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1 Data Structure

1.1 BIT

```

1 #define lowbit(k) (k & -k)
2 void add(vector<int> &tr, int id, int val) {
3     for (; id <= n; id += lowbit(id)) {
4         tr[id] += val;
5     }
6 }
7 int sum(vector<int> &tr, int id) {
8     int ret = 0;
9     for (; id >= 1; id -= lowbit(id)) {
10        ret += tr[id];
11    }
12    return ret;
13 }
```

1.2 Segment tree

```

1 int dfs(int lef, int rig){
2     if(lef + 2 == rig){
3         if(num[lef] > num[rig-1]){
4             return lef;
5         }
6         else{
7             return rig-1;
8         }
9     }
10 }
```

```

9     }
10    int mid = (lef + rig)/2;
11    int p1 = dfs(lef, mid);
12    int p2 = dfs(mid, rig);
13    if(num[p1] > num[p2]){
14        return p1;
15    }
16    else{
17        return p2;
18    }
19 }
```

1.3 Trie

```

1 const int MAXL = ; // 自己填
2 const int MAXC = ;
3 struct Trie {
4     int nex[MAXL][MAXC];
5     int len[MAXL];
6     int sz;
7     void init() {
8         memset(nex, 0, sizeof(nex));
9         memset(len, 0, sizeof(len));
10        sz = 0;
11    }
12    void insert(const string &str) {
13        int p = 0;
14        for (char c : str) {
15            int id = c - 'a';
16            if (!nex[p][id]) {
17                nex[p][id] = ++sz;
18            }
19            p = nex[p][id];
20        }
21        len[p] = str.length();
22    }
23    vector<int> find(const string &str, int i) {
24        int p = 0;
25        vector<int> ans;
26        for (; i < str.length(); i++) {
27            int id = str[i] - 'a';
28            if (!nex[p][id]) {
29                return ans;
30            }
31            p = nex[p][id];
32            if (len[p]) {
33                ans.pb(len[p]);
34            }
35        }
36        return ans;
37    }
38 }
```

2 DP

2.1 Josephus

```

1 int josephus (int n, int k) {
2     // 有 n 個人圍成一圈，每 k 個一次
3     return n > 1 ? (josephus(n-1, k) + k) % n : 0;
4 }
5 // 回傳最後一人的編號，0 index
```

2.2 LCS

```

1 int LCS(string s1, string s2) {
2     int n1 = s1.size(), n2 = s2.size();
3     int dp[n1+1][n2+1] = {0};
4     // dp[i][j] = s1的前i個字元和s2的前j個字元
5     for (int i = 1; i <= n1; i++) {
```

```

6   for (int j = 1; j <= n2; j++) {
7       if (s1[i - 1] == s2[j - 1]) {
8           dp[i][j] = dp[i - 1][j - 1] + 1;
9       } else {
10          dp[i][j] = max(dp[i - 1][j], dp[i][j - 1]);
11      }
12  }
13  }
14  return dp[n1][n2];
15 }

```

2.3 LIS

```

1  int LIS(vector<int> &a) { // Longest Increasing
    Subsequence
2      vector<int> s;
3      for (int i = 0; i < a.size(); i++) {
4          if (s.empty() || s.back() < a[i]) {
5              s.push_back(a[i]);
6          } else {
7              *lower_bound(s.begin(), s.end(), a[i],
8                  [](int x, int y) {return x < y;}) = a[i];
9          }
10     }
11     return s.size();
12 }

```

3 Graph

3.1 SPFA

```

1  bool SPFA(int s){
2      // 記得初始化這些陣列
3      int cnt[1000+5], dis[1000+5];
4      bool inqueue[1000+5];
5      queue<int> q;
6
7      q.push(s);
8      dis[s] = 0;
9      inqueue[s] = true;
10     cnt[s] = 1;
11     while(!q.empty()){
12         int now = q.front();
13         q.pop();
14         inqueue[now] = false;
15
16         for(auto &e : G[now]){
17             if(dis[e.t] > dis[now] + e.w){
18                 dis[e.t] = dis[now] + e.w;
19                 if(!inqueue[e.t]){
20                     cnt[e.t]++;
21                     if(cnt[e.t] > m){
22                         return false;
23                     }
24                     inqueue[e.t] = true;
25                     q.push(e.t);
26                 }
27             }
28         }
29     }
30     return true;
31 }

