

# Idea de las Máquinas de Boltzmann

# Plan de Ataque

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Qué vamos a aprender en esta sección

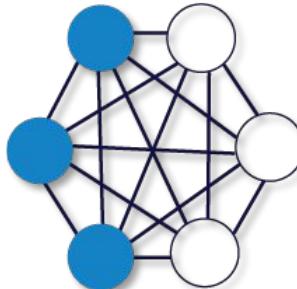
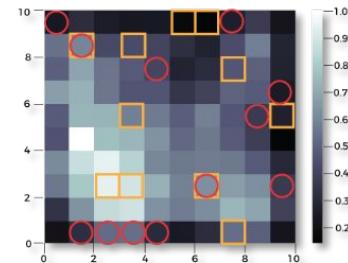
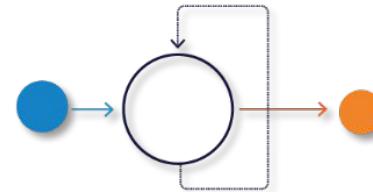
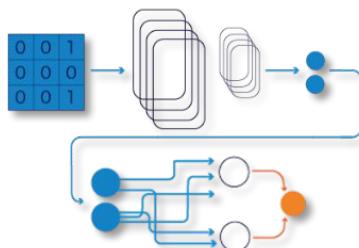
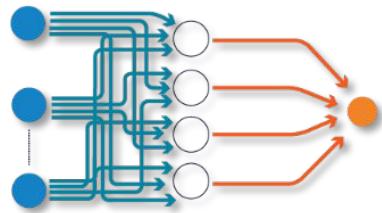
- La Máquina de Boltzmann
- Modelos basados en Energía (EBM)
- Máquinas de Boltzmann Restringidas (RBM)
- Divergencia Contrastante (CD)
- Red de Creencia Profunda (DBN)
- Máquinas de Boltzmann Profundas (DBM)

# Máquinas de Boltzmann

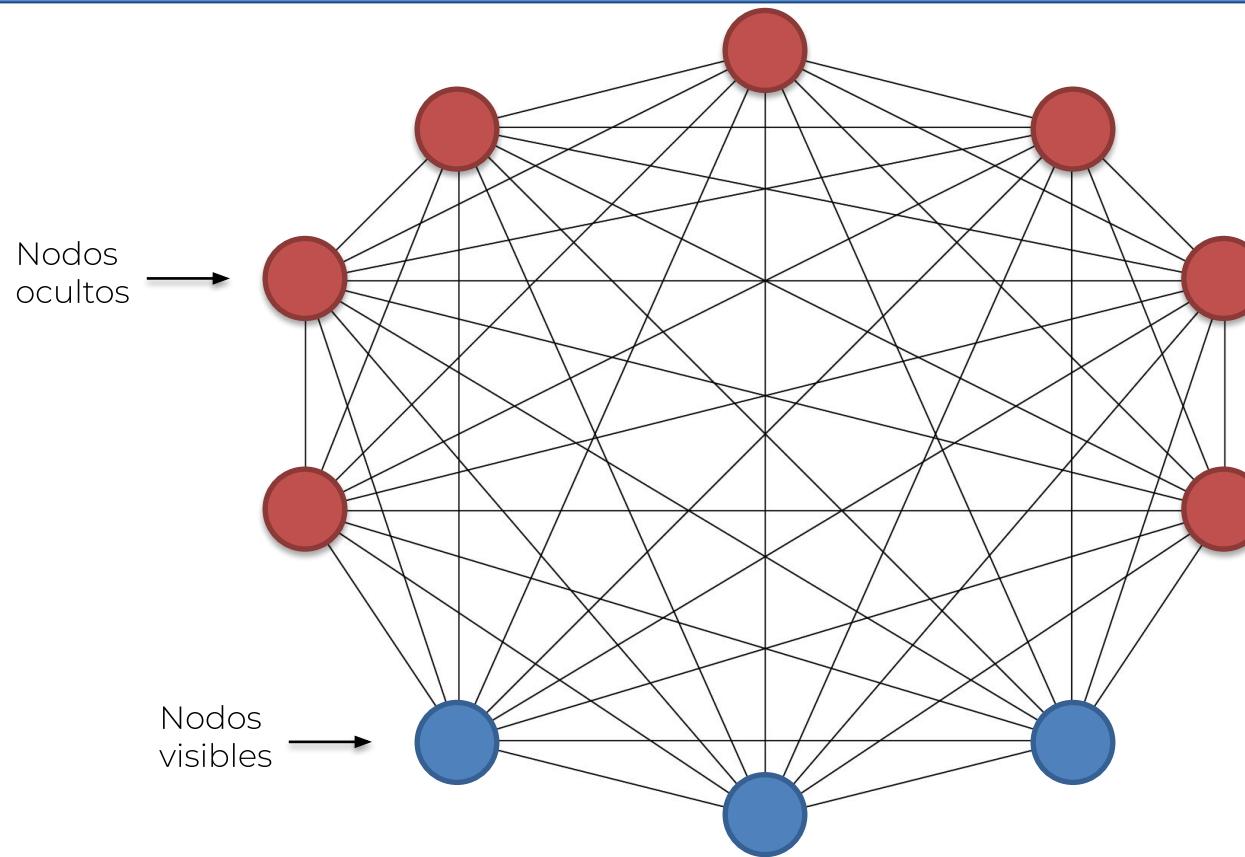
# Máquinas de Boltzmann

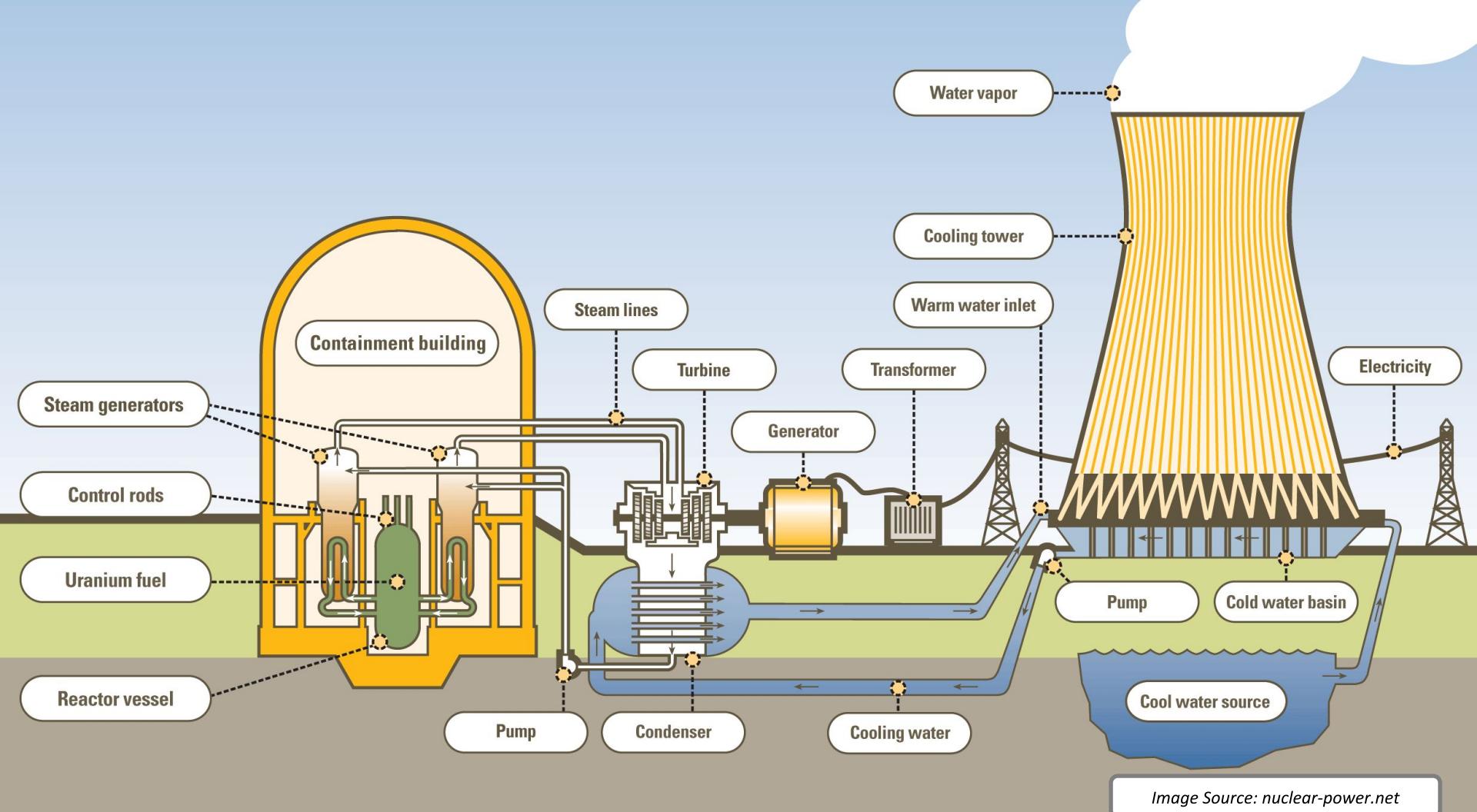
No Supervisado	Redes neuronales artificiales	Utilizado para regresión y clasificación
Supervisado	Redes neuronales convolucionales	Utilizado para la visión por ordenador
Supervisado	Redes neuronales recurrentes	Utilizado para el análisis de series temporales
Supervisado	Mapas autoorganizados	Utilizado para la detección de características
Supervisado	Máquinas de Boltzmann Profundas	Utilizado para los sistemas de recomendación
Supervisado	AutoEncoders	Utilizado para los sistemas de recomendación

