Белорусский государственный технологический университет

Кафедра Информационных Систем и Технологий

**Курс «Математическое программирование»**

**Отчёт по лабораторной работе №5**

**АЛГОРИТМЫ НА ГРАФАХ**

**(алгоритмы поиска в ширину и глубину, топологическая сортировка)**

**Вариант 10**

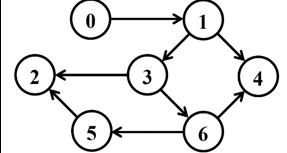
Выполнила: Сятковская Е.Д.

ФИТ 2 курс 4 группа

Минск 2022

**Алгоритм поиска в ширину(BFS)**

Исходный граф:



Текущее состояние алгоритма хранится в следующих структурах памяти:

Q – очередь вершин,

C – массив окраски вершин,

D – массив расстояний,

P – массив предшествующих вершин.

Шаг 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Q | 0 |  |  |  |  |  |  |
| C | G | W | W | W | W | W | W |
| D | 0 | I | I | I | I | I | I |
| P | N | N | N | N | N | N | N |

Шаг 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Q | 1 |  |  |  |  |  |  |
| C | B | G | W | W | W | W | W |
| D | 0 | 1 | I | I | I | I | I |
| P | N | 0 | N | N | N | N | N |

Шаг 3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Q | 3 | 4 |  |  |  |  |  |
| C | B | B | W | G | G | W | W |
| D | 0 | 1 | I | 2 | 2 | I | I |
| P | N | 0 | N | 1 | 1 | N | N |

Шаг 4

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Q | 4 | 2 | 6 |  |  |  |  |
| C | B | B | G | B | G | W | G |
| D | 0 | 1 | 3 | 2 | 2 | I | 3 |
| P | N | 0 | 3 | 1 | 1 | N | 3 |

Шаг 5

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Q | 2 | 6 |  |  |  |  |  |
| C | B | B | G | B | B | W | G |
| D | 0 | 1 | 3 | 2 | 2 | I | 3 |
| P | N | 0 | 3 | 1 | 1 | N | 3 |

Шаг 6

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Q | 6 |  |  |  |  |  |  |
| C | B | B | B | B | B | W | G |
| D | 0 | 1 | 3 | 2 | 2 | I | 3 |
| P | N | 0 | 3 | 1 | 1 | N | 3 |

Шаг 7

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Q | 5 |  |  |  |  |  |  |
| C | B | B | B | B | B | G | B |
| D | 0 | 1 | 3 | 2 | 2 | 4 | 3 |
| P | N | 0 | 3 | 1 | 1 | 6 | 3 |

Шаг 8

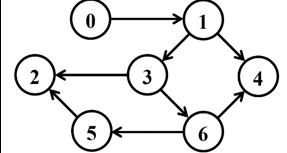
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Q |  |  |  |  |  |  |  |
| C | B | B | B | B | B | B | B |
| D | 0 | 1 | 3 | 2 | 2 | 4 | 3 |
| P | N | 0 | 3 | 1 | 1 | 6 | 3 |

Ответ: В результате получили вот такое BFS-дерево:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| P | N | 0 | 3 | 1 | 1 | 6 | 3 |

**Алгоритм поиска в глубину (DFS)**

Исходный граф:



Текущее состояние алгоритма хранится в следующих структурах памяти:

C – массив окраски вершин,

D – время окраски вершин в серый цвет,

P – массив предшествующих вершин,

F – время окраски в чёрный цвет,

t – номер шага алгоритма.

Шаг 1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | W | W | W | W | W | W |
| D | 1 | I | I | I | I | I | I |
| P | N | N | N | N | N | N | N |
| F | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

t = 1 – стартовый шаг

Шаг 2

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | W | W | W | W | W |
| D | 1 | 2 | I | I | I | I | I |
| P | N | 0 | N | N | N | N | N |
| F | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

t = 2

Шаг 3

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | W | G | W | W | W |
| D | 1 | 2 | I | 3 | I | I | I |
| P | N | 0 | N | 1 | N | N | N |
| F | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

t = 3

Шаг 4

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | G | G | W | W | W |
| D | 1 | 2 | 4 | 3 | I | I | I |
| P | N | 0 | 3 | 1 | N | N | N |
| F | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

t = 4

Шаг 5

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | B | G | W | W | W |
| D | 1 | 2 | 4 | 3 | I | I | I |
| P | N | 0 | 3 | 1 | N | N | N |
| F | 0 | 0 | 5 | 0 | 0 | 0 | 0 |

