Autonomous Steering Agents

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Chapter 1

Intent

1- implementing Craig Raynolds autonomous steering agents

2- implementing genetics algorithms

3- implementing neural network

1.1 Dependencies

$sudo apt-get install libglu1-mesa-dev freeglut3-dev mesa-common-dev

$sudo apt-get install libboost-all-dev

1.2 Resources

https://natureofcode.com/book/chapter-6-autonomous-agents

https://gamedevelopment.tutsplus.com/series/understanding-steering-behaviors-gamedev-12

https://videotutorialsrock.com/index.php

https://www.opengl.org/resources/libraries/glut/spec3/node1.html

https://learnopengl.com/Getting-started/Coordinate-Systems

Chapter 2

Hierarchical Index

2.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 3

Class Index

3.1 Class List

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

Chapter 4

File Index

4.1 File List

Here is a list of all files with brief descriptions:

Chapter 5

Class Documentation

5.1 agent Class Reference

`#include <agent.h>`

Collaboration diagram for agent:

Public Member Functions

- agent (float x, float y)
- agent ()
- ~agent ()
- void updatePosition (bool arrive)
- void setFeatures (float s, float f, float r, float m)

Public Attributes

- string name
- color fillColor
- point position
- pvector velocity
- point targetPoint
- float maxSpeed
- float maxForce
- pvector steering
- pvector force
- pvector acceleration
- pvector desiredVelocity
- float r
- float mass
- int id
- bool arrive = false

5.1.1 Detailed Description

Definition at line 18 of file agent.h.

5.1.2 Constructor & Destructor Documentation

5.1.2.1 agent() [1/2]

```
agent::agent (
            float x,
            float y )
```

Definition at line 11 of file agent.cpp.

```
11                              {
12     position        = point(x, y);
13     velocity        = pvector(0.6, 0.0);
14     acceleration    = pvector(0.0, 0.0);
15     steering        = pvector(0.0, 0.0);
16     desiredVelocity = pvector(0.0, 0.0);
17     force           = pvector(0.0, 0.0);
18     targetPoint     = point(0.0, 0.0);
19     fillColor       = color(1.0, 0.0, 0.0);
20 }
```

5.1.2.2 agent() [2/2]

```
agent::agent ( )
```

Definition at line 9 of file agent.cpp.

```
9 {}
```

5.1.2.3 ~agent()

```
agent::~agent ( )
```

Definition at line 49 of file agent.cpp.

```
49 {}
```

5.1.3 Member Function Documentation

5.1.3.1 setFeatures()

```
void agent::setFeatures (
            float s,
            float f,
            float r,
            float m )
```

Definition at line 42 of file agent.cpp.

```
42                                                      {
43     this->maxSpeed = s;
44     this->maxForce = f;
45     this->r = r;
46     this->mass = m;
47 }
```

5.1.3.2 updatePosition()

```
void agent::updatePosition (
            bool arrive )
```

Definition at line 22 of file agent.cpp.

```
22                                      {
23     force.limit(maxForce);
24     acceleration = force;
25     velocity += acceleration;
26
27     //arriving behavior implementation
28     if(arrive == true){
29         pvector diff = targetPoint - position;
30         if(diff.magnitude() > r)
31             velocity.limit(maxSpeed);
32         else
33             velocity.limit(maxSpeed * diff.magnitude() / r);
34     }
35     else
36         velocity.limit(maxSpeed);
37
38     position = position + velocity;
39     force = pvector(0,0);
40 }
```

Here is the call graph for this function:

5.1.4 Member Data Documentation

5.1.4.1 acceleration

```
pvector agent::acceleration
```

Definition at line 34 of file agent.h.

5.1.4.2 arrive

```
bool agent::arrive = false
```

Definition at line 39 of file agent.h.

5.1.4.3 desiredVelocity

```
pvector agent::desiredVelocity
```

Definition at line 35 of file agent.h.

5.1.4.4 fillColor

```
color agent::fillColor
```

Definition at line 26 of file agent.h.

5.1.4.5 force

```
pvector agent::force
```

Definition at line 33 of file agent.h.

5.1.4.6 id

```
int agent::id
```

Definition at line 38 of file agent.h.

5.1.4.7 mass

```
float agent::mass
```

Definition at line 37 of file agent.h.

5.1.4.8 maxForce

```
float agent::maxForce
```

Definition at line 31 of file agent.h.

5.1.4.9 maxSpeed

```
float agent::maxSpeed
```

Definition at line 30 of file agent.h.

5.1.4.10 name

```
string agent::name
```

Definition at line 25 of file agent.h.

5.1.4.11 position

```
point agent::position
```

Definition at line 27 of file agent.h.

5.1.4.12 r

```
float agent::r
```

Definition at line 36 of file agent.h.

5.1.4.13 steering

```
pvector agent::steering
```

Definition at line 32 of file agent.h.

5.1.4.14 targetPoint

```
point agent::targetPoint
```

Definition at line 29 of file agent.h.

5.1.4.15 velocity

```
pvector agent::velocity
```

Definition at line 28 of file agent.h.

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

- include/agent.h
- src/agent.cpp

5.2 color Class Reference

`#include <color.h>`

Collaboration diagram for color:

Public Member Functions

- color ()
  default constructor.
- color (float r, float g, float b)
  Constructor.
- void createColors ()
  fills colors vector with 8 main colors in color bar
- color getColor (int i)
  Constructor.

Public Attributes

- float R
  red condiment
- float G
  green condiment
- float B
  blue condiment
- vector< color > colors
  stores main colors

5.2.1 Detailed Description

Definition at line 20 of file color.h.

5.2.2 Constructor & Destructor Documentation

5.2.2.1 color() [1/2]

`color::color ( )`

default constructor.

Create a new color object.

See also

color(float r, float g, float b)

Definition at line 25 of file color.cpp.

```
26 {
27
28 }
```

5.2.2.2 color() [2/2]

```
color::color (
            float r,
            float g,
            float b )
```

Constructor.

Create a new color object.

Parameters

r	red (0-255)
g	green (0-255)
b	blue (0-255)

See also

path()

Definition at line 13 of file color.cpp.

```
14 {
15     R = r;
16     G = g;
17     B = b;
18 }
```

5.2.3 Member Function Documentation

5.2.3.1 createColors()

```
void color::createColors ( )
```

fills colors vector with 8 main colors in color bar

creates main colors for future use

Definition at line 30 of file color.cpp.

```
31 {
32     colors.push_back(color(0.0, 0.0, 0.0));
33     colors.push_back(color(0.0, 0.0, 1.0));
34     colors.push_back(color(0.0, 1.0, 0.0));
35     colors.push_back(color(0.0, 1.0, 1.0));
36     colors.push_back(color(1.0, 0.0, 0.0));
37     colors.push_back(color(1.0, 0.0, 1.0));
38     colors.push_back(color(1.0, 1.0, 0.0));
39     colors.push_back(color(1.0, 1.0, 1.0));
40 }
```

5.2.3.2 getColor()

```
color color::getColor (
            int i )
```

Constructor.

returns specified color from colors vector

Parameters

i	gets specified color

Returns

requested pre-created color instance

Definition at line 20 of file color.cpp.

```
21 {
22     return colors.at(i);
23 }
```

Here is the caller graph for this function:

5.2.4 Member Data Documentation

5.2.4.1 B

`float color::B`

blue condiment

blue color ratio

Definition at line 69 of file color.h.

5.2.4.2 colors

`vector<color> color::colors`

stores main colors

vector of fundamental colors

Definition at line 75 of file color.h.

5.2.4.3 G

`float color::G`

green condiment

green color ratio

Definition at line 63 of file color.h.

5.2.4.4 R

```
float color::R
```

red condiment

red color ratio

Definition at line 57 of file color.h.

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

- include/color.h
- src/color.cpp

5.3 evade Class Reference

```
#include <evade.h>
```

Inheritance diagram for evade:

Collaboration diagram for evade:

Public Member Functions

- evade ()

Static Public Member Functions

- static void loop ()

Additional Inherited Members

5.3.1 Detailed Description

Definition at line 8 of file evade.h.

5.3.2 Constructor & Destructor Documentation

5.3.2.1 evade()

```
evade::evade ( )
```

Definition at line 23 of file evade.cpp.

```
23             {
24     name = "evading";
25     createAgent(STATIC, nullptr, nullptr, nullptr);
26     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
27 }
```

5.3.3 Member Function Documentation

5.3.3.1 loop()

```
void evade::loop ( )  [static]
```

Definition at line 8 of file evade.cpp.

```
8                {
9     for(auto it = agents.begin(); it < agents.end(); it++){
10          if((*it).name == "lion"){
11              (*it).targetPoint = view.getMousePosition();
12              (*it).force  = behavior.seek(*it);
13              (*it).arrive = true;
14          }
15          else{//gazelle
16              (*it).force  = behavior.evade(agents, *it, view);
17          }
18     }
19
20     refresh();
21 }
```

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

- include/evade.h
- src/evade.cpp

5.4 flee Class Reference

```
#include <flee.h>
```

Inheritance diagram for flee:

Collaboration diagram for flee:

Public Member Functions

- flee ()

Static Public Member Functions

- static void loop ()

Additional Inherited Members

5.4.1 Detailed Description

Definition at line 8 of file flee.h.

5.4.2 Constructor & Destructor Documentation

5.4.2.1 flee()

```
flee::flee ( )
```

Definition at line 16 of file flee.cpp.

```
16           {
17     int agentCount = 196;
18     name = "fleeing troop";
19     createAgent(TROOP, &agentCount, nullptr, nullptr);
20     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
21 }
```

5.4.3 Member Function Documentation

5.4.3.1 loop()

```
void flee::loop ( )  [static]
```

Definition at line 8 of file flee.cpp.

```
8               {
9     for(auto it = agents.begin(); it < agents.end(); it++){
10         (*it).force = behavior.flee((*it), view, view.getMousePosition());
11     }
12
13     refresh();
14 }
```

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

- include/flee.h
- src/flee.cpp

5.5 flock Class Reference

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

Inheritance diagram for flock:

Collaboration diagram for flock:

Public Member Functions

- flock ()

Static Public Member Functions

- static void loop ()

Additional Inherited Members

5.5.1 Detailed Description

Definition at line 8 of file flock.h.

