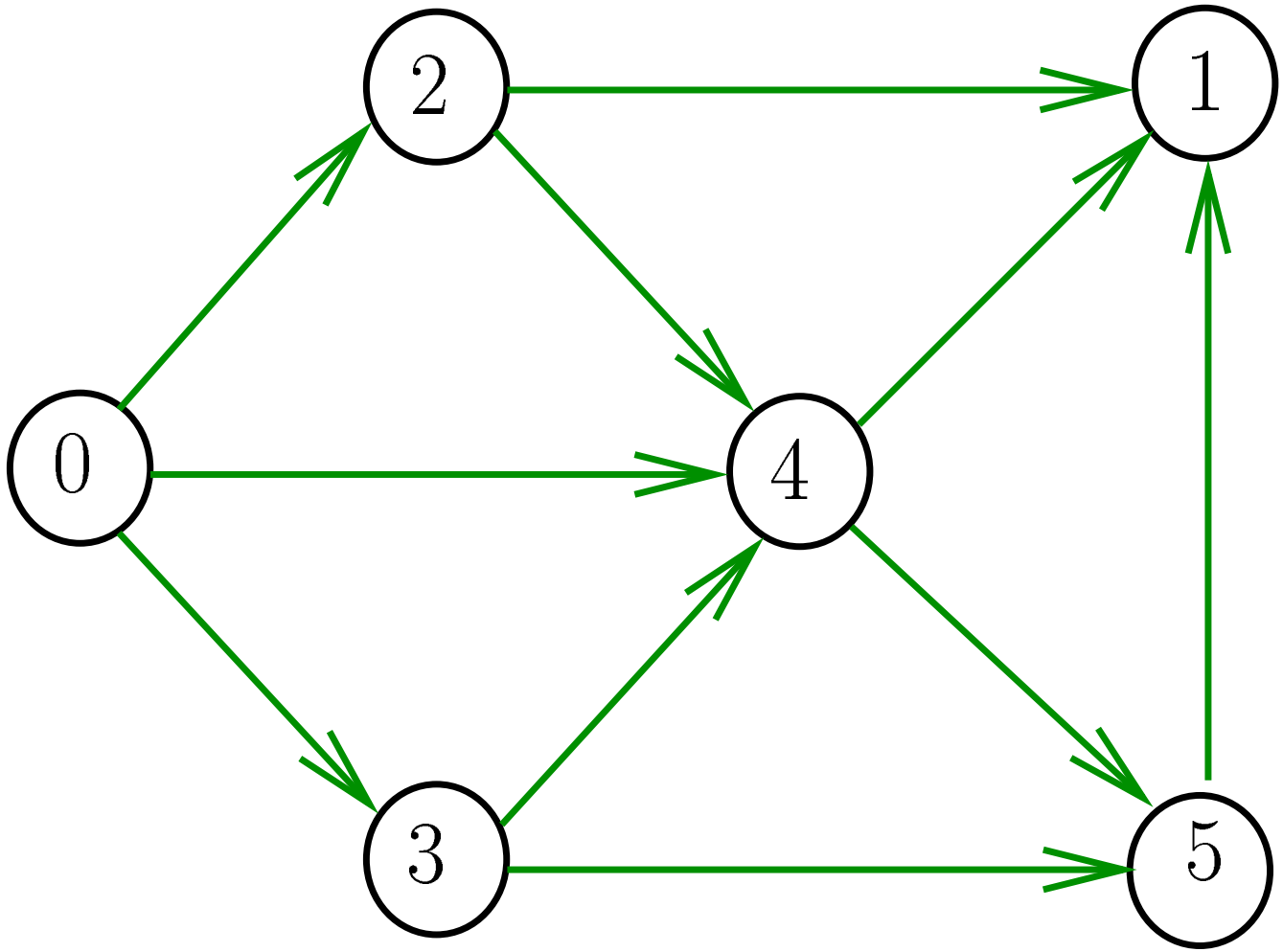
Melhores momentos

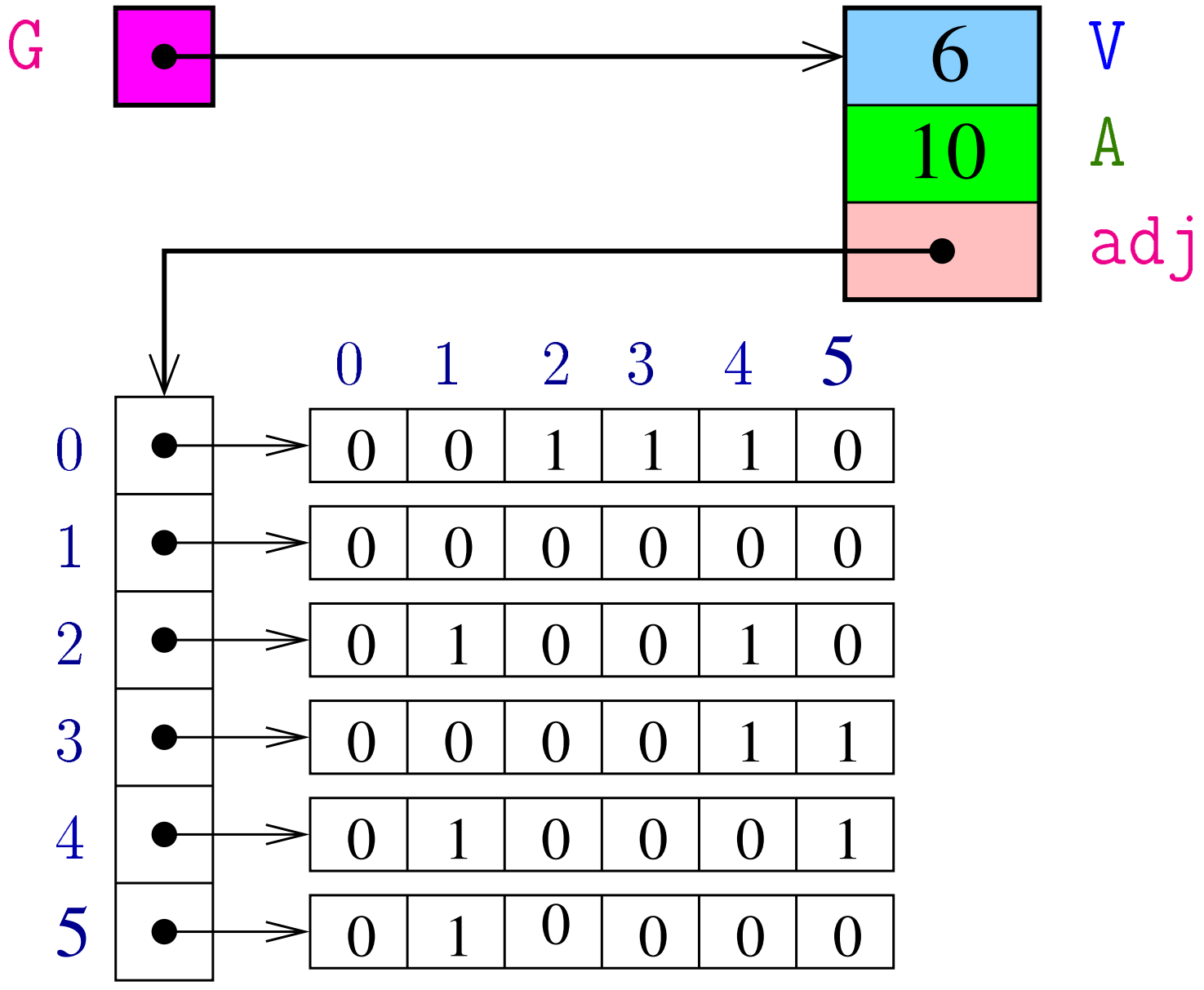
AULA 2

Digrafo

Digraph G



Estruturas de dados



Estrutura digraph

Vértices = inteiros em 0,..,V-1

A estrutura **digraph** representa um digrafo

- adj é um ponteiro para a matriz de adjacência
- V contém o número de vértices
- A contém o número de arcos do digrafo.

```
struct digraph {
    int V;
    int A;
    int **adj;
};
typedef struct digraph *Digraph;
```

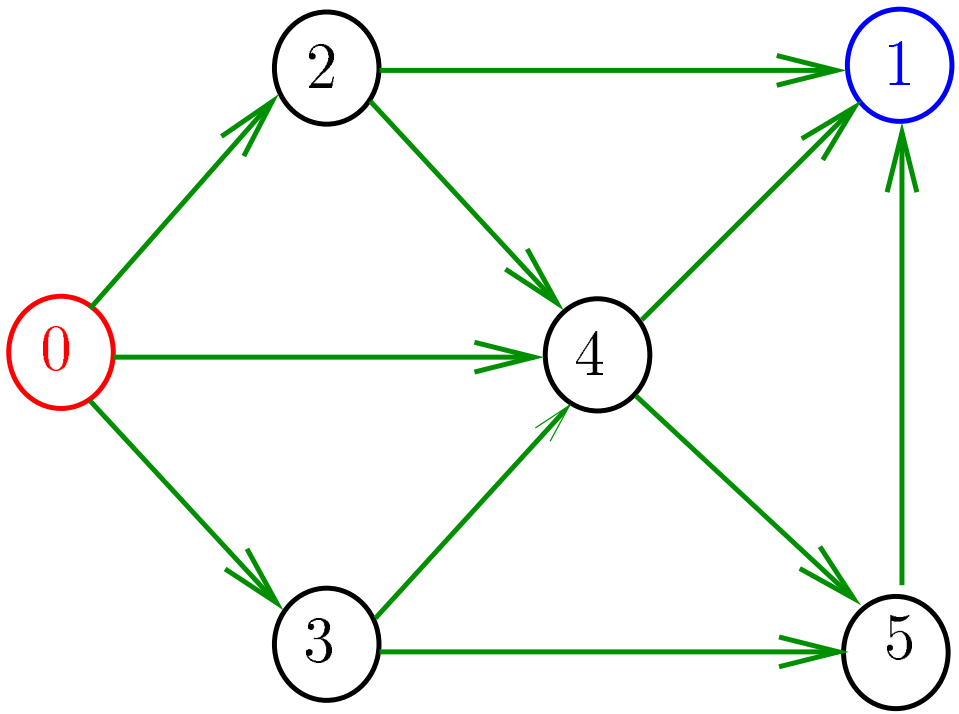
Funções básicas

```
Digraph DIGRAPHinit (int);
void DIGRAPHinsertA (Digraph,Vertex,Vertex);
void DIGRAPHremoveA (Digraph,Vertex,Vertex);
void DIGRAPHshow (Digraph);
```

Procurando um caminho

Problema: dados um digrafo `G` e dois vértices `s` e `t` decidir se existe um caminho de `s` a `t`

