

```
1: // $Id: graphics.h,v 1.2 2019-03-19 16:18:22-07 - - $
2:
3: #ifndef __GRAPHICS_H__
4: #define __GRAPHICS_H__
5:
6: #include <memory>
7: #include <vector>
8: using namespace std;
9:
10: #include <GL/freeglut.h>
11:
12: #include "rgbcolor.h"
13: #include "shape.h"
14:
15: class object {
16:     private:
17:         shared_ptr<shape> pshape;
18:         vertex center;
19:         rgbcolor color;
20:     public:
21:         object (shared_ptr<shape>, vertex, rgbcolor);
22:         void draw();
23:         void move (GLfloat delta_x, GLfloat delta_y);
24: };
25:
26: class mouse {
27:     friend class window;
28:     private:
29:         int xpos {0};
30:         int ypos {0};
31:         int entered {GLUT_LEFT};
32:         int left_state {GLUT_UP};
33:         int middle_state {GLUT_UP};
34:         int right_state {GLUT_UP};
35:     private:
36:         void set (int x, int y) { xpos = x; ypos = y; }
37:         void state (int button, int state);
38:         void draw();
39: };
40:
```

```
41:
42: class window {
43:     friend class mouse;
44:     private:
45:         static int width;           // in pixels
46:         static int height;          // in pixels
47:         static vector<object> objects;
48:         static size_t selected_obj;
49:         static mouse mus;
50:     private:
51:         static void close();
52:         static void entry (int mouse_entered);
53:         static void display();
54:         static void reshape (int width, int height);
55:         static void keyboard (GLubyte key, int, int);
56:         static void special (int key, int, int);
57:         static void motion (int x, int y);
58:         static void passivemotion (int x, int y);
59:         static void mousefn (int button, int state, int x, int y);
60:     public:
61:         static void push_back (const object& obj) {
62:             objects.push_back (obj); }
63:         static void setwidth (int width_) { width = width_; }
64:         static void setheight (int height_) { height = height_; }
65:         static void main();
66: };
67:
68: #endif
69:
```

```
1: // $Id: graphics.cpp,v 1.6 2019-05-15 18:02:12-07 - - $
2:
3: #include <iostream>
4: using namespace std;
5:
6: #include <GL/freeglut.h>
7:
8: #include "graphics.h"
9: #include "util.h"
10:
11: int window::width = 640; // in pixels
12: int window::height = 480; // in pixels
13: vector<object> window::objects;
14: size_t window::selected_obj = 0;
15: mouse window::mus;
16:
17: // Implementation of object functions.
18: object::object (shared_ptr<shape> pshape_, vertex center_,
19:                 rgbcolor color_):
20:     pshape(pshape_), center(center_), color(color_) {
21: }
22:
23: void object::draw() {
24:     pshape->draw (center, color);
25: }
26:
27: void object::move (GLfloat delta_x, GLfloat delta_y) {
28:     center.xpos += delta_x;
29:     center.ypos += delta_y;
30: }
31:
32: // Implementation of mouse functions.
33: void mouse::state (int button, int state) {
34:     switch (button) {
35:         case GLUT_LEFT_BUTTON: left_state = state; break;
36:         case GLUT_MIDDLE_BUTTON: middle_state = state; break;
37:         case GLUT_RIGHT_BUTTON: right_state = state; break;
38:     }
39: }
40:
41: void mouse::draw() {
42:     static rgbcolor color ("green");
43:     ostream text;
44:     text << "(" << xpos << "," << window::height - ypos << ")";
45:     if (left_state == GLUT_DOWN) text << "L";
46:     if (middle_state == GLUT_DOWN) text << "M";
47:     if (right_state == GLUT_DOWN) text << "R";
48:     if (entered == GLUT_ENTERED) {
49:         void* font = GLUT_BITMAP_HELVETICA_18;
50:         glColor3ubv (color.ubvec);
51:         glRasterPos2i (10, 10);
52:         auto ubytes = reinterpret_cast<const GLubyte*>
53:             (text.str().c_str());
54:         glutBitmapString (font, ubytes);
55:     }
56: }
57:
```

```
58:
59: // Executed when window system signals to shut down.
60: void window::close() {
61:     DEBUGF ('g', sys_info::execname() << ": exit ("
62:         << sys_info::exit_status() << ")");
63:     exit (sys_info::exit_status());
64: }
65:
66: // Executed when mouse enters or leaves window.
67: void window::entry (int mouse_entered) {
68:     DEBUGF ('g', "mouse_entered=" << mouse_entered);
69:     window::mus.entered = mouse_entered;
70:     if (window::mus.entered == GLUT_ENTERED) {
71:         DEBUGF ('g', sys_info::execname() << ": width=" << window::width
72:             << ", height=" << window::height);
73:     }
74:     glutPostRedisplay();
75: }
76:
77: // Called to display the objects in the window.
78: void window::display() {
79:     glClear (GL_COLOR_BUFFER_BIT);
80:     for (auto& object: window::objects) object.draw();
81:     mus.draw();
82:     glutSwapBuffers();
83: }
84:
85: // Called when window is opened and when resized.
86: void window::reshape (int width_, int height_) {
87:     DEBUGF ('g', "width=" << width_ << ", height=" << height_);
88:     window::width = width_;
89:     window::height = height_;
90:     glMatrixMode (GL_PROJECTION);
91:     glLoadIdentity();
92:     gluOrtho2D (0, window::width, 0, window::height);
93:     glMatrixMode (GL_MODELVIEW);
94:     glViewport (0, 0, window::width, window::height);
95:     glClearColor (0.25, 0.25, 0.25, 1.0);
96:     glutPostRedisplay();
97: }
98:
```

```
99:
100: // Executed when a regular keyboard key is pressed.
