

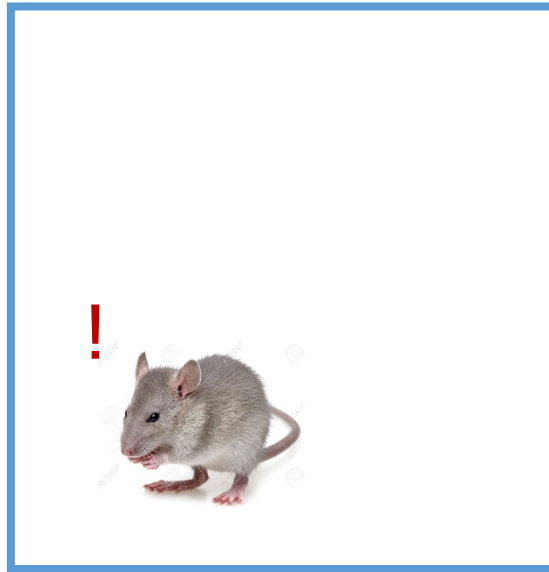
# DANS

## Team 6

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심리학과 이은성  
생명과학부 최지범

# Data

해마 영역 A와 B에 대한 neural spike data  
in rat foraging task



# Extracting data

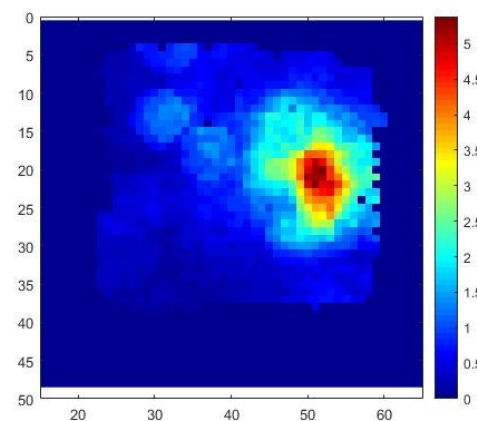
모든 tetrode에 대한 정보 구함

- Occupancy matrix
- Spike matrix
- Raw firing rate
- Smoothing

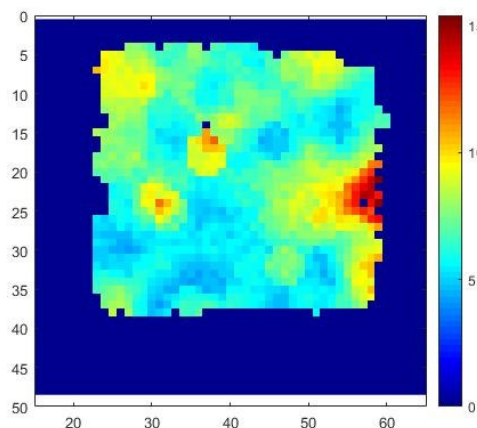
AllData						
56x6 cell						
	1	2	3	4	5	6
1 'A1'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	3.4448
2 'A2'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.2293
3 'A3'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	2.5786
4 'A4'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	3.0067
5 'A5'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.7613
6 'A6'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	2.4796
7 'A7'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	2.8767
8 'A8'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.8956
9 'A9'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.7185
10 'A10'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	2.1715
11 'A11'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	2.8226
12 'A12'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.7500
13 'A13'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.8767
14 'A14'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	2.1208
15 'A15'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.3411
16 'A16'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.6770
17 'A17'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.7881
18 'A18'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.7548
19 'A19'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.7209
20 'A20'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	2.0610
21 'A21'	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	48x72 dou...	1.4763

# Task #1

## A-B comparison

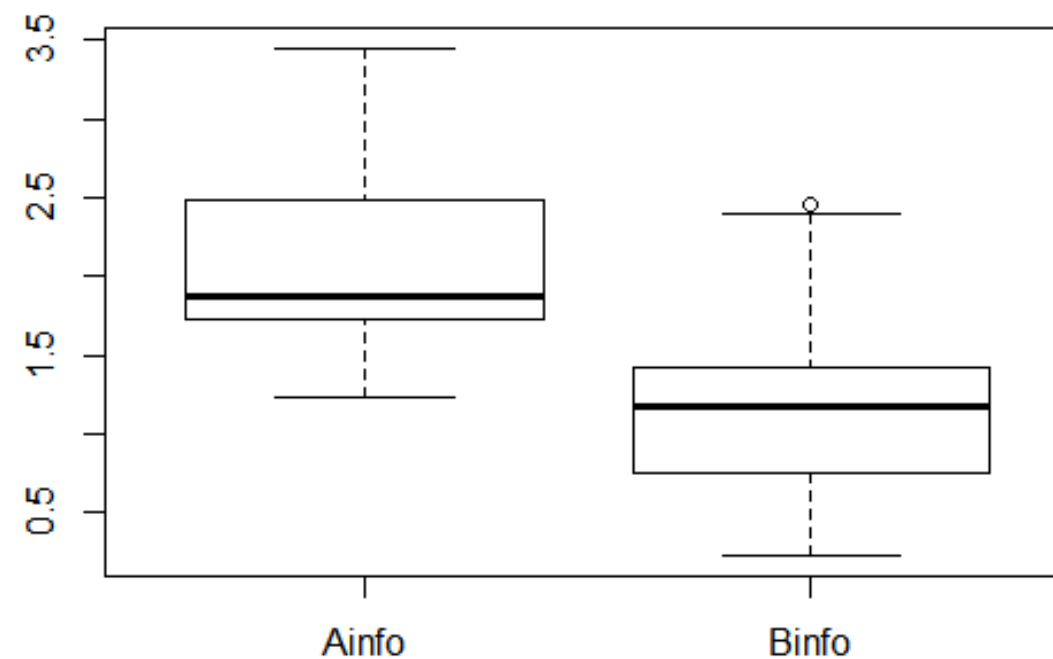


Group A  
Info:  
1.76



Group B  
Info:  
0.23

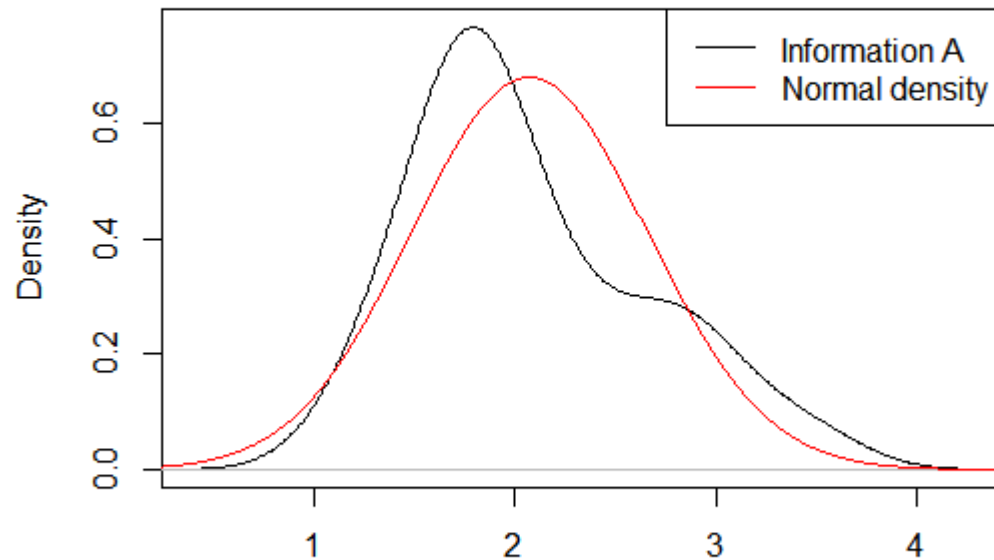
**Spatial Information between Areas A and B**



