Báo cáo Phân tích thiết kế giải thuật

1. **Nêu bài toán**

Với thuật toán Dijsktra hay Bellman đã giải quyết vấn đề tìm đường đi ngắn nhất từ 1 đỉnh tới n đỉnh còn lại trong đồ thị. Bài toán đặt ra ở đây là tìm đường đi ngắn nhất giữa mọi cặp đỉnh trong đồ thị (có thể có trọng số âm nhưng không có chu trình âm) sau một lần chạy thuật toán

1. **Mô tả chi tiết thuật toán**

* Cho đồ thị có hướng, có trọng số G = (V, E) với n đỉnh và m cạnh, không có chu trình âm.
* Gọi d(u, v) là khoảng cách từ u tới v
* Từ ma trận trọng số ta tính lại các d[u, v] thành độ dài đường đi ngắn nhất từ u tới v
* Với mọi đỉnh k của đồ thị được xét theo thứ tự từ 1 tới n , xét mọi cặp đỉnh u, v. Cực tiểu hóa theo công thức:

d[u, v] := min(d[u, v], d[u, k] + d[k, v])

* Công thức đó thể hiện rằng nếu đường đi từ u tới v đang có lại dài hơn đường đi từ u tới k cộng với đường đi từ k tới v thì ta bỏ đường đi từ u tới v hiện tại và coi đường đi từ u tới v là nối của u tới k và k tới v
* Sử dụng một ma trận p để lưu lại đường đi
* Giả mã

for k := 1 to n do

for u := 1 to n do

for v := 1 to n do

d[u, v] := min(d[u, v], d[u, k] + d[k, v]);

1. **Hoạt động của thuật toán**

***Bộ dữ liệu 1:***

8

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Các bước của thuật toán:

* Bước 1: (Khởi tạo)

