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Computer Science Department
قسم الحاسب الآلي

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Adam College
Department

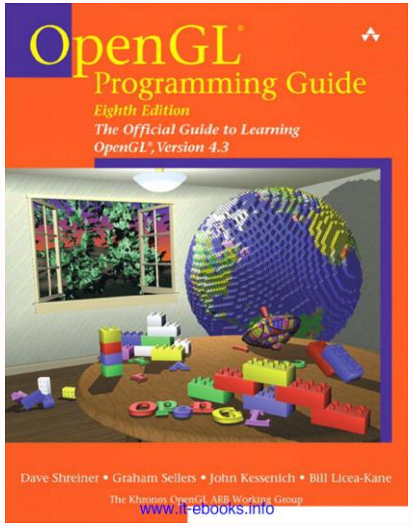
Computer Graphics Course, 3-6803430

LAB

T.Mariah Khayat

References

- *Lab Lectures, Computer Graphics, Taif University, Faculty Of Computers And Information Technology, TA. Maha Thafar &TA. Haifa Alshehri, TA.Sohair Soliman & L.Shakila Bano.*
- *OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 4.3, 8th edition, Dave Shreiner, Graham Sellers, John Kessenich, Bill Licea-Kane & The Khronos OpenGL ARB Working Group, Addison-Wesley.*



OpenGL
Programming Guide
Eighth Edition
The Official Guide to Learning OpenGL, Version 4.3
Dave Shreiner • Graham Sellers • John Kessenich • Bill Licea-Kane
The Khronos OpenGL ARB Working Group
www.it-ebooks.info

Lecture Four

Drawing Triangles, Quads and Polygons using OpenGL

Computer Graphics Course, 3-6803430

T.Mariah Khayat

content

1. Attributes in OpenGL
2. Triangles in OpenGL
3. Draw Triangles using OpenGL
4. Draw Triangle Fan using OpenGL
5. Quads in OpenGL
6. Draw a Square using OpenGL
7. Polygons in OpenGL
8. Draw an Ark Using OpenGL

Attributes in OpenGL

- **Attributes: are part of the OpenGL and determine the appearance of objects.**
- **Color** deal with all objects **(points, lines, triangles, quads, polygons).**
- Each color component stored separately in the frame buffer.
- Usually 8 bits per component in buffer.
- Note: in **`glColor3f`** **the color values range from** 0.0 to 1.0 , while in **`glColor3ub`** **the** values range from 0 to 255.

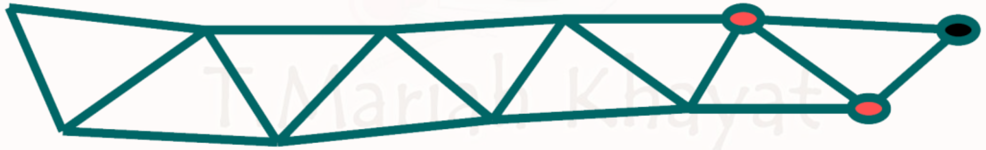
Attributes in OpenGL

- **Size** and **width** (points, lines).
- **Stipple** pattern (lines, polygons).

- Polygon mode:
  - Display as filled: (solid color) use the:
    - ❖`glPolygonMode(GL_FRONT_AND_BACK, GL_FILL);`
  - Display edges use the functions:
    - ❖`glPolygonMode(GL_FRONT_AND_BACK, GL_LINE);`

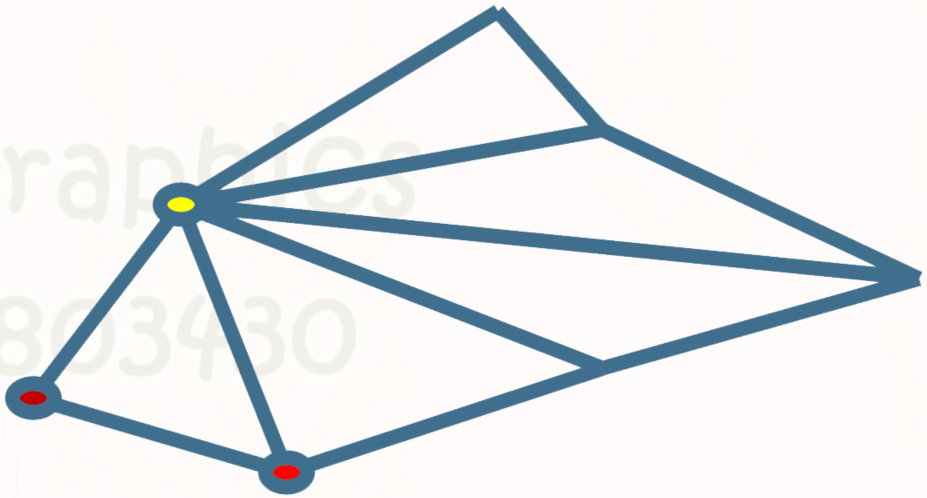
Triangles in OpenGL

- **There are 3 functions** with Triangle: {S | _STRIP | _FAN}.
- **Triangle (GL_TRIANGLES):**
  - to draw normal Triangle. & Represent triangle as 3 vertices.
- **Triangle Strip** : **(GL_TRIANGLE_STRIP):**
  - Group of triangles sharing 2 vertices from previous triangle.
  - Use triangles to represent a solid object as a mesh.
  - Triangles frequently appear in strips:



Triangles in OpenGL

- **Triangular Fans: (GL_TRIANGLE_FAN):**
  - Connected group sharing 1 common vertex, and 1 from previous triangle.

