

# **Relatório — Fluxo em Redes (Caminho Mínimo)**

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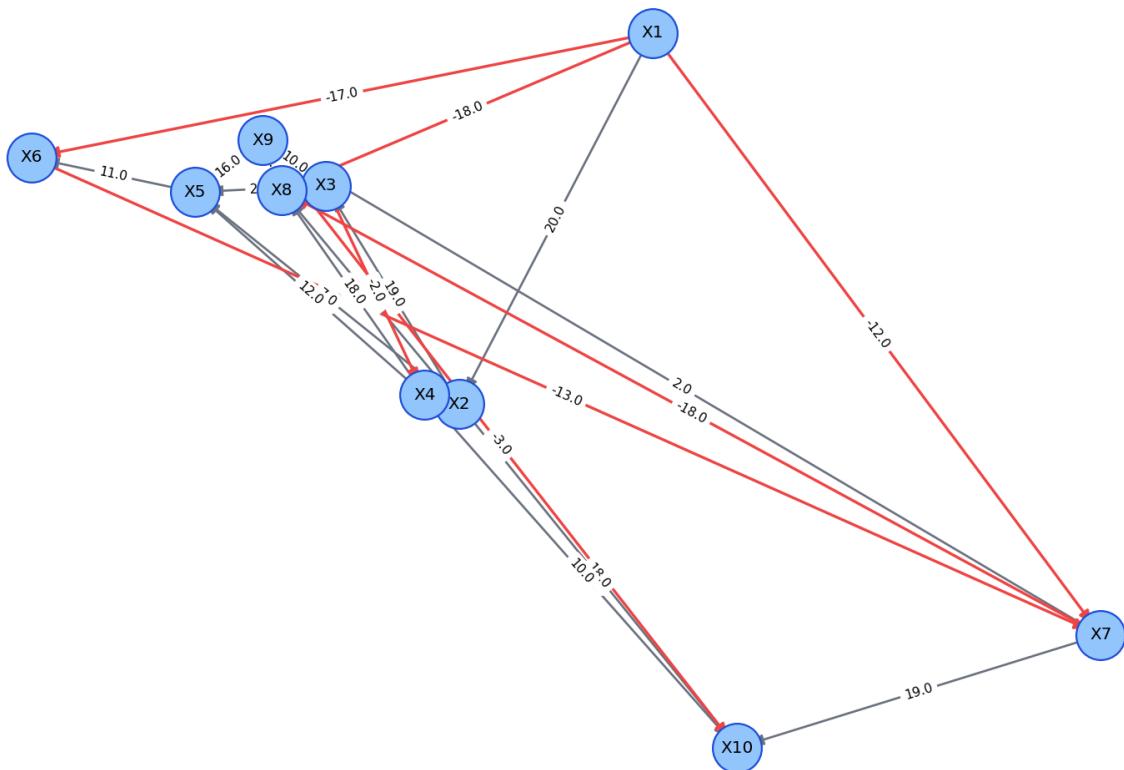
# Simulação 1 — Bellman recursivo em DAG