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 |  |  |  | ∞ | ∞ | ∞ | ∞ |
| 2 | 0 | 4 | 2 |  | ∞ | ∞ | ∞ | ∞ | ∞ |
| 3 | 4 | 0 | 1 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
|  | 2 | 1 | 0 | 4 | ∞ | 3 | ∞ | ∞ |  |
| ∞ | ∞ | ∞ | 4 | 0 | 8 | 5 | ∞ | ∞ | ∞ |
|  |  | ∞ | ∞ | 8 | 0 | ∞ | 2 | 10 | 6 |
| ∞ | ∞ | ∞ | 3 | 5 | ∞ | 0 | 4 | 1 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 2 | 4 | 0 | 7 |  |
| ∞ | ∞ | ∞ | ∞ | ∞ | 10 | 1 | 7 | 0 | 3 |
| ∞ | ∞ | ∞ |  | ∞ | 6 | ∞ |  | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* Bước 2: (bước lặp)
  + k = 1:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 |  |  |  | ∞ | ∞ | ∞ | ∞ |
| 2 | 0 | 4 | 2 |  | ∞ | ∞ | ∞ | ∞ | ∞ |
| 3 | 4 | 0 | 1 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
|  | 2 | 1 | 0 | 4 | ∞ | 3 | ∞ | ∞ |  |
| ∞ | ∞ | ∞ | 4 | 0 | 8 | 5 | ∞ | ∞ | ∞ |
|  |  | ∞ | ∞ | 8 | 0 | ∞ | 2 | 10 | 6 |
| ∞ | ∞ | ∞ | 3 | 5 | ∞ | 0 | 4 | 1 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 2 | 4 | 0 | 7 |  |
| ∞ | ∞ | ∞ | ∞ | ∞ | 10 | 1 | 7 | 0 | 3 |
| ∞ | ∞ | ∞ |  | ∞ | 6 | ∞ |  | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* + k = 2:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 |  |  | ∞ | ∞ | ∞ | ∞ |
| 2 | 0 | 4 | 2 |  | ∞ | ∞ | ∞ | ∞ | ∞ |
| 3 | 4 | 0 | 1 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 4 | 2 | 1 | 0 | 4 | ∞ | 3 | ∞ | ∞ |  |
| ∞ | ∞ | ∞ | 4 | 0 | 8 | 5 | ∞ | ∞ | ∞ |
|  |  | ∞ | ∞ | 8 | 0 | ∞ | 2 | 10 | 6 |
| ∞ | ∞ | ∞ | 3 | 5 | ∞ | 0 | 4 | 1 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 2 | 4 | 0 | 7 |  |
| ∞ | ∞ | ∞ | ∞ | ∞ | 10 | 1 | 7 | 0 | 3 |
| ∞ | ∞ | ∞ |  | ∞ | 6 | ∞ |  | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* + k = 3:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 |  |  | ∞ | ∞ | ∞ | ∞ |
| 2 | 0 | 4 | 2 |  | ∞ | ∞ | ∞ | ∞ | ∞ |
| 3 | 4 | 0 | 1 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 4 | 2 | 1 | 0 | 4 | ∞ | 3 | ∞ | ∞ |  |
| ∞ | ∞ | ∞ | 4 | 0 | 8 | 5 | ∞ | ∞ | ∞ |
|  |  | ∞ | ∞ | 8 | 0 | ∞ | 2 | 10 | 6 |
| ∞ | ∞ | ∞ | 3 | 5 | ∞ | 0 | 4 | 1 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 2 | 4 | 0 | 7 |  |
| ∞ | ∞ | ∞ | ∞ | ∞ | 10 | 1 | 7 | 0 | 3 |
| ∞ | ∞ | ∞ |  | ∞ | 6 | ∞ |  | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* + k = 4:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 | 8 |  | 7 | ∞ | ∞ | ∞ |
| 2 | 0 | 3 | 2 | 6 | ∞ | 5 | ∞ | ∞ | ∞ |
| 3 | 3 | 0 | 1 | 5 | ∞ | 4 | ∞ | ∞ | ∞ |
| 4 | 2 | 1 | 0 | 4 | ∞ | 3 | ∞ | ∞ |  |
| 8 | 6 | 5 | 4 | 0 | 8 | 5 | ∞ | ∞ | ∞ |
|  |  | ∞ | ∞ | 8 | 0 | ∞ | 2 | 10 | 6 |
| 7 | 5 | 4 | 3 | 5 | ∞ | 0 | 4 | 1 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 2 | 4 | 0 | 7 |  |
| ∞ | ∞ | ∞ | ∞ | ∞ | 10 | 1 | 7 | 0 | 3 |
| ∞ | ∞ | ∞ |  | ∞ | 6 | ∞ |  | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 4 | 0 | 4 | 0 | 0 | 0 |
| 0 | 0 | 4 | 0 | 4 | 0 | 4 | 0 | 0 | 0 |
| 0 | 4 | 0 | 0 | 4 | 0 | 4 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* + k = 5:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 | 8 | 16 | 7 | ∞ | ∞ | ∞ |
| 2 | 0 | 3 | 2 | 6 | 14 | 5 | ∞ | ∞ | ∞ |
| 3 | 3 | 0 | 1 | 5 | 13 | 4 | ∞ | ∞ | ∞ |
| 4 | 2 | 1 | 0 | 4 | 12 | 3 | ∞ | ∞ |  |
| 8 | 6 | 5 | 4 | 0 | 8 | 5 | ∞ | ∞ | ∞ |
| 16 | 14 | 13 | 12 | 8 | 0 | 13 | 2 | 10 | 6 |
| 7 | 5 | 4 | 3 | 5 | 13 | 0 | 4 | 1 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 2 | 4 | 0 | 7 |  |
| ∞ | ∞ | ∞ | ∞ | ∞ | 10 | 1 | 7 | 0 | 3 |
| ∞ | ∞ | ∞ |  | ∞ | 6 | ∞ |  | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 4 | 5 | 4 | 0 | 0 | 0 |
| 0 | 0 | 4 | 0 | 4 | 5 | 4 | 0 | 0 | 0 |
| 0 | 4 | 0 | 0 | 4 | 5 | 4 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 |
| 4 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 5 | 5 | 5 | 0 | 0 | 5 | 0 | 0 | 0 |
| 4 | 4 | 4 | 0 | 0 | 5 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

