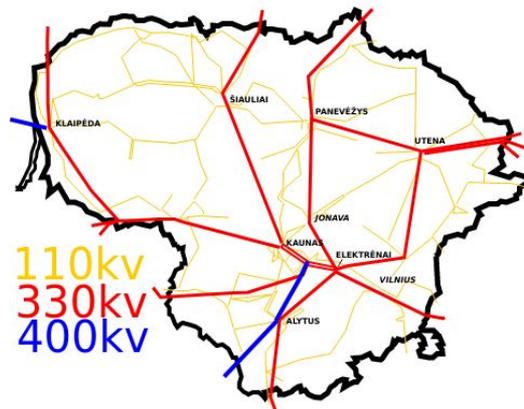




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Distância entre os nós

Prof. Fabrício Olivetti de França

O Caminho da Informação



O Caminho da Informação

$d(v_i, v_j)$ = tamanho do menor caminho entre v_i e v_j

$$\bar{d} = \frac{1}{n \cdot (n - 1)} \sum_{v_i, v_j \in V, v_i \neq v_j} d(v_i, v_j)$$



O Caminho da Informação

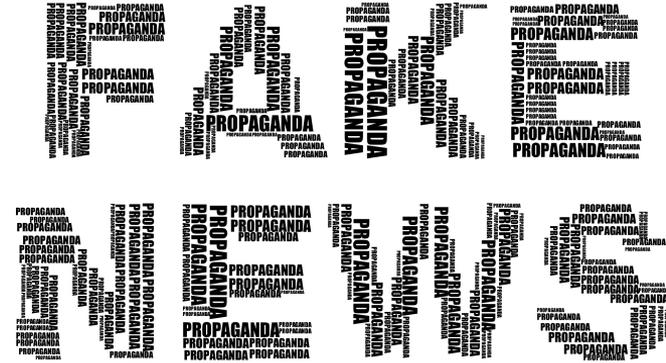
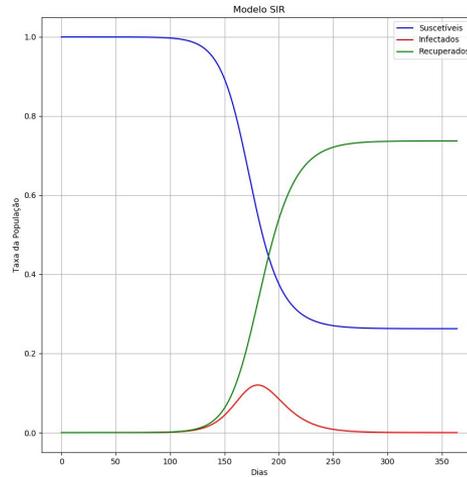
$d(v_i, v_j)$ = tamanho do menor caminho entre v_i e v_j

$$\bar{d} = \frac{1}{n \cdot (n - 1)} \sum_{v_i, v_j \in V, v_i \neq v_j} d(v_i, v_j)$$

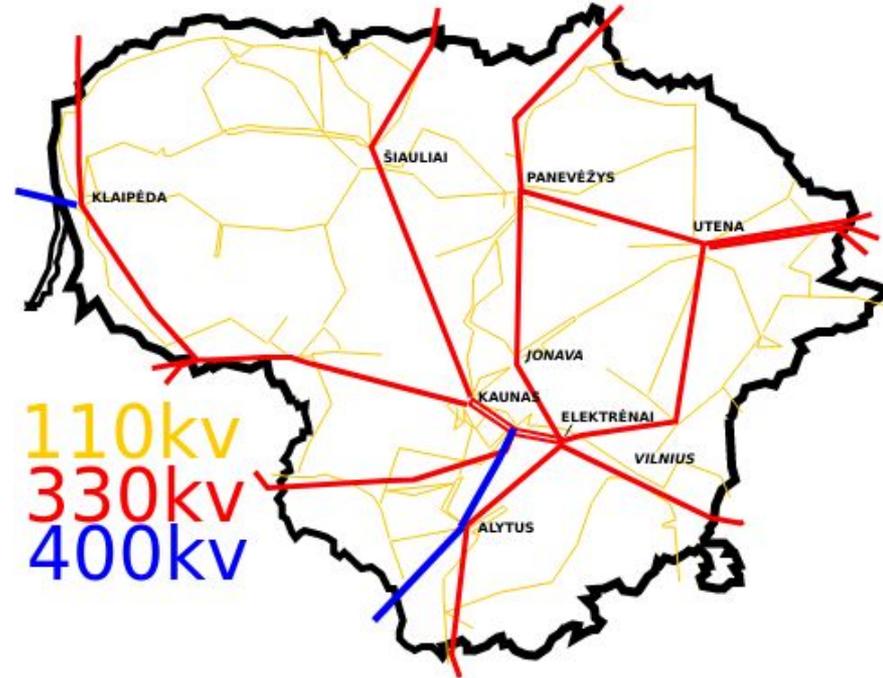
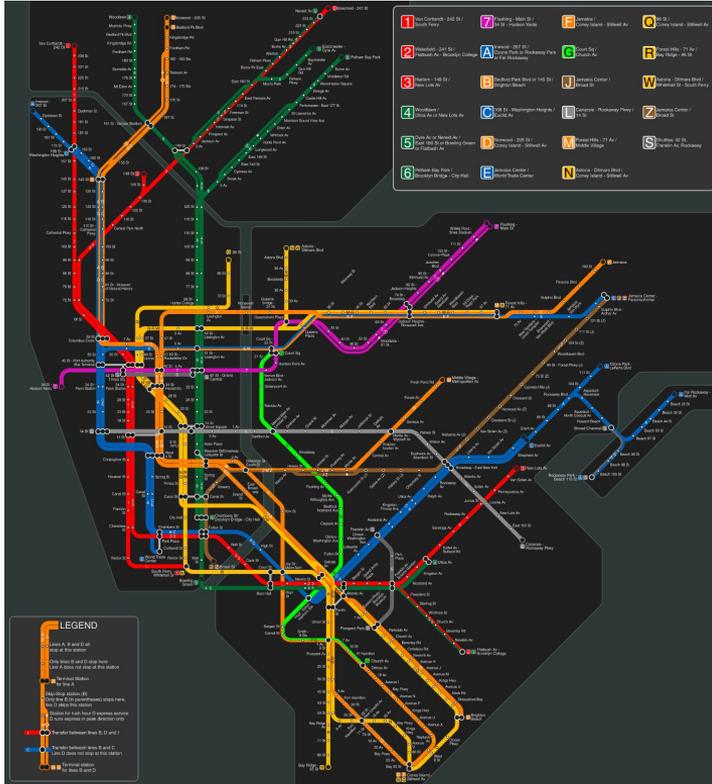
$$diam = \max_{v_i, v_j} d(v_i, v_j)$$



O Caminho da Informação

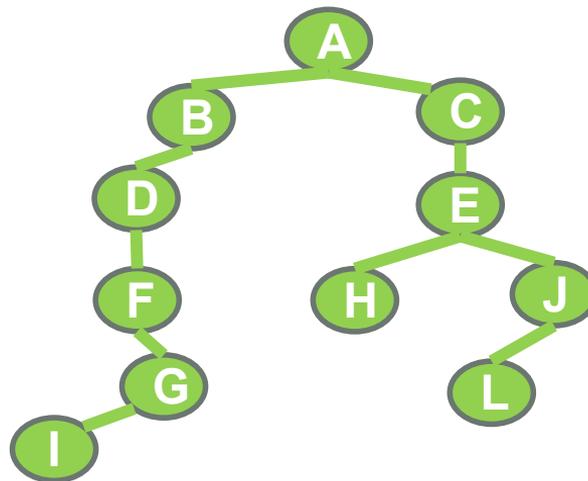


O Caminho da Informação





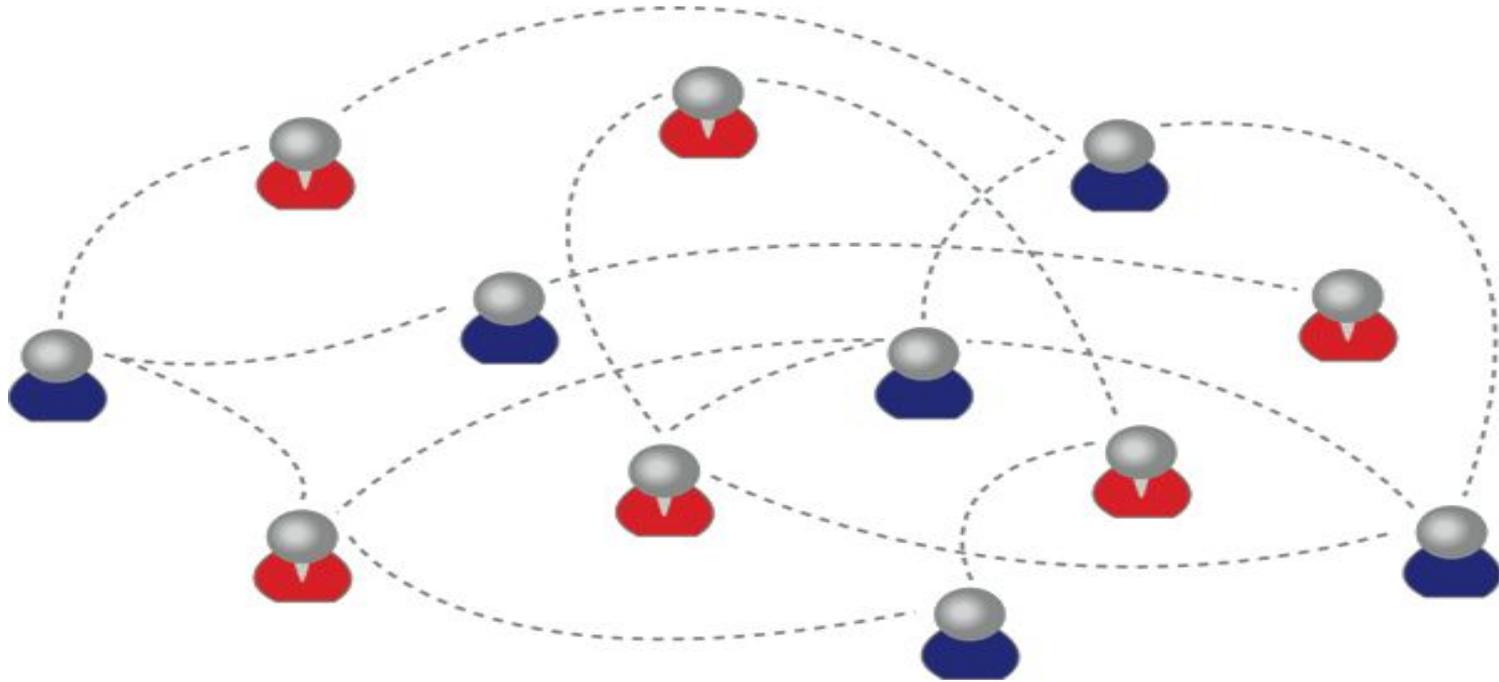
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DISTÂNCIA EM REDES NÃO PONDERADAS

