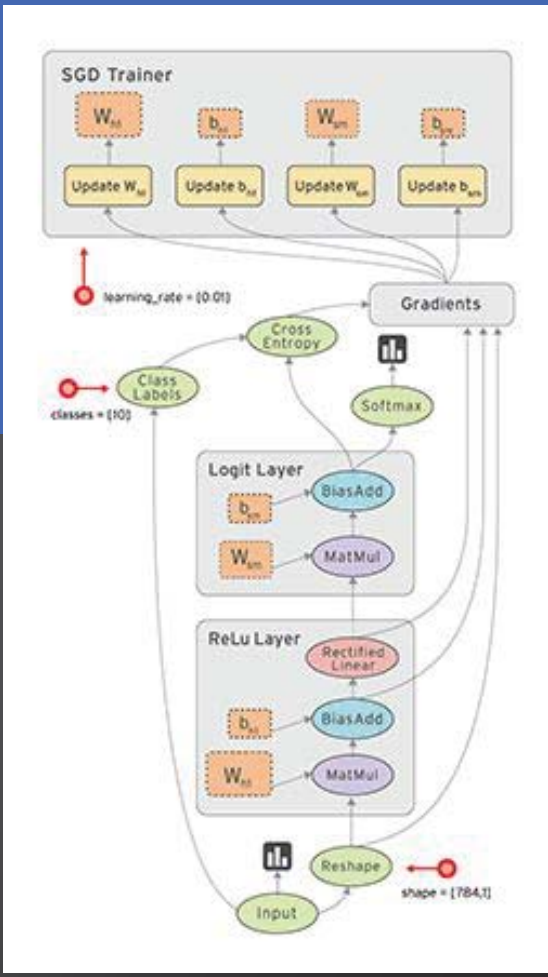
What is Tensorflow?

- Open source Machine Learning library
- Especially useful for Deep Learning
- For research and production
- Apache 2.0 license

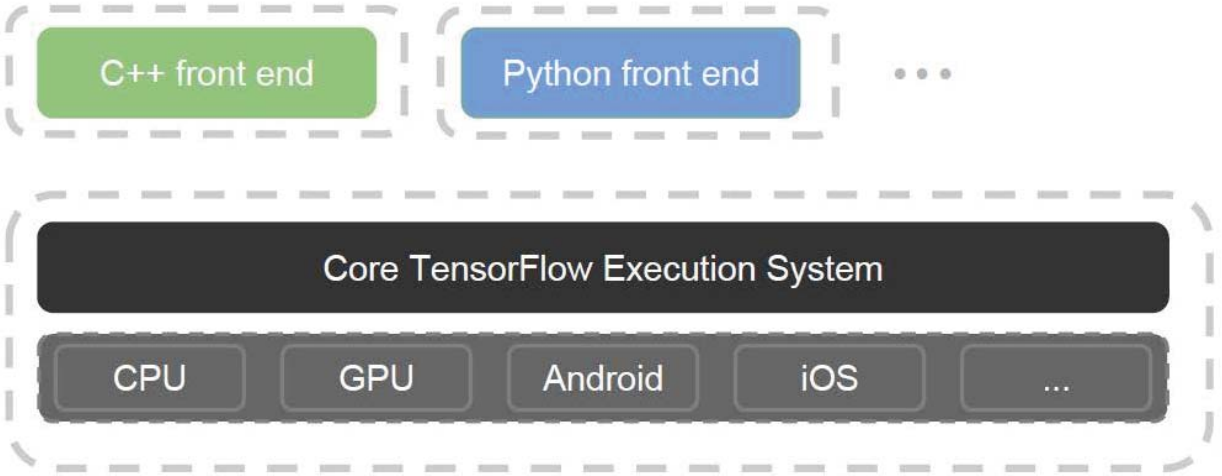
Data Flow Graphs

Computation is defined as a directed acyclic graph (DAG) to optimize an objective function

- Graph is defined in high-level language (Python, C++, go)
- Graph is compiled and optimized
- Graph is executed (in parts or fully) on available low
- level devices (CPU, GPU)
- Data (tensors) flow through the graph
- TensorFlow can compute gradients automatically



