ACM ICPC Regional 2014

1. Generales

1.1. VIM Setting.

```
"␣basic␣setting
set␣ts=4
set␣bs=2
set␣ruler
set␣nu
syntax␣on
set␣hlsearch
set␣showmatch
set␣showmode
set␣autoindent
set␣incsearch
set␣copyindent

" set leader to ,
let mapleader=","
let g:mapleader=","

"␣,/␣turn␣off␣search␣highlighting
nmap␣<leader>/␣:nohl<CR>

" allow multiple indentation/deindentation in visual mode
vnoremap < <gv
vnoremap > >gv
```

2. Data Structures

3. Flow

4. Graph

4.1. SPFA.

```
const int MAX = 1000000;
typedef struct A{
   int y,dis;
   A(int _y,int _dis){
      y = _y, dis = _dis;
   }
}AA;
vector <AA> v[10];
int d[10],in[10],pre[10];

void backtrack(int x){
   if(x==-1)return ;
   backtrack(pre[x]);
   printf("%d␣",x);
}

int main()
{
   for(int N,M;scanf("␣%d␣%d",&N,&M)==2;){
      for(int n=0;n<N;n++)
         v[n].clear(), d[n] = MAX, in[n] = 0, pre[n] = -1;
      for(int m=0,a,b,c;m<M;m++){
         scanf("␣%d␣%d␣%d",&a,&b,&c);
         v[a].push_back(A(b,c));
         v[b].push_back(A(a,c));
      }
      d[0] = 0;
      queue <int> q;
      q.push(0);
      while(!q.empty()){
         int x = q.front();q.pop();
         in[x] = 0;
         for(int i=0;i<v[x].size();i++){
            int y = v[x][i].y, dis = v[x][i].dis;
            if(d[x] + dis < d[y]) {
               d[y] = d[x] + dis;
               pre[y] = x;
               if(in[y]==0){
                  in[y] = 1;
                  q.push(y);
               }
            }
         }
      }
      for(int n=1;n<N;n++)
         printf("0␣->␣%d␣:␣%d\n",n,d[n]);
      backtrack(3);
      printf("\n");
   }
   return 0;
}
```

5. Geometry

6. Number Theory

7. Problems

8. String

9. Other

9.1. Merge Sort.

```
void MergeSort(int a[],int n)
{
	if(n<=1) return;

	int x,y,i,left[n/2],right[n/2];
	x = n/2;
	y = n-x;

	for(i=0;i<x;i++) left[i]=a[i];
	for(i=0;i<y;i++) right[i]=a[x+i];

	MergeSort(left,x);
	MergeSort(right,y);
	Merge(a,left,right,x,y);
}
```

```
void Merge(int a[],int left[],int right[],int x,int y)
{
	int i=0,j=0,k=0;
	while(i<x && j<y)
	{
		if(left[i] < right[j])
	   a[k]=left[i++];
		else
	   a[k]=right[j++];
		k++;
	}
	while(i<x) a[k++]=left[i++];
	while(j<y) a[k++]=right[j++];
}
```

10. Math

10.1. Catalan Number. Binary trees with $n+1$ vertices.

$$C_{n+1} = \sum_{i=0}^{n} C_i C_{n-i}$$

$$C_n = \frac{1}{n+1}\binom{2n}{n} = \binom{2n}{n} - \binom{2n}{n+1}$$

10.2. Stirling Numbers(1^{st} kind). Arrangements of an n element set into k cycles.

$$\begin{bmatrix} n \\ k \end{bmatrix} = (n-1)\begin{bmatrix} n-1 \\ k \end{bmatrix} + \begin{bmatrix} n-1 \\ k-1 \end{bmatrix}$$

10.3. Stirling Numbers(2^{nd}kind). # of ways of dividing n distinct element into k non-empty sets.

$$\begin{Bmatrix} n \\ k \end{Bmatrix} = k\begin{Bmatrix} n-1 \\ k \end{Bmatrix} + \begin{Bmatrix} n-1 \\ k-1 \end{Bmatrix}$$

Adems:

$$\begin{Bmatrix} n \\ k \end{Bmatrix} = \frac{1}{k!}\sum_{j=0}^{k}(-1)^{k-j}\binom{k}{j} j^n$$

