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Reti, folle, mercati ed epidemie

L'uso sociale dell'informatica

27 gennaio 2025,
Aula Magna DISIT Alessandria

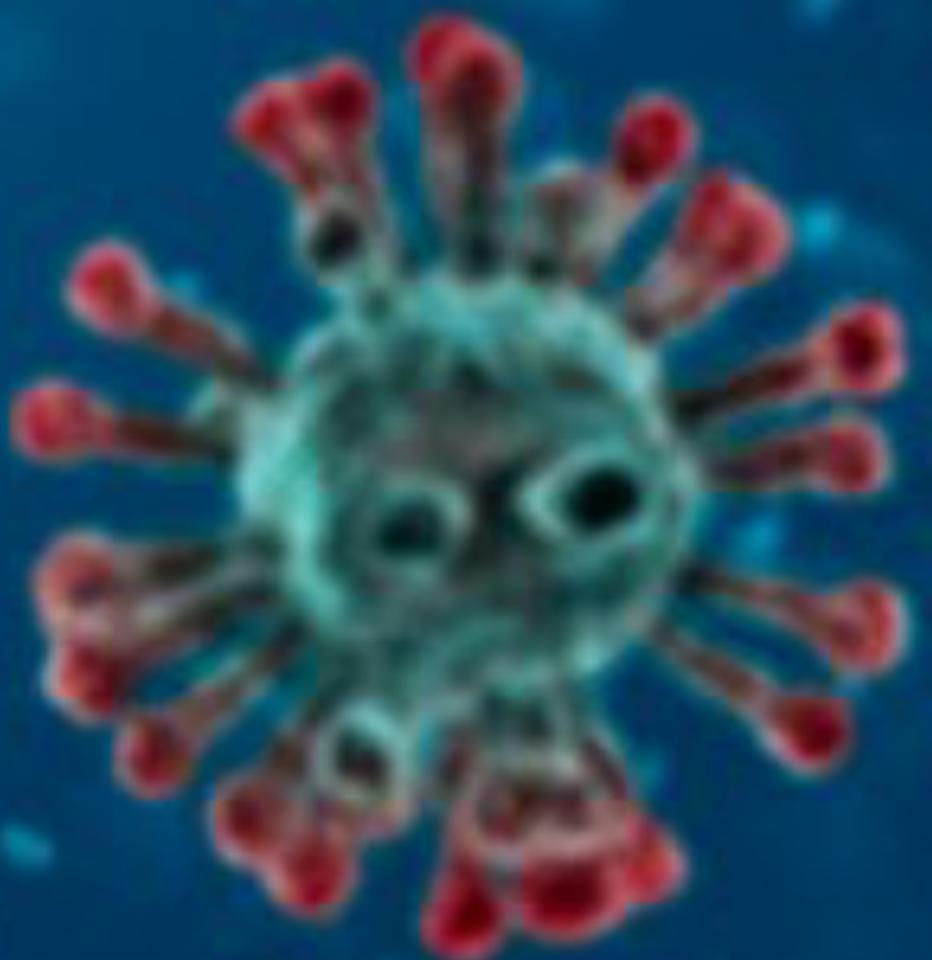
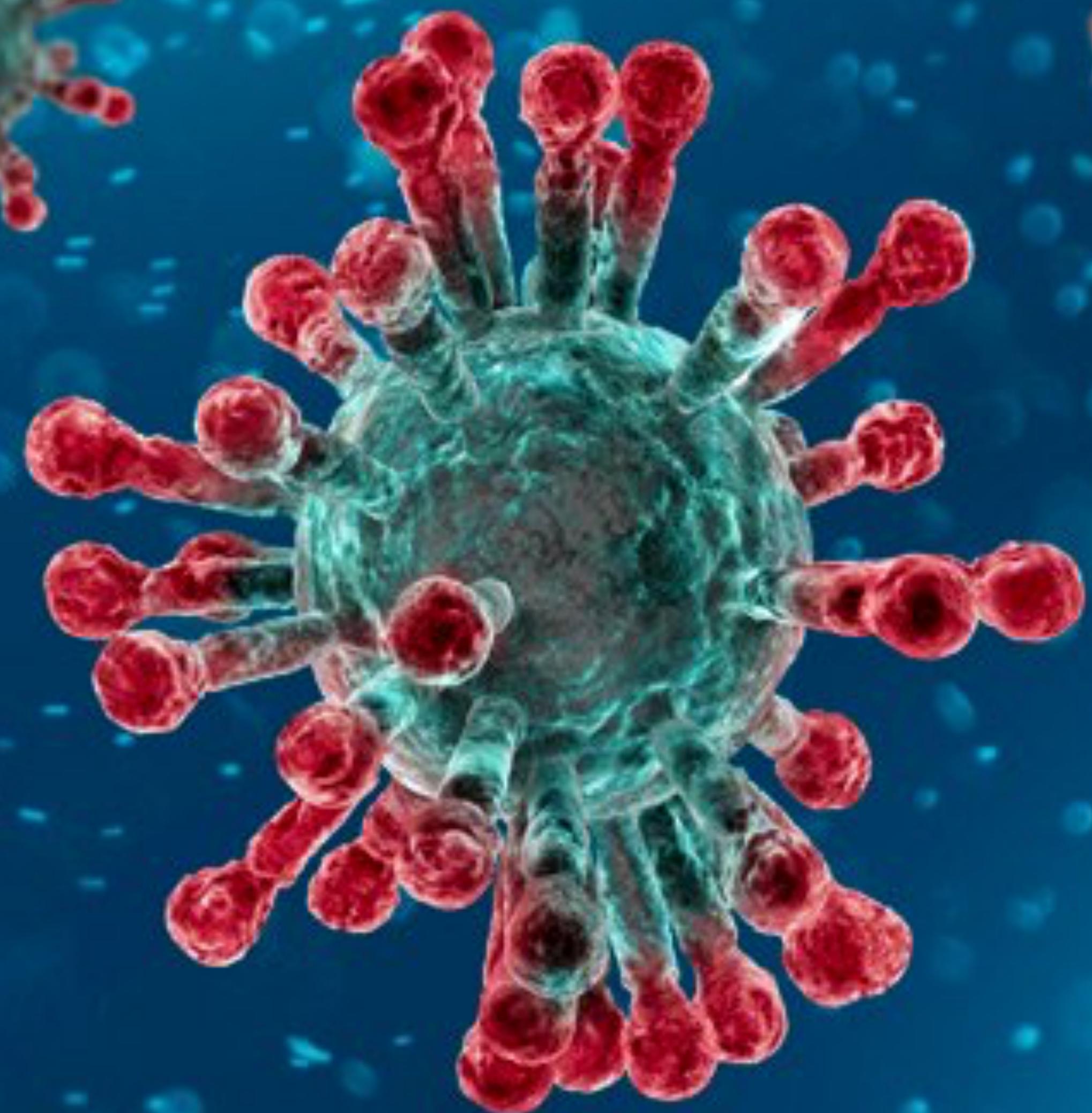
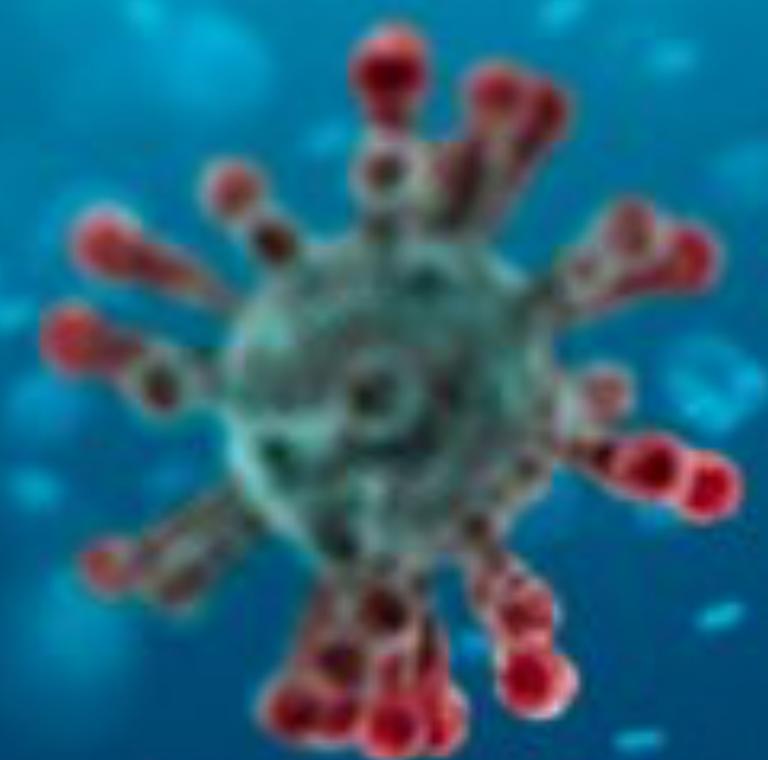
Cosa hanno in comune...?



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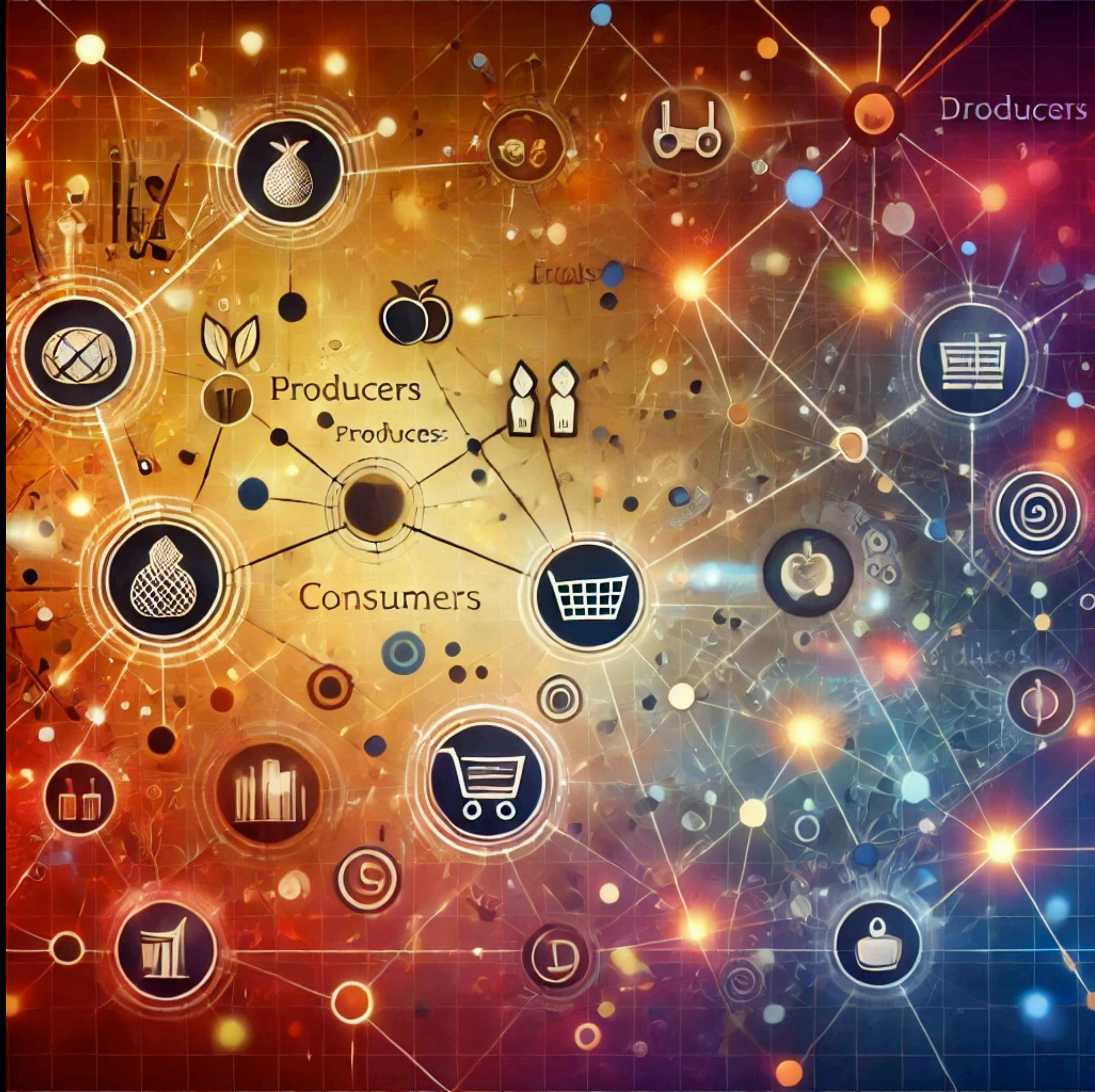














