

# 论题 1-11 作业

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## 1 [DH] Problem 4.1

- (a)  $S \leftarrow 0$ ;  
for  $i$  going from 1 to  $N$  do the following:  
    if  $A[i, 1] > A[A[i, 2], 1]$  then  $S \leftarrow S + A[i, 1]$ ;  
output  $S$ .

- (b) Suppose the root of the binary tree is  $R$ .

$S \leftarrow 0$ ;  
 $P \leftarrow R$ ;  
 $N \leftarrow$  the content of the first offspring of  $R$ ;  
if the content of  $R > \text{get the salary of } N\text{th employee}$  then  $S \leftarrow S +$  the content of  $R$ ;  
while  $P$  has a second offspring do the following:  
     $P \leftarrow$  the second offspring of  $P$ ;  
     $N \leftarrow$  the content of the first offspring of  $S$ ;  
    if the content of  $P > \text{get the salary of } N\text{th employee}$  then  $S \leftarrow S +$  the content of  $P$ ;  
output  $S$ .

subroutine **get the salary of  $N$ th employee**

$T \leftarrow R$ ;  
do the following  $N - 1$  times:  
     $T \leftarrow$  the second offspring of  $T$ ;  
 $T \leftarrow$  the second offspring of  $T$ ;  
return the content of  $T$ ;

## 2 [DH] Problem 4.2

- (a)  $S \leftarrow 0$ ;  
call **add**( $T, 0$ );

output  $S$ .

subroutine **add**( $P, x$ )

$S \leftarrow S + x$ ;

$N \leftarrow 1$ ;

while  $P$  has an  $N$ th offspring do the following:

    call **add**(the  $N$ th offspring of  $P, x + 1$ );

$N \leftarrow N + 1$ ;

return.

(b)  $S \leftarrow 0$ ;

call **count**( $T, 0$ );

output  $S$ ;

subroutine **count**( $P, x$ )

if  $x = K$  then do the following:

$S \leftarrow S + 1$ ;

    return;

$N \leftarrow 1$ ;

while  $P$  has an  $N$ th offspring do the following:

    call **count**(the  $N$ th offspring of  $P, x + 1$ );

$N \leftarrow N + 1$ ;

return.

(c)  $R \leftarrow \text{false}$ ;

call **check**( $T, 0$ );

output  $R$ .

subroutine **check**( $P, x$ )

if  $x$  is even then do the following:

    if  $P$  doesn't have a first offspring then do the following:

$R \leftarrow \text{true}$ ;

        return;

$N \leftarrow 1$ ;

while  $P$  has an  $N$ th offspring do the following:

    call **check**(the  $N$ th offspring of  $P, x + 1$ );

$N \leftarrow N + 1$ ;

return.

### 3 [DH] Problem 4.8

Suppose that the maximal distance between any two points on a polygon occurs between  $M$  and  $N$ . First, regard  $N$  as an arbitrary fixed point, and consider point  $M$ .

Case 1:  $M$  is in the polygon. Extend  $NM$  cutting the polygon at  $E$  (Figure 2(a)).  $NE$  is longer than  $NM$ .

Case 2:  $M$  is on one edge of the polygon, but  $M$  is not a vertex (Figure 2(b)). Let the edge where  $M$  is on be  $AB$ . At least one of  $\angle NMA$  and  $\angle NMB$  is not less than 90 degrees. Assume, WLOG, that  $\angle NMA \geq 90^\circ$ . By the law of sines, we get  $NA > NM$ .

Now, we have proved that for arbitrary  $N$ , the length of  $NM$  is maximal when  $M$  is a vertex of the polygon. Consider point  $N$ , we can prove that the length of  $MN$  is maximal when  $N$  is a vertex of the polygon likewise (Figure 2(c)). Hence, the maximal distance between any two points on a polygon occurs between two of the vertices.  $\square$