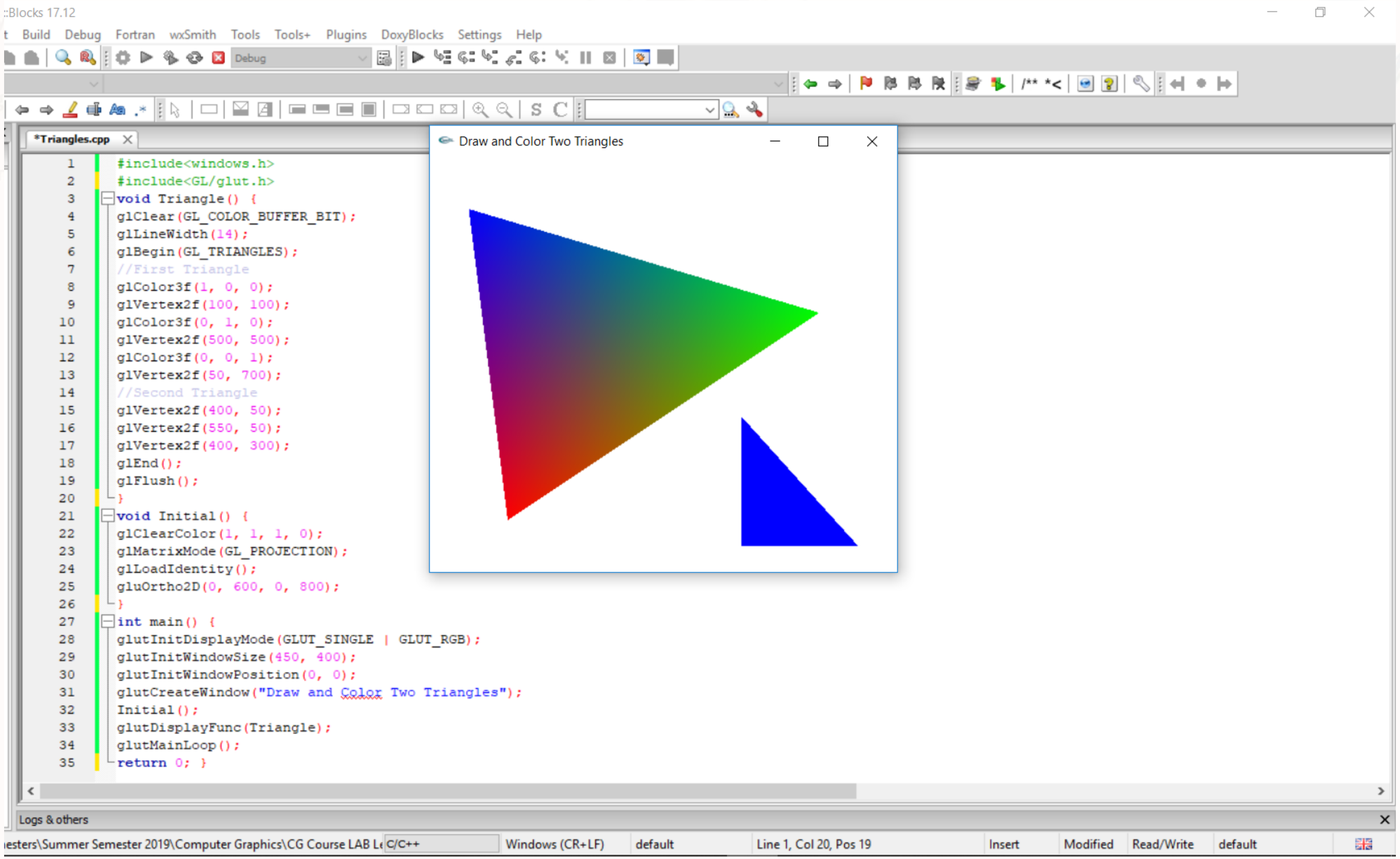


- **For tri-strips and fans**,
  - A new triangle is defined by 1 new vertex added to the strip or fans.

Draw Triangles using OpenGL

```
#include<windows.h>
#include<GL/glut.h>
void Triangle() {
glClear(GL_COLOR_BUFFER_BIT);
glLineWidth(14);
glBegin(GL_TRIANGLES);
//First Triangle
glColor3f(1, 0, 0);
glVertex2f(100, 100);
glColor3f(0, 1, 0);
glVertex2f(500, 500);
glColor3f(0, 0, 1);
glVertex2f(50, 700);
//Second Triangle
glVertex2f(400, 50);
glVertex2f(550, 50);
glVertex2f(400, 300);
glEnd();
glFlush();
}
void Initial() {
glClearColor(1, 1, 1, 0);
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
gluOrtho2D(0, 600, 0, 800);
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(450, 400);
glutInitWindowPosition(0, 0);
glutCreateWindow("Draw and Color Two Triangles");
Initial();
glutDisplayFunc(Triangle);
glutMainLoop();
return 0; }
```

Draw Triangles using OpenGL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t Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help
Debug
*Triangles.cpp
Draw and Color Two Triangles
Logs & others

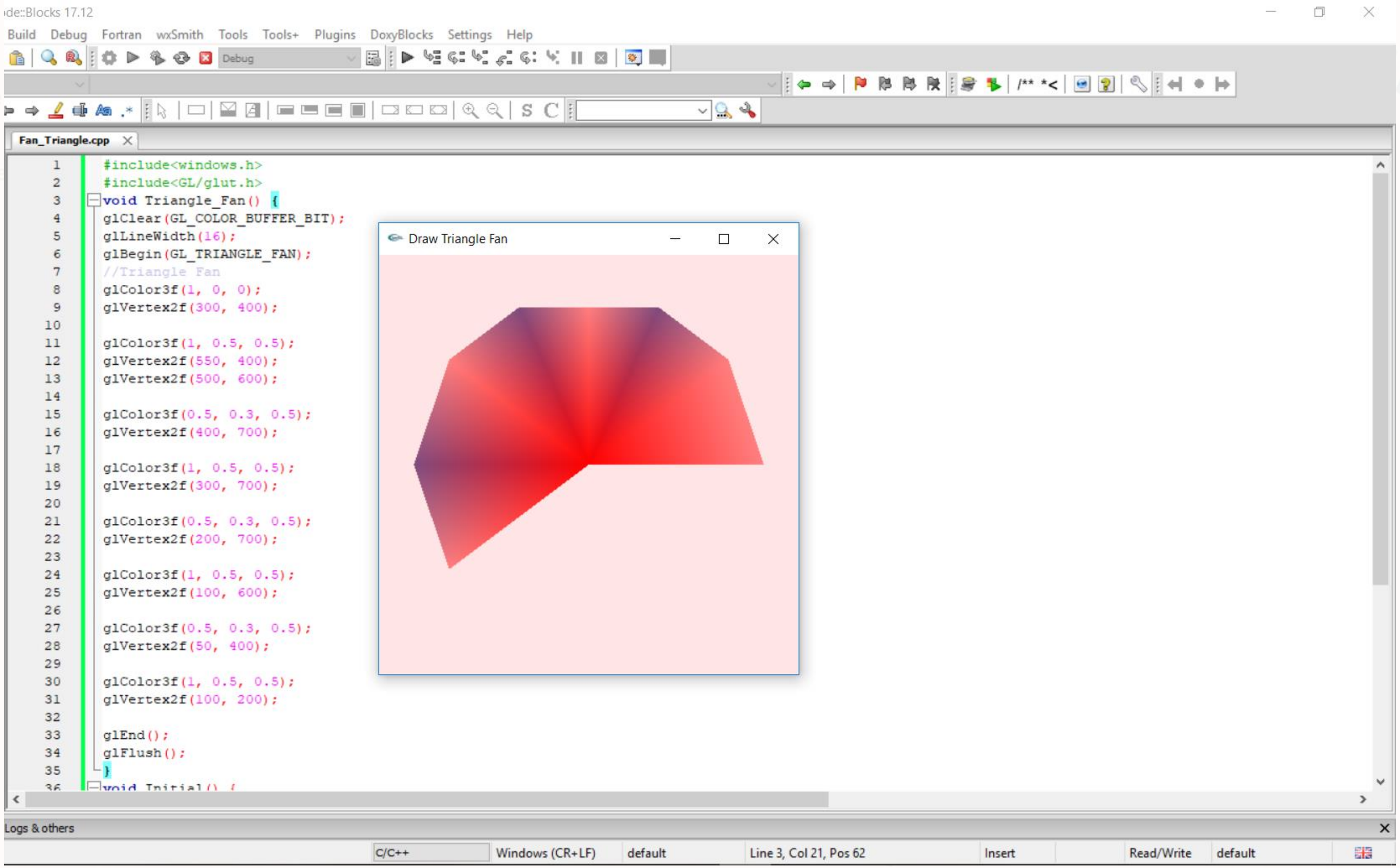
```cpp
#include<windows.h>
#include<GL/glut.h>
void Triangle() {
glClear(GL_COLOR_BUFFER_BIT);
glLineWidth(14);
glBegin(GL_TRIANGLES);
//First Triangle
glColor3f(1, 0, 0);
glVertex2f(100, 100);
glColor3f(0, 1, 0);
glVertex2f(500, 500);
glColor3f(0, 0, 1);
glVertex2f(50, 700);
//Second Triangle
glVertex2f(400, 50);
glVertex2f(550, 50);
glVertex2f(400, 300);
glEnd();
glFlush();
}
void Initial() {
glClearColor(1, 1, 1, 0);
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
gluOrtho2D(0, 600, 0, 800);
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(450, 400);
glutInitWindowPosition(0, 0);
glutCreateWindow("Draw and Color Two Triangles");
Initial();
glutDisplayFunc(Triangle);
glutMainLoop();
return 0; }
```

```
esters\Summer Semester 2019\Computer Graphics\CG Course LAB L   C/C++   Windows (CR+LF)   default   Line 1, Col 20, Pos 19   Insert   Modified   Read/Write   default
```

