1* Introduction. This is a hastily written implementation of the daghull algorithm.

```
format Graph int    /* gb_graph defines the Graph type and a few others */
format Vertex int
format Arc int
format Area int
#include "gb_graph.h"
#include "gb_rand.h"
#include "gb_miles.h"
int n = 128;
⟨ Global variables 2 ⟩
⟨ Procedures 13* ⟩
main(argc, argv)
    int argc;
    char **argv;
{
  ⟨ Local variables 7 ⟩
  Graph *g;
  int kk, kkk, xrnd, yrnd;
  char str[10];
  if (argc ≠ 2) n = 100;
  else if (sscanf(argv[1], "%d", &n) ≠ 1) {
    printf("Usage: %s [n]\n", argv[0]); exit(1);
  }
  else if (n < 20) {
    printf("n should be at least 20!\n"); exit(1);
  }
  g = gb_new_graph(n);
  gb_init_rand(0);
  for (kk = 0, v = g→vertices; kk < n; kk++, v++) {
    sprintf(str, "%d", kk);
    v→name = gb_save_string(str);
    kkk = kk/(n/10) + 1;
    kkk = kkk * kkk * 100;
    xrnd = gb_next_rand( );
    if (xrnd & #1000000) xrnd = xrnd % 100;
    else xrnd = kkk − (xrnd % 100);
    yrnd = gb_next_rand( );
    if (yrnd & #1000000) {
      v→x.I = xrnd − kkk/2;
      v→y.I = (yrnd % kkk) − kkk/2;
    }
    else {
      v→x.I = (yrnd % kkk) − kkk/2;
      v→y.I = xrnd − kkk/2;
    }
    if (n < 150) printf("point %s=(%d,%d)\n", v→name, v→x.I, v→y.I);
  }
  mems = ccs = 0;
  ⟨ Find convex hull of g 8 ⟩;
  printf("Total of %d mems and %d calls on ccw.\n", mems, ccs);
}
```

13* Determinants. I need code for the primitive function *ccw*. Floating-point arithmetic suffices for my purposes.

We want to evaluate the determinant

$$ccw(u,v,w) = \begin{vmatrix} u(x) & u(y) & 1 \\ v(x) & v(y) & 1 \\ w(x) & w(y) & 1 \end{vmatrix} = \begin{vmatrix} u(x)-w(x) & u(y)-w(y) \\ v(x)-w(x) & v(y)-w(y) \end{vmatrix}.$$

```
⟨ Procedures 13* ⟩ ≡
  int ccw(u, v, w)
      Vertex *u, *v, *w;
  { register double wx = (double) w→x.I, wy = (double) w→y.I;
    register double det = ((double) u→x.I − wx) * ((double) v→y.I − wy) − ((double)
        u→y.I − wy) * ((double) v→x.I − wx);
    Vertex *uu = u, *vv = v, *ww = w, *t;
    if (det ≡ 0) {
      det = 1;
      if (u→x.I > v→x.I ∨ (u→x.I ≡ v→x.I ∧ (u→y.I > v→y.I ∨ (u→y.I ≡ v→y.I ∧ u→z.I > v→z.I)))) {
        t = u; u = v; v = t; det = −det;
      }
      if (v→x.I > w→x.I ∨ (v→x.I ≡ w→x.I ∧ (v→y.I > w→y.I ∨ (v→y.I ≡ w→y.I ∧ v→z.I > w→z.I)))) {
        t = v; v = w; w = t; det = −det;
      }
      if (u→x.I > v→x.I ∨ (u→x.I ≡ v→x.I ∧ (u→y.I > v→y.I ∨ (u→y.I ≡ v→y.I ∧ u→z.I < v→z.I)))) {
        det = −det;
      }
    }
    if (n < 150)
      printf("cc(%s %s %s) is %s\n", uu→name, vv→name, ww→name, det > 0 ? "true" : "false");
    ccs++;
    return (det > 0);
  }
```

This code is used in section 1*.

The following sections were changed by the change file: 1, 13.

Arc: 4, 5, 7.
Area: 5.
argc: 1*
argv: 1*
ccs: 1*, 2, 13*
ccw: 2, 10, 11, 13*
det: 13*
exit: 1*
first_inst: 4, 5, 6, 10, 12.
g: 1*
gb_alloc: 4.
gb_graph: 1*
gb_init_rand: 1*
gb_new_graph: 1*
gb_next_rand: 1*
gb_save_string: 1*
Graph: 1*
init_area: 6.
inst: 3, 6, 11, 12.
kk: 1*
kkk: 1*
main: 1*
mems: 1*, 2.
n: 1*
name: 1*, 6, 9, 12, 13*
next: 3, 6, 10, 11, 12.
next_inst: 4, 5, 6, 11, 12.
o: 2.
oo: 2, 6, 8, 10, 11.
p: 7.
pred: 3, 6, 10, 11.
printf: 1*, 6, 9, 12, 13*
q: 7.
r: 7.