



Prof. Giancarlo Ruffo giancarlo.ruffo@uniupo.it

Reti, folle, mercati ed epidemie

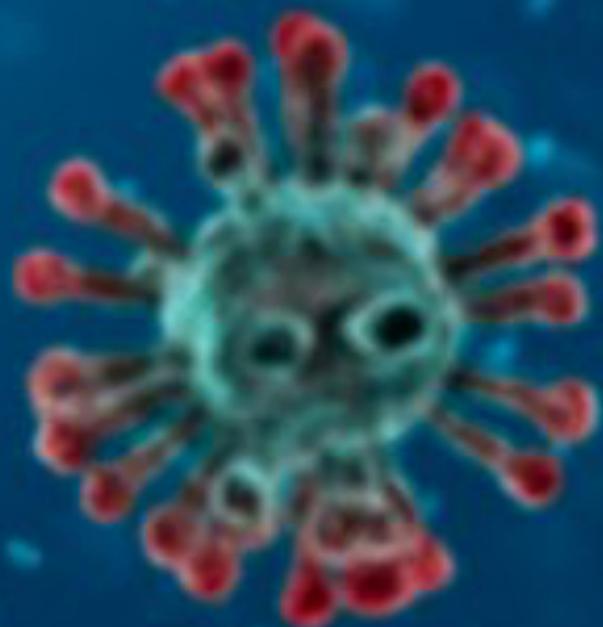
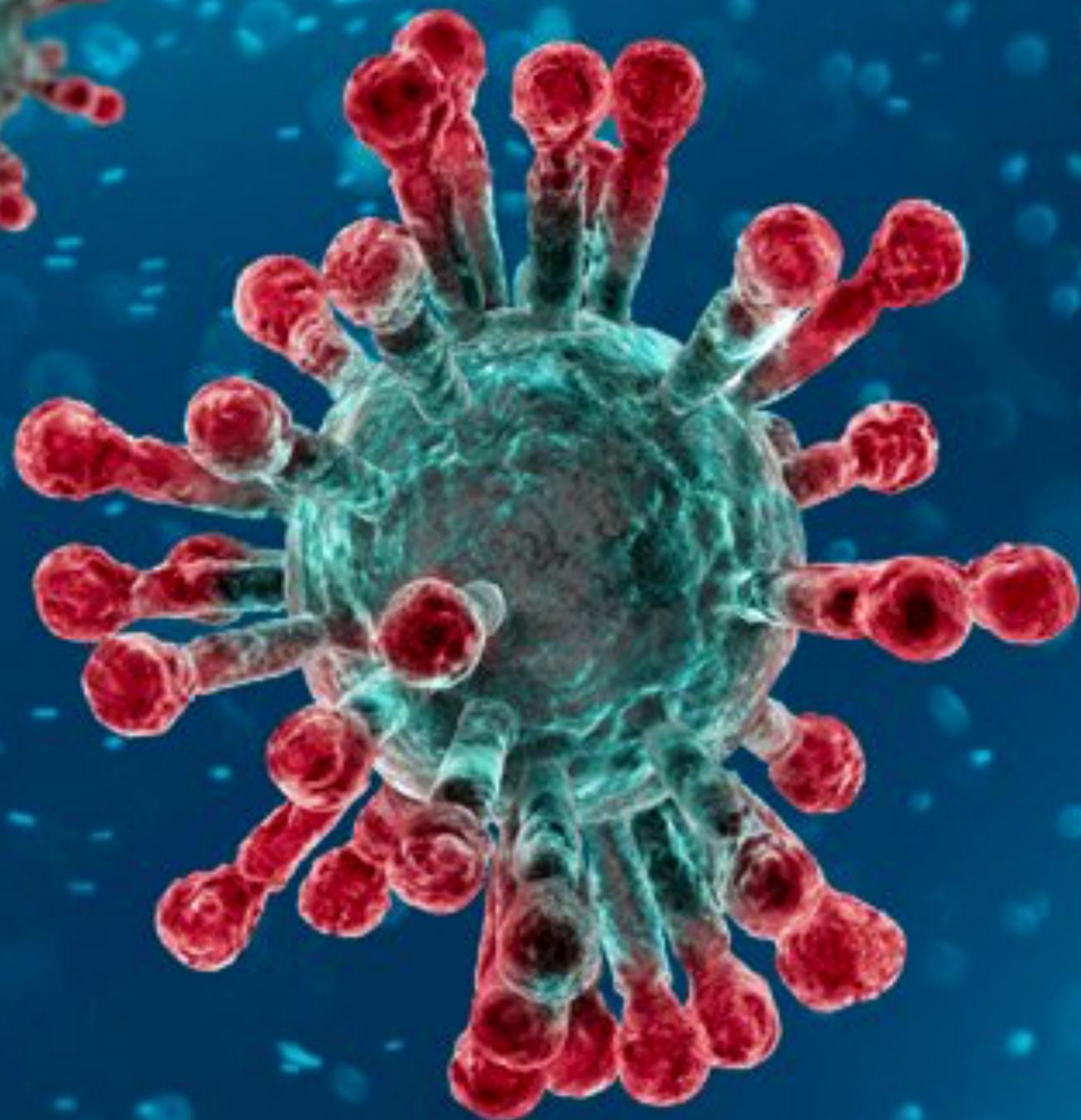
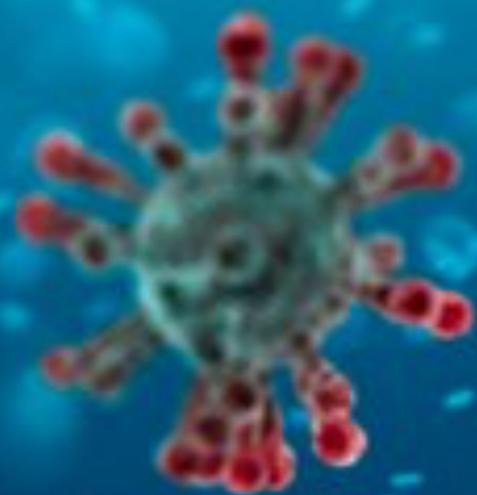
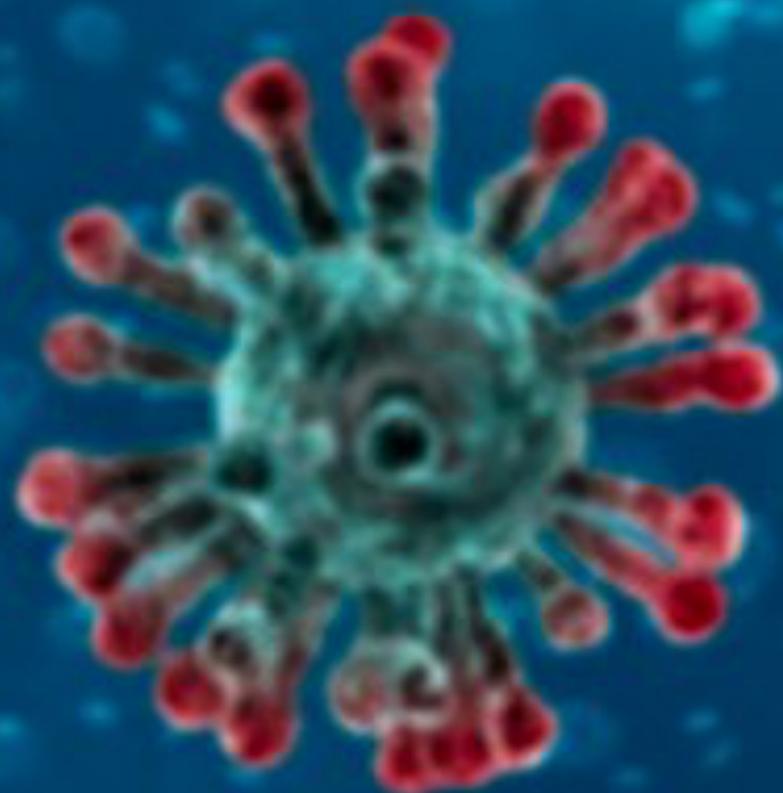
L'uso sociale dell'informatica

27 gennaio 2025,
Aula Magna DISIT Alessandria

Cosa hanno in comune...?