Sistemi complessi



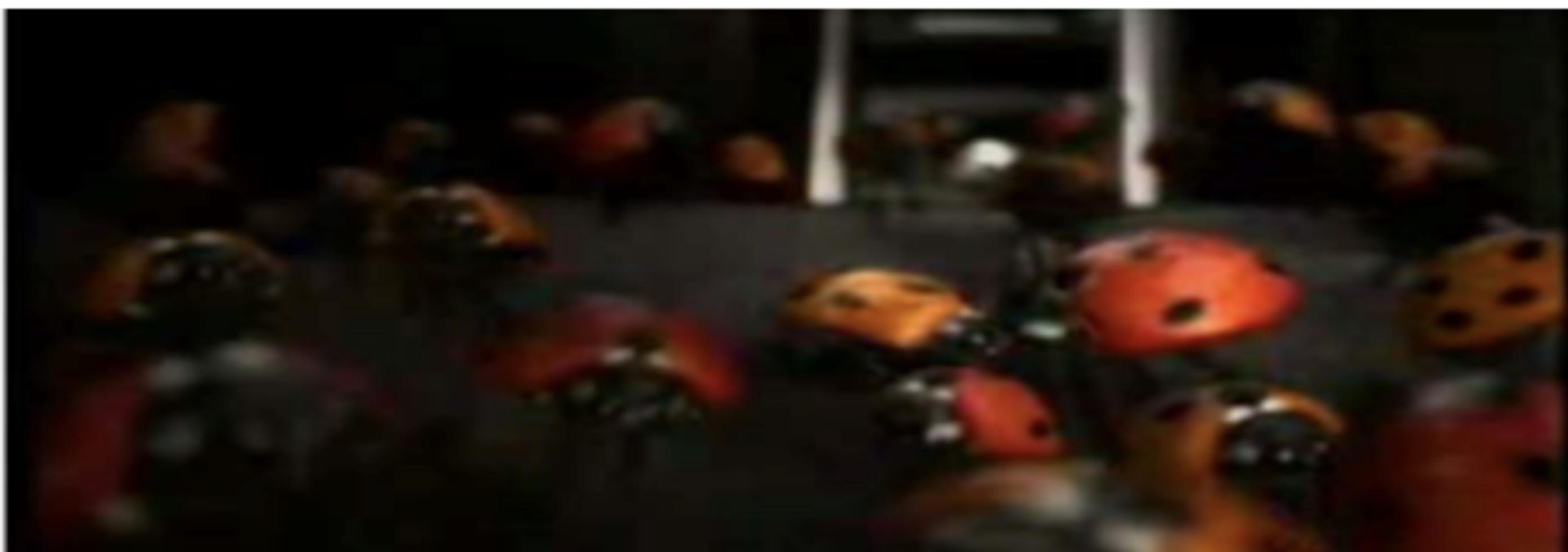
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Un esempio: conformismo sociale



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Exhibit 1

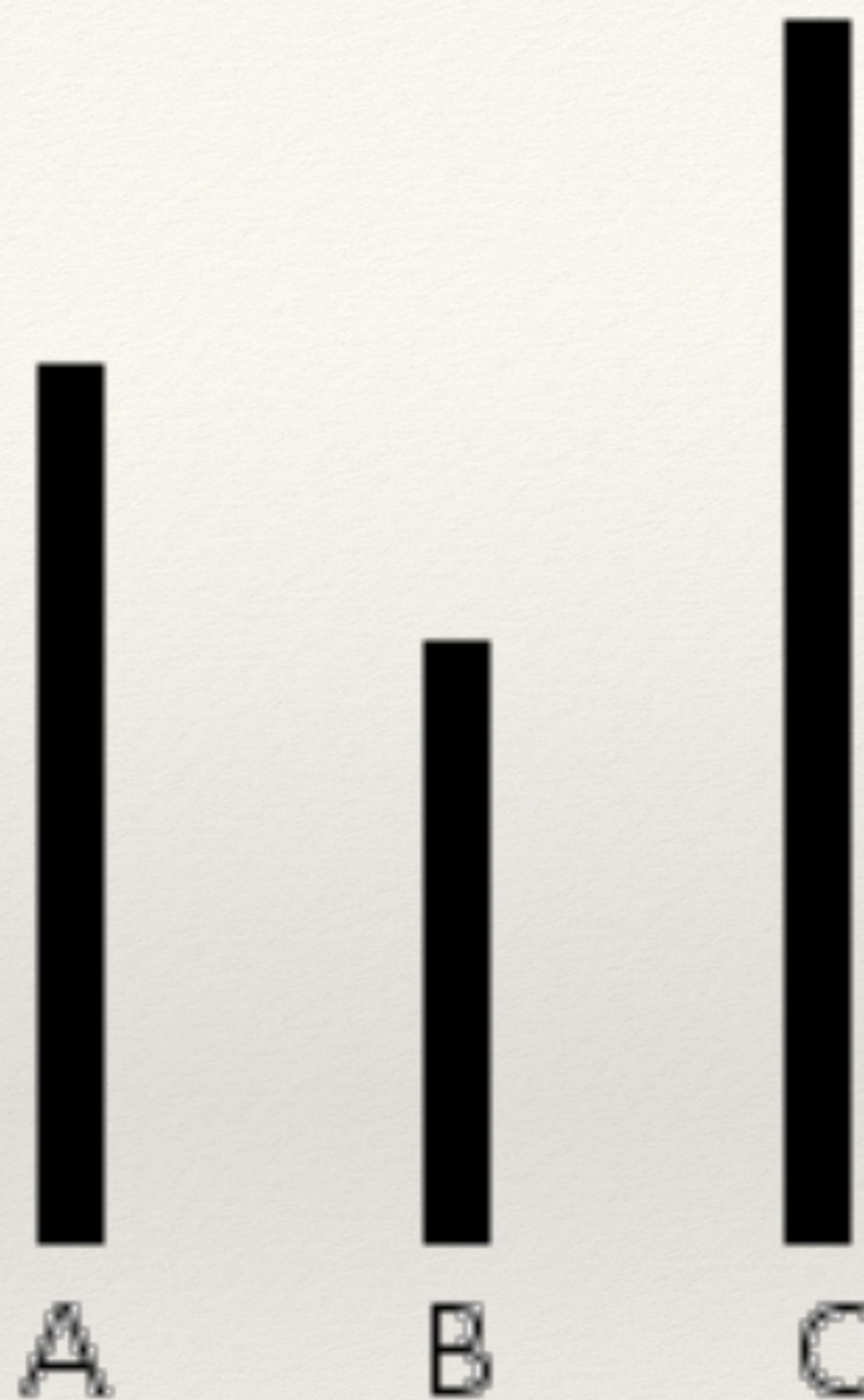
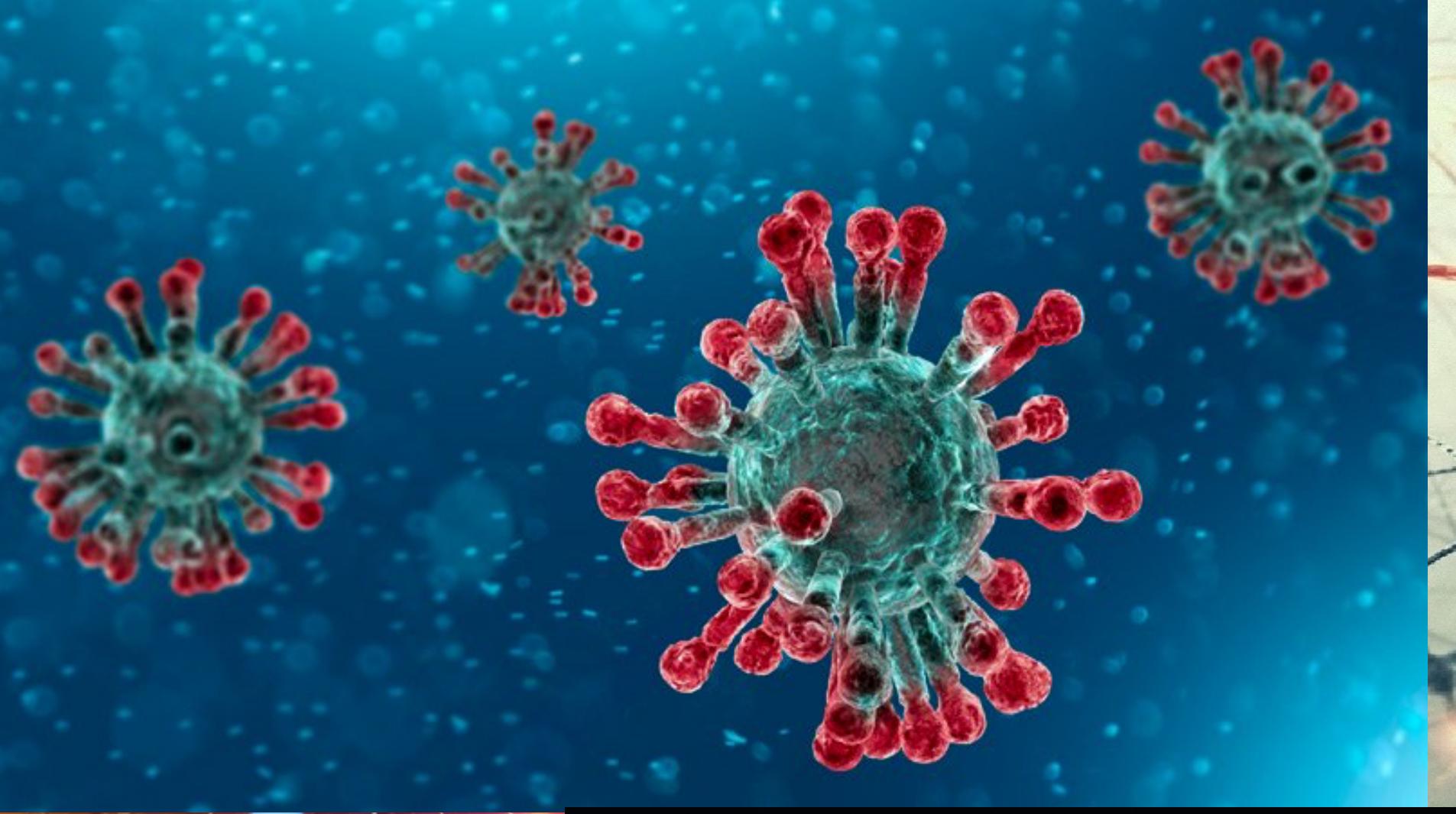


Exhibit 2

Altri esempi



Le reti sono ovunque (come la matematica...)