5.5.2 Constructor & Destructor Documentation

5.5.2.1 flock()

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

Definition at line 28 of file flock.cpp.

```
28             {
29     int agentCount = 50;
30     float maxForce = 0.3;
31     float maxSpeed = 0.8;
32     name = "flocking agents";
33     createAgent(RANDOM, &agentCount, &maxForce, &maxSpeed);
34     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
35 }
```

5.5.3 Member Function Documentation

5.5.3.1 loop()

```
void flock::loop ( )  [static]
```

Definition at line 8 of file flock.cpp.

```
8                {
9     for(auto it = agents.begin(); it < agents.end(); it++){
10          view.forceInScreen((*it));
11
12          pvector sep = behavior.separation(agents, *it);
13          sep.mul(1.5);
14          pvector ali = behavior.align(agents, *it);
15          ali.mul(4);
16          pvector coh = behavior.cohesion(agents, *it);
17          coh.mul(0.1);
18
19          (*it).force = sep + ali + coh;
20          (*it).desiredVelocity = (*it).force + (*it).velocity;
21          (*it).targetPoint = (*it).position + (*it).desiredVelocity;
22          (*it).arrive = true;
23     }
24
25     refresh();
26 }
```

Here is the call graph for this function:

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

- include/flock.h
- src/flock.cpp

5.6 flowField Class Reference

`#include <flowField.h>`

Collaboration diagram for flowField:

Public Member Functions

- flowField ()
  default constructor.
- flowField (pvector p)
  constructor.
- pvector getField (int x, int y)
  get force for individual pixel

5.6.1 Detailed Description

Definition at line 18 of file flowField.h.

5.6.2 Constructor & Destructor Documentation

5.6.2.1 flowField() [1/2]

```
flowField::flowField ( )
```

default constructor.

Create a new flowField object.

See also

flowField(pvector p)

Definition at line 15 of file flowField.cpp.

```
15 {}
```

5.6.2.2 flowField() [2/2]

```
flowField::flowField (
            pvector p )
```

constructor.

Create a new flowField object.

Parameters

p	force vector

See also

flowField()

Definition at line 10 of file flowField.cpp.

```
11 {
12     createFlowField(p);
13 }
```

5.6.3 Member Function Documentation

5.6.3.1 getField()

```
pvector flowField::getField (
            int x,
            int y )
```

get force for individual pixel

get force for a specific position

Parameters

x	x cprovidesoordinate
y	y coordinate

Returns

returns force at specified position

Definition at line 36 of file flowField.cpp.

```
37 {
38     return uniformField[x][y];
39 }
```

Here is the caller graph for this function:

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

- include/flowField.h
- src/flowField.cpp

5.7 graphics Class Reference

```
#include <graphics.h>
```

Collaboration diagram for graphics:

Public Member Functions

- void drawWall (float border, color color)
- void drawAgent (agent &agent, color &color)
- void drawLine (point p1, point p2, color cl)
- void drawPath (path &path, color color)
- void drawPoint (point p)
- void drawCircle (point p, float radius)
- void drawText (string text, point p)
- void forceInScreen (agent &agent)
- void refreshScene ()
- point getMousePosition ()
- void initGraphics (int *argv, char **argc, void(*callback)())

Static Public Member Functions

- static void timerEvent (int value)
- static void handleKeypress (unsigned char key, int x, int y)
- static void mouseButton (int button, int state, int x, int y)
- static void handleResize (int w, int h)
- static void mouseMove (int x, int y)

Static Public Attributes

- static int target_x = -WIDTH
- static int target_y = HEIGHT

5.7.1 Detailed Description

Definition at line 15 of file graphics.h.

5.7.2 Member Function Documentation

5.7.2.1 drawAgent()

```
void graphics::drawAgent (
            agent & agent,
            color & color )
```

Definition at line 162 of file graphics.cpp.

```
162                                                 {
163     glPushMatrix();
164     glTranslatef(agent.position.x, agent.position.y, 0.0f);
165     glRotatef(agent.velocity.getAngle(), 0.0f, 0.0f, 1.0f);
166     glBegin(GL_TRIANGLES);
167     glColor3f( color.R, color.G, color.B);
168     glVertex3f( 1.0f,  0.0f, 0.0f);
169     glVertex3f(-1.0f,  0.5f, 0.0f);
170     glVertex3f(-1.0f, -0.5f, 0.0f);
171     glEnd();
172     glPopMatrix();
173 }
```

Here is the call graph for this function:

5.7.2.2 drawCircle()

```
void graphics::drawCircle (
            point p,
            float radius )
```

Definition at line 124 of file graphics.cpp.

```
124                                                 {
125     glBegin(GL_LINE_STRIP);
126     glLineWidth(2);
127     for (int i = 0; i <= 300; i++) {
128       float angle = 2 * PI * i / 300;
129       float x = cos(angle) * radius;
130       float y = sin(angle) * radius;
131       glVertex2d(p.x + x, p.y + y);
132     }
133     glEnd();
134 }
```

5.7.2.3 drawLine()

```
void graphics::drawLine (
            point p1,
            point p2,
            color cl )
```

Definition at line 115 of file graphics.cpp.

```
115                                                     {
116     glColor3f( cl.R, cl.G, cl.B);
117     glLineWidth(2);
118     glBegin(GL_LINES);
119     glVertex2f(p1.x, p1.y);
120     glVertex2f(p2.x, p2.y);
121     glEnd();
122 }
```

5.7.2.4 drawPath()

```
void graphics::drawPath (
            path & path,
            color color )
```

Definition at line 102 of file graphics.cpp.

```
102                                                 {
103     point p1, p2;
104     for(auto it = path.points.begin(); it < path.points.end()-1; it++){
105         p1 = point((*it).x, (*it).y - path.width/2) ;
106         p2 = point((*(it+1)).x, (*(it+1)).y - path.width/2);
107         drawLine(p1, p2, color.getColor(BLUE));
108 
109         p1 = point((*it).x, (*it).y + path.width/2) ;
110         p2 = point((*(it+1)).x, (*(it+1)).y + path.width/2);
111         drawLine(p1, p2, color.getColor(BLUE));
112     }
113 }
```

Here is the call graph for this function:

5.7.2.5 drawPoint()

```
void graphics::drawPoint (
            point p )
```

Definition at line 136 of file graphics.cpp.

```
136                                 {
137     glColor3f(1,1,1);
138     glPointSize(4.0);
139     glBegin(GL_POINTS);
140     glVertex2f(p.x, p.y);
141     glEnd();
142 }
```

Here is the caller graph for this function:

5.7.2.6 drawText()

```
void graphics::drawText (
            string text,
            point p )
```

Definition at line 14 of file graphics.cpp.

```
14                                          {
15    glColor3f (0.0, 0.0, 1.0);
16    //glRasterPos2f(-34, 32.5);
17    glRasterPos2f(p.x, p.y);
18    for ( string::iterator it=text.begin(); it!=text.end(); ++it){
19       glutBitmapCharacter(GLUT_BITMAP_9_BY_15, *it);
20    }
21 }
```

Here is the caller graph for this function:

5.7.2.7 drawWall()

```
void graphics::drawWall (
            float border,
            color color )
```

Definition at line 144 of file graphics.cpp.

```
144                                                 {
145     point p1 {-border,  border};
146     point p2 { border,  border};
147     drawLine(p1, p2, color.getColor(BLUE));
148
149     p1 = point ( border,  border);
150     p2 = point ( border, -border);
151     drawLine(p1, p2, color.getColor(BLUE));
152
153     p1 = point (  border, -border);
154     p2 = point ( -border, -border);
155     drawLine(p1, p2, color.getColor(BLUE));
156
157     p1 = point (-border,  border);
158     p2 = point (-border, -border);
159     drawLine(p1, p2, color.getColor(BLUE));
160 }
```

Here is the call graph for this function:

5.7.2.8 forceInScreen()

```
void graphics::forceInScreen (
              agent & agent )
```

Definition at line 52 of file graphics.cpp.

```
52                                      {
53     if(agent.position.x > WIDTH)
54        agent.position.x -= 2 * WIDTH;
55     if(agent.position.x < -WIDTH)
56        agent.position.x += 2 * WIDTH;
57     if(agent.position.y > HEIGHT)
58        agent.position.y -= 2 * HEIGHT;
59     if(agent.position.y < -HEIGHT)
60        agent.position.y += 2 * HEIGHT;
61 }
```

5.7.2.9 getMousePosition()

```
point graphics::getMousePosition ( )
```

Definition at line 48 of file graphics.cpp.

```
48                                  {
49    return point (graphics::target_x, graphics::target_y);
50 }
```

Here is the call graph for this function:

5.7.2.10 handleKeypress()

```
void graphics::handleKeypress (
              unsigned char key,
              int x,
              int y )  [static]
```

Definition at line 99 of file graphics.cpp.

```
99                                                          {
100     if (key == ESC){ exit(0); }
101 }
```

Here is the caller graph for this function:

5.7.2.11 handleResize()

```
void graphics::handleResize (
              int w,
              int h )  [static]
```

Definition at line 70 of file graphics.cpp.

```
70                                      {
71     glViewport(0, 0, w, h);  //Tell OpenGL how to convert from coordinates to pixel values
72     glMatrixMode(GL_PROJECTION); //Switch to setting the camera perspective
73     glLoadIdentity(); //Reset the camera
74     //Set the camera perspective
75     gluPerspective(45.0,                   //The camera angle
76                    (double)w / (double)h, //The width-to-height ratio
77                    1.0,                   //The near z clipping coordinate
78                    200.0);                //The far z clipping coordinate
79 }
```

Here is the caller graph for this function:

5.7.2.12 initGraphics()

```
void graphics::initGraphics (
              int * argv,
              char ** argc,
              void(*)() callback )
```

Definition at line 32 of file graphics.cpp.

```
32                                                                          {
33     glutInit(argv, argc);
34     glutInitDisplayMode(GLUT_DOUBLE | GLUT_RGB | GLUT_DEPTH);
35     glutInitWindowSize(400, 400);
36     glutCreateWindow("Autonomous Steering Agents");
37     glClearColor(0.7f, 0.7f, 0.7f, 1.0f); //set background color
38     glEnable(GL_DEPTH_TEST);
39     glutDisplayFunc(*callback);
40     glutMouseFunc(graphics::mouseButton);
41     glutPassiveMotionFunc(graphics::mouseMove);
42     glutKeyboardFunc(graphics::handleKeypress);
43     glutReshapeFunc(graphics::handleResize);
44     glutTimerFunc(5, graphics::timerEvent, 0);
45     glutMainLoop();
46 }
```

Here is the call graph for this function:

5.7.2.13 mouseButton()

```
void graphics::mouseButton (
              int button,
              int state,
              int x,
              int y )  [static]
```

Definition at line 93 of file graphics.cpp.

```
93                                                                  {
94     if (button == GLUT_LEFT_BUTTON && state == GLUT_DOWN){
95         cout « "zdf";
96     }
97 }
```

Here is the caller graph for this function:

5.7.2.14 mouseMove()

```
void graphics::mouseMove (
              int x,
              int y )  [static]
```

Definition at line 63 of file graphics.cpp.

```
63                                  {
64     //TODO: mouse position to glut
65     //TODO: magic numbers
66     graphics::target_x = x / 5.88 - 34;
67     graphics::target_y = 34 - y / 5.88;
68 }
```

Here is the caller graph for this function:

5.7.2.15 refreshScene()

```
void graphics::refreshScene ( )
```

Definition at line 24 of file graphics.cpp.

```
24                          {
25     glutSwapBuffers();
26     glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
27     glMatrixMode(GL_MODELVIEW); //Switch to the drawing perspective
28     glLoadIdentity(); //Reset the drawing perspective
29     glTranslatef(0.0f, 0.0f, -85.0f); //Move to the center of the triangle
30 }
```

5.7.2.16 timerEvent()

```
void graphics::timerEvent (
             int value )  [static]
```

Definition at line 83 of file graphics.cpp.

```
83                                  {
84     glutPostRedisplay(); //Tell GLUT that the display has changed
85     glutTimerFunc(20, timerEvent, 0);
86     /*counter++;
87     if(counter == _100_MS * 2){
88        counter = 0;
89        graphics::timerEventFlag = true;
90     }*/
91 }
```

Here is the caller graph for this function:

5.7.3 Member Data Documentation

5.7.3.1 target_x

```
int graphics::target_x = -WIDTH  [static]
```

Definition at line 33 of file graphics.h.