FAKE

BOERS

FAKE

FAKE NEWS

BOCCARDI

RAKE

RAKE



Sistemi complessi







Un esempio: conformismo sociale





Exhibit 1



A



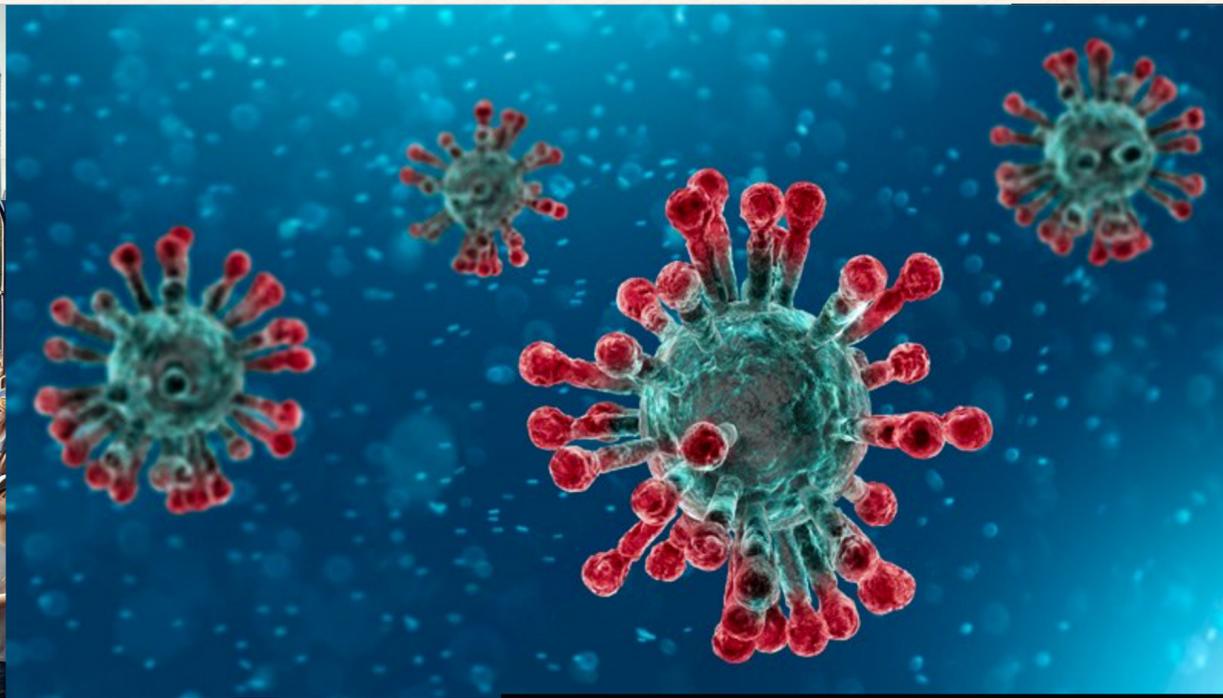
B



C

Exhibit 2

Altri esempi



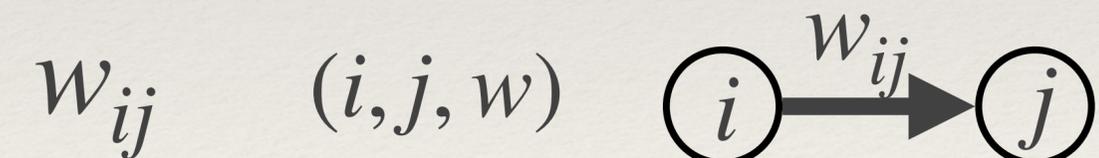
Le reti sono ovunque (come la matematica...)

- Un grafo è fatto di nodi e collegamenti
- Nodi (o vertici)
- Collegamenti (o archi)
- I grafi possono essere orientati o non orientati
- I grafi possono essere con peso o senza peso

$$G = (N, L)$$

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

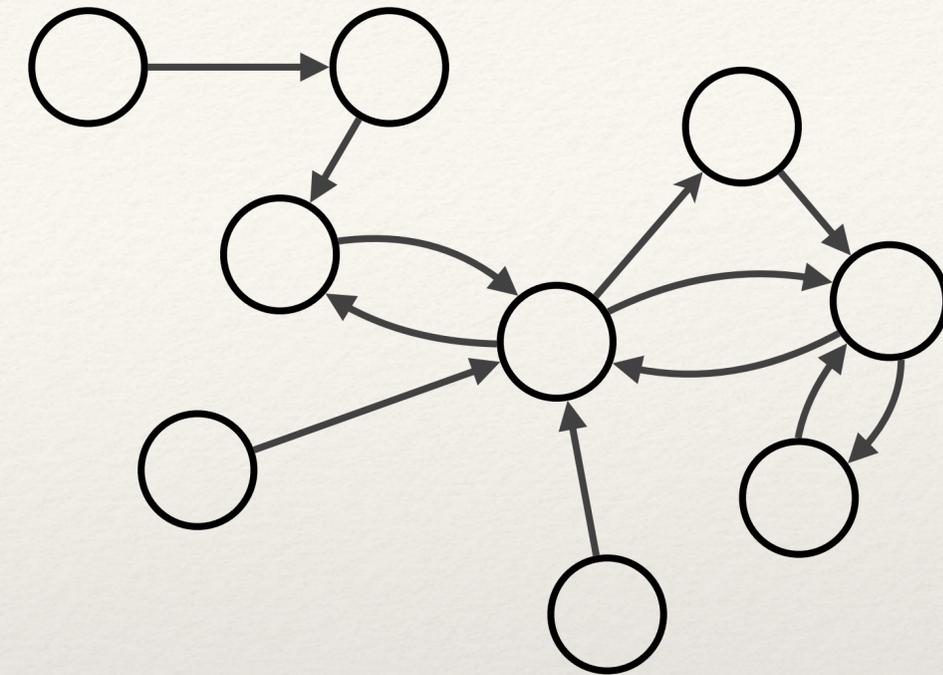
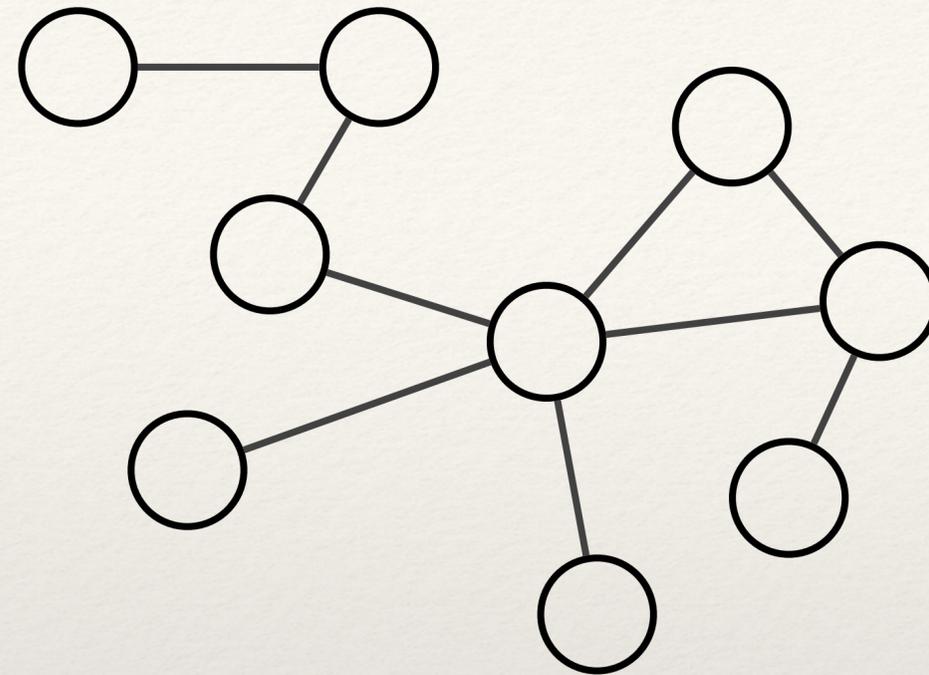
$$L = \{(i, j) : i, j \in N\}$$



