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Operating Systems CSE460

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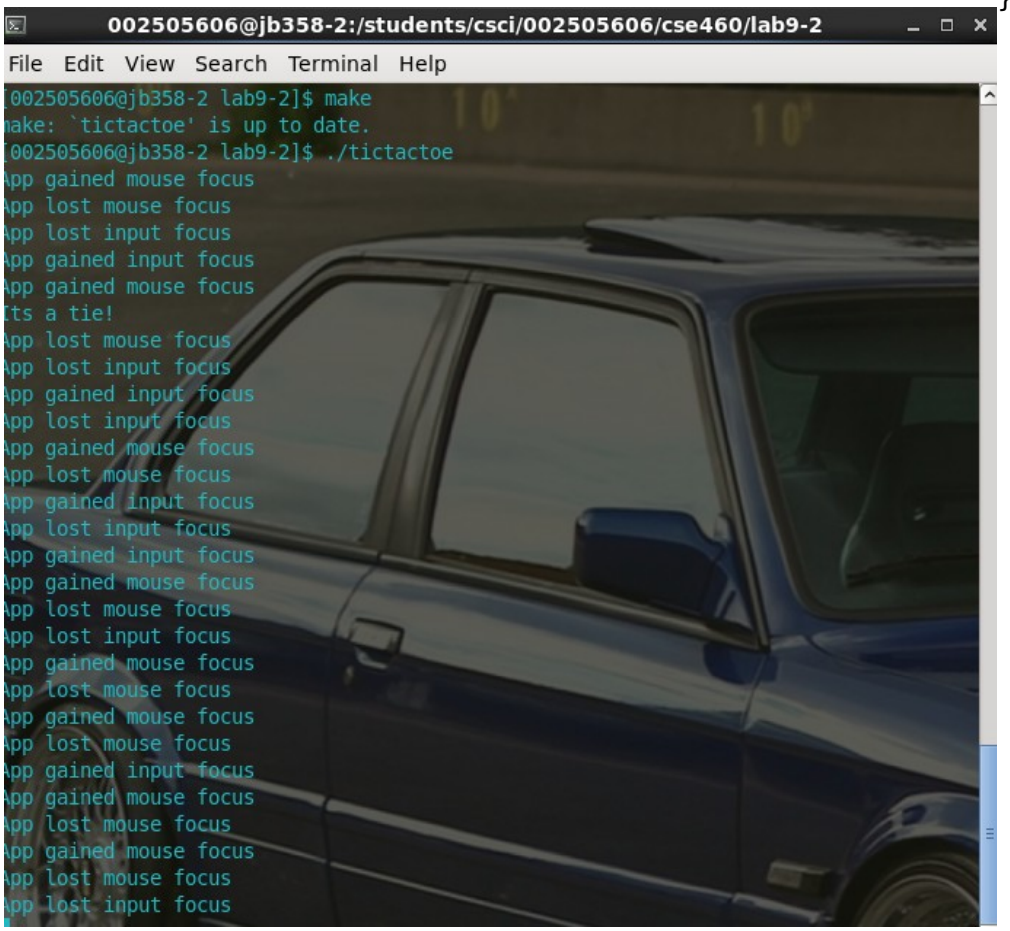
Lab #9