# A-B comparison

## 정규성 검사 (Shapiro test)

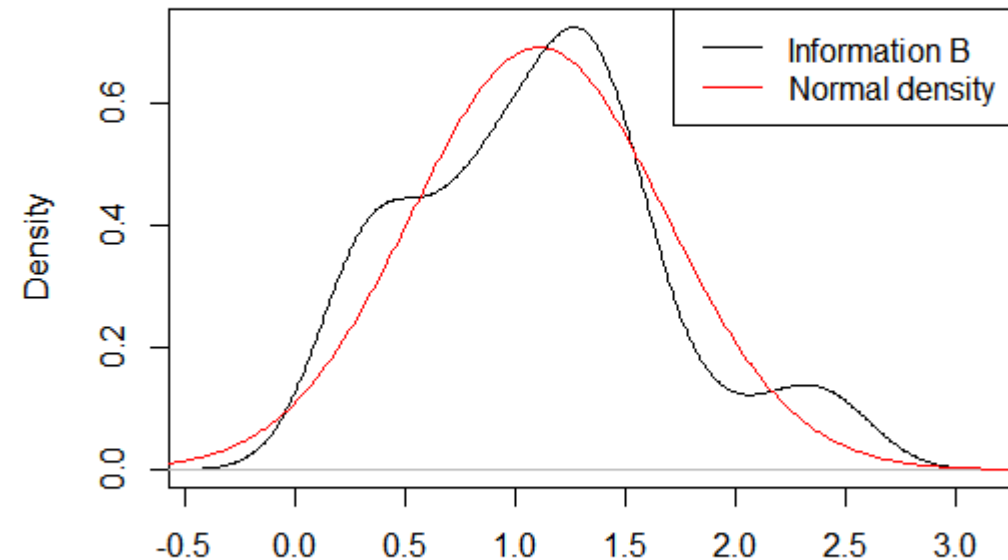
Density Plot of Spatial Information in A



N = 21 Bandwidth = 0.2772

w = 0.92, p = 0.087

Density Plot of Spatial Information in B

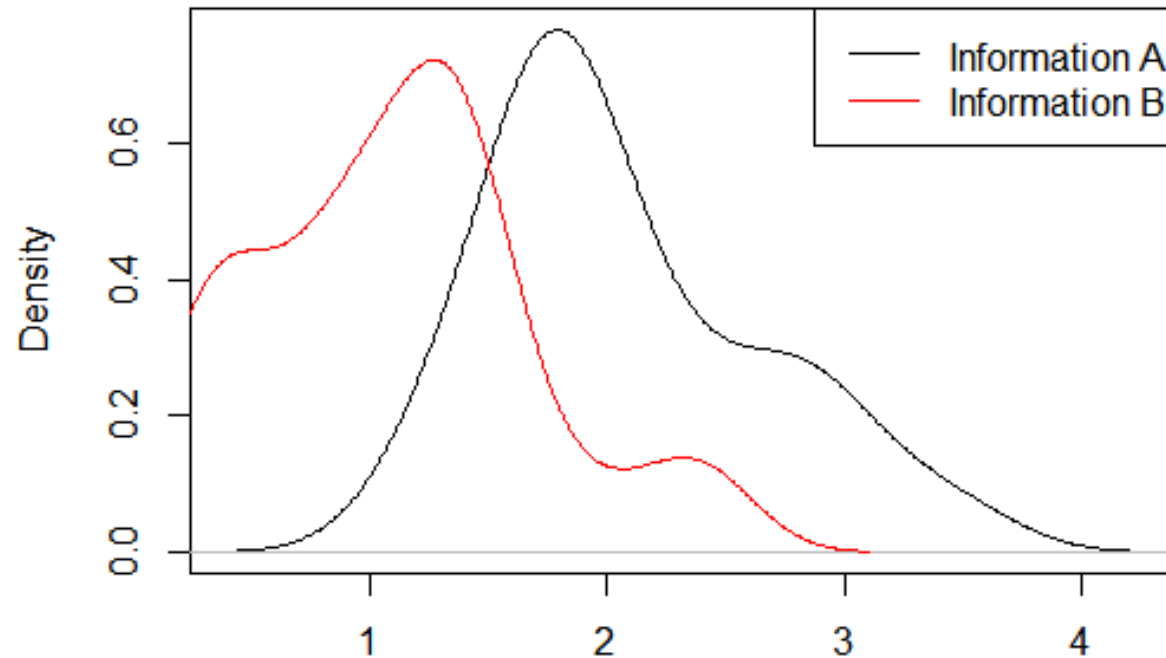


N = 35 Bandwidth = 0.2197

w = 0.952, p = 0.136

# A-B comparison

Permutation Test **Density Plot of Spatial Information A and B**



N = 21 Bandwidth = 0.2772

T = 674 ,  $p < .5$

# A-B comparison

## Logistic regression - Information

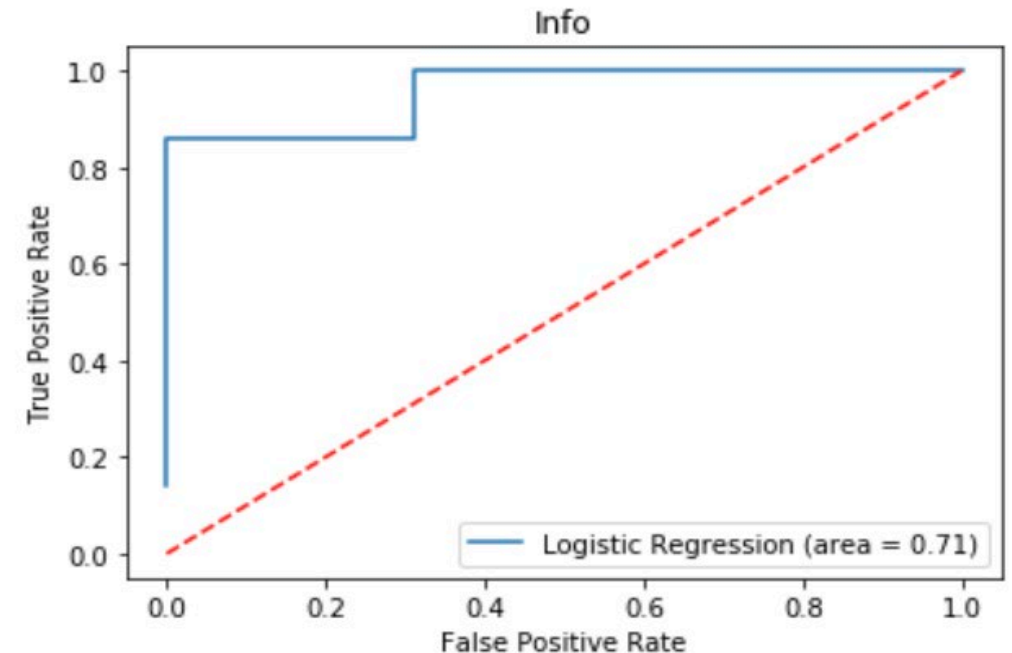
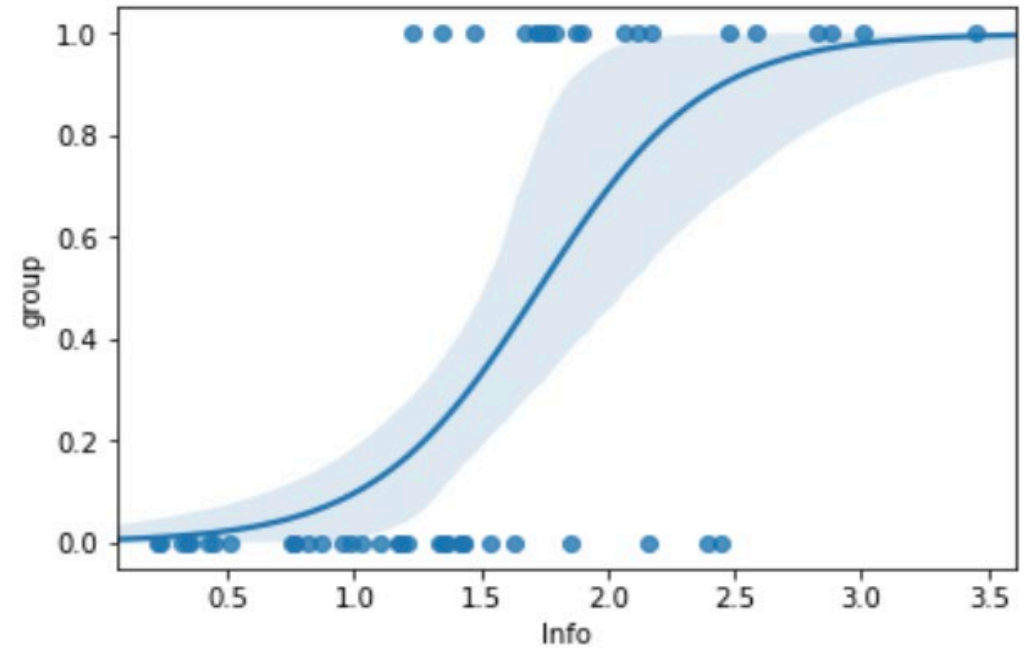
Current function value: 0.691797  
Iterations 3