5.7.3.2 target_y

```
int graphics::target_y = HEIGHT  [static]
```

Definition at line 34 of file graphics.h.

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

- include/graphics.h
- src/graphics.cpp

5.8 mouseFollower Class Reference

`#include <mouseFollower.h>`

Inheritance diagram for mouseFollower:

Collaboration diagram for mouseFollower:

Public Member Functions

- mouseFollower ()

Static Public Member Functions

- static void loop ()

Additional Inherited Members

5.8.1 Detailed Description

Definition at line 8 of file mouseFollower.h.

5.8.2 Constructor & Destructor Documentation

5.8.2.1 mouseFollower()

`mouseFollower::mouseFollower ( )`

Definition at line 17 of file mouseFollower.cpp.

```
17                              {
18     int agentCount = 30;
19     float maxForce = 0.3;
20     float maxSpeed = 0.6;
21     name = "mouse following";
22     createAgent(RANDOM, &agentCount, &maxForce, &maxSpeed);
23     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
24 }
```

5.8.3 Member Function Documentation

5.8.3.1 loop()

```
void mouseFollower::loop ( )  [static]
```

Definition at line 8 of file mouseFollower.cpp.

```
8                           {
9     for(auto it = agents.begin(); it < agents.end(); it++){
10        (*it).targetPoint = view.getMousePosition();
11        (*it).force  = behavior.seek(*it);
12        (*it).arrive = true;
13     }
14     refresh();
15 }
```

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

- include/mouseFollower.h
- src/mouseFollower.cpp

5.9 obstacle Class Reference

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

Collaboration diagram for obstacle:

Public Member Functions

- obstacle ()
  Default constructor.
- obstacle (point p, float r)
  Constructor.

Public Attributes

- point p
  x and y coordinates
- float r
  the bigger radius the bigger the obstacle

5.9.1 Detailed Description

Definition at line 12 of file obstacle.h.

5.9.2 Constructor & Destructor Documentation

5.9.2.1 obstacle() [1/2]

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

Default constructor.

Create a new obstacle object.

See also

obstacle(point p, float r);

Definition at line 15 of file obstacle.cpp.

```
15 {}
```

5.9.2.2 obstacle() [2/2]

```
obstacle::obstacle (
            point p,
            float r )
```

Constructor.

Create a new obstacle object.

Parameters

p	center of the circular obstacle
r	radius of the obstacle

See also

obstacle(point p, float r);

Definition at line 17 of file obstacle.cpp.

```
17                                      {
18     this->p = p;
19     this->r = r;
20 }
```

5.9.3 Member Data Documentation

5.9.3.1 p

```
point obstacle::p
```

x and y coordinates

center point of the obstacle

Definition at line 34 of file obstacle.h.

5.9.3.2 r

```
float obstacle::r
```

the bigger radius the bigger the obstacle

radius of the obstacle

Definition at line 40 of file obstacle.h.

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

- include/obstacle.h
- src/obstacle.cpp

5.10 obstacleAvoidance Class Reference

```
#include <obstacleAvoidance.h>
```

Inheritance diagram for obstacleAvoidance:

Collaboration diagram for obstacleAvoidance:

Public Member Functions

- obstacleAvoidance ()

Static Public Member Functions

- static void loop ()
- static void createObstacle (vector< obstacle > &obstacles)

Static Public Attributes

- static vector< obstacle > obstacles

Additional Inherited Members

5.10.1 Detailed Description

Definition at line 9 of file obstacleAvoidance.h.

5.10.2 Constructor & Destructor Documentation

5.10.2.1 obstacleAvoidance()

```
obstacleAvoidance::obstacleAvoidance ( )
```

Definition at line 34 of file obstacleAvoidance.cpp.

```
34                                  {
35     name = "avoid obstacles";
36     createAgent(STATIC, nullptr, nullptr, nullptr);
37     createObstacle(obstacles);
38     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
39 }
```

5.10.3 Member Function Documentation

5.10.3.1 createObstacle()

```
void obstacleAvoidance::createObstacle (
            vector< obstacle > & obstacles )  [static]
```

Definition at line 28 of file obstacleAvoidance.cpp.

```
28                                                                  {
29     obstacles.push_back(obstacle(point(0,0), 8));
30     obstacles.push_back(obstacle(point(-20,0), 3));
31     obstacles.push_back(obstacle(point(20,-10), 4));
32 }
```

Here is the call graph for this function:

5.10.3.2 loop()

```
void obstacleAvoidance::loop ( )  [static]
```

Definition at line 10 of file obstacleAvoidance.cpp.

```
10                              {
11     for(auto it = agents.begin(); it < agents.end(); it++){
12         for(auto it = obstacles.begin(); it < obstacles.end(); it++){
13             point p = (*it).p;
14             view.drawCircle(p, (*it).r);
15         }
16
17         (*it).targetPoint = view.getMousePosition();
18         pvector seek  = behavior.seek(*it);
19         seek.mul(0.5);
20
21         pvector avoid = behavior.avoid(obstacles, *it);
22         (*it).force = avoid + seek;
23         (*it).arrive = true;
24     }
25     refresh();
26 }
```

Here is the call graph for this function:

5.10.4 Member Data Documentation

5.10.4.1 obstacles

```
vector< obstacle > obstacleAvoidance::obstacles  [static]
```

Definition at line 13 of file obstacleAvoidance.h.

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

- include/obstacleAvoidance.h
- src/obstacleAvoidance.cpp

5.11 path Class Reference

```
#include <path.h>
```

Collaboration diagram for path:

Public Member Functions

- path ()

  Default constructor.
- path (float width)

  Constructor.
- void addPoint (point p)

  adds a new point to the path

Public Attributes

- vector< point > points

  points added to the path
- int width

  defines width of the path

5.11.1 Detailed Description

Definition at line 15 of file path.h.

5.11.2 Constructor & Destructor Documentation

5.11.2.1 path() [1/2]

```
path::path ( )
```

Default constructor.

Create a new path object.

See also

path(float width)

Definition at line 16 of file path.cpp.

```
17 {
18
19 }
```

5.11.2.2 path() [2/2]

```
path::path (
            float width )
```

Constructor.

Create a new path object.

Parameters

width	The width of the path.

See also

path()

Definition at line 21 of file path.cpp.

```
22 {
23     this->width = width;
24 }
```

5.11.3 Member Function Documentation

5.11.3.1 addPoint()

```
void path::addPoint (
            point p )
```

adds a new point to the path

Used when customizing path

Parameters

point	new point to add to the path

Definition at line 11 of file path.cpp.

```
12 {
13     points.push_back(p);
14 }
```

Here is the caller graph for this function:

5.11.4 Member Data Documentation

5.11.4.1 points

```
vector<point> path::points
```

points added to the path

path is created from these points

Definition at line 43 of file path.h.

5.11.4.2 width

```
int path::width
```

defines width of the path

path width

Definition at line 49 of file path.h.

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

- include/path.h
- src/path.cpp

5.12 pathFollower Class Reference

```
#include <pathFollower.h>
```

Inheritance diagram for pathFollower:

Collaboration diagram for pathFollower:

Public Member Functions

- pathFollower ()

Static Public Member Functions

- static void loop ()
- static void createPath (path &p)

Static Public Attributes

- static path myPath

Additional Inherited Members

5.12.1 Detailed Description

Definition at line 8 of file pathFollower.h.

5.12.2 Constructor & Destructor Documentation

5.12.2.1 pathFollower()

```
pathFollower::pathFollower ( )
```

Definition at line 28 of file pathFollower.cpp.

```
28                          {
29     int agentCount = 40;
30     float maxForce = 0.2;
31     float maxSpeed = 0.4;
32     myPath = path(8);
33     createPath(myPath);
34     name = "path following";
35     createAgent(RANDOM, &agentCount, &maxForce, &maxSpeed);
36     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
37 }
```

5.12.3 Member Function Documentation

5.12.3.1 createPath()

```
void pathFollower::createPath (
            path & p )  [static]
```

Definition at line 21 of file pathFollower.cpp.

```
21                                      {
22     p.addPoint(point(-40,  5));
23     p.addPoint(point(-14, 15));
24     p.addPoint(point( 10,  7));
25     p.addPoint(point( 40, 12));
26 }
```

Here is the call graph for this function:

5.12.3.2 loop()

```
void pathFollower::loop ( )  [static]
```

Definition at line 10 of file pathFollower.cpp.

```
10                          {
11     for(auto it = agents.begin(); it < agents.end(); it++){
12         view.drawPath(myPath, myColor);
13         pvector seek = behavior.stayInPath_2(*it, myPath, view);
14         pvector sep  = behavior.separation(agents, *it);
15         sep.mul(5);
16         (*it).force = sep + seek;
17     }
18     refresh();
19 }
```

Here is the call graph for this function:

5.12.4 Member Data Documentation

5.12.4.1 myPath

```
path pathFollower::myPath  [static]
```

Definition at line 12 of file pathFollower.h.

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

- include/pathFollower.h
- src/pathFollower.cpp

5.13 point Class Reference

```
#include <point.h>
```

Collaboration diagram for point:

Public Member Functions

- point (float x, float y)
- point ()
- void div (float d)
- void mul (float d)
- void print (const string &s)
- point operator+ (pvector const &obj)
- point operator+ (point const &obj)
- pvector operator- (point const &obj)
- bool operator== (point const &obj)
- void getNormalPoint (point predicted, point start, point end)

Public Attributes

- float x
- float y

5.13.1 Detailed Description

Definition at line 8 of file point.h.

