

# MODELLING SEQUENCES

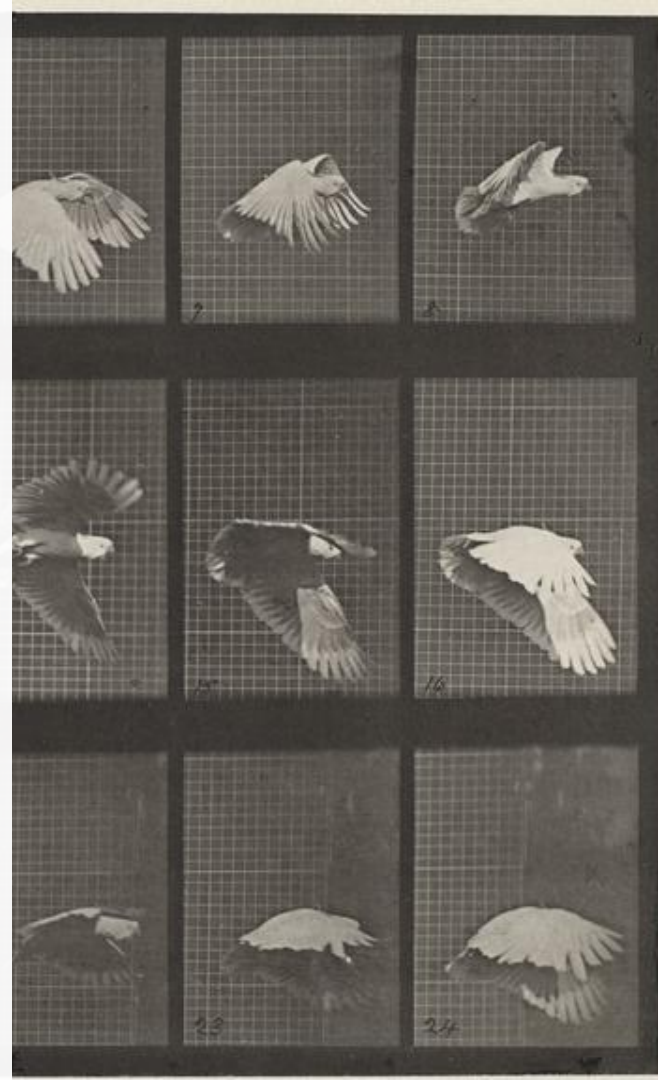
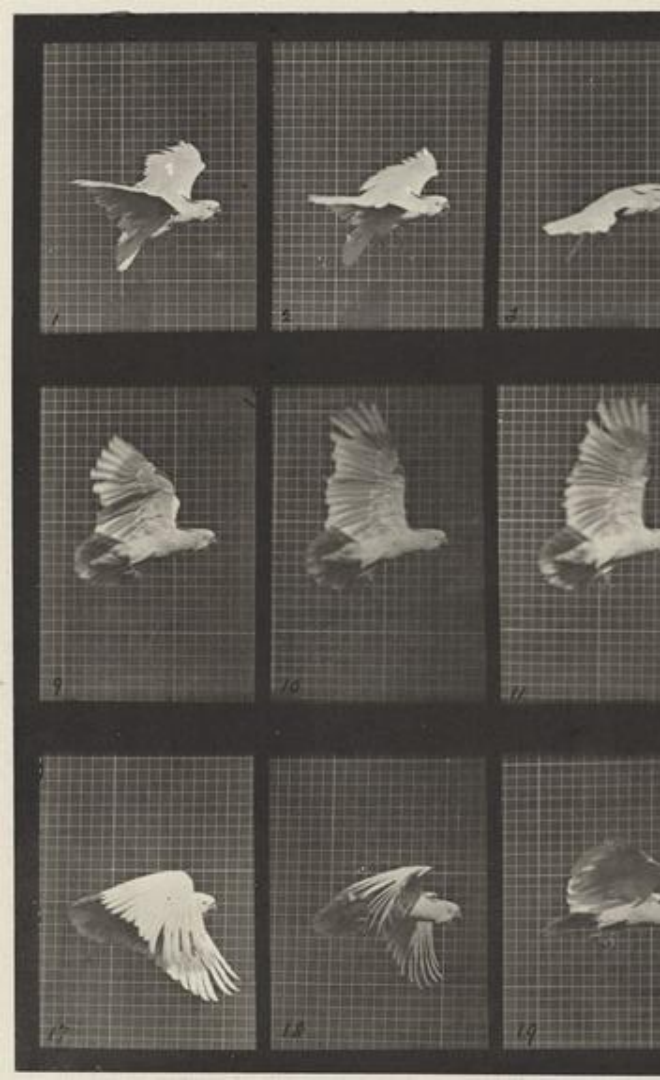
WITH  
HIDDEN MARKOV  
MODELS