Results: Logit

```
=====
Model:                Logit                Pseudo R-squared: -0.046
Dependent Variable:   group                AIC:                79.4813
Date:                2019-02-21 22:10      BIC:                81.5066
No. Observations:    56                   Log-Likelihood:    -38.741
Df Model:            0                    LL-Null:         -37.048
Df Residuals:        55                   LLR p-value:      nan
Converged:           1.0000               Scale:           1.0000
No. Iterations:      3.0000
=====
```

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
Info	0.0633	0.1629	0.3884	0.6977	-0.2560	0.3826

=====



# A-B comparison

## Logistic regression

### - Spike

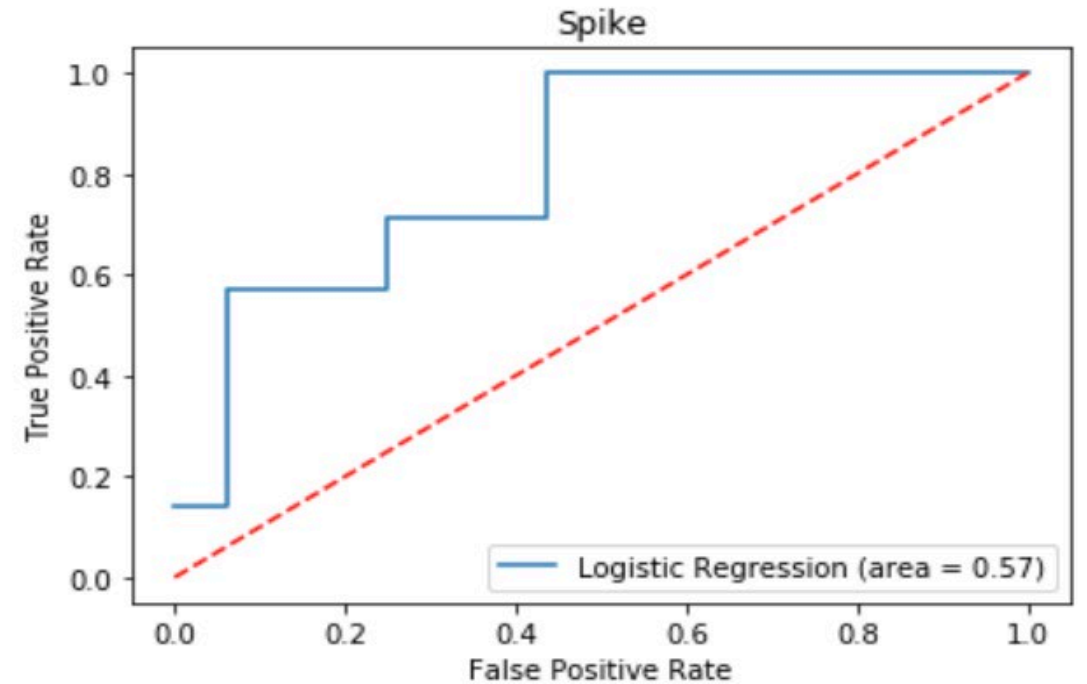
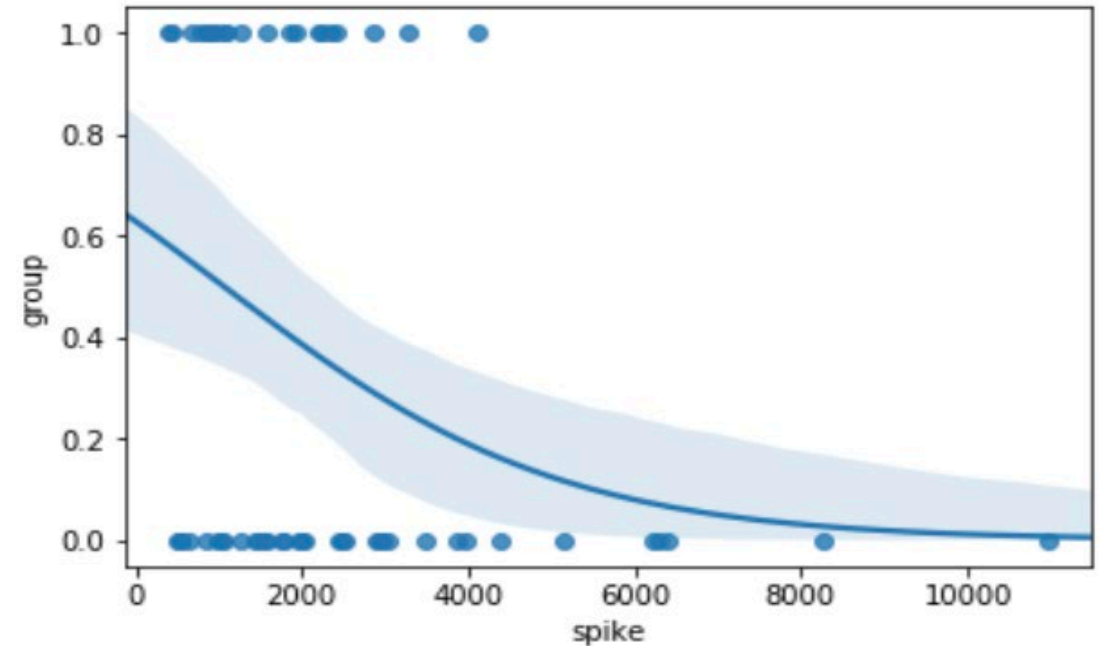
Current function value: 0.611662  
Iterations 5

Results: Logit

```
=====
Model:                Logit                Pseudo R-squared: 0.075
Dependent Variable:    group                AIC:                70.5062
Date:                 2019-02-21 22:11      BIC:                72.5315
No. Observations:     56                  Log-Likelihood:     -34.253
Df Model:              0                  LL-Null:            -37.048
Df Residuals:          55                  LLR p-value:        nan
Converged:             1.0000              Scale:             1.0000
No. Iterations:        5.0000
=====
```

	Coef.	Std.Err.	z	P> z	[0.025	0.975]
spike	-0.0003	0.0001	-2.5938	0.0095	-0.0005	-0.0001

```
=====
```