# Máquinas de Boltzmann

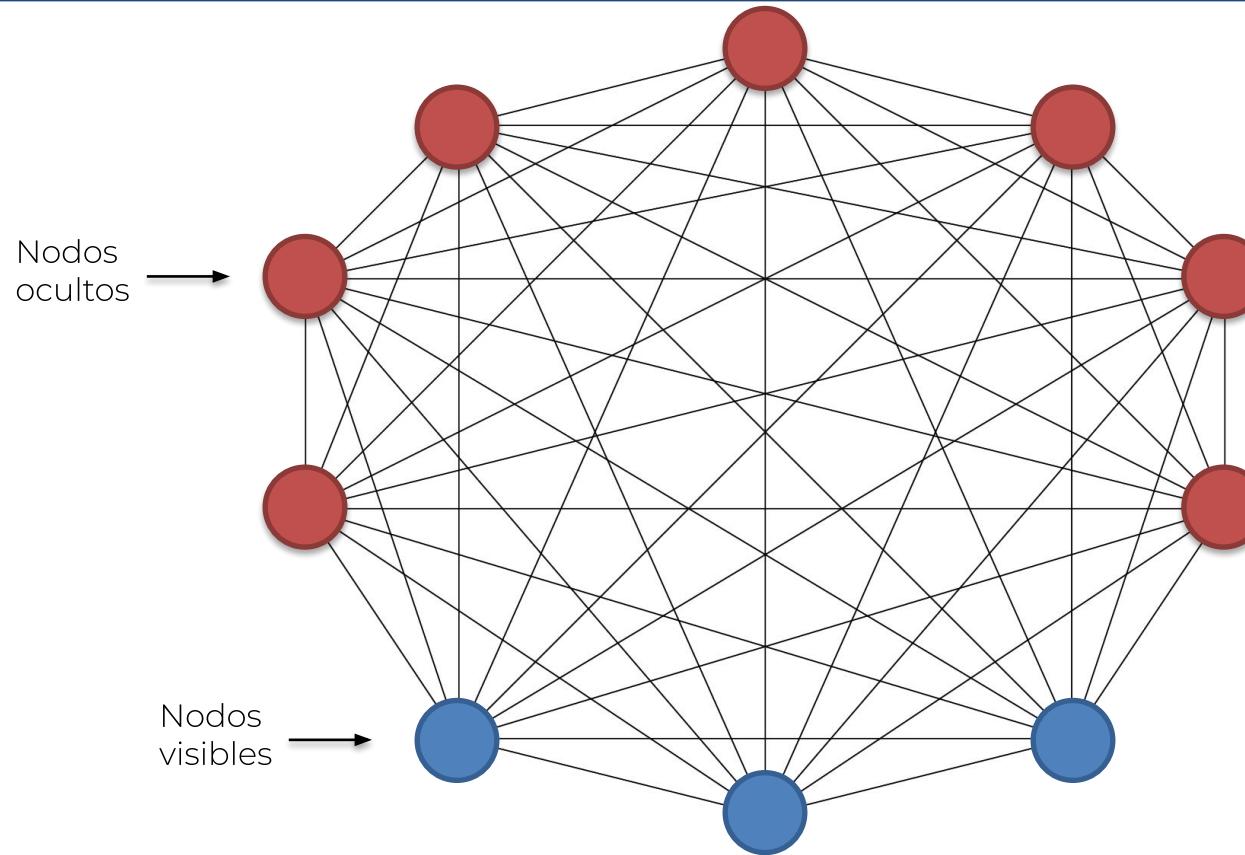


# Máquinas de Boltzmann





# Máquinas de Boltzmann

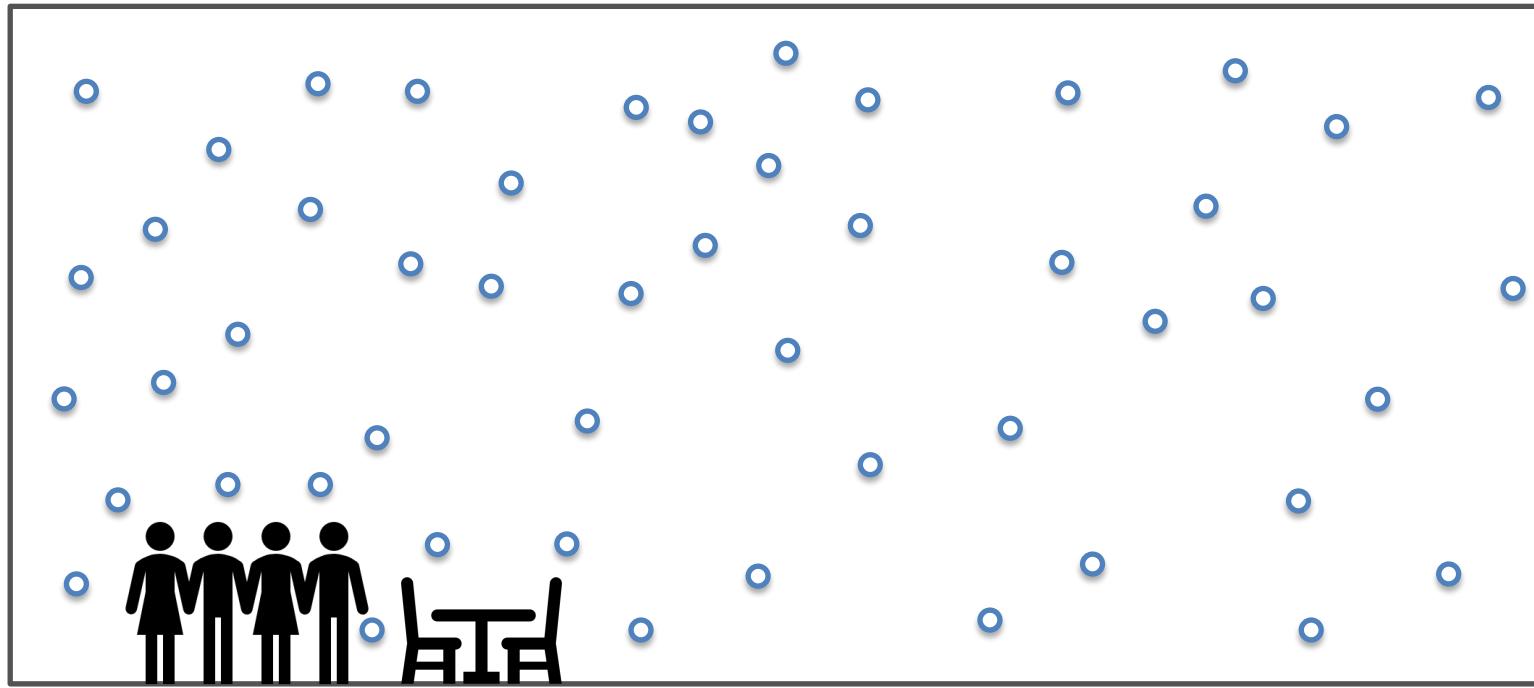


# Modelos basados en Energía

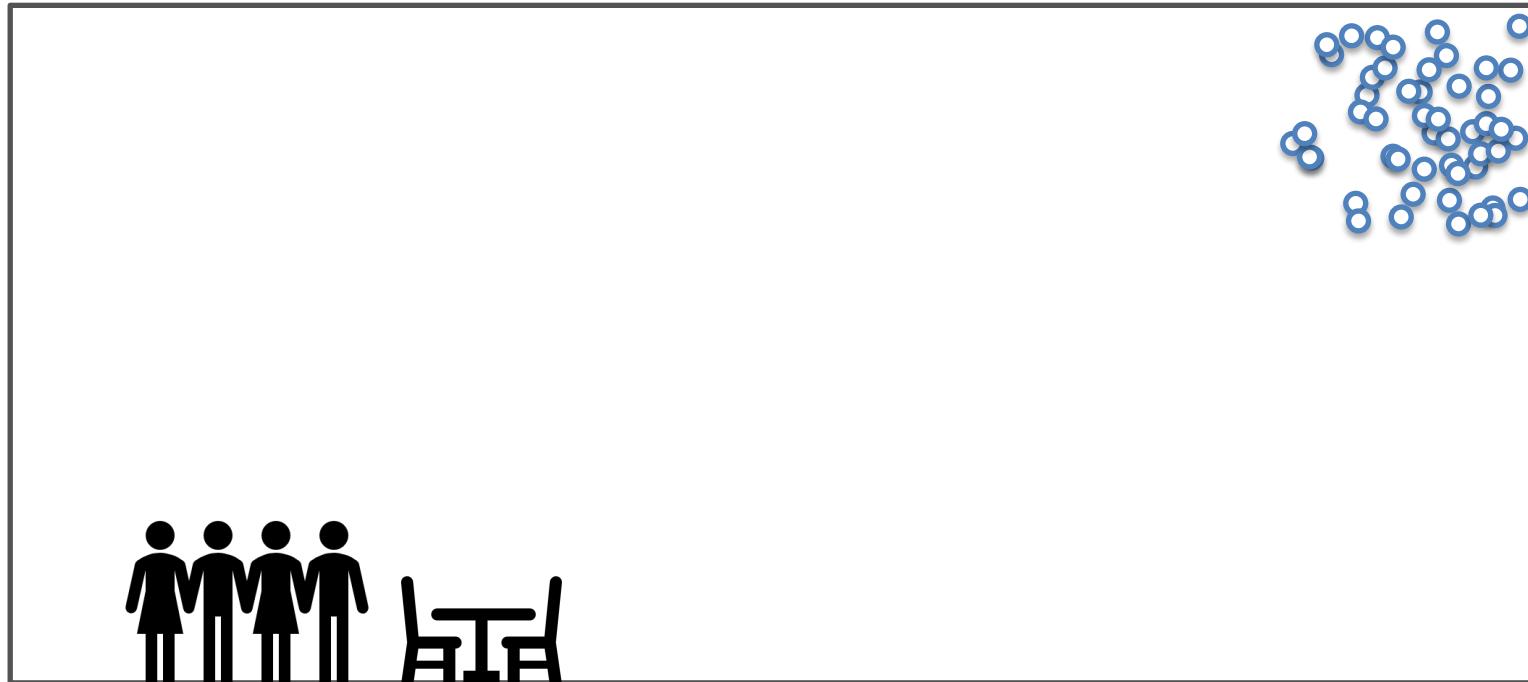
# Modelos basados en Energía

$$p_i = \frac{e^{-\varepsilon_i/kT}}{\sum_{j=1}^M e^{-\varepsilon_j/kT}}$$

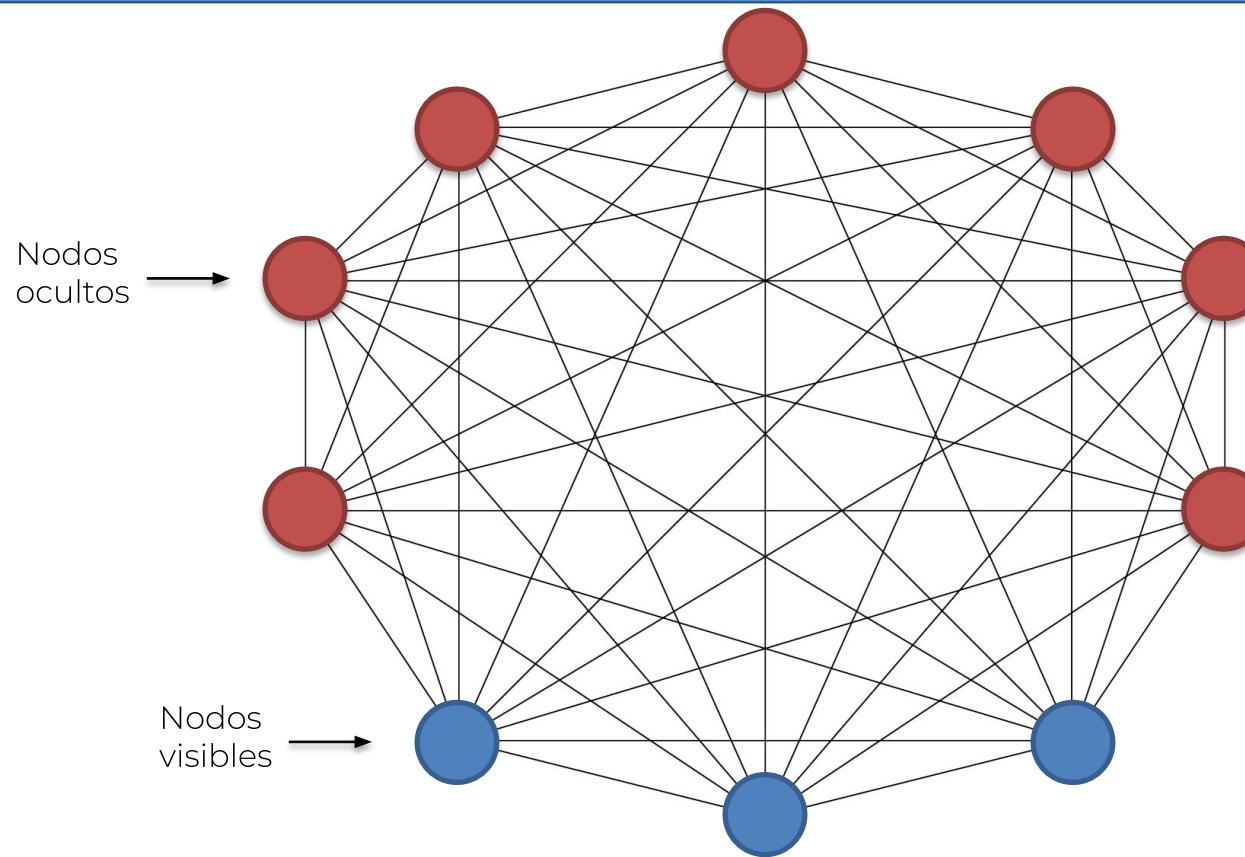
# Modelos basados en Energía



# Modelos basados en Energía



# Máquinas de Boltzmann



# Modelos basados en Energía

$$E(v, h) = - \sum_i a_i v_i - \sum_j b_j h_j - \sum_i \sum_j v_i w_{i,j} h_j$$