Prof. Fabrício Olivetti de França

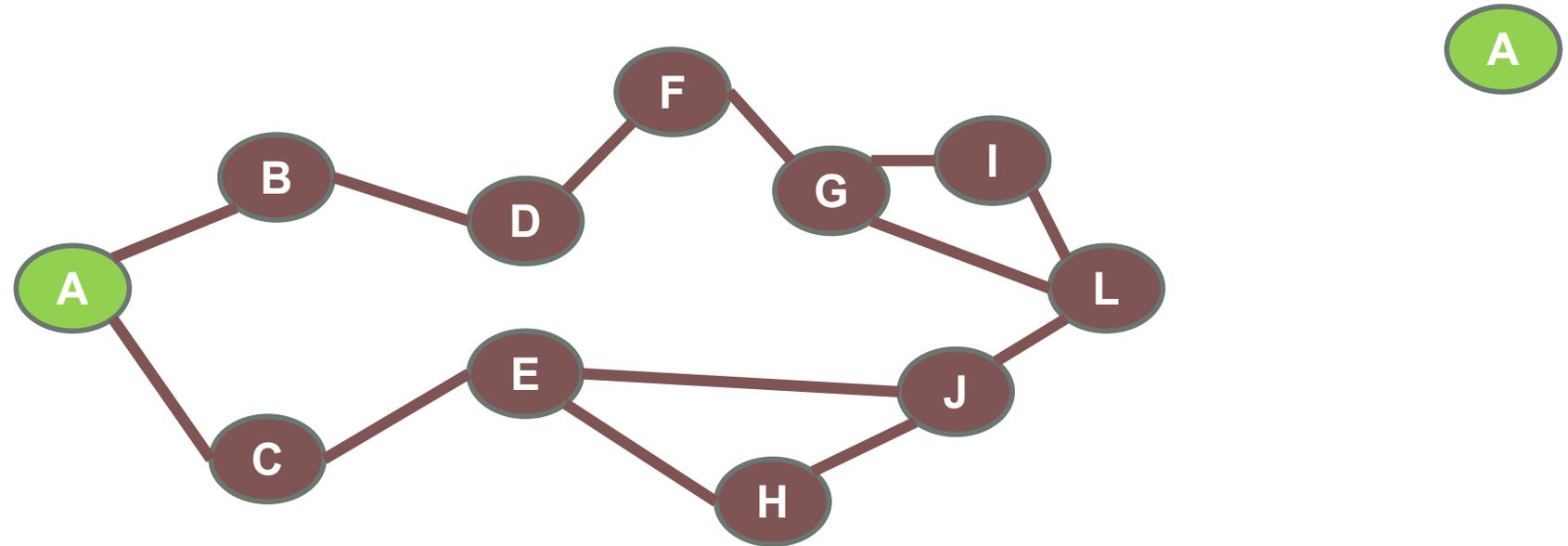
Percurso em Redes Sociais



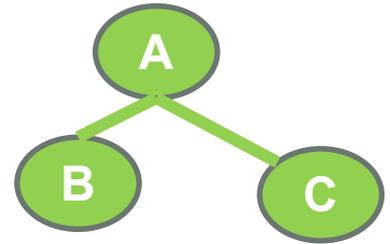
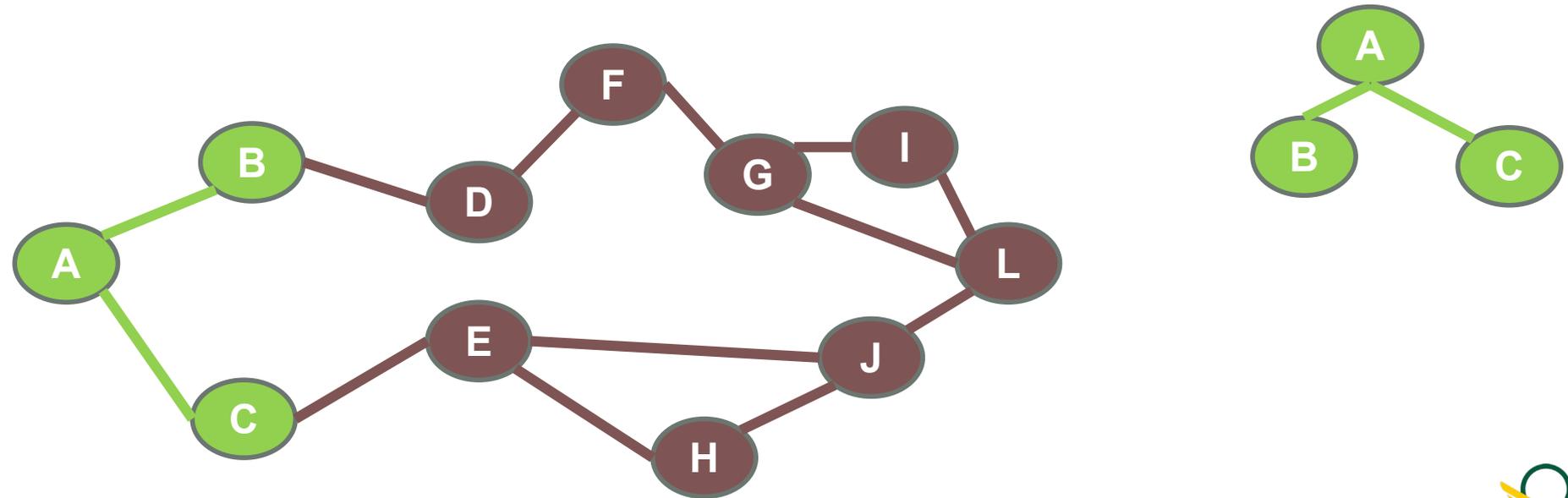
Percurso em Redes Sociais



