

SWARM INTELLIGENCE IN STARCRAFT 2

DEMONSTRATION

SWARM INTELLIGENCE



Collective behaviour from a collection of animals/insects



Every entity/agent self-contained in a decentralised population



Simple rules to guide every agent

Repulsion and Attraction

STARCRAFT 2

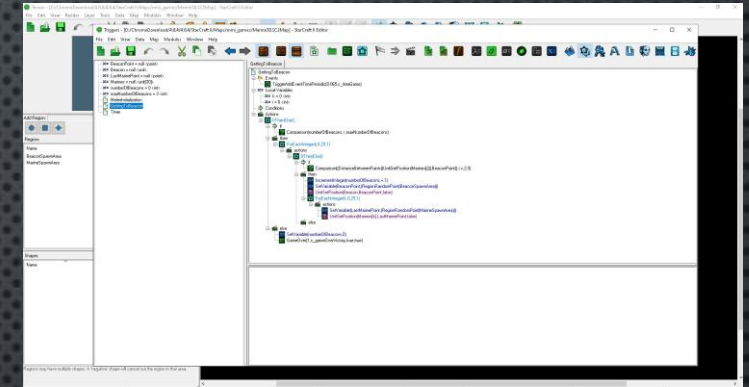
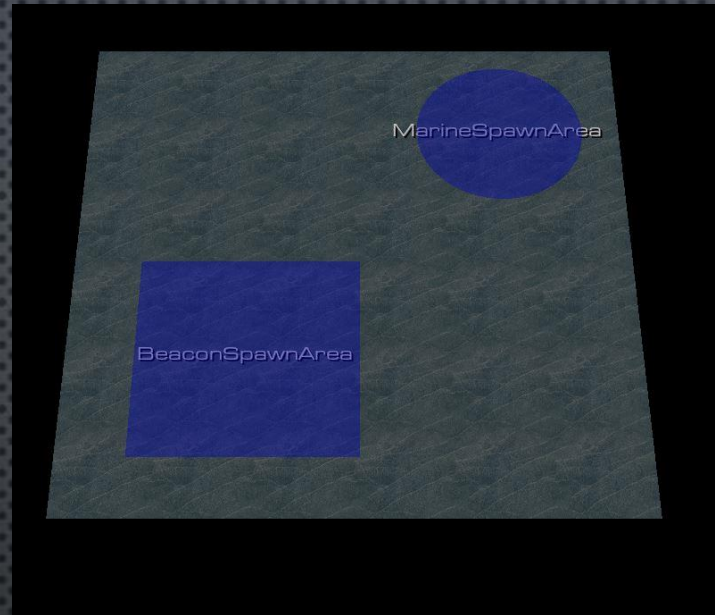
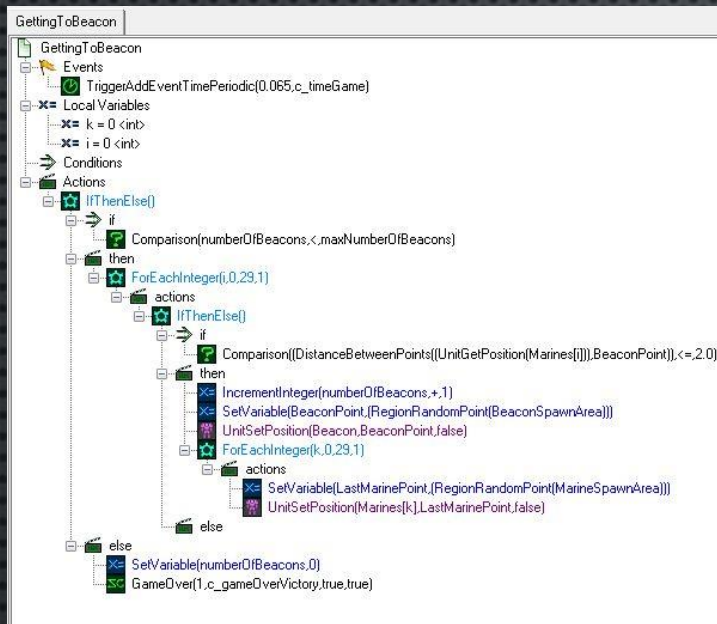
- REAL TIME STRATEGY GAME
- DYNAMIC ENVIRONMENT
- PLETHORA OF UNITS
- NOT A SIMULATION LIKE ARGOS
- BALANCING AND REFINING THE GAME SINCE 2010
- INITIAL STARCRAFT 1 LAUNCH DATES BACK TO 1998

