Other Machine Learning Methods

Bacon

Planet	1 Length of day	2 Length of year	3 Distance from sun	4 Diameter	5 Mass	6 Number of moons
Mercury	**58.00**	**0.24**	**0.39**	**0.38**	**0.05**	**0**
Venus	**244.00**	**0.62**	**0.72**	**0.95**	**0.82**	**0**
Earth	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1**
Mars	**1.03**	**1.88**	**1.52**	**0.53**	**0.11**	**2**
Jupiter	**0.41**	**11.86**	**5.20**	**11.19**	**318.35**	**16**
Saturn	**0.43**	**29.46**	**9.54**	**9.41**	**95.30**	**15**
Uranus	**0.67**	**84.01**	**19.19**	**4.06**	**14.60**	**5**
Neptune	**0.75**	**164.80**	**30.07**	**3.88**	**17.30**	**2**
Pluto	**6.38**	**248.40**	**39.52**	**0.24**	**0.08**	**1**

- Try random mathematical operations until you find a correlation
  Almost exact equality is an easy one to detect
- Examples
  Venus: Y=0.62; D=0.72; Y^2=0.3844; D^3=0.3732; Y^2/D^3=1.03
  Mars: Y=1.88; D=1.52; Y^2=3.5344; D^3=3.5118; Y^2/D^3=1.01
- Bacon rediscovered Kepler's laws of planetary motion

Inductive learning

- Like decision tree learning, from specific facts induce general rules
- But here facts are logical predicates
  and rules are logical formulæ that are (supposed to be) true
- A bit like Prolog in reverse
- Background $\wedge$ Hypothesis $\wedge$ Descriptions $\models$ Classifications
- Background is the knowledge you already have, could be $\varnothing$
- Descriptions are the facts the training data is based on
- Classifications is the training examples we are to induce from
- Hypothesis is the thing we're trying to discover - a new rule. Example:
  Background =
  mother(X, Y) $\vee$ father(X, Y) $\Rightarrow$ parent(X, Y)
  Descriptions =
  father(phillip, charles), father(philip, anne),
  mother(elizabethb, margaret), mother(elizabethb, elizabethw),
  married(diana, charles), married(elizabethw, philip),
  male(philip), male(charles), female(beatrice), female(margaret),
  and many more, there are 20 people in the example
  Classifications =
  grandparent(elizabethb, charles),
  grandparent(elizabethw, beatrice),
  $\neg$grandparent(elizabethb, harry),
  $\neg$grandparent(philip, elizabethb)

and some more.

There are 400 facts like this, but we don't know them all

Hypothesis = the desired general rule for grandparent(X, Y)

Top-down method

- Start with the most general possible rule:
  true ⇒ grandparent(X, Y)
  Everybody is everybody's grandparent
- Add conditions, one-by-one, to the left
- There are a lot we could try:
  father(X, Y) ⇒ grandparent(X, Y)
  that gets many many things wrong
  parent(X, Z) ⇒ grandparent(X, Y)
  much better, so we'll keep this one
- And carry on like that, adding extra conditions
- Maybe you'll try parent(Z, Y) at some point, giving
  parent(Z, Y) ∧ parent(X, Z) ⇒ grandparent(X, Y)
  which will work nicely, so you'll stop
- Of course, it gets much more complicated than that
  Some rules don't just have conjunctions as their conditions