# A-B comparison

## Logistic regression

### - Smooth firing rate

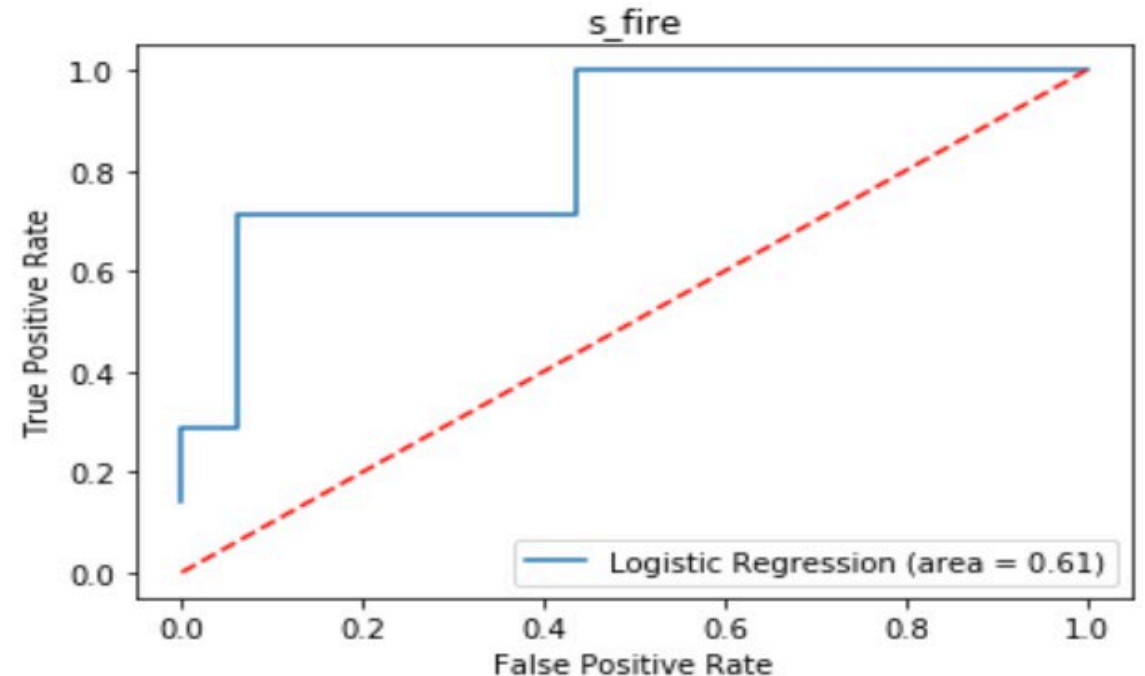
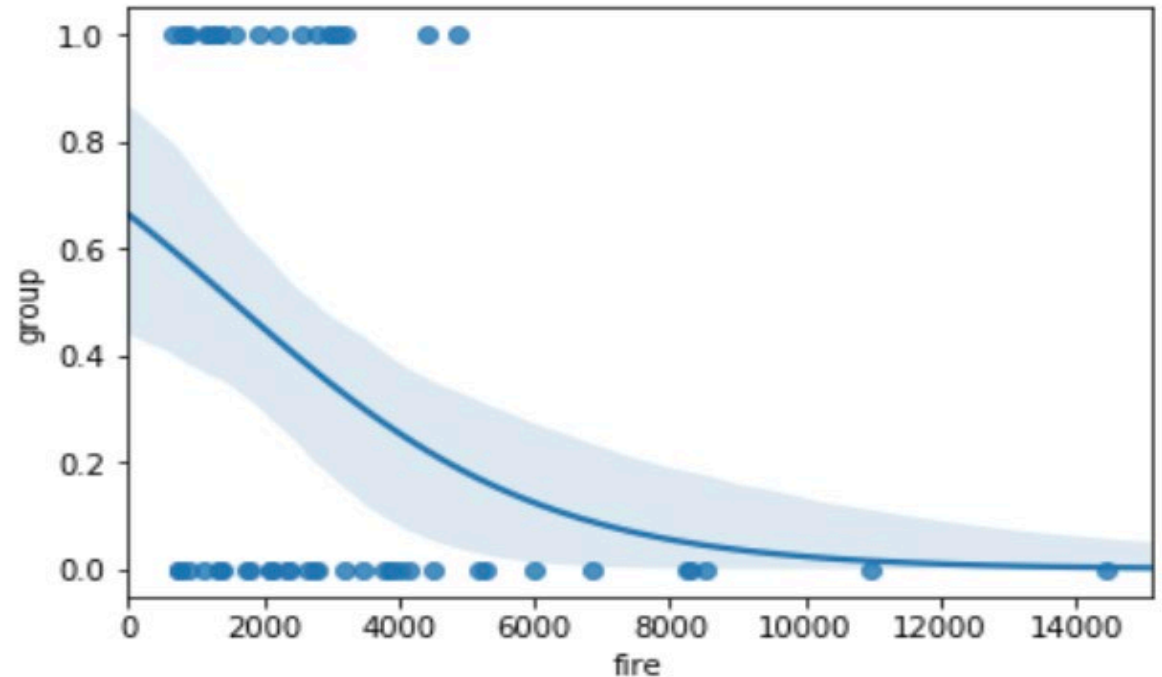
Current function value: 0.604130

Iterations 5

Results: Logit

```
=====
Model:                Logit                Pseudo R-squared: 0.087
Dependent Variable:   group                AIC:                69.6626
Date:                2019-02-21 22:19      BIC:                71.6879
No. Observations:    56                  Log-Likelihood:    -33.831
Df Model:            0                   LL-Null:         -37.048
Df Residuals:        55                  LLR p-value:      nan
Converged:           1.0000              Scale:          1.0000
No. Iterations:      5.0000
=====
```

```
=====
              Coef.   Std.Err.    z    P>|z|    [0.025   0.975]
-----+-----
fire   -0.0002    0.0001   -2.6802  0.0074   -0.0004  -0.0001
=====
```



# A-B comparison

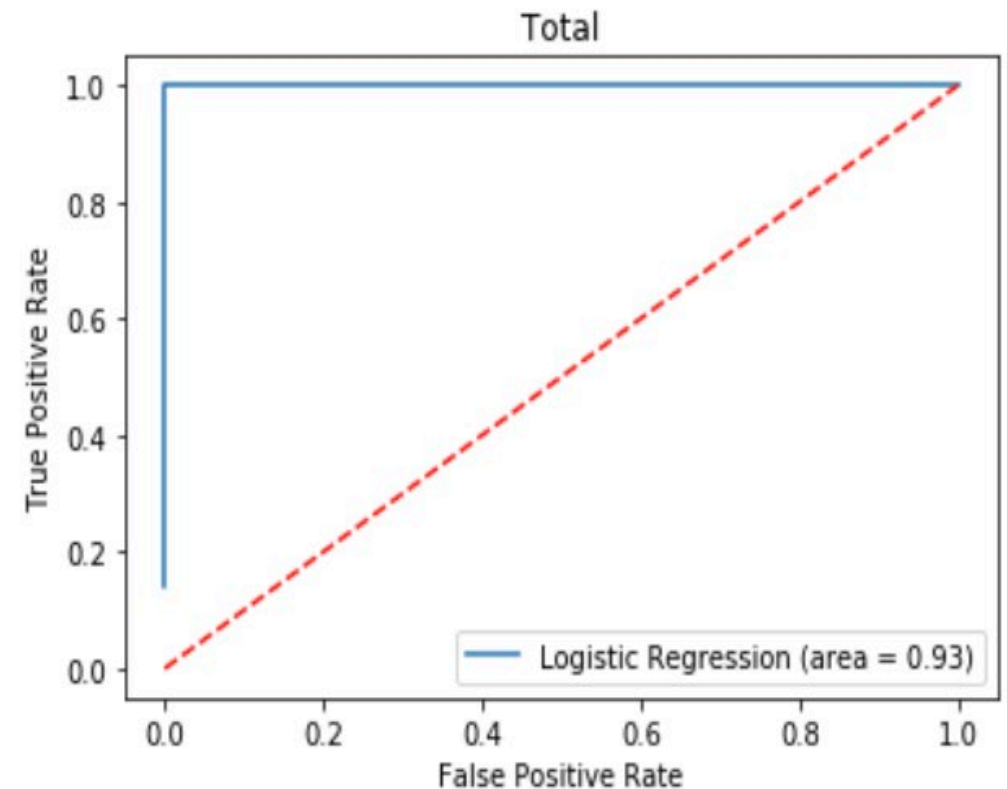
## Logistic regression

- Total (Information + Spike + Smooth firing rate)