MOTIVATION AND OBJECTIVES

- NO PRIOR WORK EXIST REGARDING SWARM INTELLIGENCE IN SC2
- VARIETY OF ENVIRONMENTS ,BUILDING AND UNITS
- TRY TO IMPLEMENT THE BASICS OF SWARM INTELLIGENCE (REPULSION AND ATTRACTION)
- GUIDED BY PREVIOUS WORK THAT FOCUSED ON A SWARM/FLOCK OF ROBOTS
- MAIN SOURCE OF INSPIRATION :
 - SWARM INTELLIGENCE IN SWARM ROBOTICS [HTTPS://HAL.ARCHIVES-OUVERTES.FR/HAL-01405919/DOCUMENT](https://hal.archives-ouvertes.fr/hal-01405919/document)
 - SELF-ORGANIZED FLOCKING WITH A MOBILE ROBOT SWARM [HTTPS://HAL.ARCHIVES-OUVERTES.FR/HAL-01406049/DOCUMENT](https://hal.archives-ouvertes.fr/hal-01406049/document)

LIMITATIONS AND OBSTACLES

- AVAILABLE APIs ARE :
 - PYSC2 FROM DEEP MIND(REINFORCEMENT LEARNING)
 - AGENT->ACTION->ENVIRONMENT->REWARDS/PENALTY
 - NOT DIRECT ACCESS TO UNIT ACTIONS
 - PYTHON-SC2 ADAPTATION FROM THE OFFICIAL C++
 - C++ API COMPLEX CONCURRENCY PROBLEM
 - PYTHON-SC2 THE MOST STABLE GIVEN STARCRAFT 2 4.0.4 IS USED



