Machine Learning and Deep Learning

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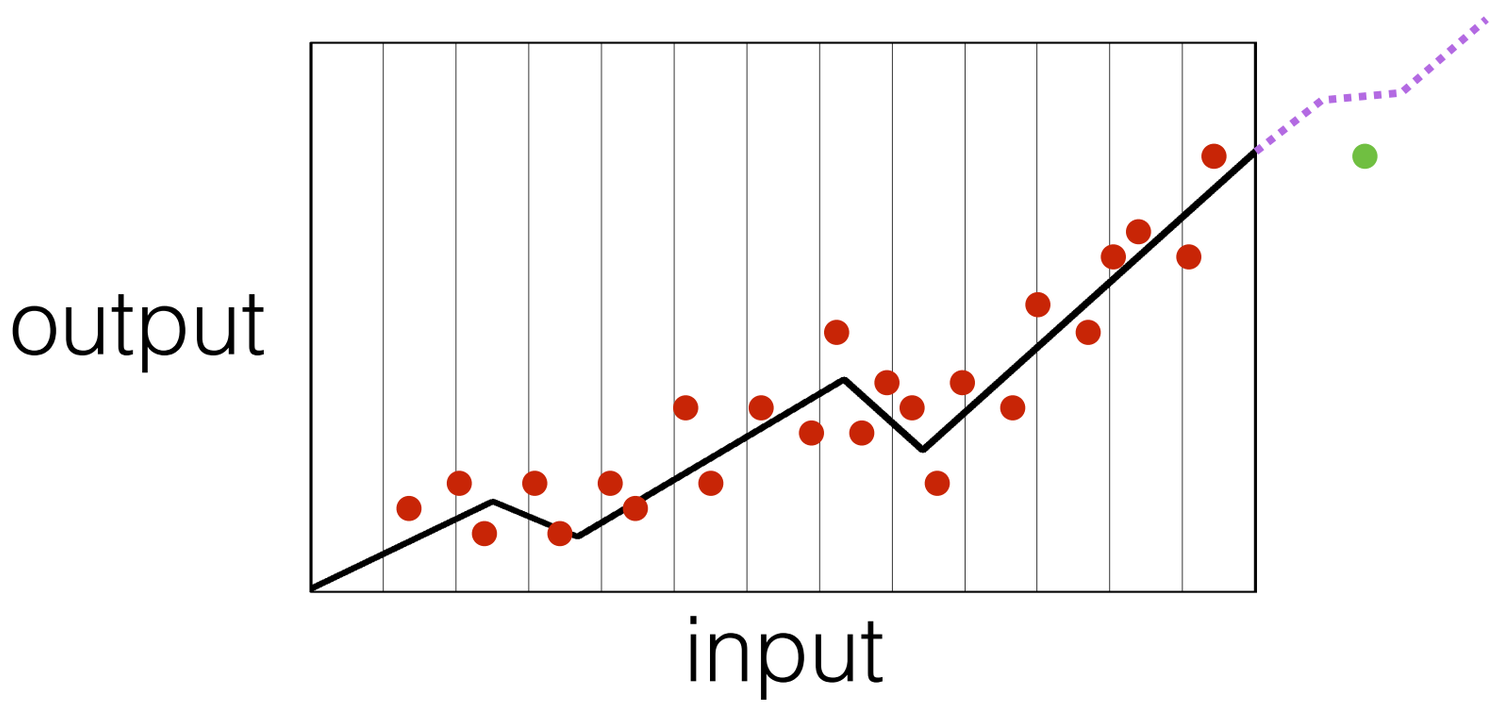
Workshop on Machine Learning - Observatoire de Geneve

