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CSE 520-01

Homework 1

Homework 1

Part 1 (success):

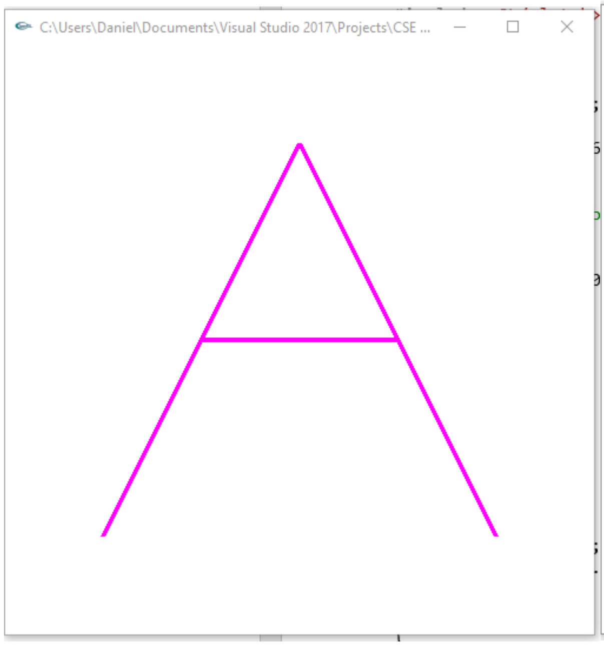

C:\Users\Daniel\Documents\Visual Studio 2017\Projects\CSE ...

Figure "A"

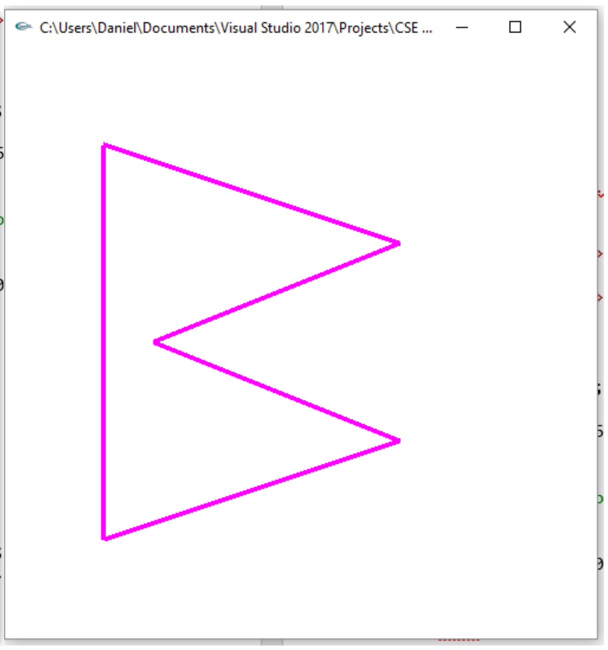
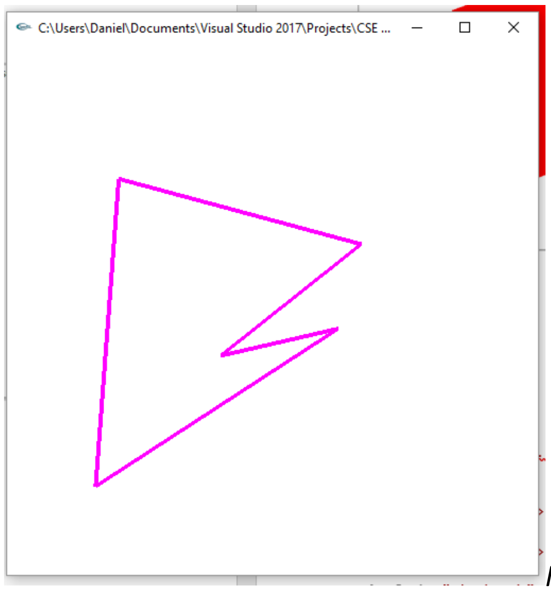

C:\Users\Daniel\Documents\Visual Studio 2017\Projects\CSE ...

Figure "B"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Mid morphing between A and B