| 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

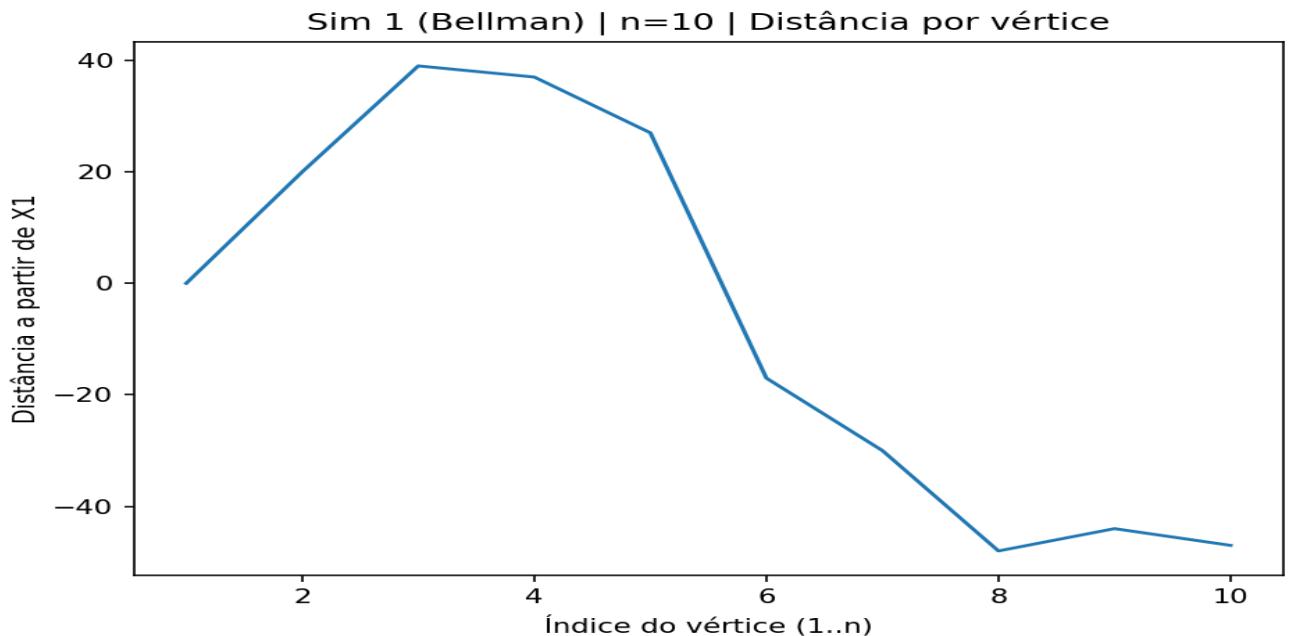
Simulação 1 — Bellman | n=10



## 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       |



## Execução n=100

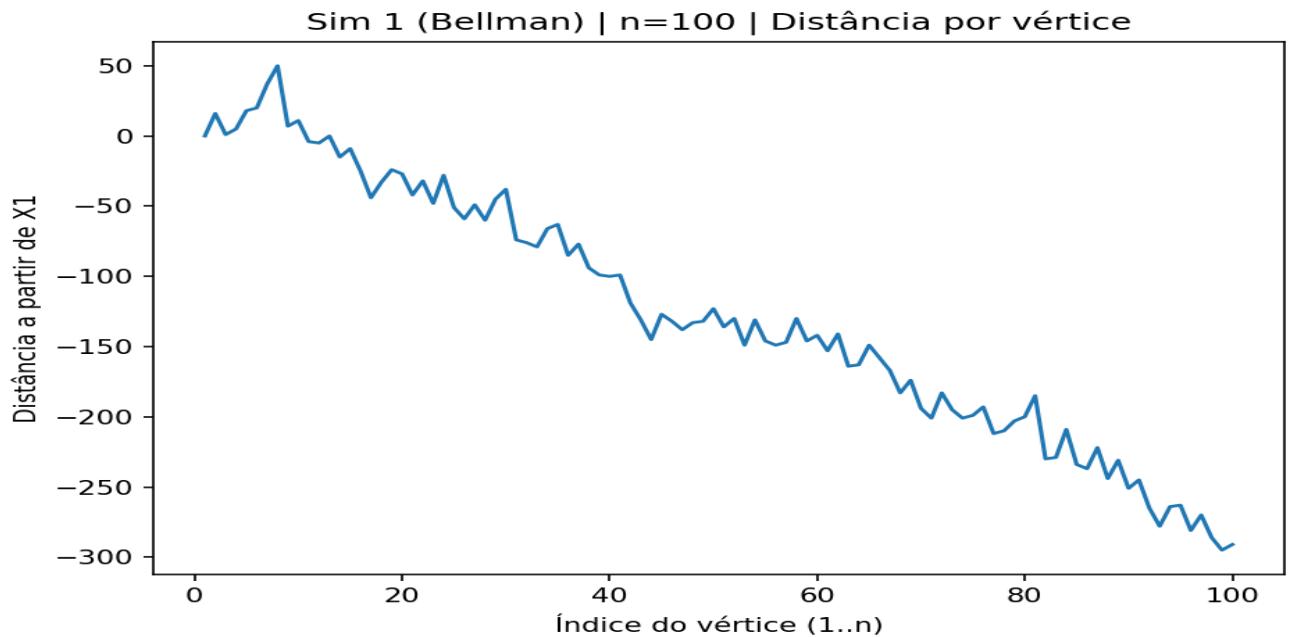
- Arestas (m): 1307 | densidade efetiva: 0.132 | arestas negativas: 462
- Alcançáveis a partir de X1: 100/100
- Tempo de execução: 0.000424 s

