

# Inductive Programming: Tutorial 4

## Hypothesising an Algorithm from One example

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The aim of this tutorial is to help you understand concepts in Lecture 4, involving Hypothesising an Algorithm from One example.

### Question 1

Give an example of a textual analogy problem and its expected solution.

### Solution

Textual analogy:

alice	ECILA
bert	?

Expected answer:

alice	ECILA
bert	TREB

### Question 2

Describe two known human phenomena relevant to textual analogy.

### Solution

1. “People can learn .. concepts from just one example, but it remains a mystery how this is accomplished.” (Lake et al, Proc Cognitive Science, 2011)
2. Average human vocabulary - 10,000 - 42,000 (Goulden et al, 1990)

### Question 3

Describe the relevant known results of three models of learnability.

### Solution

**Gold 1967:** No infinite language, in the Chomsky hierarchy, can be exactly identified from a positive example sequence.

**Valiant 1984:**  $k$ -CNF propositional formulae can be learned efficiently (polynomial time) with high accuracy from a randomly selected positive example sequence.

**Muggleton 1996:** Given a Bayes' prior distribution over hypotheses, efficient (polynomial runtime) logic programs can be learned efficiently, with high expected accuracy, from a randomly selected positive example sequence.

### Question 4

Derive the solution for one-shot learning using Bayes' positive only MAP selection.

### Solution

$$\begin{aligned} p(H|E) &= \frac{p(H)p(E|H)}{p(E)} \\ &= p(H) \left( \frac{1}{g(H)} \right)^m c_m \\ -\ln p(H|E) &= sz(H) + m (\ln g(H)) + d_m \end{aligned}$$

Minimise  $-\ln p(H|E)$  over  $H \in \mathcal{H}$

### Question 5

Describe the key findings for one-shot learning and its relationship to the generality of the target.

### Solution

$$\begin{aligned} EA(1|g(T)) &\geq 95\% \text{ when } g(T) \leq 0.01 \\ \text{Expected accuracy below default} \end{aligned}$$

Accurate one-shot learning requires a low-generality target