* + k = 6:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 | 8 | 16 | 7 | 18 | 26 | 22 |
| 2 | 0 | 3 | 2 | 6 | 14 | 5 | 16 | 24 | 20 |
| 3 | 3 | 0 | 1 | 5 | 13 | 4 | 15 | 23 | 19 |
| 4 | 2 | 1 | 0 | 4 | 12 | 3 | 14 | 22 | 18 |
| 8 | 6 | 5 | 4 | 0 | 8 | 5 | 10 | 18 | 14 |
| 16 | 14 | 13 | 12 | 8 | 0 | 13 | 2 | 10 | 6 |
| 7 | 5 | 4 | 3 | 5 | 13 | 0 | 4 | 1 | 19 |
| 18 | 16 | 15 | 14 | 10 | 2 | 4 | 0 | 7 | 8 |
| 26 | 24 | 23 | 22 | 18 | 10 | 1 | 7 | 0 | 3 |
| 22 | 20 | 19 | 18 | 14 | 6 | 19 | 8 | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 4 | 5 | 4 | 6 | 6 | 6 |
| 0 | 0 | 4 | 0 | 4 | 5 | 4 | 6 | 6 | 6 |
| 0 | 4 | 0 | 0 | 4 | 5 | 4 | 6 | 6 | 6 |
| 2 | 0 | 0 | 0 | 0 | 5 | 0 | 6 | 6 | 6 |
| 4 | 4 | 4 | 0 | 0 | 0 | 0 | 6 | 6 | 6 |
| 5 | 5 | 5 | 5 | 0 | 0 | 5 | 0 | 0 | 0 |
| 4 | 4 | 4 | 0 | 0 | 5 | 0 | 0 | 0 | 6 |
| 6 | 6 | 6 | 6 | 6 | 0 | 0 | 0 | 0 | 6 |
| 6 | 6 | 6 | 6 | 6 | 0 | 0 | 0 | 0 | 0 |
| 6 | 6 | 6 | 6 | 6 | 0 | 6 | 6 | 0 | 0 |

* + k = 7:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 | 8 | 16 | 7 | 11 | 8 | 22 |
| 2 | 0 | 3 | 2 | 6 | 14 | 5 | 9 | 6 | 20 |
| 3 | 3 | 0 | 1 | 5 | 13 | 4 | 8 | 5 | 19 |
| 4 | 2 | 1 | 0 | 4 | 12 | 3 | 7 | 4 | 18 |
| 8 | 6 | 5 | 4 | 0 | 8 | 5 | 9 | 6 | 14 |
| 16 | 14 | 13 | 12 | 8 | 0 | 13 | 2 | 10 | 6 |
| 7 | 5 | 4 | 3 | 5 | 13 | 0 | 4 | 1 | 19 |
| 11 | 9 | 8 | 7 | 9 | 2 | 4 | 0 | 5 | 8 |
| 8 | 6 | 5 | 4 | 6 | 10 | 1 | 5 | 0 | 3 |
| 22 | 20 | 19 | 18 | 14 | 6 | 19 | 8 | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 4 | 5 | 4 | 7 | 7 | 6 |
| 0 | 0 | 4 | 0 | 4 | 5 | 4 | 7 | 7 | 6 |
| 0 | 4 | 0 | 0 | 4 | 5 | 4 | 7 | 7 | 6 |
| 2 | 0 | 0 | 0 | 0 | 5 | 0 | 7 | 7 | 6 |
| 4 | 4 | 4 | 0 | 0 | 0 | 0 | 7 | 7 | 6 |
| 5 | 5 | 5 | 5 | 0 | 0 | 5 | 0 | 0 | 0 |
| 4 | 4 | 4 | 0 | 0 | 5 | 0 | 0 | 0 | 6 |
| 7 | 7 | 7 | 7 | 7 | 0 | 0 | 0 | 7 | 6 |
| 7 | 7 | 7 | 7 | 7 | 0 | 0 | 7 | 0 | 0 |
| 6 | 6 | 6 | 6 | 6 | 0 | 6 | 6 | 0 | 0 |

* + k = 8:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 | 8 | 13 | 7 | 11 | 8 | 19 |
| 2 | 0 | 3 | 2 | 6 | 11 | 5 | 9 | 6 | 17 |
| 3 | 3 | 0 | 1 | 5 | 10 | 4 | 8 | 5 | 16 |
| 4 | 2 | 1 | 0 | 4 | 9 | 3 | 7 | 4 | 15 |
| 8 | 6 | 5 | 4 | 0 | 8 | 5 | 9 | 6 | 14 |
| 13 | 11 | 10 | 9 | 8 | 0 | 6 | 2 | 7 | 6 |
| 7 | 5 | 4 | 3 | 5 | 6 | 0 | 4 | 1 | 12 |
| 11 | 9 | 8 | 7 | 9 | 2 | 4 | 0 | 5 | 8 |
| 8 | 6 | 5 | 4 | 6 | 7 | 1 | 5 | 0 | 3 |
| 19 | 17 | 16 | 15 | 14 | 6 | 12 | 8 | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 4 | 8 | 4 | 7 | 7 | 8 |
| 0 | 0 | 4 | 0 | 4 | 8 | 4 | 7 | 7 | 8 |
| 0 | 4 | 0 | 0 | 4 | 8 | 4 | 7 | 7 | 8 |
| 2 | 0 | 0 | 0 | 0 | 8 | 0 | 7 | 7 | 8 |
| 4 | 4 | 4 | 0 | 0 | 0 | 0 | 7 | 7 | 6 |
| 8 | 8 | 8 | 8 | 0 | 0 | 8 | 0 | 8 | 0 |
| 4 | 4 | 4 | 0 | 0 | 8 | 0 | 0 | 0 | 8 |
| 7 | 7 | 7 | 7 | 7 | 0 | 0 | 0 | 7 | 6 |
| 7 | 7 | 7 | 7 | 7 | 8 | 0 | 7 | 0 | 0 |
| 8 | 8 | 8 | 8 | 6 | 0 | 8 | 6 | 0 | 0 |