○ Un grafo è fatto di nodi e collegamenti

$$G = (N, L)$$

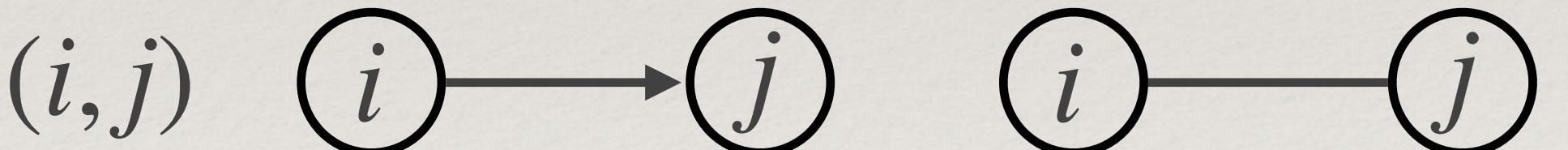
○ Nodi (o vertici)

$$N = \{n_1, n_2, \dots, n_l\} = \{1, 2, \dots, l\}$$

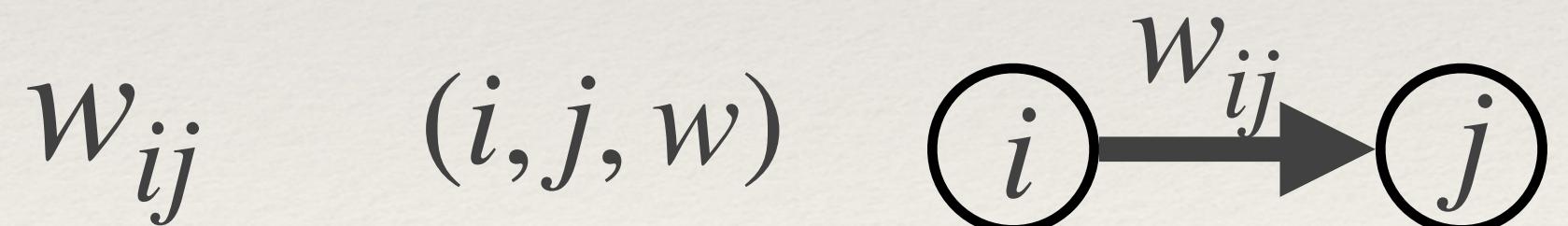
○ Collegamenti (o archi)

$$L = \{(i, j) : i, j \in N\}$$

○ I grafi possono essere orientati o non orientati



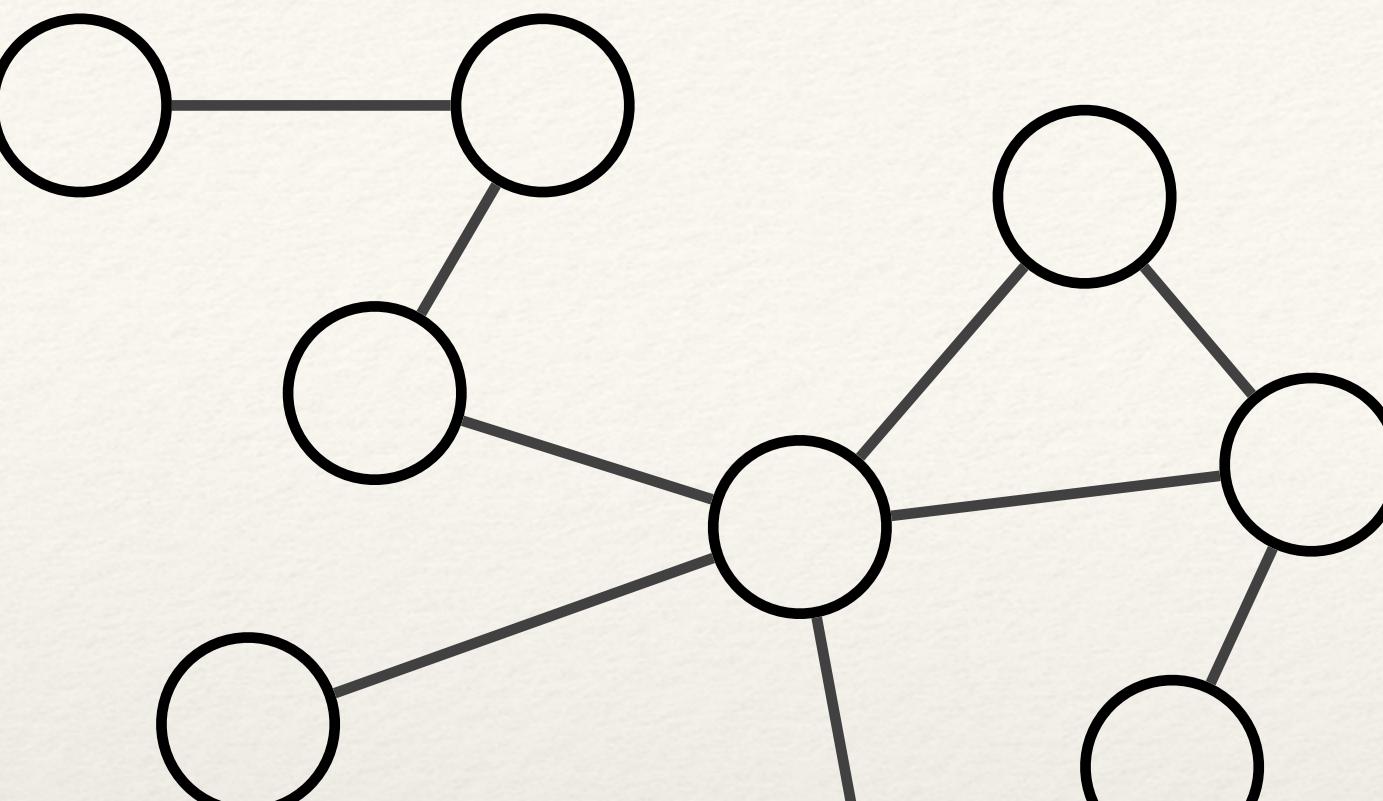
○ I grafi possono essere con peso o senza peso



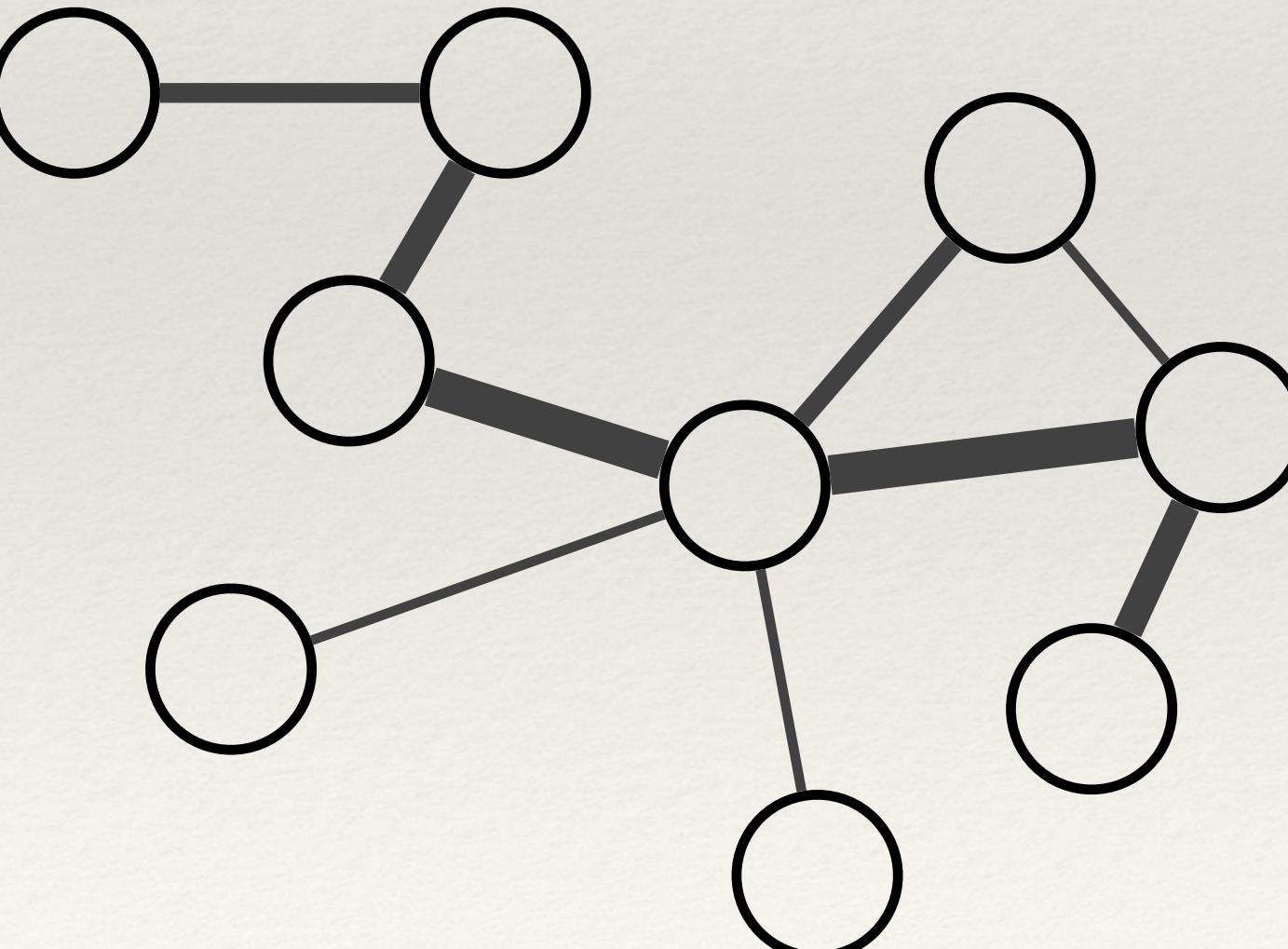
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Senza peso