101: void window::keyboard (GLubyte key, int x, int y) {
102:     enum {BS = 8, TAB = 9, ESC = 27, SPACE = 32, DEL = 127};
103:     DEBUGF ('g', "key=" << unsigned (key) << ", x=" << x << ", y=" << y);
104:     window::mus.set (x, y);
105:     switch (key) {
106:         case 'Q': case 'q': case ESC:
107:             window::close();
108:             break;
109:         case 'H': case 'h':
110:             //move_selected_object (
111:             break;
112:         case 'J': case 'j':
113:             //move_selected_object (
114:             break;
115:         case 'K': case 'k':
116:             //move_selected_object (
117:             break;
118:         case 'L': case 'l':
119:             //move_selected_object (
120:             break;
121:         case 'N': case 'n': case SPACE: case TAB:
122:             break;
123:         case 'P': case 'p': case BS:
124:             break;
125:         case '0': case '1': case '2': case '3': case '4':
126:         case '5': case '6': case '7': case '8': case '9':
127:             //select_object (key - '0');
128:             break;
129:         default:
130:             cerr << unsigned (key) << ": invalid keystroke" << endl;
131:             break;
132:     }
133:     glutPostRedisplay();
134: }
135:
```

```
136:
137: // Executed when a special function key is pressed.
138: void window::special (int key, int x, int y) {
139:     DEBUGF ('g', "key=" << key << ", x=" << x << ", y=" << y);
140:     window::mus.set (x, y);
141:     switch (key) {
142:         case GLUT_KEY_LEFT: //move_selected_object (-1, 0); break;
143:         case GLUT_KEY_DOWN: //move_selected_object (0, -1); break;
144:         case GLUT_KEY_UP: //move_selected_object (0, +1); break;
145:         case GLUT_KEY_RIGHT: //move_selected_object (+1, 0); break;
146:         case GLUT_KEY_F1: //select_object (1); break;
147:         case GLUT_KEY_F2: //select_object (2); break;
148:         case GLUT_KEY_F3: //select_object (3); break;
149:         case GLUT_KEY_F4: //select_object (4); break;
150:         case GLUT_KEY_F5: //select_object (5); break;
151:         case GLUT_KEY_F6: //select_object (6); break;
152:         case GLUT_KEY_F7: //select_object (7); break;
153:         case GLUT_KEY_F8: //select_object (8); break;
154:         case GLUT_KEY_F9: //select_object (9); break;
155:         case GLUT_KEY_F10: //select_object (10); break;
156:         case GLUT_KEY_F11: //select_object (11); break;
157:         case GLUT_KEY_F12: //select_object (12); break;
158:         default:
159:             cerr << unsigned (key) << ": invalid function key" << endl;
160:             break;
161:     }
162:     glutPostRedisplay();
163: }
164:
```

```
165:
166: void window::motion (int x, int y) {
167:     DEBUGF ('g', "x=" << x << ", y=" << y);
168:     window::mus.set (x, y);
169:     glutPostRedisplay();
170: }
171:
172: void window::passivemotion (int x, int y) {
173:     DEBUGF ('g', "x=" << x << ", y=" << y);
174:     window::mus.set (x, y);
175:     glutPostRedisplay();
176: }
177:
178: void window::mousefn (int button, int state, int x, int y) {
179:     DEBUGF ('g', "button=" << button << ", state=" << state
180:         << ", x=" << x << ", y=" << y);
181:     window::mus.state (button, state);
182:     window::mus.set (x, y);
183:     glutPostRedisplay();
184: }
185:
186: void window::main () {
187:     static int argc = 0;
188:     glutInit (&argc, nullptr);
189:     glutInitDisplayMode (GLUT_RGBA | GLUT_DOUBLE);
190:     glutInitWindowSize (window::width, window::height);
191:     glutInitWindowPosition (128, 128);
192:     glutCreateWindow (sys_info::execname().c_str());
193:     glutCloseFunc (window::close);
194:     glutEntryFunc (window::entry);
195:     glutDisplayFunc (window::display);
196:     glutReshapeFunc (window::reshape);
197:     glutKeyboardFunc (window::keyboard);
198:     glutSpecialFunc (window::special);
199:     glutMotionFunc (window::motion);
200:     glutPassiveMotionFunc (window::passivemotion);
201:     glutMouseFunc (window::mousefn);
202:     DEBUGF ('g', "Calling glutMainLoop()");
203:     glutMainLoop();
204: }
205:
```

```
1: // $Id: interp.h,v 1.2 2016-05-04 16:26:26-07 - - $
2:
3: #ifndef __INTERP_H__
4: #define __INTERP_H__
5:
6: #include <iostream>
7: #include <unordered_map>
8: #include <vector>
9: using namespace std;
10:
11: #include "debug.h"
12: #include "graphics.h"
13: #include "shape.h"
14:
15: class interpreter {
16:     public:
17:         using shape_map = unordered_map<string,shape_ptr>;
18:         using parameters = vector<string>;
19:         using param = parameters::const_iterator;
20:         using range = pair<param,param>;
21:         void interpret (const parameters&);
22:         interpreter() {}
23:         ~interpreter();
24:         interpreter (const interpreter&) = delete;
25:         interpreter& operator= (const interpreter&) = delete;
26:
27:     private:
28:         using interpreterfn = void (*) (param, param);
29:         using factoryfn = shape_ptr (*) (param, param);
30:
31:         static unordered_map<string,interpreterfn> interp_map;
32:         static unordered_map<string,factoryfn> factory_map;
33:         static shape_map objmap;
34:
35:         static void do_define (param begin, param end);
36:         static void do_draw (param begin, param end);
37:
38:         static shape_ptr make_shape (param begin, param end);
39:         static shape_ptr make_text (param begin, param end);
40:         static shape_ptr make_ellipse (param begin, param end);
41:         static shape_ptr make_circle (param begin, param end);
42:         static shape_ptr make_polygon (param begin, param end);
43:         static shape_ptr make_rectangle (param begin, param end);
44:         static shape_ptr make_square (param begin, param end);
45:         static shape_ptr make_line (param begin, param end);
46: };
47:
48: #endif
49:
```



```
1: // $Id: interp.cpp,v 1.3 2019-03-19 16:18:22-07 - - $
2:
3: #include <memory>
4: #include <string>
5: #include <vector>
6: using namespace std;
7:
8: #include <GL/freeglut.h>
9:
10: #include "debug.h"
11: #include "interp.h"
12: #include "shape.h"
13: #include "util.h"
14:
15: unordered_map<string,interpreter::interpreterfn>