* + k = 9:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 | 8 | 13 | 7 | 11 | 8 | 11 |
| 2 | 0 | 3 | 2 | 6 | 11 | 5 | 9 | 6 | 9 |
| 3 | 3 | 0 | 1 | 5 | 10 | 4 | 8 | 5 | 8 |
| 4 | 2 | 1 | 0 | 4 | 9 | 3 | 7 | 4 | 7 |
| 8 | 6 | 5 | 4 | 0 | 8 | 5 | 9 | 6 | 9 |
| 13 | 11 | 10 | 9 | 8 | 0 | 6 | 2 | 7 | 6 |
| 7 | 5 | 4 | 3 | 5 | 6 | 0 | 4 | 1 | 4 |
| 11 | 9 | 8 | 7 | 9 | 2 | 4 | 0 | 5 | 8 |
| 8 | 6 | 5 | 4 | 6 | 7 | 1 | 5 | 0 | 3 |
| 11 | 9 | 8 | 7 | 9 | 6 | 4 | 8 | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 4 | 8 | 4 | 7 | 7 | 9 |
| 0 | 0 | 4 | 0 | 4 | 8 | 4 | 7 | 7 | 9 |
| 0 | 4 | 0 | 0 | 4 | 8 | 4 | 7 | 7 | 9 |
| 2 | 0 | 0 | 0 | 0 | 8 | 0 | 7 | 7 | 9 |
| 4 | 4 | 4 | 0 | 0 | 0 | 0 | 7 | 7 | 9 |
| 8 | 8 | 8 | 8 | 0 | 0 | 8 | 0 | 8 | 0 |
| 4 | 4 | 4 | 0 | 0 | 8 | 0 | 0 | 0 | 9 |
| 7 | 7 | 7 | 7 | 7 | 0 | 0 | 0 | 7 | 6 |
| 7 | 7 | 7 | 7 | 7 | 8 | 0 | 7 | 0 | 0 |
| 9 | 9 | 9 | 9 | 9 | 0 | 9 | 6 | 0 | 0 |

* + k = 10:

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 2 | 3 | 4 | 8 | 13 | 7 | 11 | 8 | 11 |
| 2 | 0 | 3 | 2 | 6 | 11 | 5 | 9 | 6 | 9 |
| 3 | 3 | 0 | 1 | 5 | 10 | 4 | 8 | 5 | 8 |
| 4 | 2 | 1 | 0 | 4 | 9 | 3 | 7 | 4 | 7 |
| 8 | 6 | 5 | 4 | 0 | 8 | 5 | 9 | 6 | 9 |
| 13 | 11 | 10 | 9 | 8 | 0 | 6 | 2 | 7 | 6 |
| 7 | 5 | 4 | 3 | 5 | 6 | 0 | 4 | 1 | 4 |
| 11 | 9 | 8 | 7 | 9 | 2 | 4 | 0 | 5 | 8 |
| 8 | 6 | 5 | 4 | 6 | 7 | 1 | 5 | 0 | 3 |
| 11 | 9 | 8 | 7 | 9 | 6 | 4 | 8 | 3 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 2 | 4 | 8 | 4 | 7 | 7 | 9 |
| 0 | 0 | 4 | 0 | 4 | 8 | 4 | 7 | 7 | 9 |
| 0 | 4 | 0 | 0 | 4 | 8 | 4 | 7 | 7 | 9 |
| 2 | 0 | 0 | 0 | 0 | 8 | 0 | 7 | 7 | 9 |
| 4 | 4 | 4 | 0 | 0 | 0 | 0 | 7 | 7 | 9 |
| 8 | 8 | 8 | 8 | 0 | 0 | 8 | 0 | 8 | 0 |
| 4 | 4 | 4 | 0 | 0 | 8 | 0 | 0 | 0 | 9 |
| 7 | 7 | 7 | 7 | 7 | 0 | 0 | 0 | 7 | 6 |
| 7 | 7 | 7 | 7 | 7 | 8 | 0 | 7 | 0 | 0 |
| 9 | 9 | 9 | 9 | 9 | 0 | 9 | 6 | 0 | 0 |