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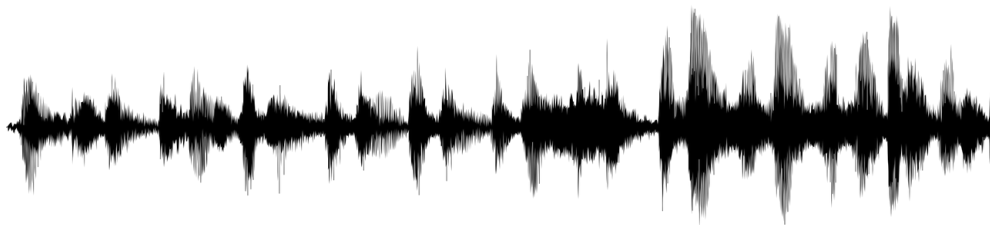
PYTHON IRELAND  
MEETUP

MARCH 2017

ALICE LYNCH

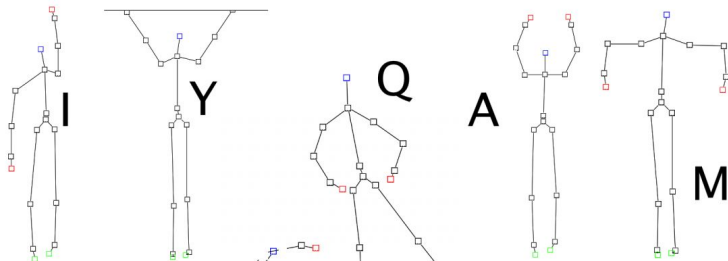


# HIDDEN MARKOV MODEL (HMM)

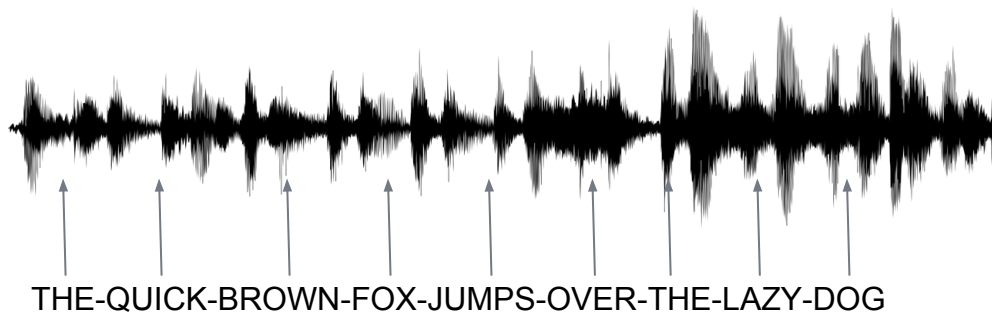


## SEQUENTIAL DATA

- Speech Recognition
- Gene Sequence Alignment
  - Human Genome Project
- Assistive Technology & Robotics

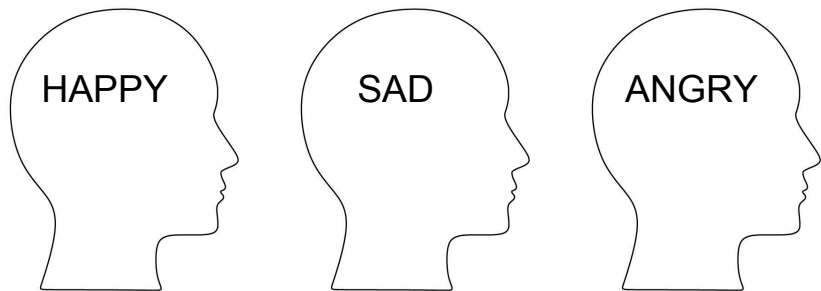


## HIDDEN MARKOV MODEL (HMM)



- Infer **Hidden States** (words)  
From a sequence of **observations**  
(sounds)
- Future State only depends on  
Current State