## 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, |



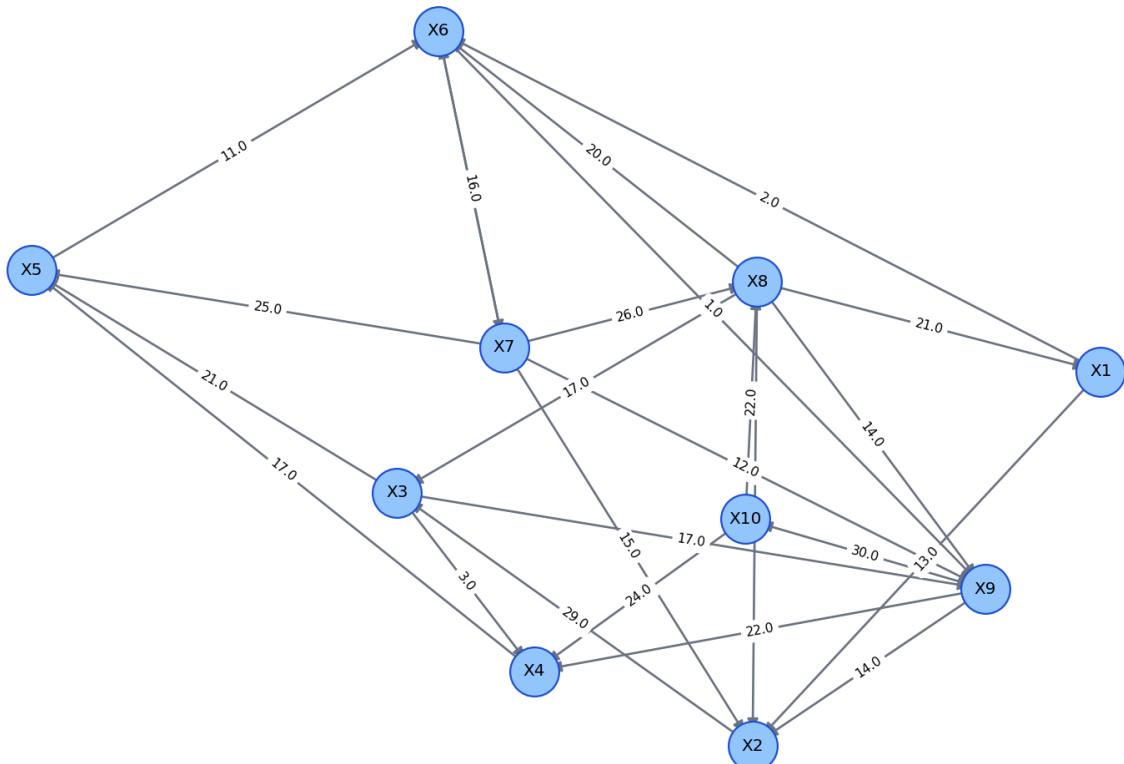
## Simulação 2 — Dijkstra com Heap (Best-First)