Exemplo: para `s` = 0 e `t` = 1 a resposta é SIM



Procurando um caminho

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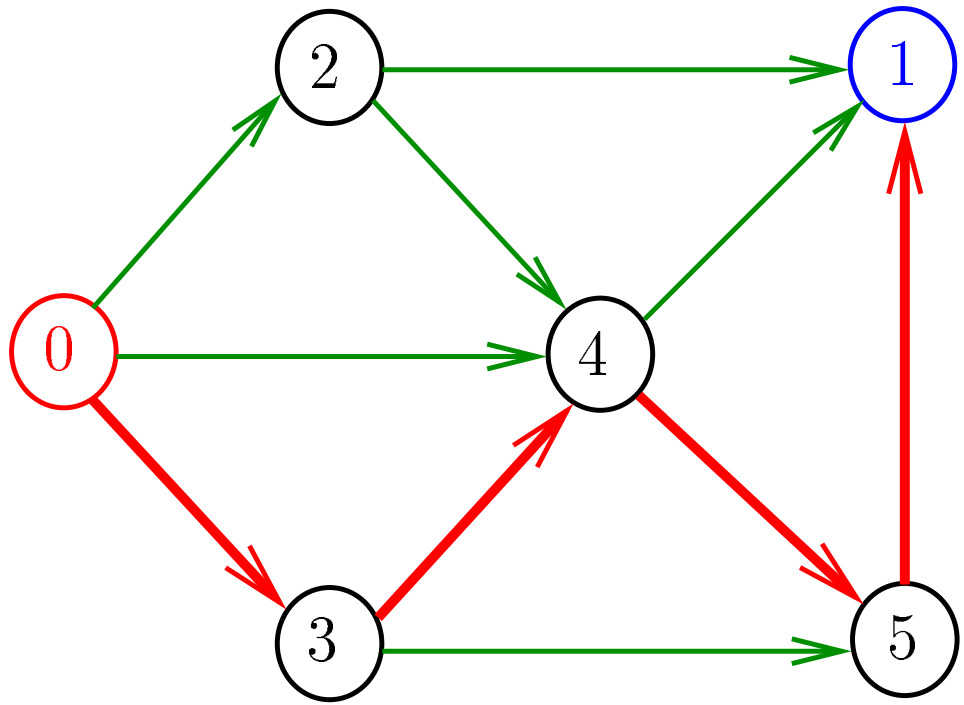
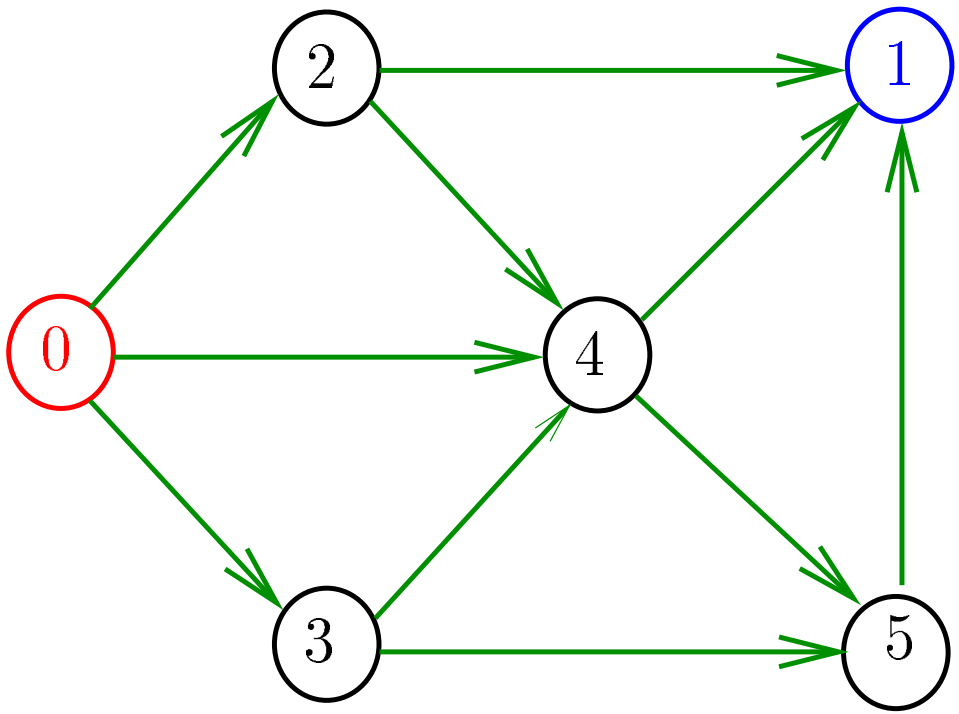


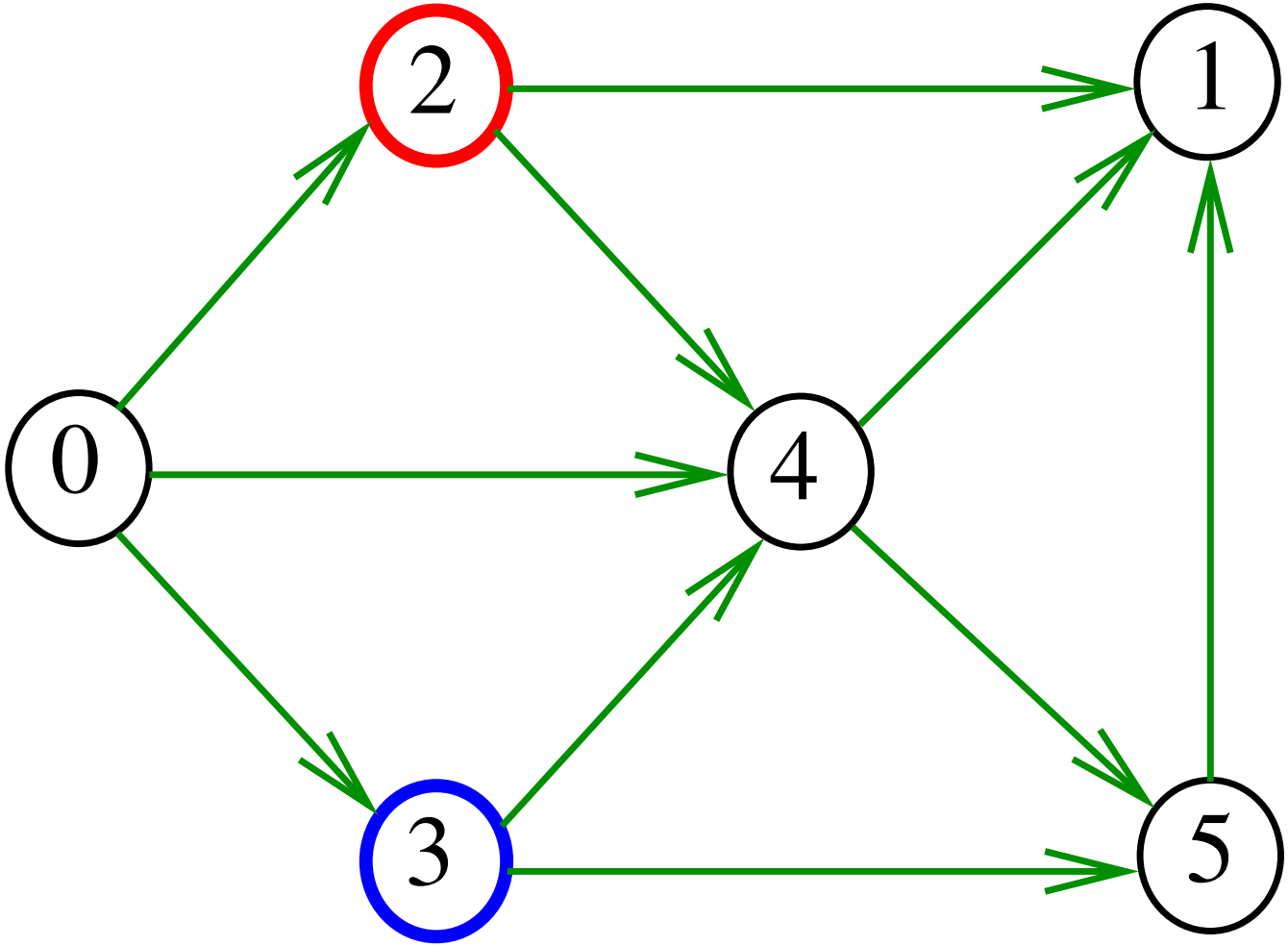
Procurando um caminho

Problema: dados um digrafo `G` e dois vértices `s` e `t` decidir se existe um caminho de `s` a `t`

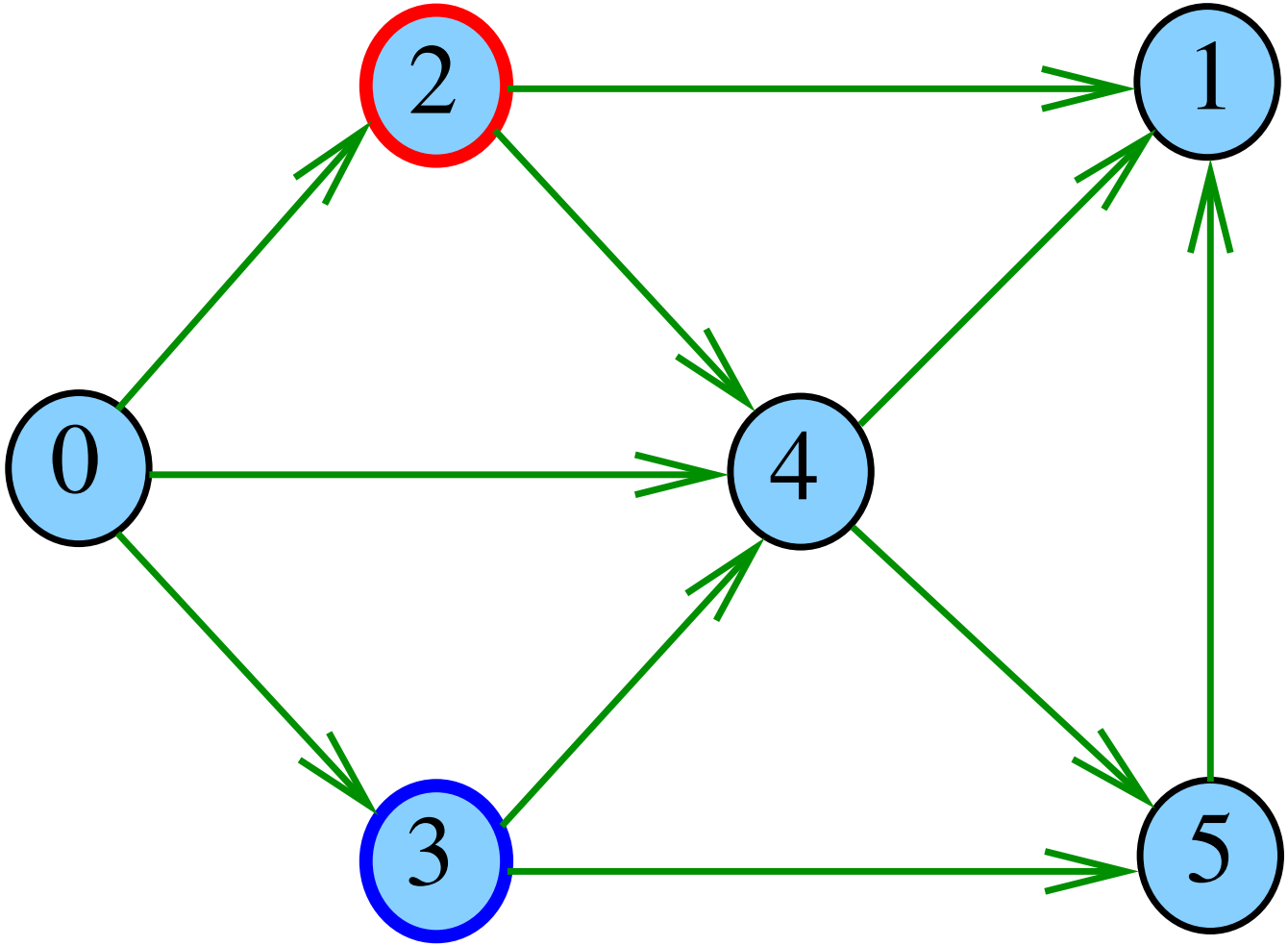
Exemplo: para `s` = 5 e `t` = 4 a resposta é NÃO