5.13.2 Constructor & Destructor Documentation

5.13.2.1 point() [1/2]

```
point::point (
            float x,
            float y )
```

Definition at line 8 of file point.cpp.

```
8                           {
9    this->x = x;
10    this->y = y;
11 }
```

5.13.2.2 point() [2/2]

```
point::point ( )
```

Definition at line 13 of file point.cpp.

```
13 {}
```

Here is the caller graph for this function:

5.13.3 Member Function Documentation

5.13.3.1 div()

```
void point::div (
            float d )
```

Definition at line 28 of file point.cpp.

```
28                      {
29     x = x / d;
30     y = y / d;
31 }
```

Here is the caller graph for this function:

5.13.3.2 getNormalPoint()

```
void point::getNormalPoint (
            point predicted,
            point start,
            point end )
```

Definition at line 53 of file point.cpp.

```
53                                                          {
54     pvector a = predicted - start;
55     pvector b = end - start;
56     b.normalize();
57     float a_dot_b = a.dotProduct(b);
58     b.mul(a_dot_b);
59     point normalPoint = start + b;
60     this->x = normalPoint.x;
61     this->y = normalPoint.y;
62 }
```

Here is the call graph for this function: Here is the caller graph for this function:

5.13.3.3 mul()

```
void point::mul (
            float d )
```

Definition at line 33 of file point.cpp.

```
33                      {
34     x = x * d;
35     y = y * d;
36 }
```

Here is the caller graph for this function:

5.13.3.4 operator+() [1/2]

```
point point::operator+ (
            point const & obj )
```

Definition at line 39 of file point.cpp.

```
39                                      {
40     point res;
41     res.x = x + obj.x;
42     res.y = y + obj.y;
43     return res;
44 }
```

5.13.3.5 operator+() [2/2]

```
point point::operator+ (
            pvector const & obj )
```

Definition at line 15 of file point.cpp.

```
15                                          {
16     point res;
17     res.x = x + obj.x;
18     res.y = y + obj.y;
19     return res;
20 }
```

5.13.3.6 operator-()

```
pvector point::operator- (
            point const & obj )
```

Definition at line 46 of file point.cpp.

```
46                                          {
47     pvector res;
48     res.x = x - obj.x;
49     res.y = y - obj.y;
50     return res;
51 }
```

5.13.3.7 operator==()

```
bool point::operator== (
            point const & obj )
```

Definition at line 22 of file point.cpp.

```
22                                         {
23     if(x == obj.x && y == obj.y)
24        return true;
25     return false;
26 }
```

5.13.3.8 print()

```
void point::print (
            const string & s )
```

Definition at line 64 of file point.cpp.

```
64                                  {
65     cout « " " « s « " " « x « " " « y « endl;
66 }
```

5.13.4 Member Data Documentation

5.13.4.1 x

```
float point::x
```

Definition at line 10 of file point.h.

5.13.4.2 y

```
float point::y
```

Definition at line 11 of file point.h.

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

- include/point.h
- src/point.cpp

5.14 prison Class Reference

```
#include <prison.h>
```

Inheritance diagram for prison:

Collaboration diagram for prison:

Public Member Functions

- prison ()

Static Public Member Functions

- static void loop ()

Additional Inherited Members

5.14.1 Detailed Description

Definition at line 8 of file prison.h.

5.14.2 Constructor & Destructor Documentation

5.14.2.1 prison()

```
prison::prison ( )
```

Definition at line 17 of file prison.cpp.

```
17              {
18     int agentCount = 30;
19     float maxForce = 0.5;
20     float maxSpeed = 0.6;
21
22     name = "stay in prison";
23     createAgent(RANDOM, &agentCount, &maxForce, &maxSpeed);
24     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
25 }
```

5.14.3 Member Function Documentation

5.14.3.1 loop()

```
void prison::loop ( )  [static]
```

Definition at line 8 of file prison.cpp.

```
8                   {
9     for(auto it = agents.begin(); it < agents.end(); it++){
10          view.drawWall(WALL, myColor);
11          (*it).force  = behavior.stayInArea(*it, WALL - DISTANCE);
12          (*it).force += behavior.separation(agents, *it);
13     }
14     refresh();
15 }
```

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

- include/prison.h
- src/prison.cpp

5.15 pursuit Class Reference

```
#include <pursuit.h>
```

Inheritance diagram for pursuit:

Collaboration diagram for pursuit:

Public Member Functions

- pursuit ()

Static Public Member Functions

- static void loop ()

Additional Inherited Members

5.15.1 Detailed Description

Definition at line 8 of file pursuit.h.

5.15.2 Constructor & Destructor Documentation

5.15.2.1 pursuit()

```
pursuit::pursuit ( )
```

Definition at line 23 of file pursuit.cpp.

```
23                  {
24     name = "pursuit";
25     createAgent(STATIC, nullptr, nullptr, nullptr);
26     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
27 }
```

5.15.3 Member Function Documentation

5.15.3.1 loop()

```
void pursuit::loop ( )  [static]
```

Definition at line 8 of file pursuit.cpp.

```
8                   {
9     for(auto it = agents.begin(); it < agents.end(); it++){
10          if((*it).name == "gazelle"){
11              (*it).targetPoint = view.getMousePosition();
12              (*it).force  = behavior.seek(*it);
13          }
14          else{//lion
15              (*it).force  = behavior.pursuit(agents, *it, view);
16          }
17          (*it).arrive = true;
18     }
19
20     refresh();
21 }
```

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

- include/pursuit.h
- src/pursuit.cpp

5.16 pvector Class Reference

```
#include <pvector.h>
```

Collaboration diagram for pvector:

Public Member Functions

- pvector ()
- pvector (float x, float y)
- float magnitude ()
- pvector & normalize ()
- void div (float i)
- void mul (float i)
- void add (pvector p)
- void limit (float limit)
- float getAngle ()
- float dotProduct (pvector v)
- float angleBetween (pvector v)
- pvector operator+= (pvector const &obj)
- pvector operator+ (pvector const &obj)
- pvector operator- (pvector const &obj)
- pvector operator- (point const &obj)
- pvector operator+ (point const &obj)
- bool operator== (pvector const &obj)
- void print (const string &s)

Public Attributes

- float x
- float y

5.16.1 Detailed Description

Definition at line 11 of file pvector.h.

5.16.2 Constructor & Destructor Documentation

5.16.2.1 pvector() [1/2]

```
pvector::pvector ( )
```

Definition at line 25 of file pvector.cpp.

```
25 {}
```

5.16.2.2 pvector() [2/2]

```
pvector::pvector (
            float x,
            float y )
```

Definition at line 27 of file pvector.cpp.

```
27                                {
28     this->x = x;
29     this->y = y;
30 }
```

5.16.3 Member Function Documentation

5.16.3.1 add()

```
void pvector::add (
            pvector p )
```

Definition at line 42 of file pvector.cpp.

```
42                              {
43     x = x + p.x;
44     y = y + p.y;
45 }
```

5.16.3.2 angleBetween()

```
float pvector::angleBetween (
            pvector v )
```

Definition at line 15 of file pvector.cpp.

```
15                                      {
16     float angle = this->dotProduct(v) / (this->magnitude() * v.magnitude());
17     angle = acos(angle)  * 180 / PI;
18     return angle;
19 }
```

Here is the call graph for this function: Here is the caller graph for this function:

5.16.3.3 div()

```
void pvector::div (
            float i )
```

Definition at line 32 of file pvector.cpp.

```
32                             {
33     x = x / i;
34     y = y / i;
35 }
```

Here is the caller graph for this function:

5.16.3.4 dotProduct()

```
float pvector::dotProduct (
            pvector v )
```

Definition at line 21 of file pvector.cpp.

```
21                                      {
22     return ((x * v.x) + (y * v.y));
23 }
```

Here is the caller graph for this function:

5.16.3.5 getAngle()

```
float pvector::getAngle ( )
```

Definition at line 9 of file pvector.cpp.

```
9                          {
10    float angle;
11    angle = atan2 (this->y, this->x) * 180 / PI;
12    return angle;
13 }
```

Here is the caller graph for this function:

5.16.3.6 limit()

```
void pvector::limit (
              float limit )
```

Definition at line 64 of file pvector.cpp.

```
64                                  {
65    this->normalize();
66    this->mul(limit);
67 }
```

Here is the call graph for this function: Here is the caller graph for this function:

5.16.3.7 magnitude()

```
float pvector::magnitude ( )
```

Definition at line 47 of file pvector.cpp.

```
47                          {
48    return sqrt((this->x * this->x) + (this->y * this->y));
49 }
```

Here is the caller graph for this function:

5.16.3.8 mul()

```
void pvector::mul (
              float i )
```

Definition at line 37 of file pvector.cpp.

```
37                          {
38    x = x * i;
39    y = y * i;
40 }
```

Here is the caller graph for this function:

5.16.3.9 normalize()

```
pvector & pvector::normalize ( )
```

Definition at line 51 of file pvector.cpp.

```
51                              {
52     float magnitude = this->magnitude();
53     if(magnitude != 0){
54        this->x = this->x / magnitude;
55        this->y = this->y / magnitude;
56     }
57     else{
58        this->x = 0;
59        this->y = 0;
60     }
61     return *this;
62 }
```

Here is the caller graph for this function:

5.16.3.10 operator+() [1/2]

```
pvector pvector::operator+ (
             point const & obj )
```

Definition at line 88 of file pvector.cpp.

```
88                                          {
89     pvector res;
90     res.x = x + obj.x;
91     res.y = y + obj.y;
92     return res;
93 }
```

5.16.3.11 operator+() [2/2]

```
pvector pvector::operator+ (
             pvector const & obj )
```

Definition at line 69 of file pvector.cpp.

```
69                                            {
70     pvector res;
71     res.x = x + obj.x;
72     res.y = y + obj.y;
73     return res;
74 }
```

5.16.3.12 operator+=()

```
pvector pvector::operator+= (
             pvector const & obj )
```

Definition at line 76 of file pvector.cpp.

```
76                                             {
77     x = x + obj.x;
78     y = y + obj.y;
79     return *this;
80 }
```

5.16.3.13 operator-() [1/2]

```
pvector pvector::operator- (
            point const & obj )
```

Definition at line 95 of file pvector.cpp.

```
95                                          {
96     pvector res;
97     res.x = x - obj.x;
98     res.y = y - obj.y;
99     return res;
100 }
```

5.16.3.14 operator-() [2/2]

```
pvector pvector::operator- (
            pvector const & obj )
```

Definition at line 106 of file pvector.cpp.

```
106                                             {
107     pvector res;
108     res.x = x - obj.x;
109     res.y = y - obj.y;
110     return res;
111 }
```

5.16.3.15 operator==()

```
bool pvector::operator== (
            pvector const & obj )
```

Definition at line 82 of file pvector.cpp.

```
82                                          {
83     if(x == obj.x && y == obj.y)
84        return true;
85     return false;
86 }
```

5.16.3.16 print()

```
void pvector::print (
            const string & s )
```

Definition at line 102 of file pvector.cpp.

```
102                                     {
103     cout << s << " " << x << " " << y << endl;
104 }
```

5.16.4 Member Data Documentation

5.16.4.1 x

```
float pvector::x
```

Definition at line 13 of file pvector.h.