16: interpreter::interp_map {
17:     {"define" , &interpreter::do_define },
18:     {"draw"    , &interpreter::do_draw   },
19: };
20:
21: unordered_map<string,interpreter::factoryfn>
22: interpreter::factory_map {
23:     {"text"      , &interpreter::make_text      },
24:     {"ellipse"   , &interpreter::make_ellipse   },
25:     {"circle"    , &interpreter::make_circle    },
26:     {"polygon"   , &interpreter::make_polygon   },
27:     {"rectangle" , &interpreter::make_rectangle},
28:     {"square"    , &interpreter::make_square    },
29: };
30:
31: interpreter::shape_map interpreter::objmap;
32:
33: interpreter::~interpreter() {
34:     for (const auto& itor: objmap) {
35:         cout << "objmap[" << itor.first << "] = "
36:              << *itor.second << endl;
37:     }
38: }
39:
40: void interpreter::interpret (const parameters& params) {
41:     DEBUGF ('i', params);
42:     param begin = params.cbegin();
43:     string command = *begin;
44:     auto itor = interp_map.find (command);
45:     if (itor == interp_map.end()) throw runtime_error ("syntax error");
46:     interpreterfn func = itor->second;
47:     func (++begin, params.cend());
48: }
49:
50: void interpreter::do_define (param begin, param end) {
51:     DEBUGF ('f', range (begin, end));
52:     string name = *begin;
53:     objmap.emplace (name, make_shape (++begin, end));
54: }
55:
```

```
56:
57: void interpreter::do_draw (param begin, param end) {
58:     DEBUGF ('f', range (begin, end));
59:     if (end - begin != 4) throw runtime_error ("syntax error");
60:     string name = begin[1];
61:     shape_map::const_iterator itor = objmap.find (name);
62:     if (itor == objmap.end()) {
63:         throw runtime_error (name + ": no such shape");
64:     }
65:     rgbcolor color {begin[0]};
66:     vertex where {from_string<GLfloat> (begin[2]),
67:                  from_string<GLfloat> (begin[3])};
68:     window::push_back (object (itor->second, where, color));
69: }
70:
71: shape_ptr interpreter::make_shape (param begin, param end) {
72:     DEBUGF ('f', range (begin, end));
73:     string type = *begin++;
74:     auto itor = factory_map.find(type);
75:     if (itor == factory_map.end()) {
76:         throw runtime_error (type + ": no such shape");
77:     }
78:     factoryfn func = itor->second;
79:     return func (begin, end);
80: }
81:
82: shape_ptr interpreter::make_text (param begin, param end) {
83:     DEBUGF ('f', range (begin, end));
84:     return make_shared<text> (nullptr, string());
85: }
86:
87: shape_ptr interpreter::make_ellipse (param begin, param end) {
88:     DEBUGF ('f', range (begin, end));
89:     return make_shared<ellipse> (GLfloat(), GLfloat());
90: }
91:
92: shape_ptr interpreter::make_circle (param begin, param end) {
93:     DEBUGF ('f', range (begin, end));
94:     return make_shared<circle> (GLfloat());
95: }
96:
97: shape_ptr interpreter::make_polygon (param begin, param end) {
98:     DEBUGF ('f', range (begin, end));
99:     return make_shared<polygon> (vertex_list());
100: }
101:
102: shape_ptr interpreter::make_rectangle (param begin, param end) {
103:     DEBUGF ('f', range (begin, end));
104:     return make_shared<rectangle> (GLfloat(), GLfloat());
105: }
106:
107: shape_ptr interpreter::make_square (param begin, param end) {
108:     DEBUGF ('f', range (begin, end));
109:     return make_shared<square> (GLfloat());
110: }
111:
```

```
1: // $Id: rgbcolor.h,v 1.3 2019-03-19 15:53:52-07 - - $
2:
3: #ifndef __RGBCOLOR_H__
4: #define __RGBCOLOR_H__
5:
6: #include <string>
7: #include <unordered_map>
8: using namespace std;
9:
10: #include <GL/freeglut.h>
11:
12: struct rgbcolor {
13:     union {
14:         GLubyte ubvec[3];
15:         struct {
16:             GLubyte red {};
17:             GLubyte green {};
18:             GLubyte blue {};
19:         } rgb {};
20:     };
21:     explicit rgbcolor() = default;
22:     explicit rgbcolor (GLubyte red, GLubyte green, GLubyte blue):
23:         rgb ({red, green,blue}) {};
24:     explicit rgbcolor (const string&);
25:     operator string() const;
26: };
27:
28: ostream& operator<< (ostream&, const rgbcolor&);
29:
30: extern const std::unordered_map<std::string,rgbcolor> color_names;
31:
32: #endif
33:
```

```
1: // $Id: rgbcolor.cpp,v 1.2 2019-02-28 15:24:20-08 - - $
2:
3: #include <cctype>
4: #include <iomanip>
5: #include <iostream>
6: #include <sstream>
7: #include <stdexcept>
8: #include <unordered_map>
9: #include <vector>
10: using namespace std;
11:
12: #include "rgbcolor.h"
13:
14: #include "colors.cppgen"
15:
16: rgbcolor::rgbcolor (const string& name) {
17:     auto entry = color_names.find (name);
18:     if (entry != color_names.end()) {
19:         *this = entry->second;
20:     }else {
21:         invalid_argument error ("rgbcolor::rgbcolor(" + name + ")");
22:         if (name.size() != 8) throw error;
23:         string prefix = name.substr (0, 2);
24:         if (not (prefix == "0x" or prefix == "0X")) throw error;
25:         for (size_t index = 0; index < 3; ++index) {
26:             string hex = name.substr (index * 2 + 2, 2);
27:             for (char digit: hex) if (not isxdigit(digit)) throw error;
28:             ubvec[index] = stoul (hex, nullptr, 16);
29:         }
30:     }
31: }
32:
33: rgbcolor::operator string() const {
34:     ostringstream result;
35:     result << "0x"
36:         << hex << setiosflags (ios::uppercase) << setfill ('0')
37:         << setw(2) << static_cast<unsigned> (rgb.red)
38:         << setw(2) << static_cast<unsigned> (rgb.green)
39:         << setw(2) << static_cast<unsigned> (rgb.blue);
40:     return result.str();
41: }
42:
43: ostream& operator<< (ostream& out, const rgbcolor& color) {
44:     out << string (color);
45:     return out;
46: }
47:
```

```
1: // $Id: shape.h,v 1.2 2016-05-04 16:26:26-07 - - $
2:
3: #ifndef __SHAPE_H__
4: #define __SHAPE_H__
5:
6: #include <iomanip>
7: #include <iostream>
8: #include <memory>
9: #include <utility>
10: #include <vector>
11: using namespace std;
12:
13: #include "rgbcolor.h"
14:
15: //
16: // Shapes constitute a single-inheritance hierarchy, summarized
17: // here, with the superclass listed first, and subclasses indented
18: // under their immediate superclass.
