Starling Murmuration

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Contents

1 Starling Murmurations 1

2 Class Index 3

2.1 Class List . . . 3

3 File Index 5

3.1 File List . . . 5

4 Class Documentation 7

4.1 boid Class Reference . . . 7

4.1.1 Constructor & Destructor Documentation . . . 8

4.1.1.1 boid() [1/3] . . . 8

4.1.1.2 boid() [2/3] . . . 8

4.1.1.3 boid() [3/3] . . . 8

4.1.2 Member Function Documentation . . . 8

4.1.2.1 boundPosition() . . . 8

4.1.2.2 getFlapStatus() . . . 8

4.1.2.3 getPosition() . . . 9

4.1.2.4 getPrevPosTime() . . . 9

4.1.2.5 getPrevVelocity() . . . 9

4.1.2.6 getVelocity() . . . 9

4.1.2.7 moveBoidToNewPos() . . . 9

4.1.2.8 rule1and2() . . . 9

4.1.2.9 rule3() . . . 9

4.1.2.10 setFlapStatus() . . . 9

4.1.2.11 setPosition() . . . 10
4.1.2.12 setPrevPosTime() . . . 10
4.1.2.13 setPrevVelocity() . . . 10
4.1.2.14 setSystem() . . . 10
4.1.2.15 setVelocity() . . . 10
4.1.2.16 strongWind() . . . 10
4.1.2.17 tendAwayFromPlace() . . . 10
4.1.2.18 tendToPlace() . . . 11
4.1.2.19 updateFlapStatus() . . . 11
4.1.3 Member Data Documentation . . . 11
4.1.3.1 flapStatus . . . 11
4.1.3.2 position . . . 11
4.1.3.3 prevPosTime . . . 11
4.1.3.4 prevVelocity . . . 11
4.1.3.5 sys . . . 11
4.1.3.6 velocity . . . 12
4.2 obstacle Class Reference . . . 12
4.2.1 Member Function Documentation . . . 12
4.2.1.1 boid() [1/2] . . . 13
4.2.1.2 boid() [2/2] . . . 13
4.2.1.3 boundPosition() . . . 13
4.2.1.4 getFlapStatus() . . . 13
4.2.1.5 getPosition() . . . 13
4.2.1.6 getPrevPosTime() . . . 13
4.2.1.7 getVelocity() . . . 13
4.2.1.8 limitVelocity() . . . 14
4.2.1.9 moveBoidToNewPos() . . . 14
4.2.1.10 operator()() . . . 14
4.2.1.11 rule1and2() . . . 14
4.2.1.12 rule3() . . . 14

4.2.1.13 setPosition() . . . 14
4.2.1.14 setPrevPosTime() . . . 14
4.2.1.15 setVelocity() . . . 15
4.2.1.16 strongWind() . . . 15
4.2.1.17 tendAwayFromPlace() . . . 15
4.2.1.18 tendToPlace() . . . 15
4.2.1.19 updateFlapStatus() . . . 15
4.2.2 Member Data Documentation . . . 15
4.2.2.1 flapStatus . . . 15
4.2.2.2 position . . . 15
4.2.2.3 prevPosTime . . . 16
4.2.2.4 prevVelocity . . . 16
4.2.2.5 velocity . . . 16
4.3 predator Class Reference . . . 16
4.3.1 Constructor & Destructor Documentation . . . 17
4.3.1.1 predator() [1/3] . . . 17
4.3.1.2 predator() [2/3] . . . 17
4.3.1.3 predator() [3/3] . . . 17
4.3.2 Member Function Documentation . . . 17
4.3.2.1 boundPosition() . . . 17
4.3.2.2 getFlapStatus() . . . 18
4.3.2.3 getPosition() . . . 18
4.3.2.4 getPrevPosTime() . . . 18
4.3.2.5 getPrevVelocity() . . . 18
4.3.2.6 getVelocity() . . . 18
4.3.2.7 movePredatorToNewPos() . . . 18
4.3.2.8 rule1() . . . 18
4.3.2.9 rule3() . . . 18
4.3.2.10 setFlapStatus() . . . 19
4.3.2.11 setPosition() . . . 19

4.3.2.12 setPrevPosTime() . . . 19
4.3.2.13 setPrevVelocity() . . . 19
4.3.2.14 setSystem() . . . 19
4.3.2.15 setVelocity() . . . 19
4.3.2.16 strongWind() . . . 19
4.3.2.17 tendAwayFromPlace() . . . 20
4.3.2.18 tendToPlace() . . . 20
4.3.2.19 updateFlapStatus() . . . 20
4.3.3 Member Data Documentation . . . 20
4.3.3.1 flapStatus . . . 20
4.3.3.2 position . . . 20
4.3.3.3 prevPosTime . . . 20
4.3.3.4 prevVelocity . . . 20
4.3.3.5 sys . . . 21
4.3.3.6 velocity . . . 21
4.4 system Class Reference . . . 21
4.4.1 Constructor & Destructor Documentation . . . 22
4.4.1.1 system() . . . 22
4.4.2 Member Function Documentation . . . 22
4.4.2.1 addBoid() [1/4] . . . 22
4.4.2.2 addBoid() [2/4] . . . 22
4.4.2.3 addBoid() [3/4] . . . 22
4.4.2.4 addBoid() [4/4] . . . 23
4.4.2.5 addObstacle() [1/2] . . . 23
4.4.2.6 addObstacle() [2/2] . . . 23
4.4.2.7 addPredator() [1/4] . . . 23
4.4.2.8 addPredator() [2/4] . . . 23
4.4.2.9 addPredator() [3/4] . . . 23
4.4.2.10 addPredator() [4/4] . . . 23
4.4.2.11 findNearestBoid() . . . 24

4.4.2.12 findNeighbouringBoids() [1/2] . . . 24
4.4.2.13 findNeighbouringBoids() [2/2] . . . 24
4.4.2.14 findObstaclesForPredator() . . . 24
4.4.2.15 findVeryCloseObjects() . . . 24
4.4.2.16 flock() . . . 24
4.4.2.17 getBoids() . . . 24
4.4.2.18 getNumBoids() . . . 25
4.4.2.19 getNumObstacles() . . . 25
4.4.2.20 getNumPredators() . . . 25
4.4.2.21 getObstacles() . . . 25
4.4.2.22 getPredators() . . . 25
4.4.2.23 getWind() . . . 25
4.4.2.24 getWindPresent() . . . 25
4.4.2.25 setNumBoids() . . . 25
4.4.2.26 setNumObstacles() . . . 26
4.4.2.27 setNumPredators() . . . 26
4.4.2.28 setWind() . . . 26
4.4.2.29 setWindPresent() . . . 26
4.4.2.30 startWithBoids() . . . 26
4.4.2.31 updateSystem() . . . 26
4.4.3 Member Data Documentation . . . 26
4.4.3.1 boids [1/2] . . . 27
4.4.3.2 boids [2/2] . . . 27
4.4.3.3 numBoids . . . 27
4.4.3.4 numObstacles . . . 27
4.4.3.5 numPredators . . . 27
4.4.3.6 obstacles [1/2] . . . 27
4.4.3.7 obstacles [2/2] . . . 27
4.4.3.8 predators [1/2] . . . 27
4.4.3.9 predators [2/2] . . . 28
4.4.3.10 wind . . . 28
4.4.3.11 windPresent . . . 28

5 File Documentation **29**

5.1 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/boid.h File Reference . 29

5.1.1 Macro Definition Documentation 29

5.1.1.1 maxDistForRule1 29

5.2 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/controls.h File Reference 29

5.2.1 Function Documentation 30

5.2.1.1 computeMatricesFromInputs() 30

5.2.1.2 getModelMatrix() 30

5.2.1.3 getProjectionMatrix() 30

5.2.1.4 getViewMatrix() 30

5.3 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/flock.h File Reference . 30

5.4 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/obstacle.h File Reference 30

5.5 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/params.h File Reference 31