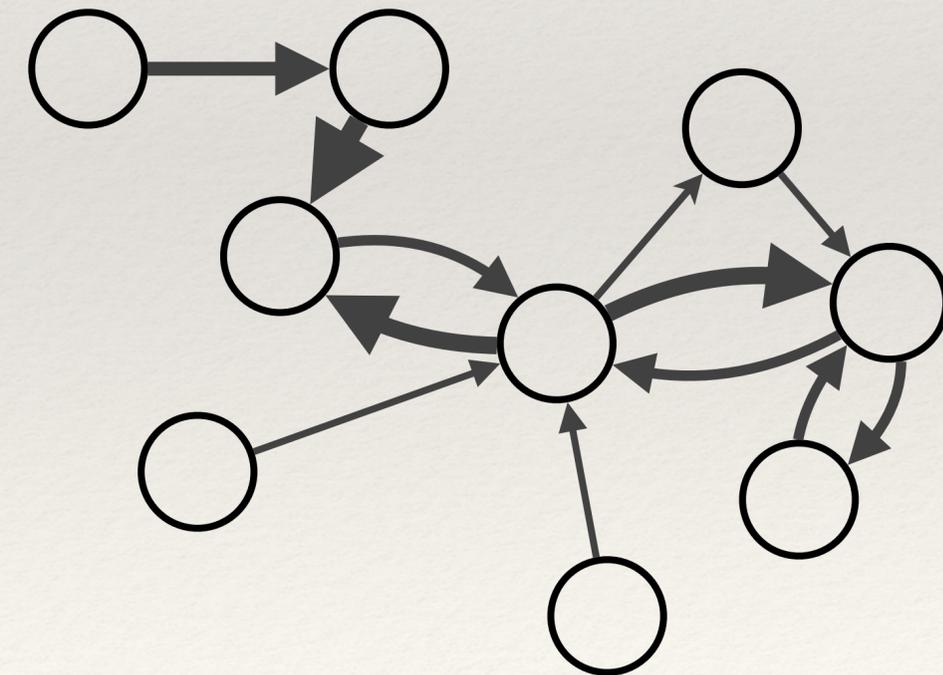
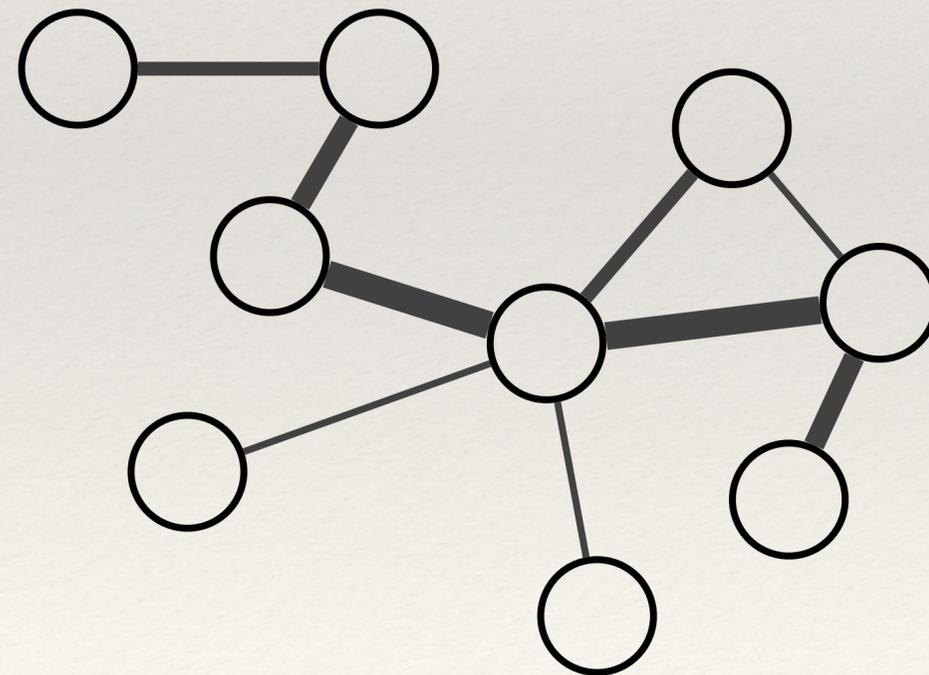
Non orientati

