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1 Tabelas

tipo	bits	min...max	precisao
char	8	0..127	2
signed char	8	-128..127	2
unsigned char	8	0..255	2
short	16	-32.768 .. 32.767	4
unsigned short	16	0 .. 65.535	4
int	32	-2x10**9 .. 2 x 10**9	9
unsigned int	32	0 .. 4x10**9	9
int64_t	64	-9 x 10**18 .. 9 x 10**18	18
uint64_t	64	0 .. 18 x 10**18	19

Tabela 1: Limites de representação de dados

0! = 1
1! = 1
2! = 2
3! = 6
4! = 24
5! = 120
6! = 720
7! = 5.040
8! = 40.320
9! = 362.880
10! = 3.628.800
11! = 39.916.800
12! = 479.001.600 [limite do (unsigned) int]
13! = 6.227.020.800
14! = 87.178.291.200
15! = 1.307.674.368.000
16! = 20.922.789.888.000
17! = 355.687.428.096.000
18! = 6.402.373.705.728.000
19! = 121.645.100.408.832.000
20! = 2.432.902.008.176.640.000 [limite do (u)int64_t]

Tabela 2: Fatorial

Tipo	%
char	c
int	d
float	e, E, f, g, G
int (octal)	o
int (hexa)	x, X
uint	u
char*	s

Tabela 3: scanf() - %[*][width][modifiers]type

modifiers	tipo
h	short int (d, i, n), or unsigned short int (o, u, x)
l	long int (d, i, n), or unsigned long int (o, u, x), or double (e, f, g)
L	long double (e, f, g)

Tabela 4: scanf() %[*][width][modifiers]type

função	descrição
atof	Convert string to double
atoi	Convert string to integer
atol	Convert string to long integer
strtod	Convert string to double
strtol	Convert string to long integer
strtoul	Convert string to unsigned long integer

Tabela 5: stdlib

função	descrição
cos	Compute cosine
sin	Compute sine
tan	Compute tangent
acos	Compute arc cosine
asin	Compute arc sine
atan	Compute arc tangent
atan2	Compute arc tangent with two parameters
cosh	Compute hyperbolic cosine
sinh	Compute hyperbolic sine
tanh	Compute hyperbolic tangent
exp	Compute exponential function
frexp	Get significand and exponent
ldexp	Generate number from significand and exponent
log	Compute natural logarithm
log10	Compute common logarithm
modf	Break into fractional and integral parts
pow	Raise to power
sqrt	Compute square root
ceil	Round up value
fabs	Compute absolute value
floor	Round down value
fmod	Compute remainder of division

Tabela 6: math (angulos em radianos)

2 Codigos

2.1 Exemplos

```cpp
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>

#include <inttypes.h>
#include <ctype.h>

#include <algorithm>
#include <utility>
#include <iostream>

#include <map>
#include <set>
#include <vector>
#include <sstream>

using namespace std;

#define abs(a) ((a) > 0 ? (a) : -(a))

int main()
{
    int n;

    cin >> n;

    for (int i = 0; i < n; i++)
    {

    }

    while (cin >> n)
    {

    }
    return 0;
}
```

Código 1: Modelo

```cpp
const double EPS = 1e-10;
/**
 * -1 se x < y
 * 0 se x = y
 * 1 se x > y
 */
inline int cmp (double x, double y = 0, double tol = EPS)
{
    return (x <= y + tol) ? (x + tol < y) ? -1 : 0 : 1;
}
```

Código 2: comparcao de ponto flutuante

```
set ai noet ts=4 sw=4 bs=2
syn on
mat Keyword "\<foreach\>"
```