5.5.1 Macro Definition Documentation 31

5.5.1.1 flapStates 31

5.5.1.2 maxSpeed 31

5.5.1.3 minDistance 32

5.5.1.4 minDistanceForObstacles 32

5.5.1.5 minDistanceForPredators 32

5.5.1.6 v1Mul 32

5.5.1.7 v2Mul 32

5.5.1.8 v3Mul 32

5.5.1.9 v4Mul 32

5.5.1.10 velocityDivision 32

5.5.1.11 vMul 33

5.5.1.12 xmax 33

5.5.1.13 xmin 33

5.5.1.14 ymax 33

5.5.1.15 ymin 33

5.5.1.16 zmax 33

5.5.1.17 zmin . . . 33
5.6 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/predator.h File Reference 33
5.7 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/shader.h File Reference 34
5.7.1 Function Documentation . . . 34
5.7.1.1 LoadShaders() . . . 34
5.8 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/system.h File Reference 34
5.9 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/README.md File Reference . 34
5.10 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/boid.cpp File Reference . . 34
5.10.1 Function Documentation . . . 35
5.10.1.1 compareFloats() . . . 35
5.10.1.2 limitVelocity() . . . 35
5.10.1.3 normalizeVelocity() . . . 35
5.10.1.4 printvec() . . . 35
5.11 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/inout.cpp File Reference . . 36
5.11.1 Function Documentation . . . 37
5.11.1.1 computeRotationOfFrame() . . . 37
5.11.1.2 createBuffers() . . . 38
5.11.1.3 display() . . . 38
5.11.1.4 display_obstacle() . . . 38
5.11.1.5 endEverything() . . . 38
5.11.1.6 initializeEverything() . . . 38
5.11.1.7 initializeWindow() . . . 38
5.11.1.8 mouseButtonCallback() . . . 38
5.11.1.9 output() . . . 39
5.11.1.10 setObjectID() . . . 39
5.11.1.11 setShaders() . . . 39
5.11.2 Variable Documentation . . . 39
5.11.2.1 allow . . . 39
5.11.2.2 angle_x . . . 39
5.11.2.3 angle_y . . . 39

5.11.2.4 boidColor . . . 39
5.11.2.5 elementbuffer_flap . . . 40
5.11.2.6 elementbuffer_obstacle . . . 40
5.11.2.7 FoV . . . 40
5.11.2.8 indices_flap . . . 40
5.11.2.9 indices_obstacle . . . 40
5.11.2.10 LightID . . . 40
5.11.2.11 lightPos . . . 40
5.11.2.12 MatrixID . . . 40
5.11.2.13 MatrixID_lighting . . . 41
5.11.2.14 ModelMatrixID . . . 41
5.11.2.15 ModelMatrixID_lighting . . . 41
5.11.2.16 normalbuffer_obstacle . . . 41
5.11.2.17 normals_obstacle . . . 41
5.11.2.18 obstacleColor . . . 41
5.11.2.19 position . . . 41
5.11.2.20 predatorColor . . . 42
5.11.2.21 programID . . . 42
5.11.2.22 programID_lighting . . . 42
5.11.2.23 projectionMatrix . . . 42
5.11.2.24 quit . . . 42
5.11.2.25 rotationMatrixFrame . . . 42
5.11.2.26 rotMatrix . . . 42
5.11.2.27 scalingFactorID . . . 42
5.11.2.28 scalingFactorID_lighting . . . 43
5.11.2.29 Speed . . . 43
5.11.2.30 sys . . . 43
5.11.2.31 vertexbuffer_flap1 . . . 43
5.11.2.32 vertexbuffer_flap2 . . . 43
5.11.2.33 vertexbuffer_obstacle . . . 43

5.11.2.34 vertexColorID . . . 43
5.11.2.35 vertexColorID_lighting . . . 43
5.11.2.36 vertexNormalID . . . 44
5.11.2.37 vertexPosID . . . 44
5.11.2.38 vertexPosID_ligthing . . . 44
5.11.2.39 vertices_flap1 . . . 44
5.11.2.40 vertices_flap2 . . . 44
5.11.2.41 vertices_obstacle . . . 44
5.11.2.42 viewMatrix . . . 45
5.11.2.43 ViewMatrixID . . . 45
5.11.2.44 ViewMatrixID_lighting . . . 45
5.11.2.45 window . . . 45
5.12 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/main.cpp File Reference . . . 45
5.12.1 Function Documentation . . . 46
5.12.1.1 initializeEverything() . . . 46
5.12.1.2 main() . . . 46
5.12.1.3 mouseButtonCallback() . . . 46
5.12.1.4 output() . . . 46
5.12.1.5 print() . . . 46
5.12.2 Variable Documentation . . . 46
5.12.2.1 quit . . . 47
5.12.2.2 sys . . . 47
5.12.2.3 window . . . 47
5.13 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/predator.cpp File Reference 47
5.13.1 Function Documentation . . . 47
5.13.1.1 compareFloats() . . . 47
5.13.1.2 limitVelocity() . . . 48
5.13.1.3 normalizeVelocity() . . . 48
5.13.1.4 printvec() . . . 48
5.14 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/shader.cpp File Reference . 48
5.14.1 Function Documentation . . . 48
5.14.1.1 LoadShaders() . . . 48
5.15 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/system.cpp File Reference . 49
5.15.1 Function Documentation . . . 49
5.15.1.1 distance() . . . 49

Index **51**

Chapter 1

Starling Murmurations

The software structure is designed to simulate the motion of Starlings using C++. OpenGL is used for animation.

Getting Started

Prerequisites

To install glew:

```
cd external/glew-1.13.0
make
sudo -s
make install
make clean
```

To install openGL:

```
cd external/glfw-3.1.2
mkdir build
cd build
cmake ..
make
sudo make install
```

To install glm:

```
cd external/glm-0.9.7.1
mkdir build
cd build
cmake ..
make
sudo make install
```

Installing

For Mac type:

```
make clean
make mac
```

For Linux type:

```
make clean
make linux
```

Usage

To start the program type

```
./app <number of starlings to start with (Default 500)>
```

To add more boids to the screen, point at the desired position on the window and left click while pressing "B" on Keyboard. To add predators to the screen, point at the desired position on the window and left click while pressing "P" on Keyboard. To add still obstacles to the screen, point at the desired position on the window and left click while pressing "O" on Keyboard.

For rotating the frame of view, use the arrow keys.

Chapter 2

Class Index

2.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

boid 7
obstacle 12
predator 16
system 21

Chapter 3

File Index

3.1 File List

Here is a list of all files with brief descriptions:

/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/boid.h 29
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/controls.h 29
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/flock.h 30
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/obstacle.h 30
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/params.h 31
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/predator.h 33
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/shader.h 34
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/system.h 34
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/boid.cpp 34
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/inout.cpp 36
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/main.cpp 45
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/predator.cpp 47
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/shader.cpp 48
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/system.cpp 49

Chapter 4

Class Documentation

4.1 boid Class Reference

`#include <boid.h>`

Public Member Functions

- boid (class system ∗)
- boid (vec3, class system ∗)
- boid (vec3, vec3, class system ∗)
- pair< vec3, vec3 > rule1and2 ()
- pair< vec3, vec3 > rule3 ()
- vec3 strongWind ()
- vec3 tendToPlace (vec3)
- vec3 tendAwayFromPlace ()
- void moveBoidToNewPos ()
- vec3 boundPosition (vec3)
- vec3 getPosition ()
- void setPosition (vec3)
- vec3 getVelocity ()
- void setVelocity (vec3)
- vec3 getPrevVelocity ()
- void setPrevVelocity (vec3)
- long getPrevPosTime ()
- void setPrevPosTime (long)
- int getFlapStatus ()
- void setFlapStatus (int)
- int updateFlapStatus ()
- void setSystem (class system ∗)

Private Attributes

- vec3 position
- vec3 velocity
- vec3 prevVelocity
- long prevPosTime
- int flapStatus
- class system ∗ sys

4.1.1 Constructor & Destructor Documentation

4.1.1.1 boid() [1/3]

```
boid::boid (
            class system * s )
```

4.1.1.2 boid() [2/3]

```
boid::boid (
            vec3 pos,
            class system * s )
```

4.1.1.3 boid() [3/3]

```
boid::boid (
            vec3 pos,
            vec3 vel,
            class system * s )
```