***Bộ dữ liệu 2:***

12

6

20

8

7

3

1

5

4

11

9

3

1

3

8

6

10

4

2

5

5

2

15

9

6

2

Các bước của thuật toán:

* Bước 1: (Khởi tạo)

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 8 | 6 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 8 | 0 | 3 | ∞ | 5 | ∞ | ∞ | ∞ | ∞ | ∞ |
| 6 | 3 | 0 | 3 | 1 | ∞ | 20 | ∞ | ∞ | ∞ |
| ∞ | ∞ | 3 | 0 | 2 | ∞ | 4 | ∞ | ∞ | 6 |
| ∞ | 5 | 1 | 2 | 0 | 15 | ∞ | ∞ | ∞ | ∞ |
| ∞ | ∞ | ∞ | ∞ | 15 | 0 | 9 | ∞ | 2 | 6 |
| ∞ | ∞ | 20 | 4 | ∞ | 9 | 0 | 12 | ∞ | 5 |
| ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | 12 | 0 | 11 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 2 | ∞ | 11 | 0 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 6 | 5 | ∞ | ∞ | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Kết quả: (k = 10)

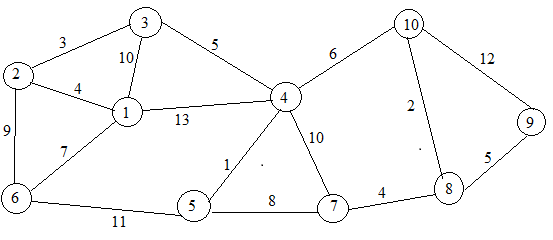
Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 8 | 6 | 9 | 7 | 22 | 13 | 25 | 24 | 18 |
| 8 | 0 | 3 | 6 | 6 | 4 | 10 | 22 | 21 | 15 |
| 6 | 3 | 0 | 3 | 1 | 16 | 7 | 19 | 18 | 12 |
| 9 | 6 | 3 | 0 | 2 | 13 | 4 | 16 | 15 | 9 |
| 7 | 4 | 1 | 2 | 0 | 15 | 6 | 18 | 17 | 11 |
| 22 | 19 | 16 | 1 | 15 | 0 | 9 | 13 | 2 | 6 |
| 13 | 10 | 7 | 4 | 6 | 9 | 0 | 12 | 11 | 5 |
| 25 | 22 | 19 | 16 | 18 | 13 | 12 | 0 | 11 | 17 |
| 24 | 21 | 18 | 15 | 17 | 2 | 11 | 11 | 0 | 8 |
| 18 | 15 | 12 | 9 | 11 | 6 | 5 | 17 | 8 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 3 | 3 | 5 | 4 | 7 | 6 | 7 |
| 0 | 0 | 0 | 3 | 3 | 5 | 4 | 7 | 6 | 7 |
| 0 | 0 | 0 | 0 | 0 | 5 | 4 | 7 | 6 | 7 |
| 3 | 3 | 0 | 0 | 0 | 7 | 0 | 7 | 7 | 7 |
| 3 | 3 | 0 | 0 | 0 | 0 | 4 | 7 | 6 | 7 |
| 5 | 5 | 5 | 7 | 0 | 0 | 0 | 9 | 0 | 0 |
| 4 | 4 | 4 | 0 | 4 | 0 | 0 | 0 | 6 | 0 |
| 7 | 7 | 7 | 7 | 7 | 9 | 0 | 0 | 0 | 7 |
| 6 | 6 | 6 | 7 | 6 | 0 | 6 | 0 | 0 | 6 |
| 7 | 7 | 7 | 7 | 7 | 0 | 0 | 7 | 6 | 0 |

***Bộ dữ liệu 3:***

******

Các bước của thuật toán:

* Bước 1: (Khởi tạo)