$$P(v, h) = \frac{1}{Z} e^{-E(v, h)}$$

# Modelos basados en Energía

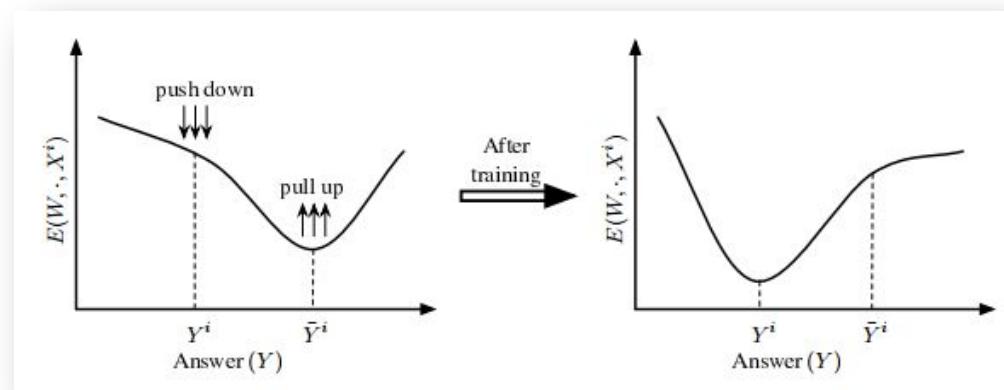
Lectura adicional:

*A Tutorial on Energy-Based Learning*

de Yann LeCun et al. (2006)

Link:

<http://yann.lecun.com/exdb/publis/pdf/lecun-06.pdf>



# Modelos basados en En

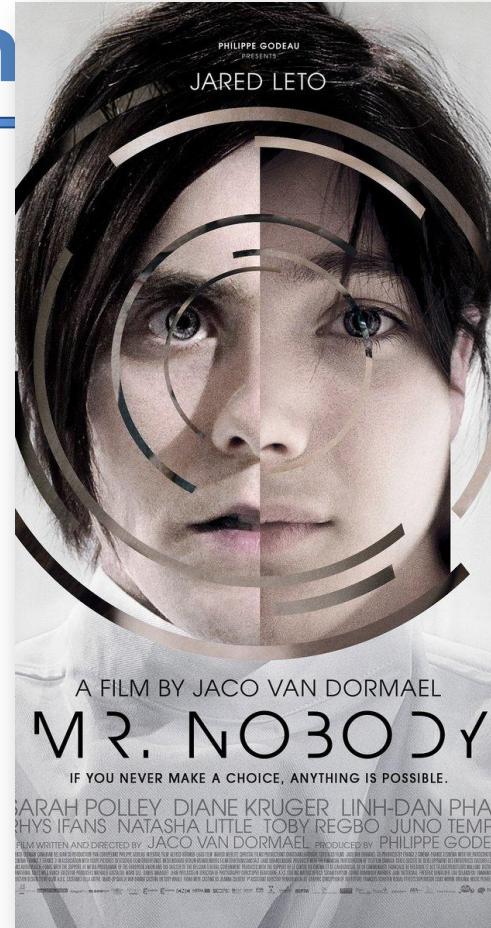
Lectura Adicional:

*Mr. Nobody (Pelicula)*

de Jaco Van Dormael (2009)

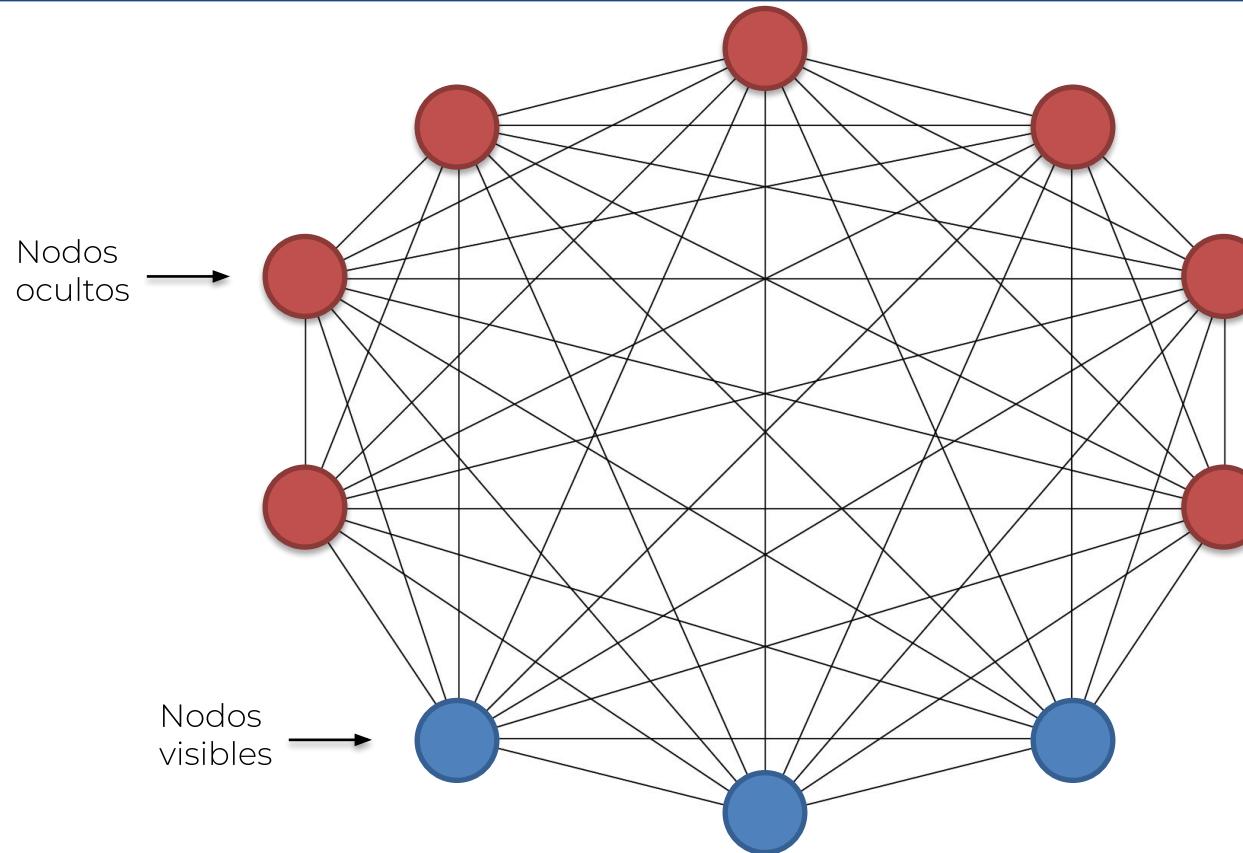
Link:

