

Teoria dos Grafos - 2018.2 - Profª Patrícia Machado

Exercício Prático 02

Grupos: 3-4 participantes

(Os grupos devem se registrar previamente na planilha indicada no Classroom)

Prazo para a Entrega: Definido na Programação de Aulas e na Tarefa do Classroom para esta prática

Questão 1

A planilha apresentada no arquivo Mail-network-50.xlsx (anexo a esta tarefa), representa uma versão simplificada de dados de envio de e-mail entre usuários de uma instituição europeia¹. Existe um arco entre u e v se o usuário u enviou para o usuário v ao menos um e-mail.

1) Carregue este arquivo na ferramenta yEd para criar um grafo representando os relacionamentos descritos entre os usuários.

2) Utilize a ferramenta yEd para criar uma visualização gráfica adequada para este grafo, utilizando um dos layouts disponíveis.

3) Salve o grafo resultante no formato .gml

Formato da Entrega:

- Arquivo .gml gerado
- Arquivo .pdf ou .jpg com a visualização gráfica (item 2))
- Arquivo .txt com a justificativa para a escolha do layout de visualização

Questão 2

Um engenheiro do setor de planejamento de trânsito da cidade deve verificar a orientação do trânsito de um bairro, onde todas as vias só podem ser trafegadas em mão única. Para tal, ele deve descobrir:

1. Se é possível trafegar em ambos os sentidos de um cruzamento para qualquer outro do cruzamento bairro, quais deslocamentos não são possíveis, se existirem? (Por exemplo, dados dois cruzamentos a e b , não necessariamente adjacentes, existe um caminho de a para b e de b para a ?)

Esboço de saída correta:

Q2.1. Não é possível deslocamento nos seguintes sentidos:

1->8 | 1->11 | 1->12 | 1->13 | 1->14 | 1->15 | 1->16 | 1->17 | 1->18 | 1->19 | 1->20 | 2->8 | 2->11 | 2->12 | 2->13 | 2->14 | 2->15 | 2->16 | 2->17 | 2->18 | 2->19 | 2->20 | 3->8 | 3->11 | 3->12 | 3->13 | 3->14 | 3->15 | 3->16 | 3->17 | 3->18 | 3->19 | 3->20 | 4->1 | 4->2 | 4->3 | 4->5 | 4->6 | 4->7 | 4->8 | 4->9 | 4->10 | 4->11 | 4->12 | 4->13 | 4->14 | 4->15 | 4->16 | 4->17 | 4->18 | 4->19 | 4->20 | 5->8 | 5->11 | 5->12 | 5->13 | 5->14 | 5->15 | 5->16 | 5->17 | 5->18 | 5->19 | 5->20 | 6->8 | 6->11 | 6->12 | 6->13 | 6->14 | 6->15 | 6->16 | 6->17 | 6->18 | 6->19 | 6->20 | 7->8 | 7->11 | 7->12 | 7->13 | 7->14 | 7->15 | 7->16 | 7->17 | 7->18 | 7->19 | 7->20 | 8->13 | 8->17 | 8->20 | 9->1 | 9->2 | 9->3 | 9->4 | 9->5 | 9->6 | 9->7 | 9->8 | 9->11 | 9->12 | 9->13 | 9->14 | 9->15 | 9->16 | 9->17 | 9->18 | 9->19 | 9->20 | 10->1 | 10->2 | 10->3 | 10->4 | 10->5 | 10->6 | 10->7 | 10->8 | 10->9 | 10->11 | 10->12 | 10->13 | 10->14 | 10->15 | 10->16 | 10->17 | 10->18 | 10->19 | 10->20 | 11->8 | 11->12 | 11->13 | 11->16 | 11->17 | 11->20 | 12->8 | 12->13 | 12->17 | 12->20 | 13->1 | 13->2 | 13->3 | 13->4 | 13->5 | 13->6 | 13->7 | 13->8 | 13->11 | 13->12 | 13->15 | 13->16 | 13->17 | 13->19 | 13->20 | 14->1 | 14->2 | 14->3 | 14->4 | 14->5 | 14->6 | 14->7 | 14->8 | 14->9 | 14->11 | 14->12 | 14->13 | 14->15 | 14->16 | 14->17 | 14->19 | 14->20 | 15->1 | 15->2 | 15->3 | 15->4 | 15->5 | 15->6 | 15->7 | 15->8 | 15->9 | 15->11 | 15->12 | 15->13 | 15->16 | 15->17 | 15->20 | 16->1 | 16->2 | 16->3 | 16->4 | 16->5 | 16->6 | 16->7 | 16->8 | 16->9 | 16->11 | 16->12 | 16->13 | 16->17 | 16->20 | 17->1 | 17->2 | 17->3 | 17->4 | 17->5 | 17->6 | 17->7 | 17->8 |

