Relatório — Fluxo em Redes (Caminho Mínimo)

Gerado em 2026-01-21T00:02:41.817641Z
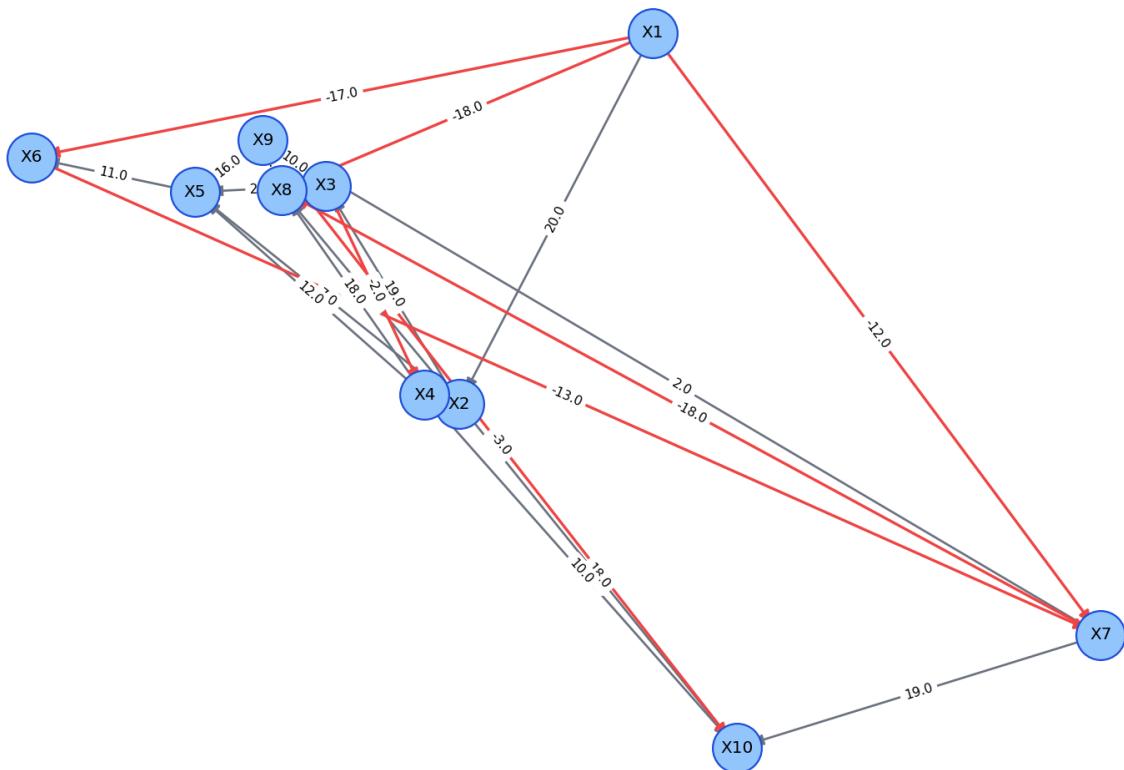
Simulação 1 — Bellman recursivo em DAG

n	m	neg_edges	runtime_s	dist_mean	dist_std
10	22	7	0.000021	-6.30	33.56
100	1307	462	0.000424	-126.24	90.15

Execução n=10

• Arestas (m): 22 | densidade efetiva: 0.244 | arestas negativas: 7

• Alcançáveis a partir de X1: 10/10

• Tempo de execução: 0.000021 s
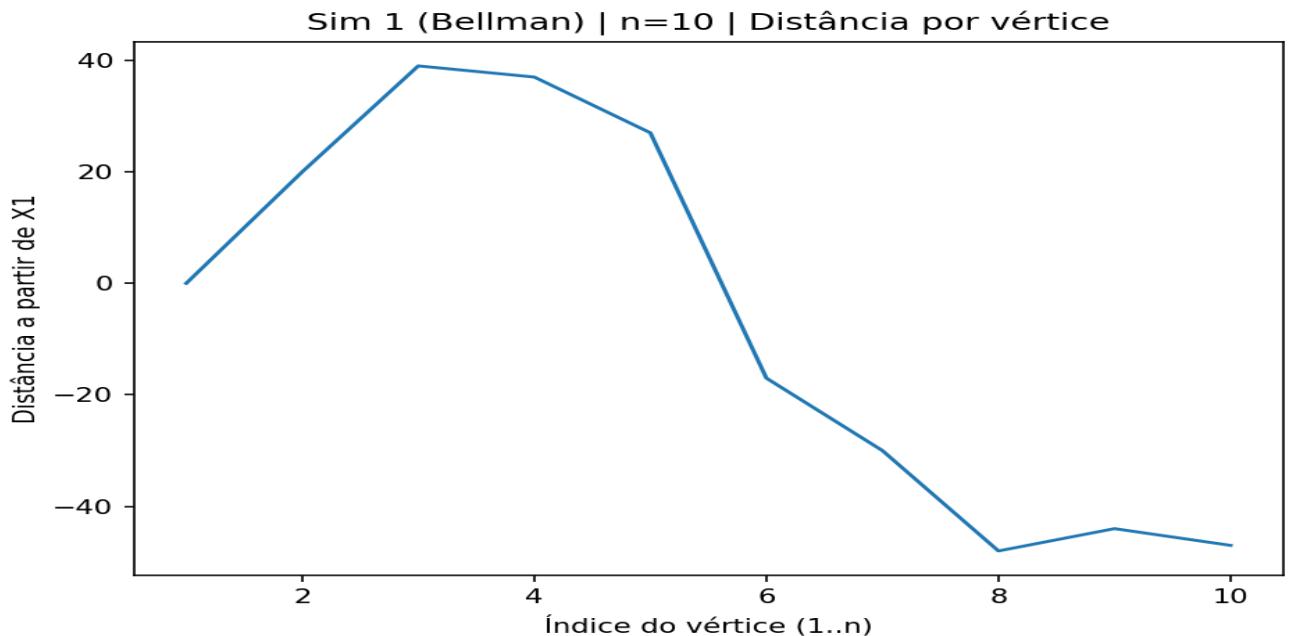
Simulação 1 — Bellman | n=10