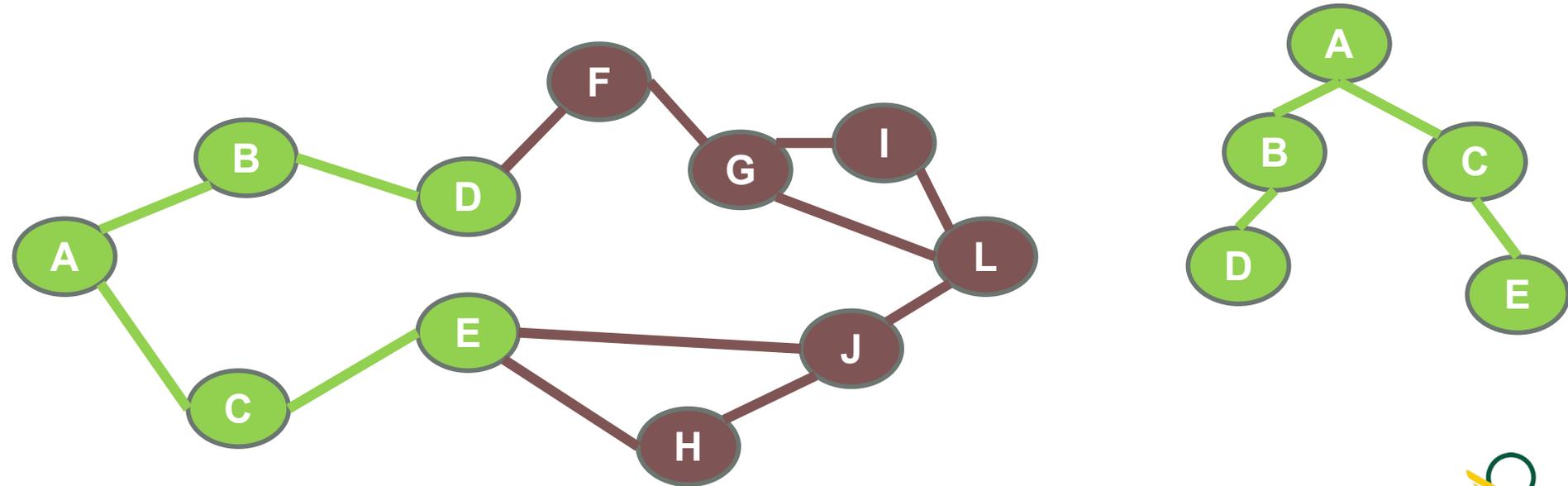
Percurso em Redes Sociais



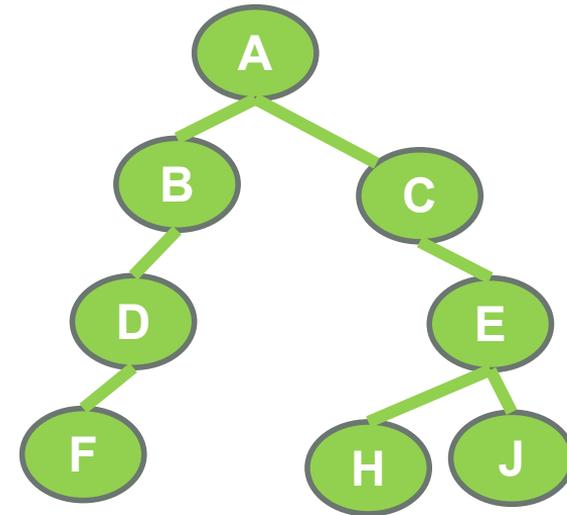
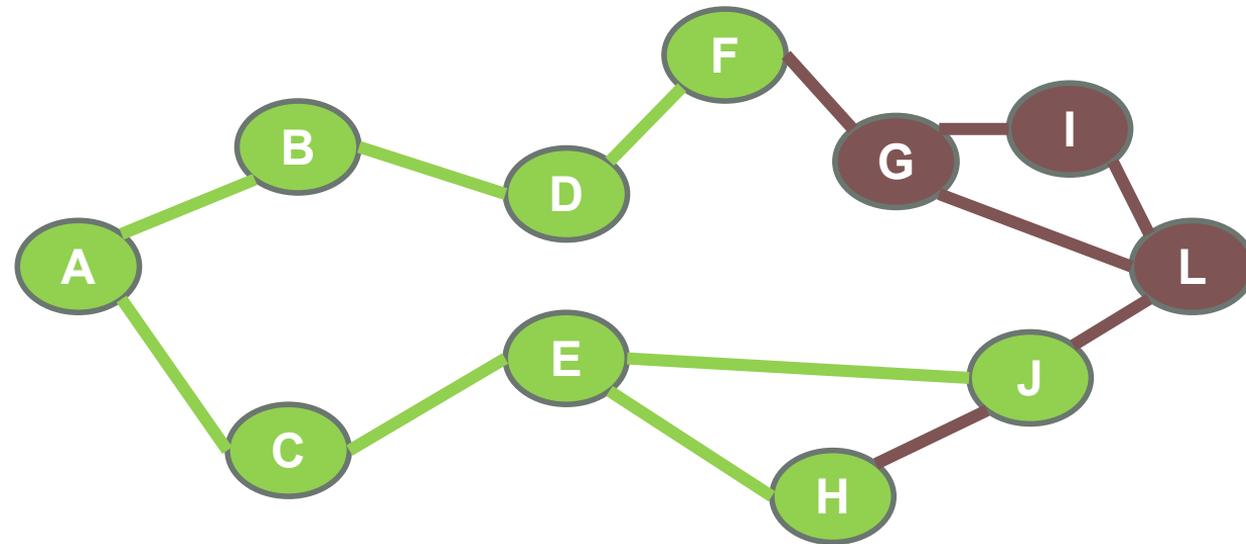
Percurso em Redes Sociais



