Contents

1.1 init.el

linum   emacs24

```
 1  ;key
 2  (keyboard-translate ?\C-h ?\C-?)
 3  (global-set-key "\M-g" 'goto-line)
 4
 5  ;tab
 6  (setq-default indent-tabs-mode nil)
 7  (setq-default tab-width 4)
 8  (setq indent-line-function 'insert-tab)
 9
10  ;line number
11  (global-linum-mode t)
12  (setq linum-format "%4d ")
```

1.2 tpl.cpp

```cpp
 1  #include <bits/stdc++.h>
 2  using namespace std;
 3
 4  #define rep(i,a) for(int i = 0;i < (a); i++)
 5  #define repi(i,a,b) for(int i = (a); i < (b); i++)
 6  #define repd(i,a,b) for(int i = (a); i >= (b); i--)
 7  #define repit(i,a) for(__typeof((a).begin()) i = (a).begin(); i != (a).end(); i++)
 8  #define all(u) (u).begin(),(u).end()
 9  #define rall(u) (u).rbegin(),(u).rend()
10  #define UNIQUE(u) (u).erase(unique(all(u)),(u).end())
11  #define pb push_back
12  #define mp make_pair
13  const int INF = 1e9;
14  const double EPS = 1e-8;
15  const double PI = acos(-1.0);
16
17  typedef long long ll;
18  typedef vector<int> vi;
19  typedef vector<vi> vvi;
20  typedef pair<int,int> pii;
21
22  int main(){
23  }
```

2.1 Aho-Corasick

$O(N + M)$

```cpp
1  struct PMA{
2      PMA* next[256];     //0 is failure link
3      vi matched;
4      PMA(){memset(next, 0, sizeof(next));}
5      ~PMA(){rep(i,256) if(next[i]) delete next[i];}
6  };
7  vi set_union(const vi &a,const vi &b){
8      vi res;
```

```
9         set_union(all(a), all(b), back_inserter(res));
10        return res;
11 }
12 // pattern
13 PMA *buildPMA(vector<string> pattern){
14     PMA *root = new PMA, *now;
15     root->next[0] = root;
16     rep(i, patter.size()){
17         now = root;
18         rep(j, pattern[i].size()){
19             if(now->next[(int)pattern[i][j]] == 0)
20                 now->next[(int)pattern[i][j]] = new PMA;
21             now = now->next[(int)pattern[i][j]];
22         }
23         now->matched.push_back(i);
24     }
25     queue<PMA*> que;
26     repi(i,1,256){
27         if(!root->next[i]) root->next[i] = root;
28         else {
29             root->next[i]->next[0] = root;
30             que.push(root->next[i]);
31         }
32     }
33     while(!que.empty()){
34         now = que.front(); que.pop();
35         repi(i,1,256){
36             if(now->next[i]){
37                 PMA *next = now->next[0];
38                 while(!next->next[i]) next = next->next[0];
39                 now->next[i]->next[0] = next->next[i];
40                 now->next[i]->matched = set_union(now->next[i]->matched, next->next[i]->
                          matched);
41                 que.push(now->next[i]);
42             }
43         }
44     }
45     return root;
46 }
47 void match(PMA* &pma, const string s, vi &res){
48     rep(i,s.size()){
49         int c = s[i];
50         while(!pma->next[c])
51             pma = pma->next[0];
52         pma = pma->next[c];
53         rep(j,pma->matched.size())
54             res[pma->matched[j]] = 1;
55     }
56 }
```

3

3.1

3.1.1

$O(E)$

u   k   art   k-1   u   .   unique
          .

```
1 vi G[MAX], art; // art
2 int num[MAX], low[MAX], t, V;
3
```

```
4  void visit(int v, int u){
5      low[v] = num[v] = ++t;
6      repit(e,G[v]){
7          int w = *e;
8          if (num[w] == 0) {
9              visit(w, v);
10             low[v] = min(low[v], low[w]);
11             if ((num[v] == 1 && num[w] != 2) ||
12                 (num[v] != 1 && low[w] >= num[v])) art.pb(v);
13         }
14         else low[v] = min(low[v], num[w]);
15     }
16 }
17 void art_point(){
18     memset(low, 0, sizeof(low));
19     memset(num, 0, sizeof(num));
20     art.clear();
21     rep(u,V) if (num[u] == 0) {
22         t = 0;
23         visit(u, -1);
24     }
25     /*
26     sort(all(art));
27     UNIQUE(art);
28     */
29 }
```