4.1.2 Member Function Documentation

4.1.2.1 boundPosition()

```
vec3 boid::boundPosition (
            vec3 vel )
```

4.1.2.2 getFlapStatus()

```
int boid::getFlapStatus ( )
```

4.1.2.3 getPosition()

```
vec3 boid::getPosition ( )
```

4.1.2.4 getPrevPosTime()

```
long boid::getPrevPosTime ( )
```

4.1.2.5 getPrevVelocity()

```
vec3 boid::getPrevVelocity ( )
```

4.1.2.6 getVelocity()

```
vec3 boid::getVelocity ( )
```

4.1.2.7 moveBoidToNewPos()

```
void boid::moveBoidToNewPos ( )
```

4.1.2.8 rule1and2()

```
pair< vec3, vec3 > boid::rule1and2 ( )
```

4.1.2.9 rule3()

```
pair< vec3, vec3 > boid::rule3 ( )
```

4.1.2.10 setFlapStatus()

```
void boid::setFlapStatus (
            int s )
```

4.1.2.11 setPosition()

```
void boid::setPosition (
            vec3 position )
```

4.1.2.12 setPrevPosTime()

```
void boid::setPrevPosTime (
            long prevPosTime )
```

4.1.2.13 setPrevVelocity()

```
void boid::setPrevVelocity (
            vec3 v )
```

4.1.2.14 setSystem()

```
void boid::setSystem (
            class system * s )
```

4.1.2.15 setVelocity()

```
void boid::setVelocity (
            vec3 velocity )
```

4.1.2.16 strongWind()

```
vec3 boid::strongWind ( )
```

4.1.2.17 tendAwayFromPlace()

```
vec3 boid::tendAwayFromPlace ( )
```

4.1.2.18 tendToPlace()

```
vec3 boid::tendToPlace (
            vec3 place )
```

4.1.2.19 updateFlapStatus()

```
int boid::updateFlapStatus ( )
```

4.1.3 Member Data Documentation

4.1.3.1 flapStatus

```
int boid::flapStatus  [private]
```

4.1.3.2 position

```
vec3 boid::position  [private]
```

4.1.3.3 prevPosTime

```
long boid::prevPosTime  [private]
```

4.1.3.4 prevVelocity

```
vec3 boid::prevVelocity  [private]
```

4.1.3.5 sys

```
class system* boid::sys  [private]
```

4.1.3.6 velocity

```
vec3 boid::velocity  [private]
```

The documentation for this class was generated from the following files:

- /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/boid.h
- /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/boid.cpp

4.2 obstacle Class Reference

```
#include <obstacle.h>
```

Public Member Functions

- boid (vec3)
- boid (vec3, vec3)
- operator() ()
- vec3 rule1and2 ()
- vec3 rule3 ()
- vec3 strongWind ()
- vec3 tendToPlace ()
- vec3 tendAwayFromPlace ()
- void boundPosition ()
- void limitVelocity ()
- void moveBoidToNewPos ()
- vec3 getPosition ()
- void setPosition (vec3)
- vec3 getVelocity ()
- void setVelocity (vec3)
- long getPrevPosTime ()
- void setPrevPosTime (long)
- int getFlapStatus ()
- int updateFlapStatus ()

Private Attributes

- vec3 position
- vec3 velocity
- vec3 prevVelocity
- long prevPosTime
- int flapStatus

4.2.1 Member Function Documentation

4.2.1.1 boid() [1/2]

```
obstacle::boid (
             vec3  )
```

4.2.1.2 boid() [2/2]

```
obstacle::boid (
             vec3 ,
             vec3  )
```

4.2.1.3 boundPosition()

```
void obstacle::boundPosition ( )
```

4.2.1.4 getFlapStatus()

```
int obstacle::getFlapStatus ( )
```

4.2.1.5 getPosition()

```
vec3 obstacle::getPosition ( )
```

4.2.1.6 getPrevPosTime()

```
long obstacle::getPrevPosTime ( )
```

4.2.1.7 getVelocity()

```
vec3 obstacle::getVelocity ( )
```

4.2.1.8 limitVelocity()

```
void obstacle::limitVelocity ( )
```

4.2.1.9 moveBoidToNewPos()

```
void obstacle::moveBoidToNewPos ( )
```

4.2.1.10 operator()()

```
obstacle::operator() ( )
```

4.2.1.11 rule1and2()

```
vec3 obstacle::rule1and2 ( )
```

4.2.1.12 rule3()

```
vec3 obstacle::rule3 ( )
```

4.2.1.13 setPosition()

```
void obstacle::setPosition (
            vec3  )
```

4.2.1.14 setPrevPosTime()

```
void obstacle::setPrevPosTime (
            long  )
```

4.2.1.15 setVelocity()

```
void obstacle::setVelocity (
             vec3  )
```

4.2.1.16 strongWind()

```
vec3 obstacle::strongWind ( )
```

4.2.1.17 tendAwayFromPlace()

```
vec3 obstacle::tendAwayFromPlace ( )
```

4.2.1.18 tendToPlace()

```
vec3 obstacle::tendToPlace ( )
```

4.2.1.19 updateFlapStatus()

```
int obstacle::updateFlapStatus ( )
```

4.2.2 Member Data Documentation

4.2.2.1 flapStatus

```
int obstacle::flapStatus  [private]
```

4.2.2.2 position

```
vec3 obstacle::position  [private]
```

4.2.2.3 prevPosTime

```
long obstacle::prevPosTime  [private]
```

4.2.2.4 prevVelocity

```
vec3 obstacle::prevVelocity  [private]
```

4.2.2.5 velocity

```
vec3 obstacle::velocity  [private]
```

The documentation for this class was generated from the following file:

- /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/obstacle.h

4.3 predator Class Reference

```
#include <predator.h>
```

Public Member Functions

- predator (class system *)
- predator (vec3, class system *)
- predator (vec3, vec3, class system *)
- vec3 rule1 ()
- vec3 rule3 ()
- vec3 strongWind ()
- vec3 tendToPlace (vec3)
- vec3 tendAwayFromPlace ()
- vec3 boundPosition (vec3)
- void movePredatorToNewPos ()
- vec3 getPosition ()
- void setPosition (vec3)
- vec3 getVelocity ()
- void setVelocity (vec3)
- vec3 getPrevVelocity ()
- void setPrevVelocity (vec3)
- long getPrevPosTime ()
- void setPrevPosTime (long)
- int getFlapStatus ()
- int updateFlapStatus ()
- void setFlapStatus (int)
- void setSystem (class system *)

Private Attributes

- vec3 position
- vec3 velocity
- vec3 prevVelocity
- long prevPosTime
- int flapStatus
- class system * sys

4.3.1 Constructor & Destructor Documentation

4.3.1.1 predator() [1/3]

```
predator::predator (
            class system * s )
```

4.3.1.2 predator() [2/3]

```
predator::predator (
            vec3 pos,
            class system * s )
```

4.3.1.3 predator() [3/3]

```
predator::predator (
            vec3 pos,
            vec3 vel,
            class system * s )
```

4.3.2 Member Function Documentation

4.3.2.1 boundPosition()

```
vec3 predator::boundPosition (
            vec3 vel )
```

4.3.2.2 getFlapStatus()

```
int predator::getFlapStatus ( )
```

4.3.2.3 getPosition()

```
vec3 predator::getPosition ( )
```

4.3.2.4 getPrevPosTime()

```
long predator::getPrevPosTime ( )
```

4.3.2.5 getPrevVelocity()

```
vec3 predator::getPrevVelocity ( )
```

4.3.2.6 getVelocity()

```
vec3 predator::getVelocity ( )
```

4.3.2.7 movePredatorToNewPos()

```
void predator::movePredatorToNewPos ( )
```

4.3.2.8 rule1()

```
vec3 predator::rule1 ( )
```

4.3.2.9 rule3()

```
vec3 predator::rule3 ( )
```

4.3.2.10 setFlapStatus()

```
void predator::setFlapStatus (
            int s )
```

4.3.2.11 setPosition()

```
void predator::setPosition (
            vec3 position )
```