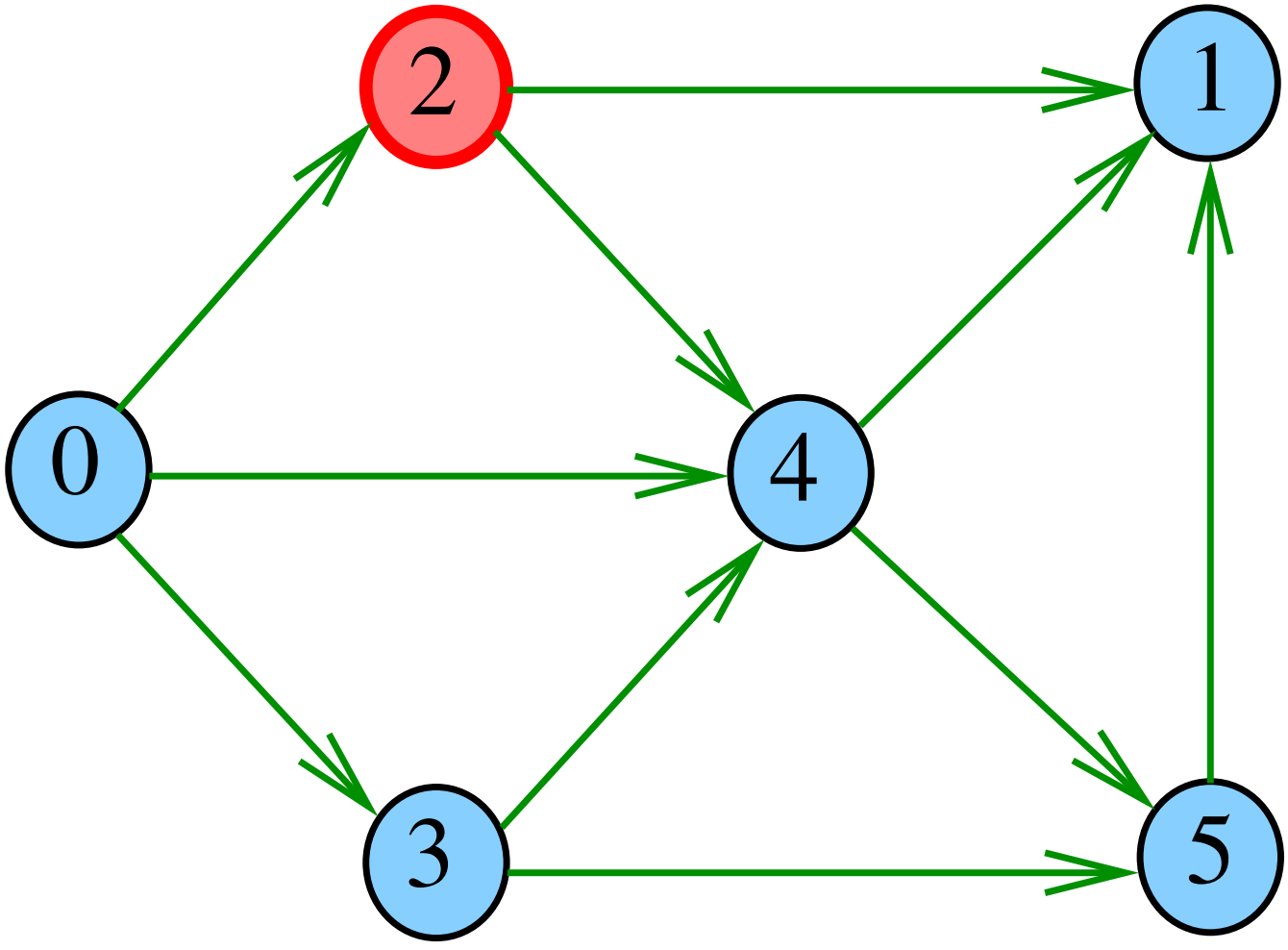
DIGRAPHpath(G,2,3)



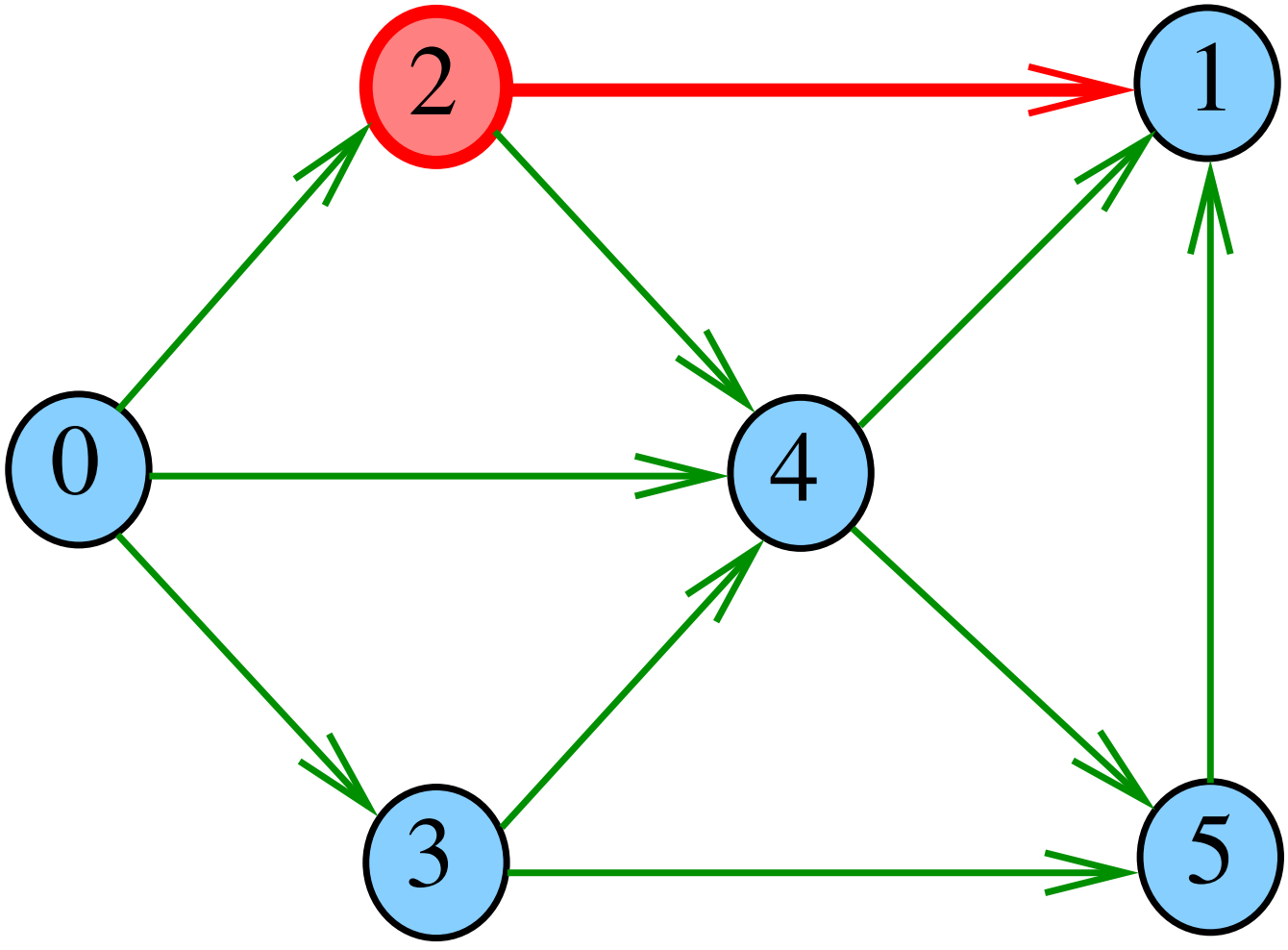
DIGRAPHpath(G,2,3)



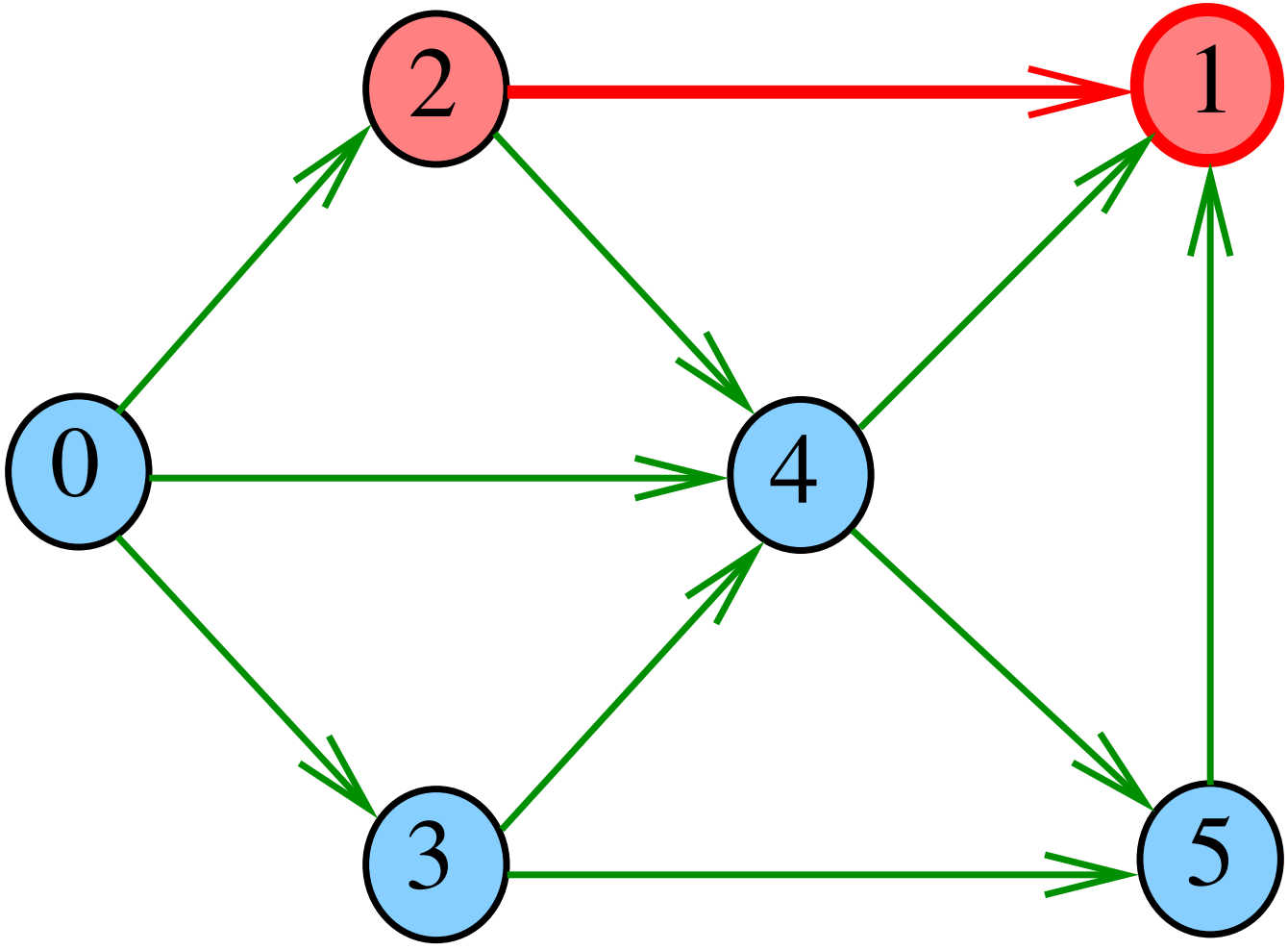
pathR(G,2)



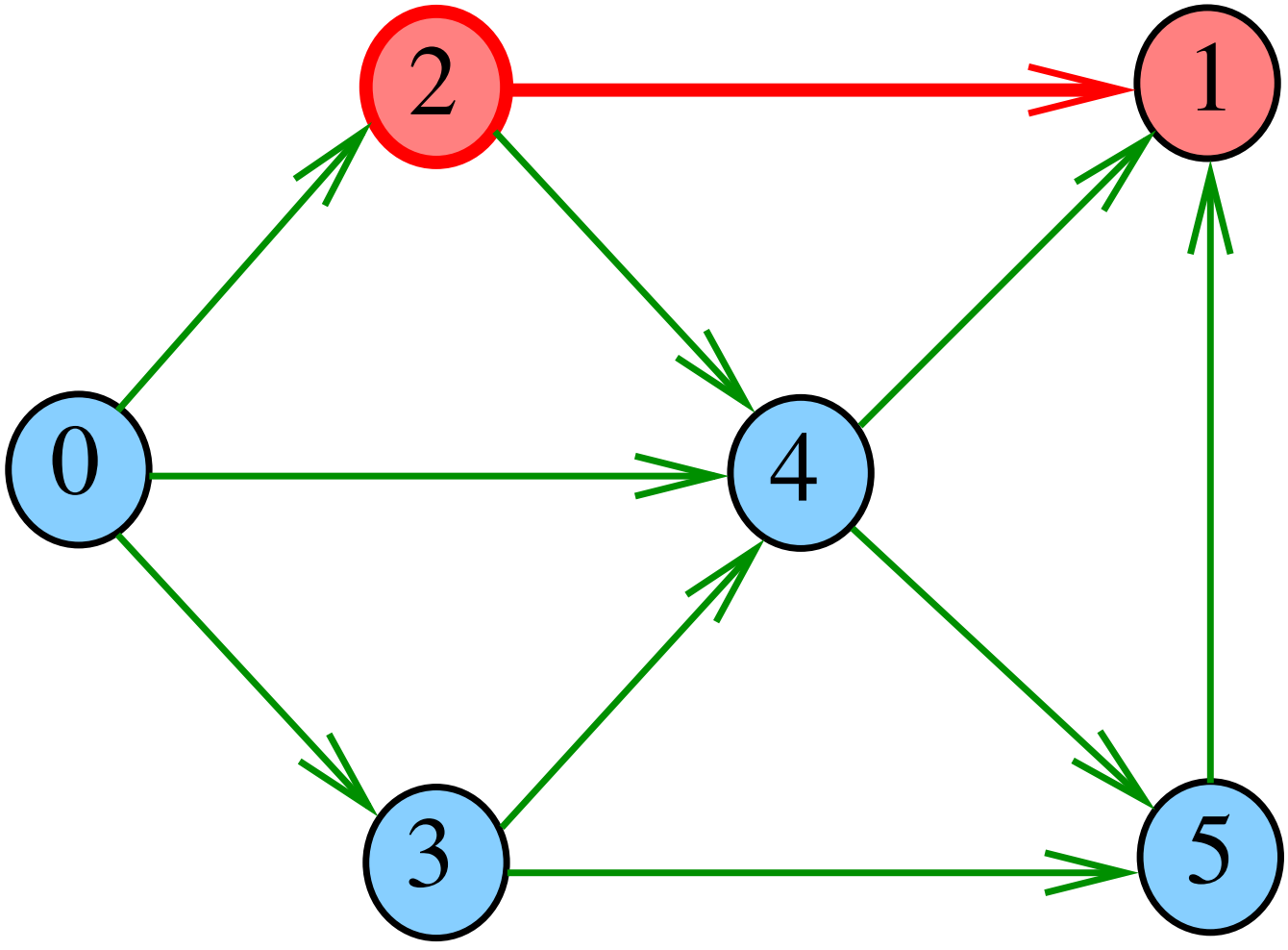
pathR(G,2)