| 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

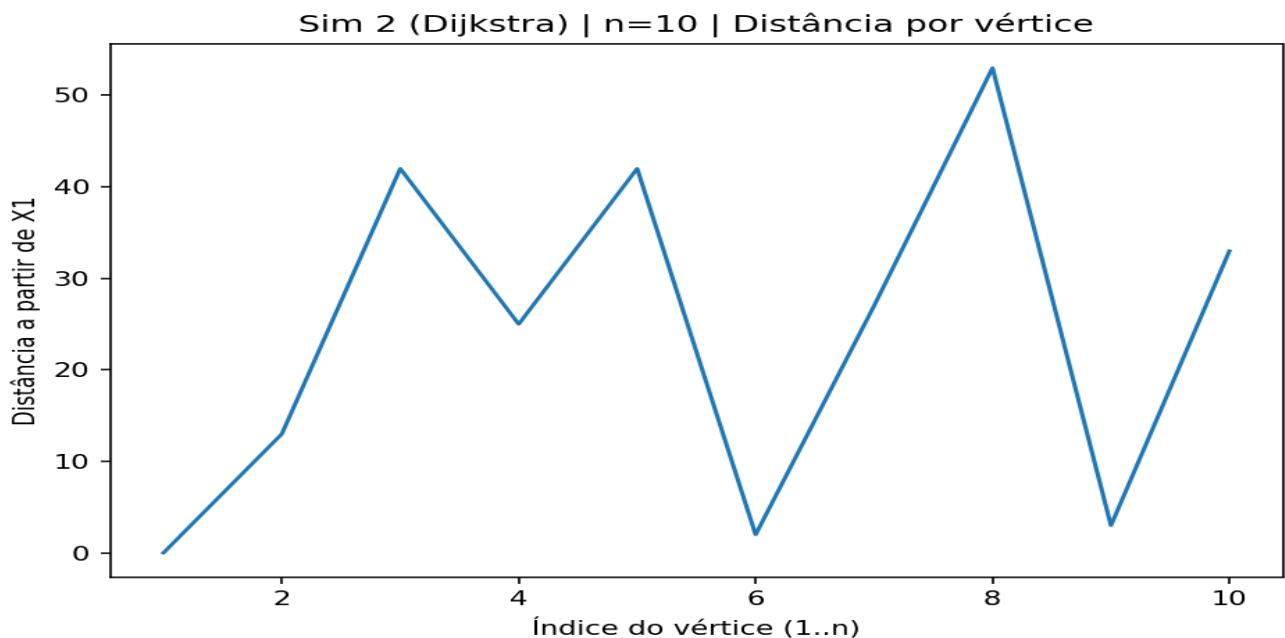
Simulação 2 — Dijkstra | n=10



### 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       |



## Execução n=100

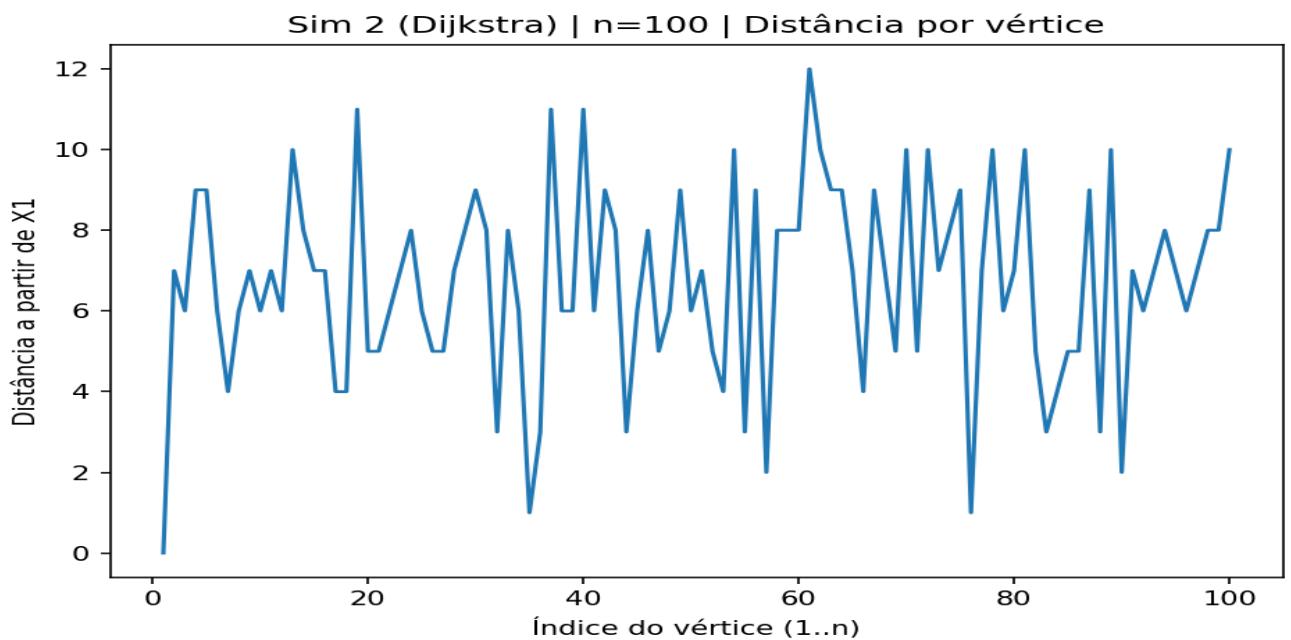
- Arestas (m): 2549 | densidade efetiva: 0.257 | arestas negativas: 0
- Alcançáveis a partir de X1: 100/100
- Tempo de execução: 0.000386 s