4.3.2.12 setPrevPosTime()

```
void predator::setPrevPosTime (
            long prevPosTime )
```

4.3.2.13 setPrevVelocity()

```
void predator::setPrevVelocity (
            vec3 v )
```

4.3.2.14 setSystem()

```
void predator::setSystem (
            class system * s )
```

4.3.2.15 setVelocity()

```
void predator::setVelocity (
            vec3 velocity )
```

4.3.2.16 strongWind()

```
vec3 predator::strongWind ( )
```

4.3.2.17 tendAwayFromPlace()

```
vec3 predator::tendAwayFromPlace ( )
```

4.3.2.18 tendToPlace()

```
vec3 predator::tendToPlace (
            vec3 place )
```

4.3.2.19 updateFlapStatus()

```
int predator::updateFlapStatus ( )
```

4.3.3 Member Data Documentation

4.3.3.1 flapStatus

```
int predator::flapStatus  [private]
```

4.3.3.2 position

```
vec3 predator::position  [private]
```

4.3.3.3 prevPosTime

```
long predator::prevPosTime  [private]
```

4.3.3.4 prevVelocity

```
vec3 predator::prevVelocity  [private]
```

4.3.3.5 sys

```
class system* predator::sys  [private]
```

4.3.3.6 velocity

```
vec3 predator::velocity  [private]
```

The documentation for this class was generated from the following files:

- /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/predator.h
- /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/predator.cpp

4.4 system Class Reference

```
#include <flock.h>
```

Public Member Functions

- flock ()
- void addBoid (boid)
- void addPredator (predator)
- void addObstacle (obstacle)
- vector< vector< vec3 > > findNeighbouringBoids (vec3)
- system ()
- void addBoid (class boid)
- void addBoid (vec3)
- void addBoid (vec3, vec3)
- void addPredator (class predator)
- void addPredator (vec3)
- void addPredator (vec3, vec3)
- void addObstacle (vec3)
- vector< pair< vec3, vec3 > > findNeighbouringBoids (vec3)
- pair< vector< pair< vec3, vec3 > >, vector< pair< vec3, vec3 > > > findVeryCloseObjects (vec3)
- pair< vec3, vec3 > findNearestBoid (vec3)
- pair< vector< pair< vec3, vec3 > >, vector< pair< vec3, vec3 > > > findObstaclesForPredator (vec3)
- void startWithBoids (int)
- int getNumBoids ()
- void setNumBoids (int)
- int getNumPredators ()
- void setNumPredators (int)
- int getNumObstacles ()
- void setNumObstacles (int)
- void updateSystem ()
- vector< class boid > & getBoids ()
- vector< class predator > & getPredators ()
- vector< vec3 > & getObstacles ()
- vec3 getWind ()
- void setWind (vec3)
- bool getWindPresent ()
- void setWindPresent (bool)

Private Attributes

- vector< boid * > boids
- vector< predator * > predators
- vector< obstacle * > obstacles
- vector< class boid > boids
- vector< class predator > predators
- vector< vec3 > obstacles
- int numBoids
- int numPredators
- int numObstacles
- bool windPresent
- vec3 wind

4.4.1 Constructor & Destructor Documentation

4.4.1.1 system()

```
system::system ( )
```

4.4.2 Member Function Documentation

4.4.2.1 addBoid() [1/4]

```
void system::addBoid (
            boid b )
```

4.4.2.2 addBoid() [2/4]

```
void system::addBoid (
            class boid  )
```

4.4.2.3 addBoid() [3/4]

```
void system::addBoid (
            vec3 pos )
```

4.4.2.4 addBoid() [4/4]

```
void system::addBoid (
            vec3 pos,
            vec3 vel )
```

4.4.2.5 addObstacle() [1/2]

```
void system::addObstacle (
            obstacle  )
```

4.4.2.6 addObstacle() [2/2]

```
void system::addObstacle (
            vec3 o )
```

4.4.2.7 addPredator() [1/4]

```
void system::addPredator (
            predator p )
```

4.4.2.8 addPredator() [2/4]

```
void system::addPredator (
            class predator  )
```

4.4.2.9 addPredator() [3/4]

```
void system::addPredator (
            vec3 pos )
```

4.4.2.10 addPredator() [4/4]

```
void system::addPredator (
            vec3 pos,
            vec3 vel )
```

4.4.2.11 findNearestBoid()

```
pair< vec3, vec3 > system::findNearestBoid (
            vec3 p )
```

4.4.2.12 findNeighbouringBoids() [1/2]

```
vector< pair< vec3, vec3 > > system::findNeighbouringBoids (
            vec3 b )
```

4.4.2.13 findNeighbouringBoids() [2/2]

```
vector<pair<vec3,vec3> > system::findNeighbouringBoids (
            vec3  )
```

4.4.2.14 findObstaclesForPredator()

```
pair< vector< pair< vec3, vec3 > >, vector< pair< vec3, vec3 > > > system::findObstacles↩
ForPredator (
            vec3 b )
```

4.4.2.15 findVeryCloseObjects()

```
pair< vector< pair< vec3, vec3 > >, vector< pair< vec3, vec3 > > > system::findVeryClose↩
Objects (
            vec3 b )
```

4.4.2.16 flock()

```
system::flock ( )
```

4.4.2.17 getBoids()

```
vector< boid > & system::getBoids ( )
```

4.4.2.18 getNumBoids()

```
int system::getNumBoids ( )
```

4.4.2.19 getNumObstacles()

```
int system::getNumObstacles ( )
```

4.4.2.20 getNumPredators()

```
int system::getNumPredators ( )
```

4.4.2.21 getObstacles()

```
vector< vec3 > & system::getObstacles ( )
```

4.4.2.22 getPredators()

```
vector< class predator > & system::getPredators ( )
```

4.4.2.23 getWind()

```
vec3 system::getWind ( )
```

4.4.2.24 getWindPresent()

```
bool system::getWindPresent ( )
```

4.4.2.25 setNumBoids()

```
void system::setNumBoids (
            int n )
```

4.4.2.26 setNumObstacles()

```
void system::setNumObstacles (
            int n )
```

4.4.2.27 setNumPredators()

```
void system::setNumPredators (
            int n )
```

4.4.2.28 setWind()

```
void system::setWind (
            vec3 w )
```

4.4.2.29 setWindPresent()

```
void system::setWindPresent (
            bool wp )
```

4.4.2.30 startWithBoids()

```
void system::startWithBoids (
            int n )
```

4.4.2.31 updateSystem()

```
void system::updateSystem ( )
```

4.4.3 Member Data Documentation

4.4.3.1 boids [1/2]

```
vector<boid*> system::boids  [private]
```

4.4.3.2 boids [2/2]

```
vector<class boid> system::boids  [private]
```

4.4.3.3 numBoids

```
int system::numBoids  [private]
```

4.4.3.4 numObstacles

```
int system::numObstacles  [private]
```

4.4.3.5 numPredators

```
int system::numPredators  [private]
```

4.4.3.6 obstacles [1/2]

```
vector<obstacle*> system::obstacles  [private]
```

4.4.3.7 obstacles [2/2]

```
vector<vec3> system::obstacles  [private]
```

4.4.3.8 predators [1/2]

```
vector<predator*> system::predators  [private]
```

4.4.3.9 predators [2/2]

```
vector<class predator> system::predators  [private]
```

4.4.3.10 wind

```
vec3 system::wind  [private]
```

4.4.3.11 windPresent

```
bool system::windPresent  [private]
```

The documentation for this class was generated from the following files:

- /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/flock.h
- /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/system.h
- /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/system.cpp

Chapter 5

File Documentation

5.1 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/boid.h File Reference

```
#include "params.h"
```

Classes

- class boid

Macros

- #define maxDistForRule1 0.2

5.1.1 Macro Definition Documentation

5.1.1.1 maxDistForRule1

```
#define maxDistForRule1 0.2
```

5.2 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/controls.h File Reference

Functions

- void computeMatricesFromInputs ()
- glm::mat4 getViewMatrix ()
- glm::mat4 getProjectionMatrix ()
- glm::mat4 getModelMatrix ()

