CS 349 - User Interfaces **Winter 2018**

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5.1 Events

5.1.1 Event Driven Programming

In event driven programming nothing happens unless some other event occurs first. i.e

- User presses a key,
- User moves the mouse
- Window is resized/closed/covered
- Timer expires

5.1.1.1 Events Defined

- English : An observable occurrence, often extraordinary occurrence
- User Interface Architecture : A message to notify an application that something happened
- Examples
  - Keyboard
  - Pointer Events
  - Window crossing
  - Input focus
  - Window events
  - Timer

5.1.1.2 Role of the Base Window System

- Collect event information
- Put relevant information in a known structure
- Order teh events by time
- Decide which application/window should get event
- Deliver the event
- Some events come from teh user via the underlying hardware; some from the window manager

5.1.1.3 Receiving events

- In X windows, applications get the next event using : `XNextEvent(Display* display, XEvent* evt)`
  - Gets and removes teh next event in the queue
  - **If empty, it blocks until another event arrives**
- To avoid blocking you can use `XPending(Display* display)`

5.1.1.4 Selecting input events to listen to

Selecting Input Events to "listen to"

```
// Tell the window manager what input events you want.
XSelectInput( display, window,
              ButtonPressMask | KeyPressMask |
              ButtonMotionMask );
```

- Defined masks:

  ```
  NoEventMask, KeyPressMask, KeyReleaseMask,
  ButtonPressMask, ButtonReleaseMask, EnterWindowMask,
  LeaveWindowMask, PointerMotionMask,
  PointerMotionHintMask, Button1MotionMask,
  Button2MotionMask, ..., ButtonMotionMask,
  KeymapStateMask, ExposureMask, VisibilityChangeMask,
  ...
  ```

- See
  - http://www.tronche.com/gui/x/xlib/events/types.html
  - http://www.tronche.com/gui/x/xlib/events/mask.html

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5.1.1.5 Event Structure

- X uses a union

```
typedef union {
   int type;
   XKeyEvent xkey;
   XButtonEvent xbutton;
   XMotionEvent xmotion;
   // etc. ...
} XEvent;
```

- Each structure contains at least the following

```
typedef struct {
   int type;
   unsigned long serial;  // sequential #
   Bool send_end;   // from SendEvent request?
   Display* display; // display event was read from
   Window window; // window which event is relative to
} X___Event;
```

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5.1.2 Animation

Animation is the simulation of movement created by displaying a series of pictures, or frames

Animation Timing and Responding to Events (non-blocking)

```
while( true ) {

   if (XPending(display) > 0) { // any events pending?
      XNextEvent(display, &event ); // yes, process them
      switch( event.type ) {
        // handle event cases here ...
      }
   }

   // now() is a helper function I made
   unsigned long end = now(); // time in microseconds

   if (end - lastRepaint > 1000000/FPS) { // repaint at FPS
      handleAnimation(xinfo); // update animation objects
      repaint(xinfo); // my repaint
      lastRepaint = now(); // remember when the paint happened
   }

   // IMPORTANT: sleep for a bit to let other processes work
   if (XPending(xinfo.display) == 0) {
      usleep(1000000 / FPS - (end - lastRepaint));
   }
}
```

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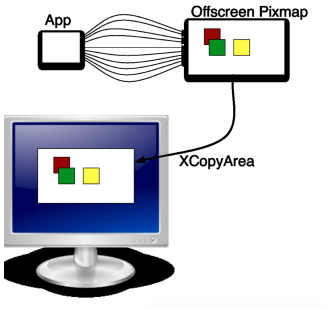
5.1.3 Double Buffering

Flickering can occur when an intermediate image is on the display. To resolve this we can use double buffering, which involves rendering images off screen to a buffer and then fast copying the buffer to the screen



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5.1.4 Painting Advice

- Keep it simple
  - Clear everything and redraw each frame
  - Use advanced methods, only if you really need them for performance
- Don't repaint too often. Consider adding a "someChanged" bool flag
- Don't flush too often