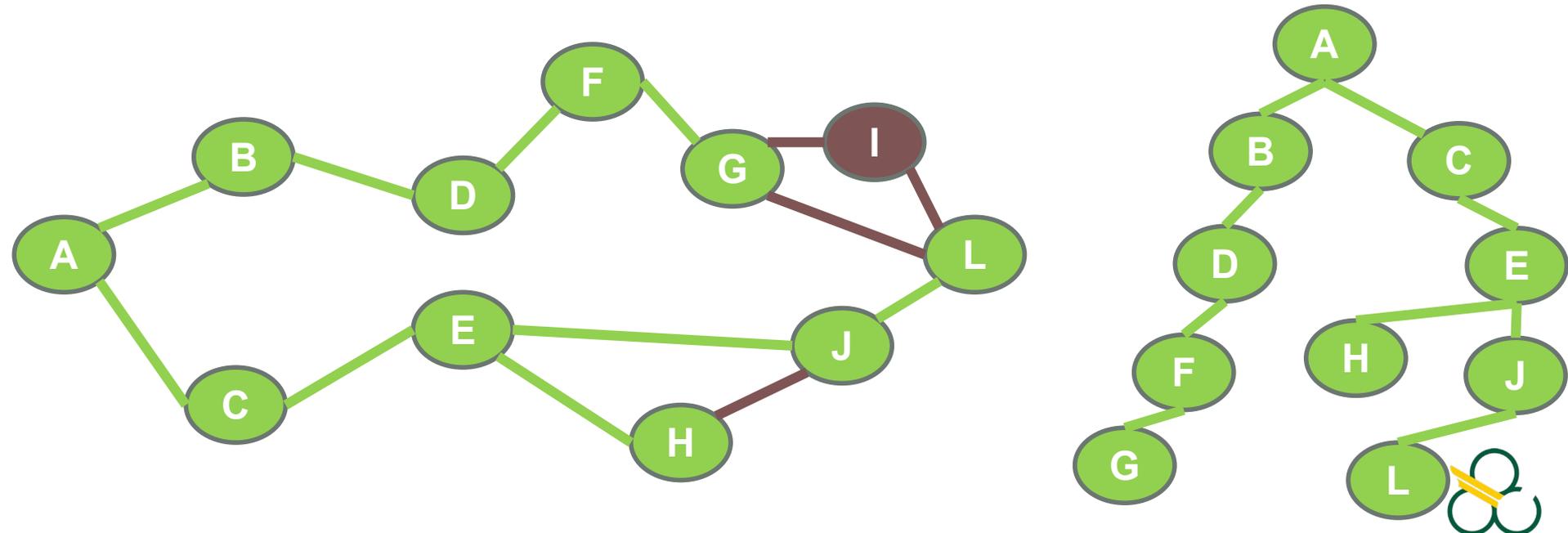
Percurso em Redes Sociais



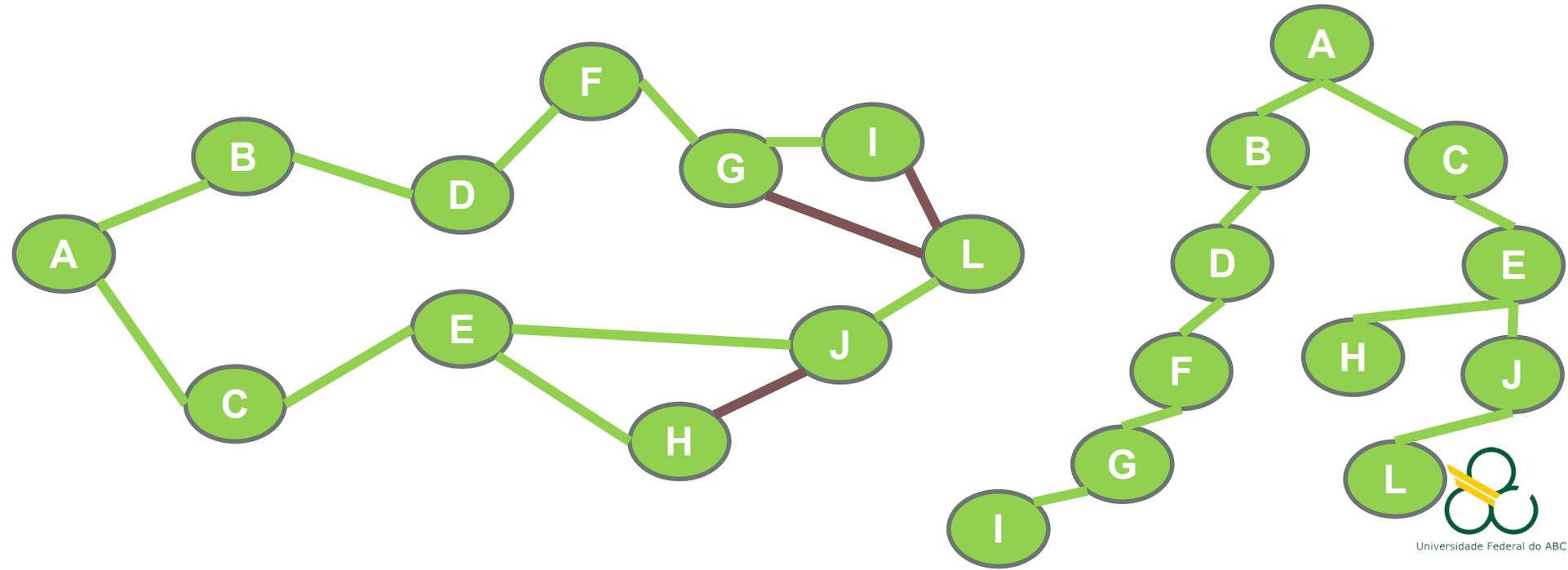
Percurso em Redes Sociais



Percurso em Redes Sociais

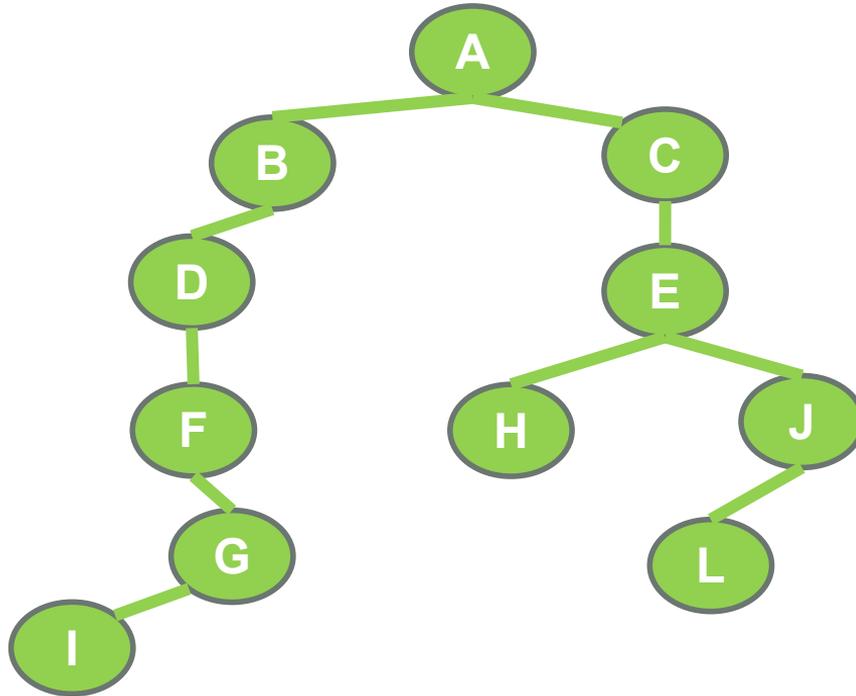


Percurso em Redes Sociais



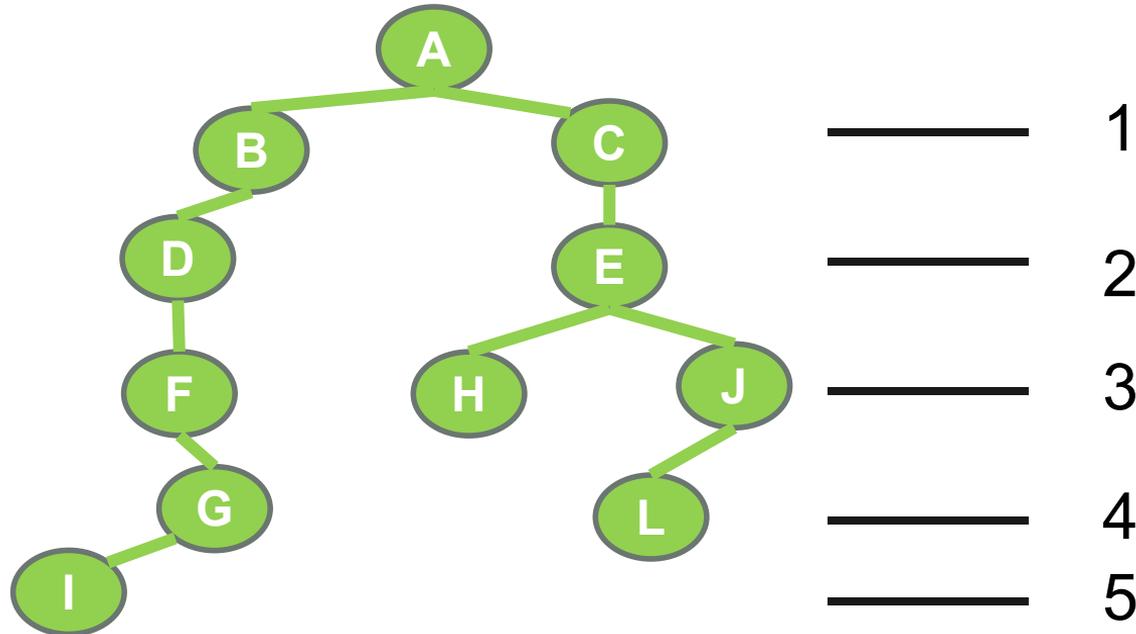
Percurso em Redes Sociais

Busca em Largura

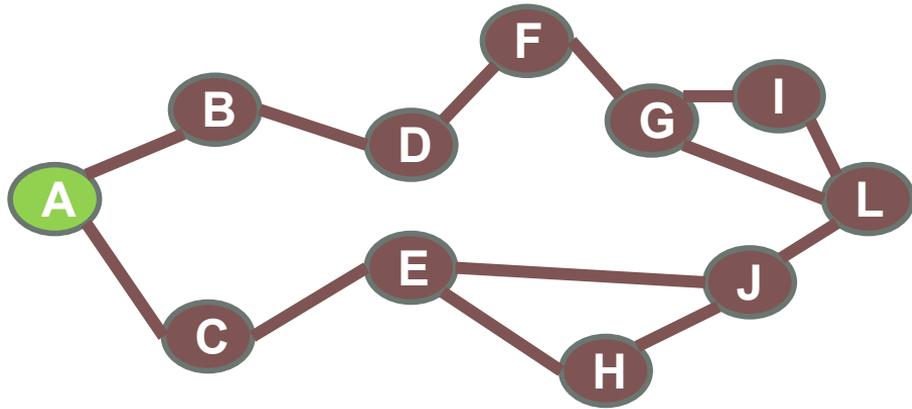


Percurso em Redes Sociais

$$d(A, -) = [1, 1, 2, 2, 3, 3, 3, 4, 4, 5]$$



Percurso em Redes Sociais



$$d(A, -) = [1, 1, 2, 2, 3, 3, 3, 4, 4, 5]$$

$$d(B, -) = [1, 2, 2, 3, 3, 4, 4, 4, 4]$$

$$d(C, -) = [2, 2, 2, 3, 3, 4, 4, 4]$$

$$d(D, -) = [1, 2, 3, 3, 4, 4, 5]$$

$$d(E, -) = [1, 1, 2, 3, 3, 4]$$

$$d(F, -) = [1, 2, 2, 3, 4]$$

$$d(G, -) = [1, 1, 2, 3]$$

$$d(H, -) = [1, 2, 3]$$

$$d(I, -) = [1, 2]$$

$$d(J, -) = [1]$$



Percurso em Redes Sociais

$$d(A, -) = [1, 1, 2, 2, 3, 3, 3, 4, 4, 5] = 28$$

$$d(B, -) = [1, 2, 2, 3, 3, 4, 4, 4, 4] = 27$$

$$d(C, -) = [2, 2, 2, 3, 3, 4, 4, 4] = 24$$

$$d(D, -) = [1, 2, 3, 3, 4, 4, 5] = 22$$

$$d(E, -) = [1, 1, 2, 3, 3, 4] = 14$$

$$d(F, -) = [1, 2, 2, 3, 4] = 12$$

$$d(G, -) = [1, 1, 2, 3] = 7$$

$$d(H, -) = [1, 2, 3] = 6$$

$$d(I, -) = [1, 2] = 3$$

$$d(J, -) = [1] = 1$$



Percurso em Redes Sociais

$$d(A, -) = [1, 1, 2, 2, 3, 3, 3, 4, 4, 5] = 28$$

$$d(B, -) = [1, 2, 2, 3, 3, 4, 4, 4, 4] = 27$$

$$d(C, -) = [2, 2, 2, 3, 3, 4, 4, 4] = 24$$

$$d(D, -) = [1, 2, 3, 3, 4, 4, 5] = 22$$

$$d(E, -) = [1, 1, 2, 3, 3, 4] = 14$$

$$d(F, -) = [1, 2, 2, 3, 4] = 12$$

$$d(G, -) = [1, 1, 2, 3] = 7$$

$$d(H, -) = [1, 2, 3] = 6$$

$$d(I, -) = [1, 2] = 3$$

$$d(J, -) = [1] = 1$$

$$= \frac{28 + 27 + 24 + 22 + 14 + 12 + 7 + 6 + 3 + 1}{55} = 2.62$$



Percurso em Redes Sociais

diâmetro = 5

$$d(A, -) = [1, 1, 2, 2, 3, 3, 3, 4, 4, 5]$$

$$d(B, -) = [1, 2, 2, 3, 3, 4, 4, 4, 4]$$

$$d(C, -) = [2, 2, 2, 3, 3, 4, 4, 4]$$

$$d(D, -) = [1, 2, 3, 3, 4, 4, 5]$$

$$d(E, -) = [1, 1, 2, 3, 3, 4]$$

$$d(F, -) = [1, 2, 2, 3, 4]$$

$$d(G, -) = [1, 1, 2, 3]$$

$$d(H, -) = [1, 2, 3]$$

$$d(I, -) = [1, 2]$$

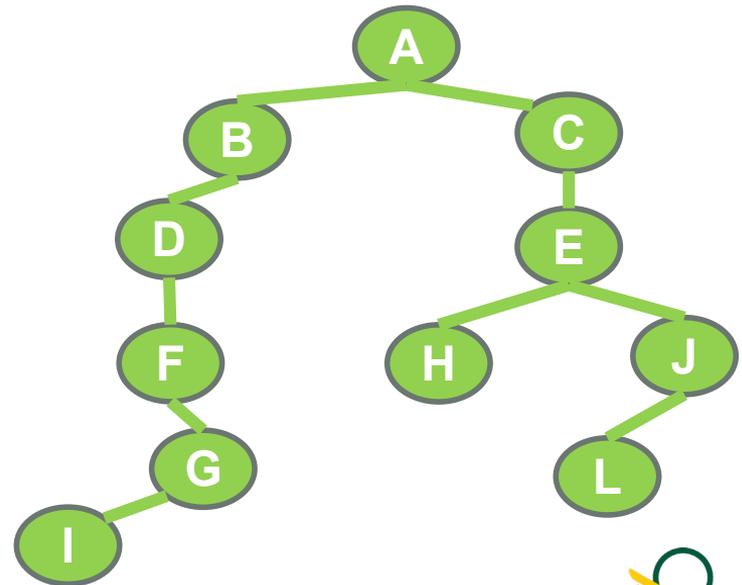
$$d(J, -) = [1]$$



ÁRVORE

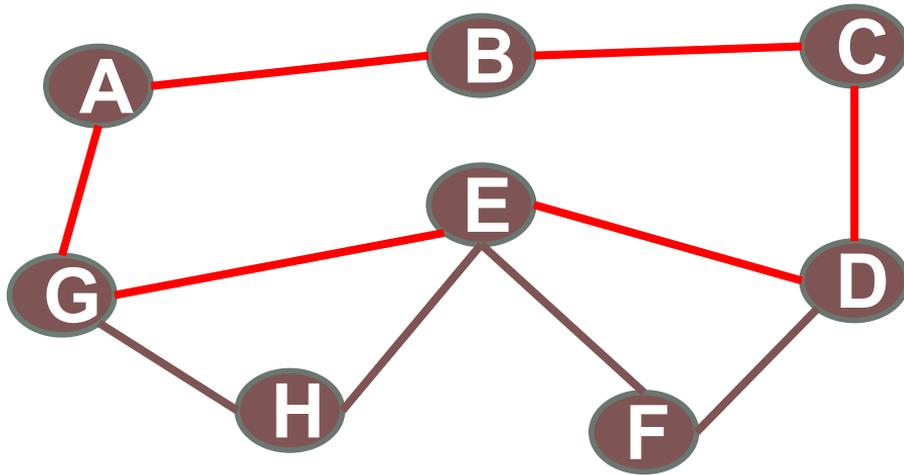
Essa estrutura resultante do procedimento, que mostra o caminho da informação pelos nós, é conhecida como **ÁRVORE**.

