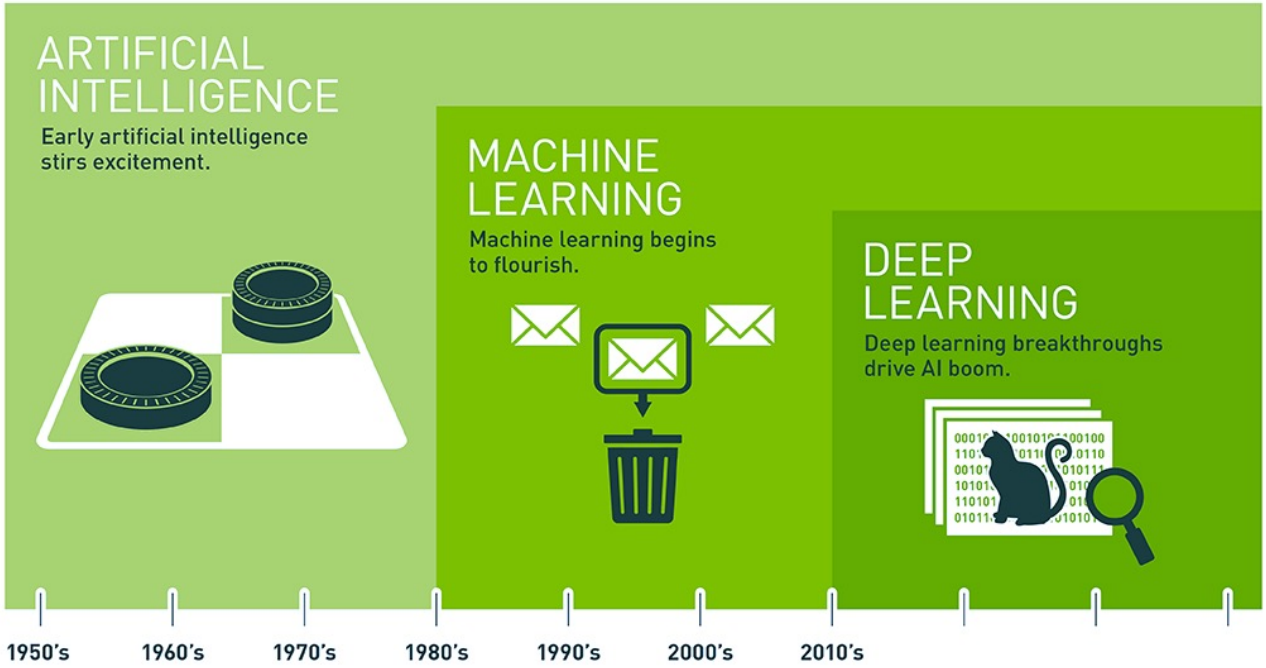
What is Machine Learning?

Timeline



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

History and Examples

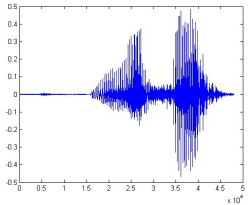
- Machine Learning
  - Grew out of work in AI
  - New capability for computers
- Examples
  - Database mining
    - Large datasets from growth of automation and web
    - Web click data, medical records, biology and engineering
  - Applications can't program by hand
    - Autonomous helicopter, handwriting recognition, most of Natural Language Processing (NLP) and computer vision
  - Self-customizing programs
    - Amazon, Netflix product recommendations
- Understanding human learning (brain, real AI)

Definitions

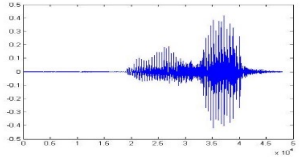
- Arthur Samuel (1959). **Machine Learning**: Field of study that gives computers the ability to learn without being explicitly programmed.
- Tom Mitchell (1998). **Well-posed learning problem**: A computer program is said to *learn* from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E.

Illustrated Explanation

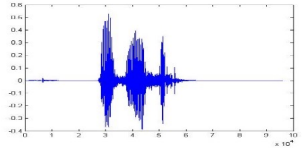
Learning .....



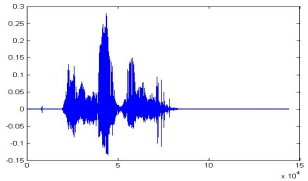
You said “Hello.”