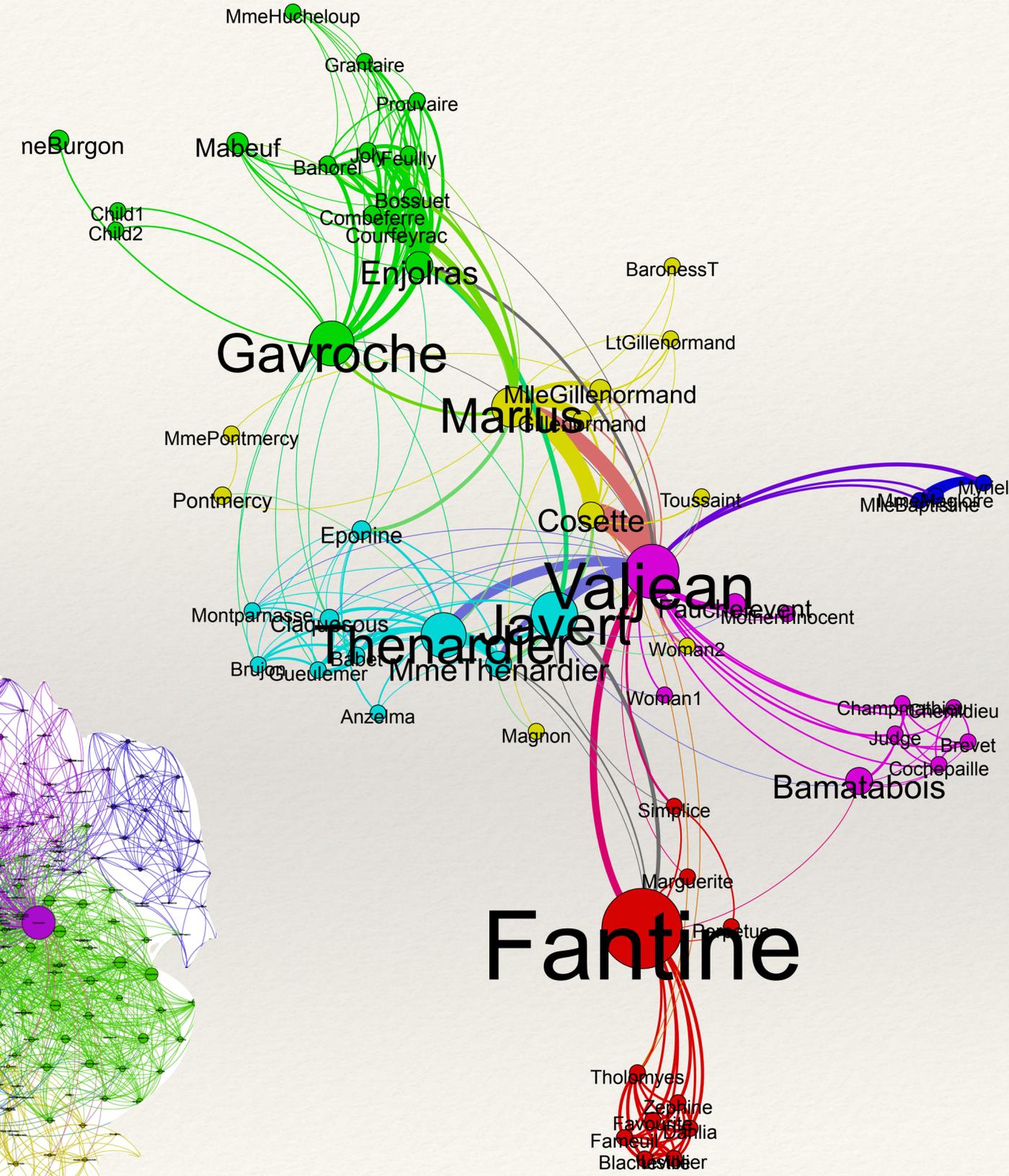
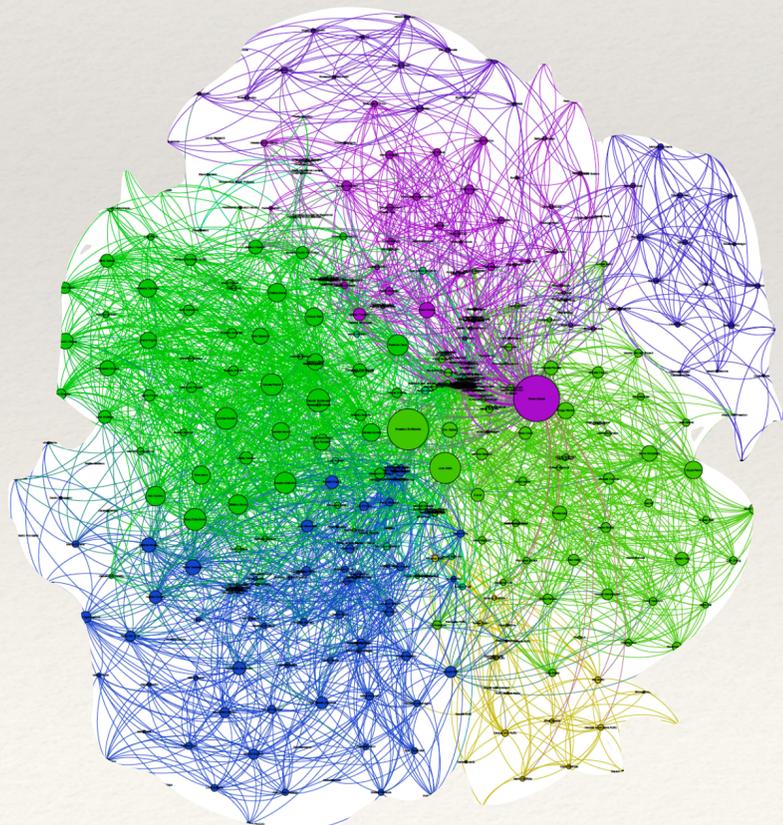
Orientati

Senza peso



Con peso





E l'informatica, cosa c'entra?



L'informatica fornisce strutture dati...



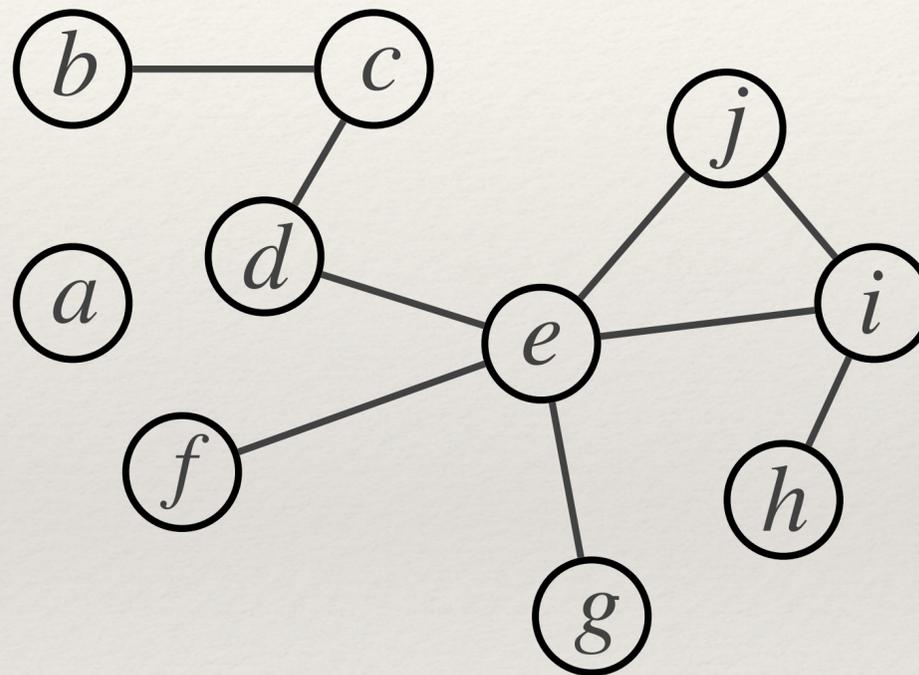
Matrice di adiacenza

Grafo non orientato

matrice $N \times N$

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

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



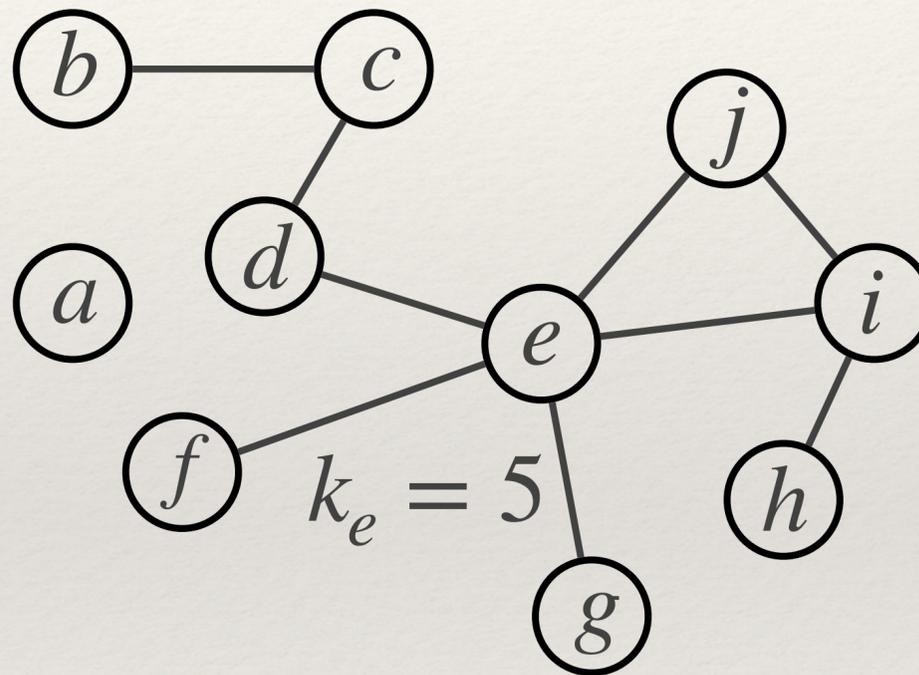
	a	b	c	d	e	f	g	h	i	j
a	0	0	0	0	0	0	0	0	0	0
b	0	0	1	0	0	0	0	0	0	0
c	0	1	0	1	0	0	0	0	0	0
d	0	0	1	0	1	0	0	0	0	0
e	0	0	0	1	0	1	1	0	1	1
f	0	0	0	0	1	0	0	0	0	0
g	0	0	0	0	1	0	0	0	0	0
h	0	0	0	0	0	0	0	0	1	0
i	0	0	0	0	1	0	0	1	0	1
j	0	0	0	0	1	0	0	0	1	0