Código 3: .vimrc para a configuração do vim

```
/* printf example */
#include <stdio.h>

int main()
{
    printf ("Characters: %c %c \n", 'a', 65);
    printf ("Decimals: %d %ld\n", 1977, 650000L);
    printf ("Preceding with blanks: %10d \n", 1977);
    printf ("Preceding with zeros: %010d \n", 1977);
    printf ("Some different radixes: %d %x %o %#x %#o \n", 100, 100, 100,
        100, 100);
    printf ("floats: %4.2f %+.0e %E %4.2f\n", 3.1416, 3.1416, 3.1416, 3.1);
    printf ("Width trick: %*d \n", 5, 10);
    printf ("%s \n", "A string");
    return 0;
}
/* %[flags (-, +, etc)][width][.precision][length (h,l,L)]specifier
Characters: a A
Decimals: 1977 650000
Preceding with blanks:       1977
Preceding with zeros: 0000001977
Some different radixes: 100 64 144 0x64 0144
floats: 3.14 +3e+000 3.141600E+000 3.10
Width trick:    10
A string
*/
```

Código 4: printf

```
#include <iostream>
#include <map>
using namespace std;

int main ()
{
  map<char,int> mymap;
  map<char,int>::iterator it;
  pair<map<char,int>::iterator,bool> ret;

  // first insert function version (single parameter):
  mymap.insert ( pair<char,int>('a',100) );
  mymap.insert ( pair<char,int>('z',200) );

  ret=mymap.insert (pair<char,int>('z',500) );
  if (ret.second==false)
  {
    cout << "element 'z' already existed";
    cout << " with a value of " << ret.first->second << endl;
  }

  // third insert function version (range insertion):
  map<char,int> anothermap;
  anothermap.insert(mymap.begin(),mymap.find('c'));

  // showing contents:
  cout << "mymap contains:\n";
  for ( it=mymap.begin() ; it != mymap.end(); it++ )
    cout << (*it).first << " => " << (*it).second << endl;

  map<char,string> mymap;
  mymap['a']="an element";
  if (mymap.count('a') > 0)
      cout << mymap['a'] << " is an element of mymap.\n";

  while (!mymap.empty())
  {
     cout << mymap.begin()->first << " => ";
     cout << mymap.begin()->second << endl;
     map<char, int>::iterator erasedelement = mymap.erase(mymap.begin());
  }

  return 0;
}
```

Código 5: exemplo de map

```
#include <iostream>
#include <set>
using namespace std;

int main ()
{
  multiset<int> mymultiset;
  multiset<int>::iterator it;

  // set some initial values:
  for (int i=1; i<=5; i++) mymultiset.insert(i*10);   // 10 20 30 40 50

  cout << "size: " << (int) mymultiset.size() << endl;
  cout << "count: " << (int) mymultiset.count(10) << endl;

  it=mymultiset.find(20);
  mymultiset.erase (it);

  if (! mymultiset.empty)
   mymultiset.erase (mymultiset.find(40));

  for (it=mymultiset.begin(); it!=mymultiset.end(); it++)
    cout << " " << *it;

  int myints[]={19,72,4,36,20,20};
```

```
26    multiset<int> first (myints,myints+3);      // 4,19,72
27    multiset<int> second (myints+3,myints+6);   // 20,20,36
28
29    first.swap(second); // troca conteudo. o primeiro fica [20,20,36] e o
          segundo [4,19,72]
30
31    return 0;
32  }
```

Código 6: exemplo de set e multset

```
1   #include <iostream>
2   #include <list>
3   using namespace std;
4
5   int main ()
6   {
7     list<int> mylist (2,100);          // two ints with a value of 100
8     mylist.push_front (200);
9     mylist.push_back (300);
10
11    it = mylist.begin();
12    mylist.insert (it,10);
13    mylist.insert (it,2,20); // two ints with a value of 20
14
15    mylist.reverse(); // Reverses the order of the elements in the list.
16
17    cout << "mylist contains:";
18    for (list<int>::iterator it=mylist.begin(); it!=mylist.end(); ++it)
19      cout << " " << *it;
20
21    cout << "Popping out the elements in mylist:";
22    while (!mylist.empty())
23    {
24      cout << " " << mylist.front();
25      mylist.pop_front();
26    }
27
28    while (!mylist.empty())
29    {
30      cout << " " << mylist.back();
31      mylist.pop_back();
32    }
33
34    cout << mylist.size() << endl;
35
36    return 0;
37  }
```