MAP CREATION

STARCRAFT 2 EDITOR TO CREATE THE ENVIRONMENT

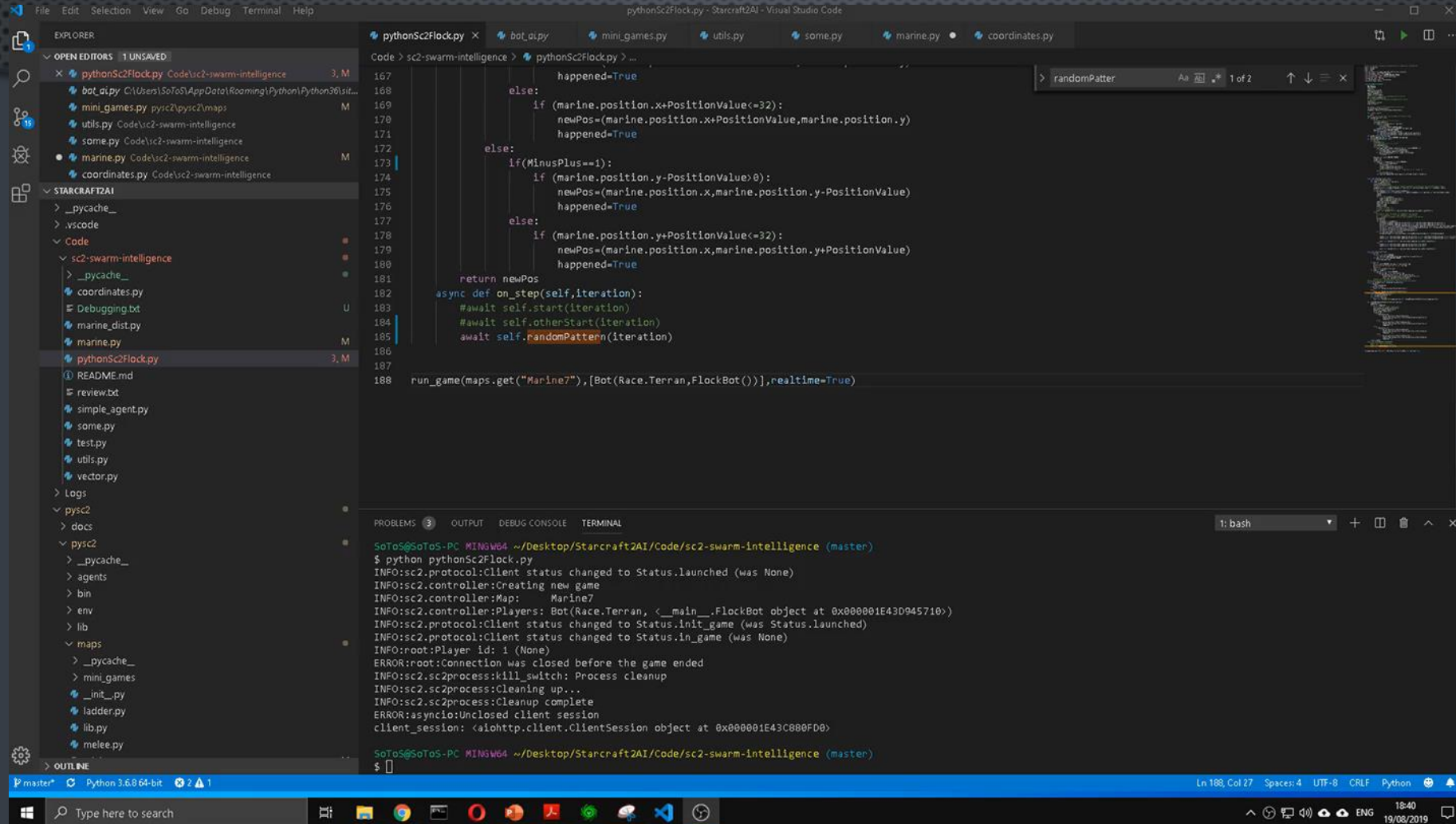
BEHAVIOURAL LOOP

- INITIALISATION PHASE
 - SYNC MARINES
 - FOR EVERY MARINE
 - FIND NEIGHBOURS (BASED ON RANGE OR CLOSEST)
 - CHECK MARINE IS NOT TOO FAR FROM THE SWARM, JOIN BACK THE SWARM
 - CALCULATE THE FORCE OF MOVEMENT BASED ON NEIGHBOURS
 - ADD ADDITIONAL FORCE FOR INFORMED MARINES

IMPORTANT PARAMETERS

- POPULATION SIZE
- NUMBER OF INFORMED
- AMOUNT OF NEIGHBOURS
- MINIMUM CLOSEST NEIGHBOURS
- SOCIAL, INDIVIDUAL AND ELASTICITY
- DESIRED DISTANCE THRESHOLD
- NEIGHBOUR RADIUS