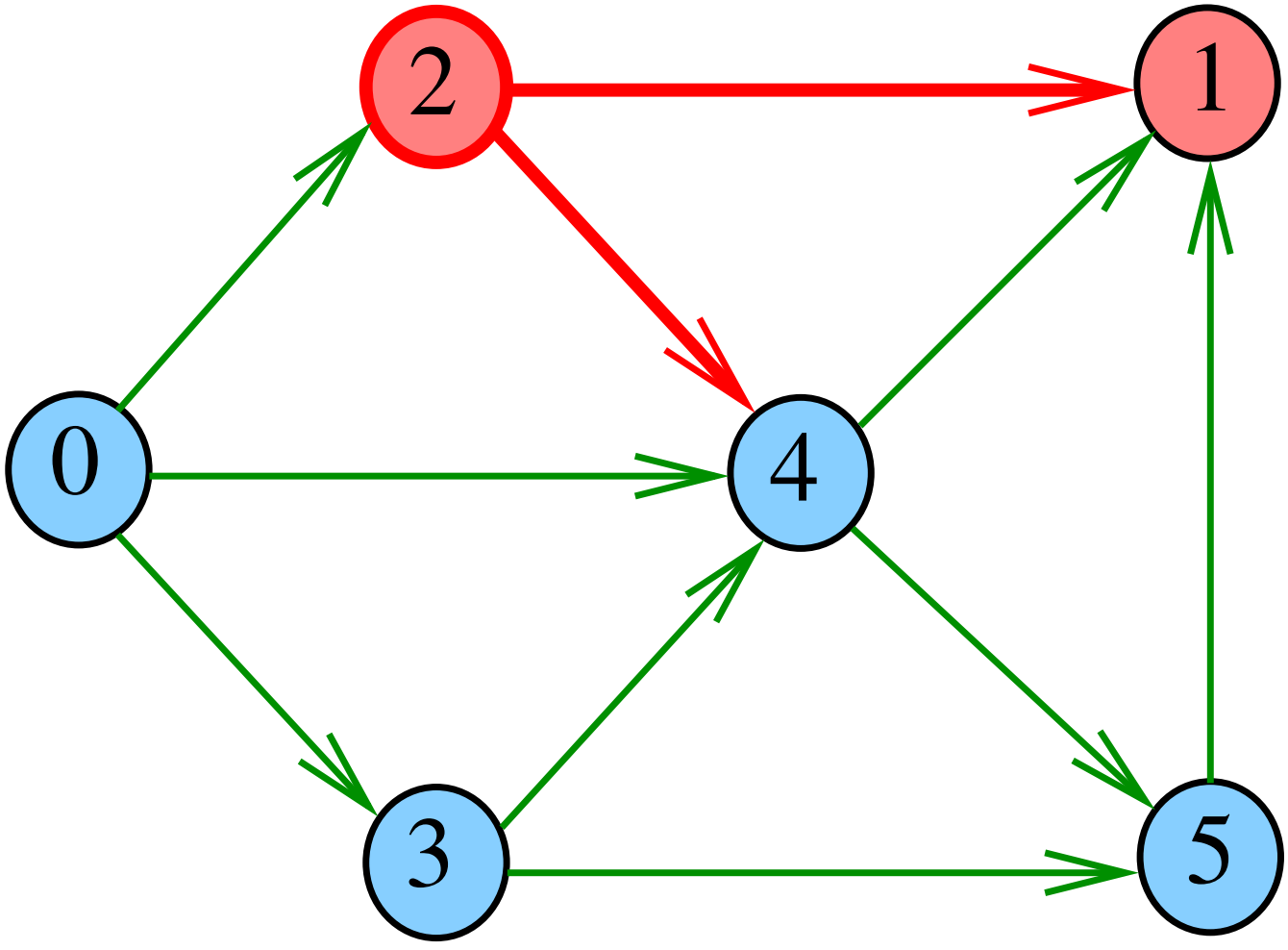
pathR(G,1)



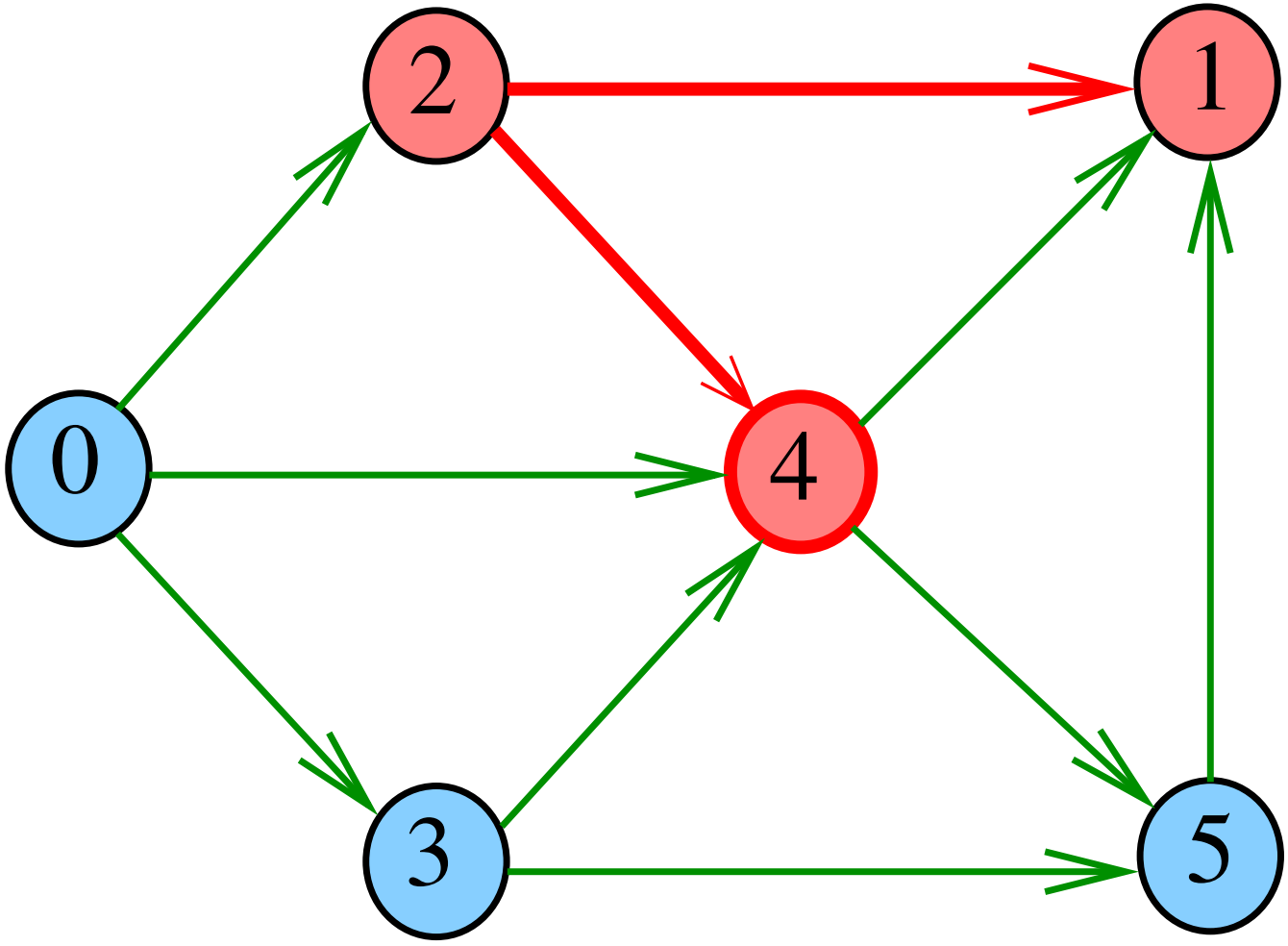
pathR(G,2)



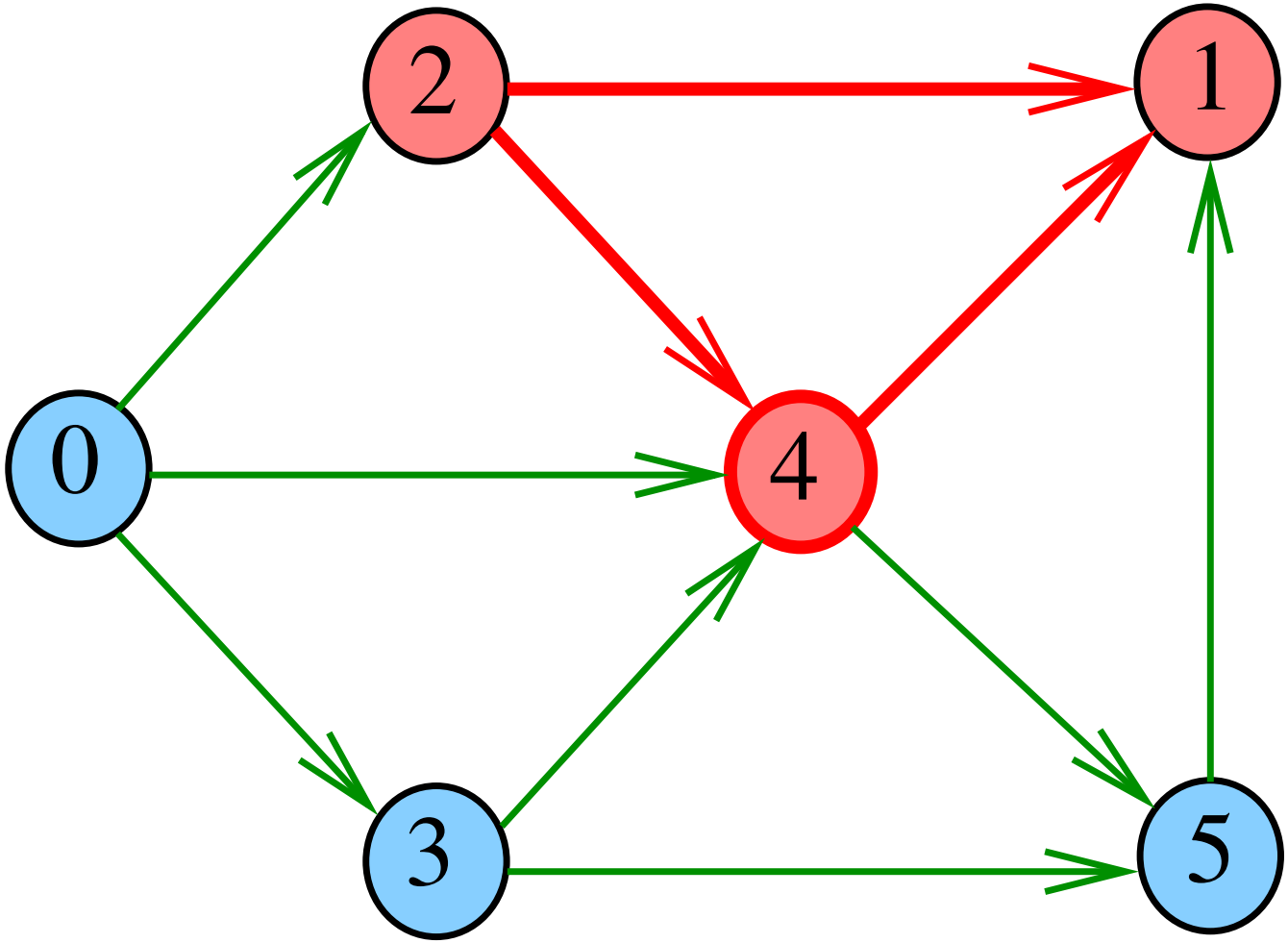
pathR(G,2)