Código 7: exemplo de list

```
1   #include <iostream>
2   #include <queue>
3   using namespace std;
4
5   int main ()
6   {
7     queue<int> myqueue;
8     int sum (0);
9
10    for (int i=1;i<=10;i++) myqueue.push(i);
11
12    myqueue.back() -= myqueue.front();
13
14    cout << "size: " << (int) myqueue.size() << endl;
15
16    while (!myqueue.empty())
17    {
18       sum += myqueue.front();
19       myqueue.pop();
20    }
21
22    cout << "total: " << sum << endl;
23
24    return 0;
25  }
```

Código 8: exemplo de queue

```
1   #include <iostream>
2   #include <queue>
3   using namespace std;
4
5   int main ()
6   {
7     priority_queue<int> mypq;
8
9     mypq.push(30);
10    mypq.push(100);
11    mypq.push(25);
12    mypq.push(40);
13
14    cout << "size: " << (int) mypq.size() << endl;
15
16    cout << "Popping out elements...";
17    while (!mypq.empty())
18    {
19       cout << " " << mypq.top();
20       mypq.pop();
21    }
22    cout << endl;
23
24    return 0;
25  }
```

Código 9: exemplo de priority queue

```
1   #include <iostream>
2   #include <stack>
3   using namespace std;
4
5   int main ()
```

```
{
  stack<int> mystack;
  int sum = 0;

  mystack.push(10);
  mystack.push(20);

  mystack.top() -= 5;

  while (!mystack.empty())
  {
     sum += mystack.top();
     mystack.pop();
  }

  cout << "size: " << (int) mystack.size() << endl;

  return 0;
}
```

Código 10: exemplo de stack

```
#include <iostream>
#include <vector>
using namespace std;

int main ()
{
  vector<int> myvector (3,100);
  vector<int>::iterator it;

  myvector.reserve(100);

  for (i=0; i<myvector.size(); i++)
    myvector.at(i)=i; // = myvector[i] = i

  it = myvector.begin();
  it = myvector.insert ( it , 200 );
  myvector.insert (it,2,300);

  vector<int> anothervector (2,400);
  int myarray [] = { 501,502,503 };
  myvector.insert (it+2,anothervector.begin(),anothervector.end());
  myvector.insert (myvector.begin(), myarray, myarray+3);

  cout << "myvector contains:";
  for (it=myvector.begin(); it<myvector.end(); it++)
    cout << " " << *it;
  cout << endl;

  // erase the 6th element
  myvector.erase (myvector.begin()+5);
  int sum;
  while (!myvector.empty())
  {
     sum += myvector.back();
     myvector.pop_back();
  }

  return 0;
}
```

Código 11: exemplo de vector

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

bool myfunction (int i,int j) { return (i<j); }

struct myclass {
  bool operator() (int i,int j) { return (i<j);}
} myobject;

int compare (const void * a, const void * b)
{
  return ( *(int*)a - *(int*)b );
}


int main () {
  int myints[] = {32,71,12,45,26,80,53,33};
  vector<int> myvector (myints, myints+8);               // 32 71 12 45 26
      80 53 33

  // using default comparison (operator <):
  sort (myvector.begin(), myvector.begin()+4);           //(12 32 45 71)26
      80 53 33
  // using function as comp
  sort (myvector.begin()+4, myvector.end(), myfunction); // 12 32 45 71(26
      33 53 80)
  // using object as comp
  sort (myvector.begin(), myvector.end(), myobject);     //(12 26 32 33 45
      53 71 80)

  // if stable is need
  stable_sort (myvector.begin(), myvector.end(), myfunction);

