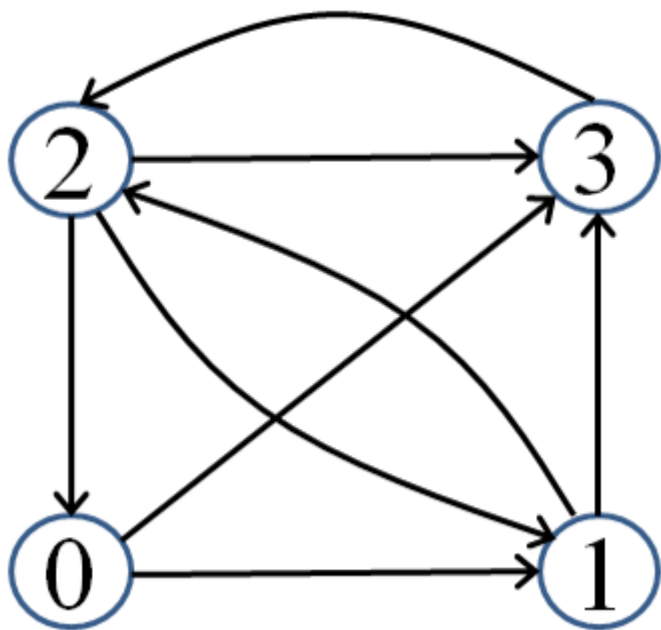


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非线性结构--图和排序

对于有 n 个顶点的有向图 G ，设计算法，找出 G 中长度为 k ($k \leq n$) 的路径条数。



例如：上图中1到2长度为2的路径有1（132）条，长度为3的路有2条（1212,1232）。2到3的长度为2的路径有2条（203，213），长度为3的路径有3条（2013，2123，2323）

试编写程序，实现最小生成树的克鲁斯卡尔算法。

```

# 用Kruskal算法实现最小生成树
#建立并查集 搜索Find 合并连通域Union
import numpy as np
class MST():
    def __init__(self, edges=np.array([]), n=0, m=0):
        self.edges=edges;#无向图边的信息 格式: u v w u和v是顶点编号, 从1开始, w是边的
        权重。

        self.n=n;#无向图的顶点数
        self.m=m;#无向图的边数
        self.parent=[-1]*(n+1);#建立每个顶点所在连通域的根节点
        self.edges=self.edges[np.lexsort(self.edges.T)];
        self.mst=np.array([]);
    def __find__(self, x):
        s=x;
        while(s>=0 and self.parent[s]>=0):
            s=self.parent[s];
        while(s!=x):#压缩搜索路径
            temp=self.parent[x];
            self.parent[x]=s;
            x=temp;
        return s;

```

```

def __union__(self,N1,N2):#合并两个节点所在的连通域
    r1=self.__find__(N1);
    r2=self.__find__(N2);
    temp=self.parent[r1]+self.parent[r2];
    if(self.parent[r1]>self.parent[r2]):
        self.parent[r2]=r1;
        self.parent[r1]=temp;
    else:
        self.parent[r1]=r2;
        self.parent[r2]=temp;

def kruskal(self):
    sumweight=0;
    num=0;
    for item in self.edges:
        if(self.__find__(item[0])!=self.__find__(item[1])):
            sumweight=sumweight+item[2];
            num=num+1;
            if(num==1):
                self.mst=np.array([item]);
            else:
                self.__union__(item[0], item[1]);
                item_x=np.array(item);
                self.mst=np.insert(self.mst,0,values=item_x,axis=0);
        if(num>self.n-1):
            break
    return self.mst,sumweight;

```

试设计算法，找出给定**DAG**（有向无环图）中所有可能的拓扑序列。

编写算法，实现图的**m**着色（可参照韦尔奇.鲍威尔(**Welch Powell**) 方法）

按照快速排序的思想，编写实现链表排序的算法。

```

class Node():
    def __init__(self,data=0,next=0):
        self.data=data;
        self.next=next;
class LinkList():
    def __init__(self):
        self.head=0;
        self.length=0;
    def is_empty(self):
        if(self.head==0):
            return True;
        else:

```

```
        return False;

def get_item(self,data):
    if(self.is_empty()==True):
        print("The LinkedList is empty!");
        return -1;
    else:
        j=0;
        p=self.head;
        while(p.next!=0):
            if(data==p.data):
                return j;
            else:
                p=p.next;
                j=j+1;
        if (data == p.data):
            return j;
        print("Objects that do not exist in the linked list!");
        return -1;

def append(self,data):
    if(self.is_empty()==True):
        newNode=Node(data);
        self.head=newNode;
        self.length=self.length+1;
    else:
        newNode=Node(data);
        p=self.head;
        while(p.next!=0):
            p=p.next;
        p.next=newNode;
        self.length=self.length+1;

def insert(self,data,index):
    if(index<0 and index>self.length):
        print("the index is wrong!");
        return False;
    j=0;
    p=self.head;
    while(j<index):
        p=p.next;
        j=j+1;
    newNode=Node(data);
    pnext=p.next;
    p.next=newNode;
    newNode.next=pnext;
    self.length=self.length+1;
    return True;

def get_length(self):
    return self.length;

def delete(self,data):
    if(self.get_item(data)==-1):
```

```

        print("Objects that do not exist in the linked list!");
        return False;
    p=self.head;
    pfront=0;
    if(self.head.data==data):
        self.head=0;
        self.length=0;
        return True;
    pfront=p;
    p=p.next;
    while(p.next!=0):
        if(p.data==data):
            pfront.next=p.next;
            self.length=self.length-1;
            return True;
        else:
            pfront=p;
            p=p.next;
    if(p.data==data):
        pfront.next = p.next;
        self.length = self.length - 1;
        return True;
    return False;
def printAll(self):
    if(self.length==0):
        print("the linklist is empty!");
        return ;
    p=self.head;
    print("there are {} nodes:".format(self.length));
    while(p.next!=0):
        print(p.data,end=" ");
        p=p.next;
    print(p.data);
    return ;

def __quick_sort_location__(self, phead, pend):
    if (phead == pend or phead.next == pend):
        return phead;
    key=phead.data;
    pprev=phead;
    plast=phead;
    while(plast!=pend):
        if(plast.data<key):
            pprev=pprev.next;
            temp=pprev.data;
            pprev.data=plast.data;
            plast.data=temp;
        plast=plast.next;
    if (plast.data < key):
        pprev = pprev.next;
        temp = pprev.data;
        pprev.data = plast.data;
        plast.data = temp;
    phead.data=pprev.data;