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 4 | 10 | 13 |  | 7 | ∞ | ∞ | ∞ | ∞ |
| 4 | 0 | 3 | ∞ | 9 | ∞ | ∞ | ∞ | ∞ | ∞ |
| 10 | 3 | 0 | 5 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 13 | ∞ | 5 | 0 | 1 | ∞ | 10 | ∞ | ∞ | 6 |
| ∞ | ∞ | ∞ | 1 | 0 | 11 | 8 | ∞ | ∞ | ∞ |
| 7 | 9 | ∞ | ∞ | 11 | 0 | ∞ | ∞ | ∞ | ∞ |
| ∞ | ∞ | ∞ | 10 | 8 | ∞ | 0 | 4 | ∞ | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | 4 | 0 | 5 | 2 |
| ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | 5 | 0 | 12 |
| ∞ | ∞ | ∞ | 6 | ∞ | ∞ | ∞ | 2 | 12 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

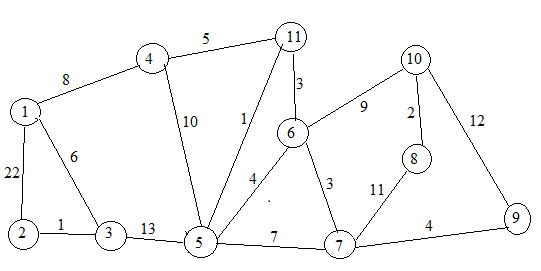
Kết quả: (k = 10)

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 4 | 7 | 12 | 13 | 7 | 21 | 20 | 25 | 18 |
| 4 | 0 | 3 | 8 | 9 | 9 | 17 | 16 | 21 | 14 |
| 7 | 3 | 0 | 5 | 6 | 12 | 14 | 13 | 18 | 11 |
| 12 | 8 | 5 | 0 | 1 | 12 | 9 | 8 | 13 | 6 |
| 13 | 9 | 6 | 1 | 0 | 11 | 8 | 9 | 14 | 7 |
| 7 | 9 | 12 | 12 | 11 | 0 | 19 | 20 | 25 | 18 |
| 21 | 17 | 14 | 9 | 8 | 19 | 0 | 4 | 9 | 6 |
| 20 | 16 | 13 | 8 | 9 | 20 | 4 | 0 | 5 | 2 |
| 25 | 21 | 18 | 13 | 14 | 25 | 9 | 5 | 0 | 7 |
| 18 | 14 | 11 | 6 | 7 | 18 | 6 | 2 | 7 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 2 | 3 | 4 | 0 | 5 | 10 | 10 | 4 |
| 0 | 0 | 0 | 3 | 4 | 0 | 5 | 10 | 10 | 4 |
| 0 | 0 | 0 | 0 | 0 | 2 | 5 | 10 | 10 | 4 |
| 0 | 0 | 0 | 0 | 0 | 5 | 5 | 10 | 10 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 5 | 10 | 10 | 5 |
| 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 8 | 8 |
| 10 | 10 | 10 | 10 | 10 | 10 | 0 | 0 | 0 | 0 |
| 10 | 10 | 10 | 10 | 10 | 10 | 8 | 0 | 0 | 8 |
| 4 | 4 | 4 | 0 | 4 | 5 | 8 | 0 | 8 | 0 |

***Bộ dữ liệu 4:*********

Các bước của thuật toán:

Bước 1: (Khởi tạo)

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 22 | 6 | 8 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 22 | 0 | 1 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 6 | 1 | 0 | ∞ | 13 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 8 | ∞ | ∞ | 0 | 10 | ∞ | ∞ | ∞ | ∞ | ∞ | 5 |
| ∞ | ∞ | 13 | 10 | 0 | 4 | 7 | ∞ | ∞ | ∞ | 1 |
| ∞ | ∞ | ∞ | ∞ | 4 | 0 | 3 | ∞ | ∞ | 9 | 3 |
| ∞ | ∞ | ∞ | ∞ | 7 | 3 | 0 | 11 | 4 | ∞ | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | 11 | 0 | ∞ | 2 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | 4 | 0 | 0 | 12 | 0 |
| ∞ | ∞ | ∞ | ∞ | ∞ | 9 | ∞ | 2 | 12 | 0 | ∞ |
| ∞ | ∞ | ∞ | 5 | 1 | 3 | ∞ | ∞ | ∞ | ∞ | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Kết quả: (k = 11)