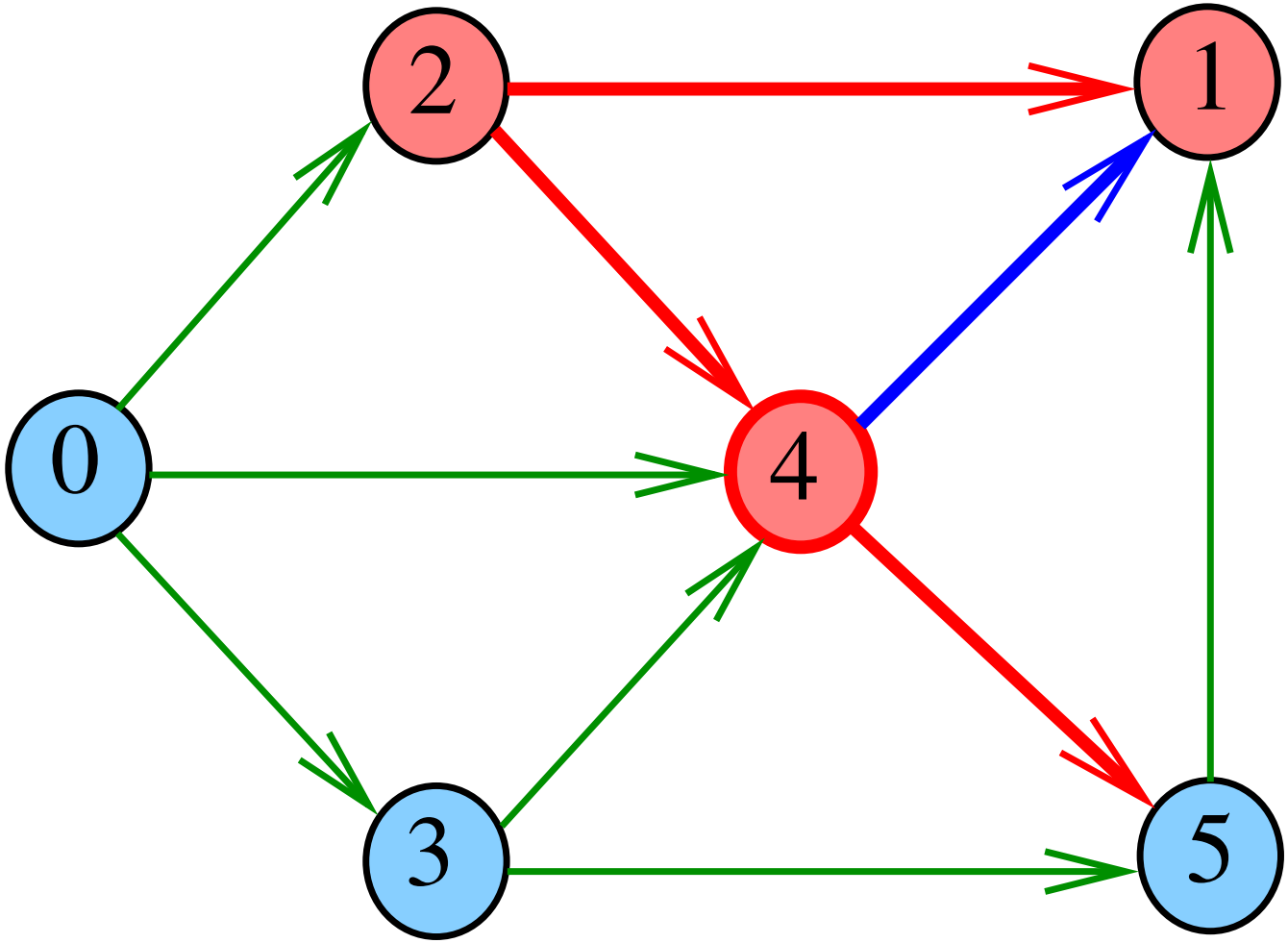
pathR(G,4)



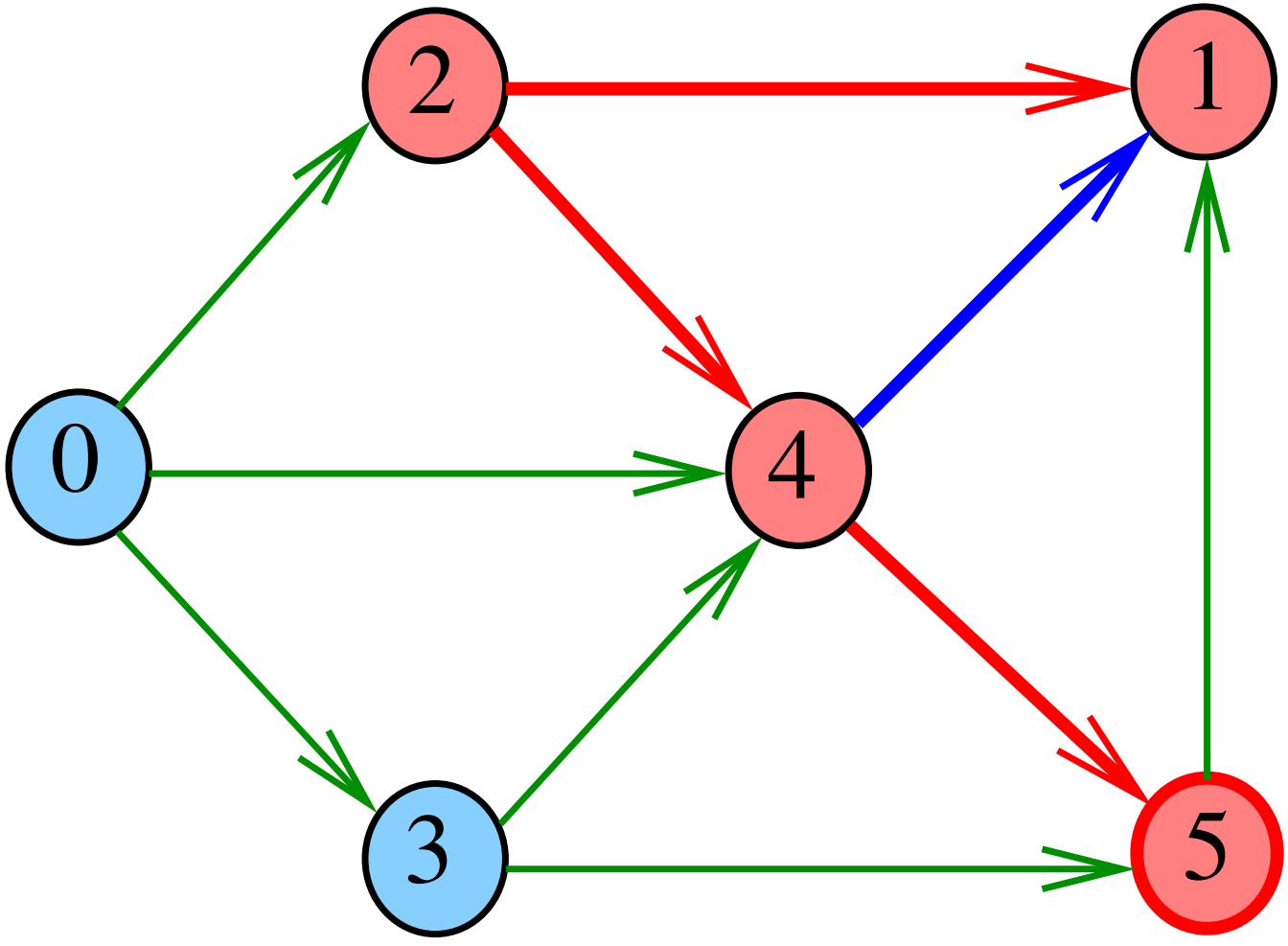
pathR(G,4)



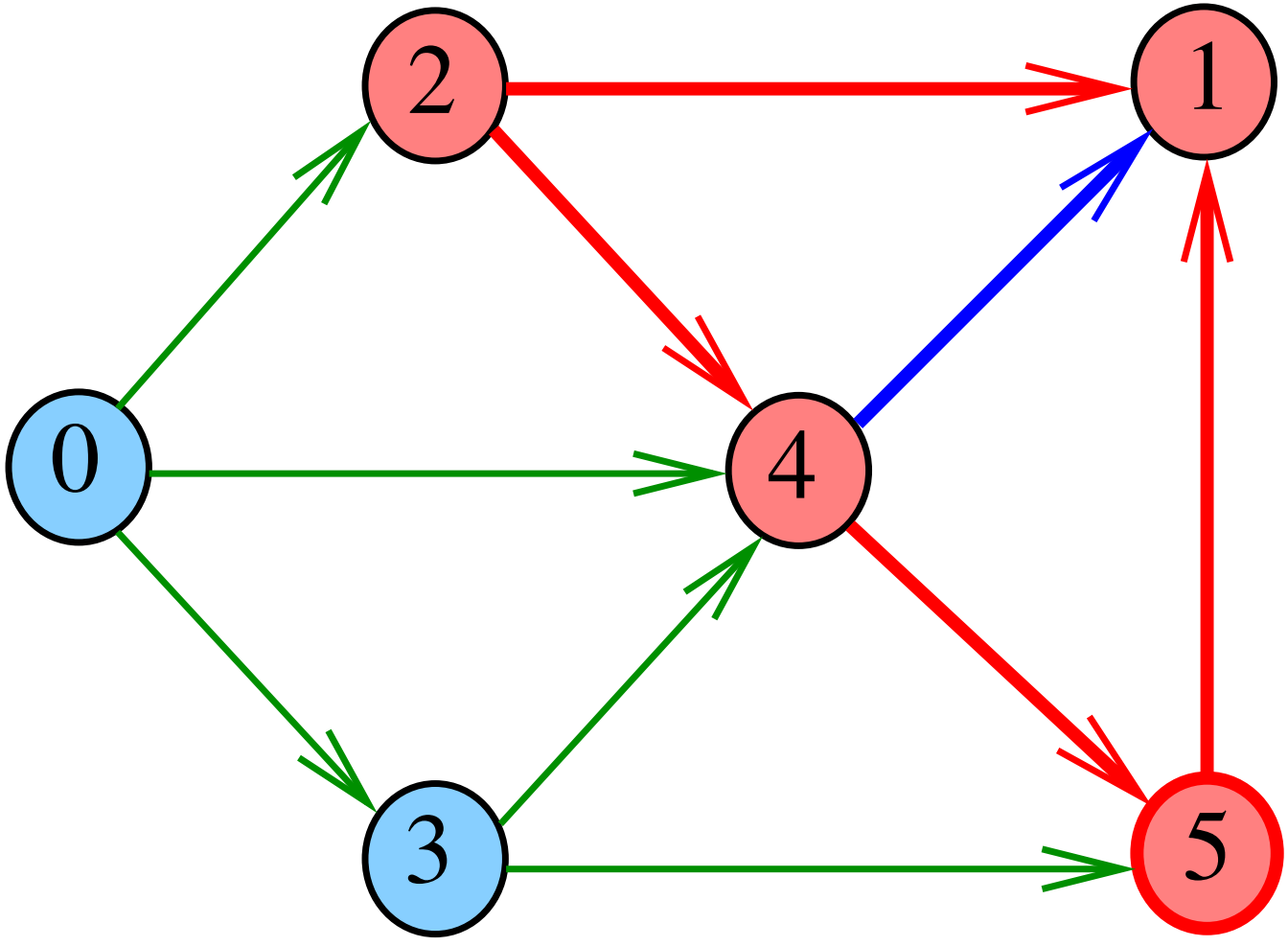
pathR(G,4)