¹ (fonte: <http://snap.stanford.edu/data/email-Eu-core.html>)

17->11 | 17->12 | 17->15 | 17->16 | 17->19 | 17->20 | 18->1 | 18->2 | 18->3 | 18->4 | 18->5 | 18->6 | 18->7 | 18->8 | 18->9 | 18->10 | 18->11 | 18->12 | 18->13 | 18->14 | 18->15 | 18->16 | 18->17 | 18->19 | 18->20 | 19->1 | 19->2 | 19->3 | 19->4 | 19->5 | 19->6 | 19->7 | 19->8 | 19->9 | 19->10 | 19->11 | 19->12 | 19->13 | 19->14 | 19->15 | 19->16 | 19->17 | 19->20 | 20->1 | 20->2 | 20->3 | 20->4 | 20->5 | 20->6 | 20->7 | 20->8 | 20->9 | 20->11 | 20->12 | 20->13 | 20->17 |

2. Se existem cruzamentos inacessíveis a partir de qualquer um dos demais. Quais?

Esboço de saída correta:

Não existem cruzamentos inacessíveis. Todos podem ser acessados a partir de pelo menos um outro.

3. Qual o tamanho mínimo, máximo e médio dos percursos (caminhos) que podem ser realizados entre cada 2 cruzamentos? O tamanho do percurso é determinado pela quantidade de trechos de vias que devem ser trafegadas no percurso.

Esboço de resposta correta:

1->2: minimo=1; maximo=1; medio=1 paths: [(1:2)]
1->3: minimo=4; maximo=4; medio=4 paths: [(1:2), (2:6), (6:7), (7:3)]
1->4: minimo=5; maximo=5; medio=5 paths: [(1:2), (2:6), (6:7), (7:3), (3:4)]
1->5: minimo=3; maximo=3; medio=3 paths: [(1:2), (2:6), (6:5)]
1->6: minimo=2; maximo=2; medio=2 paths: [(1:2), (2:6)]
1->7: minimo=3; maximo=3; medio=3 paths: [(1:2), (2:6), (6:7)]
1->9: minimo=4; maximo=4; medio=4 paths: [(1:2), (2:6), (6:5), (5:9)]
1->10: minimo=3; maximo=5; medio=4 paths: [(1:2), (2:6), (6:10)], [(1:2), (2:6), (6:5), (5:9), (9:10)]
2->1: minimo=3; maximo=3; medio=3 paths: [(2:6), (6:5), (5:1)]
2->3: minimo=3; maximo=3; medio=3 paths: [(2:6), (6:7), (7:3)]
2->4: minimo=4; maximo=4; medio=4 paths: [(2:6), (6:7), (7:3), (3:4)]
2->5: minimo=2; maximo=2; medio=2 paths: [(2:6), (6:5)]
2->6: minimo=1; maximo=1; medio=1 paths: [(2:6)]
2->7: minimo=2; maximo=2; medio=2 paths: [(2:6), (6:7)]
2->9: minimo=3; maximo=3; medio=3 paths: [(2:6), (6:5), (5:9)]
2->10: minimo=2; maximo=4; medio=3 paths: [(2:6), (6:10)], [(2:6), (6:5), (5:9), (9:10)]
3->1: minimo=4; maximo=4; medio=4 paths: [(3:2), (2:6), (6:5), (5:1)]
3->2: minimo=1; maximo=1; medio=1 paths: [(3:2)]
3->4: minimo=1; maximo=1; medio=1 paths: [(3:4)]
3->5: minimo=3; maximo=3; medio=3 paths: [(3:2), (2:6), (6:5)]
3->6: minimo=2; maximo=2; medio=2 paths: [(3:2), (2:6)]
3->7: minimo=3; maximo=3; medio=3 paths: [(3:2), (2:6), (6:7)]
3->9: minimo=4; maximo=4; medio=4 paths: [(3:2), (2:6), (6:5), (5:9)]
3->10: minimo=3; maximo=5; medio=4 paths: [(3:2), (2:6), (6:10)], [(3:2), (2:6), (6:5), (5:9), (9:10)]
5->1: minimo=1; maximo=1; medio=1 paths: [(5:1)]
5->2: minimo=2; maximo=2; medio=2 paths: [(5:1), (1:2)]
5->3: minimo=5; maximo=5; medio=5 paths: [(5:1), (1:2), (2:6), (6:7), (7:3)]
5->4: minimo=6; maximo=6; medio=6 paths: [(5:1), (1:2), (2:6), (6:7), (7:3), (3:4)]
5->6: minimo=3; maximo=3; medio=3 paths: [(5:1), (1:2), (2:6)]
5->7: minimo=4; maximo=4; medio=4 paths: [(5:1), (1:2), (2:6), (6:7)]
5->9: minimo=1; maximo=1; medio=1 paths: [(5:9)]
5->10: minimo=2; maximo=4; medio=3 paths: [(5:1), (1:2), (2:6), (6:10)], [(5:9), (9:10)]
6->1: minimo=2; maximo=2; medio=2 paths: [(6:5), (5:1)]
6->2: minimo=3; maximo=3; medio=3 paths: [(6:5), (5:1), (1:2)], [(6:7), (7:3), (3:2)]
6->3: minimo=2; maximo=2; medio=2 paths: [(6:7), (7:3)]
6->4: minimo=3; maximo=3; medio=3 paths: [(6:7), (7:3), (3:4)]