Architecture



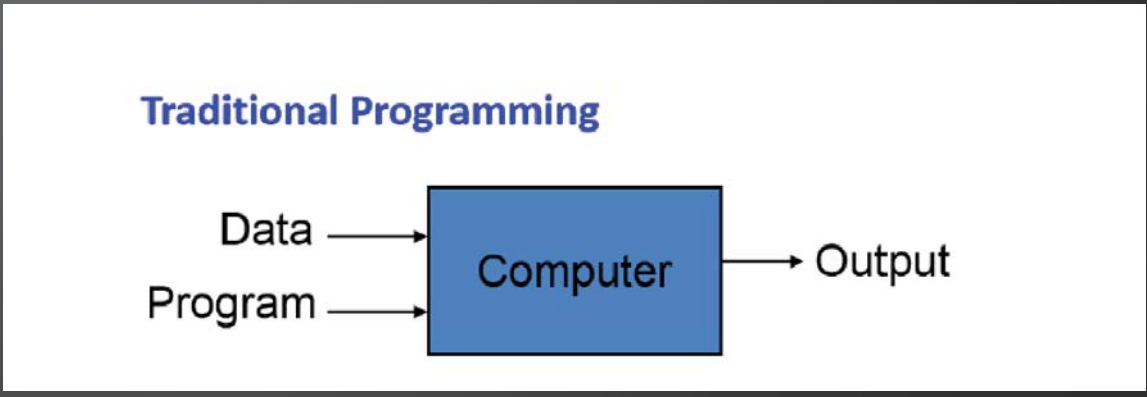
Core in C++

- Different front ends
  - Python and C++ today, community may add more

What is machine learning?

Traditional Programming

- Machine: Computer
- Input: Data, Program
- Product: Output



Machine Learning

What is the machine? Computer

Traditional Programming

Program: a function with fixed coefficients/ a model with fixed parameters.

Paradigm:

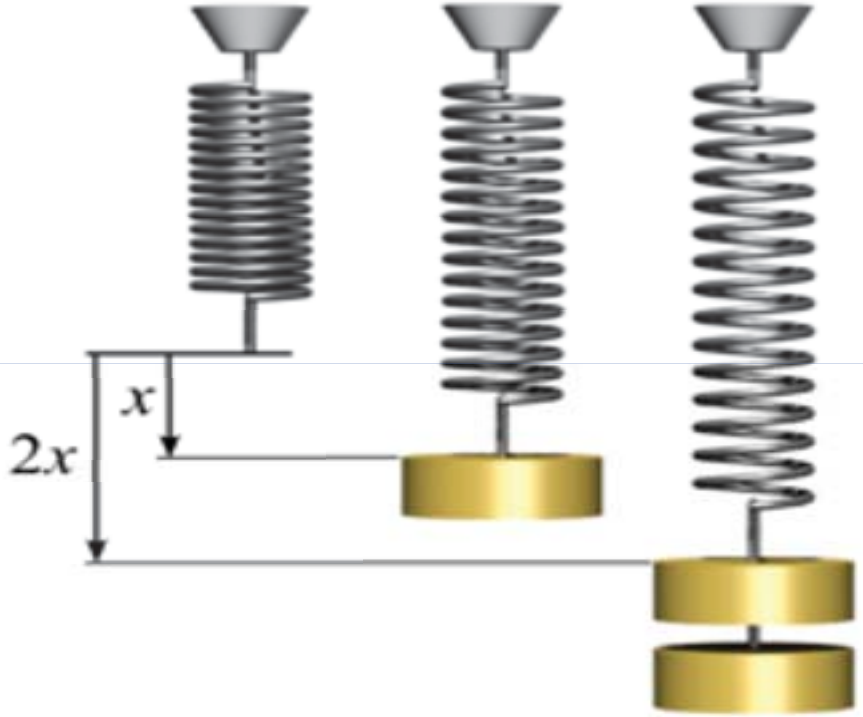
Input Data x

Define a function f(x)=ax+b # with fixed and known coefficients a and b constants

y=f(x)

Output y # Output

Example: Hooke's law for elastic spring



Source from: Wikipedia

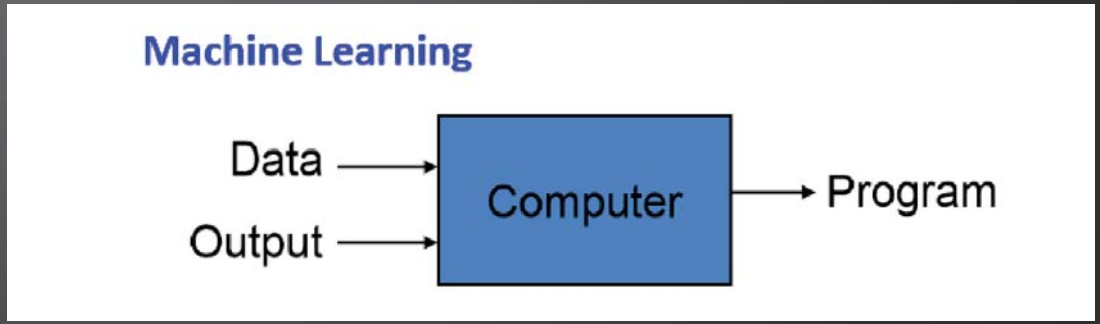
The force magnitude is proportional the elongation magnitude.

Force=f(x) where f(x)=kx # k is a known spring stiffness constant x is a variable of elongation.