Draw Triangle Fan using OpenGL

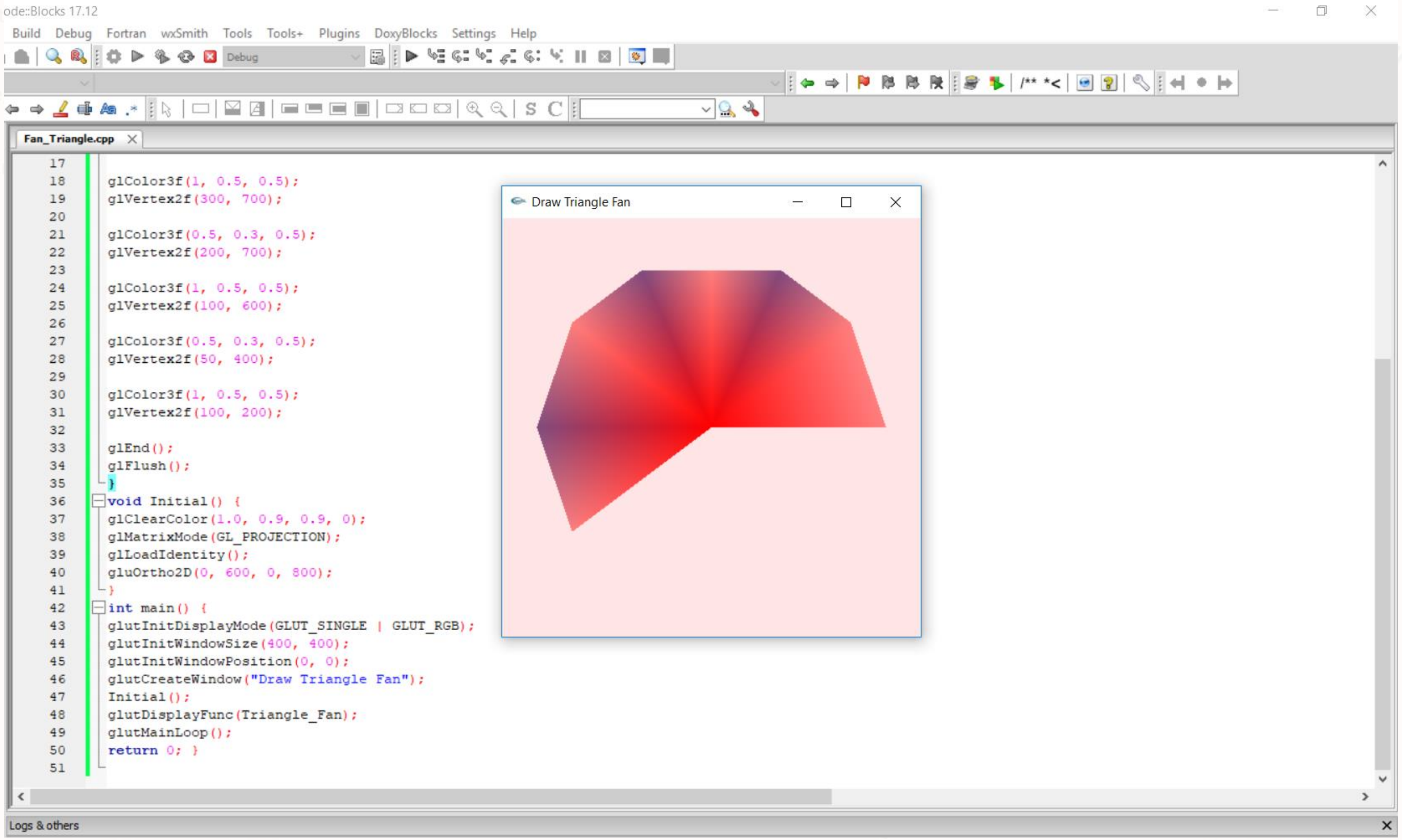
```
#include<windows.h>
#include<GL/glut.h>
void Triangle_Fan() {
glClear(GL_COLOR_BUFFER_BIT);
glLineWidth(16);
glBegin(GL_TRIANGLE_FAN);
//Triangle Fan
glColor3f(1, 0, 0);
glVertex2f(300, 400);

glColor3f(1, 0.5, 0.5);
glVertex2f(550, 400);
glVertex2f(500, 600);

glColor3f(0.5, 0.3, 0.5);
glVertex2f(400, 700);

glColor3f(1, 0.5, 0.5);
glVertex2f(300, 700);

glColor3f(0.5, 0.3, 0.5);
glVertex2f(200, 700);

glColor3f(1, 0.5, 0.5);
glVertex2f(100, 600);

glColor3f(0.5, 0.3, 0.5);
glVertex2f(50, 400);

glColor3f(1, 0.5, 0.5);
glVertex2f(100, 200);

glEnd();
glFlush();
}
void Initial() {
glClearColor(1.0, 0.9, 0.9, 0);
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
gluOrtho2D(0, 600, 0, 800);
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(400, 400);
glutInitWindowPosition(0, 0);
glutCreateWindow("Draw Triangle Fan");
Initial();
glutDisplayFunc(Triangle_Fan);
glutMainLoop();
return 0; }
```

Draw Triangle Fan using OpenGL



```
#include<windows.h>
#include<GL/glut.h>
void Triangle_Fan() {
glClear(GL_COLOR_BUFFER_BIT);
glLineWidth(16);
glBegin(GL_TRIANGLE_FAN);
//Triangle Fan
glColor3f(1, 0, 0);
glVertex2f(300, 400);

glColor3f(1, 0.5, 0.5);
glVertex2f(550, 400);
glVertex2f(500, 600);

glColor3f(0.5, 0.3, 0.5);
glVertex2f(400, 700);

glColor3f(1, 0.5, 0.5);
glVertex2f(300, 700);

glColor3f(0.5, 0.3, 0.5);
glVertex2f(200, 700);

glColor3f(1, 0.5, 0.5);
glVertex2f(100, 600);

glColor3f(0.5, 0.3, 0.5);
glVertex2f(50, 400);

glColor3f(1, 0.5, 0.5);
glVertex2f(100, 200);

glEnd();
glFlush();
}
void Initial() {
```