6->5: minimo=1; maximo=1; medio=1 paths: [[(6:5)]]
 6->7: minimo=1; maximo=1; medio=1 paths: [[(6:7)]]
 6->9: minimo=2; maximo=2; medio=2 paths: [[(6:5), (5:9)]]
 6->10: minimo=1; maximo=3; medio=2 paths: [[(6:10)], [(6:5), (5:9), (9:10)]]
 7->1: minimo=5; maximo=5; medio=5 paths: [[(7:3), (3:2), (2:6), (6:5), (5:1)]]
 7->2: minimo=2; maximo=2; medio=2 paths: [[(7:3), (3:2)]]
 7->3: minimo=1; maximo=1; medio=1 paths: [[(7:3)]]
 7->4: minimo=2; maximo=2; medio=2 paths: [[(7:3), (3:4)]]
 7->5: minimo=4; maximo=4; medio=4 paths: [[(7:3), (3:2), (2:6), (6:5)]]
 7->6: minimo=3; maximo=3; medio=3 paths: [[(7:3), (3:2), (2:6)]]
 7->9: minimo=5; maximo=5; medio=5 paths: [[(7:3), (3:2), (2:6), (6:5), (5:9)]]
 7->10: minimo=4; maximo=6; medio=5 paths: [[(7:3), (3:2), (2:6), (6:10)], [(7:3), (3:2), (2:6), (6:5), (5:9), (9:10)]]
 8->1: minimo=6; maximo=8; medio=7 paths: [[(8:7), (7:3), (3:2), (2:6), (6:5), (5:1)], [(8:12), (12:11), (11:7), (7:3), (3:2), (2:6), (6:5), (5:1)]]
 8->2: minimo=3; maximo=5; medio=4 paths: [[(8:7), (7:3), (3:2)], [(8:12), (12:11), (11:7), (7:3), (3:2)]]
 8->3: minimo=2; maximo=4; medio=3 paths: [[(8:7), (7:3)], [(8:12), (12:11), (11:7), (7:3)]]
 8->4: minimo=1; maximo=5; medio=3 paths: [[(8:4)], [(8:7), (7:3), (3:4)], [(8:12), (12:11), (11:7), (7:3), (3:4)]]
 8->5: minimo=5; maximo=7; medio=6 paths: [[(8:7), (7:3), (3:2), (2:6), (6:5)], [(8:12), (12:11), (11:7), (7:3), (3:2), (2:6), (6:5)]]
 8->6: minimo=4; maximo=6; medio=5 paths: [[(8:7), (7:3), (3:2), (2:6)], [(8:12), (12:11), (11:7), (7:3), (3:2), (2:6)]]
 8->7: minimo=1; maximo=3; medio=2 paths: [[(8:7)], [(8:12), (12:11), (11:7)]]
 8->9: minimo=6; maximo=8; medio=7 paths: [[(8:7), (7:3), (3:2), (2:6), (6:5), (5:9)], [(8:12), (12:11), (11:7), (7:3), (3:2), (2:6), (6:5), (5:9)]]
 8->10: minimo=3; maximo=9; medio=6 paths: [[(8:7), (7:3), (3:2), (2:6), (6:10)], [(8:7), (7:3), (3:2), (2:6), (6:5), (5:9), (9:10)], [(8:12), (12:16), (16:15), (15:14), (14:10)], [(8:12), (12:11), (11:10)], [(8:12), (12:11), (11:15), (15:14), (14:10)], [(8:12), (12:11), (11:7), (7:3), (3:2), (2:6), (6:10)], [(8:12), (12:11), (11:7), (7:3), (3:2), (2:6), (6:5), (5:9), (9:10)]]