Ranking de distância (mais perto → mais longe)

label	distance	path
X8	-48.00	X1 -> X6 -> X7 -> X8
X10	-47.00	X1 -> X6 -> X7 -> X8 -> X9 -> X10
X9	-44.00	X1 -> X6 -> X7 -> X8 -> X9
X7	-30.00	X1 -> X6 -> X7
X6	-17.00	X1 -> X6

X1	0.00	X1
X2	20.00	X1 -> X2
X5	27.00	X1 -> X2 -> X5
X4	37.00	X1 -> X2 -> X3 -> X4
X3	39.00	X1 -> X2 -> X3

Sim 1 (Bellman) | n=10 | Distância por vértice

Execução n=100
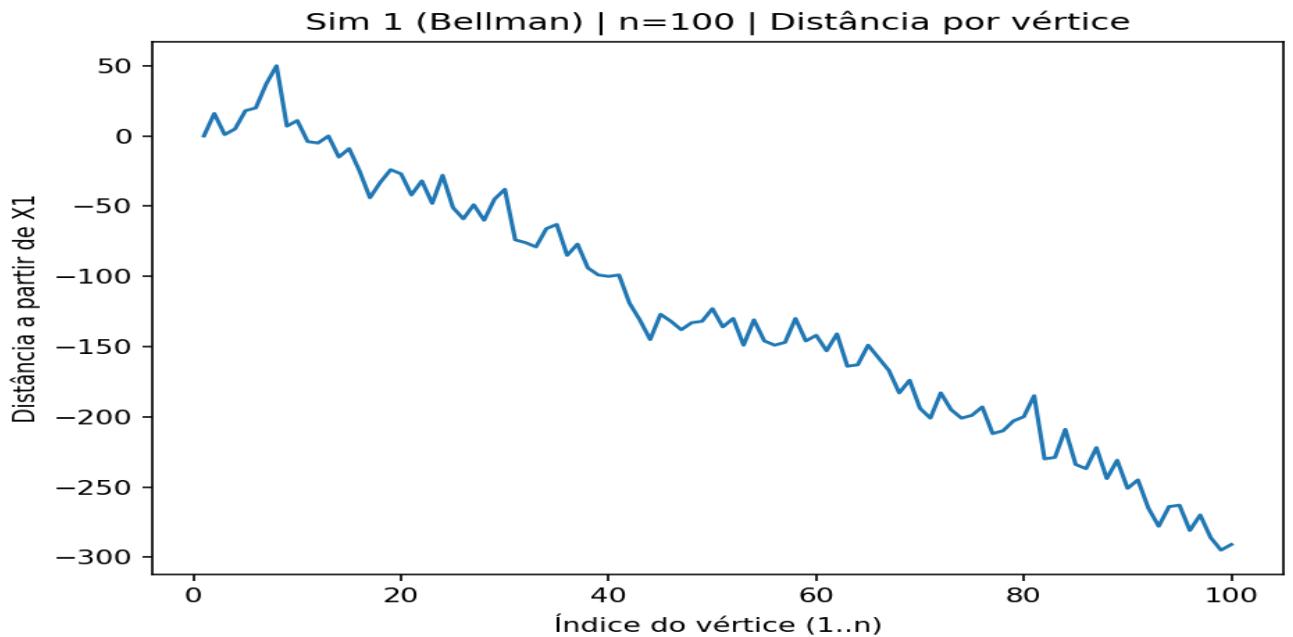
• Arestas (m): 1307 | densidade efetiva: 0.132 | arestas negativas: 462

• Alcançáveis a partir de X1: 100/100

• Tempo de execução: 0.000424 s

Top 10 mais distantes

label	distance	path
X8	50.00	X1 -> X2 -> X3 -> X4 -> X6 -> X7 -> X8
X7	37.00	X1 -> X2 -> X3 -> X4 -> X6 -> X7
X6	20.00	X1 -> X2 -> X3 -> X4 -> X6
X5	18.00	X1 -> X2 -> X3 -> X4 -> X5
X2	16.00	X1 -> X2
X10	11.00	X1 -> X2 -> X3 -> X9 -> X10
X9	7.00	X1 -> X2 -> X3 -> X9
X4	5.00	X1 -> X2 -> X3 -> X4
X3	1.00	X1 -> X2 -> X3
X1	0.00	X1

Top 10 mais próximos

label	distance	path
X99	-295.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X100	-291.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X98	-286.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X96	-281.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X93	-278.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X97	-270.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X92	-265.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X94	-264.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X95	-263.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,
X90	-251.00	x1,x2,x3,x4,x15,x16,x17,x20,x21,x25,x26,x33,x38,x39,x40,x41,x42,x43,x44,x61,x67,x68,x69,x70,x71,x77,x82,x83,x88,x89,