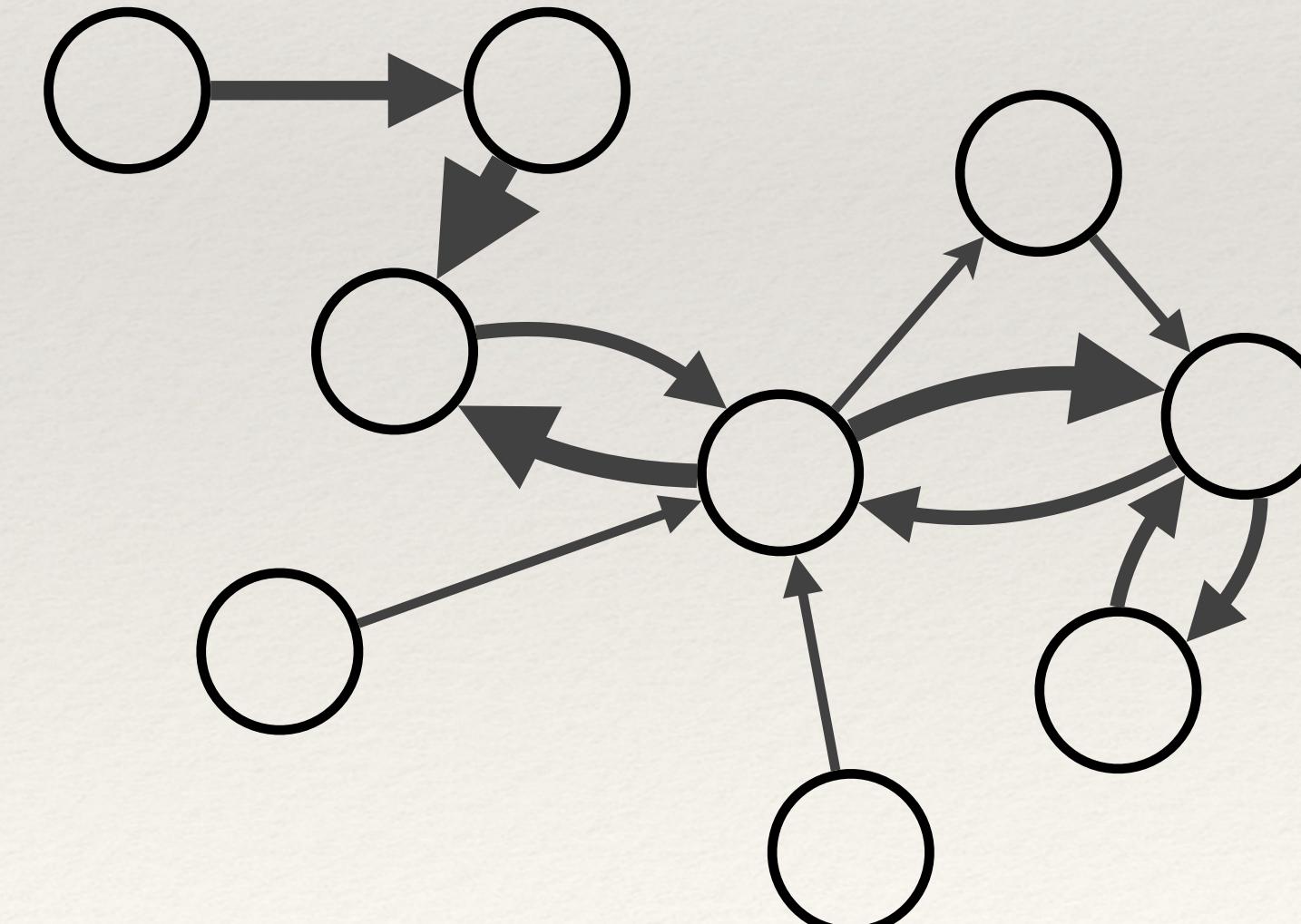
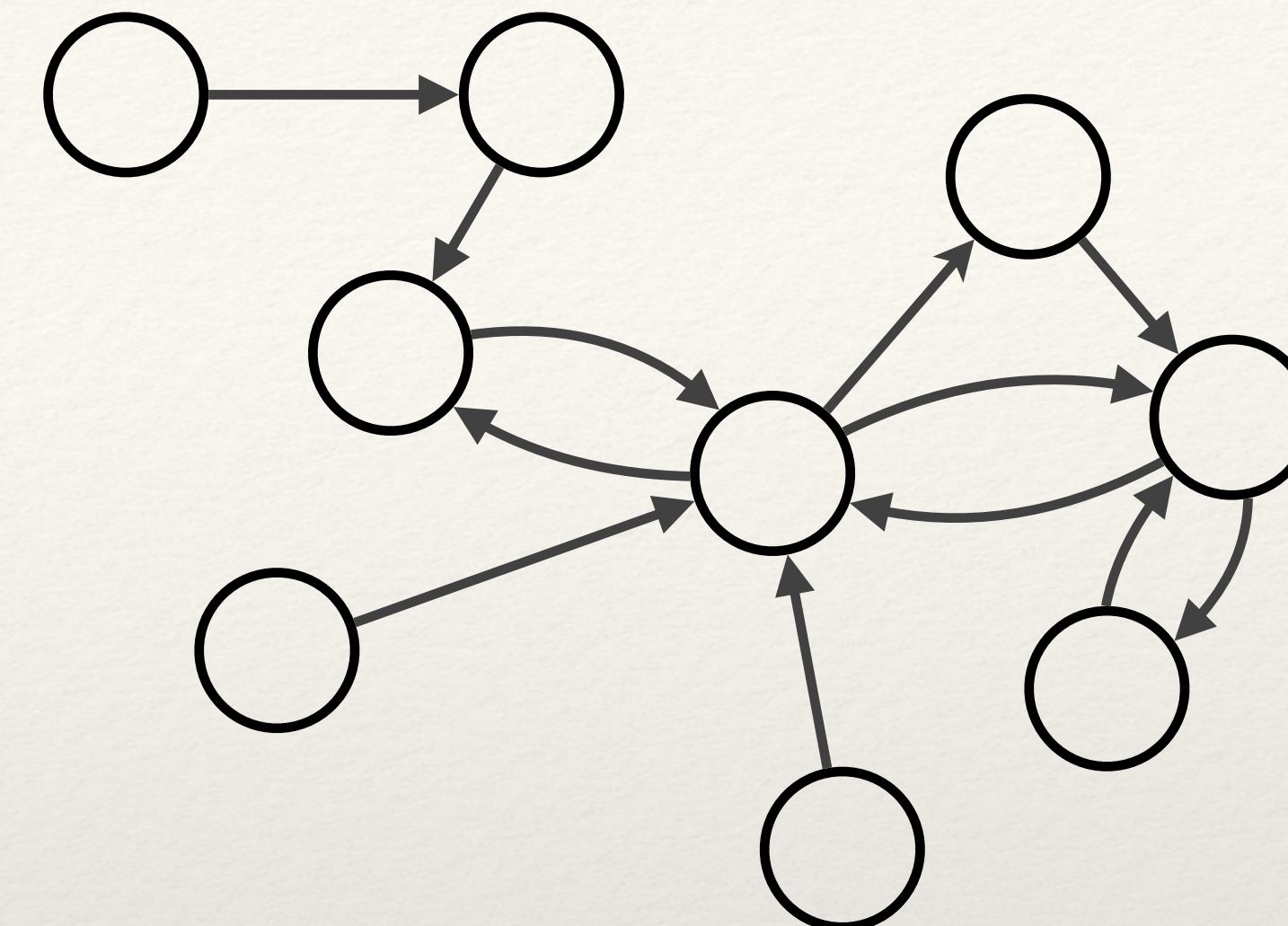


Con peso



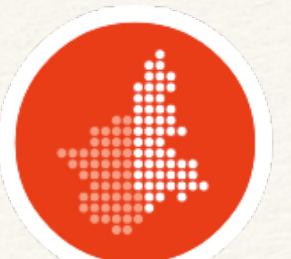
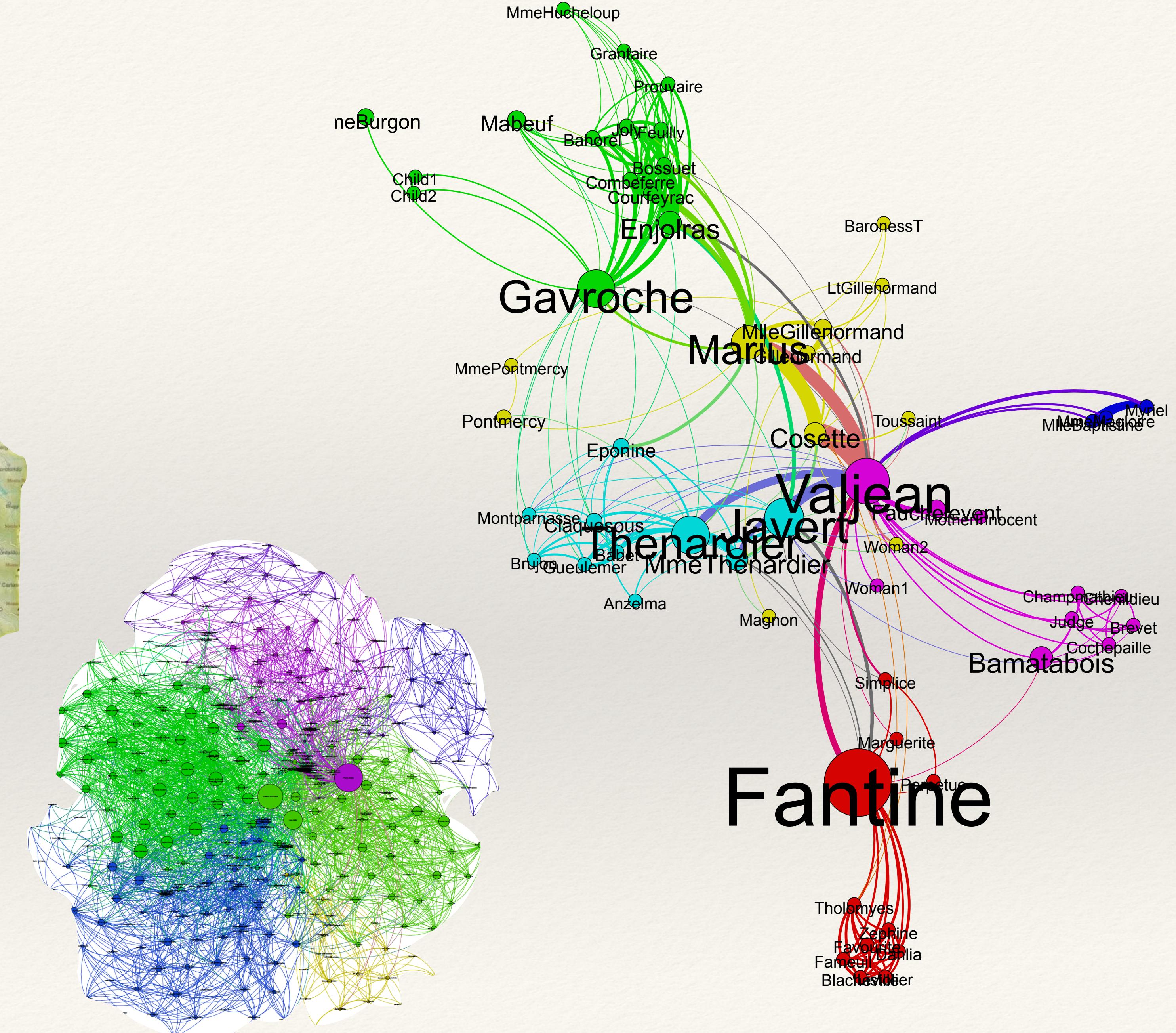
Non orientati

Orientati



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E l'informatica, cosa c'entra?



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L'informatica fornisce strutture dati...



