Machine Learning – II
CSL7050

Deepak

Distributed Representations

- A **local representation** for integers $i \in \{1, 2, \ldots, N\}$ is a vector $\mathrm{r}(i)$ of N bits with a single 1 and $N - 1$ zeros, $r_j(i) = \mathbf{1}_{i=j}$, called the **one-hot** representation of i.

- A distributed representation for the same integer is a vector of $\log_2 N$ bits, which is a much more compact way to represent i.

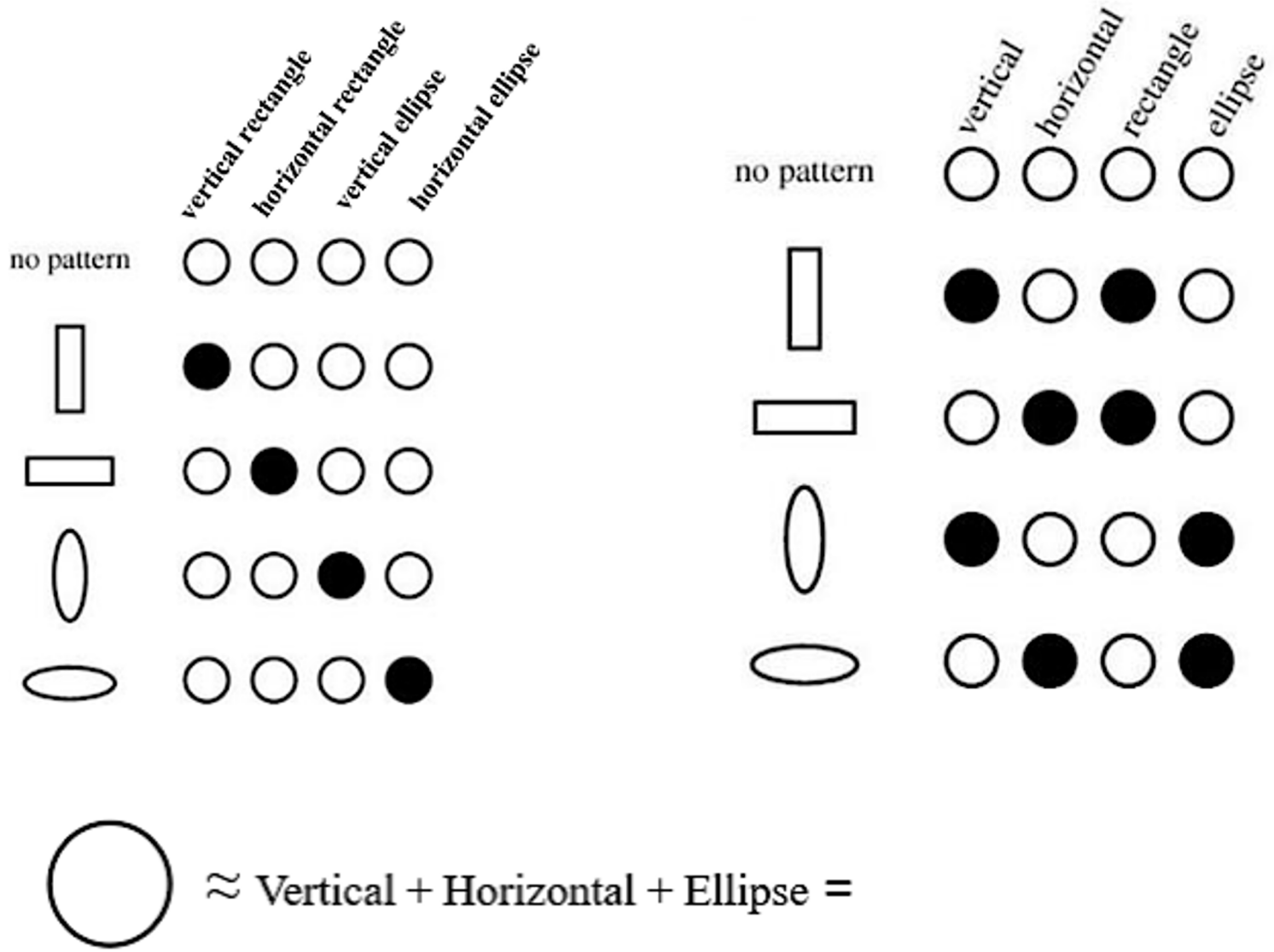
Y. Bengio, **Learning Deep Architectures for AI**, 2009

