1. Intro.   Creating a graph for the distinct positions in all games of tic-tac-toe.

```
#define rank  z.I      /* number of moves made */
#define link  y.V      /* next vertex of same rank */
#define head  x.V       /* first vertex of given rank */
#define winner  w.I      /* is this a winning position? */
#define bitcode  v.I      /* binary representation of this position */
```

```
#include "gb_graph.h"
#include "gb_save.h"
  Vertex * pos[1 ≪ 18];
```

```
  int move[9];
  int win[16] = {       /* the board is now numbered 263/917/584 */
  #05040, #10011, #00504, #04101, #10044, #01410, #14400, #11100};
  int place[18] = {4, 4, 9, 9, 6, 6, 1, 1, 8, 8, 10, 10, 2, 2, 0, 0, 5, 5};
  main( )
  {
    register k, l, board;

    Vertex * u, *v;
    Graph * g = gb_new_graph(5478);
    strcpy(g→util_types, "ZIIVVIZZZZZZZZ");
    strcpy(g→id, "tictactoe");
    for (k = 0; k < 8; k++)  win[k + 8] = win[k] ≪ 1;
    l = board = 0;
    pos[0] = u = v = g→vertices;
    v→rank = v→winner = v→bitcode = 0;
    v→link = Λ, (g→vertices + 0)→head = v;
    v→name = gb_save_string("␣␣␣/␣␣␣/␣␣␣");
newlev:  move[l] = 3;
tryit:
    if (¬(board & move[l])) {
      board += move[l] & (l & 1 ? #55555 : #aaaaa);
      if (pos[board]) {
        gb_new_arc(v, pos[board], 1);
        goto unmove;
      }
      pos[board] = ++u;
      u→rank = l + 1, u→winner = 0, u→bitcode = board;
      u→name = gb_save_string("␣␣␣/␣␣␣/␣␣␣");
      for (k = 0; k < 18; k++)
        if (board & (1 ≪ k))  u→name[place[k]] = ((l ⊕ k) & 1 ? 'O' : 'X');
      u→link = (g→vertices + l + 1)→head, (g→vertices + l + 1)→head = u;
      gb_new_arc(v, u, 1);
      for (k = 0; k < 16; k++)
        if ((board & win[k]) ≡ win[k]) {
          u→winner = 1;
          goto unmove;
        }
      if (l ≡ 8) goto unmove;
      l++, v = u;
      goto newlev;
```

```
    }
tryagain:  move[l] ≪= 2;
    if (move[l] < (1 ≪ 18)) goto tryit;
    if (l > 0) {
        l−−, v = pos[board & ∼move[l]];
    unmove:  board &= ∼move[l];
        goto tryagain;
    }
    save_graph(g, "/tmp/tictactoe.gb");
}
```

2. Index.

TICTACTOE1