

# Week 1: The Learning Problem

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## What is Machine Learning

1. **Machine learning** is the process of acquiring skill with experience accumulated from *data*
  - A more concrete definition: Improve some *performance measure* with experience **computed** from data
2. Application of ML:
  - When human cannot program the system manually
  - When human cannot *define the solution* clearly
  - When rapid decision making is involved
  - Need to tailor to individual use cases at massive scale
3. Key essence of ML (Which problems can make use of ML?)
  - Exists some *underlying pattern* to be learned (so performance measure can improve as more experiences are gained)
  - But without programmable/clear definition
  - There are *data* about the pattern (inputs to learn from)

## Components of Machine Learning

1. Components of a ML problem and its corresponding model
  - **Unknown** target function  $f$  (real world pattern)
  - Collection of training examples  $D : (x_1, y_1), \dots, (x_N, y_N)$
  - Learning algorithm  $A$
  - Hypothesis  $g$ , with the hope that  $g \approx f$  (training outcome)
  - Assume there exists a set of hypothesis  $H$ , such that  $g \in H = \{h_k\}$ 
    - $H$  can contain both good and invalid hypotheses
    - The hope is that training algorithm  $A$  will pick out the hypothesis  $g$ , which closest resembles the real world pattern  $f$
2. In summary: Machine learning uses *data* to compute **hypothesis**  $g$  that *approximates* **target**  $f$