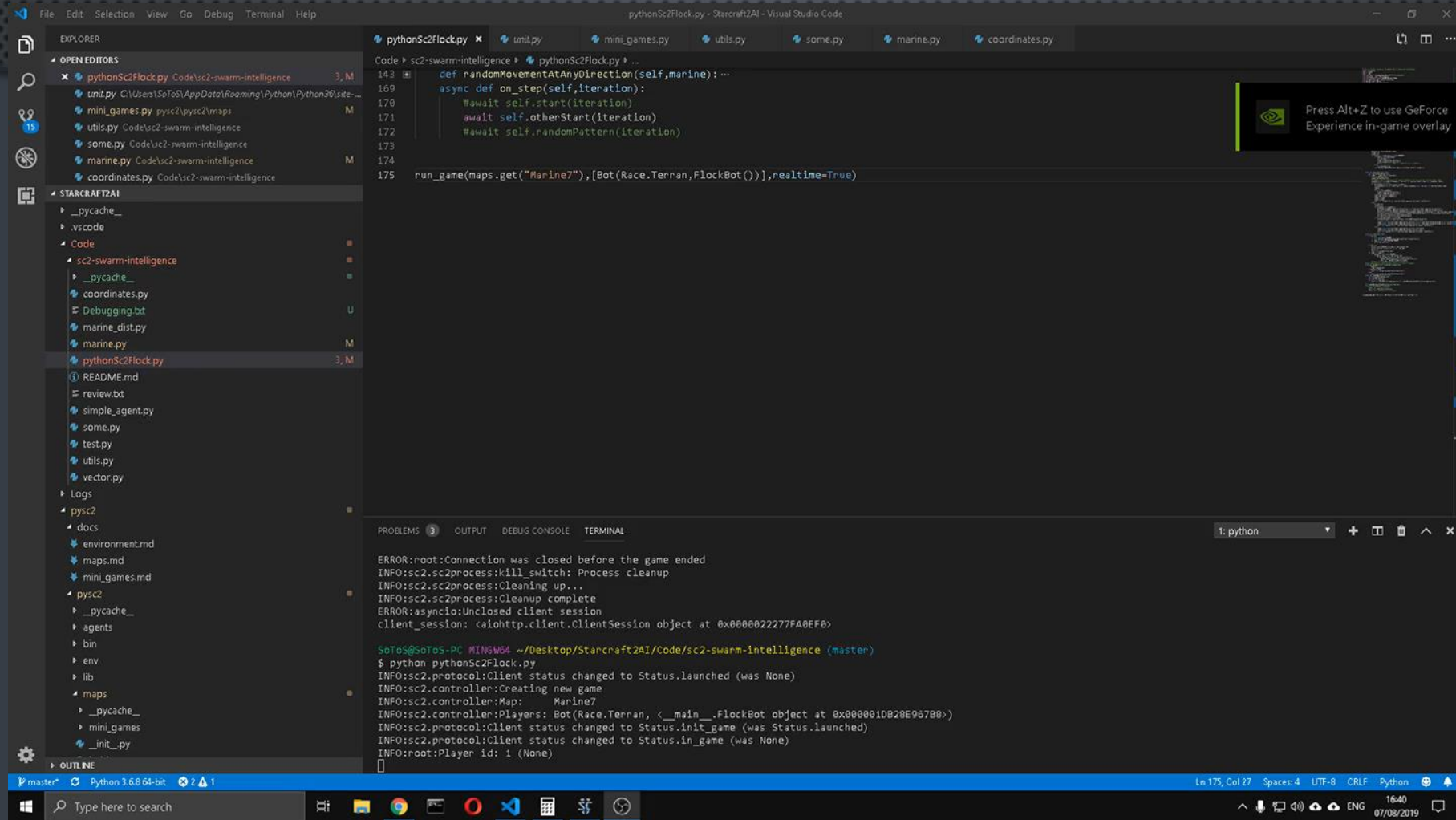
RANDOM MOVEMENT



```
pythonSc2Flock.py
167         happened=True
168     else:
169         if (marine.position.x+PositionValue<=32):
170             newPos=(marine.position.x+PositionValue,marine.position.y)
171             happened=True
172     else:
173         if (MinusPlus==1):
174             if (marine.position.y-PositionValue>0):
175                 newPos=(marine.position.x,marine.position.y-PositionValue)
176                 happened=True
177     else:
178         if (marine.position.y+PositionValue<=32):
179             newPos=(marine.position.x,marine.position.y+PositionValue)
180             happened=True
181     return newPos
182     async def on_step(self,iteration):
183         #await self.start(iteration)
184         #await self.otherStart(iteration)
185         await self.randomPattern(iteration)
186
187
188 run_game(maps.get("Marine7"),[Bot(Race.Terran,FlockBot())],realtime=True)
```