10.4. **Bell Numbers.** Count the number of ways to divide n elements into subsets.

$$\mathcal{B}_{n+1} = \sum_{k=0}^{n} \binom{n}{k} \mathcal{B}_k$$

x	0	1	2	3	4	5	6	7	8	9	10
$\mathcal{B}_x$	1	1	2	5	15	52	203	877	4.140	21.147	115.975

10.5. **Derangement.** Permutation that leaves no element in the original location.

$$!n = (n-1)(!(n-1)+!(n-2)); !1 = 0, !2 = 1$$

$$!n = n! \sum_{k=0}^{n} \frac{(-1)^k}{k!}$$

10.6. **Nmeros armnicos.**

$$H_n = \sum_{k=1}^{n} \frac{1}{k}$$

$$\frac{1}{2n+1} < H_n - \ln n - \gamma < \frac{1}{2n}$$

$$\gamma = 0.577215664901532860606512090082402431042159335\ldots$$

10.7. **Fibonacci Number.** $f_0 = 0$, $f_1 = 1$:

$$f_n = \frac{1}{\sqrt{5}}(\frac{1+\sqrt{5}}{2})^n - \frac{1}{\sqrt{5}}(\frac{1-\sqrt{5}}{2})^n$$

$$f_{n+1}^2 + f_n^2 = f_{2n+1}, f_{n+2}^2 - f_n^2 = f_{2n+2}$$

$$f_n = \sum_{j=0}^{\lfloor \frac{n}{2} \rfloor} \binom{n-j}{j}$$

10.8. **Sums of Combinations.**

$$\sum_{i=n}^{m} \binom{i}{n} = \binom{m+1}{n+1}$$

$$\sum_{i=0}^{k} \binom{n}{i} \binom{m}{k-i} = \binom{n+m}{k}$$

10.9. **Generating functions.**

$(1,1,1,1,1,1,\ldots)$	$\frac{1}{1-z}$
$(1,-1,1,-1,1,-1,\ldots)$	$\frac{1}{1+z}$
$(1,0,1,0,1,0,\ldots)$	$\frac{1}{1-z^2}$
$(1,0,\ldots,0,1,0,1,0,\ldots,0,1,0,\ldots)$	$\frac{1}{1-z^2}$
$(1,2,3,4,5,6,\ldots)$	$\frac{1}{(1-z)^2}$
$(1,\binom{m+1}{m},\binom{m+2}{m},\binom{m+3}{m},\ldots)$	$\frac{1}{(1-z)^{m+1}}$
$(1,c,\binom{c+1}{2},\binom{c+2}{3},\ldots)$	$\frac{1}{(1-z)^c}$
$(1,c,c^2,c^3,\ldots)$	$\frac{1}{1-cz}$
$(0,1,\frac{1}{2},\frac{1}{3},\frac{1}{4},\ldots)$	$\ln\frac{1}{1-z}$

10.10. **Combination Basis.** Occupancy n Balls into m Boxes

	Balls labeled	Boxes labeled	Any Box Empty	# of ways
(1)	N	N	N	$P_m(n)-P_{m-1}(n)$
(2)	N	N	Y	$P_m(n)$
(3)	N	Y	N	$\binom{n-1}{m-1}$
(4)	N	Y	Y	$\binom{n+m-1}{n}$
(5)	Y	N	N	$\left\{{n \atop m}\right\}$
(6)	Y	N	Y	$\left\{{n \atop 1}\right\}+\ldots+\left\{{n \atop m}\right\}$
(7)	Y	Y	N	$m!\left\{{n \atop m}\right\}$
(8)	Y	Y	Y	m^n

* $P_m(n)$:# of partitions of n into $1,2,...,m$ with repetition allowed.
* $P_m(n)=P_{m-1}(n)+P_m(n-m)$
* $(8)=\sum_{i=1}^{m}\binom{m}{i}(7)$
* $(4)=\sum_{i=1}^{m}\binom{m}{i}(3)$

Taylor's series:

$$f(x)=f(a)+(x-a)f'(a)+\frac{(x-a)^2}{2}f''(a)+\cdots=\sum_{i=0}^{\infty}\frac{(x-a)^i}{i!}f^{(i)}(a).$$

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