

Nantong University ICPC Team Notebook (2018-19)

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第一章 输入输出

1.1 取消同步

```
1 std::ios::sync_with_stdio(false);
2 std::cin.tie(0);
```

1.2 浮点数输出格式

```
1 //include <iomanip>
2
3 std::cout << std::fixed << std::setprecision(12) << ans << std::endl;
```

1.3 整型快速输入

```
1 // 整型
2 //若读入不成功，返回false
3 //ios::sync_with_stdio(true)
4 //include <cctype>
5 bool quick_in(int &x) {
6     char c;
7     while((c = getchar()) != EOF && !isdigit(c));
8     if(c == EOF) {
9         return false;
10    }
11    x = 0;
12    do {
13        x *= 10;
14        x += c - '0';
15    } while((c = getchar()) != EOF && isdigit(c));
16    return true;
17 }
18
19 //带符号整型
20 //直接=返回值
21 //include <cctype>
22 int read() {
23     int x = 0, l = 1; char ch = getchar();
24     while (!isdigit(ch)) {if (ch=='-') l=-1; ch=getchar();}
```

```
25     while (isdigit(ch)) x=x*10+(ch^48),ch=getchar();
26     return x*1;
27 }
28
29 template <class T>
30 inline bool Read(T &ret) {
31     char c; int sgn;
32     if(c=getchar(),c==EOF) return 0; //EOF
33     while(c!='-'&&(c<'0' || c>'9')) c=getchar();
34     sgn=(c=='-') ?-1:1 ;
35     ret=(c=='-') ?0:(c-'0');
36     while(c=getchar(),c>='0'&&c<='9')
37         ret=ret*10+(c-'0');
38     ret*=sgn;
39     return 1;
40 }
```

1.4 字符串快速输入

```
1 bool quick_in(char *p) {
2     char c;
3     while((c = getchar()) != EOF && (c == '\u000a' || c == '\n'));
4     if(c == EOF) {
5         return false;
6     }
7     do {
8         *p++ = c;
9     } while((c=getchar()) != EOF && c != '\u000a' && c != '\n');
10    *p = 0;
11    return true;
12 }
```

1.5 整型快速输出

```
1 void quick_out(int x) {
2     char str[13];
3     if(x) {
4         int i;
5         for(i = 0; x; ++i) {
6             str[i] = x % 10 + '0';
7             x /= 10;
8         }
9         while(i--) {
10            putchar(str[i]);
11        }
12    } else {
13        putchar('0');
14    }
15 }
```

1.6 字符串快速输出

```
1 void quick_out(char *p) {  
2     while(*p) {  
3         putchar(*p++);  
4     }  
5 }
```

1.7 python 输入

```
1 a, b, c =map(int,input().split(' '))
```

第二章 动态规划

2.1 背包问题

```
1  const int maxn=100005;
2  int w[maxn],v[maxn],num[maxn];
3  int W,n;
4  int dp[maxn];
5
6  void ZOP(int weight, int value) {
7      for(int i = W; i >= weight; i--) {
8          dp[i]=std::max(dp[i],dp[i-weight]+value);
9      }
10 }
11
12 void CP(int weight, int value){
13     for(int i = weight; i <= W; i++) {
14         dp[i] = std::max(dp[i], dp[i-weight]+value);
15     }
16 }
17
18 void MP(int weight, int value, int cnt){
19     if(weight*cnt >= W) {
20         CP(weight, value);
21     } else {
22         for(int k = 1; k < cnt; k <= 1) {
23             ZOP(k*weight, k*value), cnt -= k;
24         }
25         ZOP(cnt*weight, cnt*value);
26     }
27 }
```