 8->11: minimo=2; maximo=2; medio=2 paths: [[(8:12), (12:11)]]
 8->12: minimo=1; maximo=1; medio=1 paths: [[(8:12)]]
 8->14: minimo=4; maximo=4; medio=4 paths: [[(8:12), (12:16), (16:15), (15:14)], [(8:12), (12:11), (11:15), (15:14)]]
 8->15: minimo=3; maximo=3; medio=3 paths: [[(8:12), (12:16), (16:15)], [(8:12), (12:11), (11:15)]]
 8->16: minimo=2; maximo=2; medio=2 paths: [[(8:12), (12:16)]]
 8->18: minimo=5; maximo=5; medio=5 paths: [[(8:12), (12:16), (16:15), (15:19), (19:18)], [(8:12), (12:16), (16:15), (15:14), (14:18)], [(8:12), (12:11), (11:15), (15:19), (19:18)], [(8:12), (12:11), (11:15), (15:14), (14:18)]]
 8->19: minimo=4; maximo=4; medio=4 paths: [[(8:12), (12:16), (16:15), (15:19)], [(8:12), (12:11), (11:15), (15:19)]]
 9->10: minimo=1; maximo=1; medio=1 paths: [[(9:10)]]
 11->1: minimo=6; maximo=6; medio=6 paths: [[(11:7), (7:3), (3:2), (2:6), (6:5), (5:1)]]
 11->2: minimo=3; maximo=3; medio=3 paths: [[(11:7), (7:3), (3:2)]]
 11->3: minimo=2; maximo=2; medio=2 paths: [[(11:7), (7:3)]]
 11->4: minimo=3; maximo=3; medio=3 paths: [[(11:7), (7:3), (3:4)]]
 11->5: minimo=5; maximo=5; medio=5 paths: [[(11:7), (7:3), (3:2), (2:6), (6:5)]]
 11->6: minimo=4; maximo=4; medio=4 paths: [[(11:7), (7:3), (3:2), (2:6)]]
 11->7: minimo=1; maximo=1; medio=1 paths: [[(11:7)]]
 11->9: minimo=6; maximo=6; medio=6 paths: [[(11:7), (7:3), (3:2), (2:6), (6:5), (5:9)]]
 11->10: minimo=1; maximo=7; medio=4 paths: [[(11:10)], [(11:7), (7:3), (3:2), (2:6), (6:10)], [(11:7), (7:3), (3:2), (2:6), (6:5), (5:9), (9:10)], [(11:15), (15:14), (14:10)]]
 11->14: minimo=2; maximo=2; medio=2 paths: [[(11:15), (15:14)]]
 11->15: minimo=1; maximo=1; medio=1 paths: [[(11:15)]]
 11->18: minimo=3; maximo=3; medio=3 paths: [[(11:15), (15:19), (19:18)], [(11:15), (15:14), (14:18)]]

