Comp3402   Braitenberg Vehicles

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Purpose	(i) To create a neural circuit to form a Braitenberg vehicle. (ii) To investigate the behaviour of the vehicle when the neural circuit parametes are changed
Files Required	Webots project folders on website. **3402_Brait1_R.wbt** world and the controller **3402_Brait1_R.c**
ILO Contribution	3
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Assignment Info.	
Homework	Read Chapter6

Activities

1   Braitenberg Vehicles 2a and 2b

These vehicles have two light sensors (eyes) and two driving wheels. Depending on how the motors are connected to the eyes, the vehicle will either approach the light or flee from it. Here's the two vehicles shown on the left. The neurons available are shown on the right.
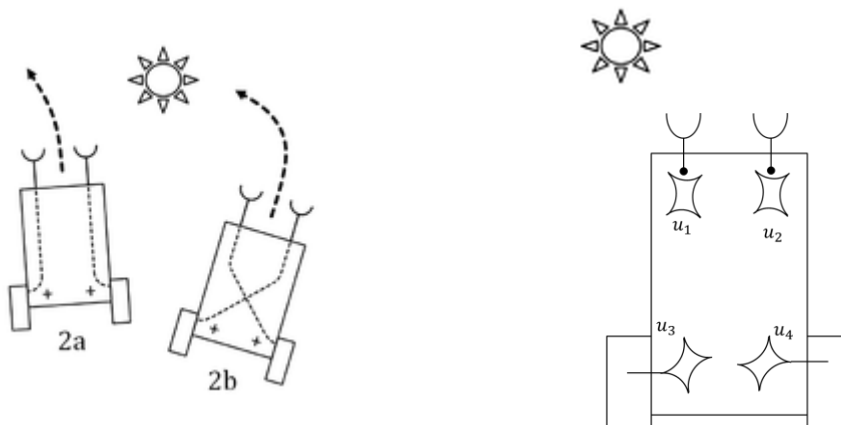
There are two sensory neurons u_1 and u_2 and two motor neurons u_3 and u_4. Let's figure out how to build a neural circuit so the vehicle is attracted to the light (2b).

(a) First answer these questions. (i) Which eye receives more light (left or right) and why? (ii) To drive towards the light which motor should turn faster (left or right).

(b) Assuming we are going to work exclusively with excitatory synapses, which neurons should be wired to which?

(c) Download and unzip the folder **Braitenberg_Assets.** Open up the world **3402_Brait1_R.wbt** where you will find a single ePuck and a single light source. Make sure the controller **3402_Brait1_R.c** is selected and open in the editor.
Look for the following lines of code which get the left and right light intensities

```
leftIntens  = getLightVal(leftEyeVal);
rightIntens = getLightVal(rightEyeVal);
```

Now look for the following lines of code which drive the left and right motors

```
omegaL = u3*MAX_SPEED;
omegaR = u4*MAX_SPEED;
// Webots stuff
wb_motor_set_velocity(left_motor,  omegaL);
wb_motor_set_velocity(right_motor, omegaR);
```

Now we must design a neural circuit between the eyes and the motors.

(d) Look for these lines of code which correspond to the sensory neurons. They receive the light intensity input. Use the variables `leftIntens`, `rightIntens u1`, `u2` and `tau` to code the behaviour of the neurons

```
dudt1 =
dudt2 =
```

Now connect these neurons to the motor neurons completing the lines of code

```
dudt3 =
dudt4 =
```

(e) Compile your controller ⚙ then run the world ▶ and you should see the vehicle moving towards the light.

(f) Why does the vehicle speed up as it approaches the light? Why does it eventually stop?

2   Investigations!

(a) First let's have a look at the effect of `tau`, the time constant which is currently set to 0.05 seconds. Think, how will the behaviour of the vehicle change if you increase `tau` to say 0.1 or more? (This will really test your understanding of the time constant!). Investigate!

(b) Rewire your neural circuit to get vehicle type-2a behaviour.

3   Optional Challenge of Understanding

An ambitious student wants to get the vehicle to slow down as it approaches the light. So she introduces a 5th neuron which *sums* the outputs of neurons 1 and 2, and then *subtracts* its value from neurons 3 and 4. You get her rationale. Here is her circuit
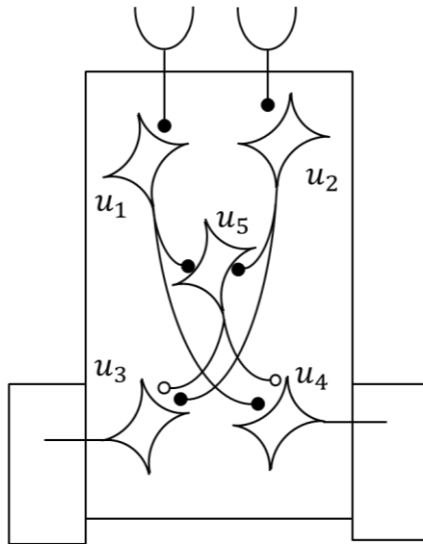
Neurons 1 and 2 excite neurons 4 and 3 respectively as before. In addition neurons 1 and 2 excite neuron 5, so their values are summed. Then the value of neuron 5 is subtracted from neurons 3 and 4.

(a) Explain why this circuit does not give the anticipated result, and explain how the vehicle will behave with this circuit.

HINT: Write down the *equilibrium* equations for all neurons, then solve them. It's actually quite straightforward.

(b) Build the circuit and verify your explanation is correct.