## 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         |



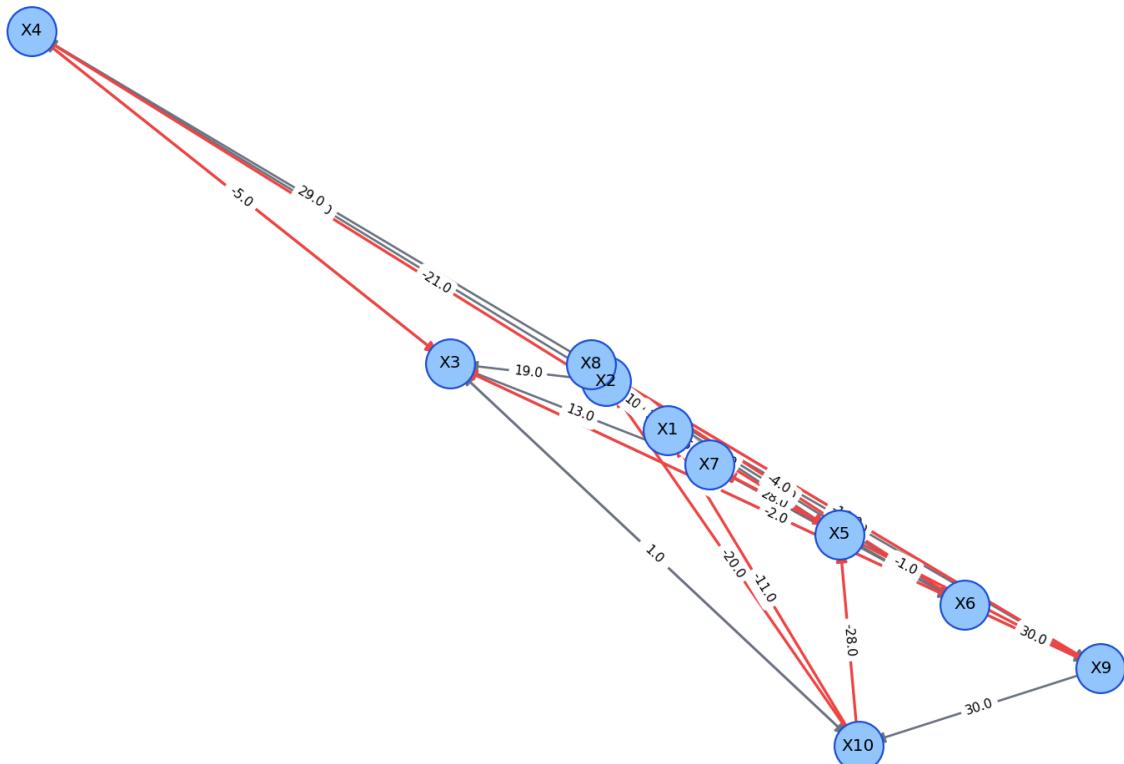
## Simulação 3 — Floyd-Warshall (matriz de custos)