1. We finished all parts of the lab, and completed the entire lab and will give ourselves full credit.

```
#include <SDL/SDL.h>
#include <SDL/SDL_thread.h>
#include <stdlib.h>
#include <stdio.h>
#include <deque>
#include "surface.h"
#include "io_threads.h"
#include "sound.h"

using namespace std;
SDL_mutex *key_mutex;           //mutex for accessing key queues
SDL_mutex *mouse_mutex;         //mutex for accessing mouse queues

extern deque<Point>mouseq;      //queue to save mouse coordinates
extern bool quit;               //defined in io_threads.cpp to signal all threads
to quit

int main()
{
    SDL_Surface *screen;

    const int VWIDTH = 640;
    const int VHEIGHT = 480;

    Surface surf( VWIDTH, VHEIGHT, "Tic-tac-toe" );
    SDL_SetEventFilter ( FilterEvents );

    //create mutexes for accessing key queues and mouse queue
    key_mutex = SDL_CreateMutex();
    mouse_mutex = SDL_CreateMutex();

    if ( key_mutex == NULL )
        printf( "Failed to create key_mutex!\n");
    if ( mouse_mutex == NULL )
        printf( "Failed to create mouse_mutex!\n" );

    SDL_Thread *kthread, *mthread, *gthread, *sthread;
    kthread = SDL_CreateThread( key_thread, NULL);
    mthread = SDL_CreateThread( mouse_thread, NULL);
    gthread = SDL_CreateThread( game_thread, &surf );
    sthread = SDL_CreateThread( sound_thread, &surf );

    while( !quit ) {            //keep updating screen until some thread wants to
quit
```

```
      SDL_PumpEvents();
      if ( SDL_PeepEvents ( NULL, 0, SDL_PEEKEVENT, SDL_QUITMASK) ) {
        break;
      }

      //Update the screen
      surf.updateSurface();
      SDL_Delay(20);            //give up some CPU time
   }

    //don't exit until all threads are done
    SDL_WaitThread(  mthread, NULL );
    SDL_WaitThread(  kthread, NULL );
    SDL_WaitThread(  gthread, NULL );
    SDL_WaitThread(  sthread, NULL );

    //release the resources
    SDL_DestroyMutex ( mouse_mutex );
    SDL_DestroyMutex ( key_mutex );
    return 0;
                                                                    }
```




```
#include "SDL/SDL.h"
#include "SDL/SDL_image.h"
#include "SDL/SDL_mixer.h"
#include "SDL/SDL_thread.h"
#include <string>
#include <iostream>
```

```
#include <stdlib.h>
#include <vector>               //STL library
#include <deque>                //STL Library
#include "surface.h"
#include "point.h"
#include "sound.h"

using namespace std;

extern dequekeyq;               //a queue to save values of keys pressed
extern dequemouseq;     //queue to save mouse coordinates
extern dequenumq;               //queue to save digits
extern bool quit;               //global variable to quit game
extern SDL_mutex *key_mutex;    //mutex to lock key variables
extern SDL_mutex *mouse_mutex;  //mutext to lock mouse variables

bool game_over = false;         //shared with sound_thread

//parameters for figure #
const int x0 = 20, y0 = 20;
const int dx = 50, dy = 50, len = 150;
const int xLEFT = x0 + dx;
const int xRIGHT = x0 + 2*dx;
const int yTOP = y0 + dy;
const int yBOTTOM = y0 + 2*dy;

//centers for drawing crosses or circles on #
Point draw_centers[9] = {
    Point ( x0,  y0  ), Point(  x0 + dx, y0  ), Point ( x0 + 2*dx, y0  ),
    Point ( x0,  y0+dy ), Point(  x0+dx, y0 + dy ), Point ( x0 + 2*dx, y0 + dy ),
    Point ( x0,  y0+2*dy ), Point(  x0+dx, y0 + 2*dy ), Point ( x0+2*dx, y0
+2*dy )
};

/*
  Given 'start' and 'x', find the quadrant number.
  The first row starts at 0, second row at 3 and third row at 6.
*/
int check_x ( int start, int x )
{
  if ( x <= xLEFT )
    return start;
  else if ( x <= xRIGHT )
    return start + 1;
  else
    return start + 2;

  return 0;
}

//check which quadrant the point is in
int check_quadrant ( Point p )
{
  if ( p.y <= yTOP )            //in either quadrant 0, 1, or 2
    return  check_x ( 0, p.x );
  else if ( p.y <= yBOTTOM )    //in either 3, 4, or 5
    return check_x ( 3, p.x );
  else                          //in either 7, 7, or 8
```

```
    return check_x ( 6, p.x );
}

//load an image on 'screen' at 'center'
int load_image (   SDL_Surface *screen, char *image_name, Point center )
{
  SDL_Surface *image;
  SDL_Rect source, offset;

  image = IMG_Load(  image_name );
  if ( image == NULL ) {
    cout << "Unable to load image\n";
    return 1;
  }
  source.x = 0;
  source.y = 0;
  source.w = image->w;
  source.h = image->h;
  offset.x = center.x;
  offset.y = center.y;
  offset.w = image->w;
  offset.h = image->h;
  SDL_BlitSurface ( image, &source, screen, &offset );
}

/*
 * Some of the following are copied from Sun's Java Tic Tac Toe demo program
 * In this game a position is represented by a white and black
 * bitmask. A bit is set if a position is occupied. There are
 * 9 squares so there are 1<<9 possible positions for each
 * side. An array of 1<<9 booleans is created, it marks
 * all the winning positions.