“Hi.”



“How are you?”

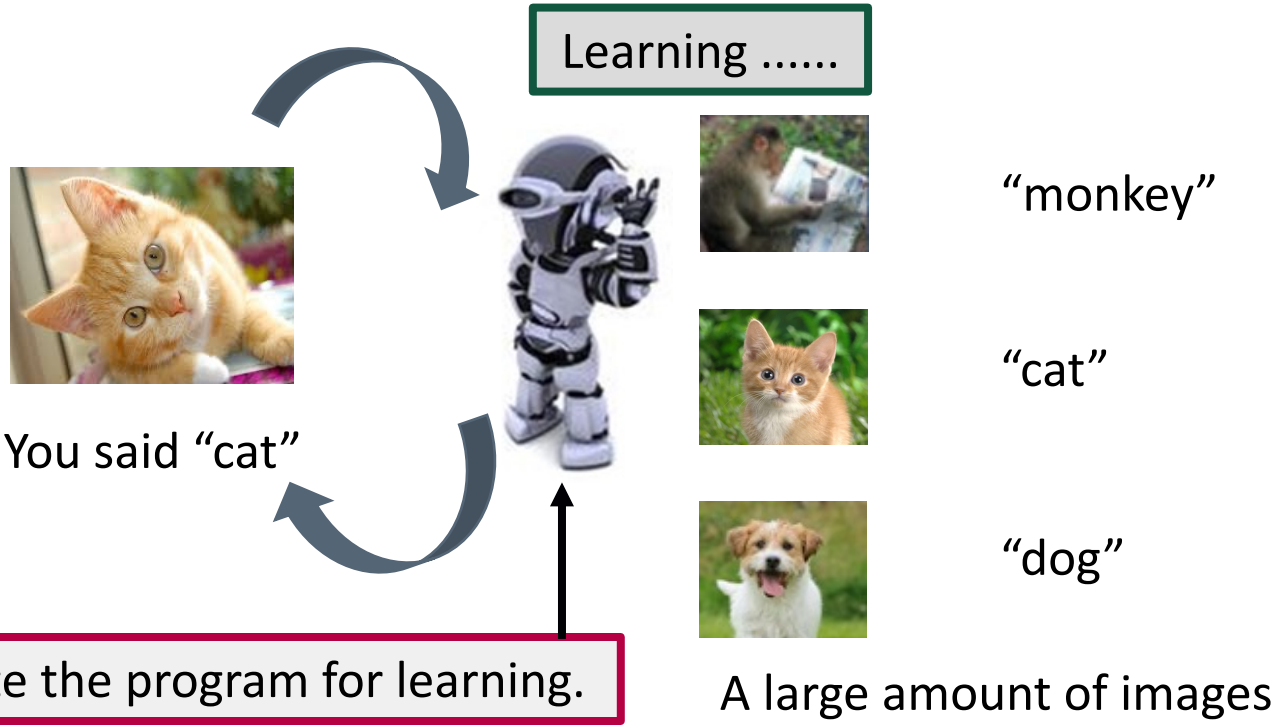


“Goodbye.”

You write the program for learning.

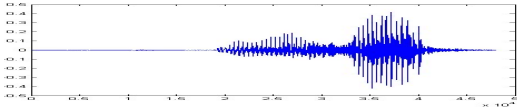
A large amount of audio data

Illustrated Explanation, Cont'd



Machine Learning ≈ Looking for a Function

- Speech recognition

$f($  $)=$“How are you?”

- Image recognition

$f($ $)=$“cat”

- Playing Go

$f($ $)=$“5-5” (next move)

- Dialogue system

f(“How are you?”)=“I am fine.”

(what the user said) (system response)

Image Recognition: $f($ $)=$ “cat”

Framework: Part I

A set of function

Model

$f_1, f_2 \cdots$

$f_1($ $)=$ “cat”

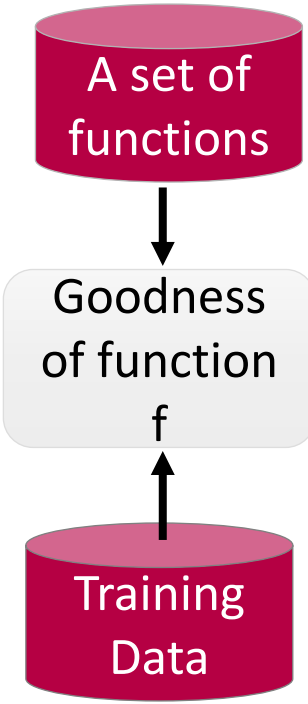
$f_2($ $)=$“monkey”

$f_1($ $)=$“dog”

$f_2($ $)=$ “snake”

Image Recognition: $f($ $)=$ "cat"

Framework: Part II



$f_1($ $)=$ "cat"

$f_2($ $)=$ "monkey"

Better!