Current function value: 0.456409  
Iterations 7

Results: Logit

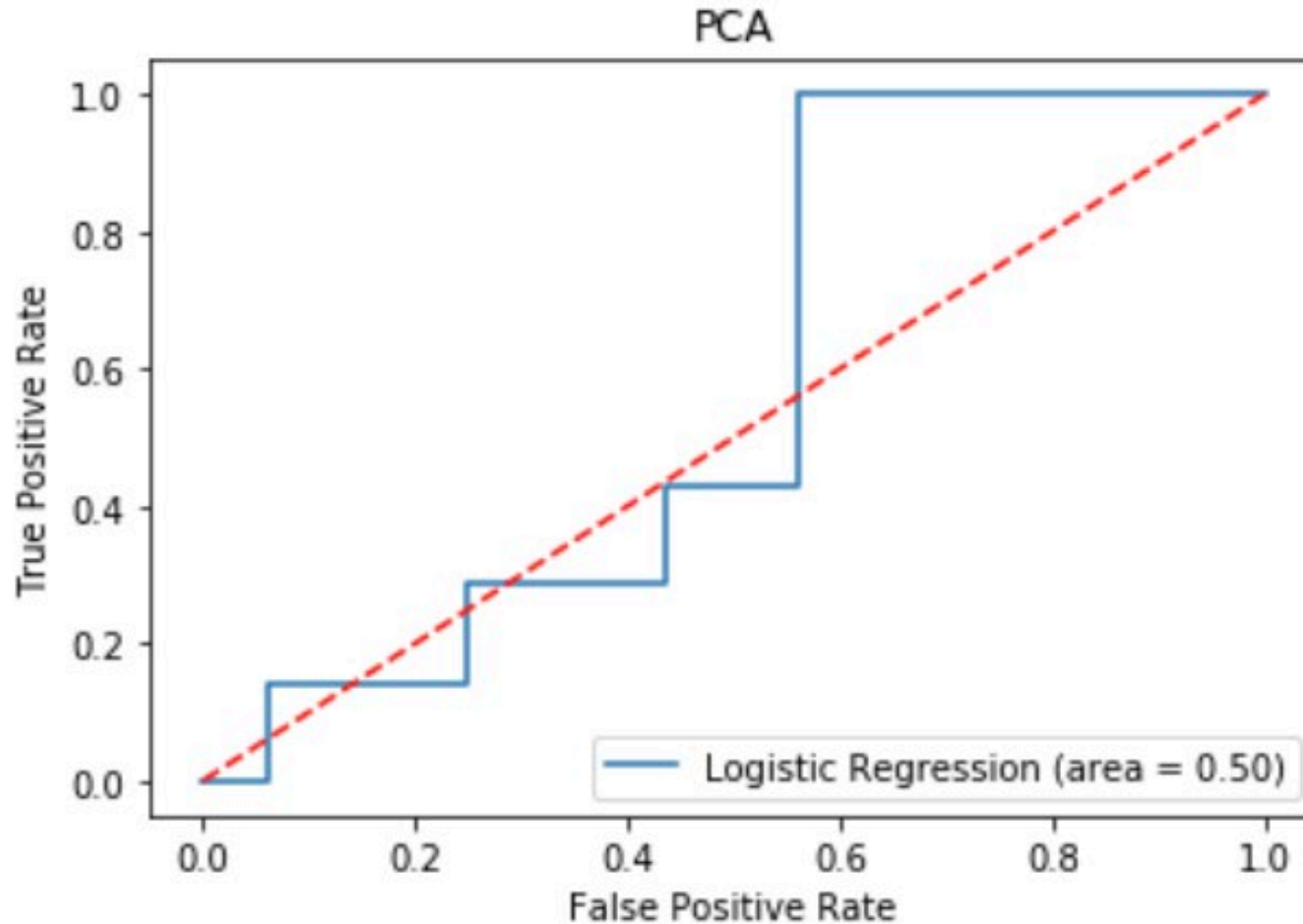
=====						
Model:	Logit		Pseudo R-squared: 0.310			
Dependent Variable:	group		AIC:	57.1178		
Date:	2019-02-21 22:12		BIC:	63.1938		
No. Observations:	56		Log-Likelihood:	-25.559		
Df Model:	2		LL-Null:	-37.048		
Df Residuals:	53		LLR p-value:	1.0246e-05		
Converged:	1.0000		Scale:	1.0000		
No. Iterations:	7.0000					
-----						
	Coef.	Std.Err.	z	P> z	[0.025	0.975]
-----						
spike	0.0088	0.0037	2.3363	0.0195	0.0014	0.0161
Info	0.7379	0.2880	2.5625	0.0104	0.1735	1.3023
s_fire	-0.0073	0.0029	-2.4831	0.0130	-0.0130	-0.0015
=====						



# A-B comparison

PCA

- Total (Information + Spike + firing rate)

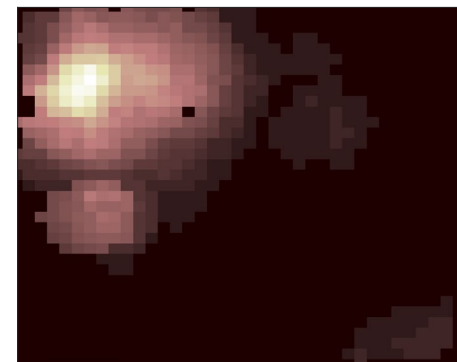
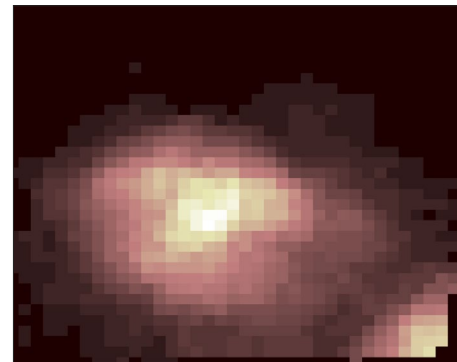
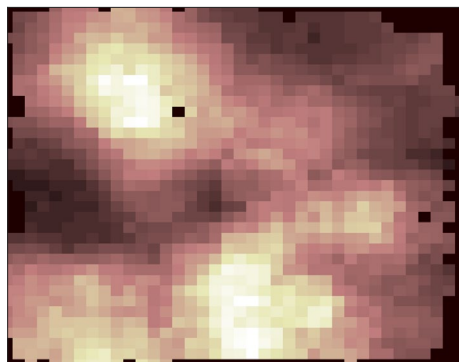
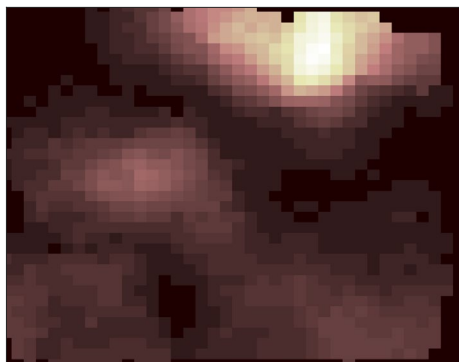