5.16.4.2 y

```
float pvector::y
```

Definition at line 14 of file pvector.h.

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

- include/pvector.h
- src/pvector.cpp

5.17 random Class Reference

```
#include <random.h>
```

Collaboration diagram for random:

Static Public Member Functions

- static void createRandomArray (int *arr, int size)

5.17.1 Detailed Description

Definition at line 3 of file random.h.

5.17.2 Member Function Documentation

5.17.2.1 createRandomArray()

```
void random::createRandomArray (
            int * arr,
            int size )  [static]
```

Definition at line 7 of file random.cpp.

```
7                                                   {
8     srand(time(NULL));
9     for(int i=0; i<size; i++)
10        arr[i] = i+1;
11
12     for (int i=0; i < size; i++){
13        int r = rand() % size;
14        swap(arr[i], arr[r]);
15     }
16 }
```

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

- include/random.h
- src/random.cpp

5.18 scenario Class Reference

`#include <scenario.h>`

Inheritance diagram for scenario:

Collaboration diagram for scenario:

Public Member Functions

- scenario ()
- void createAgent (int type, int *count, float *force, float *speed)
- void initGL (int *argv, char **argc)

Static Public Member Functions

- static void refresh ()

Public Attributes

- void(* callback)()

Static Public Attributes

- static vector< agent > agents
- static graphics view
- static steeringBehavior behavior
- static color myColor
- static string name

5.18.1 Detailed Description

Definition at line 12 of file scenario.h.

5.18.2 Constructor & Destructor Documentation

5.18.2.1 scenario()

```
scenario::scenario ( )
```

Definition at line 18 of file scenario.cpp.

```
19 {
20     srand(time(NULL));
21     myColor.createColors();
22     view = graphics();
23 }
```

5.18.3 Member Function Documentation

5.18.3.1 createAgent()

```
void scenario::createAgent (
            int type,
            int * count,
            float * force,
            float * speed )
```

Definition at line 95 of file scenario.cpp.

```
96 {
97     if(type == TROOP){
98         createTroop(*count);
99     }
100     else if(type == RANDOM){
101         createRandomAgents(*count, *force, *speed);
102     }
103     else if(type == STATIC){
104         createStaticAgents();
105     }
106     else{
107         //error message
108     }
109 }
```

5.18.3.2 initGL()

```
void scenario::initGL (
            int * argv,
            char ** argc )
```

Definition at line 13 of file scenario.cpp.

```
13                                          {
14     view.initGraphics(argc, argv, callback);
15 }
```

Here is the caller graph for this function:

5.18.3.3 refresh()

```
void scenario::refresh ( )  [static]
```

Definition at line 25 of file scenario.cpp.

```
25                      {
26     for(auto it = agents.begin(); it < agents.end(); it++){
27        (*it).updatePosition((*it).arrive);
28        view.drawAgent(*it, (*it).fillColor);
29     }
30
31     view.drawText(name, point(-34, 32.25)); //TODO: magic numbers, define left corner
32     view.refreshScene();
33 }
```

Here is the call graph for this function:

5.18.4 Member Data Documentation

5.18.4.1 agents

```
vector< agent > scenario::agents  [static]
```

Definition at line 18 of file scenario.h.

5.18.4.2 behavior

```
steeringBehavior scenario::behavior  [static]
```

Definition at line 20 of file scenario.h.

5.18.4.3 callback

```
void(* scenario::callback) ()
```

Definition at line 23 of file scenario.h.

5.18.4.4 myColor

```
color scenario::myColor  [static]
```

Definition at line 21 of file scenario.h.

5.18.4.5 name

```
string scenario::name  [static]
```

Definition at line 22 of file scenario.h.

5.18.4.6 view

```
graphics scenario::view  [static]
```

Definition at line 19 of file scenario.h.

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

- include/scenario.h
- src/scenario.cpp

5.19 steeringBehavior Class Reference

```
#include <steeringBehavior.h>
```

Collaboration diagram for steeringBehavior:

Public Member Functions

- pvector stayInArea (agent &agent, int turnPoint)
- pvector inFlowField (agent &agent, flowField &flow)
- pvector stayInPath (agent &agent, path &path)
- pvector stayInPath_2 (agent &agent, path &path, graphics view)
- pvector seek (agent &agent)
- pvector separation (vector< agent > agents, agent &agent)
- pvector cohesion (vector< agent > boids, agent &agent)
- pvector align (vector< agent > boids, agent &agent)
- pvector wander (agent &agent)
- pvector pursuit (vector< agent > boids, agent &pursuer, graphics view)
- pvector evade (vector< agent > boids, agent &evader, graphics view)
- pvector flee (agent &agent, graphics &view, point p)
- pvector avoid (vector< obstacle > obstacles, agent &agent)
- void setAngle (pvector &p, float angle)

5.19.1 Detailed Description

Definition at line 28 of file steeringBehavior.h.

5.19.2 Member Function Documentation

5.19.2.1 align()

```
pvector steeringBehavior::align (
            vector< agent > boids,
            agent & agent )
```

Definition at line 105 of file steeringBehavior.cpp.

```
105                                                                    {
106     float neighborDist = 30; //TODO: magic numer
107     pvector sum {0,0};
108     int count = 0;
109     for(auto it = boids.begin(); it < boids.end(); it++){
110        float d = (agent.position - (*it).position).magnitude();
111        if( (d >0) && (d < neighborDist) ){
112           sum += (*it).velocity;
113           count++;
114        }
115     }
116     if(count>0){
117        sum.div(count);
118        sum.normalize().mul(agent.maxSpeed);
119        agent.steering = sum - agent.velocity;
120        return agent.steering;
121     }
122     return pvector(0,0);
123 }
```

Here is the call graph for this function:

5.19.2.2 avoid()

```
pvector steeringBehavior::avoid (
            vector< obstacle > obstacles,
            agent & agent )
```

Definition at line 166 of file steeringBehavior.cpp.

```
166                                                                    {
167     float dynamic_length = agent.velocity.magnitude() / agent.maxSpeed;
168     pvector vel = agent.velocity;
169     vel.normalize().mul(dynamic_length);
170     pvector ahead  = vel + agent.position;
171     vel.mul(6);
172     pvector ahead2 = vel + agent.position;
173     //view.drawPoint(point(ahead.x, ahead.y));
174     //view.drawPoint(point(ahead2.x, ahead2.y));
175
176     for(auto it = obstacles.begin(); it < obstacles.end(); it++){
177        float dist  = (ahead  - (*it).p).magnitude();
178        float dist2 = (ahead2 - (*it).p).magnitude();
179        if(dist < (*it).r + 2 || dist2 < (*it).r + 2){
180           pvector avoidance = ahead - (*it).p;
181           avoidance.normalize().mul(20);
182           /*a = point(avoidance.x, avoidance.y);
183           view.drawLine(agent.position, agent.position + a, color(0,1,0));*/
184           return avoidance;
185        }
186     }
187     return pvector(0,0);
188 }
```

Here is the call graph for this function:

5.19.2.3 cohesion()

```
pvector steeringBehavior::cohesion (
            vector< agent > boids,
            agent & agent )
```

Definition at line 125 of file steeringBehavior.cpp.

```
125                                                                          {
126     float neighborDist = 20; //TODO: magic numer
127     point sum {0,0};
128     int count = 0;
129     for(auto it = boids.begin(); it < boids.end(); it++){
130        float d = (agent.position - (*it).position).magnitude();
131        if( (d >0) && (d < neighborDist) ){
132           sum = sum + (*it).position;
133           count++;
134        }
135     }
136     if(count>0){
137        sum.div(count);
138        agent.targetPoint = sum;
139        return seek(agent);
140     }
141     return pvector(0,0);
142 }
```

Here is the call graph for this function:

5.19.2.4 evade()

```
pvector steeringBehavior::evade (
            vector< agent > boids,
            agent & evader,
            graphics view )
```

Definition at line 36 of file steeringBehavior.cpp.

```
36                                                                                                  {
37     agent target;
38     for(auto it = boids.begin(); it < boids.end(); it++){
39        if((*it).name == "lion"){
40           target = *it;
41        }
42     }
43
44     point p = point(evader.position.x + 2, evader.position.y - 2);
45     view.drawText(evader.name, p);
46     p = point(target.position.x + 2, target.position.y - 2);
47     view.drawText(target.name, p);
48
49     pvector targetVel = target.velocity;
50     targetVel.mul(5);//TODO: magic number
51
52     point futurePos = target.position + targetVel;
53     view.drawPoint(futurePos);
54
55     pvector dist = evader.position - futurePos;
56     dist.normalize().mul( 1 / dist.magnitude() );
57
58     evader.targetPoint = evader.position + dist;
59     return flee(evader, view, futurePos);
60 }
```

Here is the call graph for this function:

5.19.2.5 flee()

```
pvector steeringBehavior::flee (
            agent & agent,
            graphics & view,
            point p )
```

Definition at line 20 of file steeringBehavior.cpp.

```
20                                                                          {
21     pvector dist = agent.targetPoint - p;
22     view.drawPoint(agent.targetPoint);
23
24     if(dist.magnitude() < 15){  //TODO: magic number
25        agent.arrive = false;
26        agent.desiredVelocity = agent.position - p;
27     }
28     else{
29        agent.arrive = true;
30        agent.desiredVelocity = agent.targetPoint - agent.position;
31     }
32     agent.steering = agent.desiredVelocity - agent.velocity;
33     return agent.steering;
34 }
```

Here is the call graph for this function:

5.19.2.6 inFlowField()

```
pvector steeringBehavior::inFlowField (
            agent & agent,
            flowField & flow )
```

Definition at line 236 of file steeringBehavior.cpp.

```
236                                                                         {
237     //pos_x, pos_y must be non negative integer
238     int pos_x = abs((int)agent.position.x) % WIDTH;
239     int pos_y = abs((int)agent.position.y) % HEIGHT;
240     //TODO: modification required for non uniform fields
241     return flow.getField(pos_x, pos_y);
242 }
```

Here is the call graph for this function:

5.19.2.7 pursuit()

```
pvector steeringBehavior::pursuit (
            vector< agent > boids,
            agent & pursuer,
            graphics view )
```