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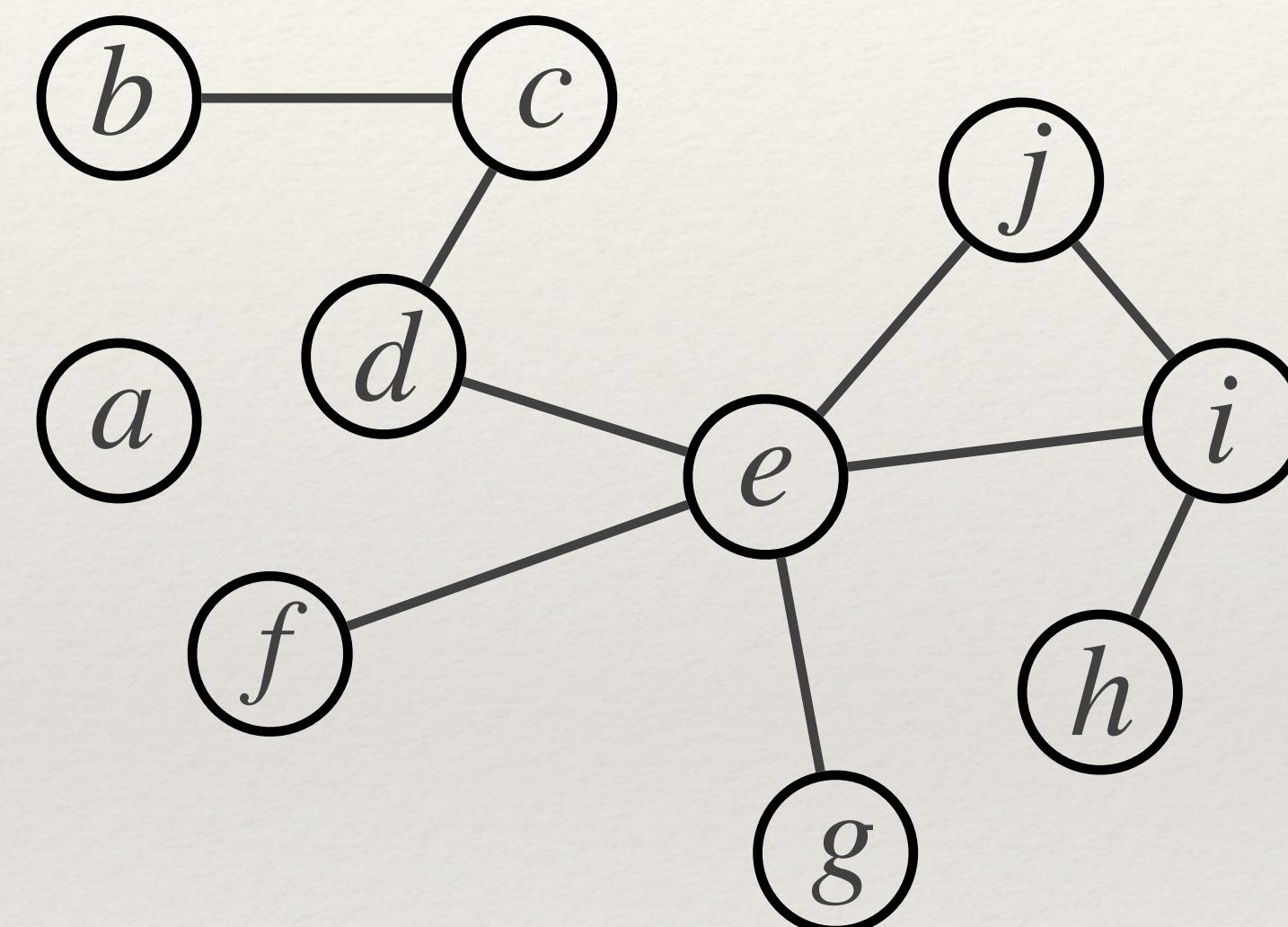
Matrice di adiacenza

Grafo non orientato

matrice $N \times N$

$$a_{ij} = \begin{cases} 0 & \text{nessun collegamento} \\ 1 & (i, j) \in L \end{cases}$$

matrice simmetrica: $a_{ij} = a_{ji}$



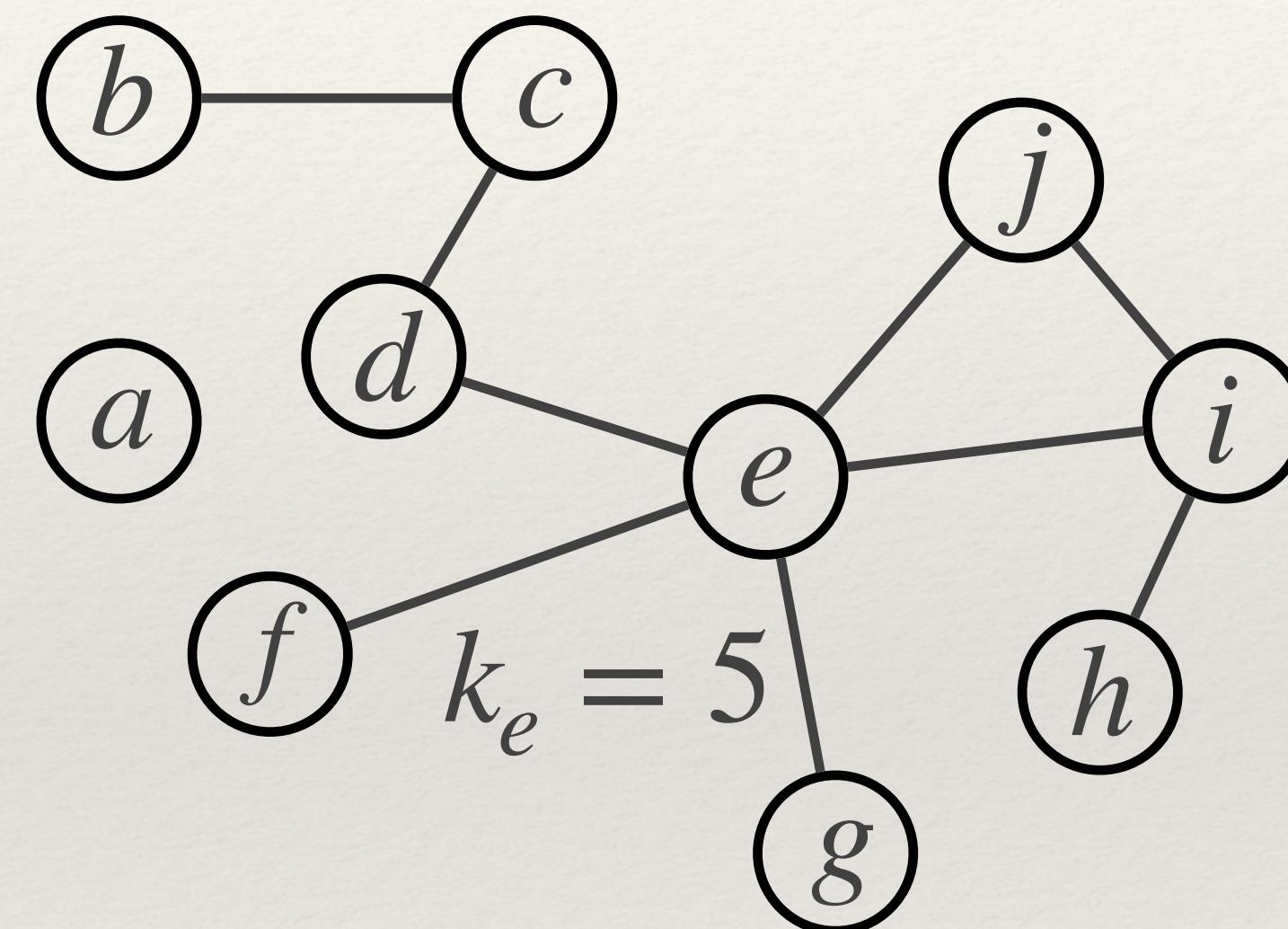
	a	b	c	d	e	f	g	h	i	j
a	0	0	0	0	0	0	0	0	0	0
b	0	0	1	0	0	0	0	0	0	0
c	0	1	0	1	0	0	0	0	0	0
d	0	0	1	0	1	0	0	0	0	0
e	0	0	0	1	0	1	1	0	1	1
f	0	0	0	0	1	0	0	0	0	0
g	0	0	0	0	1	0	0	0	0	0
h	0	0	0	0	0	0	0	0	1	0
i	0	0	0	0	1	0	0	1	0	1
j	0	0	0	0	1	0	0	0	1	0



Matrice di adiacenza

Calcolo del grado

$$k_i = \sum_j a_{ij} = \sum_j a_{ji}$$



	a	b	c	d	e	f	g	h	i	j
a	0	0	0	0	0	0	0	0	0	0
b	0	0	1	0	0	0	0	0	0	0
c	0	1	0	1	0	0	0	0	0	0
d	0	0	1	0	1	0	0	0	0	0
e	0	0	0	1	0	1	1	0	1	1
f	0	0	0	0	1	0	0	0	0	0
g	0	0	0	0	1	0	0	0	0	0
h	0	0	0	0	0	0	0	0	1	0
i	0	0	0	0	1	0	0	1	0	1
j	0	0	0	0	1	0	0	0	1	0

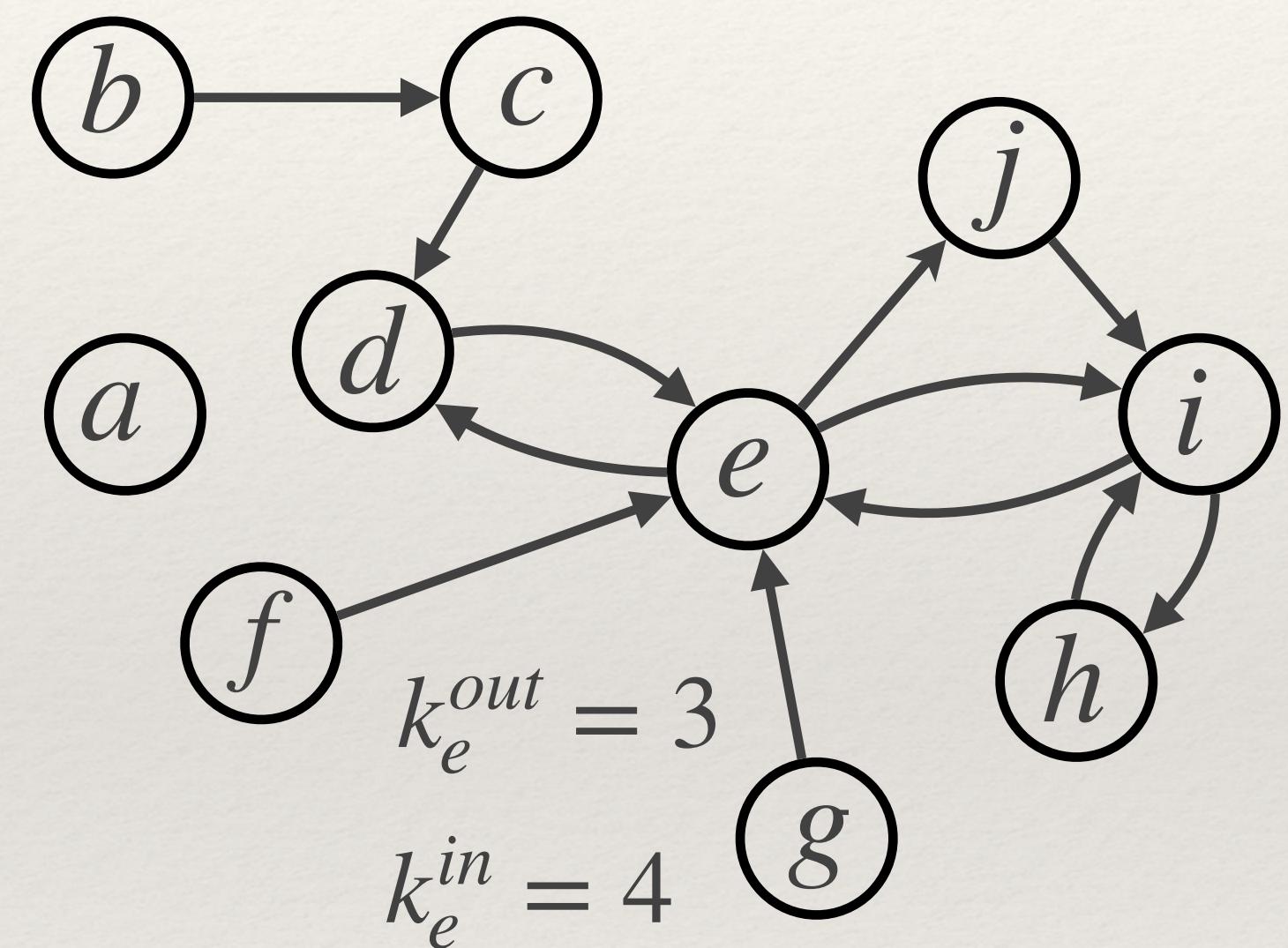


Matrice di adiacenza

Grafo orientato

$$k_i^{out} = \sum_j a_{ij}$$

$$k_i^{in} = \sum_j a_{ji}$$



	a	b	c	d	e	f	g	h	i	j
a	0	0	0	0	0	0	0	0	0	0
b	0	0	1	0	0	0	0	0	0	0
c	0	0	0	1	0	0	0	0	0	0
d	0	0	0	0	1	0	0	0	0	0
e	0	0	0	1	0	0	0	0	1	1
f	0	0	0	0	1	0	0	0	0	0
g	0	0	0	0	1	0	0	0	0	0
h	0	0	0	0	0	0	0	0	1	0
i	0	0	0	0	1	0	0	1	0	0
j	0	0	0	0	0	0	0	0	1	0