Um **ÁRVORE** é uma rede que não contém **CICLOS!**



CICLOS

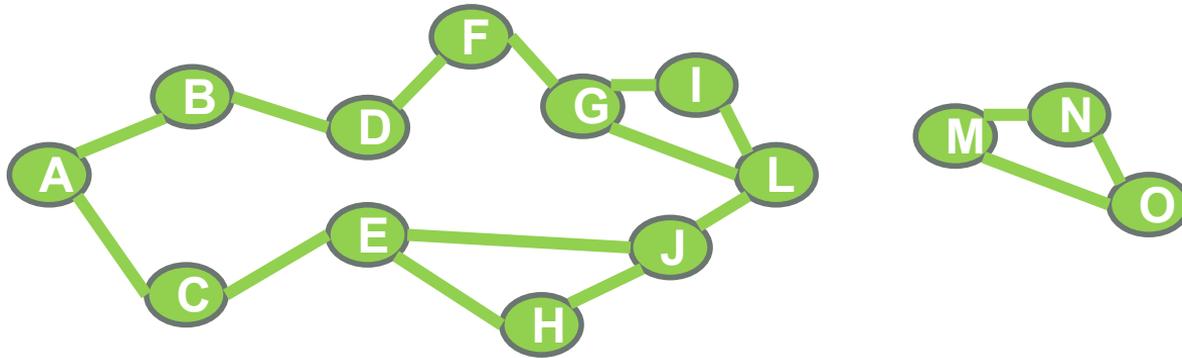
Um **CICLO** é um caminho em uma rede em que o nó final é o mesmo da origem.



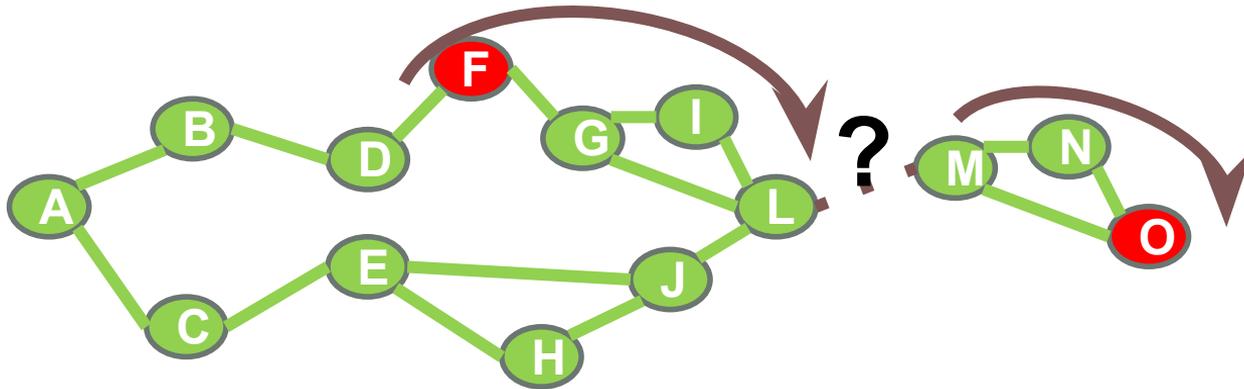
O caminho
A,B,C,D,E,G,A
forma um ciclo.



CONNECTIVIDADE



CONNECTIVIDADE

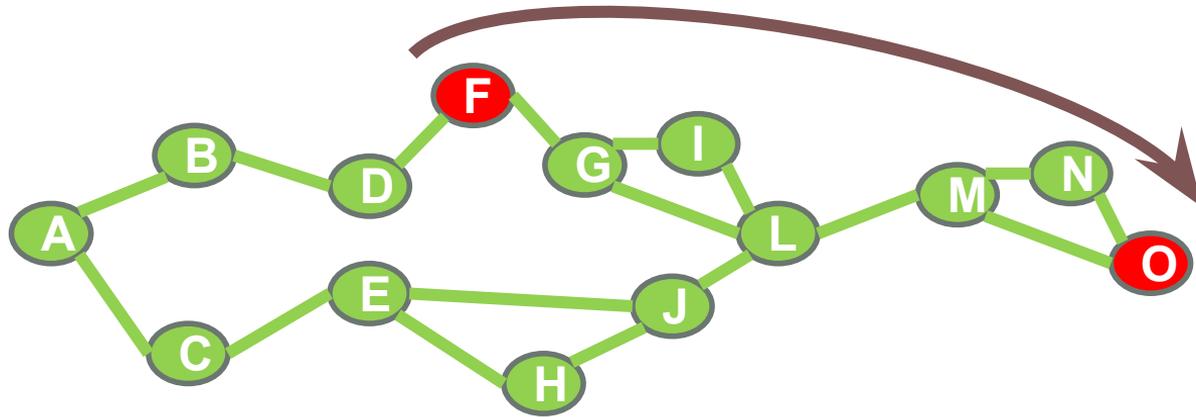


DESCONECTADA / DESCONEXA.



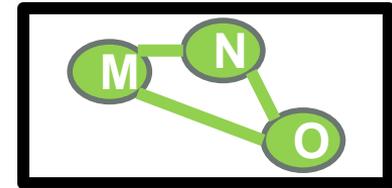
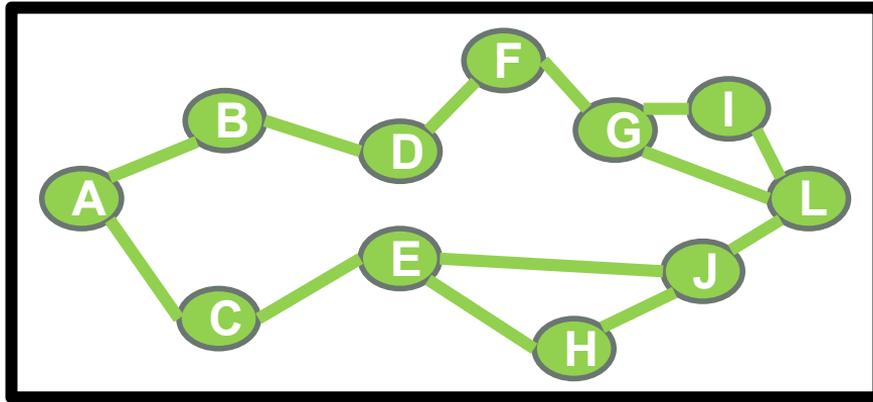
CONNECTIVIDADE

CONECTADA / CONEXA.



CONNECTIVIDADE

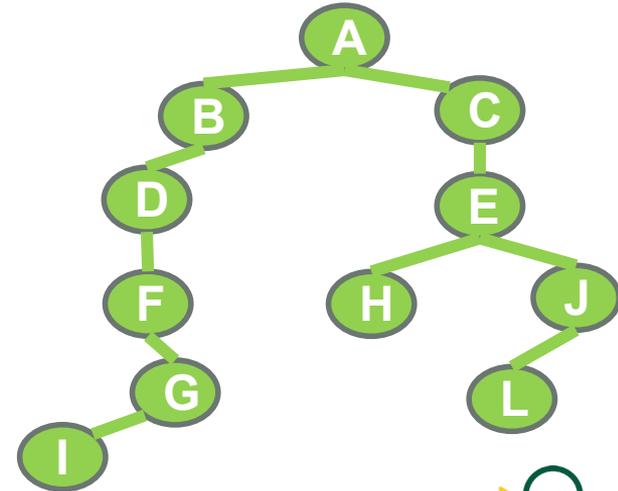
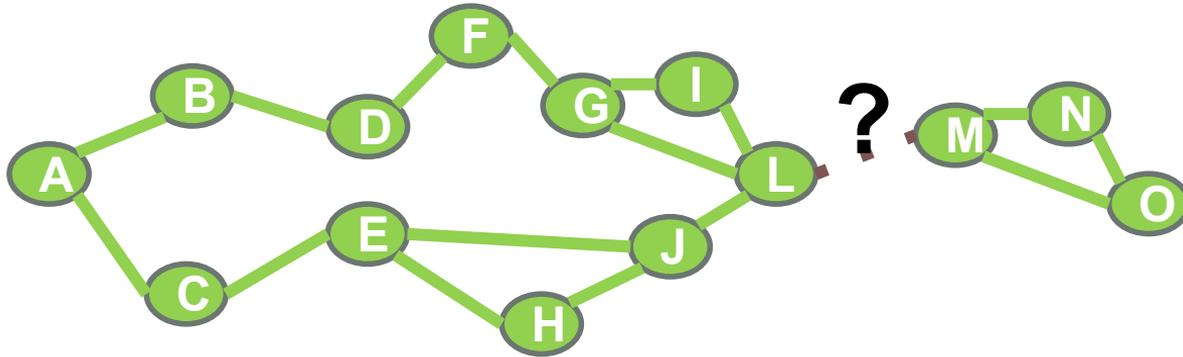
COMPONENTES CONEXOS