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

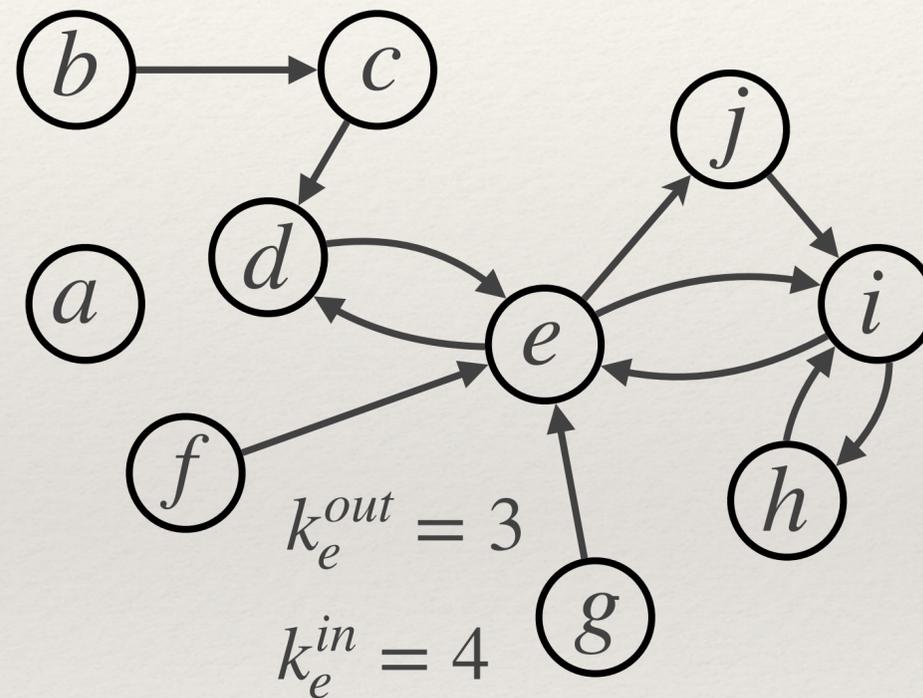


Matrici di adiacenza

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: $a_{ij} \neq a_{ji}$



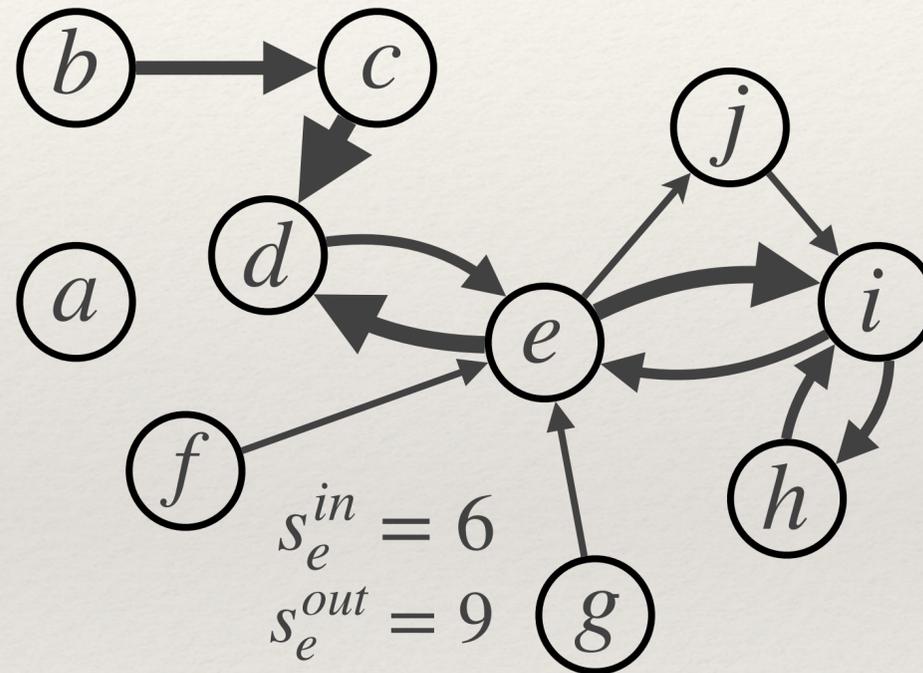
Matrici di adiacenza

Grafi con pesi

$$w_{ij}$$

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

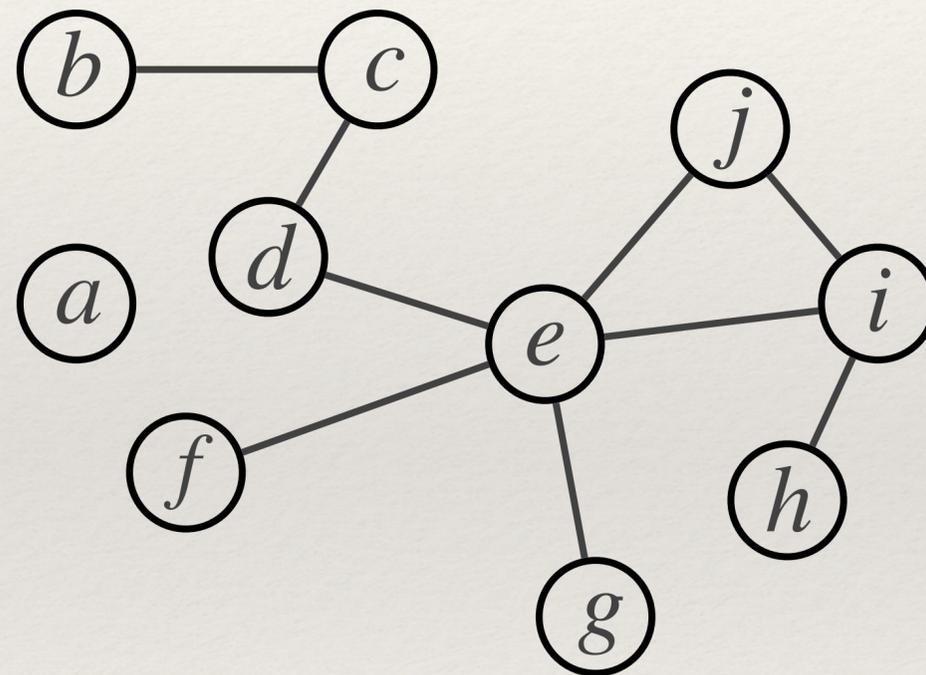
$$s_i^{in} = \sum_j w_{ji}$$



	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