| 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

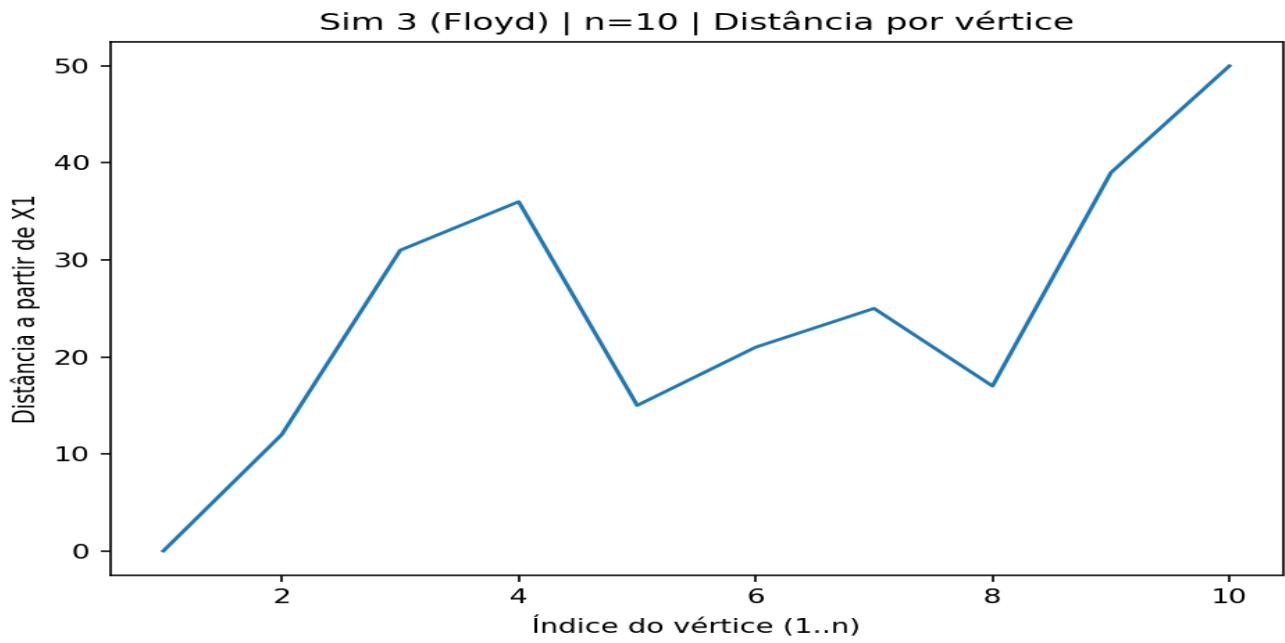
Simulação 3 — Floyd | n=10



### 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 |



## Execução n=100

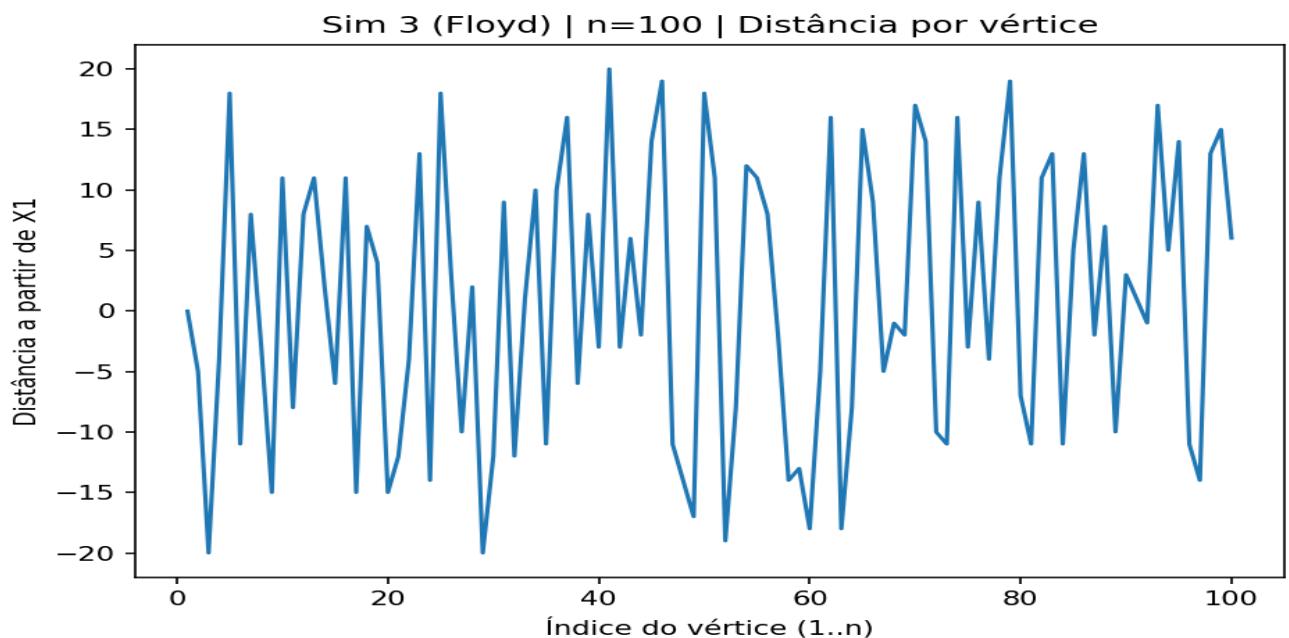
- Arestas (m): 2499 | densidade efetiva: 0.252 | arestas negativas: 564
- Alcançáveis a partir de X1: 100/100
- Tempo de execução: 1.296992 s

## 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             |



## 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    |