COMPONENTE GIGANTE

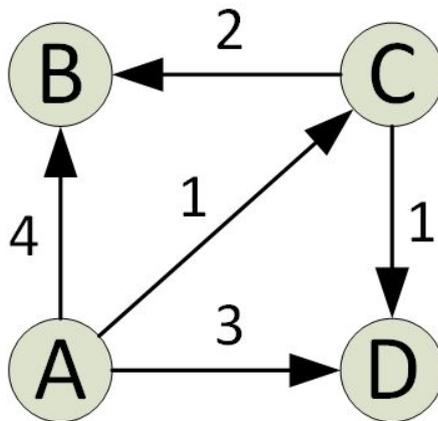


CONNECTIVIDADE





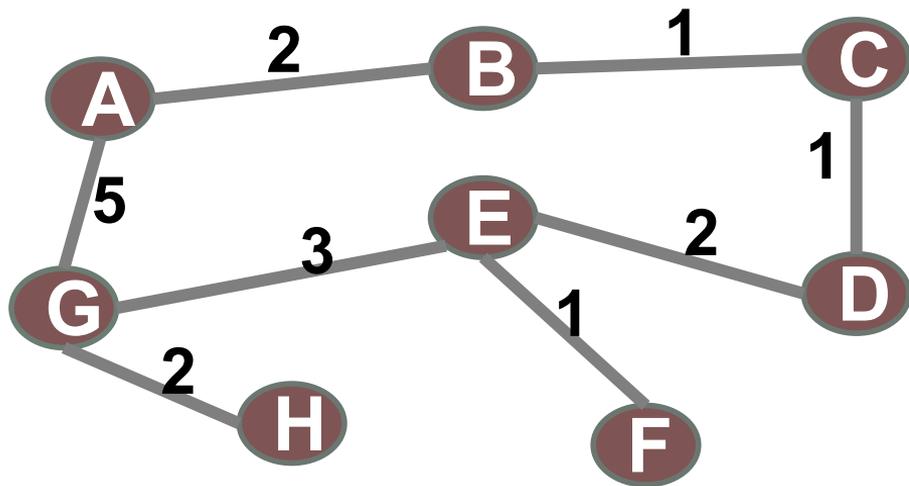
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DISTÂNCIA EM REDES PONDERADAS

Prof. Fabrício Olivetti de França

Rota de Entrega



Caminho com menos arestas:
A, G, E, F

$$\text{Custo} = 5 + 3 + 1 = 9$$

Caminho com menor custo:
A, B, C, D, E, F

$$\text{Custo} = 2 + 1 + 1 + 2 + 1 = 7$$



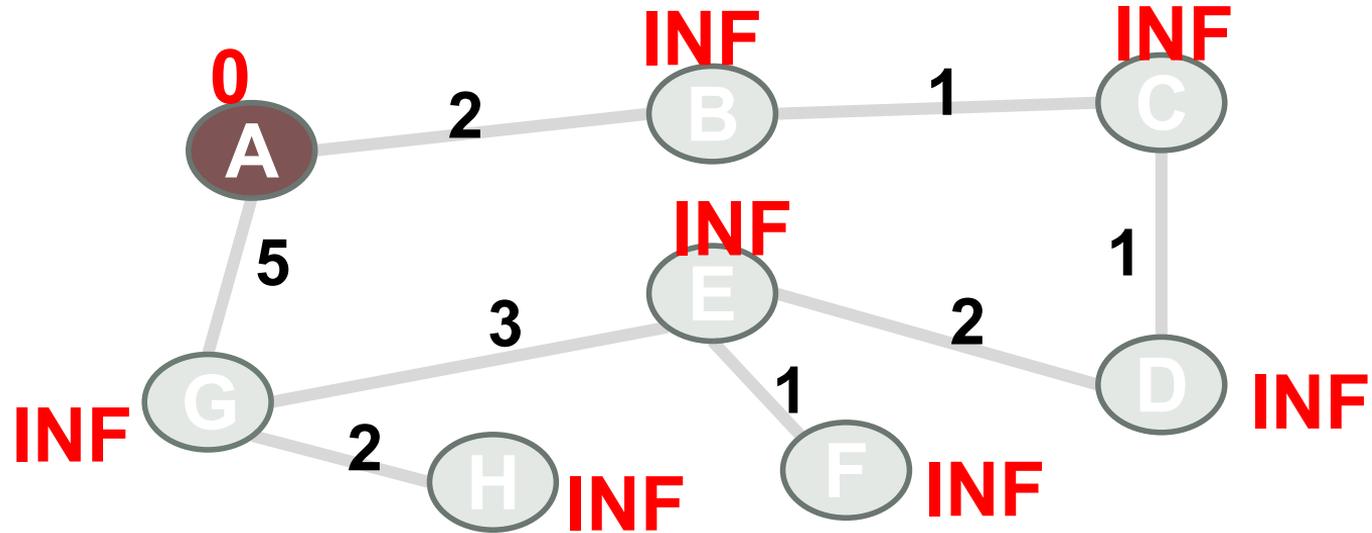
Dijkstra

Um algoritmo para encontrar o caminho mínimo em um grafo foi criado por Edsger Dijkstra em 1956.

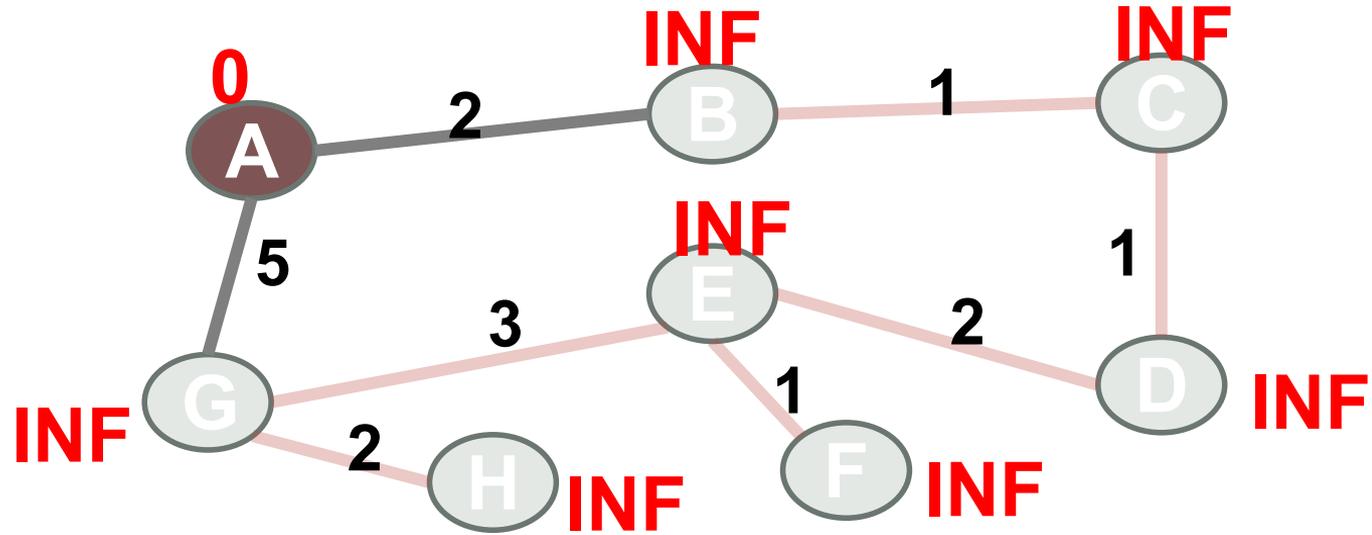
Esse algoritmo se assemelha à **BUSCA EM LARGURA**, porém toma as decisões sobre quais nós percorrer em seguida utilizando um procedimento **GULOSO**.