```

3.2 Dijkstra

```

1  struct Item{
2      int u, dis;
3      // 取路徑最短
4      bool operator < (const Item &other) const{
5          return dis > other.dis;

```

```

6      }
7  };
8  int dis[maxn];
9  vector<Edge> G[maxn];
10 void dijkstra(int s){
11     for(int i = 0; i <= n; i++){
12         dis[i] = inf;
13     }
14     dis[s] = 0;
15     priority_queue<Item> pq;
16     pq.push({s, 0});
17     while(!pq.empty()){
18         // 取路徑最短的點
19         Item now = pq.top();
20         pq.pop();
21         if(now.dis > dis[now.u]){
22             continue;
23         }
24         // 鬆弛更新，把與 now.u 相連的點都跑一遍
25         for(Edge e : G[now.u]){
26             if(dis[e.v] > now.dis + e.w){
27                 dis[e.v] = now.dis + e.w;
28                 pq.push({e.v, dis[e.v]});
29             }
30         }
31     }
32 }

```

3.3 Floyd Warshall

```

1  void floyd_warshall(){
2      for(int i = 0; i < n; i++){
3          for(int j = 0; j < n; j++){
4              G[i][j] = INF;
5          }
6          G[i][i] = 0;
7      }
8      for (int k = 0; k < n; k++){ //
9          // 嘗試每一個中繼點
10         for (int i = 0; i < n; i++){ //
11             // 計算每一個 i 點與每一個 j 點
12             for (int j = 0; j < n; j++){
13                 G[i][j] = min(G[i][j], G[i][k] + G[k][j]);
14             }
15         }
16     }
17 }

```

3.4 Disjoint set Kruskal

```

1  struct Edge{
2      int u, v, w;
3      // 用權重排序 由大到小
4      bool operator < (const Edge &other) const{
5          return w > other.w;
6      }
7  }edge[maxn];
8  // disjoint set
9  int find(int x){
10     if(parent[x] < 0){
11         return x;
12     }
13     else{
14         return parent[x] = find(parent[x]);
15     }
16 }
17 void unite(int a, int b){
18     a = find(a);
19     b = find(b);
20
21     if(a != b){
22         if(parent[a] < parent[b]){

```

```

23     parent[a] += parent[b];
24     parent[b] = a;
25 }
26 else{
27     parent[b] += parent[a];
28     parent[a] = b;
29 }
30 }
31 }
32 void kruskal(){
33     memset(parent, -1, sizeof(parent));
34     sort(edge, edge + m);
35     int i, j;
36     for(i = 0, j = 0; i < n - 1 && j < m; i++){
37         // 如果 u 和 v 的祖先相同，則 j++
38         // (祖先相同代表會產生環 所以不要)
39         while(find(edge[j].u) == find(edge[j].v)) j++;
40         // 若都會產生環 則讓兩點之間產生橋
41         // (連接兩顆子生成樹)
42         unite(edge[j].u, edge[j].v);
43         j++;
44     }
45 }