2.2 最长单调子序列 (nlogn)

```
1  int arr[maxn], n;
2
3  template<class Cmp>
4  int LIS (Cmp cmp) {
5      static int m, end[maxn];
6      m = 0;
7      for (int i=0; i<n; i++) {
8          int pos = lower_bound(end, end+m, arr[i], cmp)-end;
9          end[pos] = arr[i], m += pos==m;
```

```
10     }
11     return m;
12 }
13
14 bool greater1(int value) {
15     return value >=1;
16 }
17
18 /*****
19     std::cout << LIS(std::less<int>()) << std::endl;           //严格上升
20     std::cout << LIS(std::less_equal<int>()) << std::endl;     //非严格上升
21     std::cout << LIS(std::greater<int>()) << std::endl;        //严格下降
22     std::cout << LIS(std::greater_equal<int>()) << std::endl;  //非严格下降
23     std::cout << count_if(a,a+7,std::greater1) << std::endl;  //计数
24 *****/
```

第三章 数学

3.1 快速乘法取模

```
1 //by sevenkplus
2 #define ll long long
3 #define ld long double
4 ll mul(ll x,ll y,ll z){return (x*y-(ll)(x/(ld)z*y+1e-3)*z+z)%z;}
5
6 //by Lazer2001
7 inline long long mmul (long long a, long long b, const long long& Mod) {
8     long long lf = a * (b >> 25LL) % Mod * (1LL << 25) % Mod;
9     long long rg = a * (b & ( ( 1LL << 25 ) - 1 ) ) % Mod ;
10    return (lf + rg) % Mod ;
11 }
```

3.2 快速幂取模

```
1 using LL = long long;
2
3 LL PowMod(LL a, LL b, const LL &Mod) {
4     a %= Mod;
5     LL ans = 1;
6     while(b) {
7         if (b & 1){
8             ans = (ans * a) % Mod;
9         }
10        a = (a * a) % Mod;
11        b >>= 1;
12    }
13    return ans;
14 }
```

3.3 计算从 $C(n, 0)$ 到 $C(n, p)$ 的值

```
1 //by Yuhao Du
2 int p;
3 std::vector<int> gao(int n) {
4     std::vector<int> ret(p+1,0);
5     if (n==0) {
6         ret[0]=1;
```



```
7     } else if (n%2==0) {
8         std::vector<int> c = gao(n/2);
9         for(int i = 0; i <= p+1; i++) {
10             for(int j = 0; j <= p+1; j++) {
11                 if (i+j<=p) ret[i+j]+=c[i]*c[j];
12             }
13         }
14     } else {
15         std::vector<int> c = gao(n-1);
16         for(int i = 0; i <= p+1; i++) {
17             for(int j = 0; j <= 2; j++) {
18                 if (i+j<=p) ret[i+j]+=c[i];
19             }
20         }
21     }
22     return ret;
23 }
```

3.4 二分分数树 (Stern-Brocot Tree)

```
1  //Author:CookieC
2  //未做模板调整，请自行调整
3  #include <cmath>
4  #define LL long long
5  #define LD long double
6
7  void SternBrocot(LD X, LL &A, LL &B) {
8      A=X+0.5;
9      B=1;
10     if(A==X)
11         return;
12     LL la=X, lb=1, ra=X+1, rb=1;
13     long double C=A, a, b, c;
14     do {
15         a = la+ra;
16         b = lb+rb;
17         c = a/b;
18         if(std::abs(C-X) > std::abs(c-X)) {
19             A=a;
20             B=b;
21             C=c;
22             if(std::abs(X-C) < 1e-10) {
23                 break;
24             }
25         }
26         if(X<c) {
27             ra=a;
28             rb=b;
29         } else {
30             la=a;
31             lb=b;
32         }
33     }
```

```
33     } while(lb+rb<=1e5);  
34 }
```

第四章 图论

4.1 并查集

```
1 int fa[N];
2
3 void init(int n) {
4     for (int i = 1; i <= n; i++) fa[i] = i;
5 }
6
7 int find(int u) {
8     return fa[u] == u ? fa[u] : fa[u] = find(fa[u]);
9 }
10
11 void unin(int u, int v) {
12     fa[find(v)] = find(u);
13 }
```