HW1.cpp

```
/*
   main.cpp
*/
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <fcntl.h>
#include <sys/types.h>
#include <time.h>

#define GLEW_STATIC 1
#include <GL/glew.h>
#include <GL/glu.h>
#include <GL/glut.h>

#include "Shader.h"

using namespace std;

#define PI 3.14159265359

class Point2 {
public:
	float x;
	float y;
	Point2()
	{
		x = y = 0;
	}
	Point2(float x0, float y0)
	{
		x = x0;		y = y0;
	}
	Point2(const Point2 &p)
	{
		x = p.x;
		y = p.y;
	}
};

/*
   Global handles for the currently active program object, with its 
two shader objects
*/
```

```
static GLint win = 0;
Shader shader;

int cLoc;  //color
int rLoc;  //rotation
int sLoc;  //scale
int tLoc;  //time
int startLoc;
int endLoc;

float rx = 0.0;
float ry = 0.0;
float rz = 0.0;

float scale = 1.0;
int colorSelect = 0;
float color[] = { 1.0, 0.0, 1.0, 1.0 };

float anim = 1;

Point2 A[10], B[10];

int init(void)
{
      const char *version;
      char *VertexShaderSource, *FragmentShaderSource;
      string *vs, *fs;
      int loadstatus = 0;

      version = (const char *)glGetString(GL_VERSION);
      if (version[0] < '2' || version[1] != '.') {
            printf("This program requires OpenGL > 2.x, found %s\n",
version);
            exit(1);
      }
      printf("version=%s\n", version);

      //shader.readShaderFile((char *) "Template.vert",
&VertexShaderSource);
      //shader.readShaderFile((char *) "Template.frag",
&FragmentShaderSource);

      shader.readShaderFile((char *) "FigAB.vert",
&VertexShaderSource);
      shader.readShaderFile((char *) "FigAB.frag",
&FragmentShaderSource);
```

```
	//shader.readShaderFile((char *) "Square.vert",
&VertexShaderSource);
	//shader.readShaderFile((char *) "Square.frag",
&FragmentShaderSource);

	vs = new string(VertexShaderSource);
	fs = new string(FragmentShaderSource);

	loadstatus = shader.createShader(vs, fs);

	delete fs;
	delete vs;
	delete VertexShaderSource;
	delete FragmentShaderSource;

	//cLoc = glGetAttribLocation(shader.programObject, "vColor");
	//rLoc = glGetAttribLocation(shader.programObject, "rotate");
	tLoc = glGetUniformLocation(shader.programObject, "time1");
	startLoc = glGetAttribLocation(shader.programObject, "start");
	endLoc = glGetAttribLocation(shader.programObject, "end");

	return loadstatus;
}

static void Reshape(int width, int height)
{
	glViewport(0, 0, width, height);
	glMatrixMode(GL_PROJECTION);
	glLoadIdentity();
	glFrustum(-1.0, 1.0, -1.0, 1.0, 5.0, 25.0);
	glMatrixMode(GL_MODELVIEW);
	glLoadIdentity();
	glTranslatef(0.0f, 0.0f, -15.0f);
}

void CleanUp(void)
{
	shader.cleanUp();
	glutDestroyWindow(win);
}

static void Idle(void)
{
	float t = glutGet(GLUT_ELAPSED_TIME);
	if (anim == 0)
	{
		while (t > 2000) t -= 2000;

	}
	else if (anim == 1)
	{
		t = 0;
	}
	else
	{
		t = 2000;
	}

	glUniform1f(tLoc, t);
	glutPostRedisplay();
}

void animate()
{
	if (rz < 360)
	{
		rz += 2.0 * (PI / 180);		//need to convert degree to
radians for GLSL
	}
	else
	{
		rz = 0.0;
	}
}

static void Key(unsigned char key, int x, int y)
{
	switch (key) {
	case 27:
		CleanUp();
		exit(0);
		break;
	case 'a':
		animate();
		break;
	case 't':
		if (anim == 0)
		{
			anim = 1;
		}
		else if(anim == 1)
		{
			anim = 2;
		}
		else
		{
			anim = 0;
		}
		break;
	}
	glutPostRedisplay();
}

void makeFigures(Point2 A[], Point2 B[])
{
	A[0].x = -2;	A[0].y = -2;
	A[1].x = -1;	A[1].y = 0;
	A[2].x = -1;	A[2].y = 0;
	A[3].x = 1;		A[3].y = 0;
	A[4].x = 1;		A[4].y = 0;
	A[5].x = 2;		A[5].y = -2;
	A[6].x = 2;		A[6].y = -2;
	A[7].x = 0;		A[7].y = 2;
	A[8].x = 0;		A[8].y = 2;
	A[9].x = -2;	A[9].y = -2;

	B[0].x = -2;	B[0].y = -2;
	B[1].x = -2;	B[1].y = 2;
	B[2].x = -2;	B[2].y = 2;
	B[3].x = 1;		B[3].y = 1;
	B[4].x = 1;		B[4].y = 1;
	B[5].x = -1.5;	B[5].y = 0;
	B[6].x = -1.5;	B[6].y = 0;
	B[7].x = 1;		B[7].y = -1;
	B[8].x = 1;		B[8].y = -1;
	B[9].x = -2;	B[9].y = -2;
}

void display(void)
{
	makeFigures(A, B);

	GLfloat vec[4];

	glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
	glClearColor(1.0, 1.0, 1.0, 1.0);	//get white background
color
```

```
	glColor3f(0, 0, 1);		//red, this will have no effect if 
shader is loaded
	/*
	glLineWidth(4);
	glBegin(GL_LINE_STRIP);	//need GL_POINTS; "GL_POINT" doesn't 
work
	for (float x = -3.0; x <= 3.0; x += 0.1)
		glVertex3f(x, 0, 0);
	glEnd();
	*/
	/*
	glVertexAttrib3f(rLoc, rx, ry, rz);
	glVertexAttrib4f(cLoc, color[0], color[1], color[2], color[3]);
	glBegin(GL_QUADS);
		glVertex3f(-2.2, -2.2, 0);
		glVertex3f(2.2, -2.2, 0);
		glVertex3f(2.2, 2.2, 0);
		glVertex3f(-2.2, 2.2, 0);
	glEnd();
	*/

	glLineWidth(4);
	glBegin(GL_LINES);

	for(int i = 0; i < 10; i++)
	{
		glVertex3f(A[i].x, A[i].y, 0);
		glVertexAttrib3f(startLoc, A[i].x, A[i].y, 0);
		glVertexAttrib3f(endLoc, B[i].x, B[i].y, 0);
		i++;
		glVertex3f(A[i].x, A[i].y, 0);
		//glVertexAttrib3f(startLoc, A[i].x, A[i].y, 0);
		//glVertexAttrib3f(endLoc, B[i].x, B[i].y, 0);
	}


	/*
	//'A'
	glVertex3f(-2, -2, 0);
	glVertex3f(-1, 0, 0);

	glVertex3f(-1, 0, 0);
	glVertex3f(1, 0, 0);

	glVertex3f(1, 0, 0);
	glVertex3f(2, -2, 0);
	glVertex3f(2, -2, 0);
	glVertex3f(0, 2, 0);

	glVertex3f(0, 2, 0);
	glVertex3f(-2, -2, 0);
	*/

	/*
	//'B'
	glVertex3f(-2, -2, 0);
	glVertex3f(-2, 2, 0);

	glVertex3f(-2, 2, 0);
	glVertex3f(1, 1, 0);

	glVertex3f(1, 1, 0);
	glVertex3f(-1.5, 0, 0);

	glVertex3f(-1.5, 0, 0);
	glVertex3f(1, -1, 0);

	glVertex3f(1, -1, 0);
	glVertex3f(-2, -2, 0);
	*/

	glEnd();

	glutSwapBuffers();
	glFlush();
}


int main(int argc, char *argv[])
{
	int success = 0;

	glutInit(&argc, argv);
	glutInitWindowPosition(0, 0);
	glutInitWindowSize(500, 500);
	glutInitDisplayMode(GLUT_RGB | GLUT_DOUBLE | GLUT_DEPTH);
	win = glutCreateWindow(argv[0]);
	glutReshapeFunc(Reshape);
	glutKeyboardFunc(Key);
	glutDisplayFunc(display);
	glutIdleFunc(Idle);
```

```
        // Initialize the "OpenGL Extension Wrangler" library
        glewInit();

        success = init();
        if (success)
        {
                printf("Shaders compiled successfully!\n");
                glutMainLoop();
        }
        else
        {
                printf("infoLog:: %s\n", shader.infoLog);
        }
        return 0;
}
```