Definition at line 62 of file steeringBehavior.cpp.

```
62                                                                                  {
63     agent target;
64     for(auto it = boids.begin(); it < boids.end(); it++){
65        if((*it).name == "gazelle"){
66           target = *it;
67        }
68     }
69
70     point p = point(target.position.x + 2, target.position.y - 2);
71     view.drawText(target.name, p);
72     p = point(pursuer.position.x + 2, pursuer.position.y - 2);
73     view.drawText(pursuer.name, p);
74
75     float dist = (target.position - pursuer.position).magnitude();
76     float t = dist / target.maxSpeed;
77
78     pvector targetVel = target.velocity;
79     targetVel.mul(t);
80     point futurePos = target.position + targetVel;
81     pursuer.targetPoint = futurePos;
82     return seek(pursuer);
83 }
```

Here is the call graph for this function:

5.19.2.8 seek()

```
pvector steeringBehavior::seek (
            agent & agent )
```

Definition at line 190 of file steeringBehavior.cpp.

```
190                                         {
191     agent.desiredVelocity = agent.targetPoint - agent.position;
192     agent.steering = agent.desiredVelocity - agent.velocity;
193     return agent.steering;
194 }
```

5.19.2.9 separation()

```
pvector steeringBehavior::separation (
            vector< agent > agents,
            agent & agent )
```

Definition at line 144 of file steeringBehavior.cpp.

```
144                                                                                 {
145     float desiredSeparation = 5; //TODO: magic number
146     pvector sum = pvector(0,0);
147     int count = 0;
148     for(auto it = agents.begin(); it < agents.end(); it++){
149        float d = (agent.position - (*it).position).magnitude();
150        if( (d > 0) && (d < desiredSeparation) ){
151           pvector diff = agent.position - (*it).position;
152           diff.normalize().div(d);
153           sum = sum + diff;
154           count++;
155        }
156     }
157     if(count > 0){
158        sum.div(count);
159        sum.normalize().mul(agent.maxSpeed);
160        agent.steering = sum - agent.velocity;
161        return agent.steering;
162     }
163     return pvector(0,0);
164 }
```

Here is the call graph for this function:

5.19.2.10 setAngle()

```
void steeringBehavior::setAngle (
            pvector & p,
            float angle )
```

Definition at line 15 of file steeringBehavior.cpp.

```
15                                                  {
16     p.x = cos ( angle * PI / 180.0 );
17     p.y = sin ( angle * PI / 180.0 );
18 }
```

5.19.2.11 stayInArea()

```
pvector steeringBehavior::stayInArea (
            agent & agent,
            int turnPoint )
```

Definition at line 244 of file steeringBehavior.cpp.

```
244                                                                 {
245    if(agent.position.x >= turnPoint){
246       agent.desiredVelocity = pvector( -agent.maxSpeed, agent.velocity.y );
247       agent.steering = agent.desiredVelocity - agent.velocity;
248       return agent.steering;
249    }
250    else if(agent.position.x <= -turnPoint){
251       agent.desiredVelocity = pvector( agent.maxSpeed, agent.velocity.y );
252       agent.steering = agent.desiredVelocity - agent.velocity;
253       return agent.steering;
254    }
255    else if(agent.position.y >= turnPoint){
256       agent.desiredVelocity = pvector( agent.velocity.x, -agent.maxSpeed );
257       agent.steering = agent.desiredVelocity - agent.velocity;
258       return agent.steering;
259    }
260    else if(agent.position.y <= -turnPoint){
261       agent.desiredVelocity = pvector( agent.velocity.x, agent.maxSpeed );
262       agent.steering = agent.desiredVelocity - agent.velocity;
263       return agent.steering;
264    }
265    return pvector(0,0);
266 }
```

5.19.2.12 stayInPath()

```
pvector steeringBehavior::stayInPath (
            agent & agent,
            path & path )
```

Definition at line 218 of file steeringBehavior.cpp.

```
218                                                         {
219    point start = path.points.at(0);
220    point end   = path.points.at(1);
221    point predictedPos = agent.position + agent.velocity;
222    point normalPoint;
223    normalPoint.getNormalPoint(predictedPos, start, end);
224    pvector b = end - start;
225    b.normalize();
226
227    pvector distance  = predictedPos - normalPoint;
228    agent.targetPoint = normalPoint  + b;
229    //view.drawLine(predictedPos, normalPoint);
230    //view.drawPoint(targetPoint);
231    if(distance.magnitude() > path.width / 8)
232      return seek(agent);
233    return pvector(0,0);
234 }
```

Here is the call graph for this function:

5.19.2.13 stayInPath_2()

```
pvector steeringBehavior::stayInPath_2 (
            agent & agent,
            path & path,
            graphics view )
```

Definition at line 196 of file steeringBehavior.cpp.

```
196                                                                                 {
197     float worldRecord = 1000000; //TODO: magic number
198     point normalPoint, predictedPos, start, end;
199     pvector distance;
200     for(auto it = path.points.begin(); it < path.points.end()-1; it++){
201        start = point((*it).x, (*it).y);
202        end   = point((*(it+1)).x, (*(it+1)).y);
203        predictedPos = agent.position + agent.velocity;
204        normalPoint.getNormalPoint(predictedPos, start, end);
205        if (normalPoint.x < start.x || normalPoint.x > end.x){
206           normalPoint = end;
207        }
208        distance = predictedPos - normalPoint;
209        if (distance.magnitude() < worldRecord){
210           worldRecord = distance.magnitude();
211           agent.targetPoint = end;
212        }
213        view.drawPoint(agent.targetPoint);
214     }
215     return seek(agent);
216 }
```

Here is the call graph for this function:

5.19.2.14 wander()

```
pvector steeringBehavior::wander (
             agent & agent )
```

Definition at line 85 of file steeringBehavior.cpp.

```
85                                                {
86     pvector circleCenter = agent.velocity;
87     circleCenter.normalize().mul(CIRCLE_DISTANCE + CIRCLE_RADIUS);
88
89     int wanderAngle = (rand() % 360);
90     pvector displacement {0, 1};
91     setAngle(displacement, wanderAngle);
92     displacement.mul(CIRCLE_RADIUS);
93
94     agent.desiredVelocity = displacement + circleCenter;
95     agent.steering = agent.desiredVelocity - agent.velocity;
96
97     //move it to the center when it is out of screen
98     if(agent.position.x > WIDTH || agent.position.x < -WIDTH ||
99        agent.position.y > HEIGHT || agent.position.y < -HEIGHT)
100        agent.position = point(0,0);
101
102    return agent.steering;
103 }
```

Here is the call graph for this function:

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

- include/steeringBehavior.h
- src/steeringBehavior.cpp

5.20 wander Class Reference

`#include <wander.h>`

Inheritance diagram for wander:

Collaboration diagram for wander:

Public Member Functions

- wander ()

Static Public Member Functions

- static void loop ()

Additional Inherited Members

5.20.1 Detailed Description

Definition at line 8 of file wander.h.

5.20.2 Constructor & Destructor Documentation

5.20.2.1 wander()

```
wander::wander ( )
```

Definition at line 16 of file wander.cpp.

```
16              {
17     int agentCount = 30;
18     float maxForce = 0.3;
19     float maxSpeed = 0.6;
20
21     name = "wandering objects";
22     createAgent(RANDOM, &agentCount, &maxForce, &maxSpeed);
23     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
24 }
```

5.20.3 Member Function Documentation

5.20.3.1 loop()

```
void wander::loop ( )  [static]
```

Definition at line 8 of file wander.cpp.

```
8                   {
9     for(auto it = agents.begin(); it < agents.end(); it++){
10        (*it).force = behavior.wander(*it);
11     }
12
13     refresh();
14 }
```

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

- include/wander.h
- src/wander.cpp

5.21 windy Class Reference

`#include <windy.h>`

Inheritance diagram for windy:

Collaboration diagram for windy:

Public Member Functions

- windy ()

Static Public Member Functions

- static void loop ()

Static Public Attributes

- static flowField flow

Additional Inherited Members

5.21.1 Detailed Description

Definition at line 9 of file windy.h.

5.21.2 Constructor & Destructor Documentation

5.21.2.1 windy()

`windy::windy ( )`

Definition at line 21 of file windy.cpp.

```
21             {
22     int agentCount = 30;
23     float maxForce = 0.3;
24     float maxSpeed = 0.6;
25
26     name = "flow field";
27     createAgent(RANDOM, &agentCount, &maxForce, &maxSpeed);
28     callback = reinterpret_cast <void(*)()> ( (void *)(&loop) );
29 }
```

5.21.3 Member Function Documentation

5.21.3.1 loop()

```
void windy::loop ( )  [static]
```

Definition at line 10 of file windy.cpp.

```
10                  {
11      for(auto it = agents.begin(); it < agents.end(); it++){
12           flow = flowField(pvector(GRAVITY));
13           (*it).force  = behavior.inFlowField(*it, flow);
14
15           flow = flowField(pvector(WIND_WEST));
16           (*it).force += behavior.inFlowField(*it, flow);
17      }
18      refresh();
19  }
```

5.21.4 Member Data Documentation

5.21.4.1 flow

```
flowField windy::flow  [static]
```

Definition at line 13 of file windy.h.

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

- include/windy.h
- src/windy.cpp

Chapter 6

File Documentation

6.1 include/agent.h File Reference

```
#include "point.h"
#include "color.h"
#include "flowField.h"
#include <vector>
#include <string>
```
Include dependency graph for agent.h:

6.2 include/color.h File Reference

color class used for agent, path, wall etc. color

```
#include <vector>
```
Include dependency graph for color.h: This graph shows which files directly or indirectly include this file:

Classes

- class color

Enumerations

- enum num {
  BLACK =0, BLUE, GREEN, CYAN,
  RED, MAGENDA, YELLOW, WHITE }
  used to get color from colors vector

6.2.1 Detailed Description

color class used for agent, path, wall etc. color

Author

Mehmet Rıza Öz - mehmetrizaoz@gmail.com

Date

13.05.2021

6.2.2 Enumeration Type Documentation

6.2.2.1 num

```
enum num
```

used to get color from colors vector

color names for fundamental colors

Enumerator

BLACK	
BLUE	
GREEN	
CYAN	
RED	
MAGENDA	
YELLOW	
WHITE	

Definition at line 18 of file color.h.

```
18 { BLACK=0, BLUE, GREEN, CYAN, RED, MAGENDA, YELLOW, WHITE };
```

6.3 include/evade.h File Reference

```
#include "scenario.h"
#include <vector>
```

Include dependency graph for evade.h: This graph shows which files directly or indirectly include this file:

Classes

- class evade

6.4 include/flee.h File Reference

```
#include "scenario.h"
#include <vector>
```

Include dependency graph for flee.h: This graph shows which files directly or indirectly include this file:

Classes

- class flee

6.5 include/flock.h File Reference

```
#include "scenario.h"
#include <vector>
```
Include dependency graph for flock.h: This graph shows which files directly or indirectly include this file:

Classes

- class flock

6.6 include/flowField.h File Reference

flowField class, screen can be filled with a force for each pixel

```
#include "pvector.h"
```
Include dependency graph for flowField.h: This graph shows which files directly or indirectly include this file:

Classes

- class flowField

Macros

- #define WIDTH 34
- #define HEIGHT 34
- #define WIND_WEST 0.1, 0.0
- #define GRAVITY 0.0, -0.1

6.6.1 Detailed Description

flowField class, screen can be filled with a force for each pixel

Author

Mehmet Rıza Öz - mehmetrizaoz@gmail.com

Date

13.05.2021

6.6.2 Macro Definition Documentation

6.6.2.1 GRAVITY

```
#define GRAVITY 0.0, -0.1
```

Definition at line 16 of file flowField.h.