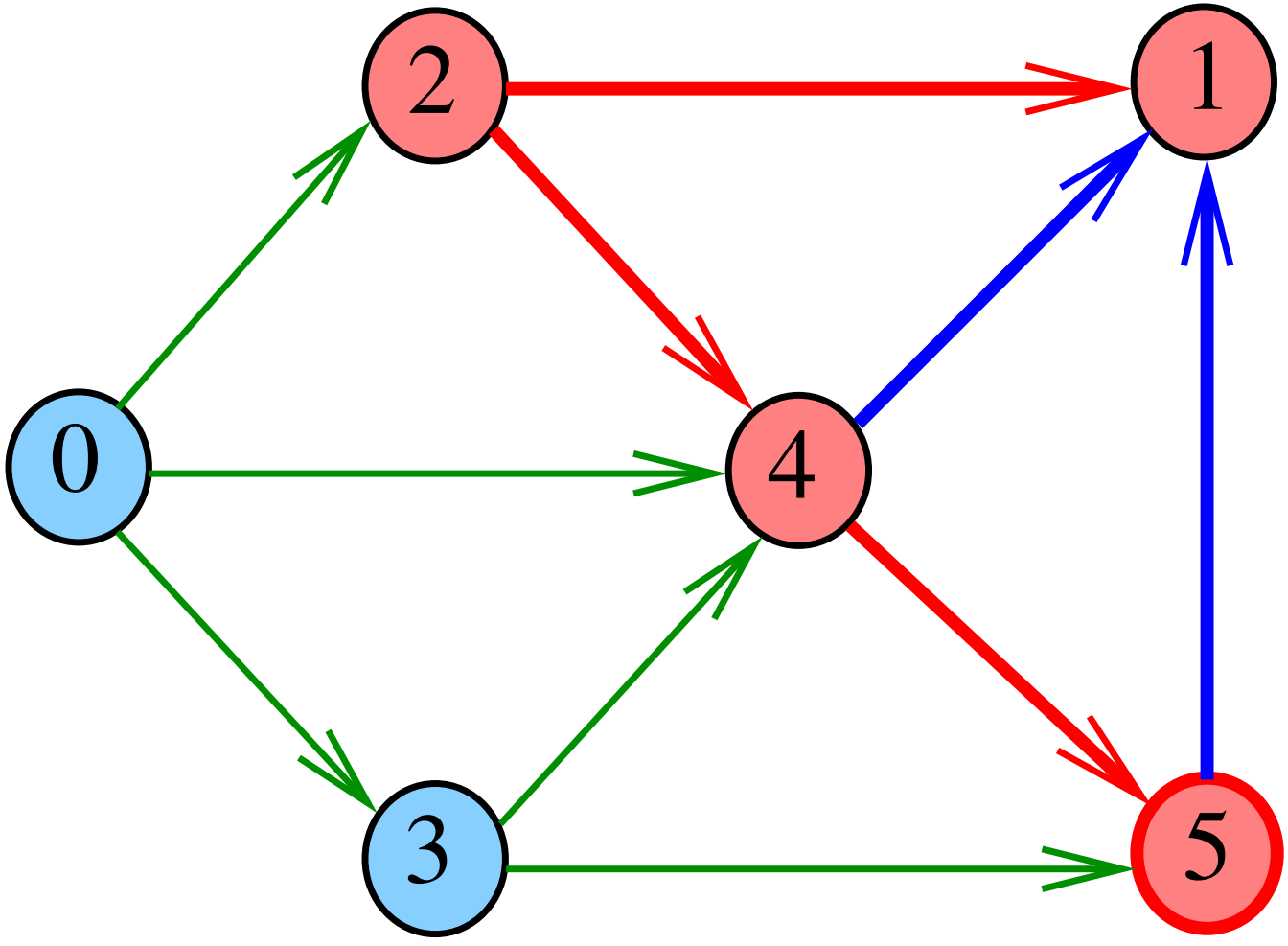
pathR(G,5)



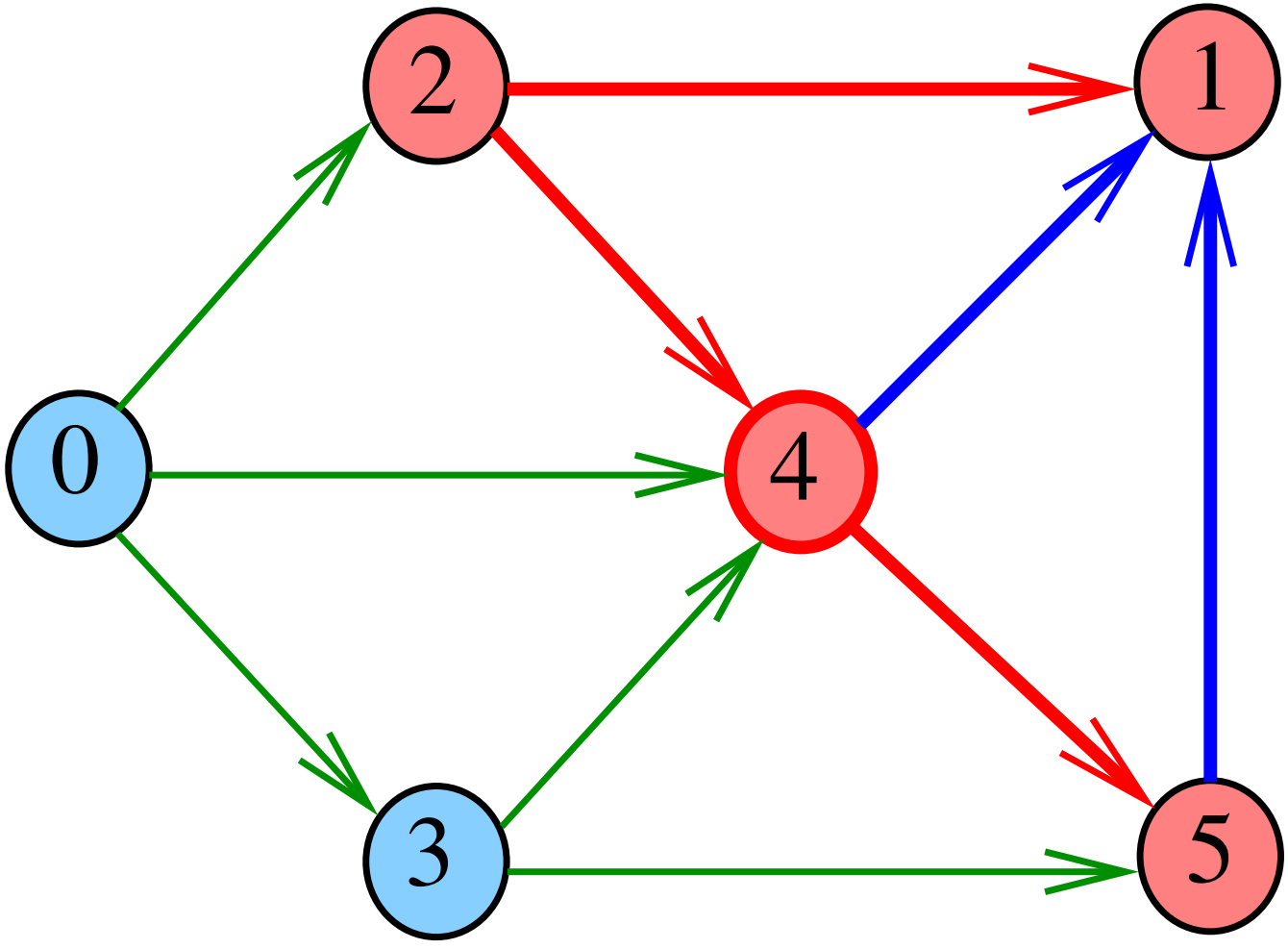
pathR(G,5)



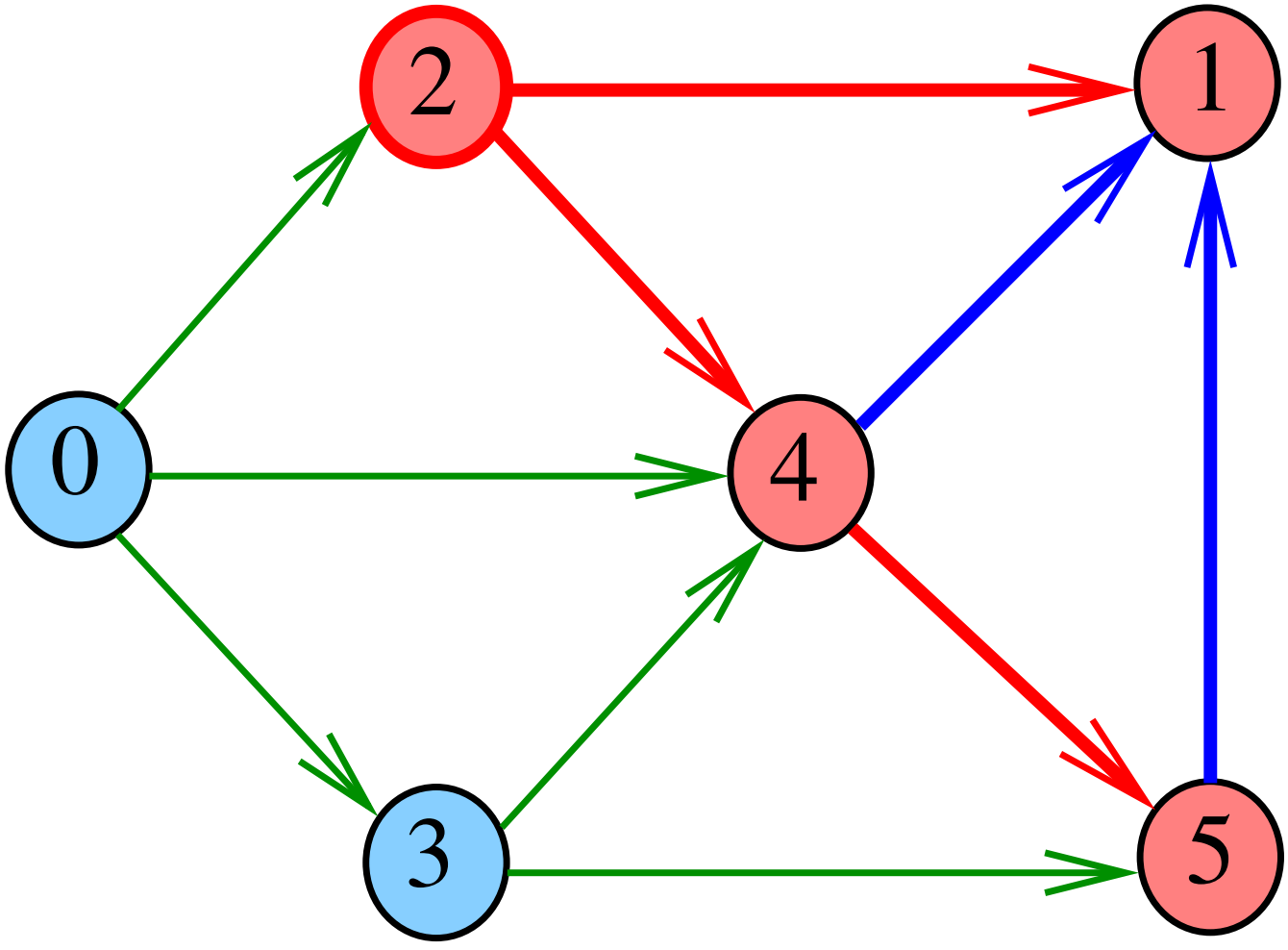
pathR(G,5)