```

3.5 KM

```

1  const int X = 50; // x的點數，等於Y的點數
2  const int Y = 50; // Y的點數
3  int adj[X][Y]; // 精簡過的adjacency matrix
4  int lx[X], ly[Y]; // vertex labeling
5  int mx[X], my[Y]; //
6  // X各點的配對對象、Y各點的配對對象
7  int q[X], *qf, *qb; // BFS queue
8  int p[X]; // BFS
9  // parent，交錯樹之偶點，指向上一個偶點
10 bool vx[X], vy[Y]; // 記錄是否在交錯樹上
11 int dy[Y], pdy[Y]; // 表格
12
13 void relax(int x){ // relaxation
14     for (int y=0; y<Y; ++y)
15         if (adj[x][y] != 1e9)
16             if (lx[x] + ly[y] - adj[x][y] < dy[y]){
17                 dy[y] = lx[x] + ly[y] - adj[x][y];
18                 pdy[y] = x; //
19                 // 記錄好是從哪個樹葉連出去的
20             }
21 }
22
23 void reweight(){ // 調整權重、調整表格
24     int d = 1e9;
25     for (int y=0; y<Y; ++y) if (!vy[y]) d = min(d, dy[y]);
26     for (int x=0; x<X; ++x) if (vx[x]) lx[x] -= d;
27     for (int y=0; y<Y; ++y) if (vy[y]) ly[y] += d;
28     for (int y=0; y<Y; ++y) if (!vy[y]) dy[y] -= d;
29 }
30
31 void augment(int x, int y){ // 擴充路徑
32     for (int ty; x != -1; x = p[x], y = ty){
33         ty = mx[x]; my[y] = x; mx[x] = y;
34     }
35 }
36
37 bool branch1(){ // 延展交錯樹：使用既有的等邊
38     while (qf < qb)
39         for (int x=*qf++, y=0; y<Y; ++y)
40             if (!vy[y] && lx[x] + ly[y] == adj[x][y]){
41                 vy[y] = true;
42                 if (my[y] == -1){
43                     augment(x, y);
44                     return true;
45                 }
46                 int z = my[y];
47                 *qb++ = z; p[z] = x; vx[z] = true;
48                 relax(z);
49             }
50     return false;
51 }

```

```

44 }
45 bool branch2(){ // 延展交錯樹：使用新添的等邊
46     for (int y=0; y<Y; ++y){
47         if (!vy[y] && dy[y] == 0){
48             vy[y] = true;
49             if (my[y] == -1){
50                 augment(pdy[y], y);
51                 return true;
52             }
53             int z = my[y];
54             *qb++ = z; p[z] = pdy[y]; vx[z] = true;
55             relax(z);
56         }
57     }
58     return false;
59 }
60 int Hungarian(){
61     // 初始化vertex labeling
62     // memset(lx, 0, sizeof(lx)); // 任意值皆可
63     memset(ly, 0, sizeof(ly));
64     for (int x=0; x<X; ++x)
65         for (int y=0; y<Y; ++y)
66             lx[x] = max(lx[x], adj[x][y]);
67
68     // x側每一個點，分別建立等邊交錯樹。
69     memset(mx, -1, sizeof(mx));
70     memset(my, -1, sizeof(my));
71     for (int x=0; x<X; ++x){
72         memset(vx, false, sizeof(vx));
73         memset(vy, false, sizeof(vy));
74         memset(dy, 0x7f, sizeof(dy));
75         qf = qb = q;
76         *qb++ = x; p[x] = -1; vx[x] = true; relax(x);
77         while (true){
78             if (branch1()) break;
79             reweight();
80             if (branch2()) break;
81         }
82     }
83     // 計算最大權完美匹配的權重
84     int weight = 0;
85     for (int x=0; x<X; ++x)
86         weight += adj[x][mx[x]];
87     return weight;
88 }

```

3.6 Dinic

```

1  // Maximum Flow
2  const int V = 100, E = 1000;
3  int adj[V]; // adjacency lists，初始化為-1。
4  struct Element {int b, r, next;} e[E*2];
5  int en = 0;
6  void addedge(int a, int b, int c){
7      e[en] = (Element){b, c, adj[a]}; adj[a] = en++;
8      e[en] = (Element){a, 0, adj[b]}; adj[b] = en++;
9  }
10 int d[V]; // 最短距離
11 bool visit[V]; // BFS/DFS visit record
12 int q[V]; // queue
13 int BFS(int s, int t){ // 計算最短路徑，求出容許圖
14     memset(d, 0x7f, sizeof(d));
15     memset(visit, false, sizeof(visit));
16     int qn = 0;
17     d[s] = 0;
18     visit[s] = true;
19     q[qn++] = s;
20
21     for (int qf=0; qf<qn; ++qf){
22         int a = q[qf];
23         for (int i = adj[a]; i != -1; i = e[i].next){
24             int b = e[i].b;
25             if (e[i].r > 0 && !visit[b]){
26                 d[b] = d[a] + 1;
27                 visit[b] = true;