La matrice non è simmetrica: $a_{ij} \neq a_{ji}$

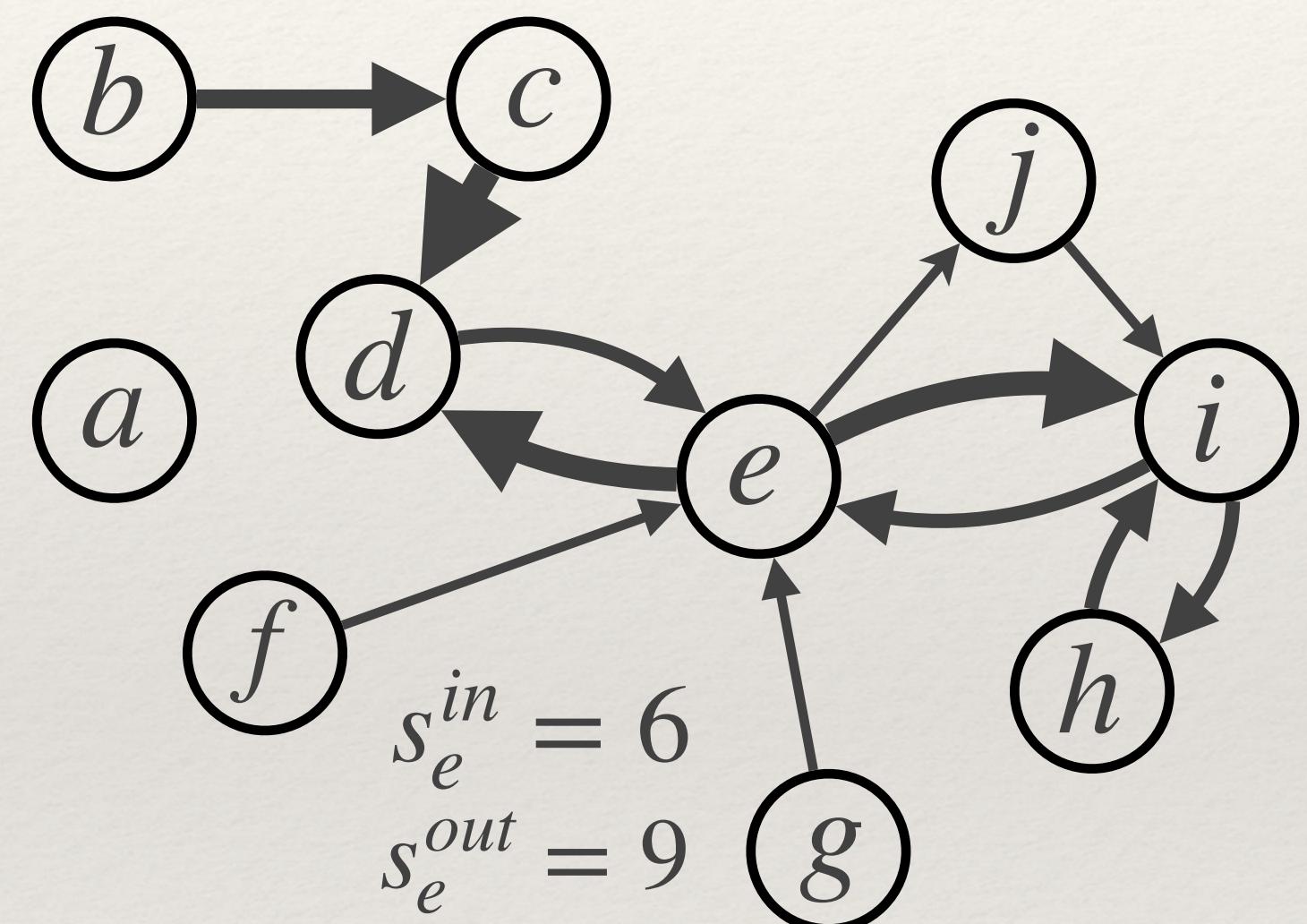
Matrice di adiacenza

Grafi con pesi

$$w_{ij}$$

$$s_i^{out} = \sum_j w_{ij}$$

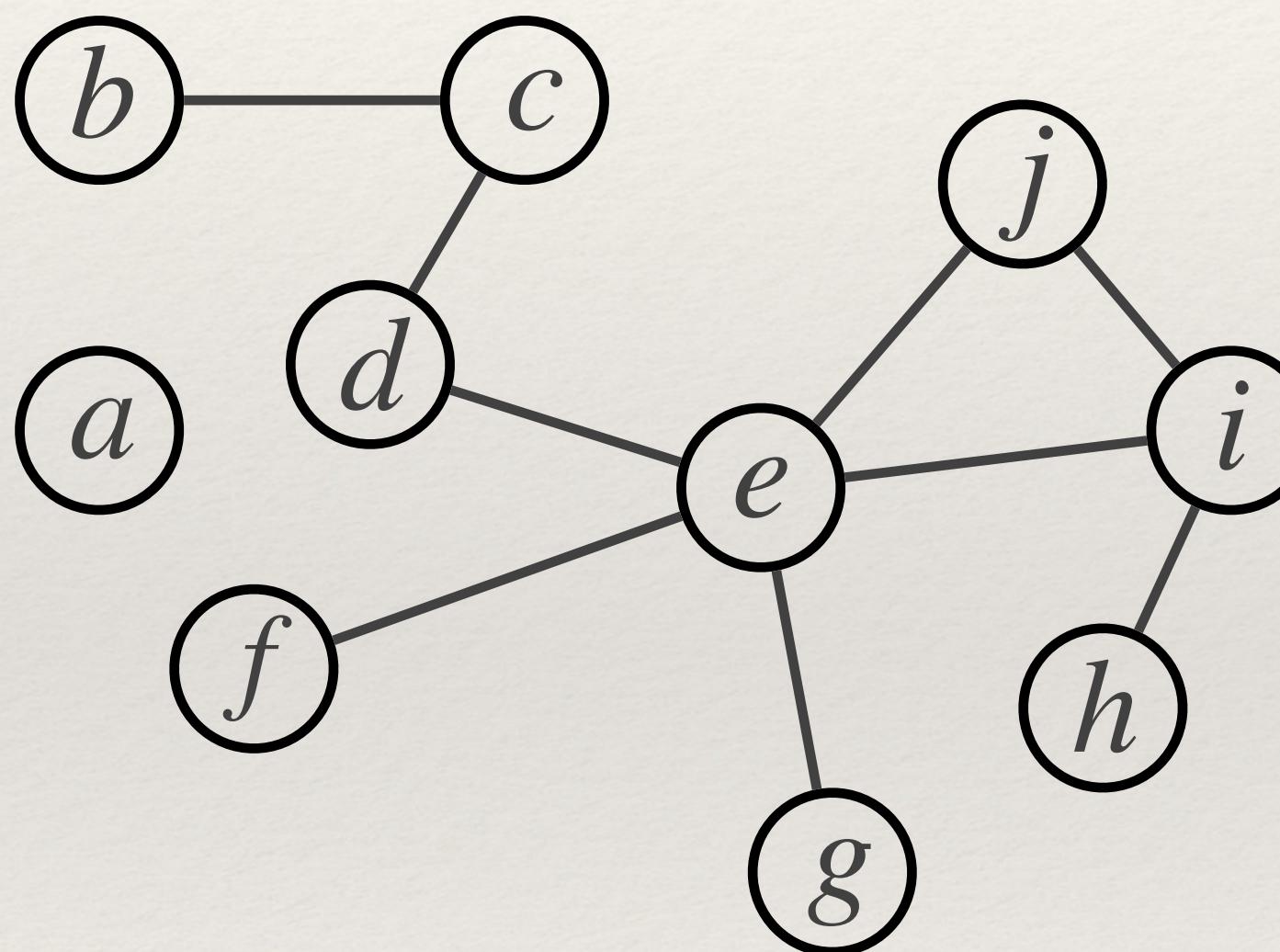
$$s_i^{in} = \sum_j w_{ji}$$



	a	b	c	d	e	f	g	h	i	j
a	0	0	0	0	0	0	0	0	0	0
b	0	0	3	0	0	0	0	0	0	0
c	0	0	0	4	0	0	0	0	0	0
d	0	0	0	0	2	0	0	0	0	0
e	0	0	0	4	0	0	0	0	4	1
f	0	0	0	0	1	0	0	0	0	0
g	0	0	0	0	1	0	0	0	0	0
h	0	0	0	0	0	0	0	0	2	0
i	0	0	0	0	2	0	0	2	0	0
j	0	0	0	0	0	0	0	0	2	0