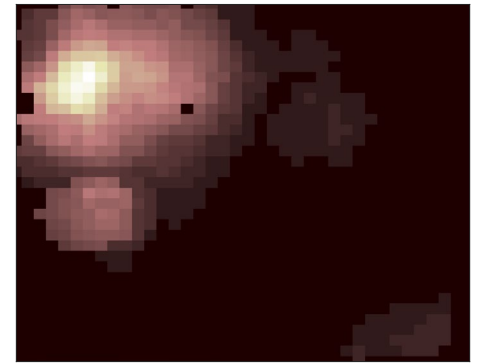
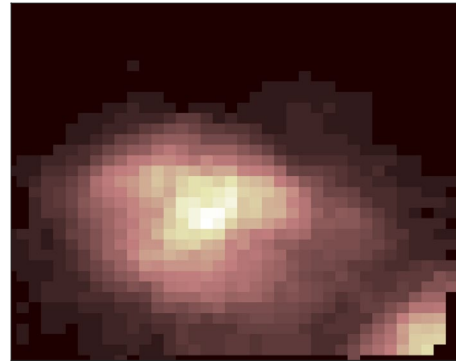
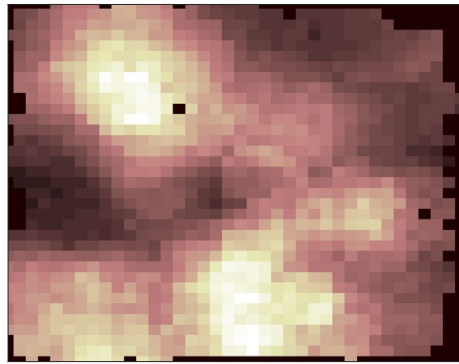
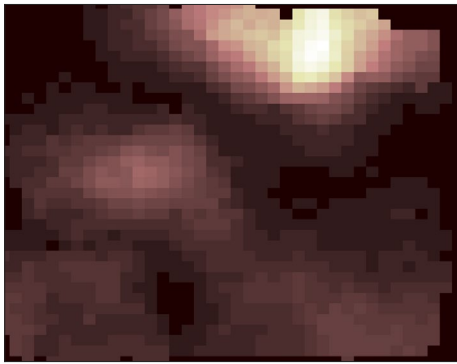
# Model Comparison

Information	Spike	Firing rate	Total	PCA
0.71	0.57	0.61	0.93	0.5

# Bayesian inference

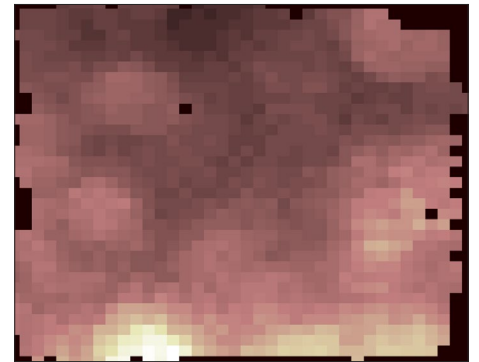
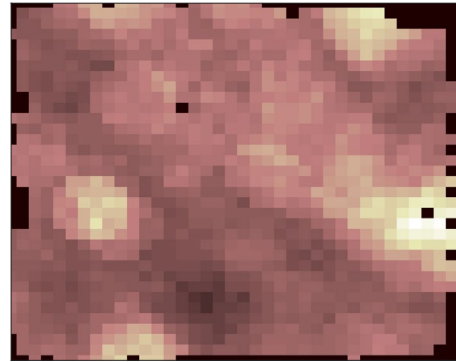
다수의 place cell activity를 통해 쥐의 실제 위치를 추측





0~12 min: Training

12~18.7 min: Evaluation



$$p(x|n) = \frac{p(n|x) p(x)}{p(n)}$$

$$P(n \text{ events in interval}) = \frac{\lambda^n}{n!} e^{-\lambda}, \quad P(n|x) = \frac{(\tau\lambda(x))^n}{n!} e^{(-\tau\lambda(x))}$$

21 cells in region A, 35 cells in region B

35 x 38 grids in the map

Each cell has spike map denoted  $n_j$ 's.

$$\begin{aligned} p_i(x_i|n) &= p_i(x_i|(n_1, n_2, \dots, n_N)) \\ &= p_i(x_i|n_1)p_i(x_i|n_2) \dots p_i(x_i|n_N) \end{aligned}$$

where

$$p_i(x_i|n_j) \propto p_i(n_j|x_i) \sim \text{p. d. f of Poiss}(\lambda_i(x_i))$$

In each grid  $(x_i)$ , probability to be there given the spike counts can be achieved. Get an estimate by argmax, then get an error distance  $(|\hat{x}_i - x_i|)$  for region A and B.

$$(\text{Error of A})/(\text{Error of B}) = 0.91$$



# Training Other Patterns

+  
Task

DA

NS

DANS!



