

# HIDDEN MARKOV MODEL FOR TASK INFERENCE

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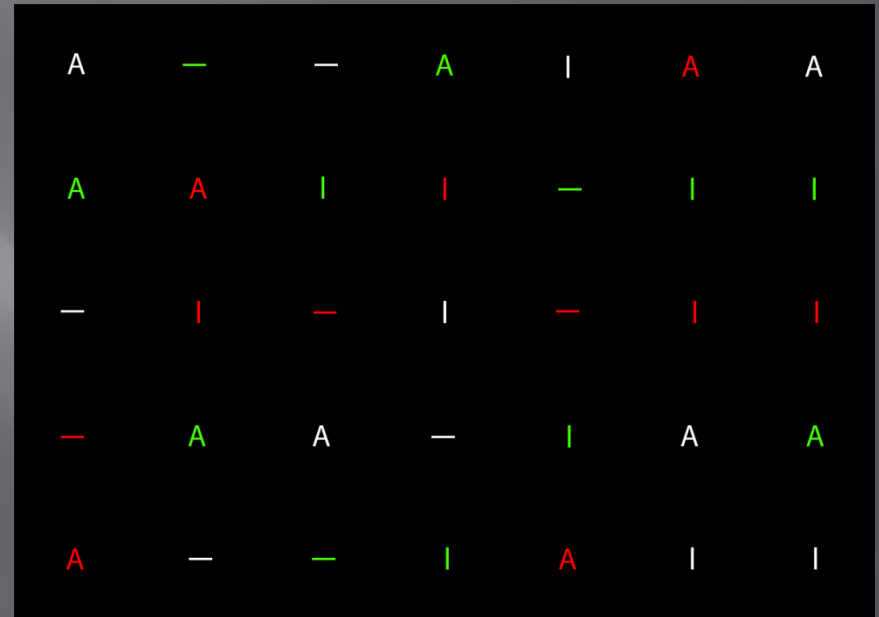
# Problem Statement

- ▣ 4 tasks

A	—	—	A		A	A
A	A			—		
—		—		—		
—	A	A	—		A	A
A	—	—		A		

# Problem Statement

- ▣ 4 tasks
- ▣ Counting number of
  - 1) characters 'A'
  - 2) green bars
  - 3) horizontal bars
  - 4) vertical bars



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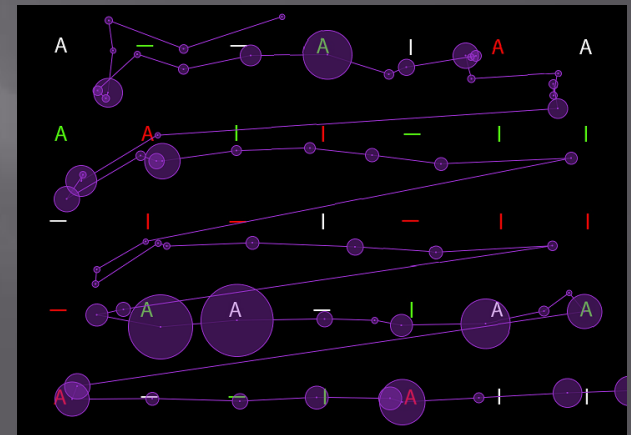
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Training HMM's for each task

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Training HMM's for each task

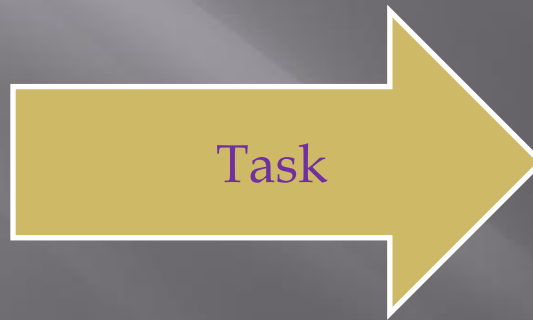
Task inference for a new given **Eye gaze trajectory**

# MOTIVATION

## ▣ Yabus Process



[2]