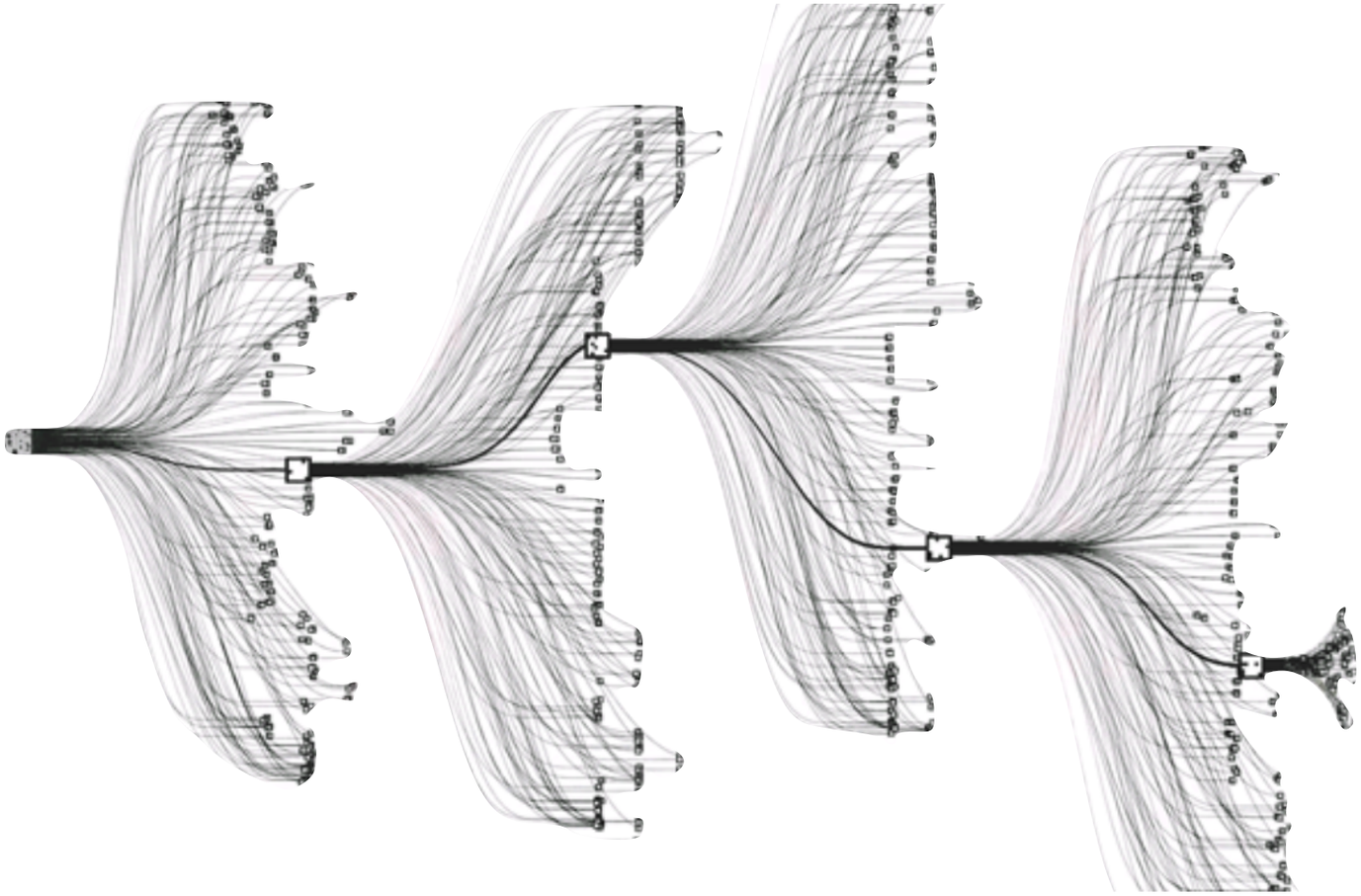
Building Machines

- We are interested in finding a function (a machine), by using some observed data
- We want the function to fit well new data



Knowledge-Based Approach

- List of all the knowledge and formal rules
  - works for games and simple systems
  - leads to a combinatorial problem
  - **not general (often we do not know the rules)**



Machine Learning

- The machine automatically learns from examples
  - machine learning
  - no need to identify and explain rules
  - **general and flexible**

training set (data,label)

label?

new data

Features

- Machines solve tasks/decisions by using the provided information (data)

- Data is often encoded into more focused relevant information (features) to simplify the decision

$$x \rightarrow \phi(x)$$

data feature

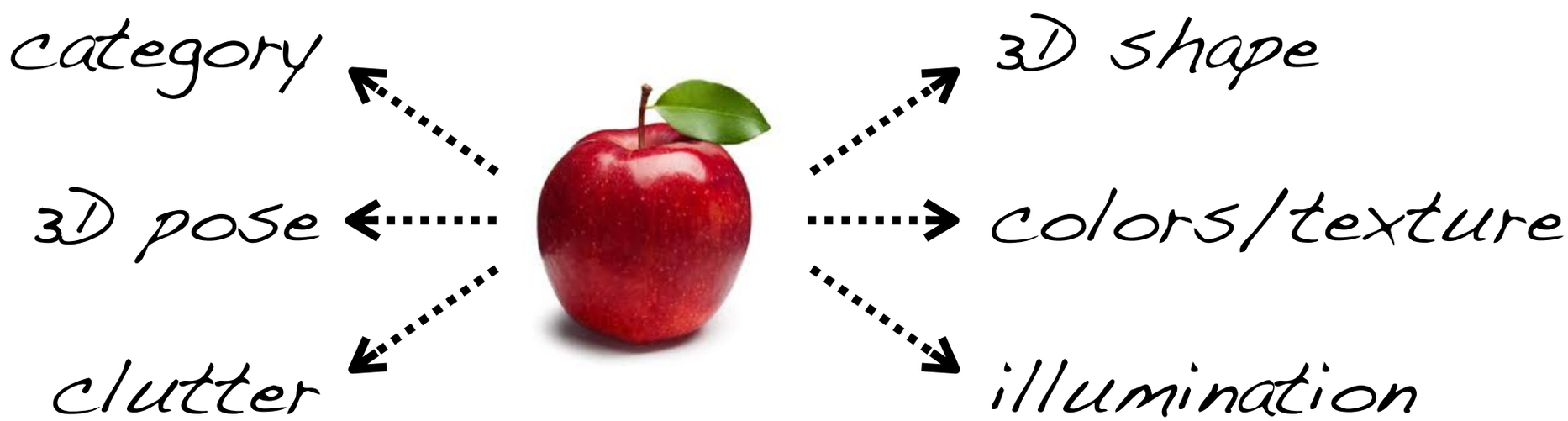
- Features can be hand-made/encoded

  - <u>Operators often do not know the optimal features</u>

Representation Learning

- Features or, more in general, an **internal representation** or a hierarchy of concepts should be learned automatically