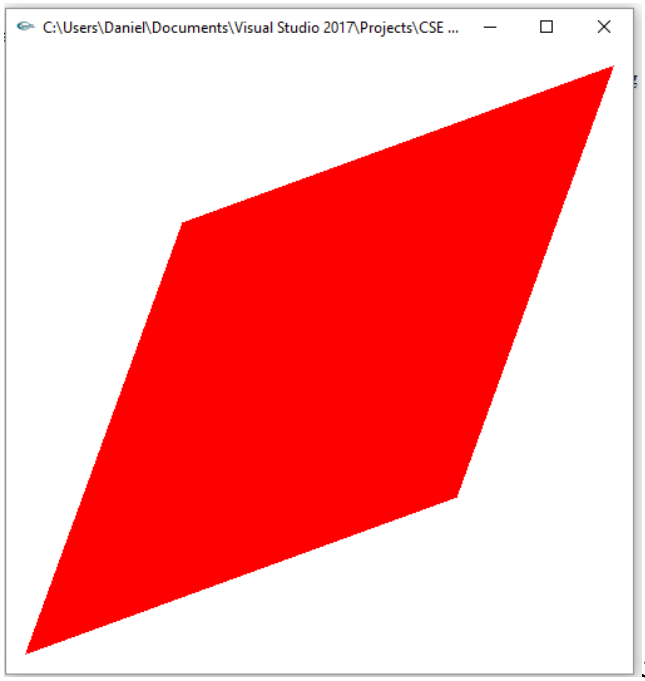
FigAB.vert

```
/*
        FigAB.vert
*/
uniform float time1;
attribute vec3 start;
attribute vec3 end;

void main(void)
{
        float s = 2000.0;
        float t;
        t = time1 / s;

        vec4 v4;
      v4 = gl_Vertex;

        v4.xy = mix(start.xy, end.xy, t);

      gl_Position = gl_ProjectionMatrix *  gl_ModelViewMatrix * v4;
}
```