5.2.1 Function Documentation

5.2.1.1 computeMatricesFromInputs()

```
void computeMatricesFromInputs ( )
```

5.2.1.2 getModelMatrix()

```
glm::mat4 getModelMatrix ( )
```

5.2.1.3 getProjectionMatrix()

```
glm::mat4 getProjectionMatrix ( )
```

5.2.1.4 getViewMatrix()

```
glm::mat4 getViewMatrix ( )
```

5.3 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/flock.h File Reference

Classes

- class system

5.4 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/obstacle.h File Reference

Classes

- class obstacle

5.5 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/params.h File Reference

```
#include <thread>
#include <bits/stdc++.h>
#include <unistd.h>
#include <vector>
#include <iostream>
#include <math.h>
#include <GL/glew.h>
#include <GLFW/glfw3.h>
#include <glm/glm.hpp>
#include <glm/gtc/matrix_transform.hpp>
#include <glm/gtx/vector_angle.hpp>
#include <glm/gtx/transform.hpp>
```

Macros

- #define xmin -2.4
- #define ymin -1.8
- #define zmin -2.4
- #define xmax 2.4
- #define ymax 1.8
- #define zmax 2.4
- #define maxSpeed 0.05
- #define minDistance 0.0235
- #define minDistanceForPredators 0.048
- #define minDistanceForObstacles 0.20
- #define flapStates 15
- #define velocityDivision (maxSpeed∗3000000)
- #define vMul 5
- #define v1Mul 0.9
- #define v2Mul 0.9
- #define v3Mul 0.8
- #define v4Mul 1.7

5.5.1 Macro Definition Documentation

5.5.1.1 flapStates

```
#define flapStates 15
```

5.5.1.2 maxSpeed

```
#define maxSpeed 0.05
```

5.5.1.3 minDistance

```
#define minDistance 0.0235
```

5.5.1.4 minDistanceForObstacles

```
#define minDistanceForObstacles 0.20
```

5.5.1.5 minDistanceForPredators

```
#define minDistanceForPredators 0.048
```

5.5.1.6 v1Mul

```
#define v1Mul 0.9
```

5.5.1.7 v2Mul

```
#define v2Mul 0.9
```

5.5.1.8 v3Mul

```
#define v3Mul 0.8
```

5.5.1.9 v4Mul

```
#define v4Mul 1.7
```

5.5.1.10 velocityDivision

```
#define velocityDivision (maxSpeed*3000000)
```

5.5.1.11 vMul

```
#define vMul 5
```

5.5.1.12 xmax

```
#define xmax 2.4
```

5.5.1.13 xmin

```
#define xmin -2.4
```

5.5.1.14 ymax

```
#define ymax 1.8
```

5.5.1.15 ymin

```
#define ymin -1.8
```

5.5.1.16 zmax

```
#define zmax 2.4
```

5.5.1.17 zmin

```
#define zmin -2.4
```

5.6 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/predator.h File Reference

```
#include "params.h"
```

Classes

- class predator

5.7 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/shader.h File Reference

Functions

- GLuint LoadShaders (const char *vertex_file_path, const char *fragment_file_path)

5.7.1 Function Documentation

5.7.1.1 LoadShaders()

```
GLuint LoadShaders (
            const char * vertex_file_path,
            const char * fragment_file_path )
```

5.8 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/system.h File Reference

```
#include "params.h"
```

Classes

- class system

5.9 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/README.md File Reference

5.10 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/boid.cpp File Reference

```
#include "boid.h"
#include "predator.h"
#include "system.h"
#include "params.h"
```

Functions

- bool compareFloats (float A, float B)
- void printvec (vec3 vv)
- vec3 limitVelocity (vec3 v)
- vec3 normalizeVelocity (vec3 v)

5.10.1 Function Documentation

5.10.1.1 compareFloats()

```
bool compareFloats (
            float A,
            float B )
```

5.10.1.2 limitVelocity()

```
vec3 limitVelocity (
            vec3 v )
```

5.10.1.3 normalizeVelocity()

```
vec3 normalizeVelocity (
            vec3 v )
```

5.10.1.4 printvec()

```
void printvec (
            vec3 vv )
```

5.11 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/inout.cpp File Reference

```
#include <GL/glew.h>
#include <GLFW/glfw3.h>
#include <glm/glm.hpp>
#include <glm/gtc/matrix_transform.hpp>
#include <glm/gtx/vector_angle.hpp>
#include <glm/gtx/transform.hpp>
#include "shader.h"
#include <unistd.h>
#include <vector>
#include <iostream>
#include <math.h>
#include "system.h"
#include "boid.h"
#include "params.h"
#include "predator.h"
```

Functions

- glm::mat4 computeRotationOfFrame ()
- void initializeWindow ()
- void setObjectID ()
- void createBuffers ()
- void setShaders ()
- void initializeEverything ()
- void endEverything ()
- void display (GLuint vertex)
- void display_obstacle ()
- void mouseButtonCallback (GLFWwindow *window, int button, int action, int mods)
- void output (std::vector< boid > &boids, std::vector< predator > &predators, std::vector< glm::vec3 > &obstacles)

Variables

- GLFWwindow * window
- class system sys
- bool quit
- std::vector< glm::vec3 > vertices_flap2 {glm::vec3(0,1.5,-0.102471),glm::vec3(-0.5,-0.5,-0.390471),glm::vec3(0.5,-0.5,-0.390471),glm::vec3(0,-0.5,0.475529),glm::vec3(0,-1.5,-0.102471),glm::vec3(1.4,0.5,1.0295),glm::vec3(1.77,0,1.1266),glm::vec3(1.77,0,1.0665),glm::vec3(-1.4,0.5,1.0295),glm::vec3(-1.77,0,1.1266),glm::vec3(-1.77,0,1.0295),glm::vec3(-0.0415631,0.75,0.0425294),glm::vec3(-0.150781,-0.25,0.142529),glm::vec3(-0.266067,-0.25,-0.0574706),glm::vec3(0.0415631,0.75,0.0425294),glm::vec3(0.150781,-0.25,0.142529),glm::vec3(0.266067,-0.25,-0.0574706)}
- std::vector< glm::vec3 > vertices_flap1 {glm::vec3(0,1.5,-0.102471),glm::vec3(-0.5,-0.5,-0.390471),glm::vec3(0.5,-0.5,-0.390471),glm::vec3(0,-0.5,0.475529),glm::vec3(0,-1.5,-0.102471),glm::vec3(1.4,0.5,-0.944471),glm::vec3(1.77,0,-0.981471),glm::vec3(1.77,0,-1.18147),glm::vec3(-1.4,0.5,-0.944471),glm::vec3(-1.77,0,-0.981471),glm::vec3(-1.77,0,-1.18147),glm::vec3(-0.0415631,0.75,0.0425294),glm::vec3(-0.150781,-0.25,0.142529),glm::vec3(-0.266067,-0.25,-0.0574706),glm::vec3(0.0415631,0.75,0.0425294),glm::vec3(0.150781,-0.25,0.142529),glm::vec3(0.266067,-0.25,-0.0574706)}
- std::vector< uint16_t > indices_flap {0,2,1,4,3,1,4,2,3,4,1,2,15,5,14,15,6,5,14,5,16,16,5,7,9,11,8,9,12,11,10,8,11,10,11,13,10,