SoToS@SoToS-PC MINGW64 ~/Desktop/Starcraft2AI/Code/sc2-swarm-intelligence (master)
\$ python pythonSc2Flock.py
INFO:sc2.protocol:client status changed to Status.launched (was None)
INFO:sc2.controller:Creating new game
INFO:sc2.controller:Map: Marine7
INFO:sc2.controller:Players: Bot(Race.Terran, <__main__.FlockBot object at 0x000001E43D945710>)
INFO:sc2.protocol:client status changed to Status.init_game (was Status.launched)
INFO:sc2.protocol:client status changed to Status.in_game (was None)
INFO:root:Player id: 1 (None)
ERROR:root:Connection was closed before the game ended
INFO:sc2.sc2process:kill_switch: Process cleanup
INFO:sc2.sc2process:Cleaning up...
INFO:sc2.sc2process:Cleanup complete
ERROR:asyncio:Unclosed client session
client_session: <aihttp.client.ClientSession object at 0x000001E43C880FD0>
SoToS@SoToS-PC MINGW64 ~/Desktop/Starcraft2AI/Code/sc2-swarm-intelligence (master)
\$

FLOCKING BEHAVIOUR



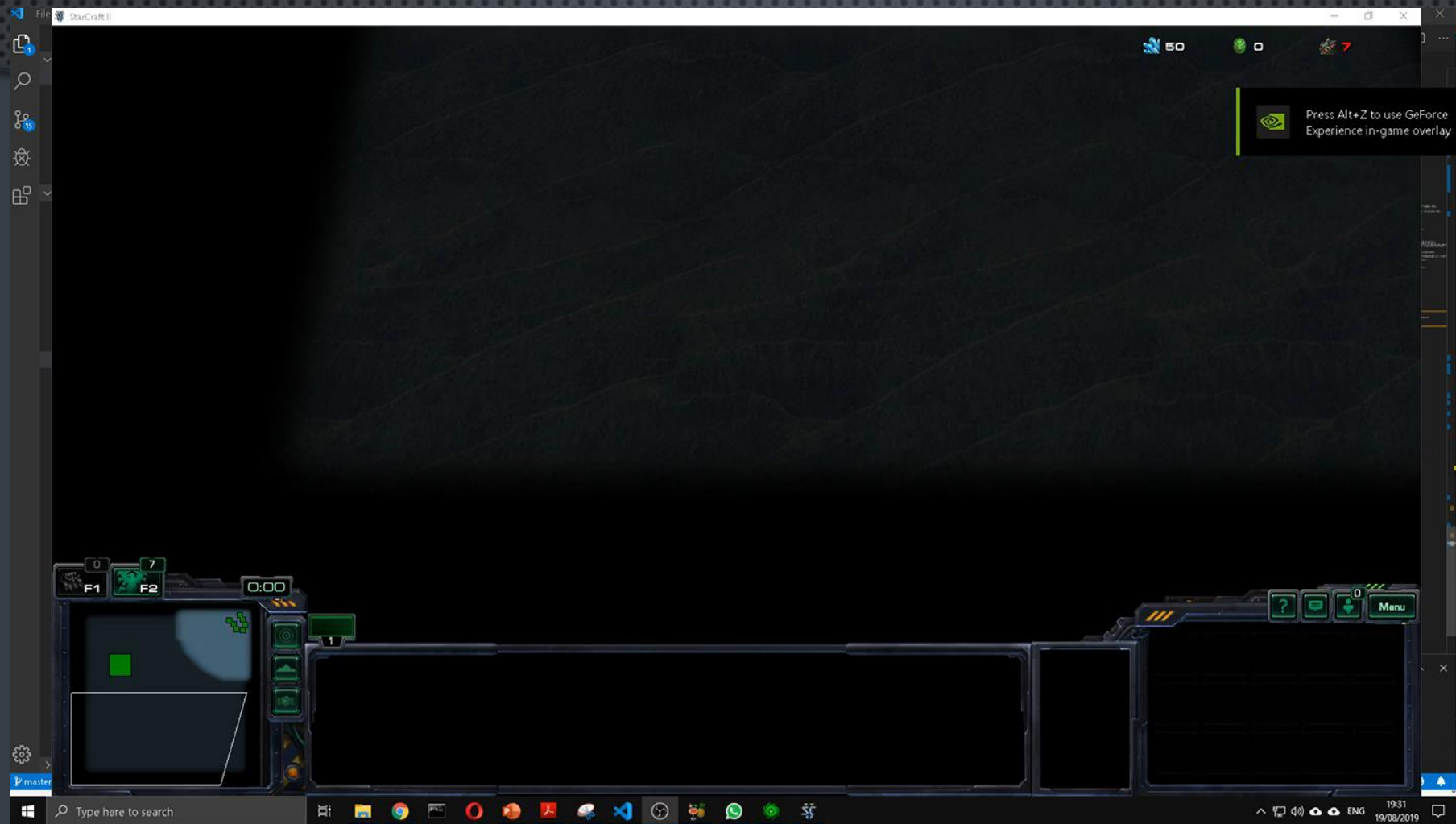
DIRECT MOVEMENT

The screenshot displays a Visual Studio Code editor window with the following components:

- EXPLORER:** Shows the project structure with files like `pythonSc2Flock.py`, `utils.py`, `some.py`, `marine.py`, and `coordinates.py`.
- Code Editor:** Displays the `pythonSc2Flock.py` file. The code includes a `FlockBot` class with methods for finding and moving towards targets. The code is as follows:

```
09 self.sync_marines(ALLIES)
70 newPos=Coordinates(0,0)
71 #neighbours=self.u.findClosest(self.amount_neighbours,self.marines,self.marines[index],index)
72 neighbours=self.u.findWithinRange(self.marines,self.marines[index],index,self.neighbour_radius)
73 forceForX=0
74 forceForY=0
75 for neighbour in neighbours:
76     distInX=(neighbour.game_marine.position.x-self.marines[index].game_marine.position.x)
77     distInY=(neighbour.game_marine.position.y-self.marines[index].game_marine.position.y)
78     distance=self.u.calculateEuclideanDistance(neighbour.game_marine.position,self.marines[index].game_marine.position)
79     force=self.elasticity*(distance-self.threshold_desired_distance)/self.threshold_desired_distance
80     forceForX=forceForX+(force*distInX/distance)
81     forceForY=forceForY+(force*distInY/distance)
82 if self.marines[index].is_informed:
83     xyTowardsTarget=self.marines[index].informedMoveTowardsTarget(10)
84
85     newPos.x=self.marines[index].game_marine.position.x+(self.individual*xyTowardsTarget.x+self.social*forceForX)