Sim 1 (Bellman) | n=100 | Distância por vértice
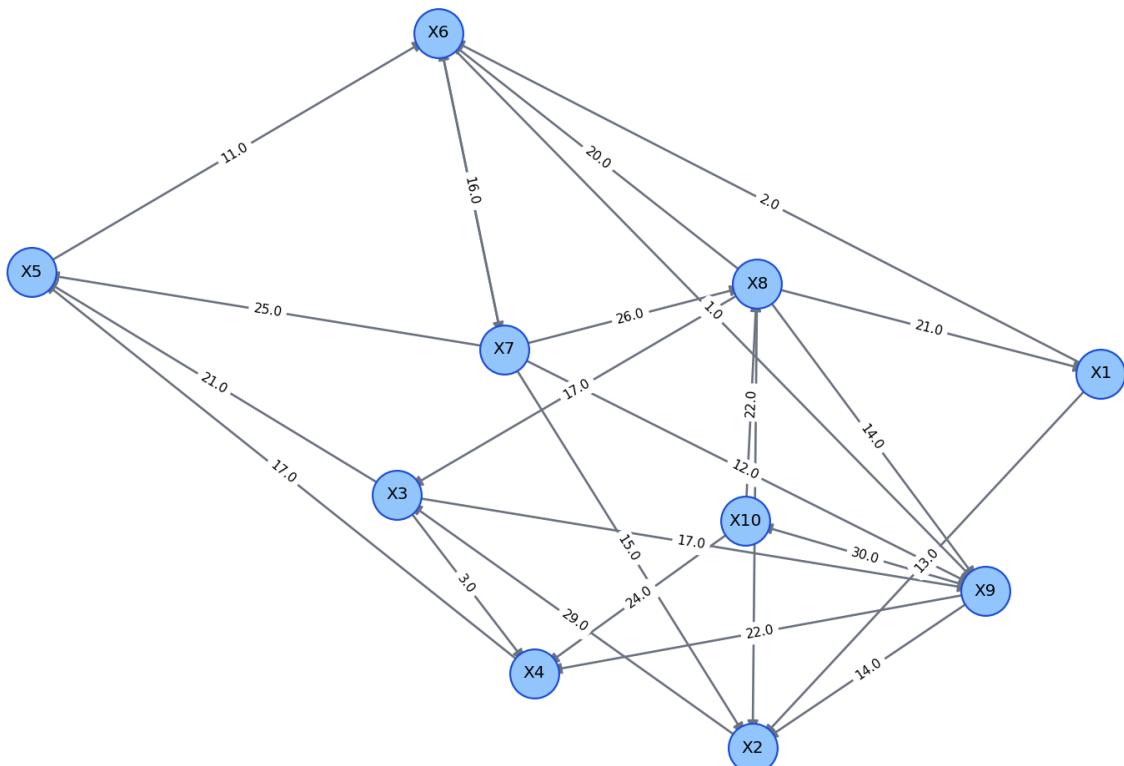
Simulação 2 — Dijkstra com Heap (Best-First)

n	m	neg_edges	runtime_s	dist_mean	dist_std
10	25	0	0.000039	24.00	17.89
100	2549	0	0.000386	6.70	2.42

Execução n=10

• Arestas (m): 25 | densidade efetiva: 0.278 | arestas negativas: 0

• Alcançáveis a partir de X1: 10/10

• Tempo de execução: 0.000039 s
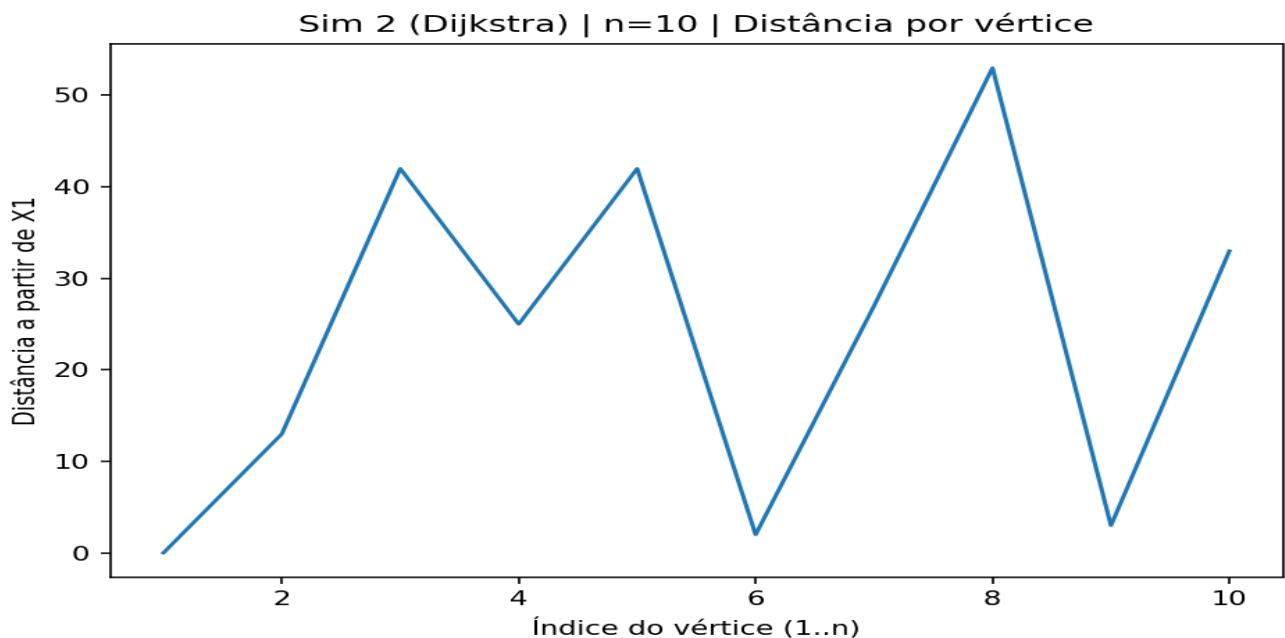
Simulação 2 — Dijkstra | n=10

Ranking de distância (mais perto → mais longe)

label	distance	path
X1	0.00	X1
X6	2.00	X1 -> X6
X9	3.00	X1 -> X6 -> X9
X2	13.00	X1 -> X2
X4	25.00	X1 -> X6 -> X9 -> X4

X7	27.00	X1 -> X6 -> X7
X10	33.00	X1 -> X6 -> X9 -> X10
X3	42.00	X1 -> X2 -> X3
X5	42.00	X1 -> X6 -> X9 -> X4 -> X5
X8	53.00	X1 -> X6 -> X7 -> X8