  // Rearranges the elements in the range [first,last), in such a way that
      the subrange [first,middle)
  // contains the smallest elements of the entire range sorted in ascending
      order, and the subrange
  // [middle,end) contains the remaining elements without any specific order
      .
  partial_sort (myvector.begin(), myvector.begin()+3, myvector.end());

  qsort (myints, 8, sizeof(int), compare);

  return 0;
}
```

Código 12: exemplo de ordenação

```
int compareMyType (const void * a, const void * b)
{
  if ( *(MyType*)a >  *(MyType*)b ) return 1;
  if ( *(MyType*)a == *(MyType*)b ) return 0;
  if ( *(MyType*)a <  *(MyType*)b ) return -1;
}

int key = 40;
item = (int*) bsearch (&key, values, n, sizeof (int), compareMyType);
```

Código 13: pesquisa binária

```
#include <iostream>
#include <iomanip> // setprecision()
using namespace std;

int main () {
  double a = 3.1415926534;
  double b = 2006.0;
  double c = 1.0e-10;

  // setprecision(1) => 1 casa decimal apos a virgula
  cout << fixed << setprecision(1) << 9.09090901 << endl;
  cout << fixed << setprecision(2) << 9.09090901 << endl;
  cout << fixed << setprecision(3) << 9.09090901 << endl;
  cout << fixed << setprecision(2) << 9.1 << endl;

  // anula o efeito de setprecision
  cout.unsetf(ios::floatfield);

  // 5 digitos no maximo
  cout.precision(5);

  cout << a << '\t' << b << '\t' << c << endl;
  cout << fixed << a << '\t' << b << '\t' << c << endl;
  cout << scientific << a << '\t' << b << '\t' << c << endl;

  // Sets the basefield format flag for the str stream to dec, hex or oct.
  int n =70;
  cout << dec << n << endl;
  cout << hex << n << endl;
  cout << oct << n << endl;

  return 0;
}
/* output
9.1
9.09
9.091
9.10
3.1416   2006    1e-10
3.14159  2006.00000       0.00000
3.14159e+00      2.00600e+03      1.00000e-10
70
46
106
*/
```

Código 14: Arredondamento e output em outras bases

2.2 Teoria dos números

```
int gcd(int x, int y)
{
   return y ? gcd(y, x % y) : abs(x);
}
uint64_t lcm(int x, int y)
{
   if (x && y) return abs(x) / gcd(x, y) * uint64_t(abs(y));
   else return uint64_t(abs(x | y));
}
```

Código 15: máximo divisor comum e mínimo multiplo comum

```
bool isPrime(int n)
{
   if (n < 0) return isPrime(-n);
   if (n == 1) return true;
   if (n < 5 || n % 2 == 0 || n % 3 == 0) return (n == 2 || n == 3);

   int maxP = sqrt(n) + 2;
   for (int p = 5; p < maxP; p += 6)
   {
      if (n % p == 0 || n % (p+2) == 0) return false;
   }
   return true;
}
```

Código 16: decide se um número é primo

```
typedef map<int, int> prime_map;
void squeeze(prime_map& M, int& n, int p)
{
   for (; n % p == 0; n /= p) M[p]++;
}
void factor(int n, prime_map& M)
{
   if (n < 0) return n = -n;
   if (n < 2) return;

   squeeze(M, n, 2);
   squeeze(M, n, 3);

   int maxP = sqrt(n) + 2;
   for (int p = 5; p < maxP; p += 6)
```

```
    {
        squeeze(M, n, p);
        squeeze(M, n, p+2);
    }
    if (n > 1) M[n]++;
}
```

Código 17: Retorna a fatoração em números primos de abs(n).

2.3 Grafos

```
#define TAM 100
#define BRANCO 0
#define CINZA 1
#define PRETO 2
bool grafo[TAM][TAM];
int pass[TAM];

bool dfs(int v)
{
    pass[v] = CINZA;

    for (int i = 0; i < TAM; i++)
    {
        if (grafo[v][i])
        {
            if (pass[i] == CINZA) return false;
            if (pass[i] == BRANCO && !dfs(i)) return false;
        }
    }

    pass[v] = PRETO;
    return true;
}

bool aciclico()
{
    memset(pass, BRANCO, TAM*sizeof(int));

    for (int i = 0; i < TAM; i++)
    {
        if (pass[i] == BRANCO)
        {
            if (!dfs(i)) return false;
        }
    }

    return true;
}
```

Código 18: Verifica se o grafo é aciclico.