```

```

        pprev.data=key;
        return pprev;

    def __quick_sort__(self,phead,pend): #作业四：5.按照快速排序的思想，编写实现链表
    排序的算法。
        if(phead==pend or phead.next==pend):
            return ;
        mid=self.__quick_sort_location__(phead,pend);
        self.__quick_sort__(phead,mid);
        self.__quick_sort__(mid.next,pend);

    def quick_sort(self):
        if(self.head==0 or self.head.next==0):
            return;
        p=self.head;
        while(p.next!=0):
            p=p.next;
        self.__quick_sort__(self.head,p);

```

按照归并排序的思想，编写实现链表排序的算法。

```

class Node():
    def __init__(self,data=0,next=0):
        self.data=data;
        self.next=next;
class LinkedList():
    def __init__(self):
        self.head=0;
        self.length=0;
    def is_empty(self):
        if(self.head==0):
            return True;
        else:
            return False;

    def get_item(self,data):
        if(self.is_empty()==True):
            print("The LinkedList is empty!");
            return -1;
        else:
            j=0;
            p=self.head;
            while(p.next!=0):
                if(data==p.data):
                    return j;
                else:
                    p=p.next;
                    j=j+1;
            if (data == p.data):
                return j;

```

```
        print("Objects that do not exist in the linked list!");
        return -1;

def append(self,data):
    if(self.is_empty()==True):
        newNode=Node(data);
        self.head=newNode;
        self.length=self.length+1;
    else:
        newNode=Node(data);
        p=self.head;
        while(p.next!=0):
            p=p.next;
        p.next=newNode;
        self.length=self.length+1;

def insert(self,data,index):
    if(index<0 and index>self.length):
        print("the index is wrong!");
        return False;
    j=0;
    p=self.head;
    while(j<index):
        p=p.next;
        j=j+1;
    newNode=Node(data);
    pnext=p.next;
    p.next=newNode;
    newNode.next=pnext;
    self.length=self.length+1;
    return True;

def get_length(self):
    return self.length;

def delete(self,data):
    if(self.get_item(data)==-1):
        print("Objects that do not exist in the linked list!");
        return False;
    p=self.head;
    pfront=0;
    if(self.head.data==data):
        self.head=0;
        self.length=0;
        return True;
    pfront=p;
    p=p.next;
    while(p.next!=0):
        if(p.data==data):
            pfront.next=p.next;
            self.length=self.length-1;
            return True;
        else:
            pfront=p;
            p=p.next;
```

```

        p=p.next;
    if(p.data==data):
        pfront.next = p.next;
        self.length = self.length - 1;
        return True;
    return False;
def printAll(self):
    if(self.length==0):
        print("the linklist is empty!");
        return ;
    p=self.head;
    print("there are {} nodes:".format(self.length));
    while(p.next!=0):
        print(p.data,end=" ");
        p=p.next;
    print(p.data);
    return ;

```

def __merge_sort__(self, phead):#作业四：6.按照归并排序的思想，编写实现链表排序的算法。

先判断链表长度是否大于1，小于1时无须排序

```
if (phead != 0 and phead.next != 0):
```

```

    pfast=phead.next;
    pslow=phead;
    # 利用快慢指针找到链表的中间节点
    while(pfast!=0 and pfast.next!=0):
        pfast=pfast.next.next;
        pslow=pslow.next;

```

递归实现归并排序

```
phead1=self.__merge_sort__(pslow.next);
```

```

pslow.next=0; #这个很重要
phead2=self.__merge_sort__(phead);

```

对子表进行合并

```

vphead=Node();
cur=vphead;#建立个伪头节点;
while(phead1!=0 and phead2!=0):
    if(phead1.data<phead2.data):
        cur.next=phead1;
        phead1=phead1.next;
    else:
        cur.next=phead2;
        phead2=phead2.next;
    cur=cur.next;
if(phead1!=0):
    cur.next=phead1;
if(phead2!=0):
    cur.next=phead2;
return vphead.next;

```

```
        return phead;
def merge_sort(self):
    if(self.length<2):
        return ;
    self.head=self.__merge_sort__(self.head);
```