FigAB.frag

```
//FigAB.frag

void main(void)
{
  gl_FragColor = vec4( 1, 0, 1, 1);    // color
}
```

Part 2 (success):


C:\Users\Daniel\Documents\Visual Studio 2017\Projects\CSE ...
Square rotating about the z-axis by pressing ‘a’

HW1.cpp

```
/*
   main.cpp
*/
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <fcntl.h>
#include <sys/types.h>

#define GLEW_STATIC 1
#include <GL/glew.h>
#include <GL/glu.h>
#include <GL/glut.h>
```

```
#include "Shader.h"

using namespace std;

#define PI 3.14159265359

/*
   Global handles for the currently active program object, with its
two shader objects
*/
static GLint win = 0;
Shader shader;

int cLoc;
int rLoc;
int sLoc;

float rx = 0.0;
float ry = 0.0;
float rz = 0.0;

float scale = 1.0;
int colorSelect = 0;
float color[] = { 1.0, 0.0, 0.0, 1.0 };

int init(void)
{
      const char *version;
      char *VertexShaderSource, *FragmentShaderSource;
      string *vs, *fs;
      int loadstatus = 0;

      version = (const char *)glGetString(GL_VERSION);
      if (version[0] < '2' || version[1] != '.') {
            printf("This program requires OpenGL > 2.x, found %s\n",
version);
            exit(1);
      }
      printf("version=%s\n", version);

      //shader.readShaderFile((char *) "Template.vert",
&VertexShaderSource);
      //shader.readShaderFile((char *) "Template.frag",
&FragmentShaderSource);
```

```
	//shader.readShaderFile((char *) "FigAB.vert",
&VertexShaderSource);
	//shader.readShaderFile((char *) "FigAB.frag",
&FragmentShaderSource);

	shader.readShaderFile((char *) "Square.vert",
&VertexShaderSource);
	shader.readShaderFile((char *) "Square.frag",
&FragmentShaderSource);

	vs = new string(VertexShaderSource);
	fs = new string(FragmentShaderSource);

	loadstatus = shader.createShader(vs, fs);

	delete fs;
	delete vs;
	delete VertexShaderSource;
	delete FragmentShaderSource;

	cLoc = glGetAttribLocation(shader.programObject, "vColor");
	rLoc = glGetAttribLocation(shader.programObject, "rotate");

	return loadstatus;
}

static void Reshape(int width, int height)
{
	glViewport(0, 0, width, height);
	glMatrixMode(GL_PROJECTION);
	glLoadIdentity();
	glFrustum(-1.0, 1.0, -1.0, 1.0, 5.0, 25.0);
	glMatrixMode(GL_MODELVIEW);
	glLoadIdentity();
	glTranslatef(0.0f, 0.0f, -15.0f);
}

void CleanUp(void)
{
	shader.cleanUp();
	glutDestroyWindow(win);
}

static void Idle(void)
{
	glutPostRedisplay();
```

```
}

void animate()
{
	if (rz < 360)
	{
		rz += 2.0 * (PI / 180);     //need to convert degree to
radians for GLSL
	}
	else
	{
		rz = 0.0;
	}
}

static void Key(unsigned char key, int x, int y)
{
	switch (key) {
	case 27:
		CleanUp();
		exit(0);
		break;
	case 'a':
		animate();
		break;
	}
	glutPostRedisplay();
}

void display(void)
{
	GLfloat vec[4];

	glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
	glClearColor(1.0, 1.0, 1.0, 1.0);     //get white background
color
	glColor3f(0, 0, 1);        //red, this will have no effect if
shader is loaded
	/*
	glLineWidth(4);
	glBegin(GL_LINE_STRIP);  //need GL_POINTS; "GL_POINT" doesn't
work
	for (float x = -3.0; x <= 3.0; x += 0.1)
		glVertex3f(x, 0, 0);
	glEnd();
	*/
	glVertexAttrib3f(rLoc, rx, ry, rz);
	glVertexAttrib4f(cLoc, color[0], color[1], color[2], color[3]);
	glBegin(GL_QUADS);
		glVertex3f(-2.2, -2.2, 0);
		glVertex3f(2.2, -2.2, 0);
		glVertex3f(2.2, 2.2, 0);
		glVertex3f(-2.2, 2.2, 0);
	glEnd();

	glutSwapBuffers();
	glFlush();
}


int main(int argc, char *argv[])
{
	int success = 0;

	glutInit(&argc, argv);
	glutInitWindowPosition(0, 0);
	glutInitWindowSize(500, 500);
	glutInitDisplayMode(GLUT_RGB | GLUT_DOUBLE | GLUT_DEPTH);
	win = glutCreateWindow(argv[0]);
	glutReshapeFunc(Reshape);
	glutKeyboardFunc(Key);
	glutDisplayFunc(display);
	glutIdleFunc(Idle);

	// Initialize the "OpenGL Extension Wrangler" library
	glewInit();

	success = init();
	if (success)
		glutMainLoop();
	else
	{
		printf("infoLog:: %s\n", shader.infoLog);
	}
	return 0;
}
```