$f_1($ $)=$ "dog"

$f_2($ $)=$ "snake"

Supervised Learning

function input:

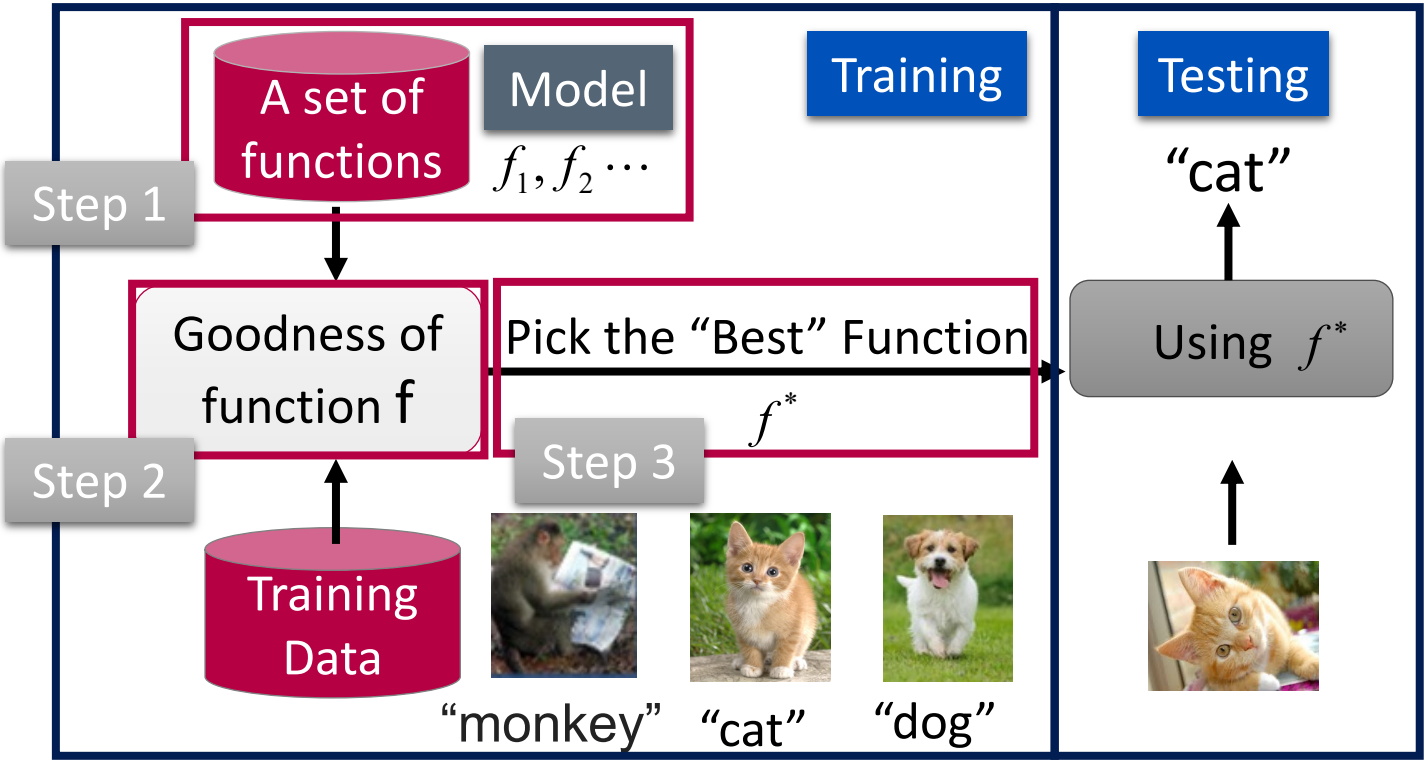
function output: "monkey"

"cat"

"dog"