- The internal representation should separate all **factors of variation** (i.e., concepts that summarize important variation of the data)

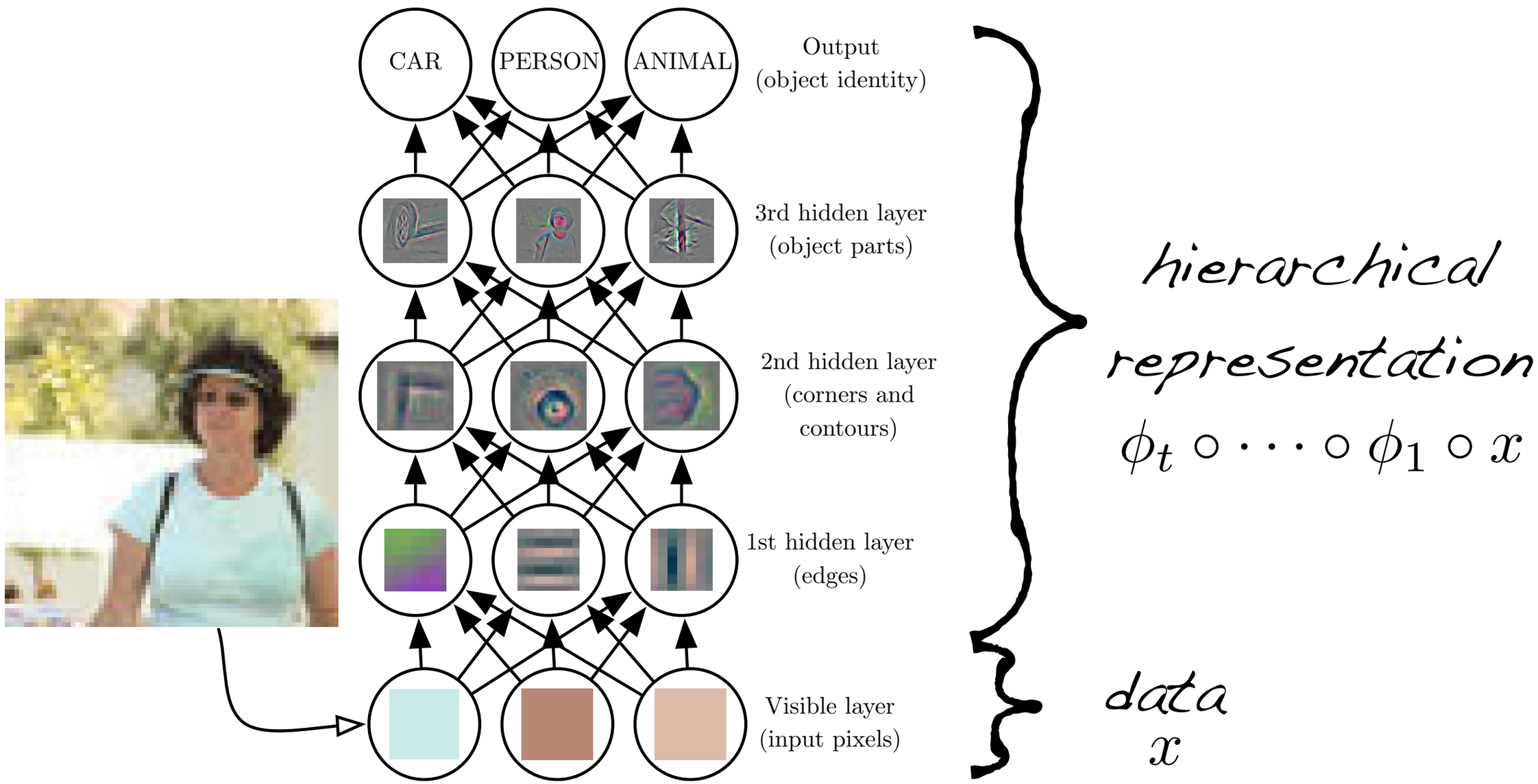


Distributed Representation

- Use many features to represent data and each feature should handle multiple data samples
- Example: Recognition of cars, trucks and birds and each can be red, green or blue
- Case #1: 1 feature for each case (3x3 = 9 features)
- Case #2: 3 features for identity and 3 for color (3+3 = 6 features)

Deep Learning

Introduces hierarchical representations (from simple to complex, from low-level features to high-level features)



Deep Learning

- **Objective**: Build a machine that can learn from experience and understand the world as a hierarchy of concepts