Distributed Representations

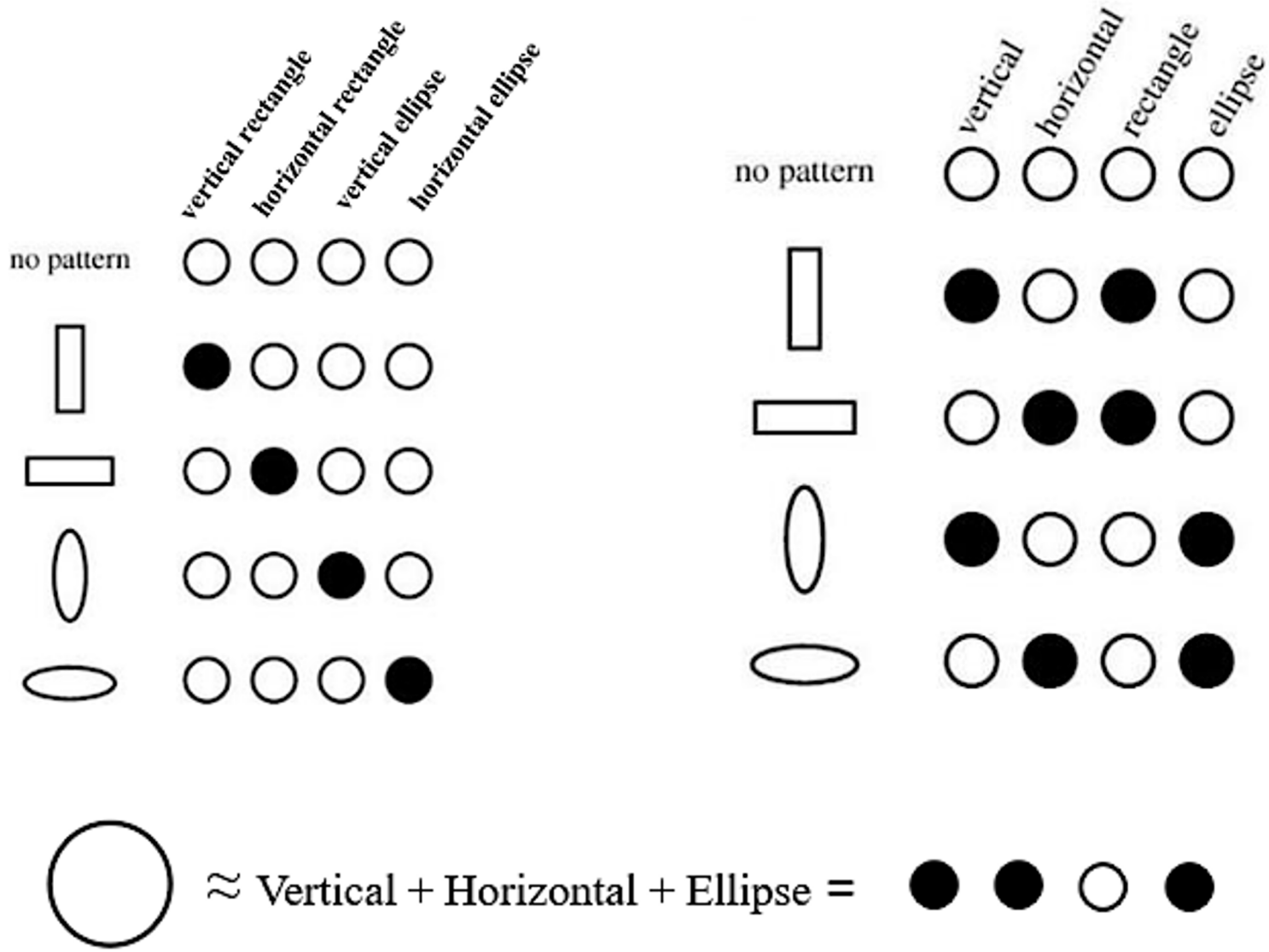
- Let's assume we want to design a storage system that stores information about vehicles.
- Given a big, yellow Volkswagen car
  - How many memory units will you use to store? – let's say 1
- Now let's say we need to store a small gray Lexus, a huge green Toyota, and Optimus Prime.
  - If we allocate one memory unit for each car model, number of units can grow exponentially.

- What if we use 3 units: 1 for the size (small, medium, big, huge, and transformers), 1 for color pattern and 1 for the brand.

http://www.cs.toronto.edu/~bonner/courses/2014s/csc321/lectures/lec5.pdf



C.R. Tosh and G.D. Ruxton, **Modelling perception with artificial neural networks**, 2010



C.R. Tosh and G.D. Ruxton, **Modelling perception with artificial neural networks**, 2010

Distributed Representations

- A distributed representation captures more information about input than one-hot representation.
  - In addition to being compact
- Our brains capture similarity between concepts using distributed representations.
  - Each concept is represented by many neurons and each neuron may fire in the context of different concepts.
- The similarity could be any appropriate measure depending on the type of distributed representation the model learns.

