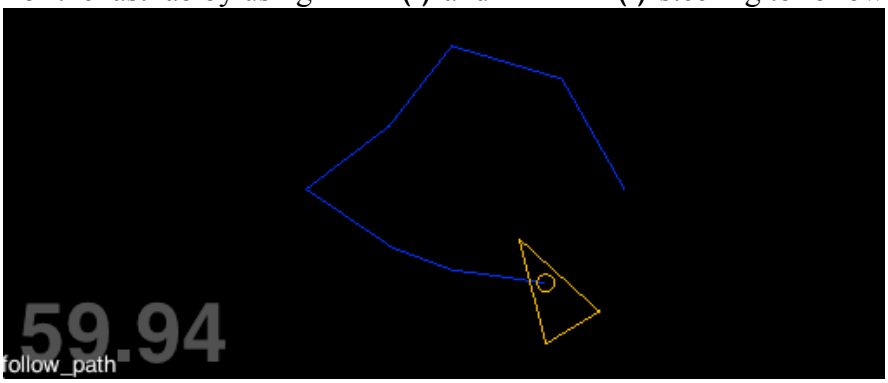
Lab – Path Following and Wandering

Download from the unit website `path.py`, which is used for path following task. The basic code you need for the `Wander()` behaviour, and some rendering code, is shown in this document.

Task 1: follow_path()

Extend the work of the last lab by using `Seek()` and `Arrive()` steering to follow a path.



- Have a close look at the Path class to understand what it does for us. Note the following:
  - The `create_random_path()` method creates a new random path for us, to which we can pass world related parameters (such a width and height).
  - Use `current_pt()` to find out the current point, `inc_current_pt()` to move current to the next point, and `is_finished()` to test for the end point in an open (non-loop) path.
- Modify the Agent class so that each agent will have it's own path and be able to follow it when in "follow_path" mode.
  - In the `__init__` method add the following (without the comments)

```
self.path = Path()
self.randomise_path()  # <-- Doesn't exist yet but you'll create it
self.waypoint_threshold = 0.0  # <-- Work out a value for this as you test!
```

  - Create the new `randomise_path()` so that it's ready to be called. In it, call the `path.create_random_path()` method using world-related parameters

```
cx = self.world.cx  # width
cy = self.world.cy  # height
margin = min(cx, cy) * (1/6)  # use this for padding in the next line ...
self.path.create_random_path(...)  # you have to figure out the parameters
```

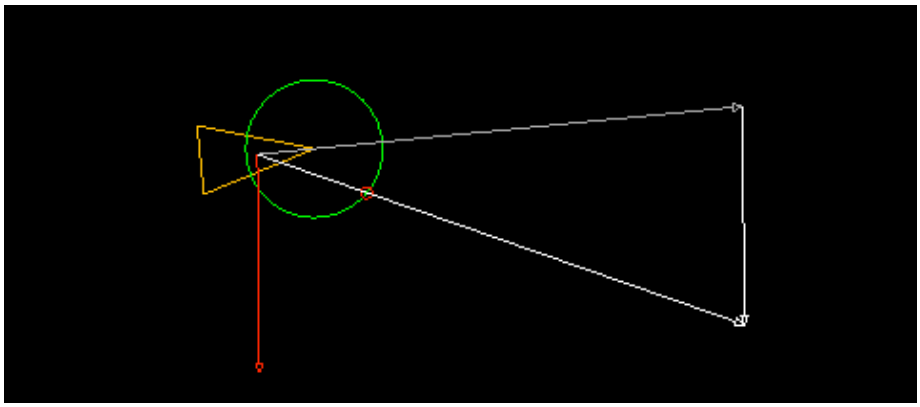
  - Add a "follow_path" mode and modify the `calculate` method to use it by calling a (new) `follow_path` method.
  - Add a `follow_path` method and code the following logical ideas:

```
# If heading to final point (is_finished?),
#     Return a slow down force vector (Arrive)
# Else
#   If within threshold distance of current way point, inc to next in path
#   Return a force vector to head to current point at full speed (Seek)
```

  - Modify the `render` method render the path if currently in "follow_path" mode.

- Alter the `main.py` file so that you can reset the agent paths in response to a key press (say 'R'), by calling looping through all the agents and calling their `randomise_path()`.
- Test it! Adjust the waypoint threshold distance (which will depend on if you use a squared distance value or not), adjust force and max speed values, and try different arrive speeds.