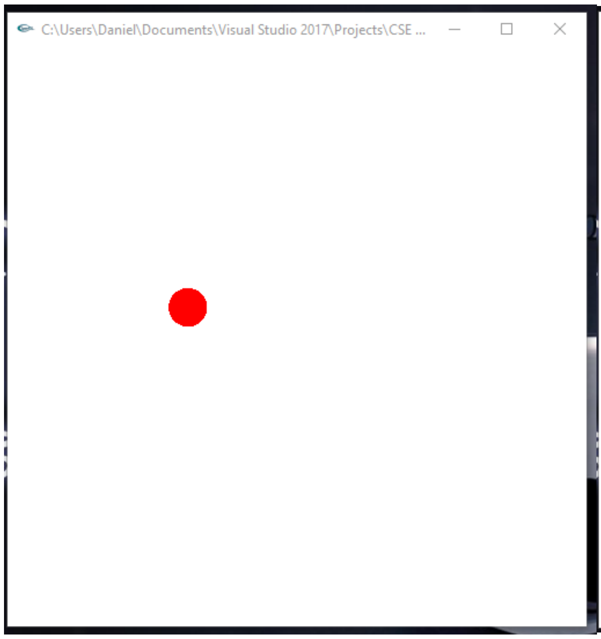
Square.frag

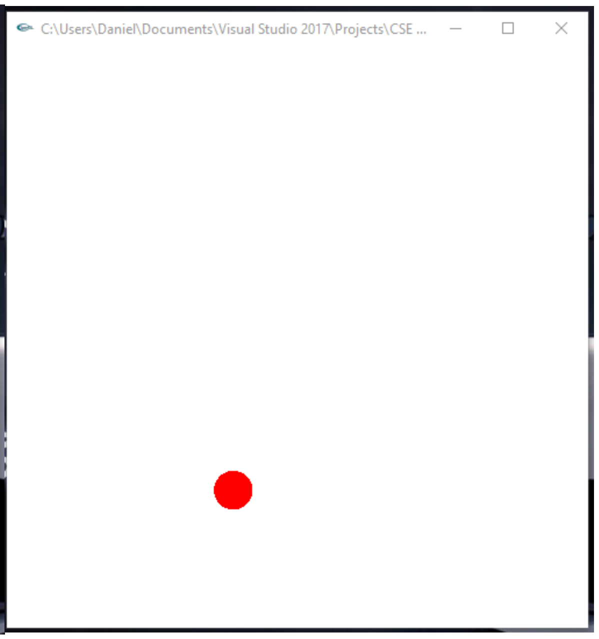
```
/*
	Square.frag
*/

varying vec4 fColor;

void main(void)
{
  //make a color with alpha of 1.0
  gl_FragColor = fColor;
}
```

Square.vert

```
attribute vec3 rotate;
attribute vec4 vColor;

varying vec4 fColor;

void main(void)
{
	vec4 v4;
	v4 = gl_Vertex;

	mat4 mRotateZ = mat4 ( cos(rotate.z), sin(rotate.z), 0, 0,//1st
col
	                      sin(rotate.z), cos(rotate.z), 0, 0,  //2nd col
	                      0, 0, 1, 0,          //3rd col
	                      0, 0, 0, 1  );       //4th col

	v4 = mRotateZ * v4;

	fColor = vColor;
	gl_Position = gl_ProjectionMatrix * gl_ModelViewMatrix * v4;
}
```

Part 3 (Partial Success):


C:\Users\Daniel\Documents\Visual Studio 2017\Projects\CSE ...


C:\Users\Daniel\Documents\Visual Studio 2017\Projects\CSE ...