<http://www.imdb.com/title/tt0485947/>

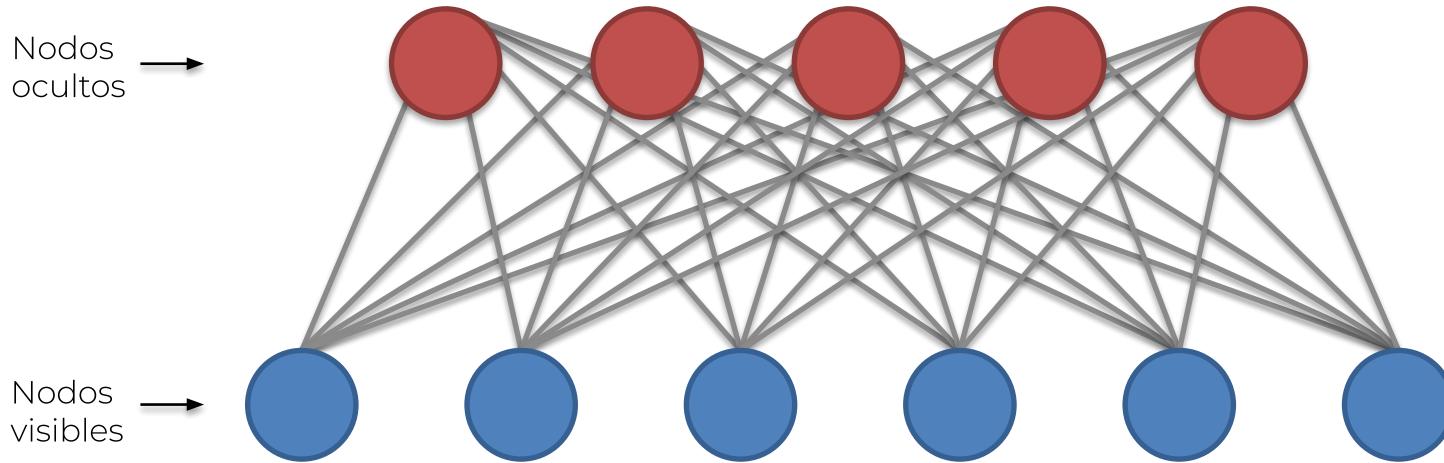


# Máquinas de Boltzmann Restringidas (RBM)

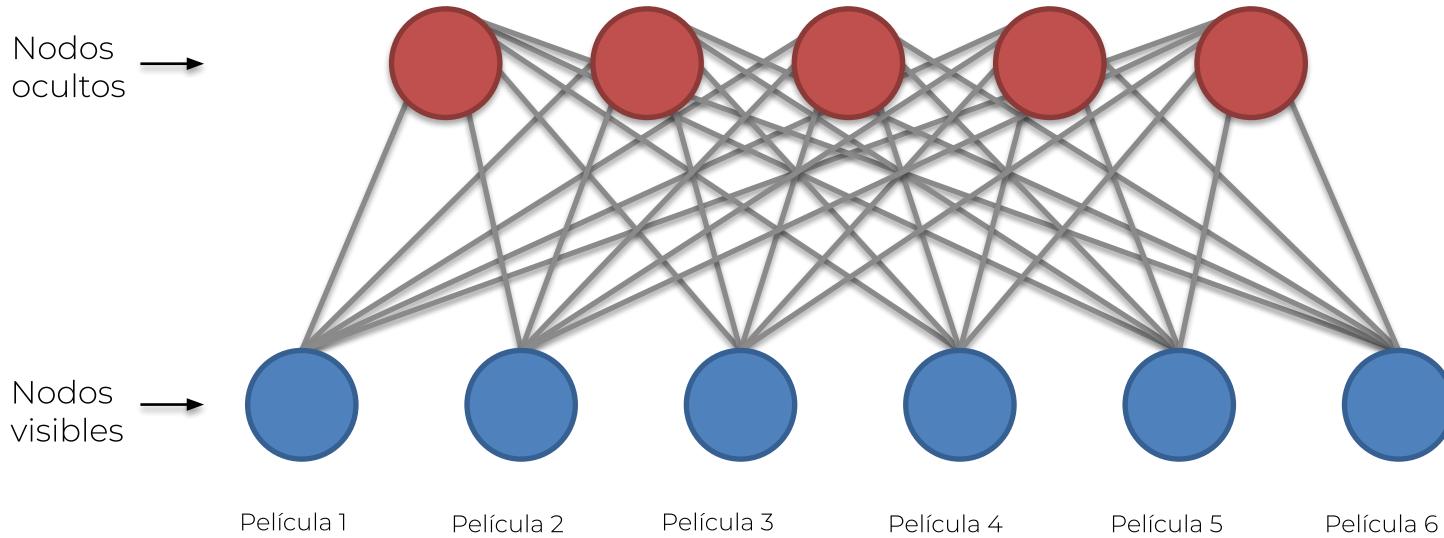
# Máquinas de Boltzmann



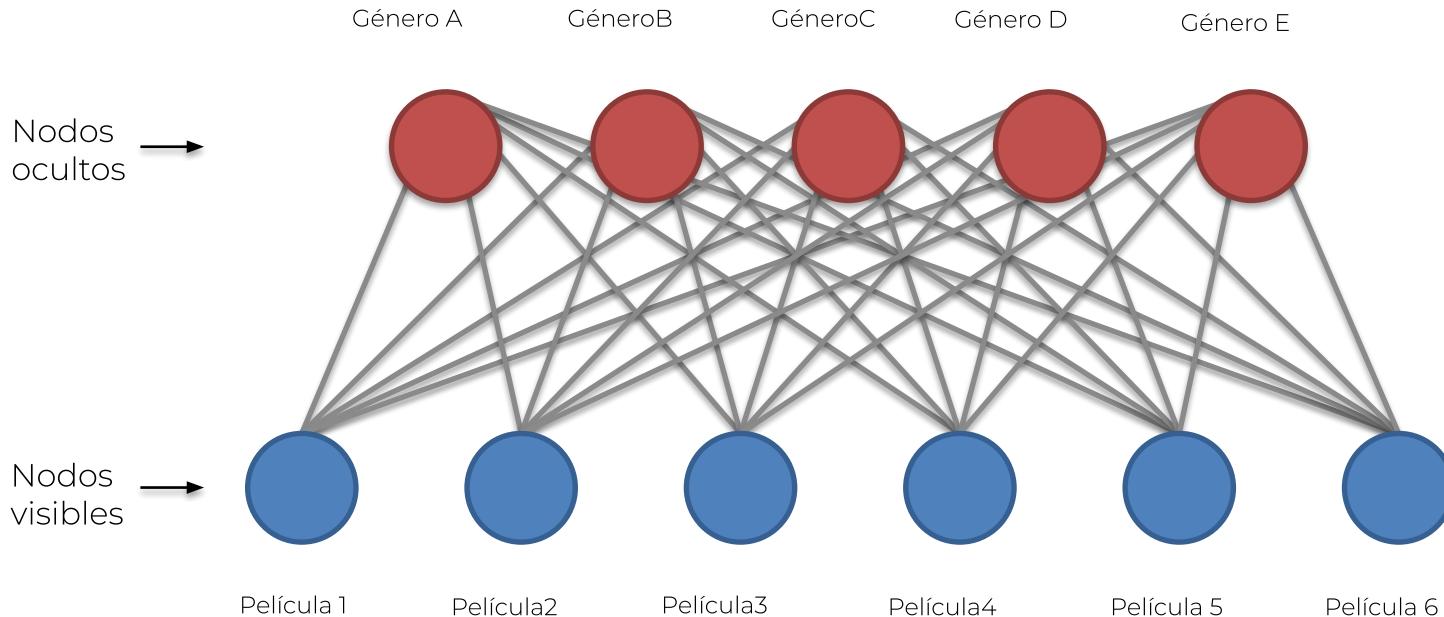
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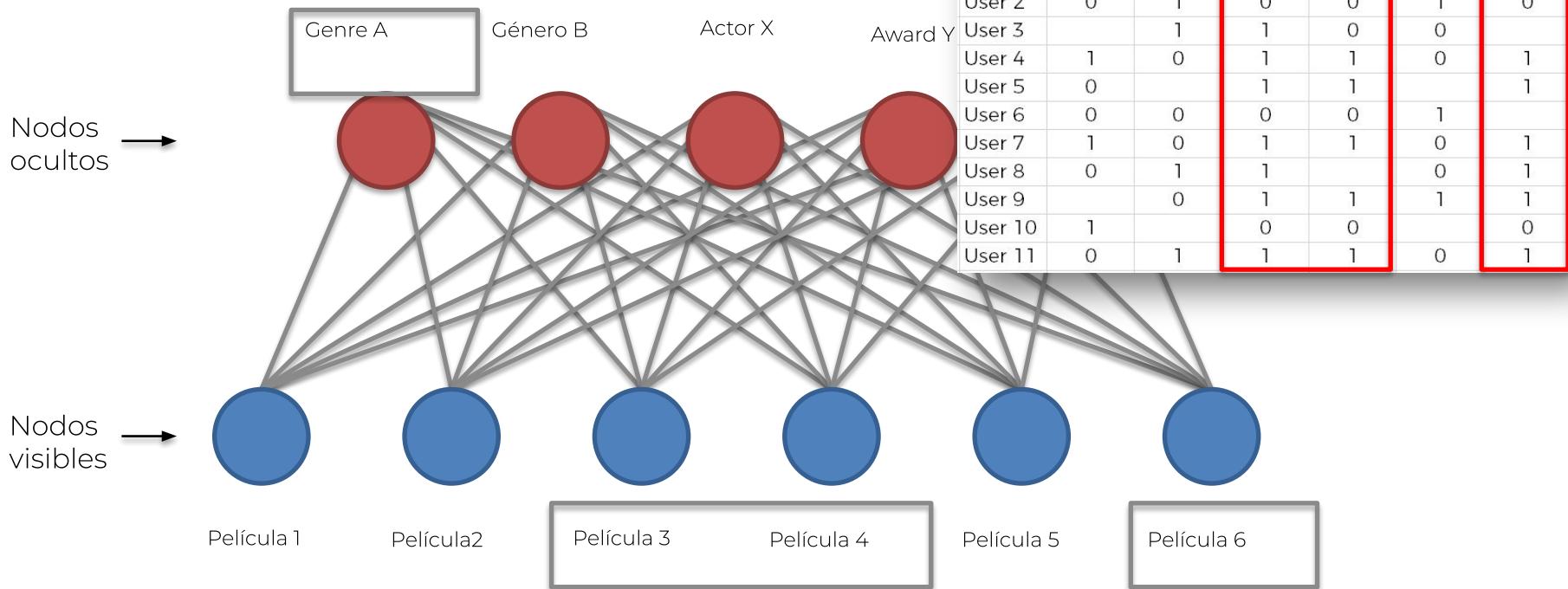
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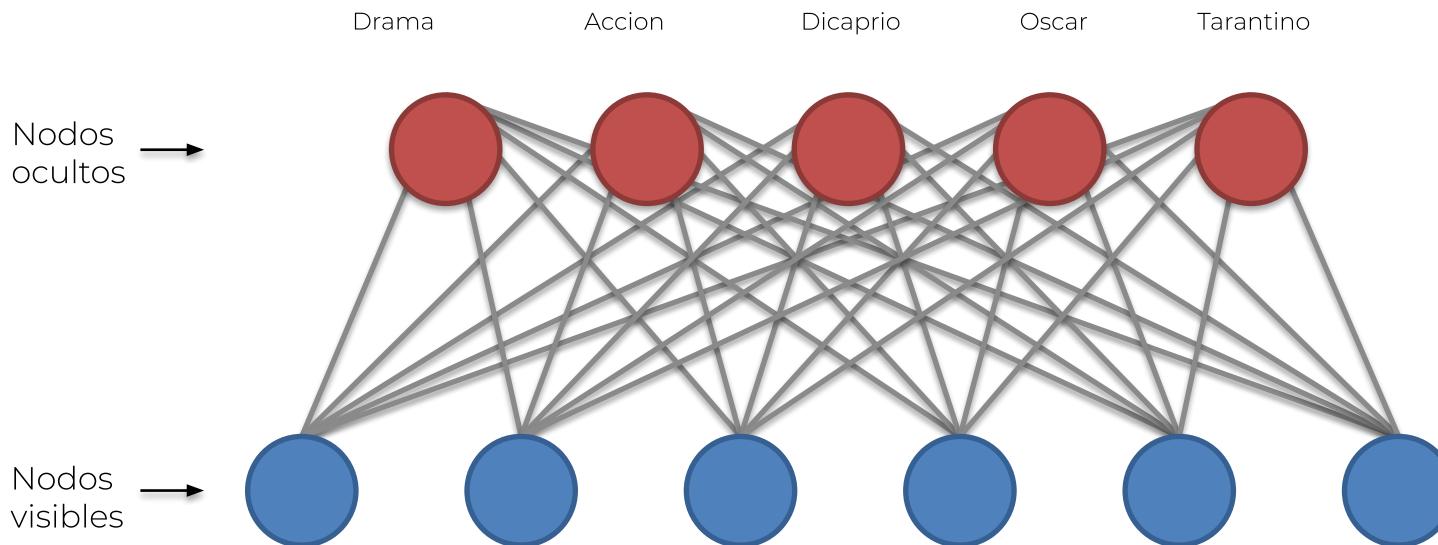