Sim 2 (Dijkstra) | n=10 | Distância por vértice

Execução n=100

- Arestas (m): 2549 | densidade efetiva: 0.257 | arestas negativas: 0
- Alcançáveis a partir de X1: 100/100
- Tempo de execução: 0.000386 s
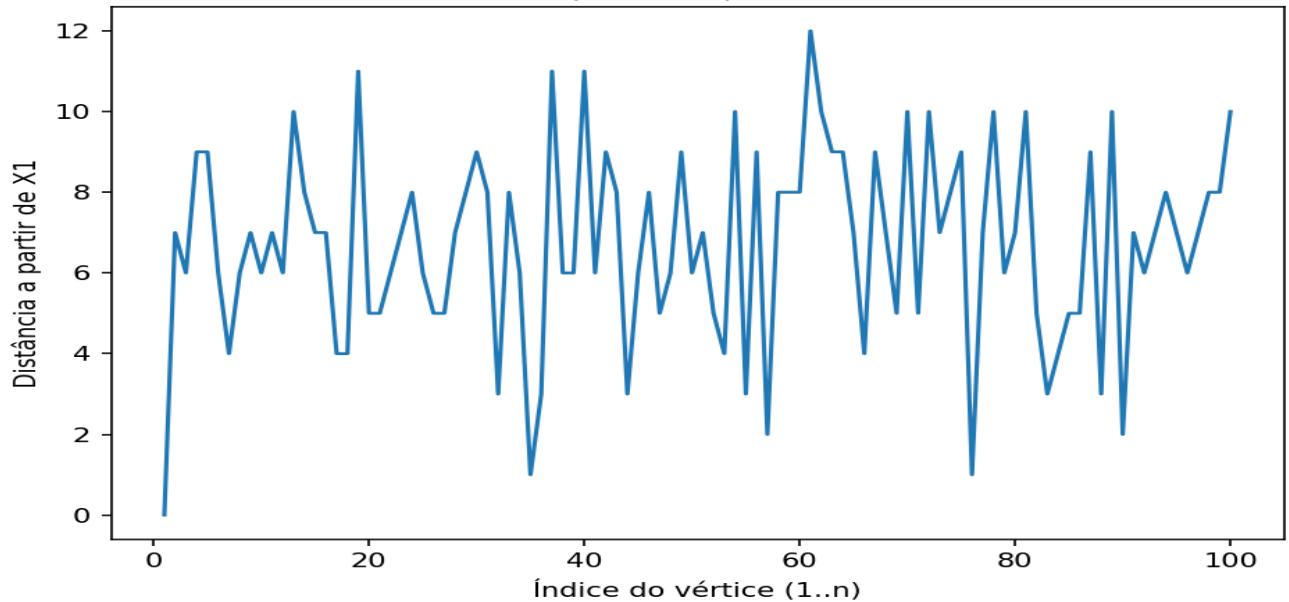
Top 10 mais distantes

label	distance	path
X61	12.00	X1 -> X32 -> X38 -> X23 -> X59 -> X4 -> X61
X37	11.00	X1 -> X76 -> X57 -> X36 -> X71 -> X6 -> X37
X19	11.00	X1 -> X76 -> X57 -> X55 -> X19
X40	11.00	X1 -> X32 -> X86 -> X14 -> X40
X70	10.00	X1 -> X70
X81	10.00	X1 -> X76 -> X57 -> X52 -> X68 -> X81
X72	10.00	X1 -> X76 -> X57 -> X84 -> X34 -> X60 -> X72
X100	10.00	X1 -> X32 -> X95 -> X100
X89	10.00	X1 -> X76 -> X57 -> X55 -> X85 -> X15 -> X89
X62	10.00	X1 -> X27 -> X62

Top 10 mais próximos

label	distance	path
X1	0.00	x1
X35	1.00	x1,x35
X76	1.00	x1,x76
X57	2.00	x1,x76,x57
X90	2.00	x1,x35,x90
X44	3.00	x1,x76,x57,x44
X36	3.00	x1,x76,x57,x36
X32	3.00	x1,x32
X88	3.00	x1,x76,x88
X83	3.00	x1,x83

Sim 2 (Dijkstra) | n=100 | Distância por vértice
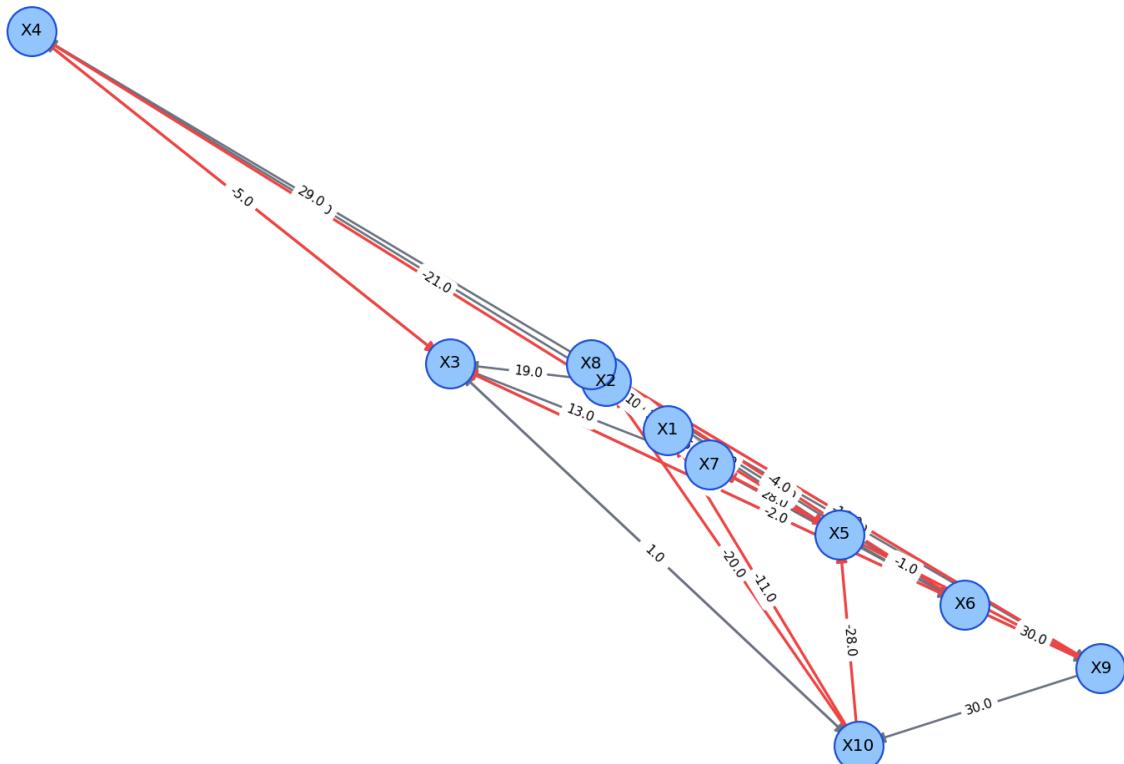
Simulação 3 — Floyd-Warshall (matriz de custos)

| n	m	neg_edges	runtime_s	dist_mean	dist_std
10	32	9	0.001228	24.60	13.97
100	2499	564	1.296992	0.77	11.33