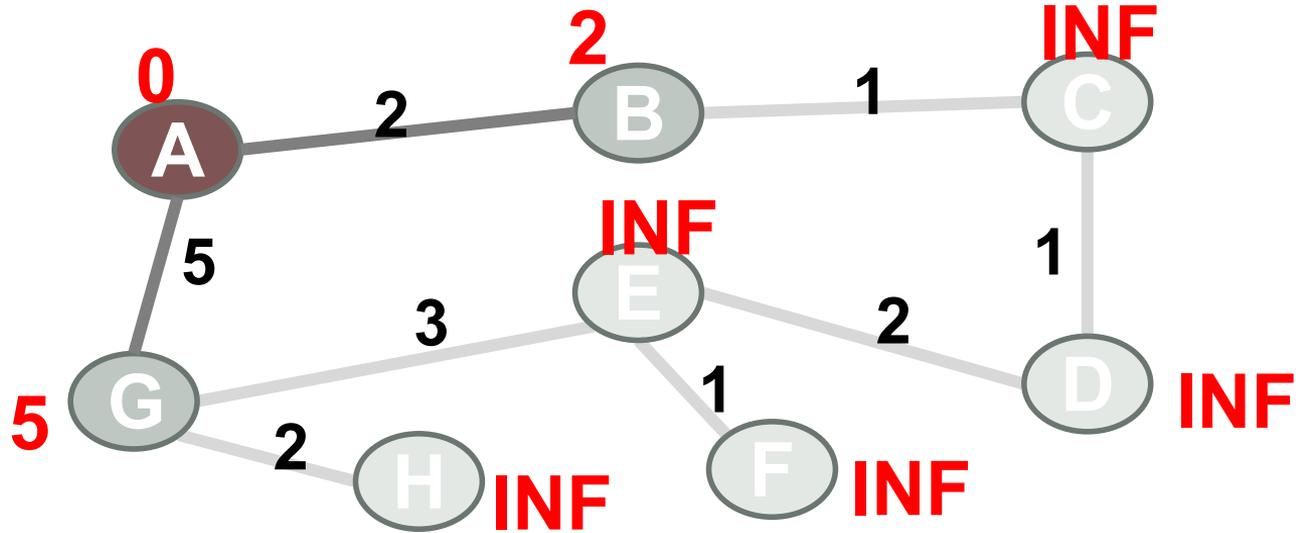
Dijkstra



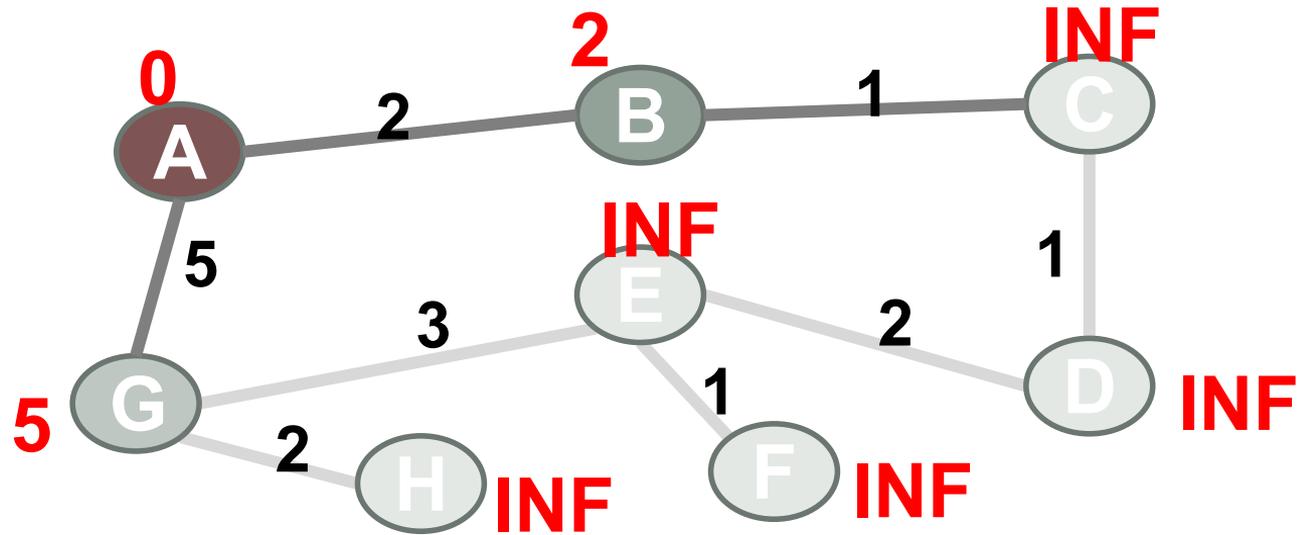
Dijkstra



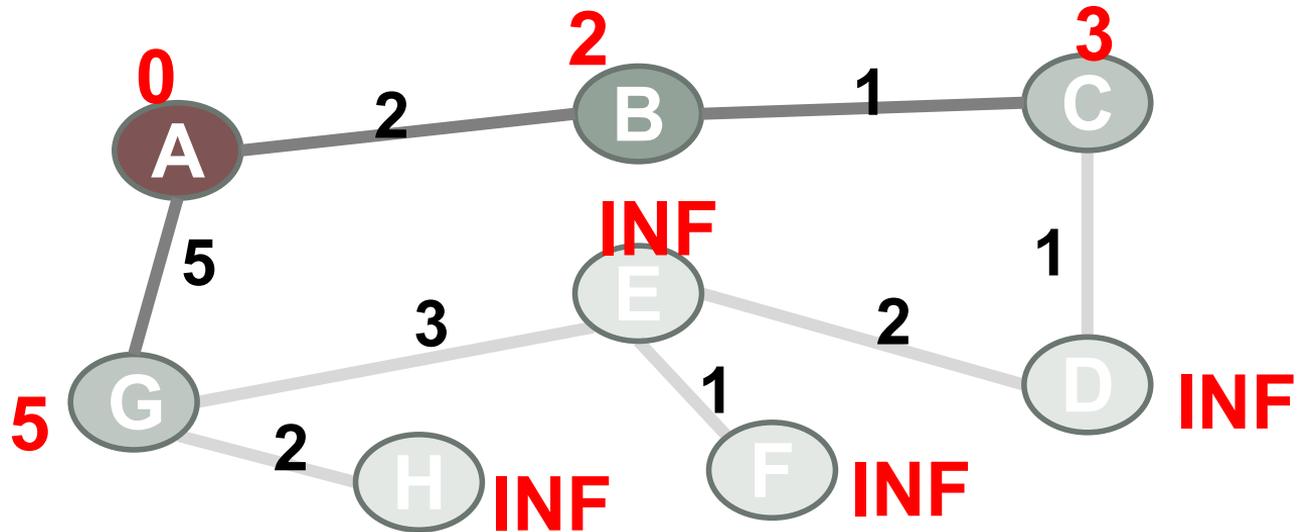
Dijkstra



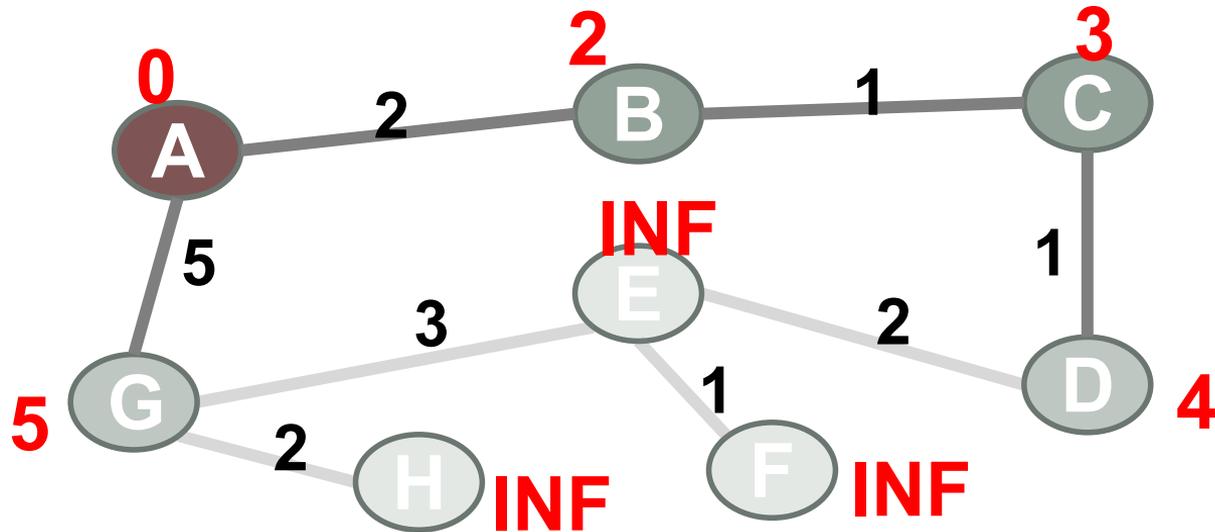
Dijkstra



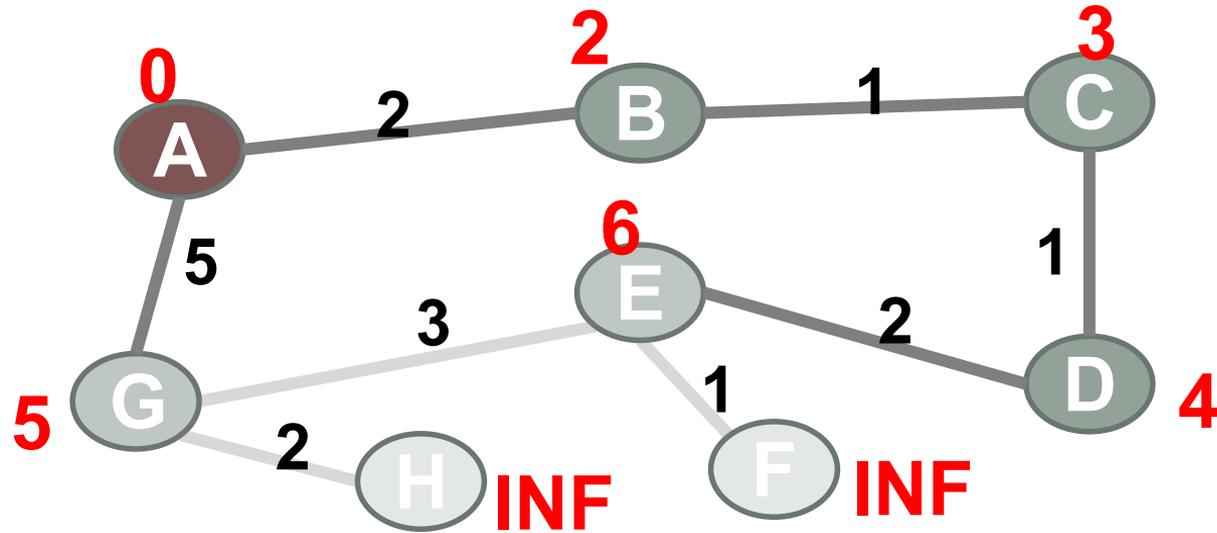
Dijkstra



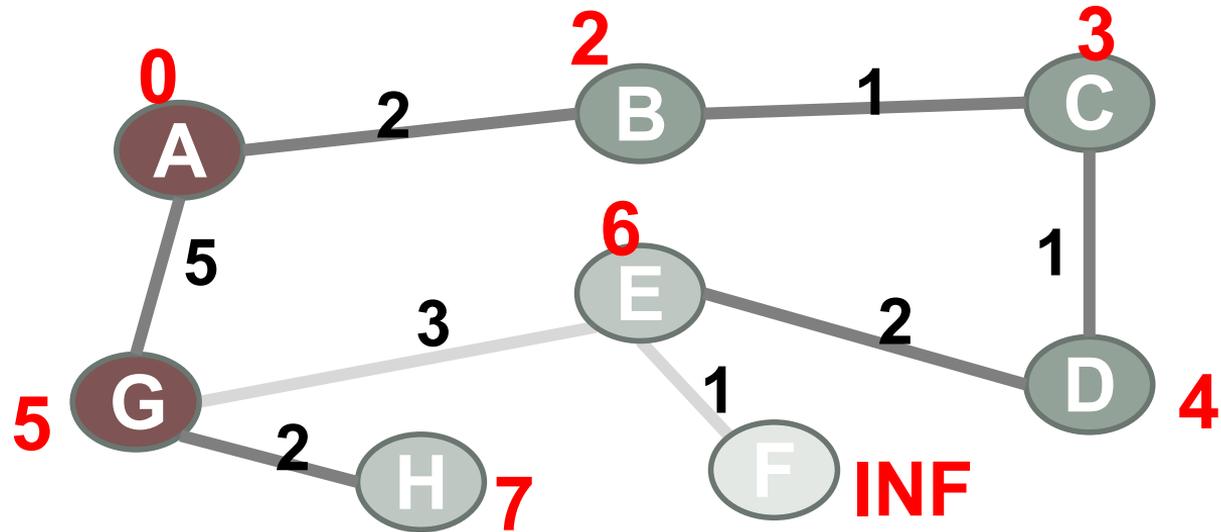
Dijkstra



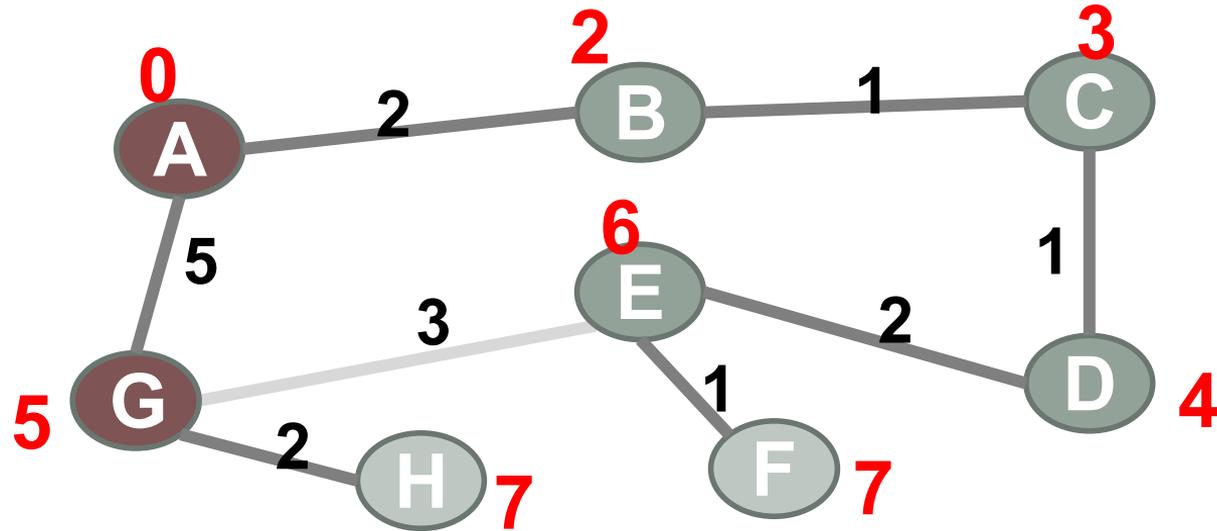
Dijkstra



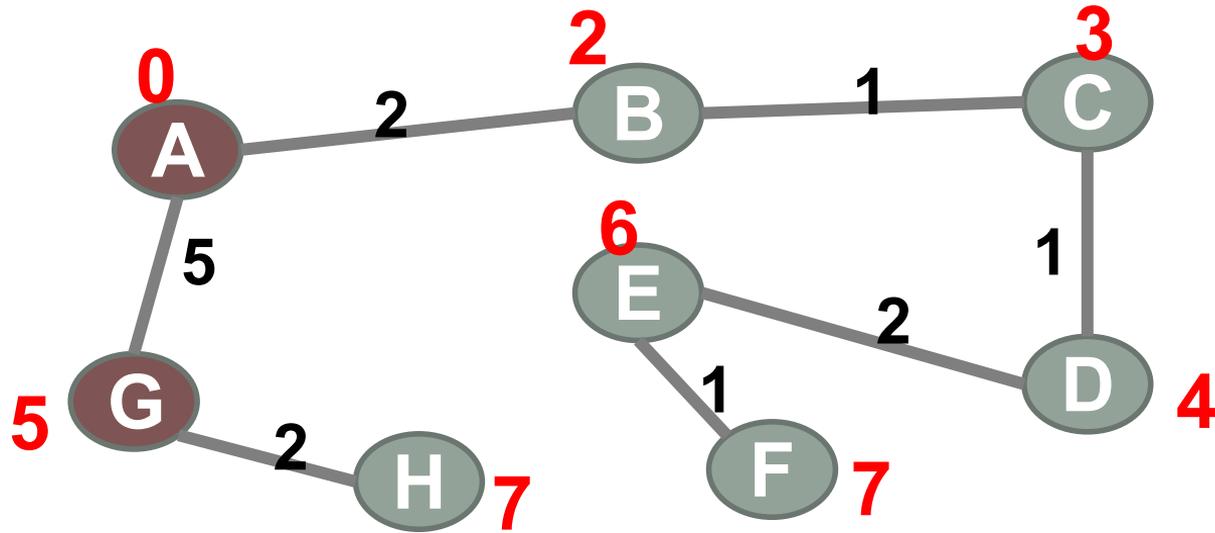
Dijkstra



Dijkstra



Dijkstra



Dijkstra

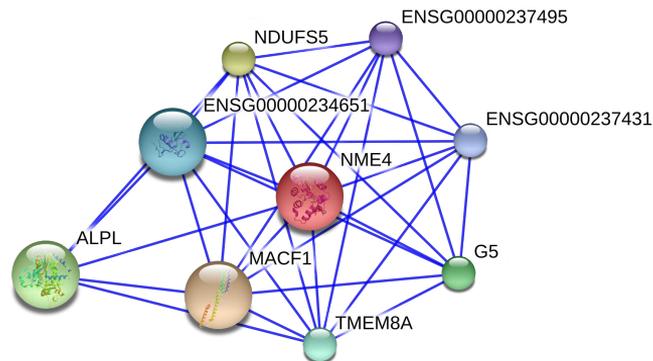
A distância média para essa rede é **4,36** e o diâmetro é igual a **9**.

Verifique!





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DISTÂNCIA EM REDES REAIS

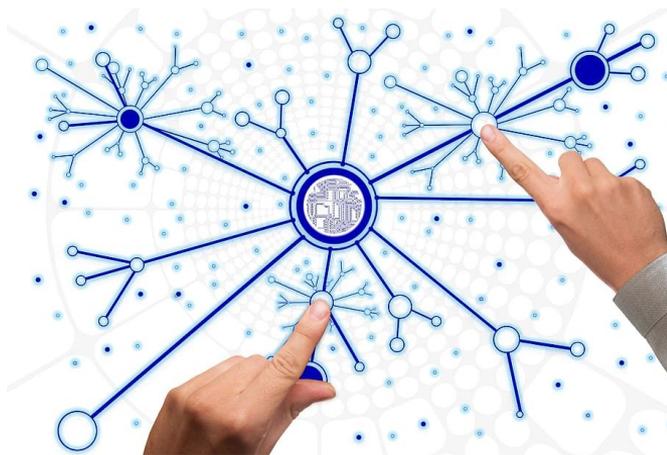
Prof. Fabrício Olivetti de França

Redes Sociais

Facebook: 721.000.000 de nós e 69.000.000.000 de arestas.

Distância média: 4.74

Diâmetro: 41



Backstrom, Lars, et al. "Four degrees of separation." *Proceedings of the 3rd Annual ACM Web Science Conference*. ACM, 2012.