**$b=0.1$**



**$b=0.5$**



**$b=0.05$**



**$b=0.01$**

**$t=30$**



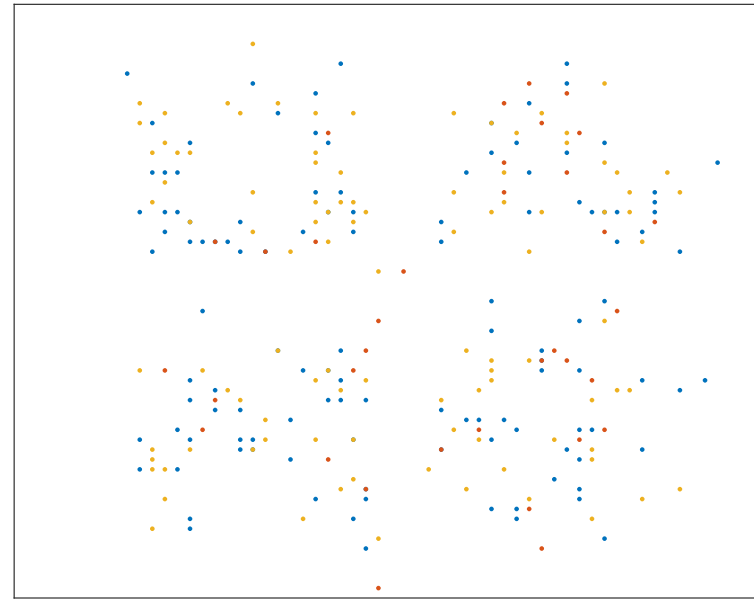
**t=30**



**t=10**



**t=100**

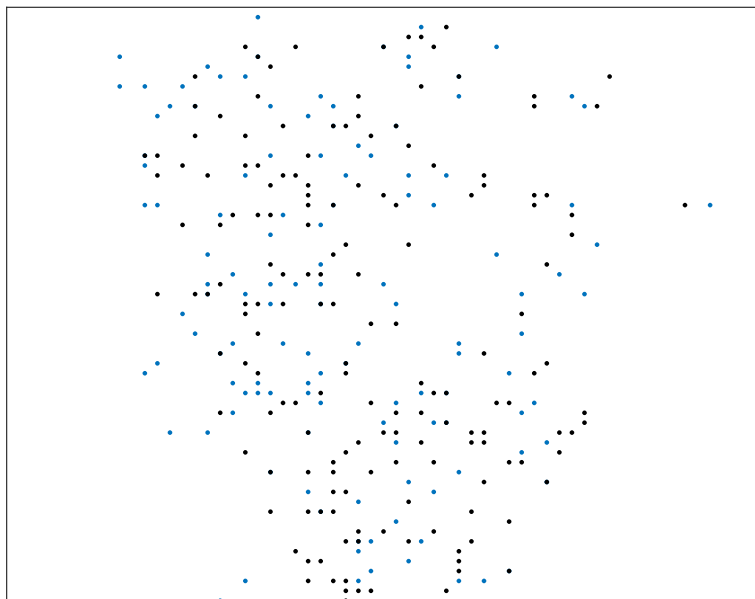


**t=5**

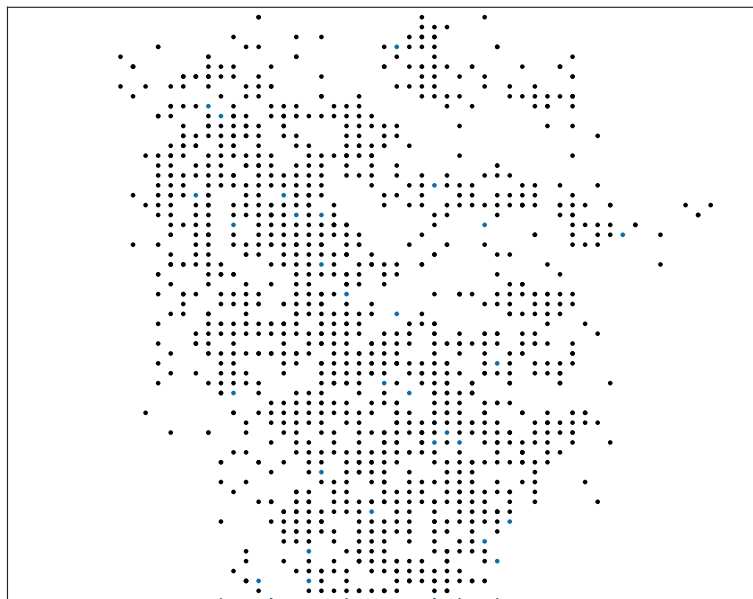
**b=0.1**



$b=0.1$      $t=30$



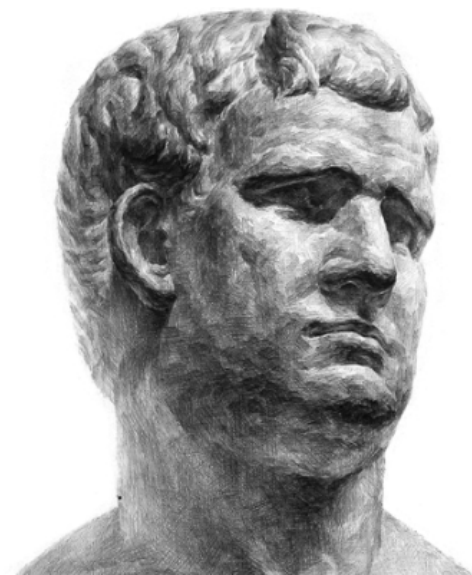
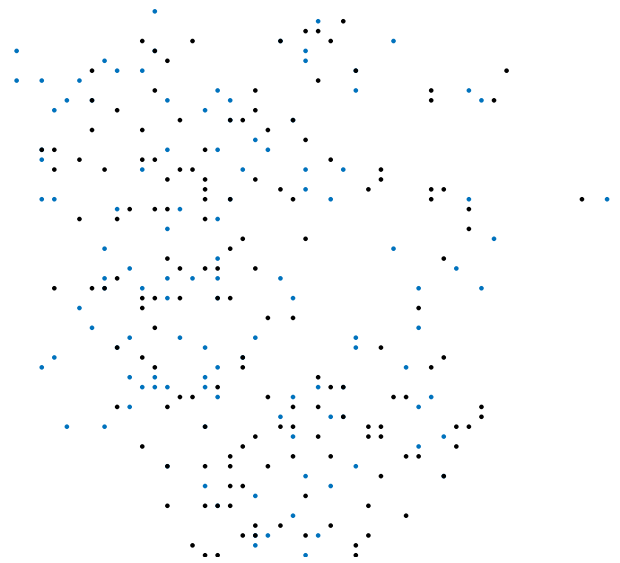
$b=0.1$   $t=5$



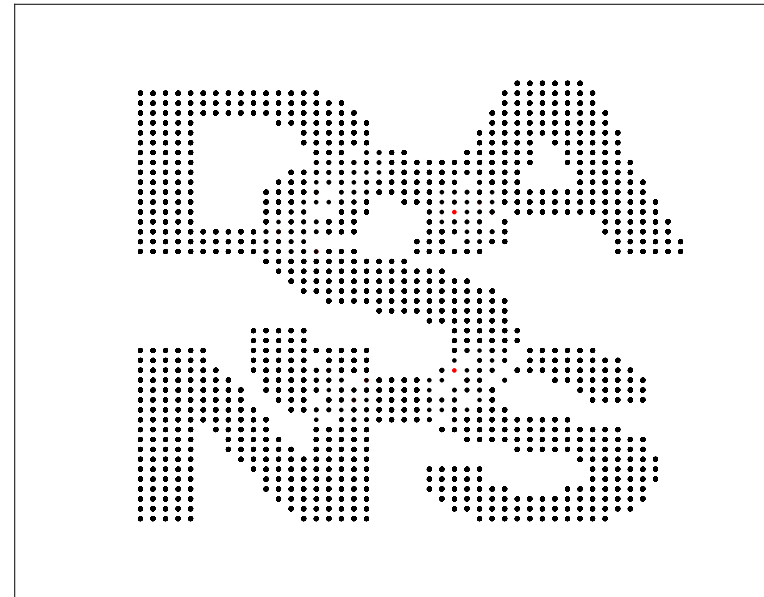
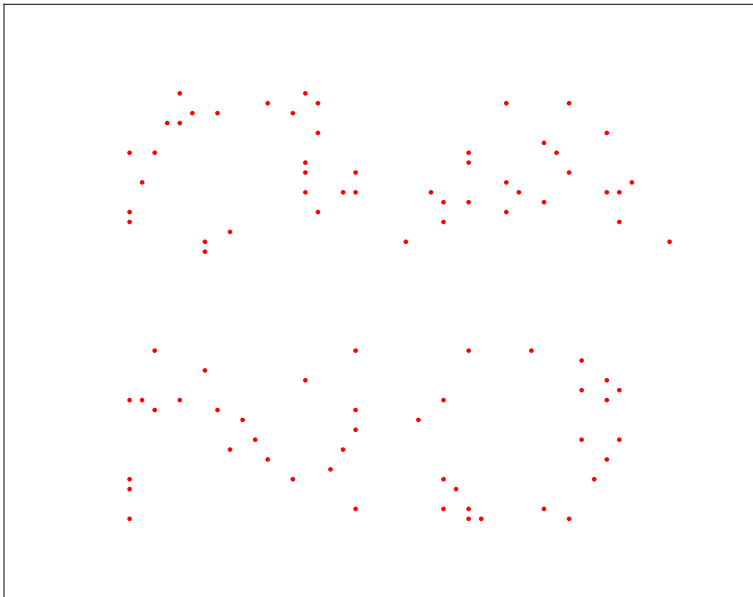
$b=0.1$   $t=10$