*/

/**
 * White's current position. The computer is white.
 */
int white;

/**
 * Black's current position. The user is black.
 */
int black;

/**
 * The squares in order of importance...
 */
const int moves[] = {4, 0, 2, 6, 8, 1, 3, 5, 7};

/**
 * The winning positions.
 */
bool won[512];
const int DONE = (1 << 9) - 1;
const int OK = 0;
const int WIN = 1;
const int LOSE = 2;
const int STALEMATE = 3;
```

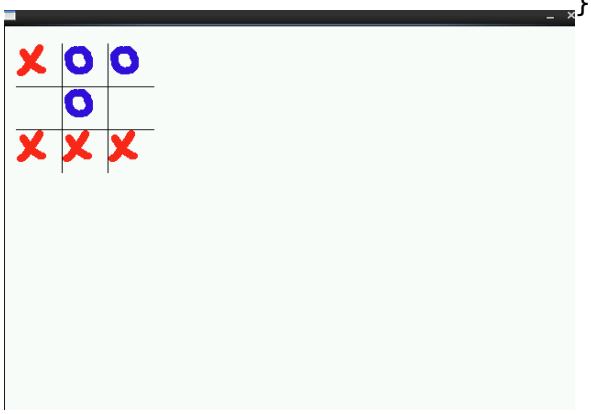
```
/**
 * Mark all positions with these bits set as winning.
 */
void isWon(int pos) {
  for (int i = 0 ; i < DONE ; i++) {
    if ((i & pos) == pos) {
      won[i] = true;
    }
   }
}

/**
 * Initialize all winning positions.
 */
void init_win () {
  for ( int i = 0; i <= DONE; i++ )     //reset all positions
    won[i] = false;
  isWon((1 << 0) | (1 << 1) | (1 << 2));
  isWon((1 << 3) | (1 << 4) | (1 << 5));
  isWon((1 << 6) | (1 << 7) | (1 << 8));
  isWon((1 << 0) | (1 << 3) | (1 << 6));
  isWon((1 << 1) | (1 << 4) | (1 << 7));
  isWon((1 << 2) | (1 << 5) | (1 << 8));
  isWon((1 << 0) | (1 << 4) | (1 << 8));
  isWon((1 << 2) | (1 << 4) | (1 << 6));
}

/**
 * Compute the best move for white.
 * return the square to take
 */
int bestMove(int white, int black) {
  int bestmove = -1;

loop:
  for (int i = 0 ; i < 9 ; i++) {
    bool continue1 = false;
    int mw = moves[i];
    if (((white & (1 << mw)) == 0) && ((black & (1 << mw)) == 0)) {
      int pw = white | (1 << mw);
      if (won[pw]) {
        // white wins, take it!
        return mw;
      }
      for (int mb = 0 ; mb < 9 ; mb++) {
        if (((pw & (1 << mb)) == 0) && ((black & (1 << mb)) == 0)) {
          int pb = black | (1 << mb);
          if (won[pb]) {
            // black wins, take another
            //continue loop;
            continue1 = true;
            continue;
          }
        } //if pw
      }// for mb
      if ( continue1 ) continue;
      // Neither white nor black can win in one move, this will do.