- std::vector< glm::vec3 > vertices_obstacle {glm::vec3(-1,-1,1),glm::vec3(1,-1,1),glm::vec3(1,1,1),glm::vec3(-1,1,1),glm::vec3(-1,-1,-1),glm::vec3(1,-1,-1),glm::vec3(1,1,-1),glm::vec3(-1,1,-1)}
- std::vector< uint16_t > indices_obstacle {0,1,3,3,1,2,2,1,5,2,5,6,3,2,7,7,2,6,3,7,4,3,4,0,0,4,1,4,5,1,4,7,6,5,4,6}
- std::vector< glm::vec3 > normals_obstacle {glm::vec3(-1,-1,1),glm::vec3(1,-1,1),glm::vec3(1,1,1),glm::vec3(-1,1,1),glm::vec3(-1,-1,-1),glm::vec3(1,-1,-1),glm::vec3(1,1,-1),glm::vec3(-1,1,-1)}
- GLuint vertexbuffer_flap2
- GLuint elementbuffer_flap
- GLuint vertexbuffer_flap1
- GLuint elementbuffer_obstacle
- GLuint vertexbuffer_obstacle
- GLuint normalbuffer_obstacle
- GLuint programID
- GLuint programID_lighting
- GLuint ModelMatrixID
- GLuint ModelMatrixID_lighting
- GLuint ViewMatrixID
- GLuint ViewMatrixID_lighting
- GLuint MatrixID
- GLuint MatrixID_lighting
- GLuint LightID
- GLuint vertexPosID
- GLuint vertexPosID_ligthing
- GLuint vertexNormalID
- GLuint vertexColorID
- GLuint vertexColorID_lighting
- GLuint scalingFactorID
- GLuint scalingFactorID_lighting
- glm::mat4 viewMatrix
- glm::mat4 projectionMatrix
- glm::mat4 rotationMatrixFrame
- float FoV = 45.0f
- glm::vec3 position = glm::vec3(0,0,5)
- glm::mat4 rotMatrix = glm::mat4(1.0f)
- float angle_y = 0.0f
- float angle_x = 0.0f
- float Speed = 0.01f
- bool allow = true
- glm::vec3 lightPos = glm::vec3(0,0,25)
- glm::vec3 predatorColor = glm::vec3(0.41,0.41,0.41)
- glm::vec3 boidColor = glm::vec3(0.078f,0.078f,0.078f)
- glm::vec3 obstacleColor = glm::vec3(0.277,0.56,0)

5.11.1 Function Documentation

5.11.1.1 computeRotationOfFrame()

```
glm::mat4 computeRotationOfFrame ( )
```

5.11.1.2 createBuffers()

```
void createBuffers ( )
```

5.11.1.3 display()

```
void display (
            GLuint vertex )
```

5.11.1.4 display_obstacle()

```
void display_obstacle ( )
```

5.11.1.5 endEverything()

```
void endEverything ( )
```

5.11.1.6 initializeEverything()

```
void initializeEverything ( )
```

5.11.1.7 initializeWindow()

```
void initializeWindow ( )
```

5.11.1.8 mouseButtonCallback()

```
void mouseButtonCallback (
            GLFWwindow * window,
            int button,
            int action,
            int mods )
```

5.11.1.9 output()

```
void output (
             std::vector< boid > & boids,
             std::vector< predator > & predators,
             std::vector< glm::vec3 > & obstacles )
```

5.11.1.10 setObjectID()

```
void setObjectID ( )
```

5.11.1.11 setShaders()

```
void setShaders ( )
```

5.11.2 Variable Documentation

5.11.2.1 allow

```
bool allow = true
```

5.11.2.2 angle_x

```
float angle_x = 0.0f
```

5.11.2.3 angle_y

```
float angle_y = 0.0f
```

5.11.2.4 boidColor

```
glm::vec3 boidColor = glm::vec3(0.078f,0.078f,0.078f)
```

5.11.2.5 elementbuffer_flap

```
GLuint elementbuffer_flap
```

5.11.2.6 elementbuffer_obstacle

```
GLuint elementbuffer_obstacle
```

5.11.2.7 FoV

```
float FoV = 45.0f
```

5.11.2.8 indices_flap

```
std::vector<uint16_t> indices_flap {0,2,1,4,3,1,4,2,3,4,1,2,15,5,14,15,6,5,14,5,16,16,5,7,9,11,8,9,12,11,10,8
```

5.11.2.9 indices_obstacle

```
std::vector<uint16_t> indices_obstacle {0,1,3,3,1,2,2,1,5,2,5,6,3,2,7,7,2,6,3,7,4,3,4,0,0,4,1,4,5,1,4,7,6,5,4
```

5.11.2.10 LightID

```
GLuint LightID
```

5.11.2.11 lightPos

```
glm::vec3 lightPos = glm::vec3(0,0,25)
```

5.11.2.12 MatrixID

```
GLuint MatrixID
```

5.11.2.13 MatrixID_lighting

```
GLuint MatrixID_lighting
```

5.11.2.14 ModelMatrixID

```
GLuint ModelMatrixID
```

5.11.2.15 ModelMatrixID_lighting

```
GLuint ModelMatrixID_lighting
```

5.11.2.16 normalbuffer_obstacle

```
GLuint normalbuffer_obstacle
```

5.11.2.17 normals_obstacle

```
std::vector<glm::vec3> normals_obstacle {glm::vec3(-1,-1,1),glm::vec3(1,-1,1),glm::vec3(1,1,1),glm↩
::vec3(-1,1,1),glm::vec3(-1,-1,-1),glm::vec3(1,-1,-1),glm::vec3(1,1,-1),glm::vec3(-1,1,-1)}
```

5.11.2.18 obstacleColor

```
glm::vec3 obstacleColor = glm::vec3(0.277,0.56,0)
```

5.11.2.19 position

```
glm::vec3 position = glm::vec3(0,0,5)
```

5.11.2.20 predatorColor

```
glm::vec3 predatorColor = glm::vec3(0.41,0.41,0.41)
```

5.11.2.21 programID

```
GLuint programID
```

5.11.2.22 programID_lighting

```
GLuint programID_lighting
```

5.11.2.23 projectionMatrix

```
glm::mat4 projectionMatrix
```

5.11.2.24 quit

```
bool quit
```

5.11.2.25 rotationMatrixFrame

```
glm::mat4 rotationMatrixFrame
```

5.11.2.26 rotMatrix

```
glm::mat4 rotMatrix = glm::mat4(1.0f)
```

5.11.2.27 scalingFactorID

```
GLuint scalingFactorID
```

5.11.2.28 scalingFactorID_lighting

```
GLuint scalingFactorID_lighting
```

5.11.2.29 Speed

```
float Speed = 0.01f
```

5.11.2.30 sys

```
class system sys
```

5.11.2.31 vertexbuffer_flap1

```
GLuint vertexbuffer_flap1
```

5.11.2.32 vertexbuffer_flap2

```
GLuint vertexbuffer_flap2
```

5.11.2.33 vertexbuffer_obstacle

```
GLuint vertexbuffer_obstacle
```

5.11.2.34 vertexColorID

```
GLuint vertexColorID
```

5.11.2.35 vertexColorID_lighting

```
GLuint vertexColorID_lighting
```

5.11.2.36 vertexNormalID

```
GLuint vertexNormalID
```

5.11.2.37 vertexPosID

```
GLuint vertexPosID
```

5.11.2.38 vertexPosID_ligthing

```
GLuint vertexPosID_ligthing
```

5.11.2.39 vertices_flap1

```
std::vector<glm::vec3> vertices_flap1 {glm::vec3(0,1.5,-0.102471),glm::vec3(-0.5,-0.5,-0.↩
390471),glm::vec3(0.5,-0.5,-0.390471),glm::vec3(0,-0.5,0.475529),glm::vec3(0,-1.5,-0.102471),glm↩
::vec3(1.4,0.5,-0.944471),glm::vec3(1.77,0,-0.981471),glm::vec3(1.77,0,-1.18147),glm::vec3(-1.↩
4,0.5,-0.944471),glm::vec3(-1.77,0,-0.981471),glm::vec3(-1.77,0,-1.18147),glm::vec3(-0.↩
0415631,0.75,0.0425294),glm::vec3(-0.150781,-0.25,0.142529),glm::vec3(-0.266067,-0.25,-0.↩
0574706),glm::vec3(0.0415631,0.75,0.0425294),glm::vec3(0.150781,-0.25,0.142529),glm::vec3(0.↩
266067,-0.25,-0.0574706)}
```