19: //
20: // shape
21: //   text
22: //   ellipse
23: //   circle
24: //   polygon
25: //   rectangle
26: //   square
27: //   diamond
28: //   triangle
29: //   right_triangle
30: //   isosceles
31: //   equilateral
32: //
33:
34: class shape;
35: struct vertex {GLfloat xpos; GLfloat ypos; };
36: using vertex_list = vector<vertex>;
37: using shape_ptr = shared_ptr<shape>;
38:
39: //
40: // Abstract base class for all shapes in this system.
41: //
42:
43: class shape {
44:     friend ostream& operator<< (ostream& out, const shape&);
45:     protected:
46:         inline shape(); // Only subclass may instantiate.
47:     public:
48:         shape (const shape&) = delete; // Prevent copying.
49:         shape& operator= (const shape&) = delete; // Prevent copying.
50:         shape (shape&&) = delete; // Prevent moving.
51:         shape& operator= (shape&&) = delete; // Prevent moving.
52:         virtual ~shape() {}
53:         virtual void draw (const vertex&, const rgbcolor&) const = 0;
54:         virtual void show (ostream&) const;
55: };
56:
```

```
57:
58: //
59: // Class for printing text.
60: //
61:
62: class text: public shape {
63:     protected:
64:         void* glut_bitmap_font = nullptr;
65:         // GLUT_BITMAP_8_BY_13
66:         // GLUT_BITMAP_9_BY_15
67:         // GLUT_BITMAP_HELVETICA_10
68:         // GLUT_BITMAP_HELVETICA_12
69:         // GLUT_BITMAP_HELVETICA_18
70:         // GLUT_BITMAP_TIMES_ROMAN_10
71:         // GLUT_BITMAP_TIMES_ROMAN_24
72:         string textdata;
73:     public:
74:         text (void* glut_bitmap_font, const string& textdata);
75:         virtual void draw (const vertex&, const rgbcolor&) const override;
76:         virtual void show (ostream&) const override;
77: };
78:
79: //
80: // Classes for ellipse and circle.
81: //
82:
83: class ellipse: public shape {
84:     protected:
85:         vertex dimension;
86:     public:
87:         ellipse (GLfloat width, GLfloat height);
88:         virtual void draw (const vertex&, const rgbcolor&) const override;
89:         virtual void show (ostream&) const override;
90: };
91:
92: class circle: public ellipse {
93:     public:
94:         circle (GLfloat diameter);
95: };
96:
97: //
98: // Class polygon.
99: //
100:
101: class polygon: public shape {
102:     protected:
103:         const vertex_list vertices;
104:     public:
105:         polygon (const vertex_list& vertices);
106:         virtual void draw (const vertex&, const rgbcolor&) const override;
107:         virtual void show (ostream&) const override;
108: };
109:
```

```
110:
111: //
112: // Classes rectangle, square, etc.