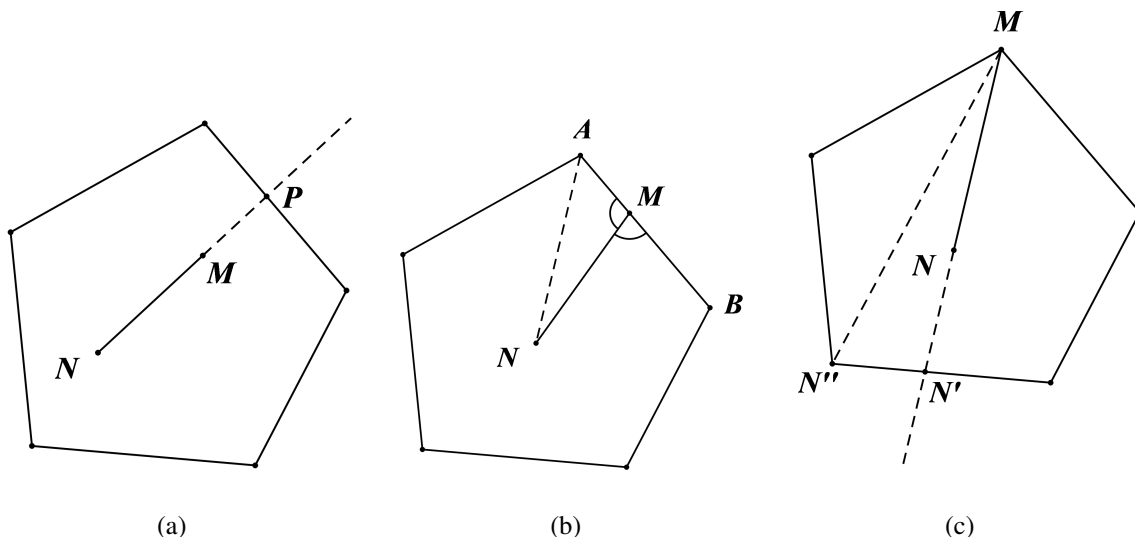


Figure 2: the distance of two points on a polygon

### 4 [DH] Problem 4.9

Language: C++

The first line of the input contains a positive integer  $n$ , giving the number of the vertices of the polygon. The following  $n + 1$  lines of the input contains the coordinates of the vertices (in clockwise or counterclockwise order). The x-coordinate and y-coordinate are separated by a space.

The output of the program is a number, the maximal distance of two points on the polygon.

```
#include <iostream>
#include <cmath>
#include <algorithm>
using namespace std;
```

```

int n;
double x[1000], y[1000];

double dist(int i1, int i2)
{
    return hypot(x[i1 % n] - x[i2 % n], y[i1 % n] - y[i2 % n]);
}

int main()
{
    double ans = 0;
    int j, k;
    cin >> n;
    for (int i = 0; i < n; i++)
        cin >> x[i] >> y[i];
    j = n;
    k = n + 1;
    while (k < 2*n)
    {
        while (!(dist(j, k) > dist(j, k - 1) && dist(j, k) > dist(j,
k + 1)))
            k++;
        ans = max(ans, dist(j, k));
        j++;
    }
    cout << ans << endl;
    return 0;
}

```

## 5 [DH] Problem 4.11

Suppose the vector is named  $V$ .

(a)  $M_1 \leftarrow$  **find maximum of first  $N$  elements**;

$I \leftarrow 1$ ;

do the following while  $V[I] \neq M_1$ :

$I \leftarrow I + 1;$   
 for  $I$  going from  $I$  to  $N - 1$  do the following:  
 $V[I] \leftarrow V[I + 1];$   
 $M_2 \leftarrow$  **find maximum of first  $N - 1$  elements**;  
 output  $M_1, M_2$ .

subroutine **find maximum of first  $n$  elements**

$A \leftarrow V[1];$   
 for  $i$  going from 2 to  $n$  do the following:  
 if  $V[i] > A$  then  $A \leftarrow V[i];$   
 return  $A$ .

(b)  $M_1 \leftarrow$  **find maximum from 1th to  $N$ th element**;  
 $I \leftarrow 1;$   
 do the following while  $V[I] \neq M_1$ :  
 $I \leftarrow I + 1;$   
 for  $I$  going from  $I$  to  $N - 1$  do the following:  
 $V[I] \leftarrow V[I + 1];$   
 $M_2 \leftarrow$  **find maximum from 1th to  $(N - 1)$ th element**;  
 output  $M_1, M_2$ .

subroutine **find maximum from  $m$ th to  $n$ th element**;

if  $m = n$  then then return  $V[m];$   
 $p \leftarrow \lfloor (m + n) / 2 \rfloor;$   
 $T_1 \leftarrow$  **find maximum from  $m$ th to  $p$ th element**;  
 $T_2 \leftarrow$  **find maximum from  $(p + 1)$ th to  $n$ th element**;  
 if  $T_1 > T_2$  then return  $T_1$ ;  
 otherwise return  $T_2$ .

