Will the candidate elimination algorithm converge to the correct Hypothesis?

Yes, under the following assumptions:

1. **There are NO errors in the training examples**

2. **There IS some hypothesis h in H that correctly describes the target concept**

Suppose there are errors in the training examples

CE will converge to the empty set
CE will REMOVE correct hypothesis from VS

CE removes every hypothesis inconsistent with each training example

What training example should the learner next request?

An example that removes some competing hypotheses from the candidates in the VS.

Optimally: an example that removes 1/2 the hypotheses

Like playing 20 questions

Suppose we have several hypotheses in the VS and no more training examples.

Given a new instance, what should the learner do?

1. Vote
2. Refuse to classify -> I don't know.
3. Supply a probability -> Answer is positive with probability =

$$\frac{\text{number of hypotheses that positively classify}}{\text{total number of hypotheses in VS}}$$

3. Supply a probability -> Answer is negative with probability =

$$\frac{\text{number of hypotheses that negatively classify}}{\text{total number of hypotheses in VS}}$$

INDUCTIVE BIAS

Current space of Hypotheses is restricted to
Conjunction of features
<Sunny AND Warm AND ... >

Suppose we unrestrict this space to all possible Hypotheses given the number of instances we need to classify.

How many instances?

4 * 3^5 = 96

Number of hypotheses = 2^(96) !!!

Conjunctions, disjunctions, negations

Let CE be allowed all these.

```
Consider three possible instances

                        x1, x2, x3
three negative instances
                        x4, x5


        S = x1 OR X2 OR X3
        G = ~x4 AND ~x5 == ~(x4 OR x5)

In general
  S is disjunction of all training instances
  G is negation of (disjunction of all training
  instances)

Perfect classification of all training instances

Cannot classify new instance, x!!

Why?

Exactly half of the hypotheses will classify positive
Exactly half of the hypotheses will classify negative



if h  E H covers x and classifies positive then
there exists
   h' E H covers x and classifies negative

remember
        H is power set of all instances
if h is in VS then h' must also be in VS

because h  correctly classifies all seen instances
and     h' correctly classifies all seen instances
```

Futility of bias free learning.

If you don’t have a bias you do not have a rational basis for generalizing/learning

EnjoySport bias ==> only considers conjunctions
EnjoySport assumes ==> Target concept describable using conjunctions

To learn you must have INDUCTIVE BIAS.

Inductive bias:

Set of assumptions needed to deductively prove that the classification assigned by a learner is correct.

Assignment 2.

Understand and apply ID3 to as2.train -- use your own definition of information gain or the book's.

Construct your decision tree

Show your decision tree and report accuracy on as2.test

Extra credit. Write id3 in C/C++