```

```

28         q[qn++] = b;
29         if (b == t) return d[t];
30     }
31 }
32 }
33 return V;
34 }
35 int DFS(int a, int df, int s, int t){ //
    求出一條最短擴充路徑，並擴充流量
36 if (a == t) return df;
37 if (visit[a]) return 0;
38 visit[a] = true;
39 for (int i = adj[a]; i != -1; i = e[i].next){
40     int b = e[i].b;
41     if (e[i].r > 0 && d[a] + 1 == d[b]){
42         int f = DFS(b, min(df, e[i].r), s, t);
43         if (f){
44             e[i].r -= f;
45             e[i^1].r += f;
46             return f;
47         }
48     }
49 }
50 return 0;
51 }
52 int dinitz(int s, int t){
53     int flow = 0;
54     while (BFS(s, t) < V)
55         while (true){
56             memset(visit, false, sizeof(visit));
57             int f = DFS(s, 1e9, s, t);
58             if (!f) break;
59             flow += f;
60         }
61     return flow;
62 }

```

```

5 | 1 : 1 5 7
6 | i = 2, binary i = 010, 看得出來切了一刀
7 | 2 : 1 | 5 7
8 | i = 3, binary i = 011
9 | 3 : 1 | 5 7
10 | i = 4, binary i = 100, 為了要切在 index=2, 所以才要 1<<j
11 | 4 : 1 5 | 7
12 | i = 5, binary i = 101
13 | 5 : 1 5 | 7
14 | i = 6, binary i = 110
15 | 6 : 1 | 5 | 7
16 | i = 7, binary i = 111
17 | 7 : 1 | 5 | 7
18 | 可以觀察出來，前兩位 bit 是 1 時代表的意義是切在哪裡*/
19 int n;
20 int num[20+7];
21 memset(num, 0, sizeof(num));
22 cin >> n;
23 for(int i = 1; i <= n; i++){
24     cin >> num[i];
25 }
26 int mini = 2147483647; // 不知道為甚麼只有 2147483647
    給過
27 // 1 << n = n * 2
28 for(int i = 0; i < (1 << n); i++){
29     int XOR = 0, OR = 0;
30     for(int j = 1; j <= n; j++){
31         OR |= num[j];
32         if((i & (1 << j))){
33             XOR ^= OR;
34             OR = 0;
35         }
36     }
37     XOR ^= OR;
38     mini = min(mini, XOR);
39 }
40 cout << mini << endl;

```

4 Other

4.1 Bubble Sort Expect Value

```

1 /* 期望值算法：
2 擲一枚公平的六面骰子，其每次「點數」的期望值是 3.5
3  $E(x) = 1 * 1/6 + 2 * 1/6 + 3 * 1/6 + 4 * 1/6 + 5 * 1/6 + 6 * 1/6$ 
4  $= (1 + 2 + 3 + 4 + 5 + 6)/6 = 3.5$ 
5 bubble sort 每兩兩之間交換機率是 1/2
6 總共會做  $C(n, 2)$  次
7  $E(x) = C(n, 2) * 1/2 = (n * (n - 1))/2 * 1/2 *$ 
8 int t, ca = 1;
9 cin >> t;
10 while(t--){
11     long long int n;
12     cin >> n;
13     cout << "Case " << ca++ << ": ";
14     // 如果  $(n * (n - 1))$  可以被 4 整除
    代表最後答案會是整數，否則會是分數
15     if((n * (n - 1)) % 4){
16         cout << ( (n * (n - 1)) / 2 ) << "/2" << endl;
17     }
18     else{
19         cout << ( (n * (n - 1)) / 2 ) / 2 << endl;
20     }
21 }