```

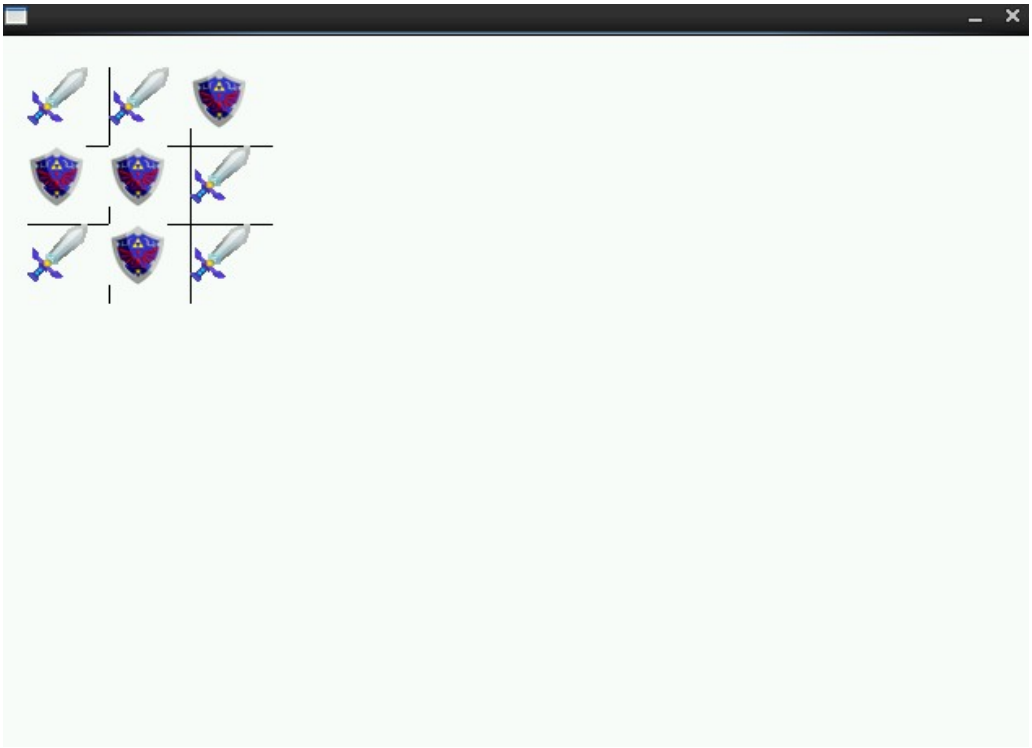
```
      if (bestmove == -1) {
        bestmove = mw;
      }
    }
  } //for i
  if (bestmove != -1) {
   return bestmove;
  }

  // No move is totally satisfactory, try the first one that is open
  for (int i = 0 ; i < 9 ; i++) {
   int mw = moves[i];
   if (((white & (1 << mw)) == 0) && ((black & (1 << mw)) == 0)) {
    return mw;
   }
  }
  // No more moves
  return -1;
} //bestMove

/**
 * User move.
 * return true if legal
 */
bool yourMove(int m) {
  if ((m < 0) || (m > 8)) {
    return false;
  }
  if (((black | white) & (1 << m)) != 0) {
    return false;
  }
  black |= 1 << m;
  return true;
}

/**
 * Computer move.
 * return true if legal
 */
int myMove() {
  if ((black | white) == DONE) {
    return -1;
  }
  int best = bestMove(white, black);
  white |= 1 << best;
  return best;
}

/**
 * Figure what the status of the game is.
 */
 int status() {
   if (won[white]) {
     return WIN;
  }
  if (won[black]) {
     return LOSE;
  }
```

```
  if ((black | white) == DONE) {
    return STALEMATE;
  }
  return OK;
}

/**
 * Who goes first in the next game?
 */

bool first = true;      //set to true again in init_board()
bool occupied[9];       //indicates if a quadrant has been marked

void init_board( Surface *surf )
{
  int x, y;

  //clear the screen
  surf->clearScreen();

  x = x0;
  y = y0 + dy;
  surf->setColor ( 0, 0, 0 );   //draw lines in black
  surf->moveTo ( x, y );
  surf->lineTo ( x + len, y );  //draw upper horizontal line
  x = x0;
  y += dy;
  surf->moveTo ( x, y );
  surf->lineTo ( x + len, y );  //draw lower horizontal line
  x = x0 + dx;
  y = y0;
  surf->moveTo ( x, y );        //draw left vertical line
  surf->lineTo ( x, y + len );
  x = x0 + 2*dx;
  y = y0;
  surf->moveTo ( x, y );
  surf->lineTo ( x, y + len );  //draw right vertical line

  white = black = 0;
  //initialize the winning positions
  init_win();
  for ( int i = 0; i < 9; ++i )
    occupied[i] = false;        //no square is occupied

  //clear the mouse queue
   SDL_mutexP ( mouse_mutex );  //lock before accessing mouseq
   while ( mouseq.size() )
      mouseq.pop_front();
   SDL_mutexV ( mouse_mutex );  //release lock

   //clear the num queue, key queue
   SDL_mutexP ( key_mutex );    //lock before clear queues
   while ( numq.size() )
      numq.pop_front();
   while ( keyq.size() )
      keyq.pop_front();
   SDL_mutexV ( key_mutex );    //release lock
}
```

```
/*
  This it the thread that plays the game.