6.6.2.2 HEIGHT

```
#define HEIGHT 34
```

Definition at line 13 of file flowField.h.

6.6.2.3 WIDTH

```
#define WIDTH 34
```

Definition at line 12 of file flowField.h.

6.6.2.4 WIND_WEST

```
#define WIND_WEST 0.1, 0.0
```

Definition at line 15 of file flowField.h.

6.7 include/graphics.h File Reference

```
#include "agent.h"
#include "path.h"
```

Include dependency graph for graphics.h: This graph shows which files directly or indirectly include this file:

Classes

- class graphics

Macros

- #define WIDTH 34
- #define HEIGHT 34
- #define ESC 27
- #define PI 3.14159265

6.7.1 Macro Definition Documentation

6.7.1.1 ESC

```
#define ESC 27
```

Definition at line 9 of file graphics.h.

6.7.1.2 HEIGHT

```
#define HEIGHT 34
```

Definition at line 7 of file graphics.h.

6.7.1.3 PI

```
#define PI 3.14159265
```

Definition at line 10 of file graphics.h.

6.7.1.4 WIDTH

```
#define WIDTH 34
```

Definition at line 6 of file graphics.h.

6.8 include/mouseFollower.h File Reference

```
#include "scenario.h"
#include <vector>
```

Include dependency graph for mouseFollower.h: This graph shows which files directly or indirectly include this file:

Classes

- class mouseFollower

6.9 include/obstacle.h File Reference

circular obstacles for agent avoidance behaviors

```
#include "point.h"
```
Include dependency graph for obstacle.h: This graph shows which files directly or indirectly include this file:

Classes

- class obstacle

6.9.1 Detailed Description

circular obstacles for agent avoidance behaviors

Author

Mehmet Rıza Öz - mehmetrizaoz@gmail.com

Date

12.05.2021

6.10 include/obstacleAvoidance.h File Reference

```
#include "scenario.h"
#include "obstacle.h"
#include <vector>
```
Include dependency graph for obstacleAvoidance.h: This graph shows which files directly or indirectly include this file:

Classes

- class obstacleAvoidance

6.11 include/path.h File Reference

path class used for path following steering behaviors.

```
#include "point.h"
#include <vector>
```
Include dependency graph for path.h: This graph shows which files directly or indirectly include this file:

Classes

- class path

6.11.1 Detailed Description

path class used for path following steering behaviors.

Author

Mehmet Rıza Öz - mehmetrizaoz@gmail.com

Date

12.05.2021

6.12 include/pathFollower.h File Reference

```
#include "scenario.h"
#include <vector>
```

Include dependency graph for pathFollower.h: This graph shows which files directly or indirectly include this file:

Classes

- class pathFollower

6.13 include/point.h File Reference

```
#include "pvector.h"
#include <string>
```

Include dependency graph for point.h: This graph shows which files directly or indirectly include this file:

Classes

- class point

6.14 include/prison.h File Reference

```
#include "scenario.h"
#include <vector>
```

Include dependency graph for prison.h: This graph shows which files directly or indirectly include this file:

Classes

- class prison

6.15 include/pursuit.h File Reference

```
#include "scenario.h"
#include <vector>
```

Include dependency graph for pursuit.h: This graph shows which files directly or indirectly include this file:

Classes

- class pursuit

6.16 include/pvector.h File Reference

```
#include <string>
```

Include dependency graph for pvector.h: This graph shows which files directly or indirectly include this file:

Classes

- class pvector

Macros

- #define PI 3.14159265

6.16.1 Macro Definition Documentation

6.16.1.1 PI

```
#define PI 3.14159265
```

Definition at line 5 of file pvector.h.

6.17 include/random.h File Reference

This graph shows which files directly or indirectly include this file:

Classes

- class random

6.18 include/scenario.h File Reference

```
#include "agent.h"
#include "graphics.h"
#include "steeringBehavior.h"
#include <vector>
```

Include dependency graph for scenario.h: This graph shows which files directly or indirectly include this file:

Classes

- class scenario

Enumerations

- enum types { RANDOM =0, STATIC, TROOP }

6.18.1 Enumeration Type Documentation

6.18.1.1 types

```
enum types
```

Enumerator

RANDOM	
STATIC	
TROOP	

Definition at line 10 of file scenario.h.

```
10 { RANDOM=0, STATIC, TROOP };
```

6.19 include/steeringBehavior.h File Reference

```
#include "flowField.h"
#include <vector>
#include "graphics.h"
#include "obstacle.h"
```

Include dependency graph for steeringBehavior.h: This graph shows which files directly or indirectly include this file:

Classes

- class steeringBehavior

Macros

- #define CIRCLE_DISTANCE 0.1
- #define CIRCLE_RADIUS 0.4
- #define FOLLOW_MOUSE 1
- #define STAY_IN_FIELD 2
- #define IN_FLOW_FIELD 3
- #define AVOID_OBSTACLE 4
- #define STAY_IN_PATH 5
- #define FLOCK 6
- #define WANDER 7
- #define FLEE 8
- #define PURSUIT 9
- #define EVADE 10

6.19.1 Macro Definition Documentation

6.19.1.1 AVOID_OBSTACLE

```
#define AVOID_OBSTACLE 4
```

Definition at line 14 of file steeringBehavior.h.

6.19.1.2 CIRCLE_DISTANCE

```
#define CIRCLE_DISTANCE 0.1
```

Definition at line 8 of file steeringBehavior.h.

6.19.1.3 CIRCLE_RADIUS

```
#define CIRCLE_RADIUS 0.4
```

Definition at line 9 of file steeringBehavior.h.

6.19.1.4 EVADE

```
#define EVADE 10
```

Definition at line 20 of file steeringBehavior.h.

6.19.1.5 FLEE

```
#define FLEE 8
```

Definition at line 18 of file steeringBehavior.h.

6.19.1.6 FLOCK

```
#define FLOCK 6
```

Definition at line 16 of file steeringBehavior.h.

6.19.1.7 FOLLOW_MOUSE

```
#define FOLLOW_MOUSE 1
```

Definition at line 11 of file steeringBehavior.h.

6.19.1.8 IN_FLOW_FIELD

```
#define IN_FLOW_FIELD 3
```

Definition at line 13 of file steeringBehavior.h.

6.19.1.9 PURSUIT

```
#define PURSUIT 9
```

Definition at line 19 of file steeringBehavior.h.

6.19.1.10 STAY_IN_FIELD

```
#define STAY_IN_FIELD 2
```

Definition at line 12 of file steeringBehavior.h.

6.19.1.11 STAY_IN_PATH

```
#define STAY_IN_PATH 5
```

Definition at line 15 of file steeringBehavior.h.

6.19.1.12 WANDER

```
#define WANDER 7
```

Definition at line 17 of file steeringBehavior.h.

6.20 include/wander.h File Reference

```
#include "scenario.h"
#include <vector>
```

Include dependency graph for wander.h: This graph shows which files directly or indirectly include this file:

Classes

- class wander

6.21 include/windy.h File Reference

```
#include "scenario.h"
#include "flowField.h"
#include <vector>
```

Include dependency graph for windy.h: This graph shows which files directly or indirectly include this file:

Classes

- class windy

6.22 main.cpp File Reference

```
#include <iostream>
#include "mouseFollower.h"
#include "prison.h"
#include "windy.h"
#include "wander.h"
#include "pursuit.h"
#include "flee.h"
#include "scenario.h"
#include "evade.h"
#include "flock.h"
#include "pathFollower.h"
#include "obstacleAvoidance.h"
```

Include dependency graph for main.cpp:

Functions

- void menu ()
- int main (int argc, char **argv)

Variables

- int mode

6.22.1 Function Documentation

6.22.1.1 main()

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

Definition at line 32 of file main.cpp.

```
32                                  {
33     menu();
34
35     scenario* sc;
36
37     if(mode == FOLLOW_MOUSE){
38        *sc = mouseFollower();
39     }
40     else if(mode == STAY_IN_FIELD){
41        *sc = prison();
42     }
43     else if(mode == IN_FLOW_FIELD){
44        *sc = windy();
45     }
46     else if(mode == WANDER){
47        *sc = wander();
48     }
49     else if(mode == PURSUIT){
50        *sc = pursuit();
51     }
52     else if(mode == FLEE){
53        *sc = flee();
54     }
55     else if(mode == EVADE){
56        *sc = evade();
57     }
58     else if(mode == FLOCK){
59        *sc = flock();
60     }
61     else if(mode == STAY_IN_PATH){
62        *sc = pathFollower();
63     }
64     else if(mode == AVOID_OBSTACLE){
65        *sc = obstacleAvoidance();
66     }
67
68     sc->initGL(&argc, argv);
69
70     return 0;
71 }
```

Here is the call graph for this function:

6.22.1.2 menu()

```
void menu ( )
```

Definition at line 18 of file main.cpp.

```
18            {
19    cout « "Follow Mouse       : 1" « endl;
20    cout « "Stay in Field      : 2" « endl;
21    cout « "In Flow Field      : 3" « endl;
22    cout « "OBSTACLE AVOIDANCE : 4" « endl;
23    cout « "Stay in Path       : 5" « endl;
24    cout « "FLOCK              : 6" « endl;
25    cout « "WANDER             : 7" « endl;
26    cout « "FLEE               : 8" « endl;
27    cout « "PURSUIT            : 9" « endl;
28    cout « "EVADE              : 10" « endl;
29    cin » mode;
30 }
```

Here is the caller graph for this function:

6.22.2 Variable Documentation

6.22.2.1 mode

```
int mode
```

Definition at line 16 of file main.cpp.

