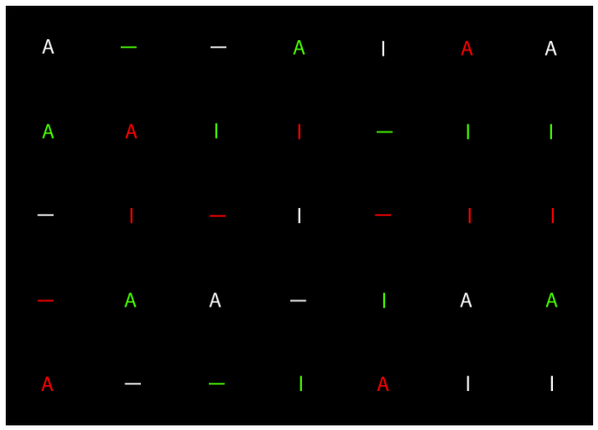
TASK INFERENCE USING HIDDEN MARKOV MODEL

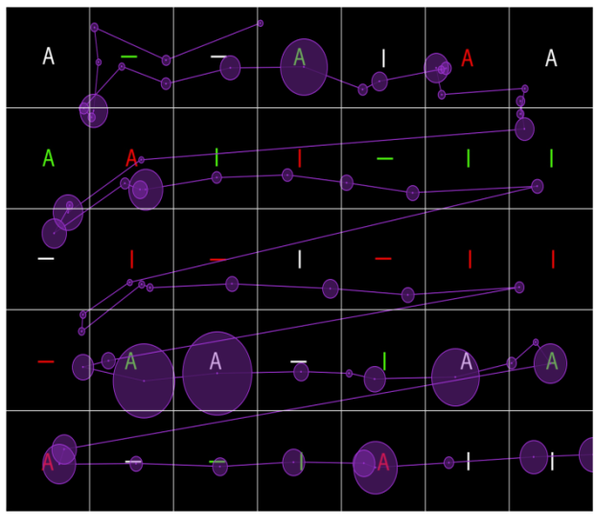
P. Yaswanth Kumar
10472

Jitendra Kumar
10316

Guide: Prof. Amitabha Mukerjee

- Problem Statement:
  - 4 Tasks.
  - Counting number of
    1. Characters ‘A’
    2. Green bars
    3. Horizontal bars
    4. Vertical bars





Training HMM’s for each task

Task inference for a new given eye trajectory

INTRODUCTION

- Yarbus Process :

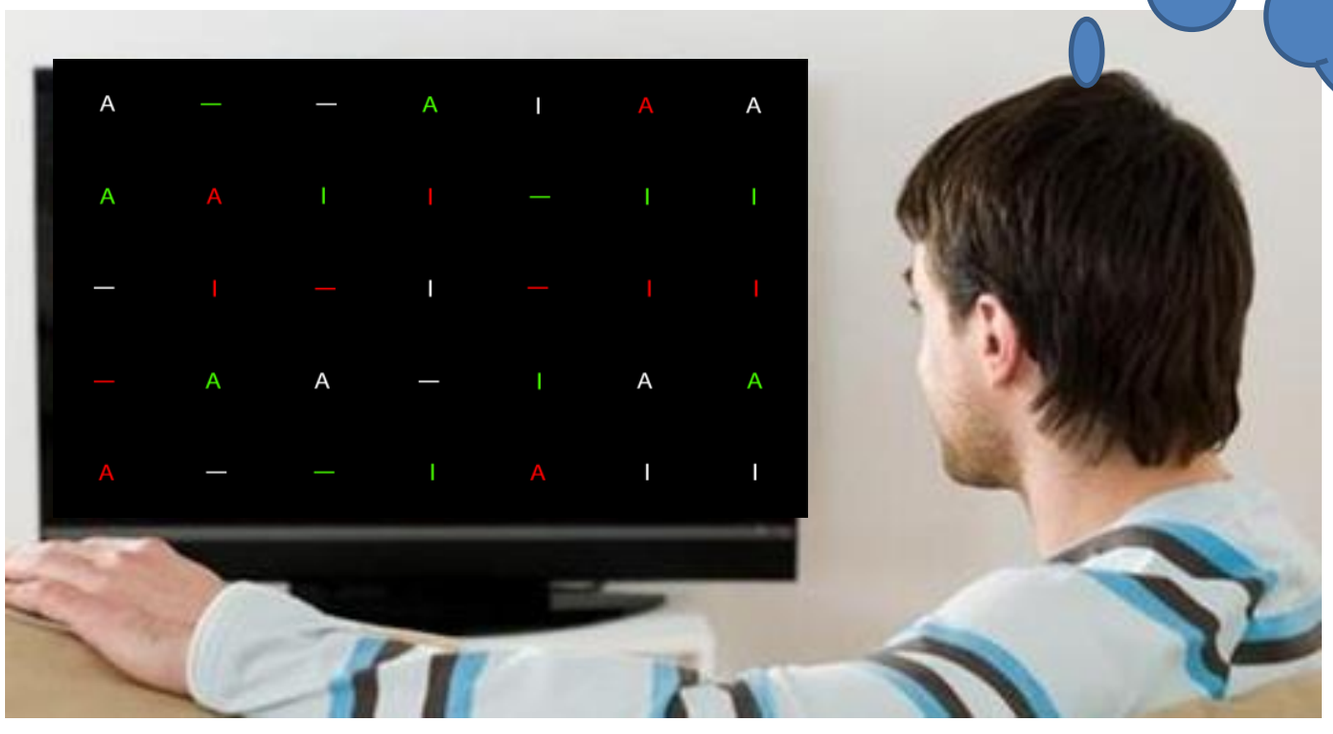
[Yarbus 1967]