*/
int game_thread ( void *surface )
{
  Point p;
  int q;

  Surface *surf = ( Surface * ) surface;
  SDL_Surface *screen = ( SDL_Surface *) surf->getSurface();

  //initialize game board and prepare to play
  init_board( surf );

  while ( !quit ) {
    if ( mouseq.size() > 0 || numq.size() > 0 ){ //either mouse clicked or a num
key pressed
      if ( mouseq.size() > 0 ) {        //mouse has been clicked
        SDL_mutexP ( mouse_mutex );     //lock before accessing mouse queue
        p = mouseq.front();             //get point from front of mouse queue
        mouseq.pop_front();             //remove point from queue
        SDL_mutexV ( mouse_mutex );     //release lock
        q = check_quadrant( p );        //check which quadrant has been clicked
      } else {                          //num key has been pressed
        SDL_mutexP ( key_mutex );       //lock before accessing num queue
        q = ( int ) numq.front() - '0';
        numq.pop_front();
        SDL_mutexV ( key_mutex );       //release lock
      }
      if ( occupied[q] ) continue;      //don't do anything if quadrant already
taken
      switch (( status() ) ) {          //check status
          case WIN:
          case LOSE:
          case STALEMATE:
            white = black = 0;
            if (first)
                white |= 1 << (int)( random() % 9);
            first = !first;
            continue;
      }  //switch
      load_image ( ( SDL_Surface *) screen, "cross.gif", draw_centers[q] );
      occupied[q] = true;
      if ( yourMove ( q ) ) {
        switch ( status() ) {
          case WIN:
            cout << "You lost!" << endl;
            game_over = true;
            play_sfx ( "end.wav" );             //play music to celebrate win
            break;
          case LOSE:
            cout << "You won!" << endl;
            game_over = true;
            play_sfx ( "gameover.wav" );        //play music to signal loss
            break;
          case STALEMATE:
```

```
            cout << "Its a tie!" << endl;
            game_over = true;
            play_sfx ( "quit.wav" );            //play music to signal STALEMATE
            break;
          default:
            if ( ( q = myMove() ) >= 0 ) {
              switch ( status() ) {
                case WIN:
                  cout << "I won!" << endl;
                  game_over = true;
                  play_sfx ( "end.wav" );
                  break;
                case LOSE:
                  cout << "I lost!" << endl;
                  game_over = true;
                  play_sfx ( "gameover.wav" );
                  break;
                case STALEMATE:
                  cout << "Its a tie!" << endl;
                  game_over = true;
                  play_sfx ( "end.wav" );
                  break;
                default:
                  break;
              } //switch
              load_image ( ( SDL_Surface *) screen, "not.gif", draw_centers[q] );
              occupied[q] = true;
            } //if myMove
          } //inner switch
        } //if yourMove
      } // if ( mouseq.size() > 0 )
      while ( game_over ) {
          while ( !keyq.size() && !quit ) //waiting for key input
            SDL_Delay( 5 );
          if ( quit ) break;              //all done
          if ( keyq.front() == 's' || keyq.front() == 'S' ) {
            init_board( surf );           //start over again
            game_over = false;
          }
      } //while ( game_over )
      SDL_Delay ( 5);                     //give up some cpu time for others
    } //while ( !quit )           //quit may be set to true in key_thread or
mouse_thread
    return 0;
}
```





MAKEFILE

```
 LIBSDL =  -L/usr/local/lib -Wl,-rpath,/usr/local/lib -lSDL  -lSDL_image -lSDL_mixer -lpthread
PLATFORM=NARM

PROG    = tictactoe
CC=$(CROSS_COMPILE)g++

INCLS=  -I/usr/include

#source codes
SRCS = tictactoe.cpp io_threads.cpp game_thread.cpp sound.cpp surface.cpp
#substitute .c by .o to obtain object filenames
OBJS = $(SRCS:.cpp=.o)

#$< evaluates to the target's dependencies,
#$@ evaluates to the target

$(PROG): $(OBJS)
        $(CXX) -o $@ $(OBJS)  $(LIBSDL)

$(OBJS):
        $(CC) -c  $*.cpp $(INCLS) -D$(PLATFORM)

clean:
        rm $(OBJS)
```