```

4.2 ORXOR

```

1 /* 如何切區段，之所以要 1<<n 是為了可以跑 000~111
2 i = 0, binary i = 000
3 0 : 1 5 7
4 i = 1, binary i = 001

```

4.3 Race to 1

```

1 const int N = 1000000;
2 bool sieve[N+5];
3 vector<int> pri;
4 double dp[N+5];
5 void Linear_Sieve(){ // 線性篩
6     for (int i = 2; i < N; i++){
7         if (!sieve[i])
8             pri.push_back(i);
9         for (int p: pri){
10             if (i * p >= N){
11                 break;
12             }
13             sieve[i * p] = true;
14             if (i % p == 0){
15                 break;
16             }
17         }
18     }
19 }
20 double dfs(int n){
21     if(dp[n] != -1) return dp[n];
22     dp[n] = 0;
23     if(n == 1) return dp[n];
24     int total = 0, prime = 0;
25     for(int i = 0; i < pri.size() && pri[i] <= n; i++){
26         total++;
27         if(n % pri[i]) continue;
28         prime++;
29         dp[n] += dfs(n/pri[i]);
30     }
31     dp[n] = (dp[n] + total)/prime; // 算期望值
32     return dp[n];
33 }
34 int main(){

```

```

35     int t;
36     int num;
37     int ca = 1;
38     for(int i = 0; i <= N; i++){
39         dp[i] = -1;
40     }
41     Linear_Sieve();
42     cin >> t;
43     while(t--){
44         cin >> num;
45
46         cout << "Case " << ca++ << ": " << fixed <<
            setprecision(10) << dfs(num) << endl;
47     }
48 }

```

4.4 X drawing

```

1 long long int n, a, b, p, q, r, s;
2 cin >> n >> a >> b;
3 cin >> p >> q >> r >> s;
4 for(long long int i = p; i <= q; i++){
5     for(long long int j = r; j <= s; j++){
6         if(abs(i - a) == abs(j - b)){
7             cout << '#';
8         }
9         else{
10             cout << '.';
11         }
12     }
13     cout << endl;
14 }

```

4.5 Big Mod

```

1 '''
2 Mod
3 pow(x, y, z) = x^y % z
4 '''
5 # python 如何讀取直到 EOF 用 try except
6 try:
7     while True:
8         # input().split() 用空格切開讀取一整行
9         # map (型態, input().split()) 才能把值全讀成
10            int
11            B, P, M = map(int, input().split())
12            print(pow(B, P, M))
13 except EOFError:
14     exit

```

4.6 Crested Ibis vs Monster

```

1 /* dp 背包 - 重量/價值/可重複使用
2 因為這題可以重複使用同一條魔法
3 所以可以這樣dp*/
4 int h, n;
5 cin >> h >> n;
6 for(int i = 1; i <= n; i++){
7     cin >> a[i] >> b[i];
8 }
9 memset(dp, 0x3f3f3f3f, sizeof(dp));
10 dp[0][0] = 0;
11 for(int i = 1; i <= n; i++){
12     for(int j = 0; j <= h; j++){
13         dp[i][j] = min(dp[i-1][j], dp[i][max(0, j -
            a[i])] + b[i]);
14     }
15 }
16 cout << dp[n][h] << endl;

```

4.7 dpd Knapsack 1

```

1 // dp 背包 - 時間/數量/價值 - 第幾分鐘符合
2 int N, W;
3 cin >> N >> W;
4 int w[100000+5];
5 int v[100000+5];
6 for(int i = 0; i < N; i++){
7     cin >> w[i] >> v[i];
8 }
9 long long int dp[100000+5];
10 memset(dp, 0, sizeof(dp));
11 for(int i = 0; i < N; i++){
12     for(int j = W; j >= w[i]; j--){
13         dp[j] = max(dp[j], dp[j - w[i]] + v[i]);
14     }
15 }
16 cout << dp[W] << endl;

```

4.8 Fraction Floor Sum

```

1 /* [N/i] == M
2 -> M <= N/i < M + 1
3 -> N/(M+1) < i <= N/M */
4 long long int N;
5 cin >> N;
6 long long int ans = 0;
7 for(long long int i = 1; i <= N; i++){
8     long long int M = N / i;
9     long long int n = N / M;
10     // 總共會有 n - i 個的 [N/i] 值都是 M
11     ans += (n - i + 1) * M;
12     // 更新跳過 以免重複計算
13     i = n;
14 }
15 cout << ans << endl;