Redes Tecnológicas

Transmissão de Energia - Leste dos EUA: 49.597 nós e 62.985 arestas.

Distância média: 35,8

Diâmetro: 96



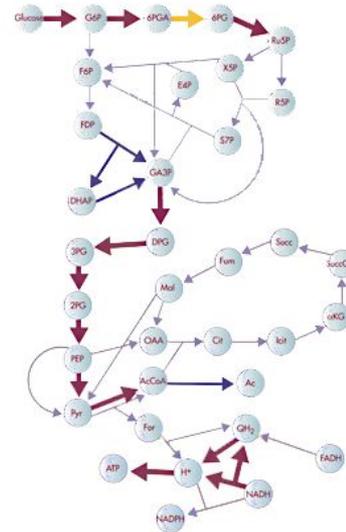
Hines, Paul, et al. "The topological and electrical structure of power grids." *System Sciences (HICSS), 2010 43rd Hawaii International Conference on*. IEEE, 2010.

Redes Biológicas

Reações metabólicas (E. Coli): 906 nós e 1.230 arestas.

Distância média: 8

Diâmetro: 12



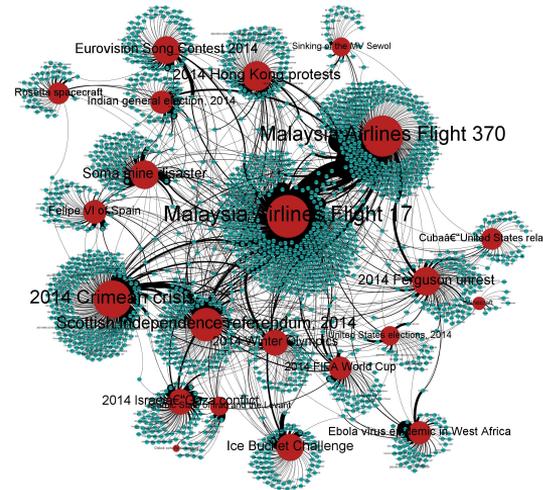
Arita, Masanori. "The metabolic world of Escherichia coli is not small." *Proceedings of the National Academy of Sciences of the United States of America* 101.6 (2004): 1543-1547.

Redes de Informação

Co-autoria da área de Saúde no Brasil: 114.169 nós e 659.332 arestas.

Distância média: 6,9

Diâmetro: 23



Mena-Chalco, Jesús Pascual, et al. "Brazilian bibliometric coauthorship networks." *Journal of the Association for Information Science and Technology*(2014).