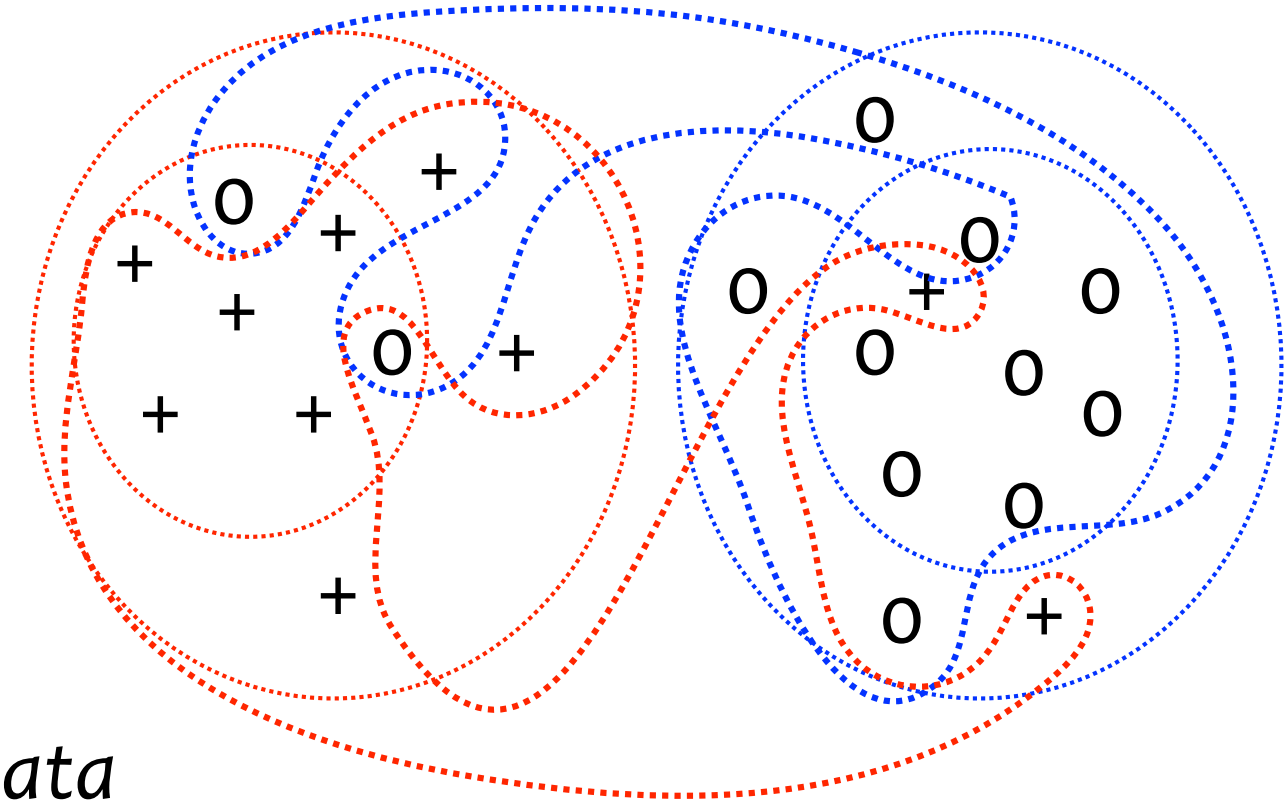
Concept formation as induction



Fit the data

Overfit the data?

Oververfitting and underfitting in induction

- Rome has a subway

  -> Rome has a subway

- Rome, Venice have subways ->

  -> All Italian cities have subways

- Rome, Venice, Paris have subways

  -> All cities beginning with R, V or P have subways [a natural kind?]

  -> All European cities have subways [a compositional concept]

- Rome, Venice, Paris, New York have subways

  -> All cities have subways

- But Saint-Jeannet, France does not have a subway

  -> All large European cities have subways

- … etc.