Free examination of the picture

Estimate the ages of the people

Remember clothes of the people

Inverse Yarbus Process

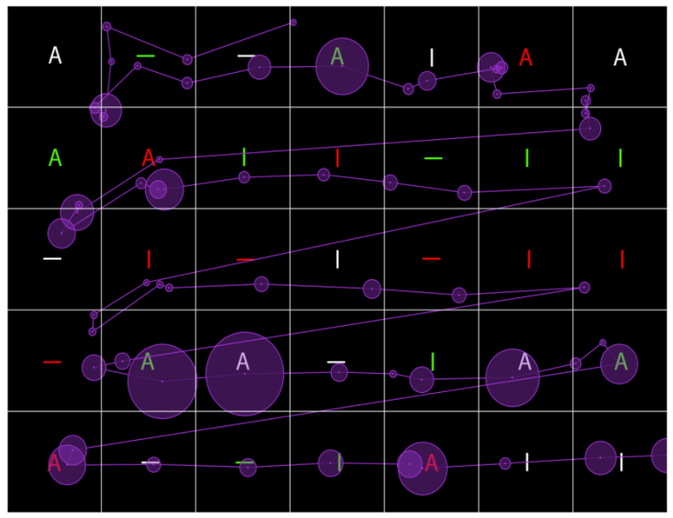


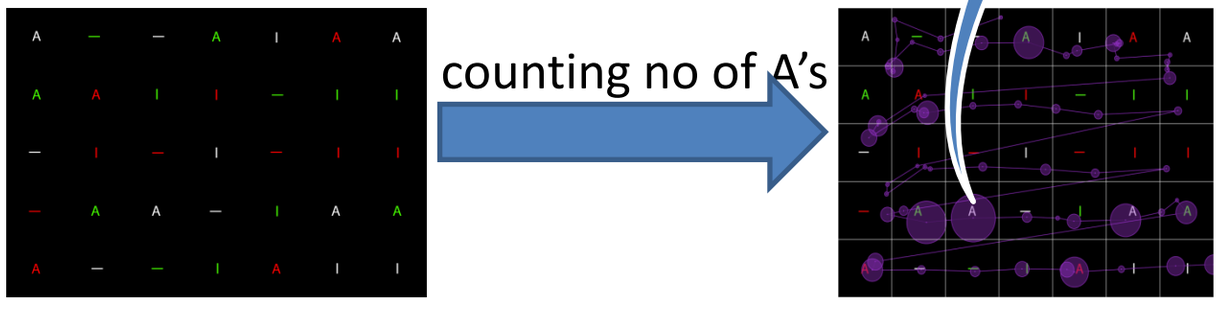
TASK

TASK ??

TRAINING HMMs

- For each task :
  - ➢ Get the people
  - ➢ Give them task
  - ➢ Collect eye gaze trajectories obtained





Observed sequence of states observed from the above trajectory is

9,3,4,5,6,14,15,15,9,18,22,23,

24,25,26,27,28,29,29,31,32,

33,33,35,35

Hidden Markov Model

$\lambda = (A, B, \pi)$ → HMM Model Parameters

Initial state probabilities

$\pi_i = P[q_1 = S_i], \quad 1 \leq i \leq N.$

State Transition Matrix

$A = \{a_{ij}\}$

$a_{ij} = P[q_{t+1} = S_j | q_t = S_i],$

$1 \leq i, j \leq N.$

Observation Probability Matrix

$B = \{b_j(k)\}$

$b_j(k) = P[v_k \text{ at } t | q_t = S_j]$

$1 \leq k \leq M. \quad 1 \leq j \leq N$

[Narayanan 2006]

BAUM-WELCH ALGORITHM

Constructs a HMM for each task by taking the observed sequence of states matrix obtained.

$$\lambda = (A, B, \pi)$$

A = State Transition Matrix

B = Observation Probability Matrix

Π = Initial State Observation Matrix

[π, A, B] = dhmm_em(data, π_e, A_e, B_e,'max_iter',5);

FORWARD ALGORITHM

- Used For Task Inference
- For a new given observation sequence, find the likelihood of each task using their HMMs

Loglik = dhmm_logprob(data_new, π, A, B);

Task with maximum loglikehood value is the REQUIRED TASK.

- RESULTS :

For 8 test data sets loglikelihood values obtained are :

RESULT <4x8 double>

	1	2	3	4	5	6	7	8
1	-68.1936	-60.4541	-80.6011	-84.8511	-78.3745	-75.6521	-82.2972	-69.2814
2	-80.0594	-72.5376	-55.6824	-66.2969	-73.5374	-72.4116	-69.0423	-66.4744
3	-73.7965	-76.4363	-65.8082	-75.5385	-70.7605	-68.5534	-73.4736	-70.9167
4	-75.4621	-72.2702	-67.9874	-63.6914	-73.4466	-77.8487	-61.2939	-66.0169

- Conclusion :

So we are able to infer the task even in case of off-target fixations.

- Future Work :

This can also be implemented in videos or in case of moving objects.

- References:

[1] **Haji-Abolhassani, A.** and Clark, J.J., "Visual Task Inference Using Hidden Markov Models", proceedings of International Joint Conference on Artificial Intelligence (IJCAI), pp. 1678--1683, 2011

[Yarbus 1967] A.L. Yarbus. Eye movements during perception of complex objects. Eye movements and vision, 7:171–196, 1967.

[Narayanan,2006]http://www.cs.umd.edu/~djacobs/CMSC828/ApplicationsHMMs.pdf

[4] Source Code: http://www.cs.ubc.ca/~murphyk/Software/HMM/hmm.html