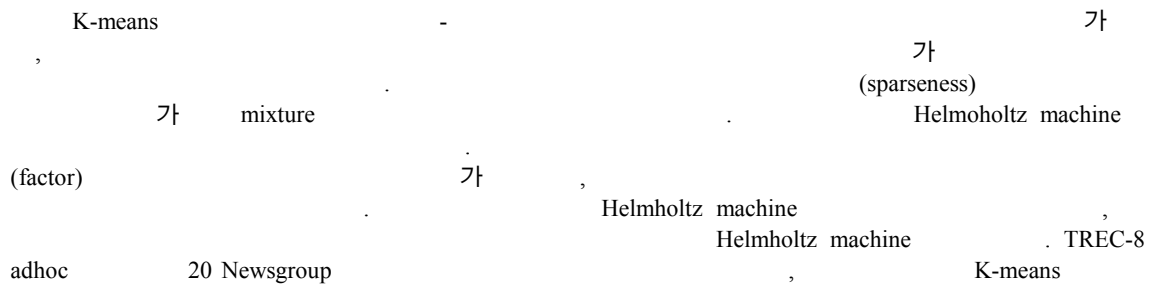


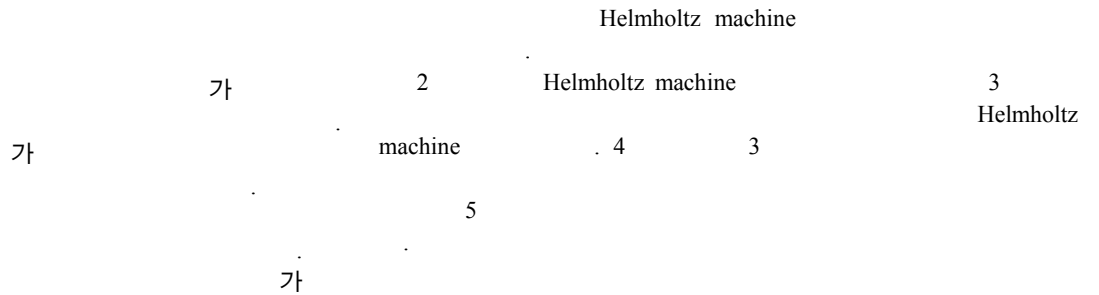
Topical Clustering of Documents using Helmholtz Machines with Competitive Units

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1.



2. Helmholtz Machine

Helmholtz machine [1, 2]

Helmholtz machine (recognition network) (generative network)

machine (self-supervised) Helmholtz

$D = \{d^{(1)}, d^{(2)}, \dots, d^{(n)}\}$

(likelihood)가

Helmholtz machine Θ D $d^{(i)}$ 가

가 Helmholtz machine Helmholtz machine[1, 2]

$$\log(D|\Theta) = \sum_{t=1}^T \log \left[\sum_{\alpha^{(t)}} P(d^{(t)}, \alpha^{(t)} | \Theta) \right] \quad (1)$$

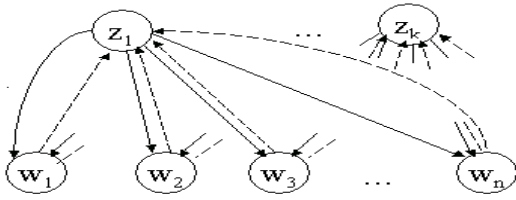
$\alpha^{(t)}$ 가 $d^{(t)}$ 가 P 가

가 Jensen

$$\begin{aligned} \log(D|\Theta) &= \sum_{t=1}^T \log \left[\sum_{\alpha^{(t)}} P(d^{(t)}, \alpha^{(t)} | \Theta) \right] \\ &= \sum_{t=1}^T \log \left[\sum_{\alpha^{(t)}} Q(\alpha^{(t)}) \frac{P(d^{(t)}, \alpha^{(t)} | \Theta)}{Q(\alpha^{(t)})} \right] \\ &\geq \sum_{t=1}^T \sum_{\alpha^{(t)}} Q(\alpha^{(t)}) \log \frac{P(d^{(t)}, \alpha^{(t)} | \Theta)}{Q(\alpha^{(t)})} \end{aligned} \quad (2)$$

generalized EM

가 Q Helmoltz machine



1 Helmoltz machine

3. Helmholtz machine

Helmholtz machine

$$P(s_j = 1) = \frac{1}{1 + \exp(-\sum_j w_{ji} s_j)} \quad (3)$$

s_j 가 w_{ji} 가 i 가

competitive [3]

sigmoid Competitive

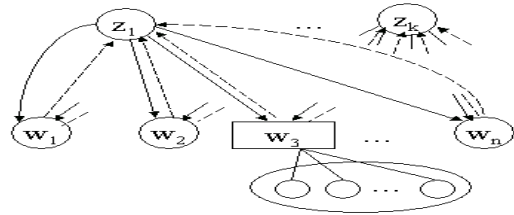
$$P(s_i = 1) = 1 - \frac{1}{1 + \sum_j \exp(w_{ji})} \quad (4)$$

(4) $\exp(w_{ji})$ $s_j=1$ s_i 1

odds ratio

, [9] 가

가



2 Helmholtz machine

가 (replica) w_3 w_3
 가 3 3
 Helmoltz machine wake-sleep
 [5] sleep , wake
 , w_3 가 가

4.

Helmholtz machine

가 가 가

4.1

TREC-8 adhoc 50
 가 4
 1,069
 20 Newsgroup Lang [6]
 20
 1,000 , 20,000
 science recreation
 4 500

1

TREC (1069)	<i>Foreign minorities, Germany Estonia, economy Invention, scientific discoveries King Husayn, peace</i>
Science (2000)	<i>Sci.crypt, sci.electronics, sci.med, sci.space</i>
Recreation (2000)	<i>Rec.autos, rec.motorcycles rec.sport.baseball, rec.sport.hockey</i>

4.2

'Boolean'

'bag-of-words' [7]

(stop-list)

(5)

[8]

2000

4.3

2

가

4

Helmholtz machine

, K-means

Helmholtz

machine

$$I(w) = p(d) \sum_{d \in D} p(w|d) \log \frac{p(w|d)}{p(w)},$$

$$p(d) = \frac{1}{m}, \quad p(w) = \frac{\sum_d n(w|d)}{\sum_w \sum_d n(w|d)},$$

$$p(w|d) = \frac{n(w|d)}{\sum_w n(w|d)} \quad (5)$$

2

(%)

	Helmholtz machines		K-means
	Numeric	Binary	
TREC-8 adhoc	2.2 (4)	7.7 (4)	20.2 (8)
Science	14.9 (4) 13.6 (6)	16.2 (6)	32.1 (8).
Recreation	9.7 (5)	11.6 (5)	29.2 (8)

가 4

‘Recreation’

‘autos’ ‘motorcycle’, ‘baseball’ ‘hockey’

가

가 5

3

$P(w|z)$ 가

Helmholtz machine Multiple cause mixture

model[5]

3 ‘Recreation’

	$P(w z)$	10
1	bike, ride, good, riding, motorcycle, bmw, bikes, ama, road, rider	
2	game, time, year, baseball, play, good, games, league, season, team	
3	team, hockey, season, year, nhl, game, pittsburgh, toronto, play, fan	
4	car, engine, good, cars, drive, people, speed, ford, make, price	
5	world, time, people, good, mail, make, canada, real, read, post	

‘Science’

가 4 , 5 가

가 4 , 5

(accuracy)

48.5%, 58.6%

6

2

5.

Multiple cause model

Helmholtz machine

가

가

(BR-2-1-G-06)

BK21

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