Execução n=10

- Arestas (m): 32 | densidade efetiva: 0.356 | arestas negativas: 9
- Alcançáveis a partir de X1: 10/10
- Tempo de execução: 0.001228 s
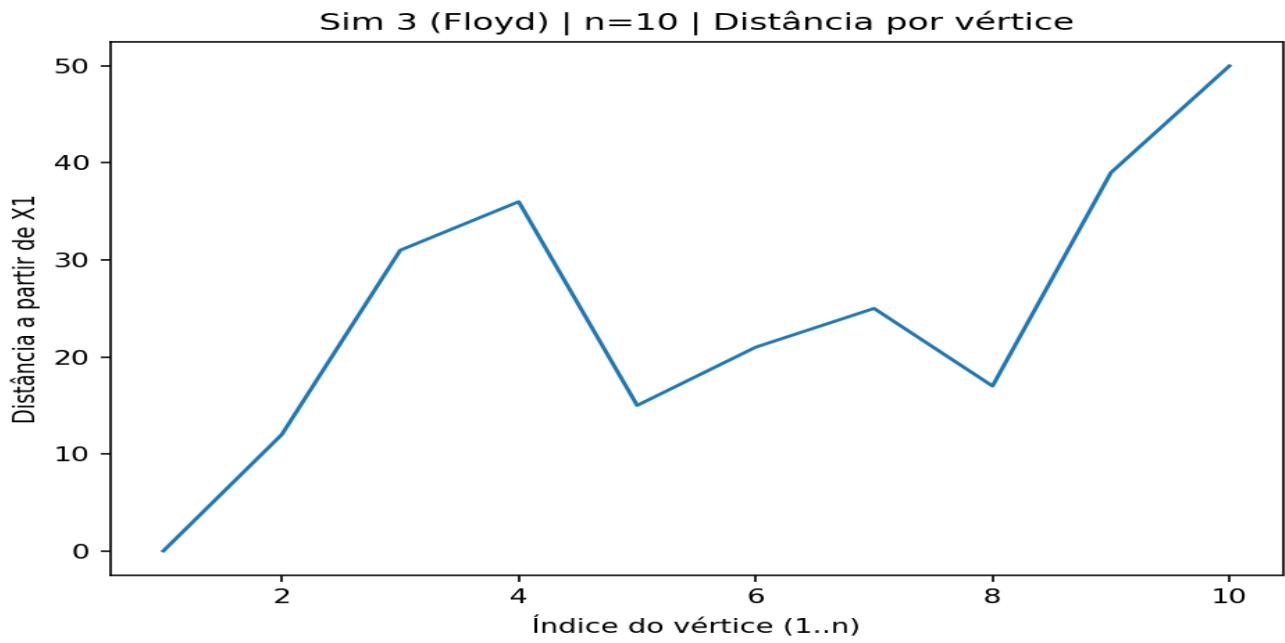
Simulação 3 — Floyd | n=10

Ranking de distância (mais perto → mais longe)

label	distance	path
X1	0.00	X1
X2	12.00	X1 -> X2
X5	15.00	X1 -> X2 -> X4 -> X5
X8	17.00	X1 -> X2 -> X6 -> X8
X6	21.00	X1 -> X2 -> X6

X7	25.00	X1 -> X7
X3	31.00	X1 -> X2 -> X3
X4	36.00	X1 -> X2 -> X4
X9	39.00	X1 -> X2 -> X9
X10	50.00	X1 -> X2 -> X3 -> X10

Sim 3 (Floyd) | n=10 | Distância por vértice

Execução n=100
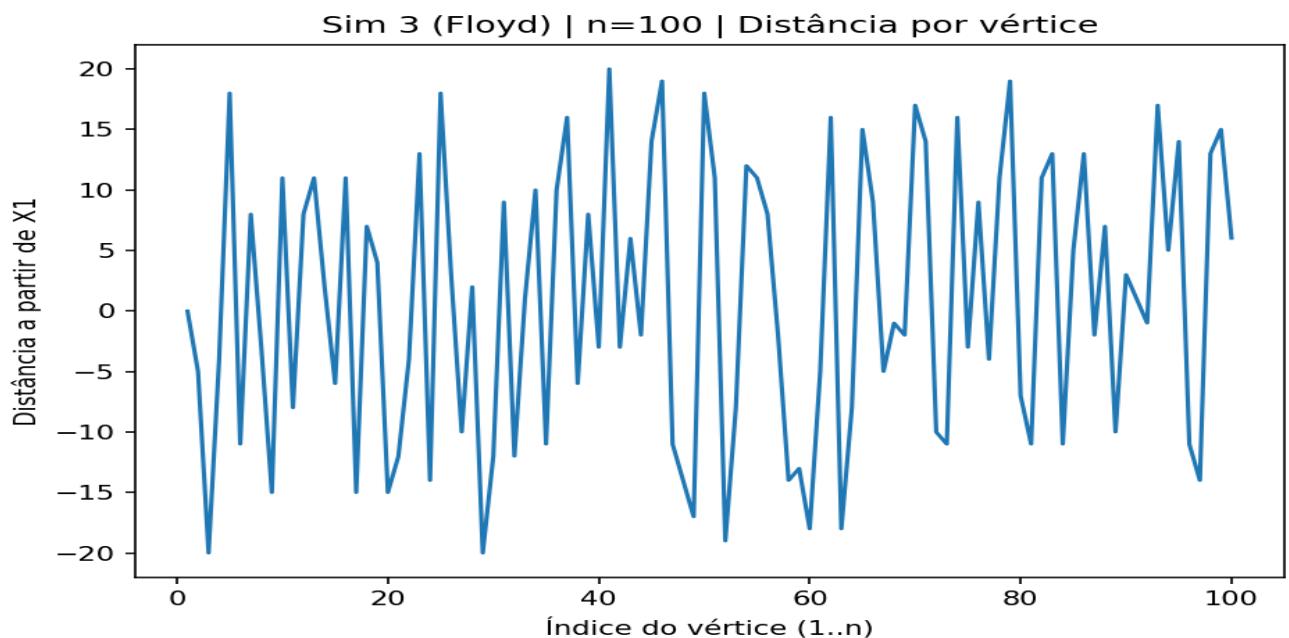
• Arestas (m): 2499 | densidade efetiva: 0.252 | arestas negativas: 564