5.11.2.40 vertices_flap2

```
std::vector<glm::vec3> vertices_flap2 {glm::vec3(0,1.5,-0.102471),glm::vec3(-0.5,-0.5,-0.↩
390471),glm::vec3(0.5,-0.5,-0.390471),glm::vec3(0,-0.5,0.475529),glm::vec3(0,-1.5,-0.102471),glm↩
::vec3(1.4,0.5,1.0295),glm::vec3(1.77,0,1.1266),glm::vec3(1.77,0,1.0665),glm::vec3(-1.4,0.↩
5,1.0295),glm::vec3(-1.77,0,1.1266),glm::vec3(-1.77,0,1.0295),glm::vec3(-0.0415631,0.75,0.↩
0425294),glm::vec3(-0.150781,-0.25,0.142529),glm::vec3(-0.266067,-0.25,-0.0574706),glm::vec3(0.↩
0415631,0.75,0.0425294),glm::vec3(0.150781,-0.25,0.142529),glm::vec3(0.266067,-0.25,-0.↩
0574706)}
```

5.11.2.41 vertices_obstacle

```
std::vector<glm::vec3> vertices_obstacle {glm::vec3(-1,-1,1),glm::vec3(1,-1,1),glm::vec3(1,1,1),glm↩
::vec3(-1,1,1),glm::vec3(-1,-1,-1),glm::vec3(1,-1,-1),glm::vec3(1,1,-1),glm::vec3(-1,1,-1)}
```

5.11.2.42 viewMatrix

```
glm::mat4 viewMatrix
```

5.11.2.43 ViewMatrixID

```
GLuint ViewMatrixID
```

5.11.2.44 ViewMatrixID_lighting

```
GLuint ViewMatrixID_lighting
```

5.11.2.45 window

```
GLFWwindow* window
```

5.12 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/main.cpp File Reference

```
#include <iostream>
#include "system.h"
#include <chrono>
#include "boid.h"
#include "predator.h"
#include <glm/glm.hpp>
#include <stdlib.h>
```

Functions

- void output (std::vector< boid > &, std::vector< predator > &, std::vector< glm::vec3 > &)
- void initializeEverything ()
- void mouseButtonCallback (GLFWwindow *, int, int, int)
- void print (string)
- int main (int argc, char *argv[ ])

Variables

- GLFWwindow * window
- bool quit = false
- class system sys

5.12.1 Function Documentation

5.12.1.1 initializeEverything()

```
void initializeEverything ( )
```

5.12.1.2 main()

```
int main (
            int argc,
            char * argv[] )
```

5.12.1.3 mouseButtonCallback()

```
void mouseButtonCallback (
            GLFWwindow * ,
            int ,
            int ,
            int  )
```

5.12.1.4 output()

```
void output (
            std::vector< boid > & ,
            std::vector< predator > & ,
            std::vector< glm::vec3 > &  )
```

5.12.1.5 print()

```
void print (
            string  )
```

5.12.2 Variable Documentation

5.12.2.1 quit

```
bool quit = false
```

5.12.2.2 sys

```
class system sys
```

5.12.2.3 window

```
GLFWwindow* window
```

5.13 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/predator.cpp File Reference

```
#include "boid.h"
#include "predator.h"
#include "system.h"
#include "params.h"
```

Functions

- bool compareFloats (float, float)
- void printvec (vec3)
- vec3 limitVelocity (vec3)
- vec3 normalizeVelocity (vec3)

5.13.1 Function Documentation

5.13.1.1 compareFloats()

```
bool compareFloats (
            float ,
            float  )
```

5.13.1.2 limitVelocity()

```
vec3 limitVelocity (
            vec3  )
```

5.13.1.3 normalizeVelocity()

```
vec3 normalizeVelocity (
            vec3  )
```

5.13.1.4 printvec()

```
void printvec (
            vec3  )
```

5.14 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/shader.cpp File Reference

```
#include <stdio.h>
#include <string>
#include <vector>
#include <iostream>
#include <fstream>
#include <algorithm>
#include <sstream>
#include <stdlib.h>
#include <string.h>
#include <GL/glew.h>
#include "shader.h"
```

Functions

- GLuint LoadShaders (const char *vertex_file_path, const char *fragment_file_path)

5.14.1 Function Documentation

5.14.1.1 LoadShaders()

```
GLuint LoadShaders (
            const char * vertex_file_path,
            const char * fragment_file_path )
```

5.15 /Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/system.cpp File Reference

```
#include "system.h"
#include "boid.h"
#include "predator.h"
```

Functions

- float distance (vec3 a, vec3 b)

5.15.1 Function Documentation

5.15.1.1 distance()

```
float distance (
            vec3 a,
            vec3 b )
```

Index

/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/README.md, 34
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/boid.h, 29
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/controls.h, 29
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/flock.h, 30
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/obstacle.h, 30
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/params.h, 31
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/predator.h, 33
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/shader.h, 34
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/include/system.h, 34
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/boid.cpp, 34
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/inout.cpp, 36
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/main.cpp, 45
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/predator.cpp, 47
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/shader.cpp, 48
/Users/madhur/Documents/Sem 6/COP290/Assignment 2/git/Code/src/system.cpp, 49

addBoid
    system, 22
addObstacle
    system, 23
addPredator
    system, 23
allow
    inout.cpp, 39
angle_x
    inout.cpp, 39
angle_y
    inout.cpp, 39

boid, 7
    boid, 8
    boundPosition, 8
    flapStatus, 11
    getFlapStatus, 8
    getPosition, 8
    getPrevPosTime, 9
    getPrevVelocity, 9
    getVelocity, 9
    moveBoidToNewPos, 9
    obstacle, 12, 13
    position, 11
    prevPosTime, 11
    prevVelocity, 11
    rule1and2, 9
    rule3, 9
    setFlapStatus, 9
    setPosition, 9
    setPrevPosTime, 10
    setPrevVelocity, 10
    setSystem, 10
    setVelocity, 10
    strongWind, 10
    sys, 11
    tendAwayFromPlace, 10
    tendToPlace, 10
    updateFlapStatus, 11
    velocity, 11
boid.cpp
    compareFloats, 35
    limitVelocity, 35
    normalizeVelocity, 35
    printvec, 35
boid.h
    maxDistForRule1, 29
boidColor
    inout.cpp, 39
boids
    system, 26, 27
boundPosition
    boid, 8
    obstacle, 13
    predator, 17

compareFloats
    boid.cpp, 35
    predator.cpp, 47
computeMatricesFromInputs
    controls.h, 30
computeRotationOfFrame
    inout.cpp, 37
controls.h
    computeMatricesFromInputs, 30
    getModelMatrix, 30
    getProjectionMatrix, 30
    getViewMatrix, 30

createBuffers
inout.cpp, 37

display
inout.cpp, 38
display_obstacle
inout.cpp, 38
distance
system.cpp, 49

elementbuffer_flap
inout.cpp, 39
elementbuffer_obstacle
inout.cpp, 40
endEverything
inout.cpp, 38

findNearestBoid
system, 23
findNeighbouringBoids
system, 24
findObstaclesForPredator
system, 24
findVeryCloseObjects
system, 24
flapStates
params.h, 31
flapStatus
boid, 11
obstacle, 15
predator, 20
flock
system, 24
FoV
inout.cpp, 40

getBoids
system, 24
getFlapStatus
boid, 8
obstacle, 13
predator, 17
getModelMatrix
controls.h, 30
getNumBoids
system, 24
getNumObstacles
system, 25
getNumPredators
system, 25
getObstacles
system, 25
getPosition
boid, 8
obstacle, 13
predator, 18
getPredators
system, 25
getPrevPosTime
boid, 9
obstacle, 13
predator, 18
getPrevVelocity
boid, 9
predator, 18
getProjectionMatrix
controls.h, 30
getVelocity
boid, 9
obstacle, 13
predator, 18
getViewMatrix
controls.h, 30
getWind
system, 25
getWindPresent
system, 25

indices_flap
inout.cpp, 40
indices_obstacle
inout.cpp, 40
initializeEverything
inout.cpp, 38
main.cpp, 46
initializeWindow
inout.cpp, 38
inout.cpp
allow, 39
angle_x, 39
angle_y, 39
boidColor, 39
computeRotationOfFrame, 37
createBuffers, 37
display, 38
display_obstacle, 38
elementbuffer_flap, 39
elementbuffer_obstacle, 40
endEverything, 38
FoV, 40
indices_flap, 40
indices_obstacle, 40
initializeEverything, 38
initializeWindow, 38
LightID, 40
lightPos, 40
MatrixID_lighting, 40
MatrixID, 40
ModelMatrixID_lighting, 41
ModelMatrixID, 41
mouseButtonCallback, 38
normalbuffer_obstacle, 41
normals_obstacle, 41
obstacleColor, 41
output, 38
position, 41
predatorColor, 41
programID_lighting, 42

programID, 42
projectionMatrix, 42
quit, 42
rotMatrix, 42
rotationMatrixFrame, 42
scalingFactorID_lighting, 42
scalingFactorID, 42
setObjectID, 39
setShaders, 39
Speed, 43
sys, 43
vertexColorID_lighting, 43
vertexColorID, 43
vertexNormalID, 43
vertexPosID_ligthing, 44
vertexPosID, 44
vertexbuffer_flap1, 43
vertexbuffer_flap2, 43
vertexbuffer_obstacle, 43
vertices_flap1, 44
vertices_flap2, 44
vertices_obstacle, 44
viewMatrix, 44
ViewMatrixID_lighting, 45
ViewMatrixID, 45
window, 45