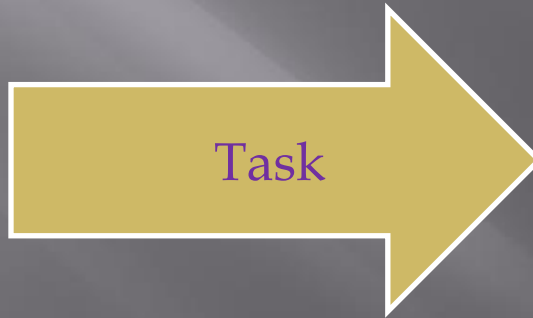
[2]

# MOTIVATION

## ▣ Yabus Process



[2]



[2]

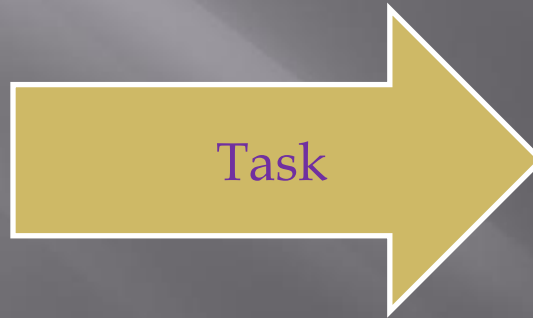
Many methods exist for Yabus Process.

# MOTIVATION

## ▣ Yarbus Process



[2]



[2]

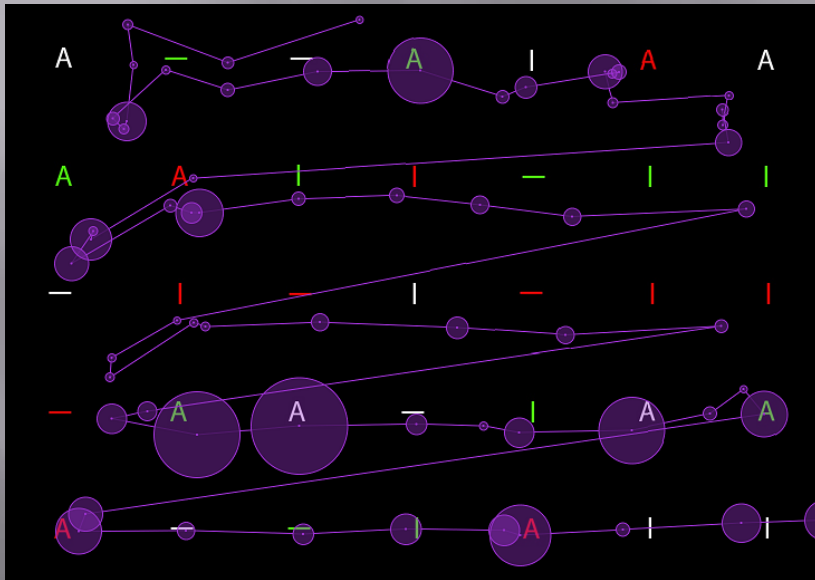
Many methods exist for Yarbus Process.

**Inverse Yarbus Process ?**



# MOTIVATION

- ▣ Inverse Yabus Process :



TASK ?

# TRAINING HMMs

▣ For each task :

Get the people

Give them task

Collect Eye Gaze Trajectory obtained.



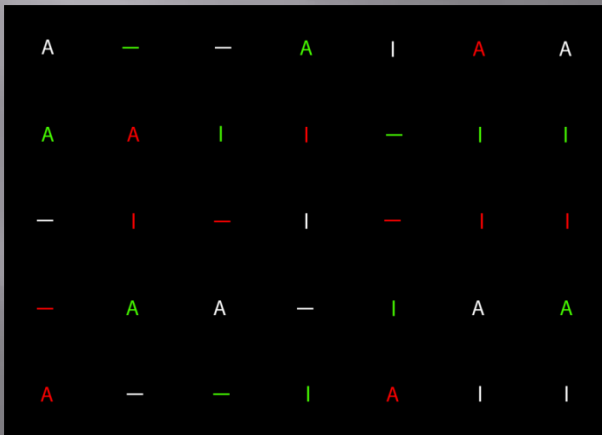
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▣ For each task :