What is machine learning:

Machine Learning

- Machine: Computer
- Input: Data, Output(Target, Label)
- Product:
- Program/
- Model/Function



Machine Learning

Paradigm:

Input: Data and Desired Target

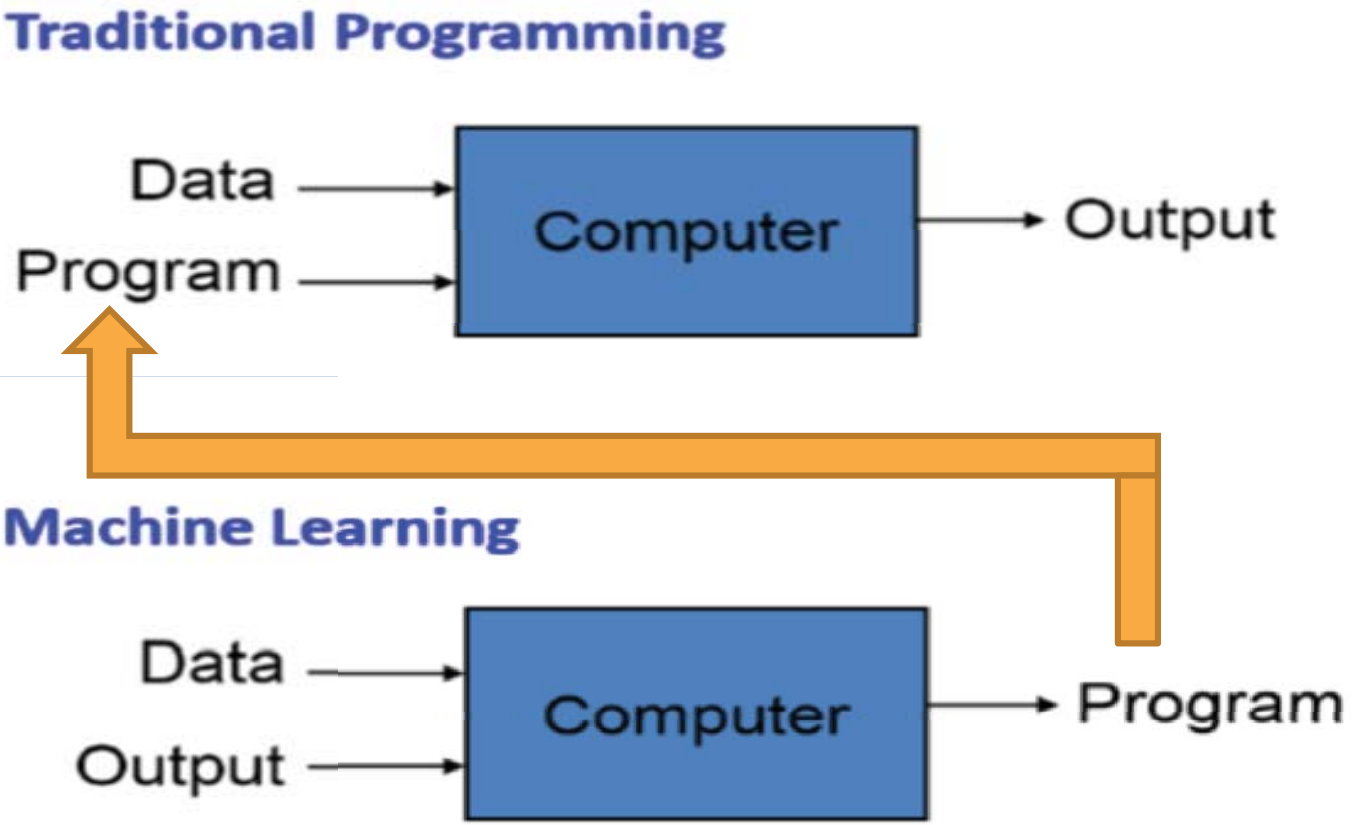
Define a model f(x)=ax+b #with unknown coefficients a and b variables.

Figure out a, b, and c by optimization procedure.

Program: a model f(x)=ax+b #with optimal coefficients a and b.

Prediction: the same as the traditional programming

Given x0 and output f(x0)=a(x0)+b



The output of the machine learning can be used as the input of the traditional programming for prediction if the input data used in traditional programming is different from the input data used in machine learning.

Normal distribution From Wikipedia

The probability density of the normal distribution is

$$f(x \mid \mu, \sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

where

- μ is the mean or expectation of the distribution (and also its median and mode),
- σ is the standard deviation, and
- σ^2 is the variance.

Excise: Draw the curve of the normal distribution function/Gaussian function

Linear Regression Model

Writing on the blackboard

Exercise: Traditional Programming

Compute Linear Regression Line in 2d space

Input data: set {(x1,y1),…,(xn,yn)}

Output: parameters slope and intercept

Ref: videos: minimizing squared error to regression line,v1,v2,v3, v4

Linear Regression Model

Experiment

Simulation Experiment 1:

For example: Learning the spring's stiffness from experiment data.

Simulation Experiment 2: A linear regression Model for a spring's Model

Synthetic data: Hooke's law for elastic spring with Gaussian noise

Lab#1 Linear Regression Model

- https://github.com/tccnchsu/Deep-Learning---Hsu---SoSe18
- Linear Regression Programming with Tensorflow
- https://github.com/sherrym/tf-tutorial/blob/master/1_linear_regression_model.ipynb
- Sheery Videos