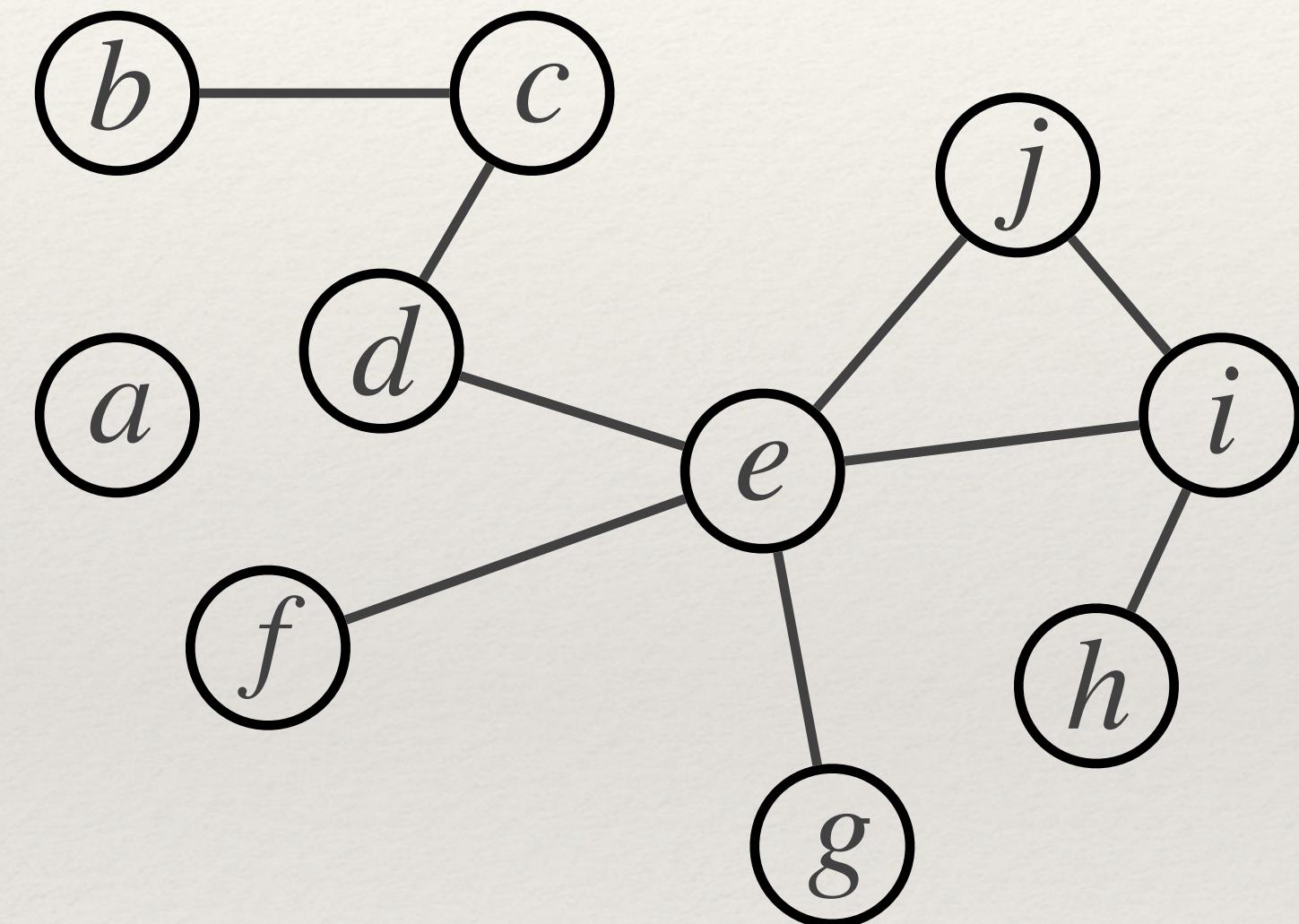
Liste di adiacenza



a	b	c	d
b	c	d	e
c	d	e	f
d	e	f	i
e	f	g	j
f	g	h	g
g	h	i	
h	i	j	
i	j		
j			



Liste di collegamenti (edge list)



b	c
c	d
d	e
e	f
e	g
e	h
e	i
j	i

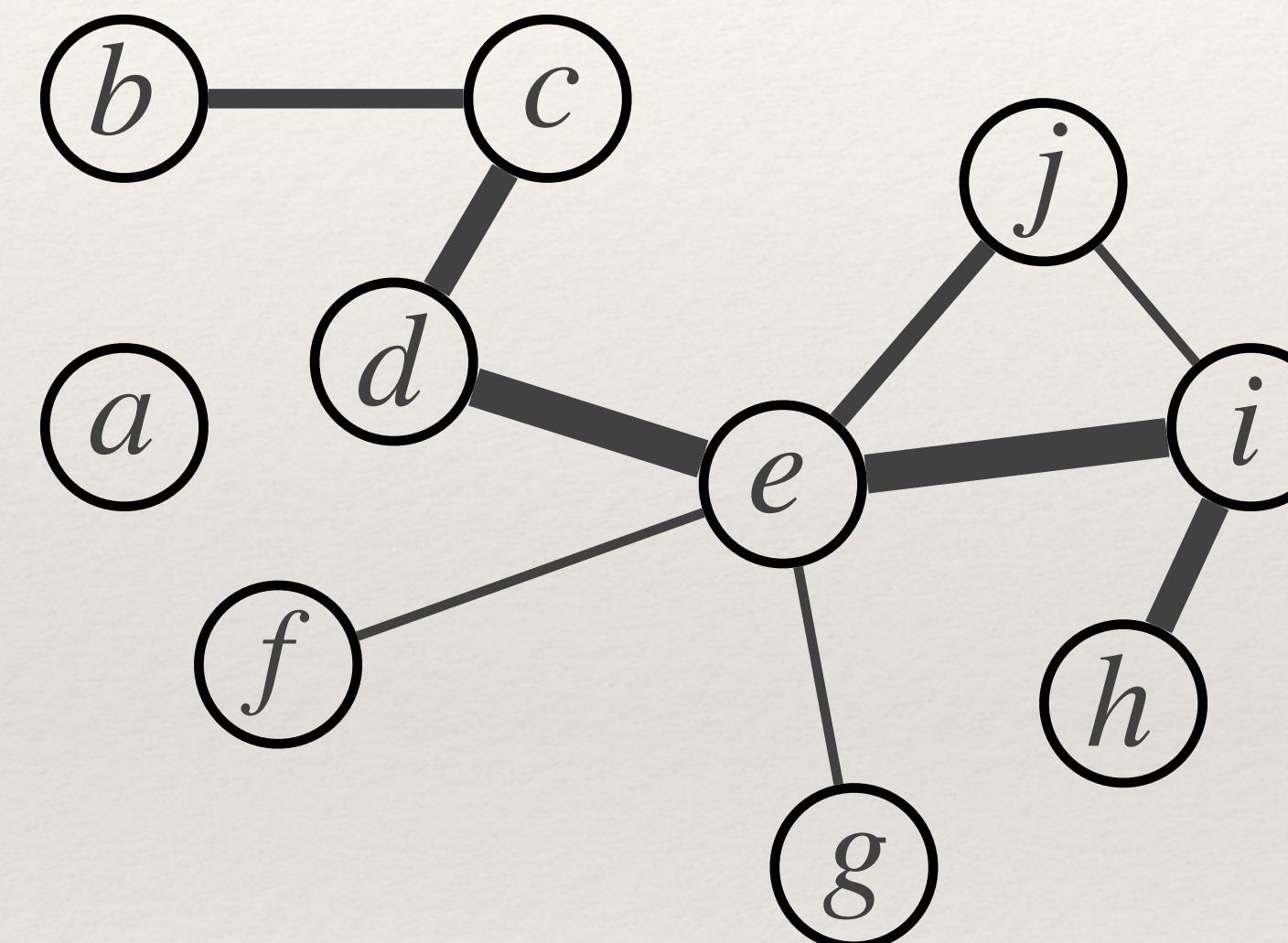
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Liste di collegamenti con pesi



b	c	2
c	d	3
d	e	4
e	f	4
e	g	1
e	i	1
e	j	2
h	i	3
i	j	1

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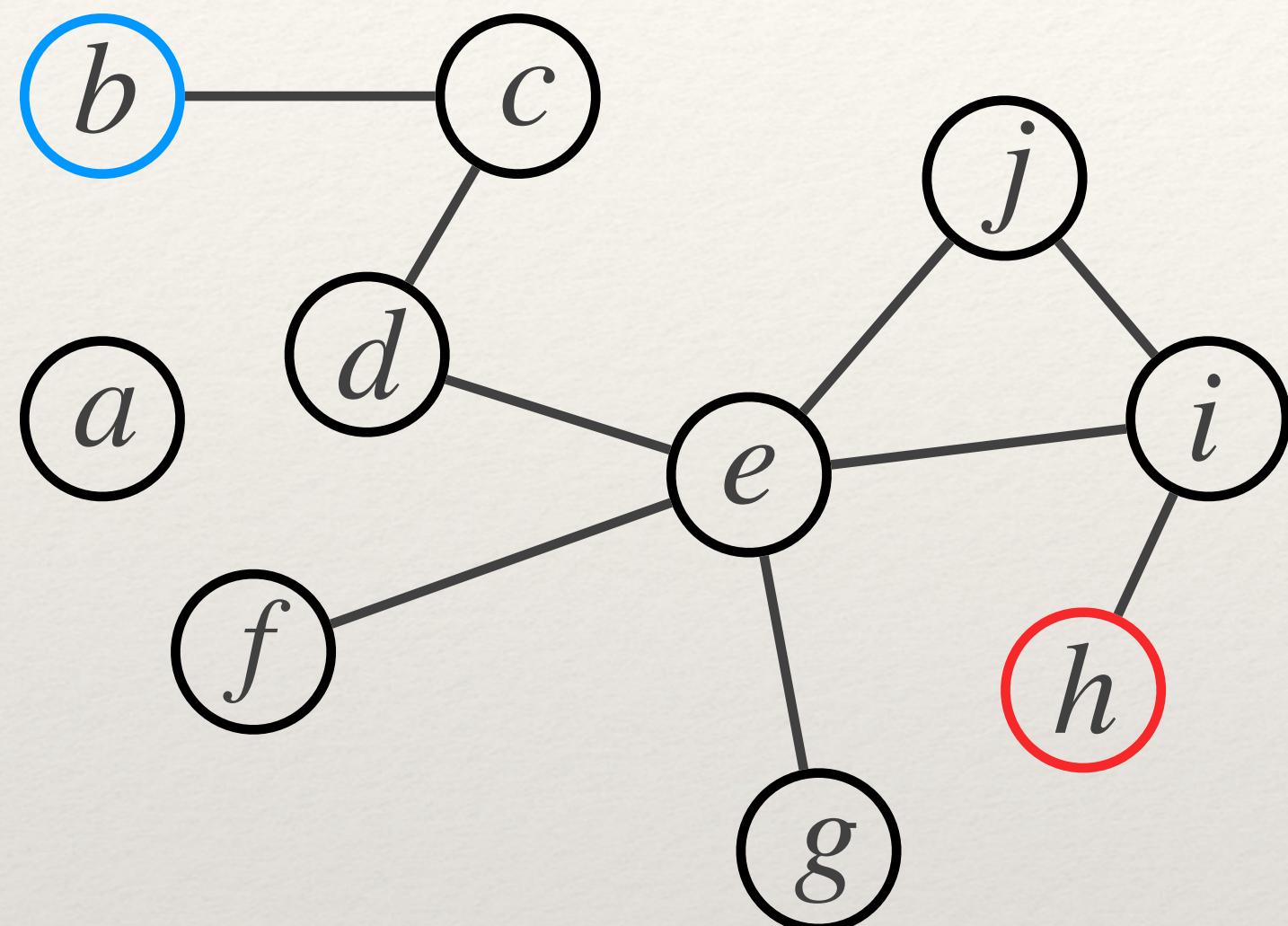
... e algoritmi



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Trovare i cammini (ed i cammini minimi)