86     newPos.y=self.marines[index].game_marine.position.y+(self.individual*xyTowardsTarget.y+self.social*forceForY)
87     await self.moveUnit(0,self.marines[index].game_marine,newPos.tupleStyle())
88 else:
89     newPos.x=self.marines[index].game_marine.position.x+forceForX
90     newPos.y=self.marines[index].game_marine.position.y+forceForY
91     await self.moveUnit(0,self.marines[index].game_marine,newPos.tupleStyle())
92
93 async def start(self,iter):
94     if iter==0:
95         for m in self.units(MARINE):
96             self.marines.append(Marine(m.tag,m.position.x,m.position.y))
97         for bea in self.units(BEACON_TERRAN):
98             print(bea.position)
99
100     if iter==1:
```
- TERMINAL:** Shows a traceback error: `TypeError: 'NoneType' object is not subscriptable`. The error occurs in the `run_game` function, which is called by the `run_game` function in the `main.py` file.

FLOCKING WITH CANNON



FLOCKING IN LARGER NUMBERS

The image shows a Visual Studio Code editor window with the title "pythonSc2Flock.py - Starcraft2AI - Visual Studio Code". The Explorer panel on the left shows a project structure with folders like "sc2-swarm-intelligence" and "STARCRRAFT2AI". The main editor displays the "pythonSc2Flock.py" file, which contains the following code:

```
1 # This is the bot running on the python-SC2 scripted one from Dentosal
2 import sc2,marine
3 import random
4 import time
5 from sc2 import run_game,maps,Race,Difficulty,constants
6 from sc2.player import Bot,Computer
7 from sc2.constants import MARINE,BEACON_TERRAN
8 from sc2.position import Point2,Pointlike
9 from marine import Marine
10 from coordinates import Coordinates
11 from utils import Utils
12
13 class FlockBot(sc2.BotAI):
14     marines=[]
15     UNIT=MARINE
16     u=Utils()
17     population_size=50
18     amount_neighbours=5
19     number_of_informed=1
20     min_closest_neighbours=round(population_size/10)
21     # max_neighbours_considered=round(population_size/2)
22     social=0.1
23     individual=1-social
24     elasticity=0.5
25     threshold_desired_distance=1.5
26     #neighbour_radius=1.5*threshold_desired_distance
27     neighbour_radius=2*threshold_desired_distance
28     def __init__(self):
29         pass
30     #Need for syncing marines from the game with marine class
31     def syncMarines(self,iter):
```