## 6 [DH] Problem 4.12

Suppose there are  $M$  nodes and  $N$  edges in the graph, the nodes are numbered from 1 to  $M$  and the edges are stored in vector  $V$ . Every edge  $T$  support three operations: get the number of the first node it connects( $T$ .first), get the number of the second node it connects( $T$ .second) and get the length of the node( $T$ .length). Let  $U$  be an empty vector of integers. The output is the edges forming the minimal spanning tree.

call **initialize**;  
 call **quicksort from 1 to  $N$** ;

```

 $m \leftarrow 0;$ 
 $i \leftarrow 1;$ 
while  $m < M - 1$  do the following:
    if find  $V[i].\text{first} \neq \text{find } V[i].\text{second}$  then do the following:
        call union  $V[i].\text{first}$  and  $y.\text{first}$ ;
        output  $V[i]$ ;
         $m \leftarrow m + 1;$ 
     $i \leftarrow i + 1.$ 

```

subroutine **initialize**

```

for  $i$  going from 1 to  $N$  do the following:
     $U[i] = i;$ 

```

subroutine **find**  $x$

```

if  $U[x] = x$  then return  $x$ ;
 $t \leftarrow \text{find } U[x];$ 
 $U[x] \leftarrow t;$ 
return  $t.$ 

```

subroutine **union**  $x$  **and**  $y$

```

 $p \leftarrow \text{find } x;$ 
 $q \leftarrow \text{find } y;$ 
 $U[p] \leftarrow q.$ 

```

subroutine **quicksort from**  $a$  **to**  $b$

```

if  $a \geq b$  then return;
 $p \leftarrow \text{partition from } a \text{ to } b;$ 
call quicksort from  $a$  to  $p - 1$ ;
call quicksort from  $p + 1$  to  $b.$ 

```

subroutine **partition from**  $a$  **to**  $b$

```

call swap  $\lfloor (a + b)/2 \rfloor$  and  $L;$ 
 $L \leftarrow a;$ 
for  $i$  going from  $a$  to  $b - 1$  do the following:
    if  $V[i].\text{length} < V[b].\text{length}$  do the following:
        call swap  $i$  and  $L;$ 
     $L \leftarrow L + 1;$ 
call swap  $b$  and  $L;$ 
return  $L.$ 

```

subroutine **swap**  $a$  and  $b$

```
 $t \leftarrow V[a];$   
 $V[a] \leftarrow V[b];$   
 $V[b] \leftarrow t;$   
return.
```

## 7 [DH] Problem 4.13

(a) Let  $R$  be an empty vector of integers,  $S$  be an empty two-dimensional array of integers.

for  $i$  going from 0 to  $C$  do the following:

$R[i] \leftarrow 0;$

for  $j$  going from 1 to  $N$  do the following:

$S[i][j] = 0;$

for  $i$  going from 1 to  $N$  do the following:

for  $j$  going from 1 to  $Q[i]$  do the following:

for  $k$  going down from  $C$  to  $W[i]$  do the following:

if  $R[j - W[i]] + P[i] > R[j]$  do the following:

$R[j] \leftarrow R[j - W[i]] + P[i];$

for  $l$  going from 1 to  $i$  do the following:

$S[j][l] \leftarrow S[j - W[i]][l];$

$S[j][i] \leftarrow S[j][i] + 1;$

output  $S[C]$ .

(b) The output is  $[0, 1, 3, 2, 1]$ . The total profit of the knapsack is 194.

## 8 [DH] Problem 4.14

(a) Let  $S$  be an empty vector of real numbers.

while  $C \neq 0$  do the following:

$t \leftarrow$  **find best material**;

if  $W[t] \times Q[t] < C$  then do the following:

$C \leftarrow C - W[t] \times Q[t];$

$Q[t] \leftarrow 0;$

$S[t] \leftarrow Q[t];$

otherwise do the following:

$Q[t] \leftarrow Q[t] - C/W[t];$

$S[t] \leftarrow C/W[t];$   
 $C \leftarrow 0;$   
output  $S$ .

subroutine **find best material**

$i \leftarrow 1;$   
while  $Q[i] = 0$  do the following:  
     $i \leftarrow i + 1;$   
 $t \leftarrow i;$   
for  $i$  going from  $i + 1$  to  $N$  do the following:  
    if  $Q[i] > 0$  and  $P[i]/W[i] > P[t]/W[t]$  then  $t \leftarrow i;$   
return  $t$ .

(b) The output is  $[0, 1, 1.8, 5, 1]$ . The total profit of the knapsack is 200.