Ball Rising *Ball Falling*

HW1.cpp

```
/*
   main.cpp
*/
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <fcntl.h>
#include <sys/types.h>
#include <time.h>
#include <math.h>

#define GLEW_STATIC 1
#include <GL/glew.h>
#include <GL/glu.h>
#include <GL/glut.h>

#include "Shader.h"

using namespace std;

#define PI 3.14159265359
#define X .525731112119133606
#define Z .850650808352039932
```

```
/*
   Global handles for the currently active program object, with its
two shader objects
*/
static GLint win = 0;
Shader shader;

int pLoc;  //position
int tLoc;  //time
int vLoc;  //velocity

float iVelocityY = 7.0;
float iVelocityX = 1.0;
float iVelocityZ = 0.0;
float iPositionX = -2.0;
float iPositionY = -2.0;
float iPositionZ = 0.0;

int init(void)
{
      const char *version;
      char *VertexShaderSource, *FragmentShaderSource;
      string *vs, *fs;
      int loadstatus = 0;

      version = (const char *)glGetString(GL_VERSION);
      if (version[0] < '2' || version[1] != '.') {
            printf("This program requires OpenGL > 2.x, found %s\n",
version);
            exit(1);
      }
      printf("version=%s\n", version);

      shader.readShaderFile((char *) "Ball.vert", &VertexShaderSource);
      shader.readShaderFile((char *) "Ball.frag",
&FragmentShaderSource);

      vs = new string(VertexShaderSource);
      fs = new string(FragmentShaderSource);

      loadstatus = shader.createShader(vs, fs);

      vLoc = glGetUniformLocation(shader.programObject, "iVel");
      pLoc = glGetUniformLocation(shader.programObject, "iPos");
      tLoc = glGetUniformLocation(shader.programObject, "time1");
```

```
	return loadstatus;
}

static void Reshape(int width, int height)
{
	glViewport(0, 0, width, height);
	glMatrixMode(GL_PROJECTION);
	glLoadIdentity();
	glFrustum(-1.0, 1.0, -1.0, 1.0, 5.0, 25.0);
	glMatrixMode(GL_MODELVIEW);
	glLoadIdentity();
	glTranslatef(0.0f, 0.0f, -15.0f);
}

void CleanUp(void)
{
	shader.cleanUp();
	glutDestroyWindow(win);
}

static void Idle(void)
{
	float t = glutGet(GLUT_ELAPSED_TIME);
	while (t > 5000) t -= 5000;
	glUniform1f(tLoc, t);
	glutPostRedisplay();
}

static void Key(unsigned char key, int x, int y)
{
	switch (key) {
	case 27:
		CleanUp();
		exit(0);
		break;
	}
	glutPostRedisplay();
}

void display(void)
{
	GLfloat vec[4];
	int loc;

	glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
	glClearColor(1.0, 1.0, 1.0, 1.0);	//get white background 
color
	glColor3f(0, 0, 1);		//red, this will have no effect if 
shader is loaded

	glUniform3f(pLoc, iPositionX, iPositionY, iPositionZ);
	glUniform3f(vLoc, iVelocityX, iVelocityY, iVelocityZ);
	glutSolidSphere(0.2, 50, 50);

	glutSwapBuffers();
	glFlush();
}


int main(int argc, char *argv[])
{
	int success = 0;

	glutInit(&argc, argv);
	glutInitWindowPosition(0, 0);
	glutInitWindowSize(500, 500);
	glutInitDisplayMode(GLUT_RGB | GLUT_DOUBLE | GLUT_DEPTH);
	win = glutCreateWindow(argv[0]);
	glutReshapeFunc(Reshape);
	glutKeyboardFunc(Key);
	glutDisplayFunc(display);
	glutIdleFunc(Idle);

	// Initialize the "OpenGL Extension Wrangler" library
	glewInit();

	success = init();
	if (success)
	{
		printf("Shaders compiled successfully!\n");
		glutMainLoop();
	}
	else
	{
		printf("infoLog:: %s\n", shader.infoLog);
	}
	return 0;
}
```

Ball.vert

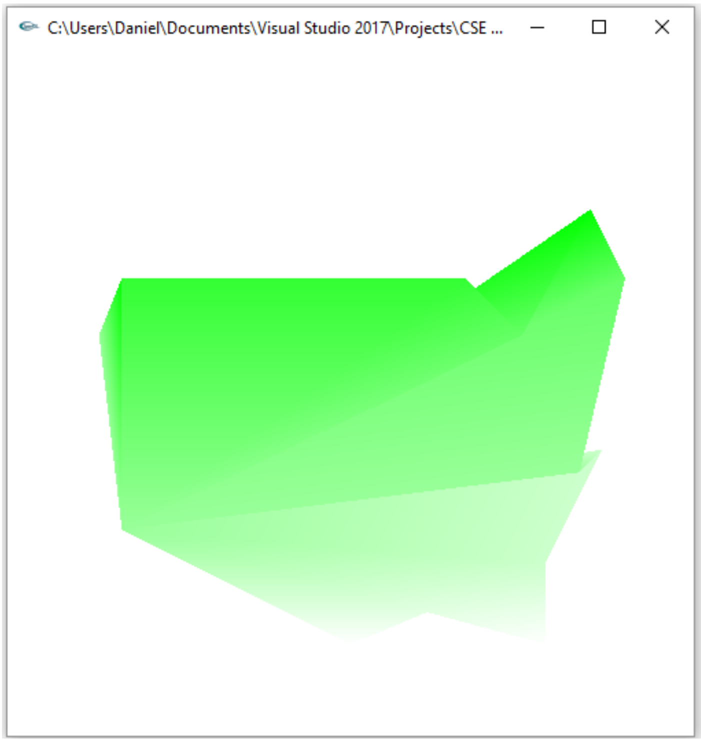
```
//Ball.vert
uniform vec3 iVel;
uniform vec3 iPos;
uniform float time1;

varying float prevY;

void main(void)
{
	float s = 1000.0;
	float g = -10.0;
	float t;
	vec3 minimum = vec3(0.0, -2.0, 0.0);
	float cor = 0.752; //coefficient of resitution for a hand ball
	t = time1 / s;

	float t1;  //time at jump
	float t2;  //time at peak
	float t3;  //time when at bottom
	float dt;  //change in time
	//float prevY;
	float dy = 0.0;  //change in y

	vec4 objPos;
	objPos = gl_Vertex;

	objPos.xyz = objPos.xyz + iPos.xyz;
	t1 = time1 / s; //initial time

	objPos.x = objPos.x + iVel.x * t;
	objPos.y = objPos.y + iVel.y * t + g / (2.0) * t * t;
	objPos.z = objPos.z + iVel.z * t;

	dy = objPos.y - iPos.y;

	if(objPos.y < dy) //ball is now falling, record peak time
	{
		t2 = t;
		dt = t2 - t1;
	}

	t3 = t;    //record time as ball falls
```

```
      if((t3 - dt) == dt)   //if change in falling time = change in
rising time, ball is at initial position / floor, bounce
      {
            objPos.y = reflect(-objPos.y, normalize(iPos.y)) * cor;
      }

      //dy = objPos.y - prevY;
      //prevY = objPos.y;

      /*
      if(objPos.y < iPos.y)
      {
            //objPos.y = reflect(-objPos.y, normalize(iPos.y)) * cor;
      }
      */

            //objPos.y = reflect(-objPos.y, normalize(iPos.y)) * cor;
            //objPos.x = reflect(objPos.x, normalize(iPos.x));

    gl_Position = gl_ModelViewProjectionMatrix * objPos;

      prevY = objPos.y;
}
```