```

4.9 Homer Simpson

```

1 // dp 背包 - 時間/數量 - 漢堡
2 int m, n, t;
3 while(cin >> m >> n >> t){
4     int dp[10000+5];
5     memset(dp, -1, sizeof(dp));
6     dp[0] = 0;
7     for(int i = m; i <= t; i++){
8         if(dp[i - m] != -1){
9             dp[i] = max(dp[i], dp[i - m] + 1);
10        }
11    }
12    for(int i = n; i <= t; i++){
13        if(dp[i - n] != -1){
14            dp[i] = max(dp[i], dp[i - n] + 1);
15        }
16    }
17    if(dp[t] == -1){ // 時間無法剛好吃滿的時候
18        for(int i = t; i >= 0; i--){
19            if(dp[i] != -1){
20                cout << dp[i] << " " << t - i << endl;
21                break;
22            }
23        }
24    }
25    else{
26        cout << dp[t] << endl;
27    }
28 }

```

4.10 Let Me Count The Ways

```

1 // dp - 時間/數量 - 硬幣排序
2 long long int n, dp[30000+5];
3 int coin[] = {1, 5, 10, 25, 50};
4 memset(dp, 0, sizeof(dp));
5 dp[0] = 1;
6 for(int i = 0; i < 5; i++){
7     for(int j = coin[i]; j < 30000+5; j++){
8         if(dp[j - coin[i]] != -1){
9             dp[j] += dp[j - coin[i]];
10        }
11    }
12 }
13 while(cin >> n){
14     if(dp[n] == 1){
15         cout << "There is only " << dp[n] << " way to
16             produce " << n << " cents change." <<
17             endl;
18     }
19     else{
20         cout << "There are " << dp[n] << " ways to
21             produce " << n << " cents change." <<
22             endl;
23     }
24 }

```

4.11 Luggage

```

1 // dp 背包 - 重量/是否成立
2 int t;
3 cin >> t;
4 cin.ignore();
5 while(t--){
6     string str;
7     getline(cin, str);
8     vector<int> v;
9     stringstream ss;
10    int num, cnt = 0, sum = 0;
11    bool dp[4000+5];
12    memset(dp, false, sizeof(dp));
13    ss << str;
14    while(ss >> num){
15        cnt++;
16        sum += num;
17        v.emplace_back(num);
18    }
19    if(sum & 1){
20        cout << "NO" << endl;
21        continue;
22    }
23    dp[0] = true;
24    for(int i = 0; i < v.size(); i++){
25        for(int j = sum; j >= v[i]; j--){
26            if(dp[j - v[i]]){
27                dp[j] = true;
28            }
29        }
30    }
31    cout << (dp[sum/2] ? "YES" : "NO") << endl;
32 }

```

4.12 Number of Pairs

```

1 /* upper_bound ex:
2 10 20 30 30 40 50
3 upper_bound for element 30 is at index 4
4 lower_bound ex:
5 10 20 30 40 50
6 lower_bound for element 30 at index 2 */
7 int t;
8 cin >> t;
9 while(t--){
10    int n, l, r;
11    vector<int> v;

```

```

12    cin >> n >> l >> r;
13    int num;
14    for(int i = 0; i < n; i++){
15        cin >> num;
16        v.emplace_back(num);
17    }
18    sort(v.begin(), v.end());
19    long long int ans = 0;
20    for(int i = 0; i < n; i++){
21        ans += (upper_bound(v.begin() + i + 1,
22            v.end(), r - v[i]) -
23            lower_bound(v.begin() + i + 1, v.end(), l
24            - v[i]));
25    }
26    cout << ans << endl;
27 }

```

4.13 SuperSale

```

1 // dp 背包 - 重量/價值/不可重複使用 - 舉重
2 int t;
3 cin >> t;
4 while(t--){
5     int n;
6     cin >> n;
7     for(int i = 0; i < n; i++){
8         cin >> edge[i].p >> edge[i].w;
9     }
10    int g, total = 0;
11    cin >> g;
12    for(int i = 0; i < g; i++){
13        int pw, dp[30+5];
14        cin >> pw;
15        memset(dp, 0, sizeof(dp));
16        for(int j = 0; j < n; j++){
17            for(int k = pw; k >= edge[j].w; k--){
18                dp[k] = max(dp[k], dp[k - edge[j].w]
19                    + edge[j].p);
20            }
21        }
22        total += dp[pw];
23    }
24    cout << total << endl;
25 }

