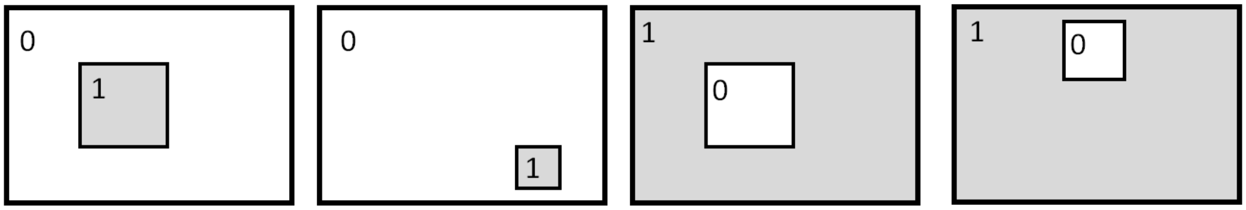
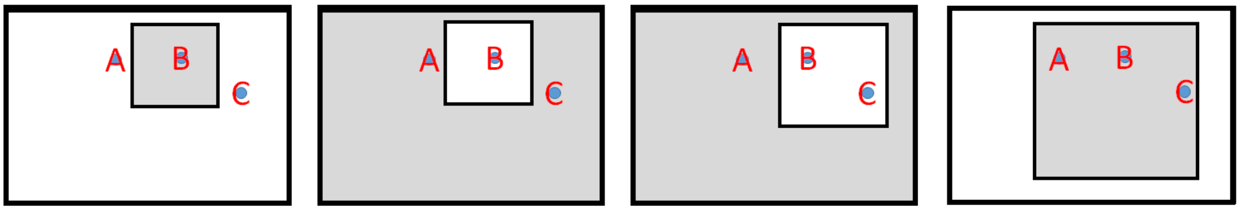
Consider a classifier hypothesis set of squares. A single hypothesis h is a square with a fixed size and location. Four example hypotheses are shown.



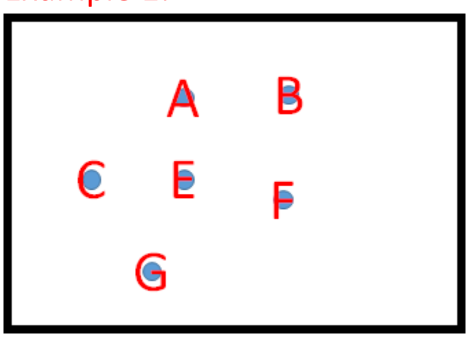
And here is examples of h that will help shatter a set of three data points.



For each data set:

- What is a set of 4 shatterable points ("none" is a possible answer)
- What is the VC dimension?

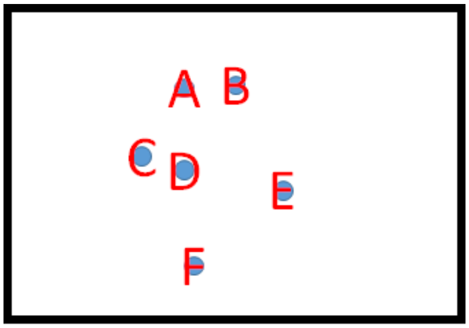
Example 1:



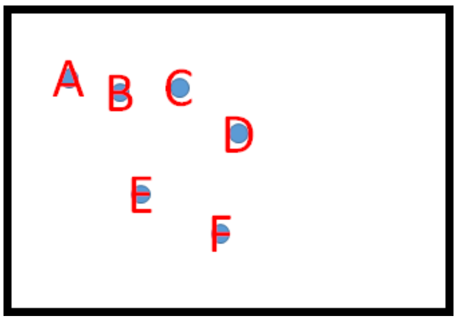
Four points: None (could shatter with rectangle, not with square!)

VC dimension: 3

Example 2:



Example 3:



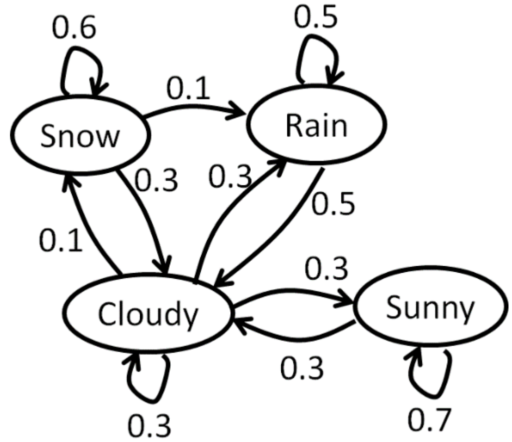
Consider the following HMM. It uses a thermometer to attempt to predict the weather.

We begin with the following estimate for our HMM parameters:

$\Pi_{snow} = 0.2$ $\Pi_{rain} = 0.3$ $\Pi_{sunny} = 0.3$ $\Pi_{cloudy} = 0.2$

$\phi_{o,i}$:

	Cold	Mild	Hot
Snow	0.8	0.2	0
Rain	0.5	0.3	0.2
Sunny	0	0.3	0.7
Cloudy	0.2	0.7	0.1



(We COULD actually learn a Gaussian function for the temperature for each state. Here, we'll just do a discrete probability table.)

We receive a new sequence of temperatures and wish to update our HMM parameters.

Sequence:
Cold Cold Hot Mild Hot

Correct alpha values are in black. Made-up alpha values are in color parentheses. You will have to find the real values below. You can use the made-up value in calculating S_t values further below.

$\alpha_t(i)$

t:	1	2	3	4	5
Snow	?? (.11)	.08	0	.00011	0
Rain	0.15	?? (.04)	.0082	.0017	.00049
Sunny	?? (.08)	0	.0056	?? (.0033)	.0020
Cloudy	0.04	.027	?? (.0044)	.0053	.00030

Correct beta values are in black. Made-up beta values are in color parentheses. You will have to find the real values below. You can use the made-up value in calculating S_t values further below.

$\beta_t(i)$

t:	1	2	3	4
Snow	.0067	.0062	.13	.05
Rain	.0097	?? (.011)	.13	?? (.08)
Sunny	.0028	.087	?? (.11)	.52
Cloudy	.0062	.047	.121	?? (.11)

Find the missing values in the tables above.

$\boldsymbol{\alpha_1(Sunny) = 0}$

$\boldsymbol{\beta_2(Sunny)} = 0.5 \times 0.2 \times 0.13 + 0.5 \times 0.1 \times .121 = \mathbf{0.019}$

What are the values:

S_2(cloudy)

S_3(snow,sunny)=**0**

S_1(rain)

Now let us presume the following S values (these are made-up values):

$S_t(i)$

t	1	2	3	4	5
Snow	0.3	0.3	0.1	0.2	0.1
Rain	0.5	0.4	0.3	0.3	0.2
Sunny	0.1	0.1	0.3	0.1	0.4
Cloudy	0.1	0.2	0.3	0.4	0.3

$S_t(i,j)$

t	1	2	3	4

Rain, Cloudy	.1	.4	.3	.2
Sunny, Rain	0	0	0	0

$\Pi_{rain} = \mathbf{0.5}$

Π_{cloudy}

$A_{rain,cloudy}$ $A_{sunny,rain}$

$\phi_{hot,rain} = \frac{0.3+0.2}{0.5+0.4+0.3+0.3+0.2} = \frac{0.5}{1.7} = \mathbf{0.29}$

$\phi_{mild,sunny}$