4.2 并查集（按秩合并）

```
1 #include <iostream>
2 #include <stack>
3 #include <utility>
4
5 class UFS {
6     private:
7         int *fa, *rank;
8         std::stack <std::pair <int*, int> > stk ;
9     public:
10         UFS() {}
11         UFS(int n) {
12             fa = new int[(const int)n + 1];
13             rank = new int[(const int)n + 1];
14             memset (rank, 0, n+1);
15             for (int i = 1; i <= n; ++i) {
16                 fa [i] = i;
17             }
18         }
19         inline int find(int x) {
20             while (x ^ fa[x]) {
21                 x = fa[x];
22             }
23             return x;
24         }
25         void merge(int x, int y) {
26             x = find(x);
27             y = find(y);
28             if (x == y) return;
29             if (rank[x] < rank[y]) {
30                 fa[x] = y;
31             } else {
32                 fa[y] = x;
33                 if (rank[x] == rank[y]) rank[x]++;
34             }
35         }
36         void split(int x, int y) {
37             x = find(x);
38             y = find(y);
39             if (x == y) return;
40             stk.push({fa[x], rank[x]});
41             fa[x] = y;
42             if (rank[x] > rank[y]) rank[y] = rank[x];
43         }
44     };
45 }
```

```

22     }
23     return x ;
24 }
25 inline int Join (int x, int y) {
26     x = find(x), y = find(y);
27     if (x == y) {
28         return 0;
29     }
30     if (rank[x] <= rank[y]) {
31         stk.push(std::make_pair (fa + x, fa[x]));
32         fa[x] = y;
33         if (rank[x] == rank[y]) {
34             stk.push(std::make_pair (rank + y, rank[y]));
35             ++rank[y];
36             return 2;
37         }
38         return 1 ;
39     }
40     stk.push(std::make_pair(fa + y, fa [y]));
41     return fa[y] = x, 1;
42 }
43 inline void Undo ( ) {
44     *stk.top( ).first = stk.top( ).second ;
45     stk.pop( ) ;
46 }
47 }T;

```

4.3 Kruskal 最小生成树

```

1  #include <vector>
2  #include <algorithm>
3
4  #define maxm 1000
5  #define maxn 1000
6
7  class Kruskal {
8      struct UdEdge {
9          int u, v, w;
10         UdEdge(){}
11         UdEdge(int u,int v,int w):u(u), v(v), w(w){}
12     };
13     int N, M;
14     UdEdge pool[maxm];
15     UdEdge *E[maxm];
16     int P[maxn];
17     int Find(int x){
18         if(P[x] == x)
19             return x;
20         return P[x] = Find(P[x]);
21     }
22     public:
23     static bool cmp(const UdEdge *a, const UdEdge *b) {

```

```

24     return a->w < b->w;
25 }
26 void Clear(int n) {
27     N = n;
28     M = 0;
29 }
30 void AddEdge(int u, int v, int w) {
31     pool[M] = UdEdge(u, v, w);
32     E[M] = &pool[M];
33     ++M;
34 }
35 int Run() {
36     int i, ans=0;
37     for(i = 1; i <= N; ++i)
38         P[i] = i;
39     std::sort(E, E+M, cmp);
40     for(i = 0; i < M; ++i) {
41         UdEdge *e = E[i];
42         int x = Find(e->u);
43         int y = Find(e->v);
44         if(x != y) {
45             P[y] = x;
46             ans += e->w;
47         }
48     }
49     return ans;
50 }
51 };