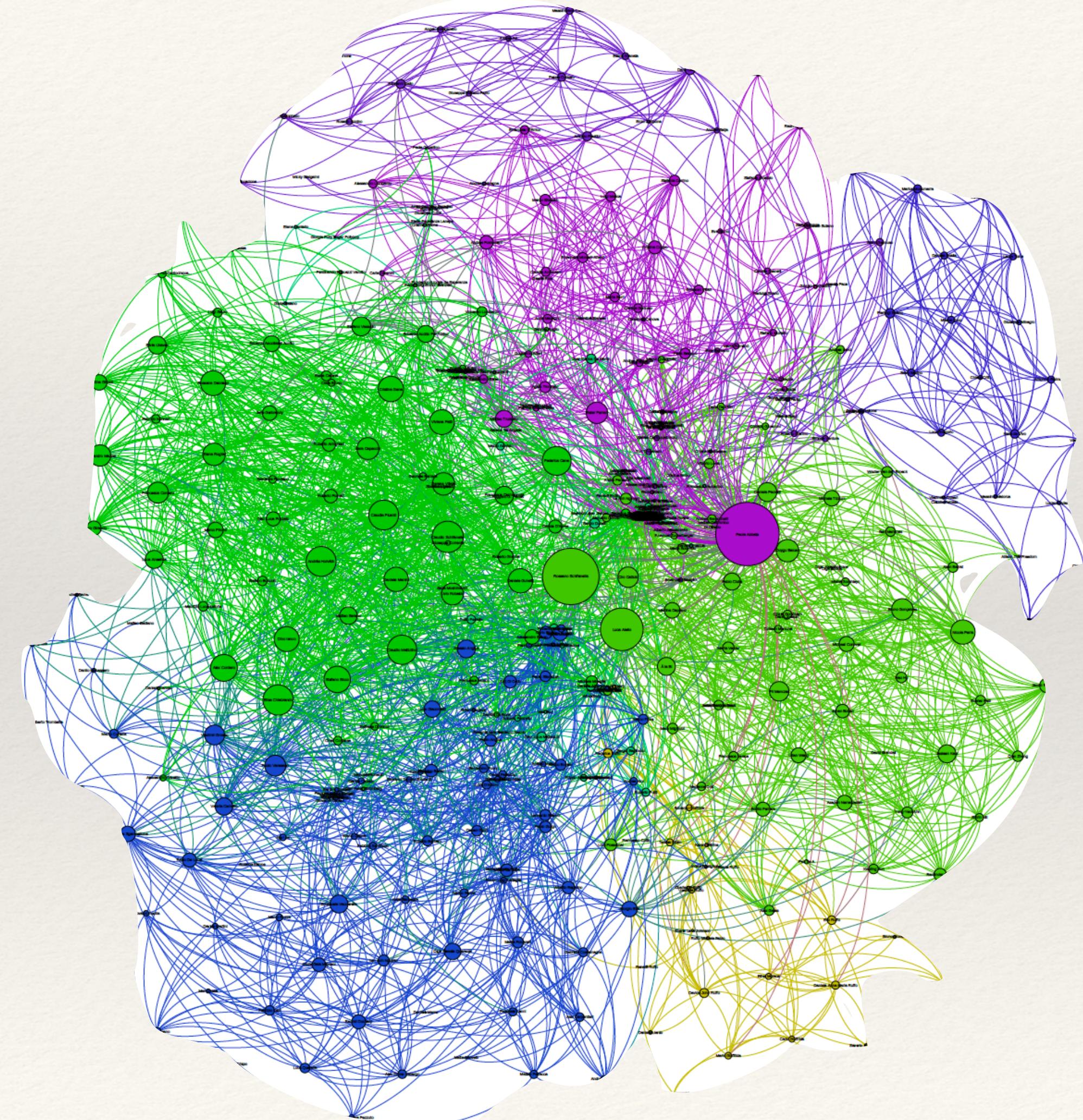
$\{b, c, d, e, i, h\}$: cammino da b a h

$\{b, c, d, e, j, i, h\}$: un altro cammino da b a h

cammino minimo determina la **distanza** tra due nodi



Visualizzare grafi di grandi dimensioni



Un esempio

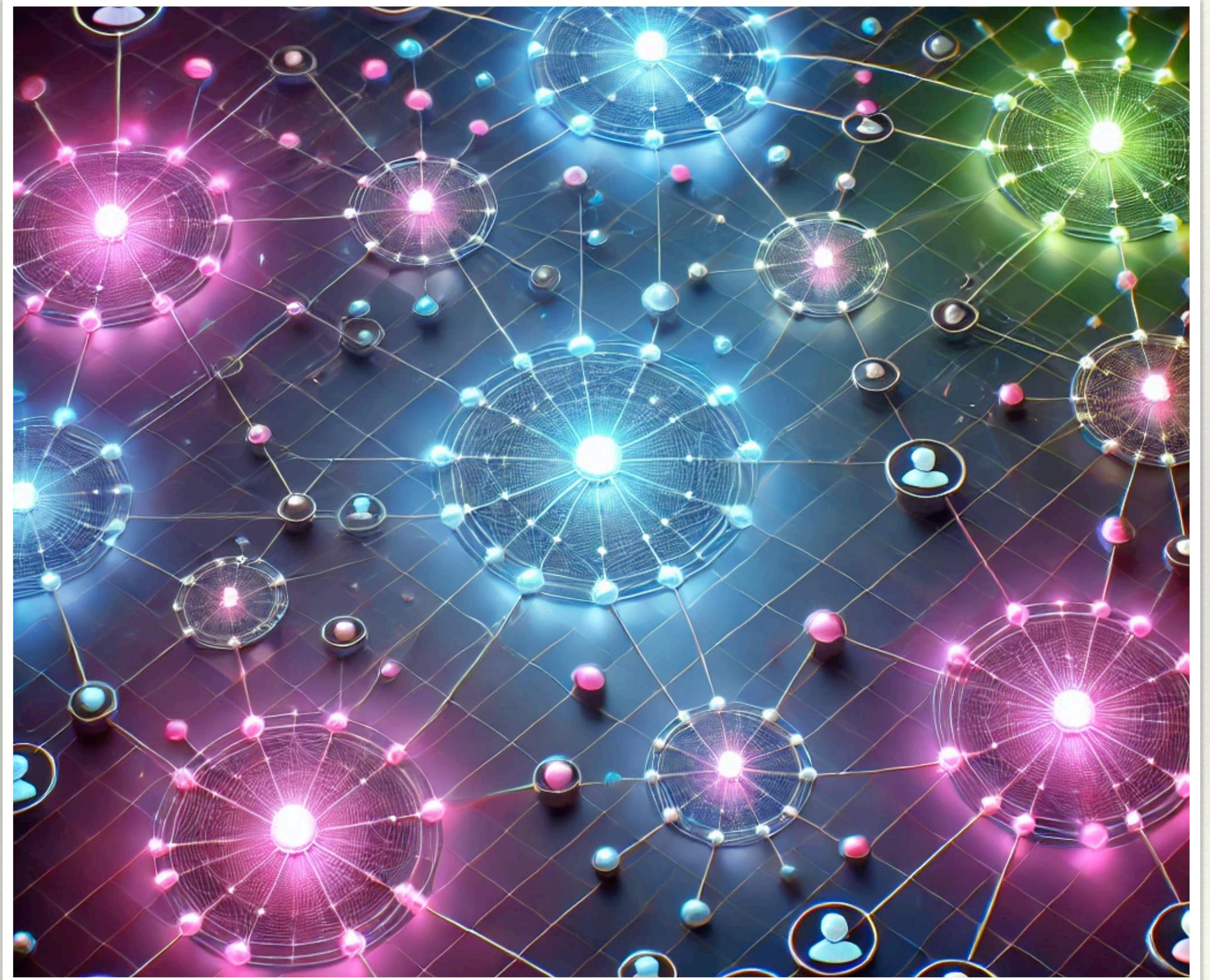


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I sei gradi di separazione

- ❖ Viviamo in mondi piccoli
- ❖ Qual è la distanza tra noi ed una qualsiasi altra persona del pianeta?



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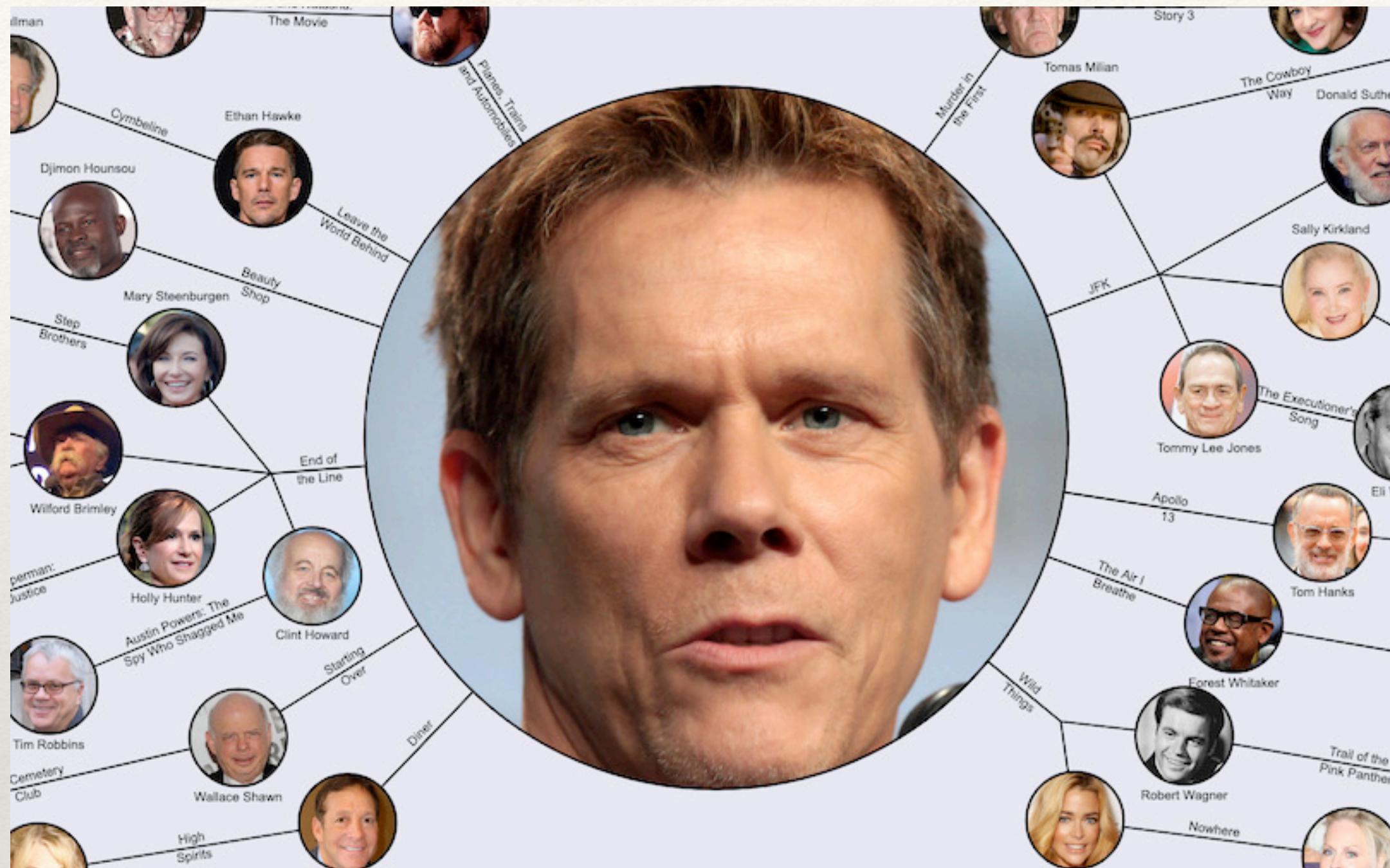
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Abbiamo bisogno di dati, di strutture dati, di algoritmi (efficienti)



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<https://oracleofbacon.org/>

Qual è la distanza tra Totò e... Zendaya?



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Totò has a Zendaya number of 3.

[Find a different link](#)

Totò

was in

Toto, Fabrizi and the Young People Today

with

Angela Luce

was in

Package, Double Package and Counterpackage

with

Bruno Bilotta

was in

Spider-Man: Far From Home

with

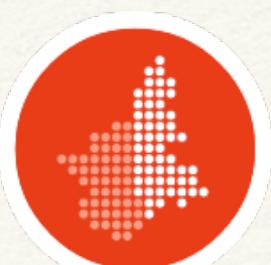
Zendaya

Zendaya

to Totò

[Find link](#)

[More options >>](#)



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Cosa abbiamo bisogno di capire?

- ❖ Come si diffondono le epidemie (trovare strategie di vaccinazione efficiente)
- ❖ Se esistono soluzioni alla congestione stradale che non peggiorino la congestione stessa
- ❖ Se possiamo limitare la diffusione delle fake news senza limitare la libertà di espressione
- ❖ Come rendere meno fragili i mercati globali
- ❖ ...



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L'informatica può interagire con tanti altri saperi alla ricerca di soluzioni trasversali



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