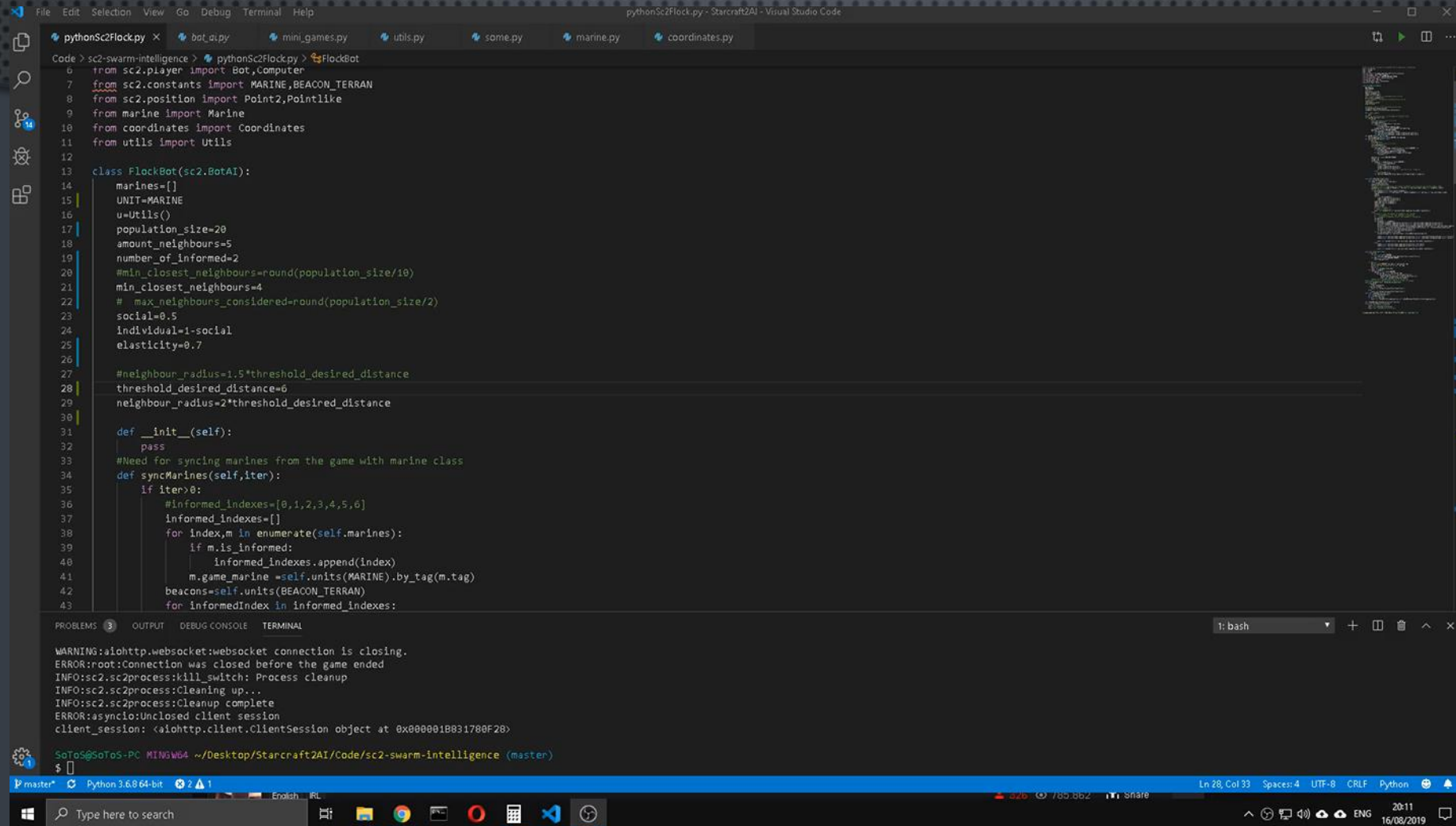
The terminal at the bottom shows the following output:

```
1: bash
File "C:\Users\SoToS\AppData\Roaming\Python\Python36\site-packages\sc2\protocol.py", line 65, in _execute
response = await self.__request(request)
File "C:\Users\SoToS\AppData\Roaming\Python\Python36\site-packages\sc2\protocol.py", line 46, in __request
raise ConnectionAlreadyClosed("Cannot receive: Connection already closed.")
sc2.protocol.ConnectionAlreadyClosed: Cannot receive: Connection already closed.
ERROR:sc2.main:resigning due to previous error
INFO:root:Result for player id: 1: Result.Defeat
WARNING:aihttp.websocket:websocket connection is closing.
ERROR:root:Connection was closed before the game ended
INFO:sc2.sc2process:kill_switch: Process cleanup
INFO:sc2.sc2process:Cleaning up...
INFO:sc2.sc2process:Cleanup complete
ERROR:asyncio:Unclosed client session
client_session: <aihttp.client.ClientSession object at 0x00000130F1F7FF90>

SoToS@SoToS-PC MINGW64 ~/Desktop/Starcraft2AI/Code/sc2-swarm-intelligence (master)
$
```

