CSE 142
Computer Programming I

Functions and Design

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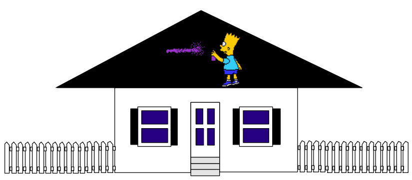
Overview

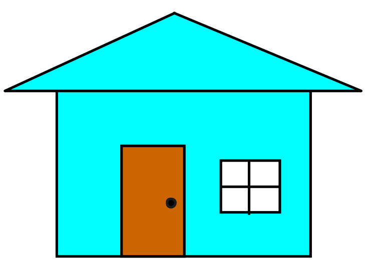
Design process
Functional decomposition
Top down vs. bottom up
Graphics primitives

Drawing a House

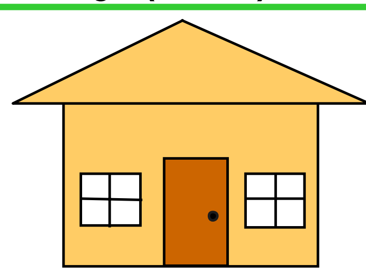


Drawing a House

Drawing a House



Drawing a (Similar) House

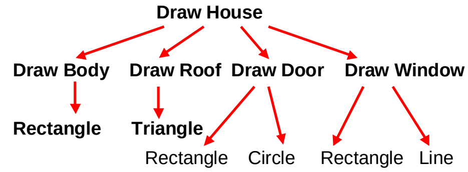


Draw House (Pseudo-code)

draw_house (color, ll_x, ll_y, num_windows)
  draw body as a colored rectangle
  draw roof as a colored triangle
  if num_windows is one
    draw door
    draw window
  if num_windows is two
    draw door
    draw window
    draw window

L-7

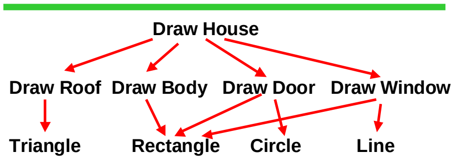
Functional Decomposition



This is a "calling tree" or "static call graph." Each function is shown, with an arrow down to each function called.

L-8

Functional Decomposition



Each function shown only once (preferred)

L-9

Analysis to Design to Programming

Analyze the problem

Then design a "big-picture" solution

- A functional decomposition shows how the pieces fit together

Then design individual functions

- May depend on low-level ("primitive") functions available

Final programming may be very detailed

L-10

Top Down vs. Bottom Up

Sometimes designers start from the big picture

- Gradually work down to smaller pieces and then to fine details
- Called the “top down approach”

Sometimes people start with small pieces

- Figure out how they can fit together pieces to solve ever larger and larger problems
- Called the “bottom up approach”

L-11

Top Down or Bottom Up?

Which approach are we following with DrawHouse?

Answer: Generally, top down. But we have to look ahead and know what low level functions will be available

Eventually, there will be graphics programming to do. Fortunately, most systems supply a library of graphics “primitives”

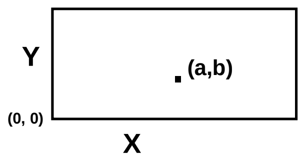
L-12

Graphics Primitive

Typical functions: clearscreen, draw circle, rectangle, line, ellipse, etc.

Typical parameters: location, color, fill, etc.

Requires a coordinate system

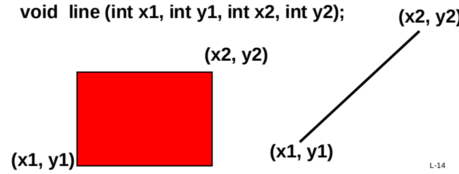


L-13

Typical 'rectangle' and 'line'

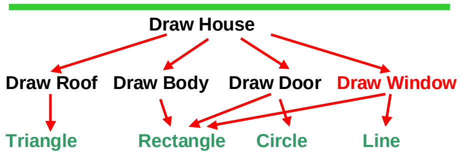
void
rectangle (int color, int x1, int y1, int x2, int y2);

void line (int x1, int y1, int x2, int y2);