Draw Triangle Fan using OpenGL


ode::Blocks 17.12
Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help
Debug
Fan_Triangle.cpp
Draw Triangle Fan
Logs & others

```
glColor3f(1, 0.5, 0.5);
glVertex2f(300, 700);

glColor3f(0.5, 0.3, 0.5);
glVertex2f(200, 700);

glColor3f(1, 0.5, 0.5);
glVertex2f(100, 600);

glColor3f(0.5, 0.3, 0.5);
glVertex2f(50, 400);

glColor3f(1, 0.5, 0.5);
glVertex2f(100, 200);

glEnd();
glFlush();
}
void Initial() {
glClearColor(1.0, 0.9, 0.9, 0);
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
gluOrtho2D(0, 600, 0, 800);
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(400, 400);
glutInitWindowPosition(0, 0);
glutCreateWindow("Draw Triangle Fan");
Initial();
glutDisplayFunc(Triangle_Fan);
glutMainLoop();
return 0; }
```

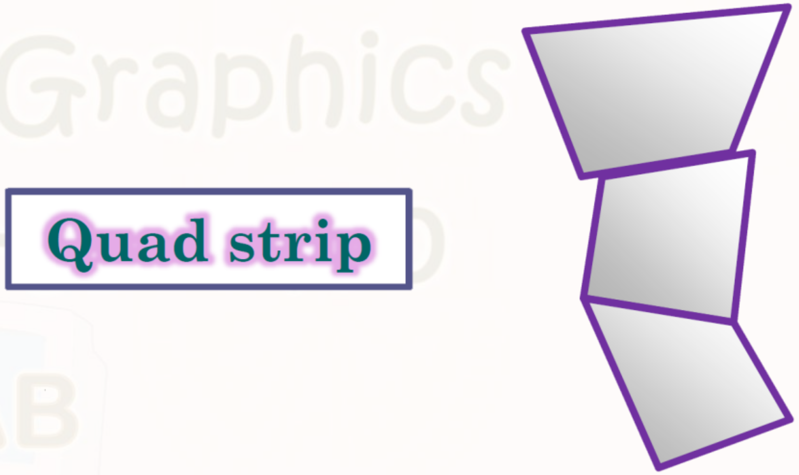
Quads using OpenGL

- **There are 2 functions** with Quad: {**S** | **_STRIP** }.

- **Quad :(GL_QUADS):**
  - To draw normal Quad & Represent as 4 vertices.
  - You can draw more than one quad by determine 4 vertex of each Quad.

Quads using OpenGL

- **Quad Strip : (GL_QUAD_STRIP):**
  - Group of Quads sharing 2 vertices from previous Quad.

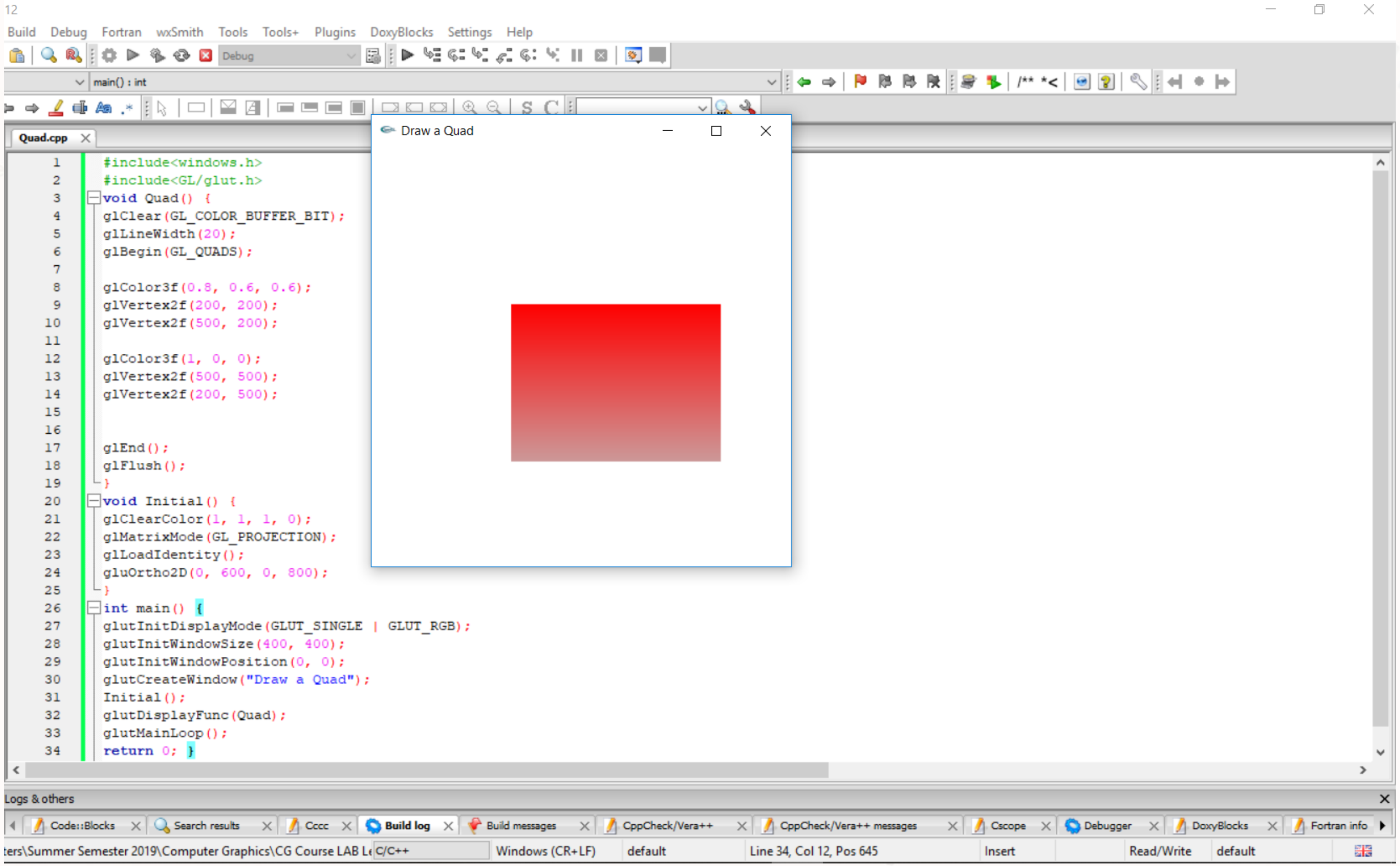


2 vertices per quad

Draw a Square using OpenGL

```
#include<windows.h>
#include<GL/glut.h>
void Quad() {
glClear(GL_COLOR_BUFFER_BIT);
glLineWidth(20);
glBegin(GL_QUADS);
glColor3f(0.8, 0.6, 0.6);
glVertex2f(200, 200);
glVertex2f(500, 200);
glColor3f(1, 0, 0);
glVertex2f(500, 500);
glVertex2f(200, 500);
glEnd();
glFlush();
}
void Initial() {
glClearColor(1, 1, 0);
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
gluOrtho2D(0, 600, 0, 800);
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(400, 400);
glutInitWindowPosition(0, 0);
glutCreateWindow("Draw a Quad");
Initial();
glutDisplayFunc(Quad);
glutMainLoop();
return 0; }
```