LightID
inout.cpp, 40
lightPos
inout.cpp, 40
limitVelocity
boid.cpp, 35
obstacle, 13
predator.cpp, 47
LoadShaders
shader.cpp, 48
shader.h, 34

main
main.cpp, 46
main.cpp
initializeEverything, 46
main, 46
mouseButtonCallback, 46
output, 46
print, 46
quit, 46
sys, 47
window, 47
MatrixID_lighting
inout.cpp, 40
MatrixID
inout.cpp, 40
maxDistForRule1
boid.h, 29
maxSpeed
params.h, 31
minDistance
params.h, 31
minDistanceForObstacles
params.h, 32
minDistanceForPredators
params.h, 32
ModelMatrixID_lighting
inout.cpp, 41
ModelMatrixID
inout.cpp, 41
mouseButtonCallback
inout.cpp, 38
main.cpp, 46
moveBoidToNewPos
boid, 9
obstacle, 14
movePredatorToNewPos
predator, 18

normalbuffer_obstacle
inout.cpp, 41
normalizeVelocity
boid.cpp, 35
predator.cpp, 48
normals_obstacle
inout.cpp, 41
numBoids
system, 27
numObstacles
system, 27
numPredators
system, 27

obstacle, 12
boid, 12, 13
boundPosition, 13
flapStatus, 15
getFlapStatus, 13
getPosition, 13
getPrevPosTime, 13
getVelocity, 13
limitVelocity, 13
moveBoidToNewPos, 14
operator(), 14
position, 15
prevPosTime, 15
prevVelocity, 16
rule1and2, 14
rule3, 14
setPosition, 14
setPrevPosTime, 14
setVelocity, 14
strongWind, 15
tendAwayFromPlace, 15
tendToPlace, 15
updateFlapStatus, 15
velocity, 16
obstacleColor
inout.cpp, 41
obstacles

system, 27
operator()
obstacle, 14
output
inout.cpp, 38
main.cpp, 46

params.h
flapStates, 31
maxSpeed, 31
minDistance, 31
minDistanceForObstacles, 32
minDistanceForPredators, 32
v1Mul, 32
v2Mul, 32
v3Mul, 32
v4Mul, 32
vMul, 32
velocityDivision, 32
xmax, 33
xmin, 33
ymax, 33
ymin, 33
zmax, 33
zmin, 33
position
boid, 11
inout.cpp, 41
obstacle, 15
predator, 20
predator, 16
boundPosition, 17
flapStatus, 20
getFlapStatus, 17
getPosition, 18
getPrevPosTime, 18
getPrevVelocity, 18
getVelocity, 18
movePredatorToNewPos, 18
position, 20
predator, 17
prevPosTime, 20
prevVelocity, 20
rule1, 18
rule3, 18
setFlapStatus, 18
setPosition, 19
setPrevPosTime, 19
setPrevVelocity, 19
setSystem, 19
setVelocity, 19
strongWind, 19
sys, 20
tendAwayFromPlace, 19
tendToPlace, 20
updateFlapStatus, 20
velocity, 21
predator.cpp
compareFloats, 47
limitVelocity, 47
normalizeVelocity, 48
printvec, 48
predatorColor
inout.cpp, 41
predators
system, 27
prevPosTime
boid, 11
obstacle, 15
predator, 20
prevVelocity
boid, 11
obstacle, 16
predator, 20
print
main.cpp, 46
printvec
boid.cpp, 35
predator.cpp, 48
programID_lighting
inout.cpp, 42
programID
inout.cpp, 42
projectionMatrix
inout.cpp, 42

quit
inout.cpp, 42
main.cpp, 46

rotMatrix
inout.cpp, 42
rotationMatrixFrame
inout.cpp, 42
rule1
predator, 18
rule1and2
boid, 9
obstacle, 14
rule3
boid, 9
obstacle, 14
predator, 18

scalingFactorID_lighting
inout.cpp, 42
scalingFactorID
inout.cpp, 42
setFlapStatus
boid, 9
predator, 18
setNumBoids
system, 25
setNumObstacles
system, 25
setNumPredators
system, 26
setObjectID

inout.cpp, 39
setPosition
boid, 9
obstacle, 14
predator, 19
setPrevPosTime
boid, 10
obstacle, 14
predator, 19
setPrevVelocity
boid, 10
predator, 19
setShaders
inout.cpp, 39
setSystem
boid, 10
predator, 19
setVelocity
boid, 10
obstacle, 14
predator, 19
setWind
system, 26
setWindPresent
system, 26
shader.cpp
LoadShaders, 48
shader.h
LoadShaders, 34
Speed
inout.cpp, 43
startWithBoids
system, 26
strongWind
boid, 10
obstacle, 15
predator, 19
sys
boid, 11
inout.cpp, 43
main.cpp, 47
predator, 20
system, 21
addBoid, 22
addObstacle, 23
addPredator, 23
boids, 26, 27
findNearestBoid, 23
findNeighbouringBoids, 24
findObstaclesForPredator, 24
findVeryCloseObjects, 24
flock, 24
getBoids, 24
getNumBoids, 24
getNumObstacles, 25
getNumPredators, 25
getObstacles, 25
getPredators, 25
getWind, 25
getWindPresent, 25
numBoids, 27
numObstacles, 27
numPredators, 27
obstacles, 27
predators, 27
setNumBoids, 25
setNumObstacles, 25
setNumPredators, 26
setWind, 26
setWindPresent, 26
startWithBoids, 26
system, 22
updateSystem, 26
wind, 28
windPresent, 28
system.cpp
distance, 49

tendAwayFromPlace
boid, 10
obstacle, 15
predator, 19
tendToPlace
boid, 10
obstacle, 15
predator, 20

updateFlapStatus
boid, 11
obstacle, 15
predator, 20
updateSystem
system, 26

v1Mul
params.h, 32
v2Mul
params.h, 32
v3Mul
params.h, 32
v4Mul
params.h, 32
vMul
params.h, 32
velocity
boid, 11
obstacle, 16
predator, 21
velocityDivision
params.h, 32
vertexColorID_lighting
inout.cpp, 43
vertexColorID
inout.cpp, 43
vertexNormalID
inout.cpp, 43
vertexPosID_ligthing

inout.cpp, 44
vertexPosID
inout.cpp, 44
vertexbuffer_flap1
inout.cpp, 43
vertexbuffer_flap2
inout.cpp, 43
vertexbuffer_obstacle
inout.cpp, 43
vertices_flap1
inout.cpp, 44
vertices_flap2
inout.cpp, 44
vertices_obstacle
inout.cpp, 44
viewMatrix
inout.cpp, 44
ViewMatrixID_lighting
inout.cpp, 45
ViewMatrixID
inout.cpp, 45

wind
system, 28
windPresent
system, 28
window
inout.cpp, 45
main.cpp, 47

xmax
params.h, 33
xmin
params.h, 33

ymax
params.h, 33
ymin
params.h, 33

zmax
params.h, 33
zmin
params.h, 33