```
#include <queue>

typedef vector<map<int, int> > AdjList;
typedef AdjList Grafo;

int dist[MAX_VERTICES];
int prev[MAX_VERTICES]; // para recuperar o caminho usando um dijoint forest set

void dijkstra(Grafo& grafo, int source)
{
    for (int i = 0; i < grafo.size(); i++)
    {
        dist[i] = INF;
        prev[i] = -1;
    }

    dist[source] = 0;
    priority_queue<pair<int, int> > heap;
    heap.push(make_pair(0, source));

    while (!heap.empty())
    {
        int u = heap.top().second;
        heap.pop();

        // para cada vizinho de u
        for (map<int,int>::iterator i = grafo[u].begin(); i != grafo[u].end(); i++)
        {
            int totalDist = dist[u] + (*i).second;
            if (totalDist <= dist[(*i).first])
            {
                dist[(*i).first] = totalDist;
                heap.push(make_pair(totalDist, (*i).first));
                prev[(*i).first] = u;
            }
        }
    }
}
```

Código 19: Caminho minimo 1 para todos pesos positivos.

```
#define SIZE 100

struct dsf
{
    int element_count;
    int parent[SIZE];
    int rank[SIZE];
};
typedef struct dsf * disjoint_set_forest_p;

void dsf_init(disjoint_set_forest_p forest, int element_count)
{
    forest->element_count = element_count;
    memset(forest->parent, 0, element_count*sizeof(int));
    memset(forest->rank, 0, element_count*sizeof(int));
```

```

   for (int i = 0; i < element_count; ++i)
      forest->parent[i] = i;
}

int dsf_find_set(disjoint_set_forest_p forest, int i)
{
    if (i != forest->parent[i])
    {
        forest->parent[i] = dsf_find_set(forest, forest->parent[i]);
    }
    return forest->parent[i];
}

void dsf_union(disjoint_set_forest_p forest, int i, int j)
{
    int x = dsf_find_set(forest, i);
    int y = dsf_find_set(forest, j);

    if (forest->rank[x] > forest->rank[y])
    {
        forest->parent[y] = x;
    }
    else
    {
        forest->parent[x] = y;
        if (forest->rank[x] == forest->rank[y])
        {
            forest->rank[y]++;
        }
    }
}
```

Código 20: Floresta dijunta de arvores

```
typedef vector<map<int, int> > AdjList;
struct Grafo
{
   int edgeCnt;
   AdjList adj;
};

struct edge
{
    int u;
    int v;
    int weight;
};

int edge_compare(const void * e1, const void * e2)
{
    struct edge * p1 = (struct edge *) e1;
    struct edge * p2 = (struct edge *) e2;
    int f = p1->weight - p2->weight;
    if (f < 0)
    {
        return -1;
    }
    else  if (f == 0)
    {
        return edge_compare1(e1, e2);
    }
    else
    {
        return 1;
    }
}

struct edge * get_edge_list(Grafo& graph)
{
    int edge_count = graph.edgeCnt;
    struct edge *edges = (struct edge*) malloc(edge_count * sizeof(struct
        edge));

    int current_edge = 0;

    for (int i = 0; i < graph.adj.size(); ++i)
    {
        for (map<int, int>::iterator j = graph.adj[i].begin(); j != graph.
            adj[i].end(); j++)
        {
            struct edge e;
            e.u = i < (*j).first ? i : (*j).first;
            e.v = i > (*j).first ? i : (*j).first;
            e.weight = (*j).second;
            edges[current_edge++] = e;
        }
    }