6.23 README.md File Reference

6.24 src/agent.cpp File Reference

```
#include "agent.h"
#include "pvector.h"
#include "graphics.h"
#include "random.h"
#include <iostream>
```

Include dependency graph for agent.cpp:

6.25 src/color.cpp File Reference

color class implementation

```
#include "color.h"
#include <vector>
```

Include dependency graph for color.cpp:

6.25.1 Detailed Description

color class implementation

Author

Mehmet Rıza Öz - mehmetrizaoz@gmail.com

Date

13.05.2021

6.26 src/evade.cpp File Reference

```
#include "scenario.h"
#include "evade.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for evade.cpp:

6.27 src/flee.cpp File Reference

```
#include "scenario.h"
#include "flee.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for flee.cpp:

6.28 src/flock.cpp File Reference

```
#include "scenario.h"
#include "flock.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for flock.cpp:

6.29 src/flowField.cpp File Reference

flowField class implementation

```
#include "flowField.h"
```

Include dependency graph for flowField.cpp:

6.29.1 Detailed Description

flowField class implementation

Author

Mehmet Rıza Öz - mehmetrizaoz@gmail.com

Date

13.05.2021

6.30 src/graphics.cpp File Reference

```
#include "graphics.h"
#include <GL/glut.h>
#include <iostream>
#include "math.h"
```

Include dependency graph for graphics.cpp:

6.31 src/mouseFollower.cpp File Reference

```
#include "scenario.h"
#include "mouseFollower.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for mouseFollower.cpp:

6.32 src/obstacle.cpp File Reference

obstacle class implementation

```
#include "obstacle.h"
#include "graphics.h"
#include "point.h"
#include <vector>
```

Include dependency graph for obstacle.cpp:

6.32.1 Detailed Description

obstacle class implementation

Author

Mehmet Rıza Öz - mehmetrizaoz@gmail.com

Date

12.05.2021

6.33 src/obstacleAvoidance.cpp File Reference

```
#include "scenario.h"
#include "obstacleAvoidance.h"
#include <iostream>
#include <GL/glut.h>
```
Include dependency graph for obstacleAvoidance.cpp:

6.34 src/path.cpp File Reference

path class implementation

```
#include "path.h"
#include "graphics.h"
```
Include dependency graph for path.cpp:

6.34.1 Detailed Description

path class implementation

Author

Mehmet Rıza Öz - mehmetrizaoz@gmail.com

Date

12.05.2021

6.35 src/pathFollower.cpp File Reference

```
#include "scenario.h"
#include "pathFollower.h"
#include <iostream>
#include <GL/glut.h>
```
Include dependency graph for pathFollower.cpp:

6.36 src/point.cpp File Reference

```
#include "point.h"
#include "pvector.h"
#include <string>
#include <iostream>
```
Include dependency graph for point.cpp:

6.37 src/prison.cpp File Reference

```
#include "scenario.h"
#include "prison.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for prison.cpp:

6.38 src/pursuit.cpp File Reference

```
#include "scenario.h"
#include "pursuit.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for pursuit.cpp:

6.39 src/pvector.cpp File Reference

```
#include "pvector.h"
#include "math.h"
#include "point.h"
#include <iostream>
#include <string>
```

Include dependency graph for pvector.cpp:

6.40 src/random.cpp File Reference

```
#include "random.h"
#include <stdlib.h>
#include <iostream>
```

Include dependency graph for random.cpp:

6.41 src/scenario.cpp File Reference

```
#include "scenario.h"
#include "random.h"
#include <iostream>
```

Include dependency graph for scenario.cpp:

6.42 src/steeringBehavior.cpp File Reference

```
#include "steeringBehavior.h"
#include "pvector.h"
#include "agent.h"
#include "path.h"
#include "point.h"
#include <vector>
#include "graphics.h"
#include "math.h"
#include "obstacle.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for steeringBehavior.cpp:

6.43 src/wander.cpp File Reference

```
#include "scenario.h"
#include "wander.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for wander.cpp:

6.44 src/windy.cpp File Reference

```
#include "scenario.h"
#include "windy.h"
#include <iostream>
#include <GL/glut.h>
```

Include dependency graph for windy.cpp:

6.45 test/test_suites.cpp File Reference

```
#include <boost/test/included/unit_test.hpp>
#include "../include/pvector.h"
#include "../include/point.h"
#include <iostream>
```

Include dependency graph for test_suites.cpp:

Macros

- #define BOOST_TEST_MODULE test_suites

Functions

- BOOST_AUTO_TEST_CASE (s1t1)
- BOOST_AUTO_TEST_CASE (s1t2)
- BOOST_AUTO_TEST_CASE (s1t3)
- BOOST_AUTO_TEST_CASE (s1t4)
- BOOST_AUTO_TEST_CASE (s1t5)
- BOOST_AUTO_TEST_CASE (s1t6)
- BOOST_AUTO_TEST_CASE (s1t7)
- BOOST_AUTO_TEST_CASE (s1t8)
- BOOST_AUTO_TEST_CASE (s1t9)
- BOOST_AUTO_TEST_CASE (s2t1)
- BOOST_AUTO_TEST_CASE (s2t2)
- BOOST_AUTO_TEST_CASE (s2t3)

6.45.1 Macro Definition Documentation

6.45.1.1 BOOST_TEST_MODULE

```
#define BOOST_TEST_MODULE test_suites
```

Definition at line 1 of file test_suites.cpp.

6.45.2 Function Documentation

6.45.2.1 BOOST_AUTO_TEST_CASE() [1/12]

```
BOOST_AUTO_TEST_CASE (
              s1t1  )
```

Definition at line 11 of file test_suites.cpp.

```
11                                {
12     pvector p1 = pvector(0, 4);
13     pvector p2 = pvector(3, 0);
14     pvector p3 = p1 + p2;
15     BOOST_CHECK(p3.magnitude() == 5);
16   }
```

Here is the call graph for this function:

6.45.2.2 BOOST_AUTO_TEST_CASE() [2/12]

```
BOOST_AUTO_TEST_CASE (
              s1t2  )
```

Definition at line 17 of file test_suites.cpp.

```
17                                {
18     pvector p1 = pvector(1, 1);
19     p1.mul(3);
20     pvector p2 = pvector(3, 3);
21     BOOST_CHECK(p1 == p2);
22   }
```

Here is the call graph for this function:

6.45.2.3 BOOST_AUTO_TEST_CASE() [3/12]

```
BOOST_AUTO_TEST_CASE (
              s1t3  )
```

Definition at line 23 of file test_suites.cpp.

```
23                              {
24     pvector p1 = pvector(5, 5);
25     p1.div(5);
26     pvector p2 = pvector(1, 1);
27     BOOST_CHECK(p1 == p2);
28   }
```

Here is the call graph for this function:

6.45.2.4 BOOST_AUTO_TEST_CASE() [4/12]

```
BOOST_AUTO_TEST_CASE (
              s1t4  )
```

Definition at line 29 of file test_suites.cpp.

```
29                              {
30     pvector p1 = pvector(1, 4);
31     pvector p2 = pvector(3, 2);
32     float dotProduct = p1.dotProduct(p2);
33     BOOST_CHECK(dotProduct == 11);
34   }
```

Here is the call graph for this function:

6.45.2.5 BOOST_AUTO_TEST_CASE() [5/12]

```
BOOST_AUTO_TEST_CASE (
              s1t5  )
```

Definition at line 35 of file test_suites.cpp.

```
35                              {
36     pvector p1 = pvector(10, 10);
37     pvector p2 = pvector(0, 10);
38     float angle = p1.angleBetween(p2);
39     BOOST_CHECK(angle == 45);
40   }
```

Here is the call graph for this function:

6.45.2.6 BOOST_AUTO_TEST_CASE() [6/12]

```
BOOST_AUTO_TEST_CASE (
              s1t6  )
```

Definition at line 41 of file test_suites.cpp.

```
41                              {
42     pvector p1 = pvector(3, 4);
43     float angle = p1.getAngle();
44     BOOST_CHECK(angle < 53.2 && angle > 52.8);
45   }
```

Here is the call graph for this function:

6.45.2.7 BOOST_AUTO_TEST_CASE() [7/12]

```
BOOST_AUTO_TEST_CASE (
              s1t7  )
```

Definition at line 46 of file test_suites.cpp.

```
46                              {
47     pvector p1 = pvector(2, 2);
48     p1.normalize();
49     float range = 0.01;
50     BOOST_CHECK_CLOSE_FRACTION(0.707, p1.x, range);
51     BOOST_CHECK_CLOSE_FRACTION(0.707, p1.y, range);
52   }
```

Here is the call graph for this function:

6.45.2.8 BOOST_AUTO_TEST_CASE() [8/12]

```
BOOST_AUTO_TEST_CASE (
              s1t8  )
```

Definition at line 53 of file test_suites.cpp.

```
53                              {
54     pvector p1 = pvector(2, 2);
55     p1.limit(3);
56     float range = 0.01;
57     BOOST_CHECK_CLOSE_FRACTION(2.12, p1.x, range);
58     BOOST_CHECK_CLOSE_FRACTION(2.12, p1.y, range);
59   }
```

Here is the call graph for this function:

6.45.2.9 BOOST_AUTO_TEST_CASE() [9/12]

```
BOOST_AUTO_TEST_CASE (
              s1t9  )
```

Definition at line 60 of file test_suites.cpp.

```
60                              {
61     pvector p1 = pvector(1, 1);
62     p1 += pvector(1,1);
63     BOOST_CHECK(p1 == pvector(2,2));
64     p1 = pvector(1,1) + pvector(3,3);
65     BOOST_CHECK(p1 == pvector(4,4));
66     p1 = pvector(4,1) - pvector(3,3);
67     BOOST_CHECK(p1 == pvector(1,-2));
68     p1 = pvector(4,1) - point(3,3);
69     BOOST_CHECK(p1 == pvector(1,-2));
70     p1 = pvector(4,1) + point(3,3);
71     BOOST_CHECK(p1 == pvector(7,4));
72   }
```

Here is the call graph for this function:

6.45.2.10 BOOST_AUTO_TEST_CASE() [10/12]

```
BOOST_AUTO_TEST_CASE (
              s2t1  )
```

Definition at line 76 of file test_suites.cpp.

```
76                              {
77     point p1 = point(1, 1);
78     p1.mul(3);
79     point p2 = point(3, 3);
80     BOOST_CHECK(p1 == p2);
81   }
```

Here is the call graph for this function:

6.45.2.11 BOOST_AUTO_TEST_CASE() [11/12]

```
BOOST_AUTO_TEST_CASE (
              s2t2  )
```

Definition at line 82 of file test_suites.cpp.

```
82                              {
83     point p1 = point(4, 4);
84     p1.div(4);
85     point p2 = point(1, 1);
86     BOOST_CHECK(p1 == p2);
87   }
```

Here is the call graph for this function:

6.45.2.12 BOOST_AUTO_TEST_CASE() [12/12]

```
BOOST_AUTO_TEST_CASE (
              s2t3  )
```

Definition at line 88 of file test_suites.cpp.

```
88                              {
89     point p1 = point(1,1) + point(3,3);
90     BOOST_CHECK(p1 == point(4,4));
91     p1 = point(1,1) + pvector(3,3);
92     BOOST_CHECK(p1 == point(4,4));
93     pvector p2 = point(1,1) - point(3,3);
94     BOOST_CHECK(p2 == pvector(-2,-2));
95   }
```

Here is the call graph for this function:

Index