The status bar at the bottom indicates "Ln 22, Col 15", "Spaces: 4", "UTF-8", "CRLF", "Python", and the date "16:44 13/08/2019".

PROPER FLOCKING IN LARGE NUMBERS



```
File Edit Selection View Go Debug Terminal Help
pythonSc2Flock.py x bot_ai.py mini_games.py utils.py some.py marine.py coordinates.py

Code > sc2-swarm-intelligence > pythonSc2Flock.py > FlockBot
6 from sc2.player import Bot, Computer
7 from sc2.constants import MARINE, BEACON_TERRAN
8 from sc2.position import Point2, Pointlike
9 from marine import Marine
10 from coordinates import Coordinates
11 from utils import Utils
12
13 class FlockBot(sc2.BotAI):
14     marines=[]
15     UNIT=MARINE
16     u=Utils()
17     population_size=20
18     amount_neighbours=5
19     number_of_informed=2
20     #min_closest_neighbours=round(population_size/10)
21     min_closest_neighbours=4
22     # max_neighbours_considered=round(population_size/2)
23     social=0.5
24     individual=1-social
25     elasticity=0.7
26
27     #neighbour_radius=1.5*threshold_desired_distance
28     threshold_desired_distance=6
29     neighbour_radius=2*threshold_desired_distance
30
31     def __init__(self):
32         pass
33     #Need for syncing marines from the game with marine class
34     def syncMarines(self, iter):
35         if iter>0:
36             #informed_indexes=[0,1,2,3,4,5,6]
37             informed_indexes=[]
38             for index,m in enumerate(self.marines):
39                 if m.is_informed:
40                     informed_indexes.append(index)
41                 m.game_marine =self.units(MARINE).by_tag(m.tag)
42             beacons=self.units(BEACON_TERRAN)
43             for informedIndex in informed_indexes:
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FUTURE WORK

- DUE TO PARAMETER TUNING PEDANTIC PHASE CAN BE AVOIDED WITH EVOLUTIONARY ALGORITHMS THAT CAN FIND A LOCAL MAXIMUM OR EVEN AIM FOR A GLOBAL MAXIMUM
- IDENTIFYING A REWARD/PENALTY SYSTEM (TIME OR SPREAD OF THE FLOCK)
- MODIFICATION IN THE API TO PROVIDE RETURN VALUES INSTEAD OF IMMEDIATE TERMINATION

THANKS FOR
YOUR ATTENTION

QUESTION TIME