```

4.4 SPFA 最短路

```

1  #include <queue>
2  #include <cstring>
3  #include <vector>
4  #define maxn 10007
5  #define INF 0x7FFFFFFF
6  using namespace std;
7  struct Edge{
8      int v,w;
9      Edge(int v,int w):v(v),w(w){}
10 };
11 int d[maxn];
12 bool inq[maxn];
13 vector<Edge> G[maxn];
14 void SPFA(int s){
15     queue<int> q;
16     memset(inq,0,sizeof(inq));
17     for(int i=0;i<maxn;++i)
18         d[i]=INF;
19     d[s]=0;
20     inq[s]=1;
21     q.push(s);

```

```

22     int u;
23     while(!q.empty()){
24         u=q.front();
25         q.pop();
26         inq[u]=0;
27         for(vector<Edge>::iterator e=G[u].begin();e!=G[u].end();++e) {
28             if(d[e->v]>d[u]+e->w){
29                 d[e->v]=d[u]+e->w;
30                 if(!inq[e->v]){
31                     q.push(e->v);
32                     inq[e->v]=1;
33                 }
34             }
35         }
36     }
37 }

```

4.5 dijkstra 最短路

```

1  #include <vector>
2  #include <queue>
3  #define INF 0x7FFFFFFF
4  #define maxn 1000
5  using namespace std;
6  class Dijkstra{
7  private:
8      struct HeapNode{
9          int u;
10         int d;
11         HeapNode(int u, int d) :u(u), d(d){}
12         bool operator < (const HeapNode &b) const{
13             return d > b.d;
14         }
15     };
16     struct Edge{
17         int v;
18         int w;
19         Edge(int v, int w) :v(v), w(w){}
20     };
21     vector<Edge>G[maxn];
22     bool vis[maxn];
23 public:
24     int d[maxn];
25     void clear(int n){
26         int i;
27         for(i=0;i<n;++i)
28             G[i].clear();
29         for(i=0;i<n;++i)
30             d[i] = INF;
31         memset(vis, 0, sizeof(vis));
32     }
33     void AddEdge(int u, int v, int w){

```

```

34     G[u].push_back(Edge(v, w));
35 }
36 void Run(int s){
37     int u;
38     priority_queue<HeapNode> q;
39     d[s] = 0;
40     q.push(HeapNode(s, 0));
41     while (!q.empty()){
42         u = q.top().u;
43         q.pop();
44         if (!vis[u]){
45             vis[u] = 1;
46             for (vector<Edge>::iterator e = G[u].begin(); e != G[u].end(); ++e)
47                 if (d[e->v] > d[u] + e->w){
48                     d[e->v] = d[u] + e->w;
49                     q.push(HeapNode(e->v, d[e->v]));
50                 }
51         }
52     }
53 }
54 };

```

4.6 Floyd 任意两点间最短路

```

1  // #define inf maxn*maxw+10
2  for(int i = 0; i < n; i++) {
3      for(int j = 0; j < n; j++) {
4          d[i][j] = inf;
5      }
6  }
7  d[0][0] = 0;
8  for(int k = 0; k < n; k++) {
9      for(int i = 0; i < n; i++) {
10         for(int j = 0; j < n; j++) {
11             d[i][j] = std::min(d[i][j], d[i][k] + d[k][j]);
12         }
13     }
14 }

```

4.7 Dinic 最大流

```

1  #include <queue>
2  #include <vector>
3  #include <cstring>
4
5  #define INF 0x7FFFFFFF
6  #define maxn 1010
7
8  using namespace std;