```

4.14 Walking on the Safe Side

```

1 // dp - 地圖更新
2 int t;
3 bool space = false;
4 cin >> t;
5 while(t--){
6     if(space){
7         cout << endl;
8     }
9     else{
10        space = true;
11    }
12    int r, c;
13    cin >> r >> c;
14    cin.ignore();
15    memset(mp, false, sizeof(mp));
16    memset(dp, 0, sizeof(dp));
17    string str;
18    for(int i = 0; i < r; i++){
19        getline(cin, str);
20        int n, num;
21        stringstream ss(str);
22        ss >> n;
23        while(ss >> num){
24            mp[n][num] = true;
25        }
26    }

```

```

27|     dp[1][1] = 1;
28|     for(int i = 1; i <= r; i++){
29|         for(int j = 1; j <= c; j++){
30|             if(mp[i][j]){
31|                 continue;
32|             }
33|             if(i > 1){
34|                 dp[i][j] += dp[i-1][j];
35|             }
36|             if(j > 1){
37|                 dp[i][j] += dp[i][j-1];
38|             }
39|         }
40|     }
41|     cout << dp[r][c] << endl;
42| }

```

5 Function

5.1 strstr

```

1| #include <stdio.h>
2| #include <string.h>
3|
4| int main(){
5|     char * c;
6|     char str1[1005], str2[1005];
7|     scanf("%s %s", str1, str2);
8|     c = strstr(str1, str2);
9|     if (c != NULL){
10|         printf("Yes\n");
11|     }
12|     else printf("No\n");
13| }
14| // Input : Hello eLl
15| // Output : No

```

5.2 substr

```

1| int main(){
2|     string str; //abcdef
3|     cin >> str;
4|     string tmp;
5|     tmp = str.substr(0, 2); //ab
6|     str = str.substr(2); //cdef
7|     cout << tmp << " " << str;
8|     return 0;
9| }

```

5.3 map set

```

1| .begin( ) // Return iterator to beginning
2| .end( ) // Return iterator to end
3| .empty( ) // 檢查是否為空
4| .size( ) // 回傳大小
5| mp.insert(pair<char, int>('a', 100))
6| st.insert(100) // 插入key、value
7| .erase( ) // 刪掉指定key和他的value
8| .clear( ) // 清空整個 map
9| m.find( )
10| cout << "a => " << mymap.find('a')->second << endl;
11| // 找出 map 裡 key
    有沒有在裡面，如果有的話會回傳元素所在的 iterator
12| s.count( ) // 返回某個值元素在 set 的個數
13| while( !mymap.empty()){
14|     cout << mymap.begin()->first << " => " <<
        mymap.begin()->second << endl;
15|     mymap.erase(mymap.begin());
16| }

```

```

17| for (auto it = mymap.begin(); it != mymap.end(); ++it)
18|     cout << it->first << " => " << it->second << endl;

```

5.4 vector

```

1| v.erase(v.begin() + 5) //拿掉第六個數
2| v.erase (v.begin(), v.begin() + 3); //拿掉前三個數

```

5.5 setprecision

```

1| // 將數字的小數部分設定為固定長度
2| cnt = 3.5555;
3| cout << fixed << setprecision(3) << cnt ;
4| // output : 3.555

```

5.6 GCD LCM

```

1| int gcd(int a, int b){
2|     return (b == 0 ? a : gcd(b, a % b));
3| }
4| int lcm(int a, int b){
5|     return a * b / gcd(a, b);
6| }
7|
8| /* 輾轉相除法 - 求兩數是否互質
9| 如果兩數互質 最終結果其中一方為0時 另一方必為1
10| 若兩數有公因數 最終結果其中一方為0時 另一方必不為1 */
11| while ( ( num1 % = num2 ) != 0 && ( num2 % = num1 ) !=
    0 );