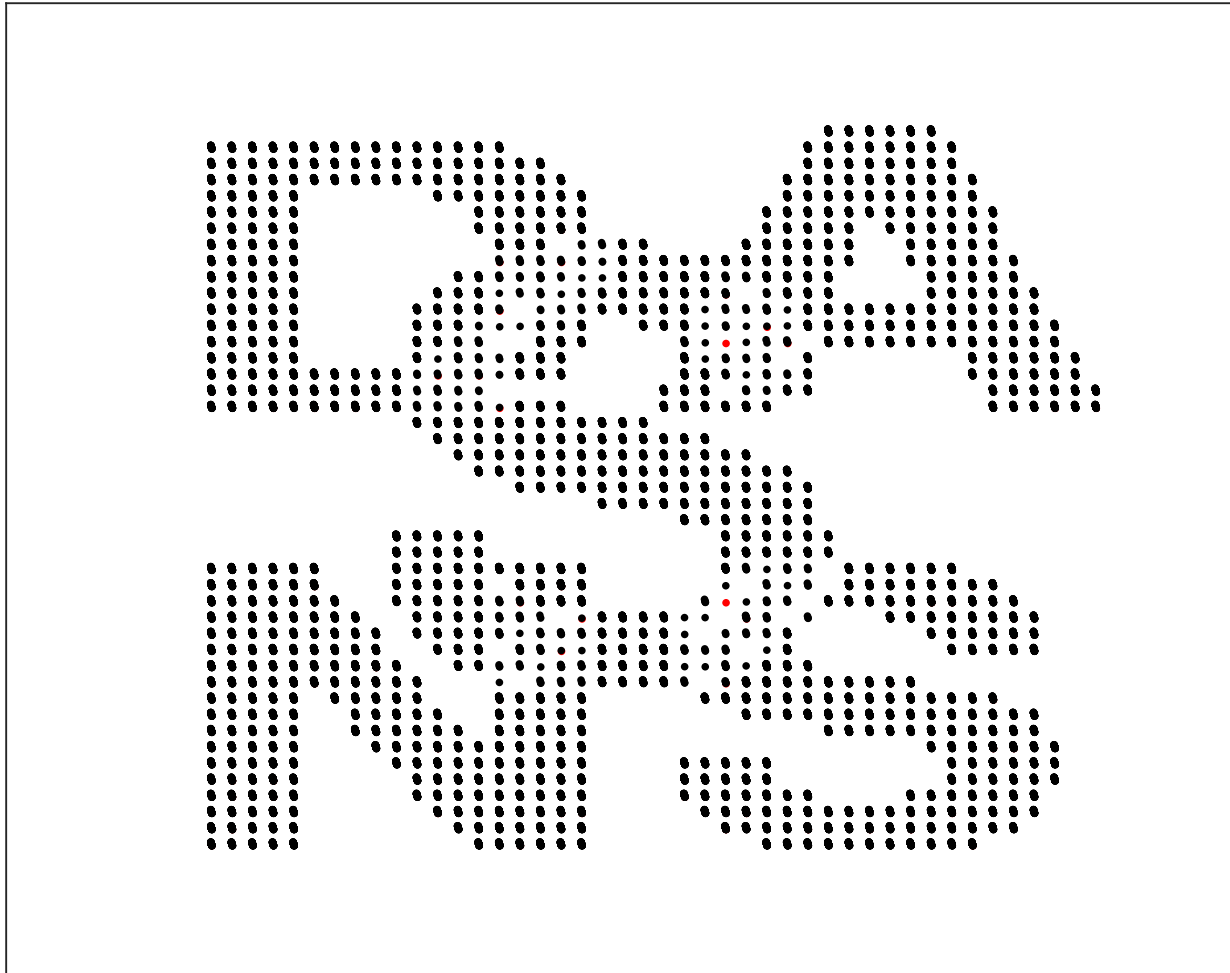
$b=0.1$   $t=100$



# Problem of Mutual Training

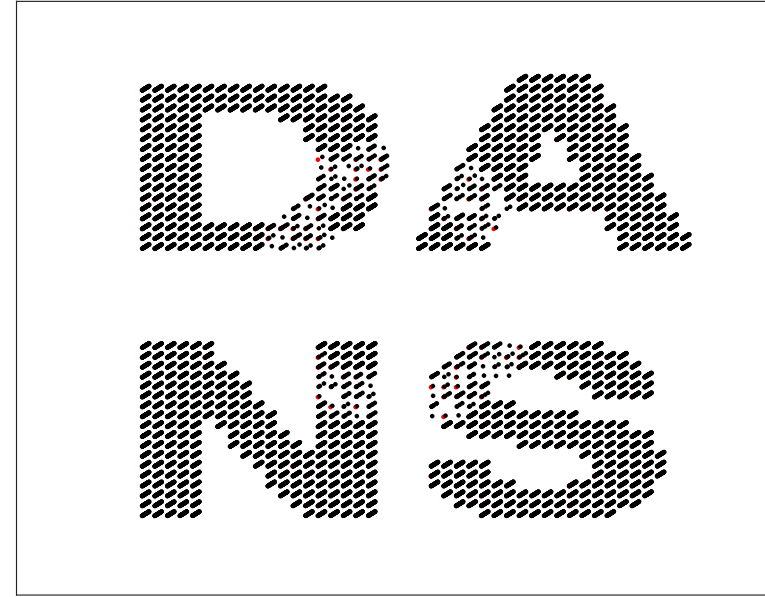
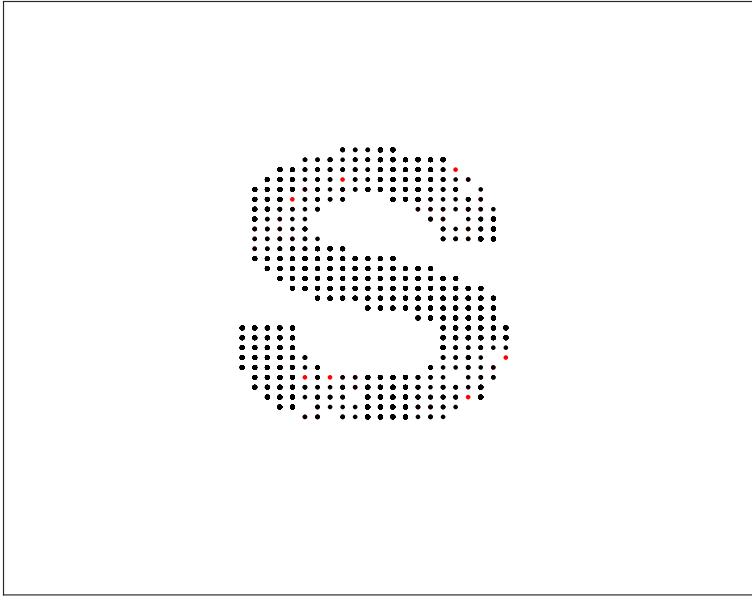


# How to Avoid Mutual Representation



Once the a node common to 's' and 'DANS' is activated, both symbols are activated.



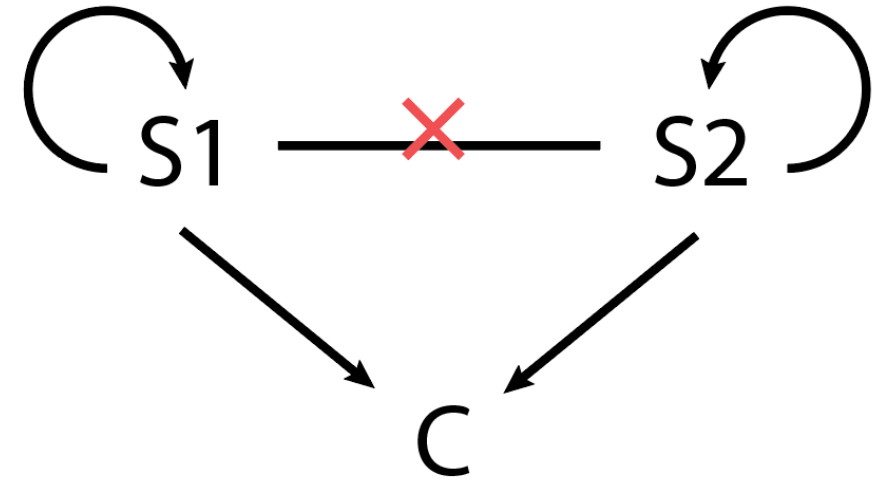


S1: nodes specific to image 1 (but not to image 2)

S2: nodes specific to image 2 (but not to image 1)

C: nodes common to image 1 and 2

Inhibit connection from C to S1, C to S2, S1 to S2, S2 to S1.




S1: nodes specific to image 1 (but not to image 2)

S2: nodes specific to image 2 (but not to image 1)

C: nodes common to image 1 and 2

Inhibit connection from C to S1, C to S2, S1 to S2, S2 to S1.



**Q&A**