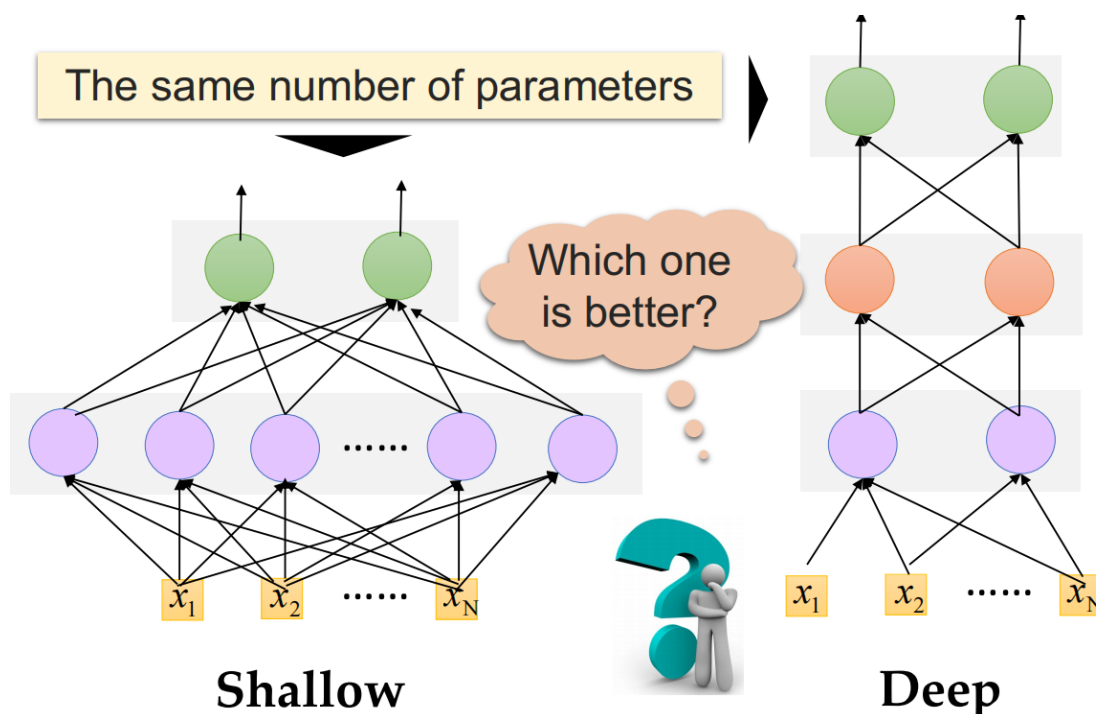# ch10: Deep Learning

## Idea: Modularization(P5-9)

- 逐层抽象和复杂,每一层学习的内容都是自动的 ,不是人为规定的

- **The Deeper, The Better**：shallow networks can represent any functions，However, using deep structures is more effective.



## What is Deep Learning?（P12-13）



- **Deep learning** (deep machine learning, or deep structured learning, or hierarchical learning, or sometimes DL) is a branch of machine learning based on a set of algorithms that attempt to <u>model high-level abstractions</u> in data by using model architectures, 对数据进行高层次抽象 with complex structures or otherwise, composed of multiple non-linear transformations.

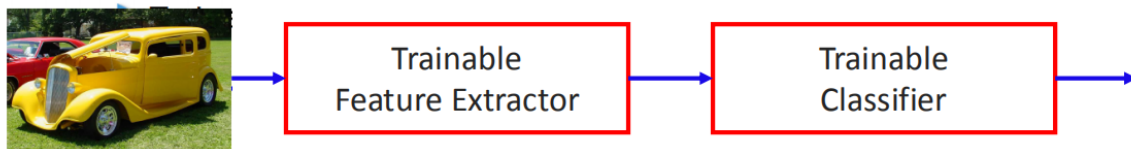**Deep Learning = Learning Data Representations/Features（P14）**

- The traditional model of pattern recognition (since the late 50′s)

  ▶ **fixed/engineered** features + **trainable** classifier
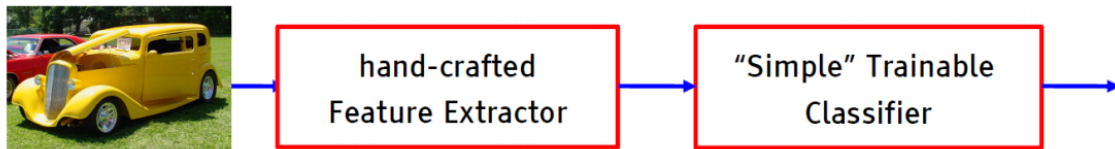


- Deep Learning/ Feature learning / End-to-end Learning 信息提取和模型处理是自动的

  ▶ **trainable** features + **trainable** classifier



**Deep Learning = Learning Hierarchical Representations(P15)**

- A hierarchy of trainable feature transforms

  ▪ each module transforms its input representations into a higher-level one.
  ▪ high-level features are more global and more invariant 越高层越相象越全局
  ▪ low-level features are shared among categories



Learned Internal Representations
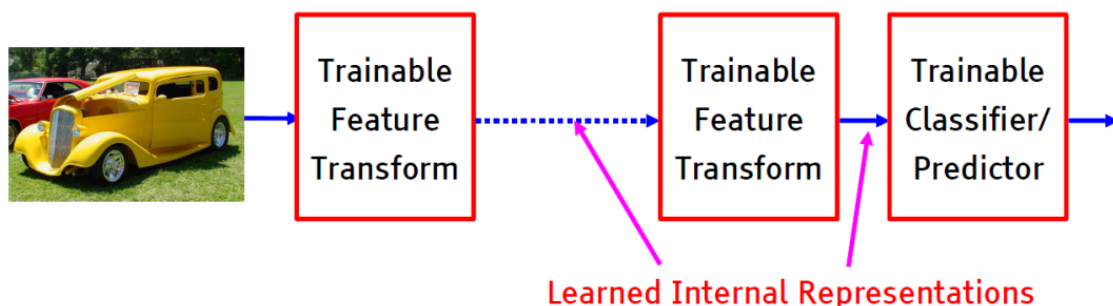
**Why has deep learning been thriving ultimately(发展）？**

- huge amount of training data **– Big Data**
- sufficient computational power **– Big Machine (GPU and Cloud)**
- highly complicated models **– Big Model**

  - Deep structure reduces the number of parameters while achieving high model complexity
  - Layered structure is very natural

## Deep (Feedforward) Neural Networks（P26）



主要用于中间层辅助模块

Loss functions:
- Square error
- Cross entropy
- Hinge loss
- Ranking loss
- …

很少使用；
原因：很难训练
把输入视作一个整体，如果有变动
要整体变动

Training:
Backpropagation

Activation functions

Sigmoid        ReLU