```

5.7 reverse

```

1| int a[10] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9};
2| reverse(a, a+5) // 轉換0~5
3|
4| vector<int> v;
5| reverse(v.begin(), v.end());
6|
7| string str = "123";
8| reverse(str.begin(), str.end());
9| cout << str << endl; //321

```

5.8 CHAR

```

1| isdigit()
2| isalnum() //判斷字母 || 數字
3| isalpha()
4| islower()
5| isupper()
6| isblank() //判斷是否為空格，或者 tab 健制表符，即
    space 和 \t
7| toupper()
8| tolower()

```

5.9 sort

```

1| priority_queue<int, vector<int>, less<int>> //大到小
2| priority_queue<int, vector<int>, greater<int>>
    //小到大
3|
4| int arr[] = {4, 5, 8, 3, 7, 1, 2, 6, 10, 9};
5|     sort(arr, arr+10);
6|
7| vector<int> v;

```

```

8 | sort(v.begin(), v.end()); //小到大
9
10 | int cmp(int a, int b){
11 |     return a > b;
12 | }
13 | sort(v.begin(), v.end(), cmp); //大到小

```

5.10 struct

```

1 | struct area{
2 |     int a, b;
3 |     bool operator<(const area rhs) const{
4 |         return a > rhs.a || (a == a && b > rhs.b);
5 |     }
6 |     bool operator!=(const area rhs) const{
7 |         return a != rhs.a || b != rhs.b;
8 |     }
9 | };

```

5.11 deque

```

1 | deque<int> que;
2 | que.push_back(10);
3 | que.push_front(20);
4 | que.front()
5 | que.back()
6 | que.pop_front()
7 | que.pop_back()
8 | cout << "Element at position 2 : " << que.at(2) << endl;

```

5.12 atan

```

1 | struct Edge{
2 |     int x, y;
3 |     Edge(int x = 0, int y = 0):x(x), y(y){}
4 |
5 | }edge[4], v[4];
6 |
7 | // 正方形判斷點模板 分別為左下 左上 右上 右下
8 | typedef Edge Vector;
9 | Vector operator + (Edge a, Edge b){
10 |     return Vector(a.x + b.x, a.y + b.y);
11 | }
12 | Vector operator - (Edge a, Edge b){
13 |     return Vector(a.x - b.x, a.y - b.y);
14 | }
15 | Vector operator / (Edge a, int b){
16 |     return Vector(a.x / b, a.y / b);
17 | }
18 | Vector orig;
19 | bool angleCmp(Edge &a, Edge &b){
20 |     double t1 = atan2(1.0 * a.x - orig.x, 1.0 * a.y - orig.y);
21 |     double t2 = atan2(1.0 * b.x - orig.x, 1.0 * b.y - orig.y);
22 |     return t1 < t2;
23 | }
24 |
25 | int main(){
26 |     for(int i = 0; i < 4; i++){
27 |         cin >> edge[i].x >> edge[i].y;
28 |     }
29 |     orig = (edge[0] + edge[1])/2;
30 |     sort(edge, edge + 4, angleCmp);
31 | }

```

5.13 python template

```

1 | import math
2 | import operator
3 |
4 | try:
5 |     while(1):
6 |         listx = []
7 |         listx.append("...")
8 |         list_s = sorted(listx) # 小到大
9 |         list_s = sorted(listx, reverse = True) # 大到小
10 |         # max(listx)
11 |         # min(listx)
12 |         # sum(listx)
13 |         # len(listx)
14 |         dicty = {}
15 |         dicty[key] = "value"
16 |         dicty= sorted(dicty.items()) # by key
17 |         dicty= sorted(dicty.items(),
18 |             key=operator.itemgetter(1)) # by value
19 |         # EOF寫法
20 |         # 階層 math.factorial(3) == 6
21 |         # 絕對值 math.fabs(x)
22 |         # 無條件進位 math.ceil(3.1) == 3
23 |         # 無條件捨去 math.floor(2.9) == 2
24 |         # C n 取 k math.comb(n, k)
25 |         # math.gcd
26 |         # math.lcm
27 |         # e 次 x 冪 math.exp(x)
28 | except EOFError:
29 |     pass

```