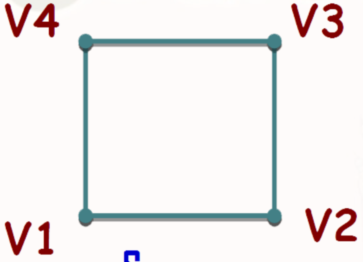
Draw a Square using OpenGL



```
#include<windows.h>
#include<GL/glut.h>
void Quad() {
glClear(GL_COLOR_BUFFER_BIT);
glLineWidth(20);
glBegin(GL_QUADS);

glColor3f(0.8, 0.6, 0.6);
glVertex2f(200, 200);
glVertex2f(500, 200);

glColor3f(1, 0, 0);
glVertex2f(500, 500);
glVertex2f(200, 500);


glEnd();
glFlush();
}
void Initial() {
glClearColor(1, 1, 1, 0);
glMatrixMode(GL_PROJECTION);
glLoadIdentity();
gluOrtho2D(0, 600, 0, 800);
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(400, 400);
glutInitWindowPosition(0, 0);
glutCreateWindow("Draw a Quad");
Initial();
glutDisplayFunc(Quad);
glutMainLoop();
return 0; }
```

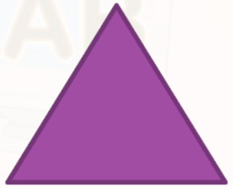
Polygons in OpenGL

- **A Polygon:** is a 2D shape that is made up of a number of vertices.
- An ordered set of vertices defines a polygon.
- You can also set other properties of the polygon, such as its color.
- **Quadrilateral** & **Triangle** is a special case of polygon.
- Use **GL_POLYGON** argument to draw polygon by determine its vertexes.

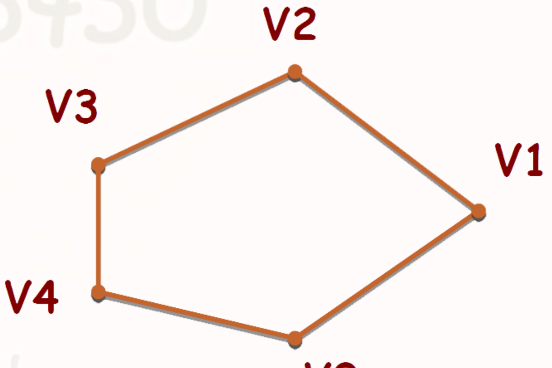


Square

(Quad)