Image Recognition: $f($ $) =$ "cat"

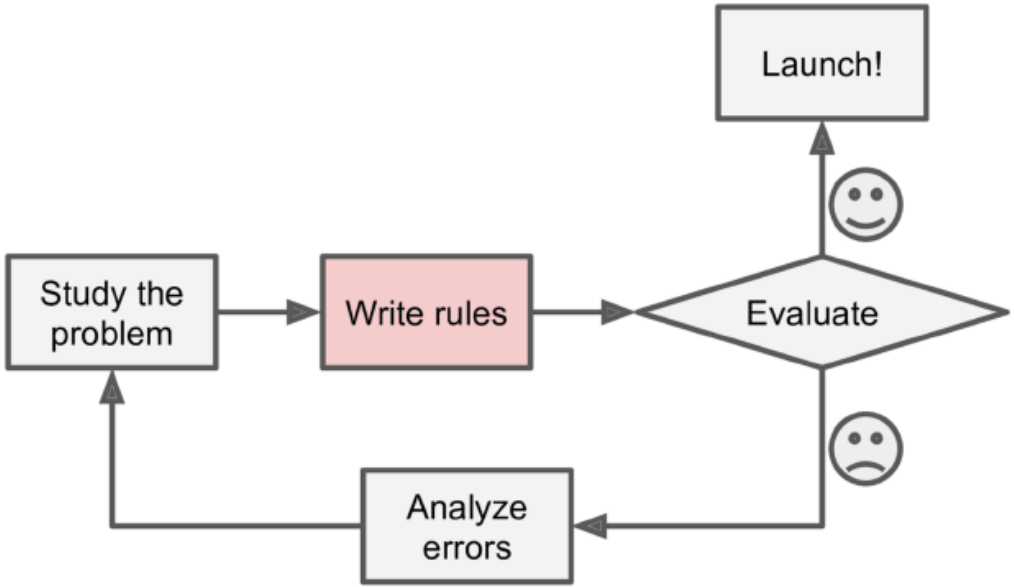
Framework: Part III

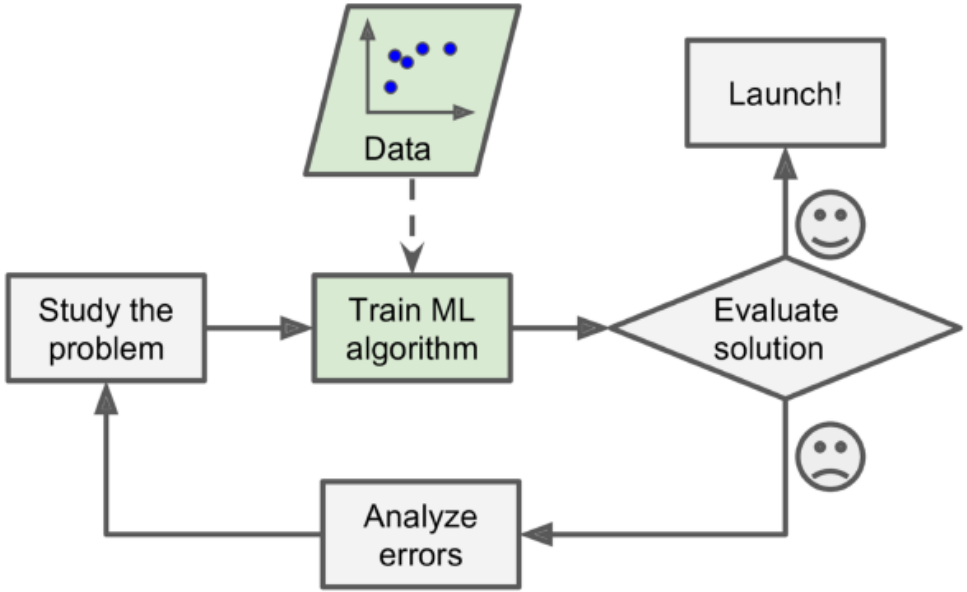


Machine Learning is not Rule Based

Issues with rule-based systems:

- Very labor intensive to build
- Rules cannot generalize to unanticipated input combinations
- Do not naturally handle uncertainty
- Expert systems seen as “brittle”



The Machine Learning Approach

- Do not reverse engineer an expert's decision process.
- Machine "learns" on its own.
- We provide the "training data".