```

```

9 struct Edge{
10     int c,f;
11     unsigned v,flip;
12     Edge(unsigned v,int c,int f,unsigned flip):v(v),c(c),f(f),flip(flip){}
13 };
14
15 /*
16  *b:BFS使用 ,
17  *a:可改进量 , 不会出现负数可改进量。
18  *p[v]:u到v的反向边, 即v到u的边。*cur[u]:i开始搜索的位置 , 此位置前所有路已满载。*s:源点。
19  *t:汇点 。
20  */
21
22 class Dinic{
23 private:
24     bool b[maxn];
25     int a[maxn];
26     unsigned p[maxn],cur[maxn],d[maxn];
27     vector<Edge> G[maxn];
28 public:
29     unsigned s,t;
30     void Init(unsigned n){
31         for(int i=0;i<=n;++i)
32             G[i].clear();
33     }
34     void AddEdge(unsigned u,unsigned v,int c){
35         G[u].push_back(Edge(v,c,0,G[v].size()));
36         G[v].push_back(Edge(u,0,0,G[u].size()-1)); //使用无向图时将0改为c即可
37     }
38     bool BFS(){
39         unsigned u,v;
40         queue<unsigned> q;
41         memset(b,0,sizeof(b));
42         q.push(s);
43         d[s]=0;
44         b[s]=1;
45         while(!q.empty()){
46             u=q.front();
47             q.pop();
48             for(auto it=G[u].begin();it!=G[u].end();++it) {
49                 Edge &e=*it;
50                 if(!b[e.v]&&e.c>e.f){
51                     b[e.v]=1;
52                     d[e.v]=d[u]+1;
53                     q.push(e.v);
54                 }
55             }
56         }
57         return b[t];
58     }
59     int DFS(unsigned u,int a){
60         if(u==t||a==0)
61             return a;
62         int flow=0,f;

```



```

63     for(unsigned &i=cur[u];i<G[u].size();++i){
64         Edge &e=G[u][i];
65         if(d[u]+1==d[e.v]&&(f=DFS(e.v,min(a,e.c-e.f)))>0){
66             a-=f;
67             e.f+=f;
68             G[e.v][e.flip].f-=f;
69             flow+=f;
70             if(!a) break;
71         }
72     }
73     return flow;
74 }
75 int MaxFlow(unsigned s,unsigned t){
76     int flow=0;
77     this->s=s;
78     this->t=t;
79     while(BFS()){
80         memset(cur,0,sizeof(cur));
81         flow+=DFS(s,INF);
82     }
83     return flow;
84 }
85 };

```

4.8 2-SAT 问题

```

1  class TwoSAT{
2      private:
3          const static int maxm=maxn*2;
4
5          int S[maxm],c;
6          vector<int> G[maxm];
7
8          bool DFS(int u){
9              if(vis[u^1])
10                 return false;
11              if(vis[u])
12                 return true;
13              vis[u]=1;
14              S[c++]=u;
15              for(auto &v:G[u])
16                 if(!DFS(v))
17                     return false;
18              return true;
19          }
20
21      public:
22          int N;
23          bool vis[maxm];
24
25          void Clear(){
26              for(int i=2;i<(N+1)*2;++i)

```

```
27         G[i].clear();
28         memset(vis,0,sizeof(bool)*(N+1)*2);
29     }
30
31     void AddClause(int x,int xv,int y,int yv){
32         x=x*2+xv;
33         y=y*2+yv;
34         G[x].push_back(y);
35         G[y].push_back(x);
36     }
37
38     bool Solve(){
39         for(int i=2;i<(N+1)*2;i+=2)
40             if(!vis[i]&&!vis[i+1]){
41                 c=0;
42                 if(!DFS(i)){
43                     while(c>0)
44                         vis[S[--c]]=0;
45                     if(!DFS(i+1))
46                         return false;
47                 }
48             }
49         return true;
50     }
51     };
```

第五章 数据结构

5.1 树状数组

```
1 void add(int i, int x) {
2     for(; i <= n; i += i & -i)
3         tree[i] += x;
4 }
5
6 int sum(int i) {
7     int ret = 0;
8     for(; i; i -= i & -i) ret += tree[i];
9     return ret;
10 }
```