• Alcançáveis a partir de X1: 100/100

• Tempo de execução: 1.296992 s

Top 10 mais distantes

label	distance	path
X41	20.00	X1 -> X12 -> X41
X46	19.00	X1 -> X47 -> X87 -> X83 -> X46
X79	19.00	X1 -> X47 -> X87 -> X90 -> X79
X25	18.00	X1 -> X47 -> X87 -> X90 -> X79 -> X25
X5	18.00	X1 -> X29 -> X5
X50	18.00	X1 -> X58 -> X64 -> X37 -> X95 -> X50
X93	17.00	X1 -> X93
X70	17.00	X1 -> X47 -> X87 -> X70
X62	16.00	X1 -> X47 -> X72 -> X84 -> X62
X74	16.00	X1 -> X12 -> X74

Top 10 mais próximos

label	distance	path
X3	-20.00	x1,x47,x72,x60,x3
X29	-20.00	x1,x29
X52	-19.00	x1,x47,x72,x84,x52
X60	-18.00	x1,x47,x72,x60
X63	-18.00	x1,x47,x72,x84,x88,x63
X49	-17.00	x1,x47,x15,x49
X17	-15.00	x1,x47,x72,x84,x88,x89,x16,x55,x17
X9	-15.00	x1,x29,x66,x9
X20	-15.00	x1,x58,x20
X24	-14.00	x1,x47,x72,x84,x31,x24

Sim 3 (Floyd) | n=100 | Distância por vértice

Parte 2 — Linguagem generativa (prompts)

Modelo utilizado e especificações

• Modelo utilizado: GPT

• Versão/fornecedor: 5.2 Thinking

• Prompt final utilizado: Dado os grafos direcionados com vértices X1..Xn: (6 arquivos .txt anexados) calcule apenas o custo do caminho mínimo de X1 até todos os demais vértices Para cada um dos arquivos .txt anexados Devolva listas de n valores d(X1)..d(Xn), uma para cada arquivo .txt.

• Observações de execução: A LLM pensou por 2m e 37 segundos ao total para as 6 simulações

Comparação LLM vs algoritmos

sim_id	sim_name	n	n_alg	n_llm	matches	compared	mean_abs_diff	max_abs_diff
1	Bellman	10	10	10	10	10	0.00	0.00
1	Bellman	100	100	98	17	98	22.73	97.00
2	Dijkstra	10	10	10	10	10	0.00	0.00
2	Dijkstra	100	100	100	27	100	1.95	7.00
3	Floyd	10	10	10	10	10	0.00	0.00
3	Floyd	100	100	104	16	100	11.70	38.00

Lado a lado — sim1 Bellman n=10

vertex	alg_distance	llm_distance	abs_diff
x1	0.00	0.00	0.00
x2	20.00	20.00	0.00
x3	39.00	39.00	0.00
x4	37.00	37.00	0.00
x5	27.00	27.00	0.00
x6	-17.00	-17.00	0.00
x7	-30.00	-30.00	0.00
x8	-48.00	-48.00	0.00
x9	-44.00	-44.00	0.00
x10	-47.00	-47.00	0.00

Lado a lado — sim1 Bellman n=100

vertex	alg_distance	llm_distance	abs_diff
x1	0.00	0.00	0.00
x2	16.00	16.00	0.00
x3	1.00	1.00	0.00

x4	5.00	5.00	0.00
x5	18.00	18.00	0.00
x6	20.00	20.00	0.00
x7	37.00	37.00	0.00
x8	50.00	50.00	0.00
x9	7.00	7.00	0.00
x10	11.00	11.00	0.00
x11	-4.00	-4.00	0.00
x12	-5.00	-5.00	0.00
x13	0.00	0.00	0.00
x14	-15.00	-15.00	0.00
x15	-9.00	-9.00	0.00
x16	-25.00	-25.00	0.00
x17	-44.00	-41.00	3.00
x18	-33.00	-50.00	17.00
x19	-24.00	-33.00	9.00
x20	-27.00	-40.00	13.00
x21	-42.00	-50.00	8.00
x22	-32.00	-10.00	22.00
x23	-48.00	-26.00	22.00
x24	-28.00	-4.00	24.00
x25	-51.00	-25.00	26.00
x26	-59.00	-33.00	26.00
x27	-49.00	-23.00	26.00
x28	-60.00	-30.00	30.00
x29	-45.00	-50.00	5.00
x30	-38.00	-46.00	8.00
x31	-74.00	-55.00	19.00
x32	-76.00	-57.00	19.00
x33	-79.00	-37.00	42.00
x34	-66.00	-46.00	20.00
x35	-63.00	-61.00	2.00
x36	-85.00	-59.00	26.00
x37	-77.00	-75.00	2.00
x38	-94.00	-84.00	10.00
x39	-99.00	-62.00	37.00
x40	-100.00	-63.00	37.00
x41	-99.00	-62.00	37.00