## HMM EXAMPLE: ROBOT WANTS TO FEEL



### **(HIDDEN) EMOTION STATES:**

$X = \{\text{HAPPY, SAD, ANGRY}\}$

### **OBSERVATIONS:**

$Y = \{ \text{PLAYING GUITAR,}$   
 $\text{WATCHING ROM-COMS ON NETFLIX,}$   
 $\text{DRINKING WHISKEY,}$   
 $\text{FACEBOOK,}$   
 $\text{WASHING THE DISHES} \}$

## HMM EXAMPLE: ROBOT WANTS TO FEEL

$P(X = \text{happy} \mid Y = \text{facebook})$

$P(X = \text{angry} \mid Y = \text{dishes})$

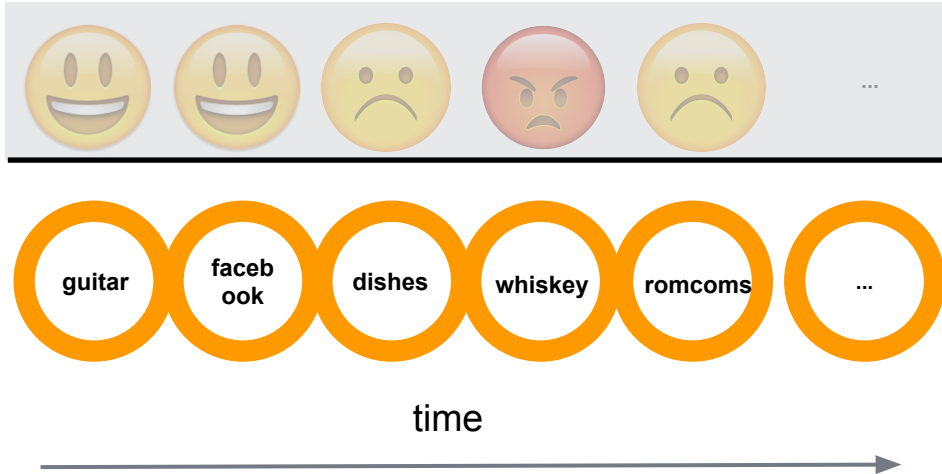
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**Emission Probability Matrix**

	guitar	facebook	dishes	whiskey	romcoms
happy	0.4	0.1	0.1	0.2	0.2
sad	0.1	0.2	0.1	0.2	0.4
angry	0.1	0.1	0.4	0.3	0.1

## HMM EXAMPLE: HUMANS BE CRAZY

- Dynamic system
- Robots makes observations every 10 minutes
- Wants to infer & predict how emotional state changes



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**Initial State Probability**

	happy	sad	angry
P0	0.6	0.3	0.1

**Transition Probability**

	happy	sad	angry
happy	0.67	0.21	0.02
sad	0.32	0.54	0.14
angry	0.11	0.27	0.62

## HMM EXAMPLE: LEARNING TO FEEL

### Given:

GGGFFWDDNNNGGNFFWWDDNNNGGGG... ← TRAINING DATA (OBSERVATIONS)

INITIAL PARAMETERS:  $P_0$ , Emission Probability, Transition Probability

### Calculates:

Probability of all sequences in the training data

### Updates:

$P_0$ , Emission Probability, Transition Probability

} Iteratively via  
Expectation- Maximisation  
algorithm

### Returns:

HHHHSSSAASSSHHHHHHAAAASSSHHHHHHH... ← MOST LIKELY STATES



## PYTHON HMM LIBRARY

<https://github.com/hmmlearn/hmmlearn>

<http://hmmlearn.readthedocs.io>

## DEMO

[https://github.com/alicelynch/  
hmm-python-meetup/](https://github.com/alicelynch/hmm-python-meetup)