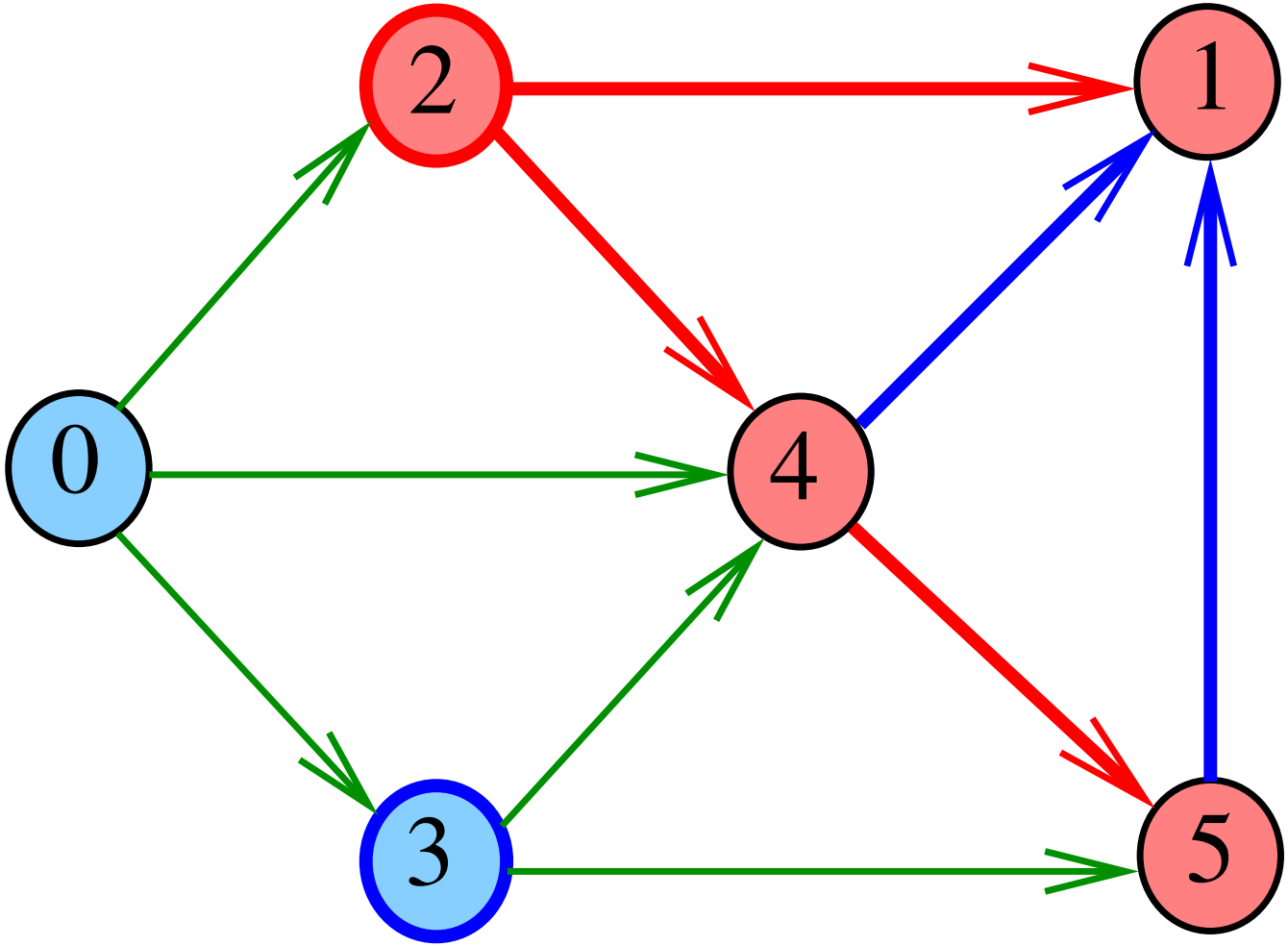
pathR(G,4)



pathR(G,2)



DIGRAPHpath(G,2,3)



DIGRAPHpath

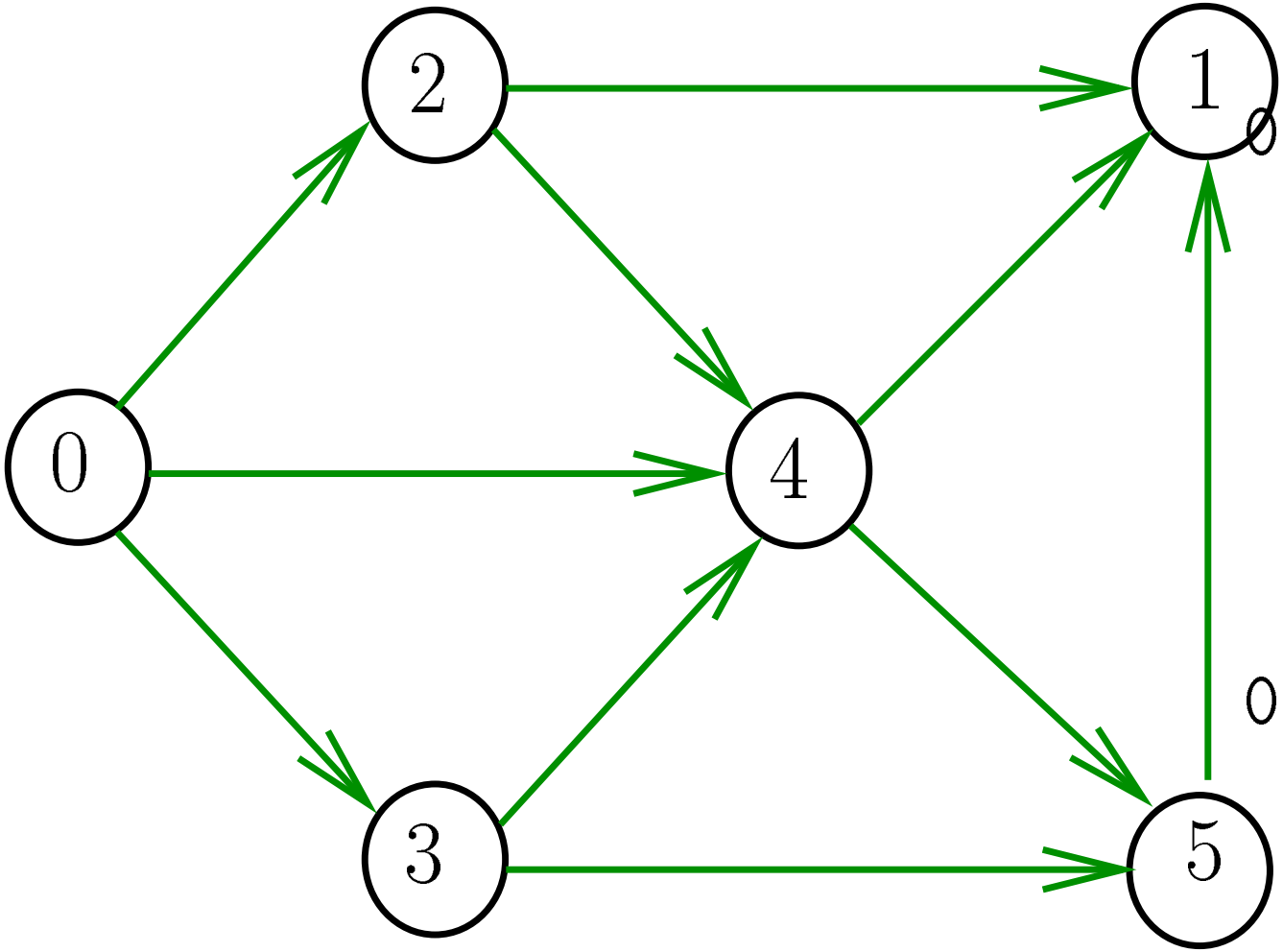
```
static int lbl[maxV];
int DIGRAPHpath (Digraph G, Vertex s, Vertex t)
{
    Vertex v;
1   for (v = 0; v < G->V; v++)
2       lbl[v] = -1;
3   pathR(G,s);
4   if (lbl[t] == -1) return 0;
5   else return 1;
}
```

pathR

Visita todos os vértices que podem ser atingidos a partir de v

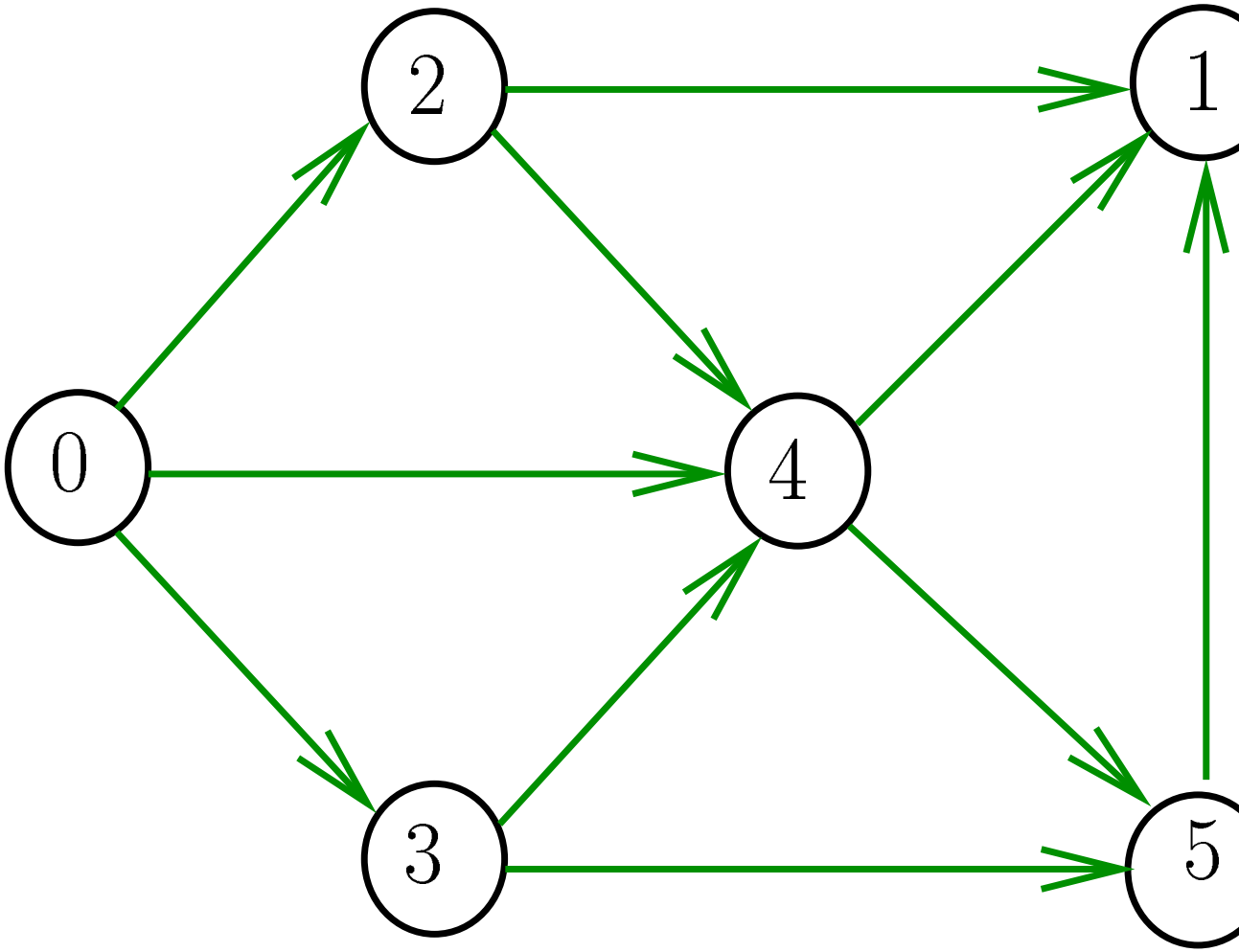
```
void pathR (Digraph G, Vertex v)
{
    Vertex w;
1   lbl[v] = 0;
2   for (w = 0; w < G->V; w++)
3       if (G->adj[v][w] == 1)
4           if (lbl[w] == -1)
5               pathR(G, w);
}
```

DIGRAPHpath(G,0,1)




```
0-2 pathR(G,2)
  2-1 pathR(G,1)
  2-4 pathR(G,4)
    4-1
    4-5 pathR(G,5
      5-1
0-3 pathR(G,3)
  3-4
  3-5
0-4
existe caminho
```

DIGRAPHpath(G,2,3)




```
2-1 pathR(G,1)
2-4 pathR(G,4)
  4-1
  4-5 pathR(G,5)
    5-1
nao existe caminh
```

Consumo de tempo

O consumo de tempo da função `PathR` para matriz de adjacência é $O(V^2)$.

O consumo de tempo da função `DIGRAPHpath` para matriz de adjacência é $O(V^2)$.