Ball.frag

```
//Ball.frag
//a minimal fragment shader

void main(void)
{
  gl_FragColor = vec4( 1, 0, 0, 1);    // color
}
```

Part 4 (success):


C:\Users\Daniel\Documents\Visual Studio 2017\Projects\CSE ...

Green = coldest, white = hottest

HW1.cpp

```
/*
   main.cpp
*/
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <fcntl.h>
#include <sys/types.h>
#include <time.h>
#include <math.h>

#define GLEW_STATIC 1
#include <GL/glew.h>
#include <GL/glu.h>
#include <GL/glut.h>

#include "Shader.h"

using namespace std;

/*
```

```
   Global handles for the currently active program object, with its
two shader objects
*/
static GLint win = 0;
Shader shader;


int init(void)
{
      const char *version;
      char *VertexShaderSource, *FragmentShaderSource;
      string *vs, *fs;
      int loadstatus = 0;

      version = (const char *)glGetString(GL_VERSION);
      if (version[0] < '2' || version[1] != '.') {
            printf("This program requires OpenGL > 2.x, found %s\n",
version);
            exit(1);
      }
      printf("version=%s\n", version);

      shader.readShaderFile((char *) "US.vert", &VertexShaderSource);
      shader.readShaderFile((char *) "US.frag", &FragmentShaderSource);

      vs = new string(VertexShaderSource);
      fs = new string(FragmentShaderSource);

      loadstatus = shader.createShader(vs, fs);

      //Set up initial uniform values
      GLchar names[][20] = { "CoolestColor", "HottestColor",
"CoolestTemp",
      "TempRange" };
      GLint loc[10];
      for (int i = 0; i < 4; ++i) {
            loc[i] = glGetUniformLocation(shader.programObject,
names[i]);
            if (loc[i] == -1)
                  printf("No such uniform named %s\n", names[i]);
      }

      glUniform3f(loc[0], 0.0, 1.0, 0.0);
      glUniform3f(loc[1], 1.0, 1.0, 1.0);
      glUniform1f(loc[2], 0.0);
      glUniform1f(loc[3], 1.0);
```

```
	return loadstatus;
}

static void Reshape(int width, int height)
{
	glViewport(0, 0, width, height);
	glMatrixMode(GL_PROJECTION);
	glLoadIdentity();
	glFrustum(-1.0, 1.0, -1.0, 1.0, 5.0, 25.0);
	glMatrixMode(GL_MODELVIEW);
	glLoadIdentity();
	glTranslatef(0.0f, 0.0f, -15.0f);
}

void CleanUp(void)
{
	shader.cleanUp();
	glutDestroyWindow(win);
}

static void Idle(void)
{
	float t = glutGet(GLUT_ELAPSED_TIME);
	while (t > 3000) t -= 3000;
	glUniform1f(tLoc, t);
	glutPostRedisplay();
}

static void Key(unsigned char key, int x, int y)
{
	switch (key) {
	case 27:
		CleanUp();
		exit(0);
		break;
	}
	glutPostRedisplay();
}

void display(void)
{
	GLfloat vec[4];
	int loc;

	glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
	glClearColor(1.0, 1.0, 1.0, 1.0);	//get white background
color
	glColor3f(0, 0, 1);		//red, this will have no effect if
shader is loaded

	loc = glGetAttribLocation(shader.programObject, "VertexTemp");
	glBegin(GL_POLYGON);
	if (loc == -1)
		printf("No such attribute named %s\n", "VertexTemp");

	//0.0 = coldest, 1.0 = hottest

	glVertexAttrib1f(loc, 0.6);
	glVertex3f(-2.0, -1.2, 0);
	glVertexAttrib1f(loc, 0.8);
	glVertex3f(-1.0, -1.5, 0);
	glVertexAttrib1f(loc, 1.0);
	glVertex3f(0.0, -2.2, 0);
	glVertexAttrib1f(loc, 0.8);
	glVertex3f(1.2, -1.7, 0);
	glVertexAttrib1f(loc, 1.0);
	glVertex3f(1.7, -2.2, 0);
	glVertexAttrib1f(loc, 0.8);
	glVertex3f(1.7, -1.5, 0);
	glVertexAttrib1f(loc, 0.8);
	glVertex3f(2.2, -0.5, 0);
	glVertexAttrib1f(loc, 0.6);
	glVertex3f(2.0, -0.7, 0);
	glVertexAttrib1f(loc, 0.4);
	glVertex3f(2.4, 1.0, 0);
	glVertexAttrib1f(loc, 0.0);
	glVertex3f(2.1, 1.6, 0);
	glVertexAttrib1f(loc, 0.4);
	glVertex3f(1.5, 0.5, 0);
	glVertexAttrib1f(loc, 0.2);
	glVertex3f(1.0, 1.0, 0);
	glVertexAttrib1f(loc, 0.2);
	glVertex3f(-2.0, 1.0, 0);
	glVertexAttrib1f(loc, 0.0);
	glVertex3f(-2.0, 1.0, 0);
	glVertexAttrib1f(loc, 0.6);
	glVertex3f(-2.2, 0.5, 0);

	glEnd();

	glutSwapBuffers();
	glFlush();
}


int main(int argc, char *argv[])
{
	int success = 0;

	glutInit(&argc, argv);
	glutInitWindowPosition(0, 0);
	glutInitWindowSize(500, 500);
	glutInitDisplayMode(GLUT_RGB | GLUT_DOUBLE | GLUT_DEPTH);
	win = glutCreateWindow(argv[0]);
	glutReshapeFunc(Reshape);
	glutKeyboardFunc(Key);
	glutDisplayFunc(display);
	glutIdleFunc(Idle);

	// Initialize the "OpenGL Extension Wrangler" library
	glewInit();

	success = init();
	if (success)
	{
		printf("Shaders compiled successfully!\n");
		glutMainLoop();
	}
	else
	{
		printf("infoLog:: %s\n", shader.infoLog);
	}
	return 0;
}
```