Natural kinds

- But can you induce “large European cities” as a concept with stable properties?
- This is a complex compositional concept

  - Does its properties follow from its constituent elements?

- Is it a natural kind?

  - i.e. a stable phenomenon of the world as it exists, with consistent properties

- We seek to “carve nature at its joints”

Puzzles of induction

- Hume's problem

  The basic problem of induction

- Hempel's paradox

  All ravens are black $(\forall x\ \text{raven}(x) \rightarrow \text{black}(x))$,

  is logically equivalent to

  All non-black things are non-ravens

  $(\forall x\ \sim\text{black}(x) \rightarrow \sim\text{raven}(x))$

  - So a white swan confirms the generalization as much as a black raven

- Goodman's problem ("grue/bleen")

Grue and Bleen (Goodman, 1955)

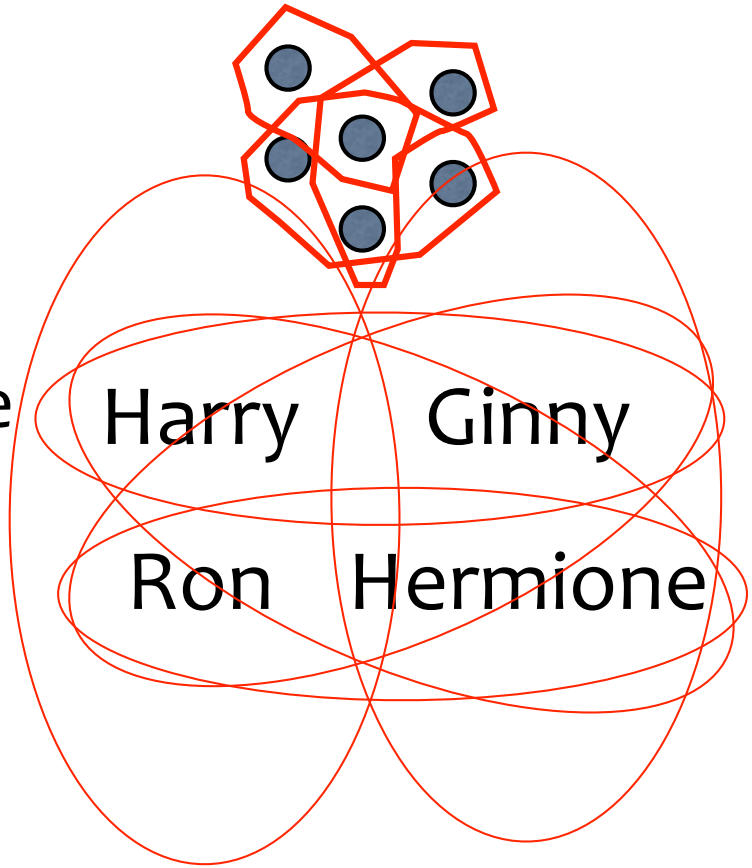
$$\text{Grue} = \begin{cases} \text{Green} < \text{time } t \\ \text{Blue} \geq \text{time } t \end{cases} \qquad \begin{cases} \text{Blue} < \text{time } t \\ \text{Green} \geq \text{time } t \end{cases} = \text{Bleen}$$

$$\text{Green} = \begin{cases} \text{Grue} < \text{time } t \\ \text{Bleen} \geq \text{time } t \end{cases} \qquad \begin{cases} \text{Bleen} < \text{time } t \\ \text{Grue} \geq \text{time } t \end{cases} = \text{Blue}$$

Grue and bleen are no more complex than green and blue

The Ugly Duckling theorem (Watanabe)

- A feature is a subset of objects



- But all objects in a set have the same number of features in common with other sets!

Male vs Female

Married couples

Weasleys vs not

- Therefore all objects are equally similar to all other objects (share the same number of features).

→You have to place constraints on what counts as a "feature," or categories are meaningless