t = 5

Шаг 6

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | B | G | W | W | G |
| D | 1 | 2 | 4 | 3 | I | I | 6 |
| P | N | 0 | 3 | 1 | N | N | 3 |
| F | 0 | 0 | 5 | 0 | 0 | 0 | 0 |

t = 6

Шаг 7

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | B | G | G | W | G |
| D | 1 | 2 | 4 | 3 | 7 | I | 6 |
| P | N | 0 | 3 | 1 | 6 | N | 3 |
| F | 0 | 0 | 5 | 0 | 0 | 0 | 0 |

t = 7

Шаг 8

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | B | G | B | W | G |
| D | 1 | 2 | 4 | 3 | 7 | I | 6 |
| P | N | 0 | 3 | 1 | 6 | N | 3 |
| F | 0 | 0 | 5 | 0 | 8 | 0 | 0 |

t = 8

Шаг 9

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | B | G | B | G | G |
| D | 1 | 2 | 4 | 3 | 7 | 9 | 6 |
| P | N | 0 | 3 | 1 | 6 | 6 | 3 |
| F | 0 | 0 | 5 | 0 | 8 | 0 | 0 |

t = 9

Шаг 10

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | B | G | B | B | G |
| D | 1 | 2 | 4 | 3 | 7 | 9 | 6 |
| P | N | 0 | 3 | 1 | 6 | 6 | 3 |
| F | 0 | 0 | 5 | 0 | 8 | 10 | 0 |

t = 10

Шаг 11

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | B | G | B | B | B |
| D | 1 | 2 | 4 | 3 | 7 | 9 | 6 |
| P | N | 0 | 3 | 1 | 6 | 6 | 3 |
| F | 0 | 0 | 5 | 0 | 8 | 10 | 11 |

t = 11

Шаг 12

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | G | B | B | B | B | B |
| D | 1 | 2 | 4 | 3 | 7 | 9 | 6 |
| P | N | 0 | 3 | 1 | 6 | 6 | 3 |
| F | 0 | 0 | 5 | 12 | 8 | 10 | 11 |

t = 12

Шаг 13

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | G | B | B | B | B | B | B |
| D | 1 | 2 | 4 | 3 | 7 | 9 | 6 |
| P | N | 0 | 3 | 1 | 6 | 6 | 3 |
| F | 0 | 13 | 5 | 12 | 8 | 10 | 11 |

t = 13

Шаг 14

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C | B | B | B | B | B | B | B |
| D | 1 | 2 | 4 | 3 | 7 | 9 | 6 |
| P | N | 0 | 3 | 1 | 6 | 6 | 3 |
| F | 14 | 13 | 5 | 12 | 8 | 10 | 11 |

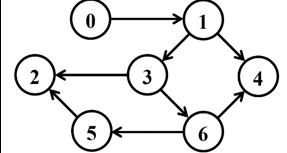
t = 14

Ответ: DFS-дерево имеет вид:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| P | N | 0 | 3 | 1 | 6 | 6 | 3 |

**Алгоритм топологической сортировки**

Исходный граф:



Топологическая сортировка – это процедура упорядочивания вершин ориентированного графа, не имеющего циклов.

При реализации топологической сортировки с помощью алгоритма поиска в глубину используется массив меток вершин, с помощью которого моделируется удаление вершин из графа и сохраняются новые номера вершин.

Шаг 1

1/

Шаг 2

2/

1/

Шаг 3

2/

1/

3/

Шаг 4

2/

1/

4/

3/

Шаг 5

2/

1/

4/5

3/

Шаг 6

2/

1/

4/5

3/

6/

Шаг 7

2/

1/

4/5

3/

7/

6/

Шаг 8

2/

1/

4/5

3/

7/8

6/

Шаг 9

2/

1/

4/5

3/

7/8

9/

6/

Шаг 10

2/

1/

4/5

3/

7/8

9/10

6/

Шаг 11

2/

1/

4/5

3/

7/8

6/11

9/10

Шаг 12

2/

1/

4/5

3/12

7/8

6/11

9/10

Шаг 13

2/13

1/

4/5

3/12

7/8

6/11

9/10

Шаг 14

2/13

1/14

4/5

3/12

7/8

6/11

9/10

Формируем очередь по мере окрашивания вершин в чёрный цвет:2 4 5 6 3 1 0