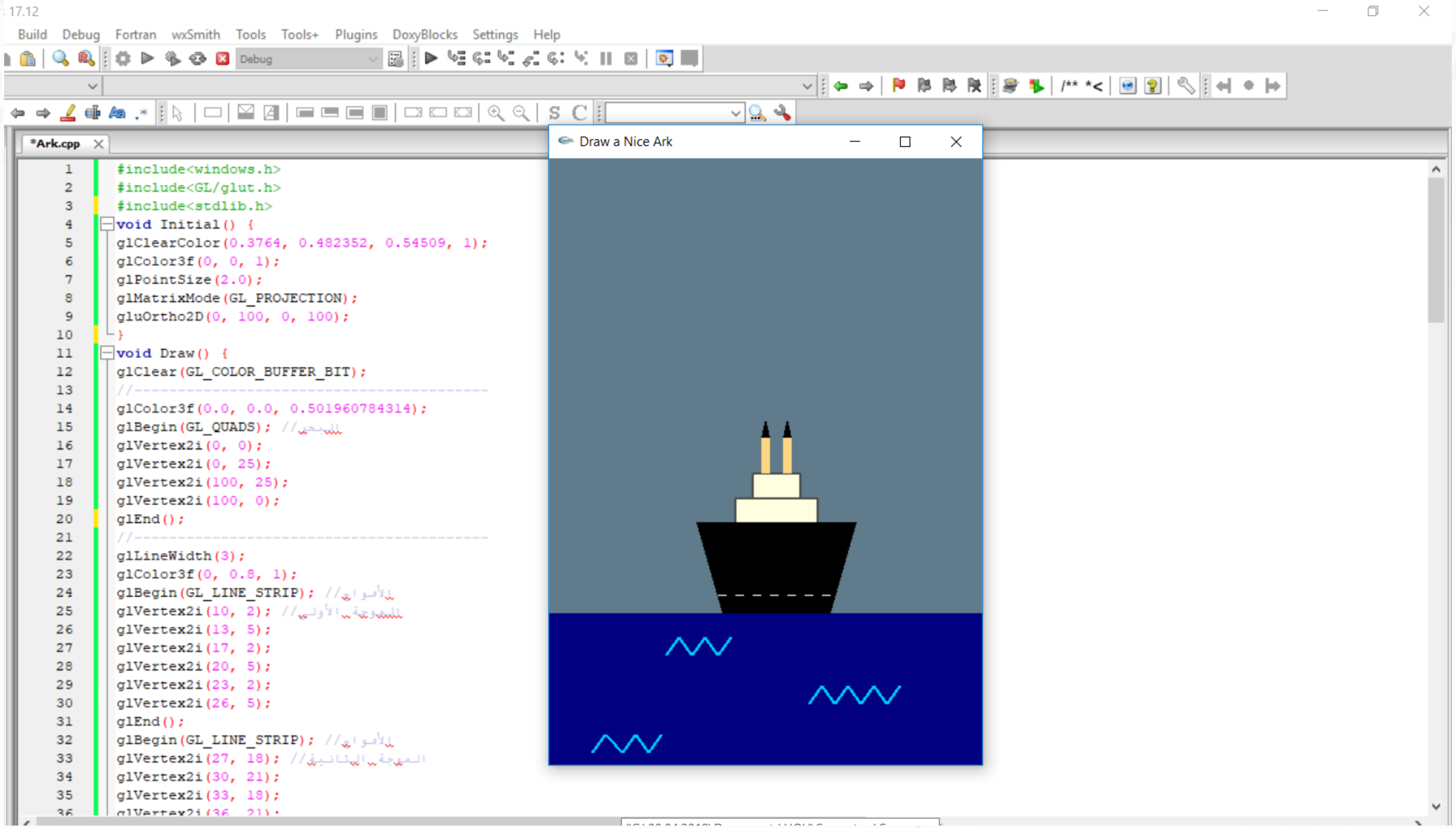


Triangle



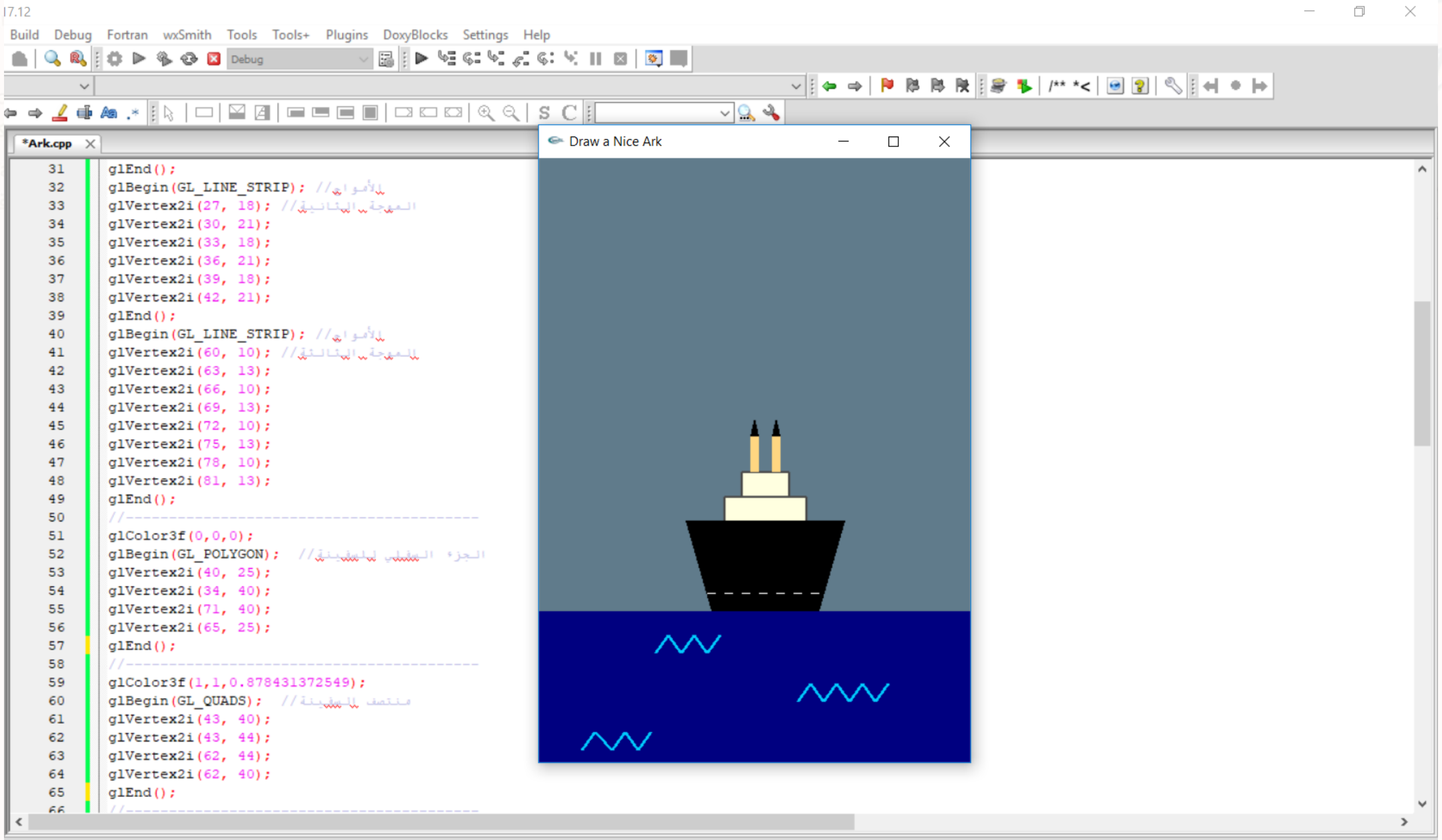
Polygon

Draw Ark using OpenGL



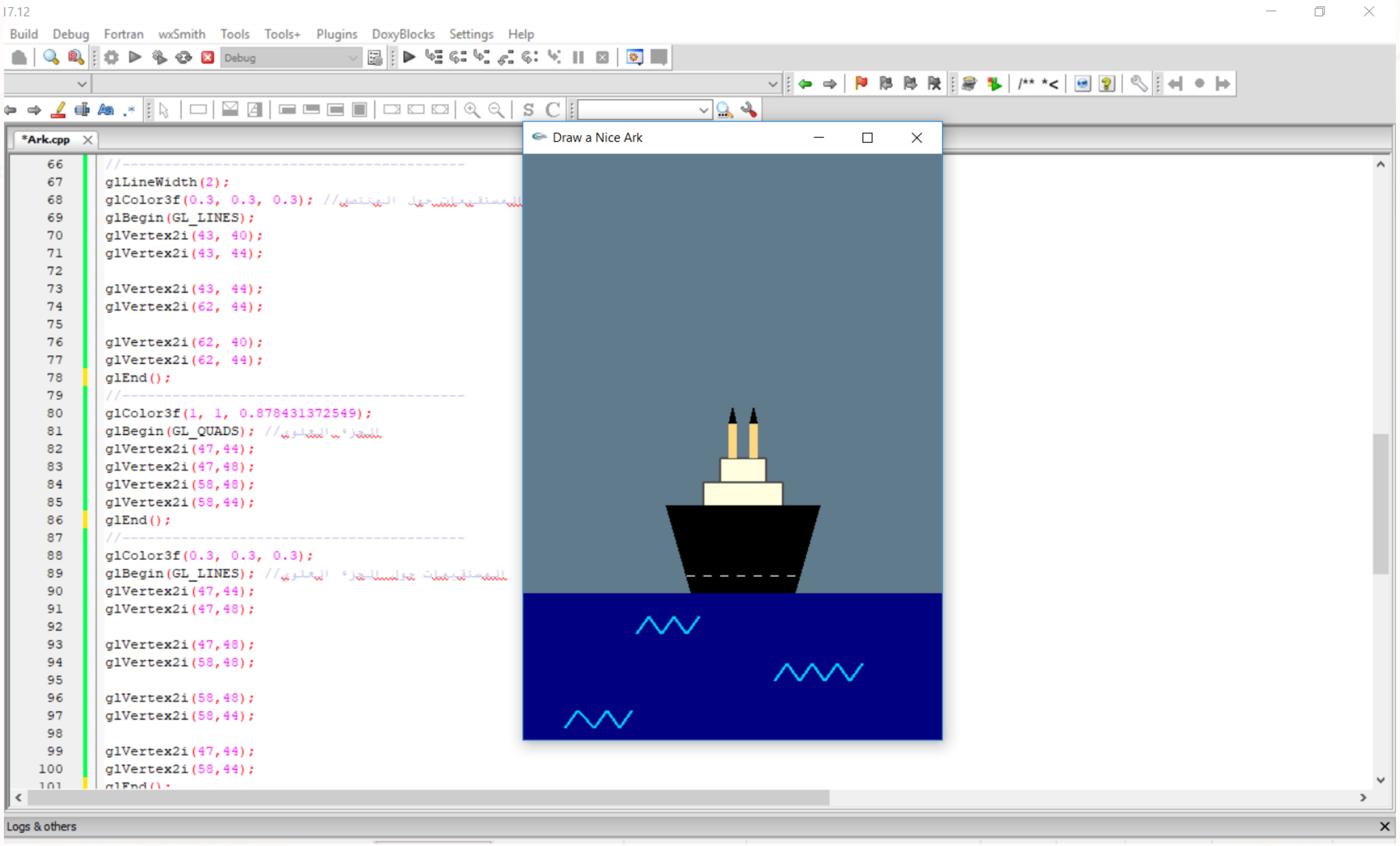
```
#include<windows.h>
#include<GL/glut.h>
#include<stdlib.h>
void Initial() {
glClearColor(0.3764, 0.482352, 0.54509, 1);
glColor3f(0, 0, 1);
glPointSize(2.0);
glMatrixMode(GL_PROJECTION);
gluOrtho2D(0, 100, 0, 100);
}
void Draw() {
glClear(GL_COLOR_BUFFER_BIT);
//--------------------------------------
glColor3f(0.0, 0.0, 0.501960784314);
glBegin(GL_QUADS); //البحر
glVertex2i(0, 0);
glVertex2i(0, 25);
glVertex2i(100, 25);
glVertex2i(100, 0);
glEnd();
//--------------------------------------
glLineWidth(3);
glColor3f(0, 0.8, 1);
glBegin(GL_LINE_STRIP); //الأمواج
glVertex2i(10, 2); //الموجة الأولى
glVertex2i(13, 5);
glVertex2i(17, 2);
glVertex2i(20, 5);
glVertex2i(23, 2);
glVertex2i(26, 5);
glEnd();
glBegin(GL_LINE_STRIP); //الأمواج
glVertex2i(27, 18); //الموجة الثانية
glVertex2i(30, 21);
glVertex2i(33, 18);
glVertex2i(36, 21);
```