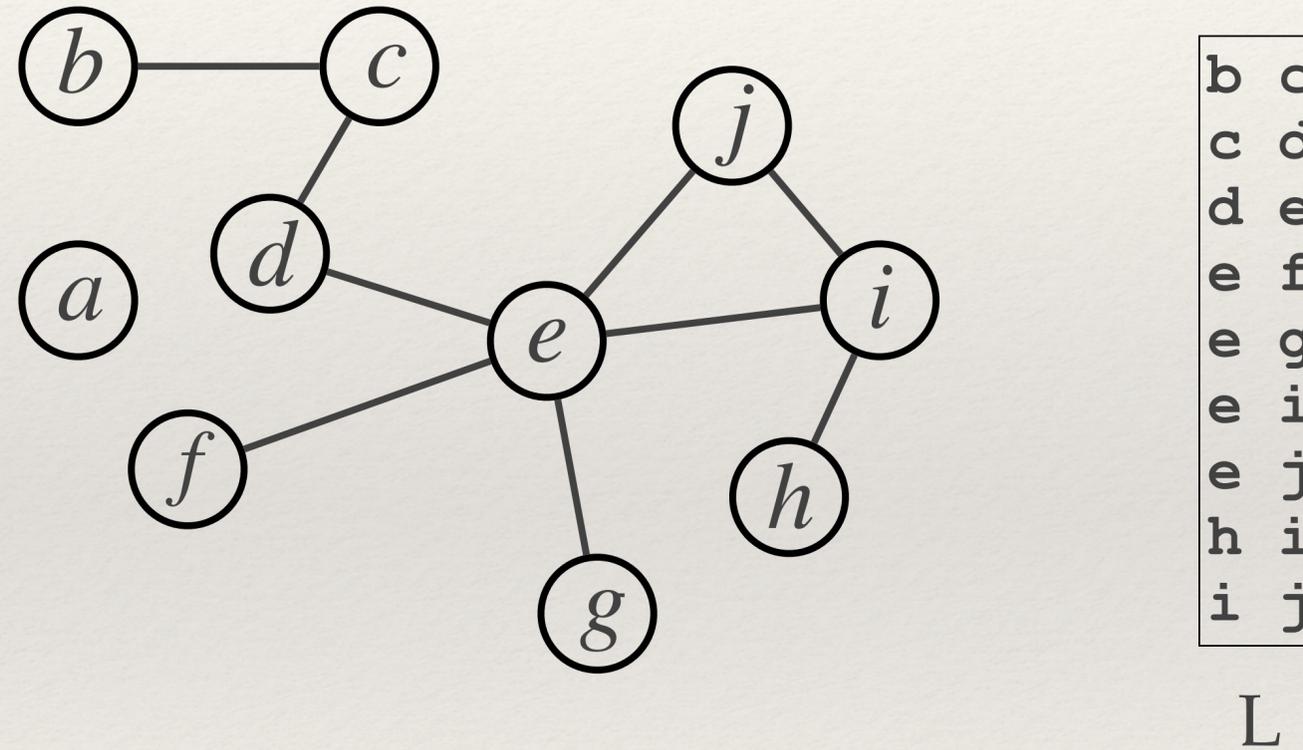
Liste di adiacenza



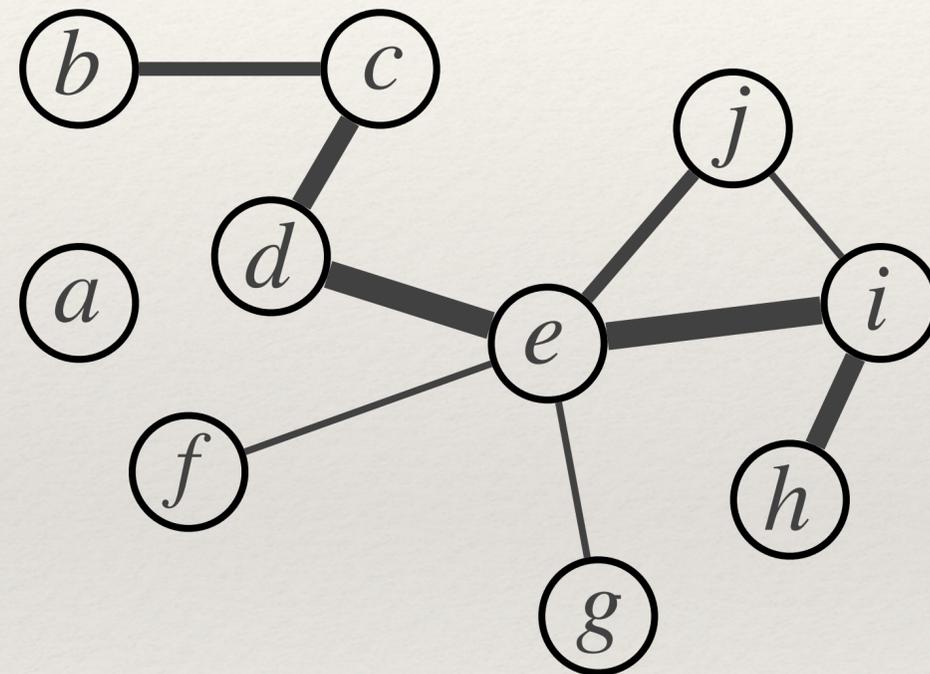
a									
b		c							
c		b	d						
d		c	e						
e		d	f	i	j	g			
f		e							
g		e							
h		i							
i		h	j						
j		e	i						



Liste di collegamenti (edge list)



Liste di collegamenti con pesi



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

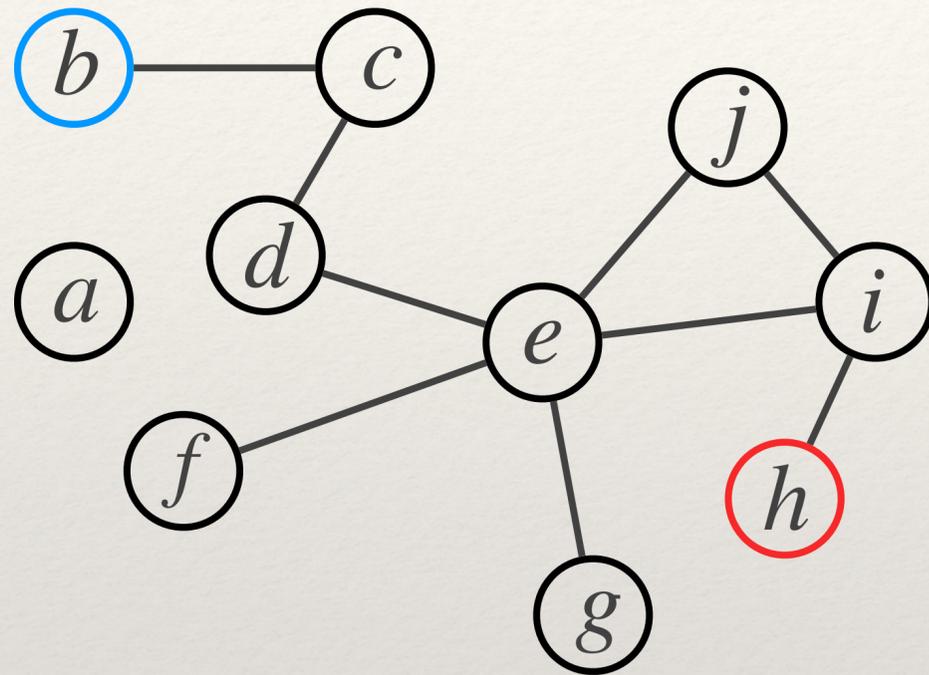
L



... e algoritmi



Trovare i cammini (ed i cammini minimi)