3.1.2

$O(V + E)$

```
1  vi G[MAX];
2  vector<pii> brdg; // brdg
3  stack<int> roots, S;
4  int num[MAX], inS[MAX], t, V;
5
6  void visit(int v, int u){
7      num[v] = ++t;
8      S.push(v); inS[v] = 1;
9      roots.push(v);
10     repit(e, G[v]){
11         int w = *e;
12         if(!num[w]) visit(w, v);
13         else if(u != w && inS[w])
14             while(num[roots.top()] > num[w])
15                 roots.pop();
16     }
17     if(v == roots.top()){
18         int tu = u, tv = v;
19         if(tu > tv) swap(tu, tv);
20         brdg.pb(pii(tu, tv));
21         while(1){
22             int w = S.top(); S.pop();
23             inS[w] = 0;
24             if(v == w) break;
25         }
26         roots.pop();
27     }
28 }
29
30 void bridge(){
31     memset(num, 0, sizeof(num));
32     memset(inS, 0, sizeof(inS));
33     brdg.clear();
34     while(S.size()) S.pop();
```

```
35        while(roots.size()) roots.pop();
36        t = 0;
37        rep(u,V) if(num[u] == 0){
38            visit(u,V);
39            brdg.pop_back();
40        }
41    }
```

3.1.3

$O(V + E)$

```
1   vi G[MAX];
2   vvi scc; //
3   stack<int> S;
4   int inS[MAX], low[MAX], num[MAX], t, V;
5
6   void visit(int v){
7       low[v] = num[v] = ++t;
8       S.push(v); inS[v] = 1;
9       repit(e,G[v]){
10          int w = *e;
11          if(num[w] == 0){
12              visit(w);
13              low[v] = min(low[v], low[w]);
14          }
15          else if(inS[w]) low[v] = min(low[v], num[w]);
16      }
17      if(low[v] == num[v]){
18          scc.pb(vi());
19          while(1){
20              int w = S.top(); S.pop();
21              inS[w] = 0;
22              scc.back().pb(w);
23              if(v == w) break;
24          }
25      }
26  }
27
28  void stronglyCC(){
29      t = 0;
30      scc.clear();
31      memset(num, 0, sizeof(num));
32      memset(low, 0, sizeof(low));
33      memset(inS, 0, sizeof(inS));
34      while(S.size()) S.pop();
35      rep(u,V) if(num[u] == 0) visit(u);
36  }
```

3.2

3.2.1

$O(EV^2)$

```
1   struct edge{int to, cap, rev;};
2   vector<edge> G[MAX];
3   int level[MAX], itr[MAX];
4
5   void add_edge(int from, int to, int cap){
6       G[from].push_back((edge){to, cap, int(G[to].size())});
7       G[to].push_back((edge){from, 0, int(G[from].size()-1)});
```

```
8   }
9
10  void bfs(int s, int t){
11      memset(level, -1, sizeof(level));
12      queue<int> que; que.push(s);
13      level[s] = 0;
14      while(!que.empty()){
15          int v = que.front(); que.pop();
16          if(v == t) return;
17          for(int i = 0; i < G[v].size(); i++){
18              edge &e = G[v][i];
19              if(e.cap <= 0 or level[e.to] != -1) continue;
20              que.push(e.to);
21              level[e.to] = level[v]+1;
22          }
23      }
24  }
25
26  int dfs(int v, int t, int f){
27      if(v == t) return f;
28      for(int &i = itr[v] ; i < G[v].size(); i++){
29          edge &e = G[v][i];
30          if(level[e.to] <= level[v] or e.cap <= 0) continue;
31          int d = dfs(e.to, t, min(f, e.cap));
32          if(d > 0){
33              e.cap -= d;
34              G[e.to][e.rev].cap += d;
35              return d;
36          }
37      }
38      return 0;
39  }
40
41  int max_flow(int s, int t){
42      int flow = 0, f;
43      while(1){
44          bfs(s, t);
45          if(level[t] == -1) return flow;
46          memset(itr, 0, sizeof(itr));
47          while((f = dfs(s, t, INF)) > 0) flow += f;
48      }
49  }
```