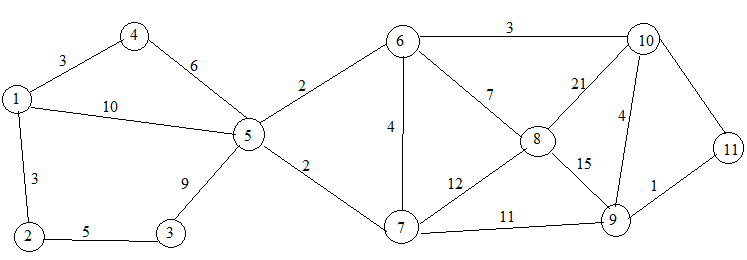
Ma trận d:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 7 | 6 | 8 | 14 | 16 | 19 | 27 | 23 | 25 | 13 |
| 7 | 0 | 1 | 15 | 14 | 18 | 21 | 9 | 25 | 27 | 15 |
| 6 | 1 | 0 | 14 | 1 | 17 | 20 | 28 | 24 | 26 | 14 |
| 8 | 15 | 14 | 0 | 6 | 8 | 11 | 19 | 15 | 17 | 5 |
| 14 | 14 | 13 | 6 | 0 | 4 | 7 | 15 | 11 | 13 | 1 |
| 16 | 18 | 17 | 8 | 4 | 0 | 3 | 11 | 7 | 9 | 3 |
| 19 | 21 | 20 | 11 | 7 | 3 | 0 | 11 | 4 | 12 | 6 |
| 27 | 29 | 28 | 19 | 15 | 11 | 11 | 0 | 14 | 2 | 14 |
| 25 | 27 | 26 | 17 | 13 | 9 | 12 | 2 | 12 | 0 | 12 |
| 13 | 15 | 14 | 5 | 1 | 3 | 6 | 14 | 10 | 12 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 3 | 0 | 0 | 11 | 11 | 11 | 11 | 11 | 11 | 4 |
| 3 | 0 | 0 | 3 | 3 | 5 | 5 | 10 | 7 | 6 | 5 |
| 0 | 0 | 0 | 1 | 0 | 5 | 5 | 10 | 7 | 6 | 5 |
| 0 | 3 | 1 | 0 | 11 | 11 | 11 | 11 | 11 | 11 | 0 |
| 11 | 3 | 0 | 11 | 0 | 0 | 0 | 10 | 7 | 6 | 0 |
| 11 | 5 | 5 | 11 | 0 | 0 | 0 | 10 | 7 | 0 | 0 |
| 11 | 5 | 5 | 11 | 0 | 0 | 0 | 0 | 0 | 6 | 6 |
| 11 | 10 | 10 | 11 | 10 | 10 | 0 | 0 | 10 | 0 | 10 |
| 11 | 7 | 7 | 11 | 7 | 7 | 0 | 10 | 0 | 0 | 7 |
| 11 | 6 | 6 | 11 | 6 | 0 | 6 | 0 | 0 | 0 | 6 |
| 4 | 5 | 5 | 0 | 0 | 0 | 6 | 10 | 7 | 6 | 0 |

***Bộ dữ liệu 5:***

****** Các bước của thuật toán:

Bước 1: (Khởi tạo)

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 3 | ∞ | 3 | 10 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 3 | 0 | 5 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| ∞ | 5 | 0 | ∞ | 9 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 3 | ∞ | ∞ | 0 | 6 | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ |
| 10 | ∞ | 9 | 6 | 0 | 2 | 2 | ∞ | ∞ | ∞ | ∞ |
| ∞ | ∞ | ∞ | ∞ | 2 | 0 | 4 | 7 | ∞ | 3 | ∞ |
| ∞ | ∞ | ∞ | ∞ | 2 | 4 | 0 | 12 | 11 | ∞ | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | 7 | 12 | 0 | 15 | 21 | ∞ |
| ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | 11 | 15 | 0 | 4 | 1 |
| ∞ | ∞ | ∞ | ∞ | ∞ | 3 | ∞ | 21 | 4 | 0 | 5 |
| ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | 1 | 5 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Kết quả: (k = 11)