Draw Ark using OpenGL


17.12
Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help
Debug
*Ark.cpp
Draw a Nice Ark

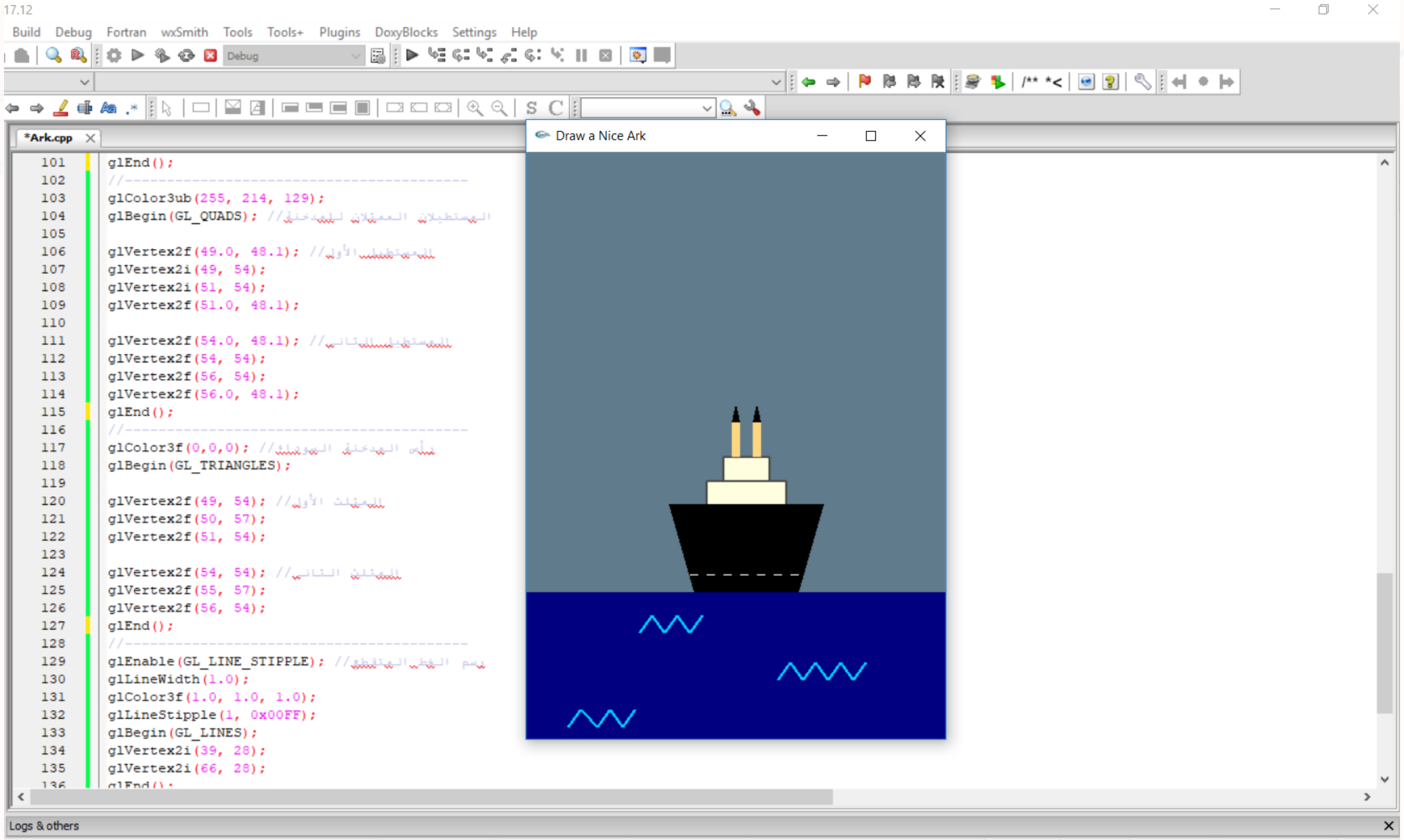
```
glEnd();
glBegin(GL_LINE_STRIP); //الأمواج
glVertex2i(27, 18); //الموجة الثانية
glVertex2i(30, 21);
glVertex2i(33, 18);
glVertex2i(36, 21);
glVertex2i(39, 18);
glVertex2i(42, 21);
glEnd();
glBegin(GL_LINE_STRIP); //الأمواج
glVertex2i(60, 10); //الموجة الثالثة
glVertex2i(63, 13);
glVertex2i(66, 10);
glVertex2i(69, 13);
glVertex2i(72, 10);
glVertex2i(75, 13);
glVertex2i(78, 10);
glVertex2i(81, 13);
glEnd();
//-----------------------------------------
glColor3f(0,0,0);
glBegin(GL_POLYGON);  //الجزء السفلي للسفينة
glVertex2i(40, 25);
glVertex2i(34, 40);
glVertex2i(71, 40);
glVertex2i(65, 25);
glEnd();
//-----------------------------------------
glColor3f(1,1,0.878431372549);
glBegin(GL_QUADS);  //منتصف السفينة
glVertex2i(43, 40);
glVertex2i(43, 44);
glVertex2i(62, 44);
glVertex2i(62, 40);
glEnd();
//-----------------------------------------
```

Draw Ark using OpenGL


17.12
Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help
Debug
*Ark.cpp
Draw a Nice Ark
Logs & others