113: //
114:
115: class rectangle: public polygon {
116:     public:
117:         rectangle (GLfloat width, GLfloat height);
118: };
119:
120: class square: public rectangle {
121:     public:
122:         square (GLfloat width);
123: };
124:
125: class diamond: public polygon {
126:     public:
127:         diamond (const GLfloat width, const GLfloat height);
128: };
129:
130: ostream& operator<< (ostream& out, const shape&);
131:
132: #endif
133:
```

```
1: // $Id: shape.cpp,v 1.2 2019-02-28 15:24:20-08 - - $
2:
3: #include <typeinfo>
4: #include <unordered_map>
5: using namespace std;
6:
7: #include "shape.h"
8: #include "util.h"
9:
10: static unordered_map<void*,string> fontname {
11:     {GLUT_BITMAP_8_BY_13      , "Fixed-8x13"      },
12:     {GLUT_BITMAP_9_BY_15     , "Fixed-9x15"     },
13:     {GLUT_BITMAP_HELVETICA_10 , "Helvetica-10"   },
14:     {GLUT_BITMAP_HELVETICA_12 , "Helvetica-12"   },
15:     {GLUT_BITMAP_HELVETICA_18 , "Helvetica-18"   },
16:     {GLUT_BITMAP_TIMES_ROMAN_10, "Times-Roman-10"},
17:     {GLUT_BITMAP_TIMES_ROMAN_24, "Times-Roman-24"},
18: };
19:
20: static unordered_map<string,void*> fontcode {
21:     {"Fixed-8x13"      , GLUT_BITMAP_8_BY_13      },
22:     {"Fixed-9x15"     , GLUT_BITMAP_9_BY_15     },
23:     {"Helvetica-10"   , GLUT_BITMAP_HELVETICA_10 },
24:     {"Helvetica-12"   , GLUT_BITMAP_HELVETICA_12 },
25:     {"Helvetica-18"   , GLUT_BITMAP_HELVETICA_18 },
26:     {"Times-Roman-10", GLUT_BITMAP_TIMES_ROMAN_10},
27:     {"Times-Roman-24", GLUT_BITMAP_TIMES_ROMAN_24},
28: };
29:
30: ostream& operator<< (ostream& out, const vertex& where) {
31:     out << "(" << where.xpos << "," << where.ypos << ")";
32:     return out;
33: }
34:
35: shape::shape() {
36:     DEBUGF ('c', this);
37: }
38:
39: text::text (void* glut_bitmap_font_, const string& textdata_):
40:     glut_bitmap_font(glut_bitmap_font_), textdata(textdata_) {
41:     DEBUGF ('c', this);
42: }
43:
44: ellipse::ellipse (GLfloat width, GLfloat height):
45:     dimension ({width, height}) {
46:     DEBUGF ('c', this);
47: }
48:
49: circle::circle (GLfloat diameter): ellipse (diameter, diameter) {
50:     DEBUGF ('c', this);
51: }
52:
```



```
53:
54: polygon::polygon (const vertex_list& vertices_): vertices(vertices_) {
55:     DEBUGF ('c', this);
56: }
57:
58: rectangle::rectangle (GLfloat width, GLfloat height):
59:     polygon({}) {
60:     DEBUGF ('c', this << "(" << width << "," << height << ")");
61: }
62:
63: square::square (GLfloat width): rectangle (width, width) {
64:     DEBUGF ('c', this);
65: }
66:
67: void text::draw (const vertex& center, const rgbcolor& color) const {
68:     DEBUGF ('d', this << "(" << center << "," << color << ")");
69: }
70:
71: void ellipse::draw (const vertex& center, const rgbcolor& color) const {
72:     DEBUGF ('d', this << "(" << center << "," << color << ")");
73: }
74:
75: void polygon::draw (const vertex& center, const rgbcolor& color) const {
76:     DEBUGF ('d', this << "(" << center << "," << color << ")");
77: }
78:
79: void shape::show (ostream& out) const {
80:     out << this << "->" << demangle (*this) << ": ";
81: }
82:
83: void text::show (ostream& out) const {
84:     shape::show (out);
85:     out << glut_bitmap_font << "(" << fontname[glut_bitmap_font]
86:         << ") \'" << textdata << "\'";
87: }
88:
89: void ellipse::show (ostream& out) const {
90:     shape::show (out);
91:     out << "{" << dimension << "}";
92: }
93:
94: void polygon::show (ostream& out) const {
95:     shape::show (out);
96:     out << "{" << vertices << "}";
97: }
98:
99: ostream& operator<< (ostream& out, const shape& obj) {
100:     obj.show (out);
101:     return out;
102: }
103:
```

```
1: // $Id: debug.h,v 1.4 2018-01-25 16:04:38-08 - - $
2:
3: #ifndef __DEBUG_H__
4: #define __DEBUG_H__
5:
6: #include <bitset>
7: #include <climits>
8: #include <string>
9: using namespace std;
10:
11: // debug -
12: //      static class for maintaining global debug flags, each indicated
13: //      by a single character.
14: // setflags -
15: //      Takes a string argument, and sets a flag for each char in the
16: //      string. As a special case, '@', sets all flags.
17: // getflag -
18: //      Used by the DEBUGF macro to check to see if a flag has been set.
19: //      Not to be called by user code.
20:
21: class debugflags {
22:     private:
23:         using flagset = bitset<UCHAR_MAX + 1>;
24:         static flagset flags;
25:     public:
26:         static void setflags (const string& optflags);
27:         static bool getflag (char flag);
28:         static void where (char flag, const char* file, int line,
29:                             const char* pretty_function);
30: };
31:
```

```
32:
33: // DEBUGF -
34: //     Macro which expands into debug code.  First argument is a
35: //     debug flag char, second argument is output code that can
36: //     be sandwiched between <<.  Beware of operator precedence.
37: //     Example:
38: //         DEBUGF ('u', "foo = " << foo);
39: //     will print two words and a newline if flag 'u' is on.
40: //     Traces are preceded by filename, line number, and function.
41:
42: #ifdef NDEBUG
43: #define DEBUGF(FLAG, CODE) ;
44: #define DEBUGS(FLAG, STMT) ;
45: #else
46: #define DEBUGF(FLAG, CODE) { \
47:     if (debugflags::getflag (FLAG)) { \
48:         debugflags::where (FLAG, __FILE__, __LINE__, \
49:             __PRETTY_FUNCTION__); \
50:         cerr << CODE << endl; \
51:     } \
52: }
53: #define DEBUGS(FLAG, STMT) { \
54:     if (debugflags::getflag (FLAG)) { \
55:         debugflags::where (FLAG, __FILE__, __LINE__, \
56:             __PRETTY_FUNCTION__); \
57:         STMT; \
58:     } \
59: }
60: #endif
61:
62: #endif
63:
```

```
1: // $Id: debug.cpp,v 1.5 2019-03-19 15:53:52-07 - - $
2:
3: #include <climits>
4: #include <iostream>
5: #include <vector>
6:
7: using namespace std;
8:
9: #include "debug.h"
10: #include "util.h"
11:
12: debugflags::flagset debugflags::flags {};
13:
14: void debugflags::setflags (const string& initflags) {
15:     for (const unsigned char flag: initflags) {
16:         if (flag == '@') flags.set();
17:         else flags.set (flag, true);
18:     }
19: }
20:
21: // getflag -
22: //     Check to see if a certain flag is on.