3.2.2

$O(EV)$

```
1   int  V;
2   vector<int> G[MAX_V];
3   int match[MAX_V];
4   bool used[MAX_V];
5
6   void add_edge(int u, int v){
7       G[u].push_back(v);
8       G[v].push_back(u);
9   }
10
11  bool dfs(int v){
12      used[v] = 1;
13      rep(i,G[v].size()){
14          int u = G[v][i], w = match[u];
15          if(w < 0 || !used[w] && dfs(w)){
16              match[v] = u;
17              match[u] = v;
18              return 1;
```

```
19            }
20        }
21        return 0;
22  }
23
24  int bi_matching(){
25      int res = 0;
26      memset(match, -1, sizeof(match));
27      rep(v,V) if(match[v] < 0){
28          memset(used, 0, sizeof(used));
29          if(dfs(v)) res++;
30      }
31      return res;
32  }
```

3.2.3

$O(FE \log V)$

```
1   struct edge{ int to, cap, cost, rev;};
2
3   int V;
4   vector<edge> G[MAX_V];
5   int h[MAX_V];
6   int dist[MAX_V];
7   int prevv[MAX_V], preve[MAX_V];
8
9   void add_edge(int from, int to, int cap, int cost){
10      G[from].push_back((edge){to, cap, cost, int(G[to].size())});
11      G[to].push_back((edge){from, 0, -cost, int(G[from].size() - 1)});
12  }
13
14  int min_cost_flow(int s, int t, int f){
15      int res = 0;
16      fill(h, h + V, 0);
17      while(f > 0){
18          priority_queue<pii, vector<pii>, greater<pii> > que;
19          fill(dist, dist + V, inf);
20          dist[s] = 0;
21          que.push(pii(0, s));
22          while(!que.empty()){
23              pii p = que.top(); que.pop();
24              int v = p.second;
25              if(dist[v] < p.first) continue;
26              rep(i,G[v].size()){
27                  edge &e = G[v][i];
28                  if(e.cap > 0 && dist[e.to] > dist[v] + e.cost + h[v] - h[e.to]){
29                      dist[e.to] = dist[v] + e.cost + h[v] - h[e.to];
30                      prevv[e.to] = v;
31                      preve[e.to] = i;
32                      que.push(pii(dist[e.to], e.to));
33                  }
34              }
35          }
36          if(dist[t] == inf) return -1;
37          rep(v,V) h[v] += dist[v];
38          int d = f;
39          for(int v = t; v != s; v = prevv[v])
40              d = min(d, G[prevv[v]][preve[v]].cap);
41          f -= d;
42          res += d * h[t];
43          for(int v = t; v != s; v = prevv[v]){
44              edge &e = G[prevv[v]][preve[v]];
45              e.cap -= d;
46              G[v][e.rev].cap += d;
```

```
47          }
48      }
49      return res;
50  }
```

3.3

$O(4^{|T|}V)$

g   . T   .

```
1   int minimum_steiner_tree(vi &T, vvi &g){
2       int n = g.size(), t = T.size();
3       if(t <= 1) return 0;
4       vvi d(g);       // all-pair shortest
5       rep(k,n)rep(i,n)rep(j,n)      //Warshall Floyd
6           d[i][j] = min(d[i][j], d[i][k] + d[k][j]);
7
8       int opt[1 << t][n];
9       rep(S,1<<t) rep(x,n)
10          opt[S][x] = INF;
11
12      rep(p,t) rep(q,n)    // trivial case
13          opt[1 << p][q] = d[T[p]][q];
14
15      repi(S,1,1<<t){     // DP step
16          if(!(S & (S-1))) continue;
17          rep(p,n) rep(E,S)
18              if((E | S) == S)
19                  opt[S][p] = min(opt[S][p], opt[E][p] + opt[S-E][p]);
20          rep(p,n) rep(q,n)
21              opt[S][p] = min(opt[S][p], opt[S][q] + d[p][q]);
22      }
23
24      int ans = INF;
25      rep(S,1<<t) rep(q,n)
26          ans = min(ans, opt[S][q] + opt[((1<<t)-1)-S][q]);
27      return ans;
28  }
```