5.2 二维树状数组

```
1 int N;
2 int c[maxn][maxn];
3
4 inline int lowbit(int t) {
5     return t & (-t);
6 }
7
8 void update(int x, int y, int v) {
9     for (int i=x; i<=N; i+=lowbit(i)) {
10         for (int j=y; j<=N; j+=lowbit(j)) {
11             c[i][j] += v;
12         }
13     }
14 }
15
16 int query(int x, int y) {
17     int s = 0;
18     for (int i=x; i>0; i-=lowbit(i)) {
19         for (int j=y; j>0; j-=lowbit(j)) {
20             s += c[i][j];
21         }
22     }
23     return s;
24 }
25
26 int sum(int x, int y, int xx, int yy) {
```

```
27     x--, y--;
28     return query(xx, yy) - query(xx, y) - query(x, yy) + query(x, y);
29 }
```

5.3 堆

```
1  const int N = 1000;
2
3  template <class T>
4  class Heap {
5      private:
6          T h[N];
7          int len;
8      public:
9          Heap() {
10             len = 0;
11         }
12         inline void push(const T& x) {
13             h[++len] = x;
14             std::push_heap(h+1, h+1+len, std::greater<T>());
15         }
16         inline T pop() {
17             std::pop_heap(h+1, h+1+len, std::greater<T>());
18             return h[len--];
19         }
20         inline T& top() {
21             return h[1];
22         }
23         inline bool empty() {
24             return len == 0;
25         }
26     };
```

5.4 RMQ

```
1  /*
2  RMQ模板:
3  A为原始数组, d[i][j]表示从i开始, 长度为(1<j)的区间最小值
4  */
5  int A[maxn];
6  int d[maxn][30];
7
8  void init(int A[], int len) {
9      for (int i = 0; i < len; i++) d[i][0] = A[i];
10     for (int j = 1; (1 < j) <= len; j++) {
11         for (int i = 0; i + (1 < j) - 1 < len; i++) {
12             d[i][j] = min(d[i][j - 1], d[i + (1 < (j - 1))][j - 1]);
13         }
14     }
```

```
14     }
15 }
16
17 int query(int l, int r) {
18     int p = 0;
19     while ((1 << (p + 1)) <= r - l + 1)p++;
20     return min(d[l][p], d[r - (1 << p) + 1][p]);
21 }
```

5.5 线段树

```
1  /*
2  线段树模板:
3  A为原始数组, sum记录区间和, Add为懒惰标记
4  */
5
6  int A[maxn], sum[maxn << 2], Add[maxn << 2];
7
8  void pushup(int rt) {
9      sum[rt] = sum[rt << 1] + sum[rt << 1 | 1];
10 }
11
12 void pushdown(int rt, int l, int r) {
13     if (Add[rt]) {
14         int mid = (l + r) >> 1;
15         Add[rt << 1] += Add[rt];
16         Add[rt << 1 | 1] += Add[rt];
17         sum[rt << 1] += (mid - l + 1)*Add[rt];
18         sum[rt << 1 | 1] += (r - mid)*Add[rt];
19         Add[rt] = 0;
20     }
21 }
22
23 void build(int l, int r, int rt) {
24     if (l == r) {
25         sum[rt] = A[l];
26         return;
27     }
28     int mid = (l + r) >> 1;
29     build(l, mid, rt << 1);
30     build(mid + 1, r, rt << 1 | 1);
31     pushup(rt);
32 }
33
34 // 区间加值
35 void update(int L, int R, int val, int l, int r, int rt) {
36     if (L <= l && R >= r) {
37         Add[rt] += val;
38         sum[rt] += (r - l + 1)*val;
39         return;
40     }
```

```
41     pushdown(rt, l, r);
42     int mid = (l + r) >> 1;
43     if (L <= mid)update(L, R, val, l, mid, rt << 1);
44     if (R > mid)update(L, R, val, mid + 1, r, rt << 1 | 1);
45     pushup(rt);
46 }
47
48 //点修改
49 void update(int index, int val, int l, int r, int rt) {
50     if (l == r) {
51         sum[rt] = val;
52         return;
53     }
54     int mid = (l + r) >> 1;
55     if (index <= mid)update(index, val, l, mid, rt << 1);
56     else update(index, val, mid + 1, r, rt << 1 | 1);
57     pushup(rt);
58 }
59
60 //区间查询
61 int query(int L, int R, int l, int r, int rt) {
62     if (L <= l && R >= r) {
63         return sum[rt];
64     }
65     pushdown(rt, l, r);
66     int mid = (l + r) >> 1;
67     int ret = 0;
68     if (L <= mid)ret += query(L, R, l, mid, rt << 1);
69     if (R > mid)ret += query(L, R, mid + 1, r, rt << 1 | 1);
70     return ret;
71 }
```