L-14

Big Picture Again

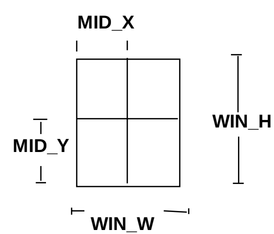


Fill in the pieces one at a time

L-15

Window Constants

Our analysis of how to describe a window



L-16

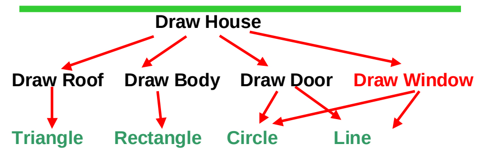
Map Analysis to C Code

Identify and declare constants
Choose parameters
Utilize primitives
Get the picky details right, too!

```
void draw_window(int x, int y)
    /* (x,y) is the lower left corner of the window */
{
    rectangle( WHITE,  x, y,  x + WIN_W, y + WIN_H);
    line( x+MID_X, y,    x + MID_X,   y + WIN_H);
    line( x,y + MID_Y,   x + WIN_W,  y + MID_Y);
}
```

L-17

Keep Filling in Pieces



Analyze and code remaining functions

Does the order matter?

- Coding could be bottom-up, even if design was top-down, and vice-versa
- If the design is good, the functions can be implemented independently

L-18

Draw House (Gory Detail I)

```
void draw_house (int color, int ll_x,
                 int ll_y, int windows)
{
    int roof_ll_x, roof_ll_y ;

    /* Draw Body */
    draw_body (color, ll_x, ll_y) ;

    /* Draw Roof */
    roof_ll_x = ll_x - OVERHANG ;
    roof_ll_y = ll_y + BODY_HEIGHT ;
    draw_roof (color, roof_ll_x , roof_ll_y) ;
```

L-19

Draw House (Gory Detail II)

```
    if (windows == 1)
    {
        draw_door (ll_x + DOOR_OFFSET_1, ll_y) ;
        draw_window (ll_x + WINDOW_OFFSET_1,
                     ll_y + WINDOW_RAISE) ;
    }
    else if (windows == 2)
    {
        draw_door (ll_x + DOOR_OFFSET_2, ll_y) ;
        draw_window (ll_x + WINDOW_OFFSET_2A,
                     ll_y + WINDOW_RAISE) ;
        draw_window (ll_x + WINDOW_OFFSET_2B,
                     ll_y + WINDOW_RAISE) ;
    }
}
```

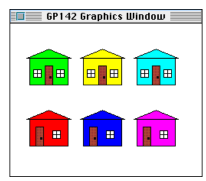
L-20

Draw House (gory details)

```
void draw_house (int color, int ll_x,
                 int ll_y, int windows)
{
    int roof_ll_x, roof_ll_y ;

    /* Draw Body */
    draw_body (color, ll_x, ll_y) ;

    /* Draw Roof */
    roof_ll_x = ll_x - OVERHANG ;
    roof_ll_y = ll_y + BODY_HEIGHT ;
    draw_roof (color, roof_ll_x , roof_ll_y) ;

    /* Draw Door and Window(s) */
    if (windows == 1)
    {
        draw_door (ll_x + DOOR_OFFSET_1, ll_y) ;
        draw_window (ll_x + WINDOW_OFFSET_1,
                     ll_y + WINDOW_RAISE) ;
    }
    else if (windows == 2)
    {
        draw_door (ll_x + DOOR_OFFSET_2, ll_y) ;
        draw_window (ll_x + WINDOW_OFFSET_2A,
                     ll_y + WINDOW_RAISE) ;
        draw_window (ll_x + WINDOW_OFFSET_2B,
                     ll_y + WINDOW_RAISE) ;
    }
}
```

L-21

Next Step: A Neighborhood



We could write 6 different functions...

Smarter - call 1 function 6 times...

L-22

Summary of Functional Decomposition

Look for **common elements** (similarities)

Parameterize for **special features** (differences)

Determine which functions will **use** others

Draw a graph to show their relationships

L-23