Ma trận d:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 3 | 8 | 3 | 9 | 11 | 11 | 18 | 18 | 14 | 19 |
| 3 | 0 | 5 | 6 | 12 | 14 | 14 | 21 | 21 | 17 | 22 |
| 8 | 5 | 0 | 11 | 9 | 11 | 11 | 18 | 18 | 14 | 19 |
| 3 | 6 | 11 | 0 | 6 | 8 | 8 | 15 | 15 | 11 | 16 |
| 9 | 12 | 9 | 6 | 0 | 2 | 2 | 9 | 9 | 5 | 10 |
| 11 | 14 | 11 | 8 | 2 | 0 | 4 | 7 | 7 | 3 | 8 |
| 11 | 14 | 11 | 8 | 2 | 4 | 0 | 11 | 11 | 7 | 12 |
| 18 | 21 | 18 | 15 | 9 | 7 | 11 | 0 | 14 | 10 | 15 |
| 18 | 21 | 18 | 15 | 9 | 7 | 11 | 14 | 0 | 4 | 1 |
| 14 | 17 | 14 | 11 | 5 | 3 | 7 | 10 | 4 | 0 | 5 |
| 19 | 22 | 19 | 16 | 10 | 8 | 12 | 15 | 1 | 5 | 0 |

Ma trận p:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 2 | 0 | 4 | 5 | 5 | 6 | 10 | 6 | 10 |
| 0 | 0 | 0 | 1 | 4 | 5 | 5 | 6 | 10 | 6 | 10 |
| 2 | 0 | 0 | 2 | 0 | 5 | 5 | 6 | 10 | 6 | 10 |
| 0 | 1 | 2 | 0 | 0 | 5 | 5 | 6 | 10 | 6 | 10 |
| 4 | 4 | 0 | 0 | 0 | 0 | 0 | 6 | 10 | 0 | 10 |
| 5 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 10 | 0 | 10 |
| 5 | 5 | 5 | 5 | 0 | 0 | 0 | 6 | 0 | 6 | 9 |
| 6 | 6 | 6 | 6 | 6 | 0 | 6 | 0 | 10 | 6 | 10 |
| 10 | 10 | 10 | 10 | 10 | 10 | 0 | 10 | 0 | 0 | 0 |
| 6 | 6 | 6 | 6 | 6 | 0 | 6 | 6 | 0 | 0 | 0 |
| 10 | 10 | 10 | 10 | 10 | 10 | 9 | 10 | 0 | 0 | 0 |

1. **Chương trình c++**

#include <iostream>

using namespace std;

#define max 1000

int a[max][max];//ma tran trong so do thi

int d[max][max];//mang ghi do dai duong di giua cac dinh

int p[max][max];//mang ghi cac dinh giua

int s[max];//mang ghi duong di

int n, u, v;

void Input(){

cout<<"Nhap dinh dau: ";

cin>>u;

cout<<"\nNhap dinh cuoi: ";

cin>>v;

freopen("FLOYD.IN", "r", stdin);

cin>>n;

cout<<"\nSo dinh cua do thi: "<< n <<endl;

for (int i = 1; i <= n; i++){

for (int j = 1; j <= n; j++){

cin>>a[i][j];

if (i != j && a[i][j] == 0)

a[i][j] = max;

}

}

}

void Print(int u, int v){

//Truy vet

if (d[u][v] >= max) {

cout<<"\nKhong co duong di"<<endl;

}

else {

cout<<"\nDuong di ngan nhat tu "<<u<<" den "<<v<< " co do dai la "<<d[u][v]<<endl;

int t = 1; int i=u; int j=v; int k;

s[t]=v;

while (p[i][j]!=0) {

k = p[i][j];

t++; s[t] = k;

j = k;

}

cout<<"\nDuong di: "<<u;

int l =t;

while(i>0) {

cout<<" -> "<<s[l];

i--;

}

}

}

void Floyd(){

int i, j, k;

//Khoi dong ma tran d va p

for (i=1; i<=n; i++){

for (j=1; j<=n;j++){

d[i][j] = a[i][j];

p[i][j]=0;

}

}

//Tinh ma tran d va p

for (k=1; k<=n;k++)

{

for (i=1; i<=n; i++){

if (d[i][k]>0 & d[i][k]<max){

for(j=1;j<=n;j++){

if(d[k][j]>0 && d[k][j]<max){

if (d[i][k] + d[k][j] < d[i][j]){

d[i][j] = d[i][k] + d[k][j];

p[i][j] = k;

}

}

}

}

}

}

}

int main(){

Input();

Floyd();

Print(u, v);

}

1. **Độ phức tạp của thuật toán**

Ở đây ta sử dụng 3 vòng for để duyệt nên độ phức tạp của thuật toán là O(n3)