5.6 珂朵莉树 (Old Driver Tree)

```
1  #include <set>
2  #include <algorithm>
3
4  using LL = long long;
5
6  struct node {
7      int l, r;
8      mutable LL v;
9      node(int L, int R = -1, LL V = 0) : l(L), r(R), v(V) {}
10     bool operator < (const node& o) const {
11         return l < o.l;
12     }
13 };
14
15 std::set<node> s;
16
17 //分割SET 返回一个pos位置的迭代器
18 std::set<node>::iterator split(int pos) {
```

```
19     auto it = s.lower_bound(node(pos));
20     if (it != s.end() && it->l == pos) return it;
21     --it;
22     if (pos > it->r) return s.end();
23     int L = it->l, R = it->r;
24     LL V = it->v;
25     s.erase(it);
26     s.insert(node(L, pos - 1, V));
27     return s.insert(node(pos, R, V)).first;
28 }
29
30 // 区间加值
31 void add(int l, int r, LL val=1) {
32     split(l);
33     auto itr = split(r+1), itl = split(l);
34     for (; itl != itr; ++itl) itl->v += val;
35 }
36
37 // 区间赋值
38 void assign(int l, int r, LL val = 0) {
39     split(l);
40     auto itr = split(r+1), itl = split(l);
41     s.erase(itl, itr);
42     s.insert(node(l, r, val));
43 }
```

第六章 字符串

6.1 前缀树

```
1 #include <cstring>
2
3 const int maxn = 10000*50+10;
4 const int max_stringlen = 26+2;
5 int trie[maxn][max_stringlen];
6 int val[maxn];
7 int trie_index;
8
9 int index_of(const char &c) {
10     return c - 'a';
11 }
12 void trie_init() {
13     trie_index = 0;
14     memset(val, 0, sizeof(val));
15     memset(trie, 0, sizeof(trie));
16 }
17 void trie_insert(char *s, int v) { //要求v!=0
18     int len = strlen(s);
19     int now = 0;
20     for (int i = 0; i < len; ++i) {
21         int idx = index_of(s[i]);
22         int &tr = trie[now][idx];
23         if (!tr) {
24             tr = ++trie_index;
25         }
26         now = tr;
27     }
28     val[now] += v;
29 }
```

6.2 后缀数组

```
1 //Author: CookiC
2 #include <cstring>
3 const int maxn = 10010;
4
5 char str[maxn];
6 int s[maxn], si[maxn], n;
7
```



```

8 void BuildSi(int m) {
9     //si为第一关键字排在第i位的后缀在s中的下标
10    //y为第二关键字排在第i位的后缀在s中的下标
11    //m为字母的种类
12    static int t1[maxn], t2[maxn], c[maxn];
13    int *x=t1, *y=t2;
14    int i;
15    //基数排序
16    memset(c, 0, sizeof(int)*m);
17    for(i=0; i<n; ++i) ++c[x[i]=s[i]];
18    for(i=1; i<m; ++i) c[i]+=c[i-1];
19    for(i=n-1; i>=0; --i) si[--c[x[i]]]=i;
20    for(int k=1; k<=n; k<=1) {
21        int p=0;
22
23        //第二关键字排序
24        for(i=n-k; i<n; ++i) y[p++]=i;
25        for(i=0; i<n; ++i) if(si[i]>=k) y[p++]=si[i]-k;
26
27        //第一关键字与第二关键字合并排序
28        memset(c, 0, sizeof(int)*m);
29        for(i=0; i<n; ++i)
30            ++c[x[y[i]]];
31        for(i=0; i<m; ++i)
32            c[i]+=c[i-1];
33        for(i=n-1; i>=0; --i)
34            si[--c[x[y[i]]]]=y[i];
35
36        //判断相邻元素是否等价，等价则标上同等大小的数字。
37        swap(x, y);
38        p=1;
39        x[si[0]]=0;
40        for(i=1; i<n; ++i)
41            x[si[i]]=y[si[i-1]]==y[si[i]]&&y[si[i-1]+k]==y[si[i]+k]?p-1:p++;
42        if(p>=n)
43            break;
44        m=p;
45    }
46 }