23:
24: bool debugflags::getflag (char flag) {
25:     // WARNING: Don't TRACE this function or the stack will blow up.
26:     return flags.test (static_cast<unsigned char> (flag));
27: }
28:
29: void debugflags::where (char flag, const char* file, int line,
30:                        const char* pretty_function) {
31:     cout << sys_info::execname() << ": DEBUG(" << flag << ") "
32:          << file << "[" << line << "]" << endl
33:          << pretty_function << endl;
34: }
35:
```

```
1: // $Id: util.h,v 1.2 2016-05-04 16:26:26-07 - - $
2:
3: //
4: // util -
5: //     A utility class to provide various services not conveniently
6: //     included in other modules.
7: //
8:
9: #ifndef __UTIL_H__
10: #define __UTIL_H__
11:
12: #include <iostream>
13: #include <sstream>
14: #include <stdexcept>
15: #include <string>
16: #include <vector>
17: using namespace std;
18:
19: #include "debug.h"
20:
21: //
22: // sys_info -
23: //     Keep track of execname and exit status. Must be initialized
24: //     as the first thing done inside main. Main should call:
25: //         sys_info::execname (argv[0]);
26: //     before anything else.
27: //
28:
29: class sys_info {
30:     friend int main (int argc, char** argv);
31:     private:
32:         static string execname_;
33:         static int exit_status_;
34:         static void execname (const string& argv0);
35:     public:
36:         sys_info() = delete;
37:         static const string& execname();
38:         static void exit_status (int status);
39:         static int exit_status();
40: };
41:
42: //
43: // datestring -
44: //     Return the current date, as printed by date(1).
45: //
46:
47: const string datestring();
48:
```

```
49:
50: //
51: // split -
52: //     Split a string into a vector<string>.. Any sequence
53: //     of chars in the delimiter string is used as a separator. To
54: //     Split a pathname, use "/". To split a shell command, use " ".
55: //
56:
57: vector<string> split (const string& line, const string& delimiter);
58:
59: //
60: // complain -
61: //     Used for starting error messages. Sets the exit status to
62: //     EXIT_FAILURE, writes the program name to cerr, and then
63: //     returns the cerr ostream. Example:
64: //         complain() << filename << ": some problem" << endl;
65: //
66:
67: ostream& complain();
68:
69: //
70: // syscall_error -
71: //     Complain about a failed system call. Argument is the name
72: //     of the object causing trouble. The extern errno must contain
73: //     the reason for the problem.
74: //
75:
76: void syscall_error (const string&);
77:
78: //
79: // operator<< (vector) -
80: //     An overloaded template operator which allows vectors to be
81: //     printed out as a single operator, each element separated from
82: //     the next with spaces. The item_t must have an output operator
83: //     defined for it.
84: //
85:
86: template <typename item_t>
87: ostream& operator<< (ostream& out, const vector<item_t>& vec);
88:
```

```
89:
90: //
91: // operator<< (pair<iterator,iterator>) -
92: //     Allow a pair of iterators to be passed in and print all of the
93: //     values between the begin and end pair.
94: //
95:
96: template <typename iterator>
97: ostream& operator<< (ostream& out, pair<iterator,iterator> range);
98:
99: //
100: // string to_string (thing) -
101: //     Convert anything into a string if it has an ostream<< operator.
102: //
103:
104: template <typename type>
105: string to_string (const type&);
106:
107: //
108: // thing from_string (const string&) -
109: //     Scan a string for something if it has an istream>> operator.
110: //
111:
112: template <typename result_t>
113: result_t from_string (const string&);
114:
115: //
116: // Demangle a C++ class name.
117: //
118: template <typename type>
119: string demangle (const type& object);
120:
121: #include "util.tcc"
122: #endif
123:
124:
```

```
1: // $Id: util.tcc,v 1.2 2016-05-04 16:26:26-07 - - $
2:
3: #include <memory>
4:
5: template <typename item_t>
6: ostream& operator<< (ostream& out, const vector<item_t>& vec) {
7:     bool want_space = false;
8:     for (const auto& item: vec) {
9:         if (want_space) cout << " ";
10:        out << item;
11:        want_space = true;
12:    }
13:    return out;
14: }
15:
16: template <typename iterator>
17: ostream& operator<< (ostream& out, pair<iterator,iterator> range) {
18:     bool want_space = false;
19:     while (range.first != range.second) {
20:         if (want_space) cout << " ";
21:         out << *range.first++;
22:         want_space = true;
23:     }
24:     return out;
25: }
26:
27:
28: template <typename item_t>
29: string to_string (const item_t& that) {
30:     ostringstream stream;
31:     stream << that;
32:     return stream.str();
33: }
34:
35: template <typename item_t>
36: item_t from_string (const string& that) {
37:     stringstream stream;
38:     stream << that;
39:     item_t result;
40:     if (not (stream >> result and stream.eof())) {
41:         throw range_error (demangle (result)
42:             + " from_string (" + that + ")");
43:     }
44:     return result;
45: }
46:
```



```
47:
48: //
49: // Demangle a class name.
50: // For __GNUC__, use __cxa_demangle.
51: // As a fallback, just use typeid.name()
52: // The functions are fully specified in this header as non-inline
53: // functions in order to avoid the need for explicit instantiation.