11->19: minimo=2; maximo=2; medio=2 paths: [[(11:15), (15:19)]]
 12->1: minimo=7; maximo=7; medio=7 paths: [[(12:11), (11:7), (7:3), (3:2), (2:6), (6:5), (5:1)]]
 12->2: minimo=4; maximo=4; medio=4 paths: [[(12:11), (11:7), (7:3), (3:2)]]
 12->3: minimo=3; maximo=3; medio=3 paths: [[(12:11), (11:7), (7:3)]]
 12->4: minimo=4; maximo=4; medio=4 paths: [[(12:11), (11:7), (7:3), (3:4)]]
 12->5: minimo=6; maximo=6; medio=6 paths: [[(12:11), (11:7), (7:3), (3:2), (2:6), (6:5)]]
 12->6: minimo=5; maximo=5; medio=5 paths: [[(12:11), (11:7), (7:3), (3:2), (2:6)]]
 12->7: minimo=2; maximo=2; medio=2 paths: [[(12:11), (11:7)]]
 12->9: minimo=7; maximo=7; medio=7 paths: [[(12:11), (11:7), (7:3), (3:2), (2:6), (6:5), (5:9)]]
 12->10: minimo=2; maximo=8; medio=5 paths: [[(12:11), (11:10)], [(12:11), (11:15), (15:14), (14:10)], [(12:11), (11:7), (7:3), (3:2), (2:6), (6:10)], [(12:11), (11:7), (7:3), (3:2), (2:6), (6:5), (5:9), (9:10)], [(12:16), (16:15), (15:14), (14:10)]]
 12->11: minimo=1; maximo=1; medio=1 paths: [[(12:11)]]
 12->14: minimo=3; maximo=3; medio=3 paths: [[(12:11), (11:15), (15:14)], [(12:16), (16:15), (15:14)]]
 12->15: minimo=2; maximo=2; medio=2 paths: [[(12:11), (11:15)], [(12:16), (16:15)]]
 12->16: minimo=1; maximo=1; medio=1 paths: [[(12:16)]]
 12->18: minimo=4; maximo=4; medio=4 paths: [[(12:11), (11:15), (15:19), (19:18)], [(12:11), (11:15), (15:14), (14:18)], [(12:16), (16:15), (15:19), (19:18)], [(12:16), (16:15), (15:14), (14:18)]]
 12->19: minimo=3; maximo=3; medio=3 paths: [[(12:11), (11:15), (15:19)], [(12:16), (16:15), (15:19)]]
 13->9: minimo=1; maximo=1; medio=1 paths: [[(13:9)]]
 13->10: minimo=2; maximo=2; medio=2 paths: [[(13:9), (9:10)], [(13:14), (14:10)]]
 13->14: minimo=1; maximo=1; medio=1 paths: [[(13:14)]]
 13->18: minimo=2; maximo=2; medio=2 paths: [[(13:14), (14:18)]]
 14->10: minimo=1; maximo=1; medio=1 paths: [[(14:10)]]
 14->18: minimo=1; maximo=1; medio=1 paths: [[(14:18)]]
 15->10: minimo=2; maximo=2; medio=2 paths: [[(15:14), (14:10)]]
 15->14: minimo=1; maximo=1; medio=1 paths: [[(15:14)]]
 15->18: minimo=2; maximo=2; medio=2 paths: [[(15:14), (14:18)], [(15:19), (19:18)]]
 15->19: minimo=1; maximo=1; medio=1 paths: [[(15:19)]]
 16->10: minimo=3; maximo=3; medio=3 paths: [[(16:15), (15:14), (14:10)]]
 16->14: minimo=2; maximo=2; medio=2 paths: [[(16:15), (15:14)]]
 16->15: minimo=1; maximo=1; medio=1 paths: [[(16:15)]]
 16->18: minimo=3; maximo=3; medio=3 paths: [[(16:15), (15:19), (19:18)], [(16:15), (15:14), (14:18)]]
 16->19: minimo=2; maximo=2; medio=2 paths: [[(16:15), (15:19)]]
 17->9: minimo=2; maximo=2; medio=2 paths: [[(17:13), (13:9)]]
 17->10: minimo=3; maximo=3; medio=3 paths: [[(17:13), (13:14), (14:10)], [(17:13), (13:9), (9:10)]]
 17->13: minimo=1; maximo=1; medio=1 paths: [[(17:13)]]
 17->14: minimo=2; maximo=2; medio=2 paths: [[(17:13), (13:14)]]
 17->18: minimo=1; maximo=3; medio=2 paths: [[(17:18)], [(17:13), (13:14), (14:18)]]
 19->18: minimo=1; maximo=1; medio=1 paths: [[(19:18)]]
 20->10: minimo=4; maximo=4; medio=4 paths: [[(20:16), (16:15), (15:14), (14:10)]]
 20->14: minimo=3; maximo=3; medio=3 paths: [[(20:16), (16:15), (15:14)]]
 20->15: minimo=2; maximo=2; medio=2 paths: [[(20:16), (16:15)]]
 20->16: minimo=1; maximo=1; medio=1 paths: [[(20:16)]]
 20->18: minimo=2; maximo=4; medio=3 paths: [[(20:16), (16:15), (15:19), (19:18)], [(20:16), (16:15), (15:14), (14:18)], [(20:19), (19:18)]]
 20->19: minimo=1; maximo=3; medio=2 paths: [[(20:19)], [(20:16), (16:15), (15:19)]]

As ruas do bairro estão modeladas por um dígrafo onde os vértices representam cruzamentos e os arcos representam a direção do trecho de uma via que relaciona diretamente dois cruzamentos. Por exemplo, se

existe um trecho da via ***v*** que liga os cruzamentos ***a*** e ***b*** e cujo trânsito é direcionado do cruzamento ***a*** para o ***b***, então o arco (***a***,***b***) pertence ao grafo.

Usando a API JGraphT (jgrapht.org), implemente um programa que recebe um grafo tal como descrito acima e compute as informações solicitadas nos item 1., 2. e 3..

Exemplo para teste: bairro.gml (em anexo a esta tarefa)

Formato da Entrega: Os seguintes arquivos devem ser anexados, em um arquivo compactado, à tarefa criada para esta prática no Classroom, incluindo:

- Código documentado (.java);
- Arquivo txt ou pdf com saída gerada para o exemplo proposto.