US.vert

```
//US.vert

//uniform qualified variables are changed at most once per primitives
uniform float CoolestTemp;
uniform float TempRange;

//attribute qualified variables are typically changed per vertex
attribute float VertexTemp;

//varying qualified variables communicate from the vertex shader to
//the fragment shader
```

```
varying float Temperature;

void main(void)
{
  //compute a temperature to be interpolated per fragment
  //  in the range [0.0, 1.0]
  Temperature = ( VertexTemp - CoolestTemp ) / TempRange;
  //Temperature = ( 1.0 - CoolestTemp ) / TempRange;
  gl_Position     = ftransform();

  /*
    Same as:
      gl_Position = gl_ProjectionMatrix * gl_ModelViewMatrix *
gl_Vertex;
      gl_Position = gl_ModelViewProjectionMatrix * gl_Vertex;
  */
}
```

US.frag

```
/*
  US.frag:
  uniform qualified variables are changed at most once per primitive
  by the application, and vec3 declares a vector of three
  floating-point numbers.
*/

uniform vec3 CoolestColor;
uniform vec3 HottestColor;

varying float Temperature;

void main(void)
{
  //get a color between coolest and hottest colors, using the
  //  mix() built-in function
  vec3 color = mix ( CoolestColor, HottestColor, Temperature );

  //make a color with alpha of 1.0
  gl_FragColor = vec4(color, 1.0);
}
```

Summary:

For this assignment we were given tasks to create 4 different shaders: one that morphs ‘A’ to ‘B’ and back, one that animates the rotation of a square about the z-axis, one that animates a ball bouncing with given initial velocity and position, and finally a shader that shows the temperature distribution across a polygon of the US. Most of these compiled and ran as intended, however the bouncing ball shader proved to be a problem. I was able to get the ball to bounce with its initial velocity and position, however difficulty appeared when trying to get it to bounce again. I attempted recording previous y positions to determine the time to reach peak and then use that time to determine when the ball had reached the floor to begin another bounce. I attempted over a dozen permutations and was still unsuccessful with the code provided being my most successful attempt. Overall, I feel I deserve full credit for parts 1,2 and 4 and partial credit for part 3 of the assignment leaving a final score of 50 points.