    return edges;
}

void kruskal(Grafo& graph, Grafo& mst)
{
    // Obtain a list of edges and sort it by weight in O(E lg E) time
    int edge_count = graph.edgeCnt;
    struct edge *edges = get_edge_list(graph);
    qsort(edges, edge_count, sizeof(struct edge), edge_compare);

    disjoint_set_forest dsf;
   dsf_init(&dsf, edge_count);

    for (int i = 0; i < edge_count; ++i)
    {
        struct edge e = edges[i];
        int uset = dsf_find_set(dsf, e.u);
        int vset = dsf_find_set(dsf, e.v);
        if (uset != vset)
        {
            mst.adj[e.u][e.v] = e.weight;
         mst.edgeCnt++;
            dsf_union(dsf, uset, vset);
```

```
        }
    }

    free(edges);
}
```

Código 21: Arvore geradora mínima kruskal

```
#define TAM 200

bool grafo[TAM][TAM];
int pass[TAM];
int n;

bool bipartido(int v, int color = 1)
{
    pass[v] = color;
    int thisColor = color;
    bool ret = true;

    color = color == 1 ? 2 : 1;

    for (int i = 0; i < n; i++)
    {
        if (grafo[v][i])
        {
            if (!pass[i]) ret = dfs(i, color);
            else if (pass[i] == thisColor) return false;

            if (!ret) return false;
        }
    }

    return ret;
}
```

Código 22: verifica se um grafo é bipartido

```
#define UNVISITED -1

int grafo[SIZE][SIZE];
int prof[SIZE];
int sorted[SIZE];
int nordem;

void dfsTopsort(int no)
{
    for (int viz = 0; viz < SIZE; viz++)
    {
        if (grafo[no][viz])
        {
            if (prof[viz] == UNVISITED)
            {
                prof[viz] = prof[no] + 1;
                dfsTopsort(viz);
            }
        }
    }

    sorted[nordem--] = no;
}

void topSort(int nvt)
{
    memset(prof, UNVISITED, nvt*sizeof(int));
    nordem = nvt - 1;

    for (int i = 0; i < nvt; i++)
    {
        if (prof[i] == UNVISITED)
        {
            prof[i] = 0;
            dfsTopsort(i);
        }
    }
}
```

Código 23: faz a ordenação topológica de um grafo acíclico

```
#define TAM 1000

int grafo[TAM][TAM];
int pred[TAM];
int f[TAM][TAM];
bool visitados[TAM];

bool dfs(int s, int t, int size)
{
    visitados[s] = true;
    if(s == t) return true;

    for(int v = 0; v < size; v++)
    {
        if(grafo[s][v] - f[s][v] > 0 && !visitados[v])
        {
            pred[v] = s;
            if(dfs(v, t, size)) return true;
        }
    }

    return false;
}

bool findPath(int s, int t, int size)
{
    memset(visitados, false, sizeof(bool)*size);
    return dfs(s, t, size);
}

int maxFlow(int size, int s, int t)
{
    int delta;
```

```
    for(int i = 0; i < size; i++)
    {
        memset(f[i], 0, sizeof(int)*size);
    }

    pred[s] = s;

    while(findPath(s, t, size))
    {
        delta = INT_MAX;
        for(int c = t; pred[c] != c; c = pred[c])
        {
            delta = min(delta, grafo[pred[c]][c] - f[pred[c]][c]);
        }

        for(int c = t; pred[c] != c; c = pred[c])
        {
            f[pred[c]][c] += delta;
            f[c][pred[c]] -= delta;
        }
    }

    int soma = 0;

    for(int i = 0; i < size; i++)
    {
        soma += f[i][t];
    }

    return soma;
}
```

Código 24: calcula fluxo máximo

2.4 Geometria

```
struct point
{
    double x, y;
    point(double x = 0, double y = 0): x(x), y(y) {}