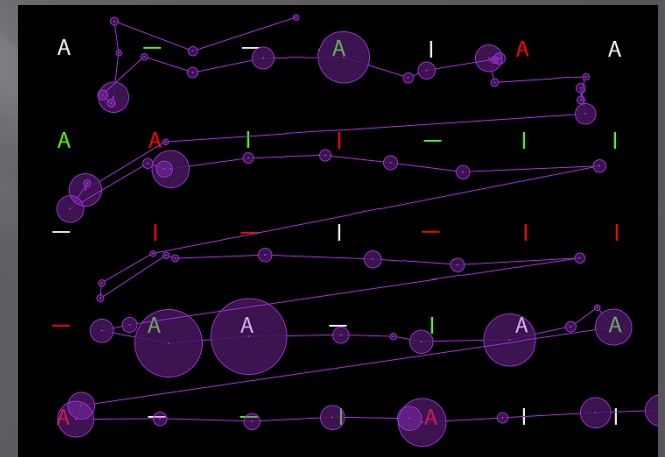
Get the people

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Collect Eye Gaze Trajectory obtained.



Count no of A's



# TRAINING HMMs

▣ For each task :

Get the people

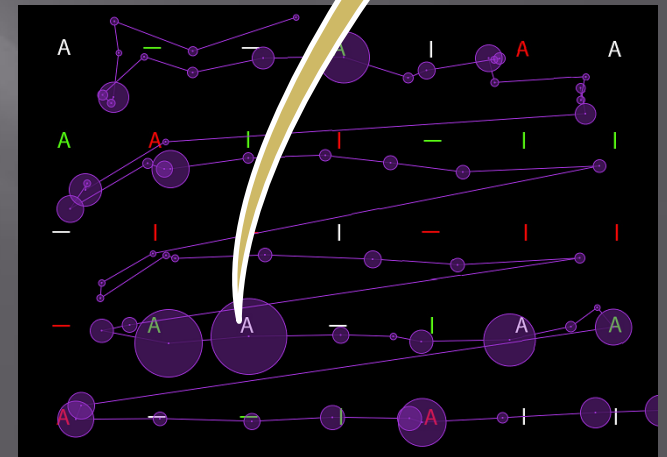
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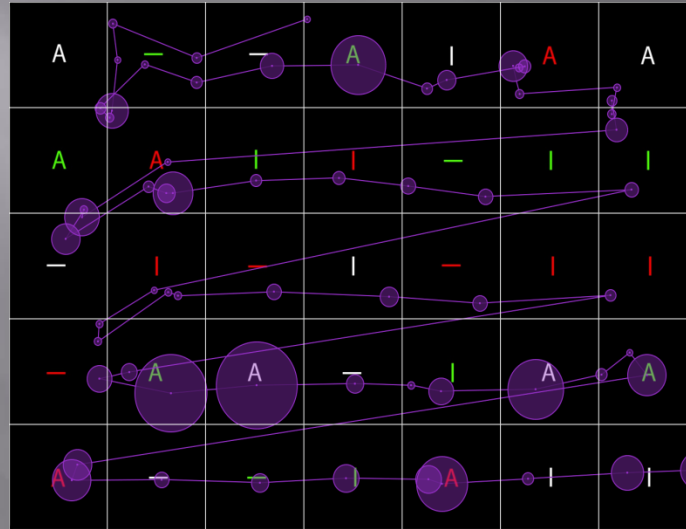
Fixation points



Count no of A's



# TRAINING HMMs



Observed Sequence of states obtained 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

# TRAINING HMMs

## ▣ 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

$\Pi$  = Initial State Observation Matrix

```
[  $\pi$ , A, B ] = dhmm_em(data,  $\pi_e$ ,  $A_e$ ,  $B_e$ , 'max_iter', 5);
```

# TASK INFERENCE

## ▣ FORWARD ALGORITHM :

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

$\text{Loglik} = \text{dhmm\_logprob}(\text{data\_new}, \pi, A, B);$

Task with maximum loglikelihood 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



# 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

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

[3] Source Code:

<http://www.cs.ubc.ca/~murphyk/Software/HMM/hmm.html>

THANK YOU !!

QUESTIONS ?