54: // http://gcc.gnu.org/onlinedocs/libstdc++/manual/ext\_demangling.html
55: //
56: #ifdef __GNUC__
57:
58: #include <cxxabi.h>
59:
60: template <typename type>
61: string demangle (const type& object) {
62:     const char* const name = typeid (object).name();
63:     int status {0};
64:     using deleter = void (*) (void*);
65:     unique_ptr<char,deleter> result {
66:         abi::__cxa_demangle (name, nullptr, nullptr, &status),
67:         std::free,
68:     };
69:     return status == 0 ? result.get() : name;
70: }
71:
72: #else
73:
74: template <typename type>
75: string demangle (const type& object) {
76:     return typeid (object).name();
77: }
78:
79: #endif
80:
```

```
1: // $Id: util.cpp,v 1.1 2015-07-16 16:47:51-07 - - $
2:
3: #include <cerrno>
4: #include <cstdlib>
5: #include <cstring>
6: #include <ctime>
7: #include <sstream>
8: #include <stdexcept>
9: #include <string>
10: #include <typeinfo>
11: using namespace std;
12:
13: #include "util.h"
14:
15: int sys_info::exit_status_ = EXIT_SUCCESS;
16: string sys_info::execname_; // Must be initialized from main().
17:
18: void sys_info_error (const string& condition) {
19:     throw logic_error ("main() has " + condition
20:         + " called sys_info::execname()");
21: }
22:
23: void sys_info::execname (const string& argv0) {
24:     if (execname_.size() != 0) sys_info_error ("already");
25:     int slashpos = argv0.find_last_of ('/') + 1;
26:     execname_ = argv0.substr (slashpos);
27:     cout << boolalpha;
28:     cerr << boolalpha;
29:     DEBUGF ('u', "execname = " << execname_);
30: }
31:
32: const string& sys_info::execname() {
33:     if (execname_.size() == 0) sys_info_error ("not yet");
34:     return execname_;
35: }
36:
37: void sys_info::exit_status (int status) {
38:     if (execname_.size() == 0) sys_info_error ("not yet");
39:     exit_status_ = status;
40: }
41:
42: int sys_info::exit_status() {
43:     if (execname_.size() == 0) sys_info_error ("not yet");
44:     return exit_status_;
45: }
46:
47: const string datestring() {
48:     time_t clock = time (NULL);
49:     struct tm* tm_ptr = localtime (&clock);
50:     char timebuf[128];
51:     strftime (timebuf, sizeof timebuf,
52:         "%a %b %e %H:%M:%S %Z %Y", tm_ptr);
53:     return timebuf;
54: }
55:
```

```
56:
57: vector<string> split (const string& line, const string& delimiters) {
58:     vector<string> words;
59:     int end = 0;
60:     for (;;) {
61:         size_t start = line.find_first_not_of (delimiters, end);
62:         if (start == string::npos) break;
63:         end = line.find_first_of (delimiters, start);
64:         words.push_back (line.substr (start, end - start));
65:     }
66:     DEBUGF ('u', words);
67:     return words;
68: }
69:
70: ostream& complain() {
71:     sys_info::exit_status (EXIT_FAILURE);
72:     cerr << sys_info::execname() << ": ";
73:     return cerr;
74: }
75:
76: void syscall_error (const string& object) {
77:     complain() << object << ": " << strerror (errno) << endl;
78: }
79:
```

```
1: // $Id: main.cpp,v 1.3 2019-05-15 18:02:12-07 - - $
2:
3: #include <fstream>
4: #include <iostream>
5: #include <unistd.h>
6: #include <vector>
7: using namespace std;
8:
9: #include "debug.h"
10: #include "graphics.h"
11: #include "interp.h"
12: #include "util.h"
13:
14: //
15: // Parse a file. Read lines from input file, parse each line,
16: // and interpret the command.
17: //
18:
19: void parsefile (const string& infilename, istream& infile) {
20:     interpreter::shape_map shapemap;
21:     interpreter interp;
22:     for (int linenr = 1;; ++linenr) {
23:         try {
24:             string line;
25:             getline (infile, line);
26:             if (infile.eof()) break;
27:             if (line.size() == 0) continue;
28:             for (;;) {
29:                 DEBUGF ('m', line);
30:                 int last = line.size() - 1;
31:                 if (line[last] != '\\') break;
32:                 line[last] = ' ';
33:                 string contin;
34:                 getline (infile, contin);
35:                 if (infile.eof()) break;
36:                 line += contin;
37:             }
38:             interpreter::parameters words = split (line, " \t");
39:             if (words.size() == 0 or words.front()[0] == '#') continue;
40:             DEBUGF ('m', words);
41:             interp.interpret (words);
42:         } catch (runtime_error& error) {
43:             complain() << infilename << ":" << linenr << ": "
44:                 << error.what() << endl;
45:         }
46:     }
47:     DEBUGF ('m', infilename << " EOF");
48: }
49:
```

```
50:
51: //
52: // Scan the option -@ and check for operands.
53: //
54:
55: void scan_options (int argc, char** argv) {
56:     opterr = 0;
57:     for (;;) {
58:         int option = getopt (argc, argv, "@:w:h:");
59:         if (option == EOF) break;
60:         switch (option) {
61:             case '@':
62:                 debugflags::setflags (optarg);
63:                 break;
64:             case 'w':
65:                 window::setwidth (stoi (optarg));
66:                 break;
67:             case 'h':
68:                 window::setheight (stoi (optarg));
69:                 break;
70:             default:
71:                 complain() << "-" << char (optopt) << ": invalid option"
72:                     << endl;
73:                 break;
74:         }
75:     }
76: }
77:
78: //
79: // Main function. Iterate over files if given, use cin if not.