    point operator +(point q) { return point(x + q.x, y + q.y); }
    point operator -(point q) { return point(x - q.x, y - q.y); }
    point operator *(double t) { return point(x * t, y * t); }
    point operator /(double t) { return point(x / t, y / t); }
    double operator *(point q) { return x * q.x + y * q.y; }
    double operator %(point q) { return x * q.y - y * q.x; }

    int cmp(point q) const
    {
        if (int t = ::cmp(x, q.x)) return t;
        return ::cmp(y, q.y);
    }

    bool operator ==(point q) const { return cmp(q) == 0; }
    bool operator !=(point q) const { return cmp(q) != 0; }
    bool operator < (point q) const { return cmp(q) < 0; }

    friend ostream& operator <<(ostream& o, point p) {
      return o << "(" << p.x << ", " << p.y << ")";
    }
    static point pivot;
};

double abs(point p) { return hypot(p.x, p.y); }
double arg(point p) { return atan2(p.y, p.x); }

point point::pivot;

typedef vector<point> polygon;

int ccw(point p, point q, point r)
{
    return cmp((p - r) % (q - r));
}

double angle(point p, point q, point r)
{
    point u = p - q, v = r - q;
    return atan2(u % v, u * v);
}
```

Código 25: ponto e poligono

```
bool between(point p, point q, point r)
{
    return ccw(p, q, r) == 0 && cmp((p - q) * (r - q)) <= 0;
}
```

Código 26: Decide se q está sobre o segmento fechado pr.

```
bool seg_intersect(point p, point q, point r, point s)
{
    point A = q - p;
    point B = s - r;
    point C = r - p;
    point D = s - q;

    int a = cmp(A % C) + 2 * cmp(A % D);
    int b = cmp(B % C) + 2 * cmp(B % D);

    if (a == 3 || a == -3 || b == 3 || b == -3) return false;
    if (a || b || p == r || p == s || q == r || q == s) return true;

    int t = (p < r) + (p < s) + (q < r) + (q < s);
    return t != 0 && t != 4;
}
```

Código 27: Decide se os segmentos fechados pq e rs têm pontos em comum.

```
double seg_distance(point p, point q, point r)
{
    point A = r - q;
    point B = r - p;
    point C = q - p;

    double a = A * A, b = B * B, c = C * C;

    if (cmp(b, a + c) >= 0) return sqrt(a);
    else if (cmp(a, b + c) >= 0) return sqrt(b);
    else return fabs(A % B) / sqrt(c);
}
```

Código 28: Calcula a distância do ponto r ao segmento pq.

```
int in_poly(point p, polygon& T)
{
    double a = 0;
    int N = T.size();
    for (int i = 0; i < N; i++)
    {
        if (between(T[i], p, T[(i+1) % N])) return -1;
        a += angle(T[i], p, T[(i+1) % N]);
    }
    return cmp(a) != 0;
}
```

Código 29: Classifica o ponto p em relação ao polígono T. Retorna 0, -1 ou 1 dependendo se p está no exterior, na fronteira ou no interior de T, respectivamente.

2.5 Outros

```
/**
The Josephus problem (or Josephus permutation) is a theoretical problem
     related to a certain counting-out game. There are people standing in a
     circle waiting to be executed. After the first man is executed, certain
     number of people are skipped and one man is executed. Then again, people
      are skipped and a man is executed. The elimination proceeds around the
     circle (which is becoming smaller and smaller as the executed people are
      removed), until only the last man remains, who is given freedom. The
     task is to choose the place in the initial circle so that you are the
     last one remaining and so survive.
 */

using namespace std;

int josephus(int n, int m)
{
    int res = 0;
    vector <int> people;
    int loc = 0;

    for (int i = 0; i < n; i++) people.push_back(i+1);

    while (people.size() > 1)
    {
        if (loc >= people.size())
            loc %= people.size();

        people.erase(people.begin()+loc);
        loc += (m-1);
    }

    return people[0];
}
```

Código 30: josephus problem