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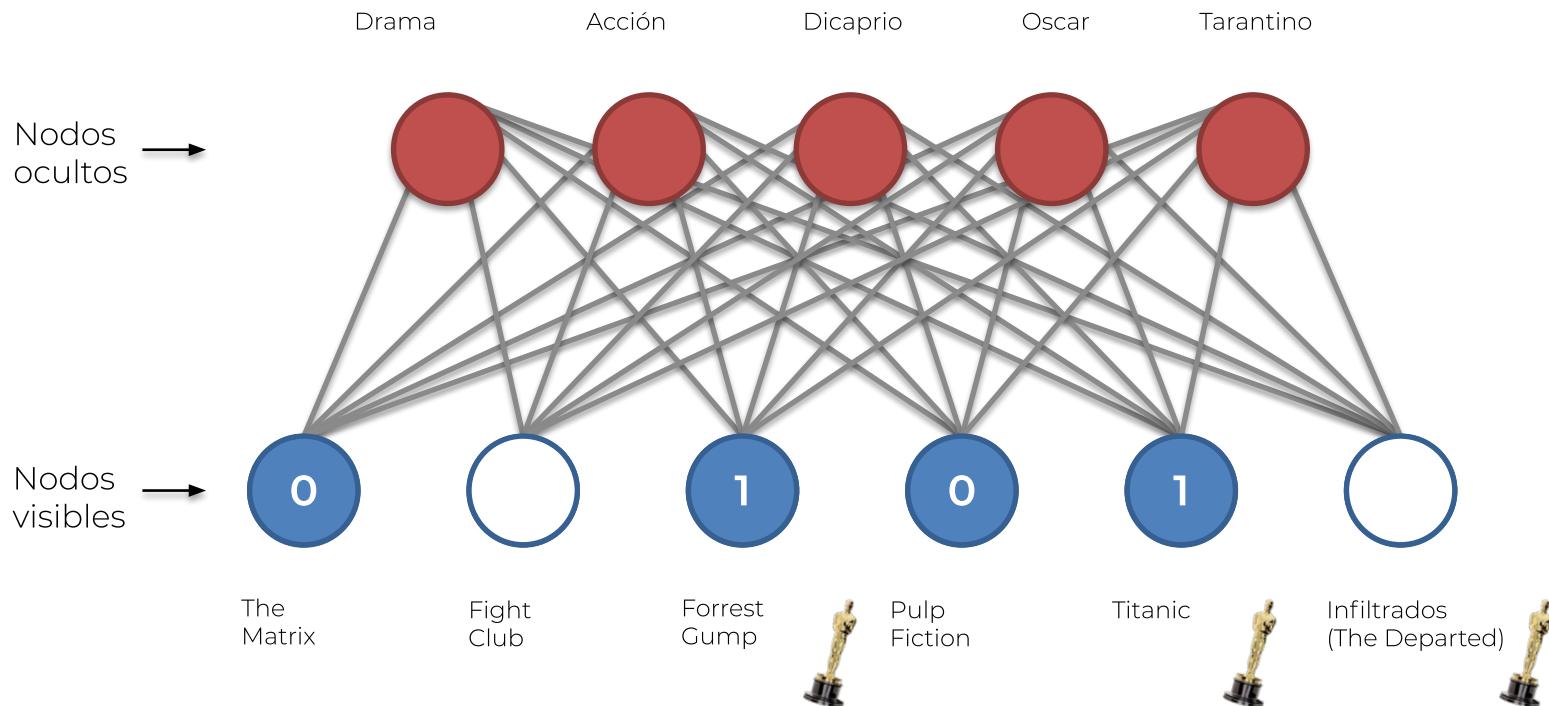
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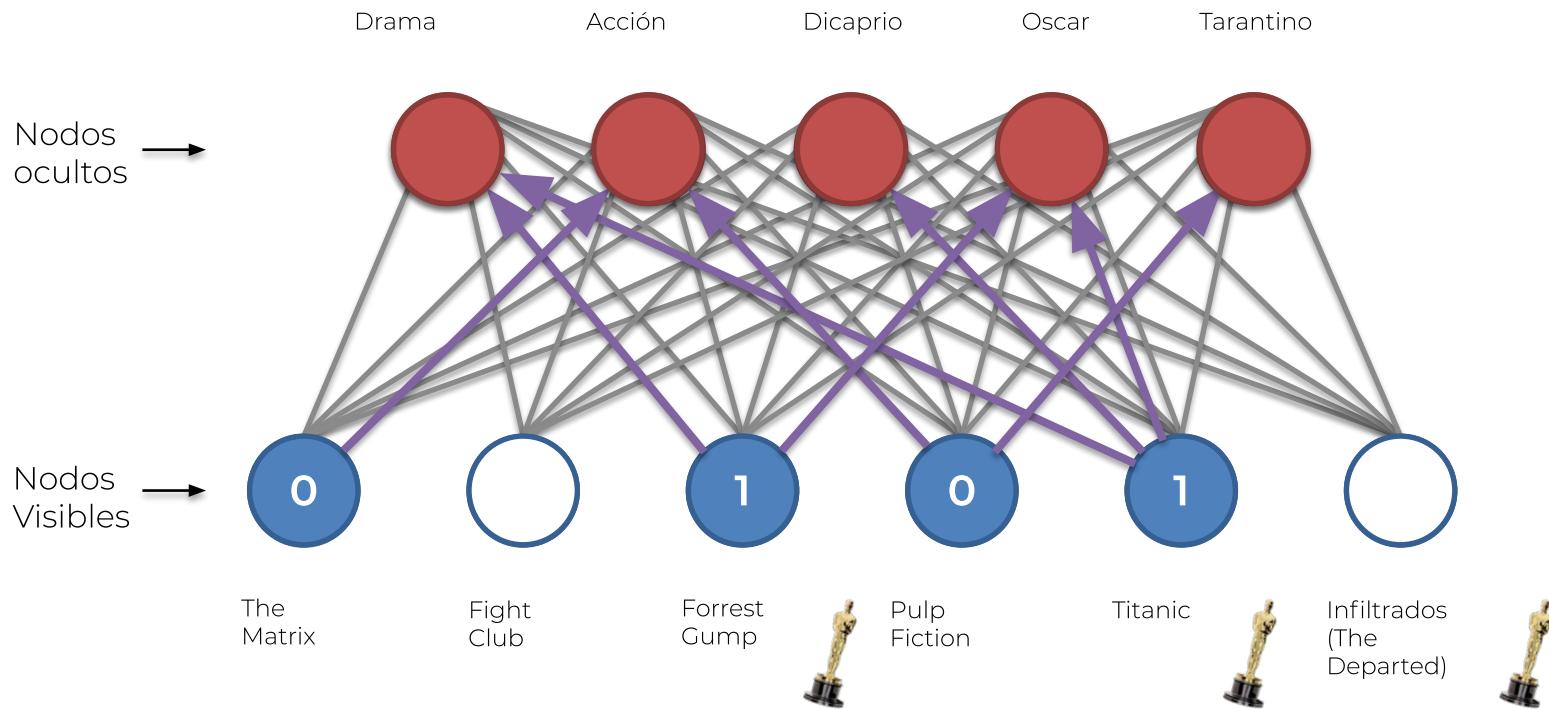
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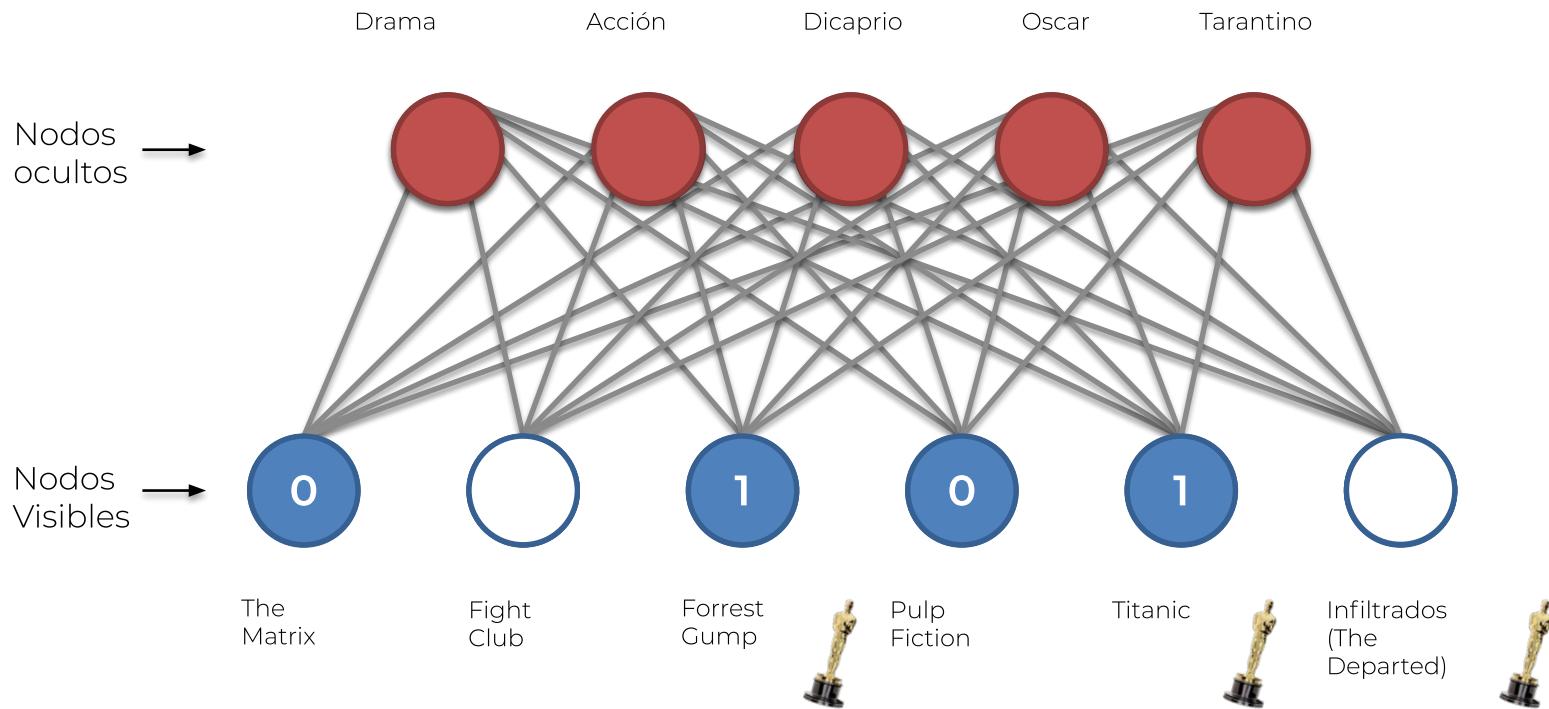
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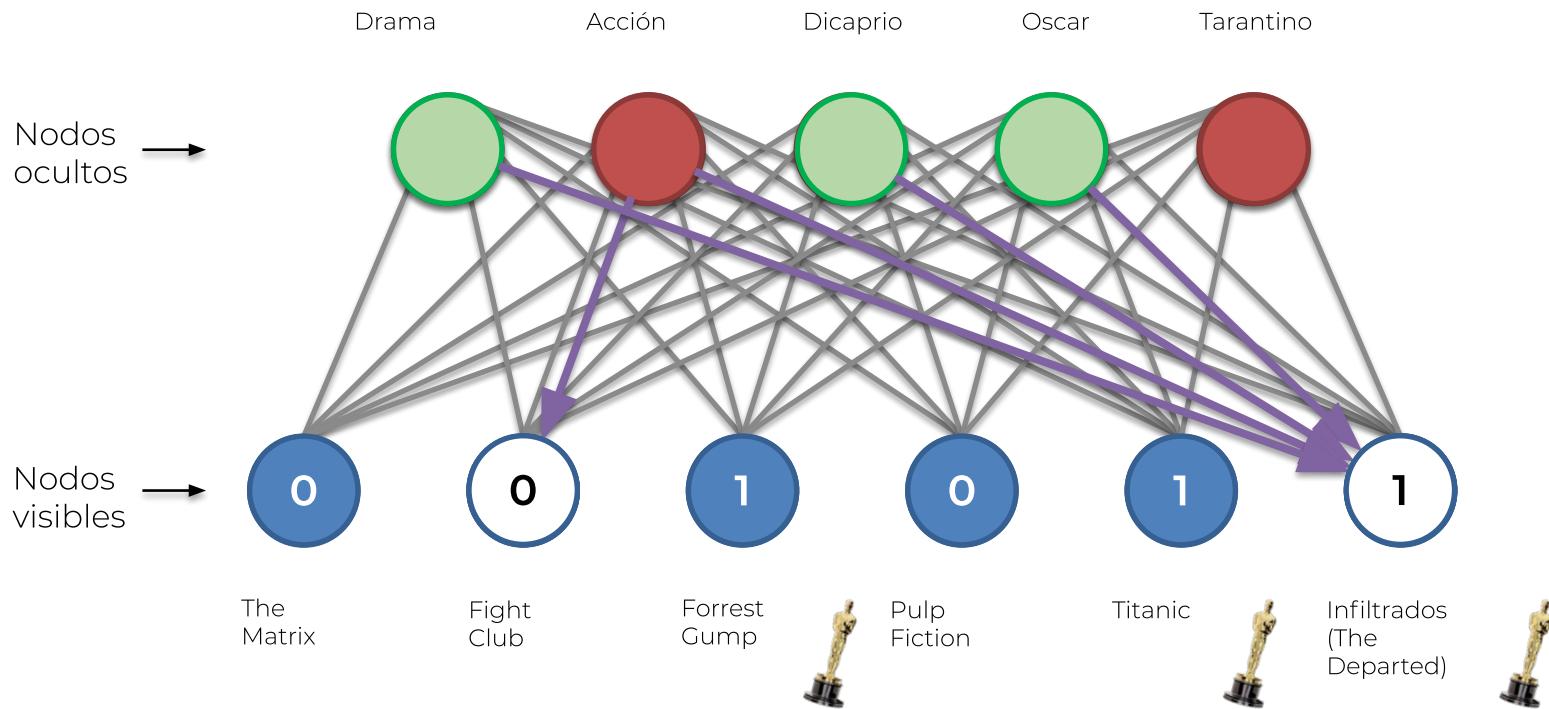
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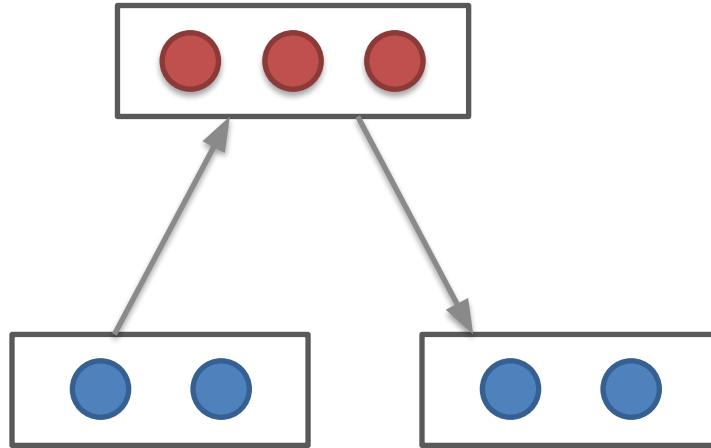