Distributed Representations

- Representations that capture features common within and across inputs improve model efficiency in the form of parameter sharing.
  - CNN
  - Compositionality
  - Hierarchical features

Distributed Representations – Word Embeddings

- Local representation?
- Distributed representation

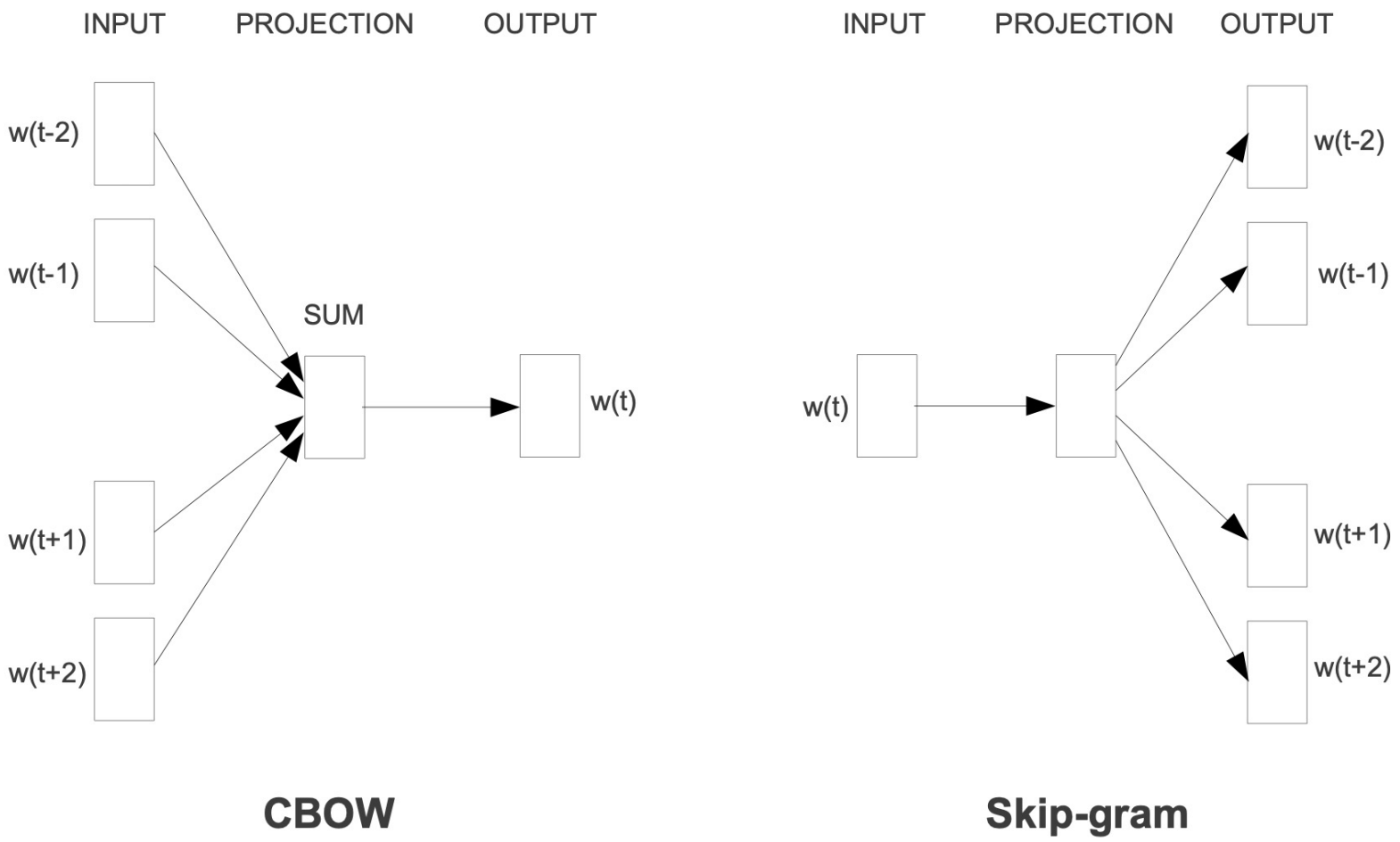
Corpus:

- Human machine interface for computer applications
- User opinion of computer system response time
- User interface management system
- System engineering for improved response time

	human	machine	system	for	...	user
human	0	1	0	1	...	0
machine	1	0	0	1	...	0
system	0	0	0	1	...	2
for	1	1	1	0	...	0
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
user	0	0	2	0	...	0

Co-occurence Matrix

Distributed Representations – Word Embeddings



T. Mikolov et al., **Efficient Estimation of Word Representations in Vector Space** , 2013

Distributed Representations

- king – man + woman = queen
- Disentangled representation