80: //
81: int main (int argc, char** argv) {
82:     sys_info::execname (argv[0]);
83:     scan_options (argc, argv);
84:     vector<string> args (&argv[optind], &argv[argc]);
85:     if (args.size() == 0) {
86:         parsefile ("-", cin);
87:     } else if (args.size() > 1) {
88:         cerr << "Usage: " << sys_info::execname() << "-@flags"
89:             << "[filename]" << endl;
90:     } else {
91:         const string infilename = args[0];
92:         ifstream infile (infilename.c_str());
93:         if (infile.fail()) {
94:             syscall_error (infilename);
95:         } else {
96:             DEBUGF ('m', infilename << "(opened OK)");
97:             parsefile (infilename, infile);
98:             // fstream objects auto closed when destroyed
99:         }
100:     }
101:     int status = sys_info::exit_status();
102:     if (status != 0) return status;
103:     window::main();
104:     return 0;
105: }
106:
```

```
1: #!/usr/bin/perl
2: # $Id: mk-colors.perl,v 1.1 2015-07-16 16:47:51-07 - - $
3: use strict;
4: use warnings;
5:
6: my %colors;
7: my $file = "/usr/share/X11/rgb.txt";
8: open RGB_TXT, "<$file" or die "$0: $file: $!";
9: while (my $line = <RGB_TXT>) {
10:     $line =~ m/^\s*(\d+)\s+(\d+)\s+(\d+)\s+(.*)/
11:         or die "$0: invalid line: $line";
12:     my ($red, $green, $blue, $name) = ($1, $2, $3, $4);
13:     $name =~ s/\s+/-/g;
14:     $colors{$name} = [$red, $green, $blue];
15: }
16: close RGB_TXT;
17:
18: print "// Data taken from source file $file\n";
19: print "const unordered_map<string,rgbcolor> color_names = {\n";
20: printf "    {%-24s, rgbcolor (%3d, %3d, %3d)},\n",
21:         "\"$_\"", @{$colors{$_}}
22:     for sort {lc $a cmp lc $b} keys %colors;
23: print "};\n";
24:
```

```
1: # $Id: Makefile,v 1.16 2019-08-01 15:33:38-07 - - $
2:
3: MKFILE      = Makefile
4: DEFPFILE    = ${MKFILE}.dep
5: NOINCL      = ci clean spotless
6: NEEDINCL    = ${filter ${NOINCL}, ${MAKECMDGOALS}}
7: GMAKE       = ${MAKE} --no-print-directory
8:
9: GPPWARN      = -Wall -Wextra -Wpedantic -Wshadow -Wold-style-cast
10: GPPOPTS     = ${GPPWARN} -fdiagnostics-color=never
11: COMPILECPP  = g++ -std=gnu++17 -g -O0 ${GPPOPTS}
12: MAKEDEPCPP  = g++ -std=gnu++17 -MM ${GPPOPTS}
13: MESALIB     = /usr/local/android-sdk/emulator/lib64/gles_mesa
14: #LINKOPTS   = -Wl,-rpath,${MESALIB}
15: LINKOPTS    =
16: UTILBIN     = /afs/cats.ucsc.edu/courses/cmpls109-wm/bin
17:
18: MODULES     = graphics interp rgbcolor shape debug util main
19: CPPSOURCE   = $(wildcard ${MODULES:=.cpp})
20: GENFILES    = colors.cppgen
21: MODFILES    = ${foreach MOD, ${MODULES}, ${MOD}.h ${MOD}.tcc ${MOD}.cpp}
22: SOURCES     = ${wildcard ${MODFILES}}
23: OTHERS      = mk-colors.perl ${MKFILE} ${DEFPFILE}
24: ALLSOURCES  = ${SOURCES} ${OTHERS}
25: EXECBIN     = gdraw
26: OBJECTS     = ${CPPSOURCE:.cpp=.o}
27: LINKLIBS    = -lGL -lGLU -lglut -ldrm -lm
28: LISTING     = Listing.ps
29:
30: all : ${EXECBIN}
31:
32: ${EXECBIN} : ${OBJECTS}
33:     ${COMPILECPP} ${LINKOPTS} -o $@ ${OBJECTS} ${LINKLIBS}
34:
35: %.o : %.cpp
36:     ${COMPILECPP} -c $<
37:     - ${UTILBIN}/checksource $<
38:     - ${UTILBIN}/cpplint.py.perl $<
39:
40: colors.cppgen: mk-colors.perl
41:     mk-colors.perl >colors.cppgen
42:
43: ci : ${ALLSOURCES}
44:     ${UTILBIN}/cid + ${ALLSOURCES}
45:     - ${UTILBIN}/checksource ${ALLSOURCES}
46:
47: lis : ${ALLSOURCES}
48:     - pkill -g 0 gv || true
49:     ${UTILBIN}/mkpspdf ${LISTING} ${ALLSOURCES}
50:
51: clean :
52:     - rm ${OBJECTS} ${DEFPFILE} core ${GENFILES}
53:
54: spotless : clean
55:     - rm ${EXECBIN} ${LISTING} ${LISTING:.ps=.pdf}
56:
```

```
57:
58: dep : ${CPPSOURCE} ${GENFILES}
59:     @ echo "# ${DEPFILE} created `LC_TIME=C date`" >${DEPFILE}
60:     ${MAKEDEPCPP} ${CPPSOURCE} >>${DEPFILE}
61:
62: ${DEPFILE} :
63:     @ touch ${DEPFILE}
64:     ${GMAKE} dep
65:
66: again :
67:     ${GMAKE} spotless dep ci all lis
68:
69: ifeq (${NEEDINCL}, )
70: include ${DEPFILE}
71: endif
72:
```



```
1: # Makefile.dep created Thu Aug  1 15:40:04 PDT 2019
2: graphics.o: graphics.cpp graphics.h rgbcolor.h shape.h util.h debug.h \
3:   util.tcc
4: interp.o: interp.cpp debug.h interp.h graphics.h rgbcolor.h shape.h \
5:   util.h util.tcc
6: rgbcolor.o: rgbcolor.cpp rgbcolor.h colors.cppgen
7: shape.o: shape.cpp shape.h rgbcolor.h util.h debug.h util.tcc
8: debug.o: debug.cpp debug.h util.h util.tcc
9: util.o: util.cpp util.h debug.h util.tcc
10: main.o: main.cpp debug.h graphics.h rgbcolor.h shape.h interp.h util.h \
11:   util.tcc
```