# Máquinas de Boltzmann Restringidas (RBM)

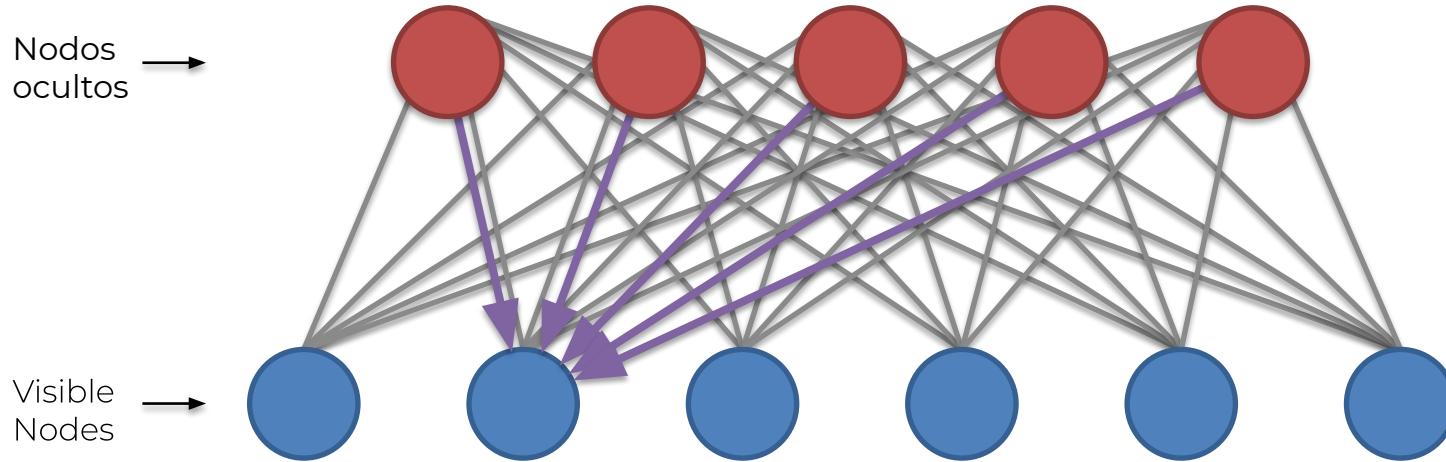


# Divergencia contrastante

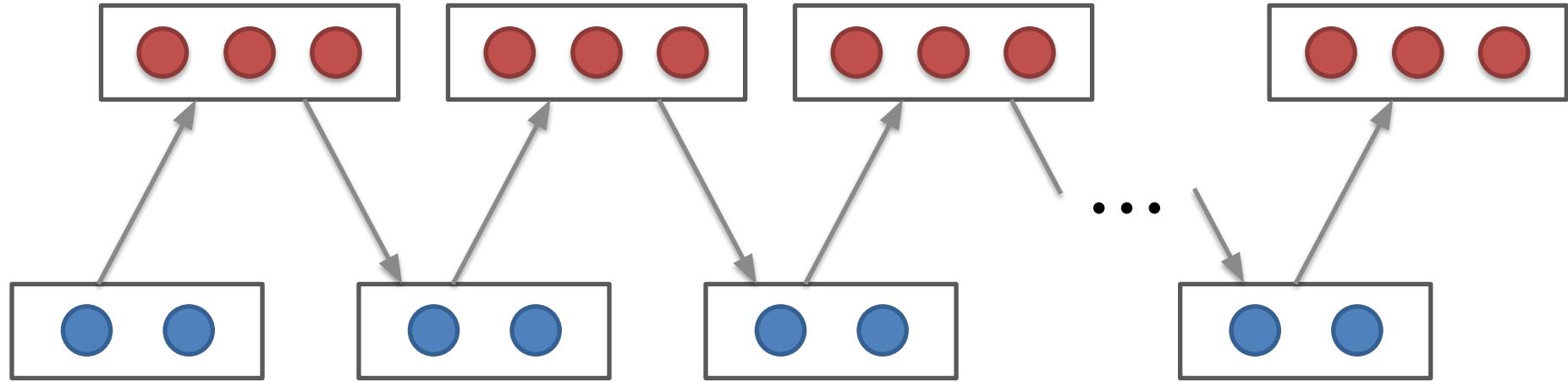
# Divergencia Contrastante



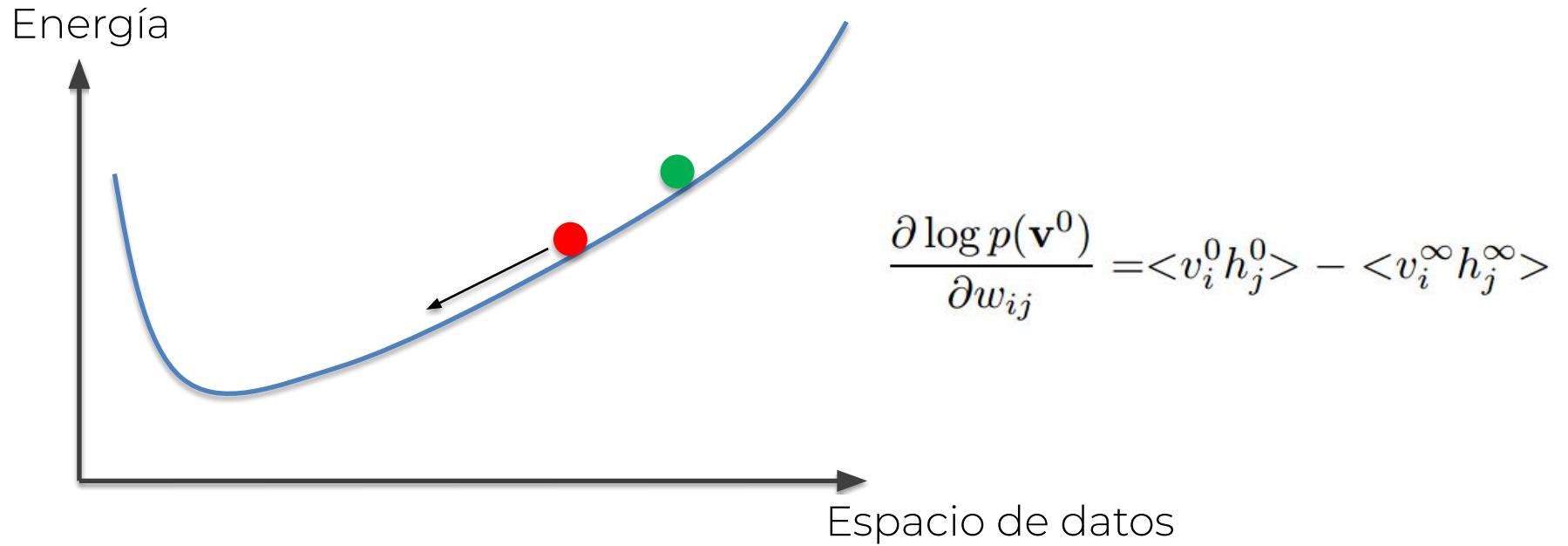
# Máquinas de Boltzmann restringidas (RBM)