x42	-119.00	-65.00	54.00
x43	-131.00	-54.00	77.00
x44	-145.00	-48.00	97.00
x45	-127.00	-60.00	67.00
x46	-132.00	-63.00	69.00
x47	-138.00	-69.00	69.00
x48	-133.00	-64.00	69.00
x49	-132.00	-71.00	61.00
x50	-123.00	-83.00	40.00
x51	-136.00	-87.00	49.00
x52	-130.00	-81.00	49.00
x53	-149.00	-84.00	65.00
x54	-131.00	-79.00	52.00
x55	-146.00	-85.00	61.00
x56	-149.00	-88.00	61.00
x57	-147.00	-99.00	48.00
x58	-130.00	-93.00	37.00
x59	-146.00	-116.00	30.00
x60	-142.00	-113.00	29.00
x61	-153.00	-136.00	17.00
x62	-141.00	-149.00	8.00
x63	-164.00	-155.00	9.00
x64	-163.00	-157.00	6.00
x65	-149.00	-170.00	21.00
x66	-158.00	-170.00	12.00
x67	-167.00	-179.00	12.00
x68	-183.00	-187.00	4.00
x69	-174.00	-191.00	17.00
x70	-194.00	-191.00	3.00
x71	-201.00	-195.00	6.00
x72	-183.00	-197.00	14.00
x73	-195.00	-214.00	19.00
x74	-201.00	-213.00	12.00
x75	-199.00	-218.00	19.00
x76	-193.00	-225.00	32.00
x77	-212.00	-232.00	20.00
x78	-210.00	-226.00	16.00
x79	-203.00	-242.00	39.00

vertex	alg_distance	llm_distance	abs_diff
x80	-200.00	-236.00	36.00
x81	-185.00	-244.00	59.00
x82	-230.00	-248.00	18.00
x83	-229.00	-247.00	18.00
x84	-209.00	-251.00	42.00
x85	-234.00	-251.00	17.00
x86	-237.00	-248.00	11.00
x87	-222.00	-253.00	31.00
x88	-244.00	-244.00	0.00
x89	-231.00	-245.00	14.00
x90	-251.00	-265.00	14.00
x91	-245.00	-278.00	33.00
x92	-265.00	-264.00	1.00
x93	-278.00	-263.00	15.00
x94	-264.00	-281.00	17.00
x95	-263.00	-270.00	7.00
x96	-281.00	-286.00	5.00
x97	-270.00	-295.00	25.00
x98	-286.00	-291.00	5.00

Lado a lado — sim2 Dijkstra n=10

vertex	alg_distance	llm_distance	abs_diff
x1	0.00	0.00	0.00
x2	13.00	13.00	0.00
x3	42.00	42.00	0.00
x4	25.00	25.00	0.00
x5	42.00	42.00	0.00
x6	2.00	2.00	0.00
x7	27.00	27.00	0.00
x8	53.00	53.00	0.00
x9	3.00	3.00	0.00
x10	33.00	33.00	0.00

Lado a lado — sim2 Dijkstra n=100

vertex	alg_distance	llm_distance	abs_diff
x1	0.00	0.00	0.00
x2	7.00	7.00	0.00

x3	6.00	6.00	0.00
x4	9.00	9.00	0.00
x5	9.00	9.00	0.00
x6	6.00	6.00	0.00
x7	4.00	4.00	0.00
x8	6.00	6.00	0.00
x9	7.00	7.00	0.00
x10	6.00	6.00	0.00
x11	7.00	10.00	3.00
x12	6.00	9.00	3.00
x13	10.00	9.00	1.00
x14	8.00	7.00	1.00
x15	7.00	5.00	2.00
x16	7.00	7.00	0.00
x17	4.00	11.00	7.00
x18	4.00	4.00	0.00
x19	11.00	10.00	1.00
x20	5.00	9.00	4.00
x21	5.00	6.00	1.00
x22	6.00	4.00	2.00
x23	7.00	8.00	1.00
x24	8.00	7.00	1.00
x25	6.00	9.00	3.00
x26	5.00	9.00	4.00
x27	5.00	6.00	1.00
x28	7.00	10.00	3.00
x29	8.00	8.00	0.00
x30	9.00	5.00	4.00
x31	8.00	9.00	1.00
x32	3.00	9.00	6.00
x33	8.00	8.00	0.00
x34	6.00	5.00	1.00
x35	1.00	7.00	6.00
x36	3.00	6.00	3.00
x37	11.00	9.00	2.00
x38	6.00	6.00	0.00
x39	6.00	8.00	2.00
x40	11.00	10.00	1.00

x41	6.00	7.00	1.00
x42	9.00	6.00	3.00
x43	8.00	7.00	1.00
x44	3.00	7.00	4.00
x45	6.00	8.00	2.00
x46	8.00	11.00	3.00
x47	5.00	7.00	2.00
x48	6.00	10.00	4.00
x49	9.00	10.00	1.00
x50	6.00	8.00	2.00
x51	7.00	9.00	2.00
x52	5.00	7.00	2.00
x53	4.00	7.00	3.00
x54	10.00	8.00	2.00
x55	3.00	7.00	4.00
x56	9.00	8.00	1.00
x57	2.00	6.00	4.00
x58	8.00	8.00	0.00
x59	8.00	9.00	1.00
x60	8.00	9.00	1.00
x61	12.00	8.00	4.00
x62	10.00	8.00	2.00
x63	9.00	9.00	0.00
x64	9.00	7.00	2.00
x65	7.00	8.00	1.00
x66	4.00	9.00	5.00
x67	9.00	7.00	2.00
x68	7.00	8.00	1.00
x69	5.00	9.00	4.00
x70	10.00	7.00	3.00
x71	5.00	11.00	6.00
x72	10.00	9.00	1.00
x73	7.00	6.00	1.00
x74	8.00	8.00	0.00
x75	9.00	10.00	1.00
x76	1.00	8.00	7.00
x77	7.00	7.00	0.00
x78	10.00	9.00	1.00

x79	6.00	6.00	0.00
x80	7.00	8.00	1.00
x81	10.00	8.00	2.00
x82	5.00	10.00	5.00
x83	3.00	9.00	6.00
x84	4.00	7.00	3.00
x85	5.00	8.00	3.00
x86	5.00	9.00	4.00
x87	9.00	9.00	0.00
x88	3.00	8.00	5.00
x89	10.00	8.00	2.00
x90	2.00	8.00	6.00
x91	7.00	7.00	0.00
x92	6.00	8.00	2.00
x93	7.00	10.00	3.00
x94	8.00	8.00	0.00
x95	7.00	7.00	0.00
x96	6.00	10.00	4.00
x97	7.00	8.00	1.00
x98	8.00	8.00	0.00
x99	8.00	8.00	0.00
x100	10.00	10.00	0.00