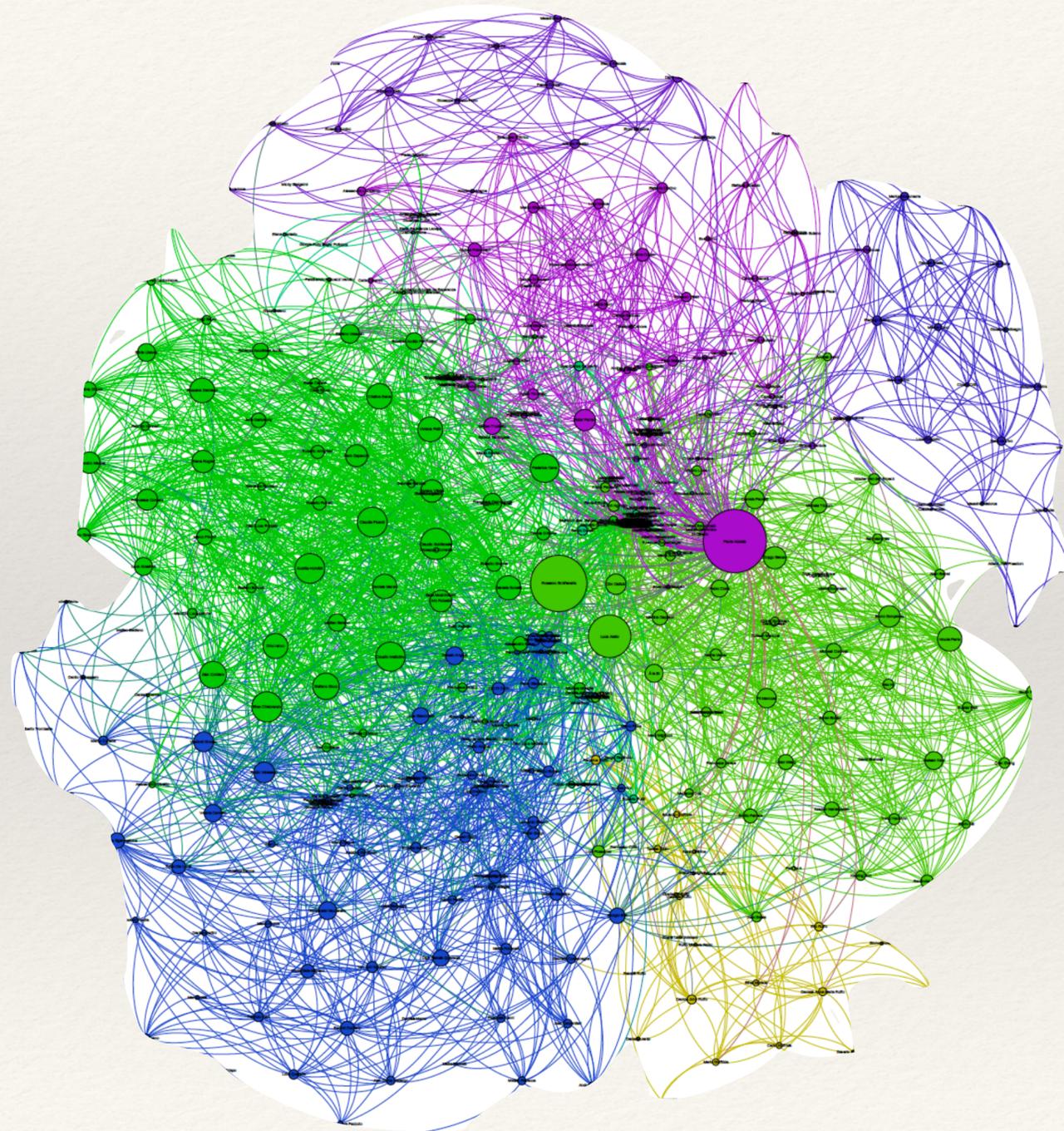
$\{b, c, d, e, i, h\}$: cammino da b a h