AULA 3

Caminhos em digrafos (continuação)

S 17.1

DIGRAPHpath

Esta versão pára assim que encontra `t`

```
static int lbl[maxV];
int DIGRAPHpath (Digraph G, Vertex s, Vertex t)
```

DIGRAPHpath

Esta versão pára assim que encontra `t`

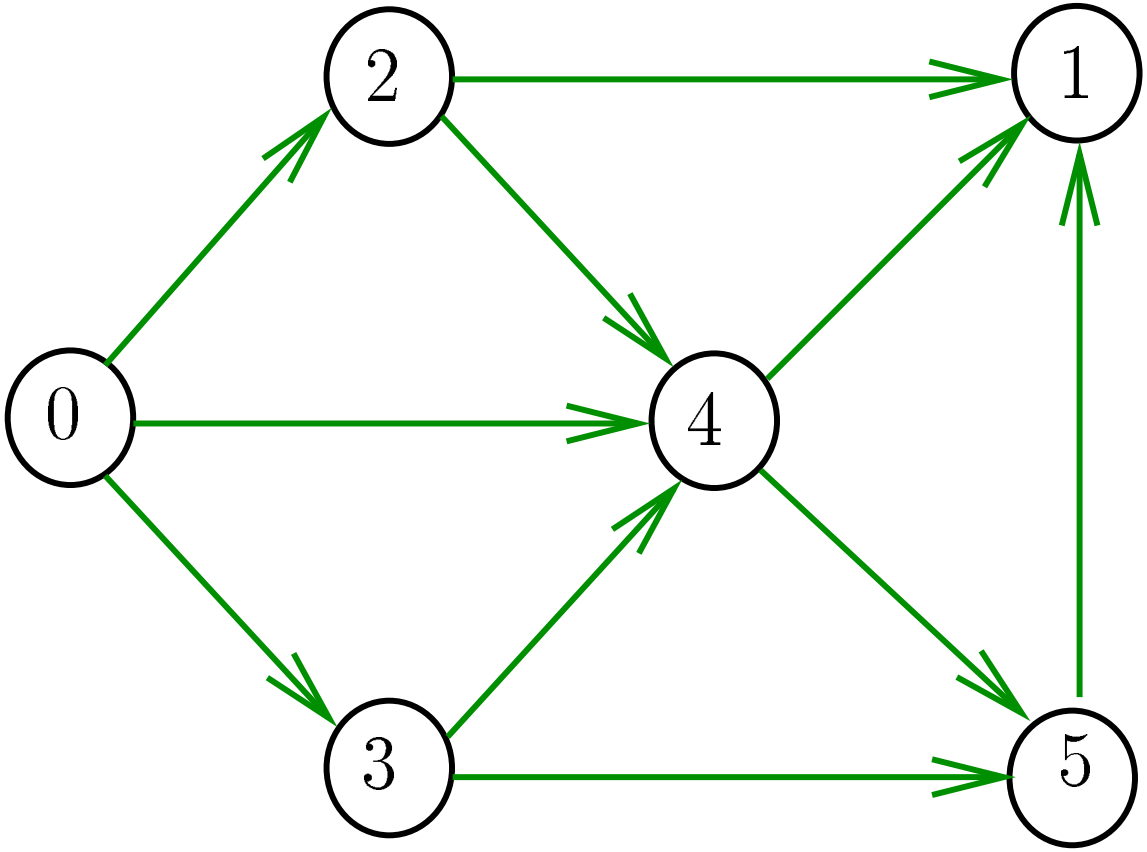
```
static int lbl[maxV];
int DIGRAPHpath (Digraph G, Vertex s, Vertex t)
{
    Vertex v;
1   for (v = 0; v < G->V; v++)
2       lbl[v] = -1;
3   return pathR(G,s,t);
}
```

pathR

Pára assim que encontra `t`

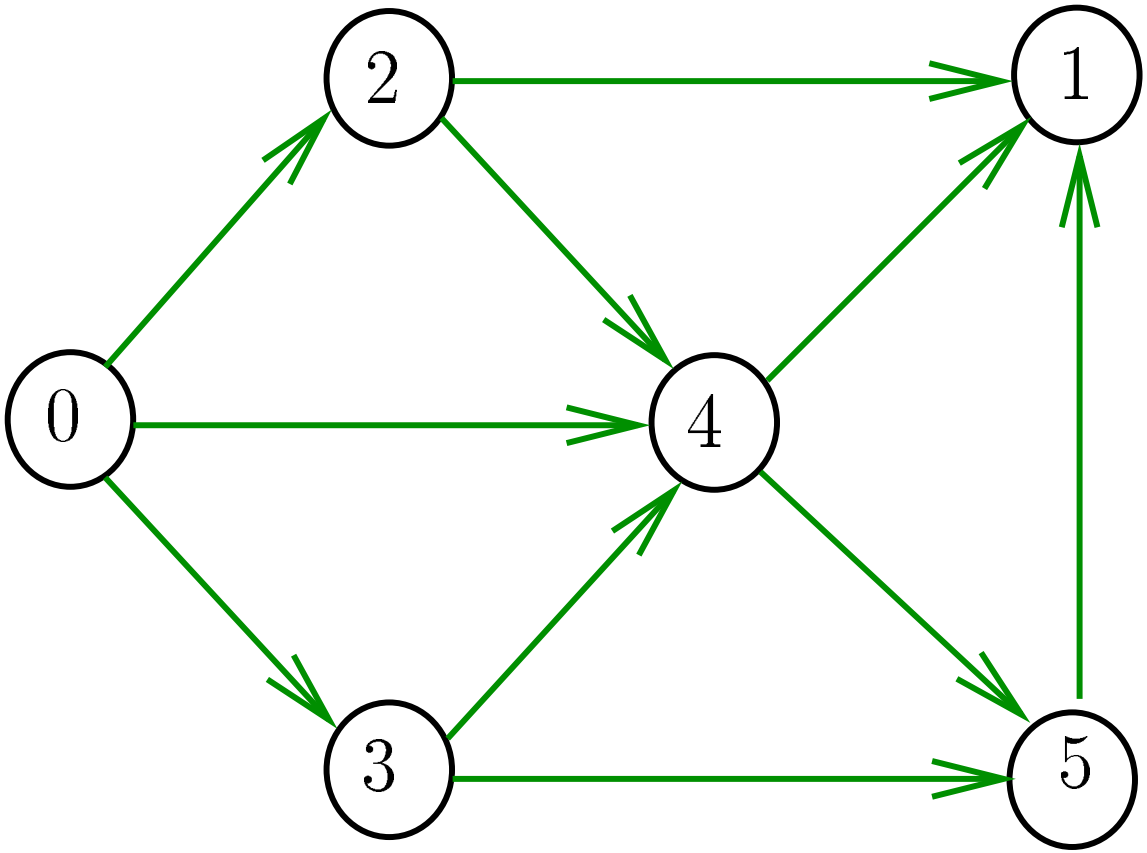
```
int pathR (Digraph G, Vertex v, Vertex t) {
    Vertex w;
0   lbl[v] = 0;
1   if (v == t) return 1;
2   for (w = 0; w < G->V; w++)
3       if (G->adj[v][w] == 1 && lbl[w] == -1)
4           if (pathR(G, w) == 1)
5               return 1;
6   return 0;
}
```

DIGRAPHpath(G,0,1)




```
0-2 pathR(G,2)
  2-1 pathR(G,1)
  2-4 pathR(G,4)
    4-1
    4-5 pathR(G,5)
      5-1
0-3 pathR(G,3)
  3-4
0-4
existe caminho
```

DIGRAPHpath(G,2,3)




```
2-1 pathR(G,1)
2-4 pathR(G,4)
   4-1
   4-5 pathR(G,5)
      5-1
nao existe caminho
```

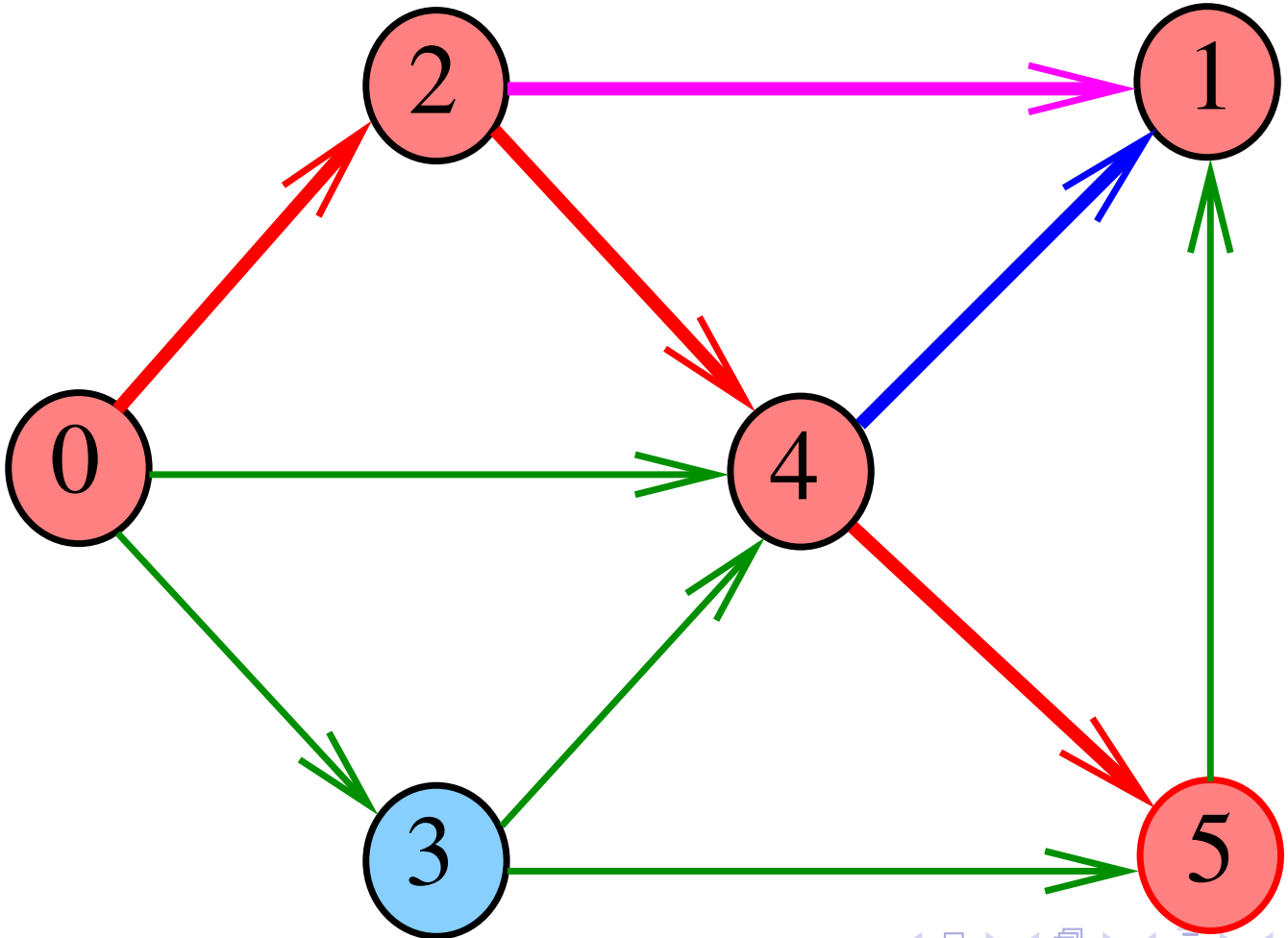
DIGRAPHpath (versão iterativa)

DIGRAPHpath (versão iterativa)

Relação invariante chave: no início de cada iteração

`caminho[0]-caminho[1]-···-caminho[k-1]`

é um caminho de `s` a `v`.



DIGRAPHpath (versão iterativa)

```
static int lbl[maxV];
int DIGRAPHpath (Digraph G, Vertex s, Vertex t)
{
      Vertex v, w;
      Vertex caminho[maxV];
      int k;
 1    for (v = 0; v < G->V; v++)
 2          lbl[v] = -1;
 3    lbl[s] = 0;
 4    caminho[0] = s;
 5    k = 1;    v = s;    w = 0;
```

DIGRAPHpath (versão iterativa)

```
 6   while (k != 1 || w != G->V)
 7       if (w == G->V) { /* volta */
 8           w = v+1;   k--;
 9           v = caminho[k-1];
10       } else if (G->adj[v][w] == 1
11                   && lbl[w] == -1) {
         /* avança */
12           lbl[w] = 0;   caminho[k++] = w;
13           v = w;   w = 0;
14       } else w = w+ 1; /* tenta próximo */

15   if (lbl[t] == -1) return 0;
16   return 1;
```