Lado a lado — sim3 Floyd n=10

vertex	alg_distance	llm_distance	abs_diff
x1	0.00	0.00	0.00
x2	12.00	12.00	0.00
x3	31.00	31.00	0.00
x4	36.00	36.00	0.00
x5	15.00	15.00	0.00
x6	21.00	21.00	0.00
x7	25.00	25.00	0.00
x8	17.00	17.00	0.00
x9	39.00	39.00	0.00
x10	50.00	50.00	0.00

Lado a lado — sim3 Floyd n=100

vertex	alg_distance	llm_distance	abs_diff
x1	0.00	0.00	0.00
x2	-5.00	-5.00	0.00
x3	-20.00	-20.00	0.00
x4	-4.00	-4.00	0.00
x5	18.00	18.00	0.00
x6	-11.00	-11.00	0.00
x7	8.00	8.00	0.00
x8	-3.00	-3.00	0.00
x9	-15.00	-15.00	0.00
x10	11.00	11.00	0.00
x11	-8.00	-8.00	0.00
x12	8.00	8.00	0.00
x13	11.00	11.00	0.00
x14	2.00	2.00	0.00
x15	-6.00	-6.00	0.00
x16	11.00	-11.00	22.00
x17	-15.00	-5.00	10.00
x18	7.00	13.00	6.00
x19	4.00	-15.00	19.00
x20	-15.00	8.00	23.00
x21	-12.00	-4.00	8.00
x22	-4.00	-12.00	8.00
x23	13.00	20.00	7.00
x24	-14.00	-10.00	4.00
x25	18.00	12.00	6.00
x26	3.00	-19.00	22.00
x27	-10.00	2.00	12.00
x28	2.00	6.00	4.00
x29	-20.00	-8.00	12.00
x30	-12.00	12.00	24.00
x31	9.00	1.00	8.00
x32	-12.00	-11.00	1.00
x33	1.00	-2.00	3.00
x34	10.00	-13.00	23.00
x35	-11.00	18.00	29.00
x36	10.00	-2.00	12.00
x37	16.00	-4.00	20.00

x38	-6.00	20.00	26.00
x39	8.00	-9.00	17.00
x40	-3.00	10.00	13.00
x41	20.00	14.00	6.00
x42	-3.00	14.00	17.00
x43	6.00	-14.00	20.00
x44	-2.00	10.00	12.00
x45	14.00	-14.00	28.00
x46	19.00	10.00	9.00
x47	-11.00	-12.00	1.00
x48	-14.00	9.00	23.00
x49	-17.00	2.00	19.00
x50	18.00	18.00	0.00
x51	11.00	9.00	2.00
x52	-19.00	19.00	38.00
x53	-8.00	2.00	10.00
x54	12.00	14.00	2.00
x55	11.00	20.00	9.00
x56	8.00	17.00	9.00
x57	-2.00	-3.00	1.00
x58	-14.00	-7.00	7.00
x59	-13.00	-1.00	12.00
x60	-18.00	0.00	18.00
x61	-5.00	1.00	6.00
x62	16.00	11.00	5.00
x63	-18.00	19.00	37.00
x64	-8.00	9.00	17.00
x65	15.00	-17.00	32.00
x66	9.00	19.00	10.00
x67	-5.00	7.00	12.00
x68	-1.00	1.00	2.00
x69	-2.00	-3.00	1.00
x70	17.00	-9.00	26.00
x71	14.00	-17.00	31.00
x72	-10.00	10.00	20.00
x73	-11.00	14.00	25.00
x74	16.00	4.00	12.00
x75	-3.00	12.00	15.00

x76	9.00	-10.00	19.00
x77	-4.00	17.00	21.00
x78	11.00	-7.00	18.00
x79	19.00	15.00	4.00
x80	-7.00	-5.00	2.00
x81	-11.00	-13.00	2.00
x82	11.00	-2.00	13.00
x83	13.00	-15.00	28.00
x84	-11.00	10.00	21.00
x85	5.00	-9.00	14.00
x86	13.00	-9.00	22.00
x87	-2.00	6.00	8.00
x88	7.00	15.00	8.00
x89	-10.00	-15.00	5.00
x90	3.00	12.00	9.00
x91	1.00	-13.00	14.00
x92	-1.00	3.00	4.00
x93	17.00	20.00	3.00
x94	5.00	20.00	15.00
x95	14.00	4.00	10.00
x96	-11.00	-3.00	8.00
x97	-14.00	13.00	27.00
x98	13.00	-20.00	33.00
x99	15.00	-1.00	16.00
x100	6.00	-7.00	13.00

Resumo executivo

sim_id	sim_name	n	m	neg_edges	runtime_s	dist_reachable	dist_mean	dist_max
1	Bellman	10	22	7	0.000021	10	-6.30	39.00
1	Bellman	100	1307	462	0.000424	100	-126.24	50.00
2	Dijkstra	10	25	0	0.000039	10	24.00	53.00
2	Dijkstra	100	2549	0	0.000386	100	6.70	12.00
3	Floyd	10	32	9	0.001228	10	24.60	50.00
3	Floyd	100	2499	564	1.296992	100	0.77	20.00