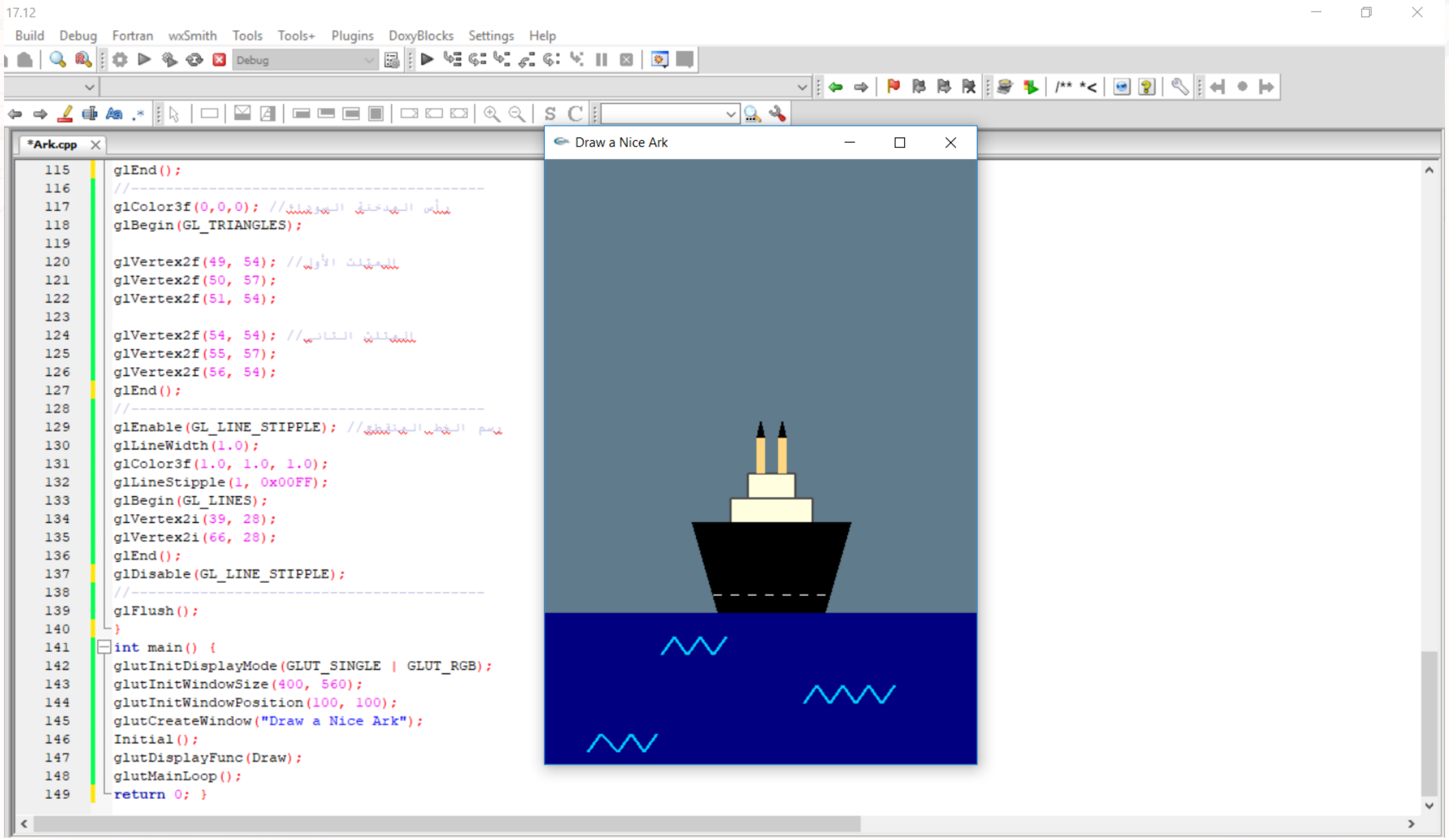
```
//----------------------------------------
glLineWidth(2);
glColor3f(0.3, 0.3, 0.3); //المستقيمات حول المنتصف
glBegin(GL_LINES);
glVertex2i(43, 40);
glVertex2i(43, 44);

glVertex2i(43, 44);
glVertex2i(62, 44);

glVertex2i(62, 40);
glVertex2i(62, 44);
glEnd();
//----------------------------------------
glColor3f(1, 1, 0.878431372549);
glBegin(GL_QUADS); //الجزء العلوي
glVertex2i(47,44);
glVertex2i(47,48);
glVertex2i(58,48);
glVertex2i(58,44);
glEnd();
//----------------------------------------
glColor3f(0.3, 0.3, 0.3);
glBegin(GL_LINES); //المستقيمات حول الجزء العلوي
glVertex2i(47,44);
glVertex2i(47,48);

glVertex2i(47,48);
glVertex2i(58,48);

glVertex2i(58,48);
glVertex2i(58,44);

glVertex2i(47,44);
glVertex2i(58,44);
glEnd();
```

Draw Ark using OpenGL



```
glEnd();
//----------------------------------------
glColor3ub(255, 214, 129);
glBegin(GL_QUADS); //المستطيلان الممثلان للمدخنة

glVertex2f(49.0, 48.1); //المستطيل الأول
glVertex2i(49, 54);
glVertex2i(51, 54);
glVertex2f(51.0, 48.1);

glVertex2f(54.0, 48.1); //المستطيل الثاني
glVertex2f(54, 54);
glVertex2f(56, 54);
glVertex2f(56.0, 48.1);
glEnd();
//----------------------------------------
glColor3f(0,0,0); //رأس المدخنة السوداء
glBegin(GL_TRIANGLES);

glVertex2f(49, 54); //المثلث الأول
glVertex2f(50, 57);
glVertex2f(51, 54);

glVertex2f(54, 54); //المثلث الثاني
glVertex2f(55, 57);
glVertex2f(56, 54);
glEnd();
//----------------------------------------
glEnable(GL_LINE_STIPPLE); //رسم الخط المتقطع
glLineWidth(1.0);
glColor3f(1.0, 1.0, 1.0);
glLineStipple(1, 0x00FF);
glBegin(GL_LINES);
glVertex2i(39, 28);
glVertex2i(66, 28);
glEnd();
```

Draw Ark using OpenGL



```
glEnd();
//------------------------------------------
glColor3f(0,0,0); //رأس المدخنة السوداء
glBegin(GL_TRIANGLES);

glVertex2f(49, 54); //المثلث الأول
glVertex2f(50, 57);
glVertex2f(51, 54);

glVertex2f(54, 54); //المثلث الثاني
glVertex2f(55, 57);
glVertex2f(56, 54);
glEnd();
//------------------------------------------
glEnable(GL_LINE_STIPPLE); //رسم الخط المتقطع
glLineWidth(1.0);
glColor3f(1.0, 1.0, 1.0);
glLineStipple(1, 0x00FF);
glBegin(GL_LINES);
glVertex2i(39, 28);
glVertex2i(66, 28);
glEnd();
glDisable(GL_LINE_STIPPLE);
//------------------------------------------
glFlush();
}
int main() {
glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB);
glutInitWindowSize(400, 560);
glutInitWindowPosition(100, 100);
glutCreateWindow("Draw a Nice Ark");
Initial();
glutDisplayFunc(Draw);
glutMainLoop();
return 0; }
```

Excercise

- Draw a Square that satisfies the following specifications:
  - Line Width = 10.
  - Vertex1 = (200, 200), Vertex2 = (200, 600), Vertex3 = (600, 600), Vertex4 = (200, 600).
  - Color of the Square = Orange.
  - Background Color = White.
  - Window Title Bar = “My Orange Square”.

وصلّى الله وبارك على نبيّنا محمد

The End Summary of Lecture Four

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Adham University College
الكلية الجامعية بأضم

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