```

6.3 后缀自动机

```

1 //Author: CookiC
2 #include <cstring>
3 #define MAXN 10000
4
5 struct State{
6     State *f, *c[26];
7     int len;
8 };
9
10 State *root, *last, *cur;

```

```
11 State StatePool[MAXN];
12
13 State* NewState(int len){
14     cur->len=len;
15     cur->f=0;
16     memset(cur->c,0,sizeof(cur->c));
17     return cur++;
18 }
19
20 void Init(){
21     cur=StatePool;
22     last=StatePool;
23     root=NewState(0);
24 }
25
26 void Extend(int w){
27     State *p = last;
28     State *np = NewState(p->len+1);
29     while(p&&!p->c[w]) {
30         p->c[w] = np;
31         p = p->f;
32     }
33     if(!p) {
34         np->f=root;
35     } else {
36         State *q=p->c[w];
37         if(p->len+1==q->len) {
38             np->f=q;
39         } else {
40             State *nq = NewState(p->len+1);
41             memcpy(nq->c, q->c, sizeof(q->c));
42             nq->f = q->f;
43             q->f = nq;
44             np->f = nq;
45             while(p&&p->c[w]==q) {
46                 p->c[w]=nq;
47                 p=p->f;
48             }
49         }
50     }
51     last=np;
52 }
53
54 bool Find(char *s,int len) {
55     int i;
56     State *p=root;
57     for(i=0;i<len;++i) {
58         if(p->c[s[i]-'a']) {
59             p=p->c[s[i]-'a'];
60         } else {
61             return false;
62         }
63     }
64     return true;
```

65 }

6.4 最长回文子串

```
1 using namespace std;
2 const int MAXN=110010;
3 char Ma[MAXN*2];
4 int Mp[MAXN*2];
5 void Manacher(char s[],int len) {
6     int l=0;
7     Ma[l++] = '$';
8     Ma[l++] = '#';
9     for(int i=0;i<len;i++) {
10         Ma[l++] =s[i] ;
11         Ma[l++] = '#';
12     }
13     Ma[l]=0 ;
14     int mx=0,id=0;
15     for(int i=0;i<l;i++) {
16         Mp[i]=mx>i?min(Mp[2*i-id-i],mx-i):1;
17         while(Ma[i+Mp[i]] == Ma[i-Mp[i]]) Mp[i]++;
18         if(i+Mp[i]>mx) {
19             mx=i+Mp[i];
20             id=i;
21         }
22     }
23 }
24 /*
25 * abaaba
26 * i:
27 * Ma[i]:$#a#b#a#a$b # a # *Mp[i]:11214127214 1 2 1
28 */
29 char s[MAXN];
30 int main() {
31     while(scanf( "%s", s)== 1) {
32         int len=strlen(s);
33         Manacher(s,len);
34         int ans=0;
35         for(int i=0;i<2*len+2;i++)
36             ans=max(ans, Mp[i] -1);
37         printf( "%d\n",ans );
38     }
39     return 0;
40 }
```