Task 2: wander()



Above is a figure that shows the green wander circle projected in front of the agent. The small red circle is the current wander target, while the grey arrow is the current velocity. A red arrow indicates the current steering force being applied to modify the current velocity so that, as a result (white arrows indicate the vector addition), the agent will heads to (through) the wander target.

In order to do some smooth wandering we first need to set up some helper code to the existing code We can start by adding drawing code to the agent to show the wander details (circle, jitter location), which then needs new wander variables (in the agent) and a new conversion routine for points from local to world space.

Add the following additional code to the `Agent` render method. *(This code should also give you some hints for the actual wander code you need to write later!)*

```
    # draw wander info?
    if self.mode == 'wander':
        # calculate the center of the wander circle in front of the agent
        wnd_pos = Vector2D(self.wander_dist, 0)
        wld_pos = self.world.transform_point(wnd_pos, self.pos, self.heading, self.side)
        # draw the wander circle
        egi.green_pen()
        egi.circle(wld_pos, self.wander_radius)
        # draw the wander target (little circle on the big circle)
        egi.red_pen()
        wnd_pos = (self.wander_target + Vector2D(self.wander_dist, 0))
        wld_pos = self.world.transform_point(wnd_pos, self.pos, self.heading, self.side)
        egi.circle(wld_pos, 3)
```

Notice that this new code uses several new wander-related variables. Add them to the `__init__` of the `Agent` class so that they can be used later. Also add or change max force and speed values.

```
    # NEW WANDER INFO
    self.wander_target = Vector2D(1, 0)
    self.wander_dist = 1.0 * scale
    self.wander_radius = 1.0 * scale
    self.wander_jitter = 10.0 * scale
    self.bRadius = scale

    # Force and speed limiting code
    self.max_speed = 20.0 * scale
    self.max_force = 500.0
```

You will also need to add the following new code to the `World` class so that it can convert a single local coordinate into a world coordinate for us (because the wander code needs a bit of this ☺). Note: There is already a similar method for transforming a group of points – you could use that.

```
    def transform_point(self, point, pos, forward, side):
        ''' Transform the given single point, using the provided position,
            and direction (forward and side unit vectors), to object world space. '''
        # make a copy of the original point (so we don't trash it)
        wld_pt = point.copy()
        # create a transformation matrix to perform the operations
        mat = Matrix33()
        # rotate
        mat.rotate_by_vectors_update(forward, side)
        # and translate
        mat.translate_update(pos.x, pos.y)
        # now transform the point (in place)
        mat.transform_vector2d(wld_pt)
        # done
        return wld_pt
```

Okay – back to the `Agent` class and the actual `wander()` code. Because we update the jitter location based on the amount of time that has occurred, this new steering behaviour will need the delta time value. So, you need to alter the Agent `update()` method so that it passes the `delta` value through to the `calculate()` method, and then the `calculate()` method can pass `delta` to the new `wander()` method.

Almost there! The wander code should look something like this. Note: You will need to import the `uniform` function from the `random` module (eg. `from random import uniform`).

```
    def wander(self, delta):
        '''  random wandering using a projected jitter circle '''
        wt = self.wander_target
        # this behaviour is dependent on the update rate, so this line must
        # be included when using time independent framerate.
        jitter_tts = self.wander_jitter * delta # this time slice
        # first, add a small random vector to the target's position
        wt += Vector2D(uniform(-1,1) * jitter_tts, uniform(-1,1) * jitter_tts)
        # re-project this new vector back on to a unit circle
        wt.normalise()
        # increase the length of the vector to the same as the radius
        # of the wander circle
        wt *= self.wander_radius
        # move the target into a position WanderDist in front of the agent
        target = wt + Vector2D(self.wander_dist, 0)
        # project the target into world space
        wld_target = self.world.transform_point(target, self.pos, self.heading, self.side)
        # and steer towards it
        return self.seek(wld_target)
```

However, to get this all working right you will need to test the wander variables, perhaps weight the wander force (or total steering force), and also the add a new limit to the steering force. You want to be able to change variables **while** the program is running: edit-restart-test is slow!

You can add the following force-limiting code to the agent `update()` method.

```
        force = self.calculate(delta)
        force.truncate(self.max_force) # <-- new force limiting code
```

Save your work for use in later labs or spikes.