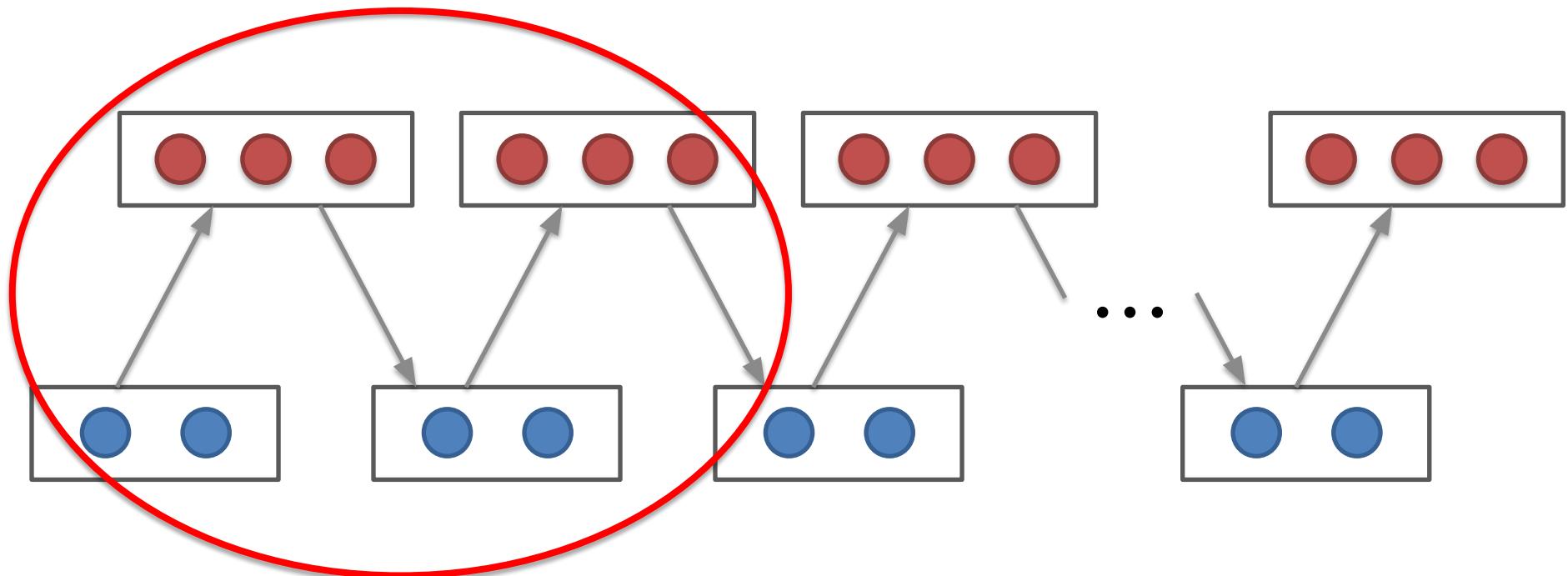
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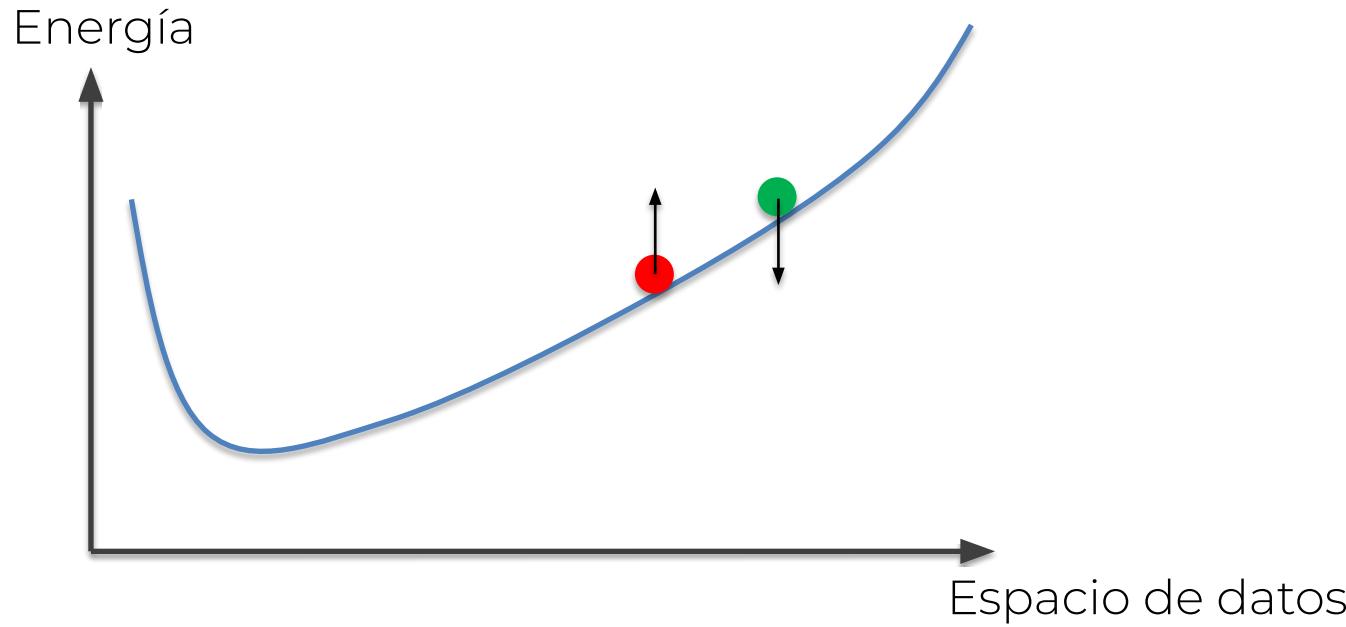
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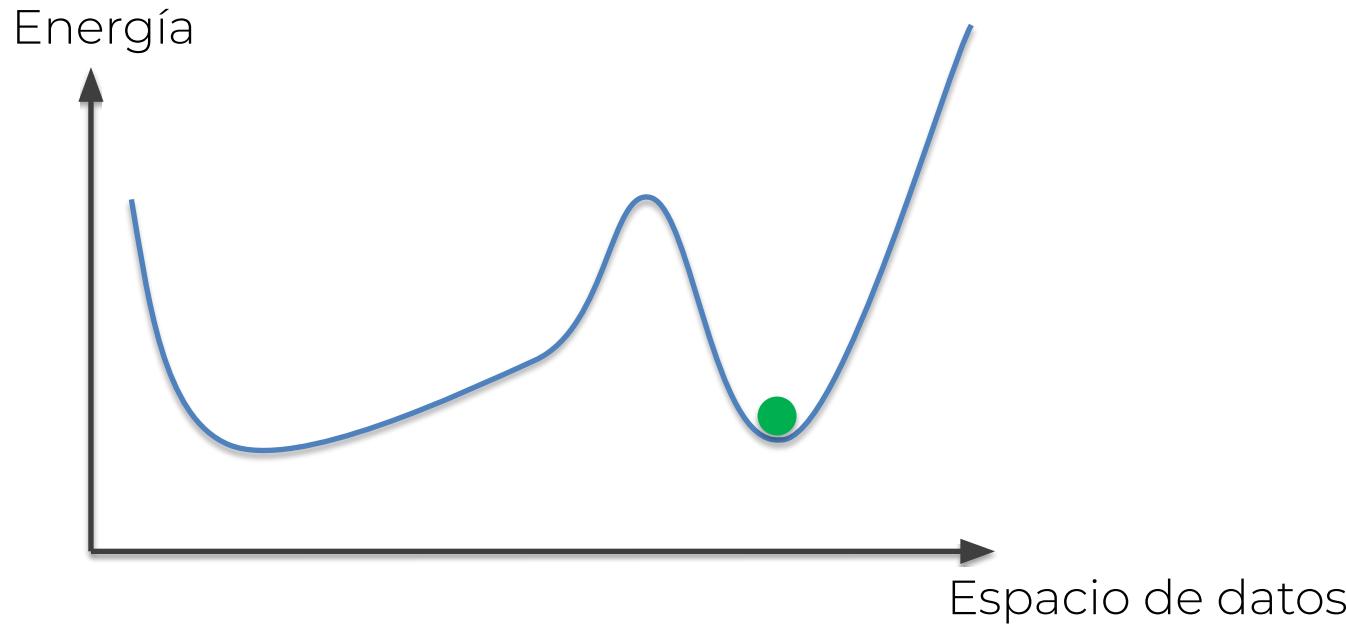
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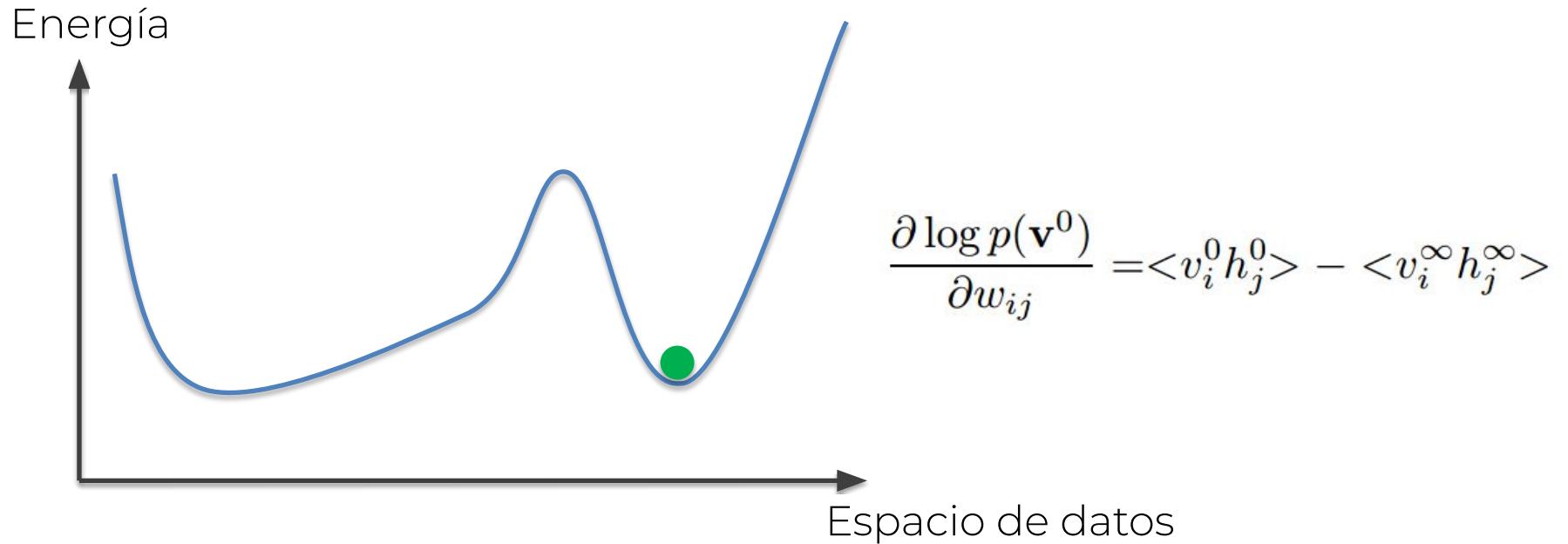
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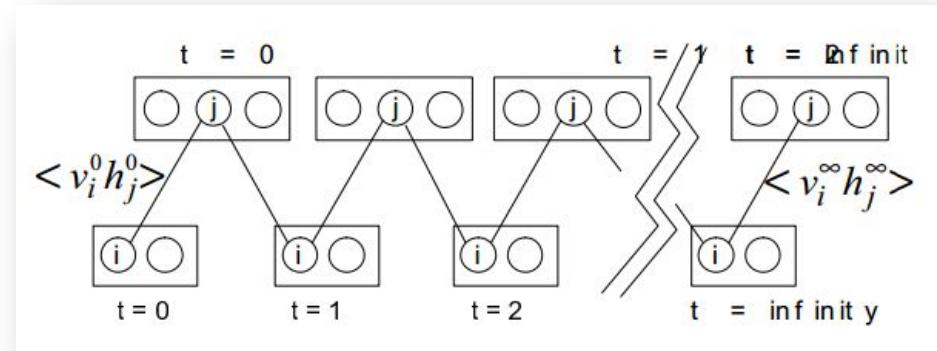


# Divergencia Contrastante

Lectura adicional:

*A fast learning algorithm for deep belief nets*

de Geoffrey Hinton et al. (2006)



Link:

<https://www.cs.toronto.edu/~hinton/absps/fastnc.pdf>

# Divergencia Contrastante

Additional Reading:

*Notes on Contrastive Divergence*  
de Oliver Woodford (2012?)

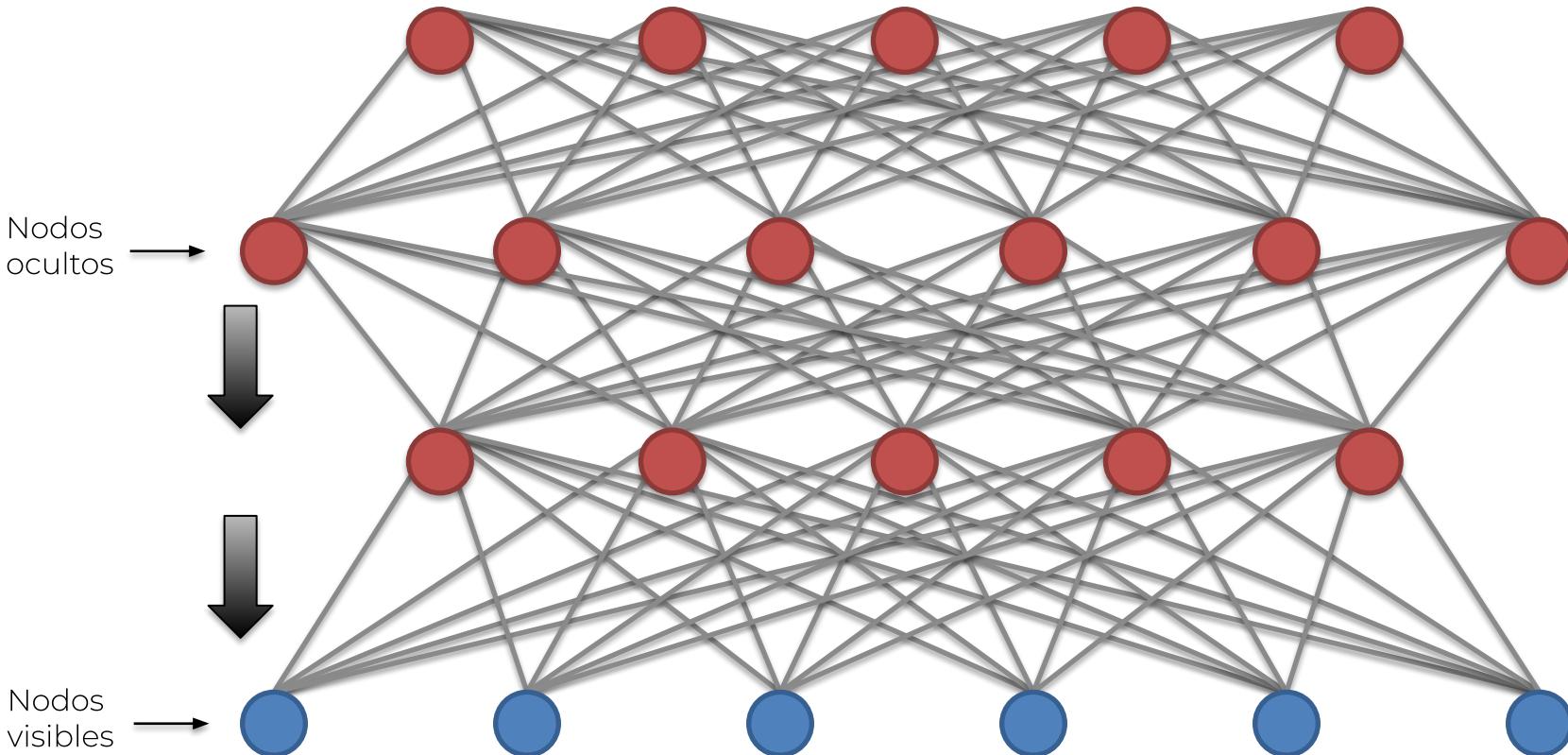
Link:

<http://www.robots.ox.ac.uk/~ojw/files/NotesOnCD.pdf>

$$\begin{aligned}\frac{\partial \log Z(\Theta)}{\partial \Theta} &= \frac{1}{Z(\Theta)} \frac{\partial Z(\Theta)}{\partial \Theta} \\ &= \frac{1}{Z(\Theta)} \frac{\partial}{\partial \Theta} \int f(x; \Theta) dx \\ &= \frac{1}{Z(\Theta)} \int \frac{\partial f(x; \Theta)}{\partial \Theta} dx \\ &= \frac{1}{Z(\Theta)} \int f(x; \Theta) \frac{\partial \log f(x; \Theta)}{\partial \Theta} dx \\ &= \int p(x; \Theta) \frac{\partial \log f(x; \Theta)}{\partial \Theta} dx \\ &= \left\langle \frac{\partial \log f(x; \Theta)}{\partial \Theta} \right\rangle_{p(x; \Theta)}\end{aligned}$$

# Red de Creencia Profunda

# Red de Creencia Profunda (DBN)



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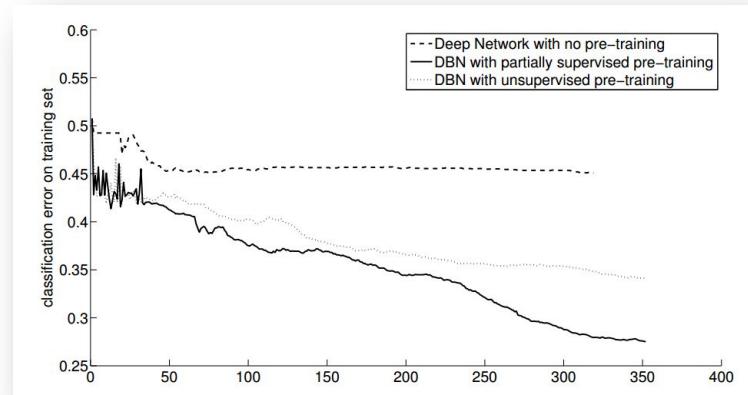
Lectura adicional:

*Greedy Layer-Wise Training of Deep Networks*

de Yoshua Bengio et al. (2006)

Link:

<http://www.iro.umontreal.ca/~lisa/poiteurs/BengioNips2006All.pdf>



# Red de Creencia Profunda (DBN)

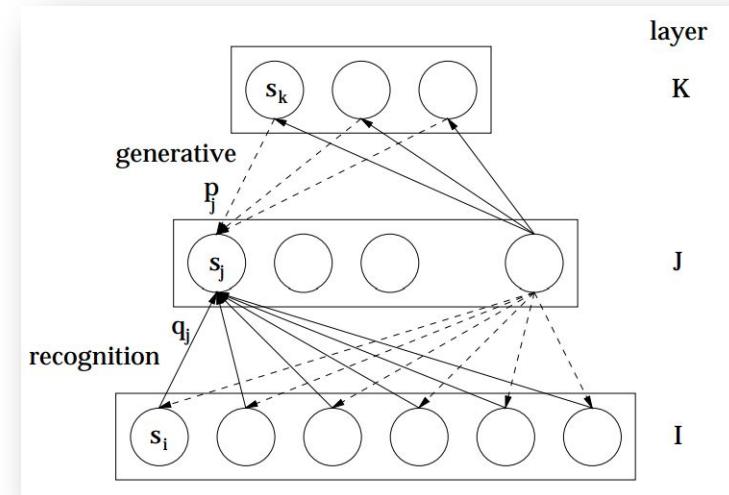
Lectura adicional:

*The wake-sleep algorithm for unsupervised neural networks*

de Geoffrey Hinton et al. (1995)

Link:

<http://www.gatsby.ucl.ac.uk/~dayan/papers/hdfn95.pdf>

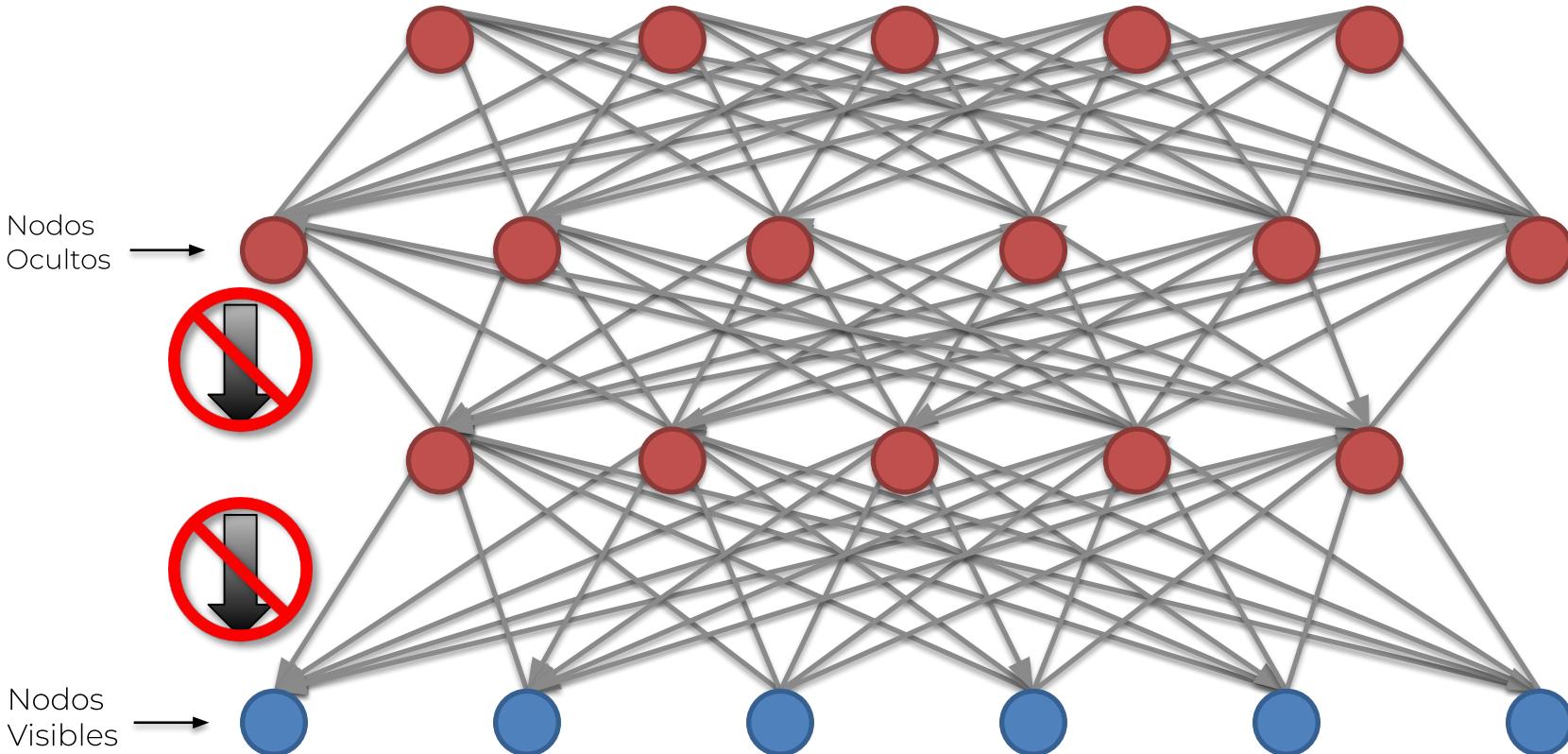


# Máquinas de Boltzmann Profundas

# Máquinas de Boltzmann Profundas (DBM)

DBN <> DBM

# Máquinas de Boltzmann Profundas (DBM)



# Máquinas de Boltzmann Profundas (DBM)

Additional Reading:

*Deep Boltzmann Machines*

de Ruslan Salakhutdinov et al. (2009?)

Link:

<http://www.utstat.toronto.edu/~rsalakhu/papers/dbm.pdf>