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

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



Visualizzare grafi di grandi dimensioni

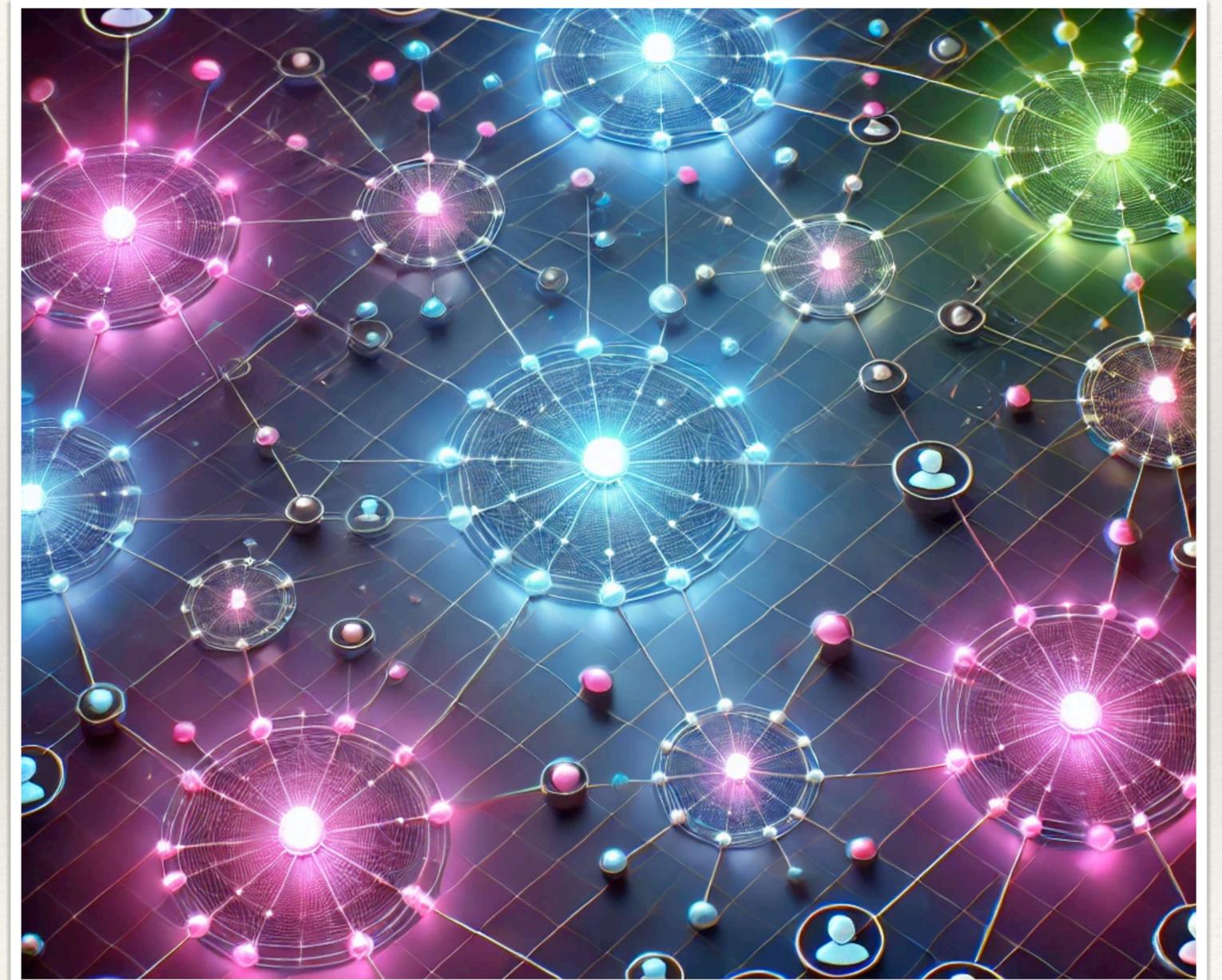


Un esempio



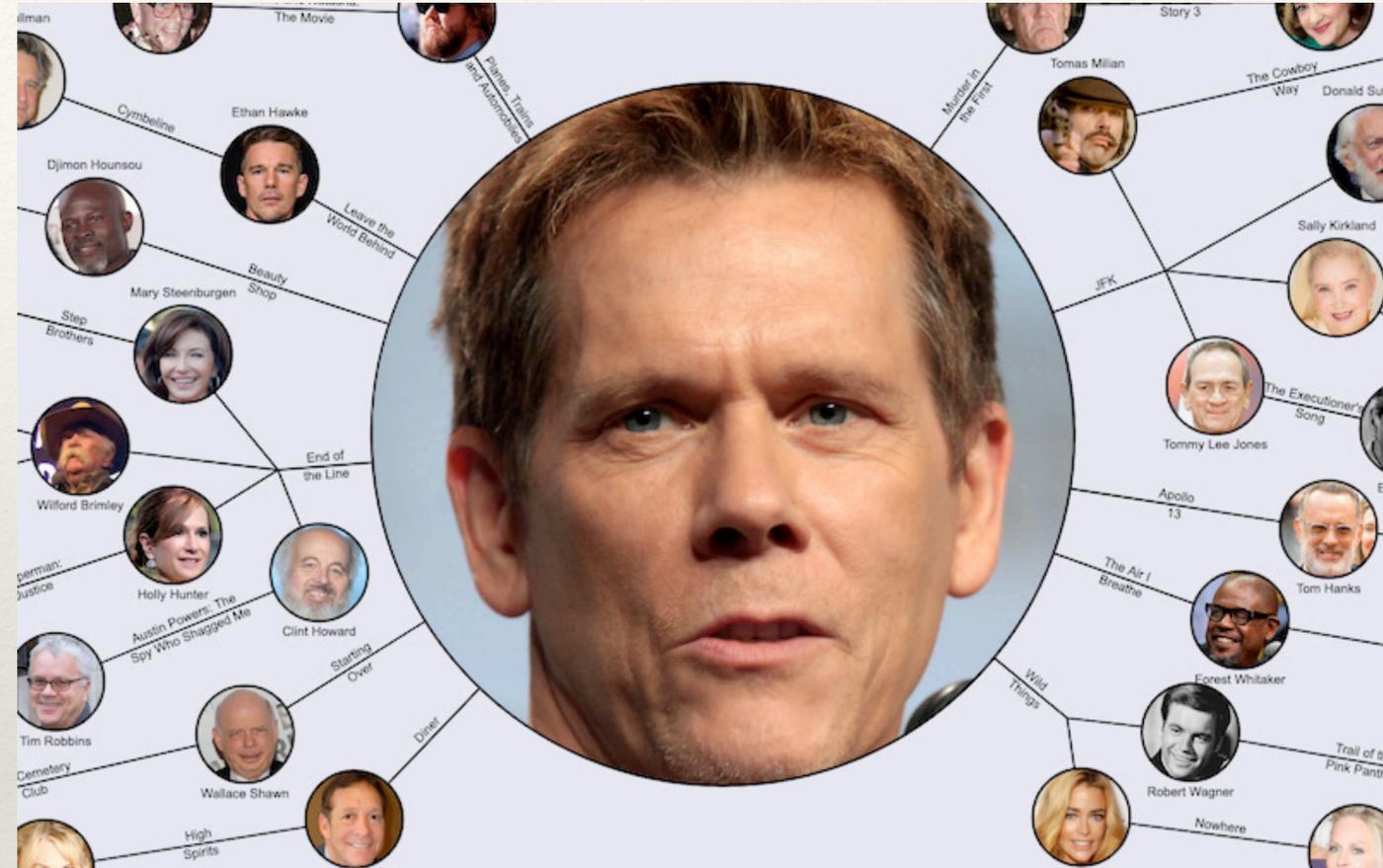
I sei gradi di separazione

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



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





<https://oracleofbacon.org/>

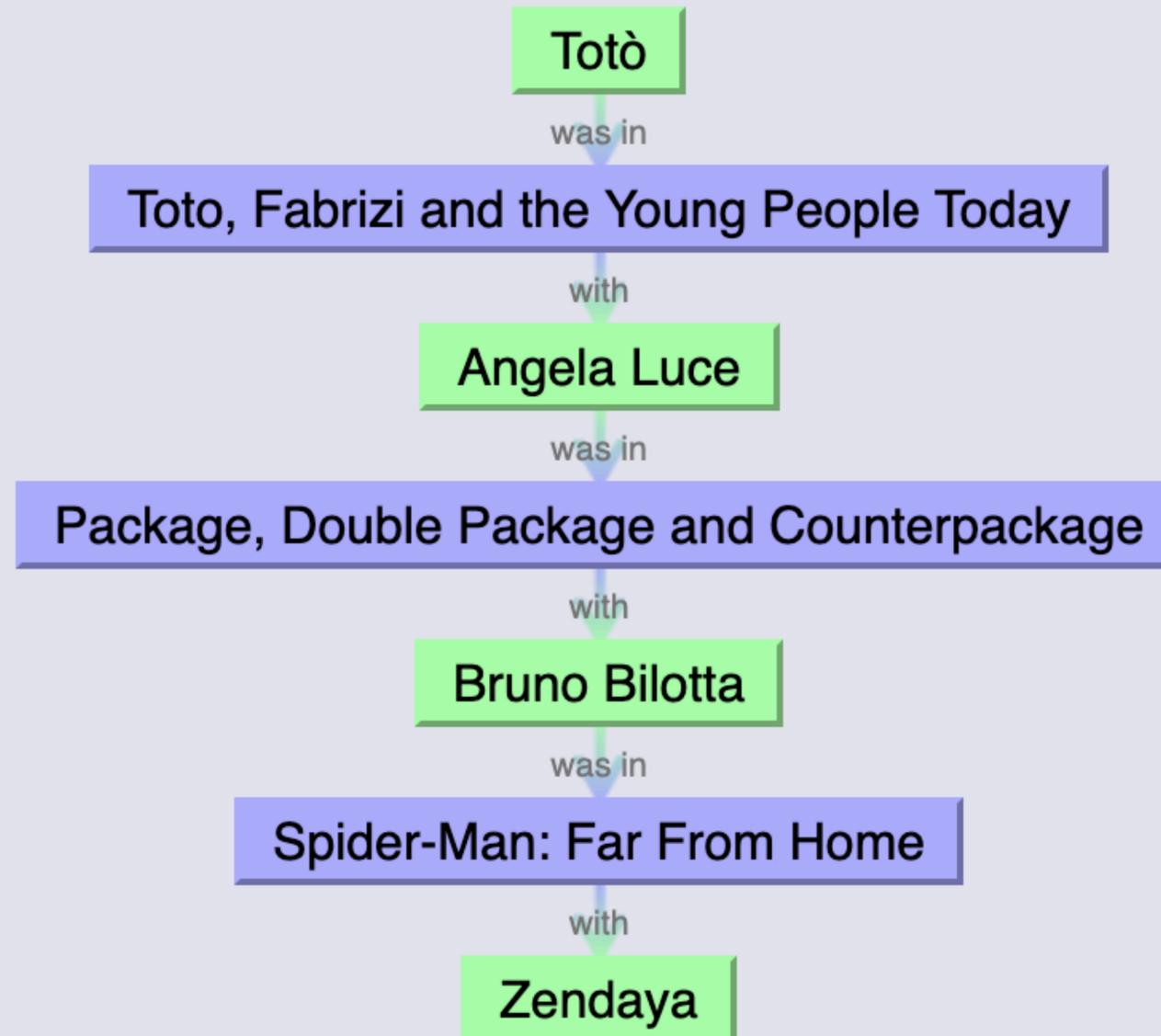


Qual è la distanza tra Totò e... Zendaya?



Totò has a Zendaya number of 3.

Find a